72.57

STRUCTURAL DYNAMIC ANALYSIS OF CONTAINMENT COOLING SYSTEM REACTOR BUILDING TRAIN "A" AND TRAIN "B" SUPPLY AND RETURN PIPING

Technical Report No. 96227-TR-03
Revision 0

prepared for:

Wolf Creek Nuclear Operating Corporation
Wolf Creek Nuclear Plant

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SUBJECT: Structural Dynamic Analysis of Containment Cooling System Reactor Building Train "A" and Train "B" Supply and Return Piping Wolf Creek Nuclear Plant

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A Patel A. Patel	2/27/98	C. W. Johnson ~~S. Gupta~~	3/3/98
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PROJECT MANAGER: [signature] FOR P. Bruck Date: 3-4-98

ENGINEERING MANAGER: [signature] for M. Eissa Date: 3-10-98

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Computer File Index

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PROGRAM NAME: ADLPIPE **VER. NO.:** 4F7B

RELEASE DATE: 2/9/96

HARDCOPY LOCATION: Attachment A

USERNAME*: cfhammer **DIRECTORY*:**

KEYWORDS: ASME, Cl. 2, 1974

DEADWEIGHT, THERMAL AND VIBRATION

Run No.	Description	Output File Name/ Input File Name*	Date::Time
1.	Train "A" Return Deadweight, Thermal, Thermal Accident and Water Hammer (Column Closure)	wlferk7b.out	9/24/97 08:59:39
2.	Train "B" Return Deadweight, Thermal, Thermal Accident Column Closure Time History and Condensation Induced Time History	trubret.out	2/05/98 08:14:38
3.	Train "A" Return Deadweight, Thermal, Thermal Accident, Water Hammer (Condensation Induced)	wlferk7a.out	1/21/98 10:38:49

* indicates optional information. If the input echo is not printed on the output file, the input file shall be identified and retained separately.

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1.0 OBJECTIVE AND SCOPE

1.1 Objective

The purpose of this evaluation is to perform a structural analysis of the Containment Cooling system, Reactor Building Train "A" and Train "B" Return lines and Supply lines at the Wolf Creek Nuclear Plant. The Train "A" and Train "B" Return lines structural dynamic analysis is based on elastic principles using the ADLPIPE computer Code [8][1]. From the results of the Train "A" and Train "B" Return lines, a qualitative assessment of the Train "A" and Train "B" Supply lines was made.

A waterhammer event has been postulated to occur due to the simultaneous occurrences of a Loss of Coolant Accident (LOCA) with Loss of Offsite Power (LOOP). This scenario as described in USNRC Bulletin 96-06, Ref. 1, results in steam formation in the coolers.

During this event, two possible waterhammers have been postulated to occur due to 1) condensate void collapse and 2) column closure. Both of these result in a column closure waterhammer which occurs after resumption of flow from pump restart. The moving flow impacts the stationary water resulting in a column closure waterhammer. This loading results in a transient pressure wave which travels through the system. Altran has performed a structural assessment of the subject piping system to determine the ability of the piping system (pipe, supports, equipment nozzles, and penetrations) to withstand such loadings, maintain the integrity of the pressure boundary, and ensure the piping will continue to pass flow.

1.2 Scope

Train "A"

The Supply line piping of Train "A" starts at Reactor Building Penetration P-71 and terminates at the inlet nozzles to Containment Coolers SGN01A and SGN01C.

The Return line piping of Train "A" starts at Containment Coolers SGN01A and SGN01C and exits the Reactor Building through Penetration P-73.

Train "B"

The Supply line piping of Train "B" starts at Reactor Building Penetration P-28 and terminates at Containment Coolers SGN01B and SGN01D.

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[1] [ ] Indicates reference number from Section 6.0

The Return line piping of Train "B" starts at Containment Coolers SGN01B and SGN01D and exits the Reactor Building through Penetration P-29.

The piping and support configuration for the containment cooling system Train "A" Return line and Train "B" Return line are shown in Figure 1 and Figure 2, respectively. The piping consists of 14", 10", 8" and 6" Schedule 40 carbon steel pipe.

2.0 EVALUATION METHODOLOGY & ACCEPTANCE CRITERIA

This section of the report discusses the analytical modeling details, applied loadings, and acceptance criteria.

2.1 Method of Analysis

The structural dynamic analysis is performed using the commercially available code ADLPIPE, Ref. 8. It is a general purpose piping analysis code used widely by the nuclear industry.

Once the time-history unbalanced wave forces are determined for each straight run of piping, they are applied to a structural model of the piping system using the ADLPIPE program.

The piping system structural model constructed for this analysis is represented by an ordered set of data which numerically describes the physical systems.

Node point coordinates and incremental lengths of the members are determined from spatial geometric drawings. The geometrical properties along with the modulus of elasticity, E, are specified for each element. The supports are represented by stiffness matrices which define restraint characteristics of the supports. The well-known equations of motion can be written in matrix form as:

$$M\{\ddot{x}\} + C\{\dot{x}\} + K\{x\} = \{f(t)\} \quad (3.1)$$

Where:

C = damping matrix		$\{x\}$	= displacement vector
M = mass matrix		$\{\dot{x}\}$	= velocity vector
K = stiffness matrix		$\{\ddot{x}\}$	= acceleration vector
		$\{f(t)\}$	= vector of applied forces

The natural frequencies and associated mode shapes can be obtained by solving the characteristic equation:

$$\det. |\lambda I - M^{-1} K| = 0 \qquad (3.2)$$

Where: M^{-1} = inverse of the mass matrix
I = identify matrix
λ = scalar eigenvalue

Each eigenvalue $\lambda_s = \omega_s^2$ of Equation (3.2) determines a natural frequency, and the associated eigenfunction $\{\phi_s\}$ is the mode shape. The matrix ϕ whose columns are the eigenvectors $\{\phi_s)$ is called the modal matrix.

