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MDTSCO DESIGN NOTE NO. 1.4-7-45

THERMAL APU/HYDRAULICS ANALYSIS PROGRAM
USER'S GUIDE AND PROGRAMMER'S MANUAL

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MCDONNELL DOUGLAS



MCDONNELL DOUGLAS TECHNICAL SERVICES CO.
HOUSTON ASTRONAUTICS DIVISION

SPACE SHUTTLE ENGINEERING AND OPERATIONS SUPPORT

DESIGN NOTE NO. 1.4-7-45

THERMAL APU/HYDRAULICS ANALYSIS PROGRAM
USER'S GUIDE AND PROGRAMMER'S MANUAL

MISSION PLANNING AND ANALYSIS DIVISION

1 OCTOBER 1976

This Design Note is Submitted to NASA Under Task Order
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TABLE OF CONTENTS

SECTION	PAGE
1.0 SUMMARY	1
2.0 INTRODUCTION	2
3.0 PROGRAM DESCRIPTION	3
3.1 General Description	3
3.1.1 Purpose and Capabilities	3
3.1.2 General Description of the APU/Hydraulic System and Its Simulation	4
3.1.3 Fear Documentation	5
3.1.4 Program Structure and Control.	12
3.2 OV-101 (ALT) and OV-102 (OFT) Functional Flowcharts . .	19
3.3 General Description of Subroutines.	38
4.0 INPUT DATA DESCRIPTION	42
4.1 Systems Data.	42
4.1.1 Node Thermal Data.	42
4.1.2 Node Coupling Data	43
4.1.3 Loss Management Matrix	44
4.1.4 System Configuration Matrix.	47
4.1.5 Line Data (ALT Model Only)	49
4.1.6 Boundary Conditions Data (ALT Model only). . . .	49
4.2 Mission Timeline Data	50
5.0 OUTPUT DATA DESCRIPTION.	52
5.1 Tabular Data Printout	52
5.1.1 Input Data Printout.	52
5.1.2 Namelist Data.	53
5.1.3 Line Heat Losses (ALT model only).	53
5.1.4 Boiler Water Level (ALT Model only).	54
5.1.5 Heat Balance - Error Values	54
5.1.6 BOILP Output	54
5.1.7 Actuator Node Number List.	55
5.1.8 Node Thermal Data.	55
5.1.9 Accumulated Consumables	56
5.1.10 Summary Table.	56

TABLE OF CONTENTS (Continued)

SECTION		PAGE
	5.2 Graphical Output.	57
6.0	SUBROUTINE REQUIREMENTS.	59
	Subroutine BOILP	60
	Subroutine BOUNDT.	65
	Subroutine DRAW.	66
	Subroutine FLIP.	71
	Subroutine FLOPWR.	72
	Subroutine FUEL.	75
	Function Subprogram FUNC	77
	Subroutine HYDACT.	78
	Subroutine HYDFLD.	82
	Function Subprogram ICNVRT	83
	Subroutine LILOAD.	84
	Subroutine LINFLO.	87
	Subroutine LOOP.	89
	Subroutine LUBOIL.	90
	Subroutine MIX	92
	Subroutine MOD	93
	Subroutine PASS.	96
	Subroutine PLATE (PLATO)	97
	Subroutine PLATEC (PLATOC)	99
	Subroutine PLOOT	103

TABLE OF CONTENTS

(Continued)

SECTION	PAGE
Subroutine PRINT (SELECT).	107
Subroutine QBAL.	112
Subroutine RSTART.	117
Subroutine SCAL.	120
Subroutine SPRAY	121
Subroutine START	125
Subroutine THERMP.	130
Subroutine THERMR.	135
Subroutine TRANS	141
Subroutine ZIPIT	142
APPENDIX A. PROGRAM USAGE.	143
A.1 Input Data Card Requirements.	146
A.2 Input Data Tape Requirements.	150
A.2.1 Mission Timeline Input Data Tape Format.	150
A.2.2 Line Data Tape Format (ALT Model only)	152
APPENDIX B. COMMON BLOCK VARIABLE DEFINITIONS.	153
APPENDIX C. GENERAL STORAGE ALLOCATION	161
APPENDIX D. SUBROUTINE LISTINGS.	167
APPENDIX E. SAMPLE OUTPUT.	229
REFERENCE	248

LIST OF FIGURES

FIGURE	TITLE	PAGE
3-1	OV-101 APU/HYDRAULIC SYSTEM FLUID LOOPS.	6
3-2	OV-102 APU/HYDRAULIC SYSTEM FLUID LOOPS.	9
3-3	PROGRAM TREE FOR OV-101 (ALT) VERSION.	13
3-4	PROGRAM TREE FOR OV-102 (OFT) VERSION	14
3-5	INPUT/OUTPUT PROGRAM FLOW SCHEMATIC FOR TAHAP.	16
3-6	FUNCTIONAL FLOWCHART FOR MAIN1	20
3-7	FUNCTIONAL FLOWCHART FOR MAIN2	30
4-1	LOSS MANAGEMENT MATRIX	45
4-2	SYSTEM CONFIGURATION MATRIX	48
6-1	FUNCTIONAL FLOWCHART FOR BOILP	62
6-2	FUNCTIONAL FLOWCHART FOR DRAW	68
6-3	FUNCTIONAL FLOWCHART FOR FLOPWR.	74
6-4	FUNCTIONAL FLOWCHART FOR FUEL.	76
6-5	FUNCTIONAL FLOWCHART FOR HYDACT.	80
6-6	FUNCTIONAL FLOWCHART FOR LILOAD.	85
6-7	FUNCTIONAL FLOWCHART FOR LINFLO.	88
6-8	FUNCTIONAL FLOWCHART FOR LUBOIL.	91
6-9	FUNCTIONAL FLOWCHART FOR MOD	94
6-10	FUNCTIONAL FLOWCHART FOR PLATE	98
6-11	FUNCTIONAL FLOWCHART FOR PLATEC.	101
6-12	FUNCTIONAL FLOWCHART FOR PLOOT	105
6-13	FUNCTIONAL FLOWCHART FOR PRINT	109

LIST OF FIGURES
(Continued)

FIGURE	TITLE	PAGE
6-14	FUNCTIONAL FLOWCHART FOR QBAL.	114
6-15	FUNCTIONAL FLOWCHART FOR RSTART.	118
6-16	FUNCTIONAL FLOWCHART FOR SPRAY	123
6-17	FUNCTIONAL FLOWCHART FOR START	127
6-18	FUNCTIONAL FLOWCHART FOR THERMP.	132
6-19	FUNCTIONAL FLOWCHART FOR THERMR.	138
A-1	DECK SETUP FOR TAHAP	144
A-2	INPUT DATA DECK SEQUENCE	145

LIST OF TABLES

TABLE	TITLE	PAGE
B-1	COMMON BLOCK REFERENCE TABLE.	154
B-2	COMMON BLOCK VARIABLE DEFINITIONS	155
C-1	GENERAL STORAGE ALLOCATION.	162

SYMBOLS

SYMBOL	DEFINITION	UNITS
A	Area	in ²
BTU	British Thermal Unit	
C or MC _p	Thermal capacitance	BTU/°R
°F	Degrees Fahrenheit	
ft ³	Cubic feet	
g.e.t.	Ground Elapsed time	
gpm	Gallons per minute	
hp	Horsepower	
hr	Hour	
lbm	Pounds mass	
N ₂ H ₄	Hydrazine	
psia	Pounds per square inch	
$\dot{Q}$	Heat rate or heat load	BTU/hr
°R	Degrees Rankine	
UA	Heat transfer coefficient	BTU/hr-°R
WC _p	Dynamic thermal capacitance	lbm-BTU/hr-lbm-°R
σ	Stephan-Boltzmann	BTU/hr-ft ² -°R ⁴
ϵ	Surface emissivity	-

1.0 SUMMARY

This volume of the Thermal APU/Hydraulics Analysis Program (TAHAP) documentation contains all the User's Guide information plus program description necessary to run and have a general understanding of the program. This information consists of general descriptions of the APU/Hydraulic System and the TAHAP model, input and output data descriptions, and specific subroutine requirements. Deck setups and input data formats are included in Appendix A while Appendices B thru E have other necessary and/or helpful information for using TAHAP. Volume II of the TAHAP documentation consists of the math model descriptions for the driver program and each of its supporting subroutines.

2.0 INTRODUCTION

McDonnell-Douglas Technical Services Co. (MDTSCO) under the Space Shuttle Engineering and Operations Support (SSEOS) contract is responsible for providing support to the Consumables Analysis Section (CAS) of the Mission Planning and Analysis Division of NASA/JSC. The Consumables Analysis Section is responsible for providing consumables budgets for the electrical, mechanical (Auxiliary Power Unit (APU)/Hydraulics), and environmental control systems of the Space Shuttle Orbiter. The MDTSCO support of CAS in this effort includes determining APU subsystem fuel (hydrazine) and APU/Hydraulic water consumables requirements, and performing various studies to assess the APU and Hydraulic system mission requirements compatibility with system operational and performance constraints. This support is partially accomplished through the use of the Thermal APU/Hydraulic Analysis Program (TAHAP). The TAHAP documentation has been divided into two volumes. This document is the User's Guide and Programmer's Manual for TAHAP. The math model descriptions of the driver program and the supporting subroutines are presented in Vol. II.

3.0 PROGRAM DESCRIPTION

The thermal APU/Hydraulics Analysis Program (TAHAP) is a dynamic simulation of the Auxiliary Power Unit/Hydraulic (APU/Hyd) System thermal performance. In the following sections there is a general description of the APU/Hyd system itself and the TAHAP model along with some background information on the model. A description of the basic program structure including reference to the routines and special variables which control the progress of the program is contained in Sec. 3.1.4 followed by a brief description of each of the TAHAP supporting subroutines.

3.1 General Description

The following sections contain a general description of the APU/Hyd system and briefly describe the way TAHAP simulates it. The purpose and capabilities of the model are also discussed along with some background information concerning the model's origin and evaluation.

3.1.1 Purpose and Capabilities of TAHAP

TAHAP is designed to simulate the APU/Hydraulic system to the level of detail required to adequately determine mission timeline-dependent consumption rates for both N_2H_4 for APU power and water for APU and Hyd system heat rejection. Its primary purpose is to compute these APU/Hydraulics consumables requirements. A secondary purpose of TAHAP is to evaluate the compatibility of system performance constraints with mission requirements. Two versions of

TAHAP were developed to run mission consumables analyses for both Approach and Landing Test (ALT) and Orbital Flight Test (OFT) missions.

3.1.2 General Description of the APU/Hydraulic system and its simulation

The Orbiter hydraulic subsystem is comprised of three essentially parallel fluid circuits which supply hydraulic power to the Flight Control surfaces, Space Shuttle Main Engine (SSME) controls, SSME, Thrust Vector Control (TVC), landing gear and other utility actuators. Each hydraulic circuit is powered by a constant pressure, variable displacement, main pump which is driven by one of three APU's in the APU subsystem. Each APU consists of a 2-stage turbine which drives the main hydraulic pump through a speed reduction gear box, roughly 19 to 1. The turbine is powered by the catalytic decomposition of liquid hydrazine (N_2H_4) supplied to a gas generator from a fuel pump-augmented blowdown supply system. A lubrication oil circulation system powered by the APU gearbox is used to provide active thermal control for each APU.

Heat rejection for each APU lube oil and hydraulic oil loop is provided by one of three water boilers for OV-101 and one of three water spray boilers for OV-102. Separate heat exchangers are provided for each of the fluid loops running through each water (spray) boiler.

The OV-101 and OV-102 APU/Hydraulic system fluid loops simulated by TAHAP are illustrated in Figures 3-1 and 3-2 respectively.

These fluid loops are simulated as follows:

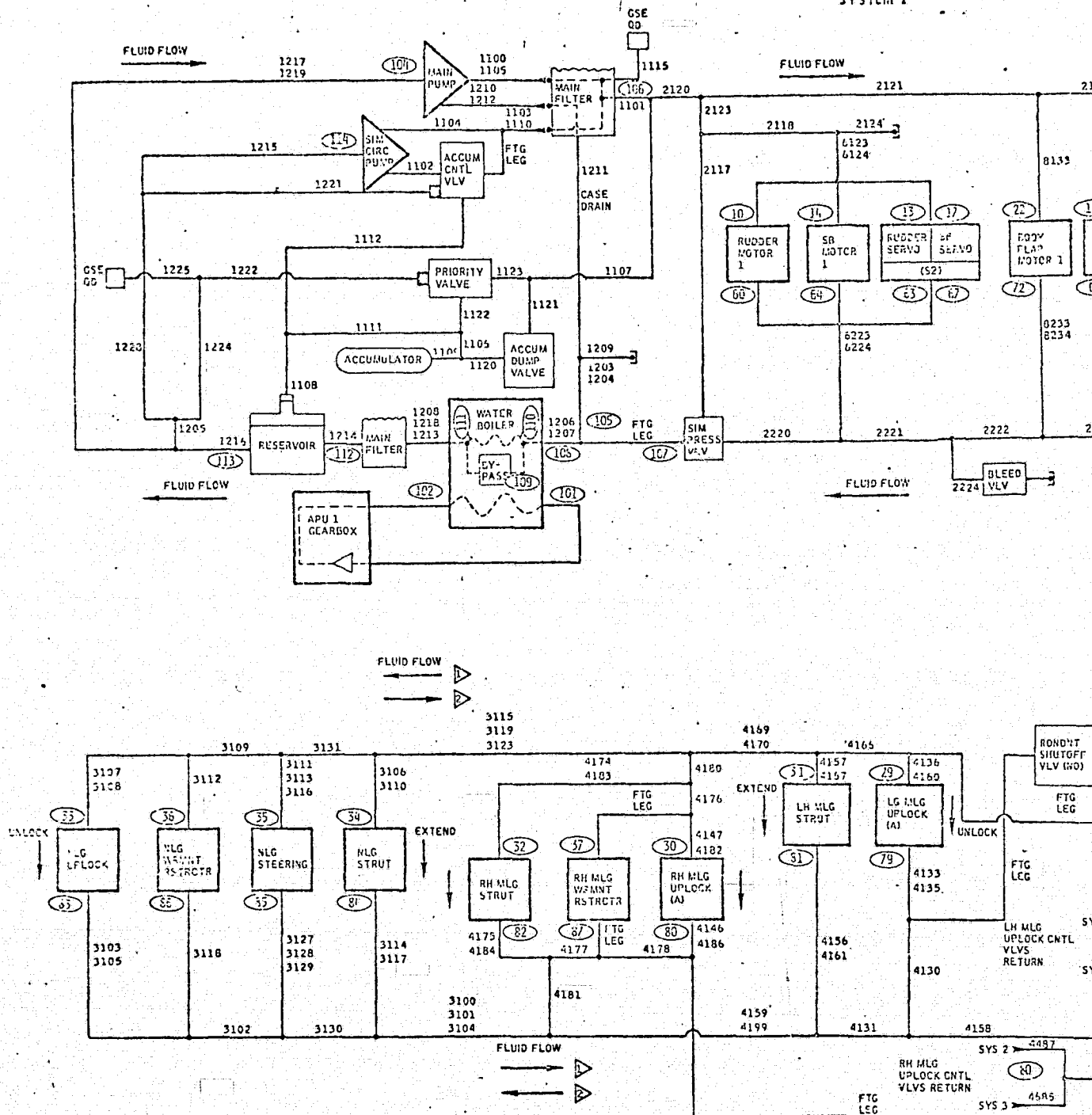
The individual instantaneous actuator flowrate demands are used for determining the heat loads on the hydraulic system and the main pump power input requirements. APU performance data, normalized to main pump input power, is used to compute fuel requirements directly. The water consumption rates are determined by computing the heat loads on the water boiler. This is accomplished by computing the thermal mass response to hydraulic heating at nodes for each actuator in the fluid circuit and computing the main pump and APU gearbox waste heat rejection. The heat sink performance of the water boiler is computed using predicted heat exchanger effectiveness for the environmental conditions and the fluid conditions at the inlet.

3.1.3 FEAR Documentation

TAHAP is an application of the FORTRAN Environmental Analysis Routines (FEAR, Ref. 1) developed by the TRW Systems Division and modified as required. The routines in FEAR were originally written as utility support for Environmental Control and Life Support Systems (ECLSS) consumables analyses models. A driver program was written for the APU/Hydraulics consumables analyses using FEAR. Consequently many of the subroutines have lines of code or large portions of arrays utilized in ECLSS applications only. These

Figure 3-1

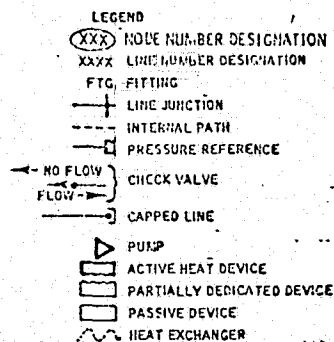
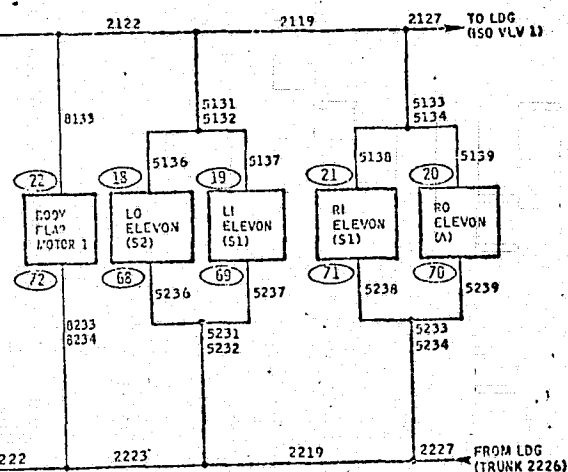
OV-101
HYDRAULIC SYSTEM FLUID LOOP DIAGRAM
SYSTEM 1



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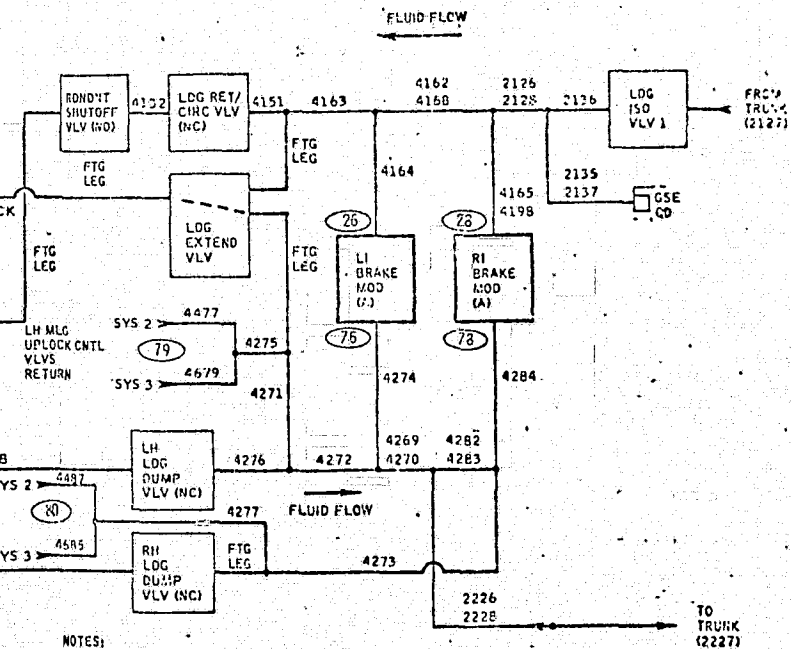


SWITCHING VALVE CONTROL:

- (A) ACTIVE PORT
- (S1) 1st STANDBY PORT
- (S2) 2nd STANDBY PORT

NODES NOT SHOWN:

- 100 TURBINE 1
- 103 WATER STORAGE TANK 1
- 250 AFT FUSELAGE BOUNDARY
- 252 LEFT WING BOUNDARY
- 253 RIGHT WING BOUNDARY
- 254 MID FUSELAGE BOUNDARY
- 255 VERTICLE STABILIZER BOUNDARY
- 256 BODY FLAP AREA BOUNDARY
- 257 RIGHT WHEEL WELL BOUNDARY
- 258 LEFT WHEEL WELL BOUNDARY
- 259 FORWARD FUSELAGE BOUNDARY
- 260 NOSE WHEEL WELL BOUNDARY
- 262 AMBIENT AIR BOUNDARY
- 275 FUEL AND ENERGY TRACKING



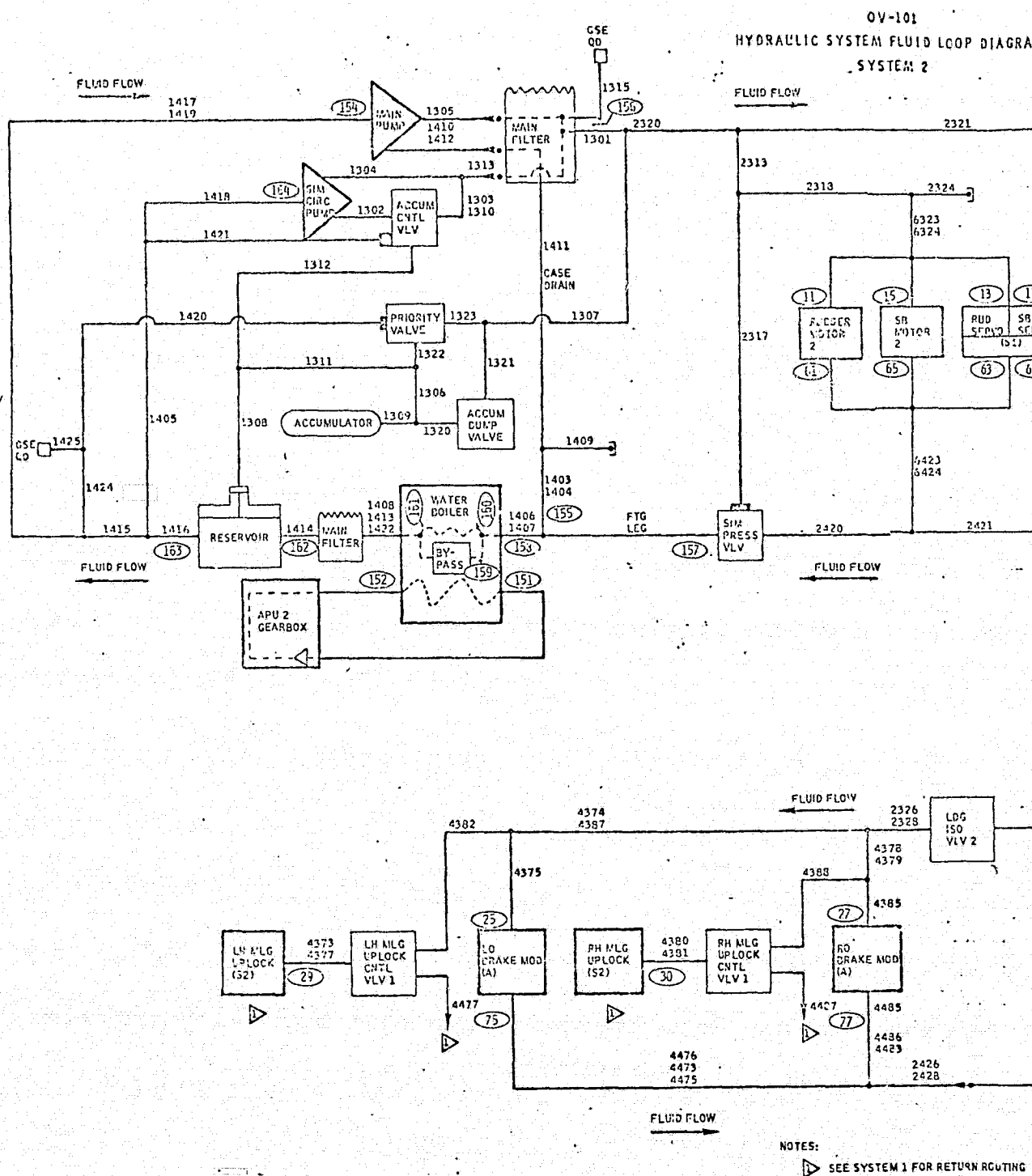
NOTES:

- ▶ FLOW DIRECTION AFTER LDG DEPLOY

ALL NODE AND LINE THERMAL COUPLING IS SHOWN IN APPENDIX E.

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Figure 3-1 contd

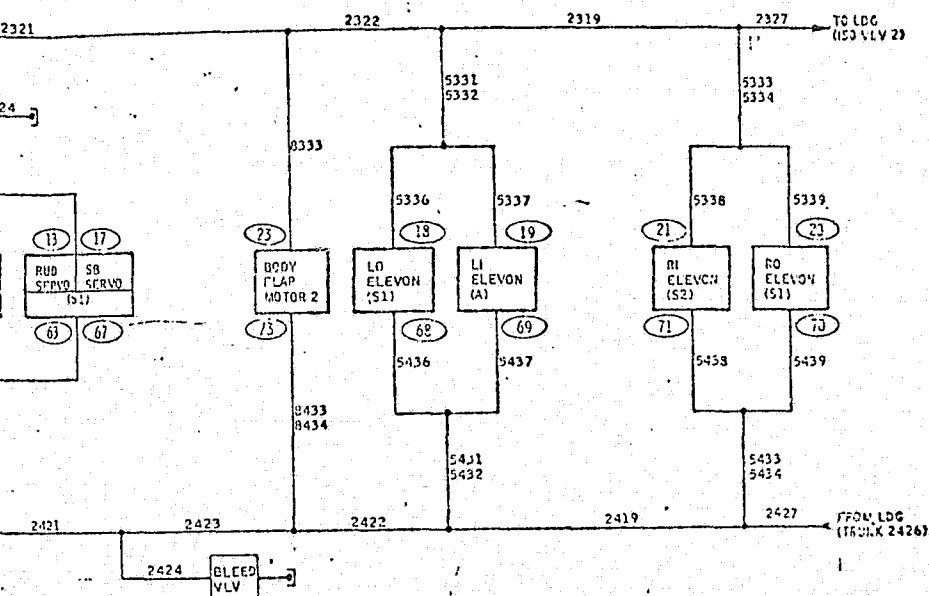


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COOP DIAGRAM



LEGEND

- (XX) NODE NUMBER DESIGNATION
- XXXX LINE NUMBER DESIGNATION
- FTG FITTING
- LINE JUNCTION
- INTERNAL PATH
- PRESSURE REFERENCE
- ← NO FLOW
- FLOW
- CAPPED LINE
- ▶ PUMP
- ▭ ACTIVE HEAT DEVICE
- ▭ PARTIALLY DEDICATED DEVICE
- ▭ PASSIVE DEVICE
- ~ HEAT EXCHANGER

SWITCHING VALVE CONTROL:

- (A) ACTIVE PORT
- (S1) 1st STANDBY PORT
- (S2) 2nd STANDBY PORT

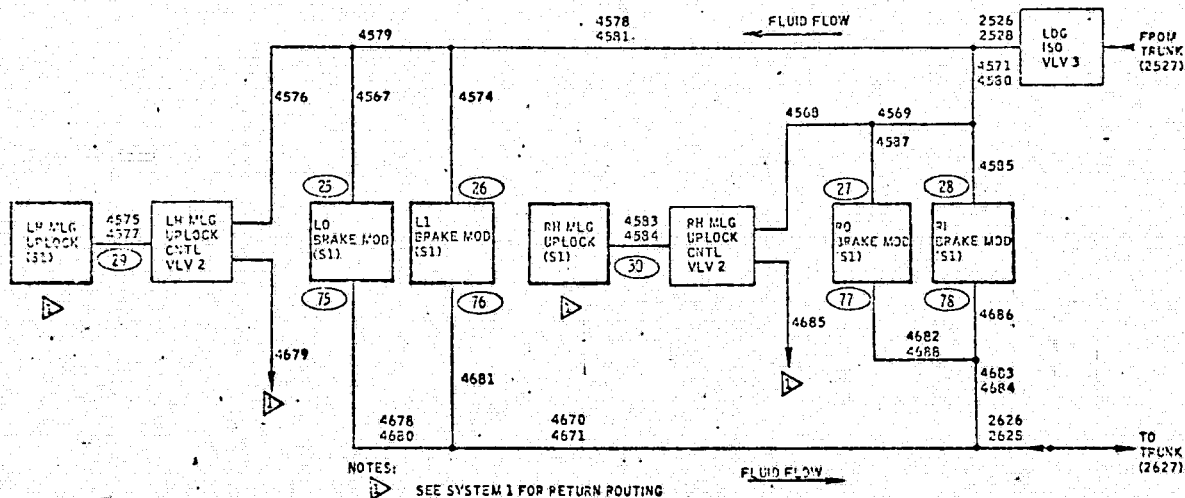
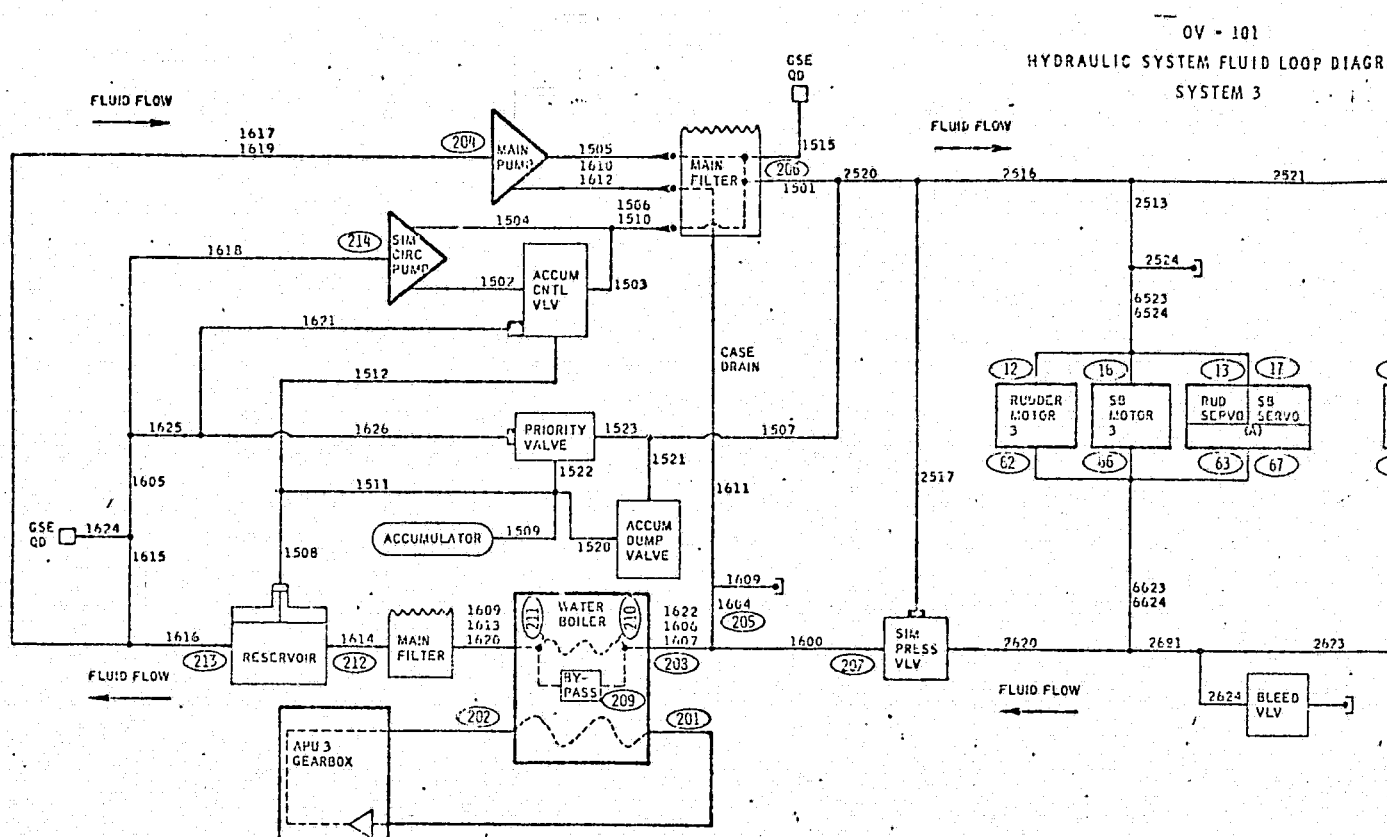
NODES NOT SHOWN:

- 150 TURBINE 2
- 153 WATER STORAGE TANK 2
- 250 AFT FUSELAGE BOUNDARY
- 252 LEFT WING BOUNDARY
- 253 RIGHT WING BOUNDARY
- 254 MID FUSELAGE BOUNDARY
- 255 VERTICLE STABILIZER BOUNDARY
- 256 BODY FLAP AREA BOUNDARY
- 257 RIGHT WHEEL WELL BOUNDARY
- 258 LEFT WHEEL WELL BOUNDARY
- 259 FORWARD FUSELAGE BOUNDARY
- 260 NOSE WHEEL WELL BOUNDARY
- 262 AMBIENT AIR BOUNDARY
- 276 FUEL AND ENERGY TRACKING

ALL NODE AND LINE THERMAL COUPLING
IS SHOWN IN APPENDIX E

FOLDOUT FRAME 2

Figure 3-1 contd.

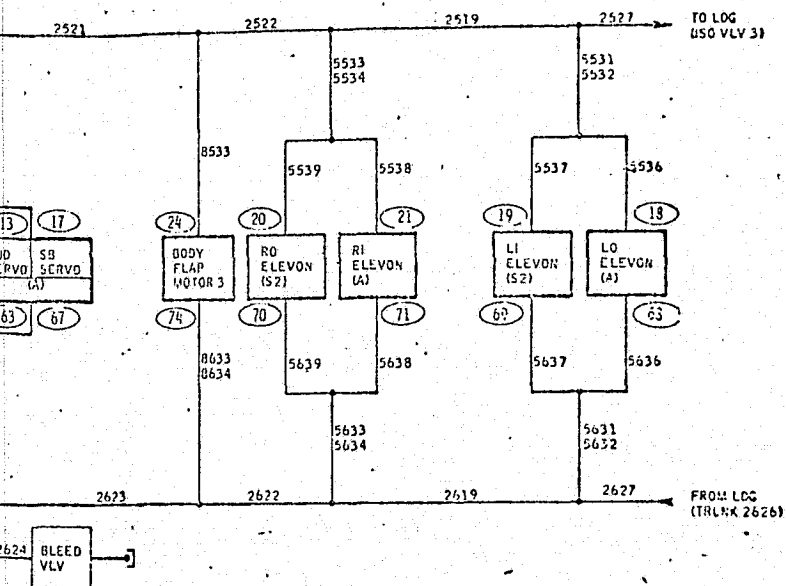


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1 contd.

101
FLUID LOOP DIAGRAM
ITEM 3



LEGEND

- (XXX) NODE NUMBER DESIGNATION
- XXXX LINE NUMBER DESIGNATION
- FTG FITTING
- +— LINE JUNCTION
- INTERNAL PATH
- |— PRESSURE REFERENCE
- ← NO FLOW
- FLOW
- | CHECK VALVE
- | CAPPED LINE
- ▶ PUMP
- ACTIVE HEAT DEVICE
- PARTIALLY DEDICATED DEVICE
- PASSIVE DEVICE
- ~ HEAT EXCHANGER

SWITCHING VALVE CONTROL:

- (A) ACTIVE PORT
- (S1) 1st STANDBY PORT
- (S2) 2nd STANDBY PORT

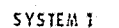
NODES NOT SHOWN:

- 200 TURBINE 3
- 203 WATER STORAGE TANK 3
- 250 AFT FUSELAGE BOUNDARY
- 252 LEFT WING BOUNDARY
- 253 RIGHT WING BOUNDARY
- 254 MID FUSELAGE BOUNDARY
- 255 VERTICLE STABILIZER BOUNDARY
- 256 BODY FLAP AREA BOUNDARY
- 257 RIGHT WHEEL WELL BOUNDARY
- 258 LEFT WHEEL WELL BOUNDARY
- 259 FORWARD FUSELAGE BOUNDARY
- 260 NOSE WHEEL WELL BOUNDARY
- 262 AMBIENT AIR BOUNDARY
- 277 FUEL AND ENERGY TRACKING

ALL NODE AND LINE THERMAL COUPLING
IS SHOWN IN APPENDIX E

FOLDOUT FRAME 2

OV-102



9

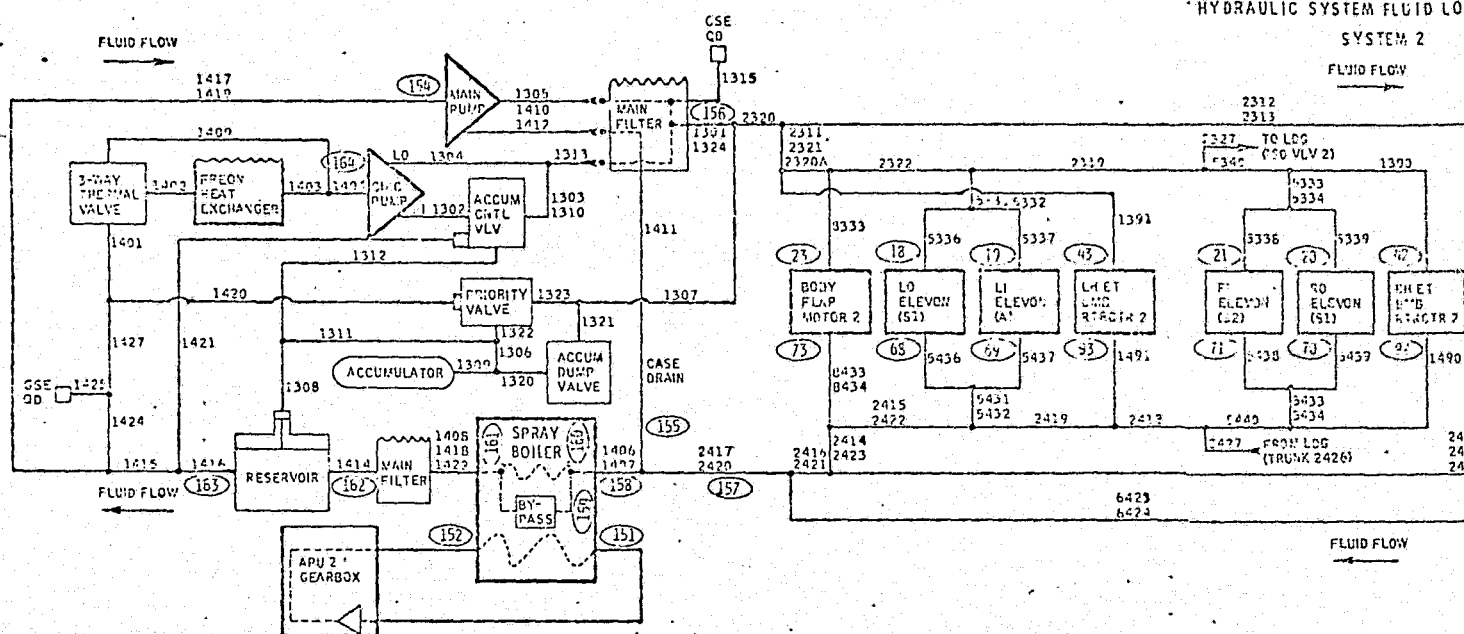
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Figure 3-2 co

OV-102

HYDRAULIC SYSTEM FLUID LO

SYSTEM 2



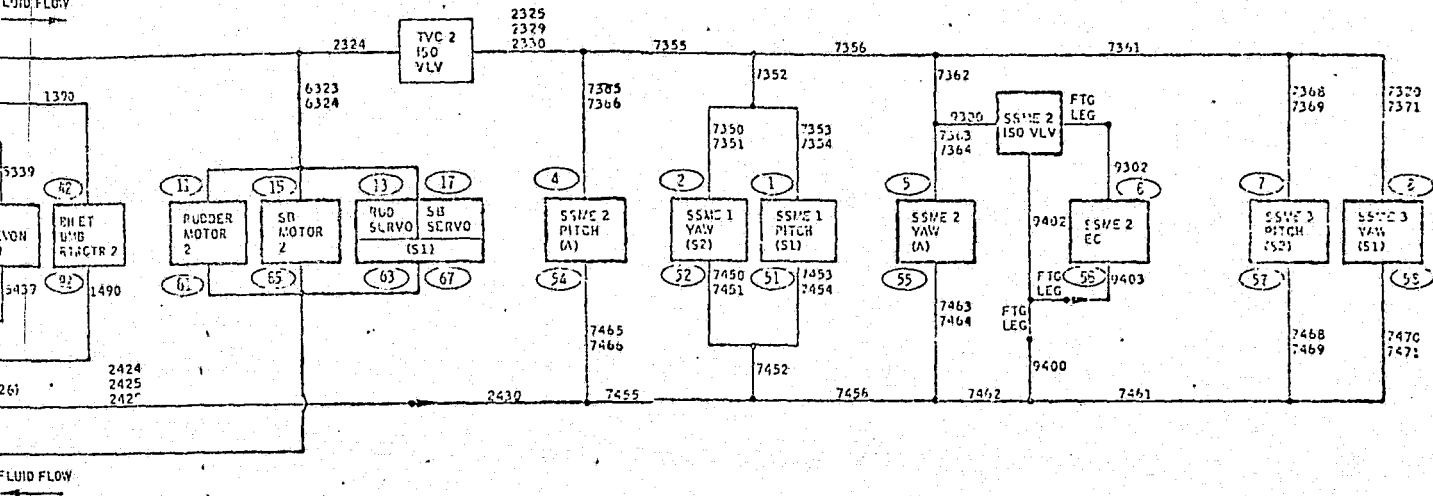
re 3-2 contd.

OV-102

SYSTEM FLUID LOOP DIAGRAM

SYSTEM 2

FLUID FLOW



FLUID FLOW

FROM
TANK
(2327)

TO
TANK
(2427)

LEGEND

(XXX) NODE NUMBER DESIGNATION

XXXX LINE NUMBER DESIGNATION

FTG FITTING

— LINE JUNCTION

--- INTERNAL PATH

□ PRESSURE REFERENCE

← NO FLOW

→ FLOW

— CAPPED LINE

△ PUMP

□ ACTIVE HEAT DEVICE

□ PARTIALLY DEDICATED DEVICE

□ PASSIVE DEVICE

~ HEAT EXCHANGER

SWITCHING VALVE CONTROL:

(A) ACTIVE PORT

(S1) 1st STANDBY PORT

(S2) 2nd STANDBY PORT

NODES NOT SHOWN:

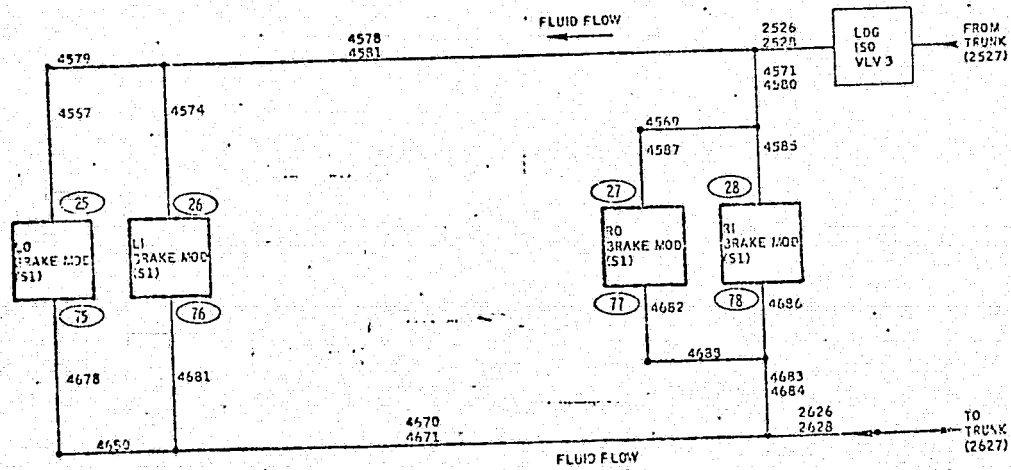
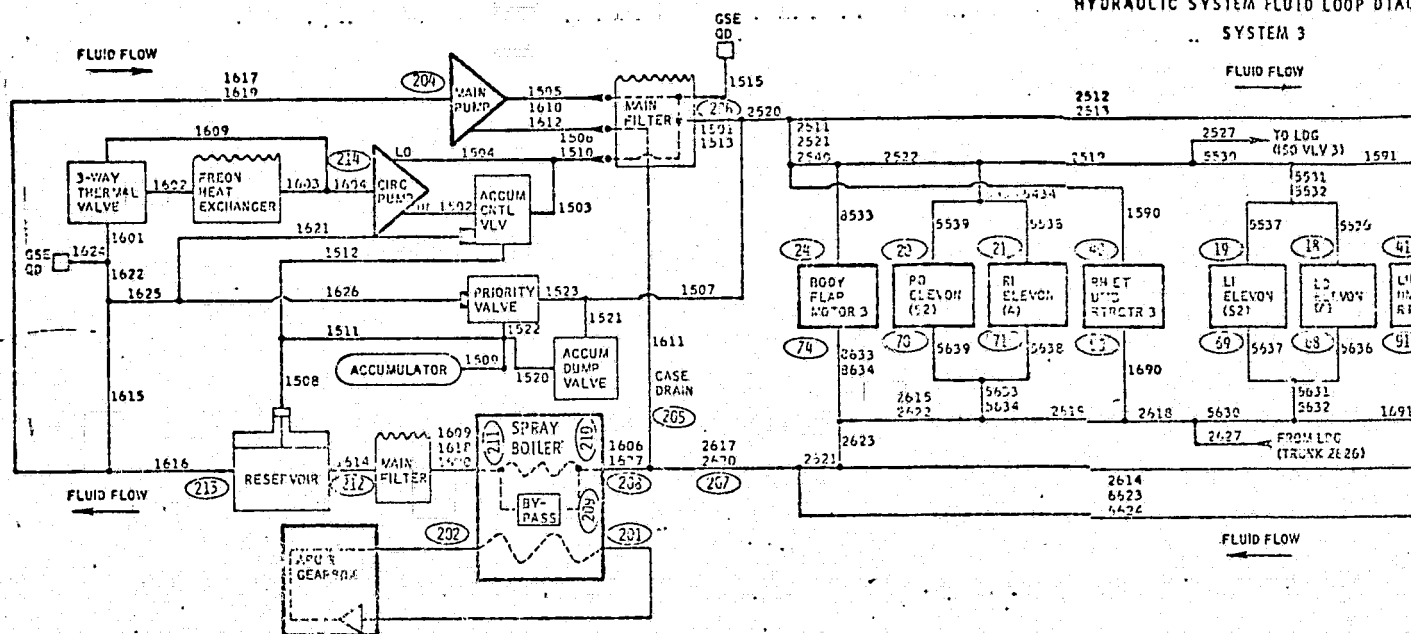
- 150 TURBINE 2
- 153 WATER STORAGE TANK 2
- 250 AFT FUSELAGE BOUNDARY
- 251 ENGINE AREA BOUNDARY
- 252 LEFT WING BOUNDARY
- 253 RIGHT WING BOUNDARY
- 254 MID FUSELAGE BOUNDARY
- 255 VERTICLE STABILIZER BOUNDARY
- 256 BODY FLAP AREA BOUNDARY
- 257 RIGHT WHEEL WELL BOUNDARY
- 258 LEFT WHEEL WELL BOUNDARY
- 259 FORWARD FUSELAGE BOUNDARY
- 260 NOSE WHEEL BOUNDARY
- 262 AMBIENT AIR BOUNDARY
- 276 FUEL AND ENERGY TRACKING

FOLDOUT FRAME 2

Figure 3-2 contd.

OV-102

HYDRAULIC SYSTEM FLUID LOOP DIAG
SYSTEM 3



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FLOW



FROM
TRUNK
(2527)

TO
TRUNK
(2627)

(XXX) NODE NUMBER DESIGNATION

XXXX LINE NUMBER DESIGNATION

ETC. ETC.

LINE 115

—+ LINE JUNCTION
INTERNAL PATH

----- INTERNAL PATH

— ☒ PRESSURE REFERENCE

← NO FLOW } CHECK VALVE

FLOW ->

—●] CAPPED LINE

7. **PLANS**

☐ PUMP
☐ ARM

☐ ACTIVE HEAT DEVICE

☐ PARTIALLY DEDICATED DEVICE

☐ PASSIVE DEVICE

 HEAT EXCHANGER

(A) ACTIVE PORT

(S) 1 1/4 STANDBY PORT

(52) 2 1/4" STANDBY PORT

(S2) 2nd STANDBY PORT

200 TURBINE 3
203 WATER STORAGE TANK 3
250 AFT FUSELAGE BOUNDARY
251 ENGINE AREA BOUNDARY
252 LEFT WING BOUNDARY
253 RIGHT WING BOUNDARY
254 MID FUSELAGE BOUNDARY
255 VERTICLE STABILIZER BOUNDARY
256 BODY FLAP AREA BOUNDARY
257 RIGHT WHEEL WELL BOUNDARY
258 LEFT WHEEL WELL BOUNDARY
259 FORWARD FUSELAGE BOUNDARY
260 NOSE WHEEL BOUNDARY
262 AMBIENT AIR BOUNDARY
277 FUEL AND ENERGY TRACKING

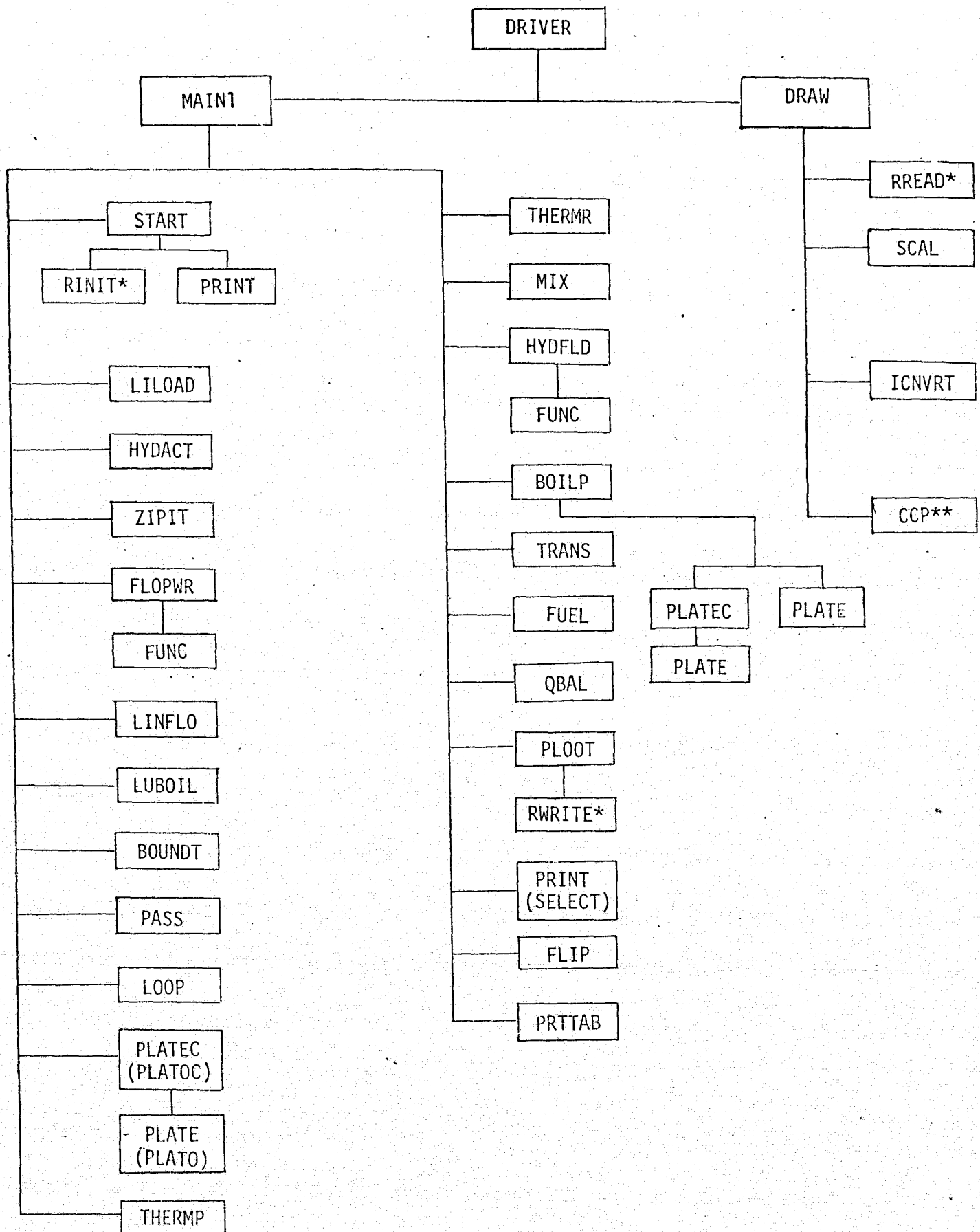
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areas have been left in the coding on a non-interference basis in order to keep from unnecessarily deviating from the general FEAR application techniques and FEAR documentation. The effort required to remove such sections has not been justified since they are essentially transparent to the user. Careful deletion of those sections, however, should not effect the running of TAHAP. These sections are not addressed in the write-up except in defining storage allocation. (Appendix D)

3.1.4 Program Structure and Control

The structure of the Thermal APU/Hydraulics Analysis Program (TAHAP) is shown in the diagrams in Figures 3-3 and 3-4. As shown, the program control is handled primarily by DRIVER, "MAIN" and DRAW. Because of its size the program needs to be overlaid. The logical place to divide the program is at the end of a mission when "MAIN" calls DRAW, which controls the use of the Cal Comp plot package. The routine, DRIVER, merely manages the switch from the first layer which has "MAIN" and all the consumables calculations, to the second layer which contains DRAW and its supporting sub-routines. "MAIN", which is consequently a subroutine, functions as the main routine of the first layer and is referred to as the main routine.

