ARTICLE NF-1000
INTRODUCTION

NF-1100 SCOPE AND GENERAL REQUIREMENTS

NF-1110 ASPECTS OF CONSTRUCTION COVERED BY THESE RULES

(a) Subsection NF contains rules for the material, design, fabrication, examination, installation, and preparation of certification documents (Certificate of Compliance and NS-1 Certificate of Conformance) for supports for components and piping which are intended to conform to the requirements for Class 1, 2, 3, and MC construction as set forth in Subsections NB, NC, ND, and NE, respectively, of this Section.

(b) They do not cover deterioration that may occur in service as a result of corrosion, erosion, radiation effects, or metallurgical instability of the materials (NCA-1130).

(c) Nuclear power plant supports (NCA-9200 provides the definitions of “support” and other terms) for which the rules are specified in this Subsection are those metal elements which transmit loads between components (NCA-1210), including piping systems, and intervening elements and the building structure. However, the term supports does not encompass a structural element the sole function of which is to carry dynamic loads caused by a postulated loss of pressure-retaining integrity.

(d) The Owner shall be responsible for assuring the adequacy of the building structure and all intervening elements in the support load path in accordance with the requirements of NCA-3240 and NCA-3250. To the extent necessary, the support designer shall consider the structural interaction with intervening elements and the building structure.

(e) Except for the requirements listed in (1) through (11), the requirements of Subsection NF do not apply to bearings, bushings, gaskets, hydraulic fluids, seals, shims, slide plates, retaining rings, wear shoes, springs, washers, wire rope, compression spring end plates, thread locking devices, cotter pins, sight glass assemblies, spring hanger travel and hydro stops, nameplates, nameplate attachment devices, padding between piping and supports, or for compression dynamic stops used as stops (stops do not include snubbers and dampers; see NF-3412.4 and NF-3412.5) for seismic and other dynamic loads that are designed primarily for compressive loading and are not connected to the support or pressure boundary.

1. The material of the exempt items shall be selected to tolerate the environmental conditions to which they will be exposed, such as temperature, fluids, humidity, and irradiation.

2. The exempt item shall be designed for the loading conditions and other requirements identified in the Design Specification.

3. Design Output Documents (NCA-3550) shall indicate items that are exempt.

4. Materials, fabrication, and installation of the exempt items shall comply with Design Output Documents.

5. Class 1 springs shall be inspected in accordance with NF-2520.

6. Washers shall comply with the requirements of NF-2128(b) and NF-4700.

7. Wire rope shall comply with the requirements of NF-2530 and Article NF-3000.

8. Compression spring end plates shall comply with the requirements of Articles NF-3000, NF-4000, NF-5000, and NF-8000.

9. Compression dynamic stops shall comply with the requirements of Articles NF-3000, NF-4000, NF-5000, and NF-8000.

10. Thread locking devices shall comply with the requirements of NF-4725.1.

11. The means by which exempt items are attached to supports shall comply with the applicable requirements of this Subsection.

NF-1120 RULES FOR SUPPORTS AND THEIR CLASSIFICATION

NF-1121 Rules for Supports

The rules of Subsection NF provide requirements for new construction and include consideration of mechanical stresses and effects which result from the constraint of free-end displacements and anchor point motions defined in NF-3121.12 and NF-3121.13, but not thermal or peak stresses.

NF-1122 Classification of Supports

Supports shall be constructed to the requirements of this Subsection that are applicable to the class of the component, including piping system, they are intended to support. Supports may be optionally classified as permitted in NCA-2134. When the components are optionally classified to a higher class as permitted in NCA-2134(d), the support need not be classified to the higher class.
NF-1130 BOUNDARIES OF JURISDICTION

NF-1131 Boundary Between Components and Supports

The jurisdictional boundary between components, including piping systems, and supports shall meet the requirements of NB-1132, NC-1132, ND-1132, or NE-1132 as applicable to the class of component.

NF-1132 Boundary Between Supports and the Building Structure

(a) Supports may bear on or may be welded, bolted, pinned, or clamped to the building structure. Typical examples of jurisdictional boundaries defined between supports and building structures are shown in Figure NF-1132-1.

(b) The jurisdictional boundary between a support and the load-carrying building structure is the surface of the building structure.

(c) For the purpose of defining the jurisdictional boundary between a support and the building structure, structural members shown on the civil/structural drawings of the plant and considered in the building structural analysis may be designated building structure even though located in the support load path. However, structural members, except as defined in (d), detailed on support drawings which are installed and used for the primary purpose of supporting piping or components shall be designated supports and be constructed to the rules of this Subsection.