Matrix Equation (3.1) represents the dynamic equilibrium of the masses of a three-dimensional structure with applied forces in any or all of the coordinate directions. Equation (3.1) can now be transformed into modal coordinates by defining the following linear transformation:

$$\{x\} = \phi\{q\} \qquad (3.3)$$

Where: $\{q\}$ = modal coordinates
ϕ = modal matrix

$$\{\dot{x}\} = \phi\,\{\ddot{q}\} \qquad (3.4)$$

Applying Equations 3.3 and 3.4 and normal mode theory, the actual time responses of the structure for the ith mass direction are:

$$x_i\,(t) = \sum_a \phi_{1,a} q_a\,(t) \qquad (3.5)$$

$$\dot{x}_i\,(t) = \sum_a \phi_{1,a} \dot{q}_a\,(t) \qquad (3.6)$$

$$\ddot{x}_i\,(t) = \sum_a \phi_{1,a} \ddot{q}_a\,(t) \qquad (3.7)$$

The solution is conducted in two parts. The first part is to find the frequencies and mode shapes of a three-dimensional structure. The second part takes the modal data, generates and solves the modal differential equations which result from time varying applied internal forces.

The time-history internal forces and displacements are then input into a series of post-processing programs used to determine the maximum forces, moments, and displacements that exist at each end of the piping elements and the maximum loads for the piping supports. The results are saved on magnetic media for future use in piping stress analysis and support load evaluation.

2.2 Analytical Model

2.2.1 Piping Model

The piping systems were coded in the ADLPIPE Computer Code, Ref. 8, and was subjected to loadings of Deadweight (D), maximum operating pressure (P), column closure waterhammer (CCWH), condensation induced waterhammer pulse (CIWH), together with thermal normal (THERM NORM) and thermal accident (THERM ACCD) conditions. The waterhammer event was evaluated as a time history dynamic analysis. The technique used to qualify the waterhammer is based on determination of the piping system response to known time dependent forces to calculate resulting stresses and loadings. The response of the piping system is computed by normal mode superposition technique. For the time history dynamic analysis, a modal damping value of 2% was used. The coding of the piping system was in accordance with the as-built isometrics of Ref. 3.

2.2.2 Support Details

Piping supports were included in the model, based on the support function shown on the support drawings [3]. Table 6.0 and 7.0 provide the hanger numbers, ADLPIPE node point and pipe support function for Train "A" and Train "B" return lines respectively. Stiffness values used were in general agreement with values from the support calculations.

2.3 Acceptance Criteria

The piping and pipe support systems were evaluated in accordance with the Wolf Creek Design Criteria for UFSAR Design Basis and Functionality acceptance[2]. Since the concurrent combination of seismic and LOOP/LOCA is not included in the UFSAR design basis and the seismic event will not cause the waterhammer, they are not combined in this analysis.

The loading combinations used for the evaluation of the Train "A" and Train "B" Return lines are as outlined in Table 1. The thermal case, under the LOCA ambient condition, denoted as Thermal Accident (THERM ACCD) is considered a faulted event. In accordance with the requirements of the ASME III, Appendix F Code, thermal loading for one time faulted events need not be evaluated for pressure boundary components. However, as a point of reference only, stresses were calculated and compared to ASME acceptance criteria. The pipe support acceptance criteria is based on the evaluation of all loadings, including THERM ACCD. The design basis acceptance criteria is based on meeting AISC Code [4], stress allowables, with consideration of the 1.33 stress increase considered for occasional loadings. The pipe support - design basis - acceptance criteria is shown in Table 2. For the evaluation of any pipe supports that do not meet the design basis acceptance criteria, an operability acceptance criteria is utilized in accordance with the guidelines recommended in USNRC IN95-09, Ref. 5, which endorses the use of USNRC GL91-18, Ref. 6. GL91-18 provides guidance for the resolution of degraded and non-conforming conditions and/or operability. Section 6.13 of Ref. 6 (Part 9900 - Technical Guidance) provides requirements for Piping and Pipe Supports. This, in turn, endorses the use of Appendix F of the ASME Section III Code [7]. The requirements for the evaluation and loading were as agreed upon by Wolf Creek. This acceptance criteria is shown in Table 3.

3.0 RESULTS & DISCUSSION

The results of the piping qualification for the containment cooling system Reactor Building Train "A" and Train "B" are outlined below.

3.1 Discussion

The Train "A" Return line was qualified for the condensation induced waterhammer event in Altran Report 96227-TR-02 [13] with the results of the analysis included in the appropriate attachments at the end of this report. The Train "A" Return line was analyzed for the column closure waterhammer event in this report.

The Train "B" Return line evaluation for the column closure waterhammer event and the condensation induced waterhammer event were qualified in this report with the results provided in the attachments section at the end of this report. The results of the Train "B" Return line loading conditions analyzed here supersede the results from Altran Calculation 94100-C-02 [11].

