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TECHNICAL REPORT

# FLUID FLOW ANALYSIS OF THE SSME HIGH PRESSURE FUEL AND OXIDIZER TURBINE COOLANT SYSTEMS

JULY 1989

Contract NAS8-36284

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, AL 35812



Lockheed
Missiles & Space Company, Inc.
Huntsville Engineering Center
4800 Bradford Blvd., Huntsville, AL 35807

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## FOREWORD

This document presents the results of work performed for NASA-Marshall Space Flight Center by the Computational Mechanics Section of the Lockheed Missiles & Space Company, Inc., Huntsville Engineering Center. This work was performed for NASA-MSFC under Contract NAS8-36284, with Dr. Helen McConnaughey serving as technical monitor.

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# 1. INTRODUCTION AND SUMMARY

## 1.1 OBJECTIVES

The objective of this study is to provide improved analysis capability for the Space Shuttle Main Engine (SSME) high pressure fuel and oxidizer turbine coolant systems. Each of the systems was analyzed to determine fluid flow rates and thermodynamic and transport properties at all key points in the systems.

## 1.2 SUMMARY

Existing computer codes developed by Lockheed for NASA-MSFC were used as a baseline for these analyses. These codes were modified to provide improved analysis capability. The major areas of improvement are listed below.

- A review of the drawings was performed, and pertinent geometry changes were included in the models.
- Improvements were made in the calculation of thermodynamic and transport properties for a mixture of hydrogen and steam.
- A one-dimensional turbine model for each system is included as a subroutine to each code. This provides a closed loop analysis with a minimum of required boundary conditions as input.
- An improved labyrinth seal model is included in the high pressure fuel turbine coolant model.

The modifications and the analysis results are presented in detail in the following sections.

# 2. GENERAL THEORY OF FLUID FLOW RELATIONS

The fluid flow model solves the steady state continuity, momentum, and energy equations to obtain thermodynamic and transport properties at various stations in the coolant systems. The models compute changes in fluid flow properties between stations using coolant system geometrical data, pressure loss factors, heat transfer rates, and bearing and labyrinth seal models discussed below.

## 2.1 FLOW EQUATIONS

The mass continuity, momentum, and energy conservation equations are cast in one-dimensional, incompressible form to describe the fluid flow from station to station. The continuity equation states that the fluid flow rate is con served from station to station. The momentum equation is cast in the form

$$P_{T2} = P_{T1} - \Delta P_{loss} + \Delta P_{cen}$$

where

$P_{T2}$ is the total pressure at the downstream station

$P_{T1}$ is the total pressure at the upstream station

$\Delta P_{loss}$ is the change in pressure due to friction or turbulence

and

$\Delta P_{cen}$ is the change in pressure due to centrifugal effects.

The term $\Delta P_{loss}$ depends on the type of flow passage involved and is evaluated using the relationship

$$\Delta P_{loss} = K \, (\rho V_F^2 / 2 \, g_c)$$

where

$\rho$ is the fluid density

$V_F$ is the fluid flow velocity (excluding centrifugal components)

$g_c$ is the gravitational constant

and

K is a pressure loss factor that depends on the type of flow.

The values of K for several types of flow may be obtained from Ref. 1 and are presented in Table 2-1. The dynamic pressure term $\rho V_F^2/2\ g_c$ is evaluated at the station with the smaller flow area.

Table 2-1 PRESSURE LOSS FACTORS (K)

| Type of Passage | Value of K (Ref. 1) | Remarks |
|---|---|---|
| Smooth Pipe (Darcy Weisbach) | $K = fL/D$ | $f = 0.184/R^{0.2}$<br>L = length<br>D = hydraulic diameter<br>R = Reynolds number |
| Mitered Bend | $K = fL_e/D$ | $L_e$ = equivalent length<br>(See page A-27 of Ref. 1) |
| Sudden Expansion | $K = [1 - (D_1/D_2)^2]^2$ | $D_1$ = smaller hydraulic diameter<br>$D_2$ = larger hydraulic diameter |
| Sudden Contraction | | See page A-26 of Ref. 1 |
| Entrance from Large Volume | K = 0.50<br>K = 0.23<br>K = 0.04 | Sharp-edged entrance<br>Rounded entrance<br>Well-rounded entrance |
| Exit to Large Volume | K = 1.0 | $V_F \simeq 0.0$ (small flow velocity) |

The resultant pressure changes $\Delta P_{loss}$ may be modified by an expansion factor (Y) for compressible fluid flows. Expansion factors for several types of passages may be obtained from pages A-21 and A-22 of Ref. 1; the change in pressure becomes

$$\Delta P_{loss} = \Delta P_{loss}/Y^2$$

This expansion factor may be ignored for $\Delta P_{loss}/P_{T1}$ values of less than 10% and for up to 40% if the fluid density is replaced by the average density between stations 1 and 2 (Ref. 1)

The term $\Delta P_{loss}$ also includes the pressure losses that occur in bearings and labyrinth seals. These pressure losses will be discussed in subsequent paragraphs.

The term $\Delta P_{cen}$ accounts for pressure changes due to centrifugal effects of the spinning fluid and may be computed from the relationship

$$\Delta P_{cen} = K_c \rho (V_{T2}^2 - V_{T1}^2)/2 g_c$$

where $V_{T1}$ and $V_{T2}$ are the upstream and downstream tangential velocities. The term $K_c$ is a frictional loss factor equal to unity for frictional dissipation.

For flow about spinning disks the pressure change is computed from the relationship

$$dP_s = \rho w_s^2 \eta^2 R \, dR/g_c$$

where

$dP_s$ = differential static pressure

$w_s$ = shaft angular velocity

$\eta$ = ratio of fluid to shaft angular velocities

$R$ = radial distance from spin axis.

Relationships for $\eta$ may be obtained from Ref. 2 for inward and outward flows through smooth and bladed disk/housing configurations. The effect on total pressure $\Delta P_{cen}$ must be determined from $dP_s$ and dynamic pressure.

These various contributions to pressure changes also affect the energy of the fluid through the energy equation

$$H_{T2} = H_{T1} + \frac{\dot{Q}_{1-2}}{\dot{m}} + \Delta H_{cen}$$

where

$H_T$ = total enthalpy per pound of fluid
$\dot{Q}_{1-2}$ = heat transferred to the fluid
$\Delta H_{cen}$ = change in total enthalpy due to centrifugal effects.

Changes in pressure due to centrifugal effects result in a change in total enthalpy equal to

$$\Delta H_{cen} = \Delta P_{cen}/\rho$$

For spinning disks the heat generation term $\Delta H_{cen}$ becomes (Ref. 2):

$$\Delta H_{cen} = \left(\frac{2\pi N}{60}\right)^3 \left(\frac{1}{12}\right)^5 \frac{\rho\,(R_1^5 - R_2^5)}{4\,g_c\,J}\,C_m$$

where $C_m$ is a coefficient depending on disk/housing configuration,

and $J = 778.2$ lbf-ft/Btu.

The above equations represent solutions to the general flow equations which will adequately describe the flow in the coolant systems.

## 2.2 BEARING MODEL

The bearing model computes the pressure drop in the fluid flowing through ball bearings. The pressure loss term $\Delta P_B$ is computed by solving the quadratic equation

$$\alpha(\Delta P_B)^2 - \dot{m}^2 (\Delta P_B) - \beta \dot{m}^2 = 0$$

where

$$\alpha = 288 \rho g_c A^2 C^2$$

$$\beta = \rho (RK)^2 \frac{(2\pi N/60)^2}{288 g_c}$$

N = shaft rpm

The coefficients A, C, R, and K are bearing constants supplied by NASA-MSFC.

## 2.3 LABYRINTH SEAL MODEL

The labyrinth seal model now used by the high pressure fuel turbine coolant model is an empirical leakage prediction program for straight-through labyrinth seals developed for NASA-MSFC by Texas A&M University (Ref. 3). This program is included as a subroutine in the fuel turbine coolant program.

## 2.4 THERMODYNAMIC AND TRANSPORT PROPERTIES

The high pressure fuel and oxidizer turbine coolant systems are complex flow systems comprising several flow paths in which the fluid is pure hydrogen and other flow paths containing a mixture of $H_2$ and $H_2O$. Thermodynamic and transport properties for hydrogen are computed from the GASP computer code (Ref. 4).

To evaluate real thermodynamic properties for $H_2/H_2O$ gas mixtures the WASP computer code (Ref. 5) is used to calculate $H_2O$ properties. The gas

components are assumed to occupy the entire volume at the mixture temperature and pressure, and the thermodynamic properties are mass fraction weighted to obtain mixture properties. The compressibility factor is assumed to obey the law of additive volumes and is computed accordingly.

To obtain thermodynamic properties for a mixture containing $H_2O$ in the liquid phase, the following procedure is employed:

- $P_M$ and $H_M$ are the known thermodynamic properties (except at turbine inlet and discharge stations where $P_M$ and $T_M$ are known)
- Assume $T_M$ and compute $P_V$
- Check if $P_{H_2O} > P_V$ (two-phase if true)
- Compute a gas phase mole fraction required to give $P_{H_2OG} = P_V$
- Compute XL and $X_G$
- $H_{TM} = X_H H_H + X_L H_L + X_G H_G$
- Iterate on $T_M$ until $H_{TM} = H_M$.

This procedure is extended to include the solid region when $P_M$ and $H_M$ are known. However, in the solid region, the thermodynamic state cannot be defined by $P_M$ and $T_M$ alone.

In general, the properties routine evaluates thermodynamic properties of $H_2O$ for four separate regions:

1. $T_M > T_{crit}$
   Composition is all gas, properties evaluated at $P_M$ and $T_M$

2. $T_M < T_{crit}$, $P_V > P_M$
   Composition is all gas, properties evaluated at $P_M$ and $T_M$

3. $P_V < P_M$, $P_V > P_{H_2O}$
   Composition is in vapor state.
   Enthalpy is evaluated by computing liquid enthalpy at $P_M$ and $T_M$ and adding the heat of vaporization. Transport properties are evaluated for saturated vapor only.

4. $P_V < P_M$, $P_V < P_{H_2O}$
   Composition is two phase

   - Liquid/vapor
   - Liquid
     Vapor phase is negligible
   - Solid/liquid
     Vapor phase is negligible
   - Solid
     Vapor and liquid phases negligible

   where

   $T_M$ = mixture temperature
   $P_M$ = mixture pressure
   $T_{crit}$ = critical temperature of $H_2O$
   $P_V$ = vapor pressure of $H_2O$ at $T_M$
   $P_{H_2O}$ = $H_2O$ partial pressure based on total mixture mole fraction
   $P_{H_2OG}$ = $H_2O$ partial pressure based on gas phase mole fraction
   $X_L$ = the mass fraction of liquid $H_2O$ in the total mixture
   $X_G$ = the mass fraction of $H_2O$ vapor in the total mixture
   $H_H$ = $H_2$ enthalpy at $P_M$ and $T_M$
   $H_L$ = $H_2O$ liquid enthalpy at $P_M$ and $T_M$
   $H_G$ = $H_2O$ vapor enthalpy at $P_M$ and $T_M$
   $H_M$ = mixture enthalpy
   $H_{TM}$ = computed mixture enthalpy.

In the two-phase region, the mixture density computed by the program is the homogeneous two-phase density. The compressibility factor is computed for the gas phase only.

Transport properties are evaluated for a mixture of gases using the method of Wilke for computing viscosity and the method of Vanderslice for computing thermal conductivity (see Reference 6). Mixture transport properties are evaluated for the gas phase only.

# 3. HIGH PRESSURE FUEL TURBINE COOLANT ANALYSIS

## 3.1 TURBINE COOLANT SYSTEM

The existing high pressure fuel turbopump (HPFTP) turbine coolant system flow model developed by Lockheed for NASA-MSFC was used as a baseline for this analysis. This baseline model (shown in Figure 3-1) is documented in Reference 7. The turbine coolant system was modeled to evaluate the flow properties at each of the numbered stations shown in Figure 3-1 and to compute the flow rates along each of the flow paths in the system. Two additional flow paths have been added to compute flows through the turbine blade fir trees. These are the first stage blade fir trees (stations 95 through 98) and the second stage blade fir trees (stations 99 through 101). The model comprises 101 stations and 25 flow paths.

## 3.2 MODEL IMPROVEMENT

A review of current drawings was performed and pertinent geometry changes were included in the model. Operating clearances for the turbine blade platform seals, labyrinth seal, and the lift-off seal were supplied by NASA-MSFC.

A one-dimensional turbine model is included as a subroutine in the code. This provides a closed loop analysis with a minimum of required boundary conditions as input. Estimated platform seal leakage rates are input to the turbine model, and the turbine model is executed to provide pressures as boundary conditions for the coolant flow model (stations 35, 41, 64, and 72). The coolant model is then executed and new leakage flows are computed. An input option is provided for terminating the execution at this point or continuing with another pass through each model if greater accuracy is desired.

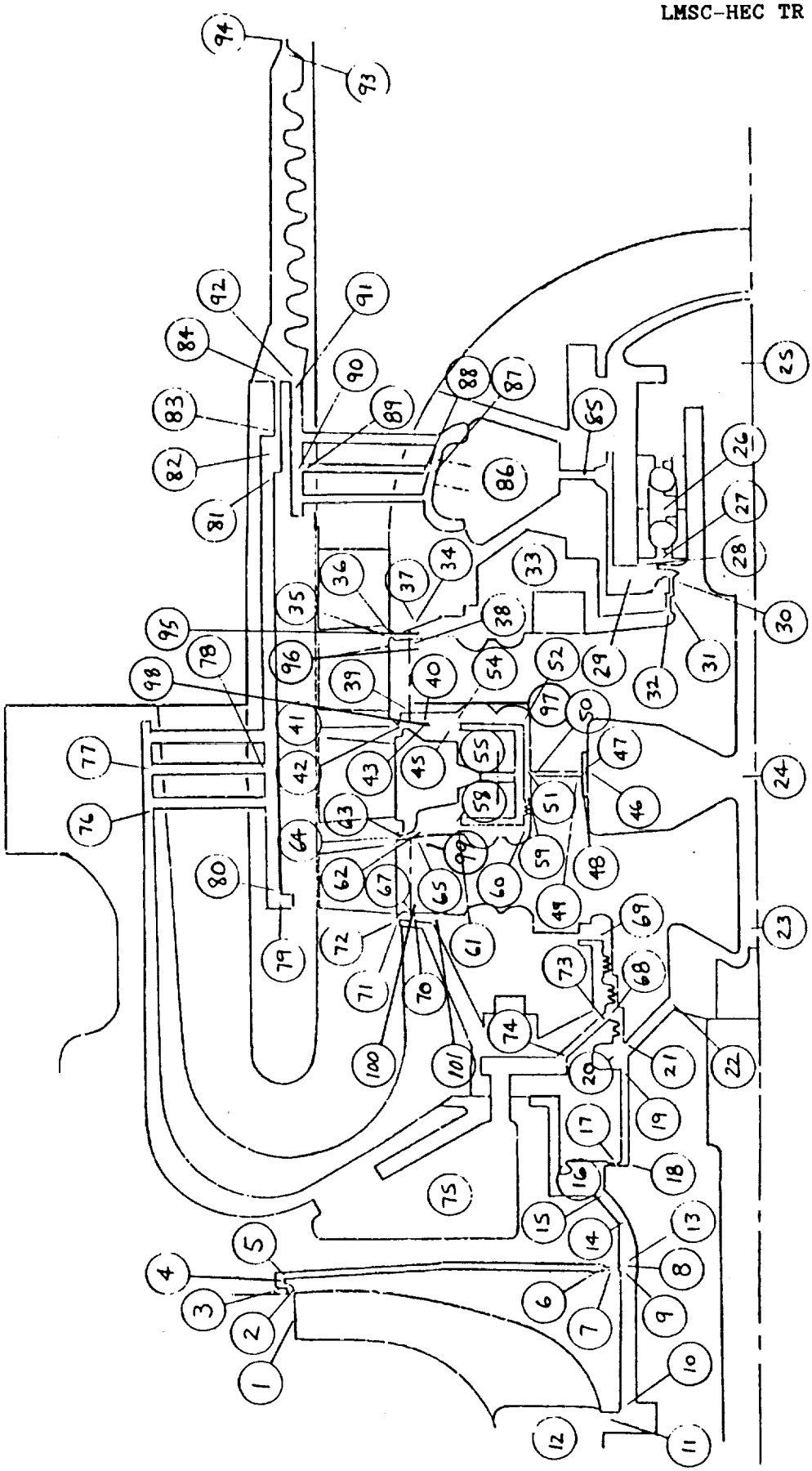


Figure 3-1 HPFTP Turbine Coolant System Schematic

An improved labyrinth seal leakage prediction program developed for NASA-MSFC by Texas A&M University (Ref. 3) is included as a subroutine in the turbine coolant program.

An improved properties subroutine for computing thermodynamic and transport properties for a mixture of $H_2$ and $H_2O$ has been added to the program. See Section 2.4 for a detailed description of this calculation procedure.

## 3.3 RESULTS

The fuel turbine coolant system was analyzed at full power level (FPL), 104% and minimum power level (MPL), using Rocketdyne engine balance data obtained from Reference 8. The results of these analyses are presented in Tables 3-1 through 3-3. These results are for a balance piston high pressure orifice gap of 0.004 inch.

## 3.4 PROGRAM INPUT GUIDE

This section describes the input data file required for execution of the HPFTP turbine coolant program.

| Column | Parameter | Description |
|---|---|---|
| Line number 1, Format (8E10.4) | | |
| 1-10 | GAP | Balance piston high pressure orifice gap, in. |
| Line number 2, Format (8E10.4) | | |
| 1-10 | RDEFO | Housing radial deflection at high pressure orifice, in. |
| 11-20 | RDEFI | Impeller radial deflection at high pressure orifice, in. |
| 21-30 | XDEF | Impeller axial deflection at high pressure orifice, positive toward turbine, in. |

Table 3-1 HPFTP TURBINE COOLANT ANALYSIS (FPL)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7091.7 | 6262.6 | 228.1 | 92.3 | 5.028 | 1.00 | 256.2 | 1209.3 | 5904.5 | 6.608 | 1.000 | 0.000 | 2.5359 |
| 2 | 6712.6 | 6224.0 | 228.1 | 97.2 | 4.944 | 1.00 | 186.1 | 935.5 | 5836.9 | 6.608 | 1.000 | 0.000 | 2.4326 |
| 3 | 6063.8 | 4828.4 | 228.1 | 99.1 | 4.598 | 1.00 | 1388.9 | 714.7 | 5310.4 | 6.608 | 1.000 | 0.000 | 1.9919 |
| 4 | 5051.3 | 4837.4 | 228.1 | 112.4 | 4.366 | 1.00 | 68.1 | 668.8 | 5158.3 | 6.608 | 1.000 | 0.000 | 1.8528 |
| 5 | 5004.6 | 4837.7 | 228.1 | 113.0 | 4.355 | 1.00 | 32.7 | 593.9 | 5151.3 | 6.608 | 1.000 | 0.000 | 1.8471 |
| 6 | 4844.5 | 4837.7 | 287.9 | 133.9 | 4.002 | 1.00 | 125.1 | 0.0 | 4933.2 | 6.608 | 1.000 | 0.000 | 1.6968 |
| 7 | 4810.2 | 4696.5 | 288.5 | 133.5 | 3.963 | 1.00 | 480.3 | 185.6 | 4873.9 | 6.608 | 1.000 | 0.000 | 1.6684 |
| 8 | 4710.1 | 4688.6 | 288.5 | 134.8 | 3.938 | 1.00 | 136.7 | 178.4 | 4857.3 | 6.608 | 1.000 | 0.000 | 1.6594 |
| 9 | 4774.6 | 4627.2 | 293.5 | 134.9 | 3.917 | 1.00 | 258.5 | 529.8 | 4828.3 | 3.821 | 1.000 | 0.000 | 1.6457 |
| 10 | 4771.7 | 4624.3 | 293.5 | 134.9 | 3.915 | 1.00 | 258.6 | 529.8 | 4826.8 | 3.821 | 1.000 | 0.000 | 1.6449 |
| 11 | 4655.9 | 4611.2 | 293.5 | 136.4 | 3.886 | 1.00 | 55.6 | 321.2 | 4806.2 | 3.821 | 1.000 | 0.000 | 1.6343 |
| 12 | 4654.6 | 4611.2 | 293.5 | 136.4 | 3.886 | 1.00 | 7.5 | 321.2 | 4806.0 | 3.821 | 1.000 | 0.000 | 1.6342 |
| 13 | 4708.7 | 4693.7 | 288.5 | 134.9 | 3.939 | 1.00 | 57.7 | 178.4 | 4859.0 | 2.787 | 1.000 | 0.000 | 1.6602 |
| 14 | 4732.7 | 4693.6 | 289.7 | 134.9 | 3.939 | 1.00 | 57.7 | 297.4 | 4859.0 | 2.787 | 1.000 | 0.000 | 1.6601 |
| 15 | 4739.4 | 4692.1 | 290.0 | 134.9 | 3.939 | 1.00 | 80.0 | 323.6 | 4858.3 | 2.787 | 1.000 | 0.000 | 1.6599 |
| 16 | 4741.6 | 4691.6 | 290.2 | 134.9 | 3.938 | 1.00 | 34.4 | 341.0 | 4857.8 | 2.787 | 1.000 | 0.000 | 1.6596 |
| 17 | 4726.3 | 4686.3 | 290.2 | 135.1 | 3.933 | 1.00 | 96.3 | 291.5 | 4853.7 | 2.787 | 1.000 | 0.000 | 1.6575 |
| 18 | 4717.9 | 4675.8 | 290.2 | 135.1 | 3.929 | 1.00 | 157.6 | 272.8 | 4848.6 | 2.787 | 1.000 | 0.000 | 1.6551 |
| 19 | 4717.0 | 4674.9 | 290.2 | 135.1 | 3.929 | 1.00 | 157.6 | 272.8 | 4848.1 | 2.787 | 1.000 | 0.000 | 1.6548 |
| 20 | 4706.5 | 4674.7 | 290.2 | 135.2 | 3.926 | 1.00 | 22.7 | 272.8 | 4846.6 | 2.787 | 1.000 | 0.000 | 1.6540 |
| 21 | 4761.1 | 4636.2 | 294.4 | 135.4 | 3.911 | 1.00 | 104.7 | 533.0 | 4827.3 | 1.887 | 1.000 | 0.000 | 1.6448 |
| 22 | 4624.8 | 4569.2 | 294.4 | 136.8 | 3.866 | 1.00 | 105.9 | 349.0 | 4783.3 | 1.887 | 1.000 | 0.000 | 1.6236 |
| 23 | 4524.3 | 4467.3 | 294.4 | 137.4 | 3.821 | 1.00 | 362.9 | 79.3 | 4730.0 | 1.887 | 1.000 | 0.000 | 1.5992 |
| 24 | 4522.7 | 4465.7 | 294.4 | 137.4 | 3.821 | 1.00 | 362.9 | 79.3 | 4729.2 | 1.887 | 1.000 | 0.000 | 1.5988 |
| 25 | 4502.3 | 4501.3 | 294.4 | 138.0 | 3.823 | 1.00 | 28.6 | 39.7 | 4740.4 | 1.102 | 1.000 | 0.000 | 1.6036 |
| 26 | 4500.4 | 4494.6 | 294.4 | 137.9 | 3.821 | 1.00 | 40.5 | 111.4 | 4737.5 | 1.102 | 1.000 | 0.000 | 1.6023 |
| 27 | 4498.1 | 4488.6 | 294.4 | 137.9 | 3.819 | 1.00 | 28.3 | 148.5 | 4734.9 | 1.102 | 1.000 | 0.000 | 1.6011 |
| 28 | 4505.2 | 4489.0 | 294.8 | 137.9 | 3.820 | 1.00 | 7.2 | 198.3 | 4735.0 | 1.102 | 1.000 | 0.000 | 1.6012 |
| 29 | 4489.0 | 4488.9 | 294.8 | 138.1 | 3.816 | 1.00 | 7.2 | 0.0 | 4732.8 | 1.102 | 1.000 | 0.000 | 1.6001 |
| 30 | 4439.6 | 4326.9 | 295.0 | 137.5 | 3.769 | 1.00 | 515.4 | 102.6 | 4661.2 | 0.639 | 1.000 | 0.000 | 1.5687 |
| 31 | 4331.1 | 4325.3 | 295.0 | 139.0 | 3.743 | 1.00 | 62.3 | 102.6 | 4645.9 | 0.639 | 1.000 | 0.000 | 1.5617 |
| 32 | 4287.9 | 4195.4 | 295.0 | 138.5 | 3.704 | 1.00 | 468.2 | 107.4 | 4587.1 | 0.639 | 1.000 | 0.000 | 1.5367 |

Table 3-1 HPFTP TURBINE COOLANT ANALYSIS (FPL) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H20 | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 4200.0 | 4195.3 | 295.0 | 139.8 | 3.682 | 1.00 | 19.0 | 107.4 | 4575.2 | 0.639 | 1.000 | 0.000 | 1.5315 |
| 34 | 4248.4 | 4224.4 | 3135.1 | 1524.6 | 0.851 | 1.00 | 297.0 | 415.6 | 5408.2 | 3.862 | 0.528 | 0.472 | 1.0529 |
| 35 | 5504.8 | 4709.5 | 3549.0 | 1817.0 | 0.889 | 1.00 | 1151.4 | 2547.0 | 5578.8 | 3.370 | 0.459 | 0.541 | 1.0539 |
| 36 | 4600.5 | 4232.0 | 3549.0 | 1852.3 | 0.788 | 1.00 | 1954.7 | 716.7 | 5637.1 | 3.370 | 0.459 | 0.541 | 1.0486 |
| 37 | 4248.4 | 4224.5 | 3134.7 | 1524.4 | 0.851 | 1.00 | 296.9 | 415.6 | 5407.9 | 3.862 | 0.528 | 0.472 | 1.0529 |
| 38 | 4399.1 | 4219.9 | 3169.5 | 1524.9 | 0.850 | 1.00 | 181.7 | 1385.4 | 5408.9 | 3.862 | 0.528 | 0.472 | 1.0528 |
| 39 | 4398.8 | 4219.7 | 3169.5 | 1524.9 | 0.850 | 1.00 | 181.7 | 1385.4 | 5408.9 | 3.862 | 0.528 | 0.472 | 1.0528 |
| 40 | 4235.1 | 4216.2 | 3237.9 | 1620.1 | 0.828 | 1.00 | 195.9 | 415.6 | 5485.6 | 5.632 | 0.506 | 0.494 | 1.0518 |
| 41 | 4498.1 | 4363.2 | 3381.1 | 1796.8 | 0.836 | 1.00 | 1161.9 | 358.8 | 5550.4 | 1.770 | 0.459 | 0.541 | 1.0502 |
| 42 | 4326.9 | 4219.5 | 3381.1 | 1799.8 | 0.808 | 1.00 | 1050.7 | 356.5 | 5556.5 | 1.770 | 0.459 | 0.541 | 1.0487 |
| 43 | 4235.1 | 4216.2 | 3237.9 | 1620.1 | 0.828 | 1.00 | 195.9 | 415.6 | 5485.6 | 5.632 | 0.506 | 0.494 | 1.0518 |
| 44 | 4233.2 | 4203.3 | 3237.9 | 1618.9 | 0.826 | 1.00 | 403.0 | 415.6 | 5483.8 | 5.779 | 0.506 | 0.494 | 1.0516 |
| 45 | 4215.2 | 4202.2 | 2959.2 | 1398.8 | 0.888 | 1.00 | 111.4 | 351.2 | 5260.5 | 6.391 | 0.554 | 0.446 | 1.0524 |
| 46 | 4507.9 | 4506.0 | 294.4 | 137.9 | 3.825 | 1.00 | 1.6 | 66.6 | 4743.0 | 0.786 | 1.000 | 0.000 | 1.6047 |
| 47 | 4678.3 | 4113.1 | 312.0 | 137.1 | 3.696 | 1.00 | 974.8 | 666.2 | 4558.8 | 0.786 | 1.000 | 0.000 | 1.5249 |
| 48 | 4310.6 | 4054.0 | 312.8 | 141.9 | 3.592 | 1.00 | 437.5 | 682.1 | 4484.4 | 0.786 | 1.000 | 0.000 | 1.4941 |
| 49 | 4236.2 | 4052.1 | 312.8 | 143.0 | 3.573 | 1.00 | 97.1 | 682.1 | 4474.1 | 0.786 | 1.000 | 0.000 | 1.4899 |
| 50 | 4505.3 | 4183.0 | 326.9 | 144.4 | 3.601 | 1.00 | 60.4 | 904.1 | 4527.9 | 0.786 | 1.000 | 0.000 | 1.5114 |
| 51 | 4218.4 | 4189.2 | 326.9 | 148.6 | 3.536 | 1.00 | 17.6 | 276.0 | 4495.5 | 0.786 | 1.000 | 0.000 | 1.4979 |
| 52 | 4218.3 | 4189.2 | 326.9 | 148.6 | 3.536 | 1.00 | 13.7 | 276.0 | 4495.5 | 0.612 | 1.000 | 0.000 | 1.4979 |
| 53 | 4222.3 | 4191.0 | 327.1 | 148.6 | 3.536 | 1.00 | 18.9 | 285.5 | 4496.3 | 0.612 | 1.000 | 0.000 | 1.4982 |
| 54 | 4215.2 | 4202.2 | 2959.2 | 1398.9 | 0.888 | 1.00 | 111.4 | 351.2 | 5260.6 | 6.391 | 0.554 | 0.446 | 1.0524 |
| 55 | 4202.2 | 4201.8 | 2959.2 | 1400.0 | 0.888 | 1.00 | 68.4 | 0.0 | 5263.1 | 6.391 | 0.554 | 0.446 | 1.0525 |
| 56 | 4201.6 | 4200.2 | 2959.2 | 1399.9 | 0.887 | 1.00 | 119.2 | 0.0 | 5262.9 | 6.391 | 0.554 | 0.446 | 1.0524 |
| 57 | 4200.2 | 4199.7 | 2959.2 | 1399.9 | 0.887 | 1.00 | 68.5 | 0.0 | 5263.1 | 6.391 | 0.554 | 0.446 | 1.0524 |
| 58 | 4214.4 | 4198.3 | 2892.5 | 1349.8 | 0.905 | 1.00 | 139.3 | 380.7 | 5192.7 | 6.565 | 0.565 | 0.435 | 1.0516 |
| 59 | 4218.4 | 4189.3 | 326.9 | 148.6 | 3.536 | 1.00 | 3.9 | 276.0 | 4495.6 | 0.174 | 1.000 | 0.000 | 1.4979 |
| 60 | 4208.5 | 4179.5 | 326.9 | 148.7 | 3.531 | 1.00 | 1.9 | 276.0 | 4490.3 | 0.174 | 1.000 | 0.000 | 1.4959 |
| 61 | 4214.4 | 4198.3 | 2892.5 | 1349.8 | 0.905 | 1.00 | 139.3 | 380.7 | 5192.7 | 6.565 | 0.565 | 0.435 | 1.0516 |
| 62 | 4215.8 | 4185.1 | 2893.0 | 1348.8 | 0.903 | 1.00 | 382.1 | 410.9 | 5190.5 | 6.468 | 0.565 | 0.435 | 1.0514 |
| 63 | 4099.7 | 3843.3 | 2893.2 | 1327.2 | 0.846 | 1.00 | 1620.8 | 424.5 | 5150.8 | 3.390 | 0.565 | 0.435 | 1.0468 |
| 64 | 3860.4 | 3843.2 | 2893.4 | 1348.1 | 0.832 | 1.00 | 24.4 | 437.2 | 5203.6 | 3.390 | 0.565 | 0.435 | 1.0478 |

