

Quality requirements for welding— Fusion welding of metallic materials

Introduction

0.1 This Japanese Industrial Standard has been made based on ISO 3834-1 Quality requirements for welding—Fusion welding of metallic materials—Part 1: Guidelines for selection and use, and ISO 3834-2 Quality requirements for welding—Fusion welding of metallic materials—Part 2: Comprehensive quality requirements published in 1994 respectively as the 1st edition.

The parts underlined with dots in this Standard are the matters not specified in the corresponding International Standards.

0.2 Welding processes are widely used to fabricate many of the constructions and in some companies they are the key feature of production. Such constructions may range from pressure vessels to domestic and agricultural equipment and include items such as cranes, bridges and other welded structures. As such, welding exerts a profound influence on the cost of fabrication and quality of the product. It is important, therefore, to ensure that welding is carried out in the most effective way and that appropriate control is exercised over all aspects of the operation.

Within the **JIS Z 9900** series of standards for quality systems, welding is to be treated as a “special process”⁽¹⁾ since welds cannot be fully verified by subsequent inspection and testing of the product to ensure that the required quality standards have been met.

Quality cannot be inspected into a product, it has to be built into it. Even the most extensive and sophisticated non-destructive testing does not improve the quality of welds.

For welded constructions to be effective and free from serious problems in production and in service, it is necessary to provide controls, from the design phase, through material selection, into fabrication and subsequent inspection. For example, poor design for welding may create serious and costly difficulties in the workshop, on site or in service. Incorrect material selection may result in welding problems such as cracking. Welding procedures have to be correctly formulated and approved to avoid imperfection. Supervision needs to be implemented to ensure that the specified quality will be achieved.

To ensure an effective welded fabrication, management needs to appreciate the sources of potential trouble and to introduce appropriate quality procedures.

Note (1) The production process which requires previous recognition of process capability as in this case is often called special process. For the approved production process equipments and employees, the record has to be maintained where appropriate (cited from **JIS Z 9901: 1998/JIS Z 9902: 1998**).

1 Scope This Japanese Industrial Standard specifies the fusion welding of metallic materials, out of the quality requirements for welding.

This Standard has been prepared with the intention of

- not being restricted by the kind of welded constructions;
- defining the quality requirements for welding in factories;
- providing the guidelines for describing the manufacturer's capability to produce the welded constructions conforming to the specified requirements;
- being usable for the reference of assessment of manufacturer, with regard to the welding capability of the manufacturer.

Besides, this Standard does not apply to the case of describing the evidence of the manufacturer's capability to accomplish the specified quality requirements in the following one or more circumstance(s):

- contract between the interested parties;
- applicable standard;
- regulatory requirement.

The requirements provided in this Standard may entirely adopted and, if unapplicable to the related welded constructions, may be optionally deleted by the manufacturer. They present the flexible frames for the welding control shown in the following examples:

Example 1 In the contract by which the manufacturer is required to set up the quality system in accordance with **JIS Z 9901** or **JIS Z 9902**, specific requirements are prepared for fusion welding.

Example 2 In the contract by which the manufacturer is required to set up the quality system other than **JIS Z 9901** or **JIS Z 9902**, specific requirements are prepared for fusion welding.

Example 3 As the guidelines for the manufacturer who intends to develop the quality system, specific requirements are prepared for fusion welding.

Example 4 In the standard which applies to the fusion welding as a part of the specific requirements or in the contract between the interested parties, the specific requirements are prepared for the documents referred to. In this case, however, **Annex 3** or **Annex 4** may be used.

Remarks : The corresponding International Standards to this Standard are as follows:

ISO 3834-1 : 1994 *Quality requirements for welding—Fusion welding of metallic materials—Part 1 : Guidelines for selection and use*

ISO 3834-2 : 1994 *Quality requirements for welding—Fusion welding of metallic materials—Part 2 : Comprehensive quality requirements*

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards indicated below shall be applied.

JIS Z 3001 *Welding terms*

JIS Z 9900 *Quality management and quality assurance standards Part 1: Guidelines for selection and use*

JIS Z 9901 *Quality systems—Model for quality assurance in design, development, production, installation and servicing*

JIS Z 9902 *Quality systems—Model for quality assurance in production, installation and servicing*

ISO 8402 *Quality management and quality assurance—Vocabulary*

Informative reference: ISO 8402 has been translated and described in JIS Z 9900 for informative reference.

3 Definitions For the purposes of this Standard, the definitions given in JIS Z 3001 and ISO 8402 and the following definitions apply.

3.1 contract

- a) Agreed requirements for constructions ordered by a customer.
- b) Manufacturer's basic specification for constructions manufactured in series for several customers, unknown to the manufacturer at the time of design and production.

- NOTES**
- 1 The contract is, in both cases, assumed to include reference to all relevant regulatory requirements.
 - 2 The role of an independent body is considered to be a matter which is determined by the contracting parties and/or the application standard.

