BUCKLE
AN ANALYTICAL COMPUTER CODE
FOR CALCULATING CREEP BUCKLING
OF AN INITIALLY OVAL TUBE

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BUCKLE
AN ANALYTICAL COMPUTER CODE FOR CALCULATING
CREEP BUCKLING OF AN INITIALLY OVAL TUBE

INTRODUCTION

BUCKLE is a one dimensional computer code compiled to calculate the change in ovality, of an initially oval, closed end finite length tube, as a function of time, temperature, neutron flux and uniform external pressure. The basic concept employed in BUCKLE is that a tube, which is slightly out-of-round, tends to become more out-of-round with time when subjected to net uniform external pressures. The timewise change in ovality occurs as a consequence of creep deformations arising from tangential compressive and tangential bending stress produced by uniform external pressures acting on an initially oval tube.

Standard tube specifications all permit a small amount of ovality in each tube. This aspect provides a realistic basis for the use of ovality-stress-creep relationships for calculating the time dependent conditions for buckling instability which are more commonly known as creep buckling or creep collapse.

Although the analytical mechanics model is one dimensional, stress biaxiality and material anisotropy effects are indirectly included through the selection of the stress coefficient in the creep equation model.

In a finite length closed-end tube under a net uniform external pressure, there will be an added stiffening effect due to the axial traction forces arising from the tube deformation. These axial traction forces vary in both magnitude and direction about the circumference of the tube and tend to retard further collapse deformation. This stiffening effect is taken into account in the buckling and collapse equations as a modifier to the infinite tube solution.

This report briefly describes the stress-ovality-creep relationships used in BUCKLE to calculate the timewise change in tube ovality due to creep deformation.

BASIC ROUTINES AND CALCULATIONS

BUCKLE

This is the main routine which:

- Defines the variables
- Calls input
- Reads material properties
- Calculates the critical pressure differential for the elastic buckling instability of a perfectly round tube
- calculates, at the point of maximum radial deflection, the tangential compressive and bending stresses at the:
 - a) inside surface
 - b) neutral circumferential bending surface
 - c) outside surface
- calculates the creep strains, based on a specified clad temperature, fast neutron flux, and time increment at the:
 - a) inside surface
 - b) neutral bending surface (this quantity is the magnitude of diametral creepdown due to the net external pressure)
 - c) outside surface
- calculates and sums the incremental change in ovality resulting from the calculated incremental creep strains at the inside and outside surfaces
- calculates the net external buckling pressure based on a yield criterion and the summed incremental changes in ovality.

INPUT

This subroutine calls the input of specified data and facilitates changes in input data without disturbing the logic of the main program. This subroutine also includes an option which allows the user to input specific materials properties or use those in the program library.

OUTPUT

This subroutine calls the output of the main program and facilitates changes in output data without disturbing the logic of the main program.

TERP

This subroutine provides for the linear interpolation of material property values (elastic modulus, Poisson's ratio, yield strength) as a function of temperature from tabular values listed in the code.

This subroutine also provides, by linear interpolation, incremental changes in average tube temperature, internal pressure and fast flux between specified time periods selected by the user.

ANALYTICAL MODEL - MECHANICS

STRAIN-DEFLECTION RELATIONSHIPS

An oval tube will become more oval upon the application of a net uniform external pressure. This mode of deformation is the most prevalent type of deformation mode and which generally will continue up to the point of buckling instability. It, however, is not necessarily the only mode of deformation to instability. Under certain conditions, the deformation may result in a higher mode which produces one or more wrinkles rather than the fundamental mode which produces an oval shape. Such deformational modes are most likely to occur when the tube has an internal support⁽¹⁾ or is subjected to dynamic loads⁽²⁾ and will not be considered further. These higher deformational modes also require more energy and do not represent the minimum energy failure condition. The analytical model employed in BUCKLE, to calculate the change in ovality as a function of time, is based on the analytical approaches developed by Wah and Gregory⁽³⁾ for creep buckling of a sandwich tube and Lempriere⁽⁴⁾ for creep buckling of a slightly curved end loaded column. The basic assumptions used in this analysis are:

- plane sections remain plane in bending
- there is no radial shear
- the deformed shape of the stressed tube can always be described by the equation:

$$w = w_0 \cos 2\theta \quad (1)$$

where:

w = radial deflection at any central angle θ
 w_0 = maximum radial deflection (i.e.: at $\theta=0$)
 θ = central angle.

Equation (1) describes an ellipse whose major diameter is: $d + 2 w_0$ and whose minor diameter is $d - 2 w_0$ and d is the diameter of the circle as shown in Figure 1.⁽⁵⁾

When an initially oval tube is subjected to a net uniform external pressure, Timoshenko⁽⁵⁾ has shown that the initial "as fabricated" ovality is increased as follows:

$$w = w_i P_{crit} / (P_{crit} - \Delta P) \quad (2)$$

where for a finite length closed end tube. (6-8)

$$P_{crit} = \frac{E}{(1 + .5 A^2)} \left(\frac{t}{R}\right) \left\{ \frac{1}{n^2(1 + B^2)^2} + \frac{n^2 - 1}{12(1 - \gamma^2)} \left(\frac{t}{R}\right)^2 (1 + A^2)^2 \right\} \quad (3)$$

and:

E = elastic modulus

γ = Poisson's Ratio

t = wall thickness

R = tube radius

ΔP = net uniform external pressure

n = number of collapse lobes

L = unsupported or collapsing length

A = ($\pi R/nL$)

B = ($nL/\pi R$)

When L is very large, the number of collapse lobes will be 2 and Equation (3) reduces to the well known elastic bucking equation for an infinitely long tube. (5,7,8)

The fundamental relationships which form the basis for calculating the time change in ovality due to creep are as follows:

$$a) \quad \sigma_{\theta} = \sigma_{\theta p} \pm \sigma_{\theta B} \quad (4)$$

$$b) \quad \epsilon_{\theta} = \epsilon_E + \epsilon_C \quad (5)$$

$$c) \quad \epsilon_{\theta} = \epsilon_{\theta m} - \chi \cdot y \quad (6)$$

$$d) \quad \chi = -\frac{1}{R^2} \left(w + \frac{d^2 w}{d\theta^2} \right) \quad (7)$$

where:

σ_{θ} = total tangential stress, psi

$\sigma_{\theta p}$ = tangential stress due to the action of the net uniform external pressure, psi

$\sigma_{\theta B}$ = tangential bending stress due to the ovality in the tube, psi

ϵ_{θ} = total tangential strain, inches/inch

ϵ_E = tangential elastic strain, inches/inch

ϵ_C = tangential creep strain, inches/inch

$\epsilon_{\theta m}$ = tangential strain at the centroidal plane, inches/inch

χ = change in curvature of the deformed tube, per inch

R = radial distance from the tube axis to the centroidal plane, inches

$$= R_m + w_0 \cos 2\theta$$

R_m = mean radius of the undeformed tube, inches

w = radial deflection of the stressed tube, inches

y = distance from the centroidal plane, inches

Assuming that the tube deforms in a manner that its shape is described by Equation (1), the change in curvature as expressed in Equation (7) becomes

$$\chi = 3w_0 \cos 2\theta / R^2 \quad (8)$$

If, from this point on, the analysis is restricted to the angle of maximum deflection (i.e.: $\theta=0$) the maximum change in curvature may be expressed as follows:

$$\chi = 3w / R^2 \quad (9)$$

As shown in Equation (6), the change in curvature is dependent upon the state of strain that exists in the tube wall. Using the values of unit strain at the O.D. and I.D. surfaces, the change in curvature can be defined as follows:

$$\chi = (\epsilon_{\theta OD} - \epsilon_{\theta ID}) / t \quad (10)$$

where:

$\epsilon_{\theta OD}$ = unit tangential strain at the O.D. surface

$\epsilon_{\theta ID}$ = unit tangential strain at the I.D. surface

combining Equations (9) and (10) gives

$$\frac{3t}{R^2} \cdot w = (\epsilon_{\theta OD} - \epsilon_{\theta ID}) \quad (11)$$

Equation (11) specifies the relationship between the tangential strains in the tube wall and the radial displacement from a true circle. If it is assumed that the tangential strains may consist of elastic and creep strain components, then the radial displacement may also vary with time and in proportion to the creep rates. The tangential elastic strains and creep rates are both functions of the applied tangential membrane and bending stresses. The tangential bending stresses are a function of the radial displacement which, under conditions conducive to creep, may also vary with time. For conditions wherein creep occurs, it becomes necessary to differentiate Equation (11) with respect to time to obtain the relationship between the tangential creep rates and the radial displacement rate.

$$3t \dot{w} (R_m - w)/(R_m + w)^3 = \dot{\epsilon}_{\theta OD} - \dot{\epsilon}_{\theta ID} \quad (12)$$

Equation (12) may now be solved by incremental methods wherein it is assumed that the stresses are constant throughout each time interval. The solution obtained is approximate and will tend to converge to the real solution if the time increments are sufficiently small.

In the subsequent section, the stress-pressure relationships for an oval tube are examined in order to derive a more direct relationship between tangential creep rates and the rate of change in radial displacement.

STRESS-PRESSURE RELATIONSHIPS

It has been shown⁽⁵⁾ that the resistance to further deformation provided by an oval tube, under the action of a net uniform external pressure, may be represented by the tangential force F and the bending movement M at points A and B as shown in Figure 1. In terms of the net uniform external pressure, the tangential forces and bending movements are:

$$F = \Delta P \cdot R = \Delta P \cdot (R_m + w_o) \quad (13)$$

and

$$M = F \cdot w \quad (14)$$

Equation (13) may be used to calculate the mean tangential stress in the tube wall. In this analysis, however, the LAME' equation was selected for calculating the tangential pressure stress.

$$\sigma_{\theta P} = \frac{P_i R_i^2 - P_o R_o^2}{R_o^2 - R_i^2} + \Delta P \left(\frac{R_i^2 \cdot R_o^2}{R_m^2 (R_o^2 - R_i^2)} \right) \quad (15)$$

where:

P_i = internal pressure

P_o = external pressure

ΔP = net uniform external pressure ($P_i - P_o$)

R_i = inside radius

R_o = external radius

R_m = centroidal radius

The tangential bending stresses, resulting from the bending moment M , are calculated from the curved beam equation⁽⁹⁾ as follows:

$$\sigma_{\theta B} = \frac{M}{Ae} \left(\frac{y}{R_n - y} \right) \quad (16)$$

where:

M = bending moment with respect to the centroid of the section

y = distance from the neutral bending plane (positive for distances toward the center of curvature and negative for distances away from the center of curvature. (See Figure 2)

A = net section area of the beam element (for a unit length of tubing, the net section area is simply the wall thickness of the tube.

See Figure 2)

e = distance from the centroidal radius to radius of the neutral bending plane (See Figure 2) = $\rho - R_n$

ρ = radius of curvature of the deformed tube

$$= \frac{\left[r^2 + \left(\frac{dr}{d\theta} \right)^2 \right]^{3/2}}{r^2 + 2 \left(\frac{dr}{d\theta} \right)^2 - r \frac{d^2 r}{d\theta^2}} = \frac{\left(R_m + w_0 \right)^2}{R_m + 5w_0} \Bigg|_{\theta=0} \quad (17)$$

R_n = radius to the neutral bending plane of the deformed tube

$$= \frac{t}{\ln \left(\frac{\rho + t}{\rho - t} \right)} \quad (18)$$

Equation (18) calculates the radius to the neutral bending plane of the deformed tube only if the deformed shape is such that $w = w_0 \cos 2\theta$ and $R = R_m + w_0 \cos 2\theta$.

At the outer surface:

$$y = y_o = -(0.5t + e) \quad (19)$$

At the inner surface:

$$y = y_i = (0.5t - e) \quad (20)$$

Substituting these values into Equation (16), the bending stresses are:

$$\sigma_{\theta BOD} = \frac{-M}{(R_n + e + 0.5t)} \left(\frac{0.5}{e} + \frac{1}{t} \right) \quad (21)$$

and

$$\sigma_{\theta BID} = \frac{M}{(R_n + e - 0.5t)} \left(\frac{0.5}{e} - \frac{1}{t} \right) \quad (22)$$

As shown in Equation (14), the bending moment is a function of the radial displacement w . As will become evident later, it will be convenient to express the bending stresses directly in terms of the radial deflection w as follows:

$$\sigma_{\theta BOD} = k'w \quad (23)$$

and

$$\sigma_{\theta BID} = k''w \quad (24)$$

Using Equations (23) and (24) Equation (4) may be rewritten as follows:

$$\sigma_{\theta OD} = \sigma_{\theta P} - k'w \quad (25)$$

and

$$\sigma_{\theta ID} = \sigma_{\theta P} + k''w \quad (26)$$

The stresses in Equations (25) and (26) determine the elastic and creep strains at the I.D. and O.D. surfaces of the deformed tube. Using Equations (25) and (26) the equations for total tangential strains may be written as follows:

$$\epsilon_{\theta OD} = \frac{\sigma_{\theta P}}{E} - \frac{k'w}{E} + \epsilon_{COD} \quad (27)$$

$$\epsilon_{\theta ID} = \frac{\sigma_{\theta P}}{E} + \frac{k''w}{E} + \epsilon_{CID} \quad (28)$$

and

$$\epsilon_{\theta OD} - \epsilon_{\theta ID} = -w \left(\frac{k' + k''}{E} \right) + \epsilon_{COD} - \epsilon_{CID} \quad (29)$$

Differentiating with respect to time:

$$\dot{\epsilon}_{\theta OD} - \dot{\epsilon}_{\theta ID} = -\dot{w} \frac{K}{E} + \dot{\epsilon}_{COD} - \dot{\epsilon}_{CID}; \text{ where } K = k' + k'' \quad (30)$$

Substituting into Equation (12) and rearranging:

$$\dot{w} = (\dot{\epsilon}_{COD} - \dot{\epsilon}_{CID}) / \left(\frac{3t(R_m - w)}{(R_m + w)^3} + \frac{K}{E} \right) \quad (31)$$

where:

$$\frac{K}{E} = \frac{\Delta PR_m}{E} \left\{ \left(\frac{0.5/e + 1/t}{R_n + e + 0.5t} \right) + \left(\frac{0.5/e - 1/t}{R_n + e - 0.5t} \right) \right\} \quad (32)$$

K/E is not a constant value, but changes as the eccentricity changes with ovality of the tube.

As pointed out for Equation (12) previously, Equation (31) can now be solved for the radial deflection by incremental methods using a sufficiently small time interval to obtain approximate convergence to the real solution. For the situation where the displacement and stresses change very little with time, relatively large time intervals may be used. However, as these changes become appreciable, the time interval must be reduced if reasonable convergence is required. With high speed computers, the time interval for each iteration may be selected small enough that the interval remains constant throughout all iterations. The error in this approach becomes appreciable only at relatively large deflections where the tube is rapidly approaching an instability condition.

In BUCKLE Equation (31) is the basic equation used to calculate the change in ovality due to creep in an initially oval tube.

The ovality amplification for an infinitely long tube is calculated by Equation (2) wherein w_1 is the sum of one-quarter of the initial "as fabricated" ovality plus the radial displacement calculated during the preceding time interval. For a finite length closed end tube, Equation (3) provides an ovality amplification correction.

The tangential membrane stress is calculated by Equation (15). The tangential bending stresses are calculated by Equation (21) and (22).

FIGURE 1. Half Section of a Deformed (Solid Line) and Undeformed (Dashed Line) Section of a Tube Showing the Geometrical Relationships Assuming $W = W_0 \cos 2\theta$

FIGURE 2. A Unit Length Segment of Tubing Showing the Pertinent Dimensions for Calculating the Bending Stress in a Curved Beam

ANALYTICAL MODEL - CREEP

There are no published data describing the creep and collapse behavior of Zircaloy clad tubing when subjected to the combined effects of biaxial compressive stresses, temperatures and neutron flux as exist in pressurized water reactors. However, there are limited creep data (number of tests and range of variables) which have been obtained from uniaxial and biaxial tension stress tests at temperatures and fast neutron fluxes generally characteristic of both pressurized and boiling water reactors. Because there are no available data describing creep and collapse under biaxial compressive stress conditions, the uniaxial and biaxial tension stress data has been used in formulating the analytical creep model. There is some risk of error in this approach because of anisotropy in the mechanical properties of zirconium and the Zircalloys. There are recent data⁽¹⁰⁾ which show a significant asymmetry in the yield locus for Zircaloy tubing subjected to internal and external pressures. A similar asymmetry in creep behavior may also exist although there generally is no direct correspondence between yield and creep strength.

The clad tube material, now commonly used for fuel cladding, is Zircaloy 2 or 4. The mechanical properties of these two alloys are quite similar and no distinction will be made for these two alloys. Most of the creep data available and used in formulating the analytical creep model was obtained from Zircaloy 2.

Equation 31 shows the relationship between hoop strain and radial deflection. The change in radial deflection with time, will be determined by the creep strain during a specified time interval. For this reason, the analytical creep model includes both transient (primary rate) and steady-state (secondary rate) creep behavior.

STEADY-STATE CREEP

The steady-state creep behavior of Zircaloy is strongly influenced by temperature, stress and neutron irradiation (>1 MeV). Microstructure--anisotropy, grain size and second phase precipitates may also influence

the steady-state creep behavior. Figure 3⁽¹¹⁾ illustrates the influence of stress and temperature on the uniaxial secondary creep rate in the absence of neutron irradiation. Figures 4, 5, 6 and 7⁽¹²⁾ illustrate the effects of stress and fast neutron flux on the diametral (tangential) creep while Figures 8 and 9⁽¹²⁾ illustrate effects of stress state and anisotropy on the creep behavior of Zircaloy 2. Figure 10⁽¹³⁾ illustrates effects of temperature on the in-reactor secondary creep rate of cold-worked Zircaloy 2. These data, together with other experimental data⁽¹⁴⁻¹⁸⁾ and published analytical creep models^(14,18-25) were used in formulating the steady-state analytical creep model.

Watkins and Wood,⁽¹⁴⁾ and Nichols⁽¹⁹⁾ have presented data and theories suggesting that the stress dependence of in-reactor creep is not readily described by a simple power function over wide ranges of stress. Based on the analysis of data,^(12,14) Watkins and Wood concluded that the stress dependence for in-reactor creep, under uniaxial and biaxial tension stresses, may be represented by the functional form, $\sinh(k\sigma)$ (see Figure 11). This functional form approximates a changing exponent in a power function, and will always take into account the algebraic sign (negative = compression and positive = tension) of the creep stresses. For these reasons, the functional form, $\sinh(k\sigma)$, was selected to define the stress dependence for the analytical creep model.

The in-reactor creep data obtained by Fidleris⁽¹³⁾ and Holmes⁽¹⁵⁾ suggest that the thermal activation for in-reactor creep is not constant over wide ranges of temperature (see Figure 10). Nichols,⁽¹⁹⁾ Gilbert⁽²¹⁾ and Piercy⁽²³⁾ theorize that certain creep mechanisms may be activated by fast neutron flux energies at temperatures where activation by thermal energy is relatively low. Figure 12 by Gilbert⁽¹⁹⁾ shows the postulated effects of neutron radiation over a fairly wide range of temperatures. The curves, shown in Figure 12, suggest that there are temperature ranges where neutron irradiation enhances creep and temperature ranges where creep strengthening occurs. In the temperature range of 300 to 350°C a discontinuity in

the $\text{Log } \dot{\epsilon}$ versus $1/T$ curve is shown suggesting that there is a basic change in creep mechanisms if it is assumed that the activation of creep mechanisms are entirely thermally controlled. Alternatively, one might speculate that a plot of $\text{Log } \dot{\epsilon}$ versus "total energy" (thermal + neutron) may result in a smooth continuous curve. Considering the data shown in Figure 10 and the postulated behavior shown in Figure 12, it appears that the analytical creep model should use separate thermal activation energies for two temperature ranges defined as follows:

- A "low" temperature range wherein the activation of creep mechanisms occurs as a result of the combined effects of neutron and thermal energy.
- A "high" temperature range wherein the activation of creep mechanisms occurs predominantly from thermal energy.

If the activation of creep mechanisms at "low" temperatures is indeed a result of the combined effects of neutron and thermal energy, then the total activation energy should consist of a thermal component and a fast neutron flux component. In several of the irradiation creep models^(14,24,25) the fast neutron flux effect is modelled by a simple power function and the thermal effect by an exponential function as follows:

- neutron flux effect = $k \phi^n$
- thermal effect = $\exp (QI/RT)$

where:

ϕ = fast flux ($E > 1 \text{ MeV}$)
 n = flux exponent ranging from 0.4 to 0.85^(14,24,25)
 QI = thermal activation energy - calories/mole
 R = universal gas constant
 T = temperature - $^{\circ}\text{K}$.

This approach was selected for the "low" temperature range creep model. Alternatively, the thermal activation and the fast neutron flux

activation terms could be combined in an exponential function. More experimental data, however, are needed in either approach to determine whether the thermal and fast flux activation energy terms are individually constant or their sum are constant throughout the "low" temperature range.

In the "high" temperature range, there appears to be a growing consensus that the activation of creep mechanisms occurs primarily as a result of thermal energy. Additional in- and ex-reactor creep data are needed to establish whether or not there is any minor fast neutron flux enhancement throughout the "high" temperature range. The data of Fidleris⁽¹³⁾ and Holmes⁽¹³⁾ (see Figure 10) were used to determine the "high" temperature creep activation energy.

For steady-state creep the analytical models are as follows:

- Low temperature range

$$\dot{\epsilon}I = BI \phi^n \exp (QI/RT) \sinh (SCI \cdot \sigma) \quad (33)$$

- High temperature range

$$\dot{\epsilon} = B \exp (Q/RT) \sinh (SC \cdot \sigma) \quad (34)$$

where

B = high temperature creep coefficient

BI = low temperature creep coefficient

ϕ = fast flux - $E > 1$ MeV

n = fast flux exponent

Q = high temperature activation energy - calories/mole °K

QI = low temperature activation energy

R = universal gas constant

T = temperature °K

σ = tangential stress - psi

SC = stress coefficient for high temperature range

SCI = stress coefficient for low temperature range

The computer code is programmed to always select the larger of the creep rates calculated by Equations (33) and (34).

Figure 13 shows the steady-state creep rate versus $1/T$ as calculated by Equations (33) and (34). The biaxial tensile creep data obtained by Watkins and Wood,⁽¹⁴⁾ and by Ibrahim⁽¹⁷⁾ were used to evaluate the coefficients BI, QI and SCI used in Equation (33). Figure 11 also shows the fit of the curve of creep rate versus biaxial tensile stress, as Equation (33), to the data of Watkins and Wood,⁽¹⁴⁾ and Ibrahim,⁽¹⁷⁾ and Ross-Ross and Hunt⁽¹⁸⁾ normalized to a temperature of 263°C and a fast neutron flux of 2.9×10^{13} nvt. The uniaxial tensile creep data obtained by Holmes⁽¹⁵⁾ and Fidleris⁽¹³⁾ were used to evaluate the B, Q and SC coefficients used in Equation (34). Uniaxial or biaxial compressive creep data are not available for use in evaluating these coefficients. It is not expected that either stress state or direction will have any appreciable effect on the creep activation energies as used in Equation (34). Considering the anisotropy and asymmetry observed in yield strength, the B, BI, SC and SCI coefficients may be significantly influenced by stress state and direction. As pointed out earlier, there is some risk of error in using uniaxial and biaxial tensile creep data to predict creep behavior under biaxial compressive stress conditions.

TRANSIENT CREEP

Transient creep is generally represented by a time hardening equation to model the reduction in creep rate as steady-state creep is approached. It was assumed that transient creep has the same stress, temperature and fast flux dependence as steady-state creep. With these assumptions the transient creep function has the form:

$$\dot{\epsilon}_T = \alpha k \exp(-k\tau) \cdot f(\phi, Q, QI, T, \sigma) \quad (35)$$

where

$$\dot{\epsilon}_T = \text{transient creep rate - inches/inch hr}$$

α = transient creep coefficient*

k = time coefficient*

τ = time in hours

$f(\phi, Q, QI, T, \sigma)$ = flux, temperature and stress functions
for steady-state creep.

EFFECTS OF ANISOTROPY AND STRESS STATE

According to accepted yield and flow theory for metals, yielding and plastic deformation in response to an applied stress is dependent upon both the magnitude and state of applied stress. Under biaxial tension or compression, the effective strength for an isotropic material would be greater than for uniaxial tension or compression by a factor of up to 1.15. Assuming a direct proportionality between stress state and strain state, the effective strain resulting from biaxial tension or compression would be less than that from uniaxial tension or compression by a factor decreasing to 0.866.

As shown in Figure 8, in-reactor creep rates under biaxial tension (internally pressurized closed end tube; i.e., $\sigma_\theta = 2\sigma_a$) test conditions are consistently less than is the case for uniaxial stress test conditions. Ibrahim⁽¹²⁾ attempted to correlate the uniaxial with biaxial tensile creep data using correlation factors based on isotropic and anisotropic considerations. Based on known texture coefficients, the correction factor for biaxiality was determined to be 0.5. The correlation between uniaxial and biaxial creep rates is shown in Figure 9. Schroeder and Holicky⁽²²⁾ also examined the effects of anisotropy from a continuum mechanics approach and based on the data used by Ibrahim, determined an adjustment factor for biaxiality of $0.64 < A_{\theta\theta} < 0.83$. These results provide a rational basis for adjusting stress coefficients to account for stress state and material anisotropy. For in-reactor creep in the low temperature range, as des-

* The values for these coefficients were determined from data reported by Fidleris⁽¹³⁾

cribed by Equation (33) the low temperature stress coefficient was determined directly from biaxial tensile creep data. Figure 11 shows the fit of Equation (33) to the available biaxial tensile creep data normalized to a fast flux of 2.9×10^{14} nvt and a temperature of 260°C.

For in-reactor creep in the high temperature range, as described by Equation (34), an attempt was made to determine the stress coefficients in the same manner as for the low temperature range. There is, however, less data for the high temperature range which can be used to establish the creep rate dependency on both stress magnitude and biaxiality. Because there is little high temperature, biaxial tensile creep data, the correction factor for stress biaxiality as suggested by Ibrahim⁽¹²⁾ is used even though there appear to be different creep rate-stress dependencies for the two temperature ranges. Figure 13 shows the creep rate data obtained by Holmes⁽¹²⁾ and Fidleris⁽¹³⁾ for a uniaxial stress of 20,000 psi superimposed on the curve of creep rate versus $1/T$ °K as calculated by Equation (34) for an effective hoop stress of 40,000 psi.

There are no published data regarding in-reactor creep under uniaxial or biaxial compressive stress. Stehle⁽²⁶⁾ reports that for Zircaloy tubing, the creep rates under biaxial compression (externally pressurized closed end tube) are less than for biaxial tension (internally pressurized closed end tube), but provided no data to establish any quantitative relationship. In contrast, Dressler⁽¹⁰⁾ reports that the yield strength under biaxial compression is less than for biaxial tension. Although the above observations by Stehle and by Dressler appear to be in conflict, they nevertheless, suggest that yielding and plastic flow are affected by stress direction as well as stress state. The apparent conflict in the above observation (e.g., creep strengthening and yield softening) may be due in part to differences in the texture of the two materials. Until creep data, obtained under biaxial compressive stress states, become available, it will be necessary to use the biaxial tensile and uniaxial tensile data with Ibrahim's⁽¹²⁾ correction in the formulation of the creep equations for creep collapse calculations.

FIGURE 3. Effect of Stress and Temperature on the Uniaxial Thermal Creep Rate (From Reference 10)

FIGURE 4. Creep Curves for Diametral Creep of Zircaloy-2 Tubes in a Fast-Neutron Flux of $2.56 \times 10^{13} \text{ n/cm}^2\text{s}$ ($>1 \text{ MeV}$) at 258 C. (From Reference 9)

FIGURE 5. Creep Curves for Diametral Creep of Zircaloy-2 Tubes in a Thermal Neutron Flux of 1.4×10^{13} to $1.5 \times 10^{14} \text{ n/cm}^2\text{s}$ at 258 C. (From Reference 9)

FIGURE 6. Creep Curves for Diametral Creep of Zircaloy-2 Tubes Out-Of-Flux at 258 C. (From Reference 9)

FIGURE 7. Tubular Creep Rates of Zircaloy-2 in and out of Fast-Neutron Flux at 9000 h and 258 C. (From Reference 9)

FIGURE 8. In-Reactor Creep Rates of Zircaloy-2 for Small Tubes, Pressure Tubes, and Uniaxial Tests Adjusted to 260 C and 2.5×10^{13} n/cm²s. The Tube Hoop Stresses and Diametral Creep Rates have been Adjusted Assuming the Deformation to be Isotropic. (From Reference 9)

FIGURE 9. In-Reactor Creep Rates of Zircaloy-2 for Small Tubes, Pressure Tubes, and Uniaxial Tests Adjusted to 260 C and 2.5×10^{13} n/cm²s. The Tube Hoop Stresses have been Adjusted by 0.5 Based on the Texture Coefficients. (From Reference 9)

FIGURE 10. Temperature Dependence of In-Reactor Creep Rate of Cold-Worked Zircaloy-2 at 14.1 kg/mm^2 Stress (20,000 psi). ● AECL results in reactor; ○ AECL results in laboratory; ▲ Holmes et al.¹¹⁾ in reactor; △ Holmes et al.¹¹⁾ in laboratory; 1---Ibrahim¹⁶⁾ lab. data at constant strain of 0.5%; 2---Ibrahim¹⁶⁾ lab. data after constant time of 100 h. (From Reference 10)

FIGURE 11. Published Biaxial Tensile Creep Data Normalized to ϕ 2.9 E 13 nvt and Temperature = 263°C. The Solid Curve was Calculated with the Low Temperature Creep Equation.

FIGURE 12. In-Reactor Creep of Cold-Worked Zircaloy-2 Showing Effect of Fast Neutron Flux on Creep Rate. (From Reference 17)

FIGURE 13. Creep Rate Versus Absolute Temperature as Calculated by the Creep Equation used in BUCKLE. Included are the High Temperature Tensile Creep Data at 20 ksi to Show the Effect of Ibrahim's Correction Factor for Uniaxial-to-Biaxial Stress State

COLLAPSE CRITERION

In the mechanics and creep model sections, the interrelationships between tangential strain, radial deflection and material creep rates were derived. These interrelationships determine the rate of change in clad tube ovality as a function of the environmental parameters of temperature, neutron flux and net uniform external pressure. At some ovality the tube becomes unstable and collapses.

