# *Flowserve - Edward Valves*

*Cast-Steel Pressure-Seal Valves:*

*Research and Development*

# Cast-Steel Pressure-Seal Valves: Research and Development

## Problem

Bolted bonnet valves in high pressure applications that are prone to bonnet leakage due to the design of the bolted flange, body to bonnet joint.

## Solution

Flowserve-Edward pressure seal valves that use pressure to assist in creating a leak tight seal between the body and bonnet.

## Are There Disadvantages With Pressure-Seal Bonnets?

There have been few problems with Flowserve-Edward pressure seal bonnets during the period since these products were introduced. Still, there are people who condemn pressure-seal valves due to bad experience with leakage problems or maintenance difficulties. In many cases, this bad experience can be traced to problems with pressure-seal valves that did not have Flowserve-Edward nameplates – or the Edward testing heritage.

Another source of problems with pressure-seal valves in general (including Edward valves in some cases) is that maintenance requires different skills than those required with bolted-bonnet valves — not necessarily more skill, but special knowledge and training. Without proper attention to a few key points, leakage or other difficulties may be encountered. The most frequent problems have been:

• Some users attempt to use the same pressure-seal gasket when reassembling the valve after maintenance. This is very poor practice for any high-pressure gasket (even a spiral-wound gasket in a bolted closure), because the gasket is partially crushed to a new shape the first time it is loaded and will not be loaded the same way the second time. Sometimes the re-used gasket passes a hydrostatic test, and it may appear to work well for months or years. However, there is a very high probability that it will leak after the valve is exposed to thermal transients. Spare gaskets should be maintained in stock or ordered in advance of scheduled maintenance.

• Many users who do replace gaskets either make their own or have them made at a local machine shop. They generally use drawings based on measurement of used parts or incorporate design or material “improvements” of their own. They cite savings in cost or lead time as reasons for not purchasing genuine spare parts, but this can be expensive in terms of lost time due to leakage problems. Edward gaskets are made using dimensions, materials, and plating that are based on decades of testing and field experience.

• Even with careful handling, disassembly of a valve with a metal pressure-seal gasket may cause minor scratches in the body bore and sometimes on the surfaces of the bonnet which contact the gasket. Unless honed or polished, the scratches may be too large for the plating on the gasket to seal over, and they will be sites for leak paths. Leakage might be small at first (even undetectable), but it often increases with time due to erosion. Careless handling or maintenance by un-trained personnel may produce more severe damage to the sealing surfaces, requiring more extensive refinishing. With proper tools and training, these problems are easily overcome.

• Even when thoroughly tightened before pressurization, a pressure-seal gasket always yields slightly under pressure. This reduces the loading on the bolts which preload the gasket, and a metal gasket (with little inherent resilience) may subsequently leak at low pressure. When a new valve is manufactured by Edward, the bolts are tightened under hydrostatic test pressure to overcome this problem. When a valve is reassembled after maintenance in the field, the pressure-seal bolts should be retightened under working pressure to assure effective long-term sealing. This step is often forgotten in the rush of having many things to do when a plant is restarted after a maintenance outage and leakage may develop later. Note: *the requirement for retightening under pressure after maintenance may present a problem for some inside containment valves in nuclear power plants. The valve may be inaccessible when it is first pressurized. For this reason, some Edward valves in this service have been equipped with special heavy-duty bolting to allow more complete preloading of the gasket before pressurization.*

Everything considered, there are no significant disadvantages of standard Flowserve-Edward pressure-seal closures when compared to known alternatives, provided that users understand their function and assure that maintenance personnel are trained in the "different" skills discussed here. There are occasional maintenance problems, but this can also be said of valves with bolted bonnets (e.g., bolts lost or damaged, gasket reuse or use of improper replacement gasket, leakage due to damaged sealing surfaces, inadequate gasket loading due to high thread friction). As previously noted, pressure-seal closures offer the advantage of smaller and lighter parts to be handled, particularly with large, higher pressure valves.

## Four Rules For Good Pressure-Seal Performance

In summary, most "problems" with conventional pressure-seal bonnet closures have been overcome in the design of the current Flowserve-Edward pressure-seal valves. Lightweight parts provide easy maintenance and leakage-free service if the following four rules are followed:

1. Take reasonable care of body and bonnet sealing surfaces during disassembly to minimize galling and scratching, and polish or hone surfaces before reassembly with the new gasket.

2. Always use a new gasket when reassembling a valve after inspection or maintenance.

3. Use only Edward pressure-seal gaskets.

4. Tighten pressure-seal bolts to recommended torque values, first during bonnet assembly and again when full working pressure is applied.

