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CALCULATIONS OF FUEL TEMPERATURE TRANSIENTS IN THE LPTR
FOLLOWING A MAIN COOLANT SYSTEM PUMP TRIP

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CALCULATIONS OF FUEL TEMPERATURE TRANSIENTS IN THE LPTR FOLLOWING A MAIN COOLANT SYSTEM PUMP TRIP*

I. INTRODUCTION

An analysis was made to determine the fuel temperature in the Livermore Pool Type Reactor, LPTR, during a transient involving a reactor scram following a cooling system pump trip.

A computer code was obtained for this purpose from L. Meem of the University of Virginia. This code was used in preparation of UVAR-18,¹ the SAR Manual of the University of Virginia Reactor. This reactor is very similar to the LPTR. The code incorporates a form of the reactor point kinetics equation with six delayed neutron groups, and standard heat transfer equations.

The code was modified for use in this study. These modifications included rewriting the code in Fortran IV from ALGO, replacing a straight line pump coastdown by an equation closely following the actual pump RPM during a pump trip, modifying flow resistance equations to conform to the conditions in the LPTR, and replacing various constants with others applicable to the LPTR.

The calculations in this study apply to a reactor scram from conditions at the "safety limit" settings. These conditions are:

- (1) 4.9 MW reactor power.
- (2) 850 GPM (53.6 dm³/S) primary coolant flow.
- (3) 125°F (51.6 °C) reactor outlet coolant temperature.
- (4) Reactor pool water depth of 6.5 meters above tank bottom.
- (5) Core configuration consisting of beryllium reflector elements, 16 fuel elements, and 5 special fuel elements (worst case core).

The results from the computer calculations represent average conditions. To determine maximum conditions, such as maximum fuel temperature, hand calculations were made based on the computer output to reflect the effect of axial

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and radial flux peaking.

Figures 1, 2, 3 and 4 show the results from the computer calculations and the hand calculations.

II. RESULTS

As shown in Figure 1, the maximum fuel temperature is 406.7°F (208.2°C) which precludes any melting of fuel. Figure 2 shows that the coolant exit temperature from the hottest channel is 230.5°F (110.3°C) which is below the saturation temperature of 232.0°F (111.1°C). The maximum coolant flow rate up through the core is 24 GPM (1.5 dm³/sec) under natural circulation conditions. Figure 3 is a plot of core coolant flow versus time during the scram.

Figure 4 is a plot of reactor power versus time following a scram.

III. DATA AND MEASUREMENTS

A. PUMP COASTDOWN

Per Reference 2, flow of a coolant through a reactor coolant system with pump coastdown after a pump trip is most accurately given by measuring pump RPM versus time.

A measurement of flow coastdown was made on September 1, 1976.

The results are given below:

<u>% FLOW (RPM)</u>	<u>TIME (SEC)</u>
100.0	0.0
71.3	0.5
34.8	1.0
22.6	1.5

<u>% FLOW (RPM)</u>	<u>TIME (SEC)</u>
17.4	2.0
14.8	2.5
11.3	3.0
9.6	3.5
9.6	4.0
7.8	4.5
5.2	5.0
4.3	5.5
1.7	6.0
5.2	6.5
0.9	7.0
0.0	7.5

The measurements were made at the completion of a 3-MW power run with the average pool temperature at 92°F (33°C). The core consisted of 19 fuel elements and 5 special elements (the LPTR nominal core) and the pump trip occurred 30 seconds after reactor scram. Due to inaccuracies in the data at low RPM and in the interest of conservatism in the calculations an empirical curve was developed which represents slightly faster coastdown and results in zero flow (RPM) at a time of 5 seconds. The equation is:

$$\%FLOW = 0.583333t^4 - 8.208333t^3 + 42.41667t^2 - 99.7917t + 100$$

The above equation was incorporated in the computer program.

B. REACTIVITY

The computer code incorporates a point kinetics equation with six delayed neutron groups.

From Ref. 3, Figure 4.3-8 one obtains a curve of control rod position versus rod worth. Per W. J. Richards, LPTR Reactor Supervisor, the following information was provided:

- (1) 350 millisec. time lapse from time main coolant pump trips until control rods release.
- (2) rods travel 25 in. (63.5 cm) in .4 sec.
- (3) minimum rod drop is 13.75 in. (34.9 cm). This height results in the least amount of negative reactivity available for insertion during a scram.

Using (2) above, the rod drop velocity is determined from which the rod drop distance versus time is calculated. From Figure 4.3-8 of Ref. 3, the control rod position versus rod worth curve, the negative reactivity (ρ) insertion corresponding to a particular rod drop distance is calculated. The below table shows these results:

<u>TIME (SEC)</u>	<u>REACTIVITY (ρ)</u>
0.0	0.0
0.05	-2.64×10^{-2}
0.10	-4.884×10^{-2}
0.15	-6.732×10^{-2}
0.20	-7.524×10^{-2}
0.25	-7.656×10^{-2}

The above values of time versus ρ are input values to the code.

IV. CALCULATIONS

Appendix A is a listing of the code. Figures 1 to 4 are plots of the code output. To obtain the hotspot fuel temperature and maximum coolant outlet temperature the following hand calculations were made.

A. RADIAL PEAKING

From section 4.4.3 of Ref. 3 :

$$\frac{P_{He}}{P_{TOTAL}} = 0.078 = \frac{\text{POWER IN HOTTEST ELEMENT}}{\text{TOTAL CORE POWER}}$$

There are $16 + \frac{5}{2} = 18.5$ whole fuel elements in the reactor.

The average fractional power per element is; P_{fr} :

$$P_{fr} = \frac{1}{18.5} = 0.054054$$

Thus the fuel element peaking factor is:

$$\frac{P_{He}/P_{TOTAL}}{P_{fr}} = \frac{0.078}{0.054054} = 1.443$$

$$\text{Also: } \frac{P_{Hp}}{P_{ap}} = 1.53 = \frac{\text{POWER PRODUCED IN HOTTEST PLATE}}{\text{POWER PRODUCED IN AVERAGE PLATE}}$$

P_r = Radial peaking factor for determining maximum coolant outlet temperature.

$$P_r = \frac{P_{He}/P_{TOTAL}}{P_{fr}} \cdot \frac{P_{Hp}}{P_{ap}}$$

$$P_r = (1.443)(1.53) = 2.208$$

This radial peaking factor, P_r , represents the ratio of the heat flux in the hottest channel to that in the average channel.

In calculations to determine maximum fuel temperature, additional consideration must be given to the peaking factor across an individual plate, P_{HPF} . Thus the total radial peaking factor for determining maximum fuel temperature is P_R :

P_R = Radial peaking factor for determining maximum fuel temperature..

$$P_R = P_{HPF} \frac{P_{He}}{P_{TOTAL}} \frac{P_{Hp}}{P_{ap}}$$

Radial peaking factor for the hot plate is $P_{HPF} = 1.2$ per Ref. 4.

$$P_R = (1.2)(1.53)(1.443) = 2.65$$

B. MAXIMUM REACTOR COOLANT OUTLET TEMPERATURE, TC_{MAX}

During the natural convection transient flow conditions

TC_{MAX} is calculated as follows:

TC_{MAX} = maximum coolant outlet temperature.

TIN = inlet coolant temperature.

TC = average coolant temperature.

P_r = reactor radial peaking factor = 2.208

$$TC_{MAX} = (TC - TIN) \cdot 2\sqrt{P_r} + TIN$$

Initially for steady forced convection flow TC_{MAX} is calculated as follows:

ΔT_{HC} = coolant temperature rise in hottest channel

$$= \frac{P_T \frac{P_{He}}{P_{TOTAL}} \frac{P_{Hp}}{P_{ap}}}{\rho F C_p 18 \frac{0.314}{5.34 N + 22.9}} \quad \text{Reference 3, Section 4.4.3}$$

where: P_T = total reactor power in MW

ρ = inlet coolant density

F = total reactor coolant flow

C_p = specific heat

N = number of fuel plates/18

The maximum coolant outlet temperature therefore is:

$$TC_{MAX} = TIN + \Delta T_{HC}$$

Results are given in Table 1 and plotted on Figure 2.

C. MAXIMUM FUEL TEMPERATURE

During natural circulation the maximum fuel temperature is TF_2 :

TIN = Coolant inlet temperature (constant)

TF = Average fuel temperature.

TC = Average coolant temperature.

$(TF-TC)_1 = \sqrt{P_R} \cdot (TF-TC)$ = Average fuel-coolant temperature drop
for hottest plate.

