UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
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ATLANTA, GEORGIA 30303-8931

July 19, 2005

MEMORANDUM TO: William D. Travers, Regional Administrator, Region II

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SUBJECT: DIFFERING PROFESSIONAL OPINION REGARDING OCONEE PIPE WHIP RESTRAINT (DPO-2005-003)

In response to your tasking of March 11, 2005, this memorandum provides the results of the DPO panel's review of the subject DPO. This memorandum provides the panel's conclusions for each of the major points provided by the submitter as well as recommended actions.

Introduction:

After reviewing the DPO, the panel developed a consolidated statement of concerns which captured the major points of the DPO. This statement was then provided to the DPO submitter to ensure a common understanding of the concerns. Following a phone conversation with the submitter on March 23, 2005, the panel began its review of the DPO. For convenience, and to ensure appropriate expertise was applied during the review, individual panel members reviewed specific portions of the concerns. The results of these reviews are attached. The overall conclusions of the panel, as well as the panel's consolidated recommendations contained in this memorandum, were concurred on by all members of the panel.

Conclusions:

1) The increased stresses imposed by the improperly adjusted pipe restraints did not result in a strain which approached the ultimate material strain of the pipe. Hence, pipe failure as a result of a one-time load application was unlikely.

2) The issue was appropriately dispositioned in Oconee Inspection Report 2004-005 given the assumption in the inspection report that pipe failure would not occur.

3) The Region's review of the issue was appropriate.

Recommendations:

1) NRR, explore revising the ROP to allow for the processing of performance deficiencies involving issues/initiating events that are not amenable to treatment using existing statistical techniques.

2) Include the improperly adjusted pipe restraints in the next PI&R sample inspection performed by Region II. Specifically examine the following attributes during this inspection:

- licensee corrective actions to ensure that the clearances/gaps in the restraints are maintained
- the need for the licensee to conduct routine pipe wall thickness measurements in the vicinity of the pipe restraints. If no requirements exist in this area, engage the licensee on the desirability of conducting these measurements.
- whether calculation errors in Revision 1 of the calculation were appropriately processed in the licensee's the corrective action program.
- extent of condition reviews performed by the licensee regarding other similar restraints.

3) Region II, develop a feedback form for MC 0612 to specifically require that inspection report writeups document the details of phone calls between the inspectors and NRR used to resolve inspection issues of a technical nature. Additionally, when such calls are referenced in the inspection report, change MC 0612 to require report concurrence by key NRR participants and the responsible NRR BC.

If you have any questions, please contact me at 404-562-4605.

Attachments: 1. Panel Review of Concern 1
2. Panel Review of Concern 2
3. Panel Review of Concern 3

cc w/encl:
Renee M. Pedersen, NRC/OE

X SISP REVIEW COMPLETE: Initials: ________ ☐ SISP REVIEW PENDING*: Initials: ________ *Non-Public until the review is complete
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ADAMS: ☐ Yes ACCESSION NUMBER: ML060540435

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DATE	7/19/2005	7/19/2005	7/19/2005	7/19/2005	3/ /2006	3/ /2006	3/ /2006
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Concern 1 - Part A:

The licensee's fatigue analysis of the improperly adjusted pipe whip restraint contained errors. Specific shortcomings included:

- Not properly evaluating the differential expansion between the restraint and the feedwater pipe.
- The use of an improper coefficient of thermal expansion for the whip restraint and improper modulus of elasticity for the pipe.
- Failure to appropriately consider the pretension applied to the pipe whip restraint.

In addition, the calculation did not appropriately consider the effect of potential reductions in the feedwater pipe wall thickness with time and uncertainties with the material composition of the restraint bolts.

As a result, the licensee's calculation underestimated the stress applied to the pipe by approximately 47%. This increase in stress calls into question the adequacy of the elastic analysis technique used by the licensee. Additionally an outside expert consulted by the submitter, postulated that the pipe could fail based on the fatigue analysis.

Concern 1 - Part B:

In addition to a fatigue analysis, the licensee's evaluation failed to consider the increased probability of pipe failure resulting from the stresses applied by the improperly adjusted pipe whip restraint. The DPO submitter postulates that stresses imposed by the improperly adjusted restraint as well as those imposed by seismic, pressure and dead loading could exceed the ultimate strength of the pipe, ultimately resulting in pipe failure.

