NEI Handout
10/18/07

Evaluation of Degraded Components

There are a number of techniques which can be used to evaluate degraded moderate and high energy components, including ASME Code Class 2 and 3 piping systems. These range from the simplistic to the sophisticated. Several acceptable methods are summarized below for evaluating these piping systems.

Area Reinforcement Techniques

One of the more simplistic methods to evaluate degraded piping is to use the rules contained within the ASME Code, Section III for reinforcement. If one assumes that degradation has resulted in a hole in the piping system, then the degraded piping can be evaluated. The concept is relatively simple. The area removed by the hole, including the potential increase in size due to future degradation, is replaced by excess material in the pipe. Rules are provided for how to calculate needed area, and material available for reinforcement. In addition, certain size holes do not require reinforcement. Implied in the use of the ASME Code methodology is that Code acceptable factors-of-safety have been taken into account.

Detailed Finite Element Analyses

Using generally accepted finite element analysis software packages, the degraded component can be realistically modeled. Once the model is finalized, including consideration of the current degraded situation as well as any future degradation, or holes for that matter, stress analysis can be performed for all applicable loading conditions. These analyses can be performed using elastic techniques, perfectly plastic techniques, or elastic-plastic techniques. What ever the method, results can be compared to agreed upon acceptance criteria to justify continued operation. Attached is a plot of an elbow, degraded due to flow accelerated corrosion, subject to internal pressure. Although no "holes" were included in this analysis, the methods would be the same.

Code Case N-513-1: Evaluation Criteria for Temporary Acceptance of Flaws (Moderate Energy Class 2/3 Piping)

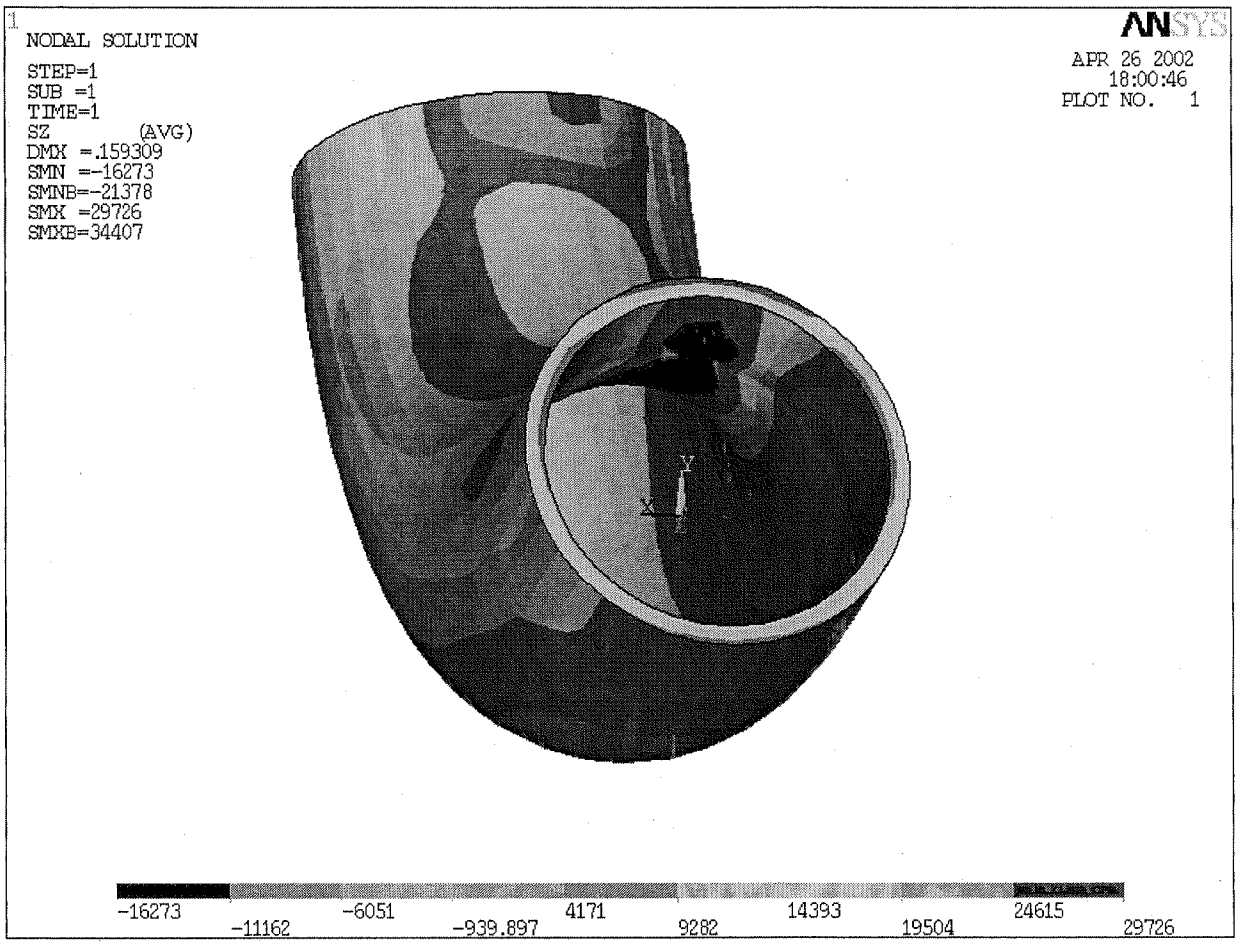
Code Case (CC) N-513-1 provides evaluation rules and criteria for temporary acceptance of flaws, including through-wall flaws in moderate energy piping. The provisions in this Code Case are focused on preventing gross failure of the affected pipe for a temporary period. The genesis of CC N-513-1 is Generic Letter 90-05 issued by the USNRC regarding temporary non-Code repairs. The Code Case allows for evaluations considering either planar or non-planar flaws.

For planar flaws, the flaw evaluation procedure used in CC N-513-1 is very similar to that discussed in Article C-1200 of ASME Code, Section XI, Appendix C. First, the flaws are characterized from inspection into planar or non-planar flaws. The interaction of multiple flaws is accounted for in the evaluation. Calculations are performed to determine the allowable flaw size for the pipe using the Code safety margins. Flaw growth of the observed flaw for the evaluation period is determined either by analytical means or by frequent periodic walkdowns. The end-of-evaluation flaw size is compared to the calculated allowable flaw size to establish the

suitability for continued operation. For non-planar flaws, CC N-513-1 uses the methods contained in Code Case N-480, which provides rules to address minimum wall requirements and integrity of pipe under pressure and bending loads. The CC N-480 requirements for Section III, Class 3 pipe have been adapted in CC N-513-1.

Flaw Evaluations

If flaws are detected in the degraded component, evaluations can be performed using classical fracture mechanics techniques, including those described in Section XI of the ASME Code, and appropriate margins to failure. Included in these evaluations would be consideration of flaw growth until the next inspection.


1
NODAL SOLUTION
STEP=1
SUB =1
TIME=1
SZ (AVG)
DMX =.159309
SMN =-16273
SMNB=-21378
SMX =29726
SMXB=34407
ANSYS
APR 26 2002
18:00:46
PLOT NO. 1
Y
X
-16273
-11162
-6051
-939.897
4171
9282
14393
19504
24615
29726