

STRUCTURAL STEELWORK SPECIFICATION

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QUALITY CHECK SHEET

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INTRODUCTION

REFERENCE TO NATIONAL STRUCTURAL STEELWORK SPECIFICATION

The National Structural Steelwork Specification (NSSS) for Building Construction 6th Edition, as modified by this project specification, applies to the project. The specification shall be read in conjunction with the General Contract Preliminaries, the General Civil and Structural Specification “SP-1001”, the Civil and Structural Drawings and all other Contract Documents.

The NSSS for Building Construction 6th Edition has been prepared for use in the UK. References to UK codes in the NSSS shall be replaced with reference to the equivalent current Irish code. Notable differences are highlighted in the following table.

Code reference in NSSS		
Location	UK Code Reference	Irish Code Reference
2.3.1	BS EN 756 S/S	IS EN ISO 14171
2.4.8	BS 7371 S/S	IS EN ISO 15502
5.2.1	BS EN 287 S/S	IS EN ISO 9606-1
5.2.1	BS EN 1418 S/S	IS EN ISO 14732
5.2.2	BS EN 287-S/S	IS EN ISO 9606-1
5.5.1	BS EN 12062	IS EN ISO 17635
5.5.3	BS EN 473	IS EN ISO 9712
5.5.5	BS EN 571-1	IS EN ISO 3452-1
5.5.5	BS EN 970	IS EN ISO 17637
5.5.5	BS EN ISO 17638	IS EN ISO 17638
5.5.5	BS EN 473	IS EN ISO 9712
5.5.6	BS EN 473	IS EN ISO 9712
5.5.6	BS EN 1714	IS EN ISO 17640
5.6.1	BS EN 1418	IS EN ISO 14732

KEY DEFINITIONS

As per the NSSS with the following modifications.

<i>Examiner/ Examining Body</i>	<i>An independent person or organisation who has been accredited by UKAS/NSAI (ISO 9001) as being competent to verify compliance of welder tests to IS EN ISO 9606-1 and welding tests to IS EN ISO 15614. Personnel who witness procedures shall be approved inspectors (PCN, EN 473) and approvals shall be by a qualified welding technologist (certified IWT or above).</i>
<i>Fillet Weld (FW)</i>	<i>A fillet weld is normally between two plates at right angles. It can also apply to plates lapped (lap weld).</i>
<i>Full Penetration Butt Weld (FPBW)</i>	<i>A weld that is fully fused for the full thickness of the material.</i>
<i>Full Strength Butt Weld (FSBW)</i>	<i>A weld that is not full penetration but is designed to develop the full strength of the connection, it may have an un-fused land in the centre.</i>
<i>Partial Penetration Butt Weld (PPBW)</i>	<i>Similar to a FSBW but is not designed to develop the full strength of the connection and will have an un-fused land</i>
<i>Works, The</i>	<i>Structural Steelwork on the Contract drawings</i>

INFORMATION REQUIRED BY STEELWORK CONTRACTOR

1.1 PROJECT SPECIFICATION FOR STRUCTURAL STEELWORK

1.1.1 PROPOSED WORKS

1.1.1.1 A BRIEF DESCRIPTION OF THE WORKS

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.1.2 INTENDED PURPOSE OF THE STRUCTURE

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.1.3 DETAILS OF THE SITE

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.1.4 BUILDING CLASS

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

The project Execution Class is EXC2 as per IS EN 1090.

1.1.1.5 EXTERNAL PARTS OF THE STRUCTURE

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

All steel in contact with the outer leaf of the structure shall be deemed external.

1.1.1.6 EXECUTION CLASS 1

All parts shall be manufactured to Execution Class is EXC2 as per IS EN 1090.

1.1.2 DESIGN

1.1.2.1 DESIGN CONCEPT

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.2 DESIGN DRAWINGS

Refer to the Civil and Structural Drawings.

1.1.2.3 DOCUMENT MANAGEMENT SYSTEMS

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.4 DESIGN STANDARDS FOR CONNECTION DESIGN

The connections shall be designed to I.S EN 1993. For simple connections, the methods in BCSA/SCI green book or ECCS Technical publication 126 should be used where practical. For moment connections, the principles in the SCI/BCSA green books should be used where practical. Where full strength welds are not full penetration welds, account shall be taken of any eccentricity between the welds and the connected part in the design.