NRR Staff Evaluation

Description of the Oconee Feedwater Pipe Whip Restraint Configurations

Oconee Drawing O-494, Rev 5, shows the restraint configurations for the three units. Each restraint consists of a 1¾- 5 UNC threaded rod and a corresponding AISC clevis. The restraint configurations for Units 1 and 2 show that the feedwater piping entering the containment penetrations have elbows at the restraint locations. The feedwater lines make an angle of 32 degrees with the -25 penetration axis and 18 degrees with the -27 penetration axis. Each restraint configuration consists of six 24" restraints and two 36" restraints. Five of the 24" restraint attachments are welded directly to the elbow and the two 36"' and one 24" restraint attachments are welded to the angled straight pipe beyond the elbow.

For Unit 3, the feedwater lines entering the penetrations are straight. The restraint configuration consists of eight 24" restraints evenly distributed around the centerline of the pipes. The attachments for the restraints are welded to the surface of the straight pipe.

Evaluation of Concern 1 - Part A

The evaluation of the DPO submitter's concerns requires a thermal expansion analysis to determine the loads and stresses in the Units 1 and 2 restraint configurations and the piping. An exact evaluation of these configurations requires a complex three-dimensional finite element analysis, since the pipes contain elbows at the restraints, and each configuration contains two size restraints (24" and 36"). However, a reasonably approximate thermal expansion analysis to determine the loads in the restraint rods and on the welded attachments may be performed, using a "strength-of-material" approach, if the restraints are assumed to be evenly distributed around the pipe circumference, similar to the Unit 3 configuration, and all eight restraints around the circumference are assumed to be either 24" or 36" long. The restraints are assumed pinned to the containment penetration frame and to the attachments that are welded to the pipe. This permits the formulation and analysis of a relatively simple model of the pipe and the restraints, similar to the one used by the licensee, which however also includes the important consideration of the axial flexibility of the pipe. The local pipe bending flexibility is not included as this acts to reduce the loads in the rods. The results reported below were calculated with such a model. The objective of the analysis was to determine the forces and stresses in the restraint rods, as a result of the constrained differential thermal expansion between the restraint rods and the pipe, and the rod forces acting on the lugs. These forces are determined from equilibrium between the rod and the pipe at the lug attachments. The stresses in the pipe at the lugs, and the potential for fatigue failure, are then obtained by the procedures shown by the licensee in Oconee Calculation OSC-8370, Revs. 1 and 2.

In OSC-8370, Rev. 1, the licensee performed thermal expansion/fatigue analyses of the rupture restraint configuration at the Unit 2 penetration 25. The model used by the licensee considered a 24" rod restraint pinned at one end to the containment penetration restraint structure and at the other end, to the outer surface of the straight pipe. The restraint did not include the clevis elasticity. This analysis is therefore strictly valid for Unit 3 only. In both calculations the licensee assumed that the pipe is infinitely stiff, a conservative assumption. The licensee assumed that the coefficients of thermal expansion and modulus of elasticity of the clevises, rods and the pipe were the same, at the temperature of the rod. The material properties were taken from USAS B31.1, 1967 at 200EF, the most conservative operating condition, On this basis, the licensee calculated in Rev. 1 the stress in a 24" rod restraint as 44,181 psi. This value is independent of the rod length, and is therefore valid for both 24'' and 36" rods. This value was based on the following material properties:

T = 200EF, E = 27.7E6 and α = 6.38E-6, for both the rods and the pipe.

where:
T = temperature, EF
E = modulus of elasticity, psi
α = coefficient of thermal expansion, in/in/EF

The pipe temperature was assumed as 450 EF.

In OSC-8370, Rev. 2, the licensee performed a more accurate approximate calculation, valid only for a 24" restraint, and determined that the stress in a rod was 43,897 psi. This was based on the following properties:

T_r = 200 EF, E_r = 29.5E6 psi, α_r = 6.38E-6 in/in/F and L_r = 24.95 inches.
T_p = 455 EF, E_p = E_r, α_p = 6.92E-6 in/in/F and L_p = 21.7 inches.

