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NEW YORK, N. Y. 10004

November 26, 1979
AEP:NRC:00305

Donald C. Cook Nuclear Plant Unit Nos. 1 and 2
Docket Nos. 50-315 and 50-316
License Nos. DPR-58 and DPR-74

Mr. J. G. Keppler, Regional Director
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Region III
799 Roosevelt Avenue
Glen Ellyn Illinois 60137

Dear Mr. Keppler:

This letter and its attachments submit to the Commission additional information with regard to the analysis, inspection, and modification of the main feedwater system at the Cook Plant.

Attachment No. 1 to this letter contains the fourth progress report on the Feedwater Line Data Collection Program in Unit No.2. Previous progress reports on this program were transmitted to you via our AEP:NRC:00221A (August 3, 1979), AEP:NRC:00221B (September 5, 1979), and AEP:NRC:00221C (October 12, 1979) submittals. This progress report, submitted in accordance with the commitment made in our AEP:NRC:00221 submittal dated June 15, 1979,addresses IE Bulletin No. 79-13, Revision 2 which we received on October 24, 1979 and also contains the information requested by members of the Washington NRC Staff during telephone conversations held on November 1, and November 6, 1979.

Attachment No. 2 to this letter contains a description of the thermal sleeve which is being installed in the feedwater elbow to the No. 4 steam generator in Unit No. 2. This information was also requested during the aforementioned telephone discussions.

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Attachment No. 3 to this letter is a copy of the Westinghouse stress analysis of our original piping system entitled "Stress Analysis of the Donald C. Cook Feedwater Piping." This analysis is submitted in accordance with the commitment made in our letter No. AEP:NRC:00221.

As the information contained herein supplements previously submitted information and is being transmitted in direct response to both written and verbal requestes by members of the NRC Staff, 10 CFR 170.22 is interpreted as requiring that no fee accompany this submittal.

Very truly yours,

John E. Dolan

John E. Dolan
Vice President

JED;em

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DC-N-6015.3.1
AEP:NRC:00305

ATTACHMENT NO. 1 TO AEP:NRC:00305

FOURTH PROGRESS REPORT ON THE
FEEDWATER LINE DATA COLLECTION PROGRAM

DONALD C. COOK UNIT NO. 2

ATTACHMENT 1
AEP:NRC:00305
PROGRESS REPORT IV
FEEDWATER LINE DATA COLLECTION

Introduction

This is the fourth progress report on the investigation of the feedwater line elbow cracking problem at Donald C. Cook Plant Units Nos. 1 and 2. Unit 2 is presently in a refueling outage, during which we performed surveillance of the nozzle-to feedwater elbow welds in accordance with the commitment made in our AEP:NRC:00221 submittal dated June 15, 1979 and in IE Report No. 50-316/79-16. In addition to those modifications already made, we plan to implement new design modifications to the feedwater system during this outage.

Surveillance

All four steam generator nozzle to elbow weld areas were radiographed. No cracks or linear indications were evident. Elbow 2 - 4 was removed,and the inside surfaces at the nozzle and elbow counterbore areas were examined by fluorescent magnetic particles. No relevant indications were found. Ultrasonic examination from the outside surfaces of the elbow and nozzle of the weld and adjacent area were performed on 2-1, 2-2 and 2-3. No indications other than those previously identified in the baseline were found.

As required by IE Report No. 50-316/79-16 all four elbow to reducer welds were also radiographed. In addition to confirming the indication on 2-3 that we were committed to repair, additional indications of slag and entrapped oxide were revealed in 2-1 and 2-2 welds due to improved radiography. None of the indications were service induced. Repairs are being made to those welds.

Design Modifications

The results of this surveillance indicates that the modifications made on Unit 2 in June of this year as described in our letter of June 7, 1979 (AEP:NRC:00216) were effective in that no cracks were shown to initiate. Therefore, these modifications, (replacing the elbows with new elbows that have a greater wall thickness in the affected area, thereby reducing stress levels; modifying the counterbore area to greatly reduce the local stress riser; and improving the control of feedwater dissolved oxygen concentration) provide assurance for the continued safe operation of the Cook units.

Continued

However, because of the severe economic consequences of having the units unavailable due to potential cracking problems we have undertaken additional design modifications to reduce the number and magnitude of the cyclic stresses caused by the thermal transients and stratified feedwater conditions.

As previously reported, the design modification to give us the capability of using heated feedwater, rather than cold auxiliary feedwater, during unit start-up and during extended hot-standby when the secondary side is available, is in progress. The design phase is now completed and we are attempting to install this modification on Unit 2 during the present refueling outage.

The arrangement (see Figure 1-1) for heating the feedwater during start-up of a unit, involves using main steam from that unit in the two highest stage heaters. Steam from the unit's auxiliary steam header will be used to drive the feedpump turbine and to pull vacuum. The heater drains go to the condenser and are returned as feedwater.

Using main steam from the unit starting up, results in feedwater temperatures which tend to track the temperatures of the steam generators. Two factors prevent an exact match of temperatures. The first, is the transport time from the heaters to the steam generators, which is greatest at low flowrates. The second is that there is a limit of 300^{o}F total rise. This means that when the saturation temperature of the main steam reaches 300^{o}F above the hotwell temperature, the steam to the heaters will be throttled to limit the total rise. The maximum feedwater temperature will be on the order of 400^{o}F.

The proposed method of operation is as follows. During the heatup of the steam generators to a low positive pressure (less than 100 psig) vacuum will be established and preparations made to transfer from auxiliary feedwater to main feedwater. Steam will be admitted slowly to the heaters to start warming piping and heaters. Initially the heating will be done in the next-to-top heater. The heater pressure will rise with the steam generator until this heater approaches its limit of 150^{o}F rise. Then the steam to this heater will be throttled and steam pressure to the top heater will continue to rise with steam generator pressure until it too reaches its limit. Automatic pressure control is provided to do this.

Continued

On a unit trip, main feedwater is tripped and auxiliary feedwater is initiated automatically. This design feature will be maintained. However, if the unit is expected to be in a hot-standby condition for a significant time, main feedwater flow and heating can be established as it is for a start-up.

We are also installing for evaluation a thermal sleeve into the feedwater elbow of steam generator 2-4 during the present refueling outage. This sleeve is designed to extend through the entire elbow and into the existing nozzle thermal sleeve. Details of the sleeve are described in Attachment No. 2. This particular feedwater elbow was chosen because it had been removed for weld repair. In order to confirm the performance of the thermal sleeve, we will undertake an instrumentation program following this outage to measure temperatures and strain on the modified elbow.