1.1.2.5 SCOPE OF DESIGN RESPONSIBILITIES, INCL. PROTECTIVE TREATMENT

All structural steel fabrication and erection shall be carried out in accordance with IS EN 1993.

All connections shall be designed and detailed by the steel fabricator in accordance with IS EN 1993-1-8 and agreed with the Engineer.

All steel works to be measured on-site and developed based on fabricator final details.

External steel shall be blast cleaned to SA 2 ½ finish to be painted or hot dip galvanized to BS EN ISO 1461 as noted in the Structural and Architectural Specification and Drawings. External steel shall at a minimum be hot dip galvanised to BS EN ISO 1461 unless otherwise noted.

All galvanised steelwork shall be subjected to post-galvanised inspection in accordance with procedure PGI- 1 in Table 10.

All steel shall be fire protected as per the fire certificate and associated drawings.

1.1.2.6 INFORMATION NECESSARY TO DESIGN THE CONNECTIONS

Refer to the Civil and Structural Drawings.

Design loading shall be provided at detailed design where required.

1.1.2.7 AESTHETIC, STRUCTURAL OR CLEARANCE LIMITS

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.8 DETAILS AND LOCATIONS OF ANY TEMPORARY WORKS ASSUMED BY THE ENGINEER IN THE DESIGN

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.9 DRAWINGS, BIM MODELS, CALCULATIONS AND OTHER INFORMATION

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

Fabrication drawings and design calculations (where required) shall be provided to the Engineer. A schedule of drawings and calculations shall be agreed prior to commencement of the Works.

1.1.2.10 MANUFACTURING PROCESSES RESTRICTIONS

Punching of holes in structural steel members shall be agreed with the Engineer prior to commencement of the Works.

1.1.2.11 DETAILS OF ANY DYNAMIC OR VIBRATING FORCES AND IF FATIGUE IS TO BE CONSIDERED

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.12 THE DESIGNATION OF THE STEEL

All Structural Steel is to be Grade S355 J0 as per IS EN 10025 and IS EN 10210 or equivalent standard approved by the Engineer

1.1.2.13 ADDITIONS, STIFFENERS AND NOTCHING

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

No notching shall be permitted without prior consent of the Engineer.

1.1.2.14 BOLT ASSEMBLIES AND THEIR COATINGS

All bolts to be stainless steel of minimum grade 1.4404 as per IS EN 10088 (SS 316) to a Specification agreed with the Engineer. All bolts grade to be Grade 8.8.

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.15 FIXINGS OR BOLTS TO THE FOUNDATIONS OR WALLS

See section 1.1.2.5.

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.16 THICKNESS AND TYPE OF BEDDING MATERIAL (GROUT) TO BE USED UNDER COLUMN BASE PLATES

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.17 FABRICATION DETAIL AND/OR RESTRICTION ON TYPES OF CONNECTION TO BE USED

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.18 CUT-OUTS, HOLES OR FITTINGS REQUIRED FOR USE BY OTHERS

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

The Contractor shall be responsible for coordination of all disciplines for full execution of the Works.

1.1.2.19 CAMBER AND PRESETS

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

Cambers shall be applied to retrofitted beams. Details of the required camber shall be agreed with the Engineer in advance of the Works.

1.1.2.20 PROPRIETARY STEEL COMPONENTS I.E. CELLULAR BEAMS, METAL DECKING, COLD ROLLED SYSTEMS.

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.21 SPECIAL MATERIAL TRACEABILITY REQUIREMENTS

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.22 SPECIAL MATERIAL REQUIREMENTS FOR CURVED MEMBERS

Refer to the General Civil and Structural Specification “SP-1001” and the Civil and Structural Drawings.

1.1.2.23 OPTIONAL CRITERIA CONTAINED IN BS EN 1090-2

N/A

1.2 BIM

Not required as part of this project, unless otherwise noted in the Contract Documents.

1.3 WORKMANSHIP

- I. All surfaces visible in the finished structures must be free from hard stamping or other permanent forms of identification.

- II. Requirements for submission of welding procedures are given in 5.3.
- III. Any attachments for the purpose of fabrication and erection shall be removed so that they do not impinge on space required for finishes or services. This shall be carried out to the satisfaction of the architect where steelwork is visible.
- IV. Production test plates are not required.
- V. The scope and frequency of inspection is given in section 5.5. Short plate girders to be considered to be restrained for the purposes of clause 7.4.8.