$(TF-TC)_2 = P_a \cdot (TF-TC)_1$ = Fuel-coolant temperature drop at
hot spot for hottest plate.

P_a = Axial peaking factor, Ref. 3, Table 4.4-2.

$P_a = 1.62$

$$TF_2 = TIN + \frac{1}{2} (TC_{MAX} - TIN) + (TF-TC)_2$$

During forced convection, TF_2 , is calculated as follows:

$$TF_2 = TIN + \frac{1}{2} (TC_{MAX} - TIN) + P_R \cdot (TF-TC) \cdot P_a$$

Results of these calculations are given in Table 1, and plotted on Figure 1.

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TABLE 1

<u>TIME (SEC)</u>	<u>TF;^oF</u>	<u>TC;^oF</u>	<u>TC_{MAX}.^oF</u>	<u>TF₂.^oF</u>
0	168.0	105.3	189.5	406.7
1	153.5	102.9	125.0	322.5
2	155.3	99.8	128.0	253.1
3	158.4	100.7	130.6	260.2
4	161.6	102.7	136.6	266.4
5	165.5	105.9	146.1	273.0
8	171.1	115.2	173.7	277.0
10	173.7	119.7	187.1	278.7
15	178.3	127.1	209.1	282.3
20	180.9	131.1	221.0	284.6
25	182.0	133.1	226.9	285.2
30	182.3	134.0	229.6	284.9
35	182.0	134.3	230.5	283.8
40	181.4	134.3	230.5	282.2
59	178.8	133.1	226.9	276.7

TIN = 85.52^oF

TF₂ = MAX. FUEL TEMP.

TC_{MAX} = MAX COOLANT OUTLET TEMP.

ENGINEERING NOTE

SUBJECT

FIGURE 1

NAME

DATE

ENGINEERING NOTE

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FIGURE 2

NAME

DATE

ENGINEERING NOTE

FILE NO.

PAGE

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FIGURE 3

NAME

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ENGINEERING NOTE

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FIGURE 4

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3. UCRL-51423 "Safety Analysis Report for Livermore Pool Type Reactor," September 19, 1974, TID-4500, U-41.
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```

PROGRAM REACTOR (INP,TAPE2=INP,OUTP,TAPE3=OUTP)
CALL CHANGE (5H+REAC)
CALL DEVICE (5H+CREATE,4H+OUTP,50000)
C COMMENT THIS PROGRAM CALCULATES TRANSIENT FUEL AND COOLANT TEMPERATURES
C IN THE REACTOR IMMEDIATELY FOLLOWING PRIMARY PUMP
C FAILURE WITH SCRAM DURING STEADY-STATE OPERATION AT A GIVEN POWER
C LEVEL.

C INPUT DATA IS AS FOLLOWS:
C P = STEADY-STATE POWER IN WATTS.
C TSTOP = AMOUNT OF TIME FOR WHICH THE ANALYSIS IS REQUIRED, IN SECS.
C TIN = INLET COOLANT TEMPERATURE IN DEGREES FAHRENHEIT.
C DELTAT = TEMPERATURE DROP ACROSS THE CORE IN DEGREES FAHRENHEIT.
C DT = TIME INCREMENT USED IN THE COMPUTATIONS, IN SECONDS.
C IQ=NUMBER OF TIME INCREMENTS BETWEEN SUCCESSIVE
C DATA PRINTOUTS.
C XGPM = INITIAL PUMP FLOW, GPM
C FOLLOW THIS FIRST CARD WITH 20 CARDS GIVING REACTIVITY INSERTED
C EVERY 0.05 SECONDS.

800 FORMAT (5E12.5,F6.1,13)
801 FORMAT (E12.5)
810 FORMAT (3X,1HT,11X,3HRHO,9X,3HMAIN,7X,
1 4HPALT,8X,8HFPROMPT=,4X,4HPABS)
820 FORMAT (6E12.5/)
REAL KC,KR,KAL,KF,MUC,MUF,MUX,K,M,LAMFLOW,KEFF,
1 LAM1,LAM2,LAM3,LAM4,LAM5,LAM6
READ (2,800) P,TSTOP,TIN,DELTAT,DT,XGPM,IQ
READ(2,801) TOUT
N=TSTOP/DT+1
PIN=P
DIMENSION FT(6000),CT(6000),F(6000),PO(6000),
1 HH(6000),REY(6000)
LOGICAL BOO,UPFLOW,DOWNFLOW
830 FORMAT (5X,F5.2,12X,F6.4,11X,F6.0,12X,F6.0,
1 11X,F6.1,12X,F5.1,12X,F5.1)
C VALUES:
DOWNFLOW=.TRUE. $ CPF=.2246 $ CPC=.998 $ G=32.17
IF(TOUT.EQ.0.) GO TO 5
DELTAT=P/(XGPM*62.222*2.23E-3*CPC*1.05435E3)
TIN=TOUT-DELTAT $ GO TO 6
5 CONTINUE
TOUT=TIN+DELTAT
6 CONTINUE
DE=.01865 $ KAL=121.7/3600 $ KR=-2.0 $ CV=.55 $ M=.25
RHOIN=62.222-.013*(TIN-72.) $ RHOC=RHOIN
TAL=.0197/12 $ TUAL=.02047/12 $ XC=.117/12 $ ZC=24.62/12
ZF=23.62/12 $ YC=2.63/12 $ YF=YC $ XF=.06/12 $ VF=333.*XF*YF*ZF
VC=333.*XC*YC*ZC $ AFLOW=.704 $ AHEAT=276.736
RHOE=206.7 $ W=XGPM*(2.23E-3)*RHOC $ WO=W
C COMMENT THE FOLLOWING BLOCK DETERMINES THE INITIAL FUEL AND COOLANT
C TEMPERATURES. FOR A GIVEN CONSTANT COOLANT TEMPERATURE, THE FUEL
C TEMPERATURE IS STEPPED FROM AN INITIAL VALUE UNTIL THE HEAT TRANSFER
C COEFFICIENT IS SUCH THAT THE HEAT REMOVED BY THE COOLANT FLOW IS EQUAL
C TO THE HEAT TRANSFERRED FROM THE FUEL TO THE COOLANT.

C INITIALIZE:
TC=TIN+DELTAT/2 $ V=W/(AFLOW*RHOC)
R=KAL/(TAL+TUAL/2)

```

APPENDIX A.

```

TEST=1000.
DO 10 IN=80,250
TF=1.*IN
CALL VIS (TC,MUC)
CALL VIS (TF,MUF)
K=(0.349+0.015*(TC-70)/30)/3600
PR=CPC*MUC/K
RE=V*RHOC*DE/MUC
H=0.116*(K/DE)*((RE*0.667-125.)*PR*0.333*(MUC/MUF)**0.14
U=(H*R)/(H+R)
BETA=TF-TC-(W*CPC*DELTAT)/(U*AHEAT)
IF (ABS(BETA).GT.TEST) GO TO 15
TEST=ABS(BETA)
10 CONTINUE
15 CONTINUE
VUP=0.
DVUP=0.
TF=TF-1
COMMENT THE VARIABLES WHICH ARE FUNCTIONS OF TIME ARE COMPUTED BY
CONSIDERING AN INCREMENTAL CHANGE DUE TO THE TIME STEP, DT. THIS METHOD
C IS COMMONLY REFERRED TO AS THE EULER METHOD.

```

```

FT(1)=TF
CT(1)=TC
F(1)=W/((2.23E-3)*RHOC)
PO(1)=P/1.E6
HH(1)=H*3600. $ REY(1)=RE
I=2

PNM= P*0.01
T1=0.0 $ RH01=0.0 $ P1=100.0 $ EL=0.000508 $ DP=0.0
B1=0.00021 $ B2=0.00102 $ B3=0.00320 $ B4=0.00150 $ B5=0.00170
B6=0.00031 $ BEFF=C.00300
LAM1=1.0/0.26 $ LAM2=1.0/0.72 $ LAM3=1.0/3.22 $ LAM4=1.0/8.66
LAM5=1.0/31.52 $ LAM6=1.0/78.66
Y1=B1*P1/LAM1
Y2=B2*P1/LAM2
Y3=B3*P1/LAM3
Y4=B4*P1/LAM4
Y5=B5*P1/LAM5
Y6=B6*P1/LAM6
IJ=6
DO 400 IN=1,N
T=IN*DT
IF (T.EQ.DT) GO TO 100
TC=TC+DTC*DT
KC=KC+CC*DTC*DT
20 IF (T.LT.1.0) GO TO 30
GO TO 60
30 IF (IJ.GT. 5) GO TO 40
GO TO 50
40 READ(2,801) RH02
WRITE(3,801) RH02
DRHO=(RH02-RH01)/5.0 $ IJ=1
50 RH0=RH01+DRHO
60 KEFF=1.0/(1.0+RH0)
DY1=(B1*P1-LAM1*Y1)*DT
DY2=(B2*P1-LAM2*Y2)*DT
DY3=(B3*P1-LAM3*Y3)*DT
DY4=(B4*P1-LAM4*Y4)*DT

```