The instantaneous buckling of tubes, under external pressure, has been rather extensively investigated. Based on experimental data and theoretical considerations, several buckling equations have been formulated.⁽⁵⁻⁸⁾ Of these buckling equations only two include the effects of the ovality of the tube. In one approach, the effect of tube deformation is accounted for indirectly by replacing the elastic modulus with a tangent, or "reduced" modulus in the theoretical elastic buckling equation.

$$P_{cr} = E' (t/R)^3 / 4 (1 - \gamma^2) \quad (35)$$

where

P_{cr} = critical collapse pressure

E' = tangent, secant or reduced modulus

t = tube wall thickness

R = mean tube radius

γ = Poisson's Ratio

The "reduced" modulus has been defined in terms of the tangent⁽³⁰⁾ and secant⁽³¹⁾ moduli as follows.

$$E_R = 4 E E_t / (\sqrt{E} + \sqrt{E_t})^2 \quad (35)$$

and

$$E_R = E_S [1 - (1 - E_t/E_S) / 1 - (1 - 4\gamma^2) E_t / 3 E_S]$$

where

E_t = tangent modulus

E_S = secant modulus

Slattery⁽³²⁾ found that the calculated instantaneous collapse pressures, based on a "reduced" modulus, compared well with experimental collapse pressure for cold-worked and stress relieved Zircaloy-2 tubing at both 24°C and 300°C. The "reduced" modulus was determined from tensile stress-strain data. For fully recrystallized Zircaloy-2 tubing, the calculated collapse pressures were always less than experimentally measured collapse pressures. The differences between experimentally measured and calculated collapse pressures were attributed to anisotropy in the elastic moduli for fully recrystallized tubing.

Sturm⁽⁶⁾ developed direct interrelationships between collapse pressure, allowable stress, ovality, number of collapsing lobes and length for a closed end tube under a net uniform external pressure.

$$P_{cr} = \sigma(t/R) \left\{ 1 + \frac{6w}{t} \left(\frac{P_c}{P_c - \Delta P} \right)^2 \left(\frac{n^2 - 1 + \gamma(\pi R/L)^2}{3K(1 - \gamma^2)} \right) \right\} \quad (38)$$

where

P = critical collapse pressure

P_c = critical instability pressure based on elastic buckling
calculated from Equation (35) using the elastic modulus

ΔP = net external pressure

σ = allowable stress

t = tube wall thickness

R = Mean tube radius

w = Radial deflection (f.e.: Ovality/4)

γ = Poisson's Ratio

n = number of collapsing lobes

L = unsupported length of the tube

K = an empirical constant dependent upon the physical restraints
on the ends of the tube and the end loading

For an infinitely long tube, Equation (38) becomes the more familiar
Timoshenko⁽⁵⁾ equation for the collapse pressure of an oval tube.

$$P_{cr} = \sigma(t/R) \left[1 + \frac{6w}{t} \left(\frac{P_c}{P_c - \Delta P} \right) \right] \quad (39)$$

The extreme value of allowable stress is generally assumed to be the yield strength of the tubing. Equation (39) was selected for calculating the collapse condition because it is a direct function of yield strength and clad tube ovality. Using Equation (39), the collapse pressure was calculated as a function of t/R for a yield strength of 35 ksi, 50 ksi, and 70 ksi. The results of these calculations are plotted in Figure 14 for comparison with the collapse pressures predicted by the "reduced" and tangent modulus methods.⁽³²⁾ Slattery⁽³²⁾ did not report the yield strength for the Zircaloy-2 tubing used in his collapse experiments. Based on the tensile properties of Zircaloy-2 clad tubing reported by Pickman,⁽³³⁾ the yield strength of the clad tubing used by Slattery,⁽³²⁾ in collapse tests, should be in the range of 50 ksi to 60 ksi. As shown in Figure 14, instantaneous collapse pressure, as calculated by BUCKLE, for an infinitely long tube with a yield strength of 50 ksi, compares well with the instan-

aneous collapse pressure calculated by the "reduced" modulus method for t/R ratios to about 0.12. For the cycle 1B fuel, the t/R ratio is approximately 0.122. Based on the calculational results shown in Figure 14, it appears that a yield strength collapse criterion is acceptable for use in a collapse analysis.

FIGURE 14. Comparisons of Calculated Instantaneous Collapse Pressures Based on a Reduced and Tangent Modulus⁽³²⁾ and Yield Strength (BUCKLE) at 3000C for a Tube with 0.0005 Inches Initial Ovality

COMPARISON WITH OBSERVED CREEP COLLAPSE

The range of collapse times⁽²⁷⁾ observed for fuel cycle 1B in the R. E. Ginna plant is shown in Figure 15. Also shown in Figure 15 are the time-to-collapse curves for several combinations of temperature, fast neutron flux and pressure differential for both an infinitely long (>5 clad tube diameters) and a finite length (<1.5 in.) axial gap in the fuel column within the fuel rod clad tube. The clad tube dimensions used are those listed in the R. E. Ginna Technical Specifications.⁽²⁸⁾ Although the operating history details for fuel cycle 1B are not precisely known, the range of temperatures and neutron flux are estimated to bracket conditions that may exist at an axial gap within the fuel column of a PWR fuel rod.

For the range of variables examined, the collapse times calculated by BUCKLE, assuming an infinitely long axial gap in the fuel column, are less than the minimum observed collapse time for cycle 1B fuel. Assuming a 1 inch long axial gap to be the minimum gap for which collapse occurred, the collapse times, calculated by BUCKLE for a closed-end, finite-length tube under uniform external pressure, are within the minimum observed collapse times with one exception. In all but one instance, however, the calculated collapse times are within the lower half of the time range for collapse observed in cycle 1B fuel. Assuming that the range of variables examined adequately bracket the operating conditions for cycle 1B fuel, there must be other factors which contribute to the rather wide range of observed collapse times. Some of the factors which may account for part of the variability in observed collapse times are discussed in the following sections.

VARIATIONS IN AXIAL GAP LENGTH

Figure 15 shows the variation in creep collapse time for an axial gap in the fuel column of $2\frac{1}{2}$ clad tube diameters, 10 clad tube diameters, and the range of variables of temperature, fast neutron flux and pressure

differential assumed to bracket cycle 1B operating conditions. Figure 15 shows that the variation in creep collapse time may range to 5000 hours, depending upon the variables of temperature, neutron flux and pressure differential. This range, however, is still less than the observed range by about 2000 hours. The actual minimum axial gap, which existed at any collapse section in cycle 1B fuel, will probably not be known until such fuel rods have been destructively examined. Based on remote, underwater visual examinations, the smallest collapse section length was reported⁽²⁹⁾ to be about 0.6 inches. On this basis, variations in the length of the axial gap as observed in cycle 1B fuel may account for at least one-half of the observed collapse time range.

VARIATIONS IN LOCAL FUEL ROD POWER AND BURNUP

The axial power profile for each fuel rod will generally change with burnup and the mode of reactor operation during each fuel cycle. At a particular axial position on a fuel rod, the timewise change in axial power and burnup will result in timewise changes in clad temperature, neutron flux and pressure buildup within the fuel rod. The calculational model for creep collapse in BUCKLE is dependent upon the variables of temperature, flux and pressure differential. Considering the differences between calculated and observed collapse times, as shown in Figure 15, the timewise variations in temperature, flux and pressure differential do not appear to be adequate to account for the entire difference. The calculations, wherein the pressure differential was linearly decreased with time, however, indicate that some of the variation in observed collapse time may be attributed to variations in local fuel rod power and burnup. For this reason, the option to change these variables stepwise or linearly with time has been programmed into BUCKLE.

VARIATIONS IN INITIAL OVALITY

Figure 16 shows the effect as calculated by BUCKLE of initial fuel clad tube ovality on the creep collapse time. There is no information as to the range of initial ovalities in the clad tubes in cycle 1B fuel. Considering potential mechanisms by which an axial gap in the fuel column can form it seems unlikely that axial gaps of a critical length for creep

collapse will form in tubes with either very small or very large ovalities. In tubes with very small initial ovalities, it is unlikely that sufficient contact forces are developed between the clad tube and fuel pellet to cause fuel column separation as the fuel densifies and shrinks. Conversely, in tubes with large initial ovalities, significant contact forces can develop from differential thermal expansion of the fuel and clad upon reaching operating temperatures and pressure. In such a fuel rod, axial separation, which occurs as the fuel densifies and shrinks, is likely to occur at many of the fuel pellet interfaces resulting in many small axial gaps throughout the fuel column. Based on these hypotheses, it seems reasonable to assume that axial gaps of a critical size for creep collapse are most likely to occur in fuel rods with initial clad tube ovality in the range of 0.0006 to 0.0012^(a) inches. As shown in Figure 15, the range of collapse times for this range of initial ovality is about 2000 hours, or less than one-half of the range of collapse times observed in cycle 1B fuel.

FUEL DENSIFICATION RATE EFFECTS

There appears to be little doubt that fuel densification was a key factor in forming the axial fuel column gap at which clad collapse occurred.^(b) As yet, the mechanism for densification has not been completely identified or understood. It appears, however, that a finite period of time is necessary for the occurrence of densification. Axial shrinkage of each fuel pellet probably occurs simultaneously with densification. The formation of an axial gap of a critical length appears to be somewhat of a chance occurrence since only about 10% of the fuel rods in cycle 1B fuel sustained collapse.⁽²⁷⁾ Assuming that the axial gap forms simultaneously and at the same rate as fuel densification occurs, the time to form an axial gap of critical size is estimated to be about 50% of the time over which fuel densification occurs. The basis for this estimate is that creep collapse was observed with axial gaps less than theoretically possible from complete in-reactor fuel densification. Although in-reactor densification

(a) Under a pressure differential of 2000 psi, this ovality range will be 0.001 to 0.002 inches.

(b) The reader should consult the USAEC Directorate of Licensing Staff Report⁽²⁷⁾ for details of the densification and collapse phenomena.

may occur rather rapidly, it can, in most cases, be expected to delay the onset of creep collapse.

Of the factors considered, all but the effect of in-reactor densification rate have been shown to be potentially major factors in accounting for the rather wide range of creep collapse times observed in cycle 1B fuel. Accordingly, BUCKLE has been programmed so that the user may take some of these factors into account in a creep collapse analysis.

FIGURE 15. Comparison of Collapse Times as Calculated by BUCKLE with Observations from the R. E. Ginna Plant. The Lower Three Curves were Obtained with the Low Temperature Creep Equation as Derived from Biaxial Tensile Creep Data. The Upper Three Curves were Obtained with the Same Creep Equation but with Collapse Conditions for a Closed End Finite Length Tube

FIGURE 16. Effects of Initial Ovality on the Calculated Time to Collapse by Creep with Collapse Conditions for a Closed End, Finite Length Tube under Uniform External Pressure

CODE USAGE LIMITATIONS

BUCKLE was compiled to calculate the change in ovality of an initially oval tube as a function of time, temperature, neutron flux and net uniform external pressure. The code makes use of an analytical mechanics model and an analytical creep model to calculate the changes in ovality. The assumptions used in formulating the analytical mechanics model necessarily place certain restrictions on the applicability to problems of buckling instability. These limitations are as follows:

1. BUCKLE does not provide the capability to calculate creep-buckling for a perfectly round tube. The analysis for such a case typically uses the "reduced modulus" method wherein the modulus is determined from isochronous creep curves.

2. The time increment used in BUCKLE must be small enough so that approximate convergence to a real solution is obtained. The convergence is generally adequate when the time increment is less than 2% of the collapse time. For short collapse times, a time interval of less than 1% should be used.

3. The stress-deflection equations used in BUCKLE are based on linear elastic theory. For engineering purposes, the creep-collapse time will be given with sufficient accuracy by this simplified theory which neglects plasticity. Creep-buckling analyses, however, should not be attempted when the stresses exceed the yield strength of the tubing.

4. BUCKLE does not provide the capability to calculate creep-buckling for a tube which is subjected to an eccentric axial load in addition to a uniform pressure load. Other methods must be used for the analysis in such cases.

The form of the analytical creep model used in BUCKLE is one of the standard generally used to describe creep behavior. Other analytical creep models may be equally suitable for calculating creep strains. The coefficients used in the analytical creep model have been derived from published uniaxial and biaxial stress creep data. The metallurgical characteristics of these test materials may not be exactly representative of current production Zircaloy fuel clad tubing. For these reasons, the User may choose to use other creep equations or select coefficients so as to obtain the best fit to data applicable to tubing for which a creep-collapse analysis is to be made.

The equations for calculating elastic buckling (Equation 3) and collapse by yielding (Equation 38) include a correction for the stiffening effect of a finite length closed end tube. In Equation (3), the correction was based on theoretical considerations⁽⁷⁾ assuming isotropic material behavior. In Equation (38), the correction was determined empirically for an essentially isotropic material.⁽⁶⁾ Some modification of the correction for the stiffening effect of a finite length, closed end tube, may be required because of anisotropic material behavior. Furthermore, the constraint conditions at the ends of an axial gap in the fuel column of a fuel rod may not be identical to those at the tube ends in Sturm's experiments.⁽⁶⁾ For these reasons, the correction for finite length, closed end tube effects, must, as yet, be regarded as an approximation.

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APPENDIX

CODE INPUT

CODE INPUT

A - Title Card

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
Any alphanumeric information	13A6	1-78

B - Creep Coefficients Card

<u>Coefficient</u>	<u>Format</u>	<u>Column(s)</u>
ALPHA = Transient creep coefficient	F10.0	1-10
TCOEF = Transient creep time coefficient	F10.0	11-21
BETA = High temperature creep equation coefficient	F10.0	21-30
BETAI = Low temperature creep equation coefficient	F10.0	31-40
Q = High temperature activation energy	F10.0	41-50
QIR = Low temperature activation energy	F10.0	51-60
SC = High temperature stress coefficient	F10.0	61-70
SCI = Low temperature stress coefficient	F10.0	71-80

C - Data Card 1

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
ROUT = Specified outside tube radius (inches)	F10.0	1-10
WALLTK = Specified tube wall thickness (inches)	F10.0	11-20
DELT = Specified time increment for each calculational iteration (hours)	F10.0	21-30
TMAX = Specified maximum time for which calculational iterations are wanted (hours)	F10.0	31-40
OVAL = Specified initial tube ovality (inches)	F10.0	41-50
EXTP = Specified external pressure (psi)	F10.0	51-60
YS = Specified yield strength to be used in all collapse calculations (psi) (User's option)	F10.0	61-70

D - Data Card 2

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
MATOPT = User's option for specifying materials properties for calculating collapse conditions. If MATOPT = False, material properties, internal to the program are used. If MATOPT = True, User will specify the materials properties, as a function of temperature, on Data Cards 7 through 10. A maximum of 16 values of temperature dependent properties may be used.	I5	I-5
NTEMP = Number of temperatures corresponding to the specified material properties if MATOPT = True.	I5	6-10
NTIME = Number of time values corresponding to specified tube temperatures (Data Card 4, 4A), internal pressures (Data Card 5, 5A) and fast flux values (Data Card 6, 6A) (NTIME minimum = 3, maximum = 16).	I5	11-15
NL = Specified number of collapse lobes (minimum = 2. For creep collapse NL = 2).	I5	16-20
CL = Specified length of the collapse (CL must be greater than 0.)	F5.0	21-25

E - Data Card 3, 3A

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
TINC = Times (in hours), beginning at 0. at which specified tube temperatures, internal pressures and/or fast flux values change. The time values must start with 0. and end with a value not to exceed TMAX.	8(F10.0)	1-80

F - Data Card 4, 4A

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
TEMPI = Tube temperatures corresponding to each value of TINC.	8(F10.0)	1-80

G - Data Card 5, 5A

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
PRESI = Internal pressures corresponding to each value of TINC.	8(F10.0)	1-80

H - Data Card 6, 6A

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
FFLUX = Fast flux values corresponding to each value of TINC.	8(F10.0)	1-80

I - Data Card 7

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
TF = Temperatures corresponding to specified material properties.	8(F10.0)	1-80

J - Data Card 8

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
YMM = Elastic moduli values corresponding to specified temperatures TF.	8(F10.0)	1-80

K - Data Card 9

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
PRR = Poisson's Ratio values corresponding to specified temperatures TF.	8(F10.0)	1-80

L - Data Card 10

<u>Variable</u>	<u>Format</u>	<u>Column(s)</u>
YLD = Yield strength values corresponding to specified temperatures TF.	8(F10.0)	1-80

SAMPLE DATA DECK

PROGRAM LISTING

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C PROGRAM BUCKLE (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT) BUCKLE 2
C MAIN PROGRAM BUCKLE 3
C ***** BUCKLE 4
C ** BUCKLE 5
C ** UNITS *** BUCKLE 6
C ** BUCKLE 7
C ***** BUCKLE 8
C LENGTH=INCHES BUCKLE 9
C STRAIN=INCHES PER INCH BUCKLE 10
C ANGLE=RADIANS BUCKLE 11
C TIME = HOURS BUCKLE 12
C TEMPERATURE = DEGREES FAHRENHEIT (INPUT) BUCKLE 13
C FORCE=POUNDS BUCKLE 14
C MOMENT =INCH POUNDS BUCKLE 15
C PRESSURE = PSIG BUCKLE 16
C STRESS = PSI BUCKLE 17
C ***** BUCKLE 18
C ** BUCKLE 19
C ** DEFINITION OF SPECIFIED CREEP CONSTANTS *** BUCKLE 20
C ** BUCKLE 21
C ***** BUCKLE 22
C ALPHA=USER SPECIFIED TRANSIENT CREEP COEFFICIENT. BUCKLE 23
C TCOEF=USER SPECIFIED TRANSIENT CREEP TIME COEFFICIENT. BUCKLE 24
C BETA =USER SPECIFIED CREEP COEFFICIENT FOR THE HIGH TEMPERATURE BUCKLE 25
C CREEP EQUATION. BUCKLE 26
C BETAI=USER SPECIFIED CREEP COEFFICIENT FOR THE LOW TEMPERATURE BUCKLE 27
C CREEP EQUATION. BUCKLE 28
C Q =USER SPECIFIED CREEP ACTIVATION ENERGY FOR THE HIGH TEMPERATURE BUCKLE 29
C CREEP EQUATION. BUCKLE 30
C QIP=USER SPECIFIED CREEP ACTIVATION ENERGY FOR THE LOW TEMPERATURE BUCKLE 31
C CREEP EQUATION. BUCKLE 32
C SC=USER SPECIFIED CREEP STRESS COEFFICIENT FOR THE HIGH BUCKLE 33
C TEMPERATURE CREEP EQUATION BUCKLE 34
C SCT=USER SPECIFIED CREEP STRESS COEFFICIENT FOR THE LOW BUCKLE 35
C TEMPERATURE CREEP EQUATION BUCKLE 36
C ***** BUCKLE 37
C ** BUCKLE 38
C ** DEFINITIONS OF SPECIFIED INPUT VARIABLES *** BUCKLE 39
C ** BUCKLE 40
C ***** BUCKLE 41
C ROHT= OUTSIDE RADIUS OF THE TUBE (INCHES) BUCKLE 42
C WALLTK= WALL THICKNESS (INCHES) BUCKLE 43
C DELT=SPECIFIED TIME INTERVAL FOR EACH CALCULATIONAL ITERATION BUCKLE 44
C TMAX=SPECIFIED MAXIMUM TIME FOR WHICH CALCULATIONAL ITERATIONS BUCKLE 45
C ARE WANTED (HOURS) BUCKLE 46
C OVAL=SPECIFIED INITIAL OVALITY (INCHES) BUCKLE 47
C EXTP=EXTERNAL PRESSURE (PSIG) BUCKLE 48
C YS=YIELD STRENGTH (OPTIONAL) BUCKLE 49
C MATOPT=USER'S OPTION FOR SPECIFYING MATERIAL PROPERTIES FOR BUCKLE 50
C INSTABILITY CALCULATIONS. BUCKLE 51
C NTEMP=NUMBER OF TEMPERATURES CORRESPONDING TO SPECIFIED MATERIAL BUCKLE 52
C PROPERTIES. BUCKLE 53
C NTIME=NUMBER OF TIME VALUES CORRESPONDING TO SPECIFIED TUBE BUCKLE 54
C TEMPERATURES, INTERNAL PRESSURES, AND FAST FLUX VALUES BUCKLE 55
C NL=NUMBER OF LOBES FORMED BY THE TUBE IN BUCKLING BUCKLE 56
C CL=COLLAPSED LENGTH (INCHES) BUCKLE 57
C TINC=TIMES (IN HOURS), BEGINNING AT TIME=0., AT WHICH SPECIFIED BUCKLE 58

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C      TUBE TEMPERATURES, INTERNAL PRESSURES AND/OR FAST FLUX      BUCKLE 59
C      VALUES CHANGE. THE TIME VALUES MUST START AT 0. AND END    BUCKLE 60
C      WITH A VALUE NOT TO EXCEED TMAX.                               BUCKLE 61
C      TEMPI=SPECIFIED TUBE TEMPERATURES (DEGREES FAHRENHEIT)        BUCKLE 62
C      PRESI=SPECIFIED INTERNAL PHESSURE (PSI)                        BUCKLE 63
C      FFLUX=FAST FLUX                                                BUCKLE 64
C      TF=TEMPERATURE NODES FOR SPECIFIED MATERIAL PROPERTIES (DEGREES F) BUCKLE 65
C      YM=ELASTIC MODULUS VALUES FOR EACH SPECIFIED TEMPERATURE TF. BUCKLE 66
C      PR=POISSON'S RATIO VALUES FOR EACH SPECIFIED TEMPERATURE TF. BUCKLE 67
C      YIELD=YIELD STRENGTH VALUES FOR EACH SPECIFIED TEMPERATURE TF. BUCKLE 68
C      ***** BUCKLE 69
C      ** BUCKLE 70
C      ** DEFINITIONS OF CALCULATIONAL VARIABLES *** BUCKLE 71
C      ** BUCKLE 72
C      ***** BUCKLE 73
C      RIN= INSIDE RADIUS OF THE TUBE BUCKLE 74
C      RM= MEAN RADIUS OF THE TUBE BUCKLE 75
C      RN= RADIUS TO THE NEUTRAL BENDING PLANE BUCKLE 76
C      RHO=RADIUS OF CURVATURE FOR THE DEFORMED TUBE AT THETA=0. BUCKLE 77
C      ECC= DISTANCE FROM THE MEAN RADIUS TO THE NEUTRAL BENDING PLANE BUCKLE 78
C      W = RADIAL DEFLECTION OF TUBE WALL BUCKLE 79
C      WS= RADIAL DEFLECTION OF TUBE WALL AT THETA=0.0 BUCKLE 80
C      DELTAP= PRESSURE DIFFERENCE BUCKLE 81
C      TEMK=TEMPERATURE, DEGREES KELVIN BUCKLE 82
C      Q= CREEP ACTIVATION ENERGY BUCKLE 83
C      GAS=GAS CONSTANT BUCKLE 84
C      ALPHA=TRANSIENT CREEP COEFFICIENT BUCKLE 85
C      BETA =HIGH TEMPERATURE STEADY STATE CREEP COEFFICIENT BUCKLE 86
C      BETA1=LOW TEMPERATURE STEADY STATE CREEP COEFFICIENT BUCKLE 87
C      SC =STRESS COEFFICIENT FOR HIGH TEMPERATURE RANGE BUCKLE 88
C      SCI=STRESS COEFFICIENT FOR LOW TEMPERATURE RANGE BUCKLE 89
C      TEP1=INCREMENTAL TANGENTIAL STRAIN AT THE ID SURFACE BUCKLE 90
C      TEP0=INCREMENTAL TANGENTIAL STRAIN AT THE OD SURFACE BUCKLE 91
C      TEPN=INCREMENTAL TANGENTIAL STRAIN AT THE NEUTRAL BENDING PLANE BUCKLE 92
C      STPN=TANGENTIAL PRESSURE STRESS AT THE NEUTRAL BENDING PLANE BUCKLE 93
C      SIGM0= TOTAL TANGENTIAL STRESS AT THE OD SURFACE BUCKLE 94
C      SIGM1= TOTAL TANGENTIAL STRESS AT THE ID SURFACE BUCKLE 95
C      SIGMN=TOTAL TANGENTIAL STRESS AT THE NEUTRAL BENDING PLANE BUCKLE 96
C      DELTAD=CHANGE IN AVERAGE TUBE OD FROM CREEP BUCKLE 97
C      AK=BUCKLING COEFFICIENT FOR FINITE LENGTH TUBES BUCKLE 98
C      OVLMT=OVALITY LIMIT. THE CALCULATIONAL METHOD ASSUMES RADIAL BUCKLE 99
C      DISPLACEMENTS ARE SMALL AS COMPARED TO THE TUBE DIAMETER. BUCKLE 100
C      FOR CALCULATIONAL PURPOSES, THE OVALITY LIMIT IS SPECIFIED BUCKLE 101
C      TO BE LESS THAN OR EQUAL TO 25 PERCENT OF THE MEAN RADIUS. BUCKLE 102
C      PCOLL=COLLAPSE PRESSURE BASED ON A YIELD CRITERION BUCKLE 103
C      PCRIT=CRITICAL BUCKLING PRESSURE FOR A THIN WALLED TUBE WITH BUCKLE 104
C      CLOSED ENDS UNDER UNIFORM EXTERNAL PRESSURE. BUCKLE 105
C      ***** BUCKLE 106
C      ** BUCKLE 107
C      ** COMMON AND DIMENSION STATEMENTS *** BUCKLE 108
C      ** BUCKLE 109
C      ***** BUCKLE 110
C      COMMON/COMA/ TITLE(13),WOND1,ROUT,WALLTK,DELT,TMAX,OVAL,ETP COMI 2
C      1,YIELD,MATOPT,NTEMP,NTIME,NL,CL,TINC(16),TEMPI(16),PRESI(16) COMI 3
C      2,FLUX(16),TF(16),TEMPH(16),TEMPT(16),PNAT(5,16),MATP(5,16) COMI 4
C      3,YH,YMH(16),PR,PRR(16),TS,YLD(16),TIME(500),OVALS(500),COVAL(500) COMI 5
C      4,INTP,TEMP,FFLUX,PCOLL,SIGM1R,SIGM0R,SIGMN,PCRIT,DELTAD,J COMI 6

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5 ALPHA,TCOEF,BETA,BETAI,Q,WIR,SC,SCI
REAL INTP,MATP
LOGICAL MATOPT
DATA (TEMPH(1),I=1,5)/70.0,300.0,500.0,700.0,900.0/
DATA (PMAT(1,1),I=1,5)/13.8E6,12.8E6,11.8E6,10.9E6,9.8E6/
DATA (PMAT(2,1),I=1,5)/0.296,0.271,0.260,0.242,0.230/
DATA (PMAT(3,1),I=1,5)/80.E3,70.E3,60.E3,50.E3,25.E3/
*****
C **
C ** PROGRAM BUCKLE BNML 1784 MAY 1974 VERSION **
C ** ** ** **
C ** ** **
1 CALL INPUT
IF (TITLE(1).EQ.WORD1) GO TO 175
IPRT=6
TIME(1)=0.0
TEPIR=0.0
TEPOR=0.0
TEPN=0.0
TEPNS=0.0
WS=0.0
DELTAD=0.0
J=1
GO TO 105
100 CONTINUE
TIME(J+1)=TIME(J)+DELT
J=J+1
105 CONTINUE
TMF=TIME(J)
TEMP=TERP(TIME,TEMP,TINC,NTIME)
TEMK=((TEMP-32.)*.556) + 2/3.
IF (.NOT.MATOPT) GO TO 115
DO 110 I=1,NTMP
YMM(I)=MATP(1,I)
PRR(I)=MATP(2,I)
YLD(I)=MATP(3,I)
TEMPT(I)=TF(I)
110 CONTINUE
GO TO 125
115 CONTINUE
DO 120 I=1,5
TEMPT(I)=TEMPM(I)
YMM(I)=PMAT(1,I)
PRR(I)=PMAT(2,I)
YLD(I)=PMAT(3,I)
120 YLD(I)=PMAT(3,I)
125 CONTINUE
PR=TERP(TEMP,PRR,TEMP,NTMP)
YM=TERP(TEMP,YMM,TEMP,NTMP)
IF (YS.GE.0.) YIELD=YS
IF (YS.LE.0.) YIELD=TERP(TEMP,YLD,TEMP,NTMP)
INTP=TERP(TIME,PRESI,TINC,NTIME)
DELTAP=INTP-EXTP
FFLUX=TERP(TIME,FLUX,TINC,NTIME)
*****
C **
C ** CALCULATION OF THE CRITICAL ELASTIC BUCKLING PRESSURE **
C ** ** **