1.4 ERECTION

- I. Refer to information from the main contractor for site plans showing position of datum level and setting-out lines.
- II. Refer to information from the main contractor for width and level of the prepared working area, access for site traffic, access equipment and cranes, and areas available for storage.
- III. Refer to information from the main contractor for availability of site services and any prearranged procedures for cooperation with other contractors.
- IV. Refer to information from the main contractor for any limitation on dimensions or weights of components to be delivered to the Site or ground capacity limits for heavy loads.
- V. Refer to (vii)
- VI. Refer to information from the main contractor for details of any underground services, overhead cables or site obstructions.
- VII. Design of the erection method and the temporary works is the responsibility of the steelwork contractor.
- VIII. Design of the erection method and the temporary works is the responsibility of the steelwork contractor. Any impact on the permanent works to be brought to the attention of the Design Engineer and LCE.
- IX. Refer to information from the main contractor for a list of the responsibilities at the interface between the steelwork and other trades
- X. Refer to information from the main contractor for a Safe Site Handover Certificate and other information necessary so that the Steelwork Contractor can comply with Section 8 (see 8.3.1).

1.5 PROTECTIVE TREATMENT

As per section 1.1.2.5.

1.6 INSPECTIONS AND TESTS

- I. Information on the requirements for welding procedure trails is given in Section 5. The Engineer shall be given the opportunity to witness these trails and any associated material tests.
- II. Provide five days advance notice for these additional requirements

1.7 PROGRAMME

- I. The steelwork contractor should refer to the key schedule dates contained within the contract documents. Fabrication drawings should only be finalised following completion of the MEP services coordination between Main Contractor and MEP Sub- Contractors. These final fabrication drawings are to include any requirements of the MEP services coordination.
- II. The steelwork contractor should refer to the key schedule dates contained within the contract documents. The steelwork contractor should also note that 15 working days will be allowed for final comment by LCE on behalf of the client on submitted drawings and calculations. Additional periods of 15 working days are to be allowed for comment by the Engineer for each resubmission of drawings and calculations.
- III. The date(s) by which the Site is expected to be ready with foundations prepared, free from obstruction, and accessible; with working surfaces, access roads and storage areas prepared and services available are to be confirmed and agreed with the Construction Manager / Main Contractor.
- IV. The proposed starting and completion dates for erection of steelwork and the dates when other contractors' activities are expected to interface with the steelwork erection programme are to be confirmed and agreed with the Construction Manager / Main Contractor."

2 MATERIALS

2.1 MATERIAL TESTING

The first paragraph is to be modified as shown below. The modifications are in italics. The second paragraph is replaced by that below.

All steel products for use in The Works shall have been specifically tested in accordance with the appropriate product standard in Table 2.1. The steel product manufacturer shall declare the results using an inspection certificate type 3.1 to IS EN 10204. *Mechanical test results in place of a type 3.1 certificate from the manufacturer are not acceptable for production steel or for steel used in welding procedures.*

The steelwork contractor shall obtain the manufacturer's test certificate for the finished product and make it available to the Engineer or Inspection Authority. Steel that is supplied as ingot or slab and subsequently rolled will require additional testing, to be confirmed by the Engineer.

3 INFORMATION PROVIDED BY THE STEELWORK CONTRACTOR

As NSSS apart from:

3.1.1 WELDING

Where any full strength weld consists of a partial penetration butt weld and superimposed fillet the component specification shall clearly show the dimensions of the nominated unfused land within the weld to enable sizing by ultrasonic inspection.

4 WORKMANSHIP - GENERAL

As NSSS, with the following inclusions:

4.1.1 TRACEABILITY OF STEEL

Add: The marking of the steel members is to ensure traceability and facilitate reuse of the steel members.

Add: The Steelwork Contractor shall produce copies of the inspection certificates for inclusion in the Health and Safety and Maintenance Files; these should be submitted to the CA.

4.1.2 MARKING STEELWORK

The second paragraph is to be modified as shown below. The modifications are in italics.

Completed components shall be marked with a durable and distinguishing erection mark, section size, and steel grade in such a way as not to damage the material. Marking shall contain sufficient information to assist checking and re- design post construction during refurbishment and at end of life. Marking should enable the element characteristics to be identified in the construction information provided to the CA for the Health and Safety and Maintenance files. Hard stamping may be used for steel grades up to and including S355, except where otherwise specified in the Project Specification. Marking shall be in a discreet but accessible location for exposed elements to the Architect's approval.

