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**NOTES:**

1. The following Design Rules shall be followed:
   1. Level D self-relieving stresses need not be considered unless as specified within a specific section of Nonmandatory Appendix F.
   2. In addition to consideration of primary stresses, stability of the component or support shall be considered when compressive stresses are present.
   3. Potential for unstable crack growth shall be considered.

2. Allowables shall be adjusted to reflect any different material behavior from that which the allowables are based. See F-1322.3.
3. Geometric nonlinearities shall be considered when appropriate.
4. Design specification requirements shall be satisfied in addition to those given in Nonmandatory Appendix F.

**NOTES:**

1. For Vessels and Pumps, the design rules given in F-1330 and F-1340 shall be used; for Valves, as an alternative to the procedures of F-1330, F-1470 can be used; for Piping, as an alternative to the procedures of F-1331, F-1430 can be used. For Core Support Structures, the procedures of F-1300 may be used except as stipulated in F-1440.
2. As an alternative to the requirements of F-1331.1, the interaction method may be used following F-1331.2 and the procedures given in A-9000.
3. Per F-1322, if elastic system analysis is used, the components and supports may be designed alternatively on the acceptance criteria provided a reevaluation of the system analysis is performed to determine that it has not been significantly invalidated due to load and stress redistribution and changes in geometry. See F-1322.1 for further discussion.
4. Stresses resulting from constraint of free ends, displacements and anchor point motion shall be considered primary stresses.
5. Neither peak stresses nor stresses resulting from thermal expansion within the support need be evaluated.
6. As an alternative to F-1332.1 through F-1332.2 requirements.
7. Per F-1334, the allowable stress presented in NF-3320 for Level A Service Condition may be increased using the following factors: the smaller of 2 or 1.167 $S_a / S_y$, if $S_a > 1.2 S_y$. Note that members must be checked for local and general instability.
8. As an alternative to the requirements in F-1334.4, a collapse load analysis is acceptable following F-1334.6.
9. As an alternative to the requirements of F-1334.1 through F-1334.5, the interaction method may be used following F-1334.7 and the procedures given in A-9000.
10. Threaded structural fasteners used in core support structures shall be evaluated using the rules of F-1440.
11. Minimum edge distance shall meet the requirements of F-1335.4.
F-1332.3 Bearing Stress. Except for pinned and bolted joints, bearing stresses need not be evaluated for loads for which Level D Service Limits are specified.

F-1332.4 Pure Shear. The average primary shear across a section loaded in pure shear shall not exceed 0.425S_y.

F-1332.5 Requirements for Compressive Stresses. Plate and shell type supports subject to compressive stresses shall be evaluated in accordance with the rules of F-1331.5(a).

F-1332.6 Stress Limits for Bolts. Bolts shall be evaluated in accordance with the rules of F-1335.

F-1332.7 Load Rating. As an alternative to the requirements of F-1332.1 through F-1332.6 above, plate and shell type supports may be qualified to Service Level D Limits using the procedure for load rating (NF-3282). The load rating for Level D Service Loadings shall be determined by the following equation:

\[
\text{load rating} = \frac{TL}{S_y} \times 0.7 \frac{S_y}{S_{yt}}
\]

where

- \( TL \) = support test load equal to or less than the load under which the support fails to perform its specified support function
- \( S_y \) = tensile strength of the support material at temperature
- \( S_{yt} \) = tensile strength of the support material at test temperature

but

\[
\frac{S_y}{S_{yt}} \leq 1
\]

F-1333 Criteria for Standard Supports

Criteria in F-1332 or F-1334 shall be applied according to whether standard supports are plate and shell or linear type supports.

F-1334 Criteria for Linear Type Supports

The criteria presented in this paragraph pertain to primary stresses only. Stresses resulting from constraint of free end displacement and anchor point motion (NF-3121.12 or NF-3121.13) shall be considered primary stresses in the evaluation.

Neither peak stresses nor stresses resulting from thermal expansion within the support need be evaluated.

Unless otherwise specified, the allowable stresses presented (NF-3320) for Level A Service Condition may be increased using the following factors: the smaller of 2 or 1.167\( S_y/S_y \) if \( S_y > 1.2 S_y \), or 1.4 if \( S_y \leq 1.2 S_y \), where \( S_y \) is the yield strength, ksi (MPa), and \( S_y \) is the ultimate tensile strength, ksi (MPa), both at temperature. In addition, members must be checked for local and general instability.