The two waterhammer pressure pulses are applied to a structural model of the piping system. The ADLPIPE [8] computer code is used, and the pressure pulse is applied as a time history load in a dynamic evaluation. The analytical technique computes the piping system response to the time dependent forcing functions. The response of the piping system is computed by the normal mode superposition technique. The piping models are shown in Figure 1 and Figure 2. The segment loading is determined by assuming that the pulse is initiated at the elbow at the end of the horizontal run and that the load propagates in each direction from this location. Forces will offset at opposing changes in direction when the pressure wave reaches the opposite ends of a segment. The pressure pulse will reflect off the free surface at the water to steam interface. The resulting segment forcing functions are shown in Attachment C.

3.2 Piping

The piping system structural evaluation was performed in accordance with the requirements of the ASME III, Subsection NC Code [9] and in accordance with the FSAR requirements for WCNP [2] as outlined in Section 2.2 and 2.3. A piping stress results summary table for the highest loaded location in the Train "A" Return line and the Train "B" Return line models are shown in Table 4. All piping stresses are within the Code allowables and meet the acceptance criteria of WCNP FSAR requirement stress limits. A summary of the Train "A" and Train "B" Return lines pipe stresses for each Code equation are included in Attachment A. The assessment of the Train "A" and "B" Supply lines is included in Attachment F.

In the Train "A" Return line model, Hanger R013 was considered "inactive" in the model. In addition, the Train "B" Return line model Hanger R001 was considered "inactive" for the qualification of the line.

3.3 Pipe Supports

The resulting pipe support loads for deadweight (D), thermal accident (THERM ACCD), column closure waterhammer (CCWH) and condensation waterhammer (CIWH) were obtained from the ADLPIPE evaluation. A combination of these loads is considered as the faulted loading condition and the pipe supports were qualified for this combined loading. Qualification was based on load ratings to previously qualified loads and ensuring that the support component interaction ratios are within the acceptable limits. A detailed evaluation of the supports are found in Attachment B. In addition, several pipe supports from Train "A" and Train "B" were welded to the pipe pressure boundary, commonly known as integral welded attachment. The evaluation of the integral welded attachments are provided in Attachment H.

3.4 Fan Cooler Nozzles

All stresses of attached piping at the nozzle are well below allowables and the integrity of the nozzle is still maintained. A comparison of the calculated nozzle loads to allowable loads is provided in Attachment G. In addition, the cooling coilings have been reviewed for the one time loading event and found acceptable.

3.5 Containment Penetrations

The stresses for the different loading conditions for the piping attached to the Reactor Building penetrations are within Code allowables. In general, penetrations are more rigid and stronger than the attached piping, and therefore, the integrity of the penetration is not compromised. The stresses at the penetration are shown in Table 5.

4.0 INPUT DATA

The ADLPIPE piping models of the containment cooling system piping for Train "A" and Train "B" Return lines were developed based on the isometric drawings provided by Wolf Creek [3]. The computer model of the Train "A" Return line piping geometry is shown in Figure 1. The computer model of the Train "B" Return line piping geometry is shown in Figure 2.

5.0 CONCLUSION

The results of the ADLPIPE computer analyses have demonstrated that the Wolf Creek Nuclear Plant Containment Cooling system Reactor Building Train "A" and Train "B" piping which are illustrated in Figure 1 and Figure 2, respectively are adequately designed to withstand both waterhammer pressure pulse events postulated to occur. The piping, supports, penetration, and cooler nozzles have each been satisfactorily evaluated for these waterhammer events. In addition, the Train "A" and Train "B" Supply lines, supports, penetration and cooler nozzles are acceptable based on a comparison to the Return lines.

For the Train "A" and Train "B" Supply and Return lines, the piping stresses meet the Wolf Creek acceptance criteria for an emergency condition. All pipe supports meet the design basis acceptance criteria for this loading condition.

6.0 REFERENCES

1. USNRC Bulletin No. 96-06, "Assurance of Equipment Operability & Containment Integrity During Design Basis Accident Conditions," September 19, 1996.

2. Updated Final Safety Analysis Report (UFSAR), Wolf Creek

3. Wolf Creek Drawings

A. Piping Isometrics

Train "B"

M-13GN02(Q) Rev.02 Containment Cooling System Reactor Building Train "B" (Supply and Return Lines)
M-13GN02 Rev.03 Containment Cooling System Reactor Building Train "B" (Supply and Return Lines)
M-23GN02 (Q) Rev.7 Containment Cooling System Reactor Building Train "B" (Supply and Return Lines)
M-15GN02 (Q) Rev. 5 Hanger Location Dwg. Containment Cooling System Reactor Building Train "B" (Supply and Return Lines)

Train "A"

M-15GN01 (Q) Rev.5 Hanger Location Dwg. Containment Cooling System Reactor Building Train "A" (Supply and Return Lines).

B. Hanger Drawings

Train "A' Supply Line

Tag. No.	Hanger No.	Drawing No.
C001		
H001		
R001		
C002	1-GN01-C002/231 (Q)	M-16GN01 Rev. 1
H002	0-GN01-H002/232 (Q)	M-06GN01 Rev. 1
C003	1-GN01-C003/232 (Q)	M-16GN01 Rev. 2
C004		
C016	1-GN01-C016/242 (Q)	M-16GN01 Rev. 5

Tag. No.	Hanger No.	Drawing No.
R002	0-GN01-R002/242 (Q)	M-06GN01 Rev. 0
R003	1-GN01-R003/252 (Q)	M-16GN01 Rev. 5
C009		
H004		
C010		
C011		
C012		
R007		
C013		
R008		
C014		