The subscript r refers to the rods and the subscript p refers to the pipe.
L = length, inches

Other than for expansion, the pipe was assumed rigid. On the same basis and using the same values, the staff verified this stress value. By including the flexibility of the pipe in the analysis, and using E_p = 27.9E6 psi at T_p = 455EF, the staff calculated the rod stress as 37,828 psi, which demonstrates that considering the pipe as rigid is a highly conservative assumption.

Using the same material properties and a similar model that included the flexibility of the pipe, the staff determined a restraint stress of 39,156 psi for the 36" rods.

Revised Analysis

To address the DPO submitter's concern regarding the material properties that the licensee should have used in his analysis, the staff revised their analyses to address this concern. The revised analyses included the rod/clevis and pipe axial elasticities.

The DPO submitter stated that the material properties used by the licensee in his initial analysis should have been different, and were therefore in error. He indicated that, based on the chemical composition of the rods provided by the licensee, the coefficient of thermal expansion should have been taken from ASME Section II, Part D, 1989 Edition, Table TE-1, "Nominal Coefficients of Thermal Expansion for Ferrous Materials," Material Group C, with a value of α_r = 5.89E-6 at 200 EF. He also indicated that the rod modulus of elasticity should have been higher, based on the reported carbon content, and quoted a value of E_r = 29.5E6, obtained from a non-ASME source.

ASME Section II, Part D, Subpart 2, contains physical property tables for ferrous materials which provide minimum values of nominal coefficients of thermal expansion at temperatures up to 800 EF, and modulii of elasticity at temperatures up to 900 EF. These metals are listed by approximate chemical composition, and metals having similar chemical composition are grouped into families of metals or Material Groups labeled A, B, C...., etc. Based on the chemical composition of a given metal, the designer/analyst chooses the design properties for the stress calculations from these tables.

The chemical composition of the rods was provided in Attachment G to OSC-8370. This attachment consists of a Duke Power internal memorandum reporting the results of chemical and mechanical testing of four of eight 24" restraints, consisting of tie-rods, nuts and clevises. These restraints were taken from Oconee Nuclear Station Unit 3 Penetration #25. The results included a chemical analysis of the rods, as well as mechanical properties such as size, yield and ultimate strengths, and elongation and reduction in area at failure. Except for a chemical analysis, similar properties were also stated for the clevises. The memorandum also presented room temperature stress-strain diagrams of the rod material up to 1.5% strain. These diagrams included values of the modulus of elasticity, determined directly from the elastic slopes of the diagrams. The average modulus of elasticity at room temperature was reported as 32.1E6 psi. This value was extrapolated to E_r = 31.3E6 psi at 200 EF. This is higher that the submitter's recommended value of E_r = 29.5E6 psi. Based on the rod chemical composition, the value of E_r that would be used in design would be obtained from Group B of Table TM-1 as E_r = 27.1E6 psi at 200 EF. Using this value in the calculations will produce lower thermal stresses. However, the value of Er=31.3E6 psi was used in the present calculation since this is the actual value that was determined from the licensee's mechanical tests.

For the pipe and the clevis, the material properties were also determined from the ASME Section II, Part D, 1992 Edition. The nominal coefficients of thermal expansion were determined from Table TE-1, Material Group A, and the modulus of elasticity E from Table TM-1, for carbon steels with C#0.30%

The analyses were revised to include the stiffness of the clevis, and was based on the following conservative properties:

For the rods:
T_r = 200 EF, E_r = 31.3E6 psi, α_r = 5.89E-6 in/in/F

For the pipe:
T_p = 455 EF, E_p = 27.48E6 psi, α_p = 7.169E-6 in/in/F
wall thickness = 1.219", nominal

For the clevis:

T_c = 200 EF, E_c = 28.8E6 psi, α_c = 6.67E-6 in/in/F

Based on a model with these material properties, the analysis for the 36" rod restraint calculated a rod stress of 47,393 psi, based on the inclusion of the pipe flexibility. Thus, the highest percentage increase over the initial licensee value of 44,181 psi was determined as 7.3% when the axial pipe flexibility is included. (It was 22% when this flexibility is not included.) The staff considers the value based on the inclusion of the axial pipe flexibility as a reasonable and realistic value, which is, however, based on conservatively assumed material properties and a conservative pipe/restraint model.

