Case N-71-20
Additional Materials for Subsection NF, Class 1, 2, 3, and MC Supports Fabricated by Welding Section III, Division 1

Inquiry: What materials, in addition to those listed in Section II, Part D, Tables 1A, 1B, 2A, 2B, and Y-1, may be used for Section III, Division 1, Classes 1, 2, 3, or MC supports constructed to the requirements of Subsection NF when the items are fabricated by welding?

Reply: It is the opinion of the Committee that as alternatives to the materials listed in the Tables of Section II, Part D referenced in Table NF-2121(a)-1, the design stress intensity and allowable stress values, the yield strength, and the ultimate tensile strength values,\(^1\) for the material specifications listed in Tables 1, 2, 3, 4 and 5 of this Case may be used in welded construction of Classes 1, 2, 3, and MC supports for Section III, Division 1. These materials may also be used for nonwelded construction.

The following additional requirements shall apply.

1 GENERAL REQUIREMENTS

The requirements of Subsection NF shall be met except as modified by this Case.

2 MATERIALS

2.1

Welding is not permitted on carbon and low alloy steels containing more than 0.35% carbon.

\(^1\) The tabulated values of tensile strength and yield strength are those which the Committee believes are suitable for use in design calculations required by Section III, Division 1. At the temperatures above room temperature, the values of tensile strength tend toward an average or expected value which may be as much as 10% above the tensile strength trend curve adjusted to the minimum specified room temperature tensile strength. At temperatures above room temperature, the yield strength values correspond to the yield strength trend curve adjusted to the minimum specified room temperature yield strength. Neither the tensile strength nor the yield strength values correspond exactly to either “average” or “minimum,” as these terms are applied to a statistical treatment of a homogeneous set of data. Neither the ASME or ASTM Material Specifications nor the rules of Section III, Division 1, require elevated temperature testing for tensile or yield strengths of production material for use in Code components. It is not intended that results of such tests, if performed, be compared with these tabulated tensile and yield strength values for ASME Code acceptance/rejection purposes for materials. If some elevated temperature test results on production material appear lower than the tabulated values by a large amount (more than the typical variability of material suggesting the possibility of some error), further investigation by retest or other means should be considered.
and for partial penetration welds and material repair welds, the nominal thickness is the depth of weld groove or weld preparation.

2.7

Where impact tests are required by this Case or the Design Specification, impact testing shall be performed in accordance with NF-2331.

2.8

The maximum measured ultimate tensile strength (UTS) of the support material shall not exceed 170 ksi (1172 MPa) unless consideration is given in the design report to the susceptibility of high-strength materials to brittleness and stress corrosion cracking.

2.9

The fracture toughness requirements listed in this Case do not supersede those within Subsection NF.

3 CLASSIFICATIONS

The materials in this Case have been grouped in S-Number groupings of base metals similar to the P-Number groupings in QW/QB-422, of Section IX.

When welding P-Number materials are listed, the corresponding S-Number welding requirements may be utilized.
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4 WELDING QUALIFICATIONS

4.1

Welding procedure qualifications, welder and welding operator performance qualifications for S-Number materials shall be in accordance with NF-4320 utilizing corresponding P-Number base materials.

4.2

Base metals not assigned S-Numbers or P-Numbers shall require separate procedure qualification.

5 CONSUMABLES CONTROL

5.1

Due consideration shall be given to protection of electrodes and fluxes for all welding processes in order to minimize moisture absorption and surface contamination.

5.2

Carbon and low alloy steel electrodes shall be supplied with a diffusible hydrogen limit of H4 for SMAW electrodes and H8 for flux cored electrodes SMAW electrodes shall be supplied in hermetically sealed containers. Immediately after the opening of the hermetically sealed container or removal of the electrodes from drying ovens, electrodes shall be stored in ovens held at a temperature of at least 250°F. E70XX electrodes that are not used within 4 hr, E80XX within 2 hr, E90XX within 1 hr, and E100XX within 1/2 hr after the opening of the hermetically sealed container or removal of the electrodes from a drying or storage oven shall be dried before use unless evidence is presented to and accepted by the Authorized Nuclear Inspector which indicates that the brand of electrode used may be exposed for longer periods of time without exceeding a moisture content of 0.4% by weight.

6 TIME OF EXAMINATION

6.1 CAUTIONARY NOTE

In addition to the requirements of NF-5120, consideration should be given to the application of magnetic particle or liquid penetrant examination after a sufficient time at ambient temperature to detect delayed cracking. This precaution is not necessary for examination after post-weld heat treatment.

