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ØRCENT: A DIGITAL COMPUTER PROGRAM FOR SATURATED AND LOW SUPERHEAT STEAM TURBINE CYCLE ANALYSIS

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H. I. Bowers

Nuclear Desalination Program

R. P. Hammond, Director
J. A. Parsons, Deputy Director
I. Spiewak, Deputy Director

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ABSTRACT

The program will perform full-load, design point calculations for steam turbine cycles supplied with throttle steam characteristic of contemporary water reactor power plants and will handle both condensing and back-pressure turbine exhaust arrangements. Turbine performance calculations are based on the General Electric Company method for large steam turbine-generators operating with saturated and low superheat throttle steam. Output includes all information normally shown on a turbine cycle heat balance diagram. The program is written in Fortran IV for the IBM 360/75 computer at Oak Ridge National Laboratory.

Keywords: AEC Sponsored + Coupling + Dual-purpose Plant + Feedwater Heating + Flowsheets + Heat Balance + Nuclear Desalination + Single-purpose Plants + Programs (computers) + Steam Cycle + Turbine-generators

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INTRODUCTION

ØRCENT was prepared specifically to provide steam turbine cycle performance data for use in evaluations conducted by the Nuclear Desalination Program at Oak Ridge National Laboratory. Special attention has been given to simplification of input data requirements for both single-problem calculations and parametric studies. The program is written in Fortran IV for the IBM 360/75 digital computer at Oak Ridge National Laboratory. Turbine performance calculations are based on the method presented by the General Electric Company for predicting the performance of large steam turbine-generators operating with saturated and low superheat throttle steam conditions.[1] Reference to this GE paper is essential for applying and understanding the program.

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[1] F. G. Baily, K. C. Cotton, and R. C. Spencer, "Predicting the Performance of Large Steam Turbine-Generators Operating with Saturated and Low Superheat Steam Conditions," General Electric Company, GER-2454A, American Power Conference, Chicago, Illinois, April 25-27, 1967.

APPLICATION AND LIMITATIONS

The program will perform full-load, design point calculations for a wide range of input parameters. Part load calculations, off-design throttle and exhaust steam conditions, and heater-out-of-service calculations cannot be handled. In most cases input parameters outside the ranges specified can be handled; however, warning messages may be printed out and the results should be viewed with some suspicion. A reasonable turbine and cycle typical of contemporary practices must be specified; otherwise, unreasonable results may be produced. Typical cycles are shown on Figures 1, 2, and 3. Input parameters are discussed below.

1. Throttle steam temperature: 0 to ~200°F above saturation temperature.
2. Throttle steam pressure: ~200 to ~2000 psia.
3. Generator: 100 to 1500 Mva; conductor cooled or conventionally cooled; rated hydrogen pressure or reduced hydrogen pressure.
4. Number of turbine sections in series: 1, 2, or 3 (tandem arrangement only). A 1-section machine consists of a low-pressure section only. A 2-section machine consists of a high-pressure section followed by a cross-over system and a low-pressure section. A 3-section machine consists of a high-pressure section followed by a cross-over system, an intermediate-pressure section, a second cross-over system, and a low-pressure section. In each instance the initial turbine section is made up of a 1-row governing stage and a non-governing stage group. The number of parallel steam flow paths in each turbine section must be specified. Pressure losses for cross-over systems are calculated as described in Table III (2nd revision) GER-2454A.
5. Turbine speed: 1800 or 3600 rpm. Other speeds can be handled, but there probably will be minor errors in condensing group exhaust loss and generator loss calculations. For example, if a 3000-rpm machine is specified, losses for 3600 rpm will be selected by the program; if a 1500-rpm machine is specified, losses for 1800 rpm will be selected.

6. External moisture separator: Optional; must be located immediately following the intermediate-pressure section of a 3-section machine or immediately following the high-pressure section of a 2-section machine. The moisture separator can drain to a feedwater heater fed from the exhaust of the preceding turbine section, to any lower pressure feedwater heater, or to the condenser.
7. Live steam reheater: Optional; 1 or 2 stages located immediately preceding the low-pressure section of a 2-section machine or immediately preceding the intermediate-pressure section of a 3-section machine. A 1-stage reheater or the second stage of a 2-stage reheater is fed with throttle steam and drains to the highest pressure feedwater heater shell. The first stage of a 2-stage reheater is fed from the highest pressure feedwater heater extraction point and drains to the next highest pressure feedwater heater shell. For a 2-stage reheat cycle the highest pressure feedwater heater extraction point must be in the high-pressure section of the machine.
8. Externally-heated reheater: Optional; 1 stage located immediately preceding the low-pressure section of a 2-section machine or immediately preceding the intermediate-pressure section of a 3-section machine.
9. Turbine exhaust: Condensing or back-pressure. If the exhaust pressure is less than 3 psia, condensing turbine calculations will be performed and it is necessary to specify the last stage bucket length and pitch diameter. Combinations of last stage bucket length and pitch diameter normally specified by General Electric are listed on Figures 16 and 17 of GER-2454A. In addition, the program can accept a 52-in. bucket with a 152-in. pitch diameter. Other combinations of bucket length and pitch diameter can also be handled, but there will be errors in exhaust loss calculations. For back-pressure turbines (exhaust pressure $\geq$ 3 psia) exhaust losses are calculated for non-condensing stage groups, and last stage bucket length and pitch diameter are not required. Back-pressure turbines are assumed to be 1% less efficient than condensing turbines.

10. Moisture removal stages: 0 to 5 in the low-pressure section only. Each moisture removal point will drain to the same or to the next lower pressure feedwater heater shell or will drain to the condenser if there are no intervening feedwater heaters.
11. Feedwater heaters: 0 to 12; optional drain cooler section; optional pumped or flashed drains; one heater can be a direct-contact type. An 8% pressure drop is assumed between the extraction stage and the shell of the feedwater heater except that 5% is assumed when the heater is fed from the high-pressure or intermediate-pressure exhaust.
12. Feedwater pump: Can be located at any point in the feedwater cycle; optional motor drive or steam turbine drive. For a 2-section or 3-section machine the feedwater pump turbine is fed from the cross-over just ahead of the low-pressure section or intermediate-pressure section, respectively. For a 1-section machine the feedwater pump turbine is fed from the main throttle steam supply. In all cases the feedwater pump turbine exhausts at the same pressure as the main turbine and the condensate is returned to the main condenser hotwell.
13. Makeup: Optional; supplied to the condenser hotwell.
14. Throttle valve stem and shaft packing leakage calculations: Optional. If these calculations are omitted, the calculated turbine cycle heat rate will be about 0.5% low and the generator output will be about 0.5% high.
15. Governing stage pitch diameter: In the absence of specific information 66 in. should be used for 1800-rpm machines and 41 in. for 3600-rpm machines. Small variations in this diameter will have only a minor effect on overall performance.

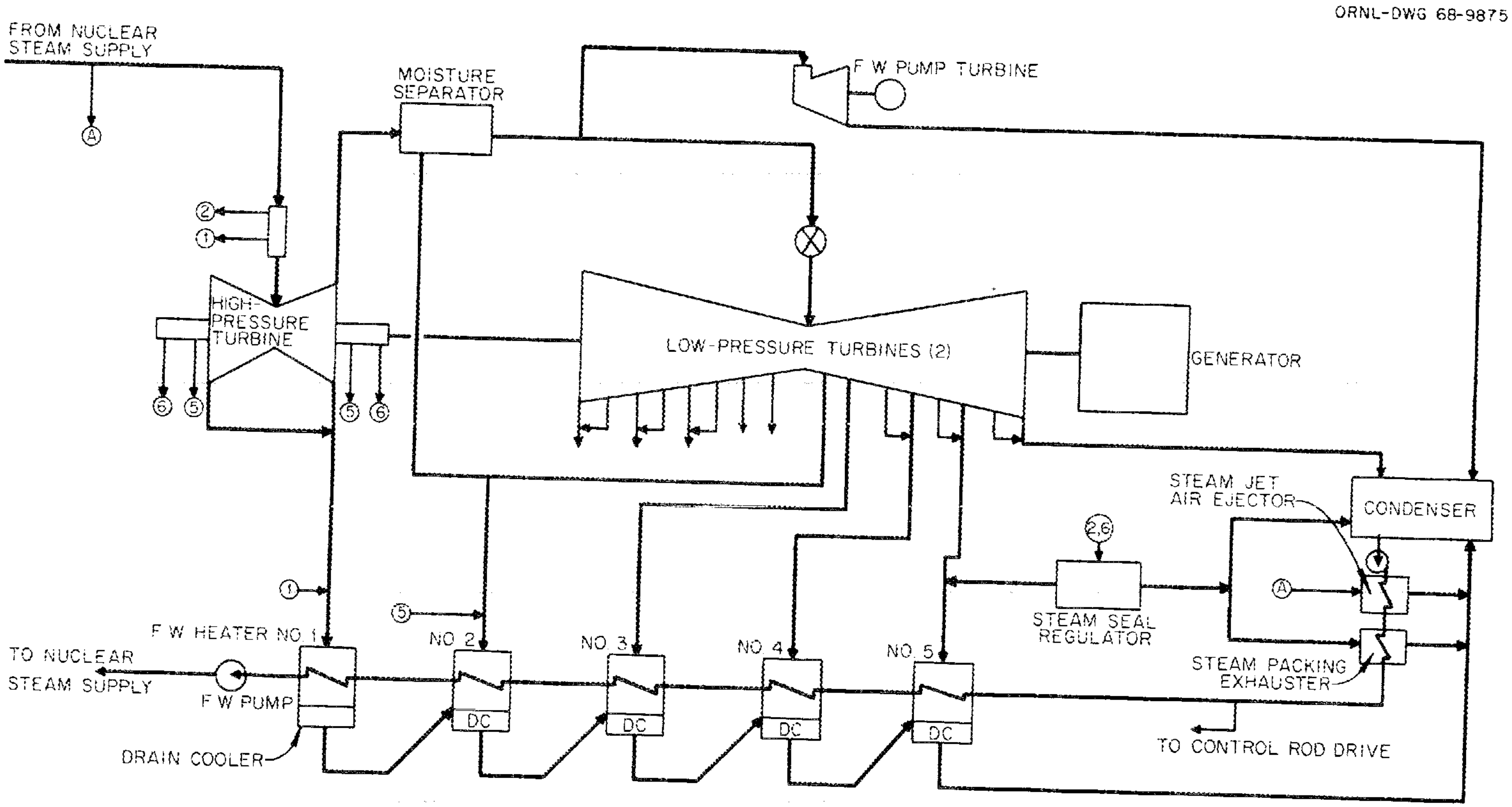

Figure 1. Typical BWR Cycle

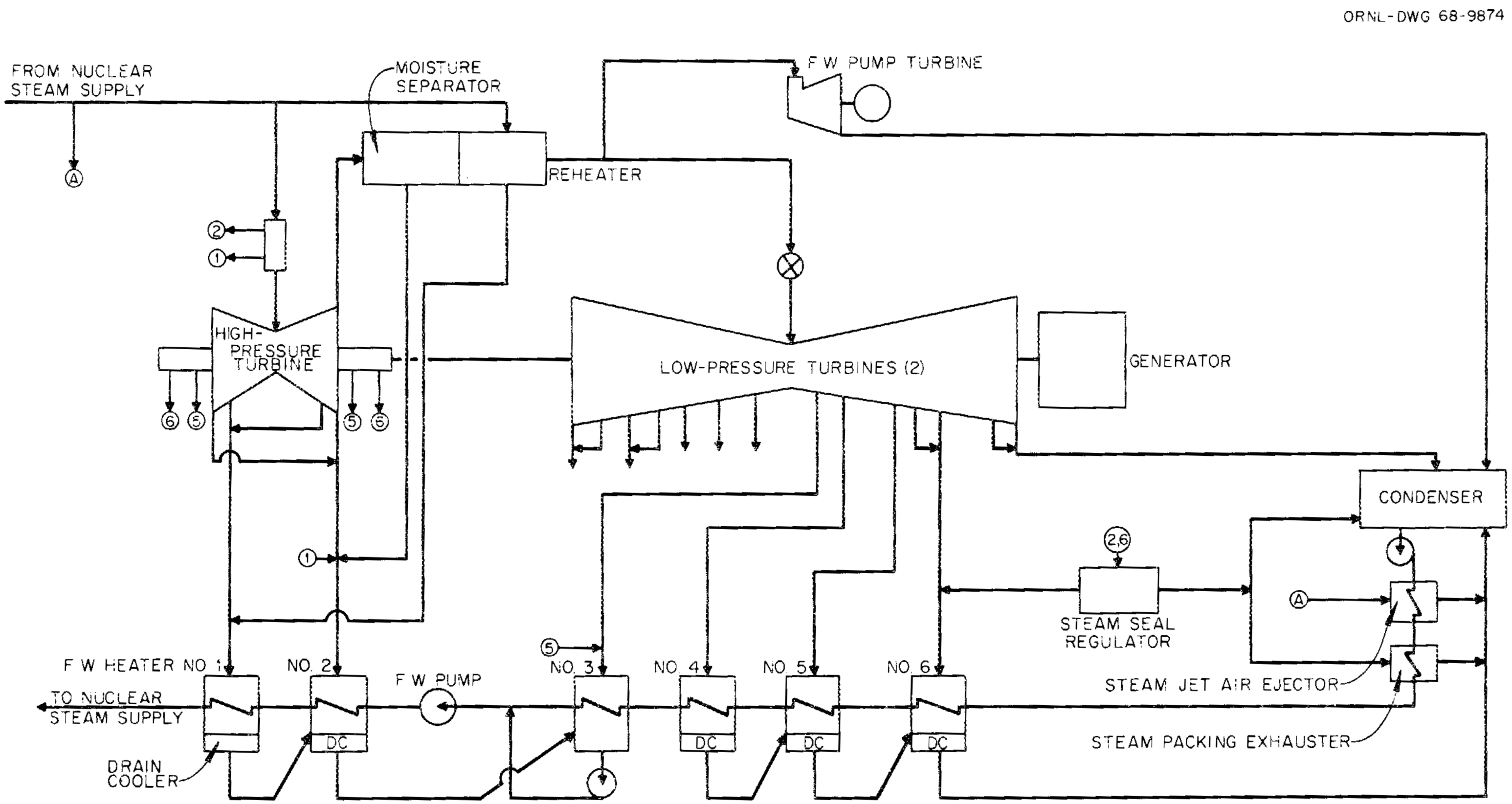

Figure 2. Typical PWR Cycle

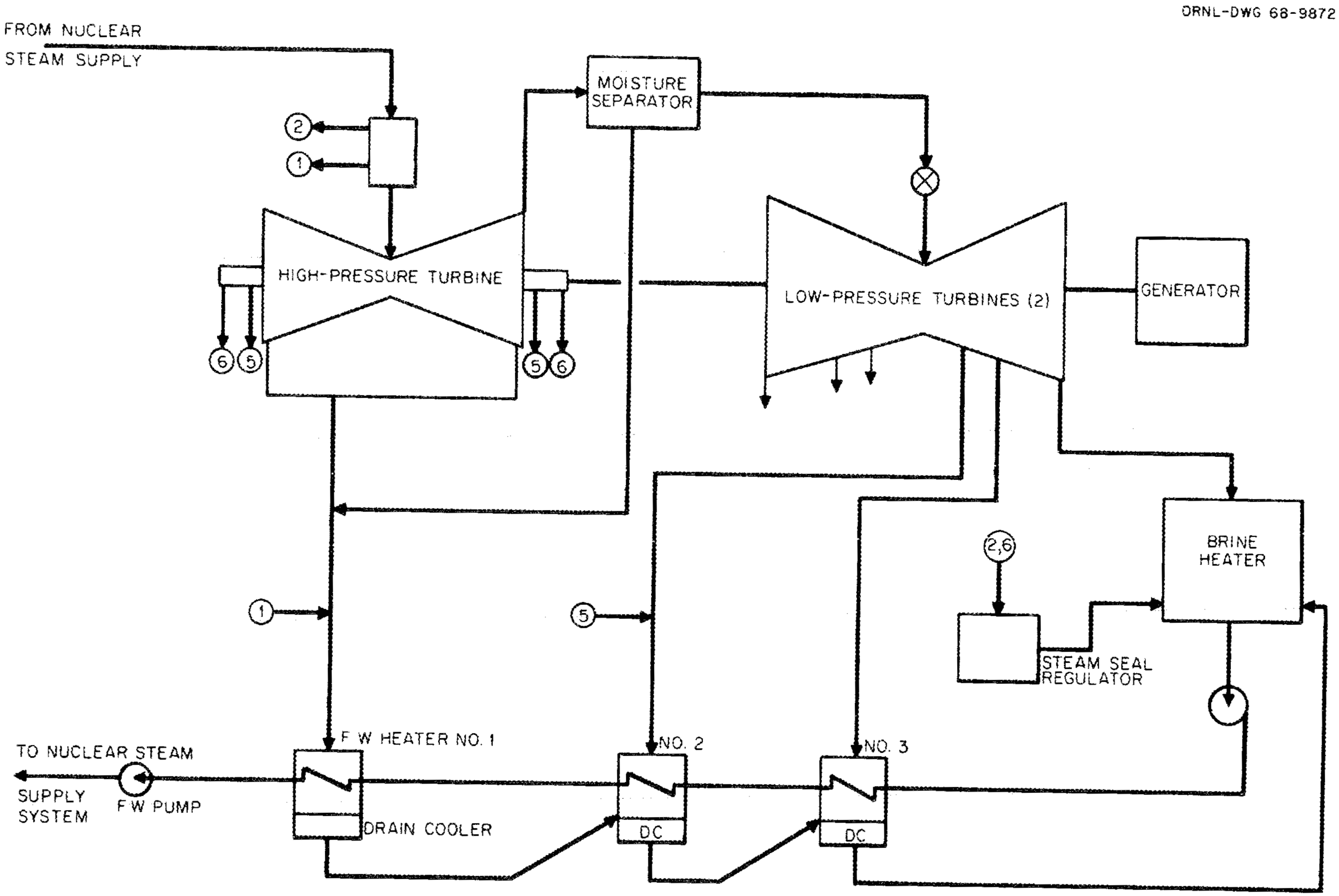

Figure 3. Typical Back-pressure Cycle

INPUT

The input data for a problem are entered on cards as shown on Figure 4 and as described below. The first card of the data deck must be a comment card containing any desired alpha-numeric information in Columns 1-72. The information on this card is used to label the output. Subsequent cards are read with the format statement, (I2, D10.0, 5D12.0, 8X). Columns 1 and 2 are reserved for an integer variable, IFLAG, which is used to identify the data in Columns 3-72. Columns 73-80 may be used for identification by the program user; they are not read by the program. Data card variables are defined below.

1. IFLAG = 1
   TT = throttle steam temperature, °F
   PT = throttle steam pressure, psia
   AMT = throttle steam moisture, %
2. IFLAG = 2
   QT = estimated throttle steam flow, lb_m/hr
   PCMU = feedwater makeup rate, %
   QCR = condensate flow by-passed to steam generator, lb_m/hr
3. IFLAG = 3
   WRATE = gross electrical output, Mwe
   GC = generator capability, Mva
   PF = generator power factor
   If ICC = 0, generator is conductor cooled
   If ICC = 1, generator is conventionally cooled
   If IH2 = 0, generator operates with rated hydrogen pressure
   If IH2 = 1, generator operates with reduced hydrogen pressure
   IR = rotational speed of turbine-generator, rpm
4. IFLAG = 4 (This card is not used and should not be included in the data deck.)
5. IFLAG = 5
   PDGS = pitch diameter of governing stage, in.
6. IFLAG = 6
   NSHAFT = number of turbine sections in series
7. IFLAG = 7 (This card is not required if NSHAFT = 1.)
   NHP = number of parallel high-pressure turbine section flow paths

8. IFLAG = 8 (This card is not required if NSHAFT < 3.)

NIP = number of parallel intermediate-pressure turbine section flow paths

PBIP = bowl pressure of intermediate-pressure turbine, psia

9. IFLAG = 9

NLP = number of parallel low-pressure turbine section flow paths

PBLP = bowl pressure of low-pressure turbine, psia (leave blank if NSHAFT = 1)

PXLPI = exhaust pressure of low-pressure turbine, in. HgA

PXLP = exhaust pressure of low-pressure turbine, psia (must be preceded by a minus sign)

PDLS = pitch diamter of last stage, in. (leave blank if PXLP $\geq$ 3 psia)

BLS = length of last stage buckets, in. (leave blank if PXLP $\geq$ 3 psia)

PCI = condenser pressure, in. HgA

PC = condenser pressure, psia (must be preceded by a minus sign)

10. IFLAG = 10

MR = number of moisture removal stages in low-pressure turbine (MR $\leq$ 5)

PMR(L) = moisture removal stage pressure, psia (L = 1,MR starting from bowl end of low-pressure turbine; leave blank if MR = 0)

11. IFLAG = 11

If MS = 0, there is no external moisture separator

If MS = N, the external moisture separator drains to Feedwater Heater No. N

If MS = NF + 1, the external moisture separator drains to the condenser

EMS = moisture separator effectiveness, % (leave blank if MS = 0)

12. IFLAG = 12

If NRH = 0, there is no reheater

If NRH > 0, there is either a 1-stage or a 2-stage live steam reheater, and

NRH = number of stages of reheat

QERH1 = estimated heating steam flow to the first stage, lb_m/hr (leave blank if NRH < 1)

TTDRH1 = terminal temperature difference of the first stage, $^{\circ}F$ (leave blank if NRH = 0)

QERH2 = estimated heating steam flow to the second stage, lb_m/hr (leave blank if NRH < 2)

TTDRH2 = terminal temperature difference of the second stage, $^{\circ}F$ (leave blank if NRH < 2)

If NRH = -1, there is a 1-stage externally-heated reheater, and

TTDRH1 = temperature of steam leaving reheater, $^{\circ}F$

13. IFLAG = 13

NF = total number of feedwater heaters (NF $\leq$ 12; NF = NFGS + NFH + NFI + NFL)

NFGS = number of feedwater heaters fed from the governing stage exhaust (NFGS $\leq$ 1)

NFH = number of feedwater heaters fed from high-pressure turbine (leave blank if NSHAFT = 1)

NFI = number of feedwater heaters fed from intermediate-pressure turbine (leave blank if NSHAFT < 3)

NFL = number of feedwater heaters fed from low-pressure turbine

14. IFLAG = 14 (one card required for each feedwater heater)

N = feedwater heater number (N = 1,NF starting from high-pressure end)

PE(N) = extraction stage pressure, psia (leave blank if feedwater heater is fed from governing stage exhaust, high-pressure turbine exhaust, or intermediate-pressure turbine exhaust)

TTD(N) = feedwater heater terminal temperature difference, $^{\circ}F$ (a direct contact feedwater heater can be specified by letting TTD(N) = 0 and ND(N) = 1)

If ND(N) = 0, the feedwater heater drain is flashed to the next lower pressure feedwater heater shell, or to the condenser hotwell when N = NF

If ND(N) = 1, the feedwater heater drain is pumped forward to the feedwater discharge from Feedwater Heater No. N

If NDC(N) = 0, the feedwater heater is not provided with a drain cooler

If NDC(N) = 1, the feedwater heater is provided with a drain cooler

TDCA(N) = drain cooler approach temperature, °F (leave blank if NDC(N) = 0)

15. IFLAG = 15

If IP = 0, the feedwater pump is located at the outlet of Feedwater Heater No. 1

If IP = N, the feedwater pump is located at the inlet of Feedwater Heater No. N

If IFPT = 0, the feedwater pump is motor driven

If IFPT = 1, the feedwater pump is turbine driven and steam flow, bowl steam enthalpy, and exhaust steam enthalpy will be calculated by the program

If IFPT = -1, the feedwater pump is turbine driven and steam flow, bowl steam enthalpy, and exhaust steam enthalpy must be input

QFPT = steam flow to feedwater pump turbine, lb_m/hr (leave blank if IFPT > -1)

HBFPT = bowl steam enthalpy to feedwater pump turbine, Btu/lb_m (leave blank if IFPT > -1)

HXFPT = exhaust steam enthalpy from feedwater pump turbine, Btu/lb_m (leave blank if IFPT > -1)

16. IFLAG = 16

QAE = steam flow to steam jet air ejector, lb_m/hr (leave blank or enter zero if there is no steam jet air ejector)

17. IFLAG = 17

If LK = 0, throttle valve stem and turbine shaft leakages will not be calculated

If LK = 1, throttle valve stem and turbine shaft leakages will be calculated

The last data card for a problem must either be blank or have a zero in Column 2 which will terminate reading of input data. Input data will be printed and control will be returned to the main program where the calculations will be started.

After the calculations are finished and the results printed, the program is ready to read a new set of input data. A new comment card is required. If a parametric study is being made, it is necessary, in addition to the comment card, to read only those data cards on which the parameters being changed are entered.

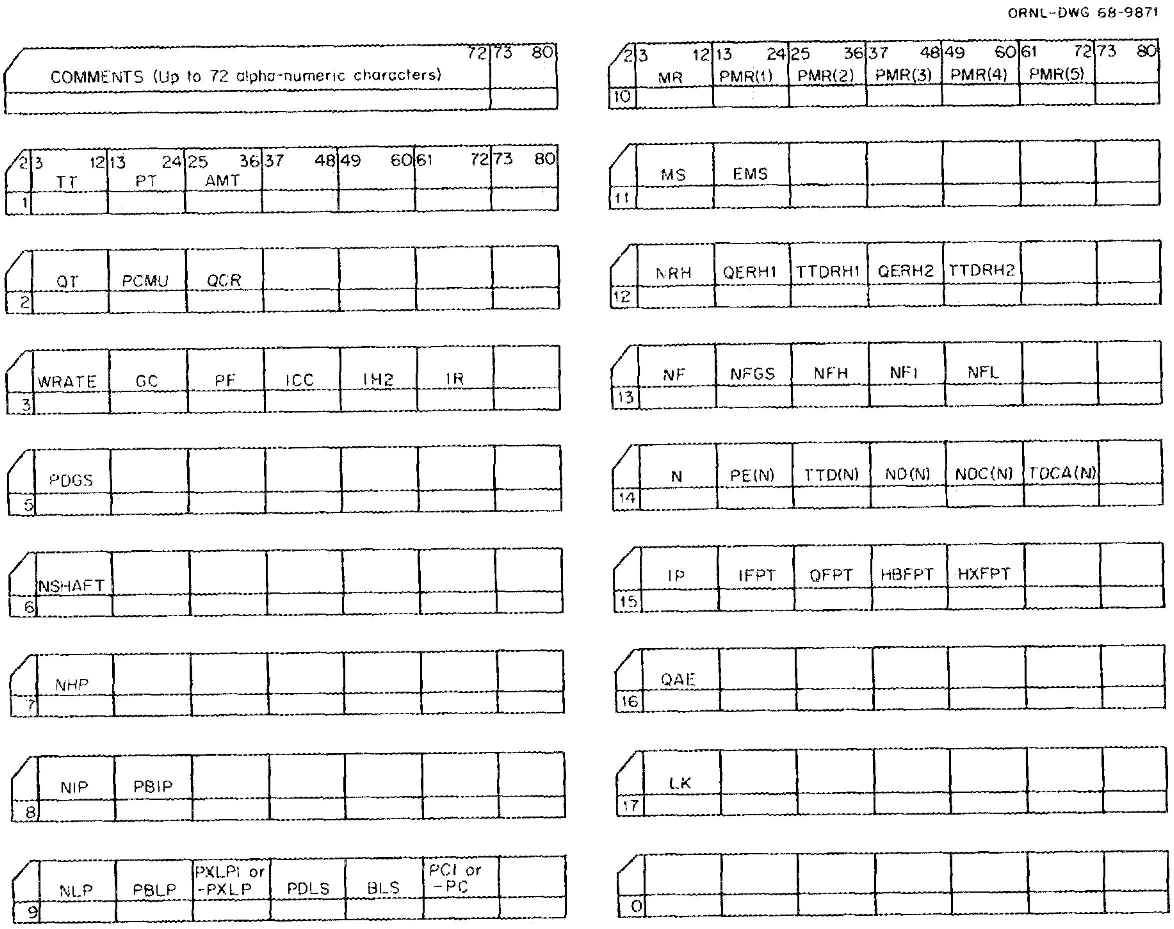

Figure 4. Data Cards

OUTPUT

Output from the program includes all information normally shown on a steam turbine cycle heat balance diagram. The input data are printed first by subroutine DATAIN before control is returned to the main program and before the calculations are performed. If iteration limits are exceeded or independent variable limits for the turbine performance functions are exceeded, warning messages will be printed next. Results of the calculations are printed by subroutine RESULT and are summarized in ten tables, each headed by the information read from the comment card.

APPENDIX A

SAMPLE PROBLEM

To illustrate the use of ØRCENT, a sample problem together with a complete input-output listing is included in this appendix. The turbine cycle selected and input data required are shown on Figure 5. The input data, entered on coding forms ready for key-punching, are shown on Figure 6. This problem required about one-half minute of machine time. An exact estimate of throttle steam flow did not reduce machine time significantly.

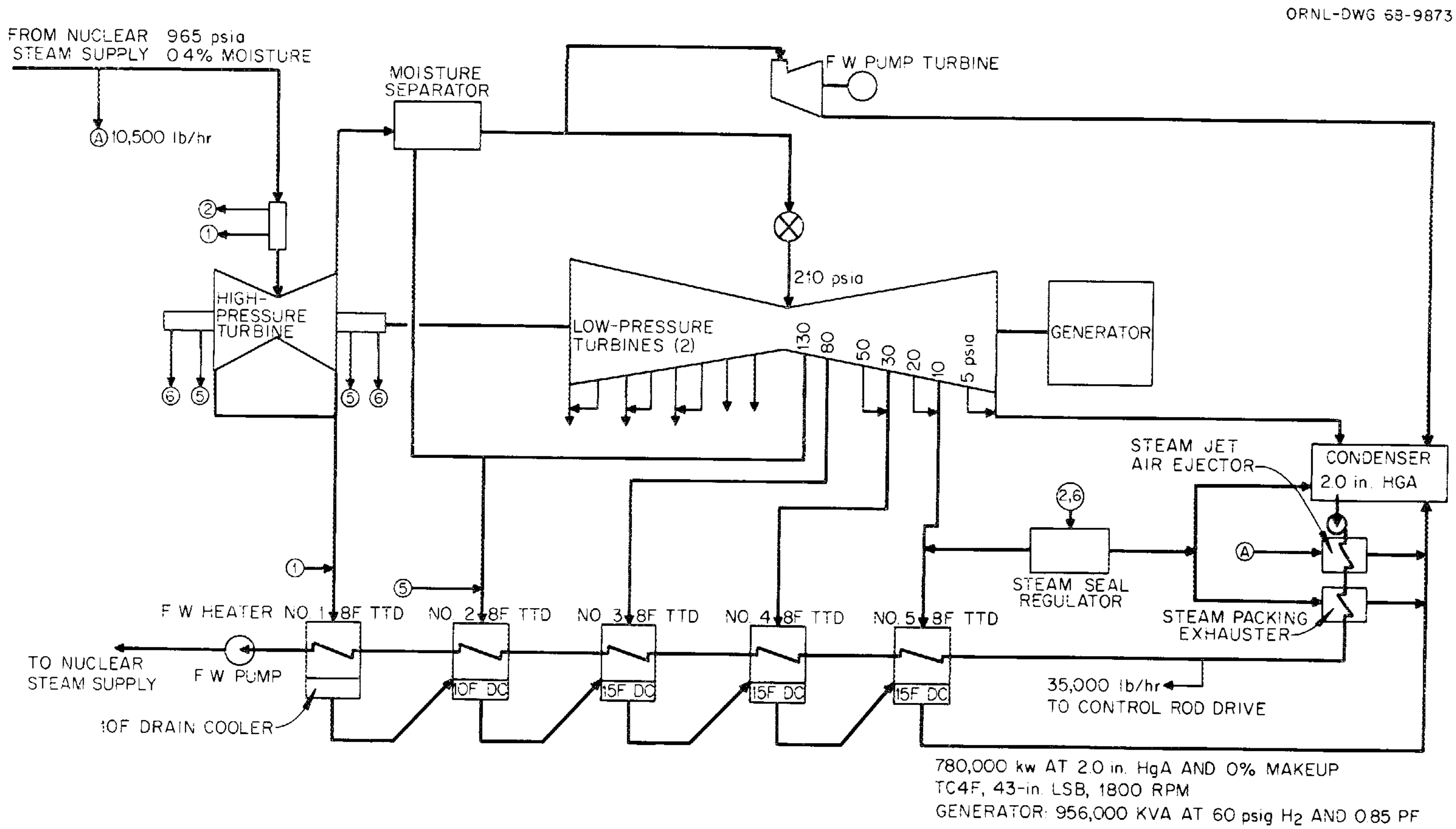

Figure 5. Turbine Cycle for Sample Problem

1–12	13–24	25–36	37–48	49–60	61–72	REFERENCE (73–80)
SAMPLE PROBLEM						
1 540.3	965.	0.4				
2 7800000.	0.	35000.				
3 780.	956.	0.85	0.	0.	1800.	
5 66.						
6 2.						
7 2.						
9 4.	210.	2.	132.	43.	2.	
10 5.	50.	30.	20.	10.	5.	
11 2.	100.					
12 0.						
13 5.	0.	1.		4.		
14 1.	0.	8.	0.	1.	10.	
14 2.	130.	8.	0.	1.	10.	
14 3.	80.	8.	0.	1.	15.	
14 4.	30.	8.	0.	1.	15.	
14 5.	10.	8.	0.	1.	15.	
15 0.	1.					
16 10500.						
17 1.						
0						

Figure 6. Input Data for Sample Problem

SAMPLE PROBLEM
STEAM TURBINE CYCLE HEAT BALANCE
ORCENT, VERSION 9/23/68

INPUT DATA

THROTTLE STEAM TEMPERATURE	540.3	F			
THROTTLE STEAM PRESSURE	965.0	PSIA			
THROTTLE STEAM MOISTURE	0.40	PER CENT			
ESTIMATED THROTTLE STEAM FLOW	7800000.	LB/HR			
FW MAKE-UP RATE (TO CONDENSER HOTWELL)	0.0	PER CENT			
CONDENSATE BY-PASSED TO STEAM GENERATOR	35000.	LB/HR			
REQUIRED ELECTRICAL OUTPUT	780.000	MWE			
GENERATOR RATED CAPABILITY	956.000	MVA			
GENERATOR POWER FACTOR	0.85				
CONDUCTOR-COOLED GENERATOR, ICC= 0					
GENERATOR OPERATION AT RATED HYDROGEN PRESSURE, IH2= 0					
ROTATIONAL SPEED OF TURBINE-GENERATOR	1800	RPM			
PITCH DIAMETER OF GOVERNING STAGE	66.00	IN.			
NO. OF TURBINE SECTIONS IN SERIES	2				
NUMBER OF PARALLEL HP SECTIONS	2				
NUMBER OF PARALLEL LP SECTIONS	4				
BOWL PRESSURE LP SECTION	210.0	PSIA			
EXHAUST PRESSURE LP SECTION	0.98232	PSIA	=	2.00	IN. HGA
CONDENSER PRESSURE	0.98232	PSIA	=	2.00	IN. HGA
PITCH DIAMETER OF LAST STAGE LP SECTION	132.00	IN.			
LENGTH OF LAST STAGE BUCKETS LP SECTION	43.00	IN.			
NO. OF MOISTURE REMOVAL STAGES LP SECTION	5				
MOISTURE REMOVAL STAGE NO. 1					
MOISTURE REMOVAL STAGE PRESSURE	50.0	PSIA			
MOISTURE REMOVAL STAGE NO. 2					
MOISTURE REMOVAL STAGE PRESSURE	30.0	PSIA			
MOISTURE REMOVAL STAGE NO. 3					
MOISTURE REMOVAL STAGE PRESSURE	20.0	PSIA			
MOISTURE REMOVAL STAGE NO. 4					
MOISTURE REMOVAL STAGE PRESSURE	10.0	PSIA			
MOISTURE REMOVAL STAGE NO. 5					
MOISTURE REMOVAL STAGE PRESSURE	5.0	PSIA			
EXTERNAL MOISTURE SEPARATOR DRAINS TO FW HEATER NO. 2, MS= 2					
MOISTURE SEPARATOR EFFECTIVENESS	100.	PER CENT			
NUMBER OF STAGES OF REHEAT	0				
TOTAL NO. OF FW HEATERS	5				
NO. OF FW HEATERS GS SECTION	0				

NO. OF FW HEATERS HP SECTION	1	
NO. OF FW HEATERS LP SECTION	4	
FW HEATER NO. 1		
EXTRACTION STAGE PRESSURE	0.0	PSIA
TERMINAL TEMPERATURE DIFFERENCE	8.0	F
DRAIN IS FLASHED, ND(1)= 0		
THERE IS A DRAIN COOLER SECTION, NDC(1)= 1		
DRAIN COOLER APPROACH TEMPERATURE DIFFERENCE	10.0	F
FW HEATER NO. 2		
EXTRACTION STAGE PRESSURE	130.0	PSIA
TERMINAL TEMPERATURE DIFFERENCE	8.0	F
DRAIN IS FLASHED, ND(2)= 0		
THERE IS A DRAIN COOLER SECTION, NDC(2)= 1		
DRAIN COOLER APPROACH TEMPERATURE DIFFERENCE	10.0	F
FW HEATER NO. 3		
EXTRACTION STAGE PRESSURE	80.0	PSIA
TERMINAL TEMPERATURE DIFFERENCE	8.0	F
DRAIN IS FLASHED, ND(3)= 0		
THERE IS A DRAIN COOLER SECTION, NDC(3)= 1		
DRAIN COOLER APPROACH TEMPERATURE DIFFERENCE	15.0	F
FW HEATER NO. 4		
EXTRACTION STAGE PRESSURE	30.0	PSIA
TERMINAL TEMPERATURE DIFFERENCE	8.0	F
DRAIN IS FLASHED, ND(4)= 0		
THERE IS A DRAIN COOLER SECTION, NDC(4)= 1		
DRAIN COOLER APPROACH TEMPERATURE DIFFERENCE	15.0	F
FW HEATER NO. 5		
EXTRACTION STAGE PRESSURE	10.0	PSIA
TERMINAL TEMPERATURE DIFFERENCE	8.0	F
DRAIN IS FLASHED, ND(5)= 0		
THERE IS A DRAIN COOLER SECTION, NDC(5)= 1		
DRAIN COOLER APPROACH TEMPERATURE DIFFERENCE	15.0	F
FW PUMP IS LOCATED AFTER FW HEATER NO. 1, IP= 0		
FW PUMP IS TURBINE DRIVEN, IFPT= 1		
STEAM FLOW TO FW PUMP TURBINE WILL BE CALCULATED		
STEAM FLOW TO STEAM JET AIR EJECTOR	10500.	LB/HR
VALVE STEM AND PACKING LEAKAGES WILL BE CALCULATED, LK= 1		

SAMPLE PROBLEM
STEAM TURBINE CYCLE HEAT BALANCE
ORCENT, VERSION 9/23/68

CALCULATED RESULTS

TABLE I OVERALL PERFORMANCE

NET TURBINE CYCLE HEAT RATE, BTU/KW-HR	10087.
NET TURBINE CYCLE EFFICIENCY, PER CENT	33.83
GROSS TURBINE CYCLE HEAT RATE, BTU/KW-HR	9949.
GROSS TURBINE CYCLE EFFICIENCY, PER CENT	34.30
GENERATOR OUTPUT, MWE	779.999
POWER REQUIRED BY TURBINE-DRIVEN FW PUMP, MW	10.814
GENERATOR OUTPUT PLUS FW PUMP POWER, MW	790.813
MECHANICAL LOSSES, KW	3678.
GENERATOR LOSSES, KW	9984.

