NES 81A0091

SEISMIC AND STRESS ANALYSIS OF THE LACBWR HIGH PRESSURE CORE SPRAY DISCHARGE LINE PIPING SYSTEM

Prepared Under NES Project 5101 for

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TABLE OF CONTENTS

LIST OF FICURES

LIST OF TABLES

LIST OF APPENDICES

1. SUMMARY

This report, prepared for Dairyland Power Cooperative, presents the results of seismic and stress analyses of the High Pressure Core Spray (HPCS) piping system discharge line for the LACBWR Nuclear Power Station. The seismic and stress analyses are performed in accordance with the design requirements for Class 1 piping components of the ASME Boiler and Pressure Vessel Code, Section III, Division 1, "Nuclear Power Plant Components", 1974. By providing seismic restraints at critical locations of the HPCS discharge line, the stresses in the piping due to a seismic event can be reduced to acceptable values. That is, the stresses due to seismic, deadweight, pressure and thermal expansion loadings, combined according to the ASME Code rules for Class 1 components would satisfy the design requirements given in the Code with the addition of seismic restraints. The detail stress analysis also indicates 2900 permissible HPCS operating cycles.

2. INTRODUCTION

In response to AEC/DL's request to review the effects of an earthquake event on the LaCrosse Boiling Water Reactor, Dairyland Power Cooperative requested Gulf United Nuclear Fuels Corporation to evaluate the adequacy of the major structures and equipment to withstand seismic loadings. The seismic study performed by Gulf United (GU) Nuclear Fuels Corporation (Reference 1) included an analysis of the main steam line which indicated that high stresses would be generated in the main steam line during a seismic event. It was also evident from these analyses that the LACBWR piping systems, in general, were not designed to accomodate horizontal accelerations, the primary earthquake induced loading condition. Anticipating the possibility of a seismically induced loss of coolant accident, it was, therefore, concluded that analyses of the major Class 1 piping systems should be performed to evaluate their structural integrity.

This report presents the seismic and stress analysis for the discharge line of the High Pressure Core Spray (HPCS) System. (The HPCS suction line analyses is presented in a separate report, NES 81A0090). The High Pressure Core Spray System is the principal emergency core cooling system. In order to verify that the seismic stresses in the HPCS discharge line are acceptable, it is necessary to show that the combined stresses in the piping system are within ASME Boiler and Pressure Vessel Code allowable values for Class 1 Components. This requires that the seismic stresses be combined with the stresses due to deadweight, pressure and thermal loadings in accordance with the ASME Code Section III,. Subsection NB rules (Reference 2).

For the static and dynamic analysis, the High Pressure Core Spray discharge line, including a portion of the sodium pentaborate discharge line has been mathematically modeled as a finite element model. Seismic restraints were provided at suitable locations in order to reduce the seismic stresses in this piping system and to isolate it for analytical purposes from the effects of the HPCS suction line and the sodium pentaborate discharge line to the 16 inch forced circulation discharge header. The static response of the HPCS Discharge Line to the dead weight, thermal expansion and anchor movement loadings have been calculated using direct stiffness displacement methods of structural analysis. The response of the HPCS Discharge Line to seismic loadings have been determined using response spectrum modal superposition methods. Stresses due to various loadings have been calculated and combined in accordance with the ASME Code Section III, Subsection NB rules.

Initial stress calculations, using the conservative stress intensification factors of the ASME Code for the socket weld coupling/reactor nozzle region, resulted in an excessive peak stress value and therefore a very low number of permissible HPCS operating cycles (100 cycles). The socket weld coupling/reactor nozzle region was re-analyzed by means of a detailed finite-element model using the ANSYS computer code. The transient thermal loadings produced by the HPCS initiation were determined using the same basic model developed for stress analysis and using the LION computer program.

Section 3.0 of this report describes the High Pressure Core Spray (HPCS) Discharge Line considered in the analysis. The loading criteria, design criteria and analytical methods used in the analyses are given in Section 4.0, 5.0 and 6.0 respectively. The results of the analyses are discussed in Section 7.0. The conclusions are summarized in Section 8.0.

3. DESCRIPTION OF PIPING SYSTEM

The High Pressure Core Spray (HPCS) System of the LACBWR power plant is designed to provide an emergency coolant spray to the reactor core in the event that reactor water level drops accidentally. This is done by either direct gravity feed of water from an overhead storage tank to the core spray header under low reactor pressure conditions, or by means of high pressure water injection under high reactor pressure conditions.

In order to simplify the piping system analysis, the long and complex HPCS piping system was divided into two sections: the first consisting generally of the suction piping which runs from the overhead storage tank to the high pressure core spray pumps and the second consisting of the discharge piping which runs from the high pressure core spray pumps to the core spray header inlet. The HPCS suction piping analysis is presented in a separate report. The subject analysis of this report is, therefore, the HPCS discharge line.

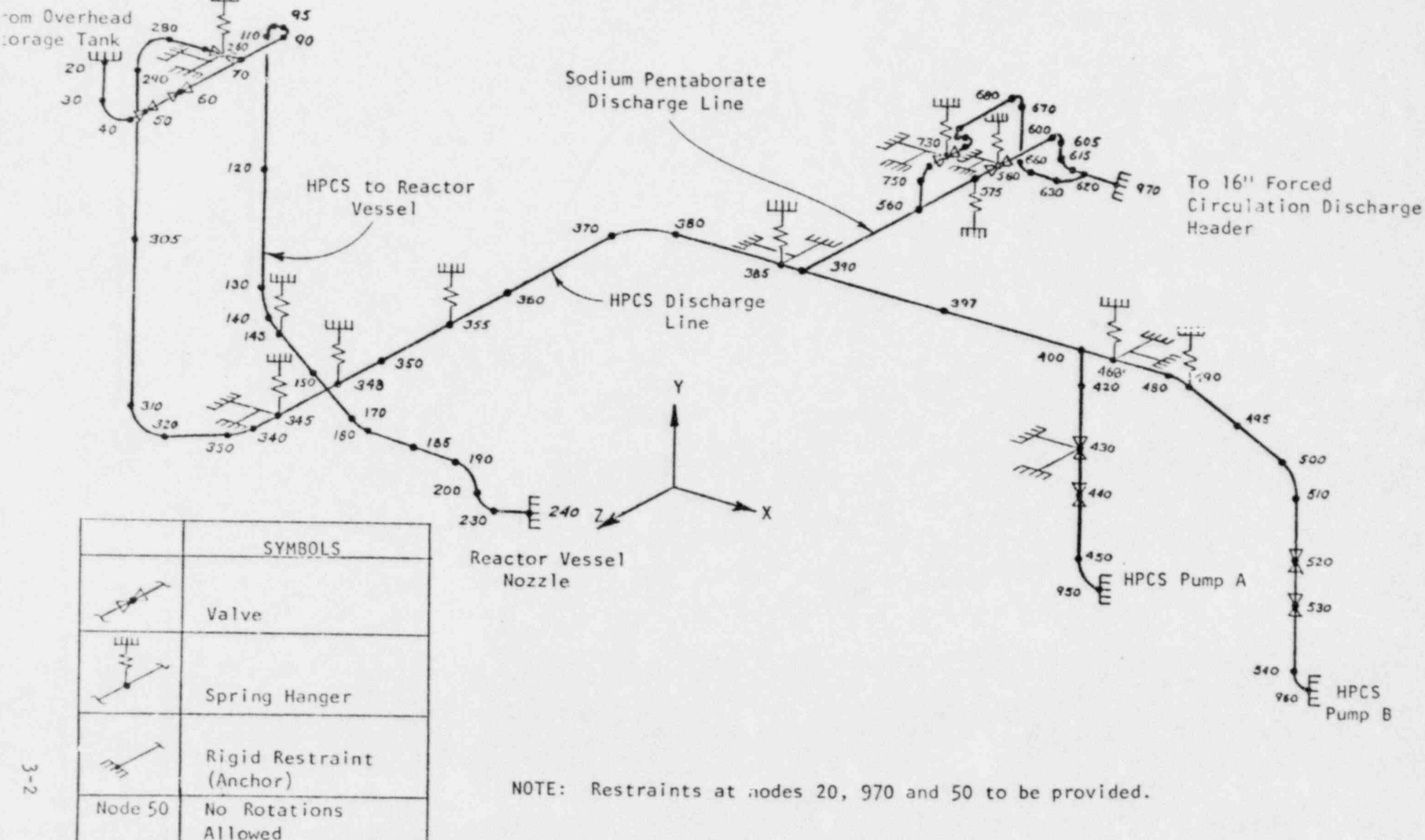
The HPCS discharge line consists of stainless steel pipe line leading from the two high pressure core spray pumps to the core spray header inside the reactor vessel. The pumps are used for core spray when the reactor remains pressurized, as in the case of a small leak below the core. When the reactor and containment building pressures are equalized, as after a major system leak or rupture, a low pressure supply line bypassing the emergency core spray pumps allows water to flow directly from the overhead storage tank (or service water line) to the core spray header. The high pressure core spray pumps are also used in the boron injection system. Redundant control valves are provided for this purpose in the core spray pumps suction and discharge lines.

Rigid anchors located at points of expected large seismic deflections serve the purpose of isolating the discharge lines from the interconnecting piping systems. Figure 3.1 shows the routing of the discharge line and the extent of suction line and sodium pentaborate lines considered in the subject analysis.

The governing design specification used in the analysis of the HPCS piping system is given in Reference 3. The piping arrangement has been taken from the drawings listed in Reference 4. Piping properties have been taken from the information given in the piping specification (Reference 3). The location of piping suspension (hangers, etc.) and their dimensional characteristics were determined from the piping drawings and actual visual inspection and measurements at the LACBWR site. Pipe properties and valve weights are summarized in Tables A-I and A-II of Appendix A.

FIGURE 3.1

PIPESD MATHEMATICAL MODEL
LACBWR HPCS DISCHARGE LINE



NOTE: Restraints at nodes 20, 970 and 50 to be provided.

4. LOADING CRITERIA

The loading conditions which must be taken into account in performing a Class I analysis of a piping system are specified in Subsection NB-3110 of Reference 2. These include dead weight, internal pressure, thermal effects; and earthquake loads. Design, operating, upset, emergency and faulted condition loadings must be considered in the analysis as specified in the stress acceptance criteria (Section 5 of this report). The static and dynamic load cases considered in the analysis are described below and the detail input data are summarized in Table A-III and A-IV of Appendix A.

4.1 Load Case 1 and 2 - Design and Operating Pressures

Piping design pressures are taken from the LACBWR piping specification (Reference 3) and are 100 psig for the piping between node points 20 and 50 and 1400 psig elsewhere in the system.

Operating pressures for the HPCS system are based on the LACBWR Safeguards Report (Reference 5). These are 100 psig up to node point 50, 1340 psig from node 50 to the reactor vessel nozzle and 1400 psig for the remainder of the system.

4.2 Load Case 3 - Dead Weight and Other Sustained Mechanical Loads

The dead weight of the piping system is calculated considering the piping to be insulated and filled with water. Other sustained loads included in the analysis are valve weights, valve operator weights, and the tributary weights from branch piping.

4.3 Load Case 4 - Seismic Anchor Movements

Seismically induced anchor movements for the OBE earthquake were estimated by calculating low frequency displacements from the containment vessel response spectra (from Reference 1) at different elevations.

4.4 Load Case 5 - Thermal Anchor Movements

Thermal expansion or contraction of the reactor vessel during start-up and shutdown results in maximum displacements of the piping system anchor at the reactor vessel nozzle (node point 240).

4.5 Load Cases 6, 7, 10 and 11 - Seismic Loading

A dynamic analysis of the piping system is performed using the response spectrum modal superposition method of analysis (Section 6.4). Two seismic loading events are considered: the safe shutdown earthquake (SSE), and the operating basis earthquake (OBE). The established design criteria

(Reference 6, Regulatory Guide 1.48, May, 1973) for Class 1 analysis specifies that the OBE (or 1/2 SSE) must be considered in conjunction with the normal and upset plant condition while the SSE must be considered in conjunction with the faulted plant condition.

Seismic inertia loading is imposed on the piping system in the form of seismic acceleration spectra which were derived for the LACBWR plant (Reference 1). The horizontal acceleration spectra used for the HPCS discharge line is that corresponding to the subsystem support points on the reactor containment shell at an elevation of 695 feet. The vertical response spectrum for the SSE loading is taken as 2/3 of the horizontal SSE ground response spectrum assuming no amplification of vertical response in the structure. For the Operating Basis Earthquake the vertical piping response spectrum is taken as 1/2 of the SSE vertical response spectrum. Damping values used are 1 percent for the OBE and 2 percent for the SSE.

The horizontal spectra in either the global X- direction or the global Z- direction are applied simultaneously with the vertical spectra in the global Y- direction. Load cases 6 and 7 represent the Operating Basis Earthquake while 10 and 11 represent the SSE earthquake. The applicable response spectra used in the analysis for dynamic load cases are shown in Table A-IV of Appendix A.

4.6 Load Case 8 - Thermal: Maximum Credible Accident

The sudden introduction of cold water from the HPCS system piping into the hot pressure vessel nozzle, due to a LOCA or other low water level condition results in a transient thermal condition in the nozzle region. This temperature transient generates stresses in the pipe due to the large temperature gradients accross the pipe wall and due to any material discontinuities present. These thermal loads which are applied at node points 230 and 240 have been calculated by means of a transient thermal analysis with the Lion Computer Code (Appendix E) and are presented in Appendix B. These loads are considered in conjunction with the upset plant condition.

4.7 Load Case 9 - Thermal: Normal Start-Up and Shutdown

During normal start-up and shutdown a temperature change of 344°F is assumed in the piping in the region of the reactor vessel HPCS discharge nozzle.

5. STRESS ACCEPTANCE CRITERIA

The requirements for acceptability of a Class 1 piping system are given in AEC Regulatory Position 1 of Reference 6 and Subsections NB-3600 of Section III of the ASME Boiler and Pressure Vessel Code, Reference 2. Calculated stresses resulting from the design and operating loading conditions given in Subsection NB-3110 and NB-3620 must meet the stress limits of equations 9 through 14 of Subsection NB-3650 of the ASME Code.

5.1 Design Conditions

The primary stress intensity, resulting from the combined effects of the design pressure (Load Case 1) and the resultant moment loading due to loads caused by dead weight (Load Case 3) and the Operating Basis Earthquake (Load Cases 6 and 7), and calculated in accordance with equation 9 of Subsection NB-3652 of the Code must be less than 1.5 times the allowable design stress intensity, S_m, at maximum temperature.

5.2 Normal Conditions

The primary plus secondary stress intensity range resulting from the combined effects of thermal expansion, linear thermal gradient and discontinuity effects (Load Case 8), operating pressure (Load Case 2), anchor movements (Load Case 4 and 5) and earthquake effects (Load Cases 6 or 7), calculated in accordance with equation 10 of the Code must be less than 3 times S_m. In the event that the above requirement is not met the piping product may still be acceptable provided the requirements of a simplified elastic-plastic discontinuity analysis are met. This requirement is met if 1) the nominal expansion stress resulting from thermal expansion and thermal anchor movements calculated in accordance with equation 12 of the Code is less than 3 S_m and 2) if the range of primary plus secondary membrane plus bending stress intensity, resulting from the combined loading of operating pressure, dead weight, one-half the range of the earthquake and thermal discontinuity stresses, calculated according to equation 13 of the code is less than 3 S_m.

The requirements for acceptability under cyclic loading conditions are met by first calculating the peak stress intensity by means of equation 11 of the Code, resulting from the loadings specified for equation 10 plus the loadings resulting from the non-linear portion of the thermal gradient through the wall thickness and then calculating the alternating stress intensity in accordance with equation 14 of the Code. The total number of operating stress cycles must then be less than those determined from the fatigue curves from Appendix I-9 of the Code for the calculated alternating stress intensity in accordance with the requirements of paragraphs NB-3653.4 and NB-3653.5 of the Code.

5.3 Upset Conditions

The requirements for acceptability under upset conditions are the same as for Normal Conditions.

5.4 Emergency Conditions

The requirement for acceptability under emergency conditions (not specified in this analysis) is that the primary stress intensity, as calculated by equation 9 of the Code, must be less than 2.25 S_m.

5.5 Faulted Conditions

Under faulted conditions the primary stress intensity resulting from the combined effects of design pressure (Load Case 1), dead weight (Load Case 3) and the vibratory motion of the full Safe Shutdown Earth uake (Load Cases 10 and 11) as calculated by equation 9 of the Code must be less than 3 S_m.

6. ANALYTICAL METHODS

6.1 Mathematical Model

In order to perform static, dynamic and stress analyses, the continuous piping system is mathematically modeled as an assembly of elastic structural elements interconnected at discrete nodal points (Figure 3.1). Nodal points are located at all points of interest in the piping system such as elbows, valves, anchorages, hangers, tee intersections, load points, all structural and material discontinuities, etc. This three dimensional multidegree-of-freedom model of the piping system is attached to the "ground" (structure) by means of rigid hangers, support springs, hydraulic snubbers and anchors. Stiffness characteristics of structural elements are related to the moment of inertia and the axial and effective shear area of the pipe cross section. The stiffness characteristics of the elbows and tee connections are modified to account for local deformation by using the flexibility factors given in the ASME Code (Reference 2).

For the seismic analysis the distributed mass of the piping system is lumped at the system nodal points. Masses are lumped so that the lumped mass, multidegree-of-freedom model represents the dynamic characteristics of the piping system. In order to reduce the number of dynamic degrees-of-freedom, only translational degrees-of-freedom are considered at each mass point (the masses associated with the rotational degrees-of-freedom are set to zero). This assumption has been shown to be completely satisfactory for accurate analysis of seismic response. Special items such as valves and actuators are modeled by lumping their masses at an appropriate offset from the center-line of the piping system.

Figures 6.1 and 6.2, show the schematic sketches of the ANSYS finite element model of the socket weld coupling/reactor nozzle region for determining the peak stresses resulting from the thermal transient produced by HPCS initiation. The triangular and quadrilateral axisymetric ring finite element model sufficiently represents the reactor vessel nozzle and its geometrical variations, the Inconel transition piece, the Inconel transition piece weld to the stainless steel (SS) socket, the SS socket to SS piping weld, and the SS piping. The same basic model with larger element sizes has been used for the transient thermal analysis using the LION computer program. Appendix E gives the details of the transient thermal analysis. The thermal analysis provides the transient temperature history for each finite element, which is used as an input thermal loading to the ANSYS analysis.

6.2 Static Load Analysis

The static load analysis involves the application of the following loading conditions and their combinations:

FIGURE 6.1

HPCS DISCHARGE NOZZLE SOCKET WELD
MATHEMATICAL MODEL GEOMETRY

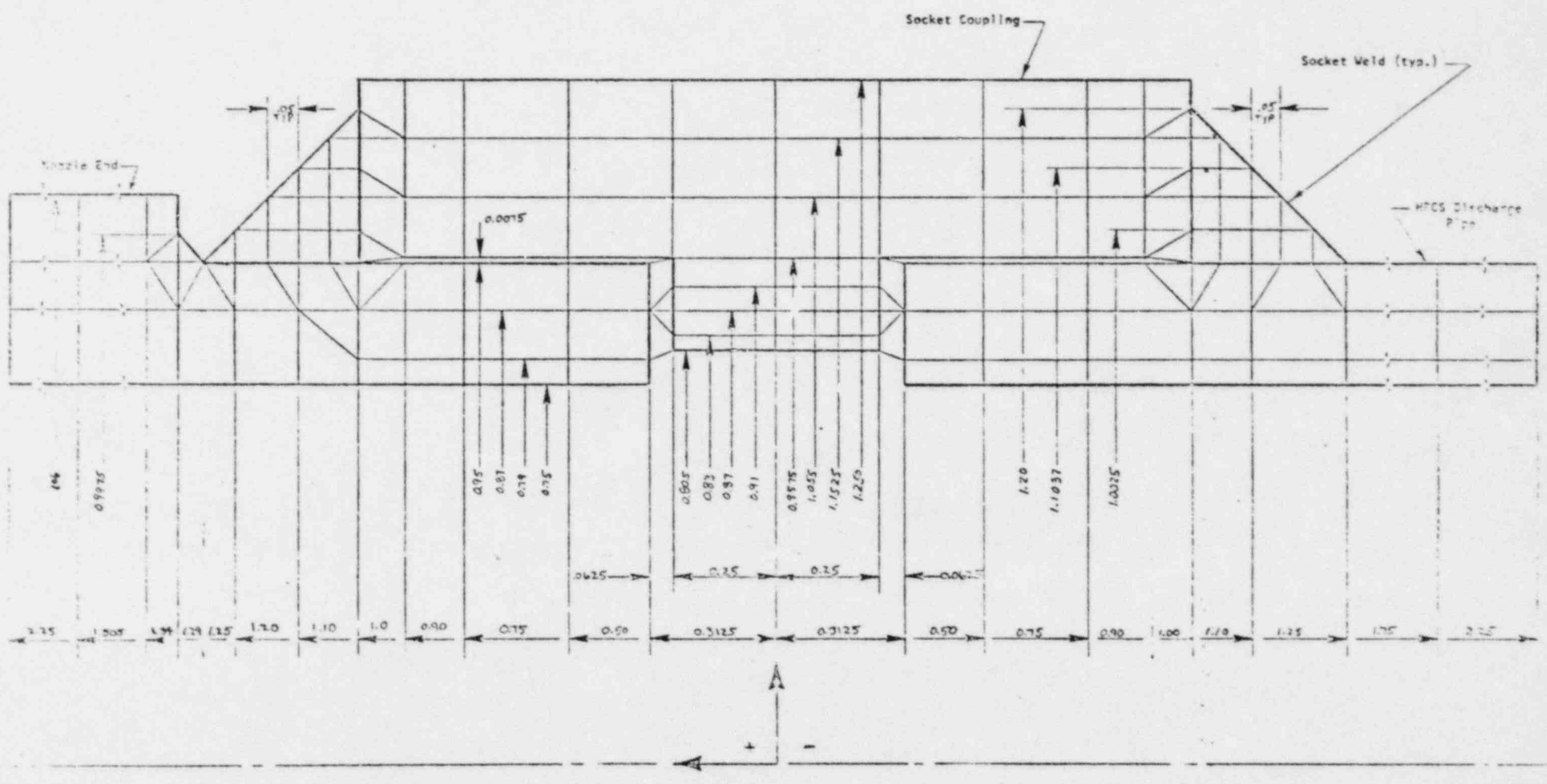
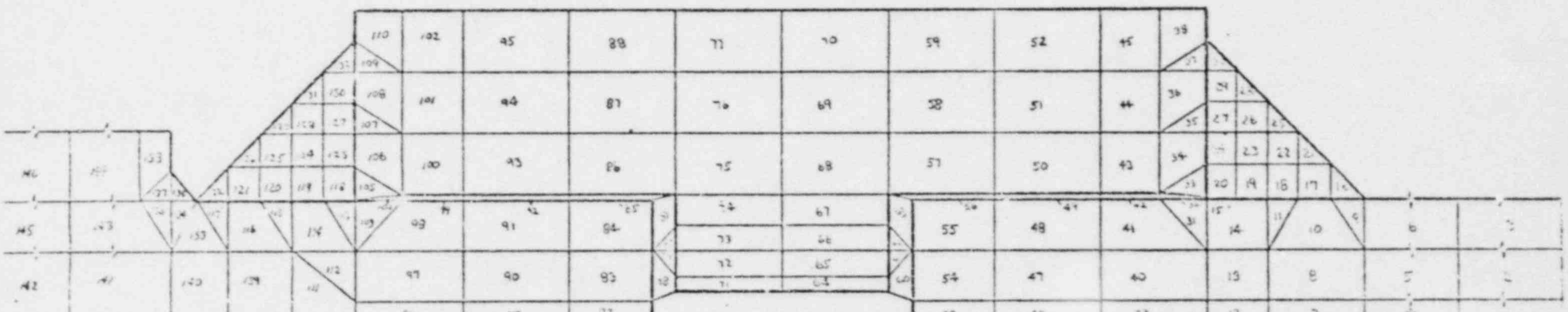
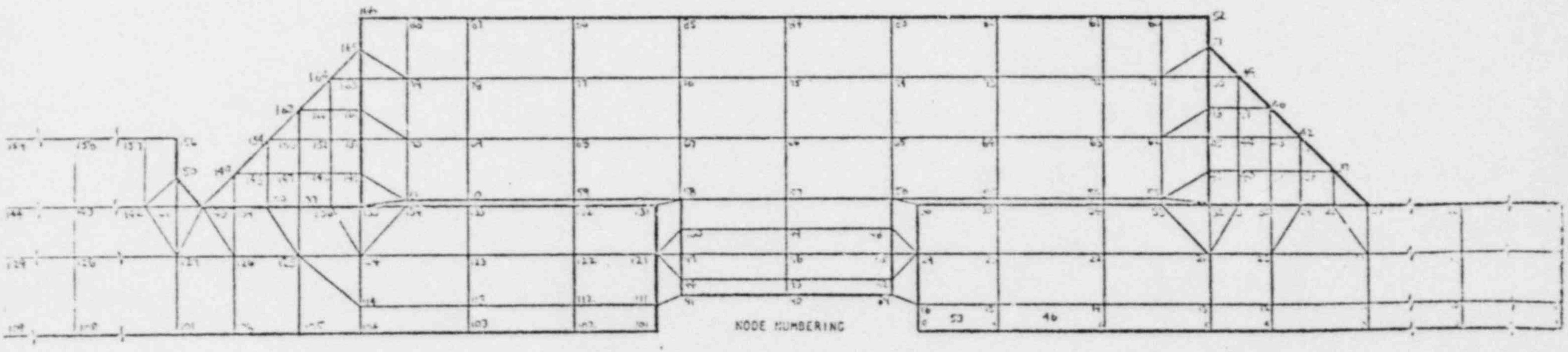


FIGURE 6.2

HPCS DISCHARGE NOZZLE SOCKET WELD
MODEL ELEMENT AND NODE NUMBERING



ELEMENT NUMBERING



NODE NUMBERING

- Design Pressure
- Gravity Loading (dead weight) and Sustained Mechanical Loads
- Support Displacement
- Thermal Expansion

For the pressure loadings, the hoop and longitudinal stresses in the affected piping are calculated using the formulae given in the Code (see Section 6.5).

For the dead weight, support displacement, or thermal expansion loading conditions the following equations of equilibrium written in matrix form are solved:

$$KU = P \qquad (1)$$

where:

K = System stiffness matrix

U = Nodal point displacement vector

P = External forces, dead weight or equivalent thermal load vector.

The system stiffness matrix is obtained from element stiffness matrices using direct stiffness methods. The unknown nodal displacements U are obtained as follows:

$$U = K^{-1} \times P \qquad (2)$$

The inversion of the stiffness matrix is performed using the Gauss-Seidel technique.

From the nodal displacements U, the member internal forces are determined using the member stiffness matrix. Finally the member internal forces are used in calculating the stresses.

6.3 Eigenvalue Analysis

The eigenvalues (natural frequencies) and the eigenvectors (mode shapes) for each of the natural modes of vibration are calculated by solving the following frequency equation:

$$\left[K - \omega_n^2 M\right] \{\phi_n\} = \{0\} \qquad (3)$$

where:

ω_n = Natural angular frequency for the n^{th} mode

M = System mass matrix

ϕ_n = Mode shape vector for the n^{th} mode

0 = Null vector

The eigenvalue/eigenvector extraction is performed using the Householder-QR technique.

6.4 Dynamic (Seismic) Load Analysis

Considering only translational degrees of freedom and assuming viscous (velocity proportional) form of damping, the equation of motion in matrix form can be expressed as follows:

$$M(\ddot{U}_t + \ddot{U}_{gt}) + C\dot{U}_t + KU_t = 0 \qquad (4)$$

where:

$\ddot{U}_t$ = Relative acceleration time history vector

$\ddot{U}_{gt}$ = Ground acceleration time history vector

C = Damping matrix

$\dot{U}_t$ = Velocity time history vector

U_t = Relative displacement time history vector

Rearranging equation (4)

$$M\ddot{U}_t + C\dot{U}_t + KU_t = -M\ddot{U}_{gt} = P_{eff} \qquad (5)$$

To uncouple equation (5), assume

$$U = \phi Y_t$$

where:

ϕ = Characteristic free vibration mode shapes matrix

Y_t = Generalized coordinate displacement time history vector

Applying the above coordinate transformation and multiplying equation (5) by the transpose of Φ and using orthogonality conditions, the following uncoupled equations of motion are obtained:

$$\ddot{Y}_{nt} + 2\,\omega_n \lambda_n \dot{Y}_{nt} + \omega_n^2\, Y_{nt} = M_n^{*-1}\, R_n\, \ddot{U}_{gt} \qquad (6)$$

where:

Y_{nt} = Generalized displacement coordinate time history for n^{th} mode.

λ_n = Damping ratio for the n^{th} node expressed as percent of critical damping

M_n^* = Generalized mass for the n^{th} node

$= \phi_n^T M \phi_n = M_i\, \phi_{in}^2$

The mode shape ϕ_n is normalized such that $M_n^* = 1$

R_n = Participation factor for the n^{th} mode

$= \phi_n^T MI = \sum M_i \phi_{in}$

I = Column vector whose elements are generally unity

The solution for the differential equation (6) is given by the Duhamel Integral:

$$Y_{nt} = \frac{R_n}{M_n^* \omega_n} \int_0^t \ddot{U}_{gt}\, e^{-\lambda_n \omega_n (t-T)} \sin \omega_n (t-T)\, dT$$

Using the response spectrum method of analysis, the maximum value of the generalized response for each mode is given by:

$$\ddot{Y}_n \max = \frac{R_n S_{an}}{M_n^*}$$

where:

$\ddot{Y}_n \max$ = Maximum generalized coordinate acceleration response for the n^{th} mode.

S_{an} = Spectral acceleration value for the n^{th} mode (from the applicable response spectrum curve)

From the maximum generalized coordinate response, the maximum acceleration ($\ddot{U}_{n\ max}$) and maximum inertia forces ($F_{n\ max}$) at each mass point are given by:

$$\ddot{U}_{n\ max} = \ddot{Y}_{n\ max}\, \phi_{in}$$

$$F_{n\ max} = M_n \ddot{U}_{n\ max}$$

The inertial forces ($F_{n\ max}$) for each of the system natural modes are applied as external static forces, and the piping system response (displacements, member internal forces and stresses) are calculated using the procedure described in Section 4.2. Total system response is then obtained by combining the individual modal response values by the square-root of the sum of the squares method; lower modes having large contribution to the response (all modes having natural frequency under 30 cycles per second) are considered and high modes with neglible participation are neglected.

6.5 Stress Analysis

The design requirements of Section III of the ASME Boiler and Pressure Vessel Code, Reference 2 (henceforth referred to as the "Code") for Class 1 piping systems are satisfied when the calculated stresses in the piping system due to thermal expansion, weight, and other sustained and mechanical loads are combined in accordance with, and meet the limitations of Subsection NB-3600 of the Code. These requirements are described below.

6.5.1 Pressure Design Check

The minimum pipe wall thickness requirements for the design pressure are met by satisfying equation (1).

$$t_m = \frac{PD_o}{2(S_m + YP)} \qquad (1)$$

where

t_m = the minimum required wall thickness, in.

P = internal design pressure, psi.

D_o = outside diameter of pipe, in.

S_m = maximum allowable stress in the material at the design temperature from Tables I-1.0 of the Code, psi.

Y = 0.4

6.5.2 Consideration of Design Conditions

The primary stress intensity limit is satisfied by meeting the requirements of equation (9)

$$B_1 \frac{PD_o}{2t} + B_2 \frac{D_o}{2I} M_i \leq 1.5S_m \qquad (9)$$

where:

B_1, B_2 = primary stress indices for the specific product under investigation (From Subsection NB-3680 of the Code)

P = design pressure, psi

D_o = outside diameter of pipe, in

t = nominal wall thickness of component

I = moment of inertia, in.^{4}

M_i = resultant moment loading due to loads caused by (1) weight, (2) earthquake, considering only one-half the range of the earthquake and excluding the effects of anchor displacements due to earthquake, and (3) other sustained design mechanical loads.

S_m = allowable design stress intensity value, psi

6.5.3 Consideration of Normal Conditions

Protection against fatigue failure is provided for by means of one of the two analyses dependent on whether the structure is subjected to elastic cycling or plastic cycling. The criterion for establishing whether the structure cycles in the elastic range or the plastic range is set forth in equation (10) of the ASME Code. Compliance with Equation (10) assures that, after a few cycles of load application, the maximum stress will remain within the range of tensile and compressive yield strengths, i.e. within the elastic range. If this criterion is met, the fatigue evaluation is based on purely elastic behavior. If the criterion is not met, an elastic-plastic discontinuity analysis must be made.

Determination of Primary Plus Secondary
Stress Intensity Range Limitations

This calculation is based upon the effect of changes which occur in mechanical or thermal loadings which take place as the system goes from one load set, such as pressure, temperature, moment, and force loading, to any other load set which follows it in time. It is the range of pressure, temperature, moment, between two load sets which is to be used in the calculations.

The primary plus secondary stress intensity range limitations are satisfied by meeting the requirements of equation (10).

$$S_n = C_1 \frac{P_o D_o}{2t} + C_2 \frac{D_o}{2I} M_i + \frac{1}{2(1-\nu)} E\alpha|\Delta T_1| + C_3 E_{ab}|\alpha_a T_a - \alpha_b T_b| \leq 3S_m$$

where:

C_1, C_2, C_3 = secondary stress indices for the specific component under investigation (NB-3680)

D_o, t, I, S_m = are as defined for Equation (9)

M_i = range of moment loading due to (1) thermal expansion (2) anchor movements from any cause, (3) earthquake effects, and (4) other mechanical loads.

$|\Delta T_1|$ = range of absolute value (without regard to sign) of the temperature difference between the temperature of the outside surface (T_o) and the temperature of the inside surface (T_i) of the piping product assuming moment generating equivalent linear temperature distribution.

$T_a(T_b)$ = range of average temperature on side a(b) of gross structural discontinuity or material discontinuity.

$\alpha_a(\alpha_b)$ = coefficient of thermal expansion on side a(b) of a gross structural discontinuity or material discontinuity at room temperature.

E_{ab} = average modulus of elasticity of the two sides of a gross structural discontinuity or material discontinuity at room temperature, psi.

$E\alpha$ = modulus of elasticity (E) times the mean coefficient of thermal expansion (α) both at room temperature, psi.

ν = poisson's ratio = 0.3

P_o = range of operating pressure, psi

Determination of Peak Stress Intensity

The peak stress intensity is calculated by means of equation (11) of the Code for every pair of load sets. This is the maximum stress intensity at a point including any local structural discontinuity (or notch) effects and any local thermal stresses.

$$S_p = K_1C_1 \frac{P_oD_o}{2t} + K_2C_2 \frac{D_o}{2I} M_i + \frac{1}{2(1-\nu)} K_3 E\alpha|\Delta T_1| + K_3C_3E_{ab}|\alpha_aT_a - \alpha_bT_b| + \frac{1}{1-\nu} E\alpha|\Delta T_2| \quad (11)$$

where:

K_b, K_2, K_3 = local stress indices for the specific component under investigation (NB-3680)

$E\alpha$ = same as in Equation (10)

ΔT_2 = range of absolute value (without regard to sign) for that portion of the nonlinear thermal gradient through the wall thickness not included in ΔT_2 of Equation 10 °F below.

For a quantitative definition of $|\Delta T|$ and $|\Delta T_2|$, see NB-3653.2(b) of the Code. All other terms are as defined in Equation (10).

The peak stress, S_p, is used to calculate the alternating stress intensity, Salt, for the fatique evaluation

Simplified Elastic-Plastic Discontinuity Analysis

If the primary plus secondary stress intensity requirements of equation (10) are not met, the fatigue evaluation must include the effects of plastic cycling by means of the simplified elastic-plastic discontinuity analysis as described below. Only those pairs of load sets not satisfying equation (10) need be considered. Equation (12) imposes a limitation of 3 S_m on the magnitude of the thermal expansion stress to prevent possible collapse due to the development of a hinge moment.

$$S_e = C_2 \frac{D_o}{2I} M_i^* \leq 3S_m \qquad (12)$$

where:

S_e = nominal value of expansion stress

M_i^* = same as M_i in Equation (10) except it includes only moments due to thermal expansion and thermal anchor movements

The range of primary plus secondary membrane plus bending stress intensity, excluding thermal bending and thermal expansion stresses shall be $\leq 3S_m$. This requirement is satisfied by meeting Equation (13) below.

$$C_1 \frac{P_o D_o}{2t} + C_2 \frac{D_o M_i}{2I} + C'_3 E_{ab} |\alpha_b T_a - \alpha_b T_b| \leq 3S_m \qquad (13)$$

Fatigue Evaluation

If the conditions of equation (10) are met, or alternatively the conditions of equations (12) and (13) are met, the value of the alternating stress intensity, Salt , is calculated by equation (14) of the Code.

$$S_{alt} = K_e \frac{S_p}{2} \qquad (14)$$

where:

S_{alt} = alternating stress intensity

S_p = peak stress intensity value calculated by Equation (11)

K_e = 1.0 for $S_n \leq 3S_m$ (i.e. when equation 10 is satisfied)

$= 1.0 + \frac{(1-n)}{n(m-1)} \left[\frac{S_n}{3S_m} - 1\right]$ for $3 S_m < S_n < 3M S_m$

$= \frac{1}{n}$ for $S_n \geq 3M S_m$

S_n = primary plus secondary stress intensity value calculated in Equation (10)

m and n = material parameters given in NB-3228.3 (b) of the Code

The number of allowable cycles, N, for a given stress cycle is then determined from applicable design fatigue curves given in Appendix I-9.0 of the Code for the calculated values of S_{alt}. If more than one operational cycle is being considered which produces significant fluctuating stresses, a cummulative usage factor must be determined in accordance with Subsection NB-3222.4 of the Code.

The cumulative usage factor, U, is defined as:

$$U = \sum U_i = \sum \frac{n_i}{N_i}$$

where:

U_i = usage factor for each type of stress cycle, i

n_i = specified number of times a given stress cycle, i, will be repeated during the life of the component

N_i = allowable number of repetitions for a given stress cycle, i, from table I-9.0 of the Code.

The cumulative usage factor, U, must not exceed 1.0.

Stress Range Calculations

The stress range evaluation is carried out by means of one or both of two analyses. The first analyses is a maximum stress range calculation in which the maximum range of stresses from each load set pair is used to form a "worst load case" which is assumed to occur over the total number of system cycles. If this conservative check results in an allowable number of cycles not exceeding the total number of system cycles, then no further analysis is required for the component. If the maximum stress range check fails, an individual stress range calculation can be made to establish component acceptability. In this evaluation the stress ranges for individual load sets are calculated, pair by pair, in such a manner as to maximize stress ranges and the cumulative usage factor, which must be less than 1.0.

6.5.4 Consideration of Upset Conditions

The procedure and stress limits for evaluating upset conditions are the same as for operating conditions.

6.5.5 Consideration of Emergency Conditions

The primary stress intensity requirements of equation (9) above (Section 5.2) must be met using a stress limit of 2.25 S_m.

6.5.6 Consideration of Faulted Conditions

The primary stress intensity requirements of equation (9) above (Section 6.6.2) for the combined loading effects of system design pressure, deadweight and the vibratary motion of the Safe Shutdown Earthquake must be met using a stress limit of $3S_m$.

7. DISCUSSION OF RESULTS

The results of the HPCS discharge line piping analysis are based on the assumption that additional restraints will be provided at node points 20, 970 and 50 as indicated in Figure 3.1. These restraints may be rigid anchors due to low thermal expansion effects in the HPCS line.

The natural frequencies of the lower modes of vibration of the piping system, up to 35 cycles per second, are given in Table 7.1 and indicate a generally flexible (low frequency) system. System deflections resulting from the various load cases are presented in appendix B, Table B-I. The maximum deflection due to dead weight is 0.076 inch at node point 170, while the maximum deflection due to the SSE seismic inertia loading is 0.680 inch at node point 140. For a flexible piping system these deflections are within acceptable values.

Table B-II of Appendix B gives the elastic support reaction forces resulting from the various load cases. These forces should be used in the design of the additional system restraints.

The results of the detailed stress analysis in accordance with the requirements of Subsection NB-3650 of the ASME Code for Class 1 piping systems are summarized in Figures 7.1 through 7.12. Significant stresses calculated by the PIPESD computer analysis using Code equations 9 through 14 for the various load combinations are indicated in these figures and are compared to the Code allowable values.

The peak stress intensity at the pressure vessel discharge nozzle socket weld (node point 240) resulting from the thermal transient (See Appendix B) and material and structural discontinuities has been calculated by means of the detailed ANSYS finite element analysis. Table 7.2 presents the results of this analysis. Table 7.2 shows that a peak thermal stress of 93.5 ksi results seven seconds after initiation of the thermal transient. This peak thermal stress is combined with the PIPESD calculated pressure and seismic stresses at node 240 (See Appendix C) to determine a peak stress intensity range, S_p of 161.7 ksi and an alternating stress intensity, S_{alt}, of 80.8 ksi (Figure 7.10). The maximum allowable number of full stress cycles for the nozzle socket weld is then 2900.

