ENCLOSURE (1)

N8110R:72-036

(NASA-CR-132185) ROCKET NOZZLE COOLANT CHANNEL THERMAL ANALYSIS PROGRAM (E25107) (Aerojet Nuclear Systems Co., Azusa, Calif.) 20 p HC $14.25 CSCL 21H G3/28 17750 Unclas

N73-25832

ENGINEERING OPERATIONS REPORT

# ROCKET NOZZLE COOLANT CHANNEL THERMAL ANALYSIS PROGRAM (E25107)

PROJECT 187. W.O. 1190-18-796

14 APRIL 1972

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CLASSIFICATION CATEGORY
Unclassified
W R Thompson 4-14-72
CLASSIFYING OFFICER DATE

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ATTENTION REPRO:

BEFORE PRINTING, CONTACT INPUT FOR PAGINATION

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# ROCKET NOZZLE COOLANT CHANNEL THERMAL ANALYSIS PROGRAM (E25107)

I. INTRODUCTION

II. SUMMARY AND RECOMMENDATIONS

III. TECHNICAL CONTENT

- A. PROGRAM DESCRIPTION
- B. PROGRAM CAPABILITIES AND LIMITATIONS
- C. USERS MANUAL
- D. SAMPLE PROBLEM
- E. COMPUTER LISTING

ATTACHMENT 1: USERS MANUAL

2: SAMPLE PROGRAM (ANSC REPORT NO. N8110R:72-030, DATED FEBRUARY 1972)

3: COMPUTER LISTING

# MATHEMATICAL MODEL

# APPENDIX A

## I. GAS CONDITIONS

At the present time gas pressure and temperature as functions of nozzle area ratio must be input in tabular form. In addition when the coolant is not hydrogen, the properties (density, thermal conductivity, viscosity and specific heat at constant pressure) must be input as functions of temperature.

## II. NOZZLE GAS-SIDE CONTOUR AND STATION LOCATION

In the case of a conical nozzle, the Z-R coordinates and developed lengths X can be computed when pertinent nozzle dimensions are known. In the case of a contoured nozzle, only the stations forward of the throat can be calculated; aft of the throat the coordinates must be input as axial length measured from the throat, and radius. The developed length X will be computed by the program. For unconventional nozzles the data must be input in tabular form at each station.

The program merely breaks the nozzle into circular arcs and connecting straight lines, and computes coordinates and developed lengths at each tangent point. It then breaks each segment down into the number of intervals input as, $N_1'$, $N_2'$, etc. If any N' is not input, an approximate length of 3 inches between stations is used. Exceptions to this are in the arc described by $R_d$ which is usually small and is therefore taken as a single segment, and the arcs described by $R_u$ and $R_\beta$ which are presently divided in half. In any case, no intervals are greater than 3 inches long.

In cases where discontinuities in the data exists such as coolant flow rates, number of coolant tubes, or where the coolant flow changes direction nozzle data at these discontinuities are inserted into the contour

data generated by the program. A table of axial coordinates called TAZ1 is used to locate all discontinuities and also to determine the flow direction at each point in the nozzle.

## III. GEOMETRIC PARAMETERS OF COOLANT TUBES

Four basic coolant tube configurations are being considered: U-Tubes (Figure 2), Truncated Tubes (Figure 3), Round or Flattened Tubes (Figure 4), and Rectangular Slots (Figure 5).

A. Round or Flattened Tubes. The gas-side radius, circumference, ambient-side radius, and side length are computed as follows:

1. $r_g = \pi R/(N_t - \pi)$
2. $s = \pi d$
3. $r_a = \pi(2R + 2r_g + s - \pi r_g)/(2N_t + \pi^2)$
4. $\ell = .5\ [s - \pi(r_g + r_a)]$

If $\ell \leq 0$, a round tube condition exists, and diameter, circumference, ambient-side radius and side length are re-computed as follows:

5. $d = 2r_g$
6. $s = \pi d$
7. $r_a = r_g$
8. $\ell = 0$

Calculation of flow area and equivalent diameter:

9. $A_f = \frac{\pi}{2}[(r_g - t_m)^2 + (r_a - t_m)^2] + \ell(r_g + r_a - 2t_m)$
10. $d_e = 4\ A_f/[\pi(r_g + r_a - 2t_m) + 2\ell]$

B. U-Tubes. The gas-side radius, back-side tube width, flow area and equivalent diameter are computed as follows:

1. $r_g = (\pi R - .5\, N_t\, t_s)/(N_t - \pi)$

When $A_f$ is input, $\ell$ is solved from the following equation:

2. $$\frac{2\pi}{N_t}\ell^2 + \left[2(r_g - t_m) + \frac{2\pi}{N_t}(R + r_g) - t_s - 2t_m\right]\ell + \pi(r_g - t_m)^2 - 2A_f = 0$$

3. $b = [2\pi(R + r_g + \ell)/N_t] - t_s$

4. $A_f = .5\,\{\pi(r_g - t_m)^2 + \ell[2(r_g - t_m) + b - 2t_m]\} - UW * UL$

5. $d_e = 4A_f/[\pi(r_g - t_m) + (b - 2t_m)] + 2|UW|$

C. Truncated Tubes. Calculations of flow area and equivalent diameter are as follows:

1. $r_g = \pi R/(N_t - \pi)$

2. $$d_{min} = \frac{2r_g}{\pi}\left[\pi - \cos^{-1}\left(\frac{t_m}{r_g}\right)\right] + \frac{2r_g}{\pi}\sin\left[\cos^{-1}\left(\frac{t_m}{r_g}\right)\right]$$

3. if $d > d_{min}$ and $d < 2r_g$ then

a. $\Theta$ is computed from the following equation:

$$\pi d = 2r_g(\pi - \Theta) + 2r_g \sin\Theta$$

b. $\ell = r_g \cos\Theta$

c. $$\alpha = \sin^{-1}\left(\frac{\ell - t_m}{r_g - t_m}\right)$$

4. If $d \leq d_{min}$ then

   a. $\ell = t_m$

   b. $\alpha = 0.$

   c. $\theta = \cos^{-1}\left(\frac{t_m}{r_g}\right)$

5. $A_f = (r_g - t_m)^2 \left(\frac{\pi}{2} + \alpha\right) + (\ell - t_m)(r_g - t_m)\cos\alpha$

6. $d_e = 4\,A_f / [2(\frac{\pi}{2} + \alpha)(r_g - t_m) + 2(r_g - t_m)\cos\alpha]$

Whenever $d > d_{min}$ and $d \geq 2r_g$ then the flow area and equivalent diameter are computed as follows:

7. $r_a = \pi(2R + 2r_g + \pi d - \pi r_g)/(2N_t + \pi^2)$

8. $\ell = .5\,[\pi d - \pi(r_g - r_a)]$

If $\ell \leq 0$ then

$d = 2r_g$

$r_a = r_g$

$s = \pi d$

$\ell = 0.$

9. $A_f = \frac{\pi}{2}[(r_g - t_m)^2 + (r_a - t_m)^2] + \ell(r_g + r_a - 2t_m)$

10. $d_e = 4\,A_f / [\pi(r_g + r_a - 2t_m) + 2\ell]$

D. Rectangular Slots. Flow area and equivalent diameter are computed as follows:

1. $W = \frac{2\pi}{N_t}(R + t_m) - \ell$

2. $A_f = W\,d_s$

3. $d_e = \frac{2A_f}{W + d_s}$

## IV. GAS PRESSURE AND TEMPERATURE AT STATIONS

After stations have been located, area ratio is calculated at each station by:

$$A/A^* = (R/R^*)^2$$

$P_\infty$ and $T_\infty$ are obtained by interpolation as a function of area ratio.

## V. BETA FACTOR AT STATIONS

$\beta$ will either be input as a function of axial length or computed by the program.

A. If input, interpolation may be made at each station.

B. If $\beta$ is to be computed, it will be input as a negative value. Having obtained gas properties at a specific station, the Prandtl number is computed by:

$$P_r = \mu C_p / k$$

Using $T_\infty$ at the station being considered, $\beta$ is computed as follows:

$$\beta = \eta^2 [P_r^{1/3} T_c + T_\infty (1 - P_r^{1/3})] / T_c$$

## VI. CALCULATION OF DESIRED PARAMETERS

Because $T_{WG}$, $T_{WL}$, $T_b$ and P are all interrelated, an iterative procedure is used for solution. The normal procedure involves assuming initial values of these four parameters, then using previous values in subsequent iterations. At the first station, guesses of $T_{WG} = T_{WL} = 1500°R$ are used and $T_b$ and P are input.

## A. CALCULATION OF THE LIQUID SIDE HEAT TRANSFER COEFFICIENT $h_\ell$

At the present time there are ten different equations and one table look up option which can be used to calculate $h_\ell$. The method utilized depends on the value of the input parameter HLC.

HLC = 1., $$h_\ell = \frac{C_L K_{cf}}{d_e}\left[\frac{\rho_{cf} d_e v}{\mu_{cf}}\right]^{.8}\left[1 + \frac{.01457\ \mu_{WL}\ \rho_b}{\mu_b\ \rho_{WL}}\right]\left[P_{r_{cf}}\right]^{.4}$$

HLC = 2., $$h_\ell = \frac{C_L K_{cf}}{d_e}\left[\frac{d_e v \rho_b}{\mu_{cf}}\right]^{.8}\left[\frac{\mu_{cf} Cp_{cf}}{K_{cf}}\right]^{.4}$$

HLC = 3., $$h_\ell = \frac{C_L K_b}{d_e}\left[\frac{d_e v \rho_b}{\mu_b}\right]^{.8}\left[\frac{\mu_b Cp_b}{K_b}\right]^{.4}\left[\frac{T_b}{T_{WL}}\right]^{.34}$$

HLC = 4., $$h_\ell = \frac{C_L K_{cf}}{d_e}\left[\frac{d_e v \rho_b}{\mu_{cf}}\right]^{.8}\left[\frac{\mu_{cf} Cp_{cf}}{K_{cf}}\right]^{.4}\left[\frac{\rho_{WL}}{\rho_b}\right]^{.8}$$

HLC = 5., $$h_\ell = \frac{C_L K_b}{d_e}\left[\frac{d_e v \rho_b}{\mu_b}\right]^{.8}\left[\frac{\mu_b Cp_b}{K_b}\right]^{.4}$$

HLC = 6., $$h_\ell = \frac{C_L K_b}{d_e}\left[\frac{d_e v \rho_b}{\mu_b}\right]^{.8}\left[\frac{\mu_b Cp_b}{K_b}\right]^{.4}\left[\frac{\mu_b}{\mu_{WL}}\right]^{.14}$$

HLC = 7., $$h_\ell = \frac{C_L K_{cf}}{d_e}\left[\frac{d_e v \rho_{cf}}{\mu_{cf}}\right]^{.8}\left[\frac{\mu_{cf} Cp_{cf}}{K_{cf}}\right]^{.4}$$

HLC = 8., $$h_\ell = \frac{C_L K_b}{d_e}\left[\frac{d_e v \rho_b}{\mu_b}\right]^{.95}\left[\frac{\mu_b Cp_b}{K_b}\right]^{.4}$$

HLC = 9., $h_\ell$ = table look up from TAHL vs. TAZ input table.

HLC = 10., $h_\ell = 0.00704 \frac{K}{d_e} Re^{.879} Pr^{.4}$

where all fluid properties are determined from:

$$\text{Property} = \frac{\int_{T_{bulk}}^{T_{wall}} (\text{Property})\, dT}{T_{wall} - T_{bulk}}$$

The coefficient is multiplied by the following terms when K5S = 1.

1. $\left[1 + \frac{4.0}{x/_{de}}\right]^{.856}$

2. and the lowest value of a., b. or c.

   a. $(1 + 1.107\ \emptyset)$ for the entrance to the throat region,

   b. $.876 \left[Re_b \left(\frac{d_e}{2R_c}\right)^2\right]^{.0666}$ for fully developed curve tube flow

   c. $(3.033 - 1.649\ \emptyset)$ to represent decay of the curvature effect.

HLC = 11. Recent analysis of 2230 points of hydrogen heat transfer data in the specific operating range of the NERVA has led to the following coolant-side correlation for hydrogen.

$$h_\ell = 0.00821 \frac{K_{film}}{d_e} Re_{film}^{.874} Pr_{film}^{.4} \left(1 + .0146 \frac{\mu_w}{\mu_b} \frac{\rho_b}{\rho_w}\right)^{.622}$$

The subscript "film" refers to properties based on the average temperature between bulk and wall.

When K5S = 1., a factor that accounts for entrance effects is multiplied times this expression and takes the following forms:

for $0 \leq x/d_e < 5.198$

Entrance factor = 1.8

for $5.198 < x/d_e \leq 120$

$$\text{Entrance factor} = \left(1 + \frac{4.0}{x/d_e}\right)^{1.030}$$

for $x/d_e \leq 120$ the entrance factor has attenuated to unity

Also when K5S = 1., a factor that accounts for coolant channel curvature, for the case in which heat transfer exists over the convex surface of the curve (the nozzle throat), is multiplied times the straight tube correlation and takes the following forms:

$$\text{curved tube factor} \begin{cases} 1 + 1.128\ \phi \\ .797 \left[ Re_b \left( \frac{d_e}{2r_c} \right)^2 \right]^{.0785} \\ 2.502 - 1.16\ \phi \end{cases}$$

in which $\phi$ is the angle of curvature in radians.

For the particular value of $\phi$, $Re_b$, and $\frac{d_e}{r_c}$ at a location on a curved tube, the expression above that yields the lowest curved tube factor is utilized.

In all cases:

$$v = \frac{\dot{W}_c}{N_{mb}\ A_f\ \rho_b}$$

$K_b$, $\mu_b$, $\rho_b$, $Cp_b$ are evaluated at P and $T_b$. $K_{cf}$, $\mu_{cf}$, $\rho_{cf}$, $Cp_{cf}$ evaluated at P and $T_{cf} = (T_B + T_{WL})/2$. $K_{WL}$, $\mu_{WL}$, $\rho_{WL}$, $Cp_{WL}$ are evaluated at P and $T_{WL}$.

For $h_\ell$ calculations for HLC = 2 through 9 the following modification to $h_\ell$ is performed whenever $T_{WL}$ is greater than the saturation temperature $T_{SAT}$:

$$h_\ell = h_\ell\ C_{B1} \left( \frac{T_{WL}}{T_{SAT}} \right)^{C_{B2}}$$

B. CALCULATION OF GAS SIDE HEAT TRANSFER COEFFICIENT, $h_g$

The gas side heat transfer coefficient is calculated by one of four different computational schemes depending on the input parameter HGC. In addition, the gas properties used for three of the methods may be either (1) NBS equilibrium hydrogen, (2) values from input tables or (3) NBS para-hydrogen. This second option is controlled by the input parameter GAS.

The following relationships are available for determining gas side heat transfer coefficient.

$$(1)\quad h_g = C_G \left[ \frac{4\,\dot{W}\,\rho_{gf}}{\pi\, D^{2.25}\,\rho} \right]^{.8} \frac{\mu_{gf}^{.2}\, GU_{gf}}{P_r^{.6}}$$

$$(2)\quad h_g = C_G \left[ \frac{4\,\dot{W}\,T_\infty}{\pi\, D^{2.25}\,T_{gf}} \right]^{.8} \frac{\mu_{gf}^{.2}\, Cp_{gf}}{P_r^{.6}}$$

$$(3)\quad h_g = C_G \left[ \frac{4\,\dot{W}\,MW_{gf}\,T_\infty}{\pi\, D^{2.25}\,MW_\infty\,T_{gf}} \right]^{.8} \frac{\mu_{gf}^{.2}\, Cp_{gf}}{P_r^{.6}}$$

where: $T_{gf} = 1/2\ (\beta T_c + T_{WG})$

$\rho_{gf}$, $\mu_{gf}$, $CP_{gf}$, $Pr_{gf}$ are evaluated at $P_\infty$ and $T_{gf}$.

$\rho$ is evaluated at $P_\infty$, $T_\infty$.

$$(4)\quad h_g = C_G \frac{K_f}{X} \left[\frac{\rho_f V X}{\mu_f}\right]^{REYEXP} \left[\frac{\mu_f Cp_f}{K_f}\right]^{PRLEXP}$$

evaluated at the Eckert reference temperature

$$T_f = .5\ (T_{WG} + T_{fs}) + .22\ Pr_f^{1/3}\ (T_o - T_{fs})$$

in which: $X$ = Nozzle contour distance from core

$T_{fs}$ = free-stream temperature

$T_o$ = chamber temperature

(5) $h_g$ = Direct table look up as a function of station location from the TAHG input array.

If flow rate $\dot{W}$ changes, the axial length $Z_w$ at which the change occurs will be input. If $Z_w = 0$ then $\dot{W} = \dot{W}g_{core} = \dot{W}_{g*}$.

a. If $Z < Z_w$, $\dot{W} = \dot{W}g_{core}$

b If $Z \geq Z_w$, $\dot{W} = \dot{W}_{g*}$

The following table summarizes the options used for the various combinations of HGC and GAS. (Note that internally these are changed to IHGC and IGAS).

| VALUE FOR HGC | VALUE FOR GAS | RELATIONSHIP FOR hg | GAS PROPERTIES |
|---|---|---|---|
| 1 | 1 | No. 1 | NBS equilibrium hydrogen |
| | 2 | No. 3 | from input tables* |
| | 3 | No. 1 | NBS parahydrogen |
| 2 | 1 | No. 2 | NBS equilibrium hydrogen |
| | 2 | " | from input tables* |
| | 3 | " | NBS parahydrogen |
| 3 | 1 | Table look up** | Not applicable |
| | 2 | " | " |
| | 3 | " | " |
| 4 | 1 | No. 4 | NBS equilibrium hydrogen |
| | 2 | No. 4 | from input tables* |
| | 3 | No. 4 | NBS parahydrogen |

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* The gas properties input tables are GASMWT, GASRHO, GASMU, GASK and GASCP vs. GAST.

** The heat transfer coefficient table is TAHG vs. TAZ.

C. CALCULATION OF $h_r$

The coefficient $h_r$ is a function of FEFV which may either be input as a function of axial length or computed by the program.

1. If FEFV is input, linear interpolation is performed to obtain the value at each station.

2. If FEFV is to be computed, it will be input as a negative value. Having already determined station coordinates computation is as follows: (Subscript P refers to previous station)

a. If Z = 0, then F = 1; if Z ≠ 0, then

$$E_1 = (R/Z)^2$$

$$E_2 = (Z/R_c)^2$$

$$E_3 = 1 + (1 + E_1)E_2$$

$$F = .5\ (E_3 - \sqrt{E_3^2 - 4\ E_1\ E_2}\ )$$

$$\overline{F} = F - F_p$$

$$\overline{A} = \pi(R + R_p)\ \sqrt{(Z - Z_p)^2 + (R - R_p)^2}$$

b. Set $\varepsilon_o = .55$ and $\varepsilon_1 = 1$ if not input

$$G_o = \left[\frac{1}{\overline{F}} + (\frac{1}{\varepsilon_o} - 1) + (\pi R_c^2 \sqrt{A})\ (\frac{1}{\varepsilon_1} - 1)\right]^{-1}$$

$$G_1 = G_o\ \pi R_c^{\ 2}/\overline{A}$$

$$FEFV = G_1(T_o^{\ 4} - T_{WG}^{\ 4})/(\beta^4\ T_c^{\ 4} - T_{WG}^{\ 4})$$

3. Compute $h_r$

$$h_r = (3.3 \times 10^{-15})\ FEFV\ (\beta^4\ T_c^{\ 4} - T_{WG}^{\ 4})/(\beta T_c - T_{WG})$$

D. THERMAL CONDUCTIVITY OF TUBE WALL

Various materials may be used for tube construction, each of which has its own curve of conductivity as a function of temperature. Tables for two materials, stainless steel and Hastelloy X, are built into the program (values are listed in Appendix D); however, provision has been made to input tables representing any other material. Interpolation for the conductivity is made at the mean temperature $T_M$:

$$T_M = .5[(h_g + h_r)(T_{WG} - \beta T_c)\ \frac{t_c}{k_c}\ (r_g + t_c)/(r_g + .5\ t_c) + T_{WG} + T_{WL}]$$

E. OVERALL HEAT TRANSFER COEFFICIENT

1. Cryogenic

The coefficient U based on inside wall surface area is given by:

$$U = \{[1/(h_g + h_r)](r_g - t_m)/(r_g + t_c) + (t_c/k_c)(r_g - t_m)/(r_g + .5\ t_c) + (t_m/k_m)(r_g - t_m)/(r_g - .5\ t_m) + 1/h_\ell\}^{-1}$$

2. Non-Cryogenic

For cylindrical wall type:

$$U = \left\{ \frac{(r_g - t_m)}{k_c} \ln \frac{r_g + t_c}{r_g} + \frac{1}{h_g + h_r} \frac{r_g - t_m}{r_g + t_c} + \frac{r_g - t_m}{k_m} \ln \frac{r_g}{r_g - t_m} + \frac{1}{h_\ell} \right\}^{-1}$$

For flat wall type:

$$U = \left\{ \frac{1}{h_g + h_r} + \frac{t_m}{K_m} + \frac{t_c}{K_c} + \frac{1}{h_\ell} \right\}^{-1}$$

F. HEAT FLUX, INSIDE

The heat flux based on inside surface area is:

$$q/A = U(\beta t_c - T_b)$$

G. COMPUTATION OF WALL TEMPERATURES

1. Cryogenic

$$T_{WGC} = q/A \left\{ (t_c/K_c)(r_g - t_m)/(r_g + .5\ t_c) + (t_m/K_m)(r_g - t_m)/(r_g - .5\ t_m) + \frac{1}{h_\ell} \right\} + T_b$$

$$T_{WLC} = q/A(1/h_\ell) + T_b$$

$$T_{WM} = q/A \{(t_m/K_m)(r_g - t_m)/(r_g - .5\ t_m) + 1/h_\ell\} + T_b$$

2. Non-Cryogenic

For cylindrical wall type:

$$T_{WGC} = q/A \left\{ \frac{(r_g - t_m)}{K_m} \ln \left( \frac{r_g}{r_g - t_m} \right) + \frac{(r_g - t_m)}{K_c} \ln \left( \frac{r_g + t_c}{r_g} \right) + \frac{1}{h_\ell} \right\} + T_b$$

$$T_{WLC} = q/A(1/h_\ell) + T_b$$

$$T_{WMC} = q/A \left\{ \frac{(r_g - t_m)}{K_m} \ln \left( \frac{r_g}{r_g - t_m} \right) + \frac{1}{h_\ell} \right\} + T_b$$

For flat wall type:

$$T_{WGC} = q/A \left\{ \frac{t_m}{K_m} + \frac{t_c}{K_c} + \frac{1}{h_\ell} \right\} + T_b$$

$$T_{WLC} = q/A(1/h_\ell) + T_b$$

$$T_{WMC} = q/A \left\{ \frac{t_m}{K_m} + \frac{1}{h_\ell} \right\} + T_b$$

In the non-cryogenic case, whenever $T_{WLC} > T_{SAT} + K$, then $T_{WLC}$ is set equal to $T_{SAT} + K$ and the overall heat transfer coefficient and the above temperatures are recomputed as follows:

For cylindrical wall type:

$$U = \left\{ \frac{(r_g - t_m)}{K_c} \ln \left( \frac{r_g + t_c}{r_g} \right) + \left( \frac{r_g - t_m}{K_m} \right) \ln \left( \frac{r_g}{r_g - t_m} \right) + \frac{1}{h_g + h_r} \left( \frac{r_g - t_m}{r_g + t_c} \right) \right\}^{-1}$$

$$q/A = U(\beta t_c - T_{WLC})$$

$$T_{WGC} = q/A \left(\frac{r_g - t_m}{K_m}\right) \ln \left(\frac{r_g}{r_g - t_m}\right) + T_{WLC}$$

$$T_{WMC} = q/A \left(\frac{r_g - t_m}{K_m}\right) \ln \left(\frac{r_g}{r_g - t_m}\right) + T_{WLC}$$

For flat wall type:

$$U = \left\{\frac{t_c}{K_c} + \frac{t_m}{K_m} + \frac{1}{h_g + h_r}\right\}^{-1}$$

$$q/A = U(\beta t_c - T_{WLC})$$

$$T_{WGC} = q/A \left(\frac{t_m}{K_m}\right) + T_{WLC}$$

$$T_{WMC} = q/A \left(\frac{t_m}{K_m}\right) + T_{WLC}$$

H. HEAT FLUX, OUTSIDE

The heat flux based on outside surface area is:

$$q/A_o = (h_g + h_r)(\beta T_c - T_{WGC})$$

I. SURFACE AREA BETWEEN STATIONS

1. $\varepsilon$ is set equal to .8 unless input.
2. Compute area (subscript P refers to value at previous station) by:

$$A_s = \frac{\pi}{2} \varepsilon [(\bar{r_g} * t_c) + (\bar{r_g} * t_c)_P] \left|X - X_P\right|$$

J. HEAT INPUT TO COOLANT BETWEEN STATIONS

$$q = \left| 1/2(q/A_o + q/A_{oP}) \right| A_s N_{MB}$$

K. COOLANT BULK TEMPERATURE

1. Obtain $C_P$ at P, $T_b$

2. Compute average temperature, density, and specific heat between stations (subscript P refers to value at previous station).

$$\overline{T}_b = .5(T_b + T_{bP})$$

$$\overline{\rho} = .5(\rho_b + \rho_{bP})$$

$$\overline{C}_P = .5(C_P + C_{PP})$$

3. Obtain $\rho'$ at P, $T_{bP}$

4. Compute $T_{bc}$

a. At Station No. 1:

$$T_{bc} = T_{b_{in}} - V^2/(2gJC_P)$$

b. At other Stations:

$$T_{bc} = T_{bP} + q/(\dot{w}\,\overline{C}_P) - (V^2 - V_P^2)/(2gJ\,\overline{C}_P) - \left[1/\rho' - \overline{T}_b\left(\frac{1}{\rho} - \frac{1}{\rho'_P}\right)/(T_b - T_{bP})\right](P - P_P)/(\overline{C}_P\,J)$$

c. When $T_b = T_{bP}$, then

$$T_{bc} = T_{bP} + q/(\dot{w}\ \overline{C}_P) - (V^2 - V^2_P)/(2g\ J\ \overline{C}_P)$$

L. Compute new value of coolant pressure in subroutine CALCTP. Pressure loss is composed of friction losses and momentum losses. (Cryogenic Case)

1. At Station No. 1

a. Friction loss: $p_f = 0.$

b. Momentum loss. Set $K_1 = 1.0$ and $C_1 = 0.0$ unless input.

$$p_v = \{K_1 + C_1\ [1.895\ (A_f/A_1) - 4\ (A_f/A_1)^{1/2} + 2.105]\ 1/(A_f/A_1)^2\}$$

$$(\rho_b\ v^2/2g)$$

2. Intermediate Stations

a. Friction loss. A friction factor is computed by one of the relationships shown in (1) (2) or (3) depending on the value of the input flag, FRIC, and is modified depending upon the value of the input flag K5S.

(1) If e is input:

$$f = 0.001375\ [1 + 2 \times 10^4\ e/d_e + \mu_b \times 10^6/v\ d_e\ \rho_b)^{1/3}]$$

(2) If e is not input and FRIC = 1

$$f = 0.5\ [2.54 \log_{10} (v\ d_e\ \rho_b/\mu_b) - 2.17]^{-2}$$

(3) If e is not input and FRIC = -1 the M.F. Taylor equation is used

$$f = 2\left[.0007 + \frac{.0625}{Re_{WL}^{.32}}\right]\left[\frac{T_b}{T_{WL}}\right]^{0.5}$$

where the subscript WL refers to properties evaluated at the liquid (coolant)

This correlation was developed for surface Reynolds numbers (properties based on coolant-side wall temperature $T_{WL}$) of 3000 and greater and for the wall temperature-to-bulk temperature ratio between .35 and 7.35. Taylor has matched NRX-A6 full power pressure drop measurements. By employing his friction factor correlation over the heated surface of the coolant tube (semi-circular portion of U-tube) and employing a standard coolant bulk temperature-referenced friction factor over the unheated tube surface (legs and base of U-tube). This procedure is implemented by means of an effective friction factor, which is defined as:

$$f_{eff} = f_b \left( \frac{S_b}{S_b + S_c} \right) + f_c \left( \frac{S_c}{S_b + S_c} \right)$$

where:

$f_{eff}$ = effective friction factor

$f_b$ = friction factor referenced at coolant bulk temperature

$f_c$ = Taylor's friction factor correlation referenced at tube temperature

$S_b$ = surface area at coolant bulk temperature (legs and base of U-tube)

$S_c$ = surface area at tube crown temperature (semi-circular portion of U-tube)

4. Any of the three expressions for straight tube friction factor may be modified to account for the effect of curvature by applying Ito's correction factor.

$$(f_{eff})_{\text{curved tube}} = (f_{eff})_{\text{straight tube}} \left[ Re_b \left( \frac{d_E}{2R_c} \right)^2 \right]^{0.5}$$

If $Z_d$ and $Z_u$ are downstream and upstream tangent points, for $Z_u \leq Z < Z_d$ the friction factor is modified. When $Z^* \leq Z < Z_d$, $R_c = R_d$; when $Z_u \leq Z < Z^*$, $R_c = R_u$. This correction is made whenever K5S = 1.

5. Compute $p_f$

$$p_f = \frac{\rho V^2}{2g}\left[(FM)4\bar{f}_{eff}\ \frac{x - x_p}{\bar{d}_e} + 2K6\ \frac{T_b - T_{bp}}{\bar{T}_b}\right]$$

b. Momentum loss

(1) Compute momentum loss by:

$$p_v = \rho_b\ (v^2 - v_p^2)/(2\ g)$$

$$p_v = [\rho_b\ A_f\ v^2 - (\rho_b\ A_f\ v^2)_p]\ /\ [0.5\ (A_f + A_{f_p})\ g]$$

(2) If a discontinuity occurs in $N_{mb}$, momentum loss is computed as follows.

(a) For $N_{mb} < N_{mb_p}$

$$p_v = (1 - A_{fp}/A_f)^2\ (\rho_b\ v_p^2)/(2\ g)$$

(b) For $N_{mb} > N_{mbp}$

$$p_v = [1.895\ (A_f/A_{f_p}) - 4\ (A_f/A_{f_p})^{1/2} + 2.105]\ (\rho_b\ v^2)/(2\ g)$$

3. The computed pressure is given by:

$$p_{rc} = p_p - p_f - p_v$$

4. After the last station, the coolant has an additional loss through the discharge passage. If not input, set K3 = 1.0, $K_4$ = 1.0 and Compute outlet pressure in subroutine out by:

$$p_{out} = p_{ns} - \left\{K_3 + C_2\left[\frac{K_4 + 1.895\ \frac{A_2}{A_f} - 4\ \frac{A_2}{A_f}^{1/2} + 2.105}{(A_2/A_f)^2}\right]\right\}\frac{\rho_b\ v_{ns}^2}{2\ g}$$

M. COMPUTATION OF COOLANT PRESSURE FOR THE NON-CRYOGENIC CASE

All calculations are done the same as for the cryogenic case.

N. STRESS CALCULATION

After convergence, values of hoop stress and safety factor in the tube wall at each station are computed.

1. Stress is computed by:

$$\sigma = Pr_g/t_m$$

2. Tables of yield stress for stainless steel and Hastelloy X are listed in Appendix E and are built into the program. Provision for card input of stress vs temperature has been made in the event other materials are used. Interpolation for yield stress is made as a function of $T_{WM}$. A safety factor is computed as follows:

$$F.S. = (\sigma_{yP})/\sigma$$

VII. OPTIONAL LEG HEIGHT ITERATION

For design cases, leg height of the tube is unknown. However, a profile of $T_{wg}$ as a function of axial length can be input and an altered sequence of computation followed.

A. Compute FEFV, $\beta$, $h_r$, $h_g$, and $q/A_o$ as normally

B. Set $T_{wgc}$ equal to $T_{wg}$

C. Compute:

$$q/A = (q/A_o)\ (r_g/(r_g - t_m))$$

$$q/A_m = (q/A_o)\ (r_g/(r_g - 0.5\ t_m))$$

$$k' = t_m\ (q/A_m)$$

D. Interpolate for $k_{wg}$ at $T_{wg}$

E. Compute

$$k_m = 0.5\ (\sqrt{k_{wg}^2 - 2.4 \times 10^{-7}\ k'} + k_{wg})$$

$$T_{wlc} = T_{wg} - (q/A)\ (t_m/k_m)\ (r_g - t_m)/(r_g - 0.5\ t_m)$$

$$h_l = (q/A)/(T_{wlc} - T_b)$$

$$T_{wl} = T_{wlc}$$

$$C = [h_l/\ (C_L\ k_{cf})\ (1 + 0.01457\ \mu_w\ \rho_b/\mu_b\ \rho_w)\ ]^{1.25}$$

$$(\rho_{cf}/\mu_{cf})^{-1}\ Pr_{cf}^{-0.5}$$

F. Solve the following equation for $\ell$:

$$C = \frac{\dot{w}}{N_{mb}\ \rho_b}\ \frac{[0.25\ (\pi + 2)\ (r_g - t_m) + 0.5\ \ell]^{0.25}}{[0.5\ \pi(r_g - t_m)^2 + 2\ (r_g - t_m)\ \underline{1}]^{1.25}}$$

G. $\ell$ must be positive. If negative, set $\ell = 0$.

H. Compute: $A_f = 0.5\ \pi(r_g - t_m)^2 + 2\ (r_g - t_m)\ \ell$

$$d_e = 4\ A_f/[(\pi + 2)\ (r_g - t_m) + 2\ \ell]$$

I. Compute v, M, U, $T_{wm}$, q, $T_{bc}$, and $p_{rc}$ as normally.

J. If convergence is not attained, increment $T_{wg}$ by 100° and reiterate.

## VIII. OPTIONAL $C_g$ CALCULATION

For analysis of data, it is desirable to have the capability to compute the $C_g$ that results in a given $T_{wg}$. In this instance $T_{wg}$ is input as a function of axial length and calculation proceeds normally for FEFV, $\dot{\beta}$, $h_r$ and $h_l$. Alternate calculations are then made as follows.

A. Compute $T_m$: $T_m = 0.5\ (T_{wg} + T_{wl})$

B. Interpolate for $k_m = f\ (T_m)$.

C. Compute:

$$q/A = (T_{wg} - T_b)/[(t_m/k_m)(r_g - t_m)/(r_g - 0.5\ t_m) + 1/h_l]$$

$$q/A_o = (q/A)(r_g - t_m)/(r_g)$$

D. Compute $T_{wlc}$: $T_{wlc} = T_b + (q/A)(1/h_l)$

E. Set $T_{wgc} = T_{wg}$ and compute $T_{wm}$, q, $T_{bc}$, and $p_{rc}$ as normally, and iterate on $T_{wl}$, $T_b$, and p. In case of non-convergence, stop.

F. When converged, compute $h_g$: $h_g = (q/A_o)/(\beta T_c - T_{wg})$

G. Compute U as normally and solve the Bartz equation for $C_g$:

$$C_g = h_g(\pi D^{2.25}\ \rho/4\ \dot{W}\ \rho_{gf})(Pr^{0.6}/\mu^{0.2}\ C_p)_{gf}$$

## IX. COMPUTATION OF BURNOUT HEAT FLUX RATIO

A. Burnout value of heat flux.

1. If $P > P_{crit}$

$$Q_{Bo} = h_\ell(T_{crit} - T_b)$$

2. If $P \leq P_{crit}$ and IRBO = 1

$$Q_{Bo} = C_1 v^{K1}$$

3. If $P \leq P_{crit}$ and IRBO = 2 and VDT > VDTC where $VDT = V(T_{SAT} - T_b)$, then:

$$Q_{Bo} = [A_2 + B_2 V^{N_2 \frac{(T_{SAT}-T_b)}{B_3}} M_2] F_T F_P$$

4. If $P \leq P_{crit}$, IRBO = 2 and VDT $\leq$ VDTC, then:

$$Q_{Bo} = [A_1 + B_1 V^{N_1 (T_{SAT}-T_b)} M_1] F_T F_P$$

B. Burnout heat flux ratio:

$$R_{Bo} = \frac{|q/A_i|}{Q_{Bo}}$$

X. The following data is computed after completion of a run. These are printed after the output from the last station.

A. Outlet pressure, See Paragraph VIII,L,4.

B. Outlet (mix) temperature.

1. Look up $H_{out}$ at $p_{out}$, $T_{b_{ns}}$ and $H_{in}$ at $p_{in}$, $T_{in}$.

2. Compute $H_{mix}$ by:

$$H_{mix} = [\dot{w} H_{out} + \dot{w}_{bc} (H_{bc} + H_{in})]/(\dot{w} + \dot{w}_{bc})$$

3. Look up $T_{mix}$ at $p_{out}$, $H_{mix}$

C. Pressure drop. Compute $\Delta p$ by: $\Delta p = p_{in} - p_{out}$

D. Temperature rise. Compute $\Delta T$ by: $\Delta T = T_{mix} - T_{in}$

## NOMENCLATURE

| Engineering Symbol | Definition | Program Symbol |
|---|---|---|
| $A$ | Cross-sectional area of nozzle, $in.^2$ | AA |
| $\overline{A}$ | Total surface area between stations, $in.^2$ | ABAR |
| $A_e$ | Cross-sectional area of nozzle, exit, $in.^2$ | AE |
| $A_f$ | Cross-sectional area of single tube, $in.^2$ | AF, AFP |
| $A_s$ | Surface area of single tube, $in.^2$ | AS |
| $A_1$ | Area of inlet passage, $in.^2$ | AL |
| $A_2$ | Area of outlet passage, $in.^2$ | AO |
| $A^*$ | Throat area, $in.^2$ | ASTAR |
| $a$ | Sonic velocity of coolant, in./sec | AV |
| $b$ | Spread of U-tube legs, in. | B |
| $C$ | Constant used in solution for leg height | C1 |
| $C_g$ | Coefficient in gas-side heat transfer coefficient equation | CG |
| $C_L$ | Coefficient in coolant-side heat transfer coefficient equation | CL |
| $C_1$, $C_2$ | Constants used in computing pressure drop | CC1, CC2 |
| $C_p$ | Specific heat at constant pressure, Btu/lb-°R | CP |
| $\overline{C}_p$ | Mean value of $C_p$ between stations, Btu/lb-°R | CPBAR |
| $C_{p_{gf}}$ | $C_p$ evaluated at $T_{gf}$, Btu/lb-°R | CPGF |
| $D$ | Nozzle diameter, in. | D |
| $d$ | Undeformed tube diameter, in. | SMALD |
| $d_e$ | Equivalent diameter of coolant tube, in. | DE |
| $d_s$ | Slotted passage height | DS |
| $E_1$, $E_2$, $E_3$ | Factors used in computing FEFV | E1, E2, E3 |
| $e$ | Surface roughness of coolant passage, in. | E |
| $F$ | Shape factor | F, FP |
| $\overline{F}$ | Shape factor | FBAR |
| FEFV | Radiation factor | FEFV |
| F.S. | Factor of safety | FS |
| $f$ | Friction coefficient | FC |
| $G_0$, $G_1$ | Gray-body shape factor | GO, G1 |

| Engineering Symbol | Definition | Program Symbol |
|---|---|---|
| $g$ | Acceleration due to gravity, 386.088 in./sec$^2$ | G |
| H | Enthalpy, Btu/lb | H |
| $H_{bc}$ | Enthalpy of bolt coolant, Btu/lb | HBC |
| $H_c$ | Enthalpy at $P_c$, $T_c$, Btu/lb | HC |
| $H_{in}$ | Enthalpy at $P_{in}$, $T_{in}$, Btu/lb | HIN |
| $H_{mix}$ | Enthalpy at $P_{out}$, $T_{mix}$, Btu/lb | HMIX |
| $H_{out}$ | Enthalpy at $P_{out}$, $T_{out}$, Btu/lb | HOUT |
| $h_g$ | Gas-side heat-transfer coefficient, Btu/in.$^2$-sec-°R | HG |
| $h_l$ | Coolant-side heat-transfer coefficient, Btu/in.$^2$-sec-°R | HL HL1 |
| $h_r$ | Radiation heat-transfer coefficient, Btu/in.$^2$-sec-°R | HR |
| J | Mechanical equivalent of heat, 9339.12 in.-lb/Btu | J |
| $K_1$, $K_3$, $K_4$, $K_5$, $K_6$ | Constants used in computing pressure drop | K1, K3, K4, K5, K6 |
| k | Thermal conductivity, Btu/in.-sec-°R | |
| $k_c$ | k of tube coating, Btu/in.-sec-°R | KC |
| $k_{cf}$ | k evaluated at $T_{cf}$, Btu/in.-sec-°R | KCF |
| $k_m$ | k of tube wall, Btu/in.-sec-°R | KM, KMP |
| $k_{wg}$ | k evaluated at $T_{wg}$, Btu/in.-sec-°R | KWG |
| k' | Factor defined in Paragraph IX,C. | KFAC |
| $\underline{l}$ | Tube leg-height, in. | L |
| M | Mach number of coolant | MC |
| MR | Mixture ratio | MR |
| $N_{mb}$ | Number of tubes through which coolant flows | NMB |
| $N_t$ | Total number of tubes | NT |
| $N'_6$ | Number of station segments between nozzle exit and downstream point of tangency | N6P |
| $N'_5$ | Number of station segments between downstream point of tangency and throat | N5P |
| $N'_4$ | Number of station segments between throat and upstream point of tangency | N4P |
| $N'_3$ | Number of station segments between upstream point of tangency and covergency point of tangency | N3P |

| Engineering Symbol | Definition | Program Symbol |
|---|---|---|
| $N'_2$ | Number of station segments in knuckle | N2P |
| $N_i$ | Number of station segments in barrel section | N1P |
| P | Static pressure of combustion gases, psia | PSC |
| $P_c$ | Chamber pressure, psia | PC |
| $P_\infty$ | Gas pressure at location defined by Z | PG |
| PFM | Pressure multiplier | PFM |
| Pr | Prandtl number = $\frac{\mu c_p}{k}$ | |
| $Pr_{cf}$ | Pr evaluated at $T_{cf}$ | PRCF |
| $Pr_{gf}$ | Pr evaluated at $T_{gf}$ | PRGF |
| p | Static pressure of coolant, psia | P, PP |
| $P_D$ | Dynamic pressure change | PD |
| $P_f$ | Pressure loss due to friction, psi | PF |
| $P_{in}$ | Inlet pressure, psia | PIN |
| $P_{ns}$ | p at last station, psia | PLS |
| $P_{out}$ | p at discharge plenum, psia | POUT |
| $P_{rc}$ | Computed value of p, psia | PRC |
| $P_v$ | Pressure loss due to momentum, psi | PV |
| q | Heat transferred to coolant between stations, Btu/sec | Q |
| q/A | Heat flux based on inside surface area, Btu/in.$^2$/sec | QOA |
| $q/A_m$ | Heat flux based on mean metal area, Btu/in.$^2$-sec | QOAM |
| $q/A_o$ | Heat flux based on outside surface area, Btu/in.$^2$-sec | QOAO |
| R | Radius of nozzle, in. | R |
| $R_c$ | Radius of barrel section, in. | RC |
| $R_d$ | Downstream radius of curvature, in. | RD |
| $R_n$ | Radius at point in divergent section, in. | RN |
| $R_u$ | Upstream radius of curvature, in. | RU |
| $R_\beta$ | Convergent radius, in. | RB |
| R* | Throat radius, in. | RSTAR |

| Engineering Symbol | Definition | Program Symbol |
|---|---|---|
| R' | Radius of curvature, in. | RCV |
| $r_a$ | Ambient-side tube radius, in. | SMALRA |
| $r_g$ | Gas-side tube radius, in. | SMALRG, SMALRGP |
| S | Entropy, Btu/lb | |
| $S_c$ | S at $P_c$, $T_c$, Btu/lb | SC |
| s | Tube circumference, in. | S |
| $T_b$ | Temperature of coolant, °R | TB, TBP |
| $T_{bc}$ | TB calculated | TBC |
| $T_c$ | Chamber temperature, °R | TC |
| $T_{cf}$ | Reference temperature of coolant, °R | TRCF |
| $T_{fi}$ | Temperature of film coolant, °R | TCF |
| $T_{gf}$ | Reference temperature of gas, °R | TGF |
| $T_{in}$ | Coolant inlet temperature, °R | TIN |
| $T_m$ | Mean wall temperature, °R | TM |
| $T_{mix}$ | Temperature of nozzle and bolt coolant mixture, °R | TMIX |
| $T_{wg}$ | Temperature of gas wall, °R | TWG |
| $T_{wgc}$ | Computed value of $T_{wg}$, °R | TWGC |
| $T_{wl}$ | Temperature of coolant wall, °R | TWL |
| $T_{wlc}$ | Computed value of $T_{wl}$, °R | TWLC |
| $T_{wm}$ | Temperature of metal-coating interface, °R | TWM |
| $T_o$ | Temperature of core face, °R | TO |
| $T_\infty$ | Gas temperature at location specified by Z, °R | TINFIN |
| $T_b$ | Mean coolant temperature between stations, °R | TBAR |
| $t_c$ | Coating thickness, in. | SMALTC |
| $t_m$ | Metal thickness, in. | SMALTM |
| $t_s$ | Space thickness, in. | SMALTS |
| UW | Dimension in land and groove U tube configuration | UW |
| UL | Dimension in land and groove U tube configuration | UL |
| U | Overall heat-transfer coefficient, Btu/in.$^2$-sec-°R | U |
| V | Gas velocity, in./sec | V |
| $V_f$ | Velocity of injected film coolant, in./sec | VF |
| v | Coolant velocity, in./sec | VC, VP |

| Engineering Symbol | Definition | Program Symbol |
|---|---|---|
| $v_{ns}$ | Coolant velocity at last station, in./sec | VNS |
| W | Slotted passage width | W, WP |
| $\dot{W}$ | Gas flow rate, lb/sec | WG |
| $\dot{W}_{gcore}$ | Gas flow from core, lb/sec | WGCORE |
| $\dot{W}_g$* | Gas flow through throat, lb/sec | WGSTAR |
| $\dot{w}$ | Coolant flow rate, lb/sec | WC |
| $\dot{w}_{bc}$ | Bolt-coolant flow, lb/sec | WBC |
| $\dot{w}_f$ | Film coolant flow, lb/sec | WF |
| X | Developed length, in. | X, XP |
| X' | Developed length for initial rise in $T_{fi}$, in. | XI |
| Z | Axial length, in. | Z, EP |
| $Z_b$ | Barrel length, in. | ZB |
| $Z_d$ | Z to downstream point of tangency, in. | ZD |
| $Z_g$ | Overall length, in. | ZOL |
| $Z_n$ | Axial length from throat of point in divergent section, in. | ZN |
| $Z_u$ | Z to upstream point of tangency, in. | ZU |
| $Z_w$ | Z to location of change in $\dot{W}$, in. | ZW |
| Z* | Axial length to throat, in. | ZSTAR |
| $\alpha$ | Angle in truncated tube description | ALPHA |
| $\alpha_a$ | Divergence angle, degrees | ALPHAA |
| $\beta$ | Factor defining temperature recovery and/or film cooling | BETA |
| $\beta_a$ | Convergence angle, degrees | BETAA |
| $\gamma_c$ | Ratio of specific heats at chamber conditions | |
| $\epsilon$ | Heated area factor | EPGEOM |
| $\epsilon_0$ | Emissivity of core face | EPO |
| $\epsilon_1$ | Emissivity of tube wall | EPL |
| $\mu$ | Absolute viscosity, lb/in.-sec | |
| $\mu_b$ | $\mu$ evaluated at $T_b$, lb/in.-sec | MUB |
| $\mu_{cf}$ | $\mu$ evaluated at $T_{cf}$, lb/in.-sec | MUCF |

| Engineering Symbol | Definition | Program Symbol |
|---|---|---|
| $\mu_{gf}$ | $\mu$ evaluated at $T_{gf}$, lb/in.-sec | MUGF |
| $\mu_w$ | $\mu$ evaluated at $T_{w1}$, lb/in.-sec | MUW |
| $\rho$ | Density, lb/in.$^3$ $A_T$ $T_\infty$ $P_\infty$ | RHO |
| $\rho_b$ | $\rho$ evaluated at $T_b$, lb/in.$^3$ | RHOB, RHOBP |
| $\rho_{cf}$ | $\rho$ evaluated at $T_{cf}$, lb/in.$^3$ | RHOCF |
| $\rho_{gf}$ | $\rho$ evaluated at $T_{gf}$, lb/in.$^3$ | RHOGF |
| $\rho_w$ | $\rho$ evaluated at $T_{w1}$, lb/in.$^3$ | RHOW |
| $\overline{\rho}$ | Mean value of $\rho$ between stations, lb/in.$^3$ | RHOBAR |
| $\rho'$ | $\rho$ at previous station, lb/in.$^3$ | RHOP |
| $\sigma$ | Stress, lb/in.$^2$ | STR |
| $\sigma_{yp}$ | Yield stress, lb/in.$^2$ | STRY |
| $\theta$ | Angle in truncated tube description | THETA |

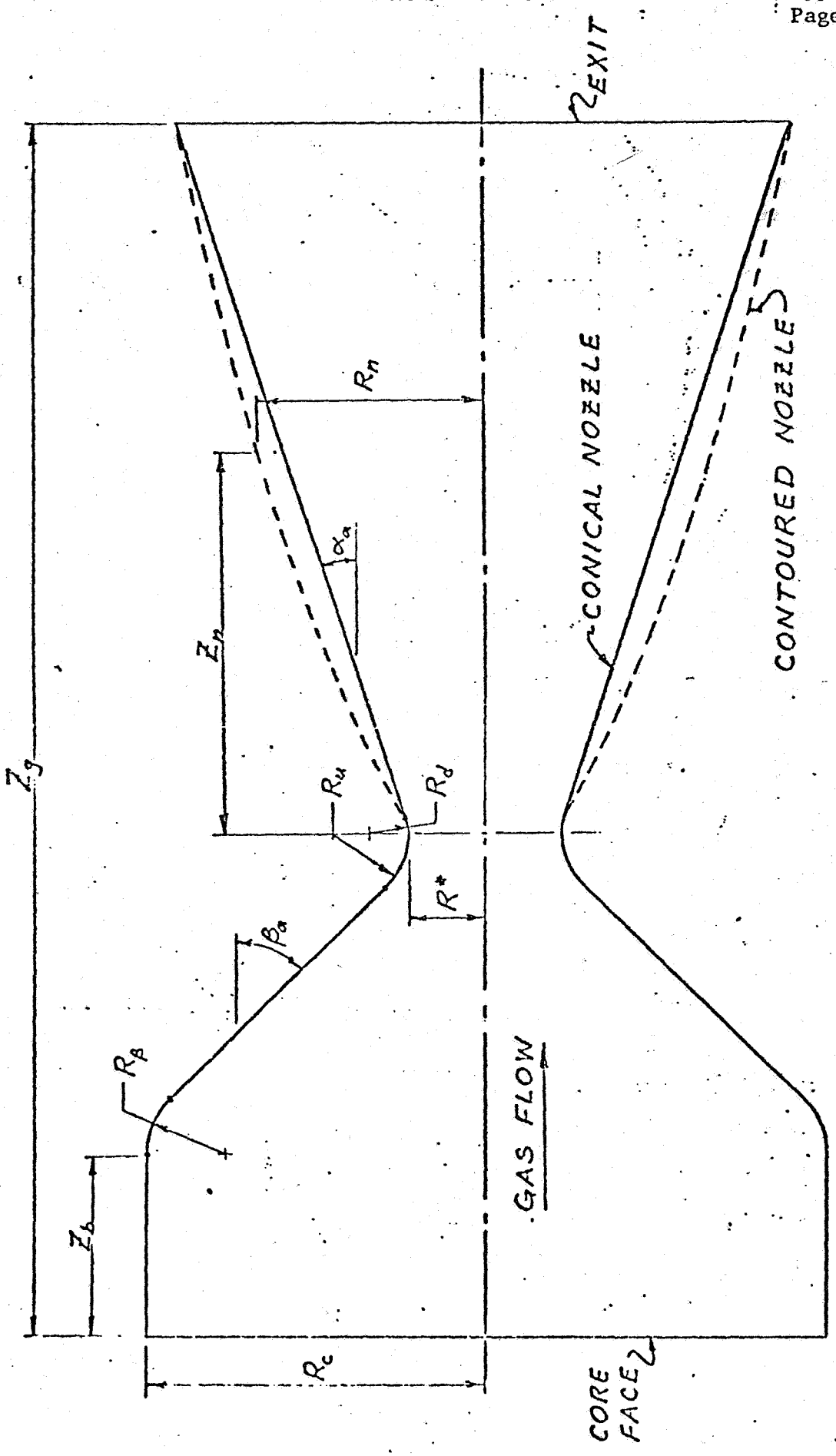


FIGURE 1
NOZZLE SYMBOLS

## 2. U-TUBE

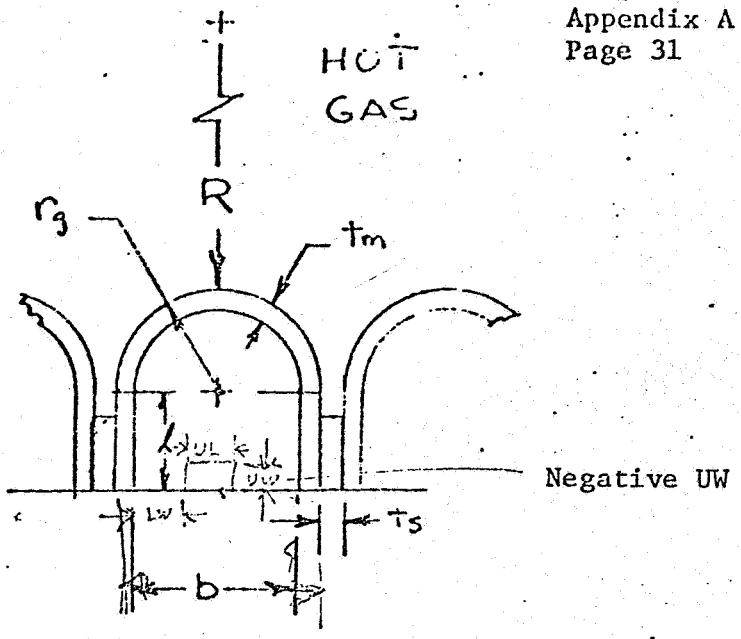


FIGURE 2

## 3. TRUNCATED

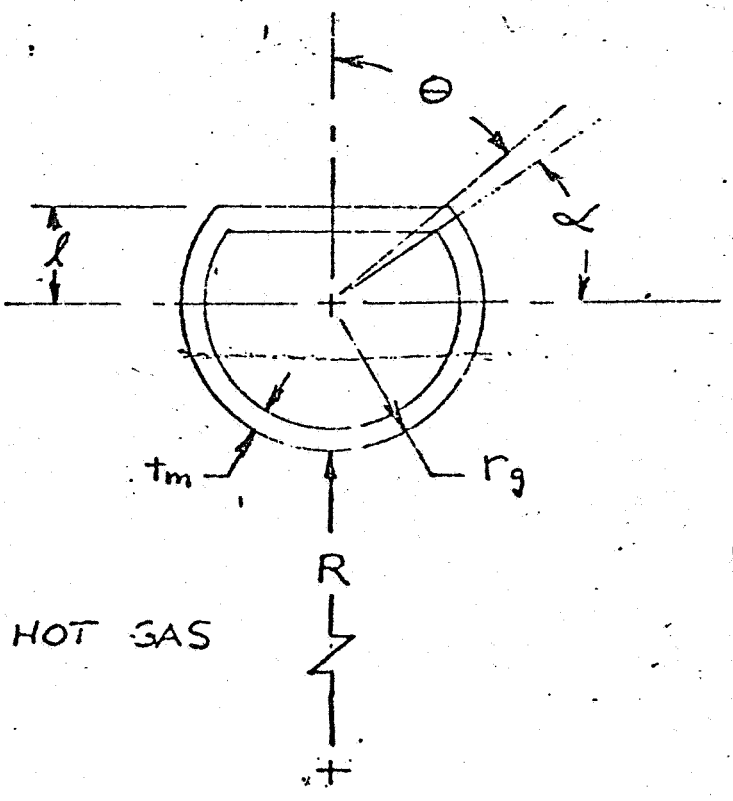


FIGURE 3

## 4. ROUND OR FLATTENED

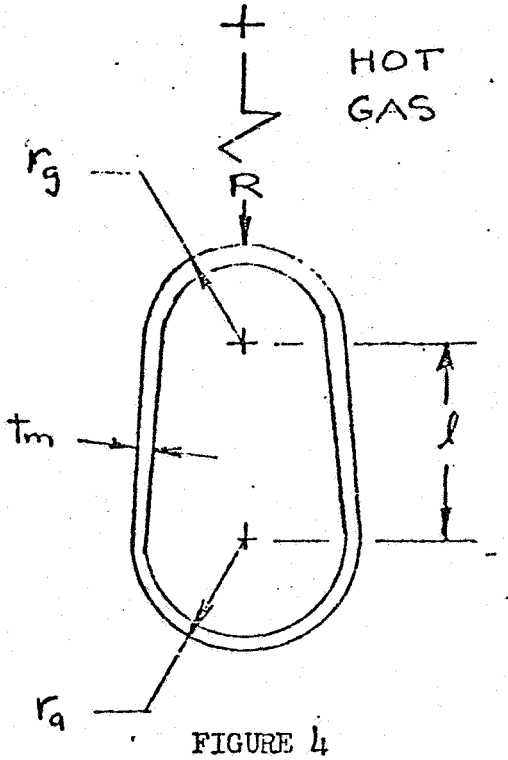


FIGURE 4

## 5. SLOTS

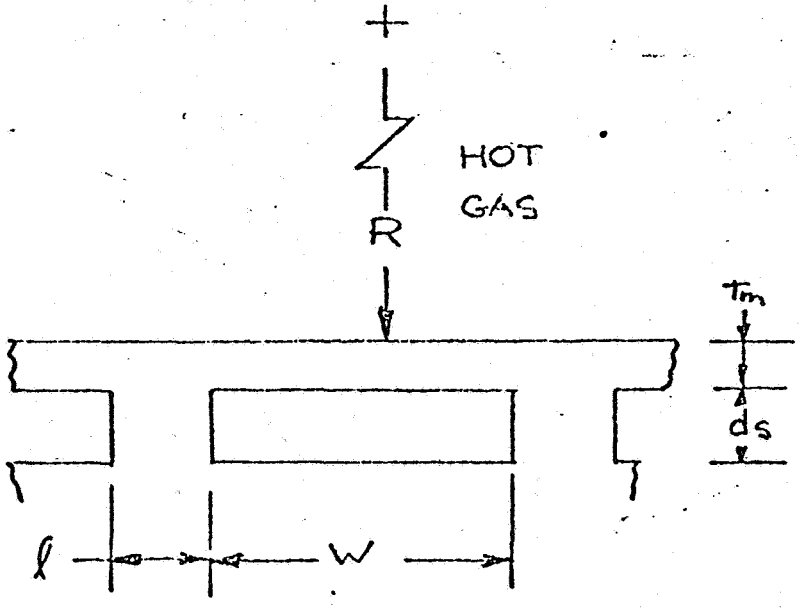


FIGURE 5

# HEAT TRANSFER (NON-CRYOGENIC AND CRYOGENIC)

## Iteration Technique

To obtain new guesses for the variables, a set of simultaneous equations is solved for $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_n$. These $\varepsilon_i$ are then added to the old guesses to form the new guesses.

Given variables $y_1, y_2, \ldots, y_n$ as functions of $x_1, x_2, \ldots, x_n$, set up the set of simultaneous equations

$$\frac{\partial y_1}{\partial x_1}\varepsilon_1 + \frac{\partial y_1}{\partial x_2}\varepsilon_2 + \frac{\partial y_1}{\partial x_3}\varepsilon_3 + \ldots + \frac{\partial y_1}{\partial x_n}\varepsilon_n = y_1 - y_1^0$$

$$\frac{\partial y_2}{\partial x_1}\varepsilon_1 + \frac{\partial y_2}{\partial x_2}\varepsilon_2 + \frac{\partial y_2}{\partial x_3}\varepsilon_3 + \ldots + \frac{\partial y_2}{\partial x_n}\varepsilon_n = y_2 - y_2^0$$

$$\vdots$$

$$\frac{\partial y_n}{\partial x_1}\varepsilon_1 + \frac{\partial y_n}{\partial x_2}\varepsilon_2 + \frac{\partial y_n}{\partial x_3}\varepsilon_3 + \ldots + \frac{\partial y_n}{\partial x_n}\varepsilon_n = y_n - y_n^0$$

In our special case $y_1 = x_1 - x_{1_c}$, $y_2 = x_2 - x_{2_c}, \ldots, y_n = x_n - x_{n_c}$ where the subscript c denotes the computed value. Since we want the guessed values (i.e., $x_1, x_2, \ldots, x_n$) to equal the computed values ($x_{1_c}, x_{2_c}, \ldots, x_{n_c}$) the $y_i$ are set to zero.

The partials are approximated by the following method:

$$\frac{\partial y_1}{\partial x_1} = \frac{y1\Delta x1 - y_1^0}{\Delta x1}$$

$$\frac{\partial y_1}{\partial x_2} = \frac{y1\Delta x2 - y_1^0}{\Delta x2}$$

$$\vdots$$

$$\frac{\partial y_1}{\partial y_n} = \frac{y1\Delta xn - y_1^0}{\Delta xn}$$

where the $\Delta x_i$ are all an arbitrary small percentage of the $x_i$, and

$$y1\Delta x1 = y_1(x_1 + \Delta x_1, x_2, x_3, \ldots, x_n)$$

$$y1\Delta x2 = y1(x_1, x_2 + \Delta x_2, x_3, \ldots, x_n)$$

$$\vdots$$

$$y1\Delta xn = y_1(x_1, x_2, x_3, \ldots, x_n + \Delta x_n)$$

The program works in the following manner: Set up the equations (1) by columns. The first time through the program gives the values of $y_o$ for the constant terms. The second time through the program, change $x_1$ to $x_1 + \Delta x_1$ which results in the values for column one of the equations. The third time through change $x_1 + \Delta x_1$ back to $x_1$ and change $x_2$ to $x_2 + \Delta x_2$ to set up column two. This repeats until the equations are set up. Then the system is solved, the $\varepsilon_i$ are added to the $x_i$ to give new guesses, and the whole procedure is repeated until the $y_1^0$ are equal to zero (plus or minus a set limit of convergence).

# APPENDIX C

## Tables of Pressure Ratio

Fixed values of $P_c/P$ to be used in setting up tables of $T_\infty$, P are:

| | | |
|---|---|---|
| 1.0 | 20.0 | 500.0 |
| 1.1 | 30.0 | 750.0 |
| 1.2 | 50.0 | 1000.0 |
| 1.3 | 75.0 | 1500.0 |
| 1.4 | 100.0 | 2000.0 |
| 1.6 | 150.0 | 2500.0 |
| 2.0 | 200.0 | 3000.0 |
| 5.0 | 300.0 | 3500.0 |
| 10.0 | 400.0 | 4000.0 |

# APPENDIX D

## Conductivity Tables

Values of thermal conductivity as a function of temperature are:

| Material | Temperature, °R | Conductivity (Btu/in.-sec-°R) |
|---|---|---|
| Hastelloy X | 530 | 0.000130 |
| | 660 | 0.000147 |
| | 960 | 0.000189 |
| | 1060 | 0.000193 |
| | 1460 | 0.000263 |
| | 1560 | 0.000277 |
| | 1760 | 0.000306 |
| | 1960 | 0.000335 |
| | 2160 | 0.000364 |
| Stainless Steel | 210 | 0.000165 |
| | 260 | 0.000169 |
| | 360 | 0.000178 |
| | 528 | 0.000195 |
| | 660 | 0.000209 |
| | 860 | 0.000227 |
| | 1060 | 0.000248 |
| | 1260 | 0.000267 |
| | 1460 | 0.000287 |
| | 1660 | 0.000306 |
| | 1860 | 0.000327 |
| | 2060 | 0.000345 |
| | 2100 | 0.000348 |
| | 2250 | 0.000361 |
| | 2450 | 0.000380 |
| | 2625 | 0.000394 |
| | 2775 | 0.000408 |

# APPENDIX E

## Yield Stress Tables

Values of yield stress as a function of temperature are:

| Material | Temperature, °R | Yield Stress psi |
|---|---|---|
| Hastelloy X | 260 | 63000 |
| | 460 | 48000 |
| | 560 | 44000 |
| | 760 | 39000 |
| | 960 | 36000 |
| | 1160 | 34000 |
| | 1660 | 32000 |
| | 1860 | 29000 |
| | 2160 | 16000 |
| | 2360 | 10000 |
| | 2560 | 5000 |
| Stainless Steel | 60 | 57000 |
| | 160 | 46000 |
| | 260 | 38000 |
| | 360 | 34000 |
| | 460 | 31000 |
| | 660 | 28000 |
| | 1060 | 23000 |
| | 1460 | 19000 |
| | 1760 | 18000 |
| | 1960 | 14000 |
| | 2210 | 6000 |
| | 2460 | 3000 |

ATTACHMENT 2

SAMPLE PROGRAM

(ANSC Report No. N8110R:72-030, Dated February 1972)

# ROCKET NOZZLE COOLANT CHANNEL

# THERMAL ANALYSIS PROGRAM

# (E25107)

N8110R:72-030

ENGINEERING OPERATIONS REPORT

# CORRELATION OF NRX-A5 AND NRX-A6 TECHNOLOGY NOZZLE TEST DATA WITH CALCULATED PERFORMANCE

PROJECT 141, WORK STATEMENT 9c

FEBRUARY 1972

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CLASSIFICATION CATEGORY
Unclassified
J J Ramsdell 2-18-72
CLASSIFYING OFFICER DATE

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# CORRELATION OF NRX-A5 AND NRX-A6 TECHNOLOGY NOZZLE TEST DATA WITH CALCULATED PERFORMANCE

## I. INTRODUCTION/SUMMARY

Calculations were made to determine factors to use with the Nozzle Heat Transfer Program (E25107) in order to model the NERVA 75K engine. The approach taken was to correlate NERVA Technology Nozzle data to the selected theoretical models and determine the appropriate correlation factors. This is an extension of the work reported in Reference (a) and sections of that report will be repeated here, in order to consolidate final major results in one report.

Early scale model heat transfer tests of the Technology Nozzle configuration are reported in References (b), (c), (d), (e) and (f). Data from these tests indicated that the heat transfer coefficients in the barrel and convergent section of the nozzle were much higher than predicted by conventional methods of calculation for chemical rocket nozzles such as References (g) and (h). This effect has also been observed in scale model tests of other nuclear nozzle configurations (References (i), (j), (k), and (l)). It is due to the fact that a conventional boundary layer does not begin to develop just aft of the reactor core, but rather there is a deceleration and coalescing of the many discrete jets of gas issuing from the core into the nozzle chamber. This effect necessitates recourse to empiricism in characterizing the nozzle gas-side heat transfer.

Also, advances have been made in the fields of fluid mechanics and heat transfer that pertain to the method employed in developing the models for liquid side heat transfer and pressure drop. As a consequence of these developments it was appropriate to update the previous model and this was done as part of the work reported in Reference (a). Since that time, however, some additional modifications have been made to the analytical model for liquid side pressure drop and additional test points from technology nozzles NRX-A5 and NRX-A6 were analyzed to determine pressure factor multiplier and heat transfer surface area multipliers. In addition, some minor changes were made in the computer code itself. This report describes the additional work and presents an example calculation for the NERVA 75K engine using the recommended model parameters.

## II. TECHNICAL DISCUSSION

### A. COMPUTER PROGRAMS EMPLOYED IN DEVELOPMENT OF GAS-SIDE THERMAL MODEL

Two technology nozzles (NRX-A5 and NRX-A6) were modeled on the E25107 regeneratively-cooled nozzle computer program (Reference (m)) by inputting the nozzle geometries (nozzle contours and coolant channel flow areas). This program solves the energy and momentum equations for a fluid flowing through a channel subjected to convective and radiative heat transfer. The major options employed in the model are summarized below.

#### 1. Coolant-side Heat Transfer Coefficient

J. O. Sane and D. W. Lunsford, previously of ANSC, examined 2230 points of hydrogen heat transfer data in the specific operating range of the NERVA nozzle and derived a new coolant-side correlation (Reference (n)). This correlation has been utilized in the new model:

$$Nu_{\substack{\text{straight}\\ \text{tube}}} = .00821\ Re_f^{.874}\ Pr_f^{.4}\ \left(1 + .0146\ \frac{\mu_w\ \rho_b}{\mu_b\ \rho_w}\right)^{.622}$$

A factor that accounts for entrance effects is multiplied times this expression and takes the following forms:

for $0 \leq X/D_E < 5.198$

Entrance factor = 1.8

for $5.198 < X/D_E \leq 120$

Entrance factor = $\left(1 + \frac{4.0}{X/D_E}\right)^{1.030}$

for $X/D_E \geq 120$ the entrance factor has attenuated to unity.

A factor that accounts for coolant channel curvature, for the case in which heat transfer exists over the convex surface of the curve (the nozzle throat), is multiplied times the straight tube correlation and takes the following forms:

$$\text{curved tube factor} \begin{cases} 1 + 1.128\,\phi \\ .797\left[Re_b\left(\frac{D_E}{2R_c}\right)^2\right]^{.0785} \\ 2.502 - 1.16\,\phi \end{cases}$$

in which $\phi$ is the angle of curvature in radians.

For the particular value of $\phi$, $Re_b$, and $\frac{D_E}{R_c}$ at a location on a curved tube, the expression above that yields the lowest curved tube factor is utilized.*

2. Friction Factor Correlation

M. F. Taylor (Reference (o)) has correlated frictional pressure drop measurements for helium, hydrogen, nitrogen, air, and carbon dioxide gases flowing through heated tubes by means of the following expression for the diabatic friction factor

$$f = 2\left(.0007 + \frac{.0625}{Re_{WL}^{.32}}\right)\left(\frac{T_b}{T_{WL}}\right)^{0.5}$$

This correlation was developed for surface Reynolds numbers (properties based on coolant-side wall temperature $T_{WL}$) of 3000 and greater and for the wall temperature-to-bulk temperature ratio between .35 and 7.35. Taylor has matched NRX-A6 full power pressure drop measurements (Reference (p)) by employing his friction factor correlation over the heated surface of the coolant tube (semi-circular portion of U-tube) and employing a standard coolant bulk temperature-referenced friction factor over the unheated tube surface (legs and base of U-tube). This procedure is implemented by means of an effective friction factor, which is defined as:

$$f_{eff} = f_b \frac{S_b}{S_b + S_c} + f_c \frac{S_c}{S_b + S_c}$$

*Nomenclature used in this report is consistent with that used in Reference (m).

in which:

$f_{eff}$ = effective friction factor

$f_b$ = friction factor referenced at coolant bulk temperature

$f_c$ = Taylor's friction factor correlation referenced at tube temperature

$S_b$ = surface area at coolant bulk temperature (legs and base of U-tube)

$S_c$ = surface area at tube crown temperature (semi-circular portion of U-tube)

This expression and Taylor's friction factor correlation were added to the E25107 program, which already has a coolant bulk temperature-referenced friction factor correlation:

$$f_b = 0.5 \left[ 2.54 \log_{10} \left( \frac{V D_E \rho_b}{\mu_b} \right) - 2.17 \right]^{-2}$$

which represents adiabatic flow pressure drop data.

The effect of curvature on the straight tube friction factor was accounted for by applying Ito's correction factor (Reference (q)):

$$(f_{eff})_{\text{curved tube}} = (f_{eff})_{\text{straight tube}} \left[ Re_b \left( \frac{D_E}{2R_c} \right)^2 \right]^{0.5}$$

3. Frictional Pressure Drop Calculation

The effect of temperature gradient on pressure drop has been included by modifying the previously used relationship to the following:

$$P_f = \frac{\bar{\rho}\bar{v}^2}{2g} \left[ (PFM)\ 4\ \bar{f}_{eff} \frac{|x - x_p|}{\bar{d}_e} + 2K6 \frac{T_b - T_{b_p}}{\bar{T}_b} \right]$$

where normally K6 = 1 and PFM = 1. The inclusion of the temperature term has caused the value of PFM required to match technology nozzle data to decrease from values previously obtained.

4. Entrance and Exit Pressure Drop

The pressure drop resulting from the flow of hydrogen coolant from the inlet manifold through the coolant tube inlet holes and into the coolant tubes and out of the outlet holes was calculated by means of a loss factor for incompressible flow. The equations defining these factors are shown in Reference (m).

The entrance and exit pressure loss factors used for the Technology Nozzles are summarized below:

| | $K_1$, Entrance Factor | $K_3$, Exit Factor |
|---|---|---|
| NRX-A5 | 2.0 | 1.1 |
| NRX-A6 | 2.0 | 1.1 |

5. Coolant Temperature and Pressure Drop Iteration

The coolant pressure and temperature drop can be input to the nozzle program and it will iterate on the value of a friction factor multiplier PFM and a heat transfer surface area multiplier EPGEOM to match the input values of $\Delta P$ and $\Delta T$. This option was employed for the technology nozzle runs by inputting the measured $\Delta P$'s and $\Delta T$'s shown in Table I. The mean value for the pressure multiplier (PFM) was 0.618 and the mean value for the heated area factor (EPGEOM) was 0.887. These values were used for the analysis shown in Table 1. The assumed gas side wall temperature distributions for the technology nozzles are those shown in Figures 1 and 2.

6. Hydrogen Properties

Per direction of the Space Nuclear Systems Office the December, 1969, NBS hydrogen properties were incorporated into the nozzle computer program. Para-hydrogen properties were utilized on the coolant-side and equilibrium

hydrogen properties were employed on the gas-side. The question of para to ortho conversion within the NERVA nozzle coolant channels has yet to be resolved at the date of this writing.

B. GAS-SIDE HEAT TRANSFER COEFFICIENT

All theoretical gas side heat transfer coefficients were calculated by the integral boundary layer method described in Reference (r). The option utilized for determination of skin friction coefficient was the method of Coles and the value used for the boundary layer interaction exponent was 0.25.

Another input to the boundary layer code is the value for the ratio of utilized to theoretical skin friction coefficient. This value effects the calculated heat transfer coefficient because the relationship used to obtain Stanton number is a modified Reynolds' analogy.

The appropriate value for the ratio of required to calculated skin friction coefficient was obtained in three steps.

1. The actual total heat transfer coefficient was estimated from NRX-A5 and NRX-A6 test data using the wall temperature distributions shown in Figures 1 and 2 and the heated area factor and pressure multiplier previously determined.

2. A modified version of the integral boundary layer program was used to determine the required values for the ratio. The calculated values are shown on Figure 3.

3. An approximate envelope curve was drawn on Figure 3 and the ratio of actual to theoretical friction coefficient was taken from this curve for all subsequent boundary layer analyses. It is estimated that the high ratio values near the core face result from effects of the discrete jets issuing from the core into the chamber and that these effects are damped by the contraction ahead of the throat. Since the distance from the core face to the start of the contraction is approximately the same for the technology nozzles and the NERVA 75K nozzle, the utilized ratio was taken as a function of length in the initial zone.

In the high Mach number region where the theory is less reliable, the ratio is assumed to be a function of Mach number only. The technology

W. R. Thompson


# ROCKET NOZZLE COOLANT CHANNEL THERMAL ANALYSIS PROGRAM (E25107)

## I. INTRODUCTION

A number of computer codes have been developed to predict the thermal characteristics of liquid-cooled tube-bundle rocket nozzles. Several of these written at Aerojet General Corporation for liquid propellant chemical rocket engines were extensively modified to give a new program specifically for use in computing the heat transfer parameters for the liquid-hydrogen-cooled NERVA engine. This program (E25107), however, retains the capability of using conventional propellants as coolants and thus provides a flexible tool for nozzle design and test evaluation.

## II. SUMMARY AND RECOMMENDATIONS

A complete description of the Rocket Nozzle Coolant Channel Thermal Analysis Program (E25107) is presented, including a users manual, program listing, and a sample problem. The program is recommended for use in designing liquid cooled rocket nozzles. In addition, it is adaptable to any system in which a liquid-cooled tubular structure is used to contain and direct the flow of a hot gas.

## III. TECHNICAL CONTENT

### A. PROGRAM DESCRIPTION

Program E25107 is a highly flexible general computer code to compute the heat transfer parameters of tubular regeneratively-cooled rocket engines. The version given herein has been written for the Univac 1108.

Allowance is made for variations of various geometric and fluid parameters permitting comparisons as well as design calculations. The bulk temperature and pressure, gas-side wall temperature and liquid-side wall temperature are guessed. The program then iterates on these four values until the

computed values are equal to the assumed values within a prescribed tolerance. This procedure is followed at various increments along the nozzle beginning at the point where the coolant exists and terminating at the point where the coolant is discharged. The station data describing the nozzle contour may be input directly or may be generated by the program.

B. PROGRAM CAPABILITIES AND LIMITATIONS

The program is extremely flexible; a complete discussion of the multitude of options, given in the Users Manual, is inappropriate at this point. However, among the main features are the options available for computing the liquid-side heat transfer coefficient (11 equations or a tabular input), the gas-side heat transfer coefficient (3 equations or a tabular input), and three friction factor equations. Property data for three coolants are incorporated: water, Aerozine-50 and liquid hydrogen (both equilibrium and para forms). Tube wall material properties for stainless steel and Hastelloy-X are included; the user may input any other material in tabular form. Coolant passage geometry may be specified as rectangular slot, truncated, round or flattened, or U-tube. Thermal radiation effects can be included.

C. USERS MANUAL

A complete and up-to-date Users Manual is attached as Attachment (1).

D. SAMPLE PROBLEM

The sample problem selected is that of correlation of NRX-A5 and NRX-A6 technology nozzle test data with calculated performance. This problem is presented in Attachment (2).

E. COMPUTER LISTING

A listing of Code E25107 is included as Attachment (3).

ATTACHMENT 1

# USERS MANUAL

## ROCKET NOZZLE COOLANT CHANNEL

## THERMAL ANALYSIS PROGRAM

## (E25107)

# TECHNICAL AND USERS MANUAL FOR

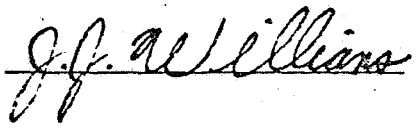
# PROGRAM E25107

# NOZZLE HEAT TRANSFER

(Revision of Program E25104)

February 1972

J. J. WILLIAMS



# NOZZLE HEAT TRANSFER

# PROGRAM E25107

## I. INTRODUCTION

### A. PROBLEM TO BE SOLVED

This program computes heat transfer parameters of tubular regeneratively-cooled rocket engines.

Allowance is made for variations of various geometric and fluid parameters permitting comparisons as well as design calculations.

This program is a modification of E25106 and E25104 which were written by T. M. Sheehy.

### B. METHOD OF APPROACH

The bulk temperature and pressure, gas-side wall temperature and liquid-side wall temperatures are guessed. The program then iterates on these four values until the computed values are equal to the assumed values within a prescribed tolerance. This procedure is followed at various increments along the nozzle beginning at the point where the coolant exists and terminating at the point where coolant is discharged.

The station data describing the nozzle contour may be input directly or may be generated by the program.

### C. MATHEMATICAL MODEL

See Appendix A.

### D. NUMERICAL METHODS USED

1. For a description of the iteration scheme, see Appendix B.
2. Interpolations performed on the station data are linear.
3. Interpolation is performed on the coolant properties by using a third degree interpolating polynominal which is continuous and has a continuous 1st derivative.

## II. INPUT DATA

### A. DISCUSSION

This program utilizes the NAMELIST feature of Fortran IV for loading in data. A complete description of how it is used will be found in the "Namelist Usage Report, Program E61214", Computing Sciences Division, by N. Cull.

### B. DATA

This section provides a list, by variable name, of all the data used by the program together with a brief description or definition.

| | ITEM | DESCRIPTION | DEFAULT VALUE |
|---|---|---|---|
| 1. | REYEXP | Exponent on Reynolds number when HGC = 4 | 0. |
| 2. | PRLEXP | Exponent on Prandtl number when HGC = 4. | 0. |
| 3. | ITRFL... | The maximum number of iterations to convergence. When this parameter is not input. | 10. |
| 4. | LW... | Land width for U-tube with/and or groove configuration. | |
| 5. | FRIC... | Friction factor flag. If FRIC is zero the friction factor equation is modified. If FRIC = -1., M. F. Taylor Equation is used. If FRIC = 1., friction factor is computed from equation shown in section VII.L.2.,(2) Appendix A. | -1. |
| 6. | SUM... | Output flag<br><br>SUM = 1, short output<br>SUM = 2, long output<br>SUM = 3, both long and short output | |
| 7. | WGSTA... | The gas flow rate, WGSTAR, is computed whenever WGSTA equals Zero. When WGSTA is non-zero then WGSTAR is input. | 0. |

| | ITEM | DESCRIPTION | DEFAULT VALUE |
|---|---|---|---|
| 8. | HLC... | Liquid-side heat transfer coefficient flag. HLC assumes values 1 through 11 depending upon which $h_\ell$ relationship is desired. (See Section VI.A of Appendix A.) HLC = 9 requires that TAHL table be input | 0. |
| 9. | HGC... | Gas-side heat transfer coefficient flag. HGC takes on the value 1, 2, 3, or 4 depending on which $h_g$ equation is desired. (See Section VI.B of Appendix Z.) HGC = 3 requires that TAHG tables be input. | 0. |
| 10 | WALL... | Wall-type flag used only for the non-cryogenic case. If equal to zero a cylindrical wall is assumed. If non-zero, a flat surface is assumed. (See Sections VI.E.2 and VI.G.2 of Appendix A.) | |
| 11. | MERCR... | = 0 if cryogenic case<br>= 1 if non-cryogenic | 0. |
| 12. | PC... | Chamber pressure | 0. |
| 13. | TC... | Chamber temperature | 0. |
| 14. | MR... | Mixture ratio | 0. |
| 15. | WGSTAR... | The gas flow rate through the throat | 0. |
| 16. | WGCORE... | The gas flow rate from the core | 0. |
| 17. | ZW... | The axial coordinate at which the flow rate $\dot{W}$ changes. (See Section VI.B of Appendix A.) | 0. |
| 18. | PIN... | Coolant inlet pressure. | 0. |
| 19. | TIN... | Coolant inlet temperature | 0. |
| 19a. | COEF(4,5)... | Constants to the 4th degree polynomial used to describe temperature dependent properties. | 0. |
| 20. | E... | Surface roughness of coolant passage. | 0. |

| | ITEM | DESCRIPTION | DEFAULT VALUE |
|---|---|---|---|
| 21. | XPLØT(10)... | Array of flags used to indicate which variables to plot versus length. The individual flags are:<br><br>XPLOT(1) = 1., coolant pressure<br>XPLOT(2) = 1., coolant bulk temperature<br>XPLOT(3) = 1., nozzle radius<br>XPLOT(4) = 1., coolant side heat transfer coefficient<br>XPLOT(5) = 1., gas side heat transfer coefficient<br>XPLOT(6) = 1., tube wall thickness<br>XPLOT(7) = 1., gas side wall temperature<br>XPLOT(8) = 1., coolant channel flow area<br>XPLOT(9) = 1., coolant channel leg height<br>XPLOT(10)= 1., gas side Cg coefficient<br><br>The short output option or the combination output option (SUM = 1. or SUM = 3.) must be used if plots are to be obtained. | 0. |
| 22. | K1... | Constant used in momentum loss equation. (See Section VI.L.1.b of Appendix A.) | 1. |
| 22a. | K2... | Constant used in the pressure drop equation. | 0. |
| 23. | K3... | Constant used in computing outlet pressure. (See Section VI.L.4 of Appendix A.) | 1. |
| 24. | K4... | Same as above. | 0. |
| 24a. | K5S... | Flag set to 1. if Ito curved tube friction factor correction is to be applied. | 1. |
| 25. | CC2... | Same as above | 0. |
| 26. | CC1... | Same as No. 22 | 0. |
| 27. | AL... | Area of inlet passage | 1.0 |
| 28. | AO | Area of outlet passage | 1.0 |
| 29. | CB1... | Constant used in hℓ equation. (See Appendix A, Section VI.A.) | 1. |
| 30. | CB2... | Same as above | 1. |
| 31. | AASTAR... | Exit area/throat area ratio (see Section C for description of when this is needed). | |

| | ITEM | DESCRIPTION | DEFAULT VALUE |
|---|---|---|---|
| 32. | RC... | Radius of barrel section | |
| 33. | RD... | Radius of curvature downstream of throat (required input when K5S = 1.) | |
| 34. | RU... | Radius of curvature upstream of throat (required input when K5S = 1.) | |
| 35. | RB... | Convergent radius | |
| 36. | RSTAR... | Throat Radius | |
| 37. | ZB... | Barrel length | |
| 38. | ZOL... | Over-all length of nozzle | |
| 39. | ALPHAA... | Divergence angle | |
| 40. | BETAA... | Convergence angle | |
| 41. | N1P... | Number of points desired in Section 1. | |
| 42. | N2P... | Number of points desired in Section 2. | |
| 43. | N3P... | Number of points desired in Section 3. | |
| 44. | N4P... | Number of points desired in Section 4. | |
| 45. | N5P... | Number of points desired in Section 5. | |
| 46. | N6P... | Number of points desired in Section 6. | |
| 47. | GAMMA... | Ratio of specific heats when TMACH(Ito) table is used to obtain local values of gas side pressure, temperature and velocity | |
| 48. | EPOGEØ... | Emissivity of core face, $\varepsilon_o$. (See Section VI.C.2.a of Appendix A.) | |
| 49. | EP1GEØ... | Emissivity of tube wall, $\varepsilon_1$. (See Section VI.C.2.a of Appendix A.) | |
| 50. | TO... | Temperature of core face | |
| 50a. | TB... | Temperature of coolant, °R. | |
| 51. | WBC... | Bolt coolant flow | |
| 52. | HBC... | Enthalpy change of bolt coolant | |

| | ITEM | DESCRIPTION |
|---|---|---|
| 53. | WF... | Film coolant flow |
| 54. | XI... | Developed length for initial rise in TFI. |
| 55. | TCF... | Reference temperature of coolant |
| 56. | VF... | Velocity of injected film coolant. |
| 57. | TWL... | Temperature of coolant wall at 1st station |
| 58. | TWG... | Temperature of gas wall at 1st station |
| 59. | ZSTAR... | Axial distance to the nozzle throat |
| 60. | ASTAR... | Throat area |
| 61. | COOL... | Designates type of coolant used.<br>= 1, NBS equilibrium hydrogen<br>= 2, Aerozine-50<br>= 3, Water<br>= 4, NBS para hydrogen |
| 62. | MW... | Molecular weight |
| 63. | ZETA... | Combustion efficiency used in computing β. |
| 64. | CONTR... | Contour subprogram bypass flag. If CONTR=2, the program checks the Material Curve Data Flag (TMKM) to obtain the nozzle contour data. Nozzle contour station data will be generated whenever CONTR=0. If CONTR=1, station data is input directly. |
| 64a. | ZD | Z to downstream point of tangency, in. (required input if K5S is input at 1.0) |
| 64b. | ZU | Z to upstream point of tangency, in. (required input if K5S is input as 1.0) |
| 65. | NTOT... | Total number of stations input |
| 65a. | SMALTC... | Coating thickness, tc, in. |
| 66. | DUMPEM... | Dump flag. If non-zero, intermediate values will be printed after each iteration. |
| 66a. | SMALTS... | Space thickness, ts, in. |
| 67. | TITLE... | Title. (Limited to 80 characters.) This information appears at the top of each page of output (must be enclosed in quotes). For UNIVAC usage the title is read from card preceding DATUM by A format. |

| | ITEM | DESCRIPTION |
|---|---|---|
| 68. | NDL... | Number of points in the table of discontinuities TAZ1. |
| 69. | DZ... | Applicable only if contour subroutine is used. Stations will be spaced DZ inches apart. |
| 70. | NC... | Nozzle contour flag:<br>= -1, input all stations<br>= 0, conical nozzle<br>= 1, contoured nozzle |
| 71 | RBO... | "Burn-Out" equations flag (see Section IX of Appendix A) |
| 72. | TATWM(25)... | Values of temperature for the yield stress table (TASTRY). (See Section VI.N.2 of Appendix A.) |
| 73. | TASTRY(25)... | Yield stress |
| 74. | TTATMR(20)... | Values of temperature for the thermal conductivity table (TAKMR). (See Section VI.D of Appendix A.) |
| 75. | TTAKMR(20)... | Thermal conductivity of tube wall. |
| 76. | TAZ(100)... | Z values for the following curves: (must be in numberical order) |
| 76.a | TASMTM(100)... | Tube metal thickness, $t_m$ |
| 76.b | TACG(100)... | Factor in gas side heat transfer coefficient, $C_g$ |
| 76.c | TACL(100)... | Factor in coolant-side heat transfer coefficient, $C_\ell$. (If TACL is negative then $C_\ell$ will be calculated from a curve Ref. AGC Report RN-S-0274.) |
| 76.d | TAKC(100)... | Thermal conductivity of tube coating, $k_c$ |
| 76.e | TATC(100)... | Coating thickness, $t_c$ |
| 76.f | TASMD(100)... | Undeformed coolant tube diameter, d |
| 76.g | TASML(100)... | Tube leg height, L for U-tube but for the rectangular slots it is the land width. |
| 76.h | TASMTS(100)... | Space thickness, $t_s$ |
| 76.i | TASMDS(100)... | Slotted passage height |
| 76.j | TABETA(100)... | Factor defining temperature recovery, $\beta$. |

| | ITEM | DESCRIPTION |
|---|---|---|
| 76.k | TAAF(100)... | Cross sectional area of single tube, $A_f$. If leg height iteration is being made TAAF must input as an initial guess to avoid a divide by zero. |
| 76.l | PXM(100)... | Table of constants from which $K_6$ is determined in the friction loss equation. (See Section VI.M.2.c of Appendix A.) |
| 76.m | PDM(100)... | Table of constants from which $K_5$ is determined in the dynamic pressure drop equation. (See Section VI.M.1.c of Appendix A.) (not used at present) |
| 76.n | TATWG(100)... | Temp. of gas wall if LHITE=1 or if CGITE=1 |
| 76.o | TAHL(100)... | Liquid side heat transfer coefficient if HLC=9 |
| 76.p | TAHG(100)... | Gas side heat transfer coefficient if HGC=3 |
| 76.q | CGITE(100)... | Table from which CGITE is determined. CGITE is the $C_g$ iteration flag. Iteration is performed on $C_g$ if and only if CGITE=0. (See Section VII of Appendix A.) |
| 76.r | PPFM(100)... | Table from which to obtain PFM used in friction factor (default to zero) |
| 76.s | EPFGEO(100)... | Table from which EPGEOM is determined. This is the heated area factor, $\epsilon$. |
| 76.t | LHITE(100)... | Table from which the leg height iteration flag is determined. If LHITE=0, the leg height iteration is performed. (See Section VII of Appendix A.) This option may be used only with HLG set to 1, 10 or 11 and may not be used with the land and groove configuration. An error will result if the computed height is negative so results computed with this option should be checked by running with LHITE=0. |
| 76.u | LH(100)... | Table from which UW, the central land width, for U-tube configurations is determined. See the U-tube figure. |
| 76.v | TMKM(100)... | Material curve data flag.<br>= 0 Stainless steel curve data is used.<br>= -1 Hastelloy X curve data is used<br>= +1 Material curve data is being input. (See Section VI.D of Appendix A.) |

| | ITEM | DESCRIPTION |
|---|---|---|
| 76.w | TUBE(100)... | Signifies type of coolant tubes used as follows:<br><br>= 1, Rectangular Slots<br>= 2, Truncated<br>= 3, Round or Flattened<br>= 4, U-Tube |
| 77. | TAZ1(100)... | Z values for the following step functions. This table also determines the flow path in that the 1st point of the table is the location at which the coolant enters the nozzle and the next point would then be downstream with respect to the direction of flow. Whenever a discontinuity occurs in any of the following tables the location at which it occurs must be input twice. |
| 77.a | TAFEFV(100)... | Radiation factor (not used in present version) |
| 77.b | TANMB(100)... | Number of coolant tubes through which the coolant is flowing. |
| 77.c | TANT(100)... | Total number of tubes |
| 77.d | TAWDOT(100)... | Coolant flow rate. |

The next four items provide for input of all nozzle station data. These are omitted when the contour flag CONTR = 0.

| | | |
|---|---|---|
| 78. | ZZZZZZ(200)... | Axial coordinate Z, measured from the injector face. |
| 79. | RRRRRR(200)... | Radius corresponding to Z |
| 80. | SSSSSS(200)... | Developed length |
| 81. | AAAAAA(200)... | Area ratio at the point Z. (Input should be negative upstream of the throat.) |

The next five tables are used to input the gas-side transport properties as a function of temperature. These are ignored when using hydrogen since the gas-side properties are obtained from hydrogen subroutine.

| | | |
|---|---|---|
| 82. | GAST(50)... | Temperature |
| 82a. | GASK(50)... | Thermal Conductivity |

| | ITEM | DESCRIPTION |
|---|---|---|
| 83. | GASCP(50)... | Specific heat at constant pressure |
| 84. | GASRHO(50)... | Density |
| 85. | GASMU(50)... | Viscosity |
| 85.a | GASMUT(50)... | Molecular weight of gas |
| 85.b | GAS... | Flag to determine gas side properties<br>GAS = 1, NBS equilibrium hydrogen<br>GAS = 2, NBS para-hydrogen<br>GAS = 3, above tables must be input |

The next four tables provide the program with a means of determining velocity, pressure and temperature of the gas as a function of area ratio:

| | | |
|---|---|---|
| 86. | TAAST(100)... | Area ratio |
| 87. | TVK(100)... | Gas velocity |
| 87.a | TRHOK(100)... | Gas density |
| 88. | TTINK(100)... | Gas temperature |
| 89. | TPK(100)... | Gas pressure |
| 89.a | TMACH(100)... | Used with GAMMA to generate TVK, TPK and TTINK if input. |

The following 14 items are constants used in the computation of the burnout heat flux ratio: (see Section IX of Appendix A)

| | | |
|---|---|---|
| 90. | VDTC... | VDTC |
| 90.a | QOABO... | Coolant burnout heat flux. |
| 91. | RBOFP... | $F_p$ |
| 92. | RBOFT... | $F_T$ |
| 93. | RBOA1... | $A_1$ |
| 94. | RBOA2... | $A_2$ |

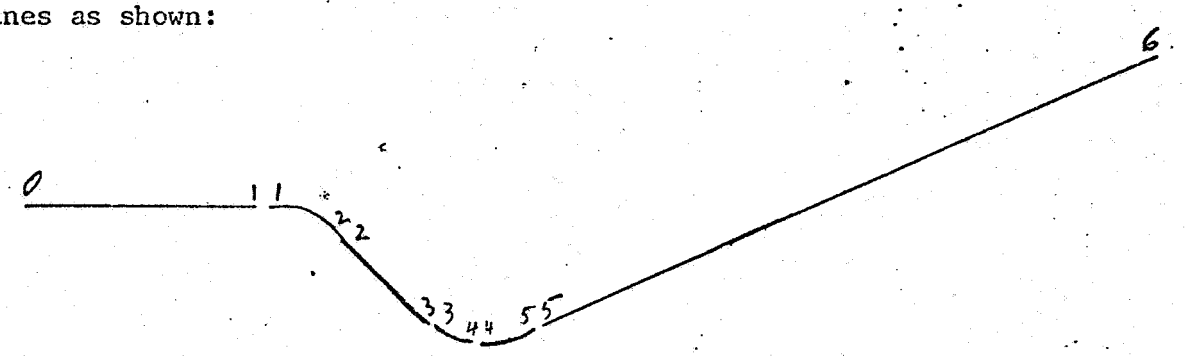
| | ITEM | DESCRIPTION |
|---|---|---|
| 95. | RBOB1... | $B_1$ |
| 96. | RBOB2... | $B_2$ |
| 97. | RBON1... | $N_1$ |
| 98. | RBON2... | $N_2$ |
| 99. | RBOM1... | $M_1$ |
| 100. | RBOM2... | $M_2$ |
| 101. | RBOK1... | $K_1$ |
| 102. | RBOC1... | $C_1$ |

The following 5 items are used if PFM and EPGEOM are to be determined from experimental data.

| | | |
|---|---|---|
| 103. | DPI... | Required pressure drop, psi |
| 104. | DTI... | Required temperature increase, °R |
| 105. | FLAG... | Flag set to 1. if PFM option is used |
| 106. | ZCHAN... | Iteration flag, see code |
| 107. | CONLHB... | Flag. See Code. |
| 108. | FILMC... | not used at present. |
| 109. | MMAT... | |
| 110. | PREXP... | |
| 111. | RBOFLG... | |
| 112. | RN... | |
| 113. | TF... | |
| 114. | THK... | |
| 115. | TSAT... | |

C. USAGE OF THE NOZZLE STATION DATA GENERATING SUBPROGRAM (CONTUR)

The program will compute the station coordinates of a nozzle by dividing the nozzle into segments of circular arcs connected by straight lines as shown:




By input of certain critical dimensions such as throat radius, convergent angle, etc., coordinates of the tangent points 0, 1, 2, ---6 are computed. Definition of a contoured divergent section by means of length and radial coordinates is required if the nozzle is of this type.