TABLE II TURBINE EXPANSION LINE

	STEAM FLOW LB/HR	PRESSURE PSIA	TEMPERATURE F	MOISTURE PER CENT	ENTHALPY BTU/LB	ENTROPY BTU/LB-F
TURBINE THROTTLE	9416640.	965.0	540.3	0.40	1190.5	
GOVERNING STAGE BOWL	9406753.	918.0	534.3	0.65	1190.5	1.3954
GOVERNING STAGE ELEP AND UEEP	9406753.	678.2	499.6	4.52	1169.4	1.3993
HP SECTION BOWL	9406753.	678.2	499.6	4.52	1169.4	1.3993
HP SECTION ELEP	9406753.	225.4	391.9	12.35	1097.0	1.4143
HP SECTION UEEP		225.4			1098.5	
EXTERNAL MOISTURE SEPARATOR INLET	8858837.	223.8			1098.5	
EXTERNAL MOISTURE SEPARATOR OUTLET	7741063.	221.6	390.5	0.00	1199.7	
LP SECTION BOWL	7605490.	210.0	386.9	0.0	1199.7	1.5420
BEFORE MOISTURE REMOVAL NO. 1		50.0	281.0	8.11	1099.2	1.5573
AFTER MOISTURE REMOVAL NO. 1		50.0	281.0	7.95	1100.6	1.5593
BEFORE MOISTURE REMOVAL NO. 2		30.0	250.3	9.94	1070.2	1.5671
AFTER MOISTURE REMOVAL NO. 2		30.0	250.3	9.67	1072.7	1.5706
BEFORE MOISTURE REMOVAL NO. 3		20.0	228.0	11.07	1049.9	1.5772
AFTER MOISTURE REMOVAL NO. 3		20.0	228.0	10.66	1053.9	1.5829
BEFORE MOISTURE REMOVAL NO. 4		10.0	193.2	12.81	1017.5	1.5950
AFTER MOISTURE REMOVAL NO. 4		10.0	193.2	11.77	1027.7	1.6106
BEFORE MOISTURE REMOVAL NO. 5		5.0	162.2	13.72	993.7	1.6232
AFTER MOISTURE REMOVAL NO. 5		5.0	162.2	10.79	1023.1	1.6705
LP SECTION ELEP	5524044.	0.98232	101.1	15.16	948.6	1.6995
LP SECTION UEEP		0.98232			962.9	

TABLE III   STEAM JET AIR EJECTOR

STEAM FLOW, LB/HR	10500.
STEAM ENTHALPY IN, BTU/LB	1190.5
STEAM ENTHALPY OUT, BTU/LB	180.1

TABLE IV EXTERNAL MOISTURE SEPARATOR DRAINS TO FW HEATER NO. 2

DRAIN FLOW, LB/HR	1067774.
DRAIN PRESSURE, PSIA	221.6
DRAIN TEMPERATURE, F	390.5
DRAIN ENTHALPY, BTU/LB	364.7

TABLE V THERE IS NO REHEATER

TABLE VI MOISTURE REMOVAL STAGES

MOISTURE REMOVAL STAGE NO.	1	2	3	4	5
DRAINS TO FW HEATER NO.	4	4	5	5	0
STAGE PRESSURE, PSIA	50.0	30.0	20.0	10.0	5.0
TEMPERATURE, F	281.0	250.3	228.0	193.2	162.2
WATER REMOVED, LB/HR	11918.	19823.	29364.	74253.	189137.
WATER ENTHALPY, BTU/LB	250.1	218.8	196.2	161.2	130.1
STEAM REMOVED, LB/HR	34177.	0.0	31865.	0.0	28709.
STEAM ENTHALPY, BTU/LB	1100.6	0.0	1053.9	0.0	1023.1

TABLE VII FW HEATERS

FW HEATER NO.	1	2	3	4	5
FW FLOW, LB/HR	9392140.	9392140.	9392140.	9392140.	9392140.
FW TEMPERATURE OUT, F	379.6	333.0	298.3	237.6	181.3
FW ENTHALPY OUT, BTU/LB	353.0	303.8	267.8	205.9	149.2
FW TEMPERATURE IN, F	333.0	298.3	237.6	181.3	102.8
FW ENTHALPY IN, BTU/LB	303.8	267.8	205.9	149.2	70.7
EXTRACTION STAGE PRESSURE, PSIA	225.4	130.0	80.0	30.0	10.0
EXTRACTION STEAM FLOW, LB/HR	581096.	249567.	520614.	396437.	495583.
EXTRACTION STEAM ENTHALPY, BTU/LB	1098.5	1163.2	1129.3	1072.7	1027.7
SHELL PRESSURE, PSIA	214.1	119.6	73.6	27.6	9.2
SHELL TEMPERATURE, F	387.6	341.0	306.3	245.6	189.3
SHELL DRAIN FLOW, LB/HR	588673.	1909858.	2430472.	2892826.	3527177.
SHELL DRAIN TEMPERATURE, F	343.0	308.3	252.6	196.3	117.8
SHELL DRAIN ENTHALPY, BTU/LB	314.3	278.2	221.1	164.3	85.7

TABLE VIII CONDENSER

CONDENSER PRESSURE, PSIA	0.98232	=	2.00	IN. HGA
CONDENSATE FLOW, LB/HR	9427140.			
CONDENSATE TEMPERATURE, F	101.1			
CONDENSATE ENTHALPY, BTU/LB	69.1			

TABLE IX CONDENSATE AND FEEDWATER

CONDENSATE FLOW BY-PASSED TO STEAM GENERATOR, LB/HR	35000.
CONDENSATE ENTHALPY BY-PASSED TO STEAM GENERATOR, BTU/LB	79.7
FW FLOW TO FW PUMP, LB/HR	9392140.
FW TEMPERATURE TO FW PUMP, F	379.5
FW ENTHALPY TO FW PUMP, BTU/LB	353.0
FW ENTHALPY RISE ACROSS FW PUMP, BTU/LB	3.9
FW PRESSURE INCREASE ACROSS FW PUMP, PSI	1056.
FW FLOW TO STEAM GENERATOR, LB/HR	9392140.
FW TEMPERATURE TO STEAM GENERATOR, F	382.0
FW ENTHALPY TO STEAM GENERATOR, BTU/LB	357.0
MAKE-UP TO CONDENSER HOTWELL, LB/HR	0.0
STEAM FLOW FROM STEAM GENERATOR, LB/HR	9427140.
STEAM ENTHALPY FROM STEAM GENERATOR, BTU/LB	1190.5
THROTTLE STEAM FLOW FW PUMP TURBINE, LB/HR	135572.
THROTTLE PRESSURE FW PUMP TURBINE, PSIA	212.7
THROTTLE ENTHALPY FW PUMP TURBINE, BTU/LB	1199.7
EXHAUST PRESSURE FW PUMP TURBINE, PSIA	0.98232
EXHAUST ENTHALPY FW PUMP TURBINE, BTU/LB	927.5

TABLE X VALVE STEM AND SHAFT LEAKAGES

STEAM SEAL REGULATOR	
FLOW TO SSR, LB/HR	15286.
ENTHALPY AT SSR, BTU/LB	1112.4
FLOW FROM SSR TO MAIN CONDENSER, LB/HR	7200.
FLOW FROM SSR TO STEAM PACKING EXHAUSTER, LB/HR	4800.
FLOW FROM SSR TO FW HEATER NO. 5, LB/HR	3286.
MAKE-UP FROM THROTTLE STEAM, LB/HR	0.0
ENTHALPY OF MAKE-UP STEAM, BTU/LB	0.0
THROTTLE VALVE STEM	
LEAK NO. 1 (DRAINS TO FW HEATER NO. 1), LB/HR	7578.
ENTHALPY LEAK NO. 1, BTU/LB	1190.5
LEAK NO. 2 (DRAINS TO SSR), LB/HR	2310.
ENTHALPY LEAK NO. 2, BTU/LB	1190.5
GOVERNING STAGE SECTION	
LEAK NO. 3 (DRAINS TO FW HEATER NO. 0), LB/HR	0.0
ENTHALPY LEAK NO. 3, BTU/LB	0.0
LEAK NO. 4 (DRAINS TO SSR), LB/HR	0.0
ENTHALPY LEAK NO. 4, BTU/LB	0.0
HP TURBINE SECTION	
TOTAL LEAK NO. 5 (DRAINS TO FW HEATER NO. 2), LB/HR	3843.
ENTHALPY LEAK NO. 5, BTU/LB	1098.5
TOTAL LEAK NO. 6 (DRAINS TO SSR), LB/HR	12977.
ENTHALPY LEAK NO. 6, BTU/LB	1098.5

APPENDIX B

FORTRAN LISTING

This appendix contains a brief description and a complete Fortran listing of the main program and the 60 subprograms. The primary function of the main program is to control the order of calculations and to call the subprograms required by the cycle specified by the input data. (It also performs some calculations.) There are no programmed stops or exits. If a convergence criterion is not satisfied or if the allowable range of an independent variable is exceeded, a warning message will be printed and calculations will continue.

1. DATAIN - reads input data cards and prints input data before returning control to main program.
2. RESULT - prints results of calculations for each problem before proceeding to the next problem.
3. AMØIST - performs internal moisture removal calculations for the low-pressure turbine (Table IV, GER-2454A).
4. FWHEAT - performs heat and mass balance calculations for the feedwater heaters.
5. FWHPAR - calculates the following feedwater heater parameters: shell pressure, shell drain temperature, feedwater inlet temperature, and feedwater outlet temperature.
6. FWPT - calculates steam flow to the feedwater pump turbine.
7. GØVERN and GSTAGE - calculate turbine governing stage performance and shell steam conditions.
8. HXTRAC - calculates feedwater heater extraction steam enthalpy after the turbine expansion line has been determined.
9. INDEX - calculates integer indices for keeping track of steam flows and enthalpies in the low-pressure turbine.
10. PRDRØP - calculates cross-over system pressure drops [Table III (2nd revision), GER-2454A].
11. REHEAT - calculates reheater parameters required for reheater heat and mass balance calculations.
12. SGRØUP - calculates turbine non-governing stage group performance and shell steam conditions.

13. SLEAK1, SLEAK2, and SLEAK3 - calculate throttle valve stem packing and turbine shaft packing leakage flows and enthalpies (Table II, GER-2454A).

14. SSRE - calculates steam seal regulator flows and enthalpies (Table II, GER-2454A).

15. XLØSS - calculates exhaust loss and used energy end-point for low-pressure condensing turbine.

16. XSEP - performs heat and mass balance calculations for external moisture separator.

17. The following 24 subprograms perform the calculations required to determine turbine efficiencies and losses (Appendix IV, GER-2454A).

FIG1	FIG8	FIG19
FIG2	FIG10	FIG20
FIG3	FIG12A	FIG21
FIG4	FIG12B	FIG22
FIG5	FIG14	UNIPØL
FIG6	FIG15	BIVPØL
FIG6A	FIG167	RATFUN
FIG7	FIG18	LAGRAN