Table 3-1 HPFTP TURBINE COOLANT ANALYSIS (FPL) (Concluded)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 65 | 4366.8 | 4182.7 | 2927.1 | 1349.8 | 0.902 | 1.00 | 126.8 | 1369.5 | 5193.2 | 3.078 | 0.565 | 0.435 | 1.0515 |
| 66 | 4366.7 | 4182.6 | 2927.1 | 1349.8 | 0.902 | 1.00 | 126.8 | 1369.5 | 5193.2 | 3.078 | 0.565 | 0.435 | 1.0515 |
| 67 | 4200.7 | 4181.3 | 2594.8 | 1213.5 | 0.982 | 1.00 | 119.7 | 410.9 | 4678.2 | 3.510 | 0.591 | 0.409 | 1.0344 |
| 68 | 4300.5 | 4288.2 | 290.2 | 137.8 | 3.750 | 1.00 | 27.5 | 172.7 | 4639.8 | 0.899 | 1.000 | 0.000 | 1.5594 |
| 69 | 4146.9 | 4133.5 | 290.2 | 138.6 | 3.679 | 1.00 | 10.2 | 183.5 | 4555.2 | 0.336 | 1.000 | 0.000 | 1.5233 |
| 70 | 4200.9 | 4181.5 | 2594.8 | 1213.5 | 0.982 | 1.00 | 119.6 | 410.9 | 4678.5 | 3.510 | 0.591 | 0.409 | 1.0344 |
| 71 | 4006.3 | 3581.2 | 2595.0 | 1164.7 | 0.888 | 1.00 | 2063.2 | 424.3 | 4287.0 | 3.510 | 0.591 | 0.409 | 1.0213 |
| 72 | 3598.6 | 3581.0 | 2595.3 | 1198.6 | 0.854 | 1.00 | 21.4 | 437.2 | 4731.8 | 3.510 | 0.591 | 0.409 | 1.0317 |
| 73 | 3986.0 | 3670.4 | 290.2 | 136.4 | 3.529 | 1.00 | 905.5 | 0.0 | 4331.7 | 0.564 | 1.000 | 0.000 | 1.4327 |
| 74 | 3956.2 | 3639.1 | 290.2 | 136.5 | 3.514 | 1.00 | 909.4 | 0.0 | 4313.4 | 0.564 | 1.000 | 0.000 | 1.4257 |
| 75 | 3638.8 | 3638.8 | 290.2 | 141.2 | 3.431 | 1.00 | 0.8 | 0.0 | 4270.6 | 0.564 | 1.000 | 0.000 | 1.4112 |
| 76 | 3638.8 | 3638.8 | 808.2 | 272.6 | 2.012 | 1.00 | 5.7 | 0.0 | 4044.7 | 0.564 | 1.000 | 0.000 | 1.2467 |
| 77 | 3637.6 | 3635.4 | 808.2 | 272.5 | 2.011 | 1.00 | 99.1 | 0.0 | 4043.4 | 0.564 | 1.000 | 0.000 | 1.2464 |
| 78 | 3635.0 | 3631.4 | 985.6 | 315.2 | 1.771 | 1.00 | 137.6 | 0.0 | 4178.2 | 0.564 | 1.000 | 0.000 | 1.2220 |
| 79 | 3631.0 | 3629.9 | 985.6 | 315.3 | 1.771 | 1.00 | 78.0 | 0.0 | 4177.9 | 0.564 | 1.000 | 0.000 | 1.2218 |
| 80 | 3630.4 | 3630.2 | 985.6 | 315.3 | 1.771 | 1.00 | 31.0 | 0.0 | 4178.1 | 0.564 | 1.000 | 0.000 | 1.2218 |
| 81 | 3630.3 | 3630.1 | 985.6 | 315.3 | 1.771 | 1.00 | 30.6 | 0.0 | 4178.1 | 0.564 | 1.000 | 0.000 | 1.2218 |
| 82 | 3630.1 | 3630.1 | 985.6 | 315.3 | 1.771 | 1.00 | 3.8 | 0.0 | 4178.1 | 0.564 | 1.000 | 0.000 | 1.2218 |
| 83 | 3624.4 | 3612.9 | 985.6 | 315.1 | 1.765 | 1.00 | 245.4 | 0.0 | 4171.7 | 0.564 | 1.000 | 0.000 | 1.2206 |
| 84 | 3612.9 | 3612.9 | 985.6 | 315.4 | 1.764 | 1.00 | 1.7 | 0.0 | 4172.7 | 0.564 | 1.000 | 0.000 | 1.2204 |
| 85 | 4470.4 | 4433.1 | 294.8 | 137.9 | 3.800 | 1.00 | 301.5 | 0.0 | 4708.3 | 0.462 | 1.000 | 0.000 | 1.5893 |
| 86 | 4433.1 | 4433.1 | 294.8 | 138.5 | 3.791 | 1.00 | 0.7 | 0.0 | 4703.3 | 0.462 | 1.000 | 0.000 | 1.5868 |
| 87 | 4431.9 | 4429.5 | 294.8 | 138.5 | 3.790 | 1.00 | 75.8 | 0.0 | 4701.7 | 0.462 | 1.000 | 0.000 | 1.5862 |
| 88 | 4429.3 | 4428.7 | 294.8 | 138.5 | 3.789 | 1.00 | 36.7 | 0.0 | 4701.0 | 0.462 | 1.000 | 0.000 | 1.5858 |
| 89 | 4429.1 | 4428.4 | 511.1 | 197.5 | 2.971 | 1.00 | 46.8 | 0.0 | 4339.9 | 0.462 | 1.000 | 0.000 | 1.4185 |
| 90 | 4428.4 | 4425.3 | 511.1 | 197.4 | 2.970 | 1.00 | 98.2 | 0.0 | 4338.7 | 0.462 | 1.000 | 0.000 | 1.4181 |
| 91 | 4168.4 | 3607.0 | 511.1 | 190.9 | 2.703 | 1.00 | 1367.8 | 0.0 | 3988.6 | 0.462 | 1.000 | 0.000 | 1.3136 |
| 92 | 3611.8 | 3611.8 | 511.1 | 200.4 | 2.599 | 1.00 | 0.9 | 0.0 | 3971.6 | 0.462 | 1.000 | 0.000 | 1.3033 |
| 93 | 3608.0 | 3599.5 | 771.9 | 263.7 | 2.054 | 1.00 | 196.3 | 0.0 | 4006.2 | 1.026 | 1.000 | 0.000 | 1.2487 |
| 94 | 3599.5 | 3599.5 | 771.9 | 263.9 | 2.053 | 1.00 | 1.8 | 0.0 | 4006.7 | 1.026 | 1.000 | 0.000 | 1.2486 |
| 95 | 4282.0 | 4224.5 | 301.4 | 140.7 | 3.678 | 1.00 | 11.4 | 380.7 | 4581.1 | 0.639 | 1.000 | 0.000 | 1.5338 |
| 96 | 4862.4 | 4221.4 | 330.7 | 140.7 | 3.677 | 1.00 | 71.6 | 1269.0 | 4579.7 | 0.147 | 1.000 | 0.000 | 1.5332 |
| 97 | 4856.7 | 4216.2 | 330.7 | 140.7 | 3.674 | 1.00 | 71.6 | 1269.0 | 4576.8 | 0.147 | 1.000 | 0.000 | 1.5320 |
| 98 | 4271.5 | 4216.2 | 330.7 | 149.2 | 3.538 | 1.00 | 2.4 | 380.7 | 4504.3 | 0.147 | 1.000 | 0.000 | 1.5012 |
| 99 | 4353.6 | 4193.0 | 2921.8 | 1349.7 | 0.904 | 1.00 | 190.6 | 1269.0 | 5192.5 | 0.096 | 0.565 | 0.435 | 1.0516 |
| 100 | 4341.5 | 4181.3 | 2921.8 | 1349.6 | 0.901 | 1.00 | 191.1 | 1269.0 | 5192.9 | 0.096 | 0.565 | 0.435 | 1.0514 |
| 101 | 4195.2 | 4181.3 | 2921.8 | 1361.7 | 0.893 | 1.00 | 3.6 | 380.7 | 5223.1 | 0.096 | 0.565 | 0.435 | 1.0520 |

F1,F2,F3,F4,F5=-0.16430E+05-0.26986E+06 0.17750E+06-0.17033E+06 0.23082E+06

FROT1,FROT2,FNET=-0.95813E+04-0.84818E+04-0.66364E+05

Table 3-2 HPFTP TURBINE COOLANT ANALYSIS (104%)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6604.1 | 5834.6 | 208.4 | 89.8 | 4.982 | 1.00 | 246.8 | 1170.6 | 5794.5 | 6.336 | 1.000 | 0.000 | 2.4495 |
| 2 | 6249.9 | 5796.1 | 208.4 | 94.5 | 4.899 | 1.00 | 178.6 | 904.0 | 5725.4 | 6.336 | 1.000 | 0.000 | 2.3519 |
| 3 | 5649.8 | 4518.2 | 208.4 | 96.3 | 4.566 | 1.00 | 1328.2 | 690.7 | 5216.4 | 6.336 | 1.000 | 0.000 | 1.9315 |
| 4 | 4715.8 | 4516.5 | 208.4 | 108.5 | 4.342 | 1.00 | 65.2 | 646.4 | 5062.4 | 6.336 | 1.000 | 0.000 | 1.8011 |
| 5 | 4672.4 | 4517.2 | 208.4 | 109.1 | 4.331 | 1.00 | 31.4 | 574.0 | 5055.7 | 6.336 | 1.000 | 0.000 | 1.7960 |
| 6 | 4523.4 | 4517.2 | 264.4 | 128.8 | 3.983 | 1.00 | 119.9 | 0.0 | 4838.1 | 6.336 | 1.000 | 0.000 | 1.6547 |
| 7 | 4492.1 | 4388.3 | 265.0 | 128.4 | 3.946 | 1.00 | 458.3 | 179.3 | 4781.1 | 6.336 | 1.000 | 0.000 | 1.6273 |
| 8 | 4400.0 | 4380.1 | 265.0 | 129.6 | 3.922 | 1.00 | 130.9 | 172.4 | 4764.5 | 6.336 | 1.000 | 0.000 | 1.6188 |
| 9 | 4459.6 | 4321.2 | 269.7 | 129.7 | 3.900 | 1.00 | 254.0 | 512.0 | 4735.3 | 3.760 | 1.000 | 0.000 | 1.6050 |
| 10 | 4456.7 | 4318.5 | 269.7 | 129.7 | 3.899 | 1.00 | 255.5 | 512.0 | 4733.8 | 3.760 | 1.000 | 0.000 | 1.6043 |
| 11 | 4347.1 | 4305.5 | 269.7 | 131.2 | 3.869 | 1.00 | 54.6 | 310.4 | 4712.8 | 3.760 | 1.000 | 0.000 | 1.5940 |
| 12 | 4345.9 | 4305.6 | 269.7 | 131.2 | 3.869 | 1.00 | 7.4 | 310.4 | 4712.7 | 3.760 | 1.000 | 0.000 | 1.5939 |
| 13 | 4398.8 | 4385.0 | 265.0 | 129.7 | 3.922 | 1.00 | 53.5 | 172.4 | 4766.2 | 2.576 | 1.000 | 0.000 | 1.6196 |
| 14 | 4421.1 | 4384.9 | 266.1 | 129.7 | 3.922 | 1.00 | 53.5 | 287.4 | 4766.2 | 2.576 | 1.000 | 0.000 | 1.6195 |
| 15 | 4427.3 | 4383.6 | 266.4 | 129.7 | 3.922 | 1.00 | 74.2 | 312.7 | 4765.6 | 2.576 | 1.000 | 0.000 | 1.6193 |
| 16 | 4429.6 | 4383.1 | 266.6 | 129.7 | 3.921 | 1.00 | 31.9 | 329.6 | 4765.1 | 2.576 | 1.000 | 0.000 | 1.6190 |
| 17 | 4415.5 | 4378.5 | 266.6 | 129.9 | 3.917 | 1.00 | 89.3 | 281.7 | 4761.3 | 2.576 | 1.000 | 0.000 | 1.6171 |
| 18 | 4408.0 | 4369.5 | 266.6 | 129.9 | 3.913 | 1.00 | 146.2 | 263.7 | 4756.6 | 2.576 | 1.000 | 0.000 | 1.6149 |
| 19 | 4407.2 | 4368.8 | 266.6 | 129.9 | 3.913 | 1.00 | 146.3 | 263.7 | 4756.2 | 2.576 | 1.000 | 0.000 | 1.6147 |
| 20 | 4398.2 | 4368.6 | 266.6 | 130.0 | 3.911 | 1.00 | 21.1 | 263.7 | 4754.8 | 2.576 | 1.000 | 0.000 | 1.6140 |
| 21 | 4449.3 | 4333.3 | 270.5 | 130.2 | 3.896 | 1.00 | 96.3 | 515.1 | 4736.1 | 1.736 | 1.000 | 0.000 | 1.6052 |
| 22 | 4322.1 | 4270.7 | 270.5 | 131.5 | 3.851 | 1.00 | 97.2 | 337.2 | 4692.6 | 1.736 | 1.000 | 0.000 | 1.5846 |
| 23 | 4228.8 | 4180.6 | 270.5 | 132.0 | 3.809 | 1.00 | 333.0 | 76.6 | 4642.2 | 1.736 | 1.000 | 0.000 | 1.5618 |
| 24 | 4227.4 | 4178.9 | 270.5 | 132.0 | 3.808 | 1.00 | 334.9 | 76.6 | 4641.4 | 1.736 | 1.000 | 0.000 | 1.5614 |
| 25 | 4210.3 | 4209.4 | 270.5 | 132.6 | 3.810 | 1.00 | 26.1 | 38.3 | 4651.5 | 1.002 | 1.000 | 0.000 | 1.5658 |
| 26 | 4208.9 | 4203.6 | 270.5 | 132.5 | 3.809 | 1.00 | 36.9 | 107.6 | 4648.9 | 1.002 | 1.000 | 0.000 | 1.5646 |
| 27 | 4207.2 | 4198.4 | 270.5 | 132.5 | 3.807 | 1.00 | 25.8 | 143.5 | 4646.5 | 1.002 | 1.000 | 0.000 | 1.5636 |
| 28 | 4213.8 | 4198.7 | 270.9 | 132.5 | 3.807 | 1.00 | 6.5 | 191.6 | 4646.6 | 1.002 | 1.000 | 0.000 | 1.5636 |
| 29 | 4198.7 | 4198.7 | 270.9 | 132.7 | 3.804 | 1.00 | 6.5 | 0.0 | 4644.4 | 1.002 | 1.000 | 0.000 | 1.5626 |
| 30 | 4159.3 | 4068.3 | 271.0 | 132.2 | 3.764 | 1.00 | 461.5 | 99.1 | 4583.9 | 0.575 | 1.000 | 0.000 | 1.5360 |
| 31 | 4071.4 | 4066.2 | 271.0 | 133.5 | 3.741 | 1.00 | 55.7 | 99.1 | 4570.3 | 0.575 | 1.000 | 0.000 | 1.5301 |
| 32 | 4036.7 | 3962.5 | 271.1 | 133.0 | 3.709 | 1.00 | 416.6 | 103.7 | 4521.1 | 0.575 | 1.000 | 0.000 | 1.5090 |

Table 3-2 HPFTP TURBINE COOLANT ANALYSIS (104%) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 3965.6 | 3961.2 | 271.1 | 134.0 | 3.691 | 1.00 | 16.9 | 103.7 | 4510.3 | 0.575 | 1.000 | 0.000 | 1.5045 |
| 34 | 4010.6 | 3989.1 | 3096.1 | 1495.3 | 0.814 | 1.00 | 285.9 | 401.6 | 5383.4 | 3.582 | 0.534 | 0.466 | 1.0503 |
| 35 | 5168.3 | 4431.1 | 3486.0 | 1759.3 | 0.850 | 1.00 | 1134.5 | 2508.6 | 5543.5 | 3.147 | 0.470 | 0.530 | 1.0517 |
| 36 | 4332.2 | 4000.2 | 3486.0 | 1794.9 | 0.756 | 1.00 | 1885.2 | 692.6 | 5604.1 | 3.147 | 0.470 | 0.530 | 1.0469 |
| 37 | 4009.3 | 3987.9 | 3095.7 | 1495.2 | 0.814 | 1.00 | 290.7 | 401.6 | 5383.0 | 3.582 | 0.534 | 0.466 | 1.0503 |
| 38 | 4144.8 | 3983.8 | 3128.3 | 1495.6 | 0.813 | 1.00 | 175.1 | 1338.8 | 5384.0 | 3.582 | 0.534 | 0.466 | 1.0502 |
| 39 | 4143.5 | 3983.6 | 3128.3 | 1495.6 | 0.813 | 1.00 | 176.3 | 1338.8 | 5384.0 | 3.582 | 0.534 | 0.466 | 1.0502 |
| 40 | 3997.4 | 3980.4 | 3192.6 | 1583.4 | 0.792 | 1.00 | 189.7 | 401.6 | 5457.3 | 5.252 | 0.514 | 0.486 | 1.0494 |
| 41 | 4245.1 | 4118.4 | 3325.3 | 1740.8 | 0.801 | 1.00 | 1142.4 | 379.7 | 5517.0 | 1.669 | 0.470 | 0.530 | 1.0483 |
| 42 | 4084.6 | 3986.0 | 3325.3 | 1743.8 | 0.775 | 1.00 | 1024.7 | 344.5 | 5523.1 | 1.669 | 0.470 | 0.530 | 1.0469 |
| 43 | 3998.2 | 3981.4 | 3192.7 | 1583.4 | 0.792 | 1.00 | 191.9 | 401.6 | 5457.3 | 5.252 | 0.514 | 0.486 | 1.0494 |
| 44 | 3996.7 | 3969.7 | 3192.7 | 1582.4 | 0.791 | 1.00 | 391.9 | 401.6 | 5455.5 | 5.391 | 0.514 | 0.486 | 1.0493 |
| 45 | 3980.2 | 3968.7 | 2917.0 | 1369.3 | 0.851 | 1.00 | 109.3 | 339.4 | 5227.5 | 5.959 | 0.560 | 0.440 | 1.0495 |
| 46 | 4214.4 | 4212.7 | 270.5 | 132.5 | 3.812 | 1.00 | 1.5 | 64.4 | 4653.4 | 0.734 | 1.000 | 0.000 | 1.5667 |
| 47 | 4386.0 | 3885.8 | 286.9 | 131.9 | 3.698 | 1.00 | 903.1 | 643.8 | 4491.5 | 0.734 | 1.000 | 0.000 | 1.4963 |
| 48 | 4067.8 | 3832.6 | 287.7 | 136.1 | 3.602 | 1.00 | 404.9 | 659.1 | 4422.1 | 0.734 | 1.000 | 0.000 | 1.4685 |
| 49 | 4003.2 | 3830.6 | 287.7 | 137.1 | 3.585 | 1.00 | 90.0 | 659.1 | 4412.4 | 0.734 | 1.000 | 0.000 | 1.4648 |
| 50 | 4254.6 | 3954.0 | 300.9 | 138.4 | 3.613 | 1.00 | 56.7 | 873.7 | 4465.3 | 0.734 | 1.000 | 0.000 | 1.4863 |
| 51 | 3984.7 | 3957.2 | 300.9 | 142.4 | 3.546 | 1.00 | 16.2 | 266.7 | 4431.0 | 0.734 | 1.000 | 0.000 | 1.4729 |
| 52 | 3984.5 | 3957.2 | 300.9 | 142.4 | 3.546 | 1.00 | 12.7 | 266.7 | 4431.0 | 0.568 | 1.000 | 0.000 | 1.4729 |
| 53 | 3988.2 | 3958.9 | 301.1 | 142.4 | 3.547 | 1.00 | 17.5 | 275.9 | 4431.7 | 0.568 | 1.000 | 0.000 | 1.4732 |
| 54 | 3981.2 | 3969.5 | 2917.1 | 1369.4 | 0.852 | 1.00 | 107.7 | 339.4 | 5227.6 | 5.959 | 0.560 | 0.440 | 1.0495 |
| 55 | 3968.7 | 3968.3 | 2917.1 | 1370.4 | 0.851 | 1.00 | 66.5 | 0.0 | 5230.0 | 5.959 | 0.560 | 0.440 | 1.0495 |
| 56 | 3968.1 | 3966.8 | 2917.1 | 1370.3 | 0.850 | 1.00 | 115.9 | 0.0 | 5229.8 | 5.959 | 0.560 | 0.440 | 1.0495 |
| 57 | 3966.8 | 3966.4 | 2917.1 | 1370.4 | 0.850 | 1.00 | 66.6 | 0.0 | 5230.0 | 5.959 | 0.560 | 0.440 | 1.0495 |
| 58 | 3979.5 | 3965.1 | 2848.9 | 1320.9 | 0.868 | 1.00 | 136.2 | 367.9 | 5154.8 | 6.125 | 0.572 | 0.428 | 1.0484 |
| 59 | 3984.5 | 3957.3 | 300.9 | 142.4 | 3.546 | 1.00 | 3.7 | 266.7 | 4431.0 | 0.166 | 1.000 | 0.000 | 1.4729 |
| 60 | 3975.5 | 3948.3 | 300.9 | 142.4 | 3.542 | 1.00 | 1.8 | 266.7 | 4425.9 | 0.166 | 1.000 | 0.000 | 1.4709 |
| 61 | 3980.4 | 3966.0 | 2848.9 | 1320.9 | 0.868 | 1.00 | 134.7 | 367.9 | 5154.8 | 6.125 | 0.572 | 0.428 | 1.0484 |
| 62 | 3980.8 | 3953.1 | 2849.4 | 1319.9 | 0.866 | 1.00 | 371.0 | 397.0 | 5152.6 | 6.036 | 0.572 | 0.428 | 1.0482 |
| 63 | 3875.8 | 3645.0 | 2849.6 | 1299.9 | 0.814 | 1.00 | 1560.7 | 410.2 | 5115.2 | 3.168 | 0.572 | 0.428 | 1.0439 |
| 64 | 3656.8 | 3641.2 | 2849.8 | 1319.1 | 0.801 | 1.00 | 23.5 | 422.5 | 5166.8 | 3.168 | 0.572 | 0.428 | 1.0450 |

Table 3-2 HPFTP TURBINE COOLANT ANALYSIS (104%) (Concluded)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 65 | 4116.1 | 3951.0 | 2881.2 | 1320.8 | 0.865 | 1.00 | 123.0 | 1323.5 | 5155.4 | 2.868 | 0.572 | 0.428 | 1.0482 |
| 66 | 4115.8 | 3950.9 | 2881.2 | 1320.8 | 0.865 | 1.00 | 123.2 | 1323.5 | 5155.4 | 2.868 | 0.572 | 0.428 | 1.0482 |
| 67 | 3967.0 | 3949.7 | 2553.6 | 1196.1 | 0.940 | 1.00 | 117.0 | 397.0 | 4618.3 | 3.268 | 0.597 | 0.403 | 1.0273 |
| 68 | 4040.5 | 4029.0 | 266.6 | 132.3 | 3.748 | 1.00 | 25.7 | 166.9 | 4563.2 | 0.840 | 1.000 | 0.000 | 1.5270 |
| 69 | 3917.7 | 3905.2 | 266.6 | 132.9 | 3.688 | 1.00 | 9.4 | 177.3 | 4492.1 | 0.311 | 1.000 | 0.000 | 1.4967 |
| 70 | 3967.6 | 3950.1 | 2553.7 | 1196.2 | 0.940 | 1.00 | 115.7 | 397.0 | 4618.3 | 3.268 | 0.597 | 0.403 | 1.0273 |
| 71 | 3791.5 | 3408.1 | 2553.9 | 1140.0 | 0.847 | 1.00 | 1998.4 | 410.0 | 4564.2 | 3.268 | 0.597 | 0.403 | 1.0329 |
| 72 | 3418.1 | 3402.1 | 2554.1 | 1180.5 | 0.822 | 1.00 | 20.6 | 422.5 | 4588.3 | 3.268 | 0.597 | 0.403 | 1.0259 |
| 73 | 3764.4 | 3491.3 | 266.6 | 131.1 | 3.548 | 1.00 | 839.0 | 0.0 | 4282.4 | 0.529 | 1.000 | 0.000 | 1.4108 |
| 74 | 3737.9 | 3462.2 | 266.6 | 131.1 | 3.533 | 1.00 | 845.4 | 0.0 | 4264.9 | 0.529 | 1.000 | 0.000 | 1.4040 |
| 75 | 3460.9 | 3460.9 | 266.6 | 135.3 | 3.456 | 1.00 | 0.8 | 0.0 | 4224.1 | 0.529 | 1.000 | 0.000 | 1.3910 |
| 76 | 3460.9 | 3460.9 | 798.2 | 270.7 | 1.951 | 1.00 | 5.5 | 0.0 | 3975.0 | 0.529 | 1.000 | 0.000 | 1.2314 |
| 77 | 3459.8 | 3457.9 | 798.2 | 270.7 | 1.950 | 1.00 | 95.9 | 0.0 | 3973.8 | 0.529 | 1.000 | 0.000 | 1.2311 |
| 78 | 3457.5 | 3454.2 | 980.3 | 314.5 | 1.708 | 1.00 | 132.8 | 0.0 | 4118.3 | 0.529 | 1.000 | 0.000 | 1.2084 |
| 79 | 3453.8 | 3452.8 | 980.3 | 314.5 | 1.707 | 1.00 | 75.9 | 0.0 | 4118.0 | 0.529 | 1.000 | 0.000 | 1.2083 |
| 80 | 3453.3 | 3453.1 | 980.3 | 314.6 | 1.707 | 1.00 | 30.2 | 0.0 | 4118.2 | 0.529 | 1.000 | 0.000 | 1.2083 |
| 81 | 3453.2 | 3453.0 | 980.3 | 314.6 | 1.707 | 1.00 | 29.8 | 0.0 | 4118.2 | 0.529 | 1.000 | 0.000 | 1.2083 |
| 82 | 3453.0 | 3453.0 | 980.3 | 314.6 | 1.707 | 1.00 | 3.7 | 0.0 | 4118.2 | 0.529 | 1.000 | 0.000 | 1.2083 |
| 83 | 3447.8 | 3437.4 | 980.3 | 314.3 | 1.702 | 1.00 | 238.1 | 0.0 | 4112.3 | 0.529 | 1.000 | 0.000 | 1.2072 |
| 84 | 3437.3 | 3437.3 | 980.3 | 314.6 | 1.701 | 1.00 | 1.6 | 0.0 | 4113.3 | 0.529 | 1.000 | 0.000 | 1.2070 |
| 85 | 4182.8 | 4151.0 | 270.9 | 132.5 | 3.789 | 1.00 | 278.4 | 0.0 | 4622.4 | 0.427 | 1.000 | 0.000 | 1.5529 |
| 86 | 4150.8 | 4150.8 | 270.9 | 133.0 | 3.781 | 1.00 | 0.7 | 0.0 | 4617.8 | 0.427 | 1.000 | 0.000 | 1.5508 |
| 87 | 4149.8 | 4147.8 | 270.9 | 133.0 | 3.780 | 1.00 | 70.3 | 0.0 | 4616.4 | 0.427 | 1.000 | 0.000 | 1.5502 |
| 88 | 4147.6 | 4147.1 | 270.9 | 133.0 | 3.780 | 1.00 | 34.0 | 0.0 | 4615.8 | 0.427 | 1.000 | 0.000 | 1.5499 |
| 89 | 4147.5 | 4146.8 | 496.3 | 194.8 | 2.891 | 1.00 | 44.0 | 0.0 | 4225.1 | 0.427 | 1.000 | 0.000 | 1.3839 |
| 90 | 4146.8 | 4144.1 | 496.3 | 194.7 | 2.890 | 1.00 | 93.3 | 0.0 | 4224.0 | 0.427 | 1.000 | 0.000 | 1.3835 |
| 91 | 3920.0 | 3436.6 | 496.3 | 188.7 | 2.648 | 1.00 | 1281.5 | 0.0 | 3912.5 | 0.427 | 1.000 | 0.000 | 1.2921 |
| 92 | 3437.4 | 3437.4 | 496.3 | 197.1 | 2.553 | 1.00 | 0.9 | 0.0 | 3896.6 | 0.427 | 1.000 | 0.000 | 1.2835 |
| 93 | 3434.1 | 3426.5 | 764.0 | 262.3 | 1.990 | 1.00 | 187.2 | 0.0 | 3938.9 | 0.956 | 1.000 | 0.000 | 1.2330 |
| 94 | 3426.4 | 3426.4 | 764.0 | 262.5 | 1.989 | 1.00 | 1.7 | 0.0 | 3939.3 | 0.956 | 1.000 | 0.000 | 1.2329 |
| 95 | 4017.1 | 3987.9 | 277.1 | 134.9 | 3.685 | 1.00 | 18.9 | 367.9 | 4515.5 | 0.575 | 1.000 | 0.000 | 1.5068 |
| 96 | 4585.1 | 3985.2 | 304.4 | 134.9 | 3.685 | 1.00 | 67.7 | 1226.3 | 4514.2 | 0.140 | 1.000 | 0.000 | 1.5062 |
| 97 | 4580.3 | 3980.4 | 304.4 | 134.9 | 3.682 | 1.00 | 67.8 | 1226.3 | 4511.5 | 0.140 | 1.000 | 0.000 | 1.5051 |
| 98 | 4032.7 | 3980.4 | 304.4 | 142.9 | 3.547 | 1.00 | 2.2 | 367.9 | 4438.3 | 0.140 | 1.000 | 0.000 | 1.4758 |
| 99 | 4104.4 | 3960.3 | 2876.3 | 1320.7 | 0.867 | 1.00 | 184.6 | 1226.3 | 5154.6 | 0.090 | 0.572 | 0.428 | 1.0483 |
| 100 | 4093.5 | 3949.6 | 2876.3 | 1320.6 | 0.865 | 1.00 | 184.8 | 1226.3 | 5155.0 | 0.090 | 0.572 | 0.428 | 1.0482 |
| 101 | 3962.3 | 3949.6 | 2876.3 | 1331.7 | 0.857 | 1.00 | 3.5 | 367.9 | 5184.6 | 0.090 | 0.572 | 0.428 | 1.0488 |

