ENCLOSURE

CALCULATION WCG-1-969
QUALIFICATION OF WORST CASES OF THERMALLY RESTRAINED STRUCTURES - PACKAGE I

QA Record DNE CALCULATIONS T.R 2PR

Sheet 1 of 230

TVA 10697 (DNE-6-86)

TITLE : Qualification of Worst Cases of Thermally Restrained Structures - Package I

Plant/Unit
WBNP / UNIT 1

PREPARING ORGANIZATION
NE, Ebasco Services Inc.

KEY NOUNS (Consult RIMS DESCRIPTORS LIST)
CEB, CALC, THERMAL, RESTRAINT, SELECTION, MISC STEEL, STRUCTURAL

BRANCH/PROJECT IDENTIFIERS
WCG-1-969

Each time these calculations are issued, preparers must ensure that the original (RO) RIMS accession number is filled in.

Rev	(for RIMS' use)	RIMS accession number
R0		B18 910907 255
R		
R		
R		

APPLICABLE DESIGN DOCUMENT(S)
WB-DC-20-21

SAR SECTION(S)
NA SAL 8-29-91

UNID SYSTEM(S)
NA SAL 8-29-91

Revision 0	R1	R2	R3
ECN NO. (or indicate Not Applicable) DCN M-16250-A			
Prepared: S. Alan Lin			
Checked/Verified: C.Y. Ou Chaoyung Ou			
Reviewed: H. Totunquey			
Approved:			
Date 9/5/91			
USE FORM TVA 10534 IF MORE SPACE REQUIRED — List all pages added by this revision			
List all pages deleted by this revision			
List all pages changed by this revision			

Safety-related? Yes [X] No [ ]

Statement of Problem.

Perform evaluation for the worst cases of thermally restrained structures for Category I structural steel and Miscellaneous steel population.

ORIGINAL

Abstract: These calculations contain an unverified assumption(s) that must be verified later. Yes [ ] No [X]

Five (5) of the fifteen (15) worst cases of the thermally restrained structures identified in Calculation WCG-1-790 R0 are evaluated and qualified in this calculation. RO SAL 8/29/91

LEGIBILITY EVALUATED and ACCEPTED for issue.

9/5/91
Signature Date

[ ] Microfilm and store calculations in RIMS Service Center
[X] Microfilm and return calculations to: Calculations Library

Microfilm and destroy. [ ]
Address: WBN N QA BLDG.

cc: RIMS, SL 26 C-K D. Kilgore WBN Trailer No. E-22

7224x

Branch/Project ID: WCG-1-969 Sheet 2 of 230

TVA

TITLE: Qualification of Worst Cases of Thermally Restrained Struc. - Package I
PREP. BY: SAL DATE: 8/20/91
CHECKED BY: J. OU DATE: 8/20/91

REVISION LOG

Revision No.	DESCRIPTION OF REVISION	Date Approved
0	Original Issue	9/5/91

TVA 10534 (EN DES-4-78)

CALCULATION DESIGN VERIFICATION (INDEPENDENT REVIEW) FORM

WCG-1-969 — BRANCH/PROJECT ID:/Calculation No.

0 — Revision

Method of design verification (independent review) used (check method used):

1. Design Review X
2. Alternate Calculation NR
3. Qualification Test NR

Justification (explain below):

Method 1: In the design review method, justify the technical adequacy of the calculation and explain how the adequacy was verified (calculation is similar to another, based on accepted handbook methods, appropriate sensitivity studies included for confidence, etc.).

Method 2: In the alternate calculation method, identify the pages where the alternate calculation has been included in the calculation package and explain why this method is adequate.

Method 3: In the qualification test method, identify the QA documented source(s) where testing adequately demonstrates the adequacy of this calculation and explain.

DESIGN REVIEW IS APPLICABLE TO THIS CALCULATION, SINCE IT IS BASED ON STANDARD ENGINEERING HANDBOOK METHODS.

8/29/91

C.Y. OU / Chaoyung Ou — Design Verifier (Independent Reviewer)

8/30/91 — Date

EBASCO SERVICES INCORPORATED

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BRANCH/PROJECT ID: WCG-1-969

BY: SAL DATE: 8/20/91 DEPT NO.: NR

CHECKED BY: J. OU DATE: 8/22/91 OFS NO.: NR

CLIENT: TVA

PROJECT: WBNP/UNIT - 1

SUBJECT: Qualif. of Worst Cases of Thermally Restrained Structures - Package I

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5. PURPOSE:

The purpose of this calculation is to qualify five (5) worst cases of the thermally restrained structures of category I structural and miscellaneous steel population.

6. APPLICABLE CRITERIA (MARKED "X")

x 1. DS-C1.7.1 R5 General Anchorage To Concrete
NR 2. DS-C1.7.3 R0 Application of Baseplate II
NR 3. DS-C1.8.1 R3 Standard Calculation for Evaluation Type II Embedded Plates
NR 4. WB-DC-20-1 R6 Concrete Structures-General
NR 5. WB-DC-20-2 R6 Reactor Building Concrete Structures
x 6. WB-DC-20-21 R6 Miscellaneous Steel Component for Category I Structures (per DCN's S-14373-A and S-16078-A)
x 7. DG-C1.6.12 R1 Evaluation of Steel Structures with Thermal Restraint.
x 8. WB-DC-20-24 R5 Dynamic Earthquake Analysis of Category I Structures and Earth Embankments
NR 9. WB-DC-40-31.53 R4 Design Criteria for Pipe Whip Restraints, Jet Deflectors and Sleeves
NR 10. (Specified)

7. APPLICABLE CODES AND STANDARDS (MARKED "X"):

x 1. AISC Manual of Steel Construction, 7th Edition
NR 2. AWS D.1.1-83, 1983, Structural Welding Code.
NR 3. ACI 318-77 Building Code Requirements for Reinforced Concrete
NR 4. (specified)

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8. ASSUMPTIONS, LITERATURE SEARCHES AND OTHER APPLICABLE BACKGROUND DATA

None

9. APPLICABLE REFERENCES (MARKED "X")

x	1.	Design of Welded Structures by O. W. Blodgett 1966
NR	2.	Formulas for Stress and Strain by R. J. Roark & W.C. Young, th Edition
NR	3.	WCG-1-580 R Selection and Grouping of Embedded Plates for Evaluation
NR	4.	WCG-1-256 R0 Concrete Quality Evaluation
NR	5.	N3-PA-34 R0 Non-linear Transient Dynamic Analysis of FW Lines-Piping Analysis Calculation No. N3-PA-34
NR	6.	QIR-CEB-WBN 90757 R0 Active List of Pipe Whip Restraints/Protective Devices (PD's)
x	7.	QIR-CEB-WBN-39-361 R0 Auxiliary Control and Reactor Buildings Acceleration & Response Spectra
NR	8.	WCG-1-370 R0 Generation of OBE 4% Damping ARS for Unit 1 ICS, SCV and SB
NR	9.	WCG-1-377 R0 Auxiliary Control Building 4% Damping Curves and Seismic Forces
x	11.	QIR-EBA-WBN-31-435 R0 Pipe Rupture Loads on Non-Primary Safety Function Structures
x	12.	WCG-1-684 R1 Design Instruction for Structural Adequacy Evaluation of Steel Platforms
x	13.	WCG-1-686 R Selection of Misc. and Structural Steel with Thermal Restraint
x	14.	WCG-1-790 R Worst Case Selection of Thermally Restrained Structures
x	15.	CSG-91-003 R0 Concrete Anchorage Stiffness for Thermal Evaluation
x	16.	WCG-2-50 R1, Vol. 6 Pressurizer Enclosure Platform @ EL. 783'-8 1/2"
x	17.	WCG-1-825 R2, Field Walkdown Data for the Platform @ EL. 783' of the Reactor Building
x	18.	WCG-1-830 R1, Walkdown of Elevation 713'-0" Platform on Drawing 48N1210-16
x	19.	WCG-1-964 R0, Evaluation of Embedded Plates for Plateforms
x	20.	WCG-1-1047 R0, Study of the Effect of Repeated Load and Load Sequence for Thermal Evaluation

x 21. Steel Structures, Design and Behavior, Second Edition, by Salmon and Johnson
x 22. Drawing 48N968 R22
x 23. Drawing 48N1210-16 R8
x 24. Drawing 48N967-1 R0
x 25. ANSYS Revision 4.3A
NR 26. (specified)

10. APPLICABLE DESIGN INPUT DATA:

See section 11.2

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11.0 CALCULATION

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11.1 Scope

A total of fifteen (15) worst cases of the thermally restrained structures of Category I structural and miscellaneous steel population were identified in Calculation WCG-1-790 (Reference 9.14: Worst Case Selection of the Thermally Restrained Structures). Five (5) of the worst cases are evaluated in this package.

Four (4) ANSYS models, as summarized in Table 11.1.1, are constructed for detailed evaluation. Geometric Configurations for these worst cases, as well as members included in each model, are presented in Figures 11.1.2 through 11.1.5.

Table 11.1.1 Summary of Models for Worst Cases in this Calculation

Model ID	Worst Case ID*	Restraint Type **	Location	Drawing No.	Elevation	Accident Temp. (°F)
PR9C	1-27 2&3-9(C)	Axial Proximity	Reactor Bldg.	48N968	783'-8 1/2"	327°
AX11	1-11	Axial	Aux. Bldg.	48N1210-16	713'-0"	210°
PR8G	2&3-8(G)	Proximity	Reactor Bldg.	48N967-1	774'-0"	327°
HD07	5-7	Header	Aux. Bldg.	48N1210-16	713'-0"	210°

* Worst Case ID as defined in Calculation WCG-1-790 (Worst Case Selection of Thermally Restrained Structures).

** See Figure 11.1.1 for Typical Thermal Restraint; For more detail, see Calculation WCG-1-686 and WCG-1-790.

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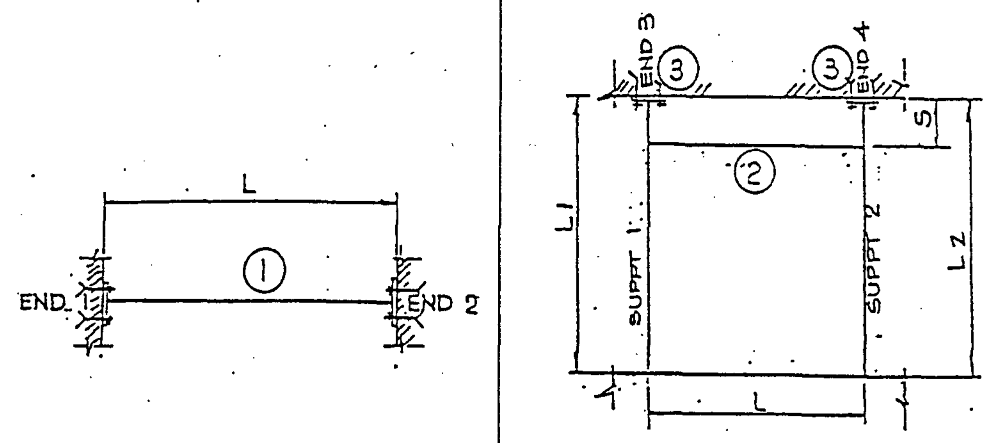
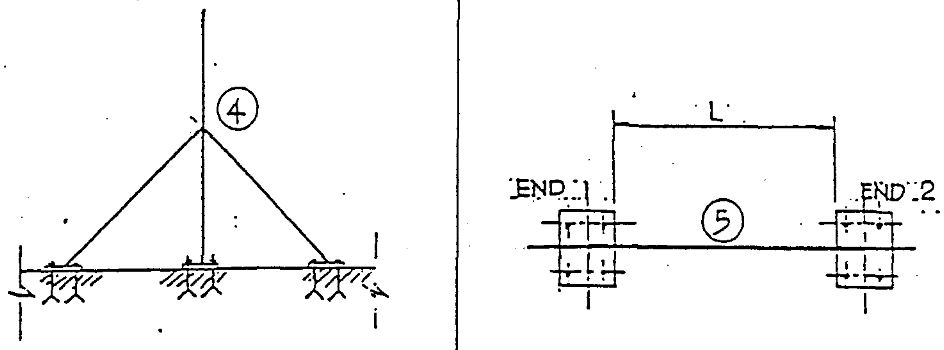
Figure 11.1.1 Typical Thermal Restraint



Case 1
Axial Restraint

Case 2&3
Proximity Restraint



Case 4
Braced Restraint

Case 5
Header Restraint

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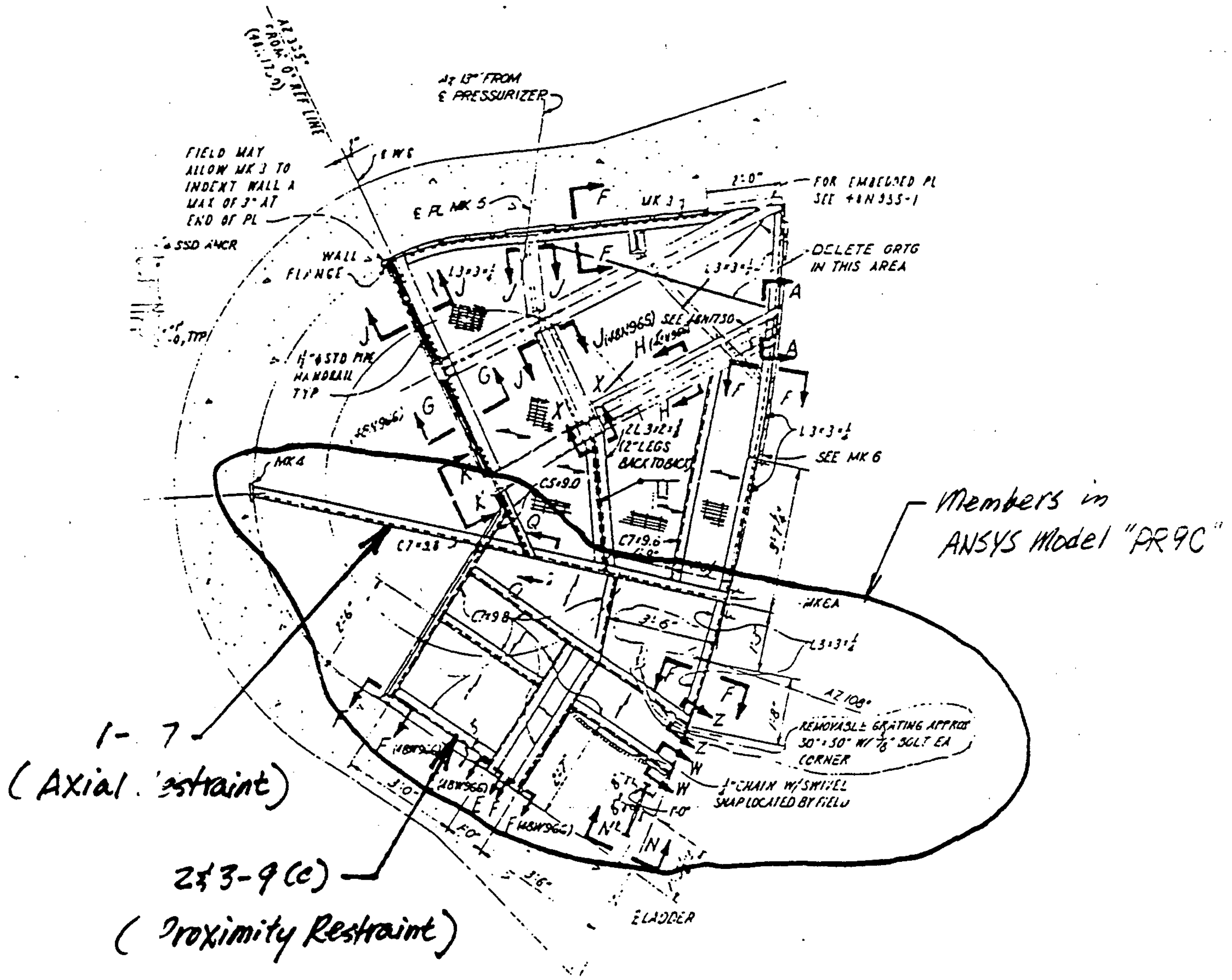
Figure 11. .2 Worst Cases 1-27 and 2&3-9(C)

(Reference: WCG-1-790)



PLAN - EL 783'-8½"
T/S 1½" BELOW EL 783'-8½" EXCEPT AS NOTED
UNIT 1 ONLY

(DWG 48N968)

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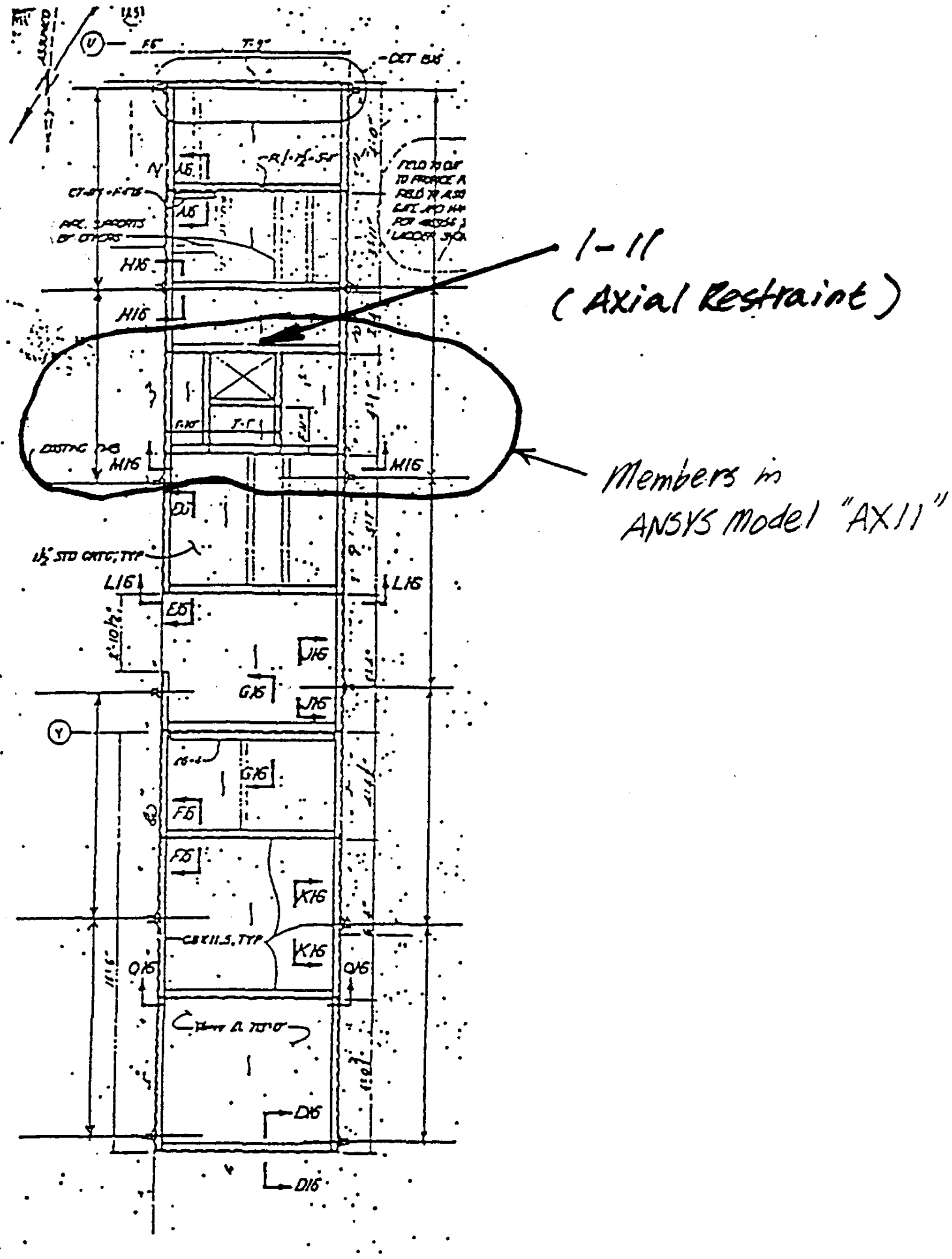
Figure 11.1.3 Worst Case 1-11

(Reference: WCG-1-790)



1-11 (Axial Restraint)

Members in ANSYS Model "AX11"

PLAN PLATFORM-EL 713'0"
UNIT 1 ONLY
¾"=1'0"

(DWG 48N1210-16)

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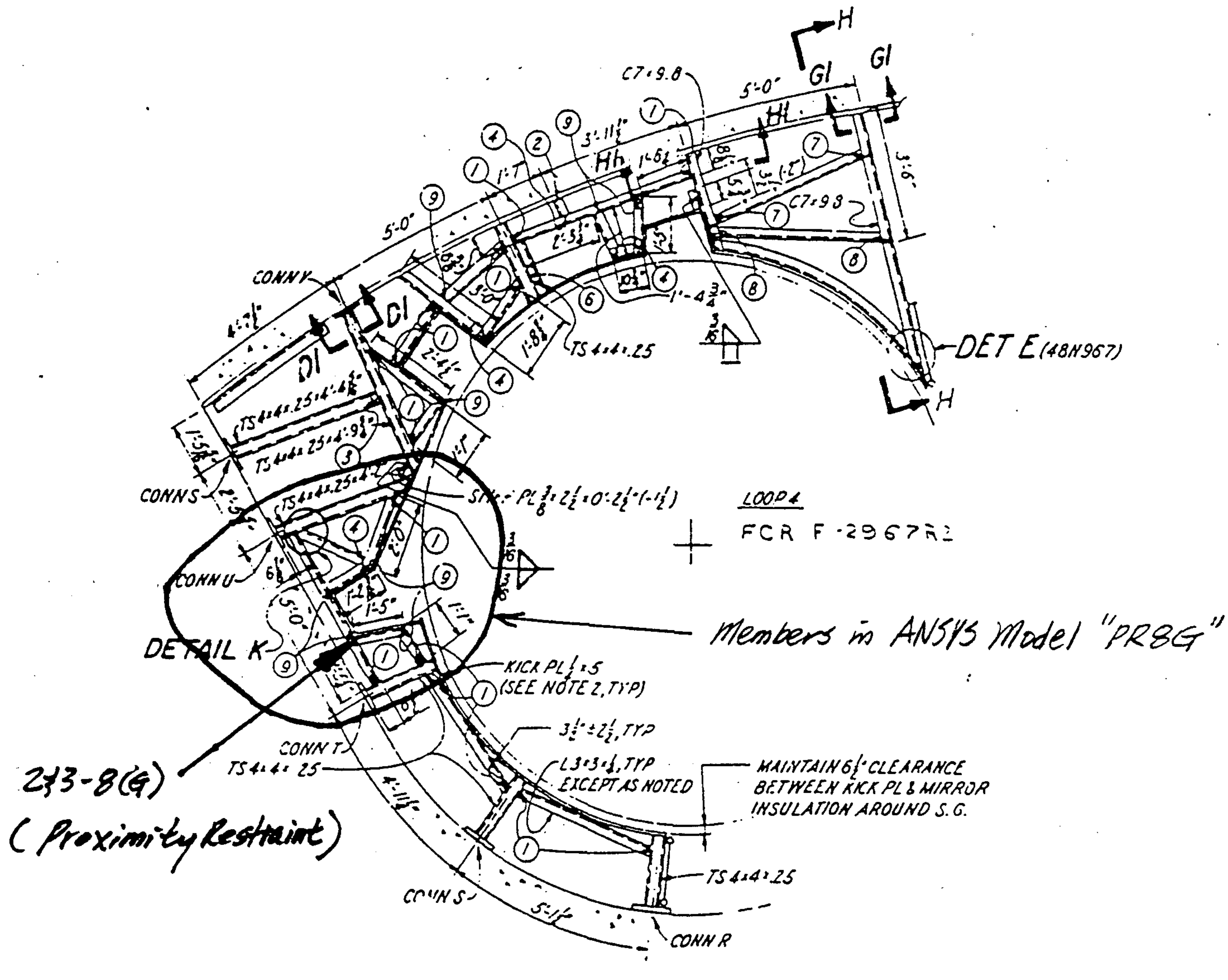
Figure 11.1.4 Worst Case 2&3-8(G)

(Reference: WCG-1-790)



(DWG 48N967-1)

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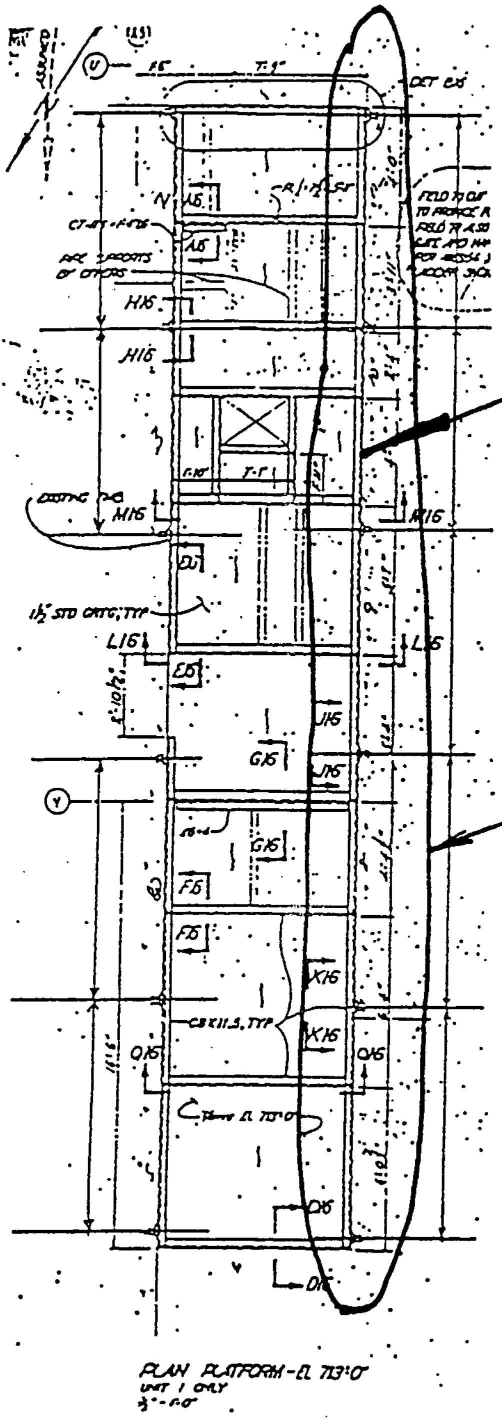
Figure 11.1.5 Worst Case 5-7

(Reference: WCG-1-790)



5-7 (Header Restraint)

Members in ANSYS Model "HD07"

(DWG 48N1210-16)

11.2 Methodology

Each worst case is evaluated and qualified per Design Criteria WB-DC-20-21, R6 (Miscellaneous Steel component for Category I Structures) and Design Guide DG-C1.6.12 R1 (Evaluation of Steel Structures with Thermal Restraint). The rigorous nonlinear analysis method using the ANSYS computer program is adopted in this evaluation.

Mathematical Model

A total of four (4) mathematical models (PR9C, AX11, PR8G and HD07) are constructed to represent five (5) worst cases (See Table 11.1.1). The models include worst case members and their adjacent members so that the combination of the thermal load and other applicable loads can be properly addressed. Five types of ANSYS elements are used to generate the models wherever applicable:

(1) STIF24 - Three dimensional thin-wall plastic beam element; This is a uniaxial element of arbitrary cross-section (open or closed) with tension-compression, bending and ST. Venant torsional capability. The element has plastic capability in the axial direction as well as a user-defined cross-section. This element is used to simulate the members which are loaded beyond yield.

(2) STIF4 - Three dimensional beam element; This element is also a uniaxial element with tension, compression, torsion, and bending capabilities. This element is used to simulate members which are in the linear elastic range.

(3) STIF14 - Three dimensional spring-damper element; This element has longitudinal

(3) STIF14 - Three dimensional spring-damper element; This element has longitudinal or torsional capability in one, two or three dimensional applications. This element is used to represent the shear stiffness of anchor bolts or rotational stiffness of the baseplate.

(4) STIF40 - Combination element; This element is a combination of a spring-slider and damper in parallel, coupled to a gap in series. Similar to the use of STIF14, this element is to simulate the nonlinear shear stiffness of anchor bolts and gaps. A bilinear curve of the stiffness can be used and the (1/32") free travel (A8.7, WB-DC-20-21 R6 and C8.0 of DG-C1.6.12 R1) can be modeled utilizing the Gap capacity of this element.

(5) STIF21 - Generalized mass element; This is a point element having up to six degrees of freedom. This element is used to represent an attachment weight on the member.

With the STIF24 element, the cross-section of members is represented by rectangular segments defined by segment points. The cross-sections of W-shape, Channels, Structural Tubing and Angles are presented in Figures 11.2.1 through 11.2.4, respectively. The stresses and strains, including elastic and plastic strains, at each segment points on the cross-section are calculated in the nonlinear analysis.

The temperature-dependent bilinear stress-strain property for the steel is used in the nonlinear analysis, as shown in Figure 11.2.5. The Modulus of Elasticity (E) decreases as temperature increases. Figure 4 (Variation in Modulus of Elasticity) in DG-C1.6.12, Section 4.2, is used to obtain E_{70}, E_{100}, E_{200}, E_{300} and E_{400} (E at 70°F, 100°F, 200°F, 300°F and 400°F respectively) as ANSYS input. 29,000 ksi is used for E_{70}. 150 ksi is used as the Tangent Modulus (Et), which is obtained from Figure 2.1.1 of "Steel Structures, Design and Behavior", Second Edition, by Salmon and Johnson. Temperature-dependent Coefficients of Thermal Expansion are also considered in the

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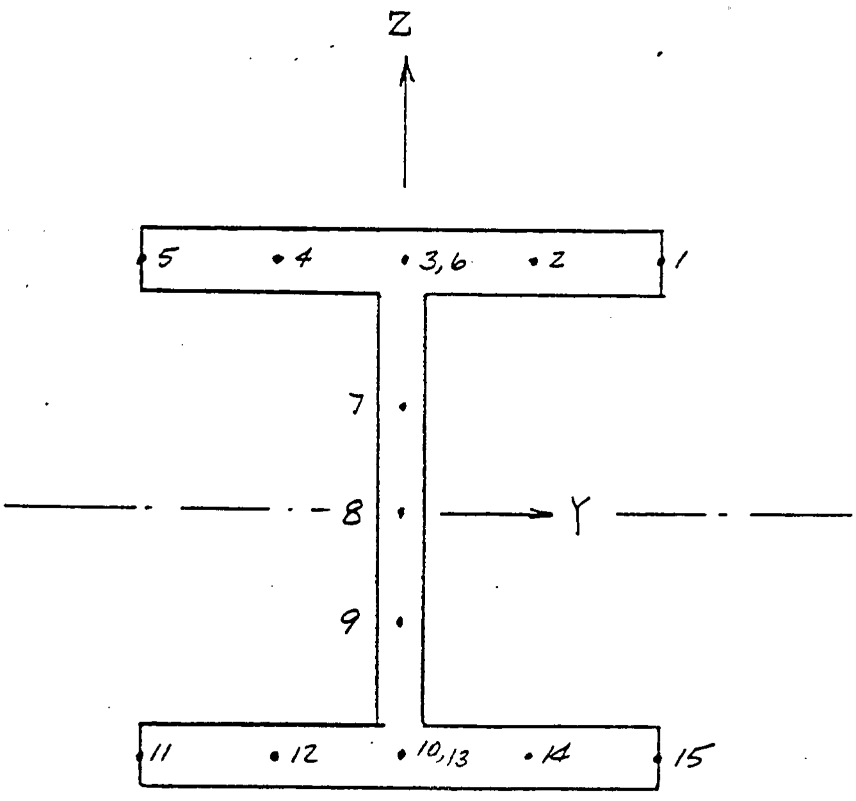

Figure 11.2.1 Segment Point Definition for Cross-section of W-Shape

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Figure 11.2.2 Segment Point Definition for Cross-section of Channel

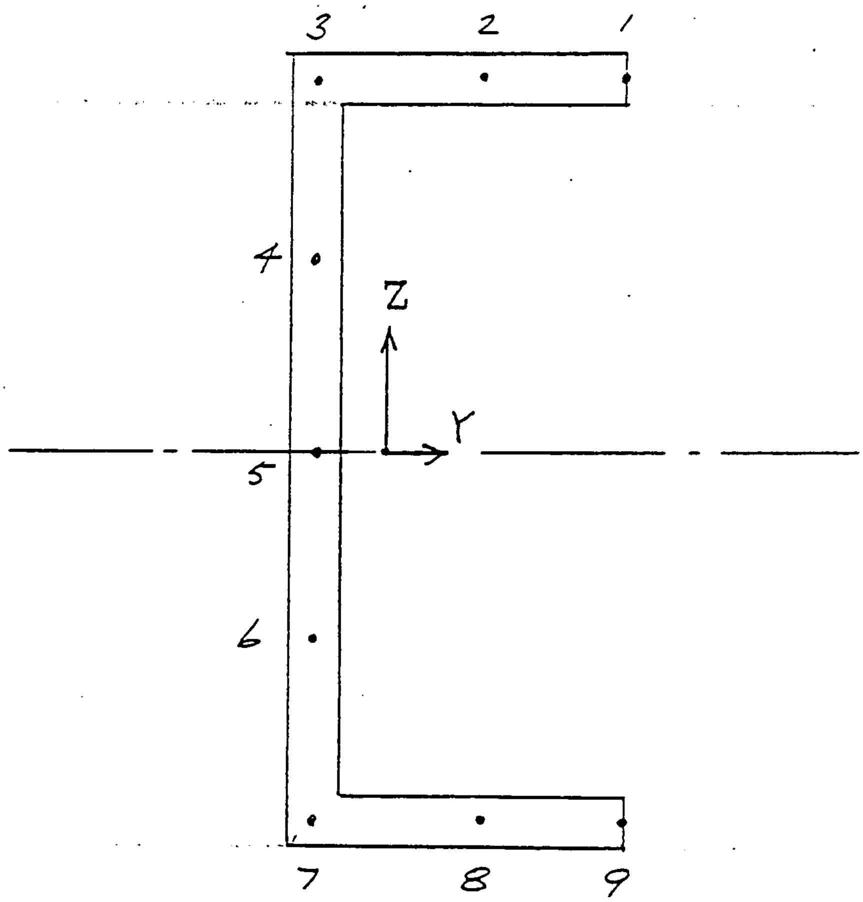

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Figure 11.2.3 Segment Point Definition for Cross-section of Structural Tubing

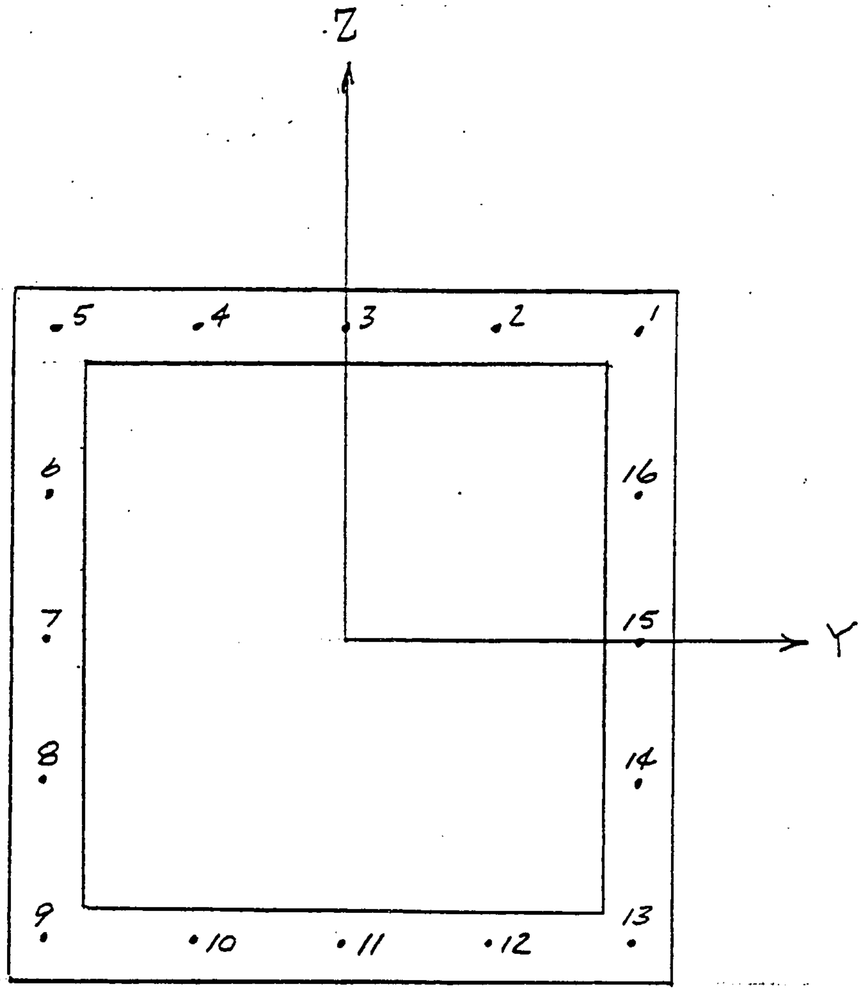

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Figure 11.2.4 Segment Point Definition for Cross-section of Angle

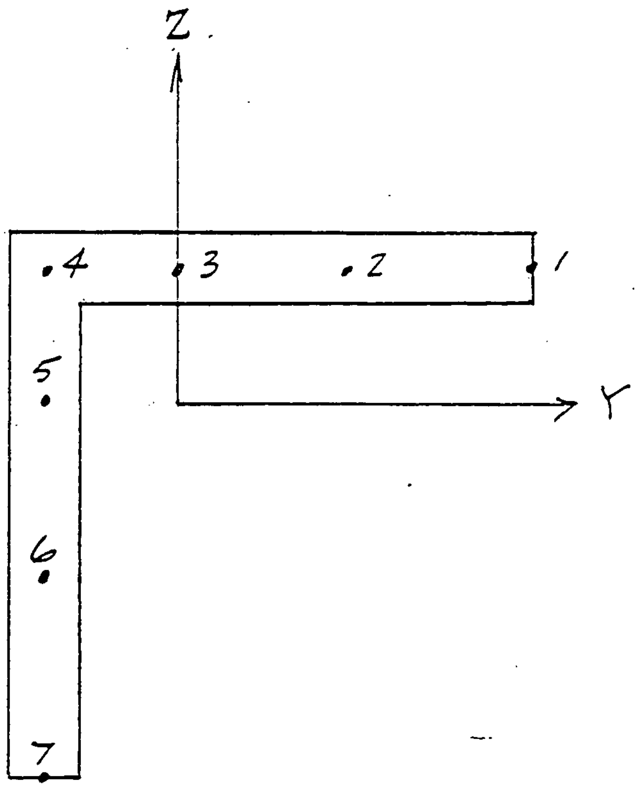
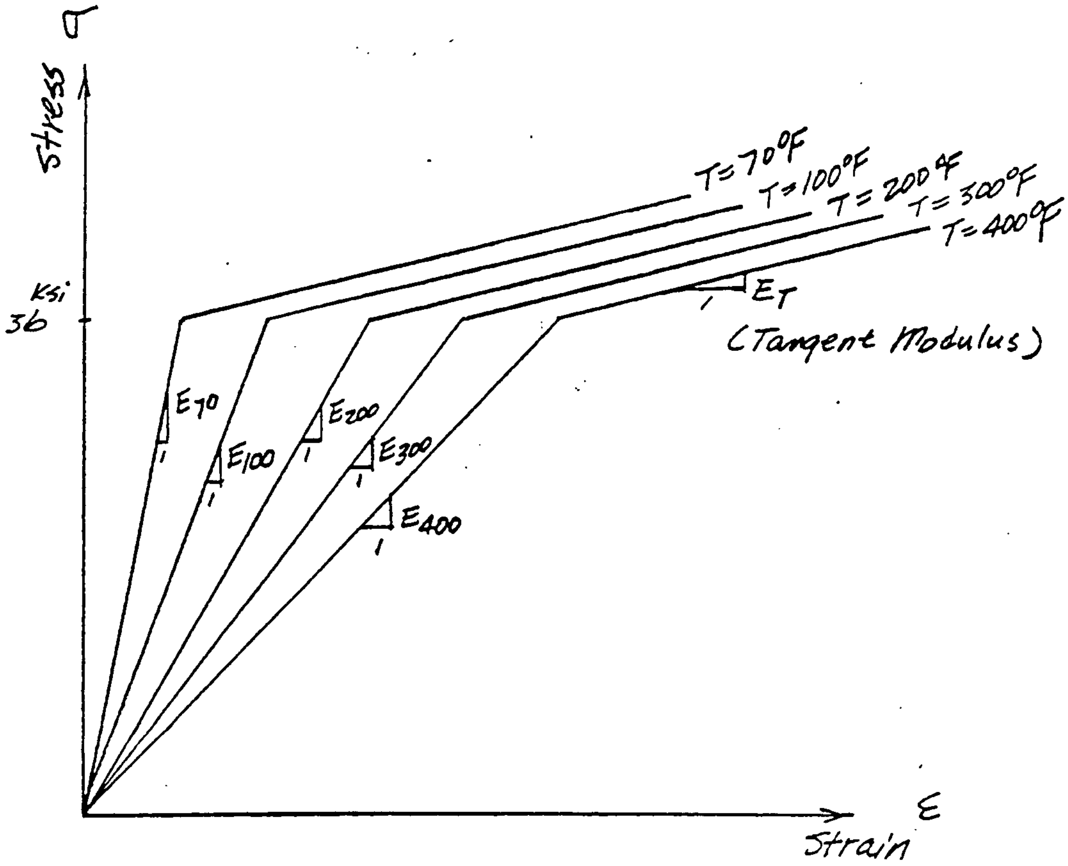


Figure 11.2.5 Temperature-Dependent Material Properties



nonlinear analysis. The formula provided in Section 4.3 of the DG-C1.6.12 is used to calculate the Coefficients of Thermal Expansion at 70°F, 100°F, 200°F, 300°F and 400°F respectively as ANSYS input. 6.5×10^{-6} in/in-°F is used for 70°F. The minimum yield strength, 36 ksi, for the ASTM A36 steel is considered in the analysis.

The ANSYS large-deflection solution method is used in the nonlinear analysis so that the stiffness matrix characterizes the deformed structure in the iterative solution process.

Boundary Condition

ANSYS Spring Elements STIF14 or STIF40 are used to model the shear stiffness of concrete anchors. The shear stiffness of anchors are obtained from Calculation CSG-91-003, which provides bilinear curves for various type and size of concrete anchors from TVA test data. Alternatively, 1000 kip/in per bolt is conservatively used as shear stiffness per DS-C1.7.1. STIF14 and STIF40 are also used as rotational spring to model the stiffness of the baseplate. The rotation stiffness of baseplate is obtained by making a computer run using BASEPLATE II program. The rotational stiffness is the moment required to create a unit rotation of the baseplate. Wherever applicable, an one thirty-second inch (1/32") is imposed at supports for the free travel per Section C8.0 of DG-C1.6.12.

Loading Condition

The loading combinations for misc. steel components for Category I structures are defined in Sections 3.2 and A4.3 of WB-DC-20-21. For the Operating Temperature conditions, To can be assumed to zero in the loading combinations (1a) through (5a) if To is less than 120°F per A8.1.2 of WB-DC-20-21. No evaluations are required for the worst cases in this package since the To's are less than 120°F for all five cases.

For Accident Temperature conditions, the most critical loading combination (8) is considered in the evaluation of the worst cases of thermally restrained structures. Dead Loads (D) and Live Loads (L) are considered per Sections 3.1.1 and 3.1.2 of WB-DC-20-21. Equivalent densities for all members are calculated to include effects of the dead load and live loads. The Equivalent Static approach is used to address the SSE loads (E') by applying Accelerations (G loads) to the structures (using the ANSYS ACEL command). In general, the peak G of the Acceleration Response Spectrum with the MMF (Multi-Mode Magnification Factor) equals to 1.5 are used unless lower G's can be justified by appropriate references. 1.2 is used for the MMF for Conduit SSE loads (per WCG-1-684). The G-loads can be obtained from QIR-CEB-WBN-89-361 (Reference 9.7) and the appropriate damping values to use are contained in WB-DC-20-24 (Dynamic Earthquake Analysis of Category I Structures and Earth Embankments). Pipe Reactions (Ra) are obtained from applicable QIR's. Thermal Loads (Ta) are obtained from environmental drawings as documented in Calculation WCG-1-686 (Reference 9.13) and WCG-1-790 (Reference 9.14). The ambient temperature is taken as 70°F. The differential between ambient and accident temperature are used for evaluation. The Pressure Equivalent Static Loads (Pa) is not considered because it is insignificant compared with Thermal Load. Pipe Rupture Loads (Yr, Yj and Ym) are not included per QIR EBA-WBN-91-435 R0 (Pipe Rupture evaluations do not consider platform and miscellaneous steel structures as essential (primary) safety targets).

An conservative loading sequence is used in the nonlinear analysis: All loads, except thermal load (Ta), are first applied on the computer model. Incremental temperature steps are then applied starting at 70°F (Ambient) up to Ta. This is the most critical loading sequence in terms of the Ductility Ratio results used for member qualification. The Ductility Ratio will be smaller if the SSE loads are applied AFTER the thermal loads. However, the final displacement results for both loading sequences are nearly identical. Parametric studies were performed (documented in Calc. WCG-1-1047) on two worst case structures (Worst Case 1-27 and 1-28) and the results indicated the differences are less than 1% comparing the maximum displacements on members with thermal restraint).

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Member Qualification

The Non-linear Acceptance Criteria applicable to the non-linear anslysis, specified in Appendix D of DG-C1.6.12 R1, is used for the qualification of members. Primary members are evaluated in accordance with the displacement based Ductility Ratios.

Connection and Anchorage Qualification

Connections and Concrete anchorage are evaluated using the Acceptance Criteria in Appendix C of DG-C1.6.12 R1. BASEPLATE II and CONAN computer programs are used to for the evaluations of concrete anchors as well as concrete pullout capacity.

Modification

DCN's will be issued for modifications if member, connection or anchorage is not accepted per WB-DC-20-21. The modified structure will be re-analyzed using Acceleration Response Spectrum B+C per WB-DC-20-24 R5. The overall behavior of the structure will be examined and the modified components will be re-evaluated.

11.3 Qualification of Worst Cases 1-27 and 2&3-9(C)

11.3.1 Mathematical Model (PR9C)

The ANSYS model PR9C is shown in Figures 11.3.1.1 and 11.3.1.1A. This model contains two worst cases: one with axial restraint (1-27) and the second with proximity restraint (2&3-9(C)). The model includes the worst case members and their adjacent members so that the combination of the thermal load and non-thermal loads can be properly addressed. ANSYS STIF24 (3-D thin-wall plastic beam element) elements are used to simulate the worst case members, e.g. elements between node 8 and 10 for the axially restrained member, elements between 2 and 5 for the proximity member, elements between nodes 1 and 9, nodes 4 and 6 for the supporting members of the proximity member. ANSYS STIF4 (beam element) elements are used to model the members adjacent to the worst case members. A column at node 32 along global Z direction is modeled with a STIF14 spring element (element 163). A beam element (element 161) is also attached at node 32 to represent the axial restraint along the line of nodes 33 and 32. Two members near nodes 25 and 26 are not included in the model because they have negligible effect on the worst case member (1-27) since the most critical part of the axially restrained member is the unbraced segment between nodes 8 and 9. ANSYS STIF21 mass elements are used to simulate hand rails at nodes 95 and 96, which are located above nodes 28 and 29 respectively. These two mass elements are connected to nodes 28 and 29 with rigid links. A small bore pipe located below node 30 is also modeled with a STIF21 mass element and connected with a rigid link to node 30. Pinned connections at nodes 2, 5 and 9 are modelled by the ANSYS CP commands to de-couple the moments between nodes 2 and 102, between nodes 5 and 105, and between nodes 9 and 109. Temperature dependent material properties, as described in Section 11.2, are used.

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Figure 11.3.1.1 ANSYS Model for Worst Cases 1-27 and 2&3-9(C)

PR9C ANSYS MODEL

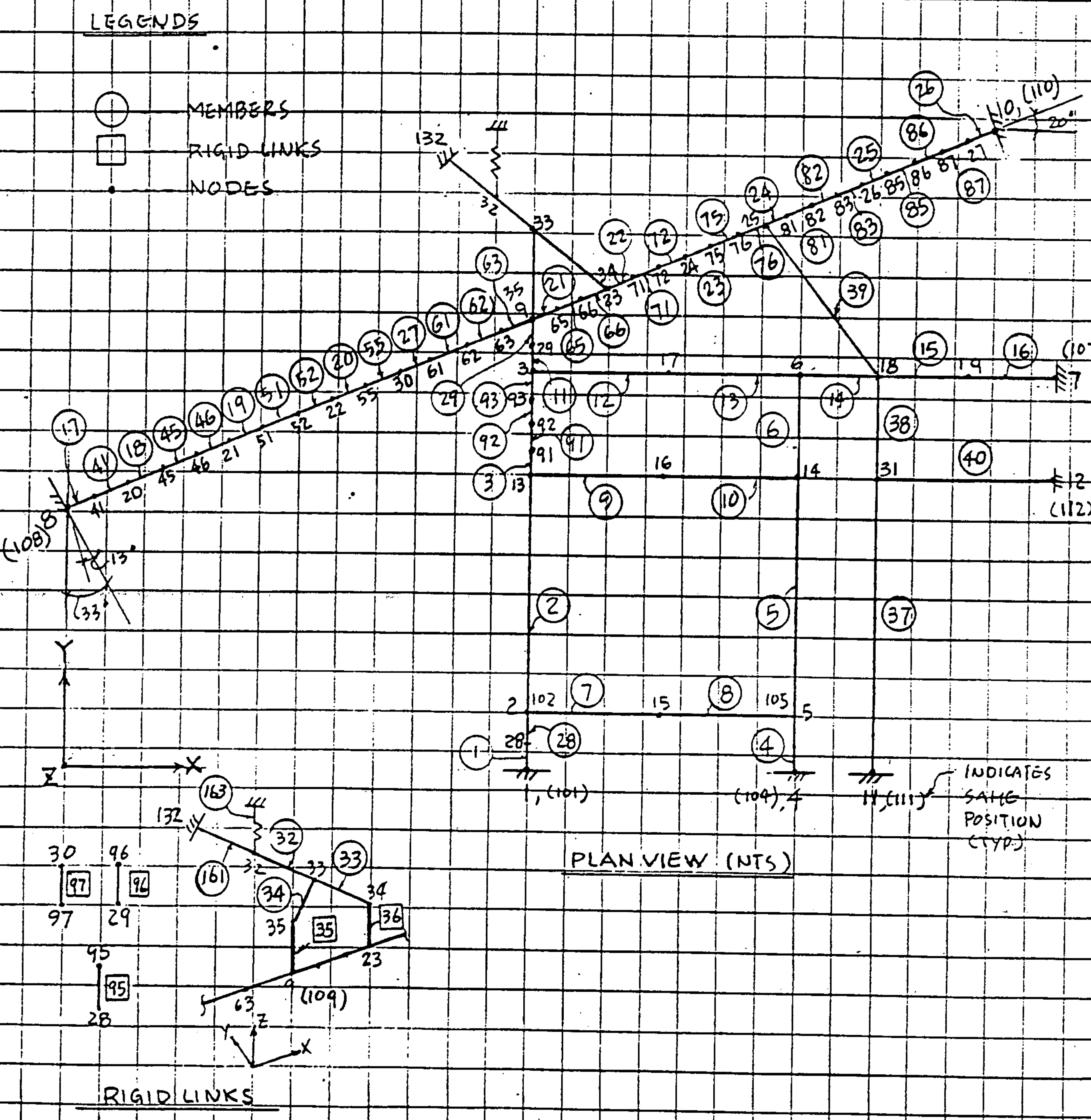

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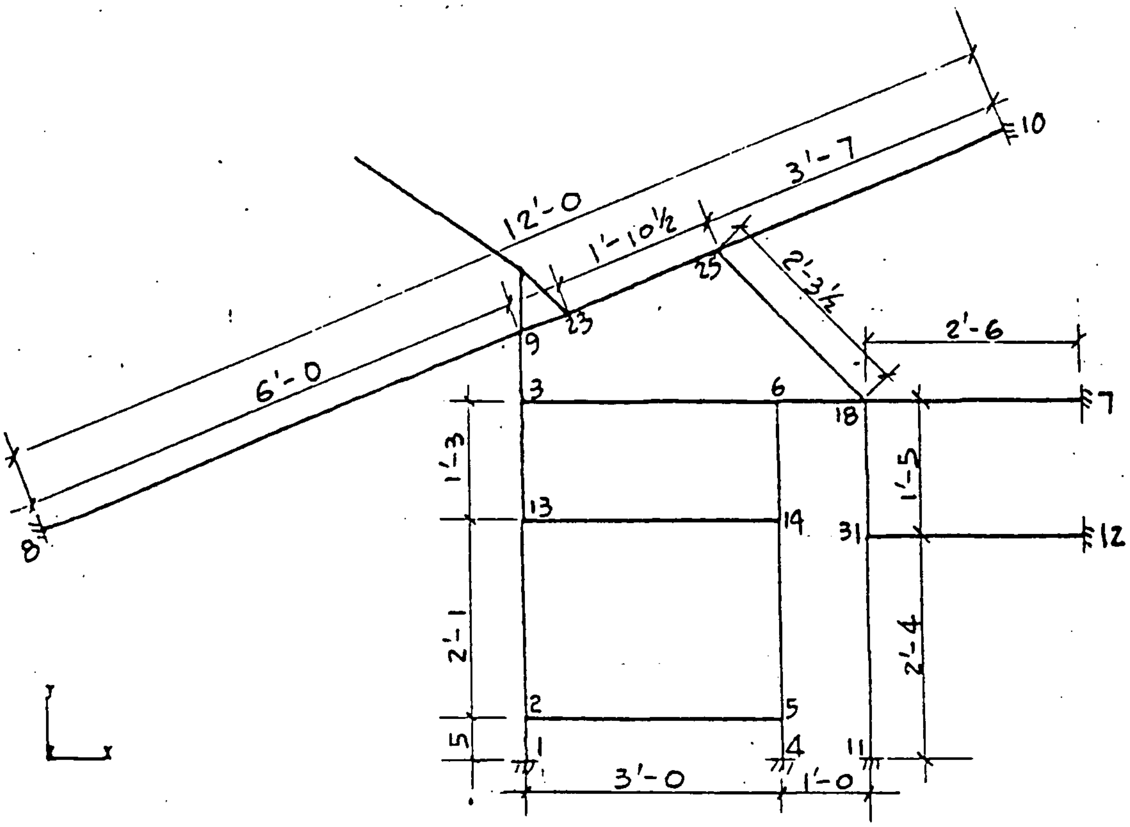
Figure 11.3.1.1A ANSYS Model for Worst Cases 1-27 and 2&3-9(C) (Model Dimension)



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11.3.1 Mathematical Model (Cont'd)

Boundary Condition

ANSYS STIF14 spring elements are used to simulate the shear stiffness of concrete anchors and the rotational stiffness of the baseplate and concrete anchorage. Shear springs are specified at all support nodes except nodes 1 and 4. Rotational springs are used at all support nodes. Nodes 101, 104, 107, 108, 110, 111 and 112, defined at the same locations of nodes 1, 4, 7, 8, 10, 11 and 12 respectively, are the support nodes for the spring elements. 4000 kip/in (1000*4) obtained from DS-C1.7.1 is used as the shear stiffness for each spring. The rotational stiffness is calculated from the output of BASEPLATE II runs. A total of five (5) baseplate models were generated as shown in Figures 11.3.1.2 through 11.3.1.6. The input files for the baseplate runs to calculate rotational stiffness are provided in Tables 11.3.1.1 through 11.3.1.5.

To represent the actual orientation of the baseplate and concrete anchorage, Nodes 8 and 108 in the ANSYS model are rotated 33°. Similarly, Nodes 10 and 110 are rotated 20°. A displacement of 1/32" is specified at nodes 12, 7, 10 in +X direction in nodal coordinate system. A displacement of 1/32" is specified at node 8 in -X direction in nodal coordinate system. A displacement of 1/32" is specified at node 11 in -Y direction. A displacement of 0.03" is specified at nodes 1 and 4 in -X and +X directions respectively. This approach has the same effect of using a Gap Element at support to allow free movement before load starts to transfer. Studies are performed in the evaluations of Worst Case 1-11 (Section 11.4) and Worst Case 2&3-8(G) (Section 11.5) to demonstrate that the analysis results are identical whether the (1/32") free travel is simulated by imposed displacement or by gap element. For details, see Sections 11.4 and 11.5.

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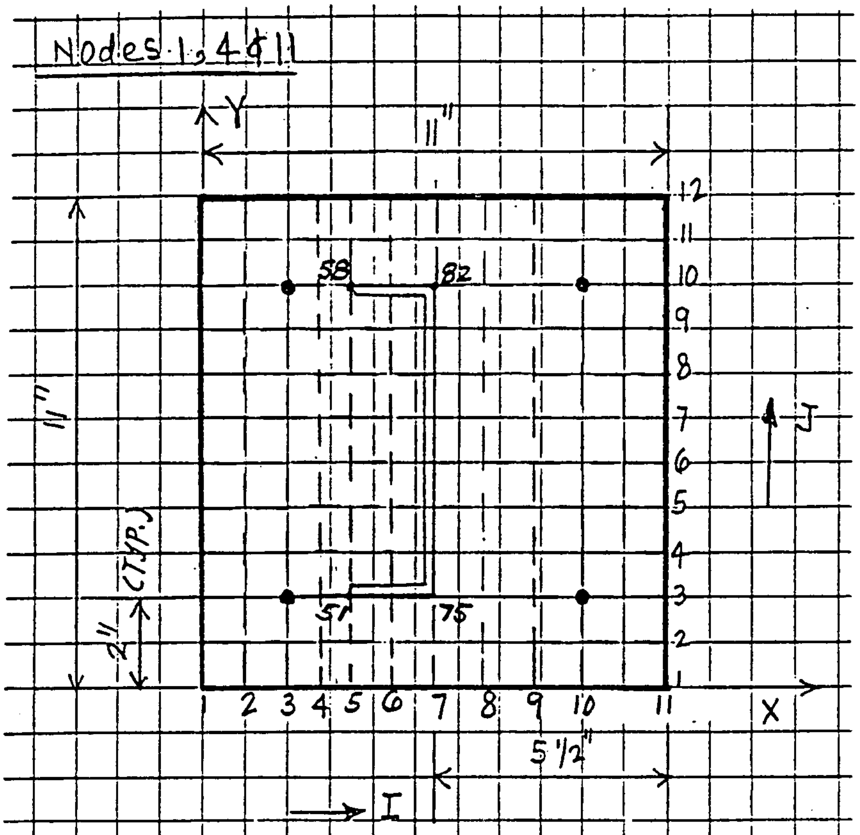
Figure 11.3.1.2 BASEPLATE II Model for Nodes 1, 4 & 11 of ANSYS Model

(Ref: WCG-1-825 R2)



PL Size: (MK3B) = 1"x11"x 0'-11" LG.

4 - 3/4" φ SSD Anchors

Attachment member : C7X9.8

Tensile Stiffness = 400 K/in

Shear Stiffness = 1000 K/in

(Ref: DS-C1.7.1)

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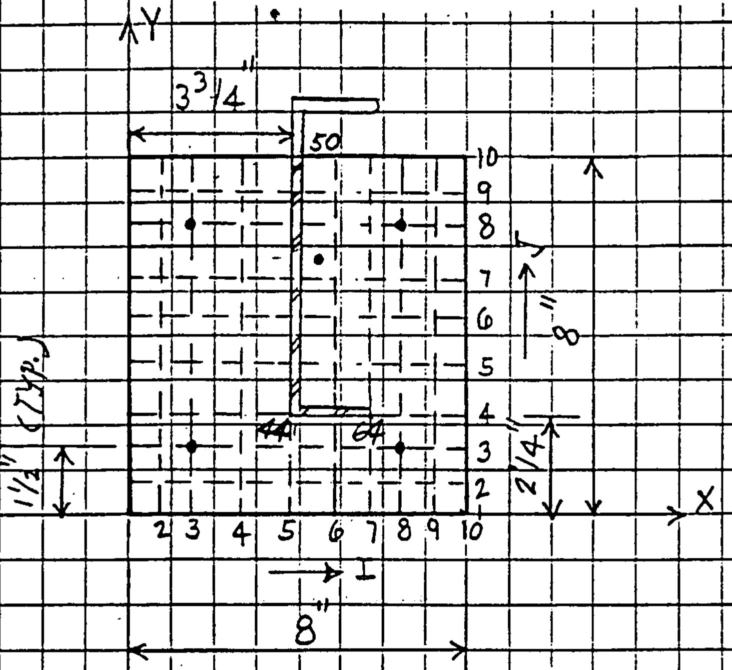
Figure 11.3.1.3 BASEPLATE II Model for Nodes 8 of ANSYS Model

(Ref: WCG-1-825 R2)

Node 8

(MK4)



⅊ size: (MK 1B) : $\frac{1}{2}$" x 8" x 0'-8" LG.