18. The following 17 subprograms calculate properties of water and steam.

TLIQH	VVAP	TSAT
HCØM	TVAPH	PSAT
TCØM	TVAPS	PRØPHS
LINT2	HLIQ	PRØPPH
HVAP	SLIQ	PRØPPS
SVAP	VLIQ	

```
C     PROGRAM ORCENT
C
C  THIS PROGRAM CALCULATES CYCLE EFFICIENCY FOR NUCLEAR TURBINES AS
C  DESCRIBED IN GER-2454A, 'PREDICTING THE PERFORMANCE OF LARGE STEAM
C  TURBINE-GENERATORS OPERATING WITH SATURATED AND LOW SUPERHEAT STEAM
C  CONDITIONS', BY F G BAILY, K C COTTON, AND R C SPENCER, LARGE STEAM
C  TURBINE-GENERATOR DEPARTMENT, GENERAL ELECTRIC COMPANY, SCHENECTADY,
C  NEW YORK, 1967
C
      IMPLICIT REAL*8(A-H,O-Z)
C
      COMMON /AM/AMBMR(5),AMAMR(5),TMR(5),MR
      COMMON /CONV/HCON,UERCON,AMCON,RHCON,WCON,PCON,SSRCON,XSPCON
      COMMON /FPT/QFPT,PBFPT,HBFPT,PXFPT,HXFPT,IFPT
      COMMON /FWH/HAEI,HAED,QR,QFS(20),HFS(20),HES(20),QMF(5),HMF(5),
     1QMG(5),HMG(5),QD(12),QF(12),QE(12),QCR,HCR,QRO,QC,I1LP,I
      COMMON /GS/QGS,HBGS,PBGS,AMBGS,SBGS,VBGS,TBGS,PXGS,AMXGS,SXGS,
     1VXGS,TXGS,HXGS,PDGS,MBGS,MXGS,NCGS,IRGS,NGS
      COMMON /HP/QBHP,PBHP,TBHP,AMBHP,HBHP,SBHP,QXHP,TXHP,AMXHP,HXHP,
     1SXHP,UEEPHP
      COMMON /HX1/PE(12),PMR(5)
      COMMON /HX2/HE(12),HE1(12),HAMR(5),HBMR(5),SAMR(5),SBMR(5),PCWD(5)
      COMMON /IN/L1(13),L2(13),J1(13),IMR(5)
      COMMON /IP/QBIP,PBIP,TBIP,AMBIP,HBIP,SBIP,QXIP,TXIP,AMXIP,HXIP,
     1SXIP,UEEPIP
      COMMON /LEAK/QLK1,HLK1,QLK2,HLK2,QLK3,HLK3,QLK4,HLK4,QLK5,HLK5,
     1QLK6,HLK6,QLK7,HLK7,QLK8,HLK8,QLK9,HLK9,QLK10,HLK10,LK,LK1,LK3,
     2LK5,LK7,LK9
      COMMON /LP/QBLP,PBLP,TBLP,AMBLP,HBLP,SBLP,QXLP,PXLP,TXLP,AMXLP,
     1HXLP,SXLP,UEEPLP
      COMMON /MIS/CMTS(18),      TC,TFP,TR,HR,WRATE,GC,WML,WGL,CMU,QFP,
     1DP,WGEN,WFWP,HTRTN,HTRTG,CEFFN,CEFFG,PC
      COMMON /PAR1/HO(12),HI(12),DAE,HC,HFP,DHP,TI(12),TD(12),TDCA(12),
     1HD(12),PLA,PLB,ND(12),NDC(12),IP,NF,NSHAFT
      COMMON /PAR2/PSH(12),TSH(12),TO(12),TTD(12),PXHP,PXIP
      COMMON /RH1/PXRH2,PIRH2,PXRH1,PIRH1,PFPT
      COMMON /RH2/QRH1,HCRH1,QRH2,HCRH2,NRH
      COMMON /RH3/TTDRH1,TTDRH2,HRH1,HRH2,PCRH1,TCRH1,PCRH2,TCRH2,TXRH1,
     1HXRH1,TXRH2,HXRH2,HIRH2,HIRH1,QRH
      COMMON /SSR/QSPE,QMC,QSSR,HSSR,PSSR,QFWH,QSSRMU,HSSRMU
      COMMON /T/QT,PT,TT,AMT,HT
      COMMON /XS1/PSX,PSI
      COMMON /XS2/HFSX,QMR
      COMMON /XS3/QSI,HSI,TSX,QSX,HSX,AMSX,EMS,MS
C
      DATA VERS/'9/23/68 '/
      HCON=1.D-1
      UERCON=1.D-3
      AMCON=1.D-4
      RHCON=1.D-6
      WCON=1.D-6
      PCON=1.D-4
      SSRCON=1.D-4
      XSPCON=1.D-6
C
C  DEFINE CONVERGENCE CRITERIA
C  HCON=ENTHALPY, BTU/LB
C  UERCON=USED ENERGY RATIO
C  AMCON=MOISTURE FRACTION
C  RHCON=REHEATER MOTIVE STEAM FLOW, (DELTA Q)/Q
C  WCON=REQUIRED ELECTRICAL OUTPUT, (DELTA W)/W
C  PCON=GOVERNING STAGE EXHAUST PRESSURE, (DELTA P)/P
C  SSRCON=STEAM SEAL REGULATOR MAKE-UP, (DELTA Q)/Q
C  XSPCON=MOISTURE REMOVED BY EXTERNAL MOISTURE SEPARATOR, (DELTA Q)/Q
C
C
C
C
C
C  DATA INPUT.  INPUT VARIABLES ARE DEFINED IN SUBROUTINE DATAIN.
```

```
C
  100 CONTINUE
      CALL DATAIN( CNTS, TT, PT, AMT, QT, WRATE, GC, PCMU, PDGS,
     1 NSHAFT, NHP, IRHP, NIP, IRIP, PBIP, NLP, IRLP, PBLP, PXLP, PDLS,
     2 BLS, MR, PMR, MS, NRH, QERH1, TTORH1, QERH2, TTORH2, NF, NFGS,
     3 NFH, NFI, NFL, PE, TTD, ND, NDC, TDCA, IP, QFPT, IFPT, QAE, LK,
     4 PF, ICC, IH2, VERS, QCR, HBFPT, HXFPT, PC, EMS)
      MAIN=0
C
C  START CALCULATIONS
C
C  THROTTLE STEAM ENTHALPY
      HT=HVAP(TT,PT)
      IF(AMT.LE.0.0)GOTO1210
      AMT1=AMT*0.01
      HT=(1.0-AMT1)*HT+AMT1*HLIQ(TT)
C
C  GOVERNING STAGE PARAMETERS
 1210 HBGS=HT
      PBGS=PT*0.9513
      NCGS=0
      IF(NSHAFT.GT.1)GOTO1220
      IRGS=IRLP
      NGS=NLP
      GOTO1230
 1220 IRGS=IRHP
      NGS=NHP
C
C  SPEED LEVEL CORRECTION
 1230 CSLP=FIG6A(IRLP)
      GOTO(1260,1250,1240),NSHAFT
 1240 CSIP=FIG6A(IRIP)
 1250 CSHP=FIG6A(IRHP)
C
C  GENERATOR
 1260 IF(ICC.EQ.0)GOTO1263
      IF(IRLP-1800)1261,1261,1262
C  ICK= 2, CONVENTIONALLY-COOLED, 1800 RPM
 1261 ICK=2
      GOTO1266
C  ICK= 1, CONVENTIONALLY-COOLED, 3600 RPM
 1262 ICK=1
      GOTO1266
 1263 IF(IRLP-1800)1264,1264,1265
C  ICK=-1, CONDUCTOR-COOLED, 1800 RPM
 1264 ICK=-1
      GOTO1266
C  ICK= 0, CONDUCTOR-COOLED, 3600 RPM
 1265 ICK=0
 1266 GCKVA=GC*1000.
      GOKVA=1000.00*WRATE/PF
      FRKVA=GOKVA/GCKVA
      PCTKVA=FRKVA*100.
C
C  GENERATOR LOSS (TANDEM COMPOUND)
C  RATED HYDROGEN PRESSURE
      GL20=FIG20(GCKVA,ICK,IRLP)
      GL21=FIG21(FRKVA,ICK)
      WGL=GOKVA*GL20*GL21*0.01
C  TEST FOR REDUCED HYDROGEN PRESSURE
      IF(IH2.EQ.0)GOTO1267
C  REDUCED HYDROGEN PRESSURE
      WGL=WGL-FIG22(GCKVA,ICK)
C
C  MECHANICAL LOSS
 1267 WML=FIG19(GCKVA)
C
C  INTERMEDIATE SYSTEM PRESSURE DROP AND PXHP
      QMR=0.
      HFSX=0.
      GOTO(1300,1270,1280),NSHAFT
```

```
 1270 MS1=MS                                                           ORCE 810
      PB=PBLP                                                          ORCE 820
      GOTO1290                                                         ORCE 830
 1280 CALL PRDROP(PXIP,PBLP,MS,0)                                      ORCE 840
      MS1=0                                                            ORCE 850
      PB=PBIP                                                          ORCE 860
 1290 CALL PRDROP(PXHP,PB,MS1,NRH)                                     ORCE 870
C                                                                      ORCE 880
C  CONDENSER HOTWELL PARAMETERS                                        ORCE 881
 1300 TC=TSAT(PC)                                                      ORCE 890
      HC=HLIQ(TC)                                                      ORCE 900
C                                                                      ORCE 910
C  STEAM JET AIR EJECTOR ENTHALPY                                      ORCE 911
      HAEI=HT                                                          ORCE 920
      HAEO=180.1                                                       ORCE 930
C                                                                      ORCE 940
C  SET INDICES FOR FW HEATER HEAT BALANCE CALCULATIONS                 ORCE 941
      I1GS=1                                                           ORCE 950
      I2GS=NFGS                                                        ORCE 960
      IF(NSHAFT.GT.1)GOTO1310                                          ORCE 970
      I1LP=I2GS+1                                                      ORCE 980
      GOTO1330                                                         ORCE 990
 1310 I1HP=I2GS+1                                                      ORCE1000
      I2HP=I2GS+NFH                                                    ORCE1010
      IF(NSHAFT.GT.2)GOTO1320                                          ORCE1020
      I1LP=I2HP+1                                                      ORCE1030
      GOTO1330                                                         ORCE1040
 1320 I1IP=I2HP+1                                                      ORCE1050
      I2IP=I2HP+NFI                                                    ORCE1060
      I1LP=I2IP+1                                                      ORCE1070
 1330 IF(MR.GT.0)GOTO1340                                              ORCE1080
      I2LP=NF                                                          ORCE1090
      GOTO1360                                                         ORCE1100
 1340 I2LP=NF+1                                                        ORCE1110
      CALL INDEX(I1LP,I2LP,NFL,MR)                                     ORCE1120
C                                                                      ORCE1130
C  FEEDWATER PUMP ENTHALPY RISE                                        ORCE1131
 1360 PLA=PT*1.25                                                      ORCE1140
      IF(PT.GE.200.)GOTO1361                                           ORCE1150
      PLB=PC                                                           ORCE1160
      GOTO1362                                                         ORCE1170
 1361 PLB=150.                                                         ORCE1180
 1362 DP=PLA-PLB                                                       ORCE1190
      EFP=0.9                                                          ORCE1200
      DHP=DP*VLIQ(TSAT(PLB))*0.18505/EFP                               ORCE1210
C                                                                      ORCE1220
C  FW HEATER PARAMETERS                                                ORCE1230
      IF(NFGS.EQ.NF)GOTO1400                                           ORCE1240
      GOTO(1390,1380,1370),NSHAFT                                      ORCE1250
 1370 IF(NFI.EQ.0)GOTO1380                                             ORCE1260
      IF(PE(I2IP).LE.(PXIP+1.0))GOTO1371                               ORCE1270
      I2I=I2IP                                                         ORCE1280
      GOTO1380                                                         ORCE1290
 1371 PE(I2IP)=PXIP                                                    ORCE1300
      I2I=I2IP-1                                                       ORCE1310
 1380 IF(NFH.EQ.0)GOTO1390                                             ORCE1320
      IF(PE(I2HP).LE.(PXHP+1.0))GOTO1381                               ORCE1330
      I2H=I2HP                                                         ORCE1340
      GOTO1390                                                         ORCE1350
 1381 PE(I2HP)=PXHP                                                    ORCE1360
      I2H=I2HP-1                                                       ORCE1370
 1390 CALL FWHPAR(NFGS+1,NF)                                           ORCE1380
C                                                                      ORCE1420
C  STEAM PACKING EXHAUSTER FLOW                                        ORCE1421
 1400 IF(LK.GT.0)GOTO1409                                              ORCE1430
      GSPE=0.                                                          ORCE1440
      HSSR=0.                                                          ORCE1450
      GOTO1440                                                         ORCE1460
 1409 GSSRMU=0.                                                        ORCE1480
      GSSRM1=0.                                                        ORCE1490
      IF(IRLP.EQ.1800)GOTO1410                                         ORCE1500
```

```
      QSPE=650.0*NLP                                                    ORCE1510
      QMC=950.0*NLP                                                     ORCE1520
      GOTO1420                                                          ORCE1530
 1410 QSPE=1200.0*NLP                                                   ORCE1540
      QMC=1800.0*NLP                                                    ORCE1550
C                                                                       ORCE1560
C  STEAM SEAL REGULATOR PRESSURE                                        ORCE1561
 1420 IF(PXLP.LE.18.0)GOTO1430                                          ORCE1570
      PSSR=PXLP                                                         ORCE1580
      GOTO1440                                                          ORCE1590
 1430 PSSR=18.0                                                         ORCE1600
C                                                                       ORCE1601
C  REHEATER                                                             ORCE1602
 1440 QRH1=QERH1                                                        ORCE1603
      QRH2=QERH2                                                        ORCE1604
      IF(NRH.NE.1)GOTO1900                                              ORCE1605
      CALL REHEAT(HE(1),PE(1),HT,PT)                                    ORCE1606
C                                                                       ORCE1607
 1900 MAIN=MAIN+1                                                       ORCE1610
      ITGS=0                                                            ORCE1620
      ITHP=0                                                            ORCE1630
      ITIP=0                                                            ORCE1640
      NCRH=0                                                            ORCE1650
      ITMS=0                                                            ORCE1660
      ITSSR=0                                                           ORCE1670
C                                                                       ORCE1680
C  STEAM FLOW FROM STEAM GENERATOR                                      ORCE1681
      QRO=QT+QAE                                                        ORCE1690
      IF(NRH.LT.1)GOTO1920                                              ORCE1700
      IF(NRH.EQ.1)GOTO1910                                              ORCE1710
      QRO=QRO+QRH2                                                      ORCE1720
      GOTO1920                                                          ORCE1730
 1910 QRO=QRO+QRH1                                                      ORCE1740
C                                                                       ORCE1750
C  MAKE-UP FLOW                                                         ORCE1751
 1920 QMU=QT*PCMU*0.01                                                  ORCE1760
C                                                                       ORCE1770
C  FEEDWATER FLOW TO STEAM GENERATOR                                    ORCE1771
      QR=QRO-QCR+QMU                                                    ORCE1780
C                                                                       ORCE1790
C  TEST FOR 1- SHAFT MACHINE AND FW PUMP TURBINE CALCULATIONS           ORCE1791
      IF(NSHAFT.GT.1)GOTO1950                                           ORCE1800
      IF(IFPT)1940,1950,1930                                            ORCE1810
C                                                                       ORCE1820
C  FW PUMP TURBINE STEAM FLOW (1-SHAFT MACHINE)                         ORCE1830
 1930 CALL FWPT(PT,HT,  PC,DHP,QR,NSHAFT)                               ORCE1840
 1940 QRO=QRO+QFPT                                                      ORCE1850
      QR=QR+QFPT                                                        ORCE1860
C                                                                       ORCE1870
 1950 CONTINUE                                                          ORCE1880
C                                                                       ORCE1890
C  GOVERNING STAGE PERFORMANCE                                          ORCE1891
C                                                                       ORCE1900
C  TEST FOR VALVE STEM LEAKAGE CALCULATIONS                             ORCE1901
 2000 IF(LK.GT.0)GOTO2001                                               ORCE1910
C                                                                       ORCE1920
C  GOVERNING STAGE FLOW, NO VALVE STEM LEAKAGE                          ORCE1921
      QGS=QT                                                            ORCE1930
      GOTO2003                                                          ORCE1940
C                                                                       ORCE1950
C  VALVE STEM LEAKAGE                                                   ORCE1951
 2001 CALL SLEAK1(NF, PE,QT,PT,HT,LK1,QLK1,HLK1,QLK2,HLK2,NFGS)         ORCE1960
C                                                                       ORCE1970
C  GOVERNING STAGE FLOW WITH VALVE STEM LEAKAGE                         ORCE1971
 2002 QGS=QT-QLK1-QLK2-QSSRMU                                           ORCE1980
C                                                                       ORCE1990
C  GS BOWL AND SHELL CONDITIONS                                         ORCE2000
 2003 CALL GSTAGE(PXLP)                                                 ORCE2010
C                                                                       ORCE2020
C  TEST FOR GOVERNING STAGE SHAFT LEAKAGE                               ORCE2021
      IF(LK.GT.0)GOTO2004                                               ORCE2030
```

```
C                                                                        ORCE2040
C   FLOW TO NEXT STAGE, NO GS SHAFT LEAKAGE                              ORCE2040
      QNEXT=QGS                                                          ORCE2041
      QXGS=QGS                                                           ORCE2050
      GOTO2005                                                           ORCE2060
C                                                                        ORCE2070
C   GS SHAFT LEAKAGE                                                     ORCE2080
 2004 CALL SLEAK2(NF, PE,NGS,IRGS,PXGS,VXGS,HXGS,LK3,QLK3,HLK3,QLK4,     ORCE2090
     1HLK4,PSSR,NFGS)                                                    ORCE2100
C                                                                        ORCE2101
C   FLOW TO NEXT STAGE WITH GS SHAFT LEAKAGE                             ORCE2110
      QNEXT=QGS-QLK3-QLK4                                                ORCE2111
      QXGS=QNEXT                                                         ORCE2120
C                                                                        ORCE2130
C   TEST FOR FW HEATER AT GS EXHAUST                                     ORCE2140
 2005 IF(NFGS.EQ.0)GOTO2030                                              ORCE2141
C                                                                        ORCE2150
C   FW HEATER HEAT BALANCE AT GS EXHAUST                                 ORCE2160
      PE(1)=PXGS                                                         ORCE2170
      HE(1)=HXGS                                                         ORCE2180
      IF(NRH.LT.2)GOTO2019                                               ORCE2190
      CALL REHEAT(HE(1),PE(1),HT,PT)                                     ORCE2200
 2019 CALL FWHPAR(1,1)                                                   ORCE2210
 2020 CALL FWHEAT(1,1,0,0,0,0)                                           ORCE2220
      ITGS=ITGS+1                                                        ORCE2230
C                                                                        ORCE2240
C   FLOW TO NEXT STAGE                                                   ORCE2250
      QNEXT=QXGS-QE(1)                                                   ORCE2251
C                                                                        ORCE2260
C   TEST FOR 2 STAGES OF REHEAT                                          ORCE2270
      IF(NRH.LT.2)GOTO2030                                               ORCE2271
C                                                                        ORCE2280
C   FLOW TO NEXT STAGE                                                   ORCE2290
      QNEXT=QNEXT-QRH1                                                   ORCE2291
C                                                                        ORCE2300
C   TEST FOR 1-SECTION MACHINE                                           ORCE2310
 2030 IF(NSHAFT.GT.1)GOTO3000                                            ORCE2311
C                                                                        ORCE2320
C   LP SECTION BOWL PRESSURE AND ENTHALPY (1-SECTION MACHINE)            ORCE2330
      PBLP=PXGS                                                          ORCE2340
      HNEXT=HXGS                                                         ORCE2350
      GOTO7000                                                           ORCE2360
C                                                                        ORCE2370
C   HIGH PRESSURE SECTION PERFORMANCE                                    ORCE2380
C                                                                        ORCE2381
C   BOWL CONDITIONS (HP SECTION)                                         ORCE2390
 3000 QBHP=QNEXT                                                         ORCE2391
      PBHP=PXGS                                                          ORCE2400
      HBHP=HXGS                                                          ORCE2410
      SBHP=SXGS                                                          ORCE2420
      VBHP=VXGS                                                          ORCE2430
      AMBHP=AMXGS                                                        ORCE2440
      MBHP=MXGS                                                          ORCE2450
      TBHP=TXGS                                                          ORCE2460
C                                                                        ORCE2470
C   SHELL CONDITIONS (HP SECTION)                                        ORCE2480
      CALL SGROUP(PBHP,TBHP,HBHP,SBHP,VBHP,AMBHP,MBHP,QBHP,NHP,CSHP,     ORCE2481
     1PXHP,TXHP,HXHP,SXHP,VXHP,AMXHP,MXHP,PIHP,TIHP,HIHP,SIHP,VIHP,      ORCE2490
     2AMIHP,MIHP,PXLP)                                                   ORCE2491
C                                                                        ORCE2492
C   EXHAUST LOSS AND UEEP (HP SECTION)                                   ORCE2500
      XLHP=FIG8(PXHP)                                                    ORCE2501
      UEEPHP=HXHP+XLHP                                                   ORCE2510
      CALL PROPPH(AMUEHP,SUEHP,VUEHP,TUEHP,MUEHP,PXHP,UEEPHP)            ORCE2520
C                                                                        ORCE2530
C   EXHAUST FLOW (HP SECTION)                                            ORCE2540
      QXHP=QBHP                                                          ORCE2541
C                                                                        ORCE2550
C   TEST FOR FW HEATERS (HP SECTION)                                     ORCE2560
 3010 IF(NFH.EQ.0)GOTO3031                                               ORCE2561
C                                                                        ORCE2570
                                                                         ORCE2580
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C    FW HEATER HEAT BALANCE (HP SECTION)                                ORCE2590
      I1=I1HP                                                           ORCE2600
      CALL HXTRAC(0,I1HP,I2HP,MRHP,HRHP,SRHP,MXHP,HXHP,SXHP,PIHP,HIHP,  ORCE2610
     1SIHP,PXHP,UEEPHP)                                                 ORCE2611
      IF(NEGS.EQ.1.OR.NRH.LT.2)GOTO3025                                 ORCE2620
      CALL REHEAT(HE(1),PE(1),HT,PT)                                    ORCE2630
      GOTO3025                                                          ORCE2640
 3020 I1=I                                                              ORCE2650
 3025 CALL FWHEAT(I1,I2HP,0,0,MS,ITGS)                                  ORCE2660
      ITHP=ITHP+1                                                       ORCE2670
C                                                                       ORCE2680
C    TEST FOR REGRESSIVE FW HEATER HEAT BALANCE CALCULATIONS            ORCE2681
      IF(I.EQ.NEGS)GOTO2020                                             ORCE2690
C                                                                       ORCE2700
C    TEST FOR ONLY ONE FW HEATER (HP SECTION)                           ORCE2701
C    TEST FOR FW HEATER AT EXHAUST (HP SECTION)                         ORCE2702
      IF(NFH.EQ.1.AND.I2H.LT.I2HP)GOTO3031                              ORCE2710
C                                                                       ORCE2720
C    EXHAUST FLOW, MORE THAN ONE FW HEATER HP SECTION,                  ORCE2721
C    OR ONLY ONE FW HEATER AND NOT LOCATED AT HP EXHAUST                ORCE2730
      QXHP=QPHP                                                         ORCE2740
      DO3030 K=I1HP,I2H                                                 ORCE2750
 3030 QXHP=QXHP-QE(K)                                                   ORCE2760
C                                                                       ORCE2770
C    TEST FOR REHEATER STEAM EXTRACTION (HP SECTION)                    ORCE2771
 3031 IF(NRH.LT.2.OR.NEGS.EQ.1)GOTO3032                                 ORCE2780
      QXHP=QXHP-QRHI                                                    ORCE2790
C                                                                       ORCE2800
C    FLOW TO NEXT SECTION                                               ORCE2801
 3032 QNEXT=QXHP                                                        ORCE2810
C                                                                       ORCE2820
C    TEST FOR SHAFT LEAKAGE CALCULATIONS                                ORCE2821
      IF(LK.EQ.0)GOTO3033                                               ORCE2830
C                                                                       ORCE2840
C    SHAFT LEAKAGE FROM EXHAUST END (HP SECTION)                        ORCE2841
      CALL SLEAK3(NF,PE,NHP,IRHP,PXHP,VUEHP,UEEPHP,LK5,QLK5,HLK5,QLK6,  ORCE2850
     1HLK6,PSSR)                                                        ORCE2851
C                                                                       ORCE2860
C    FLOW TO NEXT SECTION                                               ORCE2861
      QNEXT=QNEXT-QLK5-QLK6                                             ORCE2870
C                                                                       ORCE2880
C    TEST FOR FW HEATER AT HP EXHAUST                                   ORCE2881
 3033 IF(NFH.EQ.0.OR.I2H.EQ.I2HP)GOTO3040                               ORCE2890
C                                                                       ORCE2900
C    FLOW TO NEXT SECTION, FW HEATER AT HP EXHAUST                      ORCE2901
      QNEXT=QNEXT-QE(I2HP)                                              ORCE2910
C                                                                       ORCE2920
C    TEST FOR EXTERNAL MOISTURE SEPARATOR AND 2-SECTION MACHINE         ORCE2921
 3040 IF(MS.GT.0.AND.NSHAFT.EQ.2)GOTO4000                               ORCE2930
C                                                                       ORCE2940
C    TEST FOR REHEATER                                                  ORCE2941
      IF(NRH.NE.0)GOTO4205                                              ORCE2950
C                                                                       ORCE2960
C    ENTHALPY TO NEXT SECTION (NO MOISTURE SEPARATOR OR REHEATER)       ORCE2961
      HNEXT=UEEPHP                                                      ORCE2970
      GOTO4300                                                          ORCE2980
C                                                                       ORCE2990
C    EXTERNAL MOISTURE SEPARATOR PERFORMANCE (2-SECTION MACHINE)        ORCE2991
C                                                                       ORCE3000
C    INLET FLOW AND ENTHALPY                                            ORCE3001
 4000 QSI=QNEXT                                                         ORCE3010
      HSI=UEEPHP                                                        ORCE3020
      ITMS=ITMS+1                                                       ORCE3030
C                                                                       ORCE3040
C    HEAT AND MASS BALANCE CALCULATION                                  ORCE3041
      QMR1=QMR                                                          ORCE3050
      CALL XSEP                                                         ORCE3060
C                                                                       ORCE3070
C    TEST FOR MOISTURE FLOW TO FW HEATER AT HP SECTION EXHAUST          ORCE3071
      IF(MS.GT.I2HP)GOTO4010                                            ORCE3080
C                                                                       ORCE3090
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C   TEST FOR MOISTURE REMOVAL CONVERGENCE                                    ORCE3091
      ADQMR=DABS((QMR-QMRI)/QMR)                                             ORCE3100
      IF(ADQMR.LE.XSPCON)GOTO4010                                            ORCE3110
      IF(ITMS.GT.50)GOTO4008                                                 ORCE3120
      I1=I2HP                                                                ORCE3130
      GOTO3025                                                               ORCE3140
 4008 PRINT 4009,ADQMR                                                       ORCE3150
 4009 FORMAT('0-MAIN PROGRAM-EXTERNAL MOISTURE SEPARATOR DRAIN CALCULATIORCE3160
     1ONS DID NOT CONVERGE, ADQMR =',1PD14.6)                                ORCE3161
C                                                                            ORCE3170
C   TEST FOR REHEATER                                                        ORCE3171
 4010 IF(NRH.NE.0)GOTO4200                                                   ORCE3180
C                                                                            ORCE3190
C   FLOW AND ENTHALPY TO NEXT SECTION (NO REHEATER, 2-SECTION MACHINE)       ORCE3191
      QNEXT=QSX                                                              ORCE3200
      HNEXT=HSX                                                              ORCE3210
      GOTO4300                                                               ORCE3220
C                                                                            ORCE3230
C   REHEATER PERFORMANCE                                                     ORCE3231
C                                                                            ORCE3240
C   FLOW AND ENTHALPY TO REHEATER (EXTERNAL MOISTURE SEPARATOR)              ORCE3241
 4200 QRH=QSX                                                                ORCE3250
      HIRH1=HSX                                                              ORCE3260
      GOTO4210                                                               ORCE3270
C                                                                            ORCE3280
C   FLOW AND ENTHALPY TO REHEATER (NO MOISTURE SEPARATOR)                    ORCE3281
 4205 QRH=QNEXT                                                              ORCE3290
      HIRH1=HEEPHP                                                           ORCE3300
C                                                                            ORCE3310
C   1ST STAGE HEAT BALANCE                                                   ORCE3311
 4210 NCRH=NCRH+1                                                            ORCE3320
C                                                                            ORCE3321
C   TEST FOR TYPE OF REHEATER                                                ORCE3322
      IF(NRH.GT.0)GOTO4220                                                   ORCE3323
C                                                                            ORCE3324
C   EXTERNAL REHEATER                                                        ORCE3325
      TXRH1=TTDRH1                                                           ORCE3326
      HXRH1=HVAP(TXRH1,PXRH1)                                                ORCE3327
      GOTO4250                                                               ORCE3328
C                                                                            ORCE3329
C   LIVE STEAM REHEATER                                                      ORCE3330
 4220 QRH1=QRH*(HXRH1-HIRH1)/(HRH1-HCRH1)                                    ORCE3331
C                                                                            ORCE3340
C   TEST FOR 2ND STAGE                                                       ORCE3341
      IF(NRH.EQ.2)GOTO4221                                                   ORCE3350
C                                                                            ORCE3351
C   TEST FOR FW HEATER IN GS OR HP SECTION                                   ORCE3352
      IF((NFH+NFGS).GT.0)GOTO4230                                            ORCE3353
C                                                                            ORCE3354
C   RE-CALCULATE REACTOR STEAM AND FW FLOW                                   ORCE3355
      QRO=QT+QAE+QRH1                                                        ORCE3356
      QR=QRO-QCR+QMU                                                         ORCE3357
      GOTO4250                                                               ORCE3358
C                                                                            ORCE3360
C   2ND STAGE HEAT BALANCE                                                   ORCE3361
 4221 QRH2=QRH*(HXRH2-HIRH2)/(HRH2-HCRH2)                                    ORCE3370
C                                                                            ORCE3380
C   TEST FOR 2ND STAGE CONVERGENCE                                           ORCE3381
      ADQ2=DABS((QRH2-QERH2)/QRH2)                                           ORCE3390
      IF(ADQ2.LE.RHCON)GOTO4230                                              ORCE3400
      QERH2=QRH2                                                             ORCE3410
      GOTO4240                                                               ORCE3420
C                                                                            ORCE3430
C   TEST FOR 1ST STAGE CONVERGENCE                                           ORCE3431
 4230 ADQ1=DABS((QRH1-QERH1)/QRH1)                                           ORCE3440
      IF(ADQ1.LE.RHCON)GOTO4250                                              ORCE3450
 4240 QERH1=QRH1                                                             ORCE3460
      IF(NCRH.LE.50)GOTO4242                                                 ORCE3470
      PRINT 4241,ADQ1,ADQ2                                                   ORCE3480
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 4241 FORMAT('0-MAIN PROGRAM-REHEATER CALCULATIONS DID NOT CONVERGE, ADQ0RCE3490
     1 =',1PD14.6,5X,'ADQ2 =',1PD14.6)                                  ORCE3491
      GOTO4250                                                          ORCE3500
C                                                                       ORCE3501
C  RE-CALCULATE REACTOR STEAM AND FW FLOW                               ORCE3502
 4242 IF(NRH.EQ.1)GOTO4243                                              ORCE3503
      QRO=QT+QAE+QRH2                                                   ORCE3504
      GOTO4244                                                          ORCE3505
 4243 QRO=QT+QAE+QRH1                                                   ORCE3506
 4244 QR=QRO-QCR+QMU                                                    ORCE3507
C                                                                       ORCE3508
C  RETURN TO GS OR HP SECTION                                           ORCE3509
 4245 IF(NFGS.EQ.1)GOTO2020                                             ORCE3510
      I1=I1HP                                                           ORCE3520
      GOTO3025                                                          ORCE3530
