GENERAL SPECIFICATION

STRUCTURAL

GS EP STR 301

Fabrication of offshore steel structures

13	10/2013	§ 8.1, 8.4.a, 8.5.1.a, Table 8.1, § 8.7.1, 8.7.4.g, Table 10.2, § 9.2
12	10/2012	§ 2, 3.2, 6.4.5, 7.5.5.1, 7.9, fig. 8.4, 8.5.2, 8.7.4.b, 8.7.4.e, 8.7.8.5, 9.2, table 8.1, 10.1, table 10.2, 16, Appendix 2
11	01/2012	§ 8.5.1a, 8.5.1g, 8.7.4, 8.7.8.6, 10.1.g, appendix 2
10	01/2011	§ 8.7.8.5,8.9.6 revised
00	03/2001	First issue
Rev.	Date	Purpose of the revision

Owning entity: DEV/TEC	Managing entity: DEV/TEC/STR

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Contents

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1. Scope

This specification defines the Company's general requirements for fabrication, welding and bolting assemblies, heat treatment and inspection to apply in the fabrication of offshore steel structures.

It covers steel structures to be installed in **Cold Seas, Temperate Seas** or **Warm Seas** (as defined in Table 5.5 of Specification GS EP STR 201).

Very Cold Seas cases are not treated in this Specification. A Particular Project Specification shall be issued for fabrication, subject to Company approval.

This Specification shall be used in conjunction with a Project Particular Specification (PPS), if any, detailing the additional tests and requirements or the possible modifications to the present specification, based on the particular design conditions of the steel structures.

No deviation from the requirements stated in the present specification shall be permitted unless prior written approval has been obtained from the Company. Refer to para. 3.6 of this specification.

Attention is drawn too on certain structures that shall be subject to comply with requirements of classification society or any particular state regulation. In that case, fabrication of these structures shall comply with the most severe requirement. In the event of conflict between this specification and any other contractual document, the Contractor shall inform the Company in writing and receive written clarification or approval from the Company.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

Applicable specifications and documents are listed hereafter in the present section.

The order of precedence of the applicable documents shall be:

- The Purchase Order or Contract
- The Project Particular Specification (PPS)
- The Present General Specification
- The Codes and Standards in reference.

Unless otherwise specifically indicated in writing, the Contractor shall work in accordance with the requirements specified herein and the applicable requirements of the latest editions at date of Contract award of the referenced codes and standards, whenever requested in the present specification.

The requirements of this specification shall take precedence over the referenced codes and standards. Where this specification states no overriding requirements the referenced codes and standards shall apply in full.

The Contractor shall equip himself with copies of all the reference specifications referred to in this specification and shall make them readily available to all his inspection personnel involved on the work.

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External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
AISC	Manual of steel construction - Specification for the design, fabrication and erection of structural steel for buildings - Specification for structural joints using ASTM A325 or A490 bolts
API SPEC 2B	Specification for fabricated structural steel pipe
API RP 2A-WSD	Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design
ASME/BPVC SEC V	Boiler and pressure vessel code: non-destructive examination
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A370	Mechanical testing of steel products
ASTM A490	Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A578	Standard specification for straight-beam ultrasonic examination of plain and clad steel plates for special application
ASTM E112	Standard methods for estimating the average grain size of metals
ASTM E165	Liquid penetrant inspection
ASTM E23	Notched bar impact testing of metallic materials
ASTM E709	Standard Guide for Magnetic Particle Testing
AWS D1.1/D1.1M	Structural welding code - Steel
BS 7448 (Parts 1; 3; 4)	Fracture mechanics toughness tests - Parts 1; 3; 4
BS 7910	Guide to methods for assessing the acceptability of flaws in metallic structures
CSWIP/PCN	Requirements for the certification of personnel engaged in NDT
ISO 6892-1	Metallic materials - Tensile testing - Part 1: Method of test at room temperature
EN 10204	Metallic products - Type of inspection documents
EN 1435	Non-destructive examination of welds. Radiographic examination of welded joints
EN 462-1	Image quality of radiographs - Part 1: Concept, Image Quality Indicators (wire type), determination of image quality value
ISO 11699-1	Non-destructive testing - Industrial radiographic film - Part 1: Classification of film systems for industrial radiography

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Reference	Title
IIW/IIS doc. 62.60	Recommended practice concerning radiographic Image Quality Indicators (IQI)
ISO 14344:2010	Welding consumables - Procurement of filler materials and fluxes
ISO 148-1	Metallic materials - Charpy pendulum impact test - Part 1: Test method
ISO 3834-1	Quality requirements for fusion welding - of metallic materials - Part 1: Criteria for the selection of the appropriate level of quality requirements
ISO 4063	Welding and Allied Processes - Nomenclature of Processes and Reference Numbers
ISO 5580	Industrial Radiographic Illuminators
ISO 6507-1	Metallic materials - Vickers Hardness Test - Part 1: Test Method
ISO 8501-1	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings
ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel
ISO 8501 (All parts)	Preparation of Steel Substrates Before Application of Paints and Related Products - Visual Assessment of Surface Cleanliness - All parts

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP STR 100	Offshore steel structures - General
GS EP STR 101	Design of offshore jacket and subsea structures
GS EP STR 102	Design of offshore topside structure
GS EP STR 201	Materials for offshore steel structures
GS EP STR 202	Cast materials for steel structures
GS EP STR 203	Forged materials for steel structures
GS EP STR 204	Subsea structures: Carbon Steel Material and Fabrication
GS EP STR 304	Fabrication of welded plates girders (W.P.G.)

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Reference	Title
GS EP STR 401	Loadout, seafastening, transportation and installation of offshore structures
GS EP STR 431	Installation of piles for offshore steel structures. Driven piles
GS EP STR 432	Installation of piles for offshore steel structures. Drilled and grouted piles
GS EP STR 631	CALM buoy terminals
GS EP STR 651	General principles for a F(P)SO design
GS EP STR 901	Design rules and construction standards for ancillary structures of offshore installations

3. General

3.1 Definitions

a) Inspector

The Company's representative or a member from an Inspection Agency duly appointed by the Company to act as its representative for the purpose of the Contract shall be referred to herein as the "Inspector".

b) Site

The yards, workshops, docks, laboratories or other locations where the fabrication inspection and testing are to be performed complete or in part, shall be referred to herein as the "Site".

c) Contract Documents

The drawings, equipment lists, bills of material, material specifications, etc., latest editions, issued by the Company and attached to the Contract or the Purchase Order shall be referred to herein as the "Contract Documents".

d) Approval

Authorisation in writing given by the Company to the Contractor on a procedure or to proceed with the performance of a specific part of the work without releasing in any way the Contractor from any of his obligations to conform with the technical specifications, requisitions, etc. The words "approve", "approved" and "approval" shall be construed accordingly.

e) PPS

Used to designate the Project Particular Specification as defined in section 1.

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3.2 Approval of documents/Documentation

The following documents shall require approval of the Company or its Inspector and of an Independent Third Party (if any) prior to allowing fabrication to proceed:

- Drawings and calculation notes for temporary works or handling operations (staking, roll-up, etc.), inclusive of foundations, support points, jacking points and sling points
- Handling and lifting equipment to be used including rigging equipment, cranes, winches, etc. with review of test certificates
- List of proposed welding consumables (brand and type) with their data sheets
- Consumables handling, drying, storing, flux recycling and traceability procedure
- Sequence of fabrication, assembly, welding and erection
- Inspection test Plan
- Weld Map and Register together with all Welding Procedure Specifications (WPS) and Welding Procedure Qualification Records (WPQR)
- Welding procedure qualification test plan (i.e. up-dated status of WPQ tests of procedures under qualification)
- The Welding Procedure Qualification Tests and welder qualification tests
- List of welders and welding operators, with certificates
- Forming procedures for tubulars
- Manufacturing Procedure Specification (MPS) and Mill certificates of Contractor's supplied materials
- Identification, control and traceability procedures for materials
- Key plans showing member identification and weld marking schemes
- Inspection, dimensional and Non-Destructive Testing procedures (including report models)
- Initial available list of Non-Destructive Testing operators, with certificates
- Post-Weld Heat Treatment procedures
- Lifting, load-out and installation procedures, including details and certification of equipment to be used
- NDT maps linked with weld maps
- All sub-contractors of Contractor
- The Quality Assurance Manual and Plan.

The following documents shall be permanently updated and shall be at the Company disposal (or Company's Inspector and or Independent Third Party) for review when requested.

- Fabrication or shop drawings showing weld arrangement, location of welding at prefabrication, on yard, at erection stages and weld details

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- Updated Weld history register (see example in Appendix 3)
- Updated list of welders and welding operators, with certificates
- Inspection, Dimensional and Non-Destructive reports and production tests results if any
- Updated List of Non-Destructive Testing operators with certificates
- Post-Weld Heat Treatment charts
- All the as-built documentation.

At final reception of structural components, the fabricator shall constitute the final dossier as follows:

- All documentation approved by Company and TPI (if any) as stated above
- Last revision of Weld history register
- Last revision of Inspection, Dimensional and Non-Destructive reports and production tests results if any
- Post-Weld Heat Treatment charts
- All the as-built documentation
- Compilation of concession/deviations, if any, granted by Company and TPI (if any) during material manufacture.

3.3 Quality Assurance/Quality Control

1. The Contractor shall operate a Quality Assurance system, approved by a recognized authority. The Quality Assurance Manual shall be submitted to Company and made available to the Inspector at all times.
2. Four weeks prior to commencement of any fabrication, the Contractor shall prepare and submit to Company a written Quality Control Plan which describes the inspections to be performed during the said fabrication. The Quality Control Plan shall set forth “witness”, “hold”, “review” and “monitor” points.

3.4 Execution of the work

1. The Contractor shall furnish qualified personnel and all equipment, tools, instruments, etc. necessary to carry out qualification of welding procedures and welders, handling, fabrication, welding, inspection and cleaning of the structures according to this specification.
2. In particular, the Contractor shall have available on location suitable ovens for drying and conservation of low-hydrogen consumables and suitable equipment for preheating, post-heating and stress relieving, when needed, and to ensure a good cleaning and fit-up before welding. Such equipment shall be subject to approval by the Inspector.
3. The Contractor shall provide the necessary weather protection or sun protection to ensure that all work continues always as specified here above.
4. When conditions are (or may become) detrimental to fabrication or weld quality, the Contractor shall notify the Inspector immediately.

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5. The Contractor shall designate a competent representative familiar with all phases of fabrication with whom the Inspector may communicate at all times.
6. Should the Contractor wish to employ a sub-contractor, he shall submit its proposals in due time in writing to the Company for prior approval. The Company reserves the right to refuse or restrict the use of a particular sub-contractor.

3.5 Inspection by the Company

1. All procedures shall have prior approval of the Company. All qualification tests shall take place under the supervision of the Inspector.
2. The Contractor shall notify the Inspector sufficiently in advance to enable him to be present at qualification tests and at all other tests or stages of fabrication subject to acceptance in accordance with this specification.
3. The Contractor shall ensure that the Inspector has full and free access to all parts of the Site during all fabrication stages.
4. The Company reserves the right to re-check tests or inspections carried out by the Contractor. For this purposes, the Company may request the delivery of samples or specimens for analyse in an independent laboratory chosen by the Company.

3.6 Technical Queries/Non-Conformance Reports

1. Any Contractor's requests for clarifications or deviations to Company specifications shall be submitted to Company only through Technical Queries (TQ), the format of which shall have prior approval of the Company.
2. A deviation to specifications shall not be considered as accepted if it has not been submitted to and accepted by Company through a Technical Query.
3. Approval given by the Company to any Contractor's work procedures, specifications, equipment, etc. shall not release in any way the Contractor from his obligation to meet the Company's specifications.
4. Any work performance or test result which is found, at a later date, not in conformance with Company specifications or agreed procedure shall be subject to a Non-Conformance Report (NCR) to be issued by the Contractor for submission to Company. NCR report shall indicate the corrective action intended by the Contractor.
5. If classification of the structure is required, any Contractor's request for clarification or deviation to Classification Society Rules shall be submitted to Classification Society through a form previously agreed. Company shall be in copy of any Technical Query and Classification Society answers.

4. Drawings

4.1 General

a) In this specification, the word "Drawings" designates those drawings to be used for the fabrication and which are carried out by the Contractor acting as the Fabricator.

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According to situations, these drawings can be **Shop Drawings** and/or **Fabrication Drawings** and **As-built Drawings**. In the following, “Fabrications Drawings” shall be substituted to “Shop Drawings” when Fabrication Drawings are carried out by the Fabricator and that Shop Drawings do not exist.

b) Fabrication Drawings, Shop Drawings and As-built Drawings shall be in accordance with provisions of API RP 2A-WSD and provisions of para. 4.2 and 4.3 of present specification.

c) Designation of steels on drawings shall fully comply with para. 5.3 and 5.4 of specification GS EP STR 201.

4.2 Shop Drawings

a) The Contractor shall check the Contract Documents, including the drawings, immediately upon award of the contract, and shall promptly notify the Company of all errors and omissions.

These drawings are based on “Approved for Construction” design drawings. Any deviation shall be documented and approved by Company through Site Query system or equivalent.

b) Where necessary the Contractor shall prepare Shop Drawings (to supplement the Fabrication Drawings of the designer). Particularly, shop drawings shall be made to detail the connection of equipment or skids to the structure. No fabrication shall be performed until relevant Shop Drawings have been checked and approved by the Company, unless otherwise agreed.

Prior to submittal to the Company, all Shop Drawings shall be checked and approved by a qualified engineer in the employ of the Contractor.

c) A comprehensive numbering system shall be established by Contractor to identify structural members and shall be used on all Shop Drawings. This should relate to the member identification used for design purposes.

d) The Contractor shall be solely responsible for correctness of Shop Drawings and shall make any required modifications to fabrication due to errors in Shop Drawings.

e) Approval or review of Shop Drawings by the Company does not relieve the Contractor of his responsibility to complete the work in accordance with the Contract Documents, the Company approved Fabrication Drawings and specifications.

4.3 As-built drawings

The Contractor shall prepare as-built drawings and submit each drawing to the Company.

These drawings shall incorporate all pertinent information regarding actual material supply and fabrication, and shall be submitted to the Company within thirty (30) days after completion of the work.

4.4 Other Drawings and Data

The Contractor shall furnish any other drawings and sketches that may be requested by the Company for such purposes as indicating the construction sequences (prefabricating, assembling, lifting, load-out, etc.), the progress of the work, schedules for material delivery, weld history summary, etc.

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5. Materials

5.1 Classification of members

Members are divided into Structural Members and Non-Structural Members. Structural Members are in turn distributed into four categories of importance. Reference shall be made to section 4 of specification GS EP STR 201. Very Cold Seas cases are not treated in this Specification. A Particular Project Specification shall be issued for fabrication, subject to Company approval.

The Table 4.1 in specification GS EP STR 201 shall apply for the distribution of structural members into member categories, with precedence of the Contract Documents.

The distribution of Structural Members of the construction into categories of importance shall be subject to Company's prior approval and Classification Society if required.

Castings and Forgings shall be considered as Special Category members

5.2 Selection of materials

All materials to be used shall fully conform to the general specification GS EP STR 201, GS EP STR 202, GS EP STR 203, taking into account the classification of members defined herein.

Steel qualities shall be subject to Company's prior approval and shall fully conform to specification GS EP STR 201 and Classification Society Rules if required.

5.3 Company's supplied materials

5.3.1 Delivery of materials

Materials supplied by the Company shall be as listed in the Contract Documents. All other materials required to complete the entire work shall be furnished by the Contractor.

The Company shall make available to the Contractor a copy of materials Mill Certificates including chemical and physical properties, and NDT performed.

5.3.2 Inspection on receipt

The Contractor shall inspect all the materials supplied by the Company. He shall agree or disagree with their condition at the time of delivery on fabrication site.

The Contractor shall report all defects and damage which are rejectable on furnished materials. A confirmatory inspection may also be made by the Inspector. The Company can ask the Contractor to correct repairable defects and damage on the basis of prior and mutual agreement.

The Contractor shall be considered responsible for defects or damage which are detected after delivery on Site.

The Contractor, on accepting the responsibility of the materials, shall establish a record including date of inspection, designation and quantity of material accepted or to be repaired or replaced and any other pertinent information detailing material defects or damage and identity. This record shall be co-signed by the Contractor and the Inspector.

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5.3.3 Records of materials supplied by Company

The Contractor shall establish and carefully maintain daily records showing quantities of materials received, employed in the work, remaining in stock, surplus and scrap. These records shall be available at all times for review by the Inspector.

5.4 Contractor's supplied materials

5.4.1 Quality of materials

All materials supplied by the Contractor shall be of the grades and qualities set forth in the Contract Documents and shall meet the requirements contained in the specification GS EP STR 201 (see para. 5.2 of the present specification). Reference shall also be made to para. 6.2 of GS EP STR 201.

The Contractor shall obtain Mill test certificates for all steel products furnished as directed by the Contract Documents and the specification GS EP STR 201. These records shall be available to the Inspector at all times for review.

5.4.2 Inspection and records of materials

All materials furnished by Contractor shall be approved by the Company prior to use and may be subject to inspection and tests by the Inspector.

The Contractor shall establish and maintain daily records showing the quantities and types of all materials required, quantities in stock for the project, quantities on order and promised dates of delivery. These records shall be available at all times for review by the Inspector.

5.5 Substitution of materials

The Contractor shall not make substitution of any material specified in the Contract Documents without the prior written approval of the Company (refer to para. 6.4 of GS EP STR 201).

5.6 Storage and care of materials

All materials for the work, being the sole responsibility of the Contractor while on his premises, shall be stored in accordance with good practice, on pallets or timber blocking, off the ground and above the level of standing water.

Materials shall not be stored near sites of operations such as blast cleaning or painting that might leave undesirable deposits on the materials.

The Contractor shall store all materials for the work in a separate location, apart from those of others and shall segregate surplus and scrap materials. Different steel grades shall not be mixed.

Damaged materials or materials found to have injurious defects shall not be used in the fabrication. The Inspector shall give approval on materials that may be repaired and on repair procedures to be used.

Regarding the degree of rust, all materials found to fall into the D degree of ISO 8501-1 shall be rejected.

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5.7 Identification of materials

The Contractor shall also ensure that the Mill markings and identification on all materials are maintained throughout and transferred to all surplus and scrap. The markings and identification shall be visibly clear and recognized as being correct by the Inspector.

Marking of materials shall be as stated in the specification GS EP STR 201. Possible simplification of the transferred marking may be agreed upon by the Contractor and the Inspector. However, minimum transferred marking shall include: name of Company, name of project, steel designation, heat number, principal direction of rolling.

5.8 Materials traceability

Materials traceability shall be required for Special and First category members, as a minimum, as per API RP 2A-WSD.

6. Preparation of structural members

6.1 General

All operations carried out on base material for its preparation other than welding preparation shall be in accordance with the AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings", unless otherwise specified in this specification.

6.2 Member identification

Before starting the job, the Contractor shall establish a numbering system to identify each member or element of the structure. This identification numbering system shall be used as an aid for indexing radiographs, repairs, etc. Identification system shall be furnished to the Inspector before the start of the job.

See also para. 4.2 and 5.7 of this specification.

6.3 Cutting

Cutting may be performed by machining or by gas/plasma cutting using a mechanically guided torch.

Freehand gas cutting shall not be done, unless it is approved on a case to case basis by the Inspector.

After cutting, suitable identification markings shall be transferred onto each of the cut parts of material: see provisions stated in para. 5.7 of present specification.

6.4 Forming

When forming process results in a percentage strain exceeding 6%, the conditions of GS EP STR 201 para. 5.3.6 shall apply.

6.4.1 General

a) Forming of plates and tubes shall be carried out according to a Contractor's procedure approved by Company, out-lining the successive and controlled steps, as well as inspection

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equipment and procedures (temperature checking, etc.). Base materials are supposed to have been tested and accepted at mill according to requirements of GS EP STR 201.

b) "Cold forming", "Warm forming" and "Hot forming" are conventionally defined hereafter in Table 6.1 with respect to the working temperature θ defined as the maximum temperature of the material during the forming operation.

Table 6.1 - Definition of forming types

Type of forming	Working temperature θ
Cold	$\theta \leq 150°C$
Warm	$150 < \theta \leq 550°C$
Hot 1 (ferritic area)	$\theta > 550°C$
Hot 2 (austenitic area)	$\theta \geq 880°C$

c) Whatever the forming type and procedure, the minimum specified mechanical properties required for the base metal as stated in specification GS EP STR 201 shall be maintained after forming and heat treatment, if any, are performed.

d) Forming shall be carried out using suitable procedures and tools in order to obtain uniform surfaces free from cracks and laps, and without unacceptable thinning of the base material.

e) The Percentage Strain (PS) due to forming is defined as follows by the maximum permanent straining percentage of the tensioned face of plate (or tube) after forming:

$$PS\% = \frac{t}{D} \times 100$$

t = material thickness

D = forming diameter at mid-thickness of material

6.4.2 Cold forming

a) Cold forming producing a permanent straining exceeding the percentages shown in Table 6.2, but not exceeding 6%, shall result in:

- Either a suitable heat treatment made after forming (refer to para. 5.3.6 of GS EP STR 201)
- Or strain ageing tests when no subsequent heat treatment is carried out.

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Table 6.2 - Percentage strain limits for cold or warm forming without subsequent heat treatment

Geographical zone	Max. acceptable Percentage Strain "PS"
Temperate Seas and Warm Seas	5%
Cold Seas	4%

b) The strain ageing test shall be made as follows on a steel sample:

- Tensioning of the sample so as to obtain the same permanent elongation as that anticipated for the final product
- Then, artificial ageing by heat treatment at 250°C for one hour.

Charpy-V notch impact test shall be carried out on the steel sample in the strained condition and in the strained plus artificially aged condition.

Impact test specimens shall be cut from the test sample according to the same direction with respect to principal rolling direction as that prescribed for the steel quality in question.

Impact test specimens shall be located as close as practically possible to the tensioned face of plate.

Test results shall meet the related requirements stated for the base metal at applicable test temperature (see Table 5.3 of specification GS EP STR 201).

c) When subsequent heat treatment is intended, the forming procedure including heat treatment shall be reproduced on the test sample, for qualification purposes, as directed by para. 6.4.5 of this specification.

Care should be taken for selecting the soaking temperature of the heat treatment because such a temperature varies as a function of permanent deformation and deterioration of base metal may possibly result when soaking temperature is too high (in some cases, temperatures commonly used for weld stress relieving treatment may not be appropriate).

6.4.3 Warm forming

In all cases, the forming procedure shall be subject to a qualification test as directed by para. 6.4.5 of this specification.

Refer to provisions stated in para. 5.3.7 of specification GS EP STR 201.

6.4.4 Hot forming

a) In all cases, the forming procedure together with any proposed subsequent heat treatment shall be subject to qualification test as directed by para. 6.4.5 of this specification.

Reference shall be made to para. 5.3.8 of specification GS EP STR 201.

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b) Normalization or quench-tempering treatment is compulsory after forming to ensure regeneration of steel microstructure and restoration of mechanical properties should procedure qualification test results fail to comply with requirements, or otherwise applied as part of the forming/heat treatment process.

c) Production hot forming shall be performed in accordance with the conditions and limitations stated in the procedure qualification report, with accurate checking of working temperature. It must be carried out in such a way that excessive formation of scale on the surface of products is avoided.

d) Hot forming of quenched and tempered steels shall not be permitted unless quenching-tempering is repeated after forming.

6.4.5 Forming procedure qualification test

Forming procedure shall be qualified except for the following cases:

- Cold forming with PS% ≤ 5% for warm and temperate seas
- Cold forming with PS% ≤ 4% for cold seas.

6.4.5.1 Test sample preparation

The test sample to be used may be a piece of the production plate of sufficient dimensions to be representative of the product or a cut-off length of the first product produced. The latter solution will be preferred when hot forming.

In all cases, forming the test sample shall duplicate all conditions intended for production forming (especially, forming temperature, direction and percentage strain). When heat treatment is intended, it shall be carried out on the test sample.

6.4.5.2 Tests

a) The following specimens shall be cut for procedure qualification purposes:

- 1 tensile specimen (prismatic or round bar) to ISO 6892-1
- 1 set of 3 Charpy-V specimens to ASTM E23, ISO 148-1.

Impact test specimens shall be cut from the test sample in the same direction with respect to principal rolling direction as that of acceptance tests required for the quality of the base metal.

However, tensile test specimens shall always be cut longitudinally with respect to the axis of the forming (i.e. specimens cut parallel to the tubular axis).

All specimens shall be located as close as practically possible to the tensioned face of the plate.

Test results shall meet the minimum specified properties required for base metal at applicable test temperature (see specification GS EP STR 201) taking into account the principal rolling direction in the actual fabrication.

b) In the case of cold forming with subsequent stress relieve heat treatment (either as post forming heat treatment or as post welding heat treatment), in addition to the other specified tests, micrographic examination shall in addition to the above specified qualification tests, the

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micro structure from the base metal of test sample before forming and after forming/stress relieving shall be examined for comparison, to ensure that steel structure does not vary. After etching, the through thickness section, from the extrados to the intrados, shall be examined with a suitable magnification. At any location in the through thickness, an increase of grain size, i.e. a decrease of grain size N°, by more than one point to ASTM E112, between the structure before forming and after forming/stress relieving, shall not be acceptable.

c) For cold forming without any subsequent heat treatment, only impact tests shall be performed on the test sample, as stated in para. 6.4.2.c of this specification.

Note: for strain ageing tests only, a straining simulation on a production plate sample by tensile so as to have the same permanent deformation as the maximum obtained in production forming, is acceptable.

6.4.5.3 Records

A record of each qualified forming procedure including the results of all inspection and tests carried out on the corresponding test sample shall be jointly signed by the Contractor and the Inspector.

For hot forming, the procedure qualification record shall clearly indicate the range of acceptable working temperatures to the satisfaction of the Inspector.

6.4.5.4 Extent of qualification

A forming procedure qualification test shall be run on a sample representative of the product with minimum and maximum permanent percentage strain in each steel source, as delivery condition, grade and quality of steel. Exception is made for cold forming without subsequent heat treatment where only the maximum permanent straining is to be taken for qualification of the whole range of straining rates within the lot of products in question.

6.4.6 Forming production tests

Within the products covered by each qualified forming procedure (as defined in para. 6.4.5.4 above), production tests shall be performed regularly as follows:

- For Cold Forming: as per para. 10.9 of GS EP STR 201
- For Warm Forming and Hot Forming at temperatures below or equal to 650°C and for cold forming with subsequent stress relieving: on every 50th product per cast of steel, whatever the steel category
- For Hot Forming at temperatures above 650°C: on every 25th product per cast of steel, whatever the steel Category.

Product tests shall include, at least, the tensile and impact tests specified for qualification of the forming procedure in question (see para. 6.4.5 of this specification), except for Cold Forming without subsequent heat treatment where only impact test in the strained condition shall be carried out.

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7. Fabrication

7.1 General

Fabrication shall be in accordance with provisions of API RP 2A-WSD, unless otherwise stated in the present specification.

The Contractor shall submit for Company's approval sufficiently detailed documents pertaining to the proposed procedure and sequences he plans to use in fabrication and assembling the various parts of the structures. Parts to be prefabricated shall be clearly indicated.

The construction shall proceed on a flat and levelled surface having a foundation with sufficient resistance with regards to the expected structure weight and any additional construction live loads.

Structures and appurtenances shall be fabricated and shop assembled to the greatest possible extent. Items specified as field installed shall be fabricated such that subsequent field work will be minimized.

Although some welding requirements are given in the present section, requirements specifically regarding welding are stated in section 8 of this specification.

Reference shall be made to para. 5.8 regarding traceability of materials.

7.2 Erection loads and stability

The Contractor shall consider during Site assembly all temporary erection loads imposed on the structure from supports, jacking and slinging at each stage of the structure assembly.

The Contractor shall consider at each stage of the structural assembly (and tank testing) the local or overall stability from self weight and environmental loads, inclusive of scaffolding, staging, welding shelters and temporary works. The Contractor shall ensure that all stresses induced in the structure, during fabrication and load out, are not greater than the allowable stresses in the AISC steel construction manual.

The Contractor shall take due consideration of the effect of wind induced vortex shedding on the structure or parts of the structure during construction and take measures to prevent the occurrence thereof.

7.3 Welded connections

For welded connections and their requirements reference shall be made to para. 7.5 to 7.16 hereafter and to section 8 of this specification.

Due consideration shall be paid to welds subject to cyclic/fatigue stresses during service.

Supporting structure for rotating machinery of power in excess of 100 kW (unless otherwise agreed) or for vibration inducing machinery such as diesel engines or reciprocating compressors irrespective of their power shall be considered as fatigue sensitive structure with respect to weld design, performance and inspection. Weld profiling by grinding may be deemed necessary.

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7.4 Bolted connections

7.4.1 General

Bolting will be used only when welding is not possible and will in any case be restricted to locations shown on Contract Documents.

All bolted connections shall be in accordance with AISC "Manual of steel construction", unless stated otherwise in this specification.

- Design and assembly of structural joints using ASTM A370 standard fasteners shall be in accordance with AISC "Specification for design, fabrication and erection of structural steel for buildings"
- Design and assembly of structural joints using high-strength carbon steel bolts or equivalent fasteners tightened to a specified tension shall be in accordance with AISC "Specification for structural joints using ASTM A325 or ASTM A490 bolts".

The use of high strength bolts is subject to prior written approval of Company.

All high strength bolts shall be used with washers.

After being finally tightened, all nuts shall be locked, except for bolted joints with controlled tightening.

7.4.2 Selection of bolts, nuts and washers

Bolts, nuts and washers shall be supplied in accordance with provisions set forth in the specification GS EP STR 201.

Only three very different diameters of bolts shall be used.

7.4.3 Preparation

Holes for bolted connections shall have diameters 1.5 mm (1/16") larger than the bolt size, unless otherwise indicated on Contract Documents.

Holes shall be drilled perpendicular to the surface of the member. Holes shall not be made or enlarged by burning. Enlarging of holes shall be by reaming and then only with the approval of the Inspector. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling or reaming operations shall be removed with a reamer making a 1.5 mm (1/16") 45° bevel.

Punching is not allowed in high strength steel.

All holes shall be drilled and reamed as necessary prior to any blast cleaning.

No holes shall be drilled in structural members at locations other than those indicated on the Contract Documents.

7.4.4 Assembly

7.4.4.1 General

Bolts shall be driven accurately into holes without damage to the threads.

Bolts heads and nuts shall rest squarely and tightly against the metal.

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Unfinished bolts transmitting shear shall be threaded to such a length that no more than one thread will be within the grip of the structural members.

7.4.4.2 Standard bolts

The bolt shall be of a length that will extend entirely through but no more than 5 mm (3/16") beyond the nut.

Bolt heads and nuts shall be drawn tight against members with a suitable wrench.

Bolt heads shall be struck with a hammer while the nut is being tightened.

7.4.4.3 Joints with controlled tightening bolts (or so called slip critical connections)

For bolted joints with controlled tightening bolts (or slip critical connections), the ratio of the Tightened Length (TL) to the bolt diameter (d) shall not be less than 5 (TL/d ≥ 5) and the use of washers supplied with bolts and from the same production, are required.

In all cases, the Contractor shall prepare and submit to Company a detailed procedure for using and tightening HS bolts.

The use of this bolted joint shall not be allowed where there is spraying of liquid (oil particularly), condensation or important corrosion.

For uniform joint quality and to avoid mistakes, classes of bolts, screws and nuts shall be identical in a given project.

Surfaces of high strength bolted parts in contact with the bolt head and nut shall not have a slope of more than 1/20 with respect to a plane normal to the bolt axis. Where the slope is more than 1/20, bevelled washers shall be used.

Faying surfaces shall be free of rust, mill scale, dust, oil, paint and any foreign elements which could impair a good contact between parts. Faying surfaces shall be sand-blasted to SA 2 ½ of the Swedish standard SIS 05 59 00. Their roughness shall be such that their Ra is 6.3 micrometres. It can be measured either by a rugotest or Press-0-Film method.

High strength bolted parts shall fit solidly together when assembled and shall not be separated by any material.

Before installation, appearance of bolts shall be checked, particularly with respect to their lubrication (no additional lubrication other than that carried out by manufacturer shall be allowed). Any contaminated bolt (dust or sand) shall be rejected. Finally, the condition of threads shall be carefully checked.

Unless a tensioning hydraulic equipment can be used, the high strength bolts shall be pre-tensioned to the proper proof stress in accordance with the AISC "Specification for structural joints using ASTM A325 or ASTM A490 bolts", using the turn -of- nut tightening method. When the bolts are supplied as per GS EP STR 201 para. 13 requirements, it will be acceptable that the torque is calculated by the formula: C = 0.88 x k x d x P/1000 refer to GS EP STR 201. However, the tightening procedure shall be in conformance with the AISC requirements specified above.

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7.5 Fabrication of welded tubulars and node cans

7.5.1 General

All tubulars shall be fabricated and inspected in accordance with API SPEC 2B, unless otherwise indicated in this specification. However, the General Specification GS EP STR 201 shall apply to prefabricated items sub-contracted to pipe mills or specialized tubulars/vessel shops other than Contractor's construction facilities.

Welded tubulars shall be fabricated from formed plates welded longitudinally using Submerged Arc Welding (double sided welds).

7.5.2 Forming

Forming shall be carried out in full compliance with all provisions of para. 6.4 of this specification.

The forming procedure shall be submitted to the Company for approval prior to any tubular being formed. This procedure shall include:

- Equipment to be used, its hot or cold rolling capacity (as appropriate) and tables relating to plate thicknesses and tubular dimensions for each machine
- Sequence of operations in forming tubulars
- Methods used for avoiding "flats" along the longitudinal seam
- For hot forming, the forming temperature, heating and cooling rates, method of temperature checking and details of any proposed subsequent heat treatment.