TABLE 7.1

NATURAL FREQUENCIES OF VIBRATION
HPCS DISCHARGE LINE

MODE	FREQUENCY (CPS)	MODE	FREQUENCY (CPS)
1	3.23	14	18.84
2	5.64	15	20.76
3	6.68	16	22.04
4	7.85	17	22.27
5	9.03	18	23.42
6	9.40	19	25.20
7	11.61	20	26.31
8	11.81	21	26.62
9	12.15	22	26.77
10	13.37	23	28.39
11	15.26	24	30.02
12	16.84	25	30.63
13	18.07	26	32.98
		27	33.85

TABLE 7.2

RESULTS OF ANSYS STRESS ANALYSIS SUMMARY OF PEAK STRESSES VS TIME IN SOCKET WELD REGION

	Stress, ksi														
	Time, Seconds														
ELEMENT NO.	0	0.25	0.50	0.75	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	15.0
1	0.2	4.1	12.3	20.9	23.9	26.1	21.2	16.7	13.1	10.2	8.0	6.0	5.5	4.1	2.5
4	0.6	7.0	18.5	31.4	28.6	47.2	43.6	39.4	35.0	32.3	29.8	27.1	25.6	24.0	19.1
7	2.0	8.8	20.1	33.5	40.9	51.7	49.2	47.4	45.4	43.9	41.9	40.3	39.7	38.0	33.2
12	1.2	7.4	19.7	34.8	43.0	58.5	57.6	55.0	52.2	49.6	47.5	45.8	44.1	42.4	37.0
14	1.5	2.5	5.7	10.3	14.6	16.2	15.0	12.3	11.4	10.8	10.4	10.6	10.3	10.3	8.8
16	4.2	4.1	8.1	16.3	38.0	41.8	46.1	46.0	49.6	48.3	49.6	47.4	44.9	44.1	38.9
20	1.0	2.1	5.0	9.6	15.7	28.7	35.4	41.1	42.2	44.5	44.4	47.4	49.6	47.1	47.5
24	1.6	1.9	4.0	7.7	12.7	24.1	29.1	33.0	37.3	36.6	40.2	38.8	36.6	43.9	36.8
31	2.6	1.6	3.6	7.4	12.5	10.1	14.2	19.1	24.2	27.3	30.4	32.3	33.5	34.7	34.9
33	4.2	4.2	5.7	10.1	16.3	32.9	44.6	52.9	56.6	60.8	61.7	64.3	65.7	63.4	61.4
39	0.6	8.7	21.5	36.6	46.3	63.1	65.1	65.[illegible]	64.3	63.1	62.2	61.3	60.2	5[illegible].7	53.0
46	1.5	10.1	23.0	38.9	49.1	66.5	70.2	72.0	72.8	72.8	72.5	72.2	71.4	[illegible].2	64.5
47	2.0	1.6	3.2	7.5	11.6	28.1	37.0	43.1	48.8	51.9	54.5	55.9	56.8	57.0	54.8
53	3.1	11.0	22.5	36.2	46.2	60.2	63.7	66.3	67.4	67.9	67.8	67.7	67.1	66.2	61.2
54	3.9	3.8	5.6	9.5	13.7	27.2	35.0	41.0	46.5	49.6	52.2	53.6	54.5	54.8	52.7
64	7.7	13.4	22.5	34.6	46.1	63.3	66.3	67.5	67.0	66.0	65.2	63.9	62.7	61.4	56.1
65	6.9	6.8	8.2	11.2	17.4	34.6	40.1	43.5	44.8	45.2	45.0	44.8	44.2	43.7	40.9
71	10.4	15.1	24.5	34.8	45.7	63.2	65.6	67.6	67.3	66.4	65.6	64.4	63.3	62.1	57.1

TABLE 7.2 (continued)

RESULTS OF ANSYS STRESS ANALYSIS SUMMARY OF PEAK STRESSES VS TIME IN SOCKET WELD REGION

ELEMENT NO.	Stress, ksi														
	Time, Seconds														
	0	0.25	0.50	0.75	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	15.0
72	8.8	7.3	9.5	12.9	17.5	27.3	40.9	44.3	45.7	46.1	46.0	45.9	45.4	44.9	42.4
82	22.3	28.2	38.7	51.5	60.5	74.7	77.6	79.1	79.9	80.3	80.2	79.8	79.0	78.3	73.2
83	21.2	20.8	23.4	25.0	31.5	41.5	46.1	55.2	58.8	61.5	63.8	64.8	65.6	65.8	63.6
89	19.9	26.0	39.4	54.3	65.5	84.4	86.6	91.3	92.5	93.4	93.5	93.5	92.9	92.4	87.5
90	18.0	17.2	21.5	24.3	32.6	46.4	52.8	63.6	68.1	71.5	74.1	75.1	76.6	77.1	75.3
96	13.4	19.2	31.9	45.6	56.0	73.6	76.4	79.9	81.0	82.1	82.0	82.3	82.0	81.9	78.4
97	11.8	9.8	13.6	16.4	21.1	33.8	40.5	46.4	50.0	52.6	54.5	55.9	56.7	57.6	57.0
100	16.8	17.9	18.2	19.7	22.1	29.2	38.4	40.9	44.3	47.0	48.8	50.3	51.2	51.4	50.8
103	14.3	51.1	13.7	14.3	16.9	25.3	29.2	33.9	36.8	37.9	39.3	40.7	41.5	42.1	42.3
105	19.6	23.8	21.9	24.5	29.9	44.1	59.1	67.5	73.7	78.5	81.3	83.6	84.3	85.4	79.4
111	8.6	11.7	16.2	22.0	28.9	38.9	45.9	47.6	49.0	51.5	51.4	52.3	52.4	52.8	51.1
112	6.6	7.0	9.9	15.1	19.8	35.1	45.2	47.6	50.9	53.3	54.4	55.4	55.4	55.7	54.0
113	17.8	20.8	19.9	22.5	26.4	37.2	50.7	57.2	63.6	67.6	71.9	73.3	74.1	74.7	72.2
117	7.0	7.1	9.1	10.8	7.1	16.9	21.5	23.0	25.8	27.1	28.8	27.7	28.4	29.4	29.8
118	19.6	23.2	21.9	24.2	24.4	34.7	42.6	47.1	50.8	54.1	55.9	56.7	57.5	58.4	58.1
122	17.4	16.7	20.8	23.9	32.7	38.2	47.2	51.6	55.8	60.9	62.7	65.3	66.7	68.9	68.8
123	21.2	25.1	23.1	25.0	27.0	33.8	40.8	44.3	48.1	50.8	51.7	53.4	53.7	53.8	54.0
127	20.5	23.8	21.6	22.7	22.8	28.0	31.4	34.3	35.9	38.2	39.1	40.3	40.8	41.8	42.0

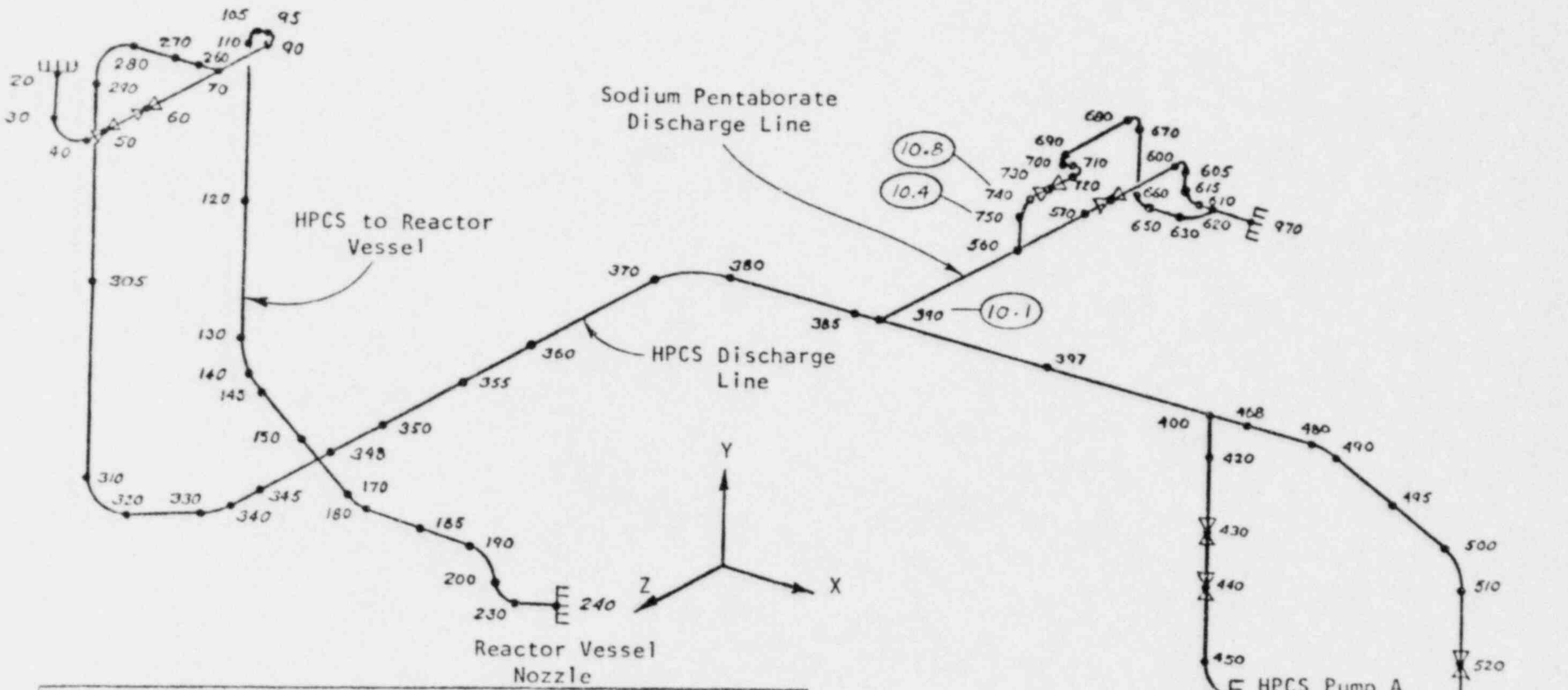
TABLE 7.2 (continued)

RESULTS OF ANSYS STRESS ANALYSIS SUMMARY OF PEAK STRESSES VS TIME IN SOCKET WELD REGION

	Stress, ksi														
	Time, Seconds														
ELEMENT NO.	0	0.25	0.50	0.75	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	15.0
130	15.7	18.8	16.0	16.3	16.5	17.3	18.1	19.4	20.1	21.6	21.6	21.9	21.6	22.2	21.8
132	28.3	35.4	29.0	29.6	30.5	31.6	31.9	33.0	33.5	34.5	35.4	35.6	36.0	36.5	36.6
133	4.6	3.9	6.0	7.3	8.0	12.7	16.1	16.8	17.1	16.5	17.9	20.3	20.5	20.6	20.5
134	12.4	11.6	14.7	16.9	16.9	26.9	35.0	39.1	37.5	46.0	44.7	52.8	54.8	56.6	59.3
135	9.7	10.8	10.9	12.3	12.9	17.6	24.1	27.6	40.0	27.4	44.8	38.7	40.8	43.6	45.1
136	9.2	9.8	10.9	12.6	14.1	20.6	21.9	23.4	28.3	28.3	31.1	28.8	29.4	28.3	30.9
137	6.3	8.1	7.2	8.1	9.2	13.3	16.9	18.1	31.1	23.8	30.6	21.9	22.3	23.3	22.1
138	2.7	3.1	3.9	5.0	6.4	9.9	13.4	14.8	14.5	17.7	11.9	19.3	20.1	22.3	20.8
139	7.8	7.4	9.0	10.6	13.6	18.8	24.2	25.0	26.0	28.9	28.6	30.4	30.9	31.6	31.6
140	6.8	8.4	8.3	9.6	12.3	17.0	21.2	21.1	21.7	21.5	21.5	21.1	20.4	20.7	19.7
141	5.3	3.3	7.0	8.1	10.3	15.5	19.8	21.2	24.5	24.3	26.7	26.0	26.2	26.0	26.0

FIGURE 7.1

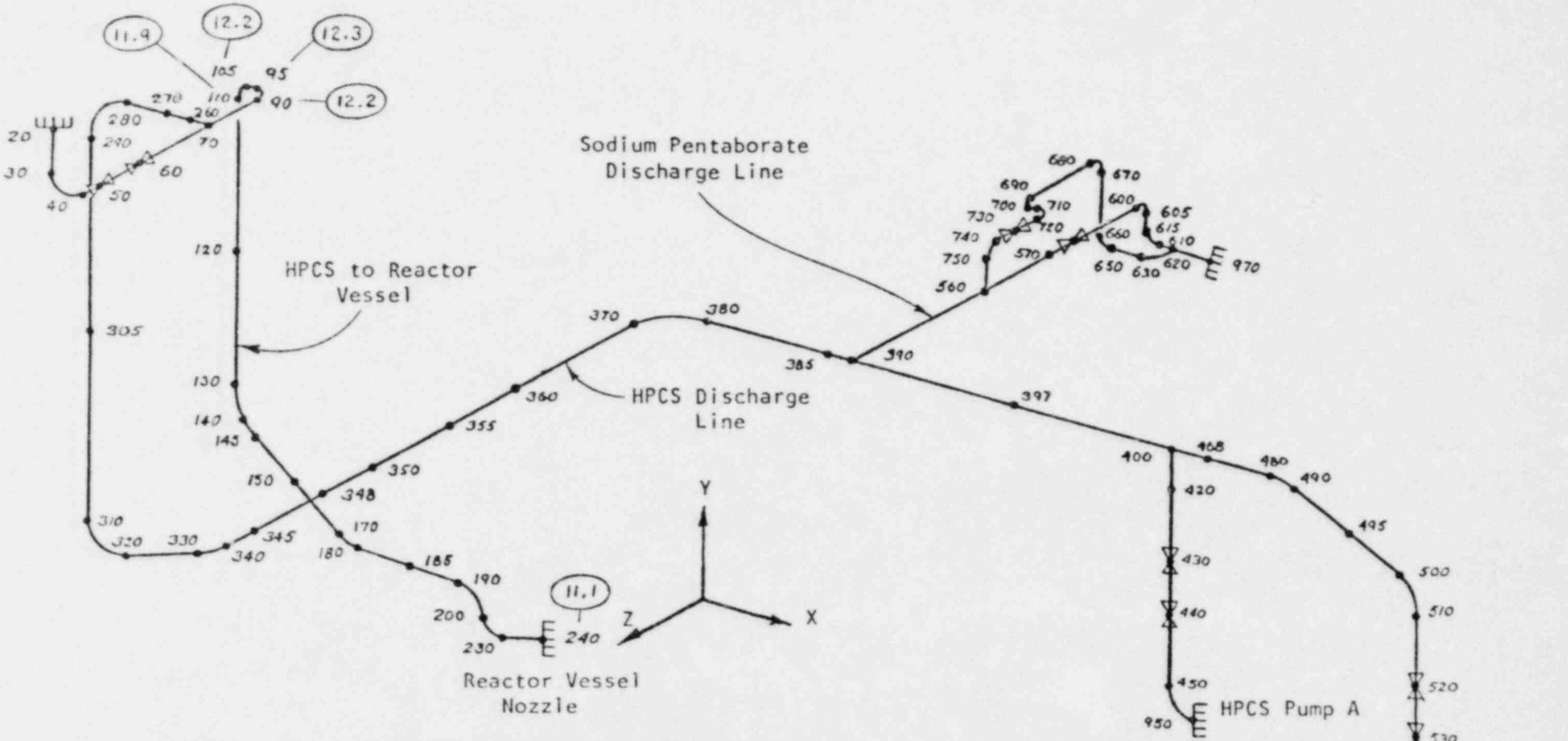
COMPLIANCE WITH ASME CODE EQUATION 9/DESIGN CONDITIONS



Load Combination I: Design Pressure, Dead Weight X + y Earthquake (OBE)
Max. Primary Stress Intensity = 12.7 ksi at node 960
Allowable Primary Stress Intensity, 1.5 Sm = 30 ksi

FIGURE 7.2

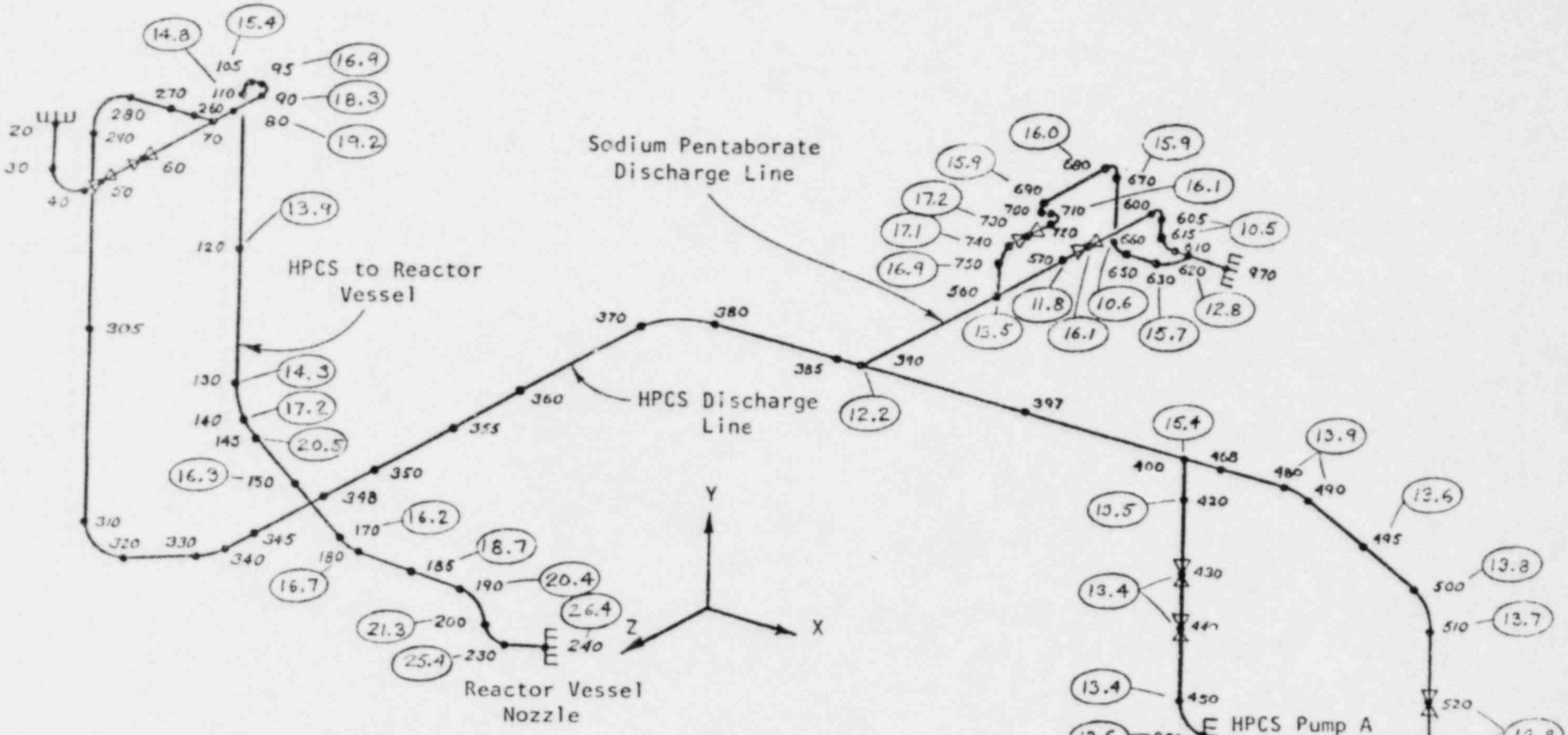
COMPLIANCE WITH ASME CODE EQUATION 9/DESIGN CONDITIONS



Load Combination 2: Design Pressure, Dead Weight, z + y Earthquake (OBE)
Max. Primary Stress Intensity = 15.2 ksi at node 960
Allowable Primary Stress Intensity, 1.5 Sm = 30 ksi

FIGURE 7.3

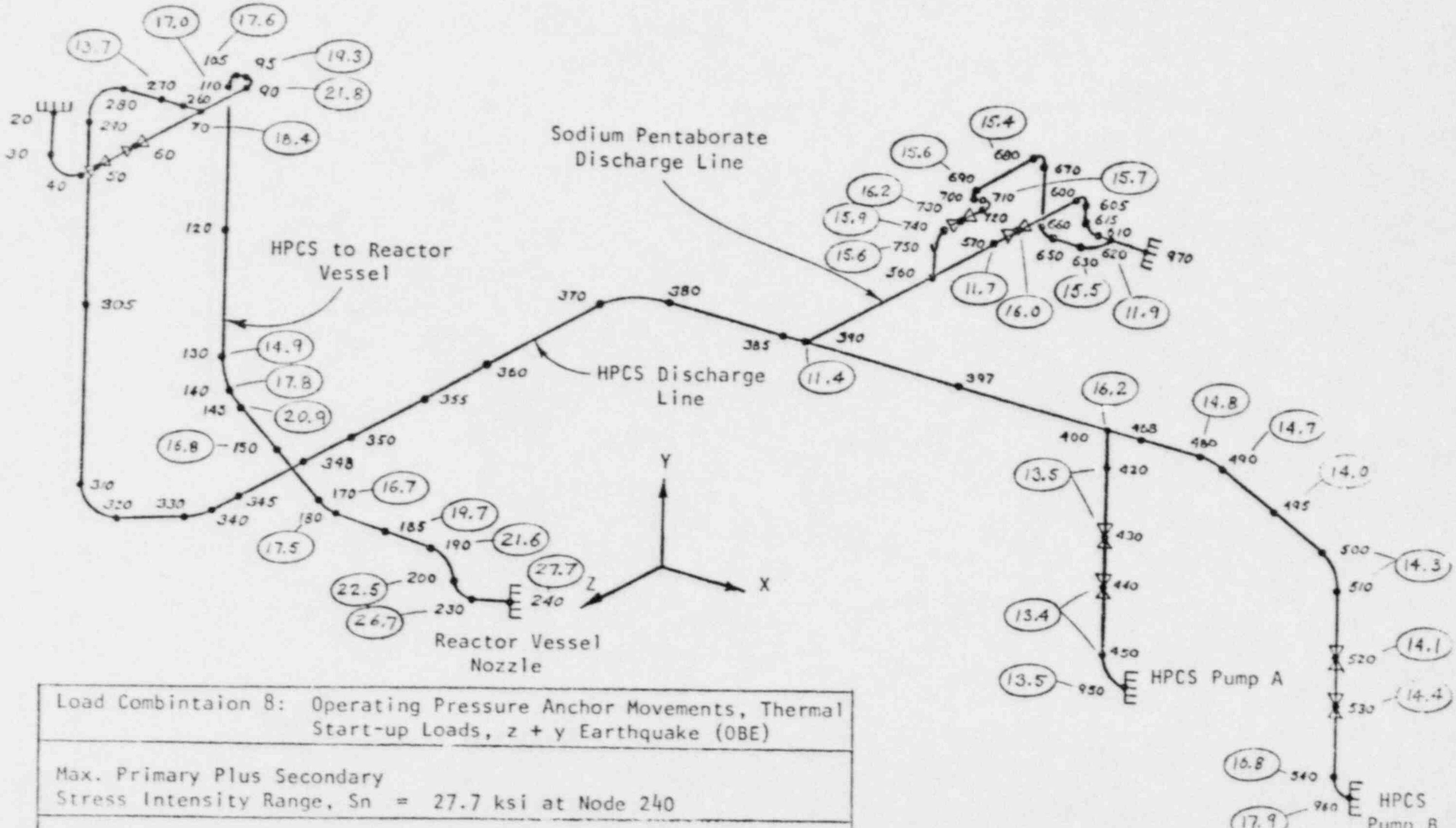
COMPLIANCE WITH ASME CODE EQUATION 10
NORMAL OPERATION CONDITIONS



Load Combination 7: Operating Pressure, Anchor Movements, Thermal Start-up, Loads, x + y Earthquake (OBE)
Max. Primary Plus Secondary Stress Intensity Range Sn = 26.4 ksi at node 240
Allowable Primary Plus Secondary Stress Intensity Range, 3 Sm = 60 ksi

FIGURE 7.4

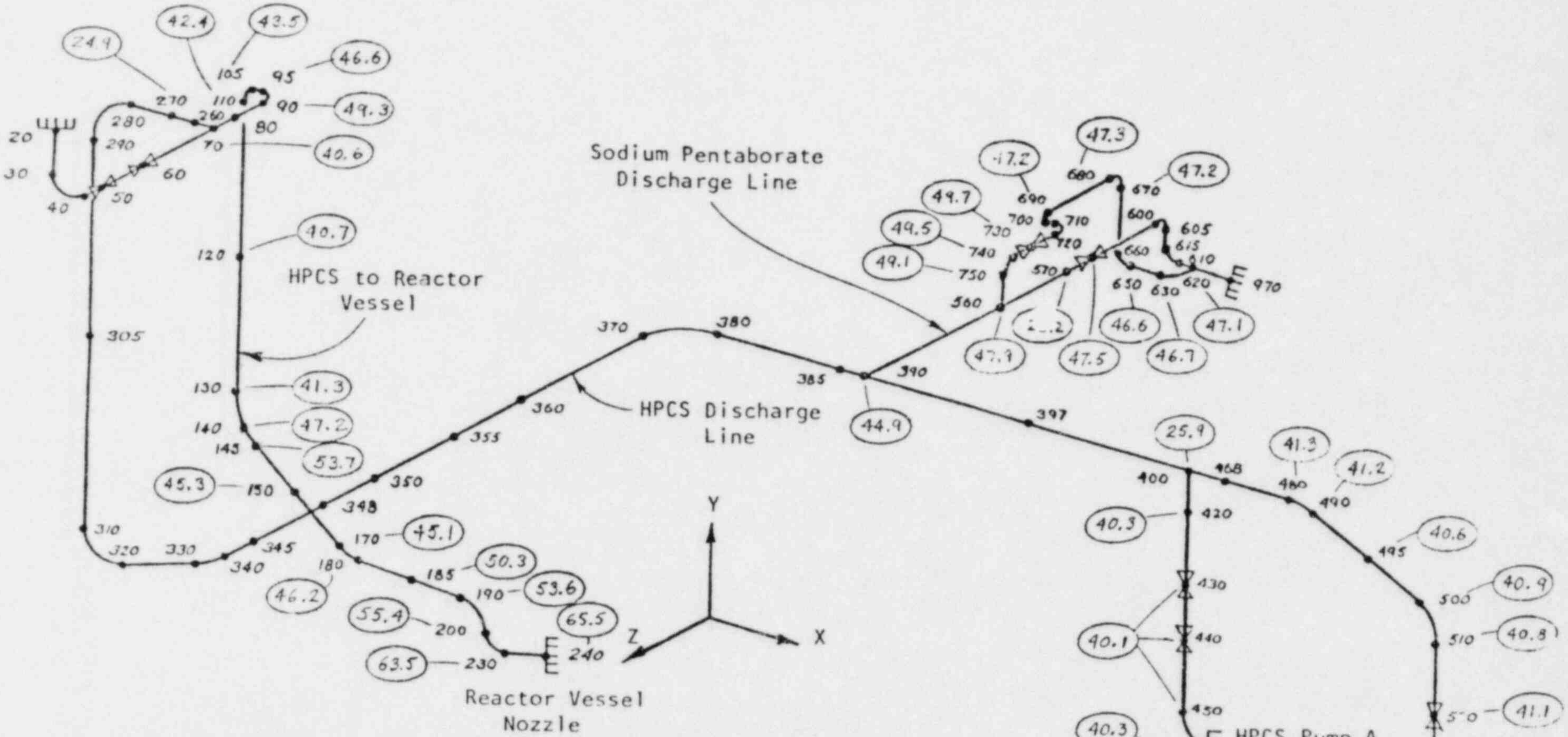
COMPLIANCE WITH ASME CODE EQUATION 10
NORMAL OPERATING CONDITIONS



Load Combintaion 8:	Operating Pressure Anchor Movements, Thermal Start-up Loads, z + y Earthquake (OBE)
Max. Primary Plus Secondary Stress Intensity Range, Sn = 27.7 ksi at Node 240	
Allowable Primary Plus Secondary Stress Intensity Range, 3 Sm = 60 ksi	

FIGURE 7.5

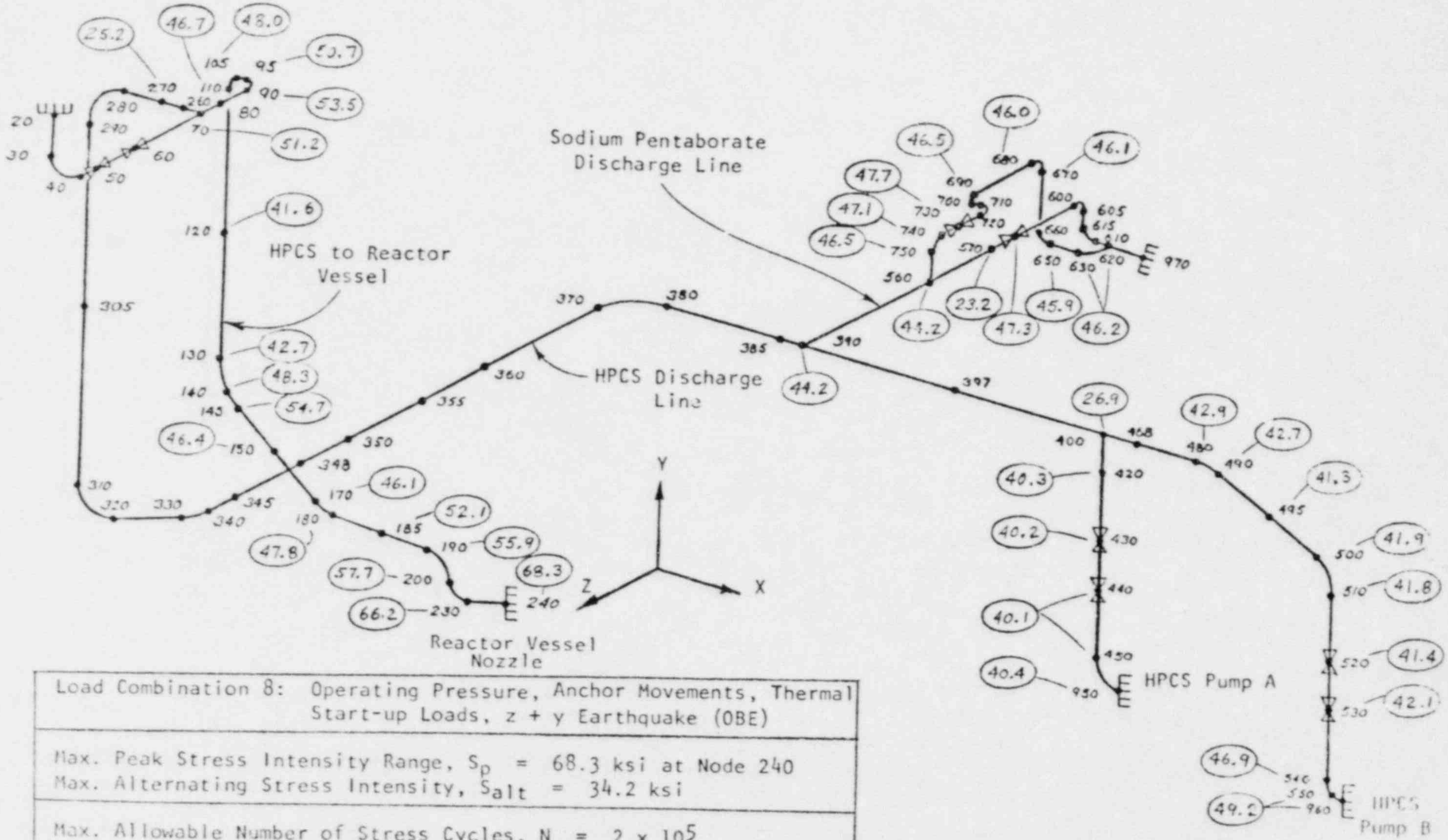
CONSIDERATION OF ASME CODE EQUATIONS 11 AND 14
NORMAL OPERATING CONDITIONS



Load Combination 7: Operating Pressure, Anchor Movements, Thermal Start-up Loads, x + y Earthquake (OBE)
Max. Peak Stress Intensity Range, S_p = 65.5 ksi at Node 240 Max. Alternating Stress Intensity, S_{alt} = 32.8 ksi
Max. Allowable Number of Stress Cycles, N = 2×10^5

FIGURE 7.6

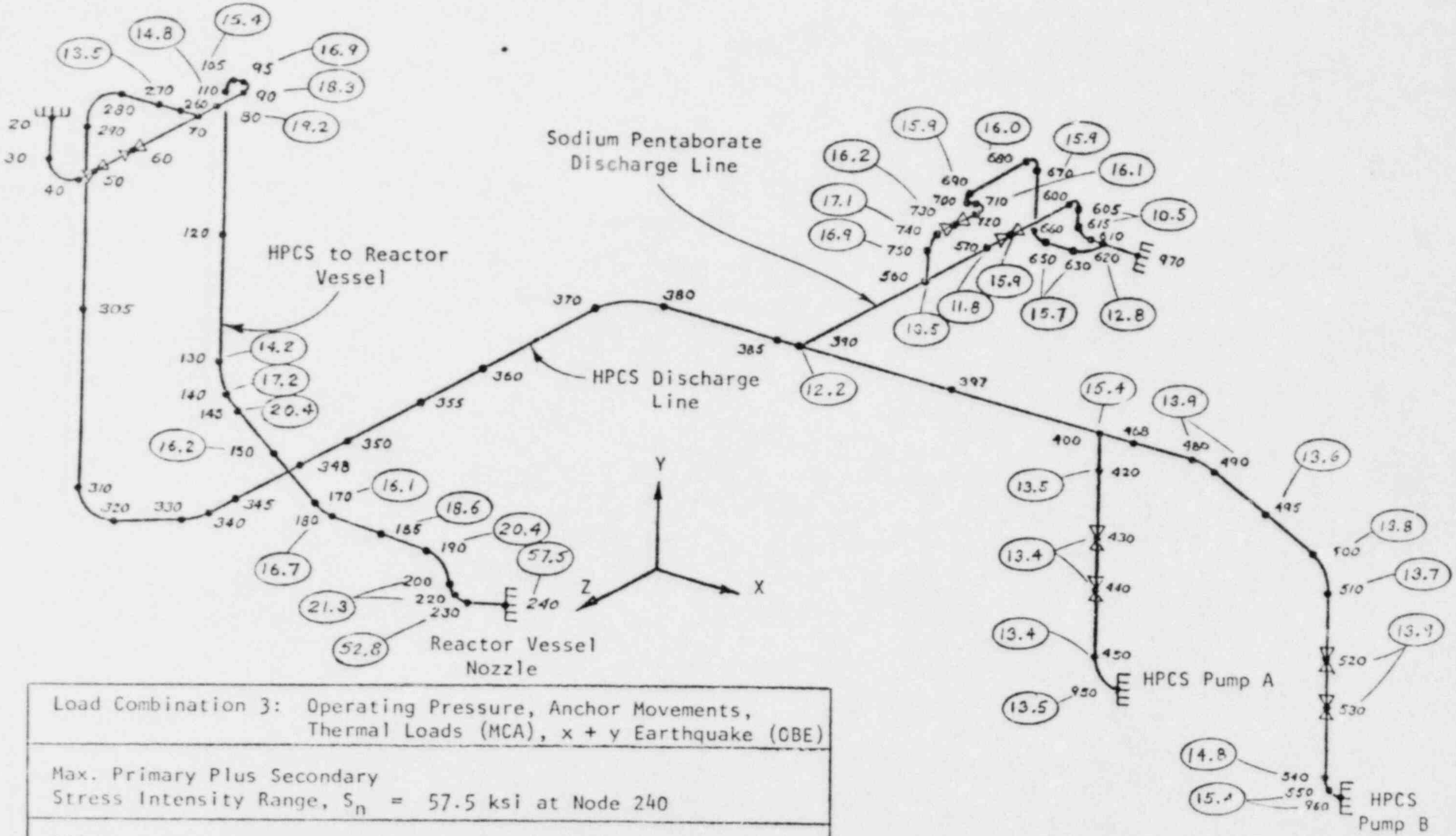
CONSIDERATION OF ASME CODE EQUATIONS 11 AND 14
NORMAL OPERATING CONDITIONS



Load Combination 8:	Operating Pressure, Anchor Movements, Thermal Start-up Loads, z + y Earthquake (OBE)
Max. Peak Stress Intensity Range, S_p = 68.3 ksi at Node 240 Max. Alternating Stress Intensity, S_{alt} = 34.2 ksi	
Max. Allowable Number of Stress Cycles, N = 2×10^5	

FIGURE 7.7

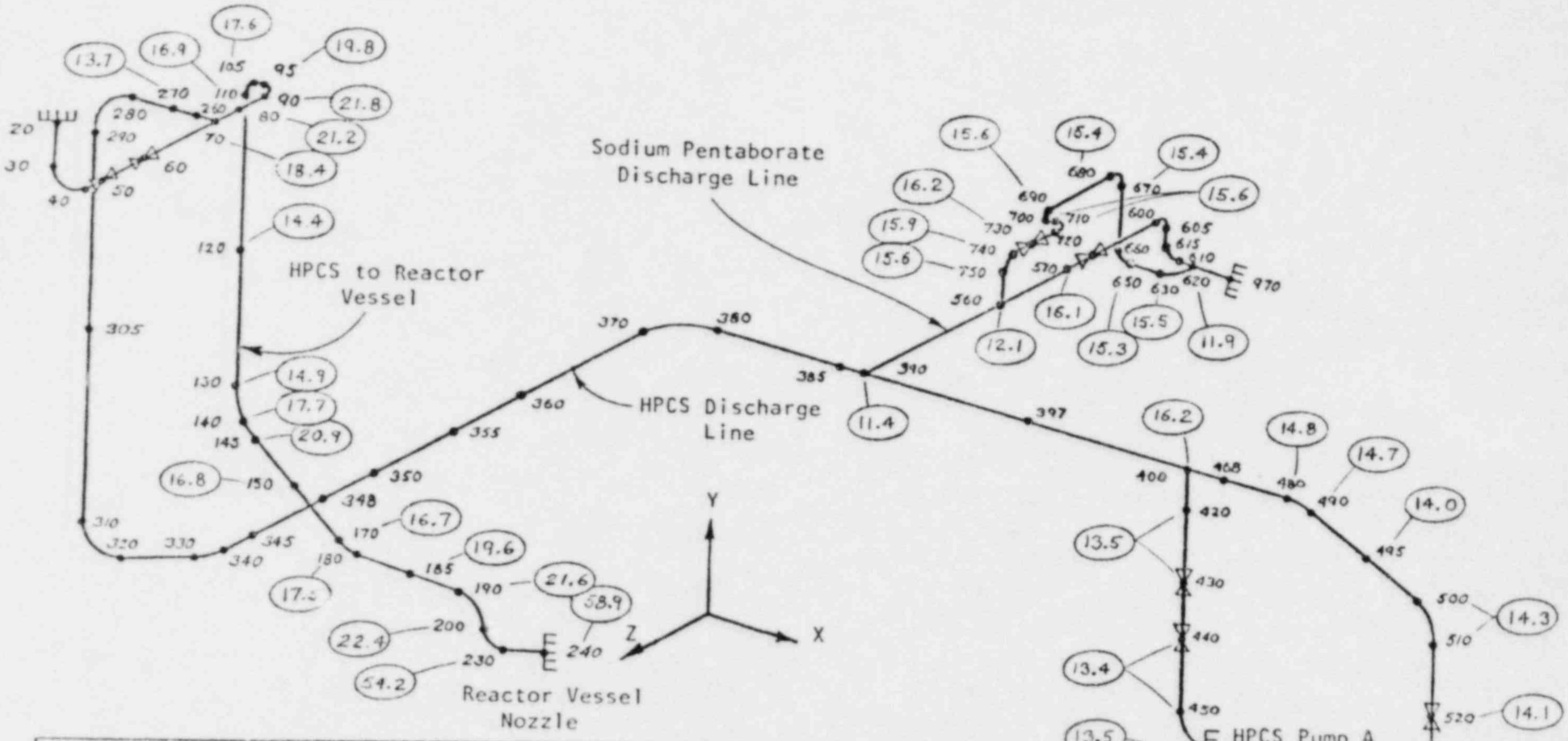
COMPLIANCE WITH ASME CODE EQUATION 10
UPSET CONDITIONS



Load Combination 3: Operating Pressure, Anchor Movements, Thermal Loads (MCA), x + y Earthquake (OBE)
Max. Primary Plus Secondary Stress Intensity Range, S_n = 57.5 ksi at Node 240
Allowable Primary Plus Secondary Stress Intensity Range, $3 S_m$ = 60.0 ksi

FIGURE 7.8

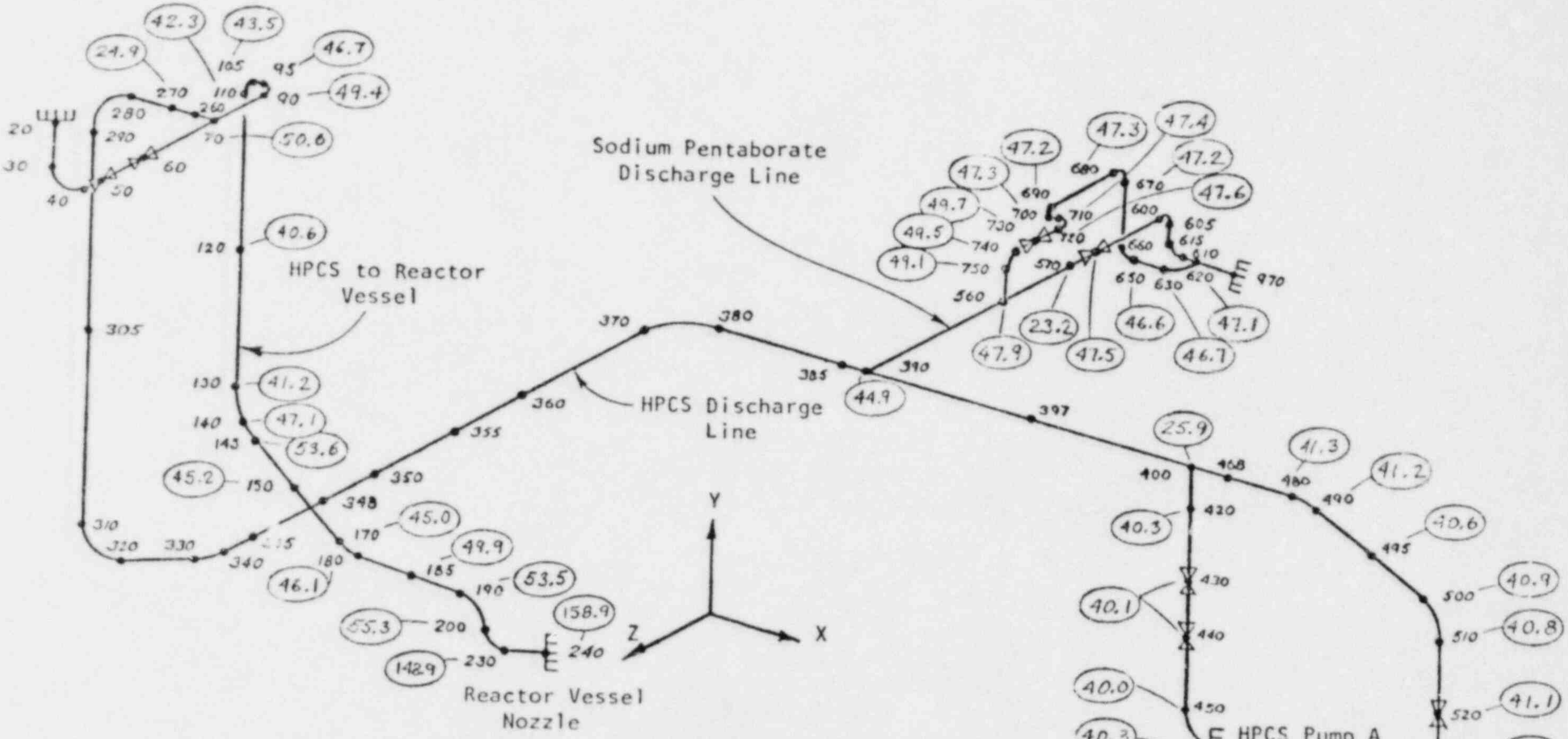
COMPLIANCE WITH ASME CODE EQUATION 10
UPSET CONDITIONS



Load Combination 4: Operating Pressure, Anchor Movements, Thermal Loads (MCA), z + y Earthquake (OBE)
Max. Primary Plus Secondary Stress Intensity Range, S_n = 58.9 ksi at Node 240
Allowable Primary Plus Secondary Stress Intensity Range, $3 S_m$ = 60 ksi