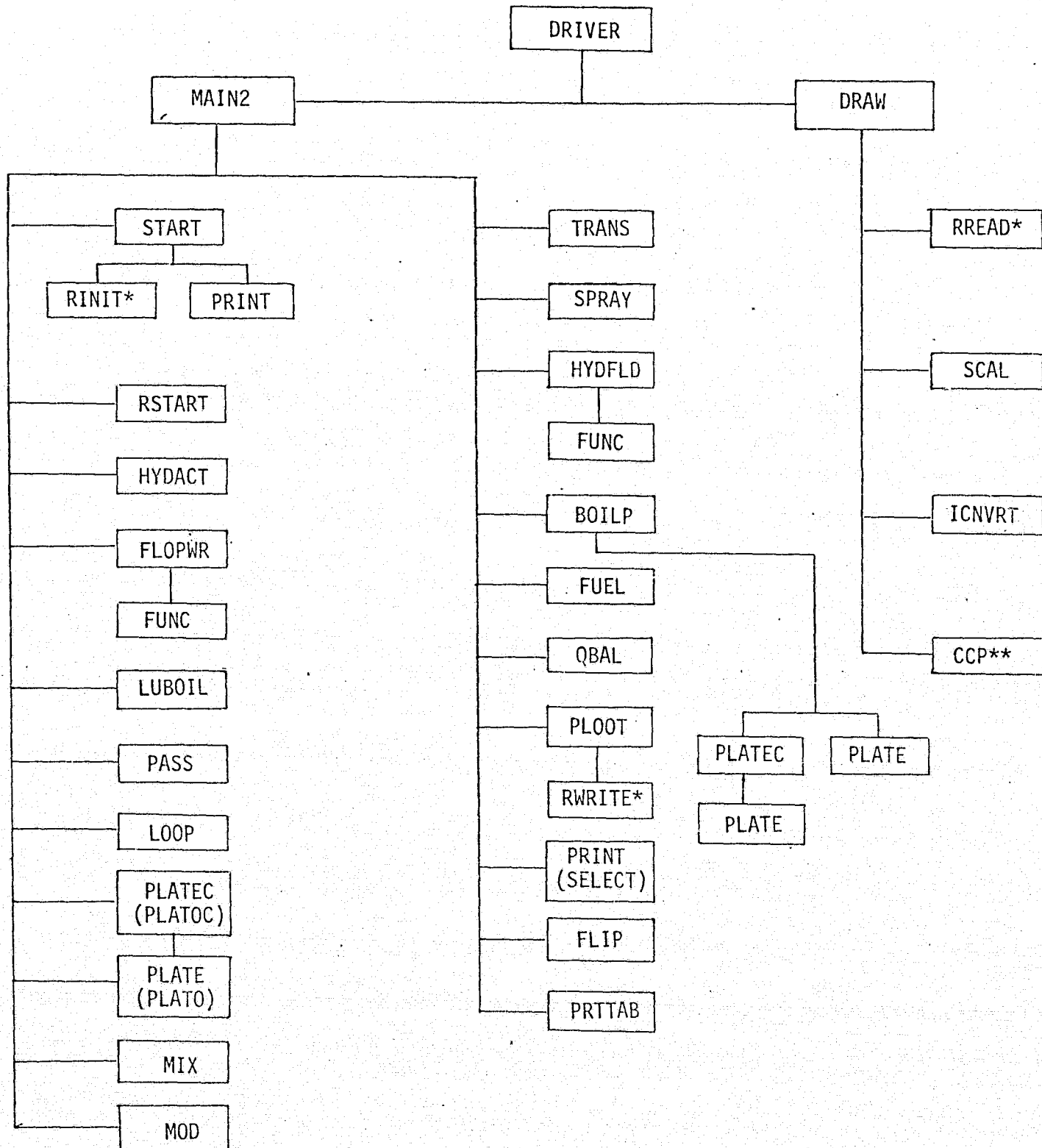
Essential to the program control are the routines START, PRINT, and PLOOT. The model is initialized by a call to START which is called only once as one of the first executable statements of



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**THIS ROUTINE AND ITS SUPPORTING ROUTINES ARE ON THE CALCOMP FASTRAND FILE

FIGURE 3-4 TAHAP (OFT VERSION) PROGRAM TREE



*THESE ROUTINES ARE CONTAINED IN THE UTILITY LIBRARY RANDIO PACKAGE

**THIS ROUTINE AND ITS SUPPORTING ROUTINES ARE ON THE CALCOMP FASTRAND FILE.

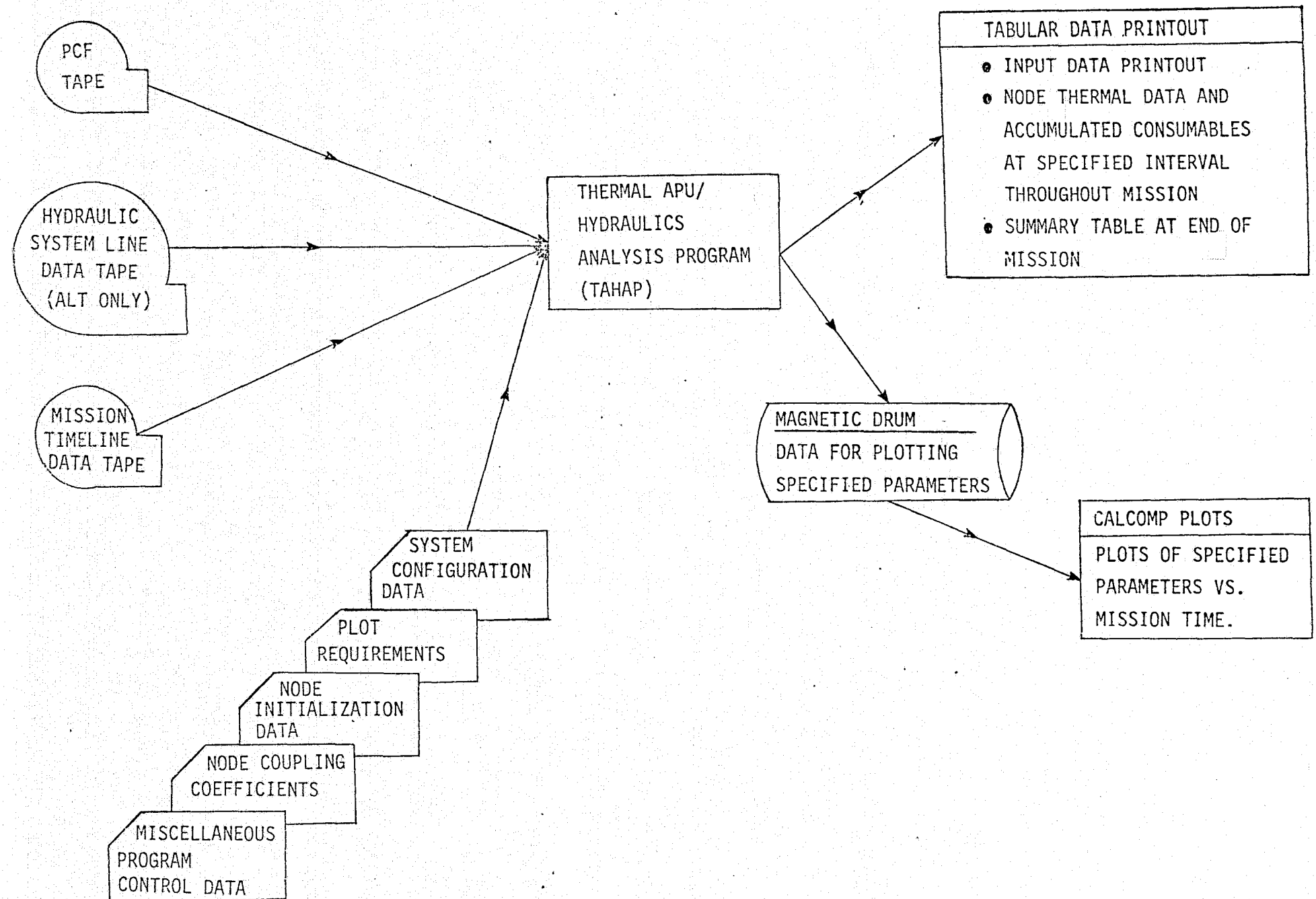
"MAIN" START zeroes blank common, reads in the input data, and sets up the computation and print intervals for the program. Once the run has been initialized by START and the hydraulic system line data tape has been read in (for ALT only) it is driven by a mission timeline which is input on tape. This timeline input includes time, total system flowrates, actuator flowrates, a configuration flag, vehicle load factor, and APU speed flag. For each time on the tape the distribution of actuators among the three systems is determined from the value of the configuration flag in conjunction with the loss management matrix which is input on cards.

PRINT, which is called each computation cycle, manages the print frequency and format while the routine, PLOOT, stores the desired parameters for plotting on magnetic drum to be retrieved later by the DRAW layer.

The input/output flow is presented in Fig 3-5.

The timing sequence is set up to use the data on a particular record until the time stored in UPTIME, the first word of each record, is reached. The present input tape being received gives the time at which the rest of the data on the tape record becomes applicable. Consequently some logic was developed for saving all the values on the tape except UPTIME until the next UPTIME has been read in. The timeline data is further processed in order to average the data over the computation cycle.

FIGURE 3-5 INPUT/OUTPUT PROGRAM FLOW SCHEMATIC FOR TAHAP



Frequency of data on the input tape often varies due to its origin i.e. the difference between input data created from simulator output tapes, trajectory tapes or just estimates of the way a mission may be run. The averaging and tape record cycling process allows the input data to be totally asynchronous with the computation cycle. Tape record frequencies greater or less than the computation cycle can be processed. The logic is, however, limited to accepting a maximum of 25 data records within one computation cycle.

Since a particular set of data will be used until the value for UPTIME is reached it is desirable to keep the program from running at its constant computation cycle during the on-orbit periods when the APU/Hyd system is shutdown on long missions (i.e. $\approx$ 163 hours on Baseline Reference Missions 1 & 2.) The program control designed for this situation involves the subroutine RSTART and the variable, FUDGE. A mission can be reinitialized at a pre-selected time by utilizing one of two options available in RSTART. The component and fluid temperatures are reinitialized just before deorbit by either reading in a new set of temperature initialization cards or defining all nodes to a predetermined constant. The time value read in from tape is scaled by the variable, FUDGE.

Example: If Pre-deorbit checkout begins at 163.46 hrs. insert an "IF" statement that will start subtracting FUDGE

with a value of 163. hrs from UPTIME at .4 hrs. This will allow a sufficient number of on-orbit solutions to bring the system to equilibrium and the time values on the plots can be easily altered to reflect the true mission time.

The value for FUDGE is input on the Summary Table control card described in Appendix A.1. For all other missions, FUDGE will default to zero.

Also integral to the basic program structure are several of the variables in the blank common block. Due to the time dependence of the component and fluid temperatures, P and F, storage locations are provided for both current and previous values through the timing indices, K and L. Until the beginning of the thermal loop, "K" refers to the most recent values of P and F. During the thermal loop "L" is filled with the present solution and "K" retains the previous. At the end of each cycle through the thermal loop "L" is filled with the present solution and "K" retains the previous. At the end of each cycle through the thermal loop the subroutine FLIP is called which exchanges the values.

Specific requirements for the control subroutines mentioned are discussed in Sec 6. Timeline input data is listed and described in detail in Sec 4.2 and general storage allocation for blank common is given in Appendix D.

3.2 OV-101 (ALT) and OV-102 (OFT) Functional Flowcharts

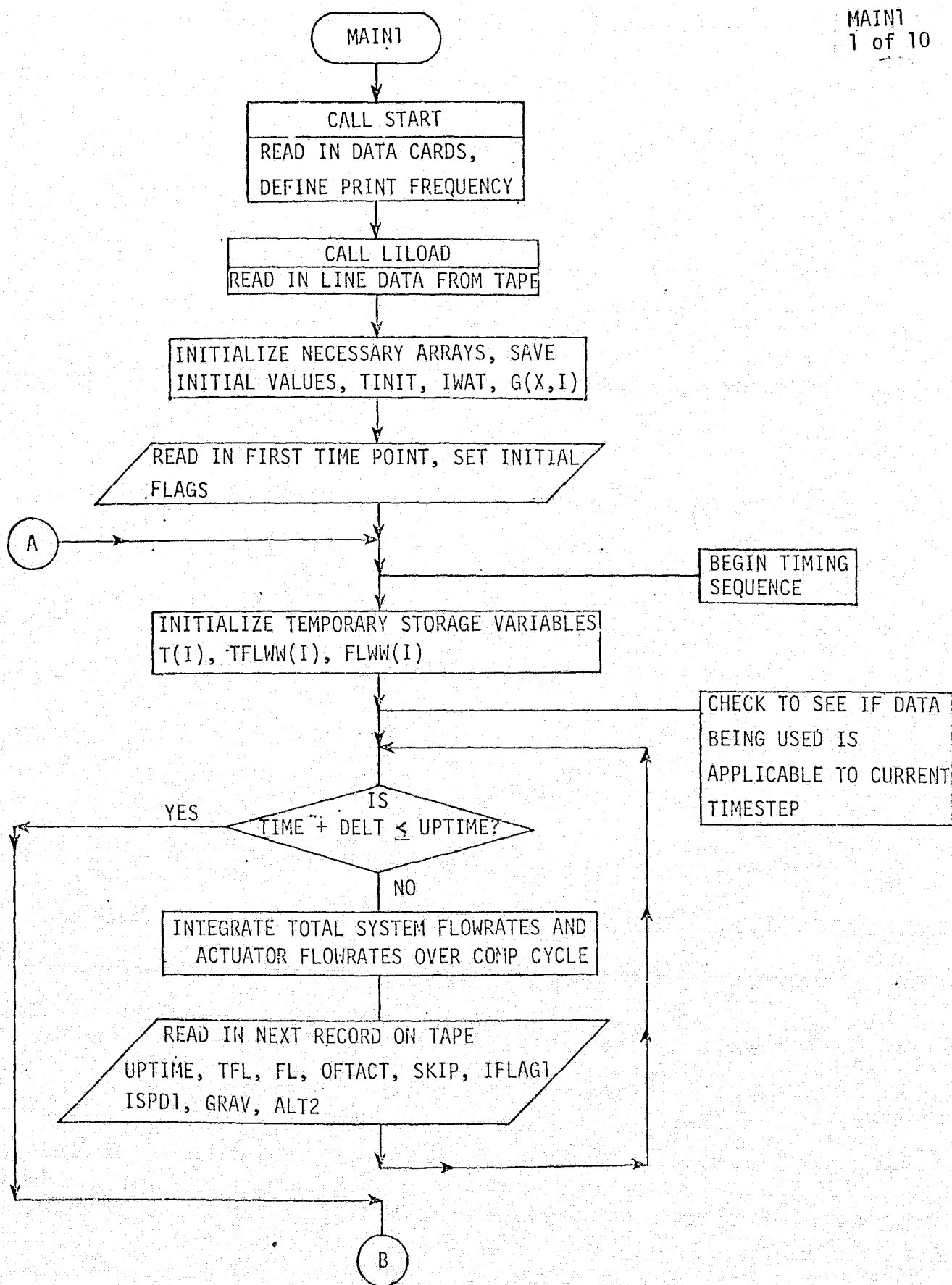
Due to differences between the OV-101 and OV-102 vehicles and the kind of mission involved, the model is split into two versions. The primary differences involve heat sink devices (water boiler for ALT, water spray boiler for OFT), and the difference in flight environment between ALT and OFT. The OV-101 vehicle is subject to atmospheric flight throughout the entire mission, while OFT missions involve relatively short operating periods in the tenuous atmosphere. Several subroutines are included in the ALT version for modeling the hydraulic lines in greater detail than is done in the OFT version. The lack of insulation on the OV-101 lines and the atmospheric environment requires that different methods for computing heat transfer be employed for OV-101 than those used for OV-102 on orbital missions.

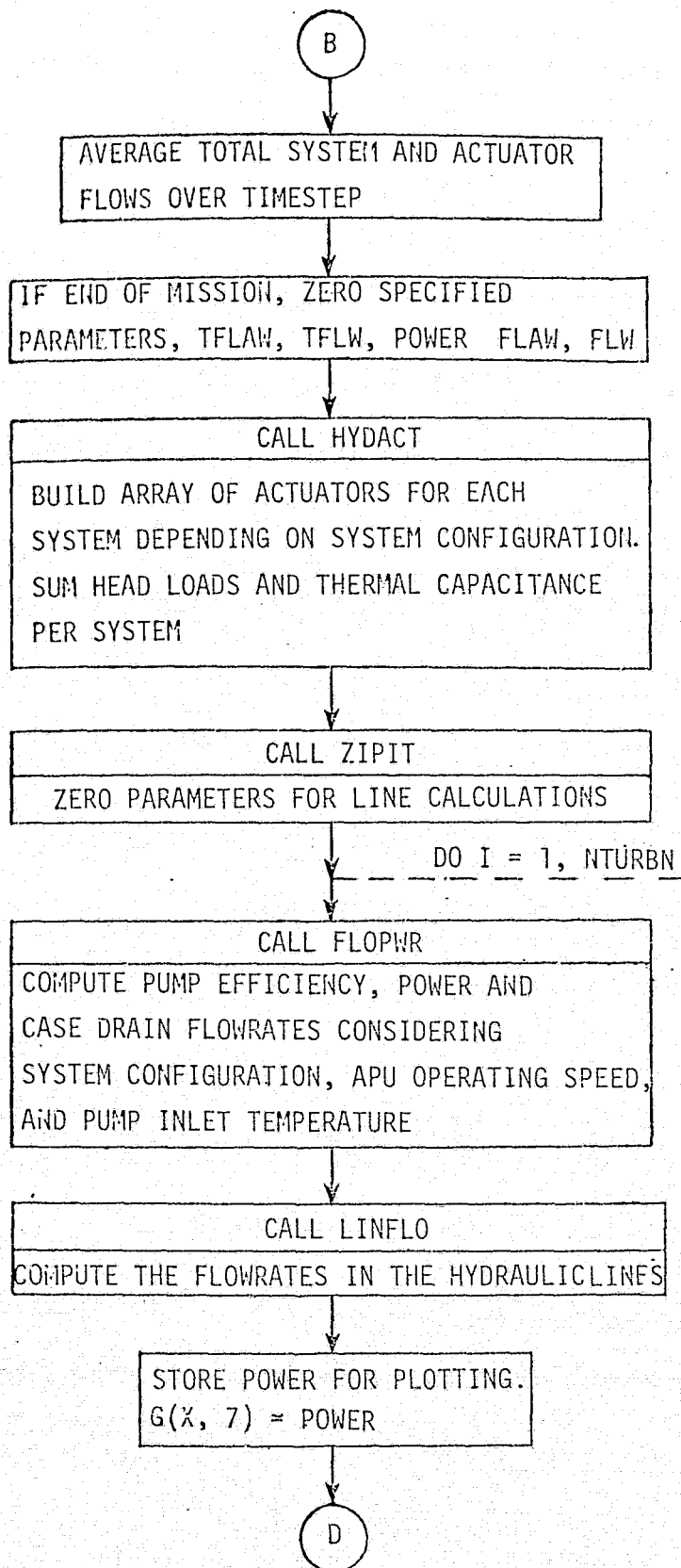
BOILP, the subroutine used to model the OV-101 water boiler is used to model the pool mode of the spray boiler on the OV-102 vehicle. The spray mode is modeled by the subroutine, SPRAY, along with several flag checks in the main routine and in MOD. All the present modeling of the spray boiler is preliminary and should be changed as soon as spray boiler design information is available.

Most of the differences are reflected in the "MAIN" routines. Functional Flowcharts for MAIN1 (ALT) and MAIN2 (OFT) are shown in Figures 3-8 and 3-9 respectively.

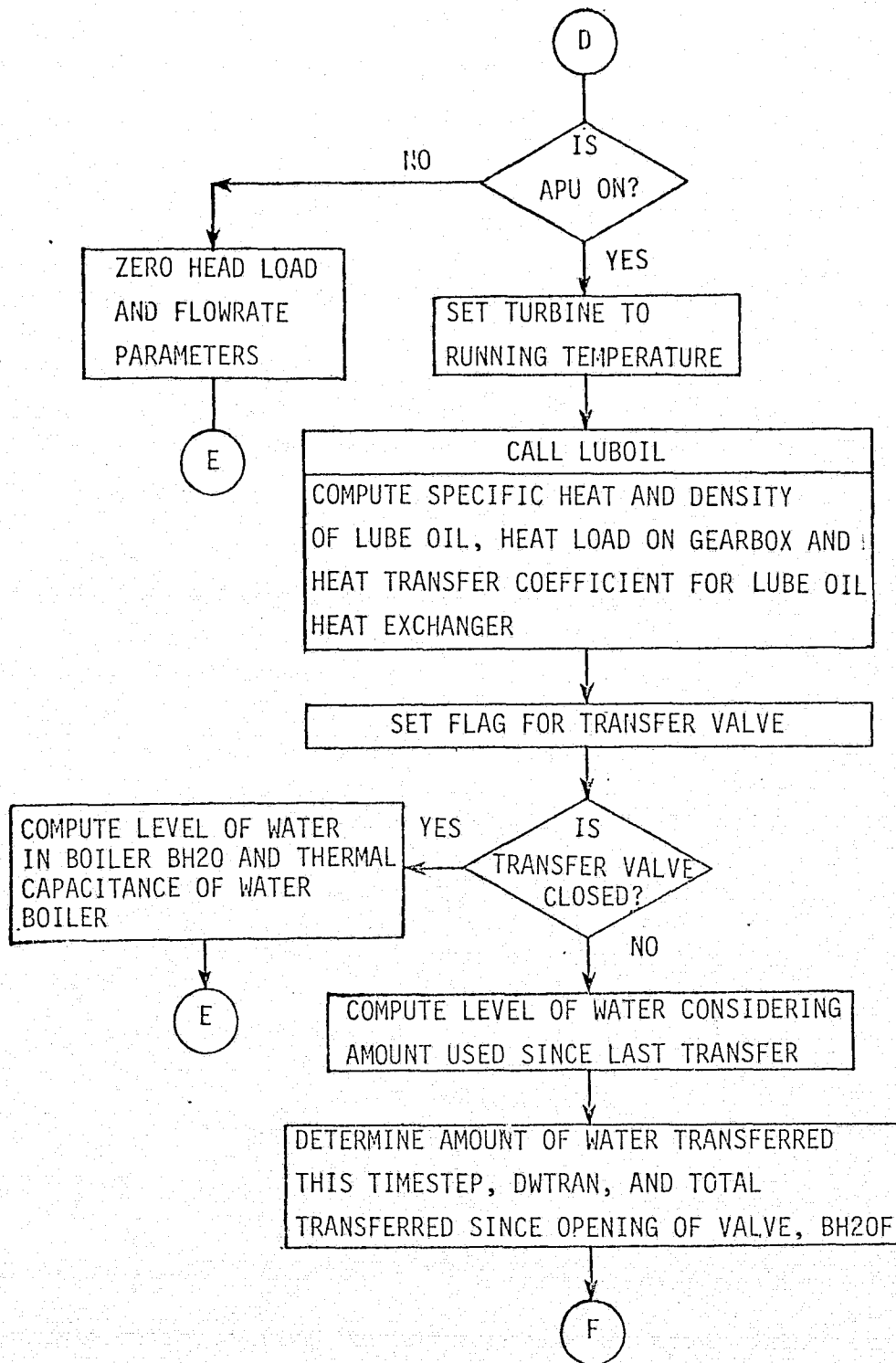
FIGURE 3-6 FUNCTIONAL FLOWCHART OF MAIN1

MAIN1
1 of 10

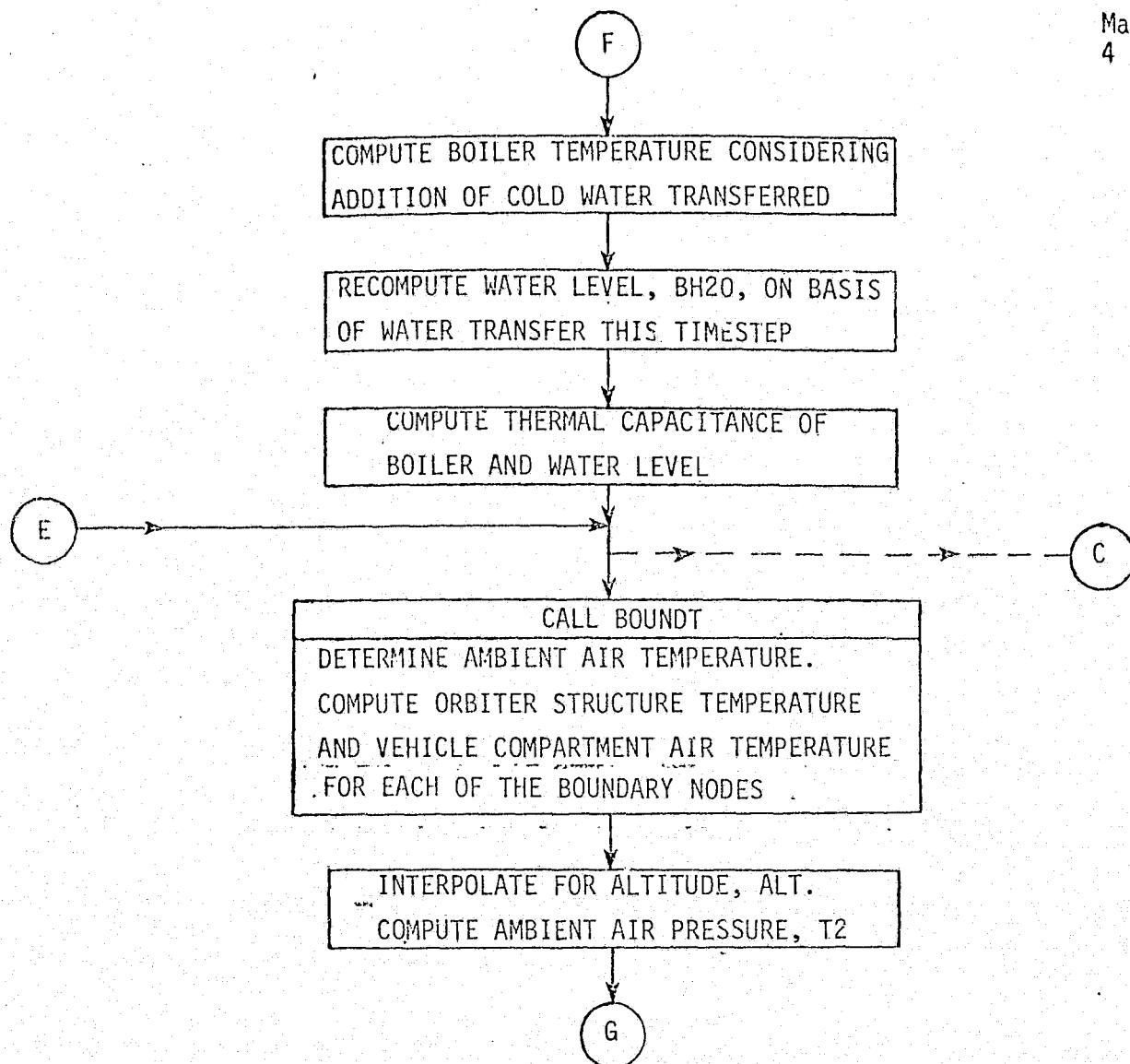


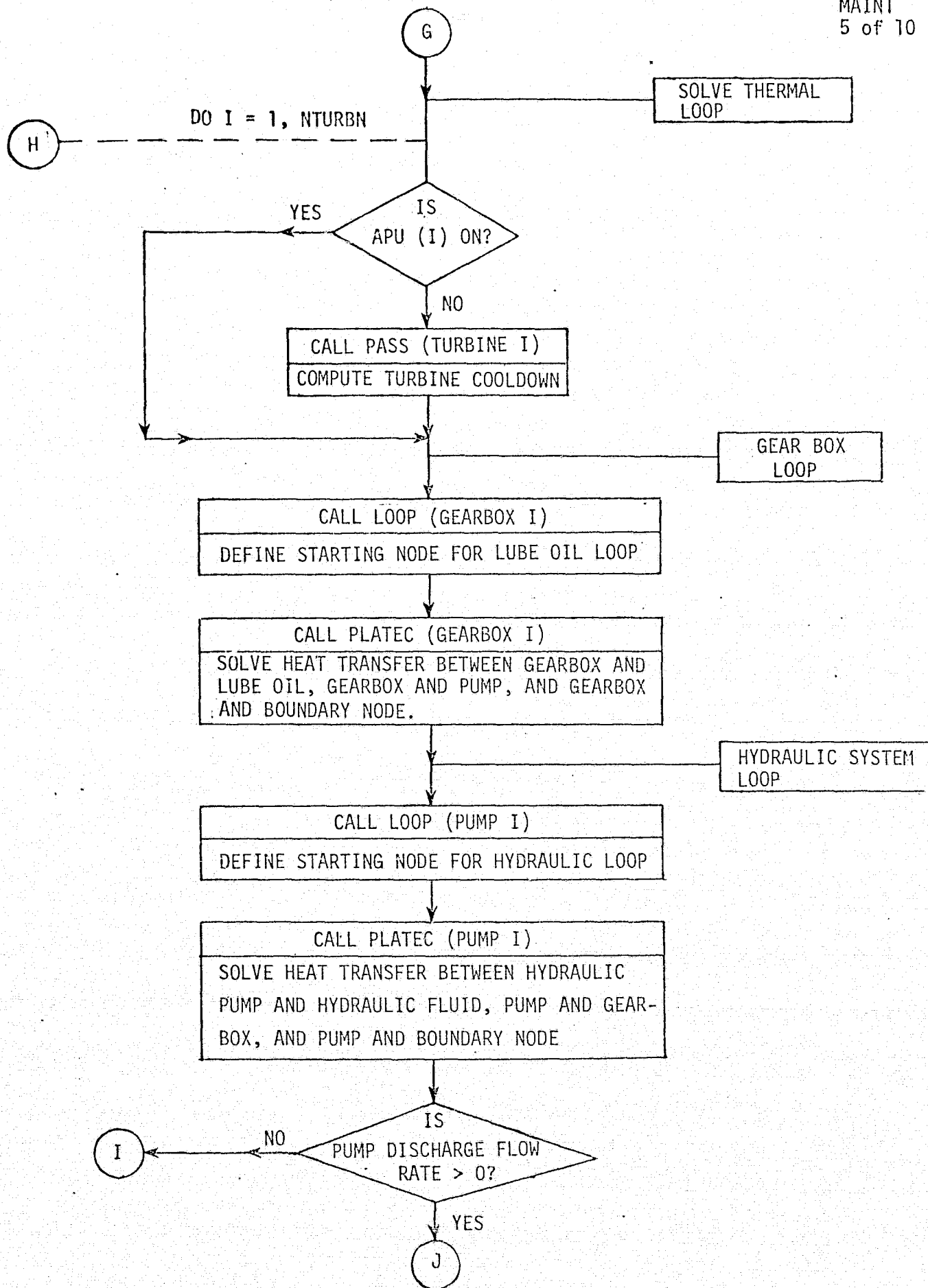


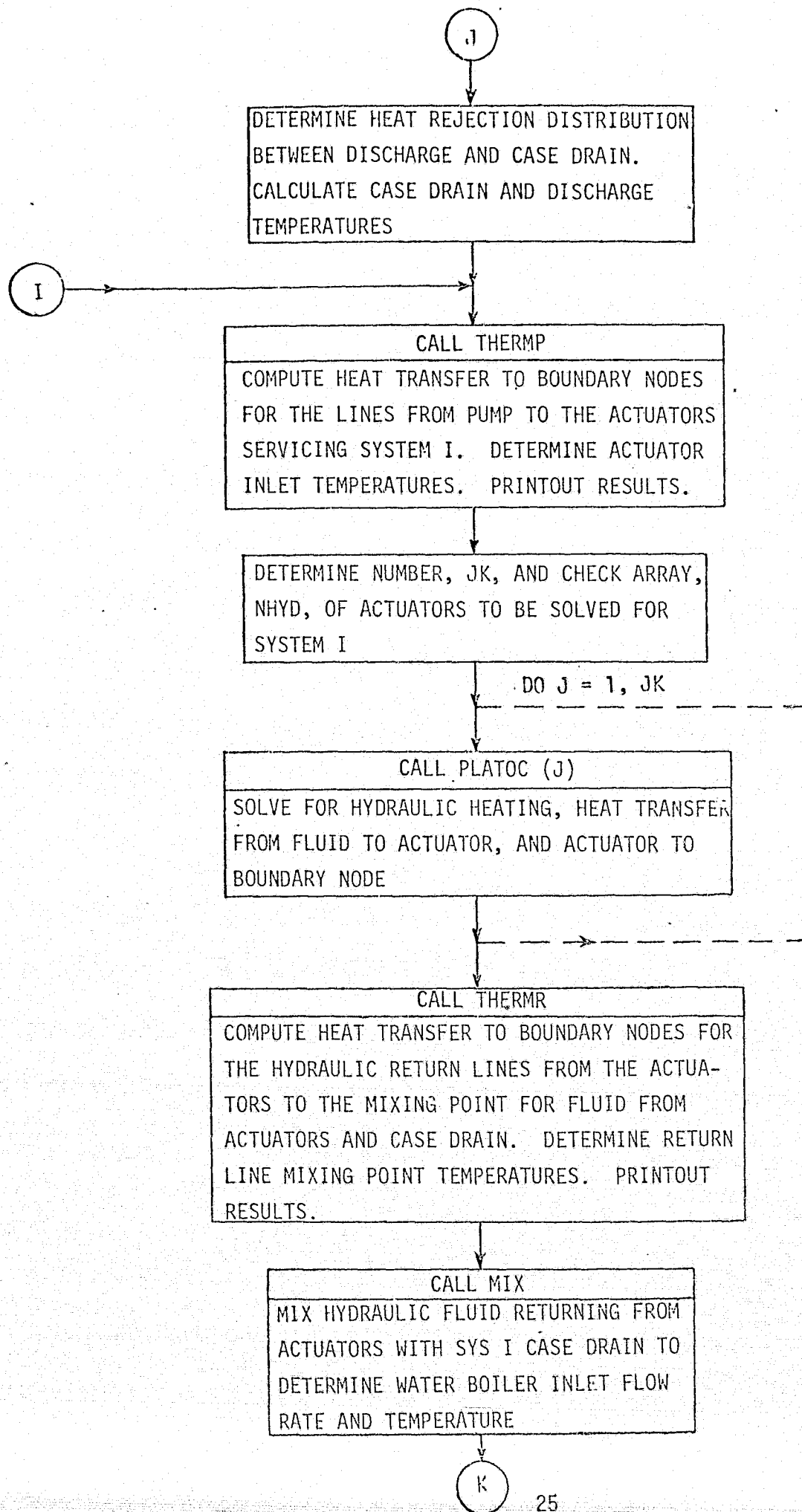
ORIGINAL PAGE IS
OF POOR QUALITY

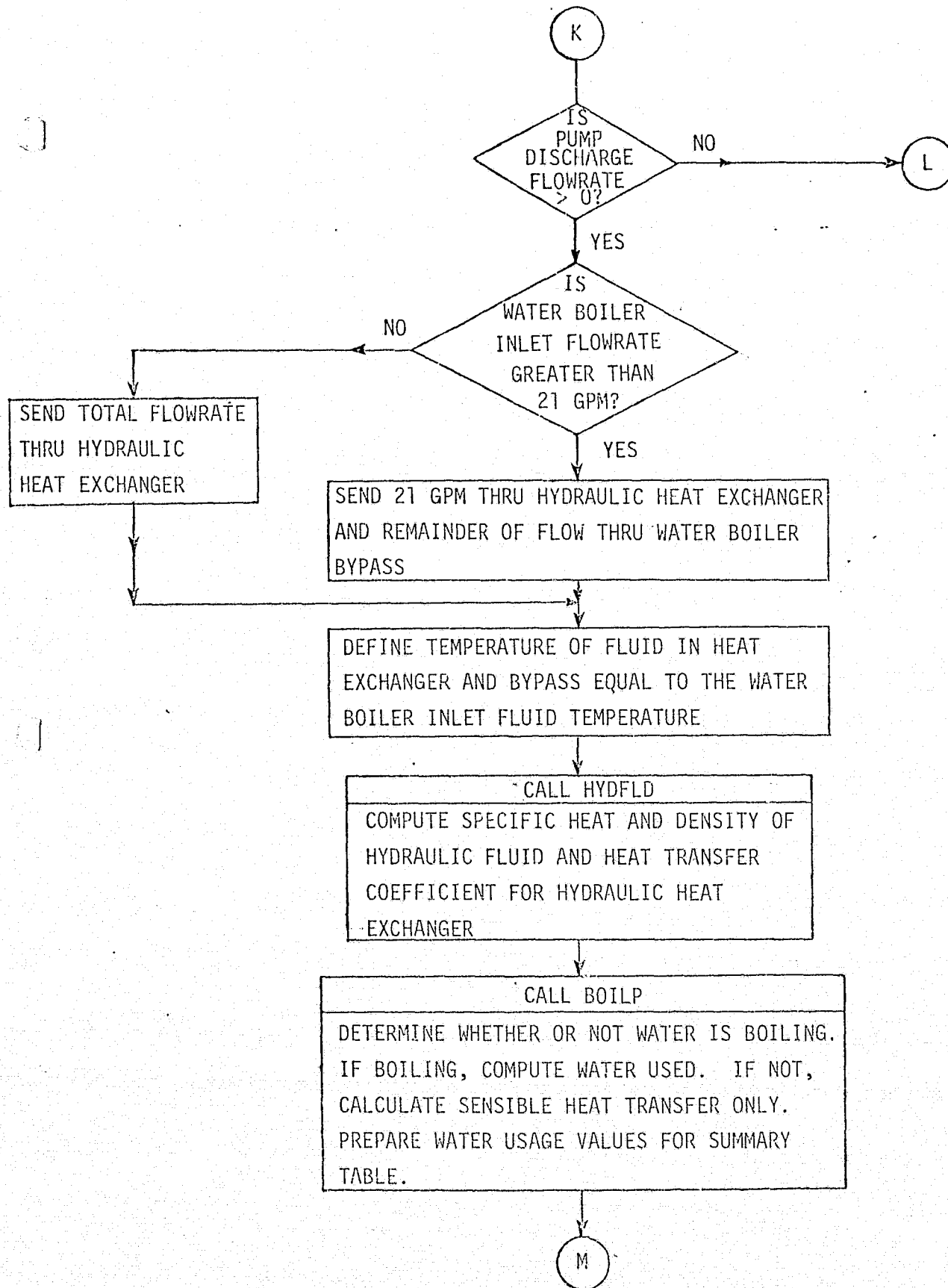


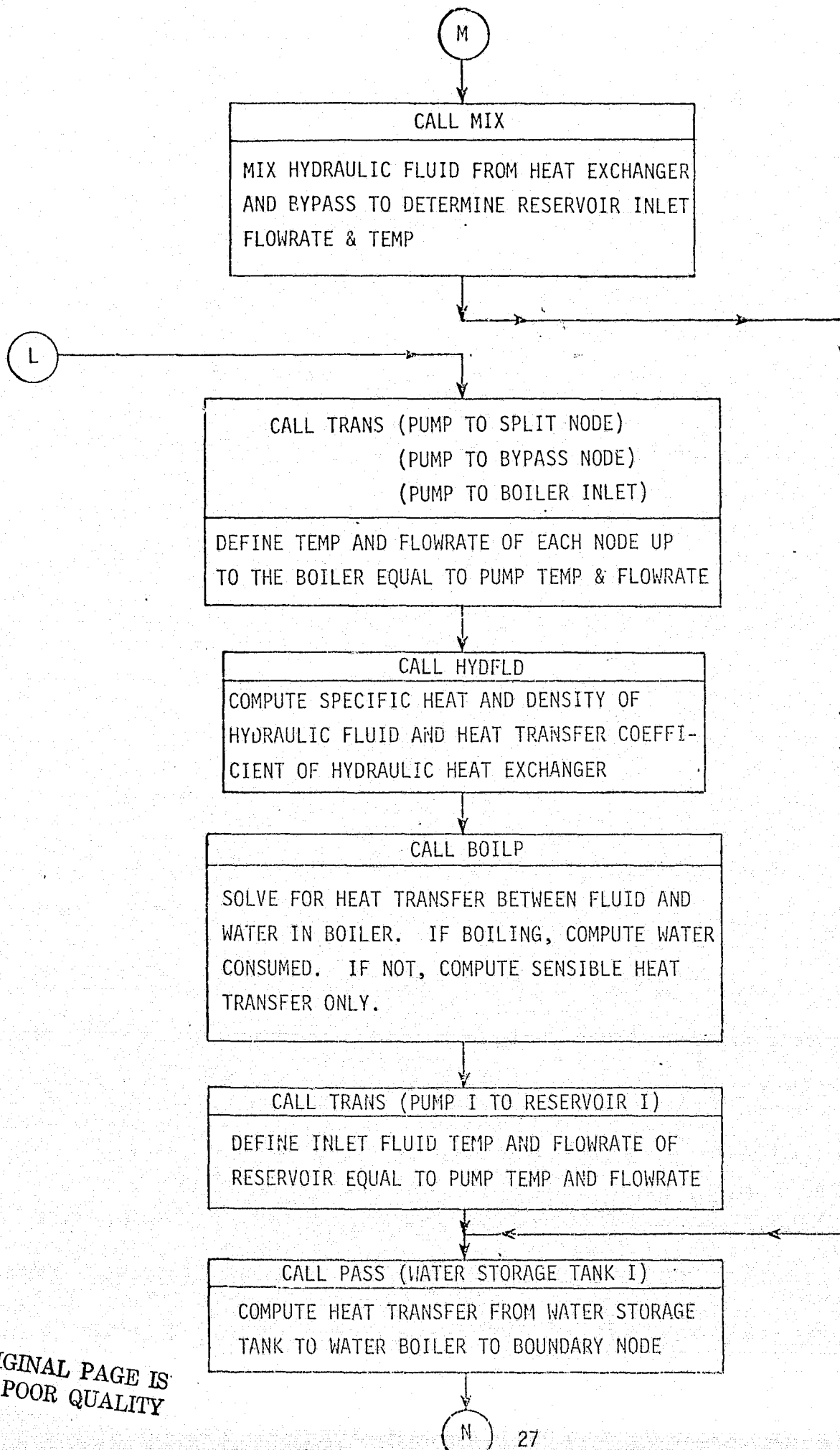
ORIGINAL PAGE IS
OF POOR QUALITY



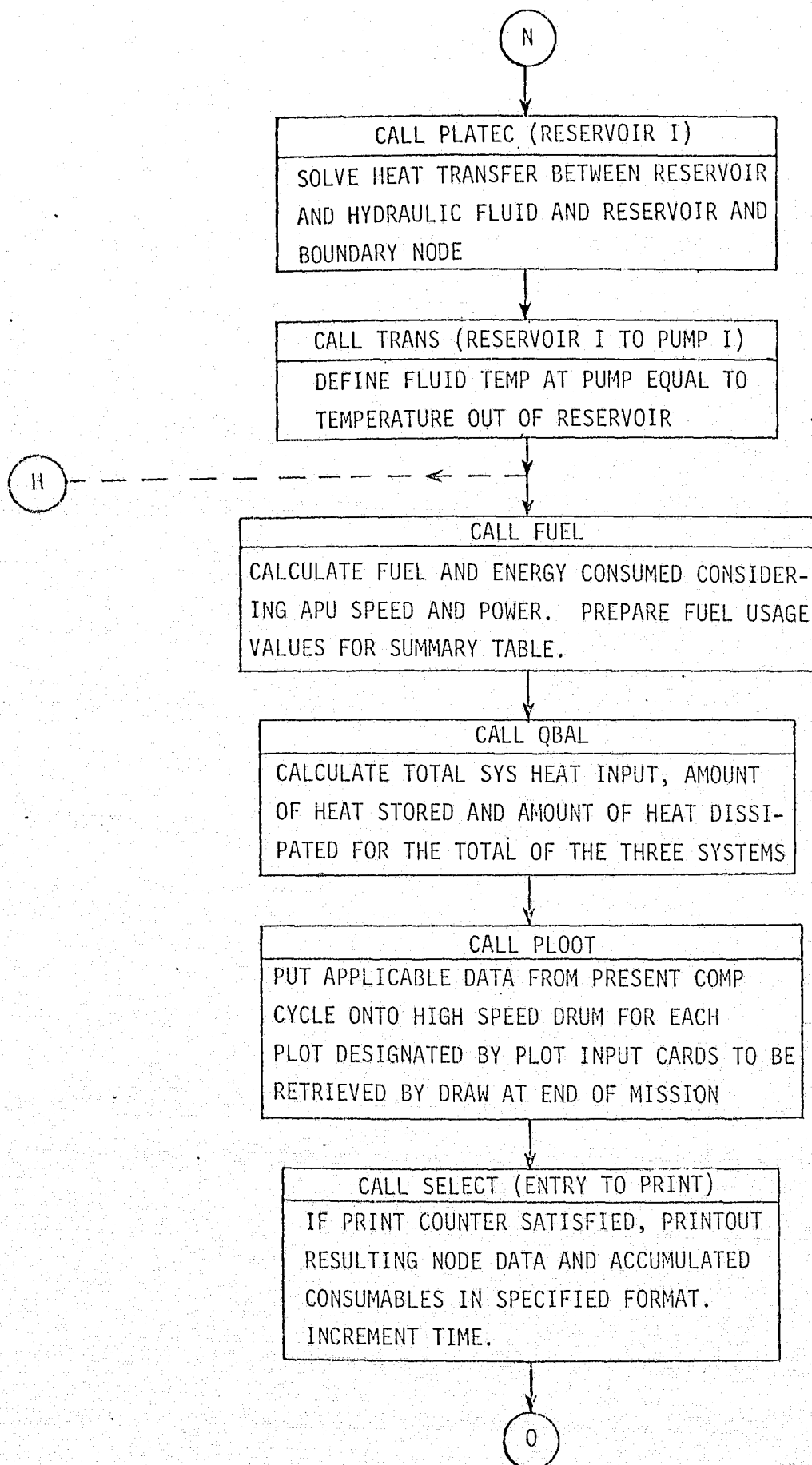








ORIGINAL PAGE IS
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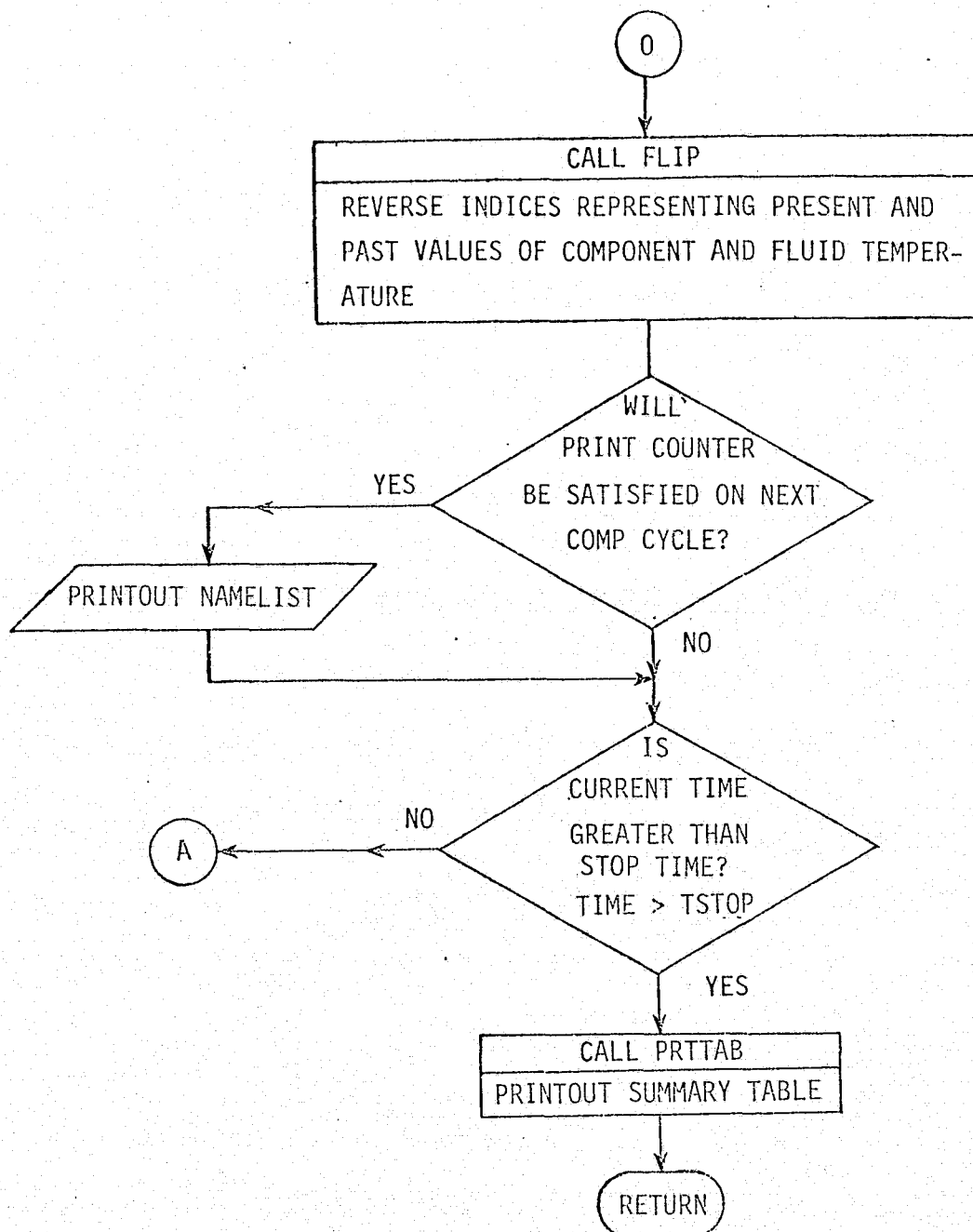
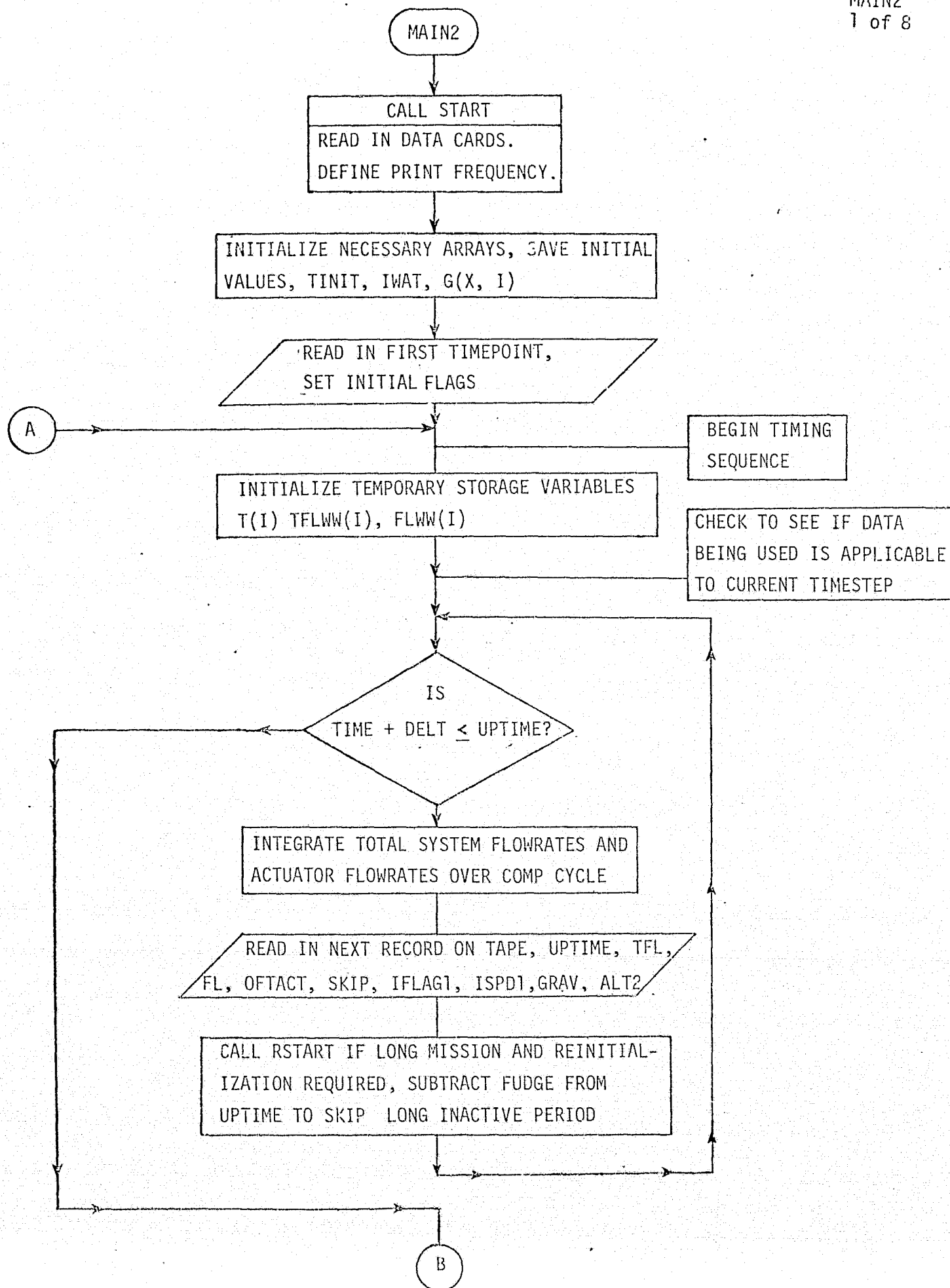
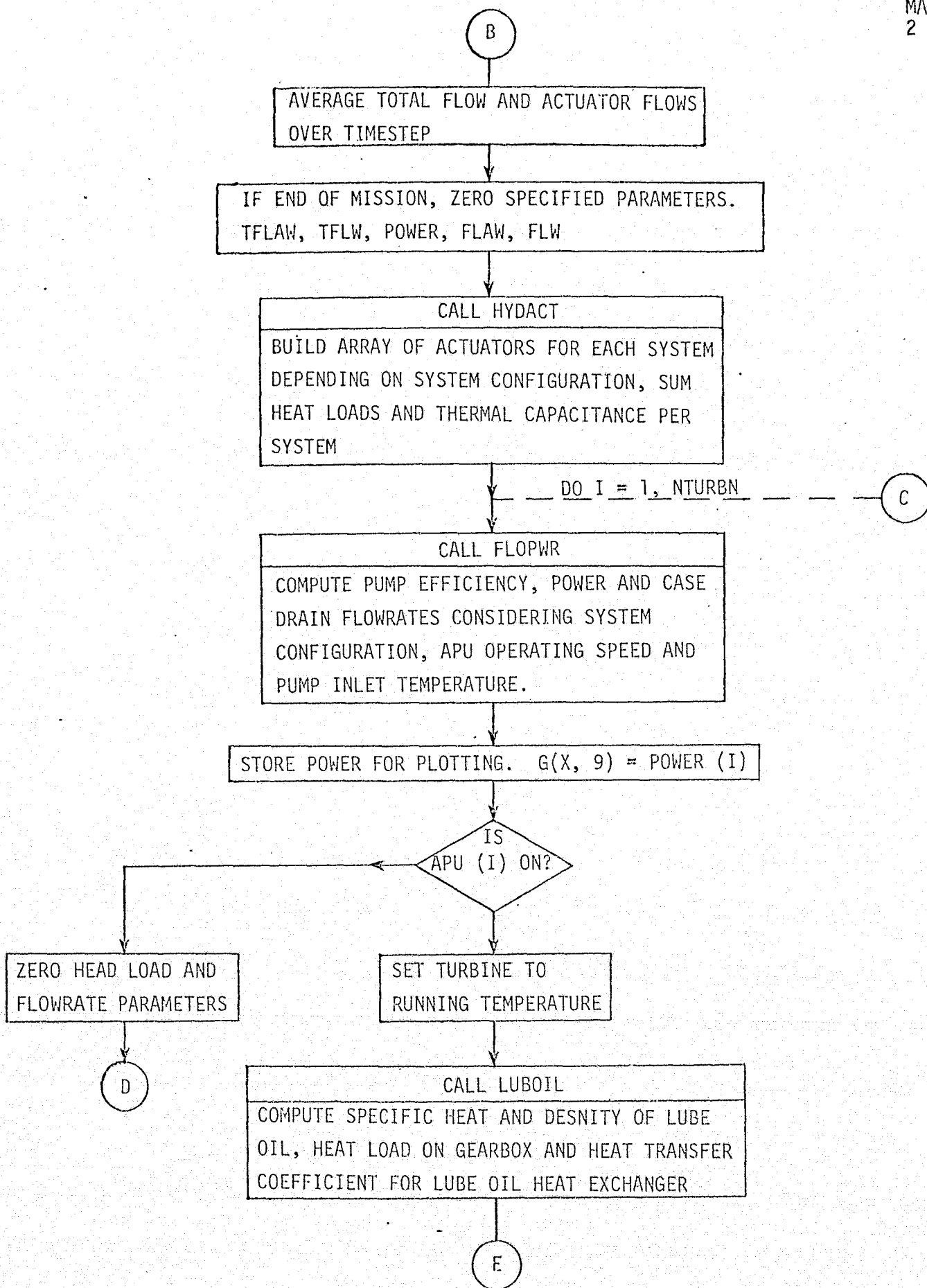
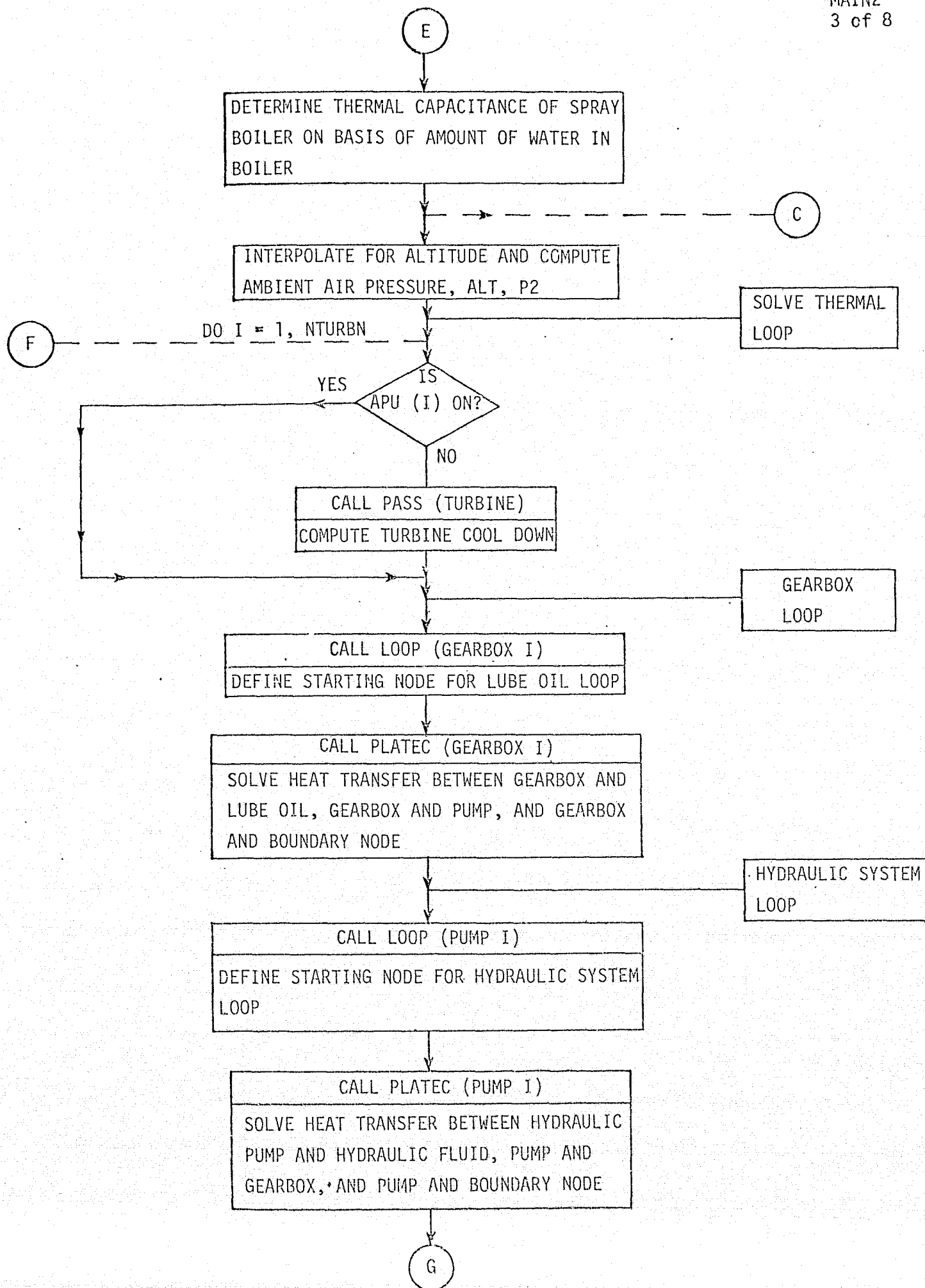