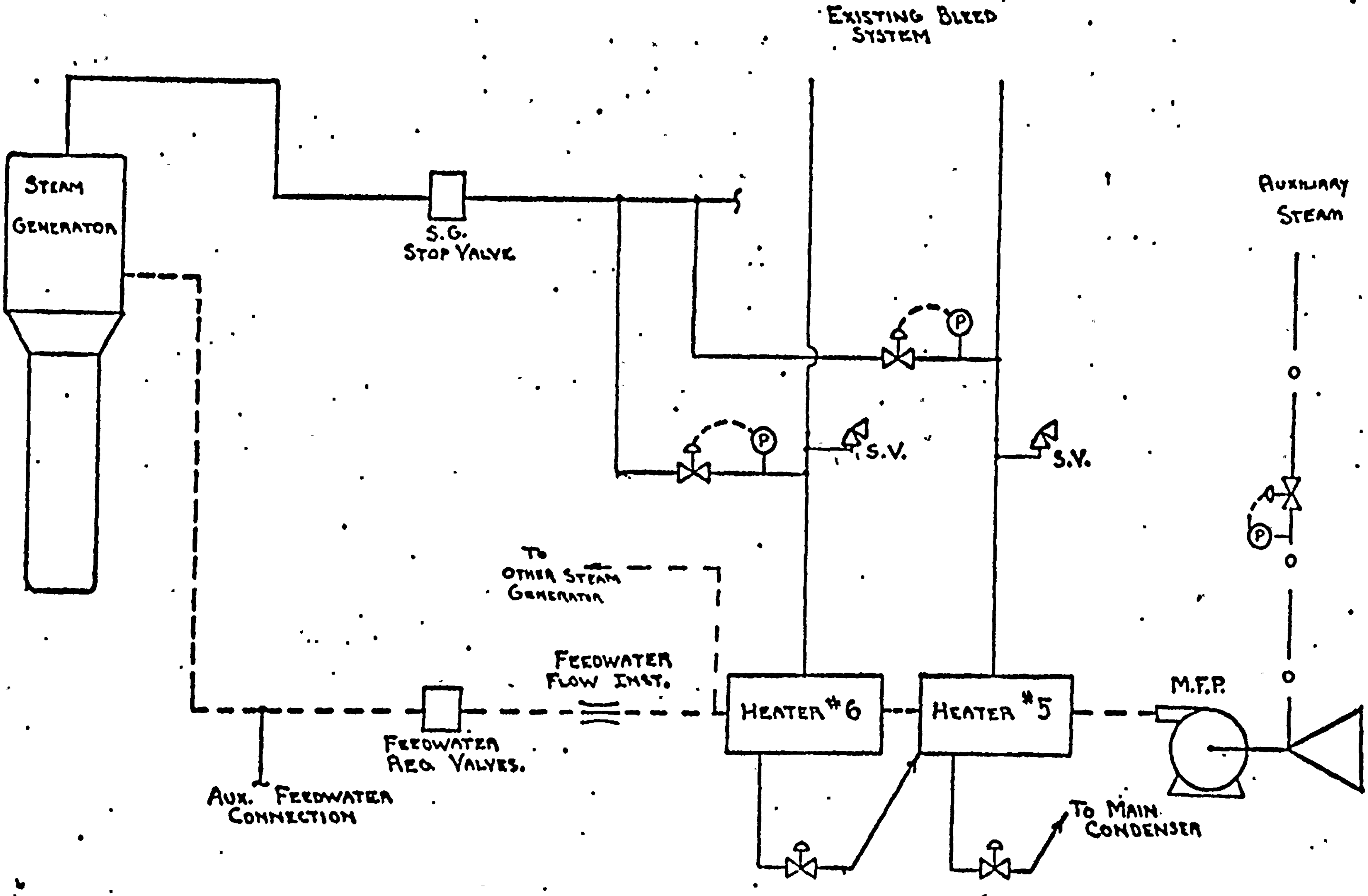
In addition, we have added weld build-up material to the outside diameter of all four steam generator feedwater nozzles to further reduce the magnitude of any cyclic stresses. The nozzle O.D. was first magnetic particle examined and then preheated to 175^{o}F minimum prior to welding. Two welders using E8018-C3 electrodes with the SMAW (Shielded Metal Arc Weld) process, worked at the same time on opposite sides of the nozzle so as to prevent distortion. Intermittant areas were covered to further avoid distortion of the nozzle due to weld shrinkage. The weld build-up was radiographed and surface examined. Post weld heat treatment will be done at 1100 - 1500^{o}F. Weld surfaces were machined or ground to a surface suitable for making a UT examination.

Conclusions

The results of our field data and analytical modeling have led to AEPSC to conclude that the thermal transient and stratified feedwater conditions that were observed in the nozzle elbow region during hot-standby and unit start-up were, along with corrosion, the major contributing factors to the initiation and/or propagation of the observed cracks. As a result of our recent surveillance, we believe that our modifications to date are effective and the new modifications outlined in this progress report further reduce the thermally induced cyclic stresses that are limited to the nozzle to elbow weld regions.

Continued

In light of these conclusions and the negative volumetric examination results identified in this report and our submittals, AEP:NRC:00221 (June 15, 1979) and AEP:NRC:00234 (July 20, 1979), we believe that further volumetric examinations on other than the nozzle-elbow weld region, as requested in IE Bulletin 79-13 Rev. 2, are not necessary. We concluded that these additional examinations are not necessary because a representative sample (approximately 40%) of the welds have already been examined with negative results. Also, confirming our oral report in Bethesda earlier this year, we have completed the examinations required on the main feedwater lines downstream of seven of the eight auxiliary feedwater connections. No recordable indications were found. We plan to perform surveillance on the nozzle to elbow weld areas on each steam generator during the next refueling outage for each unit.



FEEDWATER HEATING SYSTEM

TYPICAL ARRANGEMENT

Figure 1-1

PRELIM: JW: 11/16/79
REV: JW 11/20/79

ATTACHMENT NO. 2 TO AEP:NRC:00305

FEEDWATER ELBOW THERMAL SLEEVE INSTALLATION

ATTACHMENT 2
AEP:NRC:00305
THERMAL SLEEVE MODIFICATION

Introduction

This attachment summarizes the design and analysis efforts performed to date for the D. C. Cook feedwater line thermal sleeve modification. This modification is being made to provide protection for the pipe and nozzle against potential damage due to thermal stratification and/or stripping. One of these mechanisms, thermal stratification, has already been observed from field instrumentation. The absence or existence of thermal stripping is yet to be determined, pending results of the thermal/hydraulic flow model test being conducted as part of the Feedwater Line Owners Group Program.