FIGURE 7.9

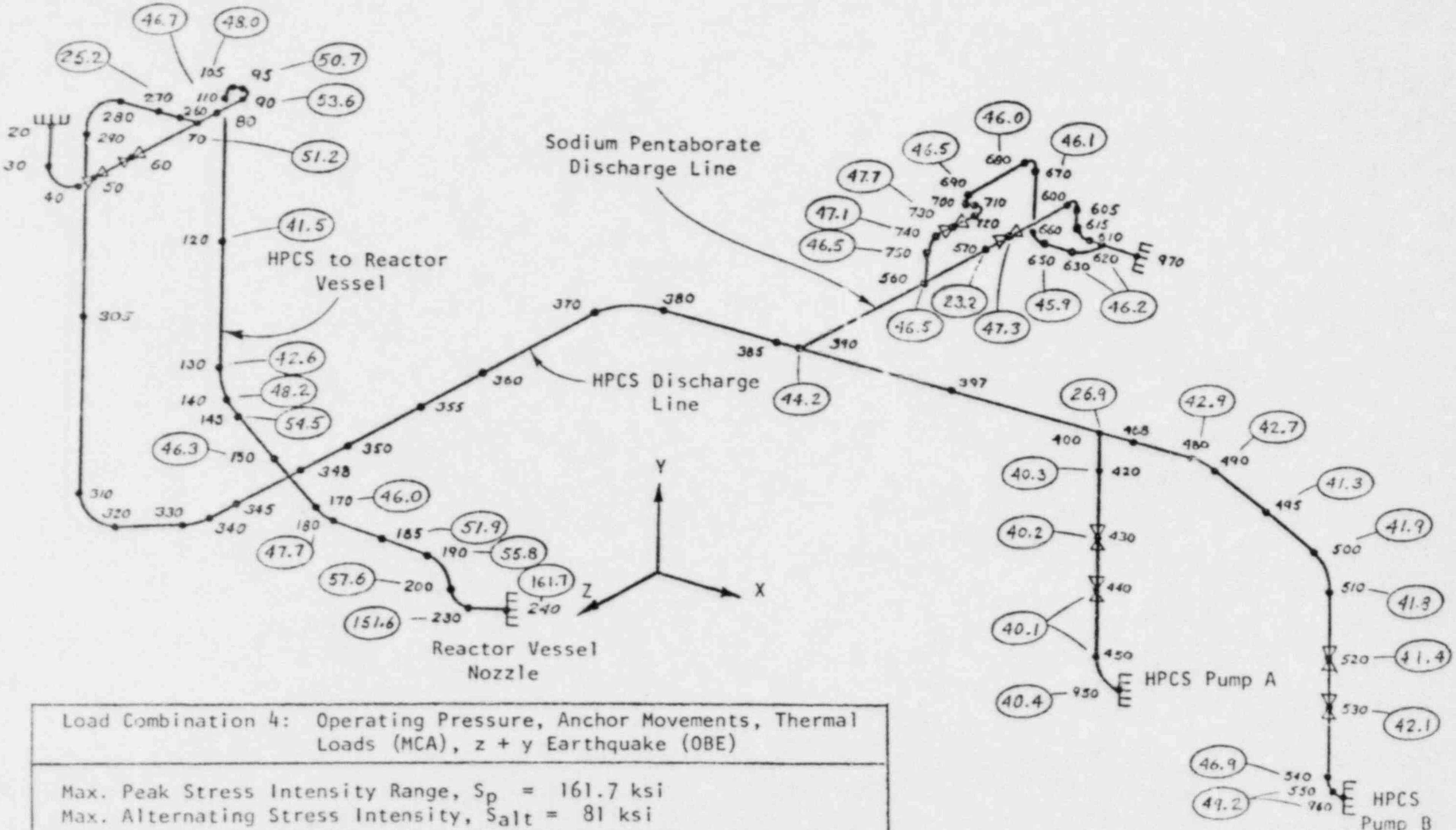
CONSIDERATION OF ASME CODE EQUATIONS 11 AND 14 UPSET CONDITIONS



Load Combination 3:	Operating Pressure, Anchor Movements, Thermal Loads (MCA), x + y Earthquake (OBE)
Max. Peak Stress Intensity Range, S_p = 158.9 ksi at Node 240 Max. Alternating Stress Intensity, S_{alt} = 79.5 ksi	
Max. Allowable Number of Stress Cycles, N = 3000	

FIGURE 7.10

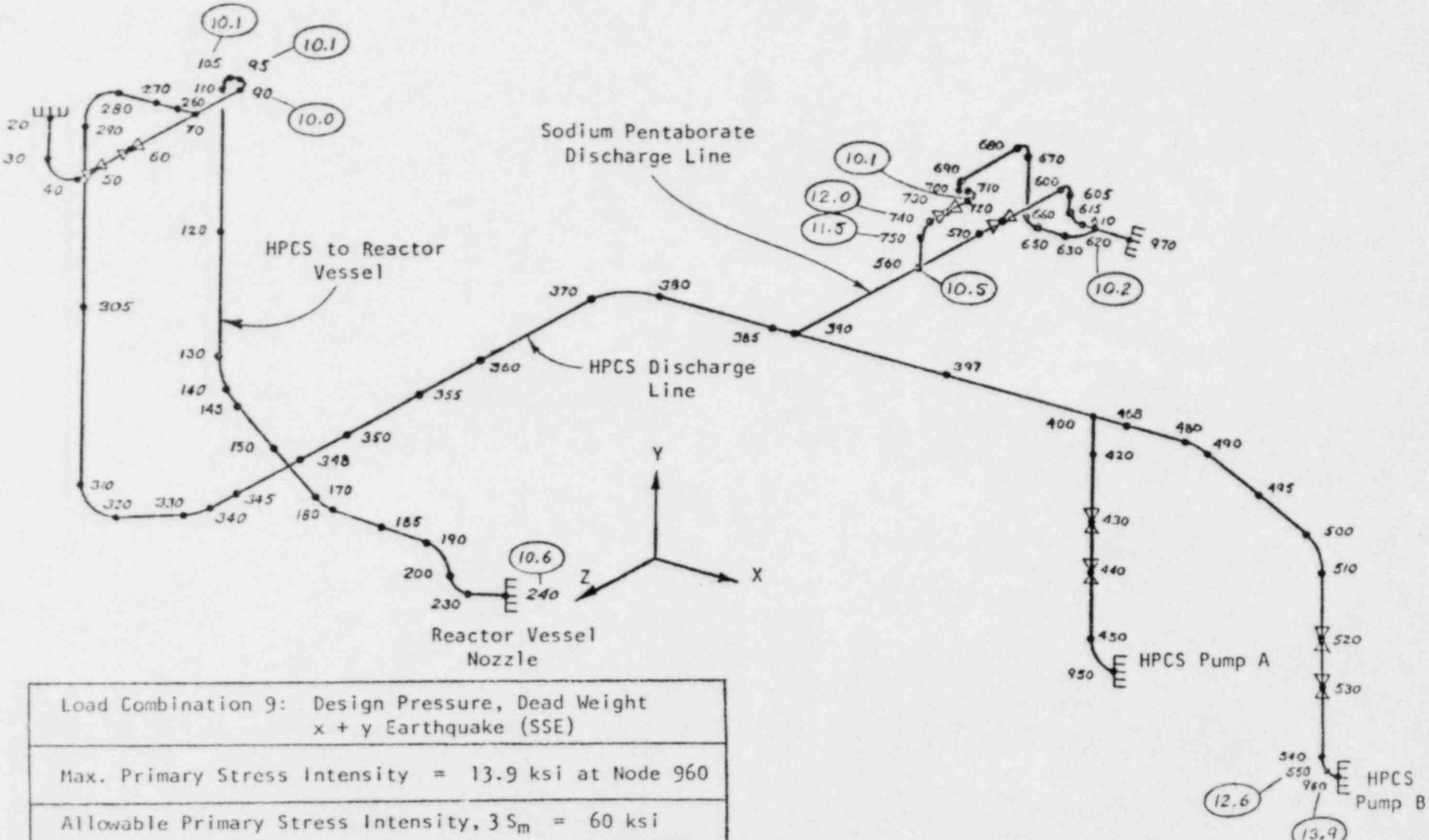
CONSIDERATION OF ASME CODE EQUATIONS 11 AND 14
UPSET CONDITIONS



Load Combination 4: Operating Pressure, Anchor Movements, Thermal Loads (MCA), z + y Earthquake (OBE)
Max. Peak Stress Intensity Range, S_p = 161.7 ksi Max. Alternating Stress Intensity, S_{alt} = 81 ksi
Max. Allowable Number of Stress Cycles, N = 2900

FIGURE 7.11

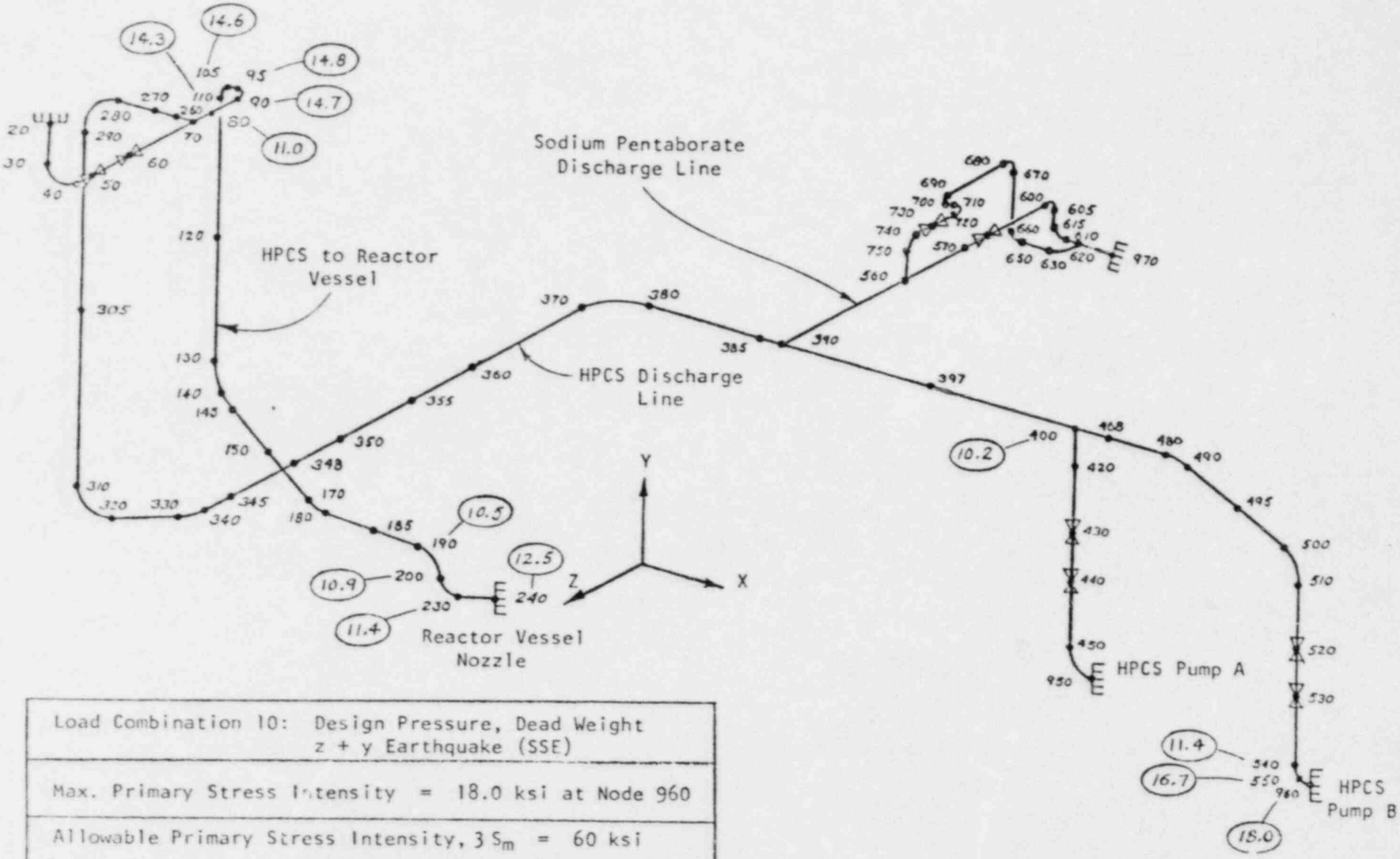
COMPLIANCE WITH ASME CODE EQUATION 9/FAULTED CONDITIONS



Load Combination 9: Design Pressure, Dead Weight x + y Earthquake (SSE)
Max. Primary Stress Intensity = 13.9 ksi at Node 960
Allowable Primary Stress Intensity, $3\,S_m$ = 60 ksi

FIGURE 7.12

COMPLIANCE WITH ASME CODE EQUATION 9/FAULTED CONDITIONS



Load Combination 10: Design Pressure, Dead Weight z + y Earthquake (SSE)
Max. Primary Stress Intensity = 18.0 ksi at Node 960
Allowable Primary Stress Intensity, $3 S_m$ = 60 ksi

8. CONCLUSIONS

The results of the analysis indicate that the deflection of the HPCS discharge piping system due to dead weight, thermal loads and the specified seismic events are acceptable and that the stresses resulting from these loads, as calculated and combined in accordance with the rules given in Subarticle NB-3650 of Section III fo the ASME Code (Reference 2), satisfy the design requirements for Class 1 piping systems provided that:

1. rigid anchors are provided as indicated by node points 20 and 970 of Figure 3.1,

2. the rotation of the eccentric accutator of the control valve CSV 204 (node point 50, Figure 3.1) is restrained by means of appropriate bars or struts,

3. the restraints are designed using the support reaction forces given in Table B-II of Appendix B, and

4. the total number of HPCS initiations is limited to 2900 cycles.*

NOTE: The HPCS system has operated (or cycled) a total of 226 times during all phases of plant testing and operation. However, only 25 operations or cycles have occurred with the LACBWR plant at or near operating temperature during its 7 year operating history. Considering a 40 year plant life, the total number of HPCS system operations with the plant at temperature is expected to be less than 150 cycles. Clearly this number is well below the maximum allowable number of cycles at operating temperature (2900 cycles).

9. REFERENCES

1. Gulf United Services Report No. SS-1162 "Seismic Evaluation of the LaCrosse Boiling Water Reactor", dated January 11, 1974.

2. ASME Boiler and Pressure Vessel Code, Section III, Division I, 1974 Edition, Nuclear Power Plant Components.

3. Sargent and Lundy Engineers "Specification for Piping System-LaCrosse Boiling Water Reactor" LACBWR #256.

4. Sargent and Lundy Engineers "LACBWR" Project Drawing Nos. 41-503362 through 503378.

5. Allis-Chalmers, "LaCrosse Boiling Water Reactor Safeguards Report Volume I and II; LACBWR #283, dated August, 1967.

6. U.S. Atomic Energy Commission - Regulatory Guide 1.48, May, 1973.

APPENDIX A

LACBWR HPCS DISCHARGE LINE PIPING ANALYSIS

PIPESD ANALYTICAL INPUT DATA

TABLE A-1

PIPE DATA HPCS DISCHARGE LINE

RUN NO.	FROM POINT	TO POINT	PIPE SIZE	O.D. (in)	WALL THICKNESS (in)	MATERIAL (ASTM)	WEIGHT OF PIPE INCL. WATER (lb/ft)	WEIGHT OF INSULTATION (lb/ft)	DESIGN TEMPERATURE (^{o}F)	DESIGN PRESSURE (psig)
1	20	50	2-1/2" Sch 40	2.875	0.203	A312/TP304	7.87	1.01	120	100
2	230	240	1-1/2" Sch 80	1.900	0.200	A376/TP304	4.40	2.04	595	1400
3	50	80	2-1/2" Sch 80	2.875	0.276	A376/TP304	9.50	2.55	595	1400
3	80	230	1-1/2" Sch 80	1.900	0.200	A376/TP304	4.40	2.04	595	1400
4	70	250	2-1/2" Sch 80	2.875	0.276	A376/TP304	9.50	2.55	595	1400
4	250	260	2" Sch 80	2.375	0.218	A376/TP304	6.30	2.29	595	1400
4	260	270	2" Sch 80	2.375	0.218	A376/TP304	6.30	0.88	595	1400
4	270	470	2-1/2" Sch 80	2.875	0.276	A376/TP304	9.50	1.014	595	1400
5	390	570	2-1/2" Sch 80	2.875	0.276	A376/TP304	9.50	1.014	595	1400
5	570 730	580 560	2" Sch 80	2.375	0.218	A376/TP304	6.30	0.88	595	1400
5	580 620	590 730	2" Sch 80	2.375	0.218	A376/TP304	6.30	2.29	595	1400
5	590	970	2-1/2" Sch 80	2.875	0.276	A376/TP304	9.50	2.55	595	1400
6 7	400 470	950 960	1-1/2" Sch 80	1.900	0.200	A376/TP304	4.40	0.76	595	1400

TABLE A-11

VALVE WEIGHTS

VALVE	NODE LOCATION	TOTAL WEIGHT (lbs)	ECCENTRIC WEIGHT (lbs)	ECCENTRICITY (in)
2-1/2" Control	50	285	145	21.72
2-1/2" Check	60	40	-	-
3-Way Control	260	215	125	21.72
1-1/2" Gate	430	52	-	-
1-1/2" Check	440	36	-	-
1-1/2" Gate	520	52	-	-
1-1/2" Check	530	36	-	-
2" Control	580	230	140	31.08
2" Control	730	230	140	31.08

TABLE A-III

STATIC LOAD CASES

PIPESD ANALYSIS

Static Load Case 1
Internal Design Pressure
Applied Pressure Loads:

RUN NO.	NODES	PRESSURE (psig)
1	20 to 50	100.0
2-7	All Others	1400.0

Static Load Case 2
Internal Operating Pressure
Applied Pressure Loads:

RUN NO.	NODES	PRESSURE (psig)
1	20 to 50	100.0
2,3	50 to 240	1340.0
4-7	All Others	1400.0

Static Load Case 3
Dead Weight
Applied Loads: 1.0G Vertical Acceleration

Static Load Case 4
Seismic Anchor Movements
Support Displacements:

NODE	DIRECTION	DISPLACEMENT (in)
240	X	0.432
240	Y	0.432

Static Load Case 5
Thermal Anchor Movements
Support Displacements:

NODE	DIRECTION	DISPLACEMENT (in)
240	X	-0.139
240	Y	1.260
240	Z	0.139

Static Load Case 8
Thermal-Maximum Credible Accident
Applied Thermal Loads:

RUN NO.	NODES	TEMPERATURE CHANGE (°F)
2	230-240	30.0

Discontinuity Stresses:

NODE NO.	LINEAR TEMP. GRADIENT, T_1 (°F)	NON-LINEAR TEMP. GRADIENT, T_2 (°F)	THERMAL DISCONTINUITY STRESS (ksi)
230	157.8	0.0	0.0
240	*	*	*

Static Load Case 9
Thermal - Normal Start-Up And Shutdown
Applied Thermal Loads:

RUN NO.	NODES	TEMPERATURE CHANGE (°F)
2	230-240	344.0

* Thermal Gradient and discontinuity stresses for node 240 are calculated in detailed ANSYS thermal stress analysis using the LION generated transient temperature profile (see Appendix B).

TABLE A-IV

SEISMIC RESPONSE SPECTRA PIPESD ANALYSIS

SPECTRUM NO. 1
(HORIZONTAL OBE)

FREQUENCY cps	ACCELERATION in/sec^2
40.00	61.82
8.00	61.82
5.98	104.33
5.20	185.47
4.20	471.41
3.80	564.14
3.35	197.06
2.95	100.46
2.39	197.06
2.25	176.74
2.10	320.71
2.00	251.16
1.62	838.48
1.60	637.56
1.58	683.93
1.37	239.57
1.30	266.62
1.00	135.2[illegible]
.83	83.07
.63	41.54
.50	1.54

SPECTRUM NO. 3
(HORIZONTAL SSE)

FREQUENCY cps	ACCELERATION in/sec^2
40.00	108.19
10.00	108.19
6.57	127.51
5.40	251.84
4.69	258.89
4.20	492.66
4.09	444.36
4.00	467.54
3.59	376.74
3.40	289.80
2.95	173.88
2.50	318.78
2.29	289.80
2.10	502.32
2.00	405.72
1.75	1120.56
1.70	919.63
1.60	985.32
1.35	434.70
1.31	434.70

SPECTRUM NO. 2
(VERTICAL OBE)

FREQUENCY cps	ACCELERATION in/sec^2
40.00	15.84
33.00	15.84
20.00	28.98
14.92	40.96
10.00	67.23
9.00	77.28
2.25	92.73
1.65	66.07
1.00	39.80
.80	35.16
.59	25.50
.40	17.00
.25	10.82
.20	7.23
.10	1.16

SPECTRUM NO. 4
(VERTICAL SSE)

FREQUENCY cps	ACCELERATION in/sec^2
40.00	31.68
33.33	32.68
20.00	51.00
14.92	68.01
9.00	108.19
2.39	132.14
2.00	106.64
1.49	81.14

TABLE A-V

DYNAMIC LOAD CASES/PIPESD ANALYSIS

Load Case No.	Load Description	Spectrum No. In Global Direction X	Y	X
6	x + y Earthquake (OBE)	1	2	0
7	z + y Earthquake (OBE)	0	2	1
10	x + y Earthquake (SSE)	3	4	0
11	z + y Earthquake (SSE)	0	4	3

APPENDIX B

LACBWR HPCS DISCHARGE LINE
PIPING ANALYSIS PIPESD ANALYSIS RESULTS

TABLE B-1 (a)

J O I N T   D I S P L A C E M E N T S (LOAD CASE 3)

DEAD LOAD

JOINT (GID)	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
20	-.0000000	-.0000000	-.0000000	.0000000	.0000000	-.0000000
30	-.0009204	-.0000861	.0003213	-.0001364	.0010362	-.0000723
40	-.0071371	-.0068045	.0046329	-.0003516	.0010750	-.0000204
50	-.0072514	-.0070744	.0046725	-.0000000	.0000000	.0000000
51	-.0072514	-.0070816	.0046704	-.0000000	.0000000	.0000000
60	-.0073978	-.0044593	.0046292	.0002214	.0000223	.0001111
65	-.0018239	.0031327	.0045944	.0002497	-.0002530	.0002317
70	.0009266	.0039497	.0045792	.0002565	-.0003048	.0002456
72	.0029179	.0047021	.0045792	.0002372	-.0003074	.0002451
80	.0074342	.0058175	.0045792	.0002141	-.0003027	.0002442
90	.0074953	.0060675	.0045792	.0001716	-.0003101	.0002294
95	.0087167	.0074734	.0038485	.0001515	-.0003269	.0002113
100	.0082166	.0074188	.0031192	.0001794	-.0003311	.0002237
105	.0087165	.0069655	.0023793	.0001974	-.0003354	.0001932
110	.0085793	.0056682	.0010832	.0002435	-.0003577	.0001339
120	.0104494	.0065799	-.0155519	.0005132	-.0004660	.0000101
130	.0126931	.0066159	-.0399810	.0007452	-.0005617	.0001206
140	.0112837	.0037439	-.0423491	.0009026	-.0005942	.0001064
145	.0097409	-.0094075	-.0387415	.0011755	-.0006016	-.0001116
150	-.0033201	-.3457072	-.0226110	.0014367	-.0005774	-.0003495
170	-.0171151	-.0759998	-.0052412	.0013056	-.0004121	.0011505
180	-.0177271	-.0729924	-.0036442	.0012357	-.0003972	.0012993
185	-.0181630	-.1493736	.0025937	.0008968	-.0002772	.0017141
190	-.0184211	-.0213120	.0059841	.0006631	-.0001909	.0016387
200	-.0284922	-.1102273	.0029695	.0005120	-.0000952	.0012499
220	-.0244777	-.1102266	.0032926	.0005058	-.0000902	.0012248
230	-.0035005	-.0040244	.0001165	.0003673	-.0000416	.0007226
240	.0000000	-.0000000	.0000000	.0000000	-.0000000	.0000000
250	.0000034	.0024141	.0024400	.0002175	-.0003784	.0002483
260	.0000000	-.0000046	.0000000	.0001190	-.0003909	.0005572
261	-.0120331	-.1000109	.0026923	.0001190	-.0003909	.0005572
270	-.0000021	-.2042892	-.0020559	.0000225	-.0003074	.0008021
280	-.0000174	-.2036539	-.0036741	-.0000171	-.0002804	.0008357
290	.0047363	-.0136719	-.0056879	-.0001243	-.0002073	.0005664
300	.0000045	.0032335	.0035449	.0002350	-.0003506	.0002642
305	.0175329	-.0144909	.0040993	-.0001877	.0000154	-.0001020
310	.0116615	-.0157134	.0058028	.0000657	.0002351	.0000071
320	.0170977	-.0159417	.0047522	.0002209	.0003034	.0002349
330	.0064851	-.1091801	.0011546	.0002969	.0003173	.0003483
340	.0037039	-.0050295	-.0010012	.0002905	.0003091	.0004419
345	.0010009	-.0018195	-.0000002	.0001791	.0002593	.0005016
348	-.0056898	.0032225	-.0010021	.0000509	.0001130	.0006413
350	-.0059120	.0018659	-.0000034	.0000686	.0000411	.0007296
355	-.0063971	-.0017584	-.0000259	-.0004165	-.0000496	.0008927
360	-.0047327	-.0252209	-.0000081	-.0004429	-.0000652	.0010463
370	-.0071202	-.0609451	-.0000119	-.0004262	-.0000411	.0012933
380	.0000088	-.2450269	.0001752	-.0003127	-.0000020	.0013324
385	.0000094	-.0039743	-.0001207	-.0001469	-.0000079	.0005657
388	.0000198	-.0024897	-.0000495	-.0001348	-.0000138	.0004529
390	.0016035	-.0012827	-.0000395	-.0001229	-.0000204	.0003535
392	.0007094	-.0023644	.0000147	-.0001173	-.0000161	.0002095
397	.0000049	-.0022712	-.0001717	-.0000340	.0000135	-.0001234

JOINT (GID)	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
398	.0000012	-.0024339	-.0002535	.0000402	-.0001238	.0000942
400	.0002010	-.0021440	-.0001849	.0000949	-.0001263	[illegible]
402	-.0002419	-.0021264	-.0001426	.0000642	-.0000732	.0000694
410	-.0002237	-.0021269	-.0001589	.0000666	-.0001224	[illegible]
420	.0001135	-.1022828	-.0004707	.0000226	-.0010127	[illegible]
430	-.0000000	-.0022976	-.0000000	-.0000354	-.0001177	[illegible]
440	-.0015298	-.0072820	.0001583	-.0000045	-.0000050	[illegible]
445	-.0022566	-.0022247	.0000716	.0000046	-.0001324	[illegible]
450	-.0000481	-.0022178	.0000592	.0000044	-.0000000	[illegible]
460	.0000005	-.0001249	.0000026	.0000013	.0000005	[illegible]
465	.0000005	-.0018437	-.0001013	.0000547	-.0000101	[illegible]
468	.0000000	-.0015646	.0000000	.0000547	-.0000779	.0000457
470	.0000307	-.0011229	.0002702	.0000546	-.0000515	[illegible]
480	.0000019	-.0013647	.0025292	.0000530	-.0001230	[illegible]
490	-.0002309	-.0014539	.0044031	.0000574	-.0000442	[illegible]
495	-.0059527	-.0006307	.0145019	.0001526	-.0001471	[illegible]
500	-.0113522	-.0043814	.0241162	.0002308	-.0001233	[illegible]
510	-.0116053	-.0045453	.0245093	.0002165	-.0001459	[illegible]
520	-.0073215	-.0045356	.0191577	.0002809	-.0001934	[illegible]
530	-.0047352	-.0045115	.0153297	.0002636	-.0001439	[illegible]
535	-.0012365	-.0044341	.0055172	.0005890	-.0000574	[illegible]
540	-.0004621	-.0044254	.0046559	.0000082	-.0000515	[illegible]
550	-.0000101	-.0003057	-.0000092	.0000477	-.0000045	[illegible]
555	.0000040	-.0016457	-.0000397	-.0001154	-.0000001	[illegible]
558	.0000037	-.0016084	-.0000420	.0000449	-.0000104	[illegible]
560	.0071235	-.0016857	-.0000421	.0000247	.0000104	[illegible]
562	.0070951	-.0016055	-.0000396	.0000289	.0000146	[illegible]
570	.0008512	-.0000978	-.0000115	.0000446	.0000946	[illegible]
575	.0005627	.0000167	-.0000077	.0000243	.0000454	[illegible]
580	.0000000	-.0000033	-.0000000	-.0000446	.0000433	[illegible]
581	-.0050040	-.0000135	-.0010021	-.0000445	.0000468	[illegible]
590	-.0017574	-.0005458	.0000001	-.0000999	.0000793	[illegible]
600	-.0017743	-.0019006	.0000005	-.0000783	.0000027	[illegible]
605	-.0017510	-.0021450	.0002036	-.0000196	.0000499	[illegible]
615	-.0004066	-.0021458	.0003510	-.0000265	.0000410	[illegible]
617	.0000010	-.0015456	.0002522	.0000033	.0000330	[illegible]
619	.0000016	-.0013459	-.0002210	.0000042	.0000014	.0001342
620	.0000009	-.1009861	.0001326	.0000194	.0000278	[illegible]
622	.0000006	-.0004734	.0000632	.0000136	.0000189	[illegible]
625	.0001040	-.1009959	.0001325	.0000411	.0000344	[illegible]
630	.0001929	-.0010973	.0001325	.0000475	.0000462	[illegible]
640	.0003765	-.0023818	.0007461	.0000769	.0000844	[illegible]
645	.0003771	-.0046849	.0008060	.0000574	.0000986	[illegible]
650	.0003778	-.1076347	.0014507	.0000343	.0001173	[illegible]
660	-.0010639	-.0091106	.0019070	.0000135	.0001424	[illegible]
670	-.0072025	-.0091140	.0017351	-.0000257	.0000205	[illegible]
680	-.0009460	-.0089754	.0016159	-.0000613	.0002451	[illegible]
685	-.0056629	-.1075023	.0016154	-.0001266	.0002567	[illegible]
690	-.0013464	-.0053667	.0016150	-.0001575	.0002352	[illegible]
700	-.0012439	-.1033943	.0009961	-.0001299	.0001571	[illegible]
710	-.0012839	-.0018474	.0004963	-.0001164	.0001714	[illegible]
720	-.0009779	-.1001109	.0000003	-.0000606	.0001103	[illegible]
730	-.0000000	-.0000035	.0000000	.0000704	.0000437	.0001767
731	-.0117074	-.1000134	.0021571	.0000734	.0000433	[illegible]
740	.0001492	-.0014243	.0000148	.0001267	-.0000009	[illegible]
745	.0024016	-.0016853	-.0000267	-.0000011	-.0000631	[illegible]
750	.0009372	-.0016782	-.0001101	.0000010	-.0000104	[illegible]
950	.0000000	-.0000000	.0000000	.0000000	.0000000	[illegible]
960	-.0000000	-.0000000	-.0000000	.0000000	-.0000000	[illegible]
970	.0000000	-.0000000	-.0000000	.0000000	.0000000	[illegible]

TABLE 3-1 (b)

J O I N T   D I S P L A C E M E N T S   (LOAD CASE 4)

SEISMIC ANCHOR MOVEMENTS - X AND Z (NODE 240) OBE

JOINT (GID)	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
20	-.0000000	.0000000	.0000000	-.0000000	.0000000	-.0000000
30	-.0001356	.0000030	.0003762	-.0000430	.0000094	-.0000198
40	-.0005662	-.0000101	.0006767	.0000139	-.0000091	-.0000079
50	-.0005563	.0005584	.0006792	.0000000	.0000000	.0000000
51	-.0005569	.0005584	.0006792	.0000000	.0000000	.0000000
60	-.0004064	.0023072	.0006904	.0001229	.0001057	.0001324
68	-.0007102	.0029875	.0007233	-.0001458	-.0000561	.0002760
70	.0000065	.0024735	.0007049	-.0002014	-.0000795	.0002925
72	.0002879	.0517610	.0007054	-.0002672	-.0001039	.0003693
80	.0009025	.0001654	.0007065	-.0003649	-.0001367	.0004973
90	.0056145	-.0170525	.0007141	-.0015939	-.0001315	.0026012
95	.0061340	-.0280740	.0000372	-.0020962	-.0002767	.0033369
100	.0053355	-.0357137	-.0005501	-.0022428	-.0002671	.0035359
105	.0063371	-.0437938	-.0011429	-.0023894	-.0002636	.0037246
110	.0189063	-.0529037	.0042095	-.0027319	-.0002003	.0044469
120	.2555074	-.1529376	.1531042	-.0036460	-.0003497	.0058472
130	.4557034	-.0929675	.2778236	-.0024687	-.0004915	.0040419
140	.4919577	-.1235103	.2975337	-.0018097	-.0005136	.0030010
145	.4795371	.0001144	.3007291	-.0014510	-.0005473	.0023943
150	.4659341	.1524617	.3165741	-.0003618	-.0008124	.0003515
170	.4376294	.0409070	.3559681	.0000176	-.0014168	-.0009157
180	.4364550	.0366937	.3619204	-.0000076	-.0014905	-.0009519
185	.4334108	.0185625	.3913397	-.0001094	-.0015851	-.0009166
190	.4319556	.0071608	.4132196	-.0002079	-.0013934	-.0006399
200	.4279509	.1033701	.4248132	-.0002789	-.0010291	-.0003361
220	.4241625	.0033699	.4246384	-.0002770	-.0010048	-.0007232
230	.4294545	.1012940	.4298533	-.0002026	-.0005667	-.0001439
240	.4320000	.0000000	.4320000	-.0000000	-.0000000	-.0000000
250	.0000039	.1005865	.0002950	-.0001900	-.0010613	.0002187
260	.0000000	-.0000035	-.0000000	-.0001603	-.0010459	.0001384
261	-.0070067	-.1000006	-.0034324	-.0001603	-.0010459	.0001394
270	-.0000062	-.0007168	-.0002659	-.0001306	-.0010425	.0001016
280	-.0000007	-.0012376	-.0004962	-.0001193	-.0000408	.0000877
290	.0007716	-.1021392	.0061953	-.0000798	-.0000285	.0000499
300	.0010052	.0016746	.0004367	-.0001367	-.0000691	.0002509
305	.0017519	-.0021372	.0024142	-.0000277	.0001026	-.0000033
310	.0019345	-.0071351	.0019025	.0000372	.0000336	.0000052
320	.0013189	-.0016251	.0006441	.0000433	.0010422	.0000210
330	.0014263	-.1004515	.0001517	.0000390	.0010422	.0000277
340	.0014550	-.0004315	.0000001	.0000325	.0000393	.0000275
345	.0000000	-.1000975	.0000000	.0000140	.0000324	.0000263
349	-.0006916	.0000236	-.0000002	-.0000018	.0000145	.0000227
350	-.0006797	.1000035	-.0000053	-.0000009	.0000057	.0000205
355	-.0004531	-.0000029	-.0000004	-.0000005	-.0000057	.0000164
360	-.0005739	-.0000404	-.0000005	-.0000017	-.0000106	.0000125
370	-.0000591	-.0001497	-.0000109	-.0000021	-.0000063	.0000062
380	-.0000005	-.1001125	.0000414	-.0000016	-.0000019	.0000042
385	-.0000004	.0000006	.0000085	-.0000006	.0000015	.0000014
388	-.0000004	-.1000046	.0000044	-.0000005	.0000014	.0000012
390	-.0000004	.0000081	.0000036	-.0000004	.0000011	.0000011
392	-.0000004	.0000112	-.0000026	-.0000004	.0000010	.0000010
397	-.0000002	.0000232	-.0000193	-.0000003	-.0001001	-.0000003

JOINT (GID)	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
398	-.0000093	.0000036	-.0000040	-.0000001	-.0000004	[illegible]
400	-.0000000	.0000023	-.0000027	-.0000001	[illegible]	[illegible]
402	-.0000004	.1000017	-.0000019	-.0000001	-.0000004	[illegible]
410	-.0000006	.0000020	-.0000022	-.0000006	-.0000004	[illegible]
420	-.0000034	.0000009	-.0000007	.0000000	-.0000003	[illegible]
430	-.0000000	.0000004	-.0000000	-.0000000	-.0000002	[illegible]
440	.0000011	.0000007	.0000001	.0000000	-.0000002	[illegible]
445	.0000009	.0000007	-.0000001	.0000000	-.0000001	[illegible]
450	.0000004	.0000007	-.0000001	.0000000	-.0000001	[illegible]
460	.0000000	.0000000	-.0000000	.0000000	[illegible]	[illegible]
465	-.0000000	.0000011	-.0000013	-.0000001	-.0000004	[illegible]
469	-.0000000	-.1000001	-.0000000	-.0000001	-.0000004	[illegible]
470	.0000000	-.0000023	.0000026	-.0000001	-.0000004	[illegible]
480	.0000000	-.1000062	.0000094	-.0000002	-.0000002	[illegible]
490	-.0000002	-.0000060	.0000102	-.0000002	-.0000002	[illegible]
495	-.0000013	-.1000001	.0000122	-.0000001	.0000000	[illegible]
500	-.0000007	.0000003	.0000103	.0000001	.0000001	[illegible]
510	.0000000	-.1000002	.0000036	.0000002	.0000001	[illegible]
520	.0000000	-.1000002	.0000049	.0000002	.0000001	[illegible]
530	.0000000	-.0000002	.0000030	.0000002	.0000000	[illegible]
535	.0000000	-.0000002	.0000005	.0000001	.0000000	[illegible]
540	.0000000	-.1000002	.0000004	.0000001	.0000000	[illegible]
550	.0000000	-.0000000	.0000000	.0000000	.0000000	[illegible]
555	-.0000035	.0000068	.0000006	-.0000004	.0000010	[illegible]
558	-.0000095	-.1000006	.0000003	-.0000000	-.0000003	[illegible]
560	-.0000085	-.1000006	.0000003	-.0000000	[illegible]	[illegible]
562	-.0000074	-.0000006	.0000002	-.0000000	[illegible]	[illegible]
570	-.0000036	-.1000001	.0000001	.0000000	[illegible]	[illegible]
575	-.0000004	-.0000001	.0000000	.0000000	[illegible]	[illegible]
580	-.1000000	.0000000	.0000000	.0000000	[illegible]	[illegible]
591	-.0000002	-.1000000	.0000003	.0000000	-.0000000	[illegible]
590	.0000002	.0000001	.0000000	.0000000	-.0000000	[illegible]
600	.0000004	.1000003	.0000000	.0000000	-.0000000	[illegible]
605	.0000002	.0000007	-.0000000	.0000000	.0000000	[illegible]
615	.0000001	.1000003	-.0000000	.0000000	.0000000	[illegible]
617	.0000000	.0000002	-.0000000	-.0000000	-.0000000	[illegible]
618	.0000000	.1000002	-.0000000	-.0000000	-.0000000	[illegible]
620	.0000000	.0000001	-.0000000	-.0000000	-.0000000	[illegible]
622	.0000000	.1000001	-.0000000	-.0000000	-.0000000	[illegible]
625	.0000000	.0000001	-.0000000	-.0000000	-.0000000	[illegible]
630	.0000000	.0000002	-.0000000	-.0000000	-.0000000	[illegible]
640	-.0000000	.0000005	-.0000001	-.0000000	-.0000000	-.0000001
645	.0000000	.0000011	-.0000002	.0000001	-.0000000	-.0000001
650	-.0000000	.0000021	-.0000003	-.0000001	-.0000000	[illegible]
660	.0000007	.0000027	-.0000005	.0000001	-.0000000	[illegible]
670	.0000057	.0000027	-.0000019	-.0000001	.0000000	[illegible]
680	.0000066	.1000028	-.0000021	-.0000000	.0000000	[illegible]
685	.0000071	.0000030	-.0000021	.0000000	.0000000	[illegible]
690	.0000066	.1000027	.0000021	.0000000	-.0000001	-.0000002
700	.0000062	.0000020	-.0000015	.0000000	-.0000002	-.0000002
710	.0000062	.1000013	-.0000009	.0000000	-.0000002	-.0000002
720	.0000052	.0000006	.0000000	.0000000	-.0000004	-.0000002
730	.0000000	-.1000050	.0000000	.0000001	-.0000004	-.0000002
731	.0000053	-.0000050	.0000017	.0000001	-.0000006	[illegible]
740	.0000066	-.0000006	.0000000	.0000000	-.0000006	-.0000001
745	-.0000049	-.0000006	.0000002	-.0000000	-.0000004	.0000000
750	.0000046	-.1000006	.0000000	-.0000000	-.0000005	-.0000001
950	.0000000	.0000000	.0000000	.0000000	-.0000000	-.0000000
960	-.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
973	.0000000	-.0000000	-.0000000	-.0000000	-.0000000	-.0000000

TABLE B-1 (c)

J O I N T   D I S P L A C E M E N T S   (LOAD CASE 5)

THERMAL ANCHOR MOVEMENTS

JOINT (GID)	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
20	.000002	.000026	-.000000	.000000	-.000000	.000003
30	.000196	.000009	-.000287	.000049	-.000014	.000037
40	.000367	.000964	-.001193	.000050	-.000013	.000011
50	.000846	.001137	-.001193	.000000	-.000000	-.000000
51	.000846	.001137	-.001193	.000000	-.000000	-.000000
60	.001163	.000853	-.001193	-.000093	-.000008	-.000352
68	.000305	-.007904	-.001194	-.000630	.000095	-.000733
70	-.000008	-.009520	-.001194	-.000721	.000115	-.000777
72	-.000391	-.011878	-.001195	-.000833	.000137	-.000773
80	-.001159	-.016480	-.001195	-.000984	.000184	-.000766
90	-.005417	-.044096	-.001202	-.001881	.000239	-.000653
95	-.005357	-.046707	-.000859	-.001656	.000097	-.000724
100	-.005453	-.045634	-.000684	-.001553	.000265	-.000779
105	-.005561	-.043292	-.000575	-.001440	.000038	-.000876
110	-.009583	-.040855	.002307	-.001151	-.000086	-.001471
120	-.109857	-.041095	.032176	-.000534	-.000581	-.002451
130	-.165566	-.041129	.069153	-.001629	-.001019	.000063
140	-.187369	-.025842	.089510	-.002377	-.001152	.001695
145	-.172729	.001333	.095652	-.003199	-.001179	.003235
150	-.195503	.274374	.126965	-.006114	-.000975	.009136
170	-.210015	.809050	.145605	-.005657	.000030	.011261
180	-.209892	.862432	.145161	-.005333	.000174	.011123
185	-.209347	1.055015	.137148	-.003737	.000627	.009573
190	-.204637	1.192017	.126241	-.002435	.000763	.007376
220	-.153344	1.242192	.134743	-.001478	.000679	.005066
222	-.167022	1.242193	.133813	-.001435	.000676	.004940
230	-.179194	1.253250	.140020	-.000629	.000357	.002602
240	-.179000	1.260000	.139000	-.000000	.000000	.000000
250	-.000035	-.004657	-.000525	-.000653	-.000104	-.000407
260	-.000000	-.000002	-.000000	-.000504	.000067	-.000679
262	.010744	-.000002	-.010043	-.000504	.000067	-.000679
270	.010101	.003407	.000263	-.000355	.000026	-.000466
280	.000002	.005749	.000374	-.000293	.000013	-.000397
290	-.000091	.009521	.002967	-.000111	.000004	-.000155
300	-.000005	-.007111	-.000453	-.000657	.000110	-.000803
305	-.004801	.009507	.001185	.000106	-.000037	.000061
310	-.002880	.009492	-.002444	-.000012	-.000077	-.000049
320	-.000254	.007735	-.001447	-.000114	-.000090	-.000154
330	-.000115	.004086	-.000362	-.000150	-.000008	-.000192
340	-.001231	.002069	.000001	-.000141	-.000100	-.000190
345	-.000000	.000549	.000000	-.000085	-.000080	-.000180
348	.001859	-.000104	.000090	.000008	-.000039	-.000156
350	.002164	-.000046	.000001	.000001	-.000015	-.000140
355	.002305	.000013	.000001	.000005	.000015	-.000112
360	.001541	.000304	.000002	.000012	.000025	-.000086
370	.000159	.001067	.000012	.000015	.000017	-.000044
380	.000002	.000806	[illegible]	.000011	.000005	-.000030
385	.000001	-.000007	[illegible]23	.000004	-.000004	-.000010
395	.000001	-.000033	-.000011	.000004	-.000003	-.000009
390	.000001	-.000059	-.000002	.000003	-.000003	-.000005
392	.000001	-.000092	.000005	.000003	-.000003	-.000007
397	.000001	-.000174	.000043	.000002	.000000	.000002