Once the coordinates of the tangent points are determined, two methods are available for automatically locating stations. In the first, the number of equal length station intervals between two tangent points can be specified for any segment; e.g., for three station intervals between Points 1 and 2, input N2P = 3. If intervals are not specified or are input zero, each segment will be divided into approximate 3 in. intervals between stations. For a contoured nozzle, stations in the divergent section aft of the downstream point of tangency (Point 5) are located by input. Stations are always placed at the tangent points.

The second method for locating stations is by even interval. This is done merely by input of the desired print interval DZ, and a non-zero number here calls this method. This interval is held throughout the nozzle regardless of whether it is conical or contoured. Again, stations are always placed at the tangent points.

Because the program works progressively in the direction of coolant flow, it is necessary to input the points of entry and exit of the coolant as axial distances in the TAZ1 table. In case of a discontinuity such as a tube split, change in direction of coolant flow or change in coolant flow rate, a double station must be input in the TAZ1 table. If a station is desired at a certain location, include a single point defining the location in the TAZ1 table. Always input TAZ1 data in direction of coolant flow.

Certain dimensions are required to be input for any case in which Subroutine CONTUR is used. These are:

| | |
|---|---|
| Chamber radius | (RC) |
| Throat radius | (RSTAR) |
| URAD | (RU) |
| DRAD | (RD) |
| Convergent radius | (RB) |
| Convergent angle | ($\beta$) |
| Divergent angle at DPT | ($\alpha$) |

Other dimensions are required to define the relative location of the nozzle forward end, throat, and exit. To accomplish this, any pair of the following may be used:

AASTAR, ZOL
AASTAR, ZB
AASTAR, ZSTAR
ZOL, ZB
ZOL, ZSTAR

If more than one pair is input, the pair nearest the top of the list is used; i.e., if AASTAR, ZB, and ZSTAR are all input, the contour will be computed using AASTAR and ZB.

In the case of a contoured nozzle, input of AASTAR is automatic as it is computed from the last point defining the contour; therefore, only a length dimension (ZOL, ZB, or ZSTAR) is required. The contour is input by defining points aft of the downstream point of tangency (Point 5) by axial distance from the throat and radius. Values are input in pairs of axial distance and radius, one pair per card, with Z in columns 1 - 10 and R in columns 11 - 20. After the last pair, include one card with a -1. between columns 1 and 10 to signify end of table.

The following examples are included to demonstrate input. (See Figure A)

1. Given: Conical nozzle, coolant enters at pt. (6) and exits at pt. (0). Overall length and barrel length known. A print interval of 2 in. is desired. There is a tube split at axial distance 15 in.

   Input: NC = 0., RC = 14., RSTAR = 5., RU = 3.5, RD = 2., RB = 4.5, ALPHAA = 17.5, BETAA = 45., ZOL = 43.5, ZB = 9., DZ = 2., NDL = 4., TAZ1 = 43.5, 15., 15., 0.,

2. Given: Conical nozzle, coolant enters at forward end, flows aft and reverses direction at aft end, and exits at forward end. Area ratio at exit and length to throat are known. Stations are desired at axial distance 5, 14, 17, 19, 20, 25, 35 and 43.5 in.

   Input: NC = 0., RC = 14., RSTAR = 5., RU = 3.5, RD = 2., RB = 4.5, ALPHAA = 17.5, BETAA = 45., AASTAR = 9., ZSTAR = 21., DZ = 0., NDL = 18., N1P = 1., N2P = 1., N4P = 1., N5P = 1., N6P = 1., TAZ1 = 0., 5., 14., 17., 19., 20., 25., 35., 43.5, 43.5, 35., 25., 20., 19., 17., 14., 5., 0.,

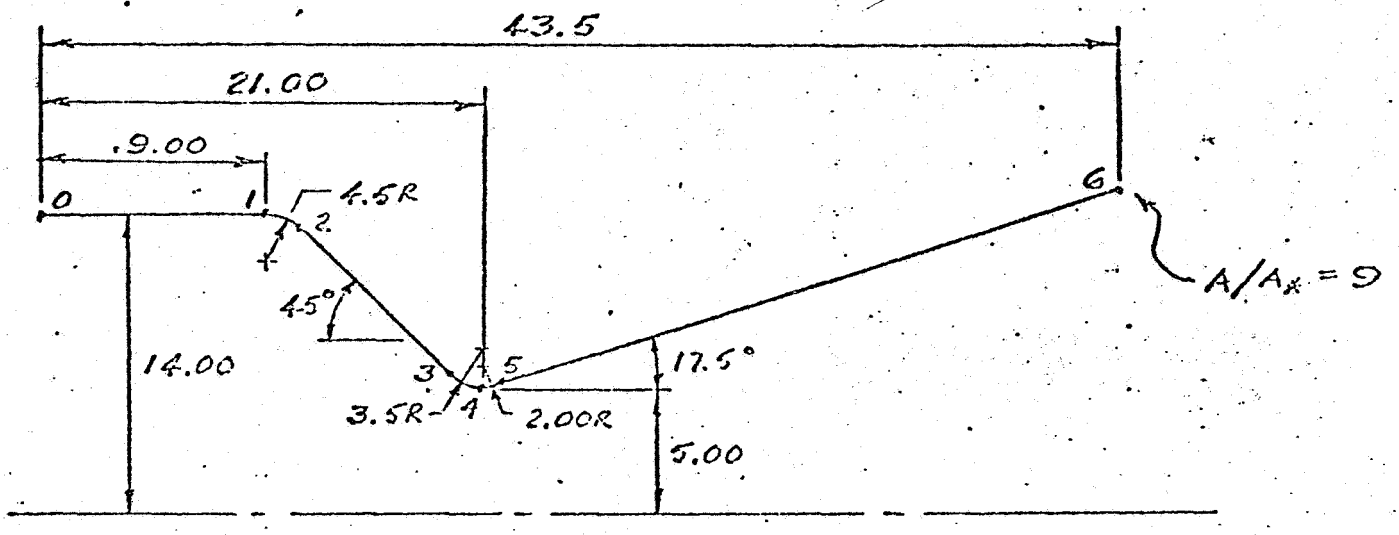
3. Given: Contoured nozzle, coolant enters at axial distance 28 in., flows aft, reverses direction at the nozzle exit, flows forward to a tube split at axial distance 28 in., continues forward and exits at the forward end. Overall length is known. Approximately 3 in. is desired between stations except between points (3) and (4) where 8 stations are necessary (the number of intervals is therefore 8 + 1 = 9).

   Input: NC = 1., RC = 14., RSTAR = 5., RU = 3.5., RD = 2., RB = 4.5, ALPHAA = 35., BETAA = 45., ZOL = 42., DZ = 0., N1P = 0., N2P = 0., N3P = 0., N4P = 9., N5P = 0., N6P = 0., NDL = 6., TAZ1 = 28., 42., 42., 28., 28., 0.,

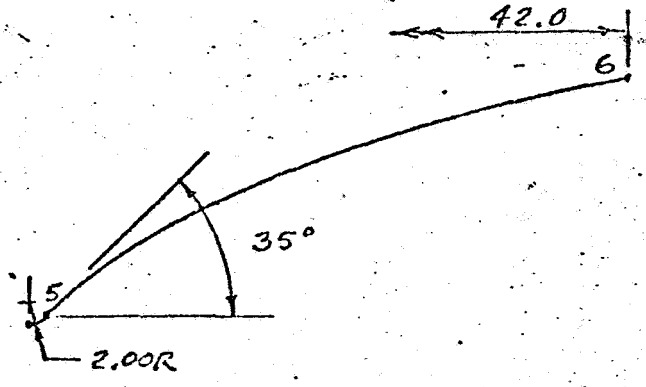
   NOTE: Place cards containing points defining contour behind &END card.

4. Given: Contoured nozzle, coolant entry at forward end and exit at aft end. Contour is to be input.

   Input: CØNTR = 1., ZSTAR = 21., NTØT = number of points input ZZZZZZ = (Axial distances to stations), RRRRRR = (Radius at stations), SSSSSS = (Developed length to stations measured from forward end), AAAAAA = (Area ratio at stations)




CONICAL NOZZLE




CONTOURED NOZZLE

```
@ ELT PTDENS,1,711119, 35519

000001                FUNCTION PTDENS(PRES,TEMP)                                    NBS22780
000002                DIMENSION PS(20),TS(20),JP(28),MX(28),LOC(30),BP(28),DP(28),BT(30)NBS22790
000003               1,DT(28),R(886)                                                NBS22800
000004                DIMENSION AA(109),AB( 97),AC(108),AD(106),AE(106),AF(108),AG(101) NBS22810
000005               1 ,AH(111),AI( 41)                                             NBS22820
000006                EQUIVALENCE( R,AA),( R( 110),AB),( R( 207),AC),( R( 315),AD)   NBS22830
000007               1    ,( R( 421),AE),( R( 527),AF),( R( 635),AG),( R( 736),AH)  NBS22840
000008               2    ,( R( 847),AI)                                            NBS22850
000009                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,165.,176.,NBS22860
000010               1182.,185.,186.5,187.25,187.46875,187.506,187.6385/             NBS22870
000011                DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,54.NBS22880
000012               179,56.72,57.80,58.57,58.99,59.18,59.29,59.34,59.353,59.356,59.4/NBS22890
000013                DATA LOC/1,23,78,105,141,155,183,201,225,240,267,321,341,377,401,NBS22900
000014               1 425,437,453,469,494,534,546,586,682,722,752,800,848,866,878/  NBS22910
000015                DATA JP/2,5,3,4,2,4,3,4,3,3,3,4,4,4,3,3,4,4,5,8,4,5,12,5,3,6,6,6/NBS22920
000016                DATA MX/0,3,1,2,0,2,1,2,1,1,1,2,2,2,1,1,2,2,3,6,2,3,10,3,1,4,4,4/NBS22930
000017                DATA BP/0.,200.,-100., 0.,0.,0.,-4.,0.,2645.28,1469.6,881.76,0.,0.NBS22940
000018               1,-44.088,587.84,293.92,73.48,-14.696,293.92,36.74,-7.348,293.92,NBS22950
000019               2180.,0.,0.,29.392,102.872,29.392/                              NBS22960
000020                DATA DP/800.,1200.0,200.0,1000.0,100.0,1000.0,7.0,1000.0,1175.68,NBS22970
000021               1 587.84,293.92,293.92,293.92,58.784,146.96,146.96,73.48,29.392, NBS22980
000022               2 73.48,36.74,14.696,73.48,10.0,7.348,1.4696,14.696,14.696,29.392/NBS22990
000023                DATA BT/180.0,180.0,500.0,500.0,1300.0,1300.0,2500.0,2500.0,36.0,NBS23000
000024               1 36.0,27.0,27.0,108.0,108.0,57.6,86.4,86.4,86.4,72.0,72.0,72.0, NBS23010
000025               2 59.4,59.4,30.0,23.4,39.6,52.2,64.8,5000.,5000./               NBS23020
000026                DATA DT/30.0,30.0,100.0,100.0,200.0,200.0,500.0,500.0,36.0,18.0,NBS23030
000027               1 9.0,9.0,9.0,14.4,7.2,7.2,7.2,7.2,3.6,3.6,7.2,1.8,1.8,6.0,5.4,3.6,NBS23040
000028               2 1.8,3.6/                                                      NBS23050
000029                DATAAA/0.,.8376,0.,.7052,0.,.6114,0.,.5412,0.,.4862,0.,.4419,0.,.4NBS23060
000030               1053,0.,.3746,0.,.3483,0.,.3255,0.,.3056,.2652,1.41,2.315,2.924,3.3NBS23070
000031               296,.2314,1.179,1.979,2.584,3.052,.1998,1.023,1.739,2.309,2.765,.17NBS23080
000032               366,.9058,1.554,2.087,2.526,.1577,.8147,1.407,1.905,2.325,.1424,.74NBS23090
000033               414,1.286,1.754,2.154,.1297,.6809,1.186,1.626,2.008,.1192,.63,1.102NBS23100
000034               5,1.516,1.881,.1101,.5865,1.029,1.421,1.769,.1021,.5489,.9656,1.338NBS23110
000035               6,1.671,.0953,.5159,.91,1.264,1.584,-.03747,.03747,.1114,-.03125,.0NBS23120
000036               73125,.09302,-.02679,.02679,.07985,-.02345,.02345,.06995,-.02085,.0NBS23130
000037               62085,.06224,-.01877,.01877,.05606,-.01706,.01706,.05099,-.01565,.0NBS23140
000038               91565,.04677,-.01445,.01445,.04282,.00464,.3605,.6912,.9949,.00341/NBS23150
000039                DATAAB/.3021,.5825,.8432,.0026,.2601,.5030,.7325,.002,.2285,.4441,NBS23160
000040               1.6479,.00161,.2037,.3972,.581,.00131,.1838,.3592,.5267,.0011,.1674NBS23170
000041               2,.3279,.4818,.0009,.1538,.3017,.4439,.00027,.1422,.2793,.4116,0.,.NBS23180
000042               301445,0.,.01252,0.,.01105,0.,.009892,0.,.008951,0.,.008174,0.,.007NBS23190
000043               4521,.000267,.1422,.2793,.4116,.000189,.1235,.2432,.3592,.000144,.1NBS23200
000044               5092,.2154,.3187,.00012,.09785,.1933,.2864,9.8E-5,.08864,.1753,.260NBS23210
000045               61,8.1E-5,.08101,.1604,.2382,6.9E-5,.07459,.1478,.2196,-.0003009,.0NBS23220
000046               7002256,.0007521,-.000251,.0001882,.0006272,-.000215,.0001611,.0005NBS23230
000047               8373,-.0001878,.0001402,.0004686,-.0001656,.0001221,.0004119,-.0001NBS23240
000048               9452,.0001042,.0003599,6.9E-6,.07459,.1478,.2196,4.6E-6,.06226/  NBS23250
000049                DATAAC/.1236,.1839,3.1E-6,.05342,.1061,.1582,9.E-7,.04677,.09301,.NBS23260
000050               11387,-3.6E-6,.04155,.08272,.1235,-1.32E-5,.0373,.07436,.1111,5.27,NBS23270
000051               25.489,5.68,4.501,4.845,5.107,3.616,4.126,4.483,2.857,3.466,3.895,2NBS23280
000052               3.319,2.935,3.395,4.994,5.143,5.27,4.533,4.743,4.886,3.958,4.27,4.5NBS23290
000053               401,3.307,3.752,4.059,2.698,3.243,3.616,2.226,2.796,3.236,1.886,2.4NBS23300
000054               535,2.857,1.639,2.15,2.588,1.453,1.924,2.319,5.033,5.112,5.183,4.81NBS23310
000055               66,4.91,4.994,4.558,4.676,4.764,4.248,4.405,4.533,3.88,4.094,4.246,NBS23320
000056               73.442,3.743,3.958,2.953,3.361,3.633,2.981,2.975,3.307,2.093,2.616,NBS23330
```

```
000057                83.002,1.804,2.309,2.698,1.588,2.059,2.462,1.423,1.856,2.226,1.293,NBS23340
000058                91.691,2.056,1.187,1.555,1.886,1.1,1.441,1.754,1.026,1.344,1.639/   NBS23350
000059                 DATAAD/.9627,1.262,1.546,.9076,1.189,1.453,4.742,4.853,4.946,5.031NBS23360
000060                1,4.43,4.584,4.709,4.816,4.024,4.279,4.417,4.558,3.165,3.778,4.05,4NBS23370
000061                2.248,1.43,2.988,3.595,3.88,-.0233,.5581,1.189,1.804,-.015,.503,1.0NBS23380
000062                35,1.568,-.0099,.4591,.945,1.423,-.0065,.4231,.8618,1.293,-.0042,.3NBS23390
000063                4928,.7943,1.187,-.0025,.3669,.7379,1.1,-.0015,.3445,.6898,1.026,-.NBS23400
000064                50007,.3249,.6483,.9627,-.0001,.3075,.612,.9076,-.07704,.02568,.130NBS23410
000065                67,.2384,-.06786,.02262,.1144,.2079,-.06066,.02022,.1018,.1844,-.05NBS23420
000066                7484,.01828,.09179,.1659,-.05004,.01668,.0836,.1508,-.04602,.01534,NBS23430
000067                8.07677,.1383,3.887,3.986,4.105,3.447,3.646,3.792,2.91,3.226,3.442,NBS23440
000068                92.323,2.76,3.051,1.857,2.317,2.67,1.549,1.963,2.326,1.34,1.701/    NBS23450
000069                 DATAAE/2.035,1.189,1.497,1.804,.7859,1.309,1.857,.6864,1.106,1.549NBS23460
000070                1,.6141,.9689,1.34,.5581,.8735,1.189,.1675,.3524,.5577,.7859,.153,.NBS23470
000071                23178,.4955,.6864,.1409,.2902,.4479,.6141,.1307,.2674,.4127,.5581,-NBS23480
000072                3.03228,.03224,.09858,.1675,-.02974,.02971,.09043,.153,-.02756,.027NBS23490
000073                454,.08359,.1409,-.02568,.02568,.07819,.1307,1.226,1.807,2.329,2.67NBS23500
000074                54,2.91,1.052,1.481,1.941,2.326,2.616,.9378,1.279,1.656,2.019,2.323NBS23510
000075                6,.8526,1.141,1.456,1.774,2.089,.7859,1.047,1.309,1.583,1.857,.0997NBS23520
000076                75,.2084,.3279,.461,.6115,.7847,.9864,1.226,.09478,.1962,.3063,.426NBS23530
000077                84,.5585,.7052,.8693,1.052,.08981,.1855,.2878,.3977,.5164,.6451,.78NBS23540
000078                951,.9388,.0859,.176,.2717,.3734,.4817,.5972,.7207,.8526,.08199/    NBS23550
000079                 DATAAF/.1675,.2599,.3524,.455,.5577,.6718,.7859,-.01936,.01932,.05NBS23560
000080                1868,.09975,-.01756,.01753,.05323,.08981,-.01615,.01611,.04882,.081NBS23570
000081                299,3.304,3.422,3.541,3.659,3.777,3.044,3.29,3.45,3.572,3.667,2.74,NBS23580
000082                33.102,3.304,3.449,3.557,2.322,2.88,3.141,3.315,3.447,1.861,2.621,2NBS23590
000083                4.959,3.17,3.313,1.551,2.329,2.76,3.014,3.179,1.358,2.045,2.546,2.8NBS23600
000084                548,3.044,1.226,1.807,2.329,2.674,2.91,.6295,2.42,2.726,2.849,2.937NBS23610
000085                6,3.005,3.061,3.11,3.153,3.191,3.227,3.259,.9338,1.076,1.265,1.599,NBS23620
000086                72.202,2.506,2.659,2.768,2.85,2.918,2.976,3.026,.8297,.9234,1.03,1.NBS23630
000087                8159,1.322,1.542,1.835,2.136,2.356,2.509,2.618,2.709,.759,.8323,.91NBS23640
000088                921,1.001,1.103,1.22,1.359,1.523,1.713,1.916,2.106,2.267,.7053/     NBS23650
000089                 DATAAG/.767,.8326,.9039,.9807,1.066,1.16,1.265,1.383,1.513,1.655,1NBS23660
000090                1.803,.6621,.7161,.7728,.8331,.8976,.9656,1.04,1.12,1.206,1.299,1.4NBS23670
000091                2,1.507,.6259,.6745,.725,.778,.8337,.8927,.9537,1.019,1.089,1.163,1NBS23680
000092                3.242,1.325,.5941,.6412,.6883,.7355,.7826,.8372,.8921,.9469,1.005,1NBS23690
000093                4.07,1.135,1.2,-.000743,.04849,.09854,0.,0.,-.000787,.04023,.08466,NBS23700
000094                5.1315,.1915,-.000437,.03393,.07032,.1097,.1534,-.000257,.02941,.06NBS23710
000095                6027,.09278,.1275,-.000177,.02599,.05289,.0808,.1098,-.000122,.0233NBS23720
000096                7,.0472,.07177,.09714,-8.3E-5,.02112,.04266,.06465,.08719,-6.5E-5,.NBS23730
000097                801932,.0381,.05888,.07931,0.,.01172,.02363,-.000111,.009736,.0198,NBS23740
000098                9-5.9E-5,.008154,.01648,-3.6E-5,.007021,.01414,-2.4E-5,.006166/     NBS23750
000099                 DATAAH/.0124,-1.5E-5,.005498,.01104,-1.1E-5,.004962,.009954,-9.E-6NBS23760
000100                1,.004521,.009063,-7.E-6,.004153,.008321,-2.2E-5,.003846,.007715,.1NBS23770
000101                2664,.248,0.,0.,0.,0.,.1469,.2418,.3397,0.,0.,0.,.1315,.2117,.3091,NBS23780
000102                3.4233,.5318,0.,.1195,.1891,.2684,.3626,.4811,.6115,.1098,.1717,.24NBS23790
000103                4,.3166,.4051,.5124,.1017,.1578,.2183,.2841,.3568,.4387,.09486,.146NBS23800
000104                53,.2009,.2592,.322,.3903,.08892,.1377,.1865,.2407,.295,.3565,.5712NBS23810
000105                6,.727,.9725,0.,0.,0.,.5124,.6559,.8514,1.116,0.,0.,.4755,.5827,.73NBS23820
000106                729,.9604,1.252,1.718,.4387,.5333,.6477,.7994,1.068,1.534,.4145,.49NBS23830
000107                856,.5914,.706,.8535,1.082,.3903,.4653,.5491,.6447,.7575,.8985,.373NBS23840
000108                94,.4399,.5151,.5986,.6928,.802,.3565,.4181,.4898,.5616,.6487/      NBS23850
000109                 DATAAI/.7358,.08892,.1865,.295,.4181,.5616,.7358,.08373,.1743,.273NBS23860
000110                11,.3822,.5044,.6439,.07931,.1649,.2562,.3545,.461,.5814,-1.32E-5,.NBS23870
000111                20373,.07436,.111,-2.97E-5,.0337,.06734,.1007,-5.14E-5,.03051,.0612NBS23880
000112                32,.09175,-.0001453,.0001042,.0003599,-.000124,8.541E-5,.0003076,-9NBS23890
000113                4.95E-5,6.714E-5,.0002542,0./                                       NBS23900
000114                 P=PRES                                                             NBS23910
000115                 IF(P.LT.1.0) P=1.0                                                 NBS23920
000116                 T=TEMP                                                             NBS23930
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000117                IF(T.LT.180.0) GO TO 8                                  NBS23940
000118                IF(T.GE.1300.0) GO TO 4                                 NBS23950
000119                IF(T.GE.480.0) GO TO 2
000120                IF(P.GE.800.) GO TO 1                                   NBS23970
000121                N=1                                                     NBS23980
000122                GO TO 33                                                NBS23990
000123              1 N=2                                                     NBS24000
000124                GO TO 33                                                NBS24010
000125              2 IF(P.GE.300.0) GO TO 3                                  NBS24020
000126                N=3                                                     NBS24030
000127                GO TO 33                                                NBS24040
000128              3 N=4                                                     NBS24050
000129                GO TO 33                                                NBS24060
000130              4 IF(T.GE.2500.0) GO TO 6                                 NBS24070
000131                IF(P.GE.100.0) GO TO 5                                  NBS24080
000132                N=5                                                     NBS24090
000133                GO TO 33                                                NBS24100
000134              5 N=6                                                     NBS24110
000135                GO TO 33                                                NBS24120
000136              6 IF(T.GE.6000.0) T=5999.99999                            NBS24130
000137                IF(P.GE.10.0) GO TO 7                                   NBS24140
000138                N=7                                                     NBS24150
000139                N1=30                                                   NBS24160
000140                GO TO 33                                                NBS24170
000141              7 N=8                                                     NBS24180
000142                N1=29                                                   NBS24190
000143                GO TO 33                                                NBS24200
000144              8 TZ=24.84+0.00317*P                                      NBS24210
000145                IF(T.LT.TZ) T=TZ                                        NBS24220
000146                IF(P.LT.881.76) GO TO 11                                NBS24230
000147                IF(P.LT.2645.28) GO TO 9                                NBS24240
000148                N=9                                                     NBS24250
000149                GO TO 33                                                NBS24260
000150              9 IF(P.LT.1469.6) GO TO 10                                NBS24270
000151                N=10                                                    NBS24280
000152                GO TO 33                                                NBS24290
000153             10 N=11                                                    NBS24300
000154                GO TO 33                                                NBS24310
000155             11 IF(T.GE.59.4) GO TO 14                                  NBS24320
000156                N=12                                                    NBS24330
000157                IF(P.GE.187.6385) GO TO 33                              NBS24340
000158                DO 12 I=2,20                                            NBS24350
000159                IF(P-PS(I))13,13,12                                     NBS24360
000160             12 CONTINUE                                                NBS24370
000161                I=20                                                    NBS24380
000162             13 TM=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))  NBS24390
000163                IF(T.GE.TM) GO TO 24                                    NBS24400
000164                GO TO 33                                                NBS24410
000165             14 IF(T.LT.108.0) GO TO 16                                 NBS24420
000166                IF(P.LT.132.264) GO TO 15                               NBS24430
000167                N=13                                                    NBS24440
000168                GO TO 33                                                NBS24450
000169             15 N=14                                                    NBS24460
000170                GO TO 33                                                NBS24470
000171             16 IF(P.LT.587.84) GO TO 17                                NBS24480
000172                N=15                                                    NBS24490
000173                GO TO 33                                                NBS24500
000174             17 IF(T.LT.72.0) GO TO 23                                  NBS24510
000175                IF(T.LT.86.4) GO TO 20                                  NBS24520
000176                IF(P.LT.293.92) GO TO 18                                NBS24530
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000177                N=16                                                  NBS24540
000178                GO TO 33                                              NBS24550
000179             18 IF(P.LT.73.48) GO TO 19                               NBS24560
000180                N=17                                                  NBS24570
000181                GO TO 33                                              NBS24580
000182             19 N=18                                                  NBS24590
000183                GO TO 33                                              NBS24600
000184             20 IF(P.LT.293.92) GO TO 21                              NBS24610
000185                N=19                                                  NBS24620
000186                GO TO 33                                              NBS24630
000187             21 IF(P.LT.36.74) GO TO 22                               NBS24640
000188                N=20                                                  NBS24650
000189                GO TO 33                                              NBS24660
000190             22 N=21                                                  NBS24670
000191                GO TO 33                                              NBS24680
000192             23 IF(P.LT.293.92) GO TO 24                              NBS24690
000193                N=22                                                  NBS24700
000194                GO TO 33                                              NBS24710
000195             24 IF(P.LT.180.0) GO TO 25                               NBS24720
000196                N=23                                                  NBS24730
000197                GO TO 33                                              NBS24740
000198             25 IF(P.GE.29.0) GO TO 27                                NBS24750
000199                IF(P.LT.2.9392) GO TO 26                              NBS24760
000200                N=24                                                  NBS24770
000201                GO TO 33                                              NBS24780
000202             26 N=25                                                  NBS24790
000203                GO TO 33                                              NBS24800
000204             27 IF(T.GE.64.8) GO TO 29                                NBS24810
000205                IF(P.GE.102.0) GO TO 28                               NBS24820
000206                N=26                                                  NBS24830
000207                GO TO 33                                              NBS24840
000208             28 N=27                                                  NBS24850
000209                GO TO 33                                              NBS24860
000210             29 N=28                                                  NBS24870
000211             33 IF(T.LE.5000.)N1=N                                    NBS24880
000212                FP=(P-BP(N))/DP(N)                                    NBS24890
000213                IP=FP                                                 NBS24900
000214                IF(IP.GT.MX(N)) IP=MX(N)                              NBS24910
000215                FI=IP                                                 NBS24920
000216                F=FP-FI                                               NBS24930
000217                FP=1.0-F                                              NBS24940
000218                FT=(T-BT(N1))/DT(N)                                   NBS24950
000219                IT=FT                                                 NBS24960
000220                FI=IT                                                 NBS24970
000221                FF=FT-FI                                              NBS24980
000222                FT=1.0-FF                                             NBS24990
000223                I=IT*JP(N)+IP+LOC(N1)                                 NBS25000
000224                J=I+JP(N)                                             NBS25010
000225                PTDENS=FP*FT*R(I)+F*FT*R(I+1)+FP*FF*R(J)+F*FF*R(J+1)  NBS25020
000226             34 PTDENS = PTDENS / 1728.0                              NBS25030
000227                RETURN                                                NBS25040
000228                END                                                   NBS25050
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@ ELT PTENTH,1,711119, 35523

000001                FUNCTION PTENTH(PRES,TEMP)                                                    NBS25060
000002                DIMENSION LOC(29),JP(24),MX(24),BP(24),DP(24),BT(29),DT(24),PS(20)NBS25070
000003               1,TS(20),TL(10),HS(10), H(1183)                                                NBS25080
000004                DIMENSION AA( 93),AB(100),AC(110),AD(101),AE(101),AF(113),AG(103)              NBS25090
000005               1 ,AH(112),AI(106),AJ(119),AK(104),AL( 21)                                     NBS25100
000006                EQUIVALENCE( H,AA),( H(  94),AB),( H( 194),AC),( H( 304),AD)                  NBS25110
000007               1    ,( H( 405),AE),( H( 506),AF),( H( 619),AG),( H( 722),AH)                  NBS25120
000008               2    ,( H( 834),AI),( H( 940),AJ),( H(1059),AK),( H(1163),AL)                  NBS25130
000009                DATA LOC/1,16,31,46,90,145,157,177,195,231,261,279,306,378,441,468NBS25140
000010               1,558,612,642,682,847,892,1028,1073,1103,1112,1121,1130,1160/                  NBS25150
000011                DATA JP/3,3,3,4,5,2,5,3,6,5,3,3,6,9,9,9,9,5,5,11,9,17,5,5/                    NBS25160
000012                DATA MX/1,1,1,2,3,0,3,1,4,3,1,1,4,7,7,7,7,3,3,9,7,15,3,3/                     NBS25170
000013                DATA BP/0.,-100.,0.,0.,.9999999,0.,300.,2645.28,1175.68,587.84,0.,NBS25180
000014               12645.28,1175.68,0.,587.84,587.84,293.92,0.,440.88,293.92,176.352,1NBS25190
000015               276.352,0.,117.568/                                                            NBS25200
000016                DATA DP/1500.,300.,40.,10.,1.,5000.,1100.,1175.68,293.92,146.96,  NBS25210
000017               1293.92,1175.68,293.92,146.96,73.48,73.48,36.74,73.48,36.74,14.696,NBS25220
000018               214.696,7.348,44.088,14.696/                                                   NBS25230
000019                DATA BT/3000.,3000.,3000.,3000.,3000.,500.,170.,90.,90.,90.,90.,  NBS25240
000020               132.4,30.6,27.,75.6,59.4,72.,72.,59.4,59.4,64.8,59.4,28.8,54.,    NBS25250
000021               25000.,5000.,5000.,5000.,5000./                                                NBS25260
000022                DATA DT/500.,500.,500.,200.,200.,500.,110.,18.,18.,18.,18.,7.2,5.4NBS25270
000023               1,5.4,7.2,1.8,3.6,3.6,1.8,.9,1.8,.9,5.4,1.8/                                   NBS25280
000024                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,165.,176.,182NBS25290
000025               1.,185.,186.5,187.25,187.46875,187.506,187.6385/                               NBS25300
000026                DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,54.NBS25310
000027               179,56.72,57.80,58.57,58.99,59.18,59.29,59.34,59.353,59.356,59.4/  NBS25320
000028                DATA TL/24.846,27.175,29.310,31.299,33.176,34.962,36.672,38.317,  NBS25330
000029               139.904,41.456/                                                                NBS25340
000030                DATA HS/-157.82,-136.56,-115.76,-95.46,-75.59,-56.08,-36.93,-17.99NBS25350
000031               1,0.69,19.30/                                                                  NBS25360
000032                DATAAA/10720.,10750.,10780.,12690.,12720.,12750.,14780.,14780.,148NBS25370
000033               110.,17060.,16960.,16960.,19700.,19330.,19260.,10720.,10720.,10730.NBS25380
000034               2,12710.,12700.,12700.,14920.,14810.,14780.,17620.,17140.,17030.,21NBS25390
000035               3390.,19940.,19580.,10720.,10720.,10720.,12730.,12710.,12700.,15020NBS25400
000036               4.,14910.,14850.,18000.,17550.,17330.,22560.,21170.,20520.,10720.,1NBS25410
000037               50720.,10720.,10720.,11520.,11500.,11500.,11520.,12360.,12320.,1231NBS25420
000038               60.,12320.,13260.,13180.,13150.,13160.,14250.,14090.,14040.,14050.NBS25430
000039               715400.,15090.,14980.,14940.,16780.,16220.,16030.,16030.,18500.,175NBS25440
000040               840.,17200.,17120.,20680.,19110.,18560.,18430.,23480.,21030.,20170.NBS25450
000041               9,19980.,27100.,23410.,22100.,21520.,10720.,10720.,10720.,10720./  NBS25460
000042                DATAAB/10720.,11540.,11520.,11520.,11510.,11510.,12410.,12370.,123NBS25470
000043               160.,12350.,12340.,13390.,13300.,13260.,13230.,13220.,14520.,14330.NBS25480
000044               2,14250.,14210.,14170.,15900.,15560.,15400.,15310.,15250.,17680.,17NBS25490
000045               3060.,16780.,16620.,16500.,20030.,18970.,18490.,18210.,18020.,2318NBS25500
000046               4.,21440.,20670.,20210.,19890.,27390.,24680.,23470.,22750.,22260.,3NBS25510
000047               52960.,28900.,27080.,26000.,25260.,1663.,1748.,3407.,3524.,5151.,52NBS25520
000048               672.,6935.,7056.,8783.,8901.,10720.,10820.,419.7,385.5,377.1,385.1,NBS25530
000049               7401.5,830.7,823.8,826.2,835.9,851.,1261.,1270.,1282.,1297.,1315.,1NBS25540
000050               8668.,1687.,1706.,1724.,1743.,102.2,129.1,159.,159.9,182.2,209.4,22NBS25550
000051               91.1,238.9,263.6,284.8,299.1,321.3,350.8,362.7,383.,419.,429.4/    NBS25560
000052                DATAAC/446.8,88.34,86.3,87.94,91.61,96.51,102.2,162.4,155.2,152.9,NBS25570
000053               1153.5,156.1,159.9,232.5,224.,219.6,218.2,218.9,221.1,299.,291.1,28NBS25580
000054               26.2,284.,283.7,284.8,364.3,357.6,353.2,350.8,350.1,350.8,431.8,424NBS25590
000055               3.8,422.9,420.9,419.,126.4,109.2,98.33,91.88,88.34,201.9,188.NBS25600
000056               44,177.2,168.7,162.4,265.3,255.1,246.2,238.6,232.5,325.1,317.4,310.NBS25610
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000057      54,304.2,299.,384.9,378.8,373.4,368.5,36    448.8,444.5,440.3,436.,NBS25620
000058      6431.8,222.2,174.7,126.4,266.9,233.7,201.9,313.5,288.4,265.3,362.4,NBS25630
000059      7342.7,325.1,414.5,398.7,384.9,465.8,457.3,448.8,-36.57,-.635,35.58NBS25640
000060      8,-24.27,11.37,46.52,-10.41,24.51,59.14,5.035,39.1,73.14,22.05,54.9NBS25650
000061      99,88.32,40.42,72.09,104.7,59.98,90.22,122.,80.6,109.3,140.1,102.2/NBS25660
000062       DATAAD/129.1,159.,-85.55,-76.17,-66.88,-57.67,-48.54,-39.65,-76.14NBS25670
000063      1,-67.02,-57.86,-48.74,-39.63,-30.42,-65.46,-56.63,-47.73,-38.82,-2NBS25680
000064      29.88,-20.81,-53.51,-45.09,-36.51,-27.86,-19.15,-10.41,-40.29,-32.3NBS25690
000065      38,-24.23,-15.89,-7.47,1.17,-25.74,-16.56,-10.9,-2.96,5.14,13.54,-9NBS25700
000066      4.88,-3.58,3.41,10.88,18.6,26.64,7.34,12.46,18.68,25.57,32.85,40.42NBS25710
000067      5,25.89,29.54,34.83,41.04,47.82,54.09,45.69,47.61,51.79,57.23,63.43NBS25720
000068      6,70.29,66.61,66.57,69.53,74.12,79.68,86.,88.34,86.3,87.94,91.61,96NBS25730
000069      7.51,102.2,-129.4,-124.6,-119.8,-115.,-110.3,-105.5,-100.8,-96.08,-NBS25740
000070      891.37,-119.4,-114.9,-110.4,-105.8,-101.2,-96.51,-91.88,-87.21,-82.NBS25750
000071      941,-107.4,-103.4,-99.26,-94.98,-90.6,-86.19,-81.71,-77.23,-72.58/ NBS25760
000072       DATAAE/-92.77,-89.71,-86.23,-82.46,-78.47,-74.37,-70.19,-65.93,-61NBS25770
000073      1.48,-73.53,-72.8,-70.77,-67.93,-64.6,-61.,-57.2,-53.28,-49.11,-41.NBS25780
000074      228,-49.57,-51.87,-50.91,-48.74,-45.9,-42.7,-39.24,-35.44,39.,-18.9NBS25790
000075      3,-26.49,-30.41,-30.39,-28.88,-26.55,-23.74,-20.45,46.52,40.72,37.0NBS25800
000076      41,34.66,33.21,32.38,32.04,32.06,32.49,88.56,79.51,72.99,68.32,65.0NBS25810
000077      51,62.69,61.11,60.1,59.63,126.4,117.8,109.2,103.8,98.33,95.1,91.88,NBS25820
000078      690.11,88.34,-30.39,-29.64,-29.88,-27.72,-26.55,-25.15,-23.74,-22.1NBS25830
000079      77,-20.45,-23.63,-23.33,-22.72,-21.84,-20.77,-19.57,-18.24,-16.82,-NBS25840
000080      815.17,-16.47,-16.59,-16.27,-15.65,-14.8,-13.76,-12.58,-11.27,-9.88NBS25850
000081      9,-8.89,-9.51,-9.56,-9.23,-8.6,-7.75,-6.72,-5.57,-4.14,-.85,-2.07/ NBS25860
000082       DATAAF/-2.56,-2.55,-2.18,-1.55,-.7,.3,1.6,7.68,5.74,4.76,4.38,4.45NBS25870
000083      1,4.85,5.5,6.34,7.34,16.7,13.93,12.37,11.57,11.3,11.45,11.88,12.53,NBS25880
000084      213.52,26.21,22.5,20.28,19.02,18.39,18.24,18.43,18.89,19.7,36.36,31NBS25890
000085      3.44,28.52,26.72,25.7,25.22,25.15,25.4,25.89,46.52,40.72,37.01,34.6NBS25900
000086      46,32.21,32.38,32.04,32.06,32.49,95.17,80.15,65.54,53.23,44.02,37.3NBS25910
000087      58,32.55,28.95,26.21,115.7,104.1,92.37,81.05,70.96,62.55,55.86,50.6NBS25920
000088      62,46.52,132.6,123.2,113.6,104.,94.83,86.45,79.09,72.87,67.54,147.7NBS25930
000089      7,139.7,131.4,123.3,115.3,107.6,100.5,94.17,88.56,161.6,154.5,147.3NBS25940
000090      8,140.2,133.2,126.3,119.8,113.7,107.5,174.7,168.7,162.6,156.6,150.5NBS25950
000091      9,144.5,138.5,132.4,126.4,177.4,161.6,143.4,121.8,95.2,186.3,171.7/NBS25960
000092       DATAAG/155.4,136.8,115.7,195.1,181.6,166.8,150.5,132.6,204.,191.4,NBS25970
000093      1177.9,163.3,147.7,212.9,201.2,188.7,175.5,161.6,222.2,210.3,198.5,NBS25980
000094      2186.6,174.7,-30.41,-30.63,-30.67,-30.59,-30.39,-22.5,-23.09,-23.44NBS25990
000095      3,-23.6,-23.63,-13.86,-14.96,-15.7,-16.18,-16.47,-4.37,-6.14,-7.4,-NBS26000
000096      48.28,-8.89,6.14,3.46,1.54,.16,-.85,17.79,13.93,11.18,9.17,7.68,30.NBS26010
000097      552,25.28,21.52,18.77,16.7,44.02,37.38,32.55,28.95,26.21,-26.48,-27NBS26020
000098      6.26,-27.92,-28.45,-28.92,-29.3,-29.62,-29.88,-30.1,-30.28,-30.41,-NBS26030
000099      721.02,-22.11,-23.,-23.75,-24.38,-24.9,-25.36,-25.73,-26.06,-26.32,NBS26040
000100      8-26.46,-14.94,-16.45,-17.67,-18.68,-19.53,-20.25,-20.85,-21.37,-21NBS26050
000101      9.81,-22.19,-22.5,-8.03,-10.16,-11.84,-13.21,-14.34,-15.28,-16.09/ NBS26060
000102       DATAAH/-16.77,-17.35,-17.85,-18.18,.01,-3.05,-5.37,-7.22,-8.72,-9.NBS26070
000103      196,-11.01,-11.9,-12.66,-13.31,-13.86,9.41,5.12,1.87,-.61,-2.6,-4.2NBS26080
000104      23,-5.58,-6.72,-7.69,-8.52,-9.12,20.71,14.43,10.1,6.72,4.1,1.99,.26NBS26090
000105      3,-1.19,-2.42,-3.47,-4.37,33.45,25.24,19.25,14.8,11.45,8.74,6.54,4.NBS26100
000106      471,3.17,1.87,.88,45.95,36.79,29.44,23.8,19.44,16.07,13.29,11.02,9.NBS26110
000107      512,7.51,6.14,56.31,47.94,39.94,33.35,28.09,23.89,20.51,17.76,15.44NBS26120
000108      6,13.49,11.96,66.66,58.21,50.23,43.14,37.17,32.25,28.21,24.89,22.11NBS26130
000109      7,19.78,17.79,74.56,67.32,59.73,52.62,46.26,40.81,36.2,32.35,29.11,NBS26140
000110      826.37,24.15,82.45,75.41,68.34,61.5,55.11,49.35,44.34,40.03,36.35,3NBS26150
000111      93.21,30.52,88.81,82.65,76.12,69.66,63.44,57.66,52.4,47.78,43.74/  NBS26160
000112       DATAAI/40.24,37.27,95.17,89.16,83.15,77.23,71.38,65.54,60.61,55.69NBS26170
000113      1,51.39,47.7,44.02,104.9,98.01,90.23,81.37,71.12,59.16,45.59,31.88,NBS26180
000114      220.95,113.3,107.3,100.8,93.63,85.67,76.79,66.95,56.39,45.95,120.4,NBS26190
000115      3115.8,110.2,104.2,97.75,90.73,83.18,75.1,66.66,127.6,123.6,118.7,1NBS26200
000116      413.4,107.8,102.1,95.85,89.29,82.45,134.8,130.4,126.1,121.8,116.4,1NBS26210
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000117                511.1,105.8,100.5,95.17,65.16,51.82,-3.47,-10.85,-14.26,-16.57,-18.NBS26220
000118                637,-19.82,-21.02,-22.04,-22.92,-23.69,-24.38,-24.99,-25.54,-26.04,NBS26230
000119                7-26.48,74.13,67.69,57.36,39.09,5.99,-3.23,-7.63,-10.52,-12.65,-14.NBS26240
000120                837,-15.78,-16.98,-18.,-18.9,-19.69,-20.39,-21.02,83.09,77.17,70.3,NBS26250
000121                961.77,50.17,31.98,12.48,3.55,-1.09,-4.43,-6.93,-8.9,-10.49,-11.86/NBS26260
000122                 DATAAJ/-13.03,-14.04,-14.94,89.04,84.56,79.06,72.84,65.52,56.54,44NBS26270
000123                1.99,30.6,17.92,9.94,4.89,1.51,-1.24,-3.43,-5.22,-6.72,-8.03,94.98,NBS26280
000124                290.77,86.16,81.07,75.42,69.01,61.59,52.84,42.58,31.64,22.32,15.46,NBS26290
000125                310.57,6.94,4.28,1.95,.01,99.84,96.27,92.24,87.87,83.15,77.97,72.25NBS26300
000126                4,65.86,58.68,50.67,42.06,33.59,26.31,20.44,15.88,12.29,9.41,104.7,NBS26310
000127                5101.3,97.67,93.82,89.72,85.3,80.54,75.38,69.76,63.63,56.98,49.93,4NBS26320
000128                62.76,35.94,29.96,24.89,20.71,109.1,105.9,102.6,99.07,95.49,91.5,87NBS26330
000129                7.5,82.95,78.39,73.16,67.98,62.13,56.27,50.2,44.14,38.79,33.45,71.,NBS26340
000130                837.3,0.,0.,0.,84.3,57.3,0.,0.,0.,97.6,72.9,43.,0.,0.,110.9,89.8,62NBS26350
000131                9.,0.,0.,124.2,107.4,83.28,48.,0.,137.5,123.5,105.9,81.,0.,150.7/  NBS26360
000132                 DATAAK/138.8,124.9,108.5,85.9,164.1,153.6,142.,128.9,113.3,177.4,1NBS26370
000133                167.9,158.,147.,134.8,78.8,62.3,45.4,0.,0.,89.8,78.3,61.,41.9,29.1,NBS26380
000134                298.8,90.1,78.9,60.1,27.8,106.7,99.5,91.1,80.6,65.2,114.,107.8,100.NBS26390
000135                38,92.8,83.1,120.8,115.2,109.2,102.5,95.,19700.,19330.,19260.,23000NBS26400
000136                4.,22040.,21810.,27350.,25260.,24730.,21390.,19940.,19580.,27180.,2NBS26410
000137                53580.,22680.,36230.,28590.,26650.,22560.,21170.,20520.,30320.,2664NBS26420
000138                60.,25020.,42210.,35060.,31640.,32960.,28900.,27090.,26000.,25260.,NBS26430
000139                740130.,34330.,31710.,30130.,29050.,49050.,41170.,37530.,35320.,338NBS26440
000140                810.,59610.,49530.,44710.,41750.,39690.,71190.,59240.,53210.,49420.NBS26450
000141                9,46750.,82920.,69950.,62910.,58310.,55020.,27100.,23410.,22100./  NBS26460
000142                 DATAAL/21520.,31750.,26350.,24440.,23590.,37610.,30000.,27280.,260NBS26470
000143                170.,44900.,34480.,30730.,29050.,53610.,39900.,34870.,32610.,63710.NBS26480
000144                2,46340.,39810.,36850./                                           NBS26490
000145                 P=PRES                                                           NBS26500
000146                 IF(P.LT.1.0) P=1.0                                               NBS26510
000147                 T=TEMP                                                           NBS26520
000148                 IF(T.LT.90.0) GO TO 10                                           NBS26530
000149                 IF(T.LT.3000.0) GO TO 5                                          NBS26540
000150                 IF(T.GE.6000.0) T=5999.99999                                     NBS26550
000151                 IF(P.LT.30.0) GO TO 3                                            NBS26560
000152                 IF(P.LT.80.0) GO TO 2                                            NBS26570
000153                 IF(P.LT.500.0) GO TO 1                                           NBS26580
000154                 N=1                                                              NBS26590
000155                 N1=25                                                            NBS26600
000156                 GO TO 33                                                         NBS26610
000157               1 N=2                                                              NBS26620
000158                 N1=26                                                            NBS26630
000159                 GO TO 33                                                         NBS26640
000160               2 N=3                                                              NBS26650
000161                 N1=27                                                            NBS26660
000162                 GO TO 33                                                         NBS26670
000163               3 IF(P.LT.5.0) GO TO 4                                             NBS26680
000164                 N=4                                                              NBS26690
000165                 N1=29                                                            NBS26700
000166                 GO TO 33                                                         NBS26710
000167               4 N=5                                                              NBS26720
000168                 N1=28                                                            NBS26730
000169                 GO TO 33                                                         NBS26740
000170               5 IF(T.LT.180.0) GO TO 70                                          NBS26750
000171                 IF(T.LT.500.0) GO TO 6                                           NBS26760
000172                 N=6                                                              NBS26770
000173                 GO TO 33                                                         NBS26780
000174               6 N=7                                                              NBS26790
000175                 GO TO 33                                                         NBS26800
000176              70 IF(P.LT.1175.68) GO TO 8                                         NBS26810
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000177                IF(P.LT.2645.28) GO TO 7                                  NBS26820
000178                N=8                                                       NBS26830
000179                GO TO 33                                                  NBS26840
000180              7 N=9                                                       NBS26850
000181                GO TO 33                                                  NBS26860
000182              8 IF(P.LT.587.84) GO TO 9                                   NBS26870
000183                N=10                                                      NBS26880
000184                GO TO 33                                                  NBS26890
000185              9 N=11                                                      NBS26900
000186                GO TO 33                                                  NBS26910
000187             10 IF(P.LT.1175.68) GO TO 12                                 NBS26920
000188                IF(P.LT.2645.28) GO TO 11                                 NBS26930
000189                N=12                                                      NBS26940
000190                GO TO 30                                                  NBS26950
000191             11 N=13                                                     NBS26960
000192                GO TO 30                                                  NBS26970
000193             12 IF(T.GE.59.4) GO TO 15                                   NBS26980
000194                N=14                                                      NBS26990
000195                IF(P.GE.187.6385) GO TO 30                                NBS27000
000196                DO 13 I=2,20                                              NBS27010
000197                IF(P-PS(I))14,14,13                                       NBS27020
000198             13 CONTINUE                                                 NBS27030
000199                I=20                                                      NBS27040
000200             14 TM=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))   NBS27050
000201                IF(T.LE.TM) GO TO 30                                      NBS27060
000202                GO TO 23                                                  NBS27070
000203             15 IF(P.LT.293.92) GO TO 20                                  NBS27080
000204                IF(P.GE.587.84) GO TO 18                                  NBS27090
000205                IF(T.GE.72.0) GO TO 17                                    NBS27100
000206                IF(P.LT.440.88) GO TO 16                                  NBS27110
000207                N=19                                                      NBS27120
000208                GO TO 33                                                  NBS27130
000209             16 N=20                                                     NBS27140
000210                GO TO 33                                                  NBS27150
000211             17 N=17                                                     NBS27160
000212                GO TO 33                                                  NBS27170
000213             18 IF(T.LT.75.6) GO TO 19                                   NBS27180
000214                N=15                                                      NBS27190
000215                GO TO 33                                                  NBS27200
000216             19 N=16                                                     NBS27210
000217                GO TO 33                                                  NBS27220
000218             20 IF(T.GE.72.0)GO TO 22                                    NBS27230
000219                IF(P.LT.176.352) GO TO 23                                 NBS27240
000220                IF(T.LT.65.7) GO TO 21                                    NBS27250
000221                N=21                                                      NBS27260
000222                GO TO 33                                                  NBS27270
000223             21 N=22                                                     NBS27280
000224                GO TO 33                                                  NBS27290
000225             22 N=18                                                     NBS27300
000226                GO TO 33                                                  NBS27310
000227             23 N=23                                                     NBS27320
000228                IF(P.GE.117.568.AND.T.LE.63.) N=24                        NBS27330
000229                GO TO 33                                                  NBS27340
000230             30 F=P/587.84                                               NBS27350
000231                I=F                                                       NBS27360
000232                IF(I.GT.8) I=8                                            NBS27370
000233                FI=I                                                      NBS27380
000234                F=F-FI                                                    NBS27390
000235                FP=1.0-F                                                  NBS27400
000236                TO=FP*TL(I+1)+F*TL(I+2)                                   NBS27410
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000237              IF(T.GE.TQ) GO TO 33                                    NBS27420
000238              PTENTH=FP*HS(I+1)+F*HS(I+2)                             NBS27430
000239              RETURN                                                  NBS27440
000240           33 IF(T.LE.5000.)N1=N                                      NBS27450
000241              FP=(P-BP(N))/DP(N)                                      NBS27460
000242              IP=FP                                                   NBS27470
000243              IF(IP.GT.MX(N)) IP=MX(N)                                NBS27480
000244              FI=IP                                                   NBS27490
000245              F=FP-FI                                                 NBS27500
000246              FP=1.0-F                                                NBS27510
000247              FT=(T-BT(N1))/DT(N)                                     NBS27520
000248              IT=FT                                                   NBS27530
000249              FI=IT                                                   NBS27540
000250              FF=FT-FI                                                NBS27550
000251              FT=1.0-FF                                               NBS27560
000252              I=IT*JP(N)+IP+LOC(N1)                                   NBS27570
000253              J=I+JP(N)                                               NBS27580
000254              PTENTH=FP*FT*H(I)+F*FT*H(I+1)+FP*FF*H(J)+F*FF*H(J+1)    NBS27590
000255              RETURN                                                  NBS27600
000256              END                                                     NBS27610
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000237                  IF(T.GE.TQ) GO TO 33                                    NBS27420
000238                  PTENTH=FP*HS(I+1)+F*HS(I+2)                             NBS27430
000239                  RETURN                                                  NBS27440
000240               33 IF(T.LE.5000.)N1=N                                      NBS27450
000241                  FP=(P-BP(N))/DP(N)                                      NBS27460
000242                  IP=FP                                                   NBS27470
000243                  IF(IP.GT.MX(N)) IP=MX(N)                                NBS27480
000244                  FI=IP                                                   NBS27490
000245                  F=FP-FI                                                 NBS27500
000246                  FP=1.0-F                                                NBS27510
000247                  FT=(T-BT(N1))/DT(N)                                     NBS27520
000248                  IT=FT                                                   NBS27530
000249                  FI=IT                                                   NBS27540
000250                  FF=FT-FI                                                NBS27550
000251                  FT=1.0-FF                                               NBS27560
000252                  I=IT*JP(N)+IP+LOC(N1)                                   NBS27570
000253                  J=I+JP(N)                                               NBS27580
000254                  PTENTH=FP*FT*H(I)+F*FT*H(I+1)+FP*FF*H(J)+F*FF*H(J+1)    NBS27590
000255                  RETURN                                                  NBS27600
000256                  END                                                     NBS27610
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@ ELT PTENTR,1,711119, 35526

000001                FUNCTION   PTENTR(PRES,TEMP).                                                    NBS15250
000002                DIMENSION LOC(30),JP(26),MX(26),BP(26),DP(26),BT(30),DT(26),PS(20)NBS15260
000003               1,TS(20),S(748)                                                                   NBS15270
000004                DIMENSION AA(111),AB(110),AC(111),AD(112),AE(110),AF(111),AG( 83)  NBS15280
000005                EQUIVALENCE( S,AA),( S( 112),AB),( S( 222),AC),( S( 333),AD)       NBS15290
000006               1     ,( S( 445),AE),( S( 555),AF),( S( 666),AG)                     NBS15300
000007                DATA LOC/1,17,33,49,77,101,125,149,167,187,207,227,242,278,328,364NBS15310
000008               1,384,404,434,464,484,520,536,635,663,683,713,721,729,737/          NBS15320
000009                DATA JP/4,4,4,4,4,4,4,3,5,4,4,3,4,5,6,5,5,6,5,5,6,4,11,4,4,5/      NBS15330
000010                DATA MX/2,2,2,2,2,2,2,1,3,2,2,1,2,3,4,3,3,4,3,3,4,2,9,2,2,3/       NBS15340
000011                DATA BP/0.,0.,0.,1.,0.,0.,0.,1.,    0.,0.,0.,1.,1469.6,587.84,0.,  NBS15350
000012               10.,0.,0.,440.88,146.96,257.18,183.7,183.7,58.784,0.,0./            NBS15360
000013                DATA DP/1000.,100.,10.,1.,1000.,100.,10.,1.,1000.,100.,10.,1.,     NBS15370
000014               11175.68,293.92,146.96,14.696,1.4696,146.96,73.48,73.48,36.74,      NBS15380
000015               229.392,7.348,44.088,14.696,1.4696/                                 NBS15390
000016                DATA BT/2000.,2000.,2000.,2000.,500.,500.,500.,500.,170.,180.,180.NBS15400
000017               1,180.,36.,18.,90.,72.,72.,27.,54.,68.4,59.4,63.,59.4,46.8,32.4,18.NBS15410
000018               2,5000.,5000.,5000.,5000./                                          NBS15420
000019                DATA DT/1000.,1000.,1000.,500.,300.,300.,300.,300.,110.,80.,80.,80NBS15430
000020               1.,18.,18.,18.,36.,36.,9.,7.2,7.2,1.8,1.8,.45,7.2,14.4,14.4/        NBS15440
000021                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,165.,176.,182NBS15450
000022               1.,185.,186.5,187.25,187.46875,187.506,187.6385/                    NBS15460
000023                DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,54.NBS15470
000024               179,56.72,57.80,58.57,58.99,59.18,59.29,59.34,59.353,59.356,59.4/   NBS15480
000025                DATAAA/17.4,15.9,15.22,14.82,18.93,17.43,16.74,16.34,20.11,18.59,1NBS15490
000026               17.91,17.51,21.23,19.63,18.92,18.51,19.67,18.17,17.49,17.09,21.2,19NBS15500
000027               2.69,19.01,18.61,22.42,20.88,20.19,19.79,23.92,22.11,21.34,20.9,21.NBS15510
000028               38,20.44,19.75,19.35,23.33,21.96,21.28,20.88,24.67,23.22,22.51,22.1NBS15520
000029               4,27.23,25.05,24.08,23.55,22.71,22.02,21.62,21.34,23.53,22.85,22.45NBS15530
000030               5,22.16,24.24,23.55,23.15,22.87,24.91,24.2,23.8,23.51,25.71,24.93,2NBS15540
000031               64.49,24.18,27.02,26.,25.46,25.08,29.42,27.85,27.05,26.52,12.54,11.NBS15550
000032               703,10.33,9.925,14.19,12.69,12.,11.6,15.3,13.79,13.11,12.71,16.14,1NBS15560
000033               84.64,13.95,13.55,16.82,15.32,14.64,14.24,17.4,15.9,15.22,14.82,14.NBS15570
000034               981,13.31,12.62,12.22,16.46,14.96,14.27,13.87,17.57,16.06,15.38/    NBS15580
000035                DATAAB/14.98,18.41,16.9,16.22,15.82,19.09,17.59,16.9,16.51,19.67,1NBS15590
000036               18.17,17.49,17.09,17.08,15.58,14.89,14.49,18.73,17.22,16.54,16.14,1NBS15600
000037               29.83,18.33,17.65,17.25,20.68,19.17,18.49,18.09,21.36,19.86,19.17,1NBS15610
000038               38.77,21.94,20.44,19.75,19.35,17.85,17.16,16.76,19.49,18.81,18.41,2NBS15620
000039               40.6,19.91,19.51,21.44,20.76,20.36,22.12,21.44,21.04,22.71,22.02,21NBS15630
000040               5.62,8.610,6.812,6.012,5.557,5.304,10.34,8.766,8.027,7.589,7.28,11.NBS15640
000041               663,10.1,9.39,8.972,8.674,12.54,11.03,10.33,9.925,9.634,11.03,9.498NBS15650
000042               7,8.793,8.371,12.33,10.82,10.12,9.713,13.37,11.87,11.18,10.77,14.18NBS15660
000043               8,12.67,11.99,11.58,14.81,13.31,12.62,12.22,13.3,11.79,11.1,10.7,14NBS15670
000044               9.6,13.09,12.41,12.01,15.64,14.14,13.45,13.05,16.45,14.94,14.26/    NBS15680
000045                DATAAC/13.86,17.08,15.58,14.89,14.49,14.06,13.37,12.97,15.36,14.68NBS15690
000046               1,14.28,16.41,15.72,15.32,17.21,16.53,16.13,17.85,17.16,16.76,1.521NBS15700
000047               2,1.365,1.245,1.155,2.387,2.16,1.993,1.863,3.191,2.876,2.66,2.5,3.9NBS15710
000048               343,3.52,3.256,3.067,4.624,4.105,3.793,3.577,5.212,4.628,4.278,4.04NBS15720
000049               41,5.713,5.101,4.724,4.468,6.153,5.532,5.14,4.871,6.756,6.015,5.57,NBS15730
000050               55.254,.694,.661,.635,.612,.59,1.702,1.638,1.58,1.529,1.482,2.706,2NBS15740
000051               6.584,2.484,2.401,2.33,3.832,3.552,3.359,3.221,3.112,5.045,4.541,4.NBS15750
000052               7209,3.994,3.837,5.654,5.342,4.96,4.692,4.494,6.407,5.933,5.561,5.2NBS15760
000053               881,5.068,6.855,6.409,6.054,5.779,5.56,7.246,6.822,6.482,6.215,5.99NBS15770
000054               98,7.749,7.252,6.941,6.756,6.571,8.628,7.088,6.213,5.608,5.141/     NBS15780
000055                DATAAD/4.793,9.082,7.606,6.811,6.3,5.91,5.598,9.461,8.037,7.279,6.NBS15790
000056               1807,6.458,6.17,9.84,8.42,7.682,7.23,6.897,6.632,10.18,8.773,8.049,NBS15800
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000057                27.61,7.29,7.034,10.64,9.167,8.397,7.997,7.749,7.5,10.43,9.048,8.34NBS15810
000058                33,7.921,7.617,11.35,9.972,9.279,8.869,8.574,12.11,10.74,10.05,9.64NBS15820
000059                44,9.355,12.91,11.47,10.72,10.35,10.13,12.53,11.34,10.65,10.25,9.96NBS15830
000060                5,13.41,12.25,11.57,11.17,10.88,14.18,13.01,12.33,11.93,11.64,14.74NBS15840
000061                6,13.73,13.,12.6,12.4,1.32,1.286,1.254,1.224,1.198,1.173,1.881,1.82NBS15850
000062                78,1.762,1.742,1.704,1.67,2.488,2.395,2.32,2.257,2.204,2.157,3.399,NBS15860
000063                83.096,2.915,2.801,2.715,2.645,4.313,4.157,3.659,3.404,3.254,3.168,NBS15870
000064                92.766,2.734,2.7,2.672,2.645,3.293,3.215,3.151,3.096,3.063,3.914/  NBS15880
000065                 DATAAE/3.749,3.633,3.544,3.482,4.653,4.368,4.172,4.029,3.912,5.214NBS15890
000066                1,4.934,4.703,4.519,4.353,5.608,5.374,5.141,4.967,4.793,6.198,5.528NBS15900
000067                2,4.808,4.203,3.914,6.523,5.983,5.495,5.042,4.653,6.804,6.318,5.899NBS15910
000068                3,5.536,5.214,7.088,6.65,6.213,5.91,5.608,3.444,3.361,3.311,3.261,3NBS15920
000069                4.212,3.162,3.689,3.553,3.464,3.396,3.341,3.293,4.081,3.793,3.655,3NBS15930
000070                5.562,3.491,3.448,4.621,4.117,3.804,3.749,3.654,3.603,4.957,4.502,4NBS15940
000071                6.16,3.963,3.835,3.759,5.168,4.809,4.506,4.203,4.059,3.914,5.383,5.NBS15950
000072                701,4.358,3.804,5.543,5.265,4.86,4.382,5.703,5.447,5.13,4.785,5.863NBS15960
000073                8,5.595,5.312,5.024,4.8,3.855,3.722,3.656,3.609,3.571,3.539,3.512,3NBS15970
000074                9.487,3.464,3.444,4.906,4.675,3.932,3.777,3.703,3.653,3.611,3.577/ NBS15980
000075                 DATAAF/3.548,3.521,3.505,5.011,4.824,4.555,3.994,3.832,3.751,3.695NBS15990
000076                1,3.651,3.615,3.584,3.566,5.117,4.995,4.795,4.466,4.043,3.881,3.797NBS16000
000077                2,3.737,3.69,3.652,3.628,5.222,5.088,4.929,4.723,4.411,4.081,3.926,NBS16010
000078                33.841,3.778,3.729,3.689,5.262,5.164,5.028,4.867,4.66,4.38,4.118,3.NBS16020
000079                4971,3.881,3.819,3.787,5.302,5.23,5.109,4.972,4.81,4.609,4.365,4.15NBS16030
000080                5,4.011,3.921,3.885,5.342,5.289,5.178,5.057,4.921,4.761,4.572,4.359NBS16040
000081                6,4.176,4.048,3.983,5.383,5.29,5.197,5.103,5.01,4.847,4.684,4.521,4NBS16050
000082                7.358,4.219,4.081,6.153,5.054,3.633,0.,6.657,5.81,4.872,3.95,7.039,NBS16060
000083                86.324,5.749,5.117,7.335,6.694,6.213,5.793,7.631,6.997,6.555,6.192,NBS16070
000084                97.863,7.259,6.841,6.505,8.095,7.55,7.088,6.825,8.321,6.889,6.071/ NBS16080
000085                 DATAAG/5.473,9.283,7.84,7.07,6.568,9.939,8.536,7.812,7.369,10.46,9NBS16090
000086                1.072,8.364,7.94,10.89,9.51,8.811,8.395,9.14,8.02,7.35,6.94,6.65,10NBS16100
000087                2.45,9.26,8.56,8.14,7.84,11.36,10.18,9.49,9.08,8.79,12.01,10.84,10.NBS16110
000088                315,9.75,9.46,12.53,11.36,10.68,10.27,9.99,12.97,11.79,11.11,10.71,NBS16120
000089                410.42,21.23,19.63,18.92,18.51,22.71,20.78,19.97,19.51,23.92,22.11,NBS16130
000090                521.34,20.9,26.84,24.,22.91,22.33,27.23,25.05,24.08,23.55,33.82,29.NBS16140
000091                619,27.26,26.33,29.42,27.85,27.05,26.52,33.46,30.94,29.69,28.88,38.NBS16150
000092                747,35.25,33.5,32.35/                                               NBS16160
000093                 P=PRES                                                             NBS16170
000094                 IF(P.LT.1.0) P=1.0                                                 NBS16180
000095                 T=TEMP                                                             NBS16190
000096                 IF(T.LT.180.) GO TO 12                                             NBS16200
000097                 IF(T.LT.2000.)GO TO 4                                              NBS16210
000098                 IF(T.GE.6000.0) T=5999.                                            NBS16220
000099                 IF(P.LT.35.3) GO TO 2                                              NBS16230
000100                 IF(P.LT.353.) GO TO 1                                              NBS16240
000101                 N=1                                                                NBS16250
000102                 N1=27                                                              NBS16260
000103                 GO TO 33                                                           NBS16270
000104               1 N=2                                                                NBS16280
000105                 N1=28                                                              NBS16290
000106                 GO TO 33                                                           NBS16300
000107               2 IF(P.LT.4.57) GO TO 3                                              NBS16310
000108                 N=3                                                                NBS16320
000109                 N1=29                                                              NBS16330
000110                 GO TO 33                                                           NBS16340
000111               3 N=4                                                                NBS16350
000112                 N1=30                                                              NBS16360
000113                 GO TO 33                                                           NBS16370
000114               4 IF(T.LT.500.) GO TO 8                                              NBS16380
000115                 IF(P.LT.35.3) GO TO 6                                              NBS16390
000116                 IF(P.LT.353.) GO TO 5                                              NBS16400
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000117            N=5                                                   NBS16410
000118            GO TO 33                                              NBS16420
000119          5 N=6                                                   NBS16430
000120            GO TO 33                                              NBS16440
000121          6 IF(P.LT.3.53) GO TO 7                                 NBS16450
000122            N=7                                                   NBS16460
000123            GO TO 33                                              NBS16470
000124          7 N=8                                                   NBS16480
000125            GO TO 33                                              NBS16490
000126          8 IF(P.LT.35.3) GO TO 10                                NBS16500
000127            IF(P.LT.353.) GO TO 9                                 NBS16510
000128            N=9                                                   NBS16520
000129            GO TO 33                                              NBS16530
000130          9 N=10                                                  NBS16540
000131            GO TO 33                                              NBS16550
000132         10 IF(P.LT.3.53) GO TO 11                                NBS16560
000133            N=11                                                  NBS16570
000134            GO TO 33                                              NBS16580
000135         11 N=12                                                  NBS16590
000136            GO TO 33                                              NBS16600
000137         12 IF(T.GE.59.4) GO TO 18                                NBS16610
000138            TZ=24.84+0.00317*P                                    NBS16620
000139            IF(T.LT.TZ) T=TZ                                      NBS16630
000140            IF(P.LT.1763.52) GO TO 14                             NBS16640
000141            N=13                                                  NBS16650
000142            GO TO 33                                              NBS16660
000143         14 IF(P.LT.734.8) GO TO 15                               NBS16670
000144            N=14                                                  NBS16680
000145            GO TO 33                                              NBS16690
000146         15 N=18                                                  NBS16700
000147            IF(P.GE.187.6385)GO TO 33                             NBS16710
000148            DO 16 I=2,20                                          NBS16720
000149            IF(P-PS(I))17,17,16                                   NBS16730
000150         16 CONTINUE                                              NBS16740
000151            I=20                                                  NBS16750
000152         17 TZ=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1)) NBS16760
000153            IF(T.LT.TZ) GO TO 33                                  NBS16770
000154            GO TO 28                                              NBS16780
000155         18 IF(P.LT.734.8) GO TO 20                               NBS16790
000156            IF(P.LT.1763.52) GO TO 19                             NBS16800
000157            N=13                                                  NBS16810
000158            GO TO 33                                              NBS16820
000159         19 N=14                                                  NBS16830
000160            GO TO 33                                              NBS16840
000161         20 IF(T.LT.90.) GO TO 23                                 NBS16850
000162            IF(P.GE.67.16) GO TO 22                               NBS16860
000163            IF(P.LT.6.716) GO TO 21                               NBS16870
000164            N=16                                                  NBS16880
000165            GO TO 33                                              NBS16890
000166         21 N=17                                                  NBS16900
000167            GO TO 33                                              NBS16910
000168         22 N=15                                                  NBS16920
000169            GO TO 33                                              NBS16930
000170         23 IF(P.LT.183.7) GO TO 28                               NBS16940
000171            IF(P.LT.440.88) GO TO 24                              NBS16950
000172            N=19                                                  NBS16960
000173            GO TO 33                                              NBS16970
000174         24 IF(T.LT.68.4) GO TO 25                                NBS16980
000175            N=20                                                  NBS16990
000176            GO TO 33                                              NBS17000
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000177          25 IF(P.LT.257.18) GO TO 26                                    NBS17010
000178             N=21                                                        NBS17020
000179             GO TO 33                                                    NBS17030
000180          26 IF(T.LT.63.)GO TO 27                                        NBS17040
000181             N=22                                                        NBS17050
000182             GO TO 33                                                    NBS17060
000183          27 N=23                                                        NBS17070
000184             GO TO 33                                                    NBS17080
000185          28 IF(P.LT.6.716) GO TO 30                                     NBS17090
000186             IF(P.LT.48.5)  GO TO 29                                     NBS17100
000187             N=24                                                        NBS17110
000188             GO TO 33                                                    NBS17120
000189          29 N=25                                                        NBS17130
000190             GO TO 33                                                    NBS17140
000191          30 N=26                                                        NBS17150
000192          33 IF(T.LE.5000.)N1=N                                          NBS17160
000193             FP=(P-BP(N))/DP(N)                                          NBS17170
000194             IP=FP                                                       NBS17180
000195             IF(IP.GT.MX(N)) IP=MX(N)                                    NBS17190
000196             FI=IP                                                       NBS17200
000197             F=FP-FI                                                     NBS17210
000198             FP=1.0-F                                                    NBS17220
000199             FT=(T-BT(N1))/DT(N)                                         NBS17230
000200             IT=FT                                                       NBS17240
000201             FI=IT                                                       NBS17250
000202             FF=FT-FI                                                    NBS17260
000203             FT=1.0-FF                                                   NBS17270
000204             I=IT*JP(N)+IP+LOC(N1)                                       NBS17280
000205             J=I+JP(N)                                                   NBS17290
000206             PTEMTR=FP*FT*S(I)+F*FT*S(I+1)+FP*FF*S(J)+F*FF*S(J+1)        NBS17300
000207             RETURN                                                      NBS17310
000208             END                                                         NBS17320
```

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@ ELT PTGAS,1,711119, 35527

000001                SUBROUTINE PTGAS(P,T)                                          1782
000002          C
000003          C     SUBROUTINE TO GET THERMODYNAMIC PROPERTIES OF THE GAS SIDE FLUID
000004          C     MODIFIED NOVEMBER 1971  J J WILLIAMS
000005                COMMON /INT/  IKMAX    ,ILHITE   ,ICGITE   ,IITREL   ,IKERR    1785
000006               1   ,IN       ,ITUBE    ,INUM     ,IDIS     ,IFRIC    ,ITNUM1  1786
000007               3       , IZPTS , IZSTEP                                        1787
000008               4    ,IWALL, IMERCR , IHGC, IHLC, IFILM, IRBO, I8085 ,ICOOL     1788
000009                COMMON/FLUIDP/A1,A2,A3,A4,A5,A6,A7,A8,A9,A10,A11,A12,A13,A14(22) 1789
000010                COMMON/TRANS/GAST(50),GASCP(50),GASK(50),GASRHO(50),GASMU(50)    1790
000011                COMMON/JOHNC/TAHG(50),IGAS,IK5,DEP,LCOOL,LGAS
000012                IPAUL=50
000013                 A 4 =T                                                         1791
000014                  A 1 =P                                                        1792
000015                GO TO (1,2,10),IGAS
000016           1    CONTINUE                                                       1794
000017          C     NBS EQUILIBRIUM HYDROGEN      (IGAS=1)
000018                A11=ETVISC(A1,A4)
000019                A7 =ETCP  (A1,A4)
000020                A8 =ETSOUN(A1,A4)
000021                A10=ETCOND(A1,A4)
000022                A5 =ETDENS(A1,A4)
000023                A13=ETENTH(A1,A4)
000024              13 RETURN
000025          C     NBS PARA HYDROGEN             (IGAS=2)
000026             10 A11= PTVISC(A1,A4)
000027                A7 = PTCP  (A1,A4)
000028                A8 = PTSOUN(A1,A4)
000029                A10= PTCOND(A1,A4)
000030                A5 = PTDENS(A1,A4)
000031                A13=PTENTH(A1,A4)
000032                GO TO 13
000033           2    CONTINUE                                                       1800
000034          C     INPUT TABULAR DATA            (IGAS=3)
000035                CALL LINT(GAST,GASRHO,T,A5,IPAUL)
000036                CALL LINT(GAST,GASMU,T,A11,IPAUL)
000037                CALL LINT(GAST,GASK,T,A10,IPAUL)
000038                CALL LINT(GAST,GASCP,T,A7,IPAUL)
000039                 RETURN                                                         1799
000040                END
```

```
@ ELT PTH,1,711119, 35528

000001                SUBROUTINE PTH (P, H, TBC)
000002          C     SUBROUTINE TO FIND THE TEMPERATURE OF HYDROGEN GIVEN THE ENTHALPY
000003          C     AND TEMPERATURE     NOVEMBER 1971
000004                COMMON /INT/          IKMAX  , ILHITE , ICGITE , IITREL , IKERR  ,
000005               1    IN     , ITUBE  , INUM   , IDIS   , IFRIC  , ITNUM1 , IZPTS  ,
000006               2    IZSTEP , IWALL  , IMERCR , IHGC   , IHLC   , IFILM  , IRBO   ,
000007               3    I8085  , ICOOL
000008                COMMON /FLUIDP/ A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12,
000009               *                A13, A14(22)
000010                COMMON /JOHNC/ TAHG(50), IGAS, IK5, DEP, LCOOL, LGAS
000011                A13 = H
000012                A1  = P
000013                GO TO (1,2,3,20),, ICOOL
000014              1 TBC=EHTEMP(P,H,QUAL)
000015                RETURN
000016              2 WRITE (6,11)
000017             11 FORMAT (' ****** YOU HAVE A PROBLEM...YOU HAVE ARZ50 IN SUBROUTINE
000018               * PTH ')
000019                STOP
000020              3 WRITE (6,10)
000021             10 FORMAT (' ****** YOU HAVE A PROBLEM...YOU HAVE WATER IN SUBROUTINE
000022               * PTH ')
000023                STOP
000024             20 TBC = PHTEMP (P, H, QUAL)
000025                RETURN
000026                END
```

@ ELT PTHEAT,1,711119, 35531

```
000001                FUNCTION PTHEAT(PRES,TEMP,KTRANS)                                 NBS27740
000002                COMMON/SPHEAT/CP(823),CV(823)                                     NBS27750
000003                DIMENSION LOC(23),JP(19),MX(19),BP(19),DP(19),BT(23),DT(19),PS(12)NBS27760
000004               1,TS(12),TL(10)                                                    NBS27770
000005                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,160./        NBS27780
000006                DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,   NBS27790
000007               154.79,56.72,57.46/                                                NBS27800
000008                DATA LOC/1,50,71,113,133,141,170,165,228,264,348,372,426,492,528, NBS27810
000009               1584,626,638,734,654,682,694,718/                                  NBS27820
000010                DATA JP/7,3,6,5,2,4,9,9,4,7,4,9,6,6,7,7,2,2,5/                    NBS27830
000011                DATA MX/5,1,4,3,0,2,2,4,2,5,2,7,4,4,5,5,0,0,3/                    NBS27840
000012                DATA BP/0.,20.,0.,1000.,100.,-1000.,1469.6,0.,1469.6,587.84,587.84NBS27850
000013               1,0.,100.,100.,40.,40.,0.,0.,1./                                   NBS27860
000014                DATA BT/2600.,2600.,2600.,2600.,800.,300.,120.,120.,25.2,27.,72., NBS27870
000015               181.,25.,56.,26.,41.,25.,25.,2600.,5000.,5000.,5000.,5000./       NBS27880
000016                DATA DP/0.,0.,200.,1000.,2000.,2000.,1175.68,293.92,1175.68,      NBS27890
000017               1146.96,146.96,73.48,100.,100.,20.,20.,40.,40.,1./                 NBS27900
000018                DATA DT/400.,400.,400.,800.,600.,100.,30.,30.,12.6,9.,3.6,9.,5.,  NBS27910
000019               15.,4.,8.,4.,8.,200./                                              NBS27920
000020                DATA TL/24.846,27.175,29.310,31.299,33.176,34.962,36.672,38.317,  NBS27930
000021               139.904,41.456/                                                    NBS27940
000022              1 P=PRES                                                            NBS27950
000023                IF(P.LT.1.0) P=1.0                                                NBS27960
000024                T=TEMP                                                            NBS27970
000025                KTR=KTRANS                                                        NBS27980
000026                IF(T.LT.126.) GO TO 9                                             NBS27990
000027                IF(T.LT.2600.) GO TO 5                                            NBS28000
000028                IF(T.GE.6000.) T=5999.99999                                       NBS28010
000029                IF(P.GE.100.) GO TO 3                                             NBS28020
000030                IF(P.GE.30.) GO TO 2                                              NBS28030
000031                IF(P.GE.5.)GO TO 20                                               NBS28040
000032                N=19                                                              NBS28050
000033                N1=19                                                             NBS28060
000034                GO TO 33                                                          NBS28070
000035             20 N=1                                                             NBS28080
000036                N1=20                                                             NBS28090
000037                GO TO 33                                                          NBS28100
000038             2 N=2                                                              NBS28110
000039                N1=21                                                             NBS28120
000040                GO TO 33                                                          NBS28130
000041             3 IF(P.GE.1000.) GO TO 4                                           NBS28140
000042                N=3                                                               NBS28150
000043                N1=22                                                             NBS28160
000044                GO TO 33                                                          NBS28170
000045             4 N=4                                                              NBS28180
000046                N1=23                                                             NBS28190
000047                GO TO 33                                                          NBS28200
000048             5 IF(T.LT.300.)GO TO 7                                             NBS28210
000049                IF(T.LT.800.)GO TO 6                                              NBS28220
000050                N=5                                                               NBS28230
000051                GO TO 33                                                          NBS28240
000052             6 N=6                                                              NBS28250
000053                GO TO 33                                                          NBS28260
000054             7 IF(P.LT.1469.6) GO TO 8                                          NBS28270
000055                N=7                                                               NBS28280
000056                GO TO 33                                                          NBS28290
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000057          8 N=8                                                          NBS28300
000058            GO TO 33                                                     NBS28310
000059          9 IF(P.LT.587.84) GO TO 12                                     NBS28320
000060            IF(P.LT.1469.6) GO TO 10                                     NBS28330
000061            N=9                                                          NBS28340
000062            GO TO 30                                                     NBS28350
000063         10 IF(P.LT.1028.72.AND.T.GE.72.0.AND.T.LT.90.0) GO TO 11        NBS28360
000064            N=10                                                         NBS28370
000065            GO TO 30                                                     NBS28380
000066         11 N=11                                                         NBS28390
000067            GO TO 33                                                     NBS28400
000068         12 IF(T.LT.81.) GO TO 13                                        NBS28410
000069            N=12                                                         NBS28420
000070            GO TO 33                                                     NBS28430
000071         13 IF(P.LT.1469.) GO TO 15                                      NBS28440
000072            TM=((.86867647E-7*P-.12613701E-3)*P+.10353383)*P+43.8056878  NBS28450
000073            IF(T.GT.TM) GO TO 14                                         NBS28460
000074            N=13                                                         NBS28470
000075            GO TO 33                                                     NBS28480
000076         14 N=14                                                         NBS28490
000077            GO TO 33                                                     NBS28500
000078         15 DO 16 I=2,12                                                 NBS28510
000079            IF(P-PS(I))17,17,16                                          NBS28520
000080         16 CONTINUE                                                     NBS28530
000081            I=12                                                         NBS28540
000082         17 TM=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))       NBS28550
000083            IF(T.GE.TM) GO TO 18                                         NBS28560
000084            N=15                                                         NBS28570
000085            IF(P.LT.40.) N=17                                            NBS28580
000086            GO TO 30                                                     NBS28590
000087         18 N=16                                                         NBS28600
000088            IF(P.LT.40.) N=18                                            NBS28610
000089            GO TO 33                                                     NBS28620
000090         30 F=P/587.84                                                   NBS28630
000091            I=F                                                          NBS28640
000092            IF(I.GT.8) I=8                                               NBS28650
000093            FI=I                                                         NBS28660
000094            F=F-FI                                                       NBS28670
000095            TQ=(1.0-F)*TL(I+1)+F*TL(I+2)                                 NBS28680
000096            IF(T.LT.TQ) T=TQ                                             NBS28690
000097         33 IF(T.LE.5000.)N1=N                                           NBS28700
000098            FP=(P-BP(N))/DP(N)                                           NBS28710
000099            IP=FP                                                        NBS28720
000100            IF(IP.GT.MX(N)) IP=MX(N)                                     NBS28730
000101            FI=I                                                         NBS28740
000102            F=F-FI                                                       NBS28750
000103            FP=1.0-F                                                     NBS28760
000104            FT=(T-BT(N1))/DT(N)                                          NBS28770
000105            IT=FT                                                        NBS28780
000106            FI=IT                                                        NBS28790
000107            FF=FT-FI                                                     NBS28800
000108            FT=1.0-FF                                                    NBS28810
000109            I=IT+JP(N)+IP+LOC(N1)                                        NBS28820
000110            J=I+JP(N)                                                    NBS28830
000111            IF(ATR.EQ.2) GOTO 37                                         NBS28840
000112            CTCP=FP*FT*CP(I)+F*FT*CP(I+1)+FP*FF*CP(J)+F*FF*CP(J+1)       NBS28850
000113            IF(N.LT.13.OR.N.GE.17) GO TO 36                              NBS28860
000114            IF(N.LT.15) GO TO 35                                         NBS28870
000115            CTCP=CTCP/(187.506-P+ABS (T-TM)*28.13)                       NBS28880
000116            GO TO 36                                                     NBS28890
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000117
000118          35 CTCP=CTCP/(ABS (T-TM)/1.8+ABS (P-187.506)*.0080089882)
000119          36 IF(KTR.GE.2) GO TO 37
000120.             PTHEAT=CTCP
000121              RETURN
000122          37 PTHEAT=FP*FT*CV(I)+F*FT*CV(I+1)+FP*FF*CV(J)+F*FF*CV(J+1)
000123              IF(KTR.LT.3) RETURN
000124              PTHEAT=CTCP/PTHEAT
000125              RETURN
                    END
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NBS28900
NBS28910
NBS28920
NBS28930
NBS28940
NBS28950
NBS28960
NBS28970
NBS28980
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@ ELT PTSOUN,1,711119, 35534