```

DY5=(B5*P1-LAM5*Y5)*DT
DY6=(B6*P1-LAM6*Y6)*DT
Y1=Y1+DY1
Y2=Y2+DY2
Y3=Y3+DY3
Y4=Y4+DY4
Y5=Y5+DY5
Y6=Y6+DY6
PLAST=P1
SUMY=LAM1*Y1+LAM2*Y2+LAM3*Y3+ LAM4*Y4+ LAM5*Y5+LAM6*Y6
DENOM=1.0-(1.0-BEFF)*KEFF
PMAIN= KEFF*SUMY/DENOM
PALT=(EL/DENOM)*(DP/DT)
P1=PMAIN-PALT
P = (0.94*P1 + 6.0)*PNM
IF (T.GT. 1.0) GO TO 70
WRITE(3,810)
WRITE(3,820) T, RHO, PMAIN, PALT, P1, P
70 DP=P1-PLAST
T1=T $ RHO1=RHO $ IJ=IJ+1
DTF=(P*(5.688E-2)/60.-U*AHEAT*(TF-TC))/(VF*RHO$
1 *CPF)
KF=KF+CF*DTF*DT
TF=TF+DTF*DT
100 CONTINUE
W=.01*W0*(.583333*(T**4)-8.206333*(T**3)+42.41667*
1 (T**2)-99.7917*T+100.)
IF(T.GT.4.93) W=0.0
IF (W.GT.0.) GO TO 110
UPFLOW=.TRUE.
DOWNFLOW=.FALSE.
110 CONTINUE
V=W/(AFLOW*RHO0)

COMMENT THE FOLLOWING BLOCK TAKES INTO ACCOUNT BOTH LAMINAR AND
C TURBULENT MODES OF FORCED DOWNFLOW THRU THE CORE.

IF (DOWNFLOW) 120,200
120 CALL VIS (TC,MUC)
CALL VIS (TF,MUF)
K=(0.349+0.015*(TC-70.)/30.)/3600.
PR=CPC*MUC/K
RE=V*RHO0*DE/MUC

COMMENT HAUSEN FORCED LAMINAR FLOW CORRELATION.

IF(RE.GT.2000.) GO TO 150
H=K*(3.66+(.0668*(DE/ZF)*RE*PR)/(1+.04*((DE/ZF)*RE*PR)**.667))/DE
GO TO 190
150 CONTINUE
LAMFLOW=T

COMMENT HAUSEN FORCED TURBULENT FLOW CORRELATION.

H=0.116*(K/DE)*(RE**.667-125.)*PR*.333*(MUC/MUF)**0.14
190 U=(H*R)/(H+R)
DTC=(U*AHEAT*(TF-TC)-2.*W*CPC*(TC-TIN))/(RHO0*CPC*VC)
GO TO 375
200 CONTINUE

```

COMMENT THE FOLLOWING BLOCK CALCULATES THE EFFECTS OF NATURAL
CONVECTION.

```

      IF (UPFLOW) 220,375
220  VUP=VUP+DVUP*DT
      RHOC = 62.222 - 0.013 * (TC - 72.)
C    IF (RE.NE.0.) GO TO 240
      DVUP=((RHOCIN-RHOC)*G-1.5*RHOC*(11.4593*VUP)**2/
1    ZC/2)/RHOC/2
      GO TO 260
240  CONTINUE
      FR=0.316/(RE**0.25)
      IF (RE.LE.2000.) FR=64./RE
      DVUP=((RHOCIN-RHOC)*G-FR*RHOC*VUP**2/DE/2.-1.5*
1    RHOCIN*(11.4593*VUP)**2/ZC/2)/RHOC/2

260  CONTINUE
      IF (RE.LE.2000.) 260,300

```

COMMENT THE EFFECTS OF LAMINAR FLOW IN THE NATURAL CONVECTION REGION
C ARE CALCULATED

```

280  CONTINUE
      TX=(TF+TC)/2
      K=(0.349+0.032*(TX-70.)/80.)/3600
      CALL VIS (TC,MUC)
      PR=CPC*MUC/K
      RE=VUP*RHOC*DE/MUC
      IF (TX.LE.90.) GRP=(0.3+3.6*(TX-40.)/50.)*1.E8
      IF (TX.GT.90. .AND. TX.LE.140.) GRP=(3.9+6.3*(TX-90.)/50.)*1.E8
      IF (TX.GT.140. .AND. TX.LE.180.) GRP=(10.2+6.9*(TX-140.)/40.)*
1    1.E8
      GRPR=GRP*ZF**3*(TF-TC)
      H=K*CV*(GRPR**M)/ZF
      GO TO 350

```

COMMENT THE EFFECTS OF TURBULENT FLOW IN THE NATURAL CONVECTION REGION
C ARE CALCULATED

```

300  CONTINUE
      CALL VIS (TC,MUC)
      CALL VIS (TF,MUF)
      IF (TC.GE.70. .AND. TC.LT.100.) K=(0.349+0.015*(TC-70.)/30.)*
1    1/3600.
      IF (TC.GE.100. .AND. TC.LT.170.) K=(0.354+0.024*(TC-100.)/70.)*
1    1/3600.
      IF (TC.GE.170. .AND. TC.LT.240.) K=(0.366+0.010*(TC-170.)/70.)*
1    1/3600.
      PR=CPC*MUC/K
      RE=VUP*RHOC*DE/MUC
      H=0.116*(K/DE)*(RE**0.667-125.)*(PR**0.333)*(MUC/MUF)**0.14
350  CONTINUE
      U=(H*R)/(H+R)
      DTC=(U*A*HEAT*(TF-TC)-2*VUP*AFLOW*RHOC*CPC*(TC-TIN))/(RHOC*CPC*VC)
375  CONTINUE
      PO(1)=P/(10**5)$ FT(1)=TF$ CT(1)=TC
      F(1)=W/((2.23E-3)*RHOC)
      IF (UPFLOW) F(1)=AFLOW*VUP*7.48*GJ.
      HH(1)=U*3600.$ REY(1)=RE$ I=I+1

```

400 CONTINUE

```

C   PRINT OUT RESULTS
   WRITE (3,402)
402  FORMAT (1H1,38HCOMPUTER CODE REACTOR OUTPUT, W. STEIN)
   WRITE (3,405)
405  FORMAT (1X,31HINPUT DATA - INITIAL CONDITION)
   WRITE (3,406) PIN,TSTOP,TIN,DELTAT,DT,XGPM,IQ,TOUT
406  FORMAT (5X,4HP = ,E12.5,2X,3HTSTOP = ,E12.5,2X,
1     6HTIN = ,E12.5,5X,9HDELTAT = ,E12.5,2X,5HDT = ,E12.5,
2     2X,7HXGPM = ,F6.1,2X,5HIQ = ,13,2X,7HTOUT = ,F6.1)
   II=25
   DO 450 I=1,N,IQ
   II=II+1
   IF (II.NE.26) GO TO 425
   WRITE (3,410)

410  FORMAT (1H1,6X,3HTIME,12X,5HPOWER,14X,4HFLOW,11X,
1     8HREYNOLDS,12X,1HH,12X,9HFUEL TEMP,7X,12HCoolant TEMP)
   WRITE (3,411)
411  FORMAT (4X,7HSECONDS,9X,6HMEGAWATTS,10X,7HGAL/MIN,11X,
1     6-HNUMBER,9X,10H(SQ.FT-HR),7X,9HDEGREES F,8X,
2     9-DEGREES F)
425  WRITE (3,830) (I-1)*DT,PO(I),F(I),REY(I),HH(I),FT(I),
1     CT(I)
   IF (II.EQ.26) II=1
450  CONTINUE
   WRITE (3,460) LAMFLOW
460  FORMAT (5X,29HFORCED LAMINAR FLOW BEGINS AT,2X,
1     F5.3,2X,7HSECONDS)
   CALL EXIT(1)
   END
   SUBROUTINE VIS (T,MU)
   DIMENSION TEST(7),C1(6),C2(6),C3(6)
   REAL MU
   DATA TEST /70.,80.,90.,100.,150.,200.,300./,
1     C1 /2.37,2.08,1.85,1.65,1.04,0.74/,
2     C2 /0.29,0.23,0.20,0.61,0.30,0.29/,
3     C3 /10.,10.,10.,50.,50.,100./
   DO 25 I=1,6
   IF (T.GE.TEST(I).AND.T.LT.TEST(I+1.)) GO TO 50
25  CONTINUE
   WRITE (3,101) T
   CALL EXIT(1)
50  J=I
   MU=(C1(J)-C2(J)*(T-TEST(J))/C3(J))/3600.
   RETURN
101  FORMAT (//,35H**FAILURE IN VISCOSITY ROUTINE**T =,E12.3)
   END