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```

CRTOR=BETAI*(FFLUX**0.85)*(1.+TFACT)*ATERMO*SINH(SCI*SIGMOR)      BUCKLE 223
IF (ABS(CRTOR).GT.ABS(CRLOW)) TEPOR=CRTOR*DELT                      BUCKLE 224
IF (ABS(CRTOR).LE.ABS(CRLOW)) TEPOR=CRTOR*DELT                      BUCKLE 225
CRTN=BETA*(1.+TFACT)*ATFHM*SINH(SC*SIGMN)                          BUCKLE 226
CRIN=BETAI*(FFLUX**0.85)*(1.+TFACT)*ATERMN*SINH(SCI*SIGMN)        BUCKLE 227
IF (ABS(CRIN).GT.ABS(CRIN)) TEPN=CRTN*DELT                         BUCKLE 228
IF (ABS(CRIN).LE.ABS(CRIN)) TEPN=CRIN*DELT                         BUCKLE 229
TEPNS=TEPNS+TEPN                                                    BUCKLE 230
*****                                                                BUCKLE 231
**                                                                    BUCKLE 232
**      CALCULATION OF THE RADIAL DEFLECTION                        *** BUCKLE 233
**                                                                    BUCKLE 234
*****                                                                BUCKLE 235
GF=3.*WALLTK*(RM-W)/(RM+W)**3                                       BUCKLE 236
DM=DSTB/YM                                                           BUCKLE 237
WS=WS*(TEPOR-TEPTR)/(GF-DM)                                         BUCKLE 238
130 CONTINUE                                                         BUCKLE 239
OVALS(J)=(4.*WS-OVAL)*AMP                                           BUCKLE 240
COVAL(J)=OVALS(J)*(-1.)                                             BUCKLE 241
*****                                                                BUCKLE 242
**                                                                    BUCKLE 243
**      CALCULATION OF THE CREEP COLLAPSE PRESSURE BASED ON A *** BUCKLE 244
**      YIELD CRITERION                                           *** BUCKLE 245
**                                                                    BUCKLE 246
*****                                                                BUCKLE 247
HK=2./(3.*(1.-PR**2))                                              BUCKLE 248
IF (CL.LE.TENDIA) CK=NL**2-1.+PR*9.87*(RM/CL)**2                  BUCKLE 249
IF (CL.GT.TENDIA) CK=NL**2-1.                                       BUCKLE 250
DK=2.*((NL**2)-1.)/(3.*(1.-PR**2))                                BUCKLE 251
IF (CL.LE.TENDIA) EK=2./(((NL**2)-1.)*(((NL*CL/(3.1416*RM))**2)  BUCKLE 252
X1.))**2))                                                         BUCKLE 253
IF (CL.LE.TENDIA) EK=0.                                             BUCKLE 254
FK=1./(DK*EK)                                                       BUCKLE 255
AK=BK*CK*FK                                                         BUCKLE 256
AA=YIELD*WALLTK/RM + PCRII*(1.-(6.*W/(WALLTK*AMP))*AK)           BUCKLE 257
RB=YIELD*PCRII*WALLTK/RM                                           BUCKLE 258
PCOLL=(AA-SQRT(AA**2-4.*RB))/2                                       BUCKLE 259
*****                                                                BUCKLE 260
**                                                                    BUCKLE 261
**      CALCULATION OF THE AVERAGE REDUCTION IN TUBE DIAMETER *** BUCKLE 262
**                                                                    BUCKLE 263
*****                                                                BUCKLE 264
DELTAD=2.*ROUT*TEPNS                                               BUCKLE 265
CALL OUTPUT                                                         BUCKLE 266
IF (ABS(DELTAD).GT.PCOLL) GO TO 135                                  BUCKLE 267
OVLMT=.25*RM                                                        BUCKLE 268
IF (COVAL(J).GT.OVLMT) GO TO 145                                    BUCKLE 269
IF (TIME(J).LT.TMAX) GO TO 100                                       BUCKLE 270
IF (TIME(J).EQ.TMAX) GO TO 155                                       BUCKLE 271
135 WRITE(6,140)                                                    BUCKLE 272
140 FORMAT(20X,"STRESS EXCEEDS YIELD STRENGTH")                    BUCKLE 273
GO TO 155                                                            BUCKLE 274
145 WRITE(6,150)                                                    BUCKLE 275
150 FORMAT(20X,"OVALITY EXCEEDS LIMIT")                             BUCKLE 276
155 INT=NTIME                                                        BUCKLE 277
JJ=J                                                                BUCKLE 278
IF (TIME(J).GT.TINC(INT)) GO TO 170                                BUCKLE 279

```

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PROGRAM BUCKLE      74/74      JPT=1      FTN 4.1.REL      05/24/74      08.51.31.
      IT=J
      DO 160 J=1,II
      J1=J
      IF(COVAL(J).GT.OVLMT) GO TO 165
      160 CONTINUE
      GO TO 170
      165 JJ=J1-1
      170 CCOVAL=OVLMT
      CALL FPLOT(1,JJ,1,TIME,COVAL,TMAX,CCOVAL,25,26,IPRT)
      GO TO 1
      175 STOP
      END
      BUCKLE      280
      BUCKLE      281
      BUCKLE      282
      BUCKLE      283
      BUCKLE      284
      BUCKLE      285
      BUCKLE      286
      BUCKLE      287
      BUCKLE      288
      BUCKLE      289
      BUCKLE      290
      BUCKLE      291

```


FUNCTION TERP 74/74 OPT=1 FTN 4.1*REL 05/23/74 08.32.36.

```

C      FUNCTION TERP(TC,CRF,CRFT,N)
C      TERP IS A LINEAR INTERPOLATION FUNCTION WHOSE VALUE IS EQUAL TO TH
C      INTERPOLATED VALUE.
C      TC-IS THE VALUE OF THE INDEPENDENT VARIABLE
C      CRF-DEPENDENT VARIABLE ARRAY
C      CRFT-INDEPENDENT VARIABLE ARRAY
C      N-NUMBER OF POINTS IN VARIABLE ARRAYS
C      DIMENSION CRF(N),CRFT(N)
      I=1
      IF (TC.LT.CRFT(1)) GO TO 101
      DO 100 I=1,N
        J=I
        IF (TC-CRFT(I)) 103,102,100
      100 CONTINUE
      101 TERP=CRF(I)
      RETURN
      102 TERP=CRF(I)
      RETURN
      103 TERP=CRF(I-1)*(CRF(I)-CRF(I-1))*(TC-CRFT(I-1))/(CRFT(I)-CRFT(I-1))
      RETURN
      END

```

```

SUBROUTINE INPUT
COMMON/COMA/ TITLE(13),WORD1,ROUT,WALLTK,DELT,TMAX,OVAL,EXTP
1,YIELD,MATOPT,NTEMP,NL,CL,TINC(16),TEMPI(16),PRESI(16)
2,FLUX(16),TF(16),TEMPM(16),TEMPT(16),PMAT(5,16),MATP(5,16)
3,YM,YMN(16),PK,PRR(16),YS,YLD(16),TIME(500),OVALS(500),COVAL(500)
4,INTP,TEMP,FFLUX,PCOLL,SIG,IR,SIGMOR,SIGMN,PCRIT,DELTAD,J
5,ALPHA,TCOEF,BETA,BETAI,Q,IR,SC,SCI
REAL INTP,MATP
LOGICAL MATOPT
DATA WORD1/6HSTOP /
READ(5,100) (TITLE(I),I=1,13)
IF(TITLE(1).EQ.WORD1) GO TO 105
READ(5,101) ALPHA,TCOEF,BETA,BETAI,Q,QIR,SC,SCI
READ(5,102) ROUT,WALLTK,DELT,TMAX,OVAL,EXTP,YS
READ(5,103) MATOPT,NTEMP,NL,CL
READ(5,104) (TINC(I),I=1,NTIME)
READ(5,104) (TEMPI(I),I=1,NTIME)
READ(5,104) (PRESI(I),I=1,NTIME)
READ(5,104) (FLUX(I),I=1,NTIME)
IF(.NOT.MATOPT) GO TO 99
READ(5,104) (TF(I),I=1,NTEMP)
READ(5,104) (MATP(1,I),I=1,NTEMP)
READ(5,104) (MATP(2,I),I=1,NTEMP)
READ(5,104) (MATP(3,I),I=1,NTEMP)
99 CONTINUE
IF(.NOT.MATOPT) NTEMP=5
RETURN
100 FORMAT(13A6)
101 FORMAT(8F10.0)
102 FORMAT(7F10.0)
103 FORMAT(L5,3I5,F5.0)
104 FORMAT(8F10.0)
105 STOP
END