7.5.3 Welding and fabrication

7.5.3.1 Welding

Welding shall be carried out in accordance with requirements of sections 8 and 13 and Appendix 2 of this specification.

7.5.3.2 Splices

The minimum distance between girth welds in tubulars and piles shall be as stated in para. 7.9 of this specification.

7.5.3.3 Tubular ends

Tubular bevels will be defined by the Contractor in compliance with the approved WPS.

When tubulars are intended to be butt welded to other tubulars of smaller wall thickness in further fabrication, a taper of 1 to 4 shall be made to allow a proper fitting.

For brace to can connection, once bevel is finalized, a scrub line (constant distant from root face) shall be marked on the brace for root face location reference for the UT inspection.

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7.5.4 Production tests

7.5.4.1 General

Production tests shall be carried out on finished tubulars pertaining to Special and 1st Category members. Production tests shall include tests on base metal and tests on welds as indicated below.

7.5.4.2 Production tests on base metal

As per para. 6.4.6 of this specification.

7.5.4.3 Production tests on welds

a) Production test plates shall be welded as longitudinal extension pieces attached to the seams during production welding. Where the Inspector deems necessary, the Contractor shall prepare representative circumferential weld test pieces. These are not normally required where the circumferential seams are welded to an identical weld procedure as the longitudinal seams.

   Each production test plate shall be labeled with a machine reference number and for longitudinal seams a tubular reference number. Test pieces for circumferential seams must be welded on identical machines and to identical procedures as the seams they represent.

b) Weld production tests shall be carried out per each WPS regularly once in every **twelve (12)** circumferential and once in every **twelve (12)** longitudinal seams in Special category tubulars and once in every **fifty (50)** circumferential and **fifty (50)** longitudinal seams for First Category tubulars. The production test program shall be made so as to test equally, as far as possible, all the wall thicknesses covered by the said WPS.

c) All tests specified for the welding procedure qualification test (see para. 8.7.5 of this specification) shall be carried out. However, the impact test and tensile test are modified as follows:

   - The transverse tensile test consists of only one specimen
   - The impact test consists of only two sets of specimens: one with the notch centered in the weld axis and the other one with the notch located on the Fusion Line (FL) or Heat Affected Zone (HAZ) and centered at the place where the lowest average absorbed energy has been measured during the Welding Procedure Qualification Test (i.e. on FL or 2 mm from FL or 5 mm from FL). This test location shall be agreed with the Inspector.

   Production test pieces shall be 100% non-destructively examined and mechanically tested in full compliance with para. 8.7.8 of this specification.

d) Failure: production test welds which fail the requirements of para. 8.7.8 of this specification shall be rejected and brought to the attention of the Inspector and the cause of the failure shall be established by the Contractor. Further examination of welds made using the same welding procedure or by the same welder shall be carried out to ensure that unacceptable welding is not present in the structure.

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7.5.5 Inspection

7.5.5.1 Weld inspection

In addition to the 100% visual inspection, radiographic and ultrasonic testing shall be carried out according to section 10 of this specification to the following extent on each finished tubular or section of tubular:

- Longitudinal weld: 100% inspection by NDT (10% NDT inspection for 2nd category tubulars), plus radiographic inspection of weld extremities over 200 mm mini.
- Girth weld: 100% inspection by NDT, whatever the tubular category.

NDT means radiography for WT ≤ 15 mm and ultrasonics or radiography for 15 < WT ≤ 35 mm and ultrasonics for WT > 35 mm.

When capping or back pass is made with a process other than SAW, then MPI shall also be required to 100% extent on Special and First category members.

7.5.5.2 Dimensional tolerances

The tolerances shall be as per section 14 of this specification.

7.5.6 Repairs

- Repairs on base material: as per API SPEC 2B and section 13 of this specification
- Repairs on weld: as per section 13 of this specification.

7.6 Fabrication of legs, piles and bracings

The provisions of para. 7.5 shall apply to prefabricated tubular members under this specification.

7.7 Fabrication of buoyancy tubes and flotation tanks

The provisions of para. 7.5 shall apply.

The flotation tanks and buoyancy tubes shall be fabricated to the same standard as the Special Category members and leak tested in accordance with section 11 of this specification.

7.8 Welded Plate Girder (WPG) fabrication

a) Unless otherwise indicated in this specification, fabrication and welding of Welded Plate Girders (WPG), also called built-up sections, shall be in accordance with provisions of AWS D1.1/D1.1M code.

b) The web to flange connections of Welded Plate Girders subject to cyclic load or high localized static loads (e.g. at nodes) shall be made with full penetration welds.

c) Web to flange connections carried out with full penetration weld require production tests using extension pieces attached to the seams during production welding. Production tests shall be one test in every twenty welds produced. All tests specified for the welding procedure qualification test (see para. 8.7.5 of this specification) shall be carried out.

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However, the impact test is modified in a same way as that for welded tubulars (i.e. only two sets of specimens as per para. 7.5.4.3.c of this specification).

d) Web to flange connections shall have a concave profile and transition smoothly into flange and web.

e) The Purchaser or PPS will state whether it is necessary or not necessary to let the web to flange connection unwelded over a distance of 500 mm at each end of WPG, in order to allow for a proper fit up at splices and nodes.

f) Reference shall be made to para. 7.9 regarding splices in WPG.

g) The dimensional tolerances shall be as stated in section 14 of this specification.

7.9 Splice fabrication and welding

Parts to be joined may be of equal or unequal sizes but abutting thicknesses shall be such that the thicker part shall not be more than twice the thickness of the thinner part.

Note: The thickness to be considered for the thicker part is the thickness before machining the taper.

Welded field splices shall be arranged to minimize overhead welding.

Lapped joints are not permitted unless approved by the Company.

Welded joints of axially aligned structural members of different material sizes, thicknesses, diameters or widths, shall be made in such a manner that the slope through the transition zone does not exceed ¼.

The transition shall be accomplished by chamfering the thicker part, tapering the wider part, sloping the weld metal or by any combination of these. The figures in AWS D1.1/D1.1M code show how to design and measure the slope.

Fillers shall not be used for welded splices.

Bolted joints of axially aligned structural members of different material sizes, thicknesses or widths shall be accomplished using fillers (shims) and splice plates or by tapering the wider part. Suggested details are given in Part 4 of the AISC “Manual of Steel Construction”.

Splices in tubulars and beams shall be in accordance with the following provisions:

- Splices in **pipes**: no two circumferential seams shall be located closer together than one pipe diameter or 900 mm, whichever is less. There shall be not more than two girth welds in any 3 metres interval of pipe. Longitudinal seams of adjoining pipe sections shall be radially offset by a minimum of 90 degrees wherever possible and shall not be less than 30 degrees radially offset without the prior approval of the Company. Longitudinal seams in adjacent cans shall be separated at the circumferential weld by at least 250 mm.
- Splices in **piles:** the minimum distance between girth welds shall be 2 pipe diameters or 2 metres, whichever is less.
- Splices in **Welded Plate Girders** and rolled sections shall not be located closer together than twice the depth of WPG or rolled section, or 1 metre, whichever is smaller.

Splices between sections of beams (i.e. rolled or built-up sections) shall be made in a single transverse plane (i.e. welds of flanges and web in the same plane) and the design of weld

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grooves shall result in a continuous and full penetration weld over the complete cross-section. To ensure full penetration of flanges, thinning of the web is to be carried out by grinding in order to allow good penetration and back welding. This web thinning is then to be properly overlaid by welding followed by grinding the overlay flush to restore the web to its previous thickness and flat and uniform condition.

7.10 Welded tubular connections (or tubular joints, tubular nodes)

a) Welded tubular nodes shall be prepared and welded in accordance with API RP 2A-WSD and the following.

b) The Contractor shall examine carefully the distribution of the joints between pre-fabricated elements so that most of the welds in important nodes are carried out in workshops as possible.

c) Unless otherwise indicated on the Contract Drawings, brace to chord welds shall be fully beveled so as to allow full penetration welds and UT inspection of the complete weld thickness, including the so-called “back-up weld”.

The term “back-up weld” is referred to the representation given in details C through D of Fig. 3.8, 3.9 or 3.10 of AWS D1.1/D1.1M:2000.

In addition, it is highlighted that the weld groove at the heel of the node shall be designed only as stated in API RP 2A-WSD and shown on Section C-C and Section C-C (alternative) of Fig. 11.1.3 of this Std (i.e. brace feather edged through its full thickness), except that “back-up weld” is still subject to inspection, as said above.

d) Fabrication schemes which allow back welding are always beneficial and shall be preferred, especially for tubular joints subject to high fatigue stresses. In this way, a more efficient groove can be prepared ensuring adequate penetration and fusion and reduced risk of root defects.

Unless otherwise agreed with the Company, double sided welds shall be required when brace O.D. exceeds 24” and/or brace thickness exceeds 38 mm (1.5”), and/or brace to can angle is less than 30°. Single sided welds may be used for brace to chord connections provided that they are stated on Company approved drawings, they have been found acceptable by an engineering fatigue assessment and that they are qualified by welding tests according to the requirements of this specification without any “back-up weld”, as said above.

e) When the reference thickness of tubular node welds exceeds 2.0” (50.8 mm), the welds shall be given a concave smooth profile by full grinding as per para. 2.36.6.6 (2) of AWS D1.1/D1.1M:2000.

f) Any possible measures shall be taken to avoid the intersection of weld seams. Any longitudinal weld on a chord member shall be positioned at least 2 x chord thickness away from incoming braces, with a minimum of 75 mm: see Figure 7.1.

g) Restrictions on longitudinal stub seams and circular can seams locations shall be as shown in Figure 7.1. The width of prohibited zones on braces shall be half the brace O.D. with a max. of 400 mm. Dimensions are understood as from weld toe to weld toe.

When braces of equal diameters overlap at X nodes, the brace longitudinal welds shall be located as shown on Figure 7.2.

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h) Where it is not possible to place weld seams clear of the brace to chord weld, then the weld seams on chord shall be ground flush. The weldment areas shall also be subjected to 100% NDT (i.e. U.T. + MPI) up to 50 mm minimum on either side of weld prior to fit-up the brace. The subsequent brace to chord weld shall then be smoothened by proper grinding at weld crossing areas (to avoid any undercut) and then checked by MPI. However, this is always providing that restrictions of para. f and g (here before) are fully met, where relevant.

i) Minimum gap between bracing foot prints shall be 75 mm (see Fig. 7.2). Minimum gap between weld toes shall be 50 mm. Where the achieved gap between weld toes is between 25 and 50 mm, local grinding and MPI shall be required in order to avoid local undercut and get a smooth weld profile.

j) Temporary attachments and permanent Non-Structural attachments (such as anode attachments) to primary structure shall be at least 75 mm from any other weld, the distance being from weld toe to weld toe.

k) Unless otherwise indicated on drawings, girth welds on cans and bracings shall be located as shown in Figure 7.3 with respect to node welds.

Figure 7.1 - Prohibited areas for stub longitudinal seams and barrel circumferential seams

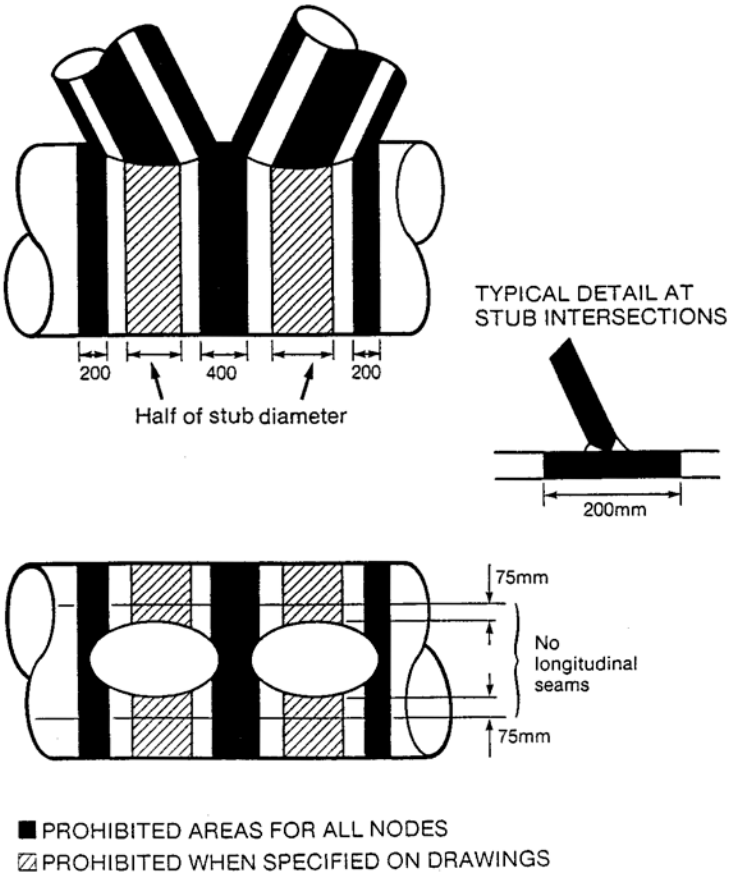

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Figure 7.2 - Location of longitudinal weld seams in X nodes

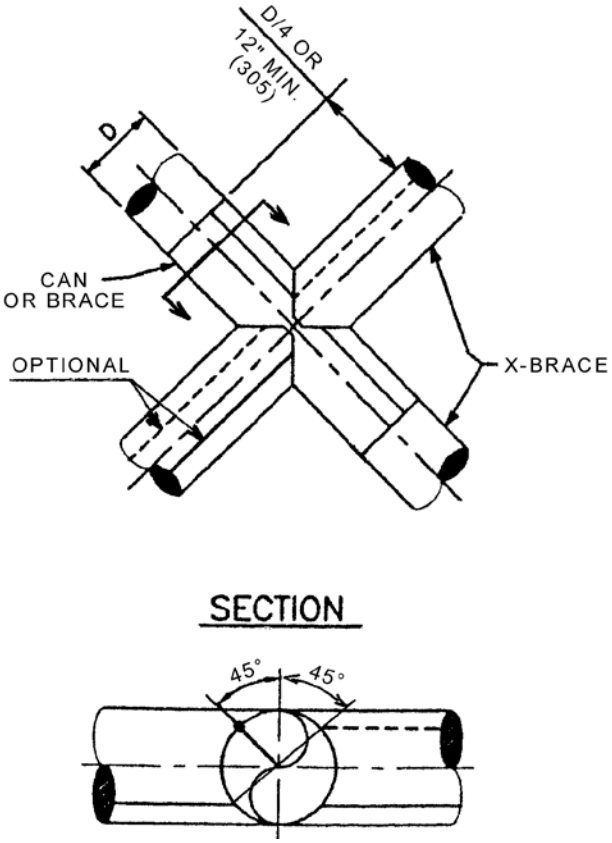

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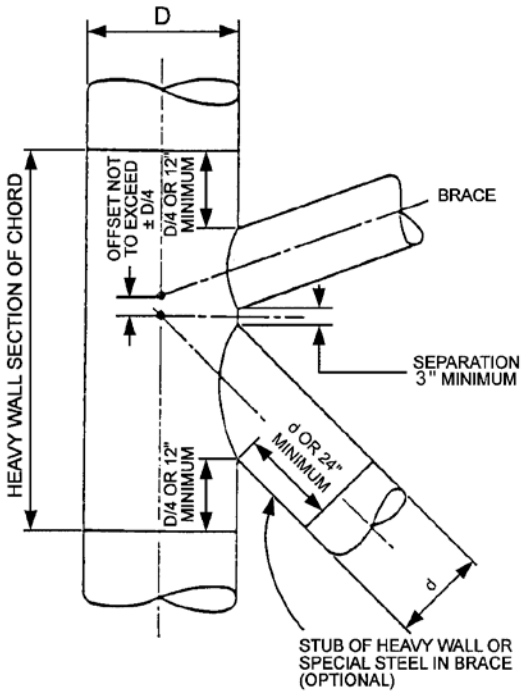
Figure 7.3 - Location of girth welds in simple joint



7.11 Shape to shape connections

When a beam frames to a column web or girder web, the design of connection and sequence of weld assembling will be such as to avoid heavily restrained welds on the web of the column or girder which might introduce lamellar tearing.

Butt welds and tee-butt welds of shapes using permanent backing strip is forbidden.

7.12 Fabrication of pad eyes

Pad eyes shall be fabricated to the standard of Special Category members. Plates shall be assembled so that the principal rolling direction is oriented in the direction of the lifting slings.

7.13 Permanent attachments

The use of doubler plates is required for fixing any permanent non-structural component less than 100 mm high to Special and First Category components (e.g. deck legs, primary girders, etc.) and welded and inspected as structural items. Non-structural components such as all supports of piping, cable trays, lights, etc. higher than 100 mm shall be addressed and welded as structural items.

When welding of attachment directly onto the structure is permitted, the location of such welded attachments shall be selected so as to avoid interference with the principal weld seams of the structure. Minimum acceptable clearance between welds shall be two (2) times the thickness of the structure with minimum of 100 mm. See, also, the provisions of para. 7.10 of this specification.

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Any welding made directly onto the structure shall be performed according to the same requirements and care, including qualification and inspection that govern the structural part onto which welding is made.

7.14 Temporary attachments welds

During construction, a temporary attachment is defined as an element introduced for some specific and temporary function on the structure: lifting lugs, lugs for scaffolding and assembly temporary supports, ladders or other fabrication and erection aids.

Attachments shall preferably not be made to the highly stressed areas of the structure. Such attachments that are deemed essential shall be approved by Company and should therefore be planned in advance.

The location of such welded attachments shall be selected so as to avoid interference with the principal weld seams of the structure. Minimum acceptable clearance between welds shall be two (2) times the thickness of the structure with minimum of 100 mm. See, also, the provisions of para. 7.10 of this specification.

Welding of attachments is to be carried out according to the same procedures that govern the structural part in question (see para. 8.9.5 of this specification).

When such items are no longer required, they shall not be broken off but removed without damage to the structure by chipping or gouging off 5 mm from the member surface and relevant temporary welds shall be ground flush and inspected according to para. 8.9.5 of this specification.

7.15 Temporary openings

The Contractor shall avoid temporary openings (or cut-outs) in Special Category members, whenever possible.

In all instances, when temporary openings are deemed necessary with approval of the Inspector, they shall be prepared with the same care as for permanent openings and with suitably radiused corners (100 mm).

Temporary openings shall then be sealed by employing the same welding and inspection procedures that govern the structural part into which they are carried out.

Temporary openings shall be indicated on shop drawings and as-built drawings.

7.16 Rat-holes

No rat-holes (or mouse-holes or cope holes or weld access holes) shall be left open in the construction. Design of temporary rat-holes shall be provided by Contractor to construction Site so that they can be properly filled by an approved welding procedure.

Permanent rat-holes in beam webs, stiffeners, diaphragms, etc. shall be avoided by a correct sequencing of work. They shall be replaced by sniped corners or temporary rat-holes having 20 mm radius and plate thinning (e.g. in stiffener plate and web) to permit welding of the through weld but to provide then a close fit-up with the through weld or beam profile. Sniped corners shall be continuously welded. Corners shall be sniped by trimming and bevelling as appropriate.

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7.17 Fabrication and Installation of ancillaries

7.17.1 Handrails, stairs, catwalks, ladders and gates

Fabrication shall be carried out according to standard GS EP STR 901.

Safety cages to ladders shall be provided where indicated on drawings. Even if not indicated on the drawings, the vertical ladders exceeding 6 metres in length shall be caged for safety on entire length except 2.10 m at bottom.

When fixing of handrails is performed by introducing them in external pipe sockets, a small hole shall be made at the base of each of those pipes to allow the evacuation of water and avoid corrosion problems.

All handrail welds shall be ground smooth.

All ladders and handrails shall be installed after surface coating or galvanizing to check the fit. At the discretion of the Company (or as shown on the drawings) certain ladders and handrails may have to be removed prior to load out. In this case, the Contractor shall mark the element prior to removal and prepare a placing drawing, which is to be supplied sufficiently in advance of the planned load-out date.

7.17.2 Bar grating

All bar grating and installation pieces shall be cut to the required dimensions and installed as dictated by the drawings. A number of bar grating panels may not be installed prior to load-out but all panels are to be test fitted and given identification marks to ease installation offshore. All bar grating supports are to be installed prior to load-out. All bar grating installed before load-out shall be secured to its supporting members, in accordance with the drawings.

Joints in grating shall occur only at points of support.

7.17.3 Riser clamps/supports

Riser clamps shall be fabricated to the requirements of this specification and to the dimensions as shown on the approved drawings.

The bolted connections shall be trial fitted to ensure that full contact is developed over the area of the connection prior to initial tightening.

The matched pairs shall be hard stamped with a unique identifying code and bolt holes shall be drilled in both halves in a single operation, to ensure matching on site.

7.18 Finishing of surfaces

Planning and finishing of cut edges will not be required unless specifically called for in the PPS or included in surface and edge preparation for welding.

All exposed edges of plates and structural shapes that are not rounded to 1.5 mm (1/16”) radius shall be broken with a power disc to a 1.5 mm (1/16”) chamfer and dressed off with a hand file or other means to remove the resulting burrs.

As fabrication of various items or portions of the structure is completed, the Contractor shall grind all welds and remove all burrs, tack welds and other marks made by scaffolding or temporary bracing used in the fabrication procedure.

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Random arc strikes shall be ground out, weld filled and ground out, weld filled and ground smooth when so directed by the Inspector. Refer to para. 8.9.9 of this specification.

7.19 Identification and marking of members

Reference is made to para. 4.2 and 6.2 of this specification.

Regulating marks for workshop or installation (erection) purposes shall be properly die stamped using low stress dies.

7.20 Transport and handling of members

All sub-assemblies, member sections, etc. shall be transported and handled by a suitable and approved method which does not induce deformation or excessive stresses.

Locations of lifting lugs and other temporary attachments are to be carefully selected to ensure that structural strength and specified material properties are maintained.

During on and off loading, transport, storage and handling, all components are to be treated in a manner such that they do not suffer damage, overload or deformation.

7.21 Correction of members

Distorted members shall be straightened as directed by clause 5.26.2 of AWS D1.1/D1.1M:2000. The temperature of heated areas as measured by approved methods shall not exceed:

- 550°C for controlled rolled steels
- 590°C or tempering temperature minus 50°C (the lowest temperature) for quenched and tempered steels, and normalized and tempered steels
- 650°C for normalized steels and other C-steels and C-Mn steels.

The Contractor shall establish and submit a detailed procedure for correction of distortions. The procedure shall include details of the methods used for heating and controlling the temperature.

For steel grades with a minimum specified yield strength of 300 MPa and above, a qualification of the procedure shall be carried out. The qualification test shall include tensile test, impact test, hardness test and micrographic test.

At production stage, hardness test may be required on heated surfaces (for comparison purposes with results of qualification test). Also, if welds are located too close to the heated areas they shall be re-checked by NDT.

Cold straightening may be used provided that distortion is less than 5%.

8. Welding

8.1 General

Welding shall be governed by API RP 2A-WSD with the appropriate references to AWS D1.1/D1.1M code, unless otherwise indicated in the present specification.

Typical welding details (to be provided) shall be applicable unless otherwise specified by Company.

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Welding Energy shall be limited to 4.5 kJ/mm.

All fabrication shall follow the requirement of ISO 3834-2 and the requirements stated in the present specification.

8.2 Surface and edge preparation

a) Surface and edge preparation for welding shall be as defined in the applicable qualified welding procedure. Additional requirements, except when amended herein, shall comply with the applicable requirements of the AWS D1.1/D1.1M code and shall be in accordance with good standard practice.

b) All gas cut surfaces and edges for welding shall be ground to white metal finish to remove carburized metal and slag. Any excessive roughness of cut surfaces as well as occasional notches shall be removed by machining or proper grinding.

c) Surfaces and edges to be welded shall be smooth, uniform and free from fins, tears, cracks, laminations or other defects which could adversely affect the quality and strength of the weld.

d) The surface of chord members (plate or pipe) to be welded in a full penetration T, K or Y - joint (including temporary or permanent attachments) such as chords of tubular joints, pad eyes, supports, etc., shall be ultrasonically inspected before welding when thickness of incoming member exceeds 25 mm.

   The area of incoming member to chord joint shall be mapped out onto the surface of the chord. This area together with the 50 mm either side of the weld shall be subject to ultrasonic inspection. The ultrasonic inspection shall be as per ASTM A578 and defect areas of 60 mm^2 and above shall not be acceptable. Material showing inacceptable defect indications or large quantities of acceptable defect indications shall be subject to review and approval of the Inspector.

e) The chord of tubular joint shall be properly rotated to avoid areas containing lamellar discontinuities.

f) Plates in which laminations are found during cutting, forming or welding shall be examined by ultrasonics to determine the extent of the defects and decide about their acceptance or rejection in mutual agreement with the Inspector.

g) Surfaces to be welded and surfaces adjacent to a weld shall be free from loose or thick scale, slag, rust, grease, oil, paint and moisture or other materials that would prevent proper welding.

h) Any welding repair to be made on base material or bevel shall be subject to qualification test.

8.3 Fit-up

a) Whenever practicable, clamps, magnets, holding devices, etc. shall be used to avoid tack welding in assembling structural members. In fit-ups where clamps cannot be used, spacer-strips will be employed to ensure the correct root gap spacing prior to tack welding. Spacer-strips shall not be welded into the joint.

b) Misalignment between faces of parallel members of equal thickness when not indicated on drawings shall not exceed 10% of the thickness, nor 3 mm.

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c) If the thickness of abutting members are different, the maximum permitted offset when measured on any of the two faces of assembly shall not exceed:

- 3 mm when thinner member is not in excess of 12.7 mm (1/2")
- 4 mm when thinner member exceeds 12.7 mm (1/2") up to 25.4 mm (1")
- 5 mm when thinner member exceeds 25.4 mm (1").

The weld contour will then ensure a smooth transition between the faces of the assembly in such a manner that the mean slope through the weld zone does not exceed ¼.

Outside the above limits, the thicker member shall be tapered by machining or grinding to a slope of not less than ¼ (see para. 7.9 of this specification).

d) When a correction is to be applied to improve misalignment, it shall be carried out using adequate mechanical means. Heating shall not be applied unless specifically approved by the Inspector. The procedure and the maximum acceptable temperature shall be as stated in para. 7.21 of this specification.

e) The root gap of the joint shall be as defined in the applicable qualified welding procedure. Spacing tools may be used to ensure proper root opening before welding.

f) Weld buttering of bevel and wide gap procedures shall be subject to qualification tests. Weld built-up shall not exceed 12 mm in thickness (refer to para. 8.7.4). Only one side of the weld can be buttered.

8.4 Welding processes

a) Shielded Metal Arc Welding (SMAW - process 111 as defined in ISO 4063), automatic Submerged Arc Welding (SAW - process 12 as defined in ISO 4063), Flux Cored Arc Welding (FCAW-SS or GS - processes 114 and 136 as defined in ISO 4063) process and Gas Tungsten Arc Welding (GTAW - process 141 as defined in ISO 4063) processes shall normally be used.

GTAW process is recommended for first pass of single sided butt welds.

Semi-automatic Gas Metal Arc Welding (GMAW - processes 131, 132, 133, 135 as defined in ISO 4063) and Flux Cored Arc Welding using metal cored wire (process 138 as defined in ISO 4063) shall not be permitted for any structural categories even for tack welding excepted when totally removed with SAW process on X bevels.

Submerged Arc Welding with addition of metallic powder (SAW - process 124 as defined in ISO 4063) shall not be permitted for any structural categories.

Automatic Gas Metal Arc Welding (GMAW) shall be subject to Company approval on a case to case basis.

b) Only Extra Low Hydrogen processes (max. 5 ml H2/100 g) shall be used for welding and tack welding of Special and First Category members or materials having specified YS above 262 MPa (38,000 psi). The same requirement shall apply for any welding on castings and forgings.

c) For Second Category members and Non-Structural members, welding processes other than Extra Low Hydrogen processes may be used, subject to prior approval by Company, for

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materials having specified YS up to 262 MPa together with thickness up to 12.70 mm (0.500").

d) The number of different welding processes shall be minimized.

e) Different welding consumables qualities (basic extra low, basic low) in a same type of consumables shall be avoided.

8.5 Welding consumables

8.5.1 Selection of consumables

a) Consumables shall conform to AWS D1.1/D1.1M code and shall have been approved by an international recognized certification body (e.g. DNV, LLOYD's, etc.). Welding consumable supplier shall guarantee grade and Charpy temperature on certificate according mechanical properties requested for base metal.

Selection of welding consumable shall be such as developing a weld metal with Yield Strength higher than SMYS of base metal (overmatching). For S420, overmatching shall be limited to 70 MPa, and to 50 Mpa for higher grades.

b) If classification of the structure is required, welding consumables shall conform to rules of the Classification Society.

c) Cellulosic electrodes are strictly forbidden for structural use.

d) Welds forming connections between steels of different grades of material shall develop the minimum specified tensile properties of the lower steel grades being joined, unless otherwise previously approved by the Company.

Welds forming connections between steels of different grades of material shall develop the minimum specified notch impact properties at the lowest temperature of steel grades being joined, unless otherwise previously approved by the Company.

e) For repair welding or multiple repairs, "extra low hydrogen" electrodes are required (i.e. maximum specified hydrogen content of 5 ml per 100 gram of weld metal).

f) For welding castings or forgings, "extra low hydrogen" electrodes are required (i.e. maximum specified hydrogen content of 5 ml per 100 gram of weld metal).

g) For SMAW process, coated electrodes shall have a minimum diameter of 2.40 mm on Structural Steels.

h) The number of different consumables shall be minimized.

i) All consumable batches (lots) used in production shall be tested (for SAW, all flux batches as well as wire batches are to be tested). Consumable batches shall be qualified at the very early stage (welding qualification or advanced production test) in order to make sure of their quality at the very beginning of the production. The test shall be carried out on butt weld on the highest grade steel used for which the lots are used in production. One tensile test transverse to the weld and a set of three Charpy V notch in weld metal at the lowest temperature for which the lots are used in production shall be carried out. Results shall meet the value of the highest grade steel for tensile test and the minimum requirement for the highest grade steel at test temperature for the Charpy test, according GS EP STR 201.

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8.5.2 Supply, storage of welding consumables

Low hydrogen electrodes and fluxes shall be supplied in sealed moisture proof containers. The unopened containers shall be stored in a dry location where a temperature of 20°C approx. is maintained at all times.

Each heat, lot (or so called batch herein) of consumables shall be subject to inspection and approval by the Inspector. 3.1 Mill test certificates from consumables manufacturers showing test results actually obtained on the said lot shall be submitted to the Inspector.

The lot and the level of testing are specified as per ISO 14344 as follows:

- Covered electrodes: class C5 or alternatively C3 provided it is limited to one heat number and when the chemical composition of wet mixes is controlled by raw material analysis and computerized weighing.
- Bare solid electrodes and rods: class S3
- Flux cored electrodes and metal cored electrodes and rods: class T3
- Flux for submerged arc welding: class F2.

The level of testing shall be as per ISO 14344 - Schedule 4 as a minimum.

Certificates of conformance are not acceptable. Batch testing of welding consumables is required from Contractor in combination with production test plan.

For steel grades above 440 MPa, SAW flux procurement, packing, storage and use shall conform to requirements of Appendix 1.

For steel grades less than 440 MPa, SAW flux shall be stored in metallic drums or double polyethylene bags with aluminum layer. If not, in addition of a sealed packaging, storage room shall guaranty an atmosphere with absolute water content less than 11 g per kg of dry air. Table of correspondence between T°C and relative humidity is given in the following table. Paper bag is not considered as a sealed packaging.

g of water vapor / kg of dry air		Temperature							
		5	10	15	20	25	27	30	35
Relative humidity %	40	2	3	4	6	8	9	11	14
	45	2	3	5	7	9	10	12	16
	50	3	4	5	7	10	11	13	18
	55	3	4	6	8	11	12	15	20
	60	3	5	6	9	12	13	16	21
	65	4	5	7	10	13	15	17	23
	70	4	5	7	10	14	16	19	25
	75	4	6	8	11	15	17	20	27
	80	4	6	9	12	16	18	22	29
	85	5	7	9	13	17	19	23	31
	90	5	7	10	13	18	20	24	33

FCAW wires shall be permanently protected from moisture.

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8.5.3 Drying procedures and use of welding consumables

As a general rule, welding electrodes shall be treated and used in accordance with recommendations of their manufacturers. In the absence of written recommendations from the manufacturers of consumables, the requirements of AWS D1.1/D1.1M shall apply.

The permissible atmospheric exposure of low hydrogen electrodes shall be two hours max., unless shorter a time is required in AWS D1.1/D1.1M.

Low hydrogen electrodes which have been in direct contact with water shall be definitely rejected and removed from the Site.

Welders shall be provided with individual portable ovens (heating quivers) for electrode conservation during the work on site.

Flux for SAW process shall be dried according Vendor's written recommendation with a minimum of 300°C during 2 hours. Waiver of this drying may be granted by Company provided packaging of flux is done with metallic drums or double polyethylene bags with aluminium layer and that Vendor certifies by written a diffusible hydrogen in sealed pack less than 5 ml/100 g of deposited metal. This certification may be based on correlation curves between hydrogen content in flux and diffusible hydrogen in deposited metal.

When necessary, drying of flux shall be performed on layers of 5 cm maxi. Drying in drums is considered as inefficient.

Holding T°C of flux shall be over 100°C.