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1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	0.	4.9C00	850.	7073.	978.6	168.0	105.3
	0.10	4.9C00	769.	6397.	866.7	163.6	105.3
	0.20	4.9C00	694.	5780.	780.4	170.3	105.3
	0.30	4.9C00	626.	5219.	699.2	173.0	105.5
	0.40	1.7C91	564.	4709.	621.0	173.5	105.7
	0.50	0.7808	508.	4235.	542.9	167.6	105.6
	0.60	0.7004	456.	3798.	469.3	162.6	105.3
	0.70	0.6558	410.	3399.	400.6	159.0	104.7
	0.80	0.6758	368.	3040.	336.8	156.3	104.2
	0.90	0.6657	331.	2719.	277.5	154.5	103.5
	1.00	0.6565	297.	2432.	222.7	153.5	102.9
	1.10	0.6481	268.	2177.	172.1	153.0	102.3
	1.20	0.6402	241.	1952.	132.5	153.0	101.7
	1.30	0.6323	217.	1754.	128.1	153.3	101.1
	1.40	0.6258	197.	1582.	124.1	153.5	100.7
	1.50	0.6193	178.	1432.	120.4	153.3	100.4
	1.60	0.6131	163.	1301.	117.0	154.1	100.2
	1.70	0.6072	149.	1188.	114.0	154.4	100.0
	1.80	0.6016	136.	1090.	111.3	154.7	99.9
	1.90	0.5962	126.	1005.	108.9	155.0	99.8
	2.00	0.5911	117.	932.	106.7	155.3	99.8
	2.10	0.5862	109.	870.	104.8	155.6	99.8
	2.20	0.5815	102.	815.	103.2	155.9	99.8
	2.30	0.5769	96.	768.	101.7	156.3	99.9
	2.40	0.5726	91.	727.	100.3	156.6	100.0

1	TIME SECCNDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR.)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	2.50	0.5583	86.	691.	99.1	156.9	100.1
	2.60	0.5542	82.	658.	98.0	157.2	100.2
	2.70	0.5503	78.	628.	97.0	157.5	100.3
	2.80	0.5565	75.	600.	96.1	157.8	100.4
	2.90	0.5528	71.	573.	95.1	158.1	100.5
	3.00	0.5492	68.	547.	94.2	158.4	100.7
	3.10	0.5457	65.	520.	93.3	158.7	100.8
	3.20	0.5423	61.	494.	92.3	159.1	101.0
	3.30	0.5390	58.	466.	91.4	159.4	101.2
	3.40	0.5358	54.	438.	90.3	159.7	101.3
	3.50	0.5326	50.	408.	89.2	160.0	101.5
	3.60	0.5296	47.	377.	88.1	160.3	101.7
	3.70	0.5266	43.	345.	86.8	160.6	101.9
	3.80	0.5237	38.	312.	85.5	160.9	102.2
	3.90	0.5209	34.	278.	84.2	161.3	102.4
	4.00	0.5181	30.	243.	82.7	161.6	102.7
	4.10	0.5155	25.	208.	81.3	162.0	102.9
	4.20	0.5128	21.	173.	79.8	162.3	103.2
	4.30	0.5103	17.	139.	78.3	162.7	103.5
	4.40	0.5078	13.	107.	76.9	163.1	103.8
	4.50	0.5053	9.	77.	75.5	163.5	104.1
	4.60	0.5029	6.	50.	74.3	163.9	104.5
	4.70	0.5006	3.	28.	73.2	164.3	104.8
	4.80	0.4983	1.	11.	72.4	164.7	105.2
	4.90	0.4961	0.	2.	72.0	165.1	105.5

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR.)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	5.00	0.4939	1.	11.	85.2	165.3	105.9
	5.10	0.4918	3.	28.	85.2	165.7	106.3
	5.20	0.4897	5.	45.	85.3	165.9	106.7
	5.30	0.4876	7.	60.	85.3	166.2	107.1
	5.40	0.4856	9.	73.	85.4	166.4	107.5
	5.50	0.4837	10.	85.	85.4	166.6	107.9
	5.60	0.4817	11.	96.	85.5	166.8	108.2
	5.70	0.4799	12.	104.	85.6	167.0	108.6
	5.80	0.4780	13.	112.	85.6	167.2	108.9
	5.90	0.4762	14.	118.	85.7	167.4	109.2
	6.00	0.4744	14.	123.	85.7	167.6	109.6
	6.10	0.4727	15.	128.	85.8	167.8	109.9
	6.20	0.4710	15.	131.	85.8	168.0	110.2
	6.30	0.4693	16.	135.	85.9	168.2	110.5
	6.40	0.4677	16.	137.	85.9	168.4	110.8
	6.50	0.4661	16.	140.	85.9	168.6	111.1
	6.60	0.4645	16.	142.	86.0	168.8	111.4
	6.70	0.4630	17.	144.	86.1	169.0	111.7
	6.80	0.4615	17.	146.	86.1	169.2	112.0
	6.90	0.4600	17.	148.	86.2	169.3	112.3
	7.00	0.4585	17.	149.	86.3	169.5	112.5
	7.10	0.4571	17.	151.	86.3	169.7	112.8
	7.20	0.4557	17.	152.	86.4	169.8	113.1
	7.30	0.4543	17.	154.	86.4	170.0	113.4
	7.40	0.4530	18.	155.	86.5	170.2	113.6

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	7.50	0.4516	18.	156.	86.5	170.3	113.9
	7.60	0.4503	18.	157.	86.6	170.5	114.2
	7.70	0.4490	18.	159.	86.6	170.6	114.4
	7.80	0.4478	18.	160.	86.7	170.8	114.7
	7.90	0.4465	18.	161.	86.7	170.9	114.9
	8.00	0.4453	18.	162.	86.8	171.1	115.2
	8.10	0.4441	18.	164.	86.8	171.2	115.4
	8.20	0.4430	18.	165.	86.9	171.4	115.7
	8.30	0.4418	18.	166.	86.9	171.5	115.9
	8.40	0.4407	19.	167.	87.0	171.7	116.2
	8.50	0.4396	19.	168.	87.0	171.8	116.4
	8.60	0.4385	19.	169.	87.1	171.9	116.7
	8.70	0.4374	19.	170.	87.1	172.1	116.9
	8.80	0.4363	19.	172.	87.1	172.2	117.1
	8.90	0.4353	19.	173.	87.2	172.4	117.3
	9.00	0.4343	19.	174.	87.2	172.5	117.6
	9.10	0.4333	19.	175.	87.3	172.6	117.8
	9.20	0.4323	19.	176.	87.3	172.7	118.0
	9.30	0.4313	19.	177.	87.3	172.9	118.2
	9.40	0.4303	19.	178.	87.4	173.0	118.4
	9.50	0.4294	19.	179.	87.4	173.1	118.7
	9.60	0.4284	20.	180.	87.5	173.2	118.9
	9.70	0.4275	20.	181.	87.5	173.4	119.1
	9.80	0.4266	20.	182.	87.5	173.5	119.3
	9.90	0.4257	20.	183.	87.6	173.6	119.5