5 WORKMANSHIP - WELDING

The following clauses replace relevant parts in Section 5, National Structural Steelwork Specification, 6th Edition. The requirements take precedence over the NSSS 6th Edition and IS EN 1090.

5.1 GENERAL

Welding shall be a metal arc process in accordance with IS EN 1011-1 and IS EN 1011-2 as appropriate, together with clauses contained in this section.

The Steelwork Contractors system for the management of welding shall meet the standard quality requirements as described in IS EN ISO 3834-3

Note: As a minimum, this requires that welding coordination is undertaken by persons with technical knowledge as that described in IS EN ISO 3834-5 (Certified International Welding Technologist, IWT).

All welding documentation (welder qualifications, welding procedure qualification records, welding procedure specifications and associated work instructions) shall be reviewed for applicability by the person responsible for welding coordination.

Joints shall be prepared in accordance with IS EN ISO 9692, parts 1 and 2. Consideration should be taken when preparing hollow sections to Annex E, IS EN 1090-2. Precautions shall be taken to ensure cleanliness of the connection prior to welding.

5.2 WELDER QUALIFICATION

5.2.1 APPROVAL

Welders shall be tested to meet the requirements of IS EN ISO 9606. Attention shall be paid to Section 9, period of validity.

5.2.2 CERTIFICATION

Welder approvals shall have been witnessed and approved by an Examiner / Examining Body who shall be an independent body accredited by UKAS/NSAI (ISO 9001).

5.2.3 VALIDITY

As required in IS EN ISO 9606 welders shall be tested within 2 years of the previous test (ultrasonic, radiographic) and the report kept with the welder's approval sheet. The welder shall be subject to re-test every 4 years.

5.2.4 LIMITATIONS

Welders shall work within the stipulated limitations as given in IS EN ISO 9606 at all times. Welds completed by welders found to be working outside stated limitations may be required to be removed.

5.3 WELDING PROCEDURES

5.3.1 PREPARATION OF WELDING PROCEDURE SPECIFICATIONS

Formal welding procedure specifications (WPSs) shall be available in accordance with IS EN ISO 15609. They shall comply with the guidance of IS EN 1011-2, Annex C, Method A in the avoidance of hydrogen cracking. Consideration shall be made of the requirements in Annex D to ensure that there is adequate toughness in the heat affected zone of the weld (HAZ). HAZ toughness shall as a minimum be equivalent to the parent steel specification. Generic work instructions are not acceptable.

All WPS shall be approved by the welding coordinator (IWT) before being used in production. Where WPSs are based on previously approved WPQRs they shall be submitted to the Examiner / Examining Body for verification of compliance with IS EN ISO 15614 and IS EN 1011. WPSs shall be made available to the Engineer, Employer or Inspection Authority on request.

Note: The suitability of WPSs for the steel to be welded includes the consideration of the actual carbon equivalent of the steel if this differs from the value (CE) recorded in the WPQR.

5.3.2 APPROVAL OF WELDING PROCEDURES

Welding procedure trials shall be welded using the same premises, equipment, consumables and operatives as planned will be used in construction. They shall be witnessed and approved by an Examiner/Examining Body (EEB). The EEB shall be approved by the engineer prior to appointment. The EEB shall be furnished with all relevant contract documentation and the project specification. It should be noted that the EEB is independent and shall provide information as requested by the Main Contractor or Engineer without recourse to the fabricator. This is to be confirmed in writing by the EEB.

Witnessing of procedures shall be undertaken by approval inspectors employed by the EEB. Inspectors shall be approved (PCN, EN473) and approval of welding procedures and welding procedure specifications shall be by an approved IWT, to IS EN 15614 as a minimum.

Consideration should be made of weld connections of non-standard types that will require approval to IS EN 15613. Particular attention is required for welding procedures used for the welding of hollow sections. This should address both hot (IS EN 10210) or cold (IS EN 10219) formed method of manufacture. Connection design places particular requirements on welding procedures for hollow sections and the requirements shown in IS EN 1090, Annex E should be met.