C                                                                       ORCE3540
C  FLOW TO NEXT SECTION                                                 ORCE3541
 4250 QNEXT=QRH                                                         ORCE3550
C                                                                       ORCE3560
C  TEST FOR 2ND STAGE                                                   ORCE3561
      IF(NRH.LT.2)GOTO4260                                              ORCE3570
C                                                                       ORCE3580
C  ENTHALPY TO NEXT TURBINE SECTION (2-STAGE REHEATER)                  ORCE3581
      HNEXT=HXRH2                                                       ORCE3590
      GOTO4300                                                          ORCE3600
C                                                                       ORCE3610
C  ENTHALPY TO NEXT TURBINE SECTION (1-STAGE REHEATER)                  ORCE3611
 4260 HNEXT=HXRH1                                                       ORCE3620
C                                                                       ORCE3630
C  TEST FOR FW PUMP TURBINE CALCULATIONS                                ORCE3631
 4300 IF(IFPT)4320,4400,4310                                            ORCE3640
C                                                                       ORCE3650
C  FW PUMP TURBINE THROTTLE STEAM FLOW                                  ORCE3660
 4310 CALL FWPT(PFPT,HNEXT,  PC,DHP,QR,NSHAFT)                          ORCE3670
C                                                                       ORCE3680
C  FLOW TO NEXT TURBINE SECTION                                         ORCE3681
 4320 QNEXT=QNEXT-QFPT                                                  ORCE3690
C                                                                       ORCE3700
C  TEST FOR 2-SECTION OR 3-SECTION MACHINE                              ORCE3701
 4400 GOTO(7000,7000,5000),NSHAFT                                       ORCE3710
C                                                                       ORCE3720
C  INTERMEDIATE PRESSURE SECTION PERFORMANCE                            ORCE3721
C  (2ND SECTION OF 3-SECTION MACHINE)                                   ORCE3722
C                                                                       ORCE3730
C  BOWL CONDITIONS (IP SECTION)                                         ORCE3731
 5000 QBIP=QNEXT                                                        ORCE3740
      HBIP=HNEXT                                                        ORCE3750
      CALL PROPPH(AMBIP,SBIP,VBIP,TBIP,MBIP,PBIP,HBIP)                  ORCE3760
C                                                                       ORCE3770
C  TEST FOR SHAFT LEAKAGE CALCULATIONS                                  ORCE3771
      IF(LK.EQ.0)GOTO5001                                               ORCE3780
C                                                                       ORCE3790
C  SHAFT LEAKAGE FROM BOWL END (IP SECTION)                             ORCE3791
      CALL SLEAK2(NF, PE,NIP,TBIP,PBIP,VBIP,HBIP,LK7,QLK7,HLK7,QLK8,    ORCE3800
     1HLK8,PSSR,NFGS)                                                   ORCE3801
C                                                                       ORCE3810
C  BOWL FLOW (IP SECTION)                                               ORCE3811
      QBIP=QBIP-QLK7-QLK8                                               ORCE3820
C                                                                       ORCE3830
C  SHELL CONDITIONS (IP SECTION)                                        ORCE3831
 5001 CALL SGROUP(PBIP,TBIP,HBIP,SBIP,VBIP,AMBIP,MBIP,QBIP,NIP,CSIP,    ORCE3840
     1PXIP,TXIP,HXIP,SXIP,VXIP,AMXIP,MXIP,PIIP,TIIP,HIIP,SIIP,VIIP,     ORCE3841
     2AMIIP,MIIP,PXLP)                                                  ORCE3842
C                                                                       ORCE3850
C  EXHAUST LOSS AND UEEP (IP SECTION)                                   ORCE3851
      XLIP=FIG8(PXIP)                                                   ORCE3860
      UEEPIP=HXIP+XLIP                                                  ORCE3870
      CALL PROPPH(AMUEIP,SUEIP,VUEIP,TUEIP,MUEIP,PXIP,UEEPIP)           ORCE3880
C                                                                       ORCE3890
C  EXHAUST FLOW (IP SECTION)                                            ORCE3891
      QXIP=QBIP                                                         ORCE3900
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C                                                                          ORCE3910
C  TEST FOR FW HEATERS (IP SECTION)                                        ORCE3911
 5010 IF(NFI.EQ.0)GOTO5042                                                 ORCE3920
C                                                                          ORCE3930
C                                                                          ORCE3940
C  FW HEATER HEAT BALANCE (IP SECTION)                                     ORCE3950
      I1=I1IP                                                              ORCE3960
      CALL HXTRAC(0,I1IP,I2IP,MBIP,HBIP,SBIP,MXIP,HXIP,SXIP,PIIP,HIIP,     ORCE3970
     1SIIP,PXIP,UEEPIP)                                                    ORCE3971
      GOTO5030                                                             ORCE3980
 5020 I1=I                                                                 ORCE3990
 5030 CALL FWHEAT(I1,I2IP,0,0,MS,ITHP)                                     ORCE4000
      ITIP=ITIP+1                                                          ORCE4010
C                                                                          ORCE4020
C  TEST FOR REGRESSIVE FW HEATER HEAT BALANCE CALCULATIONS                 ORCE4021
      IF(I.EQ.I2HP.AND.NFH.GT.0)GOTO3020                                   ORCE4030
      IF(I.EQ.NFGS)GOTO2020                                                ORCE4040
C                                                                          ORCE4050
C  TEST FOR MORE THAN ONE FW HEATER (IP SECTION)                           ORCE4051
C  TEST FOR ONLY ONE FW HEATER AND LOCATED AT EXHAUST (IP SECTION)         ORCE4052
      IF(NFI.EQ.1.AND.I2I.LT.I2IP)GOTO5042                                 ORCE4060
C                                                                          ORCE4070
C  EXHAUST FLOW, MORE THAN ONE FW HEATER IP SECTION,                       ORCE4071
C  OR ONLY ONE FW HEATER AND LOCATED AT IP EXHAUST                         ORCE4080
      QXIP=QBIP                                                            ORCE4090
      DO5040 K=I1IP,I2I                                                    ORCE4100
 5040 QXIP=QXIP-QE(K)                                                      ORCE4110
C                                                                          ORCE4120
C  FLOW TO NEXT SECTION                                                    ORCE4121
 5042 QNEXT=QXIP                                                           ORCE4130
C                                                                          ORCE4140
C  TEST FOR SHAFT LEAKAGE CALCULATIONS                                     ORCE4141
      IF(LK.EQ.0)GOTO5043                                                  ORCE4150
C                                                                          ORCE4160
C  SHAFT LEAKAGE FROM EXHAUST END (IP SECTION)                             ORCE4161
      CALL SLEAK3(NF,PE,NIP,IRIP,PXIP,VUEIP,UEEPIP,LK9,QLK9,HLK9,QLK10,    ORCE4170
     1HLK10,PSSR)                                                          ORCE4171
C                                                                          ORCE4180
C  FLOW TO NEXT SECTION                                                    ORCE4181
      QNEXT=QNEXT-QLK9-QLK10                                               ORCE4190
C                                                                          ORCE4200
C  TEST FOR FW HEATER AT IP EXHAUST                                        ORCE4201
 5043 IF(NFI.EQ.0.OR.I2I.EQ.I2IP)GOTO5050                                  ORCE4210
C                                                                          ORCE4220
C  FLOW TO NEXT SECTION, FW HEATER AT IP EXHAUST                           ORCE4221
      QNEXT=QNEXT-QE(I2IP)                                                 ORCE4230
C                                                                          ORCE4240
C  TEST FOR EXTERNAL MOISTURE SEPARATOR FOLLOWING IP SECTION               ORCE4241
 5050 IF(MS.GT.0)GOTO6000                                                  ORCE4250
C                                                                          ORCE4260
C  ENTHALPY TO LP SECTION                                                  ORCE4261
C  (NO EXTERNAL MOISTURE SEPARATOR FOLLOWING IP SECTION)                   ORCE4262
      HNEXT=UEEPIP                                                         ORCE4270
      GOTO7000                                                             ORCE4280
C                                                                          ORCE4290
C  EXTERNAL MOISTURE SEPARATOR PERFORMANCE (3-SECTION MACHINE)             ORCE4291
C                                                                          ORCE4300
C  INLET FLOW AND ENTHALPY                                                 ORCE4301
 6000 CSI=QNEXT                                                            ORCE4310
      HSI=UEEPIP                                                           ORCE4320
      ITMS=ITMS+1                                                          ORCE4330
C                                                                          ORCE4340
C  HEAT AND MASS BALANCE CALCULATION                                       ORCE4341
      QMR1=QMR                                                             ORCE4350
      CALL XSEP                                                            ORCE4360
C                                                                          ORCE4370
C  TEST FOR MOISTURE FLOW TO FW HEATER AT IP SECTION EXHAUST               ORCE4371
      IF(MS.GT.I2IP)GOTO6010                                               ORCE4380
C                                                                          ORCE4390
C  TEST FOR MOISTURE REMOVAL CONVERGENCE                                   ORCE4391
      ADQMR=DABS((QMR-QMR1)/QMR)                                           ORCE4400
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      IF(ADQMR.LE.XSPCON)GOTO6010                                        ORCE4410
      IF(ITMS.GT.50)GOTO6008                                             ORCE4420
      I1=I2IP                                                            ORCE4430
      GOTO5030                                                           ORCE4440
 6008 PRINT 4009,ADQMR                                                   ORCE4450
C                                                                        ORCE4460
C  FLOW AND ENTHALPY TO LP SECTION                                       ORCE4461
C  (EXTERNAL MOISTURE SEPARATOR FOLLOWING IP SECTION)                    ORCE4462
 6010 QNEXT=QSX                                                          ORCE4470
      HNEXT=HSX                                                          ORCE4480
C                                                                        ORCE4490
C  TEST FOR STEAM SEAL REGULATOR                                         ORCE4491
 7000 IF(LK.EQ.0)GOTO7008                                                ORCE4500
C                                                                        ORCE4510
C  STEAM SEAL REGULATOR ENTHALPY AND MAKEUP                              ORCE4511
      CALL SSRE(PSH,HT,PXLP,NSHAFT,NF)                                   ORCE4520
C                                                                        ORCE4530
C  TEST FOR SSR MAKE-UP CONVERGENCE                                      ORCE4531
      IF(QSSRMU.EQ.QSSRM1)GOTO7008                                       ORCE4540
      ADMU=DABS((QSSRMU-QSSRM1)/QSSRMU)                                  ORCE4550
      IF(ADMU.LE.SSRCON)GOTO7008                                         ORCE4560
      IF(ITSSR.GT.50)GOTO7006                                            ORCE4570
      QSSRM1=QSSRMU                                                      ORCE4580
      GOTO2002                                                           ORCE4590
 7006 PRINT 7007,ADMU                                                    ORCE4600
 7007 FORMAT('0-MAIN PROGRAM-STEAM SEAL REGULATOR MAKE-UP CALCULATIONS DORCE4610
     1ID NOT CONVERGE, ADMU =',1PD14.6)                                  ORCE4611
C                                                                        ORCE4620
C  LOW PRESSURE SECTION PERFORMANCE                                      ORCE4621
C                                                                        ORCE4630
C  BOWL CONDITIONS (LP SECTION)                                          ORCE4631
 7008 QBLP=QNEXT                                                         ORCE4640
      HBLP=HNEXT                                                         ORCE4650
      CALLPROPPH(AMBLP,SBLP,VBLP,TBLP,MBLP,PBLP,HBLP)                    ORCE4660
C                                                                        ORCE4670
C  BASE EXPANSION LINE (LP SECTION)                                      ORCE4671
 7009 IF(PXLP.GE.3.)GOTO7010                                             ORCE4680
      PX1=0.73674                                                        ORCE4690
      GOTO7020                                                           ORCE4700
 7010 PX1=PXLP                                                           ORCE4710
 7020 CALL SGROUP(PBLP,TBLP,HBLP,SBLP,VBLP,AMBLP,MBLP,QBLP,NLP,CSLP,PX1,ORCE4720
     1TX1,HX1,SX1,VX1,AMX1,MX1,PILP,TILP,HILP,SILP,VILP,AMILP,MILP,PXLP)ORCE4721
C                                                                        ORCE4730
C  TEST FOR MOISTURE REMOVAL STAGES (LP SECTION)                         ORCE4731
      IF(MR.GT.0)GOTO7029                                                ORCE4740
      HEP=HX1                                                            ORCE4750
      AMEP=AMX1                                                          ORCE4760
      GOTO7050                                                           ORCE4770
C                                                                        ORCE4780
C  MOISTURE REMOVAL CALCULATIONS (LP SECTION)                            ORCE4781
 7029 IF(MBLP.EQ.3)GOTO7030                                              ORCE4790
      PB=PBLP                                                            ORCE4800
      HB=HBLP                                                            ORCE4810
      SB=SBLP                                                            ORCE4820
      GOTO7040                                                           ORCE4830
 7030 PB=PILP                                                            ORCE4840
      HB=HILP                                                            ORCE4850
      SB=SILP                                                            ORCE4860
 7040 CALL AMOIST(MR,PMR,PB,HB,SB,PX1,HX1,SX1,HBMR,HAMR,HEP,AMBMR,AMAMR,ORCE4870
     1AMEP,SBMR,SAMR,PCWD,TMR)                                           ORCE4871
C                                                                        ORCE4880
C  SHELL CONDITIONS (LP SECTION)                                         ORCE4881
 7050 IF(PXLP.GE.3.)GOTO7060                                             ORCE4890
      HXLP=HEP+FIG15(PXLP*2.036)*FIG14(AMEP*100.0)                       ORCE4900
      GOTO7070                                                           ORCE4910
 7060 IF(MR.EQ.0)GOTO7080                                                ORCE4920
      HXLP=HEP                                                           ORCE4930
 7070 CALLPROPPH(AMXLP,SXLP,VXLP,TXLP,MXLP,PXLP,HXLP)                    ORCE4940
      GOTO7090                                                           ORCE4950
 7080 HXLP=HX1                                                           ORCE4960
      TXLP=TX1                                                           ORCE4970
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      SXLP=SX1
      VXLP=VX1
      AMXLP=AMX1
      MXLP=MX1
C
 7090 CONTINUE
C
C  FW HEATER HEAT BALANCE (LP SECTION)
 7100 KL=1
      QES(KL)=QBLP
      HES(KL)=HBLP
      IF(NFL.GT.0)GOTO7110
      IF(MR.EQ.0)GOTO7160
      GOTO7120
 7110 CALL HXTRAC(MR,I1LP,NF,MBLP,HBLP,SBLP,MXLP,HXLP,SXLP,PILP,HILP,
     1SILP,PXLP,UEEPLP)
 7120 GOTO(7121,7122,7123),NSHAFT
 7121 IT=ITGS
      GOTO7124
 7122 IT=ITHP
      GOTO7124
 7123 IT=ITIP
 7124 CALL FWHEAT(I1LP,I2LP,MR,KL,MS,IT)
C
C  TEST FOR REGRESSIVE FW HEATER HEAT BALANCE CALCULATIONS
      GOTO(7150,7140,7130),NSHAFT
 7130 IF(I.EQ.I2IP.AND.NFI.GT.0)GOTO5020
 7140 IF(I.EQ.I2HP.AND.NFH.GT.0)GOTO3020
 7150 IF(I.EQ.NFGS)GOTO2020
C
C  EXHAUST FLOW (LP SECTION)
 7160 KLT=KL
      QXLP=QES(KLT)
C
C  TEST EXHAUST PRESSURE (LP SECTION)
      IF(PXLP.GE.3.)GOTO7170
C
C  CONDENSING EXHAUST LOSS AND UEEP (LP SECTION)
      CALL  XLOSS(PXLP,TXLP,HEP,HXLP,QXLP,AMEP,AMXLP,NLP,BLS,PDLS,IRLP,
     1UEEPLP,XLLP)
      GOTO7180
C
C  BACK-PRESSURE EXHAUST LOSS AND UEEP (LP SECTION)
 7170 XLLP=FIG8(PXLP)
      UEEPLP=HXLP+XLLP
 7180 HES(KLT)=UEEPLP
C
C  GENERATOR OUTPUT
C
 8000 WHP=0.
      WIP=0.
      WLP=0.
C
C  GS SECTION
      WBTU=1.D0/3412.14D0
      WGS=QGS*(HBGS-HXGS)*WBTU
C
C  TEST FOR NUMBER OF TURBINE SECTIONS IN SERIES
      GOTO(8050,8030,8010),NSHAFT
C
C  IP SECTION
 8010 WIP=QBIP*(HBIP-UEEPIP)*WBTU
C
C  TEST FOR FW HEATERS (IP SECTION)
      IF(NFI.EQ.0)GOTO8030
C
C  SUBTRACT FW HEATER EXTRACTION STEAM (IP SECTION)
      DO8020 I=I1IP,I2I
 8020 WIP=WIP-QE(I)*(HE(I)-UEEPIP)*WBTU
C
C  HP SECTION
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 8030 WHP=ORHP*(HRHP-UEEPHP)*WBTU                                        ORCE5580
C                                                                       ORCE5590
C   TEST FOR FW HEATERS (HP SECTION)                                    ORCE5591
      IF(NFH.EQ.0)GOTO8050                                              ORCE5600
C                                                                       ORCE5610
C   TEST FOR REHEATER EXTRACTION STEAM (HP SECTION)                     ORCE5611
      IF(NRH.LT.2.OR.NEGS.EQ.1)GOTO8039                                 ORCE5620
C                                                                       ORCE5630
C   SUBTRACT REHEATER EXTRACTION STEAM (HP SECTION)                     ORCE5631
      WHP=WHP-ORH1*(HE(1)-UEEPHP)*WBTU                                  ORCE5640
C                                                                       ORCE5650
C   SUBTRACT FW HEATER EXTRACTION STEAM (HP SECTION)                    ORCE5651
 8039 DO8040 I=I1HP,I2H                                                 ORCE5660
 8040 WHP=WHP-QE(I)*(HE(I)-UEEPHP)*WBTU                                 ORCE5670
C                                                                       ORCE5680
C   LP SECTION                                                          ORCE5690
 8050 DO8060 KL=1,KLT                                                   ORCE5700
 8060 WLP=WLP+QES(KL)*(HES(KL)-HES(KL1))*WBTU                           ORCE5710
C                                                                       ORCE5800
C   NET GENERATOR OUTPUT                                                ORCE5801
      WGEN=(WGS+WHP+WIP+WLP-WML-WGL)*0.001                              ORCE5810
C                                                                       ORCE5820
C   TEST NET ELECTRICAL GENERATION CONVERGENCE                          ORCE5821
      ADW=DABS((WGEN-WRATE)/WRATE)                                      ORCE5830
      IF(ADW.LE.WGEN)GOTO8200                                           ORCE5840
C                                                                       ORCE5850
C   CHECK NUMBER OF ITERATIONS THROUGH MAIN PROGRAM                     ORCE5851
      IF(MAIN.LT.25)GOTO8100                                            ORCE5860
      PRINT 8090,ADW,WGEN                                               ORCE5870
 8090 FORMAT('0-MAIN PROGRAM-REQUIRED ELECTRICAL GENERATION DID NOT CONVORCE5880
     1ERGE, ADW =',1PD14.6,5X,'WGEN =',1PD14.6)                         ORCE5881
      GOTO8200                                                          ORCE5890
C                                                                       ORCE5900
C   CORRECT THROTTLE FLOW RATE                                          ORCE5901
 8100 QT=QT*WRATE/WGEN                                                  ORCE5910
      GOTO1900                                                          ORCE5920
C                                                                       ORCE5930
C   STEAM GENERATOR INLET ENTHALPY AND TEMPERATURE                      ORCE5931
C                                                                       ORCE5940
C   TEST FOR FW HEATERS                                                 ORCE5941
 8200 IF(NF.GT.0)GOTO8210                                               ORCE5950
C                                                                       ORCE5960
C   CONDENSER HOTWELL FLOW (NO FW HEATERS)                              ORCE5961
      QC=QR+QCR                                                         ORCE5970
C                                                                       ORCE5980
C   NO FW HEATERS                                                       ORCE5990
      HCR=HC+QAE*(HAEI-HAEO)/QC+QSPE*(HSSR-HAEO)/QC                     ORCE6000
      HR=HCR                                                            ORCE6010
      GOTO8240                                                          ORCE6020
C                                                                       ORCE6030
C   TEST DRAIN FROM FW HEATER NO. 1                                     ORCE6031
 8210 IF(ND(1).EQ.0)GOTO8220                                            ORCE6040
C                                                                       ORCE6050
C   DRAIN IS PUMPED                                                     ORCE6051
      HR=(QD(1)*HD(1)+QF(1)*HO(1))/QR                                   ORCE6060
      GOTO8230                                                          ORCE6070
C                                                                       ORCE6080
C   DRAIN IS FLASHED                                                    ORCE6081
 8220 HR=HO(1)                                                          ORCE6090
C                                                                       ORCE6100
C   TEST FOR FW PUMP LOCATION                                           ORCE6101
 8230 IF(IP.GT.0)GOTO8250                                               ORCE6110
C                                                                       ORCE6120
C   FW PUMP IS AFTER FW HEATER NO. 1                                    ORCE6130
 8240 HFP=HR                                                            ORCE6140
      QFP=QR                                                            ORCE6150
      HR=HR+DHP                                                         ORCE6160
      GOTO8251                                                          ORCE6170
C                                                                       ORCE6180
C   FW TEMPERATURE TO FW PUMP AND TO STEAM GENERATOR                    ORCE6190
 8250 QFP=QF(IP)                                                        ORCE6200
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 8251 TFP=TLIQH(HFP)                                                    ORCE6210
      TR=TCOM(PLA,HR)                                                   ORCE6220
C                                                                       ORCE6221
C  TEST FOR EXTERNAL REHEATER                                           ORCE6222
      IF(NRH.GT.-1)GOTO8255                                             ORCE6223
C                                                                       ORCE6224
C  HEAT ADDED BY EXTERNAL REHEATER                                      ORCE6225
      RHCORR=QRH*(HXRH1-HIRH1)                                          ORCE6226
      GOTO8256                                                          ORCE6227
C                                                                       ORCE6228
C  NO EXTERNAL REHEATER                                                 ORCE6229
 8255 RHCORR=0.                                                         ORCE6230
C                                                                       ORCE6231
C  TEST FOR MOTOR-DRIVEN FW PUMP                                        ORCE6232
 8256 IF(IFPT.NE.0)GOTO8260                                             ORCE6240
C                                                                       ORCE6250
C  KW FOR MOTOR DRIVE                                                   ORCE6260
      EFMCG=0.8075                                                      ORCE6270
      WFWP=DHP*QFP/(EFMCG*3412.14)                                      ORCE6280
      GOTO8270                                                          ORCE6290
C                                                                       ORCE6300
C  KW FOR TURBINE DRIVE                                                 ORCE6310
 8260 WFWP=QFPT*(HBFPT-HXFPT)*WBTU                                      ORCE6320
C                                                                       ORCE6330
C  NET AND GROSS CYCLE HEAT RATES (TURBINE-DRIVEN FW PUMP)              ORCE6331
      HTRTN=(QRD*(HT-HR)+QCR*(HR-HCR)+QMU*(HT-HR)+RHCORR)/(WGEN*1000.)  ORCE6340
      HTRTG=HTRTN*WGEN/(WGEN+WFWP*0.001)                                ORCE6350
      GOTO8280                                                          ORCE6360
C                                                                       ORCE6370
C  GROSS AND NET CYCLE HEAT RATES (MOTOR-DRIVEN FW PUMP)                ORCE6371
 8270 HTRTG=(QRD*(HT-HR)+QCR*(HR-HCR)+QMU*(HT-HR)+RHCORR)/(WGEN*1000.)  ORCE6380
      HTRTN=HTRTG*WGEN/(WGEN-WFWP*0.001)                                ORCE6390
C                                                                       ORCE6400
C  NET AND GROSS CYCLE EFFICIENCIES                                     ORCE6401
 8280 CEFFN=341214./HTRTN                                               ORCE6410
      CEFFG=341214./HTRTG                                               ORCE6420
C                                                                       ORCE6430
C  WRITE RESULTS OF CALCULATIONS                                        ORCE6431
C                                                                       ORCE6440
      CALL RESULT(VERS)                                                 ORCE6450
C                                                                       ORCE6460
      GOTO100                                                           ORCE6470
      END                                                               ORCE6480
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      SUBROUTINE DATAIN( CMTS, TT, PT, AMT, QT, WRATE, GC, PCMU, PDGS,  DATA   0
     1 NSHAFT, NHP, IRHP, NIP, IRIP, PBIP, NLP, IRLP, PBLP, PXLP, PDLS, DATA   1
     2 PLS, MR, PMR, MS, NRH, QFRH1, TTDRH1, QFRH2, TTDRH2, NF, NFGS,   DATA   2
     3 NFH, NFI, NFL, PE, TTD, ND, NDC, TDCA, IP, QFPT, IFPT, QAE, LK,  DATA   3
     4 PF, ICC, IH2, VERS, QCR, HBFPT, HXFPT, PC, EMS)                  DATA   4
      IMPLICIT REAL*8(A-H,O-Z)                                          DATA  10
C                                                                       DATA  20
C SUBPROGRAM  FOR READING AND WRITING INPUT DATA                        DATA  21
C                                                                       DATA  30
      DIMENSION CMTS(18),PMR(5),NDC(12),ND(12),PE(12),TTD(12),TDCA(12)  DATA  40
C                                                                       DATA  50
C  READ ONE COMMENT CARD (COLUMNS 1-72)                                 DATA  51
C                                                                       DATA  60
      READ 110,(CMTS(I),I=1,18)                                         DATA  70
  110 FORMAT(18A4)                                                      DATA  80
C                                                                       DATA  90
C  READ DATA CARDS                                                      DATA  91
C                                                                       DATA 100
  200 READ 210,IFLAG,DATA1,DATA2,DATA3,DATA4,DATA5,DATA6                DATA 110
  210 FORMAT(I2,D10.0,5D12.0, 8X)                                       DATA 120
C                                                                       DATA 130
      IF(IFLAG.EQ.0)GOTO300                                             DATA 140
C                                                                       DATA 150
      GOTO(1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17),IFLAG             DATA 160
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C                                                                       DATA 190
C     IFLAG=1                                                           DATA 191
C     TT=THROTTLE STEAM TEMPERATURE, F                                  DATA 192
C     PT=THROTTLE STEAM PRESSURE, PSIA                                  DATA 193
C     AMT=THROTTLE STEAM MOISTURE, PER CENT                             DATA 194
    1 TT=DATA1                                                          DATA 200
      PT=DATA2                                                          DATA 210
      AMT=DATA3                                                         DATA 220
      GOTO200                                                           DATA 230
C                                                                       DATA 240
C     IFLAG=2                                                           DATA 241
C     QT=ESTIMATED THROTTLE STEAM FLOW, LBM/HR                          DATA 242
C     PCMU=FW MAKE-UP RATE, PER CENT                                    DATA 243
C     QCR=CONDENSATE FLOW BY-PASSED TO STEAM GENERATOR, LB/HR           DATA 244
    2 QT=DATA1                                                          DATA 250
      PCMU=DATA2                                                        DATA 260
      QCR=DATA3                                                         DATA 270
      GOTO200                                                           DATA 280
C                                                                       DATA 290
C     IFLAG=3                                                           DATA 291
C     WRATE=ELECTRICAL OUTPUT, MWE                                      DATA 292
C     GC=GENERATOR CAPABILITY, MVA                                      DATA 293
C     PF=GENERATOR POWER FACTOR                                         DATA 294
C     ICC=0, CONDUCTOR-COOLED GENERATOR                                 DATA 295
C     ICC=1, CONVENTIONALLY-COOLED GENERATOR                            DATA 296
C     IH2=0, GENERATOR OPERATION AT RATED HYDROGEN PRESSURE             DATA 297
C     IH2=1, GENERATOR OPERATION AT REDUCED HYDROGEN PRESSURE           DATA 298
C     IR=ROTATIONAL SPEED OF TURBINE-GENERATOR, RPM                     DATA 299
    3 WRATE=DATA1                                                       DATA 300
      GC=DATA2                                                          DATA 310
      PF=DATA3                                                          DATA 320
      ICC=DATA4                                                         DATA 330
      IH2=DATA5                                                         DATA 340
      IR=DATA6                                                          DATA 350
C     IRHP=ROTATIONAL SPEED OF HP TURBINE, RPM                          DATA 351
      IRHP=IR                                                           DATA 360
C     IRIP=ROTATIONAL SPEED OF IP SECTION, RPM                          DATA 361
      IRIP=IR                                                           DATA 370
C     IRLP=ROTATIONAL SPEED OF LP SECTION, RPM                          DATA 371
      IRLP=IR                                                           DATA 380
      GOTO200                                                           DATA 390
C                                                                       DATA 400
C     IFLAG=4                                                           DATA 401
C     IFLAG=4 IS NOT USED                                               DATA 402
    4 CONTINUE                                                          DATA 410
      GOTO200                                                           DATA 420
C                                                                       DATA 430
C     IFLAG=5                                                           DATA 431
C     PDGS=PITCH DIAMETER OF GOVERNING STAGE, IN.                       DATA 432
    5 PDGS=DATA1                                                        DATA 440
      GOTO200                                                           DATA 450
C                                                                       DATA 460
C     IFLAG=6                                                           DATA 461
C     NSHAFT=NUMBER OF TURBINE SECTIONS IN SERIES                       DATA 462
    6 NSHAFT=DATA1                                                      DATA 470
      GOTO200                                                           DATA 480
C                                                                       DATA 490
C     IFLAG=7                                                           DATA 491
C     NHP=NUMBER OF PARALLEL HP SECTIONS                                DATA 492
    7 NHP=DATA1                                                         DATA 500
      GOTO200                                                           DATA 510
C                                                                       DATA 520
C     IFLAG=8                                                           DATA 521
C     NIP=NUMBER OF PARALLEL IP SECTIONS                                DATA 522
C     PBIP=BOWL PRESSURE IP SECTION, PSIA                               DATA 523
    8 NIP=DATA1                                                         DATA 530
      PBIP=DATA2                                                        DATA 540
      GOTO200                                                           DATA 550
C                                                                       DATA 560