<u>Train "A' Return Line</u>

Tag No.	Hanger No.	Drawing No.
R011	1-GN01-R011/251 (Q)	M-16GN01 Rev. 5
R012	1-GN01-R012/251 (Q)	M-16GN01 Rev. 3
C015	1-GN01-C015/251 (Q)	M-16GN01 Rev. 3
R010	1-GN01-R010/252 (Q)	M-16GN01 Rev. 6
H005	1-GN01-H005/252 (Q)	M-16GN01 Rev. 4
C018	1-GN01-C018/252 (Q)	M-16GN01 Rev. 4
H007	1-GN01-H007/252 (Q)	M-16GN01 Rev. 3
R009	1-GN01-R009/252 (Q)	M-16GN01 Rev. 2
R014	1-GN01-R014/252 (Q)	M-16GN01 Rev. 5
H006	1-GN01-H006/252 (Q)	M-16GN01 Rev. 2
C019	1-GN01-C019/252 (Q)	M-16GN01 Rev. 5
R005	1-GN01-R005/252 (Q)	M-16GN01 Rev. 3
R004	1-GN01-R004/242 (Q)	M-16GN01 Rev. 5
C017	1-GN01-C017/242 (Q)	M-16GN01 Rev. 2
C008	1-GN01-C008/232 (Q)	M-16GN01 Rev. 6
C007	1-GN01-C007/232 (Q)	M-16GN01 Rev. 4
H003	1-GN01-H003/232 (Q)	M-16GN01 Rev. 2
C006	1-GN01-C006/231 (Q)	M-16GN01 Rev. 6
C005	1-GN01-C005/231 (Q)	M-16GN01 Rev. 2

Train "B" Supply Line

Tag No.	Hanger No.	Drawing No.
C024	1-GN02-C024/241 (Q)	M-16GN02 Rev. 4
R014	0-GN02-R014/251 (Q)	M-06GN02 Rev. 1
R012	0-GN02-R012/251 (Q)	M-06GN02 Rev. 1
R010	0-GN02-R010/241 (Q)	M-06GN02 Rev. 1
C027	0-GN02-C027/251 (Q)	M-06GN02 Rev. 1
C026	0-GN02-C026/251 (Q)	M-06GN02 Rev. 1
C022	0-GN02-C022/231 (Q)	M-06GN02 Rev. 1
C010	0-GN02-C010/241 (Q)	M-06GN02 Rev. 2
C002	1-GN02-C002/231 (Q)	M-16GN02 Rev. 2
R008	1-GN02-R008/242 (Q)	M-16GN02 Rev. 3
C006	1-GN02-C006/231 (Q)	M-16GN02 Rev. 3
C008	1-GN02-C008/232 (Q)	M-16GN02 Rev. 3
R006	0-GN02-R006/252 (Q)	M-06GN02 Rev. 1
R004	1-GN02-R004/242 (Q)	M-16GN02 Rev. 3
C020	0-GN02-C020/252 (Q)	M-06GN02 Rev. 1
C018	0-GN02-C018/252 (Q)	M-06GN02 Rev. 1
C014	0-GN02-C014/242 (Q)	M-06GN02 Rev. 1
C012	0-GN02-C012/242 (Q)	M-06GN02 Rev. 1
R002	0-GN02-R002/231 (Q)	M-06GN02 Rev. 2
C004	1-GN02-C004/231 (Q)	M-16GN02 Rev. 4
C016	1-GN02-C016/252 (Q)	M-16GN02 Rev. 2

Train "B" Return Line

Tag No.	Hanger No.	Drawing No.
C001	1-GN02-C001/231 (Q)	M-16GN02 Rev. 4
C003	1-GN02-C003/231 (Q)	M-16GN02 Rev. 5
R001	1-GN02-R001/231 (Q)	M-16GN02 Rev. 3
C005	1-GN02-C005/231 (Q)	M-16GN02 Rev. 3
C007	1-GN02-C007/232 (Q)	M-16GN02 Rev. 2
C009	0-GN02-C009/242 (Q)	M-06GN02 Rev. 4
C011	1-GN02-C011/242 (Q)	M-16GN02 Rev. 3
C013	1-GN02-C013/242 (Q)	M-16GN02 Rev. 6
R003	1-GN02-R003/242 (Q)	M-16GN02 Rev. 3
R005	1-GN02-R005/252 (Q)	M-16GN02 Rev. 2
H001	1-GN02-H001/252 (Q)	M-16GN02 Rev. 2
R007	1-GN02-R007/252 (Q)	M-16GN02 Rev. 4

Tag No.	Hanger No.	Drawing No.
C015	1-GN02-C015/252 (Q)	M-16GN02 Rev. 4
C017	1-GN02-C017/252 (Q)	M-16GN02 Rev. 3
C019	1-GN02-C019/231 (Q)	M-16GN02 Rev. 7
R009	1-GN02-R009/241 (Q)	M-16GN02 Rev. 2
C021	1-GN02-C021/241 (Q)	M-16GN02 Rev. 3
R015	1-GN02-R015/251 (Q)	M-16GN02 Rev. 2
C028	1-GN02-C028/251 (Q)	M-16GN02 Rev. 2
C025	1-GN02-C025/251 (Q)	M-16GN02 Rev. 2
R013	1-GN02-R013/251 (Q)	M-16GN02 Rev. 7

4. American Institute of Steel Construction, "Manual of Steel Construction," Eight Edition, 1980, AISC Chicago.

5. USNRC IN95-09: "Use of Inappropriate Guidelines & Criteria for Nuclear Piping and Support Evaluation & Design."

6. USNRC GL91-18, "Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded & Nonconforming Conditions and Operability."

7. ASME B&PVC Section III, Appendices. 1989.

8. ADLPIPE, "Static & Dynamic Pipe Stress Analysis," Version 4F7B, Research Engineers, Yorba Linda, CA.

9. ASME, Section III, Subsection NC, Div. 1, 1974 with Addendum through 1976.

10. WCNOC Station Procedure CN-3.01

11. Altran Corporation Calculation No. 94100-C-02, "Structural Dynamic Analysis of ESW System Waterhammer," Rev. 1, June 1995.