(d) The Design Specification shall designate whether surface-mounted base plates intended to receive loads transmitted by supports are to be within the jurisdiction of Subsection NF or building structure. Fully or partially embedded steel elements intended to receive loads transmitted by supports; grout; concrete anchors; and hold-down bolts, nuts, and washers shall be designated building structure.

(e) If the means by which the support is connected to the building structure is a weld, the weld shall fall within the jurisdiction of this Subsection.

(f) If the means by which the support is connected to the building structure is a bolted joint to a building structural steel member, the bolts shall fall within the jurisdiction of this Subsection.

NF-1133 Boundary Between Supports and Intervening Elements

The jurisdictional boundary between supports and intervening elements in the support load path is the surface of the intervening elements. Supports may bear on or may be welded, bolted, pinned, or clamped to intervening elements. The means by which supports are connected to intervening elements shall fall within the jurisdiction of this Subsection.

NF-1200 TYPES OF SUPPORTS AND ATTACHMENTS

NF-1210 TYPES OF SUPPORTS

NF-1211 General Requirements

In this Subsection all supports are categorized into three separate types based on the general design procedure used for analysis of the support (NF-3140). Requirements for materials, design, fabrication, and examination for each of the three types are provided in the following Articles of this Subsection. These support types are defined in NF-1212 through NF-1215.

NF-1212 Plate- and Shell-Type Supports

A Plate- and Shell-Type Support is a support such as a skirt or saddle which is fabricated from plate and shell elements and is normally subjected to a biaxial stress field.

NF-1213 Linear-Type Support

A Linear-Type Support is defined as acting under essentially a single component of direct stress. Such elements may also be subjected to shear stresses. Examples of such structural elements are tension and compression struts, beams and columns subjected to bending, trusses, frames, rings, arches, and cables. Energy-absorbing parts designed to dissipate energy by yielding and which are incorporated into a linear-type piping support shall be constructed in accordance with Mandatory Appendix NF-III.

NF-1214 Standard Supports

Typical Standard Supports are described in MSS SP-58, Pipe Hangers and Supports, Materials, Design, and Manufacture, which was developed and approved by the Manufacturers Standardization Society of the Valve and Fittings Industry. Typical catalog items are shown in Figure NF-1214-1. The capacities of standard supports may be determined using plate and shell analysis or linear analysis or load rating. Examples of standard supports are (a) rigid supports consisting of anchors, guides, restraints, rolling or sliding supports, and rod-type hangers (b) constant and variable type spring hangers (c) snubbers (d) sway braces and vibration dampeners (e) structural attachments such as ears, shoes, lugs, rings, clamps, slings, straps, and clevises (f) dampers

NF-1215 Primary and Secondary Members

Support members are also categorized as primary or secondary according to function. These member types are defined in the following paragraphs.

(a) Primary Members. Primary members of supports are defined as those members designed to carry loads under any postulated load condition.
NF-3133 Stress Analysis

A detailed stress analysis or Design Report, as required by NCA-3550 for all supports, shall be prepared in sufficient detail to show that each of the stress limits of NF-3200 or NF-3300 is satisfied when the support is subjected to the loadings of NF-3110.

NF-3134 Support Tolerances

(a) Tolerances shall be specified by the designer in the design output documents. Fabrication tolerances and local installation tolerances as contained in Nonmandatory Appendix NF-D are only mandatory when invoked by the designer.

(b) When specifying the support tolerances, the support designer shall consider the piping support location/orientation tolerances specified by the piping designer (Section III Appendices, Nonmandatory Appendix T, T-1230).

NF-3140 GENERAL DESIGN PROCEDURES

NF-3141 Types of Procedures

(a) The design procedure which may be used is dependent on the type of support being designed and the Class of construction involved. Three design procedures are recognized, namely

1) design by analysis
   - (a) maximum shear stress theory
   - (b) maximum stress theory

2) experimental stress analysis (Section III Appendices, Mandatory Appendix II)

3) load rating

(b) Unless either the experimental stress analysis procedure or the load rating procedure is used, the requirements of the following paragraphs apply.