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	10.00	0.4249	20.	184.	87.6	173.7	119.7
	10.10	0.4240	20.	185.	87.6	173.8	119.9
	10.20	0.4231	20.	186.	87.7	174.0	120.1
	10.30	0.4223	20.	187.	87.7	174.1	120.3
	10.40	0.4215	20.	188.	87.7	174.2	120.5
	10.50	0.4207	20.	188.	87.8	174.3	120.6
	10.60	0.4199	20.	189.	87.8	174.4	120.8
	10.70	0.4191	20.	190.	87.8	174.5	121.0
	10.80	0.4183	20.	191.	87.8	174.6	121.2
	10.90	0.4175	20.	192.	87.9	174.7	121.4
	11.00	0.4168	20.	193.	87.9	174.8	121.6
	11.10	0.4160	21.	194.	87.9	174.9	121.7
	11.20	0.4153	21.	195.	88.0	175.0	121.9
	11.30	0.4145	21.	195.	88.0	175.1	122.1
	11.40	0.4138	21.	196.	88.0	175.2	122.2
	11.50	0.4131	21.	197.	88.1	175.3	122.4
	11.60	0.4124	21.	198.	88.1	175.4	122.6
	11.70	0.4117	21.	199.	88.1	175.5	122.7
	11.80	0.4110	21.	200.	88.1	175.6	122.9
	11.90	0.4104	21.	200.	88.2	175.7	123.1
	12.00	0.4097	21.	201.	88.2	175.8	123.2
	12.10	0.4090	21.	202.	88.2	175.9	123.4
	12.20	0.4084	21.	203.	88.2	176.0	123.5
	12.30	0.4078	21.	203.	88.3	176.1	123.7
	12.40	0.4071	21.	204.	88.3	176.2	123.8

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	12.50	0.4035	21.	205.	88.3	176.3	124.0
	12.60	0.4059	21.	206.	88.3	176.4	124.1
	12.70	0.4053	21.	206.	88.4	176.5	124.3
	12.80	0.4047	21.	207.	88.4	176.6	124.4
	12.90	0.4041	21.	208.	88.4	176.7	124.5
	13.00	0.4035	21.	208.	88.4	176.7	124.7
	13.10	0.4029	22.	209.	88.5	176.8	124.8
	13.20	0.4023	22.	210.	88.5	176.9	125.0
	13.30	0.4018	22.	210.	88.5	177.0	125.1
	13.40	0.4012	22.	211.	88.5	177.1	125.2
	13.50	0.4006	22.	212.	88.6	177.2	125.4
	13.60	0.4001	22.	212.	88.6	177.2	125.5
	13.70	0.3995	22.	213.	88.6	177.3	125.6
	13.80	0.3990	22.	214.	88.6	177.4	125.7
	13.90	0.3985	22.	214.	88.6	177.5	125.9
	14.00	0.3980	22.	215.	88.7	177.6	126.0
	14.10	0.3974	22.	216.	88.7	177.6	126.1
	14.20	0.3969	22.	216.	88.7	177.7	126.2
	14.30	0.3964	22.	217.	88.7	177.8	126.3
	14.40	0.3959	22.	217.	88.7	177.9	126.5
	14.50	0.3954	22.	218.	88.8	177.9	126.6
	14.60	0.3949	22.	219.	88.8	178.0	126.7
	14.70	0.3944	22.	219.	88.8	178.1	126.8
	14.80	0.3939	22.	220.	88.8	178.1	126.9
	14.90	0.3935	22.	220.	88.8	178.2	127.0

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	15.00	0.3930	22.	221.	88.9	178.3	127.1
	15.10	0.3925	22.	221.	88.9	178.4	127.2
	15.20	0.3921	22.	222.	88.9	178.4	127.3
	15.30	0.3916	22.	222.	88.9	178.5	127.4
	15.40	0.3911	22.	223.	88.9	178.6	127.5
	15.50	0.3907	22.	223.	89.0	178.6	127.6
	15.60	0.3902	22.	224.	89.0	178.7	127.7
	15.70	0.3898	23.	224.	89.0	178.8	127.8
	15.80	0.3894	23.	225.	89.0	178.8	127.9
	15.90	0.3889	23.	225.	89.0	178.9	128.0
	16.00	0.3885	23.	226.	89.0	178.9	128.1
	16.10	0.3881	23.	226.	89.1	179.0	128.2
	16.20	0.3876	23.	227.	89.1	179.1	128.3
	16.30	0.3872	23.	227.	89.1	179.1	128.4
	16.40	0.3868	23.	228.	89.1	179.2	128.5
	16.50	0.3864	23.	228.	89.1	179.2	128.6
	16.60	0.3860	23.	229.	89.1	179.3	128.7
	16.70	0.3856	23.	229.	89.2	179.4	128.8
	16.80	0.3852	23.	230.	89.2	179.4	128.8
	16.90	0.3848	23.	230.	89.2	179.5	128.9
	17.00	0.3844	23.	231.	89.2	179.5	129.0
	17.10	0.3840	23.	231.	89.2	179.6	129.1
	17.20	0.3836	23.	231.	89.2	179.6	129.2
	17.30	0.3832	23.	232.	89.2	179.7	129.3
	17.40	0.3829	23.	232.	89.3	179.7	129.3

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	17.50	0.3825	23.	233.	89.3	179.8	129.4
	17.60	0.3821	23.	233.	89.3	179.8	129.5
	17.70	0.3817	23.	233.	89.3	179.9	129.6
	17.80	0.3814	23.	234.	89.3	179.9	129.6
	17.90	0.3810	23.	234.	89.3	180.0	129.7
	18.00	0.3806	23.	235.	89.3	180.0	129.8
	18.10	0.3803	23.	235.	89.3	180.1	129.9
	18.20	0.3799	23.	235.	89.4	180.1	129.9
	18.30	0.3796	23.	236.	89.4	180.2	130.0
	18.40	0.3792	23.	236.	89.4	180.2	130.1
	18.50	0.3789	23.	237.	89.4	180.3	130.1
	18.60	0.3785	23.	237.	89.4	180.3	130.2
	18.70	0.3782	23.	237.	89.4	180.3	130.3
	18.80	0.3778	23.	238.	89.4	180.4	130.3
	18.90	0.3775	23.	238.	89.4	180.4	130.4
	19.00	0.3772	23.	238.	89.5	180.5	130.5
	19.10	0.3768	23.	239.	89.5	180.5	130.5
	19.20	0.3765	23.	239.	89.5	180.6	130.6
	19.30	0.3762	23.	239.	89.5	180.6	130.7
	19.40	0.3759	23.	240.	89.5	180.6	130.7
	19.50	0.3755	23.	240.	89.5	180.7	130.8
	19.60	0.3752	23.	240.	89.5	180.7	130.8
	19.70	0.3749	23.	241.	89.5	180.7	130.9
	19.80	0.3746	23.	241.	89.5	180.8	131.0
	19.90	0.3743	23.	241.	89.5	180.8	131.0

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	20.00	0.3739	24.	242.	89.5	180.9	131.1
	20.10	0.3736	24.	242.	89.6	180.9	131.1
	20.20	0.3733	24.	242.	89.6	180.9	131.2
	20.30	0.3730	24.	242.	89.6	181.0	131.2
	20.40	0.3727	24.	243.	89.6	181.0	131.3
	20.50	0.3724	24.	243.	89.6	181.0	131.3
	20.60	0.3721	24.	243.	89.6	181.1	131.4
	20.70	0.3718	24.	244.	89.6	181.1	131.4
	20.80	0.3715	24.	244.	89.6	181.1	131.5
	20.90	0.3712	24.	244.	89.6	181.2	131.5
	21.00	0.3709	24.	244.	89.6	181.2	131.6
	21.10	0.3707	24.	245.	89.6	181.2	131.6
	21.20	0.3704	24.	245.	89.6	181.2	131.7
	21.30	0.3701	24.	245.	89.6	181.3	131.7
	21.40	0.3698	24.	245.	89.7	181.3	131.8
	21.50	0.3695	24.	246.	89.7	181.3	131.8
	21.60	0.3692	24.	246.	89.7	181.4	131.9
	21.70	0.3690	24.	246.	89.7	181.4	131.9
	21.80	0.3687	24.	246.	89.7	181.4	132.0
	21.90	0.3684	24.	247.	89.7	181.4	132.0
	22.00	0.3681	24.	247.	89.7	181.5	132.1
	22.10	0.3679	24.	247.	89.7	181.5	132.1
	22.20	0.3676	24.	247.	89.7	181.5	132.1
	22.30	0.3673	24.	247.	89.7	181.5	132.2
	22.40	0.3671	24.	248.	89.7	181.6	132.2

