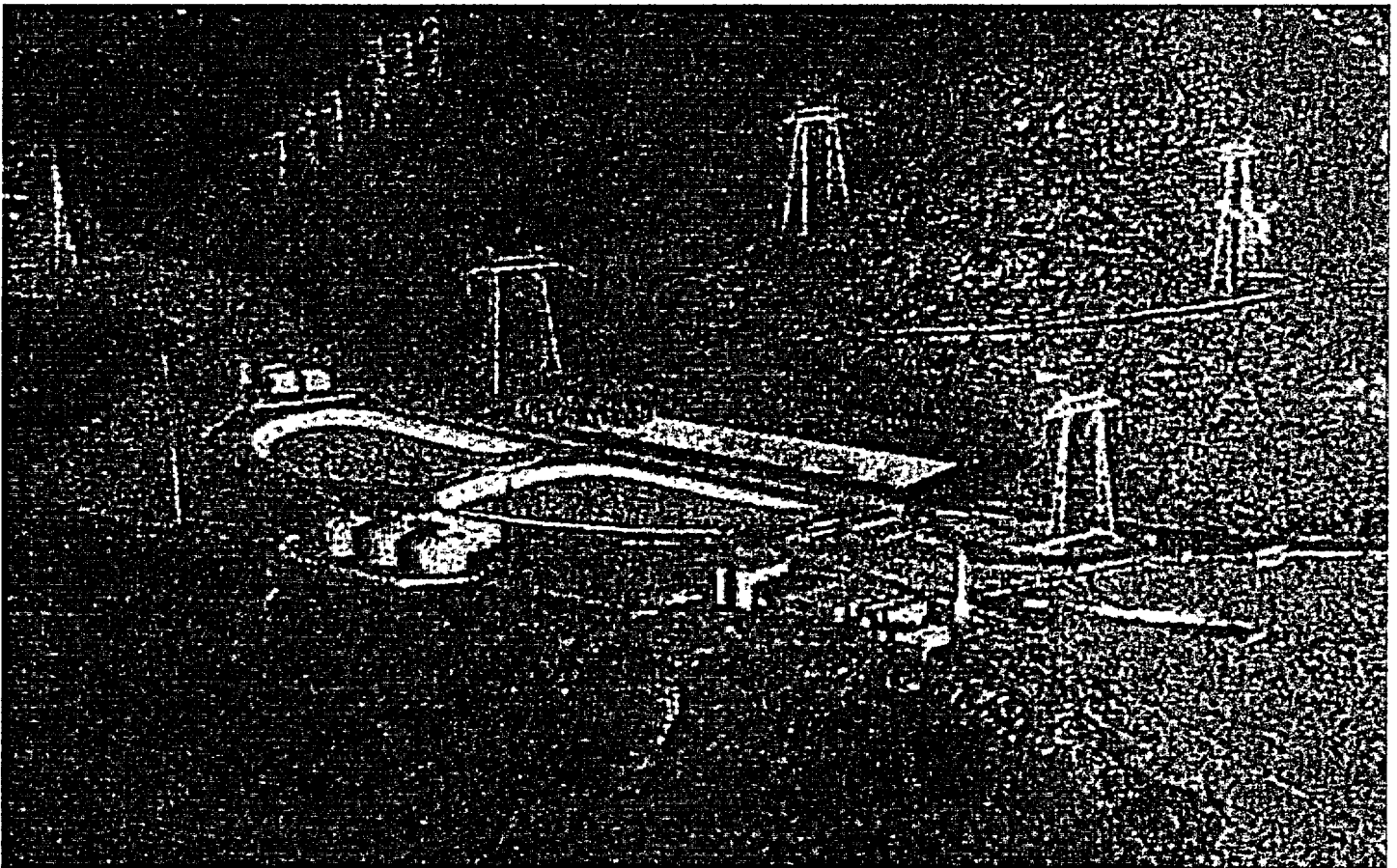


# ATTACHMENT

5-2

**DIABLO CANYON POWER PLANT**  
**INDEPENDENT SPENT FUEL STORAGE INSTALLATION**  
**CALCULATION NO. PGE-009-CALC-006, REV.0**  
**"ISFSI CASK STORAGE PAD**  
**CONCRETE SHRINKAGE AND THERMAL STRESSES"**



**PREPARED BY:**

**ENERCON SERVICES, INC.**  
**400 Valley Road, Suite 104**  
**Mt. Arlington, NJ 07856**

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ENGINEERING CALCULATION COVER SHEET

Calc. No. PGE-009-CALC-006

Rev. 0

Sheet 1 of 55

Title: ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses

Client: PG&E

Job No. PGE-009

Purpose Of Calculation:

The purpose of this calculation is to compute the forces and moments within the storage pad for the temperatures resulting from the heat of hydration during the curing process and from the shrinkage of the concrete. The ISFSI Facility will contain (7) pads, which will support (20) HI-Storm Storage Casks per pad. The results from this Calculation, along with the results from the seismic analysis, Calculation No. PGE-009-CALC-003, will be used in Calculation No. PGE-009-CALC-007 to evaluate the concrete per the design codes and to determine the size of steel reinforcement.

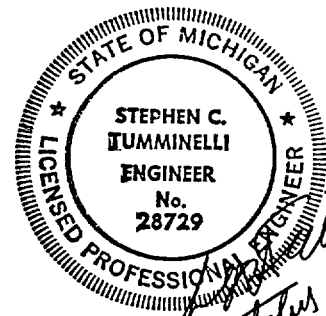
NOTE: This Calculation is furnished as part of PG&E Contract No. 4600010841, Change Order No. 001

Scope Of Revision:

Initial issue.

Revision Impact On Results:

N/A



Handwritten signature and date: Stephen C. Tumminelli, October 2002

- Checked: Safety Related, Preliminary Calculation

- Unchecked: Non-Safety Related
- Checked: Final

Approvals (Print Name and Sign)

Table with 2 columns: Name/Title and Date. Rows include Originator (S.C. TUMMINELLI), Reviewer, Verification Engineer (K.L. WHITMORE), and Approver (R.F. EVERS), all dated September 20, 2002.



**ENGINEERING CALCULATION  
REVISION STATUS SHEET**

**ENERCON SERVICES, INC.**

**CALCULATION NO.            PGE-009-CALC-006**

**ENGINEERING CALCULATION REVISION SUMMARY**

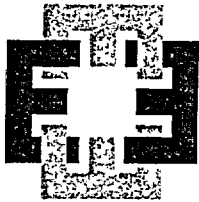
| <u>REVISION NO.</u> | <u>DATE</u> | <u>DESCRIPTION</u> |
|---------------------|-------------|--------------------|
| 0                   | 9/20/02     | Initial Issue      |

**CALCULATION SHEET REVISION STATUS**

| <u>SHEET NO.</u> | <u>REVISION NO.</u> | <u>SHEET NO.</u> | <u>REVISION NO.</u> |
|------------------|---------------------|------------------|---------------------|
| All              | 0                   | N/A              | N/A                 |

**APPENDIX AND ATTACHMENT REVISION STATUS**

| <u>APPENDIX<br/>NUMBER</u> | <u>ISSUE<br/>DATE</u> | <u>REV.<br/>DATE</u> | <u>REISSUE<br/>DATE</u> | <u>APPENDIX<br/>NUMBER</u> | <u>ISSUE<br/>DATE</u> | <u>REV.<br/>DATE</u> | <u>REISSUE<br/>DATE</u> |
|----------------------------|-----------------------|----------------------|-------------------------|----------------------------|-----------------------|----------------------|-------------------------|
| TH-Loads                   | 9/20/02               |                      |                         | SH-Loads                   | 9/20/02               |                      |                         |
| RPad-TH                    | 9/20/02               |                      |                         | RPad-SH                    | 9/20/02               |                      |                         |
| EPad-TH                    | 9/20/02               |                      |                         | EPad-SH                    | 9/20/02               |                      |                         |
| DPad-TH                    | 9/20/02               |                      |                         | DPad-SH                    | 9/20/02               |                      |                         |
| SPad-TH                    | 9/20/02               |                      |                         | SPad-SH                    | 9/20/02               |                      |                         |
| FPad-TH                    | 9/20/02               |                      |                         | FPad-SH                    | 9/20/02               |                      |                         |
| TPad-TH                    | 9/20/02               |                      |                         | FTPad-SH                   | 9/20/02               |                      |                         |
| LSPad-TH                   | 9/20/02               |                      |                         |                            |                       |                      |                         |
| LCPad-TH                   | 9/20/02               |                      |                         |                            |                       |                      |                         |
| STPad-TH                   | 9/20/02               |                      |                         |                            |                       |                      |                         |



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|                 |   |            |                           |    |           |
|-----------------|---|------------|---------------------------|----|-----------|
| JOB. NO.        | <u>PGE-009</u>  | SHEET      | <u>3</u>                  | OF | <u>55</u> |
| PROJECT         | <u>DCPP ISFSI</u>   | DATE       | <u>September 20, 2002</u> |    |           |
| SUBJECT         | <u>ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses</u> |            |                           |    |           |
| CLIENT          | <u>PG&amp;E-DCPP</u>  | ORIGINATOR | <u>S. C. Tumminelli</u>   |    |           |
| REVIEWER        | <u>K. L. Whitmore</u>   | APPROVED   | <u>R. F. Evers</u>        |    |           |
| CALCULATION NO. | <u>PGE-009-CALC-006</u>   | REVISION   | <u>0</u>                  |    |           |

*[Handwritten signatures: K. L. Whitmore and R. F. Evers]*

Method of Review:

The calculation has been independently reviewed in accordance with the requirements of ENERCON Corporate Standard Procedure 3.01. The independent verification of the calculation was performed by a detailed review and check of the entire calculation. This included verification of inputs, methodology, results and conclusions as well as a check of the mathematical accuracy of the computations.

Results:

The calculation has been independently verified to be mathematically correct and to be performed in accordance with license and design basis requirements and applicable codes. Inputs are appropriate and are obtained from verified source documents. The calculation is sufficiently documented and detailed to permit independent verification. No assumptions are made other than conservative simplifying assumptions which are identified and do not require confirmation. The methodology used is appropriate and consistent with the purpose of the calculation.

With the exception of the use of non-linear contact elements between the bottom of the concrete support pad and the surface of the rock, the analysis documented in this calculation is a straightforward, first order linear static analysis. The analysis is performed using ANSYS, a computer analysis code that is in widespread use throughout the nuclear industry and that is known to produce accurate results when utilized appropriately.

The use of the non-linear contact elements has been separately verified in computer verification and validation report PGE-009-VVR-003. These elements are designed to transfer compression loads from the concrete pad to the rock but to not transfer any tension loads across the surface. This allows the pad to lift free from the rock in the model if the loads and geometry indicate that liftoff should occur. As documented in PGE-009-VVR-003, these elements have been shown to produce results that are consistent with theoretical values and hand calculations. Thus, the use of these elements in the analysis produces appropriate results.

Thus, the analysis has been independently verified to be technically correct and to be consistent with license and design basis requirements. The results and conclusions accurately reflect the findings of the calculation.



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**CALCULATION  
DESIGN VERIFICATION  
CHECKLIST**

Calc. No. PGE-009-CALC-006

Rev. 0

Page 3A of 55

Title:

**CHECKLIST ITEMS**

|     |   | YES                                 | NO                       | N/A                                 |
|-----|---|-------------------------------------|--------------------------|-------------------------------------|
| 1.  | <b>Design Inputs</b> - Were the design inputs correctly selected, referenced (latest revision), consistent with the design basis and incorporated in the calculation?                                     | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 2.  | <b>Assumptions</b> - Were the assumptions reasonable and adequately described, justified and/or verified, and documented?   | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 3.  | <b>Quality Assurance</b> - Were the appropriate QA classification and requirements assigned to the calculation?   | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 4.  | <b>Codes, Standard and Regulatory Requirements</b> - Were the applicable codes, standards and regulatory requirements, including issue and addenda, properly identified and their requirements satisfied? | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 5.  | <b>Construction and Operating Experience</b> - Have applicable construction and operating experience been considered?   | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 6.  | <b>Interfaces</b> - Have the design interface requirements been satisfied, including interactions with other calculations?  | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 7.  | <b>Methods</b> - Was the calculation methodology appropriate and properly applied to satisfy the calculation objective?   | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 8.  | <b>Design Outputs</b> - Was the conclusion of the calculation clearly stated, did it correspond directly with the objectives and are the results reasonable compared to the inputs?                       | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |
| 9.  | <b>Radiation Exposure</b> - Has the calculation properly considered radiation exposure to the public and plant personnel?   | <input type="checkbox"/>            | <input type="checkbox"/> | <input checked="" type="checkbox"/> |
| 10. | <b>Acceptance Criteria</b> - Are the acceptance criteria incorporated in the calculation sufficient to allow verification that the design requirements have been satisfactorily accomplished?             | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>            |

Comments: See reviewers comments on page 3.

*(Print Name and Sign)*

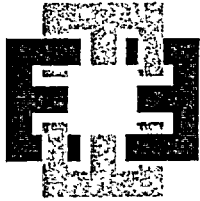
Reviewer: Kenneth L. Whitmore/

Date

09/20/02

Others:

Date



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|                        |   |                   |                           |           |           |
|------------------------|---|-------------------|---------------------------|-----------|-----------|
| <b>JOB. NO.</b>        | <u>PGE-009</u>  | <b>SHEET</b>      | <u>4</u>                  | <b>OF</b> | <u>55</u> |
| <b>PROJECT</b>         | <u>DCPP ISFSI</u>   | <b>DATE</b>       | <u>September 20, 2002</u> |           |           |
| <b>SUBJECT</b>         | <u>ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses</u> |                   |                           |           |           |
| <b>CLIENT</b>          | <u>PG&amp;E-DCPP</u>  | <b>ORIGINATOR</b> | <u>S. C. Tumminelli</u>   |           |           |
| <b>REVIEWER</b>        | <u>K. L. Whitmore</u>   | <b>APPROVED</b>   | <u>R. F. Evers</u>        |           |           |
| <b>CALCULATION NO.</b> | <u>PGE-009-CALC-006</u>   | <b>REVISION</b>   | <u>0</u>                  |           |           |

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| <b>CLIENT</b>          | <u>PG&amp;E-DCPP</u>  | <b>ORIGINATOR</b> | <u>S. C. Tumminelli</u>   |           |           |
| <b>REVIEWER</b>        | <u>K. L. Whitmore</u>   | <b>APPROVED</b>   | <u>R. F. Evers</u>        |           |           |
| <b>CALCULATION NO.</b> | <u>PGE-009-CALC-006</u>   | <b>REVISION</b>   | <u>0</u>                  |           |           |

**Appendices:**

| <b>Thermal Stress Analysis Documentation Appendices:</b> |  | <b>Pages</b> |
|--|--|--------------|
| TH-Loads   | Applied loads  | 6            |
| RPad-TH  | ANSYS file documenting the analyses and temperatures | 55           |
| EPad-TH  | ANSYS file documenting equilibrium                   | 18           |
| DPad-TH  | ANSYS file documenting the displacements             | 13           |
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| STPad-TH   | ANSYS Stress Plots                                   | 12           |

| <b>Shrinkage Stress Analysis Documentation Appendices:</b> |   | <b>Pages</b> |
|--|---|--------------|
| SH-Loads   | Applied loads   | 2            |
| RPad-SH  | ANSYS files documenting the analyses and temperatures                       | 11           |
| EPad-SH  | ANSYS files documenting equilibrium   | 6            |
| DPad-SH  | ANSYS files documenting the displacements                                   | 7            |
| SPad-SH  | ANSYS files documenting the stresses  | 9            |
| FPad-SH  | ANSYS files documenting the internal forces                                 | 13           |
| FTPad-SH   | ANSYS files documenting the internal forces for the top sections of the pad | 25           |



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| CLIENT          | <u>PG&amp;E-DCPP</u>  | ORIGINATOR | <u>S. C. Tumminelli</u>   |    |           |
| REVIEWER        | <u>K. L. Whitmore</u>   | APPROVED   | <u>R. F. Evers</u>        |    |           |
| CALCULATION NO. | <u>PGE-009-CALC-006</u>   | REVISION   | <u>0</u>                  |    |           |

### ISFSI Pad Shrinkage and Thermal Analysis

The purpose of this calculation is to determine the thermal and shrinkage stresses of the ISFSI storage pad and to provide thermal and shrinkage forces and moments. These forces and moments, together with the seismic forces and moments from a previous calculation (Reference 1), will be used to demonstrate that the design is compliant with the ACI Code and to size the pad reinforcement.

This calculation follows the same general format as the seismic calculation (Reference 1) and makes extensive use of the analytical strategies presented there. Consequently, frequent references to that calculation will be made herein.

The storage pad analyzed here is 105 feet N-S by 68 feet E-W and nominally 8 feet thick. The seismic calculation analyzed a 7.5-foot thick pad. That thickness is the thinnest that the pad can be, while 8 feet is the thickest. The surface of the pad is contoured to facilitate drainage, while the bottom is at a constant elevation. In a seismic event the design relies upon the mass of the pad to hold the casks and the pad down to the rock. Hence it is appropriate to use the minimum pad thickness for the seismic analysis, since this minimizes the pad mass. The use of the maximum pad thickness in this calculation is appropriate since this maximizes the applied heat and temperatures within the pad.

The pad will be constructed using a leveling pad or "mud" mat. This "mud" mat will be an unreinforced concrete mat that will be placed upon the prepared rock to provide a level surface that will be used to construct the pad. The thickness of the mat will vary depending upon the constructor's technique to excavate the rock to a level surface. However, since the mat is not explicitly modeled, and since its properties are conservatively bounded by the properties of the rock, regardless of its thickness, the actual constructed thickness of the mat does not affect the results of this calculation.

PG&E (Reference 2) provided the shrinkage and thermal data. The temperature data provided are the internal concrete pad temperatures as a function of time that occur as the heat generated by cement hydration is dissipated through the structure to the ambient. That calculation is for a specific concrete mix as specified by PG&E, and for a pad that is cast all at once, i.e., the underlying assumption is that the 105 by 68 by 8 foot concrete pad is instantaneously installed and begins to heat due to cement hydration. The calculation assumes that all the generated heat dissipates both upward to the concrete surface and then to air, and downward to the underlying rock strata. Heat dissipated out to the sides of the concrete is not considered. However, given the shape of the pad, the heat that may dissipate from the sides will be a small portion of the total and hence negligible. The actual amount of heat that will be dissipated from the sides of the pad will be a function of the type of concrete form, steel or wood, that is used. The steel form will allow more heat dissipation than the wood form but both will have a negligible effect on the pad responses computed here, though very some local and inconsequential stresses on the edges of the pad may arise. The heating transient due to cement hydration lasts for eight days.

The shrinkage strains are a result of the moisture loss and the moisture gradient that is established in the concrete. The shrinkage process is very slow, reaching maximum shrinkage at 117 days, and therefore,



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| SUBJECT         | <u>ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses</u> |            |                           |    |           |
| CLIENT          | <u>PG&amp;E-DCPP</u>  | ORIGINATOR | <u>S. C. Tumminelli</u>   |    |           |
| REVIEWER        | <u>K. L. Whitmore</u>   | APPROVED   | <u>R. F. Evers</u>        |    |           |
| CALCULATION NO. | <u>PGE-009-CALC-006</u>   | REVISION   | <u>0</u>                  |    |           |

does not occur within the same time frame as the heat up due to cement hydration. Hence, the two effects can be considered separately.

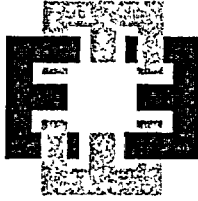
Two separate analyses are performed, one for the thermal stress analysis and one for the shrinkage stress analysis. The thermal stress analysis is performed incrementally. Incremental temperatures at selected times are derived from the pad temperatures from PG&E (Reference 2). These are applied to a finite element model and the Young's modulus of the concrete is adjusted, to account for the strength gain and gain in stiffness, for each of the selected times. The total pad response at a selected time is the sum of all the individual responses up to and including the response at that time. The shrinkage stress analysis is performed in one execution. More detail is provided below.

### References

- 1 ENERCON Calculation PGE-009-CALC-003, ISFSI Cask Storage Pad Seismic Analysis, latest revision.
- 2 PG&E Calculation 52.27.100.701, ISFSI Foundation Pad – Thermal and Shrinkage Values, Rev 2, November 8, 2001
- 3 ACI 207.1R-96, Mass Concrete
- 4 ACI 207.R2-95, Effect of Restraint, Volume Change, and Reinforcement on Cracking of Mass Concrete.

### Temperature Data

The pad temperatures through the thickness with respect to time were provided by PG&E (Reference 2). Numerical data is provided at the top surface (see Sheet 58, Reference 2) and in 0.5 foot increments through the pad thickness and for four feet into the rock beneath the pad, (see Table 3, Reference 2). This same data is provided graphically, see plots in Figures 5, 6 and 7 in Reference 2. These plots were examined and eleven times were selected for analysis. The times were chosen because they produce stresses that reasonably bound the maximum demand on the pad resulting from the distribution of temperatures considering the shapes of the curves relative to one another. The following times were selected and are shown in Table 1 below.



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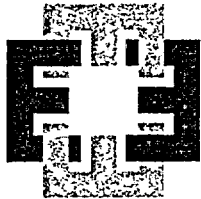
**JOB. NO.** PGE-009 **SHEET** 8 **OF** 55  
**PROJECT** DCPP ISFSI **DATE** September 20, 2002  
**SUBJECT** ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses  
**CLIENT** PG&E-DCPP **ORIGINATOR** S. C. Tumminelli  
**REVIEWER** K. L. Whitmore **APPROVED** R. F. Evers  
**CALCULATION NO.** PGE-009-CALC-006 **REVISION** 0

**Table 1 - Selection of times for Thermal Stress Analysis**

| Time (days) | Discussion  |
|-------------|---|
| 0.25        | Temperature 0.5 feet from the top surface departs from others   |
| 0.50        | Temperature 0.5 feet from the top surface peaks   |
| 0.625       | Temperature 1 foot from the top surface peaks   |
| 1.125       | Temperature 2 feet from the top surface peaks   |
| 1.625       | Temperature 3 feet from the top surface peaks   |
| 2.125       | Temperature 4 feet from the top surface peaks. Temperatures at 6, 7 and 7.5 feet from the top surface at or near peak.  |
| 2.375       | Temperature 5 feet from the top surface peaks. Temperatures at 6, 7 and 7.5 feet from the top surface at or near peak.  |
| 3.125       | Temperatures 4 and 6 feet from the top surface are equal. This is transition point. Beyond this point the temperature 4 feet from the top surface is colder and is cooling more rapidly than the temperature 6 feet from the top surface. |
| 4.125       | Temperature at pad/rock interface peaks   |
| 6.125       | Temperatures through the thickness are declining at the same rate (more or less)  |
| 7.875       | Temperatures through the thickness are declining at the same rate (more or less)  |

The PG&E thermal temperature analysis (Reference 2) and, consequently, the current thermal stress analysis anticipate that the maximum pad forces and moments due to temperature will occur within the first few days of casting the pad. (This will be shown to be true.) This was based, in part, on the discussion provided in Reference 4, Chapters 2 and 2.1. It is especially true for the ISFSI pad because this pad is a high strength mass concrete structure. The concrete has a high proportion of cement and flyash. Therefore, the heat effects and resultant temperatures within the first few days of casting the pad will be the most severe thermal effects the pad will ever experience.

Table 2 provides the temperatures above ambient at the selected times from Table 3 in Reference 2. The PG&E calculation uses a differencing scheme that does not provide temperature values at every depth at every time step. Where that occurred, linear interpolation was used to compute the required value from the data at adjacent depths, holding the time constant. Interpolation from one time to another was not performed.



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**PROJECT** DCPP ISFSI **DATE** September 20, 2002  
**SUBJECT** ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses  
**CLIENT** PG&E-DCPP **ORIGINATOR** S. C. Tumminelli  
**REVIEWER** K. L. Whitmore **APPROVED** R. F. Evers  
**CALCULATION NO.** PGE-009-CALC-006 **REVISION** 0

**Table 2 (1/2) – Pad Temperatures Above Ambient (Degrees F) vs. Time**

| Elevation* | Depth* | Time (days) |       |       |       |       |       |
|------------|--------|-------------|-------|-------|-------|-------|-------|
|            |        | 0.25        | 0.50  | 0.625 | 1.125 | 1.625 | 2.125 |
| 8          | 0.0    | 15.00       | 12.50 | 9.50  | 4.10  | 2.00  | 1.20  |
| 7.5        | 0.5    | 18.00       | 28.50 | 27.15 | 19.71 | 14.21 | 11.15 |
| 7          | 1.0    | 19.67       | 28.92 | 38.24 | 29.43 | 22.97 | 18.91 |
| 6.5        | 1.5    | 21.33       | 29.33 | 42.79 | 39.69 | 34.96 | 31.00 |
| 6          | 2.0    | 21.33       | 38.00 | 47.33 | 49.95 | 46.95 | 43.08 |
| 5          | 3.0    | 21.33       | 46.66 | 55.99 | 70.99 | 73.24 | 71.02 |
| 4          | 4.0    | 21.33       | 46.66 | 55.99 | 76.10 | 83.42 | 84.38 |
| 3          | 5.0    | 21.33       | 46.66 | 55.99 | 76.31 | 84.76 | 87.05 |
| 2          | 6.0    | 21.33       | 46.45 | 55.78 | 73.64 | 79.96 | 81.49 |
| 1          | 7.0    | 20.50       | 41.91 | 51.24 | 63.12 | 66.86 | 67.77 |
| 0.5        | 7.5    | 19.66       | 37.58 | 39.62 | 50.73 | 55.18 | 57.05 |
| 0.0        | 8.0    | 10.67       | 23.33 | 28.00 | 38.33 | 43.49 | 46.32 |
| -0.5       | 8.5    | 1.67        | 9.08  | 16.38 | 25.93 | 31.81 | 35.59 |
| -1         | 9.0    | 0.84        | 4.75  | 4.75  | 13.53 | 20.13 | 24.85 |
| -2         | 10.0   | 0           | 0.21  | 0.21  | 3.02  | 7.00  | 10.82 |
| -3         | 11.0   | 0           | 0     | 0     | 0.35  | 1.73  | 3.71  |
| -4         | 12.0   | 0           | 0     | 0     | 0.01  | 0.26  | 0.79  |

\* See notes after Table 2 (2/2).



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**PROJECT** DCPP ISFSI **DATE** September 20, 2002  
**SUBJECT** ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses  
**CLIENT** PG&E-DCPP **ORIGINATOR** S. C. Tumminelli  
**REVIEWER** K. L. Whitmore **APPROVED** R. F. Evers  
**CALCULATION NO.** PGE-009-CALC-006 **REVISION** 0

**Table 2 (2/2) – Pad Temperatures Above Ambient (Degrees F) vs. Time**

| Elevation <sup>1,3</sup> | Depth <sup>2,3</sup> | Time (days) |       |       |       |       |
|--------------------------|----------------------|-------------|-------|-------|-------|-------|
|                          |                      | 2.375       | 3.125 | 4.125 | 6.125 | 7.875 |
| 8                        | 0.0                  | 1.00        | 0.50  | 0.20  | 0.20  | 0.20  |
| 7.5                      | 0.5                  | 10.21       | 8.08  | 6.05  | 4.67  | 3.98  |
| 7                        | 1.0                  | 17.63       | 14.56 | 11.42 | 8.81  | 7.48  |
| 6.5                      | 1.5                  | 29.53       | 25.63 | 21.14 | 16.38 | 13.87 |
| 6                        | 2.0                  | 41.43       | 36.69 | 30.85 | 23.94 | 20.25 |
| 5                        | 3.0                  | 69.51       | 63.91 | 55.57 | 43.79 | 37.21 |
| 4                        | 4.0                  | 83.84       | 79.64 | 71.29 | 57.64 | 49.52 |
| 3                        | 5.0                  | 87.13       | 84.41 | 77.30 | 64.53 | 56.43 |
| 2                        | 6.0                  | 81.58       | 79.73 | 74.40 | 64.58 | 57.83 |
| 1                        | 7.0                  | 67.97       | 67.31 | 64.40 | 58.80 | 54.24 |
| 0.5                      | 7.5                  | 57.68       | 58.32 | 57.13 | 53.77 | 50.39 |
| 0.0                      | 8.0                  | 47.38       | 49.32 | 49.86 | 48.74 | 46.54 |
| -0.5                     | 8.5                  | 37.05       | 40.15 | 42.13 | 42.79 | 41.56 |
| -1                       | 9.0                  | 26.71       | 30.97 | 34.40 | 36.83 | 36.58 |
| -2                       | 10.0                 | 12.55       | 16.94 | 21.12 | 25.18 | 26.03 |
| -3                       | 11.0                 | 4.76        | 7.76  | 10.95 | 14.47 | 15.48 |
| -4                       | 12.0                 | 1.12        | 2.15  | 3.33  | 4.70  | 5.13  |

1. Elevation 0 is the pad/rock interface. Thus, temperatures for elevations below 0 are for the rock. These temperatures were input to the analysis along with a conservatively chosen value for the coefficient of thermal expansion for the rock, i.e., a low value.
2. Depth is the depth below the top surface of the pad.
3. The data in Reference 2 is presented in two ways. The first is in Table 3 where the elevation is referred to as "Depth,ft". This correlates to the Elevation column here. The second is in Figures 5, 6 and 7, where the data is presented in "ft from Top Surface". This is the Depth column here.



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**CLIENT** PG&E-DCPP **ORIGINATOR** S. C. Tumminelli  
**REVIEWER** K. L. Whitmore **APPROVED** R. F. Evers  
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**Shrinkage Data**

Shrinkage data is provided in the form of microstrain through the pad thickness, see Reference 2 Sheet 52. Rather than revise various analytical input mechanisms, the shrinkage strains were converted to temperatures (see Table 3) through the use of the following equivalency:

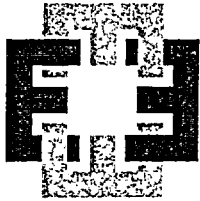
$$\epsilon_{sh} = \alpha \Delta T$$

where:  $\epsilon_{sh}$  is the specified shrinkage strain  
 $\alpha$  is the material coefficient of expansion = 5.18E-6 in/in/degree F  
 $\Delta T$  is the temperature that produces the equivalent shrinkage strain

**Table 3 – Applied Equivalent Shrinkage Temperatures (Degrees F)**

| Elevation * | Equivalency Calculation          |                                    |
|-------------|----------------------------------|------------------------------------|
|             | Specified Shrinkage Micro Strain | Equivalent Temperature (Degrees F) |
| 8           | 463                              | -89.38                             |
| 7.5         | 128                              | -24.71                             |
| 7           | 35                               | -6.76                              |
| 6.5         | 2.2                              | -0.42                              |
| 6           | -12                              | 2.32                               |
| 5           | -23                              | 4.44                               |
| 4           | -25                              | 4.83                               |
| 3           | -25                              | 4.83                               |
| 2           | -25                              | 4.83                               |
| 1           | -25                              | 4.83                               |
| 0.5         | -25                              | 4.83                               |
| 0.0         | -25                              | 4.83                               |

\* Elevation 0 is the pad/rock interface



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| CLIENT          | <u>PG&amp;E-DCPP</u>  | ORIGINATOR | <u>S. C. Tumminelli</u>   |    |           |
| REVIEWER        | <u>K. L. Whitmore</u>   | APPROVED   | <u>R. F. Evers</u>        |    |           |
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### Concrete Properties

As the concrete cures, the strength and consequently, Young's modulus, increase. PG&E provided the relationship of concrete strength with respect to time, see Reference 2, Sheet 49. The Young's moduli used in the analysis are based upon the Mix Design, which is expected to bound the values that will be produced in the structure. Table 4 provides the moduli used in the thermal stress analysis.

The 90-day Mix Design strength is 5600 psi, which results in a Young's modulus of 4.265E6 psi. Following the guidance in Section 3.4.2 of Reference 3, 2/3 of this value = 2.844E6 psi is used in the shrinkage stress analysis to account for the effects of creep.





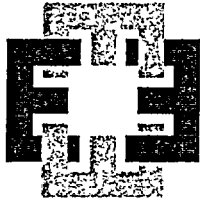
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Table 4 – Concrete Strength and Young’s Moduli

| Time (days) | Specified $f'_c$ | Mix Design $f'_c$ | $E = 57000\sqrt{f'_c}$ |
|-------------|------------------|-------------------|------------------------|
| 0.25*       | 234              | 262.5             | 0.924E6                |
| 0.50*       | 469              | 525               | 1.306E6                |
| 0.625       | 586              | 656               | 1.460E6                |
| 0.75*       | 703              | 787.5             |                        |
| 1.00*       | 937              | 1050              |                        |
| 1.125       | 1054             | 1187              | 1.964E6                |
| 1.625       | 1523             | 1712              | 2.358E6                |
| 2.00*       | 1875             | 2100              |                        |
| 2.125       | 1961             | 2200              | 2.674E6                |
| 2.375       | 2133             | 2393              | 2.788E6                |
| 3.00*       | 2562             | 2870              |                        |
| 3.125       | 2604             | 2919              | 3.080E6                |
| 4.125       | 2939             | 3294              | 3.271E6                |
| 5.00*       | 3232             | 3620              |                        |
| 6.125       | 3448             | 3863              | 3.543E6                |
| 7.00*       | 3616             | 4050              |                        |
| 7.875       | 3699             | 4143              | 3.669E6                |
| 10.00*      | 3902             | 4370              |                        |
| 90.00*      | 5000             | 5600              |                        |

\* Values for specified and mix design  $f'_c$  from Reference 2. The other values are obtained by linear interpolation.