```


SUBROUTINE OUTPUT 74/74 OPT=1 FTN 4.1+REL 05/23/74 15.18.39.

```
108 WRITE(6,109) TIME(J),INTP,TEMP,FFLUX,DELTAD,OVALS(J),PCOLL,SIGMIR,      52
      XSIGMOR,SIGNN      53
109 FORMAT(3(2X,F10.2),1(2X,E10.4),2(2X,F10.5),4(2X,E10.4),1/)      54
      RETURN      55
      END      56
```

```

C      SUBROUTINE FPLLOT(N,IXMAX,M,X,Y,XMAXI,C,IVERM,IHORM,IPRT)
C      DIMENSION X(M,IXMAX),Y(M,IXMAX),A(45,120),C(M),AL(34),XMAXI(M)
C      THIS ROUTINE IS AN ON LINE PLOTTER FOR UP TO 5 CURVES IN THE FIRST
C      QUADRANT.
C      INPUT EXPLANATION
C      X = THE VARIABLE ALONG THE ABSCISSA. (MUST BE POSITIVE)
C      Y = THE ORDINATE VARIABLE AT MESH POINT X. (MUST BE POSITIVE)
C      XMAXI = THE MAXIMUM VALUE OF X.
C      C = THE MAXIMUM VALUE OF Y.
C      N = THE NUMBER OF CURVES TO BE REPRESENTED.
C      IXMAX = THE NUMBER OF MESH POINTS ALONG X. (10 INCREMENTS = 11 POI
C      M = THE DIMENSION OF C IN THE CALLING PROGRAM.
C      IVERM = THE NUMBER OF VERTICAL SPACES TO BE USED FOR THE PLOT * 5.
C      IHORM = THE NUMBER OF HORIZONTAL SPACES TO BE USED FOR THE PLOT *
C      IF IVERM AND IHORM ARE LESS THAN 32 AND 35, RESPECTIVELY, THEY ARE
C      SET TO 45 AND 106, RESPECTIVELY, BY THE CODE.
C      DATA (AL(I),I=1,34)/1HR,1HE,1HT,1HE,1HM,1HA,1HP,1HS,1HS,1H
1E,1HL,1HN,1HO,1HI,1HS,1HN,1HE,1HM,1HI,1HO,1HI,1H2,1H3,1H4,
21HS,1H6,1H7,1H8,1H9,1H1 /
C      DATA BLANK/6H /
C      DATA E1,E2,E3 /1HX,1HY,1H, /
C      IF (IVERM.LT.32) IVERM=45
C      IF (IHORM.LT.35) IHORM=106
C      IVERT=IVERM-4
C      IHOR=IHORM-5
C      IVERT=IVERT-1
C      IHOR=IHOR-1
C      DO 100 I=1,N
C      DO 100 J=1,IXMAX
C      X(I,J)=X(I,J)/XMAXI(I)
C      Y(I,J)=Y(I,J)/C(I)
C      DO 110 I=1,IVERM
C      DO 110 J=1,IHORM
C      A(I,J)=BLANK
C      DO 120 J=1,IVERT
C      A(J,6)=AL(23)
C      A(J,IHORM)=AL(23)
C      IF (IVERT.NE.4) GO TO 140
C      DO 130 J=1,4,1,4
C      A(J,106)=E3
C      IEND=IHOR*4
C      DO 150 J=6,IEND
C      A(1,J)=AL(23)
C      A(IVERT,J)=AL(23)
C      FPLLOT 2
C      FPLLOT 3
C      FPLLOT 4
C      FPLLOT 5
C      FPLLOT 6
C      FPLLOT 7
C      FPLLOT 8
C      FPLLOT 9
C      FPLLOT 10
C      FPLLOT 11
C      FPLLOT 12
C      FPLLOT 13
C      FPLLOT 14
C      FPLLOT 15
C      FPLLOT 16
C      FPLLOT 17
C      FPLLOT 18
C      FPLLOT 19
C      FPLLOT 20
C      FPLLOT 21
C      FPLLOT 22
C      FPLLOT 23
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C      FPLLOT 44
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C      FPLLOT 46
C      FPLLOT 47
C      FPLLOT 48
C      FPLLOT 49
C      FPLLOT 50
C      FPLLOT 51
C      FPLLOT 52
C      FPLLOT 53
C      FPLLOT 54
C      FPLLOT 55
C      FPLLOT 56
C      FPLLOT 57
C      FPLLOT 58

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```

C
IF (IEND.NE.105) GO TO 170
DO 160 J=6,96,10
  A(J,6)=E3
  C
  A(1,J)=E3
  A(41,J)=E3
  CONTINUE
  ISTART=(VERT-25.)/2.+.501
  IEND=ISTART+12
  DO 180 I=ISTART,IEND
    IBEG=ISTART+15
    A(I,2)=AL(22-I,ISTART)
    IEND=ISTART+23
    A(IEND+3,2)=E2
    DO 190 I=IBEG,IEND
      A(I,2)=AL(9-I,IBEG)
      DO 200 I=1,N
        DO 200 J=1,IXMAX
          IF (Y(I,J).LT.0.) GO TO 200
          I1=HOR*X(I,J)+6.501
          I2=VERT*(1.0-Y(I,J))+1.501
          A(I2,I1)=AL(1+24)
        CONTINUE
        B=0.0
        DO 210 I=1,11
          I1=VERT*B+1.501
          IF (I.GT.1.AND.I.LT.11) A(I1,3)=E3
          A(I1,4)=AL(35-I)
          B=B+.1
        B=0.
        DO 220 I=1,11
          I2=HOR*B+6.501
          IF (I.GT.1.AND.I.LT.11) A(I,VERT+2+I2-1)=E3
          A(I,VERT+2,I2)=AL(23+I)
        B=B+.1
        ISTART=(HOR-25.)/2.+.501
        IEND=ISTART+12
        DO 230 I=ISTART,IEND
          A(I,VERM,I)=AL(22-I,ISTART)
          IBEG=ISTART+15
          IEND=ISTART+23
          A(I,VERM,IEND+3)=E1
          DO 240 I=IBEG,IEND
            A(I,VERM,I)=AL(9-I,IBEG)
            WRITE(IPRT,99)
            99 FORMAT('1',26X,'CREEP COLLAPSE ANALYSIS - TIME (X) VERSES OVALITY
              X(Y)',)
            DO 250 I=1,IVERM
              WRITE (IPRT,260) (A(I,J),J=1,IVERM)
              WRITE(IPRT,270)
              WRITE (IPRT,280) (E1,I,XMAX,I(I),E2,I,C(I),I=1,N)
              RETURN
            C
            260 FORMAT (120A1)
            270 FORMAT(17H MULTIPLIERS / )
            280 FORMAT(5(+X,A1,I1,1H=,1PE9.2,1X,/,A1,I1,1H=,E9.2) )
          END
        FPLLOT 59
        FPLLOT 60
        FPLLOT 61
        FPLLOT 62
        FPLLOT 63
        FPLLOT 64
        FPLLOT 65
        FPLLOT 66
        FPLLOT 67
        FPLLOT 68
        FPLLOT 69
        FPLLOT 70
        FPLLOT 71
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        FPLLOT 113
        FPLLOT 114
        FPLLOT 115

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SAMPLE PROBLEM

SAMPLE PROBLEM 1. TEMP, FFLUX, CELTAP = CONSTANT

 * SUMMARY OF INPUT DATA *

CLADDING RADIUS	ROUT	.21000	INCHES
CLAD WALL THICKNESS	WALLTK	.02500	INCHES
TIME INCREMENTS	DELT	100.00	HOURS
MAXIMUM OPERATING TIME	TMAX	25000.00	HOURS
INITIAL QUALITY	QUAL	.000700	INCHES
CLADDING EXTERNAL PRESSURE	EXTD	2000.00	PSI
YIELD STRENGTH	YIELD	.5000E+05	PSI
MATERIAL PROPERTIES	MATOPT	F	
TRUEUSER SPECIFIED			
FALSE=CODE LIBRARY			
NUMBER OF TEMP. MODES FOR MAT. PROP.	NTEMP	5	
NUMBER OF TIME STEPS	NTIME	5	
MAX=16, MIN=3			
NUMBER OF LOOPS	NL	2	
COLLAPSE LENGTH	CL	2.	INCHES

 * SUMMARY OF CONSTANT OUTPUT VARIABLES *

ELASTIC COLLAPSE PRESSURE PCRT 6487.98 PSI

POISSONS RATIO TEMP.	YOUNGS MODULUS TEMP.	YIELD STRENGTH TEMP.	YIELD STRENGTH VALUE
70.0 .2900	70.0 .138E+08	70.0 .800E+05	
300.0 .2710	300.0 .128E+08	300.0 .700E+05	
500.0 .2600	500.0 .118E+08	500.0 .600E+05	
700.0 .2420	700.0 .103E+08	700.0 .500E+05	
900.0 .2300	900.0 .900E+07	900.0 .250E+05	

TIME (HOURS)	INTERNAL PRESSURE (PSI)	CLAS TEMP (0 FGF)	FAST FLUX (NV)	CREEP-DOWN DELTA-D (IN.)	OVALITY (IN.)	YIELD COLLAPSE (PSIG)	T. STRESS AT ID (PSI)	T. STRESS AT OD (PSI)	T. STRESS NPLANE (PSI)
0.00	500.00	625.00	7000E+14	0.00000	-0.00091	.5210E+04	-0.1240E+05	-0.1370E+05	-0.1305E+05
100.00	500.00	625.00	7000E+14	-0.00002	-0.00093	.5210E+04	-0.1240E+05	-0.1370E+05	-0.1305E+05
200.00	500.00	625.00	7000E+14	-0.00005	-0.00095	.5199E+04	-0.1239E+05	-0.1371E+05	-0.1305E+05
300.00	500.00	625.00	7000E+14	-0.00007	-0.00097	.5187E+04	-0.1237E+05	-0.1372E+05	-0.1305E+05
400.00	500.00	625.00	7000E+14	-0.00010	-0.00099	.5176E+04	-0.1236E+05	-0.1374E+05	-0.1305E+05
500.00	500.00	625.00	7000E+14	-0.00012	-0.00101	.5165E+04	-0.1234E+05	-0.1375E+05	-0.1305E+05
600.00	500.00	625.00	7000E+14	-0.00015	-0.00103	.5153E+04	-0.1233E+05	-0.1376E+05	-0.1305E+05
700.00	500.00	625.00	7000E+14	-0.00017	-0.00105	.5142E+04	-0.1231E+05	-0.1378E+05	-0.1305E+05
800.00	500.00	625.00	7000E+14	-0.00019	-0.00107	.5130E+04	-0.1230E+05	-0.1379E+05	-0.1304E+05
900.00	500.00	625.00	7000E+14	-0.00022	-0.00110	.5118E+04	-0.1228E+05	-0.1381E+05	-0.1304E+05
1000.00	500.00	625.00	7000E+14	-0.00024	-0.00112	.5106E+04	-0.1226E+05	-0.1382E+05	-0.1304E+05
1100.00	500.00	625.00	7000E+14	-0.00027	-0.00114	.5094E+04	-0.1225E+05	-0.1384E+05	-0.1304E+05
1200.00	500.00	625.00	7000E+14	-0.00029	-0.00117	.5082E+04	-0.1223E+05	-0.1386E+05	-0.1304E+05
1300.00	500.00	625.00	7000E+14	-0.00032	-0.00119	.5070E+04	-0.1221E+05	-0.1387E+05	-0.1304E+05
1400.00	500.00	625.00	7000E+14	-0.00034	-0.00122	.5058E+04	-0.1219E+05	-0.1389E+05	-0.1304E+05
1500.00	500.00	625.00	7000E+14	-0.00036	-0.00124	.5046E+04	-0.1218E+05	-0.1390E+05	-0.1304E+05
1600.00	500.00	625.00	7000E+14	-0.00039	-0.00127	.5033E+04	-0.1216E+05	-0.1392E+05	-0.1304E+05
1700.00	500.00	625.00	7000E+14	-0.00041	-0.00129	.5021E+04	-0.1214E+05	-0.1394E+05	-0.1304E+05
1800.00	500.00	625.00	7000E+14	-0.00044	-0.00132	.5008E+04	-0.1212E+05	-0.1396E+05	-0.1303E+05
1900.00	500.00	625.00	7000E+14	-0.00046	-0.00135	.4995E+04	-0.1210E+05	-0.1398E+05	-0.1303E+05
2000.00	500.00	625.00	7000E+14	-0.00049	-0.00138	.4983E+04	-0.1208E+05	-0.1399E+05	-0.1303E+05
2100.00	500.00	625.00	7000E+14	-0.00051	-0.00141	.4970E+04	-0.1206E+05	-0.1401E+05	-0.1303E+05
2200.00	500.00	625.00	7000E+14	-0.00053	-0.00143	.4957E+04	-0.1204E+05	-0.1403E+05	-0.1303E+05
2300.00	500.00	625.00	7000E+14	-0.00056	-0.00146	.4944E+04	-0.1201E+05	-0.1405E+05	-0.1303E+05
2400.00	500.00	625.00	7000E+14	-0.00058	-0.00149	.4931E+04	-0.1199E+05	-0.1407E+05	-0.1303E+05
2500.00	500.00	625.00	7000E+14	-0.00061	-0.00153	.4917E+04	-0.1197E+05	-0.1409E+05	-0.1302E+05
2600.00	500.00	625.00	7000E+14	-0.00063	-0.00156	.4904E+04	-0.1195E+05	-0.1412E+05	-0.1302E+05
2700.00	500.00	625.00	7000E+14	-0.00066	-0.00159	.4890E+04	-0.1192E+05	-0.1414E+05	-0.1302E+05
2800.00	500.00	625.00	7000E+14	-0.00068	-0.00162	.4877E+04	-0.1190E+05	-0.1416E+05	-0.1302E+05
2900.00	500.00	625.00	7000E+14	-0.00070	-0.00166	.4863E+04	-0.1187E+05	-0.1418E+05	-0.1302E+05

3100.00	500.00	625.00	.7000E+14	-.00073	-.00169	.4849E+04	-.1165E+05	-.1420E+05	-.1302E+05
3100.00	500.00	625.00	.7000E+14	-.00075	-.00173	.4836E+04	-.1182E+05	-.1423E+05	-.1302E+05
3200.00	500.00	625.00	.7000E+14	-.00078	-.00176	.4822E+04	-.1189E+05	-.1425E+05	-.1301E+05
3300.00	500.00	625.00	.7000E+14	-.00080	-.00180	.4808E+04	-.1177E+05	-.1428E+05	-.1301E+05
3400.00	500.00	625.00	.7000E+14	-.00083	-.00184	.4793E+04	-.1174E+05	-.1430E+05	-.1301E+05
3500.00	500.00	625.00	.7000E+14	-.00085	-.00188	.4779E+04	-.1172E+05	-.1433E+05	-.1301E+05
3600.00	500.00	625.00	.7000E+14	-.00087	-.00191	.4765E+04	-.1169E+05	-.1435E+05	-.1301E+05
3700.00	500.00	625.00	.7000E+14	-.00090	-.00195	.4750E+04	-.1166E+05	-.1438E+05	-.1301E+05
3800.00	500.00	625.00	.7000E+14	-.00092	-.00199	.4736E+04	-.1163E+05	-.1441E+05	-.1300E+05
3900.00	500.00	625.00	.7000E+14	-.00095	-.00204	.4721E+04	-.1160E+05	-.1443E+05	-.1300E+05
4000.00	500.00	625.00	.7000E+14	-.00097	-.00208	.4707E+04	-.1157E+05	-.1446E+05	-.1300E+05
4100.00	500.00	625.00	.7000E+14	-.00100	-.00212	.4692E+04	-.1154E+05	-.1449E+05	-.1300E+05
4200.00	500.00	625.00	.7000E+14	-.00102	-.00217	.4677E+04	-.1151E+05	-.1452E+05	-.1300E+05
4300.00	500.00	625.00	.7000E+14	-.00104	-.00221	.4662E+04	-.1147E+05	-.1455E+05	-.1299E+05
4400.00	500.00	625.00	.7000E+14	-.00107	-.00226	.4647E+04	-.1144E+05	-.1458E+05	-.1299E+05
4500.00	500.00	625.00	.7000E+14	-.00109	-.00230	.4631E+04	-.1141E+05	-.1461E+05	-.1299E+05
4600.00	500.00	625.00	.7000E+14	-.00112	-.00235	.4616E+04	-.1137E+05	-.1464E+05	-.1299E+05
4700.00	500.00	625.00	.7000E+14	-.00114	-.00240	.4601E+04	-.1134E+05	-.1468E+05	-.1299E+05
4800.00	500.00	625.00	.7000E+14	-.00116	-.00245	.4585E+04	-.1130E+05	-.1471E+05	-.1298E+05
4900.00	500.00	625.00	.7000E+14	-.00119	-.00250	.4569E+04	-.1127E+05	-.1474E+05	-.1298E+05
5000.00	500.00	625.00	.7000E+14	-.00121	-.00255	.4554E+04	-.1123E+05	-.1478E+05	-.1298E+05
5100.00	500.00	625.00	.7000E+14	-.00124	-.00260	.4538E+04	-.1119E+05	-.1481E+05	-.1298E+05
5200.00	500.00	625.00	.7000E+14	-.00126	-.00266	.4522E+04	-.1115E+05	-.1485E+05	-.1297E+05
5300.00	500.00	625.00	.7000E+14	-.00129	-.00271	.4506E+04	-.1111E+05	-.1488E+05	-.1297E+05
5400.00	500.00	625.00	.7000E+14	-.00131	-.00277	.4490E+04	-.1107E+05	-.1492E+05	-.1297E+05
5500.00	500.00	625.00	.7000E+14	-.00133	-.00283	.4474E+04	-.1103E+05	-.1496E+05	-.1297E+05
5600.00	500.00	625.00	.7000E+14	-.00136	-.00289	.4457E+04	-.1099E+05	-.1500E+05	-.1296E+05
5700.00	500.00	625.00	.7000E+14	-.00138	-.00294	.4441E+04	-.1094E+05	-.1504E+05	-.1296E+05
5800.00	500.00	625.00	.7000E+14	-.00141	-.00301	.4424E+04	-.1090E+05	-.1508E+05	-.1296E+05
5900.00	500.00	625.00	.7000E+14	-.00143	-.00307	.4408E+04	-.1086E+05	-.1512E+05	-.1296E+05
6000.00	500.00	625.00	.7000E+14	-.00145	-.00313	.4391E+04	-.1081E+05	-.1516E+05	-.1295E+05
6100.00	500.00	625.00	.7000E+14	-.00148	-.00320	.4374E+04	-.1076E+05	-.1520E+05	-.1295E+05
6200.00	500.00	625.00	.7000E+14	-.00150	-.00326	.4357E+04	-.1072E+05	-.1525E+05	-.1295E+05

6300.00	500.00	625.00	.7000E+14	-.00153	-.00333	.4340E+04	-.1067E+05	-.1529E+05	-.1295E+05
6400.00	500.00	625.00	.7000E+14	-.00155	-.00340	.4323E+04	-.1062E+05	-.1534E+05	-.1294E+05
6500.00	500.00	625.00	.7000E+14	-.00157	-.00347	.4306E+04	-.1057E+05	-.1539E+05	-.1294E+05
6600.00	500.00	625.00	.7000E+14	-.00160	-.00354	.4289E+04	-.1052E+05	-.1543E+05	-.1294E+05
6700.00	500.00	625.00	.7000E+14	-.00162	-.00361	.4272E+04	-.1046E+05	-.1548E+05	-.1293E+05
6800.00	500.00	625.00	.7000E+14	-.00165	-.00369	.4254E+04	-.1041E+05	-.1553E+05	-.1293E+05
6900.00	500.00	625.00	.7000E+14	-.00167	-.00376	.4236E+04	-.1035E+05	-.1558E+05	-.1293E+05
7000.00	500.00	625.00	.7000E+14	-.00169	-.00384	.4219E+04	-.1030E+05	-.1563E+05	-.1292E+05
7100.00	500.00	625.00	.7000E+14	-.00172	-.00392	.4201E+04	-.1024E+05	-.1568E+05	-.1292E+05
7200.00	500.00	625.00	.7000E+14	-.00174	-.00400	.4183E+04	-.1018E+05	-.1574E+05	-.1292E+05
7300.00	500.00	625.00	.7000E+14	-.00177	-.00408	.4165E+04	-.1012E+05	-.1579E+05	-.1291E+05
7400.00	500.00	625.00	.7000E+14	-.00179	-.00417	.4147E+04	-.1006E+05	-.1585E+05	-.1291E+05
7500.00	500.00	625.00	.7000E+14	-.00181	-.00425	.4129E+04	-.1000E+05	-.1590E+05	-.1290E+05
7600.00	500.00	625.00	.7000E+14	-.00184	-.00434	.4111E+04	-.9940E+04	-.1596E+05	-.1290E+05
7700.00	500.00	625.00	.7000E+14	-.00186	-.00443	.4093E+04	-.9876E+04	-.1602E+05	-.1290E+05
7800.00	500.00	625.00	.7000E+14	-.00189	-.00452	.4074E+04	-.9811E+04	-.1608E+05	-.1289E+05
7900.00	500.00	625.00	.7000E+14	-.00191	-.00461	.4056E+04	-.9744E+04	-.1614E+05	-.1289E+05
8000.00	500.00	625.00	.7000E+14	-.00193	-.00471	.4037E+04	-.9676E+04	-.1621E+05	-.1288E+05
8100.00	500.00	625.00	.7000E+14	-.00196	-.00480	.4019E+04	-.9607E+04	-.1627E+05	-.1288E+05
8200.00	500.00	625.00	.7000E+14	-.00198	-.00490	.4000E+04	-.9536E+04	-.1633E+05	-.1288E+05
8300.00	500.00	625.00	.7000E+14	-.00200	-.00500	.3981E+04	-.9464E+04	-.1640E+05	-.1287E+05
8400.00	500.00	625.00	.7000E+14	-.00203	-.00510	.3962E+04	-.9391E+04	-.1647E+05	-.1287E+05
8500.00	500.00	625.00	.7000E+14	-.00205	-.00521	.3943E+04	-.9316E+04	-.1654E+05	-.1286E+05
8600.00	500.00	625.00	.7000E+14	-.00208	-.00531	.3924E+04	-.9240E+04	-.1661E+05	-.1286E+05
8700.00	500.00	625.00	.7000E+14	-.00210	-.00542	.3905E+04	-.9162E+04	-.1668E+05	-.1285E+05
8800.00	500.00	625.00	.7000E+14	-.00212	-.00553	.3886E+04	-.9082E+04	-.1675E+05	-.1285E+05
8900.00	500.00	625.00	.7000E+14	-.00215	-.00565	.3867E+04	-.9001E+04	-.1683E+05	-.1284E+05
9000.00	500.00	625.00	.7000E+14	-.00217	-.00576	.3847E+04	-.8919E+04	-.1690E+05	-.1284E+05
9100.00	500.00	625.00	.7000E+14	-.00219	-.00588	.3828E+04	-.8834E+04	-.1698E+05	-.1283E+05
9200.00	500.00	625.00	.7000E+14	-.00222	-.00600	.3808E+04	-.8748E+04	-.1706E+05	-.1283E+05
9300.00	500.00	625.00	.7000E+14	-.00224	-.00612	.3789E+04	-.8661E+04	-.1714E+05	-.1282E+05
9400.00	500.00	625.00	.7000E+14	-.00227	-.00625	.3769E+04	-.8571E+04	-.1722E+05	-.1282E+05
9500.00	500.00	625.00	.7000E+14	-.00229	-.00638	.3749E+04	-.8480E+04	-.1731E+05	-.1281E+05

9600.00	500.00	625.00	7000E+14	-.00231	-.00651	.3729E+04	-.8387E+04	-.1739E+05	-.1280E+05
9700.00	500.00	625.00	7000E+14	-.00234	-.00654	.3709E+04	-.8293E+04	-.1748E+05	-.1280E+05
9800.00	500.00	625.00	7000E+14	-.00236	-.00677	.3689E+04	-.8196E+04	-.1757E+05	-.1279E+05
9900.00	500.00	625.00	7000E+14	-.00238	-.00691	.3669E+04	-.8098E+04	-.1766E+05	-.1279E+05
10000.00	500.00	625.00	7000E+14	-.00241	-.00705	.3649E+04	-.7997E+04	-.1775E+05	-.1278E+05
10100.00	500.00	625.00	7000E+14	-.00243	-.00720	.3629E+04	-.7895E+04	-.1785E+05	-.1277E+05
10200.00	500.00	625.00	7000E+14	-.00245	-.00734	.3609E+04	-.7790E+04	-.1795E+05	-.1277E+05
10300.00	500.00	625.00	7000E+14	-.00248	-.00749	.3588E+04	-.7684E+04	-.1804E+05	-.1276E+05
10400.00	500.00	625.00	7000E+14	-.00250	-.00764	.3568E+04	-.7575E+04	-.1814E+05	-.1275E+05
10500.00	500.00	625.00	7000E+14	-.00252	-.00780	.3547E+04	-.7465E+04	-.1825E+05	-.1275E+05
10600.00	500.00	625.00	7000E+14	-.00255	-.00796	.3527E+04	-.7352E+04	-.1835E+05	-.1274E+05
10700.00	500.00	625.00	7000E+14	-.00257	-.00812	.3506E+04	-.7237E+04	-.1846E+05	-.1273E+05
10800.00	500.00	625.00	7000E+14	-.00260	-.00829	.3485E+04	-.7120E+04	-.1857E+05	-.1272E+05
10900.00	500.00	625.00	7000E+14	-.00262	-.00845	.3465E+04	-.7000E+04	-.1868E+05	-.1272E+05
11000.00	500.00	625.00	7000E+14	-.00264	-.00863	.3444E+04	-.6878E+04	-.1879E+05	-.1271E+05
11100.00	500.00	625.00	7000E+14	-.00267	-.00880	.3423E+04	-.6754E+04	-.1890E+05	-.1270E+05
11200.00	500.00	625.00	7000E+14	-.00269	-.00898	.3402E+04	-.6627E+04	-.1902E+05	-.1269E+05
11300.00	500.00	625.00	7000E+14	-.00271	-.00916	.3381E+04	-.6498E+04	-.1914E+05	-.1269E+05
11400.00	500.00	625.00	7000E+14	-.00274	-.00935	.3360E+04	-.6366E+04	-.1926E+05	-.1268E+05
11500.00	500.00	625.00	7000E+14	-.00276	-.00954	.3339E+04	-.6232E+04	-.1939E+05	-.1267E+05
11600.00	500.00	625.00	7000E+14	-.00278	-.00973	.3318E+04	-.6095E+04	-.1951E+05	-.1266E+05
11700.00	500.00	625.00	7000E+14	-.00280	-.00993	.3297E+04	-.5955E+04	-.1964E+05	-.1265E+05
11800.00	500.00	625.00	7000E+14	-.00283	-.01013	.3275E+04	-.5813E+04	-.1977E+05	-.1264E+05
11900.00	500.00	625.00	7000E+14	-.00285	-.01033	.3254E+04	-.5667E+04	-.1991E+05	-.1263E+05
12000.00	500.00	625.00	7000E+14	-.00287	-.01054	.3233E+04	-.5519E+04	-.2004E+05	-.1262E+05
12100.00	500.00	625.00	7000E+14	-.00290	-.01076	.3211E+04	-.5369E+04	-.2018E+05	-.1261E+05
12200.00	500.00	625.00	7000E+14	-.00292	-.01098	.3190E+04	-.5215E+04	-.2033E+05	-.1260E+05
12300.00	500.00	625.00	7000E+14	-.00294	-.01120	.3168E+04	-.5058E+04	-.2047E+05	-.1259E+05
12400.00	500.00	625.00	7000E+14	-.00297	-.01143	.3147E+04	-.4898E+04	-.2062E+05	-.1258E+05
12500.00	500.00	625.00	7000E+14	-.00299	-.01166	.3125E+04	-.4735E+04	-.2077E+05	-.1257E+05
12600.00	500.00	625.00	7000E+14	-.00301	-.01189	.3104E+04	-.4568E+04	-.2093E+05	-.1256E+05
12700.00	500.00	625.00	7000E+14	-.00304	-.01214	.3082E+04	-.4399E+04	-.2108E+05	-.1255E+05
12800.00	500.00	625.00	7000E+14	-.00306	-.01238	.3060E+04	-.4226E+04	-.2124E+05	-.1254E+05

12900.00	500.00	625.00	.7300E+14	-.00308	-.01263	.3039E+04	-.4049E+04	-.2141E+05	-.1253E+05
13000.00	500.00	625.00	.7300E+14	-.00310	-.01289	.3017E+04	-.3869E+04	-.2157E+05	-.1252E+05
13100.00	500.00	625.00	.7300E+14	-.00313	-.01315	.2995E+04	-.3686E+04	-.2174E+05	-.1251E+05
13200.00	500.00	625.00	.7300E+14	-.00315	-.01342	.2973E+04	-.3499E+04	-.2192E+05	-.1249E+05
13300.00	500.00	625.00	.7300E+14	-.00317	-.01369	.2951E+04	-.3308E+04	-.2209E+05	-.1248E+05
13400.00	500.00	625.00	.7300E+14	-.00319	-.01397	.2929E+04	-.3113E+04	-.2227E+05	-.1247E+05
13500.00	500.00	625.00	.7300E+14	-.00322	-.01426	.2907E+04	-.2915E+04	-.2246E+05	-.1246E+05
13600.00	500.00	625.00	.7300E+14	-.00324	-.01455	.2885E+04	-.2712E+04	-.2265E+05	-.1244E+05
13700.00	500.00	625.00	.7300E+14	-.00326	-.01484	.2863E+04	-.2505E+04	-.2284E+05	-.1243E+05
13800.00	500.00	625.00	.7300E+14	-.00329	-.01515	.2841E+04	-.2295E+04	-.2313E+05	-.1242E+05
13900.00	500.00	625.00	.7300E+14	-.00331	-.01545	.2819E+04	-.2079E+04	-.2323E+05	-.1240E+05
14000.00	500.00	625.00	.7300E+14	-.00333	-.01577	.2797E+04	-.1860E+04	-.2344E+05	-.1239E+05
14100.00	500.00	625.00	.7300E+14	-.00335	-.01609	.2775E+04	-.1636E+04	-.2365E+05	-.1237E+05
14200.00	500.00	625.00	.7300E+14	-.00338	-.01642	.2752E+04	-.1408E+04	-.2386E+05	-.1236E+05
14300.00	500.00	625.00	.7300E+14	-.00340	-.01676	.2730E+04	-.1175E+04	-.2407E+05	-.1234E+05
14400.00	500.00	625.00	.7300E+14	-.00342	-.01710	.2708E+04	-.9366E+03	-.2430E+05	-.1233E+05
14500.00	500.00	625.00	.7300E+14	-.00344	-.01746	.2685E+04	-.6937E+03	-.2452E+05	-.1231E+05
14600.00	500.00	625.00	.7300E+14	-.00346	-.01781	.2663E+04	-.4458E+03	-.2475E+05	-.1230E+05
14700.00	500.00	625.00	.7300E+14	-.00349	-.01818	.2641E+04	-.1927E+03	-.2499E+05	-.1228E+05
14800.00	500.00	625.00	.7300E+14	-.00351	-.01856	.2618E+04	.6568E+02	-.2523E+05	-.1226E+05
14900.00	500.00	625.00	.7300E+14	-.00353	-.01894	.2596E+04	.3295E+03	-.2547E+05	-.1224E+05
15000.00	500.00	625.00	.7300E+14	-.00355	-.01933	.2573E+04	.5990E+03	-.2572E+05	-.1223E+05
15100.00	500.00	625.00	.7300E+14	-.00357	-.01973	.2551E+04	.8743E+03	-.2598E+05	-.1221E+05
15200.00	500.00	625.00	.7300E+14	-.00360	-.02015	.2528E+04	.1156E+04	-.2624E+05	-.1219E+05
15300.00	500.00	625.00	.7300E+14	-.00362	-.02057	.2506E+04	.1443E+04	-.2651E+05	-.1217E+05
15400.00	500.00	625.00	.7300E+14	-.00364	-.02100	.2483E+04	.1737E+04	-.2679E+05	-.1215E+05
15500.00	500.00	625.00	.7300E+14	-.00366	-.02144	.2460E+04	.2038E+04	-.2707E+05	-.1213E+05
15600.00	500.00	625.00	.7300E+14	-.00368	-.02189	.2437E+04	.2346E+04	-.2735E+05	-.1211E+05
15700.00	500.00	625.00	.7300E+14	-.00371	-.02236	.2415E+04	.2661E+04	-.2765E+05	-.1209E+05
15800.00	500.00	625.00	.7300E+14	-.00373	-.02283	.2392E+04	.2983E+04	-.2795E+05	-.1207E+05
15900.00	500.00	625.00	.7300E+14	-.00375	-.02332	.2369E+04	.3313E+04	-.2826E+05	-.1205E+05
16000.00	500.00	625.00	.7300E+14	-.00377	-.02382	.2346E+04	.3652E+04	-.2857E+05	-.1202E+05
16100.00	500.00	625.00	.7300E+14	-.00379	-.02434	.2322E+04	.3999E+04	-.2890E+05	-.1200E+05

16200.00	500.00	625.00	.7000E+14	-.00331	-.02487	.2299E+04	.4354E+04	-.2923E+05	-.1198E+05
16300.00	500.00	625.00	.7000E+14	-.00383	-.02541	.2276E+04	.4719E+04	-.2957E+05	-.1195E+05
16400.00	500.00	625.00	.7000E+14	-.00386	-.02597	.2253E+04	.5094E+04	-.2992E+05	-.1193E+05
16500.00	500.00	625.00	.7000E+14	-.00388	-.02655	.2229E+04	.5478E+04	-.3028E+05	-.1190E+05
16600.00	500.00	625.00	.7000E+14	-.00390	-.02714	.2205E+04	.5873E+04	-.3065E+05	-.1187E+05
16700.00	500.00	625.00	.7000E+14	-.00392	-.02775	.2182E+04	.6279E+04	-.3103E+05	-.1185E+05
16800.00	500.00	625.00	.7000E+14	-.00394	-.02838	.2158E+04	.6697E+04	-.3142E+05	-.1182E+05
16900.00	500.00	625.00	.7000E+14	-.00396	-.02903	.2134E+04	.7127E+04	-.3183E+05	-.1179E+05