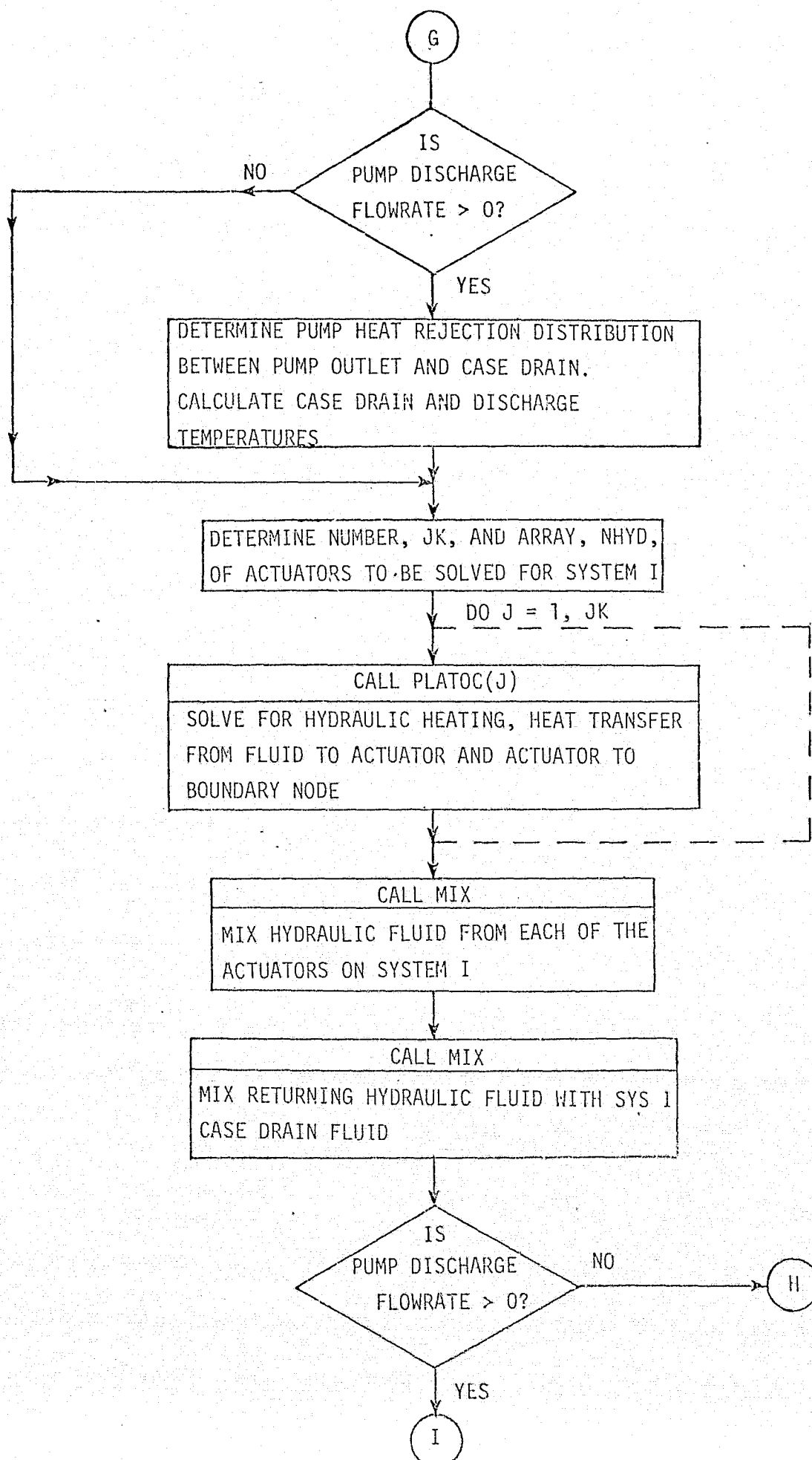
FIGURE 3-7 FUNCTIONAL FLOWCHART OF MAIN2

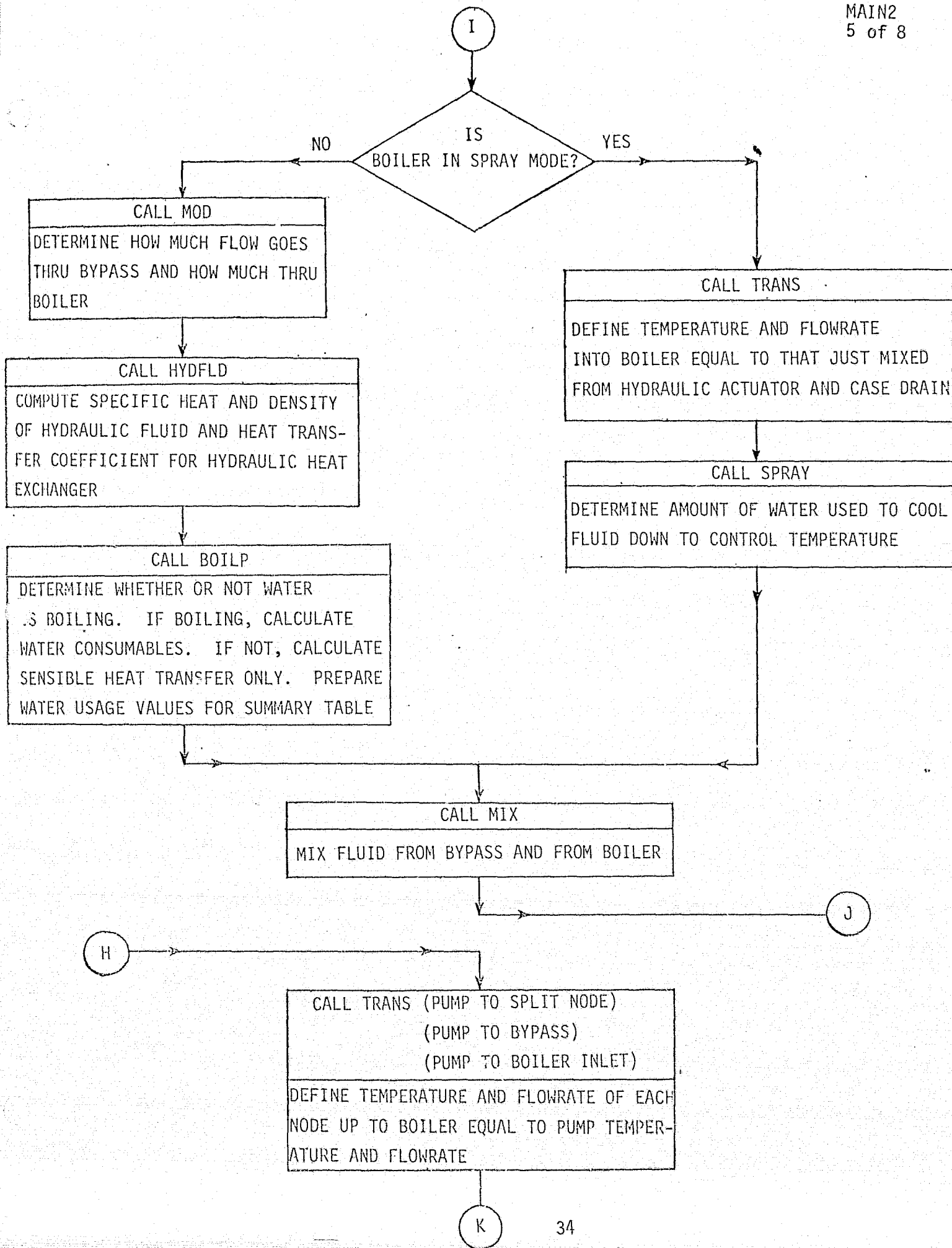
MAIN2
1 of 8

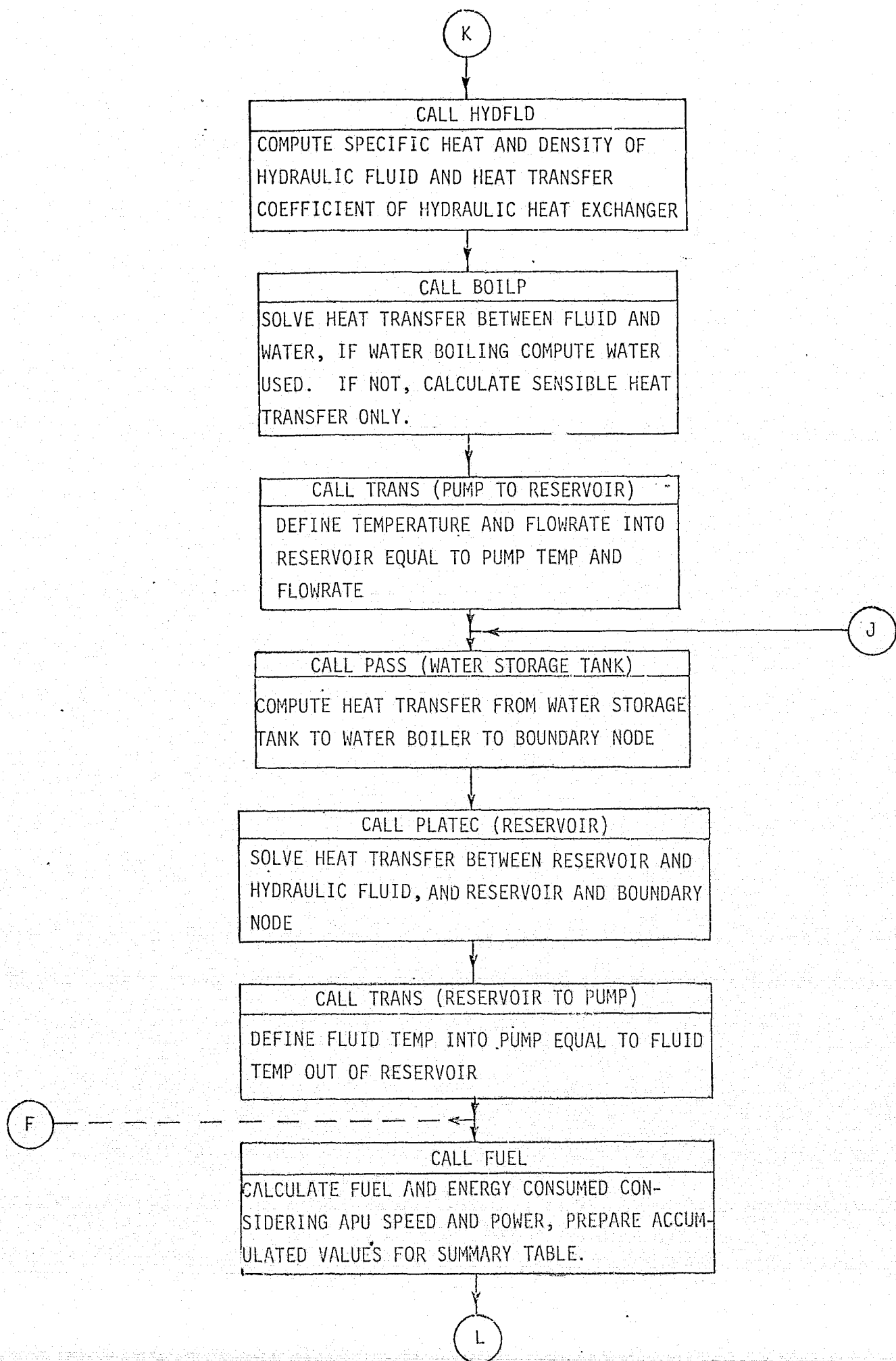


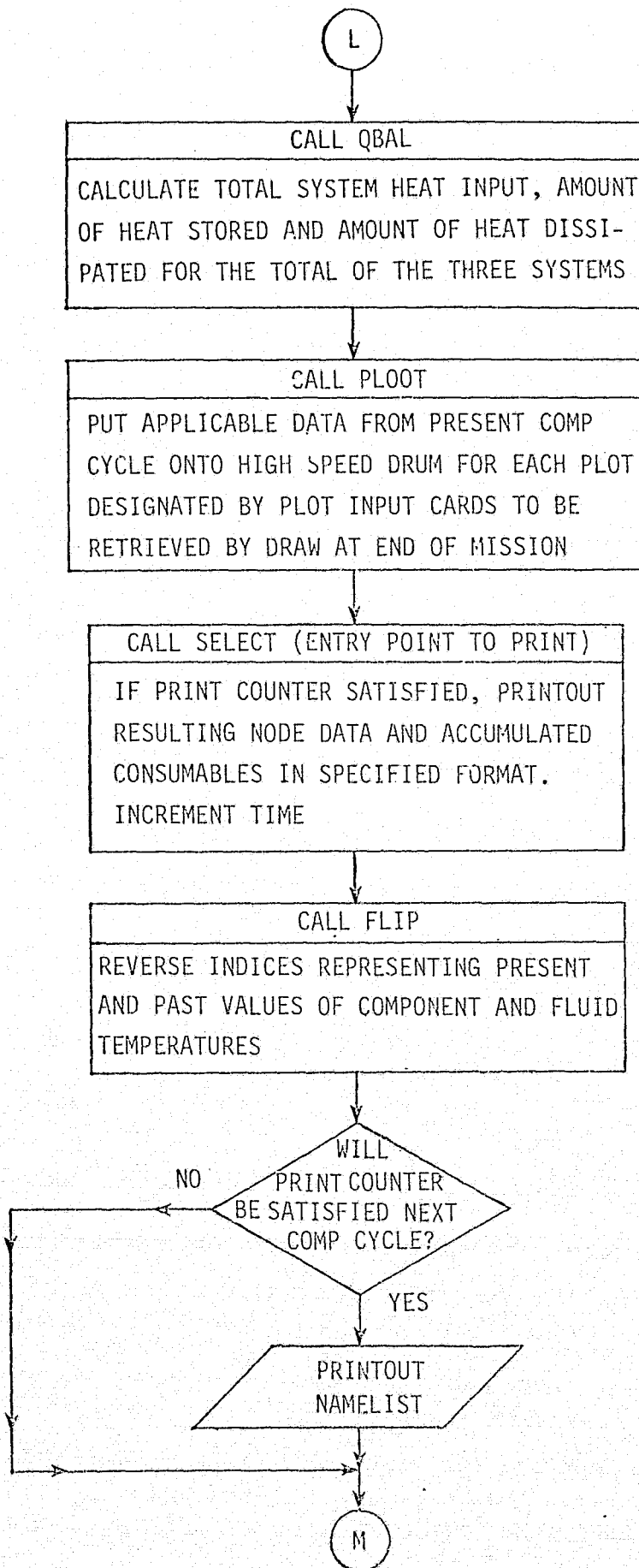


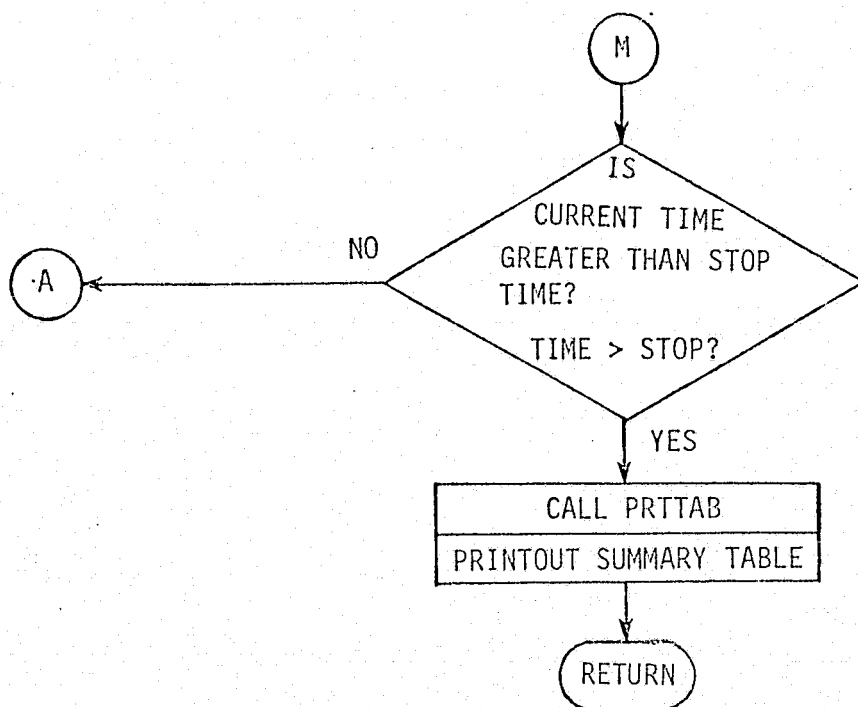












3.3 General Description of Subroutines

The following is a brief description of each of the subroutines called from either the ALT or OFT versions of the Thermal APU/ Hydraulics Analysis Program (TAHAP)

- BOILP - Determines sensible and evaporative heat sink performance of water boiler, computes and integrates consumption rates.
- DRAW - Retrieves data to be plotted from high speed drum, prepares it and calls the CALCOMP routines.
- FLIP - Reverses timing indices.
- FLOPWR - Computes pump efficiency, shaft horsepower, and case drain flowrate, converts flowrate units.
- FUEL - Calculates fuel rates, fuel and energy consumed and accumulates consumables preparing accumulated values for summary table.
- FUNC - Function subprogram which outputs value of polynomial curve fit evaluated at a given X.
- HYDACT - Uses system configuration flag and loss management matrix to build array of actuator system assignments.
- HYDFLD - Solves equations for specific heat and density of hydraulic fluid, computes heat transfer coefficient for water boiler hydraulic heat exchanger.
- ICNVRT - Converts node numbers to hollerith characters for plot titles.

- LILoad - Reads in line data and constructs necessary arrays.
(ALT model only)
- LINFLO - Defines the flowrates in the hydraulic lines.(ALT model only)
- LOOP - Defines current temperature of starting node of thermal loop equal to that node's most recent temperature solution.
- LUBOIL - Solves equations for specific heat and density of lubrication oil, computes heat transfer coefficient for tube oil heat exchanger.
- MIX - Determines resulting flow and fluid temperature from mixing of flow from several branches.
- MOD - Solves general equations to proportion flow split between two branches in response to prescribed temperature control location and proportional gains.
- PASS - Solves heat transfer equations for a passive (external to fluid loop) component.
- PLATE - Determines diffusion node heating.
- PLATO - Determines hydraulic and diffusion node heating.(Entry point to PLATE)
- PLATEC - Determines diffusion node heating for components thermally coupled to other components or boundary nodes.
- PLATOC - Determines hydraulic and diffusion node heating for components thermally coupled to other diffusion and/or boundary nodes. (Entry point to PLATEC)

- PLOOT - Puts data for requested CALCOMP plots onto high speed drum.
- PRINT (SELECT) - Provides print-out in specified format and updates time.
- QBAL - Performs a heat balance by computing the total heat in, total heat out, and total heat stored in the system for the purpose of error detection, and numerical error magnitude assessment.
- RSTART - Reinitializes node data for long missions. (OFT model only)
- SCAL - Performs scaling for CALCOMP plots, used by DRAW.
- START - Reads input data in specified formats and sets up coupling data.
- SPRAY - Presently used for simulating spray boiler and computing water consumed. Should be replaced as soon as spray boiler design data is available. (OFT model only)
- THERMP - Computes the heat loss in the hydraulic pressure lines from the pump to the actuators due to conduction, radiation, and convection coupling, determines actuator inlet fluid temperatures, and prints out line data. (ALT model only)
- THERMR - Computes the heat loss in the hydraulic return lines from the actuators due to conduction, radiation, and convection coupling, computes fluid branch mixing temperatures, and prints out line data. (ALT Model only)

TRANS - Transfers fluid temperature and flowrates from one node to another.

ZIPIT - Zeroes several arrays for line data calculations. (ALT only)

4.0 INPUT DATA DESCRIPTION

The thermal APU/Hydraulics Program (TAHAP) requires that several types of data be input. The data consists of systems data and mission timeline data, the specific data required is described in the following sections along with a note as to the mode of input (card or tape.) The format and units required for each data item as well as the input deck setup is described in Appendix A.

4.1 Systems Data

The systems data described here consisting of node thermal data, node coupling data, and the loss management and system configuration matrices must be input on cards. The hydraulic line data described in this section is input on tape and is for the ALT model only. In section 4.1.6 boundary conditions data which can be input is discussed briefly. The format and sequence of these cards are described in Appendix A.1.

4.1.1 Node Thermal Data

There are six thermal parameters which require definition at each diffusion node inlet. Four of these parameters need to be input while the remainder are computed within the program.

The parameters which must be input are:

1. Thermal capacitance, MC_p
2. Heat transfer coefficient, UA
3. Initial component temperature
4. Initial fluid temperature

The other two parameters are computed within the program and need not be assigned values on the node data card. These two parameters are,

1. Dynamic thermal capacitance (referred to as " WC_p " or "flowrate")
2. Heat load, $\dot{Q}$

Passive thermal nodes need only a value for the thermal capacitance and component temperature. Boundary nodes need only component temperature, and no data is required for arithmetic nodes. There must be a node data card for each node in the model regardless of whether or not any thermal parameters need to be specified for that node. Values will default to zero where a value is not given.

4.1.2 Node Coupling Data

The node coupling cards contain the following data:

1. I, J - the coupled nodes
2. UA_{ij} - conduction/convection coupling heat transfer coefficient
3. $\sigma \epsilon AF_{ij}$ - radiation coupling heat transfer coefficient.

There is a section of the START routine which rearranges this data such that one card for each pair of nodes will handle the coupling from I to J and conversely. The order of the nodes on the card is insignificant. There are several boundary nodes in the model strictly for coupling components to the vehicle structure and ambient air, the coupling cards for these node pairs also contain a flag for including heat loss to the structure in the heat balance equations in the subroutine QBAL.

4.1.3 Loss Management Matrix

The loss management matrix (LMMTRX) is one in which each row represents an actuator, and the first three columns represent the actuator's primary, first standby, and second standby systems, respectively. The fourth column is filled with zeroes for ease of manipulating the data. Each card has the actuator node number on it where it won't be read by the computer for ease in inserting or removing cards as the list of actuators changes. The data in the matrix for the present list of actuators is on Figure 4-1.

Figure 4-1 Loss Management Matrix

Primary	1st Standby	2nd Standby	Column of Zeroes	Actuator number
1	2	3	0	1
1	3	2	0	2
1	0	0	0	3
2	1	3	0	4
2	3	1	0	5
2	0	0	0	6
3	1	2	0	7
3	2	1	0	8
3	0	0	0	9
1	0	0	0	10
2	0	0	0	11
3	0	0	0	12
3	2	1	0	13
1	0	0	0	14
2	0	0	0	15
3	0	0	0	16
3	2	1	0	17
3	2	1	0	18
2	1	3	0	19
1	2	3	0	20
3	1	2	0	21
1	0	0	0	22
2	0	0	0	23

Loss Management Matrix (cont'd)

Primary	1st Standby	2nd Stanby	Column of Zeroes	Actuator number
3	0	0	0	24
2	3	0	0	25
1	3	0	0	26
2	3	0	0	27
1	3	0	0	28
1	3	2	0	29
1	3	2	0	30
1	0	0	0	31
1	0	0	0	32
1	0	0	0	33
1	0	0	0	34
1	0	0	0	35
1	0	0	0	36
1	0	0	0	37
1	0	0	0	38
2	0	0	0	39
3	0	0	0 (OFT mode1 only)	40
1	0	0	0	41
2	0	0	0	42
3	0	0	0	43

4.1.4 System Configuration Matrix

The system configuration matrix, IPDO, is comprised of each possible combination of pressurized, depressurized and off systems. Each row is input on a separate card with the row number in a column not read by the computer. This row number is used as the system configuration flag. The three columns represent systems 1, 2, and 3, respectively. After the system configuration flag is read from the input tape, the matrix is checked for the configuration of each system and computes the applicable pump efficiency and total system thermal capacitance and builds the arrays of actuators going to each system. The system configuration matrix is shown in Figure 4-2.

Figure 4-2 System Configuration Matrix

System 1	System 2	System 3	Configuration Flag
3	3	3	1
3	3	2	2
3	3	1	3
3	2	3	4
3	2	2	5
3	1	1	6
3	1	3	7
3	1	2	8
3	1	1	9
2	3	3	10
2	3	2	11
2	3	1	12
2	2	3	13
2	2	2	14
2	2	1	15
2	1	3	16
2	1	2	17
2	1	1	18
1	3	3	19
1	3	2	20
1	3	1	21
1	2	3	22
1	2	2	23
1	2	1	24
1	1	3	25
1	1	2	26
1	1	1	27

4.1.5 Line data (ALT model only)

The line data, which is read from a data tape contains the following information on each record.

1. the line number
2. a flag to distinguish between forward and reverse flow in system 1 landing gear circuit
3. coupling node number (structure node minus 250)
4. complete list of the actuators serviced by this line
5. the line number
6. line length
7. line diameter

4.1.6 Boundary conditions data (ALT model only)

The model is presently set up with an ambient air temperature vs altitude table hard coded into the subroutine BOUNDT. This table includes information for a typical cold day, hot day, and normal day profile. Another array of coefficients is hard coded in the routine which is used in the computation of secondary structure temperature and the vehicle compartment air temperature. The input required for this computation is a flag on the mission control card (described in Appendix A.1) which tells which type of ambient air profile is desired for the mission being analyzed. The computed structure temperature is stored in the component temperature locations for these same structure boundary nodes. Both values are used in determining the heat loss in the lines calculated in THERMP and THERMR. The structure temperatures are also used for the heat transfer solutions

for coupling between components and boundary nodes.

If a mission analysis is desired which needs a profile not provided by the subroutine, BOUNDT, the program can be modified to accept a timeline namelist of boundary temperatures. Values for each timestep can be found by interpolating between the values in the namelist in the same manner as the program interpolates for each altitude value. The data required in each set of the namelist profile would include:

1. The time at which the temperature values in the namelist apply
2. The secondary structure temperature
3. The vehicle compartment air temperature
4. The ambient air temperature.

4.2 Mission Timeline Data

For any mission analyzed a mission timeline input tape is required. The following data is required on each record.

1. Time, UPTIME
2. Actuator flowrates, FL
3. Total system flowrates, TFL
4. Pump shaft horsepower, SKIP (not used by TAHAP-power-values used are internally generated)
5. System configuration code, IFLAG1
6. APU operating speed flag, ISPD1
7. Vehicle load, GRAV
8. Altitude, ALT2

Although the set of actuators for OV-101 does not include some of the actuators that will be on the OV-102 vehicle there will be words on each tape record for all of the actuators. Since the last six actuators in the OV-102 list are not applicable to OV-101 their flowrates will be read into a different array and be ignored. Zeroes will be given for the flowrates of the actuators that are not applicable to the particular version being used. This procedure allows the input tape to be created in one standard format.

The specific format, data types, and units for the mission timeline tape are given in Appendix A.1.

5.0 OUTPUT DATA DESCRIPTION

The data generated by TAHAP is output in two forms; tabular data printout received every time the program is run and plots, from the CALCOMP plotter, which are only generated if desired. Although there is presently no capability in the program for graphic output via microfilm or microfiche, the tabular data printout may be output via microfilm or microfiche through the addition of a control card. The following sections describe the data generated by TAHAP, along with reference to the places in the program where the data is generated. Sample output is shown in Appendix E.

5.1 Tabular Data Printout

Each of the following sets of data, except the initial output is printed at the print frequency input on the run control card.

5.1.1 Input Data Printout

The first set of tabular data printout is generated by the START subroutine, and is a printout of the card input data. This set of printout consists of:

1. the node coupling data as it has been rearranged by START
2. the node thermal data initial values
3. the card images of the plot input data cards
4. the system configuration matrix
5. the loss management matrix

The next set of tabular data printout is generated by the LILoad subroutine, and is a printout of the line data input. (ALT model only)

1. Each line number, its coupling node and the list of actuators serviced by that line
2. A list of each line number with its location in the array of line numbers

5.1.2 Namelist Data

The namelist, UPDATE, is printed to show which timeline values were used in calculating the data that follows it. Some of this data is read from the timeline input tape and the rest is calculated internally. The parameters output via namelist are:

1. UPTIME, time to update information
2. Total system flowrates resulting from averaging
3. Actuator flowrates resulting from averaging
4. POWER, computed from averaged flowrate
5. SKIP, power values on the timeline tape
6. ALT2, altitude value read from timeline tape
7. ALT, altitude resulting from interpolation
8. IFLAG, system configuration code
9. ISPD, system operating speed flag.

5.1.3 Line heat losses (ALT model only)

Following the namelist output is the line heat loss output from THERMP and THERMR for each system.

1. The actuator number and the lines attached to them
2. The coupling node number
3. Line length

4. Inlet, outlet, and boundary temp for each line
5. Heat loss rates (BTU/min) and flowrate (gpm) in each line

This data for each system is followed by the total heat loss values for the lines on that system.

5.1.4 Boiler Water Level (ALT model only)

The amount of water (lbm) in the boiler and the amount of water (lbm) transferred from the storage tank to the boiler is tracked and is printed out for each system. These numbers are generated in MAIN1.

5.1.5 Heat Balance - Error Values

For the purpose of error detection the total heat input to the APU/hydraulic system is compared with the sum of the heat stored and the heat leaving the system. The values, computed for the three systems combined, are summed in the subroutine QBAL.

The eight values output are:

1. BTU's in due to main pump shaft power
2. BTU's in due to turbine heat leak
3. Total heat in
4. BTU's out by water boiloff
5. BTU's stored in capacitance
6. BTU's out due to coupling to structure
7. Total heat out
8. Total heat in - Total heat out

The titles for these columns of output are read from input cards.

5.1.6 BOILP Output

To track the operation of the water boiler (OV-101) and the pool

mode for the spray boiler (OV-102) the following values calculated in the subroutine, BOILP, are printed.

1. Inside boiler pressure, psia
2. Ambient air pressure, psia
3. The pressure difference, psia
4. The saturation temperature, °R
5. The boiling rate (BTU/min)
6. The flag to tell if the steam vent is choked (=2) or unchoked (=1)
7. The number of iterations required to find a pressure solution.

5.1.7 Actuator Node Number List

Due to the changes in system configuration throughout a mission, the list of actuators used by each system changes. A list of the actuators on each system is printed out each print interval. Due to the use of the loss management matrix without regard to isolation valves, an actuator will appear to be on its primary system even if it is isolated at the time or not applicable to a particular vehicle (i.e. engine and umbilical retract actuators listed on ALT missions.) The actuators have zero flowrates and have no effect on the system.

5.1.8 Node Thermal Data

The mission time and then the following data is printed out for each node in the INODES array which is defined in the main program.

1. Node number and name
2. Component temperature, °F

3. Inlet fluid temperature, °F
4. Thermal capacitance, C, BTU/°R
5. Heat transfer coefficient, UA, BTU/hr-°R
6. Dynamic thermal capacitance, wcp, $\frac{\text{lb BTU}}{\text{hr lb } ^\circ\text{R}}$
7. Heat load, Q, BTU/hr.

Some accumulated heat loss values are printed out in the "UA" column of the ALT version next to the structure nodes where there would ordinarily be zeroes. Following is a list of the structure node number and the value printed there.

- 250 - APU heat, system 1
- 251 - APU heat, system 2
- 252 - APU heat, system 3
- 253 - heat out by water, system 1
- 254 - heat out by water, system 2
- 255 - heat out by water, system 3
- 256 - line heat loss to air and structure, system 1
- 257 - line heat loss to air and structure, system 2
- 258 - line heat loss to air and structure, system 3
- 259 - component heat loss to air and structure, system 1
- 260 - component heat loss to air and structure, system 2
- 261 - component heat loss to air and structure, system 3

5.1.9 Accumulated Consumables

At the end of each set of node thermal data, the following consumables values are printed for each system.

1. accumulated water usage (lbm)
2. accumulated fuel usage (lbm)
3. accumulated energy usage (hp-hr)

5.1.10 Summary Table

At the end of the mission a consumables summary table which shows loaded and consumed values for fuel and water along with remaining margins is printed. The accumulated water values are tracked in BOILP and the accumulated fuel values are tracked in FUEL. The

summary table values are collected and printed out in the sub-routine PRTTAB. Several constants for the table are input from cards. The format and definition of these cards is in Appendix A.

5.2 Graphical Output

Several different parameters are available for plotting with no changes to the program. The parameters which will be stored on the CALCOMP tape on any given run will be determined by the input plot cards. The format of those cards is given in Appendix A.1.

On these cards there is a space for the plot type number associated with the type of plot desired. The following is a list of the available plot types with the type number. (Note: all plots have ground elapsed time as the independent parameter). Plot types 6-16 were designed for ECLSS and will not be enumerated.

1. fluid temperature (°F)
2. component temperature (°F)
3. flowrate (gpm)
4. heat rate (BTU/hr)
5. water remaining (lbm)
17. fuel used (lbm)
18. energy used (hp-hr)
19. fuel remaining (lbm)
20. ambient pressure
21. boiler pressure
22. miscellaneous; G(X,3) (boiling rate), altitude
23. miscellaneous; G(X,7) (error heat load values, power)

Due to the method of storage allocation in TAHAP, a node number is required for each plot card. For some type of plots this isn't applicable (i.e. power, altitude, fuel, and pressure) so these variables have been assigned to portions of the G-array or C-array as listed in Table C-1 or assigned an arbitrary number (use 35 for altitude.) The node number and plot type are used in PLOOT

along with the value of the plotting variable to put the necessary information onto high speed drum. Minor changes can be made within the PLOOT routine so that new parameters can be plotted as long as the variable needed is in COMMON.

The plot titles are processed in the subroutine DRAW and are based on the plot type number. The other support routines for DRAW are SCAL and ICNVRT.

If it is desired to change graphics routines, the PLOOT and DRAW routines can be deleted and replaced with a routine which generates a standard binary data tape with time as the first word on each record. With such a data tape several of the graphics packages available on EXEC 2 or EXEC 8 (e.g. STLPLT, TRWPLT) can easily be implemented.

6.0 SUBROUTINE REQUIREMENTS

This section consists of a detailed description of each subroutine called by either the ALT or OFT versions of TAHAP. The description includes each of the following items where applicable.

1. Identification
2. Purpose
3. Supporting Subroutines
4. Argument List Definitions
5. Common Block Reference
A list of the common blocks used by that routine along with each variable input or output from the routine by that block
6. Local Variable Definitions
7. Functional Flowchart
8. Subroutine Listing (see Appendix D)

Subroutine BOILP

Identification

Name - BOILP
Author/Company - T. DeLuna/MDTSCO
Machine/Language - UNIVAC 1108, EXEC 2 System/FORTRAN V

Purpose

To determine sensible and evaporative heat sink performance of water boiler and to compute water usage.

Argument List Definition

M - Inlet node of lube oil heat exchanger
M11 - Outlet node of lube oil heat exchanger
M2 - Inlet node of hydraulic heat exchanger
M32 - Outlet node of hydraulic heat exchanger
P2 - Ambient air pressure
EA - Effective steam vent orifice area
STVC - Steam valve closed flag
STVO - Steam valve open flag

Common Block Reference/Input-Output Variables

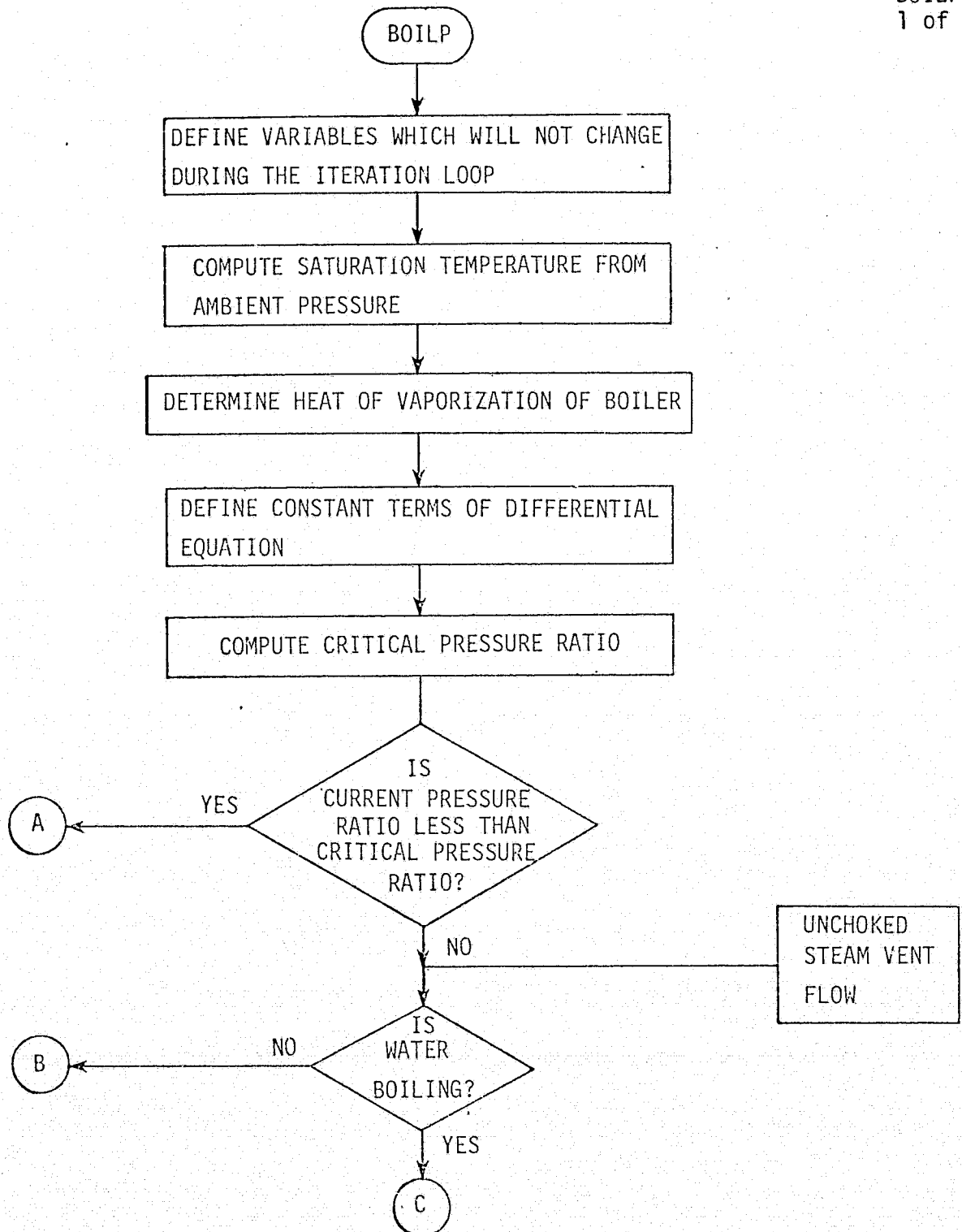
<u>Block Name</u>	<u>Input</u>	<u>Output</u>
ARRAY	G(M1,1)	G(M1,I)I=1,6, G(M2,I),I=1,6 G(M1,I)I=8,9, G(M2,I),I=8,9 FLAG, ITER
BLANK COMMON	P(M1,L), P(M2,L), F(M1,L) F(M2,L), C(M1,3), C(M2,3) IDUM(L), DELT	P(M11,6), P(M22,L), F(M11,L) F(M22,L), C(M11,3), C(M22,3)
COMEVP	IWAT	WAT, DW, WATLFT
TYME	TIMSUM	SUMARY(I,J), I=15,17, J=1,3

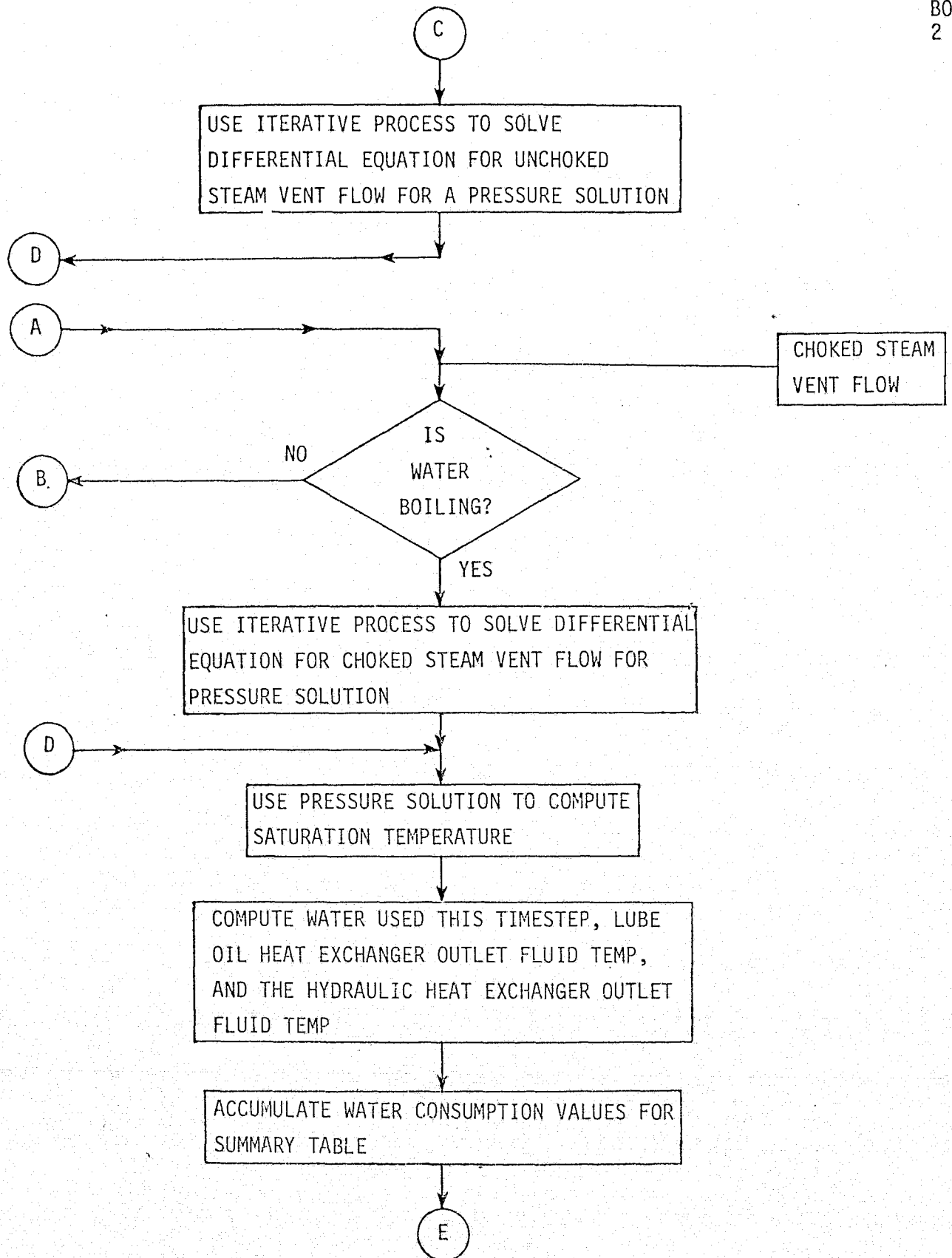
Local Variable Definitions

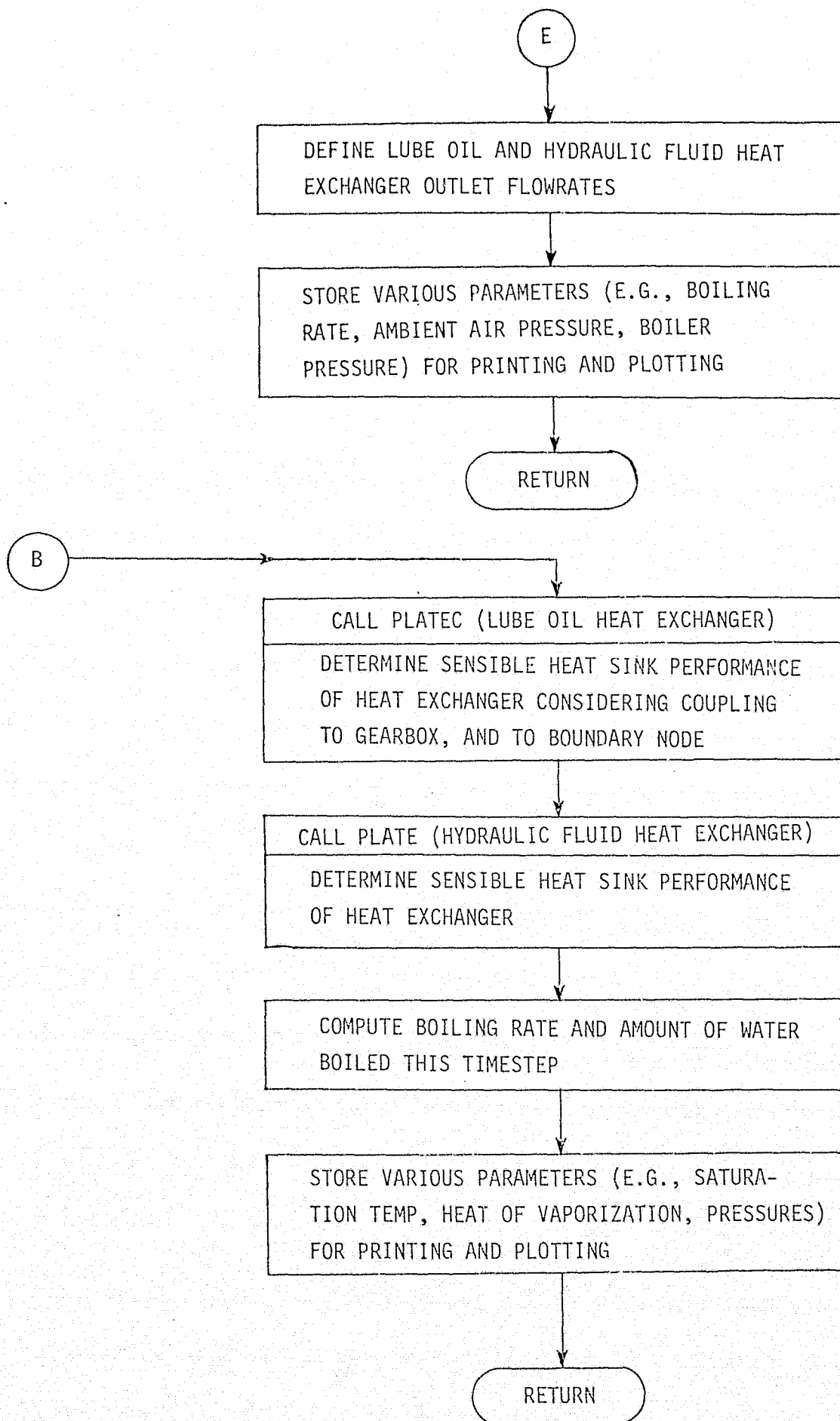
<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
A	R		} Constants derived for conversion from pressure to saturation temperature from subroutine DEWPT in FEAR
B	R		
C	R		
COEF	R		Constants for determining heat of vaporization from temperature
CRTPR	R		Critical Pressure ratio
DELW	R	lbm.	Water boiled this timestep
DELTAP	R	PSIA	Pressure difference (ambient-boiler)
FLAG	R		Flag for type of flow, 1=unchoked, 2=choked
GAMMA	R		Ratio of specific heats for steam
GRAV	R	ft-lbm/lbf-sec ²	Conversion from lbf to lbm
H	R		Heat of vaporization
ITTER			Number of iterations to get a pressure solution
PI	R	PSIA	Boiler pressure
PIDOT	R		Time derivative of boiler pressure
PIOLD	R	PSIA	Pressure calculated last comp cycle
TEMPS	R	°R	Saturation temperature
WMDOT	R	lbm/hr	Boiling rate
WNDOT	R	lbm/min	Boiling rate

FIGURE 6-1 FUNCTIONAL FLOWCHART FOR BOILP

BOILP
1 of 3







Subroutine BOUNDT (101 only)

Identification

Name - BOUNDT

Author/Company - C. A. Zook/MDTSCO

Machine/Language - Univac 1108, EXEC 2 System/FORTRAN V

Purpose

To determine the ambient air temperature and calculate the structure temperature and the compartment air temperature at each of the boundary nodes.

Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
ALTD	ALT	
Blank Common	IDUM(19), P(M,K),M=250,261 F(M,K),M=250,261	DUM(2), P(M,L),M=250,261 F(M,L),M=250,261

Local Variable Definitions

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
ALTEMP(X,1)	R	ft	Altitude values for table look-up
ALTEMP(X,2)	R	°R	Cold Day ambient air temp for corresponding altitude
ALTEMP(X,3)	R	°R	Hot Day ambient air temp for corresponding altitude
ALTEMP(X,4)	R	°R	Normal Day ambient air temp for corresponding altitude
BTEMP	R	°R	Ambient air temp at current altitude for predetermined type of environmental condition
FACTK	R	$\frac{1}{\text{sec}}$	Coefficients used in determining boundary temps

Subroutine DRAW

Identification

Name - DRAW
Author/Company - FEAR/TRW with major modification by G. Steines/MDTSCO
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To retrieve the plot data from high speed drum, rearrange it, prepare scaling and call CALCOMP routines.

Supporting Subroutines

CCP - CALCOMP routines
CDATE - Checks date for plot title
ICNVRT - Converts numeric to hollerith for plot title
SCAL - Performs x and y - axis scaling

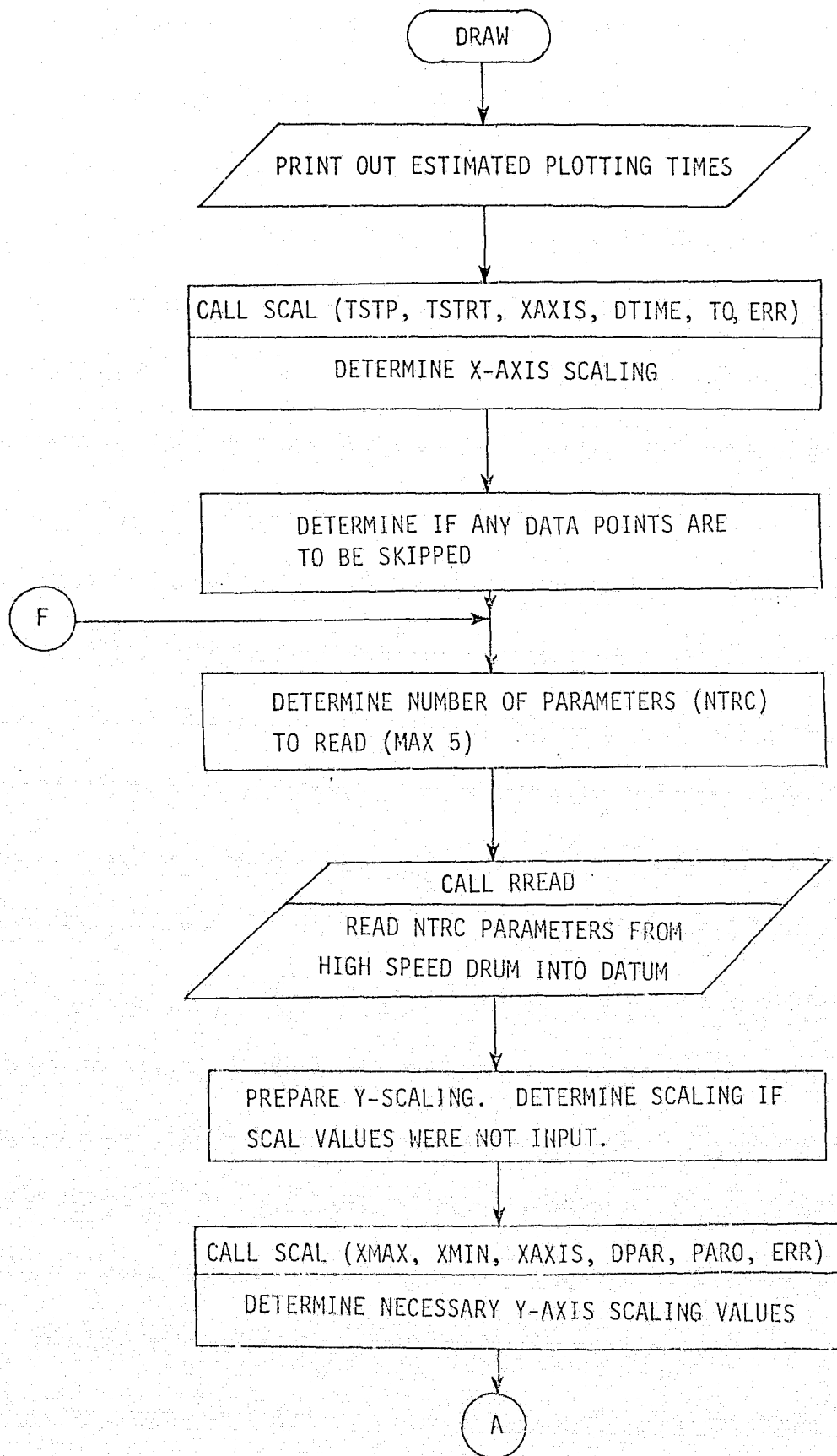
Common Block Reference/Input-Output Variables

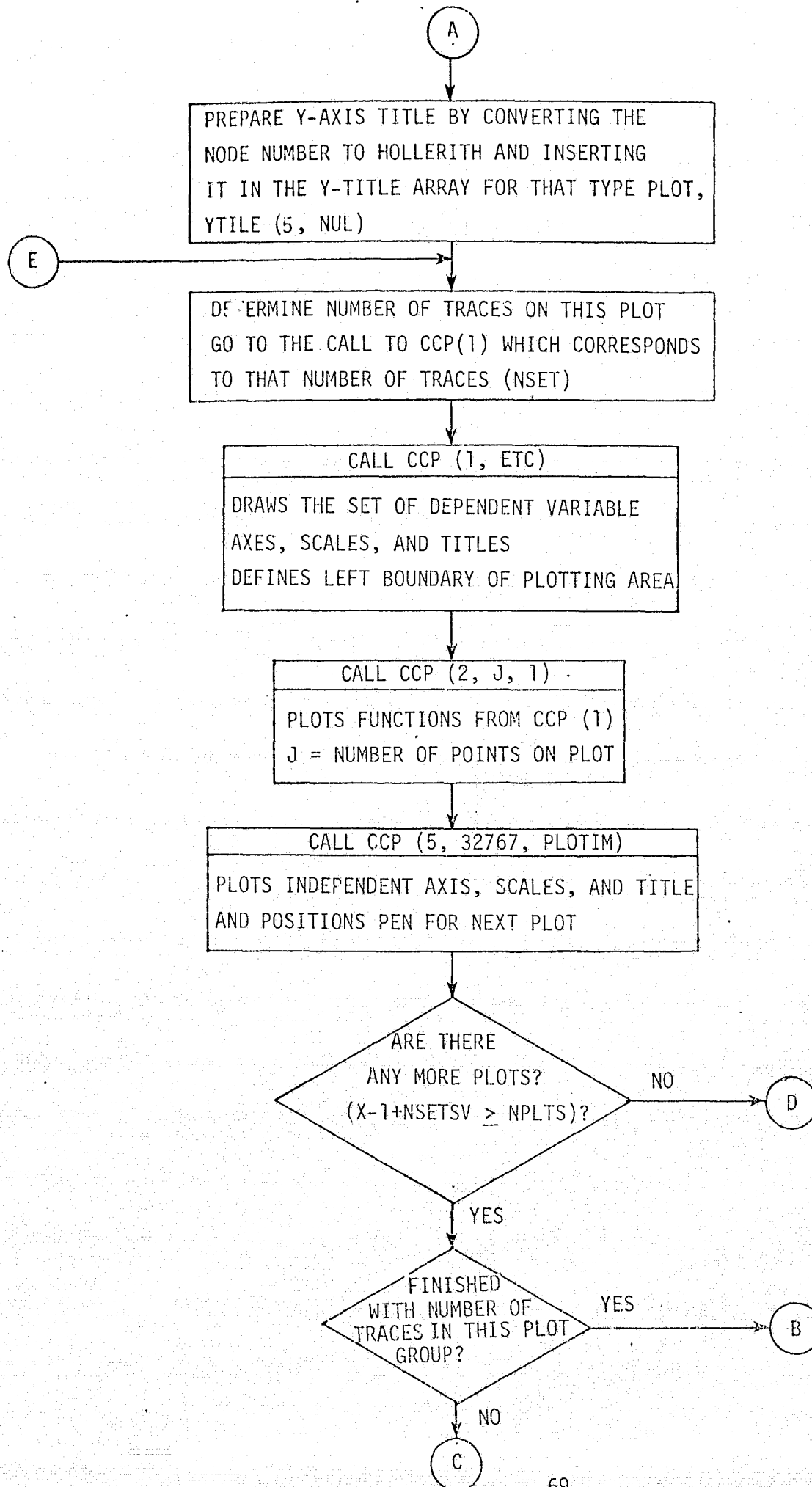
<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	DUM(25)	
LUMP2	TITLE, BIG, WFE	
PSST	NPLTS,IPLT,JPLT,TSTP,XAXIS YAXIS,NOPLT,NPLPTS,NTR, JWRADR,IRDADR	

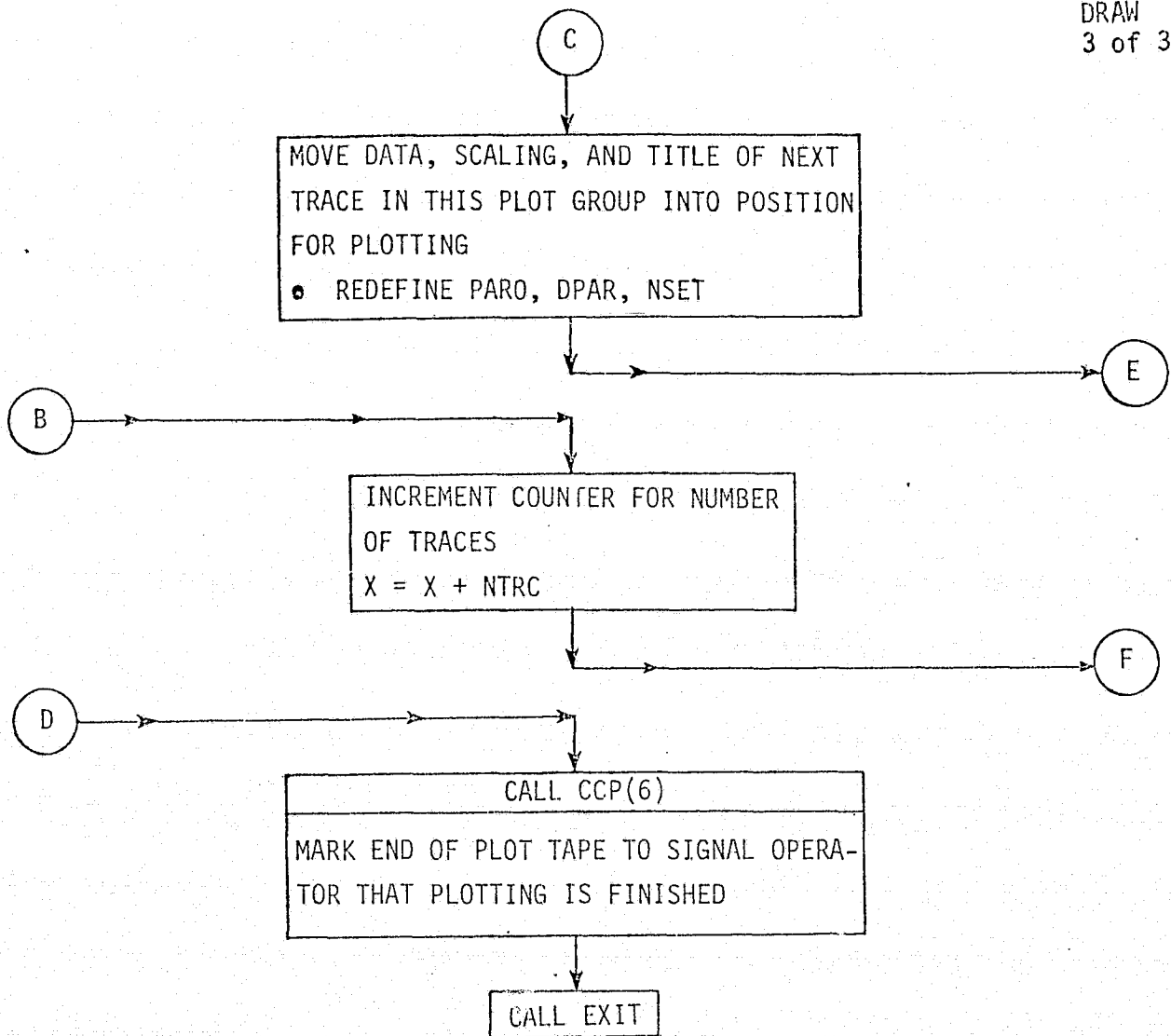
Local Variable Definitions

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
ALPHA	R		Array of data for 1st trace in group
BETA	R		Array of data for 2nd trace in group
BIG	R		Max value for y-axis (input)
DATUM	R		Array containing data for all the traces in the group
DPAR	R	66	Delta y value for y-axis

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
DTIME	R	hrs	Delta x value for x-axis
GAMMA	R		Array of data for 3rd trace in group
IDIV	I		Counter for frequency of points skipped
IPLT	I		Node number of parameter being plotted
IRDADR	I		Location on drum at which to start reading data
ISAVAD	I		Storage variable for starting location of data on drum
IWRADR	I		Location on drum at which
KTRL	I		Flag for direction of plot on paper roll
NIP	I		Counter used to determine whether
NNPLTS	I		Number of plots plus 1 (x)
NSET	I		Number of traces on plot
NSETSV	I		Total number of traces in this group of 5 (max)
PARO	R		Starting value on y-axis
PHI	R		Array of data for 4th trace
REST	R		Array into which to put data from record of high speed drum just read
STIMS	R		Array containing X values
THETA	R		Array of data for 5th trace
TITEL	I		Array containing number of y-titles to use for current group
TO	R		First value on X-axis
YTILE	I		Hollerith array of y-axis titles
XMAX	R		Max value for y-axis (determined)
XMIN	R		Min value for y-axis (determined)







Subroutine FLIP

Identification

Name - FLIP

Author/Company - FEAR/TRW - this routine formerly part of PRINT routine

Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To reverse values of timing indices K and L, to update values for cycling fluid and component temperatures.