JOINT (GID)	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
398	.000000	-.000028	.000009	.000001	.000001	.000003
400	.000002	-.000018	.000006	.000001	[illegible]	[illegible]
402	.000002	-.000014	.000004	.000000	[illegible]	[illegible]
410	.000001	-.000015	.000005	.000000	[illegible]	[illegible]
420	.000014	-.000025	.000002	-.000000	[illegible]	[illegible]
430	.000000	-.000005	.000000	.000000	[illegible]	[illegible]
440	-.000007	-.000005	-.000001	-.000000	[illegible]	[illegible]
445	-.000005	-.000005	-.000000	-.000000	.000000	[illegible]
450	-.000005	-.000005	.000000	-.000000	[illegible]	[illegible]
460	-.000000	-.000000	.000000	-.000000	[illegible]	[illegible]
465	.000000	-.000004	.000007	.000001	[illegible]	[illegible]
468	.000000	.000000	.000000	.000001	.000001	[illegible]
470	-.000000	.000018	-.000005	.000001	[illegible]	[illegible]
480	-.000000	.000048	-.000020	.000002	.000000	[illegible]
490	.000000	.000047	-.000021	.000002	[illegible]	[illegible]
495	-.000000	.000001	-.000023	.000001	-.000000	[illegible]
500	-.000005	-.000002	-.000010	.000000	[illegible]	[illegible]
510	-.000005	-.000000	-.000008	-.000000	[illegible]	[illegible]
520	-.000001	-.000000	-.000005	-.000000	[illegible]	[illegible]
530	.000000	-.000000	-.000003	-.000000	-.000000	[illegible]
535	.000000	-.000000	-.000000	-.000000	[illegible]	[illegible]
540	-.000000	-.000000	-.000003	-.000000	[illegible]	[illegible]
550	-.000000	-.000000	-.000000	.000000	-.000000	[illegible]
555	.000009	-.000050	-.000002	.000003	[illegible]	[illegible]
558	.000010	.000005	-.000001	.000000	.000001	[illegible]
560	.000007	.000005	-.000001	.000000	.000001	[illegible]
562	.000005	.000035	-.000001	-.000000	[illegible]	[illegible]
570	-.000002	.000000	-.000000	-.000000	[illegible]	[illegible]
575	-.000001	.000000	-.000000	-.000000	[illegible]	[illegible]
580	-.000000	-.000000	-.000000	.000000	[illegible]	[illegible]
581	.000037	-.000009	.000000	.000000	-.000000	-.000001
590	.000002	.000000	-.000000	.000000	-.000000	-.000001
600	.000004	.000001	-.000000	.000000	-.000000	-.000001
605	.000003	.000002	-.000000	.000000	-.000000	[illegible]
615	.000001	.000062	-.000001	.000000	-.000000	[illegible]
617	-.000000	.000001	-.000000	.000000	-.000000	[illegible]
618	-.000000	.000001	-.000000	.000000	-.000000	[illegible]
620	-.000000	.000000	-.000000	.000000	-.000000	-.000000
622	-.000000	.000000	-.000000	.000000	-.000000	[illegible]
625	-.000000	.000000	-.000000	.000000	-.000000	-.000000
630	-.000000	.000000	-.000000	.000000	-.000000	[illegible]
640	-.000000	-.000001	-.000000	.000000	-.000000	[illegible]
645	-.000001	-.000001	-.000000	.000000	-.000000	[illegible]
650	-.000001	-.000003	-.000001	.000000	-.000000	[illegible]
660	-.000002	-.000004	-.000000	.000000	-.000000	[illegible]
670	-.000010	-.000004	.000005	.000000	-.000000	[illegible]
680	-.000013	-.000004	.000006	.000000	-.000000	[illegible]
685	-.000019	-.000004	.000006	-.000000	-.000000	[illegible]
690	-.000021	-.000001	.000004	-.000000	.000000	-.000000
700	-.000021	-.000002	.000005	-.000000	.000001	[illegible]
710	-.000021	-.000003	.000003	-.000000	.000001	[illegible]
720	-.000018	-.000004	-.000000	-.000000	.000001	-.000001
730	.000000	.000000	-.000000	-.000000	.000002	[illegible]
731	.000031	.000000	-.000013	-.000000	.000002	[illegible]
740	.000023	.000004	-.000000	-.000000	.000002	[illegible]
745	.000014	.000005	-.000000	.000000	.000001	[illegible]
750	.000025	.000005	.000000	.000000	.000002	[illegible]
950	-.000000	-.000000	-.000000	-.000000	.000000	[illegible]
960	.000000	-.000000	-.000000	.000000	-.000000	[illegible]
970	-.000000	-.000000	.000002	.000000	-.000000	[illegible]

TABLE B-1 (d)

J O I N T   D I S P L A C E M E N T S (LOAD CASE 6)

OBE SEISMIC - X+Y

TOTAL RESPONSE EQUALS MODE 1 THROUGH 27 BY SOSS SUMMATION

JOINT GID	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
20	.0000000	.0000000	.0000000	.0000000	.0000000	.0000060
30	.0007449	.0000028	.0002015	.0000299	.0000040	.0000483
40	.0014235	.1034264	.0006521	.0000195	.0000232	.0000203
50	.0015021	.0004890	.0006529	.0000000	.0000000	.0000000
51	.0014037	.0004892	.0006789	.0000022	.0000000	.0000070
60	.0012027	.0000958	.0006539	.0000390	.0000308	.0000792
65	.0001674	.0018817	.0006544	.0001152	.0000539	.0001652
70	.0000023	.1021308	.0006544	.0001325	.0010595	.0001751
72	.0071907	.1024458	.0006543	.0001489	.0012677	.0001337
80	.0075695	.0031300	.0006542	.0001779	.0012840	.0001992
90	.0141997	.1106997	.0006531	.0007103	.0003466	.0005062
95	.0050659	.0107192	.0008501	.0009199	.0004629	.0005625
100	.0059701	.0094941	.0017911	.0010167	.0004870	.0005491
105	.0042704	.0082221	.0028665	.0011136	.0005091	.0006259
110	.0045987	.1065166	.0049176	.0013550	.0006115	.0007549
120	.0425001	.0065158	.0890690	.0021950	.0010432	.0010796
130	.0900417	.0068144	.1747463	.0021243	.0014273	.0012472
140	.0900957	.0013521	.1816992	.0019490	.0015229	.0009992
145	.1416693	.0000639	.1726294	.0018791	.0015650	.0009653
150	.1497152	.0129379	.1279094	.0013900	.0016175	.0007942
170	.0541763	.1198344	.0657551	.0006023	.0017717	.0005472
180	.0043207	.0149560	.0587812	.0007435	.0017320	.0005710
185	.0054724	.1105161	.0287326	.0004919	.0014693	.0004682
190	.0044907	.0044386	.0099170	.0003044	.0011499	.0003911
210	.0042527	.1021123	.0071519	.0001800	.0007537	.0002929
220	.0048940	.0021122	.0031516	.0001759	.0007291	.0002968
230	.0011556	.1007441	.0011691	.0000932	.0007484	.0001655
240	.0000100	.0000000	.0000000	.0000000	.0000000	.0000000
250	.0007014	.0010796	.0003312	.0001429	.0000545	.0001771
260	.0000000	.0000002	.0000000	.0001912	.0000597	.0001944
261	.0042959	.0000002	.0042472	.0001975	.0000597	.0001987
270	.0000008	.0009849	.0003975	.0001522	.0000728	.0001457
280	.0000012	.1017461	.0009125	.0001376	.0000776	.0001304
290	.0012451	.0071092	.0029659	.0000979	.0000952	.0000985
300	.0000018	.0016068	.0004903	.0001365	.0000559	.0001761
305	.0046597	.0031007	.0052445	.0000544	.0001172	.0000794
310	.0055869	.0030944	.0041201	.0000969	.0001723	.0000700
320	.0055239	.0025235	.0027499	.0000919	.0001854	.0000670
330	.0034472	.1015177	.0008371	.0000729	.0001760	.0000739
340	.0013442	.0034677	.0000010	.0000626	.0001542	.0000725
343	.0012066	.0000165	.0000000	.0001362	.0001383	.0000764
345	.0035599	.0000648	.0000037	.0000138	.0001147	.0000951
350	.0051879	.0007771	.0000053	.0000153	.0000993	.0001104
355	.0070746	.0001391	.0000090	.0000629	.0000572	.0001429
360	.0066687	.0037486	.0000126	.0001403	.0000736	.0001761
370	.0010746	.1115644	.0000193	.0001363	.0001000	.0002323
380	.0070549	.0131404	.0003794	.0001142	.0000530	.0002466
385	.0000227	.1002397	.0005722	.0000615	.0000815	.0002201
388	.0000126	.0005217	.0003077	.0000577	.0000958	.0002166
390	.0000324	.1011519	.0000156	.0000540	.0001111	.0002142
392	.0000315	.0017601	.0003261	.0000530	.0001046	.1001929
397	.0000173	.0048185	.0032932	.0000460	.0000385	.0000397

JOINT GID	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
398	.0000030	.0008826	.0012790	.0000566	.0001231	[illegible]
400	.0000021	.1005908	.0008925	.0000590	.0001354	[illegible]
402	.0032429	.0004426	.0006547	.0000460	.0001735	[illegible]
410	.0001391	.1004050	.0007540	.0000394	.0001326	[illegible]
420	.0005590	.0001398	.0001809	.0000037	.0001148	[illegible]
430	.0000000	.0001346	.0000000	.0000097	.0000772	[illegible]
440	.0001916	.0001717	.0000539	.0000014	[illegible]	[illegible]
445	.0001452	.1001266	.0000382	.0000044	[illegible]	[illegible]
450	.0001266	.0001267	.0000410	.0000043	[illegible]	[illegible]
460	.0000000	.1000065	.0000012	.0000006	.0000017	[illegible]
465	.0000010	.0002929	.0004670	.0000633	.0001459	[illegible]
468	.0000000	.1000848	.0000000	.0000636	.0001510	[illegible]
470	.0000004	.0005739	.0010645	.0000792	.0001904	[illegible]
480	.0000066	.1023465	.0096403	.0002718	[illegible]	[illegible]
490	.0005967	.1024409	.0113432	.0003060	[illegible]	[illegible]
495	.0150785	.0000874	.0369296	.0006247	[illegible]	[illegible]
500	.0245613	.0017367	.0605892	.0008998	.0007682	[illegible]
510	.0270637	.1021316	.0582369	.0009850	[illegible]	[illegible]
520	.0177090	.0021312	.0349128	.0010762	.0004679	[illegible]
530	.0119963	.1021709	.0271372	.0010360	.0003605	[illegible]
535	.0029584	.0021299	.0078954	.0008103	.0001466	[illegible]
540	.0023849	.1021298	.0030475	.0005626	.0001329	[illegible]
550	.0000314	.0000826	.0000009	.0000353	.0000283	[illegible]
555	.0074016	.0009963	.0000152	.0000520	.0001303	[illegible]
558	.0093731	.0006462	.0000025	.0000022	.0001369	[illegible]
560	.0094322	.1006457	.0000083	.0000024	[illegible]	[illegible]
562	.0093970	.0006290	.0000079	.0000079	[illegible]	[illegible]
570	.0027429	.1006943	.0000073	.0000135	[illegible]	[illegible]
575	.0015067	.0000962	.0000015	.0000373	[illegible]	[illegible]
580	.0000000	.0000004	.0000000	.0000448	[illegible]	[illegible]
581	.0258714	.0000004	.0014155	.0000459	[illegible]	[illegible]
590	.0117662	.1005702	.0000002	.0000749	.0001729	[illegible]
600	.0079269	.0017874	.0000005	.0000341	.0001195	[illegible]
605	.0076203	.1020747	.0002573	.0000971	.0001040	[illegible]
615	.0010145	.0020756	.0004932	.0000430	.0000170	[illegible]
617	.0000011	.1012302	.0003865	.0000328	.0000841	[illegible]
619	.0077017	.0010255	.0043197	.0000294	.0000499	[illegible]
620	.0000004	.1094094	.0001945	.0000216	.0000432	[illegible]
622	.0000005	.0002931	.0000459	.0000151	.0000263	[illegible]
625	.0001367	.1005504	.0001940	.0000203	.0000402	[illegible]
630	.0002410	.0006116	.0001837	.0000295	.0000021	.0001876
640	.0004187	.0011836	.0003722	.0000101	.0000733	[illegible]
645	.0004197	.0026906	.0007459	.0000140	.0000315	[illegible]
650	.0004207	.1047404	.0012934	.0000204	.0000043	[illegible]
660	.0009353	.0059209	.0016749	.0000152	.0001501	[illegible]
670	.0103171	.0059239	.0016773	.0000354	.0001477	[illegible]
680	.0114449	.0061696	.0018615	.0001104	[illegible]	[illegible]
685	.0351233	.1094737	.0019595	.0001497	[illegible]	[illegible]
690	.0017535	.0110600	.0019562	.0001919	[illegible]	[illegible]
700	.0005792	.1079446	.0010960	.0001441	[illegible]	[illegible]
710	.0005777	.0732917	.0004583	.0001412	[illegible]	[illegible]
720	.0000944	.1010036	.0000020	.0000944	[illegible]	.0014450
730	.0000000	.0000001	.0000000	.0000409	[illegible]	[illegible]
731	.0553390	.0000001	.0025531	.0000934	.0000665	[illegible]
740	.0017284	.0009929	.0000023	.0000329	.0000666	[illegible]
745	.0070821	.1006450	.0000107	.0000018	.0001142	[illegible]
750	.0014037	.0006468	.0000247	.0000010	.0000421	[illegible]
950	.0000000	.1000000	.0000000	.0000000	[illegible]	[illegible]
960	.0000000	.0000000	.0000000	.0000000	.0000000	[illegible]
970	.0000000	.1000000	.0000000	.0000000	.0000000	.0000000

TABLE 8-1 (e)

2.0 JOINT DISPLACEMENTS (LOAD CASE 7)

CRE SEISMIC - X+Z

TOTAL RESPONSE EQUALS MODE 1 THROUGH 27 BY SRSS SUMMATION

JOINT	DISPLACEMENTS (IN.)			ROTATIONS (RADIANS)		
GID	X	Y	Z	X	Y	Z
20	.0000003	.0000000	.0000003	.0000000	.0000000	.0000003
30	.0007945	.1000049	.0002629	.0000795	.0000203	.0000405
40	.0012028	.0005561	.0003721	.0000274	.0000197	.0000171
50	.0017693	.1006744	.0004732	.0000000	.0000000	.0000000
51	.0013346	.0006745	.0008935	.0000029	.0000060	.0000653
60	.0012242	.1007595	.0008743	.0000419	.0000242	.0001526
65	.0007563	.0029519	.0008753	.0002517	.0002801	.0003141
70	.0000033	.1037217	.0008760	.0002889	.0000943	.0003372
72	.0003315	.1046355	.0008754	.0003365	.0001232	.0003666
80	.0010631	.0064824	.0008745	.0004170	.0001700	.0004163
90	.0037203	.1247728	.0008592	.0017945	.0008355	.0012436
95	.0114791	.0264239	.0018147	.0023326	.0011301	.0013829
100	.0118737	.1232812	.0043429	.0025400	.0011909	.0014654
105	.0114793	.0199649	.0070391	.0028275	.0012439	.0015464
110	.0184424	.0162084	.0173590	.0034426	.0015079	.0018710
120	.0717043	.0162035	.2264644	.0055446	.0025774	.0027241
130	.2772329	.0161985	.4445817	.0053969	.0035237	.0026349
140	.2297355	.0072339	.4623244	.0050472	.0037604	.0025071
145	.2122092	.1000763	.4392413	.0047595	.0039228	.0024162
150	.1744566	.0258422	.3245770	.0034718	.0045854	.0020517
170	.0047515	.0393646	.1643654	.0015619	.0044954	.0013196
180	.0067439	.1370991	.1465222	.0018138	.0043910	.0012508
185	.0093291	.0184001	.0701720	.0011779	.0036929	.0009589
190	.0100477	.1074221	.0225845	.0006939	.0024553	.0006909
200	.0105973	.1033073	.0056514	.0003178	.0019524	.0004265
220	.0109162	.0033072	.0064865	.0003373	.0017904	.0004137
230	.0071397	.0011894	.0027290	.0001253	.0008344	.0002333
240	.0000003	.0000000	.0000003	.0000000	.0000000	.0000000
250	.0000023	.0017507	.0004294	.0002674	.0000751	.0003179
260	.0000000	.1000092	.0000000	.0002299	.0000731	.0002617
261	.0057022	.0000092	.0000266	.0002321	.0000731	.0002629
270	.0000005	.1013537	.0004934	.0001692	.0000919	.0001932
280	.0000010	.0027450	.0010209	.0001459	.0000995	.0001697
290	.0015504	.0041250	.0021556	.0000999	.0001161	.0001191
300	.0000030	.0027217	.0056299	.0002779	.0000826	.0003294
305	.0064633	.1041210	.0054141	.0000674	.0001712	.0000393
310	.0096194	.0041163	.0062096	.0000552	.0002407	.0000650
320	.0080937	.1032879	.0028317	.0000579	.0002564	.0000855
330	.0051240	.0017236	.0009175	.0000551	.0002641	.0000983
340	.0077323	.0005475	.0000710	.0000606	.0007416	.0000999
345	.0000000	.0002379	.0000002	.0000356	.0002126	.0000945
348	.0061340	.1000595	.0000372	.0000111	.0001314	.0001029
350	.0071553	.1003079	.0000036	.0000124	.0000747	.0001092
355	.0074643	.0001217	.0000063	.0000515	.0000450	.0001257
365	.0060579	.1070070	.0000097	.0001033	.0000895	.0001453
370	.0027632	.0045260	.0000127	.0000859	.0000779	.0001335
380	.0000111	.1071116	.0009427	.0000673	.0000306	.0001913
385	.0000041	.0001721	.0002739	.0000647	.0000423	.0001213
389	.0000073	.1003069	.0001405	.0000557	.0000481	.0001111
390	.0000076	.0006171	.0000354	.0000571	.0000548	.0001009
392	.0000074	.1006974	.0002027	.0000574	.0000657	.0000930
397	.0000041	.0026570	.0044554	.0000835	.0000713	.0000167
398	.0000007	.1005353	.0023003	.0001282	.0007121	.0006750
400	.0000005	.0003314	.0016234	.0001314	.0002405	.0000719
402	.0004305	.1003330	.0012270	.0001632	.0002773	.0000736
410	.0002455	.0002284	.0013769	.0000918	.0000393	.0000745
420	.0009509	.1001422	.0003773	.0000042	.0000040	.0000620
430	.0000000	.0001350	.0000000	.0000175	.0001366	[illegible]
440	.0001144	.0001311	.0001056	.0000012	.0001005	.0000070
445	.0001163	.0001243	.0000325	.0000094	.0000373	.0000072
450	.0001064	.1001235	.0000442	.0000092	.0000370	.0000184
460	.0000001	.0000075	.0000019	.0000010	.0000027	[illegible]
465	.0000002	.1001568	.0008537	.0001415	.0002711	.0000724
468	.0000000	.1001871	.0000000	.0001555	.0003032	.0000751
470	.0000005	.0006242	.0020157	.0001797	.0007554	[illegible]
480	.0000042	.1040298	.0207500	.0006175	.0012726	[illegible]
490	.0012309	.0043167	.0257120	.0006955	.0013344	[illegible]
495	.0745916	.1000578	.0845359	.0014252	.0020257	[illegible]
500	.0556491	.0037610	.1354670	.0020597	.0017451	.0009947
510	.0541106	.0049092	.1342770	.0022696	.0013645	[illegible]
520	.0392012	.0049070	.0603467	.0024756	.0012409	[illegible]
530	.0255540	.1049060	.0508653	.0023845	.0007915	.0011058
535	.0057206	.0049038	.0049644	.0014040	.0007203	[illegible]
540	.0047599	.1049036	.0070137	.0012944	.0000480	[illegible]
550	.0000575	.0001904	.0000020	.0001966	.0000041	[illegible]
555	.0001595	.0006232	.0000751	.0000540	.0000606	[illegible]
558	.0012511	.0025937	.0000303	.0000346	.0000120	[illegible]
560	.0012199	.1026873	.0000306	.0000051	.0000149	[illegible]
562	.0011772	.0026336	.0000239	.0000244	.0000174	[illegible]
570	.0002557	.1002936	.0000034	.0000671	.0000314	[illegible]
575	.0001543	.0002369	.0000055	.0000455	.0000295	[illegible]
580	.0000000	.0000005	.0000002	.0000713	.0000245	[illegible]
581	.0029173	.1000005	.0025152	.0000902	.0000245	[illegible]
590	.0002027	.0004094	.0000003	.0000256	.0000028	[illegible]
600	.0024587	.1005129	.0000011	.0000117	.0000152	[illegible]
605	.0003353	.0005045	.0000336	.0000075	.0000119	[illegible]
615	.0001477	.1005030	.0000636	.0000274	.0000345	.0000413
617	.0000005	.0003636	.0000630	.0000091	.0000057	[illegible]
619	.0000035	.0003157	.0000547	.0000094	.0000065	[illegible]
620	.0000004	.0002968	.0000361	.0000103	.0000061	.0000345
622	.0000003	.1001124	.0000193	.0000072	.0000047	[illegible]
625	.0000219	.0002345	.0000362	.0000158	.0000046	[illegible]
630	.0000413	.0002520	.0000363	.0000150	.0000106	[illegible]
640	.0000474	.0005477	.0000906	.0000246	.0000043	[illegible]
645	.0000474	.0010386	.0002704	.0000272	.0000072	[illegible]
650	.0000874	.0016766	.0003960	.0000255	.0000073	[illegible]
660	.0003664	.1019955	.0004155	.0000265	.0000042	[illegible]
670	.0021402	.0019595	.0014055	.0000445	.0000276	.0000372
680	.0023314	.0021646	.0015942	.0000716	.0000343	[illegible]
685	.0017114	.1031998	.0000637	.0000692	.0000409	[illegible]
690	.0009216	.0034459	.0005629	.0000344	.0007613	.0001197
700	.0007411	.0033221	.0013734	.0000966	.0010673	.0001267
710	.0007410	.1033390	.0001035	.0001769	.0000827	[illegible]
720	.0005658	.0027549	.0000029	.0007084	.0000909	.0000373
730	.0000000	.0000001	.0000000	.0003191	.0000459	.0001041
731	.0049507	.0000001	.0103733	.0003407	.0000459	.0000570
740	.0004405	.0024478	.0000098	.0001422	.0000345	.0001149
745	.0010116	.1026896	.0000501	.0000091	.0000171	.0000410
750	.0006324	.0026904	.0001146	.0000246	.0000242	.0000922
950	.0000000	.1000000	.0000000	.0000000	.0000000	.0000001
960	.0000005	.0000000	.0000000	.0000000	.0000000	.0000030
970	.0000000	.1000000	.0000000	.0000000	.0000000	.0000001

TABLE B-1 (f)

J O I N T   D I S P L A C E M E N T S (LOAD CASE 10)

SSE SEISMIC (X+Y).

TOTAL RESPONSE EQUALS MODE 1 THROUGH 27 BY SOSS SUMMATION

JOINT GID	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
20	.0000000	.0000000	.0000000	.0000000	.0030000	.0000000
30	.0000047	.1000048	.0003431	.0000507	.0000419	.0030444
40	.0024935	.0007190	.0011050	.0000330	.0002405	.0000354
50	.0074707	.1008741	.0011063	.0000000	.0030300	.0000000
51	.0027995	.0008247	.0011533	.0000079	.0030000	.0000122
60	.0020805	.0019544	.0011079	.0000646	.0030539	.0001254
65	.0002802	.0030774	.0011085	.0001770	.0030934	.0002615
70	.0000034	.0074294	.0011086	.0002038	.0030973	.0002772
72	.0003135	.0038767	.0011065	.0002268	.0001134	.0002593
80	.0003239	.1048649	.0011334	.0002690	.0001340	.0003101
90	.0064218	.0150109	.0011072	.0010474	.0005234	.0007569
95	.0077423	.1159004	.0013314	.0013553	.0006952	.0008415
100	.0077427	.2140081	.0026943	.0014975	.0007308	.0008895
105	.0077431	.1122357	.0042921	.0016401	.0007629	.0009365
110	.0079310	.3101972	.0102913	.0019953	.0009140	.1011255
120	.0721105	.3101963	.1311255	.0032304	.0011577	.0015962
130	.1331008	.3101942	.2571775	.0031280	.0021321	.3015487
140	.1344790	.0050266	.2673937	.0029293	.0022744	.0014737
145	.1240174	.3021144	.2540473	.0027692	.0023650	.0014293
150	.0707224	.0197181	.1555368	.0020531	.0025858	.0011736
170	.0057460	.1302021	.0976665	.0011918	.0026101	.3008123
180	.0059793	.0297436	.0074520	.0011053	.0025538	.0007939
185	.0096275	.0162314	.0431766	.0007361	.0021776	.0007104
190	.0130904	.0072107	.0153377	.0004715	.0017146	.0006255
200	.0078126	.1032903	.0050290	.0002926	.0011297	.0004633
220	.0076400	.0032901	.0050425	.0002664	.0010933	.0004540
230	.0027427	.1012241	.0017949	.0001565	.0005289	.0002636
240	.0000000	.0000000	.0000000	.0000000	.0030000	.0000000
250	.0070023	.1017554	.0005534	.0002283	.0030924	.0002837
260	.0000000	.0000003	.0005000	.0003237	.0001010	.0003049
261	.0067764	.0000027	.0072019	.0003751	.0001010	.0003124
272	.0000013	.0016376	.0006592	.0002555	.0001218	.0002414
280	.0000011	.1025928	.0017512	.0002343	.0001293	.0002160
290	.0000382	.2051219	.0040817	.0001570	.0001296	.0001433
300	.0000131	.1025969	.0018337	.0002140	.0000935	.0002804
305	.0274775	.0051227	.0086733	.0000914	.0001835	.0001239
310	.0154721	.3051197	.0063763	.0001692	.0002730	.0001192
320	.0086230	.3041831	.0043420	.0001450	.0002941	.0001111
330	.0057423	.1025449	.0010004	.0001246	.0002803	.0001105
340	.0029953	.0014739	.0000015	.0001066	.0002599	.0001172
345	.0000007	.1003675	.0000000	.0000514	.0002111	.0001227
348	.0064941	.0001047	.0000051	.0000212	.0001849	.0001432
350	.0046690	.0005742	.0000083	.0000234	.0001669	.0001705
355	.0117351	.1002148	.0000147	.0000961	.0000990	.0002186
360	.0110431	.0067147	.0000199	.0002131	.0001133	.0002685
370	.0017374	.0175049	.0000289	.0002049	.0001645	.0003535
380	.0020525	.0152036	.0013916	.0001712	.0000814	.0003743
385	.0000483	.0063023	.0008519	.0000918	.0001220	.0003284
388	.0000495	.0007995	.0004570	.0000862	.0001427	.0002225
390	.0000483	.0017295	.0010266	.0000807	.0001650	.0003182
392	.0000469	.0026324	.0004874	.0000792	.0001567	.0002886
397	.0010257	.3073100	.3052914	.0000717	.0000634	.0000583

JOINT GID	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
398	.0072045	.0013587	.0021032	.0000916	.0302019	.2011570
400	.0010031	.3004941	.0014635	.0000936	.0001225	[illegible]
402	.0003995	.0004037	.0010945	.0000727	.0007170	[illegible]
410	.0002267	.1007633	.0012409	.0000649	.0002175	[illegible]
420	.0029371	.0002220	.0002926	.0000259	.0001843	[illegible]
430	.0000003	.1002130	.0000000	.0000143	.0001267	[illegible]
440	.0002976	.0002094	.0000460	.0000022	.0000932	[illegible]
445	.0002327	.0002015	.0000614	.0000072	[illegible]	[illegible]
450	.0002025	.0002009	.0000664	.0000070	[illegible]	[illegible]
460	.0000001	.1000103	.0000019	.0000009	[illegible]	[illegible]
465	.0000015	.0004503	.0007584	.0001022	.0002460	[illegible]
468	.0000000	.1001373	.0000000	.0001109	.0002445	[illegible]
470	.0000017	.0038950	.0017542	.0001281	.0003177	[illegible]
480	.0009115	.1037919	.0158237	.0004400	.0009193	[illegible]
490	.0004505	.0039439	.0193254	.0064953	.0006993	[illegible]
495	.0743529	.1001447	.0597338	.0010110	.0014200	[illegible]
500	.0461257	.0028437	.0978672	.0014840	.0012655	[illegible]
510	.0451724	.1034436	.0940571	.0015911	.0011127	[illegible]
520	.0247669	.0034430	.0563992	.0017381	.0007871	[illegible]
530	.0196033	.1034424	.0357093	.0016733	.0005074	[illegible]
535	.0047123	.0034409	.0062932	.0009559	.0002037	[illegible]
540	.0039324	.1034439	.0049233	.0009039	.0001067	[illegible]
550	.0000522	.0001335	.0000014	.0001379	.0000470	[illegible]
555	.0005931	.1014988	.0000259	.0000776	.0001955	[illegible]
558	.0136880	.0009736	.0000143	.0000036	.0002047	[illegible]
560	.0137736	.1009729	.0000135	.0000037	.0001051	[illegible]
562	.0136037	.0009490	.0000129	.0000116	.0001535	[illegible]
570	.0034251	.1001471	.0000039	.0000213	.0002294	[illegible]
575	.0022040	.0001446	.0000025	.0000120	.0007519	[illegible]
580	.0000000	.0000006	.2000000	.0000563	.0001233	[illegible]
581	.0384274	.1000006	.0020961	.0000660	.0001233	[illegible]
590	.0675997	.0028398	.0000003	.0001131	.0002567	[illegible]
600	.0256555	.1026299	.0000009	.0001237	.0001707	[illegible]
605	.0034715	.0030532	.0003795	.0000344	.0001591	[illegible]
615	.0019075	.0030645	.0007243	.0000711	.0001274	[illegible]
617	.0000019	.3013080	.0005702	.0000497	.0010100	[illegible]
618	.0000017	.0015068	.0004719	.0000434	.0010739	[illegible]
620	.0000015	.0058951	.0002720	.0000322	.0010632	[illegible]
622	.0000012	.1004395	.0001267	.0000225	.0000345	[illegible]
625	.0000013	.0028074	.0002713	.0000333	.0000707	[illegible]
630	.0003541	.0007499	.0002703	.0000706	.0000754	.0002743
640	.0005141	.0017301	.0005463	.0000174	.0001274	[illegible]
645	.0006154	.0039304	.0010921	.0000207	.0001101	[illegible]
650	.0006170	.3049234	.0010914	.0000313	.0001533	[illegible]
660	.0012285	.1046473	.0023743	.0000244	.0002743	[illegible]
670	.0150749	.0056573	.0024554	.0000545	.0004139	[illegible]
680	.0157239	.0090098	.0027247	.0001519	.0014501	[illegible]
685	.0039639	.1123731	.0027227	.0002454	.0005223	[illegible]
690	.0020163	.0161512	.0027170	.0002663	.0001447	[illegible]
700	.0073125	.0110177	.0016047	.0002117	.0001709	[illegible]
710	.0059095	.1048101	.0006471	.0002072	.0001275	[illegible]
720	.0005277	.0014055	.0000029	.0001455	.0001103	[illegible]
730	.0000000	.1000001	.0000006	.0001214	.0001002	[illegible]
731	.0470236	.0000021	.0028545	.0001253	.0001102	[illegible]
740	.0018110	.0008927	.0000035	.0000496	.0001541	.0716774
745	.0103429	.3009735	.0000171	.0000029	.0002625	[illegible]
750	.0026543	.1039746	.0000377	.0000317	.0001744	.3014157
950	.0000000	.0000000	.0000000	.0000000	.0001000	.0000000
960	.0000002	.1000000	.0000003	.0000020	.0001000	.0000000
970	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000

TABLE B-1 (g)

J O I N T   D I S P L A C E M E N T S   (LOAD CASE 11)

SSF SEISMIC (Y+Z)

TOTAL RESPONSE EQUALS MODE 1 THROUGH 27 BY SOSS SUMMATION

JOINT GID	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
20	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
30	.0024932	.0000063	.0004346	.0000646	.0000344	.0000691
40	.0020344	.0009325	.0014149	.0000429	.0000332	.0000293
50	.0021469	.0010678	.0014165	.0000000	.0000000	.0000000
51	.0022591	.0010640	.0014641	.0000050	.0000000	.0000093
60	.0014939	.0013060	.0014191	.0000639	.0000421	.0002264
65	.0023969	.0044292	.0014205	.0003715	.0001243	.0004720
70	.0000053	.0055457	.0014210	.0004266	.0001455	.0005001
72	.0005069	.1064715	.0014203	.0004965	.0001573	.0005433
80	.0016185	.0095858	.0014191	.0006149	.0002555	.0006155
90	.0144166	.0364896	.0014107	.0026419	.0012345	.0018326
95	.0175955	.1389197	.0027144	.0034333	.0015676	.0020379
100	.0175004	.0342961	.0064126	.0037973	.0017569	.0021596
105	.0176012	.0294214	.0103819	.0041614	.0019350	.0022785
110	.0234170	.0239050	.0255650	.0050556	.0022232	.0027570
120	.1756900	.1230980	.3332583	.0052156	.0037989	.0040107
130	.3342922	.0238907	.6542714	.0079428	.0051978	.0038797
140	.3301652	.3115595	.5803753	.0074244	.0055427	.0039919
145	.3174105	.0001175	.6464087	.0070093	.0057914	.0035552
150	.1517556	.1392250	.4776349	.0051115	.0067512	.0029470
170	.0073917	.0532458	.2421202	.0025902	.0056238	.0019445
180	.0097982	.1560047	.2158692	.0026724	.0064632	.0010443
185	.0144395	.0274189	.1035006	.0017368	.0054242	.0014197
190	.0194526	.1111099	.0334474	.0010263	.0042076	.0010154
200	.0159335	.0049850	.0099259	.0004780	.0027314	.0006447
220	.0151995	.1049649	.0096753	.0004627	.0026401	.0005259
230	.0045422	.0017787	.0040369	.0001940	.0012323	.0003540
240	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
250	.0000075	.0026190	.0006386	.0003967	.0001205	.0004730
260	.0000000	.1000003	.0000000	.0003509	.0001257	.0003951
261	.0085130	.0000003	.0076425	.0003550	.0001257	.0003972
270	.0000012	.1020597	.0024572	.0002607	.0001603	.0002974
280	.0000016	.0035936	.0017774	.0002270	.0001738	.0002646
290	.0029739	.1054181	.0054279	.0001497	.0002026	.0001977
300	.0000047	.0046818	.0010359	.0004111	.0001298	.0004879
305	.0111551	.1064126	.0101099	.0001938	.0002934	.0001524
310	.0167480	.0054058	.0107910	.0000961	.0004190	.0001124
320	.0150739	.1050905	.0067711	.0000936	.0004499	.0001399
330	.0040072	.0026540	.0015957	.0001012	.0004420	.0001563
340	.0050471	.1013799	.0000016	.0000937	.0004200	.0001573
345	.0000000	.0017679	.0000000	.0000565	.0003694	.0001569
348	.0039245	.0000938	.0000038	.0000178	.0002293	.0001539
350	.0122571	.0024935	.0000062	.0000199	.0001366	.0001736
355	.0135269	.1021959	.0000127	.0000326	.0010785	.0002000
360	.0125129	.0044112	.0000149	.0001729	.0001556	.0002319
370	.0013245	.1135712	.0000215	.0001354	.0001349	.0002914
380	.0000193	.0112995	.0009972	.0001057	.0002515	.0003041
385	.0000139	.1002857	.0004495	.0000916	.0000692	.0001937
388	.0000135	.1025187	.0002309	.0000941	.0000787	.0001777
390	.0000132	.0009969	.0000638	.0000969	.0000394	.0001616
392	.0000128	.0014551	.0003312	.0000972	.0001071	.0001493
397	.0000073	.0043464	.0072394	.0001364	.0001155	.0000268

JOINT GID	DISPLACEMENTS (IN.) X	DISPLACEMENTS (IN.) Y	DISPLACEMENTS (IN.) Z	ROTATIONS (RADIANS) X	ROTATIONS (RADIANS) Y	ROTATIONS (RADIANS) Z
398	.0000012	.1009861	.0037273	.0002076	[illegible]	[illegible]
400	.0000003	.0005537	.0026361	.0002129	[illegible]	[illegible]
402	.0006975	.1005494	.0019953	.0001672	[illegible]	[illegible]
410	.0003944	.0005405	.0022305	.0001494	[illegible]	[illegible]
420	.0015571	.0002716	.0005109	.0001002	[illegible]	[illegible]
430	.0000000	.1002209	.0000002	.0000290	.0002213	[illegible]
440	.0001915	.0002137	.0001714	.0000022	.0001426	[illegible]
445	.0001913	.0002027	.0000543	.0000152	[illegible]	[illegible]
450	.0001744	.0002020	.0000725	.0000149	.0010534	[illegible]
460	.0000001	.1000122	.0000029	.0000017	[illegible]	[illegible]
465	.0000004	.0002637	.0013911	.0002322	.0004392	[illegible]
468	.0000000	.0003032	.0000000	.0002517	[illegible]	[illegible]
470	.0000004	.0210145	.0032644	.0002907	[illegible]	[illegible]
480	.0000070	.0065307	.0335647	.0009998	[illegible]	[illegible]
490	.0071522	.0059943	.0415925	.0011250	[illegible]	[illegible]
495	.0550950	.1000985	.1366594	.0023100	[illegible]	[illegible]
500	.1061596	.0059918	.2255227	.0033475	.0024914	[illegible]
510	.1036691	.1079395	.2163037	.0038769	.0026100	[illegible]
520	.0633958	.0079367	.1299226	.0040091	.0017155	[illegible]
530	.0417317	.1079351	.0822545	.0038555	.0012759	[illegible]
535	.0092553	.0079314	.0144994	.0022707	[illegible]	[illegible]
540	.0077011	.0079311	.0113435	.0020935	.0014657	[illegible]
550	.0002930	.0003080	.0000032	.0003176	[illegible]	[illegible]
555	.0072606	.1010499	.0000503	.0000989	[illegible]	[illegible]
559	.0019994	.0047066	.0000536	.0000079	[illegible]	[illegible]
560	.0019459	.0046955	.0000533	.0000141	.0010247	[illegible]
562	.0014749	.0046102	.0000501	.0000425	.0000247	[illegible]
570	.0004047	.1006078	.0000145	.0000173	[illegible]	[illegible]
575	.0002596	.0054142	.0000097	.0000847	[illegible]	[illegible]
580	.0000000	.1000008	.0000000	.0001747	[illegible]	[illegible]
581	.0046951	.0000008	.0045747	.0001579	[illegible]	[illegible]
590	.0003255	.1007146	.0000006	.0000443	[illegible]	[illegible]
600	.0007434	.1008957	.0000019	.0000193	.0010250	[illegible]
605	.0005499	.1008669	.0000552	.0000124	[illegible]	[illegible]
615	.0002455	.1008657	.0001345	.0000123	.0010163	[illegible]
617	.0000003	.1006253	.0001050	.0000157	.0010109	[illegible]
618	.0000009	.0005450	.0000925	.0000163	.0010107	[illegible]
620	.0000007	.1003595	.0000614	.0000179	.0010103	[illegible]
622	.0000005	.2001918	.0000371	.0000125	[illegible]	[illegible]
625	.0000369	.0004077	.0000517	.0000276	[illegible]	[illegible]
630	.0000659	.0004563	.0000619	.0000314	.0010181	[illegible]
640	.0001495	.1009529	.0001557	.0000500	[illegible]	[illegible]
645	.0001494	.0019031	.0003911	.0000475	.0010472	[illegible]
650	.0001494	.1029073	.0005679	.0000447	.0010470	[illegible]
660	.0026371	.0034577	.0007161	.0000444	.0000469	[illegible]
670	.0076571	.0034629	.0007959	.0000777	.0010434	[illegible]
680	.0019797	.0037526	.0009755	.0001748	[illegible]	[illegible]
685	.0029516	.1055359	.0009745	.0001029	[illegible]	[illegible]
690	.0015033	.0050399	.0009732	.0000585	[illegible]	[illegible]
700	.0017910	.1057766	.0008469	.0001996	.0001091	[illegible]
710	.0017924	.0059274	.0003184	.0002213	[illegible]	[illegible]
720	.0009959	.0050057	.0000014	.0003641	[illegible]	[illegible]
730	.0000000	.1000001	.0000000	.0005974	.0000756	[illegible]
731	.0072345	.0000091	.0181260	.0009953	.0000741	[illegible]
740	.0027616	.0042769	.0000172	.0002494	.0000984	[illegible]
745	.0016324	.0046973	.0000974	.0000142	.0000287	[illegible]
750	.0010716	.1047509	.0002005	.0000031	.0000411	[illegible]
950	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
960	.0000000	.1000000	.0000000	.0000000	.0000000	.0000000
970	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000

TABLE B-11 (a)

E L A S T I C   S U P P O R T   R E A C T I O N S   (LOAD CASE 3)

DEAD LOAD

SUPPORT JOINT	FORCE (LB.) X	FORCE (LB.) Y	FORCE (LB.) Z	MOMENT (IN-LB.) X	MOMENT (IN-LB.) Y	MOMENT (IN-LB.) Z
20	25.036	364.924	109.710	-121.400	-104.646	415.896
50	0.000	0.000	0.000	3484.668	-695.160	-9.000
145	0.000	86.398	0.000	0.000	0.000	0.000
240	-1.547	44.620	-.043	-585.910	47.757	-868.011
260	-8.710	460.050	-115.688	0.000	0.000	0.000
345	-17.199	97.151	10.457	0.000	0.000	0.000
348	0.000	-27.372	0.000	0.000	0.000	0.000
355	0.000	117.152	0.000	0.000	0.000	0.000
385	0.000	151.419	0.000	0.000	0.000	0.000
430	17.665	0.000	4.880	0.000	0.000	0.000
468	-12.913	82.861	-8.434	0.000	0.000	0.000
495	0.000	28.4[illegible]	0.000	0.000	0.000	0.000
575	0.000	-4.198	0.000	0.000	0.000	0.000
580	-5.959	328.359	52.060	0.000	0.000	0.000
730	19.379	353.534	-57.336	0.000	0.000	0.000
950	-12.123	158.335	-.746	-7.633	-4.805	-1010.147
960	2.291	187.545	2.582	-1582.393	56.815	-88.369
970	-5.920	64.279	2.558	-81.755	-139.362	-1125.066