000001                FUNCTION PTSOUN(PRES,TEMP)                                                    NBS17330
000002                DIMENSION LOC(23),JP(19),MX(19),BP(19),DP(19),BT(23),DT(19),PS(20)NBS17340
000003               1,TS(20),TL(10),V(522)                                                         NBS17350
000004                DIMENSION AA(105),AB(108),AC(108),AD(112),AE( 89)                             NBS17360
000005                EQUIVALENCE( V,AA),( V( 106),AB),( V( 214),AC),( V( 322),AD)                  NBS17370
000006               1     ,( V( 434),AE)                                                          NBS17380
000007                DATA TL/24.846,27.175,29.310,31.299,33.176,34.962,36.672,38.317,              NBS17390
000008               139.904,41.456/                                                                NBS17400
000009                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,165.,176.,182NBS17410
000010               1.,185.,186.5,187.25,187.46875,187.506,190./                                   NBS17420
000011                DATA TS/24.585,27.07,29.01,32.07,36.19,39.96,44.12,48.33,51.97,54.NBS17430
000012               17?,..?,.,.?,..7,.?.?,?.?,?.?,??.??,??.??,??.??,??.??,??.??,??.??/NBS17440
000013                DATA JP/5,5,5,5,3,7,6,6,11,3,4,4,6,7,4,6,12,7,4/                              NBS17450
000014                DATA MX/0,0,0,0,1,3,2,0,9,1,2,2,4,5,2,4,10,1,0/                               NBS17460
000015                DATA BP/1000.,100.,10.,0.,-3000.,1000.,2000.,1000.,0.,600.,0.,300.NBS17470
000016               1,300.,0.,10.,100.,190.,0.,1000./                                              NBS17480
000017                DATA DP/4000.,900.,90.,10.,4000.,1000.,1000.,500.,100.,200.,200.,NBS17490
000018               1100.,50.,50.,60.,40.,10.,500.,500./                                           NBS17500
000019                DATA BT/800.,800.,800.,800.,240.,120.,20.,20.,20.,25.,25.,50.,63.,NBS17510
000020               166.,25.,50.,60.,120.,50.,5100.,5000.,5000.,5000./                             NBS17520
000021                DATA DT/600.,600.,600.,600.,80.,30.,20.,20.,10.,10.,5.,5.,2.,4.,5.NBS17530
000022               1,2.,1.,30.,10./                                                               NBS17540
000023                DATA LOC/4,3,2,1,41,67,102,100,136,191,212,236,264,300,328,364,400NBS17550
000024               1,65,330,511,510,509,508/                                                      NBS17560
000025                DATAAA/5248.,5250.,5264.,5403.,6048.,6929.,6930.,6940.,7044.,7537.NBS17570
000026               1,8228.,8229.,8237.,8322.,8736.,9301.,9305.,9313.,9386.,9748.,10170NBS17580
000027               2.,10220.,10250.,10320.,10640.,10710.,10950.,11060.,11160.,11460.,1NBS17590
000028               31250.,11490.,11720.,11900.,12210.,12160.,12100.,12280.,12540.,128NBS17600
000029               40.,2135.,3067.,4414.,2590.,3466.,4524.,3033.,3865.,4782.,3445.,422NBS17610
000030               59.,5059.,3824.,4560.,5327.,4169.,4861.,5580.,4488.,5140.,5819.,478NBS17620
000031               63.,5403.,6048.,2183.,2252.,2559.,3409.,4133.,4709.,5180.,2375.,246NBS17630
000032               78.,2663.,3240.,3842.,4374.,4844.,2532.,2640.,2795.,3236.,3726.,418NBS17640
000033               89.,4613.,2681.,2788.,2927.,3284.,3688.,4088.,4471.,2834.,2950.,306NBS17650
000034               97.,3404.,3741.,4077.,4414.,4935.,5128.,5390.,5878.,6057.,6300./      NBS17660
000035                DATAAB/4403.,4737.,5022.,5496.,5895.,6193.,3713.,4199.,4570.,5146.NBS17670
000036               1,5601.,5972.,2957.,3611.,4084.,4775.,5286.,5700.,2578.,3173.,3665.NBS17680
000037               2,4418.,4982.,5416.,2559.,2984.,3409.,4133.,4709.,5180.,1812.,1769.NBS17690
000038               3,1741.,1741.,1793.,1937.,2154.,2374.,2594.,2774.,2954.,1918.,1894.NBS17700
000039               4,1881.,1888.,1915.,1980.,2087.,2228.,2385.,2545.,2701.,2016.,2003.NBS17710
000040               5,1999.,2009.,2034.,2076.,2144.,2232.,2338.,2455.,2578.,2104.,2099.NBS17720
000041               6,2102.,2115.,2139.,2175.,2225.,2290.,2366.,2453.,2568.,2183.,2197.NBS17730
000042               7,2211.,2224.,2238.,2252.,2313.,2375.,2436.,2498.,2559.,4579.,4693.NBS17740
000043               8,4798.,4251.,4405.,4544.,3885.,4080.,4252.,3419.,3685.,3905.,2847.NBS17750
000044               9,3225.,3512.,2306.,2774.,3125.,2002.,2414.,2793.,4163.,4305./      NBS17760
000045                DATAAC/4446.,4580.,3882.,4097.,4268.,4415.,3639.,3875.,4077.,4251.NBS17770
000046               1,3372.,3651.,3880.,4068.,3009.,3377.,3658.,3885.,2470.,3019.,3391.NBS17780
000047               2,3652.,3205.,3391.,3529.,3652.,2839.,3073.,3260.,3419.,2337.,2692.NBS17790
000048               3,2943.,3133.,1699.,2297.,2598.,2847.,1536.,1742.,2204.,2576.,1656.NBS17800
000049               4,1767.,2.1..,1.?.,1741.,1783.,1937.,2158.,1951.,2?0.,2455.,2596.NBS17810
000050               5,2?..,?.?..,1.?.,?.??.,?.??.,?.??.,?.??.,?.??.,1.??.,1.??.,?.??.NBS17820
000051               6,2279.,2451.,2610.,1544.,1692.,1916.,2132.,2315.,2491.,1586.,1656.NBS17830
000052               7,1616.,2010.,2192.,2371.,1608.,1679.,1751.,1921.,2091.,2252.,1671.NBS17840
000053               8,1632.,1592.,1553.,1518.,1503.,1543.,1720.,1687.,1656.,1627.,1603.NBS17850
000054               9,1595.,1586.,1766.,1739.,1714.,1692.,1676.,1669.,1673.,1812./      NBS17860
000055                DATAAD/1790.,1769.,1755.,1741.,1741.,1741.,1016.,677.,2957.,3641.,NBS17870
000056               11117.,?..,2731.,3392.,1215.,993.,2579.,3173.,1304.,1121.,0.,0.,13NBS17880
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000057          285.,1230.,1039.,0.,1461.,1351.,1180.,995.,1532.,1450.,1342.,1166.,NBS17890
000058          31599.,1538.,1468.,1392.,1663.,1616.,1569.,1525.,2745.,2854.,2964.,NBS17900
000059          43056.,3131.,3205.,2498.,2652.,2783.,2892.,2992.,3059.,2105.,2385.,NBS17910
000060          52560.,2700.,2820.,2912.,1800.,2040.,2285.,2475.,2625.,2739.,0.,134NBS17920
000061          62.,1880.,2197.,2400.,2538.,0.,523.,1301.,1804.,2129.,2337.,1249.,1NBS17930
000062          7302.,1669.,1804.,1885.,1967.,2048.,2129.,2181.,2233.,2285.,2337.,1NBS17940
000063          8310.,1285.,1247.,1427.,1634.,1789.,1896.,1966.,2038.,2103.,2161.,2NBS17950
000064          9209.,1357.,1337.,1319.,1302.,1347.,1509.,1660.,1786.,1875.,1953./ NBS17960
000065           DATAAE/2021.,2081.,1392.,1380.,1369.,1358.,1349.,1369.,1468.,1587.NBS17970
000066          1,1697.,1789.,1874.,1954.,1420.,1411.,1402.,1394.,1389.,1386.,1400.NBS17980
000067          2,1458.,1540.,1634.,1724.,1817.,1450.,1442.,1435.,1428.,1422.,1418.NBS17990
000068          3,1420.,1435.,1468.,1532.,1603.,1600.,1476.,1468.,1462.,1457.,1452.NBS18000
000069          4,1448.,1448.,1454.,1469.,1496.,1538.,1611.,1501.,1494.,1488.,1485.NBS18010
000070          5,1482.,1479.,1478.,1479.,1485.,1498.,1518.,1542.,1525.,1518.,1515.NBS18020
000071          6,1512.,1509.,1506.,1503.,1511.,1519.,1527.,1535.,1543.,12160.,1210NBS18030
000072          70.,12280.,12540.,12880.,13260.,12930.,12900.,13120.,13480.,14050.,NBS18040
000073          813900.,13610.,13700.,14050./                                       NBS18050
000074           P=PRES                                                             NBS18060
000075           IF(P.LT.1.0) P=1.0                                                 NBS18070
000076           T=TEMP                                                             NBS18080
000077           IF(T.LT.120.) GO TO 6                                              NBS18090
000078           IF(T.LT.800.) GO TO 4                                              NBS18100
000079           IF(T.GE.6000.0) T=5999.99999                                       NBS18110
000080           IF(P.LT.100.) GO TO 2                                              NBS18120
000081           IF(P.LT.1000.) GO TO 1                                             NBS18130
000082           N=1                                                                NBS18140
000083           N1=20                                                              NBS18150
000084           GO TO 33                                                           NBS18160
000085         1 N=2                                                                NBS18170
000086           N1=21                                                              NBS18180
000087           GO TO 33                                                           NBS18190
000088         2 IF(P.LT.10.)GO TO 3                                                NBS18200
000089           N=3                                                                NBS18210
000090           N1=22                                                              NBS18220
000091           GO TO 33                                                           NBS18230
000092         3 N=4                                                                NBS18240
000093           N1=23                                                              NBS18250
000094           GO TO 33                                                           NBS18260
000095         4 IF(T.LT.240.) GO TO 5                                              NBS18270
000096           N=5                                                                NBS18280
000097           GO TO 33                                                           NBS18290
000098         5 N=6                                                                NBS18300
000099           IF(P.LT.1000.) N=18                                                NBS18310
000100           GO TO 33                                                           NBS18320
000101         6 IF(P.LT.1000.)GO TO 8                                              NBS18330
000102           IF(P.LT.2000.)GO TO 7                                              NBS18340
000103           N=7                                                                NBS18350
000104           GO TO 30                                                           NBS18360
000105         7 N=8                                                                NBS18370
000106           IF((T.LT.100.).AND.(T.GE.80.).AND.(P.LT.1500.)) N=19               NBS18380
000107           GO TO 30                                                           NBS18390
000108         8 IF(T.LT.80.) GO TO 9                                               NBS18400
000109           N=9                                                                NBS18410
000110           GO TO 33                                                           NBS18420
000111         9 IF(P.LT.600.) GO TO 10                                             NBS18430
000112           N=10                                                               NBS18440
000113           GO TO 30                                                           NBS18450
000114        10 IF(P.LT.300.) GO TO 12                                             NBS18460
000115           IF(T.LT.50.) GO TO 11                                              NBS18470
000116           N=12                                                               NBS18480
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000117            IF((P.LT.550.).AND.(T.GE.63.).AND.(T.LE.73.)) N=13                NBS18490
000118            GO TO 33                                                          NBS18500
000119         11 N=11                                                              NBS18510
000120            GO TO 30                                                          NBS18520
000121         12 IF(T.LT.68.) GO TO 13                                             NBS18530
000122            N=14                                                              NBS18540
000123            GO TO 33                                                          NBS18550
000124         13 IF(T.LT.80.) GO TO 15                                             NBS18560
000125            IF(P.LT.190.) GO TO 14                                            NBS18570
000126            N=17                                                              NBS18580
000127            GO TO 33                                                          NBS18590
000128         14 N=15                                                              NBS18600
000129            GO TO 33                                                          NBS18610
000130         15 N=15                                                              NBS18620
000131            DO 16 I=2,20                                                      NBS18630
000132            IF(P.LT.PS(I)) GO TO 17                                           NBS18640
000133         16 CONTINUE                                                          NBS18650
000134            GO TO 18                                                          NBS18660
000135         17 TM=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))            NBS18670
000136            IF(T.GT.TM) GO TO 33                                              NBS18680
000137         18 IF(T.LT.50.) GO TO 19                                             NBS18690
000138            N=16                                                              NBS18700
000139            GO TO 33                                                          NBS18710
000140         19 N=11                                                              NBS18720
000141            GO TO 30                                                          NBS18730
000142         30 F =P/587.84                                                       NBS18740
000143            I=F                                                               NBS18750
000144            IF(I.GT.8) I=8                                                    NBS18760
000145            FI=I                                                              NBS18770
000146            F=F-FI                                                            NBS18780
000147            TQ=(1.-F)*TL(I+1)+F*TL(I+2)                                       NBS18790
000148            IF(T.LT.TQ) T=TQ                                                  NBS18800
000149         33 IF(T.LE.5000.)N1=N                                                NBS18810
000150            FP=(P-BP(N))/DP(N)                                                NBS18820
000151            IP=FP                                                             NBS18830
000152            IF(IP.GT.MX(N)) IP=MX(N)                                          NBS18840
000153            FI=IP                                                             NBS18850
000154            F=FP-FI                                                           NBS18860
000155            FP=1.0-F                                                          NBS18870
000156            FT=(T-BT(N1))/DT(N)                                               NBS18880
000157            IT=FT                                                             NBS18890
000158            FI=IT                                                             NBS18900
000159            FF=FT-FI                                                          NBS18910
000160            FT=1.0-FF                                                         NBS18920
000161            I=IT*JP(N)+IP+LOC(N1)                                             NBS18930
000162            J=I+JP(N)                                                         NBS18940
000163            PTSOUN=FP*FT*V(I)+F*FT*V(I+1)+FP*FF*V(J)+F*FF*V(J+1)              NBS18950
000164         34 PTSOUN = PTSOUN * 12.0                                            NBS18960
000165            RETURN                                                            NBS18970
000166            END                                                               NBS18980
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@ ELT PTVISC,1,711119, 35537

000001                FUNCTION PTVISC(PRES,TEMP)                                        NBS18990
000002                DIMENSION PS(20),TS(20),JP(21),MX(21),LOC(21),BP(21),DP(21),BT(21)NBS19000
000003               1,DT(21),V(536)                                                    NBS19010
000004                DIMENSION AA( 66),AB( 67),AC( 67),AD( 66),AE( 67),AF( 66),AG( 66) NBS19020
000005               1 ,AH( 66),AI(  5)                                                 NBS19030
000006                EQUIVALENCE( V,AA),( V(  67),AB),( V( 134),AC),( V( 201),AD)      NBS19040
000007               1     ,( V( 267),AE),( V( 334),AF),( V( 400),AG),( V( 466),AH)     NBS19050
000008               2     ,( V( 532),AI)                                               NBS19060
000009                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,165.,176.,   NBS19070
000010               1182.,185.,186.5,187.25,187.46875,187.506,187.6385/                NBS19080
000011                DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,54.NBS19090
000012               179,56.72,57.80,58.57,58.99,59.18,59.29,59.34,59.353,59.356,59.4/  NBS19100
000013                DATA LOC/1,21,37,46,55,90,112,134,155,176,204,216,276,296,320,356,NBS19110
000014               1376,436,480,510,528/                                              NBS19120
000015                DATA JP/4,4,3,3,5,3,3,3,3,4,3,6,4,6,4,5,5,11,6,3,3/                NBS19130
000016                DATA MX/2,2,1,1,3,1,1,1,1,2,1,4,2,4,2,3,3,9,4,1,1/                 NBS19140
000017                DATA BP/0.    ,0.,-1., 0.  ,1.,-10., 0. ,1469.6,1469.6,1469.6,1469.NBS19150
000018               16,0.,0.,0.,587.84,0.,293.92,190.,190.,190.,190./                  NBS19160
000019                DATA DP/1000., 1000.,3.,1500.,1.,20.,1500.,1763.52,1763.52,1175.68NBS19170
000020               1,1763.52,293.92,73.48,293.92,293.92,146.96,73.48,10.,20.,50.,50./ NBS19180
000021                DATA BT/180.,500.,2000.,2000.,3000.,3000.,3000.,30.6,41.4,63.,126.NBS19190
000022               1,27.,36.,126.,54.,99.,59.4,59.4,64.8,72.,81./                     NBS19200
000023                DATA DT/80.,500.,500.,500.,500.,500.,500.,1.8,3.6,9.,18.,3.6,18.,  NBS19210
000024               118.,9.,9.,3.6,1.8,1.8,1.8,9./                                     NBS19220
000025                DATAAA/2.354E-11,2.797E-11,3.278E-11,3.762E-11,3.1E-11,3.452E-11,3NBS19230
000026               1.812E-11,4.172E-11,3.754E-11,3.99E-11,4.22E-11,4.451E-11,4.351E-11NBS19240
000027               2,4.498E-11,4.638E-11,4.779E-11,4.906E-11,4.986E-11,5.06E-11,5.138ENBS19250
000028               3-11,4.906E-11,4.986E-11,5.06E-11,5.138E-11,7.852E-11,7.688E-11,7.5NBS19260
000029               443E-11,7.418E-11,1.033E-10,1.002E-10,9.745E-11,9.495E-11,1.256E-10NBS19270
000030               51.213E-10,1.174E-10,1.14E-10,1.256E-10,1.256E-10,1.256E-10,1.463E-NBS19280
000031               610,1.463E-10,1.462E-10,1.657E-10,1.657E-10,1.657E-10,1.256E-10,1.1NBS19290
000032               793E-10,1.14E-10,1.463E-10,1.384E-10,1.317E-10,1.657E-10,1.564E-10,NBS19300
000033               81.485E-10,1.657E-10,1.657E-10,1.657E-10,1.657E-10,1.657E-10,1.843ENBS19310
000034               9-10,1.843E-10,1.842E-10,1.842E-10,1.842E-10,2.027E-10,2.024E-10/  NBS19320
000035                DATAAB/2.023E-10,2.023E-10,2.022E-10,2.223E-10,2.215E-10,2.21E-10,NBS19330
000036               12.208E-10,2.206E-10,2.441E-10,2.427E-10,2.418E-10,2.412E-10,2.407ENBS19340
000037               2-10,2.617E-10,2.635E-10,2.634E-10,2.631E-10,2.626E-10,2.647E-10,2.NBS19350
000038               3742E-10,2.782E-10,2.801E-10,2.811E-10,1.658E-10,1.657E-10,1.655E-1NBS19360
000039               40,1.844E-10,1.842E-10,1.84E-10,2.026E-10,2.021E-10,2.018E-10,2.221NBS19370
000040               5E-10,2.201E-10,2.194E-10,2.446E-10,2.394E-10,2.377E-10,2.681E-10,2NBS19380
000041               6.608E-10,2.576E-10,2.782E-10,2.821E-10,2.794E-10,0.,1.657E-10,1.56NBS19390
000042               74E-10,1.485E-10,1.842E-10,1.736E-10,1.645E-10,2.02E-10,1.901E-10,1NBS19400
000043               8.799E-10,2.197E-10,2.06E-10,1.948E-10,2.38E-10,2.217E-10,2.094E-10NBS19410
000044               9,2.58E-10,2.373E-10,2.238E-10,2.799E-10,2.534E-10,2.385E-10,0./   NBS19420
000045                DATAAC/1.838E-10,2.745E-10,0.,1.645E-10,2.572E-10,0.,1.496E-10,2.3NBS19430
000046               141E-10,3.211E-10,1.381E-10,2.145E-10,2.94E-10,1.266E-10,1.958E-10,NBS19440
000047               22.659E-10,1.182E-10,1.804E-10,2.432E-10,1.1E-10,1.674E-10,2.237E-1NBS19450
000048               30,1.1E-10,1.674E-10,2.237E-10,9.723E-11,1.467E-10,1.938E-10,8.717ENBS19460
000049               4-11,1.308E-10,1.717E-10,7.898E-11,1.184E-10,1.547E-10,7.217E-11,1.NBS19470
000050               5084E-10,1.413E-10,6.587E-11,9.78E-11,1.297E-10,6.091E-11,9.124E-11NBS19480
000051               6,1.209E-10,6.091E-11,8.175E-11,1.02E-10,1.209E-10,5.159E-11,7.068ENBS19490
000052               7-11,8.807E-11,1.043E-10,4.432E-11,6.179E-11,7.734E-11,9.191E-11,3.NBS19500
000053               8911E-11,5.524E-11,6.936E-11,8.264E-11,3.553E-11,5.021E-11,6.317E-1NBS19510
000054               91,7.54E-11,3.28E-11,4.627E-11,5.823E-11,6.956E-11,3.134E-11/      NBS19520
000055                DATAAD/4.364E-11,5.458E-11,6.503E-11,3.05E-11,4.65E-11,6.177E-11,2NBS19530
000056               1.946E-11,4.211E-11,5.525E-11,2.962E-11,4.035E-11,5.165E-11,3.034E-NBS19540
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000057              211,3.954E-11,4.874E-11,1.29E-10,1.48E-10,1.677E-10,1.866E-10,2.058NBS19550
000058              3E-10,2.25E-10,1.033E-10,1.183E-10,1.335E-10,1.493E-10,1.656E-10,1.NBS19560
000059              4625E-10,8.563E-11,9.818E-11,1.107E-10,1.233E-10,1.363E-10,1.496E-1NBS19570
000060              50,7.246E-11,8.358E-11,9.433E-11,1.05E-10,1.158E-10,1.267E-10,6.196NBS19580
000061              6E-11,7.234E-11,8.199E-11,9.135E-11,1.006E-10,1.1E-10,5.305E-11,6.3NBS19590
000062              724E-11,7.223E-11,8.073E-11,8.902E-11,9.723E-11,4.487E-11,5.552E-11NBS19600
000063              8,6.423E-11,7.216E-11,7.974E-11,8.717E-11,3.647E-11,4.869E-11,5.747NBS19610
000064              9E-11,6.505E-11,7.214E-11,7.898E-11,6.15E-12,4.232E-11,5.16E-11/    NBS19620
000065               DATAAE/5.906E-11,6.576E-11,7.217E-11,6.56E-12,3.651E-11,4.645E-11,NBS19630
000066              15.353E-11,6.013E-11,6.587E-11,6.3E-12,7.49E-12,5.8E-12,0.,9.3E-12,NBS19640
000067              21.004E-11,1.209E-11,2.554E-11,1.198E-11,1.249E-11,1.318E-11,1.434ENBS19650
000068              3-11,1.442E-11,1.483E-11,1.53E-11,1.587E-11,1.667E-11,1.701E-11,1.7NBS19660
000069              438E-11,1.78E-11,1.877E-11,2.006E-11,2.192E-11,2.457E-11,2.739E-11,NBS19670
000070              53.019E-11,2.075E-11,2.185E-11,2.328E-11,2.513E-11,2.729E-11,2.946ENBS19680
000071              6-11,2.263E-11,2.36E-11,2.473E-11,2.617E-11,2.785E-11,2.962E-11,2.4NBS19690
000072              728E-11,2.532E-11,2.625E-11,2.744E-11,2.88E-11,3.029E-11,5.444E-11,NBS19700
000073              86.191E-11,6.881E-11,7.543E-11,4.154E-11,4.921E-11,5.559E-11,6.091ENBS19710
000074              9-11,3.164E-11,3.986E-11,4.613E-11,5.159E-11,2.517E-11,3.308E-11/   NBS19720
000075               DATAAF/3.919E-11,4.432E-11,2.234E-11,2.867E-11,3.427E-11,3.911E-11NBS19730
000076              1,2.131E-11,2.623E-11,3.099E-11,3.553E-11,2.113E-11,2.509E-11,2.9E-NBS19740
000077              211,3.28E-11,2.141E-11,2.463E-11,2.792E-11,3.134E-11,2.192E-11,2.45NBS19750
000078              37E-11,2.739E-11,3.019E-11,1.557E-11,1.635E-11,1.739E-11,1.901E-11,NBS19760
000079              42.131E-11,1.667E-11,1.738E-11,1.826E-11,1.948E-11,2.113E-11,1.774ENBS19770
000080              5-11,1.839E-11,1.916E-11,2.014E-11,2.141E-11,1.877E-11,1.941E-11,2.NBS19780
000081              6006E-11,2.099E-11,2.192E-11,3.651E-11,3.9E-11,4.148E-11,4.397E-11,NBS19790
000082              74.645E-11,2.868E-11,3.35E-11,3.675E-11,3.938E-11,4.154E-11,2.076E-NBS19800
000083              811,2.766E-11,3.178E-11,3.483E-11,3.716E-11,1.748E-11,2.262E-11,2.7NBS19810
000084              922E-11,3.068E-11,3.329E-11,1.649E-11,2.E-11,2.377E-11,2.712E-11/   NBS19820
000085               DATAAG/3.E-11,1.614E-11,1.857E-11,2.156E-11,2.448E-11,2.72E-11,1.6NBS19830
000086              112E-11,1.79E-11,2.025E-11,2.27E-11,2.517E-11,1.625E-11,1.766E-11,1NBS19840
000087              2.95E-11,2.154E-11,2.37E-11,1.649E-11,1.766E-11,1.913E-11,2.086E-11NBS19850
000088              3,2.268E-11,1.676E-11,1.774E-11,1.896E-11,2.044E-11,2.202E-11,1.707NBS19860
000089              4E-11,1.79E-11,1.892E-11,2.019E-11,2.157E-11,1.739E-11,1.82E-11,1.9NBS19870
000090              501E-11,2.016E-11,2.131E-11,2.484E-11,2.818E-11,2.97E-11,3.086E-11,NBS19880
000091              63.181E-11,3.261E-11,3.335E-11,3.401E-11,3.461E-11,3.52E-11,3.573E-NBS19890
000092              711,1.431E-11,1.56E-11,1.812E-11,2.297E-11,2.59E-11,2.757E-11,2.885NBS19900
000093              8E-11,2.987E-11,3.076E-11,3.154E-11,3.225E-11,1.368E-11,1.429E-11,1NBS19910
000094              9.511E-11,1.626E-11,1.791E-11,2.015E-11,2.259E-11,2.458E-11/         NBS19920
000095               DATAAH/2.611E-11,2.728E-11,2.831E-11,1.35E-11,1.394E-11,1.438E-11,NBS19930
000096              11.508E-11,1.578E-11,1.689E-11,1.8E-11,1.949E-11,2.099E-11,2.246E-1NBS19940
000097              21,2.394E-11,1.35E-11,1.438E-11,1.578E-11,1.8E-11,2.099E-11,2.394E-NBS19950
000098              311,1.347E-11,1.412E-11,1.503E-11,1.634E-11,1.815E-11,2.032E-11,1.3NBS19960
000099              453E-11,1.404E-11,1.471E-11,1.562E-11,1.683E-11,1.833E-11,1.363E-11NBS19970
000100              5,1.405E-11,1.459E-11,1.526E-11,1.615E-11,1.725E-11,1.377E-11,1.414NBS19980
000101              6E-11,1.458E-11,1.512E-11,1.582E-11,1.664E-11,1.377E-11,1.484E-11,1NBS19990
000102              7.604E-11,1.393E-11,1.486E-11,1.635E-11,1.409E-11,1.489E-11,1.61E-1NBS20000
000103              81,1.427E-11,1.499E-11,1.604E-11,1.445E-11,1.509E-11,1.6E-11,1.464ENBS20010
000104              9-11,1.523E-11,1.604E-11,1.464E-11,1.523E-11,1.604E-11,1.563E-11/   NBS20020
000105               DATAAI/1.606E-11,1.658E-11,1.662E-11,1.697E-11,1.736E-11/          NBS20030
000106               P=PRES                                                            NBS20040
000107               IF(P.LT.1.0) P=1.0                                                NBS20050
000108               T=TEMP                                                            NBS20060
000109               IF(T.LT.180.0) GO TO 7                                            NBS20070
000110               IF(T.GE.500.0) GO TO 1                                            NBS20080
000111               N=1                                                               NBS20090
000112               GO TO 30                                                          NBS20100
000113             1 IF(T.GE.3000.0) GO TO 4                                           NBS20110
000114               IF(T.GE.2000.0) GO TO 2                                           NBS20120
000115               N=2                                                               NBS20130
000116               GO TO 30                                                          NBS20140
```

```
000117          2 IF(P.GT.5.0) GO TO 3                                          NBS20150
000118            N=3                                                           NBS20160
000119            GO TO 30                                                      NBS20170
000120          3 N=4                                                           NBS20180
000121            GO TO 30                                                      NBS20190
000122          4 IF(T.GE.6000.0) T=5999.99999                                  NBS20200
000123            IF(P.GE.5.0) GO TO 5                                          NBS20210
000124            N=5                                                           NBS20220
000125            GO TO 30                                                      NBS20230
000126          5 IF(P.GE.30.0) GO TO 6                                         NBS20240
000127            N=6                                                           NBS20250
000128            GO TO 30                                                      NBS20260
000129          6 N=7                                                           NBS20270
000130            GO TO 30                                                      NBS20280
000131          7 IF(P.LT.1469.6) GO TO 12                                      NBS20290
000132            IF(T.GE.  63.0) GO TO 10                                      NBS20300
000133            IF(T.GE.41:4)   GO TO 9                                       NBS20310
000134            N=8                                                           NBS20320
000135          8 TZ=24.84+0.00317*P                                            NBS20330
000136            IF(T.LT.TZ) T=TZ                                              NBS20340
000137            GO TO 30                                                      NBS20350
000138          9 N=9                                                           NBS20360
000139            GO TO 30                                                      NBS20370
000140         10 IF(T.GE.117.0) GO TO 11                                       NBS20380
000141            N=10                                                          NBS20390
000142            GO TO 30                                                      NBS20400
000143         11 N=11                                                         NBS20410
000144            GO TO 30                                                      NBS20420
000145         12 IF(T.GE.59.4)  GO TO 17                                      NBS20430
000146            N=12                                                          NBS20440
000147            IF(P.GE.187.6385) GO TO 8                                     NBS20450
000148            DO 13 I=2,20                                                  NBS20460
000149            IF(P-PS(I))15,14,13                                           NBS20470
000150         13 CONTINUE                                                      NBS20480
000151         14 TL=TS(I)                                                      NBS20490
000152            GO TO 16                                                      NBS20500
000153         15 TL=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))       NBS20510
000154         16 IF(T.LE.TL) GO TO 8                                           NBS20520
000155            N=13                                                          NBS20530
000156            GO TO 30                                                      NBS20540
000157         17 IF(T.LT.126.0) GO TO 18                                       NBS20550
000158            N=14                                                          NBS20560
000159            GO TO 30                                                      NBS20570
000160         18 IF(P.LT.587.84) GO TO 19                                      NBS20580
000161            N=15                                                          NBS20590
000162            GO TO 30                                                      NBS20600
000163         19 IF(T.LT.99.0) GO TO 20                                        NBS20610
000164            N=16                                                          NBS20620
000165            GO TO 30                                                      NBS20630
000166         20 IF(P.GE.190.0)GO TO 21                                        NBS20640
000167            N=13                                                          NBS20650
000168            GO TO 30                                                      NBS20660
000169         21 IF(P.LT.293.92) GO TO 22                                      NBS20670
000170            N=17                                                          NBS20680
000171            GO TO 30                                                      NBS20690
000172         22 IF(T.GE.72.0) GO TO 24                                        NBS20700
000173            IF(T.GE.64.8) GO TO 23                                        NBS20710
000174            N=18                                                          NBS20720
000175            GO TO 30                                                      NBS20730
000176         23 N=19                                                         NBS20740
```

```
000177                GO TO 30                                                  NBS20750
000178             24 IF(T.GE.81.0) GO TO 25                                    NBS20760
000179                N=20                                                      NBS20770
000180                GO TO 30                                                  NBS20780
000181             25 N=21                                                      NBS20790
000182             30 FP=(P=BP(N))/DP(N)                                        NBS20800
000183                IP=FP                                                     NBS20810
000184                IF(IP.GT.MX(N)) IP=MX(N)                                  NBS20820
000185                F=FP-IP                                                   NBS20830
000186                FP=1.0-F                                                  NBS20840
000187                FT=(T-BT(N))/DT(N)                                        NBS20850
000188                IT=FT                                                     NBS20860
000189                FF=FT-IT                                                  NBS20870
000190                FT=1.0-FF                                                 NBS20880
000191                I=IT*JP(N)+IP+LOC(N)                                      NBS20890
000192                J=1+JP(N)                                                 NBS20900
000193                PTVISC=FP*FT*V(I)+F*FT*V(I+1)+FP*FF*V(J)+F*FF*V(J+1)      NBS20910
000194             36 PTVISC = PTVISC * 9561.0                                  NBS20920
000195                RETURN                                                    NBS20930
000196                END                                                       NBS20940
```

@ ELT ROOT,1,711119, 35539

```
000001                SUBROUTINE ROOT(N)
000002          C                                                               C
000003          C*****************************************************************C
000004          C*                                                              *C
000005          C*    SUBROUTINE TO FIND THE ROOT OF AN EQUATION OF THE FORM F(X)=0.*C
000006          C*                                                              *C
000007          C*    THE NORMAL USE IS AS FOLLOWS                              *C
000008          C*                                                              *C
000009          C*    X=0.                                                      *C
000010          C*    DX=.1                                                     *C
000011          C*    E=.001                                                    *C
000012          C*    CALL ROOT(N)                                              *C
000013          C* 10 F=X**2-X-100.                                             *C
000014          C*    CALL ROOTB(X,DX,F,E,K,$10)                                *C
000015          C*                                                              *C
000016          C*    N = MAXIMUM NUMBER OF STEPS OF SIZE DX                    *C
000017          C*        IF N IS NEGATIVE THE ERROR FROM THE FIRST TWO STEPS WILL BE*C
000018          C*        COMPARED AND THE SIGN ON DX CHANGED IF THE SECOND ERROR IS*C
000019          C*        LARGER                                                *C
000020          C*    X = THE INDEPENDENT VARIABLE                              *C
000021          C*    DX= STEP SIZE USED FOR A SIGN CHANGE IN F                 *C
000022          C*    F = FUNCTION THAT MUST GO TO ZERO FOR SOLUTION            *C
000023          C*    E = THE CONVERGENCE CRITERIA ON F                         *C
000024          C*    K = FLAG INDICATING ANSWER MODE                           *C
000025          C*        K= 0 FOR NORMAL CONVERGENCE                           *C
000026          C*        K=+1 FOR SIGN CHANGE WITHOUT CONVERGENCE WITHIN NN ITERATIONS*C
000027          C*        K=-1 FOR NO CHANGE IN SIGN OF F WITHIN N STEPS        *C
000028          C*                                                              *C
000029          C*    J J WILLIAMS              1971                            *C
000030          C*                                                              *C
000031          C*****************************************************************C
000032          C                                                               C
000033                I=0
000034                IF=1
000035                J=1
000036                LL=0
000037                LLL=0
000038                NN=100
000039                FS=0.
000040                IF(N.LT.0) LL=1
000041                N=IABS(N)
000042                ER1=0.
000043                ER2=0.
000044                RETURN
000045                ENTRY ROOTB(X,DX,F,E,K,$)
000046                E=ABS(E)
000047                IF(ABS(F).LT.0.0001*E) GO TO 101
000048                GO TO (1,2),IF
000049              1 IF(FS*F.LT.0.0) GO TO 10
000050                IF(LL.EQ.0) GO TO 40
000051                IF(J.EQ.1) ER1=F
000052                IF(J.EQ.2) ER2=F
000053                IF((J.EQ.2).AND.(LL.EQ.1).AND.(ABS(ER2).GT. ABS(ER1)).AND.
000054               1   (ER2*ER1.GT.0.0)) LLL=1
000055                IF(LLL.EQ.1) DX=-DX
000056                IF(LLL.EQ.1) LL=0
```

```
000057                J=J+1
000058             40 I=I+1
000059                IF(I.GT.N) GO TO 100
000060                XS=X
000061                X=X+DX
000062                FS=F
000063                RETURN6
000064             10 IF=2
000065                I=0
000066              3 XN=(X*FS-XS*F)/(FS-F)
000067                Z=F
000068                IF( ABS(Z).LE.E) GO TO 20
000069                XSS=X
000070                FSS=F
000071                X=XN
000072                I=I+1
000073                IF(I.GT.NN) GO TO 101
000074                RETURN6
000075              2 IF(F*FS.LT.0.00) GO TO 3
000076                FS=FSS
000077                XS=XSS
000078                GO TO 3
000079             20 X=XN
000080                K=0
000081                RETURN
000082            100 K=-1
000083                RETURN
000084            101 K=1
000085                RETURN
000086                END
```

```
@ ELT SECT,1,711119, 35541

000001                SUBROUTINE SECT
000002                COMMON /ZXR/ ZF(200),RF(200),XF(200),ARF(200),ZDIS(50)
000003               1,NF
000004                COMMON/INGRAM/ Z(200), R(200), X(200),           RDIS( 50),
000005               1     XDIS( 50), ZI(200), RI(200), SINA, SINB, COSA, COSB, TANA,
000006               2     TANB, ZO, ZB, ZSTAR, Z1, Z2, Z3, Z5, Z6, RC, R2, R3, RSTAR,
000007               3     R5, R6, X1, X2, X3, X4, X5, X6, EPS, DX01, DX12, DX23, DX34,
000008               4     DX45, DX56, A0, A1, A2, RB, RU, RD, ALPHA, BETA, XTEMP, DZ,
000009               5     ARAT
000010               6           ,    N1, N2, N3, N4, N5, N6, IPL, NDL, NC, NDFL, ND,
000011               7     NI, K
000012                N1 = N1 + 1
000013                N2 = N1 + N2
000014                N3 = N2 + N3
000015                N4 = N3 + N4
000016                N5 = N4 + N5
000017                N6 = N5 + N6
000018                Z(1) = 0.
000019                R(1) = RC
000020                X(1) = 0.
000021                IF (NC) 2010, 2010, 2000
000022           2000 N6 = N5 + IPL - 1
000023           2010 DO 2014 N = 2, N1
000024                X(N) = X(N-1) + DX01
000025                Z(N) = X(N)
000026           2014 R(N) = RC
000027                Z(N1) = Z1
000028                X(N1) = X1
000029                LL = N1 + 1
000030                DO 2018 N = LL, N2
000031                X(N) = X(N-1) + DX12
000032                ANG = (X(N) - X1) / RB
000033                Z(N)=Z1+RB* SIN(ANG)                                    00009185
000034           2018 R(N)=RC-RB+RB* COS(ANG)                                 00009190
000035                Z(N2) = Z2
000036                R(N2) = R2
000037                X(N2) = X2
000038                LL = N2 + 1
000039                DO 2020 N = LL, N3
000040                X(N) = X(N-1) + DX23
000041                Z(N) = Z(N-1) + DX23 * COSB
000042           2020 R(N) = R(N-1) - DX23 *. SINB
000043                Z(N3) = Z3
000044                R(N3) = R3
000045                X(N3) = X3
000046                LL = N3 + 1
000047                DO 2022 N = LL, N4
000048                X(N) = X(N-1) + DX34
000049                ANG = (X4 - X(N)) / RU
000050                Z(N)=ZSTAR-RU* SIN(ANG)                                 00009270
000051           2022 R(N)=RSTAR+RU-RU* COS(ANG)                              00009275
000052                Z(N4) = ZSTAR
000053                R(N4) = RSTAR
000054                X(N4) = X4
000055                LL = N4 + 1
000056                DO 2026 N = LL, N5
```

```
000057                X(N) = X(N-1) + DX45
000058                ANG = (X(N) - X4) / RD
000059                Z(N)=ZSTAR+RD* SIN(ANG)                                  00009315
000060           2026 R(N)=RSTAR+RD  -RD* COS(ANG)                             00009320
000061                Z(N5) = Z5
000062                R(N5) = R5
000063                X(N5) = X5
000064                N = N5
000065                IF (NC) 2080, 2030, 2080
000066           2030 LL = N5 + 1
000067           C    *** COORDINATES FROM DPT TO EXIT FOR CONICAL NOZZLE.
000068                DO 2034 N = LL, N6
000069                X(N) = X(N-1) + DX56
000070                Z(N) = Z(N-1) + DX56 * COSA
000071           2034 R(N) = R(N-1) + DX56 * SINA
000072                Z(N6) = Z6
000073                R(N6) = R6
000074                X(N6) = X6
000075                ND = 0
000076           2040 IF (NDFL) 2050,2050,2060
000077           2050 RETURN
000078           2060 ND = ND + 1
000079                IF (ND.GT.50) GO TO 500
000080                IF (ZDIS(ND) - Z5) 2060, 2060, 2070
000081           500  WRITE (6,505)
000082           505  FORMAT (1H0'THE SUBSCRIPT ND IN SECT IS GREATER THAN 50'/////)
000083                STOP 4
000084           C    *** COORDINATES OF DISCONTINUITIES BETWEEN DPT AND EXIT FOR CONICAL
000085           C    *** NOZZLES.
000086           2070 IF (ZDIS(ND)-Z6) 2075,206,206
000087           2075 REM=ZDIS(ND)-Z5
000088                DR = REM * TANA
000089                DX = REM / COSA
000090                RDIS(ND) = R5 + DR
000091                XDIS(ND) = X5 + DX
000092           206  NDFL = NDFL - 1
000093                GO TO 2040
000094           C    *** COMPUTE COORDINATES OF POINTS AND DISCONTINUITIES BETWEEN DPT
000095           C    *** AND EXIT FOR CONTOURED NOZZLES.
000096           2080 XTEMP = X5
000097                Z(N+1) = ZI(2)
000098                R(N+1) = RI(2)
000099                K = 0
000100                ND = 0
000101                NI = 3
000102           2090 N = N + 1
000103                CALL FIT (ZI, RI, A0, A1, A2, NI)
000104                K = 1
000105           2100 X(N) = XTEMP + DXF (ZI(NI-2), Z(N), A1, A2)
000106                IF (Z(N) - ZI(2)) 2110, 2110, 2120
000107           2110 N = N + 1
000108                Z(N) = ZI(3)
000109                R(N) = RI(3)
000110                GO TO 2100
000111           2120 CALL DIS
000112                IF (NI - IPL) 2130, 2130, 2050
000113           2130 Z(N+1) = ZI(NI)
000114                R(N+1) = RI(NI)
000115                GO TO 2090
000116                END
```

```
@ ELT SIMEQ,1,711119, 35544

000001                SUBROUTINE SIMEQ(A,B,NN,MM,NA ,ITEM,DD,NND,KERR)                  61210002
000002          C*****                                                                  61210003
000003          C     SOLVES MATRIX EQUATIONS - AX = B                                  61210004
000004          C     GAUSS ELIMINATION WITH COMPLETE PIVOTING ON ABSOLUTE LARGEST      61210005
000005          C     ELEMENT TO FORM TRIANGULAR MATRIX,WITH BACK SUBSTITUTION FOR      61210006
000006          C     SOLUTION VECTORS.                                                 61210007
000007          C******                                                                 61210008
000008          C                                                                       61210009
000009          C     CALL SIMEQ (A,B,NN,MM,NA ,ITEM,DD,NND,KERR )                      61210010
000010          C     A         =    A(1,1) OF INPUT MATRIX                           61210011
000011          C     B         =    INPUT VECTORS                                    61210012
000012          C     NN        = NUMBER OF SIMULTANEOUS EQUATIONS.                    61210013
000013          C     MM        = NUMBER OF B-VECTORS.                                 61210014
000014          C     NA        = DIMENSION OF MATRIX A,THAT IS, A(NA,--)              61210015
000015          C     ITEM      = TEMPORARY STORAGE (FOR PERMUTATION VECTOR)           61210016
000016          C                 WITH DIMENSION - ITEM(NA)                            61210017
000017          C     DD        = DETERMINANT                                          61210018
000018          C     NND       = POWER OF TEN TO MULTIPLY DETERMINANT                 61210019
000019          C     KERR      = ERROR CODE,  =K, SINGULAR RANK , =-1 SOLVED EQUATIONS 61210020
000020                DIMENSION A(NA,NA),B(NA,1)
000021                DIMENSION ITEM(2)                                                 61210022
000022          C                                                                       61210023
000023                D = 1.0
000024          C     ND        = POWERS OF TENS FACTOR FOR DETERMINANT.                61210025
000025                ND        = 0                                                     61210026
000026                N=NN                                                            61210027
000027                M=MM                                                            61210028
000028          C                                                                       61210029
000029          C     SET-UP THE PERMUTATION VECTOR.                                    61210030
000030                DO 1      I=1,N                                                   61210031
000031           1    ITEM(I)   = I                                                     61210032
000032                N1        = N-1                                                   61210033
000033                DO 60     K=1,N                                                   61210034
000034          C                                                                       61210035
000035          C     SEARCH AND SET THE ABSOLUTE LARGEST ELEMENT AS THE PIVOT.         61210036
000036          C                                                                       61210037
000037                PIVOT = 0.0
000038                DO 10     I=K,N                                                   61210039
000039                DO 9      J=K,N                                                   61210040
000040                XTEM      = A(I,J)                                                61210041
000041                IF(ABS(XTEM) .LE. ABS(PIVOT)) GO TO 9
000042                PIVOT     = XTEM                                                  61210043
000043                IS        = I                                                     61210044
000044                IT        = J                                                     61210045
000045           9    CONTINUE                                                        61210046
000046           10   CONTINUE                                                        61210047
000047          C     COMPUTE DETERMINANT AND TEST FOR SINGULAR MATRIX.                 61210048
000048          C                                                                       61210049
000049          C                                                                       61210050
000050                D         = D*PIVOT                                               61210051
000051                IF (D .NE. 0.0)  GO TO 11
000052          C     IF MATRIX IS SINGULAR,SET THE RANK OF MATRIX A IN KERR    AND EXIT61210053
000053                KERR      =    K-1                                              61210054
000054                GO TO 100                                                       61210055
000055             11 XTEM = ABS(D)
000056                IF(XTEM .LE. 1.0)  GO TO 13
```

```
000057                D = D/10.0
000058                ND       = ND+1                                          61210059
000059                GO TO 11                                                 61210060
000060             13 IF(XTEM .GE. 0.1)  GO TO 14
000061                D = D*10.0
000062                ND       = ND-1                                          61210063
000063                GO TO 11                                                 61210064
000064             14 CONTINUE                                                 61210065
000065                IF(K.EQ.IS)              GO TO 30                        61210066
000066             C                                                           61210067
000067             C     IF THE PIVOT IS NOT IN THE RIGHT ROW,INTERCHANGE ROWS. 61210068
000068             C                                                           61210069
000069                DO 20    J=1,N                                           61210070
000070                XTEM     = A(IS,J)                                       61210071
000071                A(IS,J)  = A(K,J)                                        61210072
000072                A(K ,J)  = XTEM                                          61210073
000073             20 CONTINUE                                                 61210074
000074                DO 21    J=1,M                                           61210075
000075                XTEM     = B(IS,J)                                       61210076
000076                B(IS,J)  = B(K ,J)                                       61210077
000077                B(K ,J)  = XTEM                                          61210078
000078             21 CONTINUE                                                 61210079
000079                D        = -D                                            61210080
000080             30 IF(K.EQ.IT)              GO TO 40                        61210081
000081             C                                                           61210082
000082             C     IF THE PIVOT IS NOT IN THE RIGHT COL.,EXCHANGE COLS AND RECORD 61210083
000083             C     THIS IN THE PERMUTATION VECTOR.                       61210084
000084             C                                                           61210085
000085                DO 31    I=1,N                                           61210086
000086                XTEM     = A(I,IT)                                       61210087
000087                A(I,IT)  = A(I,K )                                       61210088
000088                A(I,K )  = XTEM                                          61210089
000089             31 CONTINUE                                                 61210090
000090                D        = -D                                            61210091
000091             C                                                           61210092
000092             C     SET PERMUTATION VECTOR                                61210093
000093             C                                                           61210094
000094                I        = ITEM(IT)                                      61210095
000095                ITEM(IT) = ITEM(K )                                      61210096
000096                ITEM(K ) = I                                             61210097
000097             C                                                           61210098
000098             40 CONTINUE                                                 61210099
000099                K1       = K+1                                           61210100
000100                IF(K1.GT.N)              GO TO 60                        61210101
000101             C                                                           61210102
000102             C     MULTIPLY THE K-TH ROW.BY -A(I,K)/PIVOT AND ADD TO THE I-TH ROW 61210103
000103                DO 50    I=K1,N                                          61210104
000104                DO 50    J=K1,N                                          61210105
000105                A(I,J)   = A(I,J) - A(K,J)/PIVOT * A(I,K)                61210106
000106             50 CONTINUE                                                 61210107
000107                DO 51    I=K1,N                                          61210108
000108                DO 51    J=1,M                                           61210109
000109                B(I,J)   = B(I,J) - A(I,K)/PIVOT*B(K,J)                  61210110
000110             51 CONTINUE                                                 61210111
000111             60 CONTINUE                                                 61210112
000112             C                                                           61210113
000113             C     BACKSUBSTITUTION FOLLOWS.                             61210114
000114             C                                                           61210115
000115                DO 70    J=1,M                                           61210116
000116                B(N,J)   = B(N,J)/A(N,N)                                 61210117
```

```
000117          70    CONTINUE                                                  61210118
000118                I         = N                                             61210119
000119                DO 73     K=2,N                                           61210120
000120.               I1        = I                                             61210121
000121                I         = I-1                                           61210122
000122                PIVOT     = A(I,I)                                        61210123
000123                DO 72     IT=1,M                                          61210124
000124                XTEM = 0.0
000125                DO 71     J=I1,N                                          61210126
000126          71    XTEM      = A(I,J)*B(J,IT) + XTEM                         61210127
000127          72    B(I,IT)   = (B(I,IT) - XTEM)/PIVOT                        61210128
000128          73    CONTINUE                                                  61210129
000129        C                                                                 61210130
000130        C     USE PERMUTATION VECTOR TO EXCHANGE ROWS OF B-MATRIX.        61210131
000131        C                                                                 61210132
000132                DO 81     I=1,N                                           61210133
000133          79    IF(ITEM(I).EQ.I)        GO TO 81                          61210134
000134                K         = ITEM(I)                                       61210135
000135                DO 80     J=1,M                                           61210136
000136                XTEM      = B(K,J)                                        61210137
000137                B(K,J)    = B(I,J)                                        61210138
000138                B(I,J)    = XTEM                                          61210139
000139          80    CONTINUE                                                  61210140
000140                ITEM(I)   = ITEM(K)                                       61210141
000141                ITEM(K)   = K                                             61210142
000142                GO TO 79                                                  61210143
000143          81    CONTINUE                                                  61210144
000144                KERR=-1                                                   61210145
000145                DD        =    D                                          61210146
000146                NND       =    ND                                         61210147
000147          100   RETURN                                                    61210148
000148                END                                                       61210149
```

```
@ ELT START,1,711119, 35547

000001                SUBROUTINE START
000002                COMMON /ZXR/ ZF(200),RF(200),XF(200),ARF(200),ZDIS(50)
000003               1,NF
000004                COMMON/INGRAM/ Z(200), R(200), X(200),          RDIS( 50),
000005               1     XDIS( 50), ZI(200), RI(200), SINA, SINB, COSA, COSB, TANA,
000006               2     TANB, Z0, ZB, ZSTAR, Z1, Z2, Z3, Z5, Z6, RC, R2, R3, RSTAR,
000007               3     R5, R6, X1, X2, X3, X4, X5, X6, EPS, DX01, DX12, DX23, DX34,
000008               4     DX45, DX56, AC, A1, A2, RB, RU, RD, ALPHA, BETA, XTEMP, DZ,
000009               5     ARAT
000010               6           ,    N1, N2, N3, N4, N5, N6, IPL, NDL, NC, NDFL, ND,
000011               7     NI, K
000012            C   *** BEGIN COMPUTING COORDINATES AND DEVELOPED LENGTHS TO TANGENT PTS
000013                ALPHR = .017453 * ALPHA
000014                BETAR = .017453 * BETA
000015                SINA= SIN(ALPHR)                                          00009680
000016                SINB= SIN(BETAR)                                          00009685
000017                COSA= COS(ALPHR)                                          00009690
000018                COSB= COS(BETAR)                                          00009695
000019                TANA = SINA / COSA
000020                TANB = SINB / COSB
000021                R2 = RC - RB + RB * COSB
000022                R3 = RSTAR + RU - RU * COSB
000023                R5 = RSTAR + RD - RD * COSA
000024                Z12 = RB * SINB
000025                Z34 = RU * SINB
000026                Z45 = RD * SINA
000027                Z23 = (R2 - R3) / TANB
000028                IF (EPS) 1105, 1105, 1000
000029            C   *** AREA RATIO INPUT
000030           1000 R6=RSTAR*SQRT(EPS)
000031                R56 = R6 - R5
000032                IF (NC - 1) 1010, 1020, 1030
000033           1010 Z56 = R56 / TANA
000034                GO TO 1030
000035           1020 Z56 = ZI(IPL-1) - Z45
000036           1030 IF (Z0) 1050, 1050, 1040
000037           1040 Z5 = Z0 - Z56
000038                ZSTAR = Z5 - Z45
000039                Z6 = Z0
000040                GO TO 1080
000041           1050 IF (ZB) 1060, 1060, 1070
000042           1060 Z5 = ZSTAR + Z45
000043                Z6 = Z5 + Z56
000044           1080 Z1 = ZSTAR - Z34 - Z23 - Z12
000045                GO TO 1090
000046           1070 ZSTAR = ZB + Z12 + Z23 + Z34
000047                Z5 = ZSTAR + Z45
000048                Z6 = Z5 + Z56
000049                Z1 = ZB
000050           1090 Z3 = ZSTAR - Z34
000051                Z2 = Z3 - Z23
000052                IF (NC - 1) 1100, 1150, 1165
000053           1100 ARAT = EPS
000054                GO TO 1180
000055            C   *** AREA RATIO NOT INPUT
000056           1105 IF (ZB) 1110, 1110, 1120
```

```
000057          1110 Z1 = ZSTAR - Z34 - Z23 - Z12
000058               GO TO 1130
000059          1120 Z1 = ZB
000060               ZSTAR = Z1 + Z12 + Z23 + Z34
000061          1130 Z3 = ZSTAR - Z34
000062               Z2 = Z3 - Z23
000063               Z5 = ZSTAR + Z45
000064               Z6 = Z0
000065               IF (NC - 1) 1140, 1150, 1165
000066          1140 Z56 = Z6 - Z5
000067               R56 = Z56 * TANA
000068               R6 = R5 + R56
000069               GO TO 1170
000070         C     *** FOR CONTOURED NOZZLE, COMPUTE Z AND R COORDIATES OF INPUT POINTS
000071         C     *** AND INSERT POINT AT DPT.
000072          1150 LU = IPL - 1
000073               DO 1160 IP = 1, LU
000074               IPX = IPL - IP
000075               ZI(IPX+1) = ZSTAR + ZI(IPX)
000076          1160 RI(IPX+1) = RI(IPX)
000077          1165 ZI(1) = Z5
000078               RI(1) = R5
000079               Z6 = ZI(IPL)
000080               R6=RI(IPL)
000081          1170 ARAT = R6 * R6 / RSTAR / RSTAR
000082          1180 X45=ALPHR*RD
000083               X34=BETAR*RU
000084               X23 = Z23 / COSB
000085               X12 = BETAR * RB
000086               X1 = Z1
000087               X2 = X1 + X12
000088               X3 = X2 + X23
000089               X4 = X3 + X34
000090               X5 = X4 + X45
000091               IF (NC) 1200, 1190, 1200
000092          1190 X56 = Z56 / COSA
000093               X6 = X5 + X56
000094          1200 IF (DZ) 1210, 1210, 1240
000095          1210 IF (NC) 1220, 1220, 1230
000096         C     *** OPTION COMPUTING SEGMENTS BY SECTION
000097          1220 CALL DELT (X56, DX56, N6)
000098          1230 CALL DELT (X1 , DX01, N1)
000099               CALL DELT (X12, DX12, N2)
000100               CALL DELT (X23, DX23, N3)
000101               CALL DELT (X34, DX34, N4)
000102               CALL DELT (X45, DX45, N5)
000103         C     *** LOCATE SECTION OF NOZZLE IN WHICH DISCONTINUITIES FALL AND
000104         C     *** COMPUTE ZRX COORDINATES.  FOR CONTOURED NOZZLES, INCREMENT NDFL
000105         C     *** FOR EACH DISCONTINUITY BETWEEN DPT AND EXIT.
000106          1240 ND = 0
000107               NDFL = 0
000108          1250 ND = ND + 1
000109               IF (ZDIS(ND) - Z1) 1260, 1260, 1290
000110          1260 RDIS(ND) = RC
000111               XDIS(ND) = ZDIS(ND)
000112          1270 IF (ND - NDL) 1250, 1280, 1280
000113          1280 RETURN
000114          1290 IF (ZDIS(ND) - Z2) 1300, 1310, 1320
000115          1300 DZT = ZDIS(ND) - Z1
000116               TSQ= SQRT(RB*RB-DZT*DZT)                                00010105
```

```
000117                RDIS(ND) = RC - RB + TSQ
000118                XDIS(ND)=X1+RB* ATAN(DZT/TSQ)                    00010195
000119                GO TO 1270
000120           1310 RDIS(ND) = R2
000121                XDIS(ND) = X2
000122                GO TO 1270
000123           1320 IF (ZDIS(ND) - Z3) 1330, 1340, 1350
000124           1330 DZT = ZDIS(ND) - Z2
000125                RDIS(ND) = R2 - DZT * TANB
000126                XDIS(ND) = X2 + DZT / COSB
000127                GO TO 1270
000128           1340 RDIS(ND) = R3
000129                XDIS(ND) = X3
000130                GO TO 1270
000131           1350 IF (ZDIS(ND) - ZSTAR) 1360, 1370, 1380
000132           1360 DZT = ZSTAR - ZDIS(ND)
000133                TSQ= SQRT(RU**2-DZT**2)                          00010270
000134                RDIS(ND)=RSTAR+RU-TSQ
000135                XDIS(ND)=X4-RU* ATAN(DZT/TSQ)                    00010280
000136                GO TO 1270
000137           1370 RDIS(ND) = RSTAR
000138                XDIS(ND) = X4
000139                GO TO 1270
000140           1380 IF (ZDIS(ND) - Z5) 1390, 1400, 1410
000141           1390 DZT = ZDIS(ND) - ZSTAR
000142                TSQ= SQRT(RD*RD-DZT*DZT)                         00010315
000143                RDIS(ND)=RSTAR+RD-TSQ
000144                XDIS(ND)=X4+RD* ATAN(DZT/TSQ)                    00010325
000145                GO TO 1270
000146           1400 RDIS(ND) = R5
000147                XDIS(ND) = X5
000148           1410 IF (ZDIS(ND) - Z6) 1420, 1430, 1430
000149           1430 ZDIS(ND) = Z6
000150                RDIS(ND) = R6
000151                XDIS(ND) = X6
000152           1420 NDFL = NDFL + 1
000153                GO TO 1270
000154                END
```

```
@ ELT SUBRBO,1,711119, 35548

000001                SUBROUTINE SUBRBO                                                    2182
000002                REAL J,K1,K2,K3,K4,KC,KCF,KM,KMP,KWG,KFAC,L,MC,MR,MUB,MUCF,
000003               X      MUGF,MUW,NMB,NT,N1P,N2P,N3P,N4P,N5P,N6P,NMBP
000004                REAL  KB,KWL,K5,K5P,K6,LP,MUWL,MW,NC,NDL
000005                COMMON /INT/  IKMAX    ,ILHITE   ,ICGITE   ,IITREL   ,IKERR          2184
000006               1   ,IN       ,ITUBE    ,INUM     ,IDIS     ,IFRIC    ,ITNUM1       2185
000007               3       , IZPTS , IZSTEP                                             2186
000008               4    ,IWALL, IMERCR , IHGC, IHLC, IFILM, IRBO, I8085 ,ICOOL          2187
000009                COMMON/ CON/  AA     ,ABAR   ,AE     ,AF     ,AFP    ,AS     ,AL   ,  2188
000010               1A0    ,ASTAR ,AV     ,B      ,BETA   ,C1     ,CL     ,CG     ,CC1  ,  2189
000011               2CC2   ,CP     ,CPP    ,CPBAR ,CPGF   ,D      ,DE     ,E1     ,E2   ,  2190
000012               3E3    ,E4     ,E      ,F      ,FBAR   ,FEFV   ,FS     ,FC     ,FP   ,  2191
000013               4G0    ,G1     ,G      ,H      ,HBC    ,HC     ,HIN    ,HMIX   ,HOUT ,  2192
000014               5HG    ,HL     ,HL1    ,HR     ,J      ,K1     ,K2     ,K3     ,K4   ,  2193
000015               6KC    ,KCF    ,KM     ,KMP    ,KWG    ,KFAC   ,L      ,MC     ,MR   ,  2194
000016               7NMB   ,NT     ,N1P    ,N2P    ,N3P    ,N4P    ,N5P    ,N6P    ,PIE  ,  2195
000017               8PSC   ,PC     ,PG     ,PFM    ,PRCF   ,PRGF   ,P      ,PP     ,PF   ,  2196
000018               9PIN   ,PLS    ,POUT   ,PRC    ,PV     ,Q      ,Q0A    ,Q0AM   ,Q0AO ,  2197
000019               0R     ,RC     ,RD     ,RN     ,RU     ,RB     ,RSTAR  ,RCV    ,SMALD ,  2198
000020               1SMALRA,SMALRG,SC     ,S      ,STR    ,STRY   ,SMALTC,SMALTM,SMALTS,  2199
000021               2SMARGP,TB     ,TBP    ,TBC    ,TC     ,TRCF   ,TCF    ,TGF    ,TIN  ,  2200
000022               3TM    ,TMIX   ,TWG    ,TWGC   ,TWL    ,TWLC   ,TWM    ,TO     ,TINFIN,  2201
000023               4TBAR  ,U      ,V      ,VF     ,VC     ,VP     ,VNS    ,WG     ,WGCORE,  2202
000024               5WGSTAR,WC     ,WBC    ,WF     ,X      ,XP     ,XI     ,Z      ,ZP   ,  2203
000025               6ZB    ,ZD     ,ZOL    ,ZN     ,ZU     ,ZW     ,ZSTAR  ,EHAF   ,MUB  ,  2204
000026               7MUCF  ,MUGF   ,MUW    ,RHO    ,RHOB   ,RHOBP  ,RHOCF  ,RHOGF  ,RHOW ,  2205
000027               8RHOBAR,RP     ,EP0GEO,EP1GEO,NMBP   ,GAMMAC,SMALA  ,EPGEOM,AASTAR,  2206
000028               9SMATMP,RHOP   ,ALPHAA,BETAA  ,EP0    ,EP1                            706
000029                COMMON /THOMAS/ TTITT(296), PPPPP(296), TCRIT, PCRIT
000030                COMMON/SHEEHY/ DS,H,WP,AFBAR,K5,VCBAR,K5P,TWMC,VCP,TSAT,FCBAR,K6,     2208
000031               1 TSATK,FCP,PD,FRHOV,CPCF,MUWL,CB2,KB,CPWL,CPB,RHOWL,KWL,CB1          2209
000032               2,ZETA,MW,COEF(4,5),LP                                               2210
000033               3 ,DUMPEM,PXM(100),PDM(100),NDL,DZ,NC,SMATCP                         2211
000034                COMMON/INRBO/VDTC,RBOFP,RBOFT,RBOA1,RBOA2,RBOB1,RBOB2,RBON1,RBON2,   2212
000035               1             RBOM1,RBOM2,RBOC1,RBOK1,RBO,Q0ABO,VDT                SUBRBO
000036          1     IF (P .LE. PCRIT) GO TO 300
000037                Q0ABO=HL*(TCRIT-TB)                                                  2219
000038                GO TO 1000                                                           2220
000039          300   GO TO (400,500),IRBO                                               2221
000040          400   Q0ABO=RBOC1*(VC/12.)**RBOK1                                        2222
000041                GO TO 1000                                                           2223
000042          500   VDT=VC*(TSAT-TB)/12.                                               2224
000043                IF(VDT .GT. VDTC) GO TO 600                                          2225
000044                Q0ABO=(RBOA1+RBOB1*(VC/12.)**RBON1*(TSAT-TB)**RBOM1)*RBOFT*RBOFP     2226
000045                GO TO 1000                                                           2227
000046          600   Q0ABO=(RBOA2+RBOB2*(VC/12.)**RBON2*(TSAT-TB)**RBOM2)*RBOFT*RBOFP    2228
000047          1000  RBO= ABS(Q0A)/Q0ABO                                          00011130
000048                RETURN                                                               2230
000049                END                                                                  2231
```

```
@ ELT SUB1,1,711119, 35550

000001                SUBROUTINE SUB1(XARG,YARG)                                        2079
000002                DIMENSION T(5),PR(14,5),TARHO(14,5),PV(15,5),TAVISC(15,5),        2081
000003               1TACOND(14,5),TACP(14,5)                                           2082
000004                COMMON/FLUIDP/ A(35)                                              2083
000005                DIMENSION TRHO(22),RHO(22),TVIS(21),VIS(21),TCON(21),COND(21),    2084
000006               1 CP(21)                                                           2085
000007                COMMON /THOMAS/ TTTTT(296), PPPPP(296), TCRIT, PCRIT
000008                DIMENSION PTSAT(25),TTSAT(25)                                     1100
000009                DATA TTSAT/ 500.,560.,600.,660.,700.,760.,800.,860.,900.,960.,    1150
000010               1          1000.,1060.,1094.,12*0.  /                            1151
000011                DATA PTSAT/ .58,3.7,8.5,25.5,35.5,107.,166.,308.,430.,718.,       1152
000012               1           940.,1400.,1696.,12*0.   /                           1153
000013                DATA T / 1700., 3000., 5000., 7000., 10000.  /                    2086
000014                DATA PR / 500.,  550.,  600.,  650.,  700.,  750.,  800.,  850.,  2087
000015               1          900.,  950., 1000., 1050., 1100.,    0.,               2088
000016               2          500.,  550.,  600.,  650.,  700.,  750.,  800.,  850.,  2089
000017               3          900.,  950., 1000., 1050., 1100.,    0.,               2090
000018               4          500.,  550.,  600.,  650.,  700.,  750.,  800.,  850.,  2091
000019               5          900.,  950., 1000., 1050., 1100.,    0.,               2092
000020               6          500.,  550.,  600.,  650.,  700.,  750.,  800.,  850.,  2093
000021               7          900.,  950., 1000., 1050., 1100.,    0.,               2094
000022               8          500.,  550.,  600.,  650.,  700.,  750.,  800.,  850.,  2095
000023               9          900.,  950., 1000., 1050., 1100.,    0.  /             2096
000024                DATA TARHO / .920, .885, .871, .855, .840, .801, .762, .728, .694,2097
000025               1             .651, .608, .575, .297, .000, .924, .899, .876, .849,2098
000026               2             .823, .798, .767, .743, .719, .680, .637, .591, .536,2099
000027               3             .000, .927, .904, .880, .854, .829, .804, .779, .755,2100
000028               4             .730, .697, .662, .624, .586, .000, .930, .906, .883,2101
000029               5             .859, .836, .812, .788, .763, .739, .712, .684,.651,2102
000030               6             .620, .000, .937, .914, .891, .867, .845, .823,.802,2103
000031               7             .779, .755, .735, .708, .687, .671, .000  /       2104
000032                DATA PV / 500.,  550.,  600.,  650.,  700.,  750.,  800.,  850.,  2105
000033               1          900.,  950., 1000., 1050., 1100., 1200.,    0.,       2106
000034               2          500.,  550.,  600.,  650.,  700.,  750.,  800.,  850.,  2107
000035               3          900.,  950., 1000., 1050., 1100., 1200.,    0.,       2108
000036               4          500.,  550.,  600.,  650.,  700.,  750.,  800.,  850.,  2109
000037               5          900.,  950., 1000., 1050., 1100., 1200.,    0.,       2110
000038               6          500.,  550.,  600.,  650.,  700.,  750.,  800.,  850.,  2111
000039               7          900.,  950., 1000., 1050., 1100., 1200.,    0.,       2112
000040               8          500.,  550.,  600.,  650.,  700.,  750.,  800.,  850.,  2113
000041               9          900.,  950., 1000., 1050., 1100., 1200.,    0.   /    2114
000042                DATA TAVISC / .852E-3, .519E-3, .368E-3, .303E-3, .239E-3, .195E-3 2115
000043               1   , .152E-3, .130E-3, .108E-3, .950E-4, .780E-4, .620E-4, .460E-4 2116
000044               2   , .460E-4, .0     , .875E-3, .539E-3, .392E-3, .317E-3, .246E-3 2117
000045               3   , .199E-3, .154E-3, .132E-3, .110E-3, .970E-4, .850E-4, .700E-4 2118
000046               4   , .550E-4, .550E-4, .0     , .900E-3, .574E-3, .414E-3, .333E-3 2119
000047               5   , .253E-3, .202E-3, .167E-3, .139E-3, .117E-3, .105E-3, .920E-4 2120
000048               6   , .790E-4, .670E-4, .670E-4, .0     , .928E-3, .594E-3, .437E-3 2121
000049               7   , .340E-3, .262E-3, .215E-3, .170E-3, .147E-3, .126E-3, .111E-3 2122
000050               8   , .990E-4, .850E-4, .760E-4, .760E-4, .0     , .957E-3, .624E-3 2123
000051               9   , .456E-3, .348E-3, .272E-3, .221E-3, .181E-3, .149E-3, .129E-3 2124
000052               A   , .124E-3, .101E-3, .920E-4, .890E-4, .890E-4, .0  /          2125
000053                DATA TACOND /  .1607, .1647, .1590, .1526, .1456, .1375, .1288,   2126
000054               1        .1190, .1088, .0972, .0830, .0612, .0215, .0000, .1695,  2127
000055               2        .1657, .1600, .1538, .1467, .1392, .1304, .1220, .1132,  2128
000056               3        .1039, .0938, .0837, .0695, .0000, .1702, .1661, .1606,  2129
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000057              4        .1545, .1478, .1409, .1337, .1262, .1189, .1112, .1031,      2130
000058              5        .0943, .0855, .0000, .1712, .1668, .1613, .1555, .1494,      2131
000059              6        .1429, .1359, .1290, .1218, .1150, .1082, .1012, .0938,      2132
000060              7        .0000, .1745, .1703, .1656, .1605, .1598, .1586, .1416,      2133
000061              8        .1345, .1276, .1209, .1142, .1071, .0999, .0000  /           2134
000062               DATA TACP /  .684,  .698,  .712,  .738,  .741,  .762,  .777,  .803  2135
000063              1           , .828,  .858,  .893,  .926, 1.002,  .000,  .684,  .698  2136
000064              2           , .712,  .738,  .741,  .762,  .777,  .803,  .828,  .858  2137
000065              3           , .893,  .926, 1.002,  .000,  .684,  .698,  .712,  .738  2138
000066              4           , .741,  .762,  .777,  .803,  .828,  .858,  .893,  .926  2139
000067              5           ,1.002,  .000,  .684,  .698,  .712,  .738,  .741,  .762  2140
000068              6           , .777,  .803,  .828,  .858,  .893,  .926, 1.002,  .000  2141
000069              7           , .684,  .698,  .712,  .738,  .741,  .762,  .777 ,  .803  2142
000070              8           , .828,  .858,  .893,  .926, 1.002,  .000    /           2143
000071               DATA TRHO / 490., 520., 550., 580., 610., 640., 670., 700., 730.,  2144
000072              1            760., 790., 820., 850., 880., 910., 940., 970., 1000.,  2145
000073              2           1030.,1060.,1090.,   0.  /                               2146
000074               DATA RHO  / .920, .900, .890, .875, .860, .822, .815, .810, .800,  2147
000075              1            .780, .760, .740, .720, .690, .670, .645, .610, .575,  2148
000076              2            .516, .465, .290, .0  /                                 2149
000077               DATA TVIS / 520., 550., 580., 610., 640., 670., 700., 730., 760.,  2150
000078              1            790., 820., 850., 880., 910., 940., 970.,1000.,1030.,  2151
000079              2           1060.,1090.,   0.      /                                 2152
000080               DATA VIS  / .700E-3, .540E-3, .430E-3, .350E-3, .300E-3, .255E-3,  2153
000081              1            .220E-3, .195E-3, .170E-3, .150E-3, .135E-3, .120E-3,  2154
000082              2            .108E-3, .950E-4, .850E-4, .750E-4, .660E-4, .580E-4,  2155
000083              3            .480E-4, .230E-4, .0     /                             2156
000084               DATA TCON / 485., 510., 535., 560., 585., 610., 635., 660., 685.,  2157
000085              1            710., 735., 760., 785., 810., 835., 860., 885., 910.,  2158
000086              2            935., 960.,   0.    /                                   2159
000087               DATA COND / .1530, .1520, .1510, .1500, .1485, .1472, .1458, .1442  2160
000088              1          , .1425, .1405, .1386, .1368, .1346, .1325, .1300, .1275  2161
000089              2          , .1245, .1220, .1180, .1150, .0000   /                   2162
000090               DATA CP  / .680, .687, .694, .700, .708, .715, .724, .730, .737,   2163
000091              1           .744, .752, .764, .771, .780, .794, .805, .815, .830,   2164
000092              2           .845, .860, .000    /                                   2165
000093               IF(YARG .LT. TCRIT .OR.  XARG .LT. PCRIT) GO TO 1                  2167
000094               CALL DINT4(PR,T,TARHO,14,5,XARG,YARG,A(5))                         2168
000095               CALL DINT4(PV,T,TAVISC,15,5,XARG,YARG,A(11))                       2169
000096               CALL DINT4(PR,T,TACOND,14,5,XARG,YARG,A(10))                       2170
000097               CALL DINT4(PR,T,TACP,14,5,XARG,YARG,A(7))                          2171
000098               RETURN                                                             2172
000099             1 CALL INT4(TRHO,RHO,YARG,A(5))                                      2173
000100               CALL INT4(TVIS,VIS,YARG,A(11))                                     2174
000101               CALL INT4(TCON,COND,YARG,A(10))                                    2175
000102               CALL INT4(TCON, CP,YARG,A(7))                                      2176
000103               A(5)=A(5)*62.4/1728.                                               2177
000104               A(11)=A(11)/12.                                                    2178
000105               A(10)=A(10)/43200.                                                 2179
000106               RETURN                                                             2180
000107               ENTRY S1SAT
000108               DO 10 I=1,25
000109               TTTTT(I) = TTSAT(I)
000110            10 PPPPP(I) = PTSAT(I)
000111               PCRIT = 1696.E0
000112               TCRIT = 1094.E0
000113               RETURN
000114               END                                                                2181
```