F-1334.1 Stresses in Tension. The tensile stress on the net section, except at pin holes and in the through-plate thickness direction, shall not exceed the lesser of 1.25\( S_y \) and 0.75\( S_y \).

F-1334.2 Stresses in Shear. The shear stress on the gross section shall not exceed the lesser of 0.75\( S_y \) and 0.425\( S_y \). Gross section shall be determined in accordance with NF-3222.1(b).

F-1334.3 Axial Compression. Maximum load in axially loaded compression members shall be limited in accordance with either (a) or (b).

(a) Two-thirds of the buckling load, as determined by one of the following methods:

(1) comprehensive stability analysis which considers effects such as large deformations, deformations due to existing loading conditions, material nonlinearities, local buckling, out-of-straightness and other tolerances, load eccentricity, end conditions, residual stresses and inertia loads (for dynamic loading)

(2) testing of a full-scale prototype under conditions of support and loading the same as those to which the actual compression member is expected to be subjected

(b) the maximum allowable load for ferritic steels shall be determined in accordance with the following provided that the initial out-of-straightness does not exceed \( \frac{L}{4000} \) of the unsupported length. Effects of deformations due to existing loads shall also be considered.

(1) Except as noted in (2), the following rules shall be applied:

For \( 0 \leq \lambda \leq 1 \)

\[
\frac{P}{P_y} = \frac{1 - \lambda^2}{1.11 + 0.50\lambda + 0.17\lambda^2 - 0.28\lambda^3}
\]

For \( 1 \leq \lambda \leq \sqrt{2} \)

\[
\frac{P}{P_y} = \frac{2(1 - \lambda^2)}{3\lambda^2}
\]

For \( \lambda > \sqrt{2} \)

\[
\frac{P}{P_y} = \frac{2}{3\lambda^2}
\]

where

- \( P \) = maximum allowable load
- \( P_y \) = \( S_y/A_g \)
- \( A_g \) = area of gross section
- \( \lambda = \left( \frac{KL}{r} \right) \frac{1}{\pi} \frac{S_y}{E} \)
- \( E \) = modulus of elasticity
- \( K \) = effective length factor
- \( L \) = unbraced length.
F-1341.3 Collapse Load. Static or equivalent static loads shall not exceed 90% of the limit analysis collapse load using a yield stress which is the lesser of 2.3S_m and 0.75S_w, or 100% of the plastic analysis collapse load or test collapse load (F-1321.6).

F-1341.4 Plastic Instability Load. The plastic instability load (F-1321.7) is designated P_t and may be determined by one of the following methods:
(a) plastic analysis (NB-3213.24)
(b) experimental analysis (F-1321.8)
The applied load shall not exceed 0.7P_t.

F-1341.5 Interaction Method. Acceptability for individual members of components may be demonstrated using the interaction method. Procedures for interaction method analysis are given in A-9000. The allowable stress S_m shall not exceed 0.75S_w.

F-1341.6 Bearing Stresses. Except for pinned and bolted joints, bearing stresses need not be evaluated for loads for which Level D Service Limits are specified.

F-1341.7 Stress Limits for Bolts. Bolts shall be evaluated in accordance with the rules of F-1335.

F-1341.8 Requirements for Compressive Loads. Components subjected to compressive loads shall be evaluated in accordance with the rules of F-1331.5.

F-1342 Criteria for Plate and Shell Type Supports
(a) The criteria presented in this paragraph pertain to primary stresses only. Stresses resulting from constraint of free end displacement and anchor point motion (NF-3121.12 and NF-3121.13) shall be considered as primary stresses in the evaluation. Neither peak stresses nor stresses resulting from thermal expansion within the support need be evaluated.

(b) The allowable stresses for plate and shell type supports shall be per F-1341, with material properties provided by the applicable tables of Section II, Part D per Table NF-3121.7.1.
(c) As an alternative to the requirements of (b) above, plate and shell type supports may be qualified to Service Level D Limits using the procedure for load rating (NF-3282). The load rating for Level D Service Loadings shall be determined by the following equation:

\[
\text{load rating} = \frac{TL}{0.7S_m < S_{w}^*}\]

where

- TL = support test load equal to or less than the load under which the support fails to perform its specified support function
- S_m = tensile strength of the support material at temperature
- S_{w}^* = tensile strength of the support material at test temperature

but

\[
\frac{S_m}{S_{w}^*} \leq 1
\]

F-1343 Criteria for Standard Supports
The rules of F-1342 or F-1344 shall be applied according to whether standard supports are plate and shell or linear type supports.