E70XX electrodes that are not used within 4 hr, E80XX within 2 hr, E90XX within 1 hr, and E100XX within 1/2 hr after the opening of the hermetically sealed container or removal of the electrodes from a drying or storage oven shall be dried before use unless evidence is presented to and accepted by the Authorized Nuclear Inspector. The evidence shall indicate that the brand of electrode used may be exposed for longer periods of time without exceeding a moisture content of 0.4% by weight in accordance with AWS D1.1-2020, Paragraph 7.3.2.3, "Alternative Atmosphere Exposure Time Periods Established by Test".
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4 WELDING QUALIFICATIONS

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4.2

Base metals not assigned S-Numbers or P-Numbers shall require separate procedure qualification.

5 CONSUMABLES CONTROL

5.1

Due consideration shall be given to protection of electrodes and fluxes for all welding processes in order to minimize moisture absorption and surface contamination.

5.2

Carbon and low alloy steel electrodes shall be supplied with a diffusible hydrogen limit of 4 for SMAW electrodes and 8 for flux cored electrodes SMAW electrodes shall be supplied in hermetically sealed containers. Immediately after the opening of the hermetically sealed container or removal of the electrodes from drying ovens, electrodes shall be stored in ovens held at a temperature of at least 250°F. E70XX electrodes that are not used within 4 hr, E80XX within 2 hr, E90XX within 1 hr, and E100XX within 1/2 hr after the opening of the hermetically sealed container or removal of the electrodes from a drying or storage oven shall be dried before use unless evidence is presented to and accepted by the Authorized Nuclear Inspector which indicates that the brand of electrode used may be exposed for longer periods of time without exceeding a moisture content of 0.4% by weight.

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In addition to the requirements of NF-5120, consideration should be given to the application of magnetic particle or liquid penetrant examination after a sufficient time at ambient temperature to detect delayed cracking. This precaution is not necessary for examination after post-weld heat treatment.

7 EFFECTS OF WELDING

7.1 CAUTIONARY NOTE

Consideration should be given to the possibility of reheating cracking and deterioration of toughness properties during postweld heat treatment of susceptible materials.

8 REQUIREMENTS FOR WELDING S-NUMBER 1 GROUP-NUMBER 1 MATERIALS

8.1 PREHEAT

Preheat is not required when the base metal temperature is 50°F and above for material thickness up to and including 1 1/2 in. A preheat of 200°F minimum is required for material thickness greater than 1 1/2 in.

8.2 POSTWELD HEAT TREATMENT

8.2.1 Postweld heat treatment is not required when the material thickness is 1 1/2 in. or less. When the material thickness is greater than 1 1/2 in., up to and including 4 in., PHWT is not required provided the material, including heat-affected zone and weld metal, meets the impact testing requirement given in 8.3.

8.2.2 When not exempted by 8.2.1, the postweld heat treatment shall be performed in accordance with NF-4622.

8.3 IMPACT TEST REQUIREMENTS

When material with thickness greater than 1 1/2 in. up to and including 4 in. is not postweld heat treated, the lateral expansion at the lowest service temperature specified shall be 25 mils minimum (NF-2300).

8.4 ADDITIONAL REQUIREMENTS

For steels with vanadium and columbium in combination exceeding 0.10% or with vanadium alone exceeding 0.08%, which are given a postweld heat treatment above 700°F, the requirements for impact testing of 8.3 shall be met for these materials by separate welding procedure qualification. (This requirement should also be considered for steels in which vanadium and columbium are not specified but which may include these elements.)

9 REQUIREMENTS FOR WELDING S-NUMBER 1 GROUP NUMBER 2 AND 3 MATERIALS

9.1 PREHEAT

Preheat is not required when base metal temperature is 50°F and above for material thickness up to and including 1 in. A preheat of 200°F minimum is required for material thickness greater than 1 in.
9.2 POSTWELD HEAT TREATMENT

9.2.1 Postweld heat treatment is not required for material which has a maximum carbon content of 0.30% or less and a thickness of 1 in. or less, nor for material which has a maximum carbon content of 0.30% or less and a thickness greater than 1 in. up to and including 4 in., provided the material, including heat-affected zone and weld metal, meets the impact requirements given in 9.3.

9.2.2 When not exempted by 9.2.1, the postweld heat treatment shall be performed in accordance with NF-4622.

9.3 IMPACT TEST REQUIREMENTS

When material with thickness greater than 1 in. up to and including 4 in. is not postweld heat treated, the lateral expansion at the lowest service temperature specified shall be 25 mils minimum (NF-2300).