Transportation and storage of flux before use shall be done in closed container and flux always protected from moisture contamination. Duration at a T°C of less than 100°C shall be limited to 2 hours maximum. A special care to flux shall be implemented at the end of the working shifts.

Recycling of flux may be accepted after filtration (with size of filters mesh according Vendor's written recommendation) and a complete re-drying cycle.

Percentage of recycled flux in used flux shall be limited to 25% (75% of new flux). This percentage can be upgraded to 50% if a magnetic filtration is added to the size filtration.

If compressed air is used for flux propulsion air shall be free of oil and moisture (moisture and oil removal system after compressor).

At the end of the working shift, FCAW wires shall be stored in a dedicated area protected from moisture.

The Contractor's consumable management procedure for storing, handling, drying, flux recycling and traceability including Vendor's written recommendation shall be approved by the Inspector before fabrication commences.

8.6 Welding Procedure Specifications (WPS)

Four weeks prior to commencement of any welding, the Contractor shall submit to the Company a weld register (i.e. a detailed summary table) of all the WPS he intends to use, together with all the said WPS in their complete form. The weld register shall detail the characteristics and scope of use of each WPS.

WPS shall be produced for production welds (i.e. main welds), repair welds of main welds and base materials, weld buttering, wide gaps, etc.

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The minimum acceptable WPS shall include, at least, all items listed below:

- The identification of base metals (relevant mill certificates to be valid for the applicable range)
- The qualified range of base materials in terms of steel grade, thickness, CE and/or Pcm, diameter, etc.
- The welding process
- Design and dimensions of joint preparation, including tolerances
- Welding position(s)
- Direction of welding
- Type, size, AWS classification, manufacturer and trade name of welding electrodes, filler wires, shielding fluxes and gases. Gas mixture compositions
- Type, amperage and voltage range of welding current
- Travel speed, heat input (in kJ/mm) and wire feed speed when applicable. Number and distribution of weld runs related to each electrode or filler wire, specially for capping
- Stick-out length, when applicable
- Thickness (or depth) of tack weld, especially when SAW is used
- Mini preheating, min. and max. interpass temperature
- Post-heating and Post-Weld Heat Treatment conditions, if any
- Treatment to second side of weld including depth of backgouge / backgrind
- The reference to the applicable Welding Procedure Qualification Record (WPQR).

There shall be no more than 3 WPQR to support a single WPS.

New WPS shall be issued first as “proposed WPS” (P. WPS), then as WPS “approved for construction” (AFC) and any WPS revision shall be issued with sequential numbers and date of issue. All forms shall have prior approval of the Inspector.

The approved WPS shall be posted permanently at the location where the welding is to be performed and readily available to each welder and welding operator.

8.7 Welding Procedure Qualifications (WPQ)

8.7.1 General

a) Each applicable WPS shall be qualified by tests prior to commencement of the work as directed by the AWS D1.1/D1.1M code, and the requirements of this specification.

b) Qualified welding procedures from previous orders approved by an international and Company recognized inspection agency may be accepted without further tests provided that acceptable documentation is supplied as regard to the requirements of present specification (for example, brand name and designation of consumables shall be clearly indicated in WPS and WPQR, and Mill certificate of base material used for qualification tests shall be included in the WPQR) and subject to prior approval of the Company. However at the start of the

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fabrication, an advanced production test shall be required for butt welds and T, K, Y welds. Testing shall be as per the relevant original qualification scheme, unless otherwise agreed with the Company.

c) Pre-qualified welding procedures as defined in AWS D1.1/D1.1M code may be used without qualification test subject to prior approval by the Company.

However, such procedures shall meet the requirements of this specification and shall be restricted to members which simultaneously meet the following conditions:

- Second Category Structural Members or Non-Structural members
- Specified yield strength does not exceed 262 MPa (38,000 psi)
- Base metal wall thickness is less than 19.05 mm (0.750”).

d) Fillet welds made by SMAW processes are not subject to welding procedure qualification test when base material involved complies with the following requirements all together:

- First or Second Category structural members or Non-Structural members
- Specified yield strength does not exceed 262 MPa (38,000 psi)
- Base metal wall thickness is less than 25.4 mm (1”)
- IIW Carbon equivalent does not exceed 0.40% (ladle).

e) Reference shall be made to weld and welding requirements contained in para. 8.9 of this specification.

f) The Welding Procedure Qualification Test shall be witnessed by the Inspector and carried out under actual or simulated conditions, based upon the proposed Welding Procedure Specification (WPS).

g) For testing purposes, the thickness of material to take into consideration shall be the Reference Thickness as defined in para. 9.1 of this specification.

h) Welding on forgings and castings shall be qualified by special tests. Welding coupons defined in GS EP STR 202 / GS EP STR 203 shall be used. Test program shall be submitted for Company acceptance and may content complementary test than those defined hereafter as CTOD or fatigue tests. Tests program shall be driven by calculation note and criticality of structure.

i) The process described hereafter does not cover welds for which specific qualification is requested in PPS (fatigue full scale test, FCGR test…) for which a specific program of qualification and validity shall be agreed at the bid stage.

8.7.2 Selection of test base material

Welding procedure qualifications shall be carried out on test coupons with their Carbon Equivalent (CE), Pcm and Carbon content, in the upper limits of the materials supplied and, anyway, as per requirements on chemistry as stated in para. 8.7.4.

The chosen coupon shall be completely identified by Mill Certificate showing its ladle and product chemical composition and mechanical properties.

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8.7.3 Type and number of tests

The qualification of welding procedures shall be based upon visual inspection, non-destructive testing and mechanical testing.

Type and number of tests shall be as specified in Table 8.1.

Reference is made in this specification to para. 8.7.5 and 8.7.6 for sampling of specimens and to para. 8.7.8 for testing procedures and standards of acceptance.

Table 8.1 - Qualification of welding procedures
Type and number of tests

Joint/weld Configuration	Thick. (mm)	Non-destructive tests 100% (1) (2)	Mechanical tests						
			Transverse tensile tests	All weld Tensile test (7)	Guided bend tests (3)	Charpy V-notch tests		Macro/hardness	
						Special and 1st cat. (4)	2nd cat. (5)	Plates	Tubes
Butt welds (tubes and plates)	t ≤ 50 t > 50	Radiography UT + MPI (or LPI)	2 2	1	2 2	4 sets 6 sets	2 sets 2 sets	1 1	2 2
T,Y - Joints (plates)	t ≤ 50 t > 50	UT + MPI (or LPI) UT + MPI (or LPI)	2 **(6)** 2 **(6)**	- -	- -	4 sets 6 sets	2 sets 2 sets	1 1	- -
T, K, Y Tubular joints	t ≤ 50 t > 50	UT + MPI (or LPI) UT + MPI (or LPI)	• Tubular butt weld = same as for butt welds above • Tubular mock-up = as per para. 8.7.6						
Fillet welds	All	MPI (or LPI)	-		-	-	-	2	2

Notes:

(1) UT = Ultrasonic Testing
MPI = Magnetic Particle Inspection
LPI = Liquid Penetrant Inspection

(2) All welds to be also 100% visually inspected and checked for dimensions.

(3) Bend tests consist of one face and one root bend specimens for WT ≤ 12.5 mm and two side bend specimens for WT > 12.5 mm.

(4) In Warm Seas, the set with notch located 5 mm from fusion line is not required (i.e. only three sets for t ≤ 50 mm and five sets for t > 50 mm are required).

(5) For 2nd category members, impact tests are restricted to two sets of specimens located at weld cap: one with the notch centered in weld metal axis and one with the notch centered 2 mm from fusion line (no root Charpy tests are required).

(6) Transverse tensile test shall be sampled in a representative butt weld with similar welding parameters. For thickness and base metal essential variables, only incoming plate is considered.

(7) All weld tensile test shall be performed on welds for covering production with thickness higher than 50 mm and welding of grades S420 and above and for Special Category only. Results shall match the overmatching requirements of § 8.5.1.a of the present specification. Essential parameters for performing this test are limited to the welding consumables brand, type and diameter and the welding energy of filling passes with a tolerance of +/- 25%.

8.7.4 Limitations on qualified welding procedures

A qualified welding procedure shall be used within the limitations of the essential variables set forth in AWS D1.1/D1.1M code and following amendments. Refer also to variables specific to welding of tubular joints stated in para. 8.7.6 of this specification.

The following amendments apply only when S and 1st category are welded.

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Any change from specifications stated herein shall initiate a new procedure qualification test.

a) Personnel and Site

Qualification of a welding procedure shall be restricted to the Contractor and Site where the test weld was produced. However, in special cases, a welding procedure can be extended to other Sites from the Contractor when the said Contractor gives evidence to the satisfaction of the Company that similar equipment and Quality Assurance system are used and that his welding personnel (welders and welding supervisors) is of similar competence and aware of the application of the said welding procedure.

b) Base materials

1 - Material grades with SMYS greater than 355 MPa

Any steel with a minimum specified YS in excess of 355 MPa, i.e. S420, S460 and S500 steel grades as defined by GS EP STR 201 shall require separate welding procedure qualification test on the production material:

- Per delivering mill
- Per as-delivery condition
- Per each steel grade
- Per each steel quality (impact test requirements).

Note: Qualification done with Charpy test performed at a temperature qualifies production with Charpy test requested at a higher temperature.

The validity of such a welding procedure qualification is moreover limited to the further restrictions:

- Carbon, Carbon Equivalent and Pcm of the test material is not less than 0.02%, 0.03% and 0.02% respectively, in comparison with the materials of the order
- Welding consumables are considered as still acceptable in Company's opinion.

2 - Material grades with SMYS less than or equal to 355 MPa

Welding procedure qualification tests is required for steels corresponding to group I as defined by AWS D1.1/D1.1M, or any steels group II as defined by AWS D1.1/D1.1M, with SMYS less or equal to 355 MPa, or any steel combination as defined by AWS D1.1/D1.1M.

The validity of such a welding procedure qualification is limited to materials of the same group or steel group combination as defined above, considering the further restriction:

- Per delivering mill (group II only) for Special Category
- Per as-delivery condition (group II only)
- Per each steel quality (impact test requirements).

Note: Qualification done with Charpy test performed at a temperature qualifies production with Charpy test requested at a higher temperature.

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In addition, any welding procedure qualified as per above, will cover materials of the said group provided that:

- Minimum Specified YS does not exceed the Minimum Specified YS of the qualified material by more than 60 MPa
- Carbon Content, Carbon Equivalent and Pcm of the test material is not less than 0.02%, 0.03% and 0.02% respectively, in comparison with the materials of the order.
- Welding consumables are considered as still acceptable in Company's opinion.

c) Thickness

The thickness ranges of material qualified by a certain welding procedure shall be as per Table 8.2. Thicknesses are indicated in terms of Reference Thicknesses (T) as defined in para. 9.1 of this specification.

Table 8.2 - Range of thickness qualified for complete or partial penetration groove welds and fillet welds made on PLATES and PIPES

• Plate/pipe wall thickness (T) tested (inches)	• Plate/pipe wall thickness qualified, T (inches)
• 1/8" ≤ T < 3/8"	• 1/8" to ½"
• 3/8" ≤ T < 1"	• T/2 to 1.5 T
• 1" ≤ T ≤ 2"	• 0.75" to 2"
• T> 2"	• > 2"

Where the applicability of the WPS is based on fracture mechanics testing (e.g. CTOD) the upper thickness deviation shall not exceed the smaller of +10% and +10 mm in regard to the tested thickness.

d) Diameter

The O.D. ranges for welding procedure qualification of tubulars are as follows:

- 2" ≤ O.D. < 12"
- 12" ≤ O.D. < 24"
- O.D. ≥ 24"

Qualification on plate qualifies also for pipe 24" and over in diameter, and vice versa. Otherwise, qualification on pipe shall not qualify for plate.

e) Joint configuration

Change from butt welds to T-joints and Tubular Joints, and vice versa, shall initiate a new procedure qualification test.

Single-V (single-sided weld) qualifies for double-V (double-sided weld) welds, provided that there is no decrease in groove angle and with the same welding position for both sides.

Any change with respect to back gouging, back pass, temporary or permanent backing.

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f) Groove design/Pass distribution

As per AWS D1.1/D1.1M and the following:

- Any decrease in groove angle, root opening. Any increase in root face
- Capping passes, hot pass(es) and back passes must be distributed as per the agreed WPS
- A particular procedure must be developed and qualified by test for wide gap welds. Maximum thickness of buttering shall be 12 mm (refer to para. 8.3).

g) Welding process/Heat input

Any change from one welding process(es) to another process(es) and any mixing of processes.

A change greater than 25 percent in the heat input of any welding pass from the average value calculated for the procedure qualification test.

Heat inputs for fill passes, cap passes, root pass and hot pass shall be grouped separately in determining the average heat input qualified, and the minimum heat input for the cap pass shall not be less than the lowest heat input pass adjacent to base metal on the procedure qualification.

h) Welding consumables

Any change of specified consumable in trade name, classification, source of origin, size or combination.

i) Welding positions

As per limitations contained in AWS D1.1/D1.1M:2010, Table 4.1, except that groove welds cannot qualify for fillet welds.

j) Welding direction

A change from vertical down to vertical up welding and vice-versa.

k) Orientation of tubular joints

Any change between the following orientations:

- Can fixed vertical, brace fixed inclined
- Can fixed horizontal, brace fixed vertical
- Can fixed horizontal, brace fixed horizontal.

l) Stub to can angle of tubular joints

Stub to can angle is defined as the angle between the centerlines of stub and can.

Stub to can angle of WPQT	Angle range qualified
$\alpha > 45°$	-0°; +90°
$30° \leq \alpha \leq 45°$	-0°; +120°
$\alpha < 30°$	-0°; +130°

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m) Preheating/interpass temperature

Any change outside -0°C, +25°C from that of qualification test.

n) Post Weld Heat Treatment (PWHT)

Change from Post Weld Heat Treatment to non-Post-Weld Heat Treatment and vice versa. Any change outside specified temperature range, soaking time and cooling/heating rates.

8.7.5 Welding procedure qualification for plates and tubulars (except tubular nodes)

a) The essential variables as stated in para. 8.7.4 of this specification shall apply.

b) Type and number of tests are stated in para. 8.7.3 of this specification.

- Butt welds on plates and tubulars

  See sampling of test specimens in Figure 8.1 for plates and in Figure 8.2 for tubulars.

- T or Y groove welds on plates

  See sampling of test specimens in Figure 8.3.

- Fillet Welds

  Fillet welds shall require separate qualification tests (groove welds cannot qualify for fillet welds). One test shall be made with minimum size single-pass fillet weld and another test weld shall be made with the minimum size multiple-pass fillet weld used in construction.

  When Fillet Welds are subject to Welding Procedure Qualification Test (see para. 8.7.1 of this specification), the test weld shall be sampled for macrosection examination and hardness survey as follows:

  1. For plates: sampling at 1/3 and 2/3 of weld length
  2. For tubes: sampling at 12 o'clock and 6 o'clock position.

Testing procedures and standards of acceptance shall be as described in para. 8.7.8 of this specification.

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Welding Procedure Qualification Tests sampling of test specimens

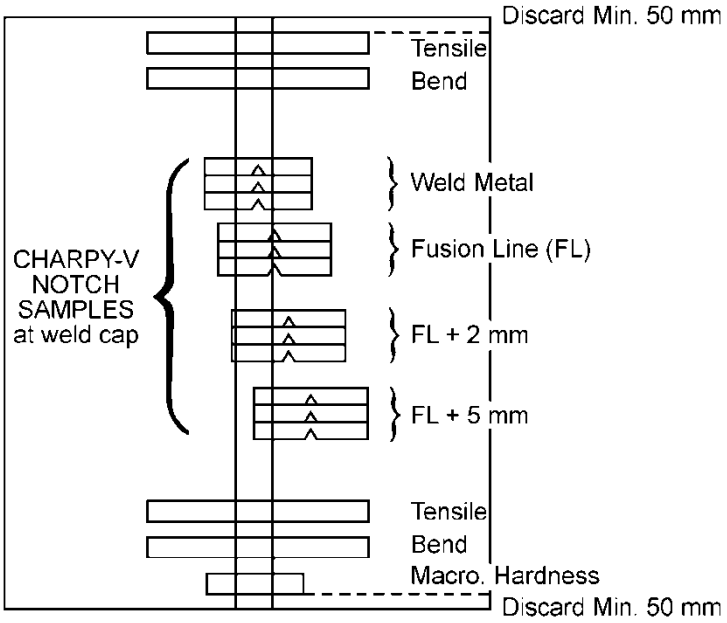

Figure 8.1 - Butt welds of plates in positions 1G, 2G, 3G and 4G

Note: additional all weld tensile test to be performed on some coupons as per Table 8.1

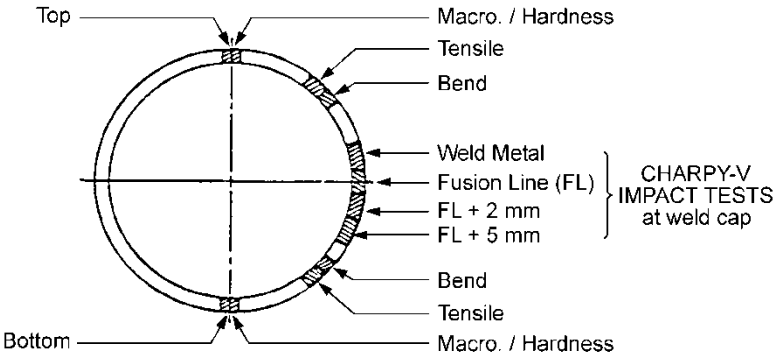

Figure 8.2 - Butt welds of tubes in positions 2G, 5G or 6G

(in 2G position only one macro./hardness specimen is required)

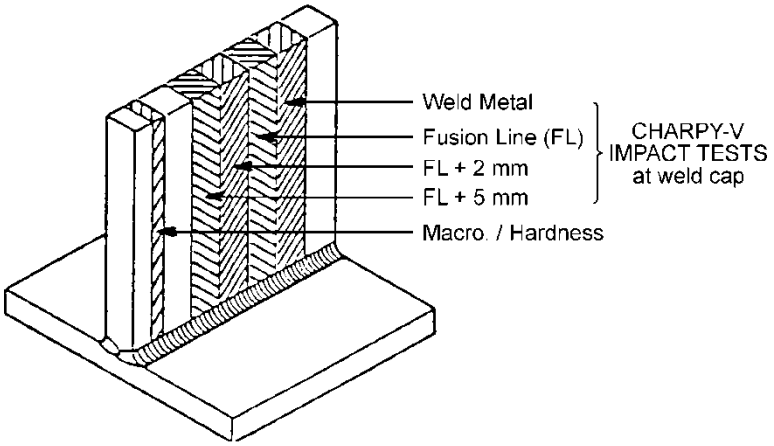

Figure 8.3 - Full penetration groove welds on plates (T-joint or Y-joint)

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Note on Figures 8.1, 8.2 and 8.3:

Charpy-V tests at root are not represented here. Type and number of tests are stated in Table 8.1 and location of Charpy specimens through the thickness in Figures 8.6, 8.7 and 8.8.

8.7.6 Welding procedure qualification for T, K, Y tubular node joints

a) Qualification tests shall be as per AWS D1.1/D1.1M:2010, with the modifications stated hereafter. Qualification tests shall include both a tubular butt weld in 6 GR position with a ½ V bevel design and a tubular mock-up. Limitations on qualified welding procedures shall be as per clause 8.7.4 of present specification, specially regarding brace thickness and diameter ranges, orientation of tubular joints and brace to can angle. Testing of the butt weld shall be made as per para. 8.7.5 for a regular butt weld including impact tests. Testing of the tubular mock-up shall include 100% UT and macrographies as required by AWS D1.1/D1.1M, each being subject to a hardness survey.

b) Brace to can angles less than 30° shall require a separate qualification test at the minimum angle of the work (refer to AWS D1.1/D1.1M:2010, clause 4.12.4.2).

8.7.7 Welding procedure qualification of welding repairs

a) Each proposed welding repair procedure using manual metal arc welding shall be qualified under realistic conditions based on test welds.

b) There shall be repair for defect in base material and repair for defects in weld. For repair in weld, the test weld shall represent a repair of simulated (or actual) defects positioned on weld Fusion Line and oriented longitudinally in the weld.

c) The repair depth shall be considered as essential variable and separate test welds shall be carried out in following cases:

- Repair for shallow defects (i.e. repair depth ≤ 5 mm), e.g. repair of defect at weld toe
- Repair for deep defects (i.e. repair depth > 5 mm)
- Multiple repairs (3 repairs maximum shall be allowed: refer to section 13).

Repair of deep defects may be simulated by filling a cut out portion of a certain depth (to be agreed) or by welding a butt weld with single V preparation, according to prior mutual agreement between the Inspector and the Contractor. The thickness of the butt weld shall be the same as that of the part to be repaired.

d) Repair for shallow defects shall be subject to qualification test only for steels having YS above 295 MPa. The performance of a bead-on-plate test is an acceptable alternate solution in that case. The test weld shall be subject to macrosection and Vickers hardness test according to provisions of para. 8.7.8.4 and 8.7.8.5.

Repair test welds for deep defects shall be subject to requirements and tests set forth for butt welds (see para. 8.7.5).

e) Reference shall also be made to para. 8.3.f regarding weld buttering.

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8.7.8 Testing procedures and standards of acceptance

8.7.8.1 General

The minimum requirements for non-destructive and destructive tests shall be as stated in Table 8.1 of this specification.

Testing procedures and standards of acceptance shall be in accordance with AWS D1.1/D1.1M code, unless otherwise specified in para. 8.7.8.2 through 8.7.8.6 hereafter and in section 10 of this specification.

Ageing of test specimens to eliminate the diffusible hydrogen shall not be permitted.

8.7.8.2 Visual inspection and Non-Destructive Testing

As per section 10 of this specification.

The test specimens shall only be cut after successful completion of the visual inspection and non-destructive tests but not earlier than 48 hours after the completion of the weld.

8.7.8.3 Tensile and bend tests

As per AWS D1.1/D1.1M code. Reference shall also be made to para. 8.5.1 of this specification.

The Tensile Strength (TS) of the welded joint shall be at least equal to the minimum specified TS for the steel grade welded. Where a result is less than the specified value but greater than 95% of it, two retests may be accepted by the Inspector and both tests must achieve a TS in excess of the specified minimum.

8.7.8.4 Macrosections

Each specimen shall be extracted transverse to weld from the completed weld at locations indicated in Figures 8.1, 8.2, 8.3 and 8.4.

The specimen shall be polished and etched for macrographic examination. This examination shall be carried out to ensure good weld profile, reasonable root penetration and freedom from weld defects according to para. 10.2 of this specification.

8.7.8.5 Vickers hardness test

a) On each macrosection as above, a Vickers hardness test shall be conducted across the Weld Metal (WM), Heat Affected Zone (HAZ) and Base Metal (BM), using a 5 kg load. The hardness survey shall be performed along lines parallel to the material surfaces and the Fusion Line of weld, as shown in Figure 8.4.

   Final polishing for hardness measurement shall be performed with 1200 polish paste minimum.

   The maximum acceptable single hardness value shall be 350 HV5 or HV10.

   For welds located in sea water under cathodic protection, maximum acceptable single hardness value shall be 300 HV5 or HV10.

   The value of 300 HV5 or HV10 may be increased to 325 HV5 or HV10 for non critical welds without fatigue or welds with PWHT.

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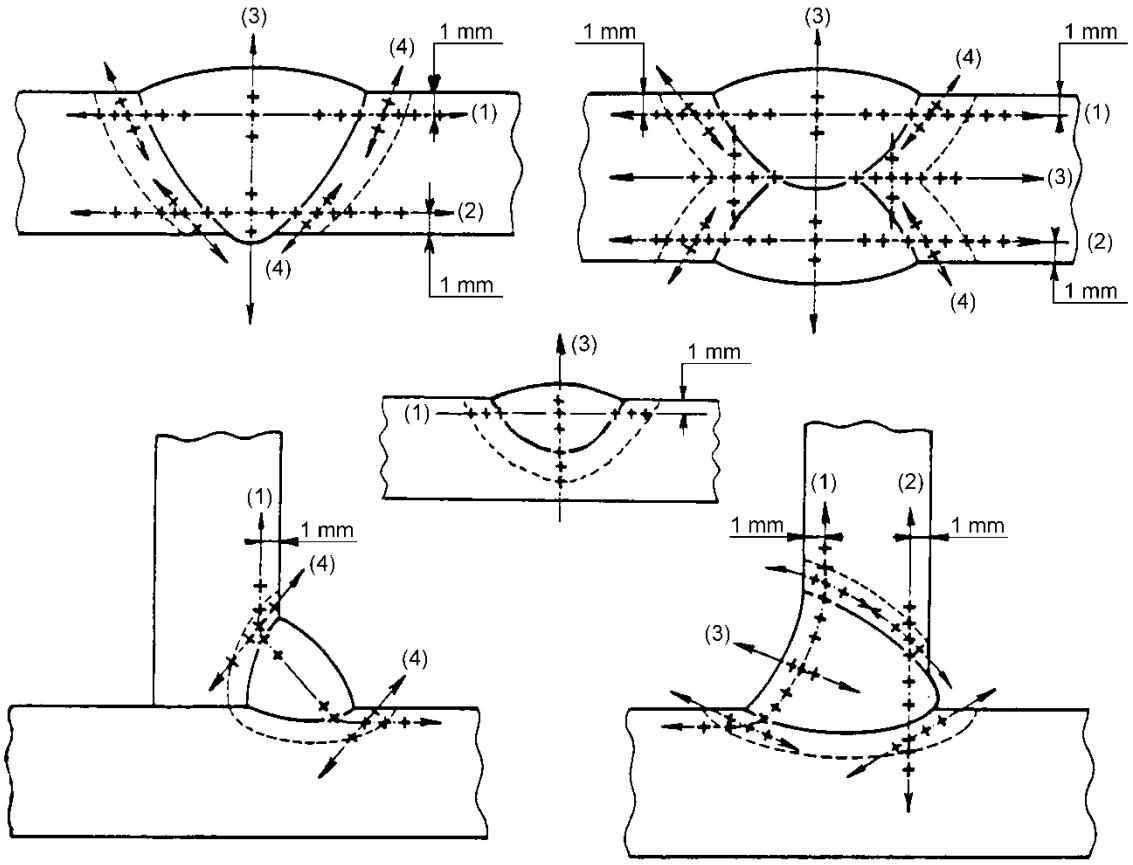
When inacceptable values of hardness are found, one retest after light machining or grinding (max 2 mm) and adequate polishing is accepted.

Figure 8.4 - Vickers Hardness Survey (5 kg load)



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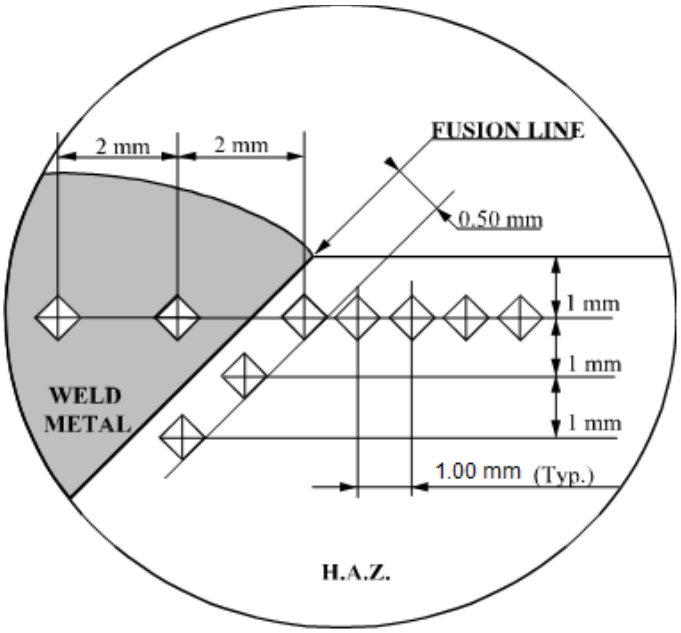
Enlargement (typical)



Notes on figure 8.4:

- Hardness surveys (1) and (2) (WM - HAZ - BM)

  Along straight line starting from 0.5 mm max. from the fusion line towards the BM (with enough indentations to reach constant values) and towards the WM (Weld Metal).

- Hardness survey (3) (WM)

  Minimum of three indentations located at centerline of Weld Metal and across each line (1) and (2) as shown on figure.

- Hardness survey (4) (HAZ)

  Minimum of three indentations along a straight line parallel to the fusion line which passes through the maximum hardness measurements found during the previous two surveys (1) and (2).

Distance between hardness indentations shall be:

- 2.0 mm in Weld Metal
- 0.5 mm in Heat Affected Zone
- 5.0 mm in Base Metal

8.7.8.6 Charpy V-notch impact tests

Impact testing shall be carried out according to ASTM E23 with the notch positioned in the Weld Metal axis, on the Fusion Line (FL), 2 mm from the FL, and 5 mm from the FL when applicable. Each impact test includes one set of three specimens.

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Figures 8.5, 8.6 and 8.7 show the locations of specimens and notch according to type of weld and material thickness.

If two or more welding consumables or welding processes are used for the same joint, impact testing may be required for the related regions of the welded joint.

The tests shall be carried out at the same temperature as that specified for the Base Material of the said Reference Thickness. However, test welds obtained from post-weld heat treated procedures may be impact tested at a temperature 10°C higher than that specified for the Base Material.

For welds between forged or cast components and steel plates, the Charpy test temperature for welding qualification shall be as below:

- HAZ + FL plate side: as that specified for the Base Material (plate) of the said Reference Thickness
- HAZ + FL casting/forging side: as that specified for the casting/forging
- WM: the lowest temperature of both.

For acceptance, the results of energy absorption shall not be less than those required for the Base Material itself (see Specification GS EP STR 201 for Materials) taking into account the principal rolling direction in the actual fabrication. However, for Special Category welds in Warm Seas when 45 mm < W.T. ≤ 65 mm, impact test in as-weld condition can be made at -30°C (instead of -40°C). For welds between dissimilar materials, results of energy absorption shall comply with the requirements specified under para. 8.5.1 of present specification. It is reminded that for crown shims, the Reference Thickness and impact test requirements shall be those of the related platform piles.

If the impact test requirements are not satisfied, the Inspector may allow three further specimens to be tested. The mean value of all six tests shall be at least equal to the specified minimum average value. All three retest specimens shall meet the specified minimum individual value.

As far as possible full size specimens (10 x 10 mm) are to be used. If sub-size test specimens are deemed necessary, absorbed energy figures required shall be those for full size specimens multiplied by the corresponding factors given in Table 8.3.

Table 8.3 - Charpy-V impact test. Sub-size test specimens

Specimen (mm)	Multiplying factor
10 x 10	1
10 x 7.5	5/6
10 x 6.7	7/9
10 x 5	2/3

The Inspector may request to have the impact specimens etched before testing to check that notch location is correct.