Common Block Reference/Input-Output Variable

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Block Common	K,L	K,L

No functional flowchart necessary

Subroutine FLOPWR

Identification

Name - FLOPWR
Author/Company - T. DeLuna/MDTSCO
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To compute pump efficiency shaft horsepower and case drain flowrate.
Also converts units on flowrate from gal/min to lbm-BTU/hr-lbm-°R considering a constant specific heat and density.

Support routine

FUNC - Function subprogram which outputs value of polynomial curve fit evaluated at a given X.

Argument List Definition

I - System no.
N - Node number counter - used to differentiate between identical nodes on each system.

Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	F(N+4,K)	C(N+I,3), I=4,6
HYD	IPDO, ISPD, IFLAG TFLW	POWER
PRESR	PDRP	

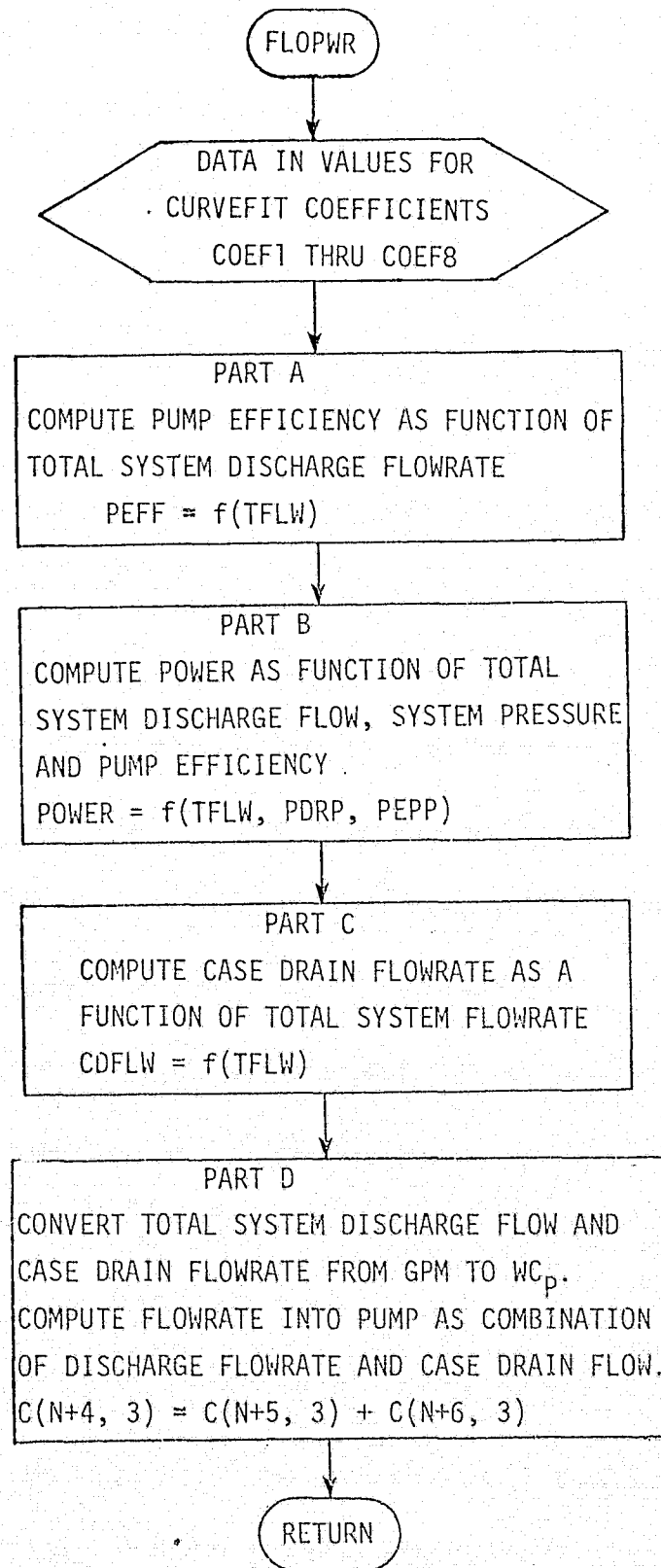
Local Variable Definition

• COEF1 thru COEF5 are used to calculate pump efficiency from total system flowrate

- COEF6 thru COEF8 are used to calculate case drain flowrate from total system flowrate

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
CDFLW	R	gal/min	Case drain flowrate at current temperature
CDH	R	gal/min	Case drain flowrate at 240° - pressurized
CDL	R	gal/min	Case drain flowrate at 105° - pressurized
COEF1	R		Coeff. for pressurized mode, 100% speed $TFLW \leq 10$ gpm
COEF2	R		Coeff for pressurized mode, 100% speed $10 \text{ gpm} < TFLW \leq 70$ gpm
COEF3	R		Coeff. for pressurized mode, 110% speed $TFLW \leq 10$ gpm.
COEF4	R		Coeff. for pressurized mode, 110% speed $10 \text{ gpm} < TFLW \leq 70$ gpm.
COEF5	R		Coeff. for depressurized mode
COEF6	R		Coeff for depressurized mode
COEF7	R		Coeff for pressurized mode, 105°F fluid
COEF8	R		Coeff for pressurized mode, 240°F fluid
ICNFIG	I		Operating configuration 3=Pres, 2=Depress, 1=off
M	I		Operating speed flag, 1=100%, 2=110%
PEFF	R		Pump Efficiency
Q	R	gal/min	Total system flowrate

FIGURE 6-3 FUNCTIONAL FLOWCHART FOR FLOPWR



Subroutine FUEL

Identification

Name - FUEL

Author/Company - T. DeLuna/MDTSCO

Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To determine accumulated fuel and energy consumed, fuel remaining and prepare accumulated fuel usage values for summary table.

Argument List Definition

TOTFUL - total fuel loaded or total usable fuel depending on form of fuel plot required (defined in MAIN)

P2 - ambient air pressure

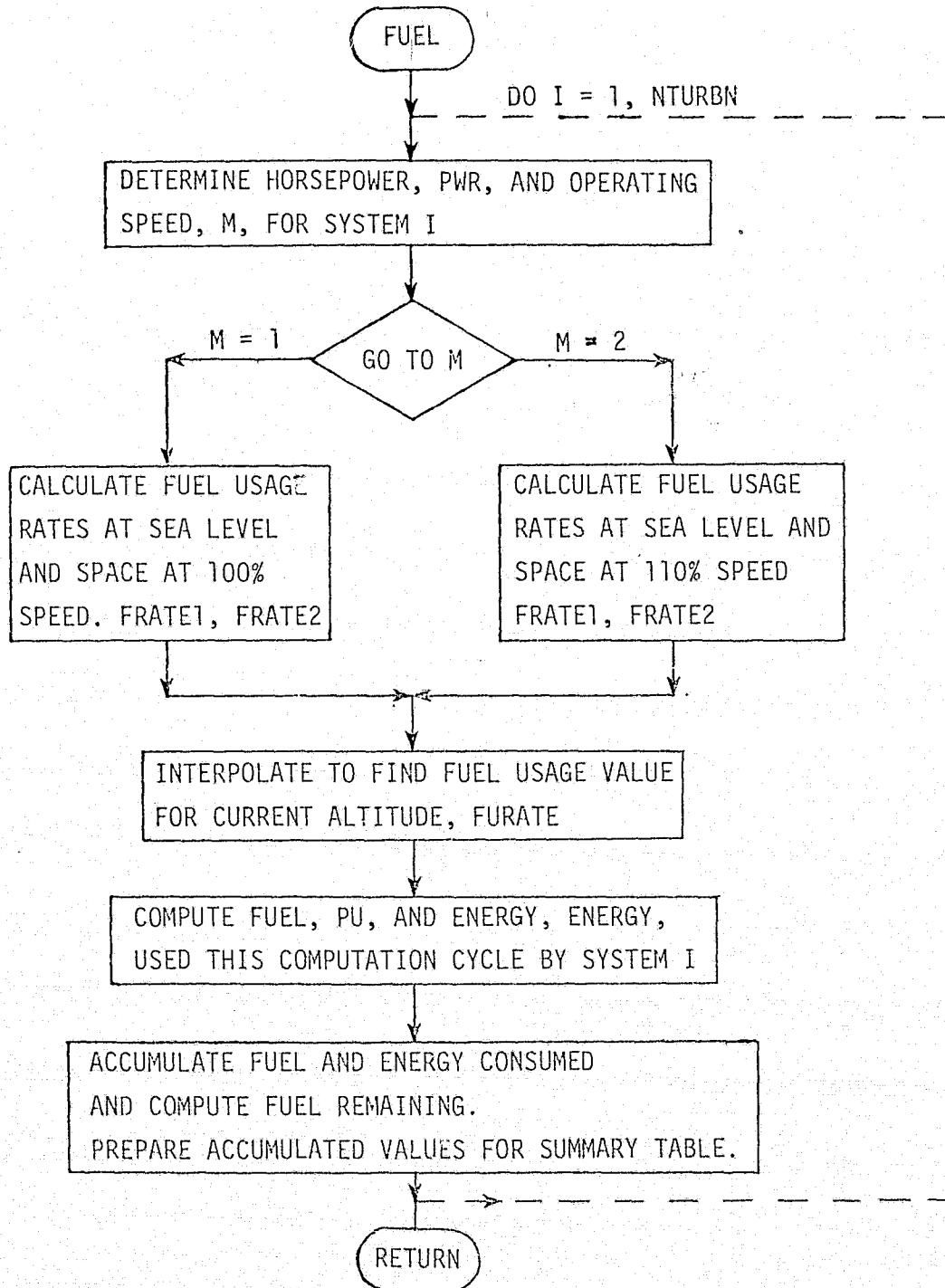
Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	TIME, DELT	C(I,J), I=275,277, J=17,19
TYME	TIMSUM	SUMARY(I,J), I=5,7, J=1,3
HYD	POWER, ISPD	

Local Variable Definitions

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
BAND	R		Value for creating band around time value so that summary table values will only be computed once.
ENERGY	R	hp-hrs	Energy consumed on current comp cycle
FRATE1	R	lbm/hr	Fuel usage rate at sea level
FRATE2	R	lbm/hr	Fuel usage rate in space
FURATE	R	lbm/hr	Fuel usage rate at current altitude
M	I		Operating speed flag, 1=100%, 2=110%
PU	R	lbm	Fuel consumed on current comp cycle
PWR	R	hp	Shaft horsepower for current system

FIGURE 6-4 FUNCTIONAL FLOWCHART OF FUEL



Function Subprogram FUNC

Identification

Name - FUNC

Author/Company - C. Avis/LEC

Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To output value of a polynomial current fit at a given X.

Argument List Definition

E - array name for coefficients being used

X - variable at which to evaluate the polynomial

FUNC - the value of the polynomial at X.

No functional flowchart necessary

Subroutine HYDACT

Identification

Name - HYDACT
Author/Company - T. DeLuna/MDTSCO
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To build the arrays of actuators assigned to each system for specified system configuration and to compute the resultant total thermal capacitance and heat load on each system.

COMMON Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	C(X,1), X=1,43, C(X,4) X=1,43	IDUM(I) I=1,13
ACT	NACT, FLW	NHYD, NHYOUT,
HYD	IPDO, LMNTRY, IFLAG	
PRESR	PDRP	

Local Variable Definitions

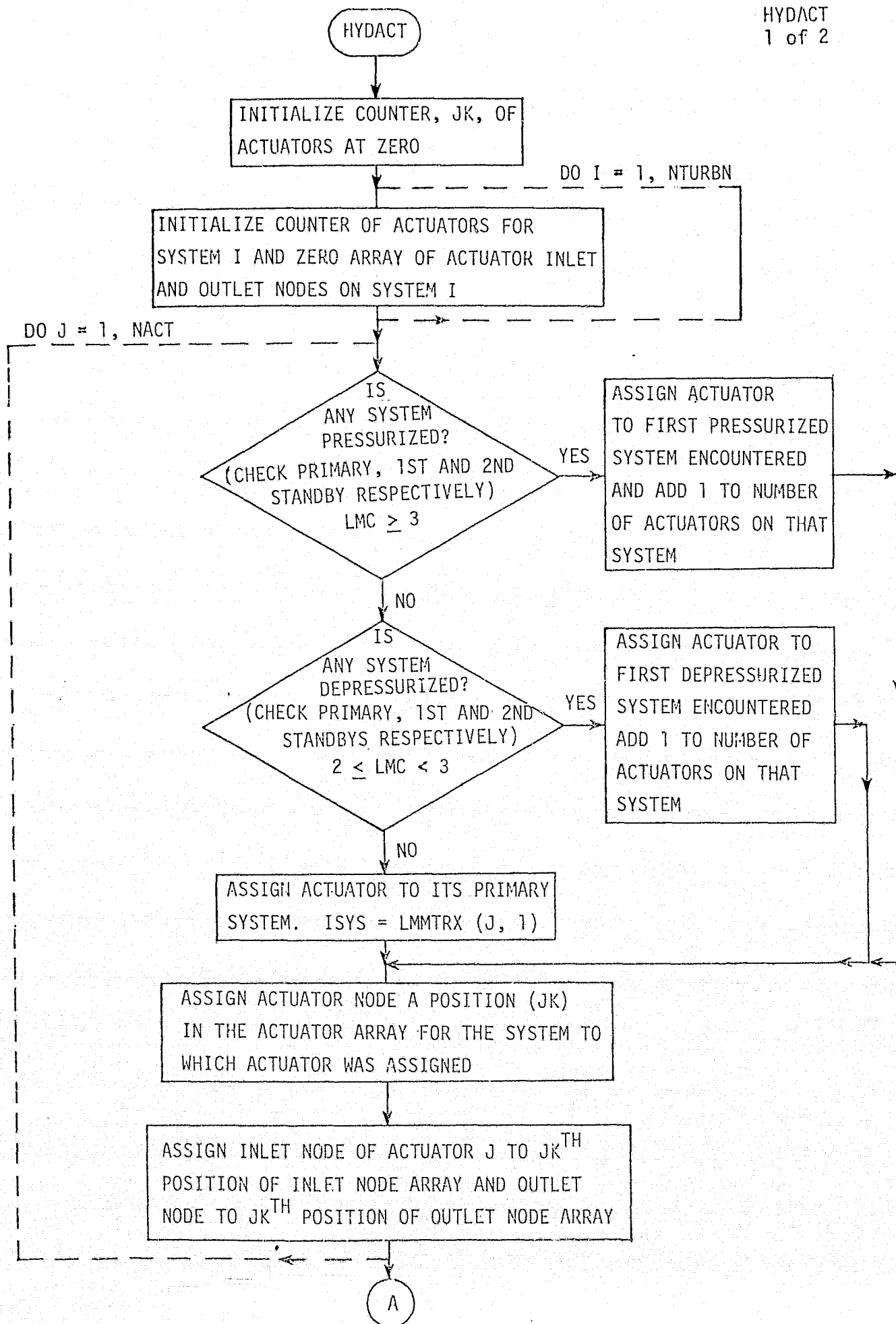
<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
ICNFIG	I		Operating, configuration, 3-pressurized 2=depressurized, 1-off
ISYS	I		System number found in loss management matrix. Final value is system that a particular actuator is on for current comp cycle.
J	I		Index used for each actuator.
JK	I		Position of actuator in actuator array for system just assigned to
JL			Total number of actuators on each system
LM	I		Column of loss management matrix being checked

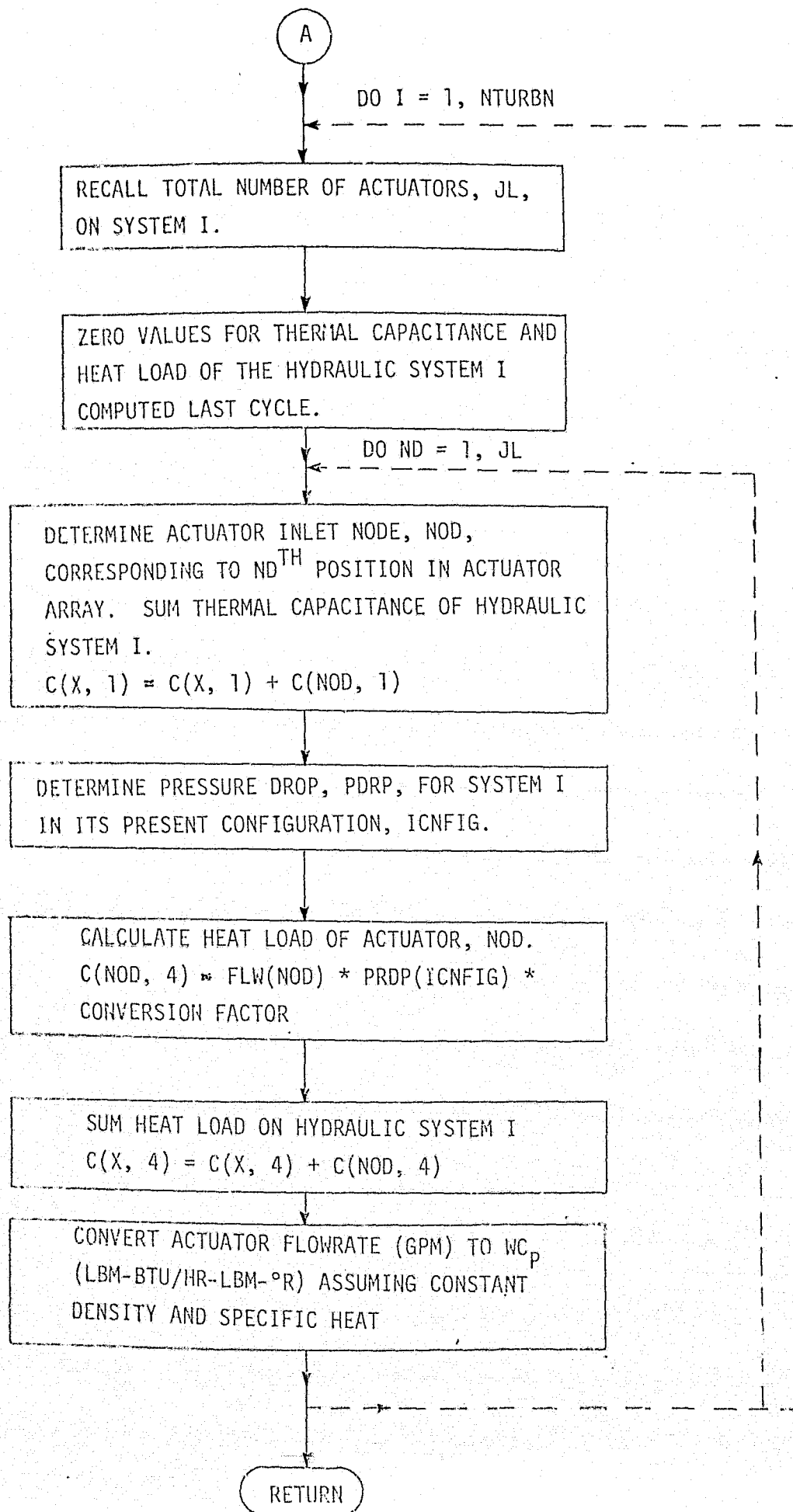
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Name	Type	Units	Description
LMC	I		Operating mode of column of matrix being directed
NOD	I		Actuator number on sys I

FIGURE 6-5 FUNCTIONAL FLOWCHART OF HYDACT

HYDACT
1 of 2





Subroutine HYDFLD

Identification

Name - HYDFLD
Author/Company - T. DeLuna/MDTSCO
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To compute specific heat and density of the hydraulic fluid and the heat transfer coefficient for the hydraulic heat exchanger.

Support Routine

FUNC - outputs value of a polynomial curve fit at a given X.

Argument List Definition

I - System number

N - Node number counter - used to differentiate between identical nodes on each system

Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	F(X,K),K,C(X,3)	C(X,2)
PRESR		SPH, DENS

Local Variable Definitions

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
CPCOEF	R		Coeff. for calculating specific heat of hydraulic fluid
RHOCOF	R		Coeff for calculating density of hydraulic fluid
TEMP	R	°R	Fluid temperature

No functional flowchart necessary.

Function Subprogram ICNVRT

Identification

Name - ICNVRT
Author/Company - FEAR/TRW
Machine/Language - UNIVAL 1108, EXEC 2 system/FORTRAN V

Purpose

To convert an integer number to hollerith characters so that they can be included in the plot title.

Argument List Definition

II - Node number of node being plotted.

Local Variable Definition

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
IIA	I		Digit holding hundredths place of node no.
IIIO	I		Digit holding times place of node no.
IIl	I		Digit holding units place of node no.

No Functional Flowchart Necessary

Subroutine LILOAD (ALT model only)

Identification

Name - LILOAD
Author/Company - J. L. Walker/MDTSCO
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To read in line data and construct actuator-time matrix.

Common Block Reference/Input-Output Variables

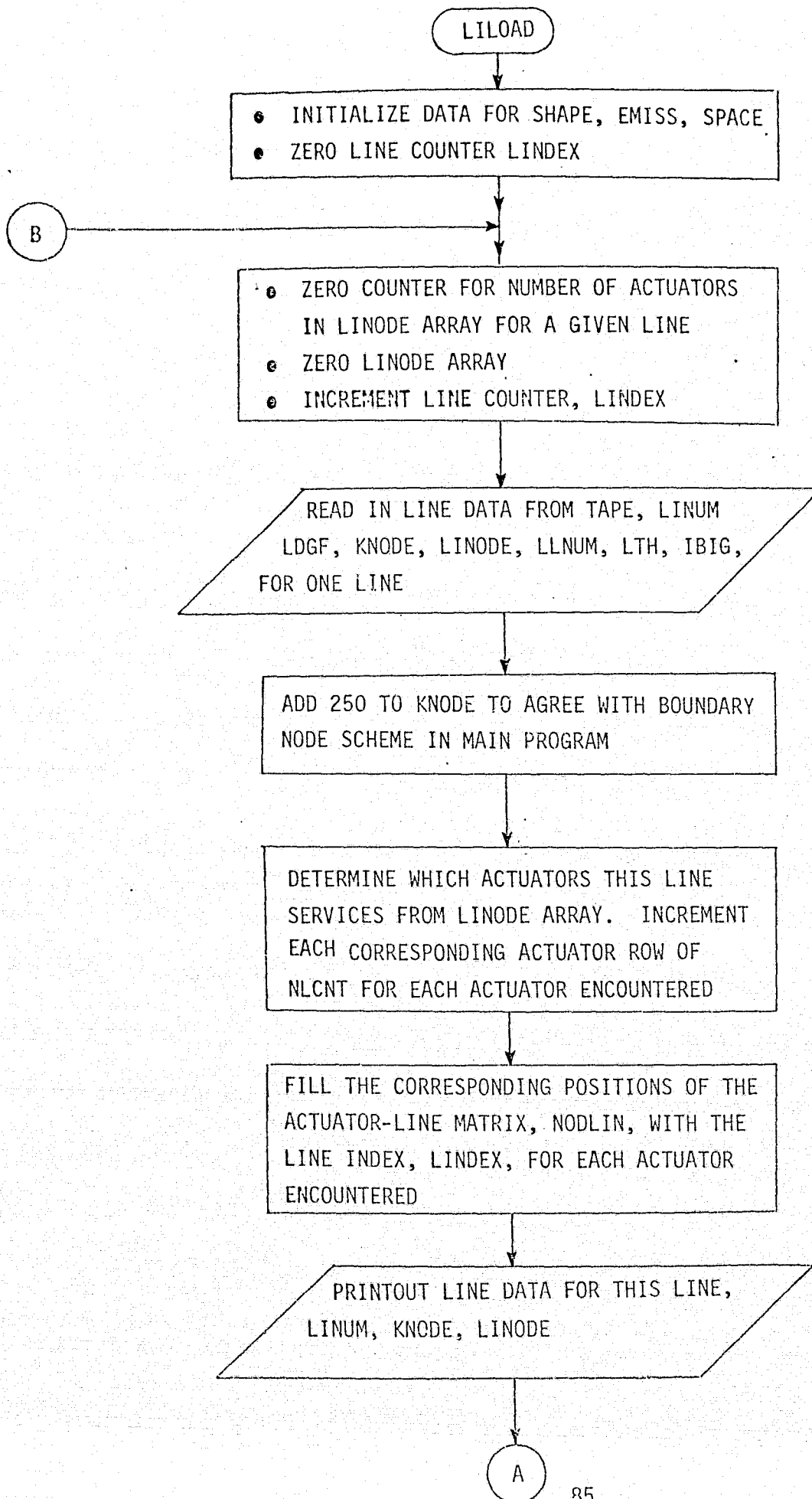
<u>Block Name</u>	<u>Input</u>	<u>Output</u>
LINES		LINUM, LDGF, KNODE, LTH, IBIG, SPACE, NODLIN, NLCNT SHAPE, EMISS

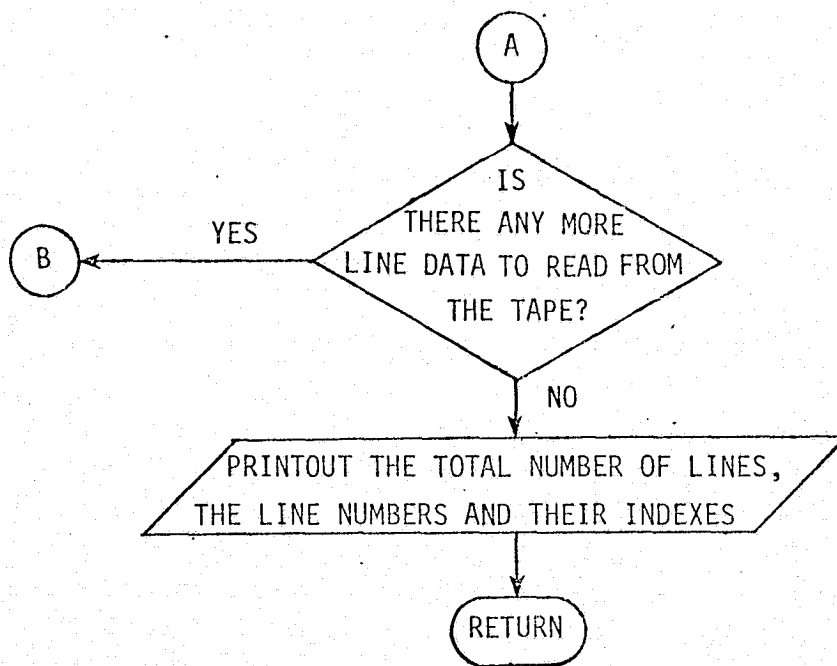
Local Variable Definition

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
LINODE	I		Array of actuator nodes serviced by line, LLNUM
LLNUM	I		Line number
LNCNT	I		Index for LINODE array
LN	I		Actuator node in LNCNT of LINODE array
NLCNT	I		Counter for number of lines servicing a particular actuator
NL	I		Column number in actuator-line matrix of the line index number

FIGURE 6-6 FUNCTIONAL FLOWCHART FOR LILOAD

LILOAD
1 of 2





Subroutine LINFLO (ALT model only)

Identification

Name - LINFLO
Author/Company - J. L. Walker/MDTSCO
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To compute the flowrate in each of the hydraulic lines.

Argument List Definition

IS - System number

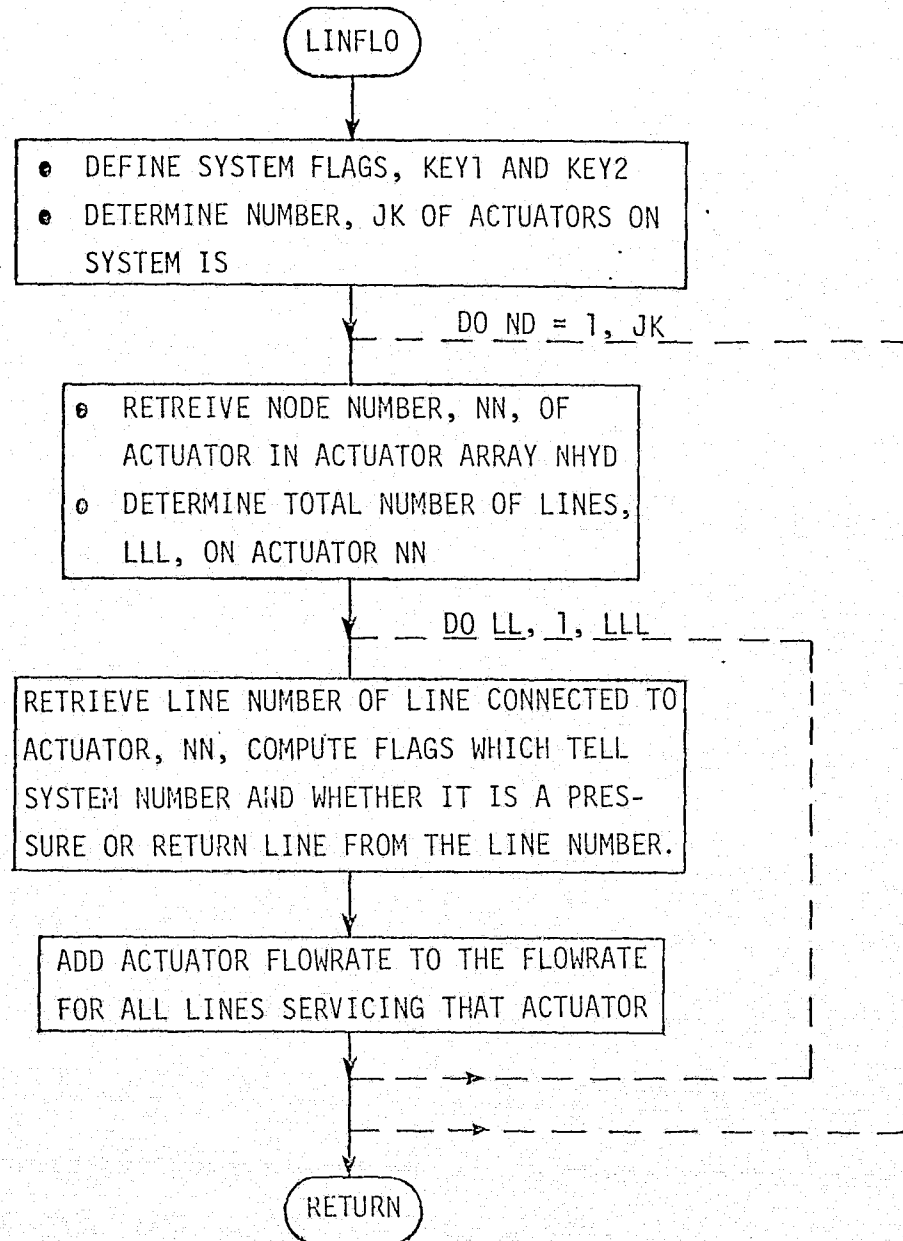
Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	IDUM	
.ACT	NHYD,FLW	
LINES	LDGF,LINUM,NLCNT NODLIN	FLOWL

Local Variable Definition

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
INTG1	I		First two digits of line number
INTG2	I		First digit times 10
INTG3	I		2nd digit of line number. Line is pressure line if off, return if even.
KEY1	I		System flag for pressure lines
KEY2	I		System flag for return lines
JK	I		Number of actuators on system IS
LLL	I		Number of lines servicing actuator NN
NN	I		Actuator node on system IS

FIGURE 6-7 FUNCTIONAL FLOWCHART FOR LINFLO



Subroutine LOOP

Identification

Name - LOOP

Author/Company - FEAR/TRW

Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To define starting node of thermal loop with most recent fluid temperature.

Argument List Definition

N - node to be updated

Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	F(N,K)	F(N,L)

No Functional Flowchart Necessary

Subroutine LUBOIL

Identification

Name - LUBOIL
Author/Company - T. DeLuna/MDTSCO
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To compute specific heat and density of the lubrication oil, the flowrate, WC_p , through the gearbox assuming constant flowrate in gal/min and the heat transfer coefficient of the lube oil heat exchanger.

Argument List Definition

I - System number
N - Node number counter - used to differentiate between identical nodes for each system.

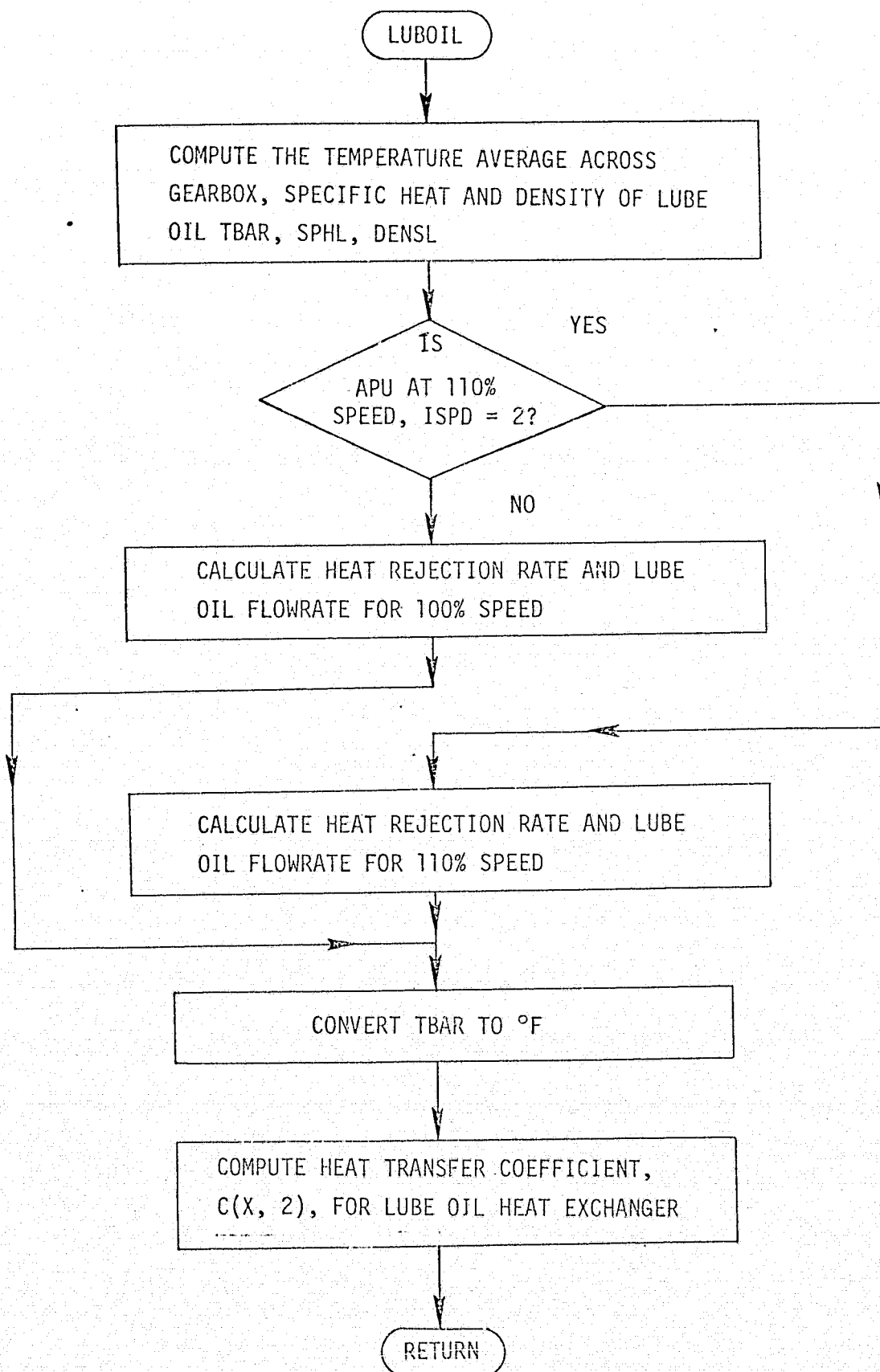
Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	K, F(N+1,K)	C(N+2,2), C(N+1,3), C(N+1,4)
HYD	ISPD, POWER	

Local Variable Definitions

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
DENSL	R	lb/ft ³	Density of lube oil
SPHL	R	BTU/lb °R	Specific heat of lube oil
TBAR	R	°R	Average of temperature across gearbox

FIGURE 6-8. FUNCTIONAL FLOWCHART OF LUBOIL



Subroutine MIX

Identification

Name - MIX

Author/Company - FEAR/TRW

Machine/Language - UNIVAC 1108/EXEC 2 system/FORTRAN V

Purposes

To determine resultant fluid flowrate, WC_p , and temperature when mixing fluid flow from two or more branches.

Argument List Definition

N - Node resulting from mix

NODES - Number of nodes to mix into N

INDEX - Array of nodes to be mixed

Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	F(INDEX(I),6) C(INDEX(I),3)	F(N,L), C(N,3)

Local Variable Definitions

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
SUM1	R	BTU/hr	Sum of the flowrate in each branch times its fluid temperature
ZUM	R	lbm-BTU/hr-lbm-°R	Sum of the flowrate in each branch

No Functional Flowchart Necessary

Note: The DIMENSION of INDEX must be defined in MAIN. The values for INDEX and the flowrate at each node in INDEX must also be supplied.

Subroutine MOD

Identification

Name - MOD
Author/Company - FEAR/TRW, modified by J. L. Walker and T. DeLuna/MDTSCO
Machine/Language - UNIVAC 1108, EXEC 2 system, FORTRAN V

Purpose

To solve equations for proportioning flow split between two branches in response to prescribed temperature, location and proportional gains.

Argument List Definition

N - Node to split
I - Split N into I, Flow XM
J - Split N into J, Flow 1-XM
M - Control node
TC - Control temperature
R - Desired gain, XM change per degree
MAX - Max value of XM
MIN - Min value of XM

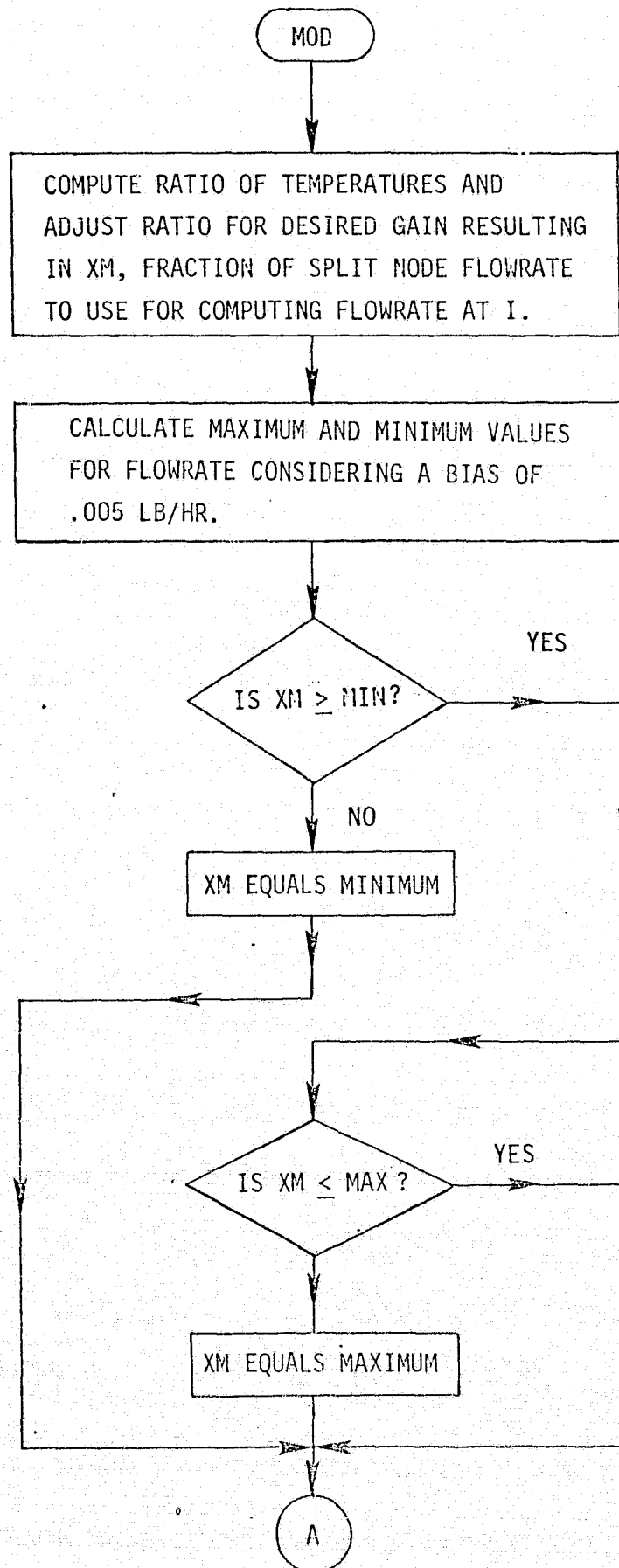
Common Block Reference/Input-Output Variables

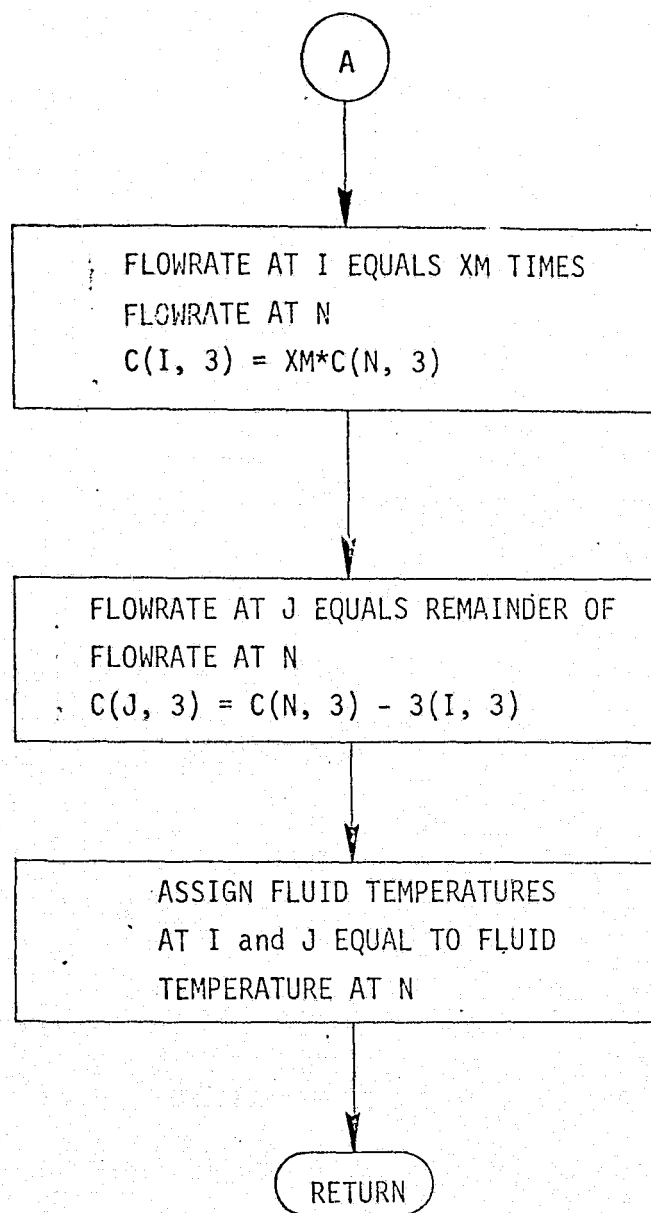
<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	F(N,L), F(I+1,L), F(M,L) C(N,3)	C(I,3), C(J,3) F(I,L), F(J,L)

Local Variable Definition

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
XM	R		Fraction of flowrate at N to assign to I
GG	R		Max value of XM minus a bias
HH	R		Min value of XM plus a bias
FOD	R	93	Adjustment to XM for desired gain

FIGURE 6-9 FUNCTIONAL FLOWCHART FOR MOD.





Subroutine Pass

Identification

Name - Pass

Author/Company - FEAR/TRW

Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To solve equations for heat transfer from a passive component.

Argument List Definition

II - Node number of passive component.

See FEAR USER's GUIDE for further documentation

No Functional Flowchart

Subroutine PLATE

Identification

Name - PLATE (PLATO, GPLT(ECLSS only)) modifications for PLATO
by T. DeLuna/MDTSCO
Author/Company - FEAR/TRW
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To determine diffusion node heating (PLATE) or to determine hydraulic and diffusion node heating. (PLATO)

Argument List Definition

M - Inlet node of component

N - Outlet Node of component

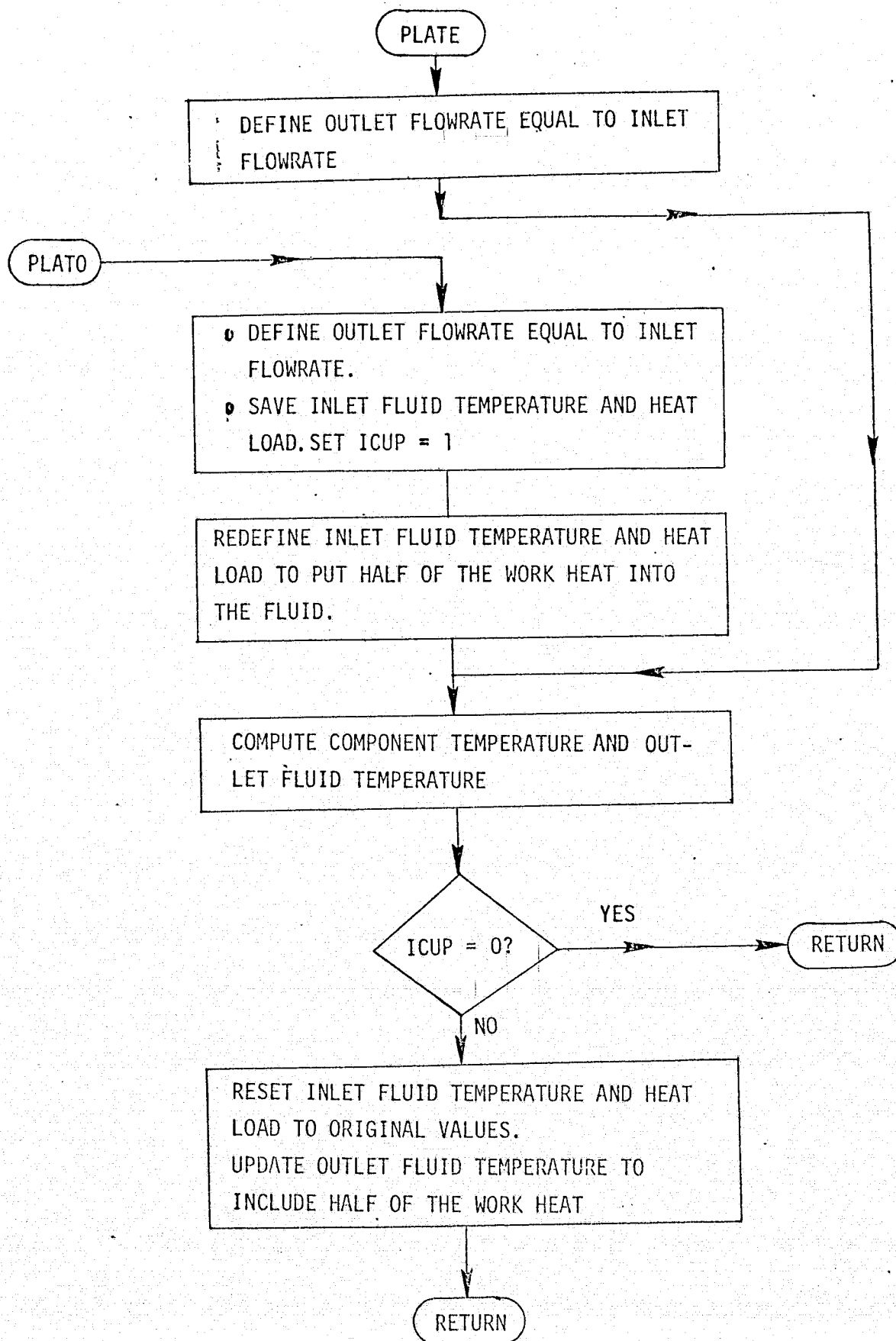
Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	C(M,3), C(N,4), F(M,L)	F(N,L), C(N,3)
	C(M,2), P(M,K), C(M,1)	P(M,L)
	DELT	

Local Variable Definitions

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
CMTRM3	R	BTU/hr-°R	Thermal capacitance
PMLMK	R	°R	Sum of the present and past values of component temperature
ICUP	I		Flag to signal that PLATO has been called.
SAVEQ	R	BTU/hr	Heat load of inlet-saved to be retrieved later
SAVET	R	°R	Fluid temp of inlet-saved to be retrieved later.
TOFML	R	°R	Twice the fluid temperature of the inlet
UAWCP	R		Ratio of the heat transfer coefficient of the inlet to the mass flowrate of the inlet.

FIGURE 6-10 FUNCTIONAL FLOWCHART OF PLATE



Subroutine PLATEC

Identification

Name - PLATEC (entry PLATOC, GPLTC(ECLSS only))
Author/Company - FEAR/TRW
Machine/Language - Univac 1108, EXEC 2 system/FORTRAN V

Purpose

To determine diffusion node heating for components thermally coupled to other components or boundary nodes (PLATEC), or to determine hydraulic and diffusion node heating for components thermally coupled to other components or boundary nodes.(PLATOC)

Supporting Subroutine

PLATE (PLATO) - Computes the heating after PLATEC (PLATOC) has factored the thermal coupling into the heat load.

Argument List Definition

II - Inlet node of component

JJ - Outlet node of component.

Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	C(II,4), P(II,K), P(NOW,K)	C(II,4)
GLOB	KEEP,IBIG,VAL LEEP, JBIG, RVAL	

Local Variable Definitions

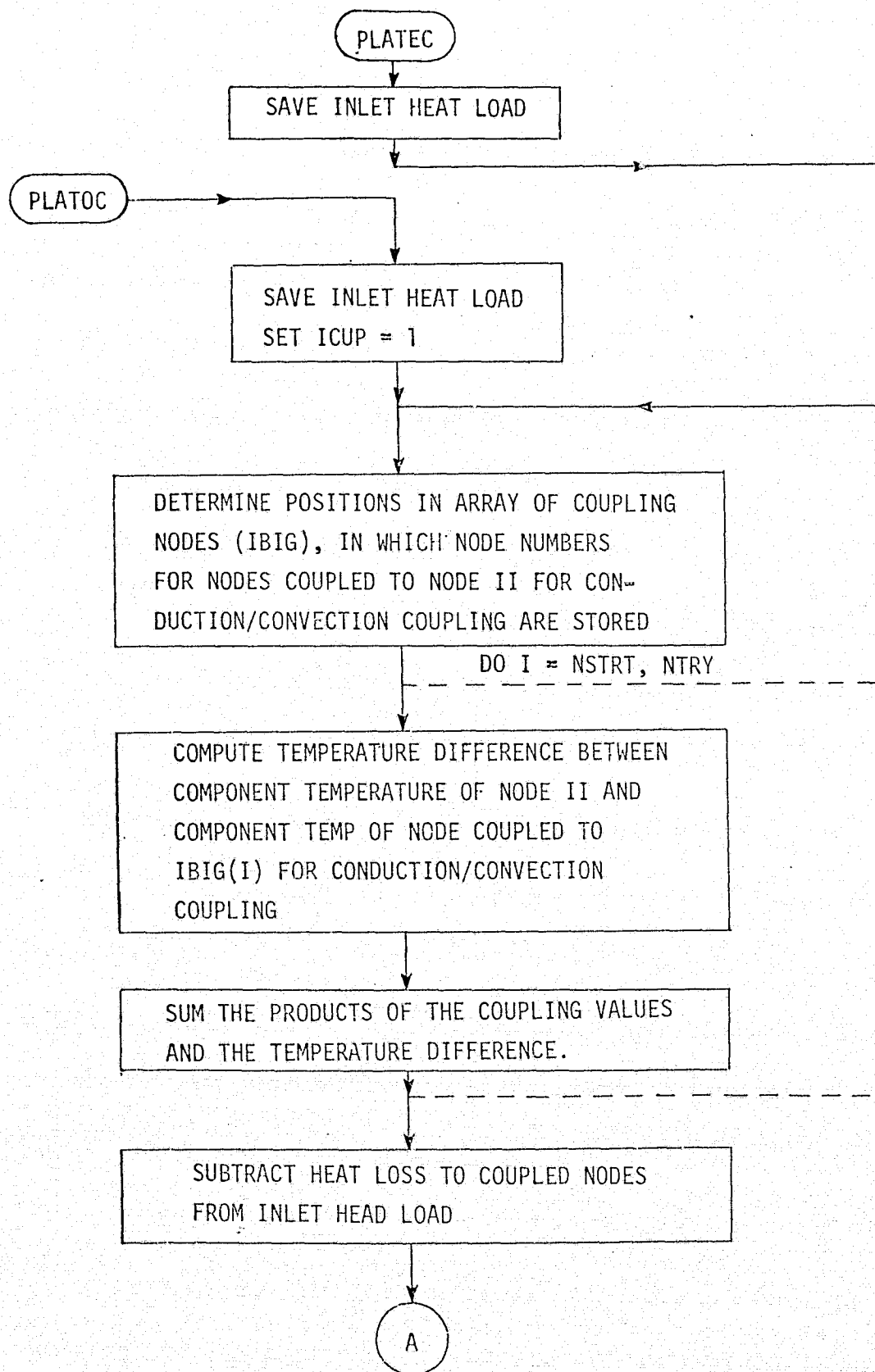
<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
AA	R	BTU/hr	Variable for saving heat load on component

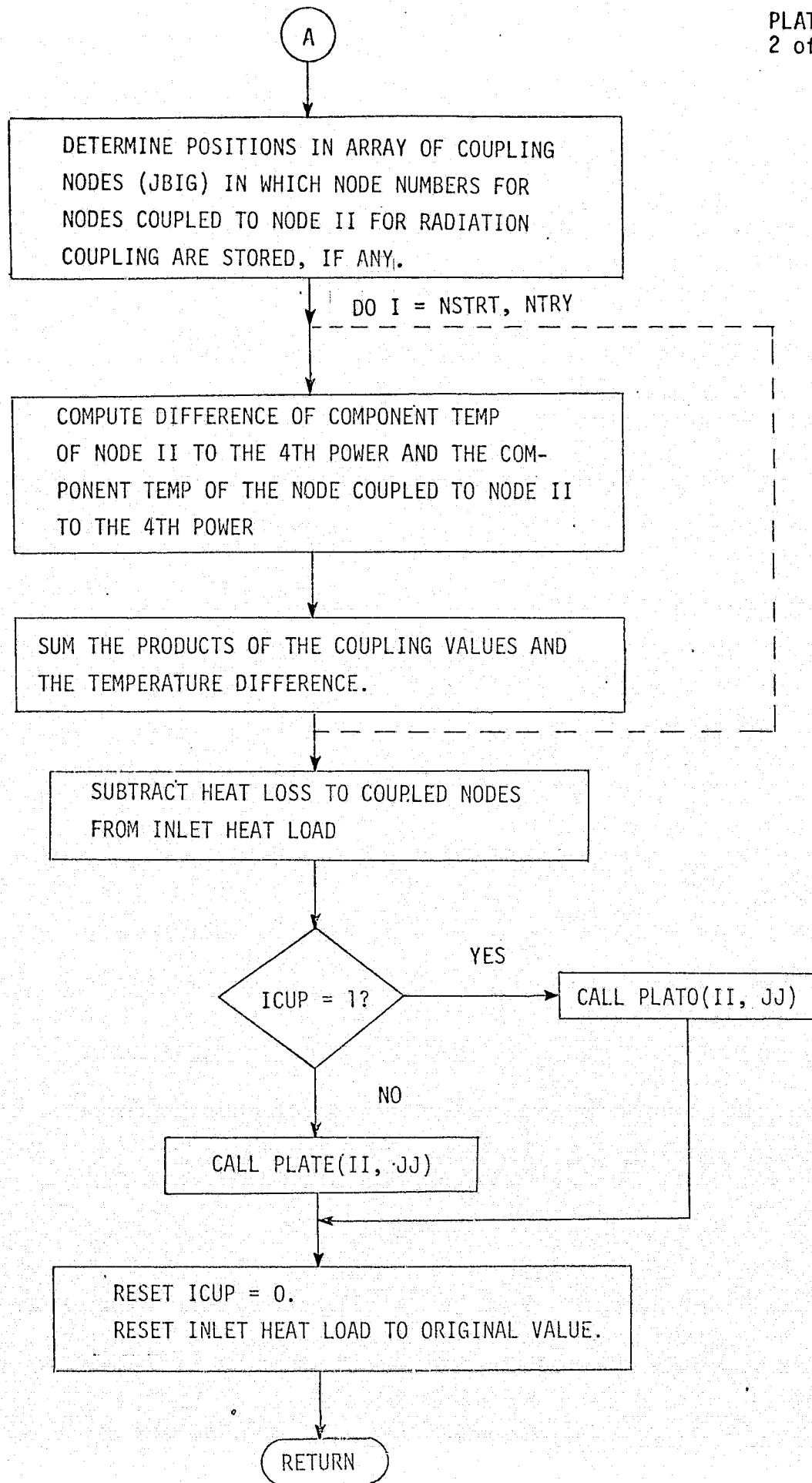
<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
ICUP	I		Flag to signal that PLATOC has been called
NSTRT	I		First position in IBIG array that contains node that node II is coupled to
NTRY	I		Last position in IBIG array that contains node that node II is coupled to
SUM	R		Sum of the products of coupling value and temperature difference for each node that II is coupled to
TEMP	R	°R	Temperature difference between node II and node which II is coupled to for conduction/convection coupling. Difference of temperature values to the 4th power for node II and each of the nodes which II is coupled to for radiation coupling

Note: Coupling values for node II to structure nodes or other components should be input through subroutine START. See Sec. 4.1.2 Node Coupling Data and Appendix A.I.

FIGURE 6-11 FUNCTIONAL FLOWCHART FOR PLATEC

PLATEC
1 of 2





Subroutine PLOOT

Identification

Name - PLOOT
Author/Company - FEAR/TRW, modified by T. DeLuna/MDTSCO
Machine/Language - Univac 1108, EXEC 2 system/FORTRAN V

Purpose

To put data for plotting on high speed drum for each plot defined by the plot input cards. (See Sec. 5.2 and Appendix A.1)

Supporting Routine

RWRITE - Subroutine in RANDIO utility routines for accessing high speed drum.

Arguments defined in local variable definitions

Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
ALTD	ALT	
ARRAY	G(MUG,I), I=1,2,3,7	
BLANK COMMON	TIME, F(MUG,L) P(MUG,L), C(MUG,I)I=1,19	
COMEVP	WATLFT	
PSST	IPLT, JPLT, NPLTS	NPLPTS, IWRADR

Local Variable Definitions

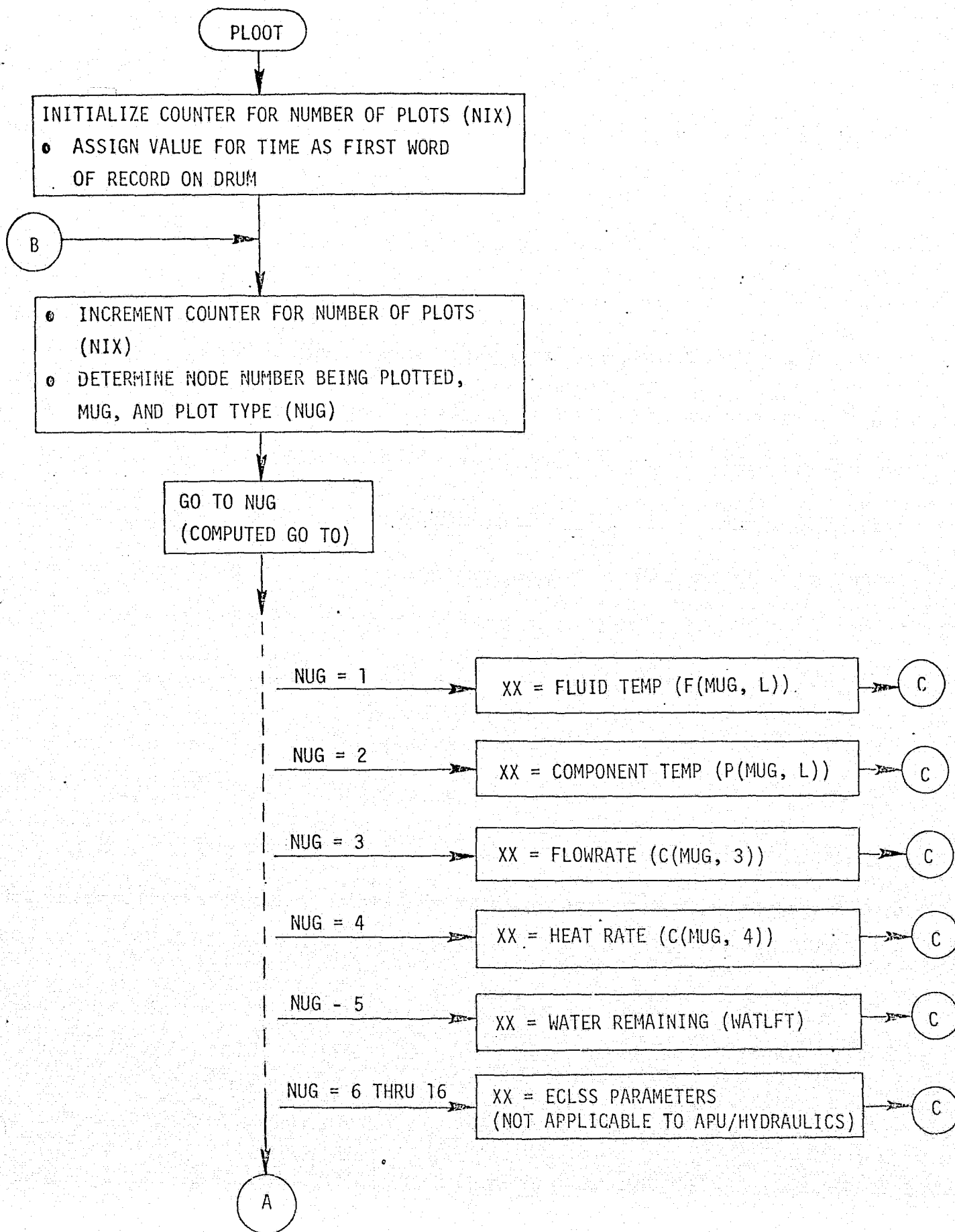
<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
ISTAT	I		Status word for utility package
IWRADR	I		Address on drum at which to write data
NIX	I		Counter for number of plots
NNPLTS	I		Number of plots plus X-parameter
NUG	I		Plot type
MUG	I		Node number being plotted

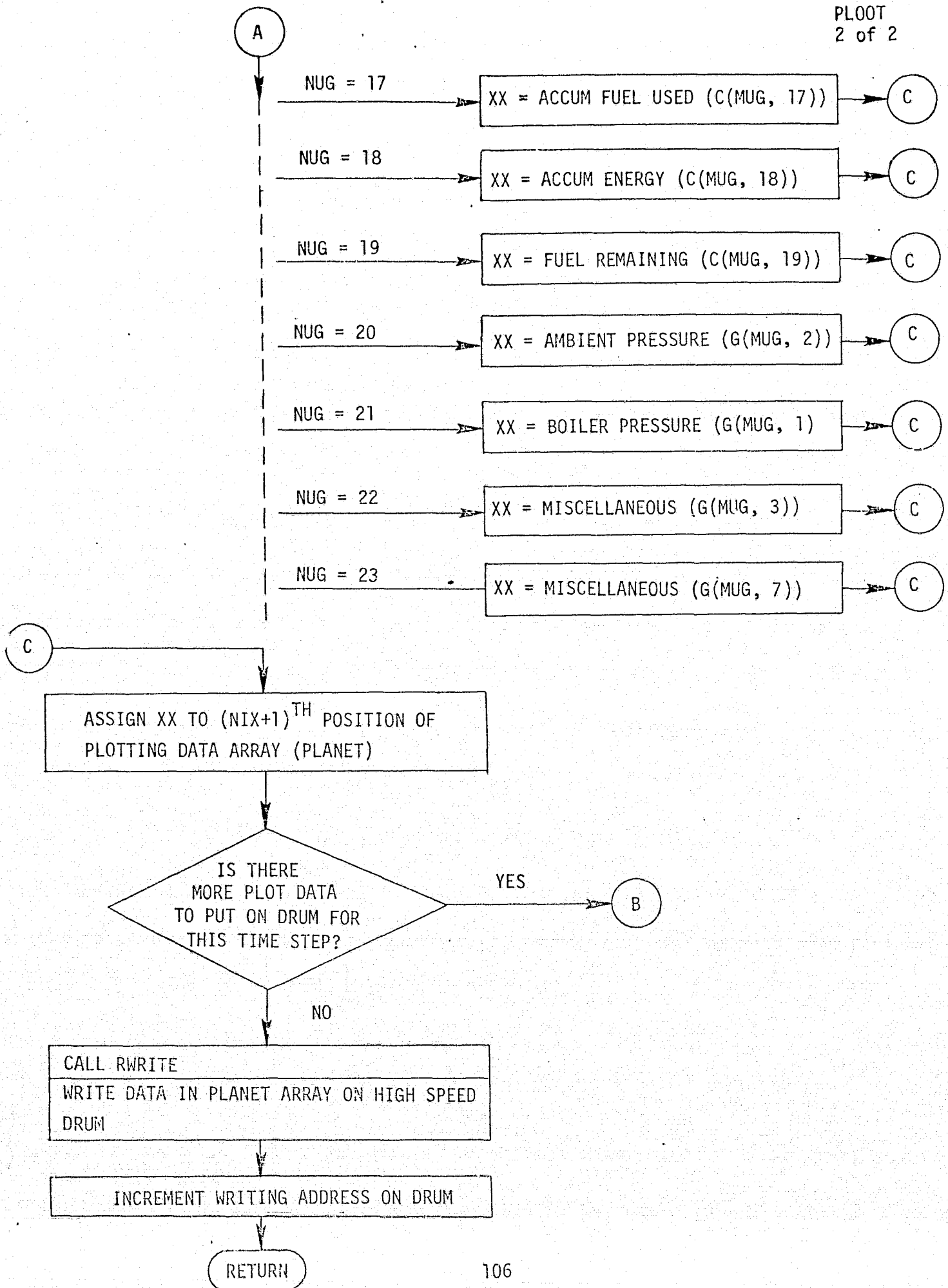
<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
PLANET	R		Array containing value of each plot parameter at this time point
XX	R		Value to be placed in PLANET array

Note: The PLOOT routine must be called prior to the call to PRINT or SELECT so that the value of TIME will agree with the data being plotted.

FIGURE 6-12
FUNCTIONAL FLOWCHART FOR PLOOT

PLOOT
1 of 2





Subroutine PRINT

Identification

Name - PRINT (SELECT)
Author/Company - FEAR/TRW, modified by T. DeLuna/MDTSCO
Machine/Language - Univac 1108, EXEC 2 system/FORTRAN V

Purpose

To printout node data of interest at specific time intervals.

Argument List Definition

Note: There are no arguments in the call to PRINT. The following arguments are in the call to the entry point (SELECT)

NP - Total number of nodes to print out
NMP - Number of nodes to list as component nodes (less than NP)
IPARI - Array of node numbers to be printed
IO - Flag to signal that SELECT has been called. Must not equal any node number in INODES array.

Common Block Reference/Input-Output Variables

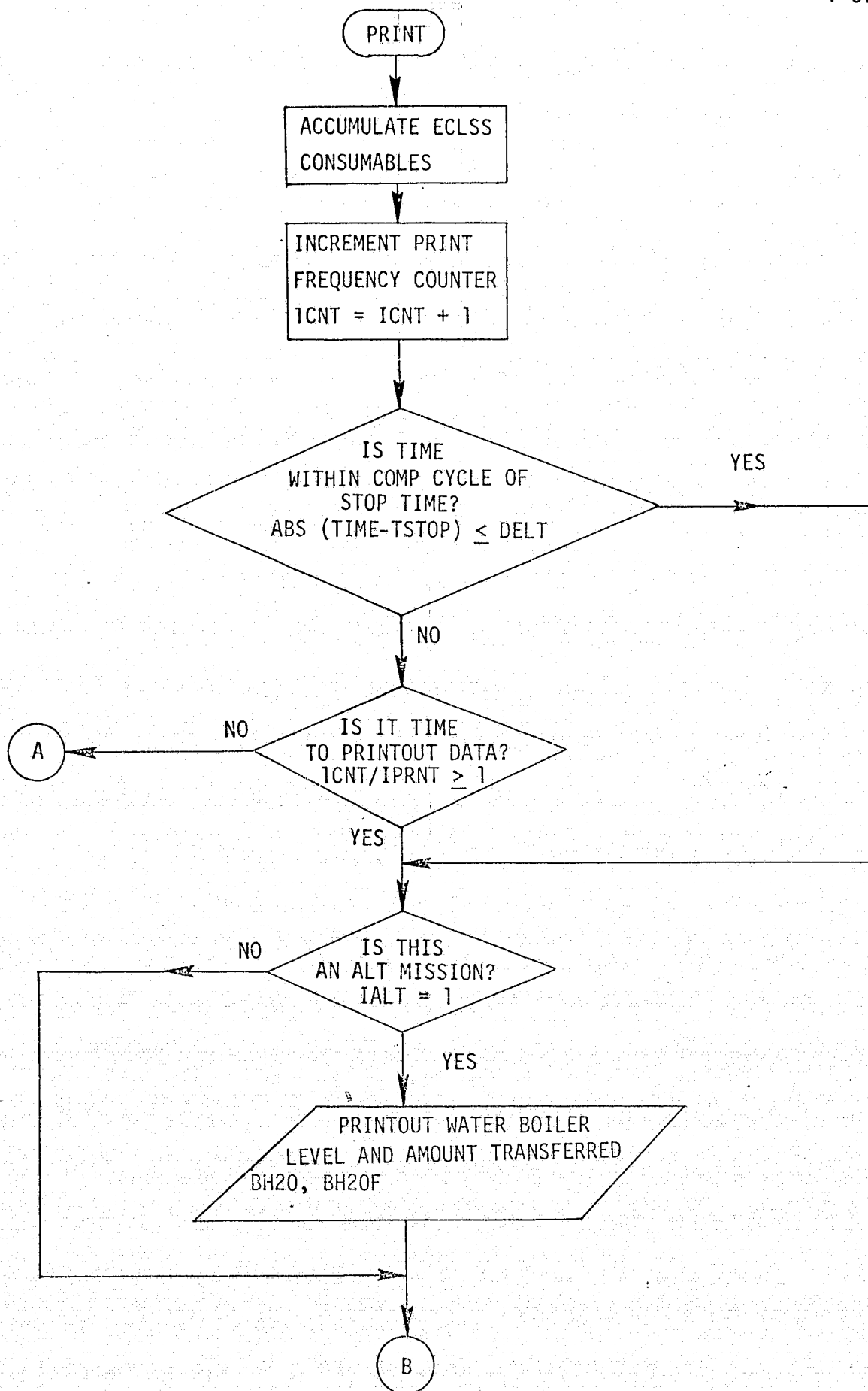
<u>Block Name</u>	<u>Input</u>	<u>Output</u>
ACT	NHYD, NHYOUT	
ALT	BH20, BH20F, IALT	
ARRAY	FLAG, G(I,7)I=1,8 G(I,J)J=1,2,3,8,9)I=102,152,202 ITTER	
BLANK COMMON	L,DELT,TIME,TSTOP,NNODES P(300,L), F(300,L), IDUM C(300,J), J=1,2,3,4,17,18,20	TIME
COMEVP	IWAT, NWAT, WAT	
PRT	AERROR, ANAME, ICNT, IPRNT	ICNT

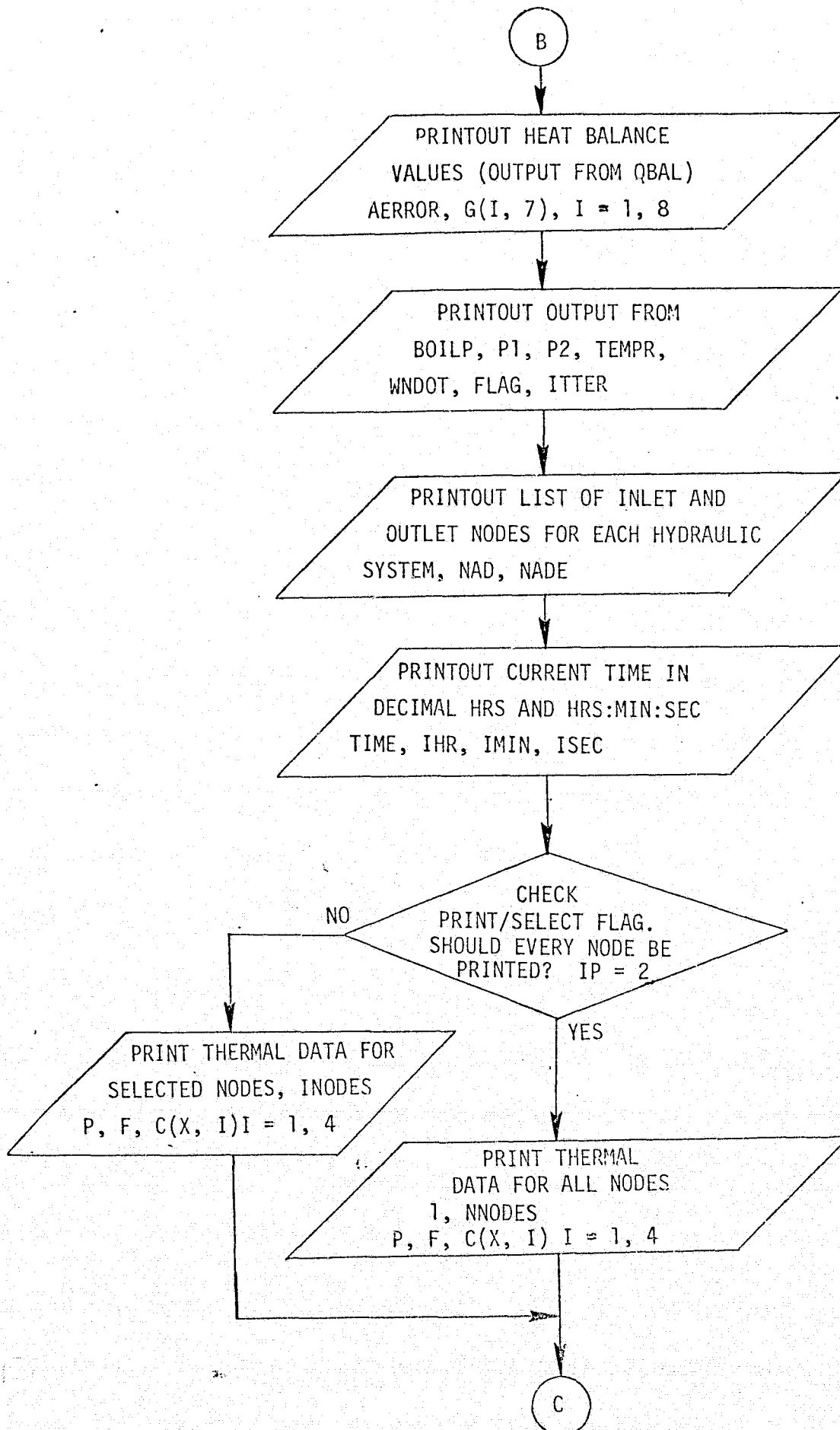
Local Variable Description

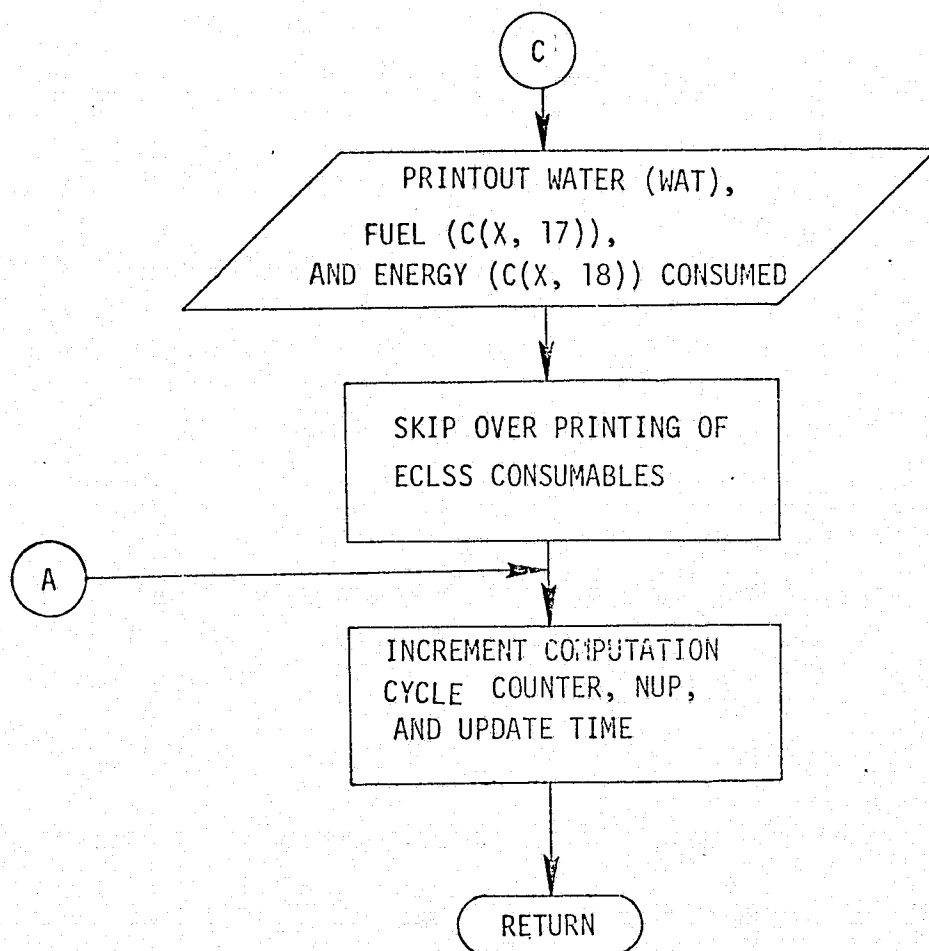
<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
IHR	I	hrs	Current mission time
IMIN	I	min.	
SEC	R	sec.	
IP	I		Flag =1 if PRINT called =2 if SELECT called
ISKP	I		Flag to restrict print of certain data on first call to the subroutine
IEND	I		Flag to designate amount of C array to print out. =4 for APU/Hydraulics
JM	I		Total number of actuators on a system
NAD	I		Array of inlet nodes on a system
NADE	I		Array of outlet nodes on a system
NMP1	I		Start of loop for printing node number connected with fuel used.
NMP3	I		End of loop for printing node numbers connected with fuel used.
VMP4	I		Start of loop for printing node numbers connected with energy used
NMP6	I		End of loop for printing node numbers connected with energy used.
NUP	I		Counter used for incrementing TIME

FIGURE 6-13 FUNCTIONAL FLOWCHART FOR PRINT

PRINT
1 of 3







Subroutine QBAL

Identification

Name - QBAL
Author/Company - T. DeLuna/MDTSCO
Machine/Language - UNIVAC 1108/EXEC 2 system/FORTRAN V

Purpose

To perform a heat balance for accuracy assessment and error detection by comparing total system heat input to total heat dissipation.

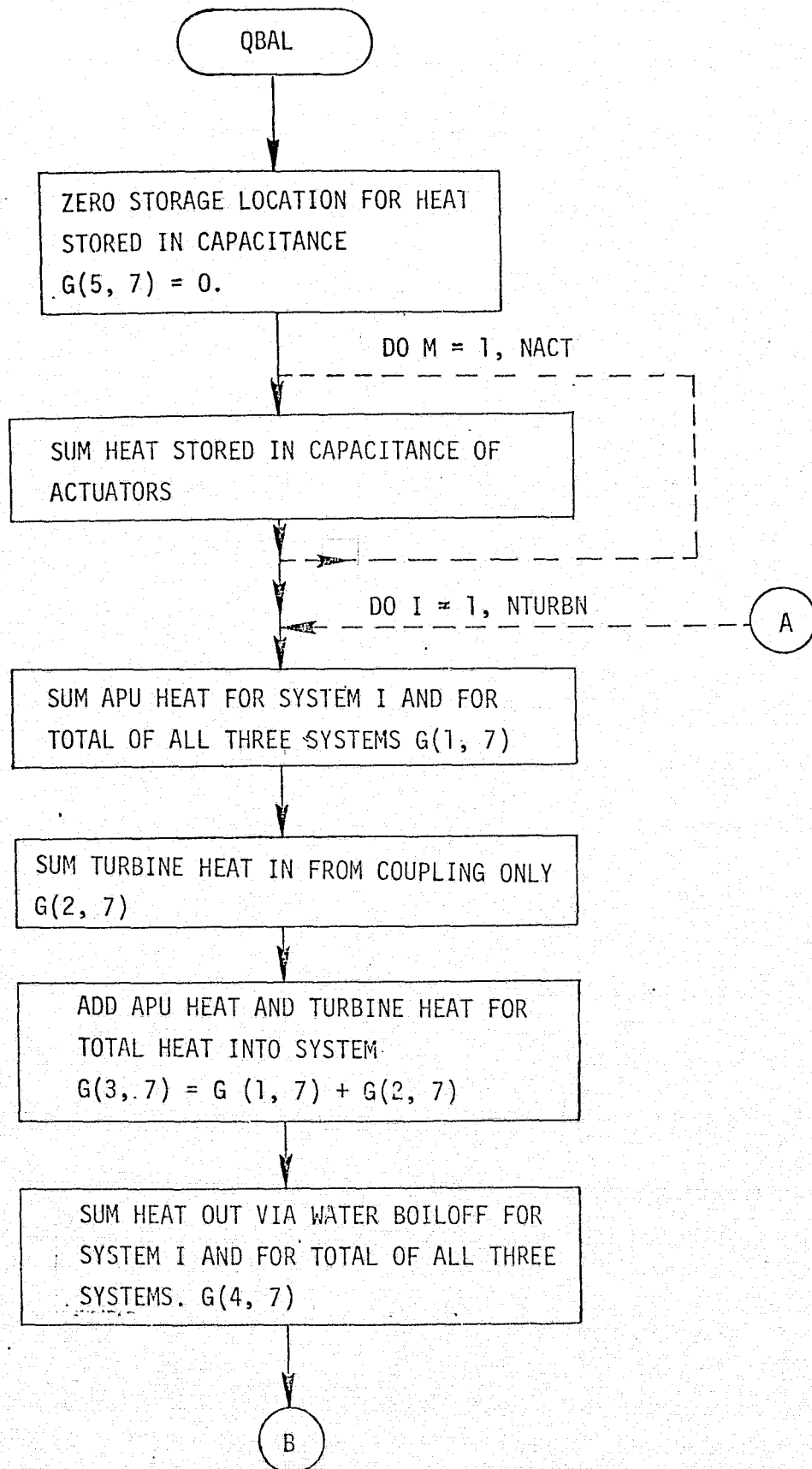
Common Block Reference/Input-Output Variables

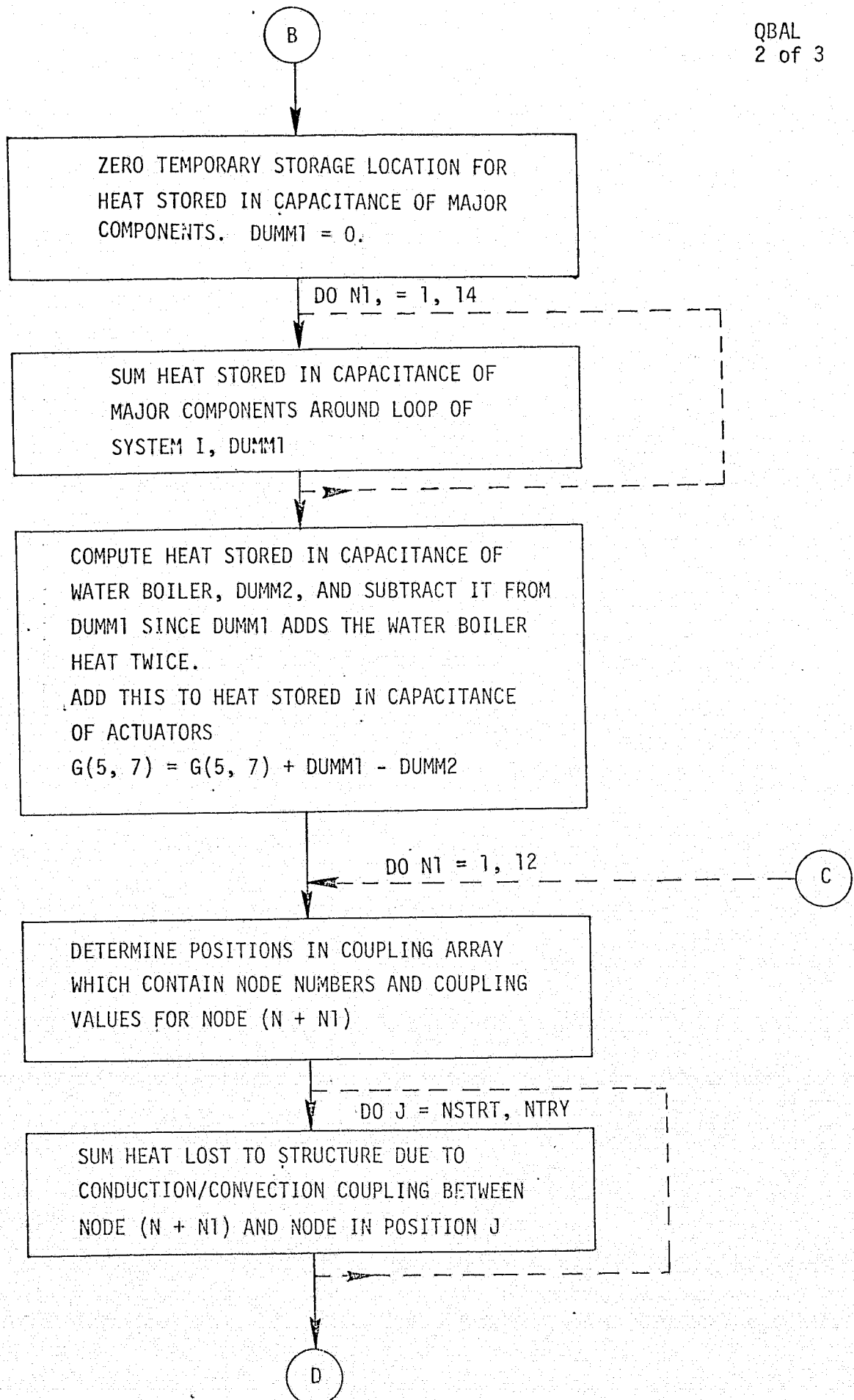
<u>Block Name</u>	<u>Input</u>	<u>Output</u>
ACT	NACT	
ARRAY	TINIT, G(X,4), G(X,5)	G(I,7), I=1, 8
BLANK COMMON	C(X,1), C(X,4), P(X,6) DELT	C(I,2), I=250,262
EXTRA	ICOUP	
GLOB	KEEP, IBIG, VAL LEEP, JBIG, RVAL	

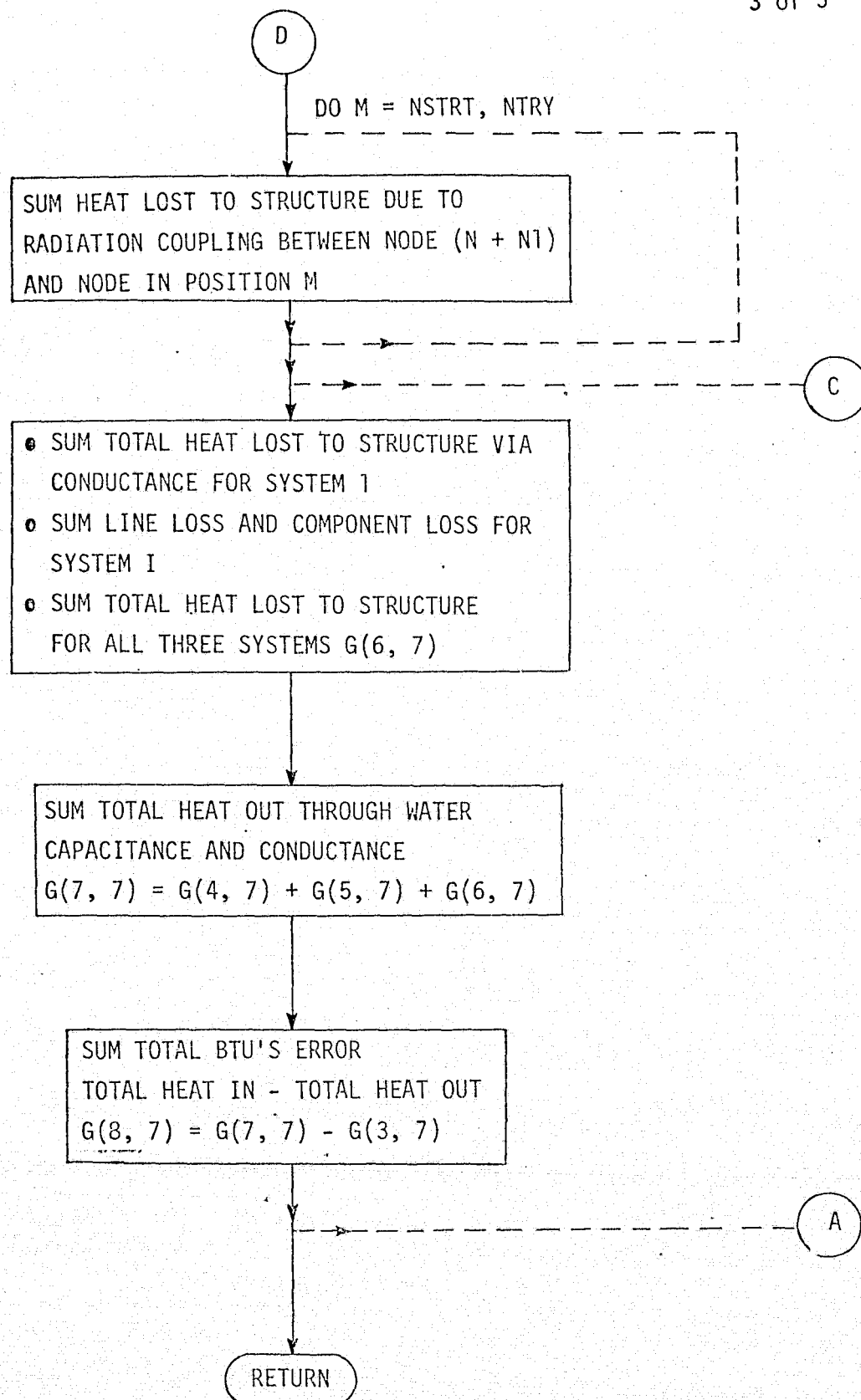
Local Variable Definitions

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
DUMM1	R	BTU	Total heat stored in component capacitance by one system counting boiler capacitance twice
DUMM2	R	BTU	Heat stored in capacitance of boiler
NSTRT	I		First structure node that node (N+1) is coupled to
NTRY	I		Last structure node that node (N+1) is coupled to
SUM	R	BTU/hr	Total BTU/hr out via conduction/convection for node (N+1) for one comp cycle

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
SUM	R	BTU/hr	Total BTU/hr out via conduction/convection for node (N+N1) for one comp cycle
SUMR	R	BTU/hr	Total BTU/hr out via radiation for node (N+N1)
TCCUP	R	BTU/hr	Total BTU/hr out via coupling to structure for one system for one comp cycle
TOTCUP	R	BTU/hr	Total BTU/hr out via coupling to structure for all three systems for one comp cycle
N1	I		Index for looping through major components on each system.







Subroutine RSTART (OFT model only)

Identification

Name - RSTART
Author/Company - T. DeLuna/MDTSCO
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To provide the capability for reinitializing the component and fluid temperature after a particular mission analysis has been started. A flag in the main program determines whether a new set of node data cards is to be read in or the temperatures are to be set to a constant temperature.

Argument List Definition

ICHECK - Flag set so that routine will only be called once

Common Block Reference/Input - Output Variables

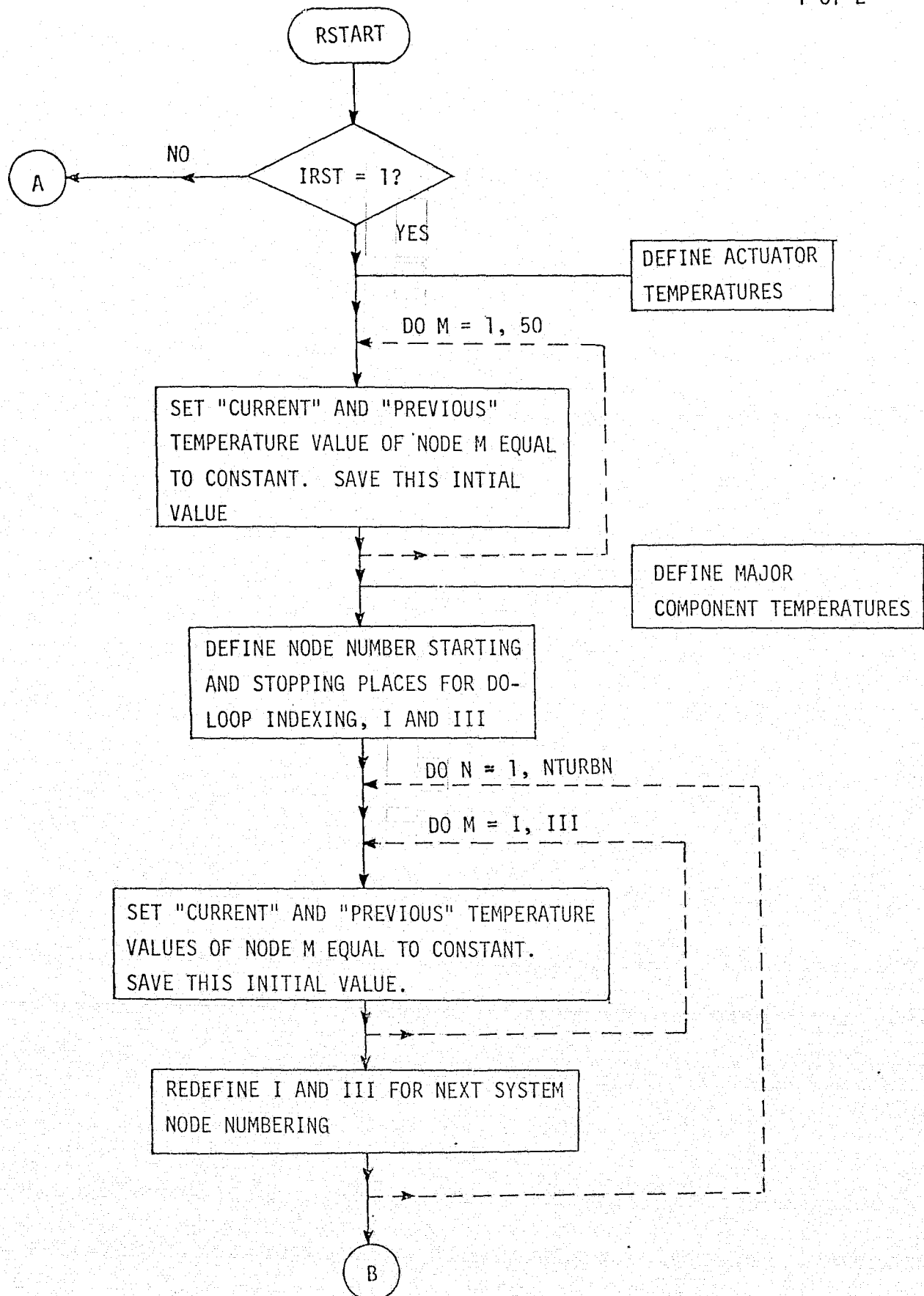
<u>Block Name</u>	<u>Input</u>	<u>Output</u>
ARRAY		TINIT
BLANK COMMON	IDUM, NNODES	P(X,1), P(X,2) F(X,1), F(X,2)
TYPE	AMSNTM	

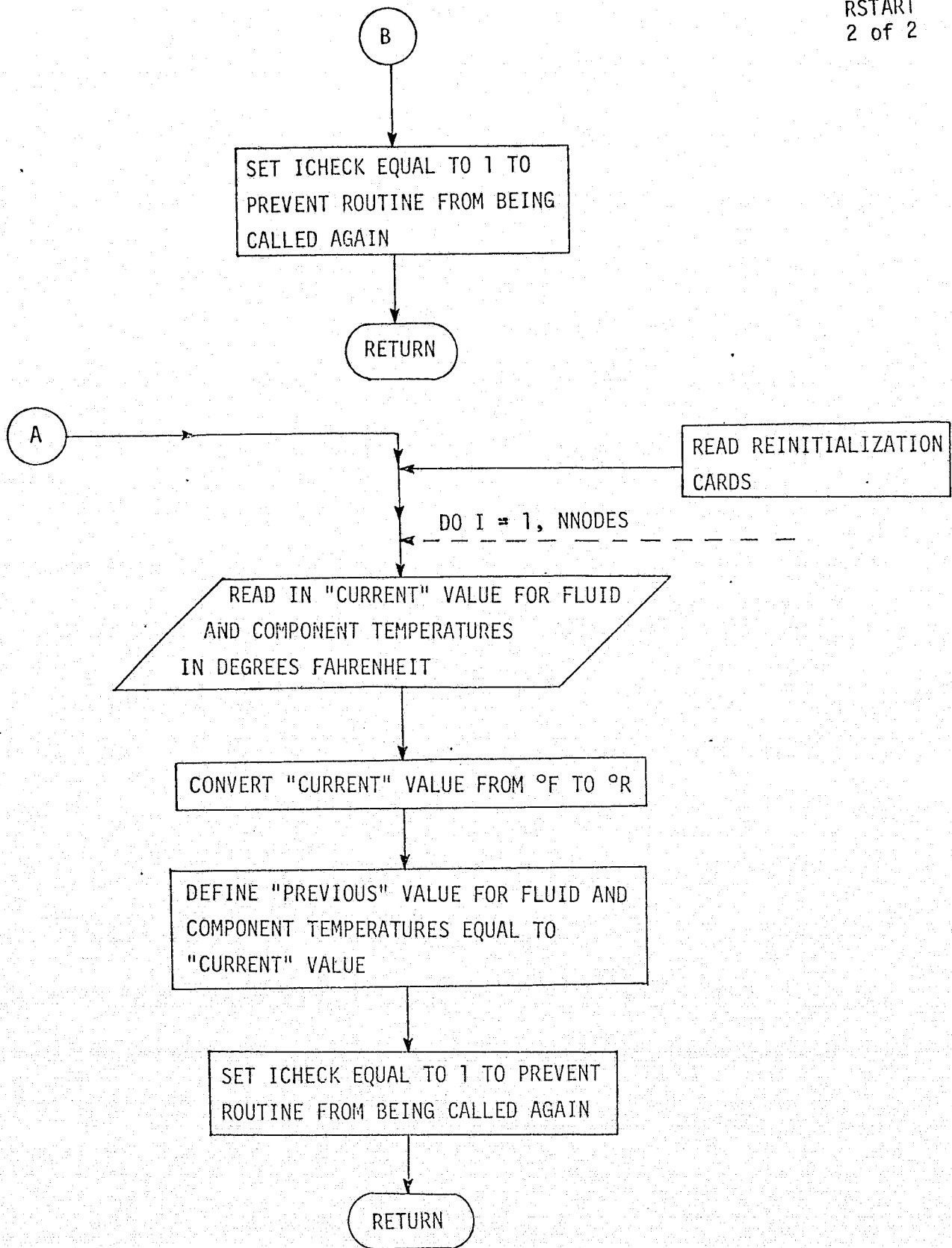
Local Variable Definition

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
IRST	I		Flag for type of temperature reinitialization 1 = define as constant 2 = read in new values Equivalenced to IDUM(14). Defined in MAIN2

FIGURE 6-15 FUNCTIONAL FLOWCHART FOR RSTART

RSTART
1 of 2





Subroutine SCAL

Identification

Name - SCAL

Author/Company - FEAR/TRW

Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To provide scaling for the x or y-axes. Support routine for DRAW

Argument List Definition

XMAX - Maximum value of parameter being scaled (input)

XMIN - Minimum value of parameter being scaled (input)

XI - Axis length desired (input)

DX - Change in parameter per inch (output)

XO - Starting value of parameter (output)

XE - Error value used in iterating for best scaling.

Local Variable Definitions

This routine consists of a mathematical process which uses the maximum and minimum values along with a desired length and iterates for a solution for the change of the parameter per inch which will be some power of 10 times 1, 2 or 5 and result in the closest possible to the desired length. The local variables, A, B, C, D, E, and W are merely terms in the equations used in this process.

No Functional Flowchart Necessary.

Subroutine SPRAY (OFT model only)

Identification

Name - SPRAY

Author/Company - T. DeLuna/MDTSCO

Machine/Language - UNIVAC 1108/EXEC 2 system/FORTRAN V

Purpose

To determine the amount of water used to keep the hydraulic fluid and lubrication oil at or under their control temperatures. This subroutine was written from preliminary information and should be rewritten as soon as spray boiler design data becomes available.

Argument List Definitions

M1 - Inlet node of lube oil heat exchanger

M2 - Inlet node of hydraulic fluid heat exchanger

M11 - Outlet node of lube oil heat exchanger

M22 - Outlet node of hydraulic fluid heat exchanger

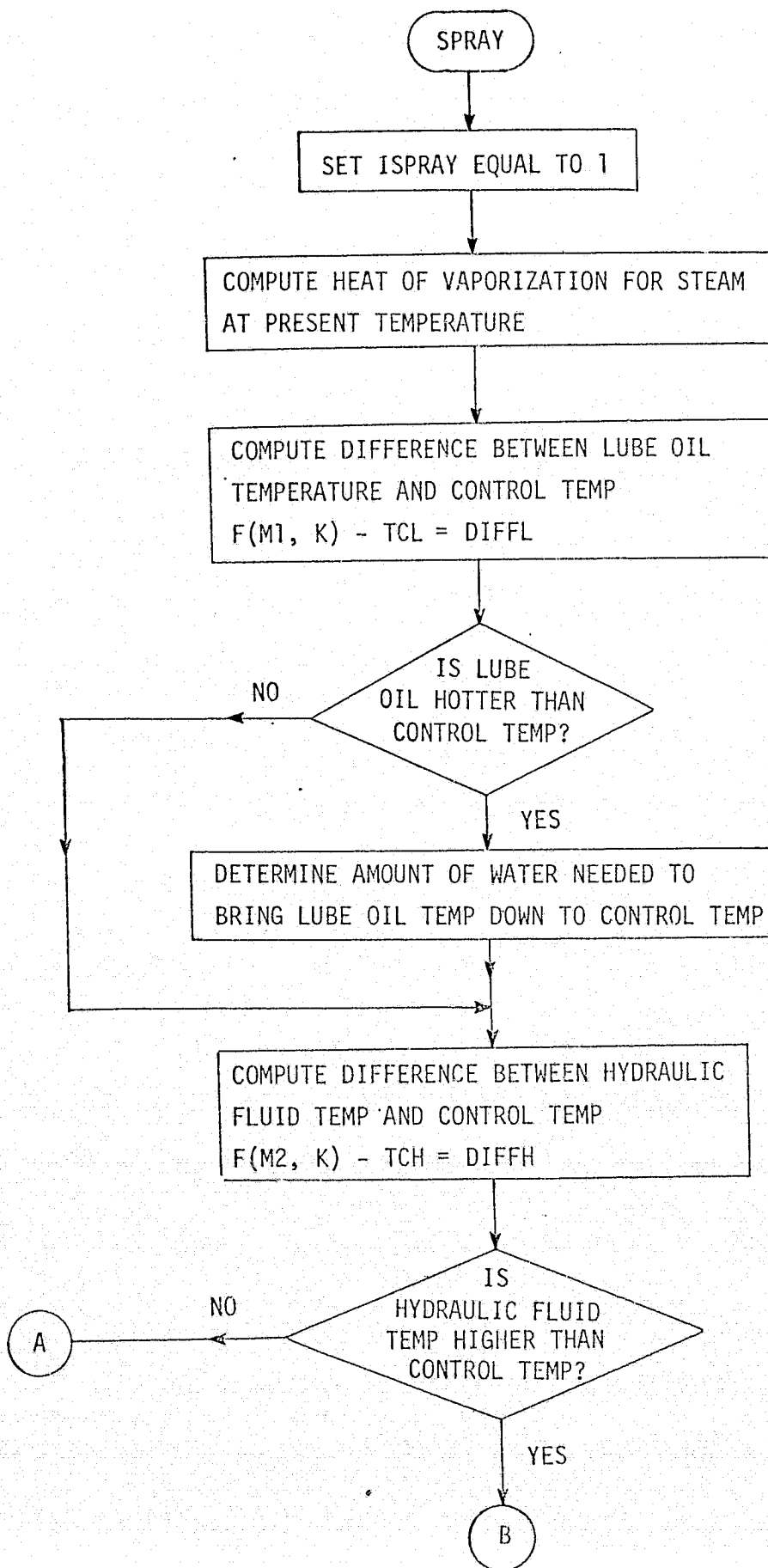
ISPRAY - Flag set to show the SPRAY routine has been called

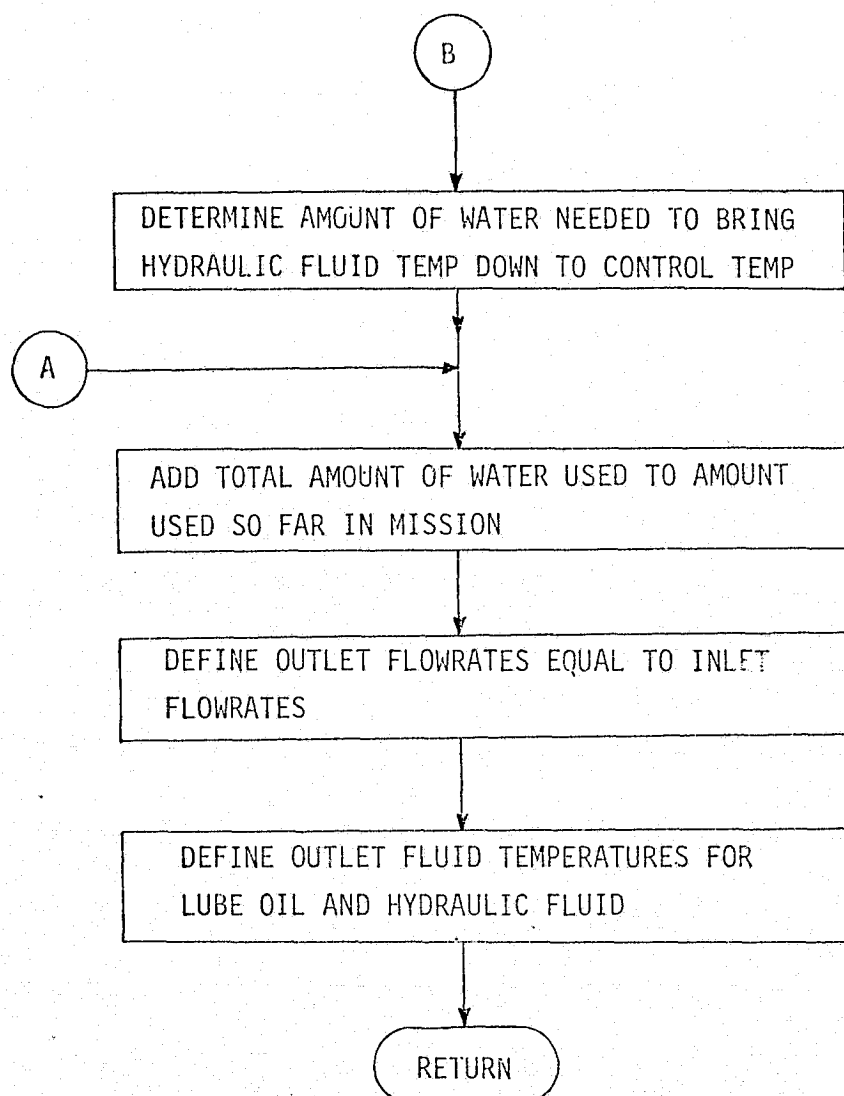
Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	P(M1,K), DELT	F(I,K), I=M11,M22
	F(I,K), I=M1,M2	C(I,3), I=M11, M22
	C(I,3), I=M1,M2	
COMEVP	IWAT, WAT	WAT

Local Variable Definitions

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
BTUH	R	BTU/hr	Heat loss rate used to bring hydraulic fluid down to control temperature
BTUL	R	BTU/hr	Heat loss rate used to bring lube oil down to control temperature
COEF	R		Coefficients for computing heat of vaporization at current temperature
DELW	R	lbm	Water used to bring fluid to control temp.
DIFFH	R	°R	Temperature diff between hydraulic fluid and control temp.
DIFFL	R	°R	Temperature diff between lube oil and control temp.
H	R		Heat of vaporization
TCH	R	°R	Control temp for hydraulic fluid
TCL	R	°R	Control temp for lube oil





Subroutine START

Identification

Name - START
Author/Company - FEAR/TRW with major modifications by T. DeLuna/MDTSCO,
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To initialize data, read in block of input cards, consolidate array of thermal coupling values, and define print frequency

Supporting Subroutines

CLOCK - Utility routine which outputs time of day

PRINT - Increment print frequency counter, Initialize TIME incrementing counter.