4 - $\frac{1}{2}$"φ x $5\frac{3}{16}$" H.D. Concrete Anchors

Attachment member : C7x9.8

For Anchors: (Ref = DS-C1.7.1)

$$\text{Tensile Stiffness} = Kt = \frac{1}{\frac{0.015}{T0} + \frac{L}{AE}}$$

$$T0 = .55 Fy \times Ast$$

$$= .55 \times 44 \times \frac{\pi}{4} \times (.5)^2$$

$$= 24.2 \times .196$$

$$= 4.75^K$$

$$= \frac{1}{\frac{0.015}{4.75} + \frac{5.18}{.196 \times 29000}}$$

$$= 246 \text{ K/in}$$

Shear Stiffness = Ks = 1000 K/in

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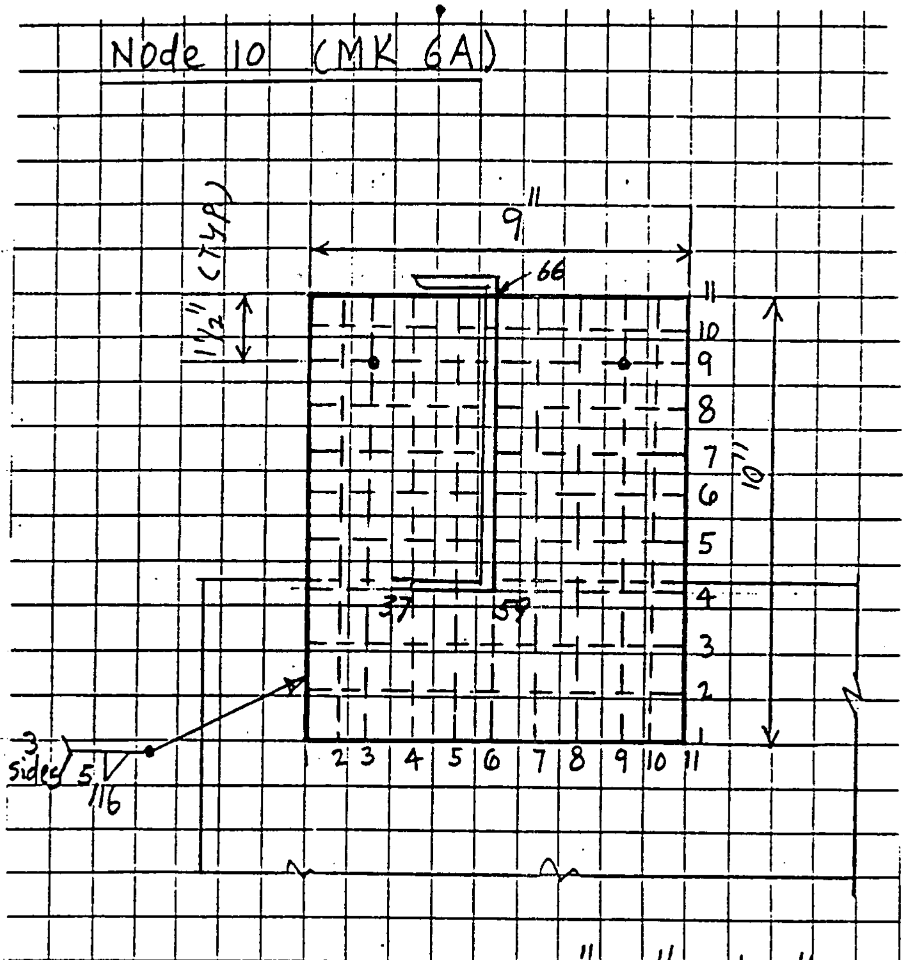
Figure 11.3.1.4 BASEPLATE II Model for Nodes 10 of ANSYS Model

(Ref = WCG-1-825R2)



PL Size: (MK 2B) = 3/4" x 9" x 0'-10" LG.
2- 1/2" ϕ SSD's
Attachment member: C7x9.8

Tensile Stiffness = 400 K/in
Shear Stiffness = 1000 K/in

(Ref: DS-C1.7.1)

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Figure 11.3.1.5 BASEPLATE II Model for Nodes 7 of ANSYS Model

(Ref: WCG-1-825 R2)

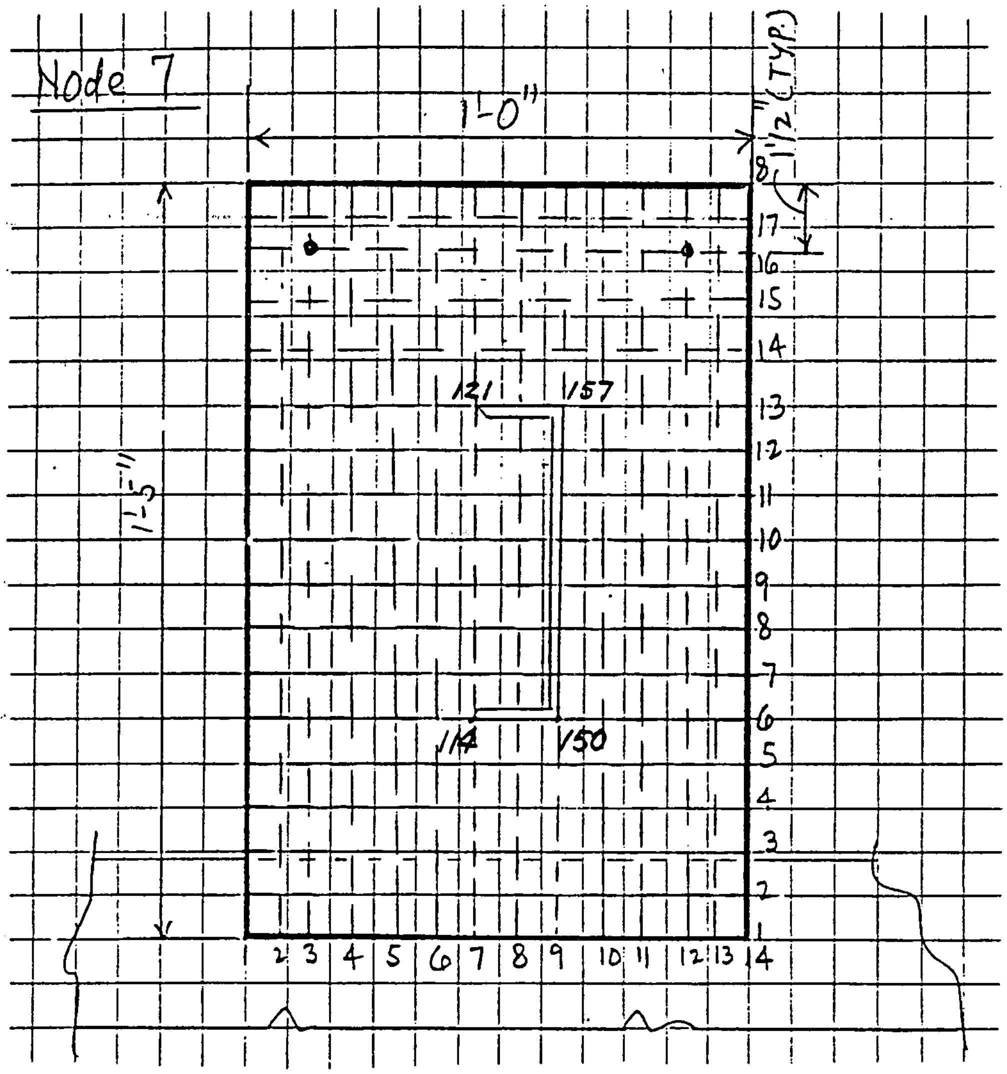

Figure 11.3.1.6 BASEPLATE II Model for Nodes 12 of ANSYS Model

(Ref = WCG-1-825 R2)

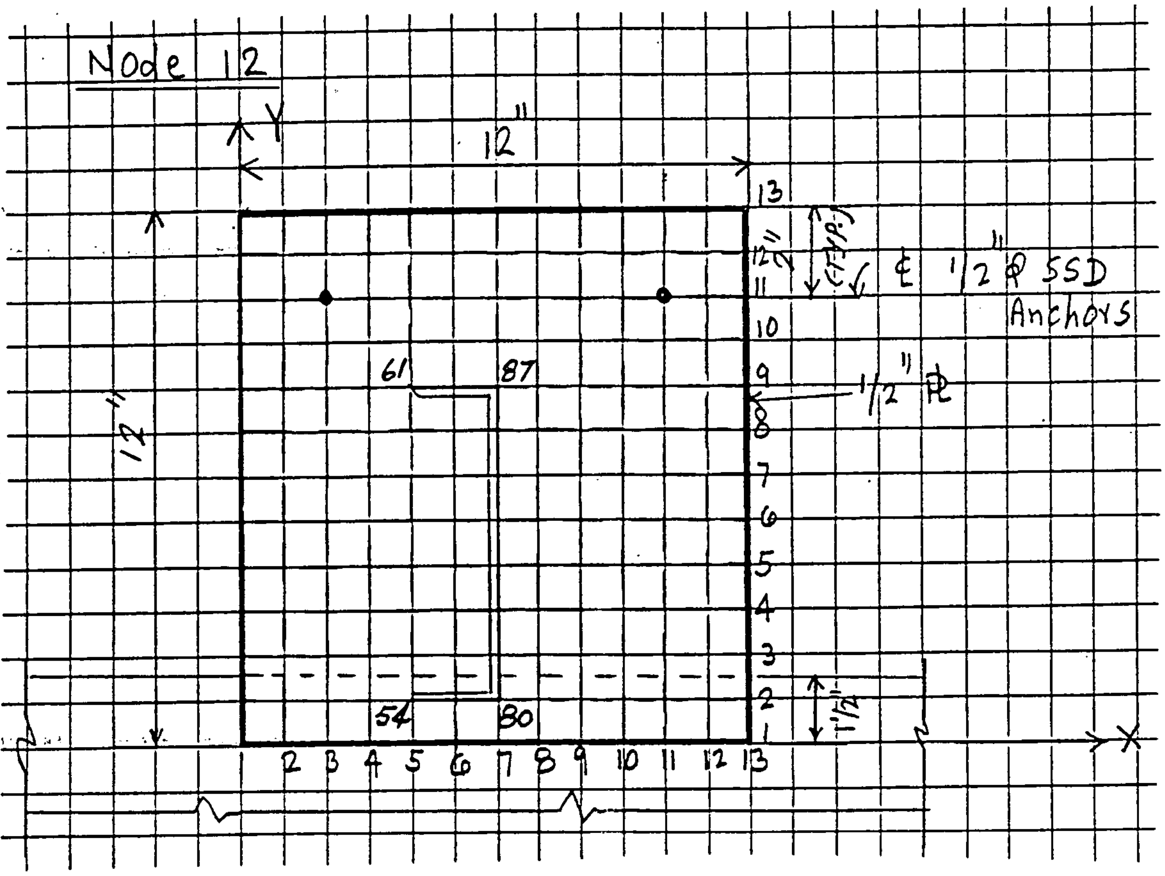

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Table 11.3.1.1 BASEPLATE II Input for Rot. Stiff. for Node 1, 4 & 11 of ANSYS Model

(Ref: Input = BS4PR9C ; Output = BS4P9CR)

```
3 BS4PR9C- NODE 4; SURF MOUNT PLATE; 48N968
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 11,12,,11,11,1.0,29/
APR 7,2,1,7.0,2.09,.366,.21/
BPR ,,1,.4E6,1.0E6,3000,3300/
BOL 3,3,1,2,2/
BOL 10,3,1,9,2/
BOL 3,10,1,2,9/
BOL 10,10,1,9,9/
END /
ATT 5,3,,3.41,2.00/
JST 5,3,7,2.09,0/
IST 7,3,10,7.0,90/
JST 7,10,5,2.09,180/
END /
END /
POI 5,3,,1.55,3.5/
LOA ,,1,0.0,0.0,0.0,100000.0,100000.0,0/
END /
END OF JOB
```

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Table 11.3.1.2 BASEPLATE II Input for Rot. Stiff. for Node 8 of ANSYS Model

(Ref: Input = BS8PR9C ; Output = BS8P9CR)

```
3 BS8PR9C-NODE-8; EMB PLATE; 48N968.
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 10,10,,8,8,.5,29/
APR 6,2,1,5.75,2.09,.366,.21/
BPR ,,1 2.46E5,1.0E6,4750,4318/
BOL 3,3,1,1.5,1.5/
BOL 8,3,1,6.5,1.5/
BOL 3,8,1,1.5,6.5/
BOL 8,8,1,6.5,6.5/
END /
ATT 5,4,,3.75,2.25/
JST 5,4,7,2.09,0/
IST 5,4,10,5.75,90/
END /
END /
POI 5,4,,.5,3.5/
LOA ,,1,0.0,0.0,0.0,100000.0,100000.0,0/
END /
END OF JOB
```

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Table 11.3.1.3 BASEPLATE II Input for Rot. Stiff. for Node 10 of ANSYS Model

(Ref: Input: BS10PR9 ; Output = BS10P9R)

```
3 BS10PR9-NODE 10; SURF MOUNT PLATE; 48N968.
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 11,11,,9,10,.75,29/
APR 7,2,1,6.63,2.09,.366,.21/
BPR ,,1,.4E6,1.0E6,1550,1400/
BOL 3,9,1,1.5,8.5/
BOL 9,9,1,7.5,8.5/
IWE 1,1,4/
JWE 1,1,11/
IWE 11,1,4/
END /
ATT 4,4,,2.29,3.37/
JST 4,4,6,2.09,0/
IST 6,4,11,6.63,90/
END /
END /
POI 4,4,,1.58,3.5/
LOA ,,1,0.0,0.0,0.0,100000.0,100000.0,0/
END /
END OF JOB
```

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Table 11.3.1.4 BASEPLATE II Input for Rot. Stiff. for Node 7 of ANSYS Model

(Ref: Input: BS7PR9C & Output = BS7P9CR)

```
3 BS7PR9C-NODE 7; SURF MOUNT PLATE; 48N968.
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 14,18,,12,17,1.0,29/
APR 7,2,1,7.0,2.09,.366,.21/
BPR ,,1,.4E6,1.0E6,3000,3300/
BOL 3,16,1,1.5,15.5/
BOL 12,16,1,10.5,15.5/
IWE 1,1,3/
JWE 1,1,14/
IWE 14,1,3/
END /
ATT 7,6,,5.41,5.0/
JST 7,6,9,2.09,0/
IST 9,6,13,7.0,90/
JST 9,13,7,2.09,180/
END /
END /
POI 7,6,,1.58,3.5/
LOA ,,1,0.0,0.0,0.0,100000.0,100000.0,0/
END /
END OF JOB
```

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Table 11.3.1.5 BASEPLATE II Input for Rot. Stiff. for Node 12 of ANSYS Model

(Ref: Input = BS12PR9'; Output = BS12P9R)

```
3 BS12PR9C-NODE 12; SURF MOUNT PLATE; 48N968.
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 13,13,,12,12,0.5,29/
APR 5,1,1,7.0,2.09,.366,.21/
BPR ,,1,.4E6,1.0E6,1550,1400/
BOL 3,11,1,2.0,10.0/
BOL 11,11,1,10.0,10.0/
IWE 1,1,2/
JWE 1,1,13/
IWE 13,1,2/
END /
ATT 5,2,,3.91,1.0/
JST 5,2,7,2.09,0/
IST 7,2,9,7.0,90/
JST 7,9,5,2.09,180/
END /
END /
POI 5,2,,1.58,3.5/
LOA ,,1,0.0,0.0,0.0,100000.0,100000.0,0/
END /
END OF JOB
```

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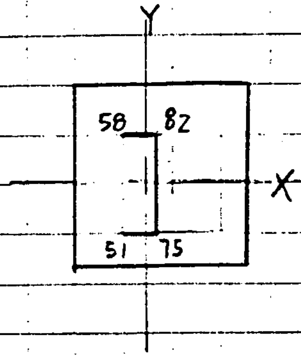
REF.

Base PL II Output File: B54P9CR (Z-displ.)

Rotational Stiffness of Base PL

Nodes 1, 4 & 11

For Mx



1) $\Delta 75 = -0.000813'' = \Delta 2$

$\Delta 82 = 0.017233'' = \Delta 1$

$L = 7''$

$$\theta = \tan^{-1} \frac{\Delta_1 + (-\Delta_2)}{L}$$

$$= \tan^{-1} \left(\frac{.017233 + 0.00813}{7} \right)$$

$$\theta = .2076^0$$

$$KMM = \frac{M}{\theta} = \frac{100}{.2076 \times \frac{\pi}{180}} = 27600 \frac{K\text{-}in}{Rad.}$$

For My

2) $\Delta 51 = .007229'' = \Delta 1$ (Z-DISP)

$\Delta 75 = -.000813'' = \Delta 2$

$L = 2.09''$

$$\theta = \tan^{-1} \frac{\Delta_1 + (-\Delta_2)}{L}$$

$$= \tan^{-1} \left(\frac{.007229 + 0.000813}{2.09} \right)$$

$$= 0.22^0$$

$$KMM = \frac{M}{\theta} = \frac{100}{.22 \times \frac{\pi}{180}} = 25989 \frac{K\text{-}in}{Rad.}$$

3) $\Delta 58 = 0.025275''$

$\Delta 82 = 0.017233''$

$L = 2.09''$

$$\theta = \tan^{-1} \frac{(0.025275 - 0.017233)}{2.09} = .22^0$$

$$KMM = \frac{100}{.22 \times \pi/180} = 25989 \text{ K-in/Rad.}$$

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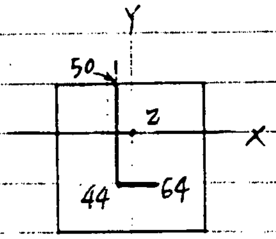
REF.

Rotational Stiffness of Base Pl

Node 8

For MX



Base Pl. II Output = BS8P9CR (z-disp.)

1) $\Delta 44 = 0.021104'' = \Delta 2$ (z-displ.)
$\Delta 50 = 0.091684'' = \Delta 1$
$L = 5.75''$

$$\theta = \tan^{-1} \frac{\Delta_1 + \Delta_2}{L} = \tan^{-1} \frac{(0.091684 - 0.021104)}{5.75}$$
$$= 0.703^{0}$$

$$K_{MM} = \frac{100}{0.703 \times \frac{\pi}{180}} = 8147 \text{ K-in/Rad.}$$

For MY

2) $\Delta 44 = 0.021104'' = \Delta 1$ (z-disp.)
$\Delta 64 = -0.005286'' = \Delta 2$
$L = 2.09''$

$$\theta = \tan^{-1} \frac{(0.021104 + 0.005286)}{2.09}$$
$$= 0.723^{0}$$

$$K_{MM} = \frac{100}{0.723 \times \frac{\pi}{180}} = 7920 \text{ K-in/Rad.}$$

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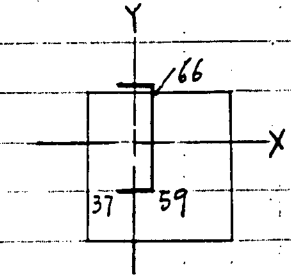
Rotational Stiffness of Base PL

Node 10

For Mx



Ref= Base PL II Output, BS10P9R (z-disp.)

1) $\Delta 59 = -.003697'' = \Delta 2$ (Z-DISP.)

$\Delta 66 = .034592'' = \Delta 1$

$L = 6.63''$

$$\theta = \tan^{-1}\left(\frac{0.034592 + 0.003697}{6.63}\right)$$

$$= 0.33^{0}$$

$$K_{MM} = \frac{100}{0.33 \times \frac{\pi}{180}} = 17{,}315 \text{ K-in/radian}$$

For My

2) $\Delta 37 = 0.006139'' = \Delta 1$ (Z-DISP.)

$\Delta 59 = -0.003697'' = \Delta 2$

$L = 2.09''$

$$\theta = \tan^{-1}\left(\frac{0.006139 + 0.003697}{2.09}\right)$$

$$= 0.27^{0}$$

$$K_{MM} = \frac{100}{0.27 \times \frac{\pi}{180}} = 21{,}249 \text{ K-in/radian}$$

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SUBJECT Qual of Worse Cases of Thermally Restrained Struct. - Package I

Rotational Stiffness of Base PL

Ref:

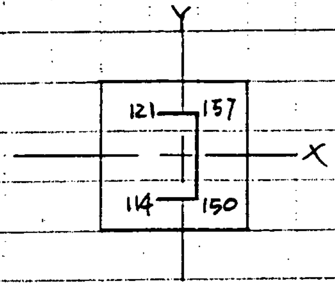
Base PL II output:

BS7P9CR

(z-disp.)

Node 7

For Mx



Δ157 = ·012269" = Δ1 (Z-DISP.)
Δ150 = -·000121" = Δ2
L = 7"

$$\theta = \tan^{-1}\left(\frac{\cdot 012269 + \cdot 000121}{7}\right)$$

$$= 0.101^{0}$$

$$KMM = \frac{100}{0.101 \times \frac{\pi}{180}} = 56498 \text{ K-in/radian}$$

For My

Δ114 = ·006187" = Δ1 ~~(Z-DISP.)~~
Δ150 = -·000121" = Δ2
L = 2·09"

$$\theta = \tan^{-1}\left(\frac{\cdot 006187 + \cdot 000121}{2\cdot 09}\right)$$

$$= 0.173^{0}$$

$$KMM = \frac{100}{\cdot 173 \times \frac{\pi}{180}} = 33132 \text{ K-in/radian}$$

Δ121 = 0.018577" = Δ1
Δ157 = 0.012269" = Δ2
L = 2·09"

$$\theta = \tan^{-1}\left(\frac{\cdot 018577 - \cdot 012269}{2\cdot 09}\right) = \cdot 173^{0}$$

$$KMM = \frac{100}{\cdot 173 \times \frac{\pi}{180}} = 33132 \text{K-in/rad.}$$

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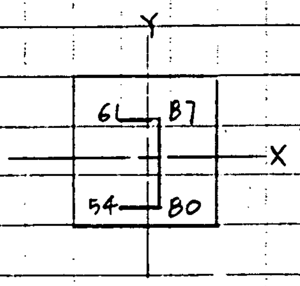
Rotational stiffness of Base PL

Ref = Base PL output = BS12P9R (z-disp)

Node 12

For Mx



1) $\Delta 87 = \cdot 030477'' = \Delta 1$ (z-DISP.)

$\Delta 80 = -\cdot 004893'' = \Delta 2$

$L = 7''$

$$\theta = \tan^{-1} \frac{\Delta 1 + \Delta 2}{L} = \tan^{-1} \left(\frac{\cdot 030477 + \cdot 004893}{7} \right)$$

$$= \cdot 2895^{\circ}$$

$$KMM = \frac{100}{\cdot 2895 \times \frac{\pi}{180}} = 19791 \text{ K-in/Rad.}$$

2) For My

$\Delta 61 = \cdot 046604'' = \Delta 1$ (z-DISP.)

$\Delta 87 = \cdot 030477'' = \Delta 2$

$L = 2 \cdot 09''$

$$\theta = \tan^{-1} \left(\frac{\cdot 046604 - \cdot 030477}{2 \cdot 09} \right)$$

$$= 0 \cdot 442^{\circ}$$

$$KMM = \frac{100}{\cdot 442 \times \frac{\pi}{180}} = 12960 \text{ K-in/Rad.}$$

$\Delta 54 = \cdot 011234''$

$\Delta 80 = -\cdot 004893''$

$L = 2 \cdot 09''$

$$\theta = \tan^{-1} \left(\frac{\cdot 011234 + \cdot 004893}{2 \cdot 09} \right) = \cdot 442^{\circ}$$

KMM = 12960 K-in/Rad.

11.3.1 Mathematical Model (Cont'd)

Loading Condition

Since these two worst case members (1-27 and 2&3-9C) are part of the worst case platform, 48N968-00PF01U1, all loading data are obtained from the platform evaluation calculation, WCG-2-50 Vol. 6, R1 (Reference 9.15). As shown in Table 11.3.1.6, equivalent densities are calculated for each member to consider the dead loads (including self-weight and grating) and the sustained live loads (10 psf per WB-DC-20-21). SSE loads are applied using the equivalent static approach. ANSYS ACEL command is used to apply the G-loads. In accordance with Calculation WCG-2-50 R1, Vol. 6, ZPA (4% damping) are used for members: 0.9G is considered for the Horizontal (N-S and E-W) directions and 0.33G is used for the Vertical direction. Small bore pipes and hand rails are modeled using ANSYS STIF21 Mass elements connected to members with rigid links. The location and the weight of the pipe and hand rails are obtained from the GTSTRUDL input file in WCG-2-50 R1, Vol. 6. 9.38G and 3.38G are applied in the Horizontal and Vertical directions for small bore pipes.

The YZ-SSE load (combination of SSE in Y and Z directions) is more critical than the XZ-SSE load (combination of SSE in X and Z directions). Therefore, YZ-SSE load is specified with DL and SLL followed by incremental temperature steps from 70°F (Ambient temperature) up to 327°F (Accident temperature). However, the XZ-SSE load is still applied in Load Step 1 in the ANSYS analysis and is for reference only. The YZ-SSE load, which supersedes the XZ-SSE load in Load Step 1, is applied in Load Step 2. The temperature loads are then specified in the following load steps from Load Step 3 up to Load Step 16 (final load step).

The ANSYS input files are presented in Section 11.3.2.

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Table 11.3.1.6 Equivalent Densities for Members of ANSYS Model "PR9C"

		BEAM	GRATING			SLL 10PSF			TOTAL
ANSYS MEMBER	STRUDL MEMBER*	DENS LB/IN^3	WA LB/FT	WB LB/FT	WG LB/IN	WA LB/FT	WB LB/FT	WL LB/IN	DENS LB/IN^3
1,28	'B6-1'	0.283	11.5	11.5	0.958	0	0	0	0.617
2	'B6-2'	0.283	11.5	11.5	0.958	0	0	0	0.617
3	'B6-3'	0.283	11.5	11.5	0.958	0	0	0	0.617
4	'B2-1'	0.283	6	6	0.500	5	5	0.417	0.602
5	'B2-2'	0.283	6	6	0.500	5	5	0.417	0.602
6	'B2-3'	0.283	6	6	0.500	5	5	0.417	0.602
7	'B3-1'	0.283	15	15	1.250	12.5	12.5	1.042	1.081
8	'B3-2'	0.283	15	15	1.250	12.5	12.5	1.042	1.081
9	'B4-1'	0.283	22.5	22.5	1.875	18.75	18.75	1.563	1.481
10	'B4-2'	0.283	22.5	22.5	1.875	18.75	18.75	1.563	1.481
11,29	'B6-4'	0.283	11.5	11.5	0.958	0	0	0	0.617
12	'B7-5'	0.283	17.325	15	1.347	15	12.5	1.146	1.152
13	'B7-4'	0.283	19.65	17.325	1.541	16	15	1.292	1.270
14	'B7-3'	0.283	14	12.22	1.093	12	10	0.917	0.983
15	'B7-2'	0.283	25	22	1.958	20	18	1.583	1.517
16	'B7-1'	0.283	28	25	2.208	23	20	1.792	1.677
21	'B9-5'	0.283	8.8	7.5	0.679	7.3	6.25	0.565	0.716
22	'B9-4'	0.283	10.7	8.8	0.813	8.9	7.3	0.675	0.801
23	'B9-3'	0.283	11.4	10.7	0.921	9.5	8.9	0.767	0.871
24	'B9-2'	0.283	13.44	11.4	1.035	11.2	9.5	0.863	0.944
25	'B9-1A'	0.283	15	13.44	1.185	12.5	11.2	0.988	1.040
26	'B9-1'	0.283	15	13.44	1.185	12.5	11.2	0.988	1.040
32	'B11-2'	0.283	23.7	23.7	1.975	13.3	13.3	1.108	1.357
33	'B11-1'	0.283	23.7	23.7	1.975	13.3	13.3	1.108	1.357
37	'B1-1'	0.283	17.5	17.5	1.458	5	5	0.417	0.936
37	'B1-2'	0.283	17.5	17.5	1.458	5	5	0.417	0.936
38	'B1-3'	0.283	6	6	0.500	5	5	0.417	0.602
40	'B5-1'	0.283	19	19	1.583	6.25	6.25	0.521	1.016
40	'B5-2'	0.283	19	19	1.583	6.25	6.25	0.521	1.016

NOTES:

WA, WB = DISTRIBUTED LOADS AT MEMBER ENDS FROM STRUDL INPUT

WG, WL = (WA+WB)/24

DENS = DS + (WG+WL)/A

DS = STEEL DENSITY=0.283; A=AREA=2.87

* See WCG-2-50, Vol.6, R1, Sht. 35 for STRUDL member plot; Sht. 125-136 for Loading Data.

11.3.2 ANSYS Input

Two ANSYS input files are presented in this section:

11.3.2.1 "PR9C" - Analysis for the Original structure

11.3.2.2 "PR9CM" - Analysis for the modified structure

Note: The member of the worst case 1-27 is not accepted per DG-C1.6.12 R1 (For details, see Section 11.3.4.1, Member Qualification for worst case 1-27). A slotted hole is installed to release the thermal-induced axial force. The modified structure is re-evaluated with the analysis "PR9CM" and the member is qualified using the results from the new analysis.

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11.3.2.1 ANSYS Input File "PR9C" (Analysis for the Original Structure)

```
/PREP7
/TITLE,PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2"
/COM
/COM   BRANCH/PROJECT ID = WCG-1-969
/COM
/COM   PREPARED BY:  SAL    8/19/91
/COM   CHECKED BY: C. Y. OU  8/19/91
/COM
/COM   INPUT:   PR9C
/COM   OUTPUT:  PR9CR
/COM   FILE12:  PR9CF
/COM   PLOT:    PR9CP
/COM
C*** ANSYS ANALSIS OPTIONS AND REFERENCES
KAN,0
KAY,6,1
KNL,1
C*** ELEMENT TYPE
ET,1,24,,,,,,1        * STIF24
ET,2,4,,,,,,1         * STIF4
ET,3,14,,1            * SPRING KX
ET,4,14,,2            * SPRING KY
ET,5,14,,3            * SPRING KZ
ET,6,14,,4            * SPRING ROTX
ET,7,14,,5            * SPRING ROTY
ET,8,14,,6            * SPRING ROTZ
ET,9,21,,,,,          * 3D MASS ELE.
ET,10,14,,0           * SPRING ALONG TWO POINTS
C*** MATERIAL PROPERTIES
EX,1,29000
RP21,1
ALPX,1,6.5E-6
RP21,1
DENS,1,0.283E-3         * STEEL DENSITY - NON-LINEAR
DENS,2,0.283E-3         * STEEL DENSITY - LINEAR
DENS,3,0.602E-3         * ELE. 4-6
DENS,4,1.081E-3         * ELE. 7-8
DENS,5,1.481E-3         * ELE. 9-10
DENS,6,0.617E-3         * ELE. 1-3, 28, 11,29
DENS,7,1.152E-3         * ELE. 12
DENS,8,1.270E-3         * ELE. 13
DENS,9,0.983E-3         * ELE. 14
DENS,10,1.517E-3        * ELE. 15
DENS,11,1.677E-3        * ELE. 16
DENS,12,0.716E-3        * ELE. 21
DENS,13,0.801E-3        * ELE. 22
DENS,14,0.871E-3        * ELE. 23
DENS,15,0.944E-3        * ELE. 24
DENS,16,1.040E-3        * ELE. 25-26
DENS,17,0.0             * ZERO DENSITY - RIGID LINK
```

11.3.2.1 ANSYS Input File "PR9C" (Continued)

```
DENS,18,1.357E-3       * ELE. 32-33
DENS,19,0.936E-3       * ELE. 37
DENS,20,0.602E-3       * ELE. 38
DENS,21,1.016E-3       * ELE. 40
C***
MPTEMP,1,70,100,200,300,400
RP21,1
MPDATA,EX,1,1,29.0E3,28.9E3,28.3E3,27.9E3,27.4E3
RP21,,1
MPDATA,ALPX,1,1,6.50E-6,6.50E-6,6.50E-6,6.67E-6,6.86E-6
RP21,,1
C***  NONLINEAR MATERIAL CONSTANT
*CREAT,MNL
NL,ARG1,13,10
NL,ARG1,19,70,100,200,300,400
NL,ARG1,25,36,36.0,36.0,36.0,36.0
NL,ARG1,31,150,150,150,150,150
*END
C***
*USE,MNL,1
*USE,MNL,3
*USE,MNL,4
*USE,MNL,6
*USE,MNL,12
*USE,MNL,13
*USE,MNL,14
*USE,MNL,15
*USE,MNL,16
C***
C***  CROSS SECTIONAL PROPERTIES
C*** CHANNEL C7X9.8 ******
CF=2.090
TCF=0.366
CD=7.00
TCW=0.210
XBR=(0.541)+0.07069      * SAL  7/10/91
C***
XO=(TCW/2)-(XBR)
CC=CF-(TCW/2)
DD=(CD-TCF)/2.
QC=CC/2
QD=DD/2
CC=CC+XO
QC=QC+XO
*STAT
C***
R,1,CC,DD,0,QC,DD,TCF                      * STIF24 REAL PROP. - C7X9.8
RMORE,XO,DD,TCF,XO,QD,TCW
RMORE,XO,0,TCW,XO,-QD,TCW
RMORE,XO,-DD,TCW,QC,-DD,TCF
```

11.3.2.1 ANSYS Input File "PR9C" (Continued)

```
RMORE,CC,-DD,TCF
C***
R,2,2.87,0.968,21.3,7.0,2.09         * C7X9.8
RMORE,,0.1
R,3,2.64,0.632,8.90,5.0,1.885        * C5X9 - ADDED MEMBERS
RMORE,,0.109
R,4,4000,5000,5000,20,20             * ANCHOR SHEAR SPRINGS & RIGID BEAM
R,5,8147                             * SPRING ROTY @NODE 8
R,6,17315                            * SPRING ROTY @NODE 10
R,7,27600                            * SPRING ROTX @NODES 1,4,11
R,8,56498                            * SPRING ROTY @NODE 7
R,9,7920                             * SPRING ROTZ @NODE 8
R,10,21249                           * SPRING ROTZ @NODE 10
R,11,25989                           * SPRING ROTZ @NODES 1,4
R,12,33132                           * SPRING ROTZ @NODE 7
R,13,1590                            * VERT. SPR. 'C24' - NODE 32
C*** GENERALIZED MASS
R,14,.020,.020,.020                       * NODE 95  (28)
R,15,.031,.031,.031                       * NODE 96  (29)
MASX=(.035)*9.38
MASX=MASX/0.9
MASY=MASX
MASZ=(.035)*4.38
MASZ=MASZ/1.33
R,16,MASX,MASY,MASZ                  * NODE 97  (30)
R,17,100,5000,5000                   * ANCHOR SHEAR SPRINGS & RIGID BEAM
R,18,19791                           * SPRING ROTY ODE  12
R,19,12960                           * SPRING ROTZ ODE 12
R,20,2885                             * SPRING AXIAL ODE 32
R,21,(300*4)                         * SHEAR SPRING ODES 1 & 4
C***
C*** NODAL COORDINATES
CSYS,0
N,1,67.68
N,101,67.68
N,2,67.68,5.
N,102,67.68,5.
N,3,67.68,44.96
N,4,103.68
N,104,103.68
N,5,103.68,5.
N,105,103.68,5.
N,6,103.68,44.96
N,7,145.68,44.96
N,107,145.68,44.96
N,8,0,29.36
N,108,0,29.36
N,9,67.68,53.96
N,109,67.68,53.96
N,10,135.36,78.76
```

11.3.2.1 ANSYS Input File "PR9C" (Continued)

```
N,110,135.36,78.76
N,11,115.68
N,111,115.68
N,12,145.68,27.96
N,112,145.68,27.96
N,13,67.68,30.
N,14,103.68,30.
N,15,85.63,5.
N,16,85.63,30.0
N,17,85.63,44.96
N,18,115.68,44.96
N,19,129.18,44.96
N,20,5.69,31.2
N,21,24.48,38.24
N,22,48.92,47.15
N,23,74.31,56.03
N,24,86.51,60.61
N,25,95.44,63.86
N,26,117.52,71.9
N,27,129.03,76.09
N,28,67.68,2.5
RP2,67,-3.75,0,29.5
N,29,67.68,46.44
RP2,67,-3.742,0,32.516
N,30,50.986,47.884
RP2,67,0.61563,-1.6914,-13.5
N,31,115.68,27.96
FILL,8,20,1,41,1
FILL,20,21,2,45,1
FILL,21,22,2,51,1
FILL,22,30,1,55,1
FILL,30,9,3,61,1
FILL,9,23,2,65,1
FILL,23,24,2,71,1
FILL,24,25,2,75,1
FILL,25,26,3,81,1
FILL,26,27,3,85,1
FILL,13,3,3,91,1
N,32,56.11,68.79,5.69          * JOINT '4A'   - REF. STRUDL MODEL
DX=(56.11)-67.68
DY=(68.79)-61.78
N,132,DX+56.11,DY+68.79,5.69
N,33,67.68,61.78,5.69          * JOINT '38A'
N,34,74.31,56.03,5.69          * JOINT '38B' ABOVE NODE23
N,35,67.68,53.96,5.69          * JOINT '39A' ABOVE NODE9
N,99,103.68,5.,100
N,100,67.68,53.96,100
C*** ELEMENT CONNECTIVITIES
MAT,6   $TYPE,1   $REAL,1      * STIF24
EN,1,1,28,100
```

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11.3.2.1 ANSYS Input File "PR9C" (Continued)

```
EN,2,2,13,100
EN,3,13,91,100      $,91,91,92,100    $,92,92,93,100    $,93,93,3,100
EN,28,28,2,100
EN,11,3,29,100
EN,29,29,109,100
MAT,3   $TYPE,1     $REAL,1       * STIF24
EN,4,4,5,99
EN,5,5,14,99
EN,6,14,6,99
MAT,4   $TYPE,1     $REAL,1       * STIF24
EN,7,102,15,99
EN,8,15,105,99
MAT,1   $TYPE,1     $REAL,1       * STIF24
EN,17,8,41,100      $,41,41,20,100
EN,18,20,45,100     $,45,45,46,100    $,46,46,21,100
EN,19,21,51,100     $,51,51,52,100    $,52,52,22,100
EN,20,22,55,100     $,55,55,30,100
EN,27,30,61,100     $,61,61,62,100    $,62,62,63,100    $,63,63,9,100
MAT,12  $TYPE,1     $REAL,1       * STIF24
EN,21,9,65,100      $,65,65,66,100    $,66,66,23,100
MAT,13  $TYPE,1     $REAL,1       * STIF24
EN,22,23,71,100     $,71,71,72,100    $,72,72,24,100
MAT,14  $TYPE,1     $REAL,1       * STIF24
EN,23,24,75,100     $,75,75,76,100    $,76,76,25,100
MAT,15  $TYPE,1     $REAL,1       * STIF24
EN,24,25,81,100     $,81,81,82,100    $,82,82,83,100    $,83,83,26,100
MAT,16  $TYPE,1     $REAL,1       * STIF24
EN,25,26,85,100     $,85,85,86,100    $,86,86,87,100    $,87,87,27,100
EN,26,27,10,100
MAT,5   $TYPE,2     $REAL,2       * STIF4
EN,9,13,16
EN,10,16,14
MAT,7   $TYPE,2     $REAL,2       * STIF4
EN,12,3,17
MAT,8   $TYPE,2     $REAL,2       * STIF4
EN,13,17,6
MAT,9   $TYPE,2     $REAL,2       * STIF4
EN,14,6,18
MAT,10  $TYPE,2     $REAL,2       * STIF4
EN,15,18,19
MAT,11  $TYPE,2     $REAL,2       * STIF4
EN,16,19,7
MAT,18  $TYPE,2     $REAL,3       * STIF4
EN,32,32,33
EN,33,33,34
MAT,2   $TYPE,2     $REAL,3       * STIF4
EN,34,33,35
MAT,19  $TYPE,2     $REAL,2       * STIF4
EN,37,11,31
MAT,20  $TYPE,2     $REAL,2       * STIF4
```

11.3.2.1 ANSYS Input File "PR9C" (Continued)

```
EN,38,31,18
MAT,2  $TYPE,2   $REAL,2     * STIF4
EN,39,18,25
MAT,21 $TYPE,2   $REAL,2     * STIF4
EN,40,31,12
MAT,17 $TYPE,2   $REAL,4     * RIGID LINK
EN,35,35,9
EN,36,34,23
EN,95,28,95
EN,96,29,96
EN,97,30,97
TYPE,3   $REAL,4   * SPRING X
EN,171,111,11
TYPE,4   $REAL,4   * SPRING KY
EN,142,108,8
TYPE,4   $REAL,4   * SPRING KY
EN,132,107,7
EN,152,110,10
EN,182,112,12
TYPE,3   $REAL,21   * SPRING KX
C*** EN,101,101,1
C*** EN,104,4,104
TYPE,5   $REAL,13  * SPRING KZ NODE 32
EN,163,132,32
TYPE,10  $REAL,20  * SPRING AXIAL NODE 32
EN,161,132,32
TYPE,6   $REAL,7   * SPRING NODES 1,4   RX
EN,114,101,1
EN,124,104,4
EN,174,111,11
TYPE,7   $REAL,8   * SPRING NODE 7  RY
EN,135,107,7
TYPE,7   $REAL,18  * SPRING NODE 12 RY
EN,175,112,12
TYPE,7   $REAL,5   * SPRING NODE 8  RY
EN,145,108,8
TYPE,7   $REAL,6   * SPRING NODE 10 RY
EN,155,110,10
TYPE,8   $REAL,11  * SPRING NODES 1,4   RZ
EN,116,101,1
EN,126,104,4
EN,176,111,11
TYPE,8   $REAL,12  * SPRING NODE 7  RZ
EN,136,107,7
TYPE,8   $REAL,19  * SPRING NODE 12 RZ
EN,186,112,12
TYPE,8   $REAL,9   * SPRING NODE 8  RZ
EN,146,108,8
TYPE,8   $REAL,10  * SPRING NODE 10 RZ
EN,156,110,10
```

11.3.2.1 ANSYS Input File "PR9C" (Continued)

```
TYPE,9   $REAL,14  * MASS NODE 95 (28)
EN,201,95
TYPE,9   $REAL,15  * MASS NODE 96 (29)
EN,202,96
TYPE,9   $REAL,16  * MASS NODE 97 (30)
EN,203,97
C***
/COM
/COM  MACRO TO SPECIFY ONE SPRING IN Y DIRECTION
/COM
*CREAT,SPR2
PSPRING,ARG1,TRAN,ARG2,ARG3
*END
C*** *USE,SPR2,1,(200*4),1      * SPRING IN X DIR.
C*** *USE,SPR2,4,(200*4),1      * SPRING IN X DIR.
C***
C*** COUPLED DOFS FOR MEMBER END RELEASES
CP,1,UX,102,2
CPLGEN,1,UY,UZ,ROTX,ROTY   * NODE2
CPSGEN,2,3,1,5             * NODE5
CPSGEN,2,7,1,5             * NODE9
CPLIST,ALL
C*** LOCAL COORDINATES SYSTEMS
LOCAL,12,0,0,29.36,0,20  $NROT,10,110,100
LOCAL,13,0,0,29.36,0,33  $NROT,8,108,100
CSYS,0
C*** BOUNDARY CONDITIONS
D,1,ROTY,,,4,3,UX,UY,UZ      * SAL  6/26/91  SAL 7/18/91
D,11,ROTY,,,,,UY,UZ
D,7,ROTX,,,12,5,UX,UZ
D,8,UZ,,,10,2,ROTX,UX
D,101,ALL,,,110,3
D,108,ALL,,,132,24
D,111,ALL,,,112,1
C*** ANALYSIS OPTIONS
ITER,-20,20
TREF,70
POSTR,,1,5
C*** PLOT GEOMETRY AND B.C.
/SHOW
/PBC,ALL,1
EPLO
/PNUM,NODE,1
EPLO
/PNUM,NODE,-1
/PNUM,ELEM,1
EPLO
/VIEW,,1,1,1
EPLO
C***
```

11.3.2.1 ANSYS Input File "PR9C" (Continued)

```
C*** DL + LL + SSE  XZ-PLANE
ACEL,0.9,0,1.33
C*** CONCENTRATED LOADS
C*** 'DL' + 'SMBOT' + 'SMBDN' + 'HANDDN' + 'HANDOT'
C*** TEMPERATURE LOADS
*CREAT,MAC
TUNIF,ARG1
LWRITE
*END
*USE,MAC,70
FDELE,ALL,ALL
C*** DL + LL + SSE  YZ-PLANE
ACEL,0,-0.9,1.33
C*** 'DL' + 'SMBCW' + 'HANDDN' + 'HANDCW'
*USE,MAC,70
C***
C*** BOUNDARY CONDITIONS - 2
C***
*CREAT,MACD
TUNIF,ARG1
D,1,UX,-ARG2
D,4,UX,ARG2
LWRITE
*END
D,11,UY,(-1/32)
D,7,UX,(1/32),,12,5
D,10,UX,(1/32)
C***
DD1=(0.03/26)
*USE,MACD,80,DD1
RP25,,10,DD1
*USE,MACD,327,0.03
AFWRITE,,1
FINISH
/INPUT,27
FINISH
/POST1
NLINE,200
*CREAT,PLD
SET,ARG1
PRRFOR
PRDISP
PLDISP
PLDISP,1
*END
*USE,PLD,1
*USE,PLD,2
*USE,PLD,28
FINISH
C***
```

11.3.2.1 ANSYS Input File "PR9C" (Continued)

```
/POST26
LINE,200
NUMVAR,50
TVAR,1
ESTR,2,1,53,TEMP
C***
*CREATE,STCN
C*** STORE STRAINS FOR CHANNEL  (J NODE)
ESTR,13,ARG1,215,EE01
ESTR,14,ARG1,216,EP01
ESTR,15,ARG1,227,EE03
ESTR,16,ARG1,228,EP03
ESTR,17,ARG1,251,EE07
ESTR,18,ARG1,252,EP07
ESTR,19,ARG1,263,EE09
ESTR,20,ARG1,264,EP09
PRVAR,2,13,14,15,16
PRVAR,2,17,18,19,20
*END
C***
*CREATE,STC1
C*** STORE STRAINS FOR CHANNEL (I NODE)
ESTR,43,ARG1,95,EE01
ESTR,44,ARG1,96,EP01
ESTR,45,ARG1,107,EE03
ESTR,46,ARG1,108,EP03
ESTR,47,ARG1,131,EE07
ESTR,48,ARG1,132,EP07
ESTR,49,ARG1,143,EE09
ESTR,50,ARG1,144,EP09
PRVAR,2,43,44,45,46
PRVAR,2,47,48,49,40
*END
C***
*CREAT,DSP
DISP,21,ARG1,UX,UX
DISP,22,ARG1,UY,UY
DISP,23,ARG1,UZ,UZ
PROD,24,21,21,,UXUX
PROD,25,22,22,,UYUY
PROD,26,23,23,,UZUZ
ADD,27,24,25,26,SS
SQRT,28,27,,,SRSS
PRVAR,2,21,22,23,28
*END
C***
*USE,STC1,1
*USE,STC1,4
C***
*USE,STCN,45
```

11.3.2.1 ANSYS Input File "PR9C" (Continued)

```
*USE,STCN,46
*USE,STCN,19
*USE,STCN,51
*USE,STCN,52
*USE,DSP,51
*USE,DSP,52
C***
*USE,STCN,28
*USE,DSP,2
*USE,STCN,4
*USE,DSP,5
*USE,DSP,1
*USE,DSP,4
C***
*CREAT,RFOR
RFORC,31,ARG1,FX,RFX
RFORC,32,ARG1,FY,RFY
RFORC,33,ARG1,FZ,RFZ
RFORC,34,ARG1,MX,RMX
RFORC,35,ARG1,MY,RMY
RFORC,36,ARG1,MZ,RMZ
PRVAR,31,32,33,34,35,36
*END
*USE,RFOR,8
*USE,RFOR,108
*USE,RFOR,10
*USE,RFOR,110
*USE,RFOR,1
*USE,RFOR,101
*USE,RFOR,4
*USE,RFOR,104
FINISH
```

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Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.2.2 ANSYS Input File "PR9CM" (Analysis for Modified structure)

```
/PREP7
/TITLE,PR9CM - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2
/COM
/COM   BRANCH/PROJECT ID = WCG-1-969
/COM
/COM   PREPARED BY:  SAL    8/19/91
/COM   CHECKED BY: C. Y. OU  8/19/91
/COM
/COM   ANALYSIS FOR THE MODIFIED STRUCTURE
/COM
/COM    INPUT:    PR9CM
/COM    OUTPUT:   PR9CMR
/COM    FILE12:   PR9CMF
/COM    PLOT:     PR9CMP
/COM
C*** ANSYS ANALSIS OPTIONS AND REFERENCES
KAN,0
KAY,6,1
KNL,1
C*** ELEMENT TYPE
ET,1,24,,,,,,1         * STIF24
ET,2,4,,,,,,1          * STIF4
ET,3,14,,1             * SPRING KX
ET,4,14,,2             * SPRING KY
ET,5,14,,3             * SPRING KZ
ET,6,14,,4             * SPRING ROTX
ET,7,14,,5             * SPRING ROTY
ET,8,14,,6             * SPRING ROTZ
ET,9,21,,,,,           * 3D MASS ELE.
ET,10,14,,0            * SPRING ALONG TWO POINTS
C*** MATERIAL PROPERTIES
EX,1,29000
RP21,1
ALPX,1,6.5E-6
RP21,1
DENS,1,0.283E-3         * STEEL DENSITY - NON-LINEAR
DENS,2,0.283E-3         * STEEL DENSITY - LINEAR
DENS,3,0.602E-3         * ELE. 4-6
DENS,4,1.081E-3         * ELE. 7-8
DENS,5,1.481E-3         * ELE. 9-10
DENS,6,0.617E-3         * ELE. 1-3, 28, 11,29
DENS,7,1.152E-3         * ELE. 12
DENS,8,1.270E-3         * ELE. 13
DENS,9,0.983E-3         * ELE. 14
DENS,10,1.517E-3        * ELE. 15
DENS,11,1.677E-3        * ELE. 16
DENS,12,0.716E-3        * ELE. 21
DENS,13,0.801E-3        * ELE. 22
DENS,14,0.871E-3        * ELE. 23
DENS,15,0.944E-3        * ELE. 24
```

11.3.2.2 ANSYS Input File "PR9CM" (Continued)

```
DENS,16,1.040E-3         * ELE. 25-26
DENS,17,0.0              * ZERO DENSITY - RIGID LINK
DENS,18,1.357E-3         * ELE. 32-33
DENS,19,0.936E-3         * ELE. 37
DENS,20,0.602E-3         * ELE. 38
DENS,21,1.016E-3         * ELE. 40
C***
MPTEMP,1,70,100,200,300,400
RP21,1
MPDATA,EX,1,1,29.0E3,28.9E3,28.3E3,27.9E3,27.4E3
RP21,,1
MPDATA,ALPX,1,1,6.50E-6,6.50E-6,6.50E-6,6.67E-6,6.86E-6
RP21,,1
C***  NONLINEAR MATERIAL CONSTANT
*CREAT,MNL
NL,ARG1,13,10
NL,ARG1,19,70,100,200,300,400
NL,ARG1,25,36,36.0,36.0,36.0,36.0
NL,ARG1,31,150,150,150,150,150
*END
C***
*USE,MNL,1
*USE,MNL,3
*USE,MNL,4
*USE,MNL,6
*USE,MNL,12
*USE,MNL,13
*USE,MNL,14
*USE,MNL,15
*USE,MNL,16
C***
C***  CROSS SECTIONAL PROPERTIES
C*** CHANNEL C7X9.8 ******
CF=2.090
TCF=0.366
CD=7.00
TCW=0.210
XBR=(0.541)+0.07069       * SAL  7/10/91
C***
XO=(TCW/2)-(XBR)
CC=CF-(TCW/2)
DD=(CD-TCF)/2.
QC=CC/2
QD=DD/2
CC=CC+XO
QC=QC+XO
*STAT
C***
R,1,CC,DD,0,QC,DD,TCF                 * STIF24 REAL PROP. - C7X9.8
RMORE,XO,DD,TCF,XO,QD,TCW
```

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Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.2.2 ANSYS Input File "PR9CM" (Continued)

```
RMORE,X0,0,TCW,X0,-QD,TCW
RMORE,X0,-DD,TCW,QC,-DD,TCF
RMORE,CC,-DD,TCF
C***
R,2,2.87,0.968,21.3,7.0,2.09      * C7X9.8
RMORE,,0.1
R,3,2.64,0.632,8.90,5.0,1.885     * C5X9 - ADDED MEMBERS
RMORE,,0.109
R,4,4000,5000,5000,20,20          * ANCHOR SHEAR SPRINGS & RIGID BEAM
R,5,8147                          * SPRING ROTY @NODE 8
R,6,17315                         * SPRING ROTY @NODE 10
R,7,27600                         * SPRING ROTX @NODES 1,4,11
R,8,56498                         * SPRING ROTY @NODE 7
R,9,0                             * SPRING ROTZ @NODE 8
R,10,21249                        * SPRING ROTZ @NODE 10
R,11,25989                        * SPRING ROTZ @NODES 1,4
R,12,33132                        * SPRING ROTZ @NODE 7
R,13,1590                         * VERT. SPR. 'C24' - NODE 32
C*** GENERALIZED MASS
R,14,.020,.020,.020                     * NODE 95  (28)

R,15,.031,.031,.031                     * NODE 96  (29)
MASX=(.035)*9.38
MASX=MASX/0.9
MASY=MASX
MASZ=(.035)*4.38
MASZ=MASZ/1.33
R,16,MASX,MASY,MASZ               * NODE 97  (30)
R,17,100,5000,5000                * ANCHOR SHEAR SPRINGS & RIGID BEAM
R,18,19791                        * SPRING ROTY ODE  12
R,19,12960                        * SPRING ROTZ ODE 12
R,20,2885                          * SPRING AXIAL ODE 32
R,21,(300*4)                      * SHEAR SPRING ODES 1 & 4
C***
C*** NODAL COORDINATES
CSYS,0
N,1,67.68
N,101,67.68
N,2,67.68,5.
N,102,67.68,5.
N,3,67.68,44.96
N,4,103.68
N,104,103.68
N,5,103.68,5.
N,105,103.68,5.
N,6,103.68,44.96
N,7,145.68,44.96
N,107,145.68,44.96
N,8,0,29.36
N,108,0,29.36
N,9,67.68,53.96
```

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Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.2.2 ANSYS Input File "PR9CM" (Continued)

```
N,109,67.68,53.96
N,10,135.36,78.76
N,110,135.36,78.76
N,11,115.68
N,111,115.68
N,12,145.68,27.96
N,112,145.68,27.96
N,13,67.68,30.
N,14,103.68,30.
N,15,85.63,5.
N,16,85.63,30.0
N,17,85.63,44.96
N,18,115.68,44.96
N,19,129.18,44.96
N,20,5.69,31.2
N,21,24.48,38.24
N,22,48.92,47.15
N,23,74.31,56.03
N,24,86.51,60.61
N,25,95.44,63.86
N,26,117.52,71.9
N,27,129.03,76.09
N,28,67.68,2.5
RP2,67,-3.75,0,29.5
N,29,67.68,46.44
RP2,67,-3.742,0,32.516
N,30,50.986,47.884
RP2,67,0.61563,-1.6914,-13.5
N,31,115.68,27.96
FILL,8,20,1,41,1
FILL,20,21,2,45,1
FILL,21,22,2,51,1
FILL,22,30,1,55,1
FILL,30,9,3,61,1
FILL,9,23,2,65,1
FILL,23,24,2,71,1
FILL,24,25,2,75,1
FILL,25,26,3,81,1
FILL,26,27,3,85,1
FILL,13,3,3,91,1
N,32,56.11,68.79,5.69          * JOINT '4A'   - REF. STRUDL MODEL
DX=(56.11)-67.68
DY=(68.79)-61.78
N,132,DX+56.11,DY+68.79,5.69
N,33,67.68,61.78,5.69          * JOINT '38A'
N,34,74.31,56.03,5.69          * JOINT '38B' ABOVE NODE23
N,35,67.68,53.96,5.69          * JOINT '39A' ABOVE NODE9
N,99,103.68,5.,100
N,100,67.68,53.96,100
C*** ELEMENT CONNECTIVITIES
```

11.3.2.2 ANSYS Input File "PR9CM" (Continued)

```
MAT,6   $TYPE,1    $REAL,1       * STIF24
EN,1,1,28,100
EN,2,2,13,100
EN,3,13,91,100     $,91,91,92,100    $,92,92,93,100    $,93,93,3,100
EN,28,28,2,100
EN,11,3,29,100
EN,29,29,109,100
MAT,3   $TYPE,1    $REAL,1       * STIF24
EN,4,4,5,99
EN,5,5,14,99
EN,6,14,6,99
MAT,4   $TYPE,1    $REAL,1       * STIF24
EN,7,102,15,99
EN,8,15,105,99
MAT,1   $TYPE,1    $REAL,1       * STIF24
EN,17,8,41,100     $,41,41,20,100
EN,18,20,45,100    $,45,45,46,100    $,46,46,21,100
EN,19,21,51,100    $,51,51,52,100    $,52,52,22,100
EN,20,22,55,100    $,55,55,30,100
EN,27,30,61,100    $,61,61,62,100    $,62,62,63,100    $,63,63,9,100
MAT,12  $TYPE,1    $REAL,1       * STIF24
EN,21,9,65,100     $,65,65,66,100    $,66,66,23,100
MAT,13  $TYPE,1    $REAL,1       * STIF24
EN,22,23,71,100    $,71,71,72,100    $,72,72,24,100
MAT,14  $TYPE,1    $REAL,1       * STIF24
EN,23,24,75,100    $,75,75,76,100    $,76,76,25,100
MAT,15  $TYPE,1    $REAL,1       * STIF24
EN,24,25,81,100    $,81,81,82,100    $,82,82,83,100    $,83,83,26,100
MAT,16  $TYPE,1    $REAL,1       * STIF24
EN,25,26,85,100    $,85,85,86,100    $,86,86,87,100    $,87,87,27,100
EN,26,27,10,100
MAT,5   $TYPE,2    $REAL,2       * STIF4
EN,9,13,16
EN,10,16,14
MAT,7   $TYPE,2    $REAL,2       * STIF4
EN,12,3,17
MAT,8   $TYPE,2    $REAL,2       * STIF4
EN,13,17,6
MAT,9   $TYPE,2    $REAL,2       * STIF4
EN,14,6,18
MAT,10  $TYPE,2    $REAL,2       * STIF4
EN,15,18,19
MAT,11  $TYPE,2    $REAL,2       * STIF4
EN,16,19,7
MAT,18  $TYPE,2    $REAL,3       * STIF4
EN,32,32,33
EN,33,33,34
MAT,2   $TYPE,2    $REAL,3       * STIF4
EN,34,33,35
MAT,19  $TYPE,2    $REAL,2       * STIF4
```

11.3.2.2 ANSYS Input File "PR9CM" (Continued)

```
EN,37,11,31
MAT,20  $TYPE,2    $REAL,2      * STIF4
EN,38,31,18
MAT,2   $TYPE,2    $REAL,2      * STIF4
EN,39,18,25
MAT,21  $TYPE,2    $REAL,2      * STIF4
EN,40,31,12
MAT,17  $TYPE,2    $REAL,4      * RIGID LINK
EN,35,35,9
EN,36,34,23
EN,95,28,95
EN,96,29,96
EN,97,30,97
TYPE,3    $REAL,4    * SPRING X
EN,171,111,11
TYPE,4    $REAL,4    * SPRING KY
EN,142,108,8
TYPE,4    $REAL,4    * SPRING KY
EN,132,107,7
EN,152,110,10
EN,182,112,12
TYPE,3    $REAL,21    * SPRING KX
C*** EN,101,101,1
C*** EN,104,4,104
TYPE,5    $REAL,13   * SPRING KZ NODE 32
EN,163,132,32
TYPE,10   $REAL,20   * SPRING AXIAL NODE 32
EN,161,132,32
TYPE,6    $REAL,7    * SPRING NODES 1,4   RX
EN,114,101,1
EN,124,104,4
EN,174,111,11
TYPE,7    $REAL,8    * SPRING NODE 7  RY
EN,135,107,7
TYPE,7    $REAL,18   * SPRING NODE 12 RY
EN,175,112,12
TYPE,7    $REAL,5    * SPRING NODE 8  RY
EN,145,108,8
TYPE,7    $REAL,6    * SPRING NODE 10 RY
EN,155,110,10
TYPE,8    $REAL,11   * SPRING NODES 1,4   RZ
EN,116,101,1
EN,126,104,4
EN,176,111,11
TYPE,8    $REAL,12   * SPRING NODE 7  RZ
EN,136,107,7
TYPE,8    $REAL,19   * SPRING NODE 12 RZ
EN,186,112,12
TYPE,8    $REAL,9    * SPRING NODE 8  RZ
EN,146,108,8
```

11.3.2.2 ANSYS Input File "PR9CM" (Continued)

```
TYPE,8   $REAL,10  * SPRING NODE 10 RZ
EN,156,110,10
TYPE,9   $REAL,14  * MASS NODE 95 (28)
EN,201,95
TYPE,9   $REAL,15  * MASS NODE 96 (29)
EN,202,96
TYPE,9   $REAL,16  * MASS NODE 97 (30)
EN,203,97
C***
/COM
/COM   MACRO TO SPECIFY ONE SPRING IN Y DIRECTION
/COM
*CREAT,SPR2
PSPRING,ARG1,TRAN,ARG2,ARG3
*END
C*** *USE,SPR2,1,(200*4),1      * SPRING IN X DIR.
C*** *USE,SPR2,4,(200*4),1      * SPRING IN X DIR.
C***
C*** COUPLED DOFS FOR MEMBER END RELEASES
CP,1,UX,102,2
CPLGEN,1,UY,UZ,ROTX,ROTY     * NODE2
CPSGEN,2,3,1,5               * NODE5
CPSGEN,2,7,1,5               * NODE9
CPLIST,ALL
C*** LOCAL COORDINATES SYSTEMS
LOCAL,12,0,0,29.36,0,20  $NROT,10,110,100
LOCAL,13,0,0,29.36,0,33  $NROT,8,108,100
CSYS,0
C*** BOUNDARY CONDITIONS
D,1,ROTY,,,4,3,UX,UY,UZ       * SAL  6/26/91  SAL 7/18/91
D,11,ROTY,,,,,UY,UZ
D,7,ROTX,,,12,5,UX,UZ
D,8,UZ,,,,,ROTX
D,10,UZ,,,,,ROTX,UX
D,101,ALL,,,110,3
D,108,ALL,,,132,24
D,111,ALL,,,112,1
C*** ANALYSIS OPTIONS
ITER,-20,20
TREF,70
POSTR,,1,5
C*** PLOT GEOMETRY AND B.C.
/SHOW
/PBC,ALL,1
EPLO
/PNUM,NODE,1
EPLO
/PNUM,NODE,-1
/PNUM,ELEM,1
EPLO
```

11.3.2.2 ANSYS Input File "PR9CM" (Continued)

```
/VIEW,,1,1,1
EPLO
C***
C*** DL + LL + SSE  XZ-PLANE
ACEL,0.9,0,1.33
C*** CONCENTRATED LOADS
C*** 'DL' + 'SMBOT' + 'SMBDN' + 'HANDDN' + 'HANDOT'
C*** TEMPERATURE LOADS
*CREAT,MAC
TUNIF,ARG1
LWRITE
*END
*USE,MAC,70
FDELE,ALL,ALL
C*** DL + LL + SSE  YZ-PLANE
ACEL,0,-0.9,1.33
C*** 'DL' + 'SMBCW' + 'HANDDN' + 'HANDCW'
*USE,MAC,70
C***
C*** BOUNDARY CONDITIONS - 2
C***
*CREAT,MACD
TUNIF,ARG1
D,1,UX,-ARG2
D,4,UX,ARG2
LWRITE
*END
D,11,UY,(-1/32)
D,7,UX,(1/32),,12,5
D,10,UX,(1/32)
C***
DD1=(0.03/26)
*USE,MACD,80,DD1
RP25,,10,DD1
*USE,MACD,327,0.03
AFWRITE,,1
FINISH
/INPUT,27
FINISH
/POST1
NLINE,200
*CREAT,PLD
SET,ARG1
PRRFOR
PRDISP
PLDISP
PLDISP,1
*END
*USE,PLD,1
*USE,PLD,2
```

11.3.2.2 ANSYS Input File "PR9CM" (Continued)

```
*USE,PLD,28
FINISH
C***
/POST26
LINE,200
NUMVAR,50
TVAR,1
ESTR,2,1,53,TEMP
C***
*CREATE,STCN
C*** STORE STRAINS FOR CHANNEL  (J NODE)
ESTR,13,ARG1,215,EE01
ESTR,14,ARG1,216,EP01
ESTR,15,ARG1,227,EE03
ESTR,16,ARG1,228,EP03
ESTR,17,ARG1,251,EE07
ESTR,18,ARG1,252,EP07
ESTR,19,ARG1,263,EE09
ESTR,20,ARG1,264,EP09
PRVAR,2,13,14,15,16
PRVAR,2,17,18,19,20
*END
C***
*CREATE,STC1
C*** STORE STRAINS FOR CHANNEL (I NODE)
ESTR,43,ARG1,95,EE01
ESTR,44,ARG1,96,EP01
ESTR,45,ARG1,107,EE03
ESTR,46,ARG1,108,EP03
ESTR,47,ARG1,131,EE07
ESTR,48,ARG1,132,EP07
ESTR,49,ARG1,143,EE09
ESTR,50,ARG1,144,EP09
PRVAR,2,43,44,45,46
PRVAR,2,47,48,49,40
*END
C***
*CREAT,DSP
DISP,21,ARG1,UX,UX
DISP,22,ARG1,UY,UY
DISP,23,ARG1,UZ,UZ
PROD,24,21,21,,UXUX
PROD,25,22,22,,UYUY
PROD,26,23,23,,UZUZ
ADD,27,24,25,26,SS
SQRT,28,27,,,SRSS
PRVAR,2,21,22,23,28
*END
C***
*USE,STC1,1
```

11.3.2.2 ANSYS Input File "PR9CM" (Continued)

```
*USE,STC1,4
C***
*USE,STCN,45
*USE,STCN,46
*USE,STCN,19
*USE,STCN,51
*USE,STCN,52
*USE,DSP,51
*USE,DSP,52
C***
*USE,STCN,28
*USE,DSP,2
*USE,STCN,4
*USE,DSP,5
*USE,DSP,1
*USE,DSP,4
C***
*CREAT,RFOR
RFORC,31,ARG1,FX,RFX
RFORC,32,ARG1,FY,RFY
RFORC,33,ARG1,FZ,RFZ
RFORC,34,ARG1,MX,RMX
RFORC,35,ARG1,MY,RMY
RFORC,36,ARG1,MZ,RMZ
PRVAR,31,32,33,34,35,36
*END
*USE,RFOR,8
*USE,RFOR,108
*USE,RFOR,10
*USE,RFOR,110
*USE,RFOR,1
*USE,RFOR,101
*USE,RFOR,4
*USE,RFOR,104
FINISH
```

11.3.3 Analysis Results

11.3.3.1 Analysis Results for "PR9C" (Analysis for the Original Structure)

The ANSYS output for the analysis "PR9C" is stored in file "PR9CR". The analysis results of the final load step (Load Step 16) are provided in this Section.

The deformed structure is plotted in Figure 11.3.3.1.1. Note that the displacements in this plot are magnified. This member is subjected to weak axis bending mainly due to thermal effect.

The reaction forces and the nodal displacements are provided in Sections 11.3.3.1.1 and 11.3.3.1.2. The maximum displacement for the Axially restrained member occurs at Node 51.

For the worst case 1-27 (Axial Restraint), the stresses and strains for elements 46, 19, 51 and 52 are listed in Section 11.3.3.1.3. Theses elements are in the neighborhood of node 51 where maximum displacements occurs. For the worst case 2&3-9(C) (Proximity Restraint), the stresses and strains for elements 7, 8, 28 and 4 are also presented in Section 11.3.3.1.3. The following explanations are provided for the labels shown in the stress and strain output.

