STEEL INDUSTRY GUIDANCE NOTES

Welding Procedure Specifications (WPSs)

Since the quality of a finished weld is not easily verifiable, welding is considered as a 'special' process in quality related Standards and one that requires strict process control. In practice this is achieved by the use of appropriate and suitably 'qualified' WPSs. Hence, it is widely accepted that WPSs are the cornerstone to achieving success in any welding operation and, as such, their importance cannot be overstated.

For Designers, Consultants and those tasked with verifying the suitability of WPSs for particular applications this Guidance Note sets out to clarify the route to development and qualification of WPSs and outlines the supporting documentation that should typically be made available by the Steelwork Contractor.

Development of WPSs:

WPSs have been a requirement of the National Structural Steelwork Specification (NSSS) for many years and the current edition states that they shall be available in accordance with BS EN ISO 15609-1, and tested in accordance with BS EN ISO 15614-1 by the Steelwork Contractor. BS EN ISO 15609-1 gives guidelines on the required technical content of a WPS and provides a useful example of the format. BS EN ISO 15614-1 specifies the tests required to qualify a WPS and the subsequent range of qualification.

Development of a company's WPSs is normally the responsibility of the Welding Engineer or, with the imminent introduction of CE Marking, that of the Responsible Welding Coordinator (RWC). The complexity and range of components being manufactured will normally determine the number of WPSs that might be required. For routine fabrications a small number of WPSs that cover a broad range of orthodox welding may suffice; whereas for more complex fabrications the WPSs may need to be specific for each particular joint. However, whether broad range or joint specific, all WPSs need to be supported by an appropriate Welding Procedure Qualification Record (WPQR).

Qualification of WPSs:

Qualification of a WPS to BS EN ISO 15614-1 is typically a four stage process, as shown in Figure 1.

This requires the formulation of three universally recognised documents:

- preliminary Welding Procedure Specification (pWPS);
- Welding Procedure Qualification Record (WPQR); and
- Welding Procedure Specification (WPS).

The purpose and differences between each of these core documents is detailed below.

Preliminary Welding Procedure Specification (pWPS):

Produced by the RWC, the primary purpose of the pWPS is as a reference document to be used by the welder to complete a welding procedure qualification test piece. Normally using the same format as that to be used for the WPS, the pWPS contains the key variables of the welding procedure to be qualified. Along with the dimensions, joint configuration, consumable type etc. it gives the suggested welding parameters to be used (i.e. Current, Voltage, travel speed) based on the RWC's knowledge and / or past experience. As the name suggests, the pWPS is a preliminary document and the welding parameters suggested, more often than not, will be subject to slight changes based on conditions set by the welder when completing the qualification test piece. It is essential, therefore, that any changes made during the test are noted on the pWPS so that the actual welding parameters can then be incorporated in the subsequent WPQR.

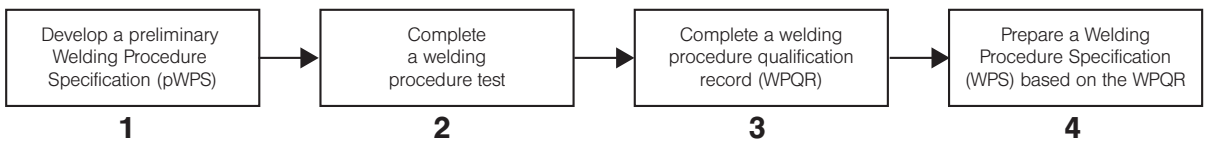

Figure 1 Stages in the WPS Qualification Process

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Welding Procedure Qualification Record (WPQR):

Not to be confused with the WPS, the WPQR is a set of documents typically comprising a WPS detailing the actual welding parameters recorded during the qualification test (i.e. those noted on the pWPS), the results of any non-destructive and destructive tests required by the standard, material certification for the test piece and the subsequent range of qualification if all tests are proven satisfactory. The range of qualification is generally based on those variables which could have a significant effect on the metallurgical properties of a finished weld, including:

- Material type and thickness
- Welding process
- Type of welding consumable
- Welding position
- Welding heat input
- Type of joint (i.e. butt weld, fillet weld etc)

For those tasked with verifying the suitability of WPSs for a particular application, the range of qualification is a critical component of the WPQR since this enables a single WPQR to be used to qualify an unlimited number of WPSs.