C     IFLAG=9                                                           DATA 561
C     NLP=NUMBER OF PARALLEL LP SECTIONS                                DATA 562
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C   PBLP=BOWL PRESSURE LP SECTION, PSIA                                DATA 563
C   PXLPI=EXHAUST PRESSURE LP SECTION, IN. HGA                         DATA 564
C   PCI=CONDENSER PRESSURE, IN. HGA                                    DATA 565
C   IF DATA3.GT.0, PXLPI=DATA3 AND PCI=DATA6                           DATA 570
C   PXLP=EXHAUST PRESSURE LP SECTION, PSIA                             DATA 571
C   PC=CONDENSER PRESSURE, PSIA                                        DATA 572
C   IF DATA3.LT.0, PXLP=-DATA3 AND PC=-DATA6                           DATA 580
C   PDLS=PITCH DIAMETER OF LAST STAGE LP SECTION, IN.                  DATA 581
C   BLS=LENGTH OF LAST STAGE BUCKETS LP SECTION, IN.                   DATA 582
    9 NLP=DATA1                                                        DATA 590
      PBLP=DATA2                                                       DATA 600
      IF(DATA3.LT.0)GOTO91                                             DATA 610
      PXLP=DATA3*0.49116                                               DATA 620
      PXLPI=DATA3                                                      DATA 630
      PC=DATA6*0.49116                                                 DATA 640
      PCI=DATA6                                                        DATA 650
      GOTO92                                                           DATA 660
   91 PXLP=-DATA3                                                      DATA 670
      PXLPI=PXLP*2.036                                                 DATA 680
      PC=-DATA6                                                        DATA 690
      PCI=PC*2.036                                                     DATA 700
   92 PDLS=DATA4                                                       DATA 710
      BLS=DATA5                                                        DATA 720
      GOTO200                                                          DATA 730
C                                                                      DATA 740
C   IFLAG=10                                                           DATA 741
C   MR=NUMBER OF MOISTURE REMOVAL STAGES LP SECTION                    DATA 742
C   PMR(L)=MOISTURE REMOVAL STAGE PRESSURE, PSIA (L=1,MR)              DATA 743
   10 MR=DATA1                                                         DATA 750
      PMR(1)=DATA2                                                     DATA 760
      PMR(2)=DATA3                                                     DATA 770
      PMR(3)=DATA4                                                     DATA 780
      PMR(4)=DATA5                                                     DATA 790
      PMR(5)=DATA6                                                     DATA 800
      GOTO200                                                          DATA 810
C                                                                      DATA 820
C   IFLAG=11                                                           DATA 821
C   MS=0, NO EXTERNAL MOISTURE SEPARATOR                               DATA 822
C   MS=N, EXTERNAL MOISTURE SEPARATOR DRAINS TO FW HEATER NO. N        DATA 823
C   MS=NF+1, EXTERNAL MOISTURE SEPARATOR DRAINS TO CONDENSER           DATA 824
C   EMS=MOISTURE SEPARATOR EFFECTIVENESS, PER CENT                     DATA 825
   11 MS=DATA1                                                         DATA 830
      EMS=DATA2                                                        DATA 841
      GOTO200                                                          DATA 840
C                                                                      DATA 850
C   IFLAG=12                                                           DATA 851
C   ABS(NRH)=NUMBER OF STAGES OF REHEAT                                DATA 852
C   IF NRH IS POSITIVE, A LIVE STEAM REHEATER IS SPECIFIED, AND        DATA 853
C   QERH1=ESTIMATED STEAM FLOW TO 1ST STAGE REHEATER, LBM/HR           DATA 854
C   TTDRH1=TERMINAL TEMPERATURE DIFFERENCE 1ST STAGE REHEATER, F       DATA 855
C   QERH2=ESTIMATED STEAM FLOW TO 2ND STAGE REHEATER, LBM/HR           DATA 856
C   TTDRH2=TERMINAL TEMPERATURE DIFFERENCE 2ND STAGE REHEATER, F       DATA 857
C   IF NRH IS NEGATIVE, AN EXTERNAL REHEATER IS SPECIFIED, AND         DATA 858
C   TTDRH1=TEMPERATURE OF STEAM LEAVING EXTERNAL REHEATER, F           DATA 859
   12 NRH=DATA1                                                        DATA 860
      QERH1=DATA2                                                      DATA 870
      TTDRH1=DATA3                                                     DATA 880
      QERH2=DATA4                                                      DATA 890
      TTDRH2=DATA5                                                     DATA 900
      GOTO200                                                          DATA 910
C                                                                      DATA 920
C   IFLAG=13                                                           DATA 921
C   NF=TOTAL NUMBER OF FW HEATERS                                      DATA 922
C   NFGS=NUMBER OF FW HEATERS GS SECTION                               DATA 923
C   NFH=NUMBER OF FW HEATERS HP SECTION                                DATA 924
C   NFI=NUMBER OF FW HEATERS IP SECTION                                DATA 925
C   NFL=NUMBER OF FW HEATERS LP SECTION                                DATA 926
   13 NF=DATA1                                                         DATA 930
      NFGS=DATA2                                                       DATA 940
      NFH=DATA3                                                        DATA 950
      NFI=DATA4                                                        DATA 960
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      NFL=DATA5                                                         DATA 970
      GOTO200                                                           DATA 980
C                                                                       DATA 990
C  IFLAG=14                                                             DATA 991
C  N=FW HEATER NUMBER                                                   DATA 992
C  PE(N)=EXTRACTION STAGE PRESSURE, PSIA                                DATA 993
C  TTD(N)=FW HEATER TERMINAL TEMPERATURE DIFFERENCE, F                  DATA 994
C  ND(N)=0, FW HEATER DRAIN IS FLASHED                                  DATA 995
C  ND(N)=1, FW HEATER DRAIN IS PUMPED                                   DATA 996
C  NDC(N)=0, NO DRAIN COOLER ON FW HEATER                               DATA 997
C  NDC(N)=1, DRAIN COOLER SECTION ON FW HEATER                          DATA 998
C  TDCA(N)=DRAIN COOLER APPROACH TEMPERATURE DIFFERENCE, F              DATA 999
   14 N=DATA1                                                           DATA1000
      PE(N)=DATA2                                                       DATA1010
      TTD(N)=DATA3                                                      DATA1020
      ND(N)=DATA4                                                       DATA1030
      NDC(N)=DATA5                                                      DATA1040
      TDCA(N)=DATA6                                                     DATA1050
      GOTO200                                                           DATA1060
C                                                                       DATA1070
C  IFLAG=15                                                             DATA1071
C  IP=0,  FW PUMP IS LOCATED AFTER FW HEATER NO. 1                      DATA1072
C  IP=N,  FW PUMP IS LOCATED BEFORE FW HEATER NO. N                     DATA1073
C  IFPT=0, FW PUMP IS MOTOR DRIVEN                                      DATA1074
C  IFPT=1, FW PUMP IS TURBINE DRIVEN AND STEAM FLOW, BOWL ENTHALPY,     DATA1075
C          AND EXHAUST ENTHALPY WILL BE CALCULATED                      DATA1080
C  IFPT=-1, FW PUMP IS TURBINE DRIVEN AND STEAM FLOW, BOWL ENTHALPY,    DATA1081
C          AND EXHAUST ENTHALPY MUST BE SPECIFIED                       DATA1090
C  QFPT=STEAM FLOW TO FW PUMP TURBINE, LBM/HR                           DATA1091
C  HBFPT=BOWL ENTHALPY FW PUMP TURBINE, BTU/LB                          DATA1092
C  HXFPT=EXHAUST ENTHALPY FW PUMP TURBINE, BTU/LB                       DATA1093
   15 IP=DATA1                                                          DATA1100
      IFPT=DATA2                                                        DATA1110
      QFPT=DATA3                                                        DATA1120
      HBFPT=DATA4                                                       DATA1130
      HXFPT=DATA5                                                       DATA1140
      GOTO200                                                           DATA1150
C                                                                       DATA1160
C  IFLAG=16                                                             DATA1161
C  QAE=STEAM FLOW TO SJAE, LBM/HR                                       DATA1162
   16 QAE=DATA1                                                         DATA1170
      GOTO200                                                           DATA1180
C                                                                       DATA1190
C  IFLAG=17                                                             DATA1191
C  LK=0, VALVE STEM AND SHAFT LEAKAGES WILL NOT BE CALCULATED           DATA1192
C  LK=1, VALVE STEM AND SHAFT LEAKAGES WILL BE CALCULATED               DATA1193
   17 LK=DATA1                                                          DATA1200
      GOTO200                                                           DATA1210
C                                                                       DATA1220
C  WRITE INPUT DATA                                                     DATA1221
C                                                                       DATA1230
  300 PRINT 310,(CMTS(K),K=1,18),VERS                                   DATA1240
  310 FORMAT('1',T10,18A4/                                              DATA1250
     1' ',T10,'STEAM TURBINE CYCLE HEAT BALANCE'/                       DATA1251
     2' ',T10,'ORCENT, VERSION ',A8)                                    DATA1252
C                                                                       DATA1260
      PRINT 320,TT,PT,AMT,QT,PCMU,QCR,WRATE,GC,PF                       DATA1270
  320 FORMAT('0',T10,'INPUT DATA'/                                      DATA1280
     1'0',T15,'THROTTLE STEAM TEMPERATURE',T70,4X,F7.1,T87,'F'/         DATA1281
     2'0',T15,'THROTTLE STEAM PRESSURE',T70,4X,F7.1,T87,'PSIA'/         DATA1282
     3'0',T15,'THROTTLE STEAM MOISTURE',T70,6X,F6.2,T87,'PER CENT'/     DATA1283
     4'0',T15,'ESTIMATED THROTTLE STEAM FLOW',T70,F10.0,T87,'LB/HR'/    DATA1284
     5'0',T15,'FW MAKE-UP RATE (TO CONDENSER HOTWELL)',                 DATA1285
     6T70,6X,F5.1,T87,'PER CENT'/                                       DATA1286
     7'0',T15,'CONDENSATE BY-PASSED TO STEAM GENERATOR',T70,F10.0,T87,  DATA1287
     8'LB/HR'/                                                          DATA1288
     9'0',T15,'REQUIRED ELECTRICAL OUTPUT',T70,4X,F9.3,T87,'MWE'/       DATA1289
     A'0',T15,'GENERATOR RATED CAPABILITY',T70,4X,F9.3,T87,'MVA'/       DATA1290
     B'0',T15,'GENERATOR POWER FACTOR',T70,7X,F5.2)                     DATA1291
C                                                                       DATA1300
      IF(ICC.EQ.0)GOTO322                                               DATA1310
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C                                                                       DATA1320
      PRINT 321,ICC                                                     DATA1330
  321 FORMAT('0',T15,'CONVENTIONALLY-COOLED GENERATOR, ICC=',I2)        DATA1340
C                                                                       DATA1350
      GOTO324                                                           DATA1360
C                                                                       DATA1370
  322 PRINT 323,ICC                                                     DATA1380
  323 FORMAT('0',T15,'CONDUCTOR-COOLED GENERATOR, ICC=',I2)             DATA1390
C                                                                       DATA1400
  324 IF(IH2.EQ.0)GOTO326                                               DATA1410
C                                                                       DATA1420
      PRINT 325,IH2                                                     DATA1430
  325 FORMAT('0',T15,'GENERATOR OPERATION AT REDUCED HYDROGEN PRESSURE, DATA1440
     1IH2=',I2)                                                         DATA1441
C                                                                       DATA1450
      GOTO328                                                           DATA1460
C                                                                       DATA1470
  326 PRINT 327,IH2                                                     DATA1480
  327 FORMAT('0',T15,'GENERATOR OPERATION AT RATED HYDROGEN PRESSURE, IHDATA1490
     12=',I2)                                                           DATA1491
C                                                                       DATA1500
  328 PRINT 329,IR,PDGS,NSHAFT                                          DATA1510
  329 FORMAT('0',T15,'ROTATIONAL SPEED OF TURBINE-GENERATOR',T70,4X,I5, DATA1520
     1T87,'RPM'/                                                        DATA1521
     2'0',T15,'PITCH DIAMETER OF GOVERNING STAGE',T70,4X,F8.2,T87,'IN.'/DATA1522
     3'0',T15,'NO. OF TURBINE SECTIONS IN SERIES',T70,7X,I2)            DATA1523
C                                                                       DATA1530
      IF(NSHAFT.EQ.1)GOTO350                                            DATA1540
C                                                                       DATA1550
      PRINT 330,NHP                                                     DATA1560
  330 FORMAT('0',T15,'NUMBER OF PARALLEL HP SECTIONS',T70,7X,I2)        DATA1570
C                                                                       DATA1580
      IF(NSHAFT.EQ.2)GOTO350                                            DATA1590
C                                                                       DATA1600
      PRINT 340,NIP,PBIP                                                DATA1610
  340 FORMAT('0',T15,'NUMBER OF PARALLEL IP SECTIONS',T70,7X,I2/        DATA1620
     1'0',T15,'BOWL PRESSURE IP SECTION',T70,5X,F6.1,T87,'PSIA')        DATA1621
C                                                                       DATA1630
  350 PRINT 360,NLP                                                     DATA1640
  360 FORMAT('0',T15,'NUMBER OF PARALLEL LP SECTIONS',T70,7X,I2)        DATA1650
C                                                                       DATA1660
      IF(NSHAFT.EQ.1)GOTO380                                            DATA1670
C                                                                       DATA1680
      PRINT 370,PBLP                                                    DATA1690
  370 FORMAT('0',T15,'BOWL PRESSURE LP SECTION',T70,5X,F6.1,T87,'PSIA') DATA1700
C                                                                       DATA1710
  380 PRINT 390,PXLP,PXLPI,PC,PCI                                       DATA1720
  390 FORMAT('0',T15,'EXHAUST PRESSURE LP SECTION',T70,6X,F9.5,T87,     DATA1730
     1'PSIA',T95,'=',F8.2,T106,'IN. HGA'/                               DATA1731
     2'0',T15,'CONDENSER PRESSURE',T70,6X,F9.5,T87,'PSIA',              DATA1732
     3T95,'=',F8.2,T106,'IN. HGA')                                      DATA1733
C                                                                       DATA1740
      IF(PXLP.GE.3.)GOTO399                                             DATA1750
C                                                                       DATA1760
      PRINT 391,PDLS,BLS                                                DATA1770
  391 FORMAT(                                                           DATA1780
     1'0',T15,'PITCH DIAMETER OF LAST STAGE LP SECTION',T70,5X,F7.2,T87,DATA1781
     2'IN.'/                                                            DATA1782
     3'0',T15,'LENGTH OF LAST STAGE BUCKETS LP SECTION',T70,6X,F6.2,T87,DATA1783
     4'IN.')                                                            DATA1784
C                                                                       DATA1790
  399 PRINT 400,MR                                                      DATA1800
  400 FORMAT('0',T15,'NO. OF MOISTURE REMOVAL STAGES LP SECTION',T70,7X,DATA1810
     1I2)                                                               DATA1811
C                                                                       DATA1820
      IF(MR.EQ.0)GOTO440                                                DATA1830
C                                                                       DATA1840
  410 DO430 L=1,MR                                                      DATA1850
C                                                                       DATA1860
      PRINT 420,L ,PMR(L)                                               DATA1870
  420 FORMAT('0',T15,'MOISTURE REMOVAL STAGE NO.',I2/                   DATA1880
```

```
     1'0',T17,'MOISTURE REMOVAL STAGE PRESSURE',T70,5X,F6.1,T87,'PSIA')
C
  430 CONTINUE
C
  440 IF(MS.EQ.0)GOTO480
C
      IF(MS.LE.NF)GOTO460
C
      PRINT 450,MS
  450 FORMAT('0',T15,'EXTERNAL MOISTURE SEPARATOR DRAINS TO CONDENSER, M
     1S=',I3)
C
      GOTO500
C
  460 PRINT 470,MS,MS
  470 FORMAT('0',T15,'EXTERNAL MOISTURE SEPARATOR DRAINS TO FW HEATER NO
     1.',I3,', MS=',I3)
C
      GOTO500
C
  480 PRINT 490,MS
  490 FORMAT('0',T15,'THERE IS NO EXTERNAL MOISTURE SEPARATOR, MS=',I2)
C
      GOTO505
C
  500 PRINT 501,EMS
  501 FORMAT('0',T15,'MOISTURE SEPARATOR EFFECTIVENESS',T70,4X,F6.0,T87,
     1'PER CENT')
C
  505 INRH=IABS(NRH)
C
      PRINT 510,INRH
  510 FORMAT('0',T15,'NUMBER OF STAGES OF REHEAT',T70,7X,I2)
C
      IF(NRH.EQ.0)GOTO540
C
      IF(NRH.GT.0)GOTO519
C
      PRINT 518,TTDRH1
  518 FORMAT('0',T15,'TEMPERATURE OF STEAM LEAVING EXTERNAL REHEATER',
     1T70,4X,F6.0,T87,'F')
C
      GOTO540
C
  519 PRINT 520,QERH1,TTDRH1
  520 FORMAT('0',T15,'ESTIMATED STEAM FLOW TO 1ST STAGE REHEATER',T70,
     12X,F8.0,T87,'LB/HR'/
     2'0',T15,'TERMINAL TEMPERATURE DIFFERENCE 1ST STAGE REHEATER',T70,
     35X,F6.1,T87,'F')
C
      IF(NRH.EQ.1)GOTO540
C
      PRINT 530,QERH2,TTDRH2
  530 FORMAT('0',T15,'ESTIMATED STEAM FLOW TO 2ND STAGE REHEATER',T70,
     12X,F8.0,T87,'LB/HR'/
     2'0',T15,'TERMINAL TEMPERATURE DIFFERENCE 2ND STAGE REHEATER',T70,
     35X,F6.1,T87,'F')
C
  540 PRINT 550,NF,NFGS
  550 FORMAT('0',T15,'TOTAL NO. OF FW HEATERS',T70,6X,I3/
     1'0',T15,'NO. OF FW HEATERS GS SECTION',T70,7X,I2)
C
      IF(NSHAFT.EQ.1)GOTO580
C
      PRINT 560,NFH
  560 FORMAT('0',T15,'NO. OF FW HEATERS HP SECTION',T70,7X,I2)
C
      IF(NSHAFT.EQ.2)GOTO580
C
      PRINT 570,NFI
  570 FORMAT('0',T15,'NO. OF FW HEATERS IP SECTION',T70,7X,I2)
```

```
C                                                                       DATA2340
  580 PRINT 590,NFL                                                     DATA2350
  590 FORMAT('0',T15,'NO. OF FW HEATERS LP SECTION',T70,7X,I2)          DATA2360
C                                                                       DATA2370
      IF(NF.EQ.0)GOTO731                                                DATA2380
C                                                                       DATA2390
  600 DO690 N=1,NF                                                      DATA2400
C                                                                       DATA2410
      PRINT 610,N ,PE(N),TTD(N)                                         DATA2420
  610 FORMAT('0',T15,'FW HEATER NO.',I3/                                DATA2430
     1'0',T17,'EXTRACTION STAGE PRESSURE',T70,4X,F7.1,T87,'PSIA'/       DATA2431
     2'0',T17,'TERMINAL TEMPERATURE DIFFERENCE',T70,6X,F5.1,T87,'F')    DATA2432
C                                                                       DATA2440
      IF(ND(N).EQ.0)GOTO630                                             DATA2450
C                                                                       DATA2460
      PRINT 620,N,ND(N)                                                 DATA2470
  620 FORMAT('0',T17,'DRAIN IS PUMPED, ND(',I2,')=',I2)                 DATA2480
C                                                                       DATA2490
      GOTO650                                                           DATA2500
C                                                                       DATA2510
  630 PRINT 640,N,ND(N)                                                 DATA2520
  640 FORMAT('0',T17,'DRAIN IS FLASHED, ND(',I2,')=',I2)                DATA2530
C                                                                       DATA2540
      IF(NDC(N).EQ.1)GOTO670                                            DATA2550
C                                                                       DATA2560
  650 PRINT 660,N,NDC(N)                                                DATA2570
  660 FORMAT('0',T17,'THERE IS NO DRAIN COOLER SECTION, NDC(',I2,')=',  DATA2580
     1I2)                                                               DATA2581
C                                                                       DATA2590
      GOTO690                                                           DATA2600
C                                                                       DATA2610
  670 PRINT 680,N,NDC(N),TDCA(N)                                        DATA2620
  680 FORMAT('0',T17,'THERE IS A DRAIN COOLER SECTION, NDC(',I2,')=',I2/DATA2630
     2'0',T17,'DRAIN COOLER APPROACH TEMPERATURE DIFFERENCE',T70,6X,    DATA2631
     3F5.1,T87,'F')                                                     DATA2632
C                                                                       DATA2640
  690 CONTINUE                                                          DATA2650
C                                                                       DATA2660
  700 IF(IP.GT.0)GOTO720                                                DATA2670
C                                                                       DATA2680
      PRINT 710,IP                                                      DATA2690
  710 FORMAT('0',T15,'FW PUMP IS LOCATED AFTER FW HEATER NO. 1, IP=',I3)DATA2700
C                                                                       DATA2710
      GOTO731                                                           DATA2720
C                                                                       DATA2730
  720 PRINT 730,IP,IP                                                   DATA2740
  730 FORMAT('0',T15,'FW PUMP IS LOCATED BEFORE FW HEATER NO.',I3,      DATA2750
     1',  IP=',I3)                                                      DATA2751
C                                                                       DATA2760
  731 IF(IFPT.EQ.0)GOTO736                                              DATA2770
C                                                                       DATA2780
      PRINT 732,IFPT                                                    DATA2790
  732 FORMAT('0',T15,'FW PUMP IS TURBINE DRIVEN, IFPT=',I3)             DATA2800
C                                                                       DATA2810
      IF(IFPT.LT.0)GOTO734                                              DATA2820
C                                                                       DATA2830
      PRINT 733                                                         DATA2840
  733 FORMAT('0',T15,'STEAM FLOW TO FW PUMP TURBINE WILL BE CALCULATED')DATA2850
C                                                                       DATA2860
      GOTO740                                                           DATA2870
C                                                                       DATA2880
  734 PRINT 735,QFPT,HBFPT,HXFPT                                        DATA2890
  735 FORMAT('0',T15,'STEAM FLOW TO FW PUMP TURBINE',T70,2X,F8.0,T87,   DATA2900
     1'LB/HR'/                                                          DATA2901
     2'0',T15,'BOWL ENTHALPY FW PUMP TURBINE',T70,F11.1,T87,'BTU/LB'/   DATA2902
     3'0',T15,'EXHAUST ENTHALPY FW PUMP TURBINE',T70,F11.1,T87,'BTU/LB')DATA2903
C                                                                       DATA2910
      GOTO740                                                           DATA2920
C                                                                       DATA2930
  736 PRINT 737,IFPT                                                    DATA2940
  737 FORMAT('0',T15,'FW PUMP IS MOTOR DRIVEN, IFPT='I2)                DATA2950
```

```
C
  740 IF(QAE.GT.0.)GOTO742
C
      PRINT 741,QAE
  741 FORMAT('0',T15,'THERE IS NO STEAM JET AIR EJECTOR, QAE =',F10.0)
C
      GOTO755
C
  742 PRINT 750,QAE
  750 FORMAT(
     1'0',T15,'STEAM FLOW TO STEAM JET AIR EJECTOR',T70,3X,F7.0,T87,
     2'LB/HR')
C
  755 IF(LK.GT.0)GOTO760
C
      PRINT 756,LK
  756 FORMAT('0',T15,'VALVE STEM AND PACKING LEAKAGES WILL NOT BE CALCUL
     1ATED, LK=',I2)
C
      RETURN
C
  760 PRINT 770,LK
  770 FORMAT('0',T15,'VALVE STEM AND PACKING LEAKAGES WILL BE CALCULATED
     1, LK=',I2)
C
      RETURN
      END
```

```
      SUBROUTINE RESULT(VERS)
      IMPLICIT REAL*8(A-H,O-Z)
C
C  THIS SUBPROGRAM PRINTS THE CALCULATED RESULTS
C
      COMMON /AM/AMBMR(5),AMAMR(5),TMR(6),MR
      COMMON /FPT/QFPT,PBFPT,HBFPT,PXFPT,HXFPT,IFPT
      COMMON /FWH/HAEI,HAEO,QR,QFS(20),HFS(20),HES(20),QMF(5),HMF(5),
     1QMG(5),HMG(5),QD(12),QF(12),QE(12),QCR,HCR,QRO,QC,I1LP,I
      COMMON /GS/QGS,HBGS,PBGS,AMBGS,SBGS,VBGS,TBGS,PXGS,AMXGS,SXGS,
     1VXGS,TXGS,HXGS,PDGS,MBGS,MXGS,NCGS,IBGS,NGS
      COMMON /HP/QBHP,PBHP,TBHP,AMBHP,HBHP,SBHP,QXHP,TXHP,AMXHP,HXHP,
     1SXHP,UEEPHP
      COMMON /HX1/PE(12),PMR(5)
      COMMON /HX2/HE(12),HEL(12),HAMR(5),HBMR(5),SAMR(5),SBMR(5),PCWD(5)
      COMMON /IN/L1(13),L2(13),J1(13),IMR(5)
      COMMON /IP/QBIP,PBIP,TBIP,AMBIP,HBIP,SBIP,QXIP,TXIP,AMXIP,HXIP,
     1SXIP,UEEPIP
      COMMON /LEAK/QLK1,HLK1,QLK2,HLK2,QLK3,HLK3,QLK4,HLK4,QLK5,HLK5,
     1QLK6,HLK6,QLK7,HLK7,QLK8,HLK8,QLK9,HLK9,QLK10,HLK10,LK,LK1,LK3,
     2LK5,LK7,LK9
      COMMON /LP/QBLP,PBLP,TBLP,AMBLP,HBLP,SBLP,QXLP,PXLP,TXLP,AMXLP,
     1HXLP,SXLP,UEEPLP
      COMMON /MIS/CMTS(18),      TC,TFP,TR,HR,WRATE,GC,WML,WGL,QMU,QFP,
     1DP,WGEN,WFWP,HTRTN,HTRTG,CEFFN,CEFFG,PC
      COMMON /PAR1/HO(12),HI(12),QAE,HC,HFP,DHP,TI(12),TD(12),TDCA(12),
     1HD(12),PLA,PLB,ND(12),NDC(12),IP,NF,NSHAFT
      COMMON /PAR2/PSH(12),TSH(12),TO(12),TTD(12),PXHP,PXIP
      COMMON /RH1/PXRH2,PIRH2,PXRH1,PIRH1,PFPT
      COMMON /RH2/QRH1,HCRH1,QRH2,HCRH2,NRH
      COMMON /RH3/TTDRH1,TTDRH2,HRH1,HRH2,PCRH1,TCRH1,PCRH2,TCRH2,TXRH1,
     1HXRH1,TXRH2,HXRH2,HIRH2,HIRH1,QRH
      COMMON /SSR/QSPE,QMC,QSSR,HSSR,PSSR,QFWH,QSSRMU,HSSRMU
      COMMON /T/QT,PT,TT,AMT,HT
      COMMON /XS1/PSX,PSI
      COMMON /XS2/HESX,QMR
      COMMON /XS3/QSI,HSI,TSX,QSX,HSX,AMSX,EMS,MS
C
      NPAGE=1
C
      PRINT 100,(CMTS(K),K=1,18),VERS,NPAGE
```

```
  100 FORMAT('1',T10,18A4/
     1' ',T10,'STEAM TURBINE CYCLE HEAT BALANCE'/
     2' ',T10,'ORCENT, VERSION ',A8/
     3'0',T10,'CALCULATED RESULTS, PAGE',I3////)
C
      PRINT 110,HTRTN,CEFFN,HTRTG,CEFFG,WGEN
  110 FORMAT('0',T10,'TABLE I  OVERALL PERFORMANCE'/
     1'0',T10,'NET TURBINE CYCLE HEAT RATE, BTU/KW-HR',T60,F8.0/
     2' ',T10,'NET TURBINE CYCLE EFFICIENCY, PER CENT',T60,F10.2/
     3'0',T10,'GROSS TURBINE CYCLE HEAT RATE, BTU/KW-HR',T60,F8.0/
     4' ',T10,'GROSS TURBINE CYCLE EFFICIENCY, PER CENT',T60,F10.2/
     5'0',T10,'GENERATOR OUTPUT, MWE',T60,F11.3)
C
      IF(IFPT.EQ.0)GOTO112
C
      WG=WGEN+WFWP*0.001
C
      PRINT 111,WFWP,WG
  111 FORMAT('0',T10,'POWER REQUIRED BY TURBINE-DRIVEN FW PUMP, MW',
     1T60,-3PF11.3/
     2' ',T10,'GENERATOR OUTPUT PLUS FW PUMP POWER, MW',T60,0PF11.3)
C
      GOTO114
C
  112 WG=WGEN-WFWP*0.001
C
      PRINT 113,WFWP,WG
  113 FORMAT('0',T10,'POWER REQUIRED BY MOTOR-DRIVEN FW PUMP, MW',
     1T60,-3PF11.3/
     2' ',T10,'GENERATOR OUTPUT MINUS FW PUMP POWER, MWE',T60,0PF11.3)
C
  114 PRINT 115,WML,WGL
  115 FORMAT('0',T10,'MECHANICAL LOSSES, KW',T60,F8.0/
     2' ',T10,'GENERATOR LOSSES, KW',T60,F8.0)
C
      NPAGE=NPAGE+1
C
      PRINT 100,(CMTS(K),K=1,18),VERS,NPAGE
C
      PRINT 120
  120 FORMAT('0',T10,'TABLE II  TURBINE EXPANSION LINE'/
     1'0',T50,'STEAM FLOW     PRESSURE     TEMPERATURE     MOISTURE     ENTH
     2ALPY     ENTROPY'/
     3' ',T50,'  LB/HR          PSIA            F           PER CENT      BTU
     4/LB      BTU/LB-F')
C
      PRINT 130,QT,PT,TT,AMT,HT,
     1QGS,PBGS,TBGS,AMBGS,HBGS,SBGS,
     2QGS,PXGS,TXGS,AMXGS,HXGS,SXGS
  130 FORMAT('0',T10,'TURBINE THROTTLE',
     1T50,F10.0,F12.1,F12.1,F14.2,F12.1/
     2' ',T10,'GOVERNING STAGE BOWL',
     3T50,F10.0,F12.1,F12.1,2PF14.2,0PF12.1,F12.4/
     4' ',T10,'GOVERNING STAGE ELEP AND UEEP',
     5T50,F10.0,F12.1,F12.1,2PF14.2,0PF12.1,F12.4)
C
      IF(NSHAFT.EQ.1)GOTO190
C
      PRINT 140,QBHP,PBHP,TBHP,AMBHP,HBHP,SBHP,
     1QXHP,PXHP,TXHP,AMXHP,HXHP,SXHP,
     2PXHP,UEEPHP
  140 FORMAT(' ',T10,'HP SECTION BOWL',
     1T50,F10.0,F12.1,F12.1,2PF14.2,0PF12.1,F12.4/
     2' ',T10,'HP SECTION ELEP',
     3T50,F10.0,F12.1,F12.1,2PF14.2,0PF12.1,F12.4/
     4' ',T10,'HP SECTION UEEP',
     5T60,F12.1,T98,F12.1)
C
      IF(NSHAFT.EQ.3)GOTO160
C
  149 IF(MS.EQ.0)GOTO151
```

```
C
      PRINT 150,QSI,PSI,HSI,
     1QSX,PSX,TSX,AMSX,HSX
  150 FORMAT(' ',T10,'EXTERNAL MOISTURE SEPARATOR INLET',
     1T50,F10.0,F12.1,T98,F12.1/
     2' ',T10,'EXTERNAL MOISTURE SEPARATOR OUTLET',
     3T50,F10.0,F12.1,F12.1,2PF14.2,0PF12.1)
C
  151 IF(NSHAFT.EQ.3)GOTO190
C
  160 IF(NRH.EQ.0)GOTO181
C
      PRINT 170,QRH,PIRH1,HIRH1,
     1QRH,PXRH1,TXRH1,HXRH1
  170 FORMAT(' ',T10,'1ST STAGE REHEATER INLET',
     1T50,F10.0,F12.1,T98,F12.1/
     2' ',T10,'1ST STAGE REHEATER OUTLET',
     3T50,F10.0,F12.1,F12.1,T98,F12.1)
C
      IF(NRH.LT.2)GOTO181
C
      PRINT 180,QRH,PIRH2,HIRH2,
     1QRH,PXRH2,TXRH2,HXRH2
  180 FORMAT(' ',T10,'2ND STAGE REHEATER INLET',
     1T50,F10.0,F12.1,T98,F12.1/
     2' ',T10,'2ND STAGE REHEATER OUTLET',
     3T50,F10.0,F12.1,F12.1,T98,F12.1)
C
  181 IF(NSHAFT.EQ.2)GOTO190
C
      PRINT 185,QBIP,PBIP,TBIP,AMBIP,HBIP,SBIP,
     1QXIP,PXIP,TXIP,AMXIP,HXIP,SXIP,
     2PXIP,UEEPIP
  185 FORMAT(' ',T10,'IP SECTION BOWL',
     1T50,F10.0,F12.1,F12.1,2PF14.2,0PF12.1,F12.4/
     2' ',T10,'IP SECTION ELEP',
     3T50,F10.0,F12.1,F12.1,2PF14.2,0PF12.1,F12.4/
     4' ',T10,'IP SECTION UEEP',
     5T60,F12.1,T98,F12.1)
C
      GOTO149
C
  190 PRINT 200,QBLP,PBLP,TBLP,AMBLP,HBLP,SBLP
  200 FORMAT(' ',T10,'LP SECTION BOWL',
     1T50,F10.0,F12.1,F12.1,2PF14.2,0PF12.1,F12.4)
C
      IF(MR.EQ.0)GOTO230
C
      DO220 L=1,MR
C
      PRINT 210,L,PMR(L),TMR(L),AMBMR(L),HBMR(L),SBMR(L),
     1L,PMR(L),TMR(L),AMAMR(L),HAMR(L),SAMR(L)
  210 FORMAT(' ',T10,'BEFORE MOISTURE REMOVAL NO.',I2,
     1T60,F12.1,F12.1,2PF14.2,0PF12.1,F12.4/
     2' ',T10,'AFTER MOISTURE REMOVAL NO.',I2,
     3T60,F12.1,F12.1,2PF14.2,0PF12.1,F12.4)
C
  220 CONTINUE
C
  230 PRINT 240,QXLP,PXLP,TXLP,AMXLP,HXLP,SXLP,
     1PXLP,UEEPLP
  240 FORMAT(' ',T10,'LP SECTION ELEP',
     1T50,F10.0,F16.5, F8.1,2PF14.2,0PF12.1,F12.4/
     2' ',T10,'LP SECTION UEEP',
     3T60,F16.5,T98,F12.1)
C
      NPAGE=NPAGE+1
C
      PRINT 100,(CMTS(K),K=1,18),VERS,NPAGE
C
      IF(QAE.GT.1.0)GOTO260
C
```

```
      PRINT 250
  250 FORMAT('0',T10,'TABLE III    THERE IS NO STEAM JET AIR EJECTOR')
C
      GOTO275
C
  260 PRINT 270,QAE,HAEI,HAEO
  270 FORMAT('0',T10,'TABLE III    STEAM JET AIR EJECTOR'/
     1'0',T10,'STEAM FLOW, LB/HR',T40,F10.0/
     2' ',T10,'STEAM ENTHALPY IN, BTU/LB',T40,F11.1/
     3' ',T10,'STEAM ENTHALPY OUT, BTU/LB',T40,F11.1)
C
  275 NPAGE=NPAGE+1
C
      PRINT 100,(CMTS(K),K=1,18),VERS,NPAGE
C
      IF(MS.GT.0)GOTO290
C
      PRINT 280
  280 FORMAT('0',T10,'TABLE IV  THERE IS NO EXTERNAL MOISTURE SEPARATOR'
     1)
C
      GOTO350
C
  290 IF(MS.LE.NF)GOTO310
C
      PRINT 300
  300 FORMAT('0',T10,'TABLE IV  EXTERNAL MOISTURE SEPARATOR DRAINS TO CO
     1NDENSER')
C
      GOTO330
C
  310 PRINT 320,MS
  320 FORMAT('0',T10,'TABLE IV  EXTERNAL MOISTURE SEPARATOR DRAINS TO FW
     1 HEATER NO.',I2)
C
  330 PRINT 340,QMR,PSX,TSX,HFSX
  340 FORMAT('0',T10,'DRAIN FLOW, LB/HR',T33,F10.0/
     1' ',T10,'DRAIN PRESSURE, PSIA',T33,F11.1/
     2' ',T10,'DRAIN TEMPERATURE, F',T33,F11.1/
     3' ',T10,'DRAIN ENTHALPY, BTU/LB',T33,F11.1)
C
  350 NPAGE=NPAGE+1
C
      PRINT 100,(CMTS(K),K=1,18),VERS,NPAGE
C
      IF(NRH.GT.0)GOTO370
C
      IF(NRH.EQ.0)GOTO359
C
      PRINT 358
  358 FORMAT('0',T10,'TABLE V  EXTERNAL REHEATER, SEE TABLE II')
C
      GOTO400
C
  359 PRINT 360
  360 FORMAT('0',T10,'TABLE V  THERE IS NO REHEATER')
C
      GOTO400
C
  370 PRINT 380,NRH,QRH1,HRH1,PCRH1,TCRH1,HCRH1
  380 FORMAT('0',T10,'TABLE V  LIVE STEAM REHEATER'/
     1'0',T10,'1ST STAGE DRAINS TO FW HEATER NO.',I2/
     2' ',T10,'1ST STAGE STEAM FLOW, LB/HR',T43,F10.0/
     3' ',T10,'1ST STAGE STEAM ENTHALPY, BTU/LB',T43,F11.1/
     4' ',T10,'1ST STAGE PRESSURE, PSIA',T43,F11.1/
     5' ',T10,'1ST STAGE DRAIN TEMPERATURE, F',T43,F11.1/
     6' ',T10,'1ST STAGE DRAIN ENTHALPY, BTU/LB',T43,F11.1)
C
      IF(NRH.EQ.1)GOTO400
C
      PRINT 390,QRH2,HRH2,PCRH2,TCRH2,HCRH2
```

```
  390 FORMAT('0',T10,'2ND STAGE DRAINS TO FW HEATER NO. 1'/
     1' ',T10,'2ND STAGE STEAM FLOW, LB/HR',T43,F10.0/
     2' ',T10,'2ND STAGE STEAM ENTHALPY, BTU/LB',T43,F11.1/
     3' ',T10,'2ND STAGE PRESSURE, PSIA',T43,F11.1/
     4' ',T10,'2ND STAGE DRAIN TEMPERATURE, F',T43,F11.1/
     5' ',T10,'2ND STAGE DRAIN ENTHALPY, BTU/LB',T43,F11.1)
C
  400 NPAGE=NPAGE+1
C
      PRINT 100,(CMTS(K),K=1,18),VERS,NPAGE
C
      IF(MR.GT.0)GOTO420
C
      PRINT 410
  410 FORMAT('0',T10,'TABLE VI  THERE ARE NO MOISTURE REMOVAL STAGES')
C
      GOTO440
C
  420 PRINT 428
  428 FORMAT('0',T10,'TABLE VI  MOISTURE REMOVAL STAGES')
C
      PRINT 429,(L,L=1,MR)
  429 FORMAT('0',T10,'MOISTURE REMOVAL STAGE NO.',T36,5(10X,I2,2X))
C
      PRINT 430,(IMR(L),L=1,MR)
  430 FORMAT(' ',T10,'DRAINS TO FW HEATER NO.',T36,5(10X,I2,2X))
C
      PRINT 431,(PMR(L),L=1,MR)
  431 FORMAT(' ',T10,'STAGE PRESSURE, PSIA',T36,5(8X,F6.1))
C
      PRINT 432,(TMR(L),L=1,MR)
  432 FORMAT(' ',T10,'TEMPERATURE, F',T36,5(8X,F6.1))
C
      PRINT 433,(QMF(L),L=1,MR)
  433 FORMAT(' ',T10,'WATER REMOVED, LB/HR',T36,5(5X,F8.0,1X))
C
      PRINT 434,(HMF(L),L=1,MR)
  434 FORMAT(' ',T10,'WATER ENTHALPY, BTU/LB',T36,5(8X,F6.1))
C
      PRINT 435,(QMG(L),L=1,MR)
  435 FORMAT(' ',T10,'STEAM REMOVED, LB/HR',T36,5(5X,F8.0,1X))
C
      PRINT 436,(HMG(L),L=1,MR)
  436 FORMAT(' ',T10,'STEAM ENTHALPY, BTU/LB',T36,5(7X,F7.1))
C
  440 NPAGE=NPAGE+1
C
      PRINT 100,(CMTS(K),K=1,18),VERS,NPAGE
