

Static Equipment Support Systems: Design, Load Paths, and Code Requirements

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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

A towering 150-foot distillation column does not just contain immense internal pressure; it must also withstand hurricane-force winds, seismic shocks, and its own massive weight without collapsing. The unsung hero ensuring this stability and protecting the critical pressure boundary is the static equipment's support system.

2 The Core Concept Explained

In static equipment design, a “support” refers to the structural component—such as a skirt, saddle, leg, or lug—that connects the pressure vessel to its foundation or surrounding structural steel. Its fundamental role is to safely and continuously transfer all imposed forces from the equipment to the ground while ensuring the vessel remains stable under all operating, testing, and environmental conditions. Design codes broadly require that these supports be arranged to accommodate maximum anticipated loadings without inducing excessive localized stresses or deformations in the pressure-retaining shell.

3 Code Insight (Where to Look)

When looking into the codes, you will generally find the requirement to consider support loadings in the general design sections outlining mandatory load combinations. Detailed design rules and formulas for specific support types (like skirts, saddles, and lugs) are often located in the design-by-rule sections or specific non-mandatory appendices of the major pressure vessel design codes. Furthermore, because supports function as structural members, the codes frequently defer to recognized civil and structural standards (such as those published by AISC or ASCE) for allowable stresses and environmental load calculations.

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

The physical reasoning behind support design revolves around managing how forces interact with thin-walled pressure boundaries:

- **Load Path:** Every force acting on the vessel (gravity, wind, earthquake, piping reactions) must find a continuous load path to the foundation.
- **Stress Distribution:** Because the pressure boundary is relatively thin, attaching a support concentrates these massive global forces into localized areas. This induces high secondary bending and local primary membrane stresses in the shell wall.
- **Failure Modes:** If a support is improperly detailed, the localized stress concentration can lead to shell buckling, structural yielding, or fatigue failure—especially when the vessel is subjected to thermal cycling, vibrations, or cyclic wind loading.

5 Key Design Checks / Governing Logic

Engineers evaluate support systems by scrutinizing the worst-case intersections of various forces:

- **Important Parameters:** The vessel's physical dimensions, center of gravity, operating temperature, and environmental site data (wind speed, seismic zone).
- **Governing Load Cases:** Designs are governed by extreme combinations. For instance, the foundation and compressive strength of the support are often governed by the hydrostatic test condition (vessel full of water). Conversely, overturning stability and maximum tension on anchor bolts are typically governed by an empty vessel facing maximum wind loads, as there is minimal dead weight to resist the uplift.

- **Critical Checks:** Engineers must verify that the support member itself will not buckle or yield, that the anchor bolts can handle the tensile uplift, and most importantly, that the local stresses in the shell at the support attachment point remain within allowable limits.

6 Design Decision Insight

Selecting the right support type is a critical early-stage design decision:

- **Skirts vs. Legs:** A cylindrical or conical skirt is heavily preferred for tall, heavy vertical vessels because it attaches continuously around the shell, uniformly distributing loads and minimizing localized stresses. Legs are economical for smaller, lighter vertical vessels but cause high point-loading and eccentric moments on the shell, making them unsuitable for tall towers or heavy cyclic service.
- **Saddle Positioning:** Horizontal vessels are almost exclusively supported by exactly two saddles. Using more than two saddles creates a statically indeterminate structure, meaning minor foundation settlement could cause one saddle to take a disproportionate amount of the load, severely overstressing the shell.
- **Thermal Behavior:** For high-temperature skirt-supported vessels, engineers use a “hot box” detail at the attachment point to create a gradual thermal gradient, preventing severe thermal discontinuity stresses between the hot expanding shell and the cooler support skirt.

7 Engineering Analogy

Think of supporting a pressure vessel like a person carrying a heavy, fragile box. If you try to balance the box on the tips of your fingers (like poorly designed support legs), the pressure is highly localized, and the box might puncture. If you support it with flat, open palms (like a continuous skirt or well-designed saddles), the weight is distributed evenly, and the box remains secure and stable even if someone bumps into you.

8 Real-World Scenario & Common Failure

A classic field issue involves horizontal vessels operating at high temperatures where both saddles are rigidly bolted to the foundation. As the vessel heats up, the metal attempts to thermally expand outward. Because both saddles are locked in place, the vessel cannot grow, inducing massive thermal stresses that can shear the anchor bolts, buckle the saddles, or tear the saddle-to-shell welds. To prevent this, one saddle must be anchored while the other saddle is provided with slotted holes and a slide plate (e.g., Teflon) to allow for unrestrained thermal expansion.

9 Interview Perspective

How this is asked: “Why do we only use two saddles on a horizontal vessel?” or “What factors drive your decision to use a skirt instead of legs on a vertical column?”

Common mistakes: Candidates often focus purely on the weight of the vessel, forgetting that environmental loads (wind/seismic) and thermal expansion are usually the governing factors in support design.

What a strong answer includes: A standout candidate will discuss the “load path,” contrast the uniform stress distribution of a skirt with the localized point-loading of legs, and explain how supports must be detailed to permit thermal growth while resisting wind/seismic overturning moments.

10 Long-Term Takeaway

A support system does much more than hold a vessel off the ground; it is the vital structural interface that negotiates the physical realities of gravity, extreme weather, and thermal expansion, all while safeguarding the integrity of the pressure boundary.

Source Attribution

The engineering principles and logic synthesized in this explanation are drawn from:

- ASME Section VIII Division 1
- ASME Section VIII Division 2
- Recognized pressure vessel design handbooks