3.2 special process Process, the results of which cannot be fully verified by subsequent inspection and testing of the product and where, for example, processing deficiencies may become apparent only after the product is in use. Accordingly, continuous monitoring and/or compliance with documented procedures is required to ensure that the specified requirements are met.

3.3 manufacturing organization Welding workshops and/or sites under the same technical and quality management.

3.4 construction Product, structure or any other welding item.

4 Contract and design review

4.1 General The manufacturer shall review the contractual requirements and the design data provided by the purchaser or in-house data for construction designed by the manufacturer. This is to ensure that all information necessary to carry out the fabrication operations is available prior to the commencement of the work. The manufacturer shall affirm his capability to meet all welding contract requirements and ensure adequate planning of all quality related activities.

Contract review is carried out by the manufacturer to verify that the contract is within his capability to perform, that sufficient resources are available to achieve delivery schedules and that documentation is clear and unambiguous. The manufacturer should ensure any variations between the contract and previous tender

documentation are identified and the purchaser notified of any programme, cost or engineering changes that may result.

The items in 4.2 are typically considered at or before the time of the contract review. The items in 4.3 usually form part of the design review and should be taken into account during the contract review if the design is not carried out by the fabricator. It shall be ensured that all relevant information has been supplied by the purchaser.

When a contract does not exist, e.g. items made for stock, the manufacturer is required to take into consideration the requirements of 4.2 whilst carrying out his design review (4.3).

4.2 Application—Contract review Contractual requirements to be considered should include:

- a) the application standard to be used, together with any supplementary requirements;
- b) the specification of welding procedures, non-destructive testing procedures and heat treatment procedures;
- c) the approach to be used for welding procedure approval;
- d) the approval of personnel;
- e) post-weld heat treatment;
- f) inspection and testing;
- g) selection, identification and/or traceability, e.g. for materials, welders and welds (see clause 16);
- h) quality control arrangements, including any involvement of an independent inspection body;
- i) other welding requirements, e.g. batch testing of consumables, ferrite content of weld metal, ageing, hydrogen content;
- j) environmental conditions relevant to welding on site, e.g. very low temperature, ambient conditions or any necessity to provide protection against adverse weather conditions;
- k) subcontracting;
- l) handling of nonconformances.

4.3 Application—Design review Design requirements to be considered should include:

- a) location, accessibility and sequence of all welds;
- b) surface finish and the weld profile;
- c) parent metal(s) specification and welded joint properties;
- d) permanent backing;
- e) welds which are to be made in the workshop, or elsewhere;

- f) dimensions and details of joint preparation and completed joint;
- g) use of special methods, e.g. to achieve full penetration without backing when welded from one side only;
- h) quality and acceptance requirements for welds;
- i) other special requirements, e.g. acceptability of peening, heat treatment.

5 Subcontracting When a manufacturer intends to use subcontracted services (e.g. welding, inspection, non-destructive testing, heat treatment), all relevant specifications and requirements shall be supplied by the manufacturer to the subcontractor. The subcontractor shall provide such records and documentation of his work as may be specified by the manufacturer.

Any subcontractor shall work under the order and responsibility of the manufacturer and fully comply with the relevant requirements of this Standard.

The manufacturer shall ensure that the subcontractor can comply with the quality requirements of the contract.

The information to be provided by the manufacturer to the sub-contractor shall include all relevant data from the contract review (see 4.2) and the design review (see 4.3). Additional requirements may need to be specified if the design of a structure is to be subcontracted.

6 Welding personnel

6.1 General The manufacturer shall have at his disposal sufficient and competent personnel for the planning, performance and supervision of the welding production according to specified requirements.

6.2 Welders All welders and welding operators shall be approved by an appropriate test according to the relevant standard.

All records of approval shall be maintained up to date.

Informative reference : The relevant standard means the standard agreed by the contracting parties, namely Japanese Industrial Standard, International Standard, group standard, etc. and their examples are given in Annex 1 (informative).

6.3 Welding coordination personnel The manufacturer shall have at his disposal appropriate welding coordination personnel according to the relevant standard, such that the welding personnel can be supplied with the necessary welding procedure specification or work instructions and that the work can be properly performed and controlled. Such persons having responsibility for quality activities shall have sufficient authority to enable any necessary action to be taken. The duties, interrelationships and limits of responsibility of such persons should be clearly defined.

7 Inspection, testing and examination personnel

7.1 General The manufacturer shall have at his disposal sufficient and competent personnel for planning and performance, supervision and inspection, testing and examination of the welding production according to specified requirements.

7.2 Non-destructive-testing personnel The non-destructive-testing personnel shall be approved in accordance with the relevant standard.

8 Equipment

8.1 Production and testing facilities The following equipment shall be available when necessary:

- a) welding power sources and other machines;
- b) equipment for joint preparation and cutting, including thermal cutting;
- c) equipment for preheating and post-weld heat treatment including temperature indicator;
- d) jigs and fixtures;
- e) cranes and handling equipment used for welding production;
- f) personnel protective equipment and other safety equipment, directly associated with welding;
- g) ovens, quivers etc. used for treatment of welding consumables;
- h) cleaning facilities;
- i) destructive and non-destructive-testing facilities.