C
      IF(NF.GT.0)GOTO460
C
      PRINT 450
  450 FORMAT('0',T10,'TABLE VII  THERE ARE NO FW HEATERS')
C
      GOTO500
C
  460 PRINT 470
  470 FORMAT('0',T10,'TABLE VII  FW HEATERS')
C
      N1=1
      N2=NF
C
      IF(NF.LE.6)GOTO480
C
      N2=6
C
  480 PRINT 481,(I,I=N1,N2)
  481 FORMAT('0',T10,'FW HEATER NO.',T44,6I14)
C
      PRINT 482,(QF(I),I=N1,N2)
  482 FORMAT(' ',T10,'FW FLOW, LB/HR ',T45,6F14.0)
```

```
C
      PRINT 483,(TO(I),I=N1,N2)
  483 FORMAT(' ',T10,'FW TEMPERATURE OUT, F',T46,6F14.1)
C
      PRINT 484,(HO(I),I=N1,N2)
  484 FORMAT(' ',T10,'FW ENTHALPY OUT, BTU/LB ',T46,6F14.1)
C
      PRINT 485,(TI(I),I=N1,N2)
  485 FORMAT(' ',T10,'FW TEMPERATURE IN, F',T46,6F14.1)
C
      PRINT 486,(HI(I),I=N1,N2)
  486 FORMAT(' ',T10,'FW ENTHALPY IN, BTU/LB ',T46,6F14.1)
C
      PRINT 487,(PE(I),I=N1,N2)
  487 FORMAT(' ',T10,'EXTRACTION STAGE PRESSURE, PSIA',T46,6F14.1)
C
      PRINT 488,(QE(I),I=N1,N2)
  488 FORMAT(' ',T10,'EXTRACTION STEAM FLOW, LB/HR ',T45,6F14.0)
C
      PRINT 489,(HE(I),I=N1,N2)
  489 FORMAT(' ',T10,'EXTRACTION STEAM ENTHALPY, BTU/LB ',T46,6F14.1)
C
      PRINT 490,(PSH(I),I=N1,N2)
  490 FORMAT(' ',T10,'SHELL PRESSURE, PSIA',T46,6F14.1)
C
      PRINT 491,(TSH(I),I=N1,N2)
  491 FORMAT(' ',T10,'SHELL TEMPERATURE, F',T46,6F14.1)
C
      PRINT 492,(QD(I),I=N1,N2)
  492 FORMAT(' ',T10,'SHELL DRAIN FLOW, LB/HR ',T45,6F14.0)
C
      PRINT 493,(TD(I),I=N1,N2)
  493 FORMAT(' ',T10,'SHELL DRAIN TEMPERATURE, F',T46,6F14.1)
C
      PRINT 494,(HD(I),I=N1,N2)
  494 FORMAT(' ',T10,'SHELL DRAIN ENTHALPY, BTU/LB ',T46,6F14.1)
C
      IF(N2.EQ.NF)GOTO500
C
      N1=7
      N2=NF
C
      GOTO480
C
  500 NPAGE=NPAGE+1
C
      PRINT 100,(CMTS(K),K=1,18),VERS,NPAGE
C
      PCI=PC*2.036
      PRINT 510,PC,PCI,QC,TC,HC
  510 FORMAT('0',T10,'TABLE VIII  CONDENSER'/
     1'0',T10,'CONDENSER PRESSURE, PSIA',T41,9X,F10.5,
     2T65,'=',T70,F10.2,T85,'IN. HGA'/
     3' ',T10,'CONDENSATE FLOW, LB/HR',T41,F14.0/
     4' ',T10,'CONDENSATE TEMPERATURE, F',T41,9X,F6.1/
     5' ',T10,'CONDENSATE ENTHALPY, BTU/LB',T41,9X,F6.1)
C
      NPAGE=NPAGE+1
C
      PRINT 100,(CMTS(K),K=1,18),VERS,NPAGE
C
      PRINT 511
  511 FORMAT('0',T10,'TABLE IX  CONDENSATE AND FEEDWATER')
C
      IF(QCR.LT.1.)GOTO519
C
      PRINT 512,QCR,HCR
  512 FORMAT(
     1'0',T10,'CONDENSATE FLOW BY-PASSED TO STEAM GENERATOR, LB/HR',
     2T70,F10.0/
     3' ',T10,'CONDENSATE ENTHALPY BY-PASSED TO STEAM GENERATOR, BTU/LB'
```

```
     4,T70,5X,F6.1)                                                      RESU2914
C                                                                        RESU2920
  519 PRINT 520,QFP,TFP,HFP,CHP,DP,QR,TR,HR,QMU                          RESU2930
  520 FORMAT(                                                            RESU2940
     1'0',T10,'FW FLOW TO FW PUMP, LB/HR',T70,F10.0/                     RESU2941
     2' ',T10,'FW TEMPERATURE TO FW PUMP, F',T70,5X,F6.1/                RESU2942
     3' ',T10,'FW ENTHALPY TO FW PUMP, BTU/LB',T70,5X,F6.1/              RESU2943
     4' ',T10,'FW ENTHALPY RISE ACROSS FW PUMP, BTU/LB',T70,5X,F6.1/     RESU2944
     5' ',T10,'FW PRESSURE INCREASE ACROSS FW PUMP, PSI',T70,4X,F6.0/    RESU2945
     6'0',T10,'FW FLOW TO STEAM GENERATOR, LB/HR',T70,F10.0/             RESU2946
     7' ',T10,'FW TEMPERATURE TO STEAM GENERATOR, F',T70,5X,F6.1/        RESU2947
     8' ',T10,'FW ENTHALPY TO STEAM GENERATOR, BTU/LB',T70,5X,F6.1/      RESU2948
     9'0',T10,'MAKE-UP TO CONDENSER HOTWELL, LB/HR',T70,F10.0)           RESU2949
C                                                                        RESU2950
      PRINT 521,QRO,HT                                                   RESU2960
  521 FORMAT('0',T10,'STEAM FLOW FROM STEAM GENERATOR, LB/HR',T70,F10.0/RESU2970
     1' ',T10,'STEAM ENTHALPY FROM STEAM GENERATOR, BTU/LB',T70,4X,F7.1)RESU2971
C                                                                        RESU2980
      IF(IFPT.LT.1)GOTO528                                               RESU2990
C                                                                        RESU3000
      PRINT 525,QFPT                                                     RESU3010
  525 FORMAT('0',T10,'THROTTLE STEAM FLOW FW PUMP TURBINE, LB/HR',T70,   RESU3020
     1F10.0)                                                             RESU3021
C                                                                        RESU3030
      PXFPTI=PXFPT*2.036                                                 RESU3040
C                                                                        RESU3050
      PRINT 527,PRFPT,HRFPT,PXFPT,PXFPTI,HXFPT                           RESU3060
  527 FORMAT(' ',T10,'THROTTLE PRESSURE FW PUMP TURBINE, PSIA',T70,      RESU3070
     1F11.1/                                                             RESU3071
     2' ',T10,'THROTTLE ENTHALPY FW PUMP TURBINE, BTU/LB',T70,F11.1/     RESU3072
     3' ',T10,'EXHAUST PRESSURE FW PUMP TURBINE, PSIA',T70,F15.5,        RESU3073
     4T90,'=',F10.2,T105,'IN. HGA'/                                      RESU3074
     5' ',T10,'EXHAUST ENTHALPY FW PUMP TURBINE, BTU/LB',T70,F11.1)      RESU3075
C                                                                        RESU3080
  528 NPAGE=NPAGE+1                                                      RESU3090
C                                                                        RESU3100
      PRINT 100,(CMTS(K),K=1,18),VERS,NPAGE                              RESU3110
C                                                                        RESU3120
      IF(LK.GT.0)GOTO550                                                 RESU3130
C                                                                        RESU3140
      PRINT 540                                                          RESU3150
  540 FORMAT('0',T10,'TABLE X    VALVE STEM AND SHAFT LEAKAGES WERE NOT CRESU3160
     1ALCULATED')                                                        RESU3161
C                                                                        RESU3170
      GOTO600                                                            RESU3180
C                                                                        RESU3190
  550 PRINT 560,QSSR,HSSR,QMC,QSPE                                       RESU3200
  560 FORMAT('0',T10,'TABLE X    VALVE STEM AND SHAFT LEAKAGES'/         RESU3210
     1'0',T10,'STEAM SEAL REGULATOR'/                                    RESU3211
     2' ',T12,'FLOW TO SSR, LB/HR',T65,F8.0/                             RESU3212
     3' ',T12,'ENTHALPY AT SSR, BTU/LB',T67,F7.1/                        RESU3213
     4' ',T12,'FLOW FROM SSR TO MAIN CONDENSER, LB/HR',T65,F8.0/         RESU3214
     5' ',T12,'FLOW FROM SSR TO STEAM PACKING EXHAUSTER, LB/HR',T65,     RESU3215
     6F8.0)                                                              RESU3216
C                                                                        RESU3220
      IF(NF.EQ.0)GOTO562                                                 RESU3230
C                                                                        RESU3240
      PRINT 561,NF,QFWH                                                  RESU3250
  561 FORMAT(' ',T12,'FLOW FROM SSR TO FW HEATER NO.',I3,', LB/HR',T65,  RESU3260
     1F8.0)                                                              RESU3261
C                                                                        RESU3270
  562 PRINT 563,QSSRMU,HSSRMU                                            RESU3280
  563 FORMAT(' ',T12,'MAKE-UP FROM THROTTLE STEAM, LB/HR',T65,F8.0/      RESU3290
     1' ',T12,'ENTHALPY OF MAKE-UP STEAM, BTU/LB',T67,F7.1)              RESU3291
C                                                                        RESU3300
      PRINT 570,LK1,QLK1,HLK1,QLK2,HLK2,LK3,QLK3,HLK3,QLK4,HLK4          RESU3310
  570 FORMAT('0',T10,'THROTTLE VALVE STEM'/                              RESU3320
     1' ',T12,'LEAK NO. 1 (DRAINS TO FW HEATER NO.',I3,'), LB/HR',T65,   RESU3321
     2F8.0/                                                              RESU3322
     3' ',T12,'ENTHALPY LEAK NO. 1, BTU/LB',T67,F7.1/                    RESU3323
     4' ',T12,'LEAK NO. 2 (DRAINS TO SSR), LB/HR',T65,F8.0/              RESU3324
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     5' ',T12,'ENTHALPY LEAK NO. 2, BTU/LB',T67,F7.1/                   RESU3325
     6'0',T10,'GOVERNING STAGE SECTION'/                                RESU3326
     7' ',T12,'LEAK NO. 3 (DRAINS TO FW HEATER NO.',I3,'), LB/HR',T65,  RESU3327
     8F8.0/                                                             RESU3328
     9' ',T12,'ENTHALPY LEAK NO. 3, BTU/LB',T67,F7.1/                   RESU3329
     A' ',T12,'LEAK NO. 4 (DRAINS TO SSR), LB/HR',T65,F8.0/             RESU3330
     B' ',T12,'ENTHALPY LEAK NO. 4, BTU/LB',T67,F7.1)                   RESU3331
C                                                                       RESU3340
      IF(NSHAFT.EQ.1)GOTO600                                            RESU3350
C                                                                       RESU3360
      PRINT 580,LK5,QLK5,HLK5,QLK6,HLK6                                 RESU3370
  580 FORMAT('0',T10,'HP TURBINE SECTION'/                              RESU3380
     1' ',T12,'TOTAL LEAK NO. 5 (DRAINS TO FW HEATER NO.',I3,'), LB/HR',RESU3381
     2T65,F8.0/                                                         RESU3382
     3' ',T12,'ENTHALPY LEAK NO. 5, BTU/LB',T67,F7.1/                   RESU3383
     4' ',T12,'TOTAL LEAK NO. 6 (DRAINS TO SSR), LB/HR',T65,F8.0/       RESU3384
     5' ',T12,'ENTHALPY LEAK NO. 6, BTU/LB',T67,F7.1)                   RESU3385
C                                                                       RESU3390
      IF(NSHAFT.EQ.2)GOTO600                                            RESU3400
C                                                                       RESU3410
      PRINT 590,LK7,QLK7,HLK7,QLK8,HLK8,LK9,QLK9,HLK9,QLK10,HLK10       RESU3420
  590 FORMAT('0',T10,'IP TURBINE SECTION'/                              RESU3430
     1' ',T12,'LEAK NO. 7 (DRAINS TO FW HEATER NO.',I3,'), LB/HR',T65,  RESU3431
     2F8.0/                                                             RESU3432
     3' ',T12,'ENTHALPY LEAK NO. 7, BTU/LB',T67,F7.1/                   RESU3433
     4' ',T12,'LEAK NO. 8 (DRAINS TO SSR), LB/HR',T65,F8.0/             RESU3434
     5' ',T12,'ENTHALPY LEAK NO. 8, BTU/LB',T67,F7.1/                   RESU3435
     6' ',T12,'TOTAL LEAK NO. 9 (DRAINS TO FW HEATER NO.',I3,'), LB/HR',RESU3436
     7T65,F8.0/                                                         RESU3437
     8' ',T12,'ENTHALPY LEAK NO. 9, BTU/LB',T67,F7.1/                   RESU3438
     9' ',T12,'TOTAL LEAK NO. 10 (DRAINS TO SSR), LB/HR',T65,F8.0/      RESU3439
     A' ',T12,'ENTHALPY LEAK NO. 10, BTU/LB',T67,F7.1)                  RESU3440
C                                                                       RESU3450
  600 CONTINUE                                                          RESU3460
C                                                                       RESU3470
      RETURN                                                            RESU3480
      END                                                               RESU3490


      SUBROUTINE AMOIST(K,P,PB,HB,SB,PX,HX,SX,HBMR,HAMR,HEP,AM,         AMOI   0
     1AM225,AMEP,   SBMR,S225,PCWD,TE)                                  AMOI   1
      IMPLICIT REAL*8(A-H,O-Z)                                          AMOI  10
C                                                                       AMOI  20
C SUBPROGRAM  FOR MOISTURE REMOVAL CALCULATIONS                         AMOI  21
C  TABLE IV (P. 14, GER-2454A)                                          AMOI  22
C                                                                       AMOI  30
      DIMENSION                                                         AMOI  40
     1PE(6),TE(6),HF(6),HFG(6),HG(6),H2S1(6),HSL(6),H2BE(6),P(5),       AMOI  41
     2AM210(6),UE(5),S210(5),HS313(5),AE(5),BE(5),SBMR(5),              AMOI  42
     3BGMLF(5),AMRE(5),AM(5),PCWD(5),PCER(5),HBMR(5),HAMR(5),S225(5),   AMOI  43
     4HS326(5),AEN(5),AM225(5),        AMLF(5),CGE(5),UEN(5),HGEP(5),   AMOI  44
     5EPM(5)                                                            AMOI  45
C                                                                       AMOI  50
      COMMON /CONV/HCON,UERCON,AMCON,RHCON,WCON,PCON,SSRCON,XSPCON      AMOI  60
C                                                                       AMOI  70
C  K=NUMBER OF MOISTURE REMOVAL POINTS                                  AMOI  71
C  HBMR=ENTHALPY BEFORE MOISTURE REMOVAL                                AMOI  72
C  HAMR=ENTHALPY AFTER MOISTURE REMOVAL                                 AMOI  73
C  HEP    =ENTHALPY AT END POINT AFTER MOISTURE REMOVAL                 AMOI  74
C  AM=MOISTURE BEFORE MOISTURE REMOVAL                                  AMOI  75
C  AM225=MOISTURE AFTER MOISTURE REMOVAL                                AMOI  76
C  AMEP  =MOISTURE AT END POINT AFTER MOISTURE REMOVAL                  AMOI  77
C  SBMR=ENTROPY BEFORE MOISTURE REMOVAL                                 AMOI  78
C  S225=ENTROPY AFTER MOISTURE REMOVAL                                  AMOI  79
C  PCWD=PER CENT WATER DRAINED                                          AMOI  80
C                                                                       AMOI  90
C  STEAM PROPERTIES                                                     AMOI  91
     L=K+1                                                              AMOI 100
     DO100 I=1,K                                                        AMOI 110
     PE(I)=P(I)                                                         AMOI 120
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```
  100 CONTINUE
      PE(L)=PX
      DO110 I=1,L
      TE(I)=TSAT(PE(I))
      HF(I)=HLIQ(TE(I))
      HG(I)=HVAP(TE(I),PE(I))
      HFG(I)=HG(I)-HF(I)
      SG=SVAP(TE(I),PE(I))
      AM2S1=(SG-1.0)/(SG-SLIQ(TE(I)))
      H2S1(I)=HG(I)-AM2S1*HFG(I)
      HSL(I)=TE(I)+459.7
  110 CONTINUE
C
C  BASE EXPANSION ANALYSIS
      DO121 I=1,K
      CALL FIG12B(PE(I),HB,SB,HX,SX,H2BE(I),S)
  121 CONTINUE
      H2BE(L)=HX
      DO122 I=1,L
      AM210(I)=1.0-(H2BE(I)-HF(I))/HFG(I)
  122 CONTINUE
      DO130 I=1,K
      UE(I)=H2BE(I)-H2BE(I+1)
      S210(I)=1.0+(H2BE(I)-H2S1(I))/HSL(I)
      HS313(I)=H2S1(I+1)+HSL(I+1)*(S210(I)-1.0)
      AE(I)=H2BE(I)-HS313(I)
      BE(I)=100.0*UE(I)/AE(I)
      BGMLE(I)=1.0-0.435*(AM210(I)+AM210(I+1))
  130 CONTINUE
C
C  MOISTURE REMOVAL CALCULATION AND NEW EXPANSION FOLLOWING MOISTURE REM
      DO150 I=1,K
      AMRE(I)=FIG10(PE(I))
      IF(I.GT.1)GOTO141
      AM(I)=AM210(I)
      GOTO142
  141 AM(I)=EPM(I-1)
  142 PCWD(I)=AMRE(I)*AM(I)
      PCEP(I)=100.0-PCWD(I)
      IF(I.GT.1)GOTO143
      HBMR(I)=H2BE(I)
      GOTO144
  143 HBMR(I)=HGEP(I-1)
  144 SBMR(I)=1.0+(HBMR(I)-H2S1(I))/HSL(I)
      HAMR(I)=(HBMR(I)*100.0-HF(I)*PCWD(I))/PCEP(I)
      S225(I)=1.0+(HAMR(I)-H2S1(I))/HSL(I)
      HS326(I)=H2S1(I+1)+HSL(I+1)*(S225(I)-1.0)
      AEN(I)=HAMR(I)-HS326(I)
      AM225(I)=1.0-(HAMR(I)-HF(I))/HFG(I)
      EPMA=0.1
      DO145 IT=1,100
      AMLE(I)=1.0-0.435*(AM225(I)+EPMA)
      CGE(I)=BE(I)*AMLE(I)/BGMLE(I)
      UEN(I)=AEN(I)*CGE(I)*0.01
      HGEP(I)=HAMR(I)-UEN(I)
      EPM(I)=1.0-(HGEP(I)-HF(I+1))/HFG(I+1)
      ADM=DABS(EPM(I)-EPMA)
      IF(ADM.LE.AMCON)GOTO150
      EPMA=EPM(I)
  145 CONTINUE
      PRINT 146,ADM,I
  146 FORMAT('0-SUBROUTINE AMOIST-END POINT MOISTURE DID NOT CONVERGE, A
     1DM =',1PD14.6,5X,'I =',I2)
  150 CONTINUE
      HEP=HGEP(K)
      AMEP=EPM(K)
      RETURN
      END
```

```
      SUBROUTINE FWHEAT(I1,I2,MR,KL,MS,IT)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR FW HEATER HEAT BALANCE
C
      DIMENSION IT1(13),QMFE(13)
C
      COMMON /CONV/HCON,UERCON,AMCON,RHCON,WCON,PCON,SSRCON,XSPCON
      COMMON /FWH/HAEI,HAEO,QR,QFS(20),HFS(20),HES(20),QMF(5),HMF(5),
     1QMG(5),HMG(5),QD(12),QF(12),QE(12),QCR,HCR,QRO,QC,I1LP,I
      COMMON /HX1/PE(12),PMR(5)
      COMMON /HX2/HE(12),HE1(12),HAMR(5),HBMR(5),SAMR(5),SBMR(5),PCWD(5)
      COMMON /IN/L1(13),L2(13),J1(13),IMR(5)
      COMMON /LEAK/QLK1,HLK1,QLK2,HLK2,QLK3,HLK3,QLK4,HLK4,QLK5,HLK5,
     1QLK6,HLK6,QLK7,HLK7,QLK8,HLK8,QLK9,HLK9,QLK10,HLK10,LK,LK1,LK3,
     2LK5,LK7,LK9
      COMMON /PAR1/HO(12),HI(12),QAE,HC,HFP,DHP,TI(12),TD(12),TDCA(12),
     1HD(12),PLA,PLB,NO(12),NDC(12),IP,NF,NSHAFT
      COMMON /RH2/QRH1,HCRH1,QRH2,HCRH2,NRH
      COMMON /SSR/QSPE,QMC,QSSR,HSSR,PSSR,QFWH,QSSRMU,HSSRMU
      COMMON /XS2/HFSX,QMR
C
      I=I1
      IT2=0
      GOTO1910
 1900 I=I+1
 1910 QMFE(I)=0.
      IT1(I)=0
      IF(MR.EQ.0)GOTO2000
      IF(L2(I).LT.L1(I))GOTO1995
C  FIND DRAIN FROM TURBINE MOISTURE REMOVAL STAGE
      M1=L1(I)
      M2=L2(I)
      DO1990 L=M1,M2
      QMF(L)=PCWD(L)*QFS(KL)*0.01
      HMF(L)=HLIQ(TSAT(PMR(L)))
      IF(I.EQ.I2)GOTO1980
      IF(PE(I).LT.(PMR(L)-1.0))GOTO1980
      QMG(L)=0.0
      HMG(L)=0.0
      QMFE(I)=QMF(L)
      GOTO2000
 1980 QMG(L)=0.005*QFS(KL)
      HMG(L)=HAMR(L)
C  FIND FLOW TO FOLLOWING STAGE
      KL=KL+1
      QFS(KL)=QFS(KL-1)-QMF(L)-QMG(L)
      HFS(KL)=HAMR(L)
      HES(KL-1)=HBMR(L)
 1990 CONTINUE
 1995 IF(I.EQ.I2)GOTO2400
C  FIND DRAIN FROM PREVIOUS FW HEATER
 2000 CONTINUE
C  FIND DRAINS TO FW HEATER SHELL
      QSUM=0.0
      SUM=0.0
C  FIND FW FLOW
      IF(I.GT.1)GOTO2020
      QF1=QR
      IF(NRH.LT.1)GOTO2040
C  ADD DRAIN FROM 1-STAGE REHEATER
      IF(NRH.EQ.2)GOTO2010
      QSUM=QSUM+QRH1
      SUM=SUM+QRH1*(HCRH1-HD(I))
      GOTO2040
C  ADD DRAIN FROM 2ND STAGE OF 2-STAGE REHEATER
 2010 QSUM=QSUM+QRH2
      SUM=SUM+QRH2*(HCRH2-HD(I))
      GOTO2040
 2020 QF1=QF(I-1)
C  ADD DRAIN FROM PREVIOUS FW HEATER
```

```
      IF(ND(I-1).EQ.1)GOTO2030
      QSUM=QSUM+QD(I-1)
      SUM=SUM+QD(I-1)*(HD(I-1)-HD(I))
C   ADD DRAIN FROM 1ST STAGE OF 2-STAGE REHEATER
 2030 IF(I.GT.2.OR.NRH.LT.2)GOTO2040
      QSUM=QSUM+QRH1
      SUM=SUM+QRH1*(HCRH1-HD(I))
C   ADD DRAIN FROM EXTERNAL MOISTURE SEPARATOR
 2040 IF(MS.NE.I)GOTO2050
      QSUM=QSUM+QMR
      SUM=SUM+QMR*(HESX-HD(I))
C   ADD DRAINS FROM VALVE STEM AND SHAFT LEAKAGES
 2050 IF(LK.EQ.0)GOTO2070
      IF(I.NE.LK1)GOTO2060
      QSUM=QSUM+QLK1
      SUM=SUM+QLK1*(HLK1-HD(I))
 2060 IF(I.NE.LK3)GOTO2061
      QSUM=QSUM+QLK3
      SUM=SUM+QLK3*(HLK3-HD(I))
 2061 IF(NSHAFT.EQ.1)GOTO2065
      IF(I.NE.LK5)GOTO2062
      QSUM=QSUM+QLK5
      SUM=SUM+QLK5*(HLK5-HD(I))
 2062 IF(NSHAFT.EQ.2)GOTO2065
      IF(I.NE.LK7)GOTO2063
      QSUM=QSUM+QLK7
      SUM=SUM+QLK7*(HLK7-HD(I))
 2063 IF(I.NE.LK9)GOTO2065
      QSUM=QSUM+QLK9
      SUM=SUM+QLK9*(HLK9-HD(I))
C   ADD DRAIN FROM STEAM SEAL REGULATOR
 2065 IF(I.LT.NF)GOTO2070
      QSUM=QSUM+QFWH
      SUM=SUM+QFWH*(HSSR-HD(I))
C   ADD DRAINS FROM TURBINE MOISTURE REMOVAL STAGES
 2070 IF(MR.EQ.0)GOTO2090
      IF(L2(I).LT.L1(I))GOTO2090
C   SUM DRAINS FROM TURBINE MOISTURE REMOVAL STAGES
      M1=L1(I)
      M2=L2(I)
      DO2080 L=M1,M2
      QSUM=QSUM+QMF(L)+QMG(L)
      SUM=SUM+QMF(L)*(HMF(L)-HD(I))+QMG(L)*(HMG(L)-HD(I))
 2080 CONTINUE
 2090 IF(ND(I).EQ.1)GOTO2100
C   HEAT BALANCE (FW HEATER DRAIN IS FLASHED)
      QF(I)=QF1
      QE(I)=(QF(I)*(HO(I)-HI(I))-SUM)/(HE(I)-HD(I))
      QD(I)=QE(I)+QSUM
      GOTO2200
C   HEAT BALANCE (FW HEATER DRAIN IS PUMPED)
 2100 CONTINUE
      QE(I)=((QF1-QSUM)*(HO(I)-HI(I))-SUM)/(HE(I)-HD(I)+HO(I)-HI(I))
      QD(I)=QE(I)+QSUM
      QF(I)=QF1-QD(I)
      IF(I.EQ.1)GOTO2200
      HI1=(QD(I)*HD(I)+QF(I)*HO(I))/QF1
      IF(IP.NE.(I-1))GOTO2110
C   CORRECT FW PUMP INLET ENTHALPY
      HFP=HI1
      HI1=HI1+DHP
C   TEST FW INLET ENTHALPY
 2110 ADH=DABS(HI1-HI(I-1))
      IT1(I)=IT1(I)+1
      IF(ADH.LE.HCON)GOTO2200
      IF(I.GT.I1)GOTO2111
      IF(IT.GT.50)GOTO2112
 2111 IF(IT1(I-1).LE.50)GOTO2114
 2112 IX=I-1
      PRINT 2113,IX,ADH
 2113 FORMAT(10-SUBROUTINE FWHEAT-FW HEATER INLET ENTHALPY IN IT1 DID NO
```

```
     1T CONVERGE, FW HEATER NO.',I3,4X,'ADH= ',1PD14.6)                 FWHE1141
      GOTO2200                                                          FWHE1150
C  RE-SET INDEX I TO PREVIOUS FW HEATER                                 FWHE1151
 2114 I=I-1                                                             FWHE1160
C  CORRECT FW INLET TEMPERATURE                                         FWHE1161
      HI(I)=HI1                                                         FWHE1170
      IF(I.LE.IP)GOTO2118                                               FWHE1180
      TI(I)=TLIOH(HI1)                                                  FWHE1190
      GOTO2119                                                          FWHE1200
 2118 TI(I)=TCOM(PLA,HI1)                                               FWHE1210
 2119 IF(NDC(I).EQ.0)GOTO2120                                           FWHE1220
C  CORRECT FW HEATER DRAIN TEMPERATURE                                  FWHE1221
      TD(I)=TI(I)+TDCA(I)                                               FWHE1230
      HD(I)=HLIQ(TD(I))                                                 FWHE1240
 2120 IF(I.EQ.(I1LP-1))GOTO2400                                         FWHE1250
      IF(I.LT.I1LP)GOTO2000                                             FWHE1260
C  RE-SET INDEX KL (FLOW TO FOLLOWING STAGE)                            FWHE1261
      KL=I-I1LP+1+L2(I)-J1(I)                                           FWHE1270
      GOTO2000                                                          FWHE1280
 2200 CONTINUE                                                          FWHE1290
      IF(I.LT.I1LP)GOTO2210                                             FWHE1300
C  FIND FLOW TO FOLLOWING STAGE                                         FWHE1301
      KL=KL+1                                                           FWHE1310
      QFS(KL)=QFS(KL-1)-QE(I)-QMFE(I)                                   FWHE1320
      HES(KL-1)=HE1(I)                                                  FWHE1330
      HES(KL)=HE(I)                                                     FWHE1340
 2210 IF(I.LT.NF)GOTO2300                                               FWHE1350
C  FIND ENTHALPY RISE ACROSS SJAE AFTER-CONDENSER AND SPE               FWHE1351
      QC=QF(I)+QCR                                                      FWHE1360
      DHAE=QAE*(HAEI-HAEO)/QC+QSPE*(HSSR-HAEO)/QC                       FWHE1370
      HI1=HC+DHAE                                                       FWHE1380
      HCR=HI1                                                           FWHE1390
      IF(IP.NE.NF)GOTO2220                                              FWHE1400
C  CORRECT FW PUMP INLET ENTHALPY                                       FWHE1401
      HFP=HI1                                                           FWHE1410
      HI1=HI1+DHP                                                       FWHE1420
C  TEST FW INLET ENTHALPY                                               FWHE1421
 2220 ADH=DABS(HI1-HI(I))                                               FWHE1430
      IT2=IT2+1                                                         FWHE1440
      IF(ADH.LE.HCON)GOTO2300                                           FWHE1450
      IF(IT2.LE.50)GOTO2229                                             FWHE1460
      PRINT 2221,I,ADH                                                  FWHE1470
 2221 FORMAT('0-SUBROUTINE FWHEAT-FW HEATER INLET ENTHALPY IN IT2 DID NOFWHE1480
     1T CONVERGE, FW HEATER NO.',I3,4X,'ADH= ',1PD14.6)                 FWHE1481
      GOTO2300                                                          FWHE1490
 2229 IF(I.LT.I1LP)GOTO2230                                             FWHE1500
C  RE-SET INDEX KL (FLOW TO FOLLOWING STAGE)                            FWHE1501
      KL=KL-1                                                           FWHE1510
C  CORRECT FW INLET TEMPERATURE                                         FWHE1511
 2230 HI(I)=HI1                                                         FWHE1520
      IF(I.LE.IP)GOTO2240                                               FWHE1530
      TI(I)=TLIOH(HI1)                                                  FWHE1540
      GOTO2250                                                          FWHE1550
 2240 TI(I)=TCOM(PLA,HI1)                                               FWHE1560
 2250 IF(NDC(I).EQ.0)GOTO2090                                           FWHE1570
C  CORRECT FW HEATER DRAIN TEMPERATURE                                  FWHE1571
      TD(I)=TI(I)+TDCA(I)                                               FWHE1580
      HD(I)=HLIQ(TD(I))                                                 FWHE1590
      GOTO2090                                                          FWHE1600
 2300 IF(I.LT.I2)GOTO1900                                               FWHE1610
 2400 RETURN                                                            FWHE1620
      END                                                               FWHE1630
```

```
      SUBROUTINE FWHPAR(N1,N2)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR FW HEATER PARAMETERS
C  SHELL PRESSURE, DRAIN TEMPERATURE, AND FW IN AND OUT TEMPERATURES
C
      COMMON /HX1/PE(12),PMR(5)
      COMMON /PAR1/HO(12),HI(12),QAE,HC,HFP,DHP,TI(12),TO(12),TDCA(12),
     1HD(12),PLA,PLB,ND(12),NDC(12),IP,NF,NSHAFT
      COMMON /PAR2/PSH(12),TSH(12),TD(12),TTD(12),PXHP,PXIP
C
      DO250 I=N1,N2
C  SHELL PRESSURE
      IF(NSHAFT.EQ.1)GOTO230
      IF(PE(I).GT.(PXHP+1.0).OR.PE(I).LT.(PXHP-1.0))GOTO220
  210 PSH(I)=0.95*PE(I)
      GOTO240
  220 IF(NSHAFT.EQ.2)GOTO230
      IF(PE(I).GT.(PXIP+1.0).OR.PE(I).LT.(PXIP-1.0))GOTO230
      GOTO210
  230 PSH(I)=0.92*PE(I)
  240 TSH(I)=TSAT(PSH(I))
C  FW OUTLET
      TO(I)=TSH(I)-TTD(I)
      IF(I.LE.IP)GOTO241
      HO(I)=HLIQ(TO(I))
      GOTO250
  241 HO(I)=HCOM(PLA,TO(I))
  250 CONTINUE
      DO310 I=N1,N2
C  FW INLET
      IF(I.EQ.NF)GOTO260
      HI(I)=HO(I+1)
      IF(ND(I+1).EQ.0)GOTO270
C  CORRECT FW INLET FOR PUMPED DRAIN AT I+1
      HI(I)=HI(I)+1.0
      GOTO270
C  CORRECT FW INLET FOR SJAE ENTHALPY RISE AND SPE ENTHALPY RISE
  260 HI(I)=HC+1.0
  270 IF(IP.NE.I)GOTO280
C  FW PUMP INLET
      HFP=HI(I)
C  CORRECT FW INLET FOR FW PUMP ENTHALPY RISE
      HI(I)=HI(I)+DHP
  280 IF(I.LE.IP)GOTO281
      TI(I)=TLIQH(HI(I))
      GOTO282
  281 TI(I)=TCOM(PLA,HI(I))
  282 IF(NDC(I).EQ.0)GOTO290
C  DRAIN WITH DRAIN COOLER
      TD(I)=TI(I)+TDCA(I)
      GOTO300
C  DRAIN WITHOUT DRAIN COOLER
  290 TD(I)=TSH(I)
  300 HD(I)=HLIQ(TD(I))
  310 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE FWPT(PB,HB,PX,DHP,QR,NSHAFT)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR CALCULATING THROTTLE STEAM FLOW TO FW PUMP TURBINE
C
      COMMON /FPT/QFPT,PBFPT,HBFPT,PXFPT,HXFPT,IFPT
C
C  FIND BOWL ENTROPY
      PBFPT=PB*0.96
```

```
      HBFPT=HB
      CALL PROPPH(AMB,SB,VB,TB,MB,PBFPT,HBFPT)
C
C  FIND ISENTROPIC EXHAUST ENTHALPY
      PXFPT=PX
      CALL PROPPS(AMXS,HXS,TXS,VXS,MXS,PXFPT,SB)
C
C  FIND USED ENERGY
      EFF=0.8
      AE=HBFPT-HXS
      UE=AE*EFF
      HXFPT=HBFPT-UE
C
C  THROTTLE STEAM FLOW TO FW PUMP TURBINE
      IF(NSHAFT.GT.1)GOTO10
      QFPT=QR*DHP/(UE-DHP)
      RETURN
   10 QFPT=QR*DHP/UE
      RETURN
      END
```

```
      SUBROUTINE GOVERN(AE,BE,W,WVO,CS,AMB,SB,MB,HB,PB,AMXS,TXS,MXS,PX,
     1AMX,SX,VX,TX,MX,HX)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR CALCULATING GOVERNING STAGE SHELL STEAM CONDITIONS
C
      COMMON /CONV/HCON,UERCON,AMCON,RHCON,WCON,PCON,SSRCON,XSPCON
C
C  CORRECTIONS TO BASE EFFICIENCY
      CWVO=FIG1(WVO,W)
      CL=FIG2(WVO)
      CE1=CWVO*CL*CS*BE
C  INITIALIZE
      TX=TXS
      HG=HVAP(TX,PX)
      HF=HLIQ(TX)
C  TEST BOWL STEAM
      IF(MB.GT.2)GOTO121
C
C  BOWL STEAM IS WET OR SATURATED
C  ASSUME EXHAUST MOISTURE
      AMX1=AMXS
C  MOISTURE CORRECTION
      DO125 IT1=1,50
  120 CM=1.0-0.435*(AMB+AMX1)
      UE=AE*CE1*CM
      HX=HB-UE
C  EXHAUST MOISTURE
      AMX=(HG-HX)/(HG-HF)
C  CHECK ASSUMED EXHAUST MOISTURE
      DAMX=DABS(AMX1-AMX)
      IF(DAMX.LE.AMCON)GOTO123
C  RE-SET EXHAUST MOISTURE
      AMX1=AMX
  125 CONTINUE
      PRINT 122,DAMX
  122 FORMAT('0-SUBROUTINE GOVERN-EXHAUST MOISTURE IN IT1 DID NOT CONVER
     1GE, DAMX =',1PD14.6)
  123 MX=1
      SX=(1.0-AMX)*SVAP(TX,PX)+AMX*SLIQ(TX,PX)
      VX=(1.0-AMX)*VVAP(TX,PX)+AMX*VLIQ(TX,PX)
      RETURN
C
C  BOWL STEAM IS SUPERHEATED
C  TEST EXHAUST STEAM
  121 IF(MXS.GT.1)GOTO140
C
```

```
C   BOWL STEAM IS SUPERHEATED AND SHELL STEAM IS WET
      SG=SVAP(TX,PX)
      SF=SLIQ(TX)
C   ASSUME EXHAUST MOISTURE AND USED ENERGY RATIO
      AMX1=0.0
      RUE1=0.0
C   MOISTURE CORRECTION
      DO151 IT2=1,100
  150 CM=1.0-0.435*AMX1*RUE1
      UE=AE*CE1*CM
      HX=HB-UE
C   TEST EXHAUST STEAM
      IF(HX-HG)124,200,201
C   FIND INTERSECTION OF EXPANSION LINE AND SATURATION LINE
C   EXHAUST MOISTURE
  124 AMX=(HG-HX)/(HG-HF)
      SX=(1.0-AMX)*SG+AMX*SF
      A=(HB-HX)/(SB-SX)
      P1=PB
      P2=PX
      DO131 IT3=1,100
      P=(P1+P2)/2.
      T=TSAT(P)
      H=HVAP(T,P)
      S=SVAP(T,P)
      H1=HB+(S-SB)*A
      ADH=DABS(H-H1)
      IF(ADH.LE.HCON)GOTO134
      IF(H.LT.H1)GOTO133
      P2=P
      GOTO131
  133 P1=P
  131 CONTINUE
      PRINT 132,ADH
  132 FORMAT('0-SUBROUTINE GOVERN-SATURATION LINE ENTHALPY IN IT3 DID NO
     1T CONVERGE, ADH =',1PD14.6)
C   USED ENERGY RATIO
  134 UEW=H-HX
      RUE=UEW/UE
C   CHECK ASSUMED USED ENERGY RATIO
      ADRUE=DABS(RUE-RUE1)
      IF(ADRUE.GT.UERCON)GOTO154
C   CHECK ASSUMED EXHAUST MOISTURE
      DAMX=DABS(AMX1-AMX)
      IF(DAMX.LE.AMCON)GOTO152
C   RE-SET EXHAUST MOISTURE AND USED ENERGY RATIO
  154 AMX1=AMX
      RUE1=RUE
  151 CONTINUE
      PRINT 160,DAMX,ADRUE
  160 FORMAT('0-SUBROUTINE GOVERN-EXHAUST MOISTURE OR USED ENERGY RATIO
     1IN IT2 DID NOT CONVERGE, DAMX =',1PD14.6,5X,'ADRUE =',1PD14.6)
  152 MX=1
      VX=(1.0-AMX)*VVAP(TX,PX)+AMX*VLIQ(TX,PX)
      RETURN
C
C   SHELL STEAM IS DRY
  140 UE=AE*CE1
      HX=HB-UE
      GOTO201
  200 MX=2
      GOTO202
  201 MX=3
      TX=TVAPH(PX,HX)
  202 AMX=0.0
      SX=SVAP(TX,PX)
      VX=VVAP(TX,PX)
      RETURN
C
      END
```

```
      SUBROUTINE GSTAGE(PXLP)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR GOVERNING STAGE CALCULATIONS
C
      COMMON /CONV/HCON,UERCON,AMCON,RHCON,WCON,PCON,SSRCON,XSPCON
      COMMON /GS/QGS,HBGS,PBGS,AMBGS,SBGS,VBGS,TBGS,PXGS,AMXGS,SXGS,
     1VXGS,TXGS,HXGS,PDGS,MBGS,MXGS,NCGS,IRGS,NGS
C
C  GS VWO BOWL CONDITIONS
      NCGS=NCGS+1
      QGSO=1.05*QGS
      IF(NCGS.GT.1)GOTO120
      CSGS=FIG6A(IRGS)
      PBGSO=PBGS*1.0091453
      CALL PROPPH(AMBGSO,SBGSO,VBGSO,TBGSO,MBGSO,PBGSO,HBGS)
C  GS VWO ISENTROPIC SHELL CONDITIONS
      W=IRGS*0.0043633*PDGS
  100 WVOO=0.5
  110 VOO=W/WVOO
      AEGSO=(VOO/223.7)**2
      HXSGSO=HBGS-AEGSO
      CALLPROPHS(PXGSO,TXSGSO,VXSGSO,AXSGSO,MXSGSO,HXSGSO,SBGSO)
C  GS VWO SHELL CONDITIONS
  120 QVN=QGSO*VBGSO/NGS
      BEGS=0.9105-19750.0/QVN
C  CORRECTION FOR BACK-PRESSURE TURBINE
      IF(PXLP.LT.3.)GOTO121
      BEGS=BEGS*0.99
  121 CALL GOVERN(AEGSO,BEGS,W,WVOO,CSGS,AMBGSO,SBGSO,MBGSO,HBGS,PBGSO,
     1AXSGSO,TXSGSO,MXSGSO,PXGSO,AMXGSO,SXGSO,VXGSO,TXGSO,MXGSO,HXGSO)
C  GS BOWL CONDITIONS
      CALL PROPPH(AMBGS,SBGS,VBGS,TBGS,MBGS,PBGS,HBGS)
C  GS ISENTROPIC SHELL CONDITIONS
      PXGS=PXGSO*0.95238
      DO131 IT=1,500
  130 CALL PROPPS(AMXSGS,HXSGS,TXSGS,VXSGS,MXSGS,PXGS,SBGS)
C  GS SHELL CONDITIONS
      AEGS=HBGS-HXSGS
      VO=223.7*DSQRT(AEGS)
      WVO=W/VO
      CALL GOVERN(AEGS,BEGS,W,WVO,CSGS,AMBGS,SBGS,MBGS,HBGS,PBGS,AMXSGS,
     1TXSGS,MXSGS,PXGS,AMXGS,SXGS,VXGS,TXGS,MXGS,HXGS)
      P=0.90703*PXGSO*VXGS/VXGSO
      ADP=DABS((P-PXGS)/PXGS)
      IF(ADP.LE.PCON)GOTO140
      PXGS=P
  131 CONTINUE
      PRINT 132,ADP
  132 FORMAT('0-SUBROUTINE GSTAGE-GOVERNING STAGE EXHAUST PRESSURE DID N
     1OT CONVERGE, ADP =',1PD14.6)
  140 RETURN
      END
```

```
      SUBROUTINE HXTRAC(MR,I1,I2,MBLP,HBLP,SBLP,MXLP,HXLP,SXLP,PIL,HIL,
     1SIL,PX,UEEP)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR FW HEATER EXTRACTION STEAM ENTHALPY
C
      COMMON /HX1/PE(12),PMR(5)
      COMMON /HX2/HE(12),HE1(12),HAMR(5),HBMR(5),SAMR(5),SBMR(5),PCWD(5)
C
C  TEST FOR PRESENCE OF MOISTURE REMOVAL STAGES
      IF(MR.GT.0)GOTO4100
C
```

```
C   NO MOISTURE REMOVAL STAGES PRESENT
      DO4060 I=I1,I2
      IF(PE(I).GT.(PX+1.0))GOTO3990
      HE(I)=UFEP
      GOTO4050
 3990 IF(MBLP.EQ.3)GOTO4000
      CALL FIG12B(PE(I),HBLP,SBLP,HXLP,SXLP,HE(I),SE)
      GOTO4050
 4000 IF(MXLP.EQ.1)GOTO4010
      CALL FIG12A(PE(I),HBLP,SBLP,HXLP,SXLP,HE(I),SE)
      GOTO4050
 4010 IF(PE(I).LT.PIL)GOTO4040
      CALL FIG12A(PE(I),HBLP,SBLP,HIL,SIL,HE(I),SE)
      GOTO4050
 4040 CALL FIG12B(PE(I),HIL,SIL,HXLP,SXLP,HE(I),SE)
 4050 HE1(I)=HE(I)
 4060 CONTINUE
      RETURN
C
C   MOISTURE REMOVAL STAGES PRESENT
 4100 DO4200 I=I1,I2
      IF(PE(I).GT.(PX+1.0))GOTO4110
      HE(I)=UFEP
      GOTO4195
 4110 DO4190 J=1,MR
      IF(PE(I).GT.(PMR(J)+1.0).OR.PE(I).LT.(PMR(J)-1.0))GOTO4120
      HE(I)=HAMR(J)
      HE1(I)=HBMR(J)
      GOTO4200
 4120 IF(PE(I).GT.PMR(J))GOTO4130
      IF(J.LT.MR)GOTO4190
      HB=HAMR(J)
      SB=SAMR(J)
      HX=HXLP
      SX=SXLP
      GOTO4180
 4130 IF(J.EQ.1)GOTO4140
      HB=HAMR(J-1)
      SB=SAMR(J-1)
      GOTO4170
 4140 IF(MBLP.EQ.3)GOTO4150
      HB=HBLP
      SB=SBLP
      GOTO4170
 4150 IF(PE(I).GT.PIL)GOTO4160
      HB=HIL
      SB=SIL
      GOTO4170
 4160 CALL FIG12A(PE(I),HBLP,SBLP,HIL,SIL,HE(I),SE)
      GOTO4195
 4170 HX=HBMR(J)
      SX=SBMR(J)
 4180 CALL FIG12B(PE(I),HB,SB,HX,SX,HE(I),SE)
      GOTO4195
 4190 CONTINUE
 4195 HE1(I)=HE(I)
 4200 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE INDEX(I1,I2,NFLP,MR)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR CALCULATING INDICES FOR LP TURBINE
C
      COMMON /HX1/PE(12),PMR(5)
      COMMON /IN/L1(13),L2(13),J1(13),IMR(5)
C
      IMR(1)=0
      IMR(2)=0
      IMR(3)=0
      IMR(4)=0
      IMR(5)=0
      JJ1=0
      LL1=0
      LL2=0
      IF(NFLP.EQ.0)GOTO2750
      NN=I2-1
      DO2740 I=I1,NN
      LL1=LL2+1
      IF(LL1.GT.MR)GOTO2730
      DO2710 L=LL1,MR
      IF(PMR(L).LT.(PE(I)-1.0))GOTO2730
      IMR(L)=I
      LL2=L
      IF(PMR(L).LT.(PE(I)+1.0).AND.PMR(L).GT.(PE(I)-1.0))GOTO2720
 2710 CONTINUE
      GOTO2730
 2720 JJ1=JJ1+1
 2730 J1(I)=JJ1
      L1(I)=LL1
      L2(I)=LL2
 2740 CONTINUE
 2750 J1(I2)=JJ1
      L1(I2)=LL2+1
      L2(I2)=MR
C
C  J1(I)=TOTAL NO. OF FW HEATER EXTRACTION AND MOISTURE REMOVAL
C    EXTRACTION POINTS THAT COINCIDE, TO AND INCLUDING FW HEATER
C    EXTRACTION POINT 'I'
C  L1(I)=FIRST MOISTURE REMOVAL EXTRACTION POINT THAT FEEDS FW HTR 'I'
C
C  L2(I)=LAST MOISTURE REMOVAL EXTRACTION POINT THAT FEEDS FW HEATER 'I'
C
C  IF L1(I)=1 AND  L2(I)=0, THEN NO MOISTURE REMOVAL EXTRACTION POINTS
C    FEED TO FW HEATER 'I'
C
      RETURN
      END
```

```
      SUBROUTINE PRDROP(PXHP,PBLP,MS,NRH)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR INTERMEDIATE SYSTEM PRESSURE DROP
C  (TABLE III, P. 138, GER-2454A)
C
      COMMON /RH1/PXRH2,PIRH2,PXRH1,PIRH1,PFPT
      COMMON /XS1/PSX,PSI
C