F1,F2,F3,F4,F5=-0.15384E+05-0.25485E+06 0.16758E+06-0.16089E+06 0.21805E+06

FROT1,FROT2,FNET=-0.86645E+04-0.76779E+04-0.61823E+05

Table 3-3 HPFTP TURBINE COOLANT ANALYSIS (MPL)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4042.5 | 3552.2 | 94.6 | 73.3 | 4.750 | 1.00 | 162.6 | 964.4 | 5168.7 | 4.760 | 1.000 | 0.000 | 1.9182 |
| 2 | 3784.3 | 3530.1 | 94.6 | 77.0 | 4.668 | 1.00 | 140.8 | 693.0 | 5079.0 | 4.760 | 1.000 | 0.000 | 1.8464 |
| 3 | 3435.4 | 2780.1 | 94.6 | 77.7 | 4.412 | 1.00 | 1034.7 | 529.4 | 4660.2 | 4.760 | 1.000 | 0.000 | 1.5234 |
| 4 | 2892.2 | 2778.3 | 94.6 | 85.3 | 4.231 | 1.00 | 50.3 | 495.4 | 4497.1 | 4.760 | 1.000 | 0.000 | 1.4469 |
| 5 | 2867.4 | 2778.6 | 94.6 | 85.6 | 4.223 | 1.00 | 24.2 | 440.0 | 4490.2 | 4.760 | 1.000 | 0.000 | 1.4439 |
| 6 | 2782.1 | 2778.6 | 127.6 | 97.4 | 3.939 | 1.00 | 90.8 | 0.0 | 4274.2 | 4.760 | 1.000 | 0.000 | 1.3609 |
| 7 | 2764.4 | 2705.0 | 128.0 | 97.1 | 3.911 | 1.00 | 348.1 | 137.5 | 4228.5 | 4.760 | 1.000 | 0.000 | 1.3380 |
| 8 | 2711.9 | 2700.4 | 128.0 | 97.8 | 3.892 | 1.00 | 99.2 | 132.2 | 4213.1 | 4.760 | 1.000 | 0.000 | 1.3327 |
| 9 | 2749.2 | 2672.0 | 130.7 | 97.9 | 3.877 | 1.00 | 172.0 | 392.4 | 4192.7 | 2.526 | 1.000 | 0.000 | 1.3231 |
| 10 | 2747.8 | 2670.7 | 130.7 | 97.9 | 3.876 | 1.00 | 172.6 | 392.4 | 4191.7 | 2.526 | 1.000 | 0.000 | 1.3227 |
| 11 | 2689.0 | 2664.8 | 130.7 | 98.7 | 3.854 | 1.00 | 36.9 | 237.9 | 4174.0 | 2.526 | 1.000 | 0.000 | 1.3167 |
| 12 | 2688.4 | 2664.8 | 130.7 | 98.7 | 3.853 | 1.00 | 5.0 | 237.9 | 4173.9 | 2.526 | 1.000 | 0.000 | 1.3167 |
| 13 | 2711.0 | 2702.8 | 128.0 | 97.9 | 3.892 | 1.00 | 46.8 | 132.2 | 4214.2 | 2.234 | 1.000 | 0.000 | 1.3333 |
| 14 | 2724.0 | 2702.7 | 128.6 | 97.9 | 3.892 | 1.00 | 46.8 | 220.3 | 4214.2 | 2.234 | 1.000 | 0.000 | 1.3333 |
| 15 | 2727.6 | 2701.7 | 128.8 | 97.9 | 3.891 | 1.00 | 64.9 | 239.7 | 4213.6 | 2.234 | 1.000 | 0.000 | 1.3330 |
| 16 | 2728.5 | 2701.4 | 128.9 | 97.9 | 3.891 | 1.00 | 27.9 | 252.6 | 4213.0 | 2.234 | 1.000 | 0.000 | 1.3327 |
| 17 | 2720.0 | 2697.9 | 128.9 | 98.0 | 3.887 | 1.00 | 78.1 | 215.9 | 4209.0 | 2.234 | 1.000 | 0.000 | 1.3311 |
| 18 | 2715.0 | 2691.1 | 128.9 | 98.0 | 3.883 | 1.00 | 127.7 | 202.1 | 4204.0 | 2.234 | 1.000 | 0.000 | 1.3288 |
| 19 | 2714.5 | 2690.5 | 128.9 | 98.0 | 3.883 | 1.00 | 127.8 | 202.1 | 4203.6 | 2.234 | 1.000 | 0.000 | 1.3286 |
| 20 | 2707.6 | 2690.4 | 128.9 | 98.1 | 3.880 | 1.00 | 18.4 | 202.1 | 4201.8 | 2.234 | 1.000 | 0.000 | 1.3280 |
| 21 | 2737.0 | 2668.6 | 131.2 | 98.2 | 3.868 | 1.00 | 85.9 | 394.8 | 4185.3 | 1.537 | 1.000 | 0.000 | 1.3205 |
| 22 | 2662.6 | 2631.7 | 131.2 | 98.9 | 3.832 | 1.00 | 86.2 | 258.5 | 4146.8 | 1.537 | 1.000 | 0.000 | 1.3048 |
| 23 | 2607.0 | 2569.8 | 131.2 | 99.1 | 3.794 | 1.00 | 294.7 | 58.7 | 4098.4 | 1.537 | 1.000 | 0.000 | 1.2837 |
| 24 | 2606.0 | 2568.3 | 131.2 | 99.1 | 3.794 | 1.00 | 297.5 | 58.7 | 4097.3 | 1.537 | 1.000 | 0.000 | 1.2832 |
| 25 | 2592.6 | 2592.0 | 131.2 | 99.6 | 3.795 | 1.00 | 23.5 | 29.4 | 4107.4 | 0.897 | 1.000 | 0.000 | 1.2890 |
| 26 | 2591.1 | 2587.8 | 131.2 | 99.5 | 3.794 | 1.00 | 33.2 | 82.5 | 4104.7 | 0.897 | 1.000 | 0.000 | 1.2877 |
| 27 | 2589.3 | 2584.2 | 131.2 | 99.5 | 3.792 | 1.00 | 23.2 | 110.0 | 4102.2 | 0.897 | 1.000 | 0.000 | 1.2865 |
| 28 | 2593.2 | 2584.4 | 131.4 | 99.5 | 3.792 | 1.00 | 5.9 | 146.9 | 4102.3 | 0.897 | 1.000 | 0.000 | 1.2866 |
| 29 | 2584.4 | 2584.3 | 131.4 | 99.7 | 3.789 | 1.00 | 5.9 | 0.0 | 4100.1 | 0.897 | 1.000 | 0.000 | 1.2860 |
| 30 | 2542.7 | 2452.1 | 131.5 | 99.0 | 3.735 | 1.00 | 466.2 | 76.0 | 4013.1 | 0.577 | 1.000 | 0.000 | 1.2459 |
| 31 | 2453.2 | 2449.6 | 131.5 | 100.3 | 3.701 | 1.00 | 56.4 | 76.0 | 3989.4 | 0.577 | 1.000 | 0.000 | 1.2401 |
| 32 | 2417.5 | 2343.1 | 131.5 | 99.7 | 3.655 | 1.00 | 425.7 | 79.5 | 3916.6 | 0.577 | 1.000 | 0.000 | 1.2080 |

Table 3-3 HPFTP TURBINE COOLANT ANALYSIS (MPL) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H20 | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 2344.7 | 2342.1 | 131.5 | 100.8 | 3.627 | 1.00 | 17.3 | 79.5 | 3897.8 | 0.577 | 1.000 | 0.000 | 1.2042 |
| 34 | 2367.4 | 2358.1 | 2486.6 | 1065.4 | 0.595 | 1.00 | 220.5 | 307.9 | 4801.8 | 2.027 | 0.636 | 0.364 | 1.0326 |
| 35 | 2893.9 | 2527.1 | 3234.1 | 1531.7 | 0.523 | 1.00 | 1026.9 | 2262.8 | 5413.7 | 1.539 | 0.520 | 0.480 | 1.0326 |
| 36 | 2488.7 | 2363.4 | 3234.1 | 1567.3 | 0.479 | 1.00 | 1458.2 | 530.9 | 5479.3 | 1.539 | 0.520 | 0.480 | 1.0307 |
| 37 | 2368.6 | 2359.3 | 2486.8 | 1065.2 | 0.596 | 1.00 | 224.1 | 307.9 | 4801.7 | 2.027 | 0.636 | 0.364 | 1.0326 |
| 38 | 2426.7 | 2357.5 | 2505.9 | 1065.5 | 0.595 | 1.00 | 135.5 | 1026.2 | 4801.9 | 2.027 | 0.636 | 0.364 | 1.0325 |
| 39 | 2426.2 | 2357.4 | 2505.9 | 1065.5 | 0.595 | 1.00 | 136.3 | 1026.2 | 4801.9 | 2.027 | 0.636 | 0.364 | 1.0325 |
| 40 | 2363.1 | 2356.1 | 2676.0 | 1191.1 | 0.558 | 1.00 | 143.5 | 307.9 | 5022.5 | 2.802 | 0.604 | 0.396 | 1.0286 |
| 41 | 2474.2 | 2402.7 | 3117.7 | 1522.7 | 0.501 | 1.00 | 1014.8 | 526.7 | 5399.5 | 0.775 | 0.520 | 0.480 | 1.0311 |
| 42 | 2391.4 | 2357.4 | 3117.7 | 1528.5 | 0.490 | 1.00 | 754.4 | 264.1 | 5410.5 | 0.775 | 0.520 | 0.480 | 1.0306 |
| 43 | 2362.9 | 2355.9 | 2676.0 | 1191.1 | 0.557 | 1.00 | 145.9 | 307.9 | 5022.5 | 2.802 | 0.604 | 0.396 | 1.0286 |
| 44 | 2362.2 | 2351.2 | 2676.0 | 1190.5 | 0.557 | 1.00 | 298.7 | 307.9 | 5021.2 | 2.891 | 0.604 | 0.396 | 1.0285 |
| 45 | 2355.9 | 2350.7 | 2290.1 | 931.5 | 0.642 | 1.00 | 82.9 | 260.1 | 4684.0 | 3.412 | 0.664 | 0.336 | 1.0516 |
| 46 | 2596.1 | 2595.1 | 131.2 | 99.5 | 3.798 | 1.00 | 1.3 | 49.3 | 4110.1 | 0.640 | 1.000 | 0.000 | 1.2901 |
| 47 | 2667.4 | 2316.0 | 140.9 | 98.5 | 3.870 | 1.00 | 792.3 | 493.5 | 3915.2 | 0.640 | 1.000 | 0.000 | 1.2032 |
| 48 | 2420.6 | 2272.2 | 141.3 | 101.7 | 3.560 | 1.00 | 356.6 | 505.2 | 3826.0 | 0.640 | 1.000 | 0.000 | 1.1793 |
| 49 | 2371.0 | 2270.3 | 141.3 | 102.4 | 3.540 | 1.00 | 79.4 | 505.2 | 3812.9 | 0.640 | 1.000 | 0.000 | 1.1769 |
| 50 | 2516.2 | 2342.1 | 149.0 | 103.3 | 3.562 | 1.00 | 50.0 | 869.7 | 3856.7 | 0.640 | 1.000 | 0.000 | 1.1966 |
| 51 | 2359.6 | 2343.6 | 149.0 | 105.6 | 3.502 | 1.00 | 14.3 | 204.4 | 3821.3 | 0.640 | 1.000 | 0.000 | 1.1908 |
| 52 | 2359.5 | 2343.7 | 149.0 | 105.6 | 3.502 | 1.00 | 11.8 | 204.4 | 3821.3 | 0.521 | 1.000 | 0.000 | 1.1908 |
| 53 | 2361.6 | 2344.6 | 149.2 | 105.6 | 3.502 | 1.00 | 16.2 | 211.5 | 3821.9 | 0.521 | 1.000 | 0.000 | 1.1911 |
| 54 | 2356.0 | 2350.8 | 2290.2 | 931.5 | 0.642 | 1.00 | 81.5 | 260.1 | 4684.0 | 3.412 | 0.664 | 0.336 | 1.0516 |
| 55 | 2350.8 | 2350.6 | 2290.2 | 932.1 | 0.642 | 1.00 | 50.5 | 0.0 | 4685.4 | 3.412 | 0.664 | 0.336 | 1.0515 |
| 56 | 2350.5 | 2349.9 | 2290.2 | 932.1 | 0.642 | 1.00 | 88.0 | 0.0 | 4685.3 | 3.412 | 0.664 | 0.336 | 1.0515 |
| 57 | 2349.9 | 2349.8 | 2290.2 | 932.1 | 0.642 | 1.00 | 50.5 | 0.0 | 4685.4 | 3.412 | 0.664 | 0.336 | 1.0515 |
| 58 | 2355.5 | 2349.2 | 2219.8 | 899.5 | 0.653 | 1.00 | 104.7 | 282.0 | 4645.4 | 3.531 | 0.675 | 0.325 | 1.0553 |
| 59 | 2359.5 | 2343.7 | 149.0 | 105.6 | 3.502 | 1.00 | 2.7 | 204.4 | 3821.4 | 0.119 | 1.000 | 0.000 | 1.1908 |
| 60 | 2354.7 | 2338.9 | 149.0 | 105.6 | 3.498 | 1.00 | 1.3 | 204.4 | 3817.3 | 0.119 | 1.000 | 0.000 | 1.1894 |
| 61 | 2355.6 | 2349.2 | 2219.8 | 899.6 | 0.653 | 1.00 | 102.9 | 282.0 | 4645.5 | 3.531 | 0.675 | 0.325 | 1.0553 |
| 62 | 2356.1 | 2343.9 | 2220.0 | 899.9 | 0.651 | 1.00 | 284.2 | 304.3 | 4646.2 | 3.480 | 0.675 | 0.325 | 1.0552 |
| 63 | 2300.9 | 2181.0 | 2220.2 | 888.9 | 0.615 | 1.00 | 1300.9 | 314.4 | 4617.8 | 1.995 | 0.675 | 0.325 | 1.0521 |
| 64 | 2186.1 | 2179.1 | 2220.3 | 894.7 | 0.611 | 1.00 | 19.5 | 323.9 | 4632.9 | 1.995 | 0.675 | 0.325 | 1.0515 |

Table 3-3 HPFTP TURBINE COOLANT ANALYSIS (MPL) (Concluded)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H20 | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 65 | 2416.0 | 2343.1 | 2238.7 | 899.6 | 0.651 | 1.00 | 84.6 | 1014.5 | 4645.6 | 1.485 | 0.675 | 0.325 | 1.0552 |
| 66 | 2416.0 | 2343.1 | 2238.7 | 899.6 | 0.651 | 1.00 | 84.6 | 1014.5 | 4645.6 | 1.485 | 0.675 | 0.325 | 1.0552 |
| 67 | 2349.1 | 2342.4 | 1839.1 | 756.9 | 0.602 | 0.89 | 101.1 | 304.3 | 5471.8 | 1.828 | 0.709 | 0.291 | 1.0711 |
| 68 | 2464.8 | 2458.1 | 128.9 | 99.4 | 3.728 | 1.00 | 21.5 | 128.0 | 4010.4 | 0.697 | 1.000 | 0.000 | 1.2462 |
| 69 | 2323.0 | 2315.7 | 128.9 | 100.0 | 3.631 | 1.00 | 9.0 | 135.9 | 3889.1 | 0.292 | 1.000 | 0.000 | 1.1981 |
| 70 | 2347.6 | 2340.9 | 1839.1 | 756.9 | 0.602 | 0.89 | 100.7 | 304.3 | 5471.8 | 1.828 | 0.709 | 0.291 | 1.0711 |
| 71 | 2265.0 | 2085.4 | 1839.3 | 743.1 | 0.561 | 0.87 | 1686.4 | 314.3 | 5415.3 | 1.828 | 0.709 | 0.291 | 1.0647 |
| 72 | 2088.5 | 2082.4 | 1839.4 | 753.8 | 0.533 | 0.90 | 17.7 | 323.9 | 5470.8 | 1.828 | 0.709 | 0.291 | 1.0633 |
| 73 | 2303.0 | 2144.0 | 128.9 | 98.4 | 3.568 | 1.00 | 639.4 | 0.0 | 3775.3 | 0.405 | 1.000 | 0.000 | 1.1471 |
| 74 | 2286.9 | 2126.8 | 128.9 | 98.4 | 3.556 | 1.00 | 643.2 | 0.0 | 3760.0 | 0.405 | 1.000 | 0.000 | 1.1414 |
| 75 | 2126.4 | 2126.4 | 128.9 | 100.8 | 3.490 | 1.00 | 0.6 | 0.0 | 3718.4 | 0.405 | 1.000 | 0.000 | 1.1356 |
| 76 | 2126.4 | 2126.3 | 605.9 | 226.6 | 1.572 | 1.00 | 5.2 | 0.0 | 3347.8 | 0.405 | 1.000 | 0.000 | 1.1219 |
| 77 | 2125.6 | 2124.2 | 605.9 | 226.5 | 1.571 | 1.00 | 91.1 | 0.0 | 3346.9 | 0.405 | 1.000 | 0.000 | 1.1217 |
| 78 | 2123.8 | 2121.4 | 769.3 | 266.1 | 1.339 | 1.00 | 130.0 | 0.0 | 3490.4 | 0.405 | 1.000 | 0.000 | 1.1185 |
| 79 | 2121.1 | 2120.3 | 769.3 | 266.2 | 1.338 | 1.00 | 74.0 | 0.0 | 3490.3 | 0.405 | 1.000 | 0.000 | 1.1184 |
| 80 | 2120.7 | 2120.6 | 769.3 | 266.2 | 1.338 | 1.00 | 29.5 | 0.0 | 3490.4 | 0.405 | 1.000 | 0.000 | 1.1184 |
| 81 | 2120.6 | 2120.5 | 769.3 | 266.2 | 1.338 | 1.00 | 29.1 | 0.0 | 3490.4 | 0.405 | 1.000 | 0.000 | 1.1184 |
| 82 | 2120.5 | 2120.5 | 769.3 | 266.2 | 1.338 | 1.00 | 3.6 | 0.0 | 3490.4 | 0.405 | 1.000 | 0.000 | 1.1184 |
| 83 | 2116.6 | 2108.8 | 769.3 | 266.0 | 1.333 | 1.00 | 232.5 | 0.0 | 3485.5 | 0.405 | 1.000 | 0.000 | 1.1175 |
| 84 | 2108.8 | 2108.8 | 769.3 | 266.2 | 1.332 | 1.00 | 1.6 | 0.0 | 3486.7 | 0.405 | 1.000 | 0.000 | 1.1175 |
| 85 | 2575.4 | 2557.6 | 131.4 | 99.5 | 3.778 | 1.00 | 209.0 | 0.0 | 4082.8 | 0.319 | 1.000 | 0.000 | 1.2779 |
| 86 | 2557.5 | 2557.5 | 131.4 | 99.8 | 3.772 | 1.00 | 0.5 | 0.0 | 4078.3 | 0.319 | 1.000 | 0.000 | 1.2768 |
| 87 | 2557.0 | 2555.8 | 131.4 | 99.8 | 3.771 | 1.00 | 52.7 | 0.0 | 4077.2 | 0.319 | 1.000 | 0.000 | 1.2763 |
| 88 | 2555.7 | 2555.4 | 131.4 | 99.8 | 3.770 | 1.00 | 25.5 | 0.0 | 4076.7 | 0.319 | 1.000 | 0.000 | 1.2761 |
| 89 | 2555.6 | 2555.2 | 338.4 | 157.6 | 2.574 | 1.00 | 37.1 | 0.0 | 3532.7 | 0.319 | 1.000 | 0.000 | 1.1834 |
| 90 | 2555.2 | 2553.5 | 338.4 | 157.6 | 2.574 | 1.00 | 78.3 | 0.0 | 3531.7 | 0.319 | 1.000 | 0.000 | 1.1831 |
| 91 | 2412.6 | 2108.4 | 338.4 | 151.5 | 2.352 | 1.00 | 1078.6 | 0.0 | 3274.9 | 0.319 | 1.000 | 0.000 | 1.1119 |
| 92 | 2107.5 | 2107.5 | 338.4 | 157.7 | 2.255 | 1.00 | 0.7 | 0.0 | 3261.8 | 0.319 | 1.000 | 0.000 | 1.1133 |
| 93 | 2105.2 | 2099.8 | 579.2 | 219.8 | 1.603 | 1.00 | 176.5 | 0.0 | 3318.2 | 0.724 | 1.000 | 0.000 | 1.1196 |
| 94 | 2099.8 | 2099.8 | 579.2 | 220.0 | 1.602 | 1.00 | 1.6 | 0.0 | 3318.6 | 0.724 | 1.000 | 0.000 | 1.1196 |
| 95 | 2373.2 | 2359.3 | 135.1 | 101.3 | 3.623 | 1.00 | 23.6 | 282.0 | 3902.5 | 0.577 | 1.000 | 0.000 | 1.2079 |
| 96 | 2704.4 | 2358.2 | 151.1 | 101.3 | 3.623 | 1.00 | 43.8 | 940.0 | 3901.6 | 0.089 | 1.000 | 0.000 | 1.2078 |
| 97 | 2702.3 | 2356.1 | 151.1 | 101.3 | 3.621 | 1.00 | 43.8 | 940.0 | 3899.8 | 0.089 | 1.000 | 0.000 | 1.2069 |
| 98 | 2386.4 | 2356.1 | 151.1 | 105.9 | 3.501 | 1.00 | 1.4 | 282.0 | 3826.1 | 0.089 | 1.000 | 0.000 | 1.1936 |
| 99 | 2410.8 | 2347.1 | 2235.8 | 899.5 | 0.653 | 1.00 | 139.5 | 940.0 | 4645.2 | 0.051 | 0.675 | 0.325 | 1.0553 |
| 100 | 2406.0 | 2342.4 | 2235.8 | 899.5 | 0.651 | 1.00 | 139.6 | 940.0 | 4645.3 | 0.051 | 0.675 | 0.325 | 1.0552 |
| 101 | 2347.9 | 2342.3 | 2235.8 | 903.4 | 0.649 | 1.00 | 2.6 | 282.0 | 4657.5 | 0.051 | 0.675 | 0.325 | 1.0548 |

F1,F2,F3,F4,F5=-0.94608E+04-0.15067E+06 0.99192E+05-0.95397E+05 0.12922E+06

FROT1,FROT2,FNET=-0.34914E+04-0.31668E+04-0.33781E+05

| Column | Parameter | Description |
|---|---|---|
| Line numbers 3 through 103, Format (I5,5X, 6E10.4) | | |
| 1-5 | IP | Flow type |
| 11-20 | A | Passage flow area, $in^2$ |
| 21-30 | D | Passage hydraulic diameter, in. |
| 31-40 | XL | Passage effective length for frictional losses, in. |
| 41-50 | XR | Radial location, in. |
| 51-60 | XK | Flow loss coefficient |
| 61-70 | EFF | Ratio of fluid to shaft rotational speed. |
| Line number 104, Format (8E10.4) | | |
| 1-10 | BAREA | Bearing area, $in^2$ |
| 11-20 | BRAD | Bearing pitch radius, in. |
| 21-30 | BC | Empirical constant |
| 31-40 | BK | Empirical constant. |
| Line number 105, Format (2I5, 7F10.5)<br>Data for interstage labyrinth seal | | |
| 1-5 | N | Final tooth number, enter 4 |
| 6-10 | J | Parameter not used; enter 0 |
| 11-20 | CL | Radial clearance from drawings, in. |
| 21-30 | PL | Tooth pitch, in. |
| 31-40 | HL | Tooth height, in. |
| 41-50 | WL | Tooth width, in. |
| 51-60 | DSHF | Shaft diameter, in. |
| 61-70 | DCASE | Case diameter, in. = DSHF+2(CL+HL) |
| 71-80 | DCL | Change in diametral clearance at operating conditions, in. |

| Column | Parameter | Description |
|---|---|---|
| Line number 106, Format (2I5, 7F10.5)<br>Data for first two teeth of turbine seal | | |
| 1-5 | N | Final tooth number, enter 6 |
| 6-80 | Same parameters as above. | |
| Line number 107, Format (2I5, 7F10.5)<br>Data for next three teeth of turbine seal | | |
| 1-5 | N | Final tooth number, enter 9 |
| 6-80 | Same parameters as above. | |
| Line number 108, Format (2I5, 7F10.5)<br>Data for final three teeth of turbine seal | | |
| 1-5 | N | Final tooth number, enter 12 |
| 6-80 | Same parameters as above. | |
| Line number 109, blank card image. | | |
| Line number 110, Format (8I5) | | |
| 1-5 | IOPT | = 1 Fixed blade coefficient and iterates to determine flow rate<br>= 2 Fixed flow rate and iterates to determine blade coefficient |
| 6-10 | IOPTX1 | = 1 Enter total pressures in pump input data<br>= 2 Enter static pressures in pump input data |
| 11-15 | ITURB | = 1 Uses programmed turbine leakage flows and makes one pass through turbine and coolant flow models<br>= 2 Uses computed leakage flows from first pass and makes an additional pass through each model |
| 16-20 | KPUMP | = 1 Reads input impeller inlet and discharge conditions and bypasses pump head rise model<br>= 2 Computes impeller inlet and discharge conditions using pump head rise model. |

| Column | Parameter | Description |
|---|---|---|
| Line number 111, Format (8E10.4) | | |
| 1-10 | WPIO | Pump inlet flow rate, lbm/s |
| 11-20 | PIOF | Pump inlet pressure, psia<br>Total pressure if IOPTX1 = 1<br>Static pressure if IOPTX1 = 2 |
| 21-30 | TIOF | Pump inlet temperature, °R |
| 31-40 | POOF | Pump discharge pressure, psia<br>Total pressure if IOPTX1 = 1<br>Static pressure if IOPTX1 = 2 |
| 41-50 | TOOF | Pump discharge temperature, °R |
| 51-60 | ETAP | Pump efficiency |
| 61-70 | RPM | Pump speed, rpm |
| 71-80 | XPL | Power level ratio. |
| Line number 112, Format (8E10.4) | | |
| 1-10 | PKNOWN(1) | Impeller discharge total pressure, psia |
| 11-20 | TKNOWN(1) | Impeller discharge temperature, °R |
| 21-30 | RKNOWN(1) | Impeller discharge density, $lbm/ft^3$ |
| 31-40 | VTKNON(1) | Impeller discharge fluid tangential velocity, ft/s. |
| Line number 113, Format (8E10.4) | | |
| 1-10 | PKNOWN(2) | Impeller inlet total pressure, psia |
| 11-20 | TKNOWN(2) | Impeller inlet temperature, °R |
| 21-30 | PKNOWN(2) | Impeller inlet density, $lbm/ft^3$ |
| 31-40 | VTKNON(2) | Impeller inlet fluid tangential velocity, ft/s. |

| Column | Parameter | Description |
|---|---|---|
| Line number 114, Format (8E10.4) | | |
| 1-10 | WDPB | Turbine inlet flow rate, lbm/s |
| 11-20 | PPB | Turbine inlet total pressure, psia |
| 21-30 | TPB | Turbine inlet total temperature, °R |
| 31-40 | HPA | Turbine horsepower, hp |
| 41-50 | TFTD | Turbine discharge total temperature, °R |
| 51-60 | PFTD | Turbine turnaround duct discharge total pressure, psia |
| 61-70 | ETANZ | Nozzle efficiency, $K_n^2$ |
| 71-80 | XKB | Blade coefficient, $K_b$. |
| Line number 115, Format (8E10.4) | | |
| 1-10 | OF | Preburner mixture ratio. |
| Line number 116, Format (8E10.4) | | |
| 1-80 | WDLEG | Legs 1 through 8 estimated flow rate at FPL, lbm/s. |
| Line number 117, Format (8E10.4) | | |
| 1-80 | WDLEG | Legs 9 through 16 estimated flow rate at FPL, lbm/s. |
| Line number 118, Format (8E10.4) | | |
| 1-80 | WDLEG | Legs 17 through 24 estimated flow rate at FPL, lbm/s. |
| Line number 119, Format (8E10.4) | | |
| 1-10 | WDLEG | Leg 25 estimated flow rate at FPL, lbm/s. |

# 4. HIGH PRESSURE OXIDIZER TURBINE COOLANT ANALYSIS

## 4.1 TURBINE COOLANT SYSTEM

The existing high pressure oxidizer turbopump (HPOTP) turbine coolant system flow model developed by Lockheed for NASA-MSFC was used as a baseline for this analysis. This baseline model (shown in Figures 4-1 and 4-2) is documented in Reference 9. The turbine coolant system was modeled to evaluate the flow properties at each of the numbered stations and to compute the flow rates along each of the flow paths in the system. Four additional stations have been included in the model for computational purposes. These are at the first stage blade exit (station 159), second stage nozzle exit (station 160), second stage blade exit (station 161), and primary turbine seal inlet (station 162). The model comprises 162 stations and 27 flow paths.

## 4.2 MODEL IMPROVEMENT

A review of current drawings was performed, and pertinent geometry changes were included in the model. Operating clearances for the interstage seal and turbine seal were supplied by NASA-MSFC. The flow path supplying coolant hydrogen to the turbine seal region at station 131 (see Figure 4-2a) has been modified and now supplies mixed coolant from the mixing chamber. The cold hydrogen supply has been blanked off, and mixed coolant is now introduced at old station location 122 shown in Figure 4-1m. This flow path now consists of stations 120 through 131.