PT:	Segment Point Number, see Figure 11.2.2 for the definition of segment point for cross-section of Channels.
TEMP:	Temperature
SIGX:	Axial Stress
EP:	Axial Elastic Strain
EPPL:	Axial Plastic Strain

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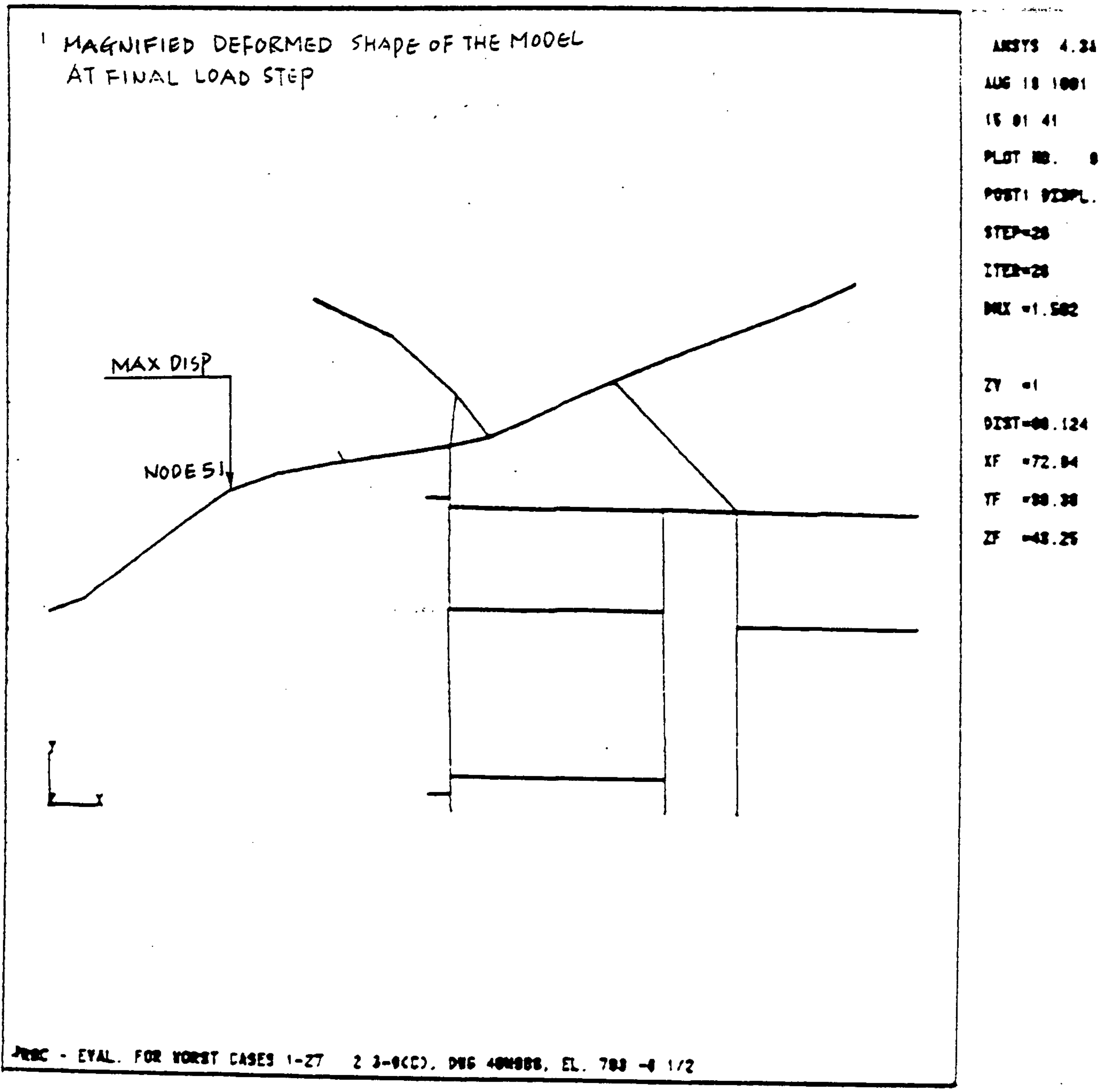
Figure 11.3.3.1.1 Deformed Shape of the Model for Analysis PR9C



For worst case 1-27 (Axial Restraint), the strain history at nodes 46, 21, 51, 52, and 22 are presented in Sections 11.3.3.1.4 through 11.3.3.1.8. These nodes are in the neighborhood of node 51 where maximum displacement occurs. The history of both elastic strain and plastic strain at segment points of 1, 3, 7, and 9 (see Figure 11.2.2 for segment point definition) are provided. Labels in the strain history print-out are defined as follows:

ITER:	Cumulative Iteration Number
TEMP:	Temperature
ARG1EE01:	Elastic Strain at Segment Point 1
ARG1EP01:	Plastic Strain at Segment Point 1
ARG1EE03:	Elastic Strain at Segment Point 3
ARG1EP03:	Plastic Strain at Segment Point 3
ARG1EE07:	Elastic Strain at Segment Point 7
ARG1EP07:	Plastic Strain at Segment Point 7
ARG1EE09:	Elastic Strain at Segment Point 9
ARG1EP09:	Plastic Strain at Segment Point 9

The yield temperature is determined where the plastic strain first appear. For example, the yield temperature for node 51 is 260°F (Section 11.3.3.1.6).

To identify the yield displacement of node 51, the displacement history of node 51 is presented in Section 11.3.3.1.9. The labels in the print-out are explained as follows:

TEMP:	Temperature
UX:	Displacement in nodal x direction
UY:	Displacement in nodal y direction
UZ:	Displacement in nodal z direction
SRSS:	Square Root of $(UX^2+UY^2+UZ^2)$

The yield displacement and the final displacement are used to determine the Ductility

Ratio (final displacement/yield displacement).

For worst case 2&3-9(C) (Proximity Restraint), the stress and strain history at nodes 2 and 5 are presented in Sections 11.3.3.1.10 and 11.3.3.1.11 respectively. The displacement history at nodes 2 and 5 are provided in Section 11.3.3.1.12 and 11.3.3.1.13 respectively. No yield occurs in the Proximity member and the Supporting members.

The member of the worst case 1-27 is not accepted per DG-C1.6.12 R1 (For details, see Section 11.3.4.1, Member Qualification for worst case 1-27). A slotted hole is installed to release the thermal-induced axial force. The modified structure is re-evaluated with the analysis "PR9CM" and the member is qualified using the results from the new analysis. The results of the analysis "PR9CM" are presented in Section 11.3.3.2.

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11.3.3.1.1 Reaction Forces

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

         ***** POST1 REACTION FORCE LISTING *****

 LOAD STEP    28  ITERATION=    20  SECTION=  1
 TIME=    0.0000         LOAD CASE=  1

 THE FOLLOWING X,Y,Z FORCES ARE IN NODAL COORDINATES

 NODE     FX               FY               FZ               MX               MY               MZ
    1   1.6503752       -4.3482587        .25531173                         -.24550348
    4  -.47005047        1.7394106        .22051535                         -.26600746
    7  -6.1124883                         .41409364        .15686290E-01
    8   50.672930                         .40827152       -.79631414
   10  -46.757535                         .42557583       -.60811805
   11                   -.39898433E-01    .67246683E-01                      .54323064E-02
   12   .47668958                         .11842651        .57760785E-02
  101   0.0000000        0.0000000        0.0000000        4.1469186        0.0000000       -13.513746
  104   0.0000000        0.0000000        0.0000000        3.7209014        0.0000000       -6.1115772
  107   0.0000000       -.24104888        0.0000000        0.0000000        7.3102569        4.7319111
  108   0.0000000       -11.616362        0.0000000        0.0000000        1.3848897       -14.339904
  110   0.0000000       -.75347139        0.0000000        0.0000000        4.9289769        .35916084
  111   .19486930        0.0000000        0.0000000        2.2017371        0.0000000       -3.0674356
  112   0.0000000       -.29075517        0.0000000        0.0000000        1.8059134        3.3153068
  132  -.88400565        .49995323        .11567178E-01    0.0000000        0.0000000        0.0000000

TOTAL  -1.2292163       -15.050431        1.9210084        8.6865872        14.923958       -28.626285
```

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11.3.3.1.2 Displacements

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

        ***** POST1 NODAL DISPLACEMENT LISTING *****

 LOAD STEP    28  ITERATION=    20  SECTION=  1
 TIME=    0.0000          LOAD CASE=  1

 THE FOLLOWING X,Y,Z DISPLACEMENTS ARE IN NODAL COORDINATES

   NODE     UX              UY              UZ              ROTX            ROTY            ROTZ
     1  -.30000000E-01  0.0000000       0.0000000      -.15025067E-03  0.0000000       .51997947E-03
     2  -.36791175E-01  .90881838E-02  -.81889725E-03  -.17883448E-03   .98458075E-05  .19818545E-02
     3  -.10206399      .81683525E-01  -.94132952E-02  -.22907114E-03   .42012134E-04 -.17224160E-02
     4   .30000000E-01  0.0000000       0.0000000      -.13481527E-03  0.0000000       .23516015E-03
     5   .26147318E-01  .87017696E-02  -.76721987E-03  -.16230317E-03  -.15121071E-04  .13637008E-02
     6  -.39888336E-01  .78064588E-01  -.88770415E-02  -.20290884E-03  -.12850342E-03 -.11701424E-02
     7   .31250000E-01  .60262219E-04   0.0000000       0.0000000      -.12938966E-03 -.14281997E-03
     8   0.0000000      .29040906E-02   0.0000000       0.0000000      -.16998769E-03  .18105940E-02
     9  -.70247157E-01  .97986193E-01  -.11010682E-01  -.25038302E-03   .47201120E-03 -.21184229E-01
    10   .31250000E-01  .18836785E-03   0.0000000       0.0000000      -.28466514E-03 -.16902482E-04
    11  -.48717325E-04 -.31250000E-01   0.0000000      -.79773082E-04  0.0000000       .11802823E-03
    12   .31250000E-01  .72688793E-04   0.0000000       0.0000000      -.91249227E-04 -.25581071E-03
    13  -.98494325E-01  .54452760E-01  -.60954534E-02  -.22346108E-03   .55706427E-05  .13535926E-02
    14  -.34919834E-01  .52124286E-01  -.56870567E-02  -.20782931E-03  -.31502955E-04  .13155114E-02
    15  -.54093220E-02  .10781880E-01  -.21081292E-02  -.10997894E-02   .97186143E-07 -.10009503E-04
    16  -.66795380E-01  .54129904E-01  -.61014739E-02  -.21603316E-03  -.10443620E-04 -.76413137E-03
    17  -.71062680E-01  .77865869E-01  -.99485094E-02  -.20980050E-03  -.32577379E-06  .57327074E-03
    18  -.19267263E-01  .48046923E-01  -.66971289E-02  -.22312842E-03  -.23362377E-03 -.19982728E-02
    19   .34552322E-02  .20240655E-01  -.33470537E-02  -.13048100E-03  -.24737729E-03 -.19363917E-02
    20  -.85014762E-02  .25468829E-01   .57671552E-02   .37743070E-02   .14085812E-02  .17746435E-01
    21  -.34491597      .88756364        .23782253E-01   .10974844E-01   .38818479E-02  .42448581E-01
    22  -.33923870      .84485813        .60033190E-01   .42279298E-01   .15115796E-01 -.37626270E-01
    23  -.22269529E-01 -.33081180E-01  -.14540636E-01  -.30965223E-03   .39826506E-03 -.18665033E-01
    24  -.43222354E-01  .34871726E-01  -.19241492E-01  -.12609761E-02  -.42692061E-03  .70033702E-02
    25  -.50079112E-01  .85143313E-01  -.17318791E-01  -.28970163E-03  -.29614651E-03  .24784091E-02
    26  -.75679907E-02  .48030027E-01  -.11327255E-01  -.20672669E-02  -.12657023E-02 -.44642064E-02
    27   .20952777E-01  .10607259E-01  -.46595104E-02  -.16519816E-02  -.11166408E-02 -.18171608E-02
    28  -.32480290E-01  .45456279E-02  -.64141351E-03  -.16671220E-03  -.19332989E-03  .14075981E-02
    29  -.98810885E-01  .84389977E-01  -.10045051E-01  -.23216657E-03  -.18830098E-03 -.25782027E-02
    30  -.31023912      .76533132        .64322340E-01   .47025625E-01   .16567796E-01 -.39133534E-01
    31  -.21818803E-01  .18038373E-01  -.34478567E-02  -.16247352E-03  -.12261337E-03  .48003957E-03
    32   .20554384      .35033846       -.72745920E-05  -.31638147E-03   .48237515E-03 -.19571970E-01
    33   .85924491E-01  .11155758       -.33146764E-02  -.31443469E-03   .48554239E-03 -.19773517E-01
    34  -.19981729E-01 -.31337005E-01  -.45097554E-02  -.30973169E-03   .39863366E-03 -.18665762E-01
    35  -.67543102E-01  .99384888E-01  -.97993916E-03  -.25044038E-03   .47165636E-03 -.21183423E-01
    41  -.10925319E-02  .10914077E-01   .29666006E-02   .19836548E-02   .51559354E-03  .39255430E-02
    45  -.12743297      .30722779        .11704922E-01   .63986722E-02   .21131703E-02  .47184794E-01
    46  -.23893782      .60427819        .17636339E-01   .86036205E-02   .29704199E-02  .46948039E-01
    51  -.46147977     1.1903594         .33884887E-01   .16320544E-01   .60278373E-02  .14252657E-01
    52  -.43909492     1.1181509         .45089254E-01   .26938664E-01   .10050178E-01 -.21729873E-01
```

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11.3.3.1.2 Displacements (Cont'd)

55	-.32487520	.80548951	.62131322E-01	.44635444E-01	.15836367E-01	-.38441020E-01
61	-.24827971	.59877239	.46636940E-01	.35551617E-01	.12817172E-01	-.40929846E-01
62	-.18486655	.42773060	.28156726E-01	.24009950E-01	.89866607E-02	-.41175061E-01
63	-.12219641	.25864551	.90293489E-02	.12243398E-01	.50051837E-02	-.39577814E-01
65	-.53732855E-01	.52551803E-01	-.12248349E-01	-.28265492E-03	.43746432E-03	-.20471250E-01
66	-.37707392E-01	.88035714E-02	-.13420483E-01	-.30297569E-03	.41327531E-03	-.19670274E-01
71	-.31475376E-01	-.23424968E-01	-.16419009E-01	-.30258923E-03	.22329195E-03	.48305135E-02
72	-.36883500E-01	.41356159E-02	-.18118576E-01	-.80365716E-03	-.13317918E-03	.70032616E-02
75	-.47055864E-01	.55814712E-01	-.18979178E-01	-.10477770E-02	-.42894424E-03	.61262393E-02
76	-.49568685E-01	.73195006E-01	-.18339954E-01	-.72946060E-03	-.38720652E-03	.46101536E-02
81	-.45587689E-01	.92783959E-01	-.17157872E-01	-.11590137E-02	-.72695948E-03	-.45039155E-03
82	-.35908107E-01	.86160775E-01	-.15967052E-01	-.17028592E-02	-.10180981E-02	-.26596548E-02
83	-.22640602E-01	.69605017E-01	-.13953572E-01	-.19876064E-02	-.11918026E-02	-.40250183E-02
85	.37588870E-03	.36537297E-01	-.97761157E-02	-.20359736E-02	-.12671433E-02	-.43106614E-02
86	.80227162E-02	.25870168E-01	-.81318298E-02	-.19561384E-02	-.12434984E-02	-.38914780E-02
87	.15060959E-01	.16779870E-01	-.64175456E-02	-.18285925E-02	-.11940360E-02	-.31034549E-02
91	-.10311296	.61259584E-01	-.70046236E-02	-.22295090E-03	-.52532955E-04	.10593093E-02
92	-.10603802	.68067826E-01	-.78566693E-02	-.22359789E-03	-.65189387E-04	.44944390E-03
93	-.10608505	.74876910E-01	-.86571618E-02	-.22557918E-03	-.33206417E-04	-.47719502E-03
95	-.44804783E-01	.41815697E-02	.50640856E-01	-.16676983E-03	-.19334073E-03	.14075908E-02
96	-.11151982	.10162726	.46572806E-01	-.23227502E-03	-.18831944E-03	-.25782152E-02
97	-.58809803	1.3815672	-.32529803E-01	.47025854E-01	.16567798E-01	-.39133528E-01
101	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
102	-.36791175E-01	.90881838E-02	-.81889725E-03	-.17883448E-03	.98458075E-05	.15672128E-03
104	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
105	.26147318E-01	.87017696E-02	-.76721987E-03	-.16230317E-03	-.15121071E-04	-.17818786E-03
107	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
108	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
109	-.70247157E-01	.97986193E-01	-.11010682E-01	-.25038302E-03	.47201120E-03	-.43985989E-02
110	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
111	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
112	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
132	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

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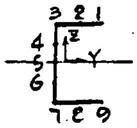

11.3.3.1.3 Stresses and Strains

```
EL=   46  NODES=   46   21  MAT=  1  PRESSURES(Z,Y)=  0.0000      0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX           EP          EPPL         EPCR         EPSW
        1  327.00   -6.0193      -.0002197    0.0000000    0.0000000    0.0000000
        2  327.00   -15.122      -.0005519    0.0000000    0.0000000    0.0000000
        3  327.00   -24.225      -.0008841    0.0000000    0.0000000    0.0000000
        4  327.00   -23.558      -.0008598    0.0000000    0.0000000    0.0000000
        5  327.00   -22.890      -.0008354    0.0000000    0.0000000    0.0000000
        6  327.00   -22.222      -.0008110    0.0000000    0.0000000    0.0000000
        7  327.00   -21.554      -.0007866    0.0000000    0.0000000    0.0000000
        8  327.00   -12.451      -.0004544    0.0000000    0.0000000    0.0000000
        9  327.00   -3.3478      -.0001222    0.0000000    0.0000000    0.0000000
END J  PT    TEMP      SIGX           EP          EPPL         EPCR         EPSW
        1  327.00    16.826       .0006141    0.0000000    0.0000000    0.0000000
        2  327.00   -10.654      -.0003888    0.0000000    0.0000000    0.0000000
        3  327.00   -30.600      -.0011168    -.0002750    0.0000000    0.0000000
        4  327.00   -30.542      -.0011147    -.0002227    0.0000000    0.0000000
        5  327.00   -30.485      -.0011126    -.0001704    0.0000000    0.0000000
        6  327.00   -30.428      -.0011105    -.0001181    0.0000000    0.0000000
        7  327.00   -30.364      -.0011082    -.0000661    0.0000000    0.0000000
        8  327.00   -4.6943      -.0001713    0.0000000    0.0000000    0.0000000
        9  327.00    22.786       .0008316    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   46   51.9207     -2.72496     .391963     -.336464     8.49554     10.8017
                           21  -51.9226      2.72060    -.384732      .345567    -11.0930    -29.0130


EL=   19  NODES=   21   51  MAT=  1  PRESSURES(Z,Y)=  0.0000      0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX           EP          EPPL         EPCR         EPSW
        1  327.00    16.800       .0006131    0.0000000    0.0000000    0.0000000
        2  327.00   -10.666      -.0003893    0.0000000    0.0000000    0.0000000
        3  327.00   -30.607      -.0011170    -.0002746    0.0000000    0.0000000
        4  327.00   -30.555      -.0011151    -.0002221    0.0000000    0.0000000
        5  327.00   -30.502      -.0011132    -.0001696    0.0000000    0.0000000
        6  327.00   -30.450      -.0011113    -.0001171    0.0000000    0.0000000
        7  327.00   -30.392      -.0011092    -.0000648    0.0000000    0.0000000
        8  327.00   -4.7014      -.0001716    0.0000000    0.0000000    0.0000000
        9  327.00    22.764       .0008308    0.0000000    0.0000000    0.0000000
END J  PT    TEMP      SIGX           EP          EPPL         EPCR         EPSW
        1  327.00    36.582       .0013351     .0038598    0.0000000    0.0000000
        2  327.00   -7.0483      -.0002572    0.0000000    0.0000000    0.0000000
        3  327.00   -36.659      -.0013379    -.0043715    0.0000000    0.0000000
        4  327.00   -36.643      -.0013373    -.0042653    0.0000000    0.0000000
        5  327.00   -36.627      -.0013368    -.0041591    0.0000000    0.0000000
        6  327.00   -36.611      -.0013362    -.0040529    0.0000000    0.0000000
        7  327.00   -36.595      -.0013356    -.0039468    0.0000000    0.0000000
        8  327.00    4.6530       .0001698    0.0000000    0.0000000    0.0000000
        9  327.00    36.646       .0013375     .0042845    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   21   51.9683     -1.63280     .367600     -.589604     11.0749     29.0127
                           51  -51.9706      1.62710    -.358224      .601407    -14.2218    -43.1462
```

11.3.3.1.3 Stresses and Strains (Cont'd)

```
EL=  51  NODES=  51  52  MAT=  1  PRESSURES(Z,Y)=  0.0000      0.0000      AVE. TEMP= 327.00
END I  PT   TEMP      SIGX          EP          EPPL        EPCR        EPSW
       1   327.00    36.555      .0013341    .0036820   0.0000000   0.0000000
       2   327.00   -7.3236     -.0002673   0.0000000   0.0000000   0.0000000
       3   327.00   -36.636     -.0013371   -.0042136   0.0000000   0.0000000
       4   327.00   -36.619     -.0013365   -.0041051   0.0000000   0.0000000
       5   327.00   -36.603     -.0013359   -.0039965   0.0000000   0.0000000
       6   327.00   -36.586     -.0013353   -.0038880   0.0000000   0.0000000
       7   327.00   -36.570     -.0013347   -.0037795   0.0000000   0.0000000
       8   327.00    4.6376      .0001693   0.0000000   0.0000000   0.0000000
       9   327.00    36.621      .0013365    .0041161   0.0000000   0.0000000
END J  PT   TEMP      SIGX          EP          EPPL        EPCR        EPSW
       1   327.00    36.172      .0013202    .0011436   0.0000000   0.0000000
       2   327.00   -13.425     -.0004900   0.0000000   0.0000000   0.0000000
       3   327.00   -34.532     -.0012603   -.0021835   0.0000000   0.0000000
       4   327.00   -34.522     -.0012599   -.0020529   0.0000000   0.0000000
       5   327.00   -34.512     -.0012596   -.0019223   0.0000000   0.0000000
       6   327.00   -34.502     -.0012592   -.0017917   0.0000000   0.0000000
       7   327.00   -34.493     -.0012589   -.0016612   0.0000000   0.0000000
       8   327.00    .92414      .0000337   0.0000000   0.0000000   0.0000000
       9   327.00    36.251      .0013230    .0016645   0.0000000   0.0000000
FORCES ON MEMBER AT NODE  51   51.9947     .407892     .333658    -1.16978     14.5376     43.0244
                          52  -51.9968    -.413593    -.324232     1.18164    -17.3900    -39.4627


EL=  52  NODES=  52  22  MAT=  1  PRESSURES(Z,Y)=  0.0000      0.0000      AVE. TEMP= 327.00
END I  PT   TEMP      SIGX          EP          EPPL        EPCR        EPSW
       1   327.00    36.152      .0013194    .0010073   0.0000000   0.0000000
       2   327.00   -13.943     -.0005089   0.0000000   0.0000000   0.0000000
       3   327.00   -34.387     -.0012550   -.0020894   0.0000000   0.0000000
       4   327.00   -34.373     -.0012545   -.0019554   0.0000000   0.0000000
       5   327.00   -34.360     -.0012540   -.0018215   0.0000000   0.0000000
       6   327.00   -34.346     -.0012535   -.0016875   0.0000000   0.0000000
       7   327.00   -34.327     -.0012528   -.0015537   0.0000000   0.0000000
       8   327.00    .79340      .0000290   0.0000000   0.0000000   0.0000000
       9   327.00    36.233      .0013224    .0015421   0.0000000   0.0000000
END J  PT   TEMP      SIGX          EP          EPPL        EPCR        EPSW
       1   327.00    8.2020      .0002993   0.0000000   0.0000000   0.0000000
       2   327.00   -13.801     -.0005037   0.0000000   0.0000000   0.0000000
       3   327.00   -29.216     -.0010663   -.0002404   0.0000000   0.0000000
       4   327.00   -29.126     -.0010630   -.0001585   0.0000000   0.0000000
       5   327.00   -28.983     -.0010578   -.0000785   0.0000000   0.0000000
       6   327.00   -28.615     -.0010443   -.0000067   0.0000000   0.0000000
       7   327.00   -26.464     -.0009658   0.0000000   0.0000000   0.0000000

       8   327.00   -4.4610     -.0001628   0.0000000   0.0000000   0.0000000
       9   327.00    17.542      .0006402   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE  52   51.9697     1.73674     .267096    -1.66902     17.8839     39.2223
                          22  -51.9717    -1.74236    -.257590     1.68099    -20.1587    -24.1384
```

EBASCO SERVICES INCORPORATED

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Chkd. by J. OU Date 8/21/91 OFS No. NR Dept. No. NR

Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.3 Stresses and Strains (Cont'd)

```
EL=    7  NODES=  102    15  MAT=  4  PRESSURES(Z,Y)=  0.0000        0.0000       AVE. TEMP= 327.00
END I  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   327.00   -.36908       -.0000135    0.0000000    0.0000000    0.0000000
        2   327.00   -.36896       -.0000135    0.0000000    0.0000000    0.0000000
        3   327.00   -.36885       -.0000135    0.0000000    0.0000000    0.0000000
        4   327.00   -.38607       -.0000141    0.0000000    0.0000000    0.0000000
        5   327.00   -.40329       -.0000147    0.0000000    0.0000000    0.0000000
        6   327.00   -.42051       -.0000153    0.0000000    0.0000000    0.0000000
        7   327.00   -.43774       -.0000160    0.0000000    0.0000000    0.0000000
        8   327.00   -.43786       -.0000160    0.0000000    0.0000000    0.0000000
        9   327.00   -.43797       -.0000160    0.0000000    0.0000000    0.0000000
END J  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   327.00    .65894E-01    .0000024    0.0000000    0.0000000    0.0000000
        2   327.00   -.31412       -.0000115    0.0000000    0.0000000    0.0000000
        3   327.00   -.69413       -.0000253    0.0000000    0.0000000    0.0000000
        4   327.00   -.64574       -.0000236    0.0000000    0.0000000    0.0000000
        5   327.00   -.59736       -.0000218    0.0000000    0.0000000    0.0000000
        6   327.00   -.54897       -.0000200    0.0000000    0.0000000    0.0000000
        7   327.00   -.50059       -.0000183    0.0000000    0.0000000    0.0000000
        8   327.00   -.12058       -.0000044    0.0000000    0.0000000    0.0000000
        9   327.00    .25943        .0000095    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE  102   1.14800     -.500041E-01  .832016E-01  .923639E-01  -.219073      -.139869E-03
                           15  -1.14801      .253117E-03 -.978182E-02  .579293E-04  -.615453      -.450919

EL=    8  NODES=   15   105  MAT=  4  PRESSURES(Z,Y)=  0.0000        0.0000       AVE. TEMP= 327.00
END I  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   327.00    .65888E-01    .0000024    0.0000000    0.0000000    0.0000000
        2   327.00   -.31412       -.0000115    0.0000000    0.0000000    0.0000000
        3   327.00   -.69412       -.0000253    0.0000000    0.0000000    0.0000000
        4   327.00   -.64574       -.0000236    0.0000000    0.0000000    0.0000000
        5   327.00   -.59736       -.0000218    0.0000000    0.0000000    0.0000000
        6   327.00   -.54897       -.0000200    0.0000000    0.0000000    0.0000000
        7   327.00   -.50059       -.0000183    0.0000000    0.0000000    0.0000000
        8   327.00   -.12058       -.0000044    0.0000000    0.0000000    0.0000000
        9   327.00    .25943        .0000095    0.0000000    0.0000000    0.0000000
END J  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   327.00   -.42276       -.0000154    0.0000000    0.0000000    0.0000000
        2   327.00   -.42283       -.0000154    0.0000000    0.0000000    0.0000000
        3   327.00   -.42289       -.0000154    0.0000000    0.0000000    0.0000000
        4   327.00   -.41314       -.0000151    0.0000000    0.0000000    0.0000000
        5   327.00   -.40339       -.0000147    0.0000000    0.0000000    0.0000000
        6   327.00   -.39363       -.0000144    0.0000000    0.0000000    0.0000000
        7   327.00   -.38388       -.0000140    0.0000000    0.0000000    0.0000000
        8   327.00   -.38381       -.0000140    0.0000000    0.0000000    0.0000000
        9   327.00   -.38374       -.0000140    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   15   1.14801     -.367526E-04  .969097E-02 -.252560E-03   .615454       .450915
                          105  -1.14800     -.499908E-01  .641383E-01  .931898E-01  -.124068      -.794080E-04
```

EBASCO SERVICES INCORPORATED

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Chkd. by J.OU Date 8/21/91 OFS No. NR Dept. No. NR

Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.3 Stresses and Strains (Cont'd)

```
EL=   28  NODES=   28    2  MAT=  6  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX            EP         EPPL         EPCR         EPSW
        1   327.00   -9.8922      -.0003610    0.0000000    0.0000000    0.0000000
        2   327.00   -1.9144      -.0000699    0.0000000    0.0000000    0.0000000
        3   327.00    6.0633       .0002213    0.0000000    0.0000000    0.0000000
        4   327.00    5.8286       .0002127    0.0000000    0.0000000    0.0000000
        5   327.00    5.5938       .0002042    0.0000000    0.0000000    0.0000000
        6   327.00    5.3591       .0001956    0.0000000    0.0000000    0.0000000
        7   327.00    5.1244       .0001870    0.0000000    0.0000000    0.0000000
        8   327.00   -2.8533      -.0001041    0.0000000    0.0000000    0.0000000
        9   327.00   -10.831      -.0003953    0.0000000    0.0000000    0.0000000
END J  PT    TEMP      SIGX            EP         EPPL         EPCR         EPSW
        1   327.00   -4.8238      -.0001760    0.0000000    0.0000000    0.0000000
        2   327.00   -.30763      -.0000112    0.0000000    0.0000000    0.0000000
        3   327.00    4.2085       .0001536    0.0000000    0.0000000    0.0000000
        4   327.00    4.0169       .0001466    0.0000000    0.0000000    0.0000000
        5   327.00    3.8252       .0001396    0.0000000    0.0000000    0.0000000
        6   327.00    3.6336       .0001326    0.0000000    0.0000000    0.0000000
        7   327.00    3.4420       .0001256    0.0000000    0.0000000    0.0000000
        8   327.00   -1.0742      -.0000392    0.0000000    0.0000000    0.0000000
        9   327.00   -5.5903      -.0002040    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   28  -4.32915      -1.64300       .222196      -.694147E-01  -2.98575     -9.46635
                            2   4.32520       1.64301      -.216357       .767642E-01   2.43756      5.35883

EL=    4  NODES=    4    5  MAT=  3  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX            EP         EPPL         EPCR         EPSW
        1   327.00   -7.6979      -.0002809    0.0000000    0.0000000    0.0000000
        2   327.00   -2.5474      -.0000930    0.0000000    0.0000000    0.0000000
        3   327.00    2.6032       .0000950    0.0000000    0.0000000    0.0000000
        4   327.00    2.3107       .0000843    0.0000000    0.0000000    0.0000000
        5   327.00    2.0182       .0000737    0.0000000    0.0000000    0.0000000
        6   327.00    1.7257       .0000630    0.0000000    0.0000000    0.0000000
        7   327.00    1.4332       .0000523    0.0000000    0.0000000    0.0000000
        8   327.00   -3.7174      -.0001357    0.0000000    0.0000000    0.0000000
        9   327.00   -8.8679      -.0003236    0.0000000    0.0000000    0.0000000
END J  PT    TEMP      SIGX            EP         EPPL         EPCR         EPSW
        1   327.00   -10.811      -.0003946    0.0000000    0.0000000    0.0000000
        2   327.00   -3.6858      -.0001345    0.0000000    0.0000000    0.0000000
        3   327.00    3.4396       .0001255    0.0000000    0.0000000    0.0000000
        4   327.00    3.2317       .0001179    0.0000000    0.0000000    0.0000000
        5   327.00    3.0237       .0001104    0.0000000    0.0000000    0.0000000
        6   327.00    2.8158       .0001028    0.0000000    0.0000000    0.0000000
        7   327.00    2.6078       .0000952    0.0000000    0.0000000    0.0000000
        8   327.00   -4.5177      -.0001649    0.0000000    0.0000000    0.0000000
        9   327.00   -11.643      -.0004249    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE    4   1.73975       .468684       .220781       .991794E-02  -3.72065     -6.11164
                            5  -1.74746      -.468678      -.209388       .442356E-02   2.64522      8.45505
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Client TVA
Project WBNP Unit 1
Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.4 Strain History at Node 46 (Element 45)
(Segment Points 1 and 3)

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

         ANSYS POST26 VARIABLE LISTING

   ITER        ESTR    1 53   ESTR   45 215  ESTR   45 216  ESTR   45 227  ESTR   45 228
                 1     TEMP     ARG1EE01       ARG1EP01      ARG1EE03       ARG1EP03
   4.0000       70.0000       .318352E-06    0.00000      -.247614E-05    0.00000
   8.0000       70.0000       .239213E-05    0.00000      -.510512E-05    0.00000
   12.000       80.0000       .152621E-03    0.00000       .131580E-03    0.00000
   15.000       90.0000       .801221E-04    0.00000       .680262E-04    0.00000
   18.000       100.000       .743339E-05    0.00000       .447528E-05    0.00000
   21.000       110.000      -.654561E-04    0.00000      -.590939E-04    0.00000
   24.000       120.000      -.138539E-03    0.00000      -.122685E-03    0.00000
   27.000       130.000      -.211804E-03    0.00000      -.186303E-03    0.00000
   30.000       140.000      -.285239E-03    0.00000      -.249951E-03    0.00000
   33.000       150.000      -.358830E-03    0.00000      -.313636E-03    0.00000
   36.000       160.000      -.432557E-03    0.00000      -.377363E-03    0.00000
   42.000       170.000      -.506286E-03    0.00000      -.441139E-03    0.00000
   49.000       180.000      -.580224E-03    0.00000      -.504895E-03    0.00000
   60.000       190.000      -.653596E-03    0.00000      -.567997E-03    0.00000
   77.000       200.000      -.726399E-03    0.00000      -.630536E-03    0.00000
   96.000       210.000      -.796473E-03    0.00000      -.693752E-03    0.00000
   116.00       220.000      -.846424E-03    0.00000      -.761994E-03    0.00000
   136.00       230.000      -.894852E-03    0.00000      -.830435E-03    0.00000
   156.00       240.000      -.871349E-03    0.00000      -.913477E-03    0.00000
   176.00       250.000      -.790157E-03    0.00000      -.100777E-02    0.00000
   196.00       260.000      -.694468E-03    0.00000      -.109806E-02    0.00000
   216.00       270.000      -.606102E-03    0.00000      -.112815E-02    0.00000
   236.00       280.000      -.500020E-03    0.00000      -.112003E-02    0.00000
   256.00       290.000      -.394110E-03    0.00000      -.109988E-02    0.00000
   276.00       300.000      -.325985E-03    0.00000      -.103733E-02    0.00000
   296.00       310.000      -.276695E-03    0.00000      -.959896E-03    0.00000
   316.00       320.000      -.240156E-03    0.00000      -.909973E-03    0.00000
   336.00       327.000      -.218509E-03    0.00000      -.884242E-03    0.00000
```

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Client TVA
Project WBNP Unit 1
Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.4 Strain History at Node 46 (Element 45) (Cont'd) (Segment Points 7 and 9)

ITER	ESTR 1 53	ESTR 45 251	ESTR 45 252	ESTR 45 263	ESTR 45 264
	1 TEMP	ARG1EE07	ARG1EP07	ARG1EE09	ARG1EP09
4.0000	70 0000	-.794660E-05	0.00000	-.515211E-05	0.00000
8.0000	70.0000	.310424E-06	0.00000	.780767E-05	0.00000
12.000	80.0000	.140412E-03	0.00000	.161453E-03	0.00000
15.000	90.0000	.768373E-04	0.00000	.889332E-04	0.00000
18.000	100.000	.133228E-04	0.00000	.162809E-04	0.00000
21.000	110.000	-.501095E-04	0.00000	-.564717E-04	0.00000
24.000	120.000	-.113458E-03	0.00000	-.129311E-03	0.00000
27.000	130.000	-.176720E-03	0.00000	-.202221E-03	0.00000
30.000	140.000	-.239894E-03	0.00000	-.275183E-03	0.00000
33.000	150.000	-.302979E-03	0.00000	-.348174E-03	0.00000
36.000	160.000	-.365974E-03	0.00000	-.421168E-03	0.00000
42.000	170.000	-.428764E-03	0.00000	-.493911E-03	0.00000
49.000	180.000	-.490894E-03	0.00000	-.566224E-03	0.00000
60.000	190.000	-.552678E-03	0.00000	-.638277E-03	0.00000
77.000	200.000	-.612190E-03	0.00000	-.708054E-03	0.00000
96.000	210.000	-.670488E-03	0.00000	-.773209E-03	0.00000
116.00	220.000	-.732969E-03	0.00000	-.817400E-03	0.00000
136.00	230.000	-.795557E-03	0.00000	-.859974E-03	0.00000
156.00	240.000	-.870914E-03	0.00000	-.828786E-03	0.00000
176.00	250.000	-.955820E-03	0.00000	-.738204E-03	0.00000
196.00	260.000	-.103923E-02	0.00000	-.635640E-03	0.00000
216.00	270.000	-.106121E-02	0.00000	-.539161E-03	0.00000
236.00	280.000	-.104106E-02	0.00000	-.421057E-03	0.00000
256.00	290.000	-.101148E-02	0.00000	-.305704E-03	0.00000
276.00	300.000	-.946434E-03	0.00000	-.235085E-03	0.00000
296.00	310.000	-.864829E-03	0.00000	-.181628E-03	0.00000
316.00	320.000	-.813160E-03	0.00000	-.143343E-03	0.00000
336.00	327.000	-.787023E-03	0.00000	-.121290E-03	0.00000

11.3.3.1.5 Strain History at Node 21 (Element 46)
(Segment Points 1 and 3)

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

         ANSYS POST26 VARIABLE LISTING

  ITER        ESTR    1 53   ESTR  46 215  ESTR  46 216  ESTR  46 227  ESTR  46 228
                 1   TEMP     ARG1EE01      ARG1EP01      ARG1EE03      ARG1EP03
  4.0000        70.0000      .866323E-05   0.00000      -.574006E-05   0.00000
  8.0000        70.0000      .154236E-04   0.00000      -.150152E-04   0.00000
  12.000        80.0000      .127651E-03   0.00000       .133402E-03   0.00000
  15.000        90.0000      .734070E-04   0.00000       .636471E-04   0.00000
  18.000        100.000      .196337E-04   0.00000      -.634445E-05   0.00000
  21.000        110.000     -.336849E-04   0.00000      -.765987E-04   0.00000
  24.000        120.000     -.864965E-04   0.00000      -.147135E-03   0.00000
  27.000        130.000     -.138743E-03   0.00000      -.217976E-03   0.00000
  30.000        140.000     -.190358E-03   0.00000      -.289145E-03   0.00000
  33.000        150.000     -.241269E-03   0.00000      -.360668E-03   0.00000
  36.000        160.000     -.291392E-03   0.00000      -.432575E-03   0.00000
  42.000        170.000     -.339864E-03   0.00000      -.505117E-03   0.00000
  49.000        180.000     -.387556E-03   0.00000      -.578160E-03   0.00000
  60.000        190.000     -.433152E-03   0.00000      -.650934E-03   0.00000
  77.000        200.000     -.476712E-03   0.00000      -.724112E-03   0.00000
  96.000        210.000     -.516387E-03   0.00000      -.798881E-03   0.00000
  116.00        220.000     -.536114E-03   0.00000      -.878737E-03   0.00000
  136.00        230.000     -.552184E-03   0.00000      -.959520E-03   0.00000
  156.00        240.000     -.500214E-03   0.00000      -.105381E-02   0.00000
  176.00        250.000     -.391657E-03   0.00000      -.115915E-02   0.00000
  196.00        260.000     -.264509E-03   0.00000      -.126167E-02   0.00000
  216.00        270.000     -.124279E-03   0.00000      -.129758E-02  -.228334E-04
  236.00        280.000      .512043E-04   0.00000      -.128545E-02  -.126863E-03
  256.00        290.000      .239480E-03   0.00000      -.127622E-02  -.215034E-03
  276.00        300.000      .397551E-03   0.00000      -.123246E-02  -.274994E-03
  296.00        310.000      .502075E-03   0.00000      -.117406E-02  -.274994E-03
  316.00        320.000      .573023E-03   0.00000      -.113591E-02  -.274994E-03
  336.00        327.000      .614091E-03   0.00000      -.111678E-02  -.274994E-03
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EBASCO SERVICES INCORPORATED

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Chkd. by J OU Date 8/21/91 OFS No. NR Dept. No. NR

Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.5 Strain History at Node 21 (Element 46) (Cont'd)

(Segment Points 7 and 9)

```
  ITER        ESTR    1 53  ESTR  46 251  ESTR  46 252  ESTR  46 263  ESTR  46 264
                1   TEMP     ARG1EE07      ARG1EP07      ARG1EE09      ARG1EP09
 4.0000       70.0000      -.104927E-04  0.00000       .391057E-05   0.00000
 8.0000       70.0000      -.153523E-05  0.00000       .289036E-04   0.00000
 12.000       80.0000       .152224E-03  0.00000       .146472E-03   0.00000
 15.000       90.0000       .823654E-04  0.00000       .921252E-04   0.00000
 18.000       100.000       .123468E-04  0.00000       .383249E-04   0.00000
 21.000       110.000      -.578047E-04  0.00000      -.148909E-04   0.00000
 24.000       120.000      -.128102E-03  0.00000      -.674629E-04   0.00000
 27.000       130.000      -.198559E-03  0.00000      -.119325E-03   0.00000
 30.000       140.000      -.269191E-03  0.00000      -.170404E-03   0.00000
 33.000       150.000      -.340018E-03  0.00000      -.220618E-03   0.00000
 36.000       160.000      -.411058E-03  0.00000      -.269875E-03   0.00000
 42.000       170.000      -.482450E-03  0.00000      -.317197E-03   0.00000
 49.000       180.000      -.553433E-03  0.00000      -.362830E-03   0.00000
 60.000       190.000      -.624661E-03  0.00000      -.406880E-03   0.00000
 77.000       200.000      -.693894E-03  0.00000      -.446493E-03   0.00000
 96.000       210.000      -.762054E-03  0.00000      -.479560E-03   0.00000
 116.00       220.000      -.834282E-03  0.00000      -.491658E-03   0.00000
 136.00       230.000      -.907349E-03  0.00000      -.500013E-03   0.00000

 156.00       240.000      -.991745E-03  0.00000      -.438151E-03   0.00000
 176.00       250.000      -.108523E-02  0.00000      -.317735E-03   0.00000
 196.00       260.000      -.117875E-02  0.00000      -.181592E-03   0.00000
 216.00       270.000      -.121942E-02  0.00000      -.232854E-04   0.00000
 236.00       280.000      -.124923E-02  0.00000       .214288E-03   0.00000
 256.00       290.000      -.126589E-02 -.259908E-04   .438857E-03   0.00000
 276.00       300.000      -.123021E-02 -.660775E-04   .608720E-03   0.00000
 296.00       310.000      -.116749E-02 -.660775E-04   .717566E-03   0.00000
 316.00       320.000      -.112763E-02 -.660775E-04   .790225E-03   0.00000
 336.00       327.000      -.110818E-02 -.660775E-04   .831604E-03   0.00000
```

EBASCO SERVICES INCORPORATED

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Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.6 Strain History at Node 51 (Element 19)
(Segment Points 1 and 3)

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

        ANSYS POST26 VARIABLE LISTING

   ITER        ESTR    1 53   ESTR   19 215  ESTR   19 216  ESTR   19 227  ESTR   19 228
                1    TEMP      ARG1EE01       ARG1EP01       ARG1EE03       ARG1EP03
  4.0000       70.0000      .178657E-04    0.00000       -.883887E-05    0.00000
  8.0000       70.0000      .304412E-04    0.00000       -.266124E-04    0.00000
  12.000       80.0000      .132517E-03    0.00000        .123628E-03    0.00000
  15.000       90.0000      .838984E-04    0.00000        .520059E-04    0.00000
  18.000       100.000      .363913E-04    0.00000       -.200930E-04    0.00000
  21.000       110.000     -.100302E-04    0.00000       -.926993E-04    0.00000
  24.000       120.000     -.552745E-04    0.00000       -.165848E-03    0.00000
  27.000       130.000     -.992408E-04    0.00000       -.239576E-03    0.00000
  30.000       140.000     -.141817E-03    0.00000       -.313924E-03    0.00000
  33.000       150.000     -.182881E-03    0.00000       -.388937E-03    0.00000
  36.000       160.000     -.222294E-03    0.00000       -.464665E-03    0.00000
  42.000       170.000     -.258494E-03    0.00000       -.541593E-03    0.00000
  49.000       180.000     -.292848E-03    0.00000       -.619622E-03    0.00000
  60.000       190.000     -.323484E-03    0.00000       -.697765E-03    0.00000
  77.000       200.000     -.350337E-03    0.00000       -.777503E-03    0.00000
  96.000       210.000     -.372333E-03    0.00000       -.859814E-03    0.00000
  116.00       220.000     -.376752E-03    0.00000       -.946527E-03    0.00000
  136.00       230.000     -.375944E-03    0.00000       -.103470E-02    0.00000
  156.00       240.000     -.318364E-03    0.00000       -.113274E-02    0.00000
  176.00       250.000     -.212070E-03    0.00000       -.123930E-02    0.00000
  196.00       260.000     -.915893E-04    0.00000       -.131416E-02   -.532933E-04
  216.00       270.000      .207514E-03    0.00000       -.131693E-02   -.555589E-03
  236.00       280.000      .682939E-03    0.00000       -.132056E-02   -.121513E-02
  256.00       290.000      .115386E-02    0.00000       -.132385E-02   -.181416E-02
  276.00       300.000      .131915E-02   .958882E-03    -.132804E-02   -.257453E-02
  296.00       310.000      .132639E-02   .227471E-02    -.133229E-02   -.334740E-02
  316.00       320.000      .133175E-02   .324905E-02    -.133566E-02   -.395934E-02
  336.00       327.000      .133512E-02   .385981E-02    -.133793E-02   -.437147E-02
```

First Plastic strain

EBASCO SERVICES INCORPORATED

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Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.6 Strain History at Node 51 (Element 19) (Cont'd)

(Segment Points 7 and 9)

```
  ITER        ESTR    1 53   ESTR   19 251  ESTR   19 252  ESTR   19 263  ESTR   19 264
                1     TEMP     ARG1EE07       ARG1EP07       ARG1EE09       ARG1EP09
 4.0000       70.0000       -.135284E-04    0.00000        .131762E-04    0.00000
 8.0000       70.0000       -.359306E-05    0.00000        .534605E-04    0.00000
 12.000       80.0000        .154472E-03    0.00000        .163361E-03    0.00000
 15.000       90.0000        .826478E-04    0.00000        .114540E-03    0.00000
 18.000       100.000        .104526E-04    0.00000        .669369E-04    0.00000
 21.000       110.000       -.620782E-04    0.00000        .205910E-04    0.00000
 24.000       120.000       -.134970E-03    0.00000       -.243970E-04    0.00000
 27.000       130.000       -.208252E-03    0.00000       -.679170E-04    0.00000
 30.000       140.000       -.281954E-03    0.00000       -.109848E-03    0.00000
 33.000       150.000       -.356111E-03    0.00000       -.150055E-03    0.00000
 36.000       160.000       -.430762E-03    0.00000       -.188391E-03    0.00000
 42.000       170.000       -.506288E-03    0.00000       -.223189E-03    0.00000
 49.000       180.000       -.581656E-03    0.00000       -.254882E-03    0.00000
 60.000       190.000       -.657910E-03    0.00000       -.283629E-03    0.00000
 77.000       200.000       -.732480E-03    0.00000       -.305313E-03    0.00000
 96.000       210.000       -.805996E-03    0.00000       -.318514E-03    0.00000
 116.00       220.000       -.882704E-03    0.00000       -.312930E-03    0.00000
 136.00       230.000       -.960798E-03    0.00000       -.302047E-03    0.00000
 156.00       240.000       -.104625E-02    0.00000       -.231877E-03    0.00000
 176.00       250.000       -.113802E-02    0.00000       -.110781E-03    0.00000
 196.00       260.000       -.123338E-02    0.00000        .424902E-04    0.00000
 216.00       270.000       -.131573E-02   -.338381E-03    .425918E-03    0.00000
 236.00       280.000       -.131922E-02   -.971454E-03    .927960E-03    0.00000
 256.00       290.000       -.132217E-02   -.150722E-02    .131468E-02    .147818E-03
 276.00       300.000       -.132579E-02   -.216562E-02    .132140E-02    .136778E-02
 296.00       310.000       -.132998E-02   -.292693E-02    .132870E-02    .269518E-02
 316.00       320.000       -.133333E-02   -.353482E-02    .133409E-02    .367356E-02
 336.00       327.000       -.133559E-02   -.394675E-02    .133745E-02    .428453E-02
```

By SM Date 8/20/91

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Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.7 Strain History at Node 52 (Element 51)
(Segment Points 1 and 3)

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

          ANSYS POST26 VARIABLE LISTING

   ITER         ESTR    1 53  ESTR  51 215  ESTR  51 216  ESTR  51 227  ESTR  51 228
                   1    TEMP    ARG1EE01      ARG1EP01      ARG1EE03      ARG1EP03
  4.0000        70.0000       .267728E-04    0.00000     -.112554E-04    0.00000
  8.0000        70.0000       .425815E-04    0.00000     -.367403E-04    0.00000
  12.000        80.0000       .134384E-03    0.00000      .115371E-03    0.00000
  15.000        90.0000       .915551E-04    0.00000      .418191E-04    0.00000
  18.000        100.000       .500470E-04    0.00000     -.323051E-04    0.00000
  21.000        110.000       .981145E-05    0.00000     -.107034E-03    0.00000
  24.000        120.000      -.290616E-04    0.00000     -.182402E-03    0.00000
  27.000        130.000      -.664734E-04    0.00000     -.258448E-03    0.00000
  30.000        140.000      -.102316E-03    0.00000     -.335213E-03    0.00000
  33.000        150.000      -.136471E-03    0.00000     -.412741E-03    0.00000
  36.000        160.000      -.168807E-03    0.00000     -.491081E-03    0.00000
  42.000        170.000      -.197620E-03    0.00000     -.570767E-03    0.00000
  49.000        180.000      -.224180E-03    0.00000     -.651928E-03    0.00000
  60.000        190.000      -.246386E-03    0.00000     -.733258E-03    0.00000
  77.000        200.000      -.264337E-03    0.00000     -.816933E-03    0.00000
  96.000        210.000      -.278052E-03    0.00000     -.903602E-03    0.00000
  116.00        220.000      -.279644E-03    0.00000     -.992931E-03    0.00000
  136.00        230.000      -.276395E-03    0.00000     -.108357E-02    0.00000
  156.00        240.000      -.235811E-03    0.00000     -.117765E-02    0.00000
  176.00        250.000      -.162585E-03    0.00000     -.127492E-02    0.00000
  196.00        260.000      -.855664E-04    0.00000     -.131454E-02   -.121523E-03
  216.00        270.000       .163016E-03    0.00000     -.131707E-02   -.581510E-03
  236.00        280.000       .535449E-03    0.00000     -.131969E-02   -.105745E-02
  256.00        290.000       .911271E-03    0.00000     -.132128E-02   -.148000E-02
  276.00        300.000       .131389E-02   .363571E-05  -.131317E-02   -.187076E-02
  296.00        310.000       .131715E-02   .596767E-03  -.128070E-02   -.208435E-02
  316.00        320.000       .131927E-02   .980976E-03  -.126688E-02   -.217793E-02
  336.00        327.000       .132016E-02   .114362E-02  -.126028E-02   -.218345E-02
```

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Client TVA
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Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.7 Strain History at Node 52 (Element 51) (Cont'd)

(Segment Points 7 and 9)

ITER	ESTR 1 53	ESTR 51 251	ESTR 51 252	ESTR 51 263	ESTR 51 264
	1 TEMP	ARG1EE07	ARG1EP07	ARG1EE09	ARG1EP09
4.0000	70.0000	-.167413E-04	0.00000	.212869E-04	0.00000
8.0000	70.0000	-.488893E-05	0.00000	.744329E-04	0.00000
12.000	80.0000	.157506E-03	0.00000	.176519E-03	0.00000
15.000	90.0000	.836698E-04	0.00000	.133406E-03	0.00000
18.000	100.000	.940314E-05	0.00000	.917553E-04	0.00000
21.000	110.000	-.652472E-04	0.00000	.515980E-04	0.00000
24.000	120.000	-.140306E-03	0.00000	.130347E-04	0.00000
27.000	130.000	-.215799E-03	0.00000	-.238247E-04	0.00000
30.000	140.000	-.291757E-03	0.00000	-.588604E-04	0.00000
33.000	150.000	-.368212E-03	0.00000	-.919412E-04	0.00000
36.000	160.000	-.445197E-03	0.00000	-.122924E-03	0.00000
42.000	170.000	-.523147E-03	0.00000	-.150000E-03	0.00000
49.000	180.000	-.600962E-03	0.00000	-.173215E-03	0.00000
60.000	190.000	-.679963E-03	0.00000	-.193090E-03	0.00000
77.000	200.000	-.757153E-03	0.00000	-.204557E-03	0.00000
96.000	210.000	-.832767E-03	0.00000	-.207217E-03	0.00000
116.00	220.000	-.909643E-03	0.00000	-.196356E-03	0.00000
136.00	230.000	-.987778E-03	0.00000	-.180599E-03	0.00000
156.00	240.000	-.106649E-02	0.00000	-.124651E-03	0.00000
176.00	250.000	-.114594E-02	0.00000	-.335981E-04	0.00000
196.00	260.000	-.123881E-02	0.00000	.111688E-03	0.00000
216.00	270.000	-.131557E-02	-.308690E-03	.437338E-03	0.00000
236.00	280.000	-.131802E-02	-.754734E-03	.839830E-03	0.00000
256.00	290.000	-.131959E-02	-.114907E-02	.124389E-02	0.00000
276.00	300.000	-.127984E-02	-.143396E-02	.131646E-02	.471194E-03
296.00	310.000	-.127573E-02	-.157322E-02	.131998E-02	.111004E-02
316.00	320.000	-.126529E-02	-.165584E-02	.132214E-02	.150179E-02
336.00	327.000	-.125886E-02	-.166117E-02	.132303E-02	.166446E-02

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Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.8 Strain History at Node 22 (Element 52)

(Segment Points 1 and 3)

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2"

          ANSYS POST26 VARIABLE LISTING

  ITER        ESTR   1 53   ESTR  52 215  ESTR  52 216  ESTR  52 227  ESTR  52 228
                1   TEMP     ARG1EE01      ARG1EP01      ARG1EE03      ARG1EP03
 4.0000       70.0000      .353583E-04   0.00000     -.129496E-04   0.00000
 8.0000       70.0000      .522916E-04   0.00000     -.454511E-04   0.00000
 12.000       80.0000      .133984E-03   0.00000      .108460E-03   0.00000
 15.000       90.0000      .971078E-04   0.00000      .329252E-04   0.00000
 18.000       100.000      .611874E-04   0.00000     -.430830E-04   0.00000
 21.000       110.000      .261440E-04   0.00000     -.119596E-03   0.00000
 24.000       120.000     -.798079E-05   0.00000     -.196633E-03   0.00000
 27.000       130.000     -.411417E-04   0.00000     -.274215E-03   0.00000
 30.000       140.000     -.732897E-04   0.00000     -.352365E-03   0.00000
 33.000       150.000     -.104372E-03   0.00000     -.431105E-03   0.00000
 36.000       160.000     -.134330E-03   0.00000     -.510461E-03   0.00000
 42.000       170.000     -.161926E-03   0.00000     -.590807E-03   0.00000
 49.000       180.000     -.187694E-03   0.00000     -.672715E-03   0.00000
 60.000       190.000     -.209692E-03   0.00000     -.754435E-03   0.00000
 77.000       200.000     -.228455E-03   0.00000     -.838722E-03   0.00000
 96.000       210.000     -.245303E-03   0.00000     -.925817E-03   0.00000
 116.00       220.000     -.257951E-03   0.00000     -.101295E-02   0.00000
 136.00       230.000     -.268116E-03   0.00000     -.110056E-02   0.00000
 156.00       240.000     -.265433E-03   0.00000     -.118335E-02   0.00000
 176.00       250.000     -.251304E-03   0.00000     -.126214E-02   0.00000
 196.00       260.000     -.235837E-03   0.00000     -.130587E-02  -.412738E-04
 216.00       270.000     -.237168E-03   0.00000     -.127185E-02  -.165822E-03
 236.00       280.000     -.147972E-03   0.00000     -.124962E-02  -.215093E-03
 256.00       290.000      .313331E-05   0.00000     -.124502E-02  -.230078E-03
 276.00       300.000      .115221E-03   0.00000     -.119310E-02  -.240426E-03
 296.00       310.000      .198531E-03   0.00000     -.112775E-02  -.240426E-03
 316.00       320.000      .263448E-03   0.00000     -.108744E-02  -.240426E-03
 336.00       327.000      .299342E-03   0.00000     -.106628E-02  -.240426E-03
```

11.3.3.1.8 Strain History at Node 22 (Element 52) (Cont'd)
(Segment Points 7 and 9)

ITER	ESTR 1 53 1 TEMP	ESTR 52 251 ARG1EE07	ESTR 52 252 ARG1EP07	ESTR 52 263 ARG1EE09	ESTR 52 264 ARG1EP09
4.0000	70.0000	-.201437E-04	0.00000	.281641E-04	0.00000
8.0000	70.0000	-.563791E-05	0.00000	.921048E-04	0.00000
12.000	80.0000	.161038E-03	0.00000	.186561E-03	0.00000
15.000	90.0000	.851330E-04	0.00000	.149316E-03	0.00000
18.000	100.000	.893567E-05	0.00000	.113206E-03	0.00000
21.000	110.000	-.674924E-04	0.00000	.782473E-04	0.00000
24.000	120.000	-.144159E-03	0.00000	.444932E-04	0.00000
27.000	130.000	-.221071E-03	0.00000	.120022E-04	0.00000
30.000	140.000	-.298238E-03	0.00000	-.191631E-04	0.00000
33.000	150.000	-.375669E-03	0.00000	-.489352E-04	0.00000
36.000	160.000	-.453373E-03	0.00000	-.772411E-04	0.00000
42.000	170.000	-.531621E-03	0.00000	-.102739E-03	0.00000
49.000	180.000	-.609477E-03	0.00000	-.124456E-03	0.00000
60.000	190.000	-.688394E-03	0.00000	-.143651E-03	0.00000
77.000	200.000	-.764871E-03	0.00000	-.154605E-03	0.00000
96.000	210.000	-.838681E-03	0.00000	-.158167E-03	0.00000
116.00	220.000	-.910991E-03	0.00000	-.155996E-03	0.00000
136.00	230.000	-.983761E-03	0.00000	-.151321E-03	0.00000
156.00	240.000	-.104865E-02	0.00000	-.130734E-03	0.00000
176.00	250.000	-.110695E-02	0.00000	-.961134E-04	0.00000
196.00	260.000	-.116237E-02	0.00000	-.510573E-04	0.00000
216.00	270.000	-.117676E-02	0.00000	.237444E-04	0.00000
236.00	280.000	-.116201E-02	0.00000	.154725E-03	0.00000
256.00	290.000	-.114769E-02	0.00000	.330542E-03	0.00000
276.00	300.000	-.109860E-02	0.00000	.450143E-03	0.00000
296.00	310.000	-.102860E-02	0.00000	.538106E-03	0.00000
316.00	320.000	-.986849E-03	0.00000	.604462E-03	0.00000
336.00	327.000	-.965833E-03	0.00000	.640214E-03	0.00000

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Project WBNP Unit 1
Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.1.9 Displacement History of Node 51

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

         ANSYS POST26 VARIABLE LISTING

  ITER       ESTR    1 53   DISP  51 UX   DISP  51 UY   DISP  51 UZ   OPER  28 SQRT
              1     TEMP     51   UX       51   UY       51   UZ       SRSS
  4.0000     70.0000      -.205782E-02  .513653E-02   .152621E-01   .162343E-01
  8.0000     70.0000      -.419198E-02  .113306E-01   .468734E-01   .484053E-01
  12.000     80.0000       .689674E-02  .288424E-02   .454990E-01   .461090E-01
  15.000     90.0000       .433593E-02  .987720E-02   .458298E-01   .470822E-01
  18.000     100.000       .167650E-02  .171305E-01   .461762E-01   .492799E-01
  21.000     110.000      -.108071E-02  .246417E-01   .465407E-01   .526728E-01
  24.000     120.000      -.394257E-02  .324291E-01   .469235E-01   .571752E-01
  27.000     130.000      -.691665E-02  .405127E-01   .473249E-01   .626799E-01
  30.000     140.000      -.100113E-01  .489147E-01   .477449E-01   .690829E-01
  33.000     150.000      -.132355E-01  .576594E-01   .481837E-01   .762984E-01
  36.000     160.000      -.165996E-01  .667737E-01   .486413E-01   .842630E-01
  42.000     170.000      -.202389E-01  .766311E-01   .491644E-01   .932688E-01
  49.000     180.000      -.241026E-01  .871138E-01   .496258E-01   .103114
  60.000     190.000      -.282166E-01  .983087E-01   .502043E-01   .113935
  77.000     200.000      -.327135E-01  .110669       .506013E-01   .126009

  96.000     210.000      -.377141E-01  .124409       .507433E-01   .139552
  116.00     220.000      -.442365E-01  .141794       .509111E-01   .157017
  136.00     230.000      -.511398E-01  .160179       .510464E-01   .175722
  156.00     240.000      -.629417E-01  .189661       .513081E-01   .206314
  176.00     250.000      -.788481E-01  .228478       .515409E-01   .247135
  196.00     260.000      -.972529E-01  .273655       .506501E-01   .294806
  216.00     270.000      -.135539      .371122       .495398E-01   .398192
  236.00     280.000      -.187848      .504164       .497467E-01   .540317
  256.00     290.000      -.239528      .635453       .472668E-01   .680741
  276.00     300.000      -.307284      .807290       .424716E-01   .864838
  296.00     310.000      -.377618      .983632       .387890E-01   1.05434
  316.00     320.000      -.430055      1.11346       .357558E-01   1.19416
  336.00     327.000      -.461480      1.19036       .338849E-01   1.27713
```

Yield Displ.

Final Displ.