## The Pressure-Seal Bonnet Closure of Today

While performance of standard Flowserve-Edward pressure-seal designs has been excellent, Edward has developed an even better pressure-seal design employing a live-loaded composite gasket. The sealing function is performed by flexible graphite instead of metal-to-metal contact in this new design. Flowserve-Edward research and testing of stem packings had shown that flexible graphite has the best sealing properties of known materials for high temperature, high-pressure service, and it was decided to use it in an improved bonnet pressure-seal. The new closure design (as applied to a large Class 2500 Equiwedge gate valve) is shown in Figure 1.

A development and testing program over a two-year period provided a proven design before it was introduced into production. With high-pressure, high-temperature steam test facilities that were not available when their predecessors developed the first pressure seal bonnets, Flowserve-Edward engineers conducted exhaustive tests on test fixtures simulating three valve sizes and pressure classes - through size 14, Class 2500.

Confirmatory testing of the final design, using water at room temperature with extensive pressure cycling to 6250 psig (431 bar) and hydrostatic testing to 9375 psig (647 bar), showed both excellent sealing and resistance to extrusion of the flexible graphite. Tests with steam at 2300 psig (159 bar) and over 1000°F (538°C), with severe pressure and temperature transients, demonstrated outstanding sealing. Special instrumentation was developed to measure and quantify leakage of invisible superheated steam, and it showed peak leakage rates typically less than 1 ml/hr even at the worst periods in transient tests (much less under steady-state conditions). Under room-temperature test conditions, leakage was undetectable at either low or high pressure.

The composite gasket is die-formed from flexible graphite to a high density and fitted with integral anti-extrusion devices, resulting in a relatively rugged assembly for ease in handling during shipping and valve assembly. After installation into the valve, the gasket is compressed to an even higher density by preloading with the bonnet bolts. Flexible graphite does not require wedging for sealing, but the small taper shown on the bonnet is provided for stress minimization. Belleville springs in this design provide "live loading" as pressure increases or decreases in service.

Since the new gasket does not require close metal-to-metal fits that may be subject to galling, maintenance is much easier and sensitivity to scratches on sealing surfaces is greatly reduced. Even if scratches occur, the flexible graphite seals over them much better than the soft plating on a metal gasket. During the test program, composite gaskets sealed over body and bonnet scratches that would not have sealed with a metal gasket. Further, the inherent resilience of compressed flexible graphite adds a significant supplementary live-loading feature in the new design. The gasket resilience and the spring-loaded bolts eliminate the need for retightening under pressure in all but the severest service conditions.

With these features, the new composite pressure-seal closure offers significant advantages over either a bolted closure or a conventional pressure-seal bonnet when a large valve must be disassembled, as for seat repair. With less damage to sealing surfaces and less sensitivity to minor scratches, it offers savings in both time and cost during maintenance outages. All that is necessary is reasonable care and attention to assembly instructions, including proper bolt torques for gasket preloading.

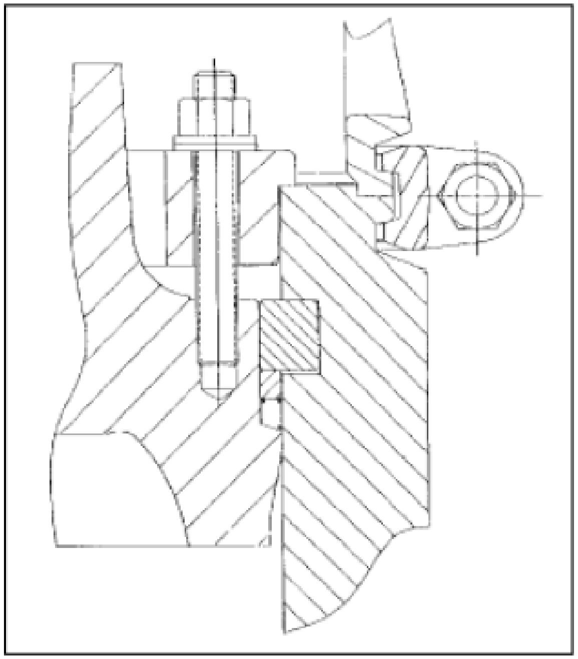

Figure 1: The flexible-graphite closure design as applied to a class 2500 Flowserve-Edward Equiwedge gate valve

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For more information about Flowserve Corporation, contact www.Flowserve.com or call USA 1-800-225-6989

**Flowserve Corporation**
**Flow Control Division**
Edward & Anchor/Darling Valves
1900 South Saunders St
Raleigh, NC 27603 USA

**Toll – Free Telephone Service**
(U.S. and Canada)
Day: 1-800-225-6989

**After Hours Customer Service**
1-800-543-3927

**U.S. Sales Office**
Phone: 919-832-0525
Fax: 919-831-3369

**Website:**
www.Flowserve.com