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Westinghouse Energy Systems

WCAP-12640
Supplement 1

# Westinghouse Owner's Group Additional Information On Pressurizer Surge Line Stratification Detailed Analysis

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November 1990

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Systems Structural Analysis

Work Performed Under Shop Order MUHP1092

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4878s/111590:10

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## EXECUTIVE SUMMARY

On November 8th and 9th 1990, representatives of the USNRC met with Westinghouse to discuss WCAP 12639 concerning the Westinghouse Owner's Group, pressurizer surge line thermal stratification generic detailed analysis.

Appendix A contains the material presented to the NRC, as a brief summary of the WCAP. Appendix B contains questions submitted by the NRC WCAP 12639 and the Westinghouse response to those questions.

This is the non-proprietary version of WCAP 12639 - Supplement 1.

# APPENDIX A

## PRESENTATION MATERIAL FOR NOVEMBER 8, 9, 1990
## WOG AND NRC MEETING ON SURGE LINE STRATIFICATION

# WESTINGHOUSE OWNER'S GROUP

## Pressurizer Surge Line Stratification

## Generic Detailed Analysis (MUHP-1091)

## NRC Presentation

November 1990

Pittsburgh, Pa.

Westinghouse Electric Corporation
Nuclear and Advanced Technology
P. O. Box 2728
Pittsburgh, PA 15230-2728

## WOG PRESSURIZER SURGELINE STRATIFICATION (MUHP-1091)
## NRC PRESENTATION NOV 1990

### A G E N D A

| | | | |
|---|---|---|---|
| 1) | Introduction | 9:00 PM - 9:30 | G. Kammerdeiner<br>S. Palusamy |
| 2) | Stratification Transients | 9:30 - 10:30 | Dave Roarty |
| 3) | Break | 10:30 - 10:45 | |
| 4) | Pipe Stress Analysis Results | 10:45 - 11:30 | T. H. Liu |
| 5) | Fatigue Analysis Results | 11:30 - 12:00 | T. H. Liu |

**Lunch 12:00 - 1:00**

| | | | |
|---|---|---|---|
| 6) | Applicability Demonstration | 1:00 - 2:00 | Dave Roarty |
| 7) | Discussion of NRC Questions | 2:00 - ?? | |

OVER00016S-5/29/90:10-27

# OVERVIEW OF RESULTS AND ACTION

## Results

- Plant Specific Analysis (Completed Or In Progress)

a,c,e

- WOG Generic Analysis

a,c,e

# INTRODUCTION

- Plants Fall Into 3 Basic Categories Per Results

[ ] a,c,e

- Summary Of Possible Near Term Actions Per Each Category

[ ] a,c,e

<u>In All Cases Continued Operation Is Justifiable</u>

# TRANSIENT DEVELOPMENT

## Operational Study

- Reviewed Heatup/Cooldown Procedures
- Developed Detailed Study Of 14 Plants
  - Questionnaire
  - On-Site Interviews
- Results
  - Obtained Confidence In Transient Applicability
  - Developed Recommendations To Improve Effects Of Future Operation On Surge Line

# STRATIFICATION TRANSIENTS

Monitoring Program And Data Reduction

- Received Data From 21 Plants
- Sufficient Data Received To Develop Conservative Transients For All Configurations
- Data Reduction Performed As Follows
    - Data Plotted: Pipe $\Delta T$ Vs System $\Delta T$ For Entire Heatup
    - Maximum Location Selected For Each Line
    - Fatigue Cycles Generated For Heatup

# STRATIFICATION TRANSIENTS

- Transients Developed Using 10 Plants
  - Other Monitoring Data Reviewed To Ensure Transients Enveloped
- Transients Based On Fatigue Cycles, Ratio Of Pipe To System $\Delta T$ (RSS), Operating Mode
- Transients Developed Based On Worse Location
- Transients Created Using Envelope of 10 Plants Excluding Venting During High System $\Delta T$
- Transient Sets Include
  - Pipe Transients Heatup/Cooldown Excluding Venting
  - Pipe Transients - Normal/Upset Operation
  - Nozzle Transients Heatup/Cooldown Excluding Venting
  - Nozzle Transients Heatup/Cooldown Excluding Venting (Special Geometry)
  - Nozzle Transients Normal/Upset Operation
- Max System $\Delta T$ Set As 320° For Steam Bubble And 210°F For Water Solid