9.4 ADDITIONAL REQUIREMENTS

For steels with vanadium and columbium in combination exceeding 0.10% or with vanadium alone exceeding 0.08%, which are given a postweld heat treatment above 700°F, the requirements for impact testing of 9.3 shall be met for these materials by separate welding qualifications. (This requirement should also be considered for steels in which vanadium and columbium are not specified but which may include these elements.)

10 REQUIREMENTS FOR WELDING S-NUMBER 3 GROUP NUMBER 3 AND 4 MATERIALS

10.1 PREHEAT

A preheat of 150°F minimum is required for material thicknesses up to and including 1 1/2 in. A preheat of 250°F minimum is required for material thickness greater than 1 1/2 in.

10.2 POSTWELD HEAT TREATMENT

10.2.1 No postweld heat treatment is required for material which has a maximum carbon content of 0.25% or less and a thickness up to and including 4 in. (102 mm) provided the material, including heat-affected zone and weld metal, meets the impact requirements given in 10.3 below.

10.2.2 When not exempted by 10.2.1 above, the postweld heat treatment shall be performed in accordance with NF-4622.

10.3 IMPACT TEST REQUIREMENTS

When material is not postweld heat treated, for material over 5/8 in. thick up to and including 1 in., the lateral expansion at the lowest service temperature specified shall be 15 mils minimum; for material thicknesses greater than 1 in. up to and including 4 in., the lateral expansion at the lowest service temperature shall be 25 mils minimum (NF-2300).

10.4 ADDITIONAL REQUIREMENTS

For steels with vanadium and columbium in combination exceeding 0.10% or with vanadium alone exceeding 0.08%, which are given a postweld heat treatment above 700°F, the requirements for impact testing of 10.3 shall be met for these materials by separate welding qualifications. (This requirement should also be considered for steels in which vanadium and columbium are not specified but which may include these elements.)

11 REQUIREMENTS FOR WELDING S-NUMBER 3 GROUP NUMBER 1 MATERIALS

11.1 PREHEAT

11.1.1 A preheat temperature of 200°F minimum is required for material thicknesses up to and including 1 1/2 in. A preheat temperature of 300°F minimum is required for material thicknesses greater than 1 1/2 in.

11.2 POSTWELD HEAT TREATMENT

11.2.1 No postweld heat treatment is required for material which has a maximum carbon content of 0.25% or less and a thickness up to and including 4 in. provided the material, including heat-affected zone and weld metal, meets the impact requirements given in 11.3.

11.2.2 When not exempted by 11.2.1, the postweld heat treatment shall be performed in accordance with NF-4622.

11.3 IMPACT TEST REQUIREMENTS

When material is not postweld heat treated, for material over 5/8 in. thick up to and including 1 in., the lateral expansion at the lowest service temperature specified shall be 15 mils minimum; for material thicknesses greater than 1 in., up to and including 4 in., the lateral expansion at the lowest service temperature specified shall be 25 mils minimum (NF-2300).

12 REQUIREMENTS FOR WELDING S-NUMBER 4 GROUP NUMBER 2 AND 3 MATERIALS

The requirements for welding S-No. 4 materials are the same as those for P-No. 4 materials.

13 REQUIREMENTS FOR WELDING S-NUMBER 5 GROUP NUMBER 2 AND 3 MATERIALS

The requirements for welding S-No 5 materials are the same as those for P-No. 5 materials.
14 REQUIREMENTS FOR WELDING S-NUMBER 8 GROUP NUMBER 1 MATERIALS

The requirements for welding S-No. 8 materials are the same as those for P-No. 8 materials.

15 REQUIREMENTS FOR WELDING S-NUMBER 11A, S-NUMBER 11B, AND S-NUMBER 11C MATERIALS

15.1 WELDING QUALIFICATIONS

15.1.1 Welding procedure qualifications and welder and welding operator qualification shall be made in accordance with Section III and as given herein.

15.1.2 Welding procedure qualification of Section IX shall be by WPS and Procedure Qualification Records (PQR) for these materials and combinations of other materials with these materials. When joints are made between two different types or grades of base material, a procedure qualification shall be made for the applicable combinations of materials, even though procedure qualification tests have been made for each of the two base materials welded to itself. (Materials of the same nominal chemical analysis and mechanical properties range, even though of different product forms, may be considered as the same type or grade.)

15.2

The following, in addition to the essential variables in Section IX, QW-250, shall be considered as essential variables requiring requalification of the welding procedure.