12. Altran Corporation Technical Report No. 96227-TR-01, "Containment Fan Cooler Response to a Simultaneous LOCA and LOOP Event," Rev. 2, February, 1997.

13. Altran Technical Report No. 96227-TR-02, "Structural Dynamic Analysis of Containment Cooling System Reactor Building Train "A", Rev 0, April, 1997.

14. Bechtel Calculations for Wolf Creek Nuclear Plant.

a.	Calc. No. GN01-3 Rev. 0	Hgr. 0-GN01-H002-232 (Q)	Train A Supply
b.	Calc. No. GN01-35 Rev. 4	Hgr. 0-GN01-C016/242 (Q)	Train A Supply
		Hgr. 0-GN01-C007/242 (Q)	
c.	Calc. No. GN01-1 Rev. 3	Hgr. 0-GN01-C003/232 (Q)	Train A Supply
		Hgr. 0-GN01-C006/231 (Q)	Train A Return
		Hgr. 0-GN01-H003/232 (Q)	Train A Return
		Hgr. 0-GN01-C007/232 (Q)	Train A Return
		Hgr. 0-GN01-C002/231 (Q)	Train A Supply
		Hgr. 0-GN01-H002/232 (Q)	Train A Supply
d.	Calc. No. GN01-12 Rev. 4	Hgr. 0-GN01-R003/252 (Q)	Train A Supply
		Hgr. 0-GN01-R005/252 (Q)	Train A Return
		Hgr. 0-GN01-R002/252 (Q)	Train A Supply
		Hgr. 0-GN01-R004/252 (Q)	Train A Return
e.	Calc No. GN01-2 Rev. 0	Hgr. 0-GN01-R002/242 (Q)	Train A Supply
f.	Calc No. GN01-14 Rev. 1	Hgr. 0-GN01-H005/252 (Q)	Train A Return
g.	Calc No. GN01-28 Rev. 4	Hgr. 0-GN01-R010/252 (Q)	Train A Return
h.	Calc No. GN01-27 Rev. 1	Hgr. 0-GN01-C015/251 (Q)	Train A Return
i.	Calc No. GN01-38 Rev. 1	Hgr. 0-GN01-R012/251 (Q)	Train A Return
j.	Calc No. GN01-32 Rev. 2	Hgr. 0-GN01-R011/251 (Q)	Train A Return
k.	Calc No. GN01-39 Rev. 1	Hgr. 0-GN01-H006/252 (Q)	Train A Return
l.	Calc No. GN01-40 Rev. 2	Hgr. 0-GN01-R014/252 (Q)	Train A Return
m.	Calc No. GN01-30 Rev. 1	Hgr. 0-GN01-R009/252 (Q)	Train A Return
n.	Calc No. GN01-22 Rev. 2	Hgr. 0-GN01-H007/252 (Q)	Train A Return
o.	Calc No. GN02-1 Rev. 2	Hgr. 0-GN02-C001/231 (Q)	Train B Return
p.	Calc No. GN02-3 Rev. 1	Hgr. 0-GN02-R001/231 (Q)	Train B Return
		Hgr. 0-GN02-R002/231 (Q)	Train B Supply
q.	Calc No. GN02-6 Rev. 3	Hgr. 0-GN02-R003/242 (Q)	Train B Return
r.	Calc No. GN02-8 Rev. 4	Hgr. 0-GN02-C005/231 (Q)	Train B Return
s.	Calc No. GN02-8-W Rev. 0	Hgr. 0-GN02-C005/231 (Q)	Train B Return
t.	Calc No. GN02-8-W-A Rev. 0	Hgr. 0-GN02-C005/231 (Q)	Train B Return
u.	Calc No. GN02-12 Rev. 1	Hgr. 0-GN02-C007/232 (Q)	Train B Return
v.	Calc No. GN02-12-W Rev. 4	Hgr. 0-GN02-C007/232 (Q)	Train B Return
w.	Calc No. P-GN02-14 Rev. 4	Hgr. 1-GN02-C015/252 (Q)	Train B Return
x.	Calc No. P-GN02-19 Rev. 5	Hgr. 1-GN02-R005/252 (Q)	Train B Return
y	Calc No. GN02-10 Rev. 3	Hgr. 0-GN02-C003/231 (Q)	Train B Return
z.	Calc No. GN02-10-W Rev. 0	Hgr. 0-GN02-C003/231 (Q)	Train B Return
aa.	Calc No. GN02-25 Rev. 1	Hgr. 0-GN02-R009/241 (Q)	Train B Return
		Hgr. 0-GN02-R010/241 (Q)	Train B Supply
ab.	Calc No. GN02-25-W Rev. 0	Hgr. 0-GN02-R009/241 (Q)	Train B Return
ac.	Calc No. GN02-27 Rev. 2	Hgr. 0-GN02-C019/231 (Q)	Train B Return