# STRATIFICATION TRANSIENTS

a,c,e

Monitoring Locations

a,c,e

Location 1 Delta T Plot

DELTA TEMPERATURE (DEG F)

CUMULATIVE TIME (HOURS)

PIPE SYS RCP A RCP B RCP C

OVER000165-5/24/90:10-7

OVER00016S-5/24/90-10-7

Location 2 Delta T Plot

a,c,e

DELTA TEMPERATURE (DEG F)

CUMULATIVE TIME (HOURS)

— PIPE — SYS — RCP A — RCP B — RCP C

OVER000165-5/24/90:10-7

Location 4 Delta T Plot

a,c,e

DELTA TEMPERATURE (DEG F)

CUMULATIVE TIME (HOURS)

- PIPE — SYSTEM — RCP A — RCP B — RCP C

OVER00016S-5/24/90-10-7

Location 5 Delta T Plot

a,c,e

DELTA TEMPERATURE (DEG F)

CUMULATIVE TIME (HOURS)

PIPE SYS RCP A RCP B RCP C

# STRATIFICATION TRANSIENTS

CYCLE COUNTING LOCATION 1
(ONE TYPICAL PLANT)

a,c,e

# STRATIFICATION TRANSIENTS

CYCLE COUNTING LOCATION 2
(ONE TYPICAL PLANT)

a,c,e

# STRATIFICATION TRANSIENTS

CYCLE COUNTING LOCATION 4
(ONE TYPICAL PLANT)

a,c,e

# STRATIFICATION TRANSIENTS

CYCLE COUNTING LOCATION 5
(ONE TYPICAL PLANT)

a,c,e

# STRATIFICATION TRANSIENTS

SURGE LINE PIPE TRANSIENTS WITH STRATIFICATION - STEAM BUBBLE PLANTS
HEATUP/COOLDOWN (HC) - 200 CYCLES TOTAL

[ ] a,c,e

# STRATIFICATION TRANSIENTS

SURGE LINE NOZZLE TRANSIENTS WITH STRATIFICATION - STEAM BUBBLE PLANTS
HEATUP/COOLDOWN (HC) - 200 CYCLES TOTAL

[ ] a,c,e

# STRATIFICATION TRANSIEN" S

SURGE LINE PIPE TRANSIENTS WITH STRATIFICATION - WATER SOLID PLANTS
HEATUP/COOLDOWN (HC) - 200 CYCLES TOTAL

[ ] a,c,e

# STRATIFICATION TRANSIENTS

SURGE LINE NOZZLE TRANSIENTS WITH STRATIFICATION - WATER SOLID PLANTS
HEATUP/COOLDOWN (HC) - 200 CYCLES TOTAL

[a,c,e]

# STRATIFICATION TRANSIENTS

SURGE LINE TRANSIENTS WITH STRATIFICATION
NORMAL AND UPSET TRANSIENT LIST

a,c,e

# STRATIFICATION TRANSIENTS

## SURGE LINE TRANSIENTS WITH STRATIFICATION
## NORMAL AND UPSET TRANSIENT LIST

a,c,e

# PIPE STRESS ANALYSIS RESULTS

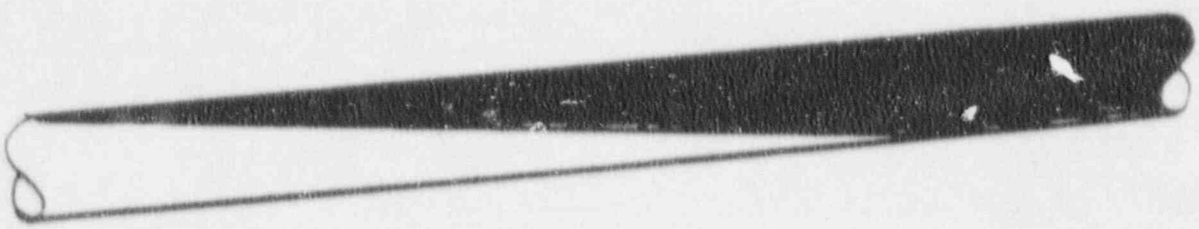
- Logic For Grouping
  - Operation Type
    - Steam Bubble
    - Water Solid
  - Slope
    - Low Slope
    - Critical Slope
    - High Slope
  - Layout And Support Configuration
    - Similarity In Shape And Proportional In Length
    - Enveloped Support Configuration
  - Experience
    - From Plant Specific Analysis

