SUBJECT: RIN 3150-AH24
Industry Codes and Standards
Amended Requirements
PIPING DESIGN CRITERIA

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I am submitting comments on the proposed rule regarding the "Piping Design Criteria For Reversing Dynamic Loads. I agree with the NRC's view that several technical issues in NUREG/CR-5361 have not been satisfactorily resolved. The proposed amendment will not resolve all of the technical issues. My comments address those unresolved issues. My view is that NRC should not be writing design rules because NRC staff does not have the requisite perspective and collective experience to develop design rules. Design rules should be developed by the ASME Code Committee. My recommendation is that the "Reversing Dynamic Loads" code rules not be accepted until all applicable technical issues are adequately resolved with the Code Committee. The code rules from 1993 should be used until resolution is achieved.

One clarification on this submittal. My comments refer to primary stress limits. In Class 1 piping, Equation 9 is used to predict the primary stress intensity. For Level D, the limit in 1992 was $3S_m$ (but not greater than $2.0S_y$) for static and dynamic loads. In 1994, the stress limit was increased to $4.5S_m$ for reversing dynamic loads. In 2001, a different equation with a B_2' index and a $3S_m$ limit was defined. The net effect of the new equation is to allow the Equation 9 primary stress to go to $4.5S_m$ for a tee and elbow and to reduce the limit to $2.25S_m$ for a "girth butt weld between items which do not have nominally identical wall thicknesses".

<u>Level D Stress Limits</u>

There is no technical justification of adequate factor of safety with the increased primary stress limit for tees and elbows for Level D. The documentation indicates an inadequate factor of safety.

NUREG/CR-5361 provides a detailed assessment of the EPRI test data that was the basis for the higher stress limits. Table 4 of the report provides "Dynamic Margin" data in Column V where dynamic margin refers to the seismic margin from the tests adjusted for certain factors. The code committee considered a seismic margin of 2 as an acceptable margin. There are eight tests with dynamic margins below 2 (Tests 5, 6, 9, 10, 11, 12, 14, and 36). The margins on these eight tests vary from 0.3 to 1.91. These data do not support the increase in the Level D stress limits. There is no document that demonstrates acceptable factor of safety at the increased stress limit.

For Class 2/3 piping, the primary stress limits are the same as Class 1 [S_m rather than S_h is used]. This is not valid. Class 2/3 piping should have a larger factor of safety than Class 1 piping consistent with existing Section III design criteria.

There are other technical issues that need to be resolved. The eight tests mentioned above failed in fatigue. If adequate seismic margin cannot be shown for inertia loads, how can there be adequate margin with the inertia loads plus seismic anchor motion at $6S_m$ (range)?

Two of the EPRI tests were on straight pipe with lugs. These tests were not evaluated in NUREG/CR-5361. Both tests failed during the first high level tests. I have concluded that the loading environment at the lugs was much less than that of the other tests because of the limitations of the test configuration. Therefore, the stress limit at a lug should be less than the limit for the "girth butt weld between items which do not have nominally identical wall thicknesses".

The code allows threaded joints. Earthquake experience data indicates that threaded joints have much lower seismic capacity than girth welds. Therefore, the stress limit at a lug should be less than the limit for the "girth butt weld between items which do not have nominally identical wall thicknesses".

Allowing a higher stress limit for a girth fillet weld than for a "girth butt weld between items which do not have nominally identical wall thicknesses" is highly questionable.

Based on the dynamic margin data presented in NUREG/CR-5361, the fatigue damage from a Level D earthquake can be significant. The code rules allow the same seismic stress limits for a piping system without any Level A/B fatigue usage as a piping system with the Level A/B fatigue usage at the limit of 1. This is not a prudent design approach.

Class 1 Level B stress limits

The Level B primary stress limits were deleted for reversing dynamic loads in 1994 for Class 1 on the basis that collapse is not a potential failure mode. Collapse is a potential failure mode. The code rules do not provide an adequate factor of safety against collapse for Level B. In addition, the Level B primary stress limit is required to ensure the validity of the elastic fatigue analysis. If the primary stress limit is exceeded, plastic cycling could significantly reduce the fatigue life.

Class 2/3 Level B stress limits

The Level B "occasional load" stress limit was deleted for reversing dynamic loads in 1994 for Class 2/3 on the basis that collapse is not a potential failure mode. Collapse is a potential failure mode. The code rules do not provide an adequate factor of safety against collapse for Level B.

The NRC proposed amendment to allow the use of the B2′ index in NC/D-3653.1 is not technically justified. The higher primary stress allowed could cause damage (inelastic strain) to the piping system. The purpose of the NC/D-3653.1 occasional load limit is to prevent such damage.

Flow Transient Reversing Dynamic Loads

The EPRI test results do not support the use of higher stress limits for reversing dynamic loads from flow transients. The higher stress limits should apply only to earthquake dynamic loads.

NB-3228.6 Inelastic Analysis

The adequacy of the inelastic analysis procedure given in NB-3228.6 has not been demonstrated. I believe that there is a code revision to eliminate this procedure.

Linear Elastic Response Spectrum Analyis

There is no valid reason to couple the stress limits to the Appendix N response spectrum analysis. The code requirements on how the earthquake dynamic loads are computed should be eliminated.

Evaluation of Anchor Motions

The NRC position on evaluation of anchor motions as stated in the proposed amendment is not technically valid or appropriate. Even with the original (pre 1994) code rules for Level D ($3S_m$), there will be significant inelastic strains in the piping system for inertial loads. The amount of inelastic strain is not a direct concern at these stress limits. The concern is whether the cyclic inelastic strains will cause a fatigue failure. As stated above under "Level D Stress Limits" the concern on the anchor motion loads is whether the fatigue damage from combined inertia and anchor motion is acceptable. Based on NUREG/CR-5361, inertial loads at $4.5S_m$ (amplitude) are predicted to cause a fatigue failure for certain geometries. Anchor motions, by themselves, at $6S_m$ (range – $3S_m$ amplitude) are questionable. Certainly, the combined inertia and anchor motions are unacceptable. The proposed NRC limit of $3S_m$ (range) is also unacceptable for the combined inertia and anchor motion case for fatigue based on NUREG/CR-5361.

The NRC position includes the phrase – "when the global piping system determinations are not underestimated by the elastic analysis". There seems to be an opinion in the technical community that elastic analysis may underpredict the strain when the stress limits are above yield. This position is not applicable for seismic response. The EPRI test data demonstrates that elastic analysis overpredicts response. Energy absorption from plasticity attenuates the dynamic response.

Adequate Design Margin at High Temperature

NRC personnel have continually referred to a technical concern about the effect of high temperature on the predicted fatigue life. The Section III code does not consider the effects of temperature on predicted fatigue life for any loading condition for temperatures less than 700 or 800 F. It is inappropriate for NRC to require the consideration of high temperature effects on fatigue for the seismic design rules. If high temperature effects are a valid NRC concern, then research should be performed by NRC to address the concern. Depending on the research results, NRC may want to recommend code changes to ASME for fatigue evaluation for all loading conditions.

Sincerely,

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