```
@ ELT SUB2,1,711119, 35552

000001                SUBROUTINE SUB2 (XARG, YARG)
000002          C COOLANT = 3, H2O
000003                DIMENSION TVIS(21), VIS(21), RHO(21),
000004               1          TCON(22), CON(22), CP (22)
000005          C
000006                COMMON /FLUIDP/ A(35)
000007          C
000008                DATA TVIS /   500.0,   535.0,   570.0,   605.0,   640.0,   675.0,
000009               1              710.0,   745.0,   780.0,   815.0,   850.0,   885.0,
000010               2              920.0,   955.0,   990.0,  1025.0,  1060.0,  1095.0,
000011               3             1130.0,  1165.0,     0.0/
000012                DATA VIS  / .127E-2, .650E-3, .420E-3, .300E-3, .235E-3, .197E-3,
000013               1            .168E-3, .146E-3, .127E-3, .112E-3, .980E-4, .880E-4,
000014               2            .800E-4, .740E-4, .680E-4, .620E-4, .560E-4, .490E-4,
000015               3            .400E-4, .200E-4, .000   /
000016                DATA RHO  /  1.000,    .998,    .994,    .986,    .975,    .962,
000017               1              .945,    .926,    .906,    .886,    .865,    .840,
000018               2              .814,    .785,    .755,    .716,    .670,    .614,
000019               3              .526,    .315,    .000/
000020                DATA TCON /   480.0,   510.0,   540.0,   570.0,   600.0,   630.0,
000021               1              660.0,   690.0,   720.0,   750.0,   780.0,   810.0,
000022               2              840.0,   870.0,   900.0,   930.0,   960.0,   990.0,
000023               3             1020.0,  1050.0,  1080.0,     0.0/
000024                DATA CON  /    .315,    .336,    .359,    .369,    .379,    .388,
000025               1              .394,    .398,    .400,    .401,    .400,    .397,
000026               2              .392,    .385,    .376,    .364,    .350,    .331,
000027               3              .312,    .293,    .274,    .000/
000028                DATA CP   /    .986,    .992,    .996,    .998,   1.000,   1.000,
000029               1             1.002,   1.005,   1.010,   1.019,   1.030,   1.044,
000030               2             1.062,   1.085,   1.112,   1.152,   1.195,   1.249,
000031               3             1.320,   1.408,   1.548,    .000/
000032                COMMON /THOMAS/ TTTTT(296), PPPPP(296), TCRIT, PCRIT
000033                DIMENSION H2O2(137), H2O1(137),
000034               X          TH2O(296), PH2O(296)
000035                DIMENSION    H2OA(159), H2OB(159)
000036                EQUIVALENCE  (PH2O(1), H2OB(1)), (PH2O(160),H2O1(1)),
000037               X             (TH2O(1), H2OA(1)), (TH2O(160),H2O2(1))
000038          C WATER
000039          C PRESSURE .VS. TEMPERATURE SATURATION TABLE
000040          C PRESSURE     PSIA
000041                DATA H2OB/.200E0, .250E0, .300E0, .350E0, .400E0, .450E0, .500E0, PH2O   7
000042               1  .600E0, .700E0, .800E0, .900E0, .100E1, .120E1, .140E1, .160E1, PH2O  15
000043               2  .180E1, .200E1, .220E1, .240E1, .260E1, .280E1, .300E1, .350E1, PH2O  23
000044               3  .400E1, .450E1, .500E1, .550E1, .600E1, .650E1, .700E1, .750E1, PH2O  31
000045               4  .800E1, .850E1, .900E1, .950E1, .100E2, .110E2, .120E2, .130E2, PH2O  39
000046               5  .140E2, .1469E2,.150E2, .160E2, .170E2, .180E2, .190E2, .200E2, PH2O  47
000047               6  .210E2, .220E2, .230E2, .240E2, .250E2, .260E2, .270E2, .280E2, PH2O  55
000048               7  .290E2, .300E2, .310E2, .320E2, .330E2, .340E2, .350E2, .360E2, PH2O  63
000049               8  .370E2, .380E2, .390E2, .400E2, .410E2, .420E2, .430E2, .440E2, PH2O  71
000050               9  .450E2, .460E2, .470E2, .480E2, .490E2, .500E2, .510E2, .520E2, PH2O  79
000051               A  .530E2, .540E2, .550E2, .560E2, .570E2, .580E2, .590E2, .600E2, PH2O  87
000052               B  .610E2, .620E2, .630E2, .640E2, .650E2, .660E2, .670E2, .680E2, PH2O  95
000053               C  .690E2, .700E2, .710E2, .720E2, .730E2, .740E2, .750E2, .760E2, PH2O 103
000054               D  .770E2, .780E2, .790E2, .800E2, .810E2, .820E2, .830E2, .840E2, PH2O 111
000055               E  .850E2, .860E2, .870E2, .880E2, .890E2, .900E2, .910E2, .920E2, PH2O 119
000056               F  .930E2, .940E2, .950E2, .960E2, .970E2, .980E2, .990E2, .100E3, PH2O 127
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000057          0  .101E3, .102E3, .103E3, .104E3, .105E3, .106E3, .107E3, .108E3, PH20 135
000058          1  .109E3, .110E3, .111E3, .112E3, .113E3, .114E3, .115E3, .116E3, PH20 143
000059          2  .117E3, .118E3, .119E3, .120E3, .121E3, .122E3, .123E3, .124E3, PH20 151
000060          3  .125E3, .126E3, .127E3, .128E3, .129E3, .130E3, .131E3, .132E3 /PH20 159
000061           DATA H201/.133E3, .134E3, .135E3, .136E3, .137E3, .138E3, .139E3, PH20 166
000062          1  .140E3, .141E3, .142E3, .143E3, .144E3, .145E3, .146E3, .147E3, PH20 174
000063          2  .148E3, .149E3, .150E3, .152E3, .154E3, .156E3, .158E3, .160E3, PH20 182
000064          3  .162E3, .164E3, .166E3, .168E3, .170E3, .172E3, .174E3, .176E3, PH20 190
000065          4  .178E3, .180E3, .182E3, .184E3, .186E3, .188E3, .190E3, .192E3, PH20 198
000066          5  .194E3, .196E3, .198E3, .200E3, .205E3, .210E3, .215E3, .220E3, PH20 206
000067          6  .225E3, .230E3, .235E3, .240E3, .245E3, .250E3, .255E3, .260E3, PH20 214
000068          7  .265E3, .270E3, .275E3, .280E3, .285E3, .290E3, .295E3, .300E3, PH20 222
000069          8  .310E3, .320E3, .330E3, .340E3, .350E3, .360E3, .370E3, .380E3, PH20 230
000070          9  .390E3, .400E3, .410E3, .420E3, .430E3, .440E3, .450E3, .460E3, PH20 238
000071          A  .470E3, .480E3, .490E3, .500E3, .520E3, .540E3, .560E3, .580E3, PH20 246
000072          B  .600E3, .620E3, .640E3, .660E3, .680E3, .700E3, .720E3, .740E3, PH20 254
000073          C  .760E3, .780E3, .800E3, .820E3, .840E3, .860E3, .880E3, .900E3, PH20 262
000074          D  .920E3, .940E3, .960E3, .980E3, .100E4, .105E4, .110E4, .115E4, PH20 270
000075          E  .120E4, .125E4, .130E4, .135E4, .140E4, .145E4, .150E4, .160E4, PH20 278
000076          F  .170E4, .180E4, .190E4, .200E4, .210E4, .220E4, .230E4, .240E4, PH20 286
000077          0  .250E4, .260E4, .270E4, .280E4, .290E4, .300E4, .310E4, .320E4, PH20 294
000078          1  .32062E4, .000 /                                                PH20 296
000079     C TEMPERATURE   R
000080           DATA H20A/513.14, 519.30, 524.47, 528.93, 532.86, 536.38, 539.58, TH20   7
000081          1  545.21, 550.08, 554.38, 558.24, 561.74, 567.92, 573.26, 577.99, TH20  15
000082          2  582.23, 586.08, 589.62, 592.89, 595.94, 598.79, 601.48, 607.57, TH20  23
000083          3  612.97, 617.83, 622.24, 626.30, 630.06, 633.56, 636.85, 639.94, TH20  31
000084          4  642.86, 645.64, 648.28, 650.80, 653.21, 657.75, 661.96, 665.88, TH20  39
000085          5  669.56, 672.00, 673.03, 676.32, 679.44, 682.41, 685.24, 687.96, TH20  47
000086          6  690.57, 693.07, 695.49, 697.82, 700.07, 702.25, 704.36, 706.41, TH20  55
000087          7  708.40, 710.33, 712.22, 714.05, 715.84, 717.58, 719.28, 720.95, TH20  63
000088          8  722.57, 724.16, 725.72, 727.25, 728.74, 730.21, 731.64, 733.05, TH20  71
000089          9  734.44, 735.80, 737.13, 738.45, 739.74, 741.01, 742.26, 743.49, TH20  79
000090          A  744.70, 745.90, 747.07, 748.23, 749.37, 750.50, 751.61, 752.71, TH20  87
000091          B  753.79, 754.85, 755.90, 756.94, 757.97, 758.99, 759.99, 760.98, TH20  95
000092          C  761.96, 762.92, 763.88, 764.83, 765.76, 766.68, 767.60, 768.50, TH20 103
000093          D  769.40, 770.29, 771.16, 772.03, 772.89, 773.74, 774.59, 775.42, TH20 111
000094          E  776.25, 777.07, 777.88, 778.68, 779.48, 780.27, 781.06, 781.83, TH20 119
000095          F  782.60, 783.36, 784.12, 784.87, 785.61, 786.35, 787.08, 787.81, TH20 127
000096          0  788.53, 789.25, 789.96, 790.66, 791.36, 792.05, 792.74, 793.42, TH20 135
000097          1  794.10, 794.77, 795.44, 796.11, 796.77, 797.42, 798.07, 798.72, TH20 143
000098          2  799.36, 799.99, 800.62, 801.25, 801.88, 802.50, 803.11, 803.72, TH20 151
000099          3  804.33, 804.94, 805.54, 806.13, 806.73, 807.32, 807.90, 808.48 /TH20 159
000100           DATA H202/809.06, 809.64, 810.21, 810.78, 811.35, 811.91, 812.47, TH20 166
000101          1  813.02, 813.57, 814.12, 814.67, 815.21, 815.76, 816.29, 816.83, TH20 174
000102          2  817.36, 817.89, 818.42, 819.46, 820.49, 821.52, 822.53, 823.53, TH20 182
000103          3  824.53, 825.51, 826.48, 827.45, 828.41, 829.35, 830.29, 831.22, TH20 190
000104          4  832.14, 833.06, 833.96, 834.86, 835.75, 836.64, 837.51, 838.38, TH20 198
000105          5  839.24, 840.10, 840.95, 841.79, 843.86, 845.90, 847.89, 849.86, TH20 206
000106          6  851.79, 853.68, 855.54, 857.37, 859.18, 860.95, 862.70, 864.42, TH20 214
000107          7  866.11, 867.78, 869.43, 871.05, 872.65, 874.23, 875.79, 877.33, TH20 222
000108          8  880.35, 883.29, 886.16, 888.97, 891.72, 894.40, 897.03, 899.60, TH20 230
000109          9  902.12, 904.59, 907.01, 909.39, 911.73, 914.02, 916.28, 918.50, TH20 238
000110          A  920.68, 922.82, 924.93, 927.01, 931.07, 935.01, 938.85, 942.58, TH20 246
000111          B  946.21, 949.75, 953.21, 956.58, 959.88, 963.10, 966.25, 969.34, TH20 254
000112          C  972.36, 975.33, 978.23, 981.08, 983.88, 986.63, 989.33, 991.98, TH20 262
000113          D  994.59, 997.16, 999.68,1002.17,1004.61,1010.57,1016.31,1021.86, TH20 270
000114          E 1027.22,1032.42,1037.46,1042.35,1047.10,1051.73,1056.23,1064.90, TH20 286
000115          F 1073.15,1081.03,1088.58,1095.82,1102.77,1109.46,1115.91,1122.12, TH20 286
000116          0 1128.13,1133.94,1139.55,1144.99,1150.26,1155.36,1160.31,1165.11, TH20 294
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000117                1 1165.40, 000.00 /                                    TH20 296
000118          C
000119                IF (YARG .LE. TCRIT  .AND.  XARG .LE. PCRIT) GO TO 1
000120                WRITE (6,10) XARG, YARG
000121          10    FORMAT ('0PCRIT OR TCRIT HAS BEEN EXCEEDED IN THE WATER PROPERTIES
000122               1***XARG = 'E15.8, '  YARG = 'E15.8)
000123                STOP 10
000124          C
000125          1     CALL INT4 ( TVIS, VIS, YARG, A(11) )
000126                CALL INT4 ( TVIS, RHO, YARG, A(5)  )
000127                CALL INT4 ( TCON, CON, YARG, A(10) )
000128                CALL INT4 ( TCON, CP , YARG, A(7)  )
000129                A(11) = A(11) /12.E0
000130                A(5) = A(5) * 62.4E0 / 1728.E0
000131                A(10) = A(10) / 43200.E0
000132                RETURN
000133                ENTRY S2SAT
000134                DO 20 I=1,296
000135                TTTTT(I) = TH20(I)
000136             20 PPPPP(I) = PH20(I)
000137                PCRIT  = 3206.7E0
000138                TCRIT  = 705.4E0
000139                RETURN
000140                END
```

nozzle Mach number distribution is shown on Figure 4. This profile was calculated as described in Reference (a). The friction coefficient ratio curve shown on Figure 3 is recommended for NERVA 75K engine analyses until more appropriate calculation techniques are developed.

C. EXAMPLE CASE

In order to illustrate use of the developed factors an example case was calculated for the 75K engine using the E25107 computer code.

The first step in the analysis was to calculate the gas side heat transfer coefficient distribution using integral boundary layer code with the factors shown on Figure 3, appropriate chamber conditions, surface Mach number distribution and estimated wall temperatures. The resulting heat transfer coefficient distribution is shown on Figure 5.

This distribution along with the other necessary data were specified for typical 75K engine conditions and the resulting output is shown as Table 2. The calculations predict lower gas-side wall temperatures than previously calculated for similar conditions in the barrel and initial portions of the convergent section. The maximum temperature is approximately 30 degrees lower than previously calculated for similar conditions. The over-all coolant temperature rise and pressure drop is approximately the same as previously calculated.

## III. REFERENCES

(a) Memorandum N4320:M1648 to J. L. Watkins from R. V. Lundin/J. O. Sane, Subject: "Updated NERVA Gas-Side Heat Transfer Model", dated 4 March 1971

(b) Scale Model Heat Transfer Tests of the NERVA Nozzle, Aerojet-General Report No. 2221, July 1962 (Confidential/Restricted Data)

(c) Scale Model Heat Transfer Tests of the NERVA Nozzle, CY 1962, Aerojet-General Report No. 2493, April 1963 (Confidential/Restricted Data)

(d) Scale Model Heat Transfer Tests of the NERVA Nozzle, CY 1963, Aerojet-General Report No. RN-S-0059, March 1964

(e) Phase I, Experimental Investigation of Heat Transfer to Nuclear Rocket Nozzles Using Shock Tube Techniques, Cornell Aeronautical Laboratory Report No. HM-1650-Y-1, December 1963

(f) Phase II, Experimental Investigation of Heat Transfer to Nuclear Rocket Nozzles Using Shock Tube Techniques, Cornell Aeronautical Laboratory Report No. HM-1650-Y-2, December 1963

(g) D. R. Bartz, "A Simple Equation for Rapid Estimation of Rocket Nozzle Convective Heat Transfer Coefficients", Jet Propulsion, 49, January 1957

(h) D. G. Elliott, D. R. Bartz, and S. Silver, Calculation of Turbulent Boundary Layer - Growth and Heat Transfer in Axi-Symmetric Nozzles, Jet Propulsion Laboratory Technical Report No. 32-387, 15 February 1963

(i) A. Fortini and R. C. Ehlers, Comparison of Experimental to Predicted Heat Transfer in a Bell-Shaped Nozzle with Upstream Flow Disturbances, NASA TN D-1743, August 1963

(j) Aerojet Report RP-TR-0009

(k) J. F. Schmidt, D. R. Boldman, R. C. Ehlers, and J. W. Coats, "Experimental Study of Effect of Simulated Reactor Core Position on Nozzle Heat Transfer", NASA TM X-1208, March 1966

(l) D. R. Boldman, H. E. Neumann, and J. F. Schmidt, "Heat Transfer in 30° and 60° Half-Angle of Convergence Nozzles with Various Diameter Uncooled Pipe Inlets", NASA TN D-4177, September 1967

(m) Technical and Users Manual for Program E25107 Nozzle Heat Transfer, J. J. Williams, dated February 1972

(n) Memorandum 4320:M1616, J. L. Watkins from J. O. Sane, Subject: "NERVA Nozzle Coolant-Side Heat Transfer Correlation", dtd 22 January 1971

(o) Taylor, Maynard F., "A Method of Correlating Local and Average Friction Coefficients for Both Laminar and Turbulent Flow of Gases Through a Smooth Tube with Surface to Fluid Bulk Temperature Ratios From .35 to 7.35", International Journal of Heat and Mass Transfer, Vol. 10, pp 1123-1128

(p) Taylor, Maynard F., "Applications of Variable Property Heat-Transfer and Friction Equations to Rocket Nozzle Coolant Passages and Comparison With Nuclear Rocket Test Results", AIAA Paper No. 70-661, presented at the AIAA 6th Propulsion Joint Specialist Conference, San Diego, California, June 15-19, 1970

(q) Ito, H., "Friction Factors for Turbulent Flow in Curved Pipes", Journal of Basic Engineering, Vol. 81, No. 2, June 1959, pp 123-124

(r) "Computer Program E95213, A Computer Code for Solution of the Integral Boundary Layer Equations", J. J. Williams, December 1969

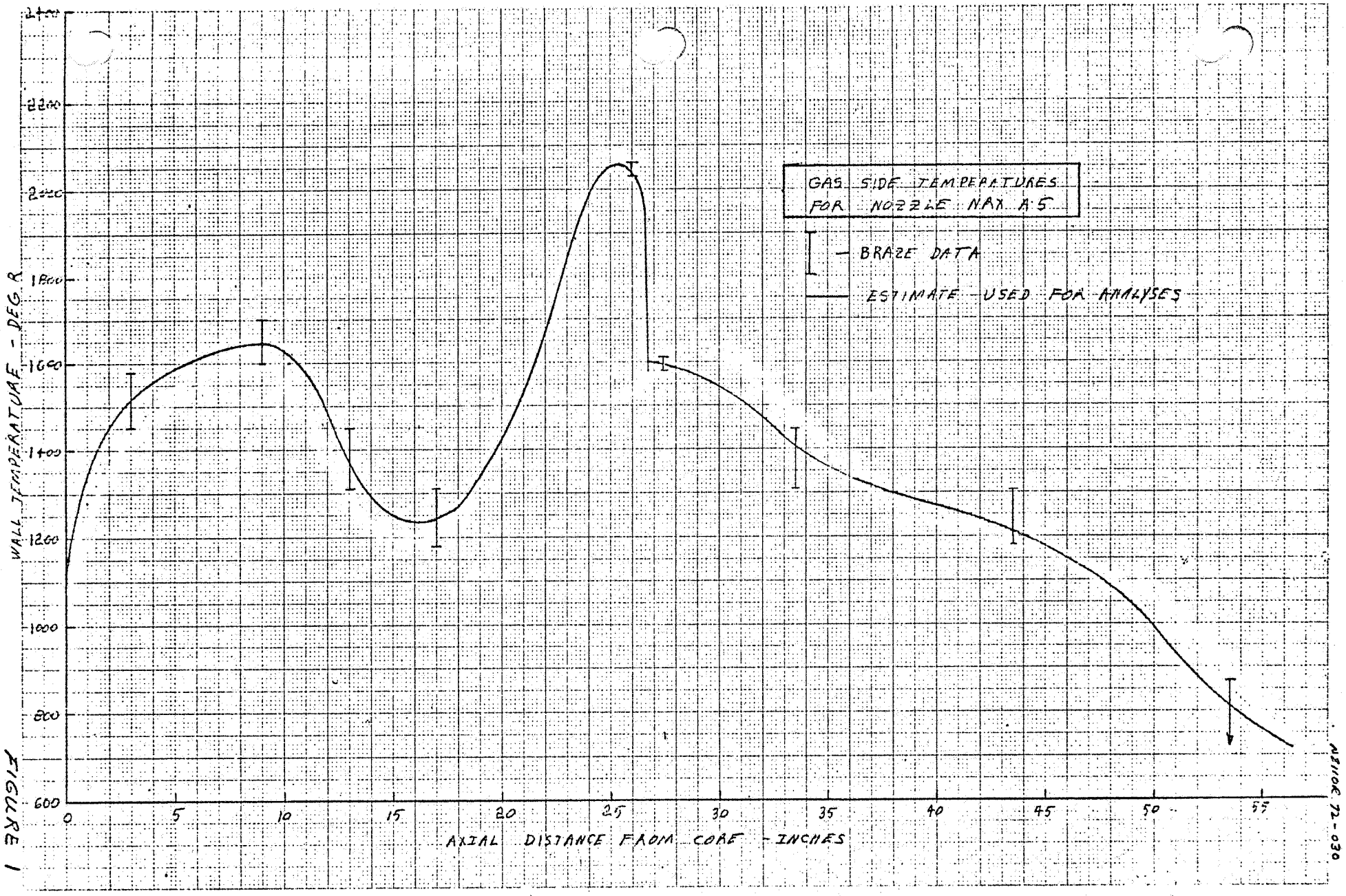



FIGURE 1

NASA-CR-72-030

EUGENE DIETZGEN CO.
MADE IN U. S. A.

NO. 340D 10½ x DIETZGEN GRAPH PAPER
10 X 10 PER HALF INCH

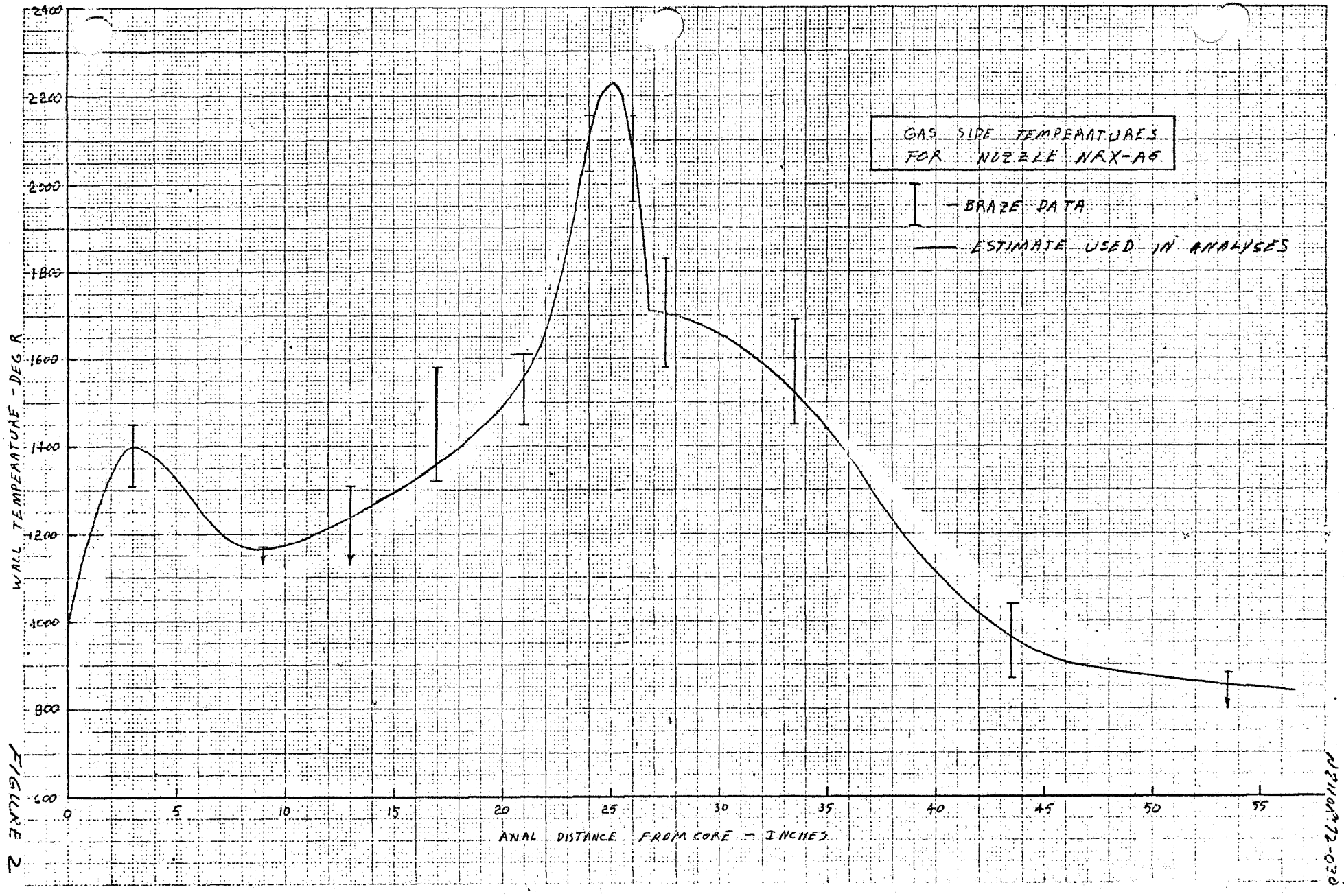



FIGURE 2

NASA-CR-72-030

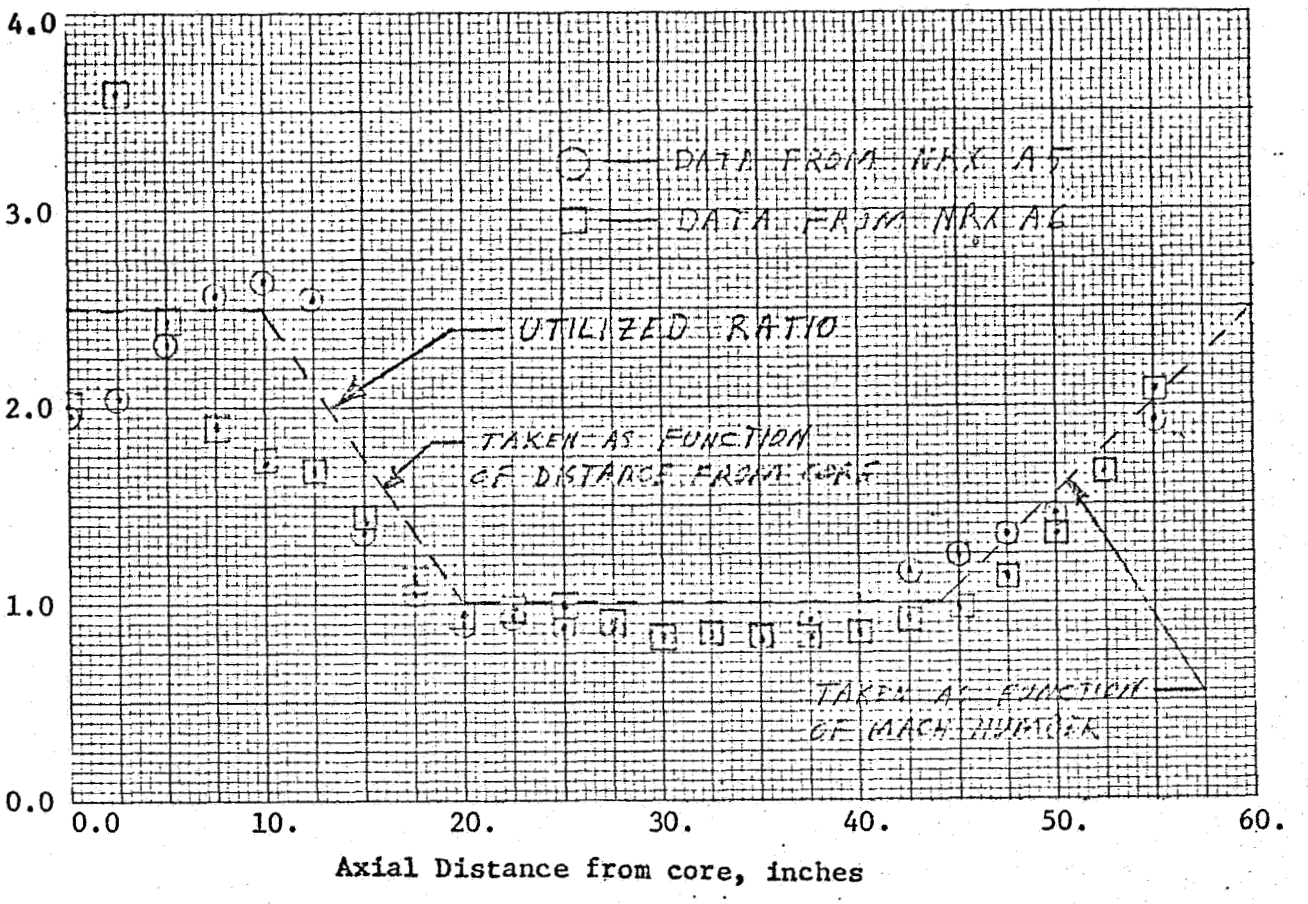
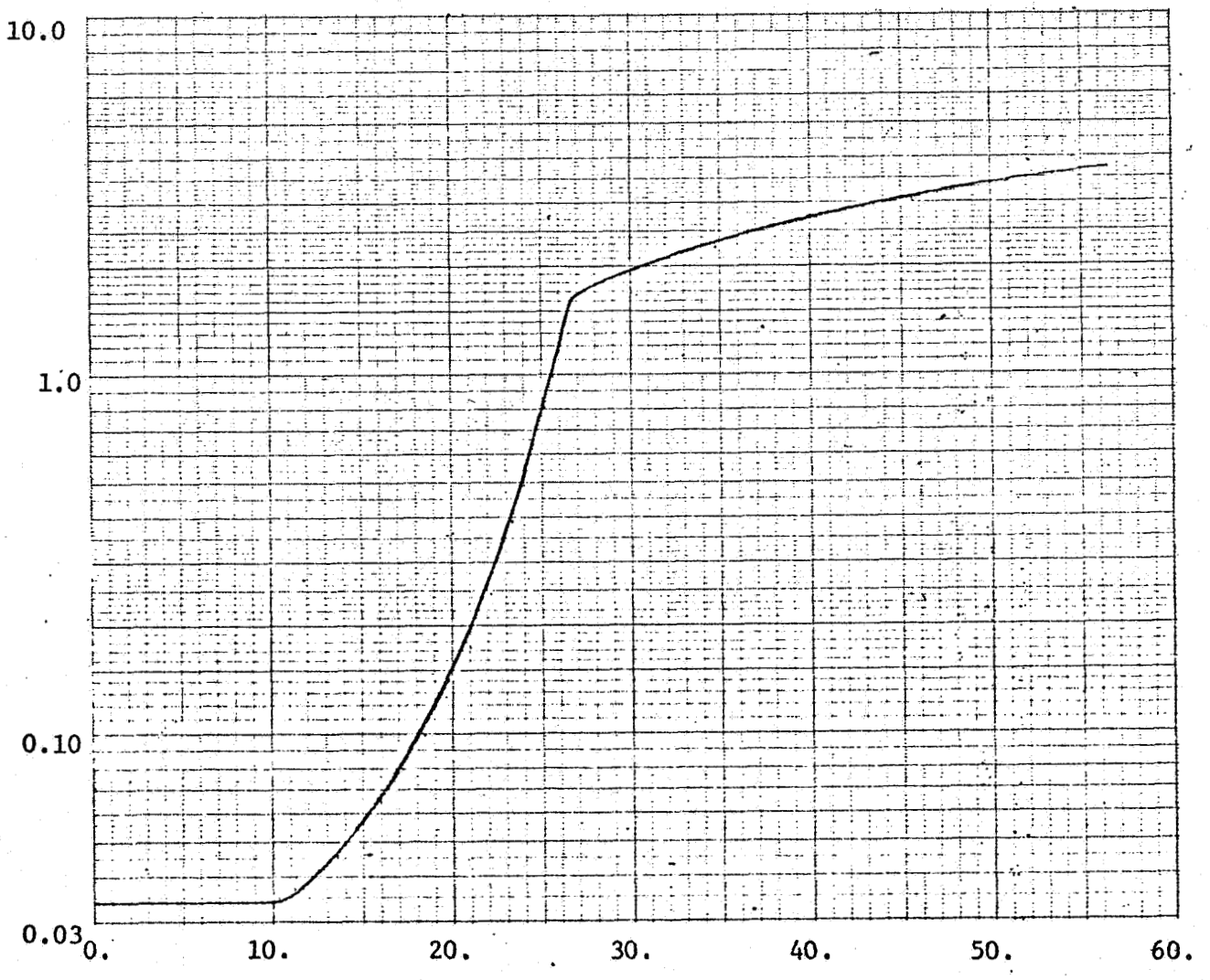
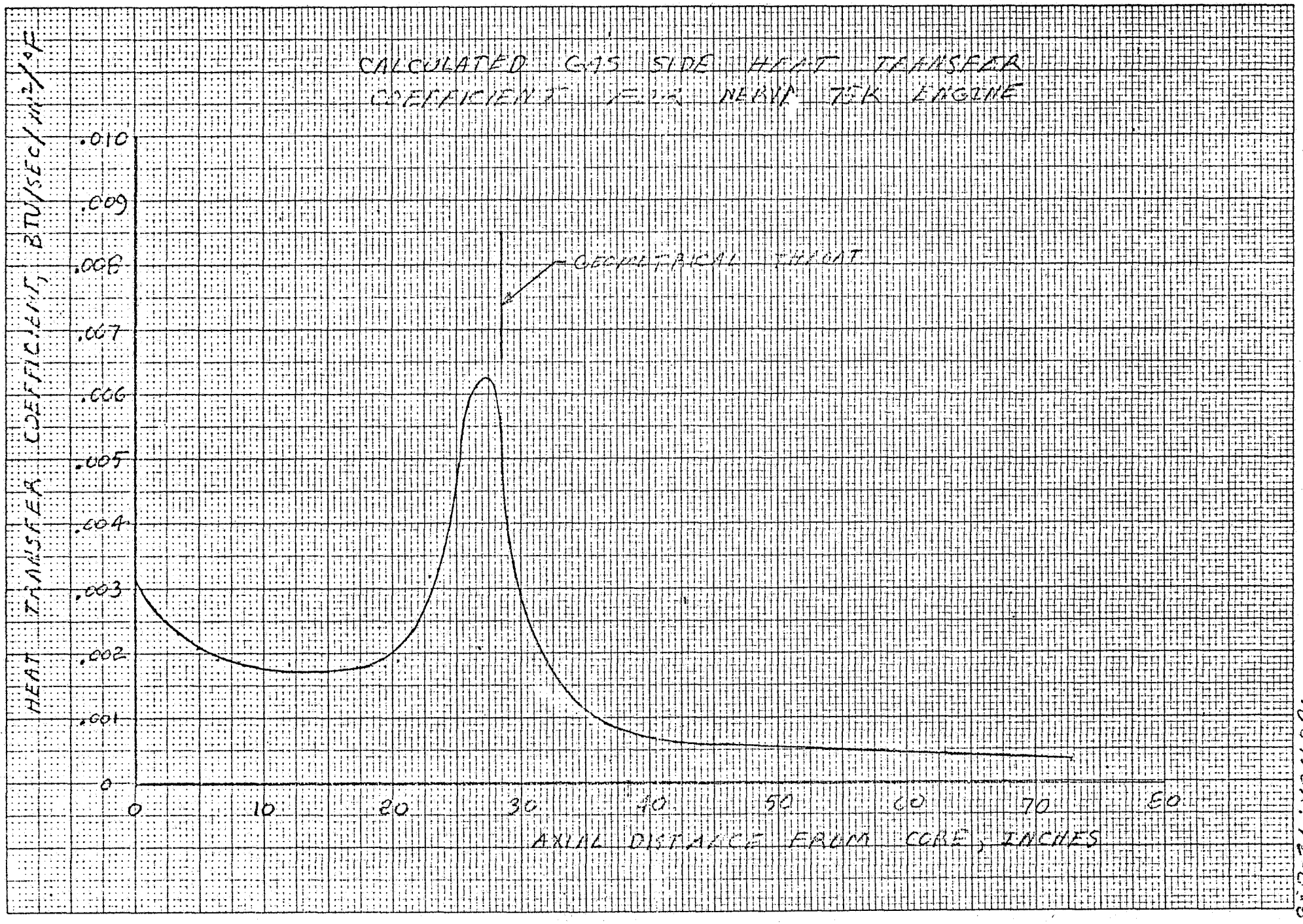



FIGURE 3 - CALCULATED FRICTION COEFFICIENT RATIO



NO. 340-10½ DIETZGEN GRAPH PAPER
10 X 10 PER HALF INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.




NAA-SR-7-0220

Figure 5

TABLE I

SUMMARY OF DATA USED TO DETERMINE VALUES
FOR HEATED AREA AND PRESSURE DROP FACTORS

| Run No. | Time Sec | PIN PSIA | TIN °R | WGSTAR lb/sec | WGCORE lb/sec | TAWDOT lb/sec | DPI PSI | DTI °R | Pc PSIA | Tc °R | EPGEOM - | PFM - | Reactor Power M.W. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RX A-5 EP-III | | | | | | | | | | | | | | |
| 1 | 25245-250 | 257.9 | 45.0 | 33.1 | 33.1 | 31.9 | 26.4 | 29.1 | 180.9 | 1919 | .5644 | .5385 | 229.7 | (1) |
| 2 | 25395-400 | 875.2 | 52.0 | 71.0 | 71.0 | 68.5 | 140.6 | 102.9 | 571.2 | 4095 | .8802 | .5708 | 1116 | |
| 3 | 25475-480 | 857.0 | 52.2 | 70.9 | 70.9 | 68.4 | 136.1 | 97.6 | 557.5 | 3939 | .8579 | .5977 | 1063 | |
| 4 | 25680-685 | 854.1 | 52.0 | 70.7 | 70.7 | 68.2 | 135.7 | 98.3 | 554.6 | 3912 | .8625 | .5828 | 1049 | |
| 5 | 25900-905 | 870.7 | 52.5 | 71.0 | 71.0 | 68.5 | 140.7 | 102.4 | 563.5 | 4003 | .8771 | .5579 | 1084 | |
| 6 | 26045-050 | 870.5 | 52.7 | 70.9 | 70.9 | 68.4 | 141.5 | 102.5 | 562.5 | 4004 | .8766 | .5722 | 1083 | |
| 7 | 26175-180 | 868.5 | 52.8 | 70.8 | 70.8 | 68.3 | 140.5 | 102.7 | 561.5 | 4005 | .8776 | .5454 | 1081 | |
| 8 | 26247-252 | 868.6 | 52.8 | 70.7 | 70.7 | 68.2 | 140.7 | 103.4 | 560.6 | 4003 | .8812 | .5368 | 1079 | |
| RX A-5 EP-IV | | | | | | | | | | | | | | |
| 9 | 12935-940 | 757.5 | 51.3 | 70.4 | 70.4 | 67.9 | 115.8 | 71.5 | 498.5 | 3245 | .7393 | .7522 | 847.4 | (1) |
| 10 | 12970-975 | 880.3 | 52.7 | 70.2 | 70.2 | 67.7 | 144.8 | 103.0 | 569.6 | 4168 | .8730 | .7188 | 1125 | |
| 11 | 13000-005 | 874.7 | 52.4 | 70.2 | 70.2 | 67.7 | 143.4 | 102.2 | 565.6 | 4122 | .8714 | .7103 | 1111 | |
| 12 | 13190-210 | 875.7 | 52.2 | 70.6 | 70.6 | 68.1 | 145.5 | 103.4 | 564.1 | 4048 | .8805 | .6857 | 1091 | |
| 13 | 13270-275 | 876.3 | 52.2 | 70.5 | 70.5 | 68.0 | 146.1 | 104.2 | 563.5 | 4056 | .8844 | .6834 | 1093 | |
| 14 | 13540-545 | 878.2 | 52.4 | 70.2 | 70.2 | 67.7 | 150.2 | 106.2 | 562.0 | 4079 | .8932 | .7318 | 1099 | |
| 15 | 13810-815 | 876.5 | 52.0 | 69.6 | 69.6 | 67.1 | 151.0 | 109.1 | 557.9 | 4118 | .9082 | .7269 | 1096 | |
| RX A-5 EP III B | | | | | | | | | | | | | | |
| 16 | 14250 | 790 | 47.9 | 67.1 | 67.1 | 64.3 | 112.0 | 86.7 | 533.0 | 3982 | .8843 | .5854 | 1022 | |
| 17 | 14400 | 876 | 49.0 | 72.5 | 72.5 | 69.5 | 134.0 | 92.8 | 580.0 | 4050 | .9074 | .6484 | 1122 | |
| 18 | 16200 | 890 | 50.0 | 73.3 | 73.3 | 70.3 | 139.0 | 97.2 | 587.0 | 4060 | .9264 | .5614 | 1135 | |
| 19 | 17700 | 901 | 51.4 | 73.1 | 73.1 | 70.1 | 141.0 | 100.3 | 594.0 | 4156 | .9356 | .4880 | 1170 | |
| 19a | Repeat of Run 19 except wall temperature increased by 100°R. | | | | | | | | | | .8819 | .5169 | 1170 | |

For 17 Samples $\text{EPGEOM} = \frac{\text{Mean}}{.887}$, $\text{PFM} = .618$

(1) Low power runs - neglect. Wall temperature profile will not match these runs.

PIN Nozzle Inlet Pressure

TIN Nozzle Inlet Temperature

WGSTAR Gas Flow Rate through the Throat

WGCORE Gas Flow Rate from the Core

TAWDOT Coolant Flow Rate

DPI Required Pressure Drop

DTI Required Coolant Bulk Temperature Increase

Pc Chamber Pressure

Tc Chamber Temperature

EPGEOM Heated area factor = $\epsilon$, for calculating surface area between stations,

$$A_s = \frac{\pi}{2} \epsilon \left[(r_g - t_c) + (r_g - t_c)_p\right] \left| X - X_p \right|$$

PFM Pressure multiplier, for calculating pressure loss due to friction,

$$P_f = \frac{\bar{\rho}\bar{v}^2}{2g} \left[(PFM) 4 \bar{f}_{eff} \frac{\left| x - x_p \right|}{d_e} + 2K6 \frac{T_b - T_{b_p}}{T_b}\right]$$

TABLE 2

SAMPLE COMPUTER CODE OUTPUT

```
NERVA  ENGINE  NOMINAL CASE  FEB 1972
$DATUM
      SUM = 3.0,
      ITREL  =  50.0  ,FRIC  =  1.0  ,WGSTA  =  1.0  ,PLC  =  11.0  ,
      HGC  =  3.000  ,WALL  =  0.0  ,MERCR  =  0.0,  ,PC  =  450.0  ,
      TC  =  4252.  ,MR  =  0.0  ,WGSTAR  =  91.80  ,WGCORE =  91.80 ,
      PIN = 1375.0 ,TIN = 60.70 ,ASTAR = 98.696 ,ZSTAR = 28.520 ,
      TWL = 800. ,TWG = 800. ,COOL = 4.0 ,AASTAR = 24.0 ,
      ZETA = 1.0 ,CONTR = 1.0 ,NDL = 5.0 ,NTOT = 40.0 ,
      NC = 1.0 ,ZW = 0.0 ,K1 = 1.00 ,K3 = 1.80,
ZU=24.558,ZD=29.906,RU=5.605,RD=2.802,K5S=1.,
      K4 = 0.0 ,CC2 = 0.0 ,CC1 = 0.0 ,MW = 0.0 ,
      LW = .100 ,
      LHITE (1) = 40*0.,
      CGITE (1) = 40* 0.0 ,
      TUBE (1) = 40* 4.0 ,
      TMKM (1) = 40* 0.0 ,
      PPFM (1) = 40* 0.618,
      EEPGEO(1) = 40* .087 ,
      TASMTS(1)= 40* .010 ,
      LH (1)= 6*.102 , .0937, .0673, .0158, .0040,
        18*.0000, 10*-.100, 2*.0000,
TAHG=.00313,.00265,.00232,.00210,.00194,.00182,.00177,.00173,.00171,.00171,
  .00173,.00178,.00188,.00203,.00238,.00297,.00415,.00530,.00608,.00624,.00515,
 .00350,.00208,.00215,.00164,.00153,.00100,.00081,.00068,.00060,.00059,.00058,
  .00055,.00051,.00049,.00046,.00043,.00040,.00039,.00035,
      TASMTM(1) = .022, .022, .022, .022, .022,
        .022, .018, .018, .018, .017, .017,
        .017, .016, .016, .015, .015, .014,
        .014, .013, .013, .013, .013, .014,
        .015, .016, .017, .018, .019, .020,
        .021, .022, .023, .024, .025, .026,
        .027, .028, .028, .028, .028,
      TAZ (1) = 00.000, 01.685, 03.370, 05.055, 06.740,
        08.425, 09.875, 11.227, 12.388, 14.408, 15.859,
        17.310, 18.761, 20.212, 21.663, 23.114, 24.565,
        25.415, 26.385, 27.435, 28.528, 29.306, 30.023,
        31.345, 32.758, 33.066, 35.878, 37.933, 40.488,
        42.552, 44.528, 46.418, 50.040, 53.503, 56.846,
        60.123, 63.353, 66.528, 69.678, 72.813,
      TAAF (1) = .0910, .0910, .0910, .0910, .0910,
        .0910, .0929, .1000, .1160, .1320, .1393,
        .1351, .1297, .1164, .1010, .0847, .0672,
        .0467, .0360, .0363, .0534, .0657, .0692,
        .0787, .0894, .0909, .1128, .1305, .1561,
        .1727, .1877, .2017, .2271, .2497, .2696,
        .2875, .3040, .3199, .2851, .2965,
      TABETA(1) = .2700, .8480, .9335, .9680, .9850,
        .9940, .9980, 1.00 , 1.00 , 1.00 , 1.00 ,
        1.00 , 1.00 , 1.00 , 1.00 , 1.00 , 1.00 ,
        1.00 , .99 , .99 , .99 , .98 , .97 ,
        .96 , .95 , .95 , .94 , .93 , .93 ,
        .93, .92 , .92 , .92 , .91 , .91 , .91 ,
        .91 ,3*.91,
      TAZ1 (1) = 72.813, 09.875, 09.875, 08.425, 0.0 ,
      TANT (1) = 216. , 216. , 216. , 216. , 216. ,
      TANMB (1) = 216. , 216. , 216. , 216. , 216. ,
TAWDOT=77.8,77.8,3*74.69,
      ZZZZZZ(1) = 00.000, 01.685, 03.370, 05.055, 06.740,
```

```
      25, 09.075, 11.227, 12.388, 14.408, 15.859,
     1.510, 18.761, 20.212, 21.663, 23.114, 24.565,
     25.415, 26.385, 27.435, 28.528, 29.306, 30.023,
     31.345, 32.758, 33.066, 35.878, 37.933, 40.488,
     42.552, 44.528, 46.413, 50.040, 53.503, 56.846,
     60.123, 63.353, 66.528, 69.678, 72.813,
   RRRRRR(1) = 21.065, 21.065, 21.065, 21.065, 21.065,
     21.065, 20.874, 20.314, 19.423, 17.403, 15.952,
     14.501, 13.050, 11.599, 10.148, 8.697 , 7.247,
     6.549, 6.032, 5.713, 5.605, 5.715, 6.037,
     6.842, 7.726, 7.927, 9.708, 11.210, 12.533,
     13.729, 14.829, 15.853, 17.725, 19.416, 20.972,
     22.420, 23.780, 25.066, 26.290, 27.459,
   AAAAAA(1) = -14.12, -14.12, -14.12, -14.12, -14.12,
     -14.12, -13.87, -13.14, -12.01, -09.64, -08.10,
     -6.69, -5.42, -4.28, -3.28, -2.41, -1.67,
     -1.37, -1.16, -1.04, 1.00, 1.04, 1.16,
     1.49, 1.9 , 2.00, 3.00, 4.00, 5.00,
     6.00, 7.00, 8.00, 10.00, 12.00, 14.00,
     16.00, 18.00, 20.00, 22.00, 24.00,
   SSSSSS(1) = 83.998, 82.313, 80.628, 78.943, 77.258,
     75.573, 74.106, 72.638, 71.171, 68.314, 66.262,
     64.210, 62.158, 60.106, 58.054, 56.002, 53.950,
     52.850, 51.749, 50.648, 49.548, 48.760, 47.972,
     46.422, 44.752, 44.392, 41.060, 38.220, 35.655,
     33.265, 31.004, 28.852, 24.772, 20.922, 17.237,
     13.652, 10.145, 06.725, 03.345, 00.000,
   TAAST (1) = - 20.0000,- 5.0000,- 1.6536,- 1.2853,- 1.1450,
     - 1.0750,- 1.0156,- 1.0044, 1.0000,
     1.3837, 2.0083, 3.0406, 3.9218, 5.4515,
     7.1216, 8.6260, 11.3326, 13.7738,
     18.1590, 22.1097, 25.7635, 34.0256, 41.4487,
     54.7178, 66.6046, 77.5459, 87.7815,
     97.4607, 106.6846, 197.4253,
   TPK (1) = 450.0000, 450.0000, 409.0909, 375.0000, 346.1538,
     321.4286, 281.2500, 225.0000, 244.5430,
     90.0000, 45.0000, 22.5000, 15.0000, 9.0000,
     6.0000, 4.5000, 3.0000, 2.2500,
     1.5000, 1.1250, 0.9000, 0.6000, 0.4500,
     0.3000, 0.2250, 0.1800, 0.1500,
     0.1286, 0.1125, 0.0450,
   TTINK (1) = 4250.0000, 4250.0000, 4161.6508, 4081.6236, 4008.5859,
     3941.4851, 3821.9220, 3626.2093, 3698.0607,
     2887.7922, 2407.6729, 1998.1818, 1789.4076, 1555.9597,
     1392.4403, 1286.3422, 1150.1874, 1062.0403,
     948.4737, 874.8162, 821.2947, 731.4761, 673.1272,
     597.7618, 548.7998, 503.2067, 485.5930,
     463.2340, 444.5725, 332.8209,
 TAFEFV=40*0.,
 $END
```

********** SUMMARY **********

COOLANT = NBS PARA-HYDROGEN PIN = 1375.0 TIN = 60.7

TC = 4252. PC = 450. WG = 91.8 WC = 77.8 MR = .00 NT = 216.

| STA | A/AT / Z | CL / CG | SUMQ / VC | TM / Q/AI | HL / HG | R / PRC | TB / DE | RG / L | AF / NMR | TWL / TWG | RE / MUB | WDOT/A / MACH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 24.00 | .0304 | 0. | .0280 | .00451 | 27.46 | 60.7 | .400 | .296 | 340. | .6514+06 | 1.2 |
| | 72.81 | .0260 | 491. | 1.3 | .00035 | 1374.23 | .557 | .1058 | 216. | 523. | .6005-06 | .0101 |
| | TUBE TYPE = U-TURE | | | | MATERIAL = STAINLESS STEEL | | | | | | | |
| 2 | 22.00 | .0262 | 966. | .0280 | .00422 | 26.29 | 64.9 | .383 | .285 | 392. | .5591+06 | 1.3 |
| | 69.68 | .0260 | 529. | 1.4 | .00039 | 1373.97 | .550 | .1225 | 216. | 587. | .5466-06 | .0112 |
| 3 | 20.00 | .0229 | 1921. | .0280 | .00241 | 25.07 | 68.9 | .365 | .320 | 623. | .2886+06 | 1.1 |
| | 66.53 | .0260 | 487. | 1.3 | .00040 | 1373.98 | .578 | .1395 | 216. | 791. | .5069-06 | .0107 |
| 4 | 18.00 | .0207 | 2837. | .0280 | .00207 | 23.78 | 72.6 | .346 | .304 | 743. | .2392+06 | 1.2 |
| | 63.35 | .0260 | 529. | 1.4 | .00043 | 1373.75 | .564 | .1593 | 216. | 909. | .4719-06 | .0120 |
| 5 | 16.00 | .0190 | 3763. | .0270 | .00203 | 22.42 | 76.1 | .326 | .288 | 796. | .2305+06 | 1.3 |
| | 60.12 | .0260 | 579. | 1.5 | .00046 | 1373.48 | .549 | .1790 | 216. | 961. | .4448-06 | .0135 |
| 6 | 14.00 | .0181 | 4700. | .0260 | .00212 | 20.97 | 79.6 | .304 | .270 | 811. | .2382+06 | 1.3 |
| | 56.85 | .0260 | 640. | 1.5 | .00049 | 1373.15 | .530 | .2003 | 216. | 978. | .4185-06 | .0154 |
| 7 | 12.00 | .0178 | 5644. | .0250 | .00236 | 19.42 | 83.0 | .281 | .250 | 776. | .2699+06 | 1.4 |
| | 53.50 | .0260 | 717. | 1.6 | .00051 | 1372.73 | .508 | .2229 | 216. | 948. | .3969-06 | .0176 |
| 8 | 10.00 | .0177 | 6606. | .0240 | .00262 | 17.72 | 86.4 | .257 | .228 | 771. | .2921+06 | 1.6 |
| | 50.04 | .0260 | 819. | 1.8 | .00055 | 1372.15 | .481 | .2468 | 216. | 952. | .3784-06 | .0206 |
| 9 | 8.00 | .0177 | 7623. | .0230 | .00318 | 15.85 | 89.8 | .229 | .202 | 701. | .3588+06 | 1.8 |
| | 46.42 | .0260 | 959. | 1.9 | .00058 | 1371.30 | .446 | .2740 | 216. | 893. | .3597-06 | .0248 |
| 10 | 7.00 | .0177 | 8134. | .0220 | .00364 | 14.83 | 91.5 | .214 | .189 | 647. | .4161+06 | 1.9 |
| | 44.53 | .0260 | 1051. | 2.0 | .00059 | 1370.71 | .426 | .2877 | 216. | 841. | .3529-06 | .0275 |
| 11 | 6.00 | .0177 | 8652. | .0210 | .00420 | 13.73 | 93.2 | .198 | .174 | 598. | .4811+06 | 2.1 |
| | 42.55 | .0260 | 1164. | 2.1 | .00060 | 1369.93 | .403 | .3033 | 216. | 796. | .3464-06 | .0308 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | 5.00 | .0177 | 9198. | .0200 | .00454 | 12.53 | 95.0 | .180 | .157 | 622. | .4789+06 | 2.3 |
| | 40.49 | .0260 | 1315. | 2.4 | .00068 | 1368.83 | .376 | .3204 | 216. | 831. | .3396-06 | .0352 |
| 13 | 4.00 | .0177 | 9807. | .0190 | .00542 | 11.21 | 97.0 | .160 | .130 | 622. | .5719+06 | 2.8 |
| | 37.93 | .0260 | 1622. | 2.8 | .00081 | 1366.45 | .366 | .3444 | 216. | 856. | .3320-06 | .0440 |
| 14 | 3.00 | .0177 | 10511. | .0180 | .00548 | 9.71 | 99.2 | .138 | .113 | 731. | .4956+06 | 3.2 |
| | 35.88 | .0260 | 1932. | 3.5 | .00100 | 1363.41 | .331 | .3666 | 216. | 987. | .3235-06 | .0532 |
| 15 | 2.00 | .0176 | 11421. | .0170 | .00585 | 7.93 | 102.1 | .112 | .091 | 957. | .3767+06 | 4.0 |
| | 33.07 | .0260 | 2490. | 5.0 | .00153 | 1357.03 | .283 | .3925 | 216. | 1265. | .3151-06 | .0694 |
| 16 | 1.90 | .0176 | 11525. | .0160 | .00585 | 7.73 | 102.4 | .109 | .089 | 1002. | .3567+06 | 4.0 |
| | 32.76 | .0260 | 2543. | 5.3 | .00164 | 1356.29 | .279 | .3956 | 216. | 1303. | .3141-06 | .0710 |
| 17 | 1.49 | .0176 | 12043. | .0150 | .00627 | 6.84 | 104.0 | .096 | .079 | 1157. | .3047+06 | 4.6 |
| | 31.35 | .0260 | 2954. | 6.6 | .00215 | 1350.65 | .253 | .4079 | 216. | 1489. | .3093-06 | .0830 |
| 18 | 1.16 | .0176 | 12570. | .0140 | .00683 | 6.04 | 105.5 | .084 | .069 | 1333. | .2587+06 | 5.2 |
| | 30.02 | .0260 | 3441. | 8.4 | .00288 | 1343.08 | .228 | .4207 | 216. | 1698. | .3043-06 | .0972 |
| 19 | 1.04 | .0176 | 12876. | .0130 | .00952 | 5.71 | 106.4 | .079 | .066 | 1212. | .3036+06 | 5.5 |
| | 29.31 | .0260 | 3676. | 10.5 | .00350 | 1338.56 | .219 | .4239 | 216. | 1651. | .3014-06 | .1043 |
| 20 | 1.00 | .0176 | 13276. | .0130 | .01493 | 5.61 | 107.3 | .078 | .053 | 1124. | .3921+06 | 6.7 |
| | 28.53 | .0260 | 4616. | 15.2 | .00515 | 1322.08 | .205 | .3485 | 216. | 1754. | .2970-06 | .1320 |
| 21 | -1.04 | .0176 | 14024. | .0130 | .03066 | 5.71 | 108.3 | .079 | .036 | 738. | .9269+06 | 9.9 |
| | 27.43 | .0260 | 7080. | 19.3 | .00624 | 1267.43 | .186 | .2168 | 216. | 1620. | .2882-06 | .2070 |
| 22 | -1.16 | .0176 | 14875. | .0130 | .02334 | 6.03 | 110.8 | .084 | .036 | 888. | .7569+06 | 10.0 |
| | 26.38 | .0260 | 7414. | 18.1 | .00608 | 1251.09 | .190 | .1941 | 216. | 1688. | .2831-06 | .2191 |
| 23 | -1.37 | .0176 | 15136. | .0140 | .01316 | 6.55 | 114.4 | .092 | .047 | 1241. | .4330+06 | 7.7 |
| | 25.41 | .0260 | 5867. | 14.8 | .00530 | 1278.63 | .213 | .2349 | 216. | 1882. | .2818-06 | .1729 |
| 24 | -1.67 | .0176 | 16407. | .0140 | .00931 | 7.25 | 117.5 | .102 | .067 | 1356. | .3229+06 | 5.4 |
| | 24.57 | .0260 | 4171. | 11.5 | .00415 | 1302.85 | .251 | .3056 | 216. | 1853. | .2806-06 | .1228 |
| 25 | -2.41 | .0176 | 17599. | .0150 | .00613 | 8.70 | 121.8 | .123 | .085 | 1456. | .2789+06 | 4.3 |
| | 23.11 | .0260 | 3456. | 8.2 | .00297 | 1308.88 | .291 | .3000 | 216. | 1833. | .2777-06 | .1020 |
| 26 | -3.28 | .0176 | 18697. | .0150 | .00546 | 10.15 | 125.6 | .145 | .101 | 1369. | .2994+06 | 3.6 |
| | 21.66 | .0260 | 3026. | 6.8 | .00238 | 1311.53 | .326 | .2830 | 216. | 1696. | .2746-06 | .0892 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | -4.28 | .0176 | 19791. | .0160 | .00494 | 11.60 | 129.4 | .166 | .116 | 1321. | .3077+06 | 3.1 |
| | 20.21 | .0260 | 2721. | 5.9 | .00203 | 1312.97 | .355 | .2664 | 216. | 1631. | .2737-06 | .0801 |
| 28 | -5.42 | .0176 | 20914. | .0160 | .00456 | 13.05 | 133.3 | .188 | .130 | 1323. | .3041+06 | 2.8 |
| | 18.76 | .0260 | 2534. | 5.4 | .00188 | 1313.47 | .378 | .2409 | 216. | 1611. | .2729-06 | .0745 |
| 29 | -6.69 | .0176 | 22105. | .0170 | .00455 | 14.50 | 137.4 | .209 | .135 | 1277. | .3251+06 | 2.7 |
| | 17.31 | .0260 | 2531. | 5.2 | .00178 | 1312.68 | .388 | .1997 | 216. | 1575. | .2720-06 | .0744 |
| 30 | -8.10 | .0176 | 23388. | .0170 | .00460 | 15.95 | 141.9 | .230 | .139 | 1244. | .3436+06 | 2.6 |
| | 15.86 | .0260 | 2562. | 5.1 | .00173 | 1311.67 | .393 | .1580 | 216. | 1540. | .2710-06 | .0752 |
| 31 | -9.64 | .0176 | 24801. | .0170 | .00521 | 17.40 | 146.7 | .252 | .132 | 1134. | .4075+06 | 2.7 |
| | 14.41 | .0260 | 2827. | 5.1 | .00171 | 1308.95 | .373 | .0987 | 216. | 1447. | .2709-06 | .0830 |
| 32 | -12.01 | .0176 | 27053. | .0180 | .00676 | 19.42 | 154.4 | .282 | .116 | 948. | .5397+06 | 3.1 |
| | 12.39 | .0260 | 3440. | 5.4 | .00171 | 1302.59 | .324 | .0228 | 216. | 1314. | .2720-06 | .1006 |
| 33 | -13.14 | .0175 | 28362. | .0180 | .00881 | 20.31 | 158.8 | .295 | .100 | 797. | .6169+06 | 3.6 |
| | 11.23 | .0260 | 4146. | 5.6 | .00173 | 1295.14 | .255 | .0063 | 216. | 1201. | .2725-06 | .1208 |
| 34 | -13.87 | .0175 | 29783. | .0180 | .01077 | 20.87 | 163.5 | .303 | .093 | 706. | .7174+06 | 3.9 |
| | 9.87 | .0260 | 4644. | 5.8 | .00177 | 1288.39 | .225 | .0000 | 216. | 1141. | .2734-06 | .1348 |
| 35 | -14.12 | .0175 | 31253. | .0220 | .01079 | 21.07 | 168.8 | .306 | .091 | 713. | .6917+06 | 3.8 |
| | 8.42 | .0260 | 4722. | 5.9 | .00182 | 1287.24 | .218 | .0035 | 216. | 1233. | .2758-06 | .1363 |
| 36 | -14.12 | .0175 | 32975. | .0220 | .01080 | 21.07 | 175.0 | .306 | .091 | 739. | .6818+06 | 3.8 |
| | 6.74 | .0260 | 4939. | 6.1 | .00194 | 1282.47 | .218 | .0035 | 216. | 1272. | .2783-06 | .1417 |
| 37 | -14.12 | .0175 | 34763. | .0220 | .01064 | 21.07 | 181.4 | .306 | .091 | 776. | .6560+06 | 3.8 |
| | 5.06 | .0260 | 5116. | 6.3 | .00210 | 1277.97 | .218 | .0035 | 216. | 1319. | .2812-06 | .1459 |
| 38 | -14.12 | .0175 | 366. | .0220 | .01052 | 21.07 | 188.0 | .306 | .091 | 808. | .6363+06 | 3.8 |
| | 3.37 | .0260 | 5325. | 6.5 | .00232 | 1273.07 | .218 | .0035 | 216. | 1360. | .2859-06 | .1507 |
| 39 | -14.12 | .0175 | 38484. | .0220 | .01093 | 21.07 | 194.5 | .306 | .091 | 787. | .6742+06 | 3.8 |
| | 1.69 | .0260 | 5551. | 6.5 | .00265 | 1267.96 | .218 | .0035 | 216. | 1339. | .2905-06 | .1560 |
| 40 | -14.12 | .0175 | 39710. | .0220 | .01938 | 21.07 | 198.7 | .306 | .091 | 304. | .1922+07 | 3.8 |
| | .00 | .0260 | 5709. | 2.1 | .00313 | 1264.04 | .218 | .0035 | 216. | 540. | .2935-06 | .1597 |

**********

FOR BOLT COOLANT OF .00 ABSORBING .00 OUTLET CONDITIONS ARE...

HALPY 504.4 TEMPERATURE 198.7 PRESSUR 1215.6 RE ING IN...
DELTA T 138.0, DELTA P 159.4
**********

ATTACHMENT 3

COMPUTER LISTING

ROCKET NOZZLE COOLANT CHANNEL

THERMAL ANALYSIS PROGRAM

(E25107)

```
@9 RUN FYEE,428235,2,200      PROGRAM E25107          04 APR 72   18:21:22.797

@ CTL UN=E25107                                       04 APR 72   18:21:22.797

@R     ASG Z=AN4534                                   04 APR 72   18:21:23.014
       AN4534 ASSIGNED UNIT  4

@N HDG                                                04 APR 72   18:21:23.023
```

@ XQT CUR 04 APR 72 18:21:23.025

1. PEF Z 18:21:23

2. IN Z 18:21:27

END OF FILE -- UNIT Z

3. TOC 18:21:45

ELEMENT TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| BLKNBS | SYMBOLIC | 19 NOV 71 | 09:50:28 | 0 | 00136670 | 14 | 154 |
| CHANGE | SYMBOLIC | 19 NOV 71 | 09:50:36 | 0 | 00143044 | 14 | 50 |
| CONTUR | SYMBOLIC | 19 NOV 71 | 09:50:39 | 0 | 00144340 | 14 | 194 |
| DELT | SYMBOLIC | 19 NOV 71 | 09:50:39 | 0 | 00151574 | 14 | 8 |
| DINT4 | SYMBOLIC | 19 NOV 71 | 09:50:41 | 0 | 00151754 | 14 | 27 |
| DIS | SYMBOLIC | 19 NOV 71 | 09:50:42 | 0 | 00152546 | 14 | 34 |
| DUMP | SYMBOLIC | 19 NOV 71 | 09:50:43 | 0 | 00153502 | 14 | 8 |
| DXF | SYMBOLIC | 19 NOV 71 | 09:50:44 | 0 | 00153662 | 14 | 14 |
| EBLKDA | SYMBOLIC | 19 NOV 71 | 09:50:46 | 0 | 00154166 | 14 | 156 |
| EFFECT | SYMBOLIC | 19 NOV 71 | 09:50:49 | 0 | 00160376 | 14 | 51 |
| ERROR | SYMBOLIC | 19 NOV 71 | 09:50:50 | 0 | 00161710 | 14 | 3 |
| EHTEMP | SYMBOLIC | 19 NOV 71 | 09:50:55 | 0 | 00161762 | 14 | 162 |
| ETCP | SYMBOLIC | 19 NOV 71 | 09:50:56 | 0 | 00166316 | 14 | 4 |
| ETDENS | SYMBOLIC | 19 NOV 71 | 09:50:59 | 0 | 00166406 | 14 | 226 |
| ETENTH | SYMBOLIC | 19 NOV 71 | 09:51:02 | 0 | 00174542 | 14 | 255 |
| ETHEAT | SYMBOLIC | 19 NOV 71 | 09:51:05 | 0 | 00203524 | 14 | 125 |
| ETSOUN | SYMBOLIC | 19 NOV 71 | 09:51:07 | 0 | 00207052 | 14 | 163 |
| ETVISC | SYMBOLIC | 19 NOV 71 | 09:51:10 | 0 | 00213424 | 14 | 196 |
| EVEN | SYMBOLIC | 19 NOV 71 | 09:51:13 | 0 | 00220714 | 14 | 134 |
| FIT | SYMBOLIC | 19 NOV 71 | 09:51:16 | 0 | 00224440 | 14 | 19 |
| INT4 | SYMBOLIC | 19 NOV 71 | 09:51:37 | 0 | 00225052 | 14 | 50 |
| LINT | SYMBOLIC | 19 NOV 71 | 09:51:41 | 0 | 00226346 | 14 | 35 |
| LINTZI | SYMBOLIC | 19 NOV 71 | 09:51:43 | 0 | 00227320 | 14 | 36 |
| NRAP1 | SYMBOLIC | 19 NOV 71 | 09:51:44 | 0 | 00230310 | 14 | 30 |
| PHTEMP | SYMBOLIC | 19 NOV 71 | 09:51:51 | 0 | 00231154 | 14 | 161 |
| PT | SYMBOLIC | 19 NOV 71 | 09:51:52 | 0 | 00235472 | 14 | 36 |
| PTCOND | SYMBOLIC | 19 NOV 71 | 09:51:55 | 0 | 00236462 | 14 | 183 |
| PTCP | SYMBOLIC | 19 NOV 71 | 09:51:56 | 0 | 00243464 | 14 | 4 |
| PTDENS | SYMBOLIC | 19 NOV 71 | 09:51:59 | 0 | 00243554 | 14 | 228 |
| PTENTH | SYMBOLIC | 19 NOV 71 | 09:52:03 | 0 | 00251744 | 14 | 256 |
| PTENTR | SYMBOLIC | 19 NOV 71 | 09:52:06 | 0 | 00260744 | 14 | 208 |
| PTGAS | SYMBOLIC | 19 NOV 71 | 09:52:07 | 0 | 00266504 | 14 | 40 |
| PTH | SYMBOLIC | 19 NOV 71 | 09:52:08 | 0 | 00267564 | 14 | 26 |
| PTHEAT | SYMBOLIC | 19 NOV 71 | 09:52:11 | 0 | 00270340 | 14 | 125 |
| PTSOUN | SYMBOLIC | 19 NOV 71 | 09:52:14 | 0 | 00273666 | 14 | 166 |
| PTVISC | SYMBOLIC | 19 NOV 71 | 09:52:17 | 0 | 00300312 | 14 | 196 |
| ROOT | SYMBOLIC | 19 NOV 71 | 09:52:19 | 0 | 00305602 | 14 | 86 |
| SECT | SYMBOLIC | 19 NOV 71 | 09:52:21 | 0 | 00310066 | 14 | 116 |
| SIMEQ | SYMBOLIC | 19 NOV 71 | 09:52:24 | 0 | 00313216 | 14 | 148 |
| START | SYMBOLIC | 19 NOV 71 | 09:52:27 | 0 | 00317246 | 14 | 154 |
| SUBRBO | SYMBOLIC | 19 NOV 71 | 09:52:28 | 0 | 00323422 | 14 | 49 |
| SUB1 | SYMBOLIC | 19 NOV 71 | 09:52:30 | 0 | 00324700 | 14 | 114 |
| SUB2 | SYMBOLIC | 19 NOV 71 | 09:52:32 | 0 | 00327774 | 14 | 140 |
| ETCOND | SYMBOLIC | 14 DEC 71 | 08:17:05 | 0 | 00333644 | 14 | 193 |
| BLOCK | SYMBOLIC | 17 DEC 71 | 12:37:58 | 0 | 00341062 | 14 | 60 |
| GEOM | SYMBOLIC | 18 DEC 71 | 13:49:18 | 0 | 00342572 | 14 | 190 |
| HGC | SYMBOLIC | 18 DEC 71 | 13:49:23 | 0 | 00347736 | 14 | 126 |
| DATA | SYMBOLIC | 18 DEC 71 | 13:49:28 | 0 | 00353302 | 14 | 123 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| OUT | | SYMBOLIC | 21 DEC 71 | 09:02:43 | 0 | 00356574 | 14 | 275 |
| IIN | | SYMBOLIC | 21 DEC 71 | 09:02:46 | 0 | 00366206 | 14 | 262 |
| SUMARY | | SYMBOLIC | 21 DEC 71 | 09:02:48 | 0 | 00375332 | 14 | 90 |
| CALCTP | | SYMBOLIC | 29 DEC 71 | 15:22:25 | 0 | 00377706 | 14 | 292 |
| ITERAT | | SYMBOLIC | 29 DEC 71 | 15:22:28 | 0 | 00407676 | 14 | 146 |
| GRAPH | | SYMBOLIC | 29 DEC 71 | 15:22:30 | 0 | 00413672 | 14 | 91 |
| FILES | | SYMBOLIC | 29 DEC 71 | 15:22:32 | 0 | 00416264 | 14 | 6 |
| BLKNBS | CODE | RELOCATABLE | 19 NOV 71 | 09:50:28 | 0 | 00416410 | 14 | 150 |
| | | | | | 1 | 00422474 | 24 | 1 |
| CHANGE | CODE | RELOCATABLE | 19 NOV 71 | 09:50:36 | 0 | 00422524 | 14 | 10 |
| | | | | | 1 | 00422740 | 36 | 1 |
| CONTUR | CODE | RELOCATABLE | 19 NOV 71 | 09:50:39 | 0 | 00423004 | 14 | 81 |
| | | | | | 1 | 00425162 | 36 | 1 |
| DELT | CODE | RELOCATABLE | 19 NOV 71 | 09:50:39 | 0 | 00425226 | 14 | 5 |
| | | | | | 1 | 00425334 | 24 | 1 |
| DINT4 | CODE | RELOCATABLE | 19 NOV 71 | 09:50:41 | 0 | 00425364 | 14 | 15 |
| | | | | | 1 | 00425706 | 24 | 1 |
| DIS | CODE | RELOCATABLE | 19 NOV 71 | 09:50:42 | 0 | 00425736 | 14 | 13 |
| | | | | | 1 | 00426224 | 24 | 1 |
| DUMP | CODE | RELOCATABLE | 19 NOV 71 | 09:50:43 | 0 | 00426254 | 14 | 8 |
| | | | | | 1 | 00426434 | 36 | 1 |
| DXF | CODE | RELOCATABLE | 19 NOV 71 | 09:50:44 | 0 | 00426500 | 14 | 10 |
| | | | | | 1 | 00426714 | 24 | 1 |
| EBLKDA | CODE | RELOCATABLE | 19 NOV 71 | 09:50:46 | 0 | 00426744 | 14 | 150 |
| | | | | | 1 | 00433030 | 24 | 1 |
| EFFECT | CODE | RELOCATABLE | 19 NOV 71 | 09:50:49 | 0 | 00433060 | 14 | 18 |
| | | | | | 1 | 00433454 | 24 | 1 |
| ERROR | CODE | RELOCATABLE | 19 NOV 71 | 09:50:50 | 0 | 00433504 | 14 | 2 |
| | | | | | 1 | 00433540 | 24 | 1 |
| EHTEMP | CODE | RELOCATABLE | 19 NOV 71 | 09:50:55 | 0 | 00433570 | 14 | 97 |
| | | | | | 1 | 00436306 | 24 | 1 |
| ETCP | CODE | RELOCATABLE | 19 NOV 71 | 09:50:56 | 0 | 00436336 | 14 | 3 |
| | | | | | 1 | 00436410 | 24 | 1 |
| ETDENS | CODE | RELOCATABLE | 19 NOV 71 | 09:50:59 | 0 | 00436440 | 14 | 145 |
| | | | | | 1 | 00442416 | 24 | 1 |
| ETENTH | CODE | RELOCATABLE | 19 NOV 71 | 09:51:02 | 0 | 00442446 | 14 | 172 |
| | | | | | 1 | 00447216 | 24 | 1 |
| ETHEAT | CODE | RELOCATABLE | 19 NOV 71 | 09:51:05 | 0 | 00447246 | 14 | 64 |
| | | | | | 1 | 00451046 | 24 | 1 |
| ETSOUN | CODE | RELOCATABLE | 19 NOV 71 | 09:51:07 | 0 | 00451076 | 14 | 105 |
| | | | | | 1 | 00453774 | 24 | 1 |
| ETVISC | CODE | RELOCATABLE | 19 NOV 71 | 09:51:10 | 0 | 00454024 | 14 | 101 |
| | | | | | 1 | 00456632 | 24 | 1 |
| EVEN | CODE | RELOCATABLE | 19 NOV 71 | 09:51:13 | 0 | 00456662 | 14 | 49 |
| | | | | | 1 | 00460140 | 36 | 1 |
| FIT | CODE | RELOCATABLE | 19 NOV 71 | 09:51:16 | 0 | 00460204 | 14 | 13 |
| | | | | | 1 | 00460472 | 24 | 1 |
| INT4 | CODE | RELOCATABLE | 19 NOV 71 | 09:51:37 | 0 | 00460522 | 14 | 26 |
| | | | | | 1 | 00461276 | 24 | 1 |
| LINT | CODE | RELOCATABLE | 19 NOV 71 | 09:51:41 | 0 | 00461326 | 14 | 13 |
| | | | | | 1 | 00461614 | 24 | 1 |
| LINTZI | CODE | RELOCATABLE | 19 NOV 71 | 09:51:43 | 0 | 00461644 | 14 | 22 |
| | | | | | 1 | 00462330 | 24 | 1 |
| NRAPI | CODE | RELOCATABLE | 19 NOV 71 | 09:51:44 | 0 | 00462360 | 14 | 14 |
| | | | | | 1 | 00462664 | 24 | 1 |
| PHTEMP | CODE | RELOCATABLE | 19 NOV 71 | 09:51:51 | 0 | 00462714 | 14 | 96 |
| | | | | | 1 | 00465414 | 24 | 1 |
| PT | CODE | RELOCATABLE | 19 NOV 71 | 09:51:52 | 0 | 00465444 | 14 | 12 |
| | | | | | 1 | 00465714 | 48 | 1 |
| PTCOND | CODE | RELOCATABLE | 19 NOV 71 | 09:51:55 | 0 | 00465774 | 14 | 118 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 00471160 | 24 | 1 |
| PTCP | CODE | RELOCATABLE | 19 NOV 71 09:51:56 | 0 | 00471210 | 14 | 3 |
| | | | | 1 | 00471262 | 24 | 1 |
| PTDENS | CODE | RELOCATABLE | 19 NOV 71 09:51:59 | 0 | 00471312 | 14 | 145 |
| | | | | 1 | 00475270 | 24 | 1 |
| PTENTH | CODE | RELOCATABLE | 19 NOV 71 09:52:03 | 0 | 00475320 | 14 | 172 |
| | | | | 1 | 00502070 | 24 | 1 |
| PTENTR | CODE | RELOCATABLE | 19 NOV 71 09:52:06 | 0 | 00502120 | 14 | 131 |
| | | | | 1 | 00505572 | 24 | 1 |
| PTGAS | CODE | RELOCATABLE | 19 NOV 71 09:52:07 | 0 | 00505622 | 14 | 14 |
| | | | | 1 | 00506126 | 48 | 1 |
| PTH | CODE | RELOCATABLE | 19 NOV 71 09:52:08 | 0 | 00506206 | 14 | 10 |
| | | | | 1 | 00506422 | 36 | 1 |
| PTHEAT | CODE | RELOCATABLE | 19 NOV 71 09:52:11 | 0 | 00506466 | 14 | 65 |
| | | | | 1 | 00510304 | 24 | 1 |
| PTSOUN | CODE | RELOCATABLE | 19 NOV 71 09:52:14 | 0 | 00510334 | 14 | 106 |
| | | | | 1 | 00513250 | 24 | 1 |
| PTVISC | CODE | RELOCATABLE | 19 NOV 71 09:52:17 | 0 | 00513300 | 14 | 101 |
| | | | | 1 | 00516106 | 24 | 1 |
| ROOT | CODE | RELOCATABLE | 19 NOV 71 09:52:19 | 0 | 00516136 | 14 | 23 |
| | | | | 1 | 00516640 | 24 | 1 |
| SECT | CODE | RELOCATABLE | 19 NOV 71 09:52:21 | 0 | 00516670 | 14 | 42 |
| | | | | 1 | 00520004 | 36 | 1 |
| SIMEQ | CODE | RELOCATABLE | 19 NOV 71 09:52:24 | 0 | 00520050 | 14 | 50 |
| | | | | 1 | 00521344 | 24 | 1 |
| START | CODE | RELOCATABLE | 19 NOV 71 09:52:27 | 0 | 00521374 | 14 | 54 |
| | | | | 1 | 00522760 | 36 | 1 |
| SUBRBO | CODE | RELOCATABLE | 19 NOV 71 09:52:28 | 0 | 00523024 | 14 | 11 |
| | | | | 1 | 00523256 | 36 | 1 |
| SUB1 | CODE | RELOCATABLE | 19 NOV 71 09:52:30 | 0 | 00523322 | 14 | 74 |
| | | | | 1 | 00525336 | 36 | 1 |
| SUB2 | CODE | RELOCATABLE | 19 NOV 71 09:52:32 | 0 | 00525402 | 14 | 80 |
| | | | | 1 | 00527542 | 36 | 1 |
| ETCOND | CODE | RELOCATABLE | 14 DEC 71 08:17:05 | 0 | 00527606 | 14 | 118 |
| | | | | 1 | 00532772 | 24 | 1 |
| BLOCK | CODE | RELOCATABLE | 17 DEC 71 12:37:58 | 0 | 00533022 | 14 | 14 |
| | | | | 1 | 00533326 | 36 | 1 |
| GEOM | CODE | RELOCATABLE | 18 DEC 71 13:49:18 | 0 | 00533372 | 14 | 77 |
| | | | | 1 | 00535460 | 60 | 1 |
| HGC | CODE | RELOCATABLE | 18 DEC 71 13:49:23 | 0 | 00535554 | 14 | 42 |
| | | | | 1 | 00536670 | 60 | 1 |
| OUT | CODE | RELOCATABLE | 21 DEC 71 09:02:43 | 0 | 00536764 | 14 | 150 |
| | | | | 1 | 00543050 | 72 | 1 |
| IIN | CODE | RELOCATABLE | 21 DEC 71 09:02:46 | 0 | 00543160 | 14 | 165 |
| | | | | 1 | 00547566 | 108 | 1 |
| SUMARY | CODE | RELOCATABLE | 21 DEC 71 09:02:48 | 0 | 00547742 | 14 | 68 |
| | | | | 1 | 00551632 | 24 | 1 |
| CALCTP | CODE | RELOCATABLE | 29 DEC 71 15:22:25 | 0 | 00551662 | 14 | 122 |
| | | | | 1 | 00555136 | 72 | 1 |
| ITERAT | CODE | RELOCATABLE | 29 DEC 71 15:22:28 | 0 | 00555246 | 14 | 46 |
| | | | | 1 | 00556452 | 36 | 1 |
| GRAPH | CODE | RELOCATABLE | 29 DEC 71 15:22:30 | 0 | 00556516 | 14 | 44 |
| | | | | 1 | 00557666 | 24 | 1 |
| FILES | CODE | RELOCATABLE | 29 DEC 71 15:22:32 | 0 | 00557716 | 14 | 3 |
| | | | | 1 | 00557770 | 12 | 1 |
| AXIS | CODE | RELOCATABLE | 17 JUL 71 13:25:29 | 1 | 00560004 | 24 | 1 |
| | | | | 0 | 00560034 | 14 | 37 |
| LINE | CODE | RELOCATABLE | 17 JUL 71 13:25:30 | 1 | 00561042 | 24 | 1 |
| | | | | 0 | 00561072 | 14 | 24 |
| NUMBER | CODE | RELOCATABLE | 17 JUL 71 13:25:32 | 1 | 00561612 | 24 | 1 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 0 | 00561642 | 14 | 24 | |
| PLOTS | CODE | RELOCATABLE | 20 DEC 71 14:54:38 | 0 | 00562362 | 14 | 44 | |
| | | | | 1 | 00563532 | 24 | 1 | |
| PLTRNS | CODE | RELOCATABLE | 24 AUG 71 11:10:31 | 0 | 00563562 | 14 | 2 | |
| | | | | 1 | 00563616 | 24 | 1 | |
| SCALE | CODE | RELOCATABLE | 17 JUL 71 13:25:27 | 1 | 00563646 | 24 | 1 | |
| | | | | 0 | 00563676 | 14 | 25 | |
| SYMBOL | CODE | RELOCATABLE | 17 JUL 71 13:25:40 | 1 | 00564434 | 24 | 1 | |
| | | | | 0 | 00564464 | 14 | 36 | |
| TABLE | CODE | RELOCATABLE | 17 JUL 71 13:25:26 | 1 | 00565454 | 24 | 1 | |
| | | | | 0 | 00565504 | 14 | 37 | |
| TUBE | CODE | PROCESSED MAP | 21 FEB 72 11:38:29 | 1 | 00566512 | 180 | 1 | |
| | | | | 62 | 00566776 | 12 | 1 | |
| HEAT | | SYMBOLIC | 21 FEB 72 11:38:33 | 0 | 00567012 | 14 | 395 | |
| HEAT | CODE | RELOCATABLE | 21 FEB 72 11:38:33 | 0 | 00601644 | 14 | 77 | |
| | | | | 1 | 00603732 | 108 | 1 | |
| HLC | | SYMBOLIC | 21 FEB 72 11:38:39 | 0 | 00604106 | 14 | 440 | |
| HLC | CODE | RELOCATABLE | 21 FEB 72 11:38:39 | 0 | 00620126 | 14 | 200 | |
| | | | | 1 | 00625506 | 72 | 1 | |
| E25107 | | ABSOLUTE | 21 FEB 72 11:38:50 | 1 | 00625616 | 47772 | 1 | |

ENTRY POINT TABLE

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AXIS | (AXIS/CODE) | 1 | 000454 | CALCTP | (CALCTP/CODE) | 1 | 002033 | CHANGE | (CHANGE/CODE) | 1 | 000071 |
| CONTUR | (CONTUR/CODE) | 1 | 001057 | DELT | (DELT/CODE) | 1 | 000030 | DINT4 | (DINT4/CODE) | 1 | 000164 |
| DIS | (DIS/CODE) | 1 | 000155 | DUMP | (DUMP/CODE) | 1 | 000074 | DXF | (DXF/CODE) | 1 | 000105 |
| EFFECT | (EFFECT/CODE) | 1 | 000210 | EHTEMP | (EHTEMP/CODE) | 1 | 000537 | ERROR | (ERROR/CODE) | 1 | 000010 |
| ETCOND | (ETCOND/CODE) | 1 | 000472 | ETCP | (ETCP/CODE) | 1 | 000016 | ETDENS | (ETDENS/CODE) | 1 | 000563 |
| ETENTH | (ETENTH/CODE) | 1 | 000602 | ETHEAT | (ETHEAT/CODE) | 1 | 000661 | ETSOUN | (ETSOUN/CODE) | 1 | 000551 |
| ETVISC | (ETVISC/CODE) | 1 | 000461 | EVEN | (EVEN/CODE) | 1 | 000646 | FACTOR | (PLOTS/CODE) | 1 | 000102 |
| FIT | (FIT/CODE) | 1 | 000146 | GEOM | (GEOM/CODE) | 1 | 001237 | GRAPH | (GRAPH/CODE) | 1 | 000505 |
| HGC | (HGC/CODE) | 1 | 000540 | HLC | (HLC/CODE) | 1 | 003376 | IIN | (IIN/CODE) | 1 | 001002 |
| INT4 | (INT4/CODE) | 1 | 000334 | ITERAT | (ITERAT/CODE) | 1 | 000603 | LINE | (LINE/CODE) | 1 | 000311 |
| LINT | (LINT/CODE) | 1 | 000125 | LINTX | (LINT/CODE) | 1 | 000147 | LINTZS | (LINTZI/CODE) | 1 | 000271 |
| LINTZ1 | (LINTZI/CODE) | 1 | 000243 | NRAP1 | (NRAP1/CODE) | 1 | 000125 | NTAB6 | (FILES/CODE) | 0 | 000003 |
| NUMBER | (NUMBER/CODE) | 1 | 000304 | OUT | (OUT/CODE) | 1 | 001513 | PHTEMP | (PHTEMP/CODE) | 1 | 000527 |
| PLOT | (PLOTS/CODE) | 1 | 000122 | PLOTS | (PLOTS/CODE) | 1 | 000000 | PLTRNS | (PLTRNS/CODE) | 1 | 000006 |
| PT | (PT/CODE) | 1 | 000140 | PTCOND | (PTCOND/CODE) | 1 | 000472 | PTCP | (PTCP/CODE) | 1 | 000016 |
| PTDENS | (PTDENS/CODE) | 1 | 000565 | PTENTH | (PTENTH/CODE) | 1 | 000605 | PTENTR | (PTENTR/CODE) | 1 | 000567 |
| PTGAS | (PTGAS/CODE) | 1 | 000162 | PTH | (PTH/CODE) | 1 | 000062 | PTHEAT | (PTHEAT/CODE) | 1 | 000661 |
| PTSOUN | (PTSOUN/CODE) | 1 | 000554 | PTVISC | (PTVISC/CODE) | 1 | 000461 | ROOT | (ROOT/CODE) | 1 | 000276 |
| ROOTS | (ROOT/CODE) | 1 | 000306 | SCALE | (SCALE/CODE) | 1 | 000321 | SECT | (SECT/CODE) | 1 | 000537 |
| SIMEQ | (SIMEQ/CODE) | 1 | 000711 | START | (START/CODE) | 1 | 000735 | SUBRBO | (SUBRBO/CODE) | 1 | 000132 |
| SUB1 | (SUB1/CODE) | 1 | 000171 | SUB2 | (SUB2/CODE) | 1 | 000127 | SUMARY | (SUMARY/CODE) | 1 | 000517 |
| SYMBOL | (SYMBOL/CODE) | 1 | 000000 | S1SAT | (SUB1/CODE) | 1 | 000214 | S2SAT | (SUB2/CODE) | 1 | 000144 |
| TABLE | (TABLE/CODE) | 1 | 000407 | TE012A | (EHTEMP/CODE) | 1 | 000546 | WHERE | (PLOTS/CODE) | 1 | 000110 |

BLOCK TABLE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SPHEAT | (BLKNBS/CODE) | 34 | BANK 2 DEPENDENT | TEHEAT | (EBLKDA/CODE) | 34 | BANK 2 DEPENDENT |
| CON | (BLOCK/CODE) | 34 | BANK 2 DEPENDENT | S | (BLOCK/CODE) | 34 | BANK 2 DEPENDENT |
| CLTABL | (BLOCK/CODE) | 34 | BANK 2 DEPENDENT | | | | |

COBOL LIBRARY TABLE EMPTY

PROCEDURE NAME TABLE EMPTY

```
@ ELT PTCP,1,711119, 35516
000001          FUNCTION PTCP(PRES,TEMP)                                NBS27620
000002          PTCP=PTHEAT(PRES,TEMP,1)                                NBS27630
000003          RETURN                                                  NBS27640
000004          END                                                     NBS27650
```

```
@ ELT SUMARY,1,711221, 32568

000001                SUBROUTINE SUMARY(IMERCR)
000002                REAL    MR, PC, PRC, NT, ID(20), M
000003                COMMON /EF/ AJ, DPI, BJ, DTI, KOUNT, IGO, IFLAG
000004                DATA BLANK /'    '/
000005                DIMENSION  C(6), T(5), M(4), DATE(9)
000006                TP = BLANK
000007                WRITE (6,1)
000008              1 FORMAT (1H1)
000009                READ (3,2) DATE
000010              2 FORMAT (9A4)
000011                WRITE (6,3) DATE
000012              3 FORMAT (' PROGRAM E25107',67X,9A4//)                                  *NEW
000013                READ (3,4) ID, NTOT                                                   **-1
000014              4 FORMAT (20A4,I4)
000015        C       WRITE (6,5) ID
000016        C     5 FORMAT (20X,20A4//)
000017                WRITE (6,5) ID, NTOT
000018              5 FORMAT (20X,20A4,I4//)
000019                WRITE (6,6)
000020              6 FORMAT (36X,'*************** SUMMARY ***************'/)
000021                READ (3,7) C, PIN, TIN
000022              7 FORMAT ( 6A4,2F6.1)
000023                WRITE (6,8) C, PIN, TIN
000024              8 FORMAT (8X,'COOLANT = '6A4,23X,'PIN = 'F6.1,23X,'TIN = 'F6.1/)
000025                READ (3,9) TC, PC, WG, WC, MR, NT
000026              9 FORMAT (2F5.0,2F7.1,F5.2,F5.0)
000027                WRITE (6,10) TC, PC, WG, WC, MR, NT
000028             10 FORMAT(14X,'TC = 'F5.0,6X,'PC = 'F5.0,6X,'WG = 'F7.1,6X,'WC = ',
000029               X   F7.1,6X,'MR = 'F5.2,6X,'NT = 'F5.0/)
0 0030                WRITE (6,11)
000031             11 FORMAT (' ************************************************************
000032               X************************************************************00040260
000033               X')                                                          00040265
000034                WRITE (6,12)
000035             12 FORMAT (' STA      A/AT         CL       SUMQ ,       TM          HL
000036               1     R        TB        RG        AF       TWL              RE     WDOT/A
000037               *')
000038                WRITE (6,13)
000039             13 FORMAT ('           Z           CG        VC       Q/AI          HG
000040               1   PRC       DE         L       NMB       TWG             MUB      MACH
000041               2 ')                                                         00040335
000042                DO 50 I=1,NTOT
000043                READ (3,14)  N, AASTAR, CL, E4, TM, HL, R
000044             14 FORMAT (I3,F7.2,F7.4,F7.0,F7.4,F8.5,F6.2)
000045                READ (3,15)   TTBC, SMALRG, AF, TTWLC, RE, WDOTOA
000046             15 FORMAT (F6.1,2F6.3,F6.0,E11.4,F6.1)
000047                WRITE (6,16) N, AASTAR, CL, E4, TM, HL, R, TTBC, SMALRG, AF,
000048               X             TTWLC, RE, WDOTOA
000049             16 FORMAT ('0',I3,3X,F7.2,3X,F7.4,3X,F7.0,3X,F7.4,3X,F8.5,3X,F6.2,3X,
000050               X   F6.1,3X,2(F6.3,3X),F6.0,3X,E11.4,3X,F6.1)
000051                READ (3,17)   Z, CG, VC, QOA, HG, PRC
000052             17 FORMAT (F7.2,F7.4,F7.0,F5.1,F9.5,F8.2)
000053                READ (3,18)  DE, L, NMB, TTWGC, MUB, MC
000054             18 FORMAT (F8.3,F7.4,F5.0,F6.0,E11.4,F6.4)
000055                WRITE (6,19) Z, CG, VC, QOA, HG, PRC, DE, L, NMB, TTWGC, MUB, MC
000056             19 FORMAT (7X,F7.2,3X,F7.4,3X,F7.0,4X,F5.1,3X,F9.5,2X,F8.2,2X,F8.3,  00040460
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@ ELT BLKNBS,1,711119, 35428