RINIT - RANDIO utility routine for acquiring starting address on high speed drum

Common Block Reference/Input-Output Variables

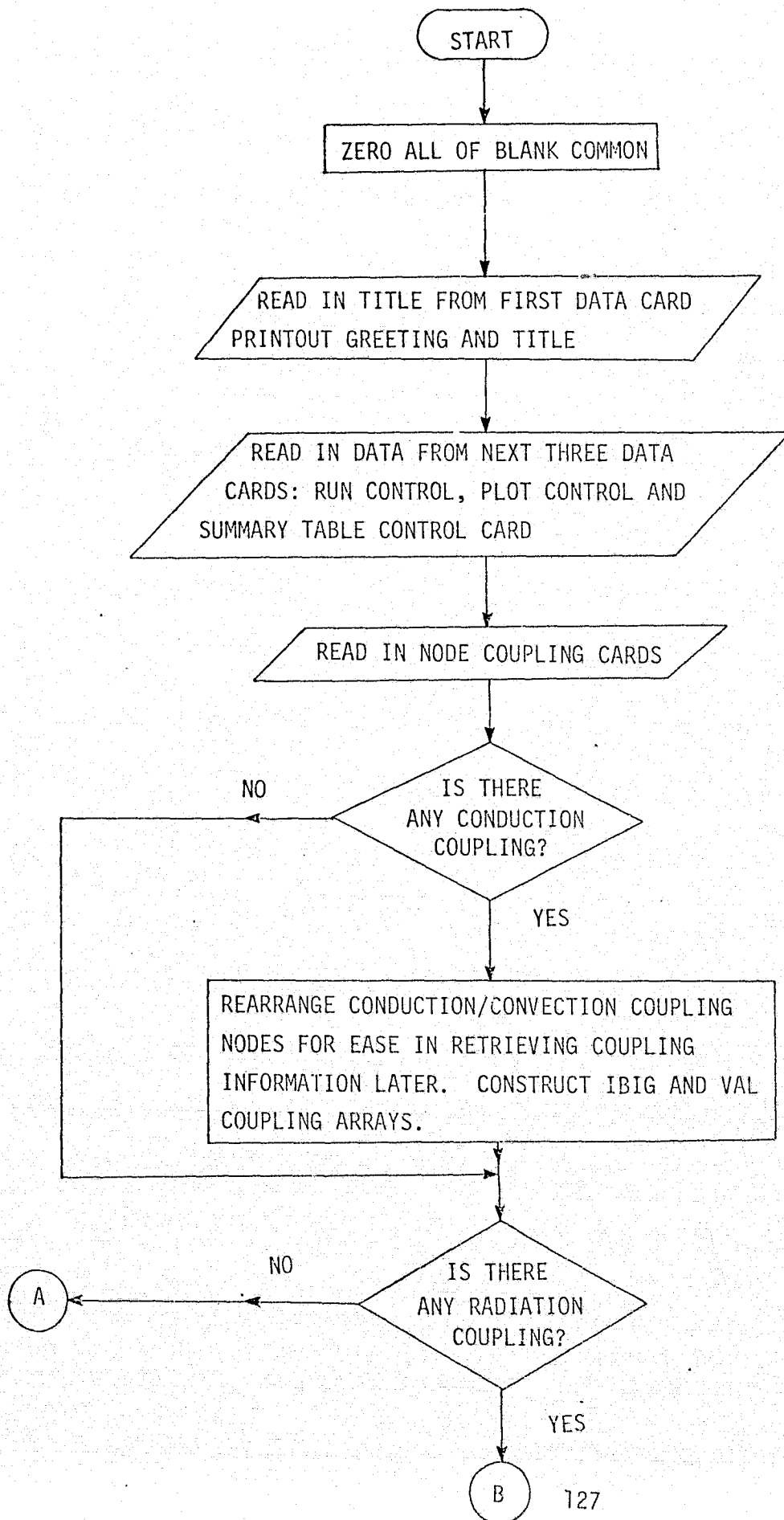
<u>Block Name</u>	<u>Input</u>	<u>Output</u>
ACT	NACT	
Blank Common		A11
Extra		ICOUP
Glob		A11
HYD		IPDO, LMMTRX
LUMP2		A11
PRT		A11
PSST		A11
TYME		TIMSUM, AMSNTM, FUDGE SUMARY(I,J) I=1,4, J=1,3 SUMARY(I,J) I=11,13,14,J=1,3

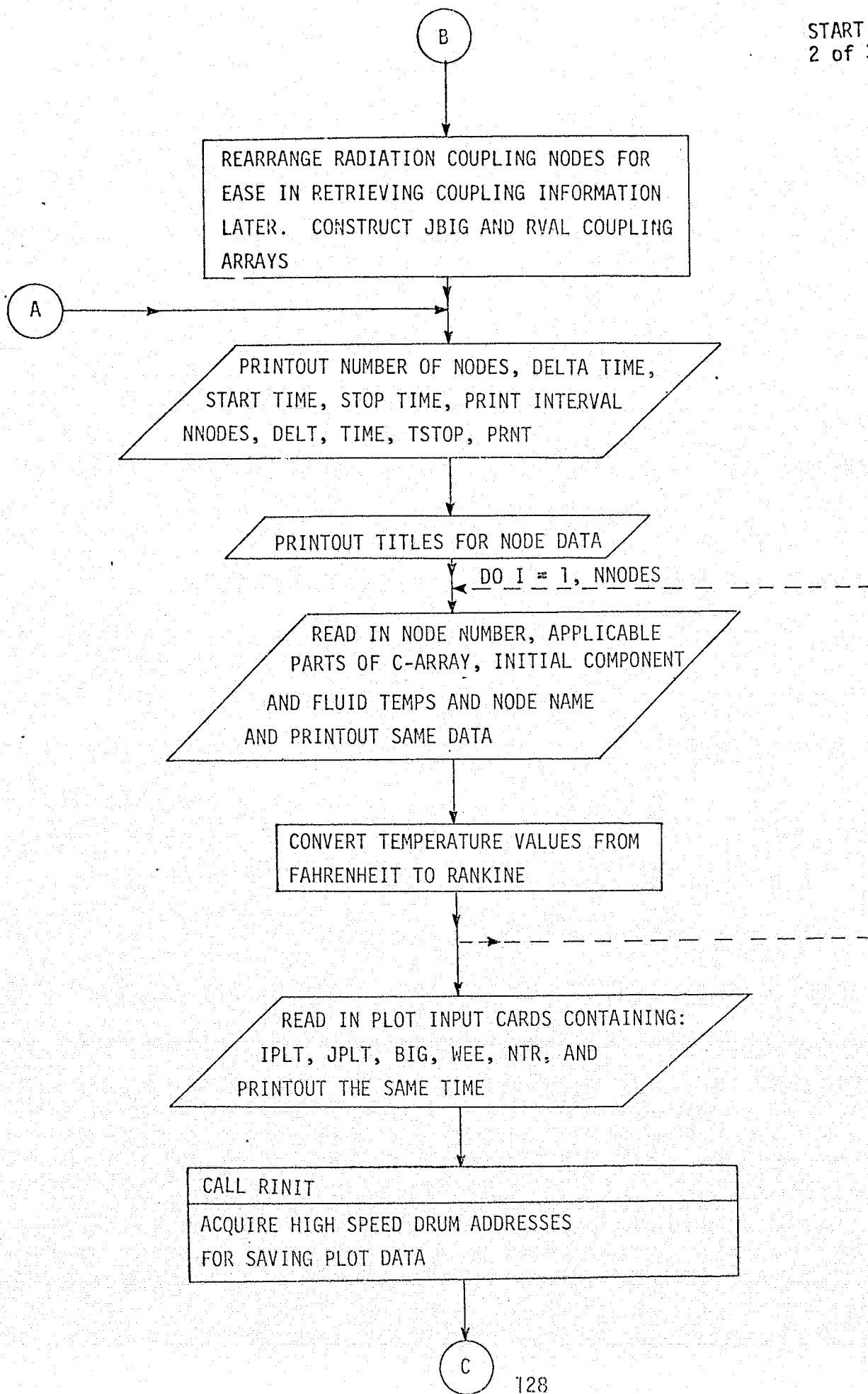
Local Variable Definitions

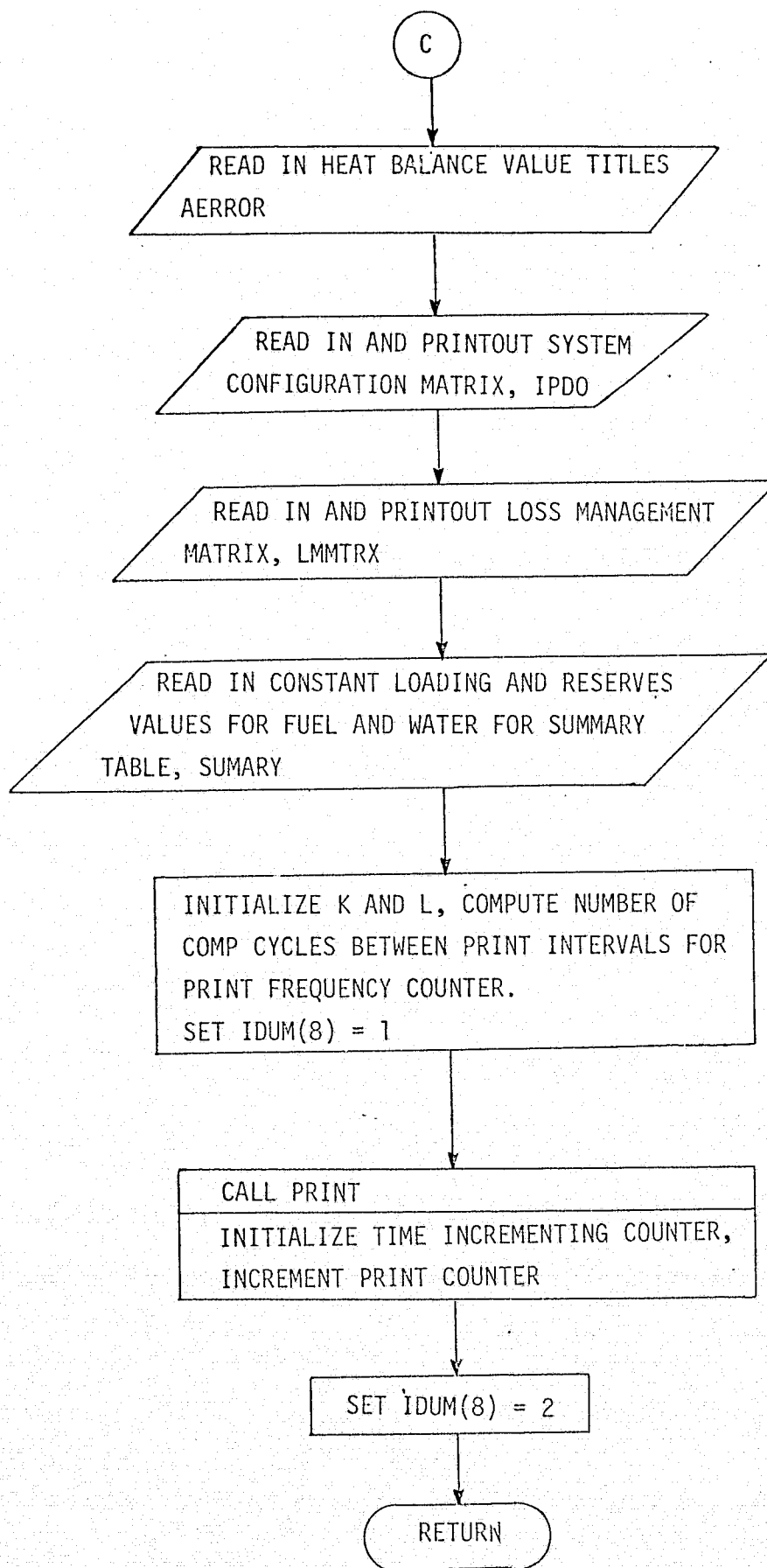
<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
CLICK	R		Argument in call to CLOCK routine. Used for greeting printout
ICOUPL	I		Flag for restricting addition of heat lost through coupling to certain components =1 if should be considered.
IERROR	I		Index for reading in error calculation titles
IWORK	I		Node number pair for coupling
IZERO	I		Array equivalenced to all of blank common for ease in initializing at zero
JJ	I		Counter used for assigning each conduction coupling node and value a position in arrays being created, IBIG, VAL
LL	I		Counter used for assigning each radiation coupling node and value a position in arrays being created, JBIG, RVAL
LOCK	I		Variable used in greeting printout
MOREV	I		Variable from original version-use unknown
NCON	I		Counter for number of conduction coupling values read
NJ	I		First node of coupling node pair
NK	I		Second node of coupling node pair
NODE	I		Node number on input card and subsequent position in blank common array
NRAD	I		Counter for number of radiator coupling values read
NSC	I		Number of coupling data cards to be read
NSYSUP	I		Index for reading loss management matrix
WORDS	R (hollerith words)		Array of words to choose from in creating greeting. Greeting has no bearing on run- ignore
WORK	R		Array of coupling values read (1) - conduction/convection (2) - radiation

FIGURE 6-17 FUNCTIONAL FLOWCHART FOR START

START
1 of 3







Subroutine THERMP (ALT model only)

Identification

Name - THERMP
Author/Company - J. L. Walker/MDTSCO
Machine/Language - UNIVAC 1108/EXEC 2 system/FORTRAN V

Purpose

To determine the heat loss and resultant fluid temperature in the hydraulic pressure lines from the pump to the actuators due to conduction convection and radiation coupling to vehicle structure and compartment air.

Argument List Definition

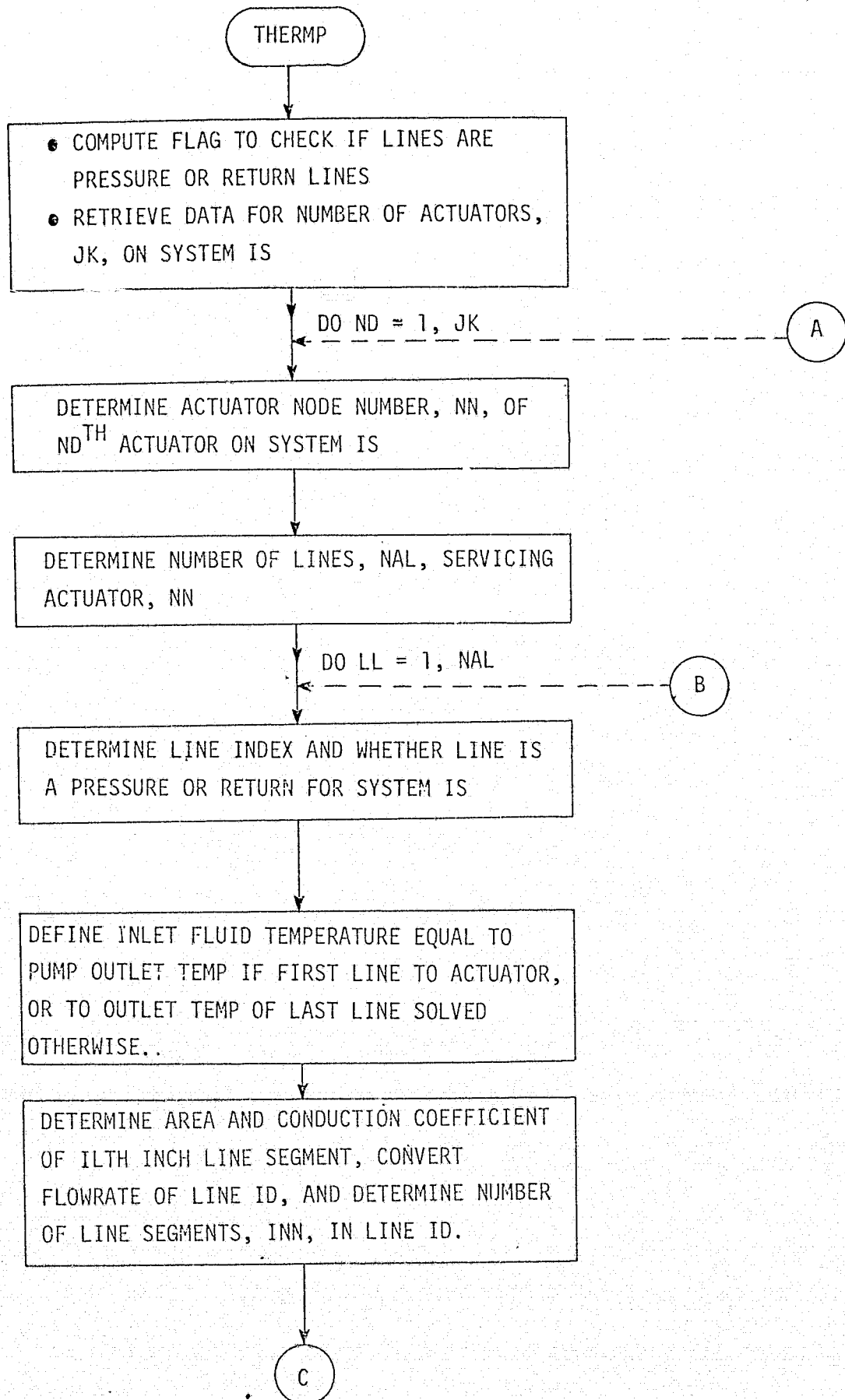
IS - System number
N1 - Node number counter - used to differentiate between identical nodes on each system
PAMB - Ambient air pressure

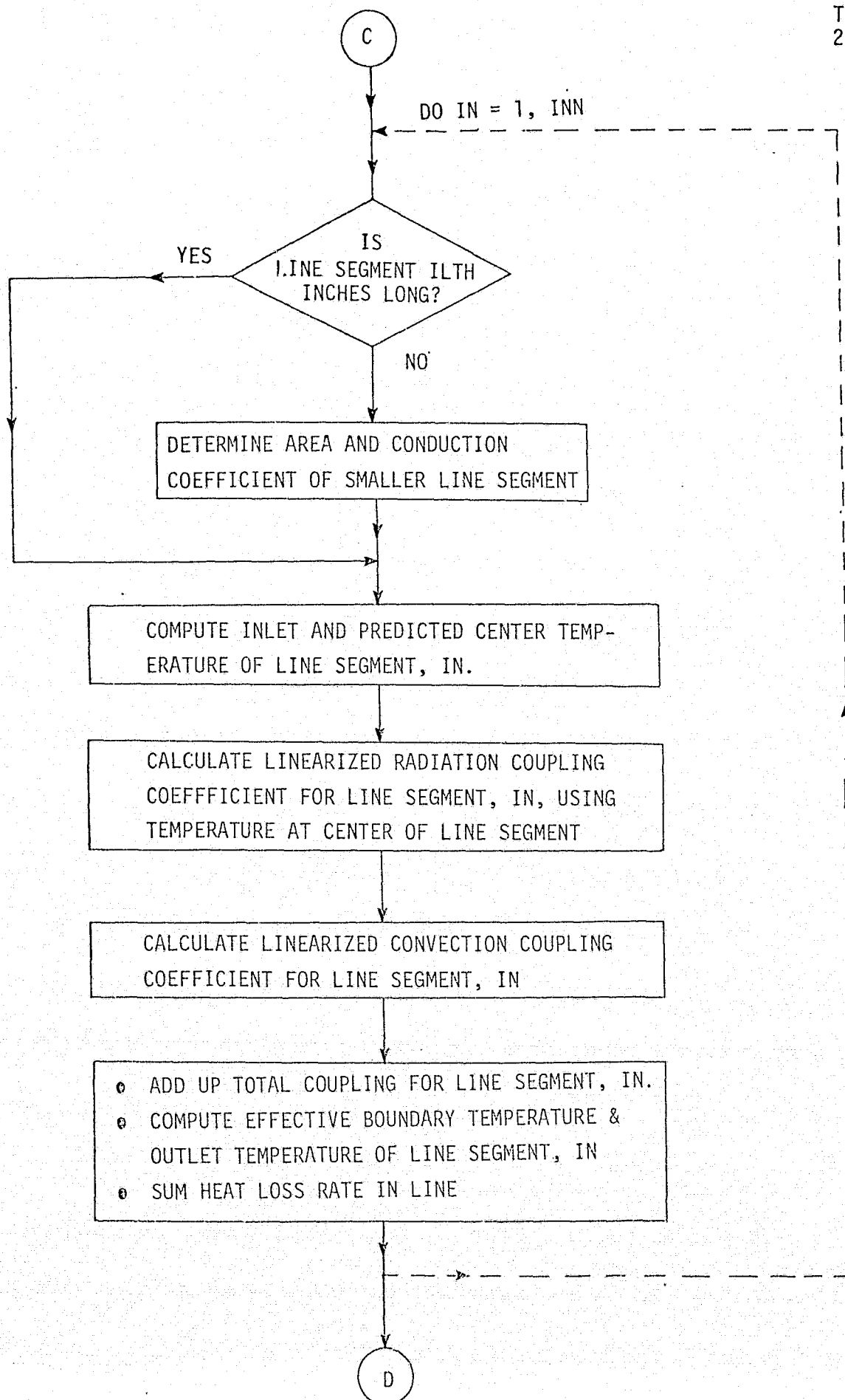
Common Block Reference/Input-Output Variable

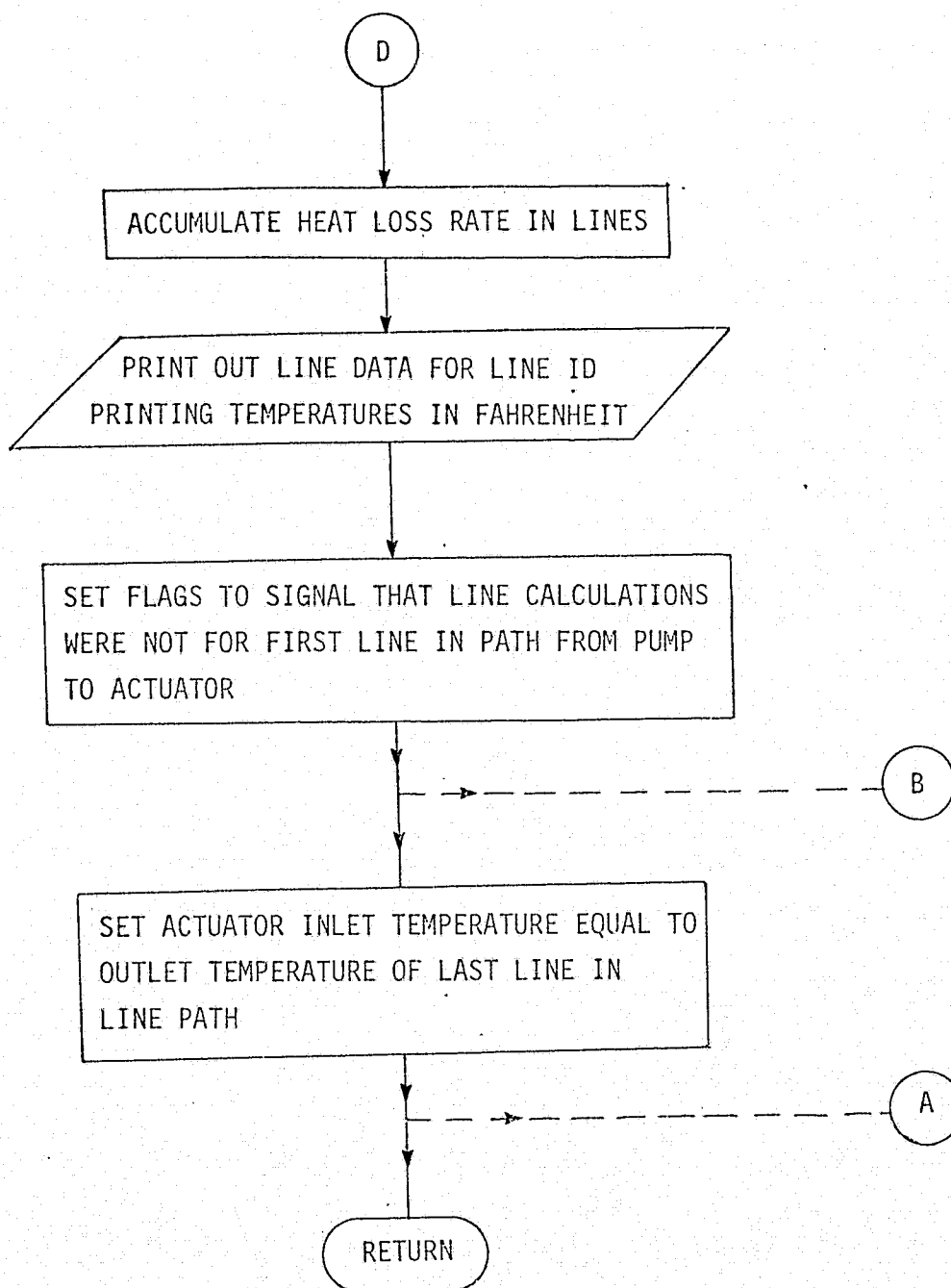
<u>Block Name</u>	<u>Input</u>	<u>Output</u>
ACT	NHYD, FLW	
Blank Common	IDUM, F(X,L), P(X,L)	C(I,4), I-251, 263 F(X,L)
LINES	FLOWL, IBIG, KNODE, LDGF, LINUM, LTH, NLCNT, NODLIN, SPACE, TEMPOT	TEMPIN, TEMPOT, QDOTL
PRT	ICNT, IPRNT	

Local Variable Definitions

<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
AREA	R	in ²	Area of the line segment being solved
BASE	R	BTU/hr-ft ² -°F	Convection coefficient base factor for current temp
ILTH	I	in.	Length of line segment to use in line solutions
ID	I		Line index of line being solved
INN	I		Number of line segments in line ID
INTG3	I		Second digit in line number
JK	I		Number of actuators on system IS
KEY1	I		Flag to determine if line ID is a pressure line for system IS.
KEY2	I		Flag to determine if present line being solved is first line downstream of pump.
K1	I		Number of 16ths of an inch in diameter of line
K2	I		Structure node coupled to line ID
LASTID	I		Line index for the previous line solved
LTHEND	I	in.	Line segment shorter than ILTH remaining at end of line or length of line shorter than ILTH
NAL	I		Number of lines to be solved for actuator NN
NN	I		Actuator inlet node number
T2	R	°R	Temperature of structure node that line ID is coupled to.
TI	R	°R	Inlet fluid temperature of line segment
TC	R	°R	Predicted center temperature of line segment
TO	R	°R	Outlet fluid temperature of line segment
TEMPZ	R	°R ³	Coefficient computed using boundary temperature and temperature at center point of line segment to linearize radiation coupling
TFILM	R	°R	Convection film temperature
TBEFF	R	°R	Effective boundary temperature
UACOND	R	BTU/hr-°R	Conduction coupling coefficient
UA CONV	R	BTU/hr-°R	Linearized convection coupling coefficient
UARAD	R	BTU/hr-°R	Linearized radiation coupling coefficient
UA	R	BTU/hr-°R	Combined coupling coefficient







Subroutine THERMR (ALT model only)

Identification

Name - THERMR

Author/Company - J. L. Walker/MDTSCO

Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To determine heat loss and resultant fluid temperature in hydraulic return lines from the actuators to case drain mix node due to conduction, convection and radiation coupling to vehicle structure and compartment air.

Argument List Definition

IS - System number

N1 - Node number counter - used to differentiate between identical nodes on each system

PAMB - Ambient air pressure

Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
ACT	NHYD, FLW	
Blank Common	IDUM, F, P, DELT, C(I,4) I=251,263	C(I,4), I=251, 263 C(X,3)
LINES	NODLIN, NLCNT, LINUM FLOWL, SPACE, LTH, LDGF TEMPOT, KNODE, IBIG	QDOTL
HYD	IPDO, IFLAG	
PRESR	PDRP	
PRT	ICNT, IPRNT	

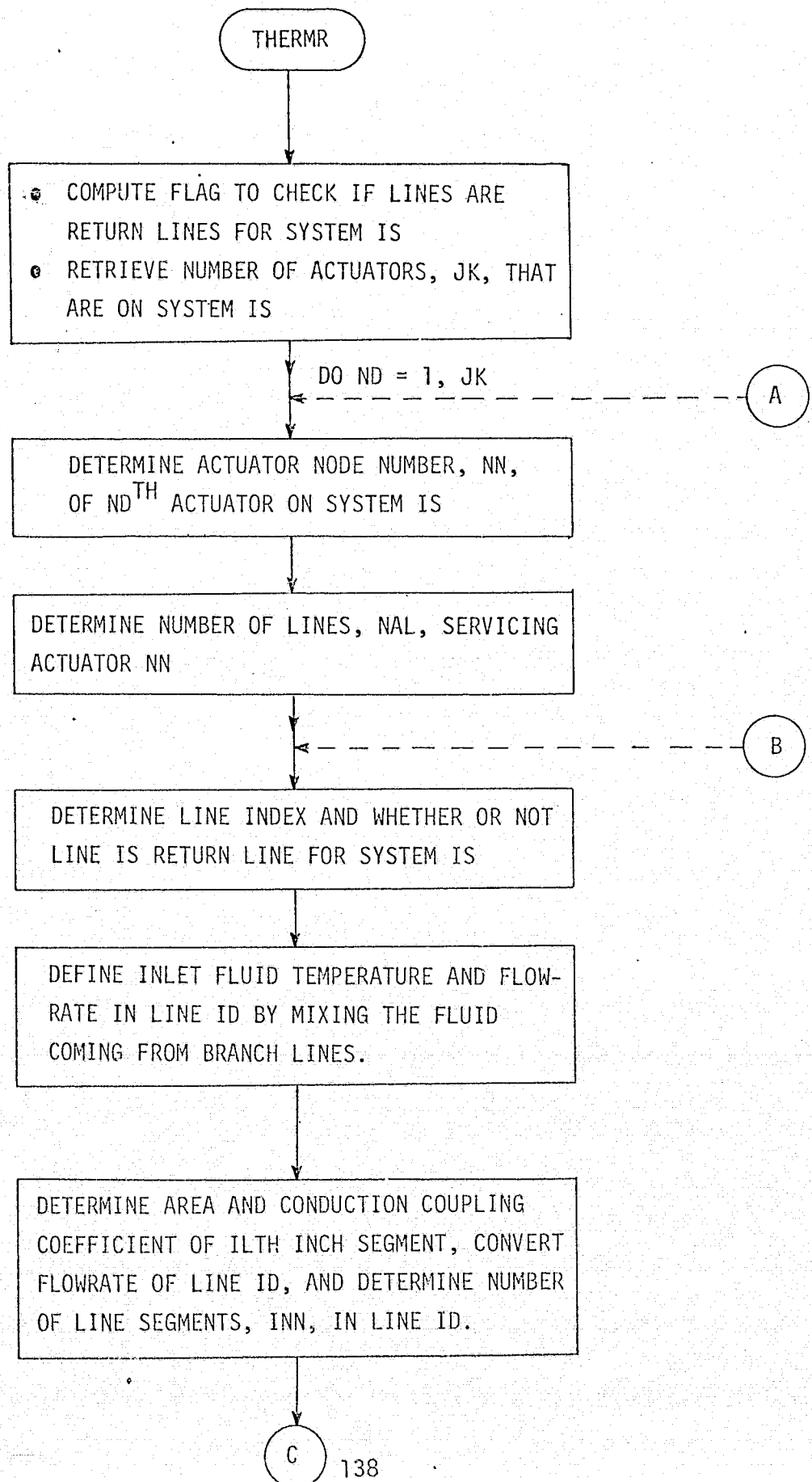
Local Variable Definitions

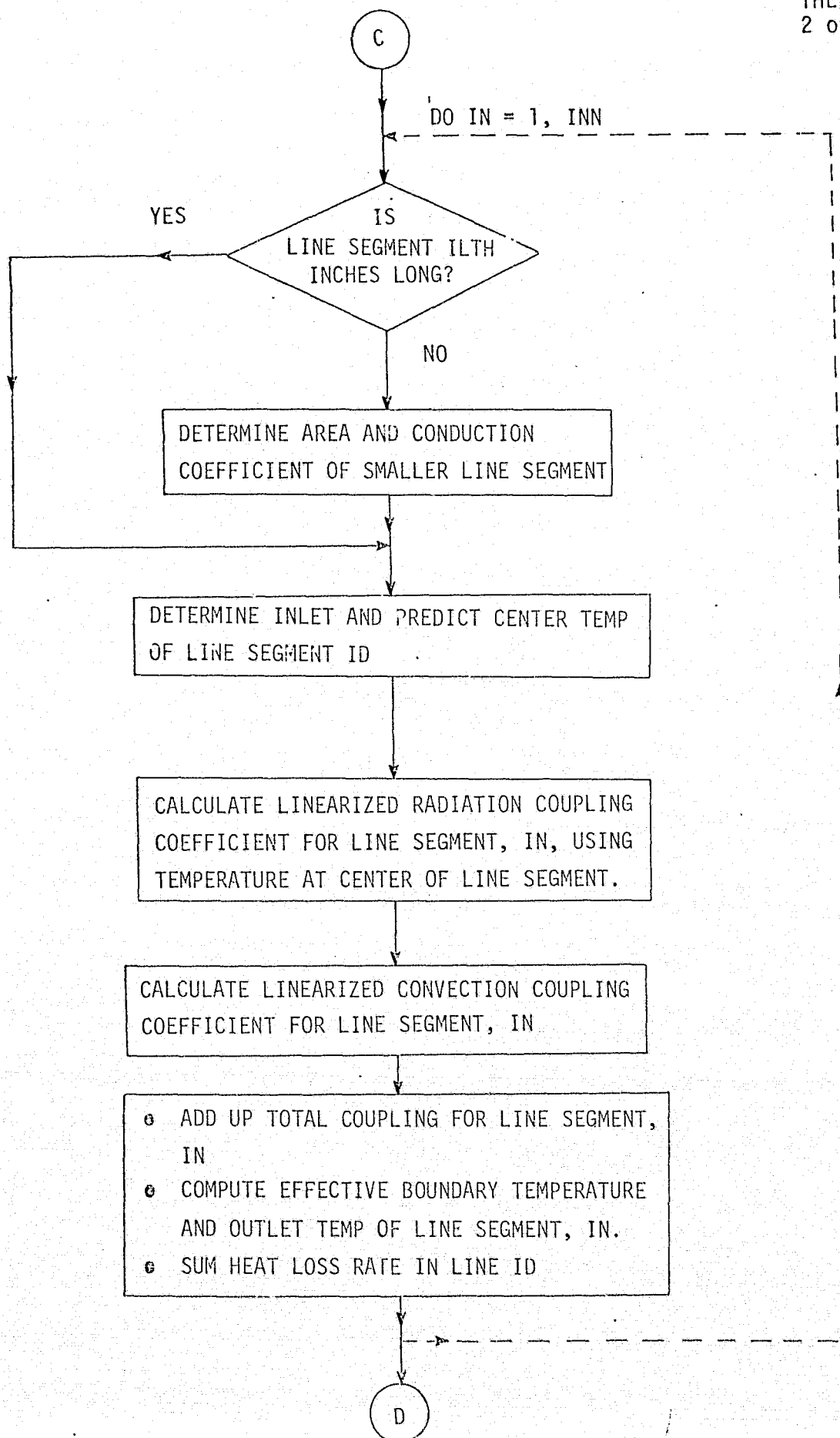
Name	Type	Units	Description
AREA	R	in ²	Area of line segment being solved
BASE	R	BTU/hr-ft ² -°R	Convection coefficient base factor for current kmp
CAPHR	R	BTU/min	System capacitance heat soak rate
ICNFIG	I		Present system configuration 3=pressurized, 2=depressurized, 1=off
ID			Line index of line being solved
ILTH	I		Length of line segments to use in line solutions
INN	I		Number of line segments in line ID
INTG3	I		Second digit in line number
JK	I		Number of actuators on sys IS
KEY1	I		Flag to determine if line ID is a return line or system IS.
KEY2	I		Flag to determine if line ID is first line in actuator's return line path
KEY3	I		Flag used in determining total flowrate in return lines
K1	I		Number of 16th of an inch in the line's diameter
K2	I		Structure node coupled to line ID.
LASTID			Line index for the previous line solved
LTHEND	I	in	Length of remainder of line after line divided into segments of length, ILTH
NAL	I		Number of lines to be solved for actuator, MM
NN	I		Actuator node number
T2	R	°R	Temperature of structure node that line ID is coupled to.
TI	R	°R	Inlet fluid temperature
TC	R	°R	Predicted center temperature of line segment
TO	R	°R	Outlet fluid temperature of line segment
TEMPZ	R	°R	Coefficient computed using boundary temperature and temperature at center of line segment to linearize radiation coupling
TFILM	R	°R	Convection film temperature

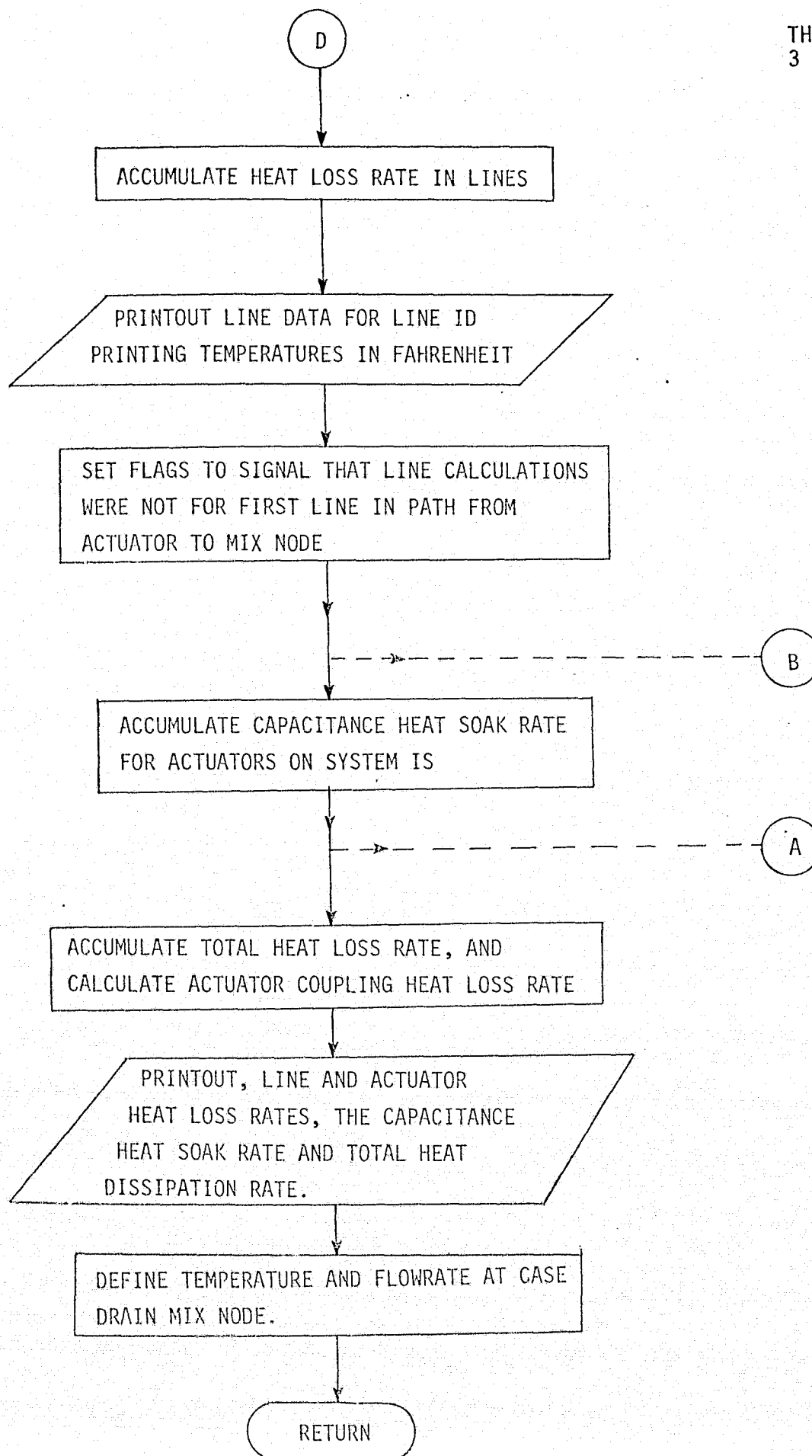
<u>Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
TBEFF	R	°R	Effective boundary temperature
UACOND	R	BTU/hr-°R	Conduction coupling coefficient
UACONV	R	BTU/hr-°R	Linearized convection coupling coefficient
UARAD	R	BTU/hr-°R	Linearized radiation coupling coefficient
UA	R	BTU/hr-°R	Combined coupling coefficient

FIGURE 6-19 FUNCTIONAL FLOWCHART FOR THERMR

THERMR
1 of 3







Subroutine TRANS

Identification

Name - TRANS (GTRANS (ECLSS only))
Author/Company - FEAR/TRW
Machine/Language - UNIVAC 1108, EXEC 2 system/FORTRAN V

Purpose

To transfer flowrate and fluid temperature data from node II to node JJ.

Argument List Definition

II - Node with known flowrate and fluid temperature

JJ - Node to which to transfer data

Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common	F(II,L), C(II,3)	F(JJ,L), C(JJ,3)

No Functional Flowchart Necessary

Subroutine ZIPIT

Identification

Name - ZIPIT

Author/Company - J. L. Walker/MDTSCO

Machine/Language - UNI VAC 1108/EXEC 2 system/FORTRAN V

Purpose

To zero line flowrate, heat rate, and temperature arrays and to zero line heat loss rate arrays.

Common Block Reference/Input-Output Variables

<u>Block Name</u>	<u>Input</u>	<u>Output</u>
Blank Common		C(I, 4), I=251,253
Lines		FLOWL, TEMPIN, TEMPOUT, FLACUM, FLOWT, QDOTL

No Functional Flowchart Necessary

APPENDIX A. PROGRAM USAGE

This appendix presents the information necessary to execute TAHAP successfully. An overall deck setup, the sequence of the input data cards, and the specific data card requirements and the format of those cards are listed and described. Differences between the ALT and OFT versions are noted where they occur.

Deck setup for TAHAP is illustrated in Figure A-1. The input data deck card sequence is summarized in Figure A-2. Data format requirements for data cards are summarized in Section A.1 and for data tapes in Section A.2.

FIGURE A-1 DECK SETUP FOR TAHAP

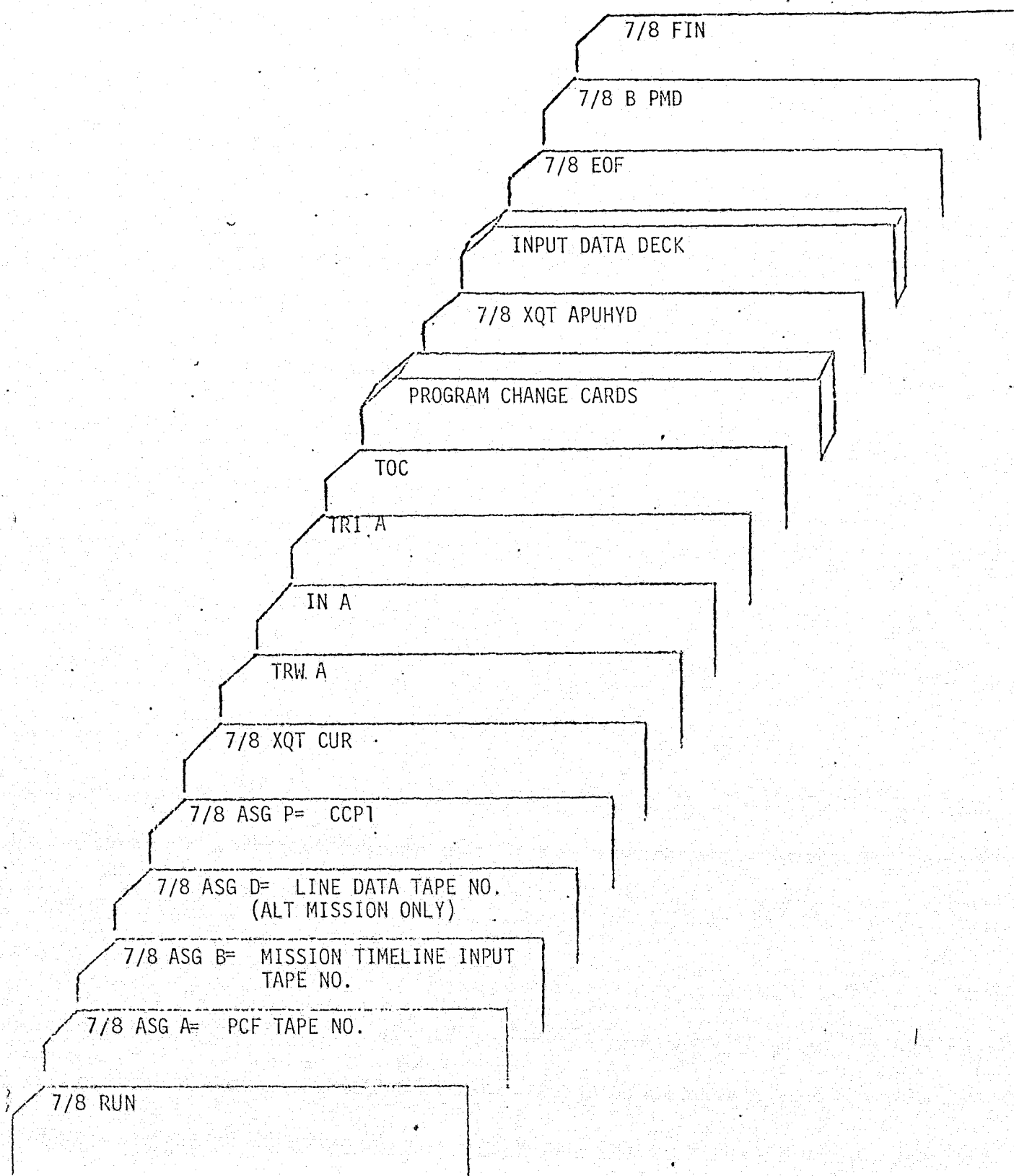


FIGURE A-2 INPUT DATA DECK SEQUENCE

TAHAP REQUIRES THAT THE INPUT CARDS BE IN THE FOLLOWING ORDER:

1. TITLE CARD
2. MISSION CONTROL CARD
3. PLOT CONTROL CARD
4. SUMMARY TABLE CONTROL CARD
5. NODE COUPLING CARDS
6. NODE THERMAL DATA CARDS
7. PLOT INPUT CARDS
8. HEAT BALANCE TITLE CARDS
9. SYSTEM CONFIGURATION MATRIX
10. LOSS MANAGEMENT MATRIX
11. SUMMARY TABLE CONSTANTS

A.1 INPUT DATA CARD FORMAT REQUIREMENTS

The following lists summarize the card formats for each of the cards identified in Figure A-2. All integer values must be right justified.

1. Title card

<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
A	1 - 72	Any title

2. Mission run control card

<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
I	1 - 5	Number of nodes
F	11 - 20	Time computation increment (hrs)
F	21 - 30	Mission start time (hrs)
F	31 - 40	Mission stop time (hrs)
F	41 - 50	Print interval (hrs)
I	51 - 55	Number of CALCOMP plot traces
I	56 - 60	Number of Coupling Data cards
I	66 - 70	Flag for type of Ambient Air Temp profile 2 = Cold Day, 3 = Hot Day, 4 = Nominal (ALT Only)

3. Plot control card

<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
I	1 - 5	PLTSEQ (input the value "1")
F	11 - 20	Mission stop time
F	21 - 30	X-axis length (inches)
F	31 - 40	Y-axis length (inches)
I	41 - 50	NO PLOT (ignore)

4. Summary Table control card

<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
F	1 - 10	Time at end of Pre-Launch Phase (hrs)
F	11 - 20	Time at touchdown (hrs)
F	21 - 30	Time at end of Post touchdown (hrs)
F	31 - 40	Length of Mission from Takeoff (hrs)
F	41 - 50	Fudge time for long missions

5. Node Coupling cards (one card for each pair of nodes)

<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
I	1 - 5	I} coupled nodes
I	6 - 10	J}
F	11 - 20	Conduction/ convection coupling heat transfer coefficient from I to J and conversely BTU/hr - °R
F	21 - 30	Radiation coupling heat transfer coefficient from I to J and conversely BTU/hr - °R ⁴
I	50	Flag for including heat transfer in heat balance equations in QBAL 1 = coupled to structure, 0 = internally coupled

NOTE: Input only one card for each pair of coupled nodes.
The order is insignificant.

6. Node Thermal Data cards (one card for each node)

<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
I	1 - 5	Node number, I
I	7	Indicator defining number of additional cards (used for ECLSS only)
F	11 - 20	C(I, 1) - Thermal capacitance, MC _p BTU/°R
F	21 - 30	C(I, 2) - Heat transfer coeff., UA BTU/hr - °R
F	31 - 40	C(I, 3) - Dynamic thermal capacitance, WC _p lbm-BTU/hr-lbm-°R
F	41 - 50	C(I, 4) - Heat load, Q BTU/hr
F	51 - 60	P(I, X) - Initial component temperature °F
F	61 - 70	F(I, X) - Initial fluid temperature °F
A	71 - 80	Component or node name

7. Plot Input cards

<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
I	1 - 5	Node number
I	6 - 10	Type of plot desired (see Sec. 5.2)
F	11 - 20	Max value of dependent variable if machine scaling is not desired
F	21 - 30	Min value of dependent variable if machine scaling is not desired
I	31 - 35	Number of traces on this plot. This number must be on the plot card for each of the traces

7. (continued)

One card is required for each trace. The cards for the traces on the same plot must be kept together.

8. Heat balance title cards (8 cards)

Titles for each value output as described in Sec. 5.1.5.

<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
A	1 - 12	Title of heat balance value

9. System Configuration Matrix (27 cards)

<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
I	1 - 5	Number representing configuration of System 1
I	6 - 10	Number representing configuration of System 2
I	11 - 15	Number representing configuration of System 3
I	16 - 27	System configuration number (optional - written on card to help keep cards in order, not read.)

3 = Pressurized, 2 = Depressurized, 1 = Off

Cards must be in numerical order for configurations 1 - 27.

10. Loss Management Matrix

<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
I	1 - 5	Primary system for node I
I	6 - 10	1st standby system for node I
I	11 - 15	2nd standby system for node I
I	16 - 20	Input a zero
I	21 - 27	Node number (I) (optional - written on card to keep cards in order, not read)

Cards must be in numerical order for nodes 1 - total number of actuators, NACT. Presently there are 37 actuators for ALT model, 43 actuators for OFT model. The variable, NACT, defined by data statement in MAIN determines number of cards to be read.

11. Summary Table constants

	<u>FORMAT</u>	<u>COLUMNS</u>	<u>DATA</u>
a.	F	1 - 10	Loading value for fuel, system 1 (lbm)
	F	11 - 20	Loading value for fuel, system 2 (lbm)
	F	21 - 30	Loading value for fuel, system 3 (lbm)
	F	31 - 35	Loading and in-flight measurement error for fuel, system 1 (lbm)
	F	36 - 40	Loading and in-flight measurement error for fuel, system 2 (lbm)
	F	41 - 45	Loading and in-flight measurement error for fuel, system 3 (lbm)
	F	46 - 50	Residual quantity for fuel, system 1 (lbm)
	F	51 - 55	Residual quantity for fuel, system 2 (lbm)
	F	56 - 60	Residual quantity for fuel, system 3 (lbm)
b.	F	1 - 10	Loading value for water, system 1 (lbm)
	F	11 - 20	Loading value for water, system 2 (lbm)
	F	21 - 30	Loading value for water, system 3 (lbm)
	F	31 - 40	Residual quantity for water, system 1 (lbm)
	F	41 - 50	Residual quantity for water, system 2 (lbm)

A.2 INPUT DATA TAPE FORMAT REQUIREMENTS

Data tape inputs include both mission timelines and fine data.

A.2.1 Mission Timeline Input Data Tape Format

Each record of the timeline input tape must contain each of the following 56 words:

<u>Word #</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
1	R	hrs	Time
2	R	GPM	Flowrates for:
3	R	GPM	SSME 1 TVC Pitch
4	R	GPM	SSME 1 TVC Yaw
5	R	GPM	SSME 1 Engine Controller
6	R	GPM	SSME 2 TVC Pitch
7	R	GPM	SSME 2 TVC Yaw
8	R	GPM	SSME 2 Engine Controller
9	R	GPM	SSME 3 TVC Pitch
10	R	GPM	SSME 3 TVC Yaw
11	R	GPM	SSME Engine Controller
12	R	GPM	Rudder Motor #1
13	R	GPM	Rudder Motor #2
14	R	GPM	Rudder Motor #3
15	R	GPM	Rudder Servo
16	R	GPM	Speed Brake Motor #1
17	R	GPM	Speed Brake Motor #2
18	R	GPM	Speed Brake Motor #3
19	R	GPM	Speed Brake Servo
20	R	GPM	LO Elevon
21	R	GPM	LI Elevon
22	R	GPM	RO Elevon
23	R	GPM	RI Elevon
24	R	GPM	Body Flap Motor #1
25	R	GPM	Body Flap Motor #2
26	R	GPM	Body Flap Motor #3
27	R	GPM	LO Brake Module
28	R	GPM	LI Brake Module
29	R	GPM	RO Brake Module
30	R	GPM	RI Brake Module
31	R	GPM	L MLG Uplock
32	R	GPM	R MLG Uplock
33	R	GPM	L MLG Strut
34	R	GPM	R MLG Strut
35	R	GPM	NLG Uplock
36	R	GPM	NLG Strut
37	R	GPM	NLG Steering
38	R	GPM	NLG Restrictor

A.2.1 (continued)

<u>Word #</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>	<u>ALT</u>
			<u>OFT</u>	
39	R	GPM	LH2 ET Umbilical Retractor 1	OFTACT (1)
40	R	GPM	LH2 ET Umbilical Retractor 2	OFTACT (2)
41	R	GPM	LH2 ET Umbilical Retractor 3	OFTACT (3)
42	R	GPM	L02 ET Umbilical Retractor 1	OFTACT (4)
43	R	GPM	L02 ET Umbilical Retractor 2	OFTACT (5)
44	R	GPM	L02 ET Umbilical Retractor 3	OFTACT (6)
			Total System Flowrates for:	
45	R	GPM	System #1	
46	R	GPM	System #2	
47	R	GPM	System #3	
			Pump Shaft Horsepower for:	
48	R	HP	System #1	} not used, read and written out for comparison only
49	R	HP	System #2	
50	R	HP	System #3	
51	I	-	System Configuration Flag	
			APU Speed Flag for:	
52	I	-	System #1	
53	I	-	System #2	
54	I	-	System #3	
55	R	G	Vehicle Load Factor	
56	R	FT	Altitude	

A.2.2 Line Data Input Tape Format (ALT Model only)

Each record of the line data input tape must contain each of the following 53 words.

<u>Word #</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
1	I	-	Line number I
2	I	-	Landing gear flag to identify reverse flowlines
3	I	-	Coupling mode number (Structure mode minus 250)
4	I	-	Complete list of actuators whose line path includes Line I. Zeroes will be read if no more actuators.
50	I	-	
51	I	-	Line number I
52	I	in.	Length of line I
53	I	16th in.	Diameter of line I in number of 16th of an inch

APPENDIX B. COMMON BLOCK VARIABLE DEFINITIONS

This appendix presents definitions for each of the variables appearing in each COMMON block in either the ALT or OFT version of TAHAP including the blank COMMON. Several arrays which are large general storage arrays are defined in more detail in Appendix D. For each COMMON block, each variable name, type, units and definition is provided.

Table B-1 presents a reference table for each of the COMMON blocks.

On the left is a list of the COMMON blocks. On the right is a list of each of the routines, main program or subroutines, from which that COMMON block is referenced.