The DPO submitter also expressed a concern regarding the exclusion of rod pre-load in the licensee's calculations. Based on 300 ft-lb of torque, reported in Appendix G of OGC-8460, the staff determined a nominal value for pre-load stress of 5,414 psi in a rod, based on standard Machine Design methodology and practice. This value assumes ordinary friction coefficients for bolted connections, not those that would exist if there were rust under the nuts and the threads, as reported in Appendix G. The value of 5,414 psi is therefore considered overly conservative. Nevertheless, adding this stress to 47,393 psi, the total thermal expansion stress is calculated as 52,807 psi, or 20% above the licensee's initial value of 44,181 psi. On the same basis, the corresponding stress increase in the 24" rods is 49,494 (44,080+5414), or 12% above the initial licensee's value.

Since the geometry for the 36" rods analysis was assumed similar to that for the 24" rods, the loads acting on the lugs also increase proportionately by 20% and the lug stress reported by the licensee is also increased by the same proportion to 57,822 psi. Adding to this the maximum global stress of 16,083 psi reported by the licensee, as suggested by the DPO submitter, the largest nominal elastic cyclic stress and stress range in the pipe is determined as 73,905 psi. This is 15% above the value of 64,269 psi reported by the licensee.

The fatigue requirements in USAS B31.1 and ASME Section III, Subsection NC, are based on the piping fatigue equation:

iS = 490,000 N^(-.2)

where S=stress range, psi
N=cycles to failure
i=fatigue based stress intensification factor
=1.0 for girth butt welds

This equation, known as the Markl equation, is a best-fit to the results of a series of fatigue tests to failure on actual piping components conducted by A. R. C. Markl and reported in the Transactions of the ASME between 1947 and 1955. It is not explicitly shown in USAS B31.1 and ASME Section III, Subsection NC, but forms the basis for the fatigue criteria in these codes (Ref. NUREG/CR-3243).

Letting S=73,905 psi, and applying this equation, we get

N^(-.2) = 73,905/490,000 = 0.1508
or N = (1/0.1508)^5 = 12,812 cycles to failure.

Failure here is defined to occur when a through-wall leaking crack first appears on the outside surface of the pipe adjacent to the lug, not a total break.

Based on a factor of safety of 2 on stress applied to the fatigue equation, the probable number of cycles at which a crack will first appear on the pipe outside surface is calculated as 12,812/32 = 400. (The crack will propagate from the outer to the inner surface.) This is the allowable number of cycles with a factor of safety of 2 on stress. It is greater than the number of design cycles of 360 plant heatup/cooldowns, and also greater than the 150 cycles actually experienced by the plant to-date, as reported by the licensee. The usage factor based on these considerations is therefore 360/400 = 0.9, compared to the value of 0.16 reported by the licensee. This includes both sustained and occasional stresses, such as those resulting from thermal expansion and seismic loading. Conversely, the elastic failure stress and stress range corresponding to 360 cycles is obtained from the piping fatigue equation as S = 490,000(360)^(-.2) = 150,986 psi. The margin of safety to failure at 73,905 psi and 360 cycles would therefore be 150,986/73,905 = 2.04

The licensee also provided an ASME Section III Class 1 fatigue analysis. The staff has not evaluated this analysis.

Evaluation of Concern 1 - Part B:

In addition to a fatigue analysis, the licensee's evaluation failed to consider the increased probability of pipe failure resulting from the stresses applied by the improperly adjusted pipe whip restraint. The DPO submitter postulates that stresses imposed by the improperly adjusted restraint as well as those imposed by seismic, pressure and dead loading could exceed the ultimate strength of the pipe, ultimately resulting in pipe failure.

This concern is addressed by an order-of-magnitude comparison of the estimated strain in the pipe under the lug and the estimated nominal ultimate strain of the pipe material. The pipe is made of A106, Gr. B, steel, a highly ductile material, the same as the tests on which the Markl equation is based. The Markl equation was developed at room temperature. Assuming it is valid at higher temperatures by proportioning, the maximum strain in the pipe at the lug can be estimated on the same basis as the Markl equation, by dividing the nominal elastic stress by the pipe modulus of elasticity at temperature. Thus,