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Subject Qualif. of Worst Cases of Thermally Restrained Structures -- Package I

11.3.3.1.10 Strain History at Node 2 (Element 28)

(Segment Points 1 and 3)

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

        ANSYS POST26 VARIABLE LISTING

  ITER       ESTR   1 53   ESTR  28 215  ESTR  28 216  ESTR  28 227  ESTR  28 228
              1   TEMP      ARG1EE01      ARG1EP01      ARG1EE03      ARG1EP03
 4.0000      70.0000      .126358E-04   0.00000      .231501E-04   0.00000
 8.0000      70.0000      .282074E-04   0.00000      .262407E-04   0.00000
 12.000      80.0000      .842797E-04   0.00000      .166335E-04   0.00000
 15.000      90.0000      .711777E-04   0.00000      .197638E-04   0.00000
 18.000      100.000      .582223E-04   0.00000      .230422E-04   0.00000

 21.000      110.000      .454067E-04   0.00000      .264621E-04   0.00000
 24.000      120.000      .327331E-04   0.00000      .300249E-04   0.00000
 27.000      130.000      .202034E-04   0.00000      .337320E-04   0.00000
 30.000      140.000      .781967E-05   0.00000      .375849E-04   0.00000
 33.000      150.000     -.441581E-05   0.00000      .415852E-04   0.00000
 36.000      160.000     -.165007E-04   0.00000      .457346E-04   0.00000
 42.000      170.000     -.280059E-04   0.00000      .505317E-04   0.00000
 49.000      180.000     -.389695E-04   0.00000      .559947E-04   0.00000
 60.000      190.000     -.487900E-04   0.00000      .627303E-04   0.00000
 77.000      200.000     -.576493E-04   0.00000      .707554E-04   0.00000
 96.000      210.000     -.663898E-04   0.00000      .790809E-04   0.00000
 116.00      220.000     -.747512E-04   0.00000      .877232E-04   0.00000
 136.00      230.000     -.829416E-04   0.00000      .965189E-04   0.00000
 156.00      240.000     -.900031E-04   0.00000      .106098E-03   0.00000
 176.00      250.000     -.962415E-04   0.00000      .116188E-03   0.00000
 196.00      260.000     -.101878E-03   0.00000      .126503E-03   0.00000
 216.00      270.000     -.105902E-03   0.00000      .136529E-03   0.00000
 236.00      280.000     -.112825E-03   0.00000      .142326E-03   0.00000
 256.00      290.000     -.123040E-03   0.00000      .144571E-03   0.00000
 276.00      300.000     -.132936E-03   0.00000      .146379E-03   0.00000
 296.00      310.000     -.143865E-03   0.00000      .146863E-03   0.00000
 316.00      320.000     -.155175E-03   0.00000      .147988E-03   0.00000
 336.00      327.000     -.176050E-03   0.00000      .153595E-03   0.00000
```

11.3.3.1.10 Strain History at Node 2 (Element 28) (Cont'd)

(Segment Points 7 and 9)

ITER	ESTR 1 53	ESTR 28 251	ESTR 28 252	ESTR 28 263	ESTR 28 264
	1 TEMP	ARG1EE07	ARG1EP07	ARG1EE09	ARG1EP09
4.0000	70.0000	-.106445E-04	0.00000	-.211588E-04	0.00000
8.0000	70.0000	-.489001E-06	0.00000	.147770E-05	0.00000
12.000	80.0000	.408649E-05	0.00000	.717326E-04	0.00000
15.000	90.0000	.288165E-05	0.00000	.542956E-04	0.00000
18.000	100.000	.194347E-05	0.00000	.371235E-04	0.00000
21.000	110.000	.126817E-05	0.00000	.202128E-04	0.00000
24.000	120.000	.860009E-06	0.00000	.356822E-05	0.00000
27.000	130.000	.723384E-06	0.00000	-.128052E-04	0.00000
30.000	140.000	.862830E-06	0.00000	-.289024E-04	0.00000
33.000	150.000	.128306E-05	0.00000	-.447179E-04	0.00000
36.000	160.000	.198900E-05	0.00000	-.602464E-04	0.00000
42.000	170.000	.376870E-05	0.00000	-.747689E-04	0.00000
49.000	180.000	.742664E-05	0.00000	-.875375E-04	0.00000
60.000	190.000	.126276E-04	0.00000	-.988927E-04	0.00000
77.000	200.000	.219258E-04	0.00000	-.106479E-03	0.00000
96.000	210.000	.337828E-04	0.00000	-.111688E-03	0.00000
116.00	220.000	.462950E-04	0.00000	-.116179E-03	0.00000
136.00	230.000	.589481E-04	0.00000	-.120512E-03	0.00000
156.00	240.000	.728097E-04	0.00000	-.123292E-03	0.00000
176.00	250.000	.875194E-04	0.00000	-.124910E-03	0.00000
196.00	260.000	.102399E-03	0.00000	-.125982E-03	0.00000
216.00	270.000	.116896E-03	0.00000	-.125535E-03	0.00000
236.00	280.000	.124434E-03	0.00000	-.130717E-03	0.00000
256.00	290.000	.125952E-03	0.00000	-.141659E-03	0.00000
276.00	300.000	.125872E-03	0.00000	-.153443E-03	0.00000
296.00	310.000	.123422E-03	0.00000	-.167306E-03	0.00000
316.00	320.000	.121724E-03	0.00000	-.181439E-03	0.00000
336.00	327.000	.125619E-03	0.00000	-.204025E-03	0.00000

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11.3.3.1.11 Strain History at Node 5 (Element 4) (Segment Points 1 and 3)

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

        ANSYS POST26 VARIABLE LISTING


 ITER        ESTR    1 53   ESTR    4 95   ESTR    4 96   ESTR    4 107  ESTR    4 108
               1    TEMP     ARG1EE01       ARG1EP01       ARG1EE03       ARG1EP03
 4.0000       70.0000      -.153250E-04   0.00000        .253475E-04   0.00000
 8.0000       70.0000       .190337E-04   0.00000        .175954E-04   0.00000
 12.000       80.0000       .810100E-04   0.00000       -.522927E-04   0.00000
 15.000       90.0000       .655804E-04   0.00000       -.450494E-04   0.00000
 18.000       100.000       .501399E-04   0.00000       -.378224E-04   0.00000
 21.000       110.000       .346912E-04   0.00000       -.306093E-04   0.00000
 24.000       120.000       .192349E-04   0.00000       -.234106E-04   0.00000
 27.000       130.000       .377136E-05   0.00000       -.162269E-04   0.00000
 30.000       140.000      -.116987E-04   0.00000       -.905907E-05   0.00000
 33.000       150.000      -.271746E-04   0.00000       -.190769E-05   0.00000
 36.000       160.000      -.426557E-04   0.00000        .522646E-05   0.00000
 42.000       170.000      -.583013E-04   0.00000        .122903E-04   0.00000
 49.000       180.000      -.743689E-04   0.00000        .191327E-04   0.00000
 60.000       190.000      -.906978E-04   0.00000        .259360E-04   0.00000
 77.000       200.000      -.108182E-03   0.00000        .321893E-04   0.00000
 96.000       210.000      -.126415E-03   0.00000        .380102E-04   0.00000
 116.00       220.000      -.144501E-03   0.00000        .437083E-04   0.00000

 136.00       230.000      -.162541E-03   0.00000        .494048E-04   0.00000
 156.00       240.000      -.179638E-03   0.00000        .548064E-04   0.00000
 176.00       250.000      -.195920E-03   0.00000        .599415E-04   0.00000
 196.00       260.000      -.211388E-03   0.00000        .645806E-04   0.00000
 216.00       270.000      -.221750E-03   0.00000        .675039E-04   0.00000
 236.00       280.000      -.227826E-03   0.00000        .701418E-04   0.00000
 256.00       290.000      -.232711E-03   0.00000        .732635E-04   0.00000
 276.00       300.000      -.235794E-03   0.00000        .755023E-04   0.00000
 296.00       310.000      -.237794E-03   0.00000        .778664E-04   0.00000
 316.00       320.000      -.242681E-03   0.00000        .810392E-04   0.00000
 336.00       327.000      -.280946E-03   0.00000        .950075E-04   0.00000
```

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11.3.3.1.11 Strain History at Node 5 (Element 4) (Cont'd)

(Segment Points 7 and 9)

```
  ITER        ESTR    1 53   ESTR    4 131  ESTR    4 132  ESTR    4 143
                1    TEMP      ARG1EE07      ARG1EP07      ARG1EE09
 4.0000       70.0000       -.411777E-05   0.00000       -.447902E-04
 8.0000       70.0000       -.112882E-04   0.00000       -.984989E-05
 12.000       80.0000       -.735072E-04   0.00000        .597955E-04
 15.000       90.0000       -.687810E-04   0.00000        .418488E-04
 18.000       100.000       -.640298E-04   0.00000        .239325E-04
 21.000       110.000       -.592565E-04   0.00000        .604400E-05
 24.000       120.000       -.544609E-04   0.00000       -.118155E-04
 27.000       130.000       -.496428E-04   0.00000       -.296445E-04
 30.000       140.000       -.448021E-04   0.00000       -.474417E-04
 33.000       150.000       -.399387E-04   0.00000       -.652056E-04
 36.000       160.000       -.350524E-04   0.00000       -.829345E-04
 42.000       170.000       -.300462E-04   0.00000       -.100638E-03
 49.000       180.000       -.247229E-04   0.00000       -.118224E-03
 60.000       190.000       -.192481E-04   0.00000       -.135882E-03
 77.000       200.000       -.129641E-04   0.00000       -.153336E-03
 96.000       210.000       -.613761E-05   0.00000       -.170563E-03
 116.00       220.000        .675396E-06   0.00000       -.187534E-03
 136.00       230.000        .746666E-05   0.00000       -.204479E-03
 156.00       240.000        .140167E-04   0.00000       -.220428E-03
 176.00       250.000        .203696E-04   0.00000       -.235491E-03
 196.00       260.000        .266231E-04   0.00000       -.249345E-03
 216.00       270.000        .313399E-04   0.00000       -.257914E-03
 236.00       280.000        .339865E-04   0.00000       -.263982E-03
 256.00       290.000        .356888E-04   0.00000       -.270286E-03
 276.00       300.000        .369629E-04   0.00000       -.274333E-03
 296.00       310.000        .376049E-04   0.00000       -.278056E-03
 316.00       320.000        .392181E-04   0.00000       -.284502E-03
 336.00       327.000        .523064E-04   0.00000       -.323647E-03
```

11.3.3.1.12 Displacement History of Node 2

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

        ANSYS POST26 VARIABLE LISTING

 ITER        ESTR   1 53  DISP   2 UX   DISP   2 UY   DISP   2 UZ   OPER  28 SQRT
              1    TEMP    2     UX      2     UY      2     UZ     SRSS
 4.0000      70.0000     -.320371E-03   .173329E-04  -.106532E-02   .111259E-02
 8.0000      70.0000      .141122E-04   .676097E-04  -.984201E-03   .986622E-03
 12.000      80.0000     -.145581E-03   .481808E-03  -.573448E-03   .763004E-03
 15.000      90.0000     -.165966E-02   .808955E-03  -.691055E-03   .197140E-02
 18.000      100.000     -.317372E-02   .113711E-02  -.805138E-03   .346609E-02
 21.000      110.000     -.468777E-02   .146624E-02  -.915577E-03   .499633E-02
 24.000      120.000     -.620179E-02   .179636E-02  -.102229E-02   .653714E-02
 27.000      130.000     -.771578E-02   .212750E-02  -.112519E-02   .808242E-02
 30.000      140.000     -.922971E-02   .245966E-02  -.122419E-02   .962996E-02
 33.000      150.000     -.107436E-01   .279286E-02  -.131920E-02   .111788E-01
 36.000      160.000     -.122574E-01   .312712E-02  -.141013E-02   .127284E-01
 42.000      170.000     -.137721E-01   .346558E-02  -.148651E-02   .142790E-01
 49.000      180.000     -.152885E-01   .381021E-02  -.152872E-02   .158301E-01
 60.000      190.000     -.168069E-01   .416170E-02  -.155679E-02   .173843E-01
 77.000      200.000     -.183306E-01   .452622E-02  -.150677E-02   .189411E-01
 96.000      210.000     -.198570E-01   .489764E-02  -.139829E-02   .204998E-01
 116.00      220.000     -.213812E-01   .527155E-02  -.128022E-02   .220587E-01
 136.00      230.000     -.229051E-01   .564618E-02  -.116180E-02   .236193E-01
 156.00      240.000     -.244184E-01   .602622E-02  -.103025E-02   .251721E-01
 176.00      250.000     -.259226E-01   .641002E-02  -.888985E-03   .267182E-01
 196.00      260.000     -.274157E-01   .679529E-02  -.752212E-03   .282553E-01
 216.00      270.000     -.288510E-01   .718134E-02  -.620929E-03   .297378E-01
 236.00      280.000     -.302474E-01   .754114E-02  -.563860E-03   .311784E-01
 256.00      290.000     -.316378E-01   .787733E-02  -.574351E-03   .326088E-01
 276.00      300.000     -.330055E-01   .820941E-02  -.623740E-03   .340169E-01
 296.00      310.000     -.343650E-01   .853263E-02  -.700607E-03   .354154E-01
 316.00      320.000     -.357559E-01   .885797E-02  -.774253E-03   .368449E-01
 336.00      327.000     -.367912E-01   .908818E-02  -.818897E-03   .379059E-01
```

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11.3.3.1.13 Displacement History of Node 5

```
PR9C - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/2

         ANSYS POST26 VARIABLE LISTING


  ITER        ESTR    1 53   DISP    5 UX   DISP    5 UY   DISP    5 UZ   OPER   28 SQRT
                 1    TEMP      5     UX       5     UY       5     UZ         SRSS
 4.0000       70.0000       -.318847E-03   .112461E-05  -.541007E-03   .627975E-03
 8.0000       70.0000        .385520E-05   .173282E-04  -.532645E-03   .532941E-03
 12.000       80.0000        .237514E-02   .198222E-03  -.390766E-03   .241522E-02
 15.000       90.0000        .329823E-02   .542256E-03  -.436933E-03   .337095E-02
 18.000       100.000        .422135E-02   .886307E-03  -.482309E-03   .434027E-02
 21.000       110.000        .514449E-02   .123038E-02  -.526984E-03   .531576E-02
 24.000       120.000        .606766E-02   .157446E-02  -.570942E-03   .629455E-02
 27.000       130.000        .699088E-02   .191856E-02  -.614169E-03   .727534E-02
 30.000       140.000        .791417E-02   .226269E-02  -.656646E-03   .825742E-02
 33.000       150.000        .883752E-02   .260682E-02  -.698358E-03   .924040E-02
 36.000       160.000        .976097E-02   .295098E-02  -.739285E-03   .102241E-01
 42.000       170.000        .106836E-01   .329513E-02  -.776591E-03   .112071E-01
 49.000       180.000        .116044E-01   .363926E-02  -.803799E-03   .121882E-01
 60.000       190.000        .125232E-01   .398337E-02  -.827385E-03   .131675E-01
 77.000       200.000        .134366E-01   .432735E-02  -.825681E-03   .141404E-01
 96.000       210.000        .143472E-01   .467119E-02  -.805774E-03   .151099E-01
 116.00       220.000        .152603E-01   .501502E-02  -.783746E-03   .160823E-01
 136.00       230.000        .161739E-01   .535885E-02  -.762051E-03   .170556E-01
 156.00       240.000        .170994E-01   .570290E-02  -.739105E-03   .180404E-01
 176.00       250.000        .180351E-01   .604718E-02  -.714720E-03   .190354E-01
 196.00       260.000        .189834E-01   .639164E-02  -.683626E-03   .200422E-01
 216.00       270.000        .199968E-01   .673670E-02  -.649580E-03   .211110E-01
 236.00       280.000        .210535E-01   .708173E-02  -.648060E-03   .222221E-01
 256.00       290.000        .221166E-01   .742651E-02  -.672776E-03   .233399E-01
 276.00       300.000        .232053E-01   .777145E-02  -.690642E-03   .244818E-01
 296.00       310.000        .243031E-01   .811636E-02  -.722221E-03   .256327E-01
 316.00       320.000        .253655E-01   .846097E-02  -.750931E-03   .267500E-01
 336.00       327.000        .261473E-01   .870177E-02  -.767220E-03   .275679E-01
```

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11.3.3.2 Analysis Results for "PR9CM" (Analysis for the Modified Structure)

The ANSYS output for the analysis "PR9CM" is stored in file "PR9CMR". The analysis results of the final load step (Load Step 16) are provided in this Section.

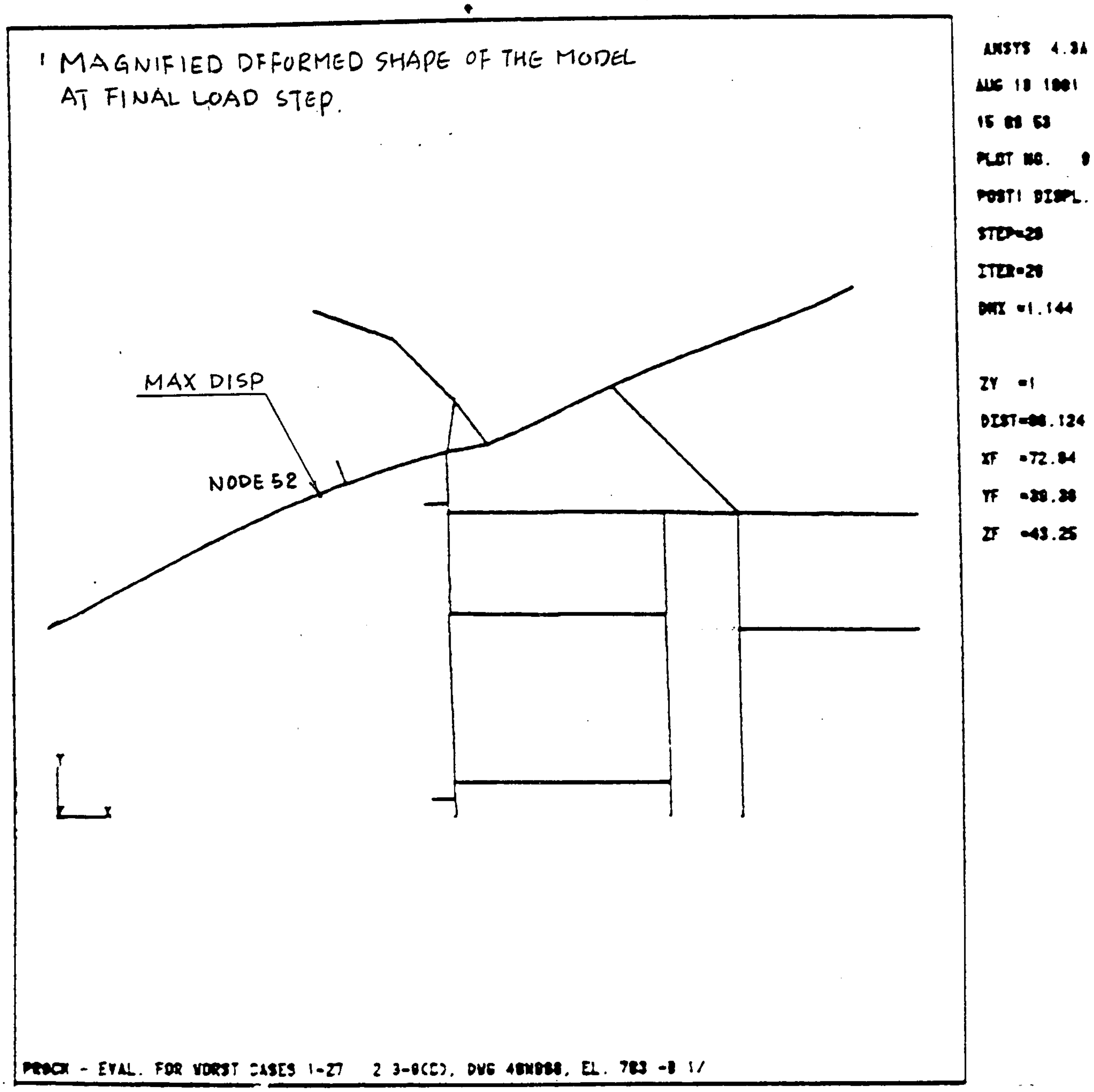
The deformed structure is plotted in Figure 11.3.3.2.1. Note that the displacements in this plot are magnified.

Since the worst case 2&3-9(C) is already qualified and the differences between the results of PR9C and PR9CM for the worst case 2&3-9(C) are insignificant, only the results related to the worst case 1-27 are presented.

The reaction forces and the nodal displacements are provided in Sections 11.3.3.2.1 and 11.3.3.2.2. The maximum displacement for the axially restrained member occurs at Node 52.

The stresses and strains for elements 19, 51, 52 and 20 are listed in Section 11.3.3.2.3. Theses elements are located arround node 52 where maximum displacements occurs. For explanation of labels, see Section 11.3.3.1. The stress and strain results indicate no yield occurs in elements located arround node 52. Since there is no yield occurs in elements arround node 52, strain and displacement history are not presented.

Figure 11.3.3.2.1 Deformed Shape of the Model for Analysis PR9CM



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11.3.3.2.1 Reaction Forces

```
PR9CM - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/

        ***** POST1 REACTION FORCE LISTING *****

 LOAD STEP    28  ITERATION=    20  SECTION=  1
 TIME=    0.0000          LOAD CASE=  1



 THE FOLLOWING X,Y,Z FORCES ARE IN NODAL COORDINATES

   NODE     FX              FY              FZ              MX              MY              MZ
     1   1.4087475       5.7494642       1.0539391                       -1.2435130
     4  -.46901430       1.7586797       .29376733                       -.35193110
     7  -4.7788720                       .56925887       .32640895E-01
     8                                   .17777728      -1.0169051
    10  -7.5205966                       .85151312      -1.2579102
    11                   .69183167      -.17641853E-01                   .96430288E-02
    12   .45629147                       .16273704       .11610257E-01
   101   0.0000000       0.0000000       0.0000000       15.165983       0.0000000      -11.928565
   104   0.0000000       0.0000000       0.0000000       7.0455124       0.0000000      -4.6363303
   107   0.0000000      -.25503964       0.0000000       0.0000000       13.208701       4.8246538
   108   0.0000000      -.47898371       0.0000000       0.0000000       .73947305       0.0000000
   110   0.0000000      -.82053205       0.0000000       0.0000000       11.675166       11.513603
   111   .19417214       0.0000000       0.0000000       3.4942703       0.0000000      -3.0640068
   112   0.0000000      -.28835107       0.0000000       0.0000000       3.1376952       3.2805424
   132   9.7142126      -5.4361256      -1.1703425       0.0000000       0.0000000       0.0000000

 TOTAL  -.99505919       .92094354       1.9210084       23.475202       27.175234      -.10102576E-01
```

By SAM Date 8/20/91 Sheet 100 of 230
Chkd. by J.OU. Date 8/21/91 OFS No. NR Dept. No. NR
Client TVA
Project WBNP Unit 1
Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.2.2 Displacements

```
PR9CM - EVAL. FOR WORST CASES 1-27 & 2&3-9(C), DWG 48N968, EL. 783'-8 1/

       ***** POST1 NODAL DISPLACEMENT LISTING *****

 LOAD STEP    28  ITERATION=    20  SECTION=  1
 TIME=    0.0000          LOAD CASE=  1

 THE FOLLOWING X,Y,Z DISPLACEMENTS ARE IN NODAL COORDINATES

  NODE    UX              UY              UZ              ROTX            ROTY            ROTZ
    1  -.30000000E-01  0.0000000       0.0000000      -.54949215E-03  0.0000000       .45898515E-03
    2  -.36020310E-01  .84409586E-02  -.30678537E-02  -.65597392E-03  -.21303923E-04   .17648799E-02
    3  -.10419775      .75870351E-01  -.25829178E-01  -.81870311E-04  -.12497013E-03   .70184635E-03
    4   .30000000E-01  0.0000000       0.0000000      -.25527219E-03  0.0000000        .17839587E-03
    5   .27004497E-01  .87009688E-02  -.14793129E-02  -.30992358E-03  -.46305603E-04   .10780986E-02
    6  -.40739911E-01  .78061166E-01  -.18462022E-01  -.45119357E-03  -.36010631E-03  -.10881638E-02
    7   .31250000E-01  .63759911E-04   0.0000000       0.0000000      -.23379059E-03  -.14561915E-03
    8  -.20054021      .11974593E-03   0.0000000       0.0000000      -.90766300E-04   .14199793E-01
    9  -.11001204      .91069247E-01  -.22470889E-01   .33651750E-03   .16671418E-02  -.19951888E-01
   10   .31250000E-01  .20513301E-03   0.0000000       0.0000000      -.67428044E-03  -.54184213E-03
   11  -.48543034E-04 -.31250000E-01   0.0000000      -.12660400E-03  0.0000000        .11789629E-03
   12   .31250000E-01  .72087768E-04   0.0000000       0.0000000      -.15854152E-03  -.25312827E-03
   13  -.90863042E-01  .50578620E-01  -.20727957E-01  -.56924994E-03  -.23541899E-03   .11362994E-02
   14  -.27625622E-01  .52128710E-01  -.11624549E-01  -.44269963E-03  -.27195468E-03   .16874800E-02
   15  -.45954008E-02  .10456144E-01  -.35908353E-02  -.14122412E-02  -.30997432E-04   .78674052E-05
   16  -.59332081E-01  .49531904E-01  -.16395609E-01  -.50382923E-03  -.25180181E-03  -.64238292E-03
   17  -.72557262E-01  .85541605E-01  -.23250711E-01  -.29645844E-03  -.18472032E-03   .19130075E-03
   18  -.19774896E-01  .47626461E-01  -.13188847E-01  -.50505135E-03  -.52080912E-03  -.18998331E-02
   19   .31764313E-02  .20419981E-01  -.62512493E-02  -.30366186E-03  -.48216550E-03  -.19334039E-02
   20  -.18487420     -.25447189E-01   .84767945E-02   .61075016E-02   .19613538E-02   .13944192E-01
   21  -.23863514      .21449039       .39257095E-01   .24596468E-01   .91286523E-02   .94145740E-02
   22  -.22332971      .30534081       .69006338E-01   .51833426E-01   .19429273E-01  -.46286656E-02
   23  -.57650276E-01 -.41183048E-01  -.30747436E-01   .15466540E-02   .17612469E-02  -.18965868E-01
   24  -.61308748E-01  .59318518E-02  -.40073752E-01  -.83803459E-03  -.31689502E-03   .72158039E-02
   25  -.66938572E-01  .66478708E-01  -.37707629E-01  -.63894768E-03  -.71713990E-03   .37342272E-02
   26  -.20323043E-01  .52703656E-01  -.21838766E-01  -.26171306E-02  -.20280227E-02  -.40313646E-02
   27   .14285298E-01  .17050612E-01  -.87978351E-02  -.22632530E-02  -.18746571E-02  -.27280712E-02
   28  -.32192487E-01  .42216820E-02  -.17279044E-02  -.60926603E-03  -.21743604E-03   .12465391E-02
   29  -.10521585      .78370355E-01  -.25918369E-01  -.18611565E-04  -.13638785E-03  -.67237960E-03

   30  -.21567684      .29523747       .70106002E-01   .54501301E-01   .20414949E-01  -.62179041E-02
   31  -.21810712E-01  .17777736E-01  -.61572626E-02  -.32793596E-03  -.22413071E-03   .48116204E-03
   32   .23181492      .40562392       .73644596E-03   .60777424E-03   .14934895E-03  -.26682337E-01
   33   .67675907E-01  .10119472      -.73290545E-02   .84876442E-03   .52119635E-03  -.23108396E-01
   34  -.47696137E-01 -.50092156E-01  -.20731750E-01   .15458175E-02   .17605936E-02  -.18966673E-01
   35  -.10052927      .89053461E-01  -.12447371E-01   .33759623E-03   .16670884E-02  -.19952224E-01
   41  -.17662738     -.67095434E-01   .42559136E-02   .30740123E-02   .94399345E-03   .14136387E-01
   45  -.20623696      .63387266E-01   .18941640E-01   .12199757E-01   .43245435E-02   .13062039E-01
   46  -.22465906      .14467193       .29222743E-01   .18354250E-01   .67089406E-02   .11549000E-01
   51  -.24716061      .28172366       .50288548E-01   .33331062E-01   .12417654E-01   .57315582E-02
   52  -.24299374      .31473135       .60392389E-01   .42368791E-01   .15833545E-01   .10430536E-02
```

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Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.2.2 Displacements (Cont'd)

55	-.21964744	.30070208	.69574136E-01	.53162630E-01	.19920204E-01	-.54156609E-02
61	-.19695594	.26614908	.47974711E-01	.40712562E-01	.15630111E-01	-.95254950E-02
62	-.17315390	.22267248	.25044172E-01	.27092068E-01	.10912864E-01	-.12919478E-01
63	-.14419467	.16443217	.14979031E-02	.13635284E-01	.62597711E-02	-.16396211E-01
65	-.92482880E-01	.46778163E-01	-.25429310E-01	.70803696E-03	.17321879E-02	-.20823160E-01
66	-.74765159E-01	.18371839E-02	-.28191384E-01	.11296169E-02	.17740591E-02	-.20535491E-01
71	-.57010160E-01	-.44967263E-01	-.33860143E-01	.18982079E-02	.13245869E-02	.21496054E-02
72	-.57591967E-01	-.23984590E-01	-.37382543E-01	.66455688E-03	.52328827E-03	.59580036E-02
75	-.64293725E-01	.29102761E-01	-.39941976E-01	-.89822796E-03	-.51366816E-03	.69956878E-02
76	-.66514610E-01	.50217249E-01	-.39164706E-01	-.85256283E-03	-.65477723E-03	.58331908E-02
81	-.61978273E-01	.81439260E-01	-.35854832E-01	-.16501863E-02	-.13078696E-02	.59458390E-03
82	-.51463509E-01	.81177079E-01	-.32304122E-01	-.22381675E-02	-.16953989E-02	-.17685945E-02
83	-.37023221E-01	.70075991E-01	-.27495642E-01	-.25299729E-02	-.19248708E-02	-.33198714E-02
85	-.11287263E-01	.42724982E-01	-.18672049E-01	-.25963168E-02	-.20365986E-02	-.40619981E-02
86	-.23425568E-02	.32999053E-01	-.15415299E-01	-.25316934E-02	-.20145060E-02	-.38560810E-02
87	.62645484E-02	.24211144E-01	-.12111160E-01	-.24222287E-02	-.19611575E-02	-.34118436E-02
91	-.94848465E-01	.56901087E-01	-.22763083E-01	-.47451818E-03	-.29390107E-03	.99506305E-03
92	-.98344954E-01	.63223976E-01	-.24337035E-01	-.36156324E-03	-.29515769E-03	.87530156E-03
93	-.10143379	.69547121E-01	-.25381370E-01	-.23060620E-03	-.23879955E-03	.77742493E-03
95	-.45237917E-01	.17540867E-01	.49459570E-01	-.60932369E-03	-.21744689E-03	.12465317E-02
96	-.11625540	.76456990E-01	.30896383E-01	-.18719923E-04	-.13640630E-03	.67236711E-03
97	-.49984273	1.0288188	-.35671093E-01	.54501530E-01	.20414952E-01	-.62178987E-02
101	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
102	-.36020310E-01	.84409586E-02	-.30678537E-02	-.65597392E-03	-.21303923E-04	.17460609E-03
104	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
105	.27004497E-01	.87009688E-02	-.14793129E-02	-.30992358E-03	-.46305603E-04	-.16023451E-03
107	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
108	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
109	-.11001204	.91069247E-01	-.22470889E-01	.33651750E-03	.16671418E-02	.62073559E-03
110	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
111	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
112	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
132	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000

EBASCO SERVICES INCORPORATED

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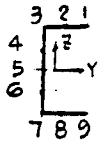
Chkd. by J OU Date 8/21/91 OFS No. NR Dept. No. NR

Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.2.3 Stresses and Strains



```
EL=   19  NODES=   21   51  MAT=  1  PRESSURES(Z,Y)=   0.0000      0.0000      AVE. TEMP= 327.00
END I  PT    TEMP       SIGX          EP         EPPL        EPCR        EPSW
        1   327.00    13.968       .0005098   0.0000000   0.0000000   0.0000000
        2   327.00    4.0221       .0001468   0.0000000   0.0000000   0.0000000
        3   327.00   -5.9240      -.0002162   0.0000000   0.0000000   0.0000000
        4   327.00   -5.5202      -.0002015   0.0000000   0.0000000   0.0000000
        5   327.00   -5.1165      -.0001867   0.0000000   0.0000000   0.0000000
        6   327.00   -4.7128      -.0001720   0.0000000   0.0000000   0.0000000
        7   327.00   -4.3091      -.0001573   0.0000000   0.0000000   0.0000000
        8   327.00    5.6370       .0002057   0.0000000   0.0000000   0.0000000
        9   327.00    15.583       .0005687   0.0000000   0.0000000   0.0000000
END J  PT    TEMP       SIGX          EP         EPPL        EPCR        EPSW
        1   327.00    18.564       .0006775   0.0000000   0.0000000   0.0000000
        2   327.00    5.3862       .0001966   0.0000000   0.0000000   0.0000000
        3   327.00   -7.7912      -.0002844   0.0000000   0.0000000   0.0000000
        4   327.00   -7.2791      -.0002657   0.0000000   0.0000000   0.0000000
        5   327.00   -6.7670      -.0002470   0.0000000   0.0000000   0.0000000
        6   327.00   -6.2548      -.0002283   0.0000000   0.0000000   0.0000000
        7   327.00   -5.7427      -.0002096   0.0000000   0.0000000   0.0000000
        8   327.00    7.4347       .0002713   0.0000000   0.0000000   0.0000000
        9   327.00    20.612       .0007523   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE   21   .110649     -.444987     .163763    -.962057     5.13534      11.8020
                           51  -.112841      .439391    -.154293     .973978    -6.51430     -15.6363

EL=   51  NODES=   51   52  MAT=  1  PRESSURES(Z,Y)=   0.0000      0.0000      AVE. TEMP= 327.00
END I  PT    TEMP       SIGX          EP         EPPL        EPCR        EPSW
        1   327.00    18.462       .0006738   0.0000000   0.0000000   0.0000000
        2   327.00    5.3372       .0001948   0.0000000   0.0000000   0.0000000
        3   327.00   -7.7875      -.0002842   0.0000000   0.0000000   0.0000000
        4   327.00   -7.2641      -.0002651   0.0000000   0.0000000   0.0000000
        5   327.00   -6.7407      -.0002460   0.0000000   0.0000000   0.0000000
        6   327.00   -6.2173      -.0002269   0.0000000   0.0000000   0.0000000
        7   327.00   -5.6939      -.0002078   0.0000000   0.0000000   0.0000000
        8   327.00    7.4308       .0002712   0.0000000   0.0000000   0.0000000
        9   327.00    20.555       .0007502   0.0000000   0.0000000   0.0000000
END J  PT    TEMP       SIGX          EP         EPPL        EPCR        EPSW
        1   327.00    22.983       .0008388   0.0000000   0.0000000   0.0000000
        2   327.00    6.6817       .0002439   0.0000000   0.0000000   0.0000000
        3   327.00   -9.6194      -.0003511   0.0000000   0.0000000   0.0000000
        4   327.00   -8.9912      -.0003281   0.0000000   0.0000000   0.0000000
        5   327.00   -8.3631      -.0003052   0.0000000   0.0000000   0.0000000
        6   327.00   -7.7349      -.0002823   0.0000000   0.0000000   0.0000000
        7   327.00   -7.1068      -.0002594   0.0000000   0.0000000   0.0000000
        8   327.00    9.1943       .0003356   0.0000000   0.0000000   0.0000000
        9   327.00    25.495       .0009305   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE   51   .114684     -.437429     .158453    -.996065     6.65749      15.5738
                           52  -.116852      .431913    -.148931     1.00805    -7.99017     -19.3429
```

EBASCO SERVICES INCORPORATED

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Chkd. by J OU. Date 8/21/91 OFS No. NR Dept. No. NR

Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.3.2.3 Stresses and Strains (Cont'd)

```
EL=   52  NODES=   52   22  MAT=  1  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 327  0
END I  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   327.00    22.853       .0008340    0.0000000    0.0000000    0.0000000
        2   327.00    6.6189       .0002416    0.0000000    0.0000000    0.0000000
        3   327.00   -9.6148      -.0003509    0.0000000    0.0000000    0.0000000
        4   327.00   -8.9722      -.0003275    0.0000000    0.0000000    0.0000000
        5   327.00   -8.3295      -.0003040    0.0000000    0.0000000    0.0000000
        6   327.00   -7.6868      -.0002805    0.0000000    0.0000000    0.0000000
        7   327.00   -7.0442      -.0002571    0.0000000    0.0000000    0.0000000
        8   327.00    9.1896       .0003354    0.0000000    0.0000000    0.0000000
        9   327.00    25.423       .0009279    0.0000000    0.0000000    0.0000000
END J  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   327.00    27.298       .0009963    0.0000000    0.0000000    0.0000000
        2   327.00    7.9435       .0002899    0.0000000    0.0000000    0.0000000
        3   327.00   -11.411      -.0004165    0.0000000    0.0000000    0.0000000
        4   327.00   -10.667      -.0003893    0.0000000    0.0000000    0.0000000
        5   327.00   -9.9236      -.0003622    0.0000000    0.0000000    0.0000000
        6   327.00   -9.1798      -.0003350    0.0000000    0.0000000    0.0000000
        7   327.00   -8.4359      -.0003079    0.0000000    0.0000000    0.0000000
        8   327.00    10.919       .0003985    0.0000000    0.0000000    0.0000000
        9   327.00    30.274       .0011049    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   52   .119094     -.429807      .153188     -1.04404      8.1747       19.2630
                           22  -.121234      .424375     -.143611      1.05610     -9.4615      -22.9663


EL=   20  NODES=   22   55  MAT=  1  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 32   0
END I  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   327.00    27.235       .0009940    0.0000000    0.0000000    0.0000000
        2   327.00    7.9132       .0002888    0.0000000    0.0000000    0.0000000
        3   327.00   -11.409      -.0004164    0.0000000    0.0000000    0.0000000
        4   327.00   -10.659      -.0003890    0.0000000    0.0000000    0.0000000
        5   327.00   -9.9085      -.0003616    0.0000000    0.0000000    0.0000000
        6   327.00   -9.1584      -.0003342    0.0000000    0.0000000    0.0000000
        7   327.00   -8.4083      -.0003069    0.0000000    0.0000000    0.0000000
        8   327.00    10.914       .0003983    0.0000000    0.0000000    0.0000000
        9   327.00    30.235       .0011035    0.0000000    0.0000000    0.0000000
END J  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   327.00    27.791       .0010143    0.0000000    0.0000000    0.0000000
        2   327.00    8.0790       .0002949    0.0000000    0.0000000    0.0000000
        3   327.00   -11.633      -.0004246    0.0000000    0.0000000    0.0000000
        4   327.00   -10.870      -.0003967    0.0000000    0.0000000    0.0000000
        5   327.00   -10.108      -.0003689    0.0000000    0.0000000    0.0000000
        6   327.00   -9.3451      -.0003411    0.0000000    0.0000000    0.0000000
        7   327.00   -8.5825      -.0003132    0.0000000    0.0000000    0.0000000
        8   327.00    11.129       .0004062    0.0000000    0.0000000    0.0000000
        9   327.00    30.841       .0011256    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   22   .126111     -.422357      .145348     -1.16197      9.54120      22.9273
                           55  -.126373      .421672     -.144135      1.16350     -9.69987     -23.3899
```

11.3.4 Member Qualification

11.3.4.1 Member Qualification for Worst Case 1-27

The member for worst case 1-27 is first evaluated using the results of the analysis "PR9C" for the original structure. The member is not qualified and requires modification. The member is then evaluated using the results of the analysis "PR9CM" for the modified structure.

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CHKD. BY J OU DATE 8/22/91 OFS NO. NR DEPT. NO. NR

CLIENT TVA

PROJECT WBNP - Unit 1

SUBJECT Qual. of Worst Cases of Therm. Restrained Struc. - Package I

References

Member Qualification for Worst Case 1-27

1. Based on the Results from the analysis for the original struct. ('PR9C'), The max displ. for worst case member (Axial Restraint) occurs at Node 51.

Sec 11.3.3.1.2
Displacement

2. Based on the Strain History at location arround Node 51 : (Nodes 46, 21, 51, 52, 22)

Sec 11.3.3.1.4
through
Sec 11.33.1.8

Temperature = 260°F when the first plastic strain occurs.

(Segment point 3, ARGIEP03
Section 11.3.3.1.6)

3. The SRSS Displ. (Node 51) @ yield temp (260°F)

= 0.294"

Sec 11.3.3.1.9
Displ. hist. of Node 51

Final (Actual) Displ. = 1.277"

$$\text{Ductility Ratio}, \mu = \frac{\text{Actual Displ.}}{\text{Yield Displ.}}$$

DG-C1.6.12 R1
D 3.2

$$= \frac{1.277}{0.294}$$

$$= 4.3 > 3 \quad \text{N.G.}$$

→ Modification is required for the Member with AXIAL Restraint

See Section 11.3.7 for Modification Design.

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CLIENT TVA

PROJECT WBNP-Unit 1

SUBJECT Qual of Worst Cases of Therm Restrained Struc. - Package I

References

Member Qualification for Worst Case 1-27 (cont'd)

Based on the Results from the analysis on the modified struc. (PR9CM):

1. Max Displ. of the worst case (1-27) member occurs at node 52 — Sec 11.3.3.2.2 Displ.

2. No yielding occurs at nodes arround Node 52 (Elements 19, 51, 52, 22) — Sec 11.3.3.2.3 Stresses & Strains

→ Ductility Ratio at Node 52 < 1.

∴ The member for worst case 1-27 is qualified.

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11.3.4.2 Member Qualification for Worst Case 2&3-9(C)

The members of the worst case 2&3-9(C) are evaluated using the results of the analysis "PR9C" for the original structure (Section 11.3.3.1).

Since the location of worst case 2&3-9(C) is far away from the region which modification is made for worst case 1-27, the members of worst case 2&3-9(C) are not re-evaluated using the results from the analysis "PR9CM" for the modified structure.

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CLIENT TVA

PROJECT WBNP - Unit 1

SUBJECT Qual. of Worst Case of Thermally Restrained Struc. - Package I

	References
Member Qualification (Results from PRSC)	
Proximity Member (ELEMENTS 7 & 8)	
1. max. displ @ Node 15	Sec 11.3.3.1.2 Displ.
2. No yielding occurs @ Node 15	Sec 11.3.3.1.3 Stresses & Strains
3. Ductility Ratio $\mu < 1$ O.K.	DG-C1.6.12 R1
Supporting Members	
(check Ductility Ratios @ Nodes 2 & 5)	
1. No yielding occurs @ Nodes 2 & 5	Sec 11.3.3.1.3 Stresses & Strains
2. Ductility Ratio , $\mu < 1$ O.K.	
The member with PROXIMITY Restraint is Qualified	

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Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.5 Connection and Anchorage Qualification for Worst Case 1-27

11.3.5.1 Connection Qualification for Worst Case 1-27

Weld connections at nodes 8 and 10 of ANSYS model are evaluated using the results of the analysis "PR9CM" for the modified structure (Section 11.3.3.2).

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PROJECT WBNP - UNIT # 1

SUBJECT QUALIF. OF WORST CASES OF THERM. REST. STRUCT. - PACK. 1

NODE 10 & 110 (FROM PRQCMF DATED 8/19/91)

NODE FORCES (ANSYS OUTPUT)

$F_x = -7.52^{K}$ $M_x = -1.26^{''-K}$

$F_y = -0.82^{K}$ $M_y = 11.68^{''-K}$

$F_z = 0.85^{K}$ $M_z = 11.51^{''-K}$

LOADS ON PLATE

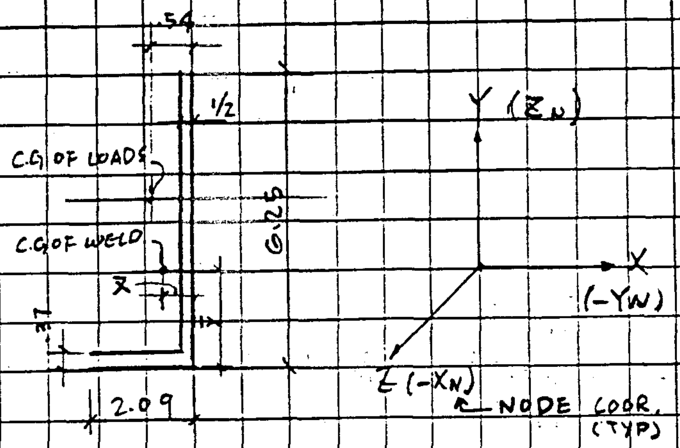
$F_x = 0.82^{K}$ $M_x = 11.68^{''-K}$

$F_y = -0.85^{K}$ $M_y = -11.51^{''-K}$

$F_z = -7.52^{K}$ $M_z = -1.26^{''-K}$

C.G. OF WELDS

WELD SIZE 3/16"



$$\bar{X} = \frac{6.25 \times 0 + 5.88 \times .2 + \frac{2.09^2}{2} + 1.88 \times \left(\frac{1.88}{2} + 9.21\right)}{6.25 + 5.88 + 2.09 + 1.88}$$

$$= \frac{1.23 + 2.18 + 2.16}{16.1} = 0.35''$$

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PROJECT WBNP - UNIT 1

SUBJECT QUALIF OF WORST CASES OF THERM. REST. STRUCTURE - PACKAGE I

NODE 10

$$\bar{y} = \frac{2.09 \times 0 + 1.88 \times 0.37 + \frac{6.25^2}{2} + 5.88 \times \left(\frac{5.88}{2} + .37\right)}{16.10}$$

$= 2.47''$

$e_x = .541 - .35 = .191''$ $C_h = 2.47''$

$e_y = 3.5 - 2.47 = 1.03''$ $C_v = 2.09 - .35 = 1.74''$

WELD PROPERTIES

$A_w = 6.25 + 5.88 + 2.09 + 1.88 = 16.1''$

$$I_x = \frac{6.25^3}{12} + \frac{5.88^3}{12} + 6.25 \times \left(\frac{6.25}{2} - 2.47\right)^2$$

$$+ 5.88 \times \left(\frac{5.88}{2} - 2.1\right)^2 + 2.09 \times 2.47^2 + 1.88 \times 2.1^2$$

$= 20.35 + 16.94 + 2.68 + 4.15 + 12.75 + 8.29$

$= 65.16 \text{ IN}^3$

$$I_y = \frac{2.09^3}{12} + \frac{1.88^3}{12} + 2.09 \times \left(\frac{2.09}{2} - 0.35\right)^2$$

$$1.88 \times \left(\frac{1.88}{2} - .14\right)^2 + 6.25 \times .35^2 + 5.88 \times 0.14^2$$

$= 0.76 + 0.55 + 1.01 + 1.20 + 0.77 + 0.12$

$= 4.41 \text{ IN}^3$

$J_w = 65.6 + 4.41 = 69.57 \text{ IN}^3$

581 2-88

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PROJECT WBNP - UNIT # 1

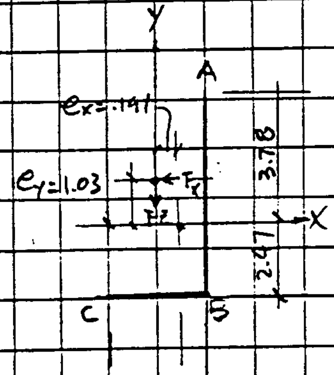
SUBJECT QUALIF. OF WORST CASES OF THERM. REST. STRUCT. - PACK. 1

$$S_{x_A} = \frac{65.16}{3.78} = 7.24 \text{ IN}^2$$

$$S_{x_B} = S_{x_C} = \frac{65.16}{2.47} = 26.38 \text{ IN}^2$$

$$S_{y_A} = S_{y_B} = \frac{4.41}{0.35} = 12.60 \text{ IN}^2$$

$$S_{y_C} = \frac{4.41}{1.74} = 2.53 \text{ IN}^2$$



NEGLECT ECCENTRIC MOMENT DUE TO COMP.

$$f_{t_c} - \frac{0.82}{16.1} - \frac{11.68}{2638} \quad \frac{11.51}{2.53} = -5.04 \text{ K/IN}$$

$$M_z = -1.26 + 0.85 \times 1.03 - 0.82 \times 0.191 = -0.54 \text{ "-K}$$

$$f_x - \frac{0.82}{16.1} + \frac{1.26 \times 2.47}{56.14} = -0.005 \text{ K/IN}$$

$$f_y = -\frac{0.85}{16.1} + \frac{1.26 \times 1.74}{56.14} = -0.01 \text{ K/IN}$$

$$f_r = (5.04^2 + 0.005^2 + 0.01^2)^{1/2} = 5.04 \text{ K/IN}$$

WELD CAPACITY = 6.19 K/IN > 5.04 K/IN

O.K

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PROJECT WBNP - UNIT #1

SUBJECT QUALIF. OF WORST CASES OF THERMALLY REST. STRUCTURE - PACK. 1

NODE 8 & 108 (RESULTS FROM PR9CMR DATED 8/19/91)

NODE FORCES (FROM ANSYS OUTPUT)

$F_x = 0.0^{K}$ $M_x = -1.02^{''-K}$

$F_y = -0.48^{K}$ $M_y = 0.74^{''-K}$

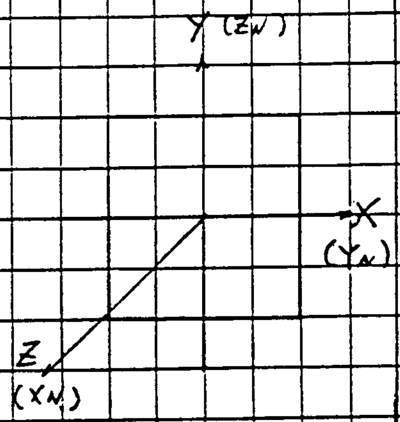
$F_z = 0.18^{K}$ $M_z = 0.0^{''-K}$

LOADS ON BASE PLATES

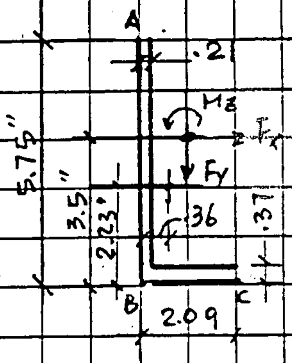
$F_x = 0.48^{K}$ $M_x = -0.74^{''-K}$

$F_y = 0.18^{K}$ $M_y = 0.0$

$F_z = 0.0$ $M_z = 1.02^{''-K}$



C.G. OF WELDS



$C_h = 2.23''$

$C_v = 2.09 - .36$

$= 1.73''$

$$\bar{x} = \frac{5.75\times0 + 5.38\times0.2 + \frac{2.09^2}{2} + (2.09-0.21)\left(\frac{1.88}{2}+.21\right)}{5.75+5.38+2.09+(2.09-0.21)} = .36''$$

$$\bar{y} = \frac{2.09\times0 + (2.09-0.21)\times0.37 + \frac{5.75^2}{2} + 5.38\times\left(\frac{5.38}{2}+.37\right)}{15.1} = 2.23$$

581 2-88

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PROJECT WBNP- UNIT 1

SUBJECT QUALIF. OF WORST CASES OF THERMALLY RESTRAINED STRUCT. - PACK. 1

WELD PROPERTIES

$$A_w = 5.75 + 5.38 + 2.09 + (2.09 - 0.21) = 15.1''$$

$$I_x = \frac{5.75^3}{12} + \frac{5.38^3}{12} + 5.75 \times \left(\frac{5.75}{2} - 2.23\right)^2 + 5.38\left(\frac{5.38}{2} - 1.86\right)^2$$

$$+ 2.09 \times 2.23^2 + (2.09 - 0.21) \times 1.86^2$$

$$= 15.84 + 12.98 + 2.39 + 3.71 + 10.39 + 6.50$$

$$= 51.81 \text{ IN}^3$$

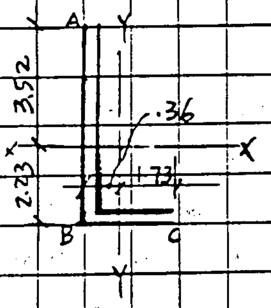
$$I_y = \frac{2.09^3}{12} + \frac{1.88^3}{12} + 2.09 \times \left(\frac{2.09}{2} - 0.36\right)^2$$

$$+ 1.88 \times \left(\frac{1.88}{2} - 0.15\right)^2 + 5.75 \times .36^2 + 5.38 \times 0.15^2$$

$$= 0.76 + 0.55 + 0.98 + 1.17 + 0.75 + 0.12$$

$$= 4.33 \text{ IN}^3$$

$$J_w = I_x + I_y = 51.81 + 4.33 = 56.14 \text{ IN}^3$$



$$S_{x_A} = \frac{51.81}{3.52} = 14.72 \text{ IN}^2$$

$$S_{x_B} = \frac{51.81}{2.23} = 23.23 \text{ IN}^2 \ (\doteq S_{x_C})$$

$$S_{y_A} = S_{y_B} = \frac{4.33}{0.36} = 12.03 \text{ IN}^2$$

$$S_{y_C} = \frac{4.33}{1.73} = 2.50 \text{ IN}^2$$

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PROJECT WBNP

SUBJECT QUALIF. OF WORST CASES OF THERM. REST. STRUCT. - PACK. 1

CHECK WELDS NODE 8

$e_x = .541 - .36 = .181$

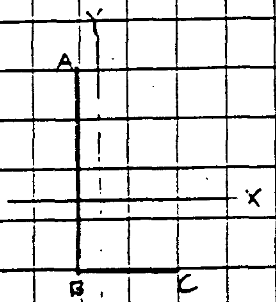
$e_y = 3.5 - 2.23 = 1.27$

$M_z = 1.49 + F_y \times e_x + F_x \times e_y$

$= 1.49 - 0.31 \times 0.181 - 0.51 \times 1.27 = 0.79^{''-K}$

$f_{tc} = \frac{F_z}{A_w} + \frac{M_x}{S_x} + \frac{M_y}{S_z}$

$= 0 + \frac{0.74}{23.23} + 0 = 0.03^{K/IN}$



$f_{x_c} = \frac{F_x}{A_w} + \frac{M_z \times C_h}{J_w}$

$= \frac{0.48}{15.10} + \frac{1.02 \times 2.23}{56.14} = 0.07^{K/IN}$

$f_y = \frac{F_y}{A_w} + \frac{M_z \times C_v}{56.14}$

$= \frac{0.18}{15.1} + \frac{1.02 \times 1.73}{56.14} = 0.04^{K/IN}$

$f_r = (0.03^2 + 0.07^2 + 0.04^2)^{1/2} = 0.09^{K/IN}$

WELD CAPACITY $= .707 \times 2/3 \times 70 \times 3/16$

$= 6.19^{K/IN} > 0.09^{K/IN}$ O.K

11.3.5.2 Anchorage Qualification for Worst Case 1-27

Concrete anchorages at node 8 and 10 of ANSYS model are evaluated using the the results of the analysis "PR9CM" for the modified structure (Section 11.3.3.2).

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PROJECT WBNP- Unit I

SUBJECT Qualif. of Worst Cases of Thermally Rest. Struc. - Package I

References.

SHEAR

DG-C1.6.12(R1)
C3.0

Shear Loading evaluation on Anchor bolts
@ Node 8 (welded stud $\frac{1}{2}''\phi$)

$UY = 0.0001'' < 0.2D = 0.2 \times \frac{1}{2}''$

$= 0.1''$

O.K.

Sec 11.3.3.2.2
Displ.

Shear Loading evaluation on Anchor bolts
@ Node 10 (SSD $\frac{3}{4}''\phi$)

Sec 11.3.3.2.2
Displ.

$UY = 0.0002'' < 0.1D = 0.1 \cdot \frac{3}{4}''$

$= 0.075''$

O.K.

TENSION

The Baseplate models used to calculate rotational stiffness at Nodes 8 & 10 (as shown in Figures 11.3.3 & 11.3.4) are used to perform BASEPLATE II analysis to obtain tension forces at anchor bolts.

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PROJECT WBNP- UNIT 1

SUBJECT Qualif. of worst cases of Therm. Rest. Struct. - Package I

	REF.
	DG-C1.6.12
The BASEPLATE Input & Output are listed	C2.3.1
in Tables 11.3.5.2.1 & 11.3.5.2.2 for Nodes 8 & 10 respectively.	
The forces applied to Base PL Models are from	
the Reactions from the analysis "PR9CM" (for the modified structure)	Sec 11.3.3.2.1 Reaction
Node 8 (1/2"φ Welded Studs)	
Max. tension on bolt = 0.06 Kip	Table 11.3.5.2.1
$0.06^{k} < T_0 = 4.75^{k}$ (Allowable) O.K.	DS-C1.7.1 Eq. 3.34
∴ The Anchorage at Node 8 is Qualified.	
Node 10 (1/2"φ SSD's)	
Max. Tension on bolt = 1.148 Kip	Table 11.3.5.2.2
$1.148^{k} < T_0 = 1.55^{k}$ (Allowable) O.K	DS-C1.7.1 Table 4
A CONAN Run is performed to check the concrete pull-out capacity for Node 10 due to G-32 Violation.	WCG-1-825
The CONAN Results indicate no pull-out problem at Node 10	Table 11.3.5.2.3
∴ The Anchorage at Node 10 is Qualified.	

Table 11.3.5.2.1 BASEPLATE II Input and Output for Anchorage at Nodes 8

(Ref. Input: B8PR9C ; output: B8PR9CR)

```
3 B8PR9C-NODE 8; EMB PLATE; 48N968.
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 10,10,,8,8,.5,29/
APR 6,2,1,5.75,2.09,.366,.21/
BPR ,,1,2.46E5,1.0E6,4750,4318/
BOL 3,3,1,1.5,1.5/
BOL 8,3,1,6.5,1.5/
BOL 3,8,1,1.5,6.5/
BOL 8,8,1,6.5,6.5/
END /
ATT 5,4,,3.75,2.25/
JST 5,4,7,2.09,0/
IST 5,4,10,5.75,90/
END /
END /
POI 5,4,,.5,3.5/
LOA ,,1,479,-178,0,-739,0,1017/
END /
END OF JOB
```

Results from Output

```
************************************************************************
*                                                                      *
*    B8PR9C-NODE 8; EMB PLATE; 48N968.                                 *
*                                                                      *
************************************************************************


                              B O L T   L O A D S
                              -------------------

   I      J
 LINE   LINE   NODE    X-SHEAR    Y-SHEAR      SRSS   Z-TENSION
 ----   ----   ----    -------    -------      ------  ---------

   3      3     23      125.        -49.        134.        60.
   8      3     73      130.        -41.        136.        51.
   3      8     28      113.        -52.        125.        14.
   8      8     78      111.        -37.        117.         0.
```

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C ent TVA

P oject WBNP Unit 1

S oject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

T ole 11.3.5.2.2 BASEPLATE II Input and Output for Anchorage at Nodes 10

(Ref: Input: B10PR9C ; Output = B10P9CR)

```
3 B10PR9C-NODE 10; SURF MOUNT PLATE; 48N968.
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 11,11,,9,10,.75,29/
APR 7,2,1,6.63,2.09,.366,.21/
BPR ,,1,.4E6,1.0E6,1550,1400/
BOL 3,9,1,1.5,8.5/
BOL 9,9,1,7.5,8.5/
IWE 1,1,4/
JWE 1,1,11/
IWE 11,1,4/
END /
ATT 4,4,,2.29,3.37/
JST 4,4,6,2.09,0/
IST 6,4,11,6.63,90/
END /
END /
POI 4,4,,1.58,3.5/
LOA ,,1,-821,-852,0,11675,-11514,1258/
END /
END OF JOB
```

Results from Output

```
                         B O L T   L O A D S
                         -------------------
   I      J
  LINE   LINE   NODE    X-SHEAR    Y-SHEAR     SRSS    Z-TENSION
  ----   ----   ----    -------    -------    ------   ---------

   3      9      31      -64.       -28.       70.       636.
   9      9      97      -65.        10.       66.      1148.
```

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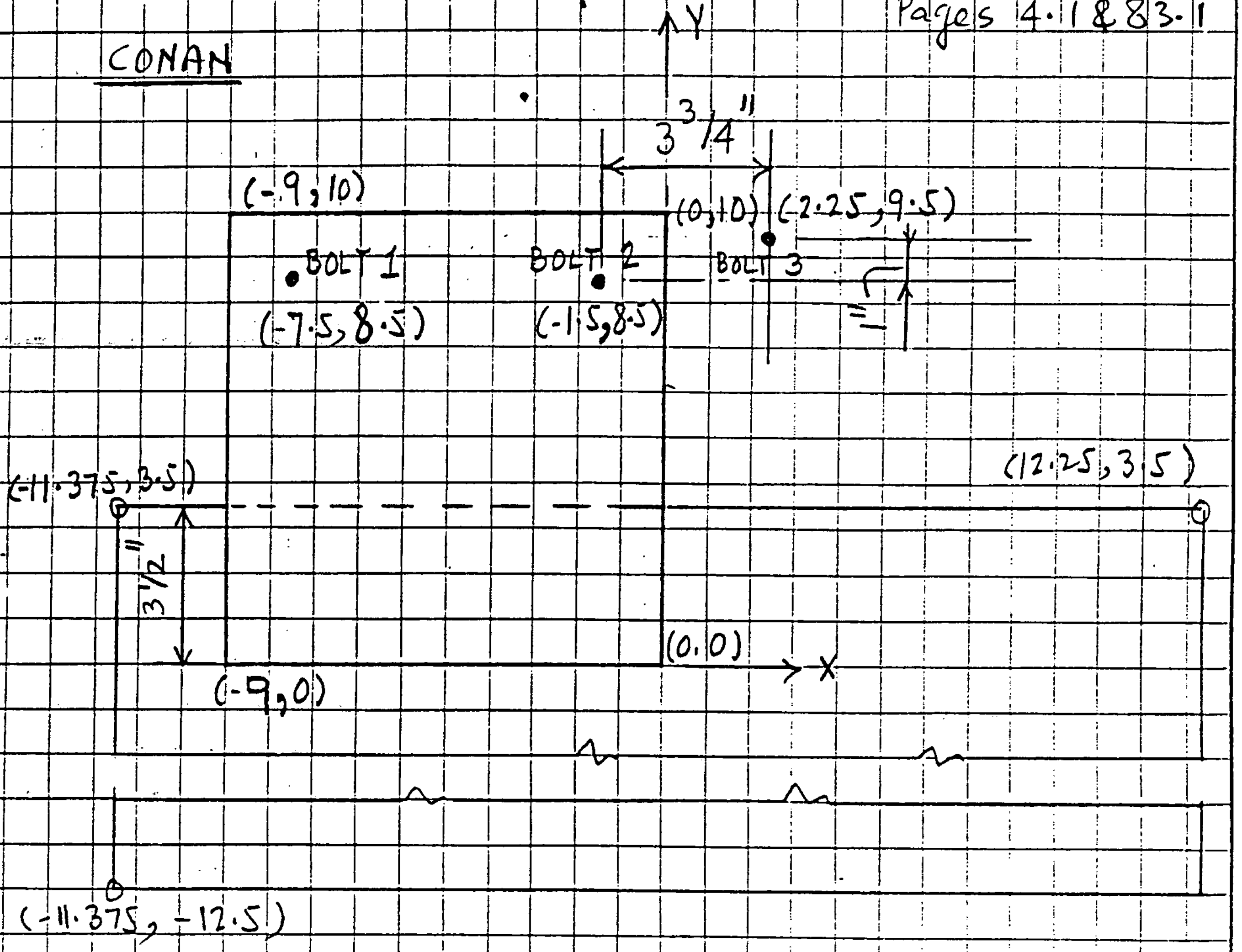
PROJECT WBNP- UNIT 1

SUBJECT Base Plates

REF.
WCG-1-825
Pages 4.1 & 83.1

Node 10

CONAN



The input and output of the CONAN analysis are shown in Table N-3.5.2.3.

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Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

Table 11.3.5.2.3 CONAN Input and Output for Anchorage at Nodes 10

(Ref = Input = C10PR9C ; Output = C10P9CR)

```
C10PR9C-NODE 10; CONAN FOR EMB. PLATE; 48N968.
BPROP
1,SD,0.5,,,A
BDATA
-7.5,8.5,1,0.636,U
-1.5,8.5,1,1.148,U
2.25,9.5,1,,U
EPDATA
12.25,3.5,-11.38,3.5,-11.38,-12.5,1.5
```

```
CONAN OUTPUT REPORT
FOR C10PR9C-NODE 10; CONAN FOR EMB. PLATE; 48N968.
LOAD CASE NO. 1

        MAX ALLOW   ALLOWABLE   APPLIED   ALLOW/APPLIED   PULLOUT
BOLT     TEN LOAD      LOAD       LOAD         LOAD          AREA