15.2.1 A change in filler metal SFA classification or to a weld metal not covered by an SFA specification.

15.2.2 An increase in the maximum or a decrease in the minimum specified preheat or interpass temperatures. The specified range of preheat temperatures shall not exceed 150°F.

15.2.3 A change in the heat treatment (procedure qualification tests shall be subjected to heat-treatment essentially equivalent to that encountered in fabrication of the item or item parts including the maximum total aggregate time at temperature or temperatures and cooling rates).

15.2.4 A change in the type of current (AC or DC), polarity, or a change in the specified range for amperage, voltage, or travel speed.

15.2.5 A change in the thickness \(T\) of the welding procedure qualification test plate as given in (a) or (b) below:

(a) For welded joints which are quenched and tempered after welding, an increase in thickness (the minimum thickness qualified in all cases is \(\frac{3}{8}\) in.

(b) For welded joints which are not quenched and tempered after welding, any change as follows:

(1) For thickness less than \(\frac{3}{8}\) in., any decrease in thickness. (The maximum thickness qualified is 27.)

(2) For thickness \(\frac{3}{8}\) in. and over, any departure from the range of \(\frac{3}{8}\) in. to 27.

15.3 CONSUMABLES CONTROL

Welding filler metal containing more than 0.06% vanadium shall not be used for welded joints that are postweld heat treated.

15.4 POSTWELD HEAT TREATMENT PROCEDURE

Postweld heat treatment shall be at a minimum temperature of 1,075°F and a maximum temperature limited only by the ability to meet the specified mechanical properties, but in no case exceeding the tempering temperature recorded on the Certified Material Test Report. Minimum holding time at the postweld heat treating temperature shall be 1 hr/in. of weld thickness, with 1 hr minimum holding time.

15.5 PREHEAT

A minimum preheat temperature of 100°F is required for material thickness up to and including \(\frac{3}{8}\) in. A minimum preheat temperature of 200°F is required for material thicknesses above \(\frac{3}{8}\) in. up to and including \(1\frac{1}{2}\) in. A minimum preheat temperature of 300°F (150°C) is required for material thickness above \(1\frac{1}{2}\) in.

15.6 POSTWELD HEAT TREATMENT

15.6.1 The preheat temperature required by 15.5 shall be maintained for 2 hr after the weld joint is completed. Postweld heat treatment shall be in accordance with 15.4.

15.6.2 Postweld heat treatment in accordance with 15.4 may be omitted for material which has a maximum carbon content of 0.23% or less and a thickness up to and including 4 in., provided the material, including heat-affected zone and weld metal, meets the impact requirements given in 15.8.

15.7 JOINT DESIGN RESTRICTIONS

Convex fillet welds as shown in Fig. NF-4427-1 are not permitted.

15.8 IMPACT TEST REQUIREMENTS

When material is not postweld heat treated per 15.4 for material over \(\frac{3}{8}\) in. thick and up to and including 1 in., the lateral expansion at the lowest service temperature specified shall be 15 mils minimum. For material thicknesses greater than 1 in. up to and including 4 in., the lateral expansion at the lowest service temperature specified shall be 25 mils minimum (NF-2300).
16 REQUIREMENTS FOR WELDING S-NUMBER 12 GROUP NUMBER 1 MATERIAL

16.1 PREHEAT

Preheat is not required when the base metal temperature is 50°F and above for material thickness up to and including 1 1/2 in. A preheat of 200°F minimum is required for material thickness greater than 1 1/2 in.

16.2 POSTWELD HEAT TREATMENT

16.2.1 Postweld heat treatment is not required when the material thickness is 1 1/2 in. or less. When the material thickness is greater than 1 1/2 in., postweld heat treatment is not required provided the material, including heat-affected zone and weld metal, meets the impact testing requirement given in 16.3.

16.2.2 When not exempted by 16.2.1, the postweld heat treatment shall be performed in accordance with NF-4622, except that it shall be at least 1,000°F and shall not exceed 1,150°F for Class 1 and Class 2 material, and 1,175°F for Class 3 material.

16.3 IMPACT TEST REQUIREMENTS

When material with thickness greater than 1 1/2 in., up to and including 4 in. is not postweld heat treated, the lateral expansion at the lowest service temperature specified shall be 25 mils minimum.

17 REQUIREMENTS FOR WELDING P-NUMBER MATERIALS

The requirements of 8 through 16 may also be used for welding of materials with the corresponding P-Number Group Number. 

Note to Editor: Renumber

18 IDENTIFICATION

This Case and revision number shall be listed on the applicable documentation accompanying shipment.