Risk Solutions

Pressure Points

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New Rules for the Use of Rod & Bar in ASME Section VIII

In ASME Section VIII, Divisions 1 and 2, new rules on the use of rod and bar will be published in the 2019 Edition (E19). These rules will offer more flexibility in the use of material for pressure vessel parts. The use of bar material has been both unclear and restrictive until these changes.

The primary technical concerns when using rod and bar material are twofold: anisotropy of mechanical properties and potential leaks. Rod (round bar) has had some limited testing in a variety of materials that indicate that there is the possibility of a significant reduction in tensile properties (anisotropy) when tested in other than the axial direction – the usual direction for testing rod. There have also been instances of leaks through rod that is cut into disks for plugs, header end caps, etc. The current rules in Section VIII, Division 1 (VIII-1) UG-6 and UG-14, and Division 2 (VIII-2) 3.2.5.2 limit the use of the material to address anisotropy concerns. There are properties other than strength of concern regarding anisotropy: ductility, toughness, fatigue and corrosion that are generally outside the scope of the Boiler & Pressure Vessel Code (the Code). In fact, numerous failures have been directly attributed to anisotropy in general industry (Ref: ASM Handbook Volume 11, Failure Analysis and Prevention, “Failures Related to Metalworking”, ASM International, 2002: pp. 8-22.).

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The philosophy of not permitting parts to be machined from bar was clarified in the following history:

- Interpretation VIII-1-92-95 (10/19/92) stated that shells could not be machined from rod or bar
- VIII-1 Code Cases 2148, 2155 and 2156 (12/6/93) provided permissions for the machining of certain parts from bar
- UG-6(b) and UG-14(b) were added in the 2005 Addenda (A05) and explicitly clarified the original intent (prohibitions) of VIII-1 UG-14.
- Interpretation VIII-1-04-93 (5/24/06) further expanded the permissions of Code Cases 2155 and 2156.
- Code Cases 2155 and 2156-1 continue to provide an alternative for using rod and bar for heads and shells (cylinders), respectively, greater than NPS 4 (DN 100).
- During the re-write of VIII-2 in the 2007 Edition, the requirements of VIII-1 UG-6(b) and UG-14 were incorporated into paragraph 3.2.5.2 of VIII-2.

The first major change that will be present in the E19 is to permit bar between "NPS 4 (DN 100)" and 8 in. diameter to be machined to form parts without ultrasonic testing (UT) or transverse tension testing, but with a 50% allowable stress penalty. Additional editorial changes were: delete the "NPS 4 (DN 100)" requirement and replace with "hot-worked diameter greater than 5.50 in. (140 mm)"; and acknowledge the apparent internal conflict within VIII-1 by cross-referencing Appendix 2, 2-2(d), where bar is permitted to be machined into flanges.

Additional major changes are as follows:

- permit any parts (even those parts that are machined across the grain, like flanges) to be machined from bar, within certain controls that are structured into (3) permissions :
  · bar up to 5.50" (140 mm) diameter with minimal controls
  · bar up to 8.00" (205 mm) diameter with a 50% penalty
  · bar greater than 5.50" (140 mm) with UT and transverse tension testing;
- revise the 30% reduction of area requirement to only apply to carbon and low-alloy steels; and
- require all parts machined across the grain to have a surface NDE.

The latter (2) revisions are the incorporation of VIII-1 Code Cases 2155 and 2156-1.

There is also a planned joint action being considered by the Section V Committee and the Subgroup Fabrication & Examination of the Section VIII Committee to review the volumetric NDE (UT) requirements and update them to modern technology.

[Note: this article is a continuation of the same topic from Pressure Points, March 2006 and August 2006. Also, a more detailed discussion is also presented in PVP2018-84823, available from ASME.]

B16.5 Flanges in Section VIII, Division 1 Design; Part 2 of 2

This is the second article of a two part series about ASME B16.5 flanges, and their application in Section VIII, Division 1 Design. In Part 1 of 2, pressure-temperature (P-T) rating, external pressure design, UG-22 loads, and how to consider these loads as they relate to B16.5 flanges have been addressed. In this article, corrosion allowance and cladding on B16.5 flanges, more details about UG-22 loadings, reducing flanges, and how to use material in a standard ASME B16.5 flange to contribute to an opening reinforcement calculation are addressed.

