AS SEEN IN THE WINTER 2007 ISSUE OF...
Valve MAGAZINE

REMANUFACTURED CONTROL VALVES: DO THEY STILL MEET CODE?

THEY HAVE BEEN PAINTED TO LOOK LIKE NEW, BUT THEY MAY NOT HAVE BEEN RE-CERTIFIED TO THEIR ORIGINAL PRESSURE CLASS.

BY BOB BAKER

The chemical process industry is facing a potential safety issue associated with the growing use of used, salvaged control valves that may no longer comply with a manufacturer's specifications as originally designed to meet consensus industry standards such as ASME B16.34.

There appears to be an awareness problem, where typically the appropriate questions are not being asked about the pressure containment integrity of these salvaged valves that are refurbished and sold back into process plants.

Solutions are currently available; however, to date there is minimal implementation by end users requiring suppliers and/or service-providers to certify that used piping components such as control valves continue to meet their original ASME B16.34 defined pressure-temperature ratings designated by class. And beyond control valves, there is applicability across a wider spectrum of valve types designed in accordance with ASME B16.34.

These used, salvaged control valves are being marketed as repaired, refurbished or remanufactured and are typically offered directly or through sales representatives by salvage firms, repair/refurbishing shops and even original equipment manufacturers (OEMs). The used valves may have been obtained from:

- salvage operations of decommissioned plants or plant units
- excess bone-yard inventory
- replacement valve upgrades via financial trade-in credit against the new purchase.

Does New Paint Equate to Meeting Code?

Resold used control valves are usually painted to look like new with the specification data, including pressure class (pressure-temperature rating), often re-applied to a new nameplate or left

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Q&A WITH AN EXPERT

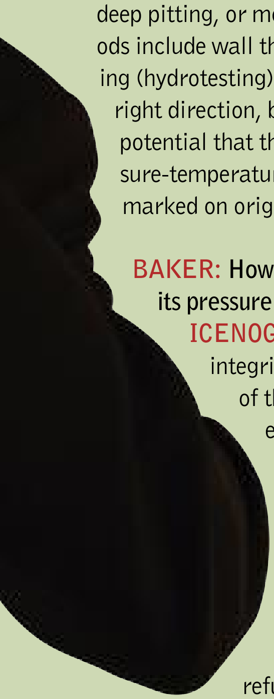
To better understand the various issues of wall thickness, including its importance to the pressure-temperature rating of a control valve, and how the ASME B16.34 standard deals with it, the author consulted Gary Icenogle, a retired engineering department manager for a global manufacturer of process equipment.

Icenogle worked in the industry for 34 years, serving 28 of those years as a member of the Valve Standards Subcommittee currently known as ASME B16.34 Subcommittee N. The initial subcommittee—organized by the American National Standards Committee B16 in December 1969 and named B16 Subcommittee 15—first met in December 1970. With Icenogle's 1971 appointment to B16 Subcommittee 15, he was extensively involved in the subcommittee's ongoing development and revisions of the B16.34 standard as we know it today.

BOB BAKER: Does a resold control valve still maintain its original pressure containment integrity?

GARY ICENOGLE: To understand the issue, one should first realize that a salvager most likely will not know what chemical process application the control valve had been in or how long it was installed.

The sophistication of salvagers, remanufacturers, refurbishers and non-OEM repair service providers results in varied methods of determining if there are potential pressure containment integrity issues due to reduced wall thickness. Typical methods involve visual inspection of the valve pressure boundaries for erosion, large or deep pitting, or more gradual corrosion. More sophisticated methods include wall thickness measurements and/or shell pressure testing (hydrotesting). Both of these methodologies are steps in the right direction, but without the proper information, there is the potential that the valve may no longer be suitable for the pressure-temperature rating for which it was originally designed (as marked on original nameplates or stamped on the valve body).



BAKER: How important is a control valve's wall thickness to its pressure containment integrity?

