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In the event of any differences in interpretation of this guide, the Finnish version shall take precedence over this translation.

NUCLEAR POWER PLANT PRESSURE VESSELS. CONSTRUCTION AND WELDING FILLER MATERIALS

CONTENTS

1 GENERAL

Guide YVL 3.0 states that only approved construction and welding filler materials may be used for fabrication of nuclear power plant pressure vessels. This guide deals with the general proceduce for approval of materials and the required control of component-specific material selection as well as with testing and marking of materials.

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GENERAL APPROVAL OF CONSTRUCTION MATERIALS

2.1
Generally Approved Construction Materials

Approval of construction materials for pressure vessels is based on SFS Standards as confirmed by the Finnish Standardization Board.

In accordance with this principle, the Institute of Radiation Protection regards as generally acceptable construction materials for pressure vessels

1 pressure vessel steels conforming to SFS Standards 1100 and 1150;

2 structural steel conforming to standards SFS 200 and SFS 250 as provided on use of structural steels for pressure vessels in standard SFS 2033;

3 steel pipes, forgings and castings as well as other construction materials conforming to SFS standards as provided on their use for pressure vessels.

In addition to these, generally acceptable construction materials include

4 pressure vessel materials approved by the Technical Inspectorate (TI). The approval shall be general, not restricted to a specific design

5 pressure vessel material conforming to the requirements of NGS Sheets approved in Finland.

6 construction materials similiar to those listed above which have been officially approved as construction materials for pressure vessel in the country of manufacture. This approval may be based on a national standard - which must be submitted to the IRP together with the construction plan - approved by the competent authority in the country of manufacture, or on a specific approval granted by the authorities. The use of structural steels for pressure vessel fabrication is, however, subject to the provisions of Standard SFS 2033.

If other than generally approved construction materials are to be used for pressure vessels, e.g. steels conforming to the mill standards of the manufacturer of the material, an approval may be applied for as provided in item 2.2 of this guide.

In the case of Class 1 and 2 pressure vessels, additional clarifying information specified under item 2.3 is required in addition to the general approval of materials presented above.

2.2
New Construction Materials

If a material which does not have the general approval required by sub-section 2.1 is to be used for fabrication of a pressure vessel, an application for an approval shall be filed with the IRP.

The documents enclosed with the application shall contain the clarifying information listed below. The extent of additional clarifying information required depends on the material involved and its intended use, as stated in sub-section 2.3.

a) Material Standard or similiar specifying

- fabrication method (melting process, killing method, vacuum treatment)
- delivered condition (working, welding, heat treatment and finishing condition)
- required material testing including acceptance tolerances
- guaranteed properties (fatigue strength, creep strength, aging resistance, physical properties)
- dimensions including tolerances
- allowable treatments that may change the delivered condition (working, welding, heat treatment, finishing) including instructions and limitations
- limitations on the use of the material

b) Clarifications (extensive statistical surveys where the changes in production and the allowable applications on the material are considered) that serve as a basis for the material data, either demonstrable throug testing or simply gurauranteed. They shall provide for the following:

- chemical composition and microstructure
- strength properties
- brittle fracture properties
- fatigue strength

- creep strength
- ageing properties (strain ageing and thermal ageing)
- hardering capacity
- radiation resistance
- corrosion resistance
- weldability

c) Information on allowable treatments affecting delivered condition, specifying

- the effect of heat treatment on material strength and toughness and microstructure
- the effect of cold and hot working on the material properties listed in item b)
- the effect of welding (specifying welding procedures, filler metals, welding parameters, heat input, preheating) on the material properties listed under b) and on cracking proness
- recommendations as to required procedure tests

In addition to the supplementary information above to be furnished in support of the application, an additional testing of the base material and weldment shall be conducted as needed under supervision of the IRP or some other organization authorized by the IRP to do so.

Following approval of the material, its suitability as a pressure vessel material is controlled in accordance with the instructions given by the IRP in the approval decision.

2.3 Effect of Safety Class and Intended Use on the Extent of Required Supplementary Information

Depending on the Safety Class and the intended use of the material, the following clarifying documents shall be furnished in connection with filing the application for general approval of materials.

a) Reactor vessel steel

All the items of information listed in sub-section 2.2 shall be provided on reactor vessel steel

b) Generally approved construction materials

In addition to the general approval, the information required by items 2b and c shall be provided on materials to be used for fabrication of Class 1 and 2 pressure vessels, to the extent that such data is not included

in the general approval. How extensive the supplementary information shall be depends upon the importance of the pressure vessel part involved and the requirements imposed by operating conditions. The effect of heat treatment and welding on material properties shall be accounted for as indicated by sub-section 2.2 c.