17000.00	500.00	625.00	.7000E+14	-.00398	-.02970	.2110E+04	.7569E+04	-.3224E+05	-.1176E+05
17100.00	500.00	625.00	.7000E+14	-.00400	-.03039	.2085E+04	.8024E+04	-.3267E+05	-.1173E+05
17200.00	500.00	625.00	.7000E+14	-.00402	-.03111	.2061E+04	.8494E+04	-.3311E+05	-.1169E+05
17300.00	500.00	625.00	.7000E+14	-.00404	-.03185	.2036E+04	.8978E+04	-.3357E+05	-.1166E+05
17400.00	500.00	625.00	.7000E+14	-.00406	-.03262	.2012E+04	.9478E+04	-.3404E+05	-.1162E+05
17500.00	500.00	625.00	.7000E+14	-.00408	-.03341	.1987E+04	.9994E+04	-.3452E+05	-.1159E+05
17600.00	500.00	625.00	.7000E+14	-.00410	-.03423	.1962E+04	.1053E+05	-.3503E+05	-.1155E+05
17700.00	500.00	625.00	.7000E+14	-.00412	-.03509	.1936E+04	.1108E+05	-.3555E+05	-.1151E+05
17800.00	500.00	625.00	.7000E+14	-.00414	-.03598	.1911E+04	.1165E+05	-.3609E+05	-.1147E+05
17900.00	500.00	625.00	.7000E+14	-.00416	-.03690	.1885E+04	.1224E+05	-.3665E+05	-.1143E+05
18000.00	500.00	625.00	.7000E+14	-.00418	-.03787	.1859E+04	.1286E+05	-.3723E+05	-.1139E+05
18100.00	500.00	625.00	.7000E+14	-.00420	-.03887	.1833E+04	.1349E+05	-.3783E+05	-.1134E+05
18200.00	500.00	625.00	.7000E+14	-.00422	-.03992	.1808E+04	.1416E+05	-.3846E+05	-.1129E+05
18300.00	500.00	625.00	.7000E+14	-.00424	-.04101	.1779E+04	.1485E+05	-.3911E+05	-.1125E+05
18400.00	500.00	625.00	.7000E+14	-.00426	-.04216	.1752E+04	.1556E+05	-.3979E+05	-.1119E+05
18500.00	500.00	625.00	.7000E+14	-.00428	-.04337	.1725E+04	.1631E+05	-.4050E+05	-.1114E+05
18600.00	500.00	625.00	.7000E+14	-.00430	-.04463	.1697E+04	.1709E+05	-.4125E+05	-.1108E+05
18700.00	500.00	625.00	.7000E+14	-.00432	-.04596	.1668E+04	.1791E+05	-.4203E+05	-.1102E+05
18800.00	500.00	625.00	.7000E+14	-.00434	-.04736	.1640E+04	.1877E+05	-.4284E+05	-.1096E+05
18900.00	500.00	625.00	.7000E+14	-.00436	-.04884	.1611E+04	.1967E+05	-.4370E+05	-.1090E+05
19000.00	500.00	625.00	.7000E+14	-.00437	-.05041	.1581E+04	.2062E+05	-.4461E+05	-.1083E+05

QUALITY EXCEEDS LIMIT

SAMPLE PROBLEM 2. TEMP. FLUX =CONSTANT, LINEARLY VARIABLE DELTAP

 * SUMMARY OF INPUT DATA *

CLADDING RADIUS	ROUT	.21000	INCHES
CLAD WALL THICKNESS	WALLTK	.02500	INCHES
TIME INCREMENTS	DELT	100.00	HOURS
MAXIMUM OPERATING TIME	TMAX	25000.00	HOURS
INITIAL QUALITY	OVAL	.000700	INCHES
CLADDING EXTERNAL PRESSURE	EXTP	2000.00	PSI
YIELD STRENGTH	YIELD	.5000E+05	PSI
MATERIAL PROPERTIES	MATOPT	F	
TRUE USER SPECIFIED			
FALSE=CODE LIBRARY			
NUMBER OF TEMP. NODES FOR MAT. PROP.	NTEMP	5	
NUMBER OF TIME STEPS	NTIME	5	
NUMBER OF LOECS	NL	2	
COLLAPSE LENGTH	CL	2.	INCHES

 * SUMMARY OF CONSTANT OUTPUT VARIABLES *

ELASTIC COLLAPSE PRESSURE PORIT 6487.98 PSI

POISSONS RATIO TEMP.	VALUE	YOUNGS MODULUS TEMP.	VALUE	YIELD STRENGTH TEMP.	VALUE
75.0	.2960	70.0	.138E+08	70.0	.800E+05
300.0	.2710	300.0	.128E+08	300.0	.700E+05
500.0	.2600	500.0	.118E+08	500.0	.600E+05
700.0	.2420	700.0	.109E+08	700.0	.500E+05
900.0	.2300	900.0	.980E+07	900.0	.250E+05

TIME (HOURS)	INTERNAL PRESSURE (PSI)	CLAD TEMP (DEG F)	FAST FLUX (NV)	CREEP-COM- DELTA-D (IN.)	OVALITY (IN.)	YIELD COLLAPSE (PSIG)	T. STRESS AT ID (PSI)	T. STRESS AT OD (PSI)	T. STRESS NPLANE (PSI)
0.00	500.00	625.00	.7300E+14	0.00000	-0.00091	.5210E+04	-0.1240E+05	-0.1370E+05	-0.1305E+05
100.00	480.00	625.00	.7000E+14	-0.0002	-0.00093	.5210E+04	-0.1254E+05	-0.1386E+05	-0.1320E+05
200.00	460.00	625.00	.7000E+14	-0.00005	-0.00096	.5190E+04	-0.1266E+05	-0.1403E+05	-0.1334E+05
300.00	440.00	625.00	.7000E+14	-0.0008	-0.00098	.5187E+04	-0.1278E+05	-0.1420E+05	-0.1349E+05
400.00	420.00	625.00	.7000E+14	-0.0010	-0.00101	.5174E+04	-0.1290E+05	-0.1438E+05	-0.1364E+05
500.00	400.00	625.00	.7000E+14	-0.0013	-0.00104	.5162E+04	-0.1301E+05	-0.1455E+05	-0.1378E+05
600.00	380.00	625.00	.7000E+14	-0.0016	-0.00107	.5149E+04	-0.1313E+05	-0.1473E+05	-0.1393E+05
700.00	360.00	625.00	.7000E+14	-0.0018	-0.00110	.5135E+04	-0.1324E+05	-0.1491E+05	-0.1407E+05
800.00	340.00	625.00	.7000E+14	-0.0021	-0.00113	.5121E+04	-0.1335E+05	-0.1509E+05	-0.1422E+05
900.00	320.00	625.00	.7000E+14	-0.0024	-0.00117	.5107E+04	-0.1346E+05	-0.1527E+05	-0.1437E+05
1000.00	300.00	625.00	.7000E+14	-0.0027	-0.00120	.5092E+04	-0.1357E+05	-0.1546E+05	-0.1451E+05
1100.00	280.00	625.00	.7000E+14	-0.0030	-0.00124	.5077E+04	-0.1368E+05	-0.1564E+05	-0.1466E+05
1200.00	260.00	625.00	.7000E+14	-0.0033	-0.00128	.5061E+04	-0.1378E+05	-0.1583E+05	-0.1480E+05
1300.00	240.00	625.00	.7000E+14	-0.0036	-0.00132	.5045E+04	-0.1388E+05	-0.1602E+05	-0.1495E+05
1400.00	220.00	625.00	.7000E+14	-0.0039	-0.00137	.5028E+04	-0.1398E+05	-0.1622E+05	-0.1509E+05
1500.00	200.00	625.00	.7000E+14	-0.0042	-0.00141	.5011E+04	-0.1407E+05	-0.1641E+05	-0.1524E+05
1600.00	180.00	625.00	.7000E+14	-0.0045	-0.00146	.4993E+04	-0.1416E+05	-0.1661E+05	-0.1538E+05
1700.00	160.00	625.00	.7000E+14	-0.0048	-0.00151	.4974E+04	-0.1425E+05	-0.1681E+05	-0.1553E+05
1800.00	140.00	625.00	.7000E+14	-0.0052	-0.00157	.4955E+04	-0.1434E+05	-0.1702E+05	-0.1567E+05
1900.00	120.00	625.00	.7000E+14	-0.0055	-0.00163	.4935E+04	-0.1442E+05	-0.1723E+05	-0.1581E+05
2000.00	100.00	625.00	.7000E+14	-0.0059	-0.00169	.4914E+04	-0.1450E+05	-0.1744E+05	-0.1596E+05
2100.00	100.00	625.00	.7000E+14	-0.0062	-0.00174	.4893E+04	-0.1442E+05	-0.1744E+05	-0.1592E+05
2200.00	110.00	625.00	.7000E+14	-0.0065	-0.00180	.4871E+04	-0.1433E+05	-0.1745E+05	-0.1588E+05
2300.00	115.00	625.00	.7000E+14	-0.0068	-0.00185	.4850E+04	-0.1425E+05	-0.1745E+05	-0.1584E+05
2400.00	120.00	625.00	.7000E+14	-0.0071	-0.00191	.4828E+04	-0.1416E+05	-0.1746E+05	-0.1580E+05
2500.00	125.00	625.00	.7000E+14	-0.0075	-0.00197	.4806E+04	-0.1408E+05	-0.1747E+05	-0.1576E+05
2600.00	130.00	625.00	.7000E+14	-0.0078	-0.00203	.4784E+04	-0.1399E+05	-0.1748E+05	-0.1572E+05
2700.00	135.00	625.00	.7000E+14	-0.0081	-0.00210	.4762E+04	-0.1390E+05	-0.1749E+05	-0.1568E+05
2800.00	140.00	625.00	.7000E+14	-0.0085	-0.00216	.4740E+04	-0.1381E+05	-0.1750E+05	-0.1564E+05
2900.00	145.00	625.00	.7000E+14	-0.0088	-0.00223	.4718E+04	-0.1372E+05	-0.1751E+05	-0.1560E+05

3350.00	155.00	625.00	.7000E+14	-.00091	-.00229	.4696E+04	-.1363E+05	-.1753E+05	-.1556E+05
3100.00	155.00	625.00	.7000E+14	-.00094	-.00236	.4673E+04	-.1354E+05	-.1754E+05	-.1552E+05
3200.00	160.00	625.00	.7000E+14	-.00097	-.00243	.4651E+04	-.1345E+05	-.1756E+05	-.1548E+05
3300.00	160.00	625.00	.7000E+14	-.00101	-.00250	.4628E+04	-.1335E+05	-.1757E+05	-.1544E+05
3400.00	170.00	625.00	.7000E+14	-.00104	-.00258	.4615E+04	-.1326E+05	-.1759E+05	-.1540E+05
3500.00	175.00	625.00	.7000E+14	-.00107	-.00265	.4583E+04	-.1316E+05	-.1761E+05	-.1535E+05
3600.00	180.00	625.00	.7000E+14	-.00110	-.00273	.4560E+04	-.1306E+05	-.1763E+05	-.1531E+05
3700.00	185.00	625.00	.7000E+14	-.00113	-.00281	.4537E+04	-.1296E+05	-.1765E+05	-.1527E+05
3800.00	190.00	625.00	.7000E+14	-.00116	-.00289	.4514E+04	-.1286E+05	-.1767E+05	-.1523E+05
3900.00	195.00	625.00	.7000E+14	-.00119	-.00297	.4490E+04	-.1276E+05	-.1769E+05	-.1519E+05
4000.00	200.00	625.00	.7000E+14	-.00123	-.00306	.4467E+04	-.1266E+05	-.1771E+05	-.1515E+05
4100.00	205.00	625.00	.7000E+14	-.00126	-.00314	.4444E+04	-.1255E+05	-.1774E+05	-.1511E+05
4200.00	210.00	625.00	.7000E+14	-.00129	-.00323	.4421E+04	-.1245E+05	-.1777E+05	-.1507E+05
4300.00	215.00	625.00	.7000E+14	-.00132	-.00332	.4397E+04	-.1234E+05	-.1779E+05	-.1503E+05
4400.00	220.00	625.00	.7000E+14	-.00135	-.00341	.4374E+04	-.1223E+05	-.1782E+05	-.1499E+05
4500.00	225.00	625.00	.7000E+14	-.00138	-.00351	.4350E+04	-.1213E+05	-.1795E+05	-.1494E+05
4600.00	230.00	625.00	.7000E+14	-.00141	-.00361	.4327E+04	-.1202E+05	-.1798E+05	-.1490E+05
4700.00	230.00	625.00	.7000E+14	-.00144	-.00370	.4303E+04	-.1190E+05	-.1791E+05	-.1486E+05
4800.00	240.00	625.00	.7000E+14	-.00147	-.00380	.4279E+04	-.1179E+05	-.1794E+05	-.1482E+05
4900.00	245.00	625.00	.7000E+14	-.00150	-.00391	.4256E+04	-.1168E+05	-.1798E+05	-.1478E+05
5000.00	250.00	625.00	.7000E+14	-.00153	-.00401	.4232E+04	-.1156E+05	-.1801E+05	-.1474E+05
5100.00	255.00	625.00	.7000E+14	-.00156	-.00412	.4208E+04	-.1145E+05	-.1805E+05	-.1469E+05
5200.00	260.00	625.00	.7000E+14	-.00159	-.00422	.4184E+04	-.1133E+05	-.1809E+05	-.1465E+05
5300.00	265.00	625.00	.7000E+14	-.00161	-.00434	.4161E+04	-.1121E+05	-.1813E+05	-.1461E+05
5400.00	270.00	625.00	.7000E+14	-.00164	-.00445	.4137E+04	-.1109E+05	-.1816E+05	-.1457E+05
5500.00	275.00	625.00	.7000E+14	-.00167	-.00456	.4113E+04	-.1097E+05	-.1811E+05	-.1453E+05
5600.00	280.00	625.00	.7000E+14	-.00171	-.00468	.4089E+04	-.1085E+05	-.1825E+05	-.1448E+05
5700.00	285.00	625.00	.7000E+14	-.00173	-.00480	.4065E+04	-.1072E+05	-.1829E+05	-.1444E+05
5800.00	290.00	625.00	.7000E+14	-.00176	-.00493	.4041E+04	-.1060E+05	-.1834E+05	-.1440E+05
5900.00	295.00	625.00	.7000E+14	-.00179	-.00505	.4017E+04	-.1047E+05	-.1838E+05	-.1436E+05
6000.00	300.00	625.00	.7000E+14	-.00181	-.00517	.3993E+04	-.1034E+05	-.1843E+05	-.1431E+05
6100.00	305.00	625.00	.7000E+14	-.00184	-.00530	.3969E+04	-.1022E+05	-.1848E+05	-.1427E+05
6200.00	310.00	625.00	.7000E+14	-.00187	-.00543	.3945E+04	-.1009E+05	-.1852E+05	-.1423E+05

6300.00	315.00	625.00	70000+14	-0.0130	-0.0556	.3921E+04	-.9954E+04	-.1857E+05	-.1419E+05
6400.00	320.00	625.00	70000+14	-0.0193	-0.0570	.3897E+04	-.9822E+04	-.1863E+05	-.1414E+05
6500.00	325.00	625.00	70000+14	-0.0195	-0.0594	.3874E+04	-.9688E+04	-.1868E+05	-.1410E+05
6600.00	330.00	625.00	70000+14	-0.0198	-0.0598	.3850E+04	-.9553E+04	-.1873E+05	-.1406E+05
6700.00	335.00	625.00	70000+14	-0.0201	-0.0612	.3826E+04	-.9416E+04	-.1879E+05	-.1401E+05
6800.00	340.00	625.00	70000+14	-0.0213	-0.0627	.3802E+04	-.9279E+04	-.1884E+05	-.1397E+05
6900.00	345.00	625.00	70000+14	-0.0216	-0.0642	.3778E+04	-.9140E+04	-.1890E+05	-.1393E+05
7000.00	350.00	625.00	70000+14	-0.0219	-0.0657	.3754E+04	-.9005E+04	-.1896E+05	-.1388E+05
7100.00	355.00	625.00	70000+14	-0.0212	-0.0672	.3730E+04	-.8859E+04	-.1902E+05	-.1384E+05
7200.00	360.00	625.00	70000+14	-0.0214	-0.0687	.3707E+04	-.8716E+04	-.1908E+05	-.1380E+05
7300.00	365.00	625.00	70000+14	-0.0217	-0.0673	.3683E+04	-.8572E+04	-.1914E+05	-.1375E+05
7400.00	370.00	625.00	70000+14	-0.0219	-0.0719	.3659E+04	-.8427E+04	-.1920E+05	-.1371E+05
7500.00	375.00	625.00	70000+14	-0.0222	-0.0736	.3636E+04	-.8281E+04	-.1927E+05	-.1366E+05
7600.00	380.00	625.00	70000+14	-0.0225	-0.0752	.3612E+04	-.8134E+04	-.1933E+05	-.1362E+05
7700.00	385.00	625.00	70000+14	-0.0227	-0.0769	.3588E+04	-.7985E+04	-.1934E+05	-.1358E+05
7800.00	390.00	625.00	70000+14	-0.0230	-0.0786	.3565E+04	-.7836E+04	-.1947E+05	-.1353E+05
7900.00	395.00	625.00	70000+14	-0.0232	-0.0803	.3541E+04	-.7685E+04	-.1953E+05	-.1349E+05
8000.00	400.00	625.00	70000+14	-0.0235	-0.0821	.3518E+04	-.7533E+04	-.1960E+05	-.1344E+05
8100.00	402.22	625.00	70000+14	-0.0237	-0.0840	.3495E+04	-.7385E+04	-.1971E+05	-.1342E+05
8200.00	404.44	625.00	70000+14	-0.0240	-0.0859	.3471E+04	-.7235E+04	-.1981E+05	-.1339E+05
8300.00	406.67	625.00	70000+14	-0.0243	-0.0878	.3448E+04	-.7083E+04	-.1992E+05	-.1337E+05
8400.00	408.89	625.00	70000+14	-0.0245	-0.0897	.3425E+04	-.6929E+04	-.2003E+05	-.1334E+05
8500.00	411.11	625.00	70000+14	-0.0248	-0.0897	.3401E+04	-.6772E+04	-.2015E+05	-.1332E+05
8600.00	413.33	625.00	70000+14	-0.0251	-0.0938	.3378E+04	-.6613E+04	-.2026E+05	-.1329E+05
8700.00	415.56	625.00	70000+14	-0.0253	-0.0938	.3354E+04	-.6451E+04	-.2038E+05	-.1327E+05
8800.00	417.78	625.00	70000+14	-0.0255	-0.0979	.3331E+04	-.6287E+04	-.2050E+05	-.1324E+05
8900.00	420.00	625.00	70000+14	-0.0258	-0.1001	.3307E+04	-.6121E+04	-.2062E+05	-.1322E+05
9000.00	422.22	625.00	70000+14	-0.0260	-0.1023	.3284E+04	-.5952E+04	-.2075E+05	-.1319E+05
9100.00	424.44	625.00	70000+14	-0.0263	-0.1045	.3260E+04	-.5780E+04	-.2088E+05	-.1316E+05
9200.00	426.67	625.00	70000+14	-0.0265	-0.1068	.3237E+04	-.5606E+04	-.2101E+05	-.1314E+05
9300.00	428.89	625.00	70000+14	-0.0267	-0.1091	.3214E+04	-.5429E+04	-.2114E+05	-.1311E+05
9400.00	431.11	625.00	70000+14	-0.0270	-0.1115	.3190E+04	-.5250E+04	-.2127E+05	-.1308E+05
9500.00	433.33	625.00	70000+14	-0.0272	-0.1139	.3167E+04	-.5068E+04	-.2141E+05	-.1306E+05

9600.00	435.56	625.00	.7000E+14	-.00275	-.01164	.3143E+04	-.4883E+04	-.2155E+05	-.1303E+05
9700.00	437.78	625.00	.7000E+14	-.00277	-.01189	.3120E+04	-.4695E+04	-.2169E+05	-.1300E+05
9800.00	440.00	625.00	.7000E+14	-.00280	-.01214	.3096E+04	-.4505E+04	-.2184E+05	-.1297E+05
9900.00	442.22	625.00	.7000E+14	-.00282	-.01240	.3073E+04	-.4312E+04	-.2198E+05	-.1295E+05
10000.00	444.44	625.00	.7000E+14	-.00284	-.01267	.3050E+04	-.4115E+04	-.2213E+05	-.1292E+05
10100.00	446.67	625.00	.7000E+14	-.00287	-.01294	.3026E+04	-.3916E+04	-.2229E+05	-.1289E+05
10200.00	448.89	625.00	.7000E+14	-.00289	-.01321	.3003E+04	-.3714E+04	-.2244E+05	-.1286E+05
10300.00	451.11	625.00	.7000E+14	-.00291	-.01349	.2979E+04	-.3509E+04	-.2260E+05	-.1283E+05
10400.00	453.33	625.00	.7000E+14	-.00294	-.01378	.2956E+04	-.3301E+04	-.2276E+05	-.1281E+05
10500.00	455.56	625.00	.7000E+14	-.00296	-.01407	.2933E+04	-.3089E+04	-.2293E+05	-.1278E+05
10600.00	457.78	625.00	.7000E+14	-.00299	-.01436	.2910E+04	-.2875E+04	-.2310E+05	-.1275E+05
10700.00	460.00	625.00	.7000E+14	-.00301	-.01467	.2886E+04	-.2657E+04	-.2327E+05	-.1272E+05
10800.00	462.22	625.00	.7000E+14	-.00303	-.01497	.2863E+04	-.2436E+04	-.2344E+05	-.1269E+05
10900.00	464.44	625.00	.7000E+14	-.00306	-.01529	.2840E+04	-.2212E+04	-.2362E+05	-.1266E+05
11000.00	466.67	625.00	.7000E+14	-.00308	-.01561	.2817E+04	-.1984E+04	-.2380E+05	-.1263E+05
11100.00	468.89	625.00	.7000E+14	-.00310	-.01593	.2793E+04	-.1753E+04	-.2398E+05	-.1260E+05
11200.00	471.11	625.00	.7000E+14	-.00312	-.01626	.2770E+04	-.1519E+04	-.2416E+05	-.1257E+05
11300.00	473.33	625.00	.7000E+14	-.00315	-.01660	.2747E+04	-.1281E+04	-.2435E+05	-.1254E+05
11400.00	475.56	625.00	.7000E+14	-.00317	-.01694	.2724E+04	-.1039E+04	-.2455E+05	-.1250E+05
11500.00	477.78	625.00	.7000E+14	-.00319	-.01730	.2701E+04	-.7939E+03	-.2474E+05	-.1247E+05
11600.00	480.00	625.00	.7000E+14	-.00322	-.01765	.2678E+04	-.5449E+03	-.2494E+05	-.1244E+05
11700.00	482.22	625.00	.7000E+14	-.00324	-.01802	.2655E+04	-.2921E+03	-.2515E+05	-.1241E+05
11800.00	484.44	625.00	.7000E+14	-.00326	-.01839	.2632E+04	-.3551E+02	-.2536E+05	-.1238E+05
11900.00	486.67	625.00	.7000E+14	-.00328	-.01877	.2609E+04	.2250E+03	-.2557E+05	-.1234E+05
12000.00	488.89	625.00	.7000E+14	-.00331	-.01915	.2586E+04	.4896E+03	-.2578E+05	-.1231E+05
12100.00	491.11	625.00	.7000E+14	-.00333	-.01955	.2563E+04	.7582E+03	-.2600E+05	-.1228E+05
12200.00	493.33	625.00	.7000E+14	-.00335	-.01995	.2541E+04	.1031E+04	-.2622E+05	-.1224E+05
12300.00	495.56	625.00	.7000E+14	-.00337	-.02036	.2518E+04	.1308E+04	-.2645E+05	-.1221E+05
12400.00	497.78	625.00	.7000E+14	-.00339	-.02078	.2495E+04	.1590E+04	-.2668E+05	-.1218E+05
12500.00	500.00	625.00	.7000E+14	-.00342	-.02120	.2472E+04	.1877E+04	-.2692E+05	-.1214E+05
12600.00	502.22	625.00	.7000E+14	-.00344	-.02164	.2450E+04	.2168E+04	-.2716E+05	-.1211E+05
12700.00	504.44	625.00	.7000E+14	-.00346	-.02208	.2427E+04	.2464E+04	-.2740E+05	-.1207E+05
12800.00	506.67	625.00	.7000E+14	-.00348	-.02254	.2404E+04	.2765E+04	-.2765E+05	-.1204E+05

12900.00	508.89	625.00	7000E+14	-.00350	-.02300	.2381E+04	.3072E+04	-.2790E+05	-.1200E+05
13000.00	511.11	625.00	7000E+14	-.00352	-.02348	.2359E+04	.3384E+04	-.2816E+05	-.1196E+05
13100.00	513.33	625.00	7000E+14	-.00354	-.02396	.2336E+04	.3701E+04	-.2843E+05	-.1193E+05
13200.00	515.56	625.00	7000E+14	-.00357	-.02446	.2313E+04	.4025E+04	-.2870E+05	-.1189E+05
13300.00	517.78	625.00	7000E+14	-.00359	-.02497	.2290E+04	.4354E+04	-.2898E+05	-.1185E+05
13400.00	520.00	625.00	7000E+14	-.00361	-.02548	.2268E+04	.4690E+04	-.2926E+05	-.1181E+05
13500.00	522.22	625.00	7000E+14	-.00363	-.02602	.2245E+04	.5032E+04	-.2955E+05	-.1178E+05
13600.00	524.44	625.00	7000E+14	-.00365	-.02656	.2222E+04	.5380E+04	-.2984E+05	-.1174E+05
13700.00	526.67	625.00	7000E+14	-.00367	-.02712	.2199E+04	.5736E+04	-.3015E+05	-.1170E+05
13800.00	528.89	625.00	7000E+14	-.00369	-.02769	.2177E+04	.6099E+04	-.3045E+05	-.1166E+05
13900.00	531.11	625.00	7000E+14	-.00371	-.02828	.2154E+04	.6469E+04	-.3077E+05	-.1162E+05
14000.00	533.33	625.00	7000E+14	-.00373	-.02888	.2131E+04	.6848E+04	-.3109E+05	-.1158E+05
14100.00	535.56	625.00	7000E+14	-.00375	-.02950	.2108E+04	.7234E+04	-.3142E+05	-.1153E+05
14200.00	537.78	625.00	7000E+14	-.00377	-.03013	.2085E+04	.7628E+04	-.3176E+05	-.1149E+05
14300.00	540.00	625.00	7000E+14	-.00379	-.03078	.2062E+04	.8032E+04	-.3211E+05	-.1145E+05
14400.00	542.22	625.00	7000E+14	-.00381	-.03145	.2039E+04	.8444E+04	-.3247E+05	-.1140E+05
14500.00	544.44	625.00	7000E+14	-.00383	-.03213	.2016E+04	.8866E+04	-.3283E+05	-.1136E+05
14600.00	546.67	625.00	7000E+14	-.00385	-.03284	.1993E+04	.9298E+04	-.3321E+05	-.1131E+05
14700.00	548.89	625.00	7000E+14	-.00387	-.03357	.1970E+04	.9740E+04	-.3359E+05	-.1127E+05
14800.00	551.11	625.00	7000E+14	-.00389	-.03432	.1946E+04	.1019E+05	-.3399E+05	-.1122E+05
14900.00	553.33	625.00	7000E+14	-.00391	-.03509	.1923E+04	.1066E+05	-.3440E+05	-.1117E+05
15000.00	555.56	625.00	7000E+14	-.00393	-.03588	.1900E+04	.1113E+05	-.3481E+05	-.1112E+05
15100.00	557.78	625.00	7000E+14	-.00395	-.03670	.1876E+04	.1162E+05	-.3524E+05	-.1107E+05
15200.00	560.00	625.00	7000E+14	-.00396	-.03755	.1853E+04	.1212E+05	-.3569E+05	-.1102E+05
15300.00	562.22	625.00	7000E+14	-.00398	-.03842	.1829E+04	.1264E+05	-.3614E+05	-.1097E+05
15400.00	564.44	625.00	7000E+14	-.00400	-.03933	.1805E+04	.1317E+05	-.3661E+05	-.1092E+05
15500.00	566.67	625.00	7000E+14	-.00402	-.04026	.1781E+04	.1371E+05	-.3710E+05	-.1086E+05
15600.00	568.89	625.00	7000E+14	-.00404	-.04123	.1757E+04	.1427E+05	-.3760E+05	-.1081E+05
15700.00	571.11	625.00	7000E+14	-.00406	-.04223	.1733E+04	.1485E+05	-.3812E+05	-.1075E+05
15800.00	573.33	625.00	7000E+14	-.00408	-.04327	.1709E+04	.1545E+05	-.3865E+05	-.1069E+05
15900.00	575.56	625.00	7000E+14	-.00409	-.04435	.1684E+04	.1606E+05	-.3920E+05	-.1063E+05
16000.00	577.78	625.00	7000E+14	-.00411	-.04547	.1660E+04	.1670E+05	-.3978E+05	-.1057E+05
16100.00	580.00	625.00	7000E+14	-.00413	-.04663	.1635E+04	.1735E+05	-.4037E+05	-.1051E+05

16200.00	592.22	625.00	.7000E+14	-.00415	-.04785	.1610E+34	.1803E+05	-.4098E+05	-.1044E+05
16300.00	584.44	625.00	.7000E+14	-.00416	-.04911	.1585E+04	.1873E+05	-.4162E+05	-.1037E+05
16400.00	586.57	625.00	.7000E+14	-.00418	-.05043	.1560E+14	.1946E+05	-.4229E+05	-.1031E+05

QUALITY EXCEEDS LIMIT

SAMPLE PROBLEM 3. TEMP, FLUX =CONSTANT, STEP VARIABLE DELTAP

 * SUMMARY OF INPUT DATA *

CLADDING RADIUS	ROUT	.2100	INCHES
CLAD WALL THICKNESS	WALLTK	.02500	INCHES
TIME INCREMENTS	DELT	100.00	HOURS
MAXIMUM OPERATING TIME	TMAX	25000.00	HOURS
INITIAL OVALITY	OVAL	.000700	INCHES
CLADDING EXTERNAL PRESSURE	EXTP	2000.00	PSI
YIELD STRENGTH	YIELD	.5000E+05	PSI
MATERIAL PROPERTIES	MATOPT	F	
TRUE=USER SPECIFIED			
FALSE=CODE LIBRARY			
NUMBER OF TEMP. NODES FOR MAT. PROP.	NTEMP	5	
NUMBER OF TIME STEPS	NTIME	8	
MAX=16, 4IN=3			
NUMBER OF LOSES	NL	2	
COLLAPSE LENGTH	CL	2.	INCHES

 * SUMMARY OF CONSTANT OUTPUT VARIABLES *

ELASTIC COLLAPSE PRESSURE PCRIT 6487.98 PSI

POISSON'S RATIO	TEMP.	YOUNG'S MODULUS	TEMP.	YIELD STRENGTH	TEMP.	YIELD STRENGTH
VALUE		VALUE		VALUE		VALUE
.2960	70.0	.139E+03	70.0	.800E+05		
.2710	300.0	.128E+08	300.0	.700E+05		
.2600	500.0	.118E+09	500.0	.600E+05		
.2420	700.0	.109E+08	700.0	.500E+05		
.2300	900.0	.980E+07	900.0	.250E+05		

TIME (HOURS)	INTERNAL PRESSURE (PSI)	CLAC TEMP (DEG F)	FAST FLOW (GPM)	CREEP-CROWN DELTA-D (IN.)	OVALITY (IN.)	YIELD COLLAPSE (PSIG)	T. STRESS AT ID (PSI)	T. STRESS AT OD (PSI)	T. STRESS NPLANE (PSI)
0.00	500.00	625.00	.7000E+14	0.0000	-.00091	.5210E+04	-.1240E+05	-.1370E+05	-.1305E+05
100.00	500.00	625.00	.7000E+14	-.0002	-.00093	.5210E+04	-.1240E+05	-.1370E+05	-.1305E+05
200.00	500.00	625.00	.7000E+14	-.0005	-.00095	.5190E+04	-.1239E+05	-.1371E+05	-.1305E+05
300.00	500.00	625.00	.7000E+14	-.0007	-.00097	.5187E+04	-.1237E+05	-.1372E+05	-.1305E+05
400.00	500.00	625.00	.7000E+14	-.0010	-.00099	.5176E+04	-.1236E+05	-.1374E+05	-.1305E+05
500.00	500.00	625.00	.7000E+14	-.0012	-.00101	.5165E+04	-.1234E+05	-.1375E+05	-.1305E+05
600.00	500.00	625.00	.7000E+14	-.0015	-.00103	.5153E+04	-.1233E+05	-.1376E+05	-.1305E+05
700.00	500.00	625.00	.7000E+14	-.0017	-.00105	.5142E+04	-.1231E+05	-.1378E+05	-.1305E+05
800.00	500.00	625.00	.7000E+14	-.0019	-.00107	.5130E+04	-.1230E+05	-.1379E+05	-.1304E+05
900.00	500.00	625.00	.7000E+14	-.0022	-.00110	.5118E+04	-.1228E+05	-.1381E+05	-.1304E+05
1000.00	500.00	625.00	.7000E+14	-.0024	-.00112	.5106E+04	-.1226E+05	-.1382E+05	-.1304E+05
1100.00	500.00	625.00	.7000E+14	-.0027	-.00114	.5094E+04	-.1225E+05	-.1384E+05	-.1304E+05
1200.00	500.00	625.00	.7000E+14	-.0029	-.00117	.5082E+04	-.1223E+05	-.1386E+05	-.1304E+05
1300.00	500.00	625.00	.7000E+14	-.0032	-.00119	.5070E+04	-.1221E+05	-.1387E+05	-.1304E+05
1400.00	500.00	625.00	.7000E+14	-.0034	-.00122	.5058E+04	-.1219E+05	-.1389E+05	-.1304E+05
1500.00	500.00	625.00	.7000E+14	-.0036	-.00124	.5046E+04	-.1218E+05	-.1390E+05	-.1304E+05
1600.00	500.00	625.00	.7000E+14	-.0039	-.00127	.5033E+04	-.1216E+05	-.1392E+05	-.1304E+05
1700.00	500.00	625.00	.7000E+14	-.0041	-.00129	.5021E+04	-.1214E+05	-.1394E+05	-.1304E+05
1800.00	500.00	625.00	.7000E+14	-.0044	-.00132	.5008E+04	-.1212E+05	-.1396E+05	-.1303E+05
1900.00	500.00	625.00	.7000E+14	-.0046	-.00135	.4995E+04	-.1210E+05	-.1398E+05	-.1303E+05
2000.00	500.00	625.00	.7000E+14	-.0050	-.00151	.4983E+04	-.1465E+05	-.1729E+05	-.1597E+05
2100.00	500.00	625.00	.7000E+14	-.0053	-.00157	.4969E+04	-.1461E+05	-.1734E+05	-.1596E+05
2200.00	500.00	625.00	.7000E+14	-.0056	-.00162	.4941E+04	-.1456E+05	-.1738E+05	-.1596E+05
2300.00	500.00	625.00	.7000E+14	-.0060	-.00167	.4920E+04	-.1451E+05	-.1742E+05	-.1596E+05