Approvals may be previously qualified and/or approved to IS EN 288 if equivalent to IS EN 15614, IS EN 15613, IS EN 15614, table 1, has specified tests that have to be conducted to approve the welding procedure. If both hardness tests and impact (Charpy) tests are specified, then impact tests shall be taken from highest impact position and hardness tests from the lowest heat input position to qualify all positions. In addition to the requirements of Table 1 all welding procedures shall have a hardness survey as a minimum.

Where required in section 3 (see 1.2(vii)) they shall be submitted for review by the Engineer at least 2 weeks prior to the start of production. Documents required to support a welding procedure qualification record are as follows:

WPQR

- Full record of all welding parameters, run times and any breaks in welding. Summary information is not acceptable
- Preheat, maintenance and interpass temperatures should be recorded, ambient is not acceptable.
- Complete mechanical test results
- Complete non-destructive test results
- Copy of the original material certificates (which should have either a full chemical analysis or the carbon equivalent)
- Consumable certificates (if available)

Summary documents are not acceptable. All welding trials and testing shall be witnessed and endorsed by the Independent Examiner/Examining Body

Note: Testing as detailed in the application standard does not provide information on mechanical properties of joints in fillet welds, partial penetration welds, tee butts or full strength welds. Where these properties are relevant to the application, an additional approval shall also be held e.g. a butt weld approval. Consideration of toughness data is required when reviewing previously approved procedures or designing new procedures. Double vee, and Single vee preparations do not allow proper sampling on the heat affected zone when making and selecting Charpy specimens. This will normally only be

achieved by using single or double bevel welds. Any toughness results that are open to question shall be revalidated using a bevel preparation. Marginal toughness results will limit the procedure to the minimum toughness of plate to be welded (see section 5.3.2, para 5

Unless otherwise notified, fillet welds, partial penetration welds, full strength butt welds and tee butt welds subject to tensile loads $> 0.5 Y_s$; tests shall be completed by additional cruciform test performed in accordance with guidance provided in IS EN ISO 9018:2003, or as agreed by the Engineer, using project specific material (steel intended to be used for the connections). All tests shall be actual material thickness, thickness ranges in ISO 15614 will not apply. Partial penetration and full strength butt welds shall have the same weld preparation, including the un-fused land, as production welds they are intended to approve. A test report shall be submitted with all the information shown in section 7, ISO 9012. The final requirements shall meet the design (information to be supplied) any evidence of lack of fusion, cracking or tearing shall be cause for rejection. Final clarification will be provided at the time that the connections are designed.

5.3.3 PREPARATION FOR PROCEDURE SPECIFICATIONS

Formal welding procedure specifications (WPSs) shall be available in accordance with IS EN ISO 15609-1, and tested in accordance with IS EN ISO 15614-1 or IS EN 15613 by the Steelwork Contractor. They shall comply with the guidance of IS EN 1011-2, Annex C, Method A in the avoidance of hydrogen cracking, and Annex D to provide adequate toughness in the heat affected zone of the weld (HAZ). WPS's for hollow sections shall follow guidance given in Annex E, IS EN 1090-2. Generic work instructions are not acceptable.

- Full penetration butt welds including tee butts shall meet the butt weld requirements of Table 1, IS EN ISO 15614-1, unless otherwise agreed. Any weld type nominated as a full strength butt weld (FSBW) shall also meet the full requirements of Table 1, IS EN ISO 15614-1. This includes the tensile test with any un-fused land as shown in the design of the weld. In addition, any change in preparation, preparation angle or type (e.g. V to a single bevel) will require re-approval.
- Fillet welds are acceptable with the requirements of Table 1, IS EN ISO 15614-1, but the additional requirements given in note 5 apply when pre-qualified procedures fail to meet the requirements of IS EN ISO 15614-1, or to confirm mechanical properties (tensile strength and impact properties) of the joint.
- Carbon equivalent (CE) is considered to be an essential variable and included in the other factors in Section 8.3, IS EN ISO 15614-1. A decrease in the CE (calculated according to the IIW formula) is allowable, but, unless otherwise agreed, any increase greater than 0.01% for steels with $CE > 0.40\%$ will require an additional test piece.