      DATA A/1.03093D0/,B/1.03413D0/
      DATA A2/1.00705D0/,B2/1.01010D0/,E2/1.02041D0/
      DATA A3/1.00705D0/,B3/1.01112D0/,C3/1.01833D0/,E3/1.01112D0/
      DATA A4/1.00705D0/,B4/1.01112D0/,C4/1.01317D0/,D4/1.01523D0/,
     1E4/1.01112D0/
C
      IF(MS.GT.0)GOTO30
C
```

```
C   NO  MOISTURE SEPARATOR
      IF(NRH.NE.0)GOTO10
C   NO  MOISTURE SEPARATOR, NO REHEATER
      PXHP=PRLP*A
      PFPT=PXHP
      RETURN
   10 PIV=PRLP*B
      IF(NRH.GT.1)GOTO20
C   NO  MOISTURE SEPARATOR, 1-STAGE REHEATER
      PXRH1=PIV*E3
      PFPT=PXRH1
      PIRH1=PXRH1*C3
      PXHP=PIRH1*A3
      RETURN
C   NO  MOISTURE SEPARATOR, 2-STAGE REHEATER
   20 PXRH2=PIV*E4
      PFPT=PXRH2
      PIRH2=PXRH2*D4
      PXRH1=PIRH2
      PIRH1=PXRH1*C4
      PXHP=PIRH1*A4
      RETURN
C
C   MOISTURE SEPARATOR
   30 PIV=PRLP*B
      IF(NRH.NE.0)GOTO40
C   MOISTURE SEPARATOR, NO REHEATER
      PSX=PIV*E2
      PFPT=PSX
      PSI=PSX*B2
      PXHP=PSI*A2
      RETURN
   40 IF(NRH.GT.1)GOTO50
C   MOISTURE SEPARATOR, 1-STAGE REHEATER
      PXRH1=PIV*E3
      PFPT=PXRH1
      PIRH1=PXRH1*C3
      PSX=PIRH1
      PSI=PSX*B3
      PXHP=PSI*A3
      RETURN
C   MOISTURE SEPARATOR, 2-STAGE REHEATER
   50 PXRH2=PIV*E4
      PFPT=PXRH2
      PIRH2=PXRH2*D4
      PXRH1=PIRH2
      PIRH1=PXRH1*C4
      PSX=PIRH1
      PSI=PSX*B4
      PXHP=PSI*A4
      RETURN
      END


      SUBROUTINE REHEAT(HE,PE,HT,PT)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR REHEATER PARAMETERS
C
      COMMON /RH1/PXRH2,PIRH2,PXRH1,PIRH1,PFPT
      COMMON /RH2/QRH1,HCRH1,QRH2,HCRH2,NRH
      COMMON /RH3/TTDRH1,TTDRH2,HRH1,HRH2,PCRH1,TCRH1,PCRH2,TCRH2,TXRH1,
     1HXRH1,TXRH2,HXRH2,HIRH2,HIRH1,QRH
C
C  1ST STAGE
      IF(NRH.EQ.1)GOTO110
      HRH1=HE
      PCRH1=PE*0.9555
      GOTO120
```

```
  110 HRH1=HT
      PCRH1=PT*0.985
  120 TCRH1=TSAT(PCRH1)
      HCRH1=HLIQ(TCRH1)
      TXRH1=TCRH1-TTDRH1
      T1=TSAT(PXRH1)
      IF(TXRH1.GE.T1)GOTO122
      TXRH1=T1
      TTDRH1=TXRH1-TCRH1
      PRINT 121,TTDRH1
  121 FORMAT('0',T10,'THERE IS A DATA ERROR IN SUBROUTINE REHEAT.'/
     1T10,'REHEATER TERMINAL TEMPERATURE DIFFERENCE HAS BEEN CHANGED TO'
     2,F10.2)
  122 HXRH1=HVAP(TXRH1,PXRH1)
      IF(NRH.EQ.1)GOTO130
C  2ND STAGE
      HRH2=HT
      PCRH2=PT*0.985
      TCRH2=TSAT(PCRH2)
      HCRH2=HLIQ(TCRH2)
      TXRH2=TCRH2-TTDRH2
      T2=TSAT(PXRH2)
      IF(TXRH2.GE.T2)GOTO124
      TXRH2=T2
      TTDRH2=TXRH2-TCRH2
      PRINT 121,TTDRH2
  124 HXRH2=HVAP(TXRH2,PXRH2)
      HIRH2=HXRH1
  130 RETURN
      END
```

```
      SUBROUTINE SGROUP(PB,TB,HB,SB,VB,AMB,MB,QB,NE,CS,PX,TX,HX,SX,VX,
     1AMX,MX,PXI,TXI,HXI,SXI,VXI,AMXI,MXI,PXLP)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR STAGE GROUP STEAM CONDITIONS
C
      COMMON /CONV/HCON,UERCON,AMCON,RHCON,WCON,PCON,SSRCON,XSPCON
C
C  INITIALIZE
      TX=TSAT(PX)
      SG=SVAP(TX,PX)
      SF=SLIQ(TX)
      HG=HVAP(TX,PX)
      HF=HLIQ(TX)
C  CORRECTION FOR BACK-PRESSURE TURBINE
      IF(PXLP.LT.3.)GOTO10
      CT=0.99
      GOTO100
   10 CT=1.
C  TEST BOWL STEAM
  100 IF(MB.GT.2)GOTO200
C
C  BOWL STEAM IS WET, OR DRY AND SATURATED
C  SHELL STEAM IS WET
      AMXS=(SG-SB)/(SG-SF)
      HXS=(1.0-AMXS)*HG+AMXS*HF
      PR=PB/PX
      VF=(3.0D+6)*VVAP(TB,PB)
      QVN=QB*VB/NE
      BE=FIG4(PR,PB,VF)
      CIVF=FIG5(QVN,PR,VF,PB)
      CM=1.0-AMB*FIG7(PR,PB)
      AE=HB-HXS
      UE=AE*BE*CIVF*CS*CM*CT
      HX=HB-UE
      GOTO510
C
```

```
C  BOWL STEAM IS SUPERHEATED                                            SGRO 291
C  TEST SHELL STEAM                                                     SGRO 292
  200 IF(SG.GT.SB)GOTO300                                               SGRO 300
C  SHELL STEAM IS SUPERHEATED                                           SGRO 301
      TXS=TVAPS(PX,SB)                                                  SGRO 310
      HXS=HVAP(TXS,PX)                                                  SGRO 320
      PR=PB/PX                                                          SGRO 330
      QVN=QB*VB/NE                                                      SGRO 340
      BE=FIG3(QVN,PR)                                                   SGRO 350
      AE=HB-HXS                                                         SGRO 360
      UE=AE*BE*CS*CT                                                    SGRO 370
      HX=HB-UE                                                          SGRO 380
      GOTO530                                                           SGRO 390
C                                                                       SGRO 400
C  BOWL STEAM IS SUPERHEATED                                            SGRO 401
C  SHELL STEAM IS WET                                                   SGRO 402
C  FIND UE FROM BOWL TO SATURATION LINE                                 SGRO 403
  300 P1=PB                                                             SGRO 410
      P2=PX                                                             SGRO 420
      DO320 IT=1,100                                                    SGRO 430
      PXI=(P1+P2)/2.                                                    SGRO 440
      PR=PB/PXI                                                         SGRO 450
      QVN=QB*VB/NE                                                      SGRO 460
      BE=FIG3(QVN,PR)                                                   SGRO 470
      TXSI=TVAPS(PXI,SB)                                                SGRO 480
      HXSI=HVAP(TXSI,PXI)                                               SGRO 490
      AEI=HB-HXSI                                                       SGRO 500
      UEI=AEI*BE*CS*CT                                                  SGRO 510
      HXI=HB-UEI                                                        SGRO 520
      TXI=TSAT(PXI)                                                     SGRO 530
      HGI=HVAP(TXI,PXI)                                                 SGRO 540
C  TEST HXI                                                             SGRO 541
      ADH=DABS(HGI-HXI)                                                 SGRO 550
      IF(ADH.LE.HCON)GOTO370                                            SGRO 560
C  RE-SET P1 OR P2                                                      SGRO 561
      IF(HGI.LT.HXI)GOTO310                                             SGRO 570
      P2=PXI                                                            SGRO 580
      GOTO320                                                           SGRO 590
  310 P1=PXI                                                            SGRO 600
  320 CONTINUE                                                          SGRO 610
      PRINT 321,ADH                                                     SGRO 620
  321 FORMAT('0-SUBROUTINE SGROUP-SATURATION LINE ENTHALPY DID NOT CONVESGRO 630
     1RGE, ADH =',1PD14.6)                                              SGRO 631
  370 IF(PX.LT.(PXI-0.1))GOTO380                                        SGRO 640
      UE=UEI                                                            SGRO 650
      HX=HXI                                                            SGRO 660
      IF(HX.GT.HG)GOTO530                                               SGRO 670
      GOTO520                                                           SGRO 680
C  FIND STEAM CONDITIONS AT SATURATION LINE                             SGRO 681
  380 MXI=2                                                             SGRO 690
      AMXI=0.0                                                          SGRO 700
      SXI=SVAP(TXI,PXI)                                                 SGRO 710
      VXI=VVAP(TXI,PXI)                                                 SGRO 720
C  FIND UE FROM SATURATION LINE TO SHELL                                SGRO 721
      PR=PXI/PX                                                         SGRO 730
      VF=(3.0D+6)*VXI                                                   SGRO 740
      QVN=QB*VXI/NE                                                     SGRO 750
      BE=FIG4(PR,PXI,VF)                                                SGRO 760
      CIVF=FIG5(QVN,PR,VF,PXI)                                          SGRO 770
      AMXS=(SG-SXI)/(SG-SF)                                             SGRO 780
      HXS=(1.0-AMXS)*HG+AMXS*HF                                         SGRO 790
      AEIX=HXI-HXS                                                      SGRO 800
      UEIX=AEIX*BE*CIVF*CS*CT                                           SGRO 810
      HX=HXI-UEIX                                                       SGRO 820
      UE=HB-HX                                                          SGRO 830
C                                                                       SGRO 840
C  FIND SHELL STEAM CONDITIONS                                          SGRO 841
C  WET                                                                  SGRO 842
  510 MX=1                                                              SGRO 850
      AMX=(HG-HX)/(HG-HF)                                               SGRO 860
      SX=(1.0-AMX)*SG+AMX*SF                                            SGRO 870
```

```
      VX=(1.0-AMX)*VVAP(TX,PX)+AMX*VLIQ(TX)
      RETURN
C  DRY AND SATURATED
  520 MX=2
      AMX=0.0
      SX=SG
      VX=VVAP(TX,PX)
      RETURN
C  SUPERHEATED
  530 MX=3
      AMX=0.0
      TX=TVAPH(PX,HX)
      SX=SVAP(TX,PX)
      VX=VVAP(TX,PX)
      RETURN
C
      END
```

```
      SUBROUTINE SLEAK1(NF,PSH,QT,PT,HT,LK1,QLK1,HLK1,QLK2,HLK2,NFGS)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR VALVE STEM PACKING LEAKAGES
C  TABLE II, P. 12, GER-2454A
C
      DIMENSION PSH(12)
C
  100 LK1=0
      QLK12=0.00105*QT
      IF(PT.GE.300.0)GOTO110
      QLK1=0.
      HLK1=0.
      QLK2=QLK12
      HLK2=HT
      RETURN
  110 IF(NF.EQ.NFGS)GOTO130
      I=NFGS+1
      DO120 IL=I,NF
      IF(PSH(IL).GT.250.0)GOTO120
      LK1=IL
      PLK1=PSH(IL)
      GOTO140
  120 CONTINUE
  130 PLK1=200.
  140 QLK2=QLK12*PLK1/PT
      QLK1=QLK12-QLK2
      HLK1=HT
      HLK2=HT
      RETURN
      END
```

```
      SUBROUTINE SLEAK2(NF,PSH,NGS,IRGS,PXGS,VXGS,HXGS,LK3,QLK3,HLK3,
     1QLK4,HLK4,PSSR,NFGS)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR TURBINE SHAFT PACKING LEAKAGES (BOWL END)
C  TABLE II, P. 12, GER-2454A
C
      DIMENSION PSH(12)
C
  200 LK3=0
      IF(PXGS.GT.PSSR)GOTO211
  210 QLK3=0.
      QLK4=0.
      HLK3=0.
      HLK4=0.
      RETURN
```

```
211 GOTO(220,210,220,210,220,210,220,210,220,210,220,210,220,210,220,
   1210),NGS
220 IF(IRGS.EQ.1800)GOTO230
    C34=600.
    C4=900.
    GOTO240
230 C34=800.
    C4=1200.
240 IF(PXGS.GE.150.0)GOTO250
    QLK3=0.
    HLK3=0.
    QLK4=C4*DSQRT(PXGS/VXGS)
    HLK4=HXGS
    RETURN
250 IF(NE.EQ.NEGS)GOTO270
    I=NEGS+1
    DO260 IL=I,NE
    IF(PSH(IL).GT.150.0)GOTO260
    LK3=IL
    PLK3=PSH(IL)
    GOTO280
260 CONTINUE
270 PLK3=100.
280 HLK3=HXGS
    CALL PROPPH(AM,S,VLK3,T,M,PLK3,HLK3)
    QLK34=C34*DSQRT(PXGS/VXGS)
    QLK4=C4*DSQRT(PLK3/VLK3)
    QLK3=QLK34-QLK4
    HLK4=HXGS
    RETURN
    END
```

```
      SUBROUTINE SLEAK3(NE,PSH,NHP,IRHP,PXHP,VXHP,HXHP,LK5,QLK5,HLK5,
     1QLK6,HLK6,PSSR)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR TURBINE SHAFT LEAKAGES (EXHAUST END)
C  TABLE II, P. 12, GEP-2454A
C
      DIMENSION PSH(12)
C
  300 LK5=0
      IF(PXHP.GT.PSSR)GOTO305
      QLK5=0.
      QLK6=0.
      HLK5=0.
      HLK6=0.
      RETURN
  305 GOTO(310,320,310,320,310,320,310,320,310,320,310,320,310,320,310,
     1320),NHP
  310 NE1=1
      NE2=NHP-1
      GOTO330
  320 NE1=0
      NE2=NHP
  330 IF(IRHP.EQ.1800)GOTO340
      C56=NE1*400.0+NE2*550.0
      C6=NE1*600.0+NE2*750.0
      GOTO350
  340 C56=NE1*500.0+NE2*750.0
      C6=NE1*700.0+NE2*1000.0
  350 IF(PXHP.GE.150.0)GOTO360
      QLK5=0.
      HLK5=0.
      QLK6=C6*DSQRT(PXHP/VXHP)
      HLK6=HXHP
      RETURN
```

```
  360 IF(NF.EQ.0)GOTO380
      DO370 IL=1,NF
      IF(PSH(IL).GT.150.0)GOTO370
      LK5=IL
      PLK5=PSH(IL)
      GOTO390
  370 CONTINUE
  380 PLK5=100.
  390 HLK5=HXHP
      CALL PROPPH(AM,S,VLK5,T,M,PLK5,HLK5)
      QLK56=C56*DSQRT(PXHP/VXHP)
      QLK6=C6*DSQRT(PLK5/VLK5)
      QLK5=QLK56-QLK6
      HLK6=HXHP
      RETURN
      END
```

```
      SUBROUTINE SSRE(PSH,HT,PXLP,NSHAFT,NF)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR STEAM SEAL REGULATOR ENTHALPY
C
      DIMENSION PSH(12)
C
      COMMON /LEAK/QLK1,HLK1,QLK2,HLK2,QLK3,HLK3,QLK4,HLK4,QLK5,HLK5,
     1QLK6,HLK6,QLK7,HLK7,QLK8,HLK8,QLK9,HLK9,QLK10,HLK10,LK,LK1,LK3,
     2LK5,LK7,LK9
      COMMON /SSR/QSPE,QMC,QSSR,HSSR,PSSR,QFWH,QSSRMU,HSSRMU
C
      QSSR=QLK2+QLK4
      HSUM=QLK2*HLK2+QLK4*HLK4
      IF(NSHAFT.EQ.1)GOTO100
      QSSR=QSSR+QLK6
      HSUM=HSUM+QLK6*HLK6
      IF(NSHAFT.EQ.2)GOTO100
      QSSR=QSSR+QLK8+QLK10
      HSUM=HSUM+QLK8*HLK8+QLK10*HLK10
  100 HSSR=HSUM/QSSR
      Q=QMC+QSPE
      IF(QSSR.GT.Q)GOTO110
      QFWH=0.
      QSSRMU=Q-QSSR
      QSSR=Q
      HSSRMU=HT
      HSUM=HSUM+QSSRMU*HSSRMU
      HSSR=HSUM/QSSR
      GOTO140
  110 QSSRMU=0.
      HSSRMU=0.
      IF(NF.GT.0)GOTO130
  120 QFWH=0.
      QMC=QSSR-QSPE
      GOTO140
  130 IF(PSSR.LE.PSH(NF))GOTO120
      QFWH=QSSR-Q
  140 IF(PXLP.LE.14.696)GOTO150
      QMC=QSSR
      QFWH=0.
      QSPE=0.
  150 RETURN
      END
```

```
      SUBROUTINE XLOSS(PA,TX,HEP,HX,QA,AMEP,AMX,NE,BL,PD,IRL,UEEP,XL2)
      IMPLICIT REAL*8(A-H,O-Z)
C
C SUBPROGRAM  FOR LP CONDENSING TURBINE UEEP
C  APPENDIX III (P. 59, GER-2454A)
C
      PX=PA*2.036
      AAN=0.021817*PD*BL
      VP=VVAP(TX,PA)
      VAN=QA*VP*(1.0-AMX)/(3600.0*AAN*NE)
      IF(VAN.GT.1400.0)GOTO10
      XL=FIG167(VAN,BL,IRL)
      AMF2=FIG14(AMX*100.)
      XL2=XL*AMF2
      UEEP=HX+XL2
      RETURN
   10 PP=PX*VAN*0.000768049
      AMF1=FIG14(AMEP*100.)
      DO21 IT=1,50
   20 DEP=FIG15(PP)
      HPP=HEP+DEP*AMF1
      P=PP*0.49116
      TPP=TSAT(P)
      VPP=VVAP(TPP,P)
      HGPP=HVAP(TPP,P)
      AMPP=(HGPP-HPP)/(HGPP-HLIQ(TPP))
      VPAN=QA*VPP*(1.0-AMPP)/(3600.0*AAN*NE)
      IF(VPAN.LE.1400.0)GOTO30
      PP=PP*VPAN/1302.0
   21 CONTINUE
      PRINT 22,VPAN
   22 FORMAT('0-SUBROUTINE XLOSS-VPAN DID NOT CONVERGE, VPAN =',1PD14.6)
   30 XL=FIG167(VPAN,BL,IRL)
      AMFP=FIG14(AMPP*100.0)
      XL2=XL*AMFP
      UEEP=HPP+XL2
      RETURN
      END
```

```
      SUBROUTINE XSEP
      IMPLICIT REAL*8(A-H,O-Z)
C
      COMMON /XS1/PSX,PSI
      COMMON /XS2/HFSX,QMR
      COMMON /XS3/QSI,HSI,TSX,QSX,HSX,AMSX,EMS,MS
C
C SUBPROGRAM  FOR EXTERNAL MOISTURE SEPARATOR CALCULATIONS
C
C  STEAM CONDITIONS AT MOISTURE SEPARATOR OUTLET BEFORE SEPARATION
      HSXB=HSI
      TSX=TSAT(PSX)
      HFSX=HLIQ(TSX)
      HGSX=HVAP(TSX,PSX)
      AMSXB=(HGSX-HSXB)/(HGSX-HFSX)
C  MOISTURE REMOVAL
      FMR=EMS*AMSXB*0.01
      QMR=FMR*QSI
      QSX=QSI-QMR
C  STEAM CONDITIONS AT MOISTURE SEPARATOR OUTLET AFTER SEPARATION
      AMSX=(AMSXB-FMR)/(1.0-FMR)
      HSX=(HSXB-FMR*HFSX)/(1.0-FMR)
      RETURN
      END
```

```
      FUNCTION FIG1(WVO,W)
      IMPLICIT REAL*8(A-H,K-Z)
C     WVO IS W/VO
C     CHECK TO SEE IF DATA IS WITHIN SPECIFIED LIMITS
      IF(WVO-0.1)3,12,12
C     IF DATA IS OUTSIDE LIMITS PRINT MESSAGE AND
C     CONTINUE EXECUTION
    3 PRINT 13,WVO
   12 IF(WVO-0.5)1,1,4
    4 PRINT 13,WVO
    1 IF(W-250.0)5,6,6
    5 PRINT 14,W
    6 IF(W-800.0)2,2,7
    7 PRINT 14,W
C     CALCULATE FIG1 AND RETURN
    2 FIG1=4.*(WVO-WVO*WVO)*(1.-0.00391*(0.5-WVO)*(0.5-WVO)
     1 *(W-250.0))
      RETURN
   13 FORMAT(7H0WVO = ,D23.16,5X,23HIS A DATA ERROR IN FIG1)
   14 FORMAT(5H0W = ,D23.16,5X,23HIS A DATA ERROR IN FIG1)
      END
```

```
      FUNCTION FIG2(WVO)
      IMPLICIT REAL*8(A-H,K-Z)
      DIMENSION A(6)
C     THE FOLLOWING IS THE LIST OF PROGRAM CONSTANTS
      DATA A/-0.14466401,0.26477802,-0.12906203,0.33025203,-0.42972103,
     1    0.22480403/,I/5/
C     TEST FOR WVO .GE.0.1 .AND..LE.0.5
      IF (WVO-0.1) 15,10,10
   10 IF (WVO-0.5) 20,20,15
C     PRINTED FLAG FOR WVO NOT WITHIN SPECIFIED LIMITS
   15 PRINT 16,WVO
   16 FORMAT(6H0WVO =,D25.16,2X,36HIS OUTSIDE SPECIFIED LIMITS FOR FIG2)
   20 CALL UNIPOL(A,WVO,Z,I)
      FIG2 = Z
      RETURN
      END
```

```
      FUNCTION FIG3(OVN,PR)
      IMPLICIT REAL*8(A-H,K-Z)
      DIMENSION AALPHA(3),ATHETA(3)
C     THE  FOLLOWING IS THE LIST OF PROGRAM CONSTANTS
      DATA AALPHA/-0.17387620D1,-0.24241363D0,0.95370576D-2/,ATHETA/
     1    -0.23694637D1,-0.99561861D-1,-0.29889354D-2/,I/2/
C     TEST FOR OVN .GE. 0.2D6 .AND..LE. 100.D6
      IF (OVN-0.2D6) 15,10,10
   10 IF (OVN-100.D6) 20,20,15
C     PRINTED FLAG FOR OVN NOT WITHIN SPECIFIED LIMITS
   15 PRINT 16,OVN
   16 FORMAT(6H0OVN =,D25.16,2X,36HIS OUTSIDE SPECIFIED LIMITS FOR FIG3)
C     TEST FOR PR .GE. 1.0 .AND..LT.500.0
   20 IF (PR-1.0) 30,25,25
   25 IF (PR-500.0) 35,30,30
C     PRINTED FLAG FOR PR NOT WITHIN SPECIFIED LIMITS
   30 PRINT 31,PR
   31 FORMAT(5H0PR =,D25.16,38H  IS OUTSIDE SPECIFIED LIMITS FOR FIG3)
   35 X = DLOG(PR)
      CALL UNIPOL(AALPHA,X,ZALPHA,I)
      ALPHA = DEXP(ZALPHA)
      CALL UNIPOL(ATHETA,X,ZTHETA,I)
      THETA = DEXP(ZTHETA)
      FIG3 = 1.0-(ALPHA+((THETA-ALPHA)/OVN)*((OVN-250000.)/0.975))
      RETURN
      END
```

```
      FUNCTION FIG4(PR,PB,VF)
      IMPLICIT REAL*8(A-H,K-Z)
C     PR IS PB/PX
      DIMENSION A(6,7)
      DATA A/0.90965965D0,-0.16800190D-1,0.22481349D-2,
     1-0.21178836D-3,0.91380561D-5,0.D0,
     2-0.52509228D-4,0.10919256D-4,-0.20090378D-4,
     30.49081537D-5,-0.35197958D-6,0.D0,
     40.27863077D-6,-0.38164297D-6,0.25227588D-6,
     5-0.54516150D-7,0.38424326D-8,0.D0,
     6-0.68155332D-9,0.10184591D-8,-0.63504086D-9,
     70.13690704D-9,-0.97149103D-11,0.D0,
     80.69937432D-12,-0.10905080D-11,0.66534494D-12,
     9-0.14337663D-12,0.10204672D-13,0.D0,
     A-0.32231499D-15,0.51336370D-15,-0.30982329D-15,
     B0.66775818D-16,-0.47614905D-17,0.D0,
     C0.54818623D-19,-0.88601007D-19, 0.53145252D-19,
     D-0.11459126D-19,0.81819448D-21,0.D0/
      ALO=DLOG(2.0D0)
      APL=DLOG(PR)
C     CALCULATE NU1
      NU1=1.0-(0.17573783-0.08220699*((VF-250000.0)/
     1 (0.975*VF)))
C     CHECK TO SEE IF INPUT ARGUMENTS ARE WITHIN SPECIFIED LIMITS
      IF(PB-2000.0)3,3,2
C     IF DATA IS OUTSIDE LIMITS PRINT MESSAGE AND
C     CONTINUE EXECUTION
    2 PRINT 13,PB
    3 IF(PR-1.0)29,5,9
   29 PRINT 14,PR
    9 IF(PR-2.0)5,5,4
    4 IF(PR-500.0)6,6,7
C     CALCULATE NU2 BY CALLING A GENERAL SUBROUTINE
C     TO COMPUTE THE BIVARIATE POLYNOMIAL
    5 CALL BIVPOL(A,PB,ALO,Z,4,6)
      NU2=Z
C     CALCULATE FIG4 WHERE PR IS BETWEEN 1.0 AND
C     2.0 INCLUSIVE
      FIG4=NU1+(NU2-NU1)*(APL/ALO)
      RETURN
    7 PRINT 14,PR
C     CALCULATE FIG4 BY CALLING A GENERAL SUBROUTINE
C     TO COMPUTE THE BIVARIATE POLYNOMIAL
    6 CALL BIVPOL(A,PB,APL,Z,4,6)
      FIG4=Z
      RETURN
   13 FORMAT(6H0PB = ,D25.16,5X,23HIS A DATA ERROR IN FIG4)
   14 FORMAT(6H0PR = ,D25.16,5X,23HIS A DATA ERROR IN FIG4)
      END
```

```
      FUNCTION FIG5(QVN,PR,VF,PB)
      IMPLICIT REAL*8(A-H,K-Z)
      DIMENSION A(3),B(1)
C     THE  FOLLOWING IS THE LIST OF PROGRAM CONSTANTS
      DATA A/-0.10239761D0,0.14091440D-1,-0.88660084D-3/,B/0.52514486D0/
     1     ,I/2/,J/1/
C     TEST FOR PR .GE. 1.0 .AND..LE. 500.
      IF (PR-1.0) 15,10,10
   10 IF (PR-500.0) 20,20,15
C     PRINTED FLAG FOR PR NOT WITHIN SPECIFIED LIMITS
   15 PRINT 16,PR
   16 FORMAT(5H0PR =,D25.16,38H  IS OUTSIDE SPECIFIED LIMITS FOR FIG5)
C     TEST FOR PB .LE. 2000.
   20 IF (PB - 2000.) 40,40,30
   30 PRINT 31,PB
   31 FORMAT (5H0PB =,D25.16,38H  IS OUTSIDE SPECIFIED LIMITS FOR FIG5)
   40 X = DLOG(PR)
      CALL RATFUN(A,B,X,K,I,J)
      KCONST = 250000.*K
      FIG5=((KCONST/QVN)+1.0)/((KCONST/VF)+1.0)
      RETURN
      END
```

```
      FUNCTION FIG6(TER)
      IMPLICIT REAL*8(A-H,K-Z)
      FIG6=8.5-(0.9)/(1.2-TER)
      RETURN
      END
```

```
      FUNCTION FIG6A(IR)
      IMPLICIT REAL*8(A-H,O-Z)
C     SPEED CORRECTION, P 20, GER-2454A
      IF(IR-1800)10,10,20
   10 FIG6A=1.01
      RETURN
   20 FIG6A=1.
      RETURN
      END
```

```
      FUNCTION FIG7(PR,PB)
      IMPLICIT REAL*8(A-H,K-Z)
C     PR IS PB/PX
      DIMENSION A(6,7)
      DATA A/0.88620962D0,-0.57966163D-1,-0.70547092D-2,
     10.53287932D-2,-0.10834413D-2,0.74799566D-4,0.73023513D-4,
     2-0.90879584D-3,0.51487177D-3,-0.15870788D-3,0.24559973D-4,
     3-0.14649524D-5,-0.93332207D-6,0.45863391D-5,-0.30414566D-5,
     40.98498064D-6,-0.15288021D-6,0.90166692D-8,0.26842196D-8,
     5-0.10384613D-7,0.72972894D-8,-0.24101082D-8,0.37440997D-9,
     6-0.21928984D-10,-0.30566380D-11,0.10644149D-10,-0.77044070D-11,
     70.25741444D-11,-0.40054815D-12,0.23384013D-13,0.15075129D-14,
     8-0.49596233D-14,0.36525359D-14,-0.12292791D-14,0.19154518D-15,
     9-0.11162844D-16,-0.26954610-18,0.85580517D-18,-0.63735459D-18,
     A0.21556766D-18,-0.33625662D-19,0.19575380D-20/
      AL1=DLOG(2.0D0)
      AP1=DLOG(PR)
C     CHECK TO SEE IF INPUT ARGUMENTS ARE WITHIN SPECIFIED LIMITS
      IF(PB-2000.0)3,3,2
C     IF DATA IS OUTSIDE LIMITS PRINT MESSAGE AND
C     CONTINUE EXECUTION
    2 PRINT 13,PB
    3 IF(PR-1.0)29,5,9
   29 PRINT 14,PR
    9 IF(PR-2.0)5,6,4
    4 IF(PR-500.0)6,6,7
C     CALCULATE NU3 BY CALLING A GENERAL SUBROUTINE
    5 CALL BIVPOL(A,PB,AL1,Z,5,6)
      NU3=Z
C     CALCULATE FIG7 WHERE PR IS BETWEEN 1.0 AND
C     2.0 INCLUDING 1.0 BUT NOT 2.0
      FIG7=0.87+(NU3-0.87)*(AP1/AL1)
      RETURN
    7 PRINT 14,PR
C     CALCULATE FIG7 BY CALLING A GENERAL SUBROUTINE
C     TO COMPUTE THE BIVARIATE POLYNOMIAL
    6 CALL BIVPOL(A,PB,AP1,Z,5,6)
      FIG7=Z
      RETURN
   13 FORMAT(6H0PB = ,D25.16,5X,23HIS A·DATA ERROR IN FIG7)
   14 FORMAT(6H0PR = ,D25.16,5X,23HIS A DATA ERROR IN FIG7)
      END
```

```
      FUNCTION FIG8(PX)
      IMPLICIT REAL*8(A-H,K-Z)
      DIMENSION A(5)
C     THE FOLLOWING IS THE LIST OF PROGRAM CONSTANTS
      DATA A/0.1304D1,0.1973D2,-0.1118D2,-0.9587D2,0.3148D3/,I/4/
C     TEST FOR PX .GE.3.0 .AND..LE.100.0 .OR.GE.100.0
      IF (PX - 3.0) 30,10,10
   10 IF (PX - 100.0) 35,15,15
   15 IF (PX - 100.0) 35,25,25
   25 FIG8 = 1.5
      RETURN
   30 PRINT 31,PX
   31 FORMAT(5H0PX =,D25.16,38H  IS OUTSIDE SPECIFIED LIMITS FOR FIG8)
   35 X = 1.0/PX
      CALL UNIPOL(A,X,Z,I)
      FIG8 = Z
      RETURN
      END
```

```
      FUNCTION FIG10(P)
      IMPLICIT REAL*8(A-H,K-Z)
      DIMENSION A(5)
C     THE FOLLOWING IS THE LIST OF PROGRAM CONSTANTS
      DATA A/0.1383D1,0.2328D2,0.8501D3,-0.51610D4,0.21358D5/,I/4/
C     TEST FOR P .LE.5.7 .OR .GT.5.7
       IF (P - 5.7 - (1.D-5)) 15,15,20
   15 FIG10 = 24.0
      RETURN
   20 X = 1.0/P
      CALL UNIPOL(A,X,Z,I)
      FIG10 = Z
      RETURN
      END
```

```
      SUBROUTINE FIG12A(P,HB,SB,HA,SA,H,S)
       IMPLICIT REAL*8(A-H,K-Z)
C     *
C     CALCULATE CONSTANT TERM RO
      RO=((SA-SB)+(0.0177)-(10.**((HB-(HA+650.))/371.)))/(HA-HB)
C     INITIALIZE ENTROPY AT END CONDITION SB
      AS=SB
C     BEGIN ITERATIVE PROCESS ON CONVERGING ENTROPY
      DO 5 I=1,50
      T=TVAPS(P,AS)
      H1=HVAP(T,P)
      S=10.**((HB-(H1+650.))/371.)+RO*(H1-HB)+SB-(0.0177)
      DIFF=S-AS
      IF(DABS(DIFF)-1.D-5)2,2,1
    1 AS=S
    5 CONTINUE
C     *
C     IF ENTROPY DOES NOT CONVERGE
C     IN 50 ITERATIONS THEN PRINT MESSAGE AND
C     RETURN THE LATEST VALUES OF H AND S TO
C     CALLING ROUTINE
C     *
      PRINT 3
    3 FORMAT(52H0ENTROPY IN FIG12A DID NOT CONVERGE IN 50 ITERATIONS)
    2 H=H1
      RETURN
      END
```

```
      SUBROUTINE FIG12B(P,HB,SB,HX,SX,H,S)
       IMPLICIT REAL*8(A-H,K-Z)
C     CALCULATE CONSTANT TERMS
      K=0.16129D5
      M=50.0*(SB-SX)
      N=0.1*(HB-HX)
      MN=M/N
      L=2500.0*(SB*SB-SX*SX)+0.01*(HB*HB-HX*HX)
      LN=L/N
      A=0.25*(1.0+MN*MN)
      B=50.0*SX+MN*(0.5*LN-0.1*HX)
      C=(50.0*SX)*(50.0*SX)+(0.1*HX)*(0.1*HX)
     1-K+LN*(0.25*LN-0.1*HX)
      SC=(0.25/A)*(B+DSQRT(B*B-4.*A*C))
      HC=0.5*(LN-2.0*MN*SC)
C     INITIALIZE ENTROPY AT END CONDITION SB
      AS=SB
      T=TSAT(P)
C     BEGIN ITERATIVE PROCESS ON CONVERGING ENTROPY
      DO 5 I=1,50
      SG=SVAP(T,P)
      M=(SG-AS)/(SG-SLIQ(T))
      HG=HVAP(T,P)
      H1=HG-M*(HG-HLIQ(T))
      S=(SC-DSQRT(K-(0.1*H1-HC)*(0.1*H1-HC)))/50.0
      DIFF=S-AS
      IF(DABS(DIFF)-1.D-5)2,2,1
    1 AS=S
    5 CONTINUE
C     *
C     IF ENTROPY DOES NOT CONVERGE
C     IN 50 ITERATIONS THEN PRINT MESSAGE AND
C     RETURN THE LATEST VALUES OF H AND S TO
C     CALLING ROUTINE
C     *
      PRINT 3
    3 FORMAT(52H0ENTROPY IN FIG12B DID NOT CONVERGE IN 50 ITERATIONS)
    2 H=H1
      RETURN
      END


      FUNCTION FIG14(M)
      IMPLICIT REAL*8(A-H,K-Z)
      FIG14 = 0.87*(1.0 - 0.01*M)*(1.0 - 0.0065*M)
      RETURN
      END


      FUNCTION FIG15(INHGA)
      IMPLICIT REAL*8(A-I,K-Z)
      DIMENSION A(3)
C     DATA FOLLOWS
      DATA A(1),A(2),A(3)/-0.23984811D2,0.57862440D2,0.31849404D1/
C     CHECK TO SEE IF INPUT ARGUMENTS ARE WITHIN SPECIFIED LIMITS
      IF(INHGA-0.25)5,2,3
C     IF DATA OUTSIDE LIMITS PRINT MESSAGE AND
C     CONTINUE EXECUTION
    5 PRINT 13,INHGA
    3 IF(INHGA-6.0)2,1,1
    1 PRINT 13,INHGA
C     CALCULATE FIG15 BY CALLING A GENERAL SUBROUTINE
C     TO COMPUTE THE UNIVARIATE POLYNOMIAL
    2 AINHGA=DLOG(INHGA)
      CALL UNIPOL(A,AINHGA,Z,2)
      FIG15=Z
      RETURN
   13 FORMAT(9H0INHGA = ,D25.16,5X,24HIS A DATA ERROR IN FIG15)
      END
```

```
      FUNCTION FIG167(VAN,BLS,IR)                                      F167 100
      IMPLICIT REAL*8(A-H,O-Z)                                         F167 105
      DIMENSION VANX(21),F20(21),F23(21),F38(21),F52(21)               F167 110
C     THE FOLLOWING IS THE LIST OF PROGRAM CONSTANTS                   F167 115
      DATA VANX/128.D0,150.D0,175.D0,200.D0,250.D0,300.D0,350.D0,400.D0,F167 120
     1 450.D0,500.D0,550.D0,600.D0,650.D0,700.D0,800.D0,900.D0,1000.D0F167 121
     2 ,1100.D0,1200.D0,1300.D0,1400.D0/,F20/25.61D0,20.64D0,16.10D0, F167 122
     3 12.75D0,8.33D0,5.53D0,4.09D0,3.73D0,3.95D0,4.90D0,6.57D0,8.65D0F167 123
     4 ,10.95D0,13.56D0,19.35D0,25.62D0,32.00D0,38.35D0,44.35D0,      F167 124
     5 49.90D0,54.70D0/,F23/53.65D0,46.50D0,40.38D0,34.35D0,24.95D0,  F167 125
     6 18.68D0,14.23D0,10.90D0,8.65D0,7.45D0,7.12D0,7.55D0,8.70D0,    F167 126
     7 10.45D0,15.45D0,21.07D0,26.95D0,33.05D0,38.75D0,44.15D0,48.90D0F167 127
     8 /,F38/51.63D0,45.50D0,38.38D0,32.65D0,23.80D0,17.43D0,12.91D0, F167 128
     9 9.80D0,7.97D0,7.07D0,7.02D0,7.72D0,9.00D0,11.00D0,16.25D0,     F167 129
     A 21.97D0,27.92D0,34.D0,39.92D0,45.25D0,49.85D0/,                 F167 130
     B               F52/71.2D0,63.5D0,55.8D0,48.D0,35.9D0,27.8D0,21.5D0, F167 131
     C 16.4D0,12.5D0,9.6D0,8.6D0,8.4D0,9.D0,10.4D0,14.4D0,19.4D0,      F167 132
     D 25.D0,30.9D0,36.4D0,41.7D0,46.5D0/,NPOINT/5/,NORDER/4/          F167 133
C     FINDING A VANX WHICH BOUNDS VAN ABOVE                            F167 135
      IF (VAN - VANX(4)) 15,15,10                                      F167 140
   10 IF (VAN - VANX(20)) 20,16,16                                     F167 145
   15 I = 1                                                            F167 150
      GO TO 60                                                         F167 155
   16 I = 17                                                           F167 160
      GO TO 60                                                         F167 165
   20 ILO = 4                                                          F167 170
      IHI = 20                                                         F167 175
      DO 25 J=1,4                                                      F167 180
      IVAN = .5*(ILO + IHI)                                            F167 185
      IF (VAN - VANX(IVAN)) 30,30,35                                   F167 190
   30 IHI = IVAN                                                       F167 195
      GO TO 25                                                         F167 200
   35 ILO = IVAN                                                       F167 205
   25 CONTINUE                                                         F167 210
      I = IHI - 3                                                      F167 215
   60 IF(IR-18))80,80,61                                               F167 216
   61 IF(BLS-20.)65,65,75                                              F167 220
   65 CALL LAGRAN(VAN,VANX,F20,Z,NPOINT,NORDER,I)                      F167 225
      FIG167 = Z                                                       F167 230
      RETURN                                                           F167 235
   75 CALL LAGRAN(VAN,VANX,F23,Z,NPOINT,NORDER,I)                      F167 245
      FIG167 = Z                                                       F167 250
      RETURN                                                           F167 255
   80 IF(BLS-52.)81,85,85                                              F167 256
   81 CALL LAGRAN(VAN,VANX,F38,Z,NPOINT,NORDER,I)                      F167 260
      FIG167 = Z                                                       F167 265
      RETURN                                                           F167 270
   85 CALL LAGRAN(VAN,VANX,F52,Z,NPOINT,NORDER,I)                      F167 271
      FIG167=Z                                                         F167 272
      RETURN                                                           F167 273
      END                                                              F167 275


      FUNCTION FIG18(PDT,PDD)                                          F18  100
C     PDT IS PD/PT                                                     F18  105
C     PDD IS PD/PD'                                                    F18  110
      IMPLICIT REAL*8(A-H,K-Z)                                         F18  115
      DIMENSION A(6,7)                                                 F18  120
      DATA A/0.10387869D0,0.51016459D-1,0.29102908D1,                  F18  121
     10.27471818D0,-0.21304563D1,0.D0,                                 F18  122
     2-0.19802735D1,-0.95190372D1,-0.37135945D2,                       F18  123
     3-0.13560028D2,0.33612332D2,0.D0,                                 F18  124
     40.10063291D2,0.20037626D3,0.69547999D2,                          F18  125
     50.98411071D2,-0.17160622D3,0.D0,                                 F18  126
     6-0.18539112D2,-0.27829006D3,-0.29449752D3,                       F18  127
     7-0.18258882D3,0.38650991D3,0.D0,                                 F18  128
     80.10749035D2,0.20073785D3,0.30482186D3,                          F18  129
     90.48723599D2,-0.29025217D3,0.D0,                                 F18  130
     A12*0.D0/                                                         F18  131
C     CHECK TO SEE IF INPUT ARGUMENTS ARE WITHIN SPECIFIED LIMITS      F18  135
```

```
      PD=1.0/PDT
      IF(PD-1.2)7,3,8
C     IF DATA OUTSIDE LIMITS PRINT MESSAGE AND
C     CONTINUE EXECUTION
    7 PRINT 13,PDT
    8 IF(PD-10.0)3,3,2
    2 PRINT 13,PDT
    3 PDINV=1.0/PDD
      IF(PDINV-0.5)9,5,10
    9 PRINT 14,PDD
   10 IF(PDINV-3.3)5,5,4
    4 PRINT 14,PDD
C     CALCULATE FIG18 BY CALLING A GENERAL SUBROUTINE
C     TO COMPUTE THE BIVARIATE POLYNOMIAL
    5 APDD=DLOG(PDD)
      CALL BIVPOL(A,PDT,APDD,Z,5,5)
      FIG18=Z
      RETURN
   13 FORMAT(7H0PDT = ,D25.16,5X,24HIS A DATA ERROR IN FIG18)
   14 FORMAT(7H0PDD = ,D25.16,5X,24HIS A DATA ERROR IN FIG18)
      END

      FUNCTION FIG19(KVA)
      IMPLICIT REAL*8(A-H,K-Z)
      DIMENSION A(3)
C     THE FOLLOWING IS THE LIST OF PROGRAM CONSTANTS
      DATA A/0.29898D3,0.294898D-2,0.612245D-9/,I/2/
C     TEST FOR KVA .GE.100000 .AND..LE.1500000
      IF (KVA - 1.D5) 15,10,10
   10 IF (KVA - 15.D5) 20,20,15
   15 PRINT 16,KVA
   16 FORMAT(6H0KVA =,D25.16,39H  IS OUTSIDE SPECIFIED LIMITS FOR FIG19)
   20 CALL UNIPOL(A,KVA,Z,I)
      FIG19 = Z
      RETURN
      END

      FUNCTION FIG20(KVA,ICK,IR)
      IMPLICIT REAL*8(A-H,K-Z)
      DIMENSION A(4),AA(4),B(1)
      DATA A(1),A(2),A(3),A(4)/-0.3429348800,0.8912646600,
     1-0.1087785100,0.3690868600-2/,AA(1),AA(2),AA(3),AA(4)/
     20.1847905001,0.56681377D-1,-0.26652558D-1,
     30.10759713D-2/,B(1)/-0.49564581D-1/
      ALO=DLOG(KVA)
C     FIND DELTA
      IF(IR-1900)2,2,1
    1 DELTA=0.
      GOTO5
    2 IF(ICK)3,3,4
    3 DELTA=-0.1
      GOTO5
    4 DELTA=-0.095
C      *
C     THE INTEGER VARIABLE ICK WILL BE SET IN THE
C     CALLING ROUTINE TO DETERMINE THE METHOD
C     USED IN COMPUTING FIG20 AS FOLLOWS
C     ICK GREATER THAN ZERO                FIG20 COMPUTED BY UNIVARIATE
C                                          POLYNOMIAL FOR CONVENTIONALLY
C                                          COOLED
C     ICK LESS THAN OR EQUAL TO ZERO       FIG20 COMPUTED BY RATIONAL
C                                          FUNCTION FOR CONDUCTOR
C                                          COOLED
C      *
C     DETERMINE BRANCH
    5 IF(ICK)20,20,10
   10 CALL UNIPOL(A,ALO,Z,3)
      FIG20=Z+DELTA
      RETURN
   20 CALL RATFUN(AA,B,ALO,Z,3,1)
      FIG20=Z+DELTA
      RETURN
      END
```

```
      FUNCTION FIG21(PCTKVA,ICK)
      IMPLICIT REAL*8(A-H,K-Z)
      DIMENSION ACD18(5),BCD18(1),ACD36(2),BCD36(2),ACONV(4),BCONV(1)
C     THE FOLLOWING IS THE LIST OF PROGRAM CONSTANTS
      DATA ACD18/-0.2272774D0,-0.2493997D2,0.3428328D2,-0.3580890ID2,
     1   0.9054416901/,BCD18/-0.1863895902/,I1/4/,J1/1/,ACD36/
     2   -0.1753594302,-0.1551513902/,BCD36/-0.6533848302,0.3128671402/,
     3   I2/1/,J2/2/,ACONV/-0.2052527102,-0.3501920302,0.2551402702,
     4   -0.2518240002/,BCONV/-0.5621849502/,I3/3/,J3/1/
C     ICK .GT. 0  IF CONDTION IS CONVENTIONALLY COOLED, 3600 + 1800 RPM
C     ICK = 0  IF CONDITION IS CONDUCTOR COOLED,3600 RPM
C     ICK .LT. 0  IF CONDITION IS CONDUCTOR COOLED, 1800 RPM
      IF (ICK) 10,20,30
   10 CALL RATFUN (ACD18,BCD18,PCTKVA,Z,I1,J1)
      FIG21 = Z
      RETURN
   20 CALL RATFUN(ACD36,BCD36,PCTKVA,Z,I2,J2)
      FIG21 = Z
      RETURN
   30 CALL RATFUN(ACONV,BCONV,PCTKVA,Z,I3,J3)
      FIG21 = Z
      RETURN
      END


      FUNCTION FIG22(KVA,ICK)
      IMPLICIT REAL*8(A-H,K-Z)
      DIMENSION A(4),AA(2),AB(2),AC(2),B(1)
      DATA A(1),A(2),A(3),A(4)/0.1094962302,0.1275556OD-3,0.7145235ID-8,
     1-0.5833349 5D-14/,B(1)/0.56299996D-5/,AB(1),AB(2)/
     20.12D3,0.96D-4/,AC(1),AC(2)/0.40D2,0.96D-4/
C     *
C     THE INTEGER VARIABLE ICK WILL BE SET IN THE
C     CALLING ROUTINE TO DETERMINE THE METHOD
C     USED IN COMPUTING FIG22 AS FOLLOWS
C     ICK GREATER THAN ZERO
C             ICK=1                          FIG22 COMPUTED BY RATIONAL
C                                            FUNCTION FOR CONVENTIONALLY
C                                            COOLED AT 3600RPM
C             ICK=2                          FIG22 COMPUTED BY UNIVARIATE
C                                            POLYNOMIAL FOR CONVENTIONALLY
C                                            COOLED AT 1800RPM
C     ICK EQUAL ZERO                         FIG22 COMPUTED BY UNIVARIATE
C                                            POLYNOMIAL FOR CONDUCTOR
C                                            COOLED AT 3600RPM
C     ICK LESS THAN ZERO                     FIG22 COMPUTED BY UNIVARIATE
C                                            POLYNOMIAL FOR CONDUCTOR