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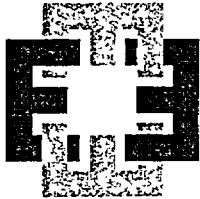
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**Material and Temperature Input Data**

Table 5 below provides the material and temperature data (function of elevation) for analysis. The Young's moduli are taken from Table 4. The delta temperatures are the differences in the temperatures (taken from Table 2) computed from time j-1 to j.

**Table 5 (1/2) – Analysis Parameters, and Applied Delta Temperatures (F) Vs Elevation**

| Elevation   | Time (days) |         |         |         |         |         |
|-------------|-------------|---------|---------|---------|---------|---------|
|             | 0.25        | 0.50    | 0.625   | 1.125   | 1.625   | 2.125   |
| Ex →        | 0.924E6     | 1.306E6 | 1.460E6 | 1.964E6 | 2.358E6 | 2.674E6 |
| Mat No. →   | 2           | 3       | 4       | 5       | 6       | 7       |
| Load Step → | 1           | 2       | 3       | 4       | 5       | 6       |
| 8           | 15.00       | -2.50   | -3.00   | -5.40   | -2.10   | -0.80   |
| 7.5         | 18.00       | 10.50   | -1.35   | -7.44   | -5.50   | -3.06   |
| 7           | 19.67       | 9.25    | 9.32    | -8.81   | -6.46   | -4.06   |
| 6.5         | 21.33       | 8.00    | 13.46   | -3.10   | -4.73   | -3.96   |
| 6           | 21.33       | 16.67   | 9.33    | 2.62    | -3.00   | -3.87   |
| 5           | 21.33       | 25.33   | 9.33    | 15.00   | 2.25    | -2.22   |
| 4           | 21.33       | 25.33   | 9.33    | 20.11   | 7.32    | 0.96    |
| 3           | 21.33       | 25.33   | 9.33    | 20.32   | 8.45    | 2.29    |
| 2           | 21.33       | 25.12   | 9.33    | 17.86   | 6.32    | 1.53    |
| 1           | 20.50       | 21.41   | 9.33    | 11.88   | 3.74    | 0.91    |
| 0.5         | 19.66       | 17.92   | 2.04    | 11.11   | 4.45    | 1.87    |
| 0.0         | 10.67       | 12.66   | 4.67    | 10.33   | 5.16    | 2.83    |
| -0.5        | 1.67        | 7.41    | 7.30    | 9.55    | 5.88    | 3.78    |
| -1          | 0.84        | 3.91    | 0       | 8.78    | 6.60    | 4.72    |
| -2          | 0           | 0.21    | 0       | 2.81    | 3.98    | 3.82    |
| -3          | 0           | 0       | 0       | 0.35    | 1.38    | 1.98    |
| -4          | 0           | 0       | 0       | 0.01    | 0.25    | 0.53    |



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**Table 5 (2/2) – Analysis Parameters, and Applied Delta Temperatures (F) Vs Elevation**

| Elevation   | Day     |         |         |         |         |
|-------------|---------|---------|---------|---------|---------|
|             | 2.375   | 3.125   | 4.125   | 6.125   | 7.875   |
| Ex →        | 2.788E6 | 3.080E6 | 3.271E6 | 3.543E6 | 3.669E6 |
| Mat. No. →  | 8       | 9       | 10      | 11      | 12      |
| Load Step → | 7       | 8       | 9       | 10      | 11      |
| 8           | -0.20   | -0.50   | -0.30   | 0       | 0       |
| 7.5         | -0.94   | -2.13   | -2.03   | -1.38   | -0.69   |
| 7           | -1.28   | -3.07   | -3.14   | -2.61   | -1.33   |
| 6.5         | -1.47   | -3.90   | -4.49   | -4.76   | -2.51   |
| 6           | -1.65   | -4.74   | -5.84   | -6.91   | -3.69   |
| 5           | -1.51   | -5.60   | -8.34   | -11.78  | -6.58   |
| 4           | -0.54   | -4.20   | -8.35   | -13.65  | -8.12   |
| 3           | 0.08    | -2.72   | -7.11   | -12.77  | -8.10   |
| 2           | 0.09    | -1.85   | -5.33   | -9.82   | -6.75   |
| 1           | 0.20    | -0.66   | -2.91   | -5.60   | -4.56   |
| 0.5         | 0.63    | 0.64    | -1.19   | -3.36   | -3.38   |
| 0.0         | 1.06    | 1.94    | 0.54    | -1.12   | -2.20   |
| -0.5        | 1.46    | 3.10    | 1.98    | 0.66    | -1.23   |
| -1          | 1.86    | 4.26    | 3.43    | 2.43    | -0.25   |
| -2          | 1.73    | 4.39    | 4.18    | 4.06    | 0.85    |
| -3          | 1.05    | 3.00    | 3.19    | 3.52    | 1.01    |
| -4          | 0.33    | 1.03    | 1.18    | 1.37    | 0.43    |

The coefficient of thermal expansion is 5.18E-6 in/in/degree F, (Reference 2, Sheet 50). The Poisson's ratio is 0.15.



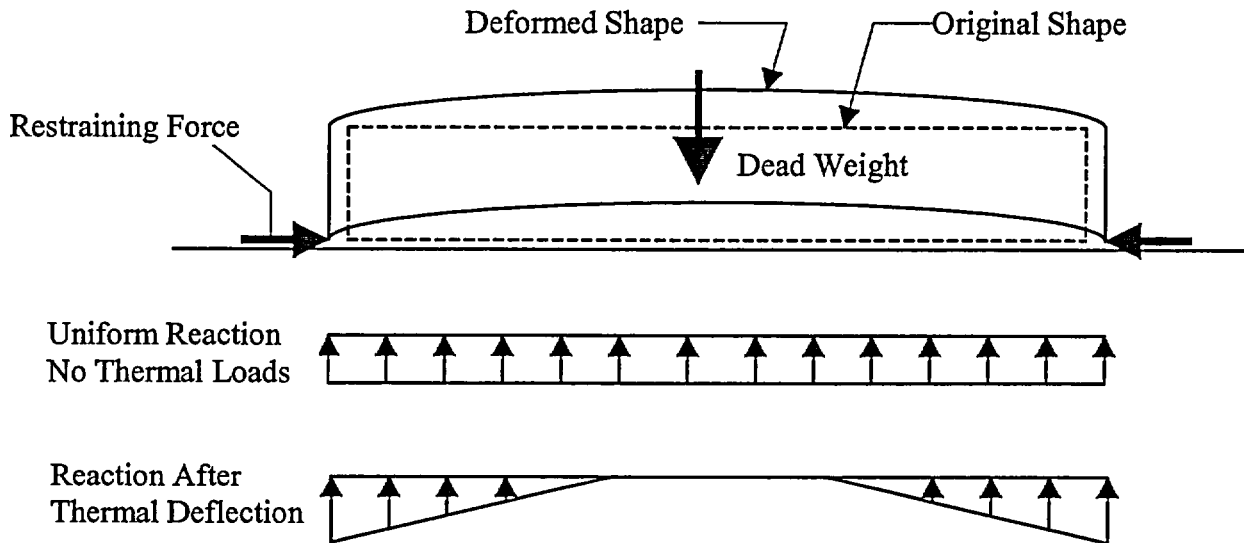
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| <b>REVIEWER</b>        | <u>K. L. Whitmore</u>   | <b>APPROVED</b>   | <u>R. F. Evers</u>        |           |           |
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**Thermal Stress Analysis Considerations**

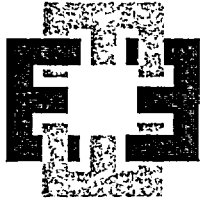
Regardless of the actual temperature distribution in the pad, since the pad sits on a rock base, that base will restrain the pad from free axial growth. As shown in Figure 1, the restraining force will produce a negative moment (tension on the top) in the pad. This will tend to lift the pad from the rock thereby altering the uniform dead weight reaction force that would otherwise occur. (The reaction distribution shown in the Figure is one of many that could exist.) This in turn will produce positive moment in the pad, relieving the stresses caused by the restraint of the rock.

Creep, particularly in the first few days after casting, will allow the pad to “settle” down on to the rock thereby reducing the positive moment. Creep will also relieve the applied temperature stresses at the same time. Hence, from an energy perspective on the pad, with the temperatures and dead weight acting at the same time, the effects of creep will be to reduce the net stresses.



**Figure 1 – Dead Weight Reaction Distribution vs. Thermal Displacement**

Thus the dead weight can be included in the calculation of the total stress. The analysis model includes contact compression only gap elements between the top of the rock and the bottom of the pad. The model relies upon a net vertical downward load to maintain numerical stability during the solution process. The analysis for the thermal case uses eleven separate time steps (see discussion below) with incremental temperatures applied to the model with eleven different values for Young’s modulus to model the effects of the concrete hardening with time. The analysis used 90% of the dead weight of the concrete (90% of 150 pcf) in the first time step and 0.9% of the dead weight in each of the subsequent ten steps. The displacements are then monitored for the summed steps to insure that the pad is always separated from the rock at the centerline of the pad, thereby maintaining the full effects of the offsetting deadweight moments in the analysis.



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| REVIEWER        | K. L. Whitmore   | APPROVED   | R. F. Evers      |                    |    |    |
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It is recognized that summing individual nonlinear analytical results is not, in the strictest sense, theoretically correct. However, given that the bulk (90%) of the dead weight is included in the first load step, and that the subsequent load steps are for essentially temperature loads only, the additional forces and moments added to this first load step are conservatively computed. This is because the compliance of a stiffer (harder) concrete pad with the rock would have the pad migrating the CG of the dead weight reaction forces toward the edges of the pad, generating more offsetting deadweight moment than is computed here (creep ignored). Thus, though the specific sums of displacements and moments etc. may not be exactly theoretically correct as in an analysis that could actually invoke a creep law, if one were known, the results here, are conservative.

**Shrinkage Stress Analysis Considerations**

Shrinkage of the pad is significant for the top one foot of concrete. This shrinkage causes tensile stresses to occur on the top surface. These stresses will curl the corners of the pad and cause the pad to lift off the rock at the corners. The pad dead weight tries to keep the pad corners down on the rock causing additional tensile stresses on the pad top surface.

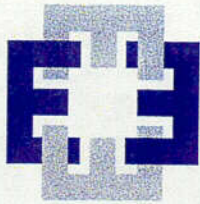
**Pad ANSYS Static Model Construction Description**

Since all loads are symmetric and since the pad is symmetric, only ¼ of the pad and confining rock is modeled. The static model is a solid finite element model designed to maximize the confinement that the rock has on the pad. This technique reasonably maximizes the rock's resistance to the pad's shrinkage and expansion, and therefore provides conservative results. The rock is modeled up to the level of the pad surface, and for a sufficient distance in all directions to accurately capture the behavior of the pad.

As in the seismic calculation, rotations of the nodes are not included in the solution. Also, as in the seismic calculation, the model is constructed in the Cartesian coordinate system with X pointing West, Y pointing up and Z pointing North.

The analysis for temperature is incremental wherein the temperature through the thickness and Young's modulus are varied with time, in eleven time steps, to model the heat up as well as the effects of strength gain, i.e., gain in Young's modulus, of the concrete. The analysis for shrinkage is performed in one step where both the equivalent shrinkage temperatures and the dead weight of the pad are applied. Since this model contains contact elements, these analyses are nonlinear and iterative.

The geometry of the pad and rock is shown in Figure 2. The completed model with the finite element mesh is shown in Figure 3. All plots presented are taken from the same viewpoint as that shown in Figures 2 and 3. The viewing direction is X = -1, Y = 0.5, and Z = -1, i.e., looking slightly down and from the pad centerline toward the far corner. Occasionally, the viewing direction will be changed to show pertinent detail. Unless the change in view direction is obvious, it will be noted.



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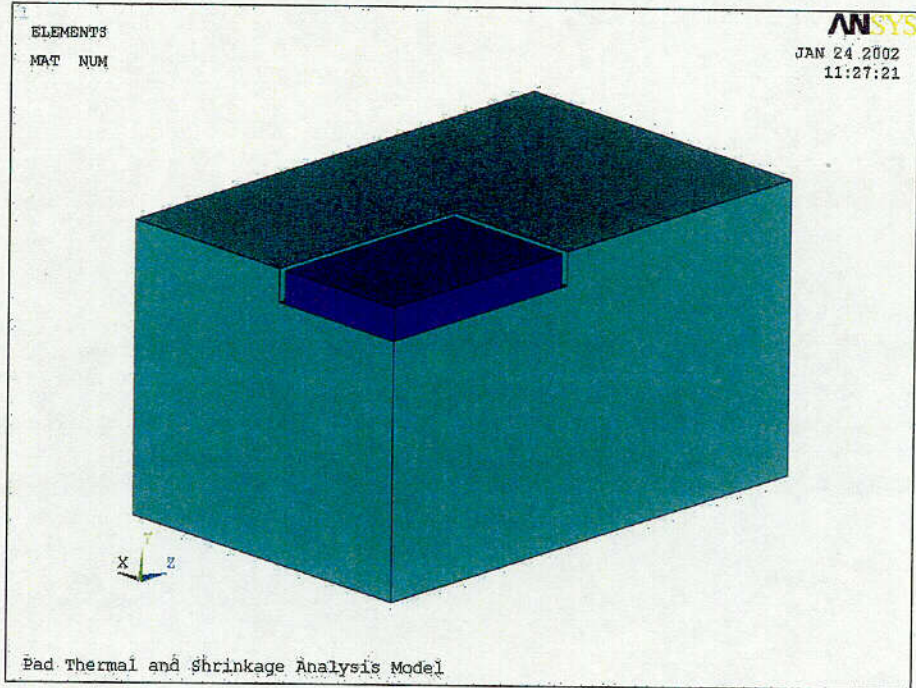


Figure 2 – Basic Pad/Rock Geometry

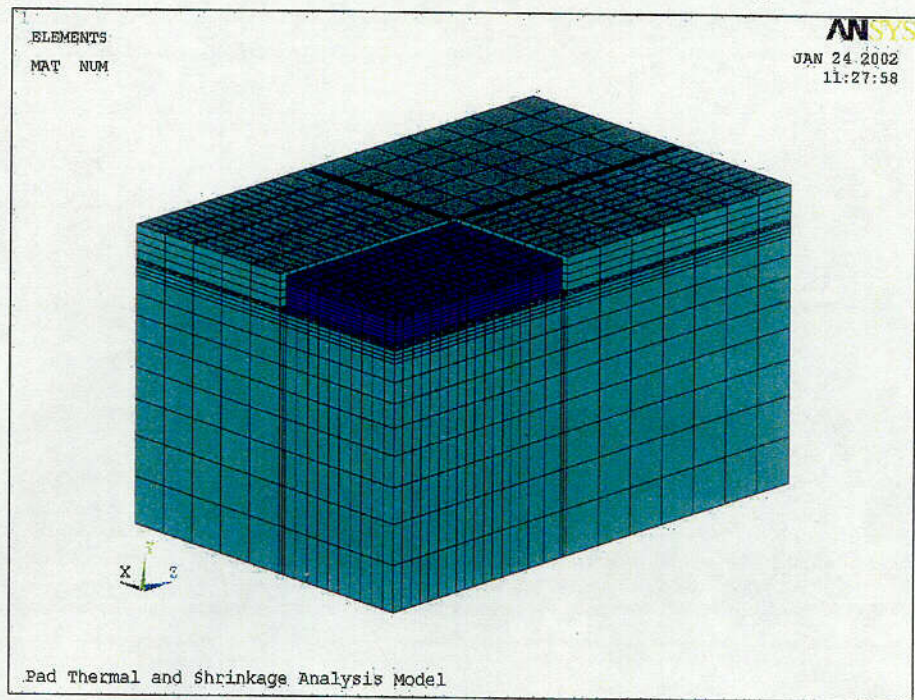
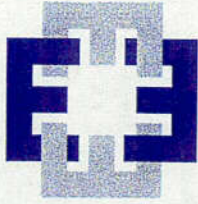


Figure 3 – Finite Element Mesh

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### Concrete Pad

The concrete pad is modeled with Element Type 2. Element Type 2 is the ANSYS SOLID45 8-noded brick structural solid element. All features invoked in the seismic analysis are invoked here. The material properties are varied with time in that they are modified at each of the eleven load steps.

The pad is modeled 8 feet thick with the thickness of the elements modeled to match the locations where the temperatures are provided. Hence the 8-foot pad is segmented into element layers with the elevations shown in Table 5. In plan, the mesh is designed to match the 17 foot segments and the 10 foot end segments modeled in the seismic calculation.

The pad geometry is shown in Figure 4 below.

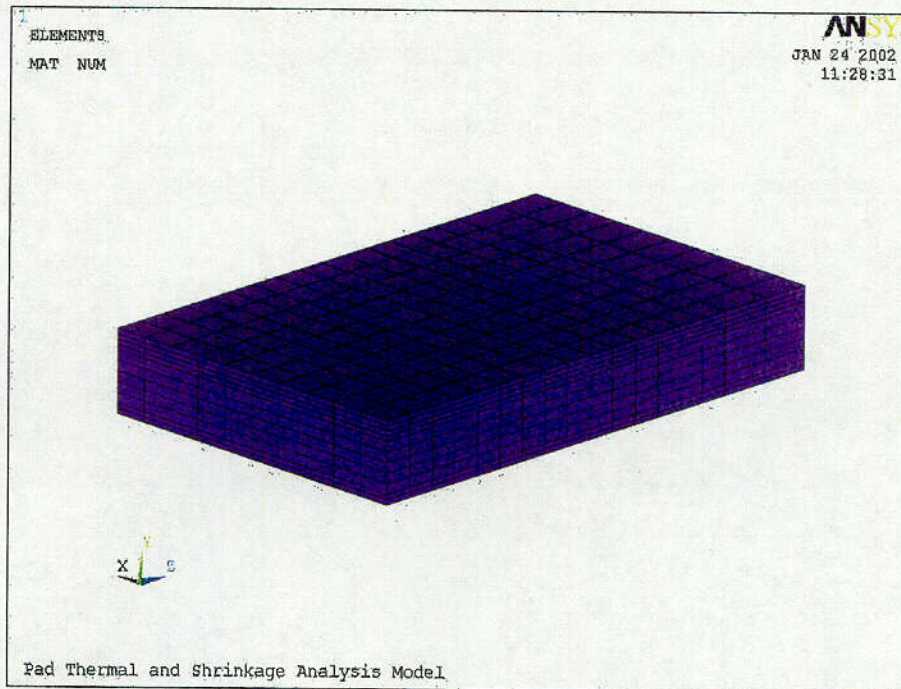
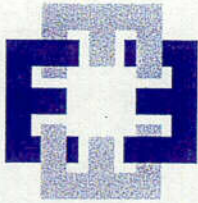


Figure 4 – Pad Mesh

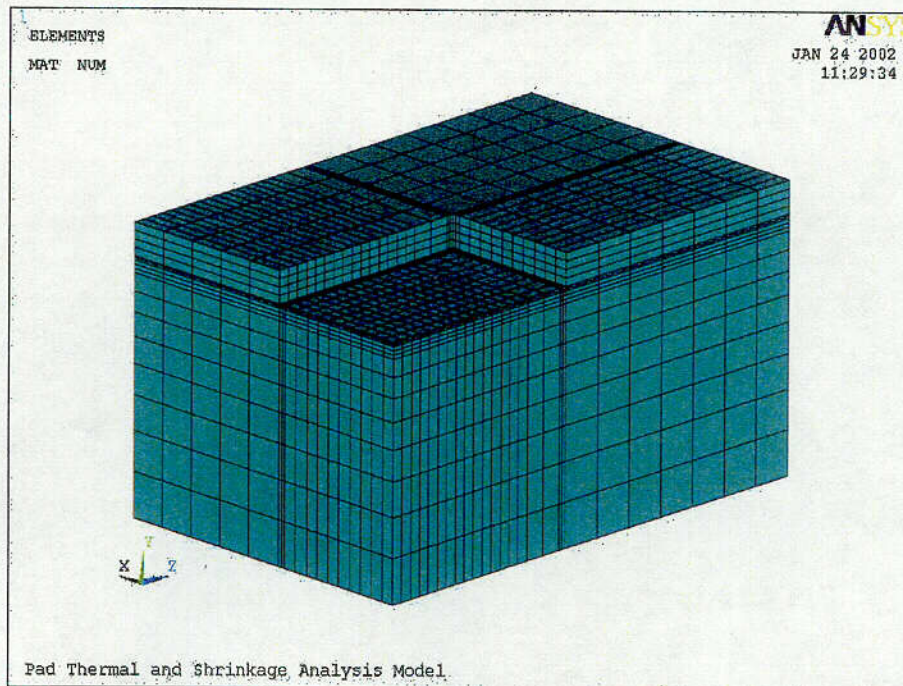


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| REVIEWER        | <u>K. L. Whitmore</u>   | APPROVED   | <u>R. F. Evers</u>        |    |           |
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### Rock

The rock is modeled with Element Type 1. Element Type 1 is the ANSYS SOLID45 8-noded brick structural solid element. All features invoked in the seismic analysis are invoked here. The rock mass is modeled to 81 feet 4 inches in the X direction, 124 feet 6 inches in the Z direction and 62 feet beneath the pad. Further, a 2-foot gap is provided around the pad to allow for some consideration for construction access. This gap is considered to be a minimum distance that will be required to install the pad. Larger gaps will provide less restraint and hence lower stresses. The element mesh is designed to mate with the pad, and to provide constraint on the boundaries of the pad model. The rock portion of the model is shown in Figure 5 below. A close up of the two-foot gap is provided in Figure 6.



**Figure 5 – Rock Mesh**

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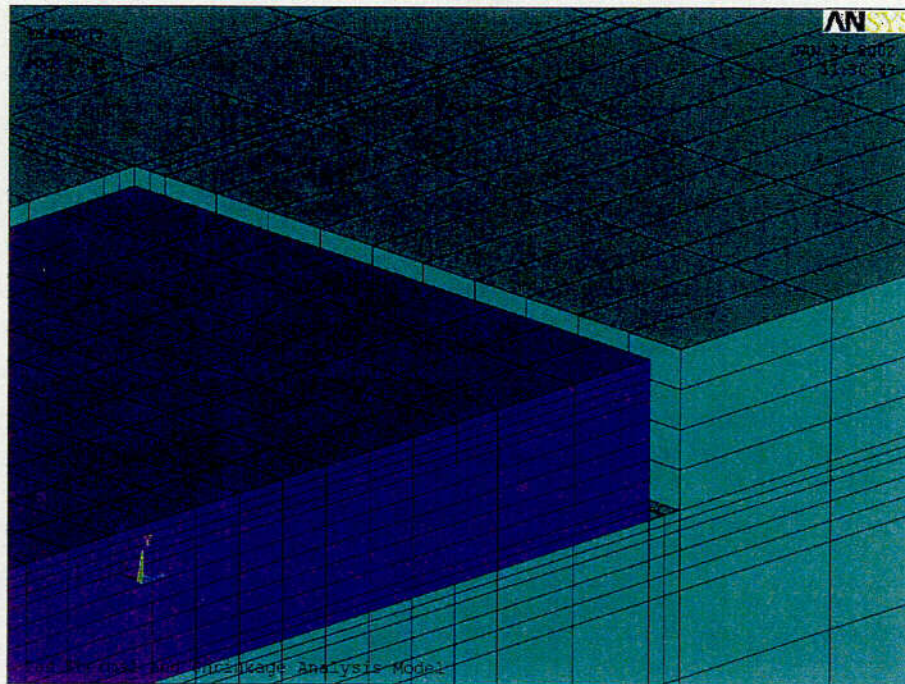


Figure 6 – Close Up of the Two-Foot Gap

The rock is designated as Material Type 1; is assumed to be homogeneous and its properties are not varied with time. The hard rock as described in the seismic report is used for this analysis. This is the stiffest rock that is reasonably expected to exist beneath the pad to an extent that it could affect the thermal response. The stiffest rock is the only rock that needs to be considered since it provides the greatest restraint to the pad. The pad stresses analyzed with the soft rock will be lower than those analyzed with the hard rock.

The PG&E temperature calculation provides some modest heat up of the rock directly beneath the pad. A literature search on the Internet provided some values for the coefficients of thermal expansion. The lower bound of these values is the conservative value to use, since this results in the lowest rock thermal expansion, and hence the greatest restraint to the pad. A coefficient of thermal expansion of  $5E-6$  in/in/degree F is specified for the sandstone (soft rock), taken from the Stone University at [www.coldspringgranite.com](http://www.coldspringgranite.com), and  $8.3 \times 10^{-6}$  in/in/degree F ( $= 15 \times 10^{-6}$  in/in/degree K/1.8) is used for the dolomite (hard rock), taken from [www.ima-eu.org](http://www.ima-eu.org). Combining properties to arrive at a conservative set to use for analysis, the following values were used for the hard rock (see Table 6). Since the coefficient of thermal expansion of the concrete “mud” mat will be higher than  $5.0 \times 10^{-6}$ , the value in Table 6 is conservative, regardless of the final thickness of the “mud” mat since the lower bound is the conservative value to use. Also, since the “mud” mat will be relatively thin and unreinforced, adjusting the Young’s Modulus is not justifiable.



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Table 6 - Rock Properties Used for Analysis

| Rock            | Young's Modulus   | Poisson's Ratio | Coefficient of Thermal Expansion |
|-----------------|-------------------|-----------------|----------------------------------|
| Dolomite - Hard | $2.0 \times 10^6$ | 0.24            | $5.0 \times 10^{-6}$             |

**Constraint Equations**

The pad model is generated completely separate from the rock model. The pad and rock models have coincident nodes at the bottom of the pad and at the top of the rock beneath the pad. These nodes are then stitched together in a manner that allows the pad to push/pull horizontally on the rock mass but does not allow the resulting curvature to affect the vertical stresses between the pad and the rock. The possibility that the pad and/or mud mat will not remain bonded to the rock, or will creep, will be addressed in subsequent calculations. These constraint equations act in combination with the contact elements described below.

Since the nodes are coincident, stitching them together simply produces continuity without any internal moments to consider. Thus, interior to the pad, all the nodes at the bottom of the pad and the top of the rock are stitched in the X and Z directions. Along the edge in the XY plane of symmetry, all nodes are stitched in the X direction, and along the edge in the YZ plane of symmetry, all nodes are stitched in the Z direction. See Figures 7, 8 and 9.

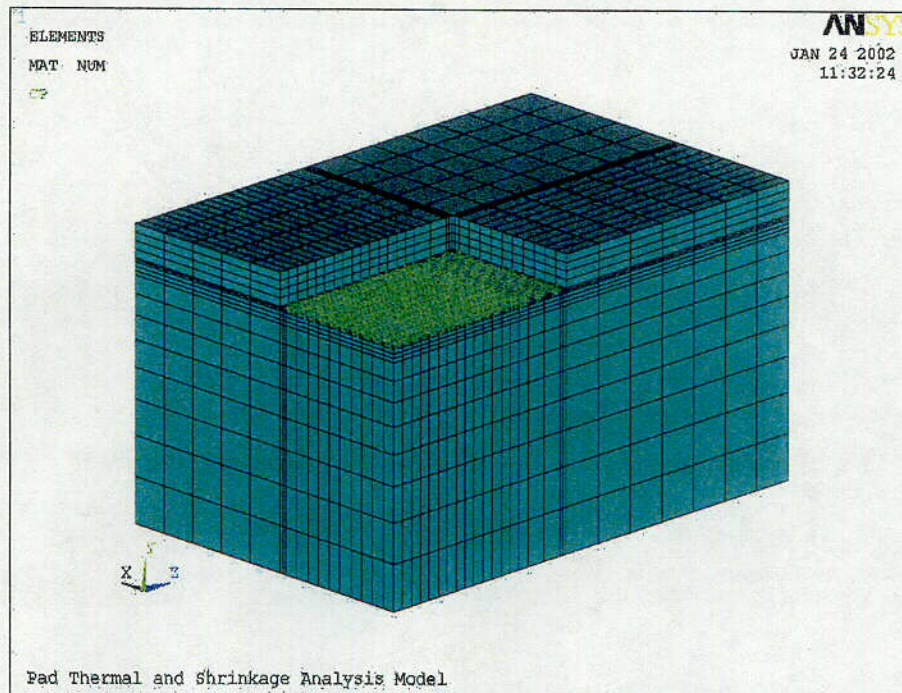
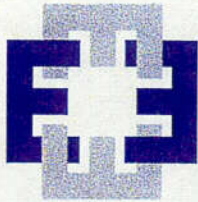


Figure 7 - Pad/Rock Constraints

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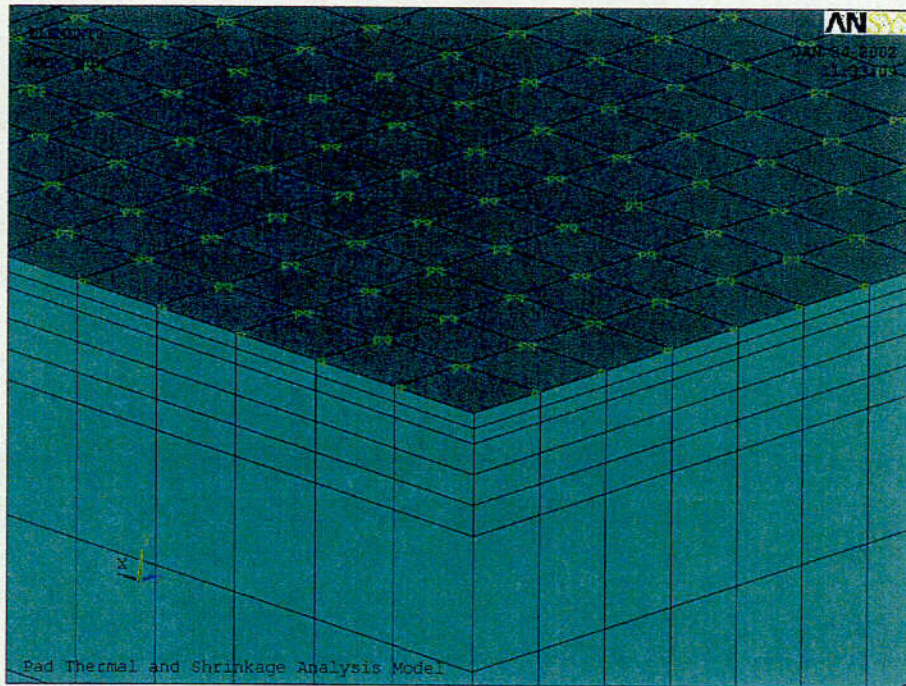


Figure 8 – Close Up of Pad/Rock Constraints on the Rock

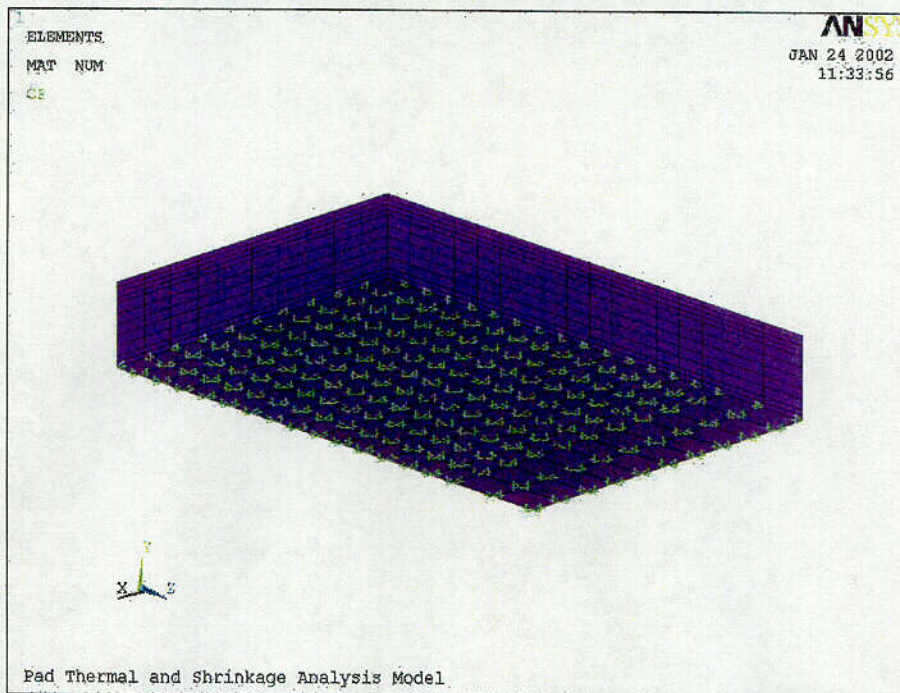
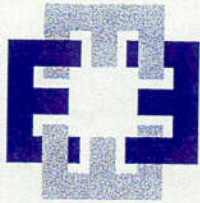


Figure 9 – Pad/Rock Constraints on the Pad – Looking Up

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### Contact Elements

The analysis model has a set of contact elements between the bottom of the pad and the top of the rock. The ANSYS contact elements are described in some detail in Reference 1. In this analysis, the CONTA174 is used on the bottom of the pad and the TARGE170 is used on the top of the rock. Since both surfaces have the same mesh refinement and have the same stiffness, the use of these elements on these surfaces is appropriate. See Figure 10.