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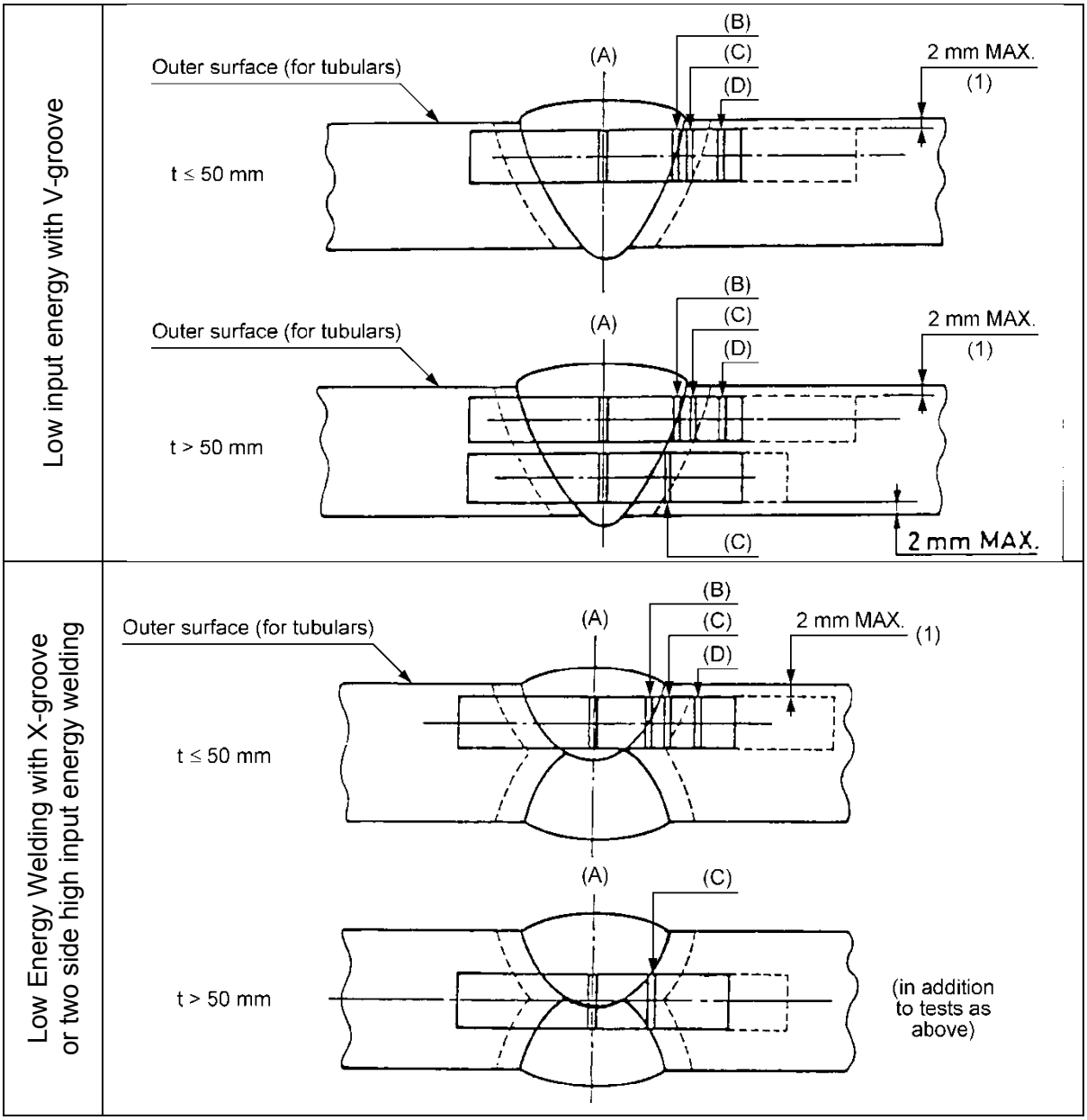
Figure 8.5 - Charpy-V Impact tests. Butt welds (2)



Notch Specimen Location:

(A) Notch at centerline of Weld Metal
(B) Centre of notch located at Fusion Line
(C) Centre of notch located 2 mm from Fusion Line
(D) Centre of notch located 5 mm from Fusion Line

(1) The shortest distance for tubulars

(2) For 2nd category members or members in Warm Sea constructions, test number is reduced as stated in Table 8.1

(3) Impact testing to be made on steeper bevel side of weld (when materials are similar)

(4) For joint between members of different Categories, impact testing is to be made on highest member Category side of weld

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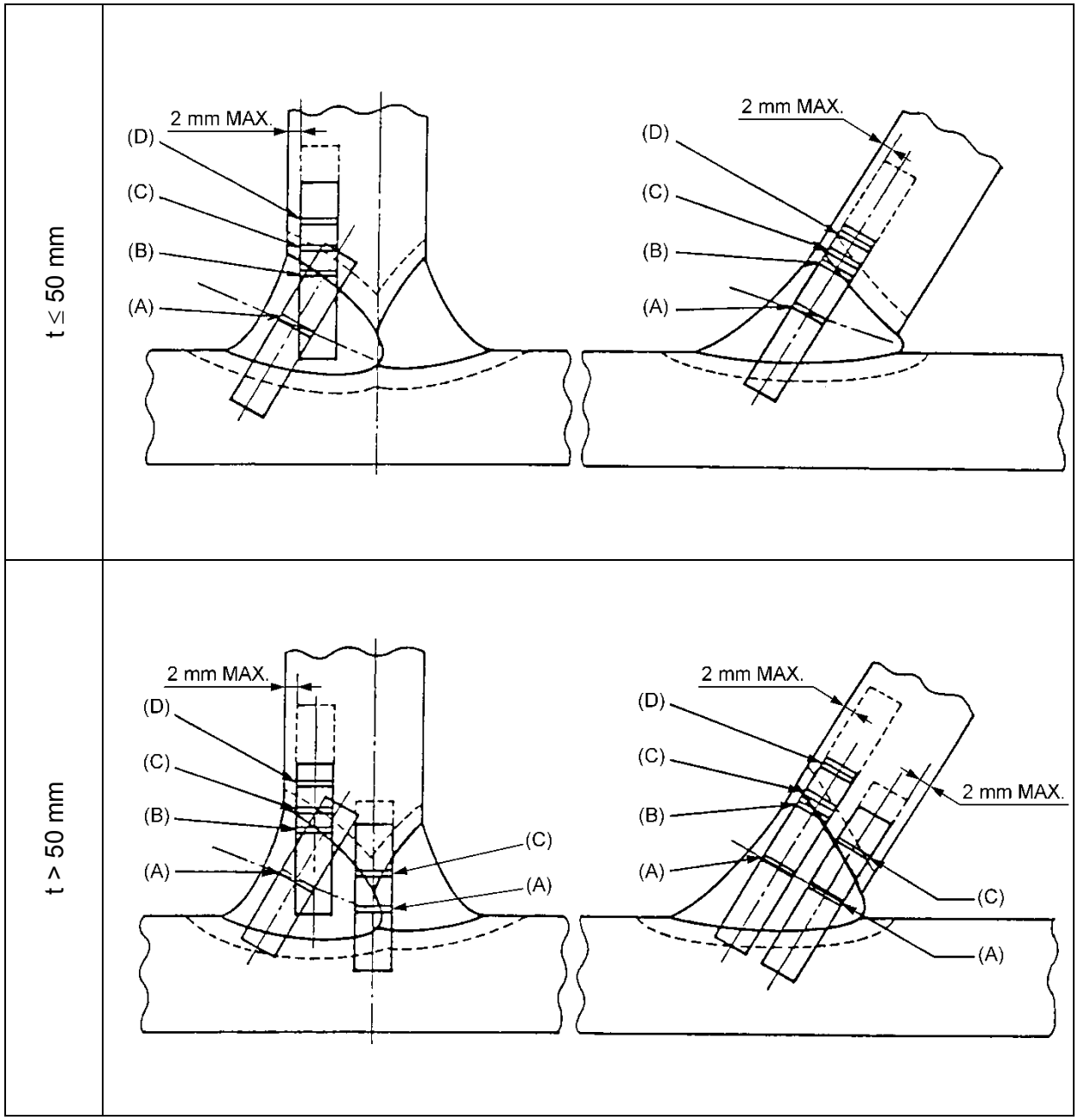
Figure 8.6 - Charpy-V Impact test. T or Y - Plate joints



Notch Specimen Location:

(A) Notch at centerline of Weld Metal

(B) Centre of notch located at Fusion Line

(C) Centre of notch located 2 mm from Fusion Line

(D) Centre of notch located 5 mm from Fusion Line

(1) For 2nd category members or members in Warm Sea constructions, test number is reduced as stated in Table 8.1.

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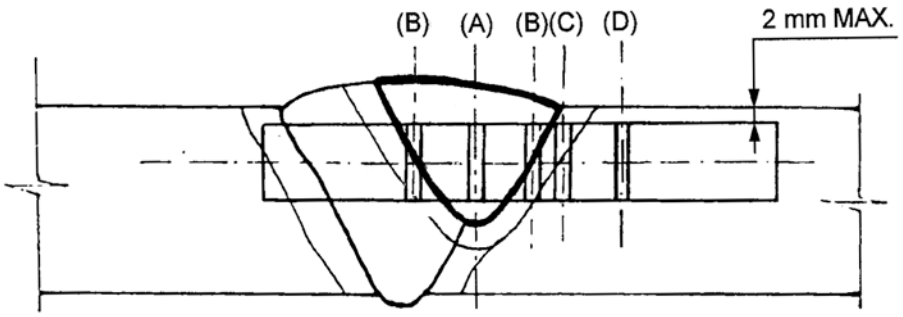
Figure 8.7 - Charpy-V notch impact test

Repair in weld - Typical (1)



Notch specimen location

(A) Notch at centerline of repair weld

(B) Centre of notch located on Fusion Line

(C) Centre of notch located 2 mm from Fusion Line

(D) Centre of notch located 5 mm from Fusion Line

(1) For 2nd category members or members in Warm Sea constructions, test number is reduced as stated in Table 8.1.

8.7.8.7 CTOD Testing

Reference shall be made to section 9 of this specification.

8.7.9 Procedure for qualification re-test

Should any welding procedure qualification test fail, the cause shall be established by Contractor prior to conducting a further test.

Furthermore, should a procedure shows poor production performance, then it shall be properly modified and requalified.

8.7.10 Welding Procedure Qualification Records (WPQR)

A record of each qualified Welding Procedure Qualification Test including the results of all inspections and tests carried out on the corresponding test weld(s) shall be jointly signed by the Contractor and the Inspector who attended the tests.

The record shall include the mill certificate of actual base material used and, particularly, shall show the CE/Pcm and as-delivery condition of steel (e.g. normalized, controlled rolled, etc.).

8.8 Welder and welding operator qualification

8.8.1 General

All welders and welding machine operators engaged on welding shall be qualified by a Company approved third party inspection agency, prior to commencement of the work, in accordance with AWS D1.1/D1.1M code and the following.

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Qualification or re-qualification of welders by tests shall be required at the start of construction or fabrication on each Site, unless otherwise previously agreed with the Company.

All welders working at construction yard shall be qualified in 6 G or 6 GR position, as a minimum.

The Contractor shall ensure that welders and welding operators of any sub-contractor are qualified in accordance with this specification.

Welder qualification tests shall be witnessed by the Inspector. When a qualification test is performed between pipe to pipe without back pass, pipe ends shall be closed during performance of test.

Repairs are permitted during qualification test provided that they are of small extent and infrequent. Numerous repairs shall be considered as sufficient cause for rejection of the welder.

The time spent for performance of the weldment should be comparable to regular production conditions.

Manual welders and welding operators who have successfully carried out a Welding Procedure Qualification Test shall be considered as qualified for the said procedure.

Qualified welders and welding operators shall be subject to additional training and/or requalification test when the quality of their work, during fabrication, appears to be repeatedly defective.

The Inspector reserves the right to disqualify a welder.

8.8.2 Identification of welders

The Contractor shall assign a specific identification symbol or number to each qualified welder. It shall be the duty of each welder to mark each weld on which he works. In the event that a welder leaves the project his symbol or number shall be cancelled, thereby ensuring that it is not re-used for any other welder.

Each qualified welder shall carry a badge with photograph, identification number, work qualification and date qualified.

8.8.3 Welder Qualification for T, K, Y tubular joints

To be as per 6 GR of AWS D1.1/D1.1M. However, the test pipe shall be min. 8” OD and 12.7 mm WT, and the restriction ring shall be min. 12” wide.

Testing to be performed: Visual inspection, full RT and/or side bend tests cut at 3, 6, 9 and 12 o'clock position, at Company’s option.

8.8.4 Visual examination and Non-Destructive Testing

All test welds to be 100% visually examined and 100% inspected by ultrasonics (or radiography, when applicable) before any mechanical specimen is removed.

8.8.5 Mechanical testing

According to AWS D1.1/D1.1M code for all kinds of welds, including fillet welds.

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8.8.6 Testing procedures and standards of acceptance

Preparation of specimens, testing procedures and standards of acceptance shall be as follows:

- Mechanical tests (other than macrographs): as per AWS D1.1/D1.1M code
- Macrographs (when required): as per para. 8.7.8.4 of this specification
- Visual inspection and non-destructive testing: as per section 10 of this specification.

If one of the test joints does not meet the requirements, the welder or welding operator may carry out at Company's discretion two new test joints of the same type as the rejected one. If both these joints meet the specification requirements the test will be considered satisfactory and if not the test will be considered failed. A welder or welding operator so failed shall not be permitted to retest until he has completed a period of retraining of one week minimum.

8.8.7 Welder qualification records

A record of the results of each qualification test weld shall be jointly signed by the contractor and the Inspector. The record shall indicate the symbol or number given to the welder for identification of his work, as stated in para. 8.8.2 of this specification.

8.8.8 List of qualified welding personnel

A list of qualified welders and welding operators shall be established by the Contractor and furnished to the Inspector before the beginning of fabrication. The minimum written information included in this list shall be:

- Contractor (name and address)
- Name of each qualified welder or welding operator
- Photograph
- Date and place of birth
- Symbol used by each welder or welding operator
- Date of qualification
- Type and extent of qualification obtained by each welder or welding operator (position, welding process, etc.).

This list shall be kept up to date by the Contractor and made available to the Inspector.

8.9 Production welding

8.9.1 General

a) The Contractor shall develop the following documents in due time:

- Weld maps
- Welding sequences for main or critical component/construction.

b) Production welding may commence when qualified welding procedures and welders as well as welding repair procedures and inspection procedures have been approved by the Inspector.

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c) Conditions of welding (preparation for welding, types and sizes of electrodes, current amperages and voltages used, preheating requirements, etc.) shall be the same for production welding as those defined in the applicable qualified welding procedures.

d) Adequate precautions shall be taken and suitable equipment shall be available on Site in order to protect the weld areas and welders from adverse weather conditions (rain, wind, snow, etc.) at the time of welding. The shielding of the welding sites shall be approved by the Inspector prior to welding.

e) Welding shall not be done on wet weld areas. Wet weld surfaces shall be thoroughly dried by preheating.

f) Welding shall be stopped when the temperature of base metal is less than -10°C. Between -10°C and +5°C, the base metal shall be preheated to an approved temperature before welding starts.

g) The Contractor shall provide the Company, on a weekly basis, with the defect rate per each welding process used, as well as the subsequent cumulative defect rates for the same.

8.9.2 Welding sequences

The sequences for assembling, joining and welding the various parts of the structures shall be planned in order to minimize distortion, warpage, shrinkage and accumulations of residual joint stresses in each part of the structures (see para. 8.6 of this specification).

Joints expected to have significant shrinkage should usually be welded before joints expected to have lesser shrinkage. They should also be welded with as little restraint as possible.

In making welds under conditions of severe shrinkage/restraint, the welding shall be carried out continuous to completion or to a point that will insure freedom from cracking before the joint is allowed to cool below the minimum specified preheat and interpass temperatures.

The Contractor shall provide and exert all necessary supervision to ensure that the planned sequences are observed.

8.9.3 Preheating and Interpass temperature

Preheating and interpass temperature shall comply with the recommendations defined in AWS D1.1/D1.1M code and the following requirements:

- Preheating shall be carried out by electrical resistance or induction equipment or with gas burners specifically made and shaped for this type of operation. Torches for flame cutting or gouging shall not be used for preheating purposes.
- When the ambient temperature in the immediate vicinity of the weld is below + 5°C the weld area shall be preheated to 20°C minimum and this temperature shall be maintained during tacking and welding (refer also to para. 8.9.1).
- Preheat and interpass temperatures must be sufficient to prevent cracking formation. Preheat temperature above the specified minimum as stated in AWS D1.1/D1.1M code may be required for highly restrained welds. In joints involving combination of base metals, preheat shall be as specified for the higher strength steel and thickest material being welded.

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- The interpass temperature shall not exceed the maximum temperature allowed in para. 8.7.4 and is restricted to 250°C max.
- The specified preheating temperature shall be reached throughout the plate wall thickness over a distance equal to the thickness of the part being welded, but not less than 76 mm (3") in all directions from the weld.
- Preheating when specified shall be applied before tack-welding and shall not exceed the maximum allowed by para. 8.7.4. If the interpass temperature falls below the required preheat temperature at any time during production, then welding must be halted until the correct preheat has been re-established.
- The temperature measurement for preheating and interpass temperature may be by thermocouples, temperature indicating crayons or contact pyrometers or a combination of these methods as may be appropriate for the type of joint being heated and method of heating.

8.9.4 Tack welds

All tack welds shall be carried out in the same conditions as the root pass of the applicable qualified welding procedure and shall be performed by qualified welders. Tack welds shall be of sufficient cross-section and length to avoid cracks, especially on High and Extra High Strength Steels materials (i.e. minimum specified YS above 295 MPa).

Tack welds shall be of a minimum length of:

- Three times the plate thickness or 40 mm, whichever is the lesser, for steels with YS up to 295 MPa
- Four times the plate thickness or 75 mm, whichever is the lesser, for steels with YS above 295 MPa.

Tack welds which form part of the complete weld shall be ground to a feather edge and completely fused with the root run.

Cracked tack welds shall be completely removed and shall not be incorporated into the finished weld.

8.9.5 Temporary welds

Temporary welds shall be minimized.

When temporary welding is deemed necessary, welding shall be carried out according to the same procedures that govern the permanent structural part in question (i.e. same care, consumables, preheating, etc., as required for the structural part).

The temporary welds shall subsequently be removed and ground flush with the base material. On High and Extra High Strength Steels (i.e. specified YS above 295 MPa) the grindings shall then be inspected by MPI or LPI.

Reference shall be made to para. 7.14 of this specification.

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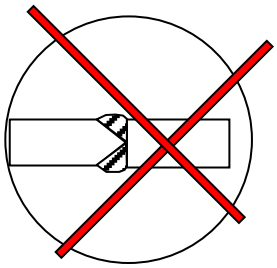
8.9.6 Welded connections

a) All welds shall conform to Appendix 2 of the present specification. All butt welds shall be double sided welds, unless specifically approved by Company on Approved For Construction (AFC) drawings. In case of back pass, the root weld shall be ground or gouged and ground to sound metal before welding on that side. This shall also be mandatory for circular welds in tubulars with O.D. ≥ 26".

For welds inspected by UT, bevels shall be chosen with the following angle with regards to the UT scanning surface: 20°, 30°, 45°.

It is reminded that the following detail is forbidden for Special and First Category:



b) All welds including fillet welds shall be continuous, unless otherwise specifically agreed with the Company.

c) Minimum size of fillet welds shall be as per Table 8.4, always providing that the minimum throat (a = 0.7 L) is met.

Table 8.4 - Minimum size of fillet welds

Material thickness of thicker part joined (mm)	Mini leg size of fillet weld (L) (mm) (2)	Mini thickness/throat of fillet weld (a) (mm)
t ≤ 12	5 (1)	3.5 (1)
12 < t ≤ 20	6	4.2
t > 20	8	5.7
(1) Minimum leg size shall be 6 mm (4.2 mm throat) for cyclically loaded structures, and Special and First Category members. (2) This leg size applies provided that the stated mini. weld throat "a" is met.		

d) All fillet welds made with stick electrodes shall include two passes minimum on Special and First Category members.

e) Use of temporary or permanent backing strip or inserts shall not be permitted, unless specifically agreed with the Company and, subsequently, properly qualified by test.

f) Welding may be interrupted after deposit reaches 1/3 thickness of the weld. When welding is interrupted before deposit reaches 1/3 of the weld thickness, preheating may be waived provided the welding procedure has been so qualified.

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If interruption of welding occurs after the preheated joint is half filled, the preheat may be removed provided that slow controlled cooling of the weld area is insured.

Whatever the joint type (preheated or not), before continuation of welding, the weld is to be inspected, visually for cracks and, if required by the Inspector, tested by Magnetic Particle Testing.

g) No chipping or grinding of the weld reinforcement shall be permitted, except when deemed necessary by the Inspector or indicated on approved drawings.

h) No welding shall be carried out on base material which has been cold formed to a permanent deformation exceeding the values stated in Table 6.2 of this specification, unless stress relieving is planned or strain ageing tests have shown that acceptable impact results are obtained on base material (see strain ageing test procedure in para. 6.4.2 of this specification).

i) Reference shall be made to para. 8.3 and 8.7.4 regarding wide gap procedures.

8.9.7 Seal welds

Unless otherwise specified, all faying surfaces shall be sealed against corrosion by continuous fillet welds having a minimum size as per Table 8.4 of this specification.

Seal welds shall be subject to Welding Procedure Qualification tests according to the same requirements as those for fillet welds.

8.9.8 Cleaning

Upon completion of each welding pass, the weld shall be cleaned of spatters, slag and flux deposits.

When the welded joint is completed, the adjoining welded surfaces shall be thoroughly cleaned of all spatters and deposits.

8.9.9 Arc strikes

No arc strikes shall be permitted outside the groove area. Hard spots resulting from accidental stray arcing shall be removed by grinding. On High Strength Steels (i.e. specified YS above 295 MPa), the ground areas shall then be inspected by MPI or LPI.

9. Fracture Mechanics Analysis and Post-Weld Heat Treatment (PWHT)

9.1 Reference Thickness

In the present section the thickness requirements are relating to a **Reference Thickness** defined as follows.

In a butt connection the Reference Thickness is the thickness of the steel plate. For butt welds at blended transitions between plates or tubulars of different thicknesses the Reference Thickness is that of the thinner part. For welds not of straight butt configuration (e.g. stub to can welds or ring stiffener to can welds) the thickness of the abutting members (e.g. stub thickness or ring stiffener thickness) shall be the Reference Thickness. In the particular case of weld between crown shims and jacket piles, the Reference Thickness shall be that of the jacket piles.

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9.2 Fracture mechanics analysis (ECA)

1. Fracture mechanics analysis (fitness-for-purpose evaluation) shall be required for Reference Thickness exceeding:
   - 60 mm for Special Category
   - 80 mm for First Category
   - For critical structure with low redundancy (such as tendon for riser towers and TLP…)
   - Structures calculated against fatigue using less stringent SN curves (with regards to the welding detail) than the recommended SN curves in the Design Code.

   The NDT techniques and acceptance criteria shall be supported by this ECA. Whatever is the result of acceptable initial defects in the ECA, minimum workmanship for NDT techniques and acceptance criteria as defined in this specification shall not been downgraded.
2. For service T°C > 15°C, the thickness limit of 60 mm stated above for Special Category may be extended to 70 mm provided that the welds are properly profiled as indicated below:
   - For butt welds: the weld reinforcement is ground as appropriate to improve the weld surface and realize a good merging of weld metal into base metal. No undercut shall be permitted
   - For T, K, Y welds and tubular node welds: the weld is given a concave smooth profile by full grinding as per para. 8.4 of AWS D1.1/D1.1M:2010. No undercuts shall be permitted.
3. Fracture Mechanics shall be performed according BS 7910 level 2A. A scope of ECA shall be preliminarily submitted to Company for acceptance, with description of load histograms - taking into account pre-service - and associated stress analysis, assessed flaws (size, type and location), toughness evaluation, steel mechanical characteristics, factors of safety with regards to covariance of evaluation of parameters… As a minimum, the factor of safety on fatigue life calculated with ECA shall be half of the requested factor of safety on fatigue life calculated with S-N curves approach but not less than 2.

   Fatigue Crack Growth Rate (FCGR) shall be as per BS 7910: mean + 2SD in the relevant environment.

   The following table specifies the FCGR values that shall be considered in Engineering Critical Assessments (ECA):

Environment	FCGR
Air	BS 7910 in air, Mean + 2SD.
Sea water + CP	BS 7910 in air, Mean + 2SD with a multiplying factor of 9.

4. For calculation, residual stresses shall be equal to the yield strength of base metal when no PWHT is performed. Residual stresses shall be decreased to 20% of yield strength of base metal when a PWHT according para. 9.3 of the present specification is performed. In case of use of alternate stress relief procedure (Ultrasonic stress relief or equivalent), residual stress decrease shall not be taken into account for ECA.
5. Toughness measurement tests (CTOD or similar) shall be conducted according BS 7448. Toughness measurement tests shall be carried out in experienced laboratories approved by

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Company. Sampling of toughness measurement tests shall be representative of the area and stress condition evaluated and submitted to Company for acceptance.

9.3 PWHT procedure specification

PWHT may be used in an attempt to improve the results of fracture mechanics analysis or the fatigue resistance. PWHT shall be carried out when required by design or when the Reference Thickness exceeds 90 mm (3.5") for Special Category.

PWHT is not required on welds between crown shims and jacket legs and on welds made offshore between piles add-ons or between deck legs and piles.

No Post-Weld Heat Treatment will be performed unless a test has proven that tensile and impact properties of base material and weld remain still acceptable after such a PWHT.

The Contractor shall submit to Company for prior approval a Procedure Specification detailing heating and cooling rates, soaking temperature range and time, heating equipment or facilities, insulation, control devices and recording equipment.

9.4 Performance of PWHT

PWHT when required shall be carried out by local heating or furnace heating according to AWS D1.1/D1.1M code and the following requirements, unless recommended procedure and temperatures furnished by manufacturer of the material are different.

PWHT shall be performed at soaking temperature not exceeding the values hereafter for a time of two minutes per mm thickness up to 76.2 mm (3") and 2 hrs 30 minutes plus 1 minute for each additional mm over 76.2 mm (3"):

- 580°C ± 15°C for controlled rolled steels
- 580°C ± 15°C or tempering temperature minus 30°C (the lowest temperature) for quenched and tempered steels
- 600°C ± 15°C for normalized steels and other C-steels.

When local PWHT is carried out, the specified temperature shall be maintained over a region extending minimum three times the material thickness on either side of the weld.

When PWHT is carried out in a furnace, the furnace atmosphere shall be controlled so as to avoid excessive oxidation of the surface of the fabrication. There shall be no direct impingement of the flame on the fabrication.

9.5 PWHT treatment records

The heat treatment cycle shall be recorded using thermocouples in effective contact with the fabrication and equally spaced over the heated area, both inside and outside the fabrication. PWHT charts shall be properly marked and scales clearly identified. Charts shall be submitted to the approval of the Inspector.

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10. Welding inspection

10.1 General

a) All welds shall be inspected and judged for acceptability in accordance with AWS D1.1/D1.1M code, unless otherwise stated in this specification.

b) Each NDT procedure shall be detailed by the Contractor and submitted for approval to the Inspector prior to use.

c) Inspection operators shall be certified CSWIP/PCN/ISO 9712, level 2 minimum. In addition, for T-K-Y UT inspection, NDT operators shall have specific qualifications in accordance AWS D1.1/D1.1M:2010 para. 6.27.2. The verification of performance of the operator shall be witnessed by TPI approved by Company.

d) Inspection personnel and equipment shall be subject to prior approval of the Inspector. The Inspector reserves the right to reject or retest all NDT personnel at any time.

e) Final Non-Destructive Tests (NDT) shall not be carried out sooner than 48 hours after completion of welding for steels with MSYS above 295 MPa and thickness above 25 mm.

The final NDT tests may be performed sooner than 48 hours after completion of welding if all the following conditions are fully applied, to the satisfaction of Company representative on SITE: extra low hydrogen consumables are used and proper procedures for consumables (procurement, storage, handling, baking, flux dryness as per Appendix 1, etc.) and drying of joint before welding are implemented to ensure that diffusible hydrogen is less than 5 ml/100 g at the welding stage. If the above requirements are not achieved to the satisfaction of Company representative, no derogation shall be accepted.

f) Final inspection of welds subject to PWHT shall be made after this treatment is performed. Previous inspection (made before PWHT) is recommended in order to avoid duplication of the heat treatment on materials where repair welding is necessary.

g) As a general rule, weld connecting members of different Categories of importance shall be subject to the inspection requirements of the most stringent Category in question (see the classification of structural members into categories in Specification GS EP STR 201). This requirement is applicable to all Categories including NS. Exception is done for topside of fixed or floating structures for connections between 2nd Category members to 1st or S category members not submitted to fatigue, for which secondary requirement for NDT extent shall and acceptance criteria shall apply.

h) All joints shall be 100% visually accepted (and duly documented) prior to proceed to additional NDT described in para. 10.3 hereafter.

i) The standards of acceptance stated in para. 10.2 hereafter shall be used for the visual and Non-Destructive Testing of Welding Procedure Qualification test welds, Welder Qualification test welds and production welds.

Standards of acceptance of welds in Non-Structural steels shall be as per standards of good practice.

The Inspector shall be the sole judge for the acceptance of welds and his decision shall be final.

j) The Contractor shall develop NDT maps in due time.

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k) At any time, Company may re-inspect welds already considered as acceptable by the Contractor. Contractor shall give free access to Company for this cross-check.

10.2 Non-Destructive Testing procedures and standards of acceptance

10.2.1 Visual Inspection

Standards of acceptance shall be as per Table 10.1 of this specification.

10.2.2 Radiographic Testing (RT)

Radiographic Testing of welds shall be carried out in accordance with AWS D1.1/D1.1M using either X-rays or gamma-rays.

The Company reserves the right to require qualification test of radiographic examination procedure to ensure that it meets the requirements of this specification.

Film systems shall conform to EN 584-1 class C4 for X-Rays and class C3 for gamma-Rays.

Double films technique is acceptable for gamma-Rays to decrease operators' exposure to radiations.

Film size shall generally be 100 x 400 mm. Smaller width films for welds without intersections may be used provided 15 mm of base metal appear on each side of weld on the radiograph.

Only lead screens are acceptable.

Radiographic techniques shall comply with EN 1435 Class A.

Image Quality Indicators (IQI) according EN 462-1 shall be used, placed transversally to the weld on the source side, for each exposure.

The image density corresponding to the sound weld metal shall not be less than 2.2 and not greater than 3.5, unless adequate viewing and satisfactory interpretation of higher density film are permitted by the viewing equipment.

Viewing conditions and facilities shall conform to ISO 5580 and shall be such that film densities up to 4.0 can be viewed and interpreted. A densitometer (with valid calibration) shall be available on Site at all times.

Final interpretation shall be carried out on dry film.

The geometrical unsharpness shall not exceed 0.25 mm.

Films shall be carefully identified. The markings shall not be placed on the weld and shall include weld number, member identification, welder's symbol and date of inspection.

Acceptance criteria shall be as per Table 10.1 of this specification.

Radioscopy or computed radiography (phosphoscreens or equivalent) could be carried out as a substitution of silvery radiography provided that:

- Basic images (without any treatment) are stored in locked files accessible to Company
- The global NDT system is satisfactory audited by Company (including witnessed comparative tests, data storage process, skills of NDT operators…).

See GS EP STR 201, Appendix 2 for substitution requirements.

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10.2.3 Ultrasonic Testing (UT)

UT shall be carried out in accordance with AWS D1.1/D1.1M/Class R for all kinds of joints. For T, K, Y joints and tubular joints with full penetration welds (refer to para. 7.10 of this specification), the “back up weld” at the root shall also be part of the testing. However, this back up weld shall be evaluated as per AWS D1.1/D1.1M/Class X.

For K or ½ V bevels, tandem technique is mandatory for special category (procedure to be submitted to Company for approval).

The UT equipment shall have been calibrated since less than six months by an independent laboratory. The calibration certificate shall be made available to the Inspector.

10.2.4 Magnetic Particle Inspection (MPI)

Procedure to be as per ASTM E709 or Article 7 of ASME/BPVC SEC V.

Acceptance criteria shall be as per Table 10.1 of this specification.

10.2.5 Liquid Penetrant Inspection (LPI)

Procedure to be as per ASTM E165 or Article 6 of ASME/BPVC SEC V.

Acceptance criteria shall be as per Table 10.1 of this specification.

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Table 10.1 - Standards of acceptance for weld defects in Structural Steels

a) Internal defects (Radiographic Testing)

	Member Category		
Type of defect	**Special Category**	**First Category**	**Second Category**
Cracks	Not acceptable	Not acceptable	Not acceptable
Lack of fusion or Incomplete penetration	- Length $\leq \frac{t}{3}$, max. 12 mm	- Length $\leq \frac{2t}{3}$, max. 25 mm	- Length $\leq$ 1.5 t, max. 50 mm
Slag inclusions	- Length $\leq \frac{2t}{3}$, max. 50 mm - Width $\leq \frac{t}{6}$, max. 4 mm	- Length $\leq$ 1.5 t, max. 75 mm - Width $\leq \frac{t}{4}$, max. 5 mm	- Length $\leq$ 3 t, max. 100 mm - Width $\leq \frac{t}{3}$, max. 6 mm
Porosities: • Isolated: max. pore diameter • Cluster: max. pore diameter • Scattered: max. accumulated pore diameters in any 10 x150 mm area of weld	t/5, max. 3.5 mm 2 mm 10 mm	t/4, max. 3.5 mm 2 mm 15 mm	t/3, max. 4.0 mm 3 mm 20 mm

b) Surface defects (Visual Inspection, MPI)

	Member Category		
Type of defect	**Special Category**	**First Category**	**Second Category**
Cracks	Not acceptable	Not acceptable	Not acceptable
Undercuts	- Static loads = Depth $\leq$ 0.4 mm Length $\leq$ 25 mm - Cyclic loads = Not acceptable	- Static loads = Depth $\leq$ 0.8 mm Length $\leq$ 25 mm - Cyclic loads = Not acceptable	Depth $\leq$ 0.8 mm Length $\leq$ 50 mm
Lack of fusion or Incomplete penetration	Not acceptable	Not acceptable	Length $\leq$ t/2, max. 10 mm
Porosities	Not acceptable	Size $\leq$ t/4, max. 3.5 mm	Size $\leq$ t/3, max. 4.0 mm

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c) Surface defects (LPI)

	Member Category		
Type of indication	**Special Category**	**First Category**	**Second Category**
Cracks	Not acceptable	Not acceptable	Not acceptable
Linear indications (7) (8) L= length of indication	- Static loads: L < 2mm - Cyclic loads: Not acceptable	- Static loads = L < 4mm - Cyclic loads: Not acceptable	L < 12mm
Non-linear indications (8) D=major axis dimension	D < 4mm	D < 6mm	D < 8mm

Notes on Table 10.1:

(1) Any form of crack or suspected crack shall be considered unacceptable regardless of its size or location.

Occurrence of cracks will initiate more extensive NDT and revision of the welding procedure.

(2) If separate elongated defects are situated on line and the distance between them is less than the length of the longest indication, the defects are to be evaluated as one continuous defect.

(3) Summation of imperfections: any accumulation of lack of fusion, incomplete penetration, undercuts and slag inclusions shall not exceed 50 mm in Special and 1st Category member and 100 mm in 2nd Category member in any 300 mm of continuous weld.

(4) Lack of fusion, incomplete penetration and undercut are not acceptable in welds of pad eyes or components subject to concentrated lifting loads (e.g. hooking parts of lifting devices and accessories).

(5) No defects are permitted at tee weld junctions (i.e. weld crossings).

(6) “t” is the nominal thickness of weld or the material Reference Thickness, whichever the lesser.

(7) For LPI, an indication shall be considered as linear if its length is three time greater than its width

(8) Any adjacent LPI indications separated by less than the major dimension of the smaller shall be assessed as a single, continuous indication

10.3 Extent of Non-Destructive Testing

Welds shall be inspected non-destructively to the extent indicated in Table 10.2 for Structural and Non-Structural welds and Table 10.3 for welds of sea-fastening. Inspection of prefabricated welded tubulars shall be as stated in para. 7.5.5.1 of this specification.

