Standard 6X: Design Calculations for Pressure-Containing Equipment

New Draft Standard under Subcommittee 6
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Since referencing an obsolete spec is awkward, an Annex (Annex I) was prepared for 16A capturing the method from that ASME Appendix.

Subcommittee 6 proposed that the method be put in a separate document to assure uniformity.
Document covers calculation methods only.
Applicable only to specified pressure containing components, i.e. bodies, bonnets, and end connectors.
No material property requirements
No quality control requirements
The product specifications may also permit the use of other methods.
2004 ASME Code Requirements

- Methods were provided for linear elastic analysis, non-linear limit analysis, and elastic/plastic finite-element analysis.
- Linear elastic analysis defined stress categories and allowable limits for each. Stress components were combined into stress intensities.
- Limit analysis assumed an elastic, perfectly plastic material and determined the collapse loading.
- Elastic analysis was based on the true stress/true strain data and was used to verify shakedown.
Task Group Charge

- Create a new API standard documenting the rules of the 2004 ASME Code.
- Problem: 16A and 6A use different allowable stresses.

<table>
<thead>
<tr>
<th>Stress value</th>
<th>Spec 6A requirement</th>
<th>Spec 16A requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max SI at test pressure</td>
<td>5/6 of $S_y$</td>
<td>90% of $S_y$</td>
</tr>
<tr>
<td>$S_m$ for standard materials</td>
<td>2/3 of $S_y$</td>
<td>2/3 of $S_y$</td>
</tr>
<tr>
<td>$S_m$ for non-standard materials</td>
<td>Lower of 2/3 $S_y$ or $\frac{1}{2} S_u$</td>
<td>2/3 of $S_y$</td>
</tr>
</tbody>
</table>
Resolution

- The task group consensus was to use the rules of 16A, since going to the slightly more conservative 6A rules would penalize 16A/16C users who had designed to higher allowable stresses.
- The 90% of Sy used in 16A and 16C is the same as the limit in the 2004 ASME Code Section VIII Division 2 part AD–151.1(a).
- Using only the yield strength as a basis follows Section VIII Division 3 practice.
Changes from Annex I to 6X

- 6X is derived from API 6A, Annex I.
- Several revisions were made to the Annex I to clarify the requirements.
- The uses of limit analysis and elastic/plastic analysis were clarified.
- The requirement regarding triaxial stress (the sum of the three principal stresses) was clarified as to the calculation basis.
Items not covered

- Design of bolting is not included since it is covered in new bolt specifications (API 20E).
- Fatigue is not covered since only API 17D requires fatigue analysis.
- Material properties and quality control are not included since they are covered differently in the product specifications.
- Rules for non-standard materials are not covered since API 6A addresses this.
Status of 6X

- The TG finalized the draft and agreed it was ready for ballot.
- API edited the document into standard API format and returned it to the TG for review.
- After review the draft standard was sent out for ballot by SC6, with an April 30 deadline.
- SC 16 and SC 17 solicited comments from their member companies, which were considered along with those from SC6 members.
3 Ballots needed

- First ballot passed, with four negative votes and over 150 comments made and resolved.
- Second ballot – API to re-ballot since there were so many technical changes. Second ballot also passed, with two negative votes, and over 100 comments and resolved.
- Third ballot – Again, because of technical changes, it was decided to re-circulate a third time. Third ballot passed with no negative votes and only 34 minor editorial comments.
Revisions due to the ballot comments

- An introduction was added to give background of the standard.
- Stress components may be combined using von Mises equivalent stress (vs. stress intensity) if permitted by the product specification.
- Removed the note that if the material has a high yield/tensile ratio a lower $S_m$ value may be used. This makes the $S_m$ determination exactly like in 16A and 16C.
- Vague language in several places strengthened to clarify mandatory requirements.
- An “Extreme Conditions” paragraph was added providing the “k” factor from the 2004 Div 2.
Follow-on actions

After publication of the Standard

- Specifications 6A, 16A and 16C should revise their design section to direct the designer to this new standard instead of the 2004 ASME Code.
- This may require several changes in the body of the specifications.
- Since 17D refers to 6A for design requirements, no change is needed, unless they want to permit the use of von Mises equivalent stress.
- The 2004 ASME Code Section VIII Division 2 can be removed from the product specifications as a referenced standard, and Standard 6X added.
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