UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET, SW, SUITE 23T85
ATLANTA, GEORGIA 30303-8931

March 11, 2005

MEMORANDUM T0: Charles R. Ogle, Chief
Engineering Branch 1
Division of Reactor Safety

Joseph J. Lenahan, Senior Reactor
Maintenance Branch
Division of Reactor Safety

Mark Hartzman, Senior Mechanical
Mechanical and Civil Engineering Branch
Division of Engineering
Office of Nuclear Reactor Regulation

Russell J. Arrighi, Enforcement Specialist
Office of Enforcement

FROM: William D. Travers, Regional Administrator **/RA/**

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

The purpose of this memorandum is to inform you that you have been selected to participate in an Ad Hoc Review Panel for the attached Differing Professional Opinion (DPO). Mr. Ogle will chair the panel. Please review the attached DPO, NRC Management Directive 10.159, “Differing Professional Opinion Program,” and Regional Office Instruction 2304, “Resolution of Differing Professional Opinions.” The panel should forward its recommendation to me by April 29, 2005.

If you have any questions or if the due date needs to be changed, please contact me at 404-562-4410.

Attachment: Memorandum from R. Pedersen dated February 25, 2005.

cc w/att: C. Evans, RII

☐ SISP REVIEW COMPLETE: Initials: __LRP___ ☐ SISP REVIEW PENDING*: Initials: ________ *Non-Public until the review is complete
☐ PUBLICLY AVAILABLE NON-PUBLICLY AVAILABLE ☐ SENSITIVE ☐ NON-SENSITIVE
ADAMS: ☐ Yes ACCESSION NUMBER:__ML060540472_

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SIGNATURE	LRP						
NAME	LPlisco						
DATE	03/11/05						
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OFFICIAL RECORD COPY DOCUMENT NAME: E:\Filenet\ML060540472.wpd

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555 - 0001

February 25, 2005

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

FROM: Renée M. Pedersen, Acting Differing Professional /RA/
Opinions Program Manager
Office of Enforcement

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

The purpose of this memorandum is to advise you of a Differing Professional Opinion (DPO) that was submitted to me on February 16, 2005.

The DPO (Attachment 1) raises concerns involving a feedwater pipe restraint issue at Oconee and how the issue was processed within the Reactor Oversight Process.

I received the DPO on February 16, 2005, and screened it in accordance with the guidance included in Management Directive (MD) 10.159, "The NRC Differing Professional Opinions Program" (Attachment 2). I have concluded that the preconditions for acceptance have been met and have accepted this issue as DPO-2005-003 within the DPO Program.

In accordance with section (D)(3)(c) of the MD Handbook, I am forwarding this DPO to you for appropriate action. In particular, you are responsible (generally within 8 days of this memorandum) for appointing members of an ad hoc panel to review the issue and make recommendations to you regarding the disposition of the issues presented in the DPO. Section (D)(4) of the MD Handbook outlines the duties and responsibilities associated with the panel and MD 10.159-036 addresses your responsibilities as a Regional Administrator. Time spent on DPO-related activities should be captured under TAC number ZG0007.

Please note that all correspondence associated with this case should include the DPO number in the subject line and should NOT be placed in ADAMS until the case is closed. In accordance with the MD, all documents associated with this case will be forwarded to the DPOPM when the case is closed and will be processed in ADAMS accordingly. To facilitate this process, please email an electronic copy of the panel tasking memorandum to "DPOPM," in addition to sending me a hard copy.

Attachment

Because we are in the process of developing additional implementing procedures and are considering changes to the Program, not all guidance may be in the MD. Therefore, I will be meeting and communicating with all parties frequently during the process to ensure everyone understands the process, goals, and responsibilities.

Finally, although this individual has not filed his DPO confidentially, all steps should be taken to treat the individual as if he had. In other words, the person's name should not be used in discussions (the person may be referred to as the "DPO submitter"), documents should be distributed on an as-need basis, and managers and staff should be counseled against "hallway talk" on the issue.

If you have any questions, please feel free to contact me at (301) 415-2741 or email DPOPM@nrc.gov.