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Unless otherwise agreed upon by the Company and the Contractor, the percentages of weld inspections shall be understood as follows:

- For welds above 2 metre long, the percentages of welds to be inspected shall mean the thorough inspection of the stated percentage of all welded connections of a given type i.e. a 20% check means inspection of 20% of the length of each welded connection in the category concerned and **not** 100% inspection of 20% of the connections
- On the contrary, for welds not exceeding two metres in length, 100% inspection is normally to be carried out on the stated percentage of the connections of the given type.

If partial checking of welds reveals that a particular weld appears defective, the entire weld shall be examined and the partial checking of all other welds made by the same welder or procedure or consumable batch since the last partial check will be extended as a minimum as specified below for a complete evaluation of the extent of defective weld.

Original specified inspection extent	Retest Special Category	Retest 1st Category	Retest 2nd Category
Spot	100%	20%	10%
5%	100%	20%	10%
10%	100%	50%	20%
20%	100%	100%	50%

If any of these welds are defective then the retesting is extended to 100% whatever the member category. Consequently, the level of inspection of the future welds of this type may be increased at the discretion of the Inspector, until satisfactory results are obtained.

As a general rule, initial inspection should be 100% until a satisfactory level of quality has been verified.

Non-Destructive Testing (NDT) shall be carried out especially on intersection of butt welds, cruciform joints, as well as on start and stop points of automatically welded seams.

Areas which have been strained in the through thickness direction by welding will be ultrasonically tested for lamellar tearing.

The Inspector shall have the right to select the welds or part of the welds to be inspected.

If difficulty is experienced in categorizing defects revealed by ultrasonic testing, radiography shall also be used to facilitate interpretation, or vice versa. At the discretion of the Inspector supplementary radiography, or substitution of radiography in lieu of ultrasonic testing, shall be used to confirm the ability of ultrasonic testing to detect and evaluate correctly defects such as root concavity and linear porosity and other root defects in single sided groove welds.

When either radiography or ultrasonic testing are used as a check or a substitution for the other technique, the acceptance criteria applied shall be as defined for the actual technique used, unless the Inspector requires otherwise.

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Table 10.2 - Minimum extent of Non-Destructive Testing (NDT)

Steel type and member classification (1)	Type of connection	Visual inspection	Radiography (7)	Ultrasonics (7)	Magnetic particle (3)
Structural Special Category	Butt welds (12)	100%	100%	100%	100%
	T, K, Y joints Tubular joints		-	100%(2)	100%
	Fillet welds		-	-	100%
Structural First Category	Butt welds (12)	100%	10% 100% (8)(4)(13)	10% 100% (8)(4)(13)	20% 100% (4)(13)
	T, K, Y joints Tubular joints		-	20% (2)(4)	20% 100% (4)
	Fillet welds		-	-	20% 100% (4)(13)
Structural Second Category	Butt welds (12)	100%	Spot (6)	Spot (6)	5% (5)
	T, K, Y joints Tubular joints		-	Spot (6)(2)	5% (5)
	Fillet welds		-	-	5% (5)
Non-Structural	All welds	100%	(10)	(10)	(11)

Notes on Table 10.2:

(1) Classification of structural members is clarified in para. 5.1 of this specification.

(2) Applies to all welds other than Butt Welds (such as T, K, Y joints and tubular joints) having full penetration. In the case of partial penetration welds, it applies only if specified weld metal thickness (i.e. weld throat) exceeds 9.5 mm.

(3) Magnetic Particle Inspection may be replaced by Liquid Penetrant Inspection with prior approval of Inspector.

(4) For Lifting/Pulling/Dynamic equipments with members in First Category, all full penetration welds shall be 100% inspected by UT or RT techniques and MPI, all fillet welds shall be 100% inspected by MPI. Inspection procedures and acceptance criteria shall comply with the Special Category ones.

(5) Applies to welds subject to dynamic and/or cyclic load e.g. fatigue stresses or welds performed on high and extra high strength steels (i.e. YS > 295 MPa).

(6) “Spot” means 0 to 5% of UT or RT inspection (depending on wt) at the Inspector’s discretion.

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(7) RT is limited to WT less than 25mm. UT can be used in lieu of RT when nominal WT exceed 20 mm in Special Category, 15 mm in First Category and 10 mm in Second Category.

(8) 100% extent for UT or RT inspection (depending on WT) of:

Butt welds in flanges of beams and columns

Circular welds of tubulars.

(9) Deleted

(10) Extent of UT or RT (when necessary) to be limited at special areas or where weld looks visually questionable or poor.

(11) MPI to 100% extent only when welding on high carbon steels (C > 0.25%) steels and alloy steels liable to quenching and cold cracking under welding operation (for example welding on bearing plates). Purpose of inspection is mainly to ensure freedom of cracks, excessive undercuts or other injurious notch defects.

(12) Extent of NDT on butt welds of prefabricated tubulars shall be as indicated in para. 7.5.5 of this specification.

(13) For stressed skin structures (walls and floors) and blast/fire walls as defined in table 4.1 (Note 6) of the GS EP STR 201:

- 100% MPI required for the peripheral welds between the plates and the main structure and openings
- 5% MPI elsewhere as per requirement of 2nd category structure
- In addition spot RT (up to 5%) shall be performed at butt welds crossing areas
- Potential extension of RT shall be according 2nd category structure.

Table 10.3 - Minimum extent of inspection of sea-fastening

			Piles	Jacket	Decks
Sea-fastening fabrication	Butt welds on tubulars	Circular Welds	N.A. (4)	100% U.T. +100% MPI	100% U.T. +100% MPI
		Longitudinal Welds		20% U.T. +20% MPI	20% U.T. +20% MPI
	Other welds within sea-fastening	Full Penetration Welds (3)	20% U.T. +20% MPI	100% U.T. +100% MPI	100% U.T. +100% MPI
		Partial Penetration and Fillet Welds	20% MPI	20% MPI	20% MPI
Sea-fastening attachments	Attachment welds to main structures (piles, jacket, deck)	Full Penetration Welds	N.A. (6)	N.A. (6)	N.A. (6)
		Fillet Welds (5)	100% MPI	100% MPI	100% MPI
	Attachment welds to barge deck	Fillet Welds (5)	100% MPI	100%MPI	100%MPI

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Notes on table 10.3:

(1) All welds shall be subject to 100% visual inspection in addition to above N.D.T.

(2) Butt welds:

- RT for W.T. ≤ 12.7 mm
- RT or U.T. for 12.7 mm < WT ≤ 40 mm
- U.T. for WT ≥ 40 mm.

(3) i.e. Butt welds and Tee-Butt welds.

(4) Assuming that no tubulars are used. Otherwise, same as for jacket and platform deck.

(5) These welds are fillet welds between doubler plates and main structure or deck plates.

(6) Full penetration welds made directly onto the main structure are normally forbidden. Doubler plates are to be used. Otherwise, all full penetration welds will be subject to 100% U.T. +100% MPI.

10.4 Inspection reports

A report of the testing technique and results of each weld inspection shall be made by the Contractor.

The report shall indicate whether the weld meets the standards of acceptance of para. 10.2 of this specification and the number of repairs made to meet these requirements.

Reports of all inspections shall be made available to the Inspector not more than 24 hours following completion of the inspection.

These documents shall be jointly signed by the Contractor and the Inspector.

The Company shall be provided with those finalized reports when the work is completed.

10.5 Weld History Summary

The Contractor shall keep up-to date a so-called Weld History Summary that shall record the progress of welding and weld inspection. This document shall include but not be limited to:

- Identification of each weld and relevant structural member
- Welding procedure used
- Symbol of welder involved in each weld
- Date each weld was made
- Welding inspection results, date of inspection and inspection report n°
- Welds repaired, defects noted and date of repairs.

The Contractor shall furnish this document to Company, upon completion of fabrication, together with test reports as above.

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11. Leak testing

All watertight compartments, with the exception of brace members, shall be subjected to a test for leakage, when required in the PPS. The Contractor shall submit a leak testing procedure to Company approval.

All elements shall be pneumatically tested to a minimum pressure of 0.5 bar for six hours.

The elements to be tested shall be all leg sections, either complete, or where internal watertight diaphragms are present, between such diaphragms, the floatation tanks and buoyancy tubes.

The pneumatic test procedure must include the following:

- The air pressure shall be held without further addition of air or loss of pressure for six hours minimum, making due allowance for temperature changes. Pressure adjusted for temperature variation at the end of the test period shall not vary more than 10% of the test pressure
- The Contractor shall examine all penetrants in pneumatically tested compartments and bracing members for tightness using a soap solution. Examination of welds and splices may also be necessary. A Halogen test may also be used
- Pressure and internal and ambient temperatures shall be automatically recorded on permanent charts during the tests. The recorder shall have a 12” circular chart with 12-hour rotation. The range of the recorder shall be not greater than 2.5 times the test pressure. A manometer shall also be connected to the compartment under test. Pressure instruments shall be connected to allow testing of the manometer while the test is in progress.

Should any leaks in the water tight compartments be found, these shall be repaired and the compartment retested as above.

12. Tank hydrostatic testing

Tanks shall be tested for strength, integrity, and leakage, when required in the PPS. The Contractor shall submit an hydrostatic testing procedure to Company approval.

Tanks shall be hydrostatically tested to a pressure of 1.25 x design pressure for one hour. This pressure is to be measured by a gauge located at the highest point of the individual tank being tested.

The testing medium shall have a minimum temperature of 5°C unless agreed in writing by the Company. An antifreeze solution of methanol or inhibited glycol may be added to the test medium with the approval of the Company.

The hydrostatic test procedure shall comply with the following:

- Prior to testing the tank shall be 100% complete and all debris removed
- The tank shall then be filled to 100% capacity with the test medium and left until temperature of structural steel and test medium are within ± 3°C of each other
- Upon completion of above, the tank shall be pressurized to the required test pressure and held for a minimum of one hour without loss of pressure

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- After completion of tests, the tank shall be drained and all equipment removed. No further work on that particular tank shall be permitted after testing unless approved by the Inspector.

Should any leaks in the tank be found, these shall be repaired and the tank retested as above.

13. Welding repairs

Injurious defects shall be removed by grinding or machining and, when necessary, repaired by welding carried out by qualified welders and using a previously qualified Welding Procedure (see para. 8.7.7). Preheating at an approved temperature shall be carried out for steels with YS above 262 MPa (38,000 psi) or WT above 25.4 mm (1").

Repair of welds containing cracks shall be permitted only after the cause of cracking has been fully clarified by Contractor to the satisfaction of Company and the approval to proceed is obtained from Company.

Unacceptable defects shall be removed by grinding, machining or arc-air gouging. Where arc-air gouging is used, all carbon, copper and other debris, including carburized metal, shall be removed by grinding or other mechanical methods approved by the Inspector.

For partial repairs in welds, the cut out portion shall be sufficiently deep and long to remove the defect. At the ends and sides of the cut there shall be a gradual taper from the base of the cut to the surface of the weld metal. The width and profile of the cut shall provide adequate access for rewelding. As a guide, the minimum repair length will not be less than 100 mm (4") even if the defect is of less extent, with 70 mm (2.75") minimum at the bottom of the repair groove.

Repairs at a same location shall be limited to 3 maximum.

The repair grooves shall be examined by LPI or MPI in the presence of the Inspector to ensure that all defects are removed, prior to rewelding.

The Inspector may request the use of extra low hydrogen electrodes for highly restrained weld repairs (see para. 8.5.1 of this specification).

The external surface of the repair weld shall be subject to suitable shaping by grinding in order to obtain an uniform appearance and to merge smoothly into the original weld metal and/or into the adjacent base metal.

Each weld repaired area shall be 100% re-inspected non-destructively according to section 10 of this specification. Additional non-destructive testing such as MPI and LPI may be requested by the Inspector.

14. Dimensional tolerances

14.1 General

The Contractor shall provide personnel, equipment and instruments necessary to monitor and control dimensions and tolerances. All instruments used shall have current valid calibration certificates. Tolerances shall be based on the theoretical setting out points and centrelines of the structure referenced to permanent approved datum points and corrected to a temperature to be defined locally on the construction Site by the Company.

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The Contractor shall submit his proposed method of monitoring dimensions and tolerances to the Company prior to commencing fabrication. Detailed dimensional control and tolerance control reports shall be submitted to the Company following each survey.

As a minimum the Contractor shall survey and control dimensions before fit-up and welding of additional components and sections. Tolerances may be checked at any stage but the final survey shall meet the specified tolerances. The final survey shall be made on complete sections and the complete structure. This survey shall show the actual values of measurements carried out.

When deemed necessary by the Contractor, he will undertake at shop a test simulating the fitting of components to be made on Site (i.e. mock-up test or trial fitting). When such a test is required on the Contract Documents, the Contractor shall notify the Company at least 7 days before the date of test.

The Contractor shall work in accordance with the requirements on tolerances stated in the present section. When no appropriate tolerance is stated below or in the referenced documents, then the tolerance shall be obtained from the Company.

Fabrication shall proceed on a flat and level surface and frequent checks shall be made on the supports and blocking, and any movement out of the level shall be immediately rectified by appropriate shimming to re-establish a level plane.

14.2 Tolerances for prefabricated members

14.2.1 General

14.2.1.1 Tolerances on length and straightness

Unless otherwise stated in the present chapter, the following shall apply:

- Tolerance on length shall be $\pm$ 0.001 L, with respect to theoretical length L of the member
- Tolerance on straightness shall be 0.15% of the theoretical length L of member, with maximum of 12 mm.

14.2.1.2 Mismatch tolerances

- At butt welds

  Mismatch tolerances for butt welds on plates are stated in para. 8.3 of this specification

  Mismatch in longitudinal and girth welds of tubulars shall not exceed t/10 or 3 mm, whichever is the lesser (t = wall thickness).

- At cruciform joints

  Eccentricity “e” between axes of plates (t_1 and t_3) at cruciform joints shall not exceed 3 mm when $t_2 < 20$ mm and 5 mm when $t_2 \geq 20$ mm, or one tenth of the nominal thickness of the thicker material (t_1), whichever is the greater.

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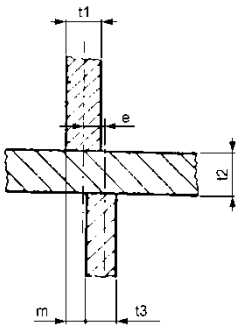
Figure 14.1 - Misalignment at cruciform joints



Eccentricity between centrelines of plate t_1 and plate t_3:

$$e = \frac{2\,m + t_3 - t_1}{2}$$

14.2.1.3 Drilling of holes for bolting

The tolerance on distance between holes or on alignment offset of the holes shall be d/10, where d is the hole diameter.

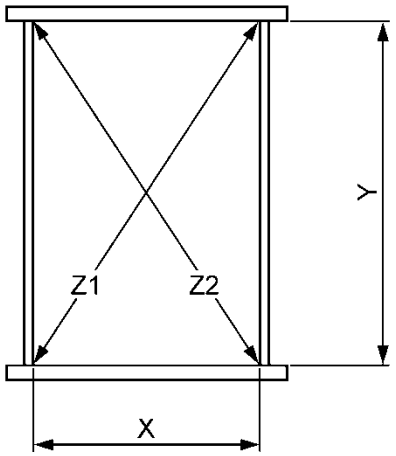
14.2.1.4 Other tolerances

Other tolerances not specified in the present para. 14.2 shall conform to applicable requirements of AWS D1.1/D1.1M code, with prior approval of the Company.

14.2.2 Welded box members

14.2.2.1 Tolerances on dimensions of the cross-section at welding ends of box members

Figure 14.2



X : ± 3 mm

Y : ± 3 mm

Z1 and Z2 : ± 4 mm

14.2.2.2 Tolerance on box geometry deflection

G shall be less than 0.001 L, with maximum of 10 mm (L = member theoretical length)

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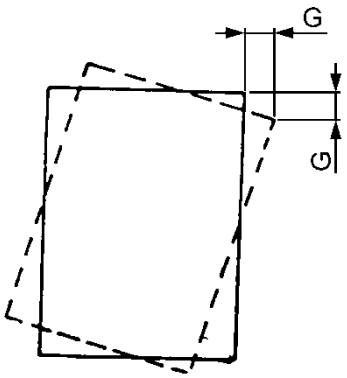
Figure 14.3



14.2.3 Welded Plate Girders (WPG)

The tolerances shall be as stated in Table 14.1.

Table 14.1 - Tolerances for Welded Plate Girders (WPG)
(see the figures on next page)

Designation	Tolerances (mm)	Figure 14…
H = total height h = web height (Height measurements are made at web location) Width “b”	± 0.003 H (max. ± 4) ± 0.003 h (max. ± 4) ± 3 max.	4 4 4
Flange rotation “t”	$t \leq 0.010\ b$	5
Symmetry error $s = \frac{b1 - b2}{2}$ Inclination of web “i”	$s \leq 0.010\ b$ (max. 5) $i \leq 0.004\ H$	6 6
Flange deflection “c” Out-of-straightness normal to web (Web buckles) “p”	$c \leq 0.010\ \frac{b}{2}$ $p \leq 0.010\ h$	7 7
Final length L of fabricated WPG	- 0; + 0.0010 L with 12 mm max.	8
Squareness at ends “v”	$v \leq 0.004\ H$	9
Straightness error “q”, or counter deflection tolerance (Deflection q is measured on web plane)	$q \leq 0.0010\ L$ with 12 mm max.	10
General deflection measured on each flange (sweep) “u”	$u \leq 0.0010\ L$ with 12 mm max.	11
Weight tolerances on each WPG calculated with respect to theoretical linear weight, welds included	+ 6% - 2%	-

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Figures of Table 14.1

Figure 14.4

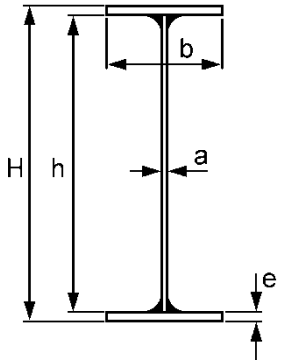


Figure 14.5

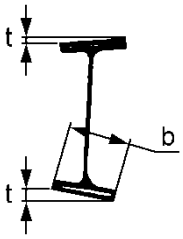


Figure 14.6

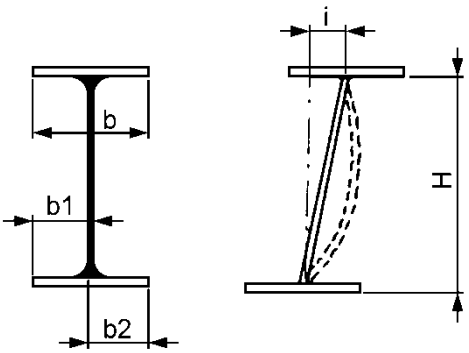


Figure 14.7

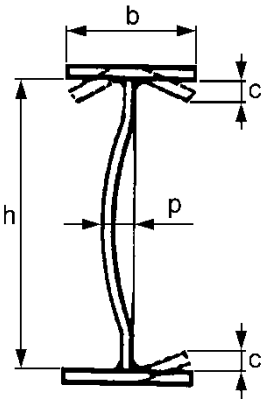


Figure 14.8

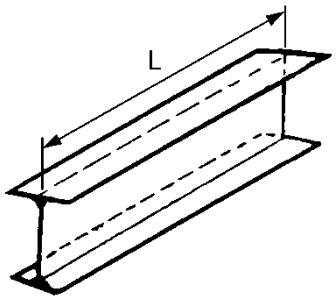


Figure 14.9

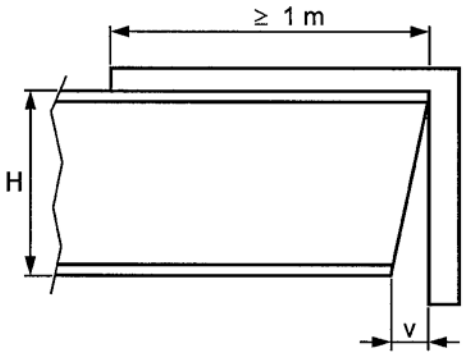


Figure 14.10

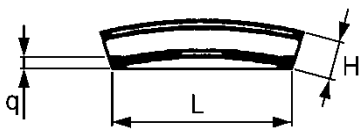
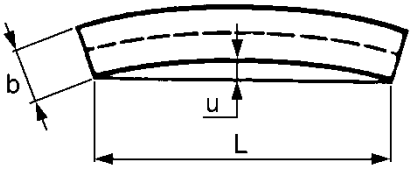


Figure 14.11



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14.2.4 Welded tubulars and tubular members

14.2.4.1 Tubulars and tubular transition sections for general structural purposes

a) Outside diameter

The external circumference shall not depart from the calculated circumference by more than:

$\pm$ 0.75% or $\pm$ 12 mm, whichever is the less.

b) Out-of-roundness

The difference between the measured maximum and minimum internal diameters shall not exceed:

- For tubulars of external diameter up to and including 650 mm: 1% of the nominal internal diameter
- For tubulars of external diameter greater than 650 mm up to and including 2000 mm: 0.75% of the nominal internal diameter
- For tubulars of external diameter greater than 2000 mm up to and including 3000 mm: $\pm$ 15 mm.

In addition, for tubular wall thickness above 2", the difference between the measured maximum and minimum internal diameters shall not exceed 10% of the tubular wall thickness.

The local out-of-roundness measured on the inside or outside of a tubular by means of a 30 degree gauge of the theoretical form of the tubular, shall not depart from the theoretical form by more than 10% of the wall thickness of the tubular.

c) Straightness

Straightness shall be in accordance with the tolerances given in API SPEC 2B para. 4.4. The straightness shall be checked in a minimum of two longitudinal planes displaced by 90 degrees.

d) Squareness at ends

The ends of tubulars or tubular sections shall be cut square within 5 mm per metre of diameter, except that the maximum allowable out-of-square shall not be more than 5 mm, with respect to a perpendicular to the tubular longitudinal axis.

e) Length

The measured length of tubulars and tubular transition sections shall be within -0 to + 15 mm of the theoretical length.

14.2.4.2 Leg assemblies, buoyancy tubes and flotation tanks

The tolerances for leg sections, buoyancy tubes and the flotation tanks, fabricated as an assembly under this specification shall be in accordance with the following additions:

a) Out-of-roundness

For sections of 3000 m diameter and greater the out-of-circularity shall be limited to 0.50% of the outside radius. Out-of-circularity shall be measured at 15 degrees intervals around the circumference of the leg sections. Out-of-circularity shall be checked at each end of every 3 m long leg section and at every ring stiffener.

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Out-of-circularity is defined as the deviation of the physical shape of the leg section from an optimum circle. The radius and centre of the optimum circle shall be calculated from the 24 radial measurements taken.

Full visual inspection for local out-of-roundness (dents and flats) shall also be made.

b) Straightness

The “reference centreline” shall be defined as the average centerline of the completed tubular assembly by measuring its location at each jacket level and at other intermediate locations when the distance between levels exceed 12 m. Then, straightness of the complete assembly shall not deviate by more than 10 mm against the “reference centerline”. This “reference centreline” shall then be taken as the theoretical centerline of leg in any subsequent assembly (see para. 14.3.5).

In a same way, straightness of a flotation tank shall be maintained within 0.20% of the entire length of the tank or 20 mm whichever is the lesser.

c) Peaking at welds

For buoyancy tubes and flotation tanks, the peaking at weld location (longitudinal or circular welds) shall not deviate by more than 2 mm from the theoretical form, when measured transverse to weld longitudinal axis using Inspector approved inside and outside templates (sectors of 20° minimum) or a dial gauge.

14.2.4.3 Piles and piles followers

The provisions of para. 14.2.4.1 of this specification shall apply with following amendments:

- The straightness tolerances shall be as defined in API RP 2A-WSD
- The overall lengths of the piles and pile followers shall be within ± 25 mm of the theoretical dimension.

14.2.5 Nodes

The tolerances specified in para. 14.2.3 and 14.2.4 of this specification shall be maintained for node girders, node barrels (i.e. cans) and stubs.

The ends of the node stubs and barrels shall be cut square within ± 5 mm of a perpendicular to the tubular longitudinal axis.

The theoretical centerline of a node stub or brace intersection shall be positioned within 5 mm of its true position for node girders and node barrels with diameters up to and including three metres and within 10 mm of its true position for node barrel diameters greater than three metres. Measurements shall be made by using the permanent work point on the node barrel or node girder and the following reference points:

- For stubs: the true centre of the machined free end of the stub
- For intersecting braces: the true centre of the brace on the surface of the node barrel or node girder.

The node can length shall be within -0 to + 15 mm of the theoretical length as measured from the centre wrap line of the node barrel.

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The node stub length shall be within -0 to + 20 mm of the theoretical length in accordance with the drawings.

14.2.6 Panels

See applicable tolerances in Tables 14.2 and 14.3.

14.2.7 Trusses

See applicable tolerances in Tables 14.4 and 14.5.

Regarding deck trusses, the Contractor shall estimate and take into account with accuracy the shrinkage of the trusses members assembled by welding. Built-up main trusses shall result after erection in upper and lower chord members perfectly straight with a vertical deflection within 0 ± 3 mm.

Therefore the Contractor shall decide if a pre-cambering of the trusses is necessary.

14.2.8 Columns in decks and superstructures

The tolerances stated for WPG (see para. 14.2.3) shall apply, where applicable.

14.2.9 Stiffeners and diaphragms

The following provisions related to stiffeners (i.e. longitudinal and transverse stiffeners, ring stiffeners, etc.) and diaphragms apply for:

- Box members (para. 14.2.2)
- WPG (para. 14.2.3)
- Welded tubulars and tubular members (para. 14.2.4)
- Nodes (para. 14.2.5)
- Columns in decks and superstructures (para. 14.2.8).

a) Stiffeners and diaphragms shall be positioned within 3 mm or one tenth of their nominal thickness, whichever is greater.

b) The outstand (or inclination) of a stiffener shall be within 3 mm of a perpendicular to the surface of the main plate (i.e. web, or flange in girders, tubular wall, etc.) at the point of attachment.

c) The out-of-straightness of a stiffener measured with respect to a parallel to the main plate (i.e. web, etc.) shall be within ± 0.003 L, with max. of 3 mm.

   L is the length of the stiffener.

d) Where tight fit of intermediate stiffeners of WPG is specified, the maximum acceptable gap shall be 1.6 mm between stiffener and flange, unless otherwise stated on the drawings.

Figures 14.16 and 14.17 related to girders are examples for illustrating the typical deviations.

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14.2.10 End plates of Girders and Columns

Deviation “h1 + h2” of end plates shall not exceed 0.005 b.

See Figure 14.18.

Table 14.2 - Panels: maximum deviation

Type of deviation	Figure	Notation	Reference length	Maximum deviation	
				0/00	in mm
Length	14.12		L	± 1.0	
Width	14.12		W	± 1.0	
Lateral deflection (sagging/hogging) over total panel	14.12	f	L	± 2.0 (1)	30
				± 1.5	25
Lateral deflection (sagging/hogging) between stiffeners	14.13	f_1	L_1 or W_1	± 4.0	3.5

Note (1): 1.5 if the panel is subject to buckling out of the panel plane because of compression forces. 2.0 if the beams are calculated as bending elements only.

Figure 14.12 - Panels: maximum total deviation

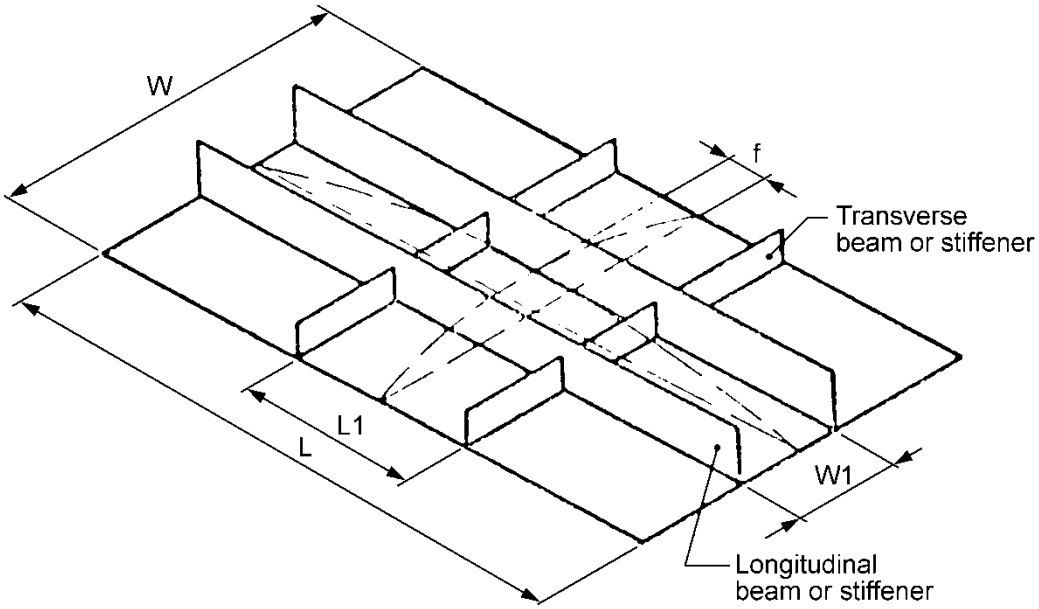

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Figure 14.13 - Panels: deviation between stiffeners

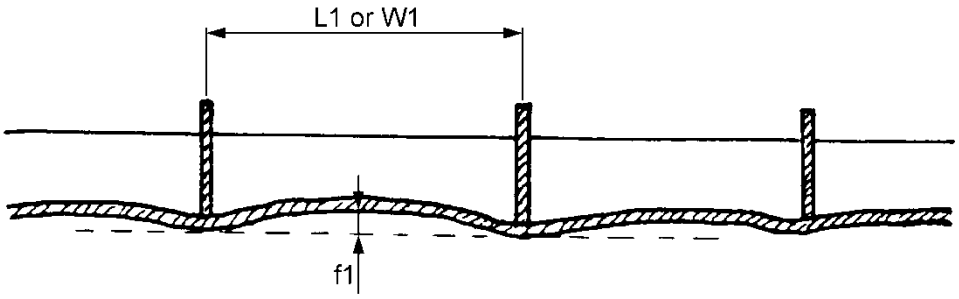

Table 14.3 - Panels: maximum deviation of longitudinal (and transverse) beams or stiffeners

Type of deviation	Figure	Notation	Reference length	Maximum deviation	
				0/00	in mm
Out-of-straightness normal to panel plane	14.14	f_1	L_1 (W_1)	± 2.0 (1) ± 1.5	
Out-of-straightness parallel to panel plane	14.14	f_2	L_1 (W_1)	± 1.5	
Inclination	14.14	v_4	b (b_1)	30	12
Position deviation	14.14	v	W_1 (L_1)	10	8

Note (1): 1.5 if the panel is subject to buckling out of the panel plane because of compression forces. 2.0 if the beams are calculated as bending elements only.