A one-dimensional turbine model is included as a subroutine in the code. This provides a closed loop analysis with a minimum of required boundary conditions as input. Estimated leakage rates into the primary turbine flow path are input to the turbine model, and the turbine model is executed to provide pressures as boundary conditions for the coolant flow model (stations 29, 159, 160, and 161). The coolant model is then executed and new leakage

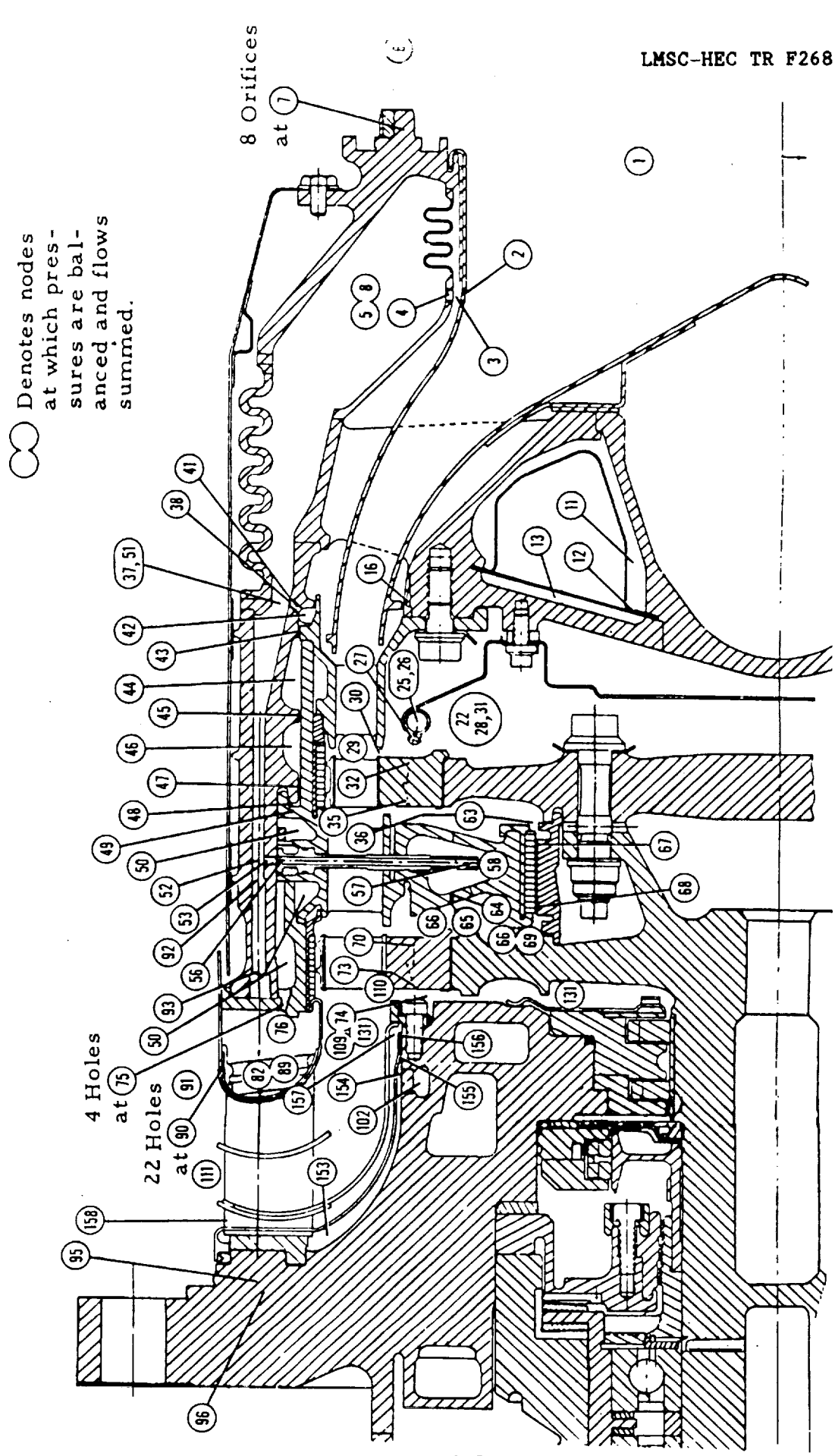



Figure 4-1 HPOTP Turbine Coolant System Schematic Diagram

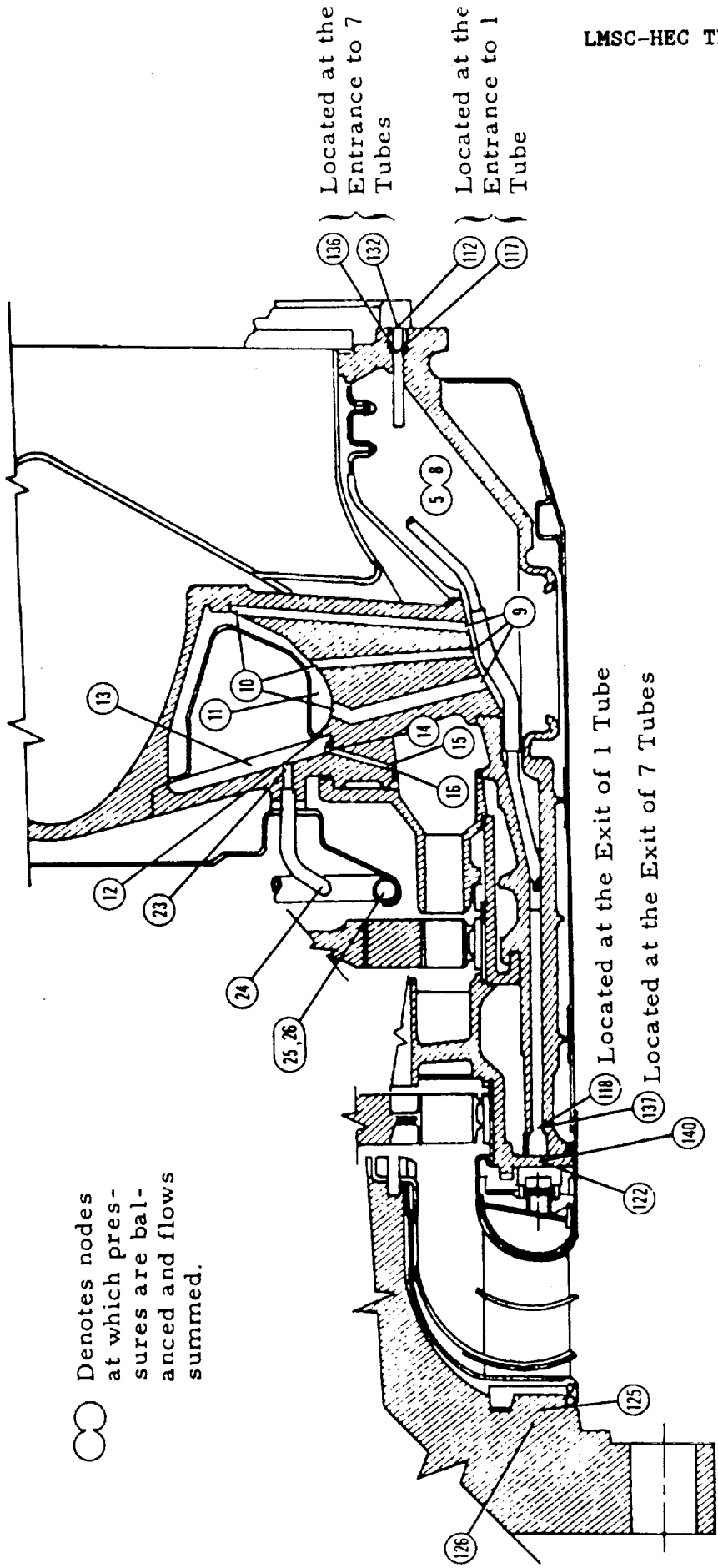

Located at the Entrance to 7 Tubes
Located at the Entrance to 1 Tube
136
132
112
117
8
5
9
10
11
13
14
15
16
12
23
24
25,26
118
Located at the Exit of 1 Tube
137
Located at the Exit of 7 Tubes
140
122
125
126
Denotes nodes at which pressures are balanced and flows summed.

Figure 4-1a

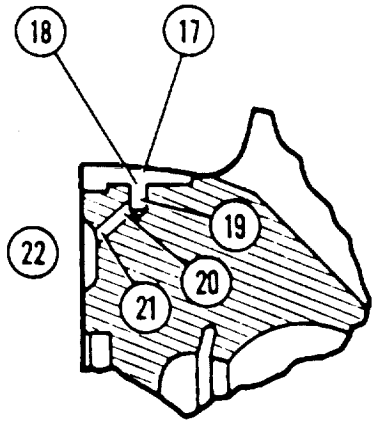



Figure 4-1b

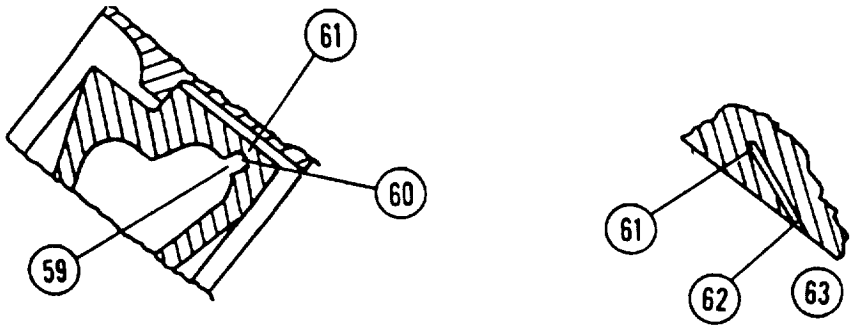



Figure 4-1c

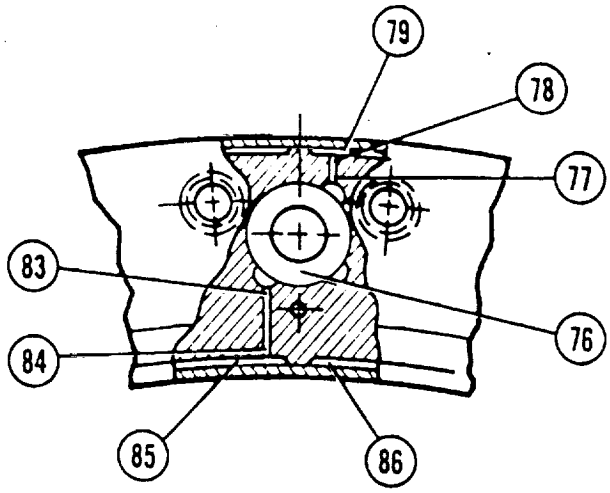
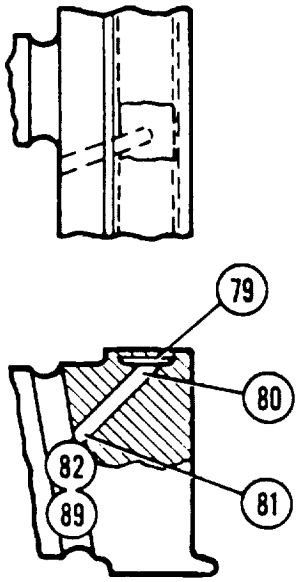



Figure 4-1d




Denotes nodes at which pressures are balanced and flows summed.