Attachments: As stated

cc: (w/o attachments)
E. Merschoff, DEDR
W. Dean, AO
F. Congel, OE

Attachment

Distribution: w/o attachments
C. Mohrwinkel, OE
DPO-2005-003 file
DPO Day File
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FILE NAME: G:\DPO Program\DPO-2005-003\DPO Tasking Memo to Region II RA.wpd
ML050550052

OFFICE	OE	OE
NAME	R. Pedersen	F. Congel
DATE	2/22/05	2/25/05

OFFICIAL RECORD COPY

Attachment

NRC Form 680 Differing Professional Opinion w/signature (Attached in pdf file via e-mail)

Attachment

1 It is my opinion that when assessing the as found condition of the over tightened whip restraints, two different conditions need to be assessed. The first being the affects of fatigue on the piping, because fatigue can degrade the piping to where it can fail under reduced loading. The second being the affect (increased risk of failure) due to the added stress/strain on the piping. I think that this opinion is supported by a statement in the ASME Section VIII code, Section 5-110.2, Significance of Compliance with Requirements for Cyclic Loading, states that “Compliance with these requirements means only that the vessel is suitable from the standpoint of possible fatigue failure; complete suitability for the specified operation is also dependent on meeting the general stress limits and any applicable special stress limits.”

a) Fatigue was evaluated and it was concluded that sufficient fatigue cycles did not occur so the piping would not be susceptible to fatigue failure. However, in my opinion, the analysis to determine the differential expansion of the whip restraint and feedwater piping was in error (16% increase), the coefficient of thermal expansion for the whip restraint was improper based on the chemical analysis of the whip restraint rods (4% increase), the modulus of elasticity was improper based on the chemical analysis of the feedwater piping (10% increase), and the analysis did not consider the fact that the whip restraints were pretensioned (11% increase). For an overall increase in stress of 47% above what was shown in the licensee’s calculation (44,181 psi vs. 64,970 psi). In addition, the ASME code also notes that “ If the stress of this type exceeds twice the yield strength of the material, the elastic analysis may be invalid and successive thermal cycles may produce incremental distortion.”

b) The increase in risk of failure due to the high stress/stain applied around the circumference of the piping, was not evaluated. It is my opinion that this part of the issue is the most significant. NRR previously concluded the following:

"The high thermal stresses caused by the bound rods resulted in an increased probability of a pipe break at the whip restraint location. EMEB does not have a procedure to quantify the increase in pipe break probability for this condition." This memo was dated October 27, 2003. On the same date, a memo from Mr. Embro (NRR) stated that "I agree with John that the probability of a pipe break is increased. It's not really possible to quantify with any precision what that increase would be."

This was and is a reasonable conclusion, as stress/strain is increased, the probability of failure of the piping is increased. DRS concluded that the piping would not fail due to fatigue and this was used to close the issue based on if it cannot fail it cannot be a problem. However, DRS and NRR disregarded the previous statements by NRR.

2. It is also my opinion that this issue is not a thermal fatigue issue. For example, if we assume that the whip restraint has the same coefficient of thermal expansion as the feedwater piping, is heated up to 465 degrees F like the feedwater pipe and the restraint is then tightened to obtain the same stress/strain on the feedwater piping, then there would be “no” fatigue cycles. The stress/strain on the feedwater piping is the same regardless of how it got there. Using the difference in thermal expansion is just a method to try to evaluate the issue. Should we assume that an over stressed pipe is OK because there are no fatigue cycles, or do we need to evaluate the over stressed condition in addition to the fatigue condition? In reality we cannot prove that the condition existed for more than one or two cycles.

In addition the ASME Code addresses this issue in Appendix 4 of ASME Section VIII, 1971, “Primary Local Membrane Stress” by stating that “Cases arise in which a membrane stress produced by pressure or other mechanical loading and associated with a primary and/or discontinuity effect produces excessive distortion in the transfer of load to other portions of the structure. Conservatism requires that such a stress be classified as a primary local membrane stress even though it has some characteristics of a secondary stress...An example of a primary local membrane stress is the membrane stress in a shell produced by external load and moment at a permanent support...” In the same Appendix, thermal stress is discussed and all the examples discuss differences in material temperatures within the structure of the component. These include hot spots in the vessel wall, differences in temperature in the cladding and wall, and differences in temperature at a branch connection.

3. It is my opinion that this issue was not processed as required by the ROP. Since the over stressed condition would have required the postulation of a break as required by a combination of the Giambusso letter, MEB 3.1, GDC 4 and the licensee’s licensing basis, and the effects of a break at this location would have rendered multiple mitigation systems inoperable, the Phase 1 and Phase 2 analyses would have required the issue to be evaluated with a Phase 3 analysis. The unresolved item was put on hold for years while the licensee tried various approaches to eliminate the issue.