	Hgr. 0-GN02-C022/231 (Q)	Train B Supply
ad. Calc No. GN02-27W Rev.0	Hgr. 1-GN02-C019/231 (Q)	Train B Return
ae. Calc No. GN02-29 Rev. 2	Hgr. 0-GN02-H001/252 (Q)	Train B Return
af. Calc No. GN02-32 Rev. 3	Hgr. 0-GN02-C011/242 (Q)	Train B Return
	Hgr. 0-GN02-C012/242 (Q)	Train B Supply
ag. Calc No. GN02-34 Rev. 4	Hgr. 0-GN02-C013/242 (Q)	Train B Return
	Hgr. 0-GN02-C014/242 (Q)	Train B Supply
ah. Calc No. GN02-34-W Rev. 0	Hgr. 0-GN02-C013/242 (Q)	Train B Return
ai. Calc No. P-GN02-39 Rev. 5	Hgr. 1-GN02-C009/242 (Q)	Train B Return
aj. Calc No. GN02-41 Rev. 3	Hgr. 0-GN02-C021/241 (Q)	Train B Return
ak. Calc No. GN02-41-W Rev. 0	Hgr. 1-GN02-C021/241 (Q)	Train B Return
al. Calc No. P-GN02-43 Rev. 3	Hgr. 1-GN02-R007/252 (Q)	Train B Return
am. Calc No. GN02-45 Rev. 1	Hgr. 0-GN02-R015/251 (Q)	Train B Return
an. Calc No. GN02-45-W Rev. 0	Hgr. 0-GN02-R015/251 (Q)	Train B Return
ao. Calc No. GN02-45-W-A Rev.0	Hgr. 0-GN02-R015/251 (Q)	Train B Return

15. Wolf Creek Nuclear Operating Corporation, Piping Class Summary, MS-01, Rev. 40, plus Design Document Change Notice dated 2/3/97.

16. Wolf Creek Nuclear Operating Corporation, Piping Class Sheets, MS-02, Rev. 42 plus Plant Modification Package Change Notice, PMP No. M-753-W-MS-02-40_01.

17. "Design of Welded Structures," by Omer W. Blodgett, The James F. Lincoln Arc Welding Foundation, 1982.

18. Bergen-Paterson Pipe Support Corp., Catelog No. 77NFR1 for Nuclear Service ASME Section III Subsection NF.

19. Grinnell Corporation DRS/LCD Package Rev. 15.

20. ALTRALUG, "A Program for the Design and Analysis of Welded Piping Attachments," Altran Document No. 92117-UM-02, Version 1, Users Manual, May 1992.

21. ASME Section III, Division 1, Nuclear Code Case N-318-3, "Procedures for Evaluation of the Design of Rectangular Cross Section Attachments on Class 2 or 3 Piping," Approval Date: September 5, 1985.

22. R.C. Rodabaugh, "Review of ASME Code Cases N-122 and N-318-Lugs on Straight Pipe," for PVRC Design Division Committee on Piping, Pumps and Valves, August 1990 Draft.

23. AISC, "Manual of Steel Construction," Seventh Edition, 1970.

24. PD STRUDL Version 0496.

Load Condition	Load Combination	Stress Allowable	ASME Section III
Normal	Dwt + P	1.0Sh	EQ 8
Emergency	Dwt + P + WH	1.8Sh	EQ 9
Thermal	Thermal or THERM ACCD	Sa	EQ 10
Thermal + Normal	Dwt + P + (Thermal or THERM ACCD)	Sa +1.0Sh	EQ.11

Table 1 - Piping Load Combinations/Acceptance Criteria

Where: Dwt = Pipe selfweight
P = Pressure
THERM ACCD = Thermal Accident from LOCA
Sa = f (1.25Sc + 0.25Sh)
WH = LOOP/LOCA waterhammer (Column Closure or Condensation Induced)
Thermal = Thermal Normal

Load Condition	Load Combination	Stress Allowable	Stress Criteria
Faulted	Dwt+WH+THERM ACCD	1.33S	S is AISC Code allowable

Table 2
Pipe Support Load Combination/Design Basis Acceptance Criteria

Load Condition	Load Combination	Stress Allowable	Code Reference
Faulted	Dwt+WH+THERM ACCD	App F limits	ASME Sect. III

Table 3
Pipe Support Load Combination/Operability Acceptance Criteria

	Load Condition	Load Combination	Data Point	Calc. Stress (psi)	Stress Criteria	Allow Stress (psi)	Int. Ratio
Train "A" Return Line	Normal	Dwt + P	1000	6,953	1.0Sh	15,000	0.47
	Emergency	Dwt + P + WH	1000	26,988	1.8 Sh	27,000	1.00
	Thermal	THERM ACCD	2690	23,162	Sa	22,500	1.03
	Thermal + Normal	THERM ACCD + Dwt. + P	2690	25,248	Sa + 1.0 Sh	37,500	0.67
Train "B" Return Line	Normal	Dwt + P	215	6,717	1.0 Sh	15,000	0.45
	Emergency	Dwt +P+WH	110	24,584	1.8 Sh	27,000	0.91
	Thermal	THERM ACCD	75	12,095	Sa	22,500	0.54

Table 4
Pipe Stress Summary

	Penetration No.	Dwt Stress (psi)	Pressure Stress (psi)	WH Stress (psi)	THERM ACCD Stress (psi)	Stress Summation (psi)	Allow Stress (psi)	Int. Ratio
Train "A" Return Line	P-73 (N.P. 1000)	5,352	1,602	20,035	6,515	33,504	45,000	0.75
Train "B" Return Line	P-29 (N.P. 5)	2,180	1,598	10,379	1,691	15,848	45,000	0.35