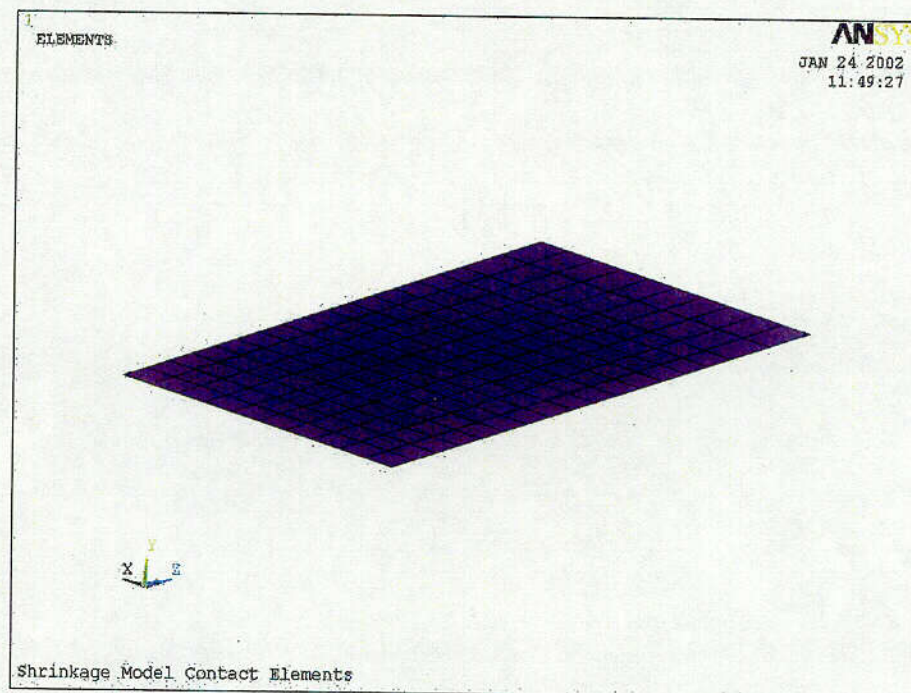
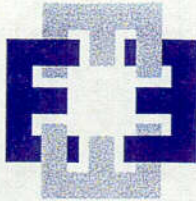


Figure 10 – Pad/Rock Contact Elements

### Material Numbers

The completed model with the material numbers is shown in Figure 11. The concrete pad material numbers are varied throughout the analysis. Material number 2 is the initial material number for the pad.



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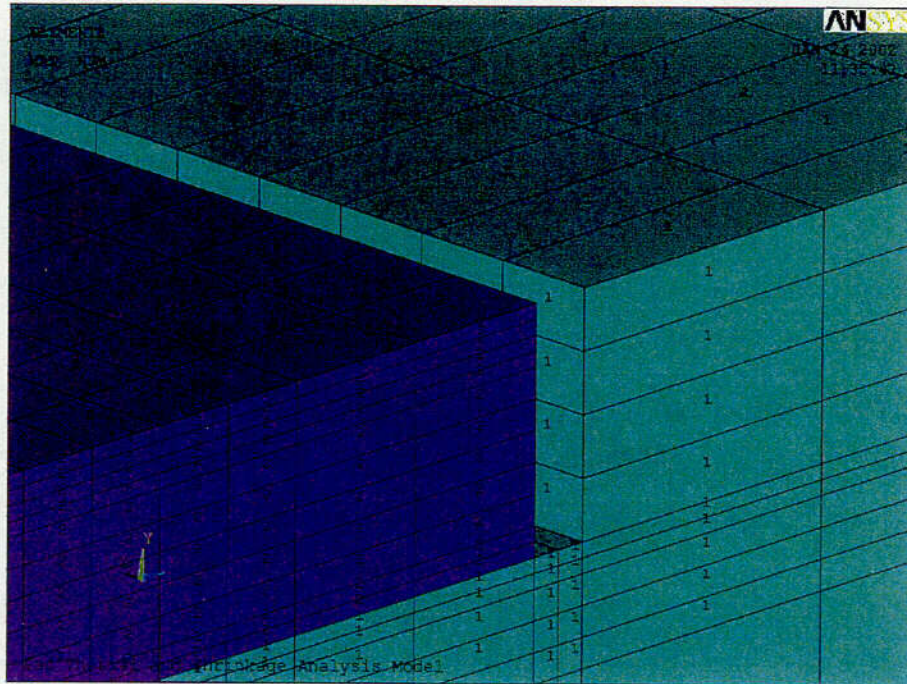


Figure 11 – Material Numbers

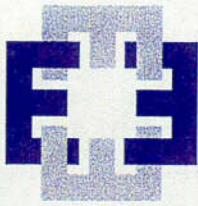
### Boundary Conditions

The boundary conditions are as follows:

- XY plane – Symmetrical BC's on the pad and the rock
- YZ plane – Symmetrical BC's on the pad and the rock
- X edge of the rock mass at  $X = 81' - 4''$  – X and Y displacements set to zero
- Z edge of the rock mass at  $Z = 124' - 6''$  – Y and Z displacement set to zero
- Bottom of the rock mass – X, Y and Z displacement set to zero

These Boundary Conditions are conservative in that they prescribe zero displacements and therefore provide maximum reasonable constraint to the pad.

Plots of the Boundary Conditions are shown in Figures 12 and 13 below.



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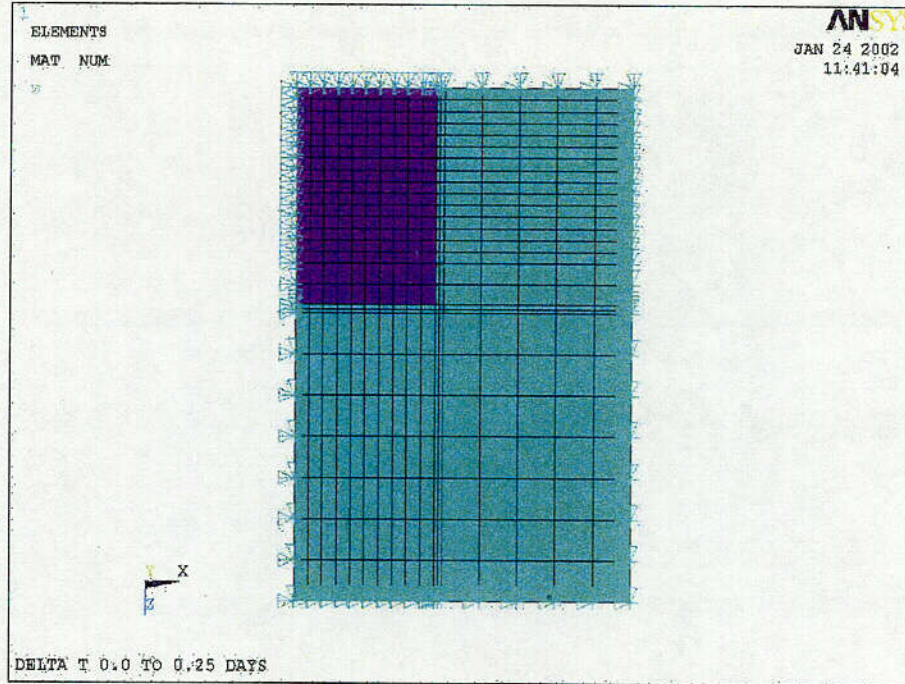


Figure 12 – Boundary Conditions – Looking Down

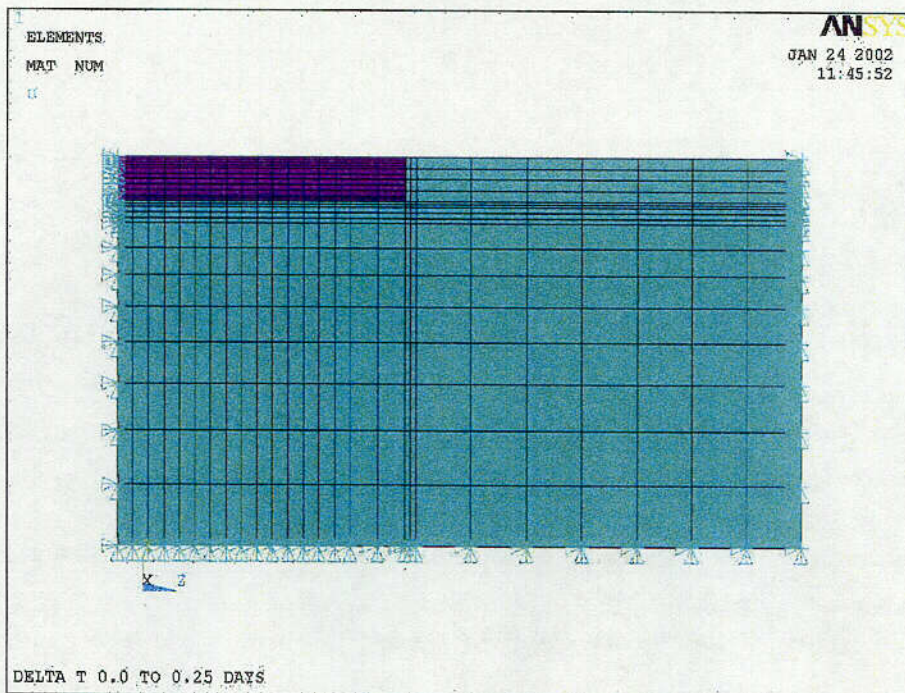
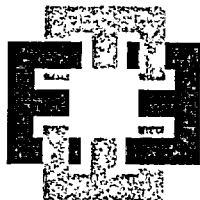


Figure 13 – Boundary Conditions

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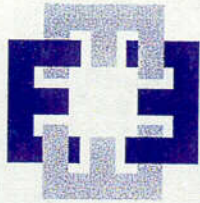
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### Loads and Analysis

The thermal stress analysis is conducted using eleven Load Steps. The delta temperatures shown in Table 5 are applied and the pad material properties are specified for each Load Step. In Load Step 1, 90% of the pad dead weight is applied, and 0.9% of the pad dead weight is applied in each of the ten subsequent Load Steps to maintain numerical stability. (Concrete density was set to 135 pcf (90% of 150) and the vertical acceleration for the first load step set to 1.0G, and 0.01G for each of the ten subsequent load steps.) The results, from each Load Step analysis, are a complete set of pad/rock responses, i.e., reactions, displacements, stresses etc. The results for each time are the algebraic sum of the individual responses to that time. These are summed and stored as Load Cases. As an example, the pad response at 2.125 days is Load Case 6 and it is the sum of Load Steps 1 through 6. As a check, the delta temperatures and summed temperatures are output to provide a means to check the input data back to the source.

The ANSYS output file that documents the generation of the loads for each load step is provided in Appendix TH-Loads. Plots of the summed applied temperatures are provided in Appendix TPad-TH. One plot from the Appendix for Load Case 7 is shown in Figure 14. The ANSYS output file that documents the analysis together with the output delta temperatures and summed temperatures is provided in Appendix RPad-TH. A comparison of the output temperatures with the temperatures in Tables 2 and 5 show them to be the same. Each summed Load Case is then checked for equilibrium. The output file that documents this check for equilibrium is provided in Appendix EPad-TH. This data demonstrates that the overall equilibrium for the rock and the pad is satisfied.

The shrinkage stress analysis is conducted in one load step. The equivalent shrinkage temperatures from Table 3 are applied along with the acceleration due to gravity. The concrete density was set to the full 150 pcf and the vertical acceleration to 1.0G. The ANSYS output file that documents the generation of the loads is provided in Appendix SH-Loads. The ANSYS output file that documents the analysis together with the output equivalent temperatures is provided in Appendix RPad-SH. A comparison of the output temperatures with the temperatures in Table 3 shows them to be the same. The analysis is then checked for equilibrium. The output file that documents this check for equilibrium is provided in Appendix EPad-SH. This data demonstrates that the overall equilibrium for the rock and the pad is satisfied. The quarter model of the pad weighs  $(52.5 \times 34 \times 8 \times 150) = 2,142,000$  lbs.



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### Analysis Results – Thermal Stress Analysis

Since Load Case 7, Pad Response at 2.375 days, results in the highest set of applied moments (see Table 9 below), plots for this Load Case will be used to show response. The other Load Cases all have the same general response shape. The difference is in the magnitude. A plot of the applied summed temperatures is shown in Figure 14. Plots for all Load Cases are in Appendix TPad-TH and the numerical results are in Appendix RPad-TH.

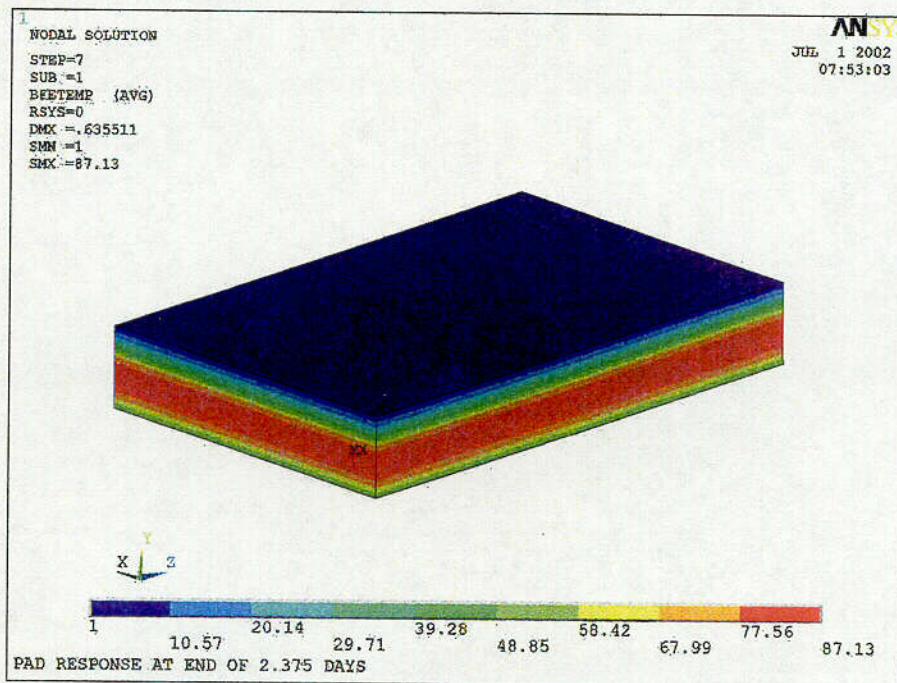
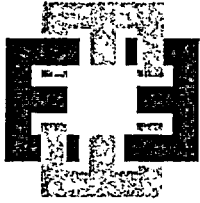


Figure 14 – Applied Temperatures at 2.375 days





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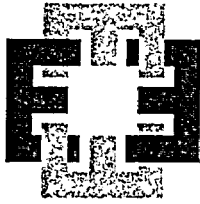
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### Pad Response – Displacements

The displacements for the individual Load Steps are shown in Appendix LSPad-TH. There are three different displaced shapes. The first is shown in Figures LS-1 and LS-1A. The deadweight in this analysis is not enough to overcome the arching action caused by the restraining forces due to net thermal expansion of the pad (see Figure LS-1). However, enough deadweight is acting to force the pad down on to the rock at its edges, Figure LS-1A. And, the deadweight does affect the displaced shape. The maximum up deflection is not at the centerline of the pad. The second shape is shown in Figures LS-2 through LS-4. In these analyses, the restraining forces cause arching action, as in LS-1, but since the deadweight is very small, the pad arches up in two directions and is only supported at its corners, Figure LS-2A. The third shape is shown in Figures LS-5 to LS-11. In these analyses, the net thermal expansion is not enough to develop restraining forces of sufficient magnitude to overcome the applied temperature upward curvatures. In these cases, the deadweight stresses add to the applied net thermal stresses, i.e., tension on the pad top, but since the deadweight is small its effect is also small.

The summed displacements of the pad for all the Load Cases are plotted in Appendix LCPad-TH to give some sense of expected deformations. The summed displacements at the pad centerline are computed in Appendix DPad-TH. To compare them to acceptable deflections, see Table 7. However, since the analysis is piecewise and sums separate nonlinear analyses, the summed displacements are not analytically exact. However, they do provide a reasonable sense of the pad's total deformation. Table 7 provides displacements for the bottom of the pad (node 113) and the top of the rock (node 133) both at the centerline of the pad. Plots of the pad vertical displacements for Load Cases 1, 2 and 7 are shown in Figures 15, 16 and 17.

The displaced shape for Load Case 1, Figure 15, shows that the dead weight is not enough to force the pad down to the rock at its centerline. However, it does alter the arching action shape. The shape for Load Case 2, Figure 16, shows that the influence of the dead weight is reduced and the arching action dominates the response. In Load Case 7, Figure 7, arching action still dominates even though three Load Steps (5 to 7) were added. In each of these three Load Steps, as discussed before, the restraining forces are not enough to force arching action. However, the magnitudes of the forces involved are not enough to alter the arching action established by the summation of Load Steps 1 through 4. The pad appears to "float" owing to the addition of the vertical displacements at the pad edges from Load Steps 5 through 11.



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Table 7 – Analytical Deflections (inches) Vs Time

| Time (days) | Load Case | Pad Bot $\delta_{y113}$ | Rock Top $\delta_{y133}$ |
|-------------|-----------|-------------------------|--------------------------|
| 0.25        | 1         | 0.824E-2                | 0.222E-2                 |
| 0.50        | 2         | 0.348                   | 0.425E-2                 |
| 0.625       | 3         | 0.499                   | 0.516E-2                 |
| 1.125       | 4         | 0.596                   | 0.824E-2                 |
| 1.625       | 5         | 0.598                   | 0.104E-1                 |
| 2.125       | 6         | 0.600                   | 0.116E-1                 |
| 2.375       | 7         | 0.600                   | 0.121E-1                 |
| 3.125       | 8         | 0.601                   | 0.132E-1                 |
| 4.125       | 9         | 0.602                   | 0.138E-1                 |
| 6.125       | 10        | 0.602                   | 0.138E-1                 |
| 7.875       | 11        | 0.601                   | 0.128E-1                 |

The single largest effect not included in the analyses is the effect of creep. Creep will reduce all the calculated deflections and stresses. Hence the expected deformations in the field are much less than these calculated values. Nevertheless, an often used value for deflections due to dead weight is  $1/320 = 105 \times 12 / 320 = 3.9$  inches. See, for example, ACI 349-97, Table 9.5(a). As the data demonstrates, even these computed deflections are not severe.



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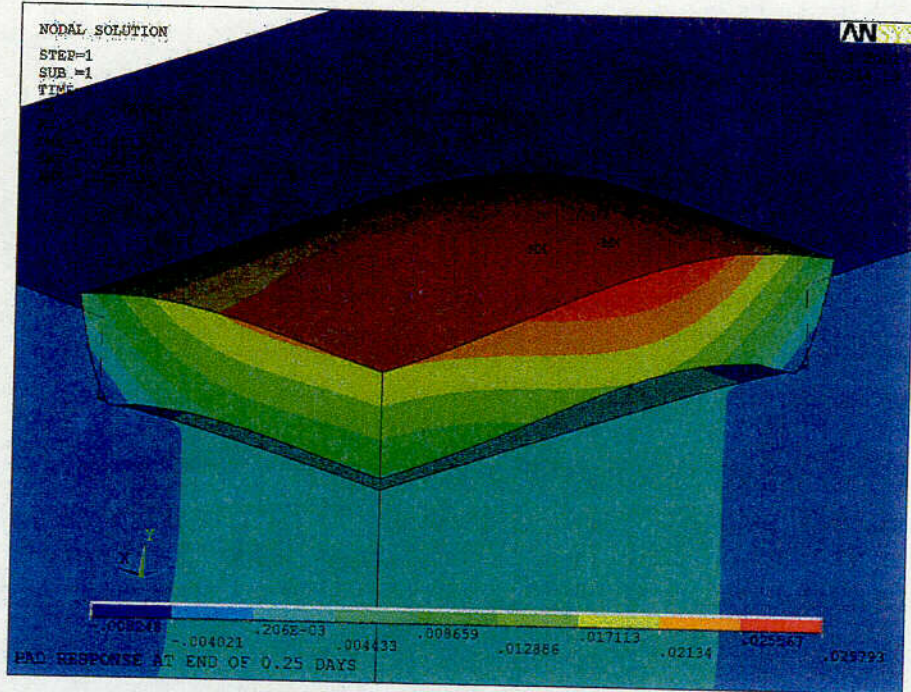


Figure 15 – Pad Vertical Analytical Displacements at 0.25 Days (same as Figure LC-1)

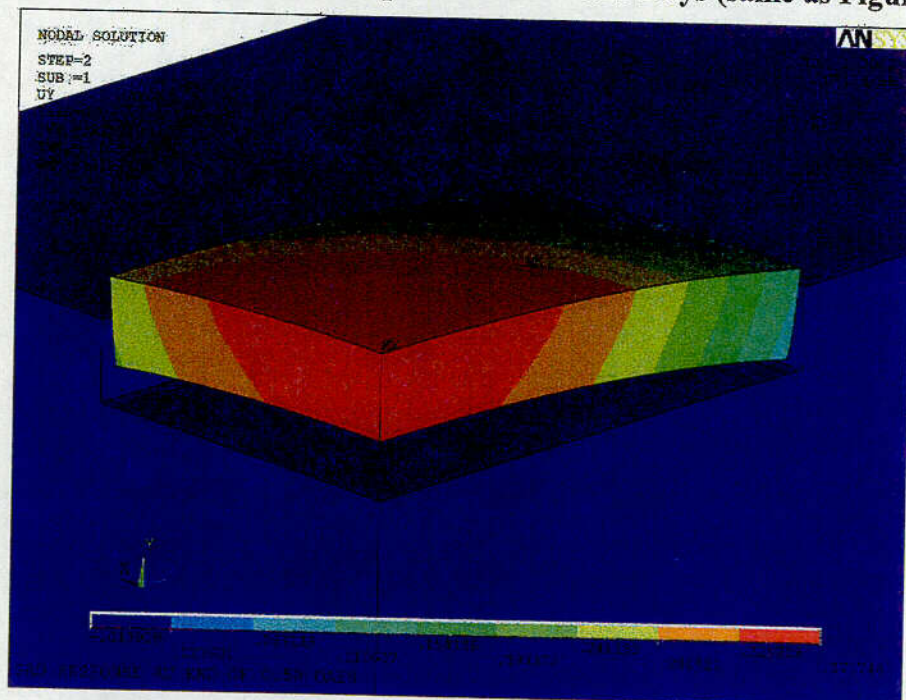
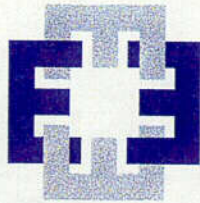


Figure 16 – Pad Vertical Analytical Displacements at 0.5 Days (same as Figure LC-2)

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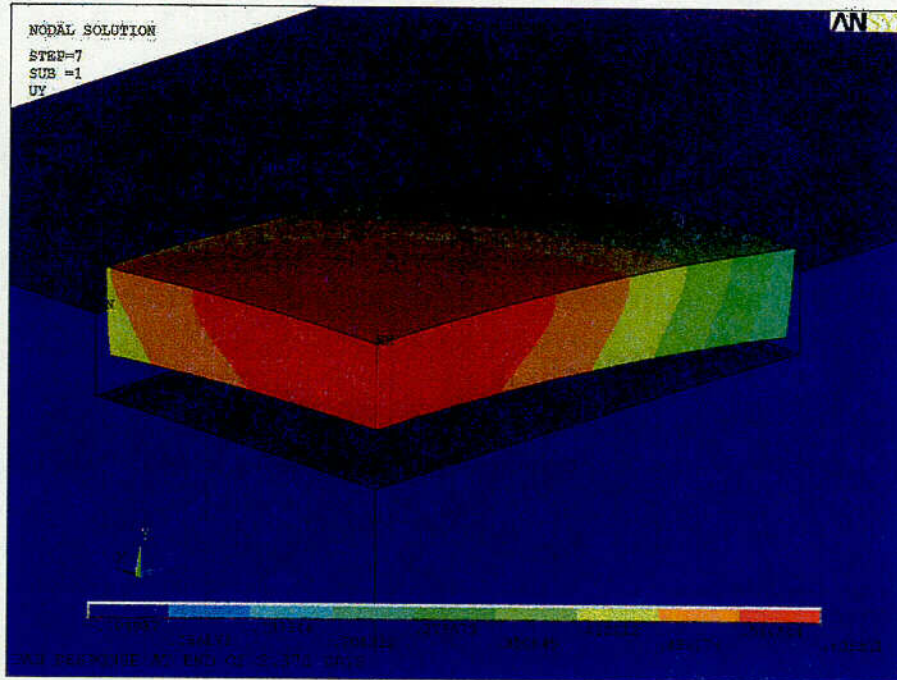
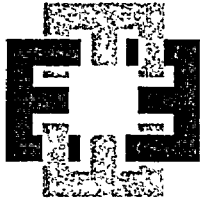


Figure 17 – Pad Vertical Analytical Displacements at 2.375 days (same as Figure LC-7)

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| REVIEWER        | <u>K. L. Whitmore</u>   | APPROVED   | <u>R. F. Evers</u>        |    |           |
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### Pad Response – Stresses

Pad stresses are plotted for Load Case 7 in Figures 18 and 19. The SX and SZ tensile stresses occur over nearly the entire top surface of the pad. A complete set of plots for all Load Cases is provided in Appendix STPad-TH. All the plots indicate roughly the same shape of stress field within the pad. This is a biaxial (X-Z) tension stress field at the top surface, and a maximum biaxial (X-Z) compression stress field just below the mid-height of the pad, and a biaxial compression stress field at the bottom of the pad.

Pad stresses are provided in Table 8 to give a sense of the level of expected cracking. The values are the highest tensile and compressive stresses in both the X and Z directions, the maximum tensile principal stress  $\sigma_{1 \text{ Max}}$ , and the minimum compressive principal stress  $\sigma_{3 \text{ Min}}$ . The concrete compressive and tensile strengths are derived from the Specified  $f'_c$  from Table 4. The ANSYS output file that documents the post processing for these stresses is provided in Appendix SPad-TH.

The stresses indicate that in the absence of creep, cracking would be expected to occur. However, the data also shows that significant creep and consequent reduction of these stresses will occur. The values of  $\sigma_{3 \text{ Min}}$  in Load Cases 1 to 3 greatly exceed the expected  $f'_c$ . The  $\sigma_3$  is plotted in Figure 20 for Load Case 3 and again in Figure 21 for Load Case 7. The extent of the stress field is very local and confined to the pad corner throughout the curing heat up. The  $\sigma_1$  is plotted in Figure 22 for Load Case 3 and Figure 23 for Load Case 7. These show that the  $\sigma_1$  is not local and the extent of expected cracking, and therefore, required crack control reinforcement is significant.



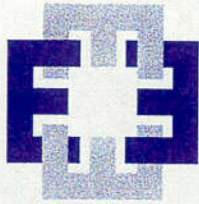
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Table 8 – Pad Stresses (psi) Vs Time

| Time (days) | Load Case | $\sigma_{X \text{ Max}}$ | $\sigma_{X \text{ Min}}$ | $\sigma_{Z \text{ Max}}$ | $\sigma_{Z \text{ Min}}$ | $\sigma_1 \text{ Max}$ | $\sigma_3 \text{ Min}$ | $f'_c$ | $f_t^*$ |
|-------------|-----------|--------------------------|--------------------------|--------------------------|--------------------------|------------------------|------------------------|--------|---------|
| 0.25        | 1         | 36                       | -123                     | 35                       | -117                     | 49                     | -464                   | 234    | 102     |
| 0.50        | 2         | 229                      | -242                     | 236                      | -256                     | 247                    | -613                   | 469    | 145     |
| 0.625       | 3         | 351                      | -300                     | 360                      | -313                     | 371                    | -701                   | 586    | 162     |
| 1.125       | 4         | 504                      | -470                     | 511                      | -493                     | 518                    | -909                   | 1054   | 218     |
| 1.625       | 5         | 525                      | -568                     | 537                      | -594                     | 540                    | -1005                  | 1523   | 261     |
| 2.125       | 6         | 488                      | -616                     | 504                      | -644                     | 514                    | -1051                  | 1961   | 297     |
| 2.375       | 7         | 465                      | -624                     | 482                      | -653                     | 516                    | -1064                  | 2133   | 309     |
| 3.125       | 8         | 379                      | -607                     | 392                      | -636                     | 478                    | -1072                  | 2604   | 342     |
| 4.125       | 9         | 274                      | -526                     | 285                      | -554                     | 368                    | -1027                  | 2939   | 363     |
| 6.125       | 10        | 130                      | -464                     | 133                      | -498                     | 150                    | -904                   | 3448   | 393     |
| 7.875       | 11        | 75                       | -443                     | 70                       | -470                     | 84                     | -803                   | 3699   | 407     |

\*  $f_t = 6.7 \sqrt{f'_c}$



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| REVIEWER        | <u>K. L. Whitmore</u>   | APPROVED   | <u>R. F. Evers</u>        |    |           |
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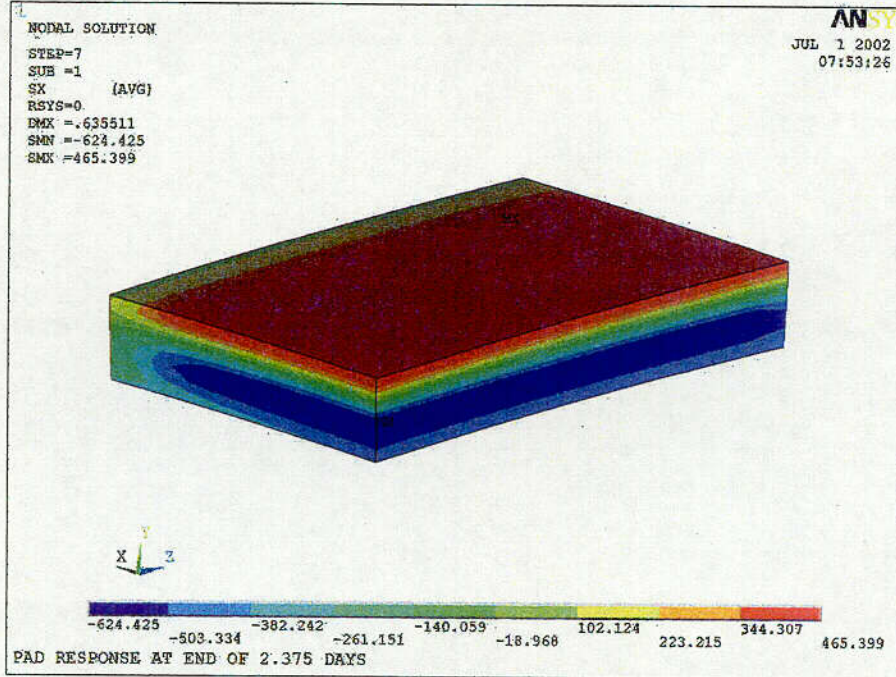


Figure 18 – Pad X Direction Stresses at 2.375 days

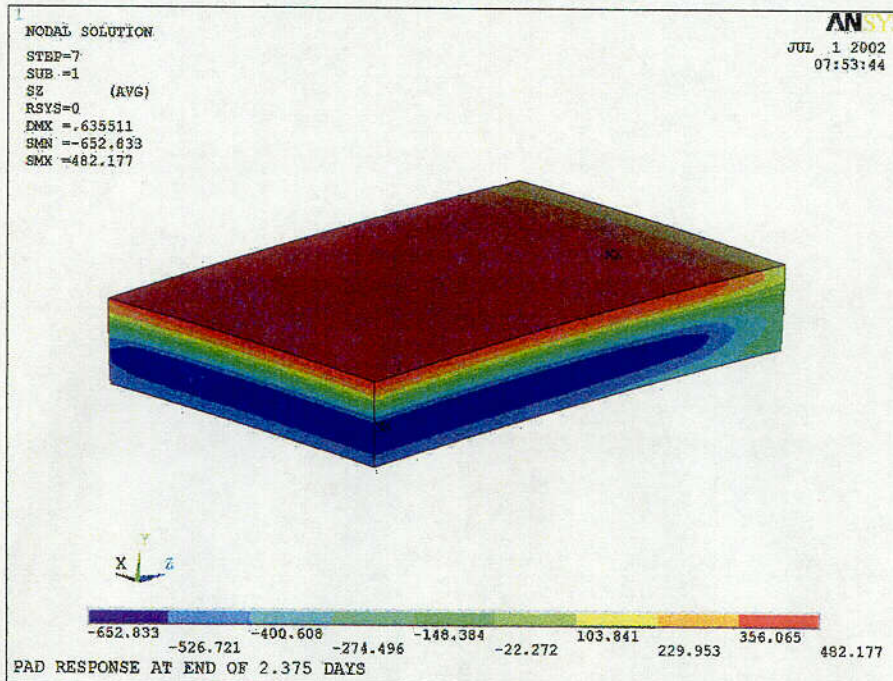
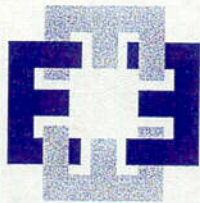