TABLE B-1

COMMON BLOCK REFERENCE TABLE

Common Block:	Routines					
Blank Common:	BOILP, HYDACT, MIX, PRINT, THERMR,	DRAW, HYDFLD, MOD, QBAL, TRANS,	DRIVER, LILOAD, PASS, RSTART, ZIPIT,	FLIP, LINFLO, PLATE, SPRAY, MAIN1,	FLOPWR, LOOP, PLATEC, START, MAIN2	FUEL LUBOIL, PLOOT, THERMP,
ACT:	HYDACT, MAIN1,	LILOAD, MAIN2	LINFLO,	PRINT,	THERMP,	THERMR,
ALT:	PRINT,	MAIN1				
ALTD:	PLOOT,	MAIN1,	MAIN2			
ARRAY:	BOILP, MAIN2	PLOOT,	PRINT,	QBAL,	RSTART,	MAIN1,
COMEVP:	BOILP,	PLOOT,	PRINT,	SPRAY,	MAIN1,	MAIN2
DAMMIT:	PLOOT,	PRINT				
EXTRA:	QBAL,	START				
GLOB:	PASS,	PLATEC,	QBAL,	START		
HYD:	FLOPWR, THERMR,	FUEL, MAIN1,	HYDACT, MAIN2	HYDFLD,	LUBOIL,	START,
LINES:	LILOAD,	LINFLO,	THERMP,	THERMR,	ZIPIT	
LUMP2:	DRIVER,	DRAW,	START			
PRESR:	FLOPWR,	HYDACT,	HYDFLD,	THERMR		
PRT:	PRINT,	START,	THERMP,	THERMR,	MAIN1,	MAIN2
PSST:	DRIVER,	DRAW,	PLOOT,	START		
TYME:	BOILP, MAIN2	FUEL,	PRTTAB,	RSTART,	START,	MAIN1

TABLE B-2
COMMON BLOCK VARIABLE DEFINITIONS

<u>Block Name</u>				
<u>Variable Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>	
<u>Blank Common</u>				
C	R	Variable	Storage array for node thermal properties. Described in detail in Appendix D.	
DUM	R	Variable	Storage array for miscellaneous real values. Described in detail in Appendix D	
F(N, X)	R	°F or °R	Fluid temperature of node N	
IDUM	I	Variable	Storage array for miscellaneous integer values. Described in detail in Appendix D	
K	I	-	Most recent or previous value index for F and P	
I	I	-	Current value index for F and P	
NNODES	I	-	Number of nodes	
P (N, X)	R	°F or °R	Component temperature of node N	
TIME	R	hrs	Current time in mission (G.E.T.)	
TSTOP	R	hrs	Mission stop time (G.E.T.)	
<u>ACT</u>				
FLW	R	GPM	Array of actuator flow rates to be used in solution	
NACT	I	-	Total number of actuators	
NHYD (I, X)	I	-	Array of actuator inlet node numbers on System I, I = 1, 3	
NHYOUT (I, X)	I	-	Array of actuator outlet node numbers on system I, I = 1, 3	

TABLE B-2
(Continued)

<u>Block Name</u>				
	<u>Variable Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
<u>ALT</u>				
	BH20	R	lbm	Amount of water currently in water boiler, system I, I = 1, 3
	BH20F(I)	R	lbm	Amount of water that has been transferred from system I storage tank, I = 1, 3
	IALT	I		Flag for type of mission 1 = ALT, 0 = OFT
<u>ALTD</u>				
	ALT	R	ft	Current altitude
<u>ARRAY</u>				
	FLAG	R	-	Flag for type of flow in boiler 1 = unchoked, 2 = choked
	G	R	Variable	Storage array for miscellaneous real values. Described in detail in Appendix D
	ITTER	I	-	Number of iterations required to find a pressure solution
	TINIT(N)	R	°R	Array for storage of initial component temperature of node N, N = 1, 300
<u>COMEVP</u>				
	DI(I)	R	lbm	Amount of water consumed in one computation cycle by system I, I = 1, 3
	IWAT(I)	I	-	Node number of heat exchanger system I, I = 1, 3
	WAT(I)	R	lbm	Amount of water consumed by system I, I = 1, 3
	WATLFT(I)	R	lbm	Amount of water remaining in system I, I = 1, 3

TABLE B-2
(Continued)

<u>Block Name</u>	<u>Variable Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
<u>DAMMIT</u>	DH	R	BTU	Values used for ECLSS Heater energy consumables
	ERG	R	BTU	
	IERG	I	-	
<u>EXTRA</u>	ICOUP(N)	I	-	Flag for determining if component N's coupling value should be used in error calculations 1 = yes, 0 = no.
<u>GLOB</u>	IBIG	I	-	Array of nodes involved in conduction/ convection coupling
	JBIG	I	-	Array of nodes involved in radiation coupling
	KEEP(N)	I	-	Array which connects node number N to positions of IBIG array which con- tain the node numbers for the nodes N is coupled to
	LEEP(N)	I		Array which connects node number N to positions of JBIG array which contain the node numbers for the nodes N is coupled to.
	RVAL	R	BTU/hr-°R	Array of radiation coupling coefficients
	VAL	R	BTU/hr-°R	Array of conduction/convection coupling coefficients
<u>HYD</u>	IFLAG	I	-	System configuration flag
	IPDO	I	-	System configuration matrix
	ISPD(I)	I	-	APU speed flag for system I, I = 1, 3
	LMMTRX	I	-	Loss Management matrix

TABLE B-2
(Continued)

Block Name

<u>Variable Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
<u>HYD (continued)</u>			
POWER	R	HP	Current pump shaft horsepower for system I, I = 1, 3.
TFLW	R	GPM	Total system flowrates for system I, I = 1, 3
<u>LINES</u>			
EMISS	R	-	Emissivity of the Titanium alloy (Ti 3Al-2.5V) hydraulic lines
FLACUM	R	GPM	Return line solution flowrate accumulator
FLOWL	R	GPM	Array of line flowrates
FLOWT	R	GPM-°R	Return line solution flowrate x temp. accumulator
IBIG(I)	I	16th in.	Diameter of line I in number of 16th of an inch
KNODE(I)	I	-	Coupling node (structure node number minus 250) for line I
LINUM(I)	I	-	Line number of line I
LDGF(I)	I	-	Landing gear flag for line I
LTH(I)	I	in.	Length of line I
NLCNT(N)	I	-	Number of line connected to actuator N
NODLIN	I		Actuator-line matrix containing each actuator connected to each line
QDOTL(I)	R	BTU/min	Heat loss rate in line I
SHAPE	R		Radiation form factor
SPACE	R		Array containing line support spacing
TEMPB	R		Not used
TEMPIN(I)	R	°R	Inlet fluid temperature for line I
TEMPOT(I)	R	°R	Outlet fluid temperature for line I

TABLE B-2
(Continued)

Block Name

<u>Variable Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
<u>LUMP2</u>			
BIG(J)	R	Variable	Maximum value for Y-axis for plot J (input)
TITLE	A	-	Title to be used for run and plots
WEE(J)	R	Variable	Minimum value for Y-axis for plot J (input)
<u>PRESR</u>			
DENS(I)	R	lbm/ft ³	Density of hydraulic oil at the heat exchanger inlet for system I, I = 1, 3
PDRP(J)	R	psid	Pressure drop for system in configuration J J = 1 = off, 2 = depressurized, 3 = pressurized
SPH(I)	R	BTU/lb-°R	Specific heat for hydraulic oil at the heat exchanger inlet for system I, I = 1, 3
<u>PRT</u>			
AERROR	A	-	Titles for heat balance - error values
ANAME(N, 2)	A	-	Name of node N, N = 1, 300
ICNT	I	-	Counter for printing at desired interval
IPRNT	I	-	Number of comp cycles between each printing
<u>PSST</u>			
IPLT(J)	I	-	Node number for plot (trace) J
IWRADR	I	-	High speed drum address at which to start writing plot data
JPLT(J)	I	-	Type of plot for plot J
NO PLOT	I	-	Not used
NPLPTS	I	-	Number of points on each plot

TABLE B-2
(Continued)

Block Name

<u>Variable Name</u>	<u>Type</u>	<u>Units</u>	<u>Description</u>
<u>PSST (continued)</u>			
NPLTS	I	-	Total number of traces
NTR	I	-	Number of traces on plot J
PLTSEQ	I	-	Not used
TSTP	R	hrs.	Stop time to be used as limit of X-axis
XAXIS	R	in.	X-axis length
YAXIS	R	in.	Y-axis length
<u>TYME</u>			
AMSNTM	R	hrs.	Length of mission from takeoff (used for reinitialization capability)
FUDGE	R	hrs.	Time value to subtract from UPTIME to avoid long period of no APU/ hydraulic activity
SUMARY	R	lbm	Storage array for consumables values for summary table. Described in detail in Appendix D.
TIMSUM	R	hrs.	Time values at which to divide consumables usage per mission phase on summary table

APPENDIX C. GENERAL STORAGE ALLOCATION

In the Thermal APU/Hydraulics Analysis Program (TAHAP), several arrays are used for general data storage. This appendix presents a detailed definition of the contents of these general storage arrays. Since this method of data storage was originally defined by FEAR (Ref. 1) large portions of the C, DUM, and IDUM arrays are used only in ECLSS consumables analyses. These areas are pointed out where they occur. The following is a list of the array names, and the COMMON blocks in which the arrays are located, whose contents are defined in Table C-1.

<u>Array Name</u>	<u>Common Block Name</u>
P	Blank COMMON
F	Blank COMMON
C	Blank COMMON
DUM	Blank COMMON
IDUM	Blank COMMON
G	ARRAY
SUMARY	TYME

TABLE C-1
GENERAL STORAGE ALLOCATION

P-array description

P (I, X) - Component Temperature at node I, I = 1, 300

F-array description

F(I, X) - Fluid Temperature at node I, I = 1, 249

Vehicle Compartment Air temp at node I, I = 250, 261

Ambient Air temperature for I = 262

C-array description

For all I, I = 1, 300

C(I, 1) - Thermal capacity	
C(I, 2) - Heat transfer coefficient	
C(I, 3) - Dynamic thermal capacitance	
C(I, 4) - Heat rate or heat flux	
C(I, 5) - Specific heat	
C(I, 6) - Concentration of H ₂ O	} Used only in ECLSS Consumables analyses
C(I, 7) - Concentration of N ₂	
C(I, 8) - Concentration of O ₂	
C(I, 9) - Concentration of CO ₂	
C(I, 10) - (varies in different routines)	
C(I, 11) - Partial pressure of H ₂ O	
C(I, 12) - Partial pressure of N ₂	
C(I, 13) - Partial pressure of O ₂	
C(I, 14) - Partial pressure of CO ₂	
C(I, 16) - Heater energy	

In the following, only the specified portions of the array are full. The node numbers assigned for I are used for the node number requirement on the plot input card if the parameter is to be plotted. The three values for I correspond to systems 1, 2, and 3, respectively.

C(I, 17) - Accumulated Fuel used, I = 275, 276, 277
 C(I, 18) - Accumulated Energy used, I = 275, 276, 277
 C(I, 19) - Fuel remaining, I = 275, 276, 277

TABLE C-1
(Continued)

DUM Array Description

- DUM(1) - DELT/2
- (2) - Ambient air temperature
- (3) - not used
- (4) - not used
- (5) - Accum consum (ECLSS) 1
- (6) - Accum consum (ECLSS) 2
- (7) - Accum consum (ECLSS) 3
- (8) - Accum consum (ECLSS) 4
- (9) - Accum consum (ECLSS) 5
- (10) - not used
- (11) - not used
- (12) - not used
- (13) - not used
- (14) - not used
- (15) - not used
- (16) - Mol. weight of H₂O (ECLSS)
- (17) - Mol. weight of N₂ (ECLSS)
- (18) - Mol. weight of O₂ (ECLSS)
- (19) - Mol. weight of CO₂ (ECLSS)
- (20) - not used
- (21) - Specific heat of H₂O (gas) (ECLSS)
- (22) - Specific heat of CO₂ (gas) (ECLSS)
- (23) - not used
- (24) - not used
- (25) - start time
- (26) - not used
- " "
- (45) - not used
- (46) - A consumable 1st condensing sub1

IDUM Array Description

- IDUM(1) - inlet node no. 1st evaporator called (ECLSS)
- (2) - inlet node no. 2nd evaporator called (ECLSS)
- (3) - inlet node no. 3rd evaporator called (ECLSS)
- (4) - inlet node no. 4th evaporator called (ECLSS)
- (5) - inlet node no. 5th evaporator called (ECLSS)
- (6) - No. of boilers
- (7) - Flag used in THCAP to properly call EVAP (ECLSS)
- (8) - Flag to prevent summing of consumables for 1st call to PRINT
- (9) - Flag to set first guess on outlet temperature on CONSUB (ECLSS)
- (10) - No. of turbines
- (11) - No. of actuators on system #1
- (12) - No. of actuators on system #2
- (13) - No. of actuators on system #3
- (14) - Flag for RSTART to signal if it should assign values or read in new cards - OFT only
- (15) - not used

TABLE C-1
(Continued)

IDUM Array Description (continued)

- IDUM(16) - No. of heaters called (ECLSS)
- (17) - Time step counter
- (18) - not used
- (19) - Flag for BOUNDT for type of ambient air temp. 2 = Cold Day, 3 = Hot Day, 4 = Nominal (ALT Only)
- (20) - Counter for number of plots to supply plot routine
- (21) - not used
- (22) - No. of condensing sublimators (ECLSS)
- (23) - Node no. of 1st condensing sublimator called (ECLSS)
- (24) - Node no. of 2nd condensing sublimator called (ECLSS)
- (25) - Node no. of 3rd condensing sublimator called (ECLSS)
- (26) - Node no. of 4th condensing sublimator called (ECLSS)
- (27) - Node no. of 5th condensing sublimator called (ECLSS)
- (28) - Flag to prevent summing consumables when THCAP is in sensible heat region (ECLSS)
- (100) - Flag set to zero when PRINT or SLEECT have written data that timestep

G Array Description

For the G-array also, only the specified portions of the array are full. The node numbers assigned for I are used for the node number requirement on the plot input card if the parameters are to be plotted. The six values for I correspond to the lube oil heat exchanger, system 1, 2, and 3, and the hydraulic heat exchanger, system 1, 2, and 3, respectively.

- G(I, 1) - Initialization and manipulation of boiler pressure (psia)
where I = 102, 152, 202, 110, 160, 210
- G(I, 2) - Ambient pressure (psia)
where I = 102, 152, 202, 110, 160, 210
- G(I, 3) - Boiling rate (lbm/min)
where I = 102, 152, 202
- G(I, 4) - Boiling rate (lbm/hr)
where I = 102, 152, 202
- G(I, 5) - Heat of vaporization
where I = 102, 152, 202
- G(I, 6) - Time derivative of the boiler pressure
where I = 102, 152, 202
- G(1, 7) - Power heat in for total of the three systems (BTU)
- G(2, 7) - Turbine heat in for total of the three systems (BTU)
- G(3, 7) - Total heat in for total of the three systems (BTU)
- G(4, 7) - Heat out by water for total of the three systems (BTU)
- G(5, 7) - Heat stored in capacitance for total of the three systems (BTU)
- G(6, 7) - Heat out via coupling to structure for total of the three systems (BTU)

TABLE C-1
(Continued)

G Array Description (continued)

G(7, 7) - Total heat out for total of the three systems
G(8, 7) - Total BTU's error, heat in minus heat out
G(101, 7) - Power, System 1 (hp)
G(151, 7) - Power, System 2 (hp)
G(201, 7) - Power, System 3 (hp)

G(I, 8) - Pressure difference between the ambient and boiler
 pressures (psia)
 where I = 102, 152, 202
G(I, 9) - Saturation temperature (deg)
 where I = 102, 152, 202

SUMARY Array Description

For each of the following definitions, J = 1, 3, representing systems
1, 2, and 3 respectively.

SUMARY(1, J) = Present loading value for fuel
SUMARY(2, J) = Loading and in-flight measurement
SUMARY(3, J) = Residual quantity for fuel
SUMARY(4, J) = Minimum usable quantity for fuel
SUMARY(5, J) = Prelaunch requirement for fuel
SUMARY(6, J) = Flight requirement for fuel
SUMARY(7, J) = Post-landing requirement for fuel
SUMARY(8, J) = 24-hr. launch hold recycle requirement for fuel
SUMARY(9, J) = 10% Dispersion factor for fuel
SUMARY(10, J) = Usable margin for fuel

SUMARY(I, J) I = 11, 20 store the water quantities which correspond
to I = 1, 10

NODE NUMBER LIST

Actuators

1	PITCH 1
2	YAW 1
3	ENG CTRL 1
4	PITCH 2
5	YAW 2
6	ENG CTRL 2
7	PITCH 3
8	YAW 3
9	ENG CTRL 3
10	RDR MTR 1
11	RDR MTR 2
12	RDR MTR 3
13	RDR SERVO
14	SB MTR 1
15	SB MTR 2
16	SB MTR 3
17	SB SERVO
18	LO ELEVON
19	LI ELEVON
20	RO ELEVON
21	RI ELEVON
22	BF MTR 1
23	BF MTR 2
24	BF MTR 3
25	LO BRK MOD
26	LI BRK MOD
27	RO BRK MOD
28	RI BRK MOD
29	L MLG UPLK
30	R MLG UPLK
31	L MLG STRT
32	R MLG STRT
33	NLG UPLOCK
34	NLG STRUT
35	NLG STRNG
36	NLG RSTR
37	RLG RSTR
51	PITCH1 OUT
52	YAW 1 OUT
53	ENG C1 OUT
54	PITCH2 OUT
55	YAW 2 OUT
56	ENG C2 OUT
61	RDMTR2 OUT
58	YAW 3 OUT
57	PITCH3 OUT
59	ENG C3 OUT
60	RDMTR1 OUT
62	RDMTR3 OUT
63	RDR SR OUT
64	SBMTR1 OUT
65	SBMTR2 OUT
66	SBMTR3 OUT
67	SB SRV OUT
68	LO ELV OUT
69	LI ELV OUT
70	RO ELV OUT
71	RI ELV OUT
72	BFMTR1 OUT
73	BFMTR2 OUT
74	BFMTR3 OUT
75	LO BRK OUT
76	LI BRK OUT
77	RO BRK OUT
78	RI BRK OUT
79	LNLGUP OUT
80	RNLGUP OUT
81	LNLGST OUT
83	NLG UP OUT
85	NLGSTG OUT
86	NLG RS OUT
84	NLGSTT OUT
82	RNLGST OUT
87	NLG RS OUT

System 1

100	TURBINE 1
101	GEARBOX 1
102	BLR1 APUHX
103	H2O TANK 1
104	PUMP 1
105	CASE DRN 1
106	PUMP 1 OUT
107	MIX HYD 1
108	CD 1 MIX
109	BLR 1 BYPS
110	BLR1 HYDHX
111	HYDHX1 OUT
112	RSRVR 1
113	RSRVR1 OUT
114	DUMMY

System 2

150	TURBINE 2
151	GEARBOX 2
152	BLR2 APUHX
153	H2O TANK 2
154	PUMP 2
155	CASE DRN 2
156	PUMP 2 OUT
157	MIX HYD 2
158	CD 2 MIX
159	BLR 2 BYPS
160	BLR2 HYDHX
161	HYDHX2 OUT
162	RSRVR 2
163	RSRVR2 OUT
164	DUMMY

System 3

200	TURBINE 3
201	GEARBOX 3
202	BLR3 APUHX
203	H2O TANK 3
204	PUMP 3
205	CASE DRN 3
206	PUMP 3 OUT
207	MIX HYD 3
208	CD 3 MIX
209	BLR 3 BYPS
210	BLR3 HYDHX
211	HYDHX3 OUT
212	RSRVR 3
213	RSRVR3 OUT
214	DUMMY

Boundary Nodes

250	AFT FUSELG
251	ENGINES
252	LEFT WING
253	RIGHT WING
254	MID FUSELG
255	VERT STAB
256	BODY FLAP
257	R WHL WELL
258	L WHL WELL
259	FWD FUSELG
260	N WHL WELL
261	DUMMY
262	AMB AIR
275	FUEL-ENERG
276	FUEL-ENERG
277	FUEL-ENERG

ORIGINAL PAGE IS
OF POOR QUALITY

APPENDIX D. SUBROUTINE LISTINGS

The following are subroutine listings for the subroutines discussed in Section 6.0

ORIGINAL PAGE IS
OF POOR QUALITY

FOR, DRIVER, DRIVER
UNIVAC 1108 FORTRAN V EXEC II LEVEL 25A - (EXEC8 LEVEL E12010010A)
THIS COMPILATION WAS DONE ON 03 SEP 76 AT 06:25:25

OV-101 (ALT) VERSION

```

1* COMMON K,L,DELT,TIME,TSTOP,NNODES
2* COMMON P(300,2),F(300,2),C(300,20)
3* COMMON DUM(100),IDUM(100)
4* COMMON /LUMP2/ TITLE(12),BIG(25),WEE(25)
5* COMMON /PSST/NPLTS,IPLT(25),JPLT(25),PLTSEG,TSTP(5),XAXIS(5),
6* YAXIS(5),NOPLT(5),NPLPTS,NTR(25),IWRADR,IRDAUR
7* CALL MAIN1
8* IF(IDUM(20).GT.0) CALL DRAW
9* END

```

END OF COMPILATION: NO DIAGNOSTICS.

OV-102 (OFT) VERSION

```

1* COMMON K,L,DELT,TIME,TSTOP,NNODES
2* COMMON P(300,2),F(300,2),C(300,20)
3* COMMON DUM(100),IDUM(100)
4* COMMON /LUMP2/ TITLE(12),BIG(25),WEE(25)
5* COMMON /PSST/NPLTS,IPLT(25),JPLT(25),PLTSEG,TSTP(5),XAXIS(5),
6* YAXIS(5),NOPLT(5),NPLPTS,NTR(25),IWRADR,IRDAUR
7* CALL MAIN2
8* IF(IDUM(20).GT.0) CALL DRAW
9* END

```

END OF COMPILATION: NO DIAGNOSTICS.

ORIGINAL PAGE IS
OF POOR QUALITY

SUBROUTINE-MAIN1				
		VARIABLE NAME	DESCRIPTION	UNITS
1	C	ALT	CURRENT ALTITUDE	FT
2	C	BH20	AMOUNT OF WATER IN BOILER	LRM
3	C	C(X,1)	THERMAL CAPACITANCE	BTU/DEG R
4	C	C(X,2)	HEAT TRANSFER COEFFICIENT	BTU/HR-DEG R
5	C	C(X,3)	DYNAMIC THERMAL CAPACITANCE	LRM-BTU/HR-LB-R
6	C		(MASS FLOWRATE X SPECIFIC HEAT)	
7	C	C(X,4)	HEAT LOAD OR HEAT RATE	BTU/HR
8	C	DNTRAN	AMOUNT OF WATER TRANSFERRED THIS COMP	LRM
9	C		CYCLE	
10	C	FL	ACTUATOR FLOWRATES READ IN	GPM
11	C	FLAW	TEMPORARY STORAGE FOR ACTUATOR FLOWRATES	GPM
12	C	FLW	ACTUATOR FLOWRATES USED FOR CURRENT	
13	C		COMP CYCLE	GPM
14	C	GRAV	C.G. LOAD FACTOR	
15	C	HS	HEIGHT OF WATER IN STANDPIPE	

25	C	IFLAG	SYSTEM CONFIGURATION FLAG	
21	C	IO	FLAG USED IN PRINT TO LIMIT NODE DATA	
22	C		PRINTING TO C(X,1) THRU C(X,4)	
23	C	ISPD	APU-OPERATING-SPEED-FLAG	
24	C	ITV	TRANSFER VALVE FLAG	
25	C	IWAT(1)	NODE NUMBER OF BOILER 1	
26	C	JK	NUMBER OF ACTUATORS ON SYSTEM 1	
27	C	NACT	TOTAL-NUMBER-OF-ACTUATORS	
28	C	WH	COUNTER FOR NUMBER OF TAPE RECORDS TO	
29	C		PROCESS PER COMP CYCLE	
30	C	NOD	ARRAY OF ACTUATOR NODE NUMBERS ON SYS 1	
31	C	NTURBN	NUMBER OF APU/HYDRAULIC-SYSTEMS	PSIA
32	C	P2	AMBIENT AIR PRESSURE	GPM
33	C	TFL	TOTAL SYSTEM FLOWRATES READ IN	GPM
34	C	TFLAW	TEMPORARY STORAGE FOR TOTAL SYSTEM	
35	C		FLOWRATES	
36	C	TFLW	TOTAL SYSTEM FLOWRATES USED FOR CURRENT	GPM
37	C		COMP CYCLE	HRS
38	C	TIME	CURRENT TIME	HRS
39	C	UPTIME	TIME AT WHICH TO UPDATE TIMELINE DATA	LBM
40	C	WAT	AMOUNT OF WATER USED SO FAR	LBM
41	C	WATLOD	AMOUNT OF WATER LOADED IN EACH SYSTEM	
42	C			
43		PARAMETER	NUMACT=37	
44		DIMENSION	PN1(5),IXP(5)	
45		DIMENSION	INODES(120)	
46		DIMENSION	II(2)	
47		DIMENSION	IO(1)	
48		DIMENSION	FL(NUMACT),FLAW(50),FLWW(50),ISPD1(3),SKIP(3),OFTACT(6)	
49		DIMENSION	T(25),TF(25,50),TTF(25,3),TFL(3),TFLWW(3),TFLAW(3)	
50		DIMENSION	KK(2)	
51		DIMENSION	ACOEFF(12)	
52		DIMENSION	HS(3),ITV(3)	
53		DIMENSION	TOTFUL(3)	
54		COMMON	K,L,DELT,TIME,TSTOP,NNODES	
55		COMMON	P(300,2),F(300,2),C(300,20)	
56		COMMON	DUM(100),IDUM(100)	
57		COMMON	/PRT/ IPRNT,ICNT,ANAME(300,2),AERROR(8,2)	
58		COMMON	/ARRAY/ G(300,10),TINIT(300),FLAG,ITTR	
59		COMMON	/TYME/ TMSUM(3),AMSNTM,FUDGE,SUMARY(20,3)	
60		COMMON	/COMVP/ IWAT(10),WAT(10),DW(10),WATLFT(3)	
61		COMMON	/ACT/ NHYD(3,50),NHYOUT(3,50),NACT,FLW(50)	
62		COMMON	/HYD/ IPOO(27,3),LMMTRX(50,4),POWER(3),ISPD(3),IFLAG,TFLW(3)	
63		COMMON	/ALT/ BH2O(3),BH2OF(3),IALT	
64		COMMON	/ALTD/ALT	
65		EQUIVALENCE	(IDUM(10),NTURBN)	
66		DATA	TOTFUL/295.,295.,295./	
67		DATA	ISPD/1.,1.,1./	
68		DATA	CCONS/2545./	
69		DATA	HPRATD/135./	
70		DATA	IO/999/	
71		DATA	ITV/0.,0.,0./	
72		DATA	WATLOD/50.,36/	
73		DATA	NACT/NUMACT/	
74		DATA	INODES/1,60,	
75			11,61,12,62,13,63,14,64,15,65,16,66,17,67,18,68,19,69,20,70,	
76			21,71,22,72,23,73,24,74,25,75,26,76,27,77,28,78,29,79,30,80,	
77			31,81,32,82,33,83,34,84,35,85,36,86,37,87,	

MAIN1
3 of 7

```

1000  IXP(1)=C
1001  P(NT,1) = P(NT+4,1)
1002  P(NT,2) = P(NT+4,2)
1003  C(NT+1,3) = 0.
1004  20 CONTINUE
1005  NT=NT+50
1006  25 CONTINUE
1007  WRITE(6,UPDATE)
1008  C
1009  C
1010  C
1011  C
1012  C
1013  C
1014  C
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```

Q TURBINE IS INITIALLY OFF
 Q SET TURBINE TEMP EQUAL TO STRUCTURE
 Q TEMPERATURE
 Q SET LUBE OIL FLOWRATE TO ZERO

MAIN1
 4 of 7

Q PRINT INITIAL NAMELIST

BEGIN TIMING SEQUENCE

777 CONTINUE

T(1)=TIME

NM=1

DO 30 I=1,NTURBN

30 TFLW(I)=0.

DO 40 J=1,NACT

40 FLW(J)=0.

IS UPTIME WITHIN THIS COMPUTATION STEP

50 IF((TIME+DELT).LE.UPTIME) GO TO 80

T(NM+1)=UPTIME-T(NM)

DO 60 I=1,NTURBN

Q INTEGRATE TOTAL SYSTEM FLOW

TTF(NM+1,1) = T(NM+1) * TFLW(I)

TFLW(I)=TFL(I)

ISPD(1)=ISPD1(1)

60 CONTINUE

DO 70 J=1,NACT

TTF(NM+1,J) = T(NM+1) * FLW(J)

FLW(J)=FL(J)

70 CONTINUE

IFLAG=IFLAG1

T(NM+1)=UPTIME

NM=N+1

READ(2,END=800) UPTIME, (FL(N),N=1,29),X,FL(30),Y,(FL(N),N=31,33),

Z,(FL(N),N=34,37),OFTACT,TFL,SKIP,IFLAG1,ISPD1,GRAY,ALT2

GO TO 50

AVERAGE BOTH TOTAL SYSTEM AND ACTUATOR FLOWRATES OVER TIMESTEP

80 IF(NM.NE.1) GO TO 110

DO 90 I=1,NTURBN

90 TFLW(I)=TFLW(I)

DO 100 J=1,NACT

100 FLW(J)=FLW(J)

GO TO 180

110 DO 130 I=1,NTURBN

DO 120 M=2,NM

TFLW(I)=TFLW(I)+TTF(M,I)

JIM

120 CONTINUE

130 CONTINUE

DO 150 J=1,NACT

DO 140 M=2,NM

FLW(J)=FLW(J)+TF(M,J)

140 CONTINUE

150 CONTINUE

DO 160 I=1,NTURBN

```

160 TFLW(I) = (TFLW(I) + ((TIME+DELT) - T(NM)) * TFLAW(I)) / DELT
160 CONTINUE
DO 170 J=1, NACT
170 FLW(J) = (FLW(J) + ((TIME+DELT) - T(NM)) * FLAW(J)) / DELT
170 CONTINUE
GO TO 200
200 UPTIME=UPTIME+4.0
200 IFLAG = 27
200 DO 201 I=1, NTURBN
200 TFLAW(I)=0.
200 TFLW(I)=0.
200 POWER(I)=0.
200 DO 202 J=1, NACT
200 FLAW(J)=0.
200 FLW(J)=0.
200 CONTINUE
200 CONTINUE
200 CONTINUE
200 CONTINUE

```

MAIN1
5 of 7

6 ZERO FLOW FOR LAST TIMEPOINT

```

CALL HYDACT
CALL ZIPIT

```

6 BUILD ACTUATOR ARRAYS

```

N1=100
DO 230 I=1, NTURBN
CALL FLOWPR(I, N1)
CALL LINFLO(I)

```

6 COMPUTE PUMP EFFICIENCY, POWER AND

```

G(N1+1,7)=POWER(I)
IF(TFLW(I).LT..0001) GO TO 210
EXP(I)=1
P(N1,1)=PNI(I)
P(N1,2)=PNI(I)
GO TO 220

```

6 CASE DRAIN FLOWRATE
6 STORE POWER FOR PLOTTING

6 TURBINE IS ON
6 SET TURBINE TEMP TO INITIAL VALUE

```

210 CONTINUE
EXP(I)=0
C(N1+1,4)=0.
C(N1+1,3)=0.
C(N1+1,4)=0.
C(N1+1,2)=0.
GO TO 217
220 CONTINUE

```

6 TURBINE IS OFF
6 SET GEAR BOX HEAT LOAD
6 AND FLOWRATE TO ZERO
6 SET HYDRAULIC HEAT LOAD
6 AND FLOWRATE TO ZERO

```

CALL LUBOIL(I, N1)
205 IF(TIME+GE+.46566) ITV(I)=1
IF(TIME+GE+.46566) GRAV=1.
IF(IALT.NE.1) GO TO 217

```

6 COMPUTE PROPERTIES OF LUBE OIL

COMPUTE THERMAL CAPACITY CONSIDERING POSITION
OF TRANSFER VALVE (FOR IQ1 ONLY)

```

HS(I)=0.
IF(ITV(I).EQ.1) GO TO 215
BH20(I)=WATLOD-WAT(I)
C(N1+2,1)=BH20(I)*13.2
C(N1+10,1)=BH20(I)*13.2
GO TO 217
215 BH20(I)=WATLOD+BH20(I)-WAT(I)

```

```

2500 BHOLD = BH2OF(1)
2510 IF (BH2OF(1).GT.57.3) HS(1)=16.*(BH2OF(1)-57.8)/15.58
2520 BH2OF(1)=BH2OF(1)+40.5829*DELT*GRAV*(14.-7.*BH2OF(1)/60.-HS(1))
2530 DWTRAN=BH2OF(1)-BHOLD
2540 P(N1+2,K)=(P(N1+2,K)*BH2OF(1)+P(N1+3,K)*DWTRAN)/(BH2OF(1)+DWTRAN)
2550 P(N1+10,K)=P(N1+2,K)
2560 BH2OF(1)=WATLOD+BH2OF(1)-WAT(1)
2570 C(N1+3,1)=TNKWAT-BH2OF(1)
2580 C(N1+2,1)=BH2OF(1)+13.2
2590 C(N1+10,1)=BH2OF(1)+13.2
2600 217 CONTINUE
2610 N1=N1+50
2620 230 CONTINUE
2630 C
2640 IF (TIME.GE.0) CALL BOUND1
2650 C
2660 COMPUTE ALTITUDE
2670 C
2680 ALT=((ALT2-ALT1)/(UPTIME-TO))*(TIME-TO)+ALT1
2690 TE=TIME
2700 ALT1=ALT
2710 ALTKM=ALT*0.3048006E-3 @ CONVERT ALTITUDE TO METRIC
2720 TERM=0.
2730 DO 225 I=1,12
2740 TERM=ALTKM*TERM+ACOE(I) @ FOR CURRENT ALTITUDE
2750 225 CONTINUE
2760 PRESUR=1.0/(TERM**4)
2770 P2=PRESUR*14.696 @ CONVERT PRESSURE FROM ATMOS. TO PSI
2780 C
2790 THERMAL LOOP
2800 C
2810 C
2820 DO 300 I=1,NTURBN
2830 IF (IXN(I).EQ.0) CALL PASS(N) @ IF TURBINE IS OFF, COMPUTE HEAT
2840 C GEAR BOX LOOP
2850 C
2860 CALL LOOP(N+1)
2870 CALL PLATEC(N+1,N+2)
2880 C
2890 C
2900 C
2910 C
2920 C
2930 C
2940 C
2950 260 CALL LOOP(N+4)
2960 C(N+4,4)=0.
2970 265 CALL PLATEC(N+4,N+6)
2980 IF (C(N+5,3).LT.1.) GO TO 784
2990 F(N+6,4)=F(N+4,4)+4.
3000 C(N+5,4)=C(N+6,3)+4.
3010 C(N+4,4)=POWER(1)*2545.-C(N+7,4)
3020 C(N+5,4)=C(N+4,4)-C(N+6,4)
3030 F(N+5,4)=F(N+4,4)+C(N+5,4)/C(N+5,3)
3040 784 CONTINUE
3050 CALL THERMP(1,N,P2)
3060 JK=IDUM(10+1)
3070 IF (JK.EQ.0) GO TO 270
3080 DO 2+8-ND=1,JK
3090 NOD=NHVD(I,ND)
3100 CALL PLATOC(NDE,NOD+50)

```

JIM3/28

JIM3/28

```

0100 269 CONTINUE
0110 CALL THERMP(1,N,P2)
0120 270 KK(1)=N+5
0130 KK(2)=N+7
0140 CALL MIX(N+8,2,KK)
0150 IF(C(N+4,3).LE.0) GO TO 275
0160 IF(C(N+8,3).GT.4379.34) GO TO 271
0170 C(N+10,3)=C(N+8,3)
0180 C(N+9,3) = 0.
0190 GO TO 273
0200 271 C(N+10,3) = 4379.34
0210 C(N+9,3) = C(N+8,3) - 4379.34
0220 273 CONTINUE
0230 F(N+10,L)=F(N+8,L)
0240 F(N+9,L) = F(N+8,L)
0250 CALL HYDFLD(1,N)
0260 CALL BOILF(N+2,N+1,N+10,N+11,P2,EA,STVC,STVO)
0270 J1(1)=N+9
0280 J1(2)=N+11
0290 CALL MIX(N+12,2,J1)
0300 GO TO 280
0310 275 CONTINUE
0320 CALL TRANS(N+4,N+8)
0330 CALL TRANS(N+4,N+9)
0340 CALL TRANS(N+4,N+10)
0350 CALL HYDFLD(1,N)
0360 CALL BOILF(N+2,N+1,N+10,N+11,P2,EA,STVC,STVO)
0370 CALL TRANS(N+8,N+12)
0380 280 CALL PASS(N+3)
0390 CALL PLATEC(N+12,N+13)
0400 CALL TRANS(N+13,N+4)
0410 CALL TRANS(N+13,N+14)
0420 N = N+50
0430 300 CONTINUE
0440 C CALL FUEL(TOTFUEL,P2) @ COMPUTE FUEL AND ENERGY CONSUMED
0450 CALL CBAL @ DO HEAT BALANCE TO DETERMINE ERROR
0460 IF(IDUM(2C).LE.0) GO TO 350 @ IF NO PLOTS DESIRED, SKIP TO SELECT
0470 CALL PLOOT @ STORE DATA FOR DESIRED PLOTS
0480 350 CALL SELECT(1:20,114,INODES,IG) @ PRINT NODE DATA AND INCREMENT TIME
0490 CALL FLIP
0500 C
0510 IF(ICNT+1.EQ.IPRNT) WRITE(6,UPDATE)
0520 IF(ETIME.LE.TSTOP) GO TO 777
0530 CALL PRITAB
0540 RETURN
0550 END
0560

```

END OF COMPILATION: NO DIAGNOSTICS.

SUBROUTINE MAIN2

	VARIABLE NAME	DESCRIPTION	UNITS
1	ALT	CURRENT ALTITUDE	FT
2	BH20	AMOUNT OF WATER IN BOILER	LBM
3	C(X,1)	THERMAL CAPACITANCE	BTU/DEG R
4	C(X,2)	HEAT TRANSFER COEFFICIENT	BTU/HR-DEG R
5	C(X,3)	DYNAMIC THERMAL CAPACITANCE (MASS FLOWRATE X SPECIFIC HEAT)	LBM-BTU/HR-LB-R
6	C(X,4)	HEAT LOAD OR HEAT RATE	BTU/HR
7	DWTRAN	AMOUNT OF WATER TRANSFERRED THIS COMP CYCLE	LBM
8	FL	ACTUATOR FLOWRATES READ IN	GPM
9	FLAW	TEMPORARY STORAGE FOR ACTUATOR FLOWRATES	GPM
10	FLW	ACTUATOR FLOWRATES USED FOR CURRENT COMP CYCLE	GPM
11	GRAY	C.G. LOAD FACTOR	
12	HS	HEIGHT OF WATER IN STANDPIPE	
13	IFLAG	SYSTEM CONFIGURATION FLAG	
14	IO	FLAG USED IN PRINT TO LIMIT NODE DATA PRINTING TO C(X,1) THRU C(X,4)	
15	ISPD	APU OPERATING SPEED FLAG	
16	ISPRAY	FLAG TO TELL IF SPRAY BOILER HAS BEEN IN USE	
17	ITV	TRANSFER VALVE FLAG	
18	ITANK(1)	NODE NUMBER OF BOILER 1	
19	JK	NUMBER OF ACTUATORS ON SYSTEM 1	
20	NACT	TOTAL NUMBER OF ACTUATORS	
21	NM	COUNTER FOR NUMBER OF TAPE RECORDS TO PROCESS PER COMP CYCLE	
22	NOD	ARRAY OF ACTUATOR NODE NUMBERS ON SYS 1	
23	NTURBN	NUMBER OF APU/HYDRAULIC SYSTEMS	
24	P2	AMBIENT AIR PRESSURE	PSIA
25	TFL	TOTAL SYSTEM FLOWRATES READ IN	GPM
26	TFLAW	TEMPORARY STORAGE FOR TOTAL SYSTEM FLOWRATES	GPM
27	TFLW	TOTAL SYSTEM FLOWRATES USED FOR CURRENT COMP CYCLE	GPM
28	TIME	CURRENT TIME	HRS
29	UPTIME	TIME AT WHICH TO UPDATE TIMELINE DATA	HRS
30	WAT	AMOUNT OF WATER USED SO FAR	LBM
31	WATLOD	AMOUNT OF WATER LOADED IN EACH SYSTEM	LBM
32	PARAMETER NUMACT=43		
33	DIMENSION PNI(5),IXP(5)		
34	DIMENSION INQUES(149)		
35	DIMENSION II(2)		
36	DIMENSION IO(1)		
37	DIMENSION FL(NUMACT),FLAW(50),FLWW(50),ISPD(13),SKIP(3)		
38	DIMENSION T(25),TF(25,50),TTF(25,3),TFL(3),TFLWW(3),TFLAW(3)		
39	DIMENSION KK(2)		
40	DIMENSION ACOEF(12)		
41	DIMENSION NODE(NUMACT)		
42	DIMENSION REFILL(3),USED(3),ITANK(3),ISPRAY(3)		
43	DIMENSION TOTFUL(3)		

ORIGINAL PAGE IS
OF POOR QUALITY

```

57* COMMON K,L,DELT,TIME,TSTOP,NNODES
58* COMMON P(300,2),F(300,2),C(300,20)
59* COMMON DUM(100),TDUM(100)
60* COMMON /PRT/ IPRT,ICNT,ALAME(300,2),AERROR(8,2)
61* COMMON /ARRAY/ G(300,10),IINIT(300),FLAG,ITTEL
62* COMMON /TIME/TIMSUM(3),AMSNTM,FUDGE,SUMARY(20,3)
63* COMMON /COMVP/ LWAT(10),WAT(10),DW(10),WATLFT(3)
64* COMMON /ACT/ NHYD(3,50),NHYOUT(3,50),NACT,FLW(50)
65* COMMON /HYD/ IF00(27,3),LMNTRX(50,4),POWER(3),ISPD(3),IFLAG,IFLW(3)
66* COMMON /ALT/ BH20(3),BH20F(3),IALT
67* COMMON /ALTD/ALT
68* EQUIVALENCE(IDUM(10),NTURBN)
69* EQUIVALENCE(IDUM(14),IRST)
70* DATA TOTFUL/275.6,275.6,275.6/
71* DATA ISPD/1,1,1/
72* DATA CCONS/2545./
73* DATA HPRATD/135./
74* DATA IO/999/
75* DATA WATLQD/1E./
76* DATA ITANK/0,0,0/REFILL/0,0,0/ISPRAY/0,0,0/
77* DATA ICHECK/0/
78* DATA NACT/NUMACT/
79* DATA INODES/1,51,2,52,3,53,4,54,5,55,6,56,7,57,8,58,9,59,10,60,11,
80* 61,12,62,13,63,14,64,15,65,16,66,17,67,18,68,19,69,20,
81* 70,21,71,22,72,23,73,24,74,25,75,26,76,27,77,28,78,29,
82* 79,30,80,31,81,32,82,33,83,34,84,35,85,36,86,37,87,38,
83* 88,39,89,40,90,41,91,42,92,43,93,
84* 100,101,102,103,104,105,106,107,108,109,110,111,112,
85* 113,114,
86* 150,151,152,153,154,155,156,157,158,159,160,161,162,
87* 163,164,
88* 200,201,202,203,204,205,206,207,208,209,210,211,212,
89* 213,214,
90* 250,251,252,253,254,255,256,257,258,259,260,261,
91* 275,276,277,278,279,280,281,282,283,284,285,286,287,288,289,290,291,292,293,294,295,296,297,298,299,300,301,302,303,304,305,306,307,308,309,310,311,312,313,314,315,316,317,318,319,320,321,322,323,324,325,326,327,328,329,330,331,332,333,334,335,336,337,338,339,340,341,342,343,344,345,346,347,348,349,350,351,352,353,354,355,356,357,358,359,360,361,362,363,364,365,366,367,368,369,370,371,372,373,374,375,376,377,378,379,380,381,382,383,384,385,386,387,388,389,390,391,392,393,394,395,396,397,398,399,400,401,402,403,404,405,406,407,408,409,410,411,412,413,414,415,416,417,418,419,420,421,422,423,424,425,426,427,428,429,430,431,432,433,434,435,436,437,438,439,440,441,442,443,444,445,446,447,448,449,450,451,452,453,454,455,456,457,458,459,460,461,462,463,464,465,466,467,468,469,470,471,472,473,474,475,476,477,478,479,480,481,482,483,484,485,486,487,488,489,490,491,492,493,494,495,496,497,498,499,500,501,502,503,504,505,506,507,508,509,510,511,512,513,514,515,516,517,518,519,520,521,522,523,524,525,526,527,528,529,530,531,532,533,534,535,536,537,538,539,540,541,542,543,544,545,546,547,548,549,550,551,552,553,554,555,556,557,558,559,560,561,562,563,564,565,566,567,568,569,570,571,572,573,574,575,576,577,578,579,580,581,582,583,584,585,586,587,588,589,590,591,592,593,594,595,596,597,598,599,600,601,602,603,604,605,606,607,608,609,610,611,612,613,614,615,616,617,618,619,620,621,622,623,624,625,626,627,628,629,630,631,632,633,634,635,636,637,638,639,640,641,642,643,644,645,646,647,648,649,650,651,652,653,654,655,656,657,658,659,660,661,662,663,664,665,666,667,668,669,670,671,672,673,674,675,676,677,678,679,680,681,682,683,684,685,686,687,688,689,690,691,692,693,694,695,696,697,698,699,700,701,702,703,704,705,706,707,708,709,710,711,712,713,714,715,716,717,718,719,720,721,722,723,724,725,726,727,728,729,730,731,732,733,734,735,736,737,738,739,740,741,742,743,744,745,746,747,748,749,750,751,752,753,754,755,756,757,758,759,760,761,762,763,764,765,766,767,768,769,770,771,772,773,774,775,776,777,778,779,780,781,782,783,784,785,786,787,788,789,790,791,792,793,794,795,796,797,798,799,800,801,802,803,804,805,806,807,808,809,810,811,812,813,814,815,816,817,818,819,820,821,822,823,824,825,826,827,828,829,830,831,832,833,834,835,836,837,838,839,840,841,842,843,844,845,846,847,848,849,850,851,852,853,854,855,856,857,858,859,860,861,862,863,864,865,866,867,868,869,870,871,872,873,874,875,876,877,878,879,880,881,882,883,884,885,886,887,888,889,890,891,892,893,894,895,896,897,898,899,900,901,902,903,904,905,906,907,908,909,910,911,912,913,914,915,916,917,918,919,920,921,922,923,924,925,926,927,928,929,930,931,932,933,934,935,936,937,938,939,940,941,942,943,944,945,946,947,948,949,950,951,952,953,954,955,956,957,958,959,960,961,962,963,964,965,966,967,968,969,970,971,972,973,974,975,976,977,978,979,980,981,982,983,984,985,986,987,988,989,990,991,992,993,994,995,996,997,998,999,1000,1001,1002,1003,1004,1005,1006,1007,1008,1009,1010,1011,1012,1013,1014,1015,1016,1017,1018,1019,1020,1021,1022,1023,1024,1025,1026,1027,1028,1029,1030,1031,1032,1033,1034,1035,1036,1037,1038,1039,1040,1041,1042,1043,1044,1045,1046,1047,1048,1049,1050,1051,1052,1053,1054,1055,1056,1057,1058,1059,1060,1061,1062,1063,1064,1065,1066,1067,1068,1069,1070,1071,1072,1073,1074,1075,1076,1077,1078,1079,1080,1081,1082,1083,1084,1085,1086,1087,1088,1089,1090,1091,1092,1093,1094,1095,1096,1097,1098,1099,1100,1101,1102,1103,1104,1105,1106,1107,1108,1109,1110,1111,1112,1113,1114,1115,1116,1117,1118,1119,1120,1121,1122,1123,1124,1125,1126,1127,1128,1129,1130,1131,1132,1133,1134,1135,1136,1137,1138,1139,1140,1141,1142,1143,1144,1145,1146,1147,1148,1149,1150,1151,1152,1153,1154,1155,1156,1157,1158,1159,1160,1161,1162,1163,1164,1165,1166,1167,1168,1169,1170,1171,1172,1173,1174,1175,1176,1177,1178,1179,1180,1181,1182,1183,1184,1185,1186,1187,1188,1189,1190,1191,1192,1193,1194,1195,1196,1197,1198,1199,1200,1201,1202,1203,1204,1205,1206,1207,1208,1209,1210,1211,1212,1213,1214,1215,1216,1217,1218,1219,1220,1221,1222,1223,1224,1225,1226,1227,1228,1229,1230,1231,1232,1233,1234,1235,1236,1237,1238,1239,1240,1241,1242,1243,1244,1245,1246,1247,1248,1249,1250,1251,1252,1253,1254,1255,1256,1257,1258,1259,1260,1261,1262,1263,1264,1265,1266,1267,1268,1269,1270,1271,1272,1273,1274,1275,1276,1277,1278,1279,1280,1281,1282,1283,1284,1285,1286,1287,1288,1289,1290,1291,1292,1293,1294,1295,1296,1297,1298,1299,1300,1301,1302,1303,1304,1305,1306,1307,1308,1309,1310,1311,1312,1313,1314,1315,1316,1317,1318,1319,1320,1321,1322,1323,1324,1325,1326,1327,1328,1329,1330,1331,1332,1333,1334,1335,1336,1337,1338,1339,1340,1341,1342,1343,1344,1345,1346,1347,1348,1349,1350,1351,1352,1353,1354,1355,1356,1357,1358,1359,1360,1361,1362,1363,1364,1365,1366,1367,1368,1369,1370,1371,1372,1373,1374,1375,1376,1377,1378,1379,1380,1381,1382,1383,1384,1385,1386,1387,1388,1389,1390,1391,1392,1393,1394,1395,1396,1397,1398,1399,1400,1401,1402,1403,1404,1405,1406,1407,1408,1409,1410,1411,1412,1413,1414,1415,1416,1417,1418,1419,1420,1421,1422,1423,1424,1425,1426,1427,1428,1429,1430,1431,1432,1433,1434,1435,1436,1437,1438,1439,1440,1441,1442,1443,1444,1445,1446,1447,1448,1449,1450,1451,1452,1453,1454,1455,1456,1457,1458,1459,1460,1461,1462,1463,1464,1465,1466,1467,1468,1469,1470,1471,1472,1473,1474,1475,1476,1477,1478,1479,1480,1481,1482,1483,1484,1485,1486,1487,1488,1489,1490,1491,1492,1493,1494,1495,1496,1497,1498,1499,1500,1501,1502,1503,1504,1505,1506,1507,1508,1509,1510,1511,1512,1513,1514,1515,1516,1517,1518,1519,1520,1521,1522,1523,1524,1525,1526,1527,1528,1529,1530,1531,1532,1533,1534,1535,1536,1537,1538,1539,1540,1541,1542,1543,1544,1545,1546,1547,1548,1549,1550,1551,1552,1553,1554,1555,1556,1557,1558,1559,1560,1561,1562,1563,1564,1565,1566,1567,1568,1569,1570,1571,1572,1573,1574,1575,1576,1577,1578,1579,1580,1581,1582,1583,1584,1585,1586,1587,1588,1589,1590,1591,1592,1593,1594,1595,1596,1597,1598,1599,1600,1601,1602,1603,1604,1605,1606,1607,1608,1609,1610,1611,1612,1613,1614,1615,1616,1617,1618,1619,1620,1621,1622,1623,1624,1625,1626,1627,1628,1629,1630,1631,1632,1633,1634,1635,1636,1637,1638,1639,1640,1641,1642,1643,1644,1645,1646,1647,1648,1649,1650,1651,1652,1653,1654,1655,1656,1657,1658,1659,1660,1661,1662,1663,1664,1665,1666,1667,1668,1669,1670,1671,1672,1673,1674,1675,1676,1677,1678,1679,1680,1681,1682,1683,1684,1685,1686,1687,1688,1689,1690,1691,1692,1693,1694,1695,1696,1697,1698,1699,1700,1701,1702,1703,1704,1705,1706,1707,1708,1709,1710,1711,1712,1713,1714,1715,1716,1717,1718,1719,1720,1721,1722,1723,1724,1725,1726,1727,1728,1729,1730,1731,1732,1733,1734,1735,1736,1737,1738,1739,1740,1741,1742,1743,1744,1745,1746,1747,1748,1749,1750,1751,1752,1753,1754,1755,1756,1757,1758,1759,1760,1761,1762,1763,1764,1765,1766,1767,1768,1769,1770,1771,1772,1773,1774,1775,1776,1777,1778,1779,1780,1781,1782,1783,1784,1785,1786,1787,1788,1789,1790,1791,1792,1793,1794,1795,1796,1797,1798,1799,1800,1801,1802,1803,1804,1805,1806,1807,1808,1809,1810,1811,1812,1813,1814,1815,1816,1817,1818,1819,1820,1821,1822,1823,1824,1825,1826,1827,1828,1829,1830,1831,1832,1833,1834,1835,1836,1837,1838,1839,1840,1841,1842,1843,1844,1845,1846,1847,1848,1849,1850,1851,1852,1853,1854,1855,1856,1857,1858,1859,1860,1861,1862,1863,1864,1865,1866,1867,1868,1869,1870,1871,1872,1873,1874,1875,1876,1877,1878,1879,1880,1881,1882,1883,1884,1885,1886,1887,1888,1889,1890,1891,1892,1893,1894,1895,1896,1897,1898,1899,1900,1901,1902,1903,1904,1905,1906,1907,1908,1909,1910,1911,1912,1913,1914,1915,1916,1917,1918,1919,1920,1921,1922,1923,1924,1925,1926,1927,1928,1929,1930,1931,1932,1933,1934,1935,1936,1937,1938,1939,1940,1941,1942,1943,1944,1945,1946,1947,1948,1949,1950,1951,1952,1953,1954,1955,1956,1957,1958,1959,1960,1961,1962,1963,1964,1965,1966,1967,1968,1969,1970,1971,1972,1973,1974,1975,1976,1977,1978,1979,1980,1981,1982,1983,1984,1985,1986,1987,1988,1989,1990,1991,1992,1993,1994,1995,1996,1997,1998,1999,2000,2001,2002,2003,2004,2005,2006,2007,2008,2009,2010,2011,2012,2013,2014,2015,2016,2017,2018,2019,2020,2021,2022,2023,2024,2025,2026,2027,2028,2029,2030,2031,2032,2033,2034,2035,2036,2037,2038,2039,2040,2041,2042,2043,2044,2045,2046,2047,2048,2049,2050,2051,2052,2053,2054,2055,2056,2057,2058,2059,2060,2061,2062,2063,2064,2065,2066,2067,2068,2069,2070,2071,2072,2073,2074,2075,2076,2077,2078,2079,2080,2081,2082,2083,2084,2085,2086,2087,2088,2089,2090,2091,2092,2093,2094,2095,2096,2097,2098,2099,2100,2101,2102,2103,2104,2105,2106,2107,2108,2109,2110,2111,2112,2113,2114,2115,2116,2117,2118,2119,2120,2121,2122,2123,2124,2125,2126,2127,2128,2129,2130,2131,2132,2133,2134,2135,2136,2137,2138,2139,2140,2141,2142,2143,2144,2145,2146,2147,2148,2149,2150,2151,2152,2153,2154,2155,2156,2157,2158,2159,2160,2161,2162,2163,2164,2165,2166,2167,2168,2169,2170,2171,2172,2173,2174,2175,2176,2177,2178,2179,2180,2181,2182,2183,2184,2185,2186,2187,2188,2189,2190,2191,2192,2193,2194,2195,2196,2197,2198,2199,2200,2201,2202,2203,2204,2205,2206,2207,2208,2209,2210,2211,2212,2213,2214,2215,2216,2217,2218,2219,2220,2221,2222,2223,2224,2225,2226,2227,2228,2229,2230,2231,2232,2233,2234,2235,2236,2237,2238,2239,2240,2241,2242,2243,2244,2245,2246,2247,2248,2249,2250,2251,2252,2253,2254,2255,2256,2257,2258,2259,2260,2261,2262,2263,2264,2265,2266,2267,2268,2269,2270,2271,2272,2273,2274,2275,2276,2277,2278,2279,2280,2281,2282,2283,2284,2285,2286,2287,2288,2289,2290,2291,2292,2293,2294,2295,2296,2297,2298,2299,2300,2301,2302,2303,2304,2305,2306,2307,2308,2309,2310,2311,2312,2313,2314,2315,2316,2317,2318,2319,2320,2321,2322,2323,2324,2325,2326,2327,2328,2329,2330,2331,2332,2333,2334,2335,2336,2337,2338,2339,2340,2341,2342,2343,2344,2345,2346,2347,2348,2349,2350,2351,2352,2353,2354,2355,2356,2357,2358,2359,2360,2361,2362,2363,2364,2365,2366,2367,2368,2369,2370,2371,2372,2373,2374,2375,2376,2377,2378,2379,2380,2381,2382,2383,2384,2385,2386,2387,2388,2389,2390,2391,2392,2393,2394,2395,2396,2397,2398,2399,2400,2401,2402,2403,2404,2405,2406,2407,2408,2409,2410,2411,2412,2413,2414,2415,2416,2417,2418,2419,2420,2421,2422,2423,2424,2425,2426,2427,2428,2429,2430,2431,2432,2433,2434,2435,2436,2437,2438,2439,2440,2441,2442,2443,2444,2445,2446,2447,2448,2449,2450,2451,2452,2453,2454,2455,2456,2457,2458,2459,2460,2461,2462,2463,2464,2465,2466,2467,2468,2469,2470,2471,2472,2473,2474,2475,2476,2477,2478,2479,2480,2481,2482,2483,2484,2485,2486,2487,2488,2489,2490,2491,2492,2493,2494,2495,2496,2497,2498,2499,2500,2501,2502,2503,2504,2505,2506,2507,2508,2509,2510,2511,2512,2513,2514,2515,2516,2517,2518,2519,2520,2521,2522,2523,2524,2525,2526,2527,2528,2529,2530,2531,2532,2533,2534,2535,2536,2537,2538,2539,2540,2541,2542,2543,2544,2545,2546,2547,2548,2549,2550,2551,2552,2553,2554,2555,2556,2557,2558,2559,2560,2561,2562,2563,2564,2565,2566,2567,2568,2569,2570,2571,2572,2573,2574,2575,2576,2577,2578,2579,2580,2581,2582,2583,2584,2585,2586,2587,2588,2589,2590,2591,2592,2593,2594,2595,2596,2597,2598,2599,2600,2601,2602,2603,2604,2605,2606,2607,2608,2609,2610,2611,2612,2613,2614,2615,2616,2617,2618,2619,2620,2621,2622,2623,2624,2625,2626,2627,2628,2629,2630,2631,2632,2633,2634,2635,2636,2637,2638,2639,2640,2641,2642,2643,2644,2645,2646,2647,2648,2649,2650,2651,2652,2653,2654,2655,2656,2657,2658,2659,2660,2661,2662,2663,2664,2665,2666,2667,2668,2669,2670,2671,2672,2673,2674,2675,2676,2677,2678,2679,2680,2681,2682,2683,2684,2685,2
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115 4 WATLEFT(J)=SUMARY(10,J)
116 DO 5 J=1,300
117 5 TINIT(J)=P(J,L)
118 TO=TIME
119 III=0
120 DO 15 J=1,2
121 DO 10 I=1,3
122 N=IWAT(1)+III
123 G(N,1)=14.7
124 10 CONTINUE
125 III=III+8
126 15 CONTINUE
127 C
128 C READ FIRST TIMEPOINT
129 C
130 READ(2)UPTIME,{FL(N),N=1,28},X,FL(29),Y,{FL(N),N=30,32},Z,
131 * {FL(N),N=33,43},TFL,SKIP,IFLAG,ISPD1,GRAV,ALT2
132 ALT=ALT2
133 ALT1=ALT2
134 C
135 NT=100
136 DO 25 I=1,NTURBN
137 PN(1)=P(NT,1)
138 IAP(1)=1
139 IF(I*FLW(1).GT..CQO1) GO TO 20
140 IAP(1)=0
141 P(NT,1)=P(NT+4,1)
142 P(NT,2)=P(NT+4,2)
143 C(NT+1,3)=0.
144 20 CONTINUE
145 NT=NT+50
146 25 CONTINUE
147 WRITE(6,UPDATE)
148 C
149 C BEGIN TIMING SEQUENCE
150 C
151 777 CONTINUE
152 T(1)=TIME
153 NM=1
154 DO 30 I=1,NTURBN
155 30 TFLW(I)=0.
156 DO 40 J=1,NACT
157 40 FLW(J)=0.
158 C
159 C IS UPTIME WITHIN THIS COMPUTATION STEP
160 C
161 50 IF((TIME+DELT).LE.UPTIME) GO TO 80
162 T(NM+1)=UPTIME-T(NM)
163 DO 60 I=1,NTURBN
164 IF(NM+1,1)=T(NM+1)*TFLW(I)
165 TFLW(I)=TFL(I)
166 ISPD(I)=ISPD1(I)
167 60 CONTINUE
168 DO 70 J=1,NACT
169 T(NM+1,J)=T(NM+1)*FLW(J)
170 FLW(J)=FL(J)
171 70 CONTINUE
172 IFLAG=IFLAG1