SUPPORTING DETAILS

a. NRR concluded the following, "The high thermal stresses caused by the bound rods resulted in an increased probability of a pipe break at the whip restraint location. EMEB does not have a procedure to quantify the increase in pipe break probability for this condition." This memo was dated October 27, 2003. On the same date, Mr. Embro (NRR) stated that "I agree with John that the probability of a pipe break is increased. It's not really possible to quantify with any precision what that increase would be." Another memo stated, "The procedure that would correlate piping stresses accedence beyond Code allowable limits with increased probability of piping break, sounds like something ideal to initiate a user need to RES for. I think it is an issue that we confronted often in the past, and will continue to see more of as long as plants continue to operate in degraded conditions.."

It is my opinion that if the tools are not in place to evaluate the condition and it has been concluded that there is an increased probability of failure, the tightened whip restraint issue should not have been closed until it could be properly evaluated.

b. I received information from a Mr. William J. O'Donnell, Ph. D, P.E., Chairman of the ASME Boiler and Pressure Vessel Code Subgroup for Fatigue Strength. He stated that "Pipe rupture would be anticipated when the combined bending, pipe whip restraint and pressure loads exceeded the plastic load of the pipe with appropriate fatigue usage under 0.2." Again note that the NRC's requirements in MEB 3.1 limits the usage factor to less than 0.1. Based on the revised calculations, the licensee clearly exceeded the usage factor of .2.

It is the inspector's opinion that this would indicate that the piping was in a degraded condition where there was a possibility of piping failure, not as stated by Region II DRS and NRR that the piping would not fail.

c. The licensee performed the analysis in file OSC-8370. The inspector found that the "first step" of the analysis was performed improperly, in that the licensee improperly calculated the differences in thermal expansion of the rod and feedwater pipe. (This was the second time the inspector noted problems with this part of the calculation) This specific calculation determines the tensional load in the rods. The tensional load was determined by the licensee's calculation to be 44,181 psi and based on this the total loading from the rods was determined to be 83,944 pounds. However, because of this specific error in the calculation, the tensional load should have been 51,301 psi and the total loading from the rods should have been 97,473 pounds per rod. (16% increase)

The calculation was performed by the licensee's engineers, it was checked by a engineering consulting firm, and it was checked by NRC experts. Since the difference in thermal expansion was performed improperly, I can only question the value of their review. This error in the calculation was provided to DRS, but was apparently ignored since it was not considered in DRS's final conclusion.

The inspector noted that the material of the whip restraint rods was unknown and the rods were hardened. The DRS inspector and the licensee both concluded that use of the same carbon steel thermal expansion coefficient for both the rod and feedwater piping was appropriate. Based on the licensee's analysis of the rod material, the inspector concluded that a different coefficient of thermal expansion should have been used. Using the ASME 1989 Section III coefficient of thermal expansion tables and based on the material analysis, a lower thermal expansion coefficient (carbon steel material group C) should have been used for the rods. Based on using the more accurate thermal expansion coefficient for the restraint rods, the tensional load would now be 53,163 psi and the total loading from the rods would be 101,011 pounds per rod. This correction adds another 4% increase to the licensee's original calculation.

The licensee's calculation used a Modulus of elasticity value of 27,700,000 psi. This value was based on earlier ASME codes which were not highly specific for the material and its alloys. Based on a review of current industry information, using the material alloys, a more accurate Modulus of Elasticity can be obtained. Based on industry information obtained from "Mat Web Material Property Data" the Modulus of Elasticity value for low carbon steel with similar alloys, should be 29,700,000 psi. Mat Web stated that for these type of alloys the 29,700,000 psi is "Typical for Steel." Reevaluating the stress again, the tensional load would now be 58,654 psi and the total loading from the rods would be 111,444 pounds per rod. This correction adds another 10% increase to the licensee's original calculation.

The licensee's calculation was based on "no" pretensioning of the rods. The inspector noted that the rods appeared to have been pretensioned. This conclusion was based on the licensee having to use a wrench to loosen the rods when the rods were in a cold condition. The licensee argued that the rods were rusted. This did not appear to be reasonable since there was no visual evidence of rusting, the nuts with "proper clearance" could be moved by hand, the nuts that were found tightened could be moved by hand once they were detensioned, and the rods were in an environment that was not conducive to rusting (high temperature >200 degrees F, in the overhead of the room, and covered with lagging). So based on this, the inspectors concluded that some amount of pretensioning should be included in the calculation to bound the effects of pretensioning. Based on experimental test data, a person with an eighteen inch wrench could apply in excess of 12,000 pounds of tension on the rods. Using this as a bounding number, the load in the rods could

have been as high as 123,444 pounds per rod. This adds about 11% to the original calculation.