Description of Modification

The feedwater line thermal sleeve modification shown in Figure 2-1, extends from the vertical pipe reducer through the elbow and into the steam generator nozzle as shown on the attached drawing. The nozzle end of the thermal sleeve contains two piston rings (contained in one groove) to seal the annular gap. This promotes a low convective heat transfer coefficient which is beneficial in reducing thermal stresses at the nozzle and pipe inside surfaces.

The nozzle thermal sleeve is 0.38" thick and fabricated from SA-106-GR B. The new thermal sleeve is 0.50" thick and also fabricated from SA-106-GR B carbon steel. An inconel 600 weld build-up is placed on the pipe reducer to accommodate welding of the new sleeve. This feature provides an improvement in fatigue strength over that of an equivalent carbon steel section.

Installation of the thermal sleeve requires I.D. machining of the steam generator nozzle and portions of the existing thermal sleeve. Metal removed by this process is replaced on the O.D. of the nozzle by weld build-up. This process also eliminates the counterbore on the nozzle weld prep (i.e., nozzle to pipe end weld prep) providing a reduction in the local stress concentrations in this region. In addition, the blend radius and taper transition in the pipe counterbore has been improved. An additional advantage is the resulting equal thickness at the nozzle to pipe weld interface. This provides a reduction in the local structural and thermal discontinuity stresses.

Design Considerations

1. Annulus Stagnation - Corrosion Potential

The annular space between the thermal sleeve and inside surfaces of nozzle and elbow will be essentially stagnant. There will be virtually no flow past the piston rings into this space. Once oxygen is consumed by normal oxidization of the steel, no further attack or surface deterioration can occur. There is no significant mechanism for concentrating any corrodent, and without concentration of some particular species, stress cracking will not occur.

2. Thermal Sleeve Vibration

An analysis was performed to determine the natural and critical flow induced stability frequencies for the thermal sleeve modification. A fundamental mode frequency of 60 Hz was obtained for the condition of feedwater flow, sleeve mass, and inside/outside fluid masses. The flow induced stability critical frequency was determined to be 446 Hz. Comparison of these with an expected excitation frequency of 325 Hz from feedwater pulsations provides ample margin of separation. Therefore, the design is judged adequate for flow induced vibration concerns.

3. Sleeve Distortion

A three-dimensional finite-element stress analysis model was used to provide the total sleeve and pipe deformation pattern for both axial and radial directions. This pattern was examined to insure that excessive ovalization of the sleeve was not obtained due to thermal stratification of the feedwater. Results of the model show that axial and radial deformation are insignificant with respect to the annular gap between the sleeve and the pipe.

Results to Date

The end of the feedwater nozzle and elbow have been modified to accommodate the thermal sleeve. Westinghouse has developed five representative feedwater circumferential temperature profiles, based on field data. These profiles were input into a three-dimensional stress model using both the original geometry and the change in geometry with the presence of the thermal sleeve. Comparisons between these cases show that the combination of the modified counterbore and the thermal sleeve will reduce stresses at the root of the elbow transition anywhere from 33 to 70 percent, with the larger reductions occurring for the most highly stressed cases.

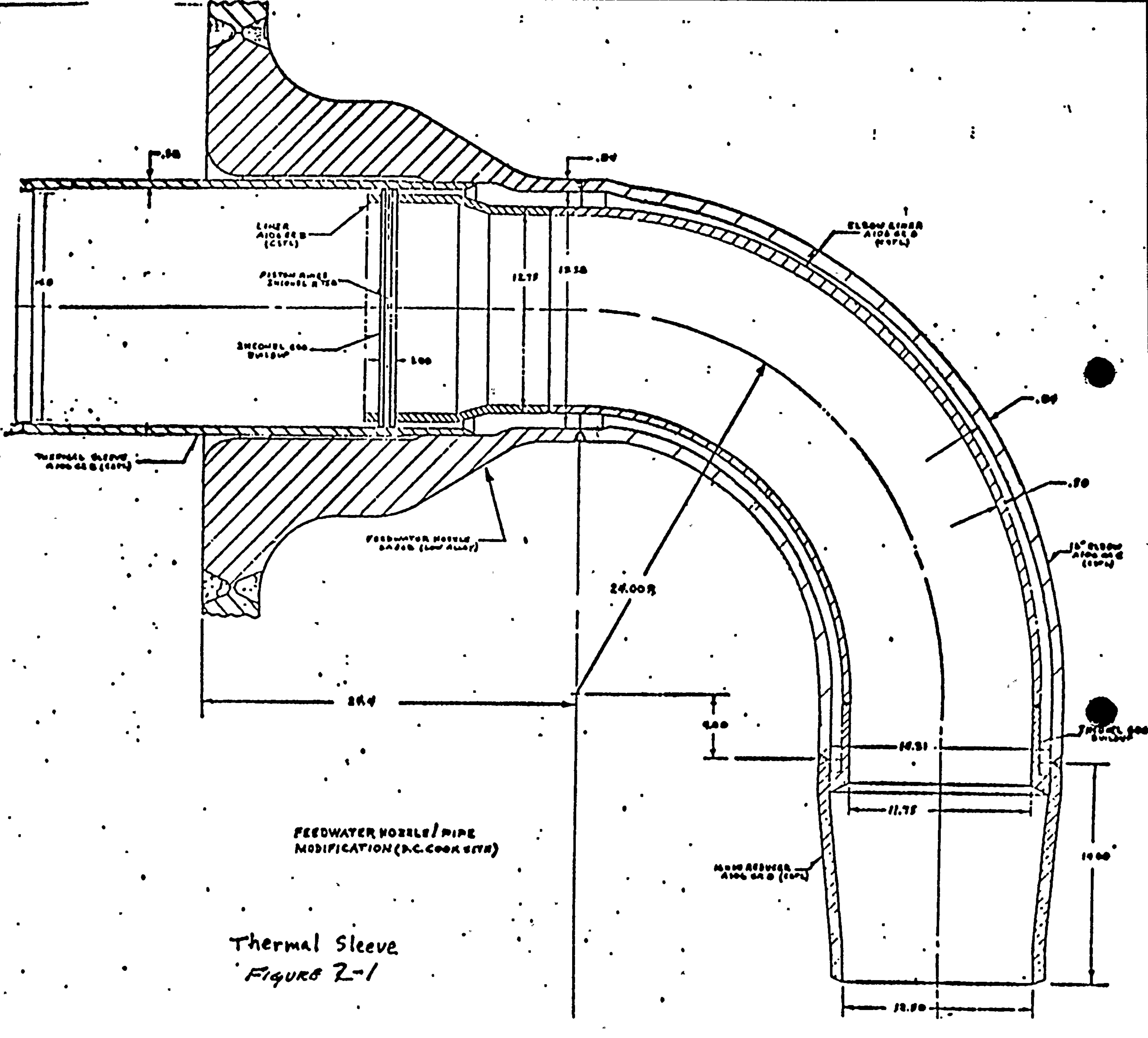
The analysis for the thermal sleeve is currently underway. The initial effort has concentrated on determining the sleeve weld finite element model stresses produced by the thermal stratification in the feedwater. A comparison of the axial stresses at the root of the counterbore transition near the sleeve weld with those for the original nozzle/elbow geometry for the five representative feedwater temperature profiles reveals that the sleeve stresses are significantly less than those for the original nozzle and elbow, particularly for the temperature profile that had the greatest contribution in the original fatigue damage calculation. Therefore, the thermal sleeve will be able to withstand the effects of stratified flow significantly better than was the original unprotected nozzle and elbow.