<table>
<thead>
<tr>
<th>Type and Class of Support</th>
<th>Plate and Shell</th>
<th>Linear</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Design by Analysis</td>
<td>Bolting</td>
</tr>
<tr>
<td>Component</td>
<td></td>
<td></td>
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<tr>
<td>Class 1</td>
<td>NF-3220, NF-3225, NF-3226, NF-3270, NF-3280</td>
<td>NF-3320, NF-3324, NF-3324, NF-3370, NF-3380</td>
</tr>
<tr>
<td>Class 2 and MC</td>
<td>NF-3250, NF-3255, NF-3256, NF-3270, NF-3280</td>
<td>NF-3350, NF-3324, NF-3324, NF-3370, NF-3380</td>
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<tr>
<td>Class 3</td>
<td>NF-3260, NF-3265, NF-3266, NF-3270, NF-3280</td>
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<td>NF-3360, NF-3324, NF-3324, NF-3370, NF-3380</td>
</tr>
</tbody>
</table>

NOTE:
(1) Supports for Class 2 vessels designed to NF-3200 shall be designed in accordance with Class 1 requirements.
(3) All of the foregoing joints shall be proportioned to resist any tension that would be developed by design moments acting in conjunction with 75% of the axial compression forces.

**NF-3324.3 Design of Lap Joints and Fillers.**

(a) Lap Joint Design. The minimum amount of lap on lap joints shall be five times the thickness of the thinner part joined but not less than 1 in. (25 mm). Lap joints subjected to axial stress shall be fillet welded along the end of both lapped parts, except where the deflection of the lapped parts is sufficiently restrained to prevent opening of the joint under maximum loading.

(b) Filler Design

(1) Bolted Construction. When bolts carrying computed stress pass through fillers thicker than 1/4 in. (6 mm), except in friction-type connections assembled with high-strength bolts, the fillers shall be extended beyond the splice material and the filler extension shall be secured by enough bolts to distribute the total stress in the member uniformly over the combined section of the member and the filler or an equivalent number of fasteners shall be included in the connection. Fillers between 1/4 in. (6 mm) and 3/4 in. (19 mm) thick, inclusive, need not be extended and developed, provided the allowable shear stress in the bolts is reduced by the factor, 0.4 (\(t - 0.25\)) [for SI units, use 0.016 (\(t - 0.6\)), where \(t\) is the total thickness of the fillers, up to 3/4 in. (19 mm).

(2) Welded Construction. In welded construction, any fillet 1/4 in. (6 mm) or more in thickness shall extend beyond the edges of the splice plate and shall be welded to the part on which it is fitted with sufficient weld to transmit the total stress in the member uniformly over the combined section of the member and the filler as an eccentric load. The welds joining the splice plate to the filler shall be sufficient to transmit the splice plate stress and shall be long enough to avoid over stressing the filler along the toe of the weld. Any fillet less than 1/4 in. (6 mm) thick shall have its edges made flush with the edges of the splice plate, and the weld size shall be the sum of the size necessary to carry the splice plate stress plus the thickness of the filler plate.

**NF-3324.4 Joint Combinations.**

(a) Combinations of Welds. If two or more of the general types of weld (groove, fillet, plug, or slot) are combined in a single joint, the effective capacity of each shall be separately computed with reference to the axis of the group, in order to determine the allowable capacity of the combination.

(b) Bolts in Combination With Welds. SA-307 bolts or high-strength bolts used in bearing-type connections shall not be considered as sharing the stress in combination with welds. Welds, if used, shall be provided to carry the entire stress in the connection. High-strength bolts installed as a friction-type connection prior to welding may be considered as sharing the stress with the welds.

**NF-3324.5 Design of Welded Joints.**

(a) Permissible Types of Welded Joints in Linear Supports. All welded joints in Linear Supports shall be as described in NF-3256.1 except that intermittent or lap joints using fillet welds may not be used for the support of Class 1 Components or Class 2 vessels designed to NF-3200. The allowable stress limits shall be as defined in (b) and (c).

(b) Design Limits. The allowable stress limits that must be satisfied for welds for Design Loadings stated in the Design Specification shall be as follows:

(1) Full Penetration Groove Welds. The stress limits for full penetration groove welds shall not exceed the applicable stress value for the base metal being joined, as specified in NF-3321.1 and Table NF-3324.5(a)-1.

(2) Partial Penetration Groove Welds

(a) Compression Normal to Effective Throat. The stress limits shall be the same as those for the base metal, as required by NF-3321.1.

(b) Tension Normal to the Axis on the Effective Throat or Shear on the Effective Throat. The stress limits shall be as specified in Table NF-3324.5(a)-1.

(3) Fillet Welds. The allowable stress limits for fillet welds shall be as specified in Table NF-3324.5(a)-1.