Table 5
Containment Penetration Stress Summary

Table 6.0 Train "A" Return Line Pipe Support Function

Pipe Support Hanger No.	Node Point (NP)	Pipe Support Function R= Rigid
C005	1200	RX and RY
C006	1340	RX and RY
H003	1380	RY
C007	1420	RX and RY
C008	1455	Lateral Rigid
C008	1460	RY
C017 (1)	1540	RX, RY, RZ
R004	1570	RX and RZ
R005	1630	RX and RZ
C019	1710	RY
C019	1715	Lateral Snubber
C018	1775	RY
C018	1780	Lateral Snubber
H005	1900	RY
R010	1980	RX
R010	1985	Z Snubber
C015	2040	RX and RY
R012	2070	X Snubber and Y Snubber
R011	2110	Z Snubber
H006	2570	RY
R014	2610	RX
R014	2615	Z Snubber
R009	2720	RX
H007	2740	RY

NOTE: (1) Integral Welded Attachment (IWA)

Table 7.0 Train "B" Return Line Pipe Support Function

Pipe Support Hanger No.	Node Point (NP)	Pipe Support Function R = Rigid
C001	40	RX and RY
C003	57	RX and RY
R001	65	RZ (inactive)
C005	85	RX and RY
C007	100	RX and RY
C009 (1)	117	RX, RY, RZ
C011	140	RY, Lateral
C013	160	RY, Lateral
R003	172	Lateral
R005	187	RX and RZ
H001	215	RY
R007 (1)	217	X Snubber
C015	223	RY and RZ
C017	240	RY and RZ
C019	320	RY and RZ
R009	335	RZ
C021 (1)	347	RX, RY, RZ
R015	390	RX
C028	399	RY and RZ
C025	407	RY and RZ
R013 (1)	409	X Snubber

NOTE: ('ntegral Welded Attachment (IWA)