1	TIME SECONDS	POWER MEGAWATT	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	22.50	0.3668	24.	248.	89.7	181.6	132.3
	22.60	0.3665	24.	248.	89.7	181.6	132.3
	22.70	0.3663	24.	248.	89.7	181.6	132.3
	22.80	0.3660	24.	249.	89.7	181.6	132.4
	22.90	0.3658	24.	249.	89.7	181.7	132.4
	23.00	0.3655	24.	249.	89.7	181.7	132.4
	23.10	0.3652	24.	249.	89.7	181.7	132.5
	23.20	0.3650	24.	249.	89.7	181.7	132.5
	23.30	0.3647	24.	250.	89.7	181.7	132.6
	23.40	0.3645	24.	250.	89.7	181.8	132.6
	23.50	0.3642	24.	250.	89.7	181.8	132.6
	23.60	0.3640	24.	250.	89.7	181.8	132.7
	23.70	0.3637	24.	250.	89.8	181.8	132.7
	23.80	0.3635	24.	251.	89.8	181.8	132.7
	23.90	0.3633	24.	251.	89.8	181.9	132.8
	24.00	0.3630	24.	251.	89.8	181.9	132.8
	24.10	0.3628	24.	251.	89.8	181.9	132.8
	24.20	0.3625	24.	251.	89.8	181.9	132.9
	24.30	0.3623	24.	251.	89.8	181.9	132.9
	24.40	0.3621	24.	252.	89.8	181.9	132.9
	24.50	0.3618	24.	252.	89.8	181.9	132.9
	24.60	0.3616	24.	252.	89.8	182.0	133.0
	24.70	0.3614	24.	252.	89.8	182.0	133.0
	24.80	0.3611	24.	252.	89.8	182.0	133.0
	24.90	0.3609	24.	252.	89.8	182.0	133.1

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	25.00	0.3607	24.	252.	89.8	182.0	133.1
	25.10	0.3604	24.	253.	89.8	182.0	133.1
	25.20	0.3602	24.	253.	89.8	182.0	133.1
	25.30	0.3600	24.	253.	89.8	182.1	133.2
	25.40	0.3598	24.	253.	89.8	182.1	133.2
	25.50	0.3596	24.	253.	89.8	182.1	133.2
	25.60	0.3593	24.	253.	89.8	182.1	133.2
	25.70	0.3591	24.	253.	89.8	182.1	133.3
	25.80	0.3589	24.	254.	89.8	182.1	133.3
	25.90	0.3587	24.	254.	89.8	182.1	133.3
	26.00	0.3585	24.	254.	89.8	182.1	133.3
	26.10	0.3582	24.	254.	89.8	182.1	133.4
	26.20	0.3580	24.	254.	89.8	182.1	133.4
	26.30	0.3578	24.	254.	89.8	182.2	133.4
	26.40	0.3576	24.	254.	89.8	182.2	133.4
	26.50	0.3574	24.	255.	89.8	182.2	133.4
	26.60	0.3572	24.	255.	89.8	182.2	133.5
	26.70	0.3570	24.	255.	89.8	182.2	133.5
	26.80	0.3568	24.	255.	89.8	182.2	133.5
	26.90	0.3566	24.	255.	89.8	182.2	133.5
	27.00	0.3564	24.	255.	89.8	182.2	133.6
	27.10	0.3562	24.	255.	89.8	182.2	133.6
	27.20	0.3559	24.	255.	89.8	182.2	133.6
	27.30	0.3557	24.	255.	89.8	182.2	133.6
	27.40	0.3555	24.	256.	89.8	182.2	133.6

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	27.50	0.3553	24.	256.	89.8	182.2	133.6
	27.60	0.3551	24.	256.	89.8	182.2	133.7
	27.70	0.3549	24.	256.	89.8	182.2	133.7
	27.80	0.3548	24.	256.	89.8	182.2	133.7
	27.90	0.3546	24.	256.	89.8	182.2	133.7
	28.00	0.3544	24.	256.	89.8	182.3	133.7
	28.10	0.3542	24.	256.	89.8	182.3	133.7
	28.20	0.3540	24.	256.	89.8	182.3	133.8
	28.30	0.3538	24.	256.	89.7	182.3	133.8
	28.40	0.3536	24.	256.	89.7	182.3	133.8
	28.50	0.3534	24.	257.	89.7	182.3	133.8
	28.60	0.3532	24.	257.	89.7	182.3	133.8
	28.70	0.3530	24.	257.	89.7	182.3	133.8
	28.80	0.3528	24.	257.	89.7	182.3	133.9
	28.90	0.3526	24.	257.	89.7	182.3	133.9
	29.00	0.3525	24.	257.	89.7	182.3	133.9
	29.10	0.3523	24.	257.	89.7	182.3	133.9
	29.20	0.3521	24.	257.	89.7	182.3	133.9
	29.30	0.3519	24.	257.	89.7	182.3	133.9
	29.40	0.3517	24.	257.	89.7	182.3	133.9
	29.50	0.3515	24.	257.	89.7	182.3	133.9
	29.60	0.3514	24.	257.	89.7	182.3	134.0
	29.70	0.3512	24.	257.	89.7	182.3	134.0
	29.80	0.3510	24.	257.	89.7	182.3	134.0
	29.90	0.3508	24.	258.	89.7	182.3	134.0

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP. DEGREES F
	30.03	0.3506	24.	258.	89.7	182.3	134.0
	30.13	0.3505	24.	258.	89.7	182.3	134.0
	30.23	0.3503	24.	258.	89.7	182.3	134.0
	30.33	0.3501	24.	258.	89.7	182.3	134.0
	30.40	0.3499	24.	258.	89.7	182.3	134.0
	30.50	0.3498	24.	258.	89.7	182.3	134.1
	30.60	0.3496	24.	258.	89.7	182.3	134.1
	30.70	0.3494	24.	258.	89.7	182.3	134.1
	30.80	0.3493	24.	258.	89.7	182.3	134.1
	30.90	0.3491	24.	258.	89.7	182.3	134.1
	31.00	0.3489	24.	258.	89.7	182.3	134.1
	31.10	0.3487	24.	258.	89.7	182.2	134.1
	31.20	0.3486	24.	258.	89.6	182.2	134.1
	31.30	0.3484	24.	258.	89.6	182.2	134.1
	31.40	0.3482	24.	258.	89.6	182.2	134.1
	31.50	0.3481	24.	258.	89.6	182.2	134.1
	31.60	0.3479	24.	258.	89.6	182.2	134.2
	31.70	0.3478	24.	259.	89.6	182.2	134.2
	31.80	0.3476	24.	259.	89.6	182.2	134.2
	31.90	0.3474	24.	259.	89.6	182.2	134.2
	32.00	0.3473	24.	259.	89.6	182.2	134.2
	32.10	0.3471	24.	259.	89.6	182.2	134.2
	32.20	0.3469	24.	259.	89.6	182.2	134.2
	32.30	0.3468	24.	259.	89.6	182.2	134.2
	32.40	0.3466	24.	259.	89.6	182.2	134.2

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	32.50	0.3465	24.	259.	89.6	182.2	134.2
	32.60	0.3463	24.	259.	89.6	182.2	134.2
	32.70	0.3461	24.	259.	89.6	182.2	134.2
	32.80	0.3460	24.	259.	89.6	182.2	134.2
	32.90	0.3458	24.	259.	89.6	182.2	134.2
	33.00	0.3457	24.	259.	89.6	182.2	134.2
	33.10	0.3455	24.	259.	89.5	182.1	134.2
	33.20	0.3454	24.	259.	89.5	182.1	134.2
	33.30	0.3452	24.	259.	89.5	182.1	134.3
	33.40	0.3451	24.	259.	89.5	182.1	134.3
	33.50	0.3449	24.	259.	89.5	182.1	134.3
	33.60	0.3448	24.	259.	89.5	182.1	134.3
	33.70	0.3446	24.	259.	89.5	182.1	134.3
	33.80	0.3445	24.	259.	89.5	182.1	134.3
	33.90	0.3443	24.	259.	89.5	182.1	134.3
	34.00	0.3442	24.	259.	89.5	182.1	134.3
	34.10	0.3440	24.	259.	89.5	182.1	134.3
	34.20	0.3439	24.	259.	89.5	182.1	134.3
	34.30	0.3437	24.	259.	89.5	182.1	134.3
	34.40	0.3436	24.	259.	89.5	182.1	134.3
	34.50	0.3434	24.	259.	89.5	182.0	134.3
	34.60	0.3433	24.	259.	89.5	182.0	134.3
	34.70	0.3431	24.	259.	89.5	182.0	134.3
	34.80	0.3430	24.	259.	89.4	182.0	134.3
	34.90	0.3429	24.	259.	89.4	182.0	134.3