(c) Service Limits, Level A Through D, and Test. The rules and stress limits which must be satisfied for welds for any Level A through D Service and Test Loading stated in the Design Specification are those given in (b) multiplied by the appropriate base material stress limit factor given in Table NF-3312.1(b)-1.

(d) Fillet Welds

(1) Minimum Size of Fillet Welds and Partial Penetration Welds. Fillet and partial penetration welds shall not be specified less than 1/6 in. (3 mm) (NF-4427). When fillet or partial penetration welds less than 1/6 in. (6 mm) are used to join heavy section members, the designer shall consider specifying preheat and special requirements for fit-up of members to ensure adequate weld deposition.

(2) Maximum Effective Size of Fillet Welds. The maximum size of a fillet weld that may be assumed in the design of a connection shall be such that the stresses in the adjacent base material do not exceed the values allowed in Tables NF-3324.5(a)-1 and NF-3321.1. The maximum size that may be used along edges of connected parts shall be as stipulated in (a) and (b)

(a) Along edges of material less than 1/4 in. (6 mm) thick, the maximum size may be equal to the thickness of the material

(b) Along edges of material 1/4 in. (6 mm) or more in thickness, the maximum size shall be 1/6 in. (1.5 mm) less than the thickness of the material, unless the weld is especially designated on the drawings to be built up to obtain full throat thickness

(3) Length of Fillet Welds

(a) The effective length of a fillet weld shall be the overall length of a full-size fillet, including returns.
(b) The heat-affected zone impact test specimens and testing methods shall conform to NF-2321. The specimens shall be removed from a location as near as practical to a depth midway between the surface and center thickness. The coupons for heat-affected zone impact specimens shall be taken transverse to the axis of the weld and etched to define the heat-affected zone. The notch of the Charpy V-notch specimen shall be cut approximately normal to the material surface in such a manner as to include as much heat-affected zone as possible in the resulting fracture. Where the material thickness permits, the axis of a specimen may be inclined to allow the root of the notch to align parallel to the fusion line. When a grain refining heat treatment is not performed on welds made by the electroslag or electrogas welding process, the notch for the impact specimens shall be located in the grain coarsened region.

(c) For the comparison of heat-affected zone values with base material values [NF-4335.2(b)], Charpy V-notch specimens shall be removed from the unaffected base material at approximately the same distance from the base material surface as the heat-affected zone specimens. The axis of the unaffected base material specimens shall be parallel to the axis of the heat-affected zone specimens, and the axis of the notch shall be normal to the surface of the base material.

NF-4335 Impact Test Requirements

When materials are required to be impact tested per NF-2300, impact tests of the weld metal and heat-affected zone shall be performed in accordance with the following subparagraphs. Exemptions from impact testing under NF-2311(b)(9) and NF-2311(b)(10) do not apply to weld metal unless the specific weld metal used is included in Table NF-2311(b)-1 (weld metal exemptions are being developed). Exemption from the impact testing requirements of this Subsection, NF-2311(b)(9) or NF-2311(b)(10) may be accepted as an alternative to the WPS impact testing requirements of this Subsection.

NF-4335.2 Impact Tests of Heat-Affected Zone.

(a) Charpy V-notch tests of the heat-affected zone of welding procedure qualification test assembly are required whenever the thickness of the weld exceeds 5/8 in. (16 mm), and either of the base materials requires impact testing in accordance with the rules of NF-2310. Exemption of base materials by NF-2311(b)(9) or NF-2311(b)(10) does not apply to the welding procedure qualification of the heat-affected zone or unaffected base material for such materials. The only exceptions to the requirements are the following:

(1) the qualification for welds in P-Nos. 1 and 3 and SA-336 F12 materials that are postweld heat treated and are made by any process other than electroslag, electrogas, or thermit

(2) the qualification for weld deposit cladding or hard-facing on any base material

(3) that portion of the heat-affected zone associated with GTAW root deposits with a maximum of two layers or 5/8 in. (5 mm) thickness, whichever is less

(b) Charpy V-notch testing shall be performed as specified in (1) through (6).

(1) Charpy V-notch test specimens representing both the heat-affected zone and the unaffected base material shall be tested. The unaffected base material shall be tested at a temperature equal to or below that specified in NF-2311(c).

(2) The Charpy V-notch tests of the unaffected base material shall meet the applicable requirements of NF-2330 for the applicable Class and acceptance category. If the requirements are not met at the test temperature, additional testing shall be performed at higher temperatures until the above requirements are met.