The procedure for this special approval of Class 1 and 2 materials is the same as for new materials.

c) Construction materials lacking general approval

On those materials that lack the general approval as defined in sub-section 2.1, all items of information listed in sub-section 2.2 shall be furnished.

In Safety Class 3 and Class NNS, such supplementary information shall be provided as to indicate that the requirements set forth in relevant standards for pressure vessel and structural steels mentioned in 2.1 are met.

Table 1 is a summary of the requirements and data to be provided in each case.

Table 1 Effect of Safety Class and Intended Use on the Extent of Required Information

	Safety Class/Intended Use		
	Reactor Vessel	Class 1 and 2	Class 3 and NNS
1. Generally approved material	- in accordance with 2.2 and 4.2	-general approval in accordance with 2.1 -special approval in accordance with 2.2 b and c 2) as a general approval	-general approval to be explained 1) as part of the construction plan
2. New material		-in accordance with 2.2	-as stated in standards listed in 2.1, cf. 2.3 c

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APPROVAL OF WELDING FILLER MATERIALS

Only welding filler materials approved by the IRP or TI for the purpose of welding pressure vessels may be used for welding nuclear power plant pressure vessels in Finland.

If a welding material not approved by the IRP or TI is to be used for welding nuclear power plant pressure vessels in Finland, an approval of the material shall be obtained from the IRP. The IRP supervises the welding of test pieces and material testing. The welding filler material is tested to Standard SFS 2034, SFS 2224, SFS 2225 or SFS 3656. Welding materials that cannot be tested to SFS Standards may be shown to be qualified for intended use in some other way approved by the IRP: they can, for example, be tested to an international or national standard, or their suitability may be demonstrated through sufficiently extensive testing in connection with a procedure test.

The application for approval shall include the following data on the welding filler material:

1 Manufacturer's description of the material (e.g. brand, grade, chemical composition, dimensions, instructions for use)

2 Testing records

3 A proposal for the grade or intended use of the material to be approved

When fabricating pressure vessels abroad, welding filler materials officially approved for this purpose in the country of manufacture may as well be used. A description of the approval shall be submitted to the IRP in the construction plan at the latest.

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COMPONENT-SPECIFIC APPROVAL OF CONSTRUCTION AND WELDING FILLER MATERIALS

Construction and welding filler materials shall be submitted to the IRP for approval, specifying the materials to be used in each pressure vessel, structural part and welded joint, all in accordance with Guides (YVL 3.0, YVL 3.1, YVL 3.2, YVL 3.3) relating to construction plans. The IRP checks whether the construction and welding filler materials are generally approved to be used in the operating conditions suggested. Depending on the intended use of an item, the IRP may, in addition to the requirements contained in a standard of the general approval, present other special requirements relating to inspection and operating characteristics.

A pre-condition for a component-specific approval of materials is that they have the general approval referred to in sections 2 and 3. The approval shall be elaborated in the construction plan.

4.1
Selection of Construction and Welding Filler Materials

Attention shall be given to the following factors when selecting construction and welding filler materials

- the Safety Class of the component or structure involved
- the significance of the part in the aggregate
- loading conditions
- the effect of operating tempature on strength and chemical resistance
- corrosion conditions
- the suitability of the material for the fabrication technique chosen

The aforementioned factors affecting the choice of materials may require more extensive testing than the material standard used.

4.2
Effect of Neutron Radiation on the Properties of Construction and Welding Filler Materials

Construction and welding materials may be selected for use in areas subjected to significant neutron radiation during operation only when it is known how their properties are changed by radiation. A description of the radiation resistance and operating conditions of materials shall be submitted to the IRP together with filing the application for approval of materials.

A detailed surveillance programme for monitoring changes in material properties shall be filed with the IRP as part of the construction plan. The extent of the surveillance programme is determined by how throughly the effect of neutron radiation on the properties of the construction and welding materials in the structure involved is known. The recommendations set forth in Standard ASTM E 185-73 are regarded as minimum requirements when the material is known well.

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TESTING AND MARKING OF MATERIALS

5.1
Material Testing

Material testing shall demonstrate that the construction and welding filler materials meet the

requirements for generally approved materials set forth in section 2, including potential additional requirements presented in the construction plan.

5.2
Material Certificates

The following items of information shall be clearly marked on the material certificate of the material: the type of certificate conforming to Standard SFS 3 or a similiar standard, including the standards, guides and regulations according to which the delivery is made. The purchase specification shall be used to guarantee that the required items of information are entered in the material certificase.