F-1344 Criteria for Linear Type Supports
The criteria presented in this paragraph pertain to primary stresses only. Stresses resulting from constraint of free end displacement and anchor point motion (NF-3121.12 and NF-3121.13) shall be considered primary stresses in the evaluation. Neither peak stresses nor stresses resulting from thermal expansion within the support need be evaluated.

Acceptability of linear type supports may be demonstrated using any one of the following methods:
(a) elastic analysis
(b) plastic analysis
(c) collapse load analysis
(d) plastic instability analysis
(e) interaction method
The primary stress limits for these alternative methods are given in F-1344.1 through F-1344.5. The other limits given in F-1344.6 and F-1344.7 shall also be satisfied as applicable.

F-1344.1 Elastic Analysis. The criteria provided in F-1334 through F-1334.5 shall be applied.

F-1344.2 Plastic Analysis. The criteria provided in F-1341.2 shall be applied. In addition, members shall be checked for local and general instability following the requirements given in F-1334.3.

F-1344.3 Collapse Load Analysis. The criteria provided in F-1334.6 shall be applied.

F-1344.4 Plastic Instability Analysis. The plastic instability load (F-1321.7) is designated P_t and may be determined by one of the following methods:
(a) plastic analysis [F-1321.4(b)];
(b) experimental analysis (F-1321.8).
The applied load shall not exceed 0.7P_t.

F-1344.5 Interaction Method. Acceptability for individual structural members of linear type supports may be demonstrated using interaction method analysis. Procedures for interaction method analysis are given in A-9000. The allowable stress S_m shall not exceed 0.75S_w.

F-1344.6 Stress Limits for Bolts. Bolts shall be evaluated in accordance with the rules of F-1335.

F-1344.7 Bearing Stresses. Except for pinned and bolted joints, bearing stresses need not be evaluated for loads for which Level D Service Limits are specified.
TABLE F-1200-1
LEVEL D SERVICE LIMITS — COMPONENTS AND SUPPORTS ELASTIC SYSTEM ANALYSIS ACCEPTANCE CRITERIA

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<th>Bearing Stress</th>
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<tr>
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<td>F-1356</td>
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GENERAL NOTES: The following Design Rules shall be followed.

(a) Level D self-relieving stresses need not be considered unless as specified within a specific section of Nonmandatory Appendix F.
(b) In addition to consideration of primary stresses, stability of the component or support shall be considered when compressive stresses are present.
(c) Potential for unstable crack growth shall be considered.
(d) Allowables shall be adjusted to reflect any different material behavior from that which the allowables are based. See F-1322.3.
(e) Geometric nonlinearities shall be considered when appropriate.
(f) Design specification requirements shall be satisfied in addition to those given in Nonmandatory Appendix F.

NOTES:

(1) For Vessels and Pumps, the design rules given in F-1330 and F-1340 shall be used; for Valves, as an alternative to the procedures of F-1300, F-1420 can be used; for piping, as an alternative to the procedures of F-1331, F-1430 can be used. For Core Support Structures, the procedures of F-1300 may be used except as stipulated in F-1440.

(2) As an alternative to the requirements of F-1331.1, the interaction method may be used following F-1331.3 and the procedures given in A-9000.

(3) Per F-1322, if elastic system analysis is used, the components and supports may be designed alternatively on the acceptance criteria of F-1340 provided a reevaluation of the system analysis is performed to determine that it has not been significantly invalidated due to load and stress redistribution and changes in geometry. See F-1322.1 for further discussion.

(4) Stresses resulting from constraint of free end displacements and anchor point motion shall be considered primary stresses. Neither peak stresses nor stresses resulting from thermal expansion within the support need be evaluated.

(5) As an alternative to F-1332.1 through F-1332.6 requirements.

(6) Per F-1334, the allowable stress presented in NF-3320 for Level A Service Condition may be increased using the following factors: the smaller of 2 or 1.167 S_s/S_p if S_p > 1.2 S_s. Note that members must be checked for local and general instability.

(7) As an alternative to the requirements in F-1334.4, a collapse load analysis is acceptable following F-1334.6.

(8) As an alternative to the requirements of F-1334.1 through F-1334.5, the interaction method may be used following F-1334.7 and the procedures given in A-9000.

(9) As an alternative to the requirements of F-1334.1 through F-1334.5, F-1332.7 may be used.

(10) Threaded structural fasteners used in core support structures shall be evaluated using the rules of F-1440.

(11) Minimum edge distance shall meet the requirements of F-1334.4.