# PIPE STRESS ANALYSIS RESULTS

- Low Slope Lines
  (Rise < 1/2 inside pipe diameter)

- Critical Slope Lines
  (1/2 inside pipe diameter < rise $\leq$ 1 inside diameter)

- High Slope Lines
  (Rise > 1 inside diameter)



# PIPE STRESS ANALYSIS RESULTS

| Group | Plant Layout Modeled (Plant Number) |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |
| 16 | |
| 17 | |

a,c,e

# PIPE STRESS ANALYSIS RESULTS

- Stratification Analysis

  - [ ] a,c,e

  -

# PIPE STRESS ANALYSIS RESULTS

- Summary Of Stress Results

  - [ ] a,c,e

# FATIGUE ANALYSIS RESULTS

## Basic Criteria

a,c,e

# FATIGUE ANALYSIS RESULTS

## Methodology

a,c,e

# FEA MODELS

a,c,e

# GENERAL COMMENTS ON ASME CODE LIMITS

- Fatigue Usage Factor Calculation

[ ]a,c,e

# APPLICABILITY DEMONSTRATION

- Checks Required For Applicability
  - Review Of Input Data List
  - Verification Of Operational Type
    - Water Solid Or Steam Bubble
    - Venting During System $\Delta T \leq 150°F$
  - Heatup/Cooldown Maximum System $\Delta T$
    - 320°F Steam Bubble
    - 210°F Water Solid
    - Past Operation By Operating Records
    - Future Operation By Operational Control
  - Deadweight, Thermal And Seismic Moments Check

# APPLICABILITY DEMONSTRATION

- Items Not Covered By Generic Analysis
  - Pressurizer Equipment Qualification
  - Pipe Displacements And Support Loads
  - Integral Welded Attachments

# APPLICABILITY DEMONSTRATION

- System $\Delta T$ Exceedance Reconciliation
- Obtain Maximum System $\Delta T$ From Past Operation ($\Delta T$ max)
- Equation 12 Reconciliation
- Fatigue Usage Factor Reconciliation

APPENDIX B

NRC QUESTIONS ON WCAP 12639 AND RESPONSES

## WOG NRC QUESTIONS

**Question 1.1 Part 1** The generic detailed analysis demonstrated acceptable ASME Section III Equation (12) stress and fatigue usage for 15 out of 43 plants. Please identify the 15 plants which were shown acceptable, the 28 plants which have not yet been shown acceptable, and the 12 plants which were qualified by plant specific analysis. For each plant, provide the calculated equation (12) stress and the fatigue usage factor based on the most current analysis.

**Reply:** Table 1 summarizes the plants in each group from the WCAP-12639 program. Table 2 summarizes the ASME equation 12 and usage factors from the WCAP-12639 analysis. Note that these results are not applicable to specific plants until the applicability evaluation is complete.

**Question 1.1 Part 2** Explain why the previous justification for continued operation still applies to those plants which were not qualified by the generic analysis.

**Reply:** The WCAP-12639 analysis resulted in usage factors which exceeded 1.0 for 40 year design life for several groups. All plants were rechecked to ensure 10 heatup/cooldown remained based on actual number of heatup and cooldowns and WCAP-12639 usage factor. Four plants did not meet this criteria and were addressed on a plant specific basis (question 1.2). Cases where equation 12 exceeded the allowable were addressed in an earlier generic JCO (WCAP-12277).

**Question 1.1 Part 3** Provide a description and schedule for completion of the plant specific analyses to be performed.

**Reply:** No plant specific analysis is being performed under the WOG program.

**Question 1.2** The generic detailed analysis does not support the conclusions of the existing JCO for four plants. Identify these plants and provide additional justification for continued operation.