 1         1.55        1.55        .64         2.44          26.55
 2         1.55        1.36       1.15         1.19          20.72
 3         1.55        1.55       1.55         1.00          26.55
```

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Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.3.6 Connection and Anchorage Qualification for Worst Case 2&3-9(C)

11.3.6.1 Connection Qualification for Worst Case 2&3-9(C)

Weld connections at nodes 1, 4, 2 and 5 of ANSYS Model are evaluated using the results of the analysis "PR9C" for the original structure (Section 11.3.3.1).

Since the weld connecitons at nodes 1, 4, 2 and 5 are far away from the region which modification is made for worst case 1-27, these connections are not re-evaluated using the results from the analysis "PR9CM" for the modified structure.

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PROJECT WBNP - UNIT # 1

SUBJECT QUALIF. OF WORST CASES OF THERM. REST. STRUCT - PACK. 1

NODE 1, 4, 11 (FROM PR9CR DATED 8/19/91)

NODE FORCES (FROM ANSYS OUTPUT)

NODE 1, 101

$F_x = 1.65^{K}$ $M_x = 4.15^{''-K}$

$F_y = -4.35^{K}$ $M_y = -0.25^{''-K}$

$F_z = 0.26^{K}$ $M_z = -13.51^{''-K}$

NODE 4, 104

$F_x = -0.47^{K}$ $M_x = 3.72^{''-K}$

$F_y = 1.74^{K}$ $M_y = -0.27^{''-K}$

$F_z = 0.22$ $M_z = -6.11^{''-K}$

NODE 11, 111

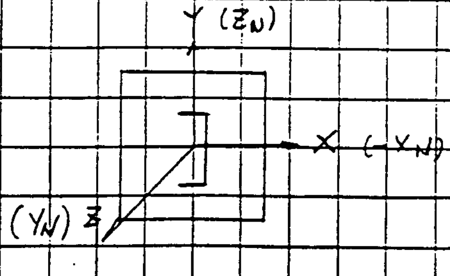
$F_x = 0.19^{K}$ $M_x = 2.20^{''-K}$

$F_y = -0.04^{K}$ $M_y = 0.05^{''-K}$

$F_z = 0.07^{K}$ $M_z = -3.07^{''-K}$

BY COMPARING THE ABOVE FORCES, LOADS ON NODE 1 GOVERNED, SINCE NODE 1, 4, 11 HAD SAME WELDING DETAIL AND PROPERTIES AS WELL AS LOADING DT. ONLY WELD AT NODE 1 WOULD BE CHECKED.

LOAD ON PLATES



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PROJECT WBNP - UNIT 1

SUBJECT QUALIF. OF WORST CASES OF THERMAL REST. STRUCT. - PACK. 1

NODE 1,101

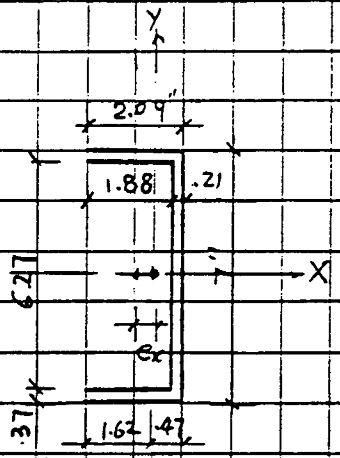
LOAD ON PLATE

$F_x = 1.65^{K}$ $M_x = 4.15^{''-K}$

$F_y = -0.26^{K}$ $M_y = 13.51^{''-K}$

$F_z = 4.35^{K}$ $M_z = 0.25^{''-K}$

WELD PROPERTIES (SIZE 3/16)



$A_w = 2 \times 2.09 + 2 \times 1.88 + 7.0 + 6.27$

$= 21.21$ IN

$\bar{y} = 3.50''$

$$\bar{x} = \frac{2.09 \times \frac{2.09}{2} \times 2 + 1.88 \times \left(\frac{1.88}{2} + 0.21\right) \times 2 + 6.27 \times 0.21}{21.21}$$

$$= \frac{4.37 + 4.32 + 1.32}{21.21} = 0.47'' \quad e_x = .541 - .47 = .07''$$

$$I_x = \frac{7^3}{12} + \frac{6.27^3}{12} + 2 \times 2.09 \times 3.5^2 + 2 \times 1.88 \times (3.5 - 0.37)^2$$

$= 28.58 + 20.54 + 51.21 + 36.84$

$= 137.17$ IN^3

$$I_y = 2 \times \frac{2.09^3}{12} + 2 \times \frac{1.88^3}{12} + 2 \times 2.09 \times \left(\frac{2.09}{2} - 0.47\right)^2$$

$$+ 2 \times 1.88 \times \left(\frac{1.88}{2} + .21 - .47\right)^2 + 7 \times .47^2 + 6.27 \times .26^2$$

$= 1.52 + 1.11 + 1.38 + 1.74 + 1.55 + .42 = 7.72$ IN^3

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$J_w = I_x + I_y = 137.17 + 7.72 = 144.89$ IN^3

$S_x = \frac{137.17}{3.5} = 39.19$ IN^2

Ch = 3.5"

Cv = 2.09 - 0.47

= 1.62"

$S_y = \frac{7.72}{1.62} = 4.77$ IN^2

$f_t = \frac{4.35}{21.21} + \frac{4.15}{39.19} + \frac{13.51}{4.77} = 3.14$ K/IN

$f_x = \frac{1.65}{21.21} + \frac{0.25 \times 3.5}{144.89} = 0.08$ K/IN

$f_y = \frac{0.26}{21.21} + \frac{0.25 \times 1.62}{144.89} = 0.05$ K/IN

$f_r = \left(3.14^2 + 0.08^2 + 0.05^2\right)^{1/2} = 3.14$ K/IN

WELD CAPACITY $= 0.707 \times 2/3 \times 70 \times 3/16$

$= 6.19$ K/IN $>$ 3.14 K/IN O.K

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CHECK CONNECTION @ NODES 2 & 5

LOADS @ NODE 102 & 105 (FROM ANSYS OUTPUT)

NODE 102 (ELEMENT 7)

$F_x = 1.15^K$ $M_x = 0.09^{''-K}$

$F_y = -0.05^K$ $M_y = -0.22^{''-K}$

$F_z = 0.08^K$ $M_z = -0.0^{''-K}$

NODE 105 (ELEMENT 15)

$F_x = -1.15^K$ $M_x = 0.09^{''-K}$

$F_y = -0.05^K$ $M_y = -0.12^{''-K}$

$F_z = 0.06^K$ $M_z = -0.0^{''-K}$

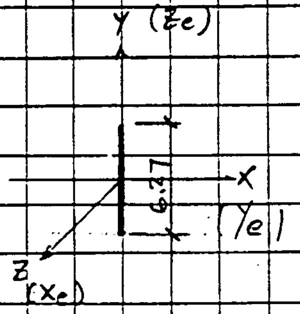
CHECK CONNECTION FOR NODE 102 WHICH GOVERNS

FORCES ON WELDS

$F_x = 0.05^K$ $M_x = 0.22^{''-K}$

$F_y = -0.08^K$ $M_y = 0.0$

$F_z = -1.15^K$ $M_z = -0.09^{''-K}$



WELD PROPERTIES

$A_w = 6.27''$ $S_x = \frac{6.27^2}{6} = 6.55 \text{ in}^2$ $S_y = 0$

$J_w = I_x + I_y = \frac{6.27^3}{12} + 0 = 20.54 \text{ in}^3$

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SUBJECT QUALIF. OF WORST CASES OF THERMAL REST. STRUCT - PACK 1

$$f_t = \frac{F_z}{A_w} + \frac{M_x}{S_x} + \frac{M_y}{S_y} = -\frac{1.15}{6.27} - \frac{0.22}{6.55} + 0 = -0.22 \ ^{K/IN}$$

$$f_x = \frac{F_x}{A_w} + \frac{M_z C_h}{J_w} = \frac{0.05}{6.27} + \frac{0.09 \times 3.135}{20.54} = 0.02 \ ^{K/IN}$$

$$f_y = \frac{F_y}{A_w} \quad \frac{M_z C_v}{J_w} = -\frac{0.08}{6.27} + 0 = 0.01 \ ^{K/IN}$$

$$f_r = \left(0.22^2 + 0.02^2 + 0.01^2\right)^{1/2} = 0.22 \ ^{K/IN}$$

WELD CAPACITY $= .707 \times 2/3 \times 70 \times 3/16$

$= 6.19 \ ^{K/IN} > 0.22 \ ^{K/IN}$.

O.K

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11.3.6.2 Anchorage Qualification for Worst Case 2&3-9(C)

Concrete anchorages at nodes 1 and 4 of ANSYS model are evaluated using the results of the anslysis "PR9C" for the original structure (Section 11.3.3.1).

Since nodes 1 and 4 are far away from the region which modification is made for worst case 1-27, the anchorage at nodes 1 and 4 are not re-evaluated using the results from the analysis "PR9CM" for the modified structure.

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References

SHEAR

Shear evaluation for anchor bolts
@ nodes 1 and 4 (SSD 3/4"φ)

DG-C1.6.12 R1
C.3.0

$UY = 0.03'' < 0.1D = 0.1 \times 3/4$
$= 0.075''$

Sec 11.3.3.1.2
Displ

O.K.

TENSION

The baseplate model used to calculate Rotational stiffness at nodes 1 & 4 (as shown in Figure 11.3.2) is used to perform BASEPLATE II analysis to obtain Tension forces at the anchor bolts.

The Input and Output of the BASEPLATE II analysis is listed in Table 11.3.6.2.1

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	Ref.
Tension Forces of Anchor Bolts are obtained	DG-C1.6.12
	R1
from BASEPLAT Output as shown in	C2.3.1
Table 11.3.6.2.1.	
Nodes 1&4 $3/4''\phi$ SSD's	
Max tension on anchor = $2428^{\#}$	Table 11.3.6.2.1
$T_0 = 3.0^k > 2.428^k$	DS-C1.7.1
	Table 4
∴ Bolts are O.K.	
Since there is G-32 Violation at	
Node 4, a CONAN evaluation is performed	
to check the Pull-out capacity.	
The Input and Output of CONAN run	
are listed in Table 11.3.6.2.2.	
The CONAN Results indicate no problem on	Table 11.3.6.2.2
Concrete Pull-out.	
∴ The Anchorage at Nodes 1 and 4 are qualified.	

Table 11.3.6.2.1 BASEPLATE II Input and Output for Anchorage at Nodes 1 and 4
(Ref: Input: B1PR9C; Output = B1PR9CR)

```
3 B1PR9C-NODES 1&4 ; SURF MOUNT PLATE; 48N968.
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 11,12,,11,11,1.0,29/
APR 7,2,1,7.0,2.09,.366,.21/
BPR ,,1,.4E6,1.0E6,3000,3300/
BOL 3,3,1,2,2/
BOL 10,3,1,9,2/
BOL 3,10,1,2,9/
BOL 10,10,1,9,9/
END /
ATT 5,3,,3.41,2.00/
JST 5,3,7,2.09,0/
IST 7,3,10,7.0,90/
JST 7,10,5,2.09,180/
END /
END /
POI 5,3,,1.55,3.5/
LOA ,,1,1650,-255,4348,4147,13514,246/
LOA ,,2,-470,-221,0,3721,6112,266/
END /
END OF JOB
```

(for Node 1)

```
                         B O L T   L O A D S
                         -------------------
  I      J
 LINE   LINE   NODE    X-SHEAR    Y-SHEAR     SRSS    Z-TENSION
 ----   ----   ----    -------    -------    ------   ---------

   3      3     27       420.        62.      425.       1930.
  10      3    111       413.        65.      418.        203.
   3     10     34       410.        59.      414.       2428.
  10     10    118       406.        70.      412.        486.
```

(for Node 4)

```
                         B O L T   L O A D S
                         -------------------
  I      J
 LINE   LINE   NODE    X-SHEAR    Y-SHEAR     SRSS    Z-TENSION
 ----   ----   ----    -------    -------    ------   ---------

   3      3     27      -105.       -70.      126.        309.
  10      3    111      -103.       -41.      111.          0.
   3     10     34      -132.       -69.      148.        566.
  10     10    118      -131.       -42.      137.         53.
```

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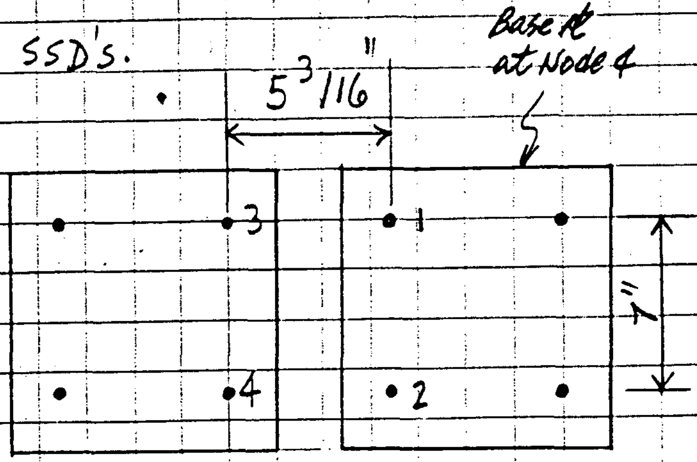
REF.

Node 4, PR9C CONAN

Anchors- 3/4"φ SSD's.

WCG-1-825 Pages 4.1, 13.1 & 23.1



Load on anchor #1 = 309#

Tab. 11.3.6.2.1

Load on anchor #2 = 566#

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Table 11.3.6.2.2 CONAN Input and Output for Anchorage at Nodes 4

(Ref: Input = C4PR9C ; Output = C4PR9CR)

```
C4PR9C-NODE 4; CONAN FOR EMB. PLATE; 48N968.
BPROP
1,SD,0.75,,,A
BDATA
0,0,1,,U
5.375,0,1,.309,U
0,7,1,,U
5.375,7,1,.566,U
```

```
CONAN OUTPUT REPORT
FOR C4PR9C-NODE 4; CONAN FOR EMB. PLATE; 48N968.
LOAD CASE NO. 1

        MAX ALLOW   ALLOWABLE    APPLIED   ALLOW/APPLIED   PULLOUT
BOLT     TEN LOAD      LOAD        LOAD        LOAD          AREA

  1        3.00        3.00        3.00         1.00         49.08
  2        3.00        2.51         .31         8.13         38.23
  3        3.00        3.00        3.00         1.00         49.08
  4        3.00        2.51         .57         4.44         38.23
```

11.3.7 Modification

A modification is required for the worst case 1-27 (member with Axially Restraint) per Section 11.3.4.1. The existing design of the member is not accepted because the ductility ratio of the member is greater than allowable (3). A slotted hole connection will be implemented at node 8 to release the axial load due the accident thermal condition per DCN M-16250-A. A second analysis "PR9CM" (See Section 11.3.2.2 for Input listing) is performed using the Response Spectrum Set B+C. The results of this analysis is shown in Section 11.3.3.2. Member, connections and Anchorage are reevaluated and qualified as shown in Sections 11.3.4 and 11.3.5.

In addition, two new STRUDL runs are performed in Calculation WCG-2-50, Vol. 6, R1, (Evaluation of Pressurizer Enclosure Platform @ EL. 783'-8 1/2") to investigate the effect of this modification. The impact of the modification is assessed mainly by comparing results of the analyses that are performed before and after the slotted hole connections incorporated into the computer model. Comparisons are performed for the following:

* Natural frequencies of the platform
* Member stress interaction ratios
* Maximum torsional moments on the members
* Forces and moments used in steel to steel connection checks
* Forces and moments used in surface mounted plate checks

The results of the comparison indicate that the differences due to the modification is negligible. For details, see WCG-2-50 R1.

The design of the slotted connection is presented as follows:

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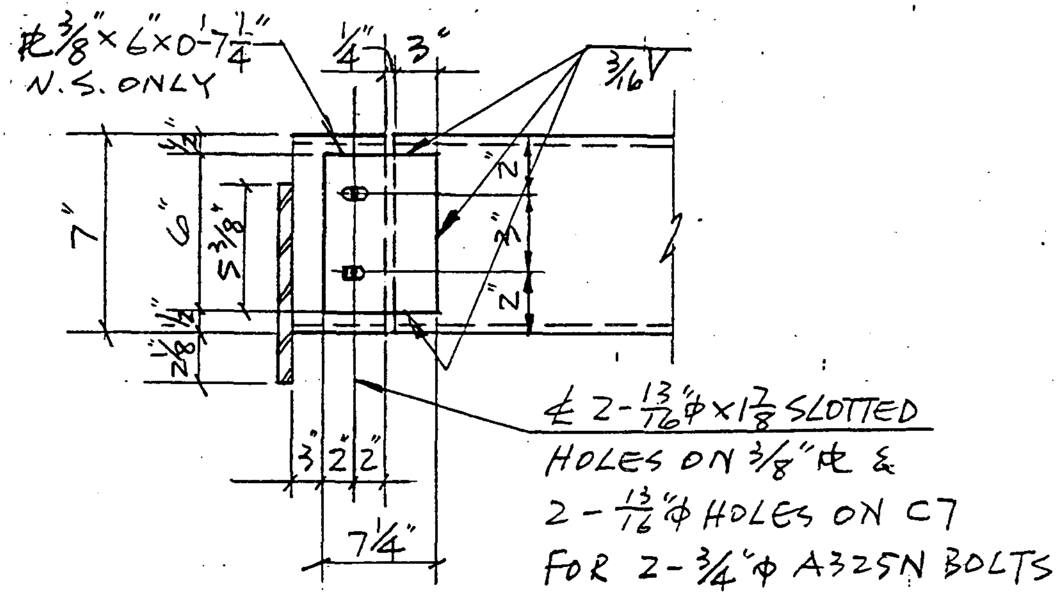
REF

Design of the Slotted Hole Connection @ Node 8

In order to qualify the worst case member 1-27, the connection at Node 8 has to be modified as per sketch shown below:



Design load : D+L/OBE

$F_y = 0.104^k$ $F_z = 0.048^k$ $M_x = 1.052^{k\cdot}$

Modification factor :

$$\text{Ratio} = \frac{\text{Spectra } B+C}{\text{Spectra } B} = \frac{9.58}{3.75} = 2.55$$

SH. 313 of WCG-2-50 Vol.6, R1

NOTE : Design load is obtained from
Calc. WCG-2-50, Vol.6, R1
Attach. K, Pg.26

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SUBJECT Qual. of Worse Cases of Therm. Restrained Structures - Package I

<u>Connection ⅊ design</u> : Try ⅊ 3/8" × 6" × 7¼"

Torsional constant $J = \frac{1}{3} \times 6 \times 0.375^3 = 0.106 \, in^4$

<u>shear stress</u> : $M_x' = 1.052 + 0.104 \times 0.541 = 1.11^{K''}$

$$\nu_x = \frac{0.048}{0.375 \times 6} = 0.21 \text{ ksi}$$

$$\nu_y = \frac{0.104}{0.375 \times 6} + \frac{1.11 \times 0.375}{0.106} = 3.97 \text{ ksi}$$

$$\therefore \nu = 2.55\sqrt{0.21^2 + 3.97^2}$$

$$= 10.13 \text{ ksi} < 0.4 \times 36 = 14.4 \text{ ksi} \quad \text{O.K}$$

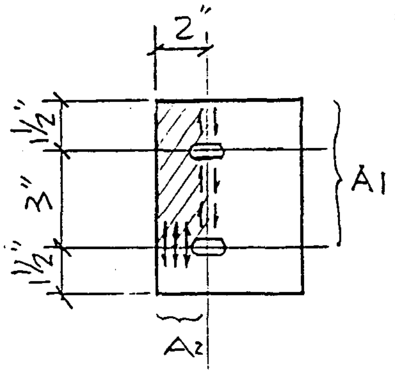
<u>Check block shear</u> : 3/8" ⅊

$F_v = 0.3 F_u = 0.3 \times 58 = 17.4$ ksi

$F_t = 0.5 F_u = 0.5 \times 58 = 29$ ksi

$A_1 = 0.375 \times (4.5 - 1.5 \times \frac{13}{16}) = 1.23 \, in^2$

$A_2 = 0.375 \times (2 - 1.875 \times \frac{1}{2}) = 0.4 \, in^2$



$R_y = 17.4 \times 1.23 + 29 \times 0.4$

$= 33^K > 2.55 F_y = 2.55 \times 0.104 = 0.27^K$ O.K.

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Check bending of connection PL :

$M_x = 0.104 \times 2.25 = 0.234^{k''}$

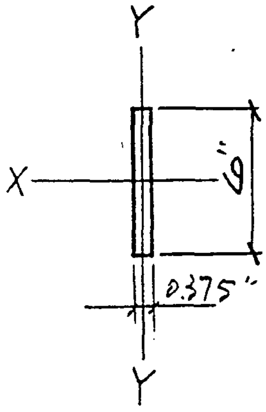
$M_y = 0.048 \times 2.25 = 0.108^{k''}$

$S_x = \frac{1}{6} \times 0.375 \times 6^2 = 2.25 \ in^3$

$S_y = \frac{1}{6} \times 6 \times 0.375^2 = 0.14 \ in^3$

$f_{bx} = \frac{0.234}{2.25} = 0.104 \ ksi$

$f_{by} = \frac{0.108}{0.14} = 0.77 \ ksi$



$\left(\frac{0.104}{21.6} + \frac{0.77}{27}\right) \times 2.55 = 0.085 < 1$ O.K.

Weld of connection PL to C7×9.8

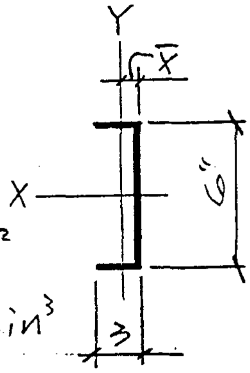
$A = 3 \times 2 + 6 = 12''$

$\bar{X} = \frac{1}{12} \times 3 \times 2 \times 1.5 = 0.75''$

$I_x = 3 \times 2 \times 3^2 + \frac{1}{12} \times 6^3 = 72 \ in^3$

$I_y = 6 \times 0.75^3 + \frac{1}{12} \times 3^3 \times 2 + 2 \times 3 \times 0.75^2$

$= 10.4 \ in^3$ $\quad I_z = 72 + 10.4 = 82.4 \ in^3$



Forces on weld :

$F_y = 0.104^k \quad M_x = 1.052 \quad F_z = 0.048^k$

$M_y = 0.048 \times (5.25 - 0.75) = 0.216^{k''}$

$M_z = 0.104 \times (5.25 - 0.75) = 0.47^{k''}$

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REF

$$f_{zt} = \frac{0.048}{12} + \frac{1.052 \times 3}{72} + \frac{0.216 \times 2.25}{10.4} = 0.095 \text{ k/"}$$

$$f_{yv} = \frac{0.104}{12} + \frac{0.47 \times 2.25}{82.4} = 0.022 \text{ k/"}$$

$$f_{xv} = \frac{0.47 \times 3}{82.4} = 0.017 \text{ k/"}$$

$$f_r = 2.55\sqrt{0.095^2 + 0.022^2 + 0.017^2} = 0.252 \text{ k/"}$$

$$w_{req'd} = \frac{0.252}{0.707 \times 21} = 0.017"$$

Min. F. W. req'd = $3/16" > 0.017"$

∴ use $3/16"$ F. W. as shown above

Design of connection bolts : 2-$3/4"\phi$ A325N

$$f_t = \frac{0.048}{2} + \frac{1.11}{3} = 0.394 \text{ k/bolt}$$

$$v_y = \frac{0.104}{2} = 0.052 \text{ k/Bolt}$$

$$V_x = \frac{0.104 \times (5.25 - 0.75)}{3} = 0.156 \text{ k/bolt}$$

Allow. single shear = 6.83^k for $t = \frac{3}{16}"$

Allow. tension $= 40 \times 0.3345 = 13.38^k$

$$v = \sqrt{0.052^2 + 0.156^2} \times 2.55 = 0.42^k < 6.83^k$$

$$f_v = \frac{0.42}{0.4418} = 0.95 \text{ ksi}$$

$$F_t = 50 - 1.6 f_v = 50 - 1.6 \times 0.95 = 48.5^{ksi} > 40 \text{ ksi}$$

use $F_t = 40^{ksi} > \frac{0.394}{0.3345} = 1.18^{ksi}$ O.K.

Use 2-$3/4"\phi$ A325N Bolts

11.4 Qualification of Worst Case 1-11

11.4.1 Mathematical Model (AX11)

The ANSYS model AX11 is shown in Figure 11.4.1.1. This model contains two members (C8x11.5) with Axial Restraint. These two members are modeled with ANSYS STIF24 elements (3-D thin-wall plastic beam elements) and the interconnecting members are modeled with STIF4 beam elements. STIF21 mass elements are used to simulate the weight of conduits at nodes 303 and 309 which are located under nodes 3 and 9 and connected to nodes 3 and 9 with rigid links. Temperature dependent material properties, as described in Section 11.2, are used.

Boundary Condition

All support nodes (nodes 1, 4, 7 and 10) are modeled as pinned connections. A (1/32") displacement is specified at nodes 4 and 10 in the +X direction and at nodes 1 and 7 in the -X direction at the third load step when temperature is 150°F. This is equivalent to specify Gap elements to allow the 1/32" free movement. A study run is performed by using gap elements (STIF40) at nodes 4 and 10 with gaps equal to 1/16" (1/32" * 2). The final results of the analysis using gap elements are identical to the results of the analysis using imposed displacements. The input file and the results (reactions and displacements at final load step) are provided in Attachment C.

Loading Condition

Equivalent densities are calculated for each member to consider the dead loads (including self-weight and grating) and the sustained lived loads. The 1 1/2 " grating weight is considered 12 psf and sustained live loads, 10 psf, based on WB-DC-20-21, Section 3.1.1. The grating and sustained live loads for members between nodes 1 and 4, and

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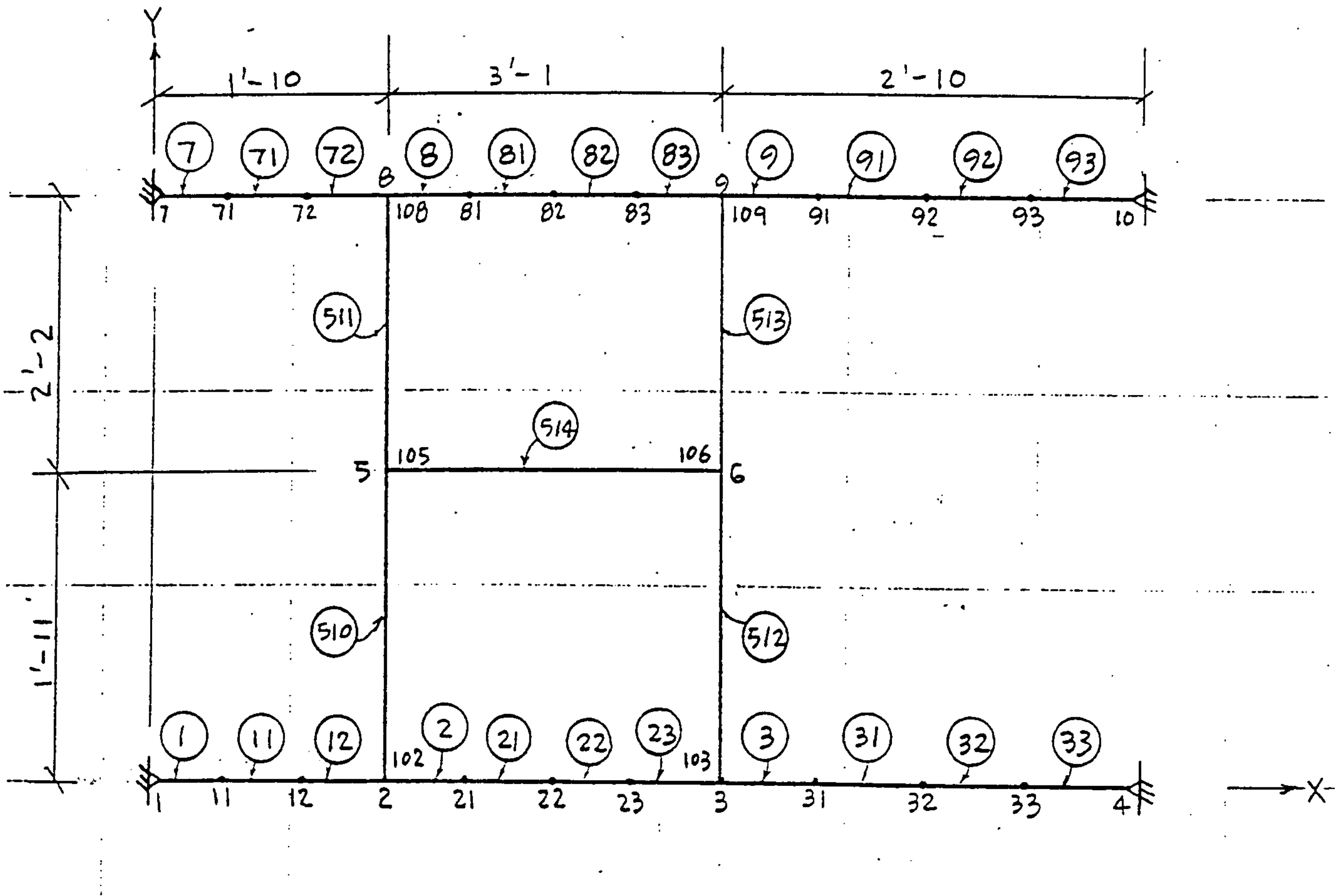
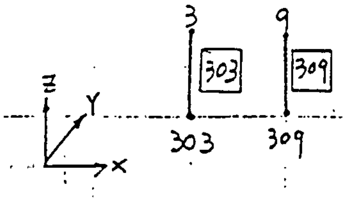
Figure 11.4.1.1 ANSYS Model for Worst Case 1-11

(MODEL AX11)



PLAN VIEW (NTS)



RIGID LINKS

LEGENDS :

○ -- MEMBER

□ -- RIGID LINK

• --- NODE

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nodes 7 and 10 are calculated as follows:

For the member between nodes 1 and 4:

Grating load per inch, W:

(67/2+49/2)*12/144 = 4.833333 #/"

Equivalent density: W/A = W/3.38 = 1.429980 lbs/in**3

A = Sectional area of C8X11.5 = 3.38 IN**2

Sustained live load per inch, W:

(67/2+49/2)*10/144 = 4.027777 #/"

Equivalent density: W/A = W/3.38 = 1.191650 lbs/in**3

Total density = 0.283 + 1.43 + 1.192 = 2.905 lbs/in**3

For the member between nodes 7 and 10:

Grating load per inch, W:

(28/2+49/2)*12/144 = 3.208333 #/"

Equivalent density: W/A = W/3.38 = 0.949211 lbs/in**3

A = Sectional area of C8X11.5 = 3.38 IN**2

Sustained live load per inch, W:

(28/2+49/2)*10/144 = 2.673611 #/"

Equivalent density: W/A = W/3.38 = 0.791009 lbs/in**3

Total density = 0.283 + 0.949 + 0.791 = 2.023 #s/in**3

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Walkdown information documented in Calculation WCG-1-830 is used to calculate attachment loads. There is no handrail attached to this portion of platform. A conduit is located at x=58.5" from node 1 under the channel. The effective conduit span is 7'-7.25" supported by the channel. From WB-DC-40-31.10 Table 3.3-1:

Conduit weight = 2.72 #/' for 1 1/2" steel conduit.
Total weight = 2.72*7.604 = 20.68 #s = 0.0207 kips

For the channel between nodes 7 and 10, one (1) 2" and two (2) 1.5" conduits, located at x=56" from node 7, are attached to the bottom of the channel. The conduit contributory span is 23.75". From WB-DC-40-31.10 Table 3.3-1:

Conduit weight = 2.72 #/' for 1 1/2" steel conduit.
Conduit weight = 3.65 #/' for 2" steel conduit.
Total weight = (2.72 + 2*3.65) * (23.75/12) = 19.83 #s =0.0198 kips

The conduits are simulated with ANSYS STIF21 mass elements (elements 303 and 309, located at 5" below nodes 3 and 9) in the ANSYS model.

A pipe support is welded to the channel between node 1 and 4. The pipe reaction forces are obtained from QIR CEB-WBN-89-103 R1. The forces and moments are tabulated in the following table and applied at nodes 3 and 23.

ANSYS Node	FX	FY	FZ	MX	MY	MZ
23	-.003	0	.307	-5.749	0	-.06
3	-.003	0	.307	-5.749	0	-.06

(Units: Kips, Inches)

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SSE loads are considered using the equivalent static approach by applying the peak G of the ARS (4% and 7% damping) with MMF=1.5 for member (per WB-DC-20-21) and MMF=1.2 for conduit supports (per WCG-1-684). The peak G-loads are obtained from QIR-CEB-WBN-89-361 (Ref. 9.7) and presented in the following table:

Direction	NS	EW	Vertical
Peak G	1.40	1.65	0.38

In the ANSYS model, 0.38G is used in the global Z (vertical) direction. 1.65G is conservatively used as the accelerations in both X and Y direction. Since the YZ-SSE (combination of SSE in Y and Z directions) is more critical than the XZ-SSE (combination of SSE in X and Z direction), the YZ-SSE is used to combine with other applicable loadings (DL, SLL and Thermal loads). However, the XZ-SSE is also applied as first load step (superseded by the second load step) in the analysis and is for reference only. The thermal load is applied by specifying incremental temperature steps from 70° up to the accident temperature 210° with an increment of 10° per load step.

The ANSYS input file is presented in Section 11.4.2.

11.4.2 ANSYS Input

```
          ***********  ANSYS INPUT DATA LISTING (FILE18)  ***********

/PREP7
/TITLE, AX11 - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"
/COM
/COM  BRANCH/PROJECT ID = WCG-1-969
/COM
/COM  PREPARED BY SAL   8/9/91
/COM  CHECKED BY J. OU  8/12/91
/COM
/COM   INPUT   = AX11
/COM   OUTPUT  = AX11R
/COM   FILE12  = AX11F
/COM   PLOT    = AX11P
/COM
C*** ANSYS ANALYSIS OPTIONS AND REFERENCES
KAN,0
KAY,6,1
KNL,1
TREF,70
C*** ELEMENT TYPE AND MATERIAL PROPERTIES
ET,1,4,,,,,,1
ET,2,24,,,,,,1
ET,3,21             * 3D MASS ELEMENT
C***
EX,1,29000
RP4,1
ALPX,1,6.5E-6
RP4,1
DENS,1,0.283E-3
DENS,2,2.905E-3        * INCLUDE DL+SLL
DENS,3,2.002E-3        * INCLUDE DL+SLL
DENS,4,0               * RIGID LINK
C***
MPTEMP,1,70,100,200,300,400
RP4,1
MPDATA,EX,1,1,29.0E3,28.9E3,28.3E3,27.9E3,27.4E3
RP4,,1
MPDATA,ALPX,1,1,6.50E-6,6.50E-6,6.50E-6,6.67E-6,6.86E-6  * ALPX=6.29 MU FOR 100F
RP4,,1
C***  NONLINEAR MATERIAL CONSTANT
*CREAT,MNL
NL,ARG1,13,10
NL,ARG1,19,70,100,200,300,400
NL,ARG1,25,36,36.0,36.0,36.0,36.0
NL,ARG1,31,150,150,150,150,150
*END
*USE,MNL,2
*USE,MNL,3
C*** MEMBER CROSS SECTIONAL PROPERTIES
R,1,3.38,1.32,32.6,8.00,2.26,  *C8X11.5
RMORE,,0.131
```

11.4.2 ANSYS Input (Cont'd)

```
C***
C***  NONLINEAR CROSS SECTIONAL PROPERTIES
C*** CHANNEL C8X11.5 *****
CF=2.260
TCF=0.390
CD=8.00
TCW=0.220
XBR=(0.571)+0.07695
C***
XO=(TCW/2)-(XBR)
CC=CF-(TCW/2)
DD=(CD-TCF)/2.
QC=CC/2
QD=DD/2
CC=CC+XO
QC=QC+XO
*STAT
C***
R,2,CC,DD,0,QC,DD,TCF                 * STIF24 REAL PROP. - C8X11.5
RMORE,XO,DD,TCF,XO,QD,TCW
RMORE,XO,0,TCW,XO,-QD,TCW
RMORE,XO,-DD,TCW,QC,-DD,TCF
RMORE,CC,-DD,TCF
C***
R3=(.0207*1.2)/1.5
R4=(.0198*1.2)/1.5
R,3,R3,R3,R3                    * CONDUIT
R,4,R4,R4,R4                    * CONDUIT
R,5,100,1000,1000               * RIGID LINK
C***
C*** NODES AND COORDINATES
X1=22     $X2=59     $Y1=23     $Y2=49
N,1,0,0
N,101,-1,0
N,2,X1,0
N,20,X1,0,5
N,102,X1,0
N,3,X2,0
N,103,X2,0
N,303,X2,0,-5
N,4,93,0
N,104,94,0
N,5,X1,Y1
N,105,X1,Y1
N,6,X2,Y1
N,106,X2,Y1
N,7,0,Y2
N,107,-1,Y2
N,8,X1,Y2
N,80,X1,Y2,5
N,108,X1,Y2
N,9,X2,Y2
N,109,X2,Y2
```

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11.4.2 ANSYS Input (Cont'd)

```
N,309,X2,Y2,-5
N,10,93,Y2
N,110,94,Y2
FILL,1,2,2,11,1
FILL,2,3,3,21,1
FILL,3,4,3,31,1
FILL,7,8,2,71,1
FILL,8,9,3,81,1
FILL,9,10,3,91,1
C***
C*** ELEMENT CONNECTIVITIES
C***
MAT,2    $TYPE,2    $REAL,2
EN,1,1,11,20        $EN,11,11,12,20    $EN,12,12,2,20
EN,2,2,21,20        $EN,21,21,22,20    $RP2,1,1,1         $EN,23,23,3,20
EN,3,3,31,20        $EN,31,31,32,20    $RP2,1,1,1         $EN,33,33,4,20
MAT,3
EN,7,7,71,80        $EN,71,71,72,80    $EN,72,72,8,80
EN,8,8,81,80        $EN,81,81,82,80    $RP2,1,1,1         $EN,83,83,9,80
EN,9,9,91,80        $EN,91,91,92,80    $RP2,1,1,1         $EN,93,93,10,80
C***
MAT,4  $TYPE,1   $REAL,5          * RIGID LINK
EN,303,3,303
EN,309,9,309
C***
MAT,4  $TYPE,3
REAL,3    $EN,503,303
REAL,4    $EN,509,309
C***
MAT,1     $TYPE,1   $REAL,1
E,102,5

E,5,108
E,103,6
E,6,109
E,105,106
C***
C*** COUPLED DOFS FOR MEMBER JOINT RELEASE
CP,1,UX,102,2
CPLGEN,1,UY,UZ               * SETS 2-3    NODE2
CPSGEN,2,1,1,3               * SETS 4-6    NODE3
CPSGEN,2,3,1,3               * SETS 7-9
CPLGEN,9,ROTX                * SET  10     NODE5
CPSGEN,2,4,1,3               * SETS 11-13  NODE6
CPSGEN,2,6,1,3               * SETS 14-16
CPLGEN,16,ROTY               * SET  17     NODE8
CPSGEN,2,1,14,17             * SETS 18-21  NODE9
C*** BOUNDARY CONDITIONS
*CREAT,BND
DDELE,ALL,ALL
D,1,UY,,,,,UZ
D,4,UY,,,,,UZ,ROTX
D,7,UY,,,,,UZ
D,10,UY,,,,,UZ,ROTX
C***
DDX=ARG1
```

11.4.2 ANSYS Input (Cont'd)

```
D,1,UX,-DDX
D,4,UX,DDX
D,7,UX,-DDX
D,10,UX,DDX
*END
*USE,BND,0
C*** ANALYSIS OPTIONS
ITER,-20,20
TREF,70
POSTR,,2,5
C*** PLOTS - GEOMETRY W/B.C.
/SHOW
/VIEW,,0,0,1
/PNUM,NODE,1
EPLO
/SHRINK,0.3
/PNUM,NODE,-1
/PNUM,ELEM,1
EPLO
/PNUM,ELEM
/PBC,ALL,1
EPLO
/VIEW,,1,1,1
EPLO
C*** LOADING CASES
C***
C***  PIPE FPL
F,3,FX,-.003,,23,20
F,3,FZ,-.307,,23,20
F,3,MX,5.749,,23,20
F,3,MZ,.06,,23,20
C***
*CREAT,MAC
TUNIF,ARG1
LWRITE
*END
C***
C*** FOR AX11 AT ELE. 713'-0",
C*** PEAK ACCEL.(G): NS=1.4, EW=1.65, VT=0.38
C*** FACTOR: MMF=1.5
MMF=1.5  $GX=MMF*1.65  $GY=MMF*1.65  $GZ=MMF*0.38
C***
C*** DL+SSE XZ-PLANE
ACEL,-GX,0,GZ+1
*USE,MAC,70
C***
C*** DL+SSE YZ-PLANE
ACEL,,-GY,GZ+1
*USE,MAC,70
C***
*USE,BND,(1/32)
*USE,MAC,150
RP7,,10
```

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11.4.2 ANSYS Input (Cont'd)

```
AFWRITE,,1
FINISH
/INPUT,27
FINISH
/POST1
/SHOW
NLINE,200
*CREAT,PRF
SET,ARG1
PRRFOR
PRDISP
PLDISP
PLDISP,1
*END
*USE,PRF,1
*USE,PRF,2
*USE,PRF,9
/VIEW,,1,1,1
PLDISP
PLDISP,1
FINISH
C***
/POST26
/SHOW
NUMVAR,50
TVAR,1
C***
ESTR,2,1,53,TEMP          * TEMPERATURE
*CREATE,STRN
C*** STORE STRAINS FOR CHANNEL
ESTR,3,ARG1,215,EE01
ESTR,4,ARG1,216,EP01
ESTR,5,ARG1,227,EE03
ESTR,6,ARG1,228,EP03
ESTR,7,ARG1,251,EE07
ESTR,8,ARG1,252,EP07
ESTR,9,ARG1,263,EE09
ESTR,10,ARG1,264,EP09
PRVAR,2,3,4,5,6
PRVAR,2,7,8,9,10
*END
C***
*CREAT,DSP
DISP,21,ARG1,UX,UX
DISP,22,ARG1,UY,UY
DISP,23,ARG1,UZ,UZ
PROD,24,21,21,,UXUX
PROD,25,22,22,,UYUY
PROD,26,23,23,,UZUZ
ADD,27,24,25,26,SS
SQRT,28,27,,,SRSS
PRVAR,2,21,22,23,28
*END
```

11.4.2 ANSYS Input (Cont'd)

```
*USE,STRN,2
*USE,DSP,21
*USE,STRN,21
*USE,DSP,22
*USE,STRN,22
*USE,DSP,23
*USE,STRN,23
*USE,DSP,3

*USE,STRN,8
*USE,DSP,81
*USE,STRN,81
*USE,DSP,82
*USE,STRN,82
*USE,DSP,83
*USE,STRN,83
*USE,DSP,9
FINISH
```

11.4.3 Analysis Results

The ANSYS output for the analysis "AX11" is stored in file "AX11R". The analysis results of the final load step (Load Step 9) are provided in this Section.

The deformed structure is plotted in Figure 11.4.3.1. Note that the displacements in this plot are magnified. This member is subjected to weak axis bending mainly due to thermal effect.

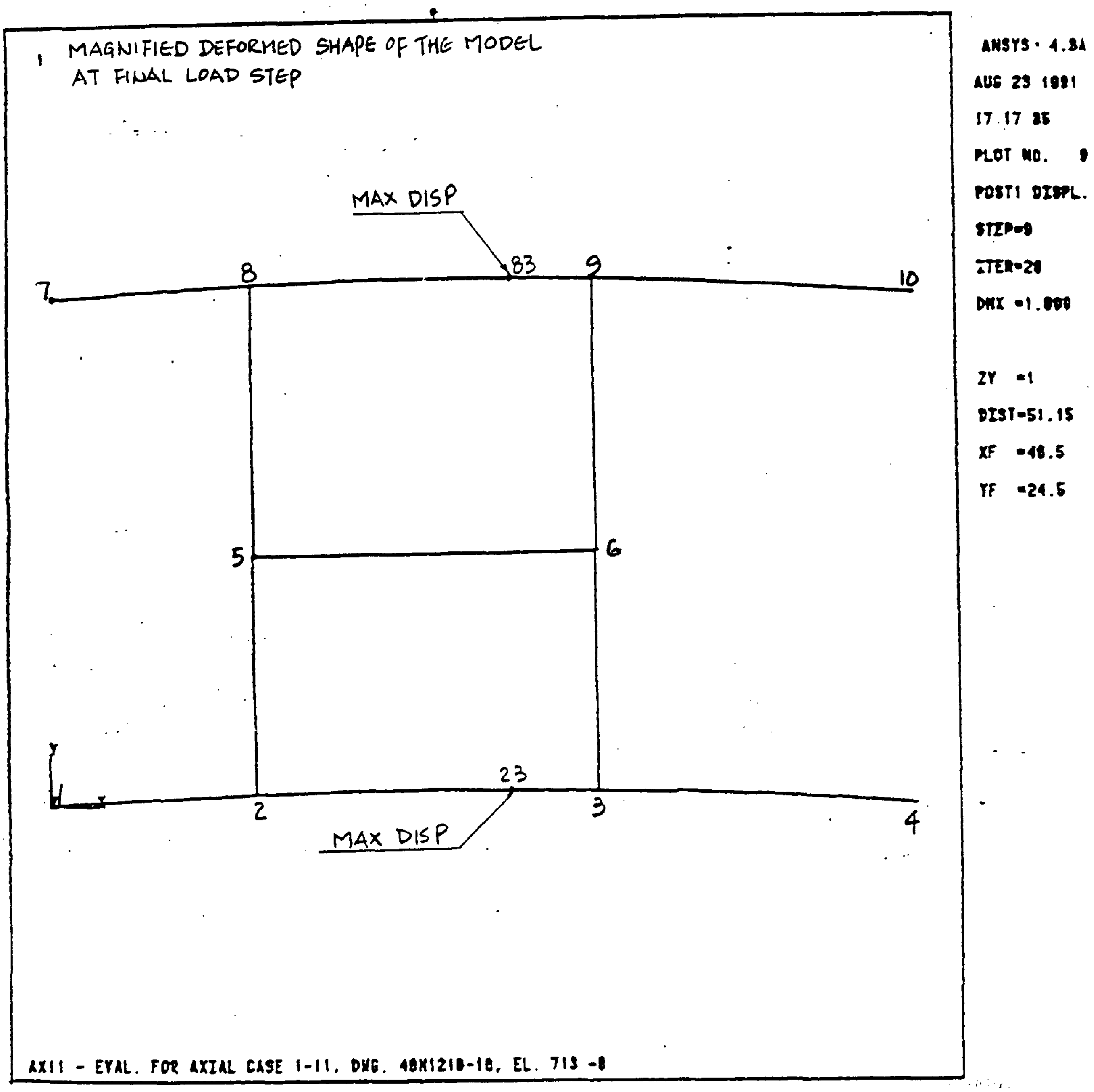
The reaction forces and the nodal displacements are provided in Sections 11.4.3.1 and 11.4.3.2 respectively. The maximum displacement for the member between nodes 1 and 4 occurs at Node 23. The maximum displacement for the member between nodes 7 and 10 occurs at Node 83.

The stresses and strains for elements arround node 23 (elements 21, 22, 23 and 3) and node 83 (elements 81, 82, 83 and 3) are presented in Section 11.4.3.3. The following explanations are provided for the labels shown in the stress and strain output.

PT:	Segment Point Number, see Figure 11.2.2 for the definition of segment point for cross-section of Channels.
TEMP:	Temperature
SIGX:	Axial Stress
EP:	Axial Elastic Strain
EPPL:	Axial Plastic Strain

The stress and strain results from output file "AX11R" indicate that no yielding occurs in the structure at the final load step (temperature = 210°F).

Figure 11.4.3.1 Deformed Shape of the Model AX11 (Worst Case 1-11)



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11.4.3.1 Reaction Forces

```
AX11 - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"

      ***** POST1 REACTION FORCE LISTING *****

LOAD STEP     9  ITERATION=    20  SECTION=  1
TIME=    0.0000         LOAD CASE=  1

THE FOLLOWING X,Y,Z FORCES ARE IN NODAL COORDINATES

  NODE     FX            FY            FZ            MX            MY            MZ


   1    15.055942    -1.2048128     1.0694251
   4   -15.049941    -1.2947006     1.0960250    -10.275460
   7    16.973767    -.90209277     .55390628
  10   -16.973768    -.78326339     .54928815     .18450515

TOTAL   .60000012E-02 -4.1848695    3.2686445    -10.090955     0.0000000     0.0000000
```

11.4.3.2 Displacements

```
AX11 - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"         16.0328  AUG  9,1991 CP=      27.461

         ***** POST1 NODAL DISPLACEMENT LISTING *****

LOAD STEP     9  ITERATION=    20  SECTION=  1
TIME=    0.0000          LOAD CASE=  1

THE FOLLOWING X,Y,Z DISPLACEMENTS ARE IN NODAL COORDINATES

  NODE       UX             UY             UZ             ROTX           ROTY           ROTZ
     1  -.31250000E-01  0.0000000      0.0000000      .33684571     -.91102546E-02  .19805924E-01
     2  -.17965737E-01  .36942408      .22212226      .31028067     -.81797670E-02  .14353553E-01
     3   .10044532E-01  .49917512      .39290142      .26562040     -.26966772E-02 -.79105298E-02
     4   .31250000E-01  0.0000000      0.0000000      0.0000000      .30777397E-02 -.20931454E-01
     5  -.21740197E-01  .39116307      .98133023E-01 -.53783054E-02  .81415268E-03  .20584943E-04
     6   .13448034E-01  .52037226      .18392250     -.90699911E-02 -.25478704E-03 -.56076173E-05
     7  -.31250000E-01  0.0000000      0.0000000     -.97184105E-02  .12664750E-02  .21010004E-01
     8  -.18179799E-01  .41571132     -.41611145E-01 -.20798344E-01  .81657336E-03  .14883195E-01
     9   .94734879E-02  .54430923     -.51894768E-01 -.19389452E-01 -.25628351E-03 -.84133419E-02
    10   .31250000E-01  0.0000000      0.0000000      0.0000000     -.10297768E-02 -.20191537E-01
    11  -.27054074E-01  .13541346      .76578161E-01  .32641765     -.91253891E-02  .19066253E-01
    12  -.22669099E-01  .26100336      .15165582      .31751752     -.87965475E-02  .17192614E-01
    21  -.11500944E-01  .47201014      .30121536      .30421276     -.70674131E-02  .96669410E-02
    22  -.45240438E-02  .52779203      .36577292      .30152770     -.57037829E-02  .41168662E-02
    23   .27196559E-02  .53102884      .41398440      .30256153     -.42422576E-02 -.18106090E-02
    31   .16291243E-01  .43455239      .30992814      .19670309     -.11011267E-02 -.13075533E-01
    32   .21907891E-01  .32253946      .21449911      .12998070      .39206043E-03 -.17377166E-01
    33   .26835822E-01  .17273634      .11030760      .64649522E-01  .17634889E-02 -.20197763E-01
    71  -.27156325E-01  .15223731     -.15762926E-01 -.14148452E-01  .11496564E-02  .20277112E-01
    72  -.22848490E-01  .29393062     -.29803172E-01 -.17863352E-01  .99866745E-03  .18171853E-01
    81  -.11707885E-01  .52949603     -.51926561E-01 -.22775326E-01  .56389512E-03  .95799491E-02
    82  -.47355336E-02  .59074728     -.57244262E-01 -.23244484E-01  .29329253E-03  .35961864E-02
    83   .24396829E-02  .59547164     -.57220546E-01 -.22120436E-01  .16378651E-04 -.25698872E-02
    91   .15564572E-01  .45228872     -.43634411E-01 -.16223982E-01 -.48742555E-03 -.13122626E-01
    92   .21183465E-01  .32406927     -.31806895E-01 -.11862432E-01 -.69624240E-03 -.16870256E-01
    93   .26355555E-01  .16922754     -.17057967E-01 -.64233121E-02 -.87773703E-03 -.19323999E-01
   102  -.17965737E-01  .36942408      .22212226     -.53899115E-02  .81528980E-03  .23234312E-03
   103   .10044532E-01  .49917512      .39290142     -.90816001E-02 -.25670448E-03 -.21722434E-03
   105  -.21740197E-01  .39116307      .98133023E-01 -.53783054E-02 -.23215341E-02  .36211564E-02
   106   .13448034E-01  .52037226      .18392250     -.53776337E-02 -.23300584E-02  .33439645E-02
   108  -.18179799E-01  .41571132     -.41611145E-01 -.53646544E-02  .81657336E-03 -.21882507E-03
   109   .94734879E-02  .54430923     -.51894768E-01 -.90563397E-02 -.25628351E-03  .23366310E-03
   303   .28619924E-01  1.8129076      .56363581      .26562042     -.26966771E-02 -.79105298E-02
   309   .10348164E-01  .44727096     -.55755912E-01 -.19389433E-01 -.25628351E-03 -.84133419E-02
```

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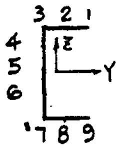
11.4.3.3 Stresses and Strains



```
EL=   21  NODES=   21    22  MAT=  2  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 210.00
END I  PT    TEMP       SIGX            EP        EPPL        EPCR        EPSW
        1   210.00     17.516       .0006393   0.0000000   0.0000000   0.0000000
        2   210.00     .52299       .0000191   0.0000000   0.0000000   0.0000000
        3   210.00    -16.470      -.0006011   0.0000000   0.0000000   0.0000000
        4   210.00    -14.729      -.0005376   0.0000000   0.0000000   0.0000000
        5   210.00    -12.988      -.0004740   0.0000000   0.0000000   0.0000000
        6   210.00    -11.247      -.0004105   0.0000000   0.0000000   0.0000000
        7   210.00    -9.5055      -.0003469   0.0000000   0.0000000   0.0000000
        8   210.00     7.4878       .0002733   0.0000000   0.0000000   0.0000000
        9   210.00     24.481       .0008935   0.0000000   0.0000000   0.0000000
END J  PT    TEMP       SIGX            EP        EPPL        EPCR        EPSW
        1   210.00     20.105       .0007338   0.0000000   0.0000000   0.0000000
        2   210.00     1.0334       .0000377   0.0000000   0.0000000   0.0000000
        3   210.00    -18.039      -.0006583   0.0000000   0.0000000   0.0000000
        4   210.00    -16.033      -.0005852   0.0000000   0.0000000   0.0000000
        5   210.00    -14.028      -.0005120   0.0000000   0.0000000   0.0000000
        6   210.00    -12.023      -.0004388   0.0000000   0.0000000   0.0000000
        7   210.00    -10.018      -.0003656   0.0000000   0.0000000   0.0000000
        8   210.00     9.0543       .0003304   0.0000000   0.0000000   0.0000000
        9   210.00     28.126       .0010265   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE   21   15.0275      -.422714      .586218      .482175      29.6158      25.5164
                           22  -15.0276       .252196     -.384760     -.211306     -34.1066     -28.6379


EL=   22  NODES=   22    23  MAT=  2  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 210.00
END I  PT    TEMP       SIGX            EP        EPPL        EPCR        EPSW
        1   210.00     20.137       .0007349   0.0000000   0.0000000   0.0000000
        2   210.00     1.0459       .0000382   0.0000000   0.0000000   0.0000000
        3   210.00    -18.046      -.0006586   0.0000000   0.0000000   0.0000000
        4   210.00    -16.042      -.0005855   0.0000000   0.0000000   0.0000000
        5   210.00    -14.038      -.0005123   0.0000000   0.0000000   0.0000000
        6   210.00    -12.035      -.0004392   0.0000000   0.0000000   0.0000000
        7   210.00    -10.031      -.0003661   0.0000000   0.0000000   0.0000000
        8   210.00     9.0605       .0003307   0.0000000   0.0000000   0.0000000
        9   210.00     28.152       .0010274   0.0000000   0.0000000   0.0000000
END J  PT    TEMP       SIGX            EP        EPPL        EPCR        EPSW
        1   210.00     20.548       .0007499   0.0000000   0.0000000   0.0000000
        2   210.00     .97396       .0000355   0.0000000   0.0000000   0.0000000
        3   210.00    -18.600      -.0006788   0.0000000   0.0000000   0.0000000
        4   210.00    -16.440      -.0006000   0.0000000   0.0000000   0.0000000
        5   210.00    -14.279      -.0005211   0.0000000   0.0000000   0.0000000
        6   210.00    -12.119      -.0004423   0.0000000   0.0000000   0.0000000
        7   210.00    -9.9591      -.0003635   0.0000000   0.0000000   0.0000000
        8   210.00     9.6148       .0003509   0.0000000   0.0000000   0.0000000
        9   210.00     29.189       .0010653   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE   22   15.0287      -.163645      .388542      .719963E-02  34.0796      28.6670
                           23  -15.0281      -.704427E-02 -.187230      .263472     -36.7425     -29.3913
```

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11.4.3.3 Stresses and Strains (Cont'd)

```
EL=   23  NODES=   23    3  MAT=  2  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 210.00
END I  PT   TEMP      SIGX          EP         EPPL         EPCR         EPSW
        1  210.00    21.310      .0007777   0.0000000    0.0000000    0.0000000
        2  210.00    1.2677      .0000463   0.0000000    0.0000000    0.0000000
        3  210.00   -18.774     -.0006852   0.0000000    0.0000000    0.0000000
        4  210.00   -16.643     -.0006074   0.0000000    0.0000000    0.0000000
        5  210.00   -14.513     -.0005297   0.0000000    0.0000000    0.0000000
        6  210.00   -12.382     -.0004519   0.0000000    0.0000000    0.0000000
        7  210.00   -10.251     -.0003741   0.0000000    0.0000000    0.0000000
        8  210.00    9.7912      .0003573   0.0000000    0.0000000    0.0000000
        9  210.00    29.833      .0010888   0.0000000    0.0000000    0.0000000
END J  PT   TEMP      SIGX          EP         EPPL         EPCR         EPSW
        1  210.00    20.643      .0007534   0.0000000    0.0000000    0.0000000
        2  210.00    1.1588      .0000423   0.0000000    0.0000000    0.0000000
        3  210.00   -18.325     -.0006688   0.0000000    0.0000000    0.0000000
        4  210.00   -16.279     -.0005941   0.0000000    0.0000000    0.0000000
        5  210.00   -14.233     -.0005195   0.0000000    0.0000000    0.0000000
        6  210.00   -12.187     -.0004448   0.0000000    0.0000000    0.0000000
        7  210.00   -10.141     -.0003701   0.0000000    0.0000000    0.0000000
        8  210.00    9.3432      .0003410   0.0000000    0.0000000    0.0000000
        9  210.00    28.827      .0010521   0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   23   15.0240     .342663E-02  -.567804E-01   4.84944     36.2436     30.0942
                            3  -15.0230    -.177704      .254994      -4.58293    -34.8017    -29.2564

EL=    3  NODES=    3   31  MAT=  2  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 210.00
END I  PT   TEMP      SIGX          EP         EPPL         EPCR         EPSW
        1  210.00    22.699      .0008284   0.0000000    0.0000000    0.0000000
        2  210.00    1.9566      .0000714   0.0000000    0.0000000    0.0000000
        3  210.00   -18.786     -.0006856   0.0000000    0.0000000    0.0000000
        4  210.00   -16.828     -.0006142   0.0000000    0.0000000    0.0000000
        5  210.00   -14.870     -.0005427   0.0000000    0.0000000    0.0000000
        6  210.00   -12.912     -.0004713   0.0000000    0.0000000    0.0000000
        7  210.00   -10.954     -.0003998   0.0000000    0.0000000    0.0000000
        8  210.00    9.7884      .0003572   0.0000000    0.0000000    0.0000000
        9  210.00    30.531      .0011143   0.0000000    0.0000000    0.0000000
END J  PT   TEMP      SIGX          EP         EPPL         EPCR         EPSW
        1  210.00    18.672      .0006815   0.0000000    0.0000000    0.0000000
        2  210.00    1.0963      .0000400   0.0000000    0.0000000    0.0000000
        3  210.00   -16.479     -.0006014   0.0000000    0.0000000    0.0000000
        4  210.00   -14.882     -.0005431   0.0000000    0.0000000    0.0000000
        5  210.00   -13.285     -.0004849   0.0000000    0.0000000    0.0000000
        6  210.00   -11.688     -.0004266   0.0000000    0.0000000    0.0000000
        7  210.00   -10.091     -.0003683   0.0000000    0.0000000    0.0000000
        8  210.00    7.4847      .0002732   0.0000000    0.0000000    0.0000000
        9  210.00    25.060      .0009146   0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE    3   15.0476     .474734     -.635374      9.68766     33.3027     31.1464
                           31  -15.0464    -.644287      .808791     -9.45449    -27.1650    -26.3906
```

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11.4.3.3 Stresses and Strains (Cont'd)

```
EL=   81  NODES=   81   82  MAT=  3  PRESSURES(Z,Y)=    0.0000        0.0000        AVE. TEMP= 210.00
END I  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   210.00     20.997      .0007663    0.0000000    0.0000000    0.0000000
        2   210.00     2.6979      .0000985    0.0000000    0.0000000    0.0000000
        3   210.00    -15.601     -.0005694    0.0000000    0.0000000    0.0000000
        4   210.00    -14.908     -.0005441    0.0000000    0.0000000    0.0000000
        5   210.00    -14.214     -.0005188    0.0000000    0.0000000    0.0000000
        6   210.00    -13.521     -.0004934    0.0000000    0.0000000    0.0000000
        7   210.00    -12.827     -.0004681    0.0000000    0.0000000    0.0000000
        8   210.00     5.4725      .0001997    0.0000000    0.0000000    0.0000000
        9   210.00     23.772      .0008676    0.0000000    0.0000000    0.0000000
END J  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   210.00     22.926      .0008367    0.0000000    0.0000000    0.0000000
        2   210.00     3.2464      .0001185    0.0000000    0.0000000    0.0000000
        3   210.00    -16.433     -.0005998    0.0000000    0.0000000    0.0000000
        4   210.00    -15.669     -.0005719    0.0000000    0.0000000    0.0000000
        5   210.00    -14.905     -.0005440    0.0000000    0.0000000    0.0000000
        6   210.00    -14.141     -.0005161    0.0000000    0.0000000    0.0000000
        7   210.00    -13.377     -.0004882    0.0000000    0.0000000    0.0000000
        8   210.00     6.3027      .0002300    0.0000000    0.0000000    0.0000000
        9   210.00     25.983      .0009483    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   81   16.9465      -.301981      .176434       .122813      11.7983      27.4776
                           82  -16.9475       .146192     -.825526E-01  .341433E-02  -12.9961     -29.5504

EL=   82  NODES=   82   83  MAT=  3  PRESSURES(Z,Y)=    0.0000        0.0000        AVE. TEMP= 210.00
END I  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   210.00     22.921      .0008365    0.0000000    0.0000000    0.0000000
        2   210.00     3.2438      .0001184    0.0000000    0.0000000    0.0000000
        3   210.00    -16.433     -.0005998    0.0000000    0.0000000    0.0000000
        4   210.00    -15.669     -.0005718    0.0000000    0.0000000    0.0000000
        5   210.00    -14.904     -.0005439    0.0000000    0.0000000    0.0000000
        6   210.00    -14.139     -.0005160    0.0000000    0.0000000    0.0000000
        7   210.00    -13.375     -.0004881    0.0000000    0.0000000    0.0000000
        8   210.00     6.3021      .0002300    0.0000000    0.0000000    0.0000000
        9   210.00     25.979      .0009481    0.0000000    0.0000000    0.0000000
END J  PT    TEMP       SIGX          EP          EPPL         EPCR         EPSW
        1   210.00     22.565      .0008236    0.0000000    0.0000000    0.0000000
        2   210.00     3.1035      .0001133    0.0000000    0.0000000    0.0000000
        3   210.00    -16.358     -.0005970    0.0000000    0.0000000    0.0000000
        4   210.00    -15.577     -.0005685    0.0000000    0.0000000    0.0000000
        5   210.00    -14.796     -.0005400    0.0000000    0.0000000    0.0000000
        6   210.00    -14.015     -.0005115    0.0000000    0.0000000    0.0000000
        7   210.00    -13.234     -.0004830    0.0000000    0.0000000    0.0000000
        8   210.00     6.2275      .0002273    0.0000000    0.0000000    0.0000000
        9   210.00     25.689      .0009376    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   82   16.9481      -.429682E-01  .771563E-01  -.803695E-01  13.0047      29.5462
                           83  -16.9482      -.112794      .167759E-01   .206665     -13.2840     -29.2233
```

11.4.3.3 Stresses and Strains (Cont'd)

```
EL=   83  NODES=   83    9  MAT=  3  PRESSURES(Z,Y)=   0.0000        0.0000       AVE. TEMP= 210.00
END I  PT     TEMP      SIGX             EP          EPPL          EPCR          EPSW
        1   210.00    22.534         .0008224    0.0000000     0.0000000     0.0000000
        2   210.00    3.0889         .0001127    0.0000000     0.0000000     0.0000000
        3   210.00   -16.356        -.0005969    0.0000000     0.0000000     0.0000000
        4   210.00   -15.572        -.0005683    0.0000000     0.0000000     0.0000000
        5   210.00   -14.788        -.0005397    0.0000000     0.0000000     0.0000000
        6   210.00   -14.003        -.0005111    0.0000000     0.0000000     0.0000000
        7   210.00   -13.219        -.0004825    0.0000000     0.0000000     0.0000000
        8   210.00    6.2258         .0002272    0.0000000     0.0000000     0.0000000
        9   210.00    25.671         .0009369    0.0000000     0.0000000     0.0000000
END J  PT     TEMP      SIGX             EP          EPPL          EPCR          EPSW
        1   210.00    19.907         .0007265    0.0000000     0.0000000     0.0000000
        2   210.00    2.2645         .0000826    0.0000000     0.0000000     0.0000000
        3   210.00   -15.378        -.0005612    0.0000000     0.0000000     0.0000000
        4   210.00   -14.632        -.0005340    0.0000000     0.0000000     0.0000000
        5   210.00   -13.886        -.0005068    0.0000000     0.0000000     0.0000000
        6   210.00   -13.139        -.0004795    0.0000000     0.0000000     0.0000000
        7   210.00   -12.393        -.0004523    0.0000000     0.0000000     0.0000000
        8   210.00    5.2498         .0001916    0.0000000     0.0000000     0.0000000
        9   210.00    22.893         .0008355    0.0000000     0.0000000     0.0000000
FORCES ON MEMBER AT NODE   83   16.9472     .214776    -.225714E-01  -.285140      13.3388      29.1978
                            9  -16.9463    -.370355     .116802       .411837     -12.6942     -26.4916
```