Figure 4-1e

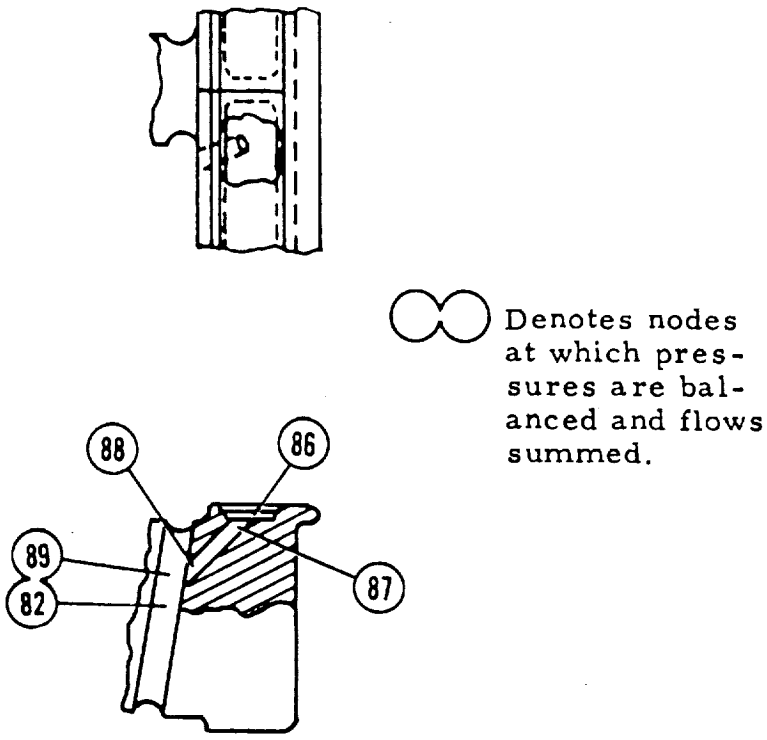



Figure 4-1f

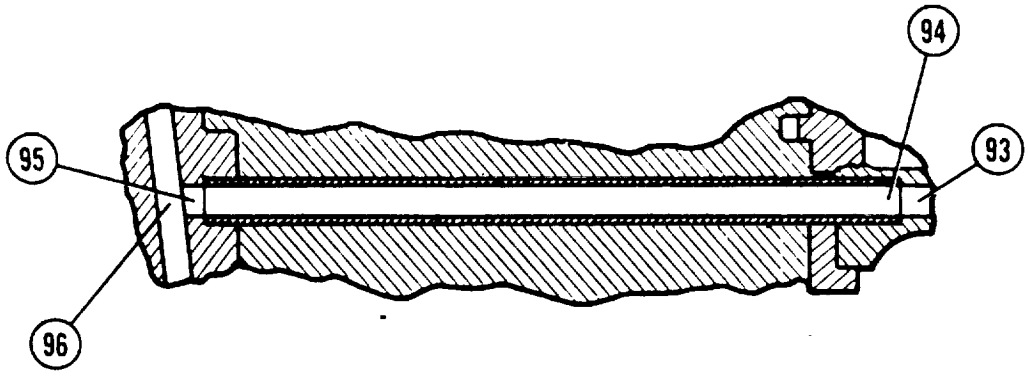



Figure 4-1g

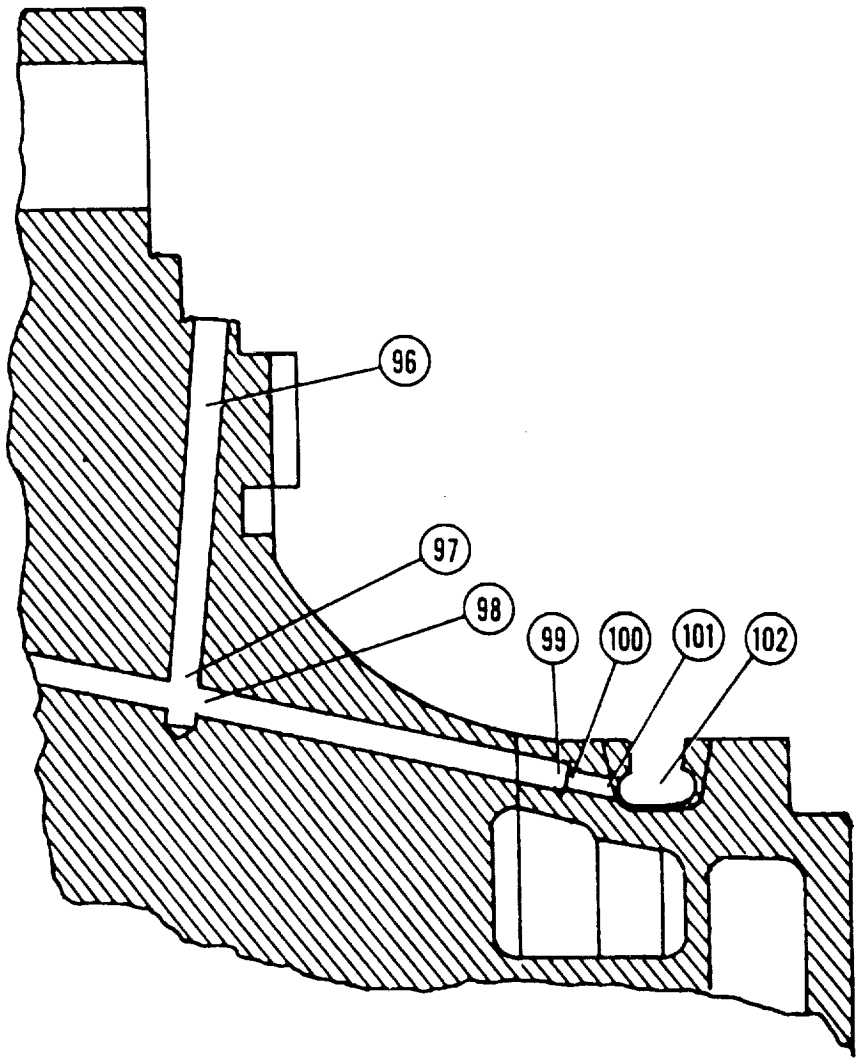



Figure 4-1h

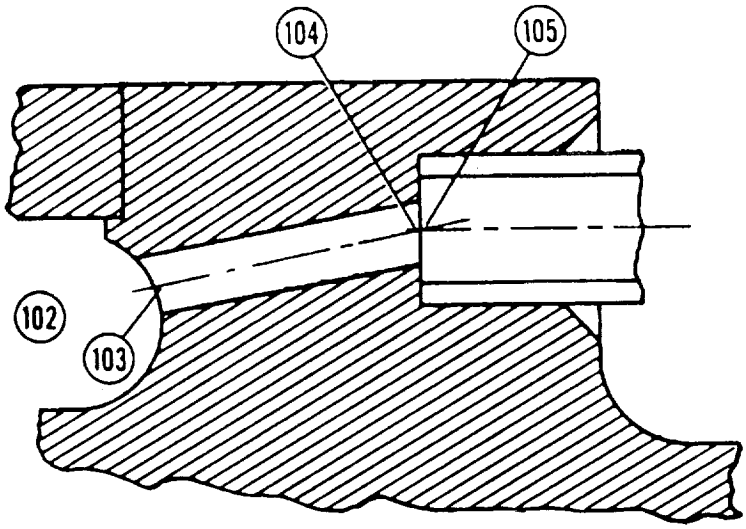



Figure 4-1i

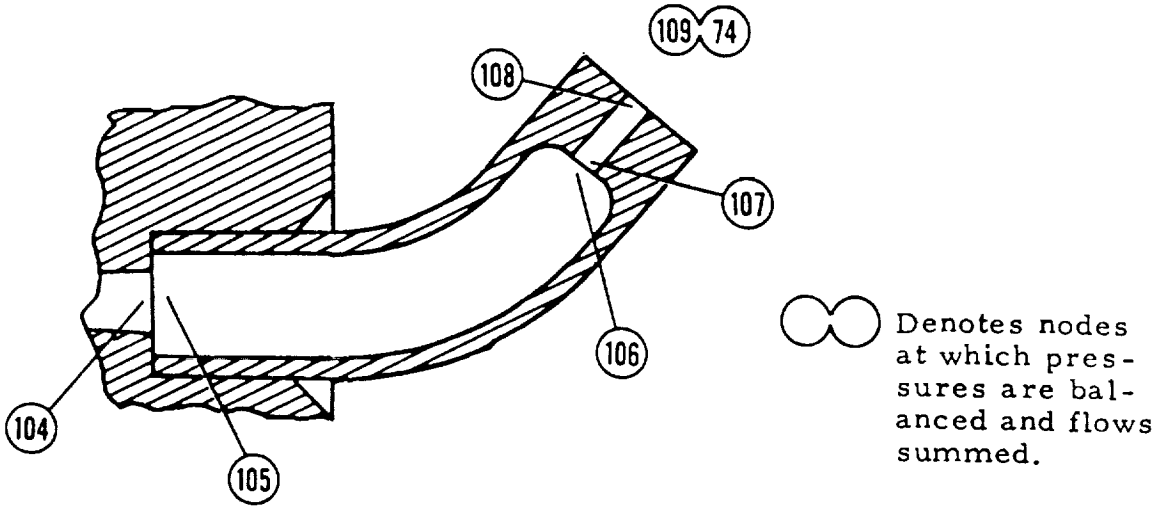



Figure 4-1j

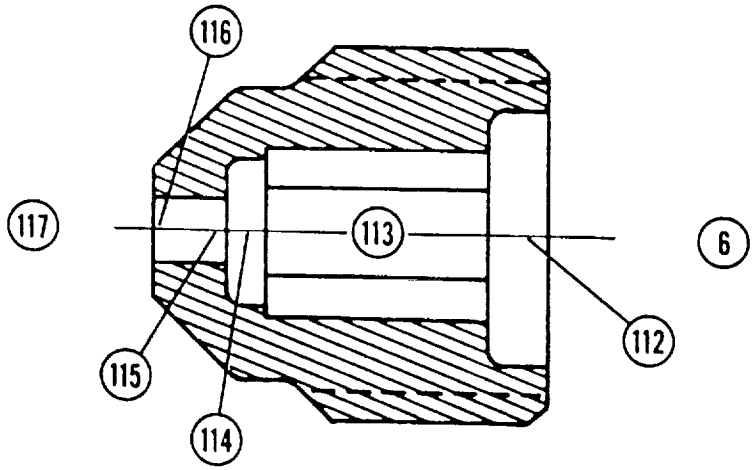



Figure 4-1k

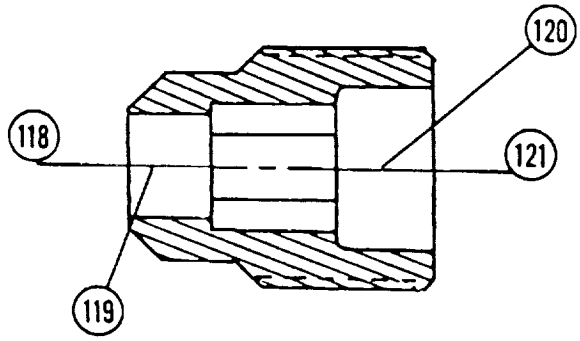



Figure 4-1ℓ

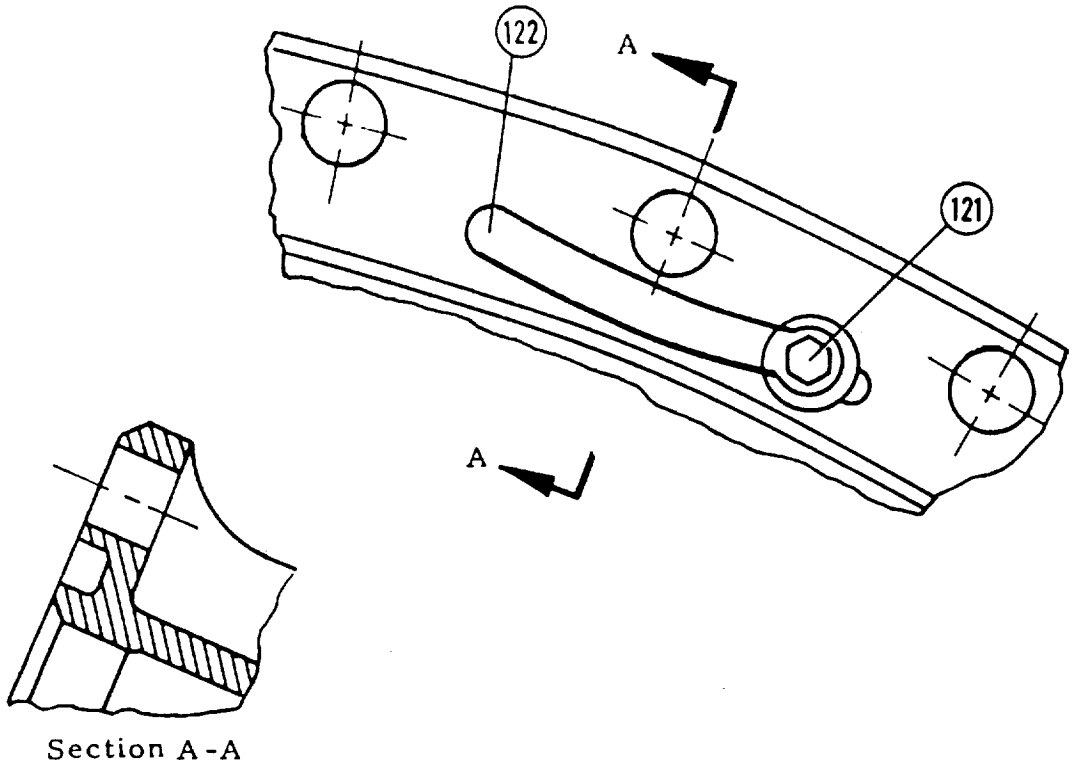



Figure 4-1m

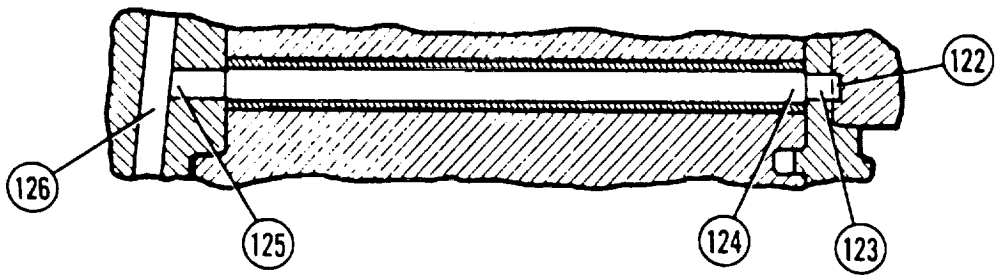



Figure 4-1n

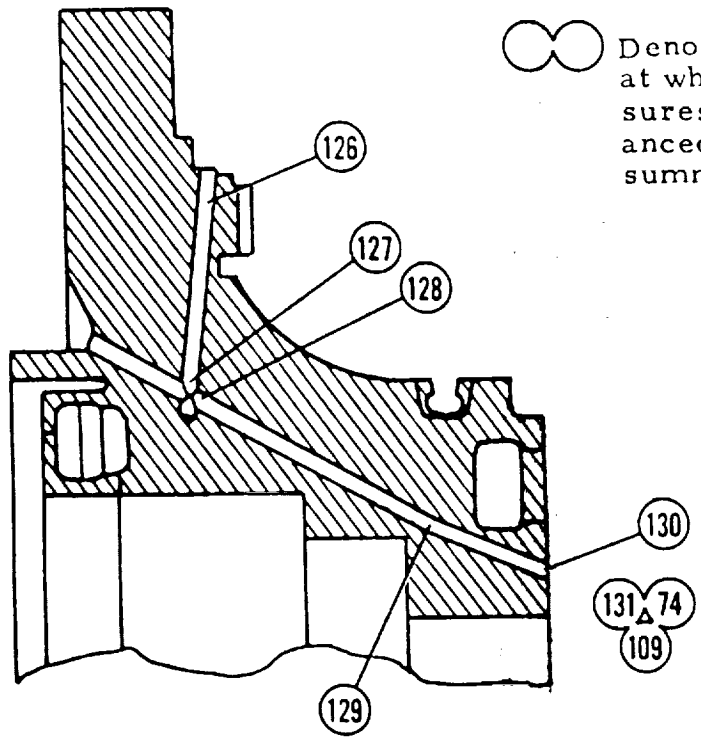



Figure 4-1o

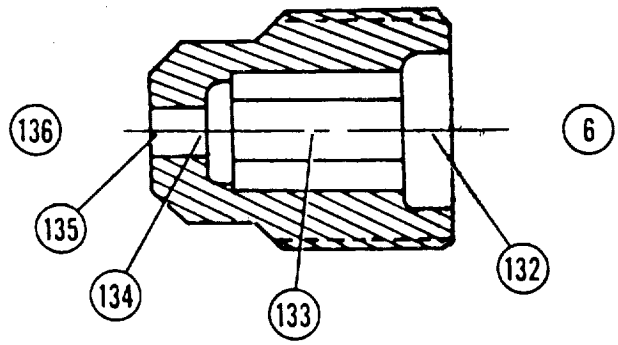



Figure 4-1p

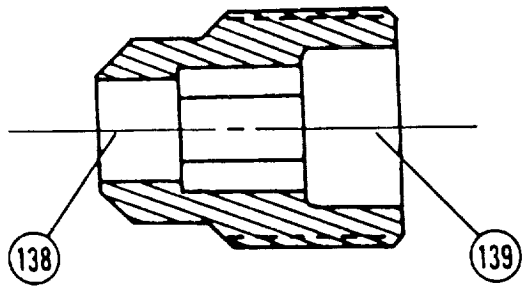



Figure 4-1q

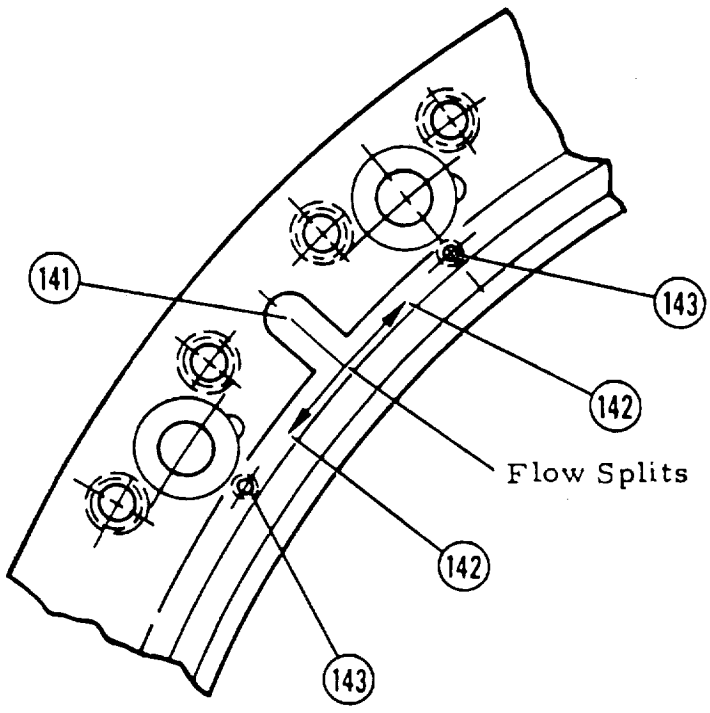



Figure 4-1r

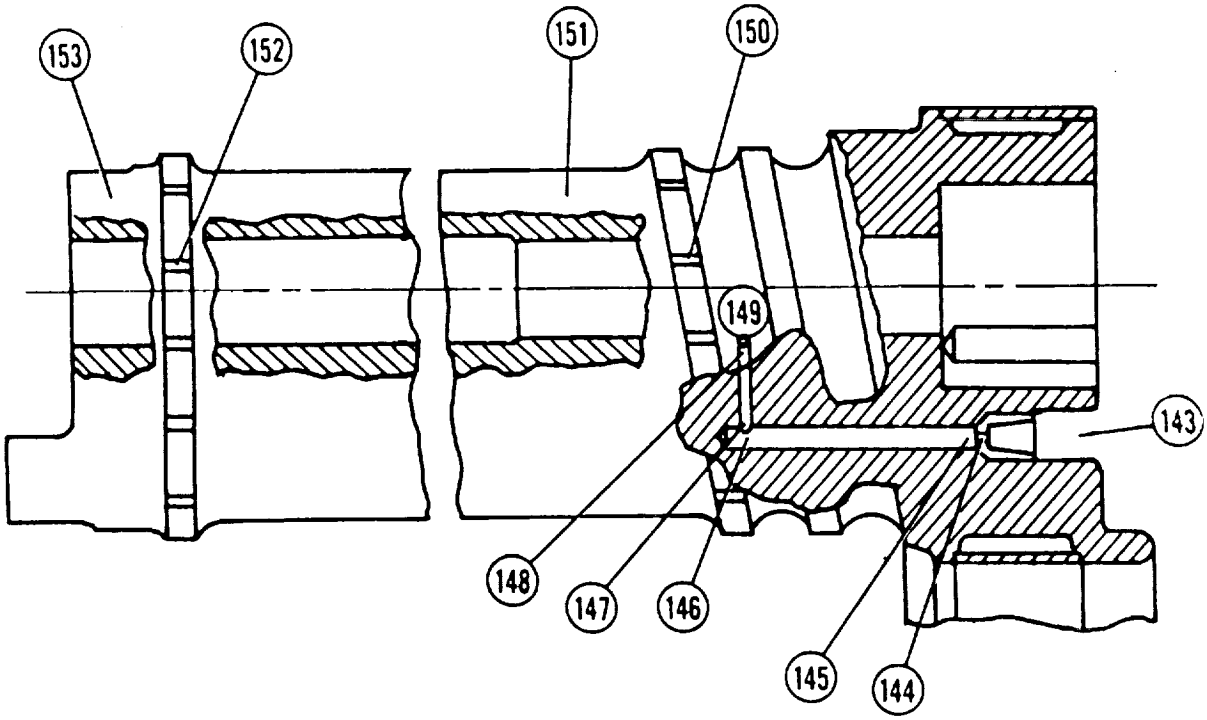



Figure 4-1s

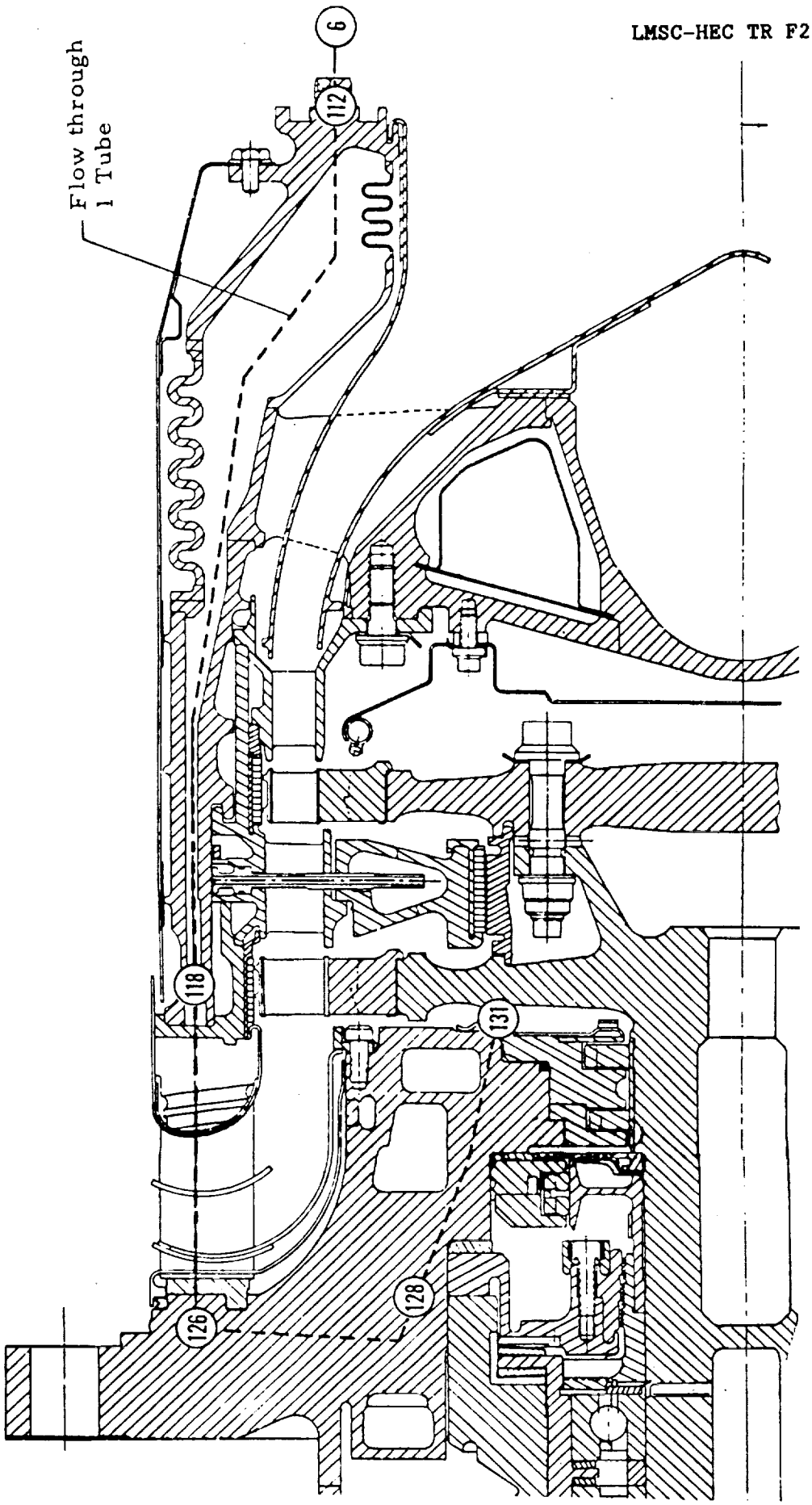



Figure 4-2a Flow Passage of Hydrogen from the Coolant Manifold at Station 6 to the Turbine Seal Region at Station 131

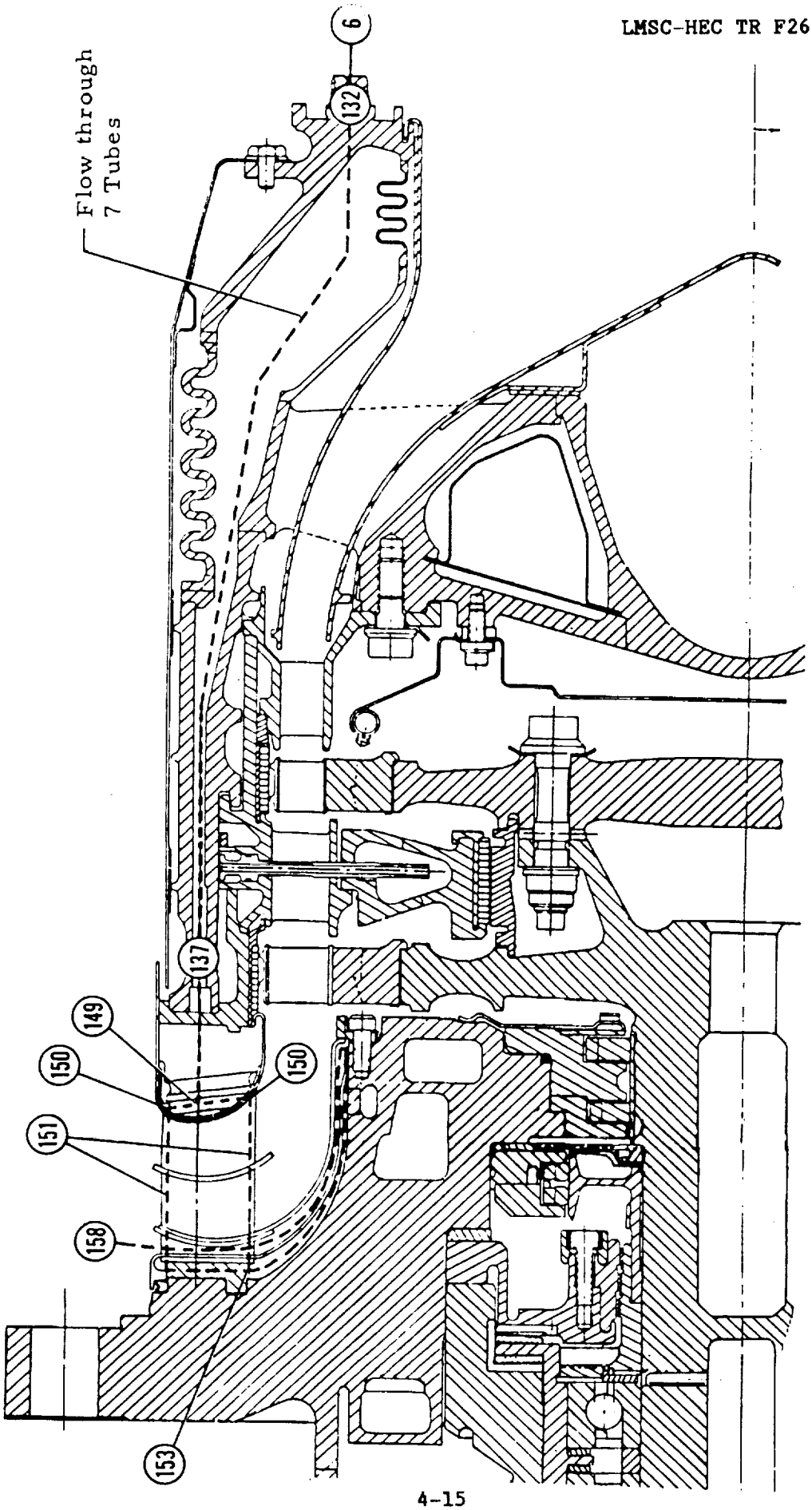



Figure 4-2b Flow Passage of Hydrogen from the Coolant Manifold at Station 6 to the Struts at Stations 149 through 153

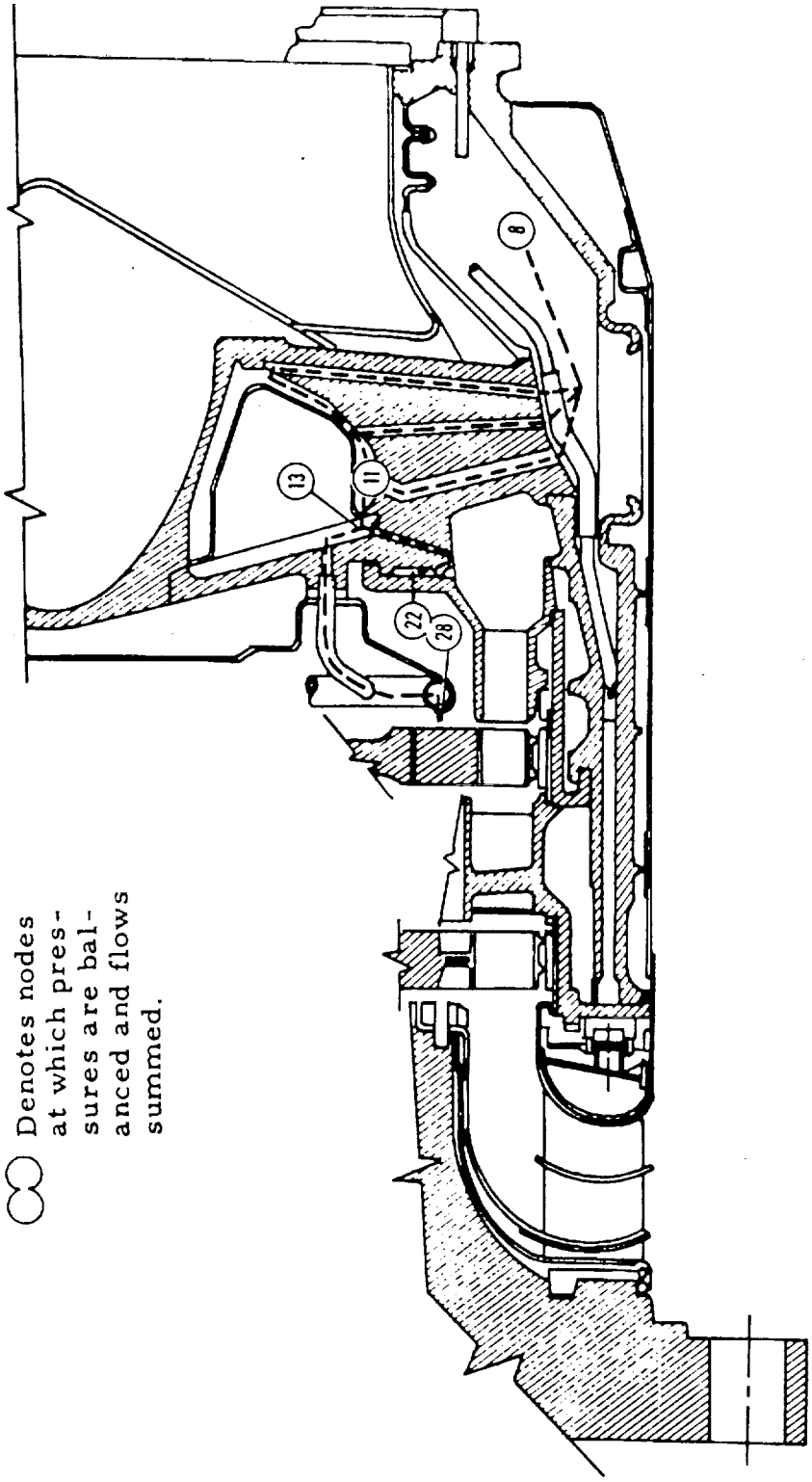



Figure 4-2c Flow Passage of Mixed Coolant from the Mixing Chamber at Station 8 to the First Stage Rotor at Stations 22 and 28

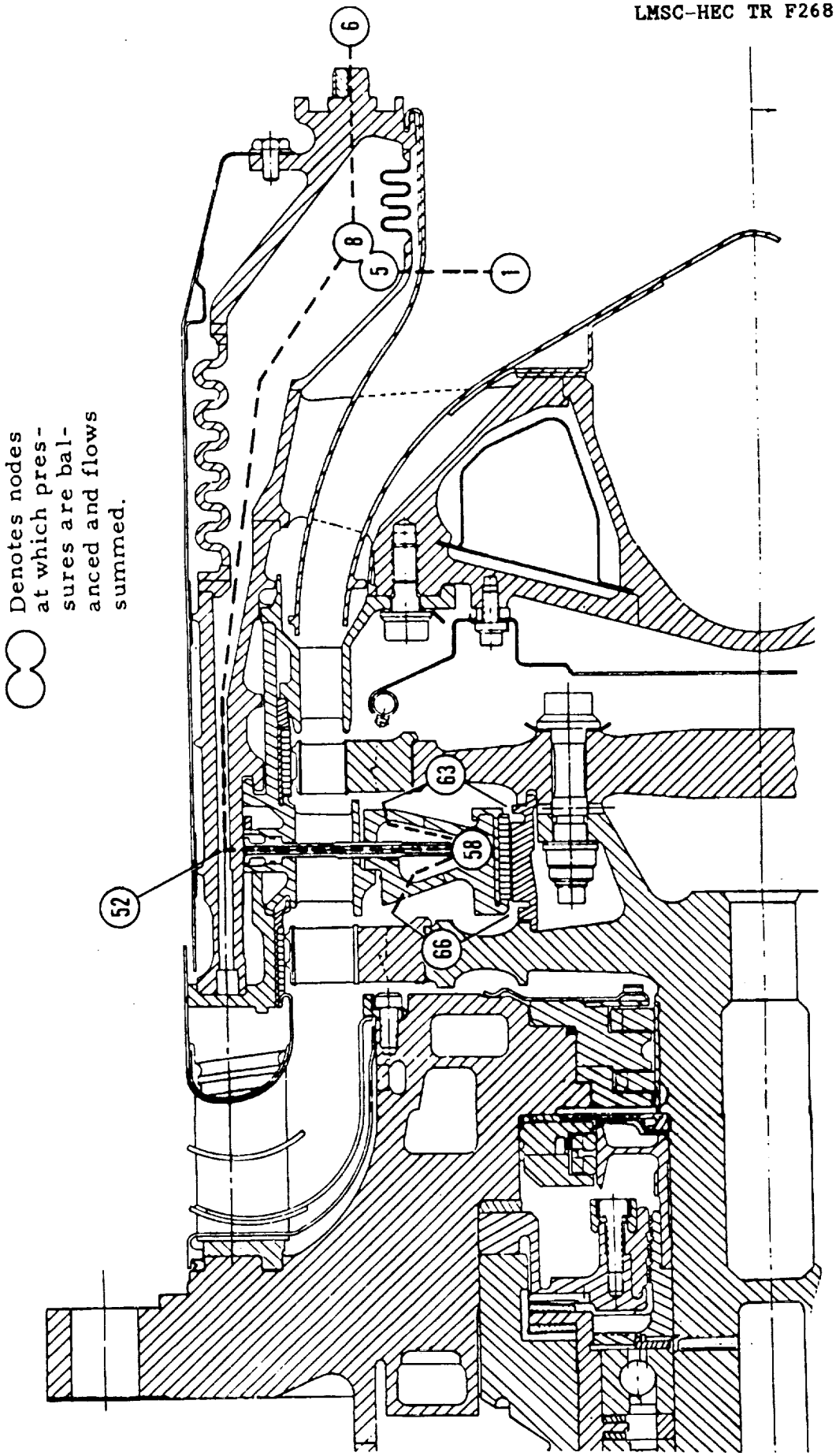



Figure 4-2d Flow Passage of Mixed Coolant from the Mixing Chamber at Station 8 to the Turbine Stator Region at Stations 63 and 66

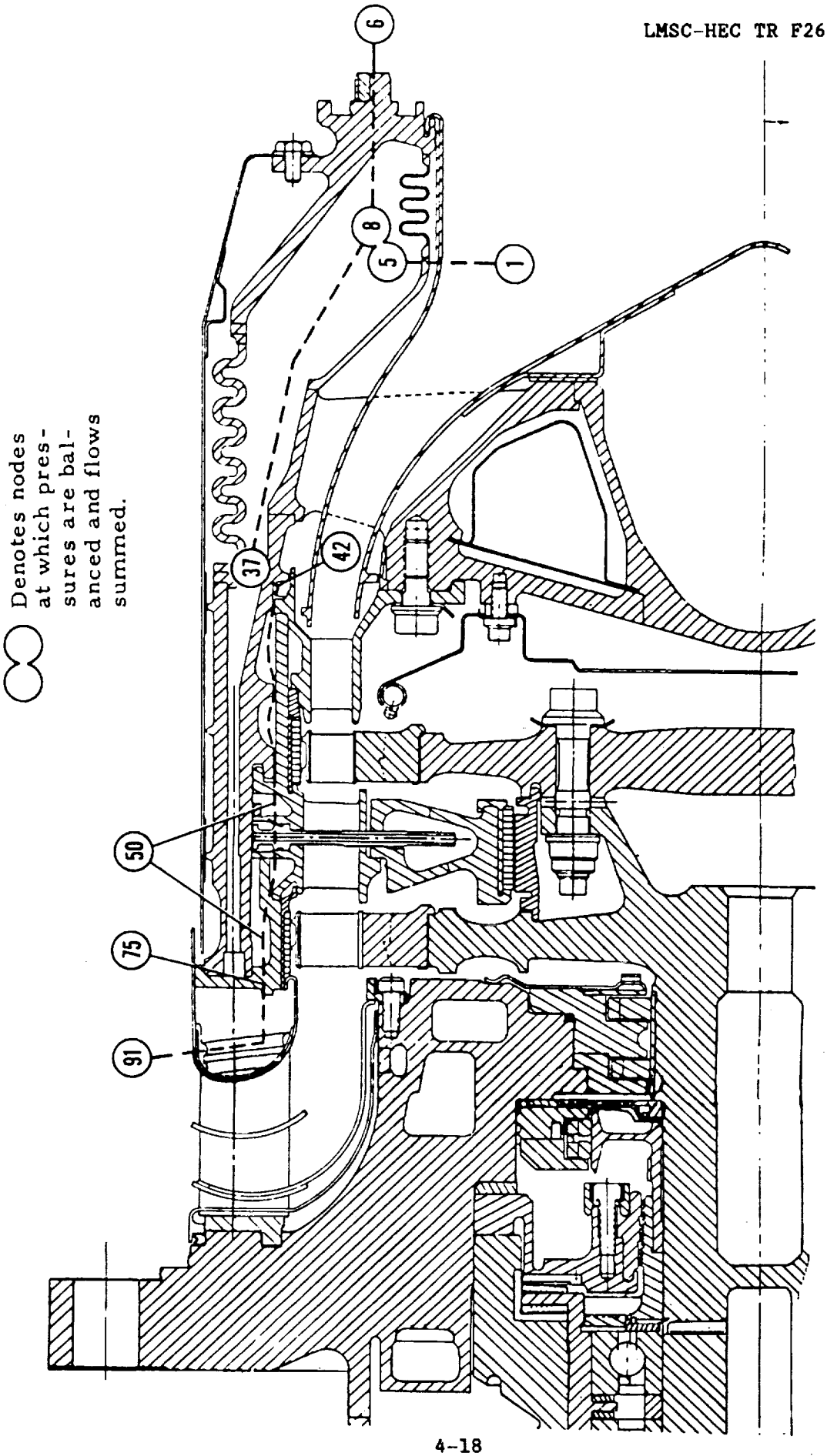



Figure 4-2e Flow Passage of Mixed Coolant from the Mixing Chamber at Station 8 to the Turbine Housing at Stations 42 through 50 and Exit Strut Region at Stations 75 through 90

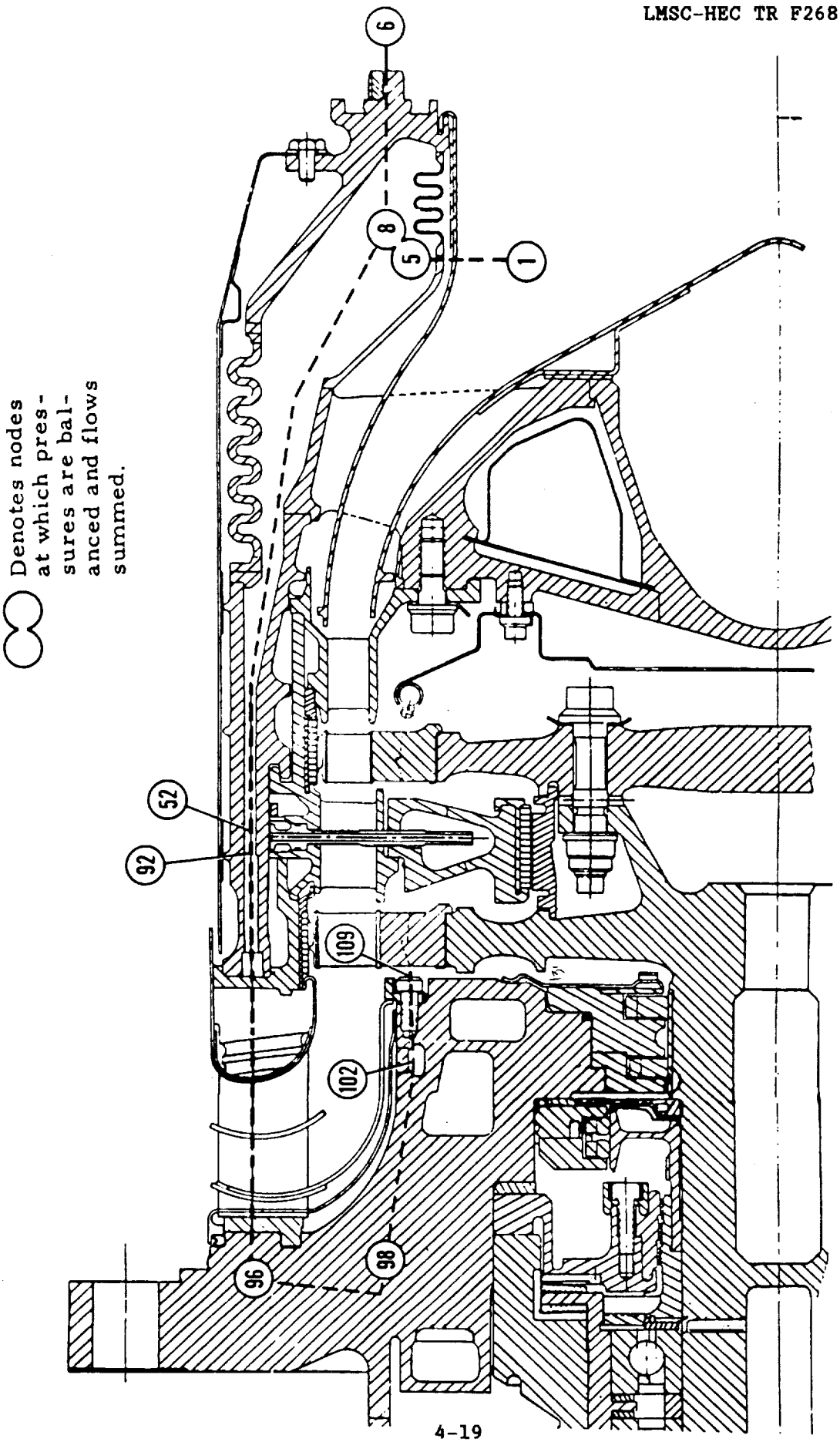



Figure 4-2f Flow Passage of Mixed Coolant from the Mixing Chamber at Station 8 to the Second Stage Rotor at Station 109

flows are computed. An input option is provided for terminating the execution at this point or continuing with another pass through each model if greater accuracy is desired.

An improved properties subroutine for computing thermodynamic and transport properties for a mixture of $H_2$ and $H_2O$ has been added to the program. Refer to Section 2.4 for a detailed description of this calculation procedure.

## 4.3 RESULTS

The oxidizer turbine coolant system was analyzed at FPL, 104%, and MPL using Rocketdyne engine balance data obtained from Reference 8. The results of these analyses are presented in Tables 4-1 through 4-3.

## 4.4 PROGRAM INPUT GUIDE

This section describes the input data file required for execution of the HPOTP turbine coolant program.

| Column | Parameter | Description |
|---|---|---|
| Line numbers 1 through 158, Format (I5, 5X, 6E10.4)) | | |
| 1-5 | IP | Flow type |
| 11-20 | A | Passage flow area, $in^2$ |
| 21-30 | D | Passage hydraulic diameter, in. |
| 31-40 | XL | Passage effective length for frictional losses, in. |
| 41-50 | XR | Radial location, in. |
| 51-60 | XK | Flow loss coefficient |
| 61-70 | EFF | Ratio of fluid to shaft rotational speed. |

Table 4-1 HPOTP TURBINE COOLANT ANALYSIS (FPL)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5599.2 | 5594.4 | 3200.8 | 1561.3 | 1.087 | 1.00 | 196.1 | 0.0 | 5448.2 | 1.609 | 0.526 | 0.474 | 1.0691 |
| 2 | 5580.8 | 5553.6 | 3200.8 | 1559.2 | 1.081 | 1.00 | 481.0 | 0.0 | 5444.8 | 1.609 | 0.526 | 0.474 | 1.0686 |
| 3 | 5553.5 | 5548.1 | 3200.8 | 1560.8 | 1.079 | 1.00 | 214.4 | 0.0 | 5448.0 | 1.609 | 0.526 | 0.474 | 1.0685 |
| 4 | 5536.1 | 5501.2 | 3200.8 | 1558.5 | 1.072 | 1.00 | 547.0 | 0.0 | 5444.3 | 1.609 | 0.526 | 0.474 | 1.0679 |
| 5 | 5500.8 | 5500.8 | 2361.2 | 903.7 | 1.375 | 1.00 | 1.0 | 0.0 | 4720.5 | 2.518 | 0.697 | 0.303 | 1.1376 |
| 6 | 5988.7 | 5987.1 | 873.6 | 279.0 | 2.751 | 1.00 | 73.3 | 0.0 | 4871.2 | 0.908 | 1.000 | 0.000 | 1.4658 |
| 7 | 5830.6 | 5505.4 | 873.6 | 275.7 | 2.636 | 1.00 | 1061.0 | 0.0 | 4707.2 | 0.908 | 1.000 | 0.000 | 1.4233 |
| 8 | 5501.6 | 5501.6 | 2361.2 | 903.6 | 1.375 | 1.00 | 1.0 | 0.0 | 4720.4 | 2.518 | 0.697 | 0.303 | 1.1376 |
| 9 | 5500.3 | 5497.6 | 2361.2 | 903.5 | 1.374 | 1.00 | 133.8 | 0.0 | 4720.1 | 0.800 | 0.697 | 0.303 | 1.1375 |
| 10 | 5499.6 | 5497.0 | 2361.2 | 903.5 | 1.374 | 1.00 | 133.9 | 0.0 | 4720.1 | 0.800 | 0.697 | 0.303 | 1.1375 |
| 11 | 5497.0 | 5497.0 | 2361.2 | 903.7 | 1.374 | 1.00 | 1.0 | 0.0 | 4720.5 | 0.800 | 0.697 | 0.303 | 1.1375 |
| 12 | 5496.2 | 5494.6 | 2361.2 | 903.6 | 1.374 | 1.00 | 103.9 | 0.0 | 4720.3 | 0.800 | 0.697 | 0.303 | 1.1374 |
| 13 | 5494.6 | 5494.6 | 2361.2 | 903.7 | 1.374 | 1.00 | 1.0 | 0.0 | 4720.5 | 0.800 | 0.697 | 0.303 | 1.1374 |
| 14 | 5409.2 | 5235.4 | 2361.2 | 900.2 | 1.321 | 1.00 | 1100.8 | 0.0 | 4712.6 | 0.117 | 0.697 | 0.303 | 1.1311 |
| 15 | 5384.0 | 5209.3 | 2361.2 | 899.8 | 1.316 | 1.00 | 1107.0 | 0.0 | 4708.4 | 0.117 | 0.697 | 0.303 | 1.1305 |
| 16 | 5207.1 | 5083.3 | 2361.2 | 900.3 | 1.287 | 1.00 | 941.4 | 0.0 | 4712.7 | 0.117 | 0.697 | 0.303 | 1.1270 |
| 17 | 5074.4 | 4947.7 | 2361.2 | 900.5 | 1.257 | 1.00 | 963.4 | 0.0 | 4713.3 | 0.117 | 0.697 | 0.303 | 1.1234 |
| 18 | 4919.2 | 4862.0 | 2361.2 | 904.1 | 1.233 | 1.00 | 652.6 | 0.0 | 4721.8 | 0.117 | 0.697 | 0.303 | 1.1206 |
| 19 | 4918.1 | 4860.3 | 2361.2 | 904.0 | 1.233 | 1.00 | 658.8 | 0.0 | 4721.7 | 0.117 | 0.697 | 0.303 | 1.1205 |
| 20 | 4769.7 | 4230.9 | 2361.2 | 889.4 | 1.105 | 1.00 | 2116.6 | 0.0 | 4681.1 | 0.117 | 0.697 | 0.303 | 1.1061 |
| 21 | 4741.9 | 4198.5 | 2361.2 | 888.9 | 1.098 | 1.00 | 2134.5 | 0.0 | 4679.9 | 0.117 | 0.697 | 0.303 | 1.1054 |
| 22 | 4191.5 | 4191.5 | 2362.8 | 912.4 | 1.072 | 1.00 | 1.0 | 0.0 | 4740.9 | 0.800 | 0.697 | 0.303 | 1.1018 |
| 23 | 5404.7 | 5221.8 | 2361.2 | 900.1 | 1.318 | 1.00 | 1130.7 | 0.0 | 4712.3 | 0.683 | 0.697 | 0.303 | 1.1308 |
| 24 | 5237.3 | 5049.4 | 2361.2 | 900.8 | 1.279 | 1.00 | 1162.0 | 0.0 | 4713.9 | 0.683 | 0.697 | 0.303 | 1.1261 |
| 25 | 5047.8 | 5045.1 | 2361.2 | 906.3 | 1.272 | 1.00 | 138.7 | 0.0 | 4726.9 | 0.683 | 0.697 | 0.303 | 1.1250 |
| 26 | 5047.6 | 5044.9 | 2361.2 | 906.3 | 1.271 | 1.00 | 139.5 | 0.0 | 4726.9 | 0.683 | 0.697 | 0.303 | 1.1250 |
| 27 | 4776.2 | 4199.0 | 2361.2 | 886.7 | 1.101 | 1.00 | 2197.3 | 0.0 | 4673.9 | 0.683 | 0.697 | 0.303 | 1.1057 |
| 28 | 4191.6 | 4191.6 | 2361.2 | 911.6 | 1.072 | 1.00 | 1.0 | 0.0 | 4740.0 | 0.800 | 0.697 | 0.303 | 1.1019 |
| 29 | 5583.9 | 4190.8 | 3201.0 | 1451.4 | 0.891 | 1.00 | 968.1 | 3376.0 | 5256.8 | 65.430 | 0.526 | 0.474 | 1.0511 |
| 30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 31 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 32 | 4320.1 | 4187.8 | 2385.2 | 912.4 | 1.071 | 1.00 | 145.9 | 1059.5 | 4740.8 | 0.145 | 0.697 | 0.303 | 1.1017 |