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	35.00	0.3427	24.	259.	89.4	182.0	134.3
	35.10	0.3426	24.	259.	89.4	182.0	134.3
	35.20	0.3424	24.	259.	89.4	182.0	134.3
	35.30	0.3423	24.	259.	89.4	182.0	134.3
	35.40	0.3421	24.	259.	89.4	182.0	134.3
	35.50	0.3420	24.	259.	89.4	182.0	134.3
	35.60	0.3419	24.	259.	89.4	181.9	134.3
	35.70	0.3417	24.	259.	89.4	181.9	134.3
	35.80	0.3416	24.	259.	89.4	181.9	134.3
	35.90	0.3414	24.	259.	89.4	181.9	134.3
	36.00	0.3413	24.	259.	89.4	181.9	134.3
	36.10	0.3412	24.	259.	89.4	181.9	134.3
	36.20	0.3410	24.	259.	89.4	181.9	134.3
	36.30	0.3409	24.	259.	89.3	181.9	134.3
	36.40	0.3408	24.	259.	89.3	181.9	134.3
	36.50	0.3406	24.	259.	89.3	181.9	134.3
	36.60	0.3405	24.	259.	89.3	181.8	134.3
	36.70	0.3404	24.	259.	89.3	181.8	134.3
	36.80	0.3402	24.	259.	89.3	181.8	134.3
	36.90	0.3401	24.	259.	89.3	181.8	134.3
	37.00	0.3400	24.	259.	89.3	181.8	134.3
	37.10	0.3398	24.	259.	89.3	181.8	134.3
	37.20	0.3397	24.	259.	89.3	181.8	134.3
	37.30	0.3396	24.	259.	89.3	181.8	134.3
	37.40	0.3394	24.	259.	89.3	181.8	134.3

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	37.50	0.3393	24.	259.	89.3	181.7	134.3
	37.60	0.3392	24.	259.	89.3	181.7	134.3
	37.70	0.3391	24.	259.	89.2	181.7	134.3
	37.80	0.3389	24.	259.	89.2	181.7	134.3
	37.90	0.3388	24.	259.	89.2	181.7	134.3
	38.00	0.3387	24.	259.	89.2	181.7	134.3
	38.10	0.3385	24.	259.	89.2	181.7	134.3
	38.20	0.3384	24.	259.	89.2	181.7	134.3
	38.30	0.3383	24.	259.	89.2	181.7	134.3
	38.40	0.3382	24.	259.	89.2	181.6	134.3
	38.50	0.3380	24.	259.	89.2	181.6	134.3
	38.60	0.3379	24.	259.	89.2	181.6	134.3
	38.70	0.3378	24.	259.	89.2	181.6	134.3
	38.80	0.3377	24.	259.	89.2	181.6	134.3
	38.90	0.3376	24.	259.	89.2	181.6	134.3
	39.00	0.3374	24.	259.	89.2	181.6	134.3
	39.10	0.3373	24.	259.	89.1	181.6	134.3
	39.20	0.3372	24.	259.	89.1	181.5	134.3
	39.30	0.3371	24.	259.	89.1	181.5	134.3
	39.40	0.3369	24.	259.	89.1	181.5	134.3
	39.50	0.3368	24.	259.	89.1	181.5	134.3
	39.60	0.3367	24.	259.	89.1	181.5	134.3
	39.70	0.3366	24.	259.	89.1	181.5	134.3
	39.80	0.3365	24.	259.	89.1	181.5	134.3
	39.90	0.3364	24.	259.	89.1	181.5	134.3

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL./MIN	REYNOLDS NUMBER	BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	40.00	0.3362	24.	259.	89.1	181.4	134.3
	40.10	0.3361	24.	259.	89.1	181.4	134.3
	40.20	0.3360	24.	259.	89.1	181.4	134.3
	40.30	0.3359	24.	259.	89.1	181.4	134.3
	40.40	0.3358	24.	259.	89.0	181.4	134.3
	40.50	0.3357	24.	259.	89.0	181.4	134.3
	40.60	0.3355	24.	259.	89.0	181.4	134.2
	40.70	0.3354	24.	259.	89.0	181.4	134.2
	40.80	0.3353	24.	259.	89.0	181.3	134.2
	40.90	0.3352	24.	259.	89.0	181.3	134.2
	41.00	0.3351	24.	259.	89.0	181.3	134.2
	41.10	0.3350	24.	259.	89.0	181.3	134.2
	41.20	0.3349	24.	259.	89.0	181.3	134.2
	41.30	0.3347	24.	259.	89.0	181.3	134.2
	41.40	0.3346	24.	259.	89.0	181.3	134.2
	41.50	0.3345	24.	259.	89.0	181.2	134.2
	41.60	0.3344	24.	259.	89.0	181.2	134.2
	41.70	0.3343	24.	259.	88.9	181.2	134.2
	41.80	0.3342	24.	259.	88.9	181.2	134.2
	41.90	0.3341	24.	259.	88.9	181.2	134.2
	42.00	0.3340	24.	259.	88.9	181.2	134.2
	42.10	0.3339	24.	259.	88.9	181.2	134.2
	42.20	0.3337	24.	259.	88.9	181.1	134.2
	42.30	0.3336	24.	259.	88.9	181.1	134.2
	42.40	0.3335	24.	259.	88.9	181.1	134.2

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL./MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	42.50	0.3334	24.	259.	88.9	181.1	134.2
	42.60	0.3333	24.	259.	88.9	181.1	134.2
	42.70	0.3332	24.	259.	88.9	181.1	134.2
	42.80	0.3331	24.	259.	88.9	181.1	134.2
	42.90	0.3330	24.	259.	88.8	181.1	134.2
	43.00	0.3329	24.	259.	88.8	181.0	134.1
	43.10	0.3328	24.	258.	88.8	181.0	134.1
	43.20	0.3327	24.	258.	88.8	181.0	134.1
	43.30	0.3326	24.	258.	88.8	181.0	134.1
	43.40	0.3325	24.	258.	88.8	181.0	134.1
	43.50	0.3324	24.	258.	88.8	181.0	134.1
	43.60	0.3323	24.	258.	88.8	181.0	134.1
	43.70	0.3322	24.	258.	88.8	180.9	134.1
	43.80	0.3321	24.	258.	88.8	180.9	134.1
	43.90	0.3319	24.	258.	88.8	180.9	134.1
	44.00	0.3318	24.	258.	88.8	180.9	134.1
	44.10	0.3317	24.	258.	88.8	180.9	134.1
	44.20	0.3316	24.	258.	88.7	180.9	134.1
	44.30	0.3315	24.	258.	88.7	180.9	134.1
	44.40	0.3314	24.	258.	88.7	180.8	134.1
	44.50	0.3313	24.	258.	88.7	180.8	134.1
	44.60	0.3312	24.	258.	88.7	180.8	134.1
	44.70	0.3311	24.	258.	88.7	180.8	134.1
	44.80	0.3310	24.	258.	88.7	180.8	134.1
	44.90	0.3309	24.	258.	88.7	180.8	134.0

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT.-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	45.00	0.3308	24.	258.	88.7	180.8	134.0
	45.10	0.3307	24.	258.	88.7	180.7	134.0
	45.20	0.3306	24.	258.	88.7	180.7	134.0
	45.30	0.3305	24.	258.	88.7	180.7	134.0
	45.40	0.3305	24.	258.	88.7	180.7	134.0
	45.50	0.3304	24.	258.	88.6	180.7	134.0
	45.60	0.3303	24.	258.	88.6	180.7	134.0
	45.70	0.3302	24.	258.	88.6	180.7	134.0
	45.80	0.3301	24.	258.	88.6	180.6	134.0
	45.90	0.3300	24.	258.	88.6	180.6	134.0
	46.00	0.3299	24.	258.	88.6	180.6	134.0
	46.10	0.3298	24.	258.	88.6	180.6	134.0
	46.20	0.3297	24.	258.	88.6	180.6	134.0
	46.30	0.3296	24.	258.	88.6	180.6	134.0
	46.40	0.3295	24.	258.	88.6	180.5	134.0
	46.50	0.3294	24.	257.	88.6	180.5	134.0
	46.60	0.3293	24.	257.	88.6	180.5	133.9
	46.70	0.3292	24.	257.	88.5	180.5	133.9
	46.80	0.3291	24.	257.	88.5	180.5	133.9
	46.90	0.3290	24.	257.	88.5	180.5	133.9
	47.00	0.3289	24.	257.	88.5	180.5	133.9
	47.10	0.3288	24.	257.	88.5	180.4	133.9
	47.20	0.3287	24.	257.	88.5	180.4	133.9
	47.30	0.3287	24.	257.	88.5	180.4	133.9
	47.40	0.3286	24.	257.	88.5	180.4	133.9