TABLE B-11 (b)

ELASTIC SUPPORT REACTIONS (LOAD CASE 4)

SEISMIC ANCHOR MOVEMENTS - X AND Z (NODE 240) OBE

SUPPORT	FORCE (LB.)			MOMENT (IN-LB.)		
JOINT	X	Y	Z	X	Y	Z
20	6.5257	-33.5644	-30.8358	339.1786	-27.2763	108.4049
50	0.0000	0.0000	0.0000	-883.3631	-181.2601	-182.8113
145	0.0008	-12.2452	0.0000	0.0000	0.0000	0.0000
240	20.9915	-11.0890	13.6953	272.7224	730.1319	172.1798
260	-26.3573	54.4503	17.6553	0.0000	0.0000	0.0000
345	-1.4461	5.2041	-.1792	0.0000	0.0000	0.0000
348	0.0000	-2.9037	0.0000	0.0000	0.0000	0.0000
355	0.0000	.1845	0.0000	0.0000	0.0000	0.0000
385	0.0000	-.0238	0.0000	0.0000	0.0000	0.0000
430	.0189	0.0000	.0030	0.0000	0.0000	0.0000
468	.2229	.0042	.0206	0.0000	0.0000	0.0000
495	0.0000	.0066	0.0000	0.0000	0.0000	0.0000
575	0.0000	.0149	0.0000	0.0000	0.0000	0.0000
580	.0033	-.0130	-.3334	0.0000	0.0000	0.0000
730	.0577	.0100	-.0296	0.0000	0.0000	0.0000
950	-.0016	-.0367	-.0005	-.0057	.0378	.2877
960	.0000	-.0018	-.0014	-.0491	-.0092	-.0002
970	-.0150	.0031	.0058	.0173	.0388	.1159

TABLE B-11 (c)

ELASTIC SUPPORT REACTIONS (LOAD CASE 5)

THERMAL ANCHOR MOVEMENTS

SUPPORT JOINT	FORCE (LB.) X	FORCE (LB.) Y	FORCE (LB.) Z	MOMENT (IN-LB.) X	MOMENT (IN-LB.) Y	MOMENT (IN-LB.) Z
20	-9.409	-36.374	1.292	-191.655	39.330	-156.309
50	0.000	0.000	0.000	-717.347	261.423	544.365
145	0.000	-142.590	0.000	0.000	0.000	0.000
240	-23.313	45.967	-11.378	111.000	-444.797	-2512.800
260	25.973	150.060	16.448	0.000	0.000	0.000
345	7.519	-29.263	-7.275	0.000	0.000	0.000
348	0.000	12.852	0.000	0.000	0.000	0.000
355	0.000	-.889	0.000	0.000	0.000	0.000
385	0.000	.131	0.000	0.000	0.000	0.000
430	-.111	0.000	-.017	0.000	0.000	0.000
468	-.506	-.020	-.049	0.000	0.000	0.000
495	0.000	-.057	0.000	0.000	0.000	0.000
575	0.000	-.045	0.000	0.000	0.000	0.000
580	.055	.004	.645	0.000	0.000	0.000
730	-.247	-.065	.151	0.000	0.000	0.000
950	.003	.260	.003	.030	-.054	-1.945
960	-.002	.019	.003	-.073	.022	.015
970	.038	.009	-.022	-.205	.161	.371

TABLE B-11 (d)

ELASTIC SUPPORT REACTIONS (LOAD CASE 6)

OBE SEISMIC - X+Y

TOTAL RESPONSE EQUALS MODE 1 THROUGH 27 BY SQSS SUMMATION

SUPPORT JOINT	FORCE (LB.) X	FORCE (LB.) Y	FORCE (LB.) Z	MOMENT (IN-LB.) X	MOMENT (IN-LB.) Y	MOMENT (IN-LB.) Z
20	16.925	11.550	7.789	153.8	69.5	279.2
50	0.000	0.000	0.000	293.1	191.8	256.0
145	0.000	7.479	0.000	0.0	0.0	0.0
240	7.203	4.467	7.193	111.7	399.7	181.2
260	19.334	15.678	20.989	0.0	0.0	0.0
345	13.291	11.560	9.322	0.0	0.0	0.0
348	0.000	7.971	0.000	0.0	0.0	0.0
355	0.000	9.278	0.000	0.0	0.0	0.0
385	0.000	9.132	0.000	0.0	0.0	0.0
430	2.456	0.000	1.577	0.0	0.0	0.0
468	23.622	4.519	10.921	0.0	0.0	0.0
495	0.000	3.889	0.000	0.0	0.0	0.0
575	0.000	25.678	0.000	0.0	0.0	0.0
580	21.531	42.449	11.552	0.0	0.0	0.0
730	91.047	9.533	18.014	0.0	0.0	0.0
950	.854	7.747	.291	2.9	13.1	53.9
960	11.788	3.010	13.495	493.8	173.7	246.5
970	5.677	7.463	6.790	90.7	186.2	651.5

TABLE B-11 (e)

E L A S T I C   S U P P O R T   R E A C T I O N S   (LOAD CASE 7)

OBE SEISMIC - Y+Z

TOTAL RESPONSE EQUALS MODE 1 THROUGH 27 BY SOSS SUMMATION

SUPPORT	FORCE (LB.)			MOMENT (IN-LB.)		
JOINT	X	Y	Z	X	Y	Z
20	14.260	16.582	9.515	198.	59.	236.
50	0.000	0.000	0.000	373.	238.	284.
145	0.000	8.165	0.000	0.	0.	0.
240	7.895	4.890	13.792	141.	929.	262.
260	15.511	20.652	23.697	0.	0.	0.
345	8.651	12.701	5.732	0.	0.	0.
348	0.000	7.333	0.000	0.	0.	0.
355	0.000	8.116	0.000	0.	0.	0.
385	0.000	6.555	0.000	0.	0.	0.
430	2.423	0.000	3.319	0.	0.	0.
468	5.717	9.971	18.398	0.	0.	0.
495	0.000	2.573	0.000	0.	0.	0.
575	0.000	63.262	0.000	0.	0.	0.
580	5.321	46.160	41.625	0.	0.	0.
730	7.255	8.525	58.847	0.	0.	0.
950	1.461	10.087	.600	6.	21.	60.
960	14.462	4.761	30.913	1138.	326.	486.
970	2.628	16.368	3.560	43.	46.	264.

TABLE B-11 (f)

ELASTIC SUPPORT REACTIONS (LOAD CASE 10)

SSE SEISMIC (X+Y).

TOTAL RESPONSE EQUA[illegible] MODE 1 THROUGH 27 BY SQSS SUMMATION

SUPPORT	FORCE (LB.)			MOMENT (IN-LB.)		
JOINT	X	Y	Z	X	Y	Z
20	29.53	19.35	13.43	262.4	121.3	487.2
50	0.00	0.00	0.00	494.5	327.7	440.2
145	0.00	12.24	0.00	0.0	0.0	0.0
240	12.44	7.09	11.77	183.4	614.6	286.8
260	33.62	26.29	36.11	0.0	0.0	0.0
345	23.16	19.62	15.45	0.0	0.0	0.0
348	0.00	12.88	0.00	0.0	0.0	0.0
355	0.00	14.33	0.00	0.0	0.0	0.0
385	0.00	14.87	0.00	0.0	0.0	0.0
430	3.84	0.00	2.54	0.0	0.0	0.0
468	36.06	7.32	18.13	0.0	0.0	0.0
495	0.00	6.62	0.00	0.0	0.0	0.0
575	0.00	38.60	0.00	0.0	0.0	0.0
580	36.05	52.72	19.06	0.0	0.0	0.0
730	133.05	13.95	26.79	0.0	0.0	0.0
950	1.44	12.20	.47	4.7	21.4	85.4
960	20.21	5.10	21.86	797.8	288.6	407.1
970	9.54	11.07	9.99	135.2	274.7	956.7

TABLE B-11 (g)

ELASTIC SUPPORT REACTIONS (LOAD CASE 11)

SSE SEISMIC (Y+Z)

TOTAL RESPONSE EQUALS MODE 1 THROUGH 27 BY SOSS SUMMATION

SUPPORT	FORCE (LB.)			MOMENT (IN-LB.)		
JOINT	X	Y	Z	X	Y	Z
20	24.14	25.29	16.49	331.	99.	399.
50	0.00	0.00	0.00	578.	376.	455.
145	0.00	12.58	0.00	0.	0.	0.
240	12.91	7.55	20.70	218.	1375.	396.
260	25.05	31.88	38.43	0.	0.	0.
345	15.25	19.64	9.49	0.	0.	0.
348	0.00	11.52	0.00	0.	0.	0.
355	0.00	13.07	0.00	0.	0.	0.
385	0.00	10.89	0.00	0.	0.	0.
430	3.94	0.00	5.38	0.	0.	0.
468	11.44	16.16	29.79	0.	0.	0.
495	0.00	4.38	0.00	0.	0.	0.
575	0.00	110.60	0.00	0.	0.	0.
580	9.03	80.65	72.55	0.	0.	0.
730	11.05	14.89	102.82	0.	0.	0.
950	2.39	16.35	.97	0.	0.	0.
960	23.50	7.82	50.09	10.	33.	97.
970	4.58	28.63	6.21	1840.	527.	786.
				75.	80.	460.

APPENDIX C

LACBWR HPCS DISCHARGE NOZZLE WELD ANSYS ANALYSIS INPUT DATA

TABLE C-1

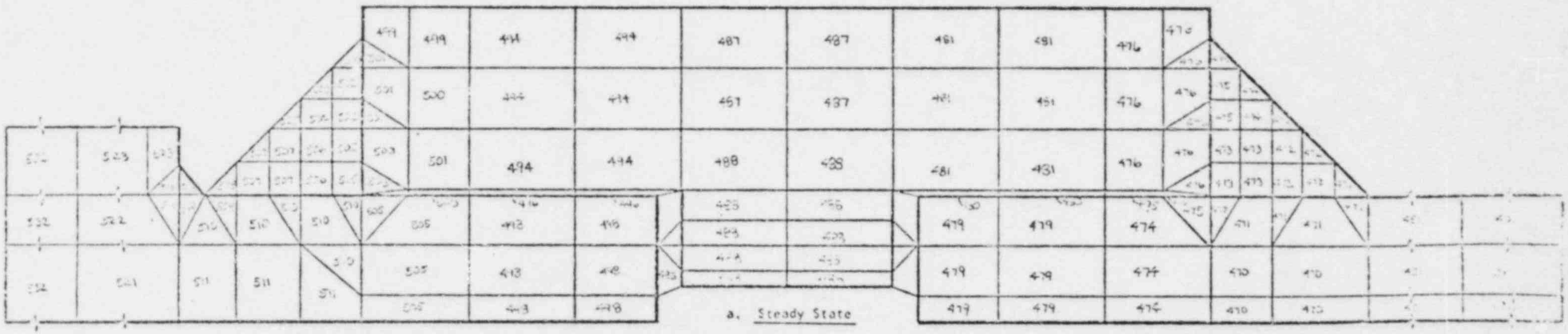
ANSYS MODEL ELEMENT PROPERTIES

HPCS DISCHARGE SOCKET WELD

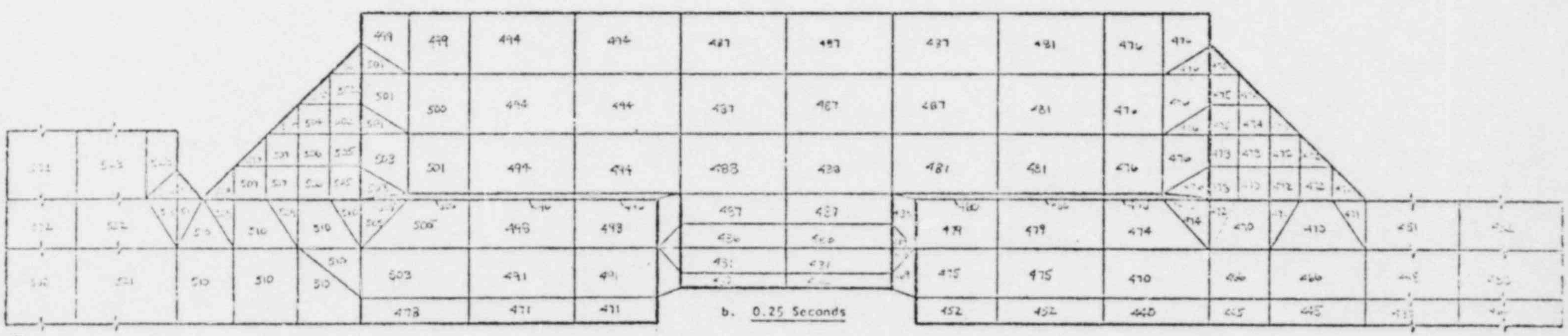
ELEMENT NUMBERS	MATERIAL	PROPERTY	TEMPERATURE, °F 70	100	200	300	400	500
1-31 33-41 43-48 50-55 57-59 64-77 86-88 93-95 100-102 105-110	STAINLESS STEEL SA376, SA312 TP304H	Elastic Modulus E, 10^6 Psi	← 27.0 →					
		Design Stress Intentity S_m, ksi	20.0	20.0	20.0	20.0	18.7	17.4
		Mean Coeff. Of Thermal Expansion, α, 10^{-6} $°F^{-1}$	9.11	9.16	9.34	9.47	9.59	9.70
		Poisson's Ratio ν	← 0.30 →					
82-84 89-91 96-98 103 111-146	INCONEL 600 SB 166	E, 10^6 Psi	← 30.0 →					
		S_m, ksi	← 23.3 →					
		α, 10^{-6}, $°F^{-1}$	7.13	7.20	7.40	7.56	7.70	7.8
		ν	← 0.30 →					
42, 49, 56 60-63 78-81 85, 92, 99, 104	DUMMY GAP	E, 10^{-6} Psi	← 0.10 →					
		α, 10^{-6} $°F^{-1}$	← 0.10 →					
		ν	← 0.30 →					

FIGURE C-1

ANSYS THERMAL TRANSIENT LOADING



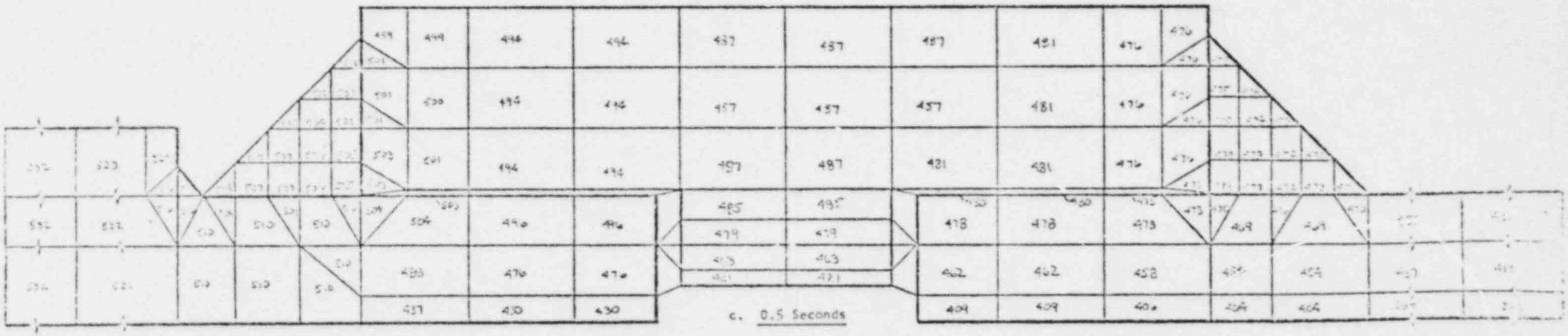
a. Steady State



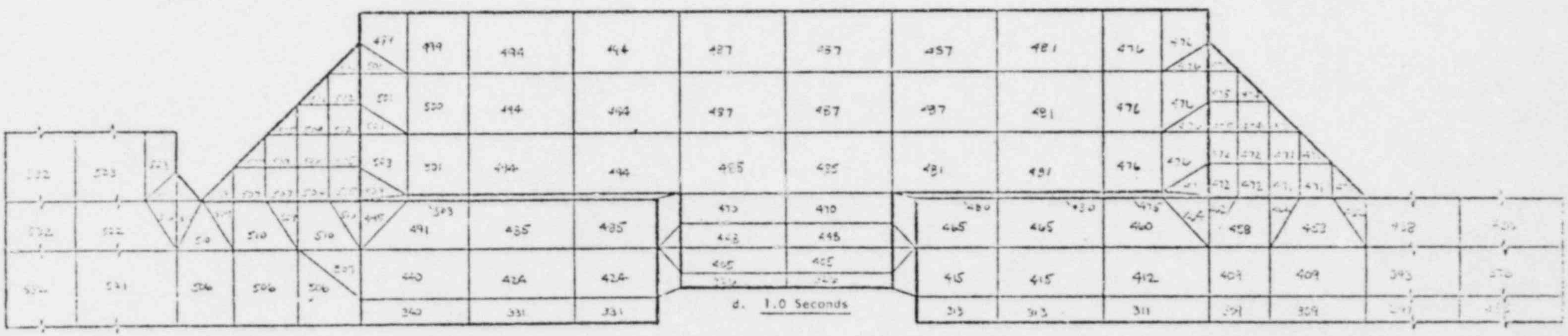
b. 0.25 Seconds

FIGURE C-1 (cont'd)

ANSYS THERMAL TRANSIENT LOADING



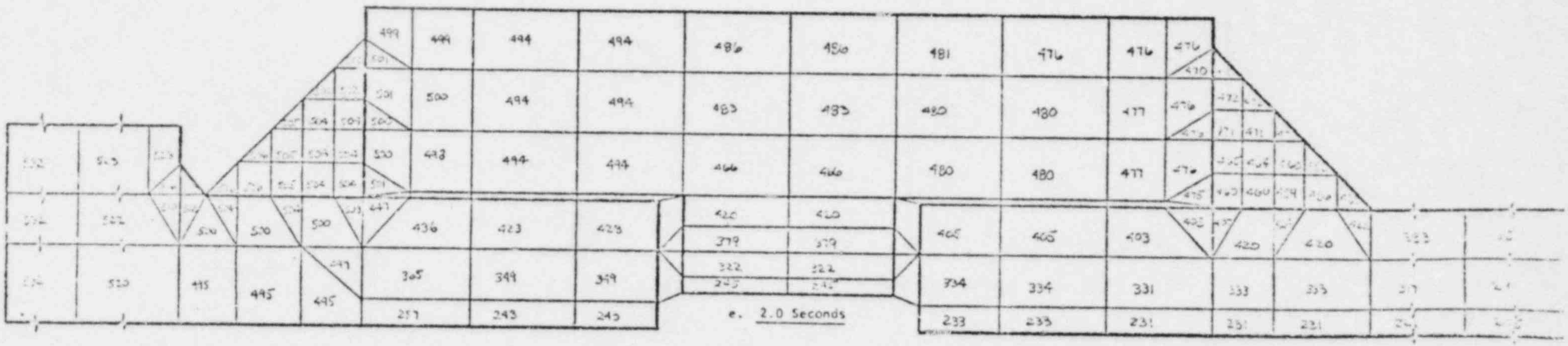
c. 0.5 Seconds



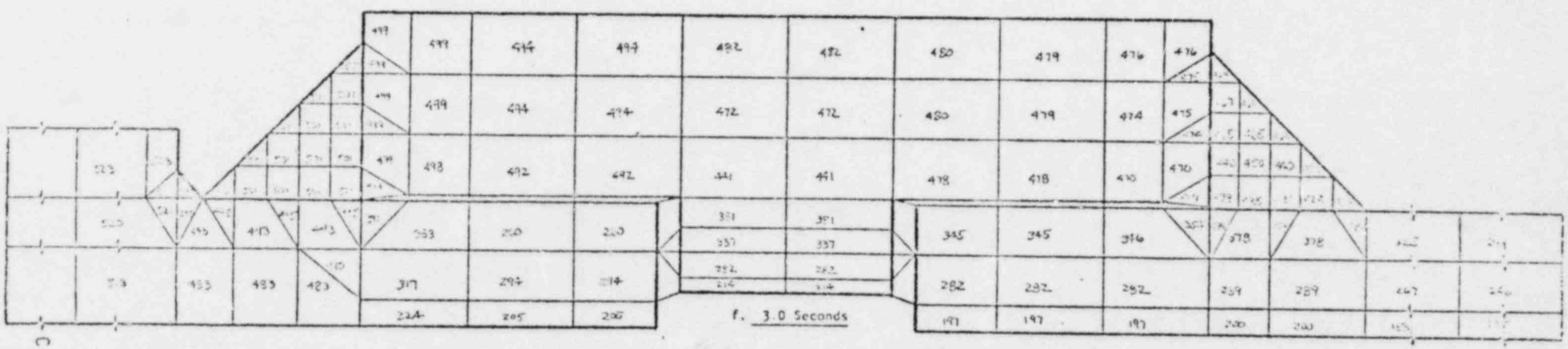
d. 1.0 Seconds

FIGURE C-1 (cont'd)

ANSYS THERMAL TRANSIENT LOADING



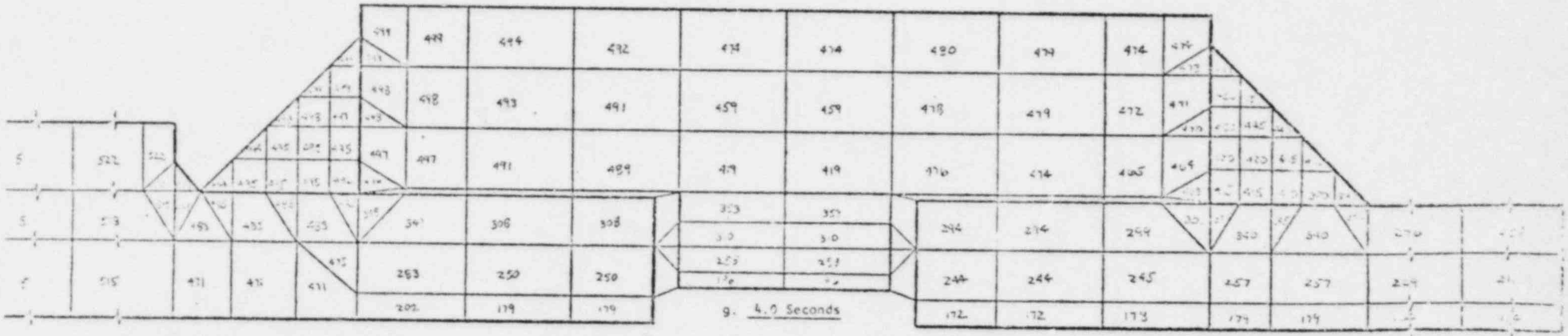
e. 2.0 Seconds



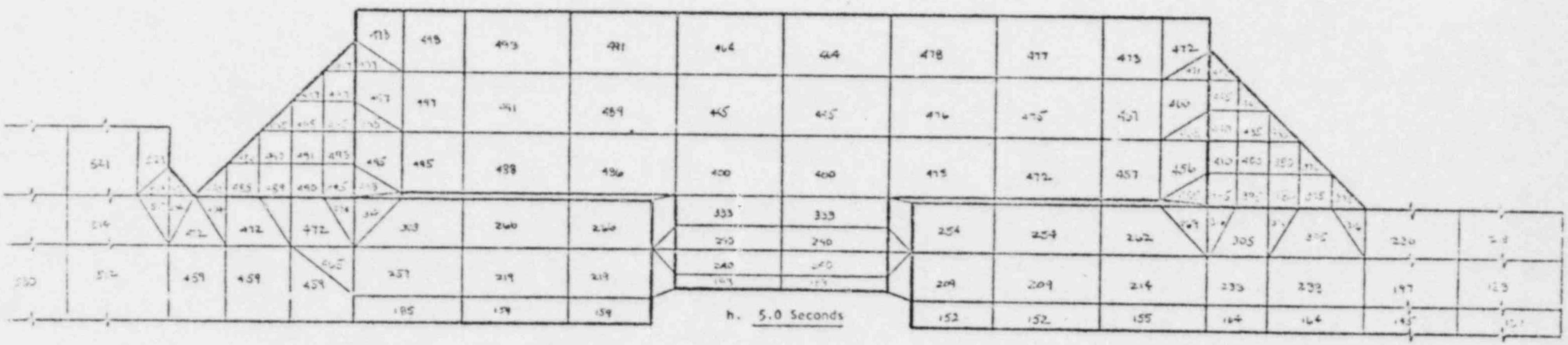
f. 3.0 Seconds

FIGURE C-1 (cont'd)

ANSYS THERMAL TRANSIENT LOADING



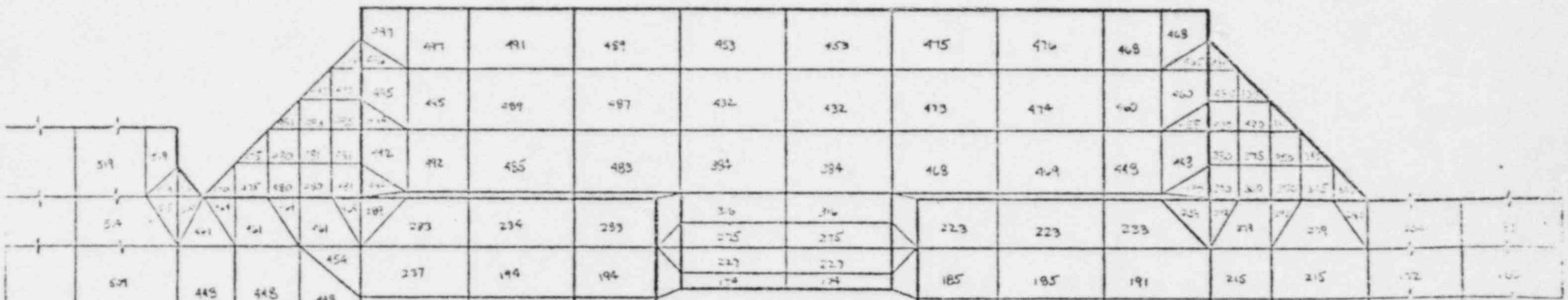
g. 4.0 Seconds



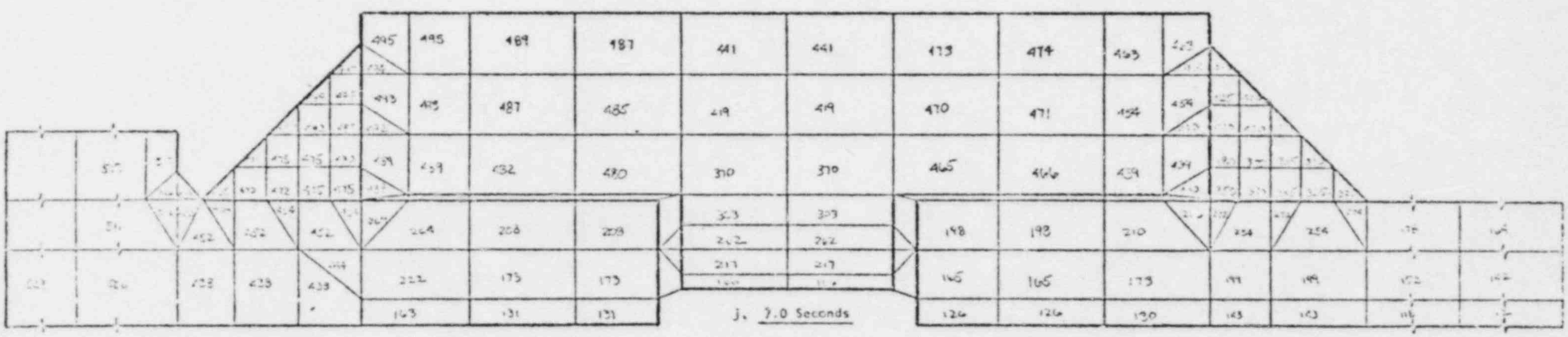
h. 5.0 Seconds

FIGURE C-1 (cont'd)

ANSYS THERMAL TRANSIENT LOADING



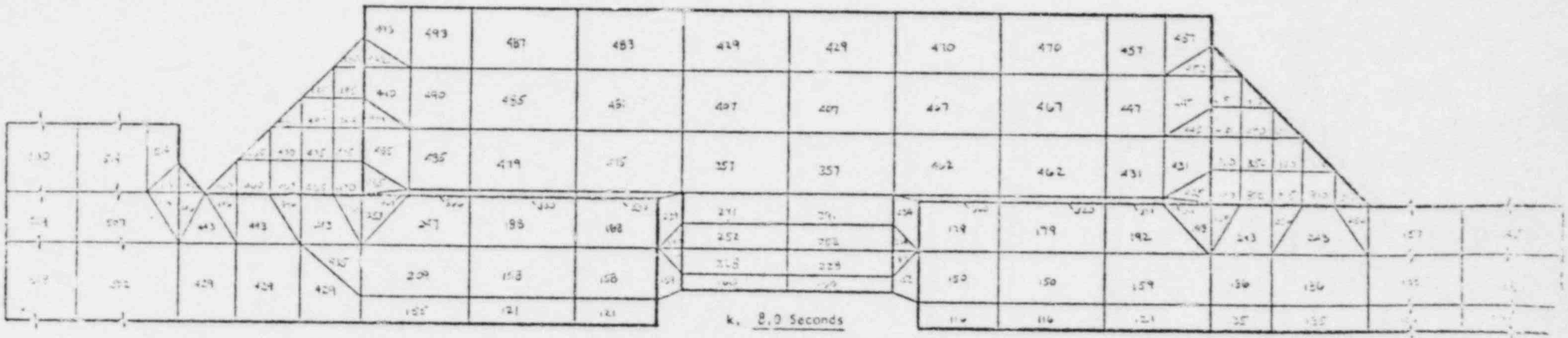
i. 6.0 Seconds



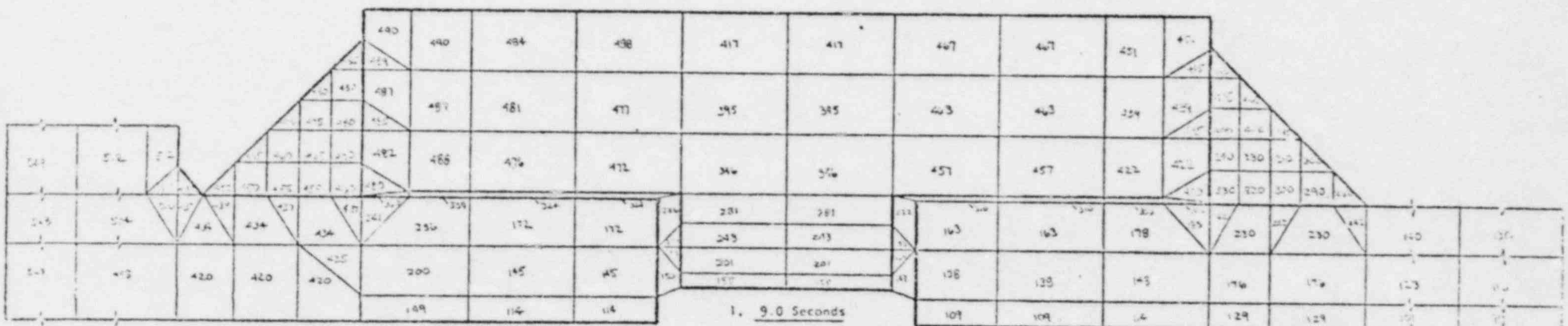
j. 7.0 Seconds

FIGURE C-. (cont'd)

ANSYS THERMAL TRANSIENT LOADING



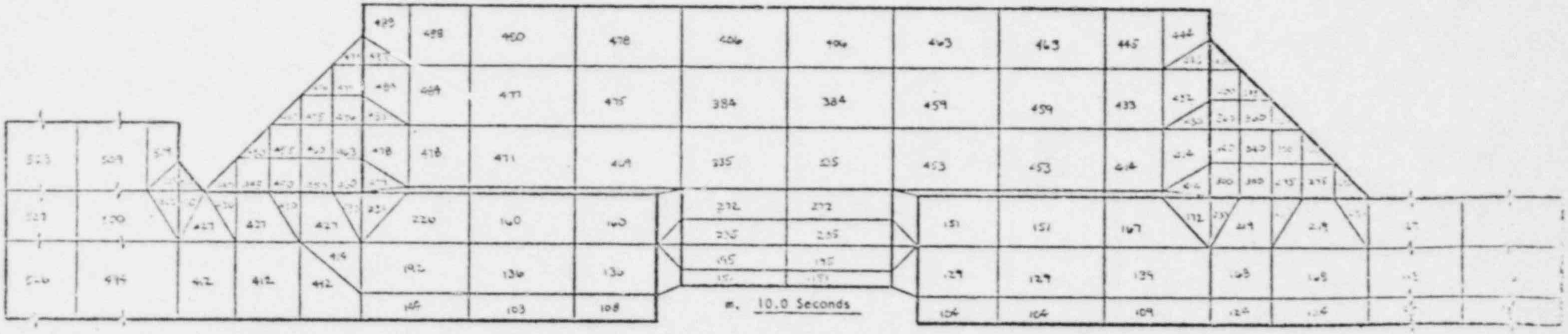
k, 8.0 Seconds



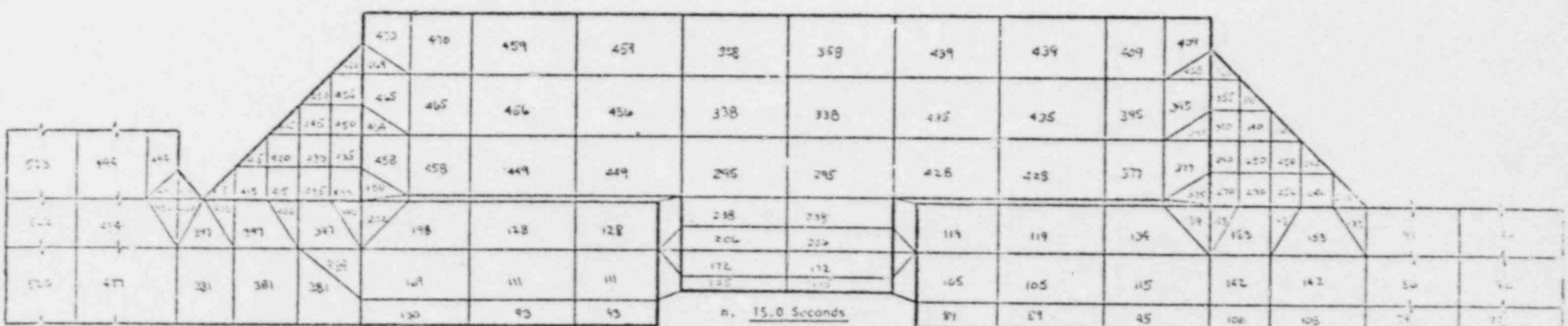
l, 9.0 Seconds

FIGURE (cont'd)

ANSYS THERMAL TRANSIENT LOADING



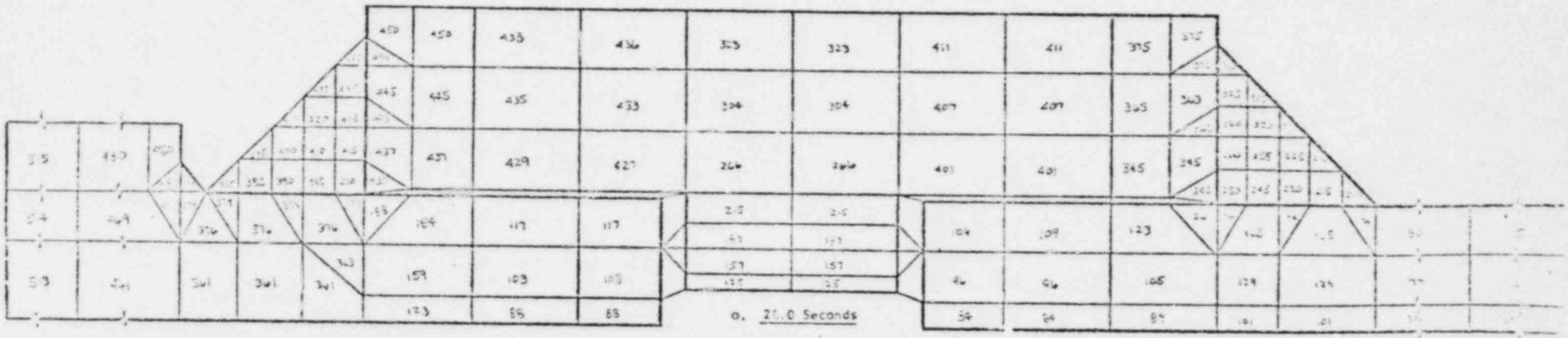
m. 10.0 Seconds



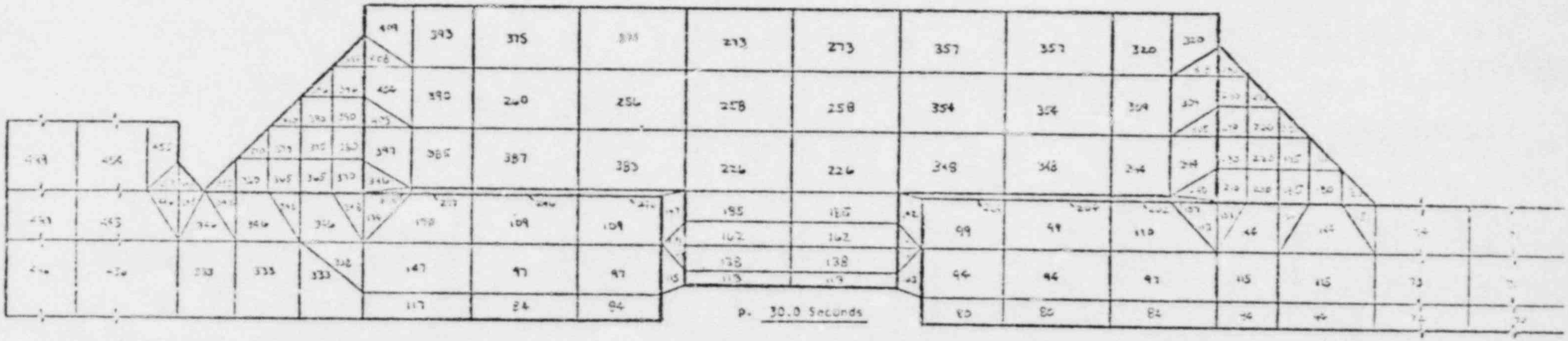
n. 15.0 Seconds

FIGURE . (cont'd)

ANSYS THERMAL TRANSIENT LOADING



o. 20.0 Seconds



p. 30.0 Seconds

APPENDIX D

ASME CODE CALCULATIONS AT HPCS DISCHARGE NOZZLE

(Refer to Code Calculations for Node 240, PIPESD Piping Analysis NES Binder S-03)

Consideration of Design Conditions

The primary stress intensity limit is satisfied if the requirement of Equation 9 is met.

$$B_1 \frac{PD_o}{2t} + B_2 \frac{D_o}{2I} \quad M_i \leq \quad 1.5S_m \qquad (9)$$

where:

B_1, B_2 = primary stress indices for the specific product under investigation.

P = design pressure, psi

D_o = outside diameter of pipe, in.

t = nominal wall thickness of product, in.

S_m = allowable design stress intensity value, psi

I = moment of inertia, in^4

M_i = resultant moment loading due to loads caused by (1) weight, (2) earthquake, considering only one-half the range of the earthquake and excluding the effects of anchor displacement due to earthquake, and (3) other sustained design mechanical loads.

From computer output S-03

For x + y Earthquake Equation 9 is satisfied as

$$4.99 + 4.87 \leq 1.5 \times 20 \qquad (9)$$

$$\text{or} \quad 9.5 \quad \leq 30.0 \text{ ksi}$$

For y + z Earthquake Equation 9 is satisfied as

$$4.99 + 6.08 \leq 1.5 \times 20 \qquad (9)$$

$$11.07 \leq 30.0 \text{ ksi}$$

Consideration of Normal Conditions

Satisfaction of Primary Plus Secondary Stress Intensity Range

Primary plus secondary stress intensity range is calculated using Equation (10)

$$S_n = C_1 \frac{P_o D_o}{2t} + C_2 \frac{D_o}{2I} M_i + \qquad (10)$$

$$\frac{1}{2(1-v)} E\alpha \left|\Delta T_1\right| + C_3 E_{ab} \left|\alpha_a T_a - \alpha_b T_b\right| \leq 3S_m$$

(Refer to ASME Code for nomanclature)

Since thermal stress components of equation (10) are not evaluated in the detail transient ANSYS stress analyses, they will be conservatively estimated from the equation (11) stress analysis results.

From Computer Output S-03

$$K_1 C_1 \frac{P_o D_o}{2t} = 38.19 \text{ ksi}$$

$$K_2 C_2 \frac{D_o}{2I} M_i = 27.24 \text{ ksi for x + y Earthquake}$$

$$= 29.99 \text{ ksi for z + y Earthquake}$$

From detail transient ANSYS stress analysis for thermal loadings: the maximum peak stress intensity due to structural and material discontinuity and linear and non-linear temperature gradient is:

$$\frac{1}{2(1-v)} K_3 E\alpha \left|\Delta T_1\right| + K_3 C_3 E_{ab} \left|\alpha_a T_{aa} - \alpha_b T_b\right| +$$

$$\frac{1}{1-v} E\alpha \left|\Delta T_2\right| = 93.5 \text{ ksi in ANSYS Model Element No. 39}$$

For Socket Weld fitting, stress indices K_1, K_2 and K_3 are

$$K_1 = 3.0; K_2 = 2.0; K_3 = 3.0$$

$$C_1 \frac{P_o D_o}{2t} = \frac{38.19}{3} = 12.73 \text{ ksi}$$

$$C_2 \frac{D_o}{2I} = \frac{27.24}{2} = 13.62 \text{ ksi for x + y Earthquake}$$

$$= \frac{29.99}{2} = 15.0 \text{ ksi for z + y Earthquake}$$

And Conservatively:

$$\frac{1}{2(1-v)} E\alpha \left|\Delta T_1\right| + C_3 E_{ab}\left| \alpha_a T_a - \alpha_b T_b \right|$$

$$= \frac{93.5}{3} = 31.17 \text{ ksi}$$

∴ Equation (10) at Node 240 is satisfied as

$$12.73 + 13.62 + 31.17 \leq 3 \times 20.0$$

$$57.52 \leq 60.0 \qquad (10) \qquad \text{For } x + y \text{ Earthquake}$$

$$12.73 + 15.0 + 31.17 \leq 3 \times 20.0$$

$$58.90 \leq 60.0 \text{ ksi} \qquad (10) \qquad \text{For } z + y \text{ Earthquake}$$

<u>Satisfaction of Peak Stress Intensity Range</u>

Peak Stress Intensity Range S_p is calculated using Equation (11)

$$S_p = K_1 C_1 \frac{P_o D_o}{2t} + K_2 C_2 \frac{D_o}{2I} M_i +$$

$$\frac{1}{2(1-\nu)} K_3 E\alpha \left|\Delta T_1\right| + K_3 C_3 E_{ab}\left| \alpha_a T_a - \alpha_b T_b \right| + \frac{1}{1-\nu} E\alpha \left|\Delta T_2\right| \qquad (11)$$

From Computer Output S - 03

$$K_1 C_1 \frac{P_o D_o}{2t} = 38.19 \text{ ksi}$$

$$K_2 C_2 \frac{D_o}{2I} M_i = 27.24 \text{ ksi for } x + y \text{ Earthquake}$$

$$= 29.99 \text{ ksi for } z + y \text{ Earthquake}$$

From detail transient and ANSYS stress analysis for thermal loading

$$\frac{1}{2(1-\nu)} K_3 E\alpha \left|\Delta T_1\right| + K_3 C_3 E_{ab}\left| \alpha_a T_a - \alpha_b T_b \right| + \frac{1}{1-\nu} E\alpha \left|\Delta T_2\right|$$

= 93.5 ksi in ANSYS Model
Element No. 89

∴ $S_p = 38.19 + 27.24 + 93.5 = 158.93$ ksi for x + y Earthquake

$S_p = 38.19 + 29.99 + 93.5 = 161.68$ ksi for z + y Earthquake

Simplified Elastic - Plastic Discontinuity Analysis

Since Equation (10) is satisfied. Equations (12) and (13) need not be evaluated.