```
EL=    9  NODES=    9   91  MAT=  3  PRESSURES(Z,Y)=   0.0000        0.0000       AVE. TEMP= 210.00
END I  PT     TEMP      SIGX             EP          EPPL          EPCR          EPSW
        1   210.00    19.853         .0007246    0.0000000     0.0000000     0.0000000
        2   210.00    2.2357         .0000816    0.0000000     0.0000000     0.0000000
        3   210.00   -15.382        -.0005614    0.0000000     0.0000000     0.0000000
        4   210.00   -14.631        -.0005340    0.0000000     0.0000000     0.0000000
        5   210.00   -13.880        -.0005066    0.0000000     0.0000000     0.0000000
        6   210.00   -13.129        -.0004792    0.0000000     0.0000000     0.0000000
        7   210.00   -12.378        -.0004518    0.0000000     0.0000000     0.0000000
        8   210.00    5.2395         .0001912    0.0000000     0.0000000     0.0000000
        9   210.00    22.857         .0008342    0.0000000     0.0000000     0.0000000
END J  PT     TEMP      SIGX             EP          EPPL          EPCR          EPSW
        1   210.00    16.049         .0005857    0.0000000     0.0000000     0.0000000
        2   210.00    1.1282         .0000412    0.0000000     0.0000000     0.0000000
        3   210.00   -13.792        -.0005034    0.0000000     0.0000000     0.0000000
        4   210.00   -13.161        -.0004803    0.0000000     0.0000000     0.0000000
        5   210.00   -12.530        -.0004573    0.0000000     0.0000000     0.0000000
        6   210.00   -11.899        -.0004343    0.0000000     0.0000000     0.0000000
        7   210.00   -11.268        -.0004112    0.0000000     0.0000000     0.0000000
        8   210.00    3.6529         .0001333    0.0000000     0.0000000     0.0000000
        9   210.00    18.573         .0006779    0.0000000     0.0000000     0.0000000
FORCES ON MEMBER AT NODE    9   16.9703     .405132    -.196161      -.381048      12.7728      26.4542
                           91  -16.9687    -.547835     .283171       .498036     -10.7357     -22.4041
```

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11.4.4 Member Qualification

As presented in Section 11.4.3, the maximum displacement for the member between nodes 1 and 4 occurs at Node 23. The maximum displacement for the member between nodes 7 and 10 occurs at Node 83. The stress and strain results of the analysis indicate that no yielding occurs in both members at the final temperature step (temperature=210°F). Therefore, the ductility ratio at both nodes 23 and 83 are less than 1. Note that the ductility ratio is defined as the ratio of the final displacement to the yield displacement.

Per DG-C1.6.12, Appendix D, the members of worst case 1-11 are qualified.

EBASCO SERVICES INCORPORATED

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Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.4.5 Connection and Anchorage Qualification

The connections at support nodes 1, 4, 7 and 10 are evaluated. The connection information is obtained from Drawing 48N1210-16 and the walkdown package (Calc. WCG-1-830). The evaluation of connections is documented in sheets 161 through 166.

Based on the analysis results presented in Section 11.4.3, the anchorage, to which the supporting channels are welded, is not affected due to thermal effect (The only force transferred to the anchorage due to thermal effect is compression force). Therefore, no further evaluation is required for the anchorage.

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PROJECT WBNP- UNIT 1

SUBJECT Qualif. of worst cases of Therm. Rest. Struct. Package I

REF.

AX11 - Dwg. 48N1210-16

Connection of Bm to base plate

Nodes 1, 4, 7, 10

use loads for node 4, because it is the max^m.

$F_x = 15.05^K$ (compression) — Output: AX11R

$F_y = 1.3^K$

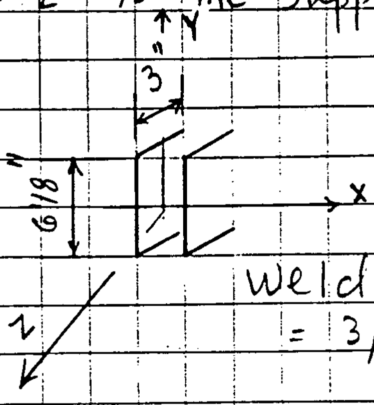
$F_z = 1.1^K$

$M_x = 10.28$ in-K

$M_y = 0$

$M_z = 0$

Connection of clip L^s to the supported Bm (C8x11.5):



Weld size = 3/16"

Forces on weld group

$F_x = 15.05^K$ $M_x = 10.28$ in-K

$F_y = 1.1^K$ $M_y = 0$

$F_z = 1.3^K$ $M_z = 0$

Weld properties

$A_w = 2 \times (3+3+6.125) = 24.25$ in.

$S_x = 2 \times (3 \times 6.125 + 6.125^2/6) = 49.26$ in^2

EBASCO SERVICES INCORPORATED

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PROJECT WBNP- UNIT 1

SUBJECT Qualif. of worst cases of Therm. Rest. struct. - Package

REF.

AX11 - Cont'd.

$$ft = \frac{Fz}{Aw} + \frac{Mx}{Sx}$$

$$= \frac{1.3}{24.25} + \frac{10.28}{49.26} = .054 + .209 = .263 \text{ K/in}$$

$$fx = \frac{15.05}{24.25} = 0.62 \text{ K/in}$$

$$fy = \frac{1.1}{24.25} = 0.045 \text{ K/in}$$

$$fr = (ft^2 + fx^2 + fy^2)^{1/2}$$

$$= (.263^2 + .62^2 + .045^2)^{1/2}$$

$$= 0.67 \text{ K/in}$$

Allowable stress on weld

= 2/3 x 70 = 46.67 ksi

Allowable load on weld

= 0.707 x 46.67 x 3/16 = 6.19 K/in

> 0.67 K/in OK

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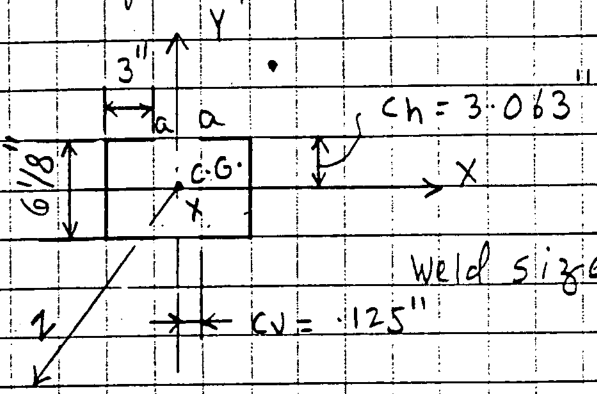
PROJECT WBNP- UNIT 1

SUBJECT Qualif. of Worst cases of Therm. Rest. struct. - Package

REF.

AX 11 - Cont'd.

Connection of Clip L^s. to Connected Bm:



Weld size : 3/16"

Forces on weld group:

$F_x = 1.3^K$

$F_y = 1.1^K$

$F_z = 15.05^K$ (compression - neglected)

$M_x = 0$

$M_y = 0$

$M_z = 10.28$ in-K

Weld properties

$A_w = 2 \times (3+3+6.125) = 24.25$ in.

$$J_w = 2 \times \left\{ \frac{(2\times3+6.125)^3}{12} - \frac{3^2(3+6.125)^2}{(2\times3+6.125)} \right\}$$

$= 173.5 \text{ in}^3$

C.G. of the weld group is at X.

Max^m stresses in welds are at pts a

ch = 3.063", cv = .125"

$$f_{th} = \frac{M_z \times C_h}{J_w} = \frac{10.28 \times 3.063}{173.5} = .18 \text{ k/in}$$

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AXII - Cont'd.

$ftv = \frac{Mz \times CV}{JW} = \frac{10.28 \times .125}{173.5} = .007$ K/in

$fsh = \frac{Fx}{AW} = \frac{1.3}{24.25} = .054$ K/in

$fsv = \frac{Fy}{AW} = \frac{1.1}{24.25} = .045$ K/in

$$fr = \left\{ (fth + fsh)^2 + (ftv + fsv)^2 \right\}^{1/2}$$

$$= \left\{ (.18 + .054)^2 + (.007 + .045)^2 \right\}^{1/2}$$

$= .24$ K/in

Allowable load on Weld

$= .707 \times 46.67 \times 3/16 = 6.19$ K/in

$> .24$ K/in OK

REF.

Design of Welded structures - Blodgett

Table 5.

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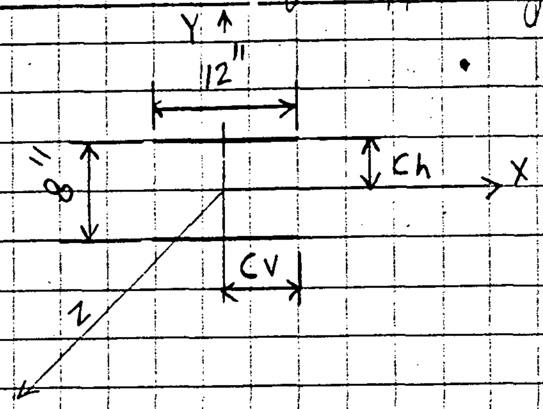
AX 11 - Cont'd.

Connection of supporting Bm to embed plate



Forces on weld group

$F_x = 1.3^K$
$F_y = 1.1^K$
$F_z = 15.05^K$ (compression - neglected)

$M_x = 0$
$M_y = 0$
$M_z = 10.28$ in K

Weld Properties

$A_W = 2 \times 12 = 24''$
$J_W = \frac{12 \times (3 \times 8^2 + 12^2)}{6} = 672 \text{ in}^3$

$C_h = 4''$, $C_V = 6''$

$f_{th} = \frac{M_z \times C_h}{J_W} = \frac{10.28 \times 4}{672} = .06$ K/in

$f_{tv} = \frac{M_z \times C_V}{J_W} = \frac{10.28 \times 6}{672} = .092$ K/in

$f_{sh} = \frac{F_X}{A_W} = \frac{1.3}{24} = .054$ K/in

REF.
Design of Welded Structures - Blodgett
Table 5

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CLIENT TVA

PROJECT WBNP- UNIT 1

SUBJECT Qualif. of worst cases of Therm. Rest. struct. - Package

AXII- Cont'd. REF.

$$fsv = \frac{Fy}{Aw} = \frac{1.1}{24} = .046 \text{ K/in}$$

$$fr = \left\{ (fth+fsh)^2 + (ftv+fsv)^2 \right\}^{1/2}$$

$$= \left\{ (.06+.054)^2 + (.092+.046)^2 \right\}^{1/2}$$

$$= 0.18 \text{ K/in}$$

Allowable load on weld

$$= .707 \times 46.67 \times 3/16 = 6.19 \text{ K/in}$$

$$> 0.18 \text{ K/in} \quad \text{OK}$$

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11.5 Qualification of Worst Case 2&3-8(G)

11.5.1 Mathematical Model (PR8G)

The ANSYS model PR8G is shown in Figure 11.5.1.1. This model contains members for a member (Angle 3x3x1/4) with Proximity Restraint, two supporting members (structural tubing TS 4x4x1/4) and other interconnecting members. ANSYS STIF24 elements (3-D thin-wall plastic beam elements) are used to simulate the proximity member and the supporting members. The interconnecting members are modeled with STIF4 beam elements. Temperature dependent material properties, as described in Section 11.2, are used.

Boundary Condition

ANSYS STIF14 spring elements and STIF40 combination elements are used to simulate the shear stiffness of concrete anchors and the rotational stiffness of the baseplate and concrete anchorage at support nodes 1 and 9. Nodes 101 and 109 are the support nodes for the spring elements. 1600 kip/in (400*4) obtained from CSG-91-0003 is used as the shear stiffness for each spring to represent the 1"ϕ Wedge Bolts. The rotational stiffness is calculated from the output of BASEPLATE II runs. A total of two (2) baseplate models were generated as shown in Figures 11.5.1.2 and 11.5.1.3. The input files for the baseplate runs to calculate rotational stiffness are provided in Tables 11.5.1.1 and 11.5.1.2.

A displacement of 1/32" is specified at node 101 in +Y direction and at node 109 in -Y direction. This approach has the same effect of using a Gap Element at support to allow free movement before load starts to transfer. A study run is performed by specifying a gap of 1/32" for the combination elements (STIF40) at both nodes 1 and 9. The final results of the analysis using gap elements are identical to the results of the analysis using imposed displacements. The input file and the results (reactions and displacements at final load step) are provided in Attachment D.

Loading Condition

As shown in Sheets 178 and 179, equivalent densities are calculated for the proximity member and the supporting members to consider the dead loads (including self-weight and grating) and the sustained live loads (10 psf per WB-DC-20-21). There is no attachment on the members per walkdown information shown in Attachment E. The SSE loads are applied using the equivalent static approach. The peak G's of the ARS, obtained from QIR-CEB-WBN-89-361 (Ref. 9.7) as shown in the following table, are applied with MMF=1.5.

Direction	NS	EW	Vertical
Peak G	3.5	3.25	1.4

In the ANSYS model, 1.4G is used in the global Z (vertical) direction and 3.5G is conservatively used as the accelerations in both X and Y direction. Since the YZ-SSE (combination of SSE in Y and Z directions) is more critical than the XZ-SSE (combination of SSE in X and Z direction), the YZ-SSE is used to combine with other applicable loadings (DL, SLL and Thermal loads). The thermal load is applied by specifying incremental temperature steps from 70° up to the accident temperature 327° with an increment of 10° per load step.

The ANSYS input file is presented in Section 11.5.2.

Figure 11.5.1.1 ANSYS Model for Worst Case 2&3-8(G)

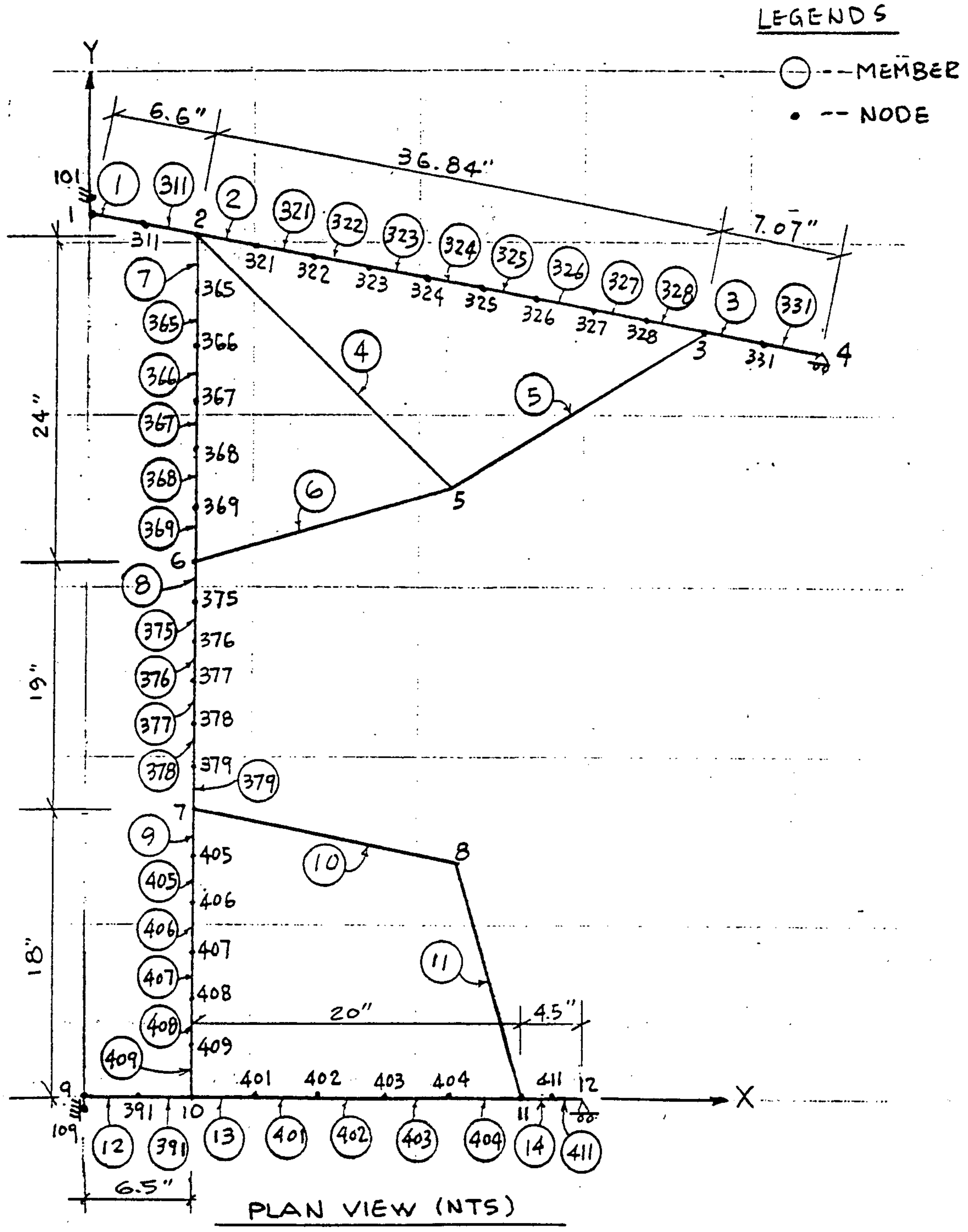

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Figure 11.5.1.2 BASEPLATE II Model for Nodes 1 of ANSYS Model

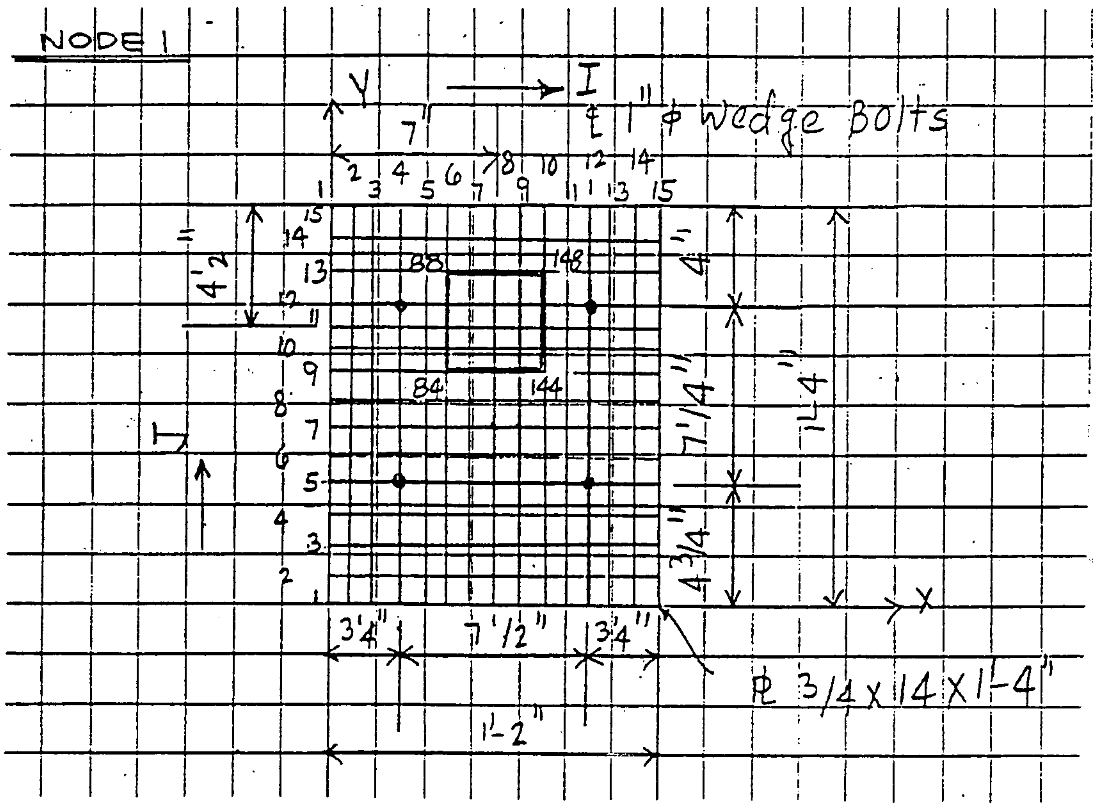

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Figure 11.5.1.3 BASEPLATE II Model for Nodes 9 of ANSYS Model

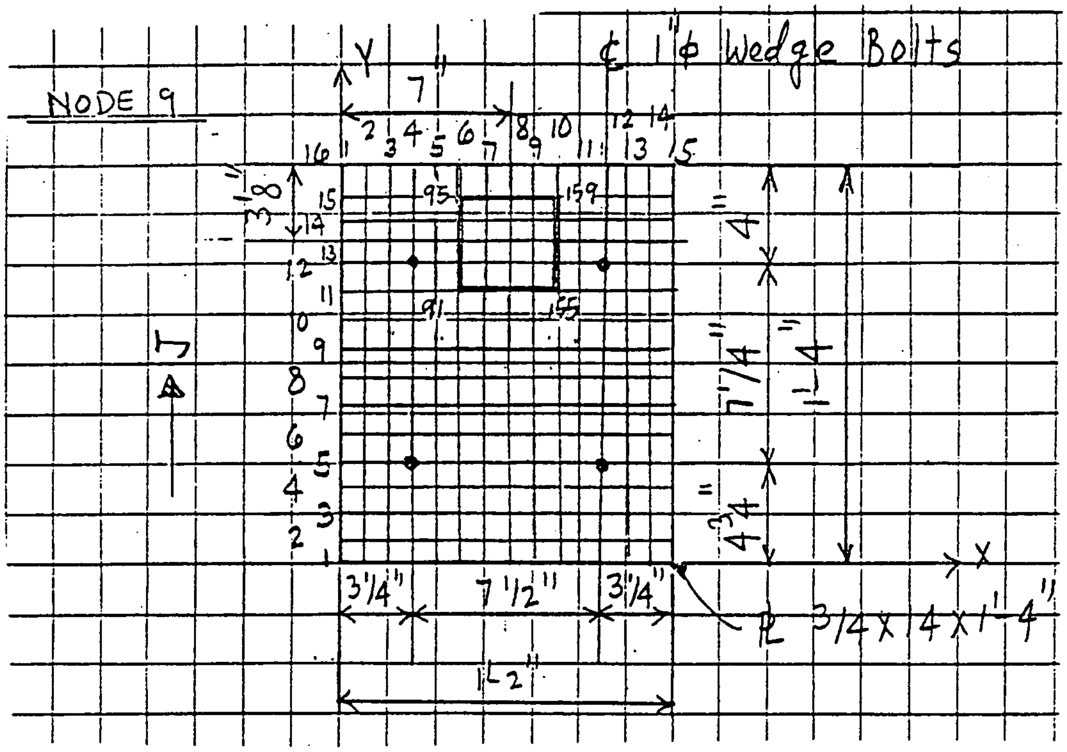

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Table 11.5.1.1 BASEPLATE II Input for Rot. Stiff. for Node 1 of ANSYS Model

(Ref: Input: BS1PR8G ; Output: BS1P8GR)

```
3 BS1PR8G-NODE 1; SURF. MOUNT. PLATE; 48W967-1
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 15,15,,14,16,.75,29/
APR 4,4,1,4,4,.25,.25/
BPR ,,1,.4E6,1.0E6/
BOL 4,5,1,3.25,4.75/
BOL 12,5,1,10.75,4.75/
BOL 4,12,1,3.25,12/
BOL 12,12,1,10.75,12/
END /
TUB 8,11,1,7,11.5/
END /
POI 8,11/
LOA ,,1,0,0,0,100000,100000,0/
END /
END OF JOB
```

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Table 11.5.1.2 BASEPLATE II Input for Rot. Stiff. for Node 9 of ANSYS Model

(Ref: Input: BS9PR8G ; Output: BS9P8GR)

```
3 BS9PR8G-NODE 9; SURF. MOUNT. PLATE; 48W967-1
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 15,16,,14,16,.75,29/
APR 4,4,1,4,4,.25,.25/
BPR ,,1,.4E6,1.0E6,5200,6700/
BOL 4,5,1,3.25,4.75/
BOL 12,5,1,10.75,4.75/
BOL 4,12,1,3.25,12/
BOL 12,12,1,10.75,12/
END /
TUB 8,13,1,7,12.88/
END /
POI 8,13/
LOA ,,1,0,0,0,100000,100000,0/
END /
END OF JOB
```

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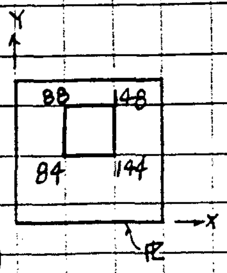
REF.

OUTPUT: BSIP8GR

PR 243-8 (G), Node 1

Rotational Stiffness

For Mx



1) $\Delta 88 = .048550'' = \Delta 1$ (Z-DISP)
$\Delta 84 = .015980 = \Delta 2$

2) $\Delta 148 = .031597'' = \Delta 1$ (Z-DISP)
$\Delta 144 = -.000972'' = \Delta 2$

$L = 4''$

1) $\theta = \tan^{-1} \dfrac{\Delta_1 - \Delta_2}{L}$

$= \tan^{-1} \dfrac{.048550 - .015980}{4} = 0.00814232$ Rad.

$= .4665^0$

$KMM = \dfrac{M}{\theta} = \dfrac{100}{.4665 \times \dfrac{\pi}{180}} = 12282 \dfrac{K\text{-in}}{Rad.}$

2) $\theta = \tan^{-1} \dfrac{\Delta_1 + (-\Delta_2)}{L}$

$= \tan^{-1} \dfrac{.031597 + .000972}{4} = 0.00814207$ Rad.

$= .4665^0$

$KMM = 12282 \dfrac{K\text{-in}}{Rad.}$

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REF.

Joint 1 Con't'd.

For My

1) $\Delta 84 = .015980'' = \Delta_1$ ~~(Z DISP)~~

$\Delta 144 = -.000972'' = \Delta_2$

2) $\Delta 88 = .048550'' = \Delta_1$

$\Delta 148 = .031597'' = \Delta_2$

$L = 4''$

1) $\theta = TAN^{-1} \dfrac{\Delta_1 + (-\Delta_2)}{4}$

$= TAN^{-1} \dfrac{.015980 + .000972}{4} = .004238 \text{ Rad.}$

$= .2428^0$

2) $\theta = TAN^{-1} \dfrac{\Delta_1 - \Delta_2}{4}$

$= TAN^{-1} \dfrac{.048550 - .031597}{4} = .004238 \text{ Rad.}$

$= .2428^0$

$$KMM = \frac{M}{\theta} = \frac{100}{.2428 \times \frac{\pi}{180}} = 23598 \frac{K\text{-}in}{Rad.}$$

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PROJECT WBNP - UNIT 1

SUBJECT Qualif. of Worst cases of Therm. Rest. struct. - Package I

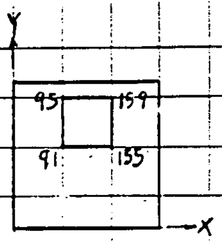
REF.

PR 2#3-8(G), Joint 9

Rotational Stiffness:

OUTPUT: B59P8GR

For Mx



1) $\Delta 91 = .024949'' = \Delta_2$

$\Delta 95 = .078465'' = \Delta_1$ (Z-DISP)

2) $\Delta 155 = .004915'' = \Delta_2$ "

$\Delta 159 = .058430'' = \Delta_1$

$L = 4''$

1) $\theta = \tan^{-1} \frac{\Delta_1 - \Delta_2}{L}$

$= \tan^{-1} \frac{.078465 - .024949}{4} = .013378$ Rad.

$= .7665^\circ$

2) $\theta = \tan^{-1} \frac{\Delta_1 - \Delta_2}{L}$

$= \tan^{-1} \frac{.058430 - .004915}{4} = .013378$ Rad.

$= .7665^\circ$

$KMM = \frac{M}{\theta} = \frac{100}{.7665 \times \frac{\pi}{180}} = 7475 \frac{K\text{-in}}{Rad}$

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Joint 9 Cont'd.

For My :

1) $\Delta 91 = .024949'' = \Delta 1$ (Z-DISP)

$\Delta 155 = .004915'' = \Delta 2$

2) $\Delta 95 = .078465'' = \Delta 1$

$\Delta 159 = .058430'' = \Delta 2$

$L = 4''$

1). $\theta = TAN^{-1} \dfrac{\Delta_1 - \Delta_2}{L}$

$= TAN^{-1} \dfrac{.024949 - .004915}{4} = .0050085$ Rad.

$= .287^0$

2) $\theta = TAN^{-1} \dfrac{\Delta_1 - \Delta_2}{L}$

$= TAN^{-1} \dfrac{.078465 - .058430}{4} = .0050088$ Rad.

$= .287^0$

$KMM = \dfrac{M}{\theta} = \dfrac{100}{.287 \times \frac{\pi}{180}} = 19965 \dfrac{K\text{-}in}{Rad.}$

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CLIENT TVA

PROJECT WBNP- UNIT 1

SUBJECT Qualif. of worst cases of Thermi. Rest. Struct. - Package I

REF.
WB-DC-20-21
SECT. 3.1.1
& 3.1.2

Calculation of density :

PR8G : 48N967-1

Proximity member :

Loads :

LL = 10 psf

Grating = 12 "

$22 \text{ psf} = \frac{22}{144} \text{ psi}$

Contributary load width on Bm

$= \frac{4'-7\frac{1}{2}''}{2} \times 12 = 27.75''$

For 1'' strip of width :

$\text{Load} = \frac{22}{144} \times \frac{27.75 \times 1}{1000} = 0.00424 \text{ kip}$

Vol. of Bm ∠3x3x1/4 for 1'' width = A x 1''
= 1.44 x 1
= 1.44 in^3

$\therefore \text{Density} = \text{Load} / \text{Vol.} = \frac{.00424}{1.44}$
$= 0.00295 \text{ K/in}^3$

Supporting members :

Longer member

Contributary load width on Bm = $\frac{2'-5\,5/8''}{2}$
= 1.234'
= 14.813''

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BY TAK DATE 7-16-91 BRANCH PROJECT I.D. = WCG-1-969 SHEET 179 OF 230

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PROJECT WBNP- UNIT 1

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For 1" strip of width :

Load from floor = $\frac{22}{144} \times \frac{14.813 \times 1}{1000}$ = .00226 K

wt. of TS 4x4x.25 : $\frac{12.02}{12} \times \frac{1}{1000}$ = .00100

.00326 K

Volume of TS 4x4x.25 = 3.54x1 = 3.54 in^3

∴ Density = .00326/3.54 = .00092 K/in^3

Shorter member :

Contributary load width on Bm = $\frac{1'\text{-}7\frac{1}{4}''}{2}$ = 0.802' = 9.625"

For 1" strip of width :

Load from floor = $\frac{22}{144} \times \frac{9.625 \times 1}{1000}$ = .00147

Wt. of TS 4x4x.25 = $\frac{12.02}{12} \times \frac{1}{1000}$ = .00100

.00247

Density = $\frac{.00247}{3.54}$ = 0.0007 K/in^3

11.5.2 ANSYS Input

```
                ***********  ANSYS INPUT DATA LISTING (FILE18)  ***********

/PREP7
/TITLE, PR8G - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP 4
/COM
/COM   BRANCH/PROJECT ID : WCG-1-969
/COM
/COM   PREPARED BY : SAL    8/15/91
/COM   CHECKED BY J. OU     8/15/91
/COM
/COM   INPUT:   PR8G
/COM   OUTPUT:  PR8GR
/COM   FILE12:  PR8GF
/COM   PLOT:    PR8GP
/COM
C*** ANSYS ANALYSIS OPTIONS AND REFERENCES
KAN,0
KAY,6,1
KNL,1
TREF,70
C*** ELEMENT TYPE AND MATERIAL PROPERTIES
ET,1,24,,,,,,1
ET,2,4,,,,,,1
ET,3,14,,1
ET,4,40,,,2      * DOF=Y
C*** MATERIAL PROPERTIES
EX,1,29000
RP3,1
ALPX,1,6.5E-6
RP3,1
C***
DENS,1,0.92E-3
DENS,2,0.70E-3
DENS,3,(0.283E-3+2.95E-3)
DENS,4,0.283E-3
C***
MPTEMP,1,70,100,200,300,400
RP4,1
MPDATA,EX,1,1,29.0E3,28.9E3,28.3E3,27.9E3,27.4E3
RP4,,1
MPDATA,ALPX,1,1,6.50E-6,6.50E-6,6.50E-6,6.67E-6,6.86E-6  * ALPX=6.29 MU FOR 100F
RP4,,1
C*** NONLINEAR MATERIAL CONSTANT
*CREAT,MNL
NL,ARG1,13,10
NL,ARG1,19,70,100,200,300,400
NL,ARG1,25,36,36.0,36.0,36.0,36.0
NL,ARG1,31,150,150,150,150,150
*END
*USE,MNL,1
*USE,MNL,2
*USE,MNL,3
```

11.5.2 ANSYS Input (Cont'd)

```
C*** MEMBER CROSS SECTIONAL PROPERTIES
R,1,3.54,8.0,8.0,4.0,4.0         * TS4X4X.25
R,2,1.44,1.24,1.24,3,3,          * L3X3X.25
RMORE,,0.03
C***
K1=(400*4)         * SAL  7/31/91
C***  GAP=(1/32)
GAP=0                     * SAL 7/24/91
FSL=(20.8*4)
R,8,K1,,,GAP,FSL            * NODE 1
GAP=0
R,5,K1,,,GAP,FSL            * NODE 9
C***
BF=4           * WIDTH
D=4            * DEPTH
TW=0.25        * WALL THICKNESS
C***
AA=(BF-TW)/2
BB=(D-TW)/2
QA=AA/2
QB=BB/2
*STAT
R,3,AA,BB,0,QA,BB,TW                   *STIF24 REAL PROP. - TS
RMORE,0,BB,TW,-QA,BB,TW
RMORE,-AA,BB,TW,-AA,QB,TW
RMORE,-AA,0,TW,-AA,-QB,TW
RMORE,-AA,-BB,TW,-QA,-BB,TW
RMORE,0,-BB,TW,QA,-BB,TW
RMORE,AA,-BB,TW,AA,-QB,TW
RMORE,AA,0,TW,AA,QB,TW
RMORE,AA,BB,TW
C***
*CREATE,ANGL
D=ARG2              * D=DEPTH          *
AF=ARG3             * AF=FLANGE        * ANGLE  L D X AF X TAW
TAW=ARG4            * TAW=THICKNESS    *
XBR=ARG5            * XBAR=CENTROID X  FROM AISC
YBR=ARG6            * YBAR=CENTROID Y
C***                     *                           ARG7=0 OR DEFAULT CASE
XX=AF-(TAW/2)            *    *4  *3  *2   *1
YY=D-(TAW/2)             *                           FOR ANGLE SHOWN LEFT
X0=XBR-(TAW/2)           *    *5  CG(XBAR,YBAR)      WHERE
Y0=YBR-(TAW/2)           *                           FLANGE IS ON RIGHT OF
XX=XX-X0                 *    *6                     WEB
YY=YY-Y0                 *
MX=XX/2                  *    *7
MY=YY/2                  *
*IF,ARG7,LE,1,:RAN
X=-XX     $X0=-X0    $MX=-MX        * CHN SIGN FOR FLANGE ON LEFT OF WEB
:RAN
```

11.5.2 ANSYS Input (Cont'd)

```
R,ARG1,XX,Y0,0,MX,Y0,TAW
RMORE,0,Y0,TAW,-X0,Y0,TAW
RMORE,-X0,0,TAW,-X0,-MY,TAW
RMORE,-X0,-YY,TAW
*END
*USE,ANGL,4,3,3,0.25,0.842,0.842,1    * L3X3X1/4    LEFT  FLANGE
C*** NODAL COORDINATES
N,1,0,62
N,101,0,64          $NDD=300
N,2,6.5,61          $FILL,1,2,1,NDD+11,1
N,102,6.5,61
N,202,6.5,61
N,3,43,56           $FILL,2,3,8,NDD+21,1
N,103,43,56
N,4,50,55           $FILL,3,4,1,NDD+31,1
N,5,22,38
N,6,6.5,37
N,106,6.5,37
N,7,6.5,18
N,8,25,12
N,108,25,12
N,208,25,12
N,9,0,0                                         $FILL,2,6,5,NDD+65,1
N,109,0,-2                                      $FILL,6,7,5,NDD+75,1
N,10,6.5            $FILL,9,10,1,NDD+91,1       $FILL,7,10,5,NDD+105,1
N,11,26.5           $FILL,10,11,4,NDD+101,1
N,12,31             $FILL,11,12,1,NDD+111,1
N,99,6.5,61,100
N,100,6.5,0,100
C*** ELEMENT CONNECTIVITIES
MAT,1  $TYPE,1   $REAL,3    * TS4X4X.25
EN,1,1,311,99       $,311,311,2,99
EN,2,2,321,99       $,321,321,322,99    $RP7,1,1,1    $EN,328,328,3,99
EN,3,3,331,99       $,331,331,4,99
MAT,2
EN,12,9,391,100     $,391,391,10,100
EN,13,10,401,100    $,401,401,402,100   $RP3,1,1,1    $EN,404,404,11,100
EN,14,11,411,100    $,411,411,12,100
C***
MAT,4  $TYPE,2   $REAL,2    * L3X3X.25
EN,4,2,5
EN,5,3,5
EN,6,6,5
C***
MAT,3  $TYPE,1   $REAL,4    * L3X3X.25
EN,7,2,365,100      $,365,365,366,100   $RP4,1,1,1    $EN,369,369,6,100
EN,8,6,375,100      $,375,375,376,100   $RP4,1,1,1    $EN,379,379,7,100
EN,9,7,405,100      $,405,405,406,100   $RP4,1,1,1    $EN,409,409,10,100
C***
MAT,4  $TYPE,2   $REAL,2    * L3X3X.25
```

11.5.2 ANSYS Input (Cont'd)

```
EN,10,7,8
EN,11,11,8
C***
C*** SPRING (STIF40)
TYPE,4   $REAL,8      * SPRING Y
EN,15,1,101
REAL,5
EN,16,109,9
C***
C*** BOUNDARY CONDITIONS
C***
D,1,UX,,,9,8,UZ,ROTX    * SAL  7/12/91
D,4,UY,,,12,8         * SAL  7/15/91
D,101,ALL
D,109,ALL
C***
C***  SPECIFY ROTATIONAL SPRINGS
PSPRING,1,ROT,12282,,2        * ROTY
PSPRING,1,ROT,23598,,,2       * ROTZ
PSPRING,9,ROT,7475,,2         * ROTY
PSPRING,9,ROT,19965,,,2       * ROTZ
C***
C*** ANALYSIS OPTIONS
ITER,-20,20
TREF,70
POSTR,,1,5
C*** PLOT GEOMETRY AND BOUNBARY CONDITIONS
/SHOW
/PNUM,NODE,1
EPLO
/SHRINK,0.3
/PNUM,NODE,-1
/PNUM,ELEM,1
EPLO
/PBC,ALL,1
/PNUM,ELEM,-1
EPLO
C*** LOADING CASES
C*** TEMPERATURE LOADS *** *
*CREAT,MAC
TUNIF,ARG1
LWRITE
*END
C***
C*** PEAK ACCEL.(G): NS=3.5  EW=3.25  VT=1.4
C*** FACTOR: MMF=1.5
MMF=1.5  $GX=MMF*3.5   $GY=MMF*3.5   $GZ=MMF*1.4
C***
C*** DL+SSE XZ-PLANE
C*** ACEL,-GX,0,GZ+1
```

11.5.2 ANSYS Input (Cont'd)

```
C*** *USE,MAC,70
C***
C*** DL+SSE YZ-PLANE
ACEL,,-GY,GZ+1          * SAL  7/15/91
*USE,MAC,70
D,101,UY,(1/32)         * SAL  7/24/91
D,109,UY,(-1/32)
*USE,MAC,80
RP25,,10
*USE,MAC,327
C***
AFWRITE,,1
FINISH
/INPUT,27
FINISH
/POST1
/SHOW
NLINE,200
*CREAT,PLD
SET,ARG1
PRRFOR
PRDISP
PLDISP
PLDISP,1
*END
*USE,PLD,1
*USE,PLD,27
FINISH
C***
/POST26
LINE,200
NUMVAR,50
TVAR,1
ESTR,2,1,53,TEMP
*CREATE,STRN
ESTR,3,ARG1,215,EE01
ESTR,4,ARG1,216,EP01
ESTR,5,ARG1,239,EE05
ESTR,6,ARG1,240,EP05
ESTR,7,ARG1,263,EE09
ESTR,8,ARG1,264,EP09
ESTR,9,ARG1,287,EE13
ESTR,10,ARG1,288,EP13
PRVAR,2,3,4,5,6
PRVAR,2,7,8,9,10
*END
C***
*CREAT,DSP
DISP,21,ARG1,UX,UX
DISP,22,ARG1,UY,UY
```

11.5.2 ANSYS Input (Cont'd)

```
DISP,23,ARG1,UZ,UZ
PROD,24,21,21,,UXUX
PROD,25,22,22,,UYUY
PROD,26,23,23,,UZUZ
ADD,27,24,25,26,SS
SQRT,28,27,,,SRSS
PRVAR,2,21,22,23,28
*END
C***
*USE,STRN,311
*USE,DSP,2
*USE,STRN,391
*USE,DSP,10
C***
*USE,DSP,1
*USE,DSP,9
C***
*USE,STRN,7
*USE,DSP,365
*USE,STRN,365
*USE,DSP,366
*USE,STRN,366
*USE,DSP,367
*USE,STRN,367
*USE,DSP,368
*USE,STRN,368
*USE,DSP,369
*USE,STRN,369
*USE,DSP,6
*USE,STRN,8
*USE,DSP,375
C***
*CREAT,RFOR
RFORC,31,ARG1,FX,RFX
RFORC,32,ARG1,FY,RFY
RFORC,33,ARG1,FZ,RFZ
RFORC,34,ARG1,MX,RMX
RFORC,35,ARG1,MY,RMY
RFORC,36,ARG1,MZ,RMZ
PRVAR,31,32,33,34,35,36
*END
*USE,RFOR,1
*USE,RFOR,101
*USE,RFOR,413
*USE,RFOR,9
*USE,RFOR,109
*USE,RFOR,415
C***
*CREAT,ST40
ESTR,41,ARG1,3,STR1
```

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11.5.2 ANSYS Input (Cont'd)

```
ESTR,42,ARG1,4,STR2
ESTR,43,ARG1,5,UI
ESTR,44,ARG1,6,UJ
ESTR,45,ARG1,7,SLIDE
ESTR,46,ARG1,8,STAT
ESTR,47,ARG1,9,OSTA
ESTR,48,ARG1,10,KCON
PRVAR,2,41,42,43,44
PRVAT,2,45,46,47,48
*END
*USE,ST40,15
*USE,ST40,16
FINISH
```

11.5.3 Analysis Results

The ANSYS output for the analysis "PR8G" is stored in file "PR8GR". The analysis results of the final load step (Load Step 27) are provided in this Section.

The deformed structure is plotted in Figure 11.5.3.1. Note that the displacements in this plot are magnified.

The reaction forces and the nodal displacements are provided in Sections 11.5.3.1 and 11.5.3.2 respectively.

The stresses and strains for elements at the center portion of the proximity member (elements 368, 369, 8, 375, 376, 377, 378 and 9), elements at the connections of the proximity member and the supporting members (elements 7, 409, 311 and 391) are presented in Section 11.5.3.3. The following explanations are provided for the labels shown in the stress and strain output.

PT:	Segment Point Number, see Figure 11.2.4 and Figure 11.2.3 for the definition of segment points for cross-section of Angles and Structural Tubings respectively.
TEMP:	Temperature
SIGX:	Axial Stress
EP:	Axial Elastic Strain
EPPL:	Axial Plastic Strain

The stress and strain results from output file "PR8GR" indicate that no yielding occurs in the structure at the final load step (temperature = 327°F).

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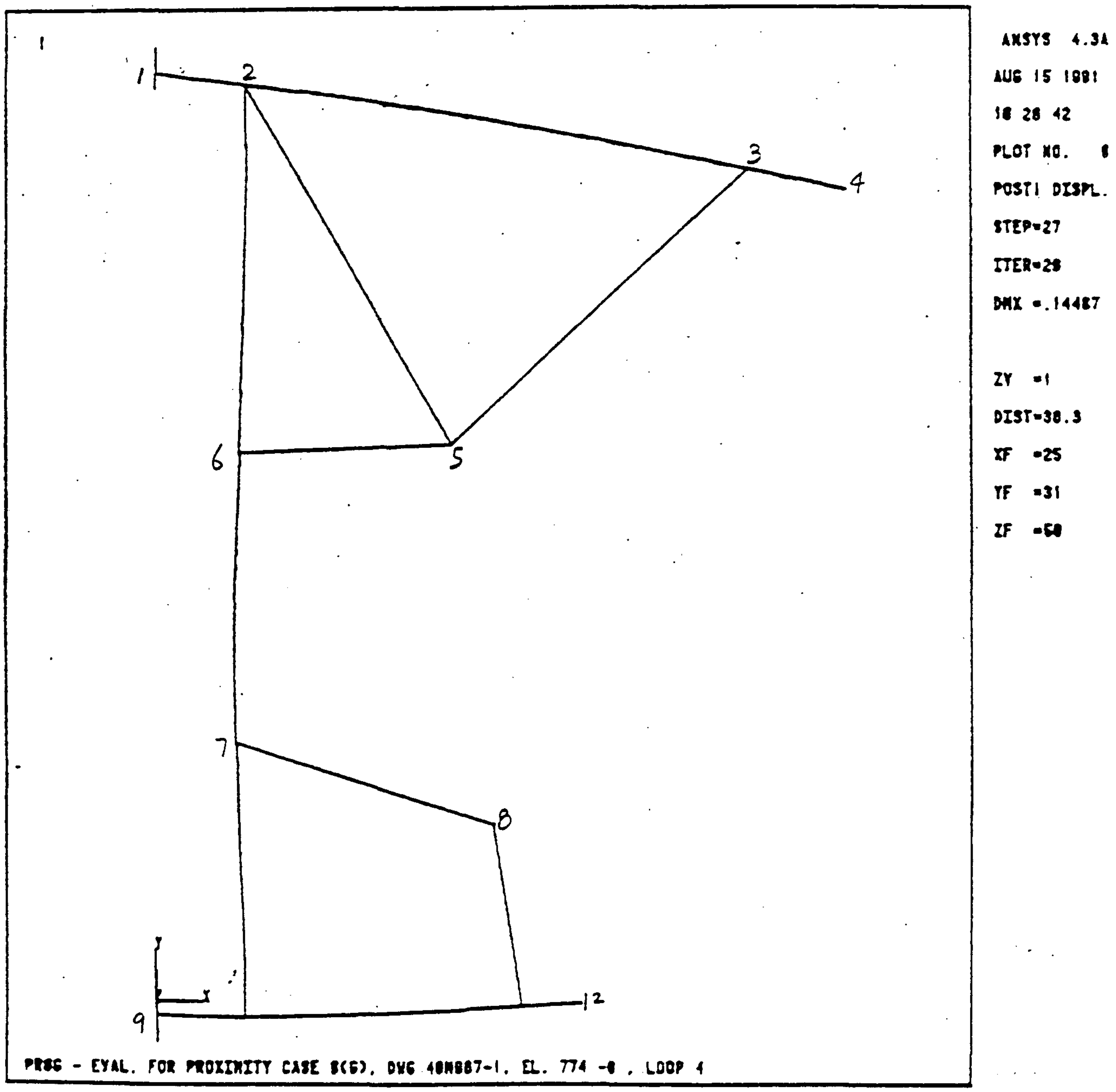
Figure 11.5.3.1 Deformed Shape of the Model PR8G (Worst Case 2&3-8(G))



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11.5.3.1 Reaction Forces

```
PR8G - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP 4

       ***** POST1 REACTION FORCE LISTING *****

 LOAD STEP     27  ITERATION=    20  SECTION=  1
 TIME=    0.0000          LOAD CASE=  1

 THE FOLLOWING X,Y,Z FORCES ARE IN NODAL COORDINATES

   NODE      FX            FY            FZ            MX            MY            MZ
     1   .39634196                   1.0985287    -9.2391064
     4                -1.4231010
     9  -.39634196                   .70198716     4.0701865
    12                 2.5637629
   101   0.0000000    -13.576338     0.0000000     0.0000000     0.0000000     0.0000000
   109   0.0000000     9.3864149     0.0000000     0.0000000     0.0000000     0.0000000
   412                                             0.0000000    -18.173587     0.0000000
   413                                             0.0000000     0.0000000    -35.983550
   414                                             0.0000000    -7.6299577     0.0000000
   415                                             0.0000000     0.0000000     8.5199924

 TOTAL   .59577232E-09 -3.0492608    1.8005159    -5.1689198    -25.803545    -27.463557
```

11.5.3.2 Displacements

```
PR8G - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP 4

        ***** POST1 NODAL DISPLACEMENT LISTING *****

  LOAD STEP    27  ITERATION=    20  SECTION=  1
  TIME=    0.0000          LOAD CASE=  1

  THE FOLLOWING X,Y,Z DISPLACEMENTS ARE IN NODAL COORDINATES

    NODE     UX             UY             UZ             ROTX           ROTY           ROTZ
      1   0.0000000      .39735211E-01  0.0000000      0.0000000      .14796928E-02  .15248559E-02
      2   .12908086E-01  .48526651E-01 -.11163992E-01  .36137257E-03  .18613742E-02  .13109438E-02
      3   .74055557E-01  .15404434E-01 -.99324985E-01  .48770534E-03  .25527004E-02 -.18518054E-02
      4   .84423773E-01  0.0000000     -.11772844      .48770812E-03  .25552903E-02 -.19936275E-02
      5   .25123251E-01 -.18843432E-02 -.53884352E-01  .29865523E-03  .25305078E-02 -.93839907E-03
      6  -.33016237E-02  .14584376E-01 -.13689831E-01 -.39732926E-03  .26325591E-02 -.14685135E-02
      7  -.14880760E-01 -.12577200E-01 -.39494171E-02  .16766035E-03  .18514510E-02  .13475793E-02
      8   .27394063E-01  .87897620E-02 -.35361194E-01 -.50237181E-03  .17421180E-02  .13634989E-02
      9   0.0000000     -.37116509E-01  0.0000000      0.0000000      .10207301E-02 -.42674643E-03
     10   .11480626E-01 -.38852437E-01 -.71859161E-02 -.18942612E-03  .11666963E-02  .16937171E-03
     11   .46909213E-01 -.99846820E-02 -.32497120E-01 -.30593186E-03  .13054160E-02  .21426074E-02
     12   .54828151E-01  0.0000000     -.38385101E-01 -.30579107E-03  .13059292E-02  .22512665E-02
    101   0.0000000      .31250000E-01  0.0000000      0.0000000      0.0000000      0.0000000
    109   0.0000000     -.31250000E-01  0.0000000      0.0000000      0.0000000      0.0000000
    311   .64810458E-02  .44305174E-01 -.52265068E-02  .18479263E-03  .16941518E-02  .17165543E-02
    321   .20646289E-01  .51718618E-01 -.19303362E-01  .38848481E-03  .20372141E-02  .74979192E-03
    322   .28083961E-01  .52711397E-01 -.28105478E-01  .41134889E-03  .21812414E-02  .22919839E-03
    323   .35244084E-01  .51680230E-01 -.37444992E-01  .43037910E-03  .22964827E-02 -.24575007E-03
    324   .42152762E-01  .48820990E-01 -.47209073E-01  .44599391E-03  .23859625E-02 -.66996523E-03
    325   .48839218E-01  .44350185E-01 -.57297412E-01  .45861539E-03  .24527039E-02 -.10383571E-02
    326   .55335780E-01  .38504974E-01 -.67622210E-01  .46866869E-03  .24997285E-02 -.13458333E-02
    327   .61677869E-01  .31543169E-01 -.78108178E-01  .47658148E-03  .25300568E-02 -.15872992E-02
    328   .67903961E-01  .23743262E-01 -.88692530E-01  .48278335E-03  .25467079E-02 -.17576569E-02
    331   .79257584E-01  .78269974E-02 -.10852473      .48775575E-03  .25549665E-02 -.19576238E-02
    365   .15448238E-01  .42894097E-01 -.13626651E-01  .39741692E-03  .31027066E-02  .42249356E-03
    366   .14950167E-01  .37250625E-01 -.15682506E-01  .30609863E-03  .39589856E-02 -.33805953E-03
    367   .12027602E-01  .31597790E-01 -.16880058E-01  .13408415E-03  .43826839E-02 -.93842648E-03
    368   .74202639E-02  .25936167E-01 -.16959449E-01 -.71563787E-04  .43283124E-02 -.13469647E-02
    369   .19871410E-02  .20265392E-01 -.15854246E-01 -.26402008E-03  .37556682E-02 -.15332264E-02
    375  -.85428536E-02  .10076225E-01 -.12666846E-01 -.57537445E-03  .33956418E-02 -.14644299E-02
    376  -.13244398E-01  .55608949E-02 -.10947024E-01 -.67182795E-03  .38022357E-02 -.12886460E-02
    377  -.16840257E-01  .10376654E-02 -.88228851E-02 -.66537303E-03  .38485915E-02 -.92931888E-03
    378  -.18732628E-01 -.34937652E-02 -.66553873E-02 -.53574851E-03  .35351892E-02 -.37593278E-03
    379  -.18295885E-01 -.80327760E-02 -.48695603E-02 -.26393645E-03  .28666475E-02  .38055440E-03
    391   .57403588E-02 -.38469318E-01 -.34743046E-02 -.94937338E-04  .11085244E-02 -.33551520E-03
```

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11.5.3.2 Displacements (Cont'd)

401	.18570879E-01	-.36779838E-01	-.11978972E-01	-.21241367E-03	.12226025E-02	.84132108E-03
402	.25658979E-01	-.32301187E-01	-.16963066E-01	-.23556191E-03	.12622611E-02	.13709242E-02
403	.32744463E-01	-.25979460E-01	-.22077421E-01	-.25886611E-03	.12878392E-02	.17618811E-02
404	.39827616E-01	-.18362825E-01	-.27269923E-01	-.28232333E-03	.13015025E-02	.20178820E-02
405	-.10631398E-01	-.16944178E-01	-.51555064E-02	.31905819E-03	.24671846E-02	.17345572E-02
406	-.53709348E-02	-.21314482E-01	-.64280665E-02	.36174752E-03	.27714307E-02	.18735131E-02
407	.16384911E-03	-.25689379E-01	-.74725787E-02	.31339070E-03	.27742568E-02	.17745845E-02
408	.52636700E-02	-.30070219E-01	-.80530705E-02	.19249892E-03	.24920788E-02	.14491328E-02
409	.92504153E-02	-.34457897E-01	-.79947316E-02	.18292050E-04	.19471157E-02	.90959985E-03
411	.50868817E-01	-.50535082E-02	-.35440848E-01	-.30582626E-03	.13058650E-02	.22242103E-02
412				0.0000000	0.0000000	0.0000000
413				0.0000000	0.0000000	0.0000000
414				0.0000000	0.0000000	0.0000000
415				0.0000000	0.0000000	0.0000000

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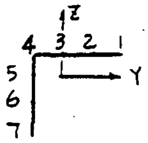
11.5.3.3 Stresses and Strains



```
PR8G - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP 4

 ***** ELEMENT STRESSES *****  TIME =   0.00000     LOAD STEP=  27   ITERATION=   20   CUM. ITER.=   81


EL=  368  NODES=  368  369  MAT=  3  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX           EP         EPPL        EPCR        EPSW
        1   327.00   -5.9924      -.0002187   0.0000000   0.0000000   0.0000000
        2   327.00   -8.2365      -.0003006   0.0000000   0.0000000   0.0000000
        3   327.00   -10.481      -.0003825   0.0000000   0.0000000   0.0000000
        4   327.00   -11.972      -.0004369   0.0000000   0.0000000   0.0000000
        5   327.00   -10.962      -.0004001   0.0000000   0.0000000   0.0000000
        6   327.00   -9.4435      -.0003447   0.0000000   0.0000000   0.0000000
        7   327.00   -7.9246      -.0002892   0.0000000   0.0000000   0.0000000
END J  PT    TEMP      SIGX           EP         EPPL        EPCR        EPSW
        1   327.00   -9.2488      -.0003375   0.0000000   0.0000000   0.0000000
        2   327.00   -9.7400      -.0003555   0.0000000   0.0000000   0.0000000
        3   327.00   -10.231      -.0003734   0.0000000   0.0000000   0.0000000
        4   327.00   -10.557      -.0003853   0.0000000   0.0000000   0.0000000
        5   327.00   -9.7264      -.0003550   0.0000000   0.0000000   0.0000000
        6   327.00   -8.4758      -.0003093   0.0000000   0.0000000   0.0000000
        7   327.00   -7.2251      -.0002637   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE  368    13.6061       .502022     -.143542     -.245830E-01   1.22088      .941094
                          369   -13.5085      -.461356      .184345      .658175E-01  -.565105      .985662

EL=  369  NODES=  369    6  MAT=  3  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX           EP         EPPL        EPCR        EPSW
        1   327.00   -9.2508      -.0003376   0.0000000   0.0000000   0.0000000
        2   327.00   -9.7406      -.0003555   0.0000000   0.0000000   0.0000000
        3   327.00   -10.230      -.0003734   0.0000000   0.0000000   0.0000000
        4   327.00   -10.556      -.0003853   0.0000000   0.0000000   0.0000000
        5   327.00   -9.7256      -.0003549   0.0000000   0.0000000   0.0000000
        6   327.00   -8.4760      -.0003093   0.0000000   0.0000000   0.0000000
        7   327.00   -7.2264      -.0002637   0.0000000   0.0000000   0.0000000
END J  PT    TEMP      SIGX           EP         EPPL        EPCR        EPSW
        1   327.00   -12.688      -.0004631   0.0000000   0.0000000   0.0000000
        2   327.00   -11.223      -.0004096   0.0000000   0.0000000   0.0000000
        3   327.00   -9.7588      -.0003562   0.0000000   0.0000000   0.0000000
        4   327.00   -8.7858      -.0003206   0.0000000   0.0000000   0.0000000
        5   327.00   -8.3549      -.0003049   0.0000000   0.0000000   0.0000000
        6   327.00   -7.7066      -.0002813   0.0000000   0.0000000   0.0000000
        7   327.00   -7.0583      -.0002576   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE  369    13.5086       .459281     -.186900     -.680038E-01   .564340     -.986030
                            6   -13.4109      -.418595      .227652      .109259       .264764      2.74178
```

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11.5.3.3 Stresses and Strains (Cont'd)

```
EL=   8  NODES=    6  375  MAT=  3  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX             EP          EPPL         EPCR         EPSW
        1   327.00   -9.1538        -.0003341    0.0000000    0.0000000    0.0000000
        2   327.00   -9.8823        -.0003607    0.0000000    0.0000000    0.0000000
        3   327.00   -10.611        -.0003873    0.0000000    0.0000000    0.0000000
        4   327.00   -11.095        -.0004049    0.0000000    0.0000000    0.0000000
        5   327.00   -9.7735        -.0003567    0.0000000    0.0000000    0.0000000
        6   327.00   -7.7846        -.0002841    0.0000000    0.0000000    0.0000000
        7   327.00   -5.7957        -.0002115    0.0000000    0.0000000    0.0000000
END J  PT    TEMP      SIGX             EP          EPPL         EPCR         EPSW
        1   327.00   -11.753        -.0004289    0.0000000    0.0000000    0.0000000
        2   327.00   -10.933        -.0003990    0.0000000    0.0000000    0.0000000
        3   327.00   -10.113        -.0003691    0.0000000    0.0000000    0.0000000
        4   327.00   -9.5676        -.0003492    0.0000000    0.0000000    0.0000000
        5   327.00   -8.6870        -.0003170    0.0000000    0.0000000    0.0000000
        6   327.00   -7.3616        -.0002687    0.0000000    0.0000000    0.0000000
        7   327.00   -6.0363        -.0002203    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE    6   13.3471       .378896      -.210537      .923629E-01   .881651      -1.63554
                          375  -13.2698      -.346670       .242787     -.596861E-01  -.163888       2.78436
```

```
EL=  375  NODES=  375  376  MAT=  3  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX             EP          EPPL         EPCR         EPSW
        1   327.00   -11.749        -.0004288    0.0000000    0.0000000    0.0000000
        2   327.00   -10.932        -.0003990    0.0000000    0.0000000    0.0000000
        3   327.00   -10.114        -.0003691    0.0000000    0.0000000    0.0000000
        4   327.00   -9.5712        -.0003493    0.0000000    0.0000000    0.0000000
        5   327.00   -8.6888        -.0003171    0.0000000    0.0000000    0.0000000
        6   327.00   -7.3609        -.0002686    0.0000000    0.0000000    0.0000000
        7   327.00   -6.0330        -.0002202    0.0000000    0.0000000    0.0000000
END J  PT    TEMP      SIGX             EP          EPPL         EPCR         EPSW
        1   327.00   -14.447        -.0005272    0.0000000    0.0000000    0.0000000
        2   327.00   -11.964        -.0004366    0.0000000    0.0000000    0.0000000
        3   327.00   -9.4818        -.0003461    0.0000000    0.0000000    0.0000000
        4   327.00   -7.8323        -.0002858    0.0000000    0.0000000    0.0000000
        5   327.00   -7.5246        -.0002746    0.0000000    0.0000000    0.0000000
        6   327.00   -7.0616        -.0002577    0.0000000    0.0000000    0.0000000
        7   327.00   -6.5986        -.0002408    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE  375   13.2698       .343911      -.243050      .568193E-01   .165583      -2.78427
                          376  -13.1926      -.311721       .275316     -.241788E-01   .655162       3.82235
```

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11.5.3.3 Stresses and Strains (Cont'd)

```
EL= 376 NODES= 376 377 MAT= 3 PRESSURES(Z,Y)=  0.0000      0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX           EP        EPPL        EPCR        EPSW
        1   327.00   -14.445      -.0005272   0.0000000   0.0000000   0.0000000
        2   327.00   -11.964      -.0004366   0.0000000   0.0000000   0.0000000
        3   327.00   -9.4829      -.0003461   0.0000000   0.0000000   0.0000000
        4   327.00   -7.8343      -.0002859   0.0000000   0.0000000   0.0000000
        5   327.00   -7.5256      -.0002747   0.0000000   0.0000000   0.0000000
        6   327.00   -7.0611      -.0002577   0.0000000   0.0000000   0.0000000
        7   327.00   -6.5966      -.0002408   0.0000000   0.0000000   0.0000000
END J  PT    TEMP      SIGX           EP        EPPL        EPCR        EPSW
        1   327.00   -17.222      -.0006285   0.0000000   0.0000000   0.0000000
        2   327.00   -12.972      -.0004734   0.0000000   0.0000000   0.0000000
        3   327.00   -8.7230      -.0003184   0.0000000   0.0000000   0.0000000
        4   327.00   -5.8994      -.0002153   0.0000000   0.0000000   0.0000000
        5   327.00   -6.2923      -.0002296   0.0000000   0.0000000   0.0000000
        6   327.00   -6.8835      -.0002512   0.0000000   0.0000000   0.0000000
        7   327.00   -7.4747      -.0002728   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE  376   13.1927      .308092     -.273192     .209023E-01  -.654213     -3.82255
                          377  -13.1154     -.275931      .305478     .117088E-01   1.57044      4.74726

EL= 377 NODES= 377 378 MAT= 3 PRESSURES(Z,Y)=  0.0000      0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX           EP        EPPL        EPCR        EPSW
        1   327.00   -17.223      -.0006286   0.0000000   0.0000000   0.0000000
        2   327.00   -12.973      -.0004735   0.0000000   0.0000000   0.0000000
        3   327.00   -8.7226      -.0003183   0.0000000   0.0000000   0.0000000
        4   327.00   -5.8984      -.0002153   0.0000000   0.0000000   0.0000000
        5   327.00   -6.2919      -.0002296   0.0000000   0.0000000   0.0000000
        6   327.00   -6.8840      -.0002512   0.0000000   0.0000000   0.0000000
        7   327.00   -7.4760      -.0002728   0.0000000   0.0000000   0.0000000
END J  PT    TEMP      SIGX           EP        EPPL        EPCR        EPSW
        1   327.00   -20.059      -.0007321   0.0000000   0.0000000   0.0000000
        2   327.00   -13.951      -.0005092   0.0000000   0.0000000   0.0000000
        3   327.00   -7.8435      -.0002863   0.0000000   0.0000000   0.0000000
        4   327.00   -3.7847      -.0001381   0.0000000   0.0000000   0.0000000
        5   327.00   -4.9985      -.0001824   0.0000000   0.0000000   0.0000000
        6   327.00   -6.8252      -.0002491   0.0000000   0.0000000   0.0000000
        7   327.00   -8.6518      -.0003158   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE  377   13.1156      .271517     -.300677    -.149678E-01  -1.57098     -4.74715
                          378  -13.0383     -.239378      .332986     .475572E-01   2.57428      5.55607
```

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Chkd. by J OL Date 8/24/91 OFS No. NR Dept. No. NR

Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.5.3.3 Stresses and Strains (Cont'd)

```
EL=  378  NODES=  378  379  MAT=  3  PRESSURES(Z,Y)=   0.0000        0.0000       AVE. TEMP= 327.00
END I  PT     TEMP       SIGX             EP          EPPL         EPCR          EPSW
        1    327.00    -20.064        -.0007323    0.0000000    0.0000000    0.0000000
        2    327.00    -13.952        -.0005092    0.0000000    0.0000000    0.0000000
        3    327.00    -7.8407        -.0002862    0.0000000    0.0000000    0.0000000
        4    327.00    -3.7796        -.0001379    0.0000000    0.0000000    0.0000000
        5    327.00    -4.9963        -.0001823    0.0000000    0.0000000    0.0000000
        6    327.00    -6.8274        -.0002492    0.0000000    0.0000000    0.0000000
        7    327.00    -8.6585        -.0003160    0.0000000    0.0000000    0.0000000
END J  PT     TEMP       SIGX             EP          EPPL         EPCR          EPSW
        1    327.00    -22.939        -.0008372    0.0000000    0.0000000    0.0000000
        2    327.00    -14.895        -.0005436    0.0000000    0.0000000    0.0000000
        3    327.00    -6.8513        -.0002500    0.0000000    0.0000000    0.0000000
        4    327.00    -1.5061        -.0000550    0.0000000    0.0000000    0.0000000
        5    327.00    -3.6531        -.0001333    0.0000000    0.0000000    0.0000000
        6    327.00    -6.8841        -.0002512    0.0000000    0.0000000    0.0000000
        7    327.00    -10.115        -.0003692    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE  378    13.0386        .234266       -.325240       -.503804E-01  -2.57690      -5.55496
                          379   -12.9613       -.202140        .357581        .829562E-01   3.65803       6.24594


EL=   9  NODES=     7  405  MAT=  3  PRESSURES(Z,Y)=   0.0000        0.0000       AVE. TEMP= 327.00
END I  PT     TEMP       SIGX             EP          EPPL         EPCR          EPSW
        1    327.00    -17.168        -.0006266    0.0000000    0.0000000    0.0000000
        2    327.00    -12.099        -.0004416    0.0000000    0.0000000    0.0000000
        3    327.00    -7.0300        -.0002566    0.0000000    0.0000000    0.0000000
        4    327.00    -3.6618        -.0001336    0.0000000    0.0000000    0.0000000
        5    327.00    -5.0464        -.0001842    0.0000000    0.0000000    0.0000000
        6    327.00    -7.1300        -.0002602    0.0000000    0.0000000    0.0000000
        7    327.00    -9.2136        -.0003363    0.0000000    0.0000000    0.0000000
END J  PT     TEMP       SIGX             EP          EPPL         EPCR          EPSW
        1    327.00    -12.908        -.0004711    0.0000000    0.0000000    0.0000000
        2    327.00    -10.329        -.0003770    0.0000000    0.0000000    0.0000000
        3    327.00    -7.7507        -.0002829    0.0000000    0.0000000    0.0000000
        4    327.00    -6.0371        -.0002203    0.0000000    0.0000000    0.0000000
        5    327.00    -6.6560        -.0002429    0.0000000    0.0000000    0.0000000
        6    327.00    -7.5874        -.0002769    0.0000000    0.0000000    0.0000000
        7    327.00    -8.5187        -.0003109    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE    7    12.1127       -.563493        .409272        .801966E-01  -2.32056      -3.87408
                          405   -12.0395        .593929       -.378551       -.493348E-01   1.13883       2.13795
```

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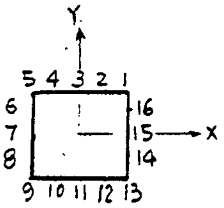
Project WBNP Unit 1
Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.5.3.3 Stresses and Strains (Cont'd)