One of the most common questions about B16.5 flanges is whether or not a modification can be made to the standard flange, and still maintain the pressure-temperature rating provided in the standard. As a general rule, any modifications made to a B16.5 flange which bring it outside of its geometric tolerances, will nullify the pressure-temperature rating though there are some exceptions to that rule as explained below.

A typical modification is to provide a single, small, centrally located opening in a blind flange. B16.5 standard refers to this as "a reducing flange", and provides dimensional limits in Table 6. As long as the dimensions fall within the limits provided in B16.5, the temperature-pressure rating would still apply to the flange. Please note that this does not mean that no calculations are required. Some other calculations may be in order; for example, UG-45 calculations if a nozzle is attached to the reducing flange.

What if there is a corrosion allowance specified on a flange? As long as there is extra material in the flange to account for the corrosion, it may be possible to maintain the pressure-temperature rating. B16.5, paragraph 5.1.1 states that erosion and corrosion allowances are the responsibility of the user. The user must account for any corrosion allowance in a standard flange, and ensure there is enough material remaining in the corroded condition to resist all loadings.

Applying a corrosion resistant cladding to B16.5 flanges is another common modification that manufacturers typically use when the flange material doesn't provide adequate resistance to corrosion. Interpretation VIII-1-15-11 (see below) states that weld overlay for corrosion resistance is permissible and will not impact the standard pressure- temperature rating of the flange as long as the flanges are not otherwise modified, and the weld overlay material is not considered for strength.

Interpretation: VIII-1-15-11
Subject: UG-11(c), Weld Overlay of ASME B16.5 Standard Flanges
Date Issued: 1st of October, 2014
Record Number: 14-314

Q: A pressure vessel with flanges that are in accordance with ASME B16.5 and ASME B16.47 has weld overlay deposited for corrosion resistance in accordance with Section VIII, Division 1, Part UCL or Section VIII, Division 2, 3.3.6. The flanges are not otherwise modified, and the weld overlay material is not considered for strength. Do these flanges meet the requirements of Section VIII, Division 1, UG-11(c) and Section VIII, Division 2, 3.2.8.3, whereby flange pressure–temperature ratings of the ASME standard may be used and the design calculations of Section VIII, Division 1, Mandatory Appendix 2 or Section VIII, Division 2, 4.16, respectively, are not required?

A: Yes.

Note: This interpretation also appears as VIII-2-15-02.

There are some situations where material from a standard flange may need to be used to reinforce an opening. If a B16.5 weld neck flange is attached directly to a shell or head where there is an opening and if the opening requires reinforcement, typically the area A2 (from the nozzle wall) would be set to zero and all the other areas would be summed to determine the reinforcement. Interpretation VIII-1-89-313R, Q&R2, provides some insight.

Interpretation: VIII-1-89-313R
Subject: Section VIII, Division; UG-40
Date Issued: February 25th, 1999
File: BC90-470*

Q: May the metal for a single nozzle reinforcement be located asymmetrically about the nozzle center line, within the stated boundaries for the limits of reinforcement, as given in UG-40?

A: Yes, provided at least half the required reinforcement be on each side of the center line of the opening.

Q: May the shell nozzle reinforcement area include bolted flange metal from a weld neck flange welded to the shell and located within the limits of reinforcement, as given in UG-40?

A: No.

Q: May shell nozzle reinforcement area include metal from the straight flange portion of a dished shell cover welded to shell and within the limits of reinforcement, as given in UG-40?

A: Yes.

The above Interpretation confirms that when performing reinforcement calculations for an opening to which a B16.5 weld neck flange is attached directly, the area A2 essentially becomes zero. If the designer needs to use any material from the nozzle wall for reinforcement, the P-T ratings are not valid anymore and Appendix 2 calculations are required to be performed on the B16.5 flanges to determine if there is any extra material available in the nozzle wall (A2) for reinforcement.

If the opening doesn't require reinforcement calculations, the weld neck flange can be attached directly to the head or shell at the opening without having to forgo the P-T rating of the flange. It is important to remember that compliance to UG-45 and UW-16 are still required.