Alternating Stress Intensity

The alternating stress intensity S_{alt} is calculated using Equation (14)

$$S_{alt} = K_e \frac{S_p}{2} \qquad (14)$$

where:

S_{alt} = alternating stress intensity

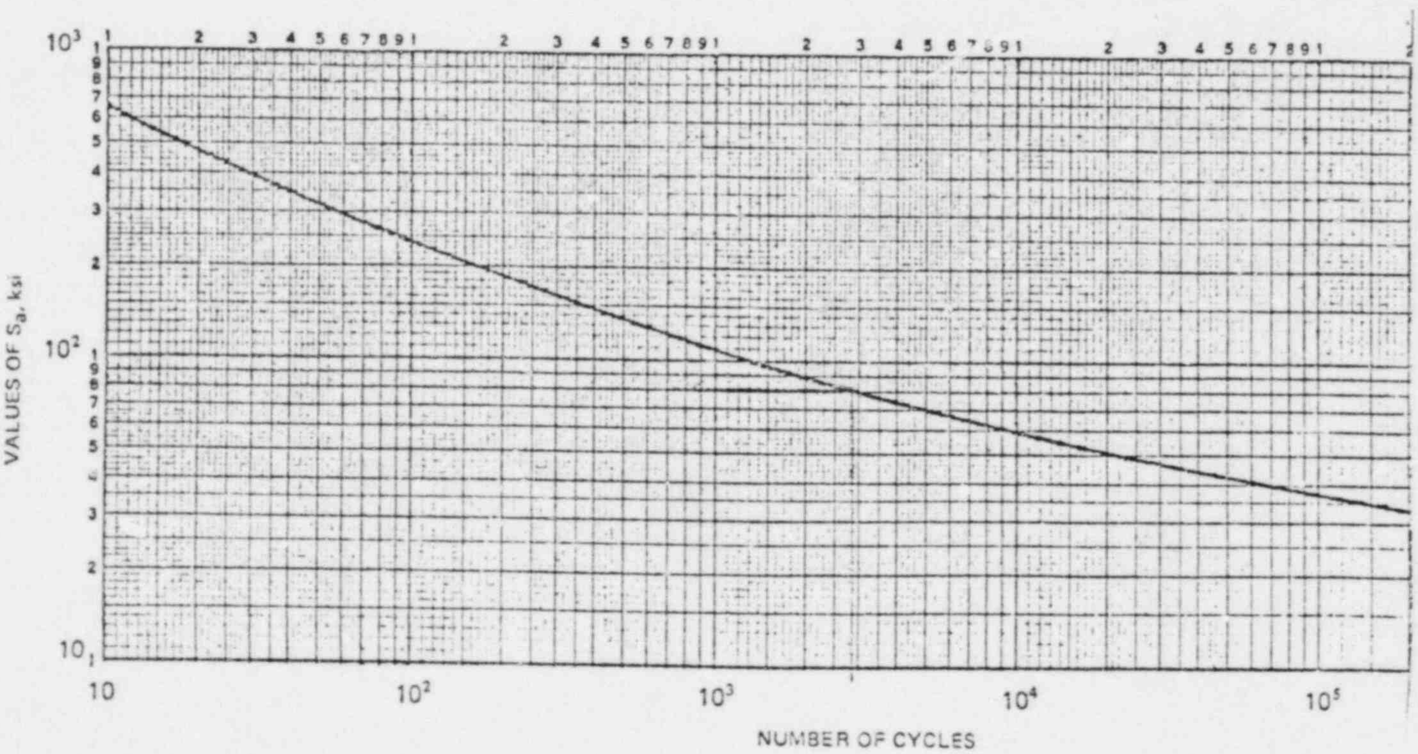
S_p = peak stress intensity value calculated by Equation (11)

K_e = 1.0 for $S_n \leq 3\ S_m$

$$\therefore\ S_{alt} = 1.0 \times \frac{158.93}{2} = 79.47 \text{ ksi for x + y Earthquake}$$

$$= 80.84 \text{ ksi for z + y Earthquake}$$

$\therefore$ From Figure I-9.2 of the ASME Code the allowable number of cycles is 2900.



NOTE:
E = 26.0 × 10⁶ psi

FIG. I-9.2 DESIGN FATIGUE CURVE FOR AUSTENITIC STEELS, NICKEL-CHROMIUM-IRON ALLOY, NICKEL-IRON-CHROMIUM ALLOY AND NICKEL-COPPER ALLOY

APPENDIX E

HPCS DISCHARGE NOZZLE THERMAL TRANSIENT ANALYSIS WITH THE LION 4 CODE

LACBWR HPCS SEISMIC THERMAL STUDY

1. PURPOSE - TO COMPUTE STEADY STATE AND TRANSIENT TEMPERATURES IN LACROSSE BOILING WATER REACTOR VESSEL NOZZLE AND HPCS PIPE, DURING EMERGENCY CORE COOLING.

2. SUMMARY - The LION 4 (Ref 1) THERMAL-HYDRAULICS code was used to compute the temperatures for LACROSSE in the HPCS pipe during Emergency cooling.

A Thermal Model was developed to find the steady state temperature distribution and the results were input as the initial temperatures in the transient analysis for maximum credible accident (HPCS water flow at 70°F, and 577.5°F to 270°F at -20°F/sec in the core; Ref. 4). The critical section of the model is shown in Figures 1 and 2.

A series of temperature means and differences were obtained to be used in thermal stress calculations.

3. Analysis - A) Materials - The pipe, coupling, and welds were all assumed to have the properties of stainless steel. The nozzle is a ferritic steel forging with an inconel extension welded to the forging, and clad with stainless steel (Ref 2., and Ref 4. fig A-18)

B) Steady State - In constructing the steady state model, the coolant was treated as a solid mass, represented by internal nodes, and the steady state temperature distribution obtained was used as input for the transient analysis. The results of the steady state analysis are shown in Figure 3.

C) Transients - In the transient analysis, the internal nodes, representing the coolant, were removed, and replaced by coolant nodes. A boundary node was placed at the entrance to the channel to ensure constant inlet temperature.

Flow is assumed to start instantaneously at time = 0.0 min. The transient analysis correspond to conditions for maximum credible accident as specified in Lacrosse Safeguard Report (Ref. 4), which specifies a 20° F/sec. vessel temperature change. The transient temperatures are shown in Figures 4 thru 30

D) Temperature Means and Differences:

T_A = Mean Temp. thru the Thickness of Material

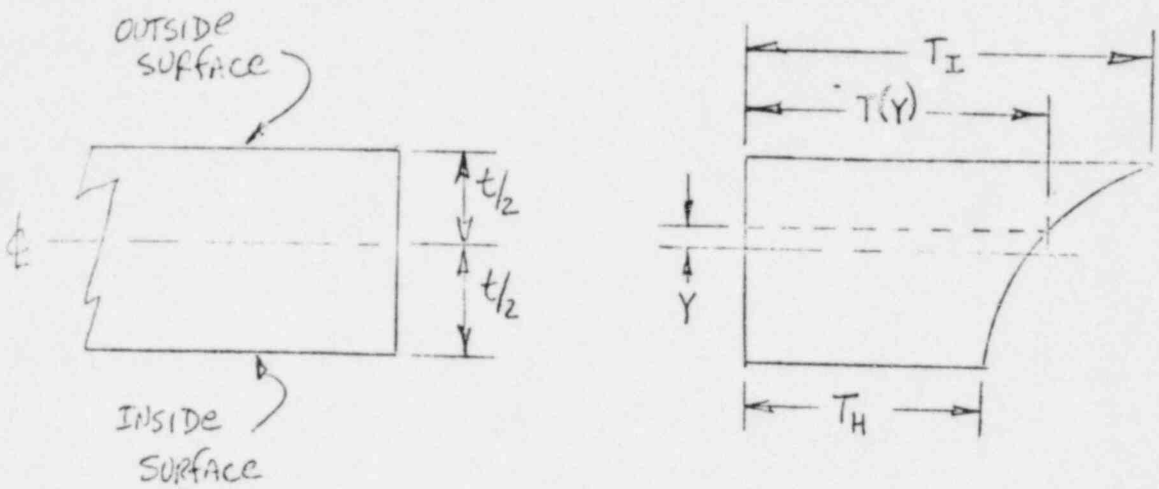
$|\Delta T_1|$ = Range of Absolute Value of the Temp. Difference between the outside surface (T_o) and the inside surface (T_i) of the material, assuming moment-generating equivalent temperature distribution (Ref. 3, pg 31).

$|\Delta T_2|$ = Range of Absolute Value for that portion of the non-linear thermal gradient through the wall, not included in $|\Delta T_1|$ (Ref. 3, pg 64).

Further, ΔT_1 is defined by:

$$\Delta T_1 = \left(\frac{12}{t^2}\right)\int_{-t/2}^{t/2} y\,T(y)\,dy$$

; see Fig A (below) and Ref. 3, pg 57.



T_I = OUTSIDE SURFACE TEMP.

T_H = INSIDE SURFACE TEMP.

$T(Y)$ = TEMP. AT POINT (Y)

t = WALL THICKNESS

FIGURE A. WALL MODEL DEFINITIONS.

ΔT_2 is Defined by:

$$\Delta T_2 = \text{MAX}\left[\left|T_A - T_I\right| - \left|\frac{\Delta T_1}{2}\right|,\ \left|T_H - T_A\right| - \left|\frac{\Delta T_1}{2}\right|,\ 0\right];\ (\text{Ref } 3.\ \text{pg } 58)$$

where T_H & T_I are inside and outside surface temperatures, respectively, and T_A is:

$$T_A = \frac{1}{t}\int_{-t/2}^{t/2} T(y)\,dy$$

ΔT_1 and ΔT_2 are further illustrated in Fig. B, Below.

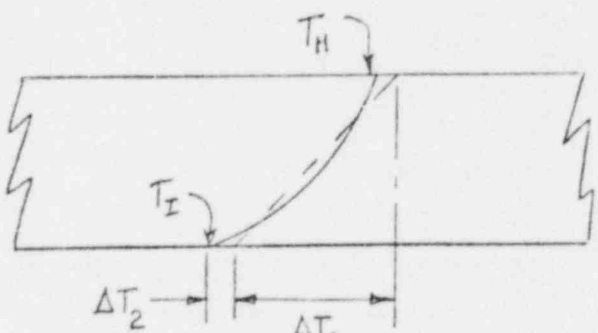


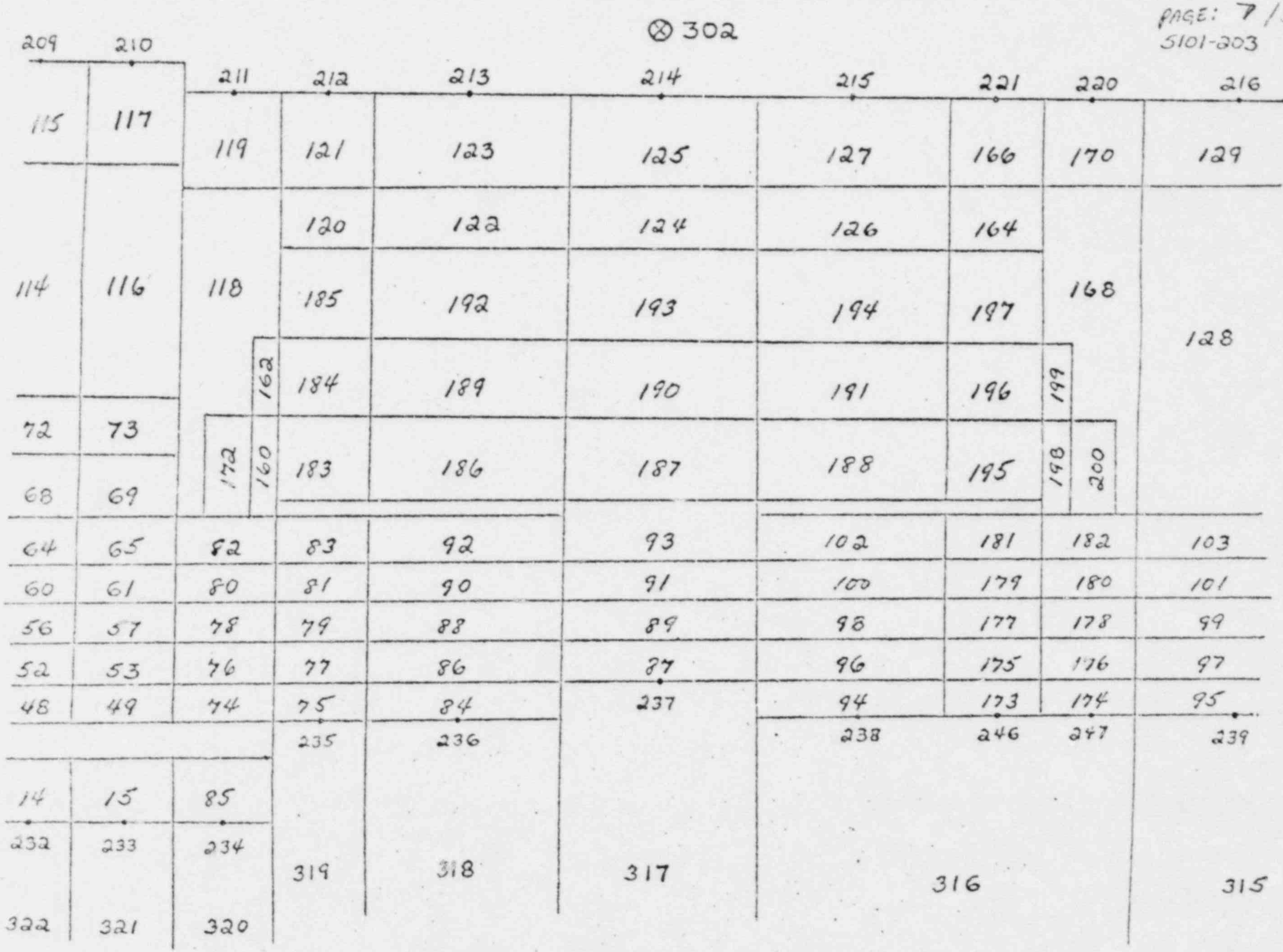
Fig. B. Graphic Presentation of Linear and Non-Linear Thermal Gradient Thru Wall Thickness (Ref. 3, Pg 36)

4. RESULTS: The steady state mean temperatures obtained from Ref. 5, are shown in Figure 3.

The transient temperature distributions obtained from Ref. 6, are shown in Figures 4 thru 30.

In addition, normal startup and shutdown transients with 150°F/hr rate of temperature changes have been considered in the thermal shock analysis. The steady state temperature distribution of Figure 3 represents the most conservative axial temperature profile during these transients and therefore were considered as such. ΔT_1 and ΔT_2 values are negligible during startup and shutdown transients (less than 2°F).

FIGURE 1 - MC-2 NODE DESIGNATIONS



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FIGU. ?E2

MODEL DIMENSIONS AND MATERIALS

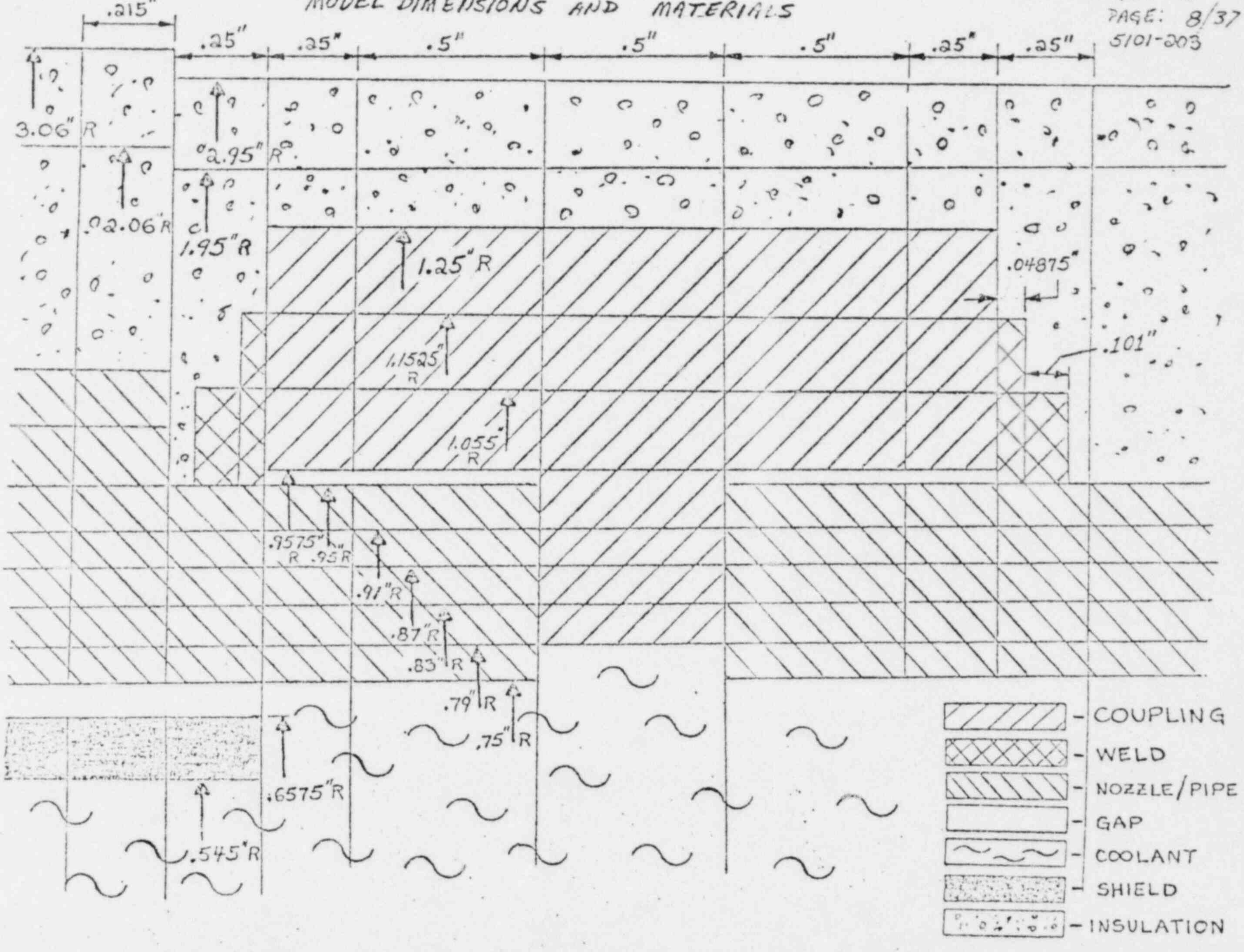

FIGURE 3 - STEADY STATE TEMPERATURE DISTRIBUTION

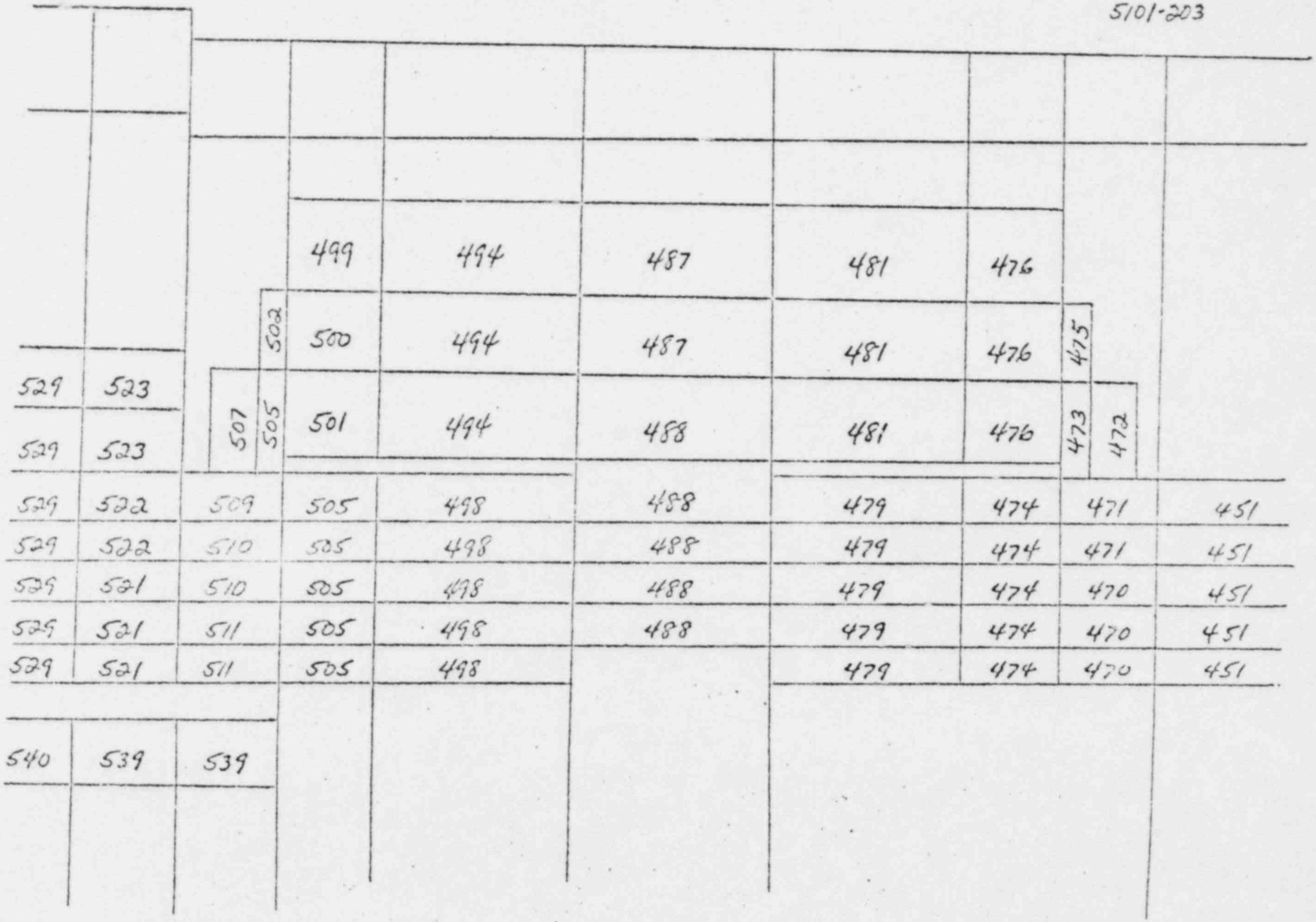

FIGURE 4 - NODE TEMPERATURES AT TIME = .01 sec

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PAGE: 10/37
5101-203

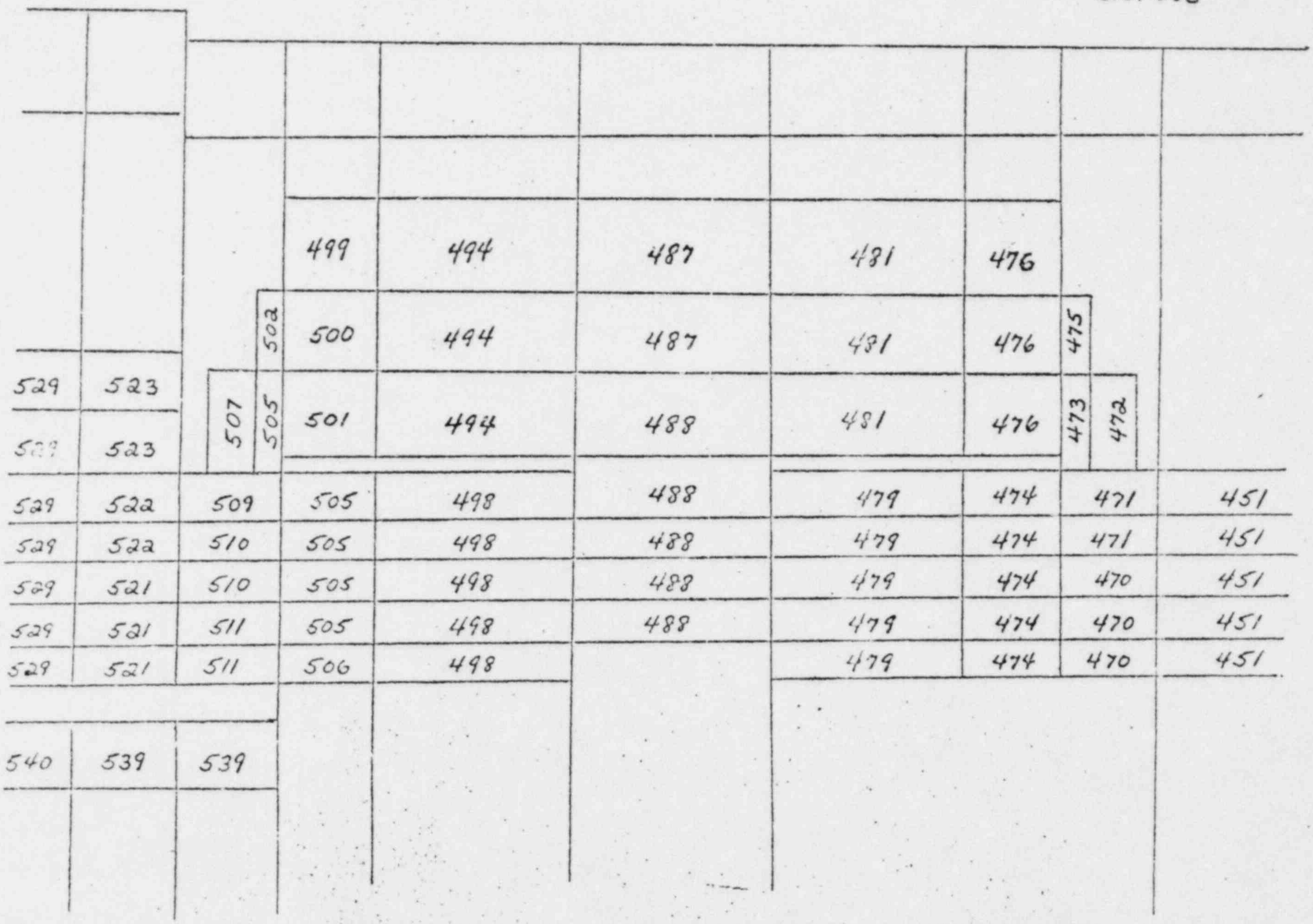

FIGURE E5 - NODE TEMPERATURES AT TIME = .25 sec

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PAGE: 11/37
5101-203

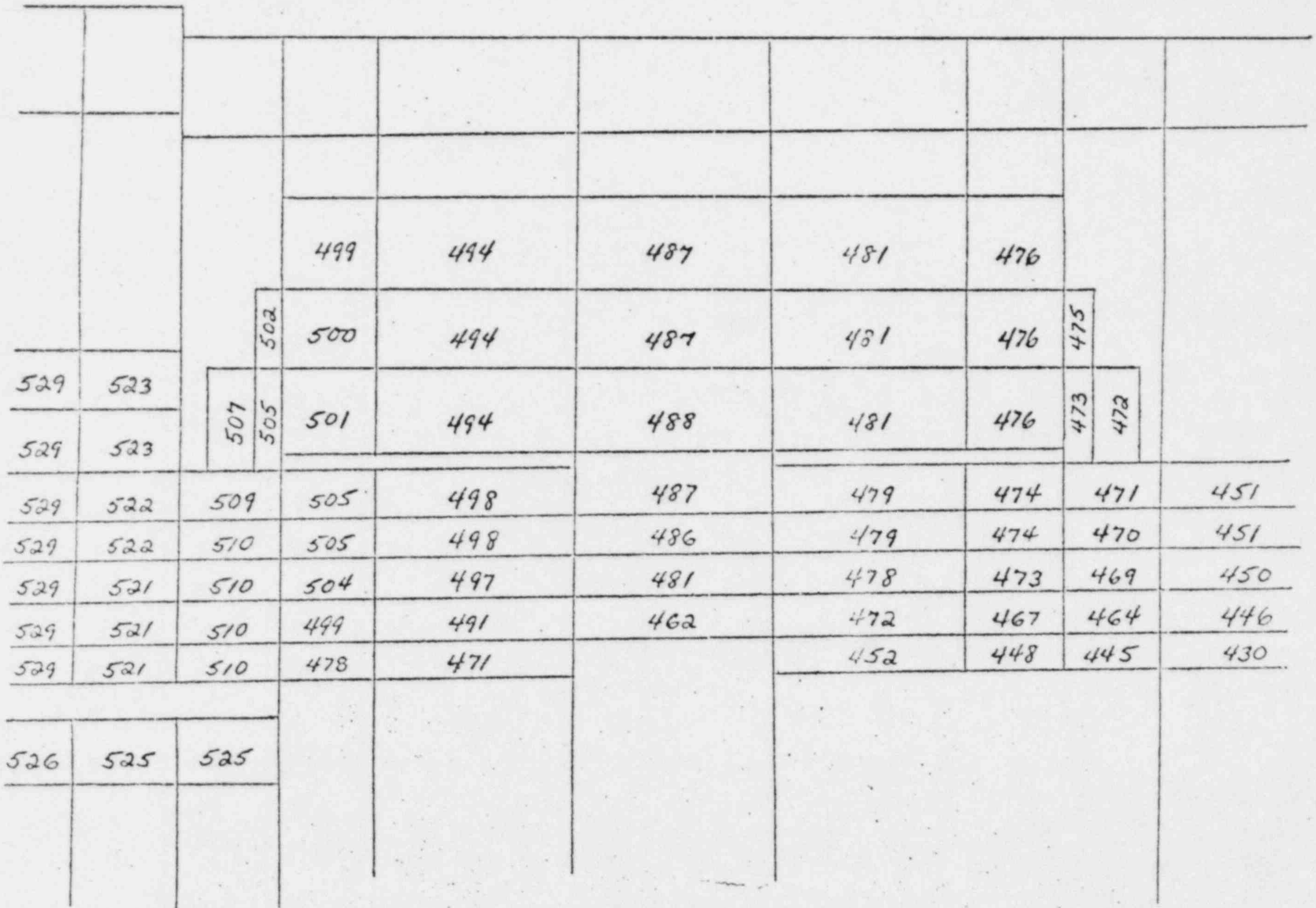

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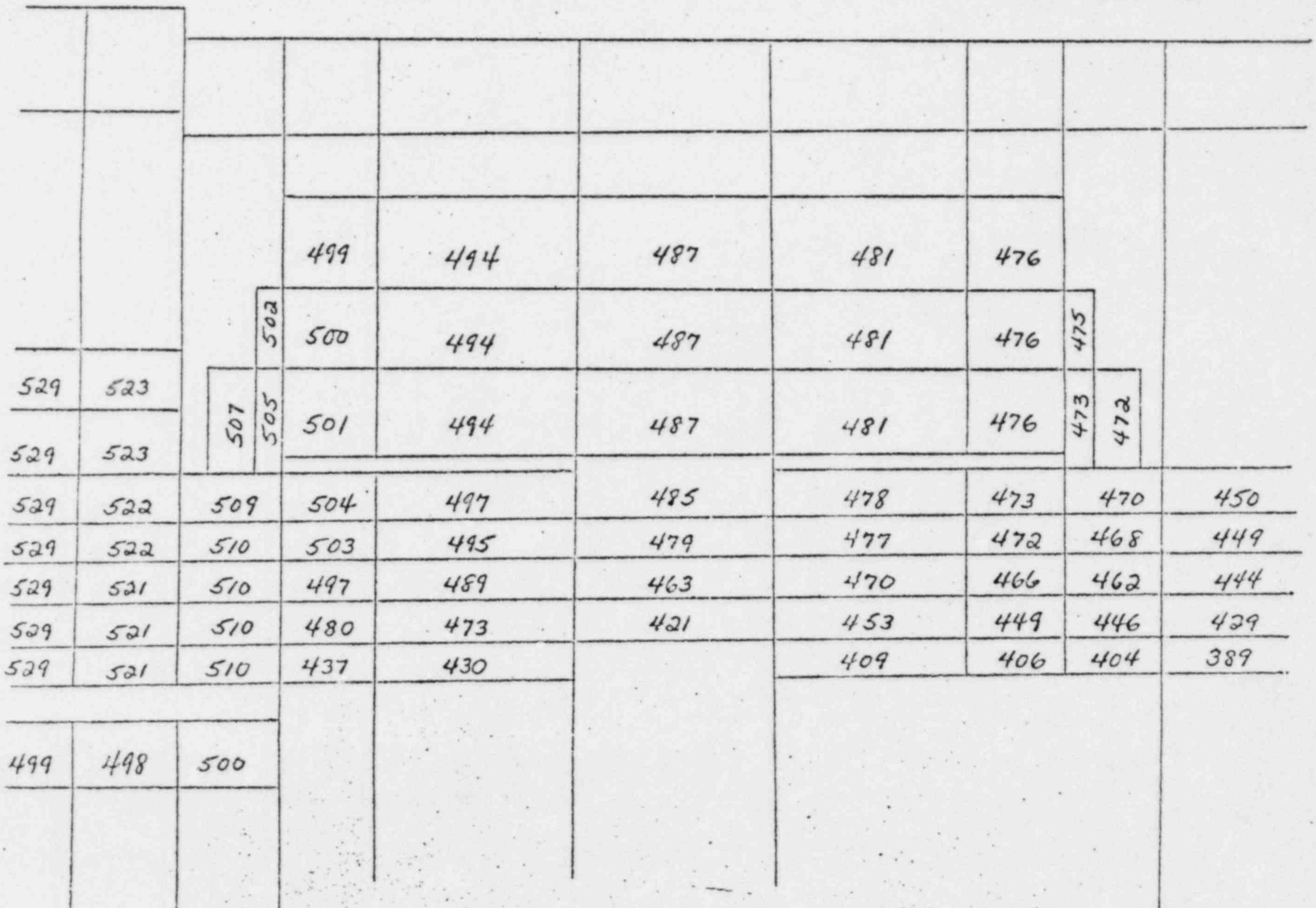
FIGURE E6 - NODE TEMPERATURES AT TIME = .5 sec



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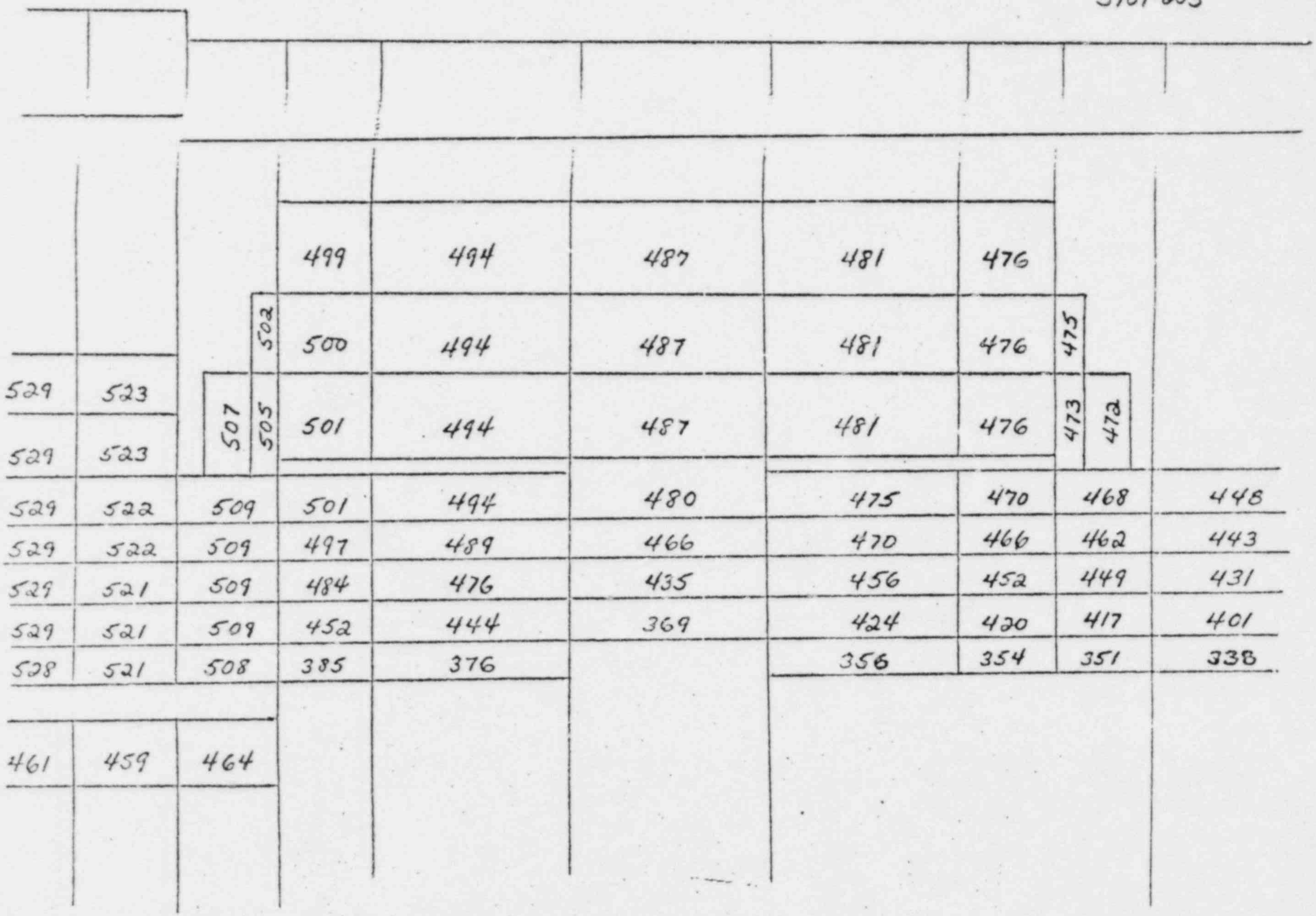
PAGE: 13/37
5101-203

FIGURE E7 -NODE TEMPERATURES AT TIME = .75 sec



FIGURE=8 -NODE TEMPERATUR..S AT TIME = 1.0 sec

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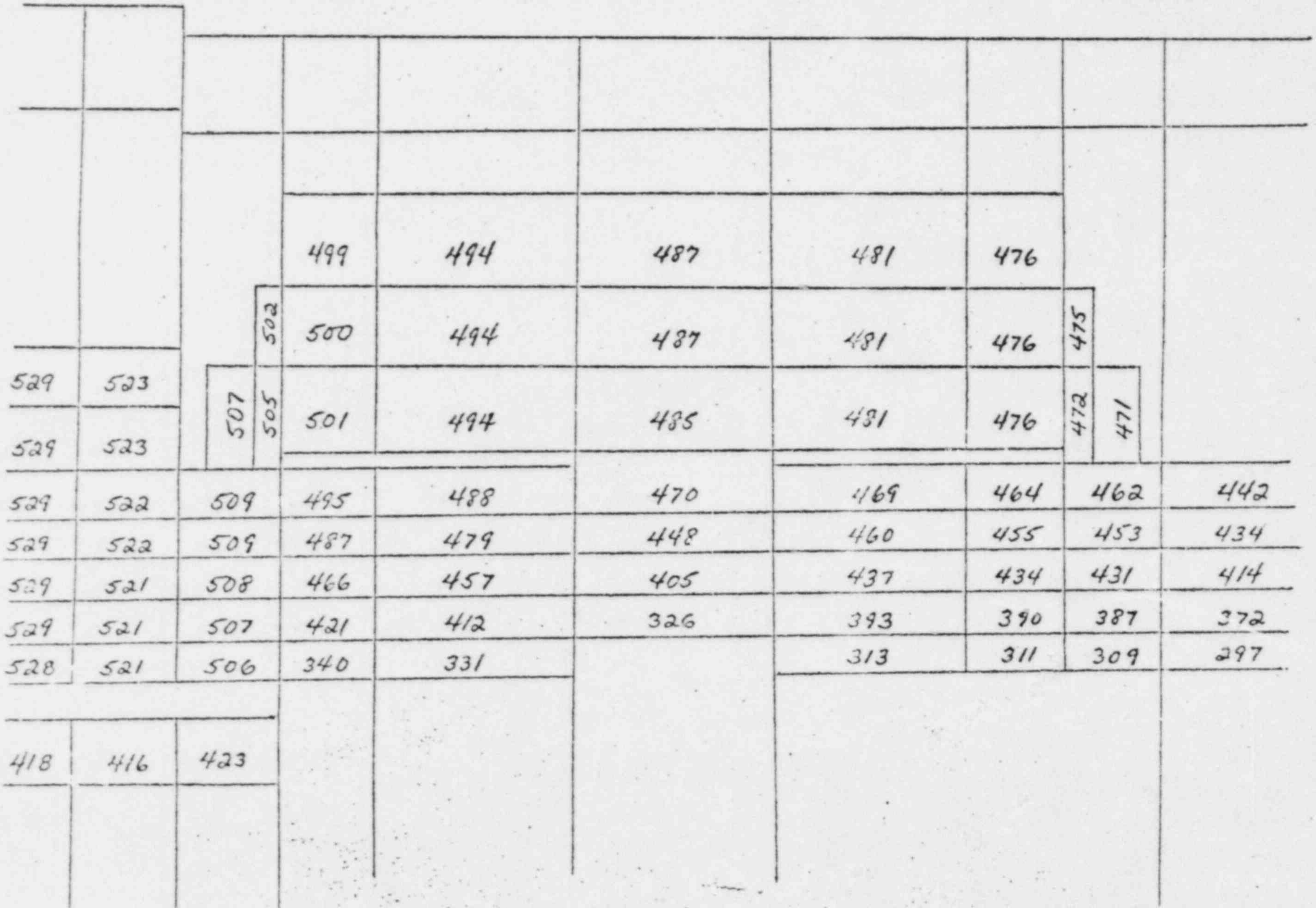
PAGE: 14/37
5101-203