000001                BLOCK DATA                                                                NBS28990
000002                COMMON/SPHEAT/AA(111),AB(111),AC(111),AD(111),AE(116),AF(112),            NBS29000
000003               1AG(111),AH(40),                                                           NBS29010
000004               2        AI(110),AJ(111),AK(111),AL(111),AM(116),AN(112),AO(111)           NBS29020
000005               3,AP(41)                                                                   NBS29030
000006                DATAAA/3.804,3.796,3.794,3.794,3.793,3.793,3.793,4.025,3.951,3.937NBS29040
000007               1,3.931,3.927,3.924,3.922,4.655,4.259,4.184,4.15,4.13,4.117,4.107,6NBS29050
000008               2.495,5.032,4.755,4.632,4.559,4.509,4.472,10.98,6.839,6.054,5.706,5NBS29060
000009               3.498,5.356,5.252,20.06,10.48,8.646,7.834,7.35,7.02,6.776,35.35,16.NBS29070
000010               483,13.18,11.55,10.58,9.919,9.429,3.793,3.792,3.792,3.924,3.917,3.9NBS29080
000011               513,4.117,4.076,4.059,4.51,4.359,4.298,5.36,4.931,4.757,7.028,6.027NBS29090
000012               6,5.62,9.936,7.923,7.103,3.793,3.791,3.791,3.791,3.791,3.79,3.916,3NBS29100
000013               7.91,3.908,3.907,3.906,3.905,4.075,4.043,4.031,4.025,4.022,4.02,4.3NBS29110
000014               86,4.236,4.192,4.172,4.161,4.183,4.933,4.581,4.457,4.401,4.369,4.34NBS29120
000015               96,6.03,5.21,4.92,4.791,4.715,4.759,7.93,6.276,5.692,5.433,5.279/  NBS29130
000016                DATAAB/5.173,3.79,3.79,3.789,3.789,3.789,4.02,4.014,4.011,4.01,4.0NBS29140
000017               108,4.346,4.29,4.265,4.25,4.24,5.173,4.912,4.796,4.726,4.679,3.47,3NBS29150
000018               2.511,3.504,3.507,3.624,3.622,3.792,3.789,3.744,4.108,4.297,4.346,3NBS29160
000019               3.658,3.842,3.961,4.015,3.537,3.637,3.708,3.749,3.479,3.535,3.579,3NBS29170
000020               4.608,3.461,3.495,3.523,3.542,3.461,3.478,3.494,3.511,2.586,2.981,3NBS29180
000021               5.396,3.693,3.806,3.785,3.434,3.187,3.036,2.861,3.089,3.309,3.498,3NBS29190
000022               6.628,3.693,3.64,3.501,3.379,3.2,3.342,3.474,3.584,3.673,3.737,3.8,NBS29200
000023               73.744,3.681,3.519,3.633,3.738,3.826,3.903,3.957,4.03,4.041,4.015,3NBS29210
000024               8.744,3.838,3.921,3.994,4.06,4.111,4.223,4.248,4.243,3.877,3.951,4.NBS29220
000025               9018,4.079,4.133,4.179,4.292,4.333,4.343,3.926,3.98,4.033,4.087/    NBS29230
000026                DATAAC/4.125,4.152,4.263,4.317,4.346,1.334,1.264,1.217,1.2,1.884,1NBS29240
000027               1.742,1.667,1.587,2.387,2.151,2.025,1.947,2.871,2.506,2.337,2.232,3NBS29250
000028               2.311,2.792,2.584,2.461,3.668,3.035,2.789,2.652,3.846,3.23,2.968,2.NBS29260
000029               3821,3.84,3.37,3.113,2.963,3.767,3.475,3.25,3.104,1.543,1.515,1.491NBS29270
000030               4,1.468,1.447,1.428,1.414,2.003,1.96,1.922,1.89,1.862,1.835,1.812,2NBS29280
000031               5.51,2.426,2.357,2.301,2.253,2.21,2.173,3.151,2.967,2.836,2.734,2.6NBS29290
000032               652,2.585,2.529,4.07,3.651,3.383,3.198,3.063,2.956,2.871,5.417,4.48NBS29300
000033               76,3.997,3.69,3.477,3.318,3.196,5.793,5.081,4.509,4.119,3.844,3.64,NBS29310
000034               83.484,4.855,4.893,4.637,4.339,4.084,3.879,3.714,4.14,4.37,4.391,4.NBS29320
000035               9286,4.134,3.98,3.841,3.735,3.956,4.069,4.083,4.035,3.954,3.863/    NBS29330
000036                DATAAD/3.505,3.692,3.819,3.881,3.891,3.868,3.824,3.378,3.516,3.654NBS29340
000037               1,3.712,3.77,3.769,3.767,5.417,4.486,3.997,3.69,5.82,4.795,4.229,3.NBS29350
000038               2862,5.887,5.022,4.43,4.033,5.639,5.107,4.573,4.163,5.23,5.054,4.64NBS29360
000039               33,4.251,4.855,4.893,4.637,4.339,2.47,2.73,3.077,3.551,4.192,4.958NBS29370
000040               45.659,5.946,5.793,2.482,2.678,2.916,3.205,3.549,3.916,4.304,4.637,NBS29380
000041               54.855,2.503,2.656,2.833,3.033,3.255,3.496,3.725,3.949,4.14,2.535,2NBS29390
000042               6.659,2.795,2.942,3.1,3.264,3.43,3.59,3.735,2.582,2.683,2.792,2.907NBS29400
000043               7,3.026,3.148,3.27,3.391,3.505,2.641,2.731,2.822,2.913,3.003,3.097,NBS29410
000044               83.191,3.284,3.378,25.22,30.03,35.61,40.25,44.37,48.45,24.47,30.12,NBS29420
000045               936.7,42.16,47.08,51.94,22.95,29.45,36.95,43.16,48.74,54.28,20.18/ NBS29430
000046                DATAAE/27.65,36.2,43.19,49.41,55.58,16.12,24.74,34.5,42.3,49.15,55NBS29440
000047               1.9,10.33,20.63,31.93,40.59,48.07,55.4,1.494,15.13,28.59,38.11,46.1NBS29450
000048               25,53.98,-19.29,10.62,24.91,35.,43.5,51.78,0.,8.28,17.76,30.56,39.5NBS29460
000049               33,48.33,0.,-55.,4.28,17.23,31.9,42.56,0.,0.,-9.11,3.79,17.,32.36,1NBS29470
000050               41.93,-5.256,1.59,0.,.11,16.88,15.48,11.,4.18,-13.56,0.,0.,23.81,18NBS29480
000051               5.76,13.42,-1.68,-17.82,0.,31.05,25.95,27.7,16.41,3.2,-10.31,38.05,NBS29490
000052               632.9,33.42,32.03,20.87,9.05,44.95,39.75,39.57,39.66,34.95,24.46,10NBS29500
000053               727.,1148.,1238.,1311.,1362.,1407.,1445.,962.3,1099.,1202.,1285.,13NBS29510
000054               844.,1394.,1438.,869.,1026.,1142.,1235.,1301.,1357.,1405.,727.5,906NBS29520
000055               9.9,1040.,1145.,1219.,1282.,1335.,533.3,742.1,895.5,1016.,1099./    NBS29530
000056                DATAAF/1170.,1230.,333.8,512.8,606.3,838.4,934.9,1015.,1083.,91.2,NBS29540
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000057      1290.2,434.2,603.4,720.3,814.5,893.8,0.,0.,153.4,302.5,433.2,558.1,NBS29550
000058      2653.3,343.4,72.4,-162.,20.,151.5,276.4,378.8,929.7,692.1,477.8,288NBS29560
000059      3.3,134.,90.2,-120.,1489.,1269.,1082.,907.6,759.5,607.4,444.7,2037.NBS29570
000060      4,1817.,1634.,1469.,1331.,1195.,1053.,2584.,2363.,2180.,2016.,1881.NBS29580
000061      5,1751.,1620.,3135.,2911.,2726.,2563.,2428.,2299.,2173.,1.566,1.557NBS29590
000062      6,1.78,1.77,2.059,2.037,2.377,2.333,2.926,2.724,1.091,3.21,2.46,5.2NBS29600
000063      786,2.456,3.245,2.428,3.431,2.434,3.025,2.461,2.813,2.463,2.7,2.465NBS29610
000064      8,2.638,2.47,2.612,35.34,16.83,13.18,11.55,10.58,9.919,9.429,54.51,NBS29620
000065      926.45,20.19,17.34,15.62,14.45,13.58,64.37,38.42,29.61,25.31,22.66/NBS29630
000066       DATAAG/20.81,19.43,56.31,49.66,39.93,34.49,30.94,28.41,26.46,9.931NBS29640
000067      1,7.923,7.103,15.62,10.89,9.417,22.66,15.12,12.73,30.94,20.32,16.85NBS29650
000068      2,7.93,6.276,5.692,5.433,5.279,5.173,10.9,7.934,6.883,6.417,6.14,5.NBS29660
000069      395,15.15,10.31,8.585,7.82,7.364,7.052,17.43,13.27,10.71,9.57,8.89,NBS29670
000070      48.424,5.173,4.912,4.796,4.726,4.679,7.052,6.278,5.935,5.731,5.591,NBS29680
000071      59.796,8.258,7.575,7.167,6.891,0.,3.802,3.799,3.797,3.797,3.796,3.8NBS29690
000072      686,3.875,3.87,3.867,3.865,4.01,3.979,3.965,3.956,3.951,4.216,4.14,NBS29700
000073      74.106,4.085,4.072,4.576,4.408,4.333,4.289,4.259,5.191,4.855,4.707,NBS29710
000074      84.618,4.558,6.202,5.582,5.308,5.144,5.032,7.785,6.713,6.238,5.954,NBS29720
000075      95.761,10.15,8.396,7.619,7.155,6.839,13.53,10.8,9.588,8.865,8.372/ NBS29730
000076       DATAAH/18.14,14.09,12.29,11.21,10.47,24.18,18.44,15.86,14.32,13.26NBS29740
000077      1,31.64,23.93,20.41,18.28,16.82,40.2,30.53,25.96,23.16,21.23,48.9,3NBS29750
000078      27.93,32.38,28.89,26.45,55.98,45.39,39.27,35.23,32.33,59.18,51.55,4NBS29760
000079      35.76,41.58,38.42,57.08,54.85,50.68,47.04,44.04/                    NBS29770
000080       DATAAI/2.819,2.811,2.809,2.809,2.808,2.808,2.808,3.032,2.963,2.95,NBS29780
000081      12.944,2.94,2.938,2.936,3.624,3.255,3.186,3.155,3.136,3.124,3.114,5NBS29790
000082      2.313,3.972,3.717,3.504,3.537,3.491,3.457,9.333,5.61,4.898,4.582,4.NBS29800
000083      3394,4.265,4.17,17.15,8.823,7.203,6.481,6.049,5.754,5.536,29.47,14.NBS29810
000084      422,11.11,9.705,8.862,8.284,7.855,2.808,2.807,2.807,2.938,2.931,2.9NBS29820
000085      528,3.124,3.086,3.07,3.492,3.353,3.296,4.268,3.878,3.719,5.762,4.86NBS29830
000086      65,4.498,8.3,6.533,5.809,2.807,2.807,2.806,2.806,2.806,2.806,2.931,NBS29840
000087      72.925,2.923,2.922,2.921,2.92,3.085,3.055,3.044,3.039,3.036,3.034,3NBS29850
000088      8.353,3.239,3.199,3.181,3.17,3.189,3.879,3.559,3.446,3.395,3.365,3.NBS29860
000089      9345,4.867,4.129,3.867,3.751,3.682,3.72,6.541,5.077,4.557,4.327/   NBS29870
000090       DATAAJ/4.189,4.095,2.806,2.806,2.805,2.804,2.803,3.034,3.029,3.026NBS29880
000091      1,3.024,3.022,3.345,3.294,3.271,3.257,3.247,4.095,3.861,3.757,3.694NBS29890
000092      2,3.652,2.485,2.509,2.519,2.52,2.639,2.637,2.807,2.803,2.884,2.996,NBS29900
000093      33.078,3.134,2.728,2.802,2.86,2.9,2.578,2.626,2.663,2.689,2.506,2.5NBS29910
000094      438,2.562,2.578,2.482,2.504,2.52,2.53,2.48,2.489,2.5,2.509,1.602,1.NBS29920
000095      5634,1.665,1.682,1.694,1.706,1.758,1.8,1.836,1.876,1.893,1.911,1.92NBS29930
000096      69,1.947,1.961,2.005,2.046,2.084,2.215,2.216,2.217,2.219,2.229,2.23NBS29940
000097      78,2.271,2.304,2.338,2.533,2.543,2.552,2.56,2.571,2.58,2.617,2.653,NBS29950
000098      82.604,2.759,2.776,2.791,2.806,2.82,2.833,2.882,2.92,2.951,2.892,2.NBS29960
000099      991,2.926,2.943,2.958,2.972,3.023,3.062,3.093,2.94,2.956,2.973/    NBS29970
000100       DATAAK/2.989,3.003,3.015,3.063,3.101,3.134,1.113,1.083,1.06,1.05,1NBS29980
000101      1.353,1.335,1.325,1.312,1.496,1.498,1.494,1.491,1.572,1.591,1.601,1NBS29990
000102      2.603,1.595,1.63,1.655,1.672,1.617,1.662,1.696,1.724,1.651,1.699,1.NBS30000
000103      3738,1.771,1.693,1.741,1.782,1.819,1.757,1.807,1.85,1.888,1.173,1.1NBS30010
000104      471,1.168,1.165,1.16,1.156,1.149,1.345,1.341,1.34,1.338,1.334,1.332NBS30020
000105      5,1.329,1.456,1.455,1.454,1.453,1.452,1.45,1.449,1.517,1.519,1.521,NBS30030
000106      61.523,1.525,1.526,1.527,1.551,1.552,1.556,1.561,1.564,1.569,1.572,NBS30040
000107      71.583,1.571,1.571,1.575,1.581,1.587,1.591,1.61,1.591,1.584,1.584,1NBS30050
000108      8.589,1.594,1.6,1.61,1.61,1.608,1.608,1.61,1.615,1.621,1.616,1.623,NBS30060
000109      91.627,1.632,1.635,1.641,1.646,1.632,1.64,1.646,1.653,1.659,1.665/ NBS30070
000110       DATAAL/1.671,1.665,1.673,1.68,1.687,1.693,1.7,1.707,1.715,1.723,1.NBS30080
000111      1731,1.738,1.744,1.751,1.757,1.583,1.571,1.571,1.575,1.597,1.578,1.NBS30090
000112      2574,1.579,1.608,1.587,1.581,1.582,1.61,1.596,1.589,1.589,1.61,1.60NBS30100
000113      34,1.598,1.598,1.61,1.61,1.608,1.608,1.485,1.511,1.534,1.557,1.577,NBS30110
000114      41.004,1.621,1.621,1.61,1.495,1.516,1.534,1.552,1.569,1.583,1.596,1NBS30120
000115      5.606,1.61,1.516,1.532,1.548,1.563,1.577,1.591,1.602,1.61,1.616,1.5NBS30130
000116      649,1.562,1.574,1.585,1.597,1.608,1.619,1.627,1.632,1.595,1.606,1.6NBS30140
```

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000117          715,1.625,1.634,1.642,1.652,1.66,1.665,1.656,1.664,1.671,1.679,1.68NBS30150
000118          86,1.693,1.701,1.708,1.715,1.131,1.132,1.133,1.133,1.133,1.131,1.24NBS30160
000119          9,1.239,1.238,1.237,1.236,1.235,1.342,1.338,1.335,1.332,1.33,1.328/NBS30170
000120           DATAAM/1.417,1.412,1.409,1.406,1.404,1.402,1.464,1.462,1.46,1.459,NBS30180
000121          11.457,1.456,1.501,1.497,1.495,1.495,1.495,1.495,1.565,1.535,1.523,NBS30190
000122          21.52,1.52,1.522,1.754,1.78,1.564,1.546,1.541,1.541,1.943,2.3,1.71,NBS30200
000123          31.585,1.564,1.557,0.,2.4,1.808,1.653,1.594,1.573,0.,0.,1.62,1.683,NBS30210
000124          41.624,1.591,1.583,2.3,3.1,0.,1.632,1.608,1.33,1.976,2.608,1.56,0.,NBS30220
000125          50.,1.522,1.66,1.736,1.617,1.495,0.,1.527,1.589,1.679,1.663,1.609,1NBS30230
000126          6.56,1.522,1.563,1.608,1.648,1.627,1.601,1.52,1.551,1.579,1.613,1.6NBS30240
000127          722,1.609,1.151,1.152,1.152,1.152,1.153,1.153,1.153,1.243,1.242,1.2NBS30250
000128          841,1.241,1.24,1.24,1.24,1.327,1.326,1.325,1.324,1.323,1.322,1.321,NBS30260
000129          91.393,1.392,1.391,1.39,1.389,1.388,1.387,1.44,1.439,1.438,1.438/  NBS30270
000130           DATAAN/1.437,1.436,1.436,1.478,1.474,1.473,1.472,1.471,1.471,1.47,NBS30280
000131          11.508,1.503,1.506,1.504,1.501,1.5,1.498,0.,0.,1.547,1.546,1.548,1.NBS30290
000132          2539,1.533,1.646,1.78,1.938,1.602,1.615,1.628,1.641,1.544,1.607,1.6NBS30300
000133          39,1.805,1.978,2.346,2.652,1.517,1.544,1.578,1.623,1.687,1.787,1.96NBS30310
000134          42,1.504,1.518,1.534,1.551,1.57,1.592,1.618,1.498,1.508,1.517,1.526NBS30320
000135          5,1.536,1.546,1.556,1.499,1.506,1.512,1.519,1.526,1.532,1.539,1.129NBS30330
000136          6,1.13,1.22,1.22,1.31,1.307,1.38,1.378,1.432,1.43,1.477,1.469,1.477NBS30340
000137          7,1.7,1.475,1.671,1.476,1.619,1.477,1.544,1.478,1.517,1.478,1.504,1NBS30350
000138          8.481,1.498,1.485,1.499,29.47,14.22,11.11,9.705,8.862,8.284,7.855,4NBS30360
000139          93.57,21.93,16.86,14.51,13.08,12.09,11.36,50.02,30.81,24.1,20.75/  NBS30370
000140           DATAA0/18.65,17.17,16.06,44.26,38.61,31.58,27.55,24.89,22.97,21.48NBS30380
000141          1,8.3,6.533,5.809,13.08,9.068,7.803,18.65,12.54,10.56,24.89,16.66,1NBS30390
000142          23.88,6.611,5.077,4.557,4.327,4.189,4.095,10.09,6.517,5.6,5.191,4.9NBS30400
000143          347,4.78,12.6,8.52,7.052,6.395,6.001,5.732,16.8,10.95,8.824,7.865,7NBS30410
000144          4.289,6.894,4.095,3.861,3.757,3.694,3.652,5.732,5.06,4.761,4.584,4.NBS30420
000145          546,8.056,6.756,6.173,5.816,5.449,0.,2.817,2.813,2.812,2.811,2.811,NBS30430
000146          62.899,2.888,2.883,2.881,2.879,3.018,2.989,2.976,2.968,2.963,3.214,NBS30440
000147          73.142,3.111,3.092,3.079,3.55,3.394,3.325,3.284,3.255,4.119,3.809,3NBS30450
000148          8.672,3.59,3.534,5.044,4.476,4.225,4.074,3.972,6.478,5.504,5.071,4.NBS30460
000149          9813,4.637,8.587,7.014,6.314,5.895,5.609,11.54,9.137,8.061,7.417/   NBS30470
000150           DATAAP/6.976,15.49,11.99,10.42,9.471,8.822,20.48,15.66,13.46,12.13NBS30480
000151          1,11.22,26.41,20.15,17.23,15.45,14.22,32.93,25.35,21,67,19.4,17.81,NBS30490
000152          239,24,30.92,26.61,23.87,21.93,44.14,36.29,31.69,28.62,26.38,46.18,NBS30500
000153          340.53,36.27,33.17,30.8,44.47,42.64,39.57,36.91,34.71/              NBS30510
000154           END                                                                NBS30520
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W ELT BLOCK,1,711217, 45478

000001          C                                                                       1
000002          C     NOVEMBER 1971 VERSION        J J WILLIAMS
000003          C                                                                       4
000004                BLOCK DATA                                                        5
000005                REAL J,K1,K2,K3,K4,KC,KCF,KM,KMP,KWG,KFAC,L,MC,MR,MUB,MUCF,
000006               X      MUGF,MUW,NMB,NT,N1P,N2P,N3P,N4P,N5P,N6P,NMBP
000007                COMMON /INT/  IKMAX    ,ILHITE   ,ICGITE   ,IITRFL   ,IKERR      7
000008               1   ,IN       ,ITUBE    ,INUM     ,IDIS     ,IFRIC    ,ITNUM1    8
000009               3       , IZPTS , IZSTEP                                          9
000010               4    ,IWALL, IMERCR , IHGC, IHLC, IFILM, IRBO, I8085 ,ICOOL      10
000011                COMMON/ CON/  AA     ,ABAR   ,AE     ,AF     ,AFP    ,AS     ,AL     ,  11
000012               1AO    ,ASTAR ,AV     ,B      ,BETA   ,C1     ,CL     ,CG     ,CC1    ,  12
000013               2CC2   ,CP     ,CPP    ,CPBAR ,CPGF   ,D      ,DE     ,E1     ,E2     ,  13
000014               3E3    ,E4     ,E      ,F      ,FBAR   ,FEFV   ,FS     ,FC     ,FP     ,  14
000015               4GO    ,G1     ,G      ,H      ,HBC    ,HC     ,HIN    ,HMIX   ,HOUT   ,  15
000016               5HG    ,HL     ,HL1    ,HR     ,J      ,K1     ,K2     ,K3     ,K4     ,  16
000017               6KC    ,KCF    ,KM     ,KMP    ,KWG    ,KFAC   ,L      ,MC     ,MR     ,  17
000018               7NMB   ,NT     ,N1P    ,N2P    ,N3P    ,N4P    ,N5P    ,N6P    ,PIE    ,  18
000019               8PSC   ,PC     ,PG     ,PFM    ,PRCF   ,PRGF   ,P      ,PP     ,PF     ,  19
000020               9PIN   ,PLS    ,POUT   ,PRC    ,PV     ,Q      ,QOA    ,QOAM   ,QOAO   ,  20
000021               OR     ,RC     ,RD     ,RN     ,RU     ,RB     ,RSTAR  ,RCV    ,SMALD  ,  21
000022               1SMALRA,SMALRG,SC     ,S      ,STR    ,STRY   ,SMALTC,SMALTM,SMALTS,  22
000023               2SMARGP,TB     ,TBP    ,TBC    ,TC     ,TRCF   ,TCF    ,TGF    ,TIN    ,  23
000024               3TM    ,TMIX   ,TWG    ,TWGC   ,TWL    ,TWLC   ,TWM    ,TO     ,TINFIN,  24
000025               4TBAR  ,U      ,V      ,VF     ,VC     ,VP     ,VNS    ,WG     ,WGCORE,  25
000026               5WGSTAR,WC     ,WBC    ,WF     ,X      ,XP     ,XI     ,Z      ,ZP     ,  26
000027               6ZB    ,ZD     ,ZOL    ,ZN     ,ZU     ,ZW     ,ZSTAR  ,EHAF   ,MUB    ,  27
000028               7MUCF  ,MUGF   ,MUW    ,RHO    ,RHOB   ,RHOBP  ,RHOCF  ,RHOGF  ,RHOW   ,  28
000029               8RHOBAR,RP     ,EP0GEO,EP1GEO,NMBP   ,GAMMAC,SMALA  ,EPGEOM,AASTAR,  29
000030               9SMATMP,RHOP   ,ALPHAA,BETAA  ,EP0    ,EP1                       30
000031                COMMON/S/ IDATA1(20),IITLE(20),INU(10),TATM(9),TAKM(9)
000032               1,TATM1(20),TAKM1(20),TATWM(25),TASTRY(25),TATMR(20),TAKMR(79),   32
000033               2  TPRPC(50)                                                      33
000034               2 , TPK(100), TTINK(100), TRHOK(100), THK(100), TVK(100), TAZ(100) 00000330
000035               3                                    ,TASMTM(100),TACG(100)       35
000036               1 ,TACL(100)   ,TAKC(100),TATC(100)  ,TASMD(100) ,TASML(100)      36
000037               2 ,TASMTS(100),TABETA(100),TAAF(100) ,TATWG(100)                  37
000038               3 ,TAFEFV(100),TANMB(100),TANT(100)  ,TAWDOT(100)                 38
000039               4   ,TAAST (100)                                                  39
000040               5   ,TASMDS(100)                                                 40
000041                COMMON/CLTABL/TATB(10),TACL2(10),ICLFG
000042                DATA TATB/40.0,50.0,60.0,65.0,70.0,75.0,77.5,80.0,84.0,440.0/
000043                DATA TACL2/.04160,.04160,.031096,.026104,.022048,.019448,
000044               1           .018512,.017992,.01760,.017054/
000045                DATA INU  / 1,30,60,90,120,150,180,210,240,270 /                  41
000046                DATA  G / 386.0886 / , J /  9339.12 /, PIE / 3.1415926 /          42
000047                 DATA  C1  / .0208 / ,  CG  /.026 /                               43
000048                DATA TPRPC / 1., 1.1, 1.2, 1.3, 1.4, 1.6, 1.75, 1.8, 1.85, 1.9,   BLOCK   **-1
000049               1  1.95, 2., 2.05, 2.1, 2.2, 2.5,                                 DATA
000050               X                                5.,10.,20.,30.,50.,75.,          48
000051               1 100.,150.,200.,300.,400.,500.,750.,1E3,15E2,2E3,25E2,3E3,35E2,   49
000052               2  4E3,  14*0.0 /
000053                DATA  TATM / 530.,660.,960.,1060.,1460.,1560.,1760.,1960.,2160./  51
000054               1,TAKM / 130E-6,147E-6,189E-6,193E-6,263E-6,277E-6,306E-6,335E-6   52
000055               2       ,364E-6 / ,TATM1 / 210.,260.,360.,528.,660.,860.,1060.,    53
000056               3       1260.,1460.,1660.,1860.,2060.,2100.,2250.,2450.,2625. ,    54
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000057          4       2775.,3*0. /,TAKM1 / 165E-6,169E-6,178E-6,195E-6,209E-6,                55
000058          2  227E-6,248E-6,267E-6,287E-6,306E-6,327E-6,345E-6,348E-6,361E-6,             57
000059          6  380E-6,394E-6,408E-6,3*0./                                                  58
000060            END
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@ ELT CALCTP,1,711229, 55345

000001          C                                                                       C
000002          C***********************************************************************C
000003          C*                                                                      *C
000004          C*       THIS VERSION OF CALCTP WRITTEN DECEMBER 1971   J J WILLIAMS    *C
000005          C*                                                                      *C
000006          C***********************************************************************C
000007          C                                                                       C
000008                SUBROUTINE CALCTP                                                 00185
000009                REAL J,K1,K2,K3,K4,KC,KCF,KM,KMP,KWG,KFAC,L,MC,MR,MUB,MUCF,
000010               X      MUGF,MUW,NMB,NT,N1P,N2P,N3P,N4P,N5P,N6P,NMBP
000011                REAL  KB,KWL,K5,K5P,K6,LP,MUWL,MW,NC,NDL
000012                COMMON/ FLUIDP / A(35)                                            00187
000013                COMMON / INT/  IKMAX      , ILHITE     , ICGITE     , IITRFL     ,
000014               1  IKERR      , IN         , ITUBE      , INUM       , IDIS       ,
000015               2  IFRIC      , ITNUM1     , IZPTS      , IZSTEP     , IWALL      ,
000016               3  IMERCR     , IHGC       , IHLC       , IFILM      , IRBO       ,
000017               4  I8085      , ICOOL      , ITF        , ISZ        , ICONLB
000018                COMMON / CORREL / SZ(3), UW, UL
000019                COMMON/ CON/  AA     ,ABAR   ,AE     ,AF     ,AFP    ,AS     ,AL     ,      00191
000020               1A0    ,ASTAR ,AV     ,B      ,BETA   ,C1     ,CL     ,CG     ,CC1    ,      00192
000021               2CC2   ,CP    ,CPP    ,CPBAR  ,CPGF   ,D      ,DE     ,E1     ,E2     ,      00193
000022               3E3    ,E4    ,E      ,F      ,FBAR   ,FEFV   ,FS     ,FC     ,FP     ,      00194
000023               4G0    ,G1    ,G      ,H      ,HBC    ,HC     ,HIN    ,HMIX   ,HOUT   ,      00195
000024               5HG    ,HL    ,HL1    ,HR     ,J      ,K1     ,K2     ,K3     ,K4     ,      00196
000025               6KC    ,KCF   ,KM     ,KMP    ,KWG    ,KFAC   ,L      ,MC     ,MR     ,      00197
000026               7NMB   ,NT    ,N1P    ,N2P    ,N3P    ,N4P    ,N5P    ,N6P    ,PIE    ,      00198
000027               8PSC   ,PC    ,PG     ,PFM    ,PRCF   ,PRGF   ,P      ,PP     ,PF     ,      00199
000028               9PIN   ,PLS   ,POUT   ,PRC    ,PV     ,Q      ,QOA    ,QOAM   ,QOAO   ,      00200
000029               OR     ,RC    ,RD     ,RN     ,RU     ,RB     ,RSTAR  ,RCV    ,SMALD  ,      00201
000030               1SMALRA,SMALRG,SC     ,S      ,STR    ,STRY   ,SMALTC,SMALTM,SMALTS,         00202
000031               2SMARGP,TB    ,TBP    ,TBC    ,TC     ,TRCF   ,TCF    ,TGF    ,TIN    ,      00203
000032               3TM    ,TMIX  ,TWG    ,TWGC   ,TWL    ,TWLC   ,TWM    ,TO     ,TINFIN,       00204
000033               4TBAR  ,U     ,V      ,VF     ,VC     ,VP     ,VNS    ,WG     ,WGCORE,       00205
000034               5WGSTAR,WC    ,WBC    ,WF     ,X      ,XP     ,XI     ,Z      ,ZP     ,      00206
000035               6ZB    ,ZD    ,ZOL    ,ZN     ,ZU     ,ZW     ,ZSTAR  ,EHAF   ,MUB    ,      00207
000036               7MUCF  ,MUGF  ,MUW    ,RHO    ,RHOB   ,RHOBP  ,RHOCF  ,RHOGF  ,RHOW   ,      00208
000037               8RHOBAR,RP    ,EP0GEO,EP1GEO,NMBP   ,GAMMAC,SMALA  ,EPGEOM,AASTAR,         00209
000038               9SMATMP,RHOP  ,ALPHAA,BETAA  ,EP0    ,EP1    ,REYEXP,PRLEXP,TR
000039                COMMON /   S/  IDATA1(20) , IITLE(20)  , INU(10)     , TATM(9)     ,
000040               1  TAKM(9)     , TATM1(20)   , TAKM1(20)  , TATWM(25)   , TASTRY(25) ,
000041               2  TATMR(20)   , TAKMR(79)   , TPRPC(50)  , TPK(100)    , TTINK(100) ,
000042               3  TRHOK(100)  , THK(100)    , TVK(100)   , TAZ(100)    , TASMTM(100),
000043               4  TACG(100)   , TACL(100)   , TAKC(100)  , TATC(100)   , TASMD(100) ,
000044               5  TASML(100)  , TASMTS(100), TABETA(100), TAAF(100)   , TATWG(100) ,
000045               6  TAFEFV(100), TANMB(100)  , TANT(100)   , TAWDOT(100), TAAST(100) ,
000046               7  TASMDS(100), TMACH(100)
000047                COMMON/SHEEHY/ DS         , W          , WP         , AFBAR      ,
000048               1  K5         , VCBAR      , K5P        , TWMC       , VCP        ,
000049               2  TSAT       , FCBAR      , K6         , TSATK      , FCP        ,
000050               3  PD         ,  FRHOV     , CPCF       , MUWL       , CB2        ,
000051               4  KB         , CPWL       , CPB        , RHOWL      , KWL        ,
000052               5  CB1        , ZETA       , MW         , COEF(4,5)  , LP         ,
000053               6  DUMPEM     , PXM(100)   , PDM(100)   , NDL        , DZ         ,
000054               7  NC         , SMATCP
000055                COMMON/REUSS/QOAOP
000056                COMMON/JOHNC/TANG(50),IGAS,IK5,DEP
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000057                COMMON /GARRY/ AVP, AVC, AVIN
000058                IF( ILHITE ) 1,2,1                                              00219
000059              2 CALL HLC                                                        00220
000060                IF( ICGITE ) 3,4,3                                              00221
000061              1 IF( IKERR.GT. 1)  GO TO 60                                      00222
000062              4 CALL HGC                                                        00223
000063              3 IF ( IHGC - 4 ) 44,33,44
000064             33 KOUNT =0
000065                TGF = .5 * (BETA*TC + TWG)
000066                Q53 = 1.0 / 3.0
000067            520 CALL PTGAS(PG,TGF)
000068                PRGF = A(7) * A(11) / A(10)
000069                TGFC = .5 * (TWG + TINFIN) + .22 * PRGF**Q53 * (TC - TINFIN)
000070                IF ( ABS(TGF-TGFC) .LE. .1 ) GO TO 530
000071                TGF = TGFC
000072                KOUNT = KOUNT + 1
000073                IF ( KOUNT .LE. 11 ) GO TO 520
000074                WRITE (6,522)
000075            522 FORMAT ('0***** TGF ITERATION IN CALCTP WILL NOT CLOSE IN 10 TRIES
000076               1 *****')
000077                WRITE (6,23) TGF, TGFC
000078             23 FORMAT (' TGF,TGFC...'2E15.8)
000079                IKERR = IITRFL + 10
000080                RETURN
000081            530 TR  = TINFIN + PRGF**Q53 * (TC - TINFIN)
000082                IF ( BETA .GT. 0.0 ) TR = BETA*TC
000083                Q50 = TR
000084                GO TO 505
000085             44 Q50 = BETA * TC
000086      C
000087      C       FILM TEMPERATURE IS COMPLETED BY THIS STATION
000088      C
000089            505 Q51 = Q50 * Q50 * Q50 * Q50
000090                Q52=  TWG * TWG * TWG * TWG                                   00226
000091                IF(FEFV.LT.0.) FEFV=G1*(T0**4 - Q52)/(Q51 - Q52)
000092                HR = 3.3E-15 * FEFV * (Q51 - Q52)/(Q50 - TWG)
000093      C
000094      C   **********RADIATION H COMPLETED**********
000095      C
000096                GO TO 59                                                      00229
000097              5 TM  = .5*(  (HG + HR)*(TWG -Q50)* SMALTC / KC  * (SMALRG+SMALTC)  00230
000098             1       / (SMALRG+.5 *SMALTC)+ TWG + TWL )                       00231
000099                CALL LINT   ( TATMR,TAKMR,TM,KM,20)                          0o001180
000100                IF ( KM .NE. 0.0 ) GO TO 400
000101                KM = 408E-6
000102                WRITE (6,450)
000103            450 FORMAT ('0', 10('************') /
000104               1        '0',  5('************') , 'IT''S TOO HOT',
000105               2             4('************') /
000106               3          '0', 10('************') )
000107            400 IF ( IMERCR .NE. 0 ) GO TO 200
000108      C                                                                       00233
000109                U =( (SMALRG -SMALTM)/ (SMALRG +SMALTC)/ (HG + HR)            00234
000110             1   +(SMALRG-SMALTM)/KC*LOG((SMALRG+SMALTC)/SMALRG)
000111             2   +(SMALRG-SMALTM)/KM*LOG(SMALRG/(SMALRG-SMALTM))
000112             3   + 1./ HL )                                                   00237
000113                U = 1./ U                                                     00238
000114                QQA  =  U * ( Q50 - TB )                                      00239
000115                TWGC = QQA*( SMALTC/ KC *(SMALRG -SMALTM)/(SMALRG+.5*SMALTC)  00240
000116             1       + SMALTM / KM * (SMALRG -SMALTM)   /(SMALRG-.5*SMALTM)   00241
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000117              2      + 1./ HL  )                                                    00242
000118              3      + TB                                                           00243
000119        C                                                                           00244
000120              TWLC =  QOA/ HL  + TB                                                00245
000121              QOAO =  (HG + HR) * (Q50 - TWG )                                     00246
000122        C                                                                           00247
000123         8    TWM  =  QOA *(  SMALTM/ KM * (SMALRG -SMALTM)/ (SMALRG -.5*SMALTM)   00248
000124             1                + 1./ HL ) .+  TB                                   00249
000125        C  PARM IN ABOVE EQ.                                                        00250
000126        C                                                                           00251
000127         300  CONTINUE
000128                 CALL PT (P,TBP)                                                   00252
000129               RHOP=A(5)                                                           00253
000130              CALL   PT ( P,TB  )                                                  00254
000131              CP=A(7)
000132                     AV=A(13)
000133              KB = A(10)
000134              IF(IN.NE.1) GO TO 9
000135        C                                                                         C
000136        C*************************FIRST STATION*************************************C
000137        C                                                                         C
000138              Q=0.
000139              IF((ICOOL.NE.1).OR.(ICOOL.NE.4)) GO TO 369
000140              AVC = AVIN - VC**2/2./J/G
000141              CALL PTH(P,AVC,TBC)
000142              GO TO 376
000143           369 TBC = TBP - VC**2/2./G/J/CP
000144           376 CONTINUE
000145              TBAR=TB
000146              AFBAR=AF
000147              VCBAR=VC
000148              RHOBAR=RHOB
000149              CPBAR=CP
000150              DEBAR=DE
000151              DTOT=0.
000152              QOAOP=QOAO
000153              GO TO 301
000154        C                                                                         C
000155        C*************************ALL STATIONS PAST FIRST***************************C
000156        C                                                                         C
000157            9 Q=ABS(0.5*(QOAOP+QOAO))*NMB*AS
000158              AFBAR=(AF+AFP)/2.
000159              VCBAR=(VC+VCP)/2.
000160              TBAR  = .5  * ( TB + TBP)                                           00258
000161              RHOBAR= .5  * ( RHOB + RHOBP)                                       00259
000162              CPBAR = .5  * ( CP   + CPP )                                        00260
000163              DEBAR=(DE+DEP)/2.
000164              DTOT=(TB-TBP)/TBAR
000165        C
000166        C     COMPUTE TBC USING PTH CALL IF HYDROGEN IS COOLANT
000167        C
000168              IF((ICOOL.NE.1).OR.(ICOOL.NE.4)) GO TO 307
000169              AVC = AVP - (VC*VC - VP*VP) /2. /G /J  + Q/WC
000170              CALL PTH (P, AVC, TBC)
000171              GO TO 301
000172           307 TBC = TBP + Q/CPBAR /WC - (VC*VC - VP*VP)
000173             1    /  2. / G / J / CPBAR                                           00263
000174        C                                                                         00264
000175              IF ( TB .NE. TBP )  TBC = TBC -(  1./RHOBAR- TBAR *                 00265
000176             1   ( (1./ RHOB - 1./ RHOP)/ ( TB - TBP) ) )*  (P - PP)/ J /CPBAR   00266
```

```
000177          301 IF (E .LE. 0.0) GO TO 3000
000178        21    FC = .001375 * (  1. +  (  2E4 * E   / DE + MUB*1E6/VC/ DE/ RHOB)    00268
000179             1                          **.3333333 )                               00269
000180                GO TO 22
000181        C
000182        C      M F TAYLOR EQUATION USED WHEN FRIC = -1.
000183        C
000184         3000 IF (IFRIC .NE. -1) GO TO 20
000185                CALL PT(P,TWL)
000186                RES = WC/(NMB*AF)*DE/A(11)*(TB/TWL)
000187        C   FRICTION FACTOR FOR CROWN
000188                FC = 2.*(.0007 + .0625/(RES**.32))*(TB/TWL)**.5
000189                CALL PT(P,TB)
000190                RECOLD = WC/(NMB*AF)*DE/A(11)
000191        C   FRICTION FACTOR FOR JACKET
000192                FCCOLD = 2.*(.0007 + .0625/(RECOLD**.32))
000193        C   WIEGHTED AVG OF FC ON CROWN AND FCCOLD ON LEGS AND JACKET
000194                FC = (FC*PIE*(SMALRG-SMALTM) + FCCOLD*(2.*L+B-2.*SMALTM+2.*ABS(UW)
000195             ?    ))/(4.*AF/DE)
000196                GO TO 22
000197          20  FC = .5/(2.54*LOG10(VC*DE*RHOB/MUB)-2.17)**2
000198           22 IF(IN.EQ.1) FCBAR=FC
000199              IF(IN.NE.1) FCBAR=(FC+FCP)/2.
000200        C
000201        C    **********MODIFY FOR ITO CORRECTION IF IK5 (K5S INPUT) IS 1*********
000202        C
000203              IF(IK5.EQ.0) GO TO 30
000204              IF ( Z .GE. ZD) GO TO 30
000205              IF ( Z .GE. ZSTAR) RCV = RD
000206              IF ( Z .LT. ZSTAR .AND. Z .GE. ZU ) RCV = RU
000207              IF ( Z .LT. ZSTAR .AND. Z .GE. ZN ) GO TO 30
000208              IF ( Z .LT. ZB ) GO TO 30
000209              IF ( Z .LT. ZN .AND. Z .GE. ZB ) RCV = RN
000210              FCBAR = FCBAR * (VC*DE*RHOB/MUB * (DE/2.0/RCV)**2)**.05
000211        30    IF((IN ).EQ. 1 ) GO TO 25                                           00275
000212              DYNQ=RHOBAR*VCBAR**2/2./G
000213              PF=DYNQ*(PFM*4.*FCBAR*ABS(X-XP)/DEBAR + 2.*K6*DTOT)                  *NEW
000214              PV=(RHOB*AF*VC**2-RHOBP*AFP*VCP**2)/( 12.*AFBAR*32.174)              **-1
000215        C                                                                         C
000216        C**************************DISCONTINUITY CHECK*****************************C
000217        C                                                                         C
000218              IF(IFIX(NMB).GT.IFIX(NMBP)) GO TO 40
000219              IF(IFIX(NMB).LT.IFIX(NMBP)) GO TO 45
000220           35 PRC = PP - PF - PV
000221              RETURN
000222        40    CONTINUE
000223              PV=(1.895*(AF/AFP)-4. * SQRT(AF/AFP)+2.105)                      00000900
000224             1      *RHOB*VC*VC  /2. /G                                       00286
000225              GO TO 35                                                        00287
000226        45    PV =  (1. - AFP / AF)**2 * RHOB *  VP * VP /  2. / G            00288
000227              GO TO 35                                                        00289
000228        C                                                                         C
000229        C**************************FIRST STATION*************************************C
000230        C                                                                         C
000231        25    PF = 0.                                                         00302
000232              PV=(K1+CC1*(1.895*AF/AL-4.* SQRT(AF/AL)+2.105) *                00000900
000233             1                    AL/ AF / AF * AL )                          00304
000234             2 * (RHOB * VC * VC /2./ G )
000235              GO TO 35
000236        59    IF( ILNITE )100,101,100                                         00307
```

```
000237          100    TWGC = TWG                                                    00308
000238          C      LEG HEIGHT ITERA                                              00309
000239                 IF ( IHGC .NE. 4 ) TR = BETA * TC
000240                 Q0AO = ( HG + HR ) * ( TR - TWG )
000241                  Q0A =   Q0AO *  SMALRG / ( SMALRG - SMALTM )                 00311
000242                 KFAC = Q0A*(SMALRG-SMALTM)*LOG(SMALRG/(SMALRG-SMALTM))
000243                 CALL LINT (TATMR,TAKMR,TWG,KM,20)                          00002130
000244                 KM = .5*(KM + SQRT(KM*KM - 1.9E-7*KFAC))
000245              50 TWLC = TWG-Q0A*(SMALRG-SMALTM)/KM*LOG(SMALRG/(SMALRG-SMALTM))
000246          60     CONTINUE                                                      00320
000247                 TWL = TWLC
000248                 HL =   Q0A / ( TWL -  TB  )                                   00321
000249                 CALL HLC                                                      00323
000250                 U = (SMALRG - SMALTM )/ SMALRG / ( HG + HR ) + SMALTM/ KM  *  00324
000251                1    (SMALRG - SMALTM )/ (SMALRG -.5 *SMALTM ) + 1. / HL      00325
000252                 U = 1./ U                                                     00326
000253                 GO  TO   8                                                    00327
000254          101    IF( ICGITE )  106,005,106                                     00290
000255          106    CONTINUE                                                      00291
000256                 TM=.5*(TWG+TWL)
000257          C      CG ITER                                                       00293
000258                 CALL LINT   (TATMR,TAKMR,TM, KM,20)                        00001920
000259                 Q0A = (SMALRG-SMALTM)/KM*LOG(SMALRG/(SMALRG-SMALTM))+1./HL
000260                 Q0A = (TWG - TB ) / Q0A                                       00297
000261                 Q0AO    =   Q0A / SMALRG * (SMALRG - SMALTM)                  00298
000262                 TWGC  =  TWG                                                  00299
000263                 TWLC  =  TB +  Q0A / HL                                       00300
000264                 GO TO 8                                                       00301
000265          C                                                                      C
000266          C**************************NON CRYOGENIC OPTION*************************C
000267          C                                                                      C
000268           200   IF(IWALL .EQ. 0 ) GO TO 201
000269                 RESG=1./(HG+HR)
000270                 RESW=SMALTM/KM
000271                 RESC=SMALTC/KC
000272                 GO TO 202
000273           201   RESC=0.
000274                 IF(SMALTC .GT. 0.) RESC=(SMALRG-SMALTM)/KC* LOG((SMALRG+SMALTC)/
000275                1                          SMALRG)
000276                 RESG= (SMALRG-SMALTM)/(SMALRG+SMALTC)/(HG+HR)
000277                 RESW= (SMALRG-SMALTM)/KM* LOG(SMALRG/(SMALRG-SMALTM))
000278           202   RESL=1./HL
000279                 U=1./(RESG+RESC+RESW+RESL)
000280                 Q0A=U*(Q50-TB)
000281                 TWGC=Q0A*(RESW+RESC+RESL)+TB
000282                 TWM =Q0A*(RESW+RESL)+TB
000283                 TWLC=Q0A*RESL+TB
000284                 IF(TWLC .LE. (TSAT+TSATK)) GO TO 203
000285                 TWLC=TSAT+TSATK
000286                 U=1./(RESC+RESW+RESG)
000287                 Q0A=U*(Q50-TWLC)
000288                 TWGC=Q0A*(RESC+RESW)+TWLC
000289                 TWM =Q0A*RESW+TWLC
000290           203   Q0AO=(HG+HR)*(Q50-TWGC)
000291                 GO TO 300
000292                 END                                                           00333
```

```
@ ELT CHANGE,1,711119, 35436

000001                SUBROUTINE CHANGE
000002                REAL KCF,K1,LHITE,MUB,NMBP,N4P,KFAC,K2,MUCF,NT,N5P,KM,K3
000003                REAL MC,MUGF,N1P,N6P,J,KMP,K4,MUW,N2P,KC,KWG,L,MR,NMB,N3P
000004                COMMON /   S/  IDATA1(20) , TITLE(20)   , INU(10)     , TATM(9)     ,
000005               1  TAKM(9)     , TATM1(20)   , TAKM1(20)  , TATWM(25)  , TASTRY(25) ,
000006               2  TATMR(20)   , TAKMR(79)   , TPRPC(50)  , TPK(100)    , TTINK(100) ,
000007               3  TRHOK(100)  , THK(100)    , TVK(100)   , TAZ(100)    , TASMTM(100),
000008               4  TACG(100)   , TACL(100)   , TAKC(100)  , TATC(100)   , TASMD(100) ,
000009               5  TASML(100)  , TASMTS(100), TABETA(100), TAAF(100)   , TATWG(100) ,
000010               6  TAFEFV(100), TANMB(100)  , TANT(100)   , TAWDOT(100), TAAST(100) ,
000011               7  TASMDS(100)
000012                COMMON / VAR/  TUBE(100)   , PPFM(100)   , EEPGEO(100), TTATMR(20) ,
000013               1  TTAKMR(79)  , MMAT(4)     , TTATWM(25) , TTASTR(25) , TMKM(100)
000014                COMMON / ADD/  RE          , WDOTOA      , MAT(4)      , LHITE(100) ,
000015               1  CGITE(100) , ZCHAN
000016                COMMON/ CON/   AA     ,ABAR   ,AE     ,AF     ,AFP    ,AS     ,AL     ,   00012030
000017               1AO     ,ASTAR ,AV     ,B      ,BETA   ,C1     ,CL     ,CG     ,CC1    ,   00012040
000018               2CC2    ,CP    ,CPP    ,CPBAR  ,CPGF   ,D      ,DE     ,E1     ,E2     ,   00012050
000019               3E3     ,E4    ,E      ,F      ,FBAR   ,FEFV   ,FS     ,FC     ,FP     ,   00012060
000020               4GO     ,G1    ,G      ,H      ,HBC    ,HC     ,HIN    ,HMIX   ,HOUT   ,   00012070
000021               5HG     ,HL    ,HL1    ,HR     ,J      ,K1     ,K2     ,K3     ,K4     ,   00012080
000022               6KC     ,KCF   ,KM     ,KMP    ,KWG    ,KFAC   ,L      ,MC     ,MR     ,   00012090
000023               7NMB    ,NT    ,N1P    ,N2P    ,N3P    ,N4P    ,N5P    ,N6P    ,PIE    ,   00012100
000024               8PSC    ,PC    ,PG     ,PFM    ,PRCF   ,PRGF   ,P      ,PP     ,PF     ,   00012110
000025               9PIN    ,PLS   ,POUT   ,PRC    ,PV     ,Q      ,QOA    ,QOAM   ,QOAO   ,   00012120
000026               OR      ,RC    ,RD     ,RN     ,RU     ,RB     ,RSTAR  ,RCV    ,SMALD  ,   00012130
000027               1SMALRA,SMALRG,SC     ,S      ,STR    ,STRY   ,SMALTC,SMALTM,SMALTS,   00012140
000028               2SMARGP,TB     ,TBP    ,TBC    ,TC     ,TRCF   ,TCF    ,TGF    ,TIN    ,   00012150
000029               3TM     ,TMIX  ,TWG    ,TWGC   ,TWL    ,TWLC   ,TWM    ,TO     ,TINFIN,   00012160
000030               4TBAR   ,U     ,V      ,VF     ,VC     ,VP     ,VNS    ,WG     ,WGCORE,   00012170
000031               5WGSTAR,WC     ,WBC    ,WF     ,X      ,XP     ,XI     ,Z      ,ZP     ,   00012180
000032               6ZB     ,ZD    ,ZOL    ,ZN     ,ZU     ,ZW     ,ZSTAR  ,EHAF   ,MUB    ,
000033               7MUCF   ,MUGF  ,MUW    ,RHO    ,RHOB   ,RHOBP  ,RHOCF  ,RHOGF  ,RHOW   ,   00012200
000034               8RHOBAR,RP     ,EP0GEO,EP1GEO,NMBP   ,GAMMAC,SMALA  ,EPGEOM,AASTAR,
000035               9SMATMP,RHOP   ,ALPHAA,BETAA  ,EP0    ,EP1    ,REYEXP,PRLEXP                  000
000036                SMD = 2* (SMALTM + DSQRT(AF/PIE))
000037                DO 10 I = 1,100
000038                IF (Z .EQ. TAZ(I)) GO TO 50
000039             10 CONTINUE
000040                WRITE (6,20) Z, TAZ
000041             20 FORMAT (' UNABLE TO LOCATE Z=',E15.8,'IN TAZ TABLE'/
000042               1  (' ', 5E15.8))
000043                STOP
000044             50 ISAVE = I
000045                TASMD(ISAVE) = SMD
000046                TUBE(ISAVE)  = 3.0
000047                LHITE(ISAVE) = 0.0
000048                TASML(ISAVE) = L
000049                RETURN
000050                END
```

```
@ ELT CONTUR,1,711119, 35439

000001                SUBROUTINE CONTUR(DATA)
000002          C     *** PROGRAM FOR GENERATING STATION LOCATIONS FOR INPUT TO NOZZLE
000003          C     *** HEAT TRANSFER PROGRAM.
000004                DIMENSION DATA(23),IITLE(20)
000005                COMMON /ZXR/ ZF(200),RF(200),XF(200),ARF(200),ZDIS(50)
000006               1,NF
000007                COMMON/INGRAM/ Z(200), R(200), X(200),           RDIS( 50),
000008               1     XDIS( 50), ZI(200), RI(200), SINA, SINB, COSA, COSB, TANA,
000009               2     TANB, ZO, ZB, ZSTAR, Z1, Z2, Z3, Z5, Z6, RC, R2, R3, RSTAR,
000010               3     R5, R6, X1, X2, X3, X4, X5, X6, EPS, DX01, DX12, DX23, DX34,
000011               4     DX45, DX56, A0, A1, A2, RB, RU, RD, ALPHA, BETA, XTEMP, DZ,
000012               5     ARAT
000013               6          ,    N1, N2, N3, N4, N5, N6, IPL, NDL, NC, NDFL, ND,
000014               7     NI, K
000015                COMMON/S/IDATA(20),IITLE
000016                RC=DATA(1)
000017                RSTAR=DATA(2)
000018                RB=DATA(3)
000019                RU=DATA(4)
000020                RD=DATA(5)
000021                ALPHA=DATA(6)
000022                BETA=DATA(7)
000023                EPS=DATA(8)
000024                ZO=DATA(9)
000025                ZB=DATA(10)
000026                ZSTAR=DATA(11)
000027                DZ=DATA(12)
000028                N1=DATA(13)
000029                N2=DATA(14)
000030                N3=DATA(15)
000031                N4=DATA(16)
000032                N5=DATA(17)
000033                N6=DATA(18)
000034                NDL=DATA(19)
000035                NC=DATA(23)
000036                IF (NC) 5040, 5010, 5070
000037           5010 CALL START
000038                IF (DZ) 5020, 5020, 5030
000039          C     *** STATION BREAKUP BY INDIVIDUAL SECTION
000040           5020 CALL SECT
000041                GO TO 5100
000042          C     *** STATION BREAKUP BY INCREMENT DZ
000043           5030 CALL EVEN
000044                GO TO 5100
000045          C     *** ALL STATIONS INPUT
000046           5040 IP = 0
000047           5050 IP = IP + 1
000048                READ (5, 9010) ZF(IP), RF(IP), XF(IP)
000049                IF (ZF(IP)) 5060, 5050, 5050
000050           5060 NF = IP - 1
000051                DO 5065 N = 1, NF
000052                Z(N) = ZF(N)
000053                R(N) = RF(N)
000054           5065 X(N) = XF(N)
000055                GO TO 5300
000056          C     *** INPUT POINTS DEFINING CONTOURED NOZZLE
```

```
000057          5070 IP = 0
000058               IF (NC - 2) 5080, 5010, 5010
000059          5080 IP = IP + 1
000060               READ (5, 9010) ZI(IP), RI(IP)
000061               IF (ZI(IP)) 5090, 5080, 5080
000062          5090 IPL = IP
000063               GO TO 5010
000064          C    *** BEGIN STATION SEQUENCING
000065          5100 NF = 1
000066               ND = 1
000067               N =  1
000068               ZF(1) = ZDIS(1)
000069               RF(1) = RDIS(1)
000070               XF(1) = XDIS(1)
000071          5110 N = N + 1
000072               IF(Z(N) .LT. ZDIS(1)) GO TO 5110
000073               IF(Z(N) .EQ. ZDIS(1)) N=N-1
000074               NF=NF+1
000075               ND=ND+1
000076               IF(ZDIS(ND) .LT. ZDIS(ND-1)) GO TO 5130
000077          5170 IF(ZDIS(ND) .LE. Z(N)) GO TO 5140
000078               ZF(NF)=Z(N)
000079               RF(NF)=R(N)
000080               XF(NF)=X(N)
000081               NF=NF+1
000082          5171 IF(N .EQ. N6) GO TO 5132
000083               N=N+1
000084               GO TO 5170
000085          5140 ZF(NF)=ZDIS(ND)
000086               RF(NF)=RDIS(ND)
000087               XF(NF)=XDIS(ND)
000088               NF=NF+1
000089               ND=ND+1
000090               IF(ND .GT. NDL) GO TO 5300
000091               IF(ZDIS(ND) .LT. ZDIS(ND-1)) GO TO 5132
000092               IF(ZDIS(ND-1) .NE. Z(N)) GO TO 5170
000093               GO TO 5171
000094          5130 IF(ZDIS(ND) .GE. Z(N)) GO TO 5131
000095               ZF(NF)=Z(N)
000096               RF(NF)=R(N)
000097               XF(NF)=X(N)
000098               NF=NF+1
000099          5132 IF(N .EQ. 1) GO TO 5171
000100               N=N-1
000101               GO TO 5130
000102          5131 ZF(NF)=ZDIS(ND)
000103               RF(NF)=RDIS(ND)
000104               XF(NF)=XDIS(ND)
000105               NF=NF+1
000106               ND=ND+1
000107               IF(ND .GT. NDL) GO TO 5300
000108               IF(ZDIS(ND) .GT. ZDIS(ND-1)) GO TO 5171
000109               IF(ZDIS(ND-1) .NE. Z(N)) GO TO 5130
000110               GO TO 5132
000111          C    *** BEGIN PRINT SEQUENCE
000112          5300 NF=NF-1
000113               WRITE (6, 9300) IITLE
000114               IF (NC) 5310, 5320, 5330
000115          5310 WRITE (6, 9310)
000116               GO TO 5340
```

```
000117          5320 WRITE (6, 9320)
000118               GO TO 5340
000119          5330 WRITE (6, 9330)
000120          5340 IF (EPS) 5400, 5400, 5350
000121          5350 IF (ZO) 5370, 5370, 5360
000122          5360 WRITE (6, 9360)
000123               GO TO 5430
000124          5370 IF (ZB) 5390, 5390, 5380
000125          5380 WRITE (6, 9380)
000126               GO TO 5430
000127          5390 WRITE (6, 9390)
000128               GO TO 5430
000129          5400 IF (ZB) 5410, 5410, 5420
000130          5410 WRITE (6, 9410)
000131               GO TO 5430
000132          5420 WRITE (6, 9420)
000133          5430 WRITE (6, 9430) RC, RSTAR, RB, RU, RD, ALPHA, BETA, ARAT,
000134              1     Z6, Z1, Z2, Z3
000135               WRITE (6, 9431) ZSTAR, Z5, DZ
000136               LINE = 0
000137               N = 0
000138          5440 N = N + 1
000139               IF (LINE) 5450, 5450, 5480
000140          5450 IF (N - 1) 5460, 5460, 5470
000141          5460 WRITE (6, 9460)
000142               GO TO 5480
000143          5470 WRITE (6, 9470)
000144          5480 D = 2. * R(N)
000145               ARAT = R(N) * R(N) / RSTAR / RSTAR
000146          5485 WRITE (6, 9485) Z(N), R(N), D, X(N), ARAT
000147               LINE = LINE + 1
000148               IF (LINE - 35) 5500, 5490, 5490
000149          5490 LINE = 0
000150          5500 IF (N - N6) 5440, 5510, 5510
000151          5510 N = 0
000152          5520 N = N + 1
000153               ARF(N) = RF(N) * RF(N) / RSTAR / RSTAR
000154               IF (ZF(N) - ZSTAR) 5530, 5540, 5540
000155          5530 ARF(N) = - ARF(N)
000156          5540 IF (N - NF) 5520, 5550, 5550
000157          5550 WRITE (6, 9550)
000158          5560 WRITE (6, 9560) (N, ZF(N), RF(N), XF(N), ARF(N), N = 1, NF)
000159               DATA(20)=Z5
000160               DATA(21)=ZSTAR
000161               DATA(22)=Z3
000162               RETURN
000163          9000 FORMAT (20A4)
000164          9010 FORMAT (7E10.0)
000165          9020 FORMAT (8I5)
000166          9300 FORMAT (1H1 //// 47X, '**** NOZZLE GEOMETRY ****'/// 30X, 20A4//)
000167          9310 FORMAT (5X, 'ALL POINTS INPUT')
000168          9320 FORMAT (5X, 'CONICAL NOZZLE')
000169          9330 FORMAT (5X, 'CONTOURED NOZZLE')
000170          9360 FORMAT (1H+, 24X, 'GEOMETRY COMPUTED FROM EPS AND ZO')
000171          9380 FORMAT (1H+, 24X, 'GEOMETRY COMPUTED FROM EPS AND ZB')
000172          9390 FORMAT (1H+, 24X, 'GEOMETRY COMPUTED FROM EPS AND ZSTAR')
000173          9410 FORMAT (1H+, 24X, 'GEOMETRY COMPUTED FROM ZO AND ZSTAR')
000174          9420 FORMAT (1H+, 24X, 'GEOMETRY COMPUTED FROM ZO AND ZB')
000175          9430 FORMAT (// 4X, 'CHAMBER RADIUS' F8.3, 6X, 'THROAT RADIUS' F8.4,
000176              1     7X, 'CONVERGENT RADIUS' F7.3, 4X, 'URAD' F7.3 // 4X, 'DRAD'
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000177              2     F7.3, 17X, 'DIVERGENCE ANGLE' F6.2, 6X, 'CONVERGENCE ANGLE'
000178              3     F6.2, 5X, 'EXIT A/AT' F6.1 // 4X, 'OVERALL LENGTH' F8.3,
000179              4     6X, 'BARREL LENGTH' F8.3, 7X, 'LENGTH TO CPT' F8.3,
000180              5     7X, 'LENGTH TO UPT' F8.3)
000181          9431 FORMAT (/4X, 'LENGTH TO THROAT', F8.3, 4X, 'LENGTH TO DPT' F8.3,
000182              1     7X, 'PRINT INCREMENT' F6.2)
000183          9460 FORMAT (1H  / 21X, 'AXIAL' 13X, 'RADIUS' 12X, 'DIAMETER' 12X,
000184              1     'SUM DEV' 14X, 'AREA' / 19X, 'DISTANCE' 51X, 'LENGTH' 13X,
000185              2     'RATIO' /)
000186          9470 FORMAT (1H1///21X, 'AXIAL' 13X, 'RADIUS' 12X, 'DIAMETER' 12X,
000187              1     'SUM DEV' 14X, 'AREA' / 19X, 'DISTANCE' 51X, 'LENGTH' 13X,
000188              2     'RATIO' /)
000189          9485 FORMAT (8X, 5(10X, F9.4))
000190          9550 FORMAT (1H1// ' STATIONS SEQUENCED ACCORDING TO COOLANT FLOW'///
000191              1     19X, 'STATION' 14X, 'AXIAL' 13X, 'RADIUS' 13X, 'SUM DEV' 14X,
000192              2     'AREA' / 38X, 'DISTANCE' 32X, 'LENGTH' 13X, 'RATIO' /)
000193          9560 FORMAT (20X, I4, 13X, F9.4, 10X, F9.4, 10X, F9.4, 10X, F9.4)
000194               END
```

```
@ ELT DATA,1,711218, 49768

000001                STANDARD TEST CASE            OCTOBER 1971   J J WILLIAMS
000002           $DATUM
000003                SUM = 3.0,
000004           ITRFL=50.0,FRIC=-1.,WGSTA=1.0,HLC=11.,ZU=24.566,ZD=30.05,RU=5.605,RD=2.802,
000005                TO = 4500.,                                                    *NEW
000006                HGC   =   1.000   ,WALL   =   0.0   ,MERCR   =   0.0   ,PC   =   445.0   ,
000007                TC    =   4295.   ,MR    =   0.0   ,WGSTAR   =   90.20   ,WGCORE =   90.20 ,
000008                PIN = 1344.0 ,TIN = 59.40 ,ASTAR = 98.696 ,ZSTAR = 28.528 ,
000009           TWL=800.,TWG=800.,COOL=4.,AASTAR=24.,
000010                ZETA = 1.0 ,CONTR = 1.0 ,NDL = 5.0 ,NTOT = 40.0 ,
000011                NC = 1.0 ,ZW = 0.0 ,K1 = 1.00 ,K3 = 1.00 ,
000012                K4 = 0.0 ,CC2 = 0.0 ,CC1 = 0.0 ,MW = 0.0 ,
000013                LW = .100 ,
000014                LHITE (1) = 40*0.,
000015                CGITE (1) = 40* 0.0 ,
000016                TUBE (1) = 40* 4.0 ,
000017                TNKM (1) = 40* 0.0 ,
000018                PPFM (1) = 40* 1.747,
000019                EEPGEO(1) = 40* .850 ,
000020                TASMTS(1)= 40* .010 ,
000021                LH (1)= 6*.102 , .0937, .0673, .0158, .0040,
000022                  18*.0000, 10*-.100, 2*.0000,
000023                TASMTM(1) = .022, .022, .022, .022, .022,
000024                   .022, .018, .018, .018, .017, .017,
000025                   .017, .016, .016, .015, .015, .014,
000026                   .014, .013, .013, .013, .013, .014,
000027                   .015, .016, .017, .018, .019, .020,
000028                   .021, .022, .023, .024, .025, .026,
000029                   .027, .028, .028, .028, .028,
000030                TAZ (1) = 00.000, 01.685, 03.370, 05.055, 06.740,
000031                   08.425, 09.875, 11.227, 12.388, 14.408, 15.859,
000032                   17.310, 18.761, 20.212, 21.663, 23.114, 24.565,
000033                   25.415, 26.385, 27.435, 28.528, 29.306, 30.023,
000034                   31.345, 32.758, 33.066, 35.878, 37.933, 40.488,
000035                   42.552, 44.528, 46.418, 50.040, 53.503, $6.846,
000036                   60.123, 63.353, 66.528, 69.678, 72.813,
000037                TAAF (1) = .0902, .0902, .0902, .0902, .0902,
000038                   .0902, .0931, .0990, .1142, .1293, .1344,
000039                   .1302, .1248, .1115, .0961, .0797, .0621,
000040                   .0416, .0303, .0306, .0472, .0590, .0628,
000041                   .0724, .0834, .0850, .1069, .1248, .1505,
000042                   .1672, .1821, .1969, .2215, .2453, .2669,
000043                   .2862, .3027, .3199, .2851, .2965,
000044                TABETA(1) = .2700, .6480, .9335, .9680, .9850,
000045                   .9940, .9980, 1.00 , 1.00 , 1.00 , 1.00 ,
000046                   1.00 , 1.00 , 1.00 , 1.00 , 1.00 , 1.00 ,
000047                   1.00 , .99 , .99 , .99 , .98 , .97 ,
000048                   .96 , .95 , .95 , .94 , .93 , .93 ,
000049                   .93, .92 ,.92 ,.92 ,.91 ,.91 ,.91 ,
000050                   .91 ,3*.91,
000051                TACO (1) = .6811, .1000, .0888, .0861, .0846,
000052                   .0847, .0830, .0756, .0644, .0527, .0460,
000053                   .0359, .0306, .0271, .0262, .0255, .0258,
000054                   .0310, .0344, .0306, .0235, .0206, .0173,
000055                   .0176, .0202, .0211, .0258, .0294, .0332,
000056                   .0372 ,.0400 ,.0419 ,.0447 ,.0475 ,.0495 ,.0496 ,
```

```
000057                .04970 ,.0498 ,.0499 ,.0500 ,
000058             TACL (1) = .01768, .01768, .01768, .01768, .01768,
000059                .01768, .01768, .01768, .01768, .01768, .01768,
000060                .01768, .01768, .01768, .01768, .01768, .02163,
000061                .02631, .02918, .02990, .02875, .02704, .01768,
000062                .01768, .01768, .01768, .01768, .01768, .01768,
000063                11*.01768 ,
000064             TAFEFV(1) = .500 , .445 , .445 , .388 , .342 ,
000065                .300 , .335 , .365 , .343 , .343 , .260 ,
000066                .201 , .180 , .180 , .180 , .173 , .090 ,
000067                .090 , .090 , .090 , .090 , .000 , .000 ,
000068                .000 , .000 , .000 , .000 , .000 , .000 ,
000069                11*0.000 ,
000070             TAZ1 (1) = 72.813, 09.875, 09.875, 08.425, 0.0 ,
000071             TANT (1) = 216. , 216. , 216. , 216. , 216. ,
000072             TANMB (1) =·216. , 216. , 216. , 216. , 216. ,
000073             TAWDOT(1) = 76.10, 76.10, 73.06, 73.06, 73.06,
000074             ZZZZZZ(1) = 00.000, 01.685, 03.370, 05.055, 06.740,
000075                06.425, 09.875, 11.227, 12.388, 14.408, 15.859,
000076                17.310, 18.761, 20.212, 21.663, 23.114, 24.565,
000077                25.415, 26.385, 27.435, 28.528, 29.306, 30.023,
000078                31.345, 32.758, 33.066, 35.878, 37.933, 40.488,
000079                42.552, 44.528, 46.418, 50.040, 53.503, 56.846,
000080                60.123, 63.353, 66.528, 69.678, 72.813,
000081             RRRRRR(1) = 21.065, 21.065, 21.065, 21.065, 21.065,
000082                21.065, 20.874, 20.314, 19.423, 17.403, 15.952,
000083                14.501, 13.050, 11.599, 10.148, 8.697 , 7.247,
000084                6.549, 6.032, 5.713, 5.605, 5.715, 6.037,
000085                6.842, 7.726, 7.927, 9.708, 11.210, 12.533,
000086                13.729, 14.829, 15.853, 17.725, 19.416, 20.972,
000087                22.420, 23.780, 25.066, 26.290, 27.459,
000088             AAAAAA(1) = -14.12, -14.12, -14.12, -14.12, -14.12,
000089                -14.12, -13.87, -13.14, -12.01, -09.64, -08.10,
000090                -6.69, -5.42, -4.28, -3.28, -2.41, -1.67,
000091                -1.37, -1.16, -1.04, 1.00, 1.04, 1.16,
000092                1.49, 1.9 , 2.00, 3.00, 4.00, 5.00,
000093                6.00, 7.00, 8.00, 10.00, 12.00, 14.00,
000094                16.00, 18.00, 20.00, 22.00, 24.00,
000095             SSSSSS(1) = 83.998, 82.313, 80.628, 78.943, 77.258,
000096                75.573, 74.106, 72.638, 71.171, 68.314, 66.262,
000097                64.210, 62.158, 60.106, 58.054, 56.002, 53.950,
000098                52.850, 51.749, 50.648, 49.548, 48.760, 47.972,
000099                46.422, 44.752, 44.392, 41.060, 38.220, 35.655,
000100                33.265, 31.004, 28.852, 24.772, 20.922, 17.237,
000101                13.652, 10.145, 06.725, 03.345, 00.000,
000102             TAAST (1) = - 20.0000,- 5.0000,- 1.6536,- 1.2853,- 1.1450,
000103                - 1.0750,- 1.0156,- 1.0044, 1.0000,
000104                1.3837, 2.0083, 3.0406, 3.9218, 5.4515,
000105                7.1216, 8.6260, 11.3326, 13.7738,
000106                18.1590, 22.1097, 25.7635, 34.0256, 41.4487,
000107                54.7178, 66.6046, 77.5459, 87.7815,
000108                97.4607, 106.6846, 197.4253,
000109             TPK (1) = 445.0000, 445.0000, 404.5455, 370.8333, 342.3077,
000110                317.8571, 278.1250, 222.5000, 242.0142,
000111                89.0000, 44.5000, 22.2500, 14.8333, 8.9000,
000112                5.9333, 4.4500, 2.9667, 2.2250,
000113                1.4833, 1.1125, 0.8900, 0.5933, 0.4450,
000114                0.2967, 0.2225, 0.1780, 0.1483,
000115                0.1271, 0.1112, 0.0445,
000116             TTINK (1) = 4295.0000, 4295.0000, 4206.4236, 4126.1622, 4052.8771,
```

```
000117                  3985.5206, 3865.4338, 3668.6896, 3741.6088,
000118                  2924.5479, 2439.5975, 2025.0369, 1813.5959, 1577.0691,
000119                  1411.3509, 1303.8852, 1165.9464, 1076.6554,
000120.                 961.6308, 887.0368, 832.8392, 741.8915, 682.8119,
000121                  606.5021, 556.9247, 520.8823, 492.9182,
000122                  470.2739, 451.3731, 338.1485,
000123          $END
```

@ ELT DELT,1,711119, 35439

```
000001                SUBROUTINE DELT (X, DX, N)
000002                IF (N) 20, 10, 20
000003          C     *** NUMBER OF SEGMENTS IN LENGTH X, IF NOT INPUT
000004             10 N = X / 3. + 1.
000005          C     *** LENGTH OF SEGMENTS APPROX. 3 INCHES IF NOT INPUT OTHERWISE
000006             20 DX = X / N
000007                RETURN
000008                END
```

```
@ ELT DINT4,1,711119, 35441

000001                SUBROUTINE DINT4(AXT,AYT,AZT,NXZT,NY,X,Y,Z)                61207001
000002                DIMENSION  AXT(5),AYT(5),AZT(5)
000003                DIMENSION TABY(5),TABZ(5)                                  DINT0030
000004                EXTERNAL INT4                                              61207002
000005                I=1                                                        DINT0050
000006              9 IF(AYT(I)-Y)3,1,1                                          DINT0060
000007              1 IF(I-2)4,4,2                                               DINT0070
000008              4 K=-1                                                       DINT0080
000009                GO TO 7                                                    DINT0090
000010              2 K=I-4                                                      DINT0100
000011                TABY(4)=AYT(I+1)                                           DINT0110
000012                L=I*NXZT+1                                                 DINT0120
000013                CALL INT4(AXT(L),AZT(L),X,TABZ(4))                         DINT0130
000014                GO TO 8                                                    DINT0140
000015              3 I=I+1                                                      DINT0150
000016              5 IF(I-NY)9,6,6                                              DINT0160
000017              6 K=I-4                                                      DINT0170
000018              7 TABY(4)=0.0                                                DINT0180
000019                TABZ(4)=0.0                                                DINT0190
000020              8 DO 10 M=1,3                                                DINT0200
000021                L=K+M+1                                                    DINT0210
000022                TABY(M)=AYT(L)                                             DINT0220
000023                L=(K+M)*NXZT+1                                             DINT0230
000024             10 CALL INT4(AXT(L),AZT(L),X,TABZ(M))                         DINT0240
000025             11 CALL INT4(TABY(1),TABZ(1),Y,Z)                             DINT0250
000026                RETURN                                                     DINT0260
000027                END                                                        DINT0270
```

```
@ ELT DIS,1,711119, 35442

000001                SUBROUTINE DIS
000002                COMMON /ZXR/ ZF(200),RF(200),XF(200),ARF(200),ZDIS(50)
000003               1,NF
000004                COMMON/INGRAM/ Z(200), R(200), X(200),           RDIS( 50),
000005               1     XDIS( 50), ZI(200), RI(200), SINA, SINB, COSA, COSB, TANA,
000006               2     TANB, ZO, ZB, ZSTAR, Z1, Z2, Z3, Z5, Z6, RC, R2, R3, RSTAR,
000007               3     R5, R6, X1, X2, X3, X4, X5, X6, EPS, DX01, DX12, DX23, DX34,
000008               4     DX45, DX56, A0, A1, A2, RB, RU, RD, ALPHA, BETA, XTEMP, DZ,
000009               5     ARAT
000010               6          ,    N1, N2, N3, N4, N5, N6, IPL, NDL, NC, NDFL, ND,
000011               7     NI, K
000012             300 IF (NDFL) 330, 330, 310
000013             310 ND = ND + 1
000014           C   *** SEARCH FOR DISCONTINUITIES AFT OF OPT
000015                 IF(ND-NDL) 320,320,330
000016             320 IF(ZDIS(ND)-Z5) 300,300,340
000017             330 XTEMP = XTEMP + DXF (ZI(NI-2), ZI(NI-1), A1, A2)
000018                 NI = NI + 1
000019                 K = 0
000020                 ND = 0
000021                 RETURN
000022           C   *** SEARCH FOR DISCONTINUITIES BETWEEN NI AND (NI-1).  FOR NI LESS
000023           C   *** THAN OR EQUAL TO 3, DO THIS BETWEEN NI AND (NI-2).
000024             340 IF (ZDIS(ND) - ZI(NI)) 350, 350, 300
000025             350 IF (ZDIS(ND) - ZI(NI-1)) 360, 360, 370
000026             360 IF (NI - 3) 370, 370, 300
000027             370 IF (K) 380, 380, 390
000028             380 CALL FIT (ZI, RI, A0, A1, A2, NI)
000029                 K = 1
000030             390 RDIS(ND) = A0 + A1 * ZDIS(ND) + A2 * ZDIS(ND) * ZDIS(ND)
000031                 XDIS(ND) = XTEMP + DXF (ZI(NI-2), ZDIS(ND), A1, A2)
000032                 NDFL = NDFL - 1
000033                 GO TO 300
000034                 END
```

```
@ ELT DUMP,1,711119, 35443

000001                  SUBROUTINE DUMP( I)                                     00553
000002                  COMMON / CON/  QQD(175)                                 00555
000003                  COMMON / S /  QQC(2720)                                 00556
000004                  IF( I .EQ. 1.OR. I .EQ. 3) WRITE(6,2) QQD               00560
000005                  IF( I .EQ. 2.OR. I .EQ. 3) WRITE(6,2) QQC               00561
000006                  RETURN                                                  00562
000007                2 FORMAT (' '10E12.5)
000008                  END                                                     00564
```

@ ELT DXF,1,711119, 35444

```
000001                FUNCTION DXF (Z1, Z2, A1, A2)
000002                IF (A2) 120, 110, 120
000003          C    *** SOLUTION FOR STRAIGHT LINE
000004            110 DXF=(Z2-Z1)* SQRT(1.0E0+A1*A1)
000005                RETURN
000006          C    *** SOLVE INTEGRAL FOR ARC LENGTH
000007            120 U1 = A1 + 2. * A2 * Z1
000008                U2 = A1 + 2. * A2 * Z2
000009                U10= SQRT(1.0E0+U1*U1)
000010                U20= SQRT(1.0E0+U2*U2)
000011                DXF=.25/A2*(U2*U20-U1*U10+ LOG((U2+U20)/                    00002615
000012               1  (U1 + U10) ) )
000013                RETURN
000014                END
```

```
@ ELT EBLKDA,1,711119, 35446

000001                BLOCK DATA
000002                COMMON/TEHEAT/AA(111),AB(111),AC(110),AD(110),AE(110),AF(111),
000003               1AG(111),AH(49),
000004               2       AI(111),AJ(111),AK(110),AL(110),AM(112),AN(109),AO(111)
000005               3  ,AP(49)
000006                DATAAA/3.804,3.796,3.794,3.794,3.793,3.793,3.793,4.033,3.959,3.945
000007               1,3.939,3.935,3.932,3.93,4.671,4.275,4.2,4.166,4.146,4.133,4.123,6.
000008               2515,5.052,4.775,4.652,4.579,4.529,4.492,11.,6.859,6.074,5.726,5.51
000009               38,5.376,5.272,20.08,10.5,8.662,7.85,7.366,7.036,6.792,35.36,16.84,
000010               413.19,11.56,10.59,9.927,9.437,3.793,3.792,3.792,3.932,3.925,3.921,
000011               54.133,4.092,4.075,4.53,4.379,4.318,5.38,4.951,4.777,7.044,6.043,5.
000012               6636,9.944,7.931,7.111,3.793,3.791,3.791,3.791,3.791,3.79,3.924,3.9
000013               718,3.916,3.915,3.914,3.913,4.091,4.059,4.047,4.041,4.038,4.036,4.3
000014               88,4.256,4.212,4.192,4.181,4.203,4.953,4.601,4.477,4.421,4.389,4.36
000015               96,6.046,5.226,4.936,4.807,4.731,4.775,7.938,6.284,5.7,5.441,5.287/
000016                DATAAB/5.181,3.79,3.789,3.789,3.789,4.036,4.03,4.027,4.026,4.
000017               1024,4.366,4.31,4.285,4.27,4.26,5.181,4.92,4.804,4.734,4.687,3.461,
000018               23.502,3.503,3.506,3.624,3.622,3.792,3.789,3.008,3.372,3.561,3.61,3
000019               3.207,3.391,3.51,3.564,3.347,3.447,3.518,3.559,3.41,3.466,3.51,3.53
000020               49,3.438,3.472,3.5,3.519,3.452,3.469,3.485,3.502,4.064,4.459,4.874,
000021               55.171,5.284,5.263,4.912,4.665,4.514,3.611,3.839,4.059,4.248,4.378,
000022               64.443,4.39,4.251,4.129,3.335,3.477,3.609,3.719,3.808,3.872,3.935,3
000023               7.879,3.816,3.2,3.314,3.419,3.507,3.584,3.638,3.711,3.722,3.696,3.1
000024               847,3.241,3.324,3.397,3.463,3.514,3.626,3.651,3.646,3.153,3.227,3.2
000025               994,3.355,3.409,3.455,3.568,3.609,3.619,3.19,3.244,3.297,3.351/
000026                DATAAC/3.389,3.416,3.527,3.581,3.61,1.338,1.268,1.221,1.204,2.056,
000027               11.914,1.839,1.759,3.078,2.842,2.716,2.638,4.314,3.949,3.78,3.675,5
000028               2.211,4.692,4.484,4.361,5.693,5.06,4.814,4.677,5.743,5.127,4.865,4.
000029               3718,5.475,5.005,4.748,4.598,5.098,4.806,4.581,4.435,1.556,1.528,1.
000030               4504,1.481,1.46,1.441,1.427,2.122,2.079,2.041,2.009,1.981,1.954,1.9
000031               531,2.94,2.856,2.787,2.731,2.683,2.64,2.603,4.066,3.882,3.751,3.649
000032               6,3.567,3.5,3.444,5.513,5.094,4.826,4.641,4.506,4.399,4.314,7.219,6
000033               7.288,5.799,5.492,5.279,5.12,4.998,7.785,7.073,6.501,6.111,5.836,5.
000034               8632,5.476,6.875,6.913,6.657,6.359,6.104,5.899,5.734,6.066,6.296,6.
000035               9317,6.212,6.06,5.906,5.767,5.492,5.713,5.826,5.84,5.792,5.711/
000036                DATAAD/5.62,5.056,5.243,5.37,5.432,5.442,5.419,5.375,4.709,4.847,4
000037               1.985,5.043,5.101,5.1,5.098,7.219,6.288,5.799,5.492,7.72,6.695,6.12
000038               29,5.762,7.856,6.991,6.399,6.002,7.649,7.117,6.583,6.173,7.256,7.08
000039               3,6.669,6.277,6.875,6.913,6.657,6.359,4.462,4.722,5.069,5.543,6.184
000040               4,6.95,7.651,7.938,7.785,4.502,4.698,4.936,5.225,5.569,5.936,6.324,
000041               56.657,6.875,4.429,4.582,4.759,4.959,5.181,5.422,5.651,5.875,6.066,
000042               64.292,4.416,4.552,4.699,4.857,5.021,5.187,5.347,5.492,4.133,4.234,
000043               74.343,4.458,4.577,4.699,4.821,4.942,5.056,3.972,4.062,4.153,4.244,
000044               84.334,4.428,4.522,4.615,4.709,25.28,30.1,35.7,40.35,44.48,48.57,24
000045               9.85,30.59,37.28,42.84,47.85,52.8,23.99,30.82,38.7,45.24,51.13/
000046                DATAAE/56.99,22.08,30.36,39.86,47.67,54.65,61.6,18.33,28.4,39.87,4
000047               19.14,57.36,65.51,11.9,24.47,38.41,49.36,58.97,68.46,3.281,18.04,35
000048               2.4,48.29,59.46,70.47,-30.9,10.86,30.25,44.76,57.36,69.8,11.34,12.5
000049               37,19.88,37.96,51.83,65.61,17.63,-45.34,9.839,20.76,40.97,57.25,24.
000050               439,15.73,2.166,11.61,21.83,43.07,10.41,-4.319,8.267,0.,10.68,24.21
000051               5,22.39,11.76,9.006,-4.132,13.7,18.04,36.35,24.05,14.97,5.05,-6.046
000052               6,16.89,50.01,36.78,34.35,19.82,11.46,3.68,63.8,49.89,45.9,41.01,26
000053               7.82,18.84,77.36,63.02,58.12,54.57,46.69,32.95,1033.,1154.,1245.,13
000054               818.,1370.,1415.,1453.,977.,1116.,1221.,1305.,1365.,1416.,1460.,901
000055               9.3,1064.,1185.,1292.,1350.,1409.,1459.,780.8,973.8,1117.,1231./
000056                DATAAF/1311.,1379.,1437.,501.2,823.8,995.3,1130.,1224.,1304.,1373.
```

```
000057      1,436.3,583.7,794.5,958.7,1071.,1166.,1246.,313.1,403.,512.3,700.6,
000058      2840.7,955.1,1052.,406.9,300.,363.2,347.6,495.2,647.8,767.5,329.3,6
000059      30.,-66.07,317.8,361.8,313.2,325.1,1116.,801.5,520.9,226.7,-17.9,-1
000060      402.,42.2,2076.,1727.,1430.,1159.,927.7,697.7,400.,3197.,2797.,2462
000061      5.,2163.,1910.,1666.,1421.,4378.,3943.,3580.,3255.,2983.,2725.,2471
000062      6.,5535.,5078.,4696.,4359.,4075.,3806.,3547.,1.57,1.561,1.802,1.792
000063      7,2.12,2.098,2.525,2.461,3.199,2.997,1.521,3.64,2.464,5.29,2.517,3.
000064      8306,2.701,3.704,3.045,3.636,3.571,3.923,4.,4.237,4.297,4.47,4.462,
000065      94.604,35.35,16.84,13.19,11.56,10.59,9.927,9.437,54.51,26.45,20.19/
000066       DATAAG/17.34,15.62,14.45,13.58,64.36,38.41,29.6,25.3,22.65,20.8,19
000067      1.42,56.3,49.65,39.92,34.48,30.93,28.4,26.45,9.939,7.931,7.111,15.6
000068      22,10.89,9.417,22.65,15.11,12.72,30.93,20.31,16.84,7.938,6.284,5.7,
000069      35.441,5.287,5.181,10.9,7.934,6.883,6.417,6.14,5.95,15.14,10.3,8.57
000070      48,7.813,7.357,7.045,17.42,13.26,10.7,9.559,8.879,8.413,5.181,4.92,
000071      54.804,4.734,4.687,7.045,6.271,5.928,5.724,5.584,9.786,8.248,7.565,
000072      67.157,6.881,0.,3.802,3.799,3.797,3.797,3.796,3.889,3.878,3.873,3.8
000073      77,3.868,4.018,3.987,3.973,3.964,3.959,4.229,4.153,4.119,4.098,4.08
000074      85,4.592,4.424,4.349,4.305,4.275,5.209,4.873,4.725,4.636,4.576,6.22
000075      92,5.602,5.328,5.164,5.052,7.805,6.733,6.258,5.974,5.781,10.17/
000076       DATAAH/8.416,7.639,7.175,6.859,13.55,10.82,9.606,8.883,8.39,18.16,
000077      114.11,12.31,11.23,10.49,24.19,18.45,15.87,14.33,13.27,31.65,23.94,
000078      220.42,18.29,16.83,40.2,30.53,25.96,23.16,21.23,48.9,37.93,32.38,28
000079      3.89,26.45,55.98,45.39,39.27,35.23,32.33,59.17,51.54,45.75,41.57,38
000080      4.41,57.07,54.84,50.67,47.03,44.03/
000081       DATAAI/2.819,2.811,2.809,2.809,2.808,2.808,2.808,3.04,2.971,2.958,
000082      12.952,2.948,2.946,2.944,3.64,3.271,3.202,3.171,3.152,3.14,3.13,5.3
000083      233,3.992,3.737,3.624,3.557,3.511,3.477,9.353,5.63,4.918,4.602,4.41
000084      34,4.285,4.19,17.17,8.839,7.219,6.497,6.065,5.77,5.552,29.48,14.23,
000085      411,12,9.713,8.87,8.292,7.863,2.808,2.807,2.807,2.946,2.939,2.936,3
000086      5.14,3.102,3.086,3.512,3.373,3.316,4.289,3.898,3.739,5.778,4.881,4.
000087      6514,8.308,6.541,5.817,2.807,2.807,2.806,2.806,2.806,2.806,2.939,2.
000088      7933,2.931,2.93,2.929,2.928,3.101,3.071,3.06,3.055,3.052,3.05,3.373
000089      8,3.259,3.219,3.201,3.19,3.209,3.899,3.579,3.466,3.415,3.385,3.365,
000090      94.883,4.145,3.883,3.767,3.698,3.736,6.549,5.085,4.565,4.335,4.197/
000091       DATAAJ/4.103,2.806,2.806,2.805,2.804,2.803,3.05,3.045,3.042,3.04,3
000092      1.038,3.365,3.314,3.291,3.277,3.267,4.103,3.869,3.765,3.702,3.66,2.
000093      2476,2.5,2.518,2.519,2.639,2.637,2.807,2.803,2.148,2.26,2.342,2.398
000094      3,2.277,2.351,2.409,2.449,2.388,2.436,2.473,2.499,2.437,2.469,2.493
000095      4,2.509,2.459,2.481,2.497,2.507,2.471,2.48,2.491,2.5,3.08,3.112,3.1
000096      543,3.16,3.172,3.184,3.236,3.278,3.316,2.626,2.643,2.661,2.679,2.69
000097      67,2.711,2.755,2.796,2.834,2.35,2.351,2.352,2.354,2.364,2.373,2.406
000098      7,2.439,2.473,2.214,2.224,2.233,2.241,2.252,2.261,2.298,2.334,2.365
000099      8,2.162,2.179,2.194,2.209,2.223,2.236,2.285,2.323,2.354,2.168,2.186
000100      9,2.202,2.219,2.234,2.248,2.299,2.338,2.369,2.204,2.22,2.237,2.253/
000101       DATAAK/2.267,2.279,2.327,2.365,2.398,1.117,1.087,1.064,1.054,1.525
000102      1,1.507,1.497,1.484,2.187,2.189,2.185,2.182,3.015,3.034,3.044,3.046
000103      2,3.495,3.53,3.555,3.572,3.642,3.687,3.721,3.749,3.548,3.596,3.635,
000104      33.668,3.328,3.376,3.417,3.454,3.086,3.138,3.181,3.219,1.186,1.184,
000105      41.181,1.178,1.173,1.169,1.162,1.464,1.46,1.459,1.457,1.453,1.451,1
000106      5.448,1.886,1.885,1.884,1.883,1.882,1.88,1.879,2.432,2.434,2.436,2.
000107      6438,2.44,2.441,2.442,2.994,2.995,2.999,3.004,3.007,3.012,3.015,3.3
000108      785,3.373,3.373,3.377,3.383,3.389,3.393,3.602,3.583,3.576,3.576,3.5
000109      881,3.586,3.592,3.63,3.63,3.628,3.628,3.63,3.635,3.641,3.542,3.549,
000110      93.553,3.558,3.561,3.567,3.572,3.389,3.397,3.403,3.41,3.416,3.422/
000111       DATAAL/3.428,3.216,3.224,3.231,3.238,3.244,3.251,3.258,3.046,3.054
000112      1,3.062,3.069,3.075,3.082,3.088,3.365,3.373,3.373,3.377,3.497,3.478
000113      2,3.474,3.479,3.577,3.556,3.55,3.551,3.62,3.606,3.599,3.599,3.636,3
000114      3.63,3.624,3.624,3.63,3.63,3.628,3.628,3.477,3.503,3.526,3.549,3.56
000115      49,3.596,3.613,3.613,3.602,3.515,3.536,3.554,3.572,3.589,3.603,3.61
000116      56,3.625,3.63,3.442,3.458,3.474,3.489,3.503,3.517,3.528,3.536,3.542
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000117      6,3.306,3.319,3.331,3.342,3.354,3.365,3.376,3.384,3.389,3.146,3.157
000118      7,3.166,3.176,3.185,3.193,3.203,3.211,3.216,2.987,2.995,3.002,3.01,
000119      83.017,3.024,3.032,3.039,3.046,1.135,1.136,1.137,1.137,1.137,1.135,
000120.     91.268,1.267,1.266,1.265,1.264,1.263,1.439,1.435,1.432,1.429,1.427/
000121       DATAAM/1.425,1.657,1.652,1.649,1.646,1.644,1.642,1.894,1.892,1.89,
000122      11.889,1.887,1.886,2.169,2.165,2.163,2.163,2.163,2.163,2.547,2.517,
000123      22.505,2.502,2.502,2.504,3.04,3.066,2.85,2.832,2.827,2.827,3.48,3.8
000124      337,3.247,3.122,3.101,3.094,1.736,4.136,3.544,3.389,3.33,3.309,1.88
000125      46,1.886,3.506,3.569,3.51,3.477,2.63,3.347,4.147,0.,3.612,3.588,2.6
000126      57,3.316,3.948,2.9,1.34,1.34,3.103,3.241,3.317,3.198,3.076,1.581,3.
000127      6297,3.359,3.449,3.433,3.379,3.33,3.431,3.472,3.517,3.557,3.536,3.5
000128      71,3.512,3.543,3.571,3.605,3.614,3.601,1.16,1.161,1.161,1.161,1.162
000129      8,1.162,1.162,1.271,1.27,1.269,1.269,1.268,1.268,1.268,1.405,1.404,
000130      91.403,1.402,1.401,1.4,1.399,1.571,1.57,1.569,1.568,1.567,1.566/
000131       DATAAN/1.565,1.749,1.748,1.747,1.747,1.746,1.745,1.745,1.944,1.94,
000132      11.939,1.938,1.937,1.937,1.936,2.176,2.171,2.174,2.172,2.169,2.168,
000133      22.166,.9145,.9145,2.462,2.461,2.463,2.454,2.448,1.919,2.053,2.211,
000134      32.773,2.786,2.799,2.812,2.155,2.218,2.301,2.416,2.589,2.957,3.263,
000135      42.627,2.654,2.688,2.733,2.797,2.897,3.072,3.041,3.055,3.071,3.088,
000136      53.107,3.129,3.155,3.33,3.34,3.349,3.358,3.368,3.378,3.388,3.491,3.
000137      6498,3.504,3.511,3.518,3.524,3.531,1.133,1.134,1.242,1.242,1.371,1.
000138      7368,1.528,1.526,1.705,1.703,1.907,1.899,1.481,1.704,1.536,1.732,1.
000139      8749,1.892,2.088,2.155,2.588,2.627,3.015,3.041,3.313,3.33,3.477,3.4
000140      991,29.48,14.23,11.12,9.713,8.87,8.292,7.863,43.57,21.93,16.86/
000141       DATAAO/14.51,13.08,12.09,11.36,50.01,30.8,24.09,20.74,18.64,17.16,
000142      116.05,44.25,38.6,31.57,27.54,24.88,22.96,21.47,8.308,6.541,5.817,1
000143      23.08,9.068,7.803,10.64,12.53,10.55,24.88,16.65,13.87,6.619,5.085,4
000144      3.565,4.335,4.197,4.103,10.09,6.517,5.6,5.191,4.947,4.78,12.59,8.51
000145      43,7.045,6.388,5.994,5.725,16.79,10.94,8.813,7.854,7.278,6.883,4.10
000146      53,3.869,3.765,3.702,3.66,5.725,5.053,4.754,4.577,4.453,8.046,6.746
000147      6,6.163,5.806,5.439,0.,2.817,2.813,2.812,2.811,2.811,2.902,2.891,2.
000148      7886,2.884,2.882,3.026,2.997,2.984,2.976,2.971,3.227,3.155,3.124,3.
000149      8105,3.092,3.566,3.41,3.341,3.3,3.271,4.137,3.827,3.69,3.608,3.552,
000150      95.064,4.496,4.245,4.094,3.992,6.498,5.524,5.091,4.833,4.657,8.607/
000151       DATAAP/7.034,6.334,5.915,5.629,11.56,9.155,8.079,7.435,6.994,15.51
000152      1,12.01,10.44,9.487,8.838,20.49,15.67,13.47,12.14,11.23,26.42,20.16
000153      2,17.24,15.46,14.23,32.93,25.35,21.67,19.4,17.81,39.24,30.92,26.61,
000154      323.87,21.93,44.14,36.29,31.69,28.62,26.38,46.17,40.52,36.26,33.16,
000155      430.79,44.46,42.63,39.56,36.9,34.7/
000156       END
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@ ELT EFFECT,1,711119, 35449

000001                SUBROUTINE EFFECT (PFM,EPGEOM)                                    00000100
000002                REAL MULT
000003                COMMON / VAR / TUBE(100)  , PPFM(100) , EEPGEO(100) ,TTATMR(20)  ,00000300
000004               1              TTAKMR(79) , MMAT(4)   , TTATWM(25) , TTASTR(25) , 00000400
000005               2              TMKM(100)                                          00000500
000006                COMMON / EF /  A,  DPI, B,  DTI, KOUNT, IGO, IFLAG                00000600
000007          C                                                                       00000800
000008                DATA INUT/0/
000009                IF ( KOUNT .NE. 1 ) GO TO 5
000010              5 IF (ABS(A) .GT. .5E0) GO TO 10
000011                IOK = 1                                                           00001100
000012                GO TO 100                                                         00001200
000013             10 IF (KOUNT .NE. 1) GO TO 20                                        00001300
000014                MULT = .10
000015                IF (A .LT. 0.E0) MULT = -MULT                                     00001500
000016                GO TO 50                                                          00001600
000017             20 IF (KOUNT .LT. 6) GO TO 30                                        00001700
000018                WRITE(6,1)                                                        00001800
000019              1 FORMAT ('0 PFM AND EPGEOM HAVE NOT CONVERGED IN 5 PASSES'/' ON TO 00001900
000020               *THE NEXT CASE...')                                              00002000
000021                IGO = 1                                                           00002100
000022                KOUNT = 1                                                         00002200
000023                RETURN                                                            00002300
000024             30 X = (PFMP*A - PFM*AP) / (A-AP)                                    00002400
000025                MULT = -(PFM-X)
000026             50 DO 60 I=1,100                                                    00002600
000027             60 PPFM(I) = MULT + PPFM(I)
000028                AP = A
000029                PFMP = PFM
000030            100 IF (ABS(B) .GT. .5E0) GO TO 110
000031                IF (IOK .NE. 1) GO TO 200                                         00003200
000032                INUT = INUT + 1
000033                IF (INUT .EQ. 1) RETURN
000034                WRITE (6,2)                                                       00003300
000035              2 FORMAT ('0CASE COMPLETED')                                        00003400
000036                IGO = 1                                                           00003500
000037                KOUNT = 1                                                         00003600
000038                RETURN                                                            00003700
000039            110 IF (KOUNT .NE. 1) GO TO 120                                       00003800
000040                MULT = .20                                                        00003900
000041                IF (B .LT. 0.E0) MULT = -MULT                                     00004000
000042                GO TO 150                                                         00004100
000043            120 X = (EPGEOP*B - EPGEOM*BP) / (B - BP)                           00004200
000044                MULT = -(EPGEOM-X)
000045            150 DO 160 I=1,100                                                  00004400
000046            160 EEPGEO(I) = MULT + EEPGEO(I)
000047                BP = B
000048                EPGEOP = EPGEOM
000049            200 KOUNT = KOUNT + 1                                               00004800
000050                RETURN                                                            00004900
000051                END                                                               00005000
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@ ELT EHTEMP,1,711119, 35455

000001                FUNCTION EHTEMP(PRES,ENTH,QUAL)
000002                DIMENSION LOC(16),JP(13),      DP(13),DH(13),BP(13),BH(16),MX(13)
000003               1,R(19),TL(19),TG(19),TF(19),SH(10),TS(10),T(429)
000004                DIMENSION AA(116),AB(111),AC(112),AD( 90)
000005                EQUIVALENCE( T,AA),( T( 117),AB),( T( 228),AC),( T( 340),AD)
000006                DATA  R/1.022,2.0,4.0,8.0,14.0,25.0,43.0,69.0,99.0,128.0,151.0,
000007               1165.0,176.0,182.0,185.0,186.5,187.25,187.46875,187.51012/
000008                DATA TG/60.35,65.19,70.69,76.60,81.50,86.38,89.99,91.24,89.18,83.9
000009               10,76.55,69.46,61.16,53.87,47.96,43.01,38.21,34.66,31.225/
000010                DATA TL/-132.80,-129.10,-124.16,-117.53,-110.29,-100.02,-86.44,-69
000011               1.5,-51.29,-33.56,-18.32,-7.62,2.73,10.26,15.84,20.35,24.71,28.00,
000012               231.225/
000013                DATA TF     /24.849,27.091,29.821,33.079,36.190,39.975,44.129,
000014               1 48.332,51.965,54.796,56.725,57.792,58.580,58.991,59.191,59.291,
000015               2 59.340,59.354,59.3568/
000016                DATA SH   /-132.81,-109.93,-87.52,-65.56,-44.,-22.76,-1.79,18.98,
000017               1 39.60,60.07/, TS/24.845,27.174,29.308,31.298,33.175,34.962,
000018               2 36.672,38.316,39.904,41.442/
000019                DATA LOC/7,100,118,150,1,178,218,9,283,331,340,358,376,400,406,
000020               1418/
000021                DATA JP/11,3,8,7,11,8,13,11,8,3,3,3,4/
000022                DATA MX/0,1,6,5,9,6,11,1,6,1,1,1,2/
000023                DATA BP/0.,0.,881.76,0.,587.84,881.76,0.,0.,73.48,0.,-40.0,-2.0,
000024               11500.0/
000025                DATA DP/3000.0,750.0,587.84,146.96,440.88,587.84,73.48,293.32,
000026               173.48,1500.0,120.0,6.0,1000.0/
000027                DATA BH/1800.0,425.0,170.61,170.61,-110.9,42.65,42.65,-134.4,
000028               1-53.32,10000.0,10000.0,10000.0,425.0,20000.,20000.,20000./
000029                DATA DH/3000.0,275.0,85.306,85.306,19.194,31.99,31.99,20.26,19.194
000030               1,5000.0,2000.0,2000.0,275.0/
000031                DATAAA/26.66,17.68,9.182,0.,0.,0.,535.,519.9,24.28,18.29,12.78,37.
000032               13,29.94,21.2,13.2,0.,0.,1400.,1379.,35.,30.59,25.05,44.51,39.95,33
000033               2.,24.7,17.11,0.,2236.,2216.,42.5,39.63,36.2,50.44,46.96,42.1,35.71
000034               3,28.27,20.9,3019.,3006.,47.55,46.44,44.12,55.34,52.91,49.26,44.56,
000035               438.58,31.47,24.53,0.,51.48,51.71,50.43,59.53,57.95,55.12,51.45,46.
000036               594,41.36,34.52,27.03,20.15,0.,0.,63.21,62.4,60.18,57.19,53.55,49.2
000037               63,44.02,37.55,30.68,24.21,0.,66.49,66.44,64.72,62.21,59.15,55.59,5
000038               71.45,46.57,40.64,34.08,27.91,69.47,70.17,68.89,66.76,64.11,61.05,5
000039               87.56,53.6,49.01,43.55,37.31,120.8,134.1,140.1,198.4,205.5,209.,285
000040               9.3,287.2,287.4,371.,369.9,368.1,453.9,451.2,448.2,535.,531.4/
000041                DATAAB/527.7,90.45,92.62,91.82,89.83,87.2,84.19,80.91,77.41,103.8,
000042               1107.5,107.8,106.5,104.4,101.8,98.94,95.86,118.9,123.2,124.3,123.6,
000043               2121.9,119.7,117.,114.1,136.1,140.5,142.,141.8,140.5,138.5,136.,133
000044               3.1,61.94,70.69,77.7,82.88,86.46,88.86,90.45,82.16,87.44,92.16,96.1
000045               46,99.36,101.9,103.8,101.2,105.2,108.8,111.9,114.7,117.,118.9,121.4
000046               5,124.6,127.5,130.1,132.4,134.4,136.1,70.27,68.89,65.93,62.11,57.56
000047               6,52.15,45.49,37.78,75.72,75.31,73.01,69.86,66.14,61.9,57.04,51.86,
000048               780.79,81.3,79.55,76.86,73.64,70.,65.99,61.53,85.65,87.03,85.78,83.
000049               846,80.57,77.31,73.75,69.9,90.45,92.62,91.82,89.83,87.2,84.19,80.91
000050               9,77.41,17.81,32.,56.7,61.51,64.78,66.76,68.04,68.89,69.47,69.85/
000051                DATAAC/70.1,70.23,70.27,30.31,45.53,56.18,62.62,66.86,69.7,71.63,7
000052               12.98,73.95,74.64,75.14,75.49,75.72,42.51,52.13,59.5,65.21,69.52,72
000053               2.7,75.05,76.79,78.09,79.07,79.81,80.37,80.79,53.,59.33,64.73,69.35
000054               3,73.18,76.27,78.73,80.67,82.19,83.39,84.33,85.07,85.65,61.94,66.52
000055               4,70.69,74.43,77.7,80.52,82.88,84.84,86.46,87.78,88.86,89.74,90.45,
000056               551.47,51.76,51.81,51.71,51.51,51.22,50.86,50.44,54.11,54.93,55.46,
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000057              655.71,55.78,55.72,55.56,55.33,56.63,56.91,58.2,58.92,59.32,59.52,5
000058              79.58,59.53,0.,57.95,60.03,61.44,62.27,62.77,63.07,63.21,0.,57.3,61
000059              8.01,63.34,64.72,65.59,66.14,66.49,0.,56.7,61.51,64.78,66.76,68.04,
000060              968.89,69.47,2818.,2809.,2800.,4038.,4046.,4040.,4984.,5120.,5140./
000061               DATAAD/2818.,2818.,2817.,3317.,3324.,3325.,3758.,3803.,3809.,4102.
000062              1,4238.,4259.,4349.,4612.,4659.,4530.,4922.,5002.,2816.,2817.,2818.
000063              2,3295.,3316.,3320.,3665.,3756.,3777.,3912.,4107.,4159.,4083.,4373.
000064              3,4458.,4212.,4578.,4693.,140.1,141.6,135.1,139.2,209.,209.9,208.2,
000065              4205.1,287.4,286.,283.1,279.4,368.1,364.9,360.9,356.4,448.2,443.9,4
000066              539.1,434.,527.7,522.5,517.2,511.7,4984.,5120.,5140.,5605.,5949.,60
000067              627.,4530.,4922.,5002.,4671.,5179.,5293.,4786.,5396.,5540.,4885.,55
000068              781.,5754.,4212.,4578.,4693.,4316.,4743.,4883.,4403.,4880.,5040.,44
000069              879.,4997.,5175./
000070               P=PRES
000071               IF(P.LT.1.0) P=1.0
000072               H=ENTH
000073               IF(H.GE.25000.) H=24999.99999
000074               Q=1.0
000075               IF(H.LT.42.65) GO TO 10
000076               IF(H.GE.170.61) GO TO 1
000077               N=6
000078               GO TO 2
000079             1 IF(H.GE.426.53) GO TO 3
000080               N=3
000081             2 IF(P.LT.881.76) N=N+1
000082               GO TO 15
000083             3 IF(H.GE.1800.0) GO TO 4
000084               N=2
000085               IF(P.GE.1500.0) N=13
000086               GO TO 20
000087             4 IF(H.GE.10800.0) GO TO 5
000088               N=1
000089               GO TO 20
000090             5 IF(P.LE.200.0) GO TO 6
000091               N=10
000092               N1=14
000093               GO TO 20
000094             6 IF(P.LE.11.0) GO TO 7
000095               N=11
000096               N1=15
000097               GO TO 20
000098             7 N=12
000099               N1=16
000100               GO TO 20
000101            10 IF(P.LT.587.84) GO TO 11
000102               N=5
000103               GO TO 15
000104            11 IF(H.GE.-53.36) GO TO 12
000105               N=8
000106               GO TO 15
000107            12 N=9
000108            15 IF(H.GT.91.39) GO TO 20
000109               PR=P/587.84
000110               I=PR
000111               IF(I.GT.8) I=8
000112               F=PR-I
000113               FP=1.0-F
000114               HS=FP*SH(I+1)+F*SH(I+2)
000115               TQ=FP*TS(I+1)+F*TS(I+2)
000116               IF(H.LT.HS) GO TO 17
```

```
000117                  IF(P.GT.187.51012) GO TO 20
000118                  IF(P.LT.1.021) GO TO 105
000119                  DO 104 I=2,19
000120                  IF(P-R(I))102,101,104
000121              101 HL=TL(I)
000122                  HG=TG(I)
000123                  TQ=TF(I)
000124                  GO TO 106
000125              102 D=R(I)-R(I-1)
000126                  PRR=R(I)-P
000127                  PPR=P-R(I-1)
000128                  HL=(TL(I)*PPR+TL(I-1)*PRR)/D
000129                  HG=(TG(I)*PPR+TG(I-1)*PRR)/D
000130                  TQ=(TF(I)*PPR+TF(I-1)*PRR)/D
000131                  GO TO 106
000132              104 CONTINUE
000133              105 HL=-132.8
000134                  HG=60.31
000135                  TQ=24.84
000136              106 IF(H.GT.HL) GO TO 16
000137                  Q=0.0
000138                  GO TO 20
000139               16 IF(H.GT.HG) GO TO 20
000140                  Q=(H-HL)/(HG-HL)
000141                  GO TO 30
000142               17 Q=(H-HS)/(0.0026806*P+25.021)
000143                  GO TO 30
000144               20 IF(H.LE.20000.)N1=N
000145                  FP=(P-BP(N))/DP(N)
000146                  IP=FP
000147                  IF(IP.GT.MX(N)) IP=MX(N)
000148                  F=FP-IP
000149                  FP=1.0-F
000150                  FH=(H-BH(N1))/DH(N)
000151                  IH=FH
000152                  FF=FH-IH
000153                  FH=1.0-FF
000154                  I=IH*JP(N)+IP+LOC(N1)
000155                  J=I+JP(N)
000156                  TQ=FP*FH*T(I)+F*FH*T(I+1)+FP*FF*T(J)+F*FF*T(J+1)
000157               30 QUAL=0
000158                  EHTEMP=TQ
000159                  RETURN
000160                  ENTRY  TE012A
000161                  RETURN
000162                  END
```

```
@ ELT ERROR,1,711119, 35450

000001                  SUBROUTINE ERROR
000002                  STOP
000003                  END
```

```
@ ELT ETCOND,1,711214, 29825

000001                FUNCTION ETCOND(PRES,TEMP)
000002          C                                                                C*NEW
000003          C*****************************************************************C*NEW
000004          C*                                                               *C*NEW
000005          C*      THIS PROGRAM HAS BEEN MODIFIED TO FORCE HIGH PRESSURE TRANSITION     *C*NEW
000006          C*      TO OCCUR AT TT2 = 3500.    IN THE PRODUCTION DECK TT2 = 3000.        *C*NEW
000007          C*           DECEMBER 1971 J J WILLIAMS                          *C*NEW
000008          C*                                                               *C*NEW
000009          C*****************************************************************C*NEW
000010          C                                                                C*NEW
000011                DIMENSION PS(19),TS(19),JP(19),MX(19),LOC(19),BP(19),DP(19),BT(19)
000012               1,DT(19),C(730)
000013                DIMENSION AA( 94),AB(102),AC(113),AD( 97),AE( 95),AF(110),AG(111)
000014               1 ,AH(  8)
000015                EQUIVALENCE( C,AA),( C(  95),AB),( C( 197),AC),( C( 310),AD)
000016               1    ,( C( 407),AE),( C( 502),AF),( C( 612),AG),( C( 723),AH)
000017                DATA TT2/3500./                                            *NEW
000018                DATAAA/.04565,.04628,.04642,.04702,.04764,.04823,.0488,.05238,.052
000019               196,.05333,.05392,.05448,.05502,.05554,.0554,.05631,.05716,.05797,.
000020               205873,.05946,.06016,.05698,.05811,.05917,.06016,.0611,.06199,.0628
000021               34,.05886,.06026,.06155,.06275,.06388,.06495,.06597,.05975,.06147,.
000022               406302,.06444,.06577,.06702,.06819,.05959,.06173,.06359,.06527,.066
000023               581,.06824,.06958,.05844,.06116,.06343,.06542,.0672,.06883,.07035,.
000024               60562,.05982,.06268,.06505,.06713,.06899,.07069,.05203,.0575,.06134
000025               7,.06425,.06669,.06882,.07074,.05495,.05435,.05902,.06276,.06566,.0
000026               86812,.07028,.05332,.05581,.05804,.06097,0.,.06016,.06281,.06516,.0
000027               96735,.06959,.06391,.06733,.07034,.07306,.07557,.06755,.07175/
000028                DATAAB/.07539,.07867,.08167,.06958,.07451,.07872,.08247,.08589,.07
000029               105,.07615,.08088,.08505,.08883,.07075,.07717,.0824,.08695,.09105,.
000030               207028,.0775,.0832,.08809,.09244,.06905,.07716,.08331,.08849,.09306
000031               3,.06716,.07088,0.,.07386,.08051,.08755,.08167,.08906,.09571,.08673
000032               4,.09533,.1028,.09001,.09956,.1078,.09223,.1025,.1114,.09306,.1039,
000033               5.1131,.09345,.1047,.1142,.09343,.1051,.1148,.09309,.1051,.115,.092
000034               641,.1047,.1147,.09147,.1039,.114,.09027,.1029,.113,.08889,.1016,.1
000035               7118,.08736,.1002,.1103,.00717,.0078,0.,0.,0.,.009233,.01023,.01
000036               8208,.01376,0.,0.,.01363,.01425,.01514,.0161,.0179,.0214,.01987,.02
000037               9032,.02086,.0215,.02229,.02333,.02637,.02676,.02719,.02767,.02819/
000038                DATAAC/.02877,.03212,.03247,.03284,.03323,.03364,.03408,.1604,.083
000039               11,.0007,0.,.2525,.154,.0602,-.12,.3682,.2566,.1448,.02011,.5029,.3
000040               2803,.2607,.1391,.6555,.5223,.3942,.268,.8239,.6804,.5439,.4114,1.0
000041               306,.8531,.7083,.5687,1.199,1.037,.8847,.7385,.2036,.1996,.1846,.15
000042               477,.1463,.129,.1231,.1,.07479,0.,.1091,.02269,0.,.1181,-9.E-5,.180
000043               55,.5482,.9326,1.317,1.704,2.09,.0225,.3633,.7182,1.082,1.459,1.839
000044               6,.009368,.2449,.5332,.8788,1.232,1.589,-.09658,.1137,.3767,.6886,1
000045               7.023,1.371,0.,0.,.2093,.4863,.8152,1.153,-.0016,.1424,0.,.2391,.59
000046               838,.9358,.086,.1947,.454,.461,0.,0.,.1801,.2459,.3842,.51,.6221,0.
000047               9,.2783,.3339,.4294,.563,.693,.824,.3848,.4405,.5207,.6309,.7636/
000048                DATAAD/.9079,.4997,.5553,.6299,.7288,.8536,.9969,.6219,.6783,.7511
000049               1,.8433,.958,1.094,.7508,.8084,.8807,.9696,1.078,1.207,.06345,.0648
000050               2,.06605,.0672,.06829,.06931,.07028,.06142,.06308,.06456,.06591,.06
000051               3715,.06831,.0694,.059,.0609,.06271,.06431,.06575,.06707,.0683,.057
000052               426,.05909,.06074,.06238,.06407,.06559,.06699,.05507,.05724,.05917,
000053               5.0609,.06246,.0639,.06548,.05217,.05503,.05732,.05931,.06108,.0626
000054               68,.06414,.04902,.05256,.05531,.05758,.05956,.06133,.06293,.04689,.
000055               705031,.05329,.05582,.05799,.05991,.06164,.04584,.04878,.05162,.054
000056               819,.05647,.0585,.06034,.06905,.07716,.08331,.08849,.09306,.06451,.
```