Table 4-1 HPOTP TURBINE COOLANT ANALYSIS (FPL) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 4315.1 | 4182.9 | 2385.2 | 912.4 | 1.070 | 1.00 | 146.0 | 1059.5 | 4740.9 | 0.145 | 0.697 | 0.303 | 1.1016 |
| 34 | 4310.0 | 4177.9 | 2385.2 | 912.4 | 1.069 | 1.00 | 146.1 | 1059.5 | 4741.0 | 0.145 | 0.697 | 0.303 | 1.1014 |
| 35 | 4304.9 | 4173.0 | 2385.2 | 912.5 | 1.067 | 1.00 | 146.3 | 1059.5 | 4741.0 | 0.145 | 0.697 | 0.303 | 1.1013 |
| 36 | 4173.0 | 4173.0 | 2764.9 | 1261.9 | 0.930 | 1.00 | 1.0 | 0.0 | 5018.7 | 1.848 | 0.592 | 0.408 | 1.0474 |
| 37 | 5501.6 | 5501.6 | 2361.2 | 903.7 | 1.375 | 1.00 | 2.0 | 0.0 | 4720.4 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 38 | 5501.4 | 5500.9 | 2361.2 | 903.6 | 1.375 | 1.00 | 56.4 | 0.0 | 4720.3 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 39 | 5501.4 | 5500.9 | 2361.2 | 903.6 | 1.375 | 1.00 | 56.4 | 0.0 | 4720.3 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 40 | 5501.4 | 5500.9 | 2361.2 | 903.6 | 1.375 | 1.00 | 56.4 | 0.0 | 4720.3 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 41 | 5501.4 | 5500.9 | 2361.2 | 903.6 | 1.375 | 1.00 | 56.4 | 0.0 | 4720.3 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 42 | 5500.9 | 5500.9 | 2361.2 | 903.7 | 1.375 | 1.00 | 2.2 | 0.0 | 4720.4 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 43 | 5500.9 | 5500.9 | 2361.2 | 903.7 | 1.375 | 1.00 | 11.7 | 0.0 | 4720.4 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 44 | 5500.9 | 5500.9 | 2361.2 | 903.7 | 1.375 | 1.00 | 1.4 | 0.0 | 4720.4 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 45 | 5500.8 | 5500.8 | 2361.2 | 903.7 | 1.375 | 1.00 | 11.9 | 0.0 | 4720.4 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 46 | 5500.8 | 5500.8 | 2361.2 | 903.7 | 1.375 | 1.00 | 2.2 | 0.0 | 4720.4 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 47 | 5500.8 | 5500.8 | 2361.2 | 903.7 | 1.375 | 1.00 | 15.4 | 0.0 | 4720.4 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 48 | 5500.8 | 5500.8 | 2361.2 | 903.7 | 1.375 | 1.00 | 2.7 | 0.0 | 4720.4 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 49 | 5500.8 | 5500.7 | 2361.2 | 903.7 | 1.375 | 1.00 | 14.0 | 0.0 | 4720.4 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 50 | 5500.7 | 5500.7 | 2361.2 | 903.7 | 1.375 | 1.00 | 1.0 | 0.0 | 4720.4 | 0.159 | 0.697 | 0.303 | 1.1376 |
| 51 | 5501.6 | 5501.6 | 2361.2 | 903.7 | 1.375 | 1.00 | 17.8 | 0.0 | 4720.4 | 1.391 | 0.697 | 0.303 | 1.1376 |
| 52 | 5501.6 | 5501.5 | 2361.2 | 903.6 | 1.375 | 1.00 | 30.6 | 0.0 | 4720.4 | 1.391 | 0.697 | 0.303 | 1.1376 |
| 53 | 5493.3 | 5477.0 | 2361.2 | 902.9 | 1.371 | 1.00 | 331.5 | 0.0 | 4718.6 | 1.050 | 0.697 | 0.303 | 1.1371 |
| 54 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 55 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 56 | 5492.4 | 5467.2 | 2361.2 | 902.5 | 1.369 | 1.00 | 413.1 | 0.0 | 4717.6 | 1.050 | 0.697 | 0.303 | 1.1369 |
| 57 | 5483.4 | 5458.1 | 2361.2 | 902.5 | 1.367 | 1.00 | 413.6 | 0.0 | 4717.7 | 1.050 | 0.697 | 0.303 | 1.1367 |
| 58 | 5458.1 | 5458.1 | 2361.2 | 903.9 | 1.365 | 1.00 | 1.0 | 0.0 | 4721.1 | 1.050 | 0.697 | 0.303 | 1.1364 |
| 59 | 5443.7 | 5414.9 | 2361.2 | 902.6 | 1.358 | 1.00 | 442.2 | 0.0 | 4717.9 | 0.553 | 0.697 | 0.303 | 1.1355 |
| 60 | 5443.2 | 5414.2 | 2361.2 | 902.6 | 1.358 | 1.00 | 444.7 | 0.0 | 4717.9 | 0.553 | 0.697 | 0.303 | 1.1355 |
| 61 | 5144.4 | 4330.0 | 2361.2 | 872.3 | 1.148 | 1.00 | 2553.7 | 0.0 | 4635.7 | 0.553 | 0.697 | 0.303 | 1.1113 |
| 62 | 5023.0 | 4185.5 | 2361.2 | 870.2 | 1.116 | 1.00 | 2626.2 | 0.0 | 4630.2 | 0.553 | 0.697 | 0.303 | 1.1077 |
| 63 | 4171.6 | 4171.6 | 2764.3 | 1261.5 | 0.930 | 1.00 | 1.0 | 0.0 | 5017.5 | 1.848 | 0.592 | 0.408 | 1.0473 |
| 64 | 4966.1 | 3843.8 | 2361.2 | 849.5 | 1.056 | 1.00 | 3123.9 | 0.0 | 4576.2 | 0.497 | 0.697 | 0.303 | 1.1013 |
| 65 | 4853.9 | 3696.5 | 2361.2 | 845.1 | 1.024 | 1.00 | 3221.5 | 0.0 | 4564.9 | 0.497 | 0.697 | 0.303 | 1.0978 |
| 66 | 3675.1 | 3675.1 | 2687.1 | 1204.0 | 0.844 | 1.00 | 1.0 | 0.0 | 4830.8 | 2.345 | 0.612 | 0.388 | 1.0367 |

Table 4-1 HPOTP TURBINE COOLANT ANALYSIS (FPL) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 67 | 4075.1 | 3959.5 | 2764.3 | 1251.5 | 0.893 | 1.00 | 1092.3 | 0.0 | 5000.6 | 1.845 | 0.592 | 0.408 | 1.0445 |
| 68 | 3946.1 | 3671.1 | 2764.3 | 1235.3 | 0.842 | 1.00 | 1732.7 | 0.0 | 4968.9 | 1.845 | 0.592 | 0.408 | 1.0404 |
| 69 | 3666.4 | 3666.4 | 2678.7 | 1200.9 | 0.842 | 1.00 | 1.0 | 0.0 | 4806.7 | 2.342 | 0.614 | 0.386 | 1.0360 |
| 70 | 3760.7 | 3643.3 | 2701.2 | 1199.4 | 0.838 | 1.00 | 411.7 | 1059.5 | 4799.5 | 0.301 | 0.614 | 0.386 | 1.0356 |
| 71 | 3732.3 | 3615.3 | 2701.2 | 1198.7 | 0.832 | 1.00 | 413.6 | 1059.5 | 4806.1 | 0.301 | 0.614 | 0.386 | 1.0355 |
| 72 | 3703.4 | 3587.0 | 2701.2 | 1198.0 | 0.826 | 1.00 | 416.5 | 1059.5 | 4812.8 | 0.301 | 0.614 | 0.386 | 1.0354 |
| 73 | 3674.3 | 3558.5 | 2701.2 | 1197.3 | 0.820 | 1.00 | 419.5 | 1059.5 | 4819.6 | 0.301 | 0.614 | 0.386 | 1.0353 |
| 74 | 3558.3 | 3558.3 | 2521.6 | 1039.4 | 0.867 | 1.00 | 1.0 | 0.0 | 4854.6 | 0.642 | 0.658 | 0.342 | 1.0654 |
| 75 | 5493.1 | 5477.8 | 2361.2 | 903.0 | 1.371 | 1.00 | 320.8 | 0.0 | 4718.8 | 0.159 | 0.697 | 0.303 | 1.1371 |
| 76 | 5477.8 | 5477.7 | 2361.2 | 903.8 | 1.370 | 1.00 | 18.2 | 0.0 | 4720.8 | 0.159 | 0.697 | 0.303 | 1.1370 |
| 77 | 4967.8 | 3797.9 | 2361.2 | 845.6 | 1.049 | 1.00 | 3199.7 | 0.0 | 4566.0 | 0.080 | 0.697 | 0.303 | 1.1005 |
| 78 | 4911.4 | 3722.1 | 2361.2 | 843.5 | 1.032 | 1.00 | 3252.9 | 0.0 | 4560.7 | 0.080 | 0.697 | 0.303 | 1.0987 |
| 79 | 3663.8 | 3656.7 | 2361.2 | 913.5 | 0.945 | 1.00 | 261.9 | 0.0 | 4745.0 | 0.080 | 0.697 | 0.303 | 1.0880 |
| 80 | 3645.7 | 3609.6 | 2361.2 | 911.5 | 0.936 | 1.00 | 594.9 | 0.0 | 4740.6 | 0.080 | 0.697 | 0.303 | 1.0870 |
| 81 | 3642.8 | 3606.3 | 2361.2 | 911.5 | 0.935 | 1.00 | 600.8 | 0.0 | 4740.6 | 0.080 | 0.697 | 0.303 | 1.0870 |
| 82 | 3606.3 | 3606.3 | 2361.2 | 914.5 | 0.933 | 1.00 | 1.0 | 0.0 | 4747.4 | 0.080 | 0.697 | 0.303 | 1.0866 |
| 83 | 4997.1 | 3905.3 | 2361.2 | 852.1 | 1.068 | 1.00 | 3064.3 | 0.0 | 4582.9 | 0.078 | 0.697 | 0.303 | 1.1026 |
| 84 | 4857.0 | 3720.4 | 2361.2 | 846.7 | 1.028 | 1.00 | 3190.0 | 0.0 | 4569.0 | 0.078 | 0.697 | 0.303 | 1.0983 |
| 85 | 3670.4 | 3663.7 | 2361.2 | 913.5 | 0.947 | 1.00 | 254.9 | 0.0 | 4745.1 | 0.078 | 0.697 | 0.303 | 1.0882 |
| 86 | 3656.5 | 3649.8 | 2361.2 | 913.7 | 0.944 | 1.00 | 256.9 | 0.0 | 4745.6 | 0.078 | 0.697 | 0.303 | 1.0878 |
| 87 | 3639.4 | 3605.0 | 2361.2 | 911.7 | 0.935 | 1.00 | 580.9 | 0.0 | 4741.1 | 0.078 | 0.697 | 0.303 | 1.0869 |
| 88 | 3636.9 | 3602.2 | 2361.2 | 911.7 | 0.934 | 1.00 | 586.3 | 0.0 | 4741.0 | 0.078 | 0.697 | 0.303 | 1.0868 |
| 89 | 3602.2 | 3602.2 | 2361.2 | 914.5 | 0.932 | 1.00 | 1.0 | 0.0 | 4747.5 | 0.078 | 0.697 | 0.303 | 1.0865 |
| 90 | 3601.8 | 3600.9 | 2361.2 | 914.5 | 0.931 | 1.00 | 91.0 | 0.0 | 4747.4 | 0.159 | 0.697 | 0.303 | 1.0864 |
| 91 | 3600.9 | 3600.9 | 2361.2 | 914.5 | 0.931 | 1.00 | 1.0 | 0.0 | 4747.5 | 0.159 | 0.697 | 0.303 | 1.0864 |
| 92 | 5485.5 | 5453.4 | 2361.2 | 902.2 | 1.367 | 1.00 | 465.4 | 0.0 | 4716.9 | 0.341 | 0.697 | 0.303 | 1.1366 |
| 93 | 5482.6 | 5450.3 | 2361.2 | 902.2 | 1.366 | 1.00 | 468.3 | 0.0 | 4716.9 | 0.341 | 0.697 | 0.303 | 1.1365 |
| 94 | 5482.2 | 5456.8 | 2361.2 | 902.5 | 1.367 | 1.00 | 415.1 | 0.0 | 4717.7 | 0.341 | 0.697 | 0.303 | 1.1366 |
| 95 | 5475.5 | 5450.1 | 2361.2 | 902.5 | 1.365 | 1.00 | 414.8 | 0.0 | 4717.8 | 0.341 | 0.697 | 0.303 | 1.1364 |
| 96 | 5437.4 | 5412.0 | 2361.2 | 902.8 | 1.357 | 1.00 | 415.3 | 0.0 | 4718.4 | 0.341 | 0.697 | 0.303 | 1.1354 |
| 97 | 5434.9 | 5409.3 | 2361.2 | 902.8 | 1.356 | 1.00 | 417.9 | 0.0 | 4718.4 | 0.341 | 0.697 | 0.303 | 1.1353 |
| 98 | 5396.5 | 5370.9 | 2361.2 | 903.0 | 1.348 | 1.00 | 418.1 | 0.0 | 4719.0 | 0.341 | 0.697 | 0.303 | 1.1342 |
| 99 | 5392.8 | 5367.0 | 2361.2 | 903.0 | 1.347 | 1.00 | 420.8 | 0.0 | 4719.0 | 0.341 | 0.697 | 0.303 | 1.1341 |

Table 4-1 HPOTP TURBINE COOLANT ANALYSIS (FPL) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 5378.3 | 5298.2 | 2361.2 | 900.3 | 1.335 | 1.00 | 742.5 | 0.0 | 4712.7 | 0.341 | 0.697 | 0.303 | 1.1328 |
| 101 | 5376.1 | 5295.3 | 2361.2 | 900.3 | 1.334 | 1.00 | 749.0 | 0.0 | 4712.7 | 0.341 | 0.697 | 0.303 | 1.1327 |
| 102 | 5295.3 | 5295.3 | 2361.2 | 904.9 | 1.328 | 1.00 | 1.0 | 0.0 | 4723.5 | 0.341 | 0.697 | 0.303 | 1.1319 |
| 103 | 5289.6 | 5278.2 | 2361.2 | 904.4 | 1.325 | 1.00 | 281.6 | 0.0 | 4722.3 | 0.341 | 0.697 | 0.303 | 1.1315 |
| 104 | 5288.8 | 5277.5 | 2361.2 | 904.4 | 1.325 | 1.00 | 282.3 | 0.0 | 4722.3 | 0.341 | 0.697 | 0.303 | 1.1315 |
| 105 | 5287.8 | 5282.3 | 2361.2 | 904.7 | 1.326 | 1.00 | 196.1 | 0.0 | 4723.0 | 0.341 | 0.697 | 0.303 | 1.1316 |
| 106 | 5287.4 | 5281.9 | 2361.2 | 904.7 | 1.326 | 1.00 | 196.0 | 0.0 | 4723.0 | 0.341 | 0.697 | 0.303 | 1.1316 |
| 107 | 4839.1 | 3642.7 | 2361.2 | 841.8 | 1.014 | 1.00 | 3290.8 | 0.0 | 4556.3 | 0.341 | 0.697 | 0.303 | 1.0968 |
| 108 | 4798.5 | 3590.4 | 2361.2 | 838.9 | 1.004 | 1.00 | 3322.8 | 0.0 | 4548.8 | 0.341 | 0.697 | 0.303 | 1.0957 |
| 109 | 3566.2 | 3566.2 | 2520.6 | 1038.5 | 0.869 | 1.00 | 1.0 | 0.0 | 4854.1 | 0.642 | 0.658 | 0.342 | 1.0657 |
| 110 | 3566.1 | 3566.1 | 2520.6 | 1038.5 | 0.869 | 1.00 | 27.1 | 0.0 | 4854.1 | 0.598 | 0.658 | 0.342 | 1.0657 |
| 111 | 3566.1 | 3566.1 | 2520.6 | 1038.5 | 0.869 | 1.00 | 4.7 | 0.0 | 4854.1 | 0.598 | 0.658 | 0.342 | 1.0657 |
| 112 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 113 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 114 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 115 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 116 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 117 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 118 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 119 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 120 | 5349.6 | 5035.6 | 2361.2 | 898.9 | 1.278 | 1.00 | 1501.0 | 0.0 | 4705.9 | 0.165 | 0.697 | 0.303 | 1.1260 |
| 121 | 5283.6 | 5192.8 | 2361.2 | 900.1 | 1.312 | 1.00 | 803.7 | 0.0 | 4712.2 | 0.165 | 0.697 | 0.303 | 1.1300 |
| 122 | 4957.4 | 3731.4 | 2361.2 | 841.4 | 1.037 | 1.00 | 3296.4 | 0.0 | 4555.0 | 0.165 | 0.697 | 0.303 | 1.0993 |
| 123 | 4957.4 | 3721.0 | 2361.2 | 839.3 | 1.036 | 1.00 | 3324.3 | 0.0 | 4549.7 | 0.165 | 0.697 | 0.303 | 1.0992 |
| 124 | 4400.0 | 4280.4 | 2361.2 | 901.8 | 1.103 | 1.00 | 1007.1 | 0.0 | 4717.2 | 0.165 | 0.697 | 0.303 | 1.1056 |
| 125 | 4375.8 | 4257.2 | 2361.2 | 903.0 | 1.097 | 1.00 | 998.0 | 0.0 | 4719.9 | 0.165 | 0.697 | 0.303 | 1.1049 |
| 126 | 4255.4 | 4133.7 | 2361.2 | 903.3 | 1.067 | 1.00 | 1024.0 | 0.0 | 4720.7 | 0.165 | 0.697 | 0.303 | 1.1016 |
| 127 | 4241.8 | 4119.3 | 2361.2 | 903.3 | 1.064 | 1.00 | 1031.3 | 0.0 | 4720.7 | 0.165 | 0.697 | 0.303 | 1.1012 |
| 128 | 4117.6 | 3992.1 | 2361.2 | 903.6 | 1.034 | 1.00 | 1056.6 | 0.0 | 4721.6 | 0.165 | 0.697 | 0.303 | 1.0979 |
| 129 | 4097.2 | 3970.7 | 2361.2 | 903.5 | 1.029 | 1.00 | 1064.6 | 0.0 | 4721.5 | 0.165 | 0.697 | 0.303 | 1.0974 |
| 130 | 3979.4 | 3549.8 | 2361.2 | 895.7 | 0.936 | 1.00 | 2054.3 | 0.0 | 4699.0 | 0.165 | 0.697 | 0.303 | 1.0875 |
| 131 | 3543.3 | 3543.3 | 2361.2 | 914.9 | 0.917 | 1.00 | 1.0 | 0.0 | 4748.5 | 0.165 | 0.697 | 0.303 | 1.0849 |
| 132 | 5987.3 | 5984.4 | 873.6 | 279.0 | 2.750 | 1.00 | 97.8 | 0.0 | 4870.3 | 0.297 | 1.000 | 0.000 | 1.4656 |

Table 4-1 HPOTP TURBINE COOLANT ANALYSIS (FPL) (Concluded)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 133 | 5979.5 | 5954.5 | 873.6 | 278.7 | 2.744 | 1.00 | 290.3 | 0.0 | 4860.3 | 0.297 | 1.000 | 0.000 | 1.4630 |
| 134 | 5801.9 | 5256.1 | 873.6 | 273.1 | 2.579 | 1.00 | 1382.1 | 0.0 | 4618.3 | 0.297 | 1.000 | 0.000 | 1.4023 |
| 135 | 5795.2 | 5242.1 | 873.6 | 273.0 | 2.575 | 1.00 | 1394.7 | 0.0 | 4613.3 | 0.297 | 1.000 | 0.000 | 1.4010 |
| 136 | 5490.3 | 5456.2 | 873.6 | 280.7 | 2.586 | 1.00 | 349.2 | 0.0 | 4699.3 | 0.297 | 1.000 | 0.000 | 1.4121 |
| 137 | 5441.0 | 5407.3 | 873.6 | 280.9 | 2.570 | 1.00 | 347.8 | 0.0 | 4683.3 | 0.297 | 1.000 | 0.000 | 1.4072 |
| 138 | 5441.0 | 5408.1 | 873.6 | 281.0 | 2.570 | 1.00 | 344.4 | 0.0 | 4683.6 | 0.297 | 1.000 | 0.000 | 1.4072 |
| 139 | 5440.2 | 5407.2 | 873.6 | 281.0 | 2.570 | 1.00 | 344.4 | 0.0 | 4683.3 | 0.297 | 1.000 | 0.000 | 1.4071 |
| 140 | 5420.6 | 5418.9 | 873.6 | 281.4 | 2.570 | 1.00 | 78.8 | 0.0 | 4688.1 | 0.297 | 1.000 | 0.000 | 1.4076 |
| 141 | 5418.9 | 5418.8 | 873.6 | 281.5 | 2.570 | 1.00 | 12.7 | 0.0 | 4688.1 | 0.297 | 1.000 | 0.000 | 1.4076 |
| 142 | 5418.8 | 5416.7 | 873.6 | 281.4 | 2.569 | 1.00 | 87.4 | 0.0 | 4687.4 | 0.297 | 1.000 | 0.000 | 1.4074 |
| 143 | 5418.2 | 5416.0 | 873.6 | 281.4 | 2.569 | 1.00 | 87.4 | 0.0 | 4687.2 | 0.297 | 1.000 | 0.000 | 1.4074 |
| 144 | 4788.7 | 3168.4 | 873.6 | 256.0 | 1.919 | 1.00 | 2646.2 | 0.0 | 3826.1 | 0.297 | 1.000 | 0.000 | 1.2119 |
| 145 | 3659.2 | 3636.6 | 873.6 | 287.7 | 1.920 | 1.00 | 330.1 | 0.0 | 4089.6 | 0.297 | 1.000 | 0.000 | 1.2373 |
| 146 | 3656.4 | 3633.8 | 873.6 | 287.7 | 1.918 | 1.00 | 330.1 | 0.0 | 4088.7 | 0.297 | 1.000 | 0.000 | 1.2370 |
| 147 | 3633.8 | 3616.0 | 873.6 | 287.9 | 1.910 | 1.00 | 293.7 | 0.0 | 4083.0 | 0.297 | 1.000 | 0.000 | 1.2354 |
| 148 | 3631.8 | 3613.9 | 873.6 | 287.9 | 1.910 | 1.00 | 294.9 | 0.0 | 4082.3 | 0.297 | 1.000 | 0.000 | 1.2352 |
| 149 | 3613.9 | 3613.9 | 873.6 | 288.3 | 1.907 | 1.00 | 1.0 | 0.0 | 4083.7 | 0.297 | 1.000 | 0.000 | 1.2350 |
| 150 | 3611.8 | 3607.7 | 873.6 | 288.2 | 1.905 | 1.00 | 141.9 | 0.0 | 4081.3 | 0.297 | 1.000 | 0.000 | 1.2345 |
| 151 | 3607.7 | 3607.7 | 873.6 | 288.3 | 1.905 | 1.00 | 1.0 | 0.0 | 4081.6 | 0.297 | 1.000 | 0.000 | 1.2344 |
| 152 | 3605.6 | 3601.4 | 873.6 | 288.2 | 1.903 | 1.00 | 142.1 | 0.0 | 4079.2 | 0.297 | 1.000 | 0.000 | 1.2339 |
| 153 | 3601.4 | 3601.4 | 873.6 | 288.3 | 1.902 | 1.00 | 1.0 | 0.0 | 4079.5 | 0.297 | 1.000 | 0.000 | 1.2339 |
| 154 | 3601.4 | 3601.4 | 873.6 | 288.3 | 1.902 | 1.00 | 14.5 | 0.0 | 4079.4 | 0.297 | 1.000 | 0.000 | 1.2338 |
| 155 | 3601.4 | 3601.1 | 873.6 | 288.3 | 1.902 | 1.00 | 39.9 | 0.0 | 4079.3 | 0.297 | 1.000 | 0.000 | 1.2338 |
| 156 | 3601.4 | 3601.0 | 873.6 | 288.3 | 1.902 | 1.00 | 39.9 | 0.0 | 4079.3 | 0.297 | 1.000 | 0.000 | 1.2338 |
| 157 | 3601.0 | 3601.0 | 873.6 | 288.3 | 1.902 | 1.00 | 13.4 | 0.0 | 4079.3 | 0.297 | 1.000 | 0.000 | 1.2338 |
| 158 | 3601.0 | 3601.0 | 873.6 | 288.3 | 1.902 | 1.00 | 1.0 | 0.0 | 4079.3 | 0.297 | 1.000 | 0.000 | 1.2338 |
| 159 | 4308.9 | 4172.5 | 3006.3 | 1458.7 | 0.880 | 1.00 | 1050.6 | 495.5 | 5279.5 | 66.084 | 0.528 | 0.472 | 1.0512 |
| 160 | 4271.9 | 3670.4 | 3006.2 | 1414.0 | 0.804 | 1.00 | 957.7 | 2312.2 | 5199.7 | 64.935 | 0.528 | 0.472 | 1.0446 |
| 161 | 3626.5 | 3562.6 | 2878.5 | 1401.1 | 0.785 | 1.00 | 837.0 | 132.9 | 5186.7 | 66.976 | 0.530 | 0.470 | 1.0433 |
| 162 | 3566.2 | 3566.2 | 2396.0 | 740.2 | 0.871 | 1.00 | 1.0 | 0.0 | 4855.0 | 0.211 | 0.925 | 0.075 | 1.1132 |

Table 4-2 HPOTP TURBINE COOLANT ANALYSIS (104%)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5253.0 | 5248.6 | 3124.9 | 1501.4 | 1.044 | 1.00 | 192.8 | 0.0 | 5391.6 | 1.394 | 0.539 | 0.461 | 1.0655 |
| 2 | 5238.0 | 5216.8 | 3124.9 | 1499.5 | 1.039 | 1.00 | 433.9 | 0.0 | 5388.4 | 1.394 | 0.539 | 0.461 | 1.0651 |
| 3 | 5216.7 | 5212.5 | 3124.9 | 1501.1 | 1.037 | 1.00 | 193.2 | 0.0 | 5391.7 | 1.394 | 0.539 | 0.461 | 1.0651 |
| 4 | 5203.1 | 5175.9 | 3124.9 | 1498.8 | 1.032 | 1.00 | 492.8 | 0.0 | 5387.9 | 1.394 | 0.539 | 0.461 | 1.0646 |
| 5 | 5175.6 | 5175.6 | 2260.8 | 859.8 | 1.331 | 1.00 | 1.0 | 0.0 | 4653.4 | 2.255 | 0.715 | 0.285 | 1.1374 |
| 6 | 5626.8 | 5625.1 | 861.5 | 277.7 | 2.657 | 1.00 | 75.9 | 0.0 | 4750.4 | 0.861 | 1.000 | 0.000 | 1.4325 |
| 7 | 5479.9 | 5177.5 | 861.5 | 274.4 | 2.545 | 1.00 | 1041.1 | 0.0 | 4593.8 | 0.861 | 1.000 | 0.000 | 1.3929 |
| 8 | 5173.9 | 5173.9 | 2260.8 | 859.9 | 1.331 | 1.00 | 1.0 | 0.0 | 4653.6 | 2.255 | 0.715 | 0.285 | 1.1373 |
| 9 | 5172.7 | 5170.2 | 2260.8 | 860.5 | 1.329 | 1.00 | 131.5 | 0.0 | 4655.4 | 0.761 | 0.715 | 0.285 | 1.1371 |
| 10 | 5172.1 | 5169.6 | 2260.8 | 860.5 | 1.329 | 1.00 | 131.7 | 0.0 | 4655.4 | 0.761 | 0.715 | 0.285 | 1.1371 |
| 11 | 5169.6 | 5169.6 | 2260.8 | 860.7 | 1.329 | 1.00 | 1.0 | 0.0 | 4655.8 | 0.761 | 0.715 | 0.285 | 1.1371 |
| 12 | 5168.8 | 5167.3 | 2260.8 | 860.6 | 1.328 | 1.00 | 102.2 | 0.0 | 4655.6 | 0.761 | 0.715 | 0.285 | 1.1370 |
| 13 | 5167.3 | 5167.3 | 2260.8 | 860.7 | 1.328 | 1.00 | 1.0 | 0.0 | 4655.8 | 0.761 | 0.715 | 0.285 | 1.1370 |
| 14 | 5087.8 | 4926.7 | 2260.8 | 852.7 | 1.284 | 1.00 | 1073.7 | 0.0 | 4634.7 | 0.111 | 0.715 | 0.285 | 1.1316 |
| 15 | 5064.3 | 4901.8 | 2260.8 | 853.1 | 1.278 | 1.00 | 1082.8 | 0.0 | 4635.7 | 0.111 | 0.715 | 0.285 | 1.1309 |
| 16 | 4899.6 | 4784.1 | 2260.8 | 856.3 | 1.247 | 1.00 | 923.4 | 0.0 | 4644.5 | 0.111 | 0.715 | 0.285 | 1.1270 |
| 17 | 4775.4 | 4657.1 | 2260.8 | 858.8 | 1.217 | 1.00 | 946.1 | 0.0 | 4645.7 | 0.111 | 0.715 | 0.285 | 1.1234 |
| 18 | 4630.5 | 4577.0 | 2260.8 | 860.9 | 1.193 | 1.00 | 641.0 | 0.0 | 4656.9 | 0.111 | 0.715 | 0.285 | 1.1206 |
| 19 | 4629.5 | 4575.5 | 2260.8 | 860.9 | 1.193 | 1.00 | 647.4 | 0.0 | 4656.8 | 0.111 | 0.715 | 0.285 | 1.1205 |
| 20 | 4491.8 | 3995.9 | 2260.8 | 834.5 | 1.087 | 1.00 | 2048.8 | 0.0 | 4587.2 | 0.111 | 0.715 | 0.285 | 1.1082 |
| 21 | 4466.2 | 3966.6 | 2260.8 | 834.3 | 1.080 | 1.00 | 2063.8 | 0.0 | 4586.6 | 0.111 | 0.715 | 0.285 | 1.1074 |
| 22 | 3960.3 | 3960.3 | 2262.5 | 868.5 | 1.041 | 1.00 | 1.0 | 0.0 | 4676.8 | 0.761 | 0.715 | 0.285 | 1.1027 |
| 23 | 5083.7 | 4914.1 | 2260.8 | 852.3 | 1.282 | 1.00 | 1102.1 | 0.0 | 4633.7 | 0.649 | 0.715 | 0.285 | 1.1313 |
| 24 | 4927.6 | 4752.7 | 2260.8 | 852.6 | 1.244 | 1.00 | 1137.0 | 0.0 | 4634.7 | 0.649 | 0.715 | 0.285 | 1.1267 |
| 25 | 4750.9 | 4748.4 | 2260.8 | 863.0 | 1.230 | 1.00 | 136.4 | 0.0 | 4662.3 | 0.649 | 0.715 | 0.285 | 1.1250 |
| 26 | 4750.7 | 4748.2 | 2260.8 | 863.0 | 1.230 | 1.00 | 137.2 | 0.0 | 4662.3 | 0.649 | 0.715 | 0.285 | 1.1250 |
| 27 | 4498.8 | 3967.5 | 2260.8 | 832.2 | 1.083 | 1.00 | 2126.6 | 0.0 | 4581.1 | 0.649 | 0.715 | 0.285 | 1.1077 |
| 28 | 3961.6 | 3961.6 | 2260.8 | 867.6 | 1.041 | 1.00 | 1.0 | 0.0 | 4675.6 | 0.761 | 0.715 | 0.285 | 1.1028 |
| 29 | 5240.3 | 3960.7 | 3125.0 | 1397.5 | 0.860 | 1.00 | 946.7 | 3301.6 | 5202.9 | 61.760 | 0.539 | 0.461 | 1.0482 |
| 30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 31 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 32 | 4075.6 | 3957.2 | 2283.2 | 868.4 | 1.040 | 1.00 | 136.1 | 1018.0 | 4676.8 | 0.132 | 0.715 | 0.285 | 1.1026 |