Based on this calculation, with 8 rods in this condition, the total load applied to the outside of the feedwater pipe at the attachment of the whip restraint would have been 987,552 pounds. In the inspector's opinion, this is not an insignificant amount of loading, even on a 30 inch feedwater line.

The licensee's analysis provided a calculated loading on the feedwater line at the point of attachment of the whip restraint and the piping. Based on the incorrect tensional loading of 44,181 psi, the local welded attachment stresses were calculated to be 48,186 psi plus 16,083 psi for seismic, pressure and dead weight loading, for a grand total of 64,268 psi. Based on the revised tensional loading of 58,654 psi plus 16,083 for seismic, pressure and dead weight loading, and an additional 6,316 psi for prestressed loading, the grand total becomes 81,053 psi.

Based on the ultimate strength of 69,100 psi and 72,000 psi documented in the US Steel Certified Test Report for the feedwater piping, it appears to the inspector that enough stress could be applied such that the pipe could break. Even disregarding the prestress loading of 6,316 psi, it appears that enough stress could be applied such that the pipe could break.

It should also be noted that ANSI B31.1, 1973, states that “Safety is the basic consideration of this Code...The designer is cautioned that the Code is not a design handbook.” The Code also allows the licensee to perform a more detailed analysis if they do not meet the actual Code requirements. Since the code is not a design handbook, it should not be used to perform a more detailed analysis. The licensee clearly exceeded the Code of record stress requirements and admitted to this fact in their calculation. When performing a more detailed analysis of the condition it is only appropriate that the licensee use the most up to date information to calculate the potential stresses as I did up above.

Based on recalculating the fatigue usage factor using the recalculated stress above and adding in the stress from pressure only, the usage factor would be 1.48 as calculated by B31.1 and .62 for actual usage assuming the condition existed since original construction, not .16 an .07 respectively as calculated by the licensee.

The fact that the piping will not break due to fatigue should not be the end of the discussion. It may take care of one mechanism for failure but neglects the potential failure due to being in an over stressed condition. However, even the fatigue argument appears to be subject to a different opinion by an outside expert.

ADDITIONAL CONCERNS WITH THE LICENSEE'S CALCULATION

ASME Code Section NB-3213.9 defines secondary stress and notes two types, "General" and "Local". ASME Code NB-3213.13 states that "For the purposes of establishing allowable stresses, two types of thermal stress are recognized, depending on the volume or area in which the distortion takes place." For local stresses, it goes on to state that "such stresses shall be considered only from the fatigue standpoint and are therefore classified as local stresses in Table NB-3217-1...Examples of local thermal stresses are 1) the stress in a small hot spot in a vessel wall." For General thermal stress, it states that "If a stress of this type exceeds twice the yield stress of the material, the elastic analysis may be invalid and successive thermal cycles may

produce incremental distortion...Examples of general thermal stress are 2) stress produced by the temperature difference between a nozzle and shell to which it is attached or 3) the equivalent linear stress produced by the radial temperature distribution in a cylindrical shell."

Since the whip restraint applied stress is applied completely around one section of the feedwater piping, it appears that this would make it a General stress and the elastic analysis may not be valid.

The licensee is using nominal piping thickness from the original material purchase specifications to determine the stresses in the calculation. The feedwater piping at the whip restraint is downstream of piping elbows and a check valve, however, no NDE piping measurements have been taken at this exact location since the piping was installed over 32 years ago.

The whip restraint bolts were supposed to be made of ASTM A490 steel. However, the ASTM code does not allow A490 to be used for bolting material as large as 1 3/4 in diameter. The licensee's analysis found that the hardness of the actual bolting material was below the minimum specified for ASTM A490. In addition, the licensee could not identify the material specification (such as A193 or A490) for the rods based on the rod alloys. This calls into question the quality of the rods.

The clearances/gaps were re-established by being set at normal operating temperature. Subsequent inspections have found the clearances missing. It is not clear as to why, since the nuts were staked in 15-20 places. The licensee committed to inspect the feedwater and steam line supports every 10 year interval but have not inspected the feedwater line terminal end containment support since original installation in 1973.

THE SDP PROCESS:

When DRS and NRR state that the pipe would not break due to fatigue, it is not clear where we are in the process.

The licensee clearly did not meet the design requirements for setting the proper gaps on the whip restraint that were intended to prevent having excessive stress on the pipe. This would be a violation.

The licensee clearly did not meet the ASME Code of record B31.1 in that stresses exceeded the code allowable of 30,000 psi.

The licensee clearly did not meet the NRC's requirements for fatigue usage of less than 0.1 contained in MEB 3.1.