73,905/27,480,000 = 0.00269 in/in

This is approximately the maximum longitudinal strain, elastic plus plastic, that the pipe experiences at the location of the lugs under the thermal expansion and preload loading due to the restraint rods and the pipe loads, including dead weight, pressure, thermal expansion and seismic loading. This represents a strain concentration in the pipe wall. The minimum yield strength at temperature for this material is given as 29,200 psi. The yield strain at temperature is therefore 0.00106 in/in. The minimum elongation in a 2" gage section was reported by Markl as 32%, so that the value of the ultimate uniform strain may be estimated as approximately 20% or 0.20 in/in. (The actual stress-strain curve was not given.) This value is assumed valid at temperature. The maximum strain in the pipe is therefore about two and one half to three times the yield strain, and considerably smaller that the estimated ultimate uniform strain of the pipe material. Unless there are undetected cracks in the pipe wall, the pipe would have to experience gross deflection and bending to attain an ultimate uniform tensile strain of 20% somewhere in the wall, at which time tensile instability of the wall would occur, followed by fracture. Most likely, the pipe would fail by a different mechanism, such as local collapse. This could occur only if the supports of the entire feedwater piping system were to fail and the system physically collapse. On this basis, the staff believes this event is highly unlikely and therefore concludes that the probability that the pipe will break on a one-time load application is small.

An additional consideration is also that the local plastic deformation will tend to relieve the pre-load calculated above after a few cycles. If the pipe were elastic/perfectly plastic, the stress due to preload would disappear entirely as the pipe deformation accommodates the thermal expansion of the restraints.

Effects of Wall Thinning

The DPO submitter also expressed a concern regarding the effect of potential wall thinning on the thermal expansion stresses.

The largest wall thinning due to flow accelerated corrosion/erosion probably occurs in the region near the extrados of the elbows. In this region there are three welded attachments and 24" rod restraints. The effect of wall thinning is to increase the flexibility of the pipe, thus relieving the thermal expansion forces in the rod restraints. However, the lug stresses may also increase, since some of the factors are dependent on the pipe wall thickness.

A calculation was performed for a 24" restraint, which followed exactly the licensee's procedure for calculating the lug stresses. The calculation hypothetically assumed that the wall thickness had thinned from the nominal wall thickness of 1.219 inches to the minimum Code wall thickness, calculated as 0.7944 inches. The rod stress was calculated as 40,942 psi, to which was added the preload stress of 5415 psi, for a total stress of 46,356 psi. Under this condition, the lug stress increased dramatically to 98,369 psi, and the total pipe stress at the lug was calculated as 114,452 psi.

Letting S=114,452 and applying Markl's equation, the cycles to failure are determined as:

N^(-.2) = 114,452/490,000 = 0.2336
or N = (1/0.2336)^5 = 1438 cycles.

These are hypothetical numbers which, however, show that thinning of the wall under the analyzed conditions could increase drastically the potential for cracking. Prudence dictates that the elbows at the penetrations be visually and volumetrically inspected at the restraint attachment locations to preclude such potential cracking

Discussion of the DPO submitter's concern that the licensee failed to appropriately consider the pre-tension applied to the whip restraints.

For Unit 2 FW Penetration 25, the inspectors reported that 6 nuts were jammed and 2 could be loosened by hand. For FW Penetration 27, 3 were jammed and 5 could be loosened by hand. The assertion that the rods were preloaded in the cold condition does not explain why some rods were preloaded and others were not. Presumably, all nuts would have been evenly preloaded to the same load.

The DPO submitter also stated that the clearance/gaps were re-established in the hot condition and the nuts staked. However, subsequent inspections found that the gaps had again closed. No explanation was offered for this phenomenon.

It is most likely that the nuts were indeed gapped as required by the installation instruction, Note 7, on Dwg. O-494. The Note also indicates that the threads were supposed to be jammed after being gapped. The inspection report writeups indicate that the nuts were apparently not staked or the threads jammed, as required. This means the nuts were probably installed with the gaps as required by Note 7, but in a loose condition. Likewise, due to clearance in the welded attachment holes, the rods also fitted loosely through the holes in the welded attachments to the pipe. During operation, the fluid flowing through the feedwater pipe in both the hot and cold conditions induces vibration in the piping. This flow-induced vibration may have caused the loose rods to shake and some of the loose nuts to rotate and twist down the threaded rods to close the gaps, and continued twisting during cooldown to ambient operation until they jammed cold against the attachments welded to the lugs on the pipe. The vibration continuously jammed the nuts, sufficient to prevent turning the nuts by hand, but a much smaller preload than shown above may have been induced as a result. However, as stated above, any local plastic deformation would have caused the preload to be relieved after a few thermal cycles. The staff therefore concludes that this concern is resolved. However, the licensee should provide a more effective method of maintaining the clearances than staking the nuts, for example, through double nutting.