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W SAVE INITIAL COMPONENT TEMPS

W SAVE START TIME

MAIN2
3 of 7

W INITIALIZE PRESSURE FOR BOILER ROUTINE

W SET ALTITUDE TO INITIAL INPUT VALUE

W SAVE INITIAL TURBINE TEMP

W TURBINE IS INITIALLY OFF
W SET TURBINE TEMP EQUAL TO STRUCTURE
W TEMPERATURE
W SET CUBE OIL FLOWRATE TO ZERO

W PRINT INITIAL NAMELIST

W INTEGRATE TOTAL SYSTEM FLOW


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173* T(NM+1)=UPTIME
174* NM=NM+1
175* READ(2,END=800)UPTIME,(FL(N),N=1,28),X,FL(29),Y,(FL(N),N=30,32),Z,
176* (FL(N),N=33,43),TFL,SKIP,IFLAG1,ISPD1,GRAY,AL12
177* IF(FIRST.EQ.0) GO TO 50
178* IF(1/CHECK.EQ.1)UPTIME= UPTIME-FUDGE
179* IF(1/CHECK.EQ.1) GO TO 50
180* IF(AMSNM.GT.4.AND.TIME.GT.4) CALL RSTART(1/CHECK)
181* IF(1/CHECK.EQ.1) UPTIME = UPTIME-FUDGE
182* GO TO 50
183*
184* C AVERAGE BOTH TOTAL SYSTEM AND ACTUATOR FLOWRATES OVER TIMESTEP
185* C
186* C
187* 80 IF(NM.NE.1)GO TO 110
188* DO 90 I=1,NTURBN
189* 90 TFLW(I)=TFLAW(I)
190* DO 100 J=1,NACT
191* 100 FLW(IJ)=FLAW(IJ)
192* GO TO 180
193* 110 DO 130 I=1,NTUREN
194* DO 120 M=2,NM
195* TFLW(I)=TFLW(I)+TIF(M,I)
196* 120 CONTINUE
197* 130 CONTINUE
198* DO 150 J=1,NACT
199* DO 140 M=2,NM
200* FLW(IJ)=FLW(IJ)+TF(M,J)
201* 140 CONTINUE
202* 150 CONTINUE
203* DO 160 I=1,NTURBN
204* TFLW(I) = (TFLW(I)+((TIME*DELT)-T(NM))* TFLAW(I))/DELT
205* 160 CONTINUE
206* DO 170 J=1,NACT
207* FLW(IJ) = (FLW(IJ) +((TIME*DELT)-T(NM)) * FLAW(IJ))/DELT
208* 170 CONTINUE
209* GO TO 200
210* 800 UPTIME=UPTIME+4.0 @ ZERO FLOW FOR LAST TIMEPOINT
211* IFLAG = 27
212* DO 801 I=1,NTURBN
213* TFLW(I)=0.
214* TFLW(I)=0.
215* 801 POWER(I)=0.
216* DO 802 J=1,NACT
217* FLW(IJ)=0.
218* FLW(IJ)=0.
219* 802 CONTINUE
220* CONTINUE
221* CONTINUE
222* C
223* C CALL HYDACT @ BUILD ACTUATOR ARRAYS
224* C
225* C
226* N1= 100
227* DO 230 I=1,NTURBN
228* CALL FLOPER(I,N1)
229* 230 CONTINUE
230* C
231* G(N1+1,7)= POWER(1)
232* IF(TFLW(1).LT..2001) GO TO 210

```

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```

231* 1XP(1)=1
232* P(N1,1)=PN1(1)
233* P(N1,2)=PN1(1)
234* GO TO 220
235*
210* CONTINUE
236* 1XP(1)=0
237* CINI(1,4)=0.
238* CINI(1,3)=0.
239* CINI(4,4)=0.
240* CINI(4,3)=0.
241* GO TO 217
220* CONTINUE
242*
243* CALL LUBOIL(1,N1)
244*
245* COMPUTE THERMAL CAPACITANCE OF BOILER.
246*
247* IF (ITANK(1).EQ.1) GO TO 215
248* IF (ALT.GT.10000) GO TO 215
249* IF (ISPRAY(1).EQ.1) ITANK(1)=1
250* IF (ITANK(1).EQ.1) REFILL(1)=WAT(1)
215* USED(1)=WAT(1)-REFILL(1)
251* BH2O(1)=WAT(1)-USED(1)
252* IF (BH2O(1).LE.0) ISPRAY(1)=1
253* IF (BH2O(1).LE.0) GO TO 217
254* CINI(2,1)=BH2O(1)+11.0
255* CINI(10,1)=BH2O(1)+11.0
217* CONTINUE
256* N1=N1+50
220* CONTINUE
257* IF (ICNT+1.EQ.IPRNT) WRITE(6,CHECK)
258*
259* COMPUTE ALTITUDE
260*
261* ALT=((ALT2-ALT1)/(UPTIME-TO))*(TIME-TO)+ALT1
262* TO=TIME
263* ALT1=ALT
264* ALTKM=ALT*.3048006E+3
265*
266* TERM=0.
267* DO 225 I=1,12
268* TERM=ALTKM*TERM+ACOE(I)
269*
225* CONTINUE
270* PRESUR=1.0/(TERM*.4)
271* PZ=PRESUR*.14.696
272*
273* THERMAL LOOP
274*
275* N=100
276* DO 300 I=1,NTURBN
277* IF (1XP(I).EQ.0) CALL PASS(N)
278*
279* GEAR BOX LOOP
280*
281* CALL LOOP(N+1)
282* CALL PLATEC(N+1,N+2)
283*
284* HYDRAULIC LOOP
285*
286*
287*
288*

```

IF TURBINE IS ON
SET TURBINE TEMP TO INITIAL VALUE

IF TURBINE IS OFF
SET GEAR BOX HEAT LOAD
AND FLOWRATE TO ZERO
SET HYDRAULIC HEAT LOAD
AND FLOWRATE TO ZERO

COMPUTE PROPERTIES OF LUBE OIL

CONVERT ALTITUDE TO METRIC

FOR CURRENT ALTITUDE

CONVERT PRESSURE FROM ATMOS. TO PSI

IF TURBINE IS OFF, COMPUTE HEAT
TRANSFER FROM TURBINE

```

289* 260 CALL LOOP(N+4)
290* C(N+4,4)=0
291* 265 CALL PLATEC(N+4,N+6)
292* JK=IDUM(10+1)
293* IF(C(N+5,3).LT.1.) GO TO 784
294* F(N+6,6) = F(N+4,L) * 4.
295* C(N+6,4) = C(N+6,3) * 4.
296* C(N+4,4) = POWER(1) * 2545. - C(N+7,4)
297* C(N+5,4) = C(N+4,4) - C(N+6,4)
298* F(N+5,L) = F(N+4,L) + C(N+5,4)/C(N+5,3)
299* 784 CONTINUE
300* IF(JK.EQ.0) GO TO 270
301* DO 268 ND=1,JK
302* NOD=NHYP(1,ND)
303* NODE(ND)=NHYP(1,ND)
304* F(NOD,L)=F(N+6,L)
305* CALL PLATOC(NOD,NOD,50)
306* 268 CONTINUE
307* CALL MIX(N+7,JK,NODE)
308* F(N+5,L) = F(N+6,L)
309* 270 KK(1)=N+5
310* KK(2)=N+7
311* CALL MIX(N+8,2,KK)
312* CALL LOOP(N+11)
313* IF(C(N+4,3).LE.0) GO TO 275
314* IF(1-SPRAY(1).NE.1.OR.ALT.LE.10000.) GO TO 272
315* CALL TRANS(N+8,N+10)
316* CALL SPRAY(N+2,N+10,N+1,N+11)
317* GO TO 273
318* 272 CONTINUE
319* IF(TIME.GT..016667) GO TO 2772
320* C(N+10,3) = 0.
321* C(N+9,3) = C(N+8,3)
322* GO TO 2774
323* 2772 IF(1-TANK(1).NE.1) GO TO 2773
324* C(N+10,3) = C(N+8,3)
325* C(N+9,3) = 0.
326* GO TO 2774
327* 2773 CALL MOD(N+8,N+10,N+12,674.,.00,-.005,1.005)
328* 2774 CONTINUE
329* F(N+10,L) = F(N+8,L)
330* F(N+9,L) = F(N+8,L)
331* CALL HYDFLD(1,N)
332* CALL BOILP(N+2,N+1,N+10,N+11,P2,EA,STVC,STVO)
333* 273 CONTINUE
334* II(1)=N+9
335* II(2)=N+11
336* CALL MIX(N+12,2,II)
337* GO TO 280
338* 275 CONTINUE
339* CALL TRANS(N+4,N+8)
340* CALL TRANS(N+4,N+9)
341* CALL TRANS(N+4,N+10)
342* CALL HYDFLD(1,N)
343* CALL BOILP(N+2,N+1,N+10,N+11,P2,EA,STVC,STVO)
344* CALL TRANS(N+4,N+12)
345* 280 CALL PASS(N+3)
346* CALL PLATEC(N+12,N+13)

```

MAIN2
6 of 7

JIM

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```

347*      CALL TRANS(N+13,N+4)
348*      N= N+50
349*      300 CONTINUE
350*      C
351*      CALL FUEL(TOTFUL,P2)          @ COMPUTE FUEL AND ENERGY CONSUMED
352*      CALL GBAL                    @ DO HEAT BALANCE TO DETERMINE ERROR
353*      CALL PLOOT                    @ STORE DATA FOR DESIRED PLOTS
354*      IF(IDUM(20),LE.0) GO TO 350   @ IF NO PLOTS DESIRED, SKIP TO SELECT
355*      350 CALL SELECT(149,143,INODES,10) @ PRINT NODE DATA AND INCREMENT TIME
356*      CALL FLIP
357*      C
358*      IF(ICNT+1.EQ.1PRNT) WRITE(6,UPDATE)
359*      IF(TIME.LE.TSTOP) GO TO 777
360*      CALL PRITAB
361*      RETURN
362*      END

```

END OF COMPILATION;

NO DIAGNOSTICS.

```

1*      SUBROUTINE BOILP(M1,M11,M2,M22,P2,EA,STVC,STVD)
2*      C
3*      C      VARIABLE NAME      DESCRIPTION      UNITS
4*      C
5*      C      COEF      CONSTANTS FOR DETERMINING HEAT OF
6*      C      CRTPR      VAPORIZATION FROM TEMPERATURE
7*      C      DELTAP      CRITICAL PRESSURE RATIO
8*      C      DELW      DIFFERENCE BETWEEN CURRENT AMBIENT      PSID
9*      C      DELW      PRESSURE AND LAST SOLUTION OF BOILER
10*      C      DELW      PRESSURE
11*      C      EA      WATER BOILED AWAY THIS TIMESTEP      LBM
12*      C      FLAG      EFFECTIVE ORIFICE AREA
13*      C      FRST      FLAG FOR TYPE OF FLOW
14*      C      GAMMA      FIRST TERM OF MAJOR DIFFERENTIAL EQN
15*      C      GAMMA      BEING SOLVED
16*      C      H      RATIO OF SPECIFIC HEATS FOR STEAM
17*      C      P1      HEAT OF VAPORIZATION
18*      C      PGUESS      BOILER PRESSURE      PSIA
19*      C      PIDOT      PRESSURE GUESS FOR ITERATION PROCESS      PSIA
20*      C      PIOLD      TIME DERIVATIVE OF PRESSURE
21*      C      RK      PRESSURE SOLUTION LAST COMP CYCLE
22*      C      STVC      PRESSURE RATIO
23*      C      STVD      STEAM VALVE CLOSED FLAG
24*      C      TEMPS      STEAM VALVE OPEN FLAG
25*      C      WMDOT      SATURATION TEMPERATURE      DEG R
26*      C      WNDOT      BOILING RATE      LBM/HR
27*      C      WNDOT      BOILING RATE      LBM/MIN
28*      C
29*      C      M1 - LUBE OIL INLET
30*      C      M11- LUBE OIL OUTLET
31*      C      M2 - HYDRAULIC FLUID INLET
32*      C      M22- HYDRAULIC FLUID OUTLET
33*      C
34*      C      DIMENSION COEF(4)
35*      C      COMMON K,L,DELT,TIME,TSTOP,NNODES
36*      C      COMMON P(300,2),F(300,2),C(300,20)
37*      C      COMMON DUM(100),IDUM(100)
38*      C      COMMON /COMEXP/ IWAT(10),WAT(10),DW(10),WATLFT(3)
39*      C      COMMON /ARRAY/ G(300,10),TINIT(300),FLAG,ITTEK
40*      C      COMMON /TYME/TIMSUM(3),AMSNM,FUDGE,SUMARY(20,3)

```



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41* EQUIVALENCE(IIDUM(6),NWAT)
42* DIMENSION KEY(125)
43* DATA GRAV/32.174/A/7449.73/B/14.9285/CC/62.68/
44* DATA GAMMA/1.31/R/85.8507/
45* DATA COEF / 1.4952841 E 03, -1.3875411E 00,
46* 1.5867400 E-03, -1.0192200 E-06 /
47* CA = EA*3600.
48* ED = GAMMA/(GAMMA+1.)
49* CKTPR=(2./(GAMMA+1.))*ED
50* ITTER=0
51* FLAG = 0.
52* PIOLD = G(M1,1)
53* P9=P2
54* IF (STVC.LE.0.) GO TO 9
55* DELTAP=G(M1,1)-P2
56* IF (DELTAP.LE.-1.5) G(M1,1)=P2-1.5
57* PIOLD=G(M1,1)
58* DELTAP=PIOLD-P2
59* PY=P2+STVC
60* IF (DELTAP.GE.STVC) KEY(M1)=1
61* IF (DELTAP.LE.STVC) KEY(M1)=0
62* IF (PIOLD.LE.-2141) KEY(M1)=0
63* IF (KEY(M1).EQ.0) GO TO 250
64* 9 CONTINUE
65* C
66* C COMPUTE SATURATION TEMP FROM AMBIENT PRESSURE
67* C
68* TEMPS=A/(B-ALOG(P9)) + CC
69* DL=1.
70* DH=1.
71* TERRY=ABS(C(M1,3))
72* IF (TERRY.LT.10.) DL=0
73* TERRY=ABS(C(M2,3))
74* IF (TERRY.LT.10.) DH=0
75* IF (P(M1,K).LT.TEMPS) GO TO 249
76* H=COEF(1)
77* DO 73 I= 2,4
78* 73 H = H + COEF(I) * P(M1,K)**(I-1)
79* TRML1 = 0.
80* TRML2 = 1.
81* TRMH1=0.
82* TRMH2=1.
83* IF (DL.LE.0) GO TO 2
84* UAWCP1=C(M1,2)/C(M1,3)
85* TRML1= EXP(-UAWCP1)
86* TRML2 = 1.-TRML1
87* DL = C(M1,3)/H*TRML2
88* 2 IF (DH.LE.0) GO TO 4
89* UAWCP2 = C(M2,2)/C(M2,3)
90* TRMH1= EXP(-UAWCP2)
91* TRMH2= 1.-TRMH1
92* DH=C(M2,3)/H*TRMH2
93* 4 FRST=(DL*F(M1,L)+DH*F(M2,L))/CA
94* E1=(GAMMA-1.)/GAMMA
95* E2=2./GAMMA
96* E3=(GAMMA+1.)/GAMMA
97* E4=(GAMMA-2.)/GAMMA
98* E5=(-1./GAMMA)

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99*      ITER=D
100*      PGUESS = P1OLD
101*      75 CONTINUE
102*      RR=P2/PGUESS
103*      P1=PGUESS
104*      PART = 8-ALOG(P1)
105*      BORIG = A/PART + CC
106*      DBORIG = P1*(PART**2.)
107*      TIMDP=C(M1,1)*A/H
108*
109*      C      CHECK CONDITIONS FOR CHOKED OR UNCHOKED FLOW
110*      C
111*      C
112*      C      UNCHOKED FLOW
113*      C
114*      IF(RR.LE.CRTPR) GO TO 100
115*      SCND=(GRAV*2.*GAMMA/R/(GAMMA-1.))**(-1./2.)
116*      YD= FRST*SCND
117*      TORIG=((P1**E1)*(P2**E2)-(P1**E1)*(P2**E3))
118*      IF(TORIG.LT.0) GO TO 151
119*      IF(ITER.GT.0) GO TO 32
120*      PIDOT=(FRST*CA-(DL+DH)*BORIG-CA/SCND*SQRT(TORIG/BORIG))*DBORIG/
121*      *TIMDP
122*      PGUESS = PIDOT*DELT+P1OLD
123*      ITER = ITER + 1
124*      GO TO 75
125*      32 CONTINUE
126*      PIDOT = (P1-P1OLD)/DELT
127*      WMDOT=DL*F(M1,L)+DH*F(M2,L)-(DL+DH)*(BORIG)-TIMDP*PIDOT/DBORIG
128*      IF(WMDOT.LE.0) ITER=70
129*      IF(WMDOT.LE.0) GO TO 250
130*      YPR=SQRT(TORIG/BORIG)+((DL+DH)*BORIG+TIMDP*PIDOT/DBORIG)*SCND/CA
131*      DELTY= YD-YPR
132*      ITER = ITER+1
133*      YC=ABS(YD)
134*      IF(YC.LE.0) CHECK=1.E-5
135*      IF(YC.LE.0) GO TO 31
136*      CHECK=ABS(DELTY/YD)
137*      31 CONTINUE
138*      IF(CHECK.LE..00001) FLAG = 1.
139*      IF(CHECK.LE..00001) GO TO 150
140*      IF(ITER.GE.500) GO TO 200
141*      DTORIG=E1*(2.)*(P1**E4)*(P2**E2)-(P1**E5)*(P2**E3))
142*      DYTRM1=(1./2.)*(1./SQRT(TORIG/BORIG))*(DTORIG/BORIG)
143*      DYTRM2=(1./2.)*(1./SQRT(TORIG/BORIG))*TORIG*(A/DBORIG/(BORIG**2.))
144*      DYTRM3=(DL+DH)*(A/DBORIG)
145*      DYTRM4=TIMDP*(1./DBORIG*DELT+(2.-PART)*PIDOT/P1/DBORIG/PART)
146*      DYDP1= DYTRM1-DYTRM2+(DYTRM3+DYTRM4)*SCND/CA
147*      V=DYDP1
148*      DELYP1=DELTY/V
149*      PGUESS=PGUESS+ DELYP1
150*      GO TO 75
151*      C
152*      C      CHOKED FLOW
153*      C
154*      100 THKD=(GRAV*GAMMA/R)*(2./(GAMMA+1.))**((GAMMA+1.)/(GAMMA-1.))
155*      IF(ITER.GT.0) GO TO 101
156*      PIDOT=(FRST*CA-BORIG*(DL+DH)-P1*CA*SQRT(THKD/BORIG))*DBORIG/TIMDP

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157* PGUESS = PIDOT*DELT*PIOLD
158* ITTER = ITTER + 1
159* GO TO 75
160* 101 CONTINUE
161* PIDOT = (P1-PIOLD)/DELT
162* WMDOT=DL*F(M1,L)+DH*F(M2,L)-(DL+DH)*(BORIG)-TIMDP*PIDOT/DBORIG
163* IF(WMDOT.LE.0) GO TO 250
164* THRD=1./SQRT(THRD)
165* ZD=FRST*THRD
166* TZORIG = (P1**2.)/BORIG
167* ZPR=SWRT(TZORIG)*((DL+DH)*BORIG+TIMDP*PIDOT/DBORIG)*THRD/CA
168* DELTZ = ZD-ZPR
169* ITTER=ITTER+1
170* ZC=ABS(ZD)
171* IF(ZC.LE.0) CHCKZ=1.E-5
172* IF(ZC.LE.0) GO TO 41
173* CHCKZ=ABS(DELTZ/ZD)
174* 41 CONTINUE
175* IF(CHCKZ.LE..0001) FLAG=2.
176* IF(CHCKZ.LE..0001) GO TO 150
177* IF(ITTER.GE.500) GO TO 200
178* DZTRM1=((1./2.)*(1./SQRT(TZORIG)))*(2.*P1/BORIG-((A*(P1**2.))
179* /((DBORIG*(BORIG**2.))))
180* DZTRM2=(DL+DH)*(A/DBORIG)
181* DZTRM3=TIMDP*(1./DBORIG/DELT*(2.-PART)*PIDOT/P1/DBORIG/PART)
182* DZDP1=DZTRM1+(DZTRM2+DZTRM3)*THRD/CA
183* VZ=DZDP1
184* DELZP1=DELTZ/VZ
185* PGUESS=PGUESS+DELZP1
186* GO TO 75
187* 200 WRITE(6,210) ITTER
188* P12=P1-P2
189* 210 FORMAT(20H NO SOLUTION IN ,12,12H ITERATIONS)
190* CALL EXIT
191* C
192* C COMPUTE SATURATION TEMPERATURE
193* C
194* 150 TEMPR=BORIG
195* GO TO 152
196* 151 CONTINUE
197* ITTER = 69
198* P1=P2
199* GO TO 250
200* 152 CONTINUE
201* P(M1,L)= TEMPR
202* P(M2,L)= TEMPR
203* G(M1,5)=H
204* G(M1,4)=WMDOT
205* H = COEF(1)
206* DO 90 I=2,4
207* 90 H =H+ COEF(I)*TEMPR**(I-1)
208* C
209* C COMPUTE WATER CONSUMED
210* C
211* DELW = WMDOT*DELT
212* F(M11,L)=TRML2*P(M1,L)+TRML1*F(M1,L)
213* F(M22,L)=TRMH2*P(M2,L)+TRMH1*F(M2,L)
214* 95 CONTINUE

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215* DO 160 I=1,10
216* IF(M1.NE.1WAT(I)) GO TO 160
217* GO TO 180
218* 160 CONTINUE
219* NWAT = NWAT + 1
220* 1WAT(NWAT)=M1
221* I = NWAT
222* 180 DW(I)= DELW
223* DU 190 I:=1,NWAT
224* WAT(I)= WAT(I) + DW(I)
225* DW(I)=0.
226* BAND=.6*DELT
227* IF(TIME.GE.(TIMSUM(1)-BAND).AND.TIME.LE.(TIMSUM(1)+BAND))
228* * SUMARY(15,I)=WAT(I)
229* IF(TIME.GE.(TIMSUM(2)-BAND).AND.TIME.LE.(TIMSUM(2)+BAND))
230* * SUMARY(16,I)=WAT(I)-SUMARY(15,I)
231* IF(TIME.GE.(TIMSUM(3)-BAND).AND.TIME.LE.(TIMSUM(3)+BAND))
232* * SUMARY(17,I)=WAT(I)-(SUMARY(15,I)+SUMARY(16,I))
233* WATLFT(I)=SUMARY(14,I)-WAT(I)
234* 190 CONTINUE
235* C(M1,3) = C(M1,3)
236* C(M2,3) = C(M2,3)
237* P12=P1-P2
238* WNDOT = WMDOT/60.
239* G(M1,3)= WNDOT
240* G(M1,9)= TEMPS
241* G(M1,1)=P1
242* G(M2,1)=P1
243* G(M1,2)=P2
244* G(M2,2)=P2
245* G(M1,6)=P1DOT
246* RETURN
247* 249 P1CLO = P9
248* 250 CONTINUE
249* CALL PLATEC(M1,M11)
250* P(M2,K)=P(M1,L)
251* CALL PLATE(M2,M22)
252* P(M1,L)=P(M2,L)
253* P1=P2
254* IF(STVO.GT.0) GO TO 252
255* IF(P(M1,L).LE.TEMPS) GO TO 252
256* WMDOT = C(M1,1)*(P(M1,L)-TEMPS)/H/DELT
257* G(M1,4) = WMDOT
258* G(M1,5) = H
259* P(M1,L)= TEMPS
260* P(M2,L)= TEMPS
261* DELW = WMDOT * DELT
262* GO TO 95
263* 252 CONTINUE
264* IF(STVO.LE.0.) GO TO 251
265* P7=P2+STVO
266* IF(G(M1,1).GT.P7) G(M1,1)=STVC +P2
267* IF(G(M1,1).LE..2141) G(M1,1)=.2141
268* P9=G(M1,1)
269* PSTAT=A/(CC-P(M1,L))+B
270* PSTAT = EXP(PSTAT)
271* P1=AMAX1(PSTAT,P9)
272* 251 CONTINUE

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273*      P12=P1-P2
274*      G(M1,8)= P12
275*      WMDOT=0.
276*      G(M1,4)=WMDOT
277*      G(M1,8)= P12
278*      WMDOT = WMDOT
279*      G(M1,9)= TEMPR
280*      G(M1,1)=P1
281*      G(M2,1)=P1
282*      G(M1,2)=P2
283*      G(M2,2)=P2
284*      G(M1,3)= 0.0
285*      G(M1,6)=1.E-6*(G(M1,1)/DELT*-1.)
286*      RETURN
287*      END

```

END OF COMPILATION: NO DIAGNOSTICS.

SUBROUTINE DRAW

DRAW
1 of 4

VARIABLE NAME	DESCRIPTION	UNITS
DATUM	ARRAY OF UP TO FIVE PARAMETERS OF DATA	
DPAR	DELTA Y-VALUE PER INCH	
DTIME	DELTA X VALUE PER INCH	
IPLT	NODE NUMBER OF PARAMETER	
JPLT	TYPE NUMBER OF PARAMETER	
KTRL	FLAG TO CONTROL DIRECTION OF PLOT	
NIP	COUNTER FOR DETERMINING IF POINTS NEED TO BE SKIPPED	
NNPLTS	NUMBER OF PLOTS + 1(FOR X)	
NPLTS	NUMBER OF PLOTS	
NSET	NUMBER OF TRACES ON CURRENT PLOT	
NSETSV	TOTAL NUMBER OF TRACES IN GROUP (5 MAX)	
NTR	NUMBER OF TRACES ON A PLOT	
NUM	NUMBER OF POINTS ALLOTTED PER TRACE	
PARO	STARTING VALUE OF Y-AXIS	
STIME	ARRAY OF X-VALUES	
TITEL	TITLE OF Y-AXIS FOR CURRENT TRACE	
TO	STARTING VALUE OF X-AXIS	HR
XAXIS	LENGTH OF X-AXIS	IN
XMAX	MAXIMUM VALUE FOR Y-AXIS	
XMIN	MINIMUM VALUE FOR Y-AXIS	
YTILE	ARRAY OF Y-AXIS TITLES	

*** SUPPORT ROUTINE FOR CALCOMP PLOTS ***

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PARAMETER NUM=1500
INTEGER YTILE,X,TITEL,PLTSEG
COMMON K,L,DELT,TIME,TSTOP,NNODES
COMMON P(300,2),F(300,2),C(300,2D)
COMMON DUM(100),IDUM(100)
COMMON/LUMP2/TITLE(12),BIG(25),WEE(25)
COMMON /PSST/NPLTS,IPLT(25),JPLT(25),PLTSEG,TSTP(5),XAXIS(5),
      YAXIS(5),NOPLOT(5),NPLPTS,NTR(25),IWKADR,IRDAKR
DIMENSION DATUM(7500),XMAX(5),XMIN(5),DPAR(5),PARO(5),TSINT(5)
DIMENSION ALPHA(NUM),BETA(NUM),GAMMA(NUM),PHI(NUM),
      THETA(NUM),STIME(NUM),REST(25)
DIMENSION YTILE(9,23),TITEL(9,5)
EQUIVALENCE (DATUM(1),ALPHA),(DATUM(1501),BETA),(DATUM(3001),GAMMA
      ),(DATUM(4501),PHI),(DATUM(6001),THETA)
DATA YTILE/1242H FLUID TEMP AT NODE (DEG K) (DEG K) F
1 COMPONENT TEMP AT NODE (DEG K)
2 LOW RATE AT NODE (LBS/HR) HEAT AT
3 NODE (BTU/HR) WATER REMAINING
4 (LBS) CONC OF H2O AT NODE (LB/LB OF D
5 DRY GAS) CONC OF O2 AT NODE (LB/LB OF DRY GAS)
6 CON OF N2 AT NODE (LB/LB OF DRY GAS) CONC OF C
7 O2 AT NODE (LB/LB OF DRY GAS) HEATER POWER AT NODE
8 (BTU/HR) PART PRES OF H2O AT NODE (PSI)
9 PART PRES OF O2 AT NODE (PSI)
A PART PRES OF N2 AT NODE (PSI) PART PRE
B OF CO2 AT NODE (MMHG) HEATER ENERGY AT
C NODE (BTU) HEAT AT NODE
D (BTU/HR SQ FT) ACCUM FUEL AT NODE (LBS)
E ACCUM ENERGY AT NODE (HP-HR)
F FUEL REMAINING (LBS) AMBIENT+BOILER
G PRESSURES (PSIA) BOILER PRESSURE
H (PSIA)
I

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```

44* J DATA X/1/
45*
46* C
47* WRITE(6,200)
48* 200 FORMAT(1H0,24X,19HEST. PLOTTING TIMES )
49* CALL CDATE(TITLE(12))
50* TSTRT(1) = DUM(25)
51* CALL SCAL(TSTP(1),TSTRT(1),XAXIS(1),DTIME,TO,ERR)
52* KTRL = 20
53* IF (XAXIS(1) .GT. 9) KTRL = 10
54* KTRL = 10
55* ISAVAD = IRDADR
56* NNPLTS = NPLTS + 1
57* IDIV = 0
58*
59* C
60* C DETERMINE IF ANY DATA POINTS ARE TO BE SKIPPED
61* C
62* NIP=1
63* IF (NNPLTS / NIP .LT. 1500) GO TO 84
64* IDIV=IDIV+1
65* IF (IDIV.GT.8) GO TO 500
66* NIP=NIP*2
67* WRITE(6,85) X,NIP
68* 85 FORMAT(20H0 THE FREQ. OF PLOT 13,20H IS BEING DOUBLED TO 13 )
69* GO TO 83
70* 84 NIPM1=NIP-1
71* MD = INT((NNPLTS*DTIME)/(NIP*20* (TSTP(1)-TSTRT(1)) +DTIME))
72* IF (MD .LT. 1) MD = 1
73*
74* C
75* C DETERMINE NUMBER OF PARAMETERS TO READ
76* C
77* 100 NTRC = NTR(X)
78* C GROUP OF 5 (MAX)
79* 4 IF (NTRC-5) 1,2,3
80* 1 NSAV=NTRC
81* IF (NTR(NTRC+X).EQ.0) GO TO 2
82* NTRC=NTRC+NTR(NTRC+X)
83* GO TO 4
84* 3 NTRC=NSAV
85* 2 CONTINUE
86*
87* C
88* C READ DATA
89* C
90* J=0
91* J=J+1 @ J IS NUMBER OF DATA POINTS IN PLOT
92* CALL RREAD (IRDADR,REST,NNPLTS,ISTAT)
93* 48 IF (ISTAT .EQ. 1) GO TO 48
94* IF (REST(1) .LT. TSTRT(1)) GO TO 49
95* STIME(J) = REST(1)
96* N1=NTRC-1
97* DO 7 IR=0,N1
98* 7 DATUM(1500*IR+J) = REST(X+IR*1)
99* IF (STIME(J) .GE. TSTP(1)) GO TO 77 @ HAVE ARRIVED AT END OF PLOT RANGE
100* 49 IRDADR = IRDADR + NNPLTS
101* IF (IRDADR .GE. IWRADR) GO TO 77 @ HAVE ARRIVED AT END OF DATA
102* IF (NIPM1.LT.1) GO TO 44
103* IRDADR = IRDADR + NIPM1 * NNPLTS
104* IF (IRDADR .GE. IWRADR) GO TO 77 @ HAVE ARRIVED AT END OF DATA
105*
106*
107*
108*
109*
110*
111*
112*
113*
114*
115*
116*
117*
118*
119*
120*
121*

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22*      GO TO 44
23*      77 IRDADR = ISAVAD
24*
25*      C      PREPARE Y SCALING
26*      C
27*      DO 8 JJ=1,NTRC
28*      K1=X-1+JJ
29*      IF (ABS(BIG(K1)),GT.1.E-10.OR.ABS(WEE(K1)),GT.1.E-10) GO TO 20
30*      XMAX(JJ)=-100000.
31*      XMIN(JJ)=100000.
32*      DO 5 II=1,J
33*      JM1=JJ-1
34*      XMAX(JJ)=AMAX1(XMAX(JJ),DATUM(JM1 *1500+1))
35*      XMIN(JJ)=AMIN1(XMIN(JJ),DATUM(JM1 *1500+1))
36*      5 CONTINUE
37*      GO TO 101
38*      20 XMAX(JJ)=BIG(K1)
39*      XMIN(JJ)=WEE(K1)
40*      101 CONTINUE
41*      CALL SCAL(XMAX(JJ),XMIN(JJ),YAXIS(1),DPAR(JJ),PARO(JJ),ERR)
42*      8 CONTINUE
43*
44*      C      PREPARE Y AXIS TITLES
45*      C
46*      DO 70 IZ=1,NTRC
47*      NUL=JPLT(X-1+IZ)
48*      YTILE(5,NUL)=ICNVRT(IPLT(X-1+IZ))
49*      DO 70 IY=1,7
50*      TITEL(IY,IZ)=YTILE(IY,NUL)
51*      70 CONTINUE
52*
53*      C      PLACE DATA FOR ONE PLOT ON TAPE
54*      C
55*      NSET=NTR(X)
56*      NSETSV=NSET
57*      C
58*      68 GO TO (11,12,13,14,15),NSET
59*      11 CALL CCP(1,KTRL,TO,DTIME,STIME,0.,11,PARO(1),UPAR(1),0.0,ALPHA
60*      * ,72,TITLE,20,20H
61*      GO TO 18
62*      12 CALL CCP(1,KTRL,TO,DTIME,STIME,0.,22,PARO(1),UPAR(1),1.14*MD,ALPHA
63*      * ,72,TITLE,20,20H
64*      * ,54,TITEL(1,1))
65*      GO TO 18
66*      13 CALL CCP(1,KTRL,TO,DTIME,STIME,0.,33,PARO(1),UPAR(1),1.14*MD,ALPHA
67*      * ,72,TITLE,20,20H
68*      * ,54,TITEL(1,2))
69*      GO TO 18
70*      14 CALL CCP(1,KTRL,TO,DTIME,STIME,0.,44,PARO(1),UPAR(1),1.14*MD,ALPHA
71*      * ,72,TITLE,20,20H
72*      * ,54,TITEL(1,3))
73*      GO TO 18
74*      15 CALL CCP(1,KTRL,TO,DTIME,STIME,0.,55,PARO(1),UPAR(1),1.14*MD,ALPHA
75*      * ,72,TITLE,20,20H
76*      * ,54,TITEL(1,4))
77*      GO TO 18
78*      16 CALL CCP(1,KTRL,TO,DTIME,STIME,0.,66,PARO(1),UPAR(1),1.14*MD,ALPHA
79*      * ,72,TITLE,20,20H
80*      * ,54,TITEL(1,5))

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```

180*      ,54,TITEL(1,3)
181*      ,54,TITEL(1,4))
182*      GO TO 18
183* 15 CALL CCP(1,KTRL,TO,DTIME,STIME,0.,55,PARO(1),DPAR(1),1,14*MD,ALPHA
184*      ,PARO(2),DPAR(2),2,16*MD,BETA
185*      ,PARO(3),DPAR(3),7,20*MD,GAMMA
186*      ,PARO(4),DPAR(4),6,22*MD,PHI
187*      ,PARO(5),DPAR(5),3,26*MD,THETA
188*      ,72,TITLE,20,20H      TIME (HRS.),54,TITEL(1,1)
189*      ,54,TITEL(1,2)
190*      ,54,TITEL(1,3)
191*      ,54,TITEL(1,4)
192*      ,54,TITEL(1,5))
193* 18 CONTINUE
194*      CALL CCP(2,J,1)
195*      CALL CCP(5,32767,PLOTIM)
196* 220 WRITE(6,202) PLOTIM
197* 202 FORMAT(22X,F7.2,5H MIN.)
198*      IF((X-1+NSETSV) .GE. NPLTS) GO TO 500
199*      IF(NSETSV+NTR(NSETSV + X) .GT. NTRC) GO TO 80
200*      C
201*      C      MOVE REMAINING DATA, SCALING AND TITLE INTO POSITION FOR PLOTTING
202*      C
203*      N1=1500*(5-NSETSV)
204*      N2=5-NSETSV
205*      DO 66 IR=1,N1
206* 66 DATUM(IR)=DATUM(1500*NSET + IR)
207*      DO 67 IR=1,N2
208*      N3=NSET + IR
209*      PARO(IR)=PARO(N3)
210*      DPAR(IR)=DPAR(N3)
211*      DO 67 IS=1,9
212*      TITEL(IS,IR)=TITEL(IS,N3)
213* 67 CONTINUE
214*      NSET=NTR(NSETSV + X)
215*      NSETSV=NSETSV+NSET
216*      GO TO 68
217*      C
218*      C      CHECK FOR MORE PLOTS
219*      C
220* 80 X=X+NTRC
221*      GO TO 100
222* 500 CALL CCP(6)
223*      CALL EXIT
224*      END

```

END OF COMPILATION:

NO DIAGNOSTICS.

SUBROUTINE FLOPWR(I,N)

FLOPWR
1 of 2

SUBROUTINE FLOPWR CALCULATES:
 PART A PUMP EFFICIENCY AS A FUNCTION OF SYSTEM
 FLOWRATE IN GPM
 PART B POWER AS A FUNCTION OF THE EFFICIENCY,
 THE FLOWRATE, AND SYSTEM CONFIGURATION
 PART C CASE DRAIN FLOWRATE AS A FUNCTION OF
 SYSTEM FLOWRATE IN GPM
 PART D CONVERTS VOLUMETRIC FLOWRATE TO MASS
 FLOWRATE

VARIABLE NAME	DESCRIPTION	UNITS
C(N+4,3)	FLOWRATE INTO PUMP	LBM-BTU/HR-LBM-K
CDFLW	CASE DRAIN FLOWRATE	GPM
COEF1	PRESSURIZED, 100%, FLOWRATE < 10 GPM	
COEF2	PRESSURIZED, 100%, FLOWRATE > 10 GPM	
COEF3	PRESSURIZED, 110%, FLOWRATE < 10 GPM	
COEF4	PRESSURIZED, 110%, FLOWRATE > 10 GPM	
COEF5	DEPRESSURIZED, 100%	
COEF6	DEPRESSURIZED	
COEF7	PRESSURIZED, 105 DEG F	
COEF8	PRESSURIZED, 240 DEG F	
I	SYSTEM NUMBER	
ICNFIG	CURRENT SYSTEM CONFIGURATION	
IPDO	SYSTEM CONFIGURATION MATRIX	
PDRP	PRESSURE DROP IN CURRENT CONFIGURATION	PSID
PEFF	PUMP EFFICIENCY	
POWER	PUMP SHAFT HORSEPOWER	HP
TFLW	PUMP DISCHARGE FLOWRATE	GPM

```

DIMENSION COEF1(7),COEF2(7),COEF3(7),COEF4(7),COEF5(7)
          ,COEF6(7),COEF7(7),COEF8(7)
*
DIMENSION CDFLW(3)
COMMON K,L,DELT,TIME,TSTOP,NNODES
COMMON P(300,2),F(300,2),C(300,20)
COMMON DUM(100),IDUM(100)
COMMON /PRESR/ SPH(3),DENS(3),PDRP(3)
COMMON /HYD/ IPDO(27,3),LMMTRX(50,4),POWER(3),ISPD(3),IFLAG,TFLW(3)
DATA COEF1/-.49346189E-2,.14800725E0,-.10542547E-1,-.10881577E-2,
          .23789028E-3,-.11009778E-4,0./
1 DATA COEF2/.29439088E0,.43650098E-1,-.13235802E-2,.14183407E-4,
          .12586157E-6,-.38812277E-8,.23373279E-10/
2 DATA COEF3/-.15472021E-2,.96847460E-1,.24697738E-2,-.26934014E-2,
          .33908812E-3,-.13621800E-4,0./
3 DATA COEF4/.23604454E0,.42172012E-1,-.11718599E-2,.11886269E-4,
          .10845819E-6,-.33402185E-8,.19827437E-10/
4 DATA COEF5/.2274319E-3,.63282103E-1,-.40051915E-2,.19070836E-3,
          -.66434421E-5,.14306783E-6,0./
5 DATA COEF6/1.834046717E00,-1.465395509E-1,8.638799447E-3,
          -2.021799545E-4,6.526222337E-7,2.702823085E-8,0./
6 DATA COEF7/1.915030204E0,-6.256168626E-2,2.163349889E-3,
          -4.183432290E-5,3.834702841E-7,-2.634044214E-9,1.670269427E-11/
7 DATA COEF8/3.746799286E0,2.058631455E-2,-5.641405274E-3,
          2.777386735E-4,-7.106378892E-6,9.105226309E-8,-4.530785863E-10/
8

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```

ICNFIG=IPDO(IFLAG,I)
M=ISPD(I)
Q=TFLW(I)
GO TO (20,30),M

```

```

64* C PART A
65* C
66* C 100% SPEED
67* C
68* 20 GO TO (22,22,24),ICNFIG
69* 22 PEFF=FUNC(COEF5,Q) @ DEPRESSURIZED

70* GO TO 50
71* 24 IF(TFLW(1).GT.10) GO TO 25
72* PEFF=FUNC(COEF1,Q)
73* GO TO 50
74* 25 PEFF=FUNC(COEF2,Q)
75* GO TO 50
76* C
77* C 110% SPEED
78* C
79* 30 IF(TFLW(1).GT.10) GO TO 35
80* PEFF=FUNC(COEF3,Q)
81* GO TO 50
82* 35 PEFF = FUNC(COEF4,Q)
83* C
84* C PART B
85* C
86* 50 POWER(1)= TFLW(1)* PDRP(ICNFIG)/(PEFF*1714.)
87* GO TO (60,70,80),ICNFIG
88* C
89* C PART C
90* C
91* C SYSTEM OFF
92* C
93* 60 CDFLW(1)=0.
94* GO TO 100
95* C
96* C DEPRESSURIZED MODE
97* C
98* 70 CDFLW(1)= FUNC(COEF6,Q)
99* GO TO 100
100* C
101* C PRESSURIZED MODE
102* C
103* 80 CDL= FUNC(COEF7,Q)
104* CDH= FUNC(COEF8,Q)
105* CDFLW(1) = CDL + (CDH-CDL) * (F(N+4,K) - 565.) /595.
106* 100 CONTINUE
107* C
108* C PART D
109* C
110* C(N+6,3) = TFLW(1)*220.
111* C(N+5,3) = CDFLW(1)*220.
112* C(N+4,3) = C(N+5,3) + C(N+6,3)
113* RETURN
114* END

```

END OF COMPILATION:

NO DIAGNOSTICS.


```

1* SUBROUTINE FUEL(TOTFUL,P2)
2*
3* C
4* C
5* C
6* C
7* C
8* C
9* C
10* C
11* C
12* C
13* C
14* C
15* C
16* C
17* C
18* C
19* C
20* C
21* C
22* C
23* C
24* C
25* C
26* C
27* C
28* C
29* C
30* C
31* C
32* C
33* C
34* C
35* C
36* C
37* C
38* C
39* C
40* C
41* C
42* C
43* C
44* C
45* C
46* C
47* C
48* C
49* C
50* C
51* C
52* C
53* C
54* C
55* C
56* C
57* C

      VARIABLE NAME          DESCRIPTION          UNITS
      -----
      BAND          INTERVAL AROUND TIME TO CHECK FOR
                     SAVING VALUES FOR SUMMARY TABLE
      FRATE1        FUEL USAGE RATE AT SEA LEVEL      LBM/HR
      FRATE2        FUEL USAGE RATE IN SPACE          LBM/HR
      FURATE        FUEL USAGE RATE AT CURRENT ALTITUDE LBM/HR
      ISPD          APU OPERATING SPEED FLAG
      PU           FUEL USED THIS COMP CYCLE          Lb

      DIMENSION TOTFUL(3)
      COMMON K,L,DELT,TIME,TSTOP,NNODES
      COMMON P(300,2),F(300,2),C(300,20)
      COMMON DUM(100),IDUM(100)
      COMMON /TIME/TIMSUM(3),AMSNM,FUDGE,SUMARY(20,3)
      COMMON/HYD/IPDO(27,3),LMMTRX(50,4),POWER(3),ISPD(3),IFLAG,TFLW(3)
      EQUIVALENCE(IDUM(10),NTURBN)
      N=274
      DO 100 I=1,NTURBN
      PWR=POWER(I)
      IF(PWR.LE.0.) GO TO 100
      M=ISPD(I)

      GO TO (10,20),M

      ***** 100% *****
10  CONTINUE
      FRATE1= 5.054* PWR + 69.55      @ SEA LEVEL 100%
      FRATE2= 4.593* PWR + 33.29      @ SPACE 100%
      GO TO 30

      ***** 110% *****
20  CONTINUE
      FRATE1= 5.054* PWR + 69.55      @ SEA LEVEL 110%
      FRATE2= 4.593* PWR + 33.29      @ SPACE 110%
30  FURATE=FRATE2+(FRATE1-FRATE2)*(P2/14.7)      @INTERPOLATE FOR ALTITUDE
      PU=FURATE*DELT
      C(N+1,17)=C(N+1,17)+PU      @SUM FUEL CONSUMED
      C(N+1,19)=TOTFUL(1)-C(N+1,17)      @COMPUTE FUEL REMAINING
      ENERGY=POWER(1)*DELT      @COMPUTE ENERGY CONSUMED
      C(N+1,18)=C(N+1,18)+ENERGY

      PREPARE FUEL USAGE INFORMATION FOR SUMMARY TABLE

      BAND = .6 * DELT
      IF(TIME.GE.(TIMSUM(1)-BAND).AND.TIME.LE.(TIMSUM(1)+BAND))
      * SUMARY(5,1)=C(N+1,17)
      IF(TIME.GE.(TIMSUM(2)-BAND).AND.TIME.LE.(TIMSUM(2)+BAND))
      * SUMARY(6,1)= C(N+1,17)-SUMARY(5,1)
      IF(TIME.GE.(TIMSUM(3)-BAND).AND.TIME.LE.(TIMSUM(3)+BAND))
      * SUMARY(7,1)=C(N+1,17)-(SUMARY(5,1) + SUMARY(6,1))

100 CONTINUE
      RETURN
      END

```

END OF COMPILATION:

NO DIAGNOSTICS.

SUBROUTINE HYDACT

LINE	CHARACTER	VARIABLE NAME	DESCRIPTION	UNITS
1*				
2*	C			
3*	C			
4*	C			
5*	C	C(N1+7,1)	THERMAL CAPACITANCE OF HYDRAULIC SYSTEM 1	
6*	C	C(N1+7,4)	HEAT LOAD ON SYSTEM 1	
7*	C	ICNFIG	SYSTEM CONFIGURATION	
8*	C	IFLAG	SYSTEM CONFIGURATION FLAG	
9*	C	JK	COUNTER FOR NUMBER OF ACTUATORS ON EACH SYSTEM	
10*	C	LM	COLUMN OF LHMTRX BEING CHECKED	
11*	C	LMC	OPERATING MODE OF COLUMN OF LHMTRX BEING CHECKED	
12*	C			
13*	C	LHMTRX	LOSS MANAGEMENT MATRIX	
14*	C	NACT	TOTAL NUMBER OF ACTUATORS	
15*	C	NHYD	ARRAY OF INLET NODE NUMBERS FOR ACTUATORS ON SYSTEM 1	
16*	C			
17*	C	NHYOUT	ARRAY OF OUTLET NODE NUMBERS FOR ACTUATORS ON SYSTEM 1	
18*	C			
19*	C	PDRP	PRESSURE DROP FOR CURRENT SYSTEM	PSID
20*	C			
21*		COMMON K,L,DELT,TIME,TSTOP,NNODES		
22*		COMMON P(300,2),F(300,2),C(300,20)		
23*		COMMON DUM(100),IDUM(100)		
24*		COMMON /ACT/ NHYD(3,50),NHYOUT(3,50),NACT,FLW(50)		
25*		COMMON /PRESR/ SPH(3),DENS(3),PDRP(3)		
26*		COMMON /HYD/ IPDO(27,3),LHMTRX(50,4),POWER(3),ISPD(3),IFLAG		
27*		EQUIVALENCE(IDUM(10),NTURBN)		
28*		DATA PDRP/0.,.740.,3000./		
29*		JK= 0		
30*		DO 10 I = 1,NTURBN		
31*		IDUM(10+I) = 0		
32*		DO 10 J=1,NACT		
33*		NHYD(I,J) = 0		
34*		NHYOUT(I,J) = 0		
35*				
36*	10	CONTINUE		

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37*      DO 60 J=1,NACT
38*      LM = 0
39*      20 LM = LM+1
40*      IF (LMMTRX(J,LM).EQ.0) GO TO 30
41*      ISYS = LMMTRX(J,LM)
42*      LMC = IPDO(IFLAG,ISYS)
43*      IF (LMC.LT.3) GO TO 20
44*      GO TO 50
45*      30 LM=0
46*      40 LM = LM + 1
47*      IF (LMMTRX(J,LM).EQ.0) ISYS=LMMTRX(J,1)
48*      IF (LMMTRX(J,LM).EQ.0) GO TO 50
49*      ISYS = LMMTRX(J,LM)
50*      LMC = IPDO(IFLAG,ISYS)
51*      IF (LMC.LT.2) GO TO 40
52*      50 IDUM(10+ISYS) = IDUM(10+ISYS) + 1
53*      JK = IDUM(10+ISYS)
54*      NHYD(ISYS,JK) = J
55*      NHYOUT(ISYS,JK) = J+50
56*      60 CONTINUE
57*      N1=100
58*      DO 80 I=1,NTURBN
59*      JL=IDUM(10+1)
60*      C(N1+7,1)=0.
61*      C(N1+7,4)=0.
62*      DO 70 ND=1,JL
63*      IF (JL.EQ.0) GO TO 79
64*      NOD=NHYD(1,ND)
65*      IF (NOD.LE.9) GO TO 65
66*      C(N1+7,1)=C(N1+7,1)+C(NOD,1) @SUM C(X,1) OF ACTUATORS PER SYSTEM
67*      65 CONTINUE
68*      ICNFIG=IPDO(IFLAG,1)
69*      C(NOD,4)=FLW(NOD)*PDRP(ICNFIG)*1.48483 @COMPUTE HEAT LOADS ON ACTUATORS
70*      C(N1+7,4)=C(N1+7,4)+C(NOD,4) @SUM C(X,4) OF ACTUATORS PER SYSTEM
71*      C(NOD,3) = FLW(NOD)*220.
72*      70 CONTINUE
73*      79 N1=N1+50
74*      80 CONTINUE
75*      RETURN
76*      END
```

END OF COMPILATION: NO DIAGNOSTICS.

```

1* SUBROUTINE LILOAD
2*
3* C
4* C VARIABLE NAME DESCRIPTION UNITS
5* C
6* C KNODE COUPLING NODE
7* C LINDEX LINE NUMBER INDEX
8* C LINUM ARRAY OF LINE NUMBERS
9* C LNODE ARRAY OF ACTUATOR IN WHOSE LINE PATHS
10* C LINUM(LINDEX) IS INCLUDED
11* C NODLIN ACTUATOR-LINE MATRIX
12* C NLCNT COUNTER FOR NUMBER OF LINES ON ACTUATOR
13*
14* C THIS S/R LOADS THE LINE DATA, CONSTRUCTS THE ACTUATOR X LINE MATRIX FROM THE
15* C LINE X ACTUATOR ROW VECTOR INPUT DATA, COMPUTES CAPACITANCE AND LOADS THE
16* C BOUNDARY NODE COUPLING VECTOR.
17* COMMON K,L,DELT,TIME,TSTOP,NNODES
18* COMMON P(300,2),F(300,2),C(300,20)
19* COMMON DUM(100),IDUM(100)
20* COMMON/LINES/ LINUM(260),KNODE(260),LTH(260),IBIG(260),FLOWL(260),
21* 1 TEMPIN(260),TEMPOT(260),LDGF(260),SPACE(20,2),
22* 2 NODLIN(50,76),NLCNT(50),QDOTL(260),SHAPE,EMISS,
23* 3 TEMPB(11,2),FLACUM(260),FLOWT(260)
24* COMMON /ACT/ NHYD(3,50),NHYOU(3,50),NACT,FLW(50)
25* DIMENSION LINDEX(46)
26* DATA SHAPE/.75/EMISS/.5/
27* DATA SPACE/3*0.,13*6*0.,16*0*0.,18*4*0.,20*8*0.,23*2*0.,24*8*0.,
28* *26*4*3*0.,29*6*3*0.,13*6*0.,16*0.,17*6*0.,20*0.,20*8*0.,22*4,
29* *0.,23*2*3*0.,26*4/
30* LINDEX=0
31* 10 CONTINUE
32* LNCNT=0
33* DO 14 I=1,30
34* 14 LINDEX(I)=0
35* LINDEX = LINDEX+1
36* IF(IEND.GT.0) GO TO 100
37* READ(4,END=100) LINUM(LINDEX),LDGF(LINDEX),KNODE(LINDEX),LNODE,
38* * LNUM,LTH(LINDEX),IBIG(LINDEX)
39* KNODE(LINDEX) = KNODE(LINDEX) + 250
40* 11 LNCNT=LNCNT+1
41* LN = LINDEX(LNCNT)
42* IF(LN.EQ.0) GO TO 12
43* NLCNT(LN) = NLCNT(LN)+1
44* NL=NLCNT(LN)
45* NODLIN(LN,NL)=LINDEX
46* GO TO 11
47* 12 LNCNT=LNCNT-1
48* WRITE(6,3) LINUM(LINDEX),KNODE(LINDEX),(LINDEX(M),M=1,LNCNT)
49* 3 FORMAT(5X,2I5,30I3)
50* GO TO 10
51* 100 LINDEX=LINDEX-1
52* WRITE(6,4) LINDEX
53* 4 FORMAT(1H1,31H ***** LINE NUMBER INDEX *****/25H TOTAL NUMBER OF
54* * LINES =,I5/)
55* DO 101 M=1,LINDEX
56* 101 WRITE(6,5) M,LINUM(M)
57* 5 FORMAT(2X,2I6)
58* RETURN
59* END

```


LINE	CHARACTER	VARIABLE NAME	DESCRIPTION	UNITS
1*		SUBROUTINE LINFL0(IS)		
2*	C			
3*	C			
4*	C			
5*	C	FLOWL	FLOWRATE IN THE HYDRAULIC LINES	GPM
6*	C	ID	POSITION OF LINE NUMBER IN THE LINE ARRAYS.	
7*	C	INTG3	SECOND DIGIT OF THE LINE NUMBER	
8*	C		1=PRESSURE LINE SYS 1, 2=RETURN SYS 1	
9*	C		3=PRESSURE LINE SYS 2, 4=RETURN SYS 