Even though a flange made in accordance with B16.5 standard may not need any calculations for internal pressure, any additional loadings must still be accounted for. As always, if there are any questions, or if you are unsure about the applicable loading conditions, please contact the Codes & Standards staff at techsupport@hsb.com.

Code Change in the 2019 Edition Concerning Section VIII Impact Testing

In a previous Pressure Points article published in August 2018, the rules of Section VIII Division 1, paragraph UG-84(h)(2)(-b) and Section VIII, Division 2, paragraph 3.11.8.3(f)(2) were discussed at length. As a reminder, these paragraphs require for Table UCS-23 and Table 3-A.1 materials (i.e., carbon and low alloy steels), that the heat treated condition of both the PQR test coupon and production joint prior to welding be the same. These conditions must match each other. For example, a PQR welded on a test coupon in the as-rolled condition (i.e. not normalized or stress relieved) may only be used to support a WPS used to weld production material that is in the as-rolled condition. Using this same WPS to weld a production joint in the normalized condition, would violate Code. One problem is that these Code rules are easily overlooked and this prompted a Code change in the 2019 Edition.

As stated, these code rules are easily overlooked and difficult to verify, unless a conscious effort was made to record the heat treated condition of the PQR test coupon, prior to welding, and this was transcribed onto the WPS used for construction as additional information. Under this approach, the WPS can be validated against the material to be joined in construction to ensure proper Code compliance.

In the 2019 Edition of Section VIII Division 1, the words in UG-84(h)(2)(-b) will be revised as follows:

> "For vessels constructed to the rules of Part UCS, the test plate material shall satisfy all of the following requirements relative to the material to be used in production:
> (-a) be of the same P-Number and Group Number;
> (-b) be in the same heat-treated condition and this heat-treated condition shall be noted on the PQR and WPS used for construction; and
> (-c) meet the minimum notch toughness requirements of (C)(4) for the thickest material of the range of base material qualified by the procedure (see figure UG-84.1)."

Similar words will be introduced into 3.11.8.3(f)(2) of Section VIII Division 2.

So what do these changes mean? These changes do not introduce new technical changes, since the requirement to use only WPS(s) for construction joints of the same heat treated condition as the PQR coupon prior to welding has been in the code since the 1987 addenda. This change now simply states that this heat treated condition must be listed on the PQR and the WPS(s) used for construction. This will make it easier for the Certificate Holder to verify that the correct WPS is being used for the construction joint. It will also make it easier for Inspectors and ASME Team Leaders to verify Code compliance.

What if my PQR(s) and WPS(s) today do not list the heat treated condition of the PQR test coupon prior to welding? If objective, defendable evidence still exists on secondary documentation for the PQR material (e.g. purchase order, Material Test Report, Material Specification, etc.), this may be used to justify an editorial revision to the existing PQR as permitted by Section IX to add the missing information. Concerning the WPS, a WPS may always be revised without requalification to add additional information, at any time as long as revision control is maintained as stated in the Certificate Holder's Quality Control Manual.

What if the heat treated condition of the PQR test coupon prior to welding is not known? Remember, this is not a new rule. If this condition is not known, then there is no way to verify Code compliance. As a result, this is not acceptable and corrective action is required.

For existing PQRs, where it is not known what the heat treated condition was prior to welding, a supplemental test coupon in the desired heat treated condition may be welded in accordance with the rules of Section IX, QW-401.1. Heat Affected Zone impact test specimens may then be removed and tested per the rules of UG-84 and/or 3.11 as applicable. This information may then be recorded on a supplemental PQR.

Do the code changes described in this article only apply to qualifications certified after the 2019 Edition becomes mandatory? The short answer is No. Any previously qualified procedures that do not identify the heat-treated condition on the PQR and WPS will need to be editorially revised as stated above or the procedures requalified.

In summary, the technical requirements behind these paragraphs have not changed and have been in the Code for many years. The only change that will be in the 2019 Edition is that the known heat treated condition must be listed on the PQR and the WPS(s) used for construction. This will first and foremost make more Certificate Holders aware of these existing Code requirements that are often overlooked as well as make it easier to validate proper Code compliance on existing and future pressure vessels and pressure vessel parts. If you have any questions concerning this change, please work with your Authorized Inspector and as always, the team of Engineers within the Codes and Standards Department may be contacted at techsupport@hsb.com to provide further support.

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