**Reply:** The four plants which required plant specific JCO's were [ ].[a,c,e] These JCO's are available from the respective utilities.

**Question 1.3** What specific instructions (in addition to WCAP-12639) are being provided to individual Licensees to demonstrate applicability of the generic analysis to their plant, update their analysis and perform additional evaluations if needed. Provide examples?

**Reply** Westinghouse has worked with many utilities to define the actions required to demonstrate applicability to the WCAP-12639 analysis. These actions are plant specific but generally comprise the following tasks:

1) Review of historical data for system temperature data and other parameters.

2) Verification of plant operating heatup and cooldown process.

3. Creation of plant specific stratification piping model and performing analysis of stratification and normal cases to generate loads and displacements for design verification.

4) ASME Code fatigue load verification analysis for design life.

5) Verification of displacements and support loads.

6) Qualification of pressurizer nozzle loads.

**Question 1.4** Will all Licensees be required to update their analysis of record for the surge line? How will differences in the Code of Record be reconciled?

**Reply:** Based on monitoring findings, all W plants have stratification loadings to some degree. This effect will be evaluated based on 88-11 requirements. Successful evaluation of the thermal stratification will be used to supplement the existing analysis of record. Therefore, no reconciliation is needed to the code of record.

**Question 3.1** Provide additional information on the correlation of measured pipe OD temperature to fluid temperature distribution. How closely does the measured delta T at the pipe OD match the fluid delta T inside the pipe? To what degree of accuracy can the measurements predict the vertical fluid temperature distribution including the hot-to-cold interface depth. How are the uncertainties accounted for in the stress analysis? Provide examples.

**Reply:** [

]$^{a,c,e}$

[

]$^{a,c,e}$

a,c,e

**Question 3.2** Describe the basis for selection of the [ ] interface levels shown in Figure 3-4 to define axial stratification profiles along the length of a particular surge line. Were the selection criteria confirmed by measurements?

**Reply:** The [ ]$^{a,c,e}$ interface levels were selected to envelope the observed variations in fluid interface depth. These levels were confirmed by measurements. An example of observed versus predicted axial stratification profiles is shown in figure 3-3 of WCAP-12639.

**Question 4.1** To what extent was plant monitoring data used to confirm the normal and upset stratification transient data presented in table 4-1?

**Reply:** In general, plant monitoring data could not be used to confirm the normal and upset transients presented in Table 4-1. However, on the few occasions when a transient from Table 4-1 occurred there was less significant transient activity monitored than predicted using the conservative methodology of WCAP-12639, Section 4-2.

**Question 4.2 Part 1** Considering the relatively low delta Ts for the normal and upset transients listed in Table 4-1 (compared to the heatup/cooldown transients in Table 4-2), did any of the events significantly contribute to fatigue usage?

**Reply:** [

]$^{a,c,e}$

**Question 4.2**
**Part 2:** Could a delta T cutoff be defined below which the thermal stresses are less than the endurance limit?

**Reply:** A delta T cutoff could be defined based on fatigue endurance limit.

**Question 4.3** The distribution of system delta T ranges presented in Section 4.5 was based on a review of historical records from 10 plants. While the data may be representative for the sample of ten plants, it may not be representative for a single plant within the group. For example, certain plants within the sample may have had consistently higher delta T ranges than others because of differences in operating practices. Provide additional justification to demonstrate that the system delta T distribution is representative and conservative for any plant in the WOG program.

**Reply:** Plant specific delta T distribution ultimately could only be verified for the period of time which the plant has operated. This is usually much less than the design life. Further, operating practices are not constant, and therefore extrapolating past practices for future operation is not necessarily correct. Therefore, it is impossible to verify that each plant is conservatively represented by the distribution. However, a process was developed and implemented to generate a set of transients which would be conservative for the design life.

**Question 4.4 Part 1** Was the detailed data reduction described in Section 4.6 and summarized in Tables 4-3 through 4-6 performed for each of the ten plants?

**Reply:** Yes.

**Question 4.4 Part 2:** Did the bounding distribution use this type of information from all ten plants for each mode of operation?