Figure 19 – Pad Z Direction Stresses at 2.375 days



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| CLIENT          | <u>PG&amp;E-DCPP</u>  | ORIGINATOR | <u>S. C. Tumminelli</u>   |    |           |
| REVIEWER        | <u>K. L. Whitmore</u>   | APPROVED   | <u>R. F. Evers</u>        |    |           |
| CALCULATION NO. | <u>PGE-009-CALC-006</u>   | REVISION   | <u>0</u>                  |    |           |

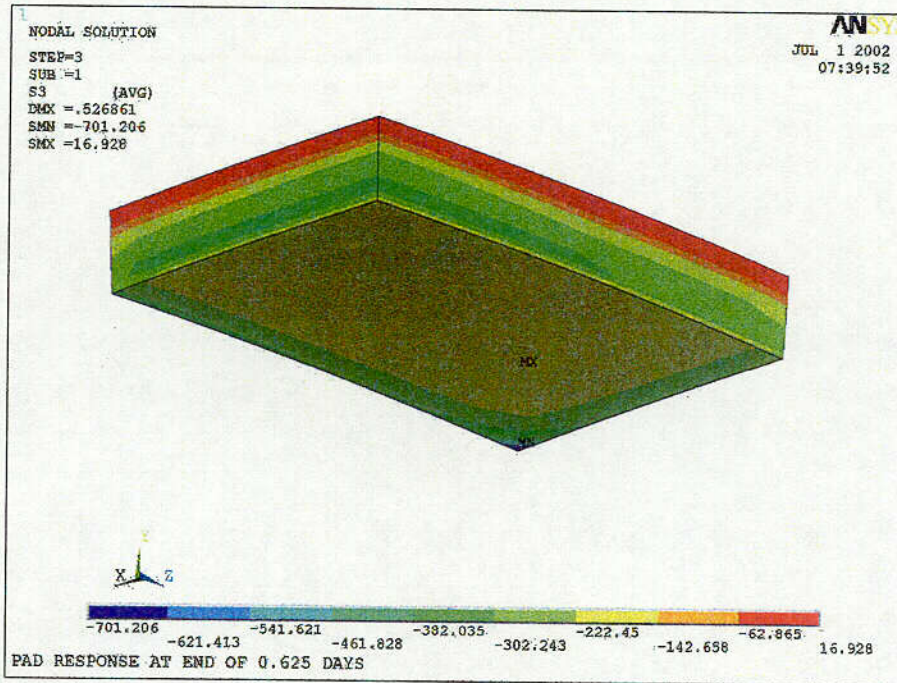


Figure 20 – Pad S3 Stresses – Load Case 3 - Viewing Direction is from -1,-0.5,-1

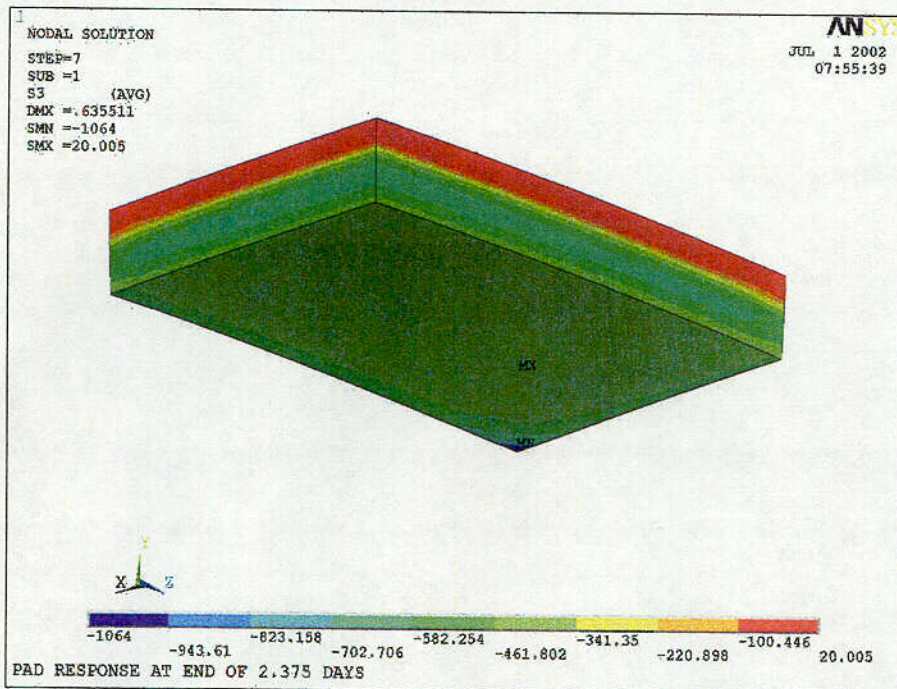
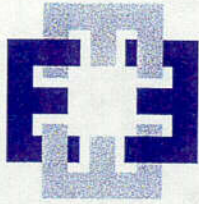


Figure 21 – Pad S3 Stresses – Load Case 7 - Viewing Direction is from -1,-0.5,-1

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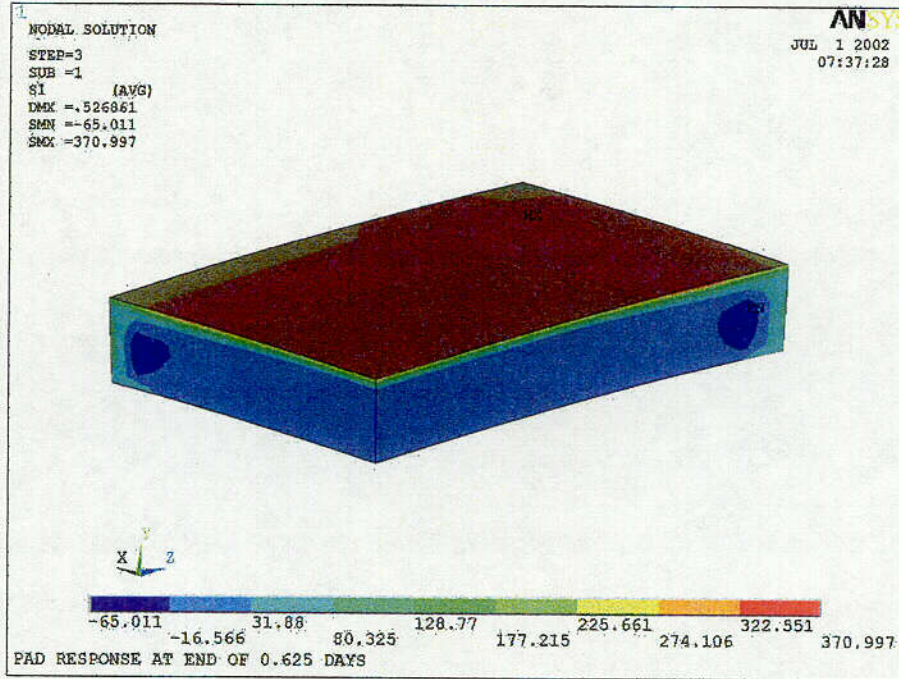


Figure 22 – Pad S1 Stresses – Load Case 3

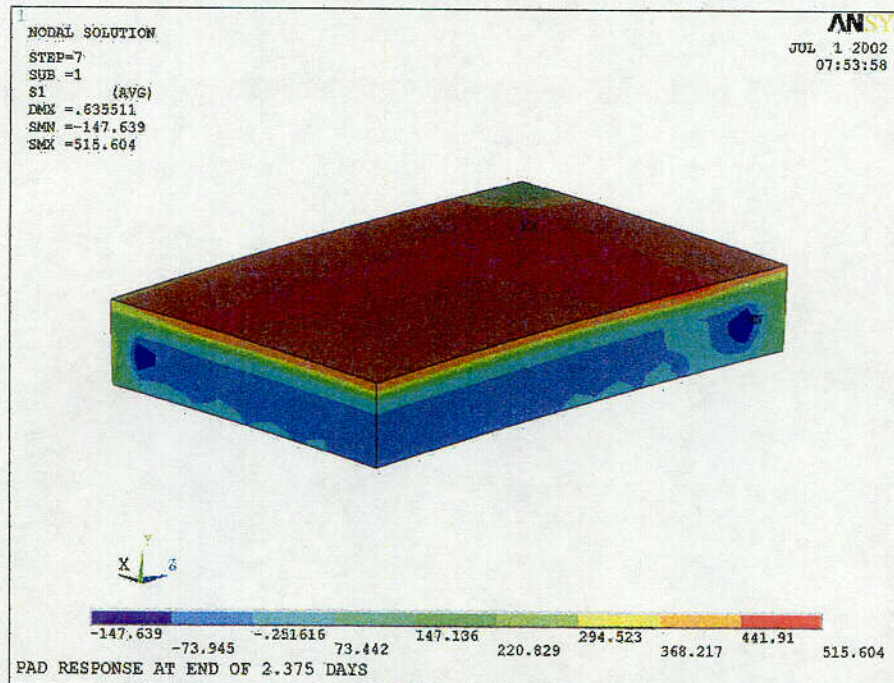


Figure 23 – Pad S1 Stresses – Load Case 7

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**Pad Response – Internal Forces**

The pad internal forces and moments will be used to size reinforcement and assess the level of expected cracking. The pad was divided into strips as discussed in Reference 1. Since the model here is only ¼ of the model used in the seismic analysis, modeled in the +X, +Z quadrant, the centerlines of this model lie at lines 5 ½ and C of the seismic model, see Figure 29, Reference 1. Since all the maximum stresses occur at the planes of symmetry, or nearly so, only the internal forces on lines 5 ½ and C are computed. (Though the Mx symbol does not appear at the edges in all the plots in Appendix STPad-TH, the stress contour maps indicate that the stresses are very close to the maxima at the edges.) The sign convention for these forces is also discussed in Reference 1. In this analysis, lines 5 ½ and C are the “last section” as described in Reference 1. The forces are provided in Table 9. The ANSYS output file documenting the post processing of these values is provided in Appendix FPad-TH. The values from the model are provided as well as the Design Values to be used for sizing the reinforcement.

**Table 9 (1/11)- Load Case 1 - Time 0.25 days**

**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

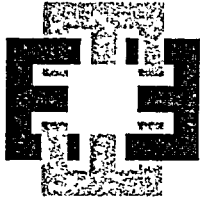
| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -18755   | -22048   | 22048             |
| Fz               | -2078832 | -1982198 | 2078832           |
| Mx               | -1793625 | 1003623  | 1793625           |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip   |          |          |          | Design<br>Values** |
|------------------|---------|----------|----------|----------|--------------------|
|                  | 5 ½ - 6 | 6-7      | 7-8      | 8-10     |                    |
| Fx               | -905053 | -1781997 | -1728982 | -987290  | 1678393            |
| Fy               | -4617   | -10354   | -12857   | -6861    | 12857              |
| Mz               | 109421  | -502375  | -2079998 | -2053499 | 3490948            |

\* Application of sign convention to maintain consistency with Reference 1 applied.

\*\* Application of sign convention to maintain consistency with Reference 1 applied. Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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**Table 9 (2/11) - Load Case 2 - Time 0.50 days**

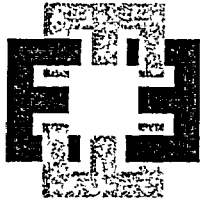
**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -18871   | -21932   | 21932             |
| Fz               | -3128490 | -3005009 | 3005009           |
| Mx               | 0.458E08 | 0.471E08 | -0.471E08         |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip     |           |           |           | Design<br>Values** |
|------------------|-----------|-----------|-----------|-----------|--------------------|
|                  | 5 ½ - 6   | 6-7       | 7-8       | 8-10      |                    |
| Fx               | -1403379  | -2780583  | -2732894  | -1557871  | 2732894            |
| Fy               | -4698     | -10515    | -13007    | -6470     | 13007              |
| Mz               | -0.234E08 | -0.475E08 | -0.490E08 | -0.284E08 | 0.490E08           |

- \* Application of sign convention to maintain consistency with Reference 1 applied.
- \*\* Application of sign convention to maintain consistency with Reference 1 applied. Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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**Table 9 (3/11) - Load Case 3 - Time 0.625 days**

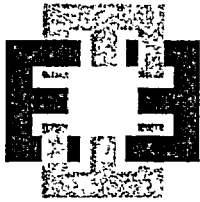
**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -18977   | -21826   | 21826             |
| Fz               | -3537558 | -3405193 | 3405193           |
| Mx               | 0.626E08 | 0.633E08 | -0.633E08         |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip     |           |           |           | Design<br>Values** |
|------------------|-----------|-----------|-----------|-----------|--------------------|
|                  | 5 ½ - 6   | 6-7       | 7-8       | 8-10      |                    |
| Fx               | -1587648  | -3151194  | -3109534  | -1773660  | 3109534            |
| Fy               | -4785     | -10678    | -13119    | -6107     | 13119              |
| Mz               | -0.318E08 | -0.643E08 | -0.657E08 | -0.377E08 | 0.657E08           |

\* Application of sign convention to maintain consistency with Reference 1 applied.  
 \*\* Application of sign convention to maintain consistency with Reference 1 applied.  
 Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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**Table 9 (4/11) - Load Case 4 - Time 1.125 days**

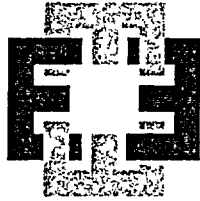
**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -19111   | -21692   | 21692             |
| Fz               | -4816988 | -4648875 | 4816988           |
| Mx               | 0.121E09 | 0.120E09 | -0.121E09         |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip     |           |           |           | Design<br>Values** |
|------------------|-----------|-----------|-----------|-----------|--------------------|
|                  | 5 ½ - 6   | 6-7       | 7-8       | 8-10      |                    |
| Fx               | -2189505  | -4356669  | -4319608  | -2460584  | 4319608            |
| Fy               | -4856     | -10832    | -13319    | -5682     | 13319              |
| Mz               | -0.602E08 | -0.121E09 | -0.123E09 | -0.700E08 | 0.123E09           |

- \* Application of sign convention to maintain consistency with Reference 1 applied.
- \*\* Application of sign convention to maintain consistency with Reference 1 applied. Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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**Table 9 (5/11) - Load Case 5 - Time 1.625 days**

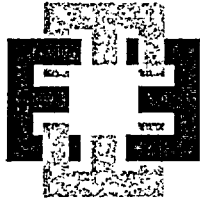
**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -19734   | -22181   | 22181             |
| Fz               | -5390017 | -5205515 | 5390017           |
| Mx               | 0.151E09 | 0.148E09 | -0.151E09         |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip     |           |           |           | Design<br>Values** |
|------------------|-----------|-----------|-----------|-----------|--------------------|
|                  | 5 ½ - 6   | 6-7       | 7-8       | 8-10      |                    |
| Fx               | -2463210  | -4907754  | -4877105  | -2777689  | 4877105            |
| Fy               | -7702     | -15932    | -14180    | -5871     | 15932              |
| Mz               | -0.743E08 | -0.149E09 | -0.150E09 | -0.852E08 | 0.150E09           |

- \* Application of sign convention to maintain consistency with Reference 1 applied.
- \*\* Application of sign convention to maintain consistency with Reference 1 applied. Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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**Table 9 (6/11) - Load Case 6 - Time 2.125 days**

**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -24522   | -22924   | 24522             |
| Fz               | -5574946 | -5388926 | 5574946           |
| Mx               | 0.163E09 | 0.159E09 | -0.163E09         |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip     |           |           |           | Design<br>Values** |
|------------------|-----------|-----------|-----------|-----------|--------------------|
|                  | 5 ½ - 6   | 6-7       | 7-8       | 8-10      |                    |
| Fx               | -2552628  | -5092094  | -5070757  | -2889199  | 5070757            |
| Fy               | -13915    | -17643    | -14699    | -6068     | 27830              |
| Mz               | -0.800E08 | -0.159E09 | -0.160E09 | -0.907E08 | 0.160E09           |

\* Application of sign convention to maintain consistency with Reference 1 applied.

\*\* Application of sign convention to maintain consistency with Reference 1 applied.  
 Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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**Table 9 (7/11) - Load Case 7 - Time 2.375 days**

**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -28239   | -23677   | 28239             |
| Fz               | -5581821 | -5399212 | 5581821           |
| Mx               | 0.166E09 | 0.162E09 | -0.166E09         |

**X Strips - Internal Forces (lbs. And in.-lbs.) - Line C**

| Force/<br>Moment | Strip     |           |           |           | Design<br>Values** |
|------------------|-----------|-----------|-----------|-----------|--------------------|
|                  | 5 ½ - 6   | 6-7       | 7-8       | 8-10      |                    |
| Fx               | -2559557  | -5110869  | -5098245  | -2906518  | 5119114            |
| Fy               | -17982    | -19557    | -15196    | -6280     | 35964              |
| Mz               | -0.816E08 | -0.162E09 | -0.162E09 | -0.918E08 | 0.163E09           |

- \* Application of sign convention to maintain consistency with Reference 1 applied.
- \*\* Application of sign convention to maintain consistency with Reference 1 applied. Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.





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**Table 9 (8/11) - Load Case 8 - Time 3.125 days**

**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -35575   | -24446   | 35575             |
| Fz               | -5456216 | -5281066 | 5456216           |
| Mx               | 0.164E09 | 0.158E09 | -0.164E09         |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip     |           |           |           | Design<br>Values** |
|------------------|-----------|-----------|-----------|-----------|--------------------|
|                  | 5 ½ - 6   | 6-7       | 7-8       | 8-10      |                    |
| Fx               | -2498078  | -4993234  | -4990939  | -2847986  | 4996156            |
| Fy               | -24934    | -21118    | -15672    | -6504     | 49868              |
| Mz               | -0.801E08 | -0.157E09 | -0.157E09 | -0.892E08 | 0.160E09           |

- \* Application of sign convention to maintain consistency with Reference 1 applied.
- \*\* Application of sign convention to maintain consistency with Reference 1 applied.  
 Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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 PROJECT DCPP ISFSI  
 SUBJECT ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses  
 CLIENT PG&E-DCPP ORIGINATOR S. C. Tumminelli  
 REVIEWER K. L. Whitmore APPROVED R. F. Evers  
 CALCULATION NO. PGE-009-CALC-006 REVISION 0

**Table 9 (9/11) - Load Case 9 - Time 4.125 days**

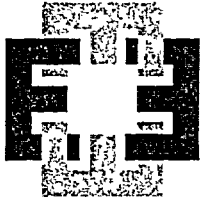
**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -44128   | -25231   | 44128             |
| Fz               | -4973948 | -4816150 | 4973948           |
| Mx               | 0.144E09 | 0.138E09 | -0.144E09         |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip     |           |           |           | Design<br>Values** |
|------------------|-----------|-----------|-----------|-----------|--------------------|
|                  | 5 ½ - 6   | 6-7       | 7-8       | 8-10      |                    |
| Fx               | -2266808  | -4535864  | -4544699  | -2597018  | 4533616            |
| Fy               | -32975    | -22679    | -16103    | -6759     | 65950              |
| Mz               | -0.705E08 | -0.137E09 | -0.136E09 | -0.773E08 | 0.141E09           |

\* Application of sign convention to maintain consistency with Reference 1 applied.  
 \*\* Application of sign convention to maintain consistency with Reference 1 applied.  
 Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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 CLIENT PG&E-DCPP ORIGINATOR S. C. Tumminelli  
 REVIEWER K. L. Whitmore APPROVED R. F. Evers  
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**Table 9 (10/11) - Load Case 10 - Time 6.125 days**

**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -54025   | -26040   | 54025             |
| Fz               | -3967223 | -3841025 | 3967223           |
| Mx               | 0.994E08 | 0.937E08 | -0.994E08         |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip     |           |           |           | Design<br>Values** |
|------------------|-----------|-----------|-----------|-----------|--------------------|
|                  | 5 ½ - 6   | 6-7       | 7-8       | 8-10      |                    |
| Fx               | -1787383  | -3581968  | -3603165  | -2064483  | 3574766            |
| Fy               | -42357    | -24255    | -16465    | -7061     | 84714              |
| Mz               | -0.492E08 | -0.924E08 | -0.912E08 | -0.519E08 | 0.984E08           |

- \* Application of sign convention to maintain consistency with Reference 1 applied.
- \*\* Application of sign convention to maintain consistency with Reference 1 applied. Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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**SUBJECT** ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses  
**CLIENT** PG&E-DCPP **ORIGINATOR** S. C. Tumminelli  
**REVIEWER** K. L. Whitmore **APPROVED** R. F. Evers  
**CALCULATION NO.** PGE-009-CALC-006 **REVISION** 0

**Table 9 (11/11) - Load Case 11 - Time 7.875 days**

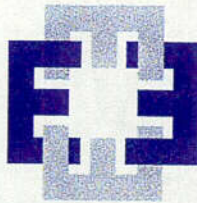
**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip    |          | Design<br>Values* |
|------------------|----------|----------|-------------------|
|                  | C-D      | D-E      |                   |
| Fy               | -61916   | -26847   | 61916             |
| Fz               | -3212272 | -3109565 | 3212272           |
| Mx               | 0.666E08 | 0.609E08 | -0.666E08         |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip     |           |           |           | Design<br>Values** |
|------------------|-----------|-----------|-----------|-----------|--------------------|
|                  | 5 ½ - 6   | 6-7       | 7-8       | 8-10      |                    |
| Fx               | -1434887  | -2881157  | -2912161  | -1673170  | 2869774            |
| Fy               | -49193    | -25814    | -16855    | -7335     | 98386              |
| Mz               | -0.338E08 | -0.602E08 | -0.584E08 | -0.333E08 | 0.676E08           |

- \* Application of sign convention to maintain consistency with Reference 1 applied.
- \*\* Application of sign convention to maintain consistency with Reference 1 applied. Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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|                 |   |            |                           |    |           |
|-----------------|---|------------|---------------------------|----|-----------|
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| PROJECT         | <u>DCPP ISFSI</u>   | DATE       | <u>September 20, 2002</u> |    |           |
| SUBJECT         | <u>ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses</u> |            |                           |    |           |
| CLIENT          | <u>PG&amp;E-DCPP</u>  | ORIGINATOR | <u>S. C. Tumminelli</u>   |    |           |
| REVIEWER        | <u>K. L. Whitmore</u>   | APPROVED   | <u>R. F. Evers</u>        |    |           |
| CALCULATION NO. | <u>PGE-009-CALC-006</u>   | REVISION   | <u>0</u>                  |    |           |

### Analysis Results – Shrinkage Stress Analysis

#### Pad Response – Displacements

The pad displacements are plotted in Figures 24 and 25 below. The maximum displacement of the pad is 0.0583 inches up at the corner. The displacements are also extracted from the data file and documented in Appendix DPad-SH.

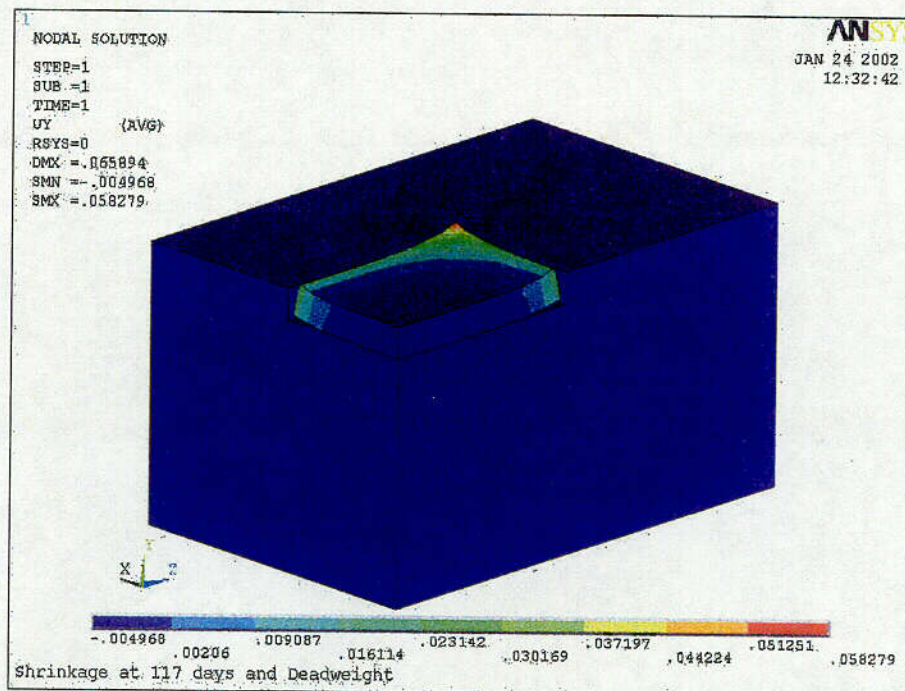
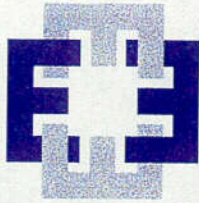


Figure 24 – Pad Shrinkage Vertical Displacements



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REVIEWER K. L. Whitmore APPROVED R. F. Evers  
CALCULATION NO. PGE-009-CALC-006 REVISION 0

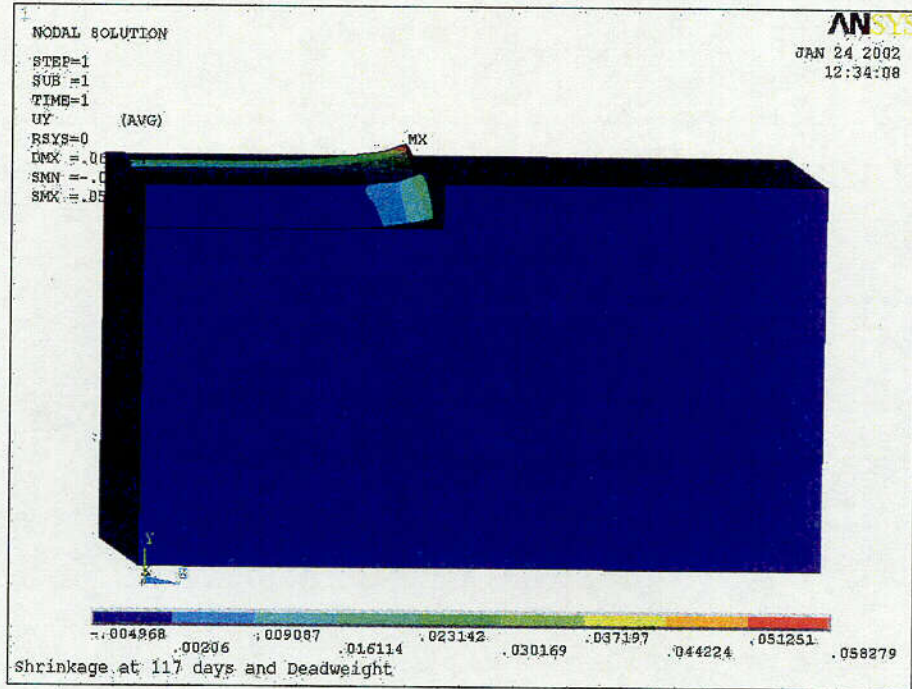
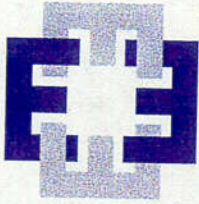


Figure 25 – Pad Shrinkage Vertical Displacements



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 CLIENT PG&E-DCPP ORIGINATOR S. C. Tumminelli  
 REVIEWER K. L. Whitmore APPROVED R. F. Evers  
 CALCULATION NO. PGE-009-CALC-006 REVISION 0

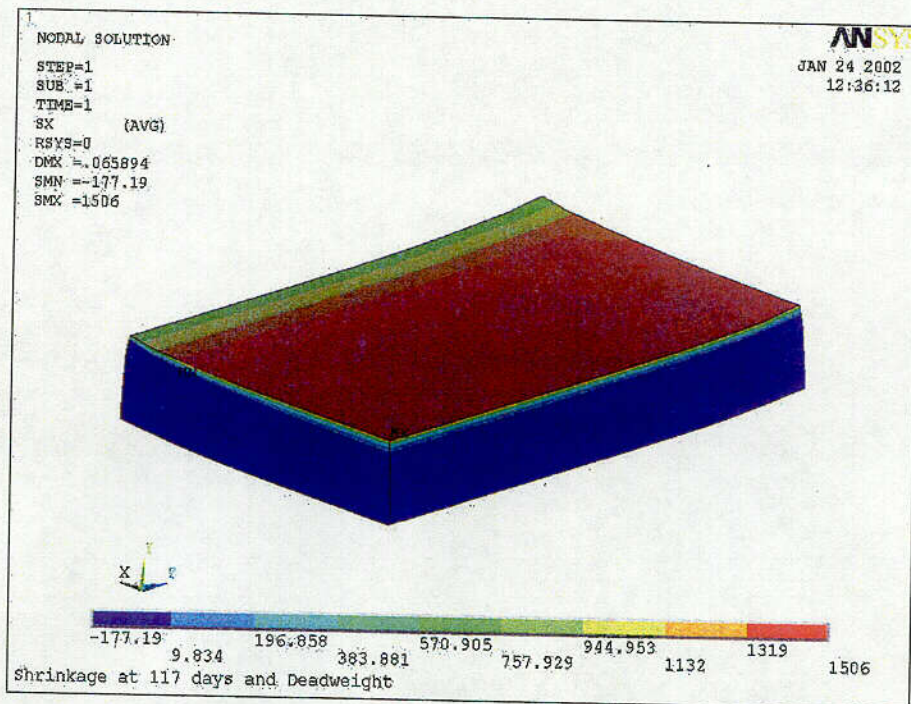
**Pad Response – Stresses**

Pad stresses are plotted in Figures 26 to 29 below. The maximum tensile stress S1 is very local to the top surface of the pad and extends almost completely over the surface. The full set of stresses are extracted from the data file and are provided in Table 10. The ANSYS run documenting this data is provided in Appendix SPad-SH.