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000057          907532,.08251,.08838,.09343,.06046,.0724,.0805,.08698,.09241/
000058           DATAAE/.05677,.06965,.07764,.08456,.09027,.05479,.06618,.07469,.08
000059          115,.08736,.03212,.03576,.04274,.05294,.06034,.0343,.03781,.04321,.
000060          205109,.05833,.03616,.03939,.04405,.05024,.05672,.03773,.04073,.044
000061          378,.04994,.05557,.03901,.04183,.04544,.04989,.05479,.03902,.05246,
000062          4.06828,.07893,.08736,.09423,.1002,.1055,.1103,.04248,.052,.0634,.0
000063          57368,.08159,.08838,.0943,.09956,.1044,.04416,.05155,.06038,.06889,
000064          6.07633,.08278,.08846,.09354,.09819,.04606,.05256,.05992,.06724,.07
000065          7398,.08003,.08547,.09042,.09498,.0479,.05376,.06016,.06659,.07267,
000066          8.07829,.08345,.0882,.09261,.0479,.06017,.07267,.08345,.09261,.0595
000067          9,.06942,.07873,.08732,.09526,.07385,.08069,.08691,.09278,.09839/
000068           DATAAF/.08811,.09256,.0965,.1003,.104,.1014,.104,.1063,.1084,.1107
000069          1,.1014,.1071,.1661,.1576,.2217,.2042,.2777,.2777,.3361,.3354,.4107
000070          2,.3942,.4107,.4058,.4036,.4023,.4014,.4607,.4479,.4423,.4389,.4366
000071          3,.5407,.5113,.4982,.4905,.4851,.6737,.6121,.5848,.5685,.5574,.8929
000072          4,.7742,.7215,.69,.6685,1.242,1.029,.9339,.8773,.8385,1.772,1.414,1
000073          5.254,1.158,1.093,2.538,1.973,1.718,1.565,1.46,3.585,2.746,2.363,2.
000074          6131,1.972,4.93,3.763,3.219,2.886,2.656,6.529,5.025,4.298,3.847,3.5
000075          731,8.241,6.483,5.581,5.006,4.598,9.796,8.013,6.995,6.318,5.825,10.
000076          883,9.406,8.404,7.685,7.14,11.,10.37,9.586,8.934,8.402,10.22,10.65,
000077          910.31,9.864,9.439,.4036,.3992,.3976,.3969,.4423,.4309,.4268,.425/
000078           DATAAG/.4983,.472,.4627,.4585,.585,.5298,.5102,.5016,.7219,.6151,.
000079          15773,.5605,.9349,.7422,.6739,.6436,1.256,.9293,.8132,.7616,1.723,1
000080          2.198,1.011,.9272,2.373,1.571,1.283,1.155,3.239,2.073,1.65,1.46,4.3
000081          34,2.722,2.128,1.859,5.665,3.531,2.73,2.363,7.155,4.495,3.463,2.981
000082          4,8.689,5.591,4.324,3.717,10.05,6.75,5.285,4.554,10.99,7.886,6.309,
000083          55.473,.3982,.3965,.3957,.4894,.4749,.4681,.6979,.6255,.5913,1.219,
000084          6.97,.8517,2.345,1.696,1.386,4.337,3.001,2.349,7.089,4.935,3.832,.3
000085          7968,.395,.3946,.4772,.462,.4582,.6369,.5608,.5416,1.01,.7463,.6794
000086          8,1.805,1.107,.9283,3.249,1.75,1.36,5.437,2.761,2.041,.3948,.3943,.
000087          93942,.4596,.4554,.4543,.5486,.5276,.5219,.7038,.6307,.6111,.9936/
000088           DATAAH/.7976,.7451,1.504,1.071,.955,2.313,1.496,1.273/
000089           DATA JP/7,5,3,6,4,3,6,6,7,5,5,9,5,2,5,4,3,3,3/
000090           DATA MX/5,3,1,4,2,1,4,4,5,3,3,7,3,0,3,2,1,1,1/
000091           DATA LOC/1,78,123,168,204,236,251,281,329,392,417,442,487,512,524,
000092          1 604,668,689,710/
000093           DATA BP/52.,700.,2500.,0.,100.,142.5,187.5,187.5,400.,700.,0.,0.,
000094          1 0.,0.,1.,0.,0.,-100.,0./
000095           DATA DP/108.,450.,1250.,20.,30.,22.5,42.5,42.5,50.,450.,175.,625.,
000096          1 1250.,3000.,1.,10.,40.,300.,1500./
000097           DATA BT/26.,28.,30.,25.,52.,56.,56.,59.,56.,60.,80.,100.,180.,500.
000098          1 ,3000.,3000.,3000.,3000.,3000./
000099           DATA DT/3.,4.,5.,11.,4.,1.,3.,3.,3.,10.,5.,20.,80.,500.,200.,200.,
000100          1 500.,500.,500./
000101           DATA PS/1.022,2.0,4.0,8.0,14.0,25.0,43.0,69.0,99.0,128.0,151.0,
000102          1165.0,176.0,182.0,185.0,186.5,187.25,187.46875,187.506/
000103           DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,
000104          154.79,56.72,57.80,58.57,58.99,59.18,59.29,59.34,59.353,59.356/
000105           P=PRES
000106           IF(P.LT.1.0) P=1.0
000107           T=TEMP
000108           IF(T.GE.6000.)T=5999.9999
000109           DIV=1.0
000110           IF(T.GE.100.0) GO TO 15
000111           TZ=24.84+.00317*P
000112           IF(T.LT.TZ)T=TZ
000113           IF(P.GE.700.0) GO TO 4
000114           IF(T.GE.80.0) GO TO 3
000115           IF(P.LT.187.506) GO TO 7
000116           IF(T.LT.56.0) GO TO 12
```

```
000117                 IF(P.GT.400.0) GO TO 2
000118                 TM=(-0.0000523467*P+0.08698291)*P+44.802441
000119                 IF(T.GE.TM) GO TO 1
000120                 N=7
000121                 DIV=(P-187.506)*.083+TM-T
000122                 GO TO 33
000123               1 N=8
000124                 DIV=(P-187.506)*.083+T-TM
000125                 GO TO 33
000126               2 N=9
000127                 GO TO 33
000128               3 N=11
000129                 GO TO 33
000130               4 IF(P.GE.2500.0) GO TO 6
000131                 IF(T.GE.60.0) GO TO 5
000132                 N=2
000133                 GO TO 33
000134               5 N=10
000135                 GO TO 33
000136               6 N=3
000137                 GO TO 33
000138               7 DO 8 I=2,19
000139                 IF(P-PS(I)) 10,9,8
000140               8 CONTINUE
000141               9 TM=TS(I)
000142                 GO TO 11
000143              10 TM=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))
000144              11 IF(T.GE.TM) GO TO 13
000145                 IF(T.LT.56.0) GO TO 12
000146                 N=6
000147                 DIV=(187.506-P)*.083+TM-T
000148                 GO TO 33
000149              12 N=1
000150                 GO TO 33
000151              13 IF(P.GE.100.0) GO TO 14
000152                 N=4
000153                 GO TO 33
000154              14 N=5
000155                 DIV=(187.506-P)*.083+T-TM
000156                 GO TO 33
000157              15 IF(T.GE.TT2) GO TO 18                                    *NEW
000158                 IF(T.GE.500.0) GO TO 17                                  **-1
000159                 IF(T.GE.180.0) GO TO 16
000160                 N=12
000161                 GO TO 33
000162              16 N=13
000163                 GO TO 33
000164              17 N=14
000165                 GO TO 33
000166              18 IF(P.GE.30.0) GO TO 20
000167                 IF(P.GE.5.0) GO TO 19
000168                 N=15
000169                 GO TO 33
000170              19 N=16
000171                 GO TO 33
000172              20 IF(P.GE.500.0) GO TO 22
000173                 IF(P.GE.100.0) GO TO 21
000174                 N=17
000175                 GO TO 33
000176              21 N=18
```

```
000177                GO TO 33
000178             22 N=19
000179             33 FP=(P-BP(N))/DP(N)
000180                IP=FP
000181                IF(IP.GT.MX(N)) IP=MX(N)
000182                F=FP-IP
000183                FP=1.0-F
000184                FT=(T-BT(N))/DT(N)
000185                IT=FT
000186                FF=FT-IT
000187                FT=1.0-FF
000188                I=IT*JP(N)+IP+LOC(N)
000189                J=I+JP(N)
000190                ETCOND=(FP*FT*C(I)+F*FT*C(I+1)+FP*FF*C(J)+F*FF*C(J+1))/DIV
000191             34 ETCOND = ETCOND / 43200.0
000192                RETURN
000193                END
```

```
@ ELT ETCP,1,711119, 35456
000001              FUNCTION ETCP(PRES,TEMP)
000002              ETCP=ETHEAT(PRES,TEMP,1)
000003              RETURN
000004              END
```

```
@ ELT ETDENS,1,711119, 35459

000001                FUNCTION ETDENS(PRES,TEMP)
000002                DIMENSION PS(20),TS(20),JP(28),MX(28),LOC(30),BP(28),DP(28),BT(30)
000003               1,DT(28),R(886)
000004                DIMENSION AA(109),AB( 97),AC(108),AD(106),AE(106),AF(108),AG(101)
000005               1 ,AH(111),AI( 40)
000006                EQUIVALENCE( R,AA),( R( 110),AB),( R( 207),AC),( R( 315),AD)
000007               1     ,( R( 421),AE),( R( 527),AF),( R( 635),AG),( R( 736),AH)
000008               2     ,( R( 847),AI)
000009                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,165.,176.,
000010               1182.,185.,186.5,187.25,187.46875,187.506,187.6385/
000011                DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,54.
000012               179,56.72,57.80,58.57,58.99,59.18,59.29,59.34,59.353,59.356,59.4/
000013                DATA LOC/1,23,78,105,141,155,183,201,225,240,267,321,341,377,401,
000014               1 425,437,453,469,494,534,546,586,682,722,752,800,848,866,878/
000015                DATA JP/2,5,3,4,2,4,3,4,3,3,3,4,4,4,3,3,4,4,5,8,4,5,12,5,3,6,6,6/
000016                DATA MX/0,3,1,2,0,2,1,2,1,1,1,2,2,2,1,1,2,2,3,6,2,3,10,3,1,4,4,4/
000017                DATA BP/0.,200.,-100., 0.,0.,0.,-4.,0.,2645.28,1469.6,881.76,0.,0.
000018               1,-44.088,587.84,293.92,73.48,-14.696,293.92,36.74,-7.348,293.92,
000019               2180.,0.,0.,29.392,102.872,29.392/
000020                DATA DP/800.,1200.0,200.0,1000.0,100.0,1000.0,7.0,1000.0,1175.68,
000021               1 587.84,293.92,293.92,293.92,58.784,146.96,146.96,73.48,29.392,
000022               2 73.48,36.74,14.696,73.48,10.0,7.348,1.4696,14.696,14.696,29.392/
000023                DATA BT/180.0,180.0,500.0,500.0,1300.0,1300.0,2500.0,2500.0,36.0,
000024               1 36.0,27.0,27.0,108.0,108.0,57.6,86.4,86.4,86.4,72.0,72.0,72.0,
000025               2 59.4,59.4,30.0,23.4,39.6,52.2,64.8,5000.0,5000.0/
000026                DATA DT/30.0,30.0,100.0,100.0,200.0,200.0,500.0,500.0,36.0,18.0,
000027               1 9.0,9.0,9.0,14.4,7.2,7.2,7.2,7.2,3.6,3.6,7.2,1.8,1.8,6.0,5.4,3.6,
000028               2 1.8,3.6/
000029                DATAAA/0.,.8376,0.,.7052,0.,.6114,0.,.5412,0.,.4862,0.,.4419,0.,.4
000030               1053,0.,.3746,0.,.3483,0.,.3255,0.,.3056,.2652,1.41,2.315,2.924,3.3
000031               296,.2314,1.179,1.979,2.584,3.052,.1998,1.023,1.739,2.309,2.765,.17
000032               366,.9958,1.554,2.087,2.526,.1577,.8147,1.407,1.905,2.325,.1424,.74
000033               414,1.286,1.754,2.154,.1297,.6809,1.186,1.626,2.008,.1192,.63,1.102
000034               5,1.516,1.881,.1101,.5865,1.029,1.421,1.769,.1021,.5489,.9656,1.338
000035               6,1.671,.0953,.5159,.91,1.264,1.584,-.03747,.03747,.1114,-.03125,.0
000036               73125,.09302,-.02679,.02679,.07985,-.02345,.02345,.06995,-.02085,.0
000037               82085,.06224,-.01877,.01877,.05606,-.01706,.01706,.05099,-.01565,.0
000038               91565,.04677,-.01445,.01445,.04282,.00464,.3605,.6912,.9949,.00341/
000039                DATAAB/.3021,.5825,.8432,.0026,.2601,.5038,.7325,.002,.2285,.4441,
000040               1.6479,.00161,.2037,.3972,.581,.00131,.1838,.3592,.5267,.0011,.1674
000041               2,.3279,.4818,.0009,.1538,.3017,.4439,.00027,.1422,.2793,.4116,0.,.
000042               301445,0.,.01252,0.,.01105,0.,.009892,0.,.008951,0.,.008174,0.,.007
000043               4521,.000267,.1422,.2793,.4116,.000189,.1235,.2432,.3592,.000144,.1
000044               5092,.2154,.3187,.00012,.09785,.1933,.2864,9.8E-5,.08864,.1753,.260
000045               61,8.1E-5,.08101,.1604,.2382,6.9E-5,.07459,.1478,.2196,-.0003009,.0
000046               7002256,.0007521,-.000251,.0001882,.0006272,-.000215,.0001611,.0005
000047               8373,-.0001878,.0001402,.0004686,-.0001656,.0001221,.0004119,-.0001
000048               9452,.0001042,.0003599,6.9E-6,.07459,.1478,.2196,4.6E-6,.06226/
000049                DATAAC/.1236,.1839,3.1E-6,.05342,.1061,.1582,9.E-7,.04677,.09301,.
000050               11387,-3.6E-6,.04155,.08272,.1235,-1.32E-5,.0373,.07436,.1111,5.27,
000051               25.489,5.68,4.501,4.845,5.107,3.616,4.126,4.483,2.857,3.466,3.895,2
000052               3.319,2.935,3.395,4.994,5.143,5.27,4.533,4.743,4.886,3.958,4.27,4.5
000053               401,3.307,3.752,4.059,2.698,3.243,3.616,2.226,2.796,3.236,1.886,2.4
000054               535,2.857,1.639,2.15,2.588,1.453,1.924,2.319,5.033,5.112,5.183,4.81
000055               66,4.91,4.994,4.558,4.676,4.764,4.248,4.405,4.533,3.88,4.094,4.246,
000056               73.442,3.743,3.958,2.953,3.361,3.633,2.481,2.975,3.307,2.093,2.616,
```

```
000057          83.002,1.804,2.309,2.698,1.508,2.059,2.462,1.423,1.856,2.226,1.293,
000058          91.691,2.056,1.187,1.555,1.886,1.1,1.441,1.754,1.026,1.344,1.639/
000059           DATAAD/.9627,1.262,1.546,.9076,1.189,1.453,4.742,4.853,4.946,5.031
000060          1,4.43,4.584,4.709,4.816,4.024,4.279,4.417,4.558,3.165,3.778,4.05,4
000061          2.248,1.43,2.988,3.595,3.68,-.0233,.5581,1.189,1.804,-.015,.503,1.0
000062          35,1.588,-.0099,.4591,.945,1.423,-.0065,.4231,.8618,1.293,-.0042,.3
000063          4928,.7943,1.187,-.0025,.3669,.7379,1.1,-.0015,.3445,.6898,1.026,-.
000064          50007,.3249,.6483,.9627,-.0001,.3075,.612,.9076,-.07704,.02568,.130
000065          67,.2384,-.06786,.02262,.1144,.2079,-.06066,.02022,.1018,.1844,-.05
000066          7484,.01828,.09179,.1659,-.05004,.01668,.0836,.1508,-.04602,.01534,
000067          8.07677,.1383,3.887,3.986,4.105,3.447,3.646,3.792,2.91,3.226,3.442,
000068          92.323,2.76,3.051,1.857,2.317,2.67,1.549,1.963,2.326,1.34,1.701/
000069           DATAAE/2.035,1.189,1.497,1.804,.7859,1.309,1.857,.6864,1.106,1.549
000070          1,.6141,.9689,1.34,.5581,.8735,1.189,.1675,.3524,.5577,.7859,.153,.
000071          23178,.4955,.6864,.1409,.2902,.4479,.6141,.1307,.2674,.4127,.5581,-
000072          3.03228,.03224,.09858,.1675,-.02974,.02971,.09043,.153,-.02756,.027
000073          454,.08359,.1409,-.02568,.02568,.07819,.1307,1.226,1.807,2.329,2.67
000074          54,2.91,1.052,1.481,1.941,2.326,2.616,.9378,1.279,1.656,2.019,2.323
000075          6,.8526,1.141,1.456,1.774,2.089,.7859,1.047,1.309,1.583,1.857,.0997
000076          75,.2084,.3279,.461,.6115,.7847,.9864,1.226,.09478,.1962,.3063,.426
000077          84,.5585,.7052,.8693,1.052,.08981,.1855,.2878,.3977,.5164,.6451,.78
000078          951,.9388,.0859,.176,.2717,.3734,.4817,.5972,.7207,.8526,.08199/
000079           DATAAF/.1675,.2599,.3524,.455,.5577,.6718,.7859,-.01936,.01932,.05
000080          1888,.09975,-.01756,.01753,.05323,.08981,-.01615,.01611,.04882,.081
000081          299,3.304,3.422,3.541,3.659,3.777,3.044,3.29,3.45,3.572,3.667,2.74,
000082          33.102,3.304,3.449,3.557,2.322,2.88,3.141,3.315,3.447,1.861,2.621,2
000083          4.959,3.17,3.313,1.551,2.329,2.76,3.014,3.179,1.358,2.045,2.546,2.8
000084          548,3.044,1.226,1.807,2.329,2.674,2.91,.6295,2.42,2.726,2.849,2.937
000085          6,3.005,3.061,3.11,3.153,3.191,3.227,3.259,.9338,1.076,1.265,1.599,
000086          72.202,2.506,2.659,2.768,2.85,2.918,2.976,3.026,.8297,.9234,1.03,1.
000087          8159,1.322,1.542,1.835,2.136,2.356,2.509,2.618,2.709,.759,.8323,.91
000088          921,1.001,1.103,1.22,1.359,1.523,1.713,1.916,2.106,2.267,.7053/
000089           DATAAG/.767,.8326,.9039,.9807,1.066,1.16,1.265,1.383,1.513,1.655,1
000090          1.803,.6621,.7161,.7728,.8331,.8976,.9656,1.04,1.12,1.206,1.299,1.4
000091          2,1.507,.6259,.6745,.725,.778,.8337,.8927,.9537,1.019,1.089,1.163,1
000092          3.242,1.325,.5941,.6412,.6883,.7355,.7826,.8372,.8921,.9469,1.005,1
000093          4.07,1.135,1.2,-.000743,.04849,.09854,0.,0.,-.000787,.04023,.08466,
000094          5.1315,.1915,-.000437,.03393,.07032,.1097,.1534,-.000257,.02941,.06
000095          6027,.09278,.1275,-.000177,.02599,.05289,.0808,.1098,-.000122,.0233
000096          7,.0472,.07177,.09714,-8.3E-5,.02112,.04266,.06465,.08719,-6.5E-5,.
000097          801932,.0381,.05888,.07931,0.,.01172,.02363,-.000111,.009736,.0198,
000098          9-5.9E-5,.008154,.01648,-3.6E-5,.007021,.01414,-2.4E-5,.006166/
000099           DATAAH/.0124,-1.5E-5,.005498,.01104,-1.1E-5,.004962,.009954,-9.E-6
000100          1,.004521,.009063,-7.E-6,.004153,.008321,-2.2E-5,.003846,.007715,.1
000101          2664,.248,0.,0.,0.,0.,.1469,.2418,.3397,0.,0.,0.,.1315,.2117,.3091,
000102          3.4233,.5318,0.,.1195,.1891,.2684,.3626,.4811,.6115,.1098,.1717,.24
000103          4,.3166,.4051,.5124,.1017,.1578,.2183,.2841,.3568,.4387,.09486,.146
000104          53,.2009,.2592,.322,.3903,.08892,.1377,.1865,.2407,.295,.3565,.5712
000105          6,.727,.9725,0.,0.,0.,.5124,.6559,.8514,1.116,0.,0.,.4755,.5827,.73
000106          729,.9604,1.252,1.718,.4387,.5333,.6477,.7994,1.068,1.534,.4145,.49
000107          856,.5914,.706,.8535,1.082,.3903,.4653,.5491,.6447,.7575,.8985,.373
000108          94,.4399,.5151,.5986,.6928,.802,.3565,.4181,.4898,.5616,.6487/
000109           DATAAI/.7358,.08892,.1865,.295,.4181,.5616,.7358,.08373,.1743,.273
000110          11,.3822,.5044,.6439,.07931,.1649,.2562,.3545,.461,.5814,-1.32E-5,.
000111          20373,.07436,.111,-2.97E-5,.0337,.06734,.1007,-5.14E-5,.03051,.0612
000112          32,.09175,-.0001453,.0001042,.0003599,-.000124,8.541E-5,.0003076,-9
000113          4.95E-5,6.714E-5,.0002542/
000114           P=PRES
000115           IF(P.LT.1.0) P=1.0
000116           T=TLNP
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000117                  IF(T.LT.180.0) GO TO 8
000118                  IF(T.GE.1300.0) GO TO 4
000119                  IF(T.GE.480.0) GO TO 2
000120                  IF(P.GE.800.) GO TO 1
000121                  N=1
000122                  GO TO 33
000123                1 N=2
000124                  GO TO 33
000125                2 IF(P.GE.300.0) GO TO 3
000126                  N=3
000127                  GO TO 33
000128                3 N=4
000129                  GO TO 33
000130                4 IF(T.GE.2500.0) GO TO 6
000131                  IF(P.GE.100.0) GO TO 5
000132                  N=5
000133                  GO TO 33
000134                5 N=6
000135                  GO TO 33
000136                6 IF(T.GE.6000.0)T=5999.99999
000137                  IF(P.GE.10.0) GO TO 7
000138                  N=7
000139                  N1=30
000140                  GO TO 33
000141                7 N=8
000142                  N1=29
000143                  GO TO 33
000144                8 TZ=24.84+0.00317*P
000145                  IF(T.LT.TZ) T=TZ
000146                  IF(P.LT.881.76) GO TO 11
000147                  IF(P.LT.2645.28) GO TO 9
000148                  N=9
000149                  GO TO 33
000150                9 IF(P.LT.1469.6) GO TO 10
000151                  N=10
000152                  GO TO 33
000153               10 N=11
000154                  GO TO 33
000155               11 IF(T.GE.59.4) GO TO 14
000156                  N=12
000157                  IF(P.GE.187.6385) GO TO 33
000158                  DO 12 I=2,20
000159                  IF(P-PS(I))13,13,12
000160               12 CONTINUE
000161                  I=20
000162               13 TM=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))
000163                  IF(T.GE.TM) GO TO 24
000164                  GO TO 33
000165               14 IF(T.LT.108.0) GO TO 16
000166                  IF(P.LT.132.264) GO TO 15
000167                  N=13
000168                  GO TO 33
000169               15 N=14
000170                  GO TO 33
000171               16 IF(P.LT.587.84) GO TO 17
000172                  N=15
000173                  GO TO 33
000174               17 IF(T.LT.72.0) GO TO 23
000175                  IF(T.LT.86.4) GO TO 20
000176                  IF(P.LT.293.92) GO TO 18
```

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000177                N=16
000178                GO TO 33
000179             18 IF(P.LT.73.48) GO TO 19
000180                N=17
000181                GO TO 33
000182             19 N=18
000183                GO TO 33
000184             20 IF(P.LT.293.92) GO TO 21
000185                N=19
000186                GO TO 33
000187             21 IF(P.LT.36.74) GO TO 22
000188                N=20
000189                GO TO 33
000190             22 N=21
000191                GO TO 33
000192             23 IF(P.LT.293.92) GO TO 24
000193                N=22
000194                GO TO 33
000195             24 IF(P.LT.180.0) GO TO 25
000196                N=23
000197                GO TO 33
000198             25 IF(P.GE.29.0) GO TO 27
000199                IF(P.LT.2.9392) GO TO 26
000200                N=24
000201                GO TO 33
000202             26 N=25
000203                GO TO 33
000204             27 IF(T.GE.64.8) GO TO 29
000205                IF(P.GE.102.0) GO TO 28
000206                N=26
000207                GO TO 33
000208             28 N=27
000209                GO TO 33
000210             29 N=28
000211             33 IF(T.LE.5000.0)N1=N
000212                FP=(P-BP(N))/DP(N)
000213                IP=FP
000214                IF(IP.GT.MX(N)) IP=MX(N)
000215                F=FP-IP
000216                FP=1.0-F
000217                FT=(T-BT(N1))/DT(N)
000218                IT=FT
000219                FF=FT-IT
000220                FT=1.0-FF
000221                I=IT*JP(N)+IP+LOC(N1)
000222                J=I+JP(N)
000223                ETDENS=FP*FT*R(I)+F*FT*R(I+1)+FP*FF*R(J)+F*FF*R(J+1)
000224             34 ETDENS = ETDENS / 1728.0
000225                RETURN
000226                END
```

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@ ELT ETENTH,1,711119, 35462

000001                FUNCTION ETENTH(PRES,TEMP)
000002                DIMENSION LOC(29),JP(24),MX(24),BP(24),DP(24),BT(29),DT(24),PS(20)
000003               1,TS(20),TL(10),HS(10),H(1183)
000004                DIMENSION AA( 93),AB(100),AC(109),AD(101),AE(101),AF(110),AG(103)
000005               1 ,AH(110),AI(107),AJ(110),AK(102),AL( 37)
000006                EQUIVALENCE( H,AA),( H(  94),AB),( H( 194),AC),( H( 303),AD)
000007               1     ,( H( 404),AE),( H( 505),AF),( H( 615),AG),( H( 718),AH)
000008               2     ,( H( 828),AI),( H( 935),AJ),( H(1045),AK),( H(1147),AL)
000009                DATA LOC/1,16,31,46,90,145,157,177,195,231,261,279,306,378,441,468
000010               1,558,612,642,682,847,892,1028,1073,1103,1112,1121,1130,1160/
000011                DATA JP/3,3,3,4,5,2,5,3,6,5,3,3,6,9,9,9,9,5,5,11,9,17,5,5/
000012                DATA MX/1,1,1,2,3,0,3,1,4,3,1,1,4,7,7,7,7,3,3,9,7,15,3,3/
000013                DATA BP/0.,-100.,0.,0.,.999999,0.,300.,2645.28,1175.68,587.84,0.,
000014               12645.28,1175.68,0.,587.84,587.84,293.92,0.,440.88,293.92,176.352,
000015               2176.352,0.,117.569/
000016                DATA DP/1500.,300.,40.,10.,1.,5000.,1100.,1175.68,293.92,146.96,
000017               1293.92,1175.68,293.92,146.96,73.48,73.48,36.74,73.48,36.74,14.696,
000018               214.696,7.348,44.088,14.696/
000019                DATA BT/3000.,3000.,3000.,3000.,3000.,500.,170.,90.,90.,90.,90.,
000020               132.4,30.6,27.,75.6,59.4,72.,72.,59.4,59.4,64.8,59.4,28.8,54.,5000.
000021               2,5000.,5000.,5000.,5000./
000022                DATA DT/500.,500.,500.,200.,200.,500.,110.,18.,18.,18.,18.,7.2,5.4
000023               1,5.4,7.2,1.8,3.6,3.6,1.8,.9,1.8,.9,5.4,1.8/
000024                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,165.,176.,182
000025               1.,185.,186.5,187.25,187.46875,187.506,187.6385/
000026                DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,54.
000027               179,56.72,57.80,58.57,58.99,59.18,59.29,59.34,59.353,59.356,59.4/
000028                DATA TL/24.846,27.175,29.310,31.299,33.176,34.962,36.672,38.317,
000029               139.904,41.456/
000030                DATA HS/-157.82,-136.56,-115.76,-95.46,-75.59,-56.08,-36.93,-17.99
000031               1,0.69,19.30/
000032                DATAAA/10720.,10750.,10780.,12690.,12720.,12750.,14780.,14780.,148
000033               110.,17060.,16960.,16960.,19700.,19330.,19260.,10720.,10720.,10730.
000034               2,12710.,12700.,12700.,14920.,14810.,14780.,17620.,17140.,17030.,21
000035               3390.,19940.,19580.,10720.,10720.,10720.,12730.,12710.,12700.,15020
000036               4.,14910.,14850.,18000.,17550.,17330.,22560.,21170.,20520.,10720.,1
000037               50720.,10720.,10720.,11520.,11500.,11500.,11520.,12360.,12320.,1231
000038               60.,12320.,13260.,13180.,13150.,13160.,14250.,14090.,14040.,14050.,
000039               715400.,15090.,14980.,14940.,16780.,16220.,16030.,16030.,18500.,175
000040               840.,17200.,17120.,20680.,19110.,18560.,18430.,23480.,21030.,20170.
000041               9,19980.,27100.,23410.,22100.,21520.,10720.,10720.,10720.,10720./
000042                DATAAB/10720.,11540.,11520.,11520.,11510.,11510.,12410.,12370.,123
000043               160.,12350.,12340.,13390.,13300.,13260.,13230.,13220.,14520.,14330.
000044               2,14250.,14210.,14170.,15900.,15560.,15400.,15310.,15250.,17680.,17
000045               3060.,16780.,16620.,16500.,20030.,16970.,18490.,18210.,18020.,23180
000046               4.,21440.,20670.,20210.,19890.,27390.,24680.,23470.,22750.,22260.,3
000047               52960.,28900.,27080.,26000.,25260.,1681.,1766.,3407.,3524.,5151.,52
000048               672.,6935.,7056.,8783.,8901.,10720.,10820.,586.9,552.7,544.3,552.3,
000049               7568.7,955.3,948.4,950.8,960.5,975.6,1314.,1323.,1335.,1350.,1368.,
000050               81686.,1705.,1724.,1742.,1761.,171.5,198.4,228.3,263.6,285.9,313.1,
000051               9352.7,370.5,395.2,436.4,450.7,472.9,514.8,526.7,547.,588.5,598.9/
000052                DATAAC/616.3,157.6,155.6,157.2,160.9,165.8,171.5,266.1,258.9,256.6
000053               1,257.2,259.8,263.6,364.1,355.6,351.2,349.8,350.5,352.7,450.6,442.7
000054               2,437.8,435.6,435.3,436.4,528.3,521.6,517.2,514.8,514.1,514.8,601.3
000055               3,594.3,592.4,590.4,588.4,588.5,195.7,170.5,167.6,161.2,157.6,305.6
000056               4,292.1,280.9,272.4,266.1,396.9,386.7,377.8,370.2,364.1,476.7,469.,
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000057          5462.,455.8,450.6,548.9,542.8,537.4,532.5,528.3,618.3,614.,609.8,60
000058          65.5,601.3,291.5,244.,195.7,370.6,337.4,305.6,445.1,420.,396.9,514.
000059          7,494.3,476.7,578.5,562.7,548.9,635.3,626.8,618.3,-36.36,-.4208,35.
000060          879,-23.08,12.56,47.71,-6.59,28.33,62.96,14.03,48.09,82.13,39.11,72
000061          9.05,105.4,68.26,99.93,132.5,100.7,130.9,162.7,135.4,164.1,194.9/
000062           DATAAD/171.5,198.4,228.3,-85.42,-76.04,-66.75,-57.54,-48.41,-39.52
000063          1,-75.6,-66.48,-57.32,-48.2,-39.09,-29.88,-63.81,-54.98,-46.08,-37.
000064          217,-28.23,-19.16,-49.69,-41.27,-32.69,-24.04,-15.33,-6.59,-32.86,-
000065          324.95,-16.8,-8.457,-.03691,8.603,-13.09,-5.91,1.75,9.69,17.79,26.1
000066          49,9.652,15.95,22.94,30.41,38.13,46.17,35.18,40.3,46.52,53.41,60.69
000067          5,68.26,63.22,66.87,72.16,78.37,85.15,91.42,93.32,95.24,99.42,104.9
000068          6,111.1,117.9,125.1,125.,128.,132.6,138.1,144.5,157.6,155.6,157.2,1
000069          760.9,165.8,171.5,-129.4,-124.6,-119.8,-115.,-110.3,-105.5,-100.8,-
000070          896.05,-91.34,-119.2,-114.7,-110.2,-105.6,-101.,-96.3,-91.67,-87.,-
000071          982.2,-106.6,-102.6,-98.44,-94.16,-89.78,-85.37,-80.89,-76.41/
000072           DATAAE/-71.76,-90.54,-87.48,-84.,-80.23,-76.24,-72.14,-67.96,-63.7
000073          1,-59.25,-68.68,-67.95,-65.92,-63.08,-59.75,-56.15,-52.35,-48.43,-4
000074          24.26,-32.29,-40.58,-42.88,-41.92,-39.75,-36.91,-33.71,-30.25,-26.4
000075          35,53.77,-4.132,-11.72,-15.64,-15.62,-14.11,-11.78,-8.972,-5.682,87
000076          4.21,81.41,77.7,75.35,73.9,73.07,72.73,72.75,73.18,143.4,134.3,127.
000077          58,123.1,119.8,117.5,115.9,114.9,114.5,195.7,187.1,178.5,173.1,167.
000078          66,164.4,161.2,159.4,157.6,-15.62,-14.87,-14.11,-12.95,-11.78,-10.3
000079          78,-8.972,-7.402,-5.682,-6.565,-6.265,-5.655,-4.775,-3.705,-2.505,-
000080          81.175,.2448,1.895,3.062,2.942,3.262,3.882,4.732,5.772,6.952,8.262,
000081          99.652,13.25,12.63,12.58,12.91,13.54,14.39,15.42,16.57,18.,24.07/
000082           DATAAF/22.85,22.36,22.37,22.74,23.37,24.22,25.22,26.52,35.52,33.58
000083          1,32.6,32.22,32.29,32.69,33.34,34.18,35.18,47.59,44.82,43.26,42.46,
000084          242.19,42.34,42.77,43.42,44.41,60.27,56.56,54.34,53.08,52.45,52.3,5
000085          32.49,52.95,53.76,73.69,68.77,65.85,64.05,63.03,62.55,62.48,62.73,6
000086          43.22,87.21,81.41,77.7,75.35,72.9,73.07,72.73,72.75,73.18,129.2,114
000087          5.2,99.6,87.29,78.08,71.44,66.61,63.01,60.27,156.4,144.8,133.1,121.
000088          67,111.7,103.2,96.55,91.31,87.21,180.2,170.8,161.2,151.6,142.5,134.
000089          71,126.7,120.5,115.2,202.5,194.5,186.2,178.1,170.1,162.4,155.3,149.
000090          8,143.4,223.7,216.6,209.4,202.3,195.3,188.4,181.9,175.8,169.6,244.,
000091          9238.,231.9,225.9,219.8,213.8,207.8,201.7,195.7,211.5,195.7,177.5/
000092           DATAAG/155.9,129.3,227.,212.4,196.1,177.5,156.4,242.7,229.2,214.4,
000093          1198.1,180.2,258.8,246.2,232.7,218.1,202.5,275.,263.3,250.8,237.6,2
000094          223.7,291.5,279.6,267.8,255.9,244.,-15.64,-15.86,-15.9,-15.82,-15.6
000095          32,-5.435,-6.025,-6.375,-6.535,-6.565,5.672,4.572,3.832,3.352,3.062
000096          4,17.77,16.,14.74,13.86,13.25,31.06,28.38,26.46,25.08,24.07,45.63,4
000097          51.77,39.02,37.01,35.52,61.41,56.17,52.41,49.66,47.59,78.08,71.44,6
000098          66.61,63.01,60.27,-11.71,-12.49,-13.15,-13.68,-14.15,-14.53,-14.85,
000099          7-15.11,-15.33,-15.51,-15.64,-5.126,-6.216,-7.106,-7.856,-8.486,-9.
000100          8006,-9.466,-9.836,-10.17,-10.43,-10.57,2.125,.6148,-.6052,-1.615,-
000101          92.465,-3.185,-3.785,-4.305,-4.745,-5.125,-5.435,10.25,8.118,6.438/
000102           DATAAH/5.068,3.938,2.998,2.188,1.508,.9279,.4279,.09789,19.54,16.4
000103          18,14.16,12.31,10.81,9.572,8.522,7.632,6.872,6.222,5.672,30.23,25.9
000104          24,22.69,20.21,18.22,16.59,15.24,14.1,13.13,12.3,11.7,42.85,36.57,3
000105          32.24,28.86,26.24,24.13,22.4,20.95,19.72,18.67,17.77,56.96,48.75,42
000106          4.76,38.31,34.96,32.25,30.05,28.22,26.68,25.38,24.39,70.87,61.71,54
000107          5.36,48.72,44.36,40.99,38.21,35.94,34.04,32.43,31.06,82.67,74.3,66.
000108          63,59.71,54.45,50.25,46.87,44.12,41.8,39.85,38.32,94.5,86.05,78.07,
000109          770.98,65.01,60.09,56.05,52.73,49.95,47.62,45.63,103.9,96.67,89.08,
000110          881.97,75.61,70.16,65.55,61.7,58.46,55.72,53.5,113.3,106.3,99.23,92
000111          9.39,86.,80.24,75.23,70.92,67.24,64.1,61.41,121.3,115.1,108.6/
000112           DATAAI/102.1,95.9,90.12,84.86,80.24,76.2,72.7,69.73,129.2,123.2,11
000113          17.2,111.3,105.4,99.6,94.67,89.75,85.45,81.76,78.08,127.,120.2,112.
000114          24,103.5,93.26,81.3,67.73,54.02,43.09,138.2,132.2,125.7,118.5,110.6
000115          3,101.7,91.87,81.31,70.87,148.2,143.6,138.,132.,125.6,118.6,111.,10
000116          42.9,94.5,158.5,154.5,149.6,144.3,138.7,133.,126.7,120.2,113.3,168.
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000117                59,164.5,160.2,155.9,150.5,145.2,139.9,134.6,129.2,79.93,66.59,11.3
000118                6,3.918,.5075,-1.802,-3.602,-5.052,-6.252,-7.272,-8.152,-8.922,-9.6
000119                712,-10.22,-10.77,-11.27,-11.71,90.02,83.58,73.25,54.98,21.88,12.66
000120                8,8.264,5.374,3.244,1.524,.1143,-1.086,-2.106,-3.006,-3.796,-4.496,
000121                9-5.126,100.2,94.23,87.36,78.83,67.23,49.04,29.54,20.61,15.97/
000122                 DATAAJ/12.63,10.13,8.165,6.575,5.205,4.035,3.025,2.125,107.3,102.8
000123                1,97.34,91.12,83.8,74.82,63.27,48.88,36.2,28.22,23.17,19.79,17.04,1
000124                24.85,13.06,11.56,10.25,114.5,110.3,105.7,100.6,94.95,88.54,81.12,7
000125                32.37,62.11,51.17,41.85,34.99,30.1,26.47,23.81,21.48,19.54,120.7,11
000126                47.1,113.1,108.7,104.,98.79,93.07,86.68,79.5,71.49,62.88,54.41,47.1
000127                53,41.26,36.7,33.11,30.23,126.8,123.4,119.8,116.,111.9,107.4,102.7,
000128                697.52,91.9,85.77,79.12,72.07,64.9,58.08,52.1,47.03,42.85,132.6,129
000129                7.4,126.1,122.6,119.,115.,111.,106.5,101.9,96.67,91.49,85.64,79.78,
000130                873.71,67.65,62.3,56.96,71.06,37.36,.06246,.06246,.06246,84.65,57.6
000131                95,.3469,.3469,.3469,98.79,74.09,44.19,1.186,1.186,113.8,92.74/
000132                 DATAAK/64.94,2.945,2.945,130.3,113.5,89.33,54.05,6.054,148.2,134.2
000133                1,116.6,91.72,10.72,167.8,155.9,142.,125.6,103.,189.,178.5,166.9,15
000134                23.8,138.2,211.5,202.,192.1,181.1,168.9,87.79,71.29,54.39,8.994,8.9
000135                394,100.5,89.02,71.72,52.62,39.82,111.5,102.8,91.55,72.75,40.45,121
000136                4.5,114.3,105.9,95.37,79.97,131.1,124.9,117.9,109.9,100.2,140.3,134
000137                5.7,128.7,122.,114.5,19700.,19330.,19260.,23000.,22040.,21810.,2735
000138                60.,25260.,24730.,21390.,19940.,19580.,27180.,23580.,22680.,36230.,
000139                728590.,26650.,22560.,21170.,20520.,30320.,26640.,25020.,42210.,350
000140                860.,31640.,32960.,28900.,27090.,26000.,25260.,40130.,34330.,31710.
000141                9,30130.,29050.,49050.,41170.,37530.,35320.,33810.,59610.,49530./
000142                 DATAAL/44710.,41750.,39690.,71190.,59240.,53210.,49420.,46750.,829
000143                120.,69950.,62910.,58310.,55020.,27100.,23410.,22100.,21520.,31750.
000144                2,26350.,24440.,23590.,37610.,30000.,27280.,26070.,44900.,34480.,30
000145                3730.,29050.,53610.,39900.,34870.,32610.,63710.,46340.,39810.,36850
000146                4./
000147                 P=PRES
000148                 IF(P.LT.1.0) P=1.0
000149                 T=TEMP
000150                 IF(T.LT.90.0) GO TO 10
000151                 IF(T.LT.3000.0) GO TO 5
000152                 IF(T.GE.6000.0)T=5999.9999
000153                 IF(P.LT.30.0) GO TO 3
000154                 IF(P.LT.80.0) GO TO 2
000155                 IF(P.LT.500.0) GO TO 1
000156                 N=1
000157                 N1=25
000158                 GO TO 33
000159               1 N=2
000160                 N1=26
000161                 GO TO 33
000162               2 N=3
000163                 N1=27
000164                 GO TO 33
000165               3 IF(P.LT.5.0) GO TO 4
000166                 N=4
000167                 N1=29
000168                 GO TO 33
000169               4 N=5
000170                 N1=28
000171                 GO TO 33
000172               5 IF(T.LT.180.0) GO TO 70
000173                 IF(T.LT.500.0) GO TO 6
000174                 N=6
000175                 GO TO 33
000176               6 N=7
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000177                GO TO 33
000178             70 IF(P.LT.1175.68) GO TO 8
000179                IF(P.LT.2645.28) GO TO 7
000180                N=8
000181                GO TO 33
000182              7 N=9
000183                GO TO 33
000184              8 IF(P.LT.587.84) GO TO 9
000185                N=10
000186                GO TO 33
000187              9 N=11
000188                GO TO 33
000189             10 IF(P.LT.1175.68) GO TO 12
000190                IF(P.LT.2645.28) GO TO 11
000191                N=12
000192                GO TO 30
000193             11 N=13
000194                GO TO 30
000195             12 IF(T.GE.59.4) GO TO 15
000196                N=14
000197                IF(P.GE.187.6385) GO TO 30
000198                DO 13 I=2,20
000199                IF(P-PS(I))14,14,13
000200             13 CONTINUE
000201                I=20
000202             14 TM=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))
000203                IF(T.LE.TM) GO TO 30
000204                GO TO 25
000205             15 IF(P.LT.293.92) GO TO 20
000206                IF(P.GE.587.84) GO TO 18
000207                IF(T.GE.72.0) GO TO 17
000208                IF(P.LT.440.88) GO TO 16
000209                N=19
000210                GO TO 33
000211             16 N=20
000212                GO TO 33
000213             17 N=17
000214                GO TO 33
000215             18 IF(T.LT.75.6) GO TO 19
000216                N=15
000217                GO TO 33
000218             19 N=16
000219                GO TO 33
000220             20 IF(T.GE.72.0)GO TO 22
000221                IF(P.LT.176.352) GO TO 23
000222                IF(T.LT.65.7) GO TO 21
000223                N=21
000224                GO TO 33
000225             21 N=22
000226                GO TO 33
000227             22 N=18
000228                GO TO 33
000229             23 N=23
000230                IF(P.GE.117.568.AND.T.LE.63.) N=24
000231                GO TO 33
000232             30 F=P/587.84
000233                I=F
000234                IF(I.GT.8) I=8
000235                F=F-I
000236                FP=1.0-F
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```
000237                TQ=FP*TL(I+1)+F*TL(I+2)
000238                IF(T.GE.TQ) GO TO 33
000239                ETENTH=FP*HS(I+1)+F*HS(I+2)
000240                RETURN
000241             33 IF(T.LT.5000.)N1=N
000242                FP=(P-BP(N))/DP(N)
000243                IP=FP
000244                IF(IP.GT.MX(N)) IP=MX(N)
000245                F=FP-IP
000246                FP=1.0-F
000247                FT=(T-BT(N1))/DT(N)
000248                IT=FT
000249                FF=FT-IT
000250                FT=1.0-FF
000251                I=IT*JP(N)+IP+LOC(N1)
000252                J=I+JP(N)
000253                ETENTH=FP*FT*H(I)+F*FT*H(I+1)+FP*FF*H(J)+F*FF*H(J+1)
000254                RETURN
000255                END
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@ ELT ETHEAT,1,711119, 35465

000001                FUNCTION ETHEAT(PRES,TEMP,KTRANS)
000002                COMMON/TEHEAT/CP(823),CV(823)
000003                DIMENSION LOC(23),JP(19),MX(19),BP(19),DP(19),BT(23),DT(19),PS(12)
000004               1,TS(12),TL(10)
000005                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,160./
000006                DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,
000007               154.79,56.72,57.46/
000008                DATA LOC/1,50,71,113,133,141,170,165,228,264,348,372,426,492,528,
000009               1584,626,638,734,654,682,694,718/
000010                DATA JP/7,3,6,5,2,4,9,9,4,7,4,9,6,6,7,7,2,2,5/
000011                DATA MX/5,1,4,3,0,2,2,4,2,5,2,7,4,4,5,5,0,0,3/
000012                DATA BP/0.,20.,0.,1000.,100.,-1000.,1469.6,0.,1469.6,587.84,
000013               1587.84,0.,100.,100.,40.,40.,0.,0.,1./
000014                DATA BT/2600.,2600.,2600.,2600.,800.,300.,120.,120.,25.2,27.,72.,
000015               181.,25.,56.,26.,41.,25.,25.,2600.,5000.,5000.,5000.,5000./
000016                DATA DP/5.,40.,200.,1000.,4900.,2000.,1175.68,293.92,1175.68,
000017               1146.96,146.96,73.48,100.,100.,20.,20.,40.,40.,1./
000018                DATA DT/400.,400.,400.,800.,600.,100.,30.,30.,12.6,9.,3.6,9.,5.,
000019               15.,4.,8.,4.,8.,200./
000020                DATA TL/24.846,27.175,29.310,31.299,33.176,34.962,36.672,38.317,
000021               139.904,41.456/
000022                KTR=KTRANS
000023              1 P=PRES
000024                IF(P.LT.1.0) P=1.0
000025                T=TEMP
000026                IF(T.LT.126.) GO TO 9
000027                IF(T.LT.2600.) GO TO 5
000028                IF(T.GE.6000.) T=5999.99999
000029                IF(P.GE.100.) GO TO 3
000030                IF(P.GE.30.) GO TO 2
000031                IF(P.GE.5.)GO TO 20
000032                N=19
000033                N1=19
000034                GO TO 33
000035             20 N=1
000036                N1=20
000037                GO TO 33
000038              2 N=2
000039                N1=21
000040                GO TO 33
000041              3 IF(P.GE.1000.) GO TO 4
000042                N=3
000043                N1=22
000044                GO TO 33
000045              4 N=4
000046                N1=23
000047                GO TO 33
000048              5 IF(T.LT.300.)GO TO 7
000049                IF(T.LT.800.)GO TO 6
000050                N=5
000051                GO TO 33
000052              6 N=6
000053                GO TO 33
000054              7 IF(P.LT.1469.6) GO TO 8
000055                N=7
000056                GO TO 33
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000057                8 N=8
000058                  GO TO 33
000059                9 IF(P.LT.587.84) GO TO 12
000060                  IF(P.LT.1469.6) GO TO 10
000061                  N=9
000062                  GO TO 30
000063               10 IF(P.LT.1028.72.AND.T.GE.72.0.AND.T.LT.90.0) GO TO 11
000064                  N=10
000065                  GO TO 30
000066               11 N=11
000067                  GO TO 33
000068               12 IF(T.LT.81.) GO TO 13
000069                  N=12
000070                  GO TO 33
000071               13 IF(P.LT.160.) GO TO 15
000072                  TM=((.86367647E-7*P-.12613701E-3)*P+.10353383)*P+43.8056878
000073                  IF(T.GT.TM) GO TO 14
000074                  N=13
000075                  GO TO 30
000076               14 N=14
000077                  GO TO 33
000078               15 DO 16 I=2,12
000079                  IF(P-PS(I))17,17,16
000080               16 CONTINUE
000081                  I=12
000082               17 TM=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))
000083                  IF(T.GE.TM) GO TO 18
000084                  N=15
000085                  IF(P.LT.40.) N=17
000086                  GO TO 30
000087               18 N=16
000088                  IF(P.LT.40.) N=18
000089                  GO TO 33
000090               30 F=P/587.84
000091                  I=F
000092                  IF(I.GT.8) I=8
000093                  F=F-I
000094                  TQ=(1.0-F)*TL(I+1)+F*TL(I+2)
000095                  IF(T.LT.TQ) T=TQ
000096               33 IF(T.LE.5000.0)N1=N
000097                  FP=(P-BP(N))/DP(N)
000098                  IP=FP
000099                  IF(IP.GT.MX(N)) IP=MX(N)
000100                  F=FP-IP
000101                  FP=1.0-F
000102                  FT=(T-BT(N1))/DT(N)
000103                  IT=FT
000104                  FF=FT-IT
000105                  FT=1.0-FF
000106                  I=IT*JP(N)+IP+LOC(N1)
000107                  J=I+JP(N)
000108                  IF(KTR.EQ.2) GOTO 37
000109                  CTCP=FP*FT*CP(I)+F*FT*CP(I+1)+FP*FF*CP(J)+F*FF*CP(J+1)
000110                  IF(N.LT.13.OR.N.GE.17) GO TO 36
000111                  IF(N.LT.15) GO TO 35
000112                  CTCP=CTCP/(187.506-P+ABS (T-TM)*28.13)
000113                  GO TO 36
000114               35 CTCP=CTCP/(ABS (T-TM)/1.8+ABS (P-187.506)*.0080089B2)
000115               36 IF(KTR.GE.2) GO TO 37
000116                  ETCP=CTCP
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```
000117            ETHEAT=ETCP
000118            RETURN
000119         37 ETCP=FP*FT*CV(I)+F*FT*CV(I+1)+FP*FF*CV(J)+F*FF*CV(J+1)
000120.           ETHEAT=ETCP
000121            IF(KTR.LT.3) RETURN
000122            ETCP=CTCP/ETCP
000123            ETHEAT=ETCP
000124            RETURN
000125            END
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@ ELT ETSOUN,1,711119, 35467

000001                FUNCTION ETSOUN(PRES,TEMP)
000002                DIMENSION LOC(23),JP(19),MX(19),BP(19),DP(19),BT(23),DT(19),PS(20)
000003               1,TS(20),TL(10),V(522)
000004                DIMENSION AA(105),AB(108),AC(108),AD(111),AE( 90)
000005                EQUIVALENCE( V,AA),( V( 106),AB),( V( 214),AC),( V( 322),AD)
000006               1     ,( V( 433),AE)
000007                DATA TL/24.846,27.175,29.310,31.299,33.176,34.962,36.672,38.317,
000008               139.904,41.456/
000009                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,165.,176.,182
000010               1.,185.,186.5,187.25,187.46875,187.506,190./
000011                DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,54.
000012               179,56.72,57.80,58.57,58.99,59.18,59.29,59.34,59.353,59.356,59.517/
000013                DATA JP/5,5,5,5,3,7,6,6,11,3,4,4,6,7,4,6,12,7,4/
000014                DATA MX/0,0,0,0,1,3,2,0,9,1,2,2,4,5,2,4,10,1,0/
000015                DATA BP/1000.,100.,10.,0.,-3000.,1000.,   2000.,1000.,0.,600.,0.,
000016               1300.,300.,0.,10.,100.,190.,0.,1000./
000017                DATA DP/4000.,900.,90.,10.,4000.,1000.,1000.,500.,100.,200.,200.,
000018               1100.,50.,50.,60.,40.,10.,500.,500./
000019                DATA BT/800.,800.,800.,800.,240.,120.,20.,20.,80.,25.,25.,50.,63.,
000020               168.,28.,50.,60.,120.,80.,5000.,5000.,5000.,5000./
000021                DATA DT/600.,600.,600.,600.,80.,30.,20.,20.,10.,10.,5.,5.,2.,4.,5.
000022               1,2.,1.,30.,10./
000023                DATA LOC/4,3,2,1,41,67,102,100,136,191,212,236,264,300,328,364,400
000024               1,65,330,511,510,509,508/
000025                DATAAA/5250.,5252.,5266.,5405.,6052.,6929.,6930.,6940.,7044.,7537.
000026               1,8227.,8228.,8236.,8321.,8734.,9298.,9302.,9310.,9384.,9745.,10160
000027               2.,10220.,10240.,10310.,10640.,10700.,10940.,11050.,11150.,11450.,1
000028               31240.,11470.,11700.,11880.,12190.,12140.,12070.,12260.,12510.,1296
000029               40.,2176.,3187.,4569.,2677.,3610.,4709.,3105.,3963.,4905.,3490.,428
000030               54.,5127.,3846.,4587.,5360.,4179.,4873.,5595.,4490.,5146.,5826.,478
000031               64.,5405.,6052.,1975.,1981.,2205.,2976.,3671.,4238.,4709.,2255.,232
000032               70.,2488.,3025.,3606.,4126.,4591.,2510.,2604.,2754.,3178.,3662.,412
000033               82.,4539.,2735.,2849.,2991.,3350.,3754.,4157.,4545.,2934.,3052.,318
000034               97.,3504.,3857.,4217.,4569.,4999.,5196.,5491.,6053.,6550.,6804./
000035                DATAAB/4294.,4632.,4919.,5397.,5800.,6089.,3276.,3774.,4155.,4749.
000036               1,5220.,5616.,2395.,3034.,3506.,4208.,4735.,5165.,2104.,2646.,3116.
000037               2,3855.,4422.,4867.,2205.,2580.,2976.,3671.,4238.,4709.,1592.,1517.
000038               3,1448.,1399.,1402.,1497.,1672.,1869.,2059.,2234.,2395.,1685.,1634.
000039               4,1590.,1562.,1553.,1582.,1654.,1763.,1894.,2033.,2173.,1781.,1747.
000040               5,1719.,1703.,1702.,1717.,1757.,1820.,1902.,1999.,2104.,1878.,1856.
000041               6,1840.,1834.,1838.,1853.,1882.,1926.,1984.,2053.,2132.,1975.,1962.
000042               7,1955.,1955.,1964.,1981.,2007.,2043.,2089.,2143.,2205.,4570.,4694.
000043               8,4809.,4200.,4355.,4495.,3691.,3888.,4063.,3047.,3317.,3542.,2358.
000044               9,2731.,3019.,1804.,2234.,2570.,1635.,1947.,2262.,4178.,4316./
000045                DATAAC/4455.,4560.,3865.,4080.,4251.,4397.,3590.,3823.,4025.,4200.
000046               1,3255.,3536.,3766.,3965.,2801.,3176.,3460.,3691.,2166.,2724.,3100.
000047               2,3381.,2930.,3100.,3248.,3381.,2465.,2698.,2886.,3047.,1915.,2256.
000048               3,2502.,2701.,1294.,1791.,2114.,2358.,1214.,1428.,1768.,2045.,1309.
000049               4,1351.,1553.,1804.,1399.,1402.,1497.,1672.,1530.,1784.,1975.,2132.
000050               5,2267.,2386.,1294.,1573.,1791.,1966.,2114.,2243.,1189.,1396.,1619.
000051               6,1807.,1966.,2104.,1198.,1295.,1479.,1665.,1830.,1974.,1232.,1270.
000052               7,1391.,1552.,1712.,1858.,1270.,1283.,1354.,1476.,1618.,1758.,1484.
000053               8,1428.,1368.,1304.,1238.,1187.,1187.,1519.,1471.,1419.,1367.,1317.
000054               9,1276.,1251.,1555.,1513.,1469.,1426.,1386.,1351.,1328.,1592./
000055                DATAAD/1555.,1517.,1481.,1448.,1420.,1399.,1009.,660.,2395.,3034.,
000056               11107.,816.,2173.,2759.,1187.,943.,2104.,2646.,1249.,1040.,0.,0.,13
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000057              200.,1124.,998.,0.,1344.,1212.,1010.,886.,1387.,1283.,1145.,894.,14
000058              330.,1346.,1247.,1131.,1474.,1405.,1329.,1251.,2455.,2574.,2677.,27
000059              469.,2853.,2930.,2175.,2327.,2456.,2565.,2664.,2752.,1143.,2034.,22
000060              505.,2343.,2461.,2564.,1184.,1043.,1910.,2094.,2240.,2363.,1220.,11
000061              614.,1506.,1802.,1996.,2148.,1253.,1165.,1049.,1422.,1718.,1915.,10
000062              707.,1033.,1303.,1422.,1512.,1590.,1658.,1718.,1773.,1824.,1870.,19
000063              815.,1061.,1030.,996.2,1121.,1277.,1403.,1489.,1561.,1626.,1685.,17
000064              940.,1789.,1101.,1076.,1052.,1031.,1060.,1178.,1294.,1394.,1473./
000065               DATAAE/1542.,1603.,1660.,1131.,1114.,1094.,1074.,1060.,1070.,1137.
000066              1,1228.,1317.,1393.,1465.,1530.,1158.,1144.,1126.,1109.,1094.,1085.
000067              2,1090.,1127.,1189.,1262.,1335.,1401.,1184.,1168.,1155.,1140.,1125.
000068              3,1114.,1108.,1113.,1134.,1178.,1233.,1294.,1208.,1192.,1180.,1167.
000069              4,1154.,1142.,1134.,1131.,1136.,1152.,1181.,1223.,1230.,1216.,1202.
000070              5,1194.,1182.,1171.,1162.,1156.,1154.,1158.,1169.,1189.,1251.,1238.
000071              6,1225.,1215.,1207.,1196.,1187.,1179.,1175.,1174.,1178.,1187.,12160
000072              7.,12100.,12280.,12540.,12880.,13260.,12930.,12900.,13120.,13480.,1
000073              84050.,13900.,13610.,13700.,14050./
000074               P=PRES
000075               IF(P.LT.1.0) P=1.0
000076               T=TEMP
000077               IF(T.LT.120.) GO TO 6
000078               IF(T.LT.800.) GO TO 4
000079               IF(T.GE.6000.) T=5999.99999
000080               IF(P.LT.100.) GO TO 2
000081               IF(P.LT.1000.) GO TO 1
000082               N=1
000083               N1=20
000084               GO TO 33
000085             1 N=2
000086               N1=21
000087               GO TO 33
000088             2 IF(P.LT.10.)GO TO 3
000089               N=3
000090               N1=22
000091               GO TO 33
000092             3 N=4
000093               N1=23
000094               GO TO 33
000095             4 IF(T.LT.240.) GO TO 5
000096               N=5
000097               GO TO 33
000098             5 N=6
000099               IF(P.LT.1000.) N=18
000100               GO TO 33
000101             6 IF(P.LT.1000.)GO TO 8
000102               IF(P.LT.2000.)GO TO 7
000103               N=7
000104               GO TO 30
000105             7 N=8
000106               IF((T.LT.100.).AND.(T.GE.80.).AND.(P.LT.1500.)) N=19
000107               GO TO 30
000108             8 IF(T.LT.80.) GO TO 9
000109               N=9
000110               GO TO 33
000111             9 IF(P.LT.600.) GO TO 10
000112               N=10
000113               GO TO 30
000114            10 IF(P.LT.300.) GO TO 12
000115               IF(T.LT.50.) GO TO 11
000116               N=12
```

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000117                IF((P.LT.550.).AND.(T.GE.63.).AND.(T.LE.73.)) N=13
000118                GO TO 33
000119             11 N=11
000120                GO TO 30
000121             12 IF(T.LT.68.) GO TO 13
000122                N=14
000123                GO TO 33
000124             13 IF(T.LT.60.) GO TO 15
000125                IF(P.LT.190.) GO TO 14
000126                N=17
000127                GO TO 33
000128             14 N=15
000129                GO TO 33
000130             15 N=15
000131                DO 16 I=2,20
000132                IF(P.LT.PS(I)) GO TO 17
000133             16 CONTINUE
000134                GO TO 18
000135             17 TM=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))
000136                IF(T.GT.TM) GO TO 33
000137             18 IF(T.LT.50.) GO TO 19
000138                N=16
000139                GO TO 33
000140             19 N=11
000141                GO TO 30
000142             30 F =P/587.84
000143                I=F
000144                IF(I.GT.8) I=8
000145                F=F-I
000146                TQ=(1.-F)*TL(I+1)+F*TL(I+2)
000147                IF(T.LT.TQ) T=TQ
000148             33 IF(T.LE.5000.0)N1=N
000149                FP=(P-BP(N))/DP(N)
000150                IP=FP
000151                IF(IP.GT.MX(N)) IP=MX(N)
000152                F=FP-IP
000153                FP=1.0-F
000154                FT=(T-BT(N1))/DT(N)
000155                IT=FT
000156                FF=FT-IT
000157                FT=1.0-FF
000158                I=IT*JP(N)+IP+LOC(N1)
000159                J=I+JP(N)
000160                ETSOUN=FP*FT*V(I)+F*FT*V(I+1)+FP*FF*V(J)+F*FF*V(J+1)
000161             34 ETSOUN = ETSOUN * 12.0
000162                RETURN
000163                END
```

```
@ ELT ETVISC,1,711119, 35470

000001                FUNCTION ETVISC(PRES,TEMP)
000002                DIMENSION PS(20),TS(20),JP(21),MX(21),LOC(21),BP(21),DP(21),BT(21)
000003               1,DT(21),V(536)
000004                DIMENSION AA( 66),AB( 67),AC( 67),AD( 66),AE( 67),AF( 66),AG( 66)
000005               1 ,AH( 66),AI(  5)
000006                EQUIVALENCE( V,AA),( V(  67),AB),( V( 134),AC),( V( 201),AD)
000007               1    ,( V( 267),AE),( V( 334),AF),( V( 400),AG),( V( 466),AH)
000008               2    ,( V( 532),AI)
000009                DATA PS/1.022,2.,4.,8.,14.,25.,43.,69.,99.,128.,151.,165.,176.,
000010               1182.,185.,186.5,187.25,187.46875,187.506,187.6385/
000011                DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,54.
000012               179,56.72,57.80,58.57,58.99,59.18,59.29,59.34,59.353,59.356,59.4/
000013                DATA LOC/1,21,37,46,55,90,112,134,155,176,204,216,276,296,320,
000014               1356,376,436,480,510,528/
000015                DATA JP/4,4,3,3,5,3,3,3,3,4,3,6,4,6,4,5,5,11,6,3,3/
000016                DATA MX/2,2,1,1,3,1,1,1,1,2,1,4,2,4,2,3,3,9,4,1,1/
000017                DATA BP/0.,0.,-1.,0.,1.,-10.,0.,1469.6,1469.6,1469.6,1469.6,0.,0.,
000018               10.,587.84,0.,293.92,190.,190.,190.,190./
000019                DATA DP/1000.,1000.,3.,1500.,1.,20.,1500.,1763.52,1763.52, 1175.68
000020               1,1763.52,293.92,73.48,293.92,293.92,146.96,73.48,10.,20.,50.,50./
000021                DATA BT/180.,500.,2000.,2000.,3000.,3000.,3000.,30.6,41.4,63.,126.
000022               1,27.,36.,126.,54.,99.,59.4,59.4,64.8,72.,81./
000023                DATA DT/80.,500.,500.,500.,500.,500.,500.,1.8,3.6,9.,18.,3.6,18.,
000024               118.,9.,9.,3.6,1.8,1.8,1.8,9./
000025                DATAAA/2.354E-11,2.797E-11,3.278E-11,3.762E-11,3.1E-11,3.452E-11,3
000026               1.812E-11,4.172E-11,3.754E-11,3.99E-11,4.22E-11,4.451E-11,4.351E-11
000027               2,4.498E-11,4.638E-11,4.779E-11,4.906E-11,4.906E-11,5.06E-11,5.138E
000028               3-11,4.906E-11,4.986E-11,5.06E-11,5.138E-11,7.852E-11,7.688E-11,7.5
000029               443E-11,7.418E-11,1.033E-10,1.002E-10,9.74E-11,9.495E-11,1.256E-10,
000030               51.213E-10,1.174E-10,1.14E-10,1.256E-10,1.256E-10,1.256E-10,1.463E-
000031               610,1.463E-10,1.462E-10,1.657E-10,1.657E-10,1.657E-10,1.256E-10,1.1
000032               795E-10,1.14E-10,1.463E-10,1.394E-10,1.317E-10,1.657E-10,1.564E-10,
000033               81.465E-10,1.657E-10,1.657E-10,1.657E-10,1.657E-10,1.657E-10,1.843E
000034               9-10,1.843E-10,1.842E-10,1.842E-10,1.842E-10,2.027E-10,2.024E-10/
000035                DATAAB/2.023E-10,2.023E-10,2.022E-10,2.223E-10,2.215E-10,2.21E-10,
000036               1[illegible]
000037               2-10,2.617E-10,2.635E-10,2.634E-10,2.631E-10,2.626E-10,2.647E-10,2.
000038               3742E-10,2.782E-10,2.801E-10,2.811E-10,1.658E-10,1.657E-10,1.655E-1
000039               40,1.844E-10,1.842E-10,1.84E-10,2.026E-10,2.021E-10,2.018E-10,2.221
000040               5E-10,2.201E-10,2.194E-10,2.446E-10,2.394E-10,2.377E-10,2.681E-10,2
000041               6.606E-10,2.576E-10,2.782E-10,2.821E-10,2.794E-10,0.,1.657E-10,1.56
000042               74E-10,1.485E-10,1.842E-10,1.736E-10,1.645E-10,2.02E-10,1.901E-10,1
000043               8.799E-10,2.197E-10,2.06E-10,1.948E-10,2.39E-10,2.217E-10,2.094E-10
000044               9,2.58E-10,2.373E-10,2.238E-10,2.799E-10,2.534E-10,2.385E-10,0./
000045                DATAAC/1.838E-10,2.745E-10,0.,1.645E-10,2.572E-10,0.,1.496E-10,2.3
000046               141E-10,3.211E-10,1.381E-10,2.145E-10,2.94E-10,1.266E-10,1.958E-10,
000047               22.659E-10,1.182E-10,1.804E-10,2.432E-10,1.1E-10,1.674E-10,2.237E-1
000048               30,1.1E-10,1.674E-10,2.237E-10,9.723E-11,1.467E-10,1.938E-10,8.717E
000049               4-11,1.308E-10,1.717E-10,7.398E-11,1.184E-10,1.547E-10,7.217E-11,1.
000050               5084E-10,1.413E-10,6.587E-11,9.78E-11,1.297E-10,6.091E-11,9.124E-11
000051               6,1.259E-10,6.091E-11,8.175E-11,1.09E-10,1.209E-10,5.159E-11,7.968E
000052               7-11,8.807E-11,1.043E-10,4.932E-11,6.179E-11,7.734E-11,9.191E-11,3.
000053               891E-11,5.524E-11,6.956E-11,8.264E-11,3.553E-11,5.021E-11,6.317E-1
000054               91,7.54E-11,3.28E-11,4.627E-11,5.823E-11,6.956E-11,3.134E-11/
000055                DATAAD/1.[illegible]
000056               1.946E-11,4.21E-11,5.525E-11,2.96E-11,4.036E-11,5.165E-11,3.034E-
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000057      211,3.954E-11,4.874E-11,1.29E-10,1.48E-10,1.677E-10,1.866E-10,2.058
000058      3E-10,2.25E-10,1.033E-10,1.183E-10,1.335E-10,1.493E-10,1.656E-10,1.
000059      4825E-10,3.563E-11,9.818E-11,1.107E-10,1.233E-10,1.363E-10,1.496E-1
000060      50,7.246E-11,8.358E-11,9.433E-11,1.05E-10,1.158E-10,1.267E-10,6.196
000061      6E-11,7.234E-11,8.199E-11,9.135E-11,1.006E-10,1.1E-10,5.305E-11,6.3
000062      724E-11,7.223E-11,8.073E-11,8.902E-11,9.723E-11,4.487E-11,5.552E-11
000063      8,6.423E-11,7.216E-11,7.974E-11,8.717E-11,3.647E-11,4.869E-11,5.747
000064      9E-11,6.505E-11,7.214E-11,7.898E-11,6.15E-12,4.232E-11,5.16E-11/
000065       DATAAE/5.906E-11,6.576E-11,7.217E-11,6.56E-12,3.651E-11,4.645E-11,
000066      15.353E-11,6.013E-11,6.587E-11,6.3E-12,7.49E-12,5.8E-12,0.,9.3E-12,
000067      21.004E-11,1.209E-11,2.554E-11,1.198E-11,1.249E-11,1.318E-11,1.434E
000068      3-11,1.442E-11,1.483E-11,1.53E-11,1.587E-11,1.667E-11,1.701E-11,1.7
000069      438E-11,1.78E-11,1.877E-11,2.006E-11,2.192E-11,2.457E-11,2.739E-11,
000070      [illegible]
000071      6-11,[illegible]
000072      728E-11,2.532E-11,2.[illegible]
000073      86.191E-11,6.881E-11,7.543E-11,4.154E-11,4.921E-11,5.559E-11,6.091E
            [illegible]
000075       DATAAF/3.919E-11,4.432E-11,2.034E-11,2.867E-11,3.427E-11,3.911E-11
000076      1,2.131E-11,2.623E-11,3.099E-11,3.553E-11,2.113E-11,2.509E-11,2.9E-
000077      211,3.28E-11,2.141E-11,2.463E-11,2.792E-11,3.134E-11,2.192E-11,2.45
000078      37E-11,2.739E-11,3.019E-11,1.557E-11,1.635E-11,1.739E-11,1.901E-11,
000079      42.131E-11,1.667E-11,1.738E-11,1.826E-11,1.948E-11,2.113E-11,1.774E
000080      5-11,1.839E-11,1.916E-11,2.014E-11,2.141E-11,1.877E-11,1.941E-11,2.
000081      6006E-11,2.099E-11,2.192E-11,3.651E-11,3.9E-11,4.148E-11,4.397E-11,
000082      74.645E-11,2.868E-11,3.35E-11,3.675E-11,3.938E-11,4.154E-11,2.076E-
000083      811,2.766E-11,3.178E-11,3.483E-11,3.716E-11,1.748E-11,2.262E-11,2.7
000084      922E-11,3.068E-11,3.329E-11,1.649E-11,2.E-11,2.377E-11,2.712E-11/
000085       DATAAG/3.E-11,1.614E-11,1.857E-11,2.156E-11,2.448E-11,2.72E-11,1.6
000086      112E-11,1.79E-11,2.025E-11,2.27E-11,2.517E-11,1.625E-11,1.766E-11,1
000087      2.95E-11,2.154E-11,2.37E-11,1.649E-11,1.766E-11,1.913E-11,2.086E-11
000088      3,2.268E-11,1.676E-11,1.774E-11,1.896E-11,2.044E-11,2.202E-11,1.707
000089      4E-11,1.79E-11,1.892E-11,2.019E-11,2.157E-11,1.739E-11,1.82E-11,1.9
000090      501E-11,2.016E-11,2.13JE-11,2.484E-11,2.818E-11,2.97E-11,3.086E-11,
000091      63.181E-11,3.261E-11,3.335E-11,3.401E-11,3.461E-11,3.52E-11,3.573E-
000092      711,1.431E-11,1.56E-11,1.812E-11,2.297E-11,2.59E-11,2.757E-11,2.885
000093      8E-11,2.987E-11,3.076E-11,3.154E-11,3.225E-11,1.368E-11,1.429E-11,1
000094      9.511E-11,1.626E-11,1.791E-11,2.015E-11,2.259E-11,2.458E-11/
000095       DATAAH/2.611E-11,2.728E-11,2.831E-11,1.35E-11,1.394E-11,1.438E-11,
000096      11.508E-11,1.578E-11,1.689E-11,1.8E-11,1.949E-11,2.099E-11,2.246E-1
000097      21,2.394E-11,1.35E-11,1.438E-11,1.578E-11,1.8E-11,2.099E-11,2.394E-
000098      311,1.347E-11,1.412E-11,1.503E-11,1.634E-11,1.815E-11,2.032E-11,1.3
000099      4[illegible]
            [illegible]
000102      7.664E-11,1.593E-11,1.486E-11,1.635E-11,1.409E-11,1.489E-11,1.61E-1
000103      81,1.427E-11,1.499E-11,1.604E-11,1.445E-11,1.509E-11,1.6E-11,1.[illegible]
000104      9-11,1.523E-11,1.604E-11,1.464E-11,1.523E-11,1.604E-11,1.563E-11/
000105       DATAAI/1.606E-11,1.656E-11,1.662E-11,1.697E-11,1.736E-11/
000106       P=PRES
000107       IF(P.LT.1.0) P=1.0
000108       T=TEMP
000109       IF(T.LT.[illegible]) GO TO 7
000110       IF(T.GE.300.0) GO TO 1
000111       N=1
000112       GO TO 30
000113     1 IF(T.GE.3000.0) GO TO 4
000114       IF(T.GE.2000.0) GO TO 2
000115       N=2
000116       GO TO 30
```

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```
000117              2 IF(P.GT.5.0) GO TO 3
000118                N=3
000119                GO TO 30
000120              3 N=4
000121                GO TO 30
000122              4 IF(T.GE.6000.0) T=5999.99999
000123                IF(P.GE.5.0) GO TO 5
000124                N=5
000125                GO TO 30
000126              5 IF(P.GE.30.0) GO TO 6
000127                N=6
000128                GO TO 30
000129              6 N=7
000130                GO TO 30
000131              7 IF(P.LT.1469.6) GO TO 12
000132                IF(T.GE.  63.0) GO TO 10
000133                IF(T.GE.41.4)   GO TO 9
000134                N=8
000135              8 TZ=24.84+0.00317*P
000136                IF(T.LT.TZ) T=TZ
000137                GO TO 30
000138              9 N=9
000139                GO TO 30
000140             10 IF(T.GE.117.0) GO TO 11
000141                N=10
000142                GO TO 30
000143             11 N=11
000144                GO TO 30
000145             12 IF(T.GE.59.4)  GO TO 17
000146                N=12
000147                IF(T.GE.167.6385) GO TO 8
000148                [illegible]
000149                IF(P.[illegible])GO TO 13
000150             13 CONTINUE
000151             14 TL=TS(I)
000152                GO TO 16
000153             15 TL=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))
000154             16 IF(T.LE.TL) GO TO 8
000155                N=13
000156                GO TO 30
000157             17 IF(T.LT.125.0) GO TO 18
000158                N=14
000159                GO TO 30
000160             18 IF(P.LT.587.84) GO TO 19
000161                N=15
000162                GO TO 30
000163             19 IF(T.LT.99.0) GO TO 20
000164                N=16
000165                GO TO 30
000166             20 IF(P.GE.190.0)GO TO 21
000167                N=13
000168                GO TO 30
000169             21 IF(P.LT.293.92) GO TO 22
000170                N=17
000171                GO TO 30
000172             22 IF(T.GE.72.0) GO TO 24
000173                IF(T.GE.64.8) GO TO 23
000174                N=18
000175                GO TO 30
000176             23 N=19
```

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```
000177                GO TO 30
000178             24 IF(T.GE.81.0) GO TO 25
000179                N=20
000180                GO TO 30
000181             25 N=21
000182             30 FP=(P-BP(N))/DP(N)
000183                IP=FP
000184                IF(IP.GT.MX(N)) IP=MX(N)
000185                F=FP-IP
000186                FP=1.0-F
000187                FT=(T-BT(N))/DT(N)
000188                IT=FT
000189                FF=FT-IT
000190                FT=1.0-FF
000191                I=IT*JP(N)+IP+LOC(N)
000192                J=I+JP(N)
                      FI...SC=FP*FT*V(I)+F*FT*V(I+1)+FP*FF*V(J)+F*FF*V(J+1)
                   35 FT...(V...) = FT...(SC + 9561.0
000195                RETURN
000196                END
```

```
@ ELT EVEN,1,711119, 35473

000001                SUBROUTINE EVEN
000002                COMMON /ZRR/ ZF(200),RF(200),XF(200),ARF(200),ZDIS(50)
000003               1,NF
000004                COMMON/INGRAM/ Z(200), R(200), X(200),          RDIS( 50),
000005               1     XDIS( 50), ZI(200), RI(200), SINA, SINB, COSA, COSB, TANA,
000006               2     TANB, ZO, ZB, ZSTAR, Z1, Z2, Z3, Z5, Z6, RC, R2, R3, RSTAR,
000007               3     R5, R6, X1, X2, X3, X4, X5, X6, EPS, DX01, DX12, DX23, DX34,
000008               4     DX45, DX56, A0, A1, A2, RB, RU, RD, ALPHA, BETA, XTEMP, DZ,
000009               5     ARAT
000010               6          ,    N1, N2, N3, N4, N5, N6, IPL, NDL, NC, NDFL, ND,
000011               7     NI, K
000012            C   *** FUNCTION DEFINING Z-COORDINATE FOLLOWING TAN PT ZZ.
000013                M(ZZ, DZZ) = (ZZ + .000001) / DZZ
000014                N = 2
000015                Z(1) = 0.
000016                R(1) = RC
000017                X(1) = 0.
000018           3000 Z(N) = Z(N-1) + DZ
000019                R(N) = RC
000020                X(N) = Z(N)
000021                IF (Z(N) - Z1) 3010, 3020, 3030
000022           3010 N = N + 1
000023                GO TO 3000
000024           3020 Z(N+1) = Z(N) + DZ
000025                GO TO 3040
000026           3030 Z(N) = Z1
000027                R(N) = RC
000028                X(N) = X1
000029                Z(N+1) = DZ * (M(Z1, DZ) + 1)
000030           3040 N = N + 1
000031                REM = Z(N) - Z1
000032                DR= SQRT(RB*RB-REM*REM)                                  00002795
000033                R(N) = RC - RB + DR
000034                X(N)=X1+RB*.ATAN(REM/DR)                                 00002805
000035                IF (Z(N) - Z2) 3020, 3050, 3060
000036           3050 Z(N+1) = Z(N) + DZ
000037                GO TO 3070
000038           3060 Z(N) = Z2
000039                R(N) = R2
000040                X(N) = X2
000041                Z(N+1) = DZ * (M(Z2, DZ) + 1)
000042           3070 N = N + 1
000043                REM = Z(N) - Z2
000044                DR = REM * TANB
000045                DX = REM / COSB
000046                R(N) = R2 - DR
000047                X(N) = X2 + DX
000048                IF (Z(N) - Z3) 3050, 3080, 3090
000049           3080 Z(N+1) = Z(N) + DZ
000050                GO TO 3100
000051           3090 Z(N) = Z3
000052                R(N) = R3
000053                X(N) = X3
000054                Z(N+1) = DZ * (M(Z3, DZ) + 1)
000055           3100 N = N + 1
000056                REM = ZSTAR - Z(N)
```

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```
000057                DR= SQRT(RU*RU-REM*REM)                                    00002920
000058                R(N) = RSTAR + RU - DR
000059                X(N)=X4-RU* ATAN(REM/DR)                                   00002930
000060                IF (Z(N) - ZSTAR) 3080, 3110, 3120
000061           3110 Z(N+1) = Z(N) + DZ
000062                GO TO 3130
000063           3120 Z(N) = ZSTAR
000064                R(N) = RSTAR
000065                X(N) = X4
000066                Z(N+1) = DZ * (M(ZSTAR, DZ) + 1)
000067           3130 N = N + 1
000068                REM = Z(N) - ZSTAR
000069                DR= SQRT(RD*RD-REM*REM)                                    00002980
000070                R(N) = RSTAR + RD - DR
000071                X(N)=X4+RD* ATAN(REM/DR)                                   00002990
000072                IF (Z(N) - Z5) 3110, 3140, 3150
000073           3140 Z(N+1) = Z(N) + DZ
000074                GO TO 3160
000075           3150 Z(N) = Z5
000076                R(N) = R5
000077                X(N) = X5
000078                Z(N+1) = DZ * (M(Z5, DZ) + 1)
000079           3160 IF (NC) 3210, 3170, 3210
000080           3170 N = N + 1
000081           C    *** COMPUTE COORDINATES FROM DPT TO EXIT FOR CONICAL NOZZLES.
000082                REM = Z(N) - Z5
000083                DR = REM * TANA
000084                DX = REM / COSA
000085                R(N) = R5 + DR
000086                X(N) = X5 + DX
000087                IF (Z(N) - Z6) 3190, 3205, 3200
000088           3190 Z(N+1) = Z(N) + DZ
000089                GO TO 3170
000090           3200 Z(N) = Z6
000091                R(N) = R6
000092                X(N) = X6
000093           3205 N6=N
000094                RETURN
000095           3210 XTEMP = X5
000096           C    *** COMPUTE COORDINATES OF PTS. AT INTERVALS DZ AND OF DISCONTINUI-
000097           C    *** TIES BETWEEN DPT AND EXIT FOR CONTOURED NOZZLES.
000098                K = 0
000099                ND = 0
000100                NI = 3
000101           3220 N = N + 1
000102           3230 IF (Z(N) - ZI(NI)) 3240, 3240, 3310
000103           3240 IF (K) 3250, 3250, 3260
000104           C    *** FIT CURVE TO NEW INTERVAL
000105           3250 CALL FIT (ZI, RI, A0, A1, A2, NI)
000106                K = 1
000107           3260 R(N) = A0 + A1 * Z(N) + A2 * Z(N) * Z(N)
000108                X(N) = XTEMP + DXF (ZI(NI-2), Z(N), A1, A2)
000109                Z(N+1) = Z(N) + DZ
000110                GO TO 3220
000111           3270 ND = 0
000112           3280 IF (NDFL) 3320, 3320, 3290
000113           3290 ND = ND + 1
000114                IF (ND.GT.50) GO TO 500
000115                IF (ZDIS(ND) - Z5) 3290, 3290, 3300
000116           500  WRITE (6,505)
```

```
000117          505   FORMAT (1H0'THE SUBSCRIPT ND IN EVEN IS GREATER THAN 50'/////)
000118                STOP 3
000119         3300   IF (ZDIS(ND) - Z5) 3305,329,329
000120          3305 REM=ZDIS(ND)-75
000121                DR = REM * TANA
000122                DX = REM / COSA
000123                RDIS(ND) = R5 + DR
000124                XDIS(ND) = X5 + DX
000125         329    NDFL = NDFL - 1
000126                GO TO 3280
000127          3310 CALL DIS
000128                IF (NI - IPL) 3230, 3230, 3320
000129          3320 N6 = N
000130          3330 Z(N) = ZI(IPL)
000131                R(N) = RI(IPL)
000132                X(N) = XTEMP + DXF (ZI(NI-2), Z(N), A1, A2)
000133                RETURN
000134                END
```

```
@ ELT FILES,1,711229, 55352

000001              NTAR$  9
000002              READ 5
000003              PRINT 6
000004              DRUM 3,SCRTCH
000005              TAPE 9,  'G'
000006              END
```

```
@ ELT FIT,1,711119, 35476

000001                SUBROUTINE FIT (ZX, RX, A, B, C, NI)
000002          C   *** FITS PARABOLA TO - -(ZX(NI-2), RX(NI-2)), (ZX(NI-1), RX(NI-1)),
000003          C   ***     AND (ZX(NI), RX(NI)).
000004                DIMENSION ZX(100), RX(100), Z(3), R(3), Q(3)
000005                NL = NI - 3
000006                DO 200 I = 1, 3
000007                NL = NL + 1
000008                Z(I) = ZX(NL)
000009                R(I) = RX(NL)
000010              200 Q(I) = Z(I) * Z(I)
000011                A = Q(1) * Z(2) + Q(3) * Z(1) + Q(2) * Z(3)
000012               1     - Q(3) * Z(2) - Q(1) * Z(3) - Q(2) * Z(1)
000013                B = (Q(1) * R(2) + Q(3) * R(1) + Q(2) * R(3)
000014               1     - Q(3) * R(2) - Q(1) * R(3) - Q(2) * R(1)) / A
000015                C = (Z(2) * R(1) + Z(1) * R(3) + Z(3) * R(2)
000016               1     - Z(2) * R(3) - Z(3) * R(1) - Z(1) * R(2)) / A
000017                A = R(1) - B * Z(1) - C * Z(1) * Z(1)
000018                RETURN
000019                END
```