**Reply:** Yes.

**Question 4.5** Please explain how data from different modes of operation was factored into the development of Table 4-2 data. Were different delta T values used for each mode?

**Reply:** Each mode was characterized by the maximum delta T expected. The following delta T values were conservatively used for each mode.

Mode 4 = 250$^{0}$F
Mode 3 = 200$^{0}$F
Mode 2 = 150$^{0}$F

**Question 4.6** Section 4.6 states that a cooldown contains less than half of the cycles of a heatup and therefore the number of cycles for heatups were multiplied by 1.5 to reflect both heatup and cooldown. Were the temperature ranges of the cooldown cycles shown to be bounded by the temperature ranges of the heatup cycles?

**Reply:** The monitoring data included much more information on heatups then cooldown since the cooldowns had not actually occurred. The cooldowns monitored to date do indicate lower delta T's and less transient activity than typical heatup cycles. The historical data also indicates lower system delta T's in general for cooldowns.

**Question 4.7** Identify the plant which indicated significantly higher stratification cycles at the nozzle as stated in Section 4.6. What geometric effect was judged to cause this?

**Reply:** This occurred at the [

]$^{a,c,e}$

**Question 4.8** Identify the plants with significantly higher cycles associated with performing venting operations during heatup as stated in Section 4.6?

**Reply:** [ ]$^{a,c,e}$

**Question 4.9** Table 4-2 shows fewer total nozzle transients in the nozzle than in the pipe. This is attributed to turbulent mixing which occurs at the nozzle when the reactor coolant pump is operating. However, even when the pump is operating, stratification does occur in the pipe and the global bending will induce nozzle stresses. How are these stresses accounted for?

**Reply:** These stresses are accounted for by including the global bending stresses from all remaining pipe transients in the nozzle fatigue analysis.

**Question 4.10** Are striping transients associated only with heatup and cooldown? If so, explain why striping does not occur during normal or upset transients.

**Reply:** [

]$^{a,c,e}$

These transients are normal/upset transients having a delta T [ ]$^{a,c,e}$

**Question 5.1** Please identify each plant associated with the plant numbers in Table 5-1

**Reply:** (See Table 1)

**Question 5.2** Describe the criteria used to define the enveloping support/restraint configuration within a subgroup. Provide examples to illustrate?

**Reply:** The enveloping support/restraint configuration within a subgroup is based on such a goal that the envelope configuration would result in conservative stress at a most critical location in the pipe. The combination of following general guideline and judgment were excercised in the process of subgrouping:

[

]$^{a,c,e}$

[

]a,c,e

**Question 6.1** How will the potential for exceeding snubber and spring hanger travel ranges be checked? What specific information and instructions will WOG provide to the individual licensees?

**Reply:** As stated in Section 6.3, the piping displacement and support loads from WOG analysis cannot be used for design since they do not reflect a plant specific configuration because of the support/restraint enveloping. The WOG report further stated in Section 10.3 that in order to obtain plant specific support loads and displacement, a plant specific global piping analysis would be needed. Only after the plant specific global piping analysis is performed and the plant specific support loads and displacements are obtained, the spring hanger and snubber travel ranges can then be verified.

**Question 6.2** The analysis of a representative surge line with enveloped supports will not provide displacements and support loads that can be used for design purposes. How will the individual plants be able to verify support adequacy and potential interferences with whip restraints or other adjacent structures?

**Reply:** (See reply to Question 6.1).

**Question 6.3** Do the temperatures presented in Table 6-1 represent fluid or metal temperatures? Are fluid and metal temperatures assumed to be equal in this analysis?

**Reply:** The pressurizer and RCL temperature presented in Table 6-1 are fluid temperatures. The $T_{top}$, $T_{bot}$ and Pipe delta T in Table 6-1 are considered metal temperatures. Throughout all structural analysis, metal temperatures were used. Metal temperature and fluid temperatures are not the same. [

]$^{a,c,e}$

**Question 6.4** Identify the plants listed in Table 6-2?

**Reply:** [

]$^{a,c,e}$

**Question 7.1** (A) Provide a brief description of the heat transfer analysis performed to determine local thermal stresses in the piping and hot leg nozzles. (B) Were only steady state conditions considered? (C) Considering the variations in fluid velocities and temperatures, how were conservative values of film coefficients arrived at?