Conclusions to Date

From the results obtained to date, it can be concluded that the thermal sleeve does indeed carry out its intended function to reduce the discontinuity stresses induced by thermal stratification during low flow conditions.

Not only are stresses in the primary boundary reduced, but the stresses in the thermal sleeve appear to be low enough to assure a significant useful life.

Final verification of these conclusions must await the outcome of the remaining stress analysis and evaluation for the design load cases.



Thermal Sleeve

Figure 2-1

ATTACHMENT NO. 3 TO AEP:NRC:00305

STRESS ANALYSIS OF THE D. C. COOK
FEEDWATER PIPING

OCTOBER 1979
REVISION 1

STRESS ANALYSIS OF THE

D. C. COOK FEEDWATER PIPING

OCTOBER 1979

REVISION 1

I. INTRODUCTION

Stress analysis was performed for the D. C. Cook feedwater line configuration to determine if the normally expected loadings could cause the observed cracking. This analysis was broken into two parts. The first was the structural analysis of the feedwater piping from the steam generator to the containment penetration for the following loads:

1. Thermal (normal operation and hot standby)
2. Weight
3. Pressure
4. Frequency

The second analysis was a 2-D detailed finite element analysis of the feedwater to piping junction for the hot standby condition which is the worst thermal transient condition.

II. STRUCTURAL ANALYSIS

The feedwater piping layout is very similar for all eight lines at D. C. Cook Units 1 and 2. The Unit 2 line 1 was chosen as typical for this analysis, The piping model shown in Figure 1 was run from the steam generator to the containment penetration which are both taken as full anchors. The piping consisted of a 16" Schedule 60 nozzle end prep followed by a 16" schedule 80 elbow and a 16" x 14" reducer. The remainder of the piping was 14" Schedule 80. The supports on the piping consisted of the following: a constant force hanger at node 150, an axial and lateral snubber at node 130 and a vertical snubber at node 190. (See Figure 1 for node number locations.)

The Westinghouse piping system analysis code, WESTDYN, was used for the analyses. This code employs lumped parameter finite element models of the piping systems for both static and modal dynamic analyses. The methods used to obtain the solution consist of the transfer matrix method and the modal response method for determining frequencies.

The criteria for evaluating piping stresses was as follows:

a. Equation 8 for sustained loads (pressure and deadweight)

$$\frac{PD_o}{4t_n} + \frac{.75iM_A}{Z} \leq 1.0\ S_h \qquad (8)$$

P = internal design pressure, psig
D_o = outside diameter of pipe, inches
t_n = nominal wall thickness of component, inches
M_A = resultant moment loading on cross section due to weight and other sustained loads, inch-pounds
Z = section modulus of pipe, inch
i = stress intensification factor

b. Equation 10 for thermal expansion

$$\frac{iM_c}{Z} \leq S_a \qquad (10)$$

Terms same as above except:

M_R = Resultant moment loading on cross section due to thermal expansion

Two thermal conditions were run. The first with the Steam Generator at 547°F and the feedwater line at 450°F representing normal operation. The second with the Steam Generator at 547°F and the feedwater line cold representing the hot shutdown condition. In both cases the vertical and horizontal growth of the Steam Generator was included.

The frequency analysis was performed for the cases of active and not active snubbers. The active snubber case gives the highest frequency response of the system. The inactive snubber case gives a lower bound on frequency response and represents the response expected for very small displacements where the snubbers have a dead band.

The results of the stress evaluation for the two thermal cases, deadweight and pressure are shown in Table 1. The major frequency response for both cases are shown in Table 2.