- Toughness is to be considered to be an essential variable and included in the other factors in Section 8.3, IS EN ISO 15614-1. The toughness of the weld metal, the Heat Affected Zone and the parent metal shall be shown on the approval record. Where this shows a reduction in material toughness compared to that of the supplied parent material, that reduction shall be subtracted from the project material to be welded. If the resultant toughness falls below the design requirements, unless otherwise agreed, the procedure shall be approved on project material. Note: This requires Charpy testing on weld metal, HAZ and parent metal, this is an additional requirement to EN 15614.
- The maximum hardness shown in the WPQR's shall be limited to 350Hv max for multi-pass welds and 380Hv for single pass welds. The WPS for both single pass and multi-pass welds at high hardness levels will be limited to the minimum heat input from the WPQR and actual carbon equivalent shown on the material certificate unless agreed otherwise by the Engineer in reference to particular welding procedure qualification records and welding procedure specifications.
- The upper limit to the range of qualification shown in EN 15614, section 8.3.2.2, table 5 shall not apply. A thickness greater than that of the test piece will require a new procedure qualification.
- The steel grouping shown in table 3, EN 15614 shall be amended. Group 1.1 will only apply to S275 steel and below (hardness tests are required), procedures qualified to this group will not be acceptable for S355 and higher grade steel. In addition, each individual group will only approve that group and not lower or upper groups. Mixing groups will require specific approval tests unless otherwise agreed by the Engineer.
- The type of joint/weld will be limited to that shown in the approval record.
- Heat inputs shown in the approval record are acceptable within the limits shown but each type of weld run must be treated separately. This applies to root, hot pass, fill and cap. Using the lowest heat input from any type and the highest heat input from a different type to gain the widest range of heat inputs is not acceptable. Full consideration of the steel microstructure is required.
- Each WPS will only be approved by a single WPQR. The use of multiple WPQR's is not acceptable.

All WPSs shall be approved by the welding coordinator (IWE) before being used in production. Where WPSs are based on previously approved WPQRs they shall be submitted to the Examiner/Examining Body for verification of compliance with this specification, EN 15614, EN 15613 and EN 1011. WPSs shall be made available to the Engineer, Employer or Inspection Authority on request.

Note: *The suitability of WPSs for the steel to be welded includes the consideration of the actual carbon equivalent of the steel if this differs from the value (CE) recorded in the WPQR.*

5.3.4 APPLICATION OF WELDING PROCEDURE SPECIFICATIONS

Formal job specific WPSs shall be available to the welder or operator prior to commencement of works.

5.4 ASSEMBLY

5.4.1 FIT-UP

Joints shall be fitted up to the dimensional accuracy required by the welding procedure, depending on the process used, to ensure that the quality in Table C.1 and C.2 in Annex C of the National Structural Steelwork Specification is satisfied.

5.4.2 JIGS

Fabrications assembled in jigs may be completely welded in the jig or may be removed from the jig after tack welding. It is the responsibility of the Steelwork Contractor to ensure the welds used before removal are adequate.

5.4.3 TACK WELDS

Tack welding may be used provided:

They are laid in the area to be welded and are thoroughly removed by grinding or gouging such that the subsequent welding is unaffected, or;

They are undertaken by a welder approved as in 5.2 as short length normal welds at least four times the thickness of the thicker part being joined, or 50 mm whichever is the greater. The procedure shall comply with 5.3, or;

They are undertaken by a welder approved to 5.2, to a welding procedure that complies with 5.3, and the tack is fully re-melted during subsequent welding (this will need to be substantiated by a welding procedure).

5.4.4 DISTORSION CONTROL

The sequence of welding a joint or a sequence of joints shall be such that distortion is controlled and minimised and specified limits not exceeded (see section 7, National Structural Steelwork Specification, Edition 6).

5.4.5 FABRICATION OR ERECTION ATTACHMENTS

Welding of attachments required for fabrication or erection shall be made in accordance with the requirements for a permanent weld and inspected.

When removal is necessary, they shall be flame cut or gouged at a point not closer than 3 mm from the surface of the parent material. The residual material may be ground flush and the affected area visually inspected. When the base material exceeds 20 mm (or carbon equivalent > than 0.43%) it shall also be checked by magnetic particle inspection. Attachments shall not be removed by hammering.

5.4.6 EXTENSION PIECES

Where the profile of the weld is maintained to the free end of a run by the use of extension pieces they shall be of material of similar composition, but not necessarily the same grade. They shall be arranged to provide continuity of preparation and shall be removed after completion of the weld and the end surface ground smooth.