2400.00	500.00	625.00	.7000E+14	-.0063	-.00173	.4895E+04	-.1446E+05	-.1747E+05	-.1595E+05
2500.00	500.00	625.00	.7000E+14	-.0066	-.00178	.4878E+04	-.1444E+05	-.1752E+05	-.1595E+05
2600.00	500.00	625.00	.7000E+14	-.0070	-.00184	.4856E+04	-.1436E+05	-.1757E+05	-.1595E+05
2700.00	500.00	625.00	.7000E+14	-.0073	-.00190	.4834E+04	-.1432E+05	-.1762E+05	-.1595E+05
2800.00	500.00	625.00	.7000E+14	-.0076	-.00197	.4812E+04	-.1424E+05	-.1767E+05	-.1594E+05
2900.00	500.00	625.00	.7000E+14	-.0080	-.00203	.4789E+04	-.1419E+05	-.1773E+05	-.1594E+05

3300.00	100.00	625.00	.7000E+14	-.00083	-.00210	.4767E+04	-.1412E+05	-.1778E+05	-.1593E+05
3400.00	100.00	625.00	.7000E+14	-.00087	-.00217	.4744E+04	-.1406E+05	-.1784E+05	-.1593E+05
3500.00	100.00	625.00	.7000E+14	-.00090	-.00224	.4721E+04	-.1400E+05	-.1790E+05	-.1593E+05
3600.00	100.00	625.00	.7000E+14	-.00093	-.00232	.4697E+04	-.1393E+05	-.1796E+05	-.1592E+05
3700.00	100.00	625.00	.7000E+14	-.00097	-.00239	.4673E+04	-.1386E+05	-.1803E+05	-.1592E+05
3800.00	100.00	625.00	.7000E+14	-.00100	-.00247	.4649E+04	-.1379E+05	-.1809E+05	-.1591E+05
3900.00	100.00	625.00	.7000E+14	-.00103	-.00255	.4625E+04	-.1371E+05	-.1816E+05	-.1591E+05
4000.00	100.00	625.00	.7000E+14	-.00107	-.00264	.4601E+04	-.1364E+05	-.1823E+05	-.1590E+05
4100.00	100.00	625.00	.7000E+14	-.00110	-.00273	.4576E+04	-.1356E+05	-.1830E+05	-.1590E+05
4200.00	100.00	625.00	.7000E+14	-.00113	-.00282	.4551E+04	-.1348E+05	-.1838E+05	-.1589E+05
4300.00	100.00	625.00	.7000E+14	-.00117	-.00291	.4526E+04	-.1339E+05	-.1846E+05	-.1589E+05
4400.00	100.00	625.00	.7000E+14	-.00120	-.00301	.4501E+04	-.1331E+05	-.1854E+05	-.1588E+05
4500.00	100.00	625.00	.7000E+14	-.00123	-.00311	.4475E+04	-.1322E+05	-.1862E+05	-.1588E+05
4600.00	100.00	625.00	.7000E+14	-.00127	-.00321	.4449E+04	-.1312E+05	-.1870E+05	-.1587E+05
4700.00	100.00	625.00	.7000E+14	-.00130	-.00331	.4423E+04	-.1303E+05	-.1879E+05	-.1587E+05
4800.00	100.00	625.00	.7000E+14	-.00133	-.00342	.4396E+04	-.1293E+05	-.1888E+05	-.1586E+05
4900.00	100.00	625.00	.7000E+14	-.00137	-.00354	.4370E+04	-.1283E+05	-.1898E+05	-.1585E+05
5000.00	100.00	625.00	.7000E+14	-.00140	-.00365	.4343E+04	-.1272E+05	-.1907E+05	-.1585E+05
5100.00	100.00	625.00	.7000E+14	-.00143	-.00377	.4315E+04	-.1261E+05	-.1917E+05	-.1584E+05
5200.00	100.00	625.00	.7000E+14	-.00147	-.00390	.4288E+04	-.1250E+05	-.1928E+05	-.1583E+05
5300.00	100.00	625.00	.7000E+14	-.00150	-.00403	.4260E+04	-.1239E+05	-.1938E+05	-.1583E+05
5400.00	100.00	625.00	.7000E+14	-.00153	-.00416	.4232E+04	-.1227E+05	-.1949E+05	-.1582E+05
5500.00	100.00	625.00	.7000E+14	-.00157	-.00430	.4204E+04	-.1214E+05	-.1961E+05	-.1581E+05
5600.00	100.00	625.00	.7000E+14	-.00160	-.00444	.4176E+04	-.1202E+05	-.1972E+05	-.1580E+05
5700.00	100.00	625.00	.7000E+14	-.00163	-.00458	.4147E+04	-.1188E+05	-.1984E+05	-.1580E+05
5800.00	100.00	625.00	.7000E+14	-.00167	-.00473	.4119E+04	-.1175E+05	-.1997E+05	-.1579E+05
5900.00	100.00	625.00	.7000E+14	-.00170	-.00489	.4089E+04	-.1161E+05	-.2010E+05	-.1578E+05
6000.00	100.00	625.00	.7000E+14	-.00173	-.00505	.4060E+04	-.1147E+05	-.2023E+05	-.1577E+05
6100.00	100.00	625.00	.7000E+14	-.00175	-.00522	.4031E+04	-.1132E+05	-.2037E+05	-.1576E+05
6200.00	100.00	625.00	.7000E+14	-.00190	-.00539	.4001E+04	-.1116E+05	-.2051E+05	-.1575E+05
6300.00	100.00	625.00	.7000E+14	-.00183	-.00556	.3971E+04	-.1100E+05	-.2066E+05	-.1574E+05
6400.00	100.00	625.00	.7000E+14	-.00186	-.00575	.3941E+04	-.1084E+05	-.2081E+05	-.1573E+05
6500.00	100.00	625.00	.7000E+14	-.00190	-.00594	.3910E+04	-.1067E+05	-.2096E+05	-.1572E+05

6300.00	100.00	625.00	7000E+14	-0.0193	-0.00613	.3880E+04	-1.050E+05	-0.2112E+05	-1.1571E+05
6400.00	100.00	625.00	7000E+14	-0.0196	-0.00633	.3849E+04	-1.032E+05	-0.2129E+05	-1.1570E+05
6500.00	100.00	625.00	7000E+14	-0.0199	-0.00654	.3818E+04	-1.013E+05	-0.2146E+05	-1.1569E+05
6600.00	100.00	625.00	7000E+14	-0.0203	-0.00675	.3786E+04	-9.94E+04	-0.2164E+05	-1.1568E+05
6700.00	100.00	625.00	7000E+14	-0.0206	-0.00698	.3755E+04	-9.74E+04	-0.2182E+05	-1.1566E+05
6800.00	100.00	625.00	7000E+14	-0.0209	-0.00720	.3723E+04	-9.53E+04	-0.2201E+05	-1.1565E+05
6900.00	100.00	625.00	7000E+14	-0.0212	-0.00744	.3691E+04	-9.32E+04	-0.2220E+05	-1.1564E+05
7000.00	100.00	625.00	7000E+14	-0.0216	-0.00768	.3659E+04	-9.11E+04	-0.2240E+05	-1.1562E+05
7100.00	100.00	625.00	7000E+14	-0.0219	-0.00794	.3627E+04	-8.88E+04	-0.2261E+05	-1.1561E+05
7200.00	100.00	625.00	7000E+14	-0.0222	-0.00820	.3594E+04	-8.65E+04	-0.2283E+05	-1.1560E+05
7300.00	100.00	625.00	7000E+14	-0.0225	-0.00847	.3561E+04	-8.41E+04	-0.2305E+05	-1.1558E+05
7400.00	100.00	625.00	7000E+14	-0.0229	-0.00874	.3528E+04	-8.18E+04	-0.2328E+05	-1.1556E+05
7500.00	100.00	625.00	7000E+14	-0.0232	-0.00903	.3495E+04	-7.94E+04	-0.2351E+05	-1.1555E+05
7600.00	100.00	625.00	7000E+14	-0.0235	-0.00933	.3462E+04	-7.65E+04	-0.2375E+05	-1.1553E+05
7700.00	100.00	625.00	7000E+14	-0.0238	-0.00963	.3429E+04	-7.37E+04	-0.2401E+05	-1.1551E+05
7800.00	100.00	625.00	7000E+14	-0.0241	-0.00995	.3395E+04	-7.09E+04	-0.2426E+05	-1.1550E+05
7900.00	100.00	625.00	7000E+14	-0.0245	-0.01028	.3361E+04	-6.80E+04	-0.2453E+05	-1.1548E+05
8000.00	100.00	625.00	7000E+14	-0.0247	-0.00987	.3327E+04	-6.28E+04	-0.2076E+05	-1.1337E+05
8100.00	100.00	625.00	7000E+14	-0.0250	-0.01010	.3303E+04	-6.11E+04	-0.2092E+05	-1.1335E+05
8200.00	100.00	625.00	7000E+14	-0.0252	-0.01033	.3279E+04	-5.93E+04	-0.2108E+05	-1.1334E+05
8300.00	100.00	625.00	7000E+14	-0.0255	-0.01057	.3255E+04	-5.75E+04	-0.2124E+05	-1.1333E+05
8400.00	100.00	625.00	7000E+14	-0.0257	-0.01091	.3231E+04	-5.57E+04	-0.2141E+05	-1.1332E+05
8500.00	100.00	625.00	7000E+14	-0.0260	-0.01106	.3206E+04	-5.38E+04	-0.2159E+05	-1.1331E+05
8600.00	100.00	625.00	7000E+14	-0.0262	-0.01131	.3182E+04	-5.19E+04	-0.2176E+05	-1.1330E+05
8700.00	100.00	625.00	7000E+14	-0.0265	-0.01158	.3158E+04	-5.00E+04	-0.2194E+05	-1.1328E+05
8800.00	100.00	625.00	7000E+14	-0.0267	-0.01184	.3133E+04	-4.80E+04	-0.2213E+05	-1.1327E+05
8900.00	100.00	625.00	7000E+14	-0.0270	-0.01211	.3109E+04	-4.59E+04	-0.2232E+05	-1.1326E+05
9000.00	100.00	625.00	7000E+14	-0.0272	-0.01239	.3084E+04	-4.39E+04	-0.2251E+05	-1.1324E+05
9100.00	100.00	625.00	7000E+14	-0.0275	-0.01268	.3059E+04	-4.17E+04	-0.2271E+05	-1.1323E+05
9200.00	100.00	625.00	7000E+14	-0.0277	-0.01297	.3035E+04	-3.95E+04	-0.2291E+05	-1.1322E+05
9300.00	100.00	625.00	7000E+14	-0.0280	-0.01327	.3010E+04	-3.73E+04	-0.2312E+05	-1.1320E+05
9400.00	100.00	625.00	7000E+14	-0.0282	-0.01358	.2985E+04	-3.50E+04	-0.2333E+05	-1.1319E+05
9500.00	100.00	625.00	7000E+14	-0.0285	-0.01389	.2960E+04	-3.27E+04	-0.2355E+05	-1.1317E+05

9600.00	400.00	625.00	70000+14	-0.0287	-0.01422	.2935E+04	-.3034E+04	-.2377E+05	-.1316E+05
9700.00	400.00	625.00	70000+14	-0.0290	-0.01455	.2910E+04	-.2789E+04	-.2400E+05	-.1314E+05
9800.00	400.00	625.00	70000+14	-0.0292	-0.01488	.2885E+04	-.2539E+04	-.2423E+05	-.1313E+05
9900.00	400.00	625.00	70000+14	-0.0295	-0.01523	.2860E+04	-.2283E+04	-.2447E+05	-.1311E+05
10000.00	400.00	625.00	70000+14	-0.0297	-0.01558	.2835E+04	-.2021E+04	-.2471E+05	-.1309E+05
10100.00	400.00	625.00	70000+14	-0.0299	-0.01595	.2810E+04	-.1752E+04	-.2496E+05	-.1307E+05
10200.00	400.00	625.00	70000+14	-0.0302	-0.01632	.2784E+04	-.1478E+04	-.2521E+05	-.1306E+05
10300.00	400.00	625.00	70000+14	-0.0304	-0.01670	.2759E+04	-.1197E+04	-.2547E+05	-.1304E+05
10400.00	400.00	625.00	70000+14	-0.0307	-0.01709	.2734E+04	-.9087E+03	-.2574E+05	-.1302E+05
10500.00	400.00	625.00	70000+14	-0.0309	-0.01750	.2708E+04	-.6138E+03	-.2602E+05	-.1300E+05
10600.00	400.00	625.00	70000+14	-0.0312	-0.01791	.2683E+04	-.3118E+03	-.2630E+05	-.1298E+05
10700.00	400.00	625.00	70000+14	-0.0314	-0.01833	.2657E+04	-.2514E+03	-.2659E+05	-.1296E+05
10800.00	400.00	625.00	70000+14	-0.0316	-0.01876	.2632E+04	.3144E+03	-.2688E+05	-.1294E+05
10900.00	400.00	625.00	70000+14	-0.0319	-0.01921	.2606E+04	.6392E+03	-.2718E+05	-.1292E+05
11000.00	400.00	625.00	70000+14	-0.0321	-0.01966	.2580E+04	.9722E+03	-.2749E+05	-.1290E+05
11100.00	400.00	625.00	70000+14	-0.0324	-0.02013	.2554E+04	.1314E+04	-.2781E+05	-.1287E+05
11200.00	400.00	625.00	70000+14	-0.0326	-0.02062	.2528E+04	.1664E+04	-.2814E+05	-.1285E+05
11300.00	400.00	625.00	70000+14	-0.0329	-0.02111	.2502E+04	.2024E+04	-.2847E+05	-.1283E+05
11400.00	400.00	625.00	70000+14	-0.0331	-0.02162	.2476E+04	.2393E+04	-.2882E+05	-.1280E+05
11500.00	400.00	625.00	70000+14	-0.0333	-0.02215	.2450E+04	.2773E+04	-.2917E+05	-.1278E+05
11600.00	400.00	625.00	70000+14	-0.0335	-0.02269	.2424E+04	.3163E+04	-.2954E+05	-.1275E+05
11700.00	400.00	625.00	70000+14	-0.0338	-0.02325	.2397E+04	.3564E+04	-.2991E+05	-.1272E+05
11800.00	400.00	625.00	70000+14	-0.0340	-0.02383	.2371E+04	.3977E+04	-.3030E+05	-.1270E+05
11900.00	400.00	625.00	70000+14	-0.0342	-0.02442	.2344E+04	.4403E+04	-.3069E+05	-.1267E+05
12000.00	400.00	625.00	70000+14	-0.0345	-0.02504	.2317E+04	.4841E+04	-.3110E+05	-.1264E+05
12100.00	400.00	625.00	70000+14	-0.0347	-0.02567	.2290E+04	.5293E+04	-.3153E+05	-.1261E+05
12200.00	400.00	625.00	70000+14	-0.0349	-0.02633	.2263E+04	.5758E+04	-.3196E+05	-.1258E+05
12300.00	400.00	625.00	70000+14	-0.0352	-0.02701	.2236E+04	.6240E+04	-.3241E+05	-.1254E+05
12400.00	400.00	625.00	70000+14	-0.0354	-0.02771	.2209E+04	.6736E+04	-.3288E+05	-.1251E+05
12500.00	400.00	625.00	70000+14	-0.0356	-0.02844	.2181E+04	.7250E+04	-.3336E+05	-.1247E+05
12600.00	400.00	625.00	70000+14	-0.0358	-0.02920	.2153E+04	.7782E+04	-.3386E+05	-.1244E+05
12700.00	400.00	625.00	70000+14	-0.0361	-0.02999	.2125E+04	.8332E+04	-.3438E+05	-.1240E+05
12800.00	400.00	625.00	70000+14	-0.0363	-0.03081	.2097E+04	.8902E+04	-.3491E+05	-.1236E+05

12900.00	400.00	625.00	.7000E+14	-.00365	-.03166	.2088E+04	.9494E+04	-.3547E+05	-.1232E+05
13000.00	400.00	625.00	.7000E+14	-.00367	-.03255	.2039E+04	.1011E+05	-.3605E+05	-.1228E+05
13100.00	400.00	625.00	.7000E+14	-.00369	-.03348	.2010E+04	.1075E+05	-.3665E+05	-.1223E+05
13200.00	400.00	625.00	.7000E+14	-.00372	-.03445	.1980E+04	.1141E+05	-.3728E+05	-.1218E+05
13300.00	400.00	625.00	.7000E+14	-.00374	-.03547	.1951E+04	.1211E+05	-.3793E+05	-.1214E+05
13400.00	400.00	625.00	.7000E+14	-.00376	-.03653	.1921E+04	.1283E+05	-.3861E+05	-.1209E+05
13500.00	400.00	625.00	.7000E+14	-.00378	-.03765	.1890E+04	.1358E+05	-.3932E+05	-.1203E+05
13600.00	400.00	625.00	.7000E+14	-.00380	-.03882	.1859E+04	.1437E+05	-.4007E+05	-.1198E+05
13700.00	400.00	625.00	.7000E+14	-.00382	-.04006	.1828E+04	.1520E+05	-.4086E+05	-.1192E+05
13800.00	400.00	625.00	.7000E+14	-.00385	-.04137	.1796E+04	.1607E+05	-.4168E+05	-.1185E+05
13900.00	400.00	625.00	.7000E+14	-.00387	-.04276	.1764E+04	.1698E+05	-.4255E+05	-.1179E+05
14000.00	400.00	625.00	.7000E+14	-.00389	-.04423	.1731E+04	.1795E+05	-.4346E+05	-.1172E+05
14100.00	400.00	625.00	.7000E+14	-.00391	-.04579	.1697E+04	.1897E+05	-.4443E+05	-.1165E+05
14200.00	400.00	625.00	.7000E+14	-.00393	-.04746	.1663E+04	.2004E+05	-.4546E+05	-.1157E+05
14300.00	400.00	625.00	.7000E+14	-.00395	-.04925	.1628E+04	.2119E+05	-.4655E+05	-.1148E+05
14400.00	400.00	625.00	.7000E+14	-.00397	-.05117	.1593E+04	.2240E+05	-.4772E+05	-.1139E+05

STRESS EXCEEDS YIELD STRENGTH

[illegible]

SAMPLE PROBLEM 4. DELTAP, FFLUX = CONSTANT, LINEARLY VARIABLE TEMP.

 * SUMMARY OF INPUT DATA *

CLADDING RADIUS	ROUT	.21000	INCHES
CLAD WALL THICKNESS	WALLTK	.02500	INCHES
TIME INCREMENTS	DELT	1.00000	HOURS
MAXIMUM OPERATING TIME	TMAX	25000.00	HOURS
INITIAL QUALITY	OVAL	.000700	INCHES
CLADDING EXTERNAL PRESSURE	EXTP	2000.00	PSI
YIELD STRENGTH	YIELD	.5000E+05	PSI
MATERIAL PROPERTIES	MATOPT	F	
TRUE/USER SPECIFIED			
FALSE=CODE LIBRARY			
NUMBER OF TEMP. NODES FOR MAT. PROP.	NTEMP	5	
NUMBER OF TIME STEPS	NTIME	5	
MAX=16, MIN=3			
NUMBER OF LOBS	NL	2	
COLLAPSE LENGTH	CL	2.	INCHES

 * SUMMARY OF CONSTANT OUTPUT VARIABLES *

ELASTIC COLLAPSE PRESSURE PCRT 6487.98 PSI

POISSONS RATIO TEMP.	YOUNGS TEMP.	MODULUS VALUE	YIELD STRENGTH TEMP.	VALUE
70.0	70.0	.139E+08	70.0	.800E+05
300.0	300.0	.129E+08	300.0	.760E+05
500.0	500.0	.113E+08	500.0	.600E+05
700.0	700.0	.109E+08	700.0	.500E+05
900.0	900.0	.980E+07	900.0	.250E+05

TIME (HOURS)	INTERNAL PRESSURE (PSI)	CLAP TEMP (DEG F)	FAST FLUX (MW)	CREEP-TOWN DELTA-D (IN.)	OVALITY (IN.)	YIELD COLLAPSE (PSIG)	T-STRESS AT ID (PSI)	T-STRESS AT OD (PSI)	T-STRESS NPLANE (PSI)
0.00	500.00	625.00	.7000E+14	0.0000	-.00091	.5210E+04	-.1240E+05	-.1370E+05	-.1305E+05
100.00	500.00	626.25	.7000E+14	-.00002	-.00093	.5208E+04	-.1240E+05	-.1370E+05	-.1305E+05
200.00	500.00	627.50	.7000E+14	-.00005	-.00095	.5196E+04	-.1239E+05	-.1371E+05	-.1305E+05
300.00	500.00	628.75	.7000E+14	-.00007	-.00097	.5183E+04	-.1237E+05	-.1372E+05	-.1305E+05
400.00	500.00	630.00	.7000E+14	-.00010	-.00099	.5171E+04	-.1236E+05	-.1374E+05	-.1305E+05
500.00	500.00	631.25	.7000E+14	-.00012	-.00101	.5158E+04	-.1234E+05	-.1375E+05	-.1305E+05
600.00	500.00	632.50	.7000E+14	-.00015	-.00104	.5145E+04	-.1233E+05	-.1377E+05	-.1305E+05
700.00	500.00	633.75	.7000E+14	-.00018	-.00106	.5131E+04	-.1231E+05	-.1378E+05	-.1305E+05
800.00	500.00	635.00	.7000E+14	-.00020	-.00108	.5118E+04	-.1229E+05	-.1380E+05	-.1304E+05
900.00	500.00	636.25	.7000E+14	-.00023	-.00111	.5104E+04	-.1227E+05	-.1381E+05	-.1304E+05
1000.00	500.00	637.50	.7000E+14	-.00025	-.00113	.5090E+04	-.1226E+05	-.1383E+05	-.1304E+05
1100.00	500.00	638.75	.7000E+14	-.00028	-.00116	.5076E+04	-.1224E+05	-.1385E+05	-.1304E+05
1200.00	500.00	640.00	.7000E+14	-.00031	-.00119	.5061E+04	-.1222E+05	-.1387E+05	-.1304E+05
1300.00	500.00	641.25	.7000E+14	-.00034	-.00121	.5047E+04	-.1220E+05	-.1388E+05	-.1304E+05
1400.00	500.00	642.50	.7000E+14	-.00036	-.00124	.5032E+04	-.1218E+05	-.1390E+05	-.1304E+05
1500.00	500.00	643.75	.7000E+14	-.00039	-.00127	.5017E+04	-.1216E+05	-.1392E+05	-.1304E+05
1600.00	500.00	645.00	.7000E+14	-.00042	-.00130	.5002E+04	-.1213E+05	-.1394E+05	-.1303E+05
1700.00	500.00	646.25	.7000E+14	-.00045	-.00133	.4987E+04	-.1211E+05	-.1396E+05	-.1303E+05
1800.00	500.00	647.50	.7000E+14	-.00047	-.00136	.4971E+04	-.1209E+05	-.1398E+05	-.1303E+05
1900.00	500.00	648.75	.7000E+14	-.00050	-.00140	.4955E+04	-.1207E+05	-.1401E+05	-.1303E+05
2000.00	500.00	650.00	.7000E+14	-.00053	-.00143	.4939E+04	-.1204E+05	-.1403E+05	-.1303E+05
2100.00	500.00	649.50	.7000E+14	-.00056	-.00147	.4924E+04	-.1202E+05	-.1405E+05	-.1303E+05
2200.00	500.00	649.17	.7000E+14	-.00059	-.00150	.4909E+04	-.1199E+05	-.1408E+05	-.1303E+05
2300.00	500.00	648.75	.7000E+14	-.00062	-.00154	.4894E+04	-.1196E+05	-.1410E+05	-.1302E+05
2400.00	500.00	648.33	.7000E+14	-.00065	-.00158	.4879E+04	-.1194E+05	-.1412E+05	-.1302E+05
2500.00	500.00	647.92	.7000E+14	-.00067	-.00161	.4864E+04	-.1191E+05	-.1415E+05	-.1302E+05
2600.00	500.00	647.50	.7000E+14	-.00070	-.00165	.4849E+04	-.1188E+05	-.1418E+05	-.1302E+05
2700.00	500.00	647.08	.7000E+14	-.00073	-.00169	.4833E+04	-.1185E+05	-.1420E+05	-.1302E+05
2800.00	500.00	646.67	.7000E+14	-.00075	-.00173	.4818E+04	-.1182E+05	-.1423E+05	-.1302E+05
2900.00	500.00	646.25	.7000E+14	-.00079	-.00177	.4802E+04	-.1179E+05	-.1426E+05	-.1301E+05

3000.00	500.00	645.83	.7000E+14	-.00081	-.00182	.4787E+04	-.1176E+05	-.1428E+05	-.1301E+05
3100.00	500.00	645.42	.7000E+14	-.00084	-.00186	.4771E+04	-.1173E+05	-.1431E+05	-.1301E+05
3200.00	500.00	645.90	.7000E+14	-.00087	-.00190	.4755E+04	-.1170E+05	-.1434E+05	-.1301E+05
3300.00	500.00	644.58	.7000E+14	-.00090	-.00195	.4739E+04	-.1167E+05	-.1437E+05	-.1301E+05
3400.00	500.00	644.17	.7000E+14	-.00092	-.00199	.4723E+04	-.1163E+05	-.1440E+05	-.1300E+05
3500.00	500.00	643.75	.7000E+14	-.00095	-.00204	.4707E+04	-.1160E+05	-.1443E+05	-.1300E+05
3600.00	500.00	643.33	.7000E+14	-.00098	-.00209	.4691E+04	-.1157E+05	-.1446E+05	-.1300E+05
3700.00	500.00	642.92	.7000E+14	-.00101	-.00214	.4675E+04	-.1153E+05	-.1450E+05	-.1300E+05
3800.00	500.00	642.50	.7000E+14	-.00103	-.00219	.4659E+04	-.1150E+05	-.1453E+05	-.1300E+05
3900.00	500.00	642.08	.7000E+14	-.00106	-.00224	.4642E+04	-.1146E+05	-.1456E+05	-.1299E+05
4000.00	500.00	641.67	.7000E+14	-.00109	-.00229	.4626E+04	-.1142E+05	-.1460E+05	-.1299E+05
4100.00	500.00	641.25	.7000E+14	-.00111	-.00234	.4609E+04	-.1138E+05	-.1463E+05	-.1299E+05
4200.00	500.00	640.83	.7000E+14	-.00114	-.00239	.4593E+04	-.1135E+05	-.1467E+05	-.1299E+05
4300.00	500.00	640.42	.7000E+14	-.00117	-.00245	.4576E+04	-.1131E+05	-.1470E+05	-.1298E+05
4400.00	500.00	640.00	.7000E+14	-.00120	-.00250	.4559E+04	-.1127E+05	-.1474E+05	-.1298E+05
4500.00	500.00	639.58	.7000E+14	-.00122	-.00256	.4542E+04	-.1122E+05	-.1478E+05	-.1298E+05
4600.00	500.00	639.17	.7000E+14	-.00125	-.00262	.4525E+04	-.1118E+05	-.1482E+05	-.1298E+05
4700.00	500.00	638.75	.7000E+14	-.00127	-.00268	.4508E+04	-.1114E+05	-.1486E+05	-.1297E+05
4800.00	500.00	638.33	.7000E+14	-.00130	-.00274	.4491E+04	-.1110E+05	-.1490E+05	-.1297E+05
4900.00	500.00	637.92	.7000E+14	-.00133	-.00280	.4474E+04	-.1105E+05	-.1494E+05	-.1297E+05
5000.00	500.00	637.50	.7000E+14	-.00135	-.00286	.4457E+04	-.1101E+05	-.1498E+05	-.1297E+05
5100.00	500.00	637.08	.7000E+14	-.00138	-.00293	.4439E+04	-.1096E+05	-.1502E+05	-.1296E+05
5200.00	500.00	636.67	.7000E+14	-.00141	-.00299	.4422E+04	-.1091E+05	-.1507E+05	-.1296E+05
5300.00	500.00	636.25	.7000E+14	-.00143	-.00306	.4404E+04	-.1087E+05	-.1511E+05	-.1296E+05
5400.00	500.00	635.83	.7000E+14	-.00146	-.00313	.4387E+04	-.1082E+05	-.1515E+05	-.1295E+05
5500.00	500.00	635.42	.7000E+14	-.00148	-.00319	.4369E+04	-.1077E+05	-.1520E+05	-.1295E+05
5600.00	500.00	635.00	.7000E+14	-.00151	-.00326	.4351E+04	-.1072E+05	-.1525E+05	-.1295E+05
5700.00	500.00	634.58	.7000E+14	-.00153	-.00334	.4334E+04	-.1067E+05	-.1529E+05	-.1295E+05
5800.00	500.00	634.17	.7000E+14	-.00156	-.00341	.4316E+04	-.1061E+05	-.1534E+05	-.1294E+05
5900.00	500.00	633.75	.7000E+14	-.00159	-.00348	.4298E+04	-.1056E+05	-.1539E+05	-.1294E+05
6000.00	500.00	633.33	.7000E+14	-.00161	-.00356	.4280E+04	-.1050E+05	-.1544E+05	-.1294E+05
6100.00	500.00	632.92	.7000E+14	-.00164	-.00364	.4262E+04	-.1045E+05	-.1549E+05	-.1293E+05
6200.00	500.00	632.50	.7000E+14	-.00166	-.00371	.4244E+04	-.1039E+05	-.1555E+05	-.1293E+05

6300.00	500.00	632.66	.7000E+14	-.00163	-.00379	.4226E+04	-.1033E+05	-.1560E+05	-.1292E+05
6400.00	500.00	631.67	.7000E+14	-.00171	-.00387	.4218E+04	-.1028E+05	-.1565E+05	-.1292E+05
6500.00	500.00	631.25	.7000E+14	-.00174	-.00396	.4190E+04	-.1022E+05	-.1571E+05	-.1292E+05
6600.00	500.00	630.83	.7000E+14	-.00176	-.00404	.4171E+04	-.1016E+05	-.1576E+05	-.1291E+05
6700.00	500.00	630.42	.7000E+14	-.00179	-.00413	.4153E+04	-.1009E+05	-.1582E+05	-.1291E+05
6800.00	500.00	630.00	.7000E+14	-.00181	-.00422	.4135E+04	-.1003E+05	-.1588E+05	-.1291E+05
6900.00	500.00	629.58	.7000E+14	-.00184	-.00430	.4116E+04	-.9967E+04	-.1594E+05	-.1290E+05
7000.00	500.00	629.17	.7000E+14	-.00186	-.00439	.4098E+04	-.9902E+04	-.1600E+05	-.1290E+05
7100.00	500.00	628.75	.7000E+14	-.00189	-.00449	.4079E+04	-.9835E+04	-.1606E+05	-.1289E+05
7200.00	500.00	628.33	.7000E+14	-.00191	-.00458	.4061E+04	-.9768E+04	-.1612E+05	-.1289E+05
7300.00	500.00	627.92	.7000E+14	-.00193	-.00468	.4042E+04	-.9699E+04	-.1618E+05	-.1289E+05
7400.00	500.00	627.50	.7000E+14	-.00196	-.00477	.4023E+04	-.9629E+04	-.1625E+05	-.1288E+05
7500.00	500.00	627.08	.7000E+14	-.00198	-.00487	.4005E+04	-.9558E+04	-.1631E+05	-.1288E+05
7600.00	500.00	626.67	.7000E+14	-.00201	-.00497	.3986E+04	-.9486E+04	-.1638E+05	-.1287E+05
7700.00	500.00	626.25	.7000E+14	-.00203	-.00506	.3967E+04	-.9412E+04	-.1645E+05	-.1287E+05
7800.00	500.00	625.83	.7000E+14	-.00205	-.00518	.3948E+04	-.9337E+04	-.1652E+05	-.1286E+05
7900.00	500.00	625.42	.7000E+14	-.00208	-.00529	.3929E+04	-.9261E+04	-.1659E+05	-.1286E+05
8000.00	500.00	625.00	.7000E+14	-.00210	-.00539	.3910E+04	-.9183E+04	-.1666E+05	-.1285E+05
8100.00	500.00	624.72	.7000E+14	-.00213	-.00550	.3891E+04	-.9104E+04	-.1673E+05	-.1285E+05
8200.00	500.00	624.44	.7000E+14	-.00215	-.00562	.3872E+04	-.9024E+04	-.1681E+05	-.1284E+05
8300.00	500.00	624.17	.7000E+14	-.00217	-.00573	.3853E+04	-.8942E+04	-.1688E+05	-.1284E+05
8400.00	500.00	623.89	.7000E+14	-.00220	-.00585	.3834E+04	-.8859E+04	-.1696E+05	-.1283E+05
8500.00	500.00	623.61	.7000E+14	-.00222	-.00596	.3815E+04	-.8774E+04	-.1704E+05	-.1283E+05
8600.00	500.00	623.33	.7000E+14	-.00224	-.00608	.3795E+04	-.8688E+04	-.1712E+05	-.1282E+05
8700.00	500.00	623.06	.7000E+14	-.00227	-.00621	.3776E+04	-.8601E+04	-.1720E+05	-.1282E+05
8800.00	500.00	622.78	.7000E+14	-.00229	-.00633	.3757E+04	-.8511E+04	-.1728E+05	-.1281E+05
8900.00	500.00	622.50	.7000E+14	-.00231	-.00646	.3737E+04	-.8421E+04	-.1736E+05	-.1281E+05
9000.00	500.00	622.22	.7000E+14	-.00234	-.00659	.3718E+04	-.8328E+04	-.1745E+05	-.1280E+05
9100.00	500.00	621.94	.7000E+14	-.00236	-.00672	.3699E+04	-.8234E+04	-.1754E+05	-.1279E+05
9200.00	500.00	621.67	.7000E+14	-.00239	-.00685	.3679E+04	-.8139E+04	-.1762E+05	-.1279E+05
9300.00	500.00	621.39	.7000E+14	-.00241	-.00699	.3659E+04	-.8044E+04	-.1771E+05	-.1278E+05
9400.00	500.00	621.11	.7000E+14	-.00243	-.00713	.3640E+04	-.7942E+04	-.1781E+05	-.1278E+05
9500.00	500.00	620.83	.7000E+14	-.00245	-.00727	.3620E+04	-.7842E+04	-.1790E+05	-.1277E+05

9600.00	500.00	620.56	70005+14	-0.0027	-0.00741	.3601E+04	-7739E+04	-0.1799E+05	-0.1276E+05
9700.00	500.00	620.28	70005+14	-0.00250	-0.00756	.3581E+04	-7635E+04	-0.1809E+05	-0.1276E+05
9800.00	500.00	620.00	70005+14	-0.00252	-0.00770	.3561E+04	-7529E+04	-0.1819E+05	-0.1275E+05
9900.00	500.00	619.72	70005+14	-0.00254	-0.00786	.3542E+04	-7422E+04	-0.1829E+05	-0.1274E+05
10000.00	500.00	619.44	70005+14	-0.00257	-0.00801	.3522E+04	-7312E+04	-0.1839E+05	-0.1274E+05
10100.00	500.00	619.17	70005+14	-0.00259	-0.00817	.3502E+04	-7200E+04	-0.1849E+05	-0.1273E+05