1	T. ME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	47.50	0.3285	24.	257.	88.5	180.4	133.9
	47.60	0.3284	24.	257.	88.5	180.4	133.9
	47.70	0.3283	24.	257.	88.5	180.4	133.9
	47.80	0.3282	24.	257.	88.5	180.3	133.9
	47.90	0.3281	24.	257.	88.5	180.3	133.9
	48.00	0.3280	24.	257.	88.4	180.3	133.9
	48.10	0.3279	24.	257.	88.4	180.3	133.9
	48.20	0.3278	24.	257.	88.4	180.3	133.8
	48.30	0.3278	24.	257.	88.4	180.3	133.8
	48.40	0.3277	24.	257.	88.4	180.3	133.8
	48.50	0.3276	24.	257.	88.4	180.2	133.8
	48.60	0.3275	24.	257.	88.4	180.2	133.8
	48.70	0.3274	24.	257.	88.4	180.2	133.8
	48.80	0.3273	24.	257.	88.4	180.2	133.8
	48.90	0.3272	24.	257.	88.4	180.2	133.8
	49.00	0.3271	24.	257.	88.4	180.2	133.8
	49.10	0.3271	24.	257.	88.4	180.2	133.8
	49.20	0.3270	24.	257.	88.3	180.1	133.8
	49.30	0.3269	24.	257.	88.3	180.1	133.8
	49.40	0.3268	24.	256.	88.3	180.1	133.8
	49.50	0.3267	24.	256.	88.3	180.1	133.8
	49.60	0.3266	24.	256.	88.3	180.1	133.8
	49.70	0.3265	24.	256.	88.3	180.1	133.7
	49.80	0.3265	24.	256.	88.3	180.1	133.7
	49.90	0.3264	24.	256.	88.3	180.0	133.7

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	50.00	0.3263	24.	256.	88.3	180.0	133.7
	50.10	0.3262	24.	256.	88.3	180.0	133.7
	50.20	0.3261	24.	256.	88.3	180.0	133.7
	50.30	0.3260	24.	256.	88.3	180.0	133.7
	50.40	0.3260	24.	256.	88.3	180.0	133.7
	50.50	0.3259	24.	256.	88.2	179.9	133.7
	50.60	0.3258	24.	256.	88.2	179.9	133.7
	50.70	0.3257	24.	256.	88.2	179.9	133.7
	50.80	0.3256	24.	256.	88.2	179.9	133.7
	50.90	0.3255	24.	256.	88.2	179.9	133.7
	51.00	0.3255	24.	256.	88.2	179.9	133.7
	51.10	0.3254	24.	256.	88.2	179.9	133.7
	51.20	0.3253	24.	256.	88.2	179.8	133.6
	51.30	0.3252	24.	256.	88.2	179.8	133.6
	51.40	0.3251	24.	256.	88.2	179.8	133.6
	51.50	0.3251	24.	256.	88.2	179.8	133.6
	51.60	0.3250	24.	256.	88.2	179.8	133.6
	51.70	0.3249	24.	256.	88.2	179.8	133.6
	51.80	0.3248	24.	256.	88.1	179.8	133.6
	51.90	0.3247	24.	256.	88.1	179.7	133.6
	52.00	0.3247	24.	256.	88.1	179.7	133.6
	52.10	0.3246	24.	255.	88.1	179.7	133.6
	52.20	0.3245	24.	255.	88.1	179.7	133.6
	52.30	0.3244	24.	255.	88.1	179.7	133.6
	52.40	0.3244	24.	255.	88.1	179.7	133.6

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	52.50	0.3243	24.	255.	88.1	179.7	133.6
	52.60	0.3242	24.	255.	88.1	179.6	133.5
	52.70	0.3241	24.	255.	88.1	179.6	133.5
	52.80	0.3240	24.	255.	88.1	179.6	133.5
	52.90	0.3240	24.	255.	88.1	179.6	133.5
	53.00	0.3239	24.	255.	88.1	179.6	133.5
	53.10	0.3238	24.	255.	88.0	179.6	133.5
	53.20	0.3237	24.	255.	88.0	179.6	133.5
	53.30	0.3237	24.	255.	88.0	179.5	133.5
	53.40	0.3236	24.	255.	88.0	179.5	133.5
	53.50	0.3235	24.	255.	88.0	179.5	133.5
	53.60	0.3234	24.	255.	88.0	179.5	133.5
	53.70	0.3234	24.	255.	88.0	179.5	133.5
	53.80	0.3233	24.	255.	88.0	179.5	133.5
	53.90	0.3232	24.	255.	88.0	179.5	133.5
	54.00	0.3231	24.	255.	88.0	179.4	133.5
	54.10	0.3231	24.	255.	88.0	179.4	133.4
	54.20	0.3230	24.	255.	88.0	179.4	133.4
	54.30	0.3229	24.	255.	88.0	179.4	133.4
	54.40	0.3228	24.	255.	87.9	179.4	133.4
	54.50	0.3228	24.	255.	87.9	179.4	133.4
	54.60	0.3227	24.	255.	87.9	179.4	133.4
	54.70	0.3226	24.	254.	87.9	179.3	133.4
	54.80	0.3226	24.	254.	87.9	179.3	133.4
	54.90	0.3225	24.	254.	87.9	179.3	133.4

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	55.00	0.3224	24.	254.	87.9	179.3	133.4
	55.10	0.3223	24.	254.	87.9	179.3	133.4
	55.20	0.3223	24.	254.	87.9	179.3	133.4
	55.30	0.3222	24.	254.	87.9	179.3	133.4
	55.40	0.3221	24.	254.	87.9	179.2	133.4
	55.50	0.3221	24.	254.	87.9	179.2	133.3
	55.60	0.3220	24.	254.	87.9	179.2	133.3
	55.70	0.3219	24.	254.	87.9	179.2	133.3
	55.80	0.3218	24.	254.	87.8	179.2	133.3
	55.90	0.3218	24.	254.	87.8	179.2	133.3
	56.00	0.3217	24.	254.	87.8	179.2	133.3
	56.10	0.3216	24.	254.	87.8	179.1	133.3
	56.20	0.3216	24.	254.	87.8	179.1	133.3
	56.30	0.3215	24.	254.	87.8	179.1	133.3
	56.40	0.3214	24.	254.	87.8	179.1	133.3
	56.50	0.3214	24.	254.	87.8	179.1	133.3
	56.60	0.3213	24.	254.	87.8	179.1	133.3
	56.70	0.3212	24.	254.	87.8	179.1	133.3
	56.80	0.3211	24.	254.	87.8	179.1	133.3
	56.90	0.3211	24.	254.	87.8	179.0	133.2
	57.00	0.3210	24.	254.	87.8	179.0	133.2
	57.10	0.3209	24.	254.	87.8	179.0	133.2
	57.20	0.3209	24.	254.	87.7	179.0	133.2
	57.30	0.3208	24.	253.	87.7	179.0	133.2
	57.40	0.3207	24.	253.	87.7	179.0	133.2

1	TIME SECONDS	POWER MEGAWATTS	FLOW GAL/MIN	REYNOLDS NUMBER	H BTU/(SQ. FT-HR)	FUEL TEMP DEGREES F	COOLANT TEMP DEGREES F
	57.50	0.3207	24.	253.	87.7	179.0	133.2
	57.60	0.3206	24.	253.	87.7	178.9	133.2
	57.70	0.3205	24.	253.	87.7	178.9	133.2
	57.80	0.3205	24.	253.	87.7	178.9	133.2
	57.90	0.3204	24.	253.	87.7	178.9	133.2
	58.00	0.3203	24.	253.	87.7	178.9	133.2
	58.10	0.3203	24.	253.	87.7	178.9	133.2
	58.20	0.3202	24.	253.	87.7	178.9	133.2
	58.30	0.3201	24.	253.	87.7	178.8	133.1
	58.40	0.3201	24.	253.	87.7	178.8	133.1
	58.50	0.3200	24.	253.	87.7	178.8	133.1
	58.60	0.3200	24.	253.	87.6	178.8	133.1
	58.70	0.3199	24.	253.	87.6	178.8	133.1
	58.80	0.3198	24.	253.	87.6	178.8	133.1
	58.90	0.3198	24.	253.	87.6	178.8	133.1
	59.00	0.3197	24.	253.	87.6	178.8	133.1

FORCED LAMINAR FLOW BEGINS AT 1.170 SECONDS

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