MECHANICS & MATERIALS

FILE: AEPFW1 DATE: 8/10/79 PLOT 1

PAGES VERSION NUMBER 2.00 AUTHOR: W A Moore

FILE USE COUNT 18 CHECKED BY: G R Ellis

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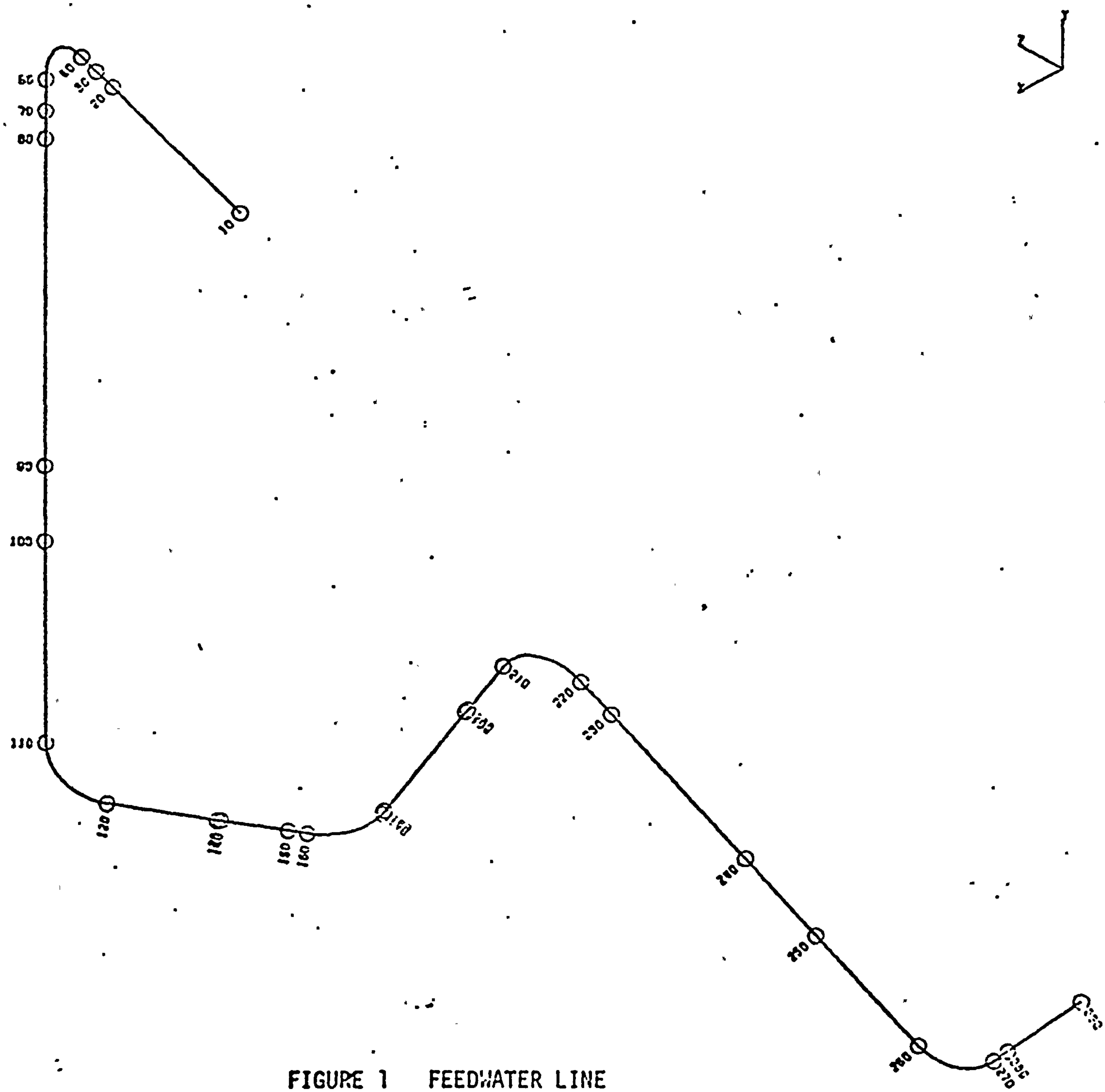


FIGURE 1 FEEDWATER LINE
STRUCTURAL MODEL

TABLE 1

STRUCTURAL ANALYSIS STRESS RESULTS

NODE #	THERMAL (KSI) HOT SHUT	THERMAL (KSI) NORMAL	ALLOWABLE (KSI)	DEADWEIGHT (KSI)	PRESSURE (KSI)	ALLOWABLE DW + P (KSI)
30 (Nozzle/ elbow weld)	5.9	11.6	22.5	1.6	5.9	15.0
50 (Weld at elbow)	4.3	9.5	22.5	.8	4.4	15.0
70 (At reducer)	5.9	14.2	22.5	.6	4.4	15.0
110	5.2	5.3	22.5	.9	4.3	15.0
220	4.4	2.5	22.5	1.2	4.3	15.0
290	5.2	3.0	22.5	2.2	4.3	15.0

TABLE 2

FREQUENCY RESPONSE (BELOW 20 HZ)

SYSTEM W/O SNUBBERS ACTIVE (HZ)

2.9 4.5 7.2 11.8 14.1

SYSTEM W/ SNUBBERS ACTIVE (HZ)

9.4 11.2 15.5 19.4

III. 2-D FINITE ELEMENT ANALYSIS

The purpose of this analysis was to investigate one possible cause of the cracking, which has occurred in the vicinity of the Steam Generator feedwater nozzle. The loading condition analyzed is the injection of 60°F auxiliary feedwater through this nozzle, which is initially at a uniform 547°F. This condition occurs as a normal function during hot shutdown.

To perform the analysis, a 2-D axisymmetric finite element model was constructed, for use with the WECAN computer code. (See Figures 2 and 3). This model was intended to predict accurate stresses in the region near (and to both sides of) the safe end girth butt weld, and to account for gross effects of the regions further than several inches (axially) from the weld. For this reason, the element mesh was more refined in the weld region than elsewhere.

Three materials were represented in the model, as shown in Figures 1 and 2. The nozzle is made of SA-508 Cl.2 carbon steel (Material 1). The piping elbow and the thermal sleeve of the nozzle are class 2, SA106 Gr. B carbon steel (Material 3). The annulus between the nozzle and the thermal sleeve is assumed to be stagnant water, with an equivalent conductivity input to account for heat transfer across the gap (Material 2). The material properties used in the analysis are listed in Table 3.

The thermal transient definition is illustrated by Figure 4. After the initiation of auxiliary feedwater injection, the flow rate is less than 200 gallons per minute. With this low flow rate, the convection film coefficient for the inside surface of the pipe and nozzle was calculated to be 193 btu/hr-ft^2-F°. (Reference: "51 Series Steam Generator Feedwater Nozzle Analysis", W Tampe Division, O. Bertsch, 10/69, Section 3.11.) It was assumed to take 9 seconds for the bulk fluid temperature to change from 547° to 60° in the nozzle, since mixing occurs as the auxiliary feedwater moves up the many feet of piping. When injection is terminated, it was conservatively assumed that the 547° water in the steam generator immediately comes back into the nozzle (in 1 sec. time), with the film coefficient remaining at 193 btu/hr-ft^2-°F. It was also assumed that the feedwater