```
@ ELT GEOM,1,711218, 49758

000001                SUBROUTINE  GEOM                                                                679
000002                REAL J,K1,K2,K3,K4,KC,KCF,KM,KMP,KWG,KFAC,L,MC,MR,MUB,MUCF,
000003               X       MUGF,MUW,NMB,NT,N1P,N2P,N3P,N4P,N5P,N6P,NMBP
000004                REAL  KB,KWL,K5,K5P,K6,LP,MUWL,MW,NC,NDL
000005                REAL LH(100),LW
000006                COMMON / ZXR/  ZZZZZZ(200), RRRRRR(200), SSSSSS(200), AAAAAA(200),
000007               1  TAZ1(50)    , INTOT
000008                COMMON / VAR/  TUBE(100)   , PPFM(100)   , EEPGEO(100), TTATMR(20) ,
000009               1  TTAKMR(79) , MMAT(4)     , TTATWM(25) , TTASTR(25) , TMKM(100)
000010                COMMON / INT/  IKMAX       , ILHITF      , ICGITE      , IITRFL      ,
000011               1  IKERR       , IN          , ITUBE       , INUM        , IDIS        ,
000012               2  IFRIC       , ITNUM1      , IZPTS       , IZSTEP      , IWALL       ,
000013               3  IMERCR      , IHGC        , IHLC        , IFILM       , IRPO        ,
000014               4  I8085       , ICOOL       , ITF         , ISZ         , ICONLB
000015                COMMON / CORREL / SZ(3), LH, LW
000016                COMMON/ CON/  AA     ,ABAR   ,AE     ,AF     ,AFP    ,AS     ,AL     ,        687
000017               1A0     ,ASTAR ,AV     ,B      ,BETA   ,C1     ,CL     ,CG     ,CC1    ,        688
000018               2CC2    ,CP    ,CPP    ,CPBAR  ,CPGF   ,D      ,DE     ,E1     ,E2     ,        689
000019               3F3     ,E4    ,E      ,F      ,FBAR   ,FEFV   ,FS     ,FC     ,FP     ,        690
000020               4G0     ,G1    ,G      ,H      ,HBC    ,HC     ,HIN    ,HMIX   ,HOUT   ,        691
000021               5HG     ,HL    ,HL1    ,HR     ,J      ,K1     ,K2     ,K3     ,K4     ,        692
000022               6KC     ,KCF   ,KM     ,KMP    ,KWG    ,KFAC   ,L      ,MC     ,MR     ,        693
000023               7NMB    ,NT    ,N1P    ,N2P    ,N3P    ,N4P    ,N5P    ,N6P    ,PIE    ,        694
000024               8PSC    ,PC    ,PG     ,PFM    ,PRCF   ,PRGF   ,P      ,PP     ,PF     ,        695
000025               9PIN    ,PLS   ,POUT   ,PRC    ,PV     ,Q      ,QQA    ,QQAM   ,QQAO   ,        696
000026               OR      ,RC    ,RD     ,RM     ,RU     ,RB     ,RSTAR  ,RCV    ,SMALD  ,        697
000027               1SMALRA,SMALRG,SC     ,S      ,STR    ,STRY   ,SMALTC,SMALTM,SMALTS,          698
000028               2SMARGP,TB     ,TBP    ,TBC    ,TC     ,TRCF   ,TCF    ,TGF    ,TIN    ,       699
000029               3TM     ,TMIX  ,TWG    ,TWGC   ,TWL    ,TWLC   ,TWM    ,TO     ,TINFIN,        700
000030               4TBAR   ,U     ,V      ,VF     ,VC     ,VP     ,VNS    ,WG     ,WGCORE,        701
000031               5WGSTAR,WC     ,WBC    ,WF     ,X      ,XP     ,XI     ,Z      ,ZP     ,       702
000032               6ZB     ,ZD    ,ZOL    ,ZN     ,ZU     ,ZW     ,ZSTAR  ,FHAF   ,MUB    ,       703
000033               7MUCF   ,MUGF  ,MUW    ,RHO    ,RHOB   ,RHOBP  ,RHOCF  ,RHOGF  ,RHOW   ,       704
000034               8RHOBAR,RP     ,EP0GEO,EP1GEO,NMBP   ,GAMMAC,SMALA  ,EPGEOM,AASTAR,          705
000035               9SMATMP,RHOP   ,ALPHAA,BETAA  ,EP0    ,EP1                                     706
000036                COMMON /   S/  IDATA1(20) , IITLE(20)  , INU(10)     , TATM(9)     ,
000037               1  TAKM(9)     , TATM1(20)  , TAKM1(20)  , TATWM(25)  , TASTRY(25)  ,
000038               2  TATMR(20)   , TAKMR(79)  , TPRPC(50)  , TPK(100)   , TTINK(100)  ,
000039               3  TRHOK(100) , THK(100)    , TVK(100)    , TAZ(100)    , TASMTM(100),
000040               4  TACG(100)   , TACL(100)   , TAKC(100)   , TATC(100)   , TASMD(100)  ,
000041               5  TASNL(100) , TASMTS(100), TABETA(100), TAAF(100)   , TATWG(100)  ,
000042               6  TAFEFV(100), TANMB(100) , TANT(100)  , TAWDOT(100), TAAST(100)  ,
000043               7  TASMDS(100)
000044                COMMON/SHEEHY/ DS          , W           , WP          , AFBAR       ,
000045               1  K5          , VCBAR       , K5P         , TWMC        , VCP         ,
000046               2  TSAT        , FCBAR       , K6          , TSATK       , FCP         ,
000047               3  PD          ,  FRHOV      , CPCF        , MUWL        , CB2         ,
000048               4  KB          , CPWL        , CPB         , RHOWL       , KWL         ,
000049               5  CB1         , ZETA        , MW          , COEF(4,5)   , LP          ,
000050               6  DUMPEM      , PXM(100)    , PDM(100)    , NDL         , DZ          ,
000051               7  NC          , SMATCP
000052                COMMON/CLTABL/TATB(10),TACL2(10),ICLFG
000053                CALL LINTX  (TAZ,TACL  ,Z,CL,100)                                    00007350
000054                IF(CL .LE. 0.) GO TO 9033
000055                ICLFG=0
000056           9034 CALL LINTX  (TAZ,TASMTM,Z,SMALTM,100)                                00007380
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000057                CALL LINTX  (TAZ,TACG  ,Z,CG,100)                    00007390
000058                IF(CG .LE. 0.) CG=.026                                  726
000059                CALL LINTX  (TAZ,TAKC  ,Z,KC,100)                    00007410
000060                IF(KC .EQ. 0.) KC=1.E10
000061                CALL LINTX  (TAZ,TATC  ,Z,SMALTC,100)                00007430
000062                CALL LINTX ( TAZ,TAAF,Z, AF,100)                     00007440
000063                TEMP=AASTAR                                             731
000064                CALL LINTX(TAAST,TVK,TEMP,V,100)                     00007470
000065                CALL LINTX(TAAST,TPK,TEMP,PG,100)                    00007480
000066                CALL LINTX(TAAST,TTINK,TEMP,TINFIN,100)              00007490
000067                CALL LINTX (TAZ,TASMD ,Z,SMALD,100)                  00007510
000068                CALL LINTX(TAZ,PXM,Z,K6,100)                         00007520
000069                CALL LINTX(TAZ,PDM,Z,K5,100)                         00007530
000070                SMALRG =  R / ( NT/ PIE - 1.E0)                         740
000071          C CHECK VARIABLE TUBE TYPE                                 00007601
000072                CALL LINTX (TAZ, TUBE, Z, TUBEE, 100)                00007604
000073                ITUBE = TUBEE                                        00007605
000074          C CHECK FOR LEG HEIGHT ITERATION
000075                IF( ILHITE ) 1,2,1                                      741
000076           9033 CALL LINTX(TATB,TACL2,TB,CL,10)
000077                ICLFG=1
000078                GO TO 9034
000079          C CHECK FOR TUBE TYPE
000080                IF ( ITUBE .LT. 1) RETURN 0
000081           2    GO TO (20,21,3,4), ITUBE                                742
000082          C *****  RECT. SLOTS
000083          20    CALL LINTX (TAZ,TASML ,Z,L,100)                      00007630
000084                CALL LINTX (TAZ,TASMDS,Z,DS,100)                     00007640
000085                W = 2.E0 * PIE * (R + SMALTM)/NT - L                    745
000086                SMALRG=(W+SMALTM)/2.0
000087                AF = W*DS                                               746
000088                DE =  2.E0 * AF / (W + DS)
000089                AS=.5*(W+L+WP+LP)* ABS(X-XP)*EPGEOM                     748
000090                IF(IN .EQ. 1) AS=0.                                     749
000091                GO TO 101                                               750
000092          C *****  TRUNCATED
000093          21    Q58 = SMALTM / SMALRG                                   751
000094                Q59=ACOS(Q58)
000095                Q60 = 2.E0 * SMALRG                                     753
000096                SMALDM = Q60 / PIE  * (PIE - Q59 +  SIN(Q59))           754
000097                IF (SMALD.LE.SMALDM) GO TO 22                           755
000098                IF(SMALD .GE. Q60) GO TO 3                              756
000099                X = 0.E0                                                757
000100                DX = .1E0                                               758
000101                E = 0.E0                                                759
000102                Q99=PIE*(1.E0-SMALD/Q60)                                760
000103                CALL ROOT(16)                                           761
000104                FOFX= SIN(X)-X+Q99                                      762
000105                WRITE(6,1000) X,DX,FOFX                                 763
000106            1000 FORMAT(3E20.8)                                         764
000107                CALL ROOTB(X,DX,FOFX,E,IK)                              765
000108                IF (IK.LT.0) WRITE (6,500)                              766
000109          500   FORMAT (78H0CANNOT FIND ROOT OF SIN(X) - X + PIE * (1 - SMALD/2SMA  767
000110          C*********************WHAT NOW...*********************************** 768
000111               1LRG) IN SUBROUTINE GEOM)                                769
000112                L = SMALRG *  COS(X)                                    770
000113                Q61 =  (L - SMALTM) / (SMALRG - SMALTM)                 771
000114                ALPHA=ASIN(Q61)
000115          23    Q62 = SMALRG - SMALTM                                   773
000116                Q63 = PIE /2.E0 + ALPHA                                 774
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```
000117                Q64= COS(ALPHA)                                                  775
000118                AF=Q62*(Q62*Q63+Q64*(L-SMALTM))                                  776
000119                DEN=Q62*(Q63+Q64)                                                777
000120                DE = 2.E0 * AF /DEN                                              778
000121                GO TO 1                                                          779
000122           22   L  = SMALTM                                                      780
000123                ALPHA  = 0.E0                                                    781
000124                X=Q59                                                            782
000125                GO  TO  23                                                       783
000126           C ***** ROUND OR FLATTENED
000127           3    S =  PIE * SMALD                                                784
000128                SMALRA =  PIE *( 2.E0*(R+ SMALRG)+S - PIE*SMALRG ) /             785
000129               1              ( 2.E0*NT + PIE*PIE )                             786
000130           35   L = (S - PIE *( SMALRG + SMALRA )) / 2.E0                        787
000131                IF(L .GE. 0.) GO TO 6                                            788
000132           5    SMALD = 2.E0* SMALRG                                            789
000133                SMALRA=     SMALRG                                              790
000134                S     = PIE * SMALD                                             791
000135                L     = 0.E0                                                    792
000136           6    Q50 =  SMALRG + SMALRA - 2.E0* SMALTM                           793
000137                AF  =  PIE / 2.E0 *(  (SMALRG -SMALTM )**2  +                   794
000138               1                    (SMALRA -SMALTM )**2  ) + L * Q50          795
000139                    DE =  4.E0* AF / ( PIE * Q50 + 2.E0*L )                     796
000140           1    CONTINUE                                                        797
000141                CALL LINTX (TAZ,TASMTS,Z,SMALTS,100)
000142                SMALRG = (PIE * R - NT * .5 * SMALTS)/(NT - PIE)
000143                IF( IN .EQ. 1 ) GO TO 100                                       798
000144                AS=  PIE/2.E0*( SMALRG-SMALTC + SMARGP-SMATCP)* ABS(X-XP)*EPGEOM 799
000145             101 CALL LINTX(TAZ,TAFEFV,Z,FEFV,100)                                *NEW
000146                IF(FEFV.LT.0.) GO TO 10                                          *NEW
000147             102 RETURN                                                          *NEW
000148              10 IF(Z.EQ.0.E0) GO TO 11                                          **-1
000149                Q51 =  R*R / Z / Z
000150                Q52 =  Z*Z / RC / RC                                            804
000151                Q53 = 1.E0 + (1.E0+ Q51)* Q52                                   805
000152                F   =  .5E0 * ( Q53 - SQRT ( Q53*Q53 - 4.E0*Q51 * Q52 )  )      806
000153                IF( Z .LT. ZSTAR ) GO TO 11                                     807
000154                   G1=0.E0                                                      808
000155                RETURN                                                          810
000156           11    IF( Z .EQ. 0.E0 ) F=1.                                         811
000157                FBAR = ABS( F - FP )                                            812
000158                ABAR = PIE*( R+ RP)*  SQRT( (Z - ZP)**2 + (R- RP)** 2 )         813
000159                GO = 1.E0/FBAR                                                  814
000160               X             +  1.E0/ EPOGEO - 1.E0 + PIE * RC * RC / ABAR *(1.E0 815
000161               1  /EP1GEO - 1.E0)                                              816
000162                GO =  1.E0 / GO                                                 817
000163                G1 =  GO * PIE * RC * RC / ABAR                                 818
000164                RETURN                                                          819
000165           C ***** U-TUBE
000166            4   CALL LINTX (TAZ ,TASML , Z , L,100)                          00008440
000167                CALL LINTX (TAZ ,TASMTS, Z , SMALTS,100)                      00008450
000168                CALL LINTX (TAZ,LH,Z,UW,100)
000169                SMALRG =  (PIE * R -NT*   .5E0 * SMALTS ) / (NT - PIE )         822
000170                IF(AF .EQ. 0.E0 ) GO TO 41                                      823
000171                QX3    =  SMALRG - SMALTM                                       824
000172                AF = AF + UW*(2*QX3-2*LW)
000173                QX1= R+SMALRG+NT*(2.E0*QX3-SMALTS -2.E0*SMALTM)/ PIE / 2.E0      826
000174                QX2= NT/2.E0*QX3*QX3 - NT/ PIE * AF                             827
000175                L  = .5E0* ( SQRT(QX1*QX1-4.E0*QY2)- QX1 )                      828
000176           41   CONTINUE                                                        829
```

```
000177                B    = 2.E0/ NT * PIE * (R+ SMALRG + L ) - SMALTS                830
000178                UL = B - 2.0*SMALTM - 2.0*LW
000179                D56 = SMALRG - SMALTM                                            831
000180                AF   = .5E0 *( PIE * D56 *D56 + L *(  2.E0* D56 + B              832
000181               1-2.E0* SMALTM ) )                                                833
000182                IF (UW .LT. 0.00) AF = AF +  ABS(UW*UL)
000183                IF (UW .GT. 0.00) AF = AF -  ABS(UW*UL)
000184                DE=4.*AF/(PIE*(SMALRG-SMALTM)+2.*L+(B-2.*SMALTM)+2.*ABS(UW))
000185                GO TO 1                                                          835
000186          C                                                                      836
000187          100   AS=0.0
000188                 GO TO 101                                                       838
000189          C                      T      H         E                            839
000190                                 E         N         D                         840
```

```
@ ELT GRAPH,1,711229, 55350

000001                SUBROUTINE GRAPH(IPLOT)
000002          C                                                               C
000003          C*****************************************************************C
000004          C*                                                              *C
000005          C*      THIS SUBROUTINE MAKES 11 X 17 INCH PLOTS OF VARIOUS PARAMETERS  *C
000006          C*      VS LENGTH      THE FOLLOWING FUNCTIONS ARE PLOTTED      *C
000007          C*                                                              *C
000008          C*      COOLANT PRESSURE                    IF IPLOT(1)  = 1    P    *C
000009          C*      COOLANT TEMPERATURE                 IF IPLOT(2)  = 1    T    *C
000010          C*      RADIUS                              IF IPLOT(3)  = 1    R    *C
000011          C*      COOLANT SIDE HEAT TRANSFER COEFFICIENT IF IPLOT(4)  = 1  HL   *C
000012          C*      GAS SIDE HEAT TRANSFER COEFFICIENT  IF IPLOT(5)  = 1    HG   *C
000013          C*      WALL THICKNESS                      IF IPLOT(6)  = 1    TMW  *C
000014          C*      GAS SIDE WALL TEMPERATURE           IF IPLOT(7)  = 1    TG   *C
000015          C*      COOLANT CHANNEL FLOW AREA           IF IPLOT(8)  = 1    ACH  *C
000016          C*      COOLANT CHANNEL LEG HEIGHT          IF IPLOT(9)  = 1    CCLH *C
000017          C*      GAS SIDE CG                         IF IPLOT(10) = 1    CG   *C
000018          C*                                                              *C
000019          C*      DECEMBER 1971       J J WILLIAMS                        *C
000020          C*                                                              *C
000021          C*****************************************************************C
000022          C                                                               C
000023                DIMENSION X(102),P(102),T(102),R(102),HL(102),HG(102),TMW(102),
000024               1        TG(102),ACH(102),CCLH(102),CG(102),IPLOT(10)
000025                DIMENSION IBUF(1000),XTITLE(2),YTITLE(2,10),TITLE(14),C(6),TA(102)
000026                DATA XTITLE/'LENGTH','  - IN '/
000027                DATA YTITLE/'PRESSU','RE    ','COOLAN','T TEMP',
000028               1            'RADIUS',' - IN ','COOLAN','T HL  ',
000029               2            'GAS SI','DE HG ','WALL T','HICKNS',
000030               3            'GAS WA','LL TEM','FLOW A','REA   ',
000031               4            'LEG HE','IGHT  ','GAS SI','DE CG '/
000032              1 FORMAT(9A4)
000033              2 FORMAT(13A6,A2,I4)
000034              3 FORMAT(6A4,2F6.1)
000035              4 FORMAT(2F5.0,2F7.1,F5.2,F5.0)
000036              5 FORMAT(I3,F7.2,F7.4,F7.0,F7.4,F8.5,F6.2)
000037              6 FORMAT(F6.1,2F6.3,F6.0,E11.4,F6.1)
000038              7 FORMAT(F7.2,F7.4,F7.0,F5.1,F9.5,F8.2)
000039              8 FORMAT(F8.3,F7.4,F5.0,F6.0,E11.4,F6.4)
000040              9 FORMAT(9A4)
000041          C
000042                TITLE(1)='**    '
000043                REWIND 3
000044                REWIND 9
000045                CALL PLOTS(IBUF,1000,9)
000046                READ(3,1) (TITLE(J),J=2,10)
000047                READ(3,2) (TITLE(J),J=2,14),A1,NTOT
000048                READ(3,3)  C,A1,A2
000049                READ(3,4) A1,A2,A3,A4,A5,A6
000050                DO 100 LL=1,NTOT
000051                READ(3,5)N,A1,A2,A3,TMW(LL),HL(LL),R(LL)
000052                READ(3,6) T(LL),A1,ACH(LL),A2,A3,A4
000053                READ(3,7) X(LL),CG(LL),A1,A2,HG(LL),P(LL)
000054                READ(3,8) A1,CCLH(LL),A2,TG(LL),A3,A4
000055                READ(3,9) C,A1,A2,A3
000056              100 CONTINUE
```

```
000057                  CALL PLOT(0.,0.,-3)
000058                  CALL SCALE(X,14.,NTOT,1)
000059                  DO 300 LL=1,10
000060                  KK=IPLOT(LL)
000061                  IF(KK.EQ.0) GO TO 300
000062                  DO 200 JJ=1,NTOT
000063                  IF(LL.EQ.1) TA(JJ)=P(JJ)
000064                  IF(LL.EQ.2) TA(JJ)=T(JJ)
000065                  IF(LL.EQ.3) TA(JJ)=R(JJ)
000066                  IF(LL.EQ.4) TA(JJ)=HL(JJ)
000067                  IF(LL.EQ.5) TA(JJ)=HG(JJ)
000068                  IF(LL.EQ.6) TA(JJ)=TMW(JJ)
000069                  IF(LL.EQ.7) TA(JJ)=TG(JJ)
000070                  IF(LL.EQ.8) TA(JJ)=ACH(JJ)
000071                  IF(LL.EQ.9) TA(JJ)=CCLH(JJ)
000072                  IF(LL.EQ.10)TA(JJ)=CG(JJ)
000073              200 CONTINUE
000074                  CALL SCALE(TA,8.0,NTOT,1)
000075                  IF(TA(NTOT+2).EQ.0.) GO TO 400
000076              150 CONTINUE
000077                  CALL AXIS(0.,0.,XTITLE,-12,15.,0.,X(NTOT+1),X(NTOT+2))
000078                  CALL AXIS(0.,0.,YTITLE(1,LL),12,9.,90.,TA(NTOT+1),TA(NTOT+2))
000079                  CALL LINE(X,TA,NTOT,1,0,2)
000080                  CALL SYMBOL(1.,9.,.21,TITLE,0.,84)
000081                  CALL PLOT(18.,0.,-3)
000082              300 CONTINUE
000083                  CALL PLOT(0.,0.,999)
000084                  REWIND 9
000085                  RETURN
000086              400 SAVE = TA(1)
000087                  TA(1)=0.
000088                  CALL SCALE(TA,8.0,NTOT,1)
000089                  TA(1)=SAVE
000090                  GO TO 150
000091                  END
```

```
@ ELT HEAT,1,720221, 41913

000001      C                                                                    1422
000002      C     PROGRAM PLACED ON PRODUCTION 19 DECEMBER 1967                  1423.
000003      C     MODIFIED NOVEMBER 1971 TO USE ONLY NBS HYDROGEN
000004      C                                                                    1424
000005      C                HEAT ANALYZER                                       1425
000006      C                                                                    1426
000007      C     A ARRAY                          UNITS                         1427
000008      C                                                                    1428
000009      C     1 PRESSURE                       PSIA                          1429
000010      C     2 Z FACTOR                       NONE                          1430
000011      C     3 QUALITY                        NONE                          1431
000012      C     4 TEMPERATURE                    DEGR                          1432
000013      C     5 DENSITY                        LBS/IN3                       1433
000014      C     6 GAMMA                          NONE                          1434
000015      C     7 CP                             BTU/LB                        1435
000016      C     8 SONIC VELOCITY                 IN/SEC                        1436
000017      C     9 ENTROPY                        BTU/LB-DEGR                   1437
000018      C    10 THERMAL COND.                  BTU/IN-SEC-DEGR               1438
000019      C    11 VISCOSITY                      LBS/IN-SEC                    1439
000020      C    12 SPECIFIC VOL.                  IN3/LBS                       1440
000021      C    13 ENTHALPY                       BTU/LB                        1441
000022      C                                                                    1442
000023      C**********SUBPROGRAM DESCRIPTION**************************************C
000024      C                                                                     C
000025      C                                                                     C
000026      C     BLKNBS   -  NBS SPECIFIC HEAT DATA FOR PARAHYDROGEN             C
000027      C     BLOCK    -  MISC BLOCK DATA                                     C
000028      C     CALCTP   -  CALCULATES TEMPERATURE AND PRESSURAE AT SINGLE TUBE STATION  C
000029      C                 CALLS HLC AND HGC                                   C
000030      C     CHANGE   -  LOADS TASMD(I) WITH 2*(SMALTM + SQRT(AF/PIE))       C
000031      C                       TUBE(I)  WITH 3.                            C
000032      C                       LHITE(I) WITH 0.                            C
000033      C                       TASML(I) WITH L                             C
000034      C     CONTUR   -  DEVELOPES STATION DATA FOR CONTOUR GENERATION       C
000035      C     DELT     -  COMPUTES NUMBER OF SEGMENTS OR SEGMENT LENGTH       C
000036      C     DXF      -  ARC LENGTH CALCULATION                              C
000037      C     DINT4    -  LINEAR DOUBLE INTERPOLATION                         C
000038      C     DIS      -  GENERATES DISCONTINUITY TABLES                      C
000039      C     DUMP     -  DUMPS CON OR S COMMONS OR BOTH BY 10E12.5           C
000040      C     EQLKDA   -  NBS SPECIFIC HEAT DATA FOR EQUILIBRIUM HYDROGEN     C
000041      C     EFFECT   -  USED FOR PEM AND EPGOM ITERATION                    C
000042      C     EHTEMP   -  NBS EQUILIBRIUM HYDROGEN SUBROUTINE TO FIND T AND R C
000043      C     ERROR    -  CALL EXIT                                           C
000044      C     ETCOND   -  NBS EQUILIBRIUM HYDROGEN THERMAL CONDUCTIVITY       C
000045      C     ETCP     -  NBS EQUILIBRIUM HYDROGEN SPECIFIC HEAT (CALLS ETHEAT)  C
000046      C     ETDENS   -  NBS EQUILIBRIUM HYDROGEN DENSITY                    C
000047      C     ETENTH   -  NBS EQUILIBRIUM HYDROGEN ENTHALPY                   C
000048      C     ETHEAT   -  NBS EQUILIBRIUM HYDROGEN SPECIFIC HEAT              C
000049      C     ETSOUN   -  NBS EQUILIBRIUM HYDROGEN SONIC SPEED                C
000050      C     ETVISC   -  NBS EQUILIBRIUM HYDROGEN VISCOSITY                  C
000051      C     EVEN     -  COMPUTES STATION GEOMETRY                           C
000052      C     FILES    -  NTAB$                                               C
000053      C     FIT      -  FITS PARABOLA TO DATA                               C
000054      C     GEOM     -  DOES TUBE GEOMETRY CALCULATIONS                     C
000055      C     GRAPH    -  PLOTS SELECTED OUTPUT VARIABLES                     C
000056      C     HEAT     -  MAIN PROGRAM          **********       MAIN PROGRAM  C
```

```
000057      C     HGC      -  GAS SIDE HEAT TRANSFER COEFFICIENT                                  C
000058      C     HLC      -  LIQUID SIDE*HEAT TRANSFER COEFFICIENT                               C
000059      C     IIN      -  INPUT SUBROUTINE                                                    C
000060      C     INT4     -  STANDARD INTERPOLATION SUBROUTINE                                   C
000061      C     ITERAT   -  GAUSS ELIMINATION ROUTINE                                           C
000062      C     LINT     -  STANDARD INTERPOLATION ROUTINE                                      C
000063      C     LINTZ1   -  MODIFICATION OF LINT                                                C
000064      C     NRAP1    -  ITERATION SUBROUTINE                                                C
000065      C     OUT      -  LONG OUTPUT SUBROUTINE                                              C
000066      C     PHTEMP   -  NBS PARAHYDROGEN SUBROUTINE TO FIND T AND Q GIVEN P AND H           C
000067      C     PT       -  SUBROUTINE TO LOOK UP FLUID PROPERTIES AS A FUNCTION OF T           C
000068      C                 AND P.  PROPERTIES DEPEND ON ICOOL AND LCOOL                        C
000069      C     PTCOND   -  NBS PARAHYDROGEN SUBROUTINE FOR,THERMAL CONDUCTIVITY                C
000070      C     PTCP     -  NBS PARAHYDROGEN SUBROUTINE FOR SPECIFIC HEAT (CALLS PTHEAT)        C
000071      C     PTDENS   -  NBS PARAHYDROGEN SUBROUTINE FOR DENSITY                             C
000072      C     PTENTH   -  NBS PARAHYDROGEN SUBROUTINE FOR ENTHALPY                            C
000073      C     PTENTR   -  NBS PARAHYDROGEN SUBROUTINE ENTROPY                                 C
000074      C     PTGAS    -  SUBROUTINE TO CALCULATE GAS PROPERTIES AS A FUNCTION OF T           C
000075      C                 AND P                                                               C
000076      C     PTH      -  SUBROUTINE TO FIND COOLAND TEMPERATURE (FOR NBS PARAHYDROGEN        C
000077      C                 ONLY) FROM P AND H                                                  C
000078      C     PTHEAT   -  NBS PARAHYDROGEN SPECIFIC HEAT                                      C
000079      C     PTDOUN   -  NBS PARAHYDROGEN SONIC SPEED                                        C
000080      C     PTVISC   -  NBS PARAHYDROGEN VISCOSITY                                          C
000081      C     ROOT     -  STANDARD ROOT FINDER                                                C
000082      C     SECT     -  DOES NOZZLE GEOMETRY CALCULATIONS                                   C
000083      C     SIMEQ    -  STANDARD MATRIX INVERSION                                           C
000084      C     START    -  NOZZLE GEOMETRY CALCULATIONS                                        C
000085      C     SUBRBO   -  BURN OUT HEAT FLUX CALCULATION                                      C
000086      C     SUB1     -  A7 50 PROPERTIES                                                    C
000087      C     SUB2     -  WATER PROPERTIES                                                    C
000088      C     SUMARY   -  SHORT OUTPUT                                                        C
000039      C*******************************************************************************C
000090            REAL J,K1,K2,K3,K4,KC,KCF,KM,KMP,KWG,KFAC,L,MC,MR,MUB,MUCF,
000091           X      MUGF,MUW,NMB,NT,N1P,N2P,N3P,N4P,N5P,N6P,NMBP
000092            REAL  KB,KWL,K5,K5P,K6,LP,MUWL,MW,NC,NDL
000093            REAL LH(100), LW
000094            REAL LHITE
000095            DIMENSION QQD(177),QQZ(252),QQW(2300),IQQX(70), QQA(15)          00015670
000096            COMMON / CORREL / SZ(3),LH,LW,DEVD ,ITO
000097            COMMON /IISUM/ISUM
000098            EQUIVALENCE (AA,QQD(1)),(DS,QQZ(1)),(TPK(1),QQW(1))                1445
000099            COMMON/IGRAPH/IPLOT(10),IPFLAG
000100            EQUIVALENCE (IDATA1(1),IQQX(1))
000101            EQUIVALENCE(QQA(1),VDTC)
000102            DIMENSION  TATEMP(11),TAYIED(11),                                00011800
000103           ?           TATEM1(12),TAYIE1(12)                                 00011810
000104            DATA  TATEMP / 260.,460.,560.,760.,960.,1160.,1660.,1860.,2160.,  00012300
000105           ?  2360.,2560. / , TAYIED / 63E3,48E3,44E3,39E3,36E3,34E3,32E3,    00012310
000106           ?  29E3,16E3,10E3,5E3     /,TATEM1   / 60.,160.,260.,360.,460.,    00012320
000107           ?  660.,1060.,1460.,1760.,1960.,2210.,2460. /, TAYIE1 / 57E3,46E3, 00012330
000108           ?  38E3,34E3,31E3,28E3,23E3,19E3,18E3,14E3,6E3,3E3    /            00012340
000109            INTEGER HS(4) /'HAST','TELL','OY X','    '/
000110            INTEGER SS(4) /'STAI','NLES','S ST','EEL '/
000111            COMMON / ADD/  RE          , WDOTOA      , MAT(4)      , LHITE(100) ,
000112           1  CGITE(100) , ZCHAN
000113            COMMON / VAR/  TUBE(100)   , PPFM(100)   , FEPGEO(100), TTATMR(20) ,
000114           1  TTAKMR(79) , MMAT(4)     , TTATWM(25) , TTASTR(25) , TMKM(100)
000115            COMMON /  CF/  AJ          , DPI         , BJ          , DTI         ,
000116           1  KOUNT       , IGO         , IFLAG
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000117                DIMENSION QQQA(551)
000118                EQUIVALENCE (QQQA(1),TUBE(1))
000119                   COMMON /FLUIDP/ A(35)                                  1446
000120                COMMON / ZXR/  ZZZZZZ(200), RRRRRR(200), SSSSSS(200), AAAAAA(200),
000121               1  TAZ1(50)    , INTOT
000122                COMMON / INT/  IKMAX       , ILHITE      , ICGITE      , IITRFL      ,
000123               1  IKERR       , IN          , ITUBE       , INUM        , IDIS        ,
000124               2  IFRIC       , ITNUM1      , IZPTS       , IZSTEP      , IWALL       ,
000125               3  IMERCR      , IHGC        , IHLC        , IFILM       , IRBO        ,
000126               4  I8085       , ICOOL       , ITF         , ISZ         , ICONLB
000127                COMMON/ CON/  AA      ,ABAR    ,AE      ,AF      ,AFP     ,AS      ,AL      ,      1454
000128               1A0     ,ASTAR ,AV      ,B       ,BETA    ,C1      ,CL      ,CG      ,CC1     ,      1455
000129               2CC2    ,CP    ,CPP     ,CPBAR   ,CPGF    ,D       ,DE      ,E1      ,E2      ,      1456
000130               3E3     ,E4    ,E       ,F       ,FBAR    ,FEFV    ,FS      ,FC      ,FP      ,      1457
000131               4G0     ,G1    ,G       ,H       ,HBC     ,HC      ,HIN     ,HMIX    ,HOUT    ,      1458
000132               5HG     ,HL    ,HL1     ,HR      ,J       ,K1      ,K2      ,K3      ,K4      ,      1459
000133               6KC     ,KCF   ,KM      ,KMP     ,KWG     ,KFAC    ,L       ,MC      ,MR      ,      1460
000134               7NMB    ,NT    ,N1P     ,N2P     ,N3P     ,N4P     ,N5P     ,N6P     ,PIE     ,      1461
000135               8PSC    ,PC    ,PG      ,PFM     ,PRCF    ,PRGF    ,P       ,PP      ,PF      ,      1462
000136               9PIN    ,PLS   ,POUT    ,PRC     ,PV      ,Q       ,QOA     ,QOAM    ,QOAO    ,      1463
000137               0R      ,RC    ,RD      ,RH      ,RU      ,RB      ,RSTAR   ,RCV     ,SMALD   ,      1464
000138               1SMALRA ,SMALRG,SC      ,S       ,STR     ,STRY    ,SMALTC  ,SMALTM  ,SMALTS  ,      1465
000139               2SMARGP ,TB    ,TBP     ,TBC     ,TC      ,TRCF    ,TCF     ,TGF     ,TIN     ,      1466
000140               3TM     ,TMIX  ,TWG     ,TWGC    ,TWL     ,TWLC    ,TWM     ,TO      ,TINFIN  ,      1467
000141               4TBAR   ,U     ,V       ,VF      ,VC      ,VP      ,VNS     ,WG      ,WGCORE  ,      1468
000142               5WGSTAR ,WC    ,WBC     ,WF      ,X       ,XP      ,XI      ,Z       ,ZP      ,      1469
000143               6ZB     ,ZD    ,ZOL     ,ZN      ,ZU      ,ZW      ,ZSTAR   ,EHAF    ,MUB     ,      1470
000144               7MUCF   ,MUGF  ,MUW     ,RHO     ,RHOB    ,RHOBP   ,RHOCF   ,RHOGF   ,RHOW    ,      1471
000145               8RHOBAR ,RP    ,EPOGEO  ,EP1GEO  ,NMBP    ,GAMMAC  ,SMALA   ,EPGEOM  ,AASTAR  ,      1472
000146               9SMATMP ,RHOP  ,ALPHAA  ,BETAA   ,EP0     ,EP1     ,REYEXP  ,PRLEXP  ,TR
000147                COMMON /    S/  IDATA1(20) , IITLE(20)   , INU(10)     , TATM(9)     ,
000148               1  TAKM(9)     , TATM1(20)   , TAKM1(20)   , TATWM(25)   , TASTRY(25)  ,
000149               2  TATMR(20)   , TAKMR(79)   , TPRPC(50)   , TPK(100)    , TTINK(100)  ,
000150               3  TRHOK(100)  , THK(100)    , TVK(100)    , TAZ(100)    , TASMTM(100) ,
000151               4  TACG(100)   , TACL(100)   , TAKC(100)   , TATC(100)   , TASMD(100)  ,
000152               5  TASML(100)  , TASMTS(100) , TABETA(100) , TAAF(100)   , TATWG(100)  ,
000153               6  TAFEFV(100) , TANMB(100)  , TANT(100)   , TAWDOT(100) , TAAST(100)  ,
000154               7  TASMDS(100) , TMACH(100)
000155                COMMON /INRBO/ VDTC        , RBOFP       , RBOFT       , RBOA1       ,
000156               1  RBOA2       , RBOB1       , RBOB2       , RBON1       , RBON2       ,
000157               2  RBOM1       , RBOM2       , RBOC1       , RBOK1       , RBO         ,
000158               3  QOABO
000159                COMMON/SHEEHY/ DS          , W           , WP          , AFBAR       ,
000160               1  K5          , VCBAR       , K5P         , TWMC        , VCP         ,
000161               2  TSAT        , FCBAR       , K6          , TSATK       , FCP         ,
000162               3  PD          , FRHOV       , CPCF        , MUWL        , CB2         ,
000163               4  KB          , CPWL        , CPB         , RHOWL       , KWL         ,
000164               5  CB1         , ZETA        , MW          , COEF(4,5)   , LP          ,
000165               6  DUMPEM      , PXM(100)    , PDM(100)    , NDL         , DZ          ,
000166               7  NC          , SMATCP
000167                COMMON /AFCM/  FILMC       , FCBETA(500) , YPT(500)    , IPT
000168                COMMON/REUSS/QOAOP                                        1488
000169                COMMON/JOHNP/TAHL(50)
000170                COMMON/JOHNC/TAHG(50),IGAS,IK5,DEP
000171                COMMON /GARRY/ AVP, AVC, AVIN
000172                EXTERNAL ERROR
000173                      A(3)=0.                                             1489
000174          C                          START THE PROGRAM                  1490
000175                DO 1001 ITOM=1,551
000176           1001 QQQA(ITOM) = 0.
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```
000177                DO 1000 ITOM=1,177                                00016230
000178           1000 QQD(ITOM)=0.                                          1492
000179                DO 2000 ITOM=1,252                                00016250
000180           2000 QQZ(ITOM)=0.                                          1494
000181                DO 3000 ITOM=1,2300                               00016270
000182           3000 QQW(ITOM)=0.                                          1496
000183                DO 3002 ITOM=1,70
000184           3002 IQQX(ITOM)=0
000185                DO 3003 ITOM=1,50
000186                TAHL(ITOM)=0.0E0
000187           3003 TAHG(ITOM)=0.0
000188                DO 3008 ITOM=1,14
000189           3008 QQA(ITOM)=0.0E0
000190                QQAOP=0.0
000191                TSATK=500.                                             1497
000192                K1=1.
000193                K2=0.
000194                K3=1.
000195                K4=0.
000196                CC1=0.
000197                CC2=0.
000198                DO 304 IIJJ=1,100
000199                PPFM(IIJJ)=1.0
000200                PXM(IIJJ)=1.                                             *NEW
000201            304 PDM(IIJJ)=1.                                             **-1
000202                CG=.026                                                1500
000203                PIE=3.1415927                                          1501
000204                DEP=0.0
000205                J=9339.12                                              1502
000206                G=386.0886                                             1503
000207                C1=.0208                                               1504
000208                AL=1.0
000209                A0=1.0
000210                K5=1.0E0
000211                K5S=1.0
000212                CB1=1.
000213                CB2=1.
000214                IITRFL = 10
000215                IGO = 0
000216                KOUNT = 1
000217                EPOGEO = 1.0
000218                EP1GEO = .55
000219                RD = 0.0
000220                FILMC = 0.0
000221                ZCHAN = 0.0
000222           1    CALL IIN                                               1505
000223                AJ = 1.0
000224                BJ = 1.0
000225            100 CALL LINTZS(TAZ1,TANT,Z,ANS)                          00016520
000226                IF (IFLAG .EQ. 1 .AND. (ABS(AJ) .LE. .5E0 .AND. ABS(BJ) .LE. .5E0)
000227               ?    ) ISUM = 3
000228                F=0.                                                   1507
000229                FP=0.                                                  1508
000230                 SPIN= PIN                                             1509
000231                 TWLP= TWL                                             1510
000232                 TWGP= TWG                                             1511
000233                   TP=TIN                                              1512
000234                   PP=PIN                                              1513
000235                   P=PIN                                               1514
000236                TBP = T9                                               1515
```

```
000237                CALL PT (PIN, TIN)
000238                AVIN = A(13)
000239          C     FIRST STATEMENT                                    1516
000240                IN = 1                                             1518
000241          999   CONTINUE                                           1519
000242                IF (IN .EQ. 1)  GO TO 10
000243                IF ( TMKM(IN-1) .EQ. TMKM(IN)) GO TO 2
000244          C MATERIAL TYPE HAS CHANGED
000245             10 ITMKM = TMKM(IN)
000246                IF (ITMKM) 11,12,13
000247          C     HASTALLY X                                         00013450
000248             11 DO 55 I1=1,9
000249                TATMR(I1)= TATM(I1)                                00013470
000250             55 TAKMR(I1) = TAKM(I1)
000251             60 DO 61 I=1,4
000252             61 MAT(I) = HS(I)
000253                ITNUM1= 9                                          00013490
000254                 DO 21 I=1,11                                      00013500
000255                TATWM(I)=TATEMP(I)                                 00013510
000256             21 TASTRY(I)=TAYIED(I)                                00013520
000257                 GO TO 8                                           00013530
000258          C     STAINLESS STEEL                                    00013540
000259             12 DO 66 I1=1,20
000260                TATMR(I1)= TATM1(I1)                               00013560
000261             66 TAKMR(I1) = TAKM1(I1)
000262             63 DO 64 I=1,4
000263             64 MAT(I) = SS(I)
000264                ITNUM1= 17                                         00013580
000265                 DO 22 I=1,12                                      00013590
000266                TATWM(I)=TATEM1(I)                                 00013600
000267             22 TASTRY(I)=TAYIE1(I)                                00013610
000268                 GO TO 8                                           00013620
000269          C     EXPECT INPUT TABLES                                00013630
000270             13 DO 77 I1=1,20
000271                TATMR(I1) = TTATMR(I1)
000272             77 TAKMR(I1) = TTAKMR(I1)
000273                DO 78 I=1,4
000274             78 MAT(I) = MMAT(I)
000275                DO 79 I=1,25
000276                TATWM(I) = TTATWM(I)
000277             79 TASTRY(I) = TTASTR(I)
000278              8 CONTINUE
000279          2        R= RRRRRR(IN)                                   1520
000280                   Z= ZZZZZZ(IN)                                   1521
000281                   X= SSSSSS(IN)                                   1522
000282                DEVD = DEVD + ABS( X-XP )
000283                IF (IN .EQ. 1) DEVD = 0.0
000284                ITO=0
000285                AASTAR = AAAAAA(IN)                                1523
000286                CALL LINTZ1 (TAZ1, TANMB, Z, NMB, 0 )
000287                CALL LINTZ1 (TAZ1, TANT,  Z, NT,  0 )
000288                CALL LINTZ1 (TAZ1, TAWDOT,Z, WC,  1 )
000289                IF (FILMC .EQ. 0.00) GO TO 33
000290                CALL LINTX (YPT, FCBETA, Z, BETA, IPT)
000291                IF ( Z .EQ. 0.00) BETA = FCBETA(1)
000292                GO TO 34
000293             33 CALL LINTX(TAZ,TABETA,Z,BETA,100)
000294             34 CALL LINTX (TAZ,EEPGEO,Z,EPGEOM,100)               00016985
000295                CALL LINTX (TAZ,PPFM  ,Z  ,PFM ,100)
000296                CALL LINT (TAZ, LIITE, Z, HITE, 100)
```

```
000297                ILHITE = HITE + .05
000298                CALL LINT(TAZ, CGITE, Z, GITE, 100)
000299                ICGITE = GITE + .05
000300          C                                                              1528
000301          C  FOR ITERATION TWG IS INPUT AS CURVE DATA                    1529
000302                 IF(ILHITE.NE.0.OR.ICGITE.NE.0) CALL LINTX(TAZ,TATWG,Z,TWG,100)
000303                 CALL GEOM                                               1531
000304          C*******************************************************************
000305          C************NOTE THAT IMERCR IS USED AS BETA TEST*******************
000306          C*******************************************************************
000307                IF (IMERCR.EQ.1) GO TO 4
000308                  CALL PTGAS(PG,TINFIN)
000309                TEMP=A(11)*A(7)/A(10)                                    1533
000310                IF( BETA.GE. 0. ) GO TO 3                                1534
000311          C      BETA TABLE GOES IN HERE                                 1535
000312                BETA=TEMP**.33333333                                     1536
000313                BETA =  BETA + TINFIN/ TC - BETA/ TC                     1537
000314               1   *TINFIN                                              1538
000315                IF(ZETA .NE. 0.) BETA=ZETA**2*BETA                       1539
000316           3    CONTINUE                                                1540
000317           4    CONTINUE                                                1541
000318          C                                                             1542
000319                CALL ITERAT                                             1543
000320          C                                                             1544
000321                IF(IKERR .LE.IITRFL )  GO TO 4000                       1545
000322                CALL OUT(IITLE,IN,INTOT,IKERR)                          1546
000323                WRITE(6,3004) IKERR,IITRFL
000324           3004 FORMAT(1X,'**** IKERR WAS GREATER THAN IITRFL ****'/1X,'**** IKERR
000325               1=',I4,' AND IITRFL=',I4,' ****')
000326                GO TO 1                                                 1547
000327           4000 CONTINUE                                                1548
000328          C       STOP ABOVE IS TEMP  UNTIL ERROR RECOVERY IS PUT IN    1549
000329          C                                                             1550
000330                IF( ICGITE .EQ. 0) GO TO 5                              1551
000331          C     YES ON ICG ITERATION                                    1552
000332                HG = GOAO / ( TR - TWG ) - HR
000333          C     U =  FROM CALC?                                         1554
000334                U =( (SMALRG -SMALTM)/ (SMALRG +SMALTC)/ (HG + HR)      1555
000335               \     +(SMALRG-SMALTM)/KC*LOG((SMALRG+SMALTC)/SMALRG)
000336               \     +(SMALRG-SMALTM)/KM*LOG(SMALRG/(SMALRG-SMALTM))
000337               ?   + 1./ HL )                                           1558
000338                U = 1./ U                                               1559
000339                CALL HGC                                                1560
000340             5 STR = PRC * (SMALRG-SMALTM) / SMALTM
000341                CALL LINTX(TATWM,TASTRY,TWM,STRY,100)
000342                FS = STRY / STR                                         1563
000343          C     PRINT                                                   1564
000344                IF(IRBO .NE. 0) CALL SUBRBO                             1565
000345                CALL OUT (IITLE, IN, INTOT, IKERR )
000346                 NMBP=NMB                                               1567
000347                DEP=DE
000348                    AFP=AF                                              1568
000349                XP=    X                                                1569
000350                RP=    R                                                1570
000351                ZP=    Z                                                1571
000352                FP=    F                                                1572
000353                SMARGP=SMALRG                                           1573
000354                GOAOP=GOAO                                              1574
000355                SMATCP=SMALTC                                           1575
000356                SMATMP=SMALTM                                           1576
```

```
000357
000358                KMP=   KM                                                1577
000359                TBP =  TBC                                               1578
000360                RHOBP= RHOB                                              1579
000361                CPP=   CP                                                1580
000362                VP=    VC                                                1581
000363                PP =   PRC                                               1582
000364                RHOP=  RHOB                                              1583
000365                LP=L                                                     1584
000366                K5P=k5                                                   1585
000367                WP=W                                                     1586
000368                VCP=VC                                                   1587
000369                FCP=FC                                                   1588
000370                AVP = AVC
000371                IF ( Z .EQ. ZN .AND. ICONLB .EQ. 1 ) GO TO 90
000372             95 IF ( ZCHAN .NE. 0.00 .AND. Z .GE. ZCHAN ) CALL CHANGE
000373                   IN=IN+1                                               1590
000374                   IF(IN  .LE. INTOT )  GO TO 999                        1591
000375                IF ( IFLAG .NE. 1 ) GO TO 282
000376                E4 = 0.0
000377                IF (IGO .EQ. 0) CALL EFFECT(PFM,EPGEOM)
000378                IF (IGO .NE. 1) GO TO 100
000379                WRITE (6,97)
000380             97 FORMAT  (1H1)
000381                WRITE (6,98) (EEPGEO(I),I=1,INTOT)
000382             98 FORMAT ('0 EPGEOM TABLE'/(1H 10F12.5))
000383                WRITE (6,99) (PPFM(I),I=1,INTOT)
000384             99 FORMAT  ('0 PFM TABLE'/(1H 10F12.5))
000385                IGO = 0
000386                IFLAG = 0
000387            282 IF ( ICONLB .NE. 1 ) GO TO 1
000388                ICONLB = 0
000389                GO TO 100
000390             90 IT = INTOT - IN
000391                DO 91 IJB=1,IT
000392                LHITE(IJB) = 0.0
000393             91 TASML(IJB) = L
000394                GO TO 95
000395                      E          N        D                             1593
```

```
W ELT HGC,1,711218, 49763

000001                SUBROUTINE HGC                                                                  00659
000002                REAL J,K1,K2,K3,K4,KC,KCF,KM,KMP,KWG,KFAC,L,MC,MR,MUB,MUCF,
000003               X      MUGF,MUW,NMB,NT,N1P,N2P,N3P,N4P,N5P,N6P,NMBP
000004                REAL   KB,KWL,K5,K5P,K6,LP,MUWL,MW,NC,NDL
000005                REAL   MWINF
000006                REAL MWGF
000007                 COMMON /FLUIDP/ A(35)                                                          00685
000008                COMMON / INT/  IKMAX      , ILHITE     , ICGITE     , IITRFL     ,
000009               1  IKERR      , IN         , ITUBE      , INUM       , IDIS       ,
000010               2  IFRIC      , ITNUM1     , IZPTS      , IZSTEP     , IWALL      ,
000011               3  IMERCR     , IHGC       , IHLC       , IFILM      , IRBO       ,
000012               4  I8085      , ICOOL      , ITF        , ISZ        , ICONLB
000013                COMMON/ CON/  AA     ,ABAR   ,AE     ,AF     ,AFP    ,AS     ,AL     ,      00689
000014               1AO    ,ASTAR ,AV     ,B      ,BETA   ,C1     ,CL     ,CG     ,CC1    ,      00690
000015               2CC2   ,CP    ,CPP    ,CPBAR  ,CPGF   ,D      ,DE     ,E1     ,E2     ,      00691
000016               3E3    ,E4    ,E      ,F      ,FBAR   ,FEFV   ,FS     ,FC     ,FP     ,      00692
000017               4GO    ,G1    ,G      ,H      ,HBC    ,HC     ,HIN    ,HMIX   ,HOUT   ,      00693
000018               5HG    ,HL    ,HL1    ,HR     ,J      ,K1     ,K2     ,K3     ,K4     ,      00694
000019               6KC    ,KCF   ,KM     ,KMP    ,KWG    ,KFAC   ,L      ,MC     ,MR     ,      00695
000020               7NMB   ,NT    ,N1P    ,N2P    ,N3P    ,N4P    ,N5P    ,N6P    ,PIE    ,      00696
000021               8PSC   ,PC    ,PG     ,PFM    ,PRCF   ,PRGF   ,P      ,PP     ,PF     ,      00697
000022               9PIN   ,PLS   ,POUT   ,PRC    ,PV     ,Q      ,QOA    ,QOAM   ,QOAO   ,      00698
000023               OR     ,RC    ,RD     ,RN     ,RU     ,RB     ,RSTAR  ,RCV    ,SMALD  ,      00699
000024               1SMALRA,SMALRG,SC     ,S      ,STR    ,STRY   ,SMALTC,SMALTM,SMALTS,         00700
000025               2SMARGP,TH    ,TBP    ,TBC    ,TC     ,TRCF   ,TCF    ,TGF    ,TIN    ,      00701
000026               3TM    ,TMIX  ,TWG    ,TWGC   ,TWL    ,TWLC   ,TWM    ,TO     ,TINFIN,       00702
000027               4TBAR  ,U     ,V      ,VF     ,VC     ,VP     ,VNS    ,WG     ,WGCORE,       00703
000028               5WGSTAR,WC    ,WBC    ,WF     ,X      ,XP     ,XI     ,Z      ,ZP     ,      00704
000029               6ZB    ,ZD    ,ZOL    ,ZN     ,ZU     ,ZW     ,ZSTAR  ,EHAF   ,MUB    ,      00705
000030               7MUCF  ,MUGF  ,MUW    ,RHO    ,RHOB   ,RHOBP  ,RHOCF  ,RHOGF  ,RHOW   ,      00706
000031               8RHOBAR,RP    ,EP0GEO ,EP1GEO ,NMBP   ,GAMMAC ,SMALA  ,EPGEOM ,AASTAR ,      00707
000032               9SMATMP,RHOP  ,ALPHAA ,BETAA  ,EP0    ,EP1    ,REYEXP ,PRLEXP ,TR
000033                COMMON /    S/  IDATA1(20) , TITLE(20)  , INU(10)    , TATM(9)    ,
000034               1  TAKM(9)    , TATM1(20)  , TAKM1(20)  , TATWM(25)  , TASTRY(25) ,
000035               2  TATMR(20)  , TAKMR(79)  , TPRPC(50)  , TPK(100)   , TTINK(100) ,
000036               3  TRHOK(100) , THK(100)   , TVK(100)   , TAZ(100)   , TASMTM(100),
000037               4  TACG(100)  , TACL(100)  , TAKC(100)  , TATC(100)  , TASMD(100) ,
000038               5  TASML(100) , TASMTS(100), TABETA(100), TAAF(100)  , TATWG(100) ,
000039               6  TAFEFV(100), TANMB(100) , TANT(100)  , TAWOOT(100), TAAST(100) ,
000040               7  TASMDS(100), TMACH(100)
000041                COMMON/SHEEHY/ DS         , W          , WP         , AFBAR      ,
000042               1  K5         , VCBAR      , K5P        , TWMC       , VCP        ,
000043               2  TSAT       , FCBAR      , K6         , TSATK      , FCP        ,
000044               3  PD         , ERHOV      , CPCF       , MUWL       , CB2        ,
000045               4  KB         , CPWL       , CPB        , RHOWL      , KWL        ,
000046               5  CBJ        , ZETA       , MW         , COEF(4,5)  , LP         ,
000047               6  DUMPEM     , PXM(100)   , PDM(100)   , NDL        , DZ         ,
000048               7  NC         , SMATCP
000049                COMMON/TRANS/GAST(50),GASCP(50),GASK(50),GASRHO(50),GASMU(50),
000050               1   GASMWT(50)
000051                COMMON/JOHNC/TAHG(50),IGAS
000052                KOUNT = 0
000053                TGF = .5 * (BETA*TC + TWG)
000054                IF (IHGC .NE. 4) GO TO 50
000055                Q53 = 1.0 / 3.0
000056              20 CALL PTGAS (PG, TGF)
```

```
000057                PRGF = A(7) * A(11) / A(10)
000058                TGFC = .5 * (TWG + TINFIN) + .22 * PRGF**053 * (TC - TINFIN)
000059                IF ( ABS(TGF-TGFC) .LE. .1 ) GO TO 30
000060                TGF = TGFC
000061                KOUNT = KOUNT + 1
000062                IF ( KOUNT .LE. 11) GO TO 20
000063                WRITE (6,22)
000064             22 FORMAT ('0***** TGF ITERATION WILL NOT CLOSE IN 10 TRIES *****')
000065                IKERR = IITREL + 10
000066                WRITE (6,23) TGF, TGFC
000067             23 FORMAT (' TGF,TGFC...'2E15.8)
000068                RETURN
000069             30 TR = TINFIN + PRGF**053 * (TC - TINFIN)
000070                IF (BETA .GT. 0.0) TR = BETA * TC
000071                XK = A(10)
000072                MUGF = A(11)
000073                CPGF = A(7)
000074                RHOGF = A(5)
000075                GO TO 60
000076             50 CALL PTGAS(PG,TGF)
000077                MUGF =  A(11)                                          00711
000078                CPGF =  A(7)                                           00712
000079                PRGF =   A(7)* A(11) /A(10)                            00713
000080                RHOGF=  A(5)                                           00714
000081                CALL PTGAS(PG,TINFIN)
000082                RHO = A(5)                                             00716
000083                D   = 2. * R                                           00717
000084             60 GO TO (100,200,200,400), IHGC
000085            100 CONTINUE
000086                IF (ZW.EQ.0.0E0)  GO TO  1                             00718
000087                IF (Z.LE.ZW)  GO TO 2                                  00719
000088              1 WG = WGSTAR                                            00720
000089                GO TO 3                                                00721
000090              2 WG = WGCORE                                            00722
000091      3         CONTINUE                                               00723
000092                IF(IGAS-3) 6,7,6                                          *NEW
000093              7 CALL LINT(GAST,GASMWT,TINFIN,MWINF,50)                 00009280**-1
000094                CALL LINT(GAST,GASMWT,TGF,MWGF,50)                     00009290
000095                QTEMP=(4.0/PIE*WG/(MWINF*TGF)*(MWGF*TINFIN)/D**2.25)**.8
000096               1   *(MUGF**.2/PRGF**.6*CPGF)
000097                GO TO 8
000098              6  QTEMP=  (4.0  /PIE* WG/RHO* RHOGF/D**2.25)**.8 * (MUGF**.2/PRGF     00724
000099             . 1**.6 *CPGF)                                              00725
000100              8    IF(ICGITE ) 4,4,5
000101      4         HG= CG *QTEMP                                          00727
000102                RETURN                                                 00728
000103      5         CG= HG / QTEMP                                         00729
000104      C  CG ITER FLAG IS YES                                           00730
000105                RETURN                                                 00731
000106            200 CONTINUE
000107                FRHOV=1.
000108                WG=WGSTAR
000109                IF(IHGC-3)55,300,55
000110             55 HG=CG*(4./PIE*WG/TGF*TINFIN/D**2.25)**.8*(MUGF**.2/PRGF**.6*CPGF)
000111                RETURN
000112            300 CALL LINTX(TAZ,TAHG,Z,HG,50)
000113                RETURN
000114            400 IF (Z .EQ. 0.0) GO TO 401
000115                IF (Z .LE. ZW) GO TO 402
000116            401 WG = WGSTAR
```

```
000117                GO TO 403
000118           402  WG = WGCORE
000119           403  Q50 = (RHOGF * V * (X + .001)/MUGF)**REYEXP
000120                Q51 = (MUGF * CPGF / XK)**PRLEXP
000121                IF (ICGITE) 404,404,405
000122           404  HG=CG*Q50*Q51*XK/(X+.001)
000123                RETURN
000124           405  CG=HG/(Q50*Q51*XK/(X+.001))
000125                RETURN
000126                END                                                    00732
```

```
000001                SUBROUTINE HLC                                                    903
000002               REAL J,K1,K2,K3,K4,KC,KCF,KM,KMP,KWG,KFAC,L,MC,MR,MUB,MUCF,
000003              X      MUGF,MUW,NMB,NT,N1P,N2P,N3P,N4P,N5P,N6P,NMBP
000004               REAL   KB,KWL,K5,K5P,K6,LP,MUWL,MW,NC,NDL
000005               REAL LHITE
000006               REAL LH(100), LW
000007                COMMON/ FLUIDP/ A(35)                                            905
000008               COMMON / INT/  IKMAX      , ILHITE     , ICGITE     , IITRFL     ,
000009              1  IKERR      , IN         , ITUBE      , INUM       , IDIS       ,
000010              2  IFRIC      , ITNUM1     , IZPTS      , IZSTEP     , IWALL      ,
000011              3  IMERCR     , IHGC       , IHLC       , IFILM      , IRBO       ,
000012              4  I8085      , ICOOL      , ITF        , ISZ        , ICONLB
000013               DIMENSION SUM(4), FN(4)
000014               COMMON / CORREL / SZ(3),LH,LW,DEVD,ITO
000015               COMMON/ CON/  AA     ,ABAR  ,AE     ,AF     ,AFP   ,AS     ,AL     ,          910
000016              1AO     ,ASTAR ,AV     ,B     ,BETA   ,C1     ,CL    ,CG     ,CC1    ,          911
000017              2CC2    ,CP    ,CPP    ,CPBAR ,CPGF   ,D      ,DE    ,E1     ,E2     ,          912
000018              3E3     ,E4    ,E      ,F     ,FBAR   ,FEFV   ,FS    ,FC     ,FP     ,          913
000019              4GO     ,G1    ,G      ,H     ,HBC    ,HC     ,HIN   ,HMIX   ,HOUT   ,          914
000020              5HG     ,HL    ,HL1    ,HR    ,J      ,K1     ,K2    ,K3     ,K4     ,          915
000021              6KC     ,KCF   ,KM     ,KMP   ,KWG    ,KFAC   ,L     ,MC     ,MR     ,          916
000022              7NMB    ,NT    ,N1P    ,N2P   ,N3P    ,N4P    ,N5P   ,N6P    ,PIE    ,          917
000023              8PSC    ,PC    ,PG     ,PFM   ,PRCF   ,PRGF   ,P     ,PP     ,PF     ,          918
000024              9PIN    ,PLS   ,POUT   ,PRC   ,PV     ,Q      ,QOA   ,QOAM   ,QOAO   ,          919
000025              OR      ,RC    ,RD     ,RN    ,RU     ,RB     ,RSTAR ,RCV    ,SMALD  ,          920
000026              1SMALRA,SMALRG,SC     ,S     ,STR    ,STRY   ,SMALTC,SMALTM,SMALTS,           921
000027              2 SMARGP, TB  ,TBP,  TBC,  TC,  TRCF,  TCF,  TGF,  TIN,
000028              3TM     ,TMIX  ,TWG    ,TWGC  ,TWL    ,TWLC   ,TWM   ,TO     ,TINFIN,          923
000029              4TBAR   ,U     ,V      ,VF    ,VC     ,VP     ,VNS   ,WG     ,WGCORE,          924
000030              5WGSTAR,WC     ,WBC    ,WF    ,X      ,XP     ,XI    ,Z      ,ZP     ,          925
000031              6ZB     ,ZD    ,ZOL    ,ZN    ,ZU     ,ZW     ,ZSTAR ,EHAF   ,MUB    ,          926
000032              7MUCF   ,MUGF  ,MUW    ,RHO   ,RHOB   ,RHOBP  ,RHOCF ,RHOGF  ,RHOW   ,          927
000033              8RHOBAR,RP     ,EPOGEO,EP1GEO,NMBP   ,GAMMAC,SMALA  ,EPGEOM,AASTAR,           928
000034              9SMATMP,RHOP   ,ALPHAA,BETAA  ,EP0    ,EP1                                      929
000035               COMMON /   S/  IDATA1(20) , TITLE(20)  , INU(10)     , TATM(9)     ,
000036              1  TAKM(9)     , TATM1(20)  , TAKM1(20)  , TATWM(25)  , TASTRY(25) ,
000037              2  TATMR(20)   , TAKMR(79)  , TPRPC(50)  , TPK(100)    , TTINK(100) ,
000038              3  TRHOK(100)  , THK(100)   , TVK(100)   , TAZ(100)    , TASMTM(100),
000039              4  TACG(100)   , TACL(100)  , TAKC(100)  , TATC(100)   , TASMD(100) ,
000040              5  TASML(100)  , TASMTS(100), TABETA(100), TAAF(100)   , TATWG(100) ,
000041              6  TAFEFV(100), TANMB(100) , TANT(100)  , TAWDOT(100), TAAST(100) ,
000042              7  TASMDS(100)
000043               COMMON/SHEEHY/ DS          , W          , WP         , AFBAR      ,
000044              1  K5          , VCBAR      , K5P        , TWMC       , VCP        ,
000045              2  TSAT        , FCBAR      , K6         , TSATK      , FCP        ,
000046              3  PD          ,  FRHOV     , CPCF       , MUWL       , CB2        ,
000047              4  KB          , CPWL       , CPB        , RHOWL      , KWL        ,
000048              5  CB1         , ZETA       , MW         , COEF(4,5)  , LP         ,
000049              6  DUMPEM      , PXM(100)   , PDM(100)   , NDL        , DZ         ,
000050              7  NC          , SMATCP
000051               COMMON/CLTABL/TATB(10),TACL2(10),ICLFG
000052          C
000053               COMMON /THOMAS/ TTITT(296), PPPPP(296), TCRIT, PCRIT
000054               COMMON/JOHNP/TAHL(50)
000055               COMMON/JOHNC/TAHG(50),IGAS,IK5,DEP                                *NFW
000056               COMMON / ADD/  RE          , WDOTOA     , MAT(4)     , LHITE(100) ,
```

```
000057              1  CGITE(100) , ZCHAN
000058               HLF(F1,F2,F3,F4,F5,F6,F7,F8,F9)=CL /DE   *F1*(DE*VC     *F2/F3)**F7      934
000059              1    *(       F3*F4/F1)**F8*(F5/F6)**F9                                    935
000060               WDOTOA = WC / (NMB * AF)                                          00009980
000061         C  THIS STEP PICKS UP CL FROM AN INTERNAL TABLE IF THE INPUT
000062         C  TABLE (TESTED IN GEOM) YIELDED A NEGATIVE VALUE
000063               IF(ICLFG.EQ.1) CALL LINTX(TATB,TACL2,TB,CL,10)
000064               CALL PT(P,TB)                                                        936
000065               IPAUL=296
000066         88    CALL LINTX(PPPPP,TTTTT,P,TSAT,IPAUL)
000067         89    RHOB=A(5)
000068               VC=WC/(NMB*AF*RHOB)                                                  938
000069               IF(MW .EQ. 0.) GO TO 2001                                            939
000070               MUB=0.                                                               940
000071               MUCF=0.                                                              941
000072               MUWL=0.                                                              942
000073               CPB=0.                                                               943
000074               CPCF=0.                                                              944
000075               CPWL=0.                                                              945
000076               KB=0.                                                                946
000077               KCF=0.                                                               947
000078               KWL=0.                                                               948
000079               TSAT=0.                                                              949
000080               TOM=P*MW/10.73                                                       950
000031               RHOB=TOM/TB                                                          951
000082               RHOCF=TOM/TCF                                                        952
000083               RHOWL=TOM/TWL                                                        953
000084               DO 2000 I=1,5                                                        954
000085               TOM=TB**(I-1)                                                        955
000086               MUB=MUB+COEF(1,I)*TOM                                                956
000087               CPB=CPB+COEF(2,I)*TOM                                                957
000088               KB=KB+COEF(3,I)*TOM                                                  958
000089               TOM=TCF**(I-1)                                                       959
000090               MUCF=MUCF+COEF(1,I)*TOM                                              960
000091               CPCF=CPCF+COEF(2,I)*TOM                                              961
000092               KCF=KCF+COEF(3,I)*TOM                                                962
000093               TOM=TWL**(I-1)                                                       963
000094               MUWL=MUWL+COEF(1,I)*TOM                                              964
000095               CPWL=CPWL+COEF(2,I)*TOM                                              965
000096               KWL=KWL+COEF(3,I)*TOM                                                966
000097          2000 TSAT=TSAT+COEF(4,I)*P**(I-1)                                         967
000098          2001 CONTINUE                                                             968
000099               GO TO (100,200,300,400,500,600,700,800,900,1100,1200),IHLC
000100          100  CONTINUE                                                           970
000101               CALL PT (P, TB)                                                      971
000102               RHOB  = A(5)                                                         972
000103               SMALA = A(8)                                                         973
000104               MUB   = A(11)                                                        974
000105               CALL PT (P, TWL)                                                     975
000106               MUW   = A(11)                                                        976
000107               RHOW  = A(5)                                                         977
000108               TCF   =  .5  *(TB + TWL)                                             978
000109               CALL  PT (P, TCF)                                                    979
000110               MUCF   = A(11)                                                       980
000111               RHOCF  = A(5)                                                        981
000112               KCF    = A(10)                                                       982
000113               PRCF   =  A(7)* A(11) /A(10)                                         983
000114               HL1= CL*KCF *(RHOCF/MUCF)**.8*PRCF**.4*(1.+.01457 *MUW*RHOB /MUB     984
000115              1     /RHOW )                                                        985
000116                 IF(ILIMITE) 1,2,1                                                 986
```

```
000117          1     CONTINUE                                                  987.
000118          C     LEG HEIGHT ITERATION HERE                                 988
000119                Q50= (HL/HL1 )**1.25 *NMB *RHOB/WC                        989
000120                Q51 = .25*PIE*(SMALRG-SMALTM)
000121                Q52= PIE / 2. *    (SMALRG - SMALTM)**2                   991
000122                Q53= 2.*(SMALRG -SMALTM)                                  992
000123                IF(IN.NE.1) GO TO 95
000124                L=.5
000125                CALL DUMP(1)
000126             95 IF(L.EQ.0.0 0) L=.1
000127                Q54=-Q50+ ABS(
000128               1      ((Q51+.5*(L+PIE/NT*(R+SMALRG+L))-.25*(SMALTS+2.*SMALTM))/
000129               2      (Q52+.5*L*(Q53+2./NT*PIE*(R+SMALRG+L)-SMALTS-2.*SMALTM))
000130               3      **5))**.25
000131                CALL NRAP1(Q54,L,I50,0.000050,1,IN)
000132                 IF(I50) 95,96,95                                         998
000133          96    IF(L .LT. 0. )  L=0.                                      999
000134                AF = Q52 + .5 * L * ( Q53 + 2. / NT * PIE * ( R + SMALRG + L )
000135               X      - SMALTS - 2. * SMALTM )
000136                DE=4.*AF/(4.*Q51+2.*(L+PIE/NT*(R+SMALRG+L))-SMALTS-2.*SMALTM)
000137                GO TO 3                                                  1002
000138          2     HL =  HL1 / DE *(WC *DE/NMB /AF/RHOB)**.8                1003
000139          3     CONTINUE                                                 1004
000140          C VC,MC                                                        1005
000141                VC      =  WC/ (NMB* AF* RHOB)                           1006
000142                MC      =  VC/ SMALA                                     1007
000143                RE = DE * VC * RHOCF / MUCF
000144                RETURN                                                   1008
000145           200  CONTINUE                                                 1009
000146                IF(MW .NE. 0.) GO TO 201                                 1010
000147                TCF=.5*(TB+TWL)
000148                CALL PT(P,TCF)                                           1011
000149                KCF=A(10)                                                1012
000150                MUCF=A(11)                                               1013
000151                CPCF=A(7)                                                1014
000152                CALL PT(P,TB)                                            1015
000153                RHOB=A(5)                                                1016
000154                MUB=A(11)
000155           201  HL=HLF(KCF,RHOB,MUCF,CPCF,1.,1.,.8,.4,0.);              1017
000156                RE = DE * VC * RHOB  / MUCF
000157                GO TO 1000                                               1018
000158           300  CONTINUE                                                 1019
000159                IF(MW .NE. 0.) GO TO 301                                 1020
000160                CALL PT(P,TB)                                            1021
000161                KB=A(10)                                                 1022
000162                RHOB=A(5)                                                1023
000163                MUB=A(11)                                                1024
000164                CPB=A(7)                                                 1025
000165           301  HL=HLF(KB,RHOB,MUB,CPB,TB,TWL,.8,.4,.34)                1026
000166                RE = DE * VC * RHOB  / MUB
000167                GO TO 1000                                               1027
000168           400  CONTINUE                                                 1028
000169                IF(MW .NE. 0.) GO TO 401                                 1029
000170                CALL PT(P,TWL)                                           1030
000171                RHOWL=A(5)                                               1031
000172                CALL PT(P,TB)                                            1032
000173                RHOB=A(5)                                                1033
000174                MUB=A(11)
000175                TCF=.5*(TB+TWL)
000176                CALL PT(P,TCF)                                           1034
```

```
000177                KCF=A(10)                                          1035
000178                MUCF=A(11)                                         1036
000179                CPCF=A(7)                                          1037
000180          401   HL=HLF(KCF,RHOB,MUCF,CPCF,RHOWL,RHOB,.8,.4,.8)    1038
000181                RE = DE * VC * RHOB  / MUCF
000182                GO TO 1000                                         1039
000183          500   CONTINUE                                           1040
000184                IF(MW .NE. 0.) GO TO 501                           1041
000185                CALL PT(P,TB)                                      1042
000186                KB =A(10)                                          1043
000187                RHOB =A(5)                                         1044
000188                MUB =A(11)                                         1045
000189                CPB =A(7)                                          1046
000190          501   HL=HLF(KB ,RHOB ,MUB ,CPB ,1.,1.,.8,.4,0.)        1047
000191                RE = DE * VC * RHOB  / MUB
000192                GO TO 1000                                         1048
000193          600   CONTINUE                                           1049
000194                IF(MW .NE. 0.) GO TO 601                           1050
000195                CALL PT(P,TWL)                                     1051
000196                MUWL=A(11)                                         1052
000197                CALL PT(P,TB)                                      1053
000198                KB=A(10)                                           1054
000199                RHOB=A(5)                                          1055
000200                MUB=A(11)                                          1056
000201                CPB=A(7)                                           1057
000202          601   HL=HLF(KB,RHOB,MUB,CPB,MUB,MUWL,.8,.4,.14)        1058
000203                RE = DE * VC * RHOB  / MUB
000204                GO TO 1000                                         1059
000205          700   CONTINUE                                           1060
000206                IF(MW .NE. 0.) GO TO 701                           1061
000207                CALL PT(P,TB)
000208                MUB=A(11)
000209                TCF=.5*(TB+TWL)
000210                CALL PT(P,TCF)                                     1062
000211                KCF=A(10)                                          1063
000212                RHOCF=A(5)                                         1064
000213                MUCF=A(11)                                         1065
000214                CPCF=A(7)                                          1066
000215          701   HL=HLF(KCF,RHOCF,MUCF,CPCF,1.,1.,.8,.4,0.)        1067
000216                RE = DE * VC * RHOCF / MUCF
000217                GO TO 1000                                         1068
000218          800   CONTINUE                                           1069
000219                IF(MW .NE. 0.) GO TO 801                           1070
000220                CALL PT(P,TB)                                      1071
000221                KB=A(10)                                           1072
000222                RHOB=A(5)                                          1073
000223                MUB=A(11)                                          1074
000224                CPB=A(7)                                           1075
000225          801   HL=HLF(KB,RHOB,MUB,CPB,1.,1.,.95,.4,0.)           1076
000226                RE = DE * VC * RHOB  / MUB
000227                GO TO 1000                                         1077
000228          900   CONTINUE                                           1078
000229                IF(MW .NE. 0.) GO TO 901                           1079
000230                TCF=.5*(TB+TWL)
000231                CALL PT(P,TCF)                                     1080
000232                KCF=A(10)                                          1081
000233                RHOCF=A(5)                                         1082
000234                MUCF=A(11)                                         1083
000235                CPCF=A(7)                                          1084
000236                CALL PT(P,TWL)                                     1085
```

```
000237                MUWL=A(11)                                                1086
000238                RHOWL=A(5)                                                1087
000239                CALL PT(P,TB)                                             1088
000240                MUB=A(11)                                                 1089
000241                RHOB=A(5)                                                 1090
000242                RE = 0.D0
000243             901 IPAUL=50
000244                CALL LINT(TAZ,TAHL,Z,HL,IPAUL)
000245            1000 IF(TWL .LE. TSAT) RETURN                                 1093
000246                IF(ICOOL.EQ.1.OR.ICOOL.EQ.4)  RETURN
000247                IF(CB1 .LT. 0.)CB1=1.                                     1094
000248                HL=HL*CB1*(TWL/TSAT)**CB2                                 1095
000249                RETURN                                                    1096
000250          C  COOLANT SIDE HEAT TRANSFER CORRELATION
000251            1100 CONTINUE
000252          C  PROPERTY = INTEGRAL FROM TB TO TWL OF PROPERTY DT
000253          C                          DIVIDED BY (TWL - TB)
000254                DENO = TWL - TB
000255                DIVR = DENO / 100.0
000256                DO 1105 I=1,4
000257            1105 SUM(I) = 0.0
000258                TCF = TB
000259                DO 1122  IM = 1,101
000260                IF(IM .EQ. 1) GO TO 1115
000261                TCF = TCF + DIVR
000262            1115 CALL PT (P, TCF)
000263                FN(1) = A(7)
000264                FN(2) = A(10)
000265                FN(3) = A(11)
000266                FN(4) = A(5)
000267                DO  1120 IL=1,4
000268                IF ( IM .GT. 1 .AND. IM .LT. 101 ) GO TO 1118
000269                SUM(IL)= SUM(IL)+ DIVR * FN(IL)/2.0
000270                GO TO 1120
000271            1118 SUM(IL)= SUM(IL)+ DIVR * FN(IL)
000272            1120 CONTINUE
000273            1122 CONTINUE
000274                CPCF  = SUM(1) / DENO
000275                KCF   = SUM(2) / DENO
000276                MUCF  = SUM(3) / DENO
000277                RHOCF = SUM(4) / DENO
000278                CALL PT (P, TB)
000279                RHOB = A(5)
000280                MUB  = A(11)
000281                PRCF = CPCF * MUCF / KCF
000282          C  STRAIGHT TUBE
000283                IF ( ILHITE .EQ. 0 ) REYB = WC*DE/(NMB*AF*MUB)
000284                HL2 = .00704*KCF*(RHOCF/MUCF)**.879185*PRCF**.4
000285                IF (IN .EQ. 1) GO TO 1140
000286            1124 IF(ILHITE.EQ.1.AND.IK5.EQ.0) GO TO 1185                  *NEW
000287                XODE = DEVD/DE                                            **-1
000288                IF ( XODE .LT.120.) HL1 = HL2*(1.+4./XODE)**.85593
000289                IF((XODE.GE.120.).AND.(DEVD.LE.SZ(1).OR.DEVD.GT.SZ(3))) HL1=HL2
000290                IF (DEVD .LE. SZ(1) .OR. DEVD .GT. SZ(3)) GO TO 1145
000291          C  CURVED SECTION
000292                IF ( DEVD .GT. SZ(2)) RCV = RU
000293                IF ( DEVD .NE. SZ(2) ) GO TO 1165
000294                PHI = (DEVD - SZ(1))/RD
000295                PPHI = PHI
000296                ISZ = 2
```

```
000297                GO TO 1107
000298          C  ANGLE OF CURVATURE IN RADIANS
000299           1165 PHI = PPHI + ( DEVD - SZ(ISZ)) /RCV
000300           1107 ER = (1.0 + 1.10716*PHI)
000301                FDR = .876720*(REYB*(DE/2./RCV)**2)**.066626
000302                EXITR = (3.03294 - 1.64904*PHI)
000303                IF ( ER .LT. FDR) GO TO 1191
000304                IF ( FDR .LT. EXITR) GO TO 1192
000305                IF ( PHI .LT. 1.082) GO TO 1193
000306                HL1 = HL2*1.2504
000307                GO TO 1145
000308           1191 HL1 = HL2*ER
000309                GO TO 1145
000310           1192 HL1 = HL2*FDR
000311                GO TO 1145
000312           1193 HL1 = HL2*EXITR
000313                GO TO 1145
000314           1140 HL1 = HL2*(1.+.8)
000315                PPHI = 0.0
000316                ISZ = 1
000317                RCV = RD
000318           1145 IF (ILHITE .EQ. 0) GO TO 1179
000319          C LEG HEIGHT ITERATION HERE
000320                Q50 = (HL/HL1)**1.13742*NMB*RHOB/WC
000321                Q51 = .25*PIE*(SMALRG - SMALTM)
000322                Q52 = PIE/2.*(SMALRG - SMALTM)**2
000323                Q53 = 2.*(SMALRG - SMALTM)
000324                IF (IN .NE. 1) GO TO 1150
000325                L = .5
000326           1150 IF (L .EQ. 0.) L=.1
000327                Q54 = -Q50 + ABS(
000328               X       ((Q51+.5*(L+PIE/NT*(R+SMALRG+L))-.25*(SMALTS+2.*SMALTM))/
000329               Y       (Q52+.5*L*(Q53+2./NT*PIE*(R+SMALRG+L)-SMALTS-2.*SMALTM))
000330               Z       **8.27696))**.13742
000331                CALL NRAP1(Q54,L,I50,0.000050,1,IN)
000332                IF (I50 .EQ. 0) GO TO 1170
000333                IF ( IN .EQ. 1 ) GO TO 1150
000334                AF = Q52 + .5*L*(Q53+2./NT*PIE*(R+SMALRG+L)
000335               X       -SMALTS-2.*SMALTM)
000336                DE = 4.*AF/(4.*Q51+2.*(L+PIE/NT*(R+SMALRG))-SMALTS-2.*SMALTM)
000337                VC = WC/(NMB*AF*RHOB)
000338                REYB = DE*VC*RHOB/MUB
000339                ITO =1
000340                GO TO 1124
000341           1170 IF (L .LT. 0.) L=0.
000342                AF = Q52 + .5*L*(Q53+2./NT*PIE*(R+SMALRG+L)
000343               X       -SMALTS-2.*SMALTM)
000344                DE = 4.*AF/(4.*Q51+2.*(L+PIE/NT*(R+SMALRG))-SMALTS-2.*SMALTM)
000345                GO TO 1180
000346           1179 HL = HL1/DE*(WC*DE/NMB/AF/RHOB)**.879185
000347           1180 CONTINUE
000348                VC = WC/(NMB*AF*RHOB)
000349                MC = VC/SMALA
000350                RE = DE*VC*RHOCF/MUCF
000351                RETURN
000352           1185 HL1=HL2
000353                GO TO 1145
000354           1200 CONTINUE
000355                CALL PT (P,TB)
000356                RHOB = A(5)
```

```
000357                SMALA = A (8)
000358                MUB = A(11)
000359                CALL PT (P,TWL)
000360                MUW = A(11)
000361                RHOW = A(5)
000362                TCF = .5*(TB + TWL)
000363                CALL PT (P,TCF)
000364                MUCF = A(11)
000365                RHOCF = A(5)
000366                KCF = A(10)
000367                PRCF = A(7)*A(11)/A(10)
000368                IF ( ILHITE .EQ. 0 ) REYB = WC*DE/(NMB*AF*MUB)
000369                HL2 = .008210*KCF*(RHOCF/MUCF)**.87413*PRCF**.4*
000370               ?     (1. + .01457*MUW*RHOB/MUB/RHOW)**.62162
000371                IF (IN .EQ. 1) GO TO 1220
000372             1202 IF(ILHITE.EQ.1.AND.IK5.EQ.0) GO TO 1280                    *NEW
000373                XODE = DEVD/DE                                               **-1
000374                IF (XODE .LT.120.)HL1 = HL2*(1.+4./XODE)**1.02993
000375                IF((XODE.GE.120.).AND.(DEVD.LE.SZ(1).OR.DEVD.GT.SZ(3))) HL1=HL2
000376                IF (DEVD .LE. SZ(1) .OR. DEVD .GT. SZ(3)) GO TO 1225
000377           C  CURVED SECTION
000378                IF ( DEVD .GT. SZ(2)) RCV = RU
000379                IF (DEVD .NE. SZ(2)) GO TO 1205
000380                PHI = (DEVD - SZ(1))/RD
000381                PPHI = PHI
000382                ISZ = 2
000383                GO TO 1207
000384           C ANGLE OF CURVATURE IN RADIANS
000385             1205 PHI = PPHI + ( DEVD - SZ(ISZ))/RCV
000386             1207 ER = 1. + 1.12792*PHI
000387                FDR = .797193*(REYB*(DE/2/RCV))**.078496
000388                EXITR = 3.07019 - 1.70658*PHI
000389                IF ( ER .LT. FDR ) GO TO 1211
000390                IF ( FDR .LT. EXITR) GO TO 1212
000391                IF ( PHI .LT. 1.082) GO TO 1213
000392                HL1 = HL2*1.2257
000393                GO TO 1225
000394             1211 HL1 = HL2*ER
000395                GO TO 1225
000396             1212 HL1 = HL2*FDR
000397                GO TO 1225
000398             1213 HL1 = HL2*EXITR
000399                GO TO 1225
000400             1220 HL1 = HL2*(1. + .8)
000401                PPHI = 0.0
000402                ISZ = 1
000403                RCV = RD
000404             1225 IF (ILHITE .EQ. 0) GO TO  1259
000405           C  LEG HEIGHT ITERATION HERE
000406                Q50 = (HL/HL1)**1.14399*NMB*RHOB/WC
000407                Q51 = .25*PIE*(SMALRG - SMALTM)
000408                Q52 = PIE/2.*(SMALRG - SMALTM)**2
000409                Q53 = 2.*(SMALRG - SMALTM)
000410                IF (IN .NE. 1) GO TO 1230
000411                L = .5
000412             1230 IF (L .EQ. 0.) L=.1
000413                Q54 = -Q50 + ABS(
000414               X       ((Q51+.5*(L+PIE/NT*(R+SMALRG+L))-.25*(SMALTS+2.*SMALTM))/
000415               Y       (Q52+.5*L+(Q53+2./NT*PIE*(R+SMALRG+L)-SMALTS-2.*SMALTM))
000416               Z       **7.94493))**.14399
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```
000417                CALL NRAP1(Q54,L,I50,0.00005,1,IN)
000418                IF (I50 .EQ. 0) GO TO 1250
000419                IF ( IN .EQ. 1 ) GO TO 1230
000420                AF = Q52 +.5*L*(Q53+2./NT*PIE*(R+SMALRG+L)
000421               X       -SMALTS - 2.*SMALTM)
000422                DE = 4.*AF/(4.*Q51+2.*(L+PIE/NT*(R+SMALRG))-SMALTS-2.*SMALTM)
000423                VC = WC/(NMB*AF*RHOB)
000424                REYB = DE*VC*RHOB/MUB
000425                ITO = 1
000426                GO TO 1202
000427           1250 IF (L .LT. 0.) L = 0.
000428                AF = Q52 + .5 * L * ( Q53 + 2. / NT * PIE* ( R + SMALRG + L )
000429               X      - SMALTS - 2. * SMALTM )
000430                DE = 4.*AF/(4.*Q51+2.*(L+PIE/NT*(R+SMALRG+L))-SMALTS-2.*SMALTM)
000431                GO TO 1260
000432           1259 HL = HL1/DE*(WC*DE/NMB/AF/RHOB)**.87413
000433           1260 CONTINUE
000434                VC = WC/(NMB*AF*RHOB)
000435                MC = VC/SMALA
000436                RE = DE*VC*RHOCF/MUCF
000437                RETURN
000438           1280 HL1=HL2
000439                 GO TO 1225
000440                END                                                    1097
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@ ELT IIN,1,711221, 32566