```
EL=    7  NODES=    2  365  MAT=  3  PRESSURES(Z,Y)=   0.0000       0.0000     AVE. TEMP= 327.00
END I  PT    TEMP        SIGX           EP          EPPL         EPCR         EPSW
        1   327.00     4.7572       .0001736    0.0000000    0.0000000    0.0000000
        2   327.00    -2.2015      -.0000803    0.0000000    0.0000000    0.0000000
        3   327.00    -9.1602      -.0003343    0.0000000    0.0000000    0.0000000
        4   327.00   -13.784       -.0005031    0.0000000    0.0000000    0.0000000
        5   327.00   -14.371       -.0005245    0.0000000    0.0000000    0.0000000
        6   327.00   -15.254       -.0005567    0.0000000    0.0000000    0.0000000
        7   327.00   -16.137       -.0005890    0.0000000    0.0000000    0.0000000
END J  PT    TEMP        SIGX           EP          EPPL         EPCR         EPSW
        1   327.00     2.4548       .0000896    0.0000000    0.0000000    0.0000000
        2   327.00    -3.6960      -.0001349    0.0000000    0.0000000    0.0000000
        3   327.00    -9.8467      -.0003594    0.0000000    0.0000000    0.0000000
        4   327.00   -13.934       -.0005085    0.0000000    0.0000000    0.0000000
        5   327.00   -13.767       -.0005024    0.0000000    0.0000000    0.0000000
        6   327.00   -13.515       -.0004933    0.0000000    0.0000000    0.0000000
        7   327.00   -13.264       -.0004841    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE    2   13.9972      .650539     .469652E-01   .118505     1.97115      10.1769
                          365  -13.8996     -.609908    -.602864E-02 -.773061E-01  -2.07714     -7.65597


EL=  409  NODES=  409   10  MAT=  3  PRESSURES(Z,Y)=   0.0000       0.0000     AVE. TEMP= 327.00
END I  PT    TEMP        SIGX           EP          EPPL         EPCR         EPSW
        1   327.00     3.2195       .0001175    0.0000000    0.0000000    0.0000000
        2   327.00    -3.1194      -.0001138    0.0000000    0.0000000    0.0000000
        3   327.00    -9.4583      -.0003452    0.0000000    0.0000000    0.0000000
        4   327.00   -13.670       -.0004989    0.0000000    0.0000000    0.0000000
        5   327.00   -12.398       -.0004525    0.0000000    0.0000000    0.0000000
        6   327.00   -10.482       -.0003826    0.0000000    0.0000000    0.0000000
        7   327.00    -8.5664      -.0003126    0.0000000    0.0000000    0.0000000
END J  PT    TEMP        SIGX           EP          EPPL         EPCR         EPSW
        1   327.00     6.9271       .0002528    0.0000000    0.0000000    0.0000000
        2   327.00    -1.3151      -.0000480    0.0000000    0.0000000    0.0000000
        3   327.00    -9.5573      -.0003488    0.0000000    0.0000000    0.0000000
        4   327.00   -15.034       -.0005487    0.0000000    0.0000000    0.0000000
        5   327.00   -13.615       -.0004969    0.0000000    0.0000000    0.0000000
        6   327.00   -11.479       -.0004189    0.0000000    0.0000000    0.0000000
        7   327.00    -9.3426      -.0003410    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE  409   11.7472     -.712716     .245011     -.666244E-01   2.67808       5.74040
                           10  -11.6740      .743188    -.214377      .975226E-01  -3.36716      -7.92425
```

11.5.3.3 Stresses and Strains (Cont'd)



```
EL= 311  NODES=  311     2  MAT=  1  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 327.00
END I  PT    TEMP       SIGX          EP         EPPL         EPCR         EPSW
        1   327.00    4.3959      .0001604    0.0000000    0.0000000    0.0000000
        2   327.00    3.5589      .0001299    0.0000000    0.0000000    0.0000000
        3   327.00    2.7220      .0000993    0.0000000    0.0000000    0.0000000
        4   327.00    1.8851      .0000688    0.0000000    0.0000000    0.0000000
        5   327.00    1.0481      .0000383    0.0000000    0.0000000    0.0000000
        6   327.00   -.63618     -.0000232    0.0000000    0.0000000    0.0000000
        7   327.00   -2.3205     -.0000847    0.0000000    0.0000000    0.0000000
        8   327.00   -4.0048     -.0001462    0.0000000    0.0000000    0.0000000
        9   327.00   -5.6891     -.0002076    0.0000000    0.0000000    0.0000000
       10   327.00   -4.8521     -.0001771    0.0000000    0.0000000    0.0000000
       11   327.00   -4.0152     -.0001465    0.0000000    0.0000000    0.0000000
       12   327.00   -3.1782     -.0001160    0.0000000    0.0000000    0.0000000
       13   327.00   -2.3413     -.0000854    0.0000000    0.0000000    0.0000000
       14   327.00   -.65698     -.0000240    0.0000000    0.0000000    0.0000000
       15   327.00    1.0273      .0000375    0.0000000    0.0000000    0.0000000
       16   327.00    2.7116      .0000990    0.0000000    0.0000000    0.0000000
END J  PT    TEMP       SIGX          EP         EPPL         EPCR         EPSW
        1   327.00    12.973      .0004735    0.0000000    0.0000000    0.0000000
        2   327.00    7.4803      .0002730    0.0000000    0.0000000    0.0000000
        3   327.00    1.9877      .0000725    0.0000000    0.0000000    0.0000000
        4   327.00   -3.5049     -.0001279    0.0000000    0.0000000    0.0000000
        5   327.00   -8.9975     -.0003284    0.0000000    0.0000000    0.0000000
        6   327.00   -10.313     -.0003764    0.0000000    0.0000000    0.0000000
        7   327.00   -11.629     -.0004244    0.0000000    0.0000000    0.0000000
        8   327.00   -12.945     -.0004725    0.0000000    0.0000000    0.0000000
        9   327.00   -14.261     -.0005205    0.0000000    0.0000000    0.0000000
       10   327.00   -8.7687     -.0003200    0.0000000    0.0000000    0.0000000
       11   327.00   -3.2761     -.0001196    0.0000000    0.0000000    0.0000000
       12   327.00    2.2165      .0000809    0.0000000    0.0000000    0.0000000
       13   327.00    7.7091      .0002814    0.0000000    0.0000000    0.0000000
       14   327.00    9.0251      .0003294    0.0000000    0.0000000    0.0000000
       15   327.00    10.341      .0003774    0.0000000    0.0000000    0.0000000
       16   327.00    11.657      .0004254    0.0000000    0.0000000    0.0000000
 FORCES ON MEMBER AT NODE  311   2.42467     -13.3031     1.06774    -6.34308    -15.7902     7.84635
                             2  -2.41577      13.2442    -1.03256     6.34308     12.3371    -51.4932
```

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Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.5.3.3 Stresses and Strains (Cont'd)

```
EL=  391  NODES=  391    10  MAT=  2  PRESSURES(Z,Y)=   0.0000       0.0000      AVE. TEMP= 327.00
END I  PT    TEMP      SIGX          EP          EPPL        EPCR        EPSW
        1   327.00   -3.4490      -.0001259   0.0000000   0.0000000   0.0000000
        2   327.00   -1.0966      -.0000400   0.0000000   0.0000000   0.0000000
        3   327.00    1.2559       .0000458   0.0000000   0.0000000   0.0000000
        4   327.00    3.6083       .0001317   0.0000000   0.0000000   0.0000000
        5   327.00    5.9608       .0002175   0.0000000   0.0000000   0.0000000
        6   327.00    5.3859       .0001966   0.0000000   0.0000000   0.0000000
        7   327.00    4.8111       .0001756   0.0000000   0.0000000   0.0000000
        8   327.00    4.2362       .0001546   0.0000000   0.0000000   0.0000000
        9   327.00    3.6613       .0001336   0.0000000   0.0000000   0.0000000
       10   327.00    1.3089       .0000478   0.0000000   0.0000000   0.0000000
       11   327.00   -1.0436      -.0000381   0.0000000   0.0000000   0.0000000
       12   327.00   -3.3960      -.0001239   0.0000000   0.0000000   0.0000000
       13   327.00   -5.7485      -.0002098   0.0000000   0.0000000   0.0000000
       14   327.00   -5.1736      -.0001888   0.0000000   0.0000000   0.0000000
       15   327.00   -4.5988      -.0001678   0.0000000   0.0000000   0.0000000
       16   327.00   -4.0239      -.0001469   0.0000000   0.0000000   0.0000000
END J  PT    TEMP      SIGX          EP          EPPL        EPCR        EPSW
        1   327.00   -10.463      -.0003819   0.0000000   0.0000000   0.0000000
        2   327.00   -4.8336      -.0001764   0.0000000   0.0000000   0.0000000
        3   327.00    .79603       .0000291   0.0000000   0.0000000   0.0000000
        4   327.00    6.4257       .0002345   0.0000000   0.0000000   0.0000000
        5   327.00    12.055       .0004400   0.0000000   0.0000000   0.0000000
        6   327.00    11.710       .0004274   0.0000000   0.0000000   0.0000000
        7   327.00    11.365       .0004148   0.0000000   0.0000000   0.0000000
        8   327.00    11.021       .0004022   0.0000000   0.0000000   0.0000000
        9   327.00    10.676       .0003896   0.0000000   0.0000000   0.0000000
       10   327.00    5.0459       .0001842   0.0000000   0.0000000   0.0000000
       11   327.00   -.58375      -.0000213   0.0000000   0.0000000   0.0000000
       12   327.00   -6.2134      -.0002268   0.0000000   0.0000000   0.0000000
       13   327.00   -11.843      -.0004322   0.0000000   0.0000000   0.0000000
       14   327.00   -11.498      -.0004196   0.0000000   0.0000000   0.0000000
       15   327.00   -11.153      -.0004070   0.0000000   0.0000000   0.0000000
       16   327.00   -10.808      -.0003945   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE  391  -.398057      9.43107      .676431      4.06414     -5.38930     -22.0543
                           10   .398032     -9.47586     -.649990     -4.06414      3.23387      52.7780
```

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Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.5.4 Member Qualification

As presented in Section 11.5.3, the stress and strain results of the analysis indicate that no yielding occurs in all elements at the final temperature step (temperature=327°F). Therefore, the ductility ratio at any node of the proximity member or the supporting members is less than 1. Note that the ductility ratio is defined as the ratio of the final displacement to the yield displacement.

Per DG-C1.6.12, Appendix D, the members of worst case 2&3-8(G) are qualified.

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Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.5.5 Connection and Anchorage Qualification for Worst Case 2&3-8(G)

11.5.5.1 Connection Qualification for Worst Case 2&3-8(G)

The connections at nodes 2 and 10, as well as the connections at support nodes 1 and 9, are evaluated. The evaluation of connections are documented in the next four sheets.

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CLIENT TVA

PROJECT WBNP - UNIT 1

SUBJECT QUALIF. OF WORST CASES OF THERM. REST. STRUCT - Package I

REF.

PRBG - 48N967 - 1

File: PR8GR

LOADS FROM ANSYS OUTPUT - DATED 8-15-91

LOADS

NODE 2 (ELEMENT 7)

$F_x = 14.00^K$ $M_x = 0.12^{''-k}$

$F_y = 0.65^K$ $M_y = 1.97^{''-k}$

$F_z = 0.05^K$ $M_z = 10.18^{''-k}$

NODE 10 (ELEMENT 409)

$F_x = -11.67^K$ $M_x = 0.10^{''-k}$

$F_y = 0.74^K$ $M_y = -3.37^{''-k}$

$F_z = -0.21^K$ $M_z = -7.92^{''-k}$

FORCES ON WELDS

NODE 2

$F_x = -0.65^K$ $M_x = -1.97^{''-k}$

$F_y = -0.05^K$ $M_y = -10.18^{''-k}$

$F_z = -14.00^K$ $M_z = -0.12^{''-k}$

NODE 10

$F_x = -0.74^{-}$ $M_x = 3.37^{''-k}$

$F_y = 0.21^K$ $M_y = 7.92^{''-k}$

$F_z = 11.67^K$ $M_z = -0.10^{''-k}$

BY SAI DATE 8/20/91 **BRANCH PROJECT I.D.** : WCG-1-969 SHEET 202 OF 230

CHKD. BY JOU DATE 8/24/91 OFS NO. NR DEPT. NO. NR

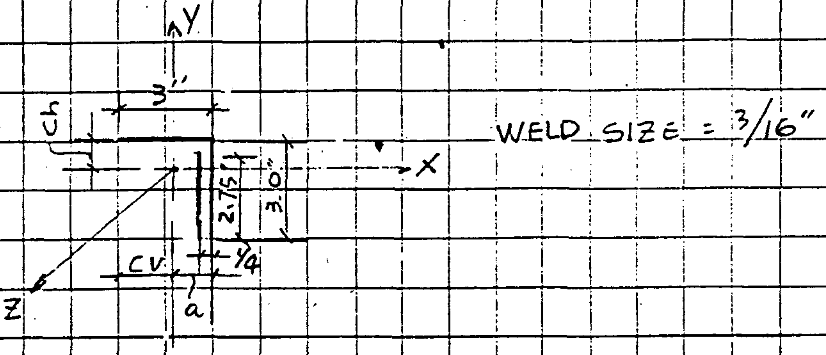
CLIENT TVA

PROJECT WBNP - UNIT 1

SUBJECT QUALIF. OF WORST CASES OF THERM. REST. STRUCT - PACKAGE

REF-

File: PR86R



$$a = \frac{1\times3\times0 + 1\times2.75\times0.25 + 1\times3\times1.5}{3+2.75+3} = 0.594"$$

$$C_v = 3 - 0.594 = 2.406"$$

$$b = \frac{1\times3\times1.5 + 1\times2.75\times\frac{2.75}{2} + 1\times3\times3}{3+2.75+3} = 1.975"$$

$$C_h = 3 - 1.975 = 1.025"$$

WELD PROPERTIES

$$A_w = 3+3+2.75 = 8.75 \text{ IN}^2$$

$$I_x = \frac{3^3}{12} + \frac{2.75^3}{12} + 3\times(1.975-1.5)^2 + 2.75\times\left(1.975 - \frac{2.75}{2}\right)^2 + 3\times1.025^2$$

$$= 2.25 + 1.73 + 0.68 + 0.99 + 3.15 = 8.80 \text{ IN}^3$$

$$I_y = \frac{3^3}{12} + 3\times0.594^2 + 2.75\times(0.594-0.25)^2 + 3\times(1.5-0.594)^2$$

$$= 2.25 + 1.06 + 0.33 + 0.33 + 2.46 = 6.1 \text{ IN}^3$$

$$J_w = I_x + I_y = 8.8 + 6.1 = 14.9 \text{ IN}^3$$

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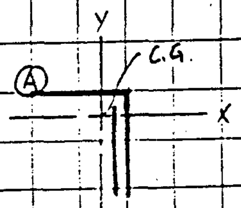
CLIENT TVA

PROJECT WBNP - UNIT 1

SUBJECT QUALIF. OF WORST CASES OF THERMAL. REST. STRUCT - PACKAGE



CRITICAL STRESS AT PT. Ⓐ

$$S_{x_A} = \frac{I_x}{C_h} = \frac{8.80}{1.025} = 8.59 \text{ IN}^2$$

$$S_{y_A} = \frac{I_y}{C_v} = \frac{6.10}{2.406} = 2.54 \text{ IN}^2$$

NODE 2

$$f_t = \frac{F_z}{A_w} + \frac{M_x}{S_x} + \frac{M_y}{S_y}$$

$$= -\frac{14.00}{8.75} - \frac{1.97}{8.59} - \frac{10.18}{2.54} = -1.6 - 0.23 - 4.0 = -5.84 \text{ K/IN}$$

$$f_x = \frac{F_x}{A_w} + \frac{M_z \cdot C_h}{J_w} = -\frac{0.65}{8.75} - \frac{0.12 \times 1.025}{14.9} = -0.08 \text{ K/IN}$$

$$f_y = \frac{F_y}{A_w} + \frac{M_z \cdot C_v}{J_w} = -\frac{0.05}{8.75} - \frac{0.12 \times 2.406}{14.9} = -0.03 \text{ K/IN}$$

$$f_r = \sqrt{(-5.84)^2 + (-0.08)^2 + (-0.03)^2} = 5.84 \text{ K/IN}$$

WELD CAPACITY $= 0.707 \times \frac{2}{3} \times 70 \times \frac{3}{16}$
$= 6.19 \text{ K/IN} > 5.84 \text{ K/IN}$ O.K

NODE 10

$$f_t = \frac{11.67}{8.75} + \frac{3.37}{8.59} + \frac{7.92}{2.54} = 1.33 + 0.39 + 3.12 = 4.84$$

$$f_x = \frac{0.74}{8.75} - \frac{0.10 \times 1.025}{14.9} = -0.09$$

$$f_y = \frac{0.21}{8.75} - \frac{0.10 \times 2.406}{14.9} = 0.01$$

$$f_r = \left(4.84^2 + (-0.09)^2 + 0.01^2\right)^{1/2} = 4.84 \text{ K/IN} < 6.19 \text{ K/IN} \text{ OK}$$

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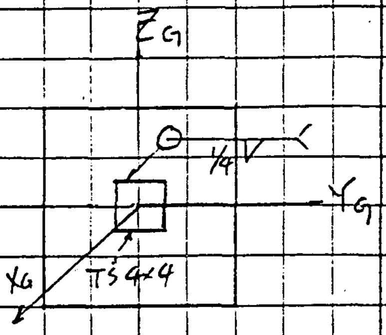
CLIENT TVA

PROJECT WBNP - UNIT 1

SUBJECT QUALIF OF WORST CASES OF THERM. REST. STRUCT. - PACKAGE

PR8G - 48N967-1

CHECK WELDS BETWEEN
TS 4x4 & BASE ℞

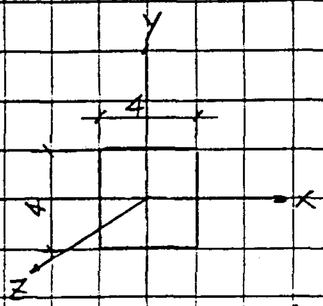


LOADS FROM ANSYS OUTPUT PR8GR
DATED 8/15/91

LOADS AT NODE 1, 101, 412 & 413

$F_x = -0.40^k$ $M_x = 9.24$
$F_y = 13.58^k$ $M_y = 18.17$
$F_z = -1.10^k$ $M_z = 35.98$

FORCES ON WELDS



$F_x = 13.58^k$ $M_x = 18.17^{''-k}$
$F_y = -1.10^k$ $M_y = 35.98^{''-k}$
$F_z = -0.40^k$ $M_z = 9.24^{''-k}$

WELD SIZE 1/4

$A_w = 4 \times 4 = 16^{in}$

$S_x = S_y = 4\times 4 + \frac{4^2}{3} = 21.33 \ in^2$

$J_w = (4+4)^3/6 = 85.33 \ in^2$

$$f_t = \frac{0.4}{16} + \frac{18.17}{21.33} + \frac{35.98}{21.33} = 2.51 \ ^{k/in}$$

$$f_x = \frac{13.58}{16} + \frac{9.24 \times 2}{85.33} = 1.07 \ ^{k/in}$$

$$f_y = \frac{-1.10}{16} + \frac{9.24 \times 2}{85.33} = 0.15 \ ^{k/in}$$

$$f_r = (2.51^2 + 1.07^2 + 0.15^2)^{1/2} = 2.73 \ ^{k/in}$$

WELD CAPACITY $= .707 \times 2/3 \times 70 \times 1/4 = 8.25^{k/in} > 2.73^{k/in}$ O.K

11.5.5.2 Anchorage Qualification for Worst Case 2&3-8(G)

For shear loading, the 1"ϕ Wedge Bolts are accepted by comparing the displacement at the anchorage to the displacement allowable per Design Guide DG-C1.6.12 R1. The displacement allowable is 0.2D (0.2 * bolt diameter) for ductile anchors (The Wedge Bolt is ductile in shear per DG-C1.6.12 R1). As shown in Section 11.5.3.2, the maximum Y-displacement at support occurs at node 1 (0.0397").

$$0.0397" < 0.2D = 0.2 * 1" = 0.2" \qquad \text{O.K.}$$

A Baseplate II analysis is performed using the results at node 1 obtain the tension in the anchor bolts. Note that the reaction at node 1 envelop the reactions at node 9. The input and output of the Baseplate II analysis are presented in Table 11.5.5.2.1. The maximum tension is 4.689 kips. The tension allowable is obtained from Table 5 of DS-C1.7.1 for the 1"ϕ Wedge Bolts.

$$4.689 \text{ kips} < \text{Tension Allowable} = 5.20 \text{ kips} \qquad \text{O.K.}$$

No G-32 violation is identified for the anchorages at nodes 1 and 9 per Calc. WCG-1-790 R0, Section 11.6.

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Project WBNP Unit 1

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Table 11.5.5.2.1 BASEPLATE II Input and Output for Anchorage at Nodes 1

(Ref: Input: B1PR8G ; Output: B1PR8GR)

```
3 B1PR8G-NODE 1; SURF. MOUNT. PLATE; 48W967-1
OUT ,,,-1,100/
CON ,,,,3000,1.7,1.7/
PLA 15,15,,14,16,.75,29/
APR 4,4,1,4,4,.25,.25/
BPR ,,1,.4E6,1.0E6/
BOL 4,5,1,3.25,4.75/
BOL 12,5,1,10.75,4.75/
BOL 4,12,1,3.25,12/
BOL 12,12,1,10.75,12/
END /
TUB 8,11,1,7,11.5/
END /
POI 8,11/
LOA ,,1,13580,-1100,0,18170,35980,9240/
END /
END OF JOB
```

```
********************************************************************************
*                                                                              *
*     B1PR8G-NODE 1; SURF. MOUNT. PLATE; 48W967-1                              *
*                                                                              *
********************************************************************************


                          B O L T   L O A D S
                          -------------------
   I      J
  LINE   LINE   NODE    X-SHEAR    Y-SHEAR     SRSS    Z-TENSION
  ----   ----   ----    -------    -------    ------   ---------

   4      5      50      2234.        842.     2387.        818.
  12      5     170      2239.      -1385.     2633.          0.
   4     12      57      4554.        795.     4623.       4689.
  12     12     177      4553.      -1352.     4750.        353.
```

11.6 Qualification of Worst Case 5-7

11.6.1 Mathematical Model (HD07)

The ANSYS model HD07 is shown in Figure 11.6.1.1. This model considers the continuous member (C8x11.5) with Header Restraints. The member is welded to embedded plates at six (6) locations. ANSYS STIF24 elements (3-D thin-wall plastic beam elements) are used to simulate this member. Temperature dependent material properties, as described in Section 11.2, are used.

Boundary Condition

The modeling of boundary condition is based on information obtained from WCG-1-830 (Walkdown) and WCG-1-964 (Evaluation of Embedded Plates for Platforms). Support nodes 1 and 6 are modeled as pinned connection and support nodes 2 through 5 are moment connection. ANSYS STIF14 elements (Spring elements) are specified at nodes 1 through 6 to simulate the shear stiffness of the concrete anchor bolts in X direction. The anchorage information is obtained from Drawings 48N1219-2 and 48N1219-3 (Plate MK 8W). There are four (4) 5/8"ϕ Welded Studs at support nodes 1 and 6; Six (6) 5/8" Weld Studs at support nodes 2 through 5. The shear stiffness of the anchor bolts are obtained from Calculation CSG-91-0003. 600 k/in per Weld Stud is considered as the shear stiffness for the STIF14 spring elements. Nodes 101 through 106 are defined at the same locations of nodes 1 through 6 as the support nodes for the spring elements.

Loading Condition

There is no attachment on the member per calc. WCG-1-830 (Walkdown package). SSE loads are applied using the equivalent static approach. Since the member (welded to embedded plate) is against the concrete wall, the XZ-SSE (combination of SSE loads of

X and Z (vertical) directions) is considered as the SSE load in the model. Dead weight (DL) of the member is combined with the XZ-SSE loads followed by incremental temperature steps from 70°F (Ambient Temperature) to 210°F (Accident Temperature).

The ANSYS input file is presented in Section 11.6.2.

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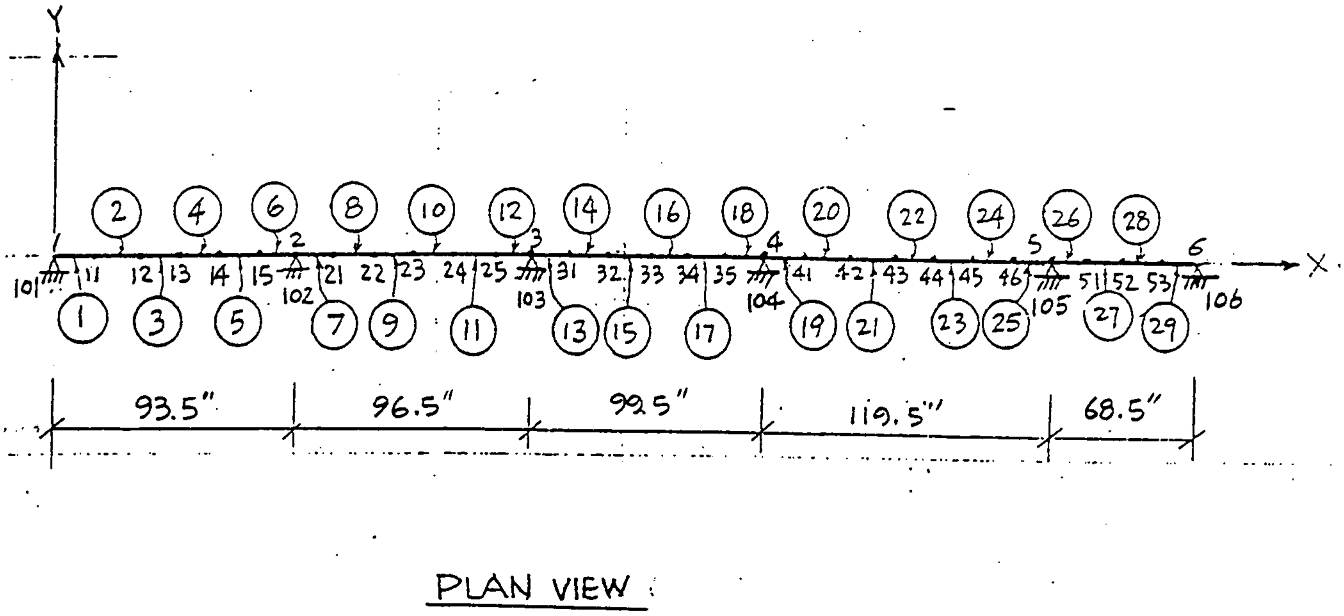
Figure 11.6.1.1 ANSYS Model for Worst Case 5-7



11.6.2 ANSYS Input

```
          ***********  ANSYS INPUT DATA LISTING (FILE18)  ***********

/PREP7
/TITLE,HD07 - EVAL. FOR HEADER RESTRAINT CASE 5-7, 48N1210-16, EL. 713'-0"
/COM
/COM  BRANCH/PROJECT ID = WCG-1-969
/COM
/COM  PREPARED BY SAL  8/26/91
/COM  CHECKED BY J. OU  8/26/91
/COM
/COM   INPUT   = HD07
/COM   OUTPUT  = HD07R
/COM   FILE12  = HD07F
/COM   PLOT    = HD07P
/COM
C*** ANSYS ANALYSIS OPTIONS AND REFERENCES TEMPERATURE
KAN,0
TREF,70
KAY,6,1
KNL,1
C***
C*** ELEMENT TYPE AND MATERIAL PROPERTIES
ET,1,24,,,,,,1
C*** ET,1,4,,,,,,1
ET,2,14,,1
EX,1,29000
ALPX,1,6.5E-6
DENS,1,1.531E-3     * C8X11.5
MPTEMP,1,70,100,200,300,400
MPDATA,EX,1,1,29.0E3,28.9E3,28.3E3,27.9E3,27.4E3
MPDATA,ALPX,1,1,6.50E-6,6.50E-6,6.50E-6,6.67E-6,6.86E-6
NL,1,13,10
NL,1,19,70,100,200,300,400
NL,1,25,36,36.0,36.0,36.0,36.0
NL,1,31,150,150,150,150,150
C***
C*** MEMBER CROSS SECTIONAL PROPERTIES
C*** R,1,3.38,1.32,32.6,8.00,2.26,  * C8X11.5
C***
C*** CHANNEL REAL CONSTRANTS
C***
*CREAT,RCHA
CF=ARG1
TCF=ARG2
CD=ARG3
TCW=ARG4
XBR=ARG5
XO=(TCW/2)-(XBR)
CC=CF-(TCW/2)
DD=(CD-TCF)/2.
QC=CC/2
QD=DD/2
```

11.6.2 ANSYS Input (Cont'd)

```
CC=CC+X0
QC=QC+X0
*STAT
C***
R,ARG6,CC,DD,0,QC,DD,TCF
RMORE,X0,DD,TCF,X0,QD,TCW
RMORE,X0,0,TCW,X0,-QD,TCW
RMORE,X0,-DD,TCW,QC,-DD,TCF
RMORE,CC,-DD,TCF
*END
*USE,RCHA,2.26,0.39,8,0.22,0.571,1      * C8X11.5
C***
R,2,(600*6)                    * SPRING STIFFNESS FOR 6 ANCHOR BOLTS
R,3,(600*4)                    * SPRING STIFFNESS FOR 4 ANCHOR BOLTS
C***
C*** NODES AND COORDINATES
C***
N,1,0,0
N,2,93.50,0.00
N,3,190.00,0.00
N,4,289.50,0.00
N,5,409.00,0.00
N,6,477.50,0.00
N,501,0,0,100
NGEN,2,100,1,6,1
C***
FILL,1,2,5,11,1
FILL,2,3,5,21,1
FILL,3,4,5,31,1
FILL,4,5,6,41,1
FILL,5,6,3,51,1
C***
C*** ELEMENT CONNECTIVITIES
MAT,1    $TYPE,1
REAL,1
E,1,11,501   $E,11,12,501  $RP4,1,1  $E,15,2,501
E,2,21,501   $E,21,22,501  $RP4,1,1  $E,25,3,501
E,3,31,501   $E,31,32,501  $RP4,1,1  $E,35,4,501
E,4,41,501   $E,41,42,501  $RP5,1,1  $E,46,5,501
E,5,51,501   $E,51,52,501  $RP2,1,1  $E,53,6,501
C***
TYPE,2
REAL,3
E,101,1
REAL,2
E,102,2
RP4,1,1
REAL,3
E,106,6
C***
```

11.6.2 ANSYS Input (Cont'd)

```
C*** BOUNDARY CONDITIONS
NSEL,,101,106
D,ALL,ALL
NALL
D,1,UY,,,6,5,UZ
D,2,UY,,,5,1,UZ,ROTX,ROTY,ROTZ
C***
C*** PLOTS - GEOMETRY W/B.C.
/SHOW
/PNUM,NODE,1
EPLO
/SHRINK,0.3
/PNUM,ELEM,1
EPLO
/PBC,ALL,1
EPLO
C*** OPERATION OPTIONS
ITER,-20,20
POSTR,,1,5
C***
C*** LOADING CASES
*CREATE,MTEM
TUNIF,ARG1
LWRITE
*END
C***
C***
C*** SEISMIC 4% PEAK SSE ACC.(G): NS=1.4, EW=1.65, VT=0.38
C*** FACTOR: MMF=1.5
MMF=1.5  $GX=MMF*1.4  $GY=MMF*1.65  $GZ=MMF*0.38
C*** DL+SSE-XZ
ACEL,GX,0,GZ+1
C***
*USE,MTEM,70
*USE,MTEM,140
RP8,,10
AFWRITE,,1
FINISH
/INPUT,27
FINISH
/POST1
*CREAT,MAC
SET,ARG1
PRRFOR
PRDISP
PLDISP
PLDISP,1
*END
/PBC,TDIS,1
/USER
/FOCUS,,234.75,,50
/DIST,,290
*USE,MAC,1
*USE,MAC,2
*USE,MAC,9
FINISH
```

11.6.3 Analysis Results

The ANSYS output for the analysis "HD07" is stored in file "HD07R". The analysis results of the final load step (Load Step 9) are provided in this Section.

The deformed structure is plotted in Figure 11.6.3.1. Note that the displacements in this plot are magnified. The maximum lateral displacement occurs at node 12.

The reaction forces and the nodal displacements are provided in Sections 11.6.3.1 and 11.6.3.2 respectively. Due to thermal expansion, nodes 1, 2 and 3 move in -X direction and nodes 4, 5, and 6 move in +X direction, as shown in the displacement output in Section 11.6.3.2. The maximum X-displacement occurs at nodes 1 and secondly, node 6.

The stresses and strains for elements near nodes 1 and 6 (elements 1 through 4 and 26 through 29) are presented in Section 11.6.3.3. These elements also include the elements (elements and 3) containing the node (21) with maximum lateral displacement. The following explanations are provided for the labels shown in the stress and strain output.

PT:	Segment Point Number, see Figure 11.2.2 for the definition of segment point for cross-section of Channels.
TEMP:	Temperature
SIGX:	Axial Stress
EP:	Axial Elastic Strain
EPPL:	Axial Plastic Strain

The stress and strain results from output file "HD07R" indicate that no yielding occurs in the structure at the final load step (temperature = 210°F).

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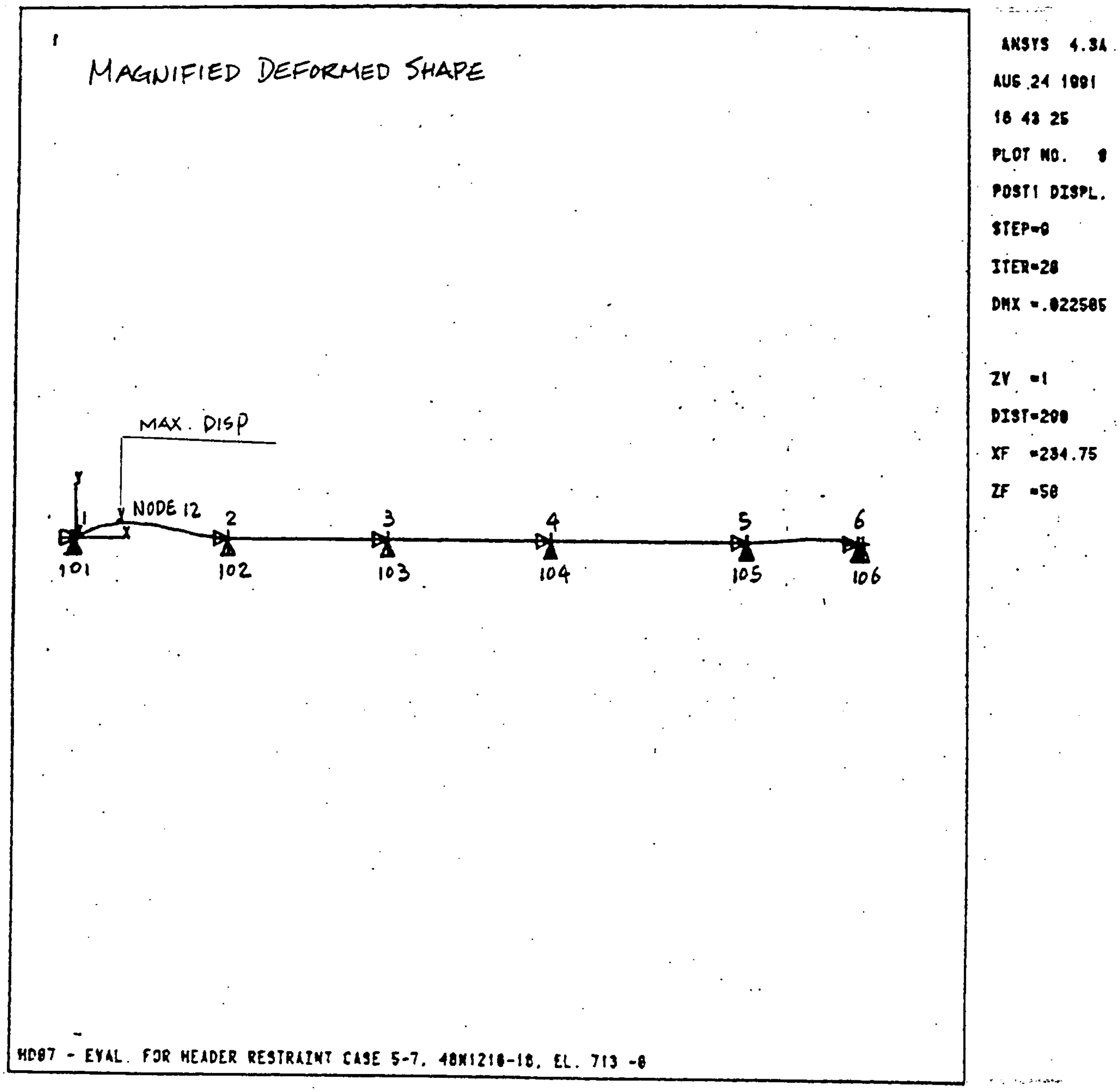
Figure 11.6.3.1 Deformed Shape of the Model HD07 (Worst Case 5-7)



11.6.3.1 Reaction Forces

```
HD07 - EVAL. FOR HEADER RESTRAINT CASE 5-7, 48N1210-16, EL. 713'-0"

        ***** POST1 REACTION FORCE LISTING *****

 LOAD STEP     9  ITERATION=    20  SECTION=  1
 TIME=    0.0000          LOAD CASE=  1

 THE FOLLOWING X,Y,Z FORCES ARE IN NODAL COORDINATES

  NODE      FX             FY             FZ             MX             MY             MZ
    1                  .12179357      .29571828
    2                 -.12179227      .84606433      .34736335E-01  .44170549      4.7244443
    3                  .37460977E-06  .78940432      .13486441E-03 -.45424018      -.29826161
    4                  .58948527E-05  .88201529      .48876782E-03 -3.2479480      .62498699E-01
    5                 -.11646035      .80115569      .75929137E-02  7.5494518      -1.5600647
    6                  .11645278      .23199001
  101   64.507925     0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
  102   19.219873     0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
  103   3.8091038     0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
  104  -1.6655594     0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
  105  -21.147825     0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
  106  -59.578720     0.0000000      0.0000000      0.0000000      0.0000000      0.0000000

 TOTAL  5.1447966     .42188475E-12  3.8463479      .42952880E-01  4.2889691      2.9286167
```

11.6.3.2 Displacements

```
HD07 - EVAL. FOR HEADER RESTRAINT CASE 5-7, 48N1210-16, EL. 713'-0"

        ***** POST1 NODAL DISPLACEMENT LISTING *****

 LOAD STEP     9  ITERATION=    20  SECTION=  1
 TIME=    0.0000          LOAD CASE=  1

 THE FOLLOWING X,Y,Z DISPLACEMENTS ARE IN NODAL COORDINATES

  NODE       UX             UY             UZ            ROTX           ROTY           ROTZ
     1  -.26878302E-01  0.0000000      0.0000000     -.89255480E-02  .41428604E-03  .47652727E-02
     2  -.53388536E-02  0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
     3  -.10580844E-02  0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
     4   .46265539E-03  0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
     5   .58743958E-02  0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
     6   .24824467E-01  0.0000000      0.0000000     -.32258834E-02 -.16568449E-03 -.21299932E-02
    11  -.23533672E-01  .59264968E-01 -.11808493E-01 -.13285244E-01  .33704937E-03  .27445492E-02
    12  -.20087205E-01  .83888564E-01 -.18844497E-01 -.15303450E-01  .20953355E-03  .44180761E-03
    13  -.16559053E-01  .75340422E-01 -.20459943E-01 -.14899200E-01  .73725032E-04 -.14004881E-02
    14  -.12947782E-01  .45779176E-01 -.17036132E-01 -.12134384E-01 -.29151681E-04 -.21864754E-02
    15  -.92132135E-02  .14142235E-01 -.97217665E-02 -.71416463E-02 -.63631854E-04 -.16620084E-02
    21  -.46989313E-02  .66700824E-04 -.80321782E-02 -.58125024E-02  .66271141E-04  .10478213E-04
    22  -.40295100E-02  .21326499E-03 -.13572029E-01 -.93610545E-02  .53235882E-04  .11338026E-04
    23  -.33309001E-02  .29164230E-03 -.15538868E-01 -.10553442E-01 -.76971238E-08 -.66126275E-08
    24  -.26028607E-02  .21314467E-03 -.13569431E-01 -.93591541E-02 -.53240270E-04 -.11340534E-04
    25  -.18451518E-02  .66638525E-04 -.80293986E-02 -.58104096E-02 -.66258082E-04 -.10470179E-04
    31  -.88270498E-03  .88636521E-04 -.86110957E-02 -.61986928E-02  .72950329E-04  .12943577E-04
    32  -.67606896E-03  .28117286E-03 -.14599325E-01 -.99897605E-02  .58628838E-04  .13973576E-04
    33  -.43850785E-03  .38350054E-03 -.16732676E-01 -.11264744E-01 -.89311030E-08 -.89317244E-08
    34  -.16965880E-03  .28099894E-03 -.14596411E-01 -.99876404E-02 -.58633971E-04 -.13976983E-04
    35   .13083974E-03  .88545388E-04 -.86080063E-02 -.61963757E-02 -.72935386E-04 -.12932744E-04
    41   .11380272E-02  .31985364E-03 -.11231889E-01 -.78919880E-02  .12028446E-03  .40090835E-04
    42   .18454350E-02  .10794776E-02 -.20269442E-01 -.13284562E-01  .12112739E-03  .53684003E-04
    43   .25841024E-02  .17186701E-02 -.25260874E-01 -.16020493E-01  .48616643E-04  .24385817E-04
    44   .33550670E-02  .17178212E-02 -.25258006E-01 -.16018515E-01 -.48653961E-04 -.24478066E-04
    45   .41600540E-02  .10779937E-02 -.20262966E-01 -.13280011E-01 -.12112455E-03 -.53665838E-04
    46   .50000902E-02  .31924587E-03 -.11226741E-01 -.78882124E-02 -.12024832E-03 -.40024408E-04
    51   .10665680E-01  .79234112E-02 -.62412889E-02 -.47661711E-02  .78494823E-05  .77443258E-03
    52   .15412906E-01  .20912577E-01 -.87413826E-02 -.69306935E-02 -.47713618E-04  .57289301E-03
    53   .20129083E-01  .22399674E-01 -.66415588E-02 -.64196762E-02 -.12133839E-03 -.52851310E-03
   101  0.0000000      0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
   102  0.0000000      0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
   103  0.0000000      0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
   104  0.0000000      0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
   105  0.0000000      0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
   106  0.0000000      0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
```

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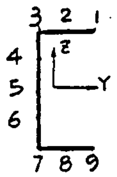
11.6.3.3 Stresses and Strains



```
HD07 - EVAL. FOR HEADER RESTRAINT CASE 5-7, 48N1210-16, EL. 713'-0"

 ***** ELEMENT STRESSES *****  TIME =   0.00000       LOAD STEP=    9  ITERATION=    20   CUM. ITER.=   40


EL=     1  NODES=     1    11  MAT=  1  PRESSURES(Z,Y)=   0.0000        0.0000       AVE. TEMP= 210.00
END I   PT     TEMP       SIGX           EP          EPPL          EPCR          EPSW
         1   210.00   -14.292       -.0005057    0.0000000     0.0000000     0.0000000
         2   210.00   -17.598       -.0006227    0.0000000     0.0000000     0.0000000
         3   210.00   -20.903       -.0007397    0.0000000     0.0000000     0.0000000
         4   210.00   -20.903       -.0007397    0.0000000     0.0000000     0.0000000
         5   210.00   -20.903       -.0007397    0.0000000     0.0000000     0.0000000
         6   210.00   -20.903       -.0007397    0.0000000     0.0000000     0.0000000
         7   210.00   -20.903       -.0007397    0.0000000     0.0000000     0.0000000
         8   210.00   -17.598       -.0006227    0.0000000     0.0000000     0.0000000
         9   210.00   -14.292       -.0005057    0.0000000     0.0000000     0.0000000
END J   PT     TEMP       SIGX           EP          EPPL          EPCR          EPSW
         1   210.00   -12.821       -.0004537    0.0000000     0.0000000     0.0000000
         2   210.00   -17.403       -.0006158    0.0000000     0.0000000     0.0000000
         3   210.00   -21.984       -.0007779    0.0000000     0.0000000     0.0000000
         4   210.00   -21.738       -.0007692    0.0000000     0.0000000     0.0000000
         5   210.00   -21.492       -.0007605    0.0000000     0.0000000     0.0000000
         6   210.00   -21.246       -.0007518    0.0000000     0.0000000     0.0000000
         7   210.00   -20.999       -.0007431    0.0000000     0.0000000     0.0000000
         8   210.00   -16.418       -.0005810    0.0000000     0.0000000     0.0000000
         9   210.00   -11.836       -.0004188    0.0000000     0.0000000     0.0000000
FORCES ON MEMBER AT NODE     1   64.5077      -.123927      .331511       .420218      -.444028E-11    4.96381
                            11  -64.3399       .121906     -.205902      -.260999      -4.18734       -6.87926


EL=     2  NODES=    11    12  MAT=  1  PRESSURES(Z,Y)=   0.0000        0.0000       AVE. TEMP= 210.00
END I   PT     TEMP       SIGX           EP          EPPL          EPCR          EPSW
         1   210.00   -12.807       -.0004532    0.0000000     0.0000000     0.0000000
         2   210.00   -17.398       -.0006156    0.0000000     0.0000000     0.0000000
         3   210.00   -21.988       -.0007781    0.0000000     0.0000000     0.0000000
         4   210.00   -21.742       -.0007694    0.0000000     0.0000000     0.0000000
         5   210.00   -21.496       -.0007607    0.0000000     0.0000000     0.0000000
         6   210.00   -21.250       -.0007520    0.0000000     0.0000000     0.0000000
         7   210.00   -21.005       -.0007433    0.0000000     0.0000000     0.0000000
         8   210.00   -16.414       -.0005808    0.0000000     0.0000000     0.0000000
         9   210.00   -11.824       -.0004184    0.0000000     0.0000000     0.0000000
END J   PT     TEMP       SIGX           EP          EPPL          EPCR          EPSW
         1   210.00   -13.293       -.0004704    0.0000000     0.0000000     0.0000000
         2   210.00   -17.686       -.0006258    0.0000000     0.0000000     0.0000000
         3   210.00   -22.080       -.0007813    0.0000000     0.0000000     0.0000000
         4   210.00   -21.714       -.0007684    0.0000000     0.0000000     0.0000000
         5   210.00   -21.348       -.0007554    0.0000000     0.0000000     0.0000000
         6   210.00   -20.981       -.0007424    0.0000000     0.0000000     0.0000000
         7   210.00   -20.615       -.0007295    0.0000000     0.0000000     0.0000000
         8   210.00   -16.222       -.0005740    0.0000000     0.0000000     0.0000000
         9   210.00   -11.829       -.0004186    0.0000000     0.0000000     0.0000000
FORCES ON MEMBER AT NODE    11   64.3401       .179490E-01   .194094       .237244       4.18116        6.89262
                            12  -64.1722      -.200048E-01  -.685223E-01  -.780714E-01  -6.22738       -6.59689
```

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Chkd. by JOU Date 8/27/91 OFS No. NR Dept. No. NR

Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.6.3.3 Stresses and Strains (Cont'd)

```
EL=   3  NODES=   12   13  MAT=  1  PRESSURES(Z,Y)=   0.0000      0.0000     AVE. TEMP= 210.00
END I  PT   TEMP       SIGX              EP         EPPL        EPCR        EPSW
        1  210.00    -13.288         -.0004702   0.0000000   0.0000000   0.0000000
        2  210.00    -17.685         -.0006258   0.0000000   0.0000000   0.0000000
        3  210.00    -22.081         -.0007814   0.0000000   0.0000000   0.0000000
        4  210.00    -21.715         -.0007684   0.0000000   0.0000000   0.0000000
        5  210.00    -21.349         -.0007555   0.0000000   0.0000000   0.0000000
        6  210.00    -20.983         -.0007425   0.0000000   0.0000000   0.0000000
        7  210.00    -20.617         -.0007295   0.0000000   0.0000000   0.0000000
        8  210.00    -16.220         -.0005740   0.0000000   0.0000000   0.0000000
        9  210.00    -11.824         -.0004184   0.0000000   0.0000000   0.0000000
END J  PT   TEMP       SIGX              EP         EPPL        EPCR        EPSW
        1  210.00    -15.632         -.0005532   0.0000000   0.0000000   0.0000000
        2  210.00    -18.422         -.0006519   0.0000000   0.0000000   0.0000000
        3  210.00    -21.213         -.0007506   0.0000000   0.0000000   0.0000000
        4  210.00    -20.854         -.0007379   0.0000000   0.0000000   0.0000000
        5  210.00    -20.495         -.0007252   0.0000000   0.0000000   0.0000000
        6  210.00    -20.136         -.0007125   0.0000000   0.0000000   0.0000000
        7  210.00    -19.778         -.0006999   0.0000000   0.0000000   0.0000000
        8  210.00    -16.988         -.0006011   0.0000000   0.0000000   0.0000000
        9  210.00    -14.197         -.0005024   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE   12   64.1720      .153895     .547295E-01  .479504E-01   6.22600     6.60192
                           13  -64.0042     -.155702     .708043E-01  .111175      -6.10075    -4.18964

EL=   4  NODES=   13   14  MAT=  1  PRESSURES(Z,Y)=   0.0000      0.0000     AVE. TEMP= 210.00
END I  PT   TEMP       SIGX              EP         EPPL        EPCR        EPSW
        1  210.00    -15.642         -.0005535   0.0000000   0.0000000   0.0000000
        2  210.00    -18.425         -.0006520   0.0000000   0.0000000   0.0000000
        3  210.00    -21.209         -.0007505   0.0000000   0.0000000   0.0000000
        4  210.00    -20.850         -.0007378   0.0000000   0.0000000   0.0000000
        5  210.00    -20.492         -.0007251   0.0000000   0.0000000   0.0000000
        6  210.00    -20.133         -.0007124   0.0000000   0.0000000   0.0000000
        7  210.00    -19.775         -.0006997   0.0000000   0.0000000   0.0000000
        8  210.00    -16.991         -.0006012   0.0000000   0.0000000   0.0000000
        9  210.00    -14.207         -.0005027   0.0000000   0.0000000   0.0000000
END J  PT   TEMP       SIGX              EP         EPPL        EPCR        EPSW
        1  210.00    -19.070         -.0006748   0.0000000   0.0000000   0.0000000
        2  210.00    -19.354         -.0006849   0.0000000   0.0000000   0.0000000
        3  210.00    -19.639         -.0006949   0.0000000   0.0000000   0.0000000
        4  210.00    -19.415         -.0006870   0.0000000   0.0000000   0.0000000
        5  210.00    -19.191         -.0006791   0.0000000   0.0000000   0.0000000
        6  210.00    -18.967         -.0006712   0.0000000   0.0000000   0.0000000
        7  210.00    -18.743         -.0006632   0.0000000   0.0000000   0.0000000
        8  210.00    -18.459         -.0006532   0.0000000   0.0000000   0.0000000
        9  210.00    -18.175         -.0006431   0.0000000   0.0000000   0.0000000
FORCES ON MEMBER AT NODE   13   64.0039      .240140    -.843182E-01 -.136517      6.09955     4.17999
                           14  -63.8360     -.241526     .209820      .295601     -3.80773    -.427007
```

11.6.3.3 Stresses and Strains (Cont'd)

```
EL=   26  NODES=    5   51  MAT=  1  PRESSURES(Z,Y)=   0.0000        0.0000      AVE. TEMP= 210.00
END I  PT     TEMP      SIGX              EP          EPPL         EPCR          EPSW
        1   210.00   -20.940         -.0007410    0.0000000    0.0000000    0.0000000
        2   210.00   -18.754         -.0006636    0.0000000    0.0000000    0.0000000
        3   210.00   -16.568         -.0005863    0.0000000    0.0000000    0.0000000
        4   210.00   -16.736         -.0005922    0.0000000    0.0000000    0.0000000
        5   210.00   -16.905         -.0005982    0.0000000    0.0000000    0.0000000
        6   210.00   -17.073         -.0006041    0.0000000    0.0000000    0.0000000
        7   210.00   -17.241         -.0006101    0.0000000    0.0000000    0.0000000
        8   210.00   -19.428         -.0006875    0.0000000    0.0000000    0.0000000
        9   210.00   -21.614         -.0007648    0.0000000    0.0000000    0.0000000
END J  PT     TEMP      SIGX              EP          EPPL         EPCR          EPSW
        1   210.00   -18.972         -.0006713    0.0000000    0.0000000    0.0000000
        2   210.00   -18.413         -.0006515    0.0000000    0.0000000    0.0000000
        3   210.00   -17.853         -.0006318    0.0000000    0.0000000    0.0000000
        4   210.00   -17.759         -.0006284    0.0000000    0.0000000    0.0000000
        5   210.00   -17.664         -.0006250    0.0000000    0.0000000    0.0000000
        6   210.00   -17.569         -.0006217    0.0000000    0.0000000    0.0000000
        7   210.00   -17.474         -.0006183    0.0000000    0.0000000    0.0000000
        8   210.00   -18.033         -.0006381    0.0000000    0.0000000    0.0000000
        9   210.00   -18.592         -.0006579    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE    5   60.3167      -.142852      .330573      .426373     -2.86551      -3.28261
                           51  -60.1322       .142445     -.192595     -.251474     -1.61412       .839759

EL=   27  NODES=   51   52  MAT=  1  PRESSURES(Z,Y)=   0.0000        0.0000      AVE. TEMP= 210.00
END I  PT     TEMP      SIGX              EP          EPPL         EPCR          EPSW
        1   210.00   -18.969         -.0006712    0.0000000    0.0000000    0.0000000
        2   210.00   -18.413         -.0006516    0.0000000    0.0000000    0.0000000
        3   210.00   -17.858         -.0006319    0.0000000    0.0000000    0.0000000
        4   210.00   -17.761         -.0006285    0.0000000    0.0000000    0.0000000
        5   210.00   -17.665         -.0006251    0.0000000    0.0000000    0.0000000
        6   210.00   -17.569         -.0006217    0.0000000    0.0000000    0.0000000
        7   210.00   -17.473         -.0006183    0.0000000    0.0000000    0.0000000
        8   210.00   -18.029         -.0006380    0.0000000    0.0000000    0.0000000
        9   210.00   -18.584         -.0006576    0.0000000    0.0000000    0.0000000
END J  PT     TEMP      SIGX              EP          EPPL         EPCR          EPSW
        1   210.00   -16.409         -.0005806    0.0000000    0.0000000    0.0000000
        2   210.00   -17.679         -.0006256    0.0000000    0.0000000    0.0000000
        3   210.00   -18.949         -.0006705    0.0000000    0.0000000    0.0000000
        4   210.00   -18.737         -.0006630    0.0000000    0.0000000    0.0000000
        5   210.00   -18.524         -.0006555    0.0000000    0.0000000    0.0000000
        6   210.00   -18.312         -.0006480    0.0000000    0.0000000    0.0000000
        7   210.00   -18.099         -.0006404    0.0000000    0.0000000    0.0000000
        8   210.00   -16.829         -.0005955    0.0000000    0.0000000    0.0000000
        9   210.00   -15.558         -.0005505    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   51   60.1321      -.160568      .184761      .241351      1.63305      -.834136
                           52  -59.9476       .159630     -.468074E-01 -.664829E-01 -3.61585      -1.90756
```

EBASCO SERVICES INCORPORATED

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Chkd. by J OU Date 8/27/91 OFS No. NR Dept. No. NR

Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

11.6.3.3 Stresses and Strains (Cont'd)

```
EL=   28  NODES=   52   53  MAT=  1  PRESSURES(Z,Y)=   0.0000        0.0000      AVE. TEMP= 210.00
END I  PT     TEMP      SIGX            EP          EPPL         EPCR         EPSW
        1   210.00   -16.406        -.0005805    0.0000000    0.0000000    0.0000000
        2   210.00   -17.678        -.0006256    0.0000000    0.0000000    0.0000000
        3   210.00   -18.951        -.0006706    0.0000000    0.0000000    0.0000000
        4   210.00   -18.738        -.0006631    0.0000000    0.0000000    0.0000000
        5   210.00   -18.525        -.0006555    0.0000000    0.0000000    0.0000000
        6   210.00   -18.312        -.0006480    0.0000000    0.0000000    0.0000000
        7   210.00   -18.100        -.0006405    0.0000000    0.0000000    0.0000000
        8   210.00   -16.827        -.0005954    0.0000000    0.0000000    0.0000000
        9   210.00   -15.555        -.0005504    0.0000000    0.0000000    0.0000000
END J  PT     TEMP      SIGX            EP          EPPL         EPCR         EPSW
        1   210.00   -14.242        -.0005040    0.0000000    0.0000000    0.0000000
        2   210.00   -16.878        -.0005972    0.0000000    0.0000000    0.0000000
        3   210.00   -19.513        -.0006905    0.0000000    0.0000000    0.0000000
        4   210.00   -19.333        -.0006841    0.0000000    0.0000000    0.0000000
        5   210.00   -19.152        -.0006777    0.0000000    0.0000000    0.0000000
        6   210.00   -18.972        -.0006713    0.0000000    0.0000000    0.0000000
        7   210.00   -18.791        -.0006649    0.0000000    0.0000000    0.0000000
        8   210.00   -16.156        -.0005717    0.0000000    0.0000000    0.0000000
        9   210.00   -13.520        -.0004784    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   52   59.9477      -.119982       .368976E-01  .510854E-01  3.61809      1.91056
                           53  -59.7632       .119052       .101025      .123744     -3.06900     -3.95729

EL=   29  NODES=   53    6  MAT=  1  PRESSURES(Z,Y)=   0.0000        0.0000      AVE. TEMP= 210.00
END I  PT     TEMP      SIGX            EP          EPPL         EPCR         EPSW
        1   210.00   -14.248        -.0005042    0.0000000    0.0000000    0.0000000
        2   210.00   -16.879        -.0005973    0.0000000    0.0000000    0.0000000
        3   210.00   -19.511        -.0006904    0.0000000    0.0000000    0.0000000
        4   210.00   -19.331        -.0006840    0.0000000    0.0000000    0.0000000
        5   210.00   -19.150        -.0006776    0.0000000    0.0000000    0.0000000
        6   210.00   -18.970        -.0006713    0.0000000    0.0000000    0.0000000
        7   210.00   -18.790        -.0006649    0.0000000    0.0000000    0.0000000
        8   210.00   -16.158        -.0005718    0.0000000    0.0000000    0.0000000
        9   210.00   -13.526        -.0004786    0.0000000    0.0000000    0.0000000
END J  PT     TEMP      SIGX            EP          EPPL         EPCR         EPSW
        1   210.00   -13.200        -.0004671    0.0000000    0.0000000    0.0000000
        2   210.00   -16.253        -.0005751    0.0000000    0.0000000    0.0000000
        3   210.00   -19.306        -.0006832    0.0000000    0.0000000    0.0000000
        4   210.00   -19.306        -.0006832    0.0000000    0.0000000    0.0000000
        5   210.00   -19.306        -.0006832    0.0000000    0.0000000    0.0000000
        6   210.00   -19.306        -.0006832    0.0000000    0.0000000    0.0000000
        7   210.00   -19.306        -.0006832    0.0000000    0.0000000    0.0000000
        8   210.00   -16.253        -.0005751    0.0000000    0.0000000    0.0000000
        9   210.00   -13.200        -.0004671    0.0000000    0.0000000    0.0000000
FORCES ON MEMBER AT NODE   53   59.7633      -.371698E-01  -.110195     -.139681      3.06781      3.95161
                            6  -59.5788       .367480E-01   .248090      .314475     -.771304E-12 -4.58453
```

11.6.4 Member Qualification

As presented in Section 11.6.3, the maximum lateral displacement for the member occurs at Node 12 and the stress and strain results of the analysis indicate that no yielding occurs in all elements at the final temperature step (temperature=210°F). Therefore, the ductility ratio at nodes 12 is less than 1. Note that the ductility ratio is defined as the ratio of the final displacement to the yield displacement.

Per DG-C1.6.12, Appendix D, the member of worst case 5-7 is qualified.

11.6.5 Connection and Anchorage Qualification for Worst Case 5-7

11.6.5.1 Connection Qualification for Worst Case 5-7

The weld connections at support nodes 1 through 6 are evaluated. The reaction forces documented in Section 11.6.3.1 are considered in the evaluation. The connection information is obtained from Drawing 48N1210-16 and WCG-1-830 R1 (walkdown package).

EBASCO SERVICES INCORPORATED

BY SAL DATE 8/26/91 **BRANCH PROJECT I.D.** WGG-1-969 SHEET 223 OF 230

CHKD. BY JOU DATE 8/27/91 OFS NO. NR DEPT. NO. NR

CLIENT TVA

PROJECT WBNP - UNIT 1

SUBJECT QUALIF. OF WORST CASES OF THERM. REST. STRUCT. PACKAGE 1

CHECK HD07 - CONNECTIONS

REF. WCG-1-830

FROM ANSYS OUTPUT HD07R DATED 8/26/91

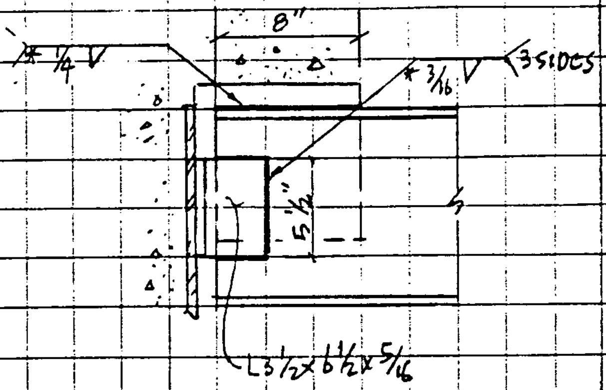
MAX LOADS AT NODE 1

NODE 1 (FROM ANSYS)

$F_x = 64.51^{K}$

$F_y = 0.12^{K}$

$F_z = 0.30^{K}$



Output File: HD07R

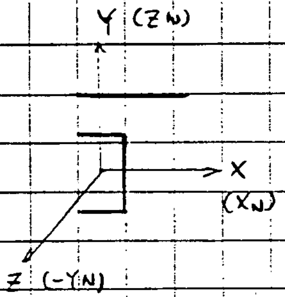
FORCES ON WELD GROUP

$F_x = -64.51^{K}$

$F_y = -0.30^{K}$

$F_z = 0.12^{K}$

* WELD SIZE PER DWG 48N1210-16 SECT D16-D16



AXIAL FORCE WILL TRANSFER THROUGH WELDING BETWEEN EMBEDDED PL AND CHANNEL AND WELD BETWEEN CLIP ANGLE AND CHANNEL TO BOTH SIDES OF WALLS. FOR SIMPLICITY JUST CONSIDERS WELD SIZE 1/4" & LENGTH 8" ONLY

$$F_t = (64.51^2 + 0.3^2 + 0.12^2)^{1/2} = 64.51 / 8 = 8.06^{k}/''$$

WELD CAPACITY : $0.707 \times 2/3 \times 70 \times 1/4 = 8.25^{k}/'' > 8.06^{k}/''$

O.K.

BY TAK DATE 8/26/91 BRANCH PROJECT I.D.: WCG-1-969 SHEET 224 OF 230

CHKD. BY J. OU DATE 8/27/91 OFS NO. NR DEPT. NO. NR

CLIENT TVA

PROJECT WBNP- UNIT 1

SUBJECT Qualif. of Worst Cases of Therm. Rest. Struct., Package I

REF.

DG-C1.6.12

C4.0

Walkdown Package

TI2007/ESI-5

HD07- Connection

Check the Connection for max^m loads as per Ansys Output.

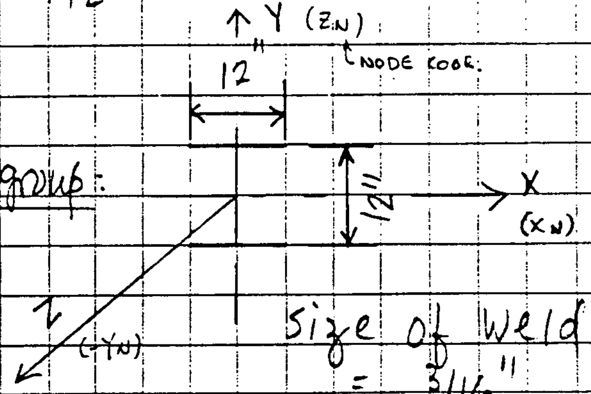
Nodes 5, 105 (max My)

$F_x = -21.15$ Kips $M_x = 0.08$ ''-k

$F_y = -0.12$ $M_y = 7.55$ ''-k

$F_z = 0.80$ K $M_z = -1.56$ ''-k

Forces on Weld group:



Size of Weld = 3/16"

$F_x = 21.15$ k $M_x = -0.08$ ''-k

$F_y = -0.80$ k $M_y = 1.56$ ''-k

$F_z = -0.12$ k $M_z = 7.55$ ''-k

Weld properties:

$A_w = 24$ in

$S_x = 12 \times 12 = 144 \text{ in}^2$

$S_y = \frac{12^2}{3} = 48 \text{ in}^2$

$J_w = \frac{12}{6} \times (3 \times 12^2 + 12^2) = 1152 \text{ in}^3$

Weld stresses

$f_t = \frac{f_z}{A_w} + \frac{M_x}{S_x} + \frac{M_y}{S_y}$

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PROJECT WBNP- UNIT 1

SUBJECT Qualif. of Worst Cases of Therm. Rest. Struct., Package I

$$ft = \frac{-0.12}{24.0} - \frac{0.08}{144.0} - \frac{1.56}{48.0} = -0.04 \text{ K/IN}$$

$$Vx = \frac{Fx}{AW} + \frac{Mz \times ch}{JW}$$

$$= \frac{21.15}{24.0} + \frac{7.55 \times 6}{1152}$$

$$= 0.88 + 0.04 = 0.92 \text{ K/IN}$$

$$Vy = \frac{Fy}{AW} + \frac{Mz \times Cv}{JW}$$

$$= \frac{-0.38}{24} + \frac{7.55 \times 6}{1152}$$

$$= -0.02 + 0.04 = 0.02 \text{ K/IN}$$

$$fr = (ft^2 + Vx^2 + Vy^2)^{1/2}$$

$$= (0.04^2 + 0.92^2 + 0.02^2)^{\frac{1}{2}}$$

$$= 0.92 \text{ K/IN}$$

Weld Capacity

$$= .707 \times \frac{2}{3} \times 70 \times 3/16$$

$$= 6.19 \text{ K/in} > 0.92 \text{ K/in OK}$$

11.6.5.2 Anchorage Qualification for Worst Case 5-7

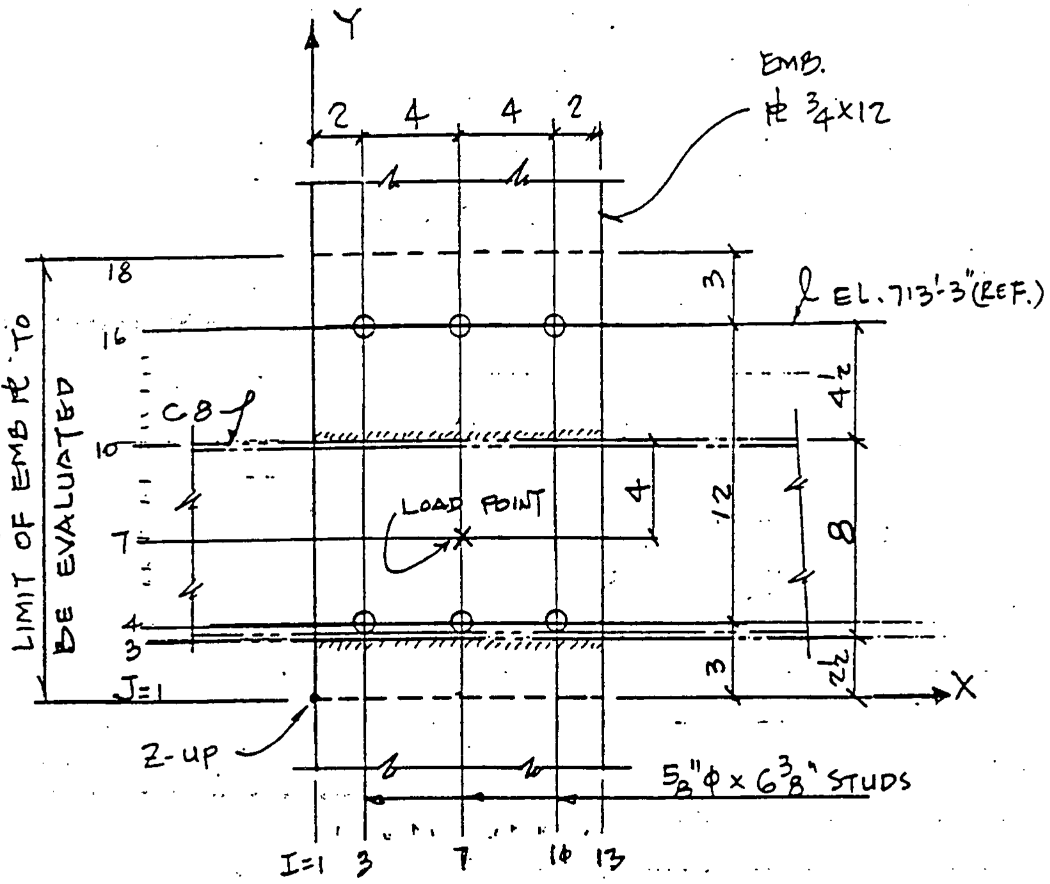
For shear loading, the 5/8"ϕ Welded Studs are accepted by comparing the displacement at the anchorage to the displacement allowable per Design Guide DG-C1.6.12 R1. The displacement allowable is 0.2D (0.2 * bolt diameter) for ductile anchors. As shown in Section 11.6.3.2, the maximum X-displacement occurs at node 1 (0.027").

0.027" < 0.2D = 0.2 * 5/8" = 0.125" **O.K.**

A BASEPLATE II model is constructed to evaluate the tension on the Weld Studs. As shown in Figure 11.6.5.2.1, the same model used in Calc. WCG-1-964 (Evaluation of Embedded Plates for Platforms) is used. The reaction forces at node 2, where the maximut moment occurs, are considered. The input and Output of the Baseplate II runs are presented in Table 11.6.5.2.1. The results of analysis indicate that the tension in the bolts are nearly zero since the moment is only 4 inch-kip. The Tension allowable is 7.429 Kip per DS-C1.7.1.

Therefore, the anchorage for worst case 5-7 are qualified.

Figure 11.6.5.2.1 BASEPLATE II Model for Anchorage at Node 2



ELEVATION

STIFFNESS OF STUDS: $A = 0.307^{in^2}$; $T_o = 0.55 \times 44 \times 0.307$
$= 7.429^{K}$

$$K_t = \frac{1}{\frac{0.015}{7.429} + \frac{6.375}{0.307 \times 29000}} = 365.6^{K/in}$$

$$K_s = 1000^{K/in}$$

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Table 11.6.5.2.1 BASEPLATE II Input and Output for Anchorage at Nodes 2

(Ref: Input: B2HD07 ; Output: B2HD07R)