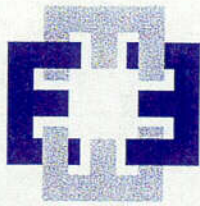
**Table 10 – Pad Stresses (psi)**

| $\sigma_X$ Max | $\sigma_X$ Min | $\sigma_Z$ Max | $\sigma_Z$ Min | $\sigma_1$ Max | $\sigma_3$ Min | $f'_c$ | $f_t^*$ |
|----------------|----------------|----------------|----------------|----------------|----------------|--------|---------|
| 1506           | -189           | 1524           | -183           | 1524           | -230           | 5000   | 474     |

$*f_t = 6.7\sqrt{f'_c}$



**Figure 26 – Pad Shrinkage SX Stresses**



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|                 |   |            |                           |    |           |
|-----------------|---|------------|---------------------------|----|-----------|
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| PROJECT         | <u>DCPP ISFSI</u>   | DATE       | <u>September 20, 2002</u> |    |           |
| SUBJECT         | <u>ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses</u> |            |                           |    |           |
| CLIENT          | <u>PG&amp;E-DCPP</u>  | ORIGINATOR | <u>S. C. Tumminelli</u>   |    |           |
| REVIEWER        | <u>K. L. Whitmore</u>   | APPROVED   | <u>R. F. Evers</u>        |    |           |
| CALCULATION NO. | <u>PGE-009-CALC-006</u>   | REVISION   | <u>0</u>                  |    |           |

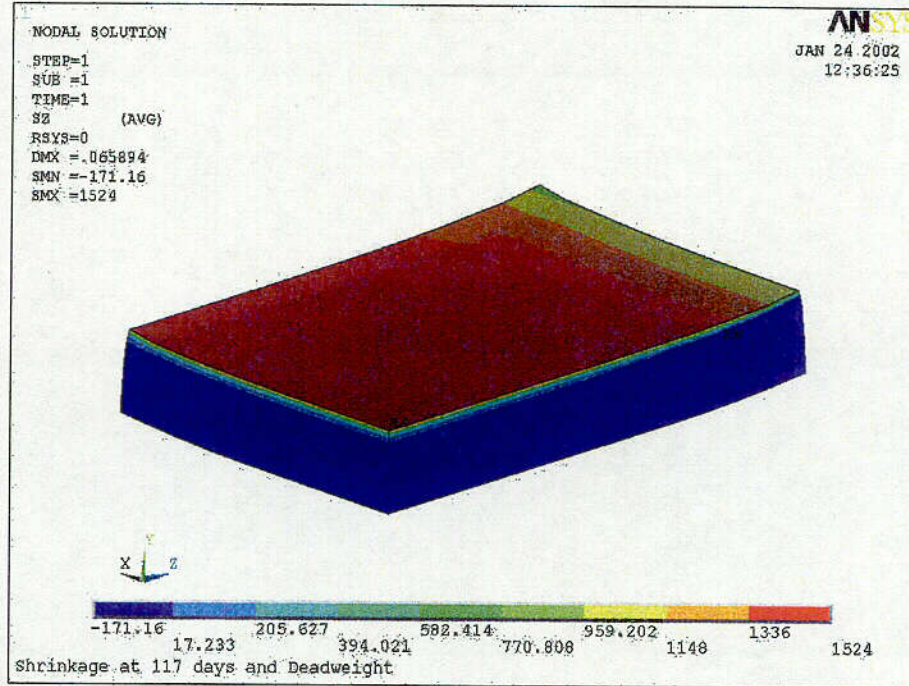


Figure 27 – Pad Shrinkage SZ Stresses

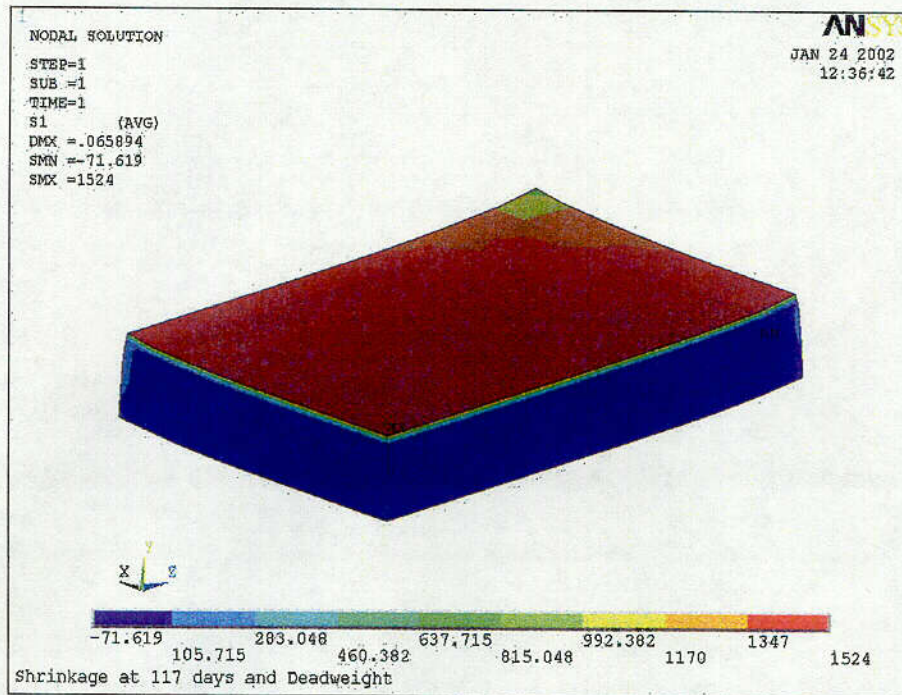


Figure 28 – Pad Shrinkage S1 Stresses

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|                 |  |            |                    |    |    |
|-----------------|--|------------|--------------------|----|----|
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| SUBJECT         | ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses |            |                    |    |    |
| CLIENT          | PG&E-DCPP  | ORIGINATOR | S. C. Tumminelli   |    |    |
| REVIEWER        | K. L. Whitmore   | APPROVED   | R. F. Evers        |    |    |
| CALCULATION NO. | PGE-009-CALC-006   | REVISION   | 0                  |    |    |

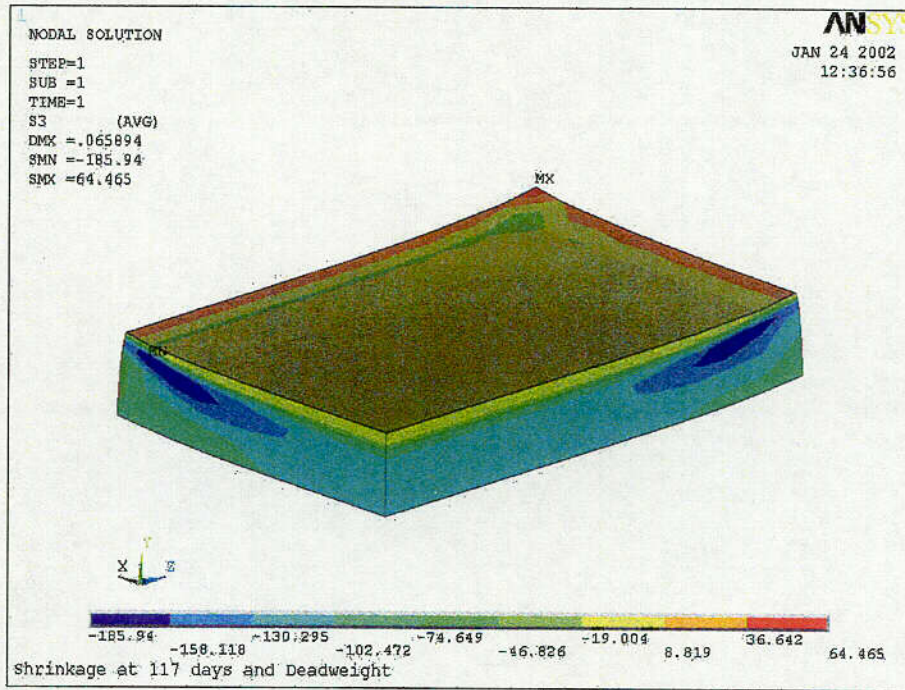


Figure 29 – Pad Shrinkage S3 Stresses



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 CLIENT PG&E-DCPP ORIGINATOR S. C. Tumminelli  
 REVIEWER K. L. Whitmore APPROVED R. F. Evers  
 CALCULATION NO. PGE-009-CALC-006 REVISION 0

**Pad Response – Internal Forces**

The pad internal forces are provided in Table 11 for lines 5 ½ and C. The ANSYS output documenting this data extraction is provided in Appendix FPad-SH.

**Table 11 - Shrinkage Stress Analysis**

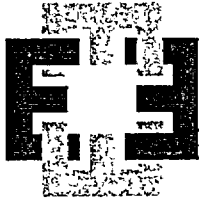
**Z Strips - Internal Forces (lbs. and in.-lbs.) - Line 5 ½**

| Force/<br>Moment | Strip   |         | Design<br>Values* |
|------------------|---------|---------|-------------------|
|                  | C-D     | D-E     |                   |
| Fy               | -33078  | -35415  | 35415             |
| Fz               | -39019  | -18571  | 39019             |
| Mx               | 0.854E8 | 0.792E8 | -0.854E8          |

**X Strips - Internal Forces (lbs. and in.-lbs.) - Line C**

| Force/<br>Moment | Strip    |          |          |          | Design<br>Values** |
|------------------|----------|----------|----------|----------|--------------------|
|                  | 5 ½ - 6  | 6-7      | 7-8      | 8-10     |                    |
| Fx               | -137830  | -314890  | -448136  | -288218  | 489971             |
| Fy               | -28244   | -57891   | -63084   | -31288   | 63084              |
| Mz               | -0.420E8 | -0.838E8 | -0.796E8 | -0.405E8 | 0.840E8            |

\* Application of sign convention to maintain consistency with Reference 1 applied.  
 \*\* Application of sign convention to maintain consistency with Reference 1 applied.  
 Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.



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**PROJECT** DCPP ISFSI **DATE** September 20, 2002  
**SUBJECT** ISFSI Cask Storage Pad Concrete Shrinkage and Thermal Stresses  
**CLIENT** PG&E-DCPP **ORIGINATOR** S. C. Tumminelli  
**REVIEWER** K. L. Whitmore **APPROVED** R. F. Evers  
**CALCULATION NO.** PGE-009-CALC-006 **REVISION** 0

Also, pad internal forces for the top 12 inches and the top 6 inches are provided in Table 12 for lines 5 ½ and C. This data is extracted from the database to provide a sense for the tension force calculated in the top sections of the pad. The ANSYS output documenting this data extraction is provided in Appendix FTPad-SH.

**Table 12 - Shrinkage Stress Analysis**

**Z Strips - Internal Forces for top 12 inches and top 6 inches (lbs.) - Line 5 ½**

| Force        | Strip   |         | Design Values * |
|--------------|---------|---------|-----------------|
|              | C-D     | D-E     |                 |
| Fz 12 inches | 1510694 | 1419874 | -1510694        |
| Fz 6 inches  | 1358678 | 1143045 | -1358678        |

**X Strips - Internal Forces for top 12 inches and top 6 inches (lbs.) - Line C**

| Force       | Strip   |         |         |        | Design Values ** |
|-------------|---------|---------|---------|--------|------------------|
|             | 5 ½ - 6 | 6-7     | 7-8     | 8-10   |                  |
| Fx12 inches | 718835  | 1430751 | 1384017 | 752669 | -1437670         |
| Fx 6 inches | 578436  | 1153356 | 1128242 | 629499 | -1156872         |

- \* Application of sign convention to maintain consistency with Reference 1 applied.
- \*\* Application of sign convention to maintain consistency with Reference 1 applied. Normalization to a 17-foot wide strip has been performed. Values for strip 5 ½ - 6 factored by 2, and values for strip 8-10 factored by 1.7.

**Summary and Conclusions**

This calculation computes applied internal forces due to pad heat up due to cement hydration and subsequent pad shrinkage. The values to be used in subsequent calculations to assess the probability of expected cracking and to size the reinforcement are provided in Tables 9, 11 and 12.



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**Appendix TH-Loads to Calculation PGE-009-CALC-006**

Originator:

*S. C. Tumminelli*  
S. C. Tumminelli

Date:

September 20, 2002

**Appendix TH-Loads**

This Appendix presents the ANSYS file documenting the applied loads for the thermal stress analysis.



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Appendix TH-Loads to Calculation PGE-009-CALC-006

### ANSYS Input File:

```

/FILE, PAD-TH
RESUME
EALL
NALL
MPLI
CMLI
/PREP7
LSCLEAR, ALL
/title, DELTA T 0.0 TO 0.25 DAYS
/COM, BC'S ALL LOAD STEPS
ACEL, 0, 1, 0
D, SYMKY, UZ, 0.0
D, SYMYZ, UX, 0.0
D, XEDGE, UX, 0.0
D, XEDGE, UY, 0.0
D, XEDGE, UZ, 0.0
D, ZEDGE, UX, 0.0
D, ZEDGE, UY, 0.0
D, ZEDGE, UZ, 0.0
D, BOT, UX, 0.0
D, BOT, UY, 0.0
D, BOT, UZ, 0.0
BFUNIF, TEMP, 0.0
BF, CONC80, TEMP, 15.00
BF, CONC75, TEMP, 18.00
BF, CONC70, TEMP, 19.67
BF, CONC65, TEMP, 21.33
BF, CONC60, TEMP, 21.33
BF, CONC50, TEMP, 21.33
BF, CONC40, TEMP, 21.33
BF, CONC30, TEMP, 21.33
BF, CONC20, TEMP, 21.33
BF, CONC10, TEMP, 20.50
BF, CONC05, TEMP, 19.66
BF, CONC00, TEMP, 10.67
BF, ROCK05, TEMP, 1.67
BF, ROCK10, TEMP, 0.84
BF, ROCK20, TEMP, 0.0
BF, ROCK30, TEMP, 0.0
BF, ROCK40, TEMP, 0.0
LSWRITE, 1
/title, DELTA T 0.25 TO 0.50 DAYS
/COM, NO DEAD WEIGHT AFTER FIRST LOAD STEP
ACEL, 0, 0.01, 0
BF, CONC80, TEMP, -2.50
BF, CONC75, TEMP, 10.50
BF, CONC70, TEMP, 9.25
BF, CONC65, TEMP, 8.00
BF, CONC60, TEMP, 16.67
BF, CONC50, TEMP, 25.33
BF, CONC40, TEMP, 25.33
BF, CONC30, TEMP, 25.33
BF, CONC20, TEMP, 25.12
BF, CONC10, TEMP, 21.41
  
```



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**Appendix TH-Loads to Calculation PGE-009-CALC-006 .**

```

BF, CONC05, TEMP, 17.92
BF, CONC00, TEMP, 12.66
BF, ROCK05, TEMP, 7.41
BF, ROCK10, TEMP, 3.91
BF, ROCK20, TEMP, 0.21
BF, ROCK30, TEMP, 0.0
BF, ROCK40, TEMP, 0.0
LSWRITE, 2
/title, DELTA T 0.50 TO 0.625 DAYS
BF, CONC80, TEMP, -3.00
BF, CONC75, TEMP, -1.35
BF, CONC70, TEMP, 9.32
BF, CONC65, TEMP, 13.46
BF, CONC60, TEMP, 9.33
BF, CONC50, TEMP, 9.33
BF, CONC40, TEMP, 9.33
BF, CONC30, TEMP, 9.33
BF, CONC20, TEMP, 9.33
BF, CONC10, TEMP, 9.33
BF, CONC05, TEMP, 2.04
BF, CONC00, TEMP, 4.67
BF, ROCK05, TEMP, 7.30
BF, ROCK10, TEMP, 0.0
BF, ROCK20, TEMP, 0.0
BF, ROCK30, TEMP, 0.0
BF, ROCK40, TEMP, 0.0
LSWRITE, 3
/title, DELTA T 0.625 TO 1.125 DAYS
BF, CONC80, TEMP, -5.40
BF, CONC75, TEMP, -7.44
BF, CONC70, TEMP, -8.81
BF, CONC65, TEMP, -3.10
BF, CONC60, TEMP, 2.62
BF, CONC50, TEMP, 15.00
BF, CONC40, TEMP, 20.11
BF, CONC30, TEMP, 20.32
BF, CONC20, TEMP, 17.86
BF, CONC10, TEMP, 11.88
BF, CONC05, TEMP, 11.11
BF, CONC00, TEMP, 10.33
BF, ROCK05, TEMP, 9.55
BF, ROCK10, TEMP, 8.78
BF, ROCK20, TEMP, 2.81
BF, ROCK30, TEMP, 0.35
BF, ROCK40, TEMP, 0.01
LSWRITE, 4
/title, DELTA T 1.125 TO 1.625 DAYS
BF, CONC80, TEMP, -2.10
BF, CONC75, TEMP, -5.50
BF, CONC70, TEMP, -6.46
BF, CONC65, TEMP, -4.73
BF, CONC60, TEMP, -3.00
BF, CONC50, TEMP, 2.25
BF, CONC40, TEMP, 7.32
BF, CONC30, TEMP, 8.45
BF, CONC20, TEMP, 6.32
BF, CONC10, TEMP, 3.74
    
```



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**Appendix TH-Loads to Calculation PGE-009-CALC-006**

```

BF, CONC05, TEMP, 4.45
BF, CONC00, TEMP, 5.16
BF, ROCK05, TEMP, 5.88
BF, ROCK10, TEMP, 6.60
BF, ROCK20, TEMP, 3.98
BF, ROCK30, TEMP, 1.38
BF, ROCK40, TEMP, 0.25
LSWRITE, 5
/title, DELTA T 1.625 TO 2.125 DAYS
BF, CONC80, TEMP, -0.80
BF, CONC75, TEMP, -3.06
BF, CONC70, TEMP, -4.06
BF, CONC65, TEMP, -3.96
BF, CONC60, TEMP, -3.87
BF, CONC50, TEMP, -2.22
BF, CONC40, TEMP, 0.96
BF, CONC30, TEMP, 2.29
BF, CONC20, TEMP, 1.53
BF, CONC10, TEMP, 0.91
BF, CONC05, TEMP, 1.87
BF, CONC00, TEMP, 2.83
BF, ROCK05, TEMP, 3.78
BF, ROCK10, TEMP, 4.72
BF, ROCK20, TEMP, 3.82
BF, ROCK30, TEMP, 1.98
BF, ROCK40, TEMP, 0.53
LSWRITE, 6
/title, DELTA T 2.125 TO 2.375 DAYS
BF, CONC80, TEMP, -0.20
BF, CONC75, TEMP, -0.94
BF, CONC70, TEMP, -1.28
BF, CONC65, TEMP, -1.47
BF, CONC60, TEMP, -1.65
BF, CONC50, TEMP, -1.51
BF, CONC40, TEMP, -0.54
BF, CONC30, TEMP, 0.08
BF, CONC20, TEMP, 0.09
BF, CONC10, TEMP, 0.20
BF, CONC05, TEMP, 0.63
BF, CONC00, TEMP, 1.06
BF, ROCK05, TEMP, 1.46
BF, ROCK10, TEMP, 1.86
BF, ROCK20, TEMP, 1.73
BF, ROCK30, TEMP, 1.05
BF, ROCK40, TEMP, 0.33
LSWRITE, 7
/title, DELTA T 2.375 TO 3.125 DAYS
BF, CONC80, TEMP, -0.50
BF, CONC75, TEMP, -2.13
BF, CONC70, TEMP, -3.07
BF, CONC65, TEMP, -3.90
BF, CONC60, TEMP, -4.74
BF, CONC50, TEMP, -5.60
BF, CONC40, TEMP, -4.20
BF, CONC30, TEMP, -2.72
BF, CONC20, TEMP, -1.85
BF, CONC10, TEMP, -0.66
    
```



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**Appendix TH-Loads to Calculation PGE-009-CALC-006**

```

BF, CONC05, TEMP, 0.64
BF, CONC00, TEMP, 1.94
BF, ROCK05, TEMP, 3.10
BF, ROCK10, TEMP, 4.26
BF, ROCK20, TEMP, 4.39
BF, ROCK30, TEMP, 3.00
BF, ROCK40, TEMP, 1.03
LSWRITE, 8
/title, DELTA T 3.125 TO 4.125 DAYS
BF, CONC80, TEMP, -0.30
BF, CONC75, TEMP, -2.03
BF, CONC70, TEMP, -3.14
BF, CONC65, TEMP, -4.49
BF, CONC60, TEMP, -5.84
BF, CONC50, TEMP, -8.34
BF, CONC40, TEMP, -8.35
BF, CONC30, TEMP, -7.11
BF, CONC20, TEMP, -5.33
BF, CONC10, TEMP, -2.91
BF, CONC05, TEMP, -1.19
BF, CONC00, TEMP, 0.54
BF, ROCK05, TEMP, 1.98
BF, ROCK10, TEMP, 3.43
BF, ROCK20, TEMP, 4.18
BF, ROCK30, TEMP, 3.19
BF, ROCK40, TEMP, 1.18
LSWRITE, 9
/title, DELTA T 4.125 TO 6.125 DAYS
BF, CONC80, TEMP, 0.0
BF, CONC75, TEMP, -1.38
BF, CONC70, TEMP, -2.61
BF, CONC65, TEMP, -4.76
BF, CONC60, TEMP, -6.91
BF, CONC50, TEMP, -11.78
BF, CONC40, TEMP, -13.65
BF, CONC30, TEMP, -12.77
BF, CONC20, TEMP, -9.82
BF, CONC10, TEMP, -5.60
BF, CONC05, TEMP, -3.36
BF, CONC00, TEMP, -1.12
BF, ROCK05, TEMP, 0.66
BF, ROCK10, TEMP, 2.43
BF, ROCK20, TEMP, 4.06
BF, ROCK30, TEMP, 3.52
BF, ROCK40, TEMP, 1.37
LSWRITE, 10
/title, DELTA T 6.125 TO 7.875 DAYS
BF, CONC80, TEMP, 0.0
BF, CONC75, TEMP, -0.69
BF, CONC70, TEMP, -1.33
BF, CONC65, TEMP, -2.51
BF, CONC60, TEMP, -3.69
BF, CONC50, TEMP, -6.58
BF, CONC40, TEMP, -8.12
BF, CONC30, TEMP, -8.10
BF, CONC20, TEMP, -6.75
BF, CONC10, TEMP, -4.56
  
```



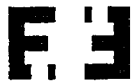


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**Appendix TH-Loads to Calculation PGE-009-CALC-006**

BF, CONC05, TEMP, -3.38  
BF, CONC00, TEMP, -2.20  
BF, ROCK05, TEMP, -1.23  
BF, ROCK10, TEMP, -0.25  
BF, ROCK20, TEMP, 0.85  
BF, ROCK30, TEMP, 1.01  
BF, ROCK40, TEMP, 0.43  
LSWRITE, 11  
FINISH  
/EXIT, NOSAVE

2



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Appendix RPad-TH to Calculation PGE-009-CALC-006

Originator:

  
S. C. Tumminelli

Date:

September 20, 2002

## Appendix RPad-TH

This Appendix presents the ANSYS output file documenting the execution of the thermal stress analysis and the output temperatures for checking.



ANSYS Output File:

ANSYS/Mechanical U

```

*-----*
| W E L C O M E   T O   T H E   A N S Y S   P R O G R A M |
*-----*

```

```

*****
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*****
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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

\* RESPONSIBILITY OF THE USER TO CONFIRM THE ACCURACY AND \*  
 \* USEFULNESS OF THE RESULTS. \*  
 \*\*\*\*\*

Completing ANSYS Load Process.

\*\*\*\*\* ANSYS COMMAND LINE ARGUMENTS \*\*\*\*\*

INITIAL JOBNAME = PAD-TH  
 BATCH MODE REQUESTED = LIST  
 MEMORY REQUESTED (MB) = 800  
 DATABASE SIZE REQUESTED (MB) = 250

\*\*\* WARNING \*\*\* CP= 0.180 TIME= 16:49:19  
 Use of the -M switch is no longer recommended for normal ANSYS use.  
 ANSYS now dynamically allocates memory as needed. Only use the -M  
 switch if you are certain that you need to do so.

PARAMETER STATUS- ( 1 PARAMETERS DEFINED)  
 (INCLUDING 1 INTERNAL PARAMETERS)

00245050 VERSION=INTEL NT RELEASE= 6.1 UP20020321  
 CURRENT JOBNAME=PAD-TH 16:49:19 JUN 10, 2002 CP= 0.180

- 1 resume
- 2 nall
- 3 eall
- 4 mpli
- 5 /com start, change the material properties for each time step, initial
- 6 /com property is no. 2. Change back to no. 2 at end and save.
- 7 /solu
- 8 /HEADER,ON,OFF,OFF,OFF,ON,OFF
- 9 elist,530
- 10 lssolve,1
- 11 esel,type,2
- 12 mpchg,3,all
- 13 eall
- 14 elist,530
- 15 lssolve,2
- 16 esel,type,2
- 17 mpchg,4,all
- 18 eall
- 19 elist,530
- 20 lssolve,3
- 21 esel,type,2
- 22 mpchg,5,all
- 23 eall
- 24 elist,530
- 25 lssolve,4
- 26 esel,type,2
- 27 mpchg,6,all
- 28 eall
- 29 elist,530
- 30 lssolve,5
- 31 esel,type,2
- 32 mpchg,7,all



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Appendix RPad-TH to Calculation PGE-009-CALC-006

```
33 eall
34 elist,530
35 lssolve,6
36 esel,type,2
37 mpchg,8,all
38 eall
39 elist,530
40 lssolve,7
41 esel,type,2
42 mpchg,9,all
43 eall
44 elist,530
45 lssolve,8
46 esel,type,2
47 mpchg,10,all
48 eall
49 elist,530
50 lssolve,9
51 esel,type,2
52 mpchg,11,all
53 eall
54 elist,530
55 lssolve,10
56 esel,type,2
57 mpchg,12,all
58 eall
59 elist,530
60 lssolve,11
61 esel,type,2
62 mpchg,2,all
63 eall
64 elist,530
65 finish
66 save
67 /POST1
68 /HEADER,ON,OFF,OFF,OFF,ON,OFF
69 /COM
70 /COM SUM RESULTS, SET TITLES AND WRITE LOAD CASE FILES FOR FURTHER
PROCESSING
71 /COM
72 LCSUM,ALL
73 LCDEF,1,1
74 LCDEF,2,2
75 LCDEF,3,3
76 LCDEF,4,4
77 LCDEF,5,5
78 LCDEF,6,6
79 LCDEF,7,7
80 LCDEF,8,8
81 LCDEF,9,9
82 LCDEF,10,10
83 LCDEF,11,11
84 LCASE,1
85 /TITLE,PAD RESPONSE AT END OF 0.25 DAYS
86 LCWRITE,1
87 LCOPER,ADD,2
88 /TITLE,PAD RESPONSE AT END OF 0.50 DAYS
```



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## Appendix RPad-TH to Calculation PGE-009-CALC-006

```
89 LCWRITE, 2
90 LCOOPER, ADD, 3
91 /TITLE, PAD RESPONSE AT END OF 0.625 DAYS
92 LCWRITE, 3
93 LCOOPER, ADD, 4
94 /TITLE, PAD RESPONSE AT END OF 1.125 DAYS
95 LCWRITE, 4
96 LCOOPER, ADD, 5
97 /TITLE, PAD RESPONSE AT END OF 1.625 DAYS
98 LCWRITE, 5
99 LCOOPER, ADD, 6
100 /TITLE, PAD RESPONSE AT END OF 2.125 DAYS
101 LCWRITE, 6
102 LCOOPER, ADD, 7
103 /TITLE, PAD RESPONSE AT END OF 2.375 DAYS
104 LCWRITE, 7
105 LCOOPER, ADD, 8
106 /TITLE, PAD RESPONSE AT END OF 3.125 DAYS
107 LCWRITE, 8
108 LCOOPER, ADD, 9
109 /TITLE, PAD RESPONSE AT END OF 4.125 DAYS
110 LCWRITE, 9
111 LCOOPER, ADD, 10
112 /TITLE, PAD RESPONSE AT END OF 6.125 DAYS
113 LCWRITE, 10
114 LCOOPER, ADD, 11
115 /TITLE, PAD RESPONSE AT END OF 7.875 DAYS
116 LCWRITE, 11
117 FINISH
118 /com print the temperatures for checking
119 EALL
120 NALL
121 /POST1
122 /HEADER, ON, OFF, OFF, OFF, ON, OFF
123 NSEL, S, LOC, X, 0.0
124 NSEL, R, LOC, Z, 0.0
125 NSEL, R, LOC, Y, 0.0, -145.0
126 NLIS
127 SET, 1
128 NSORT, LOC, Y
129 PRNSOL, BFE
130 SET, 2
131 NSORT, LOC, Y
132 PRNSOL, BFE
133 SET, 3
134 NSORT, LOC, Y
135 PRNSOL, BFE
136 SET, 4
137 NSORT, LOC, Y
138 PRNSOL, BFE
139 SET, 5
140 NSORT, LOC, Y
141 PRNSOL, BFE
142 SET, 6
143 NSORT, LOC, Y
144 PRNSOL, BFE
145 SET, 7
```



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Appendix RPad-TH to Calculation PGE-009-CALC-006

```
146 NSORT,LOC,Y
147 PRNSOL,BFE
148 SET,8
149 NSORT,LOC,Y
150 PRNSOL,BFE
151 SET,9
152 NSORT,LOC,Y
153 PRNSOL,BFE
154 SET,10
155 NSORT,LOC,Y
156 PRNSOL,BFE
157 SET,11
158 NSORT,LOC,Y
159 PRNSOL,BFE
160 LCASE,1
161 NSORT,LOC,Y
162 PRNSOL,BFE
163 LCASE,2
164 NSORT,LOC,Y
165 PRNSOL,BFE
166 LCASE,3
167 NSORT,LOC,Y
168 PRNSOL,BFE
169 LCASE,4
170 NSORT,LOC,Y
171 PRNSOL,BFE
172 LCASE,5
173 NSORT,LOC,Y
174 PRNSOL,BFE
175 LCASE,6
176 NSORT,LOC,Y
177 PRNSOL,BFE
178 LCASE,7
179 NSORT,LOC,Y
180 PRNSOL,BFE
181 LCASE,8
182 NSORT,LOC,Y
183 PRNSOL,BFE
184 LCASE,9
185 NSORT,LOC,Y
186 PRNSOL,BFE
187 LCASE,10
188 NSORT,LOC,Y
189 PRNSOL,BFE
190 LCASE,11
191 NSORT,LOC,Y
192 PRNSOL,BFE
193 NUSORT
194 FINISH
195 eall
196 nall
197 /EXIT,NOSAVE
```

```
RUN SETUP PROCEDURE FROM FILE= C:\Program Files\Ansys
Inc\ANSYS61\docu\start61.ans
```

```
/INPUT FILE= C:\Program Files\Ansys Inc\ANSYS61\docu\start61.ans LINE=
```

0





RESUME ANSYS DATA FROM FILE NAME=PAD-TH.db

\*\*\* ANSYS GLOBAL STATUS \*\*\*

TITLE = Pad thermal analysis model  
NUMBER OF ELEMENT TYPES = 5  
8812 ELEMENTS CURRENTLY SELECTED. MAX ELEMENT NUMBER = 9341  
10212 NODES CURRENTLY SELECTED. MAX NODE NUMBER = 10212  
166 KEYPOINTS CURRENTLY SELECTED. MAX KEYPOINT NUMBER = 166  
339 LINES CURRENTLY SELECTED. MAX LINE NUMBER = 339  
2 AREAS CURRENTLY SELECTED. MAX AREA NUMBER = 224  
48 VOLUMES CURRENTLY SELECTED. MAX VOL. NUMBER = 48  
22 COMPONENTS CURRENTLY DEFINED  
MAXIMUM LINEAR PROPERTY NUMBER = 12  
MAXIMUM REAL CONSTANT SET NUMBER = 1  
ACTIVE COORDINATE SYSTEM = 0 (CARTESIAN)  
MAXIMUM COUPLED D.O.F. SET NUMBER = 367

INITIAL JOBNAME = PAD-TH  
CURRENT JOBNAME = PAD-TH

10212 NODES (OF 10212 DEFINED) SELECTED BY NALL COMMAND.

8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

LIST MATERIALS 1 TO 12 BY 1  
PROPERTY= ALL

|                   |             |             |              |             |      |  |
|-------------------|-------------|-------------|--------------|-------------|------|--|
| PROPERTY TABLE EX | MAT=        | 1           | NUM. POINTS= | 1           |      |  |
| TEMPERATURE       | DATA        | TEMPERATURE | DATA         | TEMPERATURE | DATA |  |
| 0.0000            | 0.20000E+07 |             |              |             |      |  |

|                     |         |             |              |             |      |  |
|---------------------|---------|-------------|--------------|-------------|------|--|
| PROPERTY TABLE NUXY | MAT=    | 1           | NUM. POINTS= | 1           |      |  |
| TEMPERATURE         | DATA    | TEMPERATURE | DATA         | TEMPERATURE | DATA |  |
| 0.0000              | 0.24000 |             |              |             |      |  |

|                     |             |             |              |             |      |  |
|---------------------|-------------|-------------|--------------|-------------|------|--|
| PROPERTY TABLE ALPX | MAT=        | 1           | NUM. POINTS= | 1           |      |  |
| TEMPERATURE         | DATA        | TEMPERATURE | DATA         | TEMPERATURE | DATA |  |
| 0.0000              | 0.50000E-05 |             |              |             |      |  |

|                     |        |             |              |             |      |  |
|---------------------|--------|-------------|--------------|-------------|------|--|
| PROPERTY TABLE DENS | MAT=   | 1           | NUM. POINTS= | 1           |      |  |
| TEMPERATURE         | DATA   | TEMPERATURE | DATA         | TEMPERATURE | DATA |  |
| 0.0000              | 0.0000 |             |              |             |      |  |

|                   |             |             |              |             |      |  |
|-------------------|-------------|-------------|--------------|-------------|------|--|
| PROPERTY TABLE EX | MAT=        | 2           | NUM. POINTS= | 1           |      |  |
| TEMPERATURE       | DATA        | TEMPERATURE | DATA         | TEMPERATURE | DATA |  |
| 0.0000            | 0.92400E+06 |             |              |             |      |  |

|                     |         |             |              |             |      |  |
|---------------------|---------|-------------|--------------|-------------|------|--|
| PROPERTY TABLE NUXY | MAT=    | 2           | NUM. POINTS= | 1           |      |  |
| TEMPERATURE         | DATA    | TEMPERATURE | DATA         | TEMPERATURE | DATA |  |
| 0.0000              | 0.15000 |             |              |             |      |  |

|                     |             |             |              |             |      |  |
|---------------------|-------------|-------------|--------------|-------------|------|--|
| PROPERTY TABLE ALPX | MAT=        | 2           | NUM. POINTS= | 1           |      |  |
| TEMPERATURE         | DATA        | TEMPERATURE | DATA         | TEMPERATURE | DATA |  |
| 0.0000              | 0.51800E-05 |             |              |             |      |  |



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

|                |             |             |      |             |         |             |      |  |
|----------------|-------------|-------------|------|-------------|---------|-------------|------|--|
| PROPERTY TABLE | DENS        | MAT=        | 2    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.78100E-01 |             |      |             |         |             |      |  |
| PROPERTY TABLE | EX          | MAT=        | 3    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.13060E+07 |             |      |             |         |             |      |  |
| PROPERTY TABLE | NUXY        | MAT=        | 3    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.15000     |             |      |             |         |             |      |  |
| PROPERTY TABLE | ALPX        | MAT=        | 3    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.51800E-05 |             |      |             |         |             |      |  |
| PROPERTY TABLE | DENS        | MAT=        | 3    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.78100E-01 |             |      |             |         |             |      |  |
| PROPERTY TABLE | EX          | MAT=        | 4    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.14600E+07 |             |      |             |         |             |      |  |
| PROPERTY TABLE | NUXY        | MAT=        | 4    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.15000     |             |      |             |         |             |      |  |
| PROPERTY TABLE | ALPX        | MAT=        | 4    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.51800E-05 |             |      |             |         |             |      |  |
| PROPERTY TABLE | DENS        | MAT=        | 4    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.78100E-01 |             |      |             |         |             |      |  |
| PROPERTY TABLE | EX          | MAT=        | 5    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.19640E+07 |             |      |             |         |             |      |  |
| PROPERTY TABLE | NUXY        | MAT=        | 5    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.15000     |             |      |             |         |             |      |  |
| PROPERTY TABLE | ALPX        | MAT=        | 5    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.51800E-05 |             |      |             |         |             |      |  |
| PROPERTY TABLE | DENS        | MAT=        | 5    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.78100E-01 |             |      |             |         |             |      |  |
| PROPERTY TABLE | EX          | MAT=        | 6    | NUM.        | POINTS= | 1           |      |  |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA | TEMPERATURE | DATA    | TEMPERATURE | DATA |  |
| 0.0000         | 0.23580E+07 |             |      |             |         |             |      |  |
| PROPERTY TABLE | NUXY        | MAT=        | 6    | NUM.        | POINTS= | 1           |      |  |



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

|                |             |             |         |             |      |
|----------------|-------------|-------------|---------|-------------|------|
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.15000     |             |         |             |      |
| PROPERTY TABLE | ALPX MAT=   | 6 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.51800E-05 |             |         |             |      |
| PROPERTY TABLE | DENS MAT=   | 6 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.78100E-01 |             |         |             |      |
| PROPERTY TABLE | EX MAT=     | 7 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.26740E+07 |             |         |             |      |
| PROPERTY TABLE | NUXY MAT=   | 7 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.15000     |             |         |             |      |
| PROPERTY TABLE | ALPX MAT=   | 7 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.51800E-05 |             |         |             |      |
| PROPERTY TABLE | DENS MAT=   | 7 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.78100E-01 |             |         |             |      |
| PROPERTY TABLE | EX MAT=     | 8 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.27880E+07 |             |         |             |      |
| PROPERTY TABLE | NUXY MAT=   | 8 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.15000     |             |         |             |      |
| PROPERTY TABLE | ALPX MAT=   | 8 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.51800E-05 |             |         |             |      |
| PROPERTY TABLE | DENS MAT=   | 8 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.78100E-01 |             |         |             |      |
| PROPERTY TABLE | EX MAT=     | 9 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.30800E+07 |             |         |             |      |
| PROPERTY TABLE | NUXY MAT=   | 9 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.15000     |             |         |             |      |
| PROPERTY TABLE | ALPX MAT=   | 9 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
| 0.0000         | 0.51800E-05 |             |         |             |      |
| PROPERTY TABLE | DENS MAT=   | 9 NUM.      | POINTS= | 1           |      |
| TEMPERATURE    | DATA        | TEMPERATURE | DATA    | TEMPERATURE | DATA |
|                |             |             |         |             |      |



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