**Reply:** (A) Prior to the WOG pressurizer surge line program, specific heat transfer and stress transient analyses were performed. Heat transfer film coefficients were calculated for a range of expected fluid velocities and temperatures assuming forced convection. In addition, film coefficients were calculated based on free convection and compared to forced convection values.

(B) No.

(C) The film coefficients used were based on the most probable fluid velocities that supported stratified flow under the mode five operating condition, when the highest temperature difference typically occurs.

**Question 9.1** The ASME Code, Section III, 1986 Edition was used in the analysis. Since all surge lines were originally designed to earlier Code editions or to other piping codes, will a code reconciliation be performed for each plant?

**Reply:** We believe the ASME Section III Code, 1986 edition represents a more advanced, realistic and conservative code for the evaluation of thermal stratification conditions. It requires the design fatigue life evaluation through primary plus secondary stress qualification and fatigue cumulative usage factor calculation.

It should be also noted that the thermal stratification phenomena does not affect the design with respect to primary stress. Since the thermal stratification issue is being considered as a supplemental requirement to the original code evaluation, no code reconciliation to earlier edition is needed.

**Question 9.2** Provide a description of "transfer function method" (TFM), or example of its application, and a copy of reference 3.?

**Reply:** The TFM is a methodology that deals with an input signal and the output response. In the present application, the input is the temperature transients and the output is the thermal stress.

The TFM method relies on a pre-determined weight function database which is a function unique to a material point of a structural component and thus characterizing the geometrical and material conditions of a location.

The TFM method is very effective for evaluating the transient stresses in a non finite element method basis. The accuracy and quality is exactly the same as the finite element method and yet it can complete the calculations in a small fraction of the CPU time as compared with the finite element method.

The thermal stress calculated by the TFM method may be combined with other types of stresses such as the pressure stress and the external bending stress for complete mechanical analyses such as fracture and fatigue evaluations.

The theoretical basis of the TFM method is given in Ref. 3, in which verification of the methodology is given. A bench marking problem on the fatigue usage evaluation is also provided. Providing reference 3 to the NRC will be discussed. An application of this method is described in the attached ASME/PVP paper "Incorporation of Stratification Loading Mechanisms in Transfer Function Based Transient Stress and Fatigue Evaluation".

**Question 9.3** How will the assumed envelope of OBE moments be verified?

**Reply:** The assumed envelope of OBE moments are very conservative. They were calculated based on the back calculation from the maximum code allowable with some assumed nominal deadweight contribution. When the plant specific OBE moment is compared to the envelope moment, it is expected that the plant specific OBE moment will be smaller.

**Question 9.4** If the thermal striping stress intensity and peak stress range was calculated from a 2-D finite element analysis using the model shown in Figure 9-1, please clarify why and how 1-D heat transfer analysis stresses from the computer program "STRFAT2" were used?

**Reply:** A 2-D finite element analysis was used to calculate striping stresses for a delta T of 320°F. Since it was much too conservative to assume that all striping occurrences were at 320°F, a method was needed to calculate stresses at delta T levels lower than 320°F. [

]a,c,e

**Question 9.5** The paper by Fujimoto, etal., "Experimental Study of Striping at the Interface of Thermal Stratification" suggests that the surface film coefficient in the interface region may be as much as seven times the nominal value. What impact would this have on the results?

**Reply:** The higher surface film coefficient suggested by the Fujimoto paper is actually on the same order as used in the striping analysis. The heat transfer coefficient observed from test data was compared to nominal values calculated with a hydraulic diameter equal to the diameter of the pipe. The velocity, Reynolds number, and heat transfer coefficient were all calculated based on the nominal flow area of the pipe.

For surge line striping, the calculation of surface film coefficient is based on reduced flow area.

The differences in flow velocity for the stratified surge pipe versus nominal values with no stratification would be sufficient to account for, and are consistent with the larger heat transfer coefficients which are observed in the Fujimoto paper.