```
3 B2HD07 - NODE 2, EL. 713' DWG 48N1210-16
OUT ,,,-1,,3/
CON,,,,3000/
PLA 13,18, ,12.,18.,.75,29/
BPR , ,1,365.6E3,1000E3/
BOL 3,4,1,2.0,3.0/
BOL 3,16,1,2.0,15.0/
BOL 7,4,1,6.0,3.0/
BOL 7,16,1,6.0,15.0/
BOL 11,4,1,10.0,3.0/
BOL 11,16,1,10.,15.0/
END /
ATT 1,3,,0,2.5/
JST 1,3,13,12.0,0/
IST 7,3,10,8.0,90/
JST 7,10,1,6.0,180/
JST 7,10,13,6.0,0/
END /
END /
POI 1,3,,6.0,4.0/
LOA ,,1,19.2,-0.85,0,0.034,-4.72,-0.44/
END /
END OF JOB
END OF FILE
```

```
                         B O L T   L O A D S
                         -------------------
  I      J
 LINE   LINE   NODE    X-SHEAR    Y-SHEAR     SRSS    Z-TENSION
 ----   ----   ----    -------    -------    ------   ---------

  3      4      40       4.         -1.        4.         0.
  3     16      52       2.         -1.        2.         0.
  7      4     112       4.         -0.        4.         0.
  7     16     124       2.         -0.        2.         0.
 11      4     184       4.          0.        4.         0.
 11     16     196       2.          1.        2.         0.
```

12. SUMMARY OF CALCULATION RESULTS

Worst Case ID	Member Ductility Ratio	Connection	Anchorage	Remarks
1-27	$\mu = 4.3$ (Original Structure) $\mu < 1.0$ (After Modification)	Adequate	Adequate	Modification* Required
2&3-9(C)	$\mu < 1.0$	Adequate	Adequate	
1-11	$\mu < 1.0$	Adequate	Adequate	
2&3-8(G)	$\mu < 1.0$	Adequate	Adequate	
5-7	$\mu < 1.0$	Adequate	Adequate	

* Modification for worst case member 1-27 is shown in Section 11.3.7. A slotted hole connection is implemented per DCN M-16250-A.

By SAL Date 8/27/91 Sheet 230 of 230
Chkd. by J OU Date 8/27/91 OFS No. NR Dept. No. NR
Client TVA
Project WBNP Unit 1
Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

13. CONCLUSION

The thermal worst cases 1-27, 2&3-9(C), 1-11, 2&3-8(G) and 5-7 are evaluated and only one modification for worst case 1-27 is required (for detail, see Section 11.3.7). The evaluation results indicate that, after the modification is implemented, all the members, connections and anchorages for these five case of thermally restrained structure meet the requirement of the design criteria as well as all the applicable codes.

EBASCO SERVICES INCORPORATED

BRANCH/PROJECT ID: WCG-1-969

By SM Date 8/27/91 Sheet 1 of 1

Chkd. by JOU Date 8/28/91 OFS No. NR Dept. No. NR

Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

14. ATTACHMENT

TABLE OF CONTENTS

ATTACHMENT "A"
SHEET 1 OF 1

ATTACHMENT A
VERIFICATION WORKSHEET
FOR CALCULATIONS AND DRAWINGS

Task No. PWL = CA Title: QUALIF. OF WORST CASES OF THERMALLY RESTRAINED STRUCTURES - PACKAGE 1

Document No. WCG-1-969

Revision 0

QUESTIONS TO BE ADDRESSED

1 Were the inputs correctly selected at the correct revision level, and incorporated into the design?

2 Are the assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are assumptions identified for subsequent reverification after the detailed design activities are completed?

3a Are the appropriate quality requirements specified?

3b Are the appropriate quality assurance requirements specified?

4 Are the applicable codes, standards, and regulatory requirements including issue and addenda properly identified, and are their requirements for design met?

5 Have applicable construction and operating experience been considered?

6 Have the design interface requirements been satisfied?

7 Was an appropriate design method used?

8 Is the output reasonable compared to inputs?

9 Are the specified parts, equipment, and processes suitable for the required application? Are all applicable construction specifications referenced on the drawing(s)?

10 Are the specified materials compatible with each other and with the design environmental conditions to which the materials will be exposed?

11 Have adequate maintenance features and requirements been specified?

12 Are accessibility and other design provisions adequate for performing needed maintenance and repair?

13 Has adequate accessibility been provided to perform the inservice inspection expected to be required during the plantlife?

14 Has the design properly considered radiation exposure to the public and plant personnel?

15 Is the acceptance criteria incorporated in the design document sufficient to allow verification that design requirements have been satisfactorily accomplished?

16 Have adequate preoperational and subsequent periodic test requirements been appropriately specified?

17 Are adequate handling, storage, cleaning and shipping requirements specified?

18 Are adequate identification requirements specified?

19 Are requirements for record preparation review, approval, retention, etc., adequately specified?

For Calculations, only questions 1, 2, 4, 6, 7, 8 and 15 are considered applicable.

Independent Verifier C.Y. OU / Chaoyang Ou 8/30/91
Print/Sign Date

EBASCO SERVICES INCORPORATED

BRANCH/PROJECT ID: WCG-1-969

By SAV Date 8/21/91 Sheet 1 of 1

Chkd. by JOU. Date 8/27/91 OFS No. NR Dept. No. NR

Client TVA

Project WBNP Unit 1

Subject Qualif. of Worst Cases of Thermally Restrained Structures - Package I

ATTACHMENT B:

MICROFICHE LISTING FOR OUTPUT FILES

Worst Case ID	Output File Name	Microfiche Number
1-27 and 2&3-9(C)	BS4P9CR BS8P9CR BS10P9R BS7P9CR BS12P9R	TVA-F-G099738
	B8PR9CR B10P9CR C10P9CR	TVA-F-G099736
	B1PR9CR C4PR9CR	TVA-F-G099734
	PR9CR	TVA-F-G099732
	PR9CMR	TVA-F-G099730
1-11	AX11R	TVA-F-G099728
2&3-8(G)	BS1P8GR BS9P8GR B1PR8GR	TVA-F-G099726
	PR8GR	TVA-F-G099724
5-7	HD07R	TVA-F-G099720
	B2HD07R	TVA-F-G099722

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT C
SHEET 1 OF 7

```
1
             ***********  ANSYS INPUT DATA LISTING (FILE18)  **********

/PREP7
/TITLE, AX11G - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"
/COM
/COM  BRANCH/PROJECT ID = WCG-1-969
/COM
/COM  PREPARED BY SAL   8/13/91
/COM  CHECKED BY J. OU  8/13/91
/COM
/COM   FOR COMPARISON BETWEEN USING GAP ELEM. AND IMPOSED DISP.
/COM   (USE STIF40 / GAP AT SUPPORTS)
/COM
/COM   INPUT    = AX11G
/COM   OUTPUT   = AX11GR
/COM   FILE12   = AX11GF
/COM   PLOT     = AX11GP
/COM
C*** ANSYS ANALYSIS OPTIONS AND REFERENCES
KAN,0
KAY,6,1
KNL,1
TREF,70
C*** ELEMENT TYPE AND MATERIAL PROPERTIES
ET,1,4,,,,,,1
ET,2,24,,,,,,1
ET,3,21              * 3D MASS ELEMENT
ET,4,40,,,1
C***
EX,1,29000
RP4,1
ALPX,1,6.5E-6
RP4,1
DENS,1,0.283E-3
DENS,2,2.905E-3        * INCLUDE DL+SLL
DENS,3,2.002E-3        * INCLUDE DL+SLL
DENS,4,0               * RIGID LINK
C***
MPTEMP,1,70,100,200,300,400
RP4,1
MPDATA,EX,1,1,29.0E3,28.9E3,28.3E3,27.9E3,27.4E3
RP4,,1
MPDATA,ALPX,1,1,6.50E-6,6.50E-6,6.50E-6,6.67E-6,6.86E-6  * ALPX=6.29 MU FOR 100F
RP4,,1
C***  NONLINEAR MATERIAL CONSTANT
*CREAT,MNL
NL,ARG1,13,10
NL,ARG1,19,70,100,200,300,400
NL,ARG1,25,36,36.0,36.0,36.0,36.0
NL,ARG1,31,150,150,150,150,150
*END
*USE,MNL,2
*USE,MNL,3
C*** MEMBER CROSS SECTIONAL PROPERTIES
R,1,3.38,1.32,32.6,8.00,2.26,  *C8X11.5
RMORE,,0.131
C***
C***  NONLINEAR CROSS SECTIONAL PROPERTIES
C*** CHANNEL C8X11.5 *****
CF=2.260
TCF=0.390
CD=8.00
1
             ***********  ANSYS INPUT DATA LISTING (FILE18)  **********

TCW=0.220 -
XBR=(0.571)+0.07695
C***
XO=(TCW/2)-(XBR)
CC=CF-(TCW/2)
DD=(CD-TCF)/2.
QC=CC/2
```

```
QD=DD/2
CC=CC+X0
QC=QC+X0
*STAT
C***
R,2,CC,DD,0,QC,DD,TCF                   * STIF24 REAL PROP. - C8X11.5
RMORE,X0,DD,TCF,X0,QD,TCW
RMORE,X0,0,TCW,X0,-QD,TCW
RMORE,X0,-DD,TCW,QC,-DD,TCF
RMORE,CC,-DD,TCF
C***
R3=(.0207*1.2)/1.5
R4=(.0198*1.2)/1.5
R,3,R3,R3,R3                      * CONDUIT
R,4,R4,R4,R4                      * CONDUIT
R,5,100,1000,1000                 * RIGID LINK
C***
K1=10000000  * SIMULATE A FIXED SUPPORT
GAP=(1/16)
FSL=0
R,7,K1,,,GAP,FSL                  * COMB. ELEMENT
C***
C*** NODES AND COORDINATES
X1=22    $X2=59    $Y1=23    $Y2=49
N,1,0,0
N,101,-1,0
N,2,X1,0
N,20,X1,0,5
N,102,X1,0
N,3,X2,0
N,103,X2,0
N,303,X2,0,-5
N,4,93,0
N,104,94,0
N,5,X1,Y1
N,105,X1,Y1
N,6,X2,Y1
N,106,X2,Y1
N,7,0,Y2
N,107,-1,Y2
N,8,X1,Y2
N,80,X1,Y2,5
N,108,X1,Y2
N,9,X2,Y2
N,109,X2,Y2
N,309,X2,Y2,-5
N,10,93,Y2
N,110,94,Y2
FILL,1,2,2,11,1
FILL,2,3,3,21,1
FILL,3,4,3,31,1
FILL,7,8,2,71,1
FILL,8,9,3,81,1
1
             ***********  ANSYS INPUT DATA LISTING (FILE18)  **********

FILL,9,10,3,91,1
C***
C*** ELEMENT CONNECTIVITIES
C***
MAT,2    $TYPE,2    $REAL,2
EN,1,1,11,20        $EN,11,11,12,20    $EN,12,12,2,20
EN,2,2,21,20        $EN,21,21,22,20    $RP2,1,1,1        $EN,23,23,3,20
EN,3,3,31,20        $EN,31,31,32,20    $RP2,1,1,1        $EN,33,33,4,20
MAT,3
EN,7,7,71,80        $EN,71,71,72,80    $EN,72,72,8,80
EN,8,8,81,80        $EN,81,81,82,80    $RP2,1,1,1        $EN,83,83,9,80
EN,9,9,91,80        $EN,91,91,92,80    $RP2,1,1,1        $EN,93,93,10,80
C***
MAT,4  $TYPE,1   $REAL,5          * RIGID LINK
EN,303,3,303
EN,309,9,309
C***
MAT,4  $TYPE,3
```

```
REAL,3   $EN,503,303
REAL,4   $EN,509,309
C***
MAT,1    $TYPE,1   $REAL,1
E,102,5
E,5,108
E,103,6
E,6,109
E,105,106
C***         COMBINATION ELEMENTS
TYPE,4   $REAL,7
EN,104,4,104
EN,110,10,110
C***
C*** COUPLED DOFS FOR MEMBER JOINT RELEASE
CP,1,UX,102,2
CPLGEN,1,UY,UZ            * SETS 2-3   NODE2
CPSGEN,2,1,1,3            * SETS 4-6   NODE3
CPSGEN,2,3,1,3            * SETS 7-9
CPLGEN,9,ROTX             * SET  10    NODE5
CPSGEN,2,4,1,3            * SETS 11-13  NODE6
CPSGEN,2,6,1,3            * SETS 14-16
CPLGEN,16,ROTY            * SET  17     NODE8
CPSGEN,2,1,14,17          * SETS 18-21  NODE9
C*** BOUNDARY CONDITIONS
*CREAT,BND
DDELE,ALL,ALL
D,1,UY,,,,,UZ
D,4,UY,,,,,UZ,ROTX
D,7,UY,,,,,UZ
D,10,UY,,,,,UZ,ROTX
D,104,ALL
D,110,ALL
C***
DDX=ARG1
D,1,UX,-DDX
C*** D,4,UX,DDX
D,7,UX,-DDX
C*** D,10,UX,DDX
*END
*USE,BND,0
C*** ANALYSIS OPTIONS
1
           ***********  ANSYS INPUT DATA LISTING (FILE18)  ***********

ITER,-20,20
TREF,70
POSTR,,2,5
C*** PLOTS - GEOMETRY W/B.C.
/SHOW
/VIEW,,0,0,1
/PNUM,NODE,1
EPLO
/SHRINK,0.3
/PNUM,NODE,-1
/PNUM,ELEM,1
EPLO
/PNUM,ELEM
/PBC,ALL,1
EPLO
/VIEW,,1,1,1
EPLO
C*** LOADING CASES
C***
C***  PIPE FPL
F,3,FX,-.003,,23,20
F,3,FZ,-.307,,23,20
F,3,MX,5.749,,23,20
F,3,MZ,.06,,23,20
C***
*CREAT,MAC
TUNIF,ARG1
LWRITE
*END
```

```
C***
C*** FOR AX11 AT ELE, 713'-0",
C*** PEAK ACCEL.(G): NS=1.4, EW=1.65, VT=0.38
C*** FACTOR: MMF=1.5
MMF=1.5  $GX=MMF*1.65  $GY=MMF*1.65  $GZ=MMF*0.38
C***
C*** DL+SSE XZ-PLANE
ACEL,-GX,0,GZ+1
*USE,MAC,70
C***
C*** DL+SSE YZ-PLANE
ACEL,,-GY,GZ+1
*USE,MAC,70
RP15,,10
C***
C***   *USE,BND,(1/32)
C***   *USE,MAC,150
C***   RP7,,10
AFWRITE,,1
FINISH
/INPUT,27
FINISH
/POST1
/SHOW
NLINE,200
*CREAT,PRF
SET,ARG1
PRRFOR
PRDISP
PLDISP
PLDISP,1
1
               ***********  ANSYS INPUT DATA LISTING (FILE18)  ***********

*END
*USE,PRF,1
*USE,PRF,16
/VIEW,,1,1,1
PLDISP
PLDISP,1
FINISH
C***
/POST26
/SHOW
NUMVAR,50
TVAR,1
C***
ESTR,2,1,53,TEMP          * TEMPERATURE
*CREATE,STRN
C*** STORE STRAINS FOR CHANNEL
ESTR,3,ARG1,215,EE01
ESTR,4,ARG1,216,EP01
ESTR,5,ARG1,227,EE03
ESTR,6,ARG1,228,EP03
ESTR,7,ARG1,251,EE07
ESTR,8,ARG1,252,EP07
ESTR,9,ARG1,263,EE09
ESTR,10,ARG1,264,EP09
PRVAR,2,3,4,5,6
PRVAR,2,7,8,9,10
*END
C***
*CREAT,DSP
DISP,21,ARG1,UX,UX
DISP,22,ARG1,UY,UY
DISP,23,ARG1,UZ,UZ
PROD,24,21,21,,UXUX
PROD,25,22,22,,UYUY
PROD,26,23,23,,UZUZ
ADD,27,24,25,26,SS
SQRT,28,27,,,SRSS
PRVAR,2,21,22,23,28
*END
*USE,STRN,2
```

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT C
SHEET 5 OF 7

```
 281   *USE,DSP,21
 282   *USE,STRN,21
 283   *USE,DSP,22
 284   *USE,STRN,22
 285   *USE,DSP,23
 286   *USE,STRN,23
 287   *USE,DSP,3
 288   *USE,STRN,8
 289   *USE,DSP,81
 290   *USE,STRN,81
 291   *USE,DSP,82
 292   *USE,STRN,82
 293   *USE,DSP,83
 294   *USE,STRN,83
 295   *USE,DSP,9
 296   /COM   STIF40
 297   *CREAT,ST40
 298   ESTR,41,ARG1,3,STR1
 299   ESTR,42,ARG1,4,STR2
 300   ESTR,43,ARG1,5,UI
1
              ***********  ANSYS INPUT DATA LISTING (FILE18)  ***********

 301   ESTR,44,ARG1,6,UJ
 302   ESTR,45,ARG1,7,SLIDE
 303   ESTR,46,ARG1,8,STAT
 304   ESTR,47,ARG1,9,OSTA
 305   ESTR,48,ARG1,10,KCON
 306   PRVAR,2,41,42,43,44
 307   PRVAT,2,45,46,47,48
 308   *END
 309   *USE,ST40,104
 310   *USE,ST40,110
 311   FINISH
1           ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.3     A 10   CDC-TVA          JAN 1,1987
    ANSYS(R)  COPYRIGHT(C) 1971, 1978, 1982, 1983, 1985, 1987  SWANSON ANALYSIS SYSTEMS, INC. AS AN UNPUBLISHED WORK.
    PROPRIETARY DATA - UNAUTHORIZED USE, DISTRIBUTION OR DUPLICATION IS PROHIBITED.  ALL RIGHTS RESERVED.
    FOR SUPPORT CALL CDC               PHONE                    TWX

 TITLE                                                                   12.6392  AUG 27,1991 CP=       .485

        ***** ANSYS ANALYSIS DEFINITION (PREP7) *****

NEW TITLE=  AX11G - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"


 BRANCH/PROJECT ID = WCG-1-969

 PREPARED BY SAL   8/13/91
 CHECKED BY J. OU  8/13/91

  FOR COMPARISON BETWEEN USING GAP ELEM. AND IMPOSED DISP.
  (USE STIF40 / GAP AT SUPPORTS)

  INPUT   = AX11G
  OUTPUT  = AX11GR
  FILE12  = AX11GF
  PLOT    = AX11GP


C*** ANSYS ANALYSIS OPTIONS AND REFERENCES


ANALYSIS TYPE=  0   (STATIC ANALYSIS)

LARGE DEFLECTION SOLUTION (KAY(6)=1)

NON-LINEAR ANALYSIS - SUPPLY NON-LINEAR PROPERTIES

REFERENCE TEMPERATURE=  70.000  (TUNIF=  70.000)

C*** ELEMENT TYPE AND MATERIAL PROPERTIES
```

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT C
SHEET 6 OF 7

```
  ANSYS(R)  COPYRIGHT(C) 1971, 1978, 1982, 1983, 1985, 1987  SWANSON ANALYSIS SYSTEMS, INC. AS AN UNPUBLISHED WORK.
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  FOR SUPPORT CALL CDC                   PHONE                    TWX

AX11G - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"            12.6508  AUG 27,1991 CP=     36.067

       ***** POST1 REACTION FORCE LISTING *****

LOAD STEP    16  ITERATION=    20  SECTION=  1
TIME=    0.0000          LOAD CASE=  1

THE FOLLOWING X,Y,Z FORCES ARE IN NODAL COORDINATES

  NODE       FX             FY             FZ             MX             MY             MZ
    1    15.055076     -1.2048088      1.0694231
    4                  -1.2946975      1.0960269     -10.275500
    7    16.972626     -.90209648      .55390644
   10                  -.78326678      .54928806      .18449400
  104   -15.049075      0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
  110   -16.972627      0.0000000      0.0000000      0.0000000      0.0000000      0.0000000

TOTAL    .60000189E-02 -4.1848695      3.2686445     -10.091006      0.0000000      0.0000000

PRINT NODAL DISPLACEMENTS
1           ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.3      A 10   CDC-TVA           JAN 1,1987
  ANSYS(R)  COPYRIGHT(C) 1971, 1978, 1982, 1983, 1985, 1987  SWANSON ANALYSIS SYSTEMS, INC. AS AN UNPUBLISHED WORK.
  PROPRIETARY DATA - UNAUTHORIZED USE, DISTRIBUTION OR DUPLICATION IS PROHIBITED.  ALL RIGHTS RESERVED.
  FOR SUPPORT CALL CDC                   PHONE                    TWX

AX11G - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"            12.6508  AUG 27,1991 CP=     36.078

       ***** POST1 NODAL DISPLACEMENT LISTING *****

LOAD STEP    16  ITERATION=    20  SECTION=  1
TIME=    0.0000          LOAD CASE=  1

THE FOLLOWING X,Y,Z DISPLACEMENTS ARE IN NODAL COORDINATES

 NODE       UX             UY             UZ             ROTX           ROTY           ROTZ
    1   0.0000000      0.0000000      0.0000000      .33684710     -.91101187E-02  .19805316E-01
    2   .13284711E-01  .36941251      .22211774      .31028197     -.81796650E-02  .14353111E-01
    3   .41295400E-01  .49915962      .39289535      .26562120     -.26967710E-02 -.79102870E-02
    4   .62501505E-01  0.0000000      0.0000000      0.0000000      .30774802E-02 -.20930898E-01
    5   .95104981E-02  .39115152      .98131041E-01 -.53781952E-02  .81412958E-03  .20582988E-04
    6   .44698745E-01  .52035678      .18391982     -.90698438E-02 -.25478280E-03 -.56095217E-05
    7   0.0000000      0.0000000      0.0000000     -.97179568E-02  .12664394E-02  .21009426E-01
    8   .13070695E-01  .41569979     -.41610257E-01 -.20797859E-01  .81655014E-03  .14882771E-01
    9   .40724503E-01  .54429379     -.51893616E-01 -.19389094E-01 -.25627922E-03 -.84131043E-02
   10   .62501697E-01  0.0000000      0.0000000      0.0000000     -.10297491E-02 -.20190966E-01
   11   .41960892E-02  .13540926      .76576526E-01  .32641901     -.91252533E-02  .19065666E-01
   12   .85812173E-02  .26099522      .15165265      .31751885     -.87964233E-02  .17192083E-01
   21   .19749639E-01  .47199529      .30120954      .30421399     -.70673511E-02  .96666456E-02
   22   .26726643E-01  .52777533      .36576637      .30152883     -.57037697E-02  .41167441E-02
   23   .33970430E-01  .53101189      .41397775      .30256251     -.42422974E-02 -.18105459E-02
   31   .47542223E-01  .43453958      .30992312      .19670367     -.11012726E-02 -.13075150E-01
   32   .53159016E-01  .32253036      .21449552      .12998108      .39187086E-03 -.17376679E-01
   33   .58087126E-01  .17273163      .11030570      .64649701E-01  .17632624E-02 -.20197217E-01
   71   .40938538E-02  .15223313     -.15762598E-01 -.14147984E-01  .11496242E-02  .20276553E-01
   72   .84018558E-02  .29392251     -.29802543E-01 -.17862873E-01  .99863940E-03  .18171346E-01
   81   .19542765E-01  .52948121     -.51925428E-01 -.22774845E-01  .56387845E-03  .95796673E-02
   82   .26515243E-01  .59073063     -.57243000E-01 -.23244024E-01  .29328285E-03  .35960744E-02
   83   .33690575E-01  .59545478     -.57219278E-01 -.22120017E-01  .16376038E-04 -.25698196E-02
   91   .46815721E-01  .45227589     -.43633459E-01 -.16223693E-01 -.48741525E-03 -.13122252E-01
   92   .52434774E-01  .32406009     -.31806213E-01 -.11862234E-01 -.69622625E-03 -.16869776E-01
   93   .57607050E-01  .16922275     -.17057607E-01 -.64232105E-02 -.87771515E-03 -.19323451E-01
  102   .13284711E-01  .36941251      .22211774     -.53898013E-02  .81526660E-03  .23232819E-03
  103   .41295400E-01  .49915962      .39289535     -.90814528E-02 -.25670009E-03 -.21721329E-03
  104   0.0000000      0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
  105   .95104981E-02  .39115152      .98131041E-01 -.53781952E-02 -.23215148E-02  .36210506E-02
  106   .44698745E-01  .52035678      .18391982     -.53775235E-02 -.23300390E-02  .33438588E-02
  108   .13070695E-01  .41569979     -.41610257E-01 -.53645441E-02  .81655014E-03 -.21881236E-03
  109   .40724503E-01  .54429379     -.51893616E-01 -.90561924E-02 -.25627922E-03  .23364654E-03
  110   0.0000000      0.0000000      0.0000000      0.0000000      0.0000000      0.0000000
  303   .59871108E-01  1.8128959      .56363078      .26562121     -.26967709E-02 -.79102869E-02
```

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT C
SHEET 7 OF 7

```
   309    .41599177E-01   .44725731      -.55754795E-01  -.19389076E-01  -.25627922E-03  -.84131043E-02

 MAXIMUMS
 NODE        10           303            303              1              11               7
 VALUE    .62501697E-01  1.8128959      .56363078       .33684710      -.91252533E-02   .21009426E-01

 PRODUCE DISPLACEMENT PLOT, KUND= 0

 CUMULATIVE PLOT NUMBER    7 WRITTEN TO FILE FILE33_DAT    - RASTER MODE.
 PLOT TITLE=  AX11G - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"

 PRODUCE DISPLACEMENT PLOT, KUND= 1

 CUMULATIVE PLOT NUMBER    8 WRITTEN TO FILE FILE33_DAT    - RASTER MODE.
 PLOT TITLE=  AX11G - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"

 VIEW POINT FOR WINDOW  1  1.0000       1.0000       1.0000

 PRODUCE DISPLACEMENT PLOT, KUND= 0

 CUMULATIVE PLOT NUMBER    9 WRITTEN TO FILE FILE33_DAT    - RASTER MODE.
 PLOT TITLE=  AX11G - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"

 PRODUCE DISPLACEMENT PLOT, KUND= 1

 CUMULATIVE PLOT NUMBER   10 WRITTEN TO FILE FILE33_DAT    - RASTER MODE.
 PLOT TITLE=  AX11G - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"


 ***** ROUTINE COMPLETED *****  CP =        36.292

 C***

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  AX11G - EVAL. FOR AXIAL CASE 1-11, DWG. 48N1210-16, EL. 713'-0"               12.6511  AUG 27,1991 CP=     36.294


         ***** GENERAL GRAPH POSTPROCESSOR (POST26) *****

 ALL POST26 SPECIFICATIONS ARE RESET TO INITIAL DEFAULTS

 /SHOW SWITCH PLOTS TO FILE FILE33_DAT   -  RASTER MODE.

 MAXIMUM NUMBER OF VARIABLES= 50

 USE NCUMIT AS TIME VARIABLE

 C***


 VARIABLE  2  IS ELEMENT     1  ITEM  53  NAME= 1    TEMP

 START COPY FROM INPUT TO  STRN      EXT=

 C*** STORE STRAINS FOR CHANNEL


 END FILE CREATE

 C***


 START COPY FROM INPUT TO  DSP       EXT=

 END FILE CREATE

 VARIABLE  3  IS ELEMENT     2  ITEM 215  NAME= ARG1 EE01

 VARIABLE  4  IS ELEMENT     2  ITEM 216  NAME= ARG1 EP01
```

BRANCH PROJECT I.D.

WCG-1-969

ATTACHMENT D

SHEET 1 OF 7

```
1
            *********** ANSYS INPUT DATA LISTING (FILE18) ***********

 /PREP7
 /TITLE, PR8G1 - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP 4
 /COM
 /COM   BRANCH/PROJECT ID : WCG-1-969
 /COM
 /COM   PREPARED BY : SAL    8/15/91
 /COM   CHECKED BY J. OU     8/15/91
 /COM
 /COM     FOR COMPARISON BETW. USING GAP ELEMENT AND IMPOSED DISP.
 /COM      USE GAPS ON BOTH NODE 1 AND 9
 /COM      ONE LOAD STEP BEFORE GAPS CLOSE
 /COM
 /COM   INPUT:   PR8G1
 /COM   OUTPUT:  PR8G1R
 /COM   FILE12:  PR8G1F
 /COM   PLOT:    PR8G1P
 /COM
 C*** ANSYS ANALYSIS OPTIONS AND REFERENCES
 KAN,0
 KAY,6,1
 KNL,1
 TREF,70
 C*** ELEMENT TYPE AND MATERIAL PROPERTIES
 ET,1,24,,,,,,1
 ET,2,4,,,,,,1
 ET,3,14,,1
 ET,4,40,,,2    * DOF=Y
 C*** MATERIAL PROPERTIES
 EX,1,29000
 RP3,1
 ALPX,1,6.5E-6
 RP3,1
 C***
 DENS,1,0.92E-3
 DENS,2,0.70E-3
 DENS,3,(0.283E-3+2.95E-3)
 DENS,4,0.283E-3
 C***
 MPTEMP,1,70,100,200,300,400
 RP4,1
 MPDATA,EX,1,1,29.0E3,28.9E3,28.3E3,27.9E3,27.4E3
 RP4,,1
 MPDATA,ALPX,1,1,6.50E-6,6.50E-6,6.50E-6,6.67E-6,6.86E-6  * ALPX=6.29 MU FOR 100F
 RP4,,1
 C*** NONLINEAR MATERIAL CONSTANT
 *CREAT,MNL
 NL,ARG1,13,10
 NL,ARG1,19,70,100,200,300,400
 NL,ARG1,25,36,36.0,36.0,36.0,36.0
 NL,ARG1,31,150,150,150,150,150
 *END
 *USE,MNL,1
 *USE,MNL,2
 *USE,MNL,3
 C*** MEMBER CROSS SECTIONAL PROPERTIES
 R,1,3.54,8.0,8.0,4.0,4.0         * TS4X4X.25
 R,2,1.44,1.24,1.24,3,3,          * L3X3X.25
 RMORE,,0.03
 C***
 K1=(400*4)        * SAL  7/31/91
1
            *********** ANSYS INPUT DATA LISTING (FILE18) ***********

 C***  GAP=(1/32)
 GAP=(1/32)                       * SAL 8/14/91
 FSL=(20.8*4)
 R,8,K1,,,GAP,FSL          * NODE 1
 C***   GAP=0
 R,5,K1,,,GAP,FSL          * NODE 9
 C***
```

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT D
SHEET 2 OF 7

```
BF=4          * WIDTH
D=4           * DEPTH
TW=0.25       * WALL THICKNESS
C***
AA=(BF-TW)/2
BB=(D-TW)/2
QA=AA/2
QB=BB/2
*STAT
R,3,AA,BB,0,QA,BB,TW                          *STIF24 REAL PROP. - TS
RMORE,0,BB,TW,-QA,BB,TW
RMORE,-AA,BB,TW,-AA,QB,TW
RMORE,-AA,0,TW,-AA,-QB,TW
RMORE,-AA,-BB,TW,-QA,-BB,TW
RMORE,0,-BB,TW,QA,-BB,TW
RMORE,AA,-BB,TW,AA,-QB,TW
RMORE,AA,0,TW,AA,QB,TW
RMORE,AA,BB,TW
C***
*CREATE,ANGL
D=ARG2               * D=DEPTH          *
AF=ARG3              * AF=FLANGE        * ANGLE  L D X AF X TAW
TAW=ARG4             * TAW=THICKNESS    *
XBR=ARG5             * XBAR=CENTROID X  FROM AISC
YBR=ARG6             * YBAR=CENTROID Y
C***                           *                      ARG7=0 OR DEFAULT CASE
XX=AF-(TAW/2)                  *    *4  *3  *2   *1
YY=D-(TAW/2)                   *                      FOR ANGLE SHOWN LEFT
X0=XBR-(TAW/2)                 *    *5  CG(XBAR,YBAR)  WHERE
Y0=YBR-(TAW/2)                 *                      FLANGE IS ON RIGHT OF
XX=XX-X0                       *    *6                WEB
YY=YY-Y0                       *
MX=XX/2                        *    *7
MY=YY/2                        *
*IF,ARG7,LE,1,:RAN
X=-XX    $X0=-X0    $MX=-MX       * CHN SIGN FOR FLANGE ON LEFT OF WEB
:RAN
R,ARG1,XX,Y0,0,MX,Y0,TAW
RMORE,0,Y0,TAW,-X0,Y0,TAW
RMORE,-X0,0,TAW,-X0,-MY,TAW
RMORE,-X0,-YY,TAW
*END
*USE,ANGL,4,3,3,0.25,0.842,0.842,1   * L3X3X1/4    LEFT  FLANGE
C*** NODAL COORDINATES
N,1,0,62
N,101,0,64             $NDD=300
N,2,6.5,61             $FILL,1,2,1,NDD+11,1
N,102,6.5,61
N,202,6.5,61
N,3,43,56              $FILL,2,3,8,NDD+21,1
N,103,43,56
N,4,50,55              $FILL,3,4,1,NDD+31,1
N,5,22,38
1
            ***********  ANSYS INPUT DATA LISTING (FILE18)  **********

N,6,6.5,37
N,106,6.5,37
N,7,6.5,18
N,8,25,12
N,108,25,12
N,208,25,12
N,9,0,0                                         $FILL,2,6,5,NDD+65,1
N,109,0,-2                                      $FILL,6,7,5,NDD+75,1
N,10,6.5               $FILL,9,10,1,NDD+91,1    $FILL,7,10,5,NDD+105,1
N,11,26.5 -            $FILL,10,11,4,NDD+101,1
N,12,31                $FILL,11,12,1,NDD+111,1
N,99,6.5,61,100
N,100,6.5,0,100
C*** ELEMENT CONNECTIVITIES
MAT,1   $TYPE,1   $REAL,3    * TS4X4X.25
EN,1,1,311,99        $,311,311,2,99
EN,2,2,321,99        $,321,321,322,99    $RP7,1,1,1   $EN,328,328,3,99
EN,3,3,331,99        $,331,331,4,99
```

```
MAT,2
EN,12,9,391,100      $,391,391,10,100
EN,13,10,401,100     $,401,401,402,100  $RP3,1,1,1   $EN,404,404,11,100
EN,14,11,411,100     $,411,411,12,100
C***
MAT,4   $TYPE,2   $REAL,2     * L3X3X.25
EN,4,2,5
EN,5,3,5
EN,6,6,5
C***
MAT,3   $TYPE,1   $REAL,4     * L3X3X.25
EN,7,2,365,100       $,365,365,366,100  $RP4,1,1,1   $EN,369,369,6,100
EN,8,6,375,100       $,375,375,376,100  $RP4,1,1,1   $EN,379,379,7,100
EN,9,7,405,100       $,405,405,406,100  $RP4,1,1,1   $EN,409,409,10,100
C***
MAT,4   $TYPE,2   $REAL,2     * L3X3X.25
EN,10,7,8
EN,11,11,8
C***
C*** SPRING (STIF40)
TYPE,4   $REAL,8       * SPRING Y
EN,15,1,101
REAL,5
EN,16,109,9
C***
C*** BOUNDARY CONDITIONS
C***
D,1,UX,,,9,8,UZ,ROTX    * SAL  7/12/91
D,4,UY,,,12,8        * SAL  7/15/91
D,101,ALL
D,109,ALL
C***
C***  SPECIFY ROTATIONAL SPRINGS
PSPRING,1,ROT,12282,,2       * ROTY
PSPRING,1,ROT,23598,,,2      * ROTZ
PSPRING,9,ROT,7475,,2        * ROTY
PSPRING,9,ROT,19965,,,2      * ROTZ
C***
C*** ANALYSIS OPTIONS
ITER,-20,20
TREF,70
POSTR,,1,5
1
            ***********  ANSYS INPUT DATA LISTING (FILE18)  ***********

C*** PLOT GEOMETRY AND BOUNBARY CONDITIONS
/SHOW
/PNUM,NODE,1
EPLO
/SHRINK,0.3
/PNUM,NODE,-1
/PNUM,ELEM,1
EPLO
/PBC,ALL,1
/PNUM,ELEM,-1
EPLO
C*** LOADING CASES
C*** TEMPERATURE LOADS *** *
*CREAT,MAC
TUNIF,ARG1
LWRITE
*END
C***
C*** PEAK ACCEL.(G): NS=3.5  EW=3.25  VT=1.4
C*** FACTOR: MMF=1.5
MMF=1.5  $GX=MMF*3.5   $GY=MMF*3.5   $GZ=MMF*1.4
C***
C*** DL+SSE XZ-PLANE
C*** ACEL,-GX,0,GZ+1
C*** *USE,MAC,70
C***
C*** DL+SSE YZ-PLANE
ACEL,,-GY,GZ+1        * SAL  7/15/91
C*** *USE,MAC,70
```

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT D
SHEET 4 OF 7

```
C*** D,101,UY,(1/32)         * SAL  7/24/91
C*** D,109,UY,(-1/32)
C***
*USE,MAC,210
RP12,,10
*USE,MAC,327
C***
AFWRITE,,1
FINISH
/INPUT,27
FINISH
/POST1
/SHOW
NLINE,200
*CREAT,PLD
SET,ARG1
PRRFOR
PRDISP
PLDISP
PLDISP,1
*END
*USE,PLD,1
*USE,PLD,13
FINISH
C***
/POST26
LINE,200
NUMVAR,50
TVAR,1
ESTR,2,1,53,TEMP
*CREATE,STRN
1
              ***********  ANSYS INPUT DATA LISTING (FILE18)  ***********

ESTR,3,ARG1,215,EE01
ESTR,4,ARG1,216,EP01
ESTR,5,ARG1,239,EE05
ESTR,6,ARG1,240,EP05
ESTR,7,ARG1,263,EE09
ESTR,8,ARG1,264,EP09
ESTR,9,ARG1,287,EE13
ESTR,10,ARG1,288,EP13
PRVAR,2,3,4,5,6
PRVAR,2,7,8,9,10
*END
C***
*CREAT,DSP
DISP,21,ARG1,UX,UX
DISP,22,ARG1,UY,UY
DISP,23,ARG1,UZ,UZ
PROD,24,21,21,,UXUX
PROD,25,22,22,,UYUY
PROD,26,23,23,,UZUZ
ADD,27,24,25,26,SS
SQRT,28,27,,,SRSS
PRVAR,2,21,22,23,28
*END
C***
*USE,STRN,311
*USE,DSP,2
*USE,STRN,391
*USE,DSP,10
C***
*USE,DSP,1
*USE,DSP,9
C***
*USE,STRN,7
*USE,DSP,365
*USE,STRN,365
*USE,DSP,366
*USE,STRN,366
*USE,DSP,367
*USE,STRN,367
*USE,DSP,368
```

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT D
SHEET 5 OF 7

```
     *USE,STRN,368
     *USE,DSP,369
     *USE,STRN,369
     *USE,DSP,6
     *USE,STRN,8
     *USE,DSP,375
     C***
     *CREAT,RFOR
     RFORC,31,ARG1,FX,RFX
     RFORC,32,ARG1,FY,RFY
     RFORC,33,ARG1,FZ,RFZ
     RFORC,34,ARG1,MX,RMX
     RFORC,35,ARG1,MY,RMY
     RFORC,36,ARG1,MZ,RMZ
     PRVAR,31,32,33,34,35,36
     *END
     *USE,RFOR,1
     *USE,RFOR,101
     *USE,RFOR,413
     *USE,RFOR,9
1
            ***********  ANSYS INPUT DATA LISTING (FILE18)  ***********

     *USE,RFOR,109
     *USE,RFOR,415
     C***
     *CREAT,ST40
     ESTR,41,ARG1,3,STR1
     ESTR,42,ARG1,4,STR2
     ESTR,43,ARG1,5,UI
     ESTR,44,ARG1,6,UJ
     ESTR,45,ARG1,7,SLIDE
     ESTR,46,ARG1,8,STAT
     ESTR,47,ARG1,9,OSTA
     ESTR,48,ARG1,10,KCON
     PRVAR,2,41,42,43,44
     PRVAT,2,45,46,47,48
     *END
     *USE,ST40,15
     *USE,ST40,16
     FINISH
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  TITLE                                                                12.6814  AUG 27,1991 CP=      .494

        ***** ANSYS ANALYSIS DEFINITION (PREP7) *****

 NEW TITLE=  PR8G1 - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP


  BRANCH/PROJECT ID : WCG-1-969

  PREPARED BY : SAL    8/15/91
  CHECKED BY J. OU     8/15/91

   .FOR COMPARISON BETW. USING GAP ELEMENT AND IMPOSED DISP.
    USE GAPS ON BOTH NODE 1 AND 9
    ONE LOAD STEP BEFORE GAPS CLOSE

  INPUT:   PR8G1
  OUTPUT:  PR8G1R
  FILE12:  PR8G1F
  PLOT:    PR8G1P  -


 C*** ANSYS ANALYSIS OPTIONS AND REFERENCES


 ANALYSIS TYPE=  0   (STATIC ANALYSIS)

 LARGE DEFLECTION SOLUTION (KAY(6)=1)
```

```
 FOR LOAD STEP=    13  ITERATION=    20  SECTION=   1
  TIME=   0.00000        LOAD CASE=  1
  TITLE=  PR8G1 - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP

 PRINT REACTION FORCES PER NODE
1             ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.3      A 10   CDC-TVA           JAN 1,1987
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     FOR SUPPORT CALL CDC                PHONE                    TWX

  PR8G1 - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP          12.6931  AUG 27,1991 CP=     35.549

         ***** POST1 REACTION FORCE LISTING *****

  LOAD STEP    13  ITERATION=    20  SECTION=  1
  TIME=    0.0000          LOAD CASE=  1

  THE FOLLOWING X,Y,Z FORCES ARE IN NODAL COORDINATES

    NODE       FX              FY              FZ              MX              MY              MZ
      1    .39634196                       1.0985287      -9.2391064
      4                   -1.4231010
      9   -.39634196                       .70198716       4.0701865
     12                    2.5637629
    101    0.0000000      -13.576338       0.0000000       0.0000000       0.0000000       0.0000000
    109    0.0000000       9.3864149       0.0000000       0.0000000       0.0000000       0.0000000
    412                                                    0.0000000      -18.173587       0.0000000
    413                                                    0.0000000       0.0000000      -35.983550
    414                                                    0.0000000      -7.6299577       0.0000000
    415                                                    0.0000000       0.0000000       8.5199924

 TOTAL     .57180216E-09  -3.0492608       1.8005159      -5.1689198      -25.803545      -27.463557

 PRINT NODAL DISPLACEMENTS
1             ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.3      A 10   CDC-TVA           JAN 1,1987
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     FOR SUPPORT CALL CDC                PHONE                    TWX

  PR8G1 - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP          12.6931  AUG 27,1991 CP=     35.563

         ***** POST1 NODAL DISPLACEMENT LISTING *****

  LOAD STEP    13  ITERATION=    20  SECTION=  1
  TIME=    0.0000          LOAD CASE=  1

  THE FOLLOWING X,Y,Z DISPLACEMENTS ARE IN NODAL COORDINATES

    NODE       UX              UY              UZ              ROTX            ROTY            ROTZ
      1    0.0000000       .39735211E-01   0.0000000       0.0000000       .14796928E-02   .15248559E-02
      2    .12908086E-01   .48526651E-01  -.11163992E-01   .36137257E-03   .18613742E-02   .13109438E-02
      3    .74055557E-01   .15404434E-01  -.99324985E-01   .48770534E-03   .25527004E-02  -.18518054E-02
      4    .84423773E-01   0.0000000      -.11772844       .48770812E-03   .25552903E-02  -.19936275E-02
      5    .25123251E-01  -.18843432E-02  -.53884352E-01   .29865523E-03   .25305078E-02  -.93839907E-03
      6   -.33016237E-02   .14584376E-01  -.13689831E-01  -.39732926E-03   .26325591E-02  -.14685135E-02
      7   -.14880760E-01  -.12577200E-01  -.39494171E-02   .16766035E-03   .18514510E-02   .13475793E-02
      8    .27394063E-01   .87897620E-02  -.35361194E-01  -.50237181E-03   .17421180E-02   .13634989E-02
      9    0.0000000      -.37116509E-01   0.0000000       0.0000000       .10207301E-02  -.42674643E-03
     10    .11480626E-01  -.38852437E-01  -.71859161E-02  -.18942612E-03   .11666963E-02   .16937171E-03
     11    .46909213E-01  -.99846820E-02  -.32497120E-01  -.30593186E-03   .13054160E-02   .21426074E-02
     12    .54828151E-01   0.0000000      -.38385101E-01  -.30579107E-03   .13059292E-02   .22512665E-02
    101    0.0000000       0.0000000       0.0000000       0.0000000       0.0000000       0.0000000
    109    0.0000000       0.0000000       0.0000000       0.0000000       0.0000000       0.0000000
    311    .64810458E-02   .44305174E-01  -.52265068E-02   .18479263E-03   .16941518E-02   .17165543E-02
    321    .20646289E-01   .51718618E-01  -.19303362E-01   .38848481E-03   .20372141E-02   .74979192E-03
    322    .28083961E-01   .52711397E-01  -.28105478E-01   .41134889E-03   .21812414E-02   .22919839E-03
    323    .35244084E-01   .51680230E-01  -.37444992E-01   .43037910E-03   .22964827E-02  -.24575007E-03
    324    .42152762E-01   .48820990E-01  -.47209073E-01   .44599391E-03   .23859625E-02  -.66996523E-03
    325    .48839218E-01   .44350185E-01  -.57297412E-01   .45861539E-03   .24527039E-02  -.10383571E-02
    326    .55335780E-01   .38504974E-01  -.67622210E-01   .46866869E-03   .24997285E-02  -.13458333E-02
    327    .61677869E-01   .31543169E-01  -.78108178E-01   .47658148E-03   .25300568E-02  -.15872992E-02
    328    .67903961E-01   .23743262E-01  -.88692530E-01   .48278335E-03   .25467079E-02  -.17576569E-02
    331    .79257584E-01   .78269974E-02  -.10852473       .48775575E-03   .25549665E-02  -.19576238E-02
```

```
  365    .15448238E-01   .42894097E-01  -.13626651E-01   .39741692E-03   .31027066E-02   .42249356E-03
  366    .14950167E-01   .37250625E-01  -.15682506E-01   .30609863E-03   .39589856E-02  -.33805953E-03
  367    .12027602E-01   .31597790E-01  -.16880058E-01   .13408415E-03   .43826839E-02  -.93842648E-03
  368    .74202639E-02   .25936167E-01  -.16959449E-01  -.71563787E-04   .43283124E-02  -.13469647E-02
  369    .19871410E-02   .20265392E-01  -.15854246E-01  -.26402008E-03   .37556682E-02  -.15332264E-02
  375   -.85428536E-02   .10076225E-01  -.12666846E-01  -.57537445E-03   .33956418E-02  -.14644299E-02
  376   -.13244398E-01   .55608949E-02  -.10947024E-01  -.67182795E-03   .38022357E-02  -.12886460E-02
  377   -.16840257E-01   .10376654E-02  -.88228851E-02  -.66537303E-03   .38485915E-02  -.92931888E-03
  378   -.18732628E-01  -.34937652E-02  -.66553873E-02  -.53574851E-03   .35351892E-02  -.37593278E-03
  379   -.18295885E-01  -.80327760E-02  -.48695603E-02  -.26393645E-03   .28666475E-02   .38055440E-03
  391    .57403588E-02  -.38469318E-01  -.34743046E-02  -.94937338E-04   .11085244E-02  -.33551520E-03
  401    .18570879E-01  -.36779838E-01  -.11978972E-01  -.21241367E-03   .12226025E-02   .84132108E-03
  402    .25658979E-01  -.32301187E-01  -.16963066E-01  -.23556191E-03   .12622611E-02   .13709242E-02
  403    .32744463E-01  -.25979460E-01  -.22077421E-01  -.25886611E-03   .12878392E-02   .17618811E-02
  404    .39827616E-01  -.18362825E-01  -.27269923E-01  -.28232333E-03   .13015025E-02   .20178820E-02
  405   -.10631398E-01  -.16944178E-01  -.51555064E-02   .31905819E-03   .24671846E-02   .17345572E-02
  406   -.53709348E-02  -.21314482E-01  -.64280665E-02   .36174752E-03   .27714307E-02   .18735131E-02
  407    .16384911E-03  -.25689379E-01  -.74725787E-02   .31339070E-03   .27742568E-02   .17745845E-02
  408    .52636700E-02  -.30070219E-01  -.80530705E-02   .19249892E-03   .24920788E-02   .14491328E-02
  409    .92504153E-02  -.34457897E-01  -.79947316E-02   .18292050E-04   .19471157E-02   .90959985E-03
  411    .50868817E-01  -.50535082E-02  -.35440848E-01  -.30582626E-03   .13058650E-02   .22242103E-02
  412                                                    0.0000000       0.0000000       0.0000000
  413                                                    0.0000000       0.0000000       0.0000000
  414                                                    0.0000000       0.0000000       0.0000000
  415                                                    0.0000000       0.0000000       0.0000000

MAXIMUMS
NODE          4               322              4              376             367              12
VALUE    .84423773E-01   .52711397E-01  -.11772844      -.67182795E-03   .43826839E-02   .22512665E-02

PRODUCE DISPLACEMENT PLOT, KUND= 0

CUMULATIVE PLOT NUMBER   6 WRITTEN TO FILE FILE33_DAT   - RASTER MODE.
PLOT TITLE=  PR8G1 - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP

PRODUCE DISPLACEMENT PLOT, KUND= 1

CUMULATIVE PLOT NUMBER   7 WRITTEN TO FILE FILE33_DAT   - RASTER MODE.
PLOT TITLE=  PR8G1 - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP


***** ROUTINE COMPLETED *****  CP =        35.715

C***

1          ANSYS - ENGINEERING ANALYSIS SYSTEM  REVISION 4.3      A 10    CDC-TVA          JAN 1,1987
     ANSYS(R)  COPYRIGHT(C) 1971, 1978, 1982, 1983, 1985, 1987  SWANSON ANALYSIS SYSTEMS, INC. AS AN UNPUBLISHED WORK.
     PROPRIETARY DATA - UNAUTHORIZED USE, DISTRIBUTION OR DUPLICATION IS PROHIBITED.  ALL RIGHTS RESERVED.
     FOR SUPPORT CALL CDC                PHONE                    TWX

 PR8G1 - EVAL. FOR PROXIMITY CASE 8(G), DWG 48N967-1, EL. 774'-0", LOOP         12.6933  AUG 27,1991 CP=     35.717


        ***** GENERAL GRAPH POSTPROCESSOR (POST26) *****

ALL POST26 SPECIFICATIONS ARE RESET TO INITIAL DEFAULTS

NUMBER OF LINES PER PAGE SET TO200

MAXIMUM NUMBER OF VARIABLES= 50

USE NCUMIT AS TIME VARIABLE

VARIABLE  2  IS ELEMENT     1  ITEM  53  NAME= 1    TEMP

START COPY FROM INPUT TO  STRN       EXT=

END FILE CREATE

C***


START COPY FROM INPUT TO  DSP       EXT=
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BRANCH PROJECT I.D. WCG-1-969

ATTACHMENT E
SHEET 1 OF 10

APPENDIX B
Page 1 of 1

WALKDOWN PACKAGE COVERSHEET

WALKDOWN PACKAGE NO. TI-2007/ES1-TH1

Page 1 of 10

WATTS BAR UNIT - 0, 1
MAIN STEEL/PLATFORMS/MISCELLANEOUS STEEL
ENGINEERING WALKDOWN

Building: REACTOR Drawing No. 48H967-1 Rev. 0

Elevation/Location: 774'-0"/ LOOP # 4

Walkdown Team: J. Task Date 7/8/91

Walkdown Team: Z Mazza Date 7/8/91

Accepted by Walkdown Team Coordinator: Z Mazza Date 7/8/91

Revisions To Walkdowns (Sign and Date)

	1	2	3	4
Walkdown by				
Walkdown Verified by				
Walkdown Team Coordinator				

APPENDIX C
Page 1 of 9

ATTACHMENT E
SHEET 2 OF 10

WALKDOWN CHECKLIST
CIVIL CALCULATIONS PROGRAM (STEEL)

Walkdown Package No. TH
Page 2 of 10
Member No. 1 THRU 8

Description of Attribute	Within Established Criteria (Yes/No/NA)	If No, describe deviation	Comments
A. Member Configuration 1. Location	NA J.T. 7/8/91		
2. Orientation			
3. Size			
4. Sweep			
5. Copes			
6. Notches & Cuts			

Preparer: J. Tash Date: 7/8/91
Verifier: [illegible] Date: 7/8/91

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT E
SHEET 3 OF 10

APPENDIX C
Page 2 of 9

TI-2007/ESI-
Walkdown Package No. TH1
Page 3 of 10
Member No. 1 THRU 8

Description of Attribute	Within Established Criteria (Yes/No/NA)	If No, describe deviation	Comments
7. Flame Cut Edges	NA J.T. 7/8/91 ↓		
8. Other Attributes	↓		
B. Connections (Bottom or left connection) 1. Identification of connection	↓ ———	———	"
2. Size	↓		
3. Alterations	↓		

Preparer: J. Trask Date: 7/8/91
Verifier: J. Mejia Date: 7/8/91

ATTACHMENT E
SHEET 4 OF 10

APPENDIX C
Page 3 of 9

TI-2007/ESI-
Walkdown Package No. TH1
Page 4 of 10
Member No. 1 THRU 8

Description of Attribute	Within Established Criteria (Yes/No/NA)	If No, describe deviation	Comments
4. Bolting a. Type	NA J.T. 7/8/91		
b. Size			
c. Number of bolts			
d. Bolt Spacing			
e. Edge Distance			"
f. Locking Devices			
g. Nut Engagement			
h. Washers			
i. Bolt Tightness			
5. Welding a. Weld Existence and Length			
b. Weld Size			
c. Unspecified Welds			

Preparer: J. Trask Date: 7/8/91
Verifier: Date: 7/8/91

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT E
SHEET 5 OF 10

APPENDIX C
Page 4 of 9

TI-2007/ESI-
Walkdown Package No. TH1
Page 5 of 10
Member No. 1 THRU 8

Description of Attribute	Within Established Criteria (Yes/No/NA)	If No, describe deviation	Comments
6. Expansion Anchor Plate Assemblies NOTE Attach a sketch similar to Appendix G and provide all applicable info.	J.T. 7/8/91 NA		
7. Embedded Plate			
8. Clearance at End of Member			
B. Connections(cont'd) (Top or Right Connections) 1. Identification of Connection	________	________	
2. Size			
3. Alterations			

Preparer: J. Trask Date: 7/8/91
Verifier: ________ Date: 7/8/91

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT E
SHEET 6 OF 10

APPENDIX C
Page 5 of 9

TI-2007/ESI-
Walkdown Package No. TH1
Page 6 of 10
Member No. 1 THRU 8

Description of Attribute	Within Established Criteria (Yes/No/NA)	If No, describe deviation	Comments
4. Bolting a. Type	NA J.T. 7/8/91		
b. Size			
c. Number of Bolts			
d. Bolt Spacing			
e. Edge Distance			
f. Locking Devices			
g. Nut Engagement			
h. Washers			
i. Tightness			
5. Welding a. Weld Existence and Length			
b. Weld Size			
c. Unspecified Welds			

Preparer: J. Tash Date: 7/8/91
Verifier: D. Mezzone Date: 7/8/91

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT E
SHEET 7 OF 10

APPENDIX C
Page 6 of 9

TI-2007/ESI-
Walkdown Package No. TH
Page 7 of 10
Member No. 1 THRU

Description of Attribute	Within Established Criteria (Yes/No/NA)	If No, describe deviation	Comments
6. Expansion Anchor Plate Assemblies NOTE Attach a sketch similar to Appendix G and provide all applicable info.	NA J.T. 7/8/91		
7. Embedded Plate	↓		
8. Clearance at End of Member	↓		
C. Miscellaneous Details 1. Location	↓		
2. Size	↓		

Preparer: J. Tosh Date: 7/8/91
Verifier: J. Mozzone Date: 7/8/91

Walkdown Package No. TI-2007/ESI-TH1
Page 8 of 10
Member No. 1 THRU 8

ATTACHMENT E
SHEET 8 OF 10

BRANCH PROJECT I.D.
WCG-1-969

D. Attachments

Type of Support	Tag Number	Location from Bottom of col. or left end	Stiffeners (Yes/No)	Insulation (Yes/No) Thickness	Attachment Point on Beam	Comments
1. Large Bore Pipe Supports (Larger than 2" nominal diameter)	NA J.T. 7/8/91	NA J.T. 7/8/91	NA J.T. 7/8/91	NA J.T. 7/8/91	NA J.T. 7/8/91	
2. Small Bore Pipe Supports (2" nominal diameter and under)						
3. HVAC Supports						
4. Cable Tray Supports						

Preparer: J. Trask Date: 7/8/91
Verifier: J. Moffa Date: 7/8/91

Walkdown Package No. TI-2007/ESI-TH1
Page 9 of 10
Member No. 1 THRU 8

D. Attachments (continued)

Type of Support	Tag Number	Location from Bottom of col. or left end	Stiffeners (Yes/No)	Insulation (Yes/No) Thickness	Attachment Point on Beam	Comments
5. Equipment Supports	NA J.T. 7/8/91	NA J.T. 7/8/91	NA J.T. 7/8/91	NA J.T. 7/8/91	NA J.T. 7/8/91	
6. Conduit Supports						
7. Instrument Line Supports						
8. Other Supports						

Preparer: J. Trash Date: 7/8/91
Verifier: J. Moyano Date: 7/8/91

BRANCH PROJECT I.D.
WCG-1-969

ATTACHMENT 6
SHEET 9 OF 10

BRANCH PROJECT I.D.
WCG-1-969

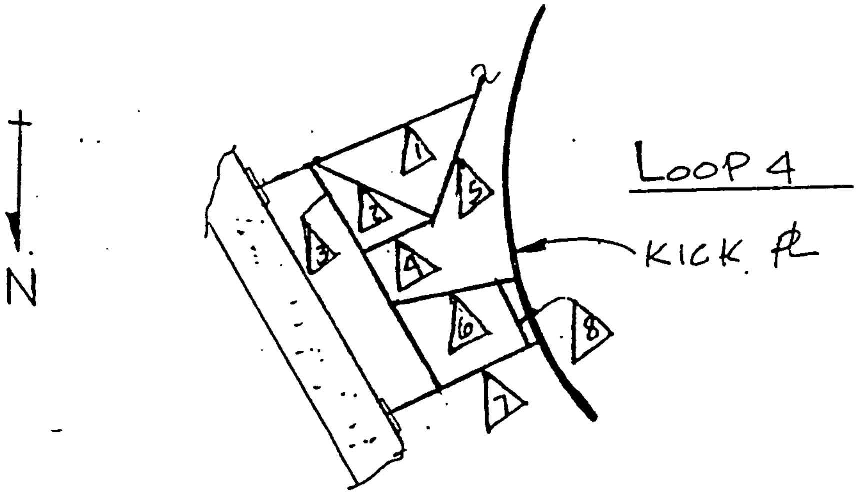
ATTACHMENT E
SHEET 10 OF 10

WBN
TI-2007
Revision 0
Page 22 of 40

APPENDIX C
Page 9 of 9

Walkdown Package No. TI-2007/ES1-7
Page 10 of 10
Member No. 1 THRU 8

CONTINUATION SHEET



PARTIAL PLAN AT EL 774'-0"
(REF DWG. 48N967-1, REV. 1)

NOTE:
"NO DISCREPANCY OF CONFIGURATION IS FOUND BETWEEN DRAWING AND INSTALLED CONDITION"

Preparer: T. Tack Date: 7/8/91
Verifier: J. Mezzera Date: 7/8/91