```

0.0000      0.78100E-01

PROPERTY TABLE EX  MAT=      10  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.32710E+07

PROPERTY TABLE NUXY MAT=      10  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.15000

PROPERTY TABLE ALPX MAT=      10  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.51800E-05

PROPERTY TABLE DENS MAT=      10  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.78100E-01

PROPERTY TABLE EX  MAT=      11  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.35430E+07

PROPERTY TABLE NUXY MAT=      11  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.15000

PROPERTY TABLE ALPX MAT=      11  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.51800E-05

PROPERTY TABLE DENS MAT=      11  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.78100E-01

PROPERTY TABLE EX  MAT=      12  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.36690E+07

PROPERTY TABLE NUXY MAT=      12  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.15000

PROPERTY TABLE ALPX MAT=      12  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.51800E-05

PROPERTY TABLE DENS MAT=      12  NUM. POINTS=  1
TEMPERATURE      DATA  TEMPERATURE      DATA  TEMPERATURE      DATA
0.0000      0.78100E-01

```

start, change the material properties for each time step, initial property is no. 2. Change back to no. 2 at end and save.

\*\*\*\*\* ANSYS SOLUTION ROUTINE \*\*\*\*\*

PRINT HEADER  
DO NOT PRINT SUBTITLE(S)



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

DO NOT PRINT LOAD STEP ID  
DO NOT PRINT NOTE LINE(S)  
PRINT COLUMN HEADER LABELS  
DO NOT PRINT REPORT TOTALS

LIST ALL SELECTED ELEMENTS IN RANGE 530 TO 530 STEP 1  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 16:49:19 JUN 10, 2002 CP= 0.391

Pad thermal analysis model

| ELEM                         | MAT | TYP | REL | ESY | SEC | TSHA | NODES    |            |    |   |     |      |      |     |
|------------------------------|-----|-----|-----|-----|-----|------|----------|------------|----|---|-----|------|------|-----|
| 530                          | 2   | 2   | 1   | 0   | 1   |      | 1        | 28         | 29 | 3 | 672 | 1050 | 1064 | 728 |
| ANSYS RELEASE 6.1 UP20020321 |     |     |     |     |     |      | 16:47:47 | 06/10/2002 |    |   |     |      |      |     |

PRINTOUT RESUMED BY /GOP

Load step file number 1. Begin solution ...

\*\*\*\*\* ANSYS SOLVE COMMAND \*\*\*\*\*

\*\*\* NOTE \*\*\* CP= 1.662 TIME= 16:49:21  
Real constant 1 has been referenced by element types 4 and 5.  
We assume it identifies a contact pair.

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 16:49:21 JUN 10, 2002 CP= 1.853

DELTA T 0.0 TO 0.25 DAYS

S O L U T I O N O P T I O N S

PROBLEM DIMENSIONALITY. . . . .3-D  
DEGREES OF FREEDOM. . . . . UX UY UZ  
ANALYSIS TYPE . . . . .STATIC (STEADY-STATE)  
NEWTON-RAPHSON OPTION . . . . .PROGRAM CHOSEN

\*\*\* NOTE \*\*\* CP= 1.883 TIME= 16:49:21  
Present time 0 is less than or equal to the previous time.  
Time will default to 1.

\*\*\* NOTE \*\*\* CP= 1.893 TIME= 16:49:21  
Nonlinear analysis, NROPT set to the FULL Newton-Raphson solution  
procedure for ALL DOFs.

SOLCONTROL,ON uses sparse matrix direct solver

\*\*\* NOTE \*\*\* CP= 1.893 TIME= 16:49:21  
The conditions for direct assembly have been met. No .emat or .erot



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

files will be produced.

\*\*\* WARNING \*\*\* CP= 1.893 TIME= 16:49:21  
 The program chosen initial timestep/load-factor is arbitrary. It is necessary for the user to supply a suitable initial timestep/load-factor through the NSUB or DELTIM command for convergence and overall efficiency.

L O A D S T E P O P T I O N S

```

LOAD STEP NUMBER. . . . . 1
TIME AT END OF THE LOAD STEP. . . . . 1.0000
AUTOMATIC TIME STEPPING . . . . . ON
  INITIAL NUMBER OF SUBSTEPS . . . . . 1
  MAXIMUM NUMBER OF SUBSTEPS . . . . . 5000
  MINIMUM NUMBER OF SUBSTEPS . . . . . 1
  START WITH TIME STEP FROM PREVIOUS SUBSTEP . YES
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS. . . . 15
STEP CHANGE BOUNDARY CONDITIONS . . . . . NO
TERMINATE ANALYSIS IF NOT CONVERGED . . . . .YES (EXIT)
CONVERGENCE CONTROLS. . . . .USE DEFAULTS
INERTIA LOADS
  ACEL . . . . . 0.0000 X 1.0000 Y 0.0000 Z
PRINT OUTPUT CONTROLS . . . . .NO PRINTOUT
DATABASE OUTPUT CONTROLS. . . . .ALL DATA WRITTEN
                                     FOR THE LAST SUBSTEP
    
```

NONLINEAR MONITORING INFO IS WRITTEN TO FILE= PAD-TH.mntr  
 MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS HAS BEEN MODIFIED  
 TO BE, NEQIT = 26, BY SOLUTION CONTROL LOGIC.

\*\*\* NOTE \*\*\* CP= 2.644 TIME= 16:49:22  
 Deformable-deformable contact pair identified by real constant set 1  
 and contact element type 5 has been set up.  
 Contact algorithm: Augmented Lagrange method  
 Contact detection at: Gauss integration point  
 Default contact stiffness factor FKN 1.0000  
 The resulting contact stiffness 0.15725E+07  
 Default penetration tolerance factor FTOLN 0.10000  
 The resulting penetration tolerance 1.1752  
 User define tangent contact stiffness FKT 0.10000E-08  
 Default Max. friction stress TAUMAX 0.10000E+21  
 Average contact surface length 39.172  
 Average contact pair depth 11.752  
 Default pinball region factor PINB 1.0000  
 The resulting pinball region 11.752  
 User define initial closure ICONT 0.10000E-05  
 \*WARNING\*: Initial penetration is included.

\*\*\* NOTE \*\*\* CP= 2.644 TIME= 16:49:22  
 Max. Initial penetration 1.421085472E-14 was detected between contact  
 element 9172 and target element 9002.  
 \*\*\*\*\*



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

\*\*\*\* CENTER OF MASS, MASS, AND MASS MOMENTS OF INERTIA \*\*\*\*

CALCULATIONS ASSUME ELEMENT MASS AT ELEMENT CENTROID

TOTAL MASS = 0.19272E+07

| CENTER OF MASS | MOM. OF INERTIA<br>ABOUT ORIGIN | MOM. OF INERTIA<br>ABOUT CENTER OF MASS |
|----------------|---------------------------------|---|
| XC = 204.00    | IXX = 0.2606E+12                | IXX = 0.6494E+11                        |
| YC = -48.000   | IYY = 0.3614E+12                | IYY = 0.8995E+11                        |
| ZC = 315.00    | IZZ = 0.1126E+12                | IZZ = 0.2793E+11                        |
|                | IXY = 0.1887E+11                | IXY = -0.2327E-03                       |
|                | IYZ = 0.2914E+11                | IYZ = -0.3052E-04                       |
|                | IZX = -0.1238E+12               | IZX = 0.2487E-02                        |

\*\*\* MASS SUMMARY BY ELEMENT TYPE \*\*\*

| TYPE | MASS         |
|------|--------------|
| 2    | 0.192718E+07 |

Range of element maximum matrix coefficients in global coordinates  
 Maximum= 549511638 at element 7329.  
 Minimum= 4772865.79 at element 5330.

\*\*\* ELEMENT MATRIX FORMULATION TIMES

| TYPE | NUMBER | ENAME    | TOTAL CP | AVE CP   |
|------|--------|----------|----------|----------|
| 1    | 6602   | SOLID45  | 2.383    | 0.000361 |
| 2    | 1870   | SOLID45  | 0.761    | 0.000407 |
| 4    | 170    | TARGE170 | 0.000    | 0.000000 |
| 5    | 170    | CONTA174 | 0.240    | 0.001414 |

Time at end of element matrix formulation CP= 6.34912968.

ALL CURRENT ANSYS DATA WRITTEN TO FILE NAME= PAD-TH.rdb  
 FOR POSSIBLE RESUME FROM THIS POINT

FORCE CONVERGENCE VALUE = 0.4319E+07 CRITERION= 0.2204E+05

SPARSE MATRIX DIRECT SOLVER.

Number of equations = 25612, Maximum wavefront = 83  
 Memory available for solver = 110.74 MB  
 Memory required for in-core = 110.74 MB  
 Optimal memory required for out-of-core = 19.96 MB  
 Minimum memory required for out-of-core = 11.21 MB

EQUIL ITER 1 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.2413E-01  
 LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.2413E-01  
 FORCE CONVERGENCE VALUE = 0.1837E+06 CRITERION= 3888.  
 EQUIL ITER 2 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.4418E-02  
 LINE SEARCH PARAMETER = 0.8312 SCALED MAX DOF INC = 0.3672E-02  
 FORCE CONVERGENCE VALUE = 0.8657E+06 CRITERION= 3987.  
 EQUIL ITER 3 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.2601E-02  
 LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.2601E-02  
 FORCE CONVERGENCE VALUE = 0.2533E+06 CRITERION= 4083.  
 EQUIL ITER 4 COMPLETED. NEW TRIANG MATRIX.. MAX DOF INC= 0.3694E-02



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

```

LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.3694E-02
FORCE CONVERGENCE VALUE = 0.4250E+06  CRITERION= 4176.
EQUIL ITER 5 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.3577E-02
LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.3577E-02
FORCE CONVERGENCE VALUE = 0.1575E+06  CRITERION= 4265.
EQUIL ITER 6 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.4873E-02
LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.4873E-02
FORCE CONVERGENCE VALUE = 0.2214E+06  CRITERION= 4339.
EQUIL ITER 7 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.2651E-02
LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.2651E-02
FORCE CONVERGENCE VALUE = 0.1319E+06  CRITERION= 4425.
EQUIL ITER 8 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.3189E-02
LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.3189E-02
FORCE CONVERGENCE VALUE = 0.1458E+06  CRITERION= 4511.
EQUIL ITER 9 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.2689E-02
LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.2689E-02
FORCE CONVERGENCE VALUE = 0.9357E+05  CRITERION= 4598.
EQUIL ITER 10 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.3610E-02
LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.3610E-02
FORCE CONVERGENCE VALUE = 0.8573E+05  CRITERION= 4684.
EQUIL ITER 11 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1675E-02
LINE SEARCH PARAMETER = 0.8603      SCALED MAX DOF INC = 0.1441E-02
FORCE CONVERGENCE VALUE = 0.9602E+05  CRITERION= 4776.
EQUIL ITER 12 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.8076E-03
LINE SEARCH PARAMETER = 0.7546      SCALED MAX DOF INC = 0.6094E-03
FORCE CONVERGENCE VALUE = 0.1254E+06  CRITERION= 4870.
EQUIL ITER 13 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1567E-02
LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.1567E-02
FORCE CONVERGENCE VALUE = 0.2742E+05  CRITERION= 4963.
EQUIL ITER 14 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1974E-02
LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.1974E-02
FORCE CONVERGENCE VALUE = 0.2014E+05  CRITERION= 5053.
EQUIL ITER 15 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1794E-02
LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.1794E-02
FORCE CONVERGENCE VALUE = 0.1529E+05  CRITERION= 5138.
EQUIL ITER 16 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.5897E-02
LINE SEARCH PARAMETER = 1.000      SCALED MAX DOF INC = 0.5897E-02
FORCE CONVERGENCE VALUE = 0.3377E-01  CRITERION= 5189.      <<< CONVERGED
>>> SOLUTION CONVERGED AFTER EQUILIBRIUM ITERATION 16
    
```

\*\*\* ELEMENT RESULT CALCULATION TIMES

| TYPE | NUMBER | ENAME    | TOTAL CP | AVE CP   |
|------|--------|----------|----------|----------|
| 1    | 6602   | SOLID45  | 1.763    | 0.000267 |
| 2    | 1870   | SOLID45  | 0.651    | 0.000348 |
| 4    | 170    | TARGE170 | 0.010    | 0.000059 |
| 5    | 170    | CONTA174 | 0.080    | 0.000472 |

\*\*\* NODAL LOAD CALCULATION TIMES

| TYPE | NUMBER | ENAME    | TOTAL CP | AVE CP   |
|------|--------|----------|----------|----------|
| 1    | 6602   | SOLID45  | 0.120    | 0.000018 |
| 2    | 1870   | SOLID45  | 0.050    | 0.000027 |
| 4    | 170    | TARGE170 | 0.000    | 0.000000 |
| 5    | 170    | CONTA174 | 0.000    | 0.000000 |

\*\*\* LOAD STEP 1 SUBSTEP 1 COMPLETED. CUM ITER = 16  
 \*\*\* TIME = 1.00000 TIME INC = 1.00000





\*\*\* ANSYS BINARY FILE STATISTICS

BUFFER SIZE USED= 16384

45.062 MB WRITTEN ON ELEMENT SAVED DATA FILE: PAD-TH.esav

8.188 MB WRITTEN ON ASSEMBLED MATRIX FILE: PAD-TH.full

19.750 MB WRITTEN ON RESULTS FILE: PAD-TH.rst

ESEL FOR LABEL= TYPE FROM 2 TO 2 BY 1

1870 ELEMENTS (OF 8812 DEFINED) SELECTED BY ESEL COMMAND.

SET MATERIAL OF SELECTED ELEMENTS TO 3

8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

LIST ALL SELECTED ELEMENTS IN RANGE 530 TO 530 STEP 1  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*

ANSYS/Mechanical U

00245050 VERSION=INTEL NT 16:56:35 JUN 10, 2002 CP= 343.404

DELTA T 0.0 TO 0.25 DAYS

| ELEM                         | MAT | TYP | REL | ESY | SEC | TSHA | NODES    |            |    |   |     |      |      |     |
|------------------------------|-----|-----|-----|-----|-----|------|----------|------------|----|---|-----|------|------|-----|
| 530                          | 3   | 2   | 1   | 0   | 1   |      | 1        | 28         | 29 | 3 | 672 | 1050 | 1064 | 728 |
| ANSYS RELEASE 6.1 UP20020321 |     |     |     |     |     |      | 16:47:47 | 06/10/2002 |    |   |     |      |      |     |

PRINTOUT RESUMED BY /GOP

Load step file number 2. Begin solution ...

\*\*\*\*\* ANSYS SOLVE COMMAND \*\*\*\*\*

\*\*\* NOTE \*\*\* CP= 344.646 TIME= 16:56:37  
Present time 0 is less than or equal to the previous time.  
Time will default to 2.

\*\*\* NOTE \*\*\* CP= 344.646 TIME= 16:56:37  
Nonlinear analysis, NROPT set to the FULL Newton-Raphson solution  
procedure for ALL DOFs.

SOLCONTROL,ON uses sparse matrix direct solver  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*

ANSYS/Mechanical U

00245050 VERSION=INTEL NT 16:56:37 JUN 10, 2002 CP= 344.786

DELTA T 0.25 TO 0.50 DAYS



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

```

LOAD STEP NUMBER. . . . . 2
TIME AT END OF THE LOAD STEP. . . . . 2.0000
AUTOMATIC TIME STEPPING . . . . . ON
  INITIAL NUMBER OF SUBSTEPS . . . . . 1
  MAXIMUM NUMBER OF SUBSTEPS . . . . . 1000
  MINIMUM NUMBER OF SUBSTEPS . . . . . 1
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS. . . . . 15
STEP CHANGE BOUNDARY CONDITIONS . . . . . NO
TERMINATE ANALYSIS IF NOT CONVERGED . . . . .YES (EXIT)
CONVERGENCE CONTROLS. . . . .USE DEFAULTS
INERTIA LOADS
  ACEL . . . . . X Y Z
  ACEL . . . . . 0.0000 0.10000E-01 0.0000
PRINT OUTPUT CONTROLS . . . . .NO PRINTOUT
DATABASE OUTPUT CONTROLS. . . . .ALL DATA WRITTEN
                                  FOR THE LAST SUBSTEP
    
```

NONLINEAR MONITORING INFO IS WRITTEN TO FILE= PAD-TH.mntr  
 MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS HAS BEEN MODIFIED  
 TO BE, NEQIT = 26, BY SOLUTION CONTROL LOGIC.

```

FORCE CONVERGENCE VALUE = 0.3698E+07 CRITERION= 0.1935E+05
EQUIL ITER 1 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1099
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.1099
FORCE CONVERGENCE VALUE = 0.1765E+06 CRITERION= 4420.
EQUIL ITER 2 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1231
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.1231
FORCE CONVERGENCE VALUE = 0.1096E+07 CRITERION= 3999.
EQUIL ITER 3 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.2059E-01
LINE SEARCH PARAMETER = 0.4326 SCALED MAX DOF INC = 0.8907E-02
FORCE CONVERGENCE VALUE = 0.1938E+07 CRITERION= 4052.
EQUIL ITER 4 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1197E-01
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.1197E-01
FORCE CONVERGENCE VALUE = 0.5270E+06 CRITERION= 4099.
EQUIL ITER 5 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.5671E-01
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.5671E-01
FORCE CONVERGENCE VALUE = 0.4011E+06 CRITERION= 4066.
EQUIL ITER 6 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.3222E-01
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.3222E-01
FORCE CONVERGENCE VALUE = 0.2222E+06 CRITERION= 4099.
EQUIL ITER 7 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1427E-01
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.1427E-01
FORCE CONVERGENCE VALUE = 0.2244E-04 CRITERION= 4167. <<< CONVERGED
>>> SOLUTION CONVERGED AFTER EQUILIBRIUM ITERATION 7
*** LOAD STEP 2 SUBSTEP 1 COMPLETED. CUM ITER = 23
*** TIME = 2.00000 TIME INC = 1.00000
    
```

```

ESEL FOR LABEL= TYPE FROM 2 TO 2 BY 1

1870 ELEMENTS (OF 8812 DEFINED) SELECTED BY ESEL COMMAND.

SET MATERIAL OF SELECTED ELEMENTS TO 4

8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

LIST ALL SELECTED ELEMENTS IN RANGE 530 TO 530 STEP 1
    
```



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

```
***** ANSYS - ENGINEERING ANALYSIS SYSTEM  RELEASE 6.1      *****
ANSYS/Mechanical U
00245050          VERSION=INTEL NT          16:59:46  JUN 10, 2002 CP=    485.618

DELTA T 0.25 TO 0.50 DAYS
```

```
      ELEM MAT TYP REL ESY SEC TSHA          NODES
      530   4   2   1   0   1          1   28   29   3   672  1050  1064  728
ANSYS RELEASE 6.1      UP20020321          16:47:47   06/10/2002
```

PRINTOUT RESUMED BY /GOP

Load step file number 3. Begin solution ...

```
***** ANSYS SOLVE      COMMAND      *****
```

```
*** NOTE ***                      CP=    486.850  TIME= 16:59:47
Present time 0 is less than or equal to the previous time.
Time will default to 3.
```

```
*** NOTE ***                      CP=    486.860  TIME= 16:59:47
Nonlinear analysis, NROPT set to the FULL Newton-Raphson solution
procedure for ALL DOFs.
```

SOLCONTROL,ON uses sparse matrix direct solver  
1

```
***** ANSYS - ENGINEERING ANALYSIS SYSTEM  RELEASE 6.1      *****
ANSYS/Mechanical U
00245050          VERSION=INTEL NT          16:59:47  JUN 10, 2002 CP=    487.010

DELTA T 0.50 TO 0.625 DAYS
```

L O A D S T E P O P T I O N S

```
LOAD STEP NUMBER. . . . . 3
TIME AT END OF THE LOAD STEP. . . . . 3.0000
AUTOMATIC TIME STEPPING . . . . . ON
  INITIAL NUMBER OF SUBSTEPS . . . . . 1
  MAXIMUM NUMBER OF SUBSTEPS . . . . . 1000
  MINIMUM NUMBER OF SUBSTEPS . . . . . 1
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS. . . . . 15
STEP CHANGE BOUNDARY CONDITIONS . . . . . NO
TERMINATE ANALYSIS IF NOT CONVERGED . . . . .YES (EXIT)
CONVERGENCE CONTROLS. . . . .USE DEFAULTS
INERTIA LOADS          X          Y          Z
  ACEL . . . . . 0.0000  0.10000E-01  0.0000
PRINT OUTPUT CONTROLS . . . . .NO PRINTOUT
DATABASE OUTPUT CONTROLS. . . . .ALL DATA WRITTEN
                                FOR THE LAST SUBSTEP
```

NONLINEAR MONITORING INFO IS WRITTEN TO FILE= PAD-TH.mntr



Appendix RPad-TH to Calculation PGE-009-CALC-006

MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS HAS BEEN MODIFIED  
TO BE, NEQIT = 26, BY SOLUTION CONTROL LOGIC.

FORCE CONVERGENCE VALUE = 0.4663E+07 CRITERION= 0.2412E+05  
EQUIL ITER 1 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.1954  
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = -0.1954  
FORCE CONVERGENCE VALUE = 0.8838 CRITERION= 1531. <<< CONVERGED  
>>> SOLUTION CONVERGED AFTER EQUILIBRIUM ITERATION 1  
\*\*\* LOAD STEP 3 SUBSTEP 1 COMPLETED. CUM ITER = 24  
\*\*\* TIME = 3.00000 TIME INC = 1.00000

ESEL FOR LABEL= TYPE FROM 2 TO 2 BY 1  
1870 ELEMENTS (OF 8812 DEFINED) SELECTED BY ESEL COMMAND.

SET MATERIAL OF SELECTED ELEMENTS TO 5

8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

LIST ALL SELECTED ELEMENTS IN RANGE 530 TO 530 STEP 1  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:00:37 JUN 10, 2002 CP= 515.141  
DELTA T 0.50 TO 0.625 DAYS

| ELEM                         | MAT | TYP | REL | ESY | SEC | TSHA | NODES    |            |    |   |     |      |      |     |
|------------------------------|-----|-----|-----|-----|-----|------|----------|------------|----|---|-----|------|------|-----|
| 530                          | 5   | 2   | 1   | 0   | 1   |      | 1        | 28         | 29 | 3 | 672 | 1050 | 1064 | 728 |
| ANSYS RELEASE 6.1 UP20020321 |     |     |     |     |     |      | 16:47:47 | 06/10/2002 |    |   |     |      |      |     |

PRINTOUT RESUMED BY /GOP

Load step file number 4. Begin solution ...

\*\*\*\*\* ANSYS SOLVE COMMAND \*\*\*\*\*

\*\*\* NOTE \*\*\* CP= 516.403 TIME= 17:00:38  
Present time 0 is less than or equal to the previous time.  
Time will default to 4.

\*\*\* NOTE \*\*\* CP= 516.403 TIME= 17:00:38  
Nonlinear analysis, NROPT set to the FULL Newton-Raphson solution  
procedure for ALL DOFs.

SOLCONTROL,ON uses sparse matrix direct solver  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:00:39 JUN 10, 2002 CP= 516.593

DELTA T 0.625 TO 1.125 DAYS



L O A D   S T E P   O P T I O N S

```

LOAD STEP NUMBER. . . . . 4
TIME AT END OF THE LOAD STEP. . . . . 4.0000
AUTOMATIC TIME STEPPING . . . . . ON
  INITIAL NUMBER OF SUBSTEPS . . . . . 1
  MAXIMUM NUMBER OF SUBSTEPS . . . . . 1000
  MINIMUM NUMBER OF SUBSTEPS . . . . . 1
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS. . . . . 15
STEP CHANGE BOUNDARY CONDITIONS . . . . . NO
TERMINATE ANALYSIS IF NOT CONVERGED . . . . .YES (EXIT)
CONVERGENCE CONTROLS. . . . .USE DEFAULTS
INERTIA LOADS                X                Y                Z
  ACEL . . . . . 0.0000      0.10000E-01  0.0000
PRINT OUTPUT CONTROLS . . . . .NO PRINTOUT
DATABASE OUTPUT CONTROLS. . . . .ALL DATA WRITTEN
                                  FOR THE LAST SUBSTEP
  
```

NONLINEAR MONITORING INFO IS WRITTEN TO FILE= PAD-TH.mntr  
 MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS HAS BEEN MODIFIED  
 TO BE, NEQIT = 26, BY SOLUTION CONTROL LOGIC.

```

FORCE CONVERGENCE VALUE = 0.6213E+07  CRITERION= 0.3175E+05
EQUIL ITER 1 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= -0.5309E-01
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = -0.5309E-01
FORCE CONVERGENCE VALUE = 0.6322  CRITERION= 5058.  <<< CONVERGED
>>> SOLUTION CONVERGED AFTER EQUILIBRIUM ITERATION 1
*** LOAD STEP 4 SUBSTEP 1 COMPLETED.  CUM ITER = 25
*** TIME = 4.00000  TIME INC = 1.00000
  
```

ESEL FOR LABEL= TYPE FROM 2 TO 2 BY 1  
 1870 ELEMENTS (OF 8812 DEFINED) SELECTED BY ESEL COMMAND.

SET MATERIAL OF SELECTED ELEMENTS TO 6

8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

LIST ALL SELECTED ELEMENTS IN RANGE 530 TO 530 STEP 1  
 1

```

***** ANSYS - ENGINEERING ANALYSIS SYSTEM  RELEASE 6.1  *****
ANSYS/Mechanical U
00245050  VERSION=INTEL NT  17:01:28  JUN 10, 2002  CP= 544.403
  
```

DELTA T 0.625 TO 1.125 DAYS

```

ELEM MAT TYP REL ESY SEC TSHA  NODES
530 6 2 1 0 1 1 28 29 3 672 1050 1064 728
ANSYS RELEASE 6.1  UP20020321  16:47:48  06/10/2002
  
```

PRINTOUT RESUMED BY /GOP



Load step file number 5. Begin solution ...

\*\*\*\*\* ANSYS SOLVE COMMAND \*\*\*\*\*

\*\*\* NOTE \*\*\* CP= 545.635 TIME= 17:01:30  
Present time 0 is less than or equal to the previous time.  
Time will default to 5.

\*\*\* NOTE \*\*\* CP= 545.635 TIME= 17:01:30  
Nonlinear analysis, NROPT set to the FULL Newton-Raphson solution  
procedure for ALL DOFs.

SOLCONTROL,ON uses sparse matrix direct solver

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:01:30 JUN 10, 2002 CP= 545.835

DELTA T 1.125 TO 1.625 DAYS

L O A D S T E P O P T I O N S

```

LOAD STEP NUMBER. . . . . 5
TIME AT END OF THE LOAD STEP. . . . . 5.0000
AUTOMATIC TIME STEPPING . . . . . ON
  INITIAL NUMBER OF SUBSTEPS . . . . . 1
  MAXIMUM NUMBER OF SUBSTEPS . . . . . 1000
  MINIMUM NUMBER OF SUBSTEPS . . . . . 1
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS. . . . . 15
STEP CHANGE BOUNDARY CONDITIONS . . . . . NO
TERMINATE ANALYSIS IF NOT CONVERGED . . . . .YES (EXIT)
CONVERGENCE CONTROLS. . . . .USE DEFAULTS
INERTIA LOADS          X          Y          Z
  ACEL . . . . . 0.0000    0.10000E-01  0.0000
PRINT OUTPUT CONTROLS . . . . .NO PRINTOUT
DATABASE OUTPUT CONTROLS. . . . .ALL DATA WRITTEN
                                FOR THE LAST SUBSTEP
    
```

NONLINEAR MONITORING INFO IS WRITTEN TO FILE= PAD-TH.mntr  
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS HAS BEEN MODIFIED  
TO BE, NEQIT = 26, BY SOLUTION CONTROL LOGIC.