A requirement of the current NSSS is that an Examiner or Examining Body shall verify that WPQRs are in accordance with BS EN ISO 15614-1. Preferably independent to the Steelwork Contractor, the Examiner / Examining Body is normally responsible for completion and / or collation of the documents that comprise the WPQR.

Essentially, the WPQR is the documentary evidence to prove that the welding parameters used in the qualification test piece do not adversely affect the mechanical properties of the parent material. In view of this, it is recommended that laboratories undertaking the required non-destructive and destructive testing of qualification test pieces are UKAS* accredited.

Welding Procedure Specification (WPS):

Usually in the form of a single sheet document, the WPS is the final link in the chain of documents required to demonstrate welding process control. It comprises all the relevant information required by a qualified welder to complete a welded joint and, unlike the WPS accompanying the WPQR which contains the actual welding parameters recorded during the qualification test weld, the WPS gives an allowable range of welding parameters that might be used. It is essential therefore that the WPS is readily available at the welder's workplace, fully understood and adhered to.

Production of WPSs is normally the responsibility of the company RWC, who should assess the type and number required based on the range of processes, joint types and the nature of work typically undertaken. Having identified and produced the number of WPSs required, each must be qualified by an appropriate WPQR. With this in mind, it is essential that the RWC and those reviewing the suitability of WPSs are fully aware of the fact that one WPQR can be used to support an unlimited number of WPSs providing they fall within the allowable range of qualification (i.e. those given in BS EN ISO 15614-1).

*UKAS - United Kingdom Accreditation Service

Key Points

1. WPSs are a requirement of the NSSS which states that they shall be available in accordance with BS EN ISO 15609-1 and tested in accordance with BS EN ISO 15614-1.
2. Whether covering a broad range or joint specific, all WPSs need to be supported by an appropriate Welding Procedure Qualification Record (WPQR).
3. Qualification of a WPS to BS EN ISO 15614-1 typically requires the formulation of 3 core documents – a preliminary Welding Procedure Specification (pWPS), a Welding Procedure Qualification Record (WPQR) and a Welding Procedure Specification (WPS).
4. The pWPS is a preliminary document based on the knowledge and / or past experience of the RWC. More often than not the suggested welding parameters in the pWPS will be subject to slight changes by the welder completing a procedure qualification test piece. These changes should be recorded on the pWPS in order to ensure that the actual parameters are incorporated in the subsequent WPQR.
5. The WPQR provides the documentary evidence required to show that the welding parameters used in the procedure qualification test piece do not adversely affect the mechanical properties of the parent material.
6. One WPQR can be used to qualify an unlimited number of WPSs providing the parameters / variables fall within the allowable range of approval i.e. those given in BS EN ISO 15614-1.
7. The WPS gives the allowable range of welding parameters that can be used to complete a welded joint. It is essential, therefore, that WPSs are readily available at the welder's workplace, fully understood and adhered to.

Further Sources of Information

1. **BS EN ISO 15609-1: 2004, Specification and qualification of welding procedures for metallic materials – Welding procedure specification – Part 1: Arc welding**
2. **BS EN ISO 15614-1: 2004, Specification and qualification of welding procedures for metallic materials – Welding procedure test – Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys**
3. **National Structural Steelwork Specification for Building Construction 5th Edition, Published by BCSA & SCI, publication No. 203/07, 2007**
4. **Typical Welding Procedure Specifications for Structural Steelwork, Published by BCSA, publication No. 50/09**
5. **Guide to Site Welding, Published by SCI, publication No. SCI P161**