would completely fill the pipe and nozzle, and that for any given cross section, the fluid temperature would be a function of time only. On the inside surface of the steam generator, the conditions remain constant in time, at 547°F and 83 btu/hr-ft^2-°F. The WECAN analysis was run in two stages. First, the fluid temperatures and film coefficients were applied as a function of time in order to calculate temperatures throughout the metal, which were written to tape. In the second stage, these temperatures were applied to the model in order to calculate stresses as a function of time, and to determine the times at which the highest stresses occur. At the controlling time points, at the location where the cracking occurred (element 274, Figure 2), stresses were extrapolated from the controids of the three nearest elements to the surface. (Constant strain elements were used.) The maximum range in surface stresses between any two time points was used to determine the surface stress intensity for this transient. The fatigue evaluation was done using the method of Section 3, NB3000 of the ASME Code. A local stress concentration factor of $K_3 = 1.7$ was applied to the surface stress intensity in order to conservatively account for the effect of the "notch" at the counterbore. Since the primary plus secondary stress intensity range S_n was less than 3.0 S_m, the alternating stress S_{alt} was calculated by taking one half the peak stress intensity. At the critical location, an alternating stress of 44.7 ksi was calculated. Per Figure XIV-1-21.3(c)-1 of the ASME Code, the S-N curve for carbon steels, the number of allowable cycles is then approximately 5000. Thus, the component meets the requirements of the ASME Code so long as the actual (or postulated) number of occurrences of this transient does not exceed 5000. The usage factor, U, is the ratio of actual to allowable cycles. If U = 1.0, the maximum allowable, fatigue cracking is not expected to occur, since there is a high degree of conservatism built into the S-N curve. A summary of stresses is given in Table 4 of this report.