```

FORCE CONVERGENCE VALUE = 0.4293E+07 CRITERION= 0.2265E+05
EQUIL ITER 1 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.1210
LINE SEARCH PARAMETER = 0.5074E-01 SCALED MAX DOF INC = -0.6139E-02
FORCE CONVERGENCE VALUE = 0.4075E+07 CRITERION= 3196.
EQUIL ITER 2 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.1149
LINE SEARCH PARAMETER = 0.5070E-01 SCALED MAX DOF INC = -0.5823E-02
FORCE CONVERGENCE VALUE = 0.3869E+07 CRITERION= 3173.
EQUIL ITER 3 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.1090
LINE SEARCH PARAMETER = 0.5067E-01 SCALED MAX DOF INC = -0.5524E-02
FORCE CONVERGENCE VALUE = 0.3673E+07 CRITERION= 3156.
EQUIL ITER 4 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.1035
LINE SEARCH PARAMETER = 0.5063E-01 SCALED MAX DOF INC = -0.5241E-02
    
```



Appendix RPad-TH to Calculation PGE-009-CALC-006

FORCE CONVERGENCE VALUE = 0.3487E+07 CRITERION= 3146.  
EQUIL ITER 5 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.9827E-01  
LINE SEARCH PARAMETER = 0.5060E-01 SCALED MAX DOF INC = -0.4972E-02  
FORCE CONVERGENCE VALUE = 0.3310E+07 CRITERION= 3143.  
EQUIL ITER 6 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.9330E-01  
LINE SEARCH PARAMETER = 0.5057E-01 SCALED MAX DOF INC = -0.4718E-02  
FORCE CONVERGENCE VALUE = 0.3143E+07 CRITERION= 3145.  
EQUIL ITER 7 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.8858E-01  
LINE SEARCH PARAMETER = 0.5054E-01 SCALED MAX DOF INC = -0.4477E-02  
FORCE CONVERGENCE VALUE = 0.2984E+07 CRITERION= 3154.  
EQUIL ITER 8 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.8410E-01  
LINE SEARCH PARAMETER = 0.5051E-01 SCALED MAX DOF INC = -0.4248E-02  
FORCE CONVERGENCE VALUE = 0.2833E+07 CRITERION= 3169.  
EQUIL ITER 9 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.7985E-01  
LINE SEARCH PARAMETER = 0.5049E-01 SCALED MAX DOF INC = -0.4032E-02  
FORCE CONVERGENCE VALUE = 0.2690E+07 CRITERION= 3189.  
EQUIL ITER 10 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.7582E-01  
LINE SEARCH PARAMETER = 0.5046E-01 SCALED MAX DOF INC = -0.3826E-02  
FORCE CONVERGENCE VALUE = 0.2555E+07 CRITERION= 3215.  
EQUIL ITER 11 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.7200E-01  
LINE SEARCH PARAMETER = 0.5044E-01 SCALED MAX DOF INC = -0.3631E-02  
FORCE CONVERGENCE VALUE = 0.2426E+07 CRITERION= 3246.  
EQUIL ITER 12 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.6836E-01  
LINE SEARCH PARAMETER = 0.5042E-01 SCALED MAX DOF INC = -0.3447E-02  
FORCE CONVERGENCE VALUE = 0.2303E+07 CRITERION= 3282.  
EQUIL ITER 13 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.6492E-01  
LINE SEARCH PARAMETER = 0.5040E-01 SCALED MAX DOF INC = -0.3272E-02  
FORCE CONVERGENCE VALUE = 0.2187E+07 CRITERION= 3322.  
EQUIL ITER 14 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.6165E-01  
LINE SEARCH PARAMETER = 0.5038E-01 SCALED MAX DOF INC = -0.3105E-02  
FORCE CONVERGENCE VALUE = 0.2077E+07 CRITERION= 3368.  
EQUIL ITER 15 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.5854E-01  
LINE SEARCH PARAMETER = 0.5036E-01 SCALED MAX DOF INC = -0.2948E-02  
FORCE CONVERGENCE VALUE = 0.1973E+07 CRITERION= 3417.  
EQUIL ITER 16 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.5559E-01  
LINE SEARCH PARAMETER = 0.5034E-01 SCALED MAX DOF INC = -0.2798E-02  
FORCE CONVERGENCE VALUE = 0.1873E+07 CRITERION= 3471.  
EQUIL ITER 17 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.5279E-01  
LINE SEARCH PARAMETER = 0.5032E-01 SCALED MAX DOF INC = -0.2657E-02  
FORCE CONVERGENCE VALUE = 0.1779E+07 CRITERION= 3529.  
EQUIL ITER 18 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.5014E-01  
LINE SEARCH PARAMETER = 0.5031E-01 SCALED MAX DOF INC = -0.2522E-02  
FORCE CONVERGENCE VALUE = 0.1690E+07 CRITERION= 3591.  
EQUIL ITER 19 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.4761E-01  
LINE SEARCH PARAMETER = 0.5029E-01 SCALED MAX DOF INC = -0.2395E-02  
FORCE CONVERGENCE VALUE = 0.1605E+07 CRITERION= 3656.  
EQUIL ITER 20 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.4522E-01  
LINE SEARCH PARAMETER = 0.5028E-01 SCALED MAX DOF INC = -0.2274E-02  
FORCE CONVERGENCE VALUE = 0.1524E+07 CRITERION= 3725.  
EQUIL ITER 21 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.4295E-01  
LINE SEARCH PARAMETER = 0.5026E-01 SCALED MAX DOF INC = -0.2159E-02  
FORCE CONVERGENCE VALUE = 0.1447E+07 CRITERION= 3797.  
EQUIL ITER 22 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.4079E-01  
LINE SEARCH PARAMETER = 0.5025E-01 SCALED MAX DOF INC = -0.2050E-02  
FORCE CONVERGENCE VALUE = 0.1375E+07 CRITERION= 3873.  
EQUIL ITER 23 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.3874E-01  
LINE SEARCH PARAMETER = 0.5024E-01 SCALED MAX DOF INC = -0.1946E-02



Appendix RPad-TH to Calculation PGE-009-CALC-006

FORCE CONVERGENCE VALUE = 0.3487E+07 CRITERION= 3146.  
EQUIL ITER 5 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.9827E-01  
LINE SEARCH PARAMETER = 0.5060E-01 SCALED MAX DOF INC = -0.4972E-02  
FORCE CONVERGENCE VALUE = 0.3310E+07 CRITERION= 3143.  
EQUIL ITER 6 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.9330E-01  
LINE SEARCH PARAMETER = 0.5057E-01 SCALED MAX DOF INC = -0.4718E-02  
FORCE CONVERGENCE VALUE = 0.3143E+07 CRITERION= 3145.  
EQUIL ITER 7 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.8858E-01  
LINE SEARCH PARAMETER = 0.5054E-01 SCALED MAX DOF INC = -0.4477E-02  
FORCE CONVERGENCE VALUE = 0.2984E+07 CRITERION= 3154.  
EQUIL ITER 8 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.8410E-01  
LINE SEARCH PARAMETER = 0.5051E-01 SCALED MAX DOF INC = -0.4248E-02  
FORCE CONVERGENCE VALUE = 0.2833E+07 CRITERION= 3169.  
EQUIL ITER 9 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.7985E-01  
LINE SEARCH PARAMETER = 0.5049E-01 SCALED MAX DOF INC = -0.4032E-02  
FORCE CONVERGENCE VALUE = 0.2690E+07 CRITERION= 3189.  
EQUIL ITER 10 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.7582E-01  
LINE SEARCH PARAMETER = 0.5046E-01 SCALED MAX DOF INC = -0.3826E-02  
FORCE CONVERGENCE VALUE = 0.2555E+07 CRITERION= 3215.  
EQUIL ITER 11 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.7200E-01  
LINE SEARCH PARAMETER = 0.5044E-01 SCALED MAX DOF INC = -0.3631E-02  
FORCE CONVERGENCE VALUE = 0.2426E+07 CRITERION= 3246.  
EQUIL ITER 12 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.6836E-01  
LINE SEARCH PARAMETER = 0.5042E-01 SCALED MAX DOF INC = -0.3447E-02  
FORCE CONVERGENCE VALUE = 0.2303E+07 CRITERION= 3282.  
EQUIL ITER 13 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.6492E-01  
LINE SEARCH PARAMETER = 0.5040E-01 SCALED MAX DOF INC = -0.3272E-02  
FORCE CONVERGENCE VALUE = 0.2187E+07 CRITERION= 3322.  
EQUIL ITER 14 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.6165E-01  
LINE SEARCH PARAMETER = 0.5038E-01 SCALED MAX DOF INC = -0.3105E-02  
FORCE CONVERGENCE VALUE = 0.2077E+07 CRITERION= 3368.  
EQUIL ITER 15 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.5854E-01  
LINE SEARCH PARAMETER = 0.5036E-01 SCALED MAX DOF INC = -0.2948E-02  
FORCE CONVERGENCE VALUE = 0.1973E+07 CRITERION= 3417.  
EQUIL ITER 16 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.5559E-01  
LINE SEARCH PARAMETER = 0.5034E-01 SCALED MAX DOF INC = -0.2798E-02  
FORCE CONVERGENCE VALUE = 0.1873E+07 CRITERION= 3471.  
EQUIL ITER 17 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.5279E-01  
LINE SEARCH PARAMETER = 0.5032E-01 SCALED MAX DOF INC = -0.2657E-02  
FORCE CONVERGENCE VALUE = 0.1779E+07 CRITERION= 3529.  
EQUIL ITER 18 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.5014E-01  
LINE SEARCH PARAMETER = 0.5031E-01 SCALED MAX DOF INC = -0.2522E-02  
FORCE CONVERGENCE VALUE = 0.1690E+07 CRITERION= 3591.  
EQUIL ITER 19 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.4761E-01  
LINE SEARCH PARAMETER = 0.5029E-01 SCALED MAX DOF INC = -0.2395E-02  
FORCE CONVERGENCE VALUE = 0.1605E+07 CRITERION= 3656.  
EQUIL ITER 20 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.4522E-01  
LINE SEARCH PARAMETER = 0.5028E-01 SCALED MAX DOF INC = -0.2274E-02  
FORCE CONVERGENCE VALUE = 0.1524E+07 CRITERION= 3725.  
EQUIL ITER 21 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.4295E-01  
LINE SEARCH PARAMETER = 0.5026E-01 SCALED MAX DOF INC = -0.2159E-02  
FORCE CONVERGENCE VALUE = 0.1447E+07 CRITERION= 3797.  
EQUIL ITER 22 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.4079E-01  
LINE SEARCH PARAMETER = 0.5025E-01 SCALED MAX DOF INC = -0.2050E-02  
FORCE CONVERGENCE VALUE = 0.1375E+07 CRITERION= 3873.  
EQUIL ITER 23 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= -0.3874E-01  
LINE SEARCH PARAMETER = 0.5024E-01 SCALED MAX DOF INC = -0.1946E-02





**ENERCON  
SERVICES, INC.**

**Appendix RPad-TH to Calculation PGE-009-CALC-006**

```

FORCE CONVERGENCE VALUE = 0.1307E+07  CRITERION= 3951.
EQUIL ITER 24 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= -0.3436E-01
LINE SEARCH PARAMETER = 0.5029E-01  SCALED MAX DOF INC = -0.1728E-02
FORCE CONVERGENCE VALUE = 0.1243E+07  CRITERION= 4033.
EQUIL ITER 25 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= -0.3206E-01
LINE SEARCH PARAMETER = 0.5029E-01  SCALED MAX DOF INC = -0.1613E-02
FORCE CONVERGENCE VALUE = 0.1181E+07  CRITERION= 4035.
EQUIL ITER 26 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= -0.3045E-01
LINE SEARCH PARAMETER = 0.5028E-01  SCALED MAX DOF INC = -0.1531E-02
FORCE CONVERGENCE VALUE = 0.1123E+07  CRITERION= 4037.
>>> SOLUTION NOT CONVERGED AFTER 26 EQUILIBRIUM ITERATIONS
*** LOAD STEP 5 SUBSTEP 1 NOT COMPLETED.  CUM ITER = 51
*** BEGIN BISECTION NUMBER 1 NEW TIME INCREMENT= 0.50000

FORCE CONVERGENCE VALUE = 0.2149E+07  CRITERION= 0.1238E+05
EQUIL ITER 1 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= -0.6246E-01
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = -0.6246E-01
FORCE CONVERGENCE VALUE = 0.4572E-04  CRITERION= 4282.  <<< CONVERGED
>>> SOLUTION CONVERGED AFTER EQUILIBRIUM ITERATION 1
*** LOAD STEP 5 SUBSTEP 1 COMPLETED.  CUM ITER = 52
*** TIME = 4.50000  TIME INC = 0.500000
*** AUTO STEP TIME:  NEXT TIME INC = 0.50000  UNCHANGED

FORCE CONVERGENCE VALUE = 0.7410E+09  CRITERION= 0.1203E+05
EQUIL ITER 1 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.2448E-01
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.2448E-01
FORCE CONVERGENCE VALUE = 0.1289E+06  CRITERION= 2599.
EQUIL ITER 2 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.2088E-02
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.2088E-02
FORCE CONVERGENCE VALUE = 0.2623E+06  CRITERION= 2667.
EQUIL ITER 3 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.1729E-02
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.1729E-02
FORCE CONVERGENCE VALUE = 0.3391E+06  CRITERION= 2729.
EQUIL ITER 4 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.1367E-02
LINE SEARCH PARAMETER = 0.9879  SCALED MAX DOF INC = 0.1350E-02
FORCE CONVERGENCE VALUE = 0.3089E+06  CRITERION= 2800.
EQUIL ITER 5 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.1404E-02
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.1404E-02
FORCE CONVERGENCE VALUE = 0.2155E+06  CRITERION= 2865.
EQUIL ITER 6 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.1080E-02
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.1080E-02
FORCE CONVERGENCE VALUE = 0.8170E+05  CRITERION= 2936.
EQUIL ITER 7 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.1067E-02
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.1067E-02
FORCE CONVERGENCE VALUE = 0.1217E+06  CRITERION= 3003.
EQUIL ITER 8 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.1207E-02
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.1207E-02
FORCE CONVERGENCE VALUE = 0.7488E+05  CRITERION= 3077.
EQUIL ITER 9 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.4289E-03
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.4289E-03
FORCE CONVERGENCE VALUE = 0.9288E+05  CRITERION= 3143.
EQUIL ITER 10 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.1226E-02
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.1226E-02
FORCE CONVERGENCE VALUE = 0.4559E+05  CRITERION= 3217.
EQUIL ITER 11 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.5802E-03
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.5802E-03
FORCE CONVERGENCE VALUE = 0.8540E+05  CRITERION= 3285.
    
```



**ENERCON  
SERVICES, INC.**

**Appendix RPad-TH to Calculation PGE-009-CALC-006**

```

EQUIL ITER 12 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.5834E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.5834E-03
FORCE CONVERGENCE VALUE = 0.3679E+05 CRITERION= 3356.
EQUIL ITER 13 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.3587E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.3587E-03
FORCE CONVERGENCE VALUE = 0.5743E+05 CRITERION= 3425.
EQUIL ITER 14 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.4073E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.4073E-03
FORCE CONVERGENCE VALUE = 0.3201E+05 CRITERION= 3495.
EQUIL ITER 15 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1592E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.1592E-03
FORCE CONVERGENCE VALUE = 0.2783E+05 CRITERION= 3565.
EQUIL ITER 16 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.3916E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.3916E-03
FORCE CONVERGENCE VALUE = 0.2008E+05 CRITERION= 3634.
EQUIL ITER 17 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1693E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.1693E-03
FORCE CONVERGENCE VALUE = 7903. CRITERION= 3709.
EQUIL ITER 18 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1500E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.1500E-03
FORCE CONVERGENCE VALUE = 5934. CRITERION= 3783.
EQUIL ITER 19 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1575E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.1575E-03
FORCE CONVERGENCE VALUE = 2298. CRITERION= 3860. <<< CONVERGED
>>> SOLUTION CONVERGED AFTER EQUILIBRIUM ITERATION 19
*** LOAD STEP 5 SUBSTEP 2 COMPLETED. CUM ITER = 71
*** TIME = 5.00000 TIME INC = 0.500000
    
```

```

ESEL FOR LABEL= TYPE FROM 2 TO 2 BY 1
1870 ELEMENTS (OF 8812 DEFINED) SELECTED BY ESEL COMMAND.
    
```

```

SET MATERIAL OF SELECTED ELEMENTS TO 7
8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.
    
```

```

LIST ALL SELECTED ELEMENTS IN RANGE 530 TO 530 STEP 1
1
    
```

```

***** ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 *****
ANSYS/Mechanical U
00245050 VERSION=INTEL NT 17:20:58 JUN 10, 2002 CP= 1446.770
    
```

DELTA T 1.125 TO 1.625 DAYS

```

ELEM MAT TYP REL ESY SEC TSHA NODES
530 7 2 1 0 1 1 28 29 3 672 1050 1064 728
ANSYS RELEASE 6.1 UP20020321 16:47:48 06/10/2002
    
```

PRINTOUT RESUMED BY /GOP

Load step file number 6. Begin solution ...

\*\*\*\*\* ANSYS SOLVE COMMAND \*\*\*\*\*





**ENERCON  
SERVICES, INC.**

**Appendix RPad-TH to Calculation PGE-009-CALC-006**

```

EQUIL ITER  6 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC=  0.4908E-03
  LINE SEARCH PARAMETER =  1.000    SCALED MAX DOF INC =  0.4908E-03
  FORCE CONVERGENCE VALUE =  0.1974E+05  CRITERION=  1494.
EQUIL ITER  7 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC=  0.2077E-03
  LINE SEARCH PARAMETER =  1.000    SCALED MAX DOF INC =  0.2077E-03
  FORCE CONVERGENCE VALUE =  0.3068E+05  CRITERION=  1522.
EQUIL ITER  8 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC=  0.2244E-03
  LINE SEARCH PARAMETER =  1.000    SCALED MAX DOF INC =  0.2244E-03
  FORCE CONVERGENCE VALUE =  8068.    CRITERION=  1549.
EQUIL ITER  9 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC=  0.7462E-04
  LINE SEARCH PARAMETER =  1.000    SCALED MAX DOF INC =  0.7462E-04
  FORCE CONVERGENCE VALUE =  7216.    CRITERION=  1580.
EQUIL ITER 10 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC=  0.5422E-04
  LINE SEARCH PARAMETER =  1.000    SCALED MAX DOF INC =  0.5422E-04
  FORCE CONVERGENCE VALUE =  866.9    CRITERION=  1612.    <<< CONVERGED
>>> SOLUTION CONVERGED AFTER EQUILIBRIUM ITERATION  10
*** LOAD STEP  6  SUBSTEP  1 COMPLETED.  CUM ITER =  81
*** TIME =  6.00000    TIME INC =  1.00000

ESEL  FOR LABEL= TYPE  FROM  2 TO  2 BY  1

  1870  ELEMENTS (OF  8812  DEFINED) SELECTED BY  ESEL  COMMAND.

SET MATERIAL OF SELECTED ELEMENTS TO  8

  8812  ELEMENTS (OF  8812  DEFINED) SELECTED BY  EALL  COMMAND.

LIST ALL SELECTED ELEMENTS IN RANGE  530 TO  530 STEP  1
1
***** ANSYS - ENGINEERING ANALYSIS SYSTEM  RELEASE 6.1  *****
ANSYS/Mechanical U
00245050    VERSION=INTEL NT    17:25:31  JUN 10, 2002 CP=  1654.369

DELTA T 1.625 TO 2.125 DAYS

      ELEM MAT TYP REL  ESY SEC TSHA    NODES
      530  8  2  1  0  1    1  28  29    3  672  1050  1064  728
ANSYS RELEASE 6.1    UP20020321    16:47:48    06/10/2002

PRINTOUT RESUMED BY /GOP

Load step file number 7.  Begin solution ...

***** ANSYS SOLVE  COMMAND *****

*** NOTE ***
Present time 0 is less than or equal to the previous time.
Time will default to 7.

*** NOTE ***
Nonlinear analysis, NROPT set to the FULL Newton-Raphson solution
procedure for ALL DOFs.

SOLCONTROL,ON uses sparse matrix direct solver

```



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Appendix RPad-TH to Calculation PGE-009-CALC-006

1

```
***** ANSYS - ENGINEERING ANALYSIS SYSTEM  RELEASE 6.1      *****
ANSYS/Mechanical U
00245050          VERSION=INTEL NT          17:25:32  JUN 10, 2002 CP=   1655.881

DELTA T 2.125 TO 2.375 DAYS
```

L O A D S T E P O P T I O N S

```
LOAD STEP NUMBER. . . . . 7
TIME AT END OF THE LOAD STEP. . . . . 7.0000
AUTOMATIC TIME STEPPING . . . . . ON
  INITIAL NUMBER OF SUBSTEPS . . . . . 1
  MAXIMUM NUMBER OF SUBSTEPS . . . . . 1000
  MINIMUM NUMBER OF SUBSTEPS . . . . . 1
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS. . . . . 15
STEP CHANGE BOUNDARY CONDITIONS . . . . . NO
TERMINATE ANALYSIS IF NOT CONVERGED . . . . .YES (EXIT)
CONVERGENCE CONTROLS. . . . .USE DEFAULTS
INERTIA LOADS          X          Y          Z
  ACEL . . . . . 0.0000      0.10000E-01  0.0000
PRINT OUTPUT CONTROLS . . . . .NO PRINTOUT
DATABASE OUTPUT CONTROLS. . . . .ALL DATA WRITTEN
                                FOR THE LAST SUBSTEP
```

```
NONLINEAR MONITORING INFO IS WRITTEN TO FILE= PAD-TH.mntr
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS HAS BEEN MODIFIED
TO BE, NEQIT = 26, BY SOLUTION CONTROL LOGIC.
```

```
FORCE CONVERGENCE VALUE = 0.1711E+07  CRITERION= 8833.
EQUIL ITER 1 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= -0.2557E-01
LINE SEARCH PARAMETER = 0.9946  SCALED MAX DOF INC = -0.2543E-01
FORCE CONVERGENCE VALUE = 0.2740E+06  CRITERION= 495.3
EQUIL ITER 2 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= -0.1640E-03
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = -0.1640E-03
FORCE CONVERGENCE VALUE = 0.1375E+05  CRITERION= 507.4
EQUIL ITER 3 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.7619E-04
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.7619E-04
FORCE CONVERGENCE VALUE = 5821.  CRITERION= 516.8
EQUIL ITER 4 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.3730E-04
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.3730E-04
FORCE CONVERGENCE VALUE = 1485.  CRITERION= 526.7
EQUIL ITER 5 COMPLETED.  NEW TRIANG MATRIX.  MAX DOF INC= 0.4652E-05
LINE SEARCH PARAMETER = 1.000  SCALED MAX DOF INC = 0.4652E-05
FORCE CONVERGENCE VALUE = 0.1407E-03  CRITERION= 537.4  <<< CONVERGED
>>> SOLUTION CONVERGED AFTER EQUILIBRIUM ITERATION 5
*** LOAD STEP 7 SUBSTEP 1 COMPLETED.  CUM ITER = 86
*** TIME = 7.00000  TIME INC = 1.00000
```