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PAGE: 15/37
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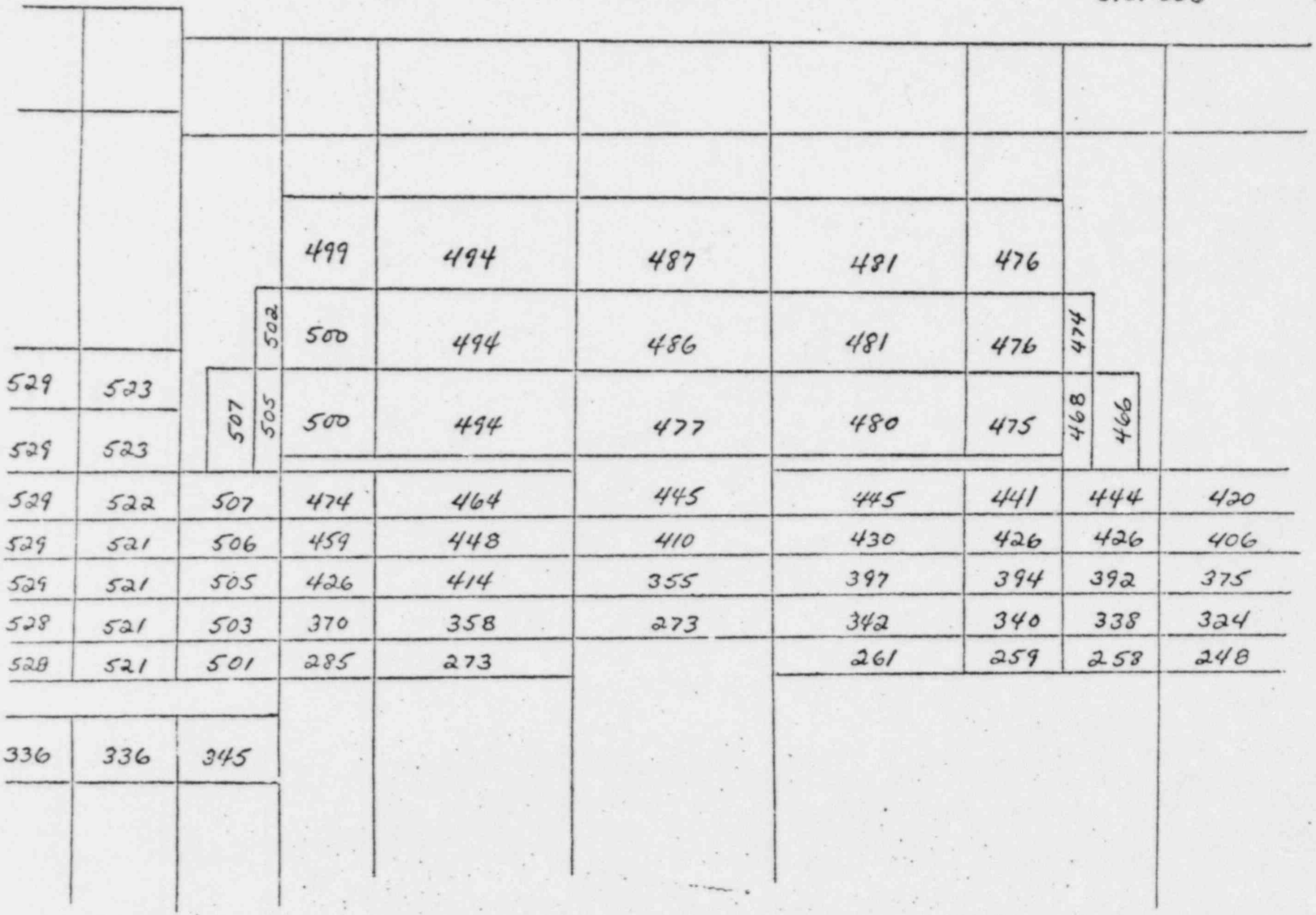
FIGURE 9 - NODE TEMPERATURES AT TIME = 1.5 sec



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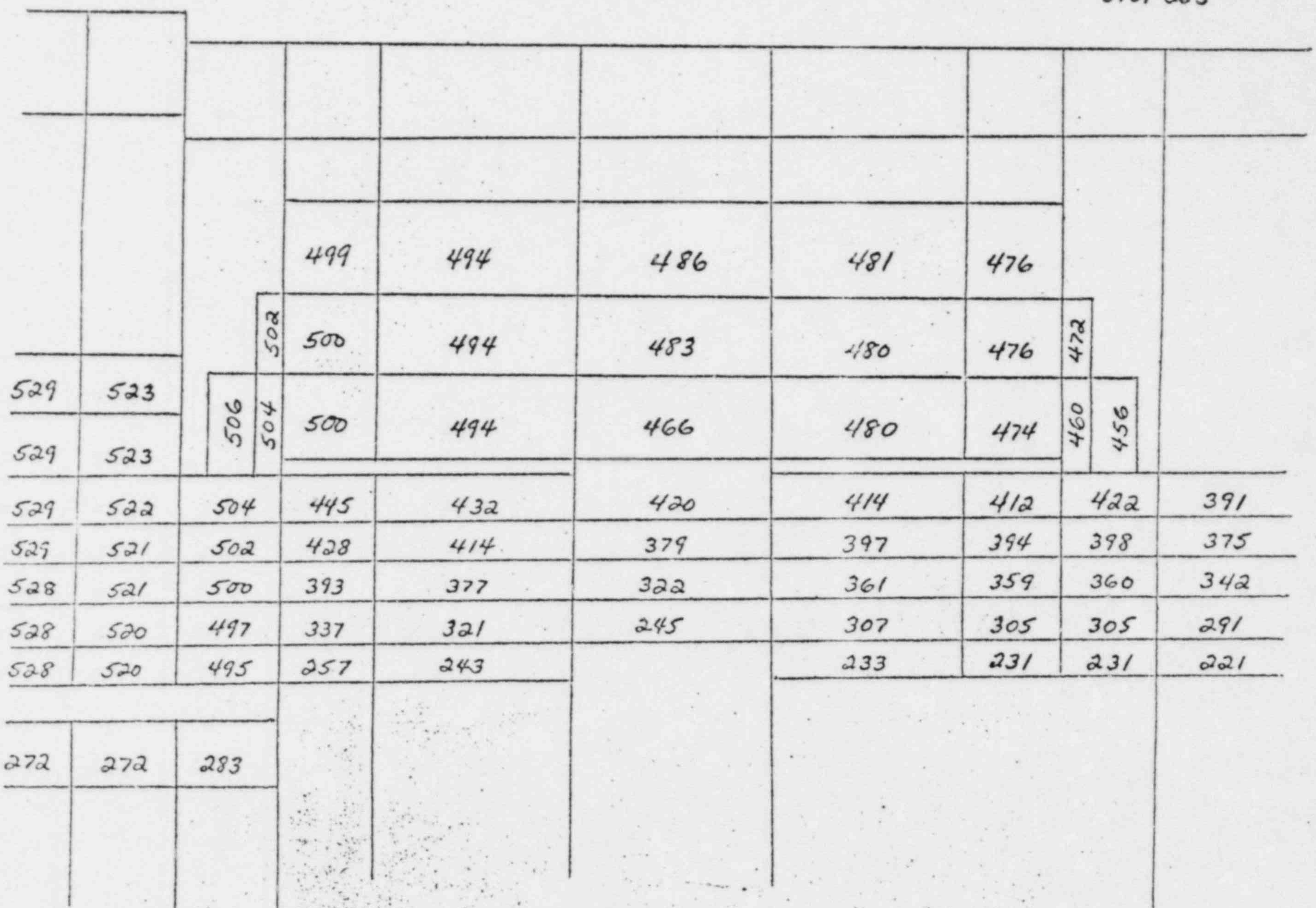
PAGE: 16/37
5101-203

FIGURE 10 - NODE TEMPERATURES AT TIME = 2.0 sec



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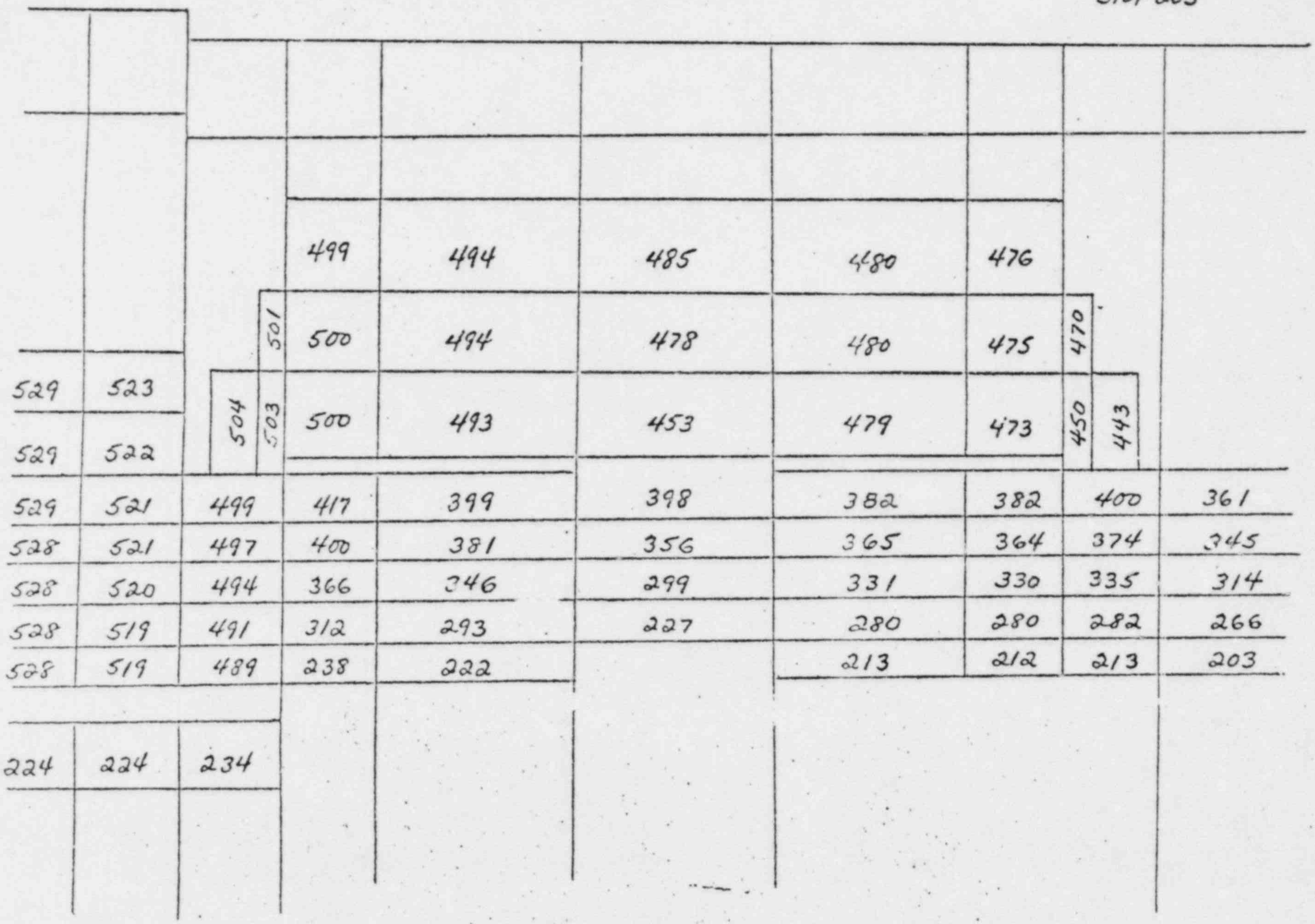
PAGE: 17/37
5101-203

FIGURE 11 - NODE TEMPERATURES AT TIME = 2.5 sec



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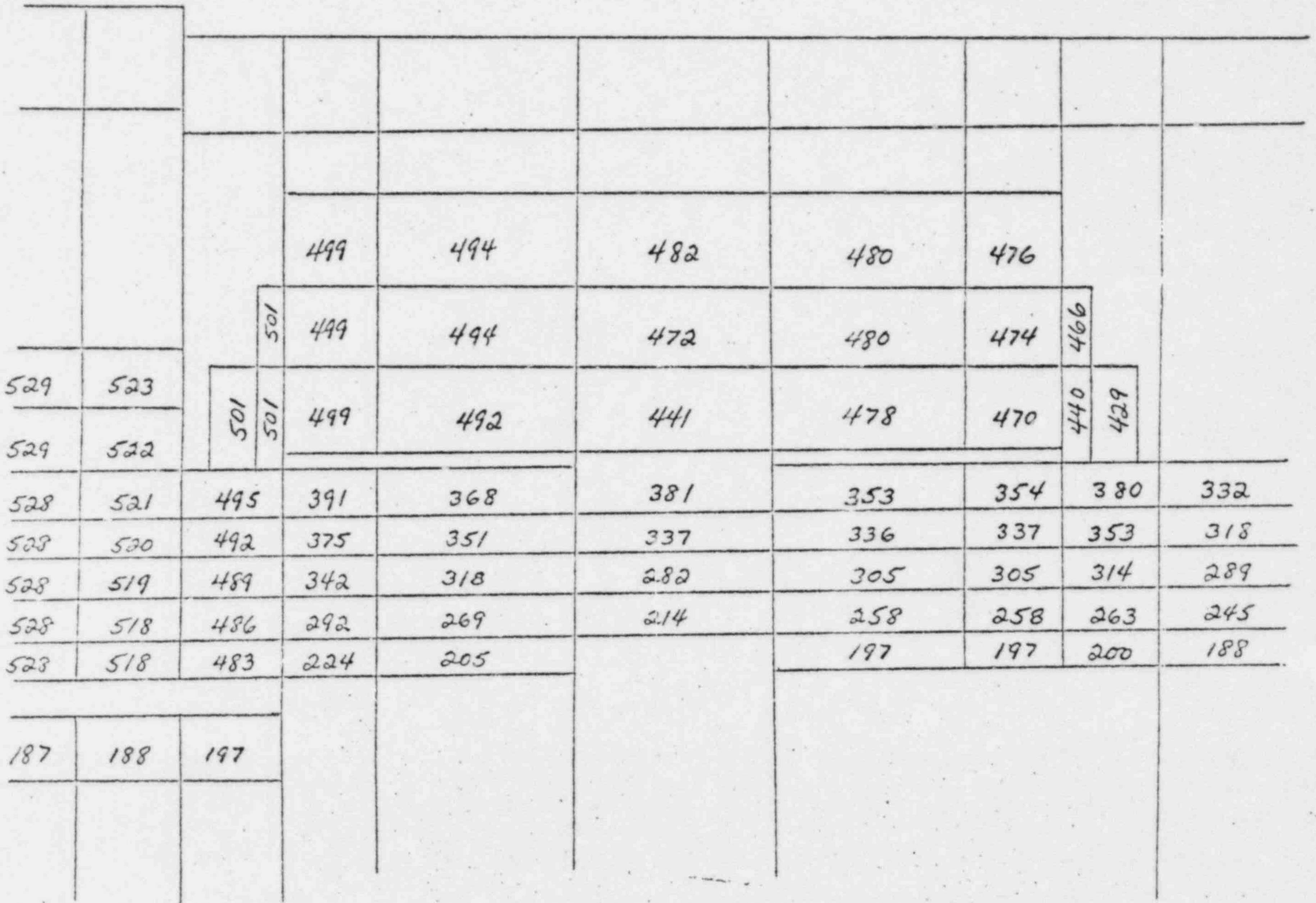
5101-203

FIGUREE12 - NODE TEMPERATURES AT TIME = 3.0 sec



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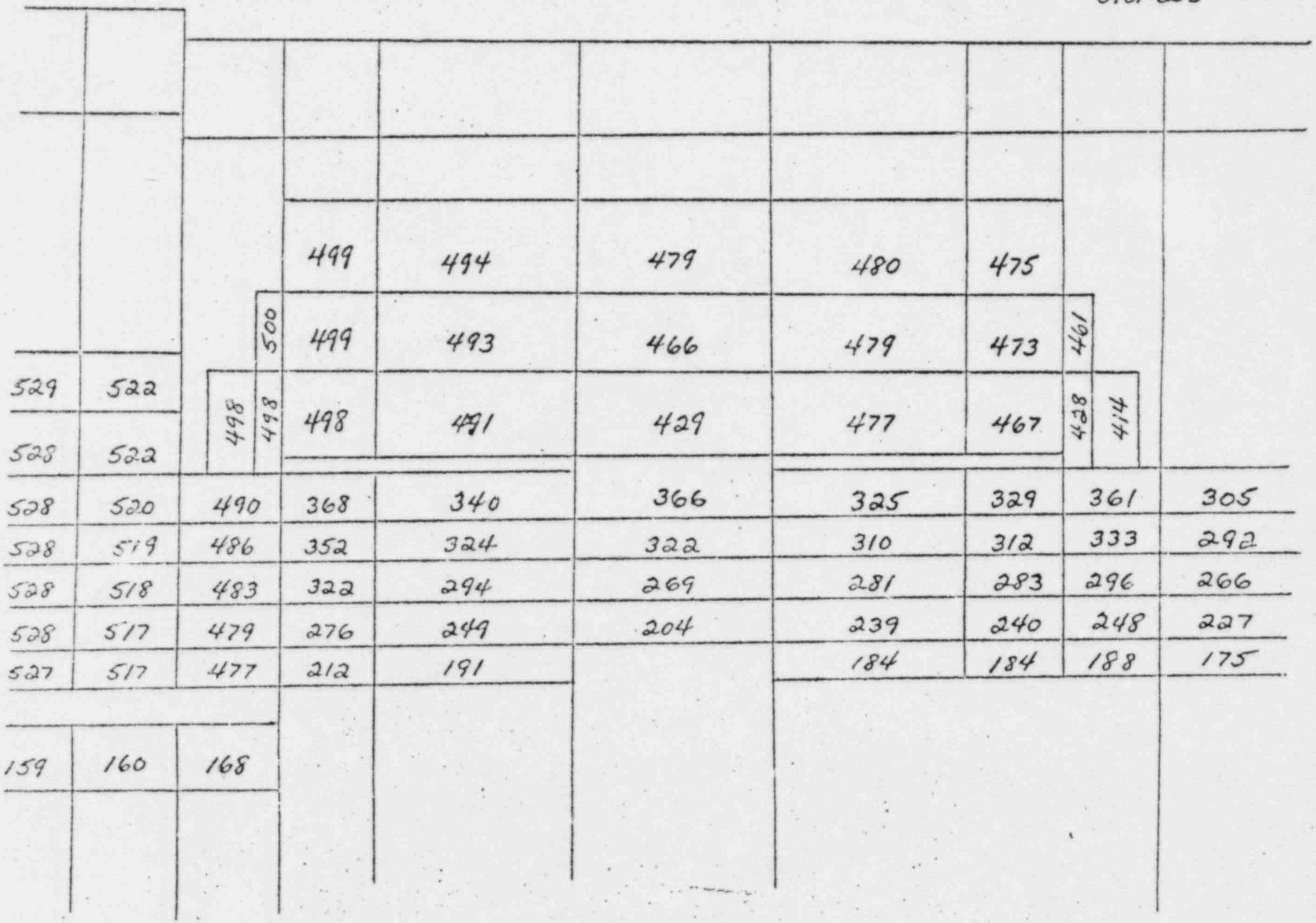
PAGE: 19/37
5101-203

FIGURE E13 - NODE TEMPERATURES AT TIME = 3.5 Sec



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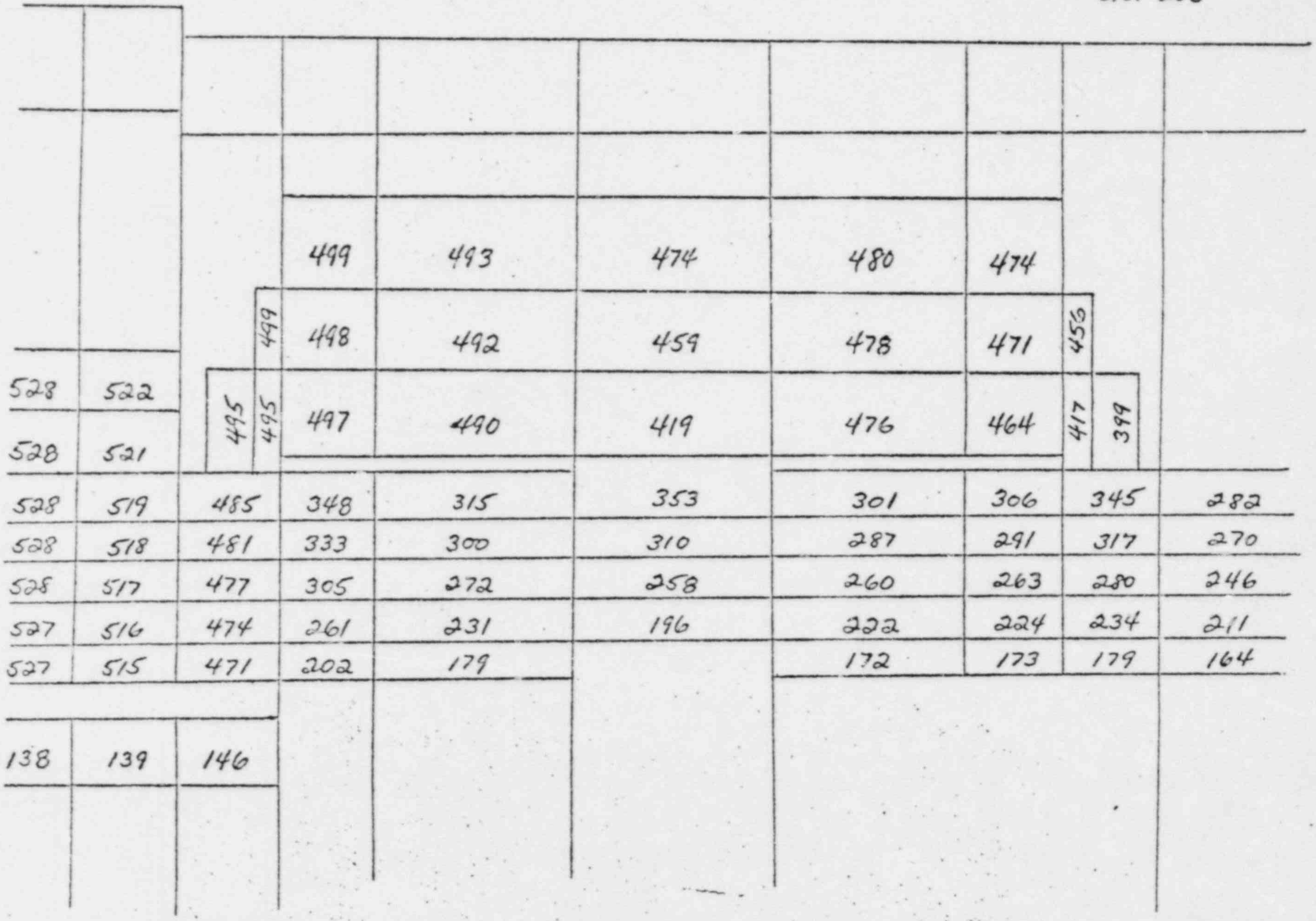
5101-203

FIGURE 14 - NODE TEMPERATU..ES AT TIME = 4.0 sec



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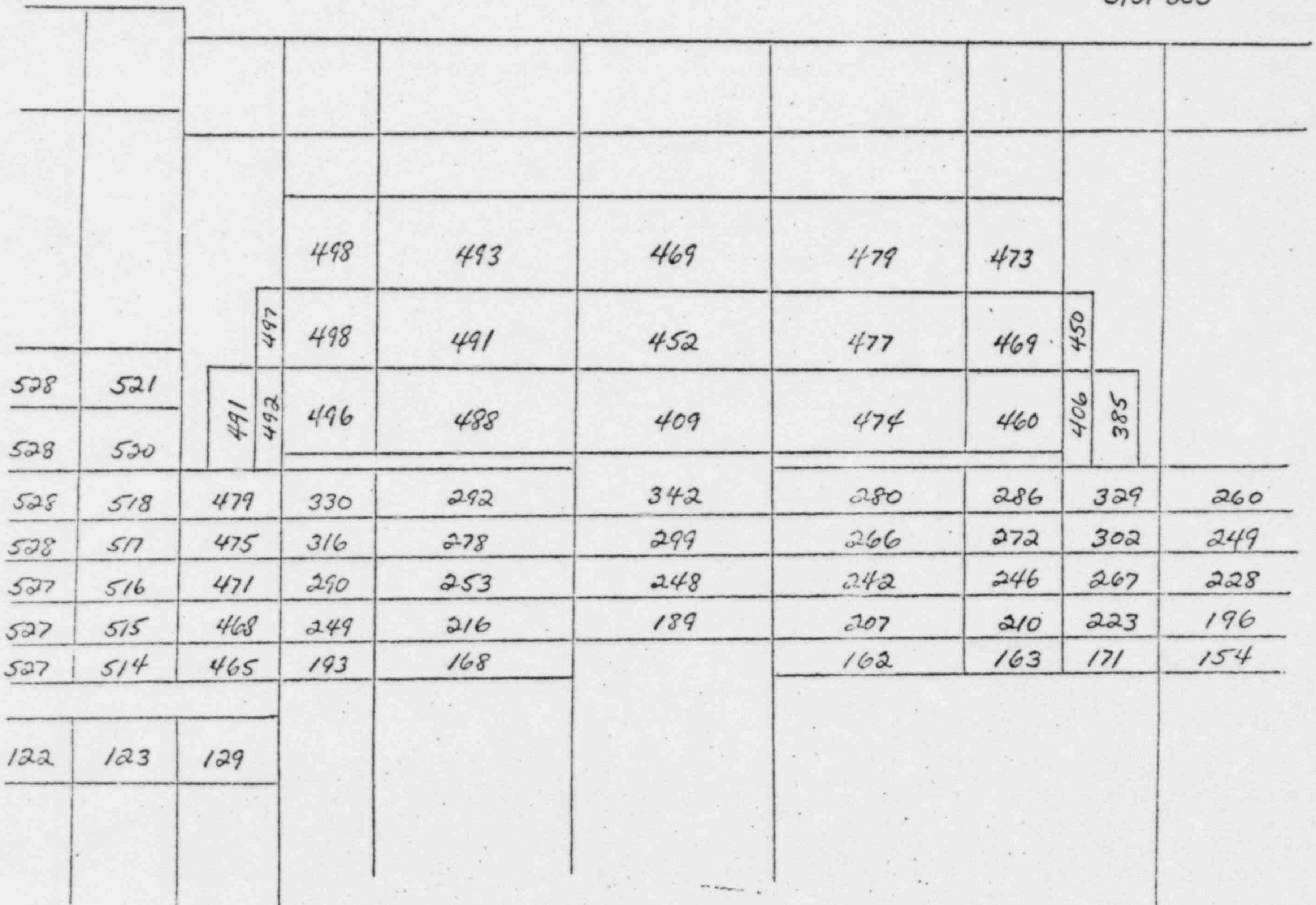
PAGE: 21/37
5101-203

FIGURE E15 - NODE TEMPERATURES AT TIME = 4.5 sec



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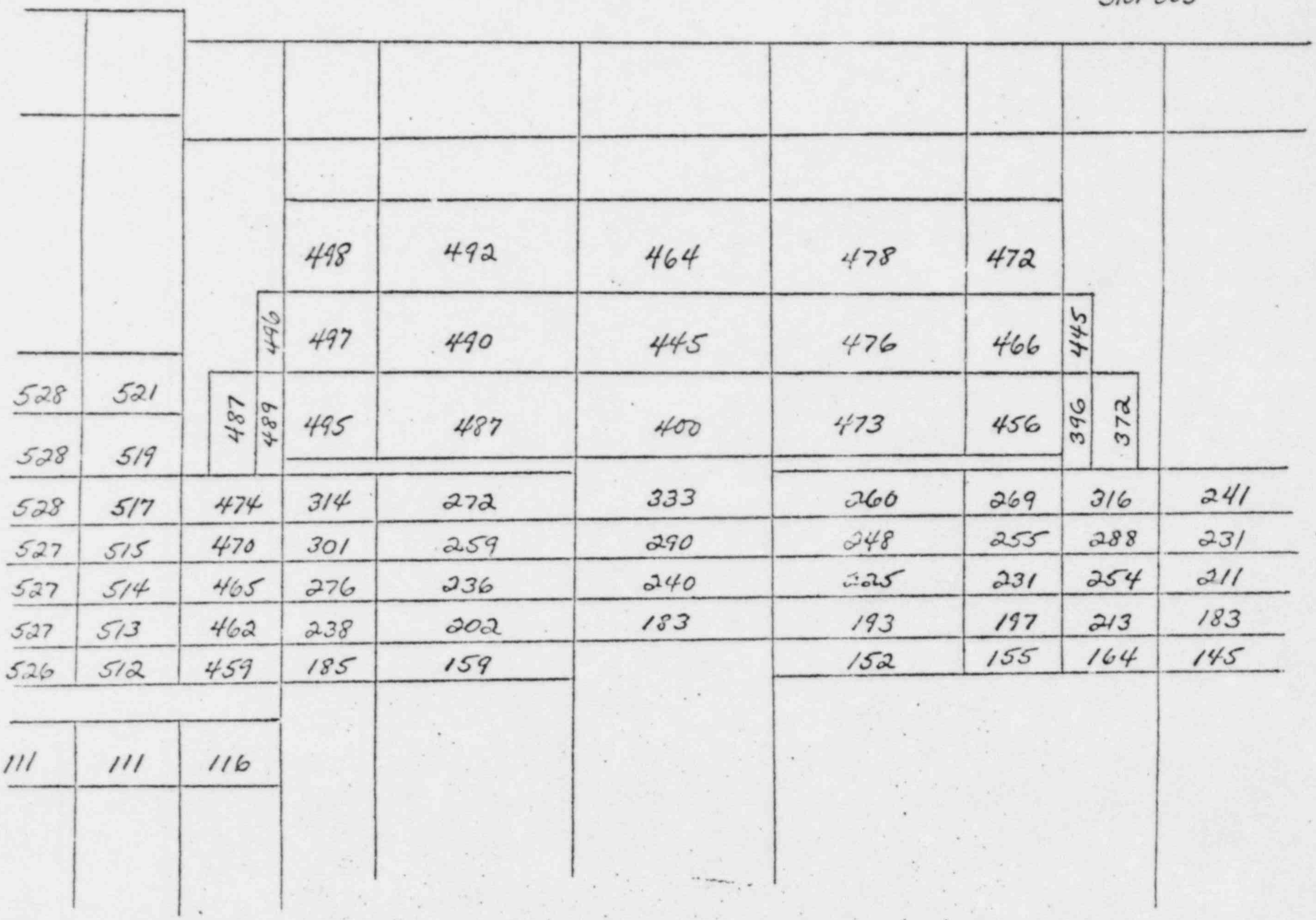
PAGE: 22/37
5101-203

FIGURE 16 - NODE TEMPERATURES AT TIME = 5.0 sec



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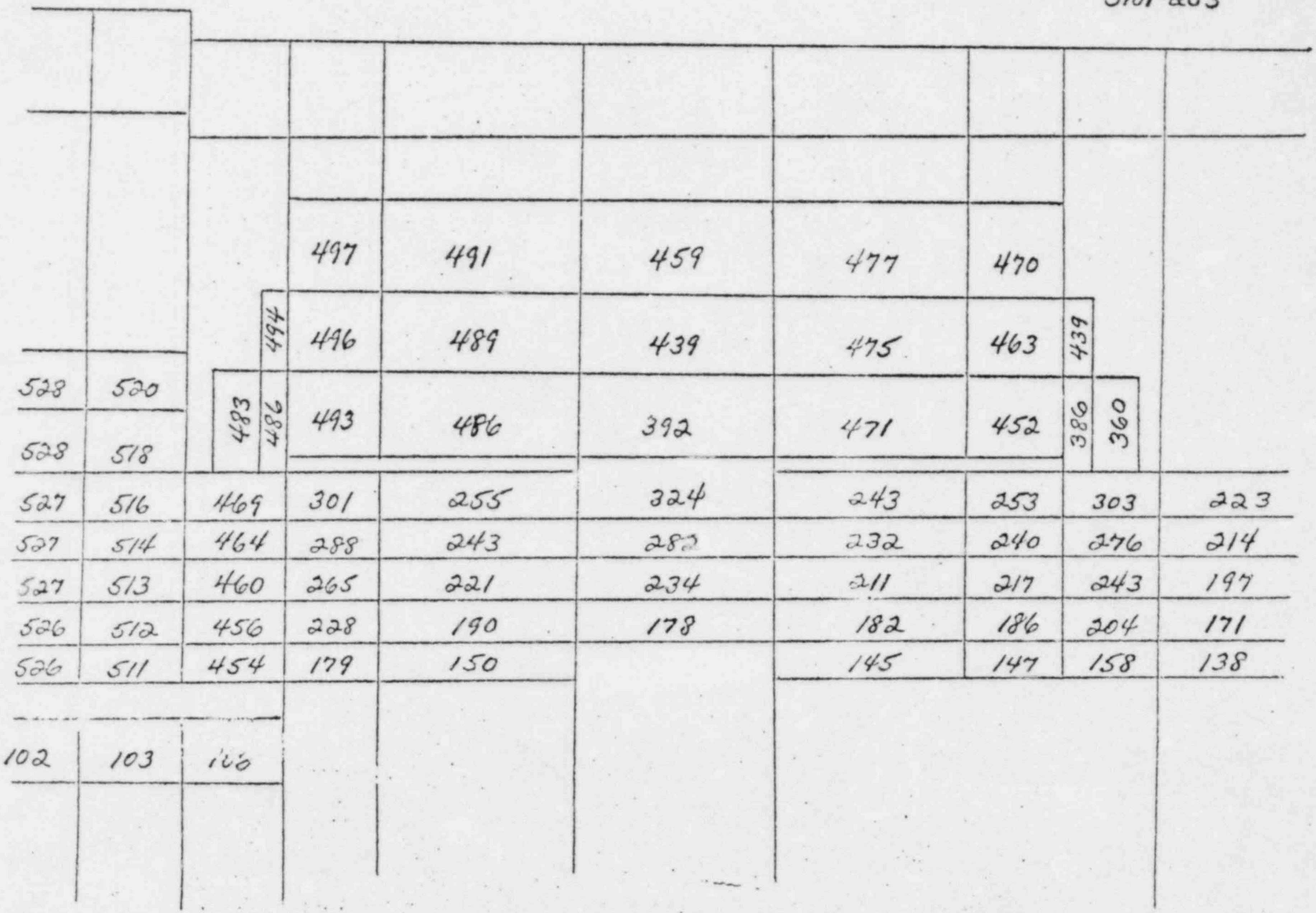
PAGE: 23/37
5101-203

FIGURE E17 - NODE TEMPERATURES AT TIME = 5.5 sec



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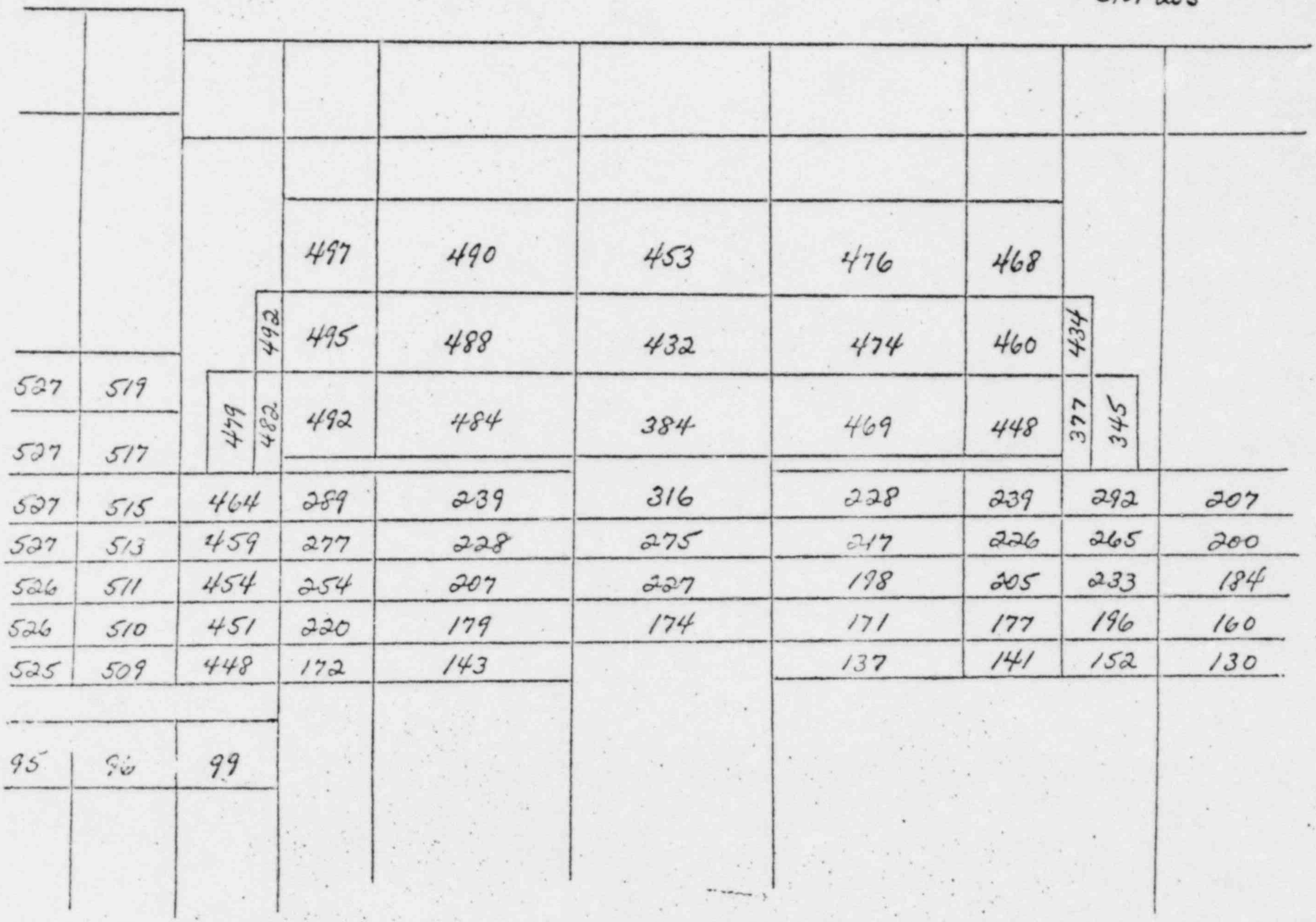
5101-203

FIGURE E18 - NODE TEMPERATUK_ S AT TIME = 6.0 sec



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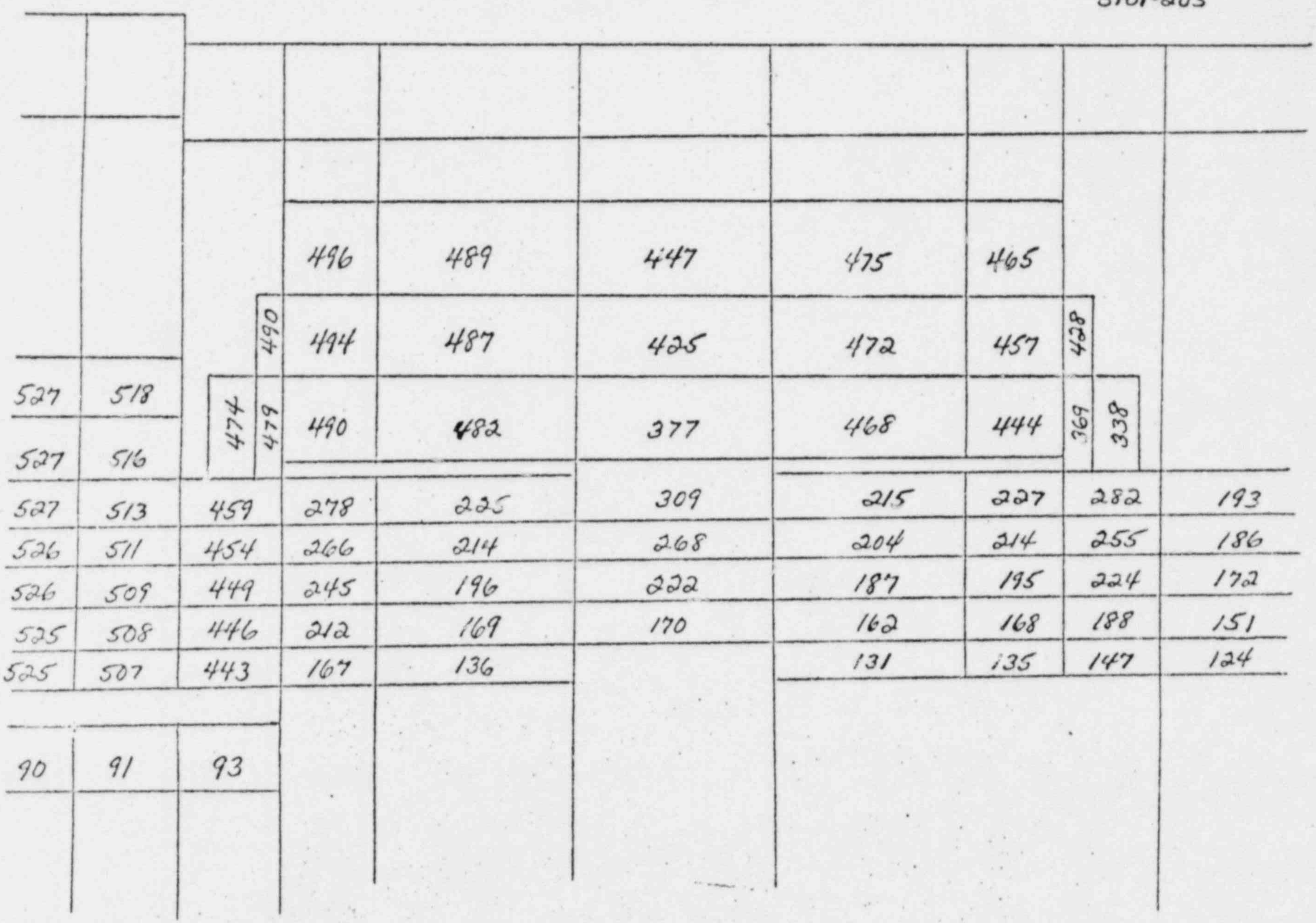
PAGE: 25/37
5101-203