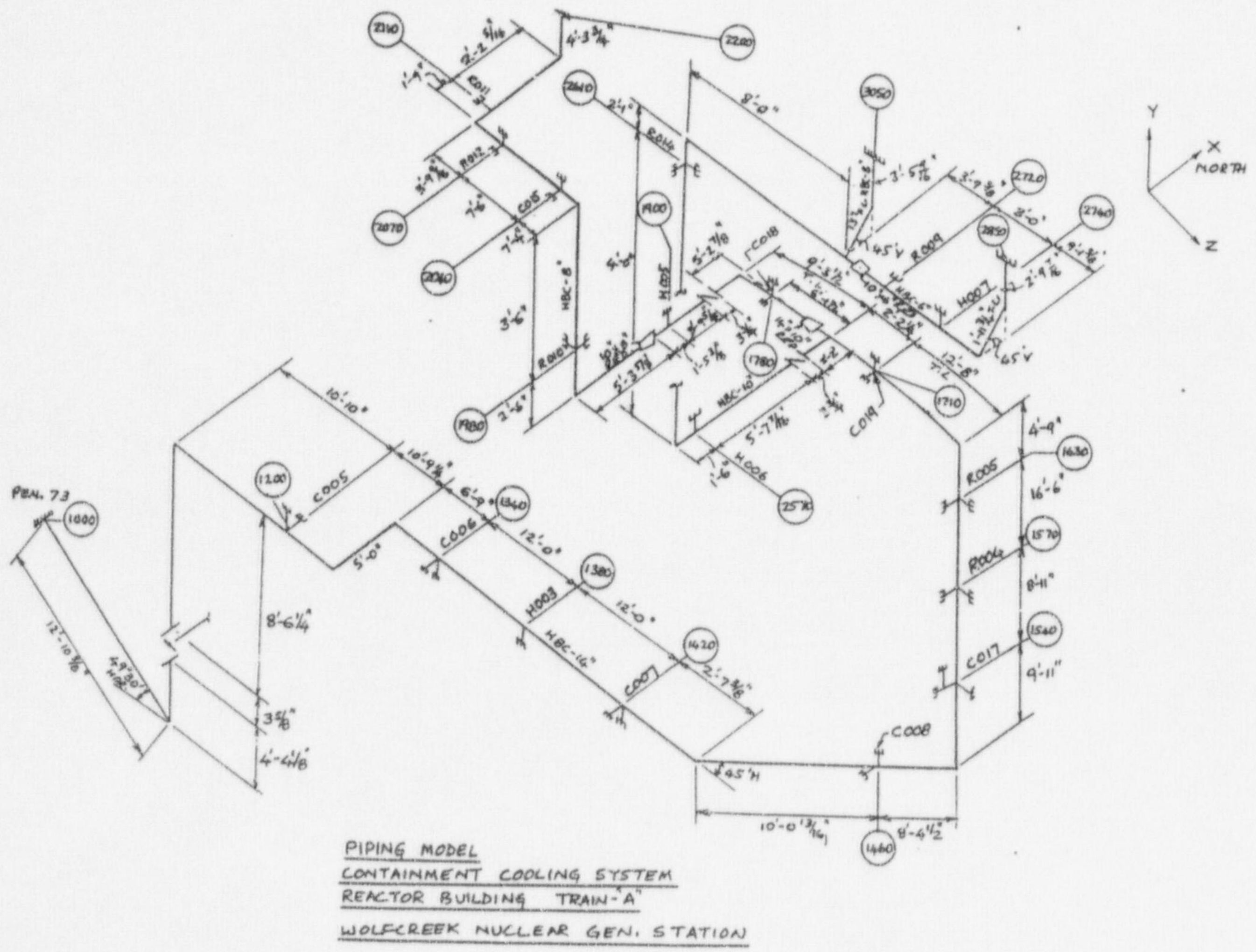

Figure 1
Stress Isometric Train "A' Return Line

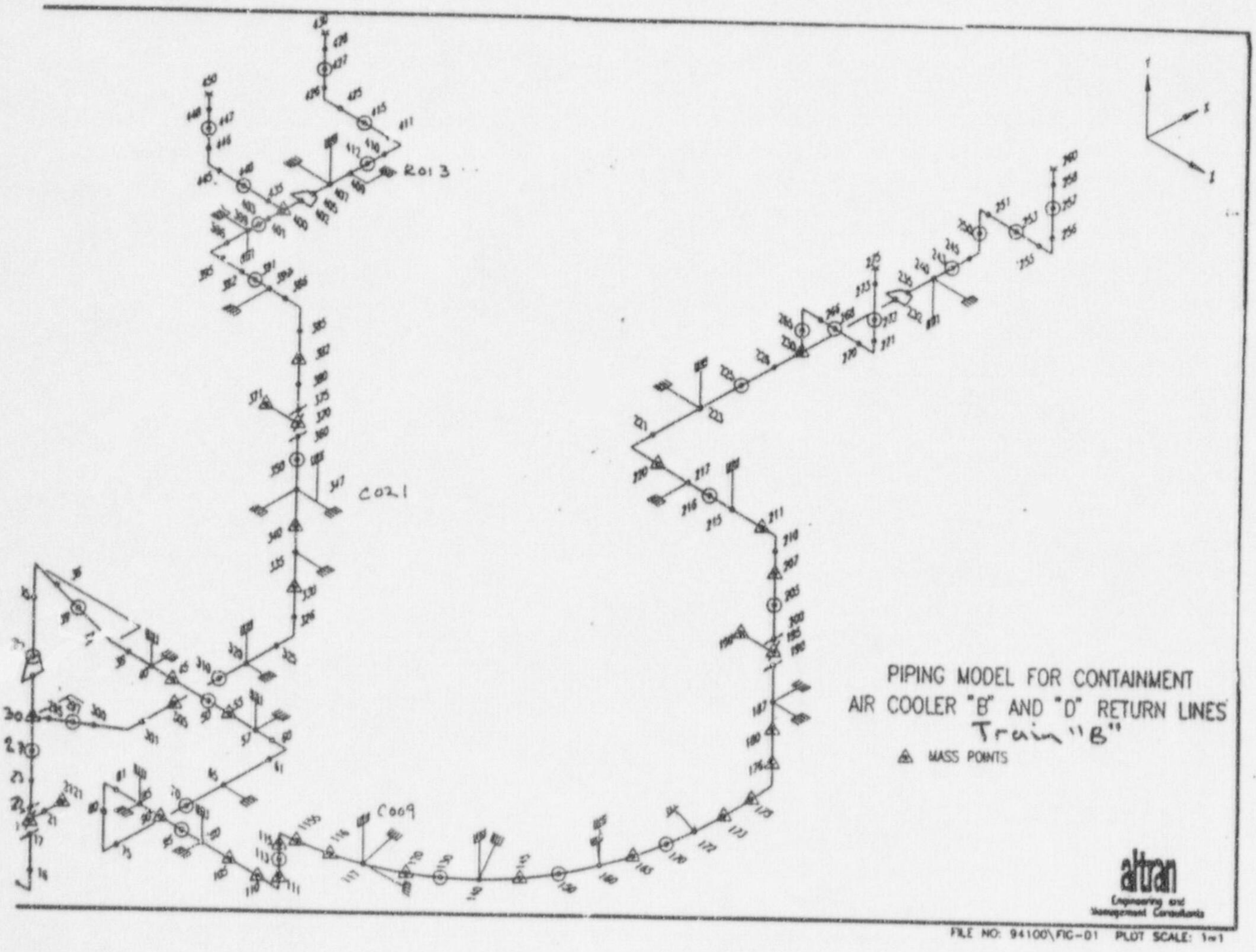

Figure 2
Stress Isometric Train "B" Return Line

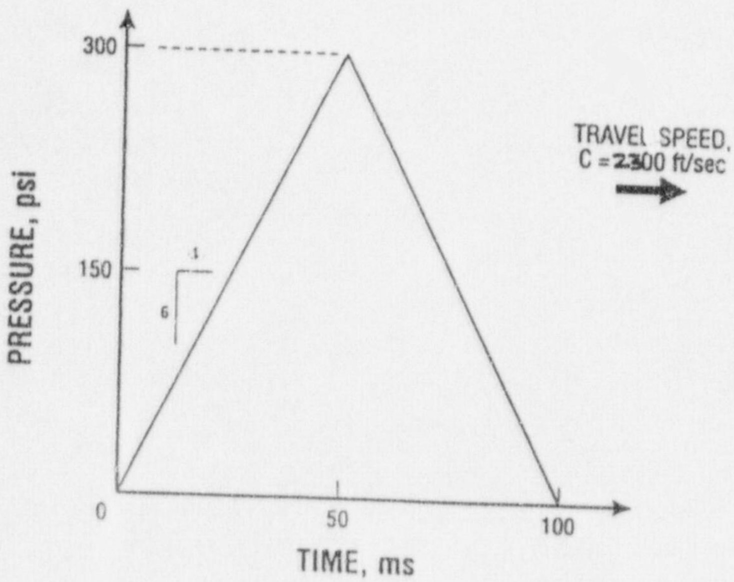

Figure 3
Waterhammer Pressure Pulse

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