```
ESEL FOR LABEL= TYPE FROM 2 TO 2 BY 1
1870 ELEMENTS (OF 8812 DEFINED) SELECTED BY ESEL COMMAND.
```

```
SET MATERIAL OF SELECTED ELEMENTS TO 9
```



Appendix RPad-TH to Calculation PGE-009-CALC-006

8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

LIST ALL SELECTED ELEMENTS IN RANGE 530 TO 530 STEP 1  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:28:06 JUN 10, 2002 CP= 1765.889  
DELTA T 2.125 TO 2.375 DAYS

| ELEM                         | MAT | TYP | REL | ESY | SEC | TSHA | NODES    |            |    |   |     |      |      |     |
|------------------------------|-----|-----|-----|-----|-----|------|----------|------------|----|---|-----|------|------|-----|
| 530                          | 9   | 2   | 1   | 0   | 1   |      | 1        | 28         | 29 | 3 | 672 | 1050 | 1064 | 728 |
| ANSYS RELEASE 6.1 UP20020321 |     |     |     |     |     |      | 16:47:48 | 06/10/2002 |    |   |     |      |      |     |

PRINTOUT RESUMED BY /GOP

Load step file number 8. Begin solution ...

\*\*\*\*\* ANSYS SOLVE COMMAND \*\*\*\*\*

\*\*\* NOTE \*\*\* CP= 1767.131 TIME= 17:28:07  
Present time 0 is less than or equal to the previous time.  
Time will default to 8.

\*\*\* NOTE \*\*\* CP= 1767.131 TIME= 17:28:07  
Nonlinear analysis, NROPT set to the FULL Newton-Raphson solution  
procedure for ALL DOFs.

SOLCONTROL,ON uses sparse matrix direct solver

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:28:08 JUN 10, 2002 CP= 1767.421  
DELTA T 2.375 TO 3.125 DAYS

L O A D S T E P O P T I O N S

LOAD STEP NUMBER. . . . . 8  
TIME AT END OF THE LOAD STEP. . . . . 8.0000  
AUTOMATIC TIME STEPPING . . . . . ON  
INITIAL NUMBER OF SUBSTEPS . . . . . 1  
MAXIMUM NUMBER OF SUBSTEPS . . . . . 1000  
MINIMUM NUMBER OF SUBSTEPS . . . . . 1  
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS. . . . . 15  
STEP CHANGE BOUNDARY CONDITIONS . . . . . NO  
TERMINATE ANALYSIS IF NOT CONVERGED . . . . .YES (EXIT)  
CONVERGENCE CONTROLS. . . . .USE DEFAULTS  
INERTIA LOADS X Y Z  
ACEL . . . . . 0.0000 0.10000E-01 0.0000  
PRINT OUTPUT CONTROLS . . . . .NO PRINTOUT



Appendix RPad-TH to Calculation PGE-009-CALC-006

DATABASE OUTPUT CONTROLS. . . . .ALL DATA WRITTEN FOR THE LAST SUBSTEP

NONLINEAR MONITORING INFO IS WRITTEN TO FILE= PAD-TH.mntr
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS HAS BEEN MODIFIED TO BE, NEQIT = 26, BY SOLUTION CONTROL LOGIC.

FORCE CONVERGENCE VALUE = 0.1434E+07 CRITERION= 7332.
EQUIL ITER 1 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.5927E-01
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.5927E-01
FORCE CONVERGENCE VALUE = 0.2973E+05 CRITERION= 1353.
EQUIL ITER 2 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.2397E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.2397E-03
FORCE CONVERGENCE VALUE = 0.3235E+05 CRITERION= 1379.
EQUIL ITER 3 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.2445E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.2445E-03
FORCE CONVERGENCE VALUE = 0.1612E+05 CRITERION= 1405.
EQUIL ITER 4 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.1145E-03
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.1145E-03
FORCE CONVERGENCE VALUE = 3510. CRITERION= 1433.
EQUIL ITER 5 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.2665E-04
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.2665E-04
FORCE CONVERGENCE VALUE = 0.6556E-03 CRITERION= 1462. <<< CONVERGED
>>> SOLUTION CONVERGED AFTER EQUILIBRIUM ITERATION 5
\*\*\* LOAD STEP 8 SUBSTEP 1 COMPLETED. CUM ITER = 91
\*\*\* TIME = 8.00000 TIME INC = 1.00000

ESEL FOR LABEL= TYPE FROM 2 TO 2 BY 1
1870 ELEMENTS (OF 8812 DEFINED) SELECTED BY ESEL COMMAND.

SET MATERIAL OF SELECTED ELEMENTS TO 10
8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

LIST ALL SELECTED ELEMENTS IN RANGE 530 TO 530 STEP 1
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*
ANSYS/Mechanical U
00245050 VERSION=INTEL NT 17:30:32 JUN 10, 2002 CP= 1870.370

DELTA T 2.375 TO 3.125 DAYS

ELEM MAT TYP REL ESY SEC TSHA NODES
530 10 2 1 0 1 1 28 29 3 672 1050 1064 728
ANSYS RELEASE 6.1 UP20020321 16:47:48 06/10/2002

PRINTOUT RESUMED BY /GOP

Load step file number 9. Begin solution ...

\*\*\*\*\* ANSYS SOLVE COMMAND \*\*\*\*\*







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Appendix RPad-TH to Calculation PGE-009-CALC-006

8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

LIST ALL SELECTED ELEMENTS IN RANGE 530 TO 530 STEP 1  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:31:49 JUN 10, 2002 CP= 1920.491

DELTA T 3.125 TO 4.125 DAYS

| ELEM                         | MAT | TYP | REL | ESY | SEC | TSHA | NODES    |            |    |   |     |      |      |     |
|------------------------------|-----|-----|-----|-----|-----|------|----------|------------|----|---|-----|------|------|-----|
| 530                          | 11  | 2   | 1   | 0   | 1   |      | 1        | 28         | 29 | 3 | 672 | 1050 | 1064 | 728 |
| ANSYS RELEASE 6.1 UP20020321 |     |     |     |     |     |      | 16:47:48 | 06/10/2002 |    |   |     |      |      |     |

PRINTOUT RESUMED BY /GOP

Load step file number 10. Begin solution ...

\*\*\*\*\* ANSYS SOLVE COMMAND \*\*\*\*\*

\*\*\* NOTE \*\*\* CP= 1921.853 TIME= 17:31:51  
Present time 0 is less than or equal to the previous time.  
Time will default to 10.

\*\*\* NOTE \*\*\* CP= 1921.853 TIME= 17:31:51  
Nonlinear analysis, NROPT set to the FULL Newton-Raphson solution  
procedure for ALL DOFs.

SOLCONTROL,ON uses sparse matrix direct solver  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:31:52 JUN 10, 2002 CP= 1922.184

DELTA T 4.125 TO 6.125 DAYS

L O A D S T E P O P T I O N S

LOAD STEP NUMBER. . . . . 10  
 TIME AT END OF THE LOAD STEP. . . . . 10.000  
 AUTOMATIC TIME STEPPING . . . . . ON  
     INITIAL NUMBER OF SUBSTEPS . . . . . 1  
     MAXIMUM NUMBER OF SUBSTEPS . . . . . 1000  
     MINIMUM NUMBER OF SUBSTEPS . . . . . 1  
 MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS. . . . . 15  
 STEP CHANGE BOUNDARY CONDITIONS . . . . . NO  
 TERMINATE ANALYSIS IF NOT CONVERGED . . . . .YES (EXIT)  
 CONVERGENCE CONTROLS. . . . .USE DEFAULTS  
 INERTIA LOADS                                   X                                   Y                                   Z  
     ACEL . . . . . 0.0000                   0.10000E-01           0.0000  
 PRINT OUTPUT CONTROLS . . . . .NO PRINTOUT



DATABASE OUTPUT CONTROLS. . . . .ALL DATA WRITTEN  
FOR THE LAST SUBSTEP

NONLINEAR MONITORING INFO IS WRITTEN TO FILE= PAD-TH.mntr  
MAXIMUM NUMBER OF EQUILIBRIUM ITERATIONS HAS BEEN MODIFIED  
TO BE, NEQIT = 26, BY SOLUTION CONTROL LOGIC.

FORCE CONVERGENCE VALUE = 0.2253E+07 CRITERION= 0.1174E+05  
EQUIL ITER 1 COMPLETED. NEW TRIANG MATRIX. MAX DOF INC= 0.3675E-01  
LINE SEARCH PARAMETER = 1.000 SCALED MAX DOF INC = 0.3675E-01  
FORCE CONVERGENCE VALUE = 69.09 CRITERION= 4270. <<< CONVERGED  
>>> SOLUTION CONVERGED AFTER EQUILIBRIUM ITERATION 1  
\*\*\* LOAD STEP 10 SUBSTEP 1 COMPLETED. CUM ITER = 94  
\*\*\* TIME = 10.0000 TIME INC = 1.00000

ESEL FOR LABEL= TYPE FROM 2 TO 2 BY 1  
1870 ELEMENTS (OF 8812 DEFINED) SELECTED BY ESEL COMMAND.

SET MATERIAL OF SELECTED ELEMENTS TO 12  
8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

LIST ALL SELECTED ELEMENTS IN RANGE 530 TO 530 STEP 1  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:32:40 JUN 10, 2002 CP= 1950.104  
DELTA T 4.125 TO 6.125 DAYS

| ELEM                         | MAT | TYP | REL | ESY | SEC | TSHA | NODES    |            |    |   |     |      |      |     |
|------------------------------|-----|-----|-----|-----|-----|------|----------|------------|----|---|-----|------|------|-----|
| 530                          | 12  | 2   | 1   | 0   | 1   |      | 1        | 28         | 29 | 3 | 672 | 1050 | 1064 | 728 |
| ANSYS RELEASE 6.1 UP20020321 |     |     |     |     |     |      | 16:47:48 | 06/10/2002 |    |   |     |      |      |     |

PRINTOUT RESUMED BY /GOP

Load step file number 11. Begin solution ...

\*\*\*\*\* ANSYS SOLVE COMMAND \*\*\*\*\*

\*\*\* NOTE \*\*\* CP= 1951.446 TIME= 17:32:43  
Present time 0 is less than or equal to the previous time.  
Time will default to 11.

\*\*\* NOTE \*\*\* CP= 1951.446 TIME= 17:32:43  
Nonlinear analysis, NROPT set to the FULL Newton-Raphson solution  
procedure for ALL DOFs.

SOLCONTROL,ON uses sparse matrix direct solver

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*





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Appendix RPad-TH to Calculation PGE-009-CALC-006

DELTA T 6.125 TO 7.875 DAYS

| ELEM | MAT | TYP | REL | ESY | SEC | TSHA | NODES |    |   |     |      |      |     |
|------|-----|-----|-----|-----|-----|------|-------|----|---|-----|------|------|-----|
| 530  | 2   | 2   | 1   | 0   | 1   | 1    | 28    | 29 | 3 | 672 | 1050 | 1064 | 728 |

FINISH SOLUTION PROCESSING

\*\*\*\*\* ROUTINE COMPLETED \*\*\*\*\* CP = 2020.545

ALL CURRENT ANSYS DATA WRITTEN TO FILE NAME= PAD-TH.db  
FOR POSSIBLE RESUME FROM THIS POINT

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:34:29 JUN 10, 2002 CP= 2021.026

DELTA T 6.125 TO 7.875 DAYS

\*\*\*\*\* ANSYS RESULTS INTERPRETATION (POST1) \*\*\*\*\*

\*\*\* WARNING \*\*\* CP= 2021.026 TIME= 17:34:29  
The current solution may have been produced using different model or boundary condition data than is currently stored. POST1 results may be erroneous unless you perform a new solution using the stored data.

\*\*\* NOTE \*\*\* CP= 2021.026 TIME= 17:34:30  
Reading results into the database (SET command) will update the current displacement and force boundary conditions in the database with the values from the results file for that load set. Note that any subsequent solutions will use these values unless action is taken to either SAVE the current values or not overwrite them (/EXIT,NOSAVE).

PRINT HEADER  
DO NOT PRINT SUBTITLE(S)  
DO NOT PRINT LOAD STEP ID  
DO NOT PRINT NOTE LINE(S)  
PRINT COLUMN HEADER LABELS  
DO NOT PRINT REPORT TOTALS

SUM RESULTS, SET TITLES AND WRITE LOAD CASE FILES FOR FURTHER PROCESSING

COMBINE ALL RECORDS INCLUDING NON-SUMMABLE

LOAD CASE 1 IS LOAD STEP 1 SUBSTEP 1 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 0.0 TO 0.25 DAYS



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Appendix RPad-TH to Calculation PGE-009-CALC-006

LOAD CASE 2 IS LOAD STEP 2 SUBSTEP 1 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 0.25 TO 0.50 DAYS

LOAD CASE 3 IS LOAD STEP 3 SUBSTEP 1 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 0.50 TO 0.625 DAYS

LOAD CASE 4 IS LOAD STEP 4 SUBSTEP 1 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 0.625 TO 1.125 DAYS

LOAD CASE 5 IS LOAD STEP 5 SUBSTEP 2 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 1.125 TO 1.625 DAYS

LOAD CASE 6 IS LOAD STEP 6 SUBSTEP 1 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 1.625 TO 2.125 DAYS

LOAD CASE 7 IS LOAD STEP 7 SUBSTEP 1 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 2.125 TO 2.375 DAYS

LOAD CASE 8 IS LOAD STEP 8 SUBSTEP 1 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 2.375 TO 3.125 DAYS

LOAD CASE 9 IS LOAD STEP 9 SUBSTEP 1 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 3.125 TO 4.125 DAYS

LOAD CASE 10 IS LOAD STEP 10 SUBSTEP 1 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 4.125 TO 6.125 DAYS

LOAD CASE 11 IS LOAD STEP 11 SUBSTEP 1 COMPLEX= 0  
FILE= PAD-TH.rst  
DELTA T 6.125 TO 7.875 DAYS

COPY LOAD CASE 1 FROM FILE TO DATABASE

\*\*\* WARNING \*\*\* CP= 2021.056 TIME= 17:34:30  
Cumulative iteration 16 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.



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Appendix RPad-TH to Calculation PGE-009-CALC-006

TITLE=  
PAD RESPONSE AT END OF 0.25 DAYS

WRITE LOAD CASE 1 TO FILE PAD-TH.101

\*\*\* WARNING \*\*\* CP= 2021.917 TIME= 17:34:35  
Cumulative iteration 23 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

LCOPER OPERATION ADD USING LOAD CASE= 2 FACTOR= 1.0000 ABS= 0

\*\*\* NOTE \*\*\* CP= 2022.438 TIME= 17:34:39  
Load case combination data may not be correct unless viewed in the  
solution phase coordinate system (RSYS=SOLU).

TITLE=  
PAD RESPONSE AT END OF 0.50 DAYS

WRITE LOAD CASE 2 TO FILE PAD-TH.102

\*\*\* WARNING \*\*\* CP= 2022.739 TIME= 17:34:39  
Cumulative iteration 24 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

LCOPER OPERATION ADD USING LOAD CASE= 3 FACTOR= 1.0000 ABS= 0

TITLE=  
PAD RESPONSE AT END OF 0.625 DAYS

WRITE LOAD CASE 3 TO FILE PAD-TH.103

\*\*\* WARNING \*\*\* CP= 2023.590 TIME= 17:34:45  
Cumulative iteration 25 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

LCOPER OPERATION ADD USING LOAD CASE= 4 FACTOR= 1.0000 ABS= 0

TITLE=  
PAD RESPONSE AT END OF 1.125 DAYS

WRITE LOAD CASE 4 TO FILE PAD-TH.104

\*\*\* WARNING \*\*\* CP= 2024.431 TIME= 17:34:50  
Cumulative iteration 71 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

LCOPER OPERATION ADD USING LOAD CASE= 5 FACTOR= 1.0000 ABS= 0

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## Appendix RPad-TH to Calculation PGE-009-CALC-006

TITLE=  
PAD RESPONSE AT END OF 1.625 DAYS

WRITE LOAD CASE 5 TO FILE PAD-TH.105

\*\*\* WARNING \*\*\* CP= 2025.292 TIME= 17:34:52  
Cumulative iteration 81 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

LCOPER OPERATION ADD USING LOAD CASE= 6 FACTOR= 1.0000 ABS= 0

TITLE=  
PAD RESPONSE AT END OF 2.125 DAYS

WRITE LOAD CASE 6 TO FILE PAD-TH.106

\*\*\* WARNING \*\*\* CP= 2026.203 TIME= 17:34:57  
Cumulative iteration 86 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

LCOPER OPERATION ADD USING LOAD CASE= 7 FACTOR= 1.0000 ABS= 0

TITLE=  
PAD RESPONSE AT END OF 2.375 DAYS

WRITE LOAD CASE 7 TO FILE PAD-TH.107

\*\*\* WARNING \*\*\* CP= 2027.025 TIME= 17:35:01  
Cumulative iteration 91 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

LCOPER OPERATION ADD USING LOAD CASE= 8 FACTOR= 1.0000 ABS= 0

TITLE=  
PAD RESPONSE AT END OF 3.125 DAYS

WRITE LOAD CASE 8 TO FILE PAD-TH.108

\*\*\* WARNING \*\*\* CP= 2027.926 TIME= 17:35:05  
Cumulative iteration 93 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

LCOPER OPERATION ADD USING LOAD CASE= 9 FACTOR= 1.0000 ABS= 0

TITLE=  
PAD RESPONSE AT END OF 4.125 DAYS

WRITE LOAD CASE 9 TO FILE PAD-TH.109



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Appendix RPad-TH to Calculation PGE-009-CALC-006

\*\*\* WARNING \*\*\* CP= 2028.627 TIME= 17:35:09  
Cumulative iteration 94 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

LCOPER OPERATION ADD USING LOAD CASE= 10 FACTOR= 1.0000 ABS= 0

TITLE=  
PAD RESPONSE AT END OF 6.125 DAYS

WRITE LOAD CASE 10 TO FILE PAD-TH.110

\*\*\* WARNING \*\*\* CP= 2029.418 TIME= 17:35:13  
Cumulative iteration 97 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

LCOPER OPERATION ADD USING LOAD CASE= 11 FACTOR= 1.0000 ABS= 0

TITLE=  
PAD RESPONSE AT END OF 7.875 DAYS

WRITE LOAD CASE 11 TO FILE PAD-TH.111

EXIT THE ANSYS POST1 DATABASE PROCESSOR

\*\*\*\*\* ROUTINE COMPLETED \*\*\*\*\* CP = 2030.279

print the temperatures for checking

8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

10212 NODES (OF 10212 DEFINED) SELECTED BY NALL COMMAND.

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:19 JUN 10, 2002 CP= 2030.279

PAD RESPONSE AT END OF 7.875 DAYS

\*\*\*\*\* ANSYS RESULTS INTERPRETATION (POST1) \*\*\*\*\*

\*\*\* WARNING \*\*\* CP= 2030.279 TIME= 17:35:19  
The current solution may have been produced using different model or  
boundary condition data than is currently stored. POST1 results may  
be erroneous unless you perform a new solution using the stored data.

PRINT HEADER  
DO NOT PRINT SUBTITLE(S)





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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

DO NOT PRINT LOAD STEP ID  
DO NOT PRINT NOTE LINE(S)  
PRINT COLUMN HEADER LABELS  
DO NOT PRINT REPORT TOTALS

SELECT FOR ITEM=LOC COMPONENT=X BETWEEN 0.0000 AND 0.0000  
KABS= 0. TOLERANCE= 0.100000E-05

626 NODES (OF 10212 DEFINED) SELECTED BY NSEL COMMAND.

RESELECT FOR ITEM=LOC COMPONENT=Z BETWEEN 0.0000 AND 0.0000  
KABS= 0. TOLERANCE= 0.100000E-05

26 NODES (OF 10212 DEFINED) SELECTED BY NSEL COMMAND.

RESELECT FOR ITEM=LOC COMPONENT=Y BETWEEN -145.00 AND 0.0000  
KABS= 0. TOLERANCE= 0.145000E-05

18 NODES (OF 10212 DEFINED) SELECTED BY NSEL COMMAND.

LIST ALL SELECTED NODES. DSYS= 0

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:19 JUN 10, 2002 CP= 2030.289

PAD RESPONSE AT END OF 7.875 DAYS

| NODE | X      | Y       | Z      | THXY | THYZ | THZX |
|------|--------|---------|--------|------|------|------|
| 1    | 0.0000 | 0.0000  | 0.0000 | 0.00 | 0.00 | 0.00 |
| 16   | 0.0000 | -24.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 26   | 0.0000 | -18.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 27   | 0.0000 | -12.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 28   | 0.0000 | -6.0000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 61   | 0.0000 | -84.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 71   | 0.0000 | -72.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 72   | 0.0000 | -60.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 73   | 0.0000 | -48.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 74   | 0.0000 | -36.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 113  | 0.0000 | -96.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 123  | 0.0000 | -90.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 133  | 0.0000 | -96.000 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 146  | 0.0000 | -108.00 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 156  | 0.0000 | -102.00 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 169  | 0.0000 | -144.00 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 179  | 0.0000 | -132.00 | 0.0000 | 0.00 | 0.00 | 0.00 |
| 180  | 0.0000 | -120.00 | 0.0000 | 0.00 | 0.00 | 0.00 |

USE LOAD STEP 1 SUBSTEP 0 FOR LOAD CASE 0

\*\*\* WARNING \*\*\* CP= 2030.289 TIME= 17:35:20  
Cumulative iteration 16 may have been solved using different model or boundary condition data than currently stored. POST1 results may be erroneous unless you RESUME from a Jobname.DB file for this substep.



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Appendix RPad-TH to Calculation PGE-009-CALC-006

SET COMMAND GOT LOAD STEP= 1 SUBSTEP= 1 CUMULATIVE ITERATION= 16  
TIME/FREQUENCY= 1.0000  
TITLE= DELTA T 0.0 TO 0.25 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:23 JUN 10, 2002 CP= 2030.980

DELTA T 0.0 TO 0.25 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 15.000  |
| 28   | 18.000  |
| 27   | 19.670  |
| 26   | 21.330  |
| 16   | 21.330  |
| 74   | 21.330  |
| 73   | 21.330  |
| 72   | 21.330  |
| 71   | 21.330  |
| 61   | 20.500  |
| 123  | 19.660  |
| 113  | 10.670  |
| 133  | 10.670  |
| 156  | 1.6700  |
| 146  | 0.84000 |
| 180  | 0.0000  |
| 179  | 0.0000  |
| 169  | 0.0000  |

USE LOAD STEP 2 SUBSTEP 0 FOR LOAD CASE 0

\*\*\* WARNING \*\*\* CP= 2030.980 TIME= 17:35:23  
Cumulative iteration 23 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

SET COMMAND GOT LOAD STEP= 2 SUBSTEP= 1 CUMULATIVE ITERATION= 23  
TIME/FREQUENCY= 2.0000  
TITLE= DELTA T 0.25 TO 0.50 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1



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Appendix RPad-TH to Calculation PGE-009-CALC-006

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
 ANSYS/Mechanical U  
 00245050 VERSION=INTEL NT 17:35:25 JUN 10, 2002 CP= 2031.521

DELTA T 0.25 TO 0.50 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | -2.5000 |
| 28   | 10.500  |
| 27   | 9.2500  |
| 26   | 8.0000  |
| 16   | 16.670  |
| 74   | 25.330  |
| 73   | 25.330  |
| 72   | 25.330  |
| 71   | 25.120  |
| 61   | 21.410  |
| 123  | 17.920  |
| 113  | 12.660  |
| 133  | 12.660  |
| 156  | 7.4100  |
| 146  | 3.9100  |
| 180  | 0.21000 |
| 179  | 0.0000  |
| 169  | 0.0000  |

USE LOAD STEP 3 SUBSTEP 0 FOR LOAD CASE 0

\*\*\* WARNING \*\*\* CP= 2031.521 TIME= 17:35:25  
 Cumulative iteration 24 may have been solved using different model or  
 boundary condition data than currently stored. POST1 results may be  
 erroneous unless you RESUME from a Jobname.DB file for this substep.

SET COMMAND GOT LOAD STEP= 3 SUBSTEP= 1 CUMULATIVE ITERATION= 24  
 TIME/FREQUENCY= 3.0000  
 TITLE= DELTA T 0.50 TO 0.625 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
 ANSYS/Mechanical U  
 00245050 VERSION=INTEL NT 17:35:27 JUN 10, 2002 CP= 2032.132

DELTA T 0.50 TO 0.625 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | -3.0000 |
| 28   | -1.3500 |



Appendix RPad-TH to Calculation PGE-009-CALC-006

27 9.3200  
 26 13.460  
 16 9.3300  
 74 9.3300  
 73 9.3300  
 72 9.3300  
 71 9.3300  
 61 9.3300  
 123 2.0400  
 113 4.6700  
 133 4.6700  
 156 7.3000  
 146 0.0000  
 180 0.0000  
 179 0.0000  
 169 0.0000

USE LOAD STEP 4 SUBSTEP 0 FOR LOAD CASE 0

\*\*\* WARNING \*\*\* CP= 2032.142 TIME= 17:35:27  
 Cumulative iteration 25 may have been solved using different model or  
 boundary condition data than currently stored. POST1 results may be  
 erroneous unless you RESUME from a Jobname.DB file for this substep.

SET COMMAND GOT LOAD STEP= 4 SUBSTEP= 1 CUMULATIVE ITERATION= 25  
 TIME/FREQUENCY= 4.0000  
 TITLE= DELTA T 0.625 TO 1.125 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
 ANSYS/Mechanical U  
 00245050 VERSION=INTEL NT 17:35:29 JUN 10, 2002 CP= 2032.763

DELTA T 0.625 TO 1.125 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | -5.4000 |
| 28   | -7.4400 |
| 27   | -8.8100 |
| 26   | -3.1000 |
| 16   | 2.6200  |
| 74   | 15.000  |
| 73   | 20.110  |
| 72   | 20.320  |
| 71   | 17.860  |
| 61   | 11.880  |
| 123  | 11.110  |
| 113  | 10.330  |
| 133  | 10.330  |



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Appendix RPad-TH to Calculation PGE-009-CALC-006

156 9.5500  
146 8.7800  
180 2.8100  
179 0.35000  
169 0.10000E-01

USE LOAD STEP 5 SUBSTEP 0 FOR LOAD CASE 0

\*\*\* WARNING \*\*\* CP= 2032.763 TIME= 17:35:29  
Cumulative iteration 71 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

SET COMMAND GOT LOAD STEP= 5 SUBSTEP= 2 CUMULATIVE ITERATION= 71  
TIME/FREQUENCY= 5.0000  
TITLE= DELTA T 1.125 TO 1.625 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:29 JUN 10, 2002 CP= 2033.264

DELTA T 1.125 TO 1.625 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | -2.1000 |
| 28   | -5.5000 |
| 27   | -6.4600 |
| 26   | -4.7300 |
| 16   | -3.0000 |
| 74   | 2.2500  |
| 73   | 7.3200  |
| 72   | 8.4500  |
| 71   | 6.3200  |
| 61   | 3.7400  |
| 123  | 4.4500  |
| 113  | 5.1600  |
| 133  | 5.1600  |
| 156  | 5.8800  |
| 146  | 6.6000  |
| 180  | 3.9800  |
| 179  | 1.3800  |
| 169  | 0.25000 |

USE LOAD STEP 6 SUBSTEP 0 FOR LOAD CASE 0

\*\*\* WARNING \*\*\* CP= 2033.274 TIME= 17:35:29  
Cumulative iteration 81 may have been solved using different model or



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Appendix RPad-TH to Calculation PGE-009-CALC-006

boundary condition data than currently stored. POST1 results may be erroneous unless you RESUME from a Jobname.DB file for this substep.

SET COMMAND GOT LOAD STEP= 6 SUBSTEP= 1 CUMULATIVE ITERATION= 81  
TIME/FREQUENCY= 6.0000  
TITLE= DELTA T 1.625 TO 2.125 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:30 JUN 10, 2002 CP= 2033.795

DELTA T 1.625 TO 2.125 DAYS

| NODE | BFTEMP   |
|------|----------|
| 1    | -0.80000 |
| 28   | -3.0600  |
| 27   | -4.0600  |
| 26   | -3.9600  |
| 16   | -3.8700  |
| 74   | -2.2200  |
| 73   | 0.96000  |
| 72   | 2.2900   |
| 71   | 1.5300   |
| 61   | 0.91000  |
| 123  | 1.8700   |
| 113  | 2.8300   |
| 133  | 2.8300   |
| 156  | 3.7800   |
| 146  | 4.7200   |
| 180  | 3.8200   |
| 179  | 1.9800   |
| 169  | 0.53000  |

USE LOAD STEP 7 SUBSTEP 0 FOR LOAD CASE 0

\*\*\* WARNING \*\*\* CP= 2033.795 TIME= 17:35:30  
Cumulative iteration 86 may have been solved using different model or boundary condition data than currently stored. POST1 results may be erroneous unless you RESUME from a Jobname.DB file for this substep.

SET COMMAND GOT LOAD STEP= 7 SUBSTEP= 1 CUMULATIVE ITERATION= 86  
TIME/FREQUENCY= 7.0000  
TITLE= DELTA T 2.125 TO 2.375 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
 ANSYS/Mechanical U  
 00245050 VERSION=INTEL NT 17:35:30 JUN 10, 2002 CP= 2034.315

DELTA T 2.125 TO 2.375 DAYS

| NODE | BFETEMP     |
|------|-------------|
| 1    | -0.20000    |
| 28   | -0.94000    |
| 27   | -1.2800     |
| 26   | -1.4700     |
| 16   | -1.6500     |
| 74   | -1.5100     |
| 73   | -0.54000    |
| 72   | 0.80000E-01 |
| 71   | 0.90000E-01 |
| 61   | 0.20000     |
| 123  | 0.63000     |
| 113  | 1.0600      |
| 133  | 1.0600      |
| 156  | 1.4600      |
| 146  | 1.8600      |
| 180  | 1.7300      |
| 179  | 1.0500      |
| 169  | 0.33000     |

USE LOAD STEP 8 SUBSTEP 0 FOR LOAD CASE 0

\*\*\* WARNING \*\*\* CP= 2034.315 TIME= 17:35:30  
 Cumulative iteration 91 may have been solved using different model or  
 boundary condition data than currently stored. POST1 results may be  
 erroneous unless you RESUME from a Jobname.DB file for this substep.

SET COMMAND GOT LOAD STEP= 8 SUBSTEP= 1 CUMULATIVE ITERATION= 91  
 TIME/FREQUENCY= 8.0000  
 TITLE= DELTA T 2.375 TO 3.125 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
 ANSYS/Mechanical U  
 00245050 VERSION=INTEL NT 17:35:31 JUN 10, 2002 CP= 2034.826

DELTA T 2.375 TO 3.125 DAYS

NODE BFETEMP



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Appendix RPad-TH to Calculation PGE-009-CALC-006

|     |          |
|-----|----------|
| 1   | -0.50000 |
| 28  | -2.1300  |
| 27  | -3.0700  |
| 26  | -3.9000  |
| 16  | -4.7400  |
| 74  | -5.6000  |
| 73  | -4.2000  |
| 72  | -2.7200  |
| 71  | -1.8500  |
| 61  | -0.66000 |
| 123 | 0.64000  |
| 113 | 1.9400   |
| 133 | 1.9400   |
| 156 | 3.1000   |
| 146 | 4.2600   |
| 180 | 4.3900   |
| 179 | 3.0000   |
| 169 | 1.0300   |

USE LOAD STEP 9 SUBSTEP 0 FOR LOAD CASE 0

\*\*\* WARNING \*\*\* CP= 2034.836 TIME= 17:35:31  
Cumulative iteration 93 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

SET COMMAND GOT LOAD STEP= 9 SUBSTEP= 1 CUMULATIVE ITERATION= 93  
TIME/FREQUENCY= 9.0000  
TITLE= DELTA T 3.125 TO 4.125 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE  
1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:32 JUN 10, 2002 CP= 2035.357

DELTA T 3.125 TO 4.125 DAYS

| NODE | BFETEMP  |
|------|----------|
| 1    | -0.30000 |
| 28   | -2.0300  |
| 27   | -3.1400  |
| 26   | -4.4900  |
| 16   | -5.8400  |
| 74   | -8.3400  |
| 73   | -8.3500  |
| 72   | -7.1100  |
| 71   | -5.3300  |
| 61   | -2.9100  |
| 123  | -1.1900  |





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Appendix RPad-TH to Calculation PGE-009-CALC-006

113 0.54000  
133 0.54000  
156 1.9800  
146 3.4300  
180 4.1800  
179 3.1900  
169 1.1800

USE LOAD STEP 10 SUBSTEP 0 FOR LOAD CASE 0

\*\*\* WARNING \*\*\* CP= 2035.357 TIME= 17:35:32  
Cumulative iteration 94 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

SET COMMAND GOT LOAD STEP= 10 SUBSTEP= 1 CUMULATIVE ITERATION= 94  
TIME/FREQUENCY= 10.000  
TITLE= DELTA T 4.125 TO 6.125 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:32 JUN 10, 2002 CP= 2035.877

DELTA T 4.125 TO 6.125 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 0.0000  |
| 28   | -1.3800 |
| 27   | -2.6100 |
| 26   | -4.7600 |
| 16   | -6.9100 |
| 74   | -11.780 |
| 73   | -13.650 |
| 72   | -12.770 |
| 71   | -9.8200 |
| 61   | -5.6000 |
| 123  | -3.3600 |
| 113  | -1.1200 |
| 133  | -1.1200 |
| 156  | 0.66000 |
| 146  | 2.4300  |
| 180  | 4.0600  |
| 179  | 3.5200  |
| 169  | 1.3700  |

USE LOAD STEP 11 SUBSTEP 0 FOR LOAD CASE 0



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Appendix RPad-TH to Calculation PGE-009-CALC-006

\*\*\* WARNING \*\*\* CP= 2035.877 TIME= 17:35:32  
Cumulative iteration 97 may have been solved using different model or  
boundary condition data than currently stored. POST1 results may be  
erroneous unless you RESUME from a Jobname.DB file for this substep.

SET COMMAND GOT LOAD STEP= 11 SUBSTEP= 1 CUMULATIVE ITERATION= 97  
TIME/FREQUENCY= 11.000  
TITLE= DELTA T 6.125 TO 7.875 DAYS

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:33 JUN 10, 2002 CP= 2036.398

DELTA T 6.125 TO 7.875 DAYS

| NODE | BFETEMP  |
|------|----------|
| 1    | 0.0000   |
| 28   | -0.69000 |
| 27   | -1.3300  |
| 26   | -2.5100  |
| 16   | -3.6900  |
| 74   | -6.5800  |
| 73   | -8.1200  |
| 72   | -8.1000  |
| 71   | -6.7500  |
| 61   | -4.5600  |
| 123  | -3.3800  |
| 113  | -2.2000  |
| 133  | -2.2000  |
| 156  | -1.2300  |
| 146  | -0.25000 |
| 180  | 0.85000  |
| 179  | 1.0100   |
| 169  | 0.43000  |

COPY LOAD CASE 1 FROM FILE TO DATABASE

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:34 JUN 10, 2002 CP= 2037.099

PAD RESPONSE AT END OF 0.25 DAYS



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

| NODE | BFETEMP |
|------|---------|
| 1    | 15.000  |
| 28   | 18.000  |
| 27   | 19.670  |
| 26   | 21.330  |
| 16   | 21.330  |
| 74   | 21.330  |
| 73   | 21.330  |
| 72   | 21.330  |
| 71   | 21.330  |
| 61   | 20.500  |
| 123  | 19.660  |
| 113  | 10.670  |
| 133  | 10.670  |
| 156  | 1.6700  |
| 146  | 0.84000 |
| 180  | 0.0000  |
| 179  | 0.0000  |
| 169  | 0.0000  |

COPY LOAD CASE 2 FROM FILE TO DATABASE

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
 ANSYS/Mechanical U  
 00245050 VERSION=INTEL NT 17:35:36 JUN 10, 2002 CP= 2037.830

PAD RESPONSE AT END OF 0.50 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 12.500  |
| 28   | 28.500  |
| 27   | 28.920  |
| 26   | 29.330  |
| 16   | 38.000  |
| 74   | 46.660  |
| 73   | 46.660  |
| 72   | 46.660  |
| 71   | 46.450  |
| 61   | 41.910  |
| 123  | 37.580  |
| 113  | 23.330  |
| 133  | 23.330  |
| 156  | 9.0800  |
| 146  | 4.7500  |
| 180  | 0.21000 |
| 179  | 0.0000  |
| 169  | 0.0000  |



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Appendix RPad-TH to Calculation PGE-009-CALC-006

COPY LOAD CASE 3 FROM FILE TO DATABASE

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:37 JUN 10, 2002 CP= 2038.581

PAD RESPONSE AT END OF 0.625 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 9.5000  |
| 28   | 27.150  |
| 27   | 38.240  |
| 26   | 42.790  |
| 16   | 47.330  |
| 74   | 55.990  |
| 73   | 55.990  |
| 72   | 55.990  |
| 71   | 55.780  |
| 61   | 51.240  |
| 123  | 39.620  |
| 113  | 28.000  |
| 133  | 28.000  |
| 156  | 16.380  |
| 146  | 4.7500  |
| 180  | 0.21000 |
| 179  | 0.0000  |
| 169  | 0.0000  |

COPY LOAD CASE 4 FROM FILE TO DATABASE

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:39 JUN 10, 2002 CP= 2039.332

PAD RESPONSE AT END OF 1.125 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 4.1000  |
| 28   | 19.710  |
| 27   | 29.430  |



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

|     |             |
|-----|-------------|
| 26  | 39.690      |
| 16  | 49.950      |
| 74  | 70.990      |
| 73  | 76.100      |
| 72  | 76.310      |
| 71  | 73.640      |
| 61  | 63.120      |
| 123 | 50.730      |
| 113 | 38.330      |
| 133 | 38.330      |
| 156 | 25.930      |
| 146 | 13.530      |
| 180 | 3.0200      |
| 179 | 0.35000     |
| 169 | 0.10000E-01 |

COPY LOAD CASE 5 FROM FILE TO DATABASE

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
 ANSYS/Mechanical U  
 00245050 VERSION=INTEL NT 17:35:40 JUN 10, 2002 CP= 2040.124

PAD RESPONSE AT END OF 1.625 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 2.0000  |
| 28   | 14.210  |
| 27   | 22.970  |
| 26   | 34.960  |
| 16   | 46.950  |
| 74   | 73.240  |
| 73   | 83.420  |
| 72   | 84.760  |
| 71   | 79.960  |
| 61   | 66.860  |
| 123  | 55.180  |
| 113  | 43.490  |
| 133  | 43.490  |
| 156  | 31.810  |
| 146  | 20.130  |
| 180  | 7.0000  |
| 179  | 1.7300  |
| 169  | 0.26000 |

COPY LOAD CASE 6 FROM FILE TO DATABASE

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.



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Appendix RPad-TH to Calculation PGE-009-CALC-006

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:42 JUN 10, 2002 CP= 2040.935

PAD RESPONSE AT END OF 2.125 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 1.2000  |
| 28   | 11.150  |
| 27   | 18.910  |
| 26   | 31.000  |
| 16   | 43.080  |
| 74   | 71.020  |
| 73   | 84.380  |
| 72   | 87.050  |
| 71   | 81.490  |
| 61   | 67.770  |
| 123  | 57.050  |
| 113  | 46.320  |
| 133  | 46.320  |
| 156  | 35.590  |
| 146  | 24.850  |
| 180  | 10.820  |
| 179  | 3.7100  |
| 169  | 0.79000 |

COPY LOAD CASE 7 FROM FILE TO DATABASE

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:43 JUN 10, 2002 CP= 2041.676

PAD RESPONSE AT END OF 2.375 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 1.0000  |
| 28   | 10.210  |
| 27   | 17.630  |
| 26   | 29.530  |
| 16   | 41.430  |
| 74   | 69.510  |
| 73   | 83.840  |
| 72   | 87.130  |
| 71   | 81.580  |



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Appendix RPad-TH to Calculation PGE-009-CALC-006

|     |        |
|-----|--------|
| 61  | 67.970 |
| 123 | 57.680 |
| 113 | 47.380 |
| 133 | 47.380 |
| 156 | 37.050 |
| 146 | 26.710 |
| 180 | 12.550 |
| 179 | 4.7600 |
| 169 | 1.1200 |

COPY LOAD CASE 8 FROM FILE TO DATABASE

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
 ANSYS/Mechanical U  
 00245050 VERSION=INTEL NT 17:35:45 JUN 10, 2002 CP= 2042.467

PAD RESPONSE AT END OF 3.125 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 0.50000 |
| 28   | 8.0800  |
| 27   | 14.560  |
| 26   | 25.630  |
| 16   | 36.690  |
| 74   | 63.910  |
| 73   | 79.640  |
| 72   | 84.410  |
| 71   | 79.730  |
| 61   | 67.310  |
| 123  | 58.320  |
| 113  | 49.320  |
| 133  | 49.320  |
| 156  | 40.150  |
| 146  | 30.970  |
| 180  | 16.940  |
| 179  | 7.7600  |
| 169  | 2.1500  |

COPY LOAD CASE 9 FROM FILE TO DATABASE

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
 ANSYS/Mechanical U



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

00245050            VERSION=INTEL NT            17:35:46    JUN 10, 2002 CP=    2043.138

PAD RESPONSE AT END OF 4.125 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 0.20000 |
| 28   | 6.0500  |
| 27   | 11.420  |
| 26   | 21.140  |
| 16   | 30.850  |
| 74   | 55.570  |
| 73   | 71.290  |
| 72   | 77.300  |
| 71   | 74.400  |
| 61   | 64.400  |
| 123  | 57.130  |
| 113  | 49.860  |
| 133  | 49.860  |
| 156  | 42.130  |
| 146  | 34.400  |
| 180  | 21.120  |
| 179  | 10.950  |
| 169  | 3.3300  |

COPY LOAD CASE 10 FROM FILE TO DATABASE

SORT ON ITEM=LOC    COMPONENT=Y            ORDER= 0    KABS= 0    NMAX=    10212

SORT COMPLETED FOR            18 VALUES.

PRINT BFE    NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM    RELEASE 6.1            \*\*\*\*\*  
ANSYS/Mechanical U

00245050            VERSION=INTEL NT            17:35:48    JUN 10, 2002 CP=    2043.839

PAD RESPONSE AT END OF 6.125 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 0.20000 |
| 28   | 4.6700  |
| 27   | 8.8100  |
| 26   | 16.380  |
| 16   | 23.940  |
| 74   | 43.790  |
| 73   | 57.640  |
| 72   | 64.530  |
| 71   | 64.580  |
| 61   | 58.800  |
| 123  | 53.770  |
| 113  | 48.740  |
| 133  | 48.740  |
| 156  | 42.790  |
| 146  | 36.830  |





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Appendix RPad-TH to Calculation PGE-009-CALC-006

180 25.180  
179 14.470  
169 4.7000

COPY LOAD CASE 11 FROM FILE TO DATABASE

SORT ON ITEM=LOC COMPONENT=Y ORDER= 0 KABS= 0 NMAX= 10212

SORT COMPLETED FOR 18 VALUES.

PRINT BFE NODAL SOLUTION PER NODE

1

\*\*\*\*\* ANSYS - ENGINEERING ANALYSIS SYSTEM RELEASE 6.1 \*\*\*\*\*  
ANSYS/Mechanical U  
00245050 VERSION=INTEL NT 17:35:49 JUN 10, 2002 CP= 2044.550

PAD RESPONSE AT END OF 7.875 DAYS

| NODE | BFETEMP |
|------|---------|
| 1    | 0.20000 |
| 28   | 3.9800  |
| 27   | 7.4800  |
| 26   | 13.870  |
| 16   | 20.250  |
| 74   | 37.210  |
| 73   | 49.520  |
| 72   | 56.430  |
| 71   | 57.830  |
| 61   | 54.240  |
| 123  | 50.390  |
| 113  | 46.540  |
| 133  | 46.540  |
| 156  | 41.560  |
| 146  | 36.580  |
| 180  | 26.030  |
| 179  | 15.480  |
| 169  | 5.1300  |

NODE SORT REMOVED

EXIT THE ANSYS POST1 DATABASE PROCESSOR

\*\*\*\*\* ROUTINE COMPLETED \*\*\*\*\* CP = 2044.550

8812 ELEMENTS (OF 8812 DEFINED) SELECTED BY EALL COMMAND.

10212 NODES (OF 10212 DEFINED) SELECTED BY NALL COMMAND.

EXIT ANSYS WITHOUT SAVING DATABASE



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**Appendix RPad-TH to Calculation PGE-009-CALC-006**

NUMBER OF ERROR MESSAGES ENCOUNTERED= 0

```

*-----*
                ANSYS RUN COMPLETED
-----
                Release 6.1                UP20020321                INTEL NT
-----
Maximum Scratch Memory Used      =      61921432 Words      236.212 MB
-----
CP Time      (sec) =      2044.560      Time = 17:35:49
Elapsed Time (sec) =      2792.000      Date  = 06/10/2002
-----*
    
```