Concern 1 - Part C:

The licensee's calculation also failed to consider that the whip restraints are on opposite sides of the pipes. This arrangement effectively causes the stress to double since the restraints are pulling in opposite directions.

There is no validity to this concern. The stresses do not double.

Conclusions:

- Elastic analysis, in conjunction with either Markl's equation or the ASME Section III fatigue procedure, is valid for the evaluation of the DPO submitter's concerns.

- More accurate results may be obtained from a three-dimensional finite element analysis, with elastic-plastic deformation capability. However, it is not clear that the extra time and expense are warranted to obtain these results. The model used in the analysis is considered adequate to obtain an estimate of the stresses involved.

- The load and stress increase in the 36" rods resulting from restrained thermal expansion is about 20% above the initial licensee calculated value, including presumed cold preload. The corresponding stress increase in the 24" rods is 12% above the initial licensee's value. These values are based on the inclusion of the axial pipe flexibility in the analysis, which the licensee did not consider in his calculation.

- The thermal expansion analysis is based on a restraint temperature of 200 EF at operating conditions. This is a conservative assumption, since it is very likely that this temperature was higher, thus reducing the calculated stresses and increasing fatigue life.

- The assumption that the rods were normally preloaded in the cold condition, and the inclusion of the preloads into the thermal expansion calculations, is significantly conservative. They are relieved after a few cycles if any plastic deformation occurs in the pipe wall.

- The actual reason for the closing of the hot clearance gaps appears to be unknown.

- Although the calculated stresses are higher, the probability that the pipe will fail in a one time load application is believed to be small.

- The criterion for postulation of a pipe break and the design basis stress range criterion were exceeded at the location of the lugs. This conclusion was previously acknowledged by the licensee and the staff has again verified it.

Recommendations:

- The licensee should implement a more positive method to assure that the clearances/gaps are maintained under all operating conditions.

- The hypothetical calculation shows that the effect of wall thinning may significantly increases the lug stresses. The Units 1 and 2 pipe elbows at the containment penetrations and the lug welds should therefore be inspected for wall thinning, in particular the restraint attachments in the extrados regions of the elbows.

Concern 2:

The NRC's review of the licensee's calculation was inadequate. Specifically, the DRS inspector assigned to review the licensee's calculation apparently ignored the information provided by the submitter related to errors in the licensee's calculation of differential expansion between the pipe and restraint.

The DPO review panel reviewed Paragraph 4OA5.11 of Inspection Report 50-269, 270, 287/2004005, which documents the NRC's review of the issue and met with the DRS inspector (and his supervisor) assigned to review the issue.

The inspection report writeup identifies the general approach used by the licensee in their calculation to support past operability, documents questions raised by the DRS inspector during his review, and contains an NCV developed in the closure of the URI. This inspection report writeup notes that although the stresses in the feedwater piping were in excess of the ASME Code allowable values, past operability was determined to be acceptable by the licensee through use of fatigue analysis. A phone conversation with an unnamed NRR expert was identified in this inspection report writeup as the basis for the NRC's conclusion that the licensee's fatigue analysis approach was acceptable. However, the DPO review panel noted that the inspection report lacked specifics associated with this phone conversation and details of any review performed by the NRR expert.

The discussion with the DRS inspector by the DPO panel confirmed the details contained in the inspection report.

Based on the information provided by the DPO submitter, the DRS inspector assigned to conduct the review of this issue questioned the licensee on the values used for the thermal expansion coefficients and the modulus of elasticity for the threaded rods in Revision 1 of Oconee Calculation Number OSC-8370, Analysis of Main Feedwater Rupture Restraints with Bounded Rods. In response, the licensee subsequently revised the calculation to correct the values for modulus of elasticity for material with carbon content greater than 0.3% and the coefficient of thermal expansion was adjusted for variations in temperature. The DPO review panel reviewed this revision to the calculation (Revision 2) and verified that the information provided by the DPO submitter and noted by the DRS inspector was incorporated into Revision 2 of the calculation.