5.4.7 PRODUCTION TEST PLATES

Where production test plates are specified for test purposes they shall be clamped in line with the joint. The grade of material, carbon equivalent and rolling direction shall match the parent plate but need not be cut from the same plate or cast.

5.5 NON-DESTRUCTIVE TESTING OF WELDS

5.5.1 SCOPE OF INSPECTION

Category A is the default level unless otherwise specified.

Table 5.1 Scope of Inspections

Scope of Inspection						
Category A Inspection				Category B Inspection		
Weld Type	Visual	MPI	Ultrasonic	Visual	MPI	Ultrasonic
FPBW	100%	100% first 5 of weld type, then 50% thereafter.	Material thickness $\geq$ 8 mm 100% first 5 of weld type then 50%	100%	100% first 5 weld type, then 20%.	Material thickness $\geq$ 8 mm 100% first 5 of weld type then 20%
FSBW	100%	100% first 5 of weld type, then 50% thereafter.	Material thickness $\geq$ 8 mm 100% first 5 of weld type then 50%	100%	100% first 5 weld type, then 20%.	Material thickness $\geq$ 8 mm 100% first 5 of weld type then 20%
PPBW	100%	100% first 5 of weld type, then 20% thereafter.	Material thickness $\geq$ 8 mm 100% first 5 of weld type then 50%	100%	100% first 5 weld type, then 20%.	Material thickness $\geq$ 8 mm 100% first 5 of weld type then 10%
FW	100%	100% first 5 of weld type, then 20%, reducing to 10% of weld length to include start/stop zones.	Material thickness $\geq$ 8 mm, leg length $\geq$ 12 mm 100% first 5 of weld type then 10% of weld length	100%	100% first 5 of weld type, then 10%, reducing to 5% of weld length to include start/stop zones.	Not required

Note: Site welds 100% inspection.

Inspection levels may be reduced from the stated requirement in Table A at the Engineers discretion. This will only be considered where fabricators have adequate quality control and assurance systems in place and can demonstrate a prolonged period of continuity of quality. Under such circumstances the steelwork contractor may submit alternative inspection levels for review and approval by the Engineer.

5.5.2 INFORMATION

The EEB inspector or Inspection Company shall be provided with all information to enable inspection to be conducted and reported. This will include access to the contract specification, WPSs, material certificates (to verify grade), fabrication records (project identification). Inspection records that fail to be identified to the project or do not have the correct acceptance criteria stated will be rejected and all work re-inspected. It is the

fabricators responsibility to ensure the inspector has the information required to perform his duties.

5.5.3 RECORD OF TESTING

The results of visual inspection, surface flaw detection and ultrasonic inspection shall be recorded and be available when requested. All defects shall be recorded in a repair register along with remedial actions and final close-out report to verify repair. Separate records for acceptable work and defective work are not acceptable.

5.5.4 VISUAL INSPECTION

Visual examination shall be made in accordance with IS EN ISO 17637, Sections 4 and 5 over the full length of the weld. Such inspections shall be performed before any required non-destructive inspection (to reduce time wastage) and results recorded as detailed in Section 5.

A full inspection report shall be made for all inspections and shall record any defects on the same sheet as acceptable work. Fabrications and welds shall be clearly identified to enable traceability of any connections inspected.

Identification of connections or welds should conform to the system adopted in the fabrication shop and should not be a separate system devised by the inspection company.

A suitably qualified person for visual inspection of welds may be a welding inspector or a welder who can provide evidence of having been trained and assessed for competence in visual inspection of the relevant types of welds during and after welding by a nationally recognised authority (TWI, PCN, CSWIP, IS EN 473). Internal company training schemes are not acceptable.

All inspectors (visual, magnetic particle, ultrasonic) shall have eye test as required in IS EN 473, IS EN ISO 9712, and have certificates to demonstrate compliance in line with Table B.

Table 5.2 Inspectors Vision Requirements

Inspectors Vision Requirements			
Type	Test	Standard	Validity
Near Vision	Jaeger	J1	12 months
Colour Vision	Ishihara	24 Plates	36 months

5.5.5 SURFACE FLAW EXAMINATION

Magnetic particle inspection (MPI) shall be in accordance with Table A and conform to the recommendations in IS EN ISO 17638.

If MPI is impractical, dye penetrant inspection (DPI) may be used in accordance with the recommendation given in IS EN ISO 3452-1, with the permission of the Engineer.