Table 4-2 HPOTP TURBINE COOLANT ANALYSIS (104%) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 4071.4 | 3953.0 | 2283.2 | 868.5 | 1.039 | 1.00 | 136.2 | 1018.0 | 4676.8 | 0.132 | 0.715 | 0.285 | 1.1025 |
| 34 | 4067.0 | 3948.7 | 2283.2 | 868.5 | 1.038 | 1.00 | 136.4 | 1018.0 | 4676.9 | 0.132 | 0.715 | 0.285 | 1.1023 |
| 35 | 4062.7 | 3944.5 | 2283.2 | 868.5 | 1.037 | 1.00 | 136.5 | 1018.0 | 4677.0 | 0.132 | 0.715 | 0.285 | 1.1022 |
| 36 | 3944.5 | 3944.5 | 2704.8 | 1226.3 | 0.898 | 1.00 | 1.0 | 0.0 | 4896.8 | 1.726 | 0.601 | 0.399 | 1.0412 |
| 37 | 5173.9 | 5173.9 | 2260.8 | 860.7 | 1.330 | 1.00 | 1.9 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 38 | 5173.7 | 5173.3 | 2260.8 | 860.6 | 1.330 | 1.00 | 52.1 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 39 | 5173.7 | 5173.3 | 2260.8 | 860.6 | 1.330 | 1.00 | 52.1 | 0.0 | 4655.6 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 40 | 5173.7 | 5173.3 | 2260.8 | 860.6 | 1.330 | 1.00 | 52.1 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 41 | 5173.7 | 5173.3 | 2260.8 | 860.6 | 1.330 | 1.00 | 52.1 | 0.0 | 4655.6 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 42 | 5173.3 | 5173.3 | 2260.8 | 860.7 | 1.330 | 1.00 | 2.1 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 43 | 5173.3 | 5173.3 | 2260.8 | 860.7 | 1.330 | 1.00 | 10.8 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 44 | 5173.3 | 5173.3 | 2260.8 | 860.7 | 1.330 | 1.00 | 1.3 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 45 | 5173.3 | 5173.3 | 2260.8 | 860.7 | 1.330 | 1.00 | 11.0 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 46 | 5173.3 | 5173.3 | 2260.8 | 860.7 | 1.330 | 1.00 | 2.1 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 47 | 5173.3 | 5173.2 | 2260.8 | 860.7 | 1.330 | 1.00 | 14.3 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 48 | 5173.2 | 5173.2 | 2260.8 | 860.7 | 1.330 | 1.00 | 2.5 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 49 | 5173.2 | 5173.2 | 2260.8 | 860.7 | 1.330 | 1.00 | 12.9 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 50 | 5173.2 | 5173.2 | 2260.8 | 860.7 | 1.330 | 1.00 | 0.9 | 0.0 | 4655.7 | 0.142 | 0.715 | 0.285 | 1.1372 |
| 51 | 5173.9 | 5173.9 | 2260.8 | 860.6 | 1.330 | 1.00 | 15.8 | 0.0 | 4655.7 | 1.198 | 0.715 | 0.285 | 1.1372 |
| 52 | 5173.9 | 5173.8 | 2260.8 | 860.6 | 1.330 | 1.00 | 27.2 | 0.0 | 4655.7 | 1.198 | 0.715 | 0.285 | 1.1372 |
| 53 | 5167.6 | 5155.2 | 2260.8 | 860.1 | 1.326 | 1.00 | 294.0 | 0.0 | 4654.2 | 0.900 | 0.715 | 0.285 | 1.1368 |
| 54 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 55 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 56 | 5166.9 | 5147.7 | 2260.8 | 859.8 | 1.325 | 1.00 | 366.2 | 0.0 | 4653.3 | 0.900 | 0.715 | 0.285 | 1.1366 |
| 57 | 5159.9 | 5140.7 | 2260.8 | 859.8 | 1.323 | 1.00 | 366.5 | 0.0 | 4653.4 | 0.900 | 0.715 | 0.285 | 1.1364 |
| 58 | 5140.7 | 5140.7 | 2260.8 | 860.8 | 1.322 | 1.00 | 1.0 | 0.0 | 4656.2 | 0.900 | 0.715 | 0.285 | 1.1362 |
| 59 | 5129.9 | 5108.2 | 2260.8 | 859.8 | 1.316 | 1.00 | 389.4 | 0.0 | 4653.6 | 0.472 | 0.715 | 0.285 | 1.1355 |
| 60 | 5129.5 | 5107.8 | 2260.8 | 859.8 | 1.316 | 1.00 | 391.2 | 0.0 | 4653.6 | 0.472 | 0.715 | 0.285 | 1.1355 |
| 61 | 4882.5 | 4098.4 | 2260.8 | 817.5 | 0.866 | 0.96 | 2883.3 | 0.0 | 5697.0 | 0.472 | 0.715 | 0.285 | 1.1147 |
| 62 | 4763.2 | 3956.3 | 2260.8 | 814.6 | 0.842 | 0.96 | 2967.1 | 0.0 | 5687.5 | 0.472 | 0.715 | 0.285 | 1.1110 |
| 63 | 3943.2 | 3943.2 | 2704.3 | 1225.7 | 0.898 | 1.00 | 1.0 | 0.0 | 4893.1 | 1.726 | 0.602 | 0.398 | 1.0411 |
| 64 | 4726.0 | 3848.7 | 2260.8 | 799.7 | 0.821 | 0.93 | 3473.9 | 0.0 | 5822.1 | 0.429 | 0.715 | 0.285 | 1.1047 |
| 65 | 4616.6 | 3506.5 | 2260.8 | 795.8 | 0.798 | 0.93 | 3579.3 | 0.0 | 5807.7 | 0.429 | 0.715 | 0.285 | 1.1011 |
| 66 | 3492.2 | 3492.2 | 2611.1 | 1164.3 | 0.822 | 1.00 | 1.0 | 0.0 | 4394.1 | 2.155 | 0.625 | 0.375 | 1.0274 |

Table 4-2 HPOTP TURBINE COOLANT ANALYSIS (104%) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 67 | 3855.8 | 3751.2 | 2704.3 | 1216.3 | 0.863 | 1.00 | 1056.7 | 0.0 | 4875.1 | 1.726 | 0.602 | 0.398 | 1.0385 |
| 68 | 3738.0 | 3489.5 | 2704.3 | 1202.1 | 0.816 | 1.00 | 1673.6 | 0.0 | 4847.5 | 1.726 | 0.602 | 0.398 | 1.0348 |
| 69 | 3485.4 | 3485.4 | 2616.0 | 1164.2 | 0.822 | 1.00 | 1.0 | 0.0 | 4390.3 | 2.155 | 0.624 | 0.376 | 1.0271 |
| 70 | 3570.3 | 3464.3 | 2636.7 | 1164.3 | 0.817 | 1.00 | 398.0 | 1018.0 | 4389.8 | 0.284 | 0.624 | 0.376 | 1.0266 |
| 71 | 3543.9 | 3438.4 | 2636.7 | 1164.3 | 0.812 | 1.00 | 400.2 | 1018.0 | 4391.2 | 0.284 | 0.624 | 0.376 | 1.0261 |
| 72 | 3517.2 | 3412.2 | 2636.7 | 1164.2 | 0.806 | 1.00 | 403.1 | 1018.0 | 4391.4 | 0.284 | 0.624 | 0.376 | 1.0256 |
| 73 | 3490.3 | 3385.9 | 2636.7 | 1164.2 | 0.800 | 1.00 | 406.0 | 1018.0 | 4390.4 | 0.284 | 0.624 | 0.376 | 1.0251 |
| 74 | 3385.6 | 3385.6 | 2445.4 | 986.8 | 0.852 | 1.00 | 1.0 | 0.0 | 4812.9 | 0.581 | 0.670 | 0.330 | 1.0701 |
| 75 | 5166.9 | 5154.4 | 2260.8 | 860.1 | 1.326 | 1.00 | 295.7 | 0.0 | 4654.2 | 0.142 | 0.715 | 0.285 | 1.1368 |
| 76 | 5154.3 | 5154.3 | 2260.8 | 860.8 | 1.325 | 1.00 | 16.8 | 0.0 | 4656.0 | 0.142 | 0.715 | 0.285 | 1.1366 |
| 77 | 4691.7 | 3473.8 | 2260.8 | 791.4 | 0.805 | 0.91 | 3728.9 | 0.0 | 5586.6 | 0.072 | 0.715 | 0.285 | 1.1009 |
| 78 | 4632.5 | 3394.1 | 2260.8 | 788.9 | 0.792 | 0.91 | 3791.6 | 0.0 | 5577.4 | 0.072 | 0.715 | 0.285 | 1.0989 |
| 79 | 3473.1 | 3467.2 | 2260.8 | 869.6 | 0.921 | 1.00 | 244.3 | 0.0 | 4681.5 | 0.072 | 0.715 | 0.285 | 1.0893 |
| 80 | 3458.3 | 3428.7 | 2260.8 | 868.2 | 0.913 | 1.00 | 545.7 | 0.0 | 4678.0 | 0.072 | 0.715 | 0.285 | 1.0884 |
| 81 | 3455.8 | 3426.0 | 2260.8 | 868.2 | 0.912 | 1.00 | 550.6 | 0.0 | 4678.0 | 0.072 | 0.715 | 0.285 | 1.0884 |
| 82 | 3425.9 | 3425.9 | 2260.8 | 870.6 | 0.910 | 1.00 | 1.0 | 0.0 | 4684.3 | 0.072 | 0.715 | 0.285 | 1.0881 |
| 83 | 4721.1 | 3590.3 | 2260.8 | 796.7 | 0.816 | 0.92 | 3568.3 | 0.0 | 5609.2 | 0.070 | 0.715 | 0.285 | 1.1035 |
| 84 | 4574.7 | 3400.0 | 2260.8 | 791.4 | 0.785 | 0.92 | 3707.1 | 0.0 | 5589.8 | 0.070 | 0.715 | 0.285 | 1.0986 |
| 85 | 3479.6 | 3474.1 | 2260.8 | 869.6 | 0.922 | 1.00 | 236.7 | 0.0 | 4681.5 | 0.070 | 0.715 | 0.285 | 1.0895 |
| 86 | 3468.2 | 3462.7 | 2260.8 | 870.0 | 0.919 | 1.00 | 234.6 | 0.0 | 4682.6 | 0.070 | 0.715 | 0.285 | 1.0891 |
| 87 | 3454.3 | 3426.4 | 2260.8 | 868.4 | 0.912 | 1.00 | 530.3 | 0.0 | 4678.4 | 0.070 | 0.715 | 0.285 | 1.0884 |
| 88 | 3452.2 | 3424.1 | 2260.8 | 868.4 | 0.911 | 1.00 | 534.6 | 0.0 | 4678.4 | 0.070 | 0.715 | 0.285 | 1.0883 |
| 89 | 3424.1 | 3424.1 | 2260.8 | 870.6 | 0.909 | 1.00 | 1.0 | 0.0 | 4684.3 | 0.070 | 0.715 | 0.285 | 1.0880 |
| 90 | 3423.7 | 3423.1 | 2260.8 | 870.5 | 0.909 | 1.00 | 83.1 | 0.0 | 4684.2 | 0.142 | 0.715 | 0.285 | 1.0880 |
| 91 | 3423.1 | 3423.1 | 2260.8 | 870.6 | 0.909 | 1.00 | 1.0 | 0.0 | 4684.4 | 0.142 | 0.715 | 0.285 | 1.0880 |
| 92 | 5161.3 | 5136.0 | 2260.8 | 859.5 | 1.323 | 1.00 | 419.8 | 0.0 | 4652.7 | 0.297 | 0.715 | 0.285 | 1.1363 |
| 93 | 5158.9 | 5133.5 | 2260.8 | 859.5 | 1.322 | 1.00 | 422.0 | 0.0 | 4652.7 | 0.297 | 0.715 | 0.285 | 1.1363 |
| 94 | 5158.6 | 5138.6 | 2260.8 | 859.8 | 1.323 | 1.00 | 374.0 | 0.0 | 4653.4 | 0.297 | 0.715 | 0.285 | 1.1364 |
| 95 | 5153.2 | 5133.3 | 2260.8 | 859.8 | 1.322 | 1.00 | 373.8 | 0.0 | 4653.5 | 0.297 | 0.715 | 0.285 | 1.1362 |
| 96 | 5123.3 | 5103.3 | 2260.8 | 860.0 | 1.315 | 1.00 | 374.2 | 0.0 | 4653.9 | 0.297 | 0.715 | 0.285 | 1.1353 |
| 97 | 5121.3 | 5101.2 | 2260.8 | 860.0 | 1.314 | 1.00 | 376.1 | 0.0 | 4653.9 | 0.297 | 0.715 | 0.285 | 1.1353 |
| 98 | 5091.2 | 5071.1 | 2260.8 | 860.1 | 1.307 | 1.00 | 376.3 | 0.0 | 4654.4 | 0.297 | 0.715 | 0.285 | 1.1344 |
| 99 | 5088.2 | 5068.0 | 2260.8 | 860.2 | 1.307 | 1.00 | 378.3 | 0.0 | 4654.5 | 0.297 | 0.715 | 0.285 | 1.1343 |

Table 4-2 HPOTP TURBINE COOLANT ANALYSIS (104%) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 5076.9 | 5014.0 | 2260.8 | 858.1 | 1.297 | 1.00 | 667.5 | 0.0 | 4649.0 | 0.297 | 0.715 | 0.285 | 1.1332 |
| 101 | 5075.1 | 5011.8 | 2260.8 | 858.1 | 1.297 | 1.00 | 672.4 | 0.0 | 4649.0 | 0.297 | 0.715 | 0.285 | 1.1331 |
| 102 | 5011.8 | 5011.8 | 2260.8 | 861.6 | 1.292 | 1.00 | 1.0 | 0.0 | 4658.4 | 0.297 | 0.715 | 0.285 | 1.1325 |
| 103 | 5007.3 | 4998.4 | 2260.8 | 861.2 | 1.289 | 1.00 | 252.6 | 0.0 | 4657.3 | 0.297 | 0.715 | 0.285 | 1.1322 |
| 104 | 5006.7 | 4997.8 | 2260.8 | 861.2 | 1.289 | 1.00 | 253.1 | 0.0 | 4657.3 | 0.297 | 0.715 | 0.285 | 1.1322 |
| 105 | 5005.9 | 5001.6 | 2260.8 | 861.4 | 1.290 | 1.00 | 175.8 | 0.0 | 4657.9 | 0.297 | 0.715 | 0.285 | 1.1323 |
| 106 | 5005.6 | 5001.3 | 2260.8 | 861.4 | 1.290 | 1.00 | 175.7 | 0.0 | 4657.9 | 0.297 | 0.715 | 0.285 | 1.1323 |
| 107 | 4622.4 | 3459.9 | 2260.8 | 793.0 | 0.795 | 0.92 | 3665.9 | 0.0 | 5595.6 | 0.297 | 0.715 | 0.285 | 1.1002 |
| 108 | 4582.4 | 3404.2 | 2260.8 | 791.2 | 0.787 | 0.92 | 3715.3 | 0.0 | 5588.5 | 0.297 | 0.715 | 0.285 | 1.0988 |
| 109 | 3392.2 | 3392.2 | 2444.4 | 986.0 | 0.853 | 1.00 | 1.0 | 0.0 | 4812.2 | 0.581 | 0.671 | 0.329 | 1.0704 |
| 110 | 3392.1 | 3392.1 | 2444.4 | 985.8 | 0.854 | 1.00 | 24.5 | 0.0 | 4811.7 | 0.531 | 0.671 | 0.329 | 1.0704 |
| 111 | 3392.1 | 3392.1 | 2444.4 | 985.8 | 0.854 | 1.00 | 4.2 | 0.0 | 4811.7 | 0.531 | 0.671 | 0.329 | 1.0704 |
| 112 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 113 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 114 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 115 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 116 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 117 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 118 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 119 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 120 | 5042.4 | 4772.6 | 2260.8 | 847.5 | 1.256 | 1.00 | 1405.2 | 0.0 | 4621.0 | 0.152 | 0.715 | 0.285 | 1.1281 |
| 121 | 4985.5 | 4906.6 | 2260.8 | 857.7 | 1.273 | 1.00 | 760.4 | 0.0 | 4648.0 | 0.152 | 0.715 | 0.285 | 1.1302 |
| 122 | 4672.6 | 3318.8 | 2260.8 | 783.1 | 0.792 | 0.90 | 3966.1 | 0.0 | 5551.3 | 0.152 | 0.715 | 0.285 | 1.0976 |
| 123 | 4672.6 | 3308.9 | 2260.8 | 782.0 | 0.793 | 0.90 | 3995.0 | 0.0 | 5546.0 | 0.152 | 0.715 | 0.285 | 1.0975 |
| 124 | 4133.4 | 4029.6 | 2260.8 | 858.2 | 1.068 | 1.00 | 952.0 | 0.0 | 4650.2 | 0.152 | 0.715 | 0.285 | 1.1059 |
| 125 | 4112.2 | 4009.0 | 2260.8 | 860.3 | 1.061 | 1.00 | 946.1 | 0.0 | 4655.9 | 0.152 | 0.715 | 0.285 | 1.1051 |
| 126 | 4007.3 | 3901.5 | 2260.8 | 860.7 | 1.035 | 1.00 | 970.2 | 0.0 | 4657.0 | 0.152 | 0.715 | 0.285 | 1.1021 |
| 127 | 3995.4 | 3889.0 | 2260.8 | 860.5 | 1.032 | 1.00 | 976.5 | 0.0 | 4656.7 | 0.152 | 0.715 | 0.285 | 1.1018 |
| 128 | 3887.6 | 3778.8 | 2260.8 | 860.9 | 1.005 | 1.00 | 998.5 | 0.0 | 4657.8 | 0.152 | 0.715 | 0.285 | 1.0988 |
| 129 | 3869.8 | 3760.1 | 2260.8 | 860.8 | 1.000 | 1.00 | 1005.5 | 0.0 | 4657.5 | 0.152 | 0.715 | 0.285 | 1.0983 |
| 130 | 3768.5 | 3404.0 | 2260.8 | 842.8 | 0.931 | 1.00 | 1898.7 | 0.0 | 4610.1 | 0.152 | 0.715 | 0.285 | 1.0908 |
| 131 | 3397.8 | 3397.8 | 2260.8 | 870.3 | 0.903 | 1.00 | 1.0 | 0.0 | 4683.7 | 0.152 | 0.715 | 0.285 | 1.0874 |
| 132 | 5625.5 | 5622.9 | 861.5 | 277.7 | 2.657 | 1.00 | 95.8 | 0.0 | 4749.6 | 0.281 | 1.000 | 0.000 | 1.4323 |

Table 4-2 HPOTP TURBINE COOLANT ANALYSIS (104%) (Concluded)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H20 | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 133 | 5618.3 | 5595.2 | 861.5 | 277.4 | 2.650 | 1.00 | 284.2 | 0.0 | 4740.0 | 0.281 | 1.000 | 0.000 | 1.4299 |
| 134 | 5453.9 | 4948.6 | 861.5 | 271.8 | 2.491 | 1.00 | 1353.2 | 0.0 | 4509.9 | 0.281 | 1.000 | 0.000 | 1.3734 |
| 135 | 5447.7 | 4935.5 | 861.5 | 271.7 | 2.487 | 1.00 | 1365.6 | 0.0 | 4505.2 | 0.281 | 1.000 | 0.000 | 1.3723 |
| 136 | 5165.4 | 5133.9 | 861.5 | 279.2 | 2.498 | 1.00 | 341.9 | 0.0 | 4587.7 | 0.281 | 1.000 | 0.000 | 1.3829 |
| 137 | 5119.5 | 5088.3 | 861.5 | 279.4 | 2.482 | 1.00 | 340.4 | 0.0 | 4572.6 | 0.281 | 1.000 | 0.000 | 1.3783 |
| 138 | 5119.4 | 5089.0 | 861.5 | 279.4 | 2.483 | 1.00 | 337.1 | 0.0 | 4572.8 | 0.281 | 1.000 | 0.000 | 1.3784 |
| 139 | 5118.7 | 5088.2 | 861.5 | 279.4 | 2.482 | 1.00 | 337.1 | 0.0 | 4572.6 | 0.281 | 1.000 | 0.000 | 1.3783 |
| 140 | 5100.5 | 5099.0 | 861.5 | 279.9 | 2.483 | 1.00 | 77.1 | 0.0 | 4577.2 | 0.281 | 1.000 | 0.000 | 1.3788 |
| 141 | 5099.0 | 5098.9 | 861.5 | 279.9 | 2.482 | 1.00 | 12.4 | 0.0 | 4577.2 | 0.281 | 1.000 | 0.000 | 1.3788 |
| 142 | 5098.9 | 5097.0 | 861.5 | 279.9 | 2.482 | 1.00 | 85.6 | 0.0 | 4576.5 | 0.281 | 1.000 | 0.000 | 1.3786 |
| 143 | 5098.3 | 5096.3 | 861.5 | 279.9 | 2.482 | 1.00 | 85.6 | 0.0 | 4576.3 | 0.281 | 1.000 | 0.000 | 1.3786 |
| 144 | 4517.5 | 3033.3 | 861.5 | 255.2 | 1.862 | 1.00 | 2572.4 | 0.0 | 3773.5 | 0.281 | 1.000 | 0.000 | 1.1995 |
| 145 | 3476.7 | 3455.8 | 861.5 | 285.4 | 1.861 | 1.00 | 321.8 | 0.0 | 4019.4 | 0.281 | 1.000 | 0.000 | 1.2228 |
| 146 | 3474.1 | 3453.2 | 861.5 | 285.4 | 1.860 | 1.00 | 321.9 | 0.0 | 4018.5 | 0.281 | 1.000 | 0.000 | 1.2226 |
| 147 | 3453.2 | 3436.8 | 861.5 | 285.5 | 1.852 | 1.00 | 286.5 | 0.0 | 4013.3 | 0.281 | 1.000 | 0.000 | 1.2211 |
| 148 | 3451.4 | 3434.8 | 861.5 | 285.5 | 1.851 | 1.00 | 287.6 | 0.0 | 4012.7 | 0.281 | 1.000 | 0.000 | 1.2209 |
| 149 | 3434.8 | 3434.8 | 861.5 | 285.9 | 1.849 | 1.00 | 1.0 | 0.0 | 4014.0 | 0.281 | 1.000 | 0.000 | 1.2207 |
| 150 | 3432.9 | 3429.1 | 861.5 | 285.8 | 1.847 | 1.00 | 138.4 | 0.0 | 4011.7 | 0.281 | 1.000 | 0.000 | 1.2203 |
| 151 | 3429.1 | 3429.1 | 861.5 | 285.9 | 1.847 | 1.00 | 1.0 | 0.0 | 4012.0 | 0.281 | 1.000 | 0.000 | 1.2202 |
| 152 | 3427.2 | 3423.4 | 861.5 | 285.9 | 1.845 | 1.00 | 138.6 | 0.0 | 4009.8 | 0.281 | 1.000 | 0.000 | 1.2198 |
| 153 | 3423.4 | 3423.4 | 861.5 | 285.9 | 1.844 | 1.00 | 1.0 | 0.0 | 4010.1 | 0.281 | 1.000 | 0.000 | 1.2197 |
| 154 | 3423.4 | 3423.3 | 861.5 | 285.9 | 1.844 | 1.00 | 14.1 | 0.0 | 4010.1 | 0.281 | 1.000 | 0.000 | 1.2197 |
| 155 | 3423.3 | 3423.0 | 861.5 | 285.9 | 1.844 | 1.00 | 38.9 | 0.0 | 4010.0 | 0.281 | 1.000 | 0.000 | 1.2197 |
| 156 | 3423.3 | 3423.0 | 861.5 | 285.9 | 1.844 | 1.00 | 38.9 | 0.0 | 4010.0 | 0.281 | 1.000 | 0.000 | 1.2197 |
| 157 | 3423.0 | 3423.0 | 861.5 | 285.9 | 1.844 | 1.00 | 13.1 | 0.0 | 4010.0 | 0.281 | 1.000 | 0.000 | 1.2197 |
| 158 | 3423.0 | 3423.0 | 861.5 | 285.9 | 1.844 | 1.00 | 1.0 | 0.0 | 4010.0 | 0.281 | 1.000 | 0.000 | 1.2197 |
| 159 | 4073.4 | 3945.8 | 2940.1 | 1404.5 | 0.850 | 1.00 | 1027.0 | 506.0 | 5226.2 | 62.389 | 0.541 | 0.459 | 1.0485 |
| 160 | 4037.8 | 3487.2 | 2939.9 | 1362.9 | 0.779 | 1.00 | 932.8 | 2252.0 | 5148.9 | 61.266 | 0.541 | 0.459 | 1.0422 |
| 161 | 3448.5 | 3389.8 | 2819.2 | 1351.1 | 0.762 | 1.00 | 813.4 | 143.3 | 5136.1 | 63.134 | 0.543 | 0.457 | 1.0410 |
| 162 | 3392.2 | 3392.2 | 2308.4 | 721.7 | 0.861 | 1.00 | 1.0 | 0.0 | 4770.8 | 0.205 | 0.915 | 0.085 | 1.1098 |