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Figure 14.14 - Panels: longitudinal and transverse beams or stiffeners

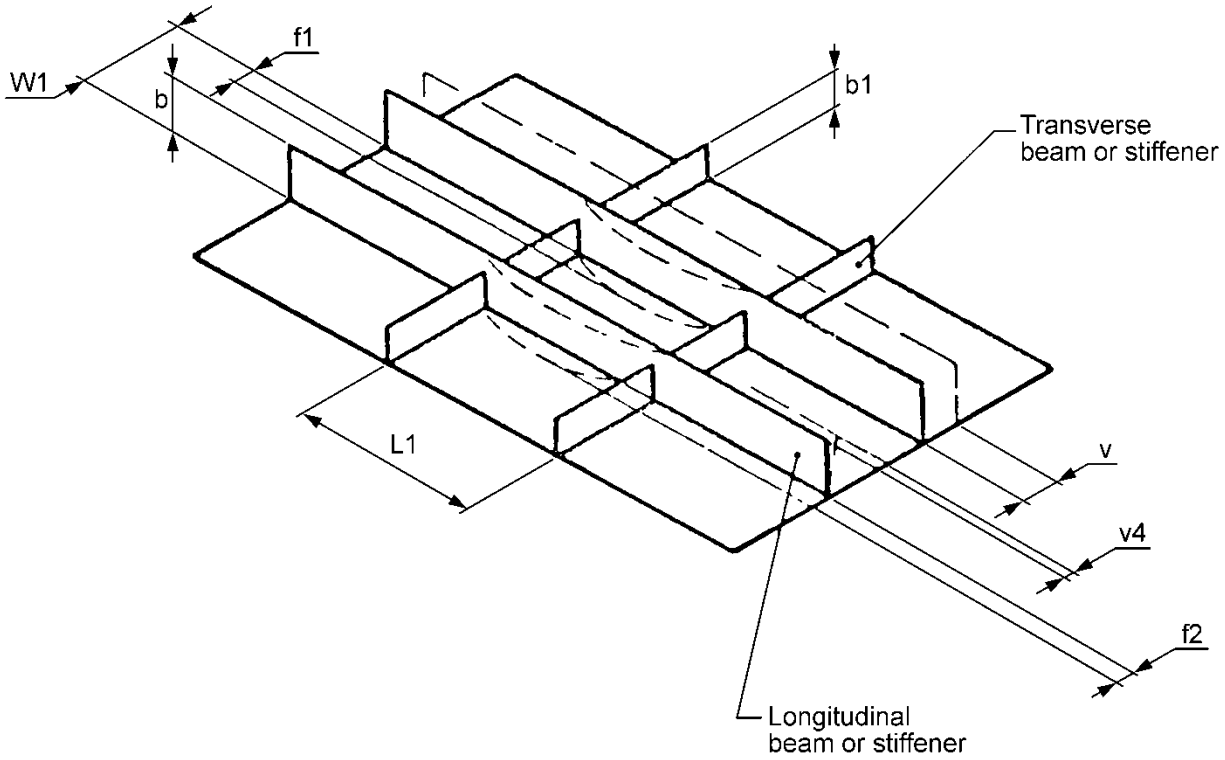

Table 14.4 - Trusses: maximum deviation

Type of deviation		Figure	Notation	Reference length	Maximum deviation	
					0/00	in mm
Lateral deflection (flanges)		14.15	f	L	± 1.5	25
Out-of-straightness parallel to truss plane		14.15	f	h	± 1.5	25
Length	truss	14.15		L	± 1.0	
	single member			L_1		
Height (depth) of truss		14.15		h	± 2.0	

Table 14.5 - Trusses: maximum deviation of single members between nodes

Type of deviation	Figure	Notation	Reference length	Maximum deviation	
				0/00	in mm
In truss plane single member	14.15	e_1	h	± 1.5	
Out-of-truss plane single member	14.15	e_2	L_1 (h)	± 1.5	

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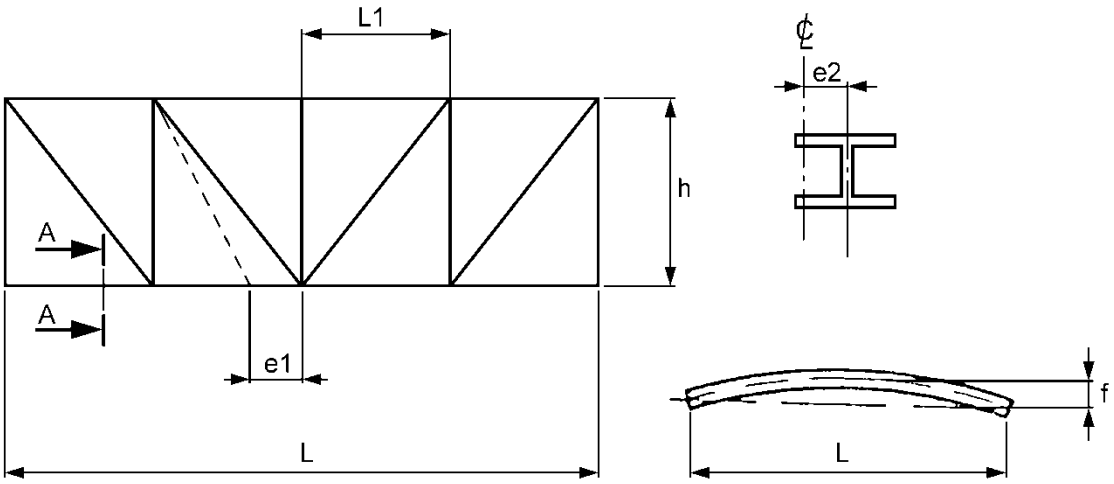
Figure 14.15 - Trusses: maximum deviation



(deflection of truss normal or parallel to truss plane)

Figure 14.16 - Girders: longitudinal stiffeners

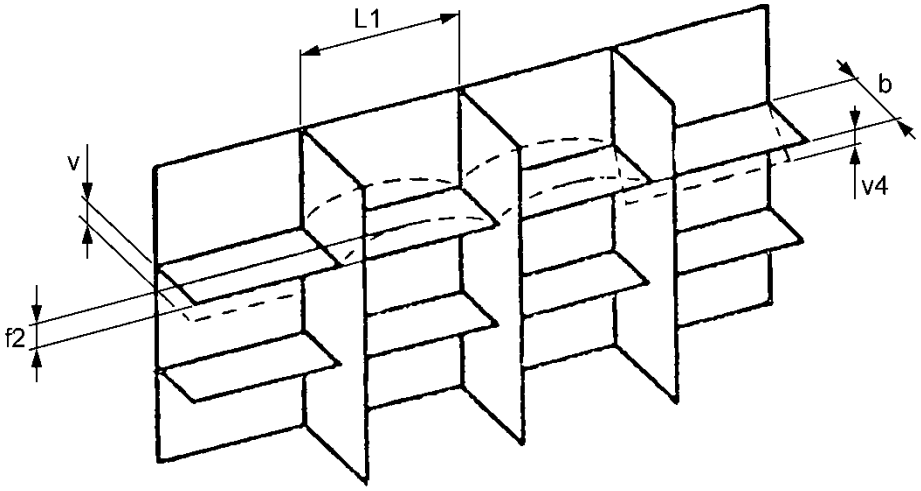


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Figure 14.17 - Girders: transverse stiffeners

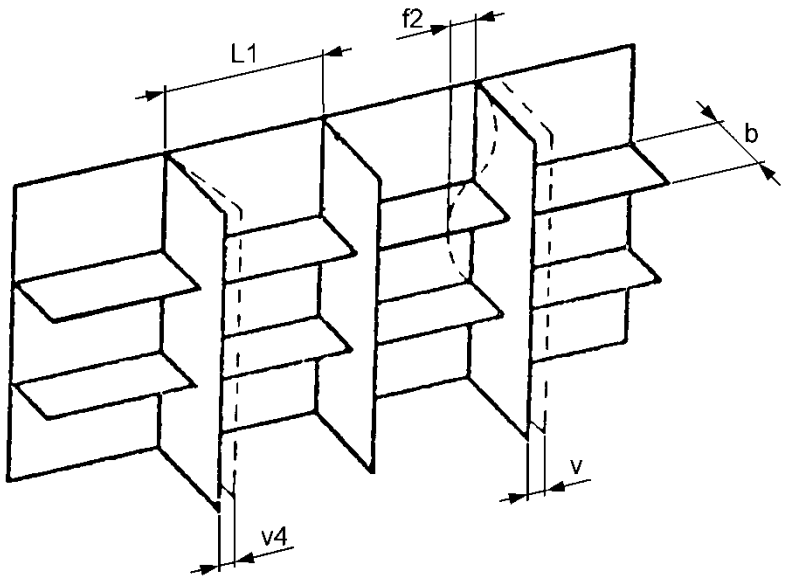
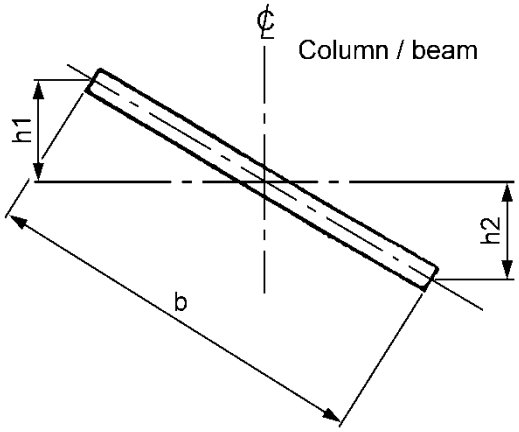


Figure 14.18 - Inclination of end plates (Girders and Columns)



14.3 Tolerances on final fabrication

14.3.1 General

The tolerances specified in para. 14.2 above shall apply, whenever applicable.

Each member of the structure shall be located accurately to the final fabrication tolerances stated in API RP 2A-WSD, unless otherwise specified hereafter.

Any other tolerances not stated herein shall be in accordance with the AISC “Specification for the Design, Fabrication and Erection of Structural Steel For Buildings and Bridges”.

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14.3.2 Columns in decks and superstructures

Inclination “e” of column shall be ± 0.0015 L, with maximum of ± 20 mm.

See Figure 14.19.

14.3.3 Trusses

Upper and lower chord members of deck trusses shall be perfectly straight with a vertical deflection within 0 ± 3 mm.

Inclination “v” of truss shall be ± 0.006 h, with maximum of ± 30 mm.

See Figure 14.20.

14.3.4 Connection at end of beams or columns

Rotation “e” of beam or column at end connection shall not exceed t/2 (t = web thickness).

See Figure 14.21.

14.3.5 Deck legs and top of jacket legs

The diagonal distance between diametrically opposed corner legs shall be within ± 12 mm of the theoretical dimension.

The centre of the legs (in horizontal plane) at stabbing points shall be within 6 mm of the theoretical dimension.

The tops of all jacket legs shall relate to the drawing elevation within a tolerance of ± 6 mm.

14.3.6 Node location

With the exception of the centre of legs at stabbing points mentioned above all nodes shall be positioned within 25 mm of their theoretical position. Having made allowance for the error in positioning the node work point, the work point at the brace end of any stub shall be within 6 mm of the theoretical.

14.3.7 Conductor guides

An overall “reference centerline” shall be defined as the average centerline of the conductor guides of the completed structure by measuring its location at each conductor guide level. The overall “reference centerline” for all guides shall not deviate by more than 25 mm from the theoretical centerline as indicated on drawings. Any three consecutive conductor guides shall not deviate by more than 12 mm against the “reference centerline” of the three guides being considered.

No single guide shall deviate from the overall “reference centerline” by more than 25 mm and its axis shall be within ± ½ degree to the theoretical centerline of the conductors, whatever they are vertical, deviated or curved.

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14.3.8 Pile guides

The centre of any pile guide shall not deviate from an optimized straight line by more than 25 mm. The optimized straight line shall not deviate from the theoretical centreline, as shown on the drawings, by more than 25 mm.

Figure 14.19 - Inclination of columns

Figure 14.20 - Inclination of truss

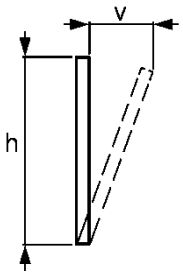
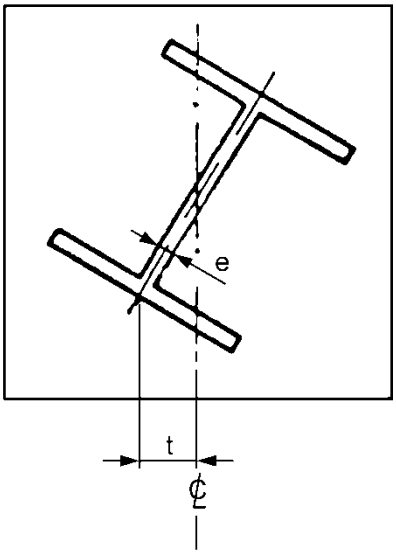


Figure 14.21 - Rotation of column or beam at end connection



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14.3.9 J-Tubes

Straightness of each installed J-tube shall be maintained within 0.15% of its entire length. Straightness deviation in any 12 metres increment shall not exceed 10 mm.

14.3.10 Miscellaneous structural tolerances

a) Deck floors

The maximum allowable deflection of panels between two consecutive joists shall not exceed 3 mm.

The Contractor shall take all necessary cares to ensure that floors are built without hollows resulting either from plating or joist deflections after welding operations. In presence of large puddles on the floor areas, the Company may ask the Contractor to provide the installation of suitable drains during fabrication stages, before load-out or after installation, unless structural repairs can resorb such deformations.

b) Landings and stairways

Landing elevations and landing and stairway locations horizontal dimensions shall be within ± 12 mm of the drawing dimensions.

The vertical distance between any two successive steps shall not vary by more than 1.5 mm and steps shall be level.

c) Openings

The centreline point of any opening shall be within a tolerance of ± 10 mm of the theoretical centre point.

The actual size of any opening shall be within a tolerance of ± 5 mm of the theoretical dimension.

d) Fencing and handrails

Fabrication and erection shall be performed to a degree of accuracy that the top rail shall be level to the eye and the fencing and handrail shall be plumb.

e) Grating

The difference in elevation in adjacent grating panels shall not exceed 1.6 mm. When installed, grating shall provide a continuously flat and level surface with no visible indication of warping.

15. Re-used structures

The re-use of existing structures (both temporary & permanent) is subject to Company approval, depending on available traceability and design/tests documentation.

Any critical parts of re-used structures or any re-used parts of structures shall be properly sand blasted and checked by MPI (base materials and welds) for cracks and other injurious defects. All bolted assemblies shall be dismantled prior to perform such inspection.

On certain structural items, such as pad-eyes, spreader bars, dead man anchors, sister plates, skid shoes, skid beams, construction supports, etc., an UT shall also be made (base materials and welds) to check for internal flaws.

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The inspection scope and procedures shall be submitted to the Inspector for prior approval. The Contractor shall advise, in due time, the Inspector about the date(s) of inspections so as to enable him to attend the said inspections.

16. Other references

Following documents are applicable:

- External documents: EN 10204, IIW/IIS doc. 62.60, ISO 6507-1
- Total General Specifications: GS EP STR 100, GS EP STR 101, GS EP STR 102, GS EP STR 204, GS EP STR 304, GS EP STR 401, GS EP STR 431, GS EP STR 432, GS EP STR 631, GS EP STR 651.

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Appendix 1 Flux dryness

Applicable for steel grades with SMYS of 440 MPa and greater

Manufacturer can choose one of the following **specification** to guarantee the flux dryness
(The resulting diffusible Hydrogen in weld deposit shall be 5 ml/100 g **max.**)

Specification A: (Originally a dry flux is packed in moisture proof sealed packing)

1 - Procurement of flux

At the time of flux packing, the diffusible hydrogen content in SAW weld deposit shall be checked on a sample of the batch of flux and shall be lower than 5 ml/100 g of weld deposit.

(This measurement may also be done through by the moisture content measurement, when evidence of correlation can be provided by flux manufacturer, based on previous comparative tests of diffusible Hydrogen versus flux moisture content. Otherwise, the acceptable maximum moisture content shall be 0.03%. The “Karl Fisher” method shall be applied).

For diffusible hydrogen testing or for moisture measurement**, NO PRE- DRYING NEITHER ANY PRE-HEATING OF FLUX SAMPLE** will be carried out before testing.

(Tests shall be carried out with the flux as it is at the time of sampling /packing. Moisture measurement will be carried out at 982°C without pre-heating of the sample.)

Results of diffusible hydrogen or moisture measurement shall be reported on the 3.1 B flux certificate for each batch. The testing condition, as stated above, shall be confirmed on the certificate.

Packing shall be of moisture proof type.

Metallic/stiff plastic drums with rubber gasket for the top tightness or double polyethylene top welded bags are acceptable.

2 - Storage of flux

Flux shall be stored in a controlled hygrometry room where the relative hygrometry shall be permanently maintained below 60%. The maximum duration of storage shall be one year (after the date of packing). Over one year, a spot check of diffusible hydrogen/moisture content shall be required.

3 - Use of flux

Drums/bags shall be checked before use. They shall be undamaged (flux in damaged bag shall be scrapped).

They shall be opened just before pouring the flux in the welding machine hopper where the temperature shall be maintained at 120°C minimum.

In case of welding stop, the remaining flux stored in hoppers shall be scrapped after 12 hours maximum.

The system of feeding, downstream the hoppers, shall be drained off before welding restart when welding has been interrupted 2 hours max.

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The feeding from hoopers shall be done by gravity where possible. Where pressurized air is used for flux conveying, the said air shall be dried with adequate equipment.

4 - Flux recycling

When manufacturer intends to recycle welding excess flux, his recycling procedure shall be submitted to Company for approval prior production starts. The procedure shall include a sketch showing the circulation of recycled flux and of sucking air.

Specification B (any other procedures)

Contractor shall demonstrate that its procedure allows obtaining dry flux at the welding point.

Flux shall be sampled at the welding point and checked at the start of production and then once per shift for inside welding and once per shift for outside welding, rotating among the welding machines.

Inspector shall have the right to impose the time of sampling when it is justified to his opinion.

Check tests and results shall comply with the above para. 1.

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Appendix 2 Welding Details

Note: Autocad A3 format of the 7 drawings presented hereafter are available at GS EP STR 301 Attached Drawings

Folio 1 - General notes

Folio 2 - Tubular joints double sided welds

Folio 3 - Tubular joints single sided welds

Folio 4 - Tubular joints seam girth welds

Folio 5 - Tubular joints framing conditions

Folio 6 - Plate double sided welds

Folio 7 - Plate single sided welds

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Appendix 2

GENERAL NOTES FOR TOPSIDES,MODULES,JACKET AND BRIDGE WELDING DETAILS:

1. a) ALL WELDS SHALL BE CONTINUOUS.
   b) WHERE ACCEESS IS POSSIBLE, ALL WELD SHALL BE DOUBLE SIDED UNLESS SPECIFICALLY NOTED ON THE DRAWINGS OR APPROVED BY COMPANY REPRESENTATIVE.
   c) FULL PENETRATION GROOVE WELD SHALL BE USED UNLESS NOTED OTHERWISE OR APPROVED BY COMPANY REPRESENTATIVE.
   d) CONTRACTOR SHALL PERFORM THE NECESSARY DETAILED DESIGN TO DERIVE THE FILLET WELD SIZE IN PARTICULAR FOR THE WPG WEB TO FLANGE CONNECTION, AND FOR THE WEB AND /OR FLANGE STIFFENERS.
2. ALL T K Y JOINTS SHALL BE WELDED IN ACCORDANCE WITH DETAILS SHOWN ON FOLIO 2 AND/OR FOLIO 3
   WHICH ARE BASED ON API RP 2A AND COMPANY SPECIFICATIONS:
   - GS STR 201: MATERIAL FOR OFFSHORE STEEL STRUCTURE
   - GS STR 301: FABRICATION FOR OFFSHORE STEEL STRUCTURE
   - GS STR 304: FABRICATION OF WELDED PLATE GIRDERS (WPG)
3. T K Y JOINTS SPECIFIED FOR WELD PROFILE CONTROL SHALL BE TESTED AS INDICATED ON THE DRAWINGS FOLIO 2 AND/OR FOLIO 3.
4. WELDS SPECIFIED FOR WELD PROFILE CONTROL SHALL RECEIVE MAGNETIC PARTICLE INSPECTION (M.P.I.) FOR SURFACE AND NEAR SURFACE DISCONTINUITIES.
5. PEENING OTHER THAN TO REMOVE WELD SPLATTER OR SLAG SHALL NOT BE ALLOWED.
6. REQUIRED WELD PROFILES SHALL BE MAINTAINED EVEN FOR WELDS THAT ARE HIDDEN (i.e. WELDS UNDER OVERLAPPING BRACES OR DIAPHRAGMS.)
7. WELD PASSES TO BE DEPOSITED IN A BALANCED MANNER TO MINIMIZE DISTORSION. ROOT PASS PLUS SUFFICIENT NUMBER OF SUBSEQUENT PASSES TO BE COMPLETED BEFORE ASSEMBLY IS TURNED.
8. ALL WELDS TO BE BACK-GOUGED AND/OR GROUND TO BRIGHT METAL AND BACK WELDED WHERE ACCESS PERMITS.
9. ALL DIAPHRAGMS WILL BE WELDED FROM BOTH SIDES UNLESS NOTED OTHERWISE ON THE DRAWINGS. THIS APPLIES TO BOTH FILLET AND FULL PENETRATION WELDS.
10. MINIMUM PREHEATING AND INTERPASS TEMPERATURES MUST BE MAINTAINED DURING THE ENTIRE WELDING PROCESS FOR RESTRAINED OR CRITICAL CONNECTIONS, SUCH AS DIAPHRAGM PLATES.
11. THE FABRICATOR IS TO ADHERE TO THE TYPICAL FRAMING DETAIL UNLESS SHOWN OR NOTED OTHERWISE ON THE DRAWINGS.
12. A- LONGITUDINAL SEAMS TO BE STAGGERED AS SHOWN ON DRAWINGS FOLIO 4 AND/OR FOLIO 5 AND GENERAL SPECIFICATION GS-STR-301 (TYPICAL AT ALL GIRTH WELD).
    B- LOCATE LONGITUDINAL SEAM WELDS 90 DEGREES MINI APART WHERE POSSIBLE, WITH 250mm MINI. APART AT ADJACENT CANS.
    C- MULTIPLE SECTION CANS ARE THOSE THAT REQUIRE THE SPLICING OF TWO CANS TO MAKE-UP THE COMPLETE CAN LENGTH.
    D- AT NODE,LOCATE LONGITUDINAL SEAM WELDS AT LEAST 75mm CLEAR FROM EACH FRAMING MEMBER.
13. MINIMUM DISTANCE BETWEEN GIRTH WELDS SHALL BE (SEE GS-STR-301):
    - ONE PIPE DIAMETER OR 900mm WHICHEVER IS LESS.
    - TWO PIPE DIAMETER OR 2 METERS, WHICHEVER IS LESS FOR PILES.
      NO MORE THAN TWO GIRTH WELDS IN ANY 3 METER INTERVAL OF PIPES.

FOLIO 1 - 1/4

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Appendix 2

GENERAL NOTES FOR WELDING :

1. ALL WELDING PROCEDURES ARE TO COMPLY WITH AWS D1-1 2004 UNLESS SUPERSEDED BY COMPANY SPECIFICATION GS STR 301.
2. ALL WELDS SHALL BE CONTINUOUS. IN PARTICULAR FOR WELDS OF JOISTS TO PLATING.
3. ALL WELDS SHALL BE FULLY SEAL WELDED EXCEPT FOR THOSE INDICATED OTHERWISE IN MUDMAT, GRATING AND MOVABLE PARTS.
4. DOUBLER PLATES SHALL BE PROVIDED FOR ALL SUPPORTS WELDED ON SPECIAL AND FIRST CATEGORY STEELS.
   AS SPECIFIED IN PARAGRAPH 8.4.1 OF COMPANY SPECIFICATIONS GS-STR-102
5. FILLET WELDS ARE INDICATED BY THE LEG SIZE (L), ALWAYS,PROVIDING THAT THE MINI THROAT IS MET.
   - MINIMUM LEG SIZE OF FILLET WELDS TO BE L=6mm FOR CYCLICALLY LOADED STRUCTURE, FOR SPECIAL AND FIRST CATEGORY MEMBERS.
   - OTHERWISE MINIMUM LEG OF FILLET WELDS TO BE AS FOLLOWS: (SEE FIGURE 2)

	MIN. LEG (L)	MIN. THROAT (a)
$t \leq 12$ mm	5 mm	3.5 mm
$12 < t \leq 20$ mm	6 mm	4.2 mm
$t > 20$ mm	8 mm	5.7 mm

   - UNLESS NOTED OTHERWISE ON DRAWINGS, OR WITHOUT DETAILED CALCULATION, DOUBLE SIDE FILLET WELDS FOR SPECIAL & FIRST CATEGORY TO BE:(SEE FIGURE 2)
     L = 0.7T, WITH T= MIN. (T1, T2)
6. THE MINIMUM SPECIFIED LEG LENGTH OF FILLET WELD SHALL BE THE DIFFERENCE OF ACTUAL WELD LENGTH AND THE ACTUAL ROOT GAP. SEE FIGURE 1)
7. MINIMUM GAP BETWEEN BRACING FOOTPRINTS IS 75mm.
8. MINIMUM GAP BETWEEN WELD TOES IS 50mm.
9. WHERE ACHIEVED GAP BETWEEN WELD TOES IS BETWEEN 25 AND 50mm, LOCAL GRINDING AND M.P.I. ARE REQUIRED IN ORDER TO AVOID LOCAL UNDER-CUT AND TO GET A SMOOTH WELD PROFILE.
10. WHEN ACCESS IS LIMITED FABRICATION TO PROVIDE 100mm CLEARANCE FOR WELDING. (SEE FIGURE 3)
11. TEMPORARY RAT HOLES SHALL BE PROVIDED ONLY TO PERFORM THE THROUGH WELD. (SEE FIGURE 4)
    THE EDGES OF THE RAT HOLES SHALL BE CHAMFERED AT 45 DEGREES.
    THE RADIUS OF THE RAT HOLES SHALL BE 20mm.
    AFTER WELDING AND INSPECTION OF THE THROUGH WELDS, THE TEMPORARY RAT HOLES SHALL BE PROPERLY FILLED WITH WELD.
    NO OPEN RAT HOLE IS ACCEPTABLE.
12. THE TEMPORARY RAT HOLES SHALL BE PREPARED AND EDGES BEVELLED BEFORE FITTING THE PIECES TOGETHER.
13. NO PERMANENT RAT HOLES SHALL BE USED UNLESS STRUCTURE IS SUBMERGED IN SEAWATER AND CATHODICALLY PROTECTED.
14. ALL BEVELS SHALL BE INDIVIDUALLY 20°, 30°, 45° WITH REGARD TO THE UT INSPECTION SURFACE

FOLIO 1 – 2/4

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Appendix 2

WINDOW GUIDELINES :

1. ALL WINDOWS SHALL BE MADE ONLY WHEN DEEMED NECESSARY. THEY ALWAYS SHALL HAVE PRIOR APPROVAL OF THE COMPANY, AS WELL AS FOR THEIR LOCATIONS AND SIZES. (REFER TO GS-STR-301).
2. WINDOW SHALL BE ORIENTATED PARALLEL TO THE CENTERLINE OF THE BRACE.
3. CORNERS SHALL HAVE MINIMUM RADIUS CUT OF 100mm OR 4 TIMES THE PLATES THICKNESS, WHICH EVER IS GREATER.
4. CERAMIC BACK-UP BARS MAY BE USED WITH PRIOR APPROVAL OF THE COMPANY. THE MAXIMUM WIDTH OF BACK-UP BAR WILL BE 51mm AND THE MINIMUM THICKNESS WILL BE 6.4mm.
5. ALL WELDS SHALL BE COMPLETE JOINT PENETRATION.
6. ALL WINDOWS SHALL BE WELDED IN SEQUENCE BY 2 WELDERS WORKING SIMULTANEOUSLY ON OPPOSITE SECTORS,STARTING BY THE 2 SECTORS PERPENDICULAR TO THE BRACE CENTRELINE. THE DETAILED WELDING PROCEDURE AND SEQUENCE SHALL HAVE PRIOR APPROVAL OF THE COMPANY.
7. ALL WINDOW WELDS WILL BE INSPECTED BY ULTRASONICS AND MPI.

FOLIO 1 - 3/4

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Appendix 2

FIGURE 1 :
FILLET WELD WITH ROOT GAP
(SEE WELDING GENERAL NOTE 6)

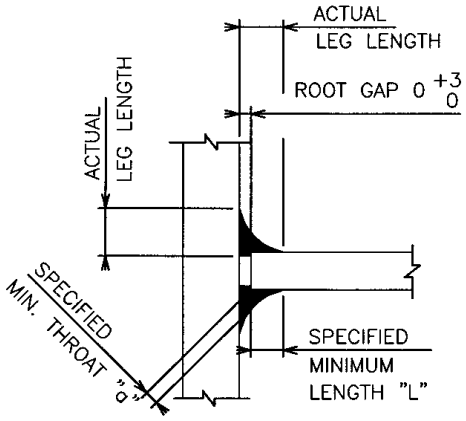


FIGURE 2 :
FILLET WELD WITHOUT ROOT GAP

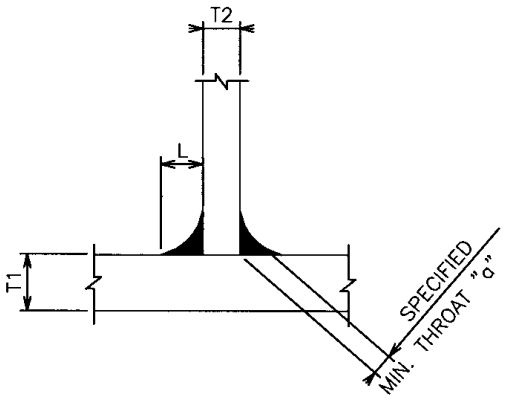


FIGURE 3 :
CLEARANCE FOR LIMITED ACCESS

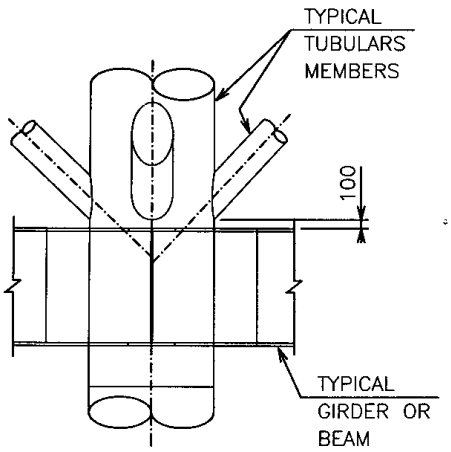
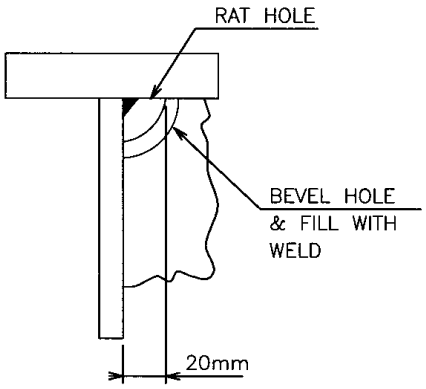


FIGURE 4 :
RAT HOLE



FOLIO 1 – 4/4

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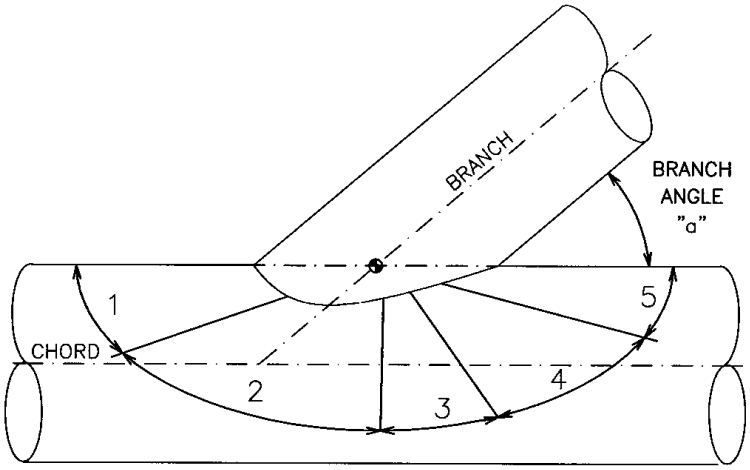
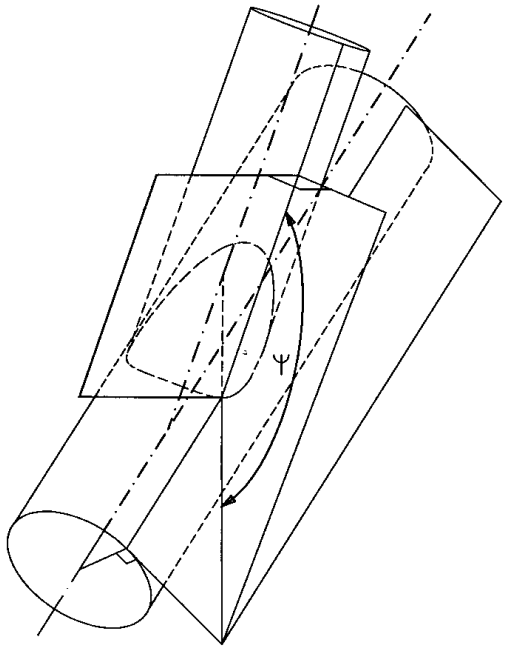
Appendix 2

TYPICAL LOCATION OF WELD TYPES



NOTE:
EXAMPLE SHOWING TYPICAL LOCATIONS WHERE THE NUMBERED WELD DETAIL TYPES (1 TO 5) SHALL BE USED ALONG THE LINE OF THE WELD.
(TRANSITIONS BETWEEN TYPES SHALL BE GRADUAL)

LOCAL DIHEDRAL



ANGLE "Ψ" IS THE ANGLE FORMED BY THE EXTERIOR SURFACES OF THE BRACE AND CHORD AT ANY POINT ON THEIR JOINT LINE (LOCAL DIHEDRAL ANGLE)

FOLIO 2 – 1/5

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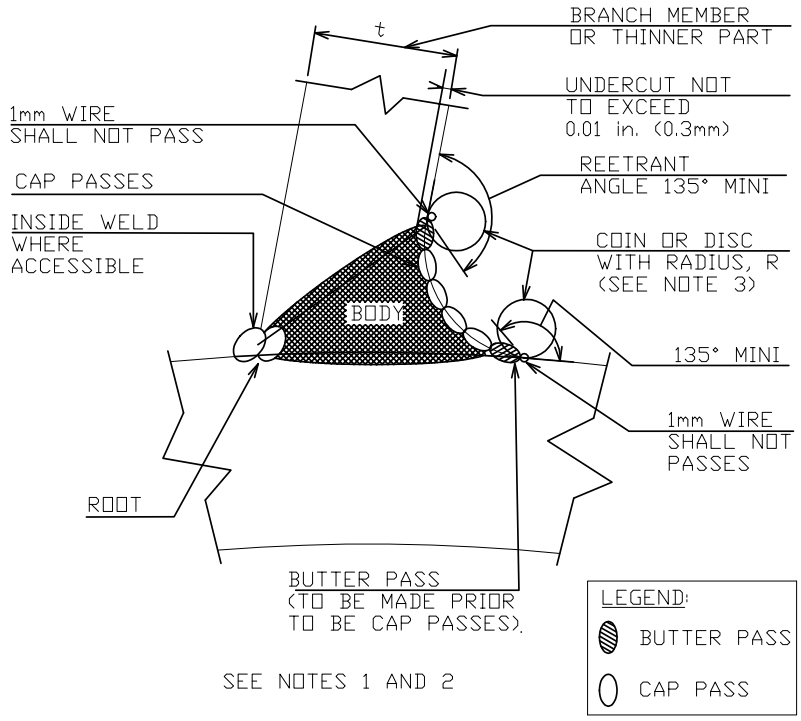
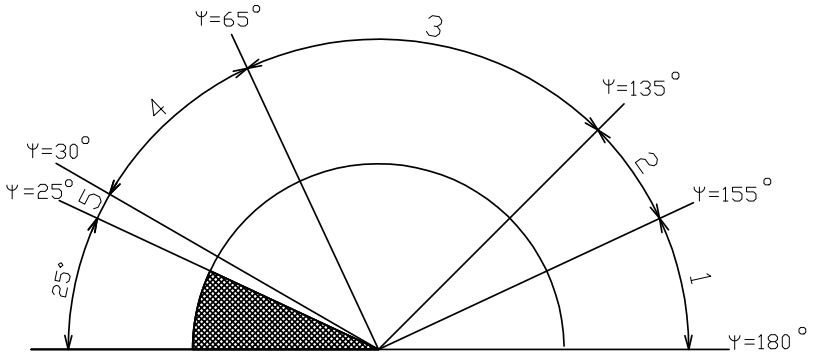
Appendix 2