The material certificate of the main parts of Class 1 and 2 components must, as a minimum, conform to the test certificate 3A as defined in Standard SFS3; for other pressure retaining parts the test certificate 3B will suffice. Similarily, the main parts of Class 3 and NNS components must, as a minimum, have the test certificate 3 B; for other pressure retaining parts, the quality certificate 2V or 2T is sufficient. The steel used for pressure vessel support structures shall be at least Grade B (IIW-367-71) and, as a materia certificate, a quality assurance (SFS 3-1) shall be provided. However, parts that are welded to the pressure frame must at least have the quality certificate 2V or 2T.

For each lot of welding filler materials, the testing data and results required by the material specification or approved standards, regulations or guides, shall be furnished. The filler metals used for the welded joints of the most important Class 1 and 2 components must be specified for each component and joint.

5.3
Sampling

Test specimens shall be taken in accordance with the sampling standard appliéd to the type of pressure vessel steel involved, or in some other manner approved by the IRP.

When the fabrication of a pressure vessel involves such processes as working and heat treatment which affect material properties, test specimens shall be taken from an item in finished condition and tested, or the changes of properties shall be known or demonstrated through tests.

Test specimens shall be taken after the last heat treatment. If the lot to be tested need receive a second heat treatment, or if the test specimens

cannot be obtained after the final heat treatment, the tests may be conducted on specimens taken earlier which shall then be heat treated together with the lot to be tested, unless there are good reasons for heat treating the test specimens separately, in which case the heat treatment of the test specimens shall be similiar to that of the lot to be tested. The heat treatment shall be performed so that the properties of the test specimens and the material to be tested are changed by the heat treatment to the same extant.

Before removing the test specimen, the inspector shall mark the number of the test specimen and his own identification mark on the material.

5.4
Material Testing Rights

The rights and qualifications of individuals and organizations conducting inspections and material testing (including the signing of material certificates) are presented in Guide YVL 1.3.

5.5
Marking and Identification of Materials

Construction materials shall be identifiable and tracable from the beginning of fabrication up to the finished product. Welding filler materials shall be handled so that they can be identified at all stages of handling.

In connection with the approval, the manufacturer´s and purchaser´s designations, charge and blank number and material grade shall be permanently stamped on the material, if the standards used do not require more extensive data. The same data must be entered in the material certificate. In Safety Class 3 and Class NNS, the marking of piping materials can be made in accordance with sub-section 9.6 of Standard SFS 2033; however, the relation to the relevant material certificate must always be apparent. In the case of Class 3 and NNS standardized parts, such as flanges, screws and nuts, markings that permit identification of the material and for which the manufacturer can issue a material certificate are sufficient.

If the material is cut up during fabrication or the markings are obliterated as a result of some process, the inspector authorized to transfer markings shall, prior to cutting up or treatment of the material, make new, permanent marks on the material parts to assure that their origin can be verified in the construction inspection.

The inspector is required to confirm the markings with his own personal identification mark.

5.6
Unsuitable Materials

Materials that during the construction of a pressure vessel turn out to be unsuitable shall not be used.

The materials may not contain laminations, cracks or other flaws that affect the strength of the pressure vessel. Minor defects existing in the material or caused by the fabrication process may be repaired but only if the purchaser gives his consent, and using methods that conform to the relevant material standard.

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REFERENCE DATA

NGS	Nordic Group for Steel Regulations NGS Sheets sold by Finnish Standardization Board
SFS 3	Certificates for materials. 2nd revised edition. 1974-05-01
SFS 200	General structural steels. Quality criteria. 2nd revised edition. November 1969.
SFS 250	Fine grain treated steels for general structural purposes. Qualities and designation. 1st edition. 1977-05-10
SFS 1100	General pressure vessel steels. Plates and bars. Quality criteria. 1st edition. 1970-11-12
SFS 1150	Constructional materials of pressure vessels. Pressure vessel steels. Fine grain treated steels. 1st edition. 1977-05-10
SFS 2033	Constructional materials of pressure vessels. Use of general structural steels for pressure vessels. Plates, pipes, bars, sections and forgings. 2nd edition. 1977-04-12
SFS 2034	Welding. Covered electrodes for manual arc welding of mild steel and low alloy steel. Code of symbols for identification. 2nd edition. 1977-02-14

SFS 2224 Electrodes for the welding of carbon steels. Quality specifications and testing. 1st edition. June 1976

SFS 2225 Electrodes for the welding of heat-resisting, low-alloy steels. Quality specifications and testing.

SFS 3656 Welding. Covered electrodes for austenitic stainless steels. Quality requirements and testing. ist edition. 1976-02-15

IIW-367-71 International Institute of Welding, Article 367-71. Recommendations for the Classification of Steel for use in Weld Structures. Article available from the Finnish Society of Welding.

ASTM E 185-73 Surveillance Tests for Nuclear Reactor Vessels. April 1973.