8.2 Description of facilities The manufacturer shall maintain a list of essential equipment, used for welding production. This list shall identify items of major equipment, essential for an evaluation of workshop capacity and capability. This includes, for example:

- a) capacity of largest cranes;
- b) size of components the workshop is able to handle;
- c) capability of mechanized or automatic welding equipment;
- d) dimensions and maximum temperature of furnaces for post-weld heat treatment;
- e) capacities of rolling, bending and cutting equipment.

Other equipment only needs to be specified by approximate total numbers which cover each general type (e.g. total number of power sources for the different welding processes).

8.3 Suitability of equipment The equipment shall be adequate for the application concerned. Approval of welding and heating equipment is not normally required, unless specified in the contract.

8.4 New equipment After installation of new (or refurbished) equipment appropriate tests of the equipment shall be performed. The tests shall verify the correct function of the equipment. The tests shall be carried out in accordance with appropriate standards, whenever relevant. Records shall be maintained of such tests.

8.5 Maintenance The manufacturer shall have documented plans for the maintenance of equipment. The plan shall ensure maintenance checks of those items in the equipment which controls variables listed in the relevant welding procedure specifications. The plans may be limited to those items which are essential for assuring the quality of the welded construction.

Examples of those items are:

- a) condition of guides in equipment for thermal cutting, mechanized welding fixtures, etc.;
- b) condition of ammeters and voltmeters, flowmeters, etc. used for the operation of the welding machines;
- c) condition of cables, hoses, connectors, etc.;
- d) condition of control system in mechanized and/or automatic welding equipment;
- e) condition of thermocouples and other temperature measurement instruments;
- f) condition of wire feeders and conduits.

Defective equipment shall not be used.

9 Welding activities

9.1 Production plan The manufacturer shall carry out adequate production planning, compatible with facilities as in 8.1. This shall include at least:

- a) specification of the sequence by which the construction shall be manufactured, e.g. as single parts or subassemblies, and the order of subsequent final assembly;
- b) identification of the individual processes required to manufacture the construction;
- c) reference to the appropriate procedure specifications for welding and allied processes;
- d) sequence in which the welds are to be made, if applicable;
- e) order and timing in which the individual processes are to be performed;
- f) specification for inspection and testing, including the involvement of any independent inspection body;
- g) environment conditions, e.g. protection from wind and rain;
- h) item identification by batches, components or parts as appropriate.

9.2 Welding procedure specification (WPS) The manufacturer shall prepare welding procedure specification in accordance with the appropriate part of the relevant standard and shall ensure that these are used correctly in production.

9.3 Welding procedure approval Welding procedures shall be approved prior to production in accordance with the appropriate part of the relevant standard. The method of approval shall be in accordance with the relevant application standards or as stated in the contract.

Other procedures, e.g. procedure for heat treatment, should only be approved if stated in the relevant application standards and/or in the contract.

9.4 Work instructions The manufacturer may use the welding procedure specification directly in the workshop for instruction purposes to the welder. Alternatively, he may use dedicated work instructions. Such dedicated work instructions shall be prepared from an approved welding procedure specification and do not require separate approval.

9.5 Documentation The manufacturer shall establish and maintain procedures for the control of relevant quality documents, e.g. welding procedure specification, welding procedure approval record, welder approval certificate.

10 Welding consumables

10.1 General Responsibilities and procedures involved in the control of welding consumables shall be specified by the manufacturer.

10.2 Batch testing Batch testing of consumables shall be required only if stated in the contract.

10.3 Storage and handling The manufacturer shall produce and implement procedures for storage, handling and use of consumables which avoid moisture pickup, oxidation, damage, etc. The procedures shall be in accordance with the supplier's recommendations.

11 Storage of parent materials Storage shall be such that the material will not be adversely affected. Identification shall be maintained during storage.

12 Post-weld heat treatment The manufacturer shall be fully responsible for the specification and the performance of any post-weld heat treatment. The procedure shall be compatible with the parent metal, welded joint, construction, etc. and in accordance with the application standard and/or specified requirements. A record of the heat treatment shall be made during the process. The record shall demonstrate that the specification has been followed and shall be traceable to the particular heat treatment operation.

13 Welding-related inspection and testing

13.1 General Inspection and testing shall be implemented at appropriate points in the manufacturing process to assure conformity with contract requirements. Location and frequency of such inspection and/or testing will depend on the contract and/or application standard, the welding process and the type of construction (see 4.2 and 4.3).

The manufacturer may carry out additional tests without restriction. Reporting of such tests is not required.

13.2 Inspection and testing before welding Before the start of welding, the following shall be checked, when necessary:

- a) suitability and validity of welders' approval certificates;