C                                            COOLED AT 1800RPM
C     *
C     DETERMINE BRANCH
      IF(ICK)40,30,5
    5 IF(ICK-2)10,20,20
   10 CALL RATFUN(A,B,KVA,Z,3,1)
      FIG22=Z
      RETURN
   20 CALL UNIPOL(AA,KVA,Z,1)
      FIG22=Z
      RETURN
   30 CALL UNIPOL(AB,KVA,Z,1)
      FIG22=Z
      RETURN
   40 CALL UNIPOL(AC,KVA,Z,1)
      FIG22=Z
      RETURN
      END
```

```
      SUBROUTINE UNIPOL(A,X,Z,I)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION A(10)
      Z = 0.0
      I1 = I + 2
      DO 1 N=1,I
      Z = Z*X
    1 Z = Z + A(I1-N)
      Z = Z*X + A(1)
      RETURN
      END
```

```
      SUBROUTINE BIVPOL(A,X,Y,Z,I,J)
      IMPLICIT REAL*8(A-H,K-Z)
      DIMENSION A(6,7)
C     INCREASE THE ROW AND COLUMN DIMENSION EACH
C     BY ONE BECAUSE ZERO SUBSCRIPTS ARE ILLEGAL
C     INCREMENT BELOW BASED ON ASSUMPTION DATA
C     IN CALLING ROUTINE IMPLICITLY LISTS A
C     ARRAY AS A(J,I) IN ORDER TO CONFORM
C     TO DEFINITION IN APPENDIX 1
      II=J+1
      JJ=I+1
C     INITIALIZE Z
      Z=0.0
      DO 1 J1=1,JJ
      DO 1 I1=1,II
    1 Z=Z+A(J1,I1)*(X**(I1-1))*(Y**(J1-1))
      RETURN
      END
```

```
      SUBROUTINE RATFUN(A,B,X,Z,I,J)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION A(10),B(5)
      ZNUM = 0.0
      ZDENOM = 0.0
      I1 = I + 2
      J1=J + 1
      DO 1 N=1,I
      ZNUM = ZNUM*X
    1 ZNUM = ZNUM + A(I1-N)
      ZNUM = ZNUM *X + A(1)
      DO 2 M=1,J
      ZDENOM = ZDENOM*X
    2 ZDENOM = ZDENOM + B(J1-M)
      ZDENOM = ZDENOM*X + 1.
      Z = ZNUM/ZDENOM
      RETURN
      END
```

```
      SUBROUTINE LAGRAN(X,T,F,Z,NPOINT,NORDER,I)
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION T(30),F(30),P(30),PNUM(30),PDENOM(30)
C     ADJUSTING NPOINT AND NORDER FOR USE IN DO LOOPS
      NPTI = NPOINT - 1 + I
      NORDI = NORDER - 1 + I
      Z = 0.0
      DO 1 J=I,NPTI
      PNUM(J) = X - T(J)
    1 P(J)=1.0
      DO 2 K=I,NPTI
      DO 3 N=I,NORDI
      IF (K - N) 20,20,10
   10 P(K) = P(K)*PNUM(N)/(T(K) - T(N))
      GO TO 3
   20 P(K) = P(K)*PNUM(N+1)/(T(K) - T(N+1))
    3 CONTINUE
    2 Z=Z+P(K)*F(K)
      RETURN
      END
```

```
      FUNCTION TLIQH(H)                                                 TLIQ   0
      IMPLICIT REAL*8(A-H,O-Z)                                          TLIQ   1
CALCULATES TEMPERATURE (F) OF SATURATED LIQUID                          TLIQ   2
C     AS FUNCTION OF ENTHALPY (BTU/LB) OF                               TLIQ  10
C     SATURATED LIQUID                                                  TLIQ  20
C     PROCEDURE SUGGESTED IN WESTINGHOUSE,                              TLIQ  30
C     TRANS ASME V80, NO4, MAY,1958.                                    TLIQ  40
C     CHECK TO SEE IF INPUT ARGUMENTS ARE WITHIN SPECIFIED LIMITS       TLIQ  50
      IF(H-18.07)21,3,25                                                TLIQ  60
C     IF DATA OUTSIDE LIMITS PRINT MESSAGE AND                          TLIQ  70
C     CONTINUE EXECUTION                                                TLIQ  80
   21 PRINT 13,H                                                        TLIQ  90
   25 IF(H-870.0)2,4,1                                                  TLIQ 100
    1 PRINT 13,H                                                        TLIQ 110
    2 IF(H-400.0)3,3,4                                                  TLIQ 120
    3 T0=H+35.0                                                         TLIQ 130
      GO TO 20                                                          TLIQ 140
    4 T0=-(H*H)/1022.49+1.855*H-172.25                                  TLIQ 150
C     BEGIN PROCESS WHEREBY H IS BOUNDED ABOVE                          TLIQ 160
C     BY H0 AND BELOW BY H1                                             TLIQ 170
   20 T1=T0-2.0                                                         TLIQ 180
      H0=HLIQ(T0)                                                       TLIQ 190
      H1=HLIQ(T1)                                                       TLIQ 200
      IF(H-H0)5,6,7                                                     TLIQ 210
    7 T0=T0+5.0                                                         TLIQ 220
      GO TO 20                                                          TLIQ 230
    6 TLIQH=T0                                                          TLIQ 240
      RETURN                                                            TLIQ 250
    5 IF(H1-H)8,9,10                                                    TLIQ 260
    9 TLIQH=T1                                                          TLIQ 270
      RETURN                                                            TLIQ 280
   10 T0=T0-1                                                           TLIQ 290
      GO TO 20                                                          TLIQ 300
C     BEGIN HALVING PROCEDURE TO FIND DESIRED T                         TLIQ 310
    8 DO 11 I=1,50                                                      TLIQ 320
      TAVG=(T1+T0)/2.0                                                  TLIQ 330
      HT=HLIQ(TAVG)                                                     TLIQ 340
      D=H-HT                                                            TLIQ 350
      DT=DABS(D)-1.D-2                                                  TLIQ 360
      IF(D)15,16,17                                                     TLIQ 370
   16 TLIQH=TAVG                                                        TLIQ 380
      RETURN                                                            TLIQ 390
   15 T0=TAVG                                                           TLIQ 400
      GO TO 18                                                          TLIQ 410
   17 T1=TAVG                                                           TLIQ 420
   18 IF(DT)19,19,11                                                    TLIQ 430
   19 TLIQH=TAVG                                                        TLIQ 440
      RETURN                                                            TLIQ 450
   11 CONTINUE                                                          TLIQ 460
      PRINT 14                                                          TLIQ 470
      TLIQH=TAVG                                                        TLIQ 480
   13 FORMAT(5H0H = ,D20.11,5X,24HIS A DATA ERROR IN TLIQH)             TLIQ 500
   14 FORMAT(40H0TLIQH DID NOT CONVERGE IN 50 ITERATIONS)               TLIQ 510
      RETURN                                                            TLIQ 511
      END                                                               TLIQ 520
```

```
      FUNCTION HCOM(P,T)                                                HCOM   0
      IMPLICIT REAL*8(A-H,O-Z)                                          HCOM   1
CALCULATES ENTHALPY (BTU/LB) OF COMPRESSED LIQUID                       HCOM   2
C     AS FUNCTION OF TEMP (F) OF SATURATED                              HCOM  10
C     LIQUID AND PRESSURE (LB/SQ.IN) BY LINEAR                          HCOM  20
C     INTERPOLATION IN TABLE 4, KEENAN + KEYES,                         HCOM  30
C     1951,PP.74-75.                                                    HCOM  40
C     PROCEDURE SUGGESTED IN WESTINGHOUSE,                              HCOM  50
C     TRANS ASME V80, NO4, MAY,1958.                                    HCOM  60
      DIMENSION PP(10),TT(14),HH(10,14),DH(5),PS(5)                     HCOM  70
      DATA PP/200.D0,400.D0,600.D0,800.D0,1000.D0,1500.D0,              HCOM  80
     12000.D0,2500.D0,3000.D0,3206.2D0/, TT/32.D0,100.D0,               HCOM  81
     2200.D0,300.D0,400.D0,500.D0,600.D0,620.D0,640.D0,                 HCOM  82
```

```
     3660.D0,680.D0,690.D0,700.D0,705.4D0/, HH/0.61D0,              HCOM  83
     41.21D0,1.80D0,2.39D0,2.99D0,4.48D0,5.97D0,7.49D0,             HCOM  84
     59.00D0,9.61D0,0.54D0,1.09D0,1.67D0,2.17D0,2.70D0,             HCOM  85
     63.99D0,5.31D0,6.58D0,7.88D0,8.45D0,0.41D0,0.88D0,             HCOM  86
     71.31D0,1.78D0,2.21D0,3.36D0,4.51D0,5.63D0,6.76D0,             HCOM  87
     87.25D0,0.23D0,0.61D0,0.97D0,1.35D0,1.75D0,2.70D0,             HCOM  88
     93.64D0,4.55D0,5.49D0,5.90D0,0.0D0,0.16D0,0.39D0,0.61D0,       HCOM  89
     A0.84D0,1.44D0,2.03D0,2.66D0,3.33D0,3.62D0,0.0D0,0.0D0,        HCOM  90
     B0.0D0,-0.05D0,-0.14D0,-0.29D0,-0.38D0,-0.41D0,-0.41D0,-0.40D0, HCOM  91
     C1.0D4,1.0D4,0.0D0,0.0D0,0.0D0,0.0D0,-2.5D0,-4.9D0,            HCOM  92
     D-6.9D0,-7.6D0,5*1.0D4,0.0D0,-1.8D0,-5.6D0,-8.7D0,-9.8D0,      HCOM  93
     E5*1.0D4,2*0.D0,-5.4D0,-10.3D0,-12.1D0,6*1.0D4,0.0D0,          HCOM  94
     F-3.1D0,-11.8D0,-14.6D0,6*1.0D4,2*0.D0,-12.2D0,-17.6D0,        HCOM  95
     G7*1.0D4,0.0D0,-8.9D0,-19.4D0,7*1.0D4,2*0.0D0,-21.6D0,8*1.0D4,0.0D0,HCOM  96
     H0.0D0/, DH/0.0D0,0.23D0,0.41D0,0.54D0,0.61D0/                 HCOM  97
C     CHECK TO SEE IF PRESSURE IS SUFFICIENT FOR A                  HCOM 100
C     COMPRESSED LIQUID - IF NOT PRINT MESSAGE                      HCOM 110
C     AND RETURN                                                    HCOM 120
      P1=PSAT(T)                                                    HCOM 130
      H1=HLIQ(T)                                                    HCOM 140
      IF(P-P1)3,3,4                                                 HCOM 150
    3 PRINT 13,P                                                    HCOM 160
      RETURN                                                        HCOM 170
    4 IF(P-200.0)10,9,9                                             HCOM 180
C     IF PRESSURE IS LESS THAN 200 A LINEAR                         HCOM 190
C     INTERPOLATION IS DONE WITH SATURATED PRESSURES                HCOM 200
C     AND TABLE ENTRIES TO CALCULATE H-H(SAT)                       HCOM 210
   10 PFRACT=P/200.0                                                HCOM 220
      DO 5 I=1,5                                                    HCOM 230
      IF(T-TT(I))6,7,5                                              HCOM 240
    7 YE=DH(6-I)                                                    HCOM 250
      GO TO 8                                                       HCOM 260
    6 YE=DH(6-I)+(DH(7-I)-DH(6-I))/(TT(I)-TT(I-1))*(T-TT(I-1))      HCOM 270
C     OBTAIN Z BY MULTIPLYING THE INTERPOLATED                      HCOM 280
C     H-H(SAT) VALUE BY THE FRACTION P/200                          HCOM 290
    8 Z=YE*PFRACT                                                   HCOM 300
      HCOM=H1+Z                                                     HCOM 310
      RETURN                                                        HCOM 320
    5 CONTINUE                                                      HCOM 330
C     VARIABLE BLANK SET TO INDICATE UPON RETURN                    HCOM 340
C     FROM LINT2 THAT INTERPOLATION FAILED                          HCOM 350
    9 BLANK=1.0D4                                                   HCOM 360
C     CALL LINEAR INTERPOLATION ROUTINE TO CALCULATE                HCOM 370
C     H-H(SAT)                                                      HCOM 380
      CALL LINT2(Z,P,T,PP,10,10,TT,14,HH,BLANK)                     HCOM 390
      HCOM=H1+Z                                                     HCOM 400
   13 FORMAT(5H0P = ,D20.11,5X,23HIS A DATA ERROR IN HCOM)          HCOM 420
      RETURN                                                        HCOM 421
      END                                                           HCOM 430


      FUNCTION TCOM(P,H)                                            TCOM   0
      IMPLICIT REAL*8(A-H,O-Z)                                      TCOM   1
CALCULATES TEMPERATURE (F) OF COMPRESSED LIQUID                     TCOM   2
C     AS FUNCTION OF THE ENTHALPY (BTU/LB) OF                       TCOM  10
C     A SATURATED LIQUID AND PRESSURE (LB/SQ.IN)                    TCOM  20
C     PROCEDURE SUGGESTED IN WESTINGHOUSE,                          TCOM  30
C     TRANS ASME V80, NO4, MAY,1958.                                TCOM  40
C     CHECK TO SEE IF PRESSURE IS SUFFICIENT FOR A                  TCOM  50
C     COMPRESSED LIQUID - IF NOT PRINT MESSAGE                      TCOM  60
C     AND RETURN                                                    TCOM  70
      T0=TLIQH(H)                                                   TCOM  80
      P1=PSAT(T0)                                                   TCOM  90
      IF(P-P1)1,1,2                                                 TCOM 100
    1 PRINT 13,P                                                    TCOM 110
      RETURN                                                        TCOM 120
C     A POSSIBLE ERROR IN THIS ROUTINE IS THE                       TCOM 130
C     ARBITRARY CHOICE OF T1 AND T2                                 TCOM 140
C     BOUND TO BY T1 BELOW AND T2 ABOVE                             TCOM 150
    2 T1=T0-20.0                                                    TCOM 160
      T2=T0+20.0                                                    TCOM 170
```

```
C       CALCULATE COMPRESSED ENTHALPY FOR T1 AND T2                     TCOM 180
        H1=HCOM(P,T1)                                                   TCOM 190
        H2=HCOM(P,T2)                                                   TCOM 200
C       CALCULATE DH/DT                                                 TCOM 210
        DHDT=(H2-H1)/(T2-T1)                                            TCOM 220
C       BEGIN ITERATIVE PROCEDURE ON TEMPERATURE                        TCOM 230
        DO 3 I=1,30                                                     TCOM 240
        H0=HCOM(P,T0)                                                   TCOM 250
C       CALCULATE T3 ESTIMATE                                           TCOM 260
        T3=(H-H0)/DHDT+T0                                               TCOM 270
C       CHECK CONVERGENCE ON TEMPERATURE                                TCOM 280
        IF(DABS(T3-T0)-1.D-2)4,4,3                                      TCOM 290
      3 T0=T3                                                           TCOM 300
C       IF CONVERGENCE FAILS PRINT MESSAGE AND                          TCOM 310
C       RETURN LATEST T3                                                TCOM 320
        PRINT 14                                                        TCOM 330
      4 TCOM=T3                                                         TCOM 340
     13 FORMAT(5H0P = ,D20.11,5X,23HIS A DATA ERROR IN TCOM)            TCOM 360
     14 FORMAT(37H0TEMPERATURE DID NOT CONVERGE IN TCOM)                TCOM 370
        RETURN                                                          TCOM 371
        END                                                             TCOM 380
```

```
        SUBROUTINE LINT2(Z,X,Y,XA,NX,LIMX,YA,NY,ZA,BLANK)               LINT   0
        IMPLICIT REAL*8(A-H,O-Z)                                        LINT   1
C       TWO INDEPENDENT VARIABLE TABLE LOOK UP AND LINEAR INTERPOLATION ROLINT  10
C       Z=FUNCTION(X,Y) , XA THE ARRAY OF X VALUES IN INCREASING ORDER ANDLINT  20
C       WITH DIMENSION LIMX AND NX NON-BLANK ENTRIES , YA THE ARRAY OF Y  LINT  30
C       WITH NY NON-BLANK ENTRIES .  BOTH XA AND YA MUST BE FILLED FROM THLINT  40
C       LOW SUBSCRIPT END .  ZA IS THE ARRAY OF Z SUCH THAT Z(I,J)=F(X(I),LINT  50
C       AND DIMENSION Z(LIMX,NY(OR GREATER)).                           LINT  60
C       BLANK IS A CONSTANT PLACED IN THE ZA TABLE TO INDICATE NO ENTRY   LINT  70
C       IF Z=BLANK UPON RETURN, THE (X,Y) DID NOT FALL WITHIN THE ZA TABLELINT  80
        DIMENSION XA(10),YA(14),ZA(140)                                 LINT  90
      1 IF(X-XA(1))99,6,2                                               LINT 100
      2 DO 4 I=2,NX                                                     LINT 110
      3 IF(X-XA(I))7,7,4                                                LINT 120
      4 CONTINUE                                                        LINT 130
      5 GO TO 99                                                        LINT 140
      6 I=2                                                             LINT 150
      7 IF(Y-YA(1))99,12,8                                              LINT 160
      8 DO 10 J=2,NY                                                    LINT 170
      9 IF(Y-YA(J))13,13,10                                             LINT 180
     10 CONTINUE                                                        LINT 190
     11 GO TO 99                                                        LINT 200
     12 J=2                                                             LINT 210
     13 K22=(J-1)*LIMX+I                                                LINT 220
     14 K12=K22-1                                                       LINT 230
     15 K11=K12-LIMX                                                    LINT 240
     16 K21=K11+1                                                       LINT 250
        IF(BLANK-ZA(K11))18,99,18                                       LINT 260
     18 IF(BLANK-ZA(K12))19,99,19                                       LINT 270
     19 IF(BLANK-ZA(K22))20,99,20                                       LINT 280
     20 IF(BLANK-ZA(K21))21,99,21                                       LINT 290
     21 A=(X-XA(I-1))/(XA(I)-XA(I-1))                                   LINT 300
     22 B=(Y-YA(J-1))/(YA(J)-YA(J-1))                                   LINT 310
     23 Z10=B*ZA(K12)+(1.-B)*ZA(K11)                                    LINT 320
     24 Z20=(1.-B)*ZA(K21)+B*ZA(K22)                                    LINT 330
     25 Z=Z20*A+(1.-A)*Z10                                              LINT 340
     26 RETURN                                                          LINT 350
     99 PRINT 101                                                       LINT 360
        Z=BLANK                                                         LINT 370
    101 FORMAT(34H0BLANK WAS RETURNED FOR Z IN LINT2)                   LINT 390
    100 RETURN                                                          LINT 391
        END                                                             LINT 400
```

```
      FUNCTION HVAP(TF,PF)
      IMPLICIT REAL*8(A-H,O-Z)
CALCULATES ENTHALPY OF STEAM REFERRED TO WATER AT 32F AND .08854 PSIA
C     KEENAN + KEYES, 1951, PP. 15-16, EQ 13-15
      COMMON /H2OQEN/ TOLD,POLD,TAU,TAU2,B0,Q,Q3,Q12,DB0,F0,F1,G1,F2,G2
     1,F3,G3
      P=PF/14.6959
      T=(TF+459.69)/1.8
      IF(T-TOLD)33,32,33
   32 IF(P-POLD)34,220,34
   33 TOLD=T
   34 POLD=P
      TAU=1./T
      TAU2=TAU*TAU
      TAU3=TAU2*TAU
      TAU12=TAU3**4
      EXTAU=-(10.**(80870.*TAU2))
      B0=EXTAU*TAU*2641.62+1.89
      Q=B0*TAU
      Q2=Q*Q
      Q3=Q2*Q
      Q12=Q3**4
      DB0=(372420.11*TAU2+1.)*EXTAU*2641.62
      F0=DB0*TAU+B0
      DG1=-3.2492D5*TAU+82.546
      G1=(-1.6246D5*TAU+82.546)*TAU
      F1=(G1*F0*2.+Q*DG1)*Q
      DG2=-2.5394D5*TAU
      G2=-1.2697D5*TAU2+.21828
      F2=(G2*F0*4.+Q*DG2)*Q3
      DG3=+1.62432D66*TAU12*TAU12*T
      G3=+6.768D64*TAU12*TAU12-3.635D-4
C     SIGNS OF G3 + DG3 REVERSED FROM K+K      AVOIDS - IN F3
      F3=(G3*F0*13.+Q*DG3)*Q12
  220 DHCT=(((P**9*F3/3.25+F2)*0.5*P*P+F1)*.5*P+F0)*P*4.3557D-2+.2158633
C     DHCT=CHANGE IN H AT CONSTANT T AS PRESSURE GOES FROM ZERO TO PF PL
C     CHANGE IN H AT 32F AS P=.08854 GOES TO P=0
      DHZP=((3.7783D-4*T+1.472)*T+DLOG(T)*47.8365)*0.43-300.420108
C     DHZP=CHANGE IN H AT ZERO PRESSURE AS TEMP. GOES FROM 32F TO TF
C     INTEGRAL(CP0*DT) EVALUATED AT 32F  = 300.420108
      HVAP=DHZP+DHCT+1075.8
C     H OF EVAPORATION AT 32F + .08854PSIA = 1075.8 BTU/LBM
      RETURN
      END

      FUNCTION SVAP(TF,PF)
      IMPLICIT REAL*8(A-H,O-Z)
CALCULATES ENTROPY OF STEAM REFERRED TO WATER AT 32F AND .08854 PSIA
C     KEENAN + KEYES, 1951, PP. 15-19, EQ. 13, 15, 16A
      COMMON /H2OQEN/ TOLD,POLD,TAU,TAU2,B0,Q,Q3,Q12,DB0,F0,F1,G1,F2,G2
     1,F3,G3
      P=PF/14.6959
      T=(TF+459.69)/1.8
      IF(T-TOLD)33,32,33
   32 IF(P-POLD)34,220,34
   33 TOLD=T
   34 POLD=P
      TAU=1./T
      TAU2=TAU*TAU
      TAU3=TAU2*TAU
      TAU12=TAU3**4
      EXTAU=-(10.**(80870.*TAU2))
      B0=EXTAU*TAU*2641.62+1.89
      Q=B0*TAU
      Q2=Q*Q
      Q3=Q2*Q
      Q12=Q3**4
      DB0=(372420.11*TAU2+1.)*EXTAU*2641.62
      F0=DB0*TAU+B0
      DG1=-3.2492D5*TAU+82.546
```

```
      G1=(-1.6246D5*TAU+82.546)*TAU
      F1=(G1*F0*2.+Q*DG1)*Q
      DG2=-2.5394D5*TAU
      G2=-1.26970D5*TAU2+.21828
      F2=(G2*F0*4.+Q*DG2)*Q3
      DG3=+1.62432D66*TAU12*TAU12*T
      G3=+6.768D64*TAU12*TAU12-3.635D-4
C     SIGNS OF G3 + DG3 REVERSED FROM K+K      AVOIDS - IN F3
      F3=(G3*F0*13.+Q*DG3)*Q12
  220 EM0= DB0*TAU2
      EM1=(-B0*Q*G1+F1)*TAU*.5
      EM2=(-B0*Q3*G2+F2)*TAU*.25
      EM3=(-B0*Q12*G3+F3)*TAU/13.
      DSCT=((((EM3*P**9+EM2)*P*P+EM1)*P+EM0)*P-DLOG(P)*4.55504)*
     1      2.41983330-2 -.56307532
C     DSCT=CHANGE IN ENTROPY AT CONSTANT TF FROM ZERO PRESSURE TO PF PLUS
C          CHANGE IN ENTROPY AT 32F FROM .08854PSIA TO 0.0PSIA
      DSZP=(DLOG(T)*1.472+7.5566D-4*T-47.8365*TAU)*.23888889-1.98022309
C     DSZP=CHANGE IN ENTROPY AT ZERO PRESSURE AS TEMP. GOES FROM 32F TO
C     INTEGRAL(CP0/T*DT) EVALUATED AT 32F  = 1.98022309
      SVAP=DSZP+DSCT+2.1877
C     S OF EVAPORATION AT 32F + .08854 PSIA = 2.1877
      RETURN
      END


      FUNCTION VVAP(TF,PF)
      IMPLICIT REAL*8(A-H,O-Z)
CALCULATES SPECIFIC VOLUME OF STEAM
C     KEENAN + KEYES, 1951, P. 15, EQ. 13
      P=PF/14.6959
      T=(TF+459.69)/1.8
      TAU=1./T
      TAU2=TAU*TAU
      TAU3=TAU2*TAU
      TAU12=TAU3**4
      EXTAU=-(10.**(80870.*TAU2))
      B0=EXTAU*TAU*2641.62+1.89
      Q=B0*TAU
      QP=Q*P
      G1=(-1.6246D5*TAU+82.546)*TAU
      G2=-1.26970D5*TAU2+.21828
      G3=+6.768D64*TAU12*TAU12-3.635D-4
C     SIGN OF G3 REVERSED FROM K+K
      B=(((G3*QP**9+G2)*QP*QP+G1)*QP+1.)*B0*.0160185
      VVAP=.07296490 8*T/P+B
      RETURN
      END


      FUNCTION TVAPH(PI,HI)
      IMPLICIT REAL*8(A-H,O-Z)
CALCULATES TEMPERATURE OF STEAM FROM PRESSURE AND ENTHALPY USING HVAP AN
C     LINEAR INTERPOLATION
      P=PI
      H=HI
C     START WITH ABOUT 50 DEGREES SUPERHEAT
      DELT=40.
      T=8574./(15.424-DLOG(P))-410.
      H1=HVAP(T,P)
      IF(H1-H)2,10,1
C   1 USE LESS SUPERHEAT
    1 DELT=-DELT
    2 T=DELT+T
    5 H0=H1
      H1=HVAP(T,P)
      DELT=(H1-H)*DELT/(H0-H1)
      T=DELT+T
      IF(DABS(DELT)-.01)10,10,5
   10 TVAPH=T
      RETURN
      END
```

```
      FUNCTION TVAPS(PI,SI)
      IMPLICIT REAL*8(A-H,O-Z)
CALCULATES TEMPERATURE OF STEAM FROM PRESSURE AND ENTROPY USING SVAP AND
C     LINEAR INTERPOLATION
      S=SI
      P=PI
C     START WITH ABOUT 50 DEGREES SUPERHEAT
      DELT=40.
      T=8574./(15.424-DLOG(P))-410.
      S1=SVAP(T,P)
      IF(S1-S)2,10,1
C   1 USE LESS SUPERHEAT
    1 DELT=-DELT
    2 T=DELT+T
    5 S0=S1
      S1=SVAP(T,P)
      DELT=(S1-S)*DELT/(S0-S1)
      T=DELT+T
      IF(DABS(DELT)-0.01)10,10,5
   10 TVAPS=T
      RETURN
      END
```

```
      FUNCTION HLIQ(TF)
      IMPLICIT REAL*8(A-H,O-Z)
CALCULATES ENTHALPY (BTU/LBM) OF SATURATED WATER FROM 50 TO 600 DEG F.
C     WESTINGHOUSE ALGORITHM, TRANS ASME V80, NO4, MAY, 1958, P.959
      T=TF
      IF(T-360.)20,20,10
C  10 TEMP ABOVE 360 F
   10 HLIQ=((((4.560246D-11*T-1.0315357D-7)*T+9.412440-5)*T-4.2753836D-2
     1      )*T+10.673802)*T-904.11706
      RETURN
C  20 TEMP BELOW 360 F
   20 HLIQ=((((9.6350315D-13*T-7.3618778D-10)*T+4.8553836D-7)*T
     1          -1.1516996D-4)*T+1.0088084)*T-32.179105
      RETURN
      END
```

```
      FUNCTION SLIQ(T)
      IMPLICIT REAL*8(A-H,O-Z)
CALCULATES ENTROPY (BTU/LBM/F) OF SATURATED WATER FROM 50F TO 670F
C     WESTINGHOUSE ALGORITHM, TRANS ASME V80, NO4, MAY, 1958, P.959
COORDINATES SHIFTED FROM ORIGINAL OF TO 360F OR 560F
      IF(T-450.)20,20,10
C  10 TEMP ABOVE 450
   10 TB=(T-560.)/110.
      SLIQ=((((((3.4265601D-3*TB+3.9726934D-3)*TB-2.1403201D-3)*TB
     1          -1.0108801D-3)*TB+5.7828937D-3)*TB+7.5137702D-3)*TB
     2          +.13690825)*TB+.76209767
      RETURN
C  20 TEMP BELOW 450
   20 TB=(T-360.)/310.
      SLIQ=((((((.01234655*TB+.01203589З)*TB-3.670358D-3)*TB-6.072333D-3
     1      )*TB+.034251697)*TB-.045979941)*TB+.39679646)*TB+.51575516
      RETURN
      END
```

```
      FUNCTION VLIQ(TF)                                                 VLIQ 100
      IMPLICIT REAL*8(A-H,O-Z)                                          VLIQ 101
CALCULATES SPECIFIC VOLUME (CU.FT./LBM) OF SATURATED WATER FROM 32F TO 6VLIQ 102
C     KEENAN + KEYES, 1951, P.21, EQ.18                                 VLIQ 105
      T=374.11-(TF-32.)/1.8                                             VLIQ 110
      CRT=T**.333333333333                                              VLIQ 115
      DEN=CRT*.1342489-3.946263D-3*T+1.                                 VLIQ 120
      VLIQ=((T**3*7.48908D-13-1.203374D-3)*T-.3151548*CRT+3.1975)       VLIQ 125
     1    *.0160185/DEN                                                 VLIQ 126
      RETURN                                                            VLIQ 130
      END                                                               VLIQ 135


      FUNCTION TSAT(P)                                                  TSAT 100
      IMPLICIT REAL*8(A-H,O-Z)                                          TSAT 101
CALCULATES SATURATION TEMPERATURE (DEG F) OF WATER, .178PSIA TO CRITICALTSAT 102
C     KEENAN + KEYES, 1951, P.14, EQ.11 + 12                            TSAT 105
      T=500.                                                            TSAT 110
      CORR=3.2                                                          TSAT 115
      FOP=DLOG(3206.37858/P)/2.30258509                                 TSAT 120
      GOTO1                                                             TSAT 125
C   4 TEMP BELOW 140C = 284F                                            TSAT 130
    4 CORR=((1.17023790-8*TK*TK+5.86826D-3)*TK+3.2437814)               TSAT 135
     1    /(2.1878462D-3*TK+1.)                                         TSAT 136
    1 TS=1165.09/(FOP/CORR+1.)                                          TSAT 140
      IF(DABS(TS-T)-.01)10,10,2                                         TSAT 145
    2 T=TS                                                              TSAT 150
      TK=(1165.09-T)/1.8                                                TSAT 155
      IF(P-52.418)4,4,3                                                 TSAT 160
C   3 TEMP ABOVE 140C = 284 F                                           TSAT 165
    3 CORR=(((6.56444D-11*TK+7.515484D-9)*TK*TK+4.14113D-2)*TK          TSAT 170
     1    +3.346313)/(1.+1.3794481D-2*TK)                               TSAT 171
      GO TO 1                                                           TSAT 175
   10 TSAT=TS-459.69                                                    TSAT 180
      RETURN                                                            TSAT 181
      END                                                               TSAT 185


      FUNCTION PSAT(TF)                                                 PSAT 100
      IMPLICIT REAL*8(A-H,O-Z)                                          PSAT 101
CALCULATES SATURATION PRESSURE IN PSIA AT TEMPERATURE TF                PSAT 102
C     DEGREES FAHRENHEIT      50 TO 705.4                               PSAT 105
C     KEENAN AND KEYES PAGE 14                                          PSAT 110
      T=(TF+459.69)/1.8                                                 PSAT 115
      X=647.27-T                                                        PSAT 120
      IF(X-234.11)20,10,10                                              PSAT 125
C  10 TEMP BELOW 140 CENT                                               PSAT 130
   10 A=((1.1702379D-8*X*X+5.86826D-3)*X+3.2437814)                     PSAT 135
     1    /(2.1878462D-3*X+1.)                                          PSAT 136
      GO TO 30                                                          PSAT 140
C  20 TEMP ABOVE 140 CENT                                               PSAT 145
   20 A=(((6.56444D-11*X+7.515484D-9)*X*X+4.14113D-2)*X+3.346313)       PSAT 150
     1    /(1.3794481D-2*X+1.)                                          PSAT 151
   30 PSAT=DEXP(-2.302585O9*A*X/T)*3206.37858                           PSAT 155
      RETURN                                                            PSAT 160
      END                                                               PSAT 165


      SUBROUTINE PROPHS(PX,TX,VX,AMX,MX,HX,SX)                          PROP   0
      IMPLICIT REAL*8(A-H,O-Z)                                          PROP  10
C                                                                       PROP  20
C  SUBPROGRAM FOR STEAM PROPERTIES WHEN H AND S ARE KNOWN               PROP  21
C                                                                       PROP  30
      P1=2500.                                                          PROP  40
      P2=0.                                                             PROP  50
      DO55 IT=1,100                                                     PROP  60
C  GUESS PX AND FIND REGION OF MOLLIER CHART                            PROP  61
      PX=(P1+P2)/2.                                                     PROP  70
      TX=TSAT(PX)                                                       PROP  80
      SGX=SVAP(TX,PX)                                                   PROP  90
      IF(SX-SGX)20,30,40                                                PROP 100
```

```
C   WET                                                                      PROP 101
    20  AMX=(SGX-SX)/(SGX-SLIQ(TX))                                          PROP 110
        MX=1                                                                 PROP 120
        HXP=(1.0-AMX)*HVAP(TX,PX)+AMX*HLIQ(TX)                               PROP 130
        GOTO50                                                               PROP 140
C   DRY AND SATURATED                                                        PROP 141
    30  AMX=0.0                                                              PROP 150
        MX=2                                                                 PROP 160
        HXP=HVAP(TX,PX)                                                      PROP 170
        GOTO50                                                               PROP 180
C   SUPERHEATED                                                              PROP 181
    40  AMX=0.0                                                              PROP 190
        MX=3                                                                 PROP 200
        TX=TVAPS(PX,SX)                                                      PROP 210
        HXP=HVAP(TX,PX)                                                      PROP 220
C   CHECK HXP AGAINST HX                                                     PROP 221
    50  ADH=DABS(HX-HXP)                                                     PROP 230
        IF(ADH.LE..01)GOTO60                                                 PROP 240
C   RE-SET P1 OR P2                                                          PROP 241
        IF(HX.LT.HXP)GOTO54                                                  PROP 250
        P2=PX                                                                PROP 260
        GOTO55                                                               PROP 270
    54  P1=PX                                                                PROP 280
    55  CONTINUE                                                             PROP 290
        PRINT 56,ADH                                                         PROP 300
    56  FORMAT('0-SUBROUTINE PROPHS-ENTHALPY DID NOT CONVERGE, ADH =',       PROP 310
       11PD14.6)                                                             PROP 311
C   FIND VX                                                                  PROP 312
    60  VX=VVAP(TX,PX)                                                       PROP 320
        IF(MX.GT.1)GOTO70                                                    PROP 330
        VX=(1.0-AMX)*VX+AMX*VLIQ(TX)                                         PROP 340
    70  RETURN                                                               PROP 350
        END                                                                  PROP 360
```

```
        SUBROUTINE PROPPH(AM,S,V,T,M,P,H)                                    PROP   0
        IMPLICIT REAL*8(A-H,O-Z)                                             PROP  10
C                                                                            PROP  20
C   SUBPROGRAM FOR STEAM PROPERTIES WHEN P AND H ARE KNOWN                   PROP  21
C                                                                            PROP  30
        T=TSAT(P)                                                            PROP  40
        HG=HVAP(T,P)                                                         PROP  50
        IF(H-HG)1,2,3                                                        PROP  60
C   WET STEAM                                                                PROP  61
     1  M=1                                                                  PROP  70
        AM=(HG-H)/(HG-HLIQ(T))                                               PROP  80
        S=(1.0-AM)*SVAP(T,P)+AM*SLIQ(T)                                      PROP  90
        V=(1.0-AM)*VVAP(T,P)+AM*VLIQ(T)                                      PROP 100
        RETURN                                                               PROP 110
C   SATURATED STEAM                                                          PROP 111
     2  M=2                                                                  PROP 120
        GOTO4                                                                PROP 130
C   SUPERHEATED STEAM                                                        PROP 131
     3  M=3                                                                  PROP 140
        T=TVAPH(P,H)                                                         PROP 150
     4  AM=0.0                                                               PROP 160
        S=SVAP(T,P)                                                          PROP 170
        V=VVAP(T,P)                                                          PROP 180
        RETURN                                                               PROP 190
        END                                                                  PROP 200
```

```
      SUBROUTINE PROPPS(AM,H,T,V,M,P,S)
      IMPLICIT REAL*8(A-H,O-Z)
C
C   SUBPROGRAM FOR STEAM PROPERTIES WHEN P AND S ARE KNOWN
C
      T=TSAT(P)
      SG=SVAP(T,P)
      IF(S-SG)1,2,3
C   WET STEAM
    1 M=1
      AM=(SG-S)/(SG-SLIQ(T))
      H=(1.0-AM)*HVAP(T,P)+AM*HLIQ(T)
      V=(1.0-AM)*VVAP(T,P)+AM*VLIQ(T)
      RETURN
C   SATURATED STEAM
    2 M=2
      GOTO4
C   SUPERHEATED STEAM
    3 M=3
      T=TVAPS(P,S)
    4 AM=0.0
      H=HVAP(T,P)
      V=VVAP(T,P)
      RETURN
      END
```

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