(d) Heat exchangers and similar vessels shall be protected with a pressure relief device of sufficient capacity to avoid overpressure in case of an internal failure.

(e) The rated pressure-relieving capacity of a pressure relief valve for other than steam, water, or air shall be determined by the method of conversion given in Section XIII, Mandatory Appendix IV.

(f) The relieving capacity of a pressure relief device for compressible fluids may be prorated at any relieving pressure greater than 1.10 \( p \), as permitted under UG-153, by applying a multiplier to the official relieving pressure and the coefficient \( K \) in Section XIII, 9.7.6.4 with the permitted absolute relieving pressure greater than 1.10 \( p \), as permitted under UG-153, by applying a multiplier to the official relieving pressure and the coefficient \( K \) in Section XIII, Mandatory Appendix IV. (See UG-155 for pressure settings.)

UG-153 OVERPRESSURE LIMITS

(a) Other than unfired steam boilers, when a pressure relief device is provided, it shall prevent the pressure from rising more than 10% or 3 psi (20 kPa), whichever is greater, above the maximum allowable working pressure, except as permitted in (1) and (2) and UG-54(c). [See UG-155 for pressure settings.]

(1) When multiple pressure relief devices are provided and set in accordance with UG-155(a), they shall prevent the pressure from rising more than 16% or 4 psi (30 kPa), whichever is greater, above the maximum allowable working pressure.

(2) When a pressure vessel can be exposed to fire or other unexpected sources of external heat, the pressure relief device(s) shall be capable of preventing the pressure from rising more than 21% above the maximum allowable working pressure. Supplemental pressure relief devices shall be installed to protect against this source of excessive pressure if the pressure relief devices used to satisfy the capacity requirements of (a) and (1) above have insufficient capacity to provide the required protection. See Nonmandatory Appendix MM, M-13 for cases where the metal temperature due to fire or other sources of external heat can cause vessel failure prior to reaching the MAWP.

(3) Pressure relief devices, intended primarily for protection against exposure of a pressure vessel to fire or other unexpected sources of external heat installed on vessels having no permanent supply connection and used for storage at ambient temperatures of nonrefrigerated liquefied compressed gases \(^{40} \) are excluded from the requirements of (1) and (2), provided

\(- \text{ (a) the pressure relief devices are capable of preventing the pressure from rising more than 20% above the maximum allowable working pressure of the vessels} \)

\(- \text{ (b) the set pressure marked on these devices do not exceed the maximum allowable working pressure of the vessels} \)

\(- \text{ (c) the vessels have sufficient ullage to avoid a liquid-full condition} \)

\(- \text{ (d) the maximum allowable working pressure of the vessels on which these pressure relief devices are installed is greater than the vapor pressure of the stored liquefied compressed gas at the maximum anticipated temperature}^{41} \text{ that the gas will reach under atmospheric conditions} \)

\(- \text{ (e) pressure relief valves used to satisfy these provisions also comply with the requirements of UG-155(e); Section XIII, 3.9(e)(5)(a); and Section XIII, Table 9.7.2-1 for fire.} \)

(b) For vessels that use overpressure protection by system design, the overpressure limits shall be per UG-154(e).

(c) The aggregate capacity of the open flow paths, or other unexpected sources of external heat installed on vessels having no permanent supply connection and used for storage at ambient temperatures of nonrefrigerated liquefied compressed gases \(^{40} \), are excluded from the requirements of (1) and (2), provided

\(- \text{ (a) the pressure relief devices are capable of preventing the pressure from rising more than 20% above the maximum allowable working pressure of the vessels} \)

\(- \text{ (b) the set pressure marked on these devices do not exceed the maximum allowable working pressure of the vessels} \)

\(- \text{ (c) the vessels have sufficient ullage to avoid a liquid-full condition} \)

\(- \text{ (d) the maximum allowable working pressure of the vessels on which these pressure relief devices are installed is greater than the vapor pressure of the stored liquefied compressed gas at the maximum anticipated temperature}^{41} \text{ that the gas will reach under atmospheric conditions} \)

\(- \text{ (e) pressure relief valves used to satisfy these provisions also comply with the requirements of UG-155(e); Section XIII, 3.9(e)(5)(a); and Section XIII, Table 9.7.2-1 for fire.} \)

UG-154 PERMITTED PRESSURE RELIEF DEVICES AND METHODS

Protection against overpressure shall be provided by pressure relief devices, open flow paths, or system design or a combination thereof in accordance with this paragraph.