FIGURE 2

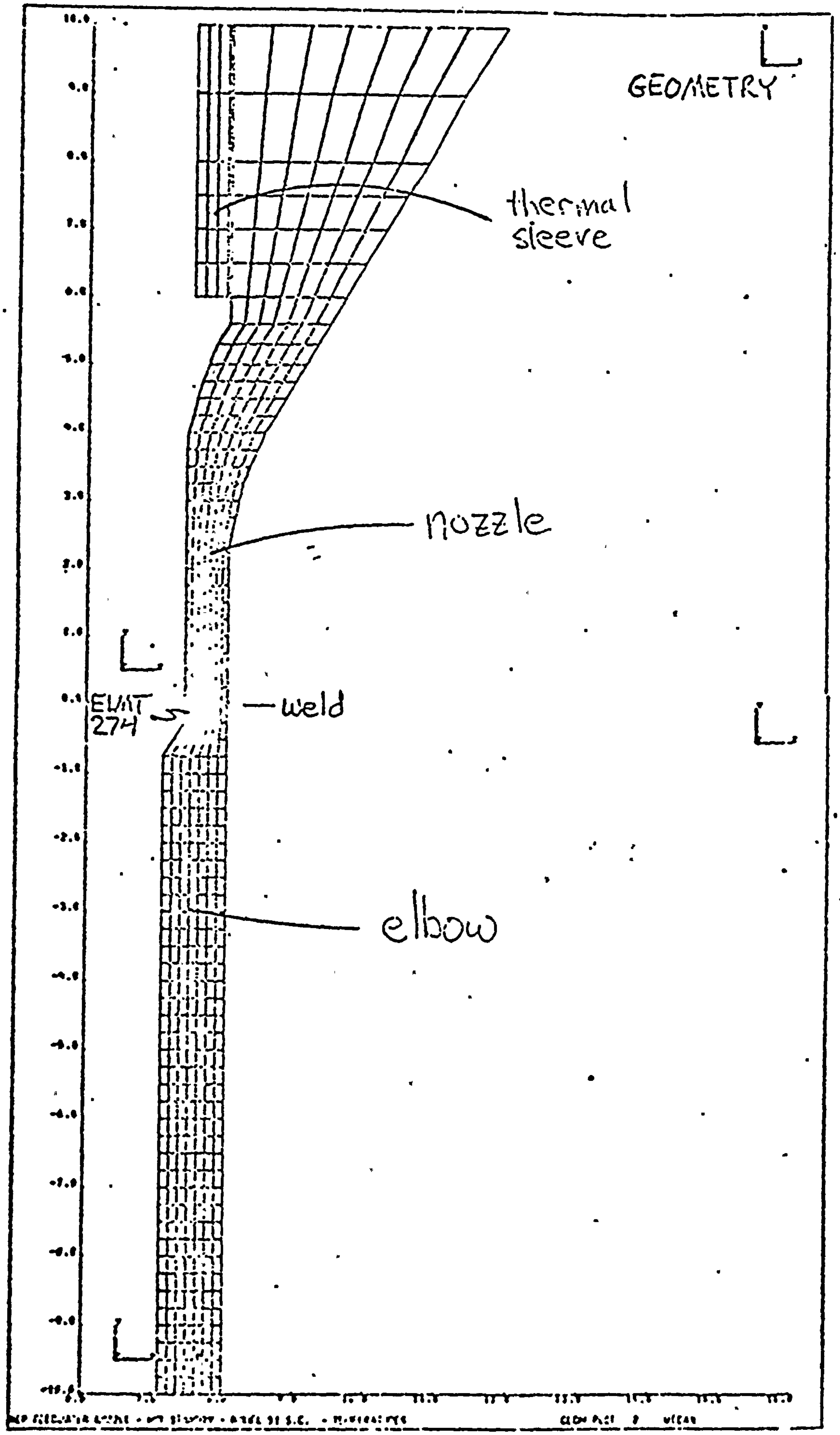
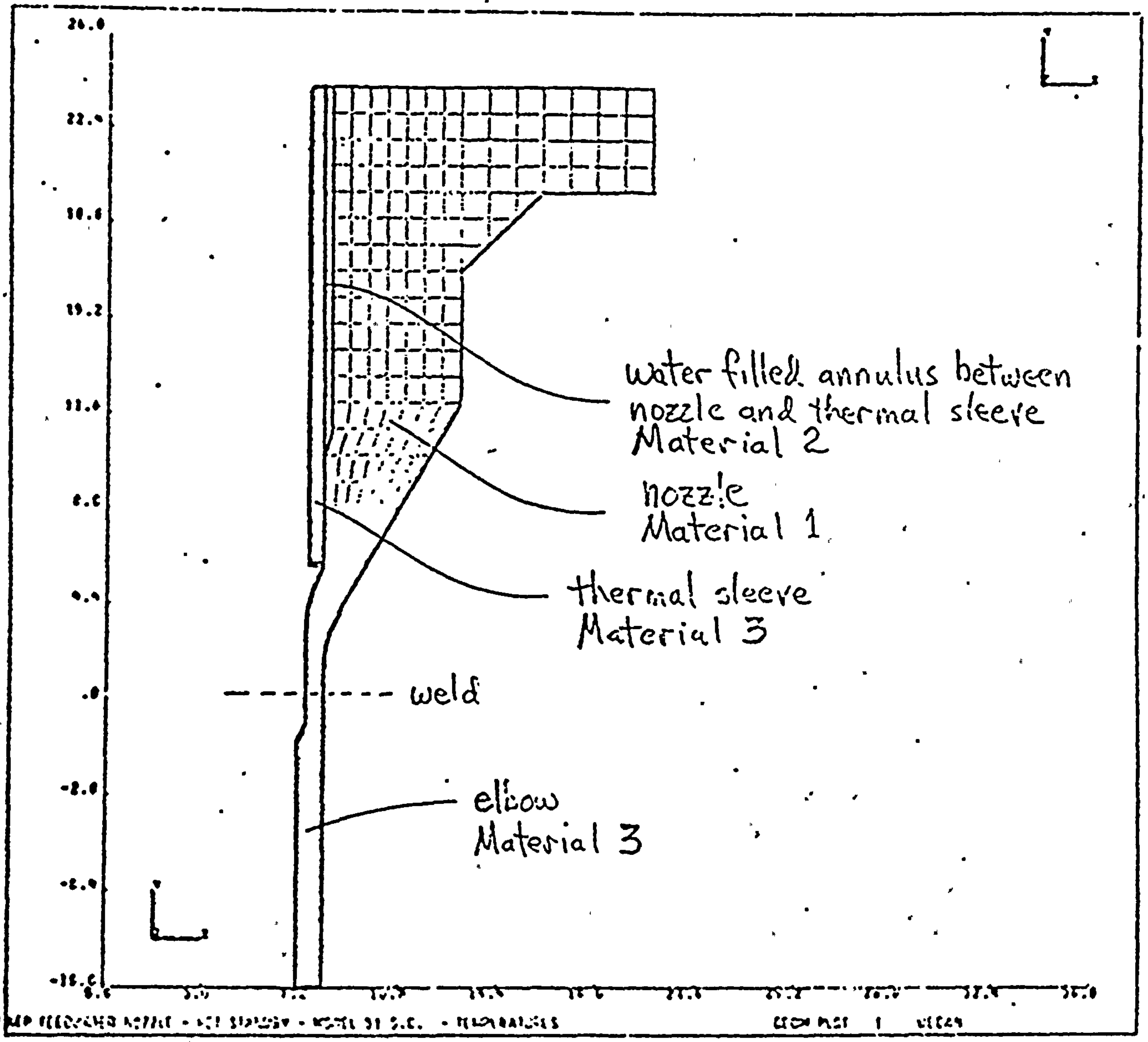
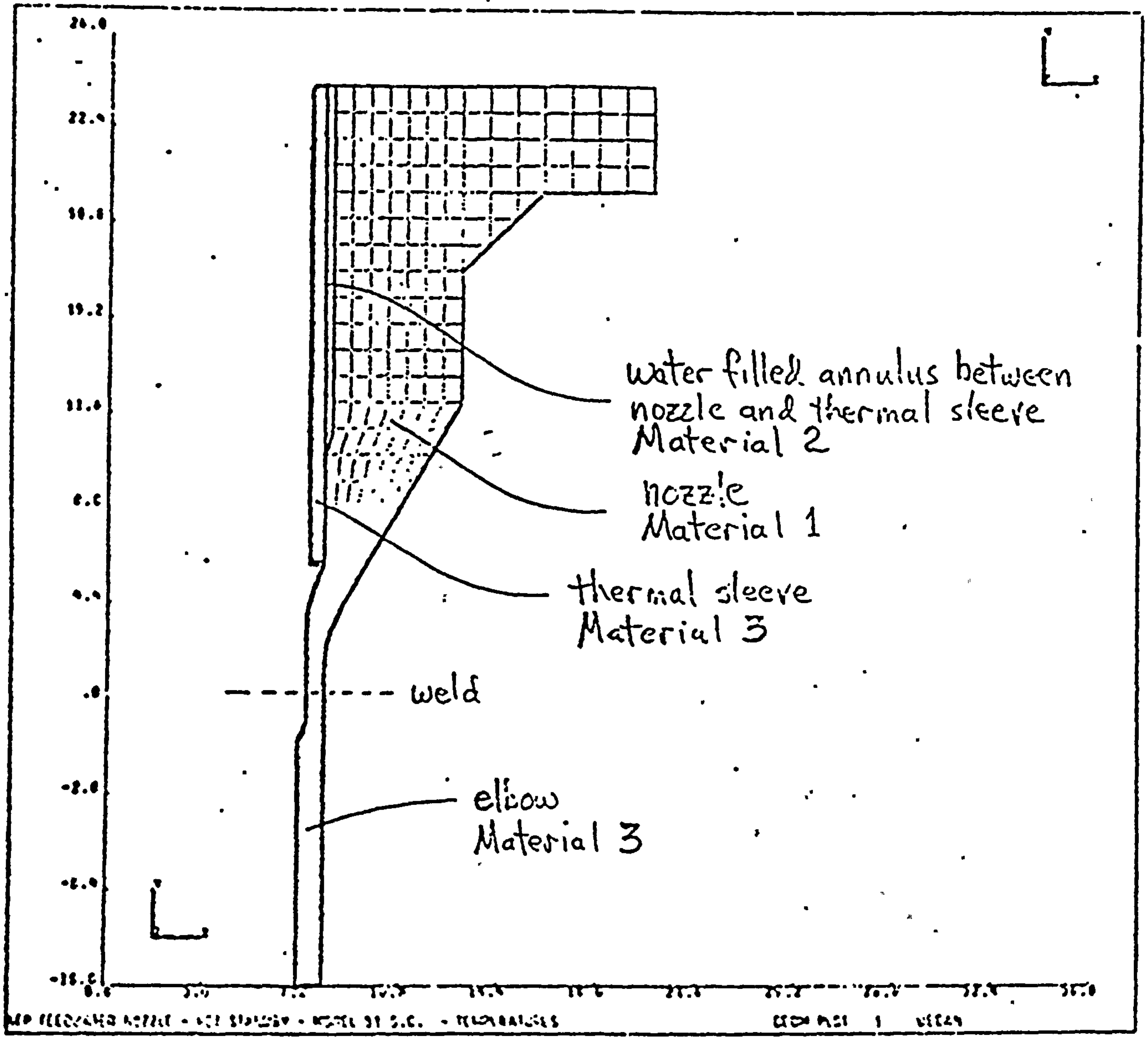