ICENOGLE: When ascertaining the pressure containment integrity of a valve, the appropriate data and application of the data is critical. With the exception of repair entities associated with the valve OEM, the typical source of wall thickness data and shell test requirements would be the ASME B16.34 standard, which gives valve design requirements to meet a specific pressure-temperature rating. It addresses minimum wall requirements as well as pressure testing requirements per pressure class.

A sophisticated salvager, remanufacturer, refurbisher or non-OEM repair shop may measure a salvaged valve's wall thickness and compare it to the required minimum wall thickness of ASME B16.34 Table 3 or the thickness calculated per the equations of Appendix VI. These entities' assumption is that if their measured wall thickness is greater than the table or calculated value, then the valve is capable of the pressure ratings for that valve size and pressure Class.

However, this is an incomplete application of the B16.34 standard that produces a potentially significant safety risk, since the minimum wall thickness described in paragraph 6.1.1 "Wall Thickness" and listed in Table 3 and Appendix VI are ONLY for cylindrical shapes. Other than bar stock bodies, most control valves are by no means cylindrical throughout, other than at their inlets and outlets. By using only Table 3 and/or the equations, a salvager will have ignored the exception paragraphs identified in paragraph 6.1.1 and detailed in paragraph 6.1.7 "Additional Metal Thickness."

For any actuated valve or valve with a non-cylindrical shape, paragraph 6.1.7 applies to ensure that the stress levels in the valve body will not approach the failure point of the material when the specific valve design is applied and functioning in a process. This important paragraph states that: "Additional metal thickness needed, e.g. for assembly loads, actuating (closing and opening) loads, shapes other than circular, and stress concentrations, must be determined by the individual manufacturers since these factors vary widely." This clearly indicates that greater wall thicknesses than the values listed in Table 3 or Appendix VI are required to account for the additional stresses.

The location and magnitude of the additional stresses requires a detailed understanding of the valve design and function, which is only known by the OEM and OEM-authorized service-providers who have access to the original and most current revisions of OEM design, manufacture and test documents. Complex valve shapes and contours may result in high stress areas whose location in the pressure boundary wall may not be known by non-OEMs. Thus, they are unlikely to measure wall thickness in these areas.

When valves are pulled for maintenance work, an end user could request inspection and re-certification of wall thickness to original design specifications. This is a solution that is not only a valuable method for increased safety, but it also provides the end user another means of demonstrating compliance to regulatory process safety management (PSM) requirements.

BAKER: We hear a lot about hydrotesting, but can it be used as sole proof of a control valve's pressure containment integrity?

ICENOGLE: Shell testing requirements are typically well understood and defined in ASME B16.34 paragraph 7.1 "Shell Test." The purpose of the shell test, typically referred to within the industry as a "hydrostatic test" or "hydrotest," is to ensure that the pressure boundary is capable of containing pressure in a static condition (as the term "hydrostatic test" implies). In other words, the shell test is performed to identify whether the pressure boundary has any material defects that could allow the fluid contained within the valve to leak to the atmosphere. *However, the shell test is not intended to be the sole requirement that defines the pressure containing capability of a valve.* The shell test is simultaneously used as a pressurized test of valve gasket joint sealing integrity.

Thus the requirements within ASME B16.34 for a valve's pressure rating are to have adequate wall thickness per paragraph 6.1 *and* to pass the appropriate shell test of 1.5 times the rated maximum cold working pressure per paragraph 7.1. Neither of these, if one is done without the other, will ensure that the pressure boundary is adequate to maintain a valve's original design pressure rating. Both are required, along with meeting the rest of the standard.

on the old nameplate. Subsequently, they are typically marketed by non-OEM third parties as "equivalent to new," "meets or exceeds OEM specifications," etc. However, unlike OEM-authorized entities, these third-party suppliers and/or service-providers do not have access to an OEM's design specifications and manufacturing standards used during new product development. Full access to all such documentation seemingly would be a prerequisite to any claim that a product meets those standards and specifications.

The significant safety concern is whether such repaired, refurbished or remanufactured control valves continue to meet the original OEM specifications as designed to the ASME B16.34 standard, thus reducing the risk of a potential "loss of containment" incident. Often these valves are aged and have been previously installed in demanding or hazardous process applications. As such, legitimate safety concerns can arise where valves are painted to look like new, yet potentially no longer meet code.