10200.00	500.00	618.89	70005+14	-0.00261	-0.00832	.3482E+04	-7087E+04	-0.1860E+05	-0.1272E+05
10300.00	500.00	618.61	70005+14	-0.00263	-0.00849	.3462E+04	-6972E+04	-0.1870E+05	-0.1272E+05
10400.00	500.00	618.33	70005+14	-0.00265	-0.00865	.3443E+04	-6855E+04	-0.1881E+05	-0.1271E+05
10500.00	500.00	618.06	70005+14	-0.00268	-0.00892	.3423E+04	-6735E+04	-0.1892E+05	-0.1270E+05
10600.00	500.00	617.78	70005+14	-0.00270	-0.00899	.3403E+04	-6614E+04	-0.1903E+05	-0.1269E+05
10700.00	500.00	617.50	70005+14	-0.00272	-0.00916	.3383E+04	-6491E+04	-0.1915E+05	-0.1269E+05
10800.00	500.00	617.22	70005+14	-0.00274	-0.00934	.3363E+04	-6366E+04	-0.1926E+05	-0.1268E+05
10900.00	500.00	616.94	70005+14	-0.00277	-0.00952	.3343E+04	-6238E+04	-0.1938E+05	-0.1267E+05
11000.00	500.00	616.67	70005+14	-0.00279	-0.00970	.3323E+04	-6119E+04	-0.1950E+05	-0.1266E+05
11100.00	500.00	616.39	70005+14	-0.00281	-0.00999	.3303E+04	-5977E+04	-0.1962E+05	-0.1265E+05
11200.00	500.00	616.11	70005+14	-0.00283	-0.01007	.3283E+04	-5843E+04	-0.1975E+05	-0.1264E+05
11300.00	500.00	615.83	70005+14	-0.00285	-0.01027	.3263E+04	-5707E+04	-0.1987E+05	-0.1264E+05
11400.00	500.00	615.56	70005+14	-0.00287	-0.01046	.3243E+04	-5569E+04	-0.2000E+05	-0.1263E+05
11500.00	500.00	615.29	70005+14	-0.00290	-0.01066	.3223E+04	-5428E+04	-0.2013E+05	-0.1262E+05
11600.00	500.00	615.00	70005+14	-0.00292	-0.01086	.3203E+04	-5285E+04	-0.2026E+05	-0.1261E+05
11700.00	500.00	614.72	70005+14	-0.00294	-0.01107	.3183E+04	-5140E+04	-0.2040E+05	-0.1260E+05
11800.00	500.00	614.44	70005+14	-0.00296	-0.01128	.3163E+04	-4992E+04	-0.2053E+05	-0.1259E+05
11900.00	500.00	614.17	70005+14	-0.00298	-0.01149	.3143E+04	-4842E+04	-0.2067E+05	-0.1258E+05
12000.00	500.00	613.89	70005+14	-0.00300	-0.01171	.3123E+04	-4689E+04	-0.2081E+05	-0.1257E+05
12100.00	500.00	613.61	70005+14	-0.00302	-0.01193	.3103E+04	-4534E+04	-0.2096E+05	-0.1256E+05
12200.00	500.00	613.33	70005+14	-0.00305	-0.01215	.3083E+04	-4376E+04	-0.2110E+05	-0.1255E+05
12300.00	500.00	613.06	70005+14	-0.00307	-0.01238	.3062E+04	-4216E+04	-0.2125E+05	-0.1254E+05
12400.00	500.00	612.78	70005+14	-0.00309	-0.01261	.3042E+04	-4053E+04	-0.2140E+05	-0.1253E+05
12500.00	500.00	612.50	70005+14	-0.00311	-0.01285	.3022E+04	-3887E+04	-0.2156E+05	-0.1252E+05
12600.00	500.00	612.22	70005+14	-0.00313	-0.01308	.3002E+04	-3718E+04	-0.2171E+05	-0.1251E+05
12700.00	500.00	611.94	70005+14	-0.00315	-0.01333	.2982E+04	-3547E+04	-0.2187E+05	-0.1250E+05
12800.00	500.00	611.67	70005+14	-0.00317	-0.01358	.2962E+04	-3373E+04	-0.2203E+05	-0.1249E+05

12900.00	500.00	611.39	70000+14	-0.0319	-0.01393	.2942E+04	-.3197E+04	-.2220E+05	-.1247E+05
13000.00	500.00	611.11	70000+14	-0.0321	-0.01408	.2922E+04	-.3017E+04	-.2236E+05	-.1246E+05
13100.00	500.00	610.83	70000+14	-0.0323	-0.01435	.2902E+04	-.2834E+04	-.2253E+05	-.1245E+05
13200.00	500.00	610.56	70000+14	-0.0325	-0.01461	.2882E+04	-.2648E+04	-.2271E+05	-.1244E+05
13300.00	500.00	610.28	70000+14	-0.0327	-0.01488	.2862E+04	-.2460E+04	-.2288E+05	-.1243E+05
13400.00	500.00	610.00	70000+14	-0.0329	-0.01516	.2842E+04	-.2268E+04	-.2306E+05	-.1241E+05
13500.00	500.00	609.72	70000+14	-0.0331	-0.01544	.2822E+04	-.2073E+04	-.2324E+05	-.1240E+05
13600.00	500.00	609.44	70000+14	-0.0333	-0.01572	.2802E+04	-.1874E+04	-.2342E+05	-.1239E+05
13700.00	500.00	609.17	70000+14	-0.0335	-0.01601	.2782E+04	-.1673E+04	-.2361E+05	-.1238E+05
13800.00	500.00	608.89	70000+14	-0.0337	-0.01630	.2761E+04	-.1468E+04	-.2380E+05	-.1236E+05
13900.00	500.00	608.61	70000+14	-0.0339	-0.01660	.2741E+04	-.1260E+04	-.2400E+05	-.1235E+05
14000.00	500.00	608.33	70000+14	-0.0341	-0.01691	.2721E+04	-.1048E+04	-.2419E+05	-.1234E+05
14100.00	500.00	608.06	70000+14	-0.0343	-0.01722	.2701E+04	-.8324E+03	-.2439E+05	-.1232E+05
14200.00	500.00	607.78	70000+14	-0.0345	-0.01753	.2681E+04	-.6134E+03	-.2460E+05	-.1231E+05
14300.00	500.00	607.50	70000+14	-0.0347	-0.01786	.2661E+04	-.3908E+03	-.2480E+05	-.1229E+05
14400.00	500.00	607.22	70000+14	-0.0349	-0.01818	.2641E+04	-.1644E+03	-.2501E+05	-.1228E+05
14500.00	500.00	606.94	70000+14	-0.0351	-0.01852	.2621E+04	.6582E+02	-.2523E+05	-.1226E+05
14600.00	500.00	606.67	70000+14	-0.0353	-0.01885	.2601E+04	.2999E+03	-.2545E+05	-.1225E+05
14700.00	500.00	606.39	70000+14	-0.0355	-0.01920	.2582E+04	.5381E+03	-.2567E+05	-.1223E+05
14800.00	500.00	606.11	70000+14	-0.0357	-0.01955	.2562E+04	.7803E+03	-.2589E+05	-.1222E+05
14900.00	500.00	605.83	70000+14	-0.0359	-0.01991	.2542E+04	.1027E+04	-.2612E+05	-.1220E+05
15000.00	500.00	605.56	70000+14	-0.0361	-0.02028	.2522E+04	.1278E+04	-.2636E+05	-.1218E+05
15100.00	500.00	605.28	70000+14	-0.0363	-0.02065	.2502E+04	.1533E+04	-.2660E+05	-.1217E+05
15200.00	500.00	605.00	70000+14	-0.0365	-0.02103	.2482E+04	.1793E+04	-.2684E+05	-.1215E+05
15300.00	500.00	604.72	70000+14	-0.0367	-0.02141	.2462E+04	.2058E+04	-.2708E+05	-.1213E+05
15400.00	500.00	604.44	70000+14	-0.0368	-0.02181	.2442E+04	.2328E+04	-.2734E+05	-.1211E+05
15500.00	500.00	604.17	70000+14	-0.0370	-0.02221	.2422E+04	.2602E+04	-.2759E+05	-.1209E+05
15600.00	500.00	603.89	70000+14	-0.0372	-0.02262	.2402E+04	.2882E+04	-.2785E+05	-.1208E+05
15700.00	500.00	603.61	70000+14	-0.0374	-0.02304	.2382E+04	.3168E+04	-.2812E+05	-.1206E+05
15800.00	500.00	603.33	70000+14	-0.0376	-0.02347	.2361E+04	.3459E+04	-.2839E+05	-.1204E+05
15900.00	500.00	603.06	70000+14	-0.0378	-0.02391	.2341E+04	.3756E+04	-.2867E+05	-.1202E+05
16000.00	500.00	602.78	70000+14	-0.0380	-0.02436	.2321E+04	.4059E+04	-.2895E+05	-.1200E+05
16100.00	500.00	602.50	70000+14	-0.0381	-0.02481	.2301E+04	.4368E+04	-.2924E+05	-.1198E+05

16200.00	500.00	502.22	7000E+14	-0.0363	-0.02528	.2281E+04	.4683E+04	-0.2954E+05	-0.1195E+05
16300.00	500.00	501.04	7000E+14	-0.0385	-0.02576	.2262E+04	.5005E+04	-0.2984E+05	-0.1193E+05
16400.00	500.00	501.57	7000E+14	-0.0367	-0.02625	.2240E+04	.5334E+04	-0.3015E+05	-0.1191E+05
16500.00	500.00	501.39	7000E+14	-0.0389	-0.02675	.2220E+04	.5670E+04	-0.3046E+05	-0.1189E+05
16600.00	500.00	501.11	7000E+14	-0.0390	-0.02726	.2199E+04	.6014E+04	-0.3078E+05	-0.1186E+05
16700.00	500.00	500.83	7000E+14	-0.0392	-0.02779	.2179E+04	.6355E+04	-0.3111E+05	-0.1184E+05
16800.00	500.00	500.56	7000E+14	-0.0394	-0.02833	.2158E+04	.6725E+04	-0.3145E+05	-0.1182E+05
16900.00	500.00	500.28	7000E+14	-0.0396	-0.02888	.2138E+04	.7092E+04	-0.3180E+05	-0.1179E+05
17000.00	500.00	500.00	7000E+14	-0.0397	-0.02945	.2117E+04	.7469E+04	-0.3215E+05	-0.1176E+05
17100.00	500.00	500.69	7000E+14	-0.0399	-0.03003	.2096E+04	.7854E+04	-0.3251E+05	-0.1174E+05
17200.00	500.00	500.38	7000E+14	-0.0401	-0.03063	.2076E+04	.8248E+04	-0.3288E+05	-0.1171E+05
17300.00	500.00	500.08	7000E+14	-0.0403	-0.03124	.2055E+04	.8653E+04	-0.3326E+05	-0.1168E+05
17400.00	500.00	500.75	7000E+14	-0.0404	-0.03187	.2034E+04	.9067E+04	-0.3365E+05	-0.1165E+05
17500.00	500.00	500.46	7000E+14	-0.0406	-0.03252	.2013E+04	.9492E+04	-0.3405E+05	-0.1162E+05
17600.00	500.00	500.13	7000E+14	-0.0408	-0.03319	.1991E+04	.9928E+04	-0.3446E+05	-0.1159E+05
17700.00	500.00	500.81	7000E+14	-0.0409	-0.03387	.1970E+04	.1038E+05	-0.3488E+05	-0.1156E+05
17800.00	500.00	500.50	7000E+14	-0.0411	-0.03458	.1949E+04	.1084E+05	-0.3532E+05	-0.1153E+05
17900.00	500.00	500.19	7000E+14	-0.0413	-0.03531	.1927E+04	.1131E+05	-0.3576E+05	-0.1150E+05
18000.00	500.00	500.88	7000E+14	-0.0414	-0.03606	.1906E+04	.1179E+05	-0.3622E+05	-0.1146E+05
18100.00	500.00	500.56	7000E+14	-0.0416	-0.03684	.1884E+04	.1230E+05	-0.3670E+05	-0.1143E+05
18200.00	500.00	500.25	7000E+14	-0.0418	-0.03764	.1862E+04	.1281E+05	-0.3718E+05	-0.1139E+05
18300.00	500.00	500.94	7000E+14	-0.0419	-0.03847	.1840E+04	.1334E+05	-0.3768E+05	-0.1135E+05
18400.00	500.00	500.63	7000E+14	-0.0421	-0.03932	.1818E+04	.1389E+05	-0.3820E+05	-0.1131E+05
18500.00	500.00	500.31	7000E+14	-0.0422	-0.04021	.1795E+04	.1445E+05	-0.3874E+05	-0.1127E+05
18600.00	500.00	500.00	7000E+14	-0.0424	-0.04113	.1773E+04	.1504E+05	-0.3929E+05	-0.1123E+05
18700.00	500.00	500.69	7000E+14	-0.0425	-0.04209	.1750E+04	.1564E+05	-0.3986E+05	-0.1119E+05
18800.00	500.00	500.38	7000E+14	-0.0427	-0.04308	.1727E+04	.1626E+05	-0.4046E+05	-0.1114E+05
18900.00	500.00	500.06	7000E+14	-0.0429	-0.04411	.1704E+04	.1691E+05	-0.4107E+05	-0.1110E+05
19000.00	500.00	500.75	7000E+14	-0.0430	-0.04519	.1680E+04	.1758E+05	-0.4171E+05	-0.1105E+05
19100.00	500.00	500.44	7000E+14	-0.0432	-0.04631	.1657E+04	.1827E+05	-0.4237E+05	-0.1100E+05
19200.00	500.00	500.13	7000E+14	-0.0433	-0.04748	.1633E+04	.1899E+05	-0.4306E+05	-0.1095E+05
19300.00	500.00	500.81	7000E+14	-0.0435	-0.04870	.1609E+04	.1975E+05	-0.4377E+05	-0.1089E+05
19400.00	500.00	500.50	7000E+14	-0.0436	-0.04999	.1584E+04	.2053E+05	-0.4452E+05	-0.1083E+05

QUALITY EXCEEDS LIMIT
 CREEP COLLAPSE ANALYSIS - TIME (X) VERSUS QUALITY (Y)

MULTIPLIERS /
 XI= 2.50E+04
 I= 4.94E-12

SAMPLE PROGRAM 5. COMBINED STEP AND LINEAR CHANGES WITH TIME .

 * SUMMARY OF INPUT DATA *

CLADDING RADIUS	RCUT	.21000	INCHES
CLAD WALL THICKNESS	WALLIK	.02500	INCHES
TIME INCREMENTS	DELT	100.000	HOURS
MAXIMUM OPERATING TIME	TMAX	25000.00	HOURS
INITIAL QUALITY	CVAL	.00700	INCHES
CLADDING EXTERNAL PRESSURE	EXTP	2000.00	PSI
YIELD STRENGTH	YIELD	.5000E+05	PSI
MATERIAL PROPERTIES	MATOPT	F	
TEMPERATURE SPECIFIED			
FALSCODE LIBRARY			
NUMBER OF TEMP. NOTES FOR MAT. PROP.	NTEMP	5	
NUMBER OF TIME STEPS	NTIME	9	
NUMBER OF MAX-16, MIN-3			
NUMBER OF LOSES	NL	2	
COLLAPSE LENGTH	CL	2.	INCHES

 * SUMMARY OF CONSTANT OUTPUT VARIABLES *

PLASTIC COLLAPSE PRESSURE PCRT 6589.66 PSI

POISSON'S RATIO TEMP.	YOUNG'S MODULUS TEMP.	YIELD STRENGTH TEMP.	VALUE
70.0	.2360	70.0	.800E+05
300.0	.2710	300.0	.700E+05
500.0	.2600	500.0	.600E+05
700.0	.2420	700.0	.500E+05
900.0	.2300	900.0	.250E+05

TIME (HOURS)	INTERNAL PRESSURE (PSI)	CLAD TEMP (°C/F)	FAST FLUX (MW)	REFLECTION DELTA-D (IN.)	OVALITY (IN.)	YIELD COLLAPSE (PSIG)	T. STRESS AT ID (PSI)	T. STRESS AT OD (PSI)	T. STRESS NPLANE (PSI)
0.00	650.00	590.00	.7000E+14	0.00000	-.00088	.5243E+04	-.1138E+05	-.1251E+05	-.1195E+05
100.00	636.84	591.05	.7053E+14	-.00002	-.00090	.5242E+04	-.1147E+05	-.1261E+05	-.1204E+05
200.00	623.68	592.11	.7105E+14	-.00003	-.00091	.5233E+04	-.1155E+05	-.1272E+05	-.1214E+05
300.00	610.53	593.16	.7158E+14	-.00005	-.00093	.5225E+04	-.1163E+05	-.1284E+05	-.1224E+05
400.00	597.37	594.21	.7211E+14	-.00007	-.00094	.5216E+04	-.1171E+05	-.1295E+05	-.1233E+05
500.00	594.21	595.26	.7263E+14	-.00009	-.00096	.5206E+04	-.1179E+05	-.1306E+05	-.1243E+05
600.00	571.05	596.32	.7316E+14	-.00011	-.00098	.5197E+04	-.1187E+05	-.1318E+05	-.1253E+05
700.00	557.89	597.37	.7368E+14	-.00013	-.00100	.5187E+04	-.1195E+05	-.1329E+05	-.1262E+05
800.00	544.74	598.42	.7421E+14	-.00015	-.00102	.5176E+04	-.1203E+05	-.1341E+05	-.1272E+05
900.00	531.58	599.47	.7474E+14	-.00017	-.00104	.5166E+04	-.1210E+05	-.1352E+05	-.1281E+05
1000.00	519.42	600.53	.7526E+14	-.00019	-.00106	.5154E+04	-.1218E+05	-.1364E+05	-.1291E+05
1100.00	505.26	601.56	.7579E+14	-.00021	-.00108	.5143E+04	-.1225E+05	-.1376E+05	-.1301E+05
1200.00	492.11	602.63	.7632E+14	-.00024	-.00111	.5131E+04	-.1232E+05	-.1388E+05	-.1310E+05
1300.00	478.95	603.68	.7684E+14	-.00026	-.00113	.5119E+04	-.1240E+05	-.1400E+05	-.1320E+05
1400.00	465.79	604.74	.7737E+14	-.00028	-.00116	.5107E+04	-.1247E+05	-.1412E+05	-.1329E+05
1500.00	452.63	605.79	.7789E+14	-.00031	-.00119	.5094E+04	-.1254E+05	-.1424E+05	-.1339E+05
1600.00	439.47	606.84	.7842E+14	-.00033	-.00122	.5080E+04	-.1260E+05	-.1437E+05	-.1348E+05
1700.00	426.32	607.89	.7895E+14	-.00036	-.00125	.5066E+04	-.1267E+05	-.1449E+05	-.1358E+05
1800.00	413.16	608.95	.7947E+14	-.00038	-.00128	.5052E+04	-.1274E+05	-.1462E+05	-.1367E+05
1900.00	400.00	610.00	.8000E+14	-.00041	-.00132	.5037E+04	-.1280E+05	-.1475E+05	-.1377E+05
2000.00	450.00	615.00	.8000E+14	-.00044	-.00133	.5018E+04	-.1245E+05	-.1436E+05	-.1340E+05
2100.00	452.54	614.75	.8035E+14	-.00046	-.00136	.5004E+04	-.1241E+05	-.1436E+05	-.1338E+05
2200.00	455.08	614.49	.8169E+14	-.00049	-.00140	.4990E+04	-.1237E+05	-.1436E+05	-.1336E+05
2300.00	457.63	614.24	.8254E+14	-.00052	-.00143	.4975E+04	-.1233E+05	-.1437E+05	-.1334E+05
2400.00	460.17	613.98	.8339E+14	-.00054	-.00146	.4961E+04	-.1229E+05	-.1437E+05	-.1332E+05
2500.00	462.71	613.73	.8424E+14	-.00057	-.00150	.4946E+04	-.1224E+05	-.1437E+05	-.1330E+05
2600.00	465.25	613.47	.8508E+14	-.00060	-.00153	.4931E+04	-.1220E+05	-.1437E+05	-.1328E+05
2700.00	467.80	613.22	.8593E+14	-.00063	-.00157	.4916E+04	-.1216E+05	-.1438E+05	-.1326E+05
2800.00	470.34	612.97	.8678E+14	-.00065	-.00160	.4901E+04	-.1211E+05	-.1438E+05	-.1324E+05
2900.00	472.88	612.71	.8763E+14	-.00068	-.00164	.4886E+04	-.1207E+05	-.1439E+05	-.1322E+05

3300.00	475.42	612.46	.8847E+14	-.00371	-.00168	.4970E+04	-.1202E+05	-.1439E+05	-.1320E+05
3400.00	477.97	612.20	.8982E+14	-.00374	-.00172	.4854E+04	-.1198E+05	-.1440E+05	-.1318E+05
3500.00	480.51	611.95	.9017E+14	-.00377	-.00176	.4838E+04	-.1193E+05	-.1440E+05	-.1316E+05
3600.00	483.05	611.69	.9102E+14	-.00379	-.00180	.4822E+04	-.1189E+05	-.1441E+05	-.1314E+05
3700.00	485.59	611.44	.9136E+14	-.00382	-.00184	.4806E+04	-.1184E+05	-.1442E+05	-.1312E+05
3800.00	488.14	611.19	.9271E+14	-.00385	-.00189	.4789E+04	-.1179E+05	-.1443E+05	-.1310E+05
3900.00	490.68	610.93	.9356E+14	-.00388	-.00193	.4773E+04	-.1174E+05	-.1444E+05	-.1308E+05
4000.00	493.22	610.68	.9441E+14	-.00391	-.00198	.4756E+04	-.1169E+05	-.1445E+05	-.1305E+05
4100.00	495.76	610.42	.9525E+14	-.00393	-.00203	.4739E+04	-.1164E+05	-.1446E+05	-.1303E+05
4200.00	498.31	610.17	.9610E+14	-.00396	-.00208	.4721E+04	-.1159E+05	-.1447E+05	-.1301E+05
4300.00	500.85	609.92	.9695E+14	-.00399	-.00213	.4704E+04	-.1154E+05	-.1448E+05	-.1299E+05
4400.00	503.39	609.66	.9780E+14	-.00402	-.00218	.4686E+04	-.1148E+05	-.1449E+05	-.1297E+05
4500.00	505.93	609.41	.9864E+14	-.00405	-.00223	.4669E+04	-.1143E+05	-.1451E+05	-.1295E+05
4600.00	508.47	609.15	.9949E+14	-.00408	-.00228	.4651E+04	-.1137E+05	-.1452E+05	-.1293E+05
4700.00	511.02	608.90	.1003E+15	-.00411	-.00234	.4632E+04	-.1132E+05	-.1454E+05	-.1291E+05
4800.00	513.56	608.64	.1012E+15	-.00414	-.00240	.4614E+04	-.1126E+05	-.1455E+05	-.1289E+05
4900.00	516.10	608.39	.1020E+15	-.00417	-.00246	.4595E+04	-.1120E+05	-.1457E+05	-.1297E+05
5000.00	518.64	608.14	.1029E+15	-.00420	-.00252	.4577E+04	-.1115E+05	-.1459E+05	-.1285E+05
5100.00	521.19	607.88	.1037E+15	-.00423	-.00258	.4558E+04	-.1109E+05	-.1461E+05	-.1282E+05
5200.00	523.73	607.63	.1046E+15	-.00425	-.00264	.4539E+04	-.1103E+05	-.1463E+05	-.1280E+05
5300.00	526.27	607.37	.1054E+15	-.00428	-.00271	.4519E+04	-.1096E+05	-.1465E+05	-.1278E+05
5400.00	528.81	607.12	.1063E+15	-.00431	-.00277	.4500E+04	-.1090E+05	-.1467E+05	-.1276E+05
5500.00	531.36	606.86	.1071E+15	-.00434	-.00284	.4480E+04	-.1084E+05	-.1469E+05	-.1274E+05
5600.00	533.90	606.61	.1080E+15	-.00437	-.00291	.4460E+04	-.1077E+05	-.1471E+05	-.1272E+05
5700.00	536.44	606.36	.1088E+15	-.00440	-.00299	.4440E+04	-.1071E+05	-.1474E+05	-.1269E+05
5800.00	538.98	606.10	.1097E+15	-.00443	-.00306	.4420E+04	-.1064E+05	-.1476E+05	-.1267E+05
5900.00	541.53	605.85	.1105E+15	-.00446	-.00314	.4399E+04	-.1057E+05	-.1479E+05	-.1265E+05
6000.00	544.07	605.59	.1114E+15	-.00449	-.00321	.4378E+04	-.1050E+05	-.1481E+05	-.1263E+05
6100.00	546.61	605.34	.1122E+15	-.00452	-.00329	.4358E+04	-.1043E+05	-.1483E+05	-.1261E+05
6200.00	549.15	605.08	.1131E+15	-.00455	-.00338	.4337E+04	-.1036E+05	-.1486E+05	-.1259E+05
6300.00	551.69	604.83	.1139E+15	-.00458	-.00346	.4316E+04	-.1029E+05	-.1489E+05	-.1256E+05
6400.00	554.24	604.58	.1147E+15	-.00461	-.00355	.4294E+04	-.1021E+05	-.1494E+05	-.1254E+05
6500.00	556.78	604.32	.1156E+15	-.00464	-.00364	.4273E+04	-.1014E+05	-.1497E+05	-.1252E+05

6300.00	559.32	604.07	.1164E+15	-.00157	-.00373	.4251E+04	-.1006E+05	-.1501E+05	-.1250E+05
6400.00	561.86	603.81	.1173E+15	-.00170	-.00382	.4229E+04	-.9983E+04	-.1505E+05	-.1247E+05
6500.00	564.41	603.56	.1181E+15	-.00173	-.00392	.4207E+04	-.9903E+04	-.1508E+05	-.1245E+05
6600.00	566.95	603.31	.1190E+15	-.00177	-.00402	.4185E+04	-.9822E+04	-.1512E+05	-.1243E+05
6700.00	569.49	603.05	.1198E+15	-.00180	-.00412	.4163E+04	-.9739E+04	-.1516E+05	-.1241E+05
6800.00	572.03	602.80	.1207E+15	-.00183	-.00422	.4140E+04	-.9655E+04	-.1520E+05	-.1238E+05
6900.00	574.58	602.54	.1215E+15	-.00186	-.00433	.4118E+04	-.9569E+04	-.1525E+05	-.1236E+05
7000.00	577.12	602.29	.1224E+15	-.00189	-.00444	.4095E+04	-.9482E+04	-.1529E+05	-.1234E+05
7100.00	579.66	602.03	.1232E+15	-.00192	-.00455	.4072E+04	-.9393E+04	-.1534E+05	-.1231E+05
7200.00	582.20	601.78	.1241E+15	-.00195	-.00466	.4049E+04	-.9302E+04	-.1538E+05	-.1229E+05
7300.00	584.75	601.53	.1249E+15	-.00198	-.00478	.4025E+04	-.9210E+04	-.1543E+05	-.1227E+05
7400.00	587.29	601.27	.1258E+15	-.00201	-.00490	.4002E+04	-.9116E+04	-.1548E+05	-.1224E+05
7500.00	589.83	601.02	.1266E+15	-.00204	-.00502	.3978E+04	-.9020E+04	-.1554E+05	-.1222E+05
7600.00	592.37	600.76	.1275E+15	-.00207	-.00515	.3954E+04	-.8923E+04	-.1559E+05	-.1220E+05
7700.00	594.92	600.51	.1283E+15	-.00210	-.00528	.3930E+04	-.8824E+04	-.1565E+05	-.1217E+05
7800.00	597.46	600.25	.1292E+15	-.00213	-.00541	.3906E+04	-.8723E+04	-.1570E+05	-.1215E+05
7900.00	600.00	600.00	.1300E+15	-.00216	-.00555	.3882E+04	-.8620E+04	-.1576E+05	-.1212E+05
8000.00	602.55	600.00	.1308E+15	-.00219	-.00579	.3854E+04	-.8508E+04	-.1691E+05	-.1284E+05
8100.00	605.11	600.00	.1316E+15	-.00222	-.00591	.3833E+04	-.8408E+04	-.1697E+05	-.1281E+05
8200.00	607.67	600.00	.1324E+15	-.00224	-.00604	.3812E+04	-.8306E+04	-.1704E+05	-.1279E+05
8300.00	610.23	600.00	.1332E+15	-.00227	-.00617	.3790E+04	-.8203E+04	-.1710E+05	-.1277E+05
8400.00	612.79	600.00	.1340E+15	-.00229	-.00631	.3769E+04	-.8097E+04	-.1717E+05	-.1275E+05
8500.00	615.34	600.00	.1348E+15	-.00232	-.00645	.3747E+04	-.8000E+04	-.1723E+05	-.1273E+05
8600.00	617.89	600.00	.1356E+15	-.00234	-.00659	.3725E+04	-.7901E+04	-.1730E+05	-.1270E+05
8700.00	620.44	600.00	.1364E+15	-.00237	-.00673	.3703E+04	-.7803E+04	-.1737E+05	-.1268E+05
8800.00	622.99	600.00	.1372E+15	-.00240	-.00688	.3681E+04	-.7705E+04	-.1744E+05	-.1266E+05
8900.00	625.54	600.00	.1380E+15	-.00242	-.00703	.3659E+04	-.7607E+04	-.1752E+05	-.1264E+05
9000.00	628.09	600.00	.1388E+15	-.00245	-.00719	.3636E+04	-.7509E+04	-.1760E+05	-.1261E+05
9100.00	630.64	600.00	.1396E+15	-.00247	-.00734	.3614E+04	-.7411E+04	-.1767E+05	-.1259E+05
9200.00	633.19	600.00	.1404E+15	-.00250	-.00751	.3591E+04	-.7313E+04	-.1775E+05	-.1257E+05
9300.00	635.74	600.00	.1412E+15	-.00253	-.00767	.3568E+04	-.7215E+04	-.1784E+05	-.1254E+05
9400.00	638.29	600.00	.1420E+15	-.00255	-.00784	.3546E+04	-.7117E+04	-.1792E+05	-.1252E+05
9500.00	640.84	600.00	.1428E+15	-.00258	-.00801	.3523E+04	-.7019E+04	-.1801E+05	-.1250E+05

9600.00	535.98	605.90	.9719E+14	-.00261	-.00819	.3500E+04	-.7074E+04	-.1913E+05	-.1247E+05
9700.00	539.20	605.96	.9764E+14	-.01263	-.00837	.3476E+04	-.6941E+04	-.1919E+05	-.1245E+05
9800.00	546.45	606.01	.9809E+14	-.01266	-.00856	.3453E+04	-.6805E+04	-.1828E+05	-.1242E+05
9900.00	542.70	606.07	.9854E+14	-.00269	-.00875	.3430E+04	-.6667E+04	-.1838E+05	-.1240E+05
10000.00	544.94	606.12	.9899E+14	-.00271	-.00894	.3416E+04	-.6526E+04	-.1848E+05	-.1238E+05
10100.00	547.19	606.16	.9944E+14	-.01274	-.00914	.3383E+04	-.6383E+04	-.1858E+05	-.1235E+05
10200.00	549.44	606.24	.9989E+14	-.00276	-.00935	.3359E+04	-.6237E+04	-.1868E+05	-.1233E+05
10300.00	551.69	606.29	.1003E+15	-.00279	-.00956	.3335E+04	-.6088E+04	-.1878E+05	-.1230E+05
10400.00	553.93	606.35	.1008E+15	-.01282	-.00977	.3311E+04	-.5937E+04	-.1889E+05	-.1228E+05
10500.00	556.18	606.41	.1012E+15	-.00284	-.00999	.3287E+04	-.5782E+04	-.1900E+05	-.1225E+05
10600.00	558.43	606.48	.1017E+15	-.01287	-.01021	.3263E+04	-.5625E+04	-.1912E+05	-.1223E+05
10700.00	560.67	606.52	.1021E+15	-.01290	-.01044	.3239E+04	-.5465E+04	-.1923E+05	-.1220E+05
10800.00	562.92	606.57	.1026E+15	-.01292	-.01068	.3215E+04	-.5312E+04	-.1935E+05	-.1217E+05
10900.00	565.17	606.63	.1030E+15	-.01295	-.01092	.3191E+04	-.5135E+04	-.1948E+05	-.1215E+05
11000.00	567.42	606.69	.1035E+15	-.01298	-.01116	.3166E+04	-.4965E+04	-.1960E+05	-.1212E+05
11100.00	569.66	606.74	.1039E+15	-.01300	-.01141	.3142E+04	-.4782E+04	-.1973E+05	-.1209E+05
11200.00	571.91	606.80	.1044E+15	-.01303	-.01167	.3117E+04	-.4616E+04	-.1986E+05	-.1207E+05
11300.00	574.16	606.86	.1048E+15	-.01306	-.01193	.3093E+04	-.4436E+04	-.1999E+05	-.1204E+05
11400.00	576.40	606.91	.1053E+15	-.01308	-.01220	.3068E+04	-.4253E+04	-.2013E+05	-.1201E+05
11500.00	578.65	606.97	.1057E+15	-.01311	-.01248	.3043E+04	-.4067E+04	-.2027E+05	-.1199E+05
11600.00	580.90	607.02	.1062E+15	-.01314	-.01276	.3018E+04	-.3877E+04	-.2042E+05	-.1196E+05
11700.00	583.15	607.08	.1066E+15	-.01316	-.01305	.2993E+04	-.3683E+04	-.2057E+05	-.1193E+05
11800.00	585.39	607.13	.1071E+15	-.01319	-.01335	.2968E+04	-.3485E+04	-.2072E+05	-.1190E+05
11900.00	587.64	607.19	.1075E+15	-.01322	-.01365	.2943E+04	-.3284E+04	-.2087E+05	-.1187E+05
12000.00	589.89	607.25	.1080E+15	-.01324	-.01396	.2918E+04	-.3078E+04	-.2103E+05	-.1184E+05
12100.00	592.13	607.30	.1084E+15	-.01327	-.01428	.2893E+04	-.2869E+04	-.2119E+05	-.1182E+05
12200.00	594.38	607.36	.1089E+15	-.01330	-.01461	.2868E+04	-.2655E+04	-.2136E+05	-.1179E+05
12300.00	596.63	607.42	.1093E+15	-.01332	-.01494	.2842E+04	-.2437E+04	-.2153E+05	-.1176E+05
12400.00	598.88	607.47	.1098E+15	-.01335	-.01528	.2817E+04	-.2215E+04	-.2170E+05	-.1173E+05
12500.00	601.12	607.53	.1102E+15	-.01338	-.01563	.2792E+04	-.1988E+04	-.2188E+05	-.1170E+05
12600.00	603.37	607.58	.1107E+15	-.01341	-.01599	.2766E+04	-.1757E+04	-.2206E+05	-.1167E+05