FIGURE 19 - NODE TEMPERATURES AT TIME = 6.5 sec



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PAGE: 26/37
5101-203

FIGURE 20 - NODE TEMPERATURES AT TIME = 7.0 sec

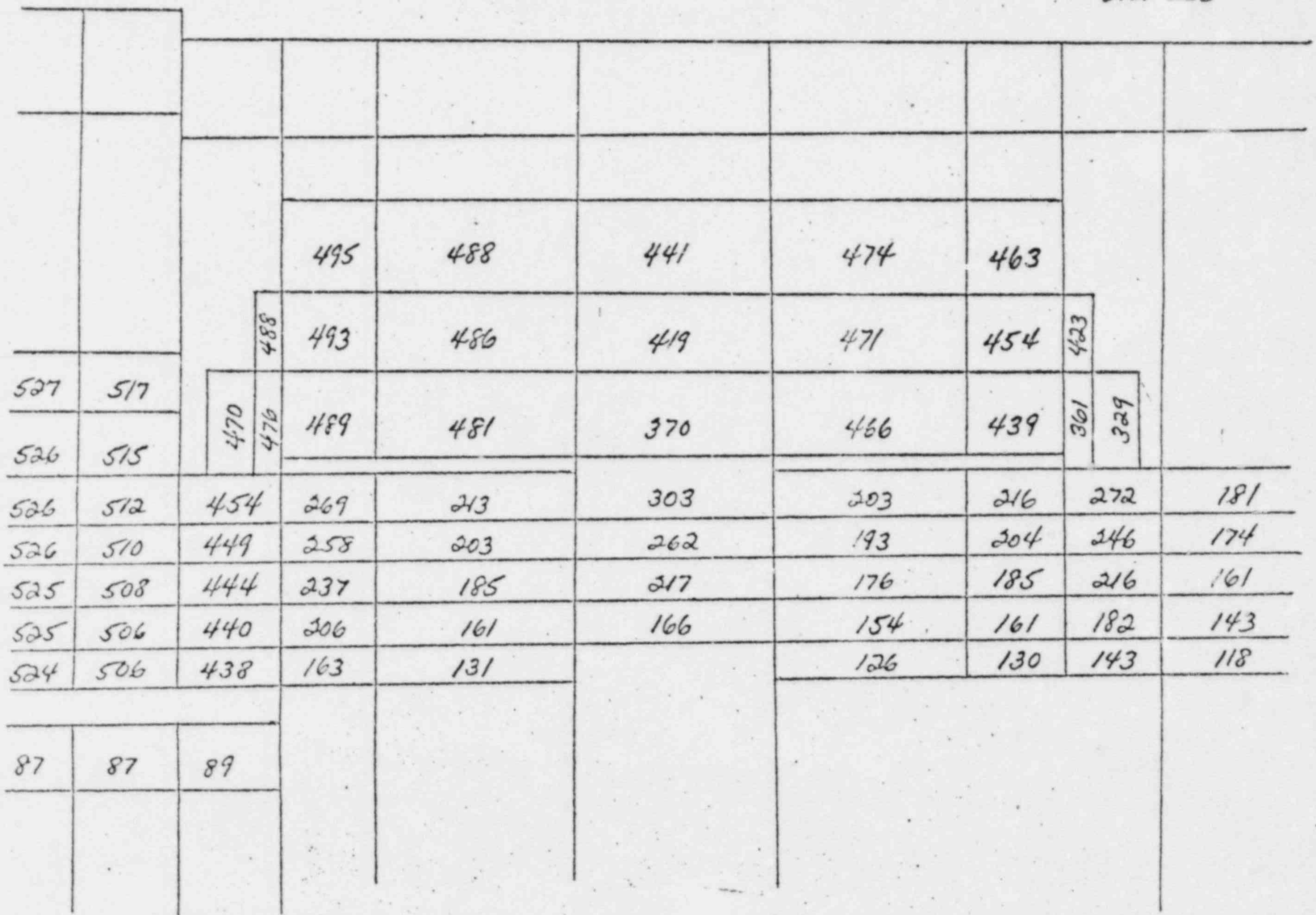

FIGURE 21 - NODE TEMPERATURES AT TIME = 7.5 sec

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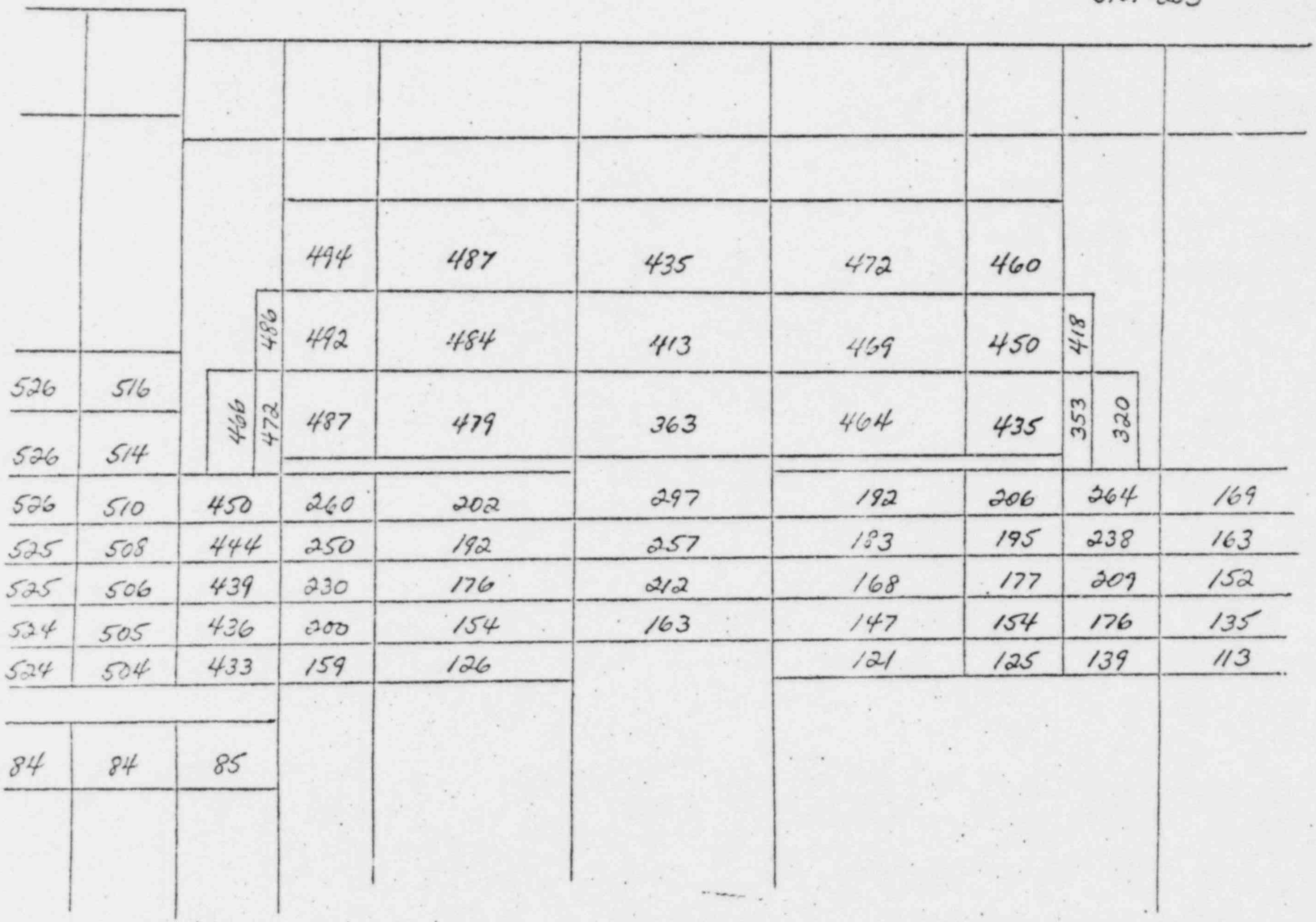
PAGE: 27 / 37
5101-203



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PAGE: 28/37
5101-203

FIGURE 22 - NODE TEMPERATURES AT TIME = 8.0 sec

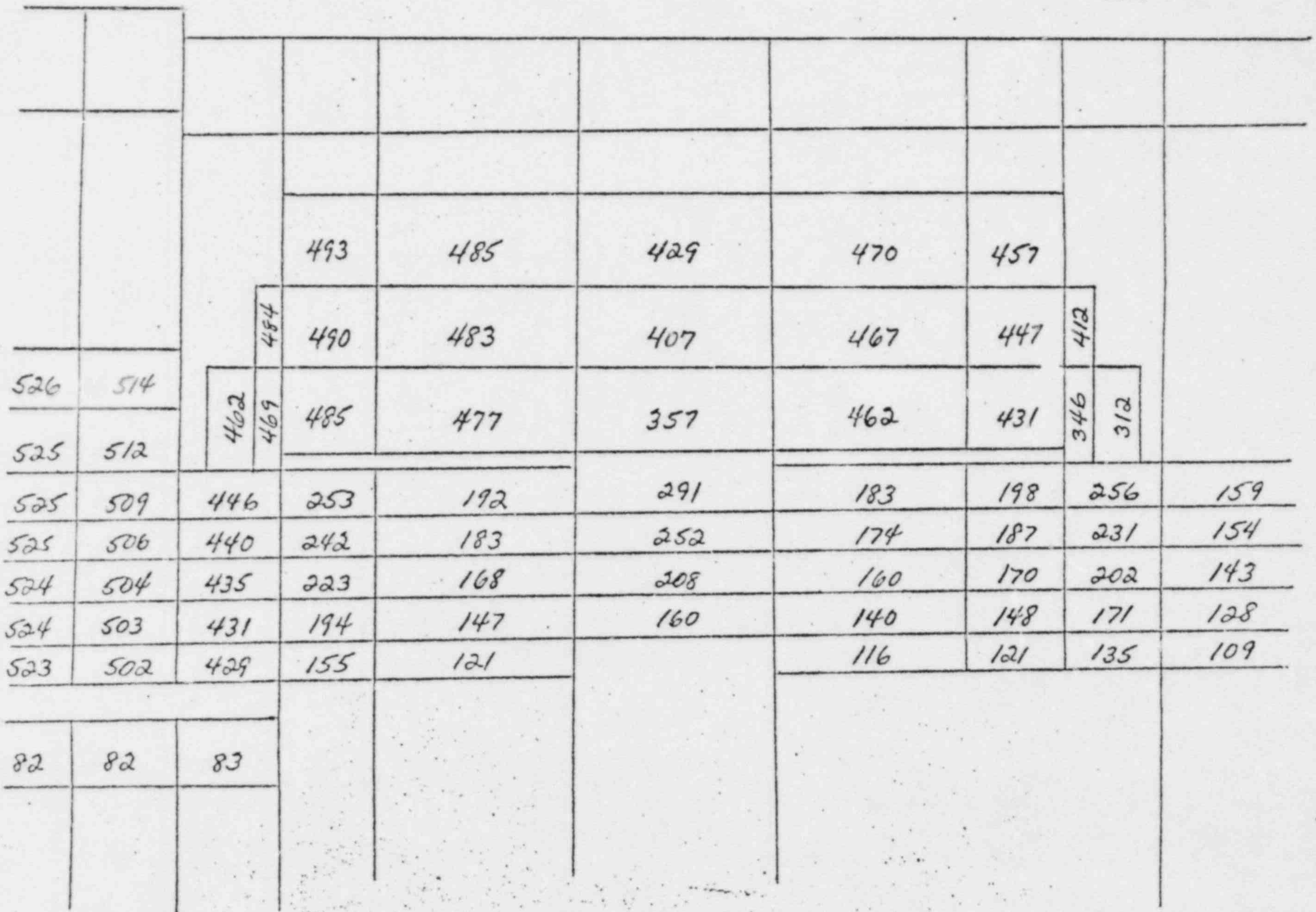

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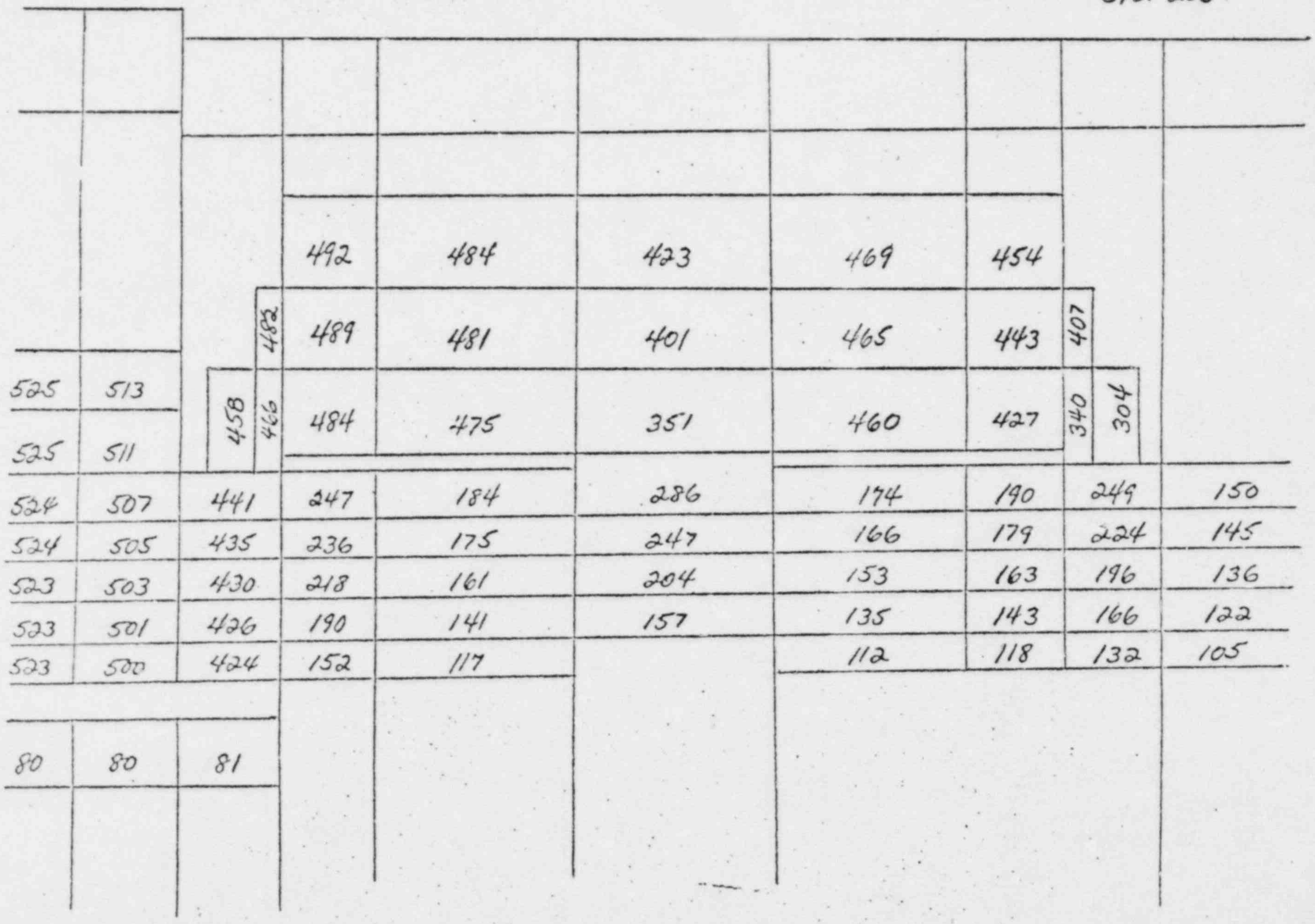
FIGURE 23 - NODE TEMPERATURES AT TIME = 8.5 sec



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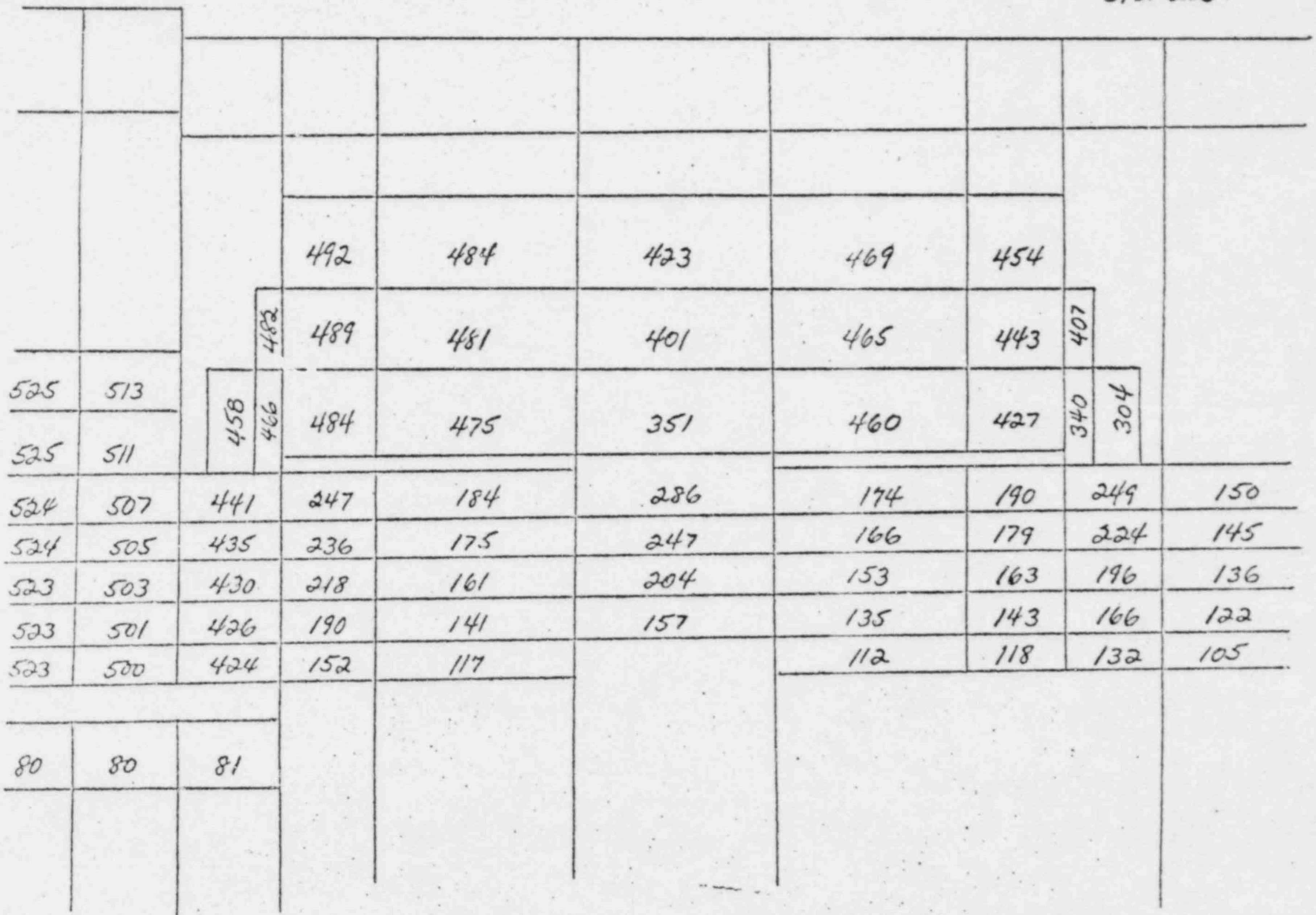
5101-203

FIGURE 23 - NODE TEMPERATURES AT TIME = 8.5 sec



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PAGE: 30/37
5101-203

FIGURE 24 - NODE TEMPERATURES AT TIME = 9.0 sec

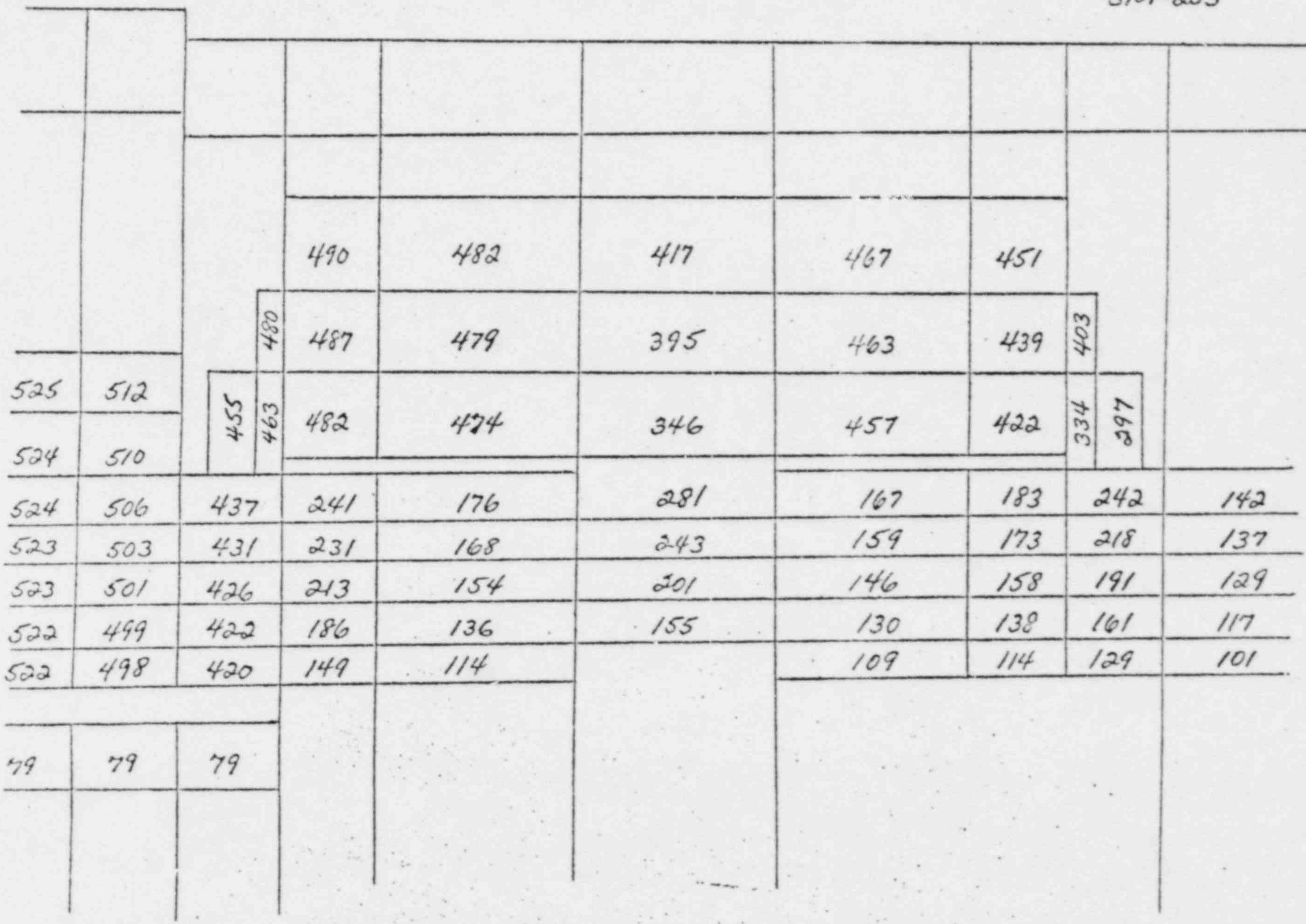

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FIGURE 25 - NODE TEMPERATURES AT TIME = 9.[illegible] sec

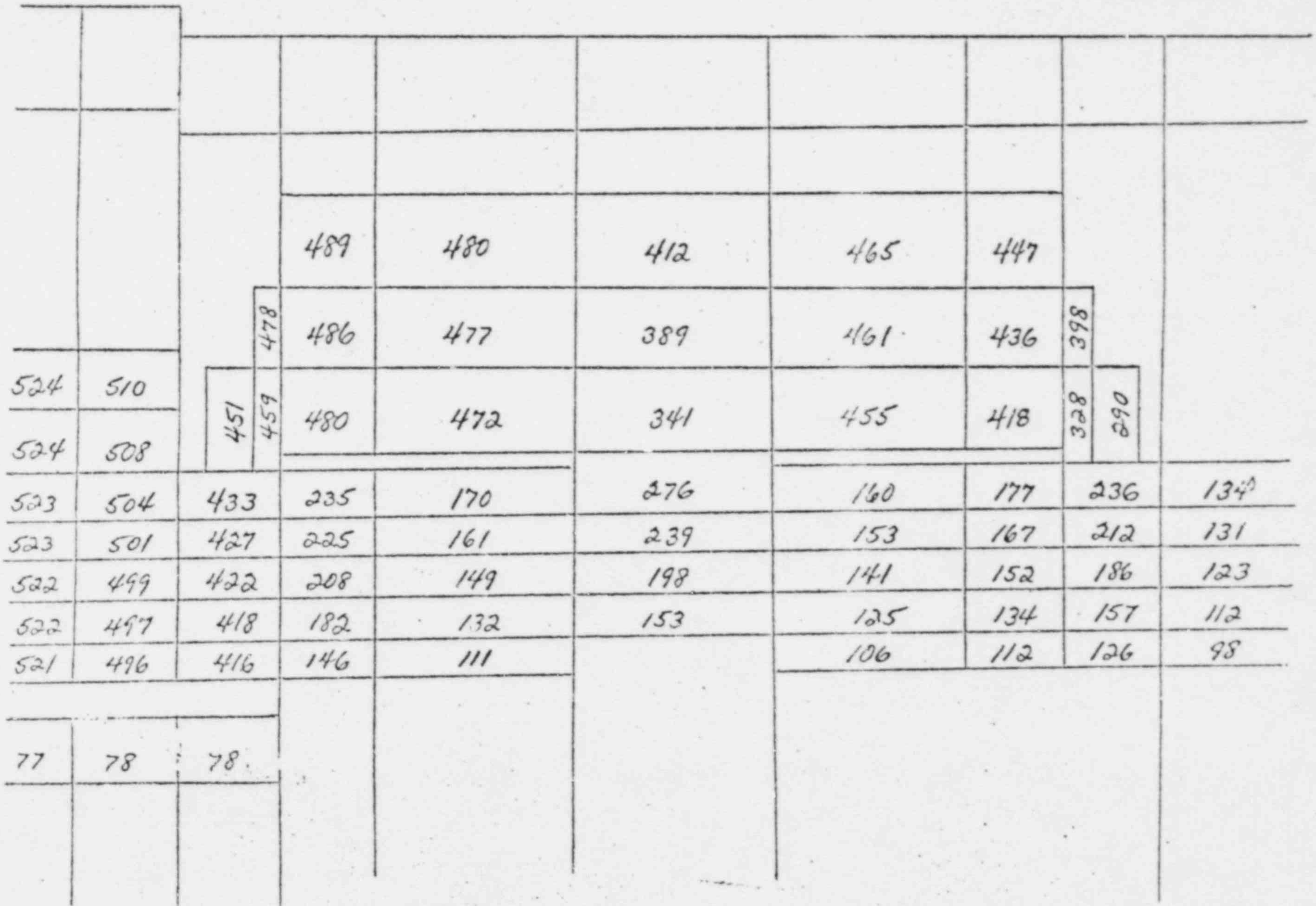

FIGURE 26 - NODE TEMPERATURES AT TIME = 10.0 sec

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				488	479	406	463	444			
			476	484	476	384	459	432	393		
523	509										
523	507	447	456	478	470	335	453	414	322	384	
522	502	430		231	164	272	155	172	230		128
522	499	423		221	156	235	147	162	207		125
521	497	418		204	144	195	136	148	182		118
521	495	414		179	128	151	121	130	154		108
520	494	412		144	108		104	109	124		95
77	77	77									

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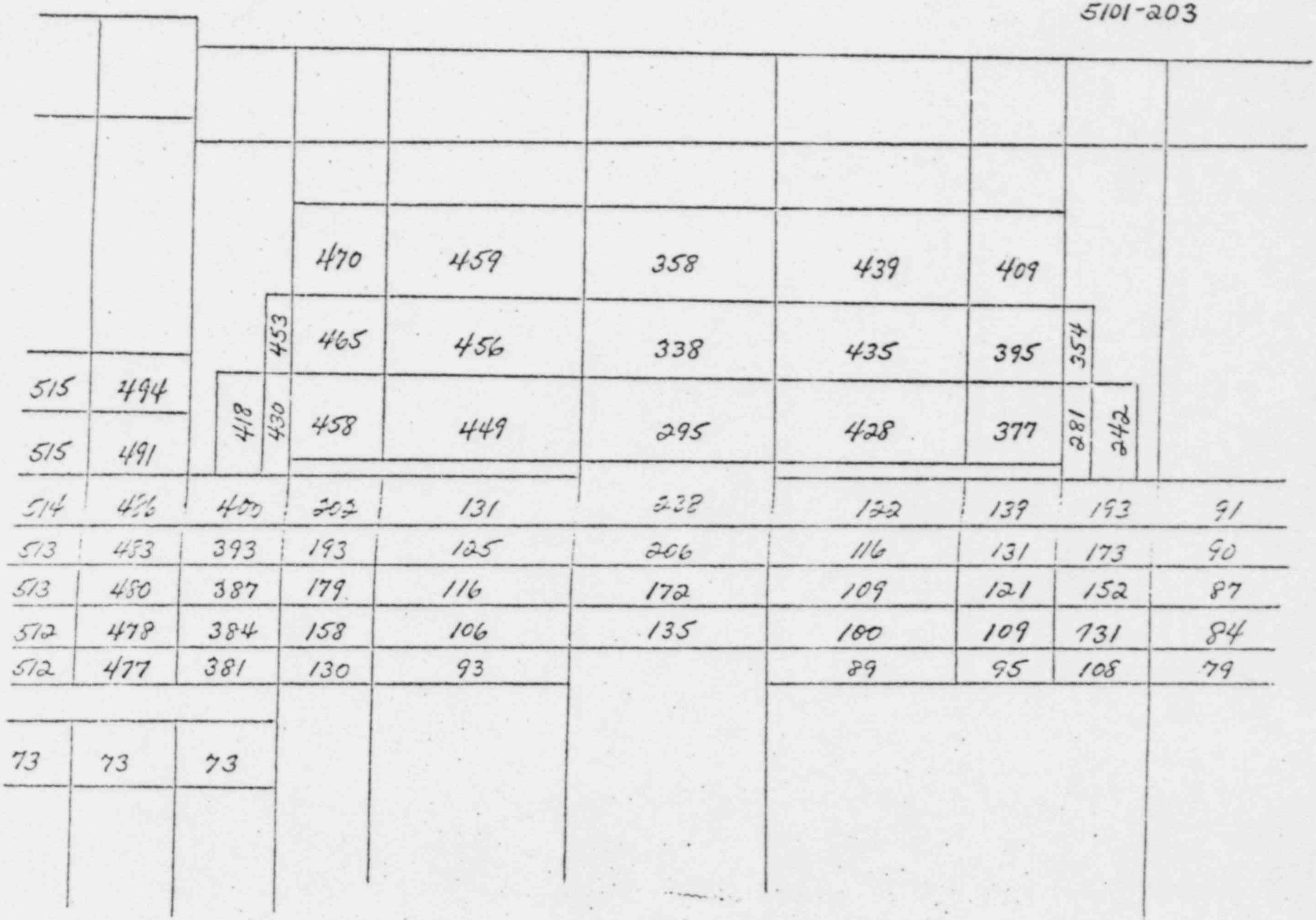
PAGE: 53/37
5101-203

FIGURE 27 - NODE TEMPERATURES AT TIME = 15.0 sec



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PAGE: 34/37
5101-203

FIGURE 28 - NODE TEMPERATURES AT TIME = 20.0 sec

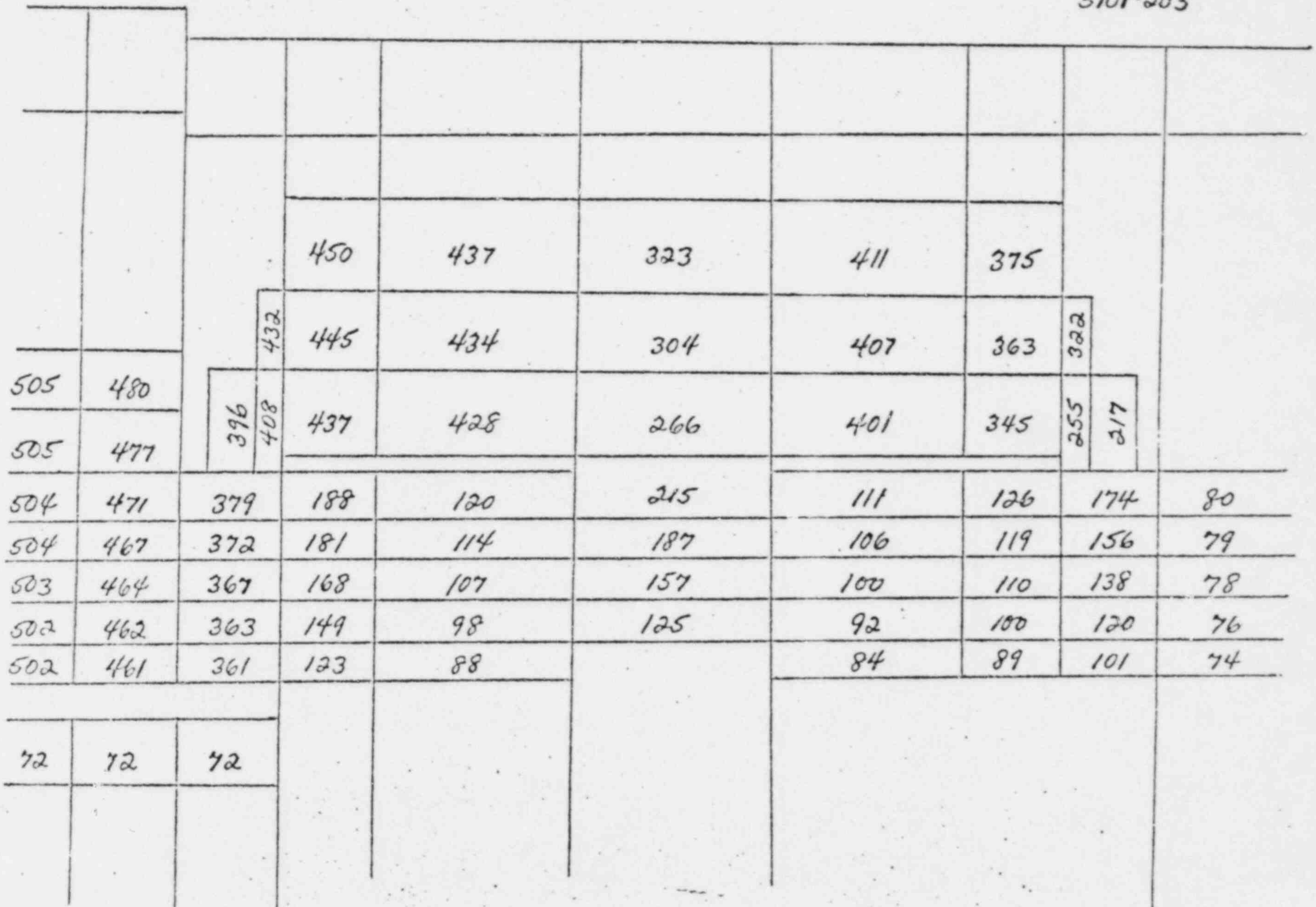

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FIGURE 29 - NODE TEMPERAT...ES AT TIME = 25.0 sec

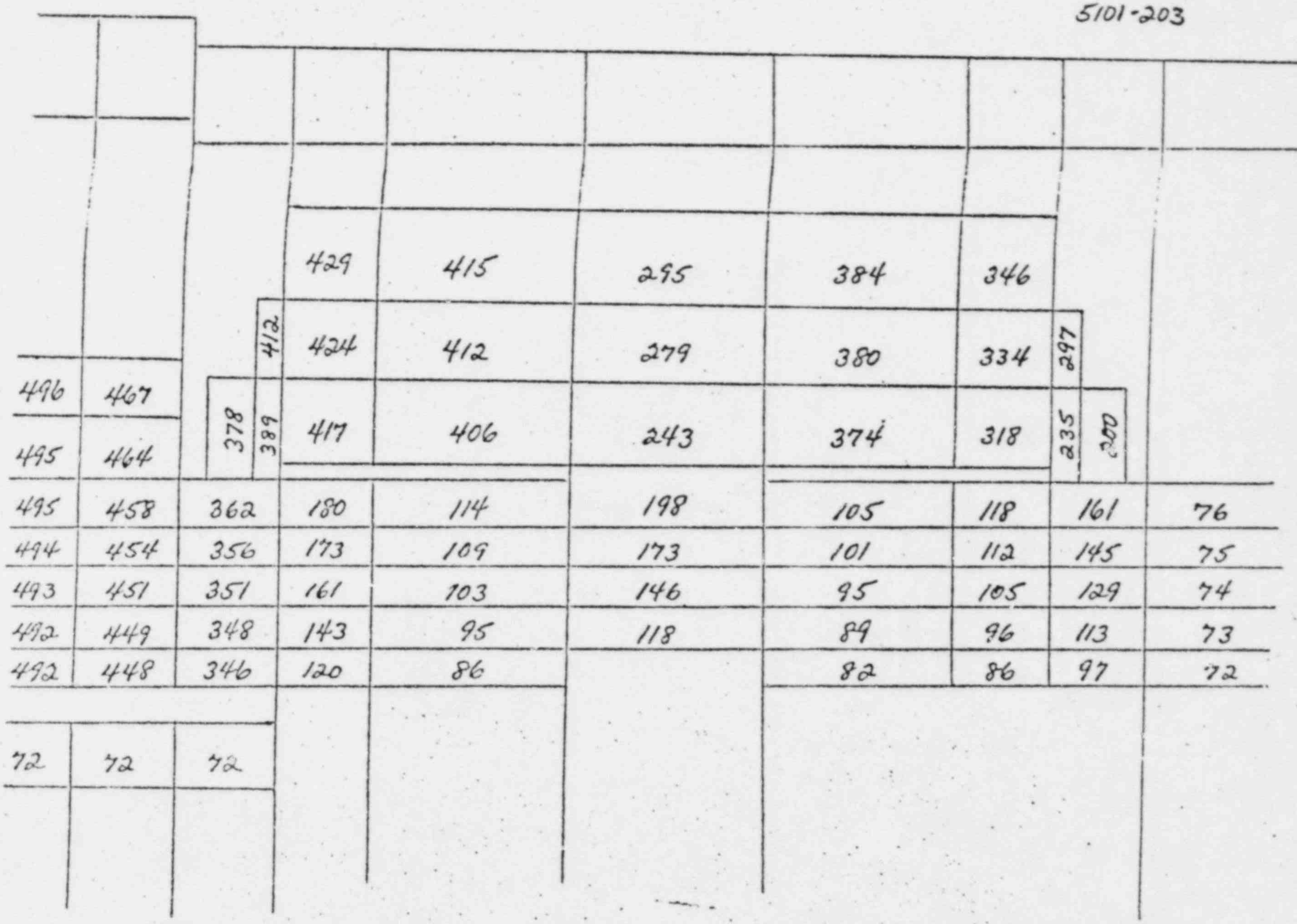

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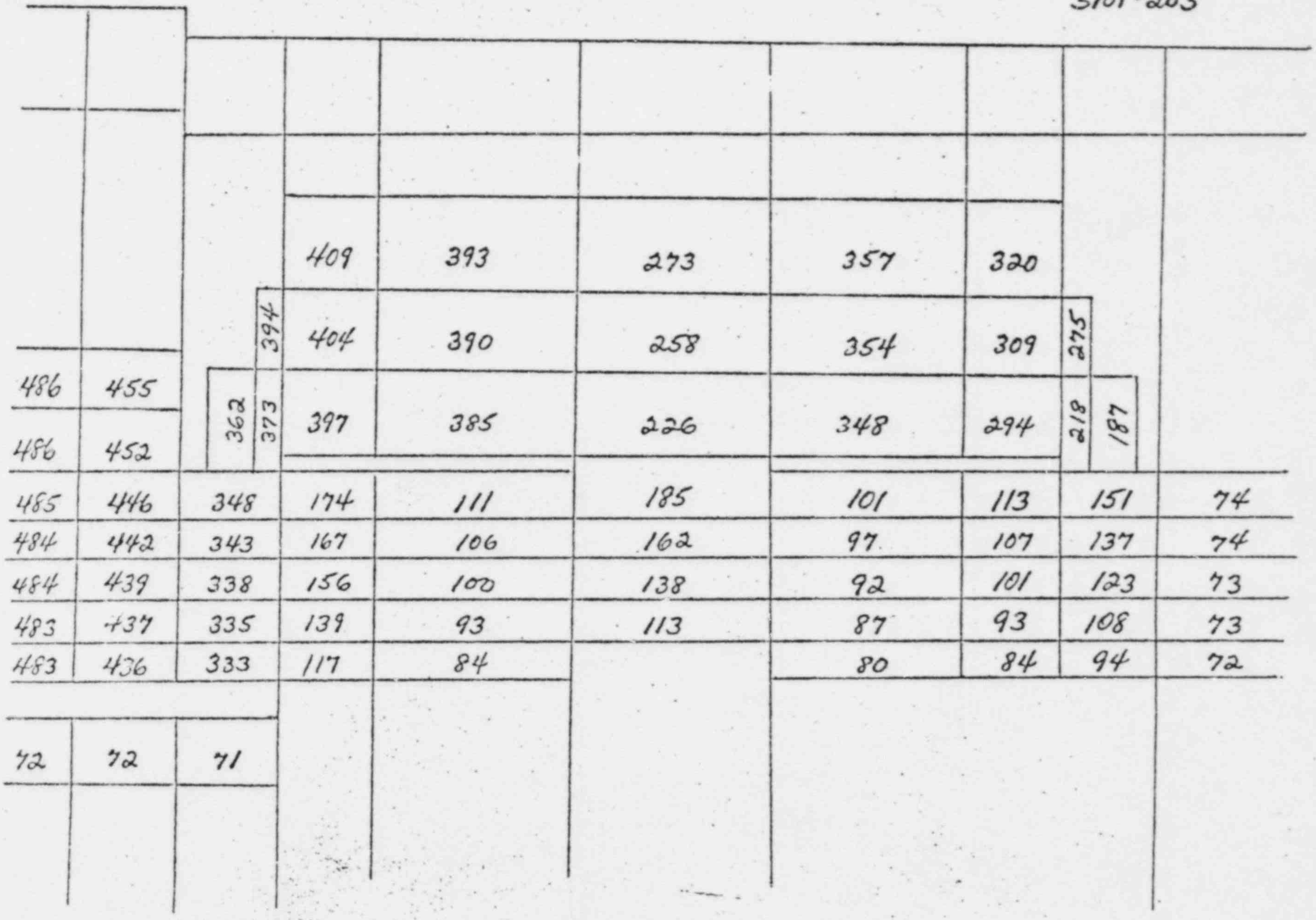
FIGURE 30 - NODE TEMPERATURES AT TIME = 30.0 sec



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2) LETTER TO I. HUSSAIN FROM H.A. TOWSLEY, DAIRYLAND POWER COOPERATIVE, NO. LAC-3477, OCT. 29, 1975.

3) ORNL-TM-3645. "NUCLEAR PIPING DESIGN", OAK RIDGE NATIONAL LABORATORY AND TELEDYNE MATERIALS RESEARCH (UNDER SUBCONTRACT NO. 3059 WITH UNION CARBIDE CORP., NUCLEAR DIVISION), FEB. 1972.

4) LACROSSE BOILING WATER REACTOR - SAFEGUARDS REPORT FOR OPERATING AUTHORIZATION - AEC CONTRACT NO. AT(11-1)-850, REVISED AUG. 1967 VOL. II P. A-4, AND FIG A-18.

5) LION 4 RUN #1, "LACBWR ECCS SEISMIC THERMAL STEADY STATE - COUPLING INCLUDED," 11-19-75.

6) LION 4 RUN # 2, "LACBWR ECCS SEISMIC THERMAL TRANSIENTS - COUPLING INCLUDED," 12-02-75.