FIGURE 3



water filled annulus between nozzle and thermal sleeve Material 2
nozzle Material 1
thermal sleeve Material 3
weld
elbow Material 3

FIGURE 3



water filled annulus between nozzle and thermal sleeve Material 2
nozzle Material 1
thermal sleeve Material 3
weld
elbow Material 3

TABLE 3

MATERIAL PROPERTIES

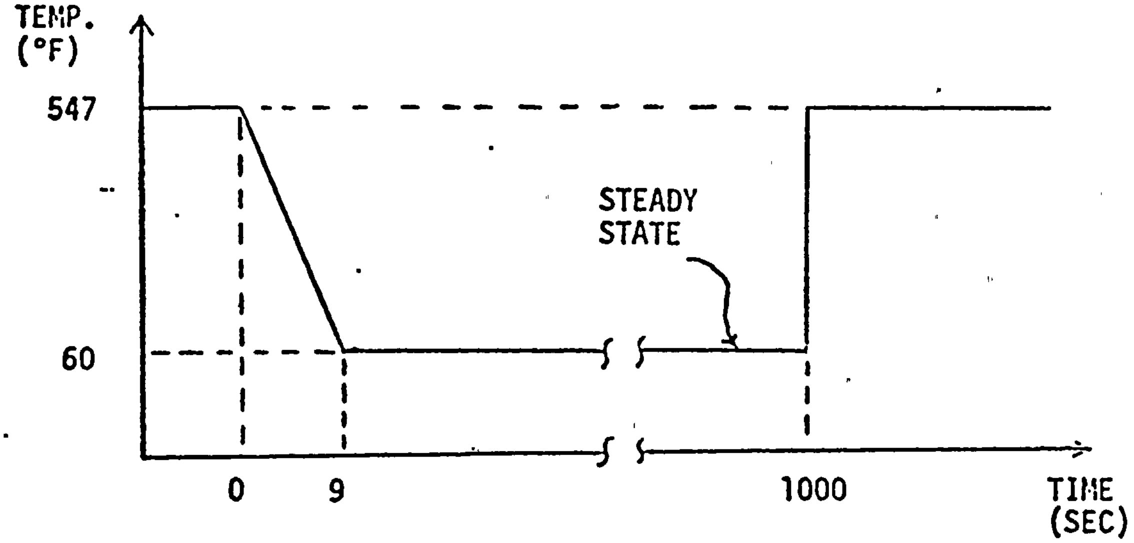
		Material 1 (Nozzle)	Material 2 (Water)	Material 3 (Pipe)
Coefficient of * Thermal Expn. 10^{-6}in/in	100°F	6.53	N.A.	5.83
	300°F	7.30		7.15
	600°F	8.35		8.55
Conductivity btu/hr-ft-f	100°F	22.0	.266	29.9
	300°F	22.5		28.4
	600°F	21.5		25.6
Specific Heat btu/lbm-f	100°F	.109	1.31	.108
	300°F	.121		.122
	600°F	.137		.138
Density lbm/in^3	100°F	.2885	.0265	.2885
	300°F	.2867		.2867
	500°F	.2841		.2841
Modulus of Elasticity 10^6 psi	100°F	29.8	N.A.	27.85
	300°F	29.0		27.4
	600°F	27.4		25.7
Poisson's Ratio		.3	N.A.	.3

* This is the instantaneous coefficient of thermal expansion and was used for the 2D finite element analysis only.

FIGURE 4

HOT STANDBY

THERMAL TRANSIENT DEFINITION



FILM COEFFICIENT FOR TRANSIENT

(A) INSIDE SURFACE OF PIPE, NOZZLE, AND THERMAL SLEEVE = $193 \dfrac{BTU}{HR\text{-}FT^2\text{-}°F}$

(B) INSIDE SURFACE OF STEAM GENERATOR $83.3 \dfrac{BTU}{HR\text{-}FT^2\text{-}°F}$

(A) ASSUMES FLOW OF 200 GPM → .38 FT/SEC

FILM PROPERTIES EVALUATED AT 290°F

(B) ASSUMES NO FORCED CONVECTION
(FREE CONVECTION ONLY)

REF: "51 SERIES STEAM GENERATOR FEEDWATER NOZZLE ANALYSIS",
O. BERTSCH 10/69, W TAMPA DIVISION SEC. 3.11

TABLE 4

STRESS SUMMARY FOR AUXILIARY FEED INJECTION

TRANSIENT AT LOCATION OF ACTUAL CRACKING

σ_y max	30.5 ksi, t < 1000 sec
σ_z max	19.4 ksi, t < 1000 sec
σ_y min	-22.1 ksi, t > 1000 sec
σ_z min	-15.0 ksi, t > 1000 sec
Stress Intensity	30.5 + 22.1 = 52.6 ksi
Peak S.I. (K = 1.7)	1.7(52.6) = 89.4 ksi
S_{alt}	.5(89.4) = 44.7 ksi

σ_x = radial σ_y = axial σ_z = hoop

IV. CONCLUSIONS

Results of structural evaluation show that all thermal,deadweight and pressure stresses are below the allowable. The frequency evaluation shows that fundamental modes of the feedwater pipe is in the range of expected Steam Generator frequencies. However, the normal operating vibration has been found to be too small to cause significant response of the feedwater piping.

The 2-D finite element analysis indicates that the allowable number of hot standby cycles is more than have been experienced by the plant even for the conservative transient assumed. Also, the design transients given in the Steam Generator E-Spec has shown acceptable values of usage factors for the feedwater nozzle. Correspondingly, analysis of the nozzle to piping junction will have an acceptable value of usage factor since the thermal transient stresses are lower at this junction than in the nozzle.

The results of the above analysis show that the normally expected operation of the feedwater system did not cause the observed cracking. Therefore, an unexpected event or events caused the cracking and these are currently under investigation.

V. REFERENCES

1. Sargent and Lundy Drawings — 1-2-5801-10, 2-5802-3, 2-5803-2

2. N.P.S. Designs Drawings — 2-GFW-74, Rev. 1; 2-GFW-75, Rev. 1; 2-GFW-76, Rev. 0; 2-GFW-77, Rev. 1

3. WESTDYN, "Documentation of Selected Westinghouse Structural Analysis Computer Codes, WCAP-8252", Revision 1, May 1977 (Non-Proprietary).