Once the calculation was corrected, the licensee did not appear to meet the usage factor of 1.0 contained in the later additions of the ASME/ANSI codes.

Based on the stresses, the licensee would be required by GDC 4 to assume a break on the feedwater line at the attachment of the whip restraint and to be able to mitigate the consequences of that break.

At what point do we try to determine the risk associated with the deficiency? Based on DRS and NRR's conclusion that the pipe would not break (due to fatigue) means that there is no risk. If the piping cannot break, then there are no consequences, no consequences then the issue can only be minor. However, even NRR conceded the fact that the increase in stress on the pipe increased the probability of failure.

For this adverse condition, we need to know how much the initiating event failure probability changes. The 1999 Oconee ASP analysis for failure of feedwater piping in the turbine building concluded that the frequency of failure would be 8.3 E-4 and this was based on 300 welds. Therefore, the failure frequency per feedwater line weld would be 2.77 E-6. If we assume one weld per feedwater line is at risk in the east penetration room, then the baseline failure frequency would be 5.54 E-6. This would be the baseline failure probability at the whip restraint location. If we assume that the over stressed condition increases the probability of failure as stated by NRR, then we have a starting point. Since all of the station's mitigation systems are at risk and containment integrity systems are at risk from a feedwater line break in the east penetration room, even a slight increase above baseline would result in a White or Yellow condition. If the initiating event probability for a failure of a feedwater piping weld is 2.77 E-6, then how much would be reasonable to assume the initiating event probability would change when the piping is placed under high stress? Using "the piping would not fail" and therefore no change in the initiating event probability, does not make any sense.

PREVIOUS HELB ISSUES

IN 2000-20, Potential Loss of Redundant Safety-Related Equipment Because of the Lack of High-Energy Line Break Barriers, noted 4 examples where conditional core damage frequencies were greater than 1 E-6 because specific safety related components were not protected from HELB. At Oconee, the plant has not been protected from feedwater HELBs in the east penetration room for many years, the piping was in an over stressed condition, and multiple trains of safety related equipment would have been affected, but because of the conclusion that "the piping would not break" the issue cannot be processed in the SDP.

VC Summer documented a similar finding for HELB in IR 98-06 (URI 98-06-01) that subsequently became a White finding. A door between safety related cabinets and the feedwater lines was left open for a short period and this increased the risk to the White threshold. In the case at Oconee, the feedwater piping is significantly over stressed, the whip restraints are significantly under designed, an expert has stated that the condition potentially damaged the piping to where a failure could occur at much lower stress levels, and the feedwater piping is in the penetration rooms where a HELB could affect multiple trains of mitigation systems, containment integrity systems and the majority of the electrical connections going into and out of containment (few of the penetrations are EQ qualified). In addition, both trains of safety related piping systems are in the east penetration rooms (with the feedwater lines) along with their associated containment isolation valves. Also, the HPI, LPI and RBS pump rooms would likely have flooded based on a piping rupture event. The licensee clearly did not meet the requirements for HELB, but the issue at Oconee is going to be dispositioned as Green because if the piping cannot fail, there are no consequences. This does not make any sense to me and does not appear to be a consistent and repeatable methodology as advertised for the ROP.

CONSEQUENCES OF NOT ADOPTING POSITION

The NRC does not have a process for dealing with degraded piping conditions (wall thinning, missing restraints, overstress conditions..etc). As the plants age, more issues of this type will surface and have to be dealt with. The failure to develop a reasonable methodology will result in continued misrepresentation and inconsistency of the risk determinations for these future issues. In addition, since every issue takes a significant amount of resources by both the licensee and the NRC to resolve, without development of a simplified process for evaluating degraded piping conditions, this waste of resources will continue.

If piping that is significantly over stressed, stressed beyond that allowed by the ASME Code, and stressed beyond that allowed by NRC requirements such as MEB 3.1, and the NRC concludes that it "cannot fail", then what is the basis for assuming that ruptures of feedwater lines, steam lines and RCS LOCAs (Initiating Events) could ever occur. If ruptures of over stressed piping cannot happen, then the line rupture SDPs used to evaluate inspection findings should be removed. Taking the position that the line cannot fail because it has not experience enough fatigue cycles prevents the inspectors from addressing these types of issues in the future.

If the usage factor is as high as I calculated, then there is potential for a piping failure at much lower stress levels than are presently assumed (fatigue usage of greater than .2). This concern is based on comments from an outside expert from the ASME Code committee on Fatigue Strength. He also recommended inspections of the piping to ensure the piping was not degraded due to the affects from the whip restraint induced stress.