Table 4-3 HPOTP TURBINE COOLANT ANALYSIS (MPL)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2877.9 | 2875.8 | 2581.3 | 1091.6 | 0.693 | 1.00 | 166.7 | 0.0 | 4853.0 | 0.716 | 0.647 | 0.353 | 1.0405 |
| 2 | 2871.6 | 2863.1 | 2581.3 | 1091.3 | 0.690 | 1.00 | 335.6 | 0.0 | 4853.0 | 0.716 | 0.647 | 0.353 | 1.0403 |
| 3 | 2863.1 | 2861.4 | 2581.3 | 1093.1 | 0.689 | 1.00 | 149.3 | 0.0 | 4852.9 | 0.716 | 0.647 | 0.353 | 1.0399 |
| 4 | 2857.7 | 2846.9 | 2581.3 | 1090.7 | 0.687 | 1.00 | 381.0 | 0.0 | 4853.0 | 0.716 | 0.647 | 0.353 | 1.0401 |
| 5 | 2846.8 | 2846.8 | 1842.3 | 696.0 | 0.813 | 0.86 | 1.0 | 0.0 | 5073.1 | 1.262 | 0.800 | 0.200 | 1.0948 |
| 6 | 3135.5 | 3132.9 | 873.2 | 289.5 | 1.704 | 1.00 | 118.3 | 0.0 | 3922.7 | 0.546 | 1.000 | 0.000 | 1.1935 |
| 7 | 3042.6 | 2849.1 | 873.2 | 285.0 | 1.603 | 1.00 | 1045.5 | 0.0 | 3810.1 | 0.546 | 1.000 | 0.000 | 1.1720 |
| 8 | 2845.7 | 2845.7 | 1842.3 | 695.9 | 0.812 | 0.86 | 1.0 | 0.0 | 5072.8 | 1.262 | 0.800 | 0.200 | 1.0948 |
| 9 | 2845.1 | 2844.0 | 1842.3 | 696.1 | 0.811 | 0.86 | 114.9 | 0.0 | 5073.9 | 0.406 | 0.800 | 0.200 | 1.0947 |
| 10 | 2844.8 | 2843.7 | 1842.3 | 696.1 | 0.811 | 0.86 | 115.1 | 0.0 | 5073.9 | 0.406 | 0.800 | 0.200 | 1.0947 |
| 11 | 2843.7 | 2843.7 | 1842.3 | 696.2 | 0.811 | 0.86 | 1.0 | 0.0 | 5074.2 | 0.406 | 0.800 | 0.200 | 1.0947 |
| 12 | 2843.3 | 2842.6 | 1842.3 | 696.2 | 0.811 | 0.86 | 89.3 | 0.0 | 5074.0 | 0.406 | 0.800 | 0.200 | 1.0946 |
| 13 | 2842.6 | 2842.6 | 1842.3 | 696.2 | 0.811 | 0.86 | 1.0 | 0.0 | 5074.2 | 0.406 | 0.800 | 0.200 | 1.0946 |
| 14 | 2805.8 | 2731.3 | 1842.3 | 691.8 | 0.789 | 0.86 | 931.8 | 0.0 | 5057.7 | 0.059 | 0.800 | 0.200 | 1.0914 |
| 15 | 2794.0 | 2719.0 | 1842.3 | 691.6 | 0.786 | 0.86 | 938.7 | 0.0 | 5057.1 | 0.059 | 0.800 | 0.200 | 1.0910 |
| 16 | 2718.1 | 2664.9 | 1842.3 | 692.8 | 0.768 | 0.86 | 798.7 | 0.0 | 5062.7 | 0.059 | 0.800 | 0.200 | 1.0890 |
| 17 | 2656.0 | 2601.6 | 1842.3 | 692.5 | 0.750 | 0.86 | 817.3 | 0.0 | 5062.5 | 0.059 | 0.800 | 0.200 | 1.0869 |
| 18 | 2589.4 | 2564.8 | 1842.3 | 694.1 | 0.736 | 0.86 | 553.3 | 0.0 | 5069.8 | 0.059 | 0.800 | 0.200 | 1.0855 |
| 19 | 2588.8 | 2564.1 | 1842.3 | 694.1 | 0.736 | 0.86 | 558.5 | 0.0 | 5069.6 | 0.059 | 0.800 | 0.200 | 1.0855 |
| 20 | 2526.4 | 2304.7 | 1842.3 | 680.4 | 0.687 | 0.85 | 1720.9 | 0.0 | 5016.6 | 0.059 | 0.800 | 0.200 | 1.0782 |
| 21 | 2513.9 | 2290.1 | 1842.3 | 680.1 | 0.683 | 0.85 | 1737.2 | 0.0 | 5015.6 | 0.059 | 0.800 | 0.200 | 1.0777 |
| 22 | 2287.6 | 2287.6 | 1843.7 | 695.3 | 0.654 | 0.87 | 1.0 | 0.0 | 5080.1 | 0.406 | 0.799 | 0.201 | 1.0762 |
| 23 | 2803.7 | 2724.9 | 1842.3 | 691.6 | 0.787 | 0.86 | 958.9 | 0.0 | 5056.8 | 0.347 | 0.800 | 0.200 | 1.0912 |
| 24 | 2725.1 | 2644.0 | 1842.3 | 691.2 | 0.765 | 0.86 | 986.9 | 0.0 | 5056.2 | 0.347 | 0.800 | 0.200 | 1.0885 |
| 25 | 2643.2 | 2642.0 | 1842.3 | 695.7 | 0.755 | 0.86 | 118.5 | 0.0 | 5075.2 | 0.347 | 0.800 | 0.200 | 1.0879 |
| 26 | 2643.0 | 2641.9 | 1842.3 | 695.7 | 0.755 | 0.86 | 119.3 | 0.0 | 5075.2 | 0.347 | 0.800 | 0.200 | 1.0879 |
| 27 | 2527.9 | 2289.1 | 1842.3 | 679.3 | 0.685 | 0.85 | 1791.0 | 0.0 | 5012.4 | 0.347 | 0.800 | 0.200 | 1.0778 |
| 28 | 2285.4 | 2285.4 | 1842.3 | 694.7 | 0.655 | 0.87 | 1.0 | 0.0 | 5077.0 | 0.406 | 0.800 | 0.200 | 1.0762 |
| 29 | 2881.0 | 2287.6 | 2582.8 | 1015.3 | 0.594 | 1.00 | 787.2 | 2745.2 | 4782.0 | 35.460 | 0.647 | 0.353 | 1.0392 |
| 30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 31 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 32 | 0.0 | 0.0 | 1853.7 | 695.4 | 0.654 | 0.87 | 0.2 | 709.9 | 5080.2 | 0.000 | 0.799 | 0.201 | 1.0762 |

Table 4-3 HPOTP TURBINE COOLANT ANALYSIS (MPL) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | 0.0 | 0.0 | 1853.7 | 695.4 | 0.654 | 0.87 | 0.2 | 709.9 | 5080.2 | 0.000 | 0.799 | 0.201 | 1.0762 |
| 34 | 0.0 | 0.0 | 1853.7 | 695.4 | 0.654 | 0.87 | 0.2 | 709.9 | 5080.2 | 0.000 | 0.799 | 0.201 | 1.0762 |
| 35 | 0.0 | 0.0 | 1853.7 | 695.4 | 0.654 | 0.87 | 0.2 | 709.9 | 5080.2 | 0.000 | 0.799 | 0.201 | 1.0762 |
| 36 | 2313.9 | 2313.9 | 2282.3 | 899.7 | 0.630 | 1.00 | 1.0 | 0.0 | 4699.0 | 0.934 | 0.693 | 0.307 | 1.0552 |
| 37 | 2845.7 | 2845.7 | 1842.3 | 696.2 | 0.812 | 0.86 | 1.7 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 38 | 2845.6 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 47.7 | 0.0 | 5074.1 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 39 | 2845.6 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 47.7 | 0.0 | 5074.1 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 40 | 2845.6 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 47.7 | 0.0 | 5074.1 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 41 | 2845.6 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 47.7 | 0.0 | 5074.1 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 42 | 2845.4 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 1.9 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 43 | 2845.4 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 9.9 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 44 | 2845.4 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 1.2 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 45 | 2845.4 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 10.1 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 46 | 2845.4 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 1.9 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 47 | 2845.4 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 13.0 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 48 | 2845.4 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 2.3 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 49 | 2845.4 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 11.8 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 50 | 2845.4 | 2845.4 | 1842.3 | 696.2 | 0.812 | 0.86 | 0.8 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0947 |
| 51 | 2845.7 | 2845.7 | 1842.3 | 696.2 | 0.812 | 0.86 | 15.0 | 0.0 | 5074.2 | 0.695 | 0.800 | 0.200 | 1.0947 |
| 52 | 2845.7 | 2845.7 | 1842.3 | 696.2 | 0.812 | 0.86 | 25.9 | 0.0 | 5074.2 | 0.695 | 0.800 | 0.200 | 1.0947 |
| 53 | 2842.2 | 2835.3 | 1842.3 | 695.8 | 0.810 | 0.86 | 280.3 | 0.0 | 5072.6 | 0.524 | 0.800 | 0.200 | 1.0944 |
| 54 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 55 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 56 | 2841.9 | 2831.2 | 1842.3 | 695.6 | 0.809 | 0.86 | 349.1 | 0.0 | 5071.8 | 0.524 | 0.800 | 0.200 | 1.0943 |
| 57 | 2837.7 | 2827.0 | 1842.3 | 695.6 | 0.808 | 0.86 | 349.4 | 0.0 | 5071.8 | 0.524 | 0.800 | 0.200 | 1.0942 |
| 58 | 2827.0 | 2827.0 | 1842.3 | 696.2 | 0.806 | 0.86 | 1.0 | 0.0 | 5074.3 | 0.524 | 0.800 | 0.200 | 1.0941 |
| 59 | 2821.0 | 2808.9 | 1842.3 | 695.5 | 0.803 | 0.86 | 372.3 | 0.0 | 5071.6 | 0.275 | 0.800 | 0.200 | 1.0936 |
| 60 | 2820.8 | 2808.6 | 1842.3 | 695.5 | 0.803 | 0.86 | 373.9 | 0.0 | 5071.6 | 0.275 | 0.800 | 0.200 | 1.0936 |
| 61 | 2698.8 | 2377.4 | 1842.3 | 675.2 | 0.718 | 0.85 | 2026.8 | 0.0 | 4993.7 | 0.275 | 0.800 | 0.200 | 1.0812 |
| 62 | 2646.5 | 2316.9 | 1842.3 | 673.5 | 0.703 | 0.85 | 2078.3 | 0.0 | 4987.9 | 0.275 | 0.800 | 0.200 | 1.0793 |
| 63 | 2313.4 | 2313.4 | 2281.9 | 899.4 | 0.630 | 1.00 | 1.0 | 0.0 | 4698.4 | 0.934 | 0.693 | 0.307 | 1.0552 |
| 64 | 2625.0 | 2184.9 | 1842.3 | 664.9 | 0.679 | 0.84 | 2442.2 | 0.0 | 4953.7 | 0.249 | 0.800 | 0.200 | 1.0756 |
| 65 | 2577.1 | 2126.4 | 1842.3 | 663.6 | 0.663 | 0.84 | 2500.8 | 0.0 | 4949.3 | 0.249 | 0.800 | 0.200 | 1.0737 |
| 66 | 2119.6 | 2119.6 | 2186.6 | 847.1 | 0.595 | 1.00 | 1.0 | 0.0 | 4627.4 | 1.184 | 0.716 | 0.284 | 1.0556 |

Table 4-3 HPOTP TURBINE COOLANT ANALYSIS (MPL) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 67 | 2276.6 | 2232.8 | 2281.9 | 899.5 | 0.609 | 1.00 | 812.9 | 0.0 | 4698.8 | 0.939 | 0.693 | 0.307 | 1.0531 |
| 68 | 2224.4 | 2121.1 | 2281.9 | 896.1 | 0.582 | 1.00 | 1278.5 | 0.0 | 4690.0 | 0.939 | 0.693 | 0.307 | 1.0506 |
| 69 | 2119.8 | 2119.8 | 2189.6 | 847.9 | 0.596 | 1.00 | 1.0 | 0.0 | 4627.4 | 1.189 | 0.715 | 0.285 | 1.0555 |
| 70 | 2149.4 | 2111.5 | 2199.7 | 847.2 | 0.594 | 1.00 | 293.1 | 709.9 | 4625.5 | 0.152 | 0.715 | 0.285 | 1.0553 |
| 71 | 2138.6 | 2100.8 | 2199.7 | 847.2 | 0.591 | 1.00 | 293.9 | 709.9 | 4625.7 | 0.152 | 0.715 | 0.285 | 1.0550 |
| 72 | 2127.7 | 2090.0 | 2199.7 | 847.3 | 0.588 | 1.00 | 295.3 | 709.9 | 4625.8 | 0.152 | 0.715 | 0.285 | 1.0547 |
| 73 | 2116.8 | 2079.2 | 2199.7 | 847.3 | 0.585 | 1.00 | 296.8 | 709.9 | 4626.0 | 0.152 | 0.715 | 0.285 | 1.0544 |
| 74 | 2079.1 | 2079.1 | 2011.1 | 753.5 | 0.497 | 0.96 | 1.0 | 0.0 | 5401.4 | 0.322 | 0.760 | 0.240 | 1.0633 |
| 75 | 2842.1 | 2835.7 | 1842.3 | 695.8 | 0.810 | 0.86 | 270.6 | 0.0 | 5072.7 | 0.079 | 0.800 | 0.200 | 1.0944 |
| 76 | 2835.7 | 2835.7 | 1842.3 | 696.2 | 0.809 | 0.86 | 15.4 | 0.0 | 5074.2 | 0.079 | 0.800 | 0.200 | 1.0944 |
| 77 | 2629.7 | 2179.8 | 1842.3 | 864.2 | 0.678 | 0.84 | 2469.4 | 0.0 | 4950.9 | 0.040 | 0.800 | 0.200 | 1.0755 |
| 78 | 2605.9 | 2149.9 | 1842.3 | 863.2 | 0.671 | 0.84 | 2503.0 | 0.0 | 4947.3 | 0.040 | 0.800 | 0.200 | 1.0745 |
| 79 | 2127.3 | 2124.6 | 1842.3 | 693.8 | 0.609 | 0.88 | 202.5 | 0.0 | 5076.8 | 0.040 | 0.800 | 0.200 | 1.0709 |
| 80 | 2120.4 | 2106.5 | 1842.3 | 692.9 | 0.606 | 0.88 | 460.0 | 0.0 | 5073.1 | 0.040 | 0.800 | 0.200 | 1.0704 |
| 81 | 2119.2 | 2105.2 | 1842.3 | 692.9 | 0.605 | 0.88 | 462.7 | 0.0 | 5073.0 | 0.040 | 0.800 | 0.200 | 1.0703 |
| 82 | 2105.1 | 2105.1 | 1842.3 | 693.8 | 0.603 | 0.88 | 1.0 | 0.0 | 5077.3 | 0.040 | 0.800 | 0.200 | 1.0703 |
| 83 | 2641.7 | 2220.7 | 1842.3 | 866.6 | 0.687 | 0.84 | 2375.0 | 0.0 | 4960.3 | 0.039 | 0.800 | 0.200 | 1.0767 |
| 84 | 2583.0 | 2150.8 | 1842.3 | 865.2 | 0.668 | 0.84 | 2438.5 | 0.0 | 4955.8 | 0.039 | 0.800 | 0.200 | 1.0744 |
| 85 | 2128.8 | 2126.3 | 1842.3 | 693.9 | 0.610 | 0.88 | 197.0 | 0.0 | 5076.8 | 0.039 | 0.800 | 0.200 | 1.0710 |
| 86 | 2123.0 | 2120.4 | 1842.3 | 693.7 | 0.608 | 0.88 | 198.6 | 0.0 | 5076.5 | 0.039 | 0.800 | 0.200 | 1.0708 |
| 87 | 2116.4 | 2103.2 | 1842.3 | 692.9 | 0.605 | 0.88 | 448.4 | 0.0 | 5073.3 | 0.039 | 0.800 | 0.200 | 1.0703 |
| 88 | 2115.4 | 2102.1 | 1842.3 | 692.9 | 0.604 | 0.88 | 451.0 | 0.0 | 5073.3 | 0.039 | 0.800 | 0.200 | 1.0702 |
| 89 | 2102.1 | 2102.1 | 1842.3 | 693.8 | 0.603 | 0.88 | 1.0 | 0.0 | 5077.3 | 0.039 | 0.800 | 0.200 | 1.0702 |
| 90 | 2102.0 | 2101.7 | 1842.3 | 693.8 | 0.603 | 0.88 | 70.0 | 0.0 | 5077.2 | 0.079 | 0.800 | 0.200 | 1.0701 |
| 91 | 2101.7 | 2101.7 | 1842.3 | 693.8 | 0.602 | 0.88 | 1.0 | 0.0 | 5077.3 | 0.079 | 0.800 | 0.200 | 1.0701 |
| 92 | 2838.9 | 2825.2 | 1842.3 | 695.4 | 0.808 | 0.86 | 395.1 | 0.0 | 5071.1 | 0.171 | 0.800 | 0.200 | 1.0941 |
| 93 | 2837.5 | 2823.8 | 1842.3 | 695.4 | 0.807 | 0.86 | 397.1 | 0.0 | 5071.1 | 0.171 | 0.800 | 0.200 | 1.0941 |
| 94 | 2837.4 | 2826.6 | 1842.3 | 695.6 | 0.808 | 0.86 | 352.0 | 0.0 | 5071.8 | 0.171 | 0.800 | 0.200 | 1.0942 |
| 95 | 2834.2 | 2823.5 | 1842.3 | 695.6 | 0.807 | 0.86 | 351.8 | 0.0 | 5071.8 | 0.171 | 0.800 | 0.200 | 1.0940 |
| 96 | 2818.0 | 2807.2 | 1842.3 | 695.5 | 0.802 | 0.86 | 352.2 | 0.0 | 5071.9 | 0.171 | 0.800 | 0.200 | 1.0935 |
| 97 | 2816.9 | 2806.0 | 1842.3 | 695.5 | 0.802 | 0.86 | 354.1 | 0.0 | 5071.9 | 0.171 | 0.800 | 0.200 | 1.0935 |
| 98 | 2800.6 | 2789.7 | 1842.3 | 695.5 | 0.797 | 0.86 | 354.3 | 0.0 | 5072.0 | 0.171 | 0.800 | 0.200 | 1.0929 |
| 99 | 2798.9 | 2787.9 | 1842.3 | 695.5 | 0.797 | 0.86 | 356.3 | 0.0 | 5072.0 | 0.171 | 0.800 | 0.200 | 1.0929 |

Table 4-3 HPOTP TURBINE COOLANT ANALYSIS (MPL) (Continued)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H2O | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100 | 2792.7 | 2758.7 | 1842.3 | 694.1 | 0.792 | 0.86 | 628.7 | 0.0 | 5066.7 | 0.171 | 0.800 | 0.200 | 1.0920 |
| 101 | 2791.7 | 2757.5 | 1842.3 | 694.1 | 0.791 | 0.86 | 632.9 | 0.0 | 5066.6 | 0.171 | 0.800 | 0.200 | 1.0920 |
| 102 | 2757.5 | 2757.5 | 1842.3 | 696.1 | 0.787 | 0.86 | 1.0 | 0.0 | 5074.8 | 0.171 | 0.800 | 0.200 | 1.0918 |
| 103 | 2755.1 | 2750.2 | 1842.3 | 695.8 | 0.786 | 0.86 | 238.2 | 0.0 | 5073.7 | 0.171 | 0.800 | 0.200 | 1.0916 |
| 104 | 2754.7 | 2749.9 | 1842.3 | 695.8 | 0.786 | 0.86 | 238.6 | 0.0 | 5073.7 | 0.171 | 0.800 | 0.200 | 1.0916 |
| 105 | 2754.3 | 2751.9 | 1842.3 | 695.9 | 0.786 | 0.86 | 165.8 | 0.0 | 5074.2 | 0.171 | 0.800 | 0.200 | 1.0916 |
| 106 | 2754.1 | 2751.8 | 1842.3 | 695.9 | 0.786 | 0.86 | 165.7 | 0.0 | 5074.2 | 0.171 | 0.800 | 0.200 | 1.0916 |
| 107 | 2571.8 | 2109.2 | 1842.3 | 662.3 | 0.660 | 0.84 | 2538.8 | 0.0 | 4944.0 | 0.171 | 0.800 | 0.200 | 1.0732 |
| 108 | 2554.6 | 2088.5 | 1842.3 | 661.8 | 0.654 | 0.84 | 2558.7 | 0.0 | 4942.5 | 0.171 | 0.800 | 0.200 | 1.0725 |
| 109 | 2080.4 | 2080.4 | 2010.3 | 753.6 | 0.497 | 0.97 | 1.0 | 0.0 | 5401.5 | 0.322 | 0.760 | 0.240 | 1.0633 |
| 110 | 2080.4 | 2080.4 | 2010.3 | 753.1 | 0.499 | 0.96 | 20.6 | 0.0 | 5399.1 | 0.261 | 0.760 | 0.240 | 1.0634 |
| 111 | 2080.4 | 2080.4 | 2010.3 | 753.1 | 0.499 | 0.96 | 3.5 | 0.0 | 5399.1 | 0.261 | 0.760 | 0.240 | 1.0634 |
| 112 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 113 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 114 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 115 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 116 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 117 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 118 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 119 | 0.0 | 0.0 | 0.0 | 0.0 | 0.000 | 0.00 | 0.0 | 0.0 | 0.0 | 0.000 | 1.000 | 0.000 | 0.0000 |
| 120 | 2785.3 | 2662.1 | 1842.3 | 688.8 | 0.775 | 0.85 | 1209.7 | 0.0 | 5046.3 | 0.080 | 0.800 | 0.200 | 1.0894 |
| 121 | 2759.3 | 2723.1 | 1842.3 | 693.9 | 0.782 | 0.86 | 658.2 | 0.0 | 5066.3 | 0.080 | 0.800 | 0.200 | 1.0909 |
| 122 | 2635.0 | 2191.1 | 1842.3 | 665.1 | 0.680 | 0.84 | 2450.4 | 0.0 | 4954.6 | 0.080 | 0.800 | 0.200 | 1.0758 |
| 123 | 2635.0 | 2188.0 | 1842.3 | 664.2 | 0.681 | 0.84 | 2467.5 | 0.0 | 4950.7 | 0.080 | 0.800 | 0.200 | 1.0758 |
| 124 | 2428.8 | 2383.4 | 1842.3 | 692.1 | 0.688 | 0.87 | 783.4 | 0.0 | 5064.5 | 0.080 | 0.800 | 0.200 | 1.0797 |
| 125 | 2418.6 | 2373.6 | 1842.3 | 692.1 | 0.685 | 0.87 | 779.2 | 0.0 | 5064.7 | 0.080 | 0.800 | 0.200 | 1.0794 |
| 126 | 2373.2 | 2327.5 | 1842.3 | 691.9 | 0.672 | 0.87 | 789.8 | 0.0 | 5064.6 | 0.080 | 0.800 | 0.200 | 1.0778 |
| 127 | 2367.6 | 2321.4 | 1842.3 | 691.8 | 0.671 | 0.87 | 797.6 | 0.0 | 5064.3 | 0.080 | 0.800 | 0.200 | 1.0776 |
| 128 | 2321.0 | 2274.0 | 1842.3 | 691.6 | 0.657 | 0.87 | 811.5 | 0.0 | 5064.3 | 0.080 | 0.800 | 0.200 | 1.0761 |
| 129 | 2312.6 | 2265.4 | 1842.3 | 691.5 | 0.655 | 0.87 | 815.8 | 0.0 | 5063.9 | 0.080 | 0.800 | 0.200 | 1.0758 |
| 130 | 2268.2 | 2115.5 | 1842.3 | 683.5 | 0.625 | 0.86 | 1498.8 | 0.0 | 5033.1 | 0.080 | 0.800 | 0.200 | 1.0715 |
| 131 | 2112.6 | 2112.6 | 1842.3 | 693.9 | 0.606 | 0.88 | 1.0 | 0.0 | 5077.4 | 0.080 | 0.800 | 0.200 | 1.0705 |
| 132 | 3134.9 | 3133.6 | 873.2 | 289.5 | 1.704 | 1.00 | 82.4 | 0.0 | 3923.1 | 0.155 | 1.000 | 0.000 | 1.1936 |

Table 4-3 HPOTP TURBINE COOLANT ANALYSIS (MPL) (Concluded)

| STA | TOTAL PRESS (PSIA) | STATIC PRESS (PSIA) | TOTAL ENTHALPY (BTU/LBM) | TEMPER-ATURE (R) | DENSITY (LBM/FT3) | FLUID QUAL | VELO-CITY (FPS) | TANG VEL (FPS) | SONIC VEL (FPS) | FLOW RATE (LBM/SEC) | MASS FRACTIONS H2 | MASS FRACTIONS H20 | ZFAC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 133 | 3131.5 | 3120.5 | 873.2 | 289.3 | 1.699 | 1.00 | 244.4 | 0.0 | 3917.8 | 0.155 | 1.000 | 0.000 | 1.1926 |
| 134 | 3053.4 | 2812.9 | 873.2 | 283.8 | 1.593 | 1.00 | 1166.3 | 0.0 | 3793.3 | 0.155 | 1.000 | 0.000 | 1.1694 |
| 135 | 3050.2 | 2806.3 | 873.2 | 283.7 | 1.590 | 1.00 | 1177.6 | 0.0 | 3790.6 | 0.155 | 1.000 | 0.000 | 1.1689 |
| 136 | 2915.9 | 2900.9 | 873.2 | 289.7 | 1.602 | 1.00 | 294.9 | 0.0 | 3845.6 | 0.155 | 1.000 | 0.000 | 1.1746 |
| 137 | 2892.0 | 2877.2 | 873.2 | 289.8 | 1.591 | 1.00 | 292.8 | 0.0 | 3837.9 | 0.155 | 1.000 | 0.000 | 1.1727 |
| 138 | 2892.0 | 2877.6 | 873.2 | 289.8 | 1.591 | 1.00 | 290.1 | 0.0 | 3838.0 | 0.155 | 1.000 | 0.000 | 1.1727 |
| 139 | 2891.6 | 2877.2 | 873.2 | 289.8 | 1.591 | 1.00 | 290.1 | 0.0 | 3837.9 | 0.155 | 1.000 | 0.000 | 1.1726 |
| 140 | 2883.0 | 2882.3 | 873.2 | 290.2 | 1.591 | 1.00 | 66.4 | 0.0 | 3841.0 | 0.155 | 1.000 | 0.000 | 1.1729 |
| 141 | 2882.3 | 2882.2 | 873.2 | 290.2 | 1.591 | 1.00 | 10.7 | 0.0 | 3841.1 | 0.155 | 1.000 | 0.000 | 1.1729 |
| 142 | 2882.2 | 2881.3 | 873.2 | 290.2 | 1.591 | 1.00 | 73.6 | 0.0 | 3840.7 | 0.155 | 1.000 | 0.000 | 1.1729 |
| 143 | 2881.9 | 2881.0 | 873.2 | 290.2 | 1.591 | 1.00 | 73.6 | 0.0 | 3840.6 | 0.155 | 1.000 | 0.000 | 1.1728 |
| 144 | 2608.5 | 1922.5 | 873.2 | 268.7 | 1.218 | 1.00 | 2173.3 | 0.0 | 3438.5 | 0.155 | 1.000 | 0.000 | 1.1035 |
| 145 | 2124.8 | 2115.1 | 873.2 | 291.2 | 1.224 | 1.00 | 271.1 | 0.0 | 3601.7 | 0.155 | 1.000 | 0.000 | 1.1151 |
| 146 | 2123.5 | 2113.9 | 873.2 | 291.2 | 1.223 | 1.00 | 269.9 | 0.0 | 3601.4 | 0.155 | 1.000 | 0.000 | 1.1150 |
| 147 | 2113.9 | 2106.3 | 873.2 | 291.3 | 1.219 | 1.00 | 240.2 | 0.0 | 3599.5 | 0.155 | 1.000 | 0.000 | 1.1145 |
| 148 | 2112.9 | 2105.3 | 873.2 | 291.3 | 1.219 | 1.00 | 241.0 | 0.0 | 3599.2 | 0.155 | 1.000 | 0.000 | 1.1144 |
| 149 | 2105.3 | 2105.3 | 873.2 | 291.6 | 1.218 | 1.00 | 1.0 | 0.0 | 3600.5 | 0.155 | 1.000 | 0.000 | 1.1144 |
| 150 | 2104.4 | 2102.6 | 873.2 | 291.5 | 1.216 | 1.00 | 115.9 | 0.0 | 3599.4 | 0.155 | 1.000 | 0.000 | 1.1142 |
| 151 | 2102.6 | 2102.6 | 873.2 | 291.6 | 1.216 | 1.00 | 1.0 | 0.0 | 3599.7 | 0.155 | 1.000 | 0.000 | 1.1142 |
| 152 | 2101.8 | 2100.0 | 873.2 | 291.5 | 1.215 | 1.00 | 116.0 | 0.0 | 3598.6 | 0.155 | 1.000 | 0.000 | 1.1140 |
| 153 | 2100.0 | 2100.0 | 873.2 | 291.6 | 1.215 | 1.00 | 1.0 | 0.0 | 3598.9 | 0.155 | 1.000 | 0.000 | 1.1140 |
| 154 | 2100.0 | 2100.0 | 873.2 | 291.6 | 1.215 | 1.00 | 11.8 | 0.0 | 3598.9 | 0.155 | 1.000 | 0.000 | 1.1140 |
| 155 | 2100.0 | 2099.8 | 873.2 | 291.6 | 1.215 | 1.00 | 32.6 | 0.0 | 3598.8 | 0.155 | 1.000 | 0.000 | 1.1140 |
| 156 | 2100.0 | 2099.8 | 873.2 | 291.6 | 1.215 | 1.00 | 32.6 | 0.0 | 3598.8 | 0.155 | 1.000 | 0.000 | 1.1140 |
| 157 | 2099.8 | 2099.8 | 873.2 | 291.6 | 1.215 | 1.00 | 11.0 | 0.0 | 3598.8 | 0.155 | 1.000 | 0.000 | 1.1140 |
| 158 | 2099.8 | 2099.8 | 873.2 | 291.6 | 1.215 | 1.00 | 1.0 | 0.0 | 3598.8 | 0.155 | 1.000 | 0.000 | 1.1140 |
| 159 | 2384.5 | 2313.9 | 2465.3 | 1024.1 | 0.594 | 1.00 | 847.3 | 575.3 | 4801.1 | 35.866 | 0.648 | 0.352 | 1.0387 |
| 160 | 2365.7 | 2115.1 | 2469.2 | 1000.6 | 0.557 | 1.00 | 751.3 | 1813.9 | 4764.9 | 35.207 | 0.648 | 0.352 | 1.0372 |
| 161 | 2112.8 | 2083.4 | 2396.4 | 995.6 | 0.550 | 1.00 | 647.4 | 236.1 | 4762.9 | 36.238 | 0.650 | 0.350 | 1.0372 |
| 162 | 2080.4 | 2080.4 | 1914.8 | 640.2 | 0.612 | 0.93 | 1.0 | 0.0 | 4765.9 | 0.141 | 0.896 | 0.104 | 1.0741 |

| Column | Parameter | Description |
|---|---|---|
| Line number 159, Format (8E10.4)) | | |
| 1-10 | SEALCL | Primary turbine seal operating clearance, in. |
| Line number 160, Format (8E10.4) | | |
| 1-10 | RPM | Pump speed, rpm |
| 11-20 | ROF | Preburner mixture ratio |
| 21-30 | XPL | Power level ratio. |
| Line number 161, Format (8E10.4) | | |
| 1-10 | WDPB | Turbine inlet flow rate, lbm/s |
| 11-20 | PPB | Turbine inlet total pressure, psia |
| 21-30 | TPB | Turbine inlet total temperature, °R |
| 31-40 | HPA | Turbine horsepower, hp |
| 41-50 | TFTD | Turbine discharge total temperature, °R |
| 51-60 | PFTD | Turbine discharge total pressure, psia |
| 61-70 | ETANZ | Nozzle efficiency, $K_n^2$ |
| 71-80 | XKB | Blade coefficient, Kb. |
| Line number 162, Format (8I5) | | |
| 1-5 | IOPT | = 1 Fixed blade coefficient and iterates to determine flow rate<br>= 2 Fixed flow rate and iterates to determine blade coefficient |
| 6-10 | ITURB | = 1 Uses programmed turbine leakage flows and makes one pass through turbine and coolant flow models<br>= 2 Uses computed leakage flows from first pass and makes an additional pass through each model. |

| Column | Parameter | Description |
|---|---|---|
| Line number 163, Format (8E10.4) | | |
| 1-10 | PKNOWN(2) | Hydrogen coolant supply pressure, psia |
| 11-20 | TKNOWN(2) | Hydrogen coolant supply temperature, °R |
| 21-30 | WKNOWN(2) | Estimated hydrogen coolant flow rate, lbm/s |
| 31-40 | RKNOWN(2) | Estimated hydrogen coolant density, $lbm/ft^3$ |
| 41-50 | VTKNON(2) | Coolant supply tangential velocity, ft/s. |
| Line number 164, Format (8E10.4) | | |
| 1-80 | WDLEG | Legs 1 through 8 estimated flow rate at FPL, lbm/s |
| Line number 165, Format (8E10.4) | | |
| 1-80 | WDLEG | Legs 9 through 16 estimated flow rate at FPL, lbm/s |
| Line number 166, Format (8E10.4) | | |
| 1-80 | WDLEG | Legs 17 through 24 estimated flow rate at FPL, lbm/s<br>Leg 19 is no longer used, input 0.0 |
| Line number 167, Format (8E10.4) | | |
| 1-30 | WDLEG | Legs 25 through 27 estimated flow rate at FPL, lbm/s. |

## 5. REFERENCES

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