Large Diameter Ball Valves in High Temperature Service

A Cornerstone Valve Case Study



About the Author

Cornerstone Valve's Application Engineer Raul Bueno serves as the technical link between Cornerstone's customers and its engineering team. He works directly with end users, EPC contractors, and distribution partners to translate process conditions into the right severe service valve solution, from initial inquiry through quotation and order.

Raul evaluates pressure, temperature, media, and cycling requirements to recommend valve type, materials, seat configuration, and actuation, and prepares the supporting torque data, general arrangement drawings, and technical submittals. His hands-on product knowledge across Cornerstone's top entry power valves and trunnion mounted designs helps customers specify valves that perform reliably in their most demanding services.

Thousands of ball valves are used in steam service. Most fall into two broad categories, and understanding both explains why large diameter ball valves in combined high temperature and high pressure service remain a specialized application.

1. **Small diameter floating or trunnion mounted ball valves** are used for drains, vents, and similar services in pressure classes from ASME 150 through 2500. Floating ball designs become size-limited as valve diameter increases, because of the stresses induced at the ball/seat interface and the design of the ball/stem joint. Above roughly 8-inch bore, operating torques rise dramatically and floating ball designs are used less often.
2. **Small and large diameter trunnion mounted ball valves** are routinely used in high pressure gas service, where pressures to 10,000 psig are not uncommon but temperatures rarely exceed 400 to 450°F. Many of these are specified metal seated. Cornerstone has produced metal seated valves for 10,000 psig service that were nitrogen gas tested and bubble tight.

Where the Applications Narrow

For this discussion, high temperature means above 500°F and high pressure means ASME Class 2500 or higher. In that combined envelope, and especially in sizes 6-inch and larger, the number of ball valve applications becomes much more limited. Heavy crude processing, for example, includes services at 950°F and 3,250 psig, but valve bores there are generally 4-inch or smaller. Many other hydrocarbon processing services run at similar temperatures but lower pressures. Cornerstone also has experience handling hot gas in Class 900 valves through 16-inch, in the 800 to 900°F range.



Cornerstone Valve – Large Bore Trunnion Mounted Ball Valve in Assembly

The Design Challenge

Each valve type faces its own challenge. In a floating ball design, high torque can damage the stem-to-ball connection or the ball/seat interface. Trunnion mounting reduces operating torque by at least 50 percent, but the valve then becomes an upstream sealing design with two potential leak paths:

- **The ball/seat interface**, the same challenge faced by a floating ball, governed by metallurgy and sphere accuracy.
- **The seal between the seat spool and the body**, which is the more difficult of the two. It must seal positively in both the radial and axial directions and respond to rapid temperature changes.

Cornerstone's Solution: Live Loaded High Temperature Seat Seal

Cornerstone developed a live loaded, high temperature seat-to-body seal that addresses this challenge directly. The design has been applied to Cornerstone's small power valves; an early field population of roughly one hundred valves recorded zero seal leaks over its first four years of service. Earlier generations of the design, developed in the late 1970s and early 1980s, operated in sizes up to 12-inch Class 900 and 10-inch Class 2500.

A representative installation is a valve at the Natref refinery, installed in 1993, operating at 800°F and pressures to 5,000 psig, which has been documented as trouble-free. The seal design is proprietary to Cornerstone Valve; detailed design information is available to customers under a confidentiality understanding.

Conclusion

Large diameter ball valves in combined high temperature, high pressure service demand more than scaling up a standard design. Trunnion mounting solves the torque problem but shifts the challenge to the seat spool-to-body seal. Cornerstone's live loaded high temperature seal, backed by decades of field history, provides a proven answer for owners who need quarter-turn reliability where few ball valve designs can follow.