A discussion of the DPO panel's review of the licensee's calculation is contained in the discussion for Concern 1 above.

Conclusions:

- The DRS inspector assigned to review this issue, considered the information provided by the DPO submitter. This was reflected in discussions with the inspector and in the revision to the calculation performed by the licensee.

Recommendations:

- Phone calls with NRR personnel were conducted as part of the Region's review of the URI. While the panel felt that this was appropriate given the limited Regional expertise in the area, details associated with these calls were not contained in the inspection report or on the docket. This could result in situations where the basis for regulatory decisions is unclear and not available for review. The panel recommends that MC 0612 be revised to specifically require that inspection report writeups document the details of phone calls between the inspectors and NRR used to resolve inspection issues of a technical nature.

- A PIP was not initiated by the licensee to document and evaluate the errors in Revision 1 of the calculation which were corrected in Revision 2 to the calculation. The panel recommends that this item be considered by the inspection team leader for review during the next Oconee PI&R inspection.

Concern 3:

The NRC's application of the ROP in regards to the improperly adjusted pipe whip restraint was inappropriate. The NRC failed to consider the increased probability of pipe failure as a result of the increased stresses imposed by the improperly adjusted pipe whip restraint. In addition, there were other violations associated with the issue such as inadequate design, not meeting the ASME code of record, and not meeting the fatigue usage as identified in MEB 3.1 that were not properly considered.

Conclusions:

- The panel concluded that given the assumption that the pipe would not fail, the issue of not maintaining proper clearances on the pipe whip restraint, as documented in IR 2004-05, was treated appropriately per the ROP and enforcement processes. The improper implementation of the design requirements (the tie rods not being installed in accordance with the design drawing) was appropriately captured in the original inspection report (IR 2002-05) and the final closure writeup (IR 2004-05), as a violation of Criterion V, "Instructions, Procedures, and Drawings." The panel also noted that the significance of the issue was appropriately developed in IR 2004-05. The panel made a similar determination of very low safety significance, Green, when it processed the issue through MC 0612.

- Notwithstanding this, the panel noted that the NRC's review of this issue, as documented in IR 2002-05 and IR 2004-05 failed to completely address the potential relationship between the increased stresses imposed by the improperly adjusted pipe whip restraint and the potential for pipe failure. The panel reviewed an e-mail dated 10/27/03 from Gene Imbro to John Fair which indicated that such a relationship was considered subsequent to the URI being opened. Specifically, the e-mail stated that: "... *the criterion for postulation of a pipe break was exceeded at the whip restraint. In addition, the licensing basis stress limits were exceeded at the location of the whip restraint*." The same e-mail stated that: "*EMEB does not have a procedure to quantify the increase in pipe break probability for this condition*." However, this aspect of the issue was not developed in the final inspection report writeup which closed the issue. As a result, the panel believes that the NRC's review of this issue, as documented in the inspection reports, is incomplete. The panel's review of the licensee's calculation presented above, determined that the strain resulting from the additional stresses on the pipe, as a result of the improperly adjusted restraint, did not exceed the ultimate material strain for the pipe. Thus, the panel does not believe that the potential for pipe failure was increased substantially. However, the panel is not aware of any existing technique for correlating the increase in pipe stress to an increased probability of pipe failure. Given this, it would be difficult to process this aspect of the issue through the significance determination process.

- The panel agrees that other violations probably existed associated with this issue that were not documented in the final closeout writeup contained in IR 2004-05. Technically, these other items could have been captured as additional examples of the existing Criterion V violation or more likely as Criterion III design control violations. However, the panel does not believe that there would be a substantial benefit from documenting these additional violations. In this regard, the panel concluded that the NCV that was issued, in all likelihood addressed the major concern and probable cause of the issue identified in the original URI writeup contained in IR 2002-05. Additionally, the collective experience of the panel members who have been associated with reactor enforcement issues, is that not all possible violations are promulgated for every issue captured in an inspection report. Often, the most prominent aspect of an issue is the subject of enforcement action. In this case, the treatment of the issue in IR 2004-05 was consistent with panel's experience.

Recommendations:

- The panel recommends that a revision to the ROP be explored that would allow for the processing of performance deficiencies involving issues/initiating events that are not amenable to treatment using existing statistical techniques.