Final surface flaw detection of a welded joint shall be carried out after completion of the weld in accordance with the hold times given in Table C.

A full inspection report shall be made for all inspections and shall record any defects on the same report as acceptable work. Fabrications and welds shall be clearly identified to enable traceability of any connections inspected.

Identification of connections or welds should conform to the system adopted in the fabrication shop and should not be a separate system devised by the inspection company.

A suitably qualified person for surface flaw detection of welds should be a welding inspector who holds a current certificate of competence from a nationally recognised authority that meets the requirements of IS EN 473, IS EN ISO 9712 (PCN, CSWIP, EN 473).

5.5.6 ULTRASONIC EXAMINATION

Where ultrasonic examination is required in accordance with Table A it shall be made in accordance with the requirements of IS EN ISO 17640 and the following:

Ultrasonic examination of the welded joint shall be carried out after completion of the weld in accordance with the hold times given in Table C.

A full inspection report shall be made for all inspections and shall record any defects on the same report as acceptable work. Fabrications and welds shall be clearly identified to enable traceability of any connections inspected.

Identification of connections or welds should conform to the system adopted in the fabrication shop and should not be a separate system devised by the inspection company.

Inspectors carrying out ultrasonic examination shall hold a current certificate of competence from a nationally recognised authority that meets the requirements of IS EN 473 IS EN ISO 9712(PCN, CSWIP, IS EN 473).

Note: In addition to weld examination through thickness ultrasonic examination of the parent material may also be necessary for weld geometries susceptible to lamellar tearing.

Table 5.3 Hold Items

Hold Times	
Carbon Equivalent (IIW)	Hold Time Required
< 0.40%	Cooling time only
$\geq 0.40\%$ - < 0.43%	24 Hours
$\geq 0.43\%$	48 Hours
<i>Note: Reductions in hold time need to be agreed in advance with the Engineer and will be based on submitted welding procedures and supplied carbon equivalent of production steel. In certain situations, hold times MAY need to be greater than shown. This is particularly important when considering weld metal hydrogen cracking of higher strength steels and cases where borderline conditions exist. This remains the responsibility of the Steelwork Contractor to determine.</i>	

5.5.7 ACCEPTANCE CRITERIA AND CORRECTIVE ACTION

Welds and adjacent material shall comply with IS EN ISO 5817, Level C. For FSBW's and PPBW's the measured un-fused land shall not be a cause for rejection as long as they meet the minimum specified requirement for penetration.

All welds shall be repaired to meet the minimum requirements, a record kept and the Engineer informed of serious defects (cracks, lamellar tears, incorrect weld type/size).

If cracking or lamellar tearing is located inspection should increase to 100% for the weld type and WPS. For less serious defects inspection of previous welds should be conducted to determine if the problem is more widespread (at least 2 welds). If further defects are located increase inspection to 100% of weld type using the same WPS and inform the Engineer. Consideration should be made as to whether the defect is a procedural problem or welder induced. Repair will require a specific repair WPS which will need approval.

6 WORKMANSHIP - BOLTING

As per NSSS.

7 WORKMANSHIP - ACCURACY OF FABRICATION

As per NSSS.

8 WORKMANSHIP - ERECTION

As NSSS.

8.1 CERTIFICATE OF COMPLETION (8.9)

The final paragraph is to be modified to read:

A record of the dimensional checks at acceptance is to be made and submitted to the Employer before acceptance.

9 WORKMANSHIP - ACCURACY OF ERECTED STEELWORK

As NSSS except the following:

9.1 DEVIATIONS (9.4)

The following is to be added to this clause:

Where it is necessary to combine permitted deviations to establish the acceptability of the position of the steelwork the deviations shall be combined using the root sum square method.

9.2 BEAM SLOPE (9.6.19)

Members other than columns shall not deviate from their specified position relative to the adjacent columns by more than 5 mm.

10 PROTECTIVE TREATMENT

As per section 1.1.2.5.

11 QUALITY ASSURANCE

As per NSSS.

12 ANNEXES

ANNEX A

This Annex is replaced by Table 5.2 in Section 5.

ANNEX B

This Annex is replaced by Table 5.1 in Section 5.

ANNEX C

Defect acceptance criteria for non-destructive testing of welds are to be as set out in 5.5.7 rather than this Annex.

ANNEX D

IS EN 17637 is to be used in place of this Annex.

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