DISC TEST FOR IMPROVED WELD PROFILE CONTROL



WELD TYPE VERSUS Ψ



FOLIO 2 – 2/5

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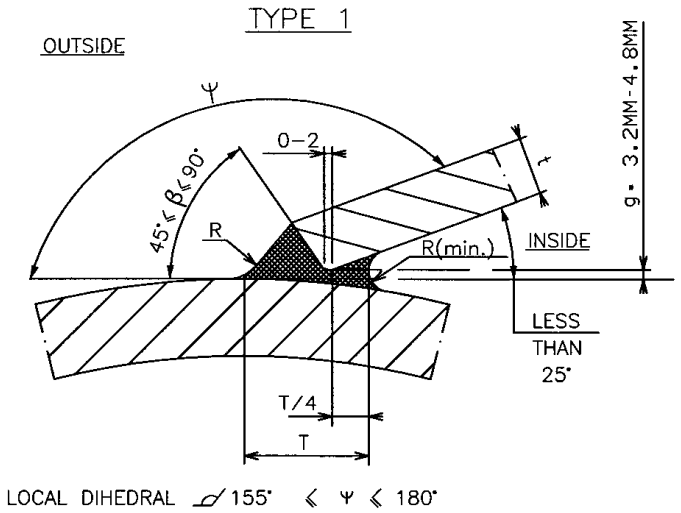
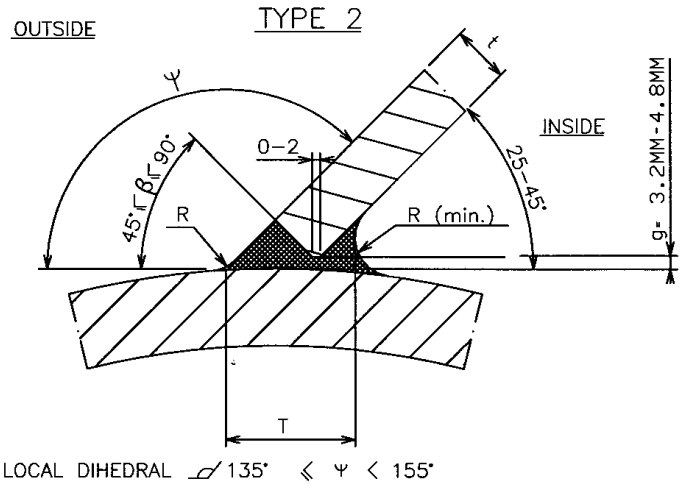


LOCAL DIHEDRAL $\measuredangle$ 155° ≤ Ψ ≤ 180°



LOCAL DIHEDRAL $\measuredangle$ 135° ≤ Ψ < 155°

FOLIO 2 – 3/5

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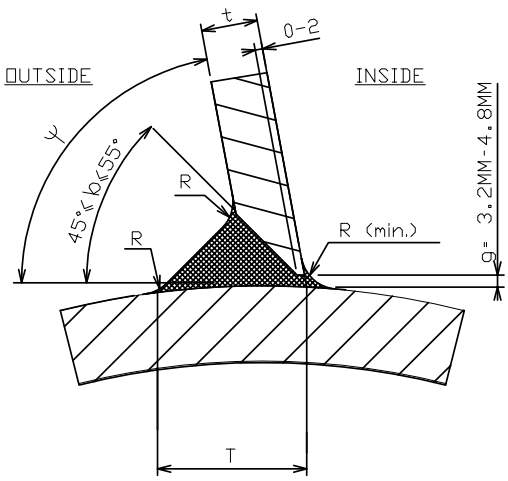
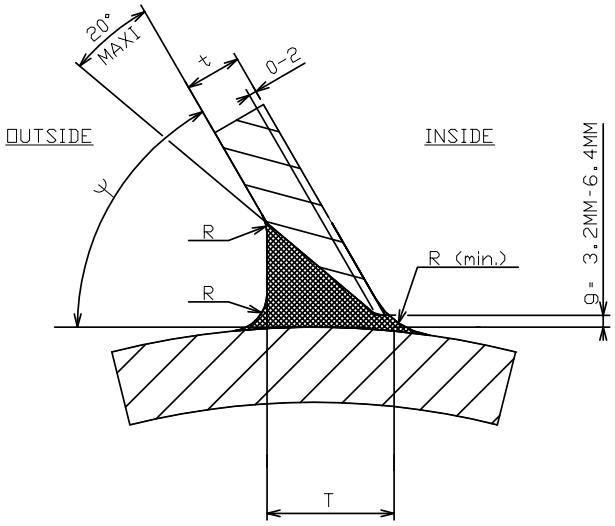
Appendix 2

TYPE 3



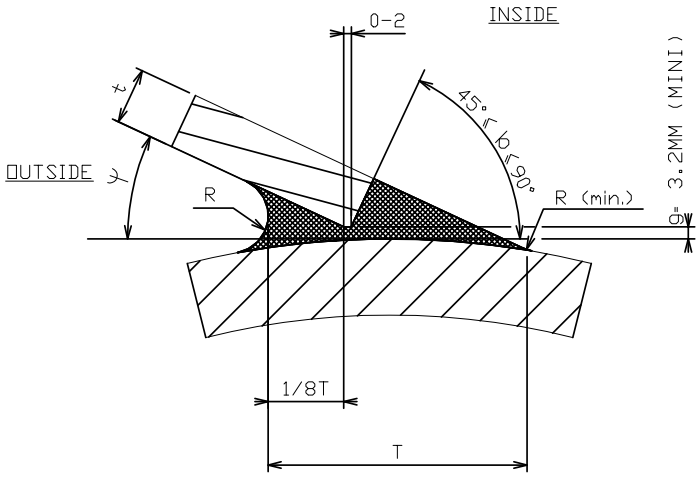
LOCAL DIHEDRAL ∠ 65° ≤ Ψ < 135°

TYPE 4



LOCAL DIHEDRAL ∠ 30° ≤ Ψ < 65°

TYPE 5



FOLIO 2 – 4/5

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Appendix 2

NOTES:

1- MPI INDICATION,EXCESSIVE CONVEXITY,OR UNDERCUT IN WELD TOE PASSES OR BETWEEN ADJACENT PASSES SHALL BE CORRECTED BY LIGHT GRINDING.

2- FINAL GRINDING MARKS SHALL BE TRANSVERSE TO THE LONGITUDINAL WELD AXIS.

3- THEORETICAL RADIUS R= t/2 , EXCEPT THAT
5/16 ≤ in. ≤ R 1 in.
OR (8mm ≤R ≤25mm)

4- FOR Ψ BETWEEN 30° TO 40° CONTRACTOR TO SELECT WELD TYPE 4 OR TYPE 5 DEPENDING ON WELDING ACCESSIBILITY.

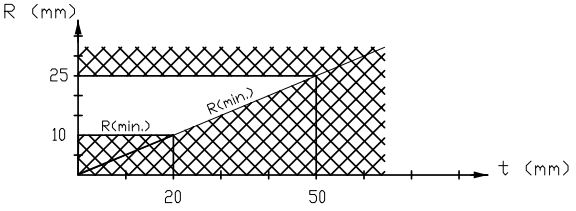
α = BRANCH ANGLE WITH CHORD

β = ANGLE BETWEEN TANGENT LINE TO CHORD AND BEVELLED EDGE OF BRANCH

T = WELD LENGTH ON CHORD SIDE
"T" TO BE AS PER FOLLOWING TABLE UNLESS OTHERWISE NOTED

Ψ	WELD TYPE	MIN. "T"
155° TO 180°	1	2.00 t
135° TO 155°	2	2.00 t
65° TO 135°	3	1.50 t
30° TO 65°	4	1.75 t
25° TO 40°	5	2.00 t

R = RADIUS AT WELD TOE



POSSIBLE VALUES OF R VERSUS t
R ≥ t/2 AND 10mm ≤ R ≤25mm

PROHIBITED ZONE FOR R

t = BRANCH THICKNESS

g = ROOT PASS OPENING

FOLIO 2 – 5/5

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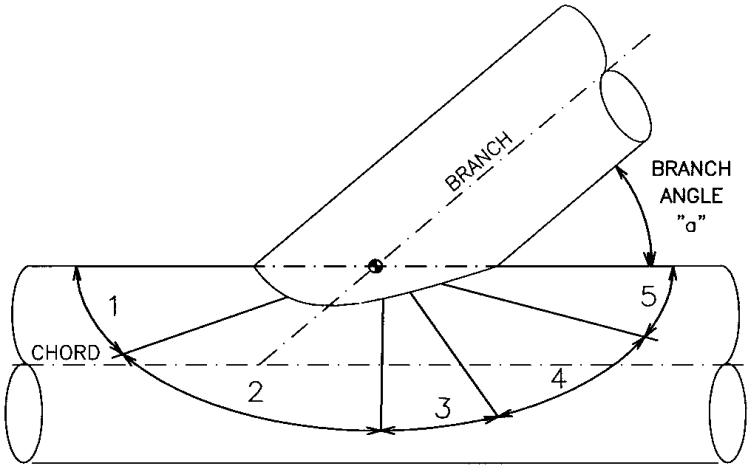
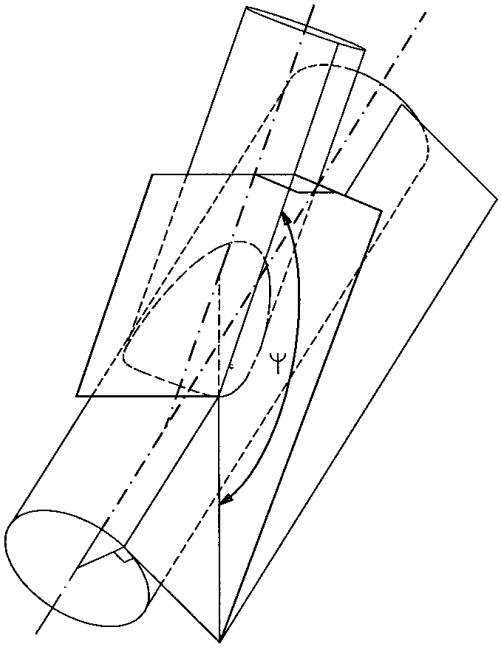
Appendix 2

TYPICAL LOCATION OF THE WELD TYPES



NOTE:
EXAMPLE SHOWING TYPICAL LOCATIONS WHERE THE NUMBERED WELD DETAIL TYPES (1 TO 5) SHALL BE USED ALONG THE LINE OF THE WELD.
(TRANSITIONS BETWEEN TYPES SHALL BE GRADUAL)

LOCAL DIHEDRAL



ANGLE "Ψ" IS THE ANGLE FORMED BY THE EXTERIOR SURFACES OF THE BRACE AND CHORD AT ANY POINT ON THEIR JOINT LINE (LOCAL DIHERAL ANGLE)

FOLIO 3 – 1/5

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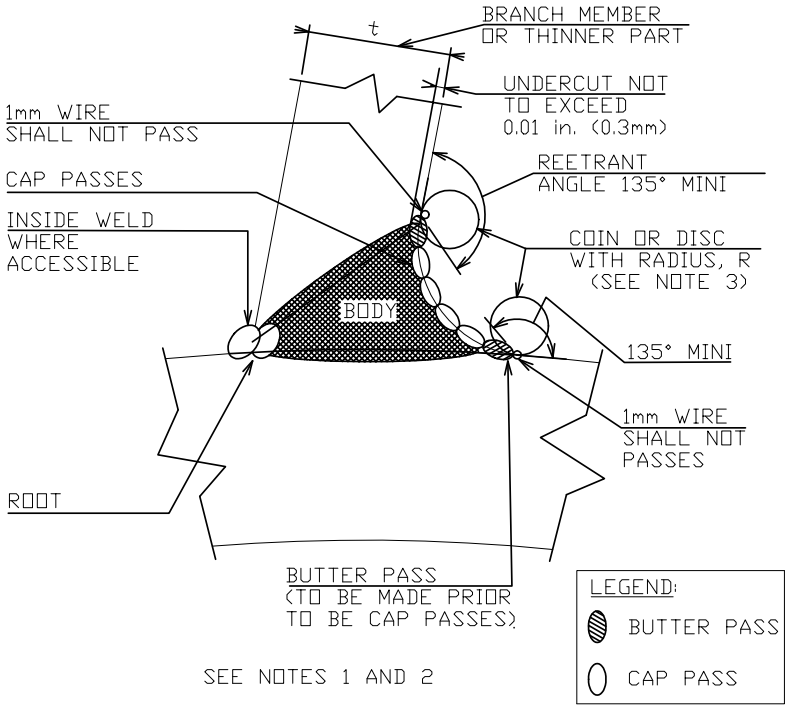
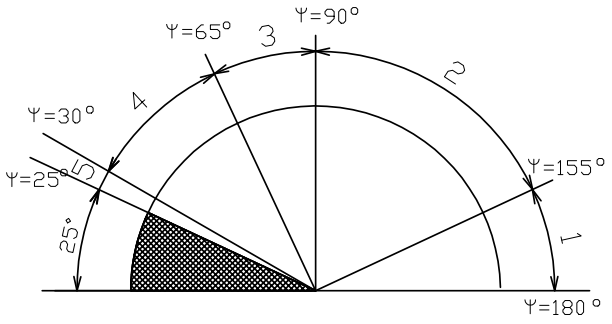
Appendix 2

DISC TEST FOR IMPROVED WELD PROFILE CONTROL



WELD TYPE VERSUS Ψ



FOLIO 3 – 2/5

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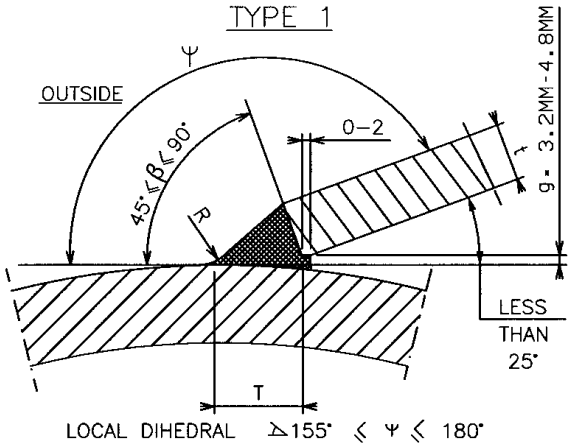
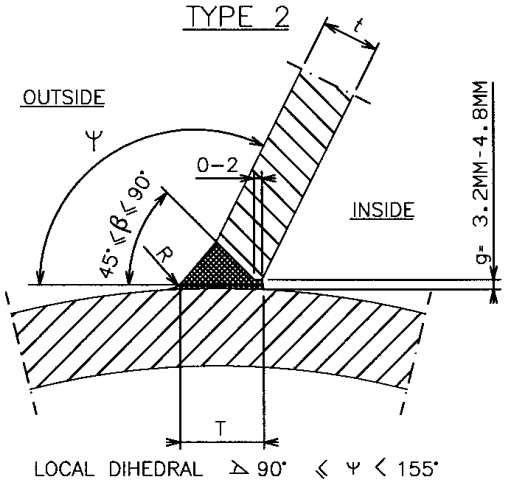
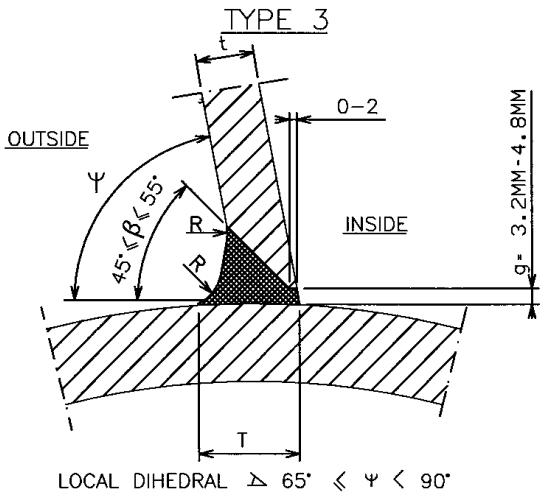
Appendix 2







FOLIO 3 – 3/5

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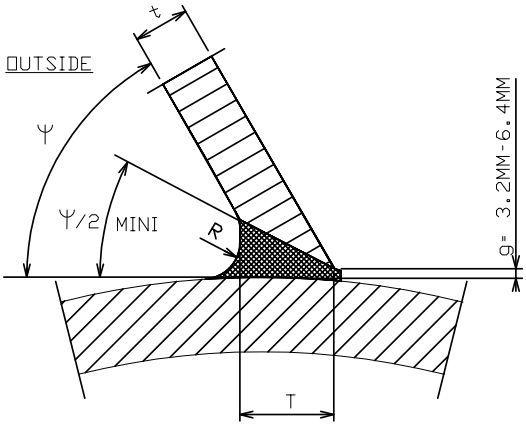
Appendix 2

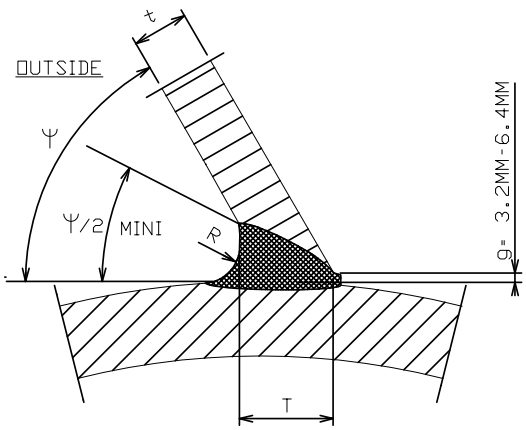
TYPE 4



LOCAL DIHEDRAL ∠ 30° ⩽ Ψ ⩽ 65°

NO ROOT FACE

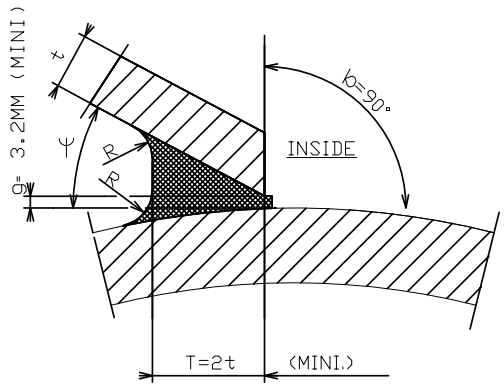
TYPE 4
(ALTERNATE)



LOCAL DIHEDRAL ∠ 30° ⩽ Ψ ⩽ 65°

GROOVE OPENED BY ARC GOUGING

TYPE 5



LOCAL DIHEDRAL ∠ 25° ⩽ Ψ ⩽ 30°

FOLIO 3 – 4/5

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Appendix 2

NOTES:

1- MPI INDICATION,EXCESSIVE CONVEXITY,OR UNDERCUT IN WELD TOE PASSES OR BETWEEN ADJACENT PASSES SHALL BE CORRECTED BY LIGHT GRINDING.

2- FINAL GRINDING MARKS SHALL BE TRANSVERSE TO THE LONGITUDINAL WELD AXIS.

3- THEORETICAL RADIUS R= t/2 , EXCEPT THAT
5/16 in.$\leq$ R $\leq$1 in.
OR (8mm $\leq$R $\leq$25mm)

4- THE WHOLE WELD THICKNESS INCLUDING TO SO-CALLED "BACK-UP WELD" IN AWS D1.1 SHALL BE SUBJECT TO INSPECTION CLASS X.

5- FOR Ψ BETWEEN 30° TO 40° CONTRACTOR TO SELECT WELD TYPE 4, 4 ALTERNATE OR TYPE 5 DEPENDING ON WELDING ACCESSIBILITY.

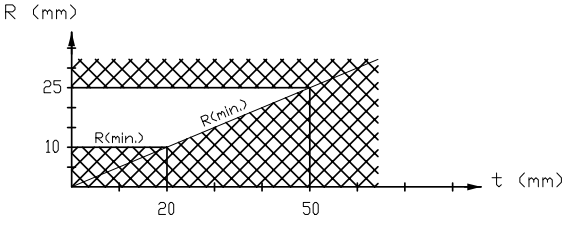
α = BRANCH ANGLE WITH CHORD

β = ANGLE BETWEEN TANGENT LINE TO CHORD AND BEVELLED EDGE OF BRANCH

T = WELD LENGTH ON CHORD SIDE
"T" TO BE AS PER FOLLOWING TABLE UNLESS OTHERWISE NOTED

Ψ	WELD TYPE	MIN. "T"
155° TO 180°	1	1.75 t
90° TO 155°	2	1.50 t
65° TO 90°	3	1.25 t
30° TO 65°	4	1.50 t
25° TO 40°	5	2.00 t

R = RADIUS AT WELD TOE



POSSIBLE VALUES OF R VERSUS t
R $\geq$ t/2 AND 10mm $\leq$ R $\leq$ 25mm

PROHIBITED ZONE FOR R

t = BRANCH THICKNESS
g = ROOT PASS OPENING

FOLIO 3 – 5/5

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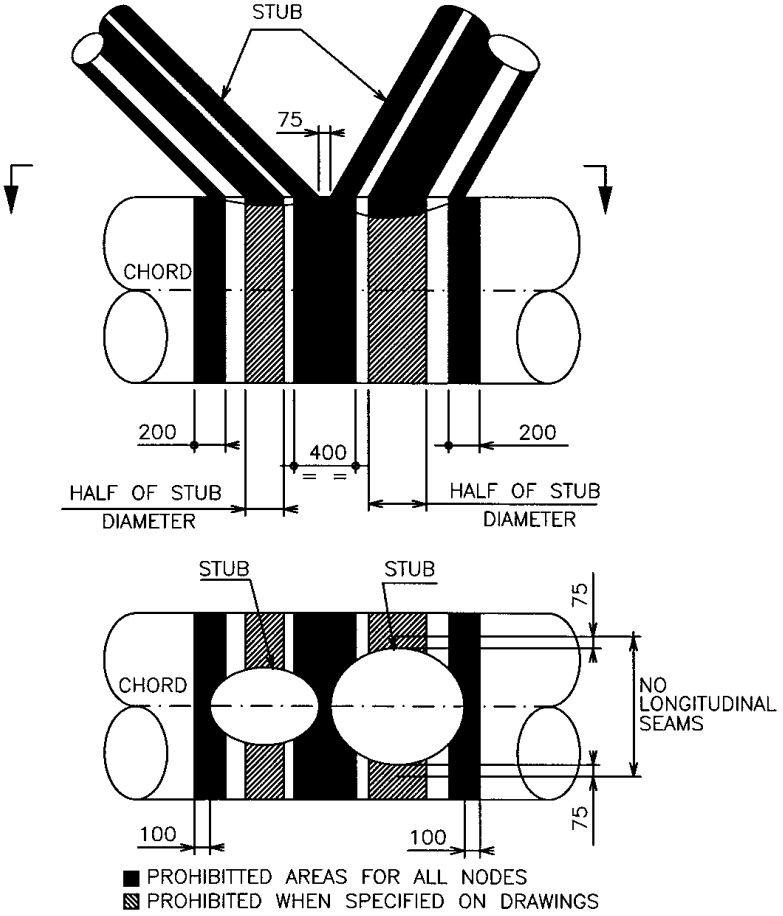
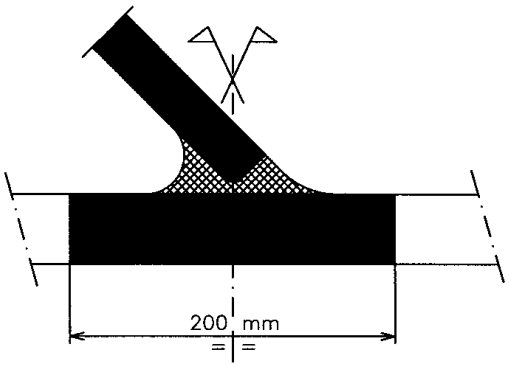
PROHIBITED AREAS FOR STUB LONGITUDINAL SEAMS AND BARREL CIRCUMFERENCIAL SEAMS



TYPICAL DETAIL AT STUB INTERSECTIONS



FOLIO 4 – 1/3

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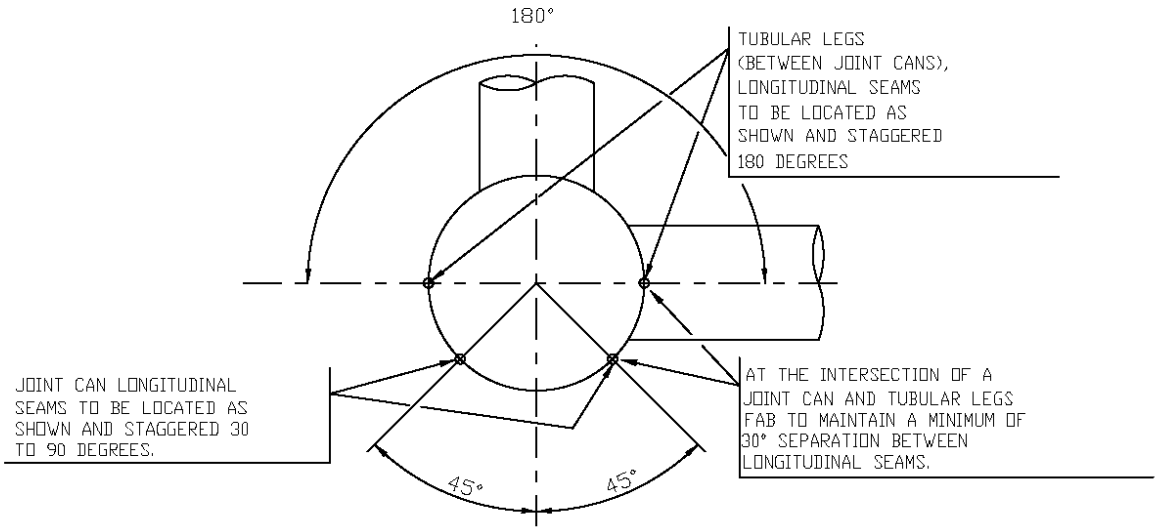
Appendix 2

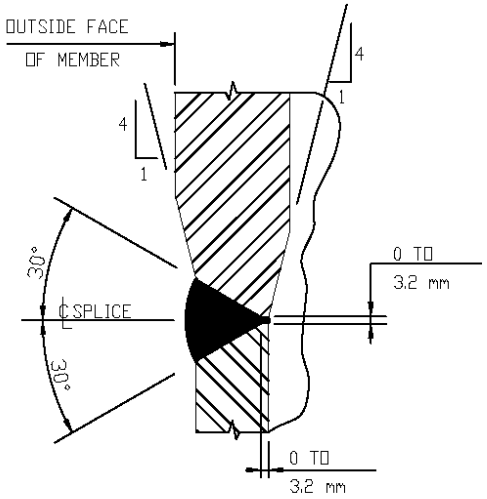
LONGITUDINAL WELD SEAM LOCATION DETAIL

LEGS

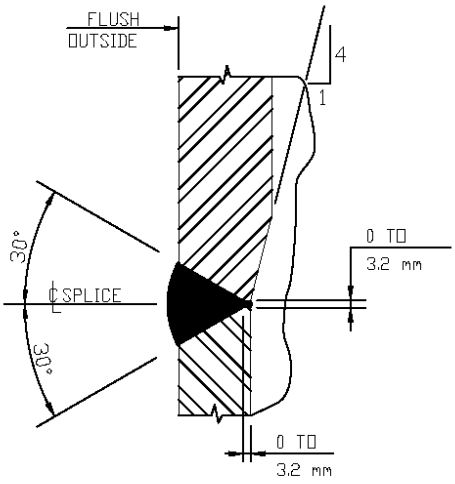


TYPICAL GIRTH WELD DETAILS

DETAIL 1



DETAIL 2



FOLIO 4 - 2/3

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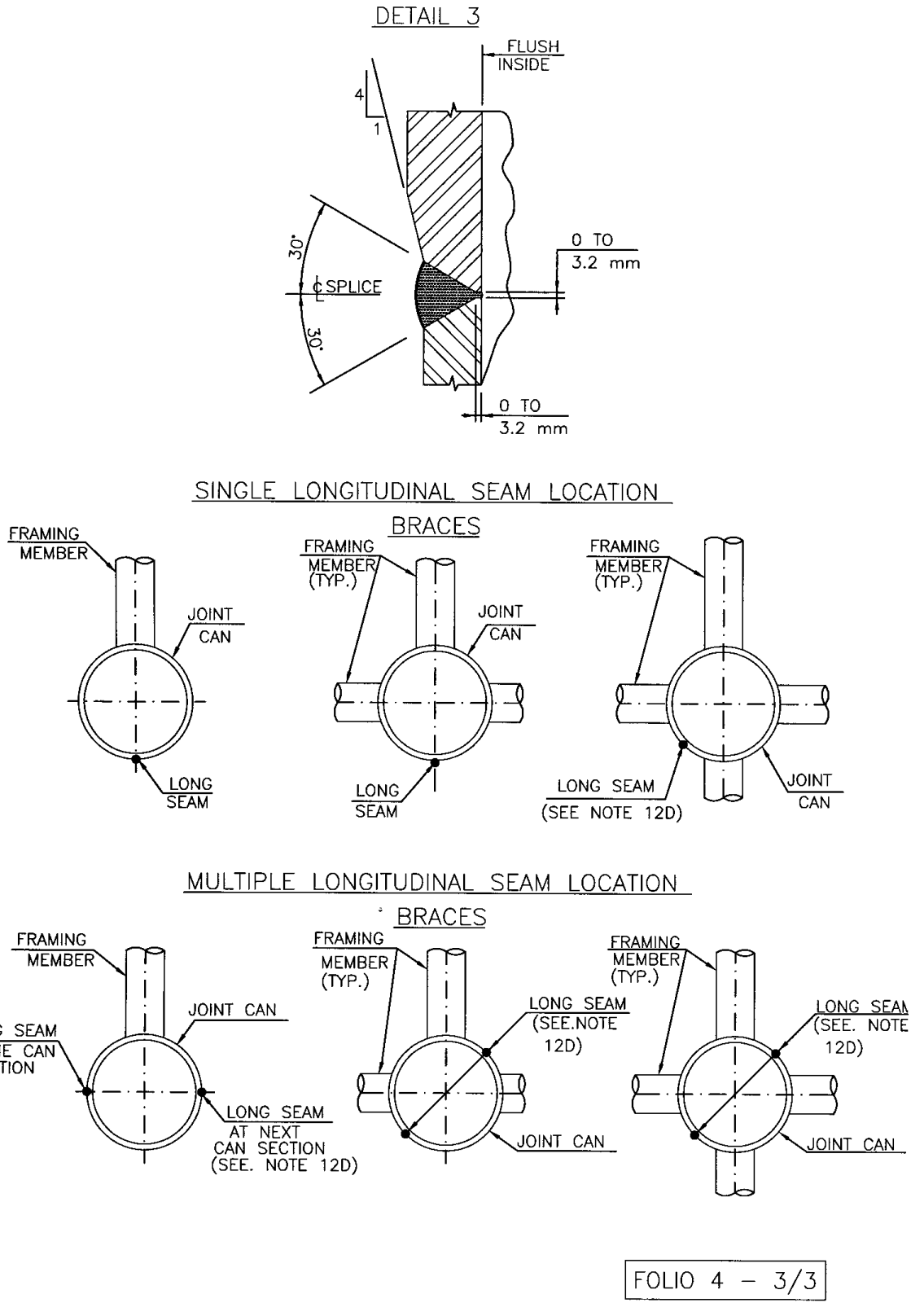

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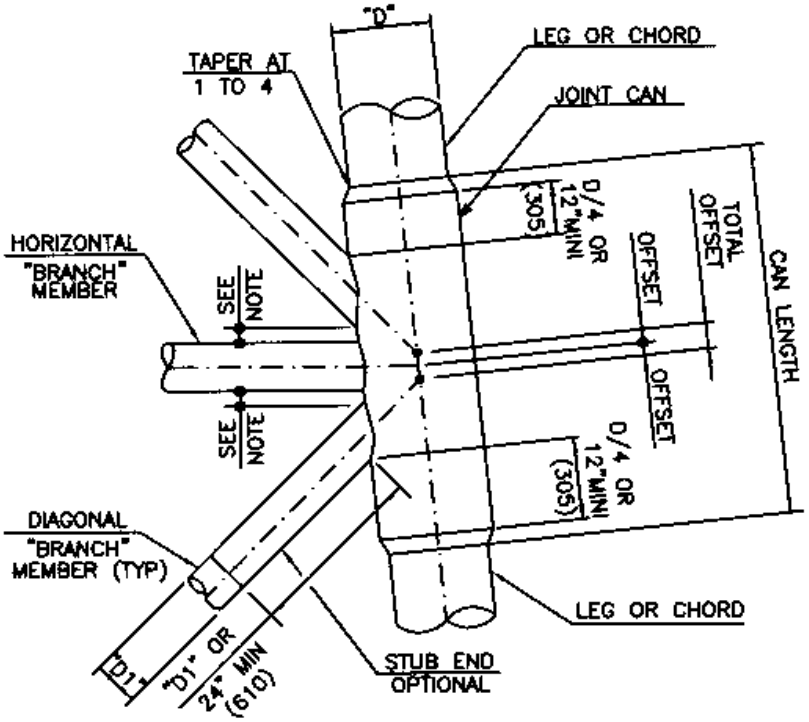
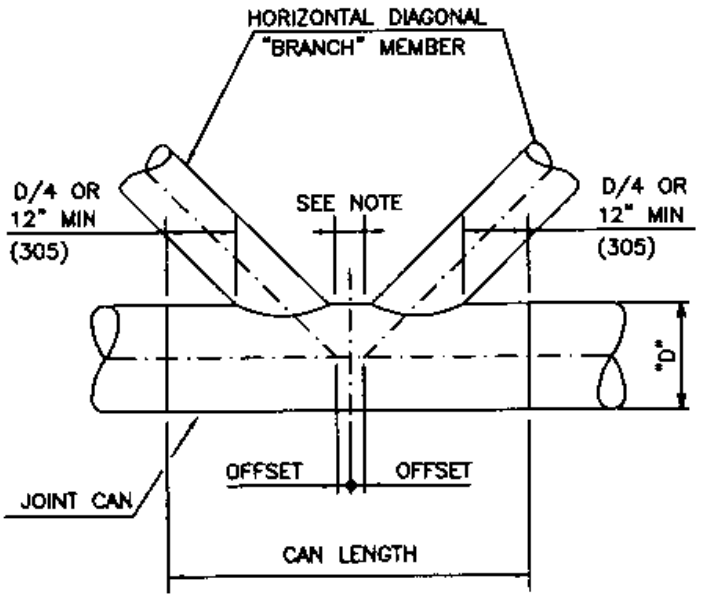
Appendix 2