**Question 9.6** Describe the methodology and significant assumptions used in developing Figure 9-2. Was a flow rate of 90 gpm assumed? Would the curve change significantly at different flow rates:

**Reply:** A model was developed to determine how quickly molecular heat conduction would attenuate a 300°F thermal striping potential.

An estimate of the transient heatup was predicted using classical heat transfer.

For this evaluation the following were assumed:

1) The interface is a full 300°F at time zero.

2) The maximum wave magnitude of the int' face was [ ]$^{a,c,e}$ based observations from tests (conservatively selected to be larger than expected based on these observations).

3) The coldest fluid which can interact with the pipe wall surface occurs at the hot-to-cold interface at a depth of [ ]$^{a,c,e}$

The development of figure 9.2 was based on a delta T of 300$^{\circ}$F which would correspond to a flow rate which is conservatively estimated to be about 90 gpm. However, flow velocity will not significantly affect the curve shown in figure 9.2 because an infinite heat transfer coefficient has been assumed at the hot/cold fluid interface.

The infinite heat transfer coefficient and the conservative wave height will envelope all cases where heat transfer coefficient may be lower than assumed.

**Question 9.7** Provide the basis for the assumed OBE moments summarized in the table in Section 9.3.1.

**Reply:** See question 9.3

**Question 9.8** Please clarify the requirements for equation 13 qualifications. It appears that the 15 plants which were shown acceptable for equation 12 and maximum usage factor must still be checked for meeting equation 13 as part of the plant specific evaluation. Moments of the hot leg nozzle must be compared to the allowable moments in Table 9-5. Are all other components of the surge line qualified to equation 13?

**Reply:** For a complete plant specific evaluation, the moments at the hot-leg nozzle must be compared with the allowable Equation 13 moments in Table 9-5.

[

]$^{a,c,e}$

**Question 9.9** Are the additional plant specific evaluations for the 28 plants that have not been qualified to equation 12 or fatigue usage being performed as part of the WOG program? How will these results be reported and what is the schedule for completion?

**Reply:** No additional plant specific evaluations are planned for the WOG program. See question 1.1.

**Question 10.1** Please explain how the permanent plant temperature sensor mounted in the surge line (TE 450) can be used to determine maximum fluid delta T?

**Reply:** For certain configurations, the TE 450 sensor can be used to determine the "pressurizer" portion of system delta T check. These configurations would have the sensor located at the top of the pipe and would be near the pressurizer. This would more accurately represent the maximum delta T in the pipe since no point in the horizontal pipe could practically have hotter fluid than this location in Mode 5.

**Question 10.2** Is each plant required to perform a plant specific global piping analysis? What specific instructions will WOG provide to each utility?

**Reply:** Yes, each plant is required to perform a plant specific global piping analysis for the reason stated in question 9.9. The specific instruction the WOG provided to each utility can be found in Chapter 10.

**Question 10.3** Section 10.4 refers to moments tabulated in section 9.2.1. Shouldn't it refer to the table in section 9.3.1?

**Reply:** Yes

**Question 10.4** The pressurizer nozzle evaluation is outside of the scope of the WOG program. Have any preliminary evaluations been performed to ensure that the pressurizer nozzle is not a concern?

**Reply:** Pressurizer nozzle was qualified in many plant specific analysis in the past, such as, Vogtle, Trojan and Comanche Peak. Pressurizer nozzle will be evaluated when plant specific analysis is performed. If past is any indication of the future, we do not expect any difficulty in qualifying them.

**Question 10.5** Will the results of the plant specific detailed analyses for those plants not shown acceptable under the generic analysis be reported in a future WOG report?

**Reply:** No

Table 1.0

| Plant | WOG Group No. | Plant | WOG Group No. |
|---|---|---|---|

[

]$^{a,c,e}$

Table 2.0

| WOG GROUP NO. | EQ 12 STRESS(KSI) | CUF |
|---|---|---|

[

]a,c,e

FIGURE 3.1-1

# APPLIED VS MEASURED TEMPERATURE PROFILES

[ ]a,c,e

NRCWOG1

FIGURE 3.1-2

# APPLIED VS MEASURED TEMPERATURE PROFILES

NON-LINEAR TEMPERATURE LOADING

a,c.e

NRCWOG2