(a) Pressure Relief Valves

(1) Pressure relief valves bearing the ASME Certification Mark with the UV Designator in accordance with Section XIII may be used. Pressure relief valves shall be of the direct spring-loaded or pilot-operated type.

(2) Pressure relief valves certified for a steam discharging capacity under the provisions of Section I and bearing the ASME Certification Mark with the V Designator for safety valves may be used on pressure vessels constructed to this Division. The rated capacity in terms of other fluids shall be determined by the method of conversion given in Section XIII, Mandatory Appendix IV. (See Section XIII, 9.2.3.)
(b) Nonreclosing Pressure Relief Devices

(1) Rupture disks bearing the ASME Certification Mark with the UD Designator in accordance with Section XIII may be used as the sole pressure-relieving device for overpressure protection.

NOTE: When rupture disk devices are used, it is recommended that the design pressure of the vessel be sufficiently above the intended operating pressure to provide sufficient margin between operating pressure and rupture disk bursting pressure to prevent premature failure of the rupture disk due to fatigue or creep.

Application of rupture disk devices to liquid service should be carefully evaluated to ensure that the design of the rupture disk device and the dynamic energy of the system on which it is installed will result in sufficient opening of the rupture disk.

(2) A pin device bearing the ASME Certification Mark with the UD Designator in accordance with Section XIII may be used as the sole pressure-relieving device for overpressure protection.

(3) Spring-Loaded Nonreclosing Pressure Relief Device

(a) A spring-loaded nonreclosing pressure relief device, pressure actuated by means that permit the spring-loaded portion of the device to open at the specified set pressure and remain open until manually reset, may be used.

(b) The calculated capacity rating of a spring-loaded nonreclosing pressure relief device shall not exceed a value based on the applicable theoretical formula (see Section XIII, 9.7.6.4) for the various media, multiplied by: \( K = \text{coefficient} = 0.62 \). The area \( A \) (square inches) in the theoretical formula shall be the flow area through the minimum opening of the spring-loaded nonreclosing pressure relief device.

(c) In lieu of the method of capacity rating in (b), a Manufacturer may have the capacity of a spring-loaded nonreclosing pressure relief device design certified in general accordance with the procedures of Section XIII, Part 9, as applicable.

(c) Combination of Devices

(1) The following combinations of devices may be used, provided they meet the requirements of Section XIII, Part 8:

(a) a rupture disk device installed between a pressure relief valve and the vessel

(b) a rupture disk device installed on the outlet side of a pressure relief valve that is opened by direct action of the pressure in the vessel

(c) A pin device installed between a pressure relief valve and the vessel

(2) A pin device shall not be installed on the outlet side of a pressure relief valve that is opened by direct action of the pressure in the vessel.

(3) Spring-loaded nonreclosing pressure relief devices may not be used in combination with any other pressure relief device.

NOTE: Use of nonreclosing pressure relief devices of some types may be advisable on vessels containing substances that may render a pressure relief valve inoperative, such as where a loss of valuable material by leakage should be avoided or where contamination of the atmosphere by leakage of noxious fluids must be avoided. The use of rupture disk devices may also be advisable when very rapid rates of pressure rise may be encountered.

(d) Open Flow Paths

(1) Flow paths or vents, open directly or indirectly to the atmosphere may be used as the sole pressure relieving device on a vessel.

(2) The calculated capacity of any pressure relief system may be determined by analyzing the total system resistance to flow. This analysis shall take into consideration the flow resistance of the piping and piping components including the exit nozzle on the vessels, elbows, tees, reducers, and valves. The calculation shall be made using accepted engineering practices for determining fluid flow through piping systems. This calculated relieving capacity shall be multiplied by a factor of 0.90 or less to allow for uncertainties inherent in this method.