(3) The heat-affected zone specimens shall be tested at the test temperature determined in (2). If the average applicable toughness value of the heat-affected zone specimens equals or exceeds the average applicable toughness value of the unaffected base material, the qualification test is acceptable for the essential and
supplemental essential variables recorded on the Welding Procedure Qualification Record. If the heat-affected zone average applicable toughness value is less than the unaffected base material average applicable toughness value, the adjustment given in (4) through (6) shall be determined and applied as provided in (2). The average applicable toughness value for each test meeting this requirement shall be determined and applied as provided in (c). Alternatively, another test coupon may be welded and tested.

(4) Additional Charpy V-notch tests shall be performed on either the heat-affected zone or the unaffected base material, or both, at temperatures where the applicable toughness values of all three specimens tested are not less than that specified in (2). The average applicable toughness value for each test meeting this requirement shall be plotted on a property-temperature graph. The difference in temperature \( T_{HAZ} \) and \( T_{UBM} \) where the heat-affected zone and the unaffected base material average applicable toughness values are the same and not less than that specified in (2) shall be used to determine the adjustment temperature \( T_{ADJ} \) where

\[
T_{ADJ} = T_{HAZ} - T_{UBM}
\]

If \( T_{ADJ} \leq 0 \), then \( T_{ADJ} = 0 \).

(5) As an alternative to (4), if the applicable toughness values of the heat-affected zone are no less than those specified in NF-2330 for the applicable Class and acceptance category and the average applicable toughness value of the heat-affected zone specimens is not less than 7 ft-lb (10 J) or 5 mils (0.13 mm) below the average applicable toughness value of the unaffected base material, \( T_{ADJ} \) may be taken as 15°F (8°C).

(6) As a second alternative to (4), if the applicable toughness values of the heat-affected zone are no less than those specified in NF-2330 for the applicable Class and acceptance category, the difference between the average applicable toughness value of the heat-affected zone and the unaffected base material shall be calculated and used as described in (c)(3).

(c) At least one of the following methods shall be used to compensate for the heat-affected zone toughness decrease due to the welding procedure.

(1) The lowest service temperature specified in the Design Specification for all of the material to be welded in production Welding Procedure Specifications supported by this Welding Procedure Qualification Record shall be increased by the adjustment temperature \( T_{ADJ} \).

(2) The specified testing temperature for the production material may be reduced by \( T_{ADJ} \).

(3) The materials to be welded may be welded using the Welding Procedure Specification, provided they exhibit toughness values that are not less than the minimum required toughness values specified in NF-2300 plus the difference in the average applicable toughness values established in (b)(6).

(d) The Charpy V-notch testing results shall be recorded on the Welding Procedure Qualification Record and any offsetting \( T_{ADJ} \) or increased toughness requirements shall be noted on the Welding Procedure Qualification Record and on the Welding Procedure Specification. More than one compensation method may be documented on the Welding Procedure Qualification Record.

(e) A Welding Procedure Specification qualified to the impact testing requirements of Subsection NB, NC, or NE may be accepted as an alternative to the Welding Procedure Specification impact testing requirements of this Subsection.

**NF-4400** RULES GOVERNING MAKING AND REPAIRING WELDS

**NF-4410** PRECAUTIONS TO BE TAKEN BEFORE WELDING

**NF-4411** Identification, Storage, and Handling of Welding Materials

Each Certificate Holder is responsible for control of the welding electrodes and other materials which are used in the fabrication and installation of supports (NF-4120). Suitable identification, storage, and handling of electrodes, flux, and other welding material shall be maintained. Precautions shall be taken to minimize absorption of moisture by electrodes and flux.

**NF-4412** Cleanliness and Protection of Weld Surfaces

The method used to prepare the base metal shall leave the weld preparation with reasonably smooth surfaces. The surfaces for welding shall be free of scale, rust, oil, grease, and other deleterious material. The work shall be protected from deleterious contamination and from rain, snow, and wind during welding. Welding shall not be performed on wet surfaces.

**NF-4420** RULES FOR MAKING WELDED JOINTS

**NF-4421** Backing Strips

The materials for backing strips, when used, shall be compatible with the base metal.

**NF-4422** Peening

The weld metal may be peened when it is deemed necessary or helpful to control distortion.

**NF-4423** Double-Welded Joints

Before applying weld metal on the second side to be welded, the root of full penetration double-welded joints shall be prepared by suitable methods, such as chipping, grinding, or thermal gouging, except for those processes of welding by which proper fusion and penetration are otherwise obtained and demonstrated to be satisfactory by welding procedure qualification.