FRAMING CONDITION I



FRAMING CONDITION II



FOLIO 5 – 1/4

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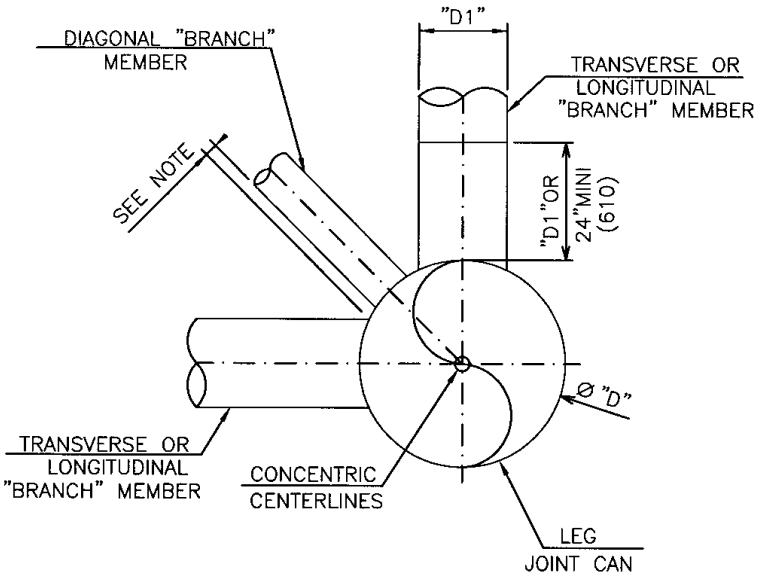
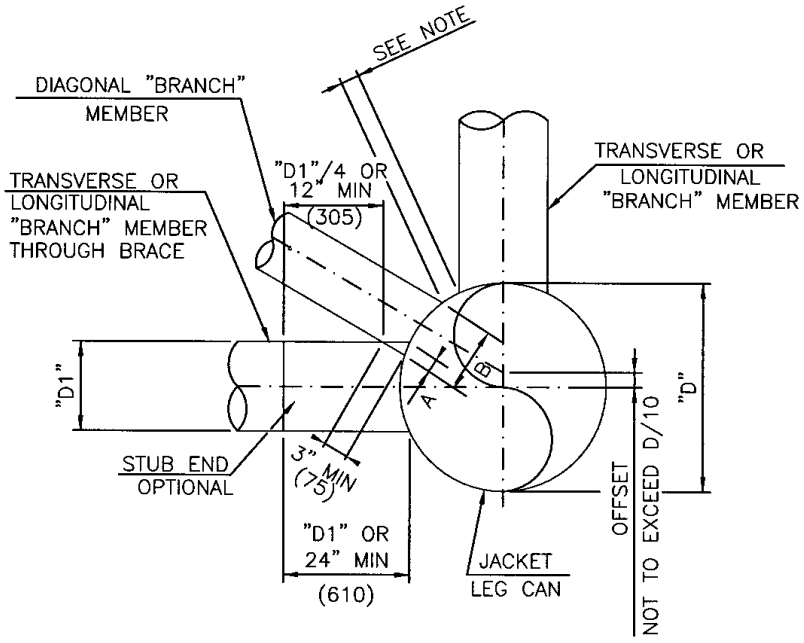
Appendix 2

FRAMING CONDITION III



FRAMING CONDITION IV

A = 0.3 B MIN
0.5 B MAX



FOLIO 5 – 2/4

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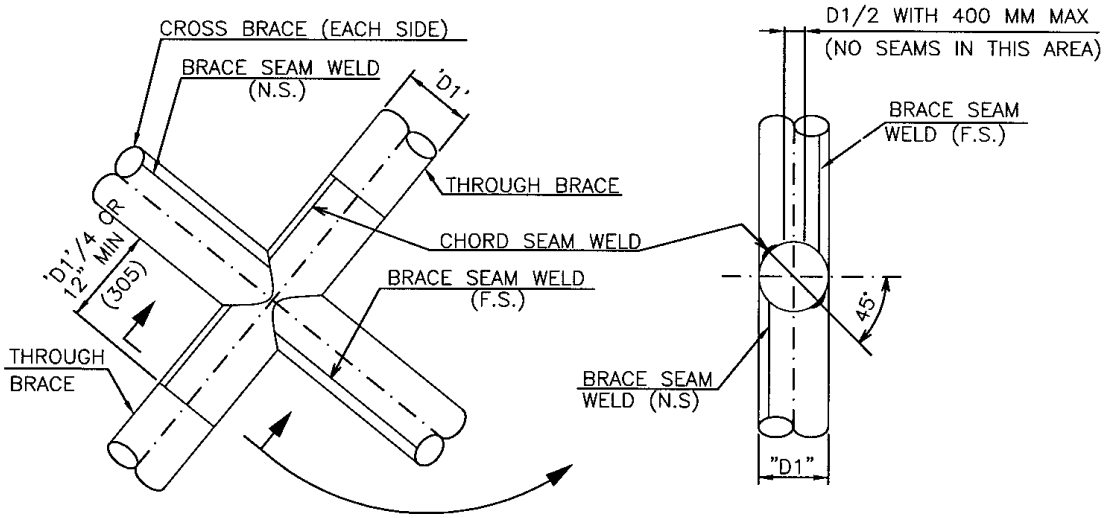
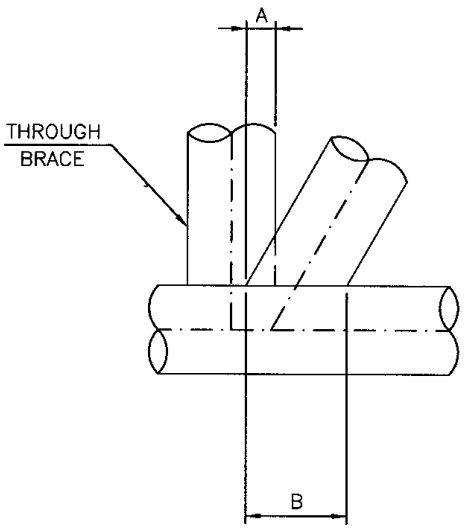
FRAMING CONDITION V

TYPICAL LONGITUDINAL SEAM WELD LOCATIONS
X – JOINTS



FRAMING CONDITION VI

A = 0.3 B MIN
0.5 B MAX



FOLIO 5 – 3/4

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NOTES FOR FRAMING CONDITION I:

1– JOINTS SHALL NOMINALLY BE CONCENTRIC WHEREVER POSSIBLE.

2– DIAGONAL AND HORIZONTAL BRACING MEMBERS SHALL NOT OVERLAP AT THEIR INTERSECTION WITH THE HEAVY WALL SECTION OF THE CHORD MEMBER.

3– MINIMUM CLEARANCE BETWEEN WELD TOES OF EACH PAIR OF BRACES SHALL BE EQUAL TO 2 INCHES (50 MM).

4– MAXIMUM THICKNESS OF THE CHORD SHALL EXTEND PAST THE OUTSIDE EDGE OF THE BRACE FOR A MINIMUM OF ONE QUARTER OF THE CHORD DIAMETER "D" OR 12 INCHES (305 MM) EXCLUDING TAPER, WHICHEVER IS GREATER.

NOTES FOR FRAMING CONDITION II:

1– HORIZONTAL JOINTS, WHERE MEMBERS IN ADJACENT PLANES ARE NOT PRESENT, SHALL BE NOMINALLY CONCENTRIC.

2– MAXIMUM THICKNESS OF THE CHORD SHALL EXTEND PAST THE OUTSIDE EDGE OF THE BRACE FOR A MINIMUM OF ONE QUARTER OF THE CHORD DIAMETER "D" OR 12 INCHES (305 MM) EXCLUDING TAPER, WHICHEVER IS GREATER.

3– INTERSECTIONS OF BRACE AND CHORD CENTERLINES MAY BE OFFSET TO MAINTAIN THE 2 INCHES (50 MM) MINIMUM CLEARANCE.

NOTES FOR FRAMING CONDITION III AND IV:

1– JOINTS SHALL BE NOMINALLY CONCENTRIC WHEREVER POSSIBLE.

2– WHERE BRACE MEMBERS OF UNEQUAL WALL THICKNESS OVERLAP, THE MEMBER WITH THE THICKEST WALL SHALL ALWAYS BE THE THROUGH MEMBER REGARDLESS OF DIAMETER.

3– WHERE BRACE MEMBERS OF EQUAL WALL THICKNESS OVERLAP, THE MEMBER WITH THE LARGEST DIAMETER SHALL BE THE THROUGH MEMBER.

4– WHERE BRACE MEMBERS OF EQUAL WALL THICKNESS AND DIAMETER OVERLAP AT CONGESTED HORIZONTAL JOINTS, THE LONGITUDINAL AND TRANSVERSE MEMBERS SHALL BE THE THROUGH MEMBERS. OTHER MEMBERS SHALL OVERLAP A MINIMUM OF 3 INCHES (75 MM).

5– THROUGH MEMBERS SHALL BE INSTALLED FIRST. NO WINDOWS SHALL BE CUT WITHOUT PRIOR COMPANY APPROVAL.

6– MAXIMUM THICKNESS OF THE CHORD SHALL EXTEND PAST THE OUTSIDE EDGE OF THE BRACE FOR A MINIMUM OF ONE QUARTER OF THE CHORD DIAMETER "D" OR 12 INCHES (305 MM) EXCLUDING TAPER, WHICHEVER IS GREATER.

NOTE: (FOR FRAMING CONDITIONS I THRU IV)
2" (50 MM) MIN. WELD TOE.
3" (75 MM) MIN. BETWEEN BRACE TRACE UNLESS NOTED OTHERWISE.

FOLIO 5 – 4/4

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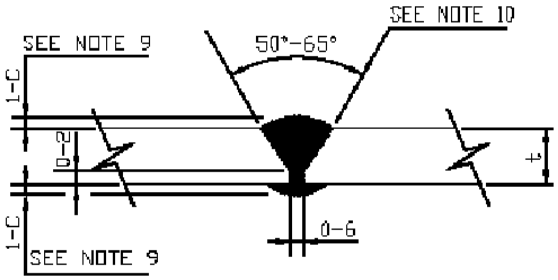
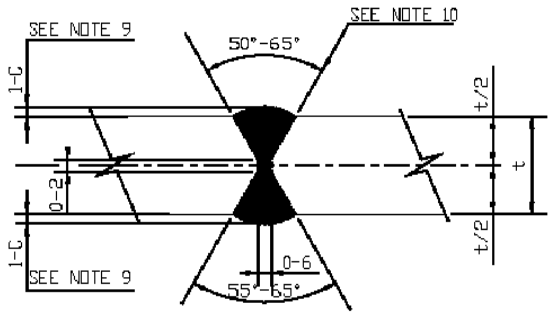
Appendix 2

1 DETAIL
0015 SCALE : /

EQUAL THICKNESS BUTT

PLATE OR TUBE BUTT





FOLIO 6 – 1/7

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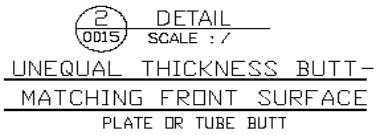

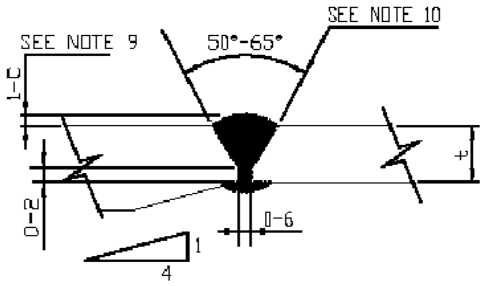

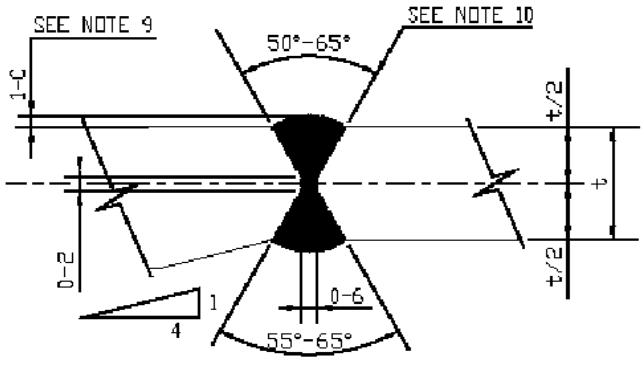

FOLIO 6 – 2/7

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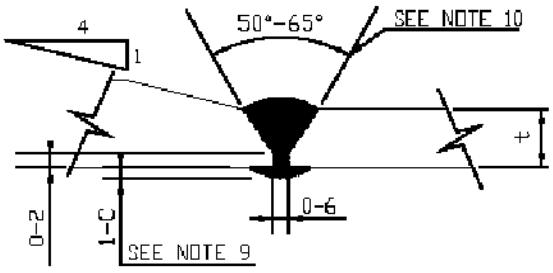
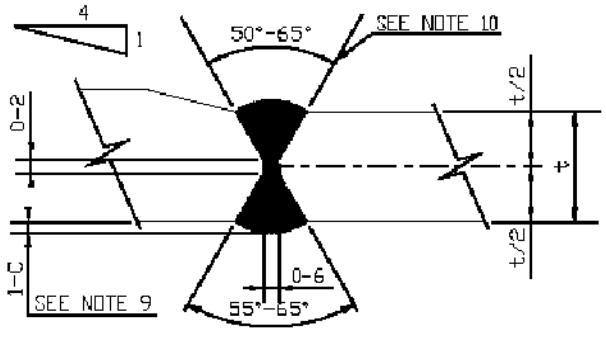
Appendix 2

3 (0015) DETAIL
SCALE : /

UNEQUAL THICKNESS BUTT-
MATCHING REAR SURFACE
PLATE OR TUBE BUTT





FOLIO 6 – 3/7

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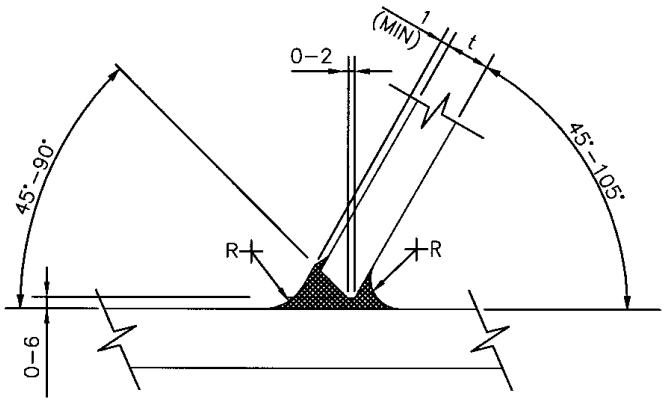
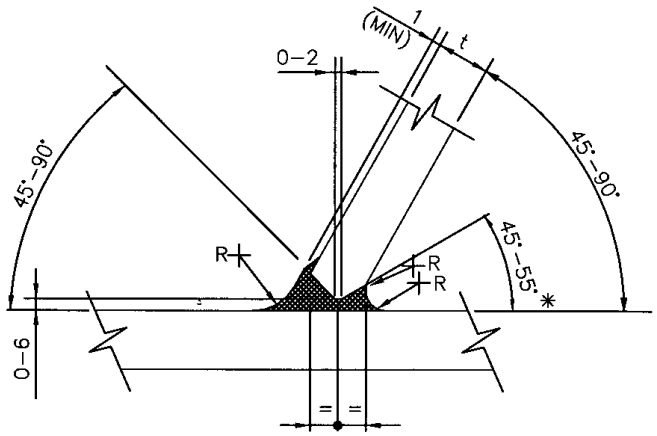
Appendix 2

DETAIL 4
T BUTT–PLATE



R = t/4 MIN. SEE NOTE 6



R = t/4 MIN. SEE NOTE 6

* ANGLE VALUE MANDATORY

FOLIO 6 – 4/7

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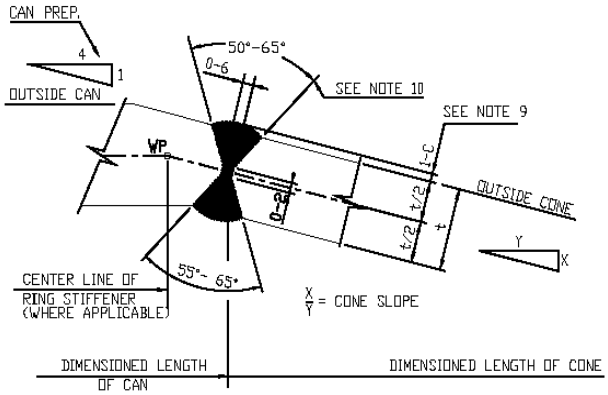
Appendix 2

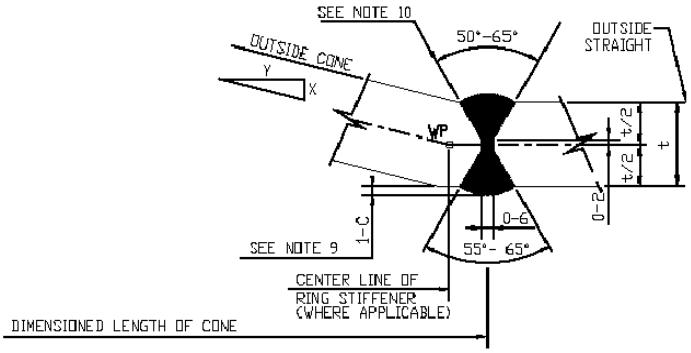
5 0015 DETAIL
SCALE : /

CONE TO TUBE
(WHERE APPLICABLE)

CAN TO CONE



CONE TO STRAIGHT



FOLIO 6 – 5/7

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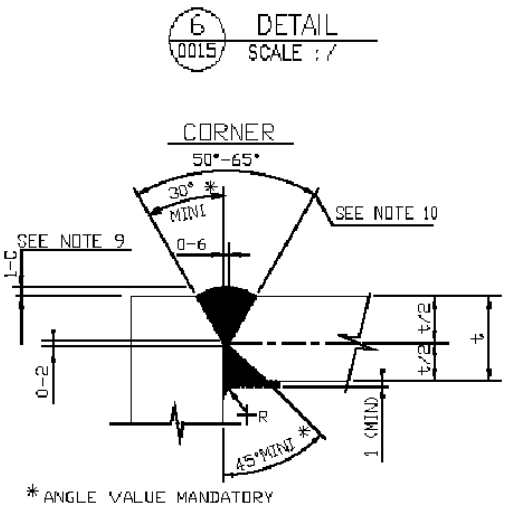

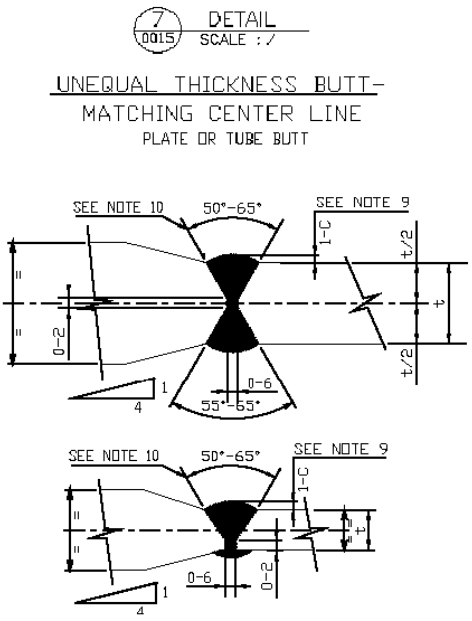

FOLIO 6 – 6/7

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Appendix 2

GENERAL NOTES:

1- ALL GROOVE WELDS SHALL BE WELDED FROM BOTH SIDES UNLESS AGREED IN WRITING BY COMPANY TO BE IMPRACTICAL OR UNLESS SHOWN AS WELDED FROM ONE SIDE ONLY ON THE DESIGN DRAWINGS.

2- UNLESS NOTED OTHERWISE, ALL STEEL SHALL BE JOINED BY COMPLETE PENETRATION GROOVE WELDS.

3- WELD DETAILS DESCRIBED ON THESE WELDING DETAIL DRAWINGS ARE APPLICABLE UNLESS EXPLICITLY NOTED OTHERWISE ON THE DESIGN DRAWINGS.

4- DETAILS SHOWN ARE APPROPRIATE FOR SMAW OR S.A.W. PROCESSES ONLY. IF OTHER WELDING PROCESSES ARE ALLOWED BY COMPANY DIMENSIONS, ANGLES AND TOLERANCES MAY BE REVISED SUBJECT TO AGREEMENT BY THE COMPANY.

5- DIMENSIONS AND ANGLES OF WELDING PREPARATIONS MAY BE SUBJECT TO VARIATION DEPENDING ON WELDING PROCEDURES AGREED WITH THE COMPANY.

6- ALL WELD PROFILES SHALL CONFORM TO THE REQUIREMENTS OF THE APPROPRIATE FABRICATION SPECIFICATION.

7- WELD PROFILE RADII INDICATE THE REQUIRED AVERAGE AS WELDED SHAPE ONLY AND DO NOT CALL FOR SURFACE GRINDING UNLESS SPECIFIED ELSEWHERE.

8- BALANCED WELD PREPARATIONS ARE RECOMMENDED FOR T > 20 mm.

9- THE MAXIMUM BUTT WELD REINFORCEMENT 'C' SHALL NO EXCEED THE FOLLOWING:

PLATE THICKNESS t (mm)	C (mm)
6 < t < 25	3
25 < t < 50	4
50 < t	5

10- ALL BEVELS SHALL BE INDIVIDUALLY 20°, 30°, 45° WITH REGARD TO THE UT INSPECTION SURFACE.

FOLIO 6 – 7/7

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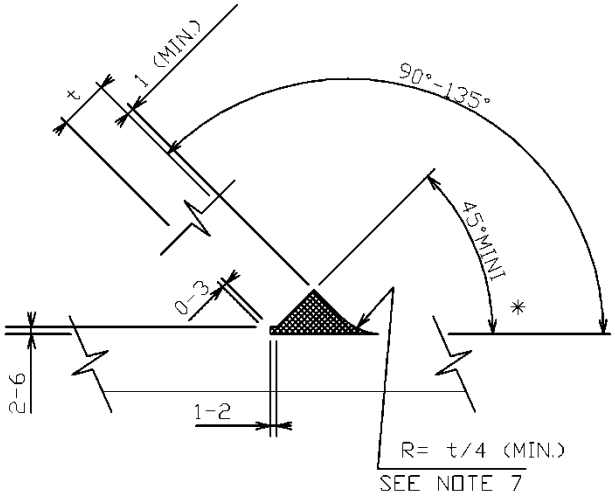
Appendix 2

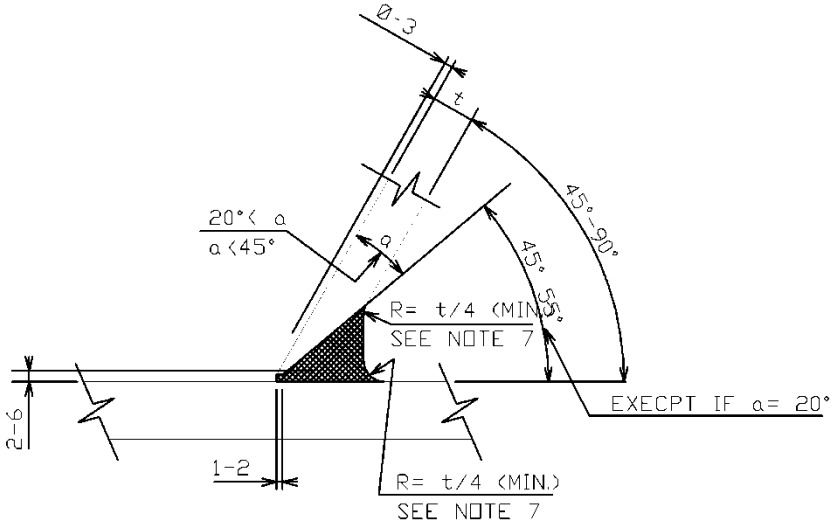
DETAIL 1

T BUTT-PLATE



"T" BUTT (OBTUSE)

* ANGLE VALUE MANDATORY



"T" BUTT (ACUTE)

FOLIO 7 1/4

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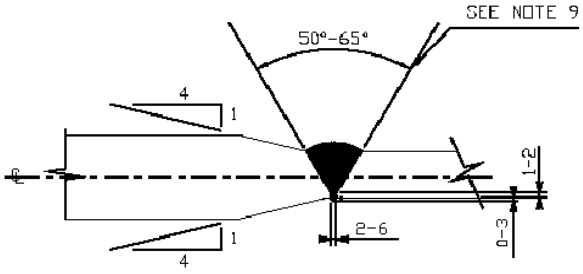
Appendix 2

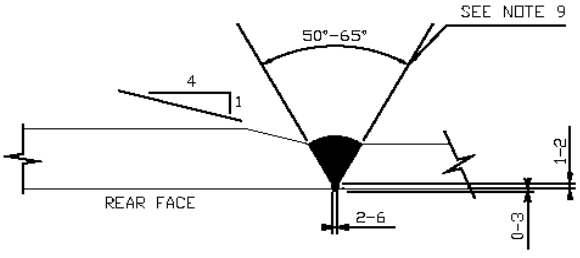
2 0016 DETAIL
SCALE : NONE

UNEQUAL THICKNESS BUTT
MATCHING CENTRE LINES
PLATE OR TUBE BUTT



3 0016 DETAIL
SCALE : NONE

UNEQUAL THICKNESS BUTT
MATCHING REAR SURFACE
PLATE OR TUBE



FOLIO 7 – 2/4

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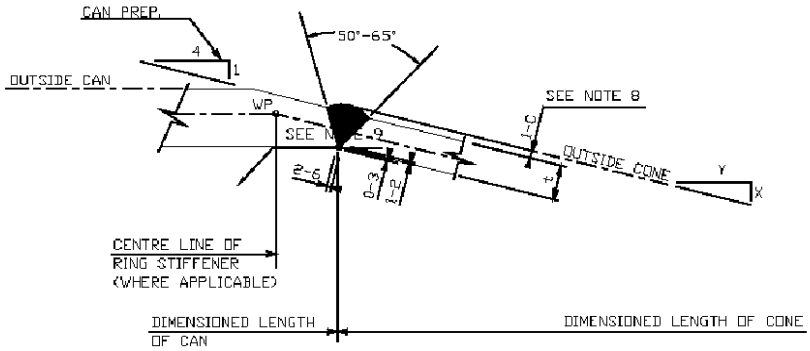
Appendix 2

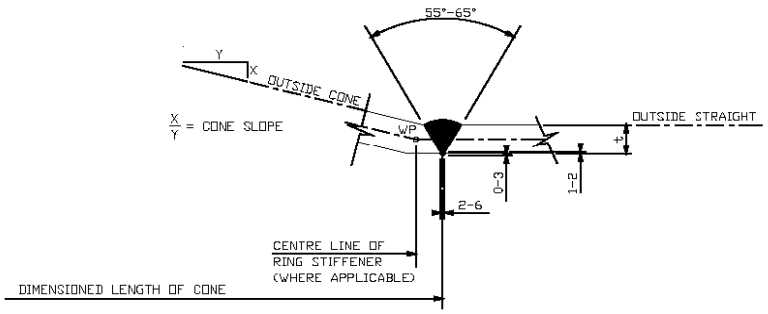
4 D016 DETAIL
SCALE : NONE

CONE TO TUBE

CAN TO CONE



CONE TO STRAIGHT



FOLIO 7 – 3/4

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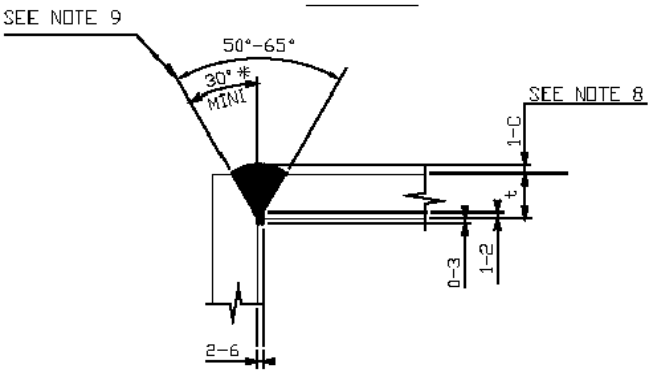
Appendix 2

5 / 0016 DETAIL
SCALE : NONE

CORNER



*ANGLE VALUE MANDATORY

NOTES:

1- WHERE ACCESS IS UNPRACTICAL OR AS SHOWN ON DESIGN DRAWING, AND AGREED IN WRITING BY COMPANY,SINGLE SIDED WELDS MAY BE USED AS SHOWN ABOVE.

2- UNLESS NOTED OTHERWISE, ALL STEEL SHALL BE JOINED BY COMPLETE PENETRATION GROOVE WELDS.

3- WELD DETAILS DESCRIBED ON THESE WELDING DETAIL DRAWINGS ARE APPLICABLE UNLESS EXPLICITLY NOTED OTHERWISE ON THE DESIGN DRAWINGS.

4- DETAILS SHOWN ARE APPROPRIATE FOR SMAW OR S.A.W. PROCESSES ONLY. IF OTHER WELDING PROCESSES ARE ALLOWED BY COMPANY DIMENSIONS, ANGLES AND TOLERANCES MAY BE REVISED SUBJECT TO AGREEMENT BY THE COMPANY.

5- DIMENSIONS AND ANGLES OF WELDING PREPARATIONS MAY BE SUBJECT TO VARIATION DEPENDING ON WELDING PROCEDURES AGREED WITH THE COMPANY.

6- ALL WELD PROFILES SHALL CONFORM TO THE REQUIREMENTS OF THE APPROPRIATE FABRICATION SPECIFICATION.

7- WELD PROFILE RADII INDICATE THE REQUIRED AVERAGE AS WELDED SHAPE ONLY AND DO NOT CALL FOR SURFACE GRINDING UNLESS SPECIFIED ELSEWHERE.

8- THE MAXIMUM BUTT WELD REINFORCEMENT 'C' SHALL NO EXCEED THE FOLLOWING:

PLATE THICKNESS t (mm)	C (mm)
6 < t < 25	3
25 < t < 50	4
50 < t	5

9- ALL BEVELS SHALL BE INDIVIDUALLY 20°, 30°, 45° WITH REGARD TO THE UT INSPECTION SURFACE.

FOLIO 7 – 4/4

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Appendix 3 Weld History Register model

1	2	3	4	5	6	7	8	9	10	11	12	13	14	14	15	16	17	18	19
							Dimensions						INSPECTION						
Drawing N°	Weld N°	Joint type	Item N° :	Heat N°	Structural members category	STEEL DESIGNATION	Diameter (mm)	Thickness (mm)	Welder identification	Position of weld	WPS N°	Date of completion	UT Lamination	Visual	Liquid Penetrant	Magnetic Particle	Radiographic testing	Ultrasonic testing	FINAL INSPECTION COMPANY
	S1	BW	110002-P-01	PX2000 11656	1	S235	NA	15	W0001	PA	WPS 0001	xx/yy/20xx	xx/yy/20xx PV-UT-002	xx/yy/20xx PV-VT-001	NA	xx/yy/20xx PV-MPI-001	NA	xx/yy/20xx PV-UT-002	
			110002-RS-02	SF25669 7882	S	S355	NA	25											

1 Last revision of drawing numbers with all welds identified
2 Identification regarding each weld
For example: S1 pour first weld
S1 R1 for repair

3 type of weld : Fillet(FW), Butt (BW), TKY, with backing or not, CJP or PJP, Tee, etc...
4 Traceability of material: identification. Define if it is a plate, SMLS, welded tubulars, hollow section, rolled section, etc...
5 Traceability of material: Heat number
6 Structural category of item : S, 1, 2 or NS
7 Steel designation as define per GS EP STR 201 or purchased material
8
9 Dimensions of item (Ref 4)
10 Welder's identification
11 Welding Positions (PA, PB, PC, etc...)
12 Reference of Welding Procedure Specification
13 Date of welding completion
14-18 Welding inspection according to §11.15 of the GS EP STR 204
19 Comments from COMPANY

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