(e) Overpressure Protection by System Design

Overpressure protection by system design in accordance with Section XIII, Part 13 is permitted.

(1) For vessels with overpressure protection by system design where the pressure is self-limited at or below the vessel MAWP, (see Section XIII, 13.2), there shall be no credible overpressure scenario in which the pressure exceeds the maximum allowable working pressure (MAWP) of the pressurized equipment at the coincident temperature.

(2) For vessels with overpressure protection by system design where the pressure is not self-limited at or below the vessel MAWP, (see Section XIII, 13.3), there shall be no credible overpressure scenario in which the pressure exceeds 116% of the MAWP times the ratio of the allowable stress value at the temperature of the overpressure scenario to the allowable stress value at the vessel design temperature. The overpressure limit shall not exceed the vessel test pressure.

UG-155 PRESSURE SETTINGS AND PERFORMANCE REQUIREMENTS

(a) When a single pressure relief device is used, the set pressure marked on the device shall not exceed the maximum allowable working pressure of the vessel. When the required capacity is provided in more than one pressure relief device, only one pressure relief device need be set at or below the maximum allowable working pressure, and the additional pressure relief devices may be set to open at higher pressures but in no case at a pressure higher than 105% of the maximum allowable working pressure, except as provided in (b).

(b) For pressure relief devices permitted in UG-153(a)(2) as protection against excessive pressure caused by exposure to fire or other sources of external heat, the device marked set pressure shall not exceed...
### Table NN-6-9
Cautionary Advice Provided to the User

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Code Reference</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>U-2(a)</td>
<td>Input from Manufacturer</td>
</tr>
<tr>
<td></td>
<td>U-4(d)(2)</td>
<td>Units of measurement</td>
</tr>
<tr>
<td></td>
<td>1(b) of &quot;Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees&quot; in the front matter</td>
<td>Code Case acceptance</td>
</tr>
<tr>
<td>Inelastic straining due to creep</td>
<td>[Note (1)]</td>
<td></td>
</tr>
<tr>
<td>Painting before pressure testing</td>
<td>UG-99(b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UG-100(f)</td>
<td></td>
</tr>
<tr>
<td>Pressure relief devices</td>
<td>Section XIII, 4.1.2(a)</td>
<td>[Note (2)]</td>
</tr>
<tr>
<td></td>
<td>Section XIII, 8.3(a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>UG-156(e)</td>
<td>[Note (3)]</td>
</tr>
<tr>
<td></td>
<td>Section XIII, IV-2</td>
<td>See in-text Note in IV-2(a)</td>
</tr>
<tr>
<td>Expansion joint design</td>
<td>5-1(d)</td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
(1) For Code reference, see endnote.14
(2) See definition of Manufacturer’s Design Range in Section XIII, Appendix A.
(3) For additional information, see endnote.90

### Table NN-6-10
Guidance Code to Users and Their Designated Agents

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Code Reference</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submittal of technical inquiries</td>
<td>1(b) of “Submittal of Technical Inquiries to the Boiler and Pressure Vessel Standards Committees” in the front matter</td>
<td></td>
</tr>
<tr>
<td>Guidance to accommodate deflagration loadings</td>
<td>H-1</td>
<td></td>
</tr>
<tr>
<td>Design criteria selection for deflagration loadings</td>
<td>H-4.1</td>
<td></td>
</tr>
<tr>
<td>Guide for preparing user’s design requirements</td>
<td>Nonmandatory Appendix KK</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Forms U-DR-1 and U-DR-2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Table KK-1</td>
<td></td>
</tr>
</tbody>
</table>

### Table NN-6-11
User–Manufacturer Rules

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Code Reference</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspection by user-inspector</td>
<td>UG-91(a)(2)</td>
<td></td>
</tr>
<tr>
<td>User’s inspector marking</td>
<td>UG-116(a)(1)(-a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Table W-3, Reference No. (12)</td>
<td></td>
</tr>
</tbody>
</table>