12700.00	605.62	607.64	.1111E+15	-.01343	-.01636	.2741E+04	-.1521E+04	-.2225E+05	-.1163E+05
12800.00	607.87	607.70	.1116E+15	-.01346	-.01674	.2715E+04	-.1281E+04	-.2244E+05	-.1160E+05

12900.00	610.11	607.75	.11207+15	-.00349	-.01712	.2609E+04	-.1035E+04	-.2264E+05	-.1157E+05
13000.00	612.36	607.61	.11255+15	-.00351	-.01752	.2664E+04	-.7849E+03	-.2284E+05	-.1154E+05
13100.00	614.61	607.67	.11295+15	-.00354	-.01792	.2638E+04	-.5294E+03	-.2305E+05	-.1151E+05
13200.00	616.85	607.32	.11345+15	-.00357	-.01834	.2612E+04	-.2686E+03	-.2326E+05	-.1147E+05
13300.00	619.10	607.98	.1138E+15	-.00359	-.01876	.2587E+04	-.2464E+01	-.2347E+05	-.1144E+05
13400.00	621.35	608.03	.1143E+15	-.00362	-.01920	.2561E+04	.2692E+03	-.2369E+05	-.1141E+05
13500.00	623.60	608.09	.1147E+15	-.00365	-.01965	.2535E+04	.5466E+03	-.2392E+05	-.1137E+05
13600.00	625.84	608.15	.1152E+15	-.00367	-.02011	.2509E+04	.8298E+03	-.2415E+05	-.1134E+05
13700.00	628.09	608.20	.1156E+15	-.00370	-.02058	.2483E+04	.1119E+04	-.2439E+05	-.1130E+05
13800.00	630.34	608.26	.1161E+15	-.00373	-.02106	.2457E+04	.1415E+04	-.2463E+05	-.1127E+05
13900.00	632.58	608.31	.1165E+15	-.00375	-.02156	.2431E+04	.1717E+04	-.2488E+05	-.1123E+05
14000.00	634.83	608.37	.1170E+15	-.00378	-.02207	.2405E+04	.2026E+04	-.2514E+05	-.1120E+05
14100.00	637.08	608.43	.1174E+15	-.00381	-.02260	.2379E+04	.2343E+04	-.2540E+05	-.1116E+05
14200.00	639.33	608.48	.1179E+15	-.00383	-.02314	.2353E+04	.2667E+04	-.2567E+05	-.1112E+05
14300.00	641.57	608.54	.1183E+15	-.00386	-.02369	.2326E+04	.2998E+04	-.2595E+05	-.1109E+05
14400.00	643.82	608.60	.1188E+15	-.00389	-.02427	.2300E+04	.3337E+04	-.2624E+05	-.1105E+05
14500.00	646.07	608.65	.1192E+15	-.00391	-.02436	.2274E+04	.3685E+04	-.2653E+05	-.1101E+05
14600.00	648.31	608.71	.1197E+15	-.00394	-.02546	.2247E+04	.4042E+04	-.2683E+05	-.1097E+05
14700.00	650.56	608.76	.1201E+15	-.00396	-.02609	.2221E+04	.4406E+04	-.2714E+05	-.1093E+05
14800.00	652.81	608.82	.1206E+15	-.00399	-.02673	.2194E+04	.4783E+04	-.2746E+05	-.1089E+05
14900.00	655.06	608.88	.1210E+15	-.00402	-.02740	.2167E+04	.5168E+04	-.2779E+05	-.1085E+05
15000.00	657.30	608.93	.1215E+15	-.00404	-.02809	.2140E+04	.5564E+04	-.2813E+05	-.1080E+05
15100.00	659.55	608.99	.1219E+15	-.00407	-.02880	.2113E+04	.5970E+04	-.2848E+05	-.1076E+05
15200.00	661.80	609.04	.1224E+15	-.00410	-.02953	.2086E+04	.6388E+04	-.2884E+05	-.1071E+05
15300.00	664.04	609.10	.1228E+15	-.00412	-.03029	.2059E+04	.6819E+04	-.2921E+05	-.1067E+05
15400.00	666.29	609.16	.1233E+15	-.00415	-.03108	.2032E+04	.7261E+04	-.2960E+05	-.1062E+05
15500.00	668.54	609.21	.1237E+15	-.00417	-.03189	.2004E+04	.7717E+04	-.2999E+05	-.1058E+05
15600.00	670.79	609.27	.1242E+15	-.00420	-.03273	.1977E+04	.8187E+04	-.3041E+05	-.1053E+05
15700.00	673.03	609.33	.1246E+15	-.00422	-.03361	.1949E+04	.8672E+04	-.3083E+05	-.1048E+05
15800.00	675.28	609.38	.1251E+15	-.00425	-.03452	.1921E+04	.9172E+04	-.3127E+05	-.1043E+05
15900.00	677.53	609.44	.1255E+15	-.00428	-.03546	.1893E+04	.9689E+04	-.3173E+05	-.1038E+05
16000.00	679.78	609.49	.1260E+15	-.00430	-.03644	.1865E+04	.1022E+05	-.3220E+05	-.1033E+05
16100.00	682.02	609.55	.1264E+15	-.00433	-.03746	.1836E+04	.1073E+05	-.3269E+05	-.1027E+05

16200.00	684.27	609.61	.1269E+15	-.00435	-.03953	.1808E+04	.1135E+05	-.3320E+05	-.1021E+05
16300.00	686.52	609.66	.1273E+15	-.00438	-.03964	.1779E+04	.1194E+05	-.3373E+05	-.1015E+05
16400.00	688.76	609.72	.1278E+15	-.00440	-.04080	.1750E+04	.1256E+05	-.3428E+05	-.1009E+05
16500.00	691.01	609.78	.1282E+15	-.00443	-.04201	.1721E+04	.1320E+05	-.3485E+05	-.1003E+05
16600.00	693.26	609.83	.1287E+15	-.00445	-.04328	.1691E+04	.1386E+05	-.3545E+05	-.9969E+04
16700.00	695.51	609.89	.1291E+15	-.00447	-.04452	.1662E+04	.1455E+05	-.3608E+05	-.9904E+04
16800.00	697.75	609.94	.1296E+15	-.00450	-.04601	.1632E+04	.1527E+05	-.3673E+05	-.9836E+04
16900.00	700.00	610.00	.1300E+15	-.00452	-.04748	.1602E+04	.1602E+05	-.3742E+05	-.9765E+04
17000.00	800.00	610.00	.1308E+15	-.00454	-.04748	.1572E+04	.1492E+05	-.3496E+05	-.9147E+04
17100.00	802.50	599.88	.1308E+15	-.00456	-.04843	.1553E+04	.1535E+05	-.3534E+05	-.9098E+04
17200.00	805.00	599.75	.1315E+15	-.00457	-.04941	.1534E+04	.1580E+05	-.3573E+05	-.9048E+04

QUALITY TOLERANCE LIMIT

CREEP COLLAPSE ANALYSIS - TIME (X) VERSUS QUALITY (Y)

MULTIPLIES /
X1= 2.50E+04
1= 4.94E-02

SAMPLE PROBLEM 5. MATERIAL PROPERTIES INPUT FROM DATA CARDS

 * SUMMARY OF INPUT DATA *

CLADDING RADIUS .2100 INCHES
 CLAD WALL THICKNESS .0250 INCHES
 TIME INCREMENTS 100.00 HOURS
 MAXIMUM OPERATING TIME 25000.00 HOURS
 INITIAL OVALITY .000700 INCHES
 CLADDING EXTERNAL PRESSURE 2000.00 PSI
 YIELD STRENGTH .3250E+05 PSI
 MATERIAL PROPERTIES
 TRUESTRESS SPECIFIED
 FALSECODE LIBRARY
 NUMBER OF TEMP. MODES FOR MAT. PROP. 5
 NUMBER OF TIME STEPS 5
 MAX=16, MIN=3
 NUMBER OF LOSES NL 2
 COLLAPSE LENGTH CL 5. INCHES

 * SUMMARY OF CONSTANT OUTPUT VARIABLES *

ELASTIC COLLAPSE PRESSURE PCRT 6652.49 PSI

POISSON'S RATIO TEMP.	VALUE	YOUNG'S MODULUS TEMP.	VALUE	YIELD STRENGTH TEMP.	VALUE
500.0	.3000	500.0	.120E+08	500.0	.600E+05
550.0	.3500	550.0	.115E+08	550.0	.550E+05
600.0	.4000	600.0	.110E+08	600.0	.350E+05
650.0	.4500	650.0	.105E+08	650.0	.300E+05
700.0	.5000	700.0	.100E+08	700.0	.250E+05

TIME (HOURS)	INTERNAL PRESSURE (PSI)	GLASS TEMP (°F)	FAST FLUX (W)	CRACK-DOWN DELTA-D (IN.)	QUALITY (IN.)	YIELD COLLAPSE (PSIG)	T. STRESS AT ID (PSI)	T. STRESS AT OD (PSI)	T. STRESS NPLANE (PSI)
0.00	500.00	625.00	.7000E+14	0.00000	-.00090	.3752E+04	-.1241E+05	-.1369E+05	-.1305E+05
100.00	500.00	625.00	.7000E+14	-.00002	-.00092	.3752E+04	-.1241E+05	-.1369E+05	-.1305E+05
200.00	500.00	625.00	.7000E+14	-.00005	-.00094	.3746E+04	-.1239E+05	-.1370E+05	-.1305E+05
300.00	500.00	625.00	.7000E+14	-.00007	-.00096	.3740E+04	-.1238E+05	-.1372E+05	-.1305E+05
400.00	500.00	625.00	.7000E+14	-.00010	-.00098	.3734E+04	-.1236E+05	-.1373E+05	-.1305E+05
500.00	500.00	625.00	.7000E+14	-.00012	-.00100	.3728E+04	-.1235E+05	-.1374E+05	-.1305E+05
600.00	500.00	625.00	.7000E+14	-.00015	-.00102	.3721E+04	-.1233E+05	-.1376E+05	-.1305E+05
700.00	500.00	625.00	.7000E+14	-.00017	-.00104	.3715E+04	-.1232E+05	-.1377E+05	-.1305E+05
800.00	500.00	625.00	.7000E+14	-.00019	-.00106	.3708E+04	-.1230E+05	-.1379E+05	-.1305E+05
900.00	500.00	625.00	.7000E+14	-.00022	-.00109	.3702E+04	-.1229E+05	-.1380E+05	-.1304E+05
1000.00	500.00	625.00	.7000E+14	-.00024	-.00111	.3695E+04	-.1227E+05	-.1382E+05	-.1304E+05
1100.00	500.00	625.00	.7000E+14	-.00027	-.00113	.3688E+04	-.1226E+05	-.1383E+05	-.1304E+05
1200.00	500.00	625.00	.7000E+14	-.00029	-.00115	.3681E+04	-.1224E+05	-.1385E+05	-.1304E+05
1300.00	500.00	625.00	.7000E+14	-.00032	-.00118	.3674E+04	-.1222E+05	-.1386E+05	-.1304E+05
1400.00	500.00	625.00	.7000E+14	-.00034	-.00120	.3667E+04	-.1220E+05	-.1388E+05	-.1304E+05
1500.00	500.00	625.00	.7000E+14	-.00036	-.00123	.3660E+04	-.1219E+05	-.1389E+05	-.1304E+05
1600.00	500.00	625.00	.7000E+14	-.00039	-.00125	.3652E+04	-.1217E+05	-.1391E+05	-.1304E+05
1700.00	500.00	625.00	.7000E+14	-.00041	-.00128	.3645E+04	-.1215E+05	-.1393E+05	-.1304E+05
1800.00	500.00	625.00	.7000E+14	-.00044	-.00130	.3638E+04	-.1213E+05	-.1395E+05	-.1303E+05
1900.00	500.00	625.00	.7000E+14	-.00046	-.00133	.3630E+04	-.1211E+05	-.1396E+05	-.1303E+05
2000.00	500.00	625.00	.7000E+14	-.00049	-.00136	.3622E+04	-.1209E+05	-.1398E+05	-.1303E+05
2100.00	500.00	625.00	.7000E+14	-.00051	-.00138	.3615E+04	-.1207E+05	-.1400E+05	-.1303E+05
2200.00	500.00	625.00	.7000E+14	-.00053	-.00141	.3607E+04	-.1205E+05	-.1402E+05	-.1303E+05
2300.00	500.00	625.00	.7000E+14	-.00056	-.00144	.3599E+04	-.1203E+05	-.1404E+05	-.1303E+05
2400.00	500.00	625.00	.7000E+14	-.00058	-.00147	.3591E+04	-.1201E+05	-.1406E+05	-.1303E+05
2500.00	500.00	625.00	.7000E+14	-.00061	-.00150	.3583E+04	-.1199E+05	-.1408E+05	-.1303E+05
2600.00	500.00	625.00	.7000E+14	-.00063	-.00153	.3575E+04	-.1196E+05	-.1410E+05	-.1302E+05
2700.00	500.00	625.00	.7000E+14	-.00066	-.00156	.3566E+04	-.1194E+05	-.1412E+05	-.1302E+05
2800.00	500.00	625.00	.7000E+14	-.00068	-.00150	.3558E+04	-.1192E+05	-.1414E+05	-.1302E+05
2900.00	500.00	625.00	.7000E+14	-.00070	-.00163	.3549E+04	-.1189E+05	-.1416E+05	-.1302E+05

3000.00	500.00	625.00	.7000E+14	-.00073	-.00166	.3541E+04	-.1187E+05	-.1419E+05	-.1302E+05
3100.00	500.00	625.00	.7000E+14	-.00075	-.00170	.3532E+04	-.1185E+05	-.1421E+05	-.1302E+05
3200.00	500.00	625.00	.7000E+14	-.00078	-.00173	.3523E+04	-.1182E+05	-.1423E+05	-.1302E+05
3300.00	500.00	625.00	.7000E+14	-.00080	-.00177	.3515E+04	-.1179E+05	-.1425E+05	-.1301E+05
3400.00	500.00	625.00	.7000E+14	-.00083	-.00180	.3506E+04	-.1177E+05	-.1428E+05	-.1301E+05
3500.00	500.00	625.00	.7000E+14	-.00095	-.00184	.3497E+04	-.1174E+05	-.1430E+05	-.1301E+05
3600.00	500.00	625.00	.7000E+14	-.00087	-.00188	.3487E+04	-.1171E+05	-.1433E+05	-.1301E+05
3700.00	500.00	625.00	.7000E+14	-.00090	-.00192	.3478E+04	-.1169E+05	-.1435E+05	-.1301E+05
3800.00	500.00	625.00	.7000E+14	-.00092	-.00195	.3469E+04	-.1166E+05	-.1438E+05	-.1301E+05
3900.00	500.00	625.00	.7000E+14	-.00095	-.00199	.3459E+04	-.1163E+05	-.1441E+05	-.1300E+05
4000.00	500.00	625.00	.7000E+14	-.00097	-.00204	.3450E+04	-.1160E+05	-.1443E+05	-.1300E+05
4100.00	500.00	625.00	.7000E+14	-.00100	-.00208	.3440E+04	-.1157E+05	-.1446E+05	-.1300E+05
4200.00	500.00	625.00	.7000E+14	-.00102	-.00212	.3430E+04	-.1154E+05	-.1449E+05	-.1300E+05
4300.00	500.00	625.00	.7000E+14	-.00104	-.00216	.3421E+04	-.1151E+05	-.1452E+05	-.1300E+05
4400.00	500.00	625.00	.7000E+14	-.00107	-.00221	.3411E+04	-.1148E+05	-.1455E+05	-.1299E+05
4500.00	500.00	625.00	.7000E+14	-.00109	-.00225	.3401E+04	-.1144E+05	-.1458E+05	-.1299E+05
4600.00	500.00	625.00	.7000E+14	-.00112	-.00230	.3390E+04	-.1141E+05	-.1461E+05	-.1299E+05
4700.00	500.00	625.00	.7000E+14	-.00114	-.00234	.3380E+04	-.1138E+05	-.1464E+05	-.1299E+05
4800.00	500.00	625.00	.7000E+14	-.00116	-.00239	.3370E+04	-.1134E+05	-.1467E+05	-.1299E+05
4900.00	500.00	625.00	.7000E+14	-.00119	-.00244	.3359E+04	-.1131E+05	-.1470E+05	-.1298E+05
5000.00	500.00	625.00	.7000E+14	-.00121	-.00249	.3349E+04	-.1127E+05	-.1474E+05	-.1298E+05
5100.00	500.00	625.00	.7000E+14	-.00124	-.00254	.3338E+04	-.1123E+05	-.1477E+05	-.1298E+05
5200.00	500.00	625.00	.7000E+14	-.00126	-.00259	.3328E+04	-.1120E+05	-.1480E+05	-.1298E+05
5300.00	500.00	625.00	.7000E+14	-.00129	-.00265	.3317E+04	-.1116E+05	-.1484E+05	-.1298E+05
5400.00	500.00	625.00	.7000E+14	-.00131	-.00270	.3306E+04	-.1112E+05	-.1488E+05	-.1297E+05
5500.00	500.00	625.00	.7000E+14	-.00133	-.00275	.3295E+04	-.1108E+05	-.1491E+05	-.1297E+05
5600.00	500.00	625.00	.7000E+14	-.00136	-.00281	.3284E+04	-.1104E+05	-.1495E+05	-.1297E+05
5700.00	500.00	625.00	.7000E+14	-.00138	-.00287	.3273E+04	-.1100E+05	-.1499E+05	-.1297E+05
5800.00	500.00	625.00	.7000E+14	-.00141	-.00293	.3261E+04	-.1096E+05	-.1503E+05	-.1296E+05
5900.00	500.00	625.00	.7000E+14	-.00143	-.00299	.3250E+04	-.1091E+05	-.1507E+05	-.1296E+05
6000.00	500.00	625.00	.7000E+14	-.00145	-.00305	.3238E+04	-.1087E+05	-.1511E+05	-.1296E+05
6100.00	500.00	625.00	.7000E+14	-.00148	-.00311	.3227E+04	-.1083E+05	-.1515E+05	-.1295E+05
6200.00	500.00	625.00	.7000E+14	-.00150	-.00317	.3215E+04	-.1078E+05	-.1519E+05	-.1295E+05

6300.00	500.00	625.00	7000E+14	-.00153	-.00324	.3203E+04	-.1073E+05	-.1523E+05	-.1295E+05
6400.00	500.00	625.00	7000E+14	-.00155	-.00330	.3192E+04	-.1069E+05	-.1520E+05	-.1295E+05
6500.00	500.00	625.00	7000E+14	-.00157	-.00337	.3180E+04	-.1064E+05	-.1532E+05	-.1294E+05
6600.00	500.00	625.00	7000E+14	-.00160	-.00344	.3167E+04	-.1059E+05	-.1537E+05	-.1294E+05
6700.00	500.00	625.00	7000E+14	-.00162	-.00351	.3155E+04	-.1054E+05	-.1541E+05	-.1294E+05
6800.00	500.00	625.00	7000E+14	-.00165	-.00358	.3143E+04	-.1049E+05	-.1546E+05	-.1293E+05
6900.00	500.00	625.00	7000E+14	-.00167	-.00365	.3131E+04	-.1043E+05	-.1551E+05	-.1293E+05
7000.00	500.00	625.00	7000E+14	-.00169	-.00372	.3118E+04	-.1038E+05	-.1556E+05	-.1293E+05
7100.00	500.00	625.00	7000E+14	-.00172	-.00380	.3106E+04	-.1033E+05	-.1561E+05	-.1292E+05
7200.00	500.00	625.00	7000E+14	-.00174	-.00388	.3093E+04	-.1027E+05	-.1566E+05	-.1292E+05
7300.00	500.00	625.00	7000E+14	-.00177	-.00395	.3081E+04	-.1022E+05	-.1571E+05	-.1292E+05
7400.00	500.00	625.00	7000E+14	-.00179	-.00403	.3068E+04	-.1016E+05	-.1576E+05	-.1291E+05
7500.00	500.00	625.00	7000E+14	-.00181	-.00412	.3055E+04	-.1010E+05	-.1582E+05	-.1291E+05
7600.00	500.00	625.00	7000E+14	-.00184	-.00420	.3042E+04	-.1004E+05	-.1587E+05	-.1291E+05
7700.00	500.00	625.00	7000E+14	-.00186	-.00428	.3029E+04	-.9978E+04	-.1593E+05	-.1290E+05
7800.00	500.00	625.00	7000E+14	-.00189	-.00437	.3016E+04	-.9916E+04	-.1598E+05	-.1290E+05
7900.00	500.00	625.00	7000E+14	-.00191	-.00446	.3002E+04	-.9853E+04	-.1604E+05	-.1290E+05
8000.00	500.00	625.00	7000E+14	-.00193	-.00455	.2989E+04	-.9788E+04	-.1610E+05	-.1289E+05
8100.00	500.00	625.00	7000E+14	-.00196	-.00464	.2976E+04	-.9722E+04	-.1616E+05	-.1289E+05
8200.00	500.00	625.00	7000E+14	-.00198	-.00473	.2962E+04	-.9655E+04	-.1623E+05	-.1288E+05
8300.00	500.00	625.00	7000E+14	-.00201	-.00483	.2949E+04	-.9586E+04	-.1629E+05	-.1288E+05
8400.00	500.00	625.00	7000E+14	-.00203	-.00493	.2935E+04	-.9516E+04	-.1635E+05	-.1287E+05
8500.00	500.00	625.00	7000E+14	-.00205	-.00503	.2921E+04	-.9445E+04	-.1642E+05	-.1287E+05
8600.00	500.00	625.00	7000E+14	-.00208	-.00513	.2908E+04	-.9373E+04	-.1649E+05	-.1287E+05
8700.00	500.00	625.00	7000E+14	-.00210	-.00523	.2894E+04	-.9298E+04	-.1655E+05	-.1286E+05
8800.00	500.00	625.00	7000E+14	-.00212	-.00534	.2880E+04	-.9223E+04	-.1662E+05	-.1286E+05
8900.00	500.00	625.00	7000E+14	-.00215	-.00544	.2866E+04	-.9146E+04	-.1669E+05	-.1285E+05
9000.00	500.00	625.00	7000E+14	-.00217	-.00555	.2851E+04	-.9068E+04	-.1677E+05	-.1285E+05
9100.00	500.00	625.00	7000E+14	-.00220	-.00566	.2837E+04	-.8988E+04	-.1684E+05	-.1284E+05
9200.00	500.00	625.00	7000E+14	-.00222	-.00578	.2823E+04	-.8916E+04	-.1692E+05	-.1284E+05
9300.00	500.00	625.00	7000E+14	-.00224	-.00589	.2809E+04	-.8843E+04	-.1699E+05	-.1283E+05
9400.00	500.00	625.00	7000E+14	-.00227	-.00601	.2794E+04	-.8770E+04	-.1707E+05	-.1283E+05
9500.00	500.00	625.00	7000E+14	-.00229	-.00613	.2780E+04	-.8695E+04	-.1715E+05	-.1282E+05

9600.00	500.00	625.00	7000E+14	-.00231	-.00626	.2765E+04	-.8564E+04	-.1723E+05	-.1262E+05
9700.00	500.00	625.00	7000E+14	-.00234	-.00638	.2750E+04	-.8474E+04	-.1731E+05	-.1281E+05
9800.00	500.00	625.00	7000E+14	-.00236	-.00651	.2736E+04	-.8382E+04	-.1740E+05	-.1280E+05
9900.00	500.00	625.00	7000E+14	-.00238	-.00664	.2721E+04	-.8290E+04	-.1749E+05	-.1280E+05
10000.00	500.00	625.00	7000E+14	-.00241	-.00677	.2706E+04	-.8194E+04	-.1757E+05	-.1279E+05
10100.00	500.00	625.00	7000E+14	-.00243	-.00691	.2691E+04	-.8097E+04	-.1766E+05	-.1279E+05
10200.00	500.00	625.00	7000E+14	-.00246	-.00705	.2676E+04	-.7998E+04	-.1775E+05	-.1278E+05
10300.00	500.00	625.00	7000E+14	-.00248	-.00719	.2661E+04	-.7898E+04	-.1785E+05	-.1277E+05
10400.00	500.00	625.00	7000E+14	-.00250	-.00733	.2646E+04	-.7795E+04	-.1794E+05	-.1277E+05
10500.00	500.00	625.00	7000E+14	-.00253	-.00748	.2631E+04	-.7690E+04	-.1804E+05	-.1276E+05
10600.00	500.00	625.00	7000E+14	-.00255	-.00763	.2616E+04	-.7584E+04	-.1814E+05	-.1275E+05
10700.00	500.00	625.00	7000E+14	-.00257	-.00778	.2600E+04	-.7475E+04	-.1824E+05	-.1275E+05
10800.00	500.00	625.00	7000E+14	-.00260	-.00794	.2585E+04	-.7364E+04	-.1834E+05	-.1274E+05
10900.00	500.00	625.00	7000E+14	-.00262	-.00810	.2569E+04	-.7251E+04	-.1844E+05	-.1273E+05
11000.00	500.00	625.00	7000E+14	-.00264	-.00826	.2554E+04	-.7136E+04	-.1855E+05	-.1273E+05
11100.00	500.00	625.00	7000E+14	-.00267	-.00842	.2538E+04	-.7019E+04	-.1866E+05	-.1272E+05
11200.00	500.00	625.00	7000E+14	-.00269	-.00859	.2523E+04	-.6900E+04	-.1877E+05	-.1271E+05
11300.00	500.00	625.00	7000E+14	-.00271	-.00876	.2507E+04	-.6778E+04	-.1888E+05	-.1270E+05
11400.00	500.00	625.00	7000E+14	-.00274	-.00894	.2492E+04	-.6653E+04	-.1900E+05	-.1270E+05
11500.00	500.00	625.00	7000E+14	-.00276	-.00912	.2476E+04	-.6527E+04	-.1911E+05	-.1269E+05
11600.00	500.00	625.00	7000E+14	-.00278	-.00930	.2460E+04	-.6398E+04	-.1923E+05	-.1268E+05
11700.00	500.00	625.00	7000E+14	-.00281	-.00949	.2444E+04	-.6266E+04	-.1935E+05	-.1267E+05
11800.00	500.00	625.00	7000E+14	-.00283	-.00967	.2428E+04	-.6132E+04	-.1948E+05	-.1266E+05
11900.00	500.00	625.00	7000E+14	-.00285	-.00987	.2412E+04	-.5995E+04	-.1960E+05	-.1265E+05
12000.00	500.00	625.00	7000E+14	-.00288	-.01006	.2396E+04	-.5856E+04	-.1973E+05	-.1264E+05
12100.00	500.00	625.00	7000E+14	-.00290	-.01027	.2380E+04	-.5714E+04	-.1986E+05	-.1264E+05
12200.00	500.00	625.00	7000E+14	-.00292	-.01047	.2364E+04	-.5570E+04	-.2000E+05	-.1263E+05
12300.00	500.00	625.00	7000E+14	-.00295	-.01068	.2348E+04	-.5422E+04	-.2013E+05	-.1262E+05
12400.00	500.00	625.00	7000E+14	-.00297	-.01089	.2332E+04	-.5272E+04	-.2027E+05	-.1261E+05
12500.00	500.00	625.00	7000E+14	-.00299	-.01111	.2316E+04	-.5118E+04	-.2042E+05	-.1260E+05
12600.00	500.00	625.00	7000E+14	-.00301	-.01133	.2300E+04	-.4962E+04	-.2056E+05	-.1259E+05
12700.00	500.00	625.00	7000E+14	-.00304	-.01156	.2283E+04	-.4803E+04	-.2071E+05	-.1258E+05
12800.00	500.00	625.00	7000E+14	-.00306	-.01179	.2267E+04	-.4641E+04	-.2086E+05	-.1257E+05

12000.00	500.00	625.00	7000E+14	-0.0338	-0.01232	.2251E+04	-.4475E+04	-.2101E+05	-.1256E+05
13000.00	500.00	625.00	7000E+14	-0.0311	-0.01226	.2234E+04	-.4306E+04	-.2117E+05	-.1255E+05
13100.00	500.00	625.00	7000E+14	-0.0313	-0.01251	.2218E+04	-.4134E+04	-.2133E+05	-.1254E+05
13200.00	500.00	625.00	7000E+14	-0.0315	-0.01276	.2201E+04	-.3959E+04	-.2149E+05	-.1252E+05
13300.00	500.00	625.00	7000E+14	-0.0314	-0.01301	.2185E+04	-.3780E+04	-.2166E+05	-.1251E+05
13400.00	500.00	625.00	7000E+14	-0.0325	-0.01327	.2168E+04	-.3598E+04	-.2182E+05	-.1250E+05
13500.00	500.00	625.00	7000E+14	-0.0322	-0.01354	.2152E+04	-.3412E+04	-.2200E+05	-.1249E+05
13600.00	500.00	625.00	7000E+14	-0.0324	-0.01381	.2135E+04	-.3223E+04	-.2217E+05	-.1248E+05
13700.00	500.00	625.00	7000E+14	-0.0327	-0.01409	.2119E+04	-.3029E+04	-.2235E+05	-.1246E+05
13800.00	500.00	625.00	7000E+14	-0.0329	-0.01437	.2102E+04	-.2832E+04	-.2253E+05	-.1245E+05
13900.00	500.00	625.00	7000E+14	-0.0331	-0.01466	.2085E+04	-.2631E+04	-.2272E+05	-.1244E+05
14000.00	500.00	625.00	7000E+14	-0.0333	-0.01495	.2069E+04	-.2426E+04	-.2291E+05	-.1243E+05
14100.00	500.00	625.00	7000E+14	-0.0336	-0.01525	.2052E+04	-.2217E+04	-.2311E+05	-.1241E+05
14200.00	500.00	625.00	7000E+14	-0.0338	-0.01556	.2035E+04	-.2004E+04	-.2330E+05	-.1240E+05
14300.00	500.00	625.00	7000E+14	-0.0340	-0.01587	.2019E+04	-.1787E+04	-.2351E+05	-.1238E+05
14400.00	500.00	625.00	7000E+14	-0.0342	-0.01619	.2002E+04	-.1565E+04	-.2371E+05	-.1237E+05
14500.00	500.00	625.00	7000E+14	-0.0345	-0.01652	.1985E+04	-.1339E+04	-.2392E+05	-.1235E+05
14600.00	500.00	625.00	7000E+14	-0.0347	-0.01685	.1968E+04	-.1108E+04	-.2414E+05	-.1234E+05
14700.00	500.00	625.00	7000E+14	-0.0349	-0.01719	.1951E+04	-.8725E+03	-.2436E+05	-.1232E+05
14800.00	500.00	625.00	7000E+14	-0.0351	-0.01754	.1935E+04	-.6322E+03	-.2458E+05	-.1231E+05
14900.00	500.00	625.00	7000E+14	-0.0354	-0.01789	.1918E+04	-.3870E+03	-.2481E+05	-.1229E+05
15000.00	500.00	625.00	7000E+14	-0.0356	-0.01826	.1901E+04	-.1367E+03	-.2504E+05	-.1228E+05
15100.00	500.00	625.00	7000E+14	-0.0358	-0.01863	.1884E+04	.1187E+03	-.2528E+05	-.1226E+05
15200.00	500.00	625.00	7000E+14	-0.0360	-0.01901	.1867E+04	.3795E+03	-.2552E+05	-.1224E+05
15300.00	500.00	625.00	7000E+14	-0.0362	-0.01940	.1850E+04	.6458E+03	-.2577E+05	-.1222E+05
15400.00	500.00	625.00	7000E+14	-0.0365	-0.01979	.1833E+04	.9177E+03	-.2602E+05	-.1221E+05
15500.00	500.00	625.00	7000E+14	-0.0367	-0.02020	.1816E+04	.1196E+04	-.2628E+05	-.1219E+05
15600.00	500.00	625.00	7000E+14	-0.0369	-0.02061	.1799E+04	.1479E+04	-.2655E+05	-.1217E+05
15700.00	500.00	625.00	7000E+14	-0.0371	-0.02104	.1782E+04	.1770E+04	-.2682E+05	-.1215E+05
15800.00	500.00	625.00	7000E+14	-0.0373	-0.02147	.1765E+04	.2066E+04	-.2709E+05	-.1213E+05
15900.00	500.00	625.00	7000E+14	-0.0375	-0.02192	.1748E+04	.2370E+04	-.2738E+05	-.1211E+05
16000.00	500.00	625.00	7000E+14	-0.0378	-0.02238	.1731E+04	.2680E+04	-.2767E+05	-.1209E+05
16100.00	500.00	625.00	7000E+14	-0.0340	-0.02285	.1714E+04	.2998E+04	-.2796E+05	-.1207E+05

16200.00	500.00	625.00	.7000E+14	-.00382	-.02333	.1696E+04	.3324E+04	-.2827E+05	-.1205E+05
16300.00	500.00	625.00	.7000E+14	-.00384	-.02332	.1679E+04	.3657E+04	-.2858E+05	-.1202E+05
16400.00	500.00	625.00	.7000E+14	-.00386	-.02333	.1662E+04	.3999E+04	-.2890E+05	-.1200E+05
16500.00	500.00	625.00	.7000E+14	-.00388	-.02385	.1644E+04	.4349E+04	-.2923E+05	-.1198E+05
16600.00	500.00	625.00	.7000E+14	-.00391	-.02338	.1627E+04	.4708E+04	-.2956E+05	-.1195E+05
16700.00	500.00	625.00	.7000E+14	-.00393	-.02593	.1609E+04	.5076E+04	-.2991E+05	-.1193E+05
16800.00	500.00	625.00	.7000E+14	-.00395	-.02650	.1592E+04	.5455E+04	-.3026E+05	-.1190E+05
16900.00	500.00	625.00	.7000E+14	-.00397	-.02708	.1574E+04	.5843E+04	-.3062E+05	-.1188E+05
17000.00	500.00	625.00	.7000E+14	-.00399	-.02768	.1557E+04	.6242E+04	-.3100E+05	-.1185E+05
17100.00	500.00	625.00	.7000E+14	-.00401	-.02830	.1539E+04	.6652E+04	-.3138E+05	-.1182E+05
17200.00	500.00	625.00	.7000E+14	-.00403	-.02894	.1521E+04	.7073E+04	-.3178E+05	-.1179E+05
17300.00	500.00	625.00	.7000E+14	-.00405	-.02960	.1503E+04	.7507E+04	-.3218E+05	-.1176E+05
17400.00	500.00	625.00	.7000E+14	-.00407	-.03027	.1485E+04	.7954E+04	-.3260E+05	-.1173E+05

STEPS EXCEEDS YIELD STRENGTH

CREEP COLLAPSE ANALYSIS - TIME (X) VERSUS OVALITY (Y)

DIMENSIONLESS PARAMETER X

MULTIPLIERS /

X1= 2.50E+34

I= 4.34E-22

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