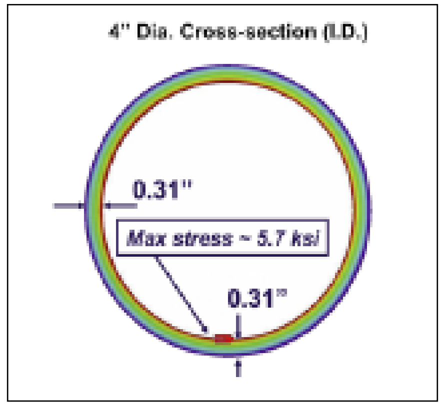


Figure 1

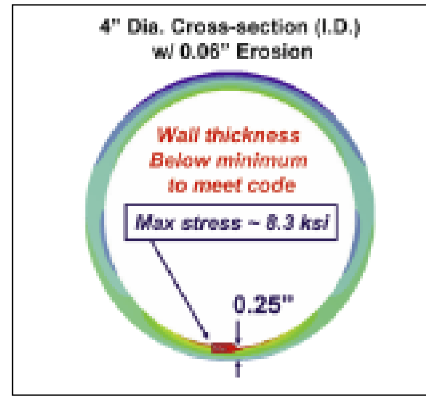


Figure 2

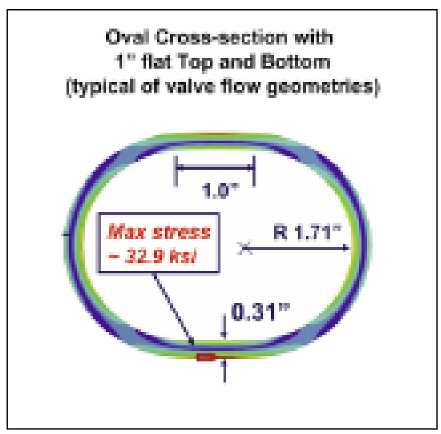


Figure 3

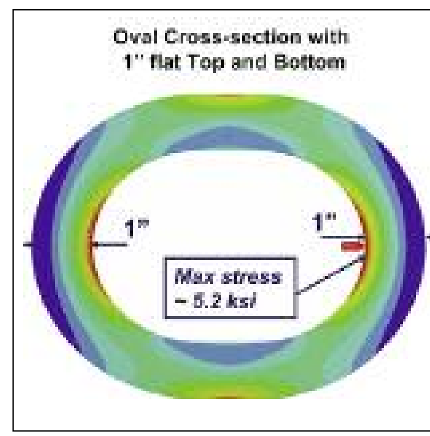


Figure 4

Industry Perception

There are industry perceptions that need to be cleared up about the pressure integrity of these salvaged, resold control valves. Often, valve pressure boundary walls are inspected but may or may not provide visible evidence of deterioration. If serious, localized damage is discovered, it will usually be weld-repaired to match the thickness of adjacent surfaces. However, the overall wall thickness may have thinned over time, and even after weld-repair, the pressure boundary wall may not meet the required design minimums as originally designed for its pressure class in accordance with ASME B16.34, *Valves, Flanged, Threaded, and Welding Ends.*

Risk Exposure

Unfortunately, a salvaged, refurbished, remanufactured or repaired valve is typically assumed to be equivalent to the original B16.34 pressure-temperature rating (class) and the pressure class designation is left on or reapplied to the nameplate or casting. Depending on available test equipment and supplier and/or service-provider sophistication, these types of valves may also be hydrotested at 1.5 times maximum cold working pressure per ASME B16.34 section 7.1. Successfully passing this test is often interpreted by both providers and purchasers as the sole indicator of pressure containment integrity. However, there continues to be oversight of the pressure boundary wall thickness as originally designed in accordance with ASME B16.34. Therefore, a salvaged, refurbished, remanufactured or repaired control valve may no longer meet its original B16.34 pressure class, and due to old nameplate or casting labels left on the valve, it may be installed in a piping system pressure class for which it is no longer suitable.