000001                SUBROUTINE IIN                                                                    1098
000002                REAL    ITRFL
000003                REAL LH(100), LW
000004                REAL J,K1,K2,K3,K4,KC,KCF,KM,KMP,KWG,KFAC,L,MC,MR,MUB,MUCF,
000005               X       MUGF,MUW,NMB,NT,N1P,N2P,N3P,N4P,N5P,N6P,NMBP
000006                REAL  KB,KWL,K5,K5P,K6,LP,MUWL,MW,NC,NDL
000007                REAL  KMAX,K5S,LHITE,MERCR,NTOT,NUM
000008                INTEGER   A(80)
000009                INTEGER   END(4)/'$ ','E ','N ','D '/
000010                COMMON / VAR/  TUBE(100)  , PPFM(100)  , EEPGEO(100), TTATMR(20) ,
000011               1  TTAKMR(79) , MMAT(4)    , TTATWM(25) , TTASTR(25) , TMKM(100)
000012                COMMON / ADD/  RE         , WDOTOA     , MAT(4)     , LHITE(100) ,
000013               1  CGITE(100) , ZCHAN
000014                COMMON /  EF/  AJ         , DPI        , BJ         , DTI        ,
000015               1  KOUNT      , IGO        , IFLAG
000016                DIMENSION DATA ( 23  )
000017                DIMENSION STPK(100),STTINK(100),STRHOK(100),STHK(100)                                  1102
000018                COMMON / ZXR/  ZZZZZZ(200), RRRRRR(200), SSSSSS(200), AAAAAA(200),
000019               1  TAZ1(50)    , INTOT
000020                COMMON /AFCM/  FILMC      , FCBETA(500), YPT(500)    , IPT
000021                COMMON / CORREL / SZ(3), LH, LW
000022                COMMON/IGRAPH/IPLOT(10),IPFLAG
000023                DIMENSION XPLOT(10)
000024                COMMON /   S/  IDATA1(20) , TITLE(20)  , INU(10)     , TATM(9)    ,
000025               1  TAKM(9)     , TATM1(20)  , TAKM1(20)  , TATWM(25)  , TASTRY(25) ,
000026               2  TATMR(20)   , TAKMR(79)  , TPRPC(50)  , TPK(100)   , TTINK(100) ,
000027               3  TRHOK(100)  , THK(100)   , TVK(100)   , TAZ(100)   , TASMTM(100),
000028               4  TACG(100)   , TACL(100)  , TAKC(100)  , TATC(100)  , TASMD(100) ,
000029               5  TASML(100)  , TASMTS(100), TABETA(100), TAAF(100)  , TATWG(100) ,
000030               6  TAFEFV(100), TANMB(100) , TANT(100)  , TAWDOT(100), TAAST(100) ,
000031               7  TASMDS(100), TMACH(100)
000032                COMMON /IISUM/ ISUM
000033                COMMON/SHEEHY/ DS         , W          , WP         , AFBAR      ,
000034               1  K5           , VCBAR      , K5P        , TWMC       , VCP        ,
000035               2  TSAT         , FCBAR      , K6         , TSATK      , FCP        ,
000036               3  PD           ,  FRHOV     , CPCF       , MUWL       , CB2        ,
000037               4  KB           , CPWL       , CPB        , RHOWL      , KWL        ,
000038               5  CB1          , ZETA       , MW         , COEF(4,5)  , LP         ,
000039               6  DUMPEM       , PXM(100)   , PDM(100)   , NDL        , DZ         ,
000040               7  NC           , SMATCP
000041                COMMON / INT/  IKMAX      , ILHITE     , ICGITE     , IITRFL     ,
000042               1  IKERR       , IN         , ITUBE      , INUM       , IDIS       ,
000043               2  IFRIC       , ITNUM1     , IZPTS      , IZSTEP     , IWALL      ,
000044               3  IMERCR      , IHGC       , IHLC       , IFILM      , IRBO       ,
000045               4  I8085       , ICOOL      , ITF        , ISZ        , ICONLB
000046                COMMON/ CON/  AA     ,ABAR   ,AE     ,AF     ,AFP    ,AS     ,AL     ,        1127
000047               1A0    ,ASTAR ,AV     ,B      ,BETA   ,C1     ,CL     ,CG     ,CC1    ,        1128
000048               2CC2   ,CP    ,CPP    ,CPBAR  ,CPGF   ,D      ,DE     ,E1     ,E2     ,        1129
000049               3E3    ,E4    ,E      ,F      ,FBAR   ,FEFV   ,FS     ,FC     ,FP     ,        1130
000050               4GO    ,G1    ,G      ,H      ,HBC    ,HC     ,HIN    ,HMIX   ,HOUT   ,        1131
000051               5HG    ,HL    ,HL1    ,HR     ,J      ,K1     ,K2     ,K3     ,K4     ,        1132
000052               6KC    ,KCF   ,KM     ,KMP    ,KWG    ,KFAC   ,L      ,MC     ,MR     ,        1133
000053               7NMB   ,NT    ,N1P    ,N2P    ,N3P    ,N4P    ,N5P    ,N6P    ,PIE    ,        1134
000054               8PSC   ,PC    ,PG     ,PFM    ,PRCF   ,PRGF   ,P      ,PP     ,PF     ,        1135
000055               9PIN   ,PLS   ,POUT   ,PRC    ,PV     ,Q      ,QQA    ,QQAM   ,QQAO   ,        1136
000056               0R     ,RC    ,RD     ,RN     ,RU     ,RR     ,RSTAR  ,RCV    ,SMALD  ,        1137
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000057                1SMALRA,SMALRG,SC    ,S     ,STR   ,STRY  ,SMALTC,SMALTM,SMALTS,      1138
000058                2SMARGP,TB    ,TBP   ,TBC   ,TC    ,TRCF  ,TCF   ,TGF   ,TIN   ,      1139
000059                3TM    ,TMIX  ,TWG   ,TWGC  ,TWL   ,TWLC  ,TWM   ,TO    ,TINFIN,      1140
000060                4TBAR  ,U     ,V     ,VF    ,VC    ,VP    ,VNS   ,WG    ,WGCORE,      1141
000061                5WGSTAR,WC    ,WBC   ,WF    ,X     ,XP    ,XI    ,Z     ,ZP    ,      1142
000062                6ZB    ,ZD    ,ZOL   ,ZN    ,ZU    ,ZW    ,ZSTAR ,EHAF  ,MUB   ,      1143
000063                7MUCF  ,MUGF  ,MUW   ,RHO   ,RHOB  ,RHOBP ,RHOCF ,RHOGF ,RHOW  ,      1144
000064                8RHOBAR,RP    ,EP0GEO,EP1GEO,NMBP  ,GAMMAC,SMALA ,EPGEOM,AASTAR,      1145
000065                9SMATMP,RHOP  ,ALPHAA,BETAA ,EP0   ,EP1   ,REYEXP,PRLEXP,TR
000066                 COMMON /INRBO/ VDTC        , RBOFP       , RBOFT       , RBOA1       ,
000067                1  RBOA2       , RBOB1       , RBOB2       , RBON1       , RBON2       ,
000068                2  RBOM1       , RBOM2       , RBOC1       , RBOK1       , RBO         ,
000069                3  QOABO
000070                 COMMON /THOMAS/ TTTTT(296), PPPPP(296), TCRIT, PCRIT
000071                 COMMON/JOHNP/TAHL(50)
000072                 COMMON/TRANS/GAST(50),GASCP(50),GASK(50),GASRHO(50),GASMU(50),
000073                1   GASMWT(50)
000074                 COMMON/JOHNC/TAHG(50),IGAS,IK5,DEP,LCOOL,LGAS
000075                 COMMON/FLUIDP/A1,A2,A3,A4,A5,A6,A7,A8,A9,A10,A11,A12,A13,A14(22)
000076                 NAMELIST /DATUM/ AAAAAA,AASTAR,AL    ,ALPHAA,AO    ,ASTAR ,BETAA ,
000077                1   CB1   ,CB2   ,CC1   ,CC2   ,CGITE ,COEF  ,CONTR ,COOL  ,DPI   ,
000078                2   DTI   ,DUMPEM,DZ    ,E     ,EEPGEO,EP0GEO,EP1GEO,FILMC ,FLAG  ,
000079                3   FRIC  ,GAS   ,GASCP ,GASK  ,GASMU ,GASMWT,GASRHO,GAST  ,HBC   ,
000080                4 HGC, HLC, ITRFL, XPLOT, KMAX, K1, K2, K3, K4, K5S,
000081                5   K6    ,LHITE ,MMAT  ,MERCR ,MR    ,MW    ,NC    ,NDL   ,NTOT  ,
000082                6   NUM   ,N1P   ,N2P   ,N3P   ,N4P   ,N5P   ,N6P   ,PC    ,PDM   ,
000083                7   PPFM  ,P1N   ,PREXP ,PXM   ,QOABO ,RB    ,RBO   ,RBOA1 ,RBOA2 ,
000084                8   RBOB1 ,RBOB2 ,RBOC1 ,RBOFLG,RBOFP ,RBOFT ,RBOK1 ,RBOM1 ,RBOM2 ,
000085                9   RBON1 ,RBON2 ,RC    ,RD    ,REYEXP,RN    ,RRRRRR,RSTAR ,RU    ,
000086                A   SMALTC,SMALTS,SSSSSS,SUM   ,TAAF  ,TAAST ,TABETA,TACG  ,TACL  ,
000087                B   TAFEFV,TAHG  ,TAHL  ,TAKC  ,TANMB ,TANT  ,TASMD ,TASMDS,TASML ,
000088                C   TASMTM,TASMTS,TASTRY,TATC  ,TATWM ,TATWG ,TAWDOT,TAZ   ,TAZ1  ,
000089                D   TB    ,TC    ,TCF   ,TF    ,THK   ,TIN   ,TITLE ,TMKM  ,TO    ,
000090                E   TPK   ,TRHOK ,TSAT  ,TTAKMR,TTATMR,TTINK ,TUBE  ,TVK   ,TWG   ,
000091                F   TWL   ,LH    ,LW    ,VDTC  ,VF    ,WALL  ,WBC   ,WF    ,WGCORE,
000092                0   WGSTA ,WGSTAR,XI    ,ZB    ,ZD    ,ZETA  ,ZN    ,ZOL   ,ZSTAR ,
000093                1   ZU    ,ZW    ,ZZZZZZ,ZCHAN ,CONLHB,TMACH ,GAMMA ,REYEXP,PRLEXP
000094                 DATA NTOT/0.0  /, TF/1.00/, FLAG/0.00/,    ITRFL/5.0  /,K5S/1.0  /0n012480
000095                 DATA FRIC/1.0E0/,MERCR/0.0E0/,COOL/1.0E0/,KMAX/27.0E0/,GAS/1.0E0/
000096                 DATA REYEXP /.8/ , PRLEXP /.3/
000097               130 FORMAT ('1',////////////////
000098                1   ,4X'**',3('*****') /2X3('*******') /' **',3('*******'),7X'*',
000099                2 2X,3(2X'*****'),6X'*',2(2X'*****'),6X,2(2X'*****'),2X'*',3X'*',
000100                3 2(2X'*****'),2(4X'*') /' ****',15X'****',6X'* *',3X'*',4X,
000101                4 2(2X'*   *'),6X'*  *',8X'*',4X,3(6X'*'),3('*'2X),1X,3(3X'*'),
000102                5 ' *',3X'*' /' ****'24X'*',3X'*',2X'***',4X'*****',2X'*',3X'*',
000103                6 6X'*',2X'***',6X'*',3X'*****',2(2X'*'),'*  ***',4X,3('* '),
000104                7 ' ***',4X'*****',2X'*',3X'*',2X'*' /' ****',4X,3('*****'),
000105                8 5X'*****',2X'*',6X'* *',4X'*',2(3X'*',2X'*'),8X'*',10X'*',
000106                9 3X'*',2X'*',6X'*  **  *',6X'* *',4X'*****',2X'*', /' ****',4X,
000107                A 'GENERAL TIRE***',4X'*',5X'* *****',2(2X'*'),1X,3(2X'*****'),
000108                B 4X'*',10X,2('*****',2X),'*'3X'*',2X'*****',3(2X'*'),5X'* *****'/
000109                C ' ****',4X,3('*****') /2(' ****',14X),27X'C O R P O R A T I O N',
000110                D /' ****',14X' ****' /' **',3('*******'),4X'S A C R A M E N T O ,
000111                E C A L I F          ' 13X'
000112                F  ',/2X,3('*******'),/4X'**',3('*****')//
000113                G '0
000114                H           '43X,2A6//33(' - -'))
000115              135 FORMAT( /////////,35X'*',15('****'),/35X,'*',59X'*',/35X'*',59X'*'
000116                1,/35X,'*',16X,'H E A T   T R A N S F E R ',17X,'*',
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000117                2 /35X'*',59X'*',/35X'*',3X,
000118                J 'C R Y O G E N I C   A N D  N O N - C R Y O G E N I C',
000119                3 2X,'*',/35X'*',59X'*'/35X'*',15('****'))
000120                 TMACH(1) = -1.0
000121                 INTEGER DMY(2)
000122                 DMY(1) = 6H
000123                 CALL DATE(12,DMY)
000124                  WRITE (6,130) DMY
000125                  WRITE (6,135)
000126                 SUM = 1.
000127                 DO 100 I=1,100                                    1173
000128                 TPK(I)=STPK(I)                                    1174
000129                 TTINK(I)=STTINK(I)                                1175
000130                 TRHOK(I)=STRHOK(I)                                1176
000131           100   THK(I)=STHK(I)                                    1177
000132                 DO 901 I2=1,10
000133           901   IPLOT(I2)=0
000134                 IPFLAG=0
000135                 AASTAR=SAASTA                                     1178
000136                 WRITE(6,1000)                                     1180
000137          1000   FORMAT(1H1)                                       1181
000138                 REWIND 3
000139           9     READ (5,10,END=500) A
000140           10    FORMAT (80A1)
000141                 WRITE (6,11) A
000142           11    FORMAT (' ' 80A1)
000143                 WRITE (3,10) A
000144                 DO 40 I2=1,76
000145                 DO 35 I3=1,4
000146                 IF ( A(I2+I3) .NE. END(I3) ) GO TO 40
000147           35    CONTINUE
000148                 GO TO 45
000149           40    CONTINUE
000150                 GO TO 9
000151           45    END FILE 3
000152                 REWIND 3
000153                 READ (3,12) TITLE
000154              12 FORMAT (20A4)
000155                 READ (3,DATUM)
000156                 DO 200 I=1,100                                    1183
000157                 STPK(I)=TPK(I)                                    1184
000158                 STTINK(I)=TTINK(I)                                1185
000159                 STRHOK(I)=TRHOK(I)                                1186
000160           200   STHK(I) = THK(I)
000161                 DO 902 I2=1,10
000162           902   IPLOT(I2)=XPLOT(I2)
000163                 DO 903 I2=1,10
000164           903   IPFLAG=IPFLAG+IPLOT(I2)
000165                 IF(IPFLAG.GT.1) IPFLAG=1
000166                 SAASTA=AASTAR                                     1188
000167                 IKMAX=KMAX                                        1189
000168                 IGAS=GAS
000169                 IITRFL=ITRFL                                      1192
000170                 INUM=NUM                                          1194
000171                 IFRIC=FRIC                                        1195
000172                 IWGSTA=WGSTA                                      1197
000173                 IHLC=HLC                                          1198
000174                 IHGC=HGC                                          1199
000175                 IWALL=WALL                                        1200
000176                 IMERCR=MERCR                                      1201
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```
000177                  IK5=K5S
000178                  ICOOL=COOL                                          1202
000179                  ISUM = SUM
000180                  ITF = TF
000181                  IFLAG = FLAG
000182                  ICONLB = CONLHB
000183                  IF(CONTR .NE. 2.) INTOT=NTOT                        1203
000184                  IF(CONTR .NE. 0. .AND. INTOT .EQ. 0.) INTOT=1       1204
000185                  IF ( TMACH(1) .LT. 0.0 ) GO TO 800
000186                  DO 850 I=1,100
000187                  056 = 1.0 + (GAMMA - 1.0) / 2.0 * TMACH(I)**2
000188                  TTINK(I) = TC / 056
000189                  TPK(I) = PC / 056**(GAMMA/(GAMMA - 1.))
000190                  CALL PTGAS ( TPK(I),TTINK(I))
000191                  TVK(I) = TMACH(I)*A8
000192              850 CONTINUE
000193              800 ICONTR = CONTR
000194                  IRBO=RBOFLG                                         1206
000195                  DATA(1)=RC                                          1207
000196                  DATA(2)=RSTAR                                       1208
000197                  DATA(3)=RB                                          1209
000198                  DATA(4)=RU                                          1210
000199                  DATA(5)=RD                                          1211
000200                  DATA(6)=ALPHAA                                      1212
000201                  DATA(7)=BETAA                                       1213
000202                  DATA(8)=AASTAR                                      1214
000203                  DATA(9)=ZOL                                         1215
000204                  DATA(10)=ZB                                         1216
000205                  DATA(11)=ZSTAR                                      1217
000206                  DATA(12)=DZ                                         1218
000207                  DATA(13)=N1P                                        1219
000208                  DATA(14)=N2P                                        1220
000209                  DATA(15)=N3P                                        1221
000210                  DATA(16)=N4P                                        1222
000211                  DATA(17)=N5P                                        1223
000212                  DATA(18)=N6P                                        1224
000213                  DATA(19)=NDL                                        1225
000214                  DATA(23)=NC                                         1226
000215                  IF (ICONTR .NE. 0 ) GO TO 203
000216                  CALL CONTUR(DATA)                                   1228
000217                  ZD=DATA(20)                                         1229
000218                  ZSTAR=DATA(21)                                      1230
000219                  ZU=DATA(22)                                         1231
000220              203 IF ( RD .LE. 0.0 ) GO TO 201
000221                  CALL LINTX (TAZ,SSSSSS,ZD,SZ(1),100)
000222                  CALL LINTX (TAZ,SSSSSS,ZSTAR,SZ(2),100)
000223                  CALL LINTX (TAZ,SSSSSS,ZU,SZ(3),100)
000224                  DO 202 IJB=1,3
000225              202 SZ(IJB) = ABS(SSSSSS(INTOT) - SZ(IJB))
000226              201 CONTINUE                                            1232
000227                  IF (TAZ1(1) .EQ. ZZZZZZ(1)) GO TO 8
000228                  IL=INTOT/2
000229                  LLA=0
000230                  DO 250 I1=1,IL
000231                  ZZZ=ZZZZZZ(I1)
000232                  RRR=RRRRRR(I1)
000233                  AAA=AAAAAA(I1)
000234                  SSS=SSSSSS(I1)
000235                  ZZZZZZ(I1)=ZZZZZZ(INTOT-LLA)
000236                  AAAAAA(I1)=AAAAAA(INTOT-LLA)
```

```
000237                RRRRRR(I1)=RRRRRR(INTOT-LLA)
000238                SSSSSS(I1)=SSSSSS(INTOT-LLA)
000239                ZZZZZZ(INTOT-LLA)=ZZZ
000240                AAAAAA(INTOT-LLA)=AAA
000241                SSSSSS(INTOT-LLA)=SSS
000242                RRRRRR(INTOT-LLA)=RRR
000243                LLA=LLA+1
000244             250 CONTINUE
000245               8    CONTINUE                                                    1254
000246                    GO TO (300,400,600,300), ICOOL
000247             300 DO 301 I=1,296
000248                    TTTTT(I)=TSAT
000249             301 PPPPP(I)=0.                                                   1258
000250                    PPPPP(2)=100000.                                          1259
000251                    RETURN                                                    1260
000252             400 CALL S1SAT
000253                       RETURN                                                 1264
000254             600 CALL S2SAT
000255                    RETURN
000256             500 IF (ZCHAN .LE. 0.0) GO TO 502
000257                    ZCHAN = 0.0
000258                    RETURN
000259             502 WRITE (6,501)
000260             501 FORMAT ('0','PROGRAM E25107 COMPLETED' )                        *NEW
000261                    STOP                                                      1267**-1
000262                      E          N             D                             1268
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@ ELT INT4,1,711119, 35497

000001                SUBROUTINE INT4(X,Y,XI,YO)                                    61205002
000002                DIMENSION X(9),Y(9),XC(4),YC(4)                               61205005
000003                EQUIVALENCE (XC(1),X1),(XC(2),X2),(XC(3),X3),(XC(4),X4),(YC(1),Y1)61205006
000004               1,(YC(2),Y2),(YC(3),Y3),(YC(4),Y4)                             61205007
000005          20    ASSIGN 30 TO NA                                               61205008
000006                J=2                                                           61205009
000007                B=XI                                                          61205010
000008          21    IF(X(J))26,22,26                                              61205011
000009          26    GO TO NA,(30,40)                                              61205012
000010          22    IF(Y(J))26,23,26                                              61205013
000011          23    IF(J-2)24,24,25                                               61205014
000012          24    YE=0.0                                                        61205015
000013                GO TO 50                                                      61205016
000014          25    ASSIGN 32 TO NB                                               61205017
000015                J=J-1                                                         61205018
000016          27    X1=X(J)                                                       61205019
000017                X2=X(J-1)                                                     61205020
000018                X3=X(J-2)                                                     61205021
000019                Y1=Y(J)                                                       61205022
000020                Y2=Y(J-1)                                                     61205023
000021                Y3=Y(J-2)                                                     61205024
000022                GO TO NB,(32,42)                                              61205025
000023          30    IF(X(J)-B)29,37,37                                            61205026
000024          37    IF(J-2)31,31,28                                               61205027
000025          28    ASSIGN 40 TO NA                                               61205028
000026          29    J=J+1                                                         61205029
000027                GO TO 21                                                      61205030
000028          31    DO 60 J=1,3                                                   61205031
000029                XC(J)=X(J)                                                    61205032
000030          60    YC(J)=Y(J)                                                    61205033
000031          32    D=X2-X1                                                       61205034
000032                A1=B-X1                                                       61205035
000033                A2=B-X2                                                       61205036
000034                YE=A1*A2/2.0/D*((Y3-Y2)/(X3-X2)-(Y2-Y1)/D)-A2/D*Y1+A1/D*Y2    61205037
000035                GO TO 50                                                      61205038
000036          40    ASSIGN 42 TO NB                                               61205039
000037                GO TO 27                                                      61205040
000038          42    X4=X(J-3)                                                     61205041
000039                Y4=Y(J-3)                                                     61205042
000040                D=X3-X2                                                       61205043
000041                A1=B-X2                                                       61205044
000042                A2=B-X3                                                       61205045
000043                XM12=(Y2-Y1)/(X2-X1)                                          61205046
000044                XM23=(Y3-Y2)/D                                                61205047
000045                XM34=(Y4-Y3)/(X4-X3)                                          61205048
000046                YE=A1*A2**2/2.0/D**2*(XM12-XM23)+A2*A1**2/2.0/D**2*(XM34-XM23)-A2*61205049
000047               1Y2/D+A1*Y3/D                                                  61205050
000048          50    YO=YE                                                         61205051
000049                RETURN                                                        61205052
000050                END                                                           61205053
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@ ELT ITERAT,1,711229, 55348

000001                SUBROUTINE ITERAT                                                    01035
000002                REAL J,K1,K2,K3,K4,KC,KCF,KM,KMP,KWG,KFAC,L,MC,MR,MUB,MUCF,
000003               X      MUGF,MUW,NMB,NT,N1P,N2P,N3P,N4P,N5P,N6P,NMBP
000004                REAL  KB,KWL,K5,K5P,K6,LP,MUWL,MW,NC,NDL
000005                REAL INEXX,IMEXX
000006                COMMON /INT/  IKMAX    ,ILHITE   ,ICGITE   ,IITRFL   ,IKERR       01057
000007               1   ,IN       ,ITUBE    ,INUM     ,IDIS     ,IFRIC    ,ITNUM1      01058
000008               3       , IZPTS , IZSTEP                                            01059
000009               4    ,IWALL, IMERCR , IHGC, IHLC, IFILM, IRBO, I8085,ICOOL
000010                COMMON/ CON/  AA     ,ABAR   ,AE     ,AF     ,AFP    ,AS     ,AL  ,01060
000011          C       PLEASE NOTE THAT C IS IN  COMMON INSTEAD OF THE NORMAL B,          01061
000012               1 C(9)    ,                                                         01062
000013          C       B IS USED IN THIS  ROUTINE FOR FAN YEE ONLY                       01063
000014               2CC2   ,CP     ,CPP    ,CPBAR ,CPGF   ,D      ,DE     ,E1     ,E2  ,01064
000015               3E3    ,E4     ,E      ,F      ,FBAR  ,FEFV   ,FS     ,FC     ,FP  ,01065
000016               4GO    ,G1     ,G      ,H      ,HBC   ,HC     ,HIN    ,HMIX   ,HOUT ,01066
000017               5HG    ,HL     ,HL1    ,HR     ,J     ,K1     ,K2     ,K3     ,K4  ,01067
000018               6KC    ,KCF    ,KM     ,KMP    ,KWG   ,KFAC   ,L      ,MC     ,MR  ,01068
000019               7NMB   ,NT     ,N1P    ,N2P    ,N3P   ,N4P    ,N5P    ,N6P    ,PIE ,01069
000020               8PSC   ,PC     ,PG     ,PFM    ,PRCF  ,PRGF   ,P      ,PP     ,PF  ,01070
000021               9PIN   ,PLS    ,POUT   ,PRC    ,PV    ,Q      ,QOA    ,QOAM   ,QOAO ,01071
000022               OR     ,RC     ,RD     ,RN     ,RU    ,RB     ,RSTAR  ,RCV    ,SMALD ,01072
000023               1SMALRA,SMALRG,SC      ,S      ,STR   ,STRY   ,SMALTC,SMALTM,SMALTS,01073
000024               2SMARGP,TB     ,TBP    ,TBC    ,TC    ,TRCF   ,TCF    ,TGF    ,TIN ,01074
000025               3TM    ,TMIX   ,TWG    ,TWGC   ,TWL   ,TWLC   ,TWM    ,TO     ,TINFIN,01075
000026               4TBAR  ,U      ,V      ,VF     ,VC    ,VP     ,VNS    ,WG     ,WGCORE,01076
000027               5WGSTAR,WC     ,WBC    ,WF     ,X     ,XP     ,XI     ,Z      ,ZP  ,01077
000028               6ZB    ,ZD     ,ZOL    ,ZN     ,ZU    ,ZW     ,ZSTAR  ,EHAF   ,MUB ,01078
000029               7MUCF  ,MUGF   ,MUW    ,RHO    ,RHOB  ,RHOBP  ,RHOCF  ,RHOGF  ,RHOW ,01079
000030               8RHOBAR,RP     ,EP0GEO,EP1GEO,NMBP   ,GAMMAC,SMALA  ,EPGEOM,AASTAR,01080
000031               9SMATMP,RHOP   ,ALPHAA,BETAA  ,EP0    ,EP1                        01081
000032                COMMON/SHEEHY/ DS,W,WP,AFBAR,K5,VCBAR,K5P,TWMC,VCP,TSAT,FCBAR,K6,
000033               1 TSATK,FCP,PD,FRHOV,CPCF,MUWL,CB2,KB,CPWL,CPB,RHOWL,KWL,CB1
000034               2,ZETA,MW,COEF(4,5),LP
000035               3 ,DUMPEM,PXM(100),PDM(100),NDL,DZ,NC,SMATCP
000036                 DIMENSION          A(4,4),B(4,4),IITEM(4)                         01082
000037                EQUIVALENCE (EEP1,B(1,1)),(EEP2,B(2,1))                           01083
000038               1          ,(EEP3,B(3,1)),(EEP4,B(4,1))                          01084
000039                 IKERR=0                                                          01085
000040          1      IKERR= IKERR+1                                                  01086
000041                CALL CALCTP                                                      01087
000042                IF(DUMPEM .NE. 0.) CALL DUMP(1)
000043                 B(1,1)=-TWL+TWLC                                                01089
000044                B(2,1)=-TWG+TWGC                                                 01090
000045                B(3,1)=-TB +TBC                                                  01091
000046                B(4,1)=-P  +PRC                                                  01092
000047                XNOR1= B(1,1)**2 + B(2,1)**2 + B(3,1)**2 + B(4,1)**2
000048                IF( ABS(B(1,1)).GT. 1.) GO TO 5                                00006555
000049                IF( ABS(B(2,1)).GT. 1.) GO TO 5                                00006560
000050                IF( ABS(B(3,1)).GT. .1) GO TO 5                                00006565
000051                IF(ABS(B(4,1)).GT.0.20) GO TO 5                                      *NEW
000052                RETURN                                                           01097**-1
000053              5 IF ( IKERR .LT. IITRFL) GO TO 10
000054                RETURN
000055             10 X01 = TWL                                                        01100
000056                X02 = TWG                                                        01101
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000057                X03 = TB                                                  01102
000058                X04 = P                                                   01103
000059                IF(ILHITE) 2,3,2                                          01104
000060          3     CONTINUE                                                  01105
000061                X1=2.
000062                TWL = TWL + X1                                            01107
000063                CALL CALCTP                                               01108
000064                A(1,1) = ( TWL-TWLC + B(1,1))/ X1                         01109
000065                A(2,1) = ( TWG-TWGC + B(2,1))/ X1                         01110
000066                A(3,1) = ( TB -TBC  + B(3,1))/ X1                         01111
000067                A(4,1) = ( P  -PRC  + B(4,1))/ X1                         01112
000068                X2=2.
000069                TWG = TWG +X2                                             01114
000070                TWL = X01                                                 01115
000071                IF(ICGITE) 4,6,4                                          01116
000072          6     CONTINUE                                                  01117
000073                CALL CALCTP                                               01118
000074                A(1,2) = ( TWL-TWLC + B(1,1))/ X2                         01119
000075                A(2,2) = ( TWG-TWGC + B(2,1))/ X2                         01120
000076                A(3,2) = ( TB -TBC  + B(3,1))/ X2                         01121
000077                A(4,2) = ( P  -PRC  + B(4,1))/ X2                         01122
000078          8     CONTINUE                                                  01123
000079                X3=0.10
000080                TB = TB +X3                                               01125
000081                TWG = X02                                                 01126
000082                CALL CALCTP                                               01127
000083                A(1,3) = ( TWL-TWLC + B(1,1))/ X3                         01128
000084                A(2,3) = ( TWG-TWGC + B(2,1))/ X3                         01129
000085                A(3,3) = ( TB -TBC  + B(3,1))/ X3                         01130
000086                A(4,3) = ( P  -PRC  + B(4,1))/ X3                         01131
000087                X4=2.
000088                P = P +X4                                                 01133
000089                TB = X03                                                  01134
000090                CALL CALCTP                                               01135
000091                A(1,4) = ( TWL-TWLC + B(1,1))/ X4                         01136
000092                A(2,4) = ( TWG-TWGC + B(2,1))/ X4                         01137
000093                A(3,4) = ( TB -TBC  + B(3,1))/ X4                         01138
000094                A(4,4) = ( P  -PRC  + B(4,1))/ X4                         01139
000095                P =X04                                                    01140
000096                CALL SIMEQ(A,B,4,1,4,IITEM,DETERM                         01141
000097               1                          ,IND ,IIERR)                   01142
000098                 IF(IIERR+1) 100,200,100                                  01143
000099          200   CONTINUE                                                  01144
000100                INEXX=1
000101                IMEXX=15
000102            225 CONTINUE
000103                B1=200.
000104                B2=200.
000105                B4=200.
000106                B3=30.0
000107                IF(0.30*P.LE.B4)  B4=0.30*P
000108                IF( ABS(EEP1).GT.B1) EEP1=B1*EEP1/( ABS(EEP1))            00006835
000109                IF( ABS(EEP2).GT.B2) EEP2=B2*EEP2/( ABS(EEP2))            00006840
000110                IF( ABS(EEP3).GT.B3) EEP3=B3*EEP3/( ABS(EEP3))            00006845
000111                IF( ABS(EEP4).GT.B4) EEP4=B4*EEP4/( ABS(EEP4))            00006850
000112                TWL = TWL + EEP1*.95
000113                TWG = TWG + EEP2*.95
000114                TB = TB + EEP3*.95
000115                P = P + EEP4*.95
000116                CALL CALCTP
```

```
000117                  E1V=TWLC-TWL
000118                  E2V=TWGC-TWG
000119                  E3V=TBC-TB
000120                  E4V=PRC-P
000121                  XNOR2=E1V**2+E2V**2+E3V**2+E4V**2
000122                  IF(INEXX.GT.IMEXX) WRITE(6,227) IN,E1V,E2V,E3V,E4V
000123                  IF(INEXX.GT.IMEXX) RETURN
000124                227 FORMAT(//'  POOR CONVERGENCE AT STATION',I4,' ERRORS ARE',4E15.5/)
000125                  IF(XNOR2.LE.XNOR1) GO TO 226
000126                  TWL=TWL-EEP1
000127                  TWG=TWG-EEP2
000128                  TB=TB-EEP3
000129                  P=P-EEP4
000130                  EEP1=EEP1/2.
000131                  EEP2=EEP2/2.
000132                  EEP3=EEP3/2.
000133                  EEP4=EEP4/2.
000134                  INEXX=INEXX+1
000135                  GO TO 225
000136                226 CONTINUE
000137                  GO TO 1                                                 01157
000138          100     STOP 1
000139          2        DO 11 I1=1,4                                           01159
000140          11      A(I1,1)=0.                                              01160
000141                    A(1,1)= 1.                                            01161
000142          4        DO 12 I1=1,4                                           01162
000143          12      A(I1,2)  =0.                                            01163
000144                    A(2,2)=1.                                             01164
000145                  GO TO 8                                                 01165
000146                  END                                                     01166
```

```
@ ELT LINT,1,711119, 35501

000001                  SUBROUTINE LINT  (XT,YT,X,Y,I)                                  00015070
000002                  DIMENSION XT(2),YT(2)                                           00015090
000003            1     CONTINUE                                                        00015100
000004                  J1=2                                                            00015110
000005               6  IF (X .EQ. XT(J1) ) GO TO 10
000006                  IF (X .LT. XT(J1) ) GO TO 50
000007                  J1=J1+1                                                         00015130
000008                  IF(J1-I)6,6,550                                                 00015140
000009           50        A=(YT(J1-1)-YT(J1))/  (XT(J1-1)-XT(J1))                      00015150
000010                   B=YT(J1-1) -A*XT(J1-1)                                         00015160
000011           500    Y=A*X+B                                                         00015170
000012             501  RETURN                                                         00015180
000013             550 Y=YT(I)                                                        00015190
000014                  GO TO 501                                                       00015200
000015              10 Y = YT(J1)
000016                 RETURN
000017                  ENTRY LINTX(XT,YT,X,Y,I)                                        00015210
000018                  GO TO 1                                                         00015220
000019                     END                                                          00015230
000020                  SUBROUTINE LINT  (XT,YT,X,Y,I)
000021                  DIMENSION XT(2),YT(2)                                             01171
000022            1     CONTINUE                                                          01172
000023                  J1=2                                                              01173
000024             6    IF(X .LE. XT(J1)) GO TO 50
000025                  J1=J1+1
000026                  IF(J1-I)6,6,550
000027           50        A=(YT(J1-1)-YT(J1))/  (XT(J1-1)-XT(J1))                      01180
000028                   B=YT(J1-1) -A*XT(J1-1)                                         01181
000029           500    Y=A*X+B                                                         01182
000030             501  RETURN
000031             550 Y=YT(I)
000032                  GO TO 501
000033                  ENTRY LINTX(XT,YT,X,Y,I)
000034                  GO TO 1                                                         01185
000035                     END                                                          01186
```

```
@ ELT LINTZI,1,711119, 35503

000001                SUBROUTINE LINTZ1 (X, Y, ARG, ANS, N )
000002                DIMENSION X(1),Y(1)                                    00015260
000003           100  IF(ARG .GE. X(J) .AND. ARG .LE. X(J+1) .OR. ARG .LE. X(J)  00015270
000004               1    .AND. ARG .GE. X(J+1) )  GO TO 1                   00015280
000005                J=J+1                                                  00015290
000006                IF(J .LE. 49) GO TO 100                                00015300
000007                WRITE(6,1000) ARG                                      00015310
000008           1000 FORMAT('1 EXHAUSTED TABLE IN SUBROUTINE LINTZ1, ARGUMENT IS  ',  00015320
000009               1 E20.8)                                                00015330
000010           1    ANS=(ARG-X(J))*(Y(J+1)-Y(J))/(X(J+1)-X(J))+Y(J)        00015340
000011                IF ( N .EQ. 0) RETURN
000012                IF(ARG .NE. X(J+1) .AND. ARG .NE. X(J)) RETURN         00015350
000013                IF(ARG .EQ. X(J) .AND. X(J) .NE. X(J+1)) RETURN        00015360
000014                IF(ARG .EQ. X(J+1) .AND. X(J+1) .NE. X(J+2)) RETURN    00015370
000015                IF (X(J+2).EQ.0.) RETURN                               00015380
000016                J=J+2                                                  00015390
000017                RETURN                                                 00015400
000018                ENTRY LINTZS(X,Y,ARG,ANS)                              00015410
000019                J=1                                                    00015420
000020                RETURN                                                 00015430
000021                END                                                    00015440
000022                SUBROUTINE LINTZ1(X,Y,ARG,ANS)
000023                DIMENSION X(1),Y(1)
000024           100  IF(ARG .GE. X(J) .AND. ARG .LE. X(J+1) .OR. ARG .LE. X(J)
000025               1    .AND. ARG .GE. X(J+1) )  GO TO 1
000026                J=J+1
000027                IF(J .LE. 49) GO TO 100
000028                WRITE(6,1000) ARG
000029           1000 FORMAT('1 EXHAUSTED TABLE IN SUBROUTINE LINTZ1, ARGUMENT IS  ',
000030               1 E20.8)
000031           1    ANS=(ARG-X(J))*(Y(J+1)-Y(J))/(X(J+1)-X(J))+Y(J)
000032                IF(ARG .NE. X(J+1) .AND. ARG .NE. X(J)) RETURN
000033                IF(ARG .EQ. X(J) .AND. X(J) .NE. X(J+1)) RETURN
000034                IF(ARG .EQ. X(J+1) .AND. X(J+1) .NE. X(J+2)) RETURN
000035                IF (X(J+2).EQ.0.) RETURN
000036                J=J+2
```

```
@ ELT NRAP1,1,711119, 35504

000001                SUBROUTINE NRAP1(FF,X,IDUM,EP,IN2,IN)                                  *NEW
000002                DIMENSION I(3)                                                         *NEW
000003                DATA I/'   HLC',','   OUT',','      '/                                *NEW
000004                DATA LS /1/                                                    01189**-1
000005                  IF ( LS.)  11,12,13                                          01191**-1
000006          13    FFX= FF                                                        01192
000007                EX=X                                                           01193
000008                X= .99*X                                                       01194
000009                 LS =0                                                         01195
000010                IDUM = 1                                                       01196
000011                RETURN                                                         01197
000012          12    DX = .01* EX                                                   01198
000013                 LS=-1                                                         01199
000014          11    CONTINUE                                                       01200
000015                 IDUM=IDUM+1                                                   01201
000016                DX = FF * DX / (FFX-FF)                                        01202
000017                IF( ABS(DX/X)-EP) 30,30,31                               00008050
000018             31 IF( ABS(DX).GT..1) DX=DX/ ABS(DX)*.1
000019                X=X - DX
000020                IF ( IDUM.GT.50 ) GO TO 60                                     01205
000021                FFX= FF                                                        01206
000022                RETURN                                                         01207
000023          30    LS=1                                                         01208
000024                 IDUM = 0                                                      01209
000025                RETURN                                                         01210
000026             60 WRITE(6,61)  IN,I(IN2),X,DX                                    *NEW
000027             61 FORMAT(' NEWTON ITERATION FAILURE AT STATION',I4,' IN SUBROUTINE',  *NEW
000028               1     A6/' FUNCTION =',1PE15.5,'   ERROR =',1PE15.5/)            *NEW
000029                GO TO 30                                                       01218**-6
000030                 END                                                           01219
```

```
@ ELT OUT,1,711221, 32563

000001                SUBROUTINE OUT                                                    1627
000002               1   (ID,N,NTOT,ITT)
000003                REAL J,K1,K2,K3,K4,KC,KCF,KM,KMP,KWG,KFAC,L,MC,MR,MUB,MUCF,
000004               X      MUGF,MUW,NMB,NT,N1P,N2P,N3P,N4P,N5P,N6P,NMBP
000005                REAL  KB,KWL,K5,K5P,K6,LP,MUWL,MW,NC,NDL
000006                REAL LHITE
000007                INTEGER  DMY(2)
000008                INTEGER   DATE
000009                COMMON /IISUM/ ISUM
000010                COMMON / EF / AJ, DPI, BJ, DTI, KOUNT, IGO, IFLAG
000011                REAL MAT
000012                COMMON /ADD/ RE, WDOTOA, MAT(4),LHITE(100),CGITE(100)
000013                COMMON/IGRAPH/IPLOT(10),IPFLAG
000014                COMMON /SHEEHY/ DS, W, WP, AFBAR, K5, VCBAR, K5P, TWMC, VCP, TSAT,
000015               2 FCBAR, K6, TSATK, FCP, PD, FRHOV, CPCF, MUWL, CB2, KB, CPWL, CPB,
000016               3 RHOWL, KWL, CB1, ZETA, MW, COEF(4,5), LP, DUMPEM, PXM(100),
000017               4 PDM(100), NDL, DZ, NC, SMATCP
000018                COMMON/ FLUIDP / A(35)                                            1631
000019                COMMON/JOHNC/TAHG(50),IGAS,IK5,DEP,LCOOL,LGAS
000020                  DIMENSION ID(20)                                                1632
000021                COMMON/ CON/  AA     ,ABAR   ,AE     ,AF     ,AFP    ,AS     ,AL     ,  1634
000022               1AO     ,ASTAR  ,AV     ,B      ,BETA   ,C1     ,CL     ,CG     ,CC1    ,  1635
000023               2CC2    ,CP     ,CPP    ,CPBAR  ,CPGF   ,D      ,DE     ,E1     ,E2     ,  1636
000024               3E3     ,E4     ,E      ,F      ,FBAR   ,FEFV   ,FS     ,FC     ,FP     ,  1637
000025               4GO     ,G1     ,G      ,H      ,HBC    ,HC     ,HIN    ,HMIX   ,HOUT   ,  1638
000026               5HG     ,HL     ,HL1    ,HR     ,J      ,K1     ,K2     ,K3     ,K4     ,  1639
000027               6KC     ,KCF    ,KM     ,KMP    ,KWG    ,KFAC   ,L      ,MC     ,MR     ,  1640
000028               7NMB    ,NT     ,N1P    ,N2P    ,N3P    ,N4P    ,N5P    ,N6P    ,PIE    ,  1641
000029               8PSC    ,PC     ,PG     ,PFM    ,PRCF   ,PRGF   ,P      ,PP     ,PF     ,  1642
000030               9PIN    ,PLS    ,POUT   ,PRC    ,PV     ,Q      ,QOA    ,QOAM   ,QOAO   ,  1643
000031               OR      ,RC     ,RD     ,RN     ,RU     ,RB     ,RSTAR  ,RCV    ,SMALD  ,  1644
000032               1SMALRA,SMALRG,SC     ,S      ,STR    ,STRY   ,SMALTC,SMALTM,SMALTS,  1645
000033               2SMARGP,TB     ,TBP    ,TBC    ,TC     ,TRCF   ,TCF    ,TGF    ,TIN    ,  1646
000034               3TM     ,TMIX   ,TWG    ,TWGC   ,TWL    ,TWLC   ,TWM    ,TO     ,TINFIN,  1647
000035               4TBAR   ,U      ,V      ,VF     ,VC     ,VP     ,VNS    ,WG     ,WGCORE,  1648
000036               5WGSTAR,WC     ,WBC    ,WF     ,X      ,XP     ,XI     ,Z      ,ZP     ,  1649
000037               6ZB     ,ZD     ,ZOL    ,ZN     ,ZU     ,ZW     ,ZSTAR  ,EHAF   ,MUB    ,  1650
000038               7MUCF   ,MUGF   ,MUW    ,RHO    ,RHOB   ,RHOBP  ,RHOCF  ,RHOGF  ,RHOW   ,  1651
000039               8RHOBAR,RP     ,EP0GEO,EP1GEO,NMBP   ,GAMMAC,SMALA  ,EPGEOM,AASTAR,  1652
000040               9SMATMP,RHOP   ,ALPHAA,BETAA  ,EP0    ,EP1                       1653
000041                COMMON/INRB07/VDTC,RB0FP,RB0FT,RB0A1,RB0A2,RB0B1,RB0B2,RB0N1,RB0N2,  1654
000042               1              RB0M1,RB0M2,RB0C1,RB0K1,RB0,Q0AB0,VDT                 OUT
000043                DIMENSION COOL(24), TUBES(20), C(6), T(5), TT(5), TP(5)
000044                DATA TT    / 'VARI','ABLE','    ','    ','    ' /                00018635
000045                DATA BLANK /'    '/
000046                COMMON /INT/ IKMAX,  ILHITE,  ICGITE,  IITRFL,  IKERR,  IN,
000047               1             ITUBE,  INUM,    IDIS,    IFRIC,   ITNUM1,
000048               2             IZPTS,  IZSTEP,  IWALL,   IMERCR,  IHGC,   IHLC,
000049               3             IFILM,  IRBO  ,  I8085,   ICOOL
000050                DATA COOL/'NBS ','EQUI','LIBR','IUM ','HYDR','OGEN',
000051               1          'AERO','ZINE','-50 ','    ','    ','    ',
000052               2          'WATE','R   ','    ','    ','    ','    ',
000053               3          'NBS ','PARA','-HYD','ROGE','N   ','    '/
000054                IF (IN .NE. 1) GO TO 8
000055                DO 5 I=1,5
000056               5 TP(I) = BLANK
```

```
000057                8 K=0
000058                  IF(ICOOL.EQ.2) K=6
000059                  IF(ICOOL.EQ.3) K=12
000060                  IF(ICOOL.EQ.4) K=18
000061                  DO 88 II=1,6
000062                  C(II)=  COOL (K+II)
000063               88 CONTINUE
000064                  DATA TUBES / 'RECT','ANGU','LAR ','SLOT','S   ',
000065                1              'TRUN','CATE','D   ','    ','    ',
000066                2              'ROUN','D OR',' FLA','TTEN','ED  ',
000067                3              'U-TU','BE  ','    ','    ','    '  /
000068                  IF ( ITUBE.EQ.1 )  K=0
000069                  IF ( ITUBE.EQ.2 )  K=5
000070                  IF ( ITUBE.EQ.3 )  K=10
000071                  IF ( ITUBE.EQ.4 )  K=15
000072                  DO 89  II=1,5
000073                  T(II) = TUBES(K+II)
000074               89 CONTINUE
000075                  PRB = 0.E0
000076                  TTIN = TIN
000077                  TTBC = TBC
000078                  TTWGC= TWGC
000079                  TTWLC= TWLC
000080                  IF (SMALTC .LE. 0.) TWM = .5*(TWLC + TWGC)
000081                  TTWM = TWM
000082                  TTINFI  = TINFIN
000083                  DMY(1) = 6H
000084                  CALL DATE(12,DMY)
000085                  E4 = E4 + Q
000086                  EHAF = EHAF + PF
000087                  IF (ISUM .EQ. 2) GO TO 200
000088                  IF (N .NE. 1) GO TO 90
000089                  E4 = 0.
000090                  EHAF = 0.
000091                  REWIND 3
000092                  WRITE (3,799) DMY
000093             799  FORMAT (2A6)
000094                  WRITE (3,800) ID,NTOT
000095             800  FORMAT (20A4,I4)
000096                  WRITE (3,801) C, PIN, TIN
000097             801  FORMAT ( 6A4,2F6.1)
000098                  WRITE (3,802)  TC, PC, WG, WC, MR, NT
000099             802  FORMAT (2F5.0,2F7.1,F5.2,F5.0)
000100                  IF (ISUM .EQ. 3) GO TO 10
000101                  GO TO 90
000102             200  IF( N .NE. 1 ) GO TO 30                                  00018480
000103              10  NP = 1                                                     1657
000104                  DMY(1) = 6H
000105                  CALL DATE (12,DMY)
000106                  E4 = 0.                                                    1659
000107                  EHAF=0.                                                    1660
000108                  WRITE (6,950)  DMY
000109                  WRITE (6,951) ID, NP, C, TT, MR, PC, TC, HC, PIN, TIN
000110        C         WRITE (6, 952)                                             1663
000111                  WRITE (6,9525)
000112                  WRITE (6, 953)                                             1664
000113                  LINE = 1                                                   1665
000114                  WRITE (6, 962)                                             1666
000115                  WRITE (6, 954)                                             1667
000116                  WRITE (6, 955)                                             1668
```

```
000117                WRITE (6, 956)                                          1669
000118                WRITE (6,9565)
000119                WRITE (6, 962)                                          1670
000120                IF (ISUM .EQ. 2) GO TO 30
000121             90 WRITE (3,803) N, AASTAR, CL, E4, SMALTM, HL, R
000122            803 FORMAT (I3,F7.2,F7.4,F7.0,F7.4,F8.5,F6.2)
000123                WRITE (3,804) TTBC, SMALRG, AF, TTWLC, RE, WDOTOA
000124            804 FORMAT (F6.1,2F6.3,F6.0,E11.4,F6.1)
000125                WRITE (3,805) Z, CG, VC, QOA, HG, PRC
000126            805 FORMAT (F7.2,F7.4,F7.0,F5.1,F9.5,F8.2)                  00019140
000127                WRITE (3,806) DE, L, NMB, TTWGC, MUB, MC
000128            806 FORMAT (F8.3,F7.4,F5.0,F6.0,E11.4,F6.4)
000129                WRITE (3,8012) T, MAT
000130           8012 FORMAT(9A4)
000131                IF (ISUM .EQ. 3) GO TO 30
000132                IF (N .NE. NTOT) RETURN
000133                GO TO 100                                               00019190
000134             30 WRITE (6,957) N,Z,TTWGC,PRC,WG,PG,NT,R,TTWM,TTBC,WC,
000135              1              TTINFI , AF, ITT, AASTAR, TTWLC, QOA, E4, BETA, L
000136                WRITE (6, 958) AS, B, DE, NMB, SMALD,SMALRA,SMALRG,SMALTC  1675
000137                WRITE (6,959) SMALTM,SMALTS,GAMMAC,SC,V,FC,PFM,PF
000138                WRITE (6,959) PV, EHAF, VC, MC, X, HG, HL, HR
000139                WRITE (6, 959) F, GO, FEFV, CL, CG, U, QOAO, Q          1678
000140                WRITE (6, 959) STR, STRY, KC, KM, KWG, CP, PRCF, MUB    1679
000141                WRITE (6, 958) MUCF, MUW, RHOB, RHOCF, RHOW,RHOBAR, AV, CPGF  1680
000142                WRITE (6, 959) PRGF, MUGF, RHO, RBO, QOABO, RHOGF, KB, KCF
000143                WRITE (6, 959) PRB, VDT, TSAT
000144                IF ( T(1) .NE. TP(1) ) WRITE (6,9595) T, MAT
000145           9595 FORMAT (8X,'TUBE TYPE = ',5A4,27X,'MATERIAL = '4A4 )
000146                DO 6 I=1,5
000147              6 TP(I) = T(I)
000148                LINE = LINE + 1                                         1682
000149                IF (LINE .EQ. 7) GO TO 50
000150             20 IF( N .NE. NTOT ) RETURN                                1684
000151                GO TO 100                                               1685
000152             50 LINE = 0                                                1686
000153                NP = NP + 1                                             1687
000154                WRITE (6, 961)                                          1688
000155                WRITE (6,951) ID, NP, C, TT, MR, PC, TC, HC, PIN, TIN   00018964
000156                IF (N - NTOT + 1) 60, 60, 100                           1690
000157             60 WRITE (6, 962)                                          1691
000158                WRITE (6, 954)                                          1692
000159                WRITE (6, 955)                                          1693
000160                WRITE (6, 956)                                          1694
000161                WRITE (6,9565)
000162                WRITE (6, 962)                                          1695
000163                RETURN                                                  1696
000164            100 IF (IMERCR .EQ. 0) GO TO 101
000165             55 POUT=P-(RHOB*VC**2/2./G)*(K3+CC2*(K4+1.895*AO/AF-4.*
000166              1     SQRT(AO/AF)+2.105)/(AO/AO*AF*AF))
000167                EP1 = TTBC - TTIN
000168                EP0 = PIN - POUT
000169                EP0 = PIN - PRC                                         00019500
000170                AJ= DPI - EP0
000171                BJ= DTI - EP1
000172                IF (ISUM .EQ. 2) GO TO 94
000173                WRITE (3,807) TTBC, PRC, EP1, EP0
000174            807 FORMAT (4F6.1)
000175                END FILE 3
000176                REWIND 3
```

```
000177                IF (ISUM .EQ. 1) GO TO 909
000178             94 WRITE (6,949) TTBC, PRC, EP1                                  00019560
000179                IF (IFLAG .NE.1) GO TO 9495
000180                WRITE (6,970) BJ, AJ
000181            970 FORMAT ('0DELTA T INPUT - DELTA T CALCULATED = 'F11.5,
000182               1 /' DELTA P INPUT - DELTA P CALCULATED = 'F11.5)
000183           9495 IF (ISUM .EQ. 2) RETURN
000184            909 CALL SUMARY(IMERCR)                                          00019570
000185            949 FORMAT('0OUTLET CONDITIONS ARE ---'/'0TEMP.    ='F6.1,' DEG.R.','
000186               1      '   PRESSURE ='F7.1,' PSIA.'/'0DELTA T  ='F6.1,' DEG.R.')
000187                RETURN
000188            101 POUT=P-(RHOB*VC**2/2./G)*(K3+CC2*(K4+1.895*A0/AF-4.*
000189               1     SQRT(A0/AF)+2.105)/(A0/A0*AF*AF))
000190               2          + 2.105) /A0/A0*AF*AF    )                        1699
000191                CALL PT( POUT, TB)                                           1700
000192                HOUT = A (13 )                                               1701
000193                CALL PT( PIN,TIN )                                           1702
000194                HIN  = A (13 )                                               1703
000195                HMIX = (WC * HOUT + WBC *( HBC+ HIN) )/ ( WC + WBC )         1704
000196                EP0  =  PIN - POUT                                           1705
000197                TMIX = TB                                                    1706
000198                IF(HBC.EQ.0.0) GO TO 2
000199             1   CALL PT( POUT, TMIX)                                       1707
000200                Q1 = HMIX - A(13)                                            1708
000201                CALL NRAP1(Q1,TMIX,I,0.0000010,2,IN)
000202                IF( I ) 1,2,1                                                1710
000203             2  EP1 = TMIX - TIN
000204                AJ= DPI -EP0
000205                BJ= DTI - EP1
000206                IF (ISUM .EQ. 2) GO TO 900
000207                WRITE (3,808) WBC, HBC, HMIX, TMIX, POUT, EP1, EP0
000208            808 FORMAT (F6.2,F7.2,2(F6.1),F7.1,F6.1,F7.1)
000209                END FILE 3
000210                REWIND 3
000211                IF (ISUM .EQ. 1) GO TO 903
000212            900 WRITE (6,960) WBC, HBC, HMIX, TMIX, POUT, EP1, EP0           00019830
000213                IF (IFLAG .NE. 1 ) GO TO 9090
000214                WRITE (6,970) BJ, AJ
000215           9090 IF (ISUM .EQ. 2) RETURN
000216            903 CALL SUMARY(IMERCR)                                          00019845
000217                IF(IPFLAG.EQ.1) CALL GRAPH(IPLOT)
000218                RETURN                                                       1713
000219            950 FORMAT ('1',27X, 'REGENERATIVE COOLING HEAT TRANSFER (NON-CRYOGENI
000220               1C AND CRYOGENIC)' // 10X, 'PROGRAM E25107',52X,2A6)          *NEW
000221            951 FORMAT(/5X,'*** '20A4,12X,'PAGE 'I3//10X,'COOLANT = '6A4,    **-1
000222               X 19X,'TUBE TYPE = '5A4 /10X,'MR = 'F5.2,
000223               1     7X, 'PC = ' F5.0, 8X, 'TC = ' F5.0, 8X, 'HC = ' F6.0,  1717
000224               2     7X, 'PIN = ' F6.1,6X,'TIN = ' F6.1)
000225          C
000226          C 952 FORMAT (/10X, 'UNITS USED IN THIS PROGRAM ARE AS FOLLOWS' //  1719
000227          C    1     15X, 'PRESSURE     = LB./SQ.IN.' 20X, 'VELOCITY' 18X,   1720
000228          C    2     '= IN./SEC.'/15X, 'TEMPERATURE  = DEG.R.' 24X, 'HEAT'1X
000229          C    3     'TRANSFER COEFFICIENT = BTU/SEC.-SQ.IN.-DEG.R.'/15X,   1722
000230          C    4     'ENTHALPY     = BTU/LB.' 23X, 'HEAT FLUX' 17X, '= BTU/SEC.-SQ  1723
000231          C    5.IN.')                                                      1724
000232          C
000233          9525 FORMAT (/10X, 'UNITS USED IN THIS PROGRAM ARE AS FOLLOWS' //
000234               1     15X, 'PRESSURE     = LB./SQ.IN.' 20X, 'VELOCITY' 18X,
000235               2     '= IN./SEC.'/15X, 'TEMPERATURE  = DEG.R.' 24X, 'HEAT'1X
000236               3     'TRANSFER COEFFICIENT = BTU/SEC.-SQ.IN.-DEG.R.'/15X,
```

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      4     'ENTHALPY     = BTU/LB.' 23X, 'HEAT FLUX' 17X, '= BTU/SEC.-SQ
     5.IN.')
  953 FORMAT (15X, 'ENTROPY      = BTU/LB.-DEG.R.' 16X, 'HEAT RATE' 17X,
     1     '= BTU/SEC.'/15X, 'DENSITY      = LB./CU.IN.' 20X, 'LENGTH'
     2     20X, '= IN.'/15X, 'VISCOSITY    = LB./IN.-SEC.' 18X, 'AREA'
     3     22X, '= SQ.IN.'/15X, 'CONDUCTIVITY = BTU/SEC.-IN.-DEG.R.'
     4     11X, 'STRESS' 20X, '= LB./SQ.IN.'/15X, 'SPECIFIC HEAT='
     5   1X'BTU/LB.-DEG.R.')
  954 FORMAT (10X, 'EFF SURF AREA   LEG SPREAD     EQUIV DIA', 8X, 'NMB'
     1     11X, 'SMD' 11X, 'RA' 12X, 'RG' 12X, 'THC'/15X, 'THM' 11X,
     2     'THS'10X, 'GAMMA' 8X, 'ENTROPY' 7X, 'GAS VEL      FRIC FACT'
     3     8X, 'PFM' 11X, 'PF'/15X, 'PV' 11X, 'SUM PF      COOL VEL'
     4     6X, 'COOL MACH     DEV DIST' 9X, 'HG' 12X, 'HL' 12X, 'HR')
  955 FORMAT (11X, 'SHAPE FACT     GRAY BODY       FEFV' 11X, 'CL' 12X,
     1     'CG' 13X, 'U' 11X, 'Q/AO' 12X, 'Q' /13X, 'STRESS' 8X,
     2     'YLD STR' 9X, 'KC' 12X, 'KM' 12X, 'KWG' 10X, 'CP-CB' 9X,
     3     'PR-CF' 8X, 'VISC-CB' //13X, 'VISC-CF' 7X, 'VISC-CW' 7X,
     4     'RHO-CB' 8X, 'RHO-CF' 8X, 'RHO-CW' 8X, 'RHOBAR' 9X, 'H-CB'
     5     10X, 'CP-GF')
  956  FORMAT(14X, 'PR-GF' 8X, 'VISC-GF' 7X, 'RHO-GB' 10X, 'RBO' 9X,
     1        'QOABO', 9X, 'RHO-GF', 9X, 'KB', 12X, 'KCF' )
 9565 FORMAT (14X, 'PRB-B',11X, 'VDT', 10X,'TSAT' )
  957 FORMAT('0STA' I4,'  Z    ='F7.2,8X,'TWG ='F6.0,8X,'PRC ='F6.1,8X,
     1     'WG   ='F7.1,6X,'PG   ='F6.1,8X,'MT ='F5.0/
     2     10X, 'R    =' F7.3, 8X, 'TWM =' F6.0, 8X, 'TB  =' F6.1, 8X,
     3'WC   ='F7.1,8X, 'TG   =' F6.0,8X, 'AF ='F6.3 /'  ITR 'I3,' A/AT'
     4     1X,'='F7.2,8X,'TWL ='F6.0,8X,'Q/AI='F7.2,7X,'SUMQ ='
     5     F7.0,8X, 'BETA =' F6.3, 8X, 'L =' F7.4)
  958 FORMAT ('0' 7X, 8E14.5)
  959 FORMAT (8X, 8E14.5)
  960 FORMAT (/10X, 'FOR BOLT COOLANT OF'  F6.2, ' LB./SEC. ABSORBING'
     1     F7.2, ' BTU/LB., OUTLET CONDITIONS ARE ---'//15X, 'ENTHALPY'
     2    1X'=' F6.1, ' BTU/LB.,  TEMP. =' F6.1, ' DEG.R.,  PRESS. ='
     3     F7.1, ' PSIA.,  RESULTING IN'//15X, 'DELTA T =' F6.1,
     4     ' DEG.R., DELTA P =' F7.1, ' PSI')
  961 FORMAT ('1'//)
  962 FORMAT (7X,  '*   *   *   *   *   *   *   *   *   *   *   *   *
     ?*   *   *   *   *   *   *   *   *   *   *   *   *   *   *   *')
      END
```

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@ ELT PHTEMP,1,711119, 35511

000001                FUNCTION PHTEMP(PRES,ENTH,QUAL)                                                  NBS10050
000002                DIMENSION LOC(16),JP(13),T(429),DP(13),DH(13),BP(13),BH(16),MX(13)NBS10060
000003               1,R(19),TL(19),TG(19),TF(19),SH(10),TS(10)                                        NBS10070
000004                DIMENSION AA(116),AB(112),AC(112),AD( 89)                                        NBS10080
000005                EQUIVALENCE( T,AA),( T( 117),AB),( T( 229),AC),( T( 341),AD)                    NBS10090
000006                DATA  R/1.022,2.0,4.0,8.0,14.0,25.0,43.0,69.0,99.0,128.0,151.0,                  NBS10100
000007               1165.0,176.0,182.0,185.0,186.5,187.25,187.46875,187.506/, TG/60.31,NBS10110
000008               265.11,70.59,76.35,80.98,85.11,87.40,86.54,81.94,74.15,64.83,56.86,NBS10120
000009               347.34,39.56,33.46,28.34,22.31,18.66,16.55/, TL/-132.8,-129.13,                  NBS10130
000010               4-124.25,-117.79,-110.86,-101.3,-89.04,-74.22,-58.58,-43.43,-30.07,NBS10140
000011               5-20.56,-11.13,-4.27,1.17,5.54,10.83,14.29,16.36/, TF/24.845,27.07,NBS10150
000012               629.81,33.07,36.18,39.96,44.12,48.33,51.97,54.79,56.72,57.80,58.57,NBS10160
000013               758.99,59.18,59.29,59.34,59.353,59.356/                                          NBS10170
000014                DATA  SH/-132.8,-109.96,-87.59,-65.71,-44.27,-23.18,-2.45,18.06,                NBS10180
000015               138.32,58.50/, TS/24.846,27.175,29.310,31.299,33.176,34.962,36.672,NBS10190
000016               238.317,39.904,41.456/                                                           NBS10200
000017                DATA LOC/7,100,118,150,1,178,218,9,283,331,340,358,376,400,406,                 NBS10210
000018               1418/                                                                            NBS10220
000019                DATA JP/11,3,8,7,11,8,13,11,8,3,3,3,4/                                           NBS10230
000020                DATA MX/0,1,6,5,9,6,11,1,6,1,1,1,2/                                              NBS10240
000021                DATA BP/0.,0.,881.76,0.,587.84,881.76,0.,0.,73.48,0.,-40.,-2.,1500NBS10250
000022               1.0/                                                                             NBS10260
000023                DATA DP/3000.0,750.0,587.84,146.96,440.88,587.84,73.48,293.32,                   NBS10270
000024               173.48,1500.0,120.0,6.0,1000.0/                                                  NBS10280
000025                DATA BH/1800.0,425.0,170.61,170.61,-110.9,42.65,42.65,-134.4,                    NBS10290
000026               1-53.32,10000.0,10000.0,10000.0,425.0,20000.,20000.,20000./                      NBS10300
000027                DATA DH/3000.0,275.0,85.306,85.306,19.194,31.99,31.99,20.26,19.194NBS10310
000028               1,5000.0,2000.0,2000.0,275.0/                                                    NBS10320
000029                DATAAA/26.93,18.54,10.35,0.,0.,0.,538.5,524.3,24.22,18.56,11.13,37NBS10330
000030               1.28,29.73,21.66,13.12,0.,0.,1400.,1379.,34.98,30.38,24.94,45.61,40NBS10340
000031               2.14,32.85,24.73,10.16,0.,2236.,2217.,42.93,40.14,36.22,52.51,48.58NBS10350
000032               3,43.,35.98,28.21,19.23,3020.,3008.,48.76,47.69,45.19,58.36,55.84,5NBS10360
000033               41.48,45.9,39.12,31.21,23.56,0.,52.66,53.63,52.51,63.38,62.26,58.95NBS10370
000034               5,54.38,48.8,42.25,34.65,27.13,19.19,0.,0.,67.7,68.04,65.68,61.94,5NBS10380
000035               67.24,51.72,45.36,38.02,30.67,23.1,0.,71.5,73.35,71.91,68.91,64.87,NBS10390
000036               760.1,54.65,48.49,41.47,33.99,26.07,74.93,78.3,77.75,75.4,71.97,67.NBS10400
000037               879,62.98,57.6,51.59,44.88,37.44,165.5,175.4,180.2,258.4,248.8,250.NBS10410
000038               95,316.,316.5,316.3,387.6,386.3,384.7,461.9,459.4,456.6,538.5,535./NBS10420
000039                DATAAB/531.4,106.4,112.,112.8,111.2,108.2,104.2,99.5,94.3,126.7,13NBS10430
000040               14.5,136.4,135.9,134.,131.2,127.7,123.6,152.8,157.6,159.5,159.5,158NBS10440
000041               2.2,156.,153.3,150.,177.,180.5,182.,182.,181.1,179.2,176.9,174.1,69NBS10450
000042               3.28,80.43,88.86,95.21,99.97,103.6,106.4,103.7,110.,115.2,119.6,123NBS10460
000043               4.2,126.2,128.7,136.4,140.2,143.5,146.4,148.9,151.,152.8,166.,168.5NBS10470
000044               5,170.7,172.6,174.3,175.7,177.,77.8,77.75,74.35,69.24,62.98,55.67,4NBS10480
000045               67.21,37.67,84.89,86.83,84.76,80.75,75.55,69.44,62.53,54.74,91.8,95NBS10490
000046               7.41,94.51,91.44,87.08,81.83,75.86,69.24,98.89,103.7,103.8,101.5,97NBS10500
000047               8.9,93.35,88.07,82.24,106.4,112.,112.8,111.2,108.2,104.2,99.5,94.3,NBS10510
000048               917.02,50.26,55.6,62.01,66.36,69.49,71.82,73.58,74.93,75.97,76.77/ NBS10520
000049                DATAAC/77.4,77.8,30.6,46.62,57.11,64.14,69.25,73.12,76.12,78.5,80.NBS10530
000050               139,81.9,83.13,84.12,84.89,43.29,54.15,62.43,68.86,73.91,77.95,81.2NBS10540
000051               22,83.9,86.11,87.94,89.47,90.76,91.8,56.29,64.12,70.62,76.07,80.62,NBS10550
000052               384.36,87.59,90.31,92.61,94.57,96.25,97.67,98.89,69.28,74.86,80.43,NBS10560
000053               484.65,88.86,92.03,95.21,97.59,99.97,101.8,103.6,105.,106.4,52.78,5NBS10570
000054               53.15,53.39,53.63,53.35,53.07,52.79,52.51,56.63,56.25,57.33,57.97,5NBS10580
000055               68.34,58.5,58.5,58.35,59.99,57.71,59.72,61.2,62.13,62.78,63.18,63.3NBS10590
000056               77,0.,57.51,60.91,63.37,65.1,66.27,67.12,67.69,0.,56.68,61.52,65.01NBS10600
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000057              8,67.46,69.21,70.52,71.49,0.,56.25,62.01,66.36,69.49,71.82,73.47,74NBS10610
000058              9.93,2825.,2816.,2810.,4043.,4051.,4045.,4991.,5132.,5153.,2819./  NBS10620
000059               DATAAD/2815.,2814.,3321.,3327.,3327.,3766.,3807.,3813.,4119.,4243.NBS10630
000060              1,4264.,4374.,4617.,4665.,4561.,4928.,5010.,2813.,2821.,2818.,3294.NBS10640
000061              2,3318.,3323.,3663.,3759.,3780.,3908.,4110.,4163.,4079.,4376.,4463.NBS10650
000062              3,4209.,4581.,4697.,180.2,181.6,179.8,176.1,250.5,250.7,248.9,245.9NBS10660
000063              4,316.3,314.9,312.5,309.3,384.7,382.,378.7,374.8,456.6,452.7,448.5,NBS10670
000064              5444.,531.4,526.7,521.9,517.2,4991.,5131.,5151.,5664.,5963.,6043.,4NBS10680
000065              6560.,4929.,5010.,4706.,5186.,5301.,4826.,5402.,5549.,4928.,5587.,5NBS10690
000066              7849.,4213.,4581.,4698.,4318.,4746.,4887.,4405.,4883.,5044.,4480.,5NBS10700
000067              8000.,5178./                                                      NBS10710
000068               P=PRES                                                           NBS10720
000069               IF(P.LT.1.0) P=1.0                                               NBS10730
000070               H=ENTH                                                           NBS10740
000071               IF(H.GE.25000.) H=24999.9999                                     NBS10750
000072               G=1.0                                                            NBS10760
000073               IF(H.LT.42.65) GO TO 10                                          NBS10770
000074               IF(H.GE.170.61) GO TO 1                                          NBS10780
000075               N=6                                                              NBS10790
000076               GO TO 2                                                          NBS10800
000077             1 IF(H.GE.426.53) GO TO 3                                          NBS10810
000078               N=3                                                              NBS10820
000079             2 IF(P.LT.881.76) N=N+1                                            NBS10830
000080               GO TO 15                                                         NBS10840
000081             3 IF(H.GE.1800.0) GO TO 4                                          NBS10850
000082               N=2                                                              NBS10860
000083               IF(P.GE.1500.0) N=13                                             NBS10870
000084               GO TO 20                                                         NBS10880
000085             4 IF(H.GE.10800.0) GO TO 5                                         NBS10890
000086               N=1                                                              NBS10900
000087               GO TO 20                                                         NBS10910
000088             5 IF(P.LE.200.0) GO TO 6                                           NBS10920
000089               N1=14                                                            NBS10930
000090               N=10                                                             NBS10940
000091               GO TO 20                                                         NBS10950
000092             6 IF(P.LE.11.0) GO TO 7                                            NBS10960
000093               N=11                                                             NBS10970
000094               N1=15                                                            NBS10980
000095               GO TO 20                                                         NBS10990
000096             7 N=12                                                             NBS11000
000097               N1=16                                                            NBS11010
000098               GO TO 20                                                         NBS11020
000099            10 IF(P.LT.587.84) GO TO 11                                         NBS11030
000100               N=5                                                              NBS11040
000101               GO TO 15                                                         NBS11050
000102            11 IF(H.GE.(-53.32)) GO TO 12                                       NBS11060
000103               N=8                                                              NBS11070
000104               GO TO 15                                                         NBS11080
000105            12 N=9                                                             NBS11090
000106            15 IF(H.GT.87.55) GO TO 20                                         NBS11100
000107               PR=P/587.84                                                      NBS11110
000108               I=PR                                                             NBS11120
000109               IF(I.GT.8) I=8                                                   NBS11130
000110               FI=I                                                             NBS11140
000111               F=PR-FI                                                          NBS11150
000112               FP=1.0-F                                                         NBS11160
000113               HS=FP*SH(I+1)+F*SH(I+2)                                          NBS11170
000114               TQ=FP*TS(I+1)+F*TS(I+2)                                          NBS11180
000115               IF(H.LT.HS) GO TO 17                                             NBS11190
000116               IF(P.GT.187.506) GO TO 20                                        NBS11200
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000117              IF(P.LT.1.021) GO TO 105                                NBS11210
000118              DO 104 I=2,19                                           NBS11220
000119              IF(P-R(I))102,101,104                                   NBS11230
000120          101 HL=TL(I)                                                NBS11240
000121              HG=TG(I)                                                NBS11250
000122              TQ=TF(I)                                                NBS11260
000123              GO TO 106                                               NBS11270
000124          102 D=R(I)-R(I-1)                                           NBS11280
000125              PRR=R(I)-P                                              NBS11290
000126              PPR=P-R(I-1)                                            NBS11300
000127              HL=(TL(I)*PPR+TL(I-1)*PRR)/D                            NBS11310
000128              HG=(TG(I)*PPR+TG(I-1)*PRR)/D                            NBS11320
000129              TQ=(TF(I)*PPR+TF(I-1)*PRR)/D                            NBS11330
000130              GO TO 106                                               NBS11340
000131          104 CONTINUE                                                NBS11350
000132          105 HL=-132.8                                               NBS11360
000133              HG=60.31                                                NBS11370
000134              TQ=24.84                                                NBS11380
000135          106 IF(H.GT.HL) GO TO 16                                    NBS11390
000136              Q=0.0                                                   NBS11400
000137              GO TO 20                                                NBS11410
000138           16 IF(H.GT.HG) GO TO 20                                    NBS11420
000139              Q=(H-HL)/(HG-HL)                                        NBS11430
000140              GO TO 30                                                NBS11440
000141           17 Q=(H-HS)/(0.0026806*P+25.021)                           NBS11450
000142              GO TO 30                                                NBS11460
000143           20 IF(H.LE.20000.)N1=N                                     NBS11470
000144              FP=(P-BP(N))/DP(N)                                      NBS11480
000145              IP=FP                                                   NBS11490
000146              IF(IP.GT.MX(N)) IP=MX(N)                                NBS11500
000147              FI=IP                                                   NBS11510
000148              F=FP-FI                                                 NBS11520
000149              FP=1.0-F                                                NBS11530
000150              FH=(H-BH(N1))/DH(N)                                     NBS11540
000151              IH=FH                                                   NBS11550
000152              FI=IH                                                   NBS11560
000153              FF=FH-FI                                                NBS11570
000154              FH=1.0-FF                                               NBS11580
000155              I=IH+JP(N)+IP+LOC(N1)                                   NBS11590
000156              J=I+JP(N)                                               NBS11600
000157              TQ=FP*FH*T(I)+F*FH*T(I+1)+FP*FF*T(J)+F*FF*T(J+1)        NBS11610
000158           30 QUAL=Q                                                  NBS11620
000159              PHTEMP=TQ                                               NBS11630
000160              RETURN                                                  NBS11640
000161              END                                                     NBS11650
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@ ELT PT,1,711119, 35512

000001                SUBROUTINE PT( P,T)                                                1761
000002          C     SUBROUTINE TO GET THERMODYNAMIC PROPERTIES OF THE COOLANT SIDE FLUID
000003                COMMON /INT/  IKMAX    ,ILHITE   ,ICGITE   ,IITRFL   ,IKERR       1764
000004               1   ,JN       ,ITUBE    ,INUM     ,IDIS     ,IFRIC    ,ITNUM1     1765
000005               3       , IZPTS , IZSTEP                                           1766
000006               4    ,IWALL, IMERCR , IHGC, IHLC, IFILM, IRBO, I8085 ,ICOOL        1767
000007                COMMON/FLUIDP/A1,A2,A3,A4,A5,A6,A7,A8,A9,A10,A11,A12,A13,A14(22)   1768
000008                COMMON/JOHNC/TAHG(50),IGAS,IK5,DEP,LCOOL,LGAS
000009                 A 4 =T                                                            1769
000010                 A 1 =P                                                            1770
000011                GO TO (1,2,3,10),ICOOL
000012           1    CONTINUE                                                          1772
000013          C     NBS EQUILIBRIUM HYDROGEN     (ICOOL=1)
000014                A11=ETVISC(A1,A4)
000015                A7 =ETCP  (A1,A4)
000016                A6 =ETSOUN(A1,A4)
000017                A10=ETCOND(A1,A4)
000018                A5 =ETDENS(A1,A4)
000019                A13=ETENTH(A1,A4)
000020             13 RETURN
000021          C     NBS PARA HYDROGEN            (ICOOL=4)
000022             10 A11=PTVISC(A1,A4)
000023                A7 =PTCP(A1,A4)
000024                A8 =PTSOUN(A1,A4)
000025                A10=PTCOND(A1,A4)
000026                A5 =PTDENS(A1,A4)
000027                A13=PTENTH(A1,A4)
000028                GO TO 13
000029           2    CONTINUE                                                          1778
000030          C     AEROZINE-50                  (ICOOL=2)
000031                CALL SUB1(A1,A4)                                                  1779
000032                RETURN                                                            1780
000033          C     WATER     PROPERTIES FROM ROCKETDYNE RESEARCH REPORT 61-14 (ICOOL=3)
000034          3     CALL SUB2 ( A1, A4 )
000035                RETURN
000036                    E        N           D                                        1781
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@ ELT PTCOND,1,711119, 35515

000001                FUNCTION PTCOND(PRES,TEMP)                                                    NBS20950
000002                DIMENSION PS(19),TS(19),JP(19),MX(19),LOC(19),BP(19),DP(19),BT(19)NBS20960
000003               1,DT(19),C(730)                                                                NBS20970
000004                DIMENSION AA( 96),AB(101),AC(114),AD( 97),AE( 97),AF(112),AG(110) NBS20980
000005               1 ,AH(  3)                                                                     NBS20990
000006                EQUIVALENCE( C,AA),( C(  97),AB),( C( 198),AC),( C( 312),AD)       NBS21000
000007               1    ,( C( 409),AE),( C( 506),AF),( C( 618),AG),( C( 728),AH)       NBS21010
000008                DATAA/.04565,.04628,.04642,.04702,.04764,.04823,.0488,.0523,.0528NBS21020
000009               18,.05324,.05384,.0544,.05494,.05546,.05525,.05616,.05701,.05781,.0NBS21030
000010               25858,.05931,.06,.05671,.05785,.05891,.0599,.06084,.06173,.06258,.0NBS21040
000011               35833,.05974,.06103,.06223,.06336,.06443,.06544,.05886,.06058,.0621NBS21050
000012               43,.06355,.06488,.06612,.0673,.05826,.0604,.06226,.06394,.06548,.06NBS21060
000013               5691,.06825,.05654,.05926,.06153,.06351,.06529,.06693,.06844,.05354NBS21070
000014               6,.05716,.06002,.06239,.06446,.06632,.06803,.04842,.05389,.05773,.0NBS21080
000015               76065,.06308,.06522,.06714,.05024,.04964,.05431,.05804,.06095,.0634NBS21090
000016               8,.06556,.05332,.05581,.05804,.06097,0.,.06,.06266,.06501,.0672,.06NBS21100
000017               9944,.06357,.067,.07001,.07273,.07524,.0668,.07099,.07464,.07791/  NBS21110
000018                DATAAB/.08092,.06825,.07318,.07739,.08114,.08456,.06836,.07402,.07NBS21120
000019               1875,.08292,.0867,.06748,.0739,.07913,.08368,.08778,.06556,.07279,.NBS21130
000020               207849,.08337,.08773,.06284,.07094,.07709,.08227,.08684,.06705,.070NBS21140
000021               377,0.,.07359,.08025,.08729,.08092,.0883,.09495,.08523,.09383,.1013NBS21150
000022               4,.08735,.09689,.1052,.08789,.09818,.107,.08684,.09768,.1069,.08538NBS21160
000023               5,.09667,.1062,.08361,.09529,.105,.08167,.09366,.1035,.07965,.0919,NBS21170
000024               6.1019,.07765,.09011,.1002,.07572,.08834,.0985,.07389,.08663,.09681NBS21180
000025               7,.0722,.085,.09517,.00717,.0078,0.,0.,0.,0.,.0089,.0099,.01175,.01NBS21190
000026               8343,0.,0.,.01173,.01235,.01324,.0142,.016,.0195,.0144,.01486,.0153NBS21200
000027               99,.01603,.01683,.01787,.01689,.01728,.01771,.01819,.01871,.01929/ NBS21210
000028                DATAAC/.01936,.01971,.02008,.02047,.02088,.02132,.1355,.0765,.02,0NBS21220
000029               1.,.1997,.1266,.0583,-.097,.2737,.1956,.1145,.0183,.355,.2739,.1924NBS21230
000030               2,.106,.4435,.3594,.2766,.1922,.5389,.4519,.3672,.2827,.6412,.5509,NBS21240
000031               3.464,.3784,.7503,.6568,.5673,.4801,.186,.1823,.1688,.1471,.1327,.1NBS21250
000032               417,.116,.0897,.06738,0.,.1033,.02061,0.,.0923,-.03742,.1647,.5027,NBS21260
000033               5.8584,1.215,1.575,1.935,.0205,.3245,.6437,.9728,1.317,1.664,.02782NBS21270
000034               6,.2195,.4653,.7696,1.083,1.402,-.051,.1085,.3222,.5864,.8749,1.178NBS21280
000035               7,0.,0.,.175,.3979,.6745,.9617,.002,.14,0.,.1714,.468,.7537,.0676,.NBS21290
000036               8171,.4237,.4227,0.,0.,.1345,.1942,.3248,.4415,.5429,0.,.1993,.2479NBS21300
000037               9,.3348,.458,.5758,.693,.2666,.3146,.3851,.4838,.603,.7319,.3369/  NBS21310
000038                DATAAD/.3841,.4481,.5344,.6445,.7709,.4104,.4577,.5192,.5976,.6964NBS21320
000039               1,.8146,.4874,.5352,.5954,.6698,.7616,.8713,.05874,.06009,.06134,.0NBS21330
000040               26249,.06357,.06459,.06556,.05558,.05724,.05872,.06007,.06131,.0624NBS21340
000041               37,.06355,.05203,.05396,.05574,.05734,.05878,.06011,.06134,.0492,.0NBS21350
000042               45102,.05267,.05431,.056,.05753,.05892,.04593,.0481,.05003,.05176,.NBS21360
000043               505332,.05476,.05634,.04202,.04488,.04717,.04916,.05093,.05253,.053NBS21370
000044               699,.0379,.04145,.0442,.04647,.04845,.05021,.05182,.0349,.03832,.04NBS21380
000045               7131,.04383,.046,.04792,.04965,.03308,.03602,.03886,.04143,.04371,.NBS21390
000046               804574,.04758,.06284,.07094,.07709,.08227,.08684,.0547,.0655,.07269NBS21400
000047               9,.07856,.08361,.0477,.05964,.06774,.07422,.07965,.04222,.0551/    NBS21410
000048                DATAAE/.06309,.07,.07572,.03963,.05101,.05952,.06634,.0722,.01936,NBS21420
000049               1.023,.02998,.04018,.04758,.02049,.024,.0294,.03728,.04452,.02161,.NBS21430
000050               202484,.02949,.03569,.04217,.02273,.02573,.02979,.03494,.04058,.023NBS21440
000051               385,.02667,.03028,.03472,.03963,.02386,.0373,.05312,.06377,.0722,.0NBS21450
000052               47907,.085,.09031,.09517,.02868,.0382,.0496,.05988,.06779,.07458,.0NBS21460
000053               5805,.08576,.09056,.03366,.04106,.04988,.0584,.06584,.07229,.07796,NBS21470
000054               6.08305,.0877,.03977,.04627,.05363,.06095,.06769,.07374,.07918,.084NBS21480
000055               713,.08069,.04614,.0582,.05841,.06483,.07091,.07653,.08169,.08644,.0NBS21490
000056               89005,.04614,.05841,.07091,.08169,.09085,.07156,.08113,.08993,.0979NBS21500
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000057                X        2X,F7.4,2X,F5.0,3X,F6.0,3X,E11.4,3X,F6.4/)
000058                  READ (3,22) T, M
000059               22 FORMAT (9A4)
000060                  IF (T(1) .EQ. TP) GO TO 50
000061                  TP = T(1)
000062                  WRITE (6,26) T, M
000063               26 FORMAT (7X,'TUBE TYPE = '5A4,21X,'MATERIAL = ' 4A4 )
000064               50 CONTINUE
000065                  WRITE (6,11)
000066                  IF (IMERCR .EQ. 0) GO TO 55
000067                  READ (3,20) TTBC, PRC, EP1, EP0
000068               20 FORMAT (4F6.1)
000069                  WRITE (6,21) TTBC, PRC, EP1, EP0
000070               21 FORMAT ('0'21X,'T-OUT = 'F6.1,5X,'P-OUT = 'F6.1,5X,'DELTA T = ',
000071                 X F6.1,5X,'DELTA P = 'F6.1/)
000072                  IF (IFLAG .NE. 1) GO TO 30
000073                  WRITE (6,31) AJ,BJ
000074               31 FORMAT (21X,'DELTA T INPUT - DELTA T CALCULATED = 'F11.5,
000075                 * / 21X,'DELTA P INPUT - DELTA P CALCULATED = 'F11.5)
000076               30 WRITE (6,11)
000077                  RETURN
000078               55 READ (3,23) WBC, HBC, HMIX, TMIX, POUT, EP1, EP0
000079                  WRITE(6,24) WBC, HBC, HMIX, TMIX, POUT, EP1, EP0
000080               24 FORMAT ('0FOR BOLT COOLANT OF 'F6.2,' ABSORBING 'F7.2,' OUTLET CON
000081                 1DITIONS ARE...'/12X,'ENTHALPY ' F6.1,' TEMPERATURE 'F6.1,' PRESSURE
000082                 2 'F7.1,'  RESULTING IN...'/24X,'DELTA T 'F6.1,', DELTA P 'F7.1)
000083               23 FORMAT (F6.2,F7.2,2(F6.1),F7.1,F6.1,F7.1)
000084                  IF (IFLAG .NE. 1) GO TO 30
000085                  WRITE (6,32) BJ, AJ
000086               32 FORMAT (36X,'DELTA T INPUT - DELTA T CALCULATED = 'F11.5,
000087                 * / 36X,'DELTA P INPUT - DELTA P CALCULATEE = 'F11.5)
000088                  WRITE (6,11)
000089                  RETURN
000090                  END

  6.                                                                    18:22:00

     END CUR
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<***Δ****1***Δ****2****Δ****3****Δ****4****Δ****5****Δ****6****Δ****7****Δ****8****Δ****9****Δ****0***Δ****1****Δ****2****Δ****3*
**********************************ISD-27.09:INFORMATION-SYSTEMS-DESIGN:28-MAR-1972**********************************
***Δ***1***Δ***2***Δ***3***Δ***4***Δ***5***Δ***6***Δ***7***Δ***0***Δ***1***Δ***2***Δ***3***Δ***4***Δ***5***Δ***6***Δ***7***Δ***0***Δ
[ ]#Δ ABCDEFGHIJKLMNOPQRSTUVWXYZ)-+<=>&$*(%:?!,\0123456789';/.\ @[ ]#Δ ABCDEFGHIJKLMNOPQRSTUVWXYZ)-+<=>&$*(%:?!,\0123456789';/.\ @[ ]#Δ

04 APR 72 P 18:22:01   IDENT=FYEE    ACCOUNT=428235  CARDS IN=   11, OUT=    0

  PAGES=  159, LINES=  7550. TIME=00:00:39 (HMS)


      ALL SOFTWARE ISD PROVIDES OR MAKES AVAILABLE FOR USE, IN ANY FORM WHATSOEVER, IS PROPRIETARY
INFORMATION OF ISD AND IS NOT TO BE COPIED OR REPRODUCED WITHOUT PRIOR WRITTEN AUTHORIZATION BY ISD.

 * * * MARCH 22, 1972       USER NOTICES   * * * * *
(1)  ISD 1108 TERMINAL SERVICE IS BEING REDUCED SLIGHTLY TO THE FOLLOWING SCHEDULE FOR ABOUT 6-8 WEEKS:
       MON:  0700-2400
       TUE:  0000-0400; 0700-2400
       WED:  0000-0400; 0700-2400
       THU:  0700-2400
       FRI:  0000-0400; 0700-2400
       SAT:  0000-2200
       SUN:  0400-2200
    ESSENTIALLY, ONLY EARLY THURSDAY MORNING, OVERNIGHT SAT & SUN SERVICE IS
    BEING CURTAILED TO ALLOW CHECKOUT OF LARGE-CORE(131K) SERVICE UNDER THE STANDARD ISD EXEC.

(2)  LARGE-CORE PRODUCTION JOBS UNDER THE SPECIAL 131K SYSTEM(LCR)
       ARE NOW BEING RUN ON AN OVERNIGHT BASIS STARTING AT 0400 EACH DAY.

(3)  ISD NOW HAS AVAILABLE REMOTE-BATCH JOB ENTRY VIA LOW-SPEED TELETYPE
       COMPATIBLE TERMINALS.  THIS SERVICE CALLED  RON/I  HAS BEEN IN USE NOW FOR ALMOST 2 MONTHS.

   ADDITIONAL INFORMATION ON (2) & (3) IS NOW AVAILABLE TO ALL INTERESTED USERS  BY CONTACTING YOUR SALESMAN AT  415-562-4204.
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000057                98,.1054,.08752,.09393,.09962,.1049,.11,.09764,.1017,.1053,.1087/  NBS21510
000058                 DATAAF/.112,.1067,.1091,.1111,.1131,.1151,.1067,.1119,.1662,.1662,NBS21520
000059                1.2218,.2218,.2777,.2777,.3362,.3354,.41,.3934,.41,.405,.4028,.4015NBS21530
000060                2,.4006,.4594,.4467,.441,.4376,.4353,.539,.5096,.4966,.4888,.4835,.NBS21540
000061                36718,.6102,.5829,.5666,.5555,.8907,.772,.7193,.6878,.6663,1.239,1.NBS21550
000062                4026,.9316,.8749,.8362,1.769,1.412,1.252,1.156,1.09,2.535,1.971,1.7NBS21560
000063                516,1.563,1.458,3.583,2.744,2.361,2.129,1.97,4.929,3.762,3.217,2.88NBS21570
000064                65,2.654,6.528,5.024,4.297,3.845,3.53,8.24,6.483,5.58,5.005,4.598,9NBS21580
000065                7.796,8.013,6.995,6.318,5.825,10.83,9.407,8.405,7.686,7.141,11.,10.NBS21590
000066                837,9.587,8.935,8.402,10.22,10.65,10.31,9.865,9.44,.4028,.3984,.396NBS21600
000067                98,.3961,.441,.4296,.4256,.4238,.4967,.4703,.461,.4569,.5831,.5278/NBS21610
000068                 DATAAG/.5083,.4996,.7197,.6129,.5751,.5583,.9325,.7399,.6716,.6412NBS21620
000069                1,1.254,.9269,.8108,.7592,1.721,1.196,1.008,.9249,2.371,1.569,1.282NBS21630
000070                2,1.153,3.238,2.071,1.649,1.459,4.339,2.721,2.127,1.857,5.664,3.531NBS21640
000071                3,2.729,2.362,7.155,4.495,3.463,2.981,8.69,5.592,4.324,3.717,10.05,NBS21650
000072                46.751,5.285,4.555,10.99,7.887,6.31,5.475,.3974,.3957,.3949,.4875,.NBS21660
000073                54731,.4663,.6955,.6232,.5889,1.217,.9678,.8495,2.344,1.695,1.385,4NBS21670
000074                6.337,3.001,2.35,7.09,4.936,3.833,.396,.3943,.3938,.4754,.4602,.456NBS21680
000075                74,.6346,.5585,.5392,1.008,.7441,.6772,1.804,1.106,.9271,3.249,1.75NBS21690
000076                8,1.36,5.438,2.763,2.042,.394,.3935,.3934,.4578,.4536,.4525,.5462,.NBS21700
000077                95252,.5196,.7016,.6285,.609,.9925,.7965,.744,1.504,1.072,.9551/    NBS21710
000078                 DATAAH/2.315,1.497,1.274/                                          NBS21720
000079                 DATA JP/7,5,3,6,4,3,6,6,7,5,5,9,5,2,5,4,3,3,3/                     NBS21730
000080                 DATA MX/5,3,1,4,2,1,4,4,5,3,3,7,3,0,3,2,1,1,1/                     NBS21740
000081                 DATA LOC/1,78,123,168,204,236,251,281,329,392,417,442,487,512,524,NBS21750
000082                1 604,668,689,710/                                                  NBS21760
000083                 DATA BP/52.,700.,2500.,0.,100.,142.5,187.5,187.5,400.,700.,0.,0.,  NBS21770
000084                1 0.,0.,1.,0.,0.,-100.,0./                                          NBS21780
000085                 DATA DP/108.,450.,1250.,20.,30.,22.5,42.5,42.5,50.,450.,175.,625.,NBS21790
000086                1 1250.,3000.,1.,10.,40.,300.,1500./                                NBS21800
000087                 DATA BT/26.,28.,30.,25.,52.,56.,56.,59.,56.,60.,80.,100.,180.,500.NBS21810
000088                1 ,3000.,3000.,3000.,3000.,3000./                                   NBS21820
000089                 DATA DT/3.,4.,5.,11.,4.,1.,3.,3.,3.,10.,5.,20.,80.,500.,200.,200.,NBS21830
000090                1 500.,500.,500./                                                   NBS21840
000091                 DATA PS/1.022,2.0,4.0,8.0,14.0,25.0,43.0,69.0,99.0,128.0,151.0,    NBS21850
000092                1165.0,176.0,182.0,185.0,186.5,187.25,187.46875,187.506/            NBS21860
000093                 DATA TS/24.845,27.07,29.81,33.07,36.18,39.96,44.12,48.33,51.97,    NBS21870
000094                154.79,56.72,57.80,58.57,58.99,59.18,59.29,59.34,59.353,59.356/     NBS21880
000095                 P=PRES                                                             NBS21890
000096                 IF(P.LT.1.0) P=1.0                                                 NBS21900
000097                 T=TEMP                                                             NBS21910
000098                 IF(T.GE.6000.)T=5999.9999                                          NBS21920
000099                 DIV=1.0                                                            NBS21930
000100                 IF(T.GE.100.0) GO TO 15                                            NBS21940
000101                 TZ=24.84+.00317*P                                                  NBS21950
000102                 IF(T.LT.TZ)T=TZ                                                    NBS21960
000103                 IF(P.GE.700.0) GO TO 4                                             NBS21970
000104                 IF(T.GE.80.0) GO TO 3                                              NBS21980
000105                 IF(P.LT.187.506) GO TO 7                                           NBS21990
000106                 IF(T.LT.56.0) GO TO 12                                             NBS22000
000107                 IF(P.GT.400.0) GO TO 2                                             NBS22010
000108                 TM=(-0.000523467*P+0.08698291)*P+44.882441                         NBS22020
000109                 IF(T.GE.TM) GO TO 1                                                NBS22030
000110                 N=7                                                                NBS22040
000111                 DIV=(P-187.506)*.083+TM-T                                          NBS22050
000112                 GO TO 33                                                           NBS22060
000113               1 N=8                                                                NBS22070
000114                 DIV=(P-187.506)*.083+T-TM                                          NBS22080
000115                 GO TO 33                                                           NBS22090
000116               2 N=9                                                                NBS22100
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000117                GO TO 33                                                  NBS22110
000118              3 N=11                                                      NBS22120
000119                GO TO 33                                                  NBS22130
000120              4 IF(P.GE.2500.0) GO TO 6                                   NBS22140
000121                IF(T.GE.60.0) GO TO 5                                     NBS22150
000122                N=2                                                       NBS22160
000123                GO TO 33                                                  NBS22170
000124              5 N=10                                                      NBS22180
000125                GO TO 33                                                  NBS22190
000126              6 N=3                                                       NBS22200
000127                GO TO 33                                                  NBS22210
000128              7 DO 8 I=2,19                                               NBS22220
000129                IF(P-PS(I)) 10,9,8                                        NBS22230
000130              8 CONTINUE                                                  NBS22240
000131              9 TM=TS(I)                                                  NBS22250
000132                GO TO 11                                                  NBS22260
000133             10 TM=TS(I-1)+(TS(I)-TS(I-1))*(P-PS(I-1))/(PS(I)-PS(I-1))   NBS22270
000134             11 IF(T.GE.TM) GO TO 13                                     NBS22280
000135                IF(T.LT.56.0) GO TO 12                                    NBS22290
000136                N=6                                                       NBS22300
000137                DIV=(187.506-P)*.083+TM-T                                 NBS22310
000138                GO TO 33                                                  NBS22320
000139             12 N=1                                                      NBS22330
000140                GO TO 33                                                  NBS22340
000141             13 IF(P.GE.100.0) GO TO 14                                  NBS22350
000142                N=4                                                       NBS22360
000143                GO TO 33                                                  NBS22370
000144             14 N=5                                                      NBS22380
000145                DIV=(187.506-P)*.083+T-TM                                 NBS22390
000146                GO TO 33                                                  NBS22400
000147             15 IF(T.GE.3000.0) GO TO 18                                 NBS22410
000148                IF(T.GE.500.0) GO TO 17                                   NBS22420
000149                IF(T.GE.180.0) GO TO 16                                   NBS22430
000150                N=12                                                      NBS22440
000151                GO TO 33                                                  NBS22450
000152             16 N=13                                                     NBS22460
000153                GO TO 33                                                  NBS22470
000154             17 N=14                                                     NBS22480
000155                GO TO 33                                                  NBS22490
000156             18 IF(P.GE.30.0) GO TO 20                                   NBS22500
000157                IF(P.GE.5.0) GO TO 19                                     NBS22510
000158                N=15                                                      NBS22520
000159                GO TO 33                                                  NBS22530
000160             19 N=16                                                     NBS22540
000161                GO TO 33                                                  NBS22550
000162             20 IF(P.GE.500.0) GO TO 22                                  NBS22560
000163                IF(P.GE.100.0) GO TO 21                                   NBS22570
000164                N=17                                                      NBS22580
000165                GO TO 33                                                  NBS22590
000166             21 N=18                                                     NBS22600
000167                GO TO 33                                                  NBS22610
000168             22 N=19                                                     NBS22620
000169             33 FP=(P-BP(N))/DP(N)                                       NBS22630
000170                IP=FP                                                     NBS22640
000171                IF(IP.GT.MX(N)) IP=MX(N)                                  NBS22650
000172                F=FP-IP                                                   NBS22660
000173                FP=1.0-F                                                  NBS22670
000174                FT=(T-BT(N))/DT(N)                                        NBS22680
000175                IT=FT                                                     NBS22690
000176                FF=FT-IT                                                  NBS22700
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000177                FT=1.0-FF                                                    NBS22710
000178                I=IT*JP(N)+IP+LOC(N)                                         NBS22720
000179                J=I+JP(N)                                                    NBS22730
000180                PTCOND=(FP*FT*C(I)+F*FT*C(I+1)+FP*FF*C(J)+F*FF*C(J+1))/DIV   NBS22740
000181             34 PTCOND = PTCOND / 43200.0                                    NBS22750
000182                RETURN                                                       NBS22760
000183                END                                                          NBS22770
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<***Δ****1****Δ****2****Δ****3****Δ****4****Δ****5****Δ****6****Δ****7****Δ****8****Δ****9****Δ****0****Δ****1****Δ****2****Δ****3*
**********************************ISD-27.09:INFORMATION-SYSTEMS-DESIGN:28-MAR-1972**********************************
***Δ***1***Δ***2***Δ***3***Δ***4***Δ***5***Δ***6***Δ***7***Δ***0***Δ***1***Δ***2***Δ***3***Δ***4***Δ***5***Δ***6***Δ***7***Δ***0***Δ
[ J#Δ ABCDEFGHIJKLMNOPQRSTUVWXYZ)-+<=>&$*(%:?!,\0123456789';/.\ @[ J#Δ ABCDEFGHIJKLMNOPQRSTUVWXYZ)-+<=>&$*(%:?!,\0123456789';/.\ @[ J#Δ

04 APR 72 P 18:22:01   IDENT=FYEE    ACCOUNT=428235  CARDS IN=   11, OUT=    0

  PAGES=  159, LINES=  7550. TIME=00:00:39 (HMS)
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