

Pressure Vessel Support Selection: Key Design Considerations

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Disclaimer: This document is meant for educational and interview preparation purposes and represents general engineering judgment. It is not an official ASME Code interpretation. Always refer to the most current edition of the applicable design code for your specific project requirements.

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1 Hook / Intro

Choosing the wrong support for a pressure vessel doesn't just make it harder to install; it can induce severe localized stresses that cause the shell to buckle under its own weight, tear during a seismic event, or rupture from restricted thermal growth. The support structure is the critical bridge between the flexible, expanding pressure boundary and the rigid foundation.

2 The Core Concept Explained

Vessel supports—whether skirts, legs, saddles, lugs, or rings—must be selected to carry the dead weight of the equipment, the operating/test fluids, and environmental loads (like wind and earthquakes) while safely transferring these forces to the foundation. Design codes, such as ASME Section VIII, Divisions 1 and 2, broadly require that all external loads be evaluated. The central design challenge is ensuring that the selected support provides structural stability without excessively concentrating stresses on the vessel shell or restraining its natural thermal expansion.

3 Code Insight (Where to Look)

In ASME Section VIII, Division 1, the requirement to evaluate support loadings is found in UG-22, while Nonmandatory Appendix G provides suggested good practices for the design of supports and attachments. For a more rigorous analytical approach, ASME Section VIII, Division 2, Part 4.15 details specific design rules, thermal gradient requirements, and localized stress evaluations for skirts, saddles, and lugs.

4 The “Why” Behind the Code (Engineering Mechanics)

- **Load Path:** Forces (such as dead weight, wind/seismic base shear, and piping thrusts) travel from the pressure-retaining shell through the attachment welds, down the support structure, into the base plates, and finally into the concrete foundation.
- **Stress Distribution:** The support type dictates how these loads enter the shell. A continuous cylindrical skirt distributes the load uniformly around the entire circumference, minimizing localized stresses. Conversely, discrete supports like legs or lugs introduce eccentric point loads that create high localized bending and shear stresses in the vessel wall.
- **Failure Modes:** Critical failure mechanisms include compressive buckling of the shell or support (especially under combined weight and wind/seismic overturning moments), local yielding at discrete attachment points, and fatigue or shear failure driven by restrained thermal expansion.

5 Key Design Checks / Governing Logic

- **Important parameters:** The vessel's center of gravity, operating and empty weights, lateral wind/seismic base shear, overturning moments, and the design temperature (which drives thermal expansion).
- **Governing load cases:** Support sizing is generally governed by either the full operating weight combined with maximum wind or earthquake loads, or the heavy water-filled condition during the field hydrostatic test.
- **Critical checks:** Engineers must evaluate the support members for axial compression and buckling, the vessel shell for local primary and secondary stresses at the attachment junction, and the base plates for safe concrete bearing pressure.

6 Design Decision Insight

Selecting a support involves balancing vessel geometry, location, and economics. For tall, heavy vertical columns, a skirt is the industry standard because it handles large overturning moments efficiently and minimizes local stresses. For small-to-medium vertical drums located at grade, braced or unbraced legs are highly economical. If a vessel is mounted high within a steel structure, lugs (often resting on low-friction sliding plates) are preferred. For horizontal vessels, designers strictly limit supports to exactly *two* saddles to prevent the vessel from acting as a statically indeterminate beam, which protects the shell from massive stress spikes if the soil settles unevenly.

7 Engineering Analogy

Think of supporting a pressure vessel like holding a large, thin plastic bowl full of hot, heavy soup. If you place the bowl on a solid, circular pot stand (a skirt), the weight is distributed evenly, and the bowl remains perfectly round. If you try to hold that same heavy bowl from the bottom using just three fingertips (legs/lugs), the weight is highly concentrated, causing the thin plastic to deform and warp around your fingers.

8 Real-World Scenario & Common Failure

A common failure scenario occurs when heavily loaded lugs or legs are attached directly to a thin-walled vertical vessel without proper reinforcement. During a high wind event or earthquake, the eccentric loads cause the discrete supports to physically deform or “punch” into the thin shell wall, leading to angular rotation of the support and severe localized yielding.

Prevention logic: When local stresses at lugs or legs become excessively high, engineers mitigate this by adding localized reinforcing pads to spread the load, or by transitioning to a full 360-degree ring girder to distribute the concentrated forces safely around the shell.

9 Interview Perspective

How this is asked: “What factors drive you to choose a skirt over legs for a vertical vessel, and how do you handle high-temperature thermal growth at the support?”

Common mistakes: Only sizing the support for operating weight while forgetting the much heavier hydrotest water weight, or failing to account for the thermal gradient between a hot vessel and a cold support.

What a strong answer includes: Contrasting the uniform stress distribution of skirts against the localized point-loads of legs/lugs. Highlighting the importance of the hydrotest load case. Mentioning design features like a “hot box” on a skirt to manage thermal gradients, or slotted holes with Teflon/Lubrite slide plates for lugs and saddles.

One follow-up question: “If you must use legs on a taller vessel in a high-wind area, how do you prevent the legs from bending or buckling?” (Answer: By adding cross-bracing or sway-bracing between the legs to absorb the lateral shear forces).

10 Long-Term Takeaway

The core engineering principle of support design is to safely transfer massive global loads—weight, wind, and seismic forces—to the foundation, while meticulously managing the localized stresses at the shell junction and allowing the pressure boundary to freely expand and contract.

11 Source Attribution (High-Level Only)

This explanation synthesizes rules and guidelines from the ASME Boiler and Pressure Vessel Code (Section VIII, Divisions 1 and 2), along with established structural methodologies detailed in standard industry pressure vessel design handbooks.