Besides posing a potential pressure containment integrity issue, a control valve no longer meeting specifications as designed to the B16.34 standard may be non-compliant to OSHA Process Safety Management (PSM) programs where the mechanical integrity element of the program encompasses piping systems and piping components such as valves, and it includes information requirements such as design codes and standards employed.

Additional Metal Thickness

ASME B16.34 paragraph 6.1.7 lists additional stresses on valves, noting these factors vary widely and must be determined by the individual manufacturer. Thus valves must be designed with additional metal thickness in stress-specific areas, enabling the valve to resist pressure boundary failure due to the combined effects of these stresses and those created by process pressure.

It should also be noted that the current ASME B16.34 standard only addresses new valves. However, logic would indicate that if a new valve requires a certain minimum wall thickness to meet a specific B16.34 pressure-temperature rating (class), then from a safety perspective, a salvaged, refurbished, remanufactured or repaired valve should meet the same minimums. Thus, if any corrosion or erosion has occurred during prior applications, these valves may no longer meet the minimum wall thickness specifications as designed to ASME B16.34 code. This may not be readily apparent unless a supplier and/or service-provider entity has access to the original design documentation.

Example

To illustrate the effect of shapes other than circular as referenced by ASME B16.34 paragraph 6.1.7, solid modeling software, calculating Von Mises stresses, was used to compute stress locations and magnitudes on the following cross-sections. Note that for Figures 1 through 4, the orientation of the cross-sections and maximum stress is not meant to represent any particular flow path location on a valve body.

Figure 1 is the base case, with a 4-inch diameter circular shape, Class 300 with 0.31-inch wall thickness and flow area of approximately 12.6 square inches. Applying the ASME B16.34 Class 300 maximum cold working pressure of 750 psig develops a 5.7 ksi maximum stress.

Again using 750 psig pressure cold working pressure, but applied to a cross section having its wall thickness diminished by 0.06 inches (representing gradual corrosion or erosion), Figure 2 shows a stress increase from 5.7 ksi to 8.3 ksi. Also note that this wall section would not be compliant with the B16.34 standard for Class 300 due to decreased wall thickness.

Next, consider the oval cross-section of Figure 3, which is typical for a globe valve's changing flow path cross-section from the inlet of the valve to the seat ring and from the seat ring to the outlet of the valve. There are very few areas of circular shape in a globe valve other than at the inlet and outlet, so the importance of B16.34 paragraph 6.1.7 is significant.

To illustrate the impact of the shape change, the flow area is held constant at approximately 12.6 square inches and the wall thickness is maintained at 0.31 inches (identical to the base case circular cross-section). When 750 psig maximum cold working pressure is applied, the maximum stress increases by nearly a factor of six from 5.7 ksi to 32.9 ksi.

To complete this example, Figure 4 shows that the wall section would need to be drastically increased to get a stress level similar to Figure 1.

The approach used in Figures 1 through 4 is a very simple illustration to what is actually a complex design effort that must account for not only the increased stresses due to shape, but the other stresses listed in B16.34 paragraph 6.1.7.

The end result is a control valve with varying wall thickness designed in accordance with B16.34 for safe operation to its pressure-temperature class ratings.

Thus, without access to OEM design specifications and casting drawings, third-party salvagers, remanufacturers, refurbishers and non-OEM repair service providers would not have the information necessary to appropriately inspect, measure and certify wall thickness needed for pressure containment integrity in critical high-stress areas.

Summary

Salvaged, refurbished, remanufactured or reconditioned valves may constitute a significant safety risk if a valve's pressure containment integrity is not adequately verified. Depending on equipment age, repair history, application severity and other factors, these valves may be out of compliance with safety standards and design standards such as ASME B16.34. The only suppliers and/or service-providers capable of performing verification and certifying conformance are those that have OEM-authorized access to the original and most current revisions of the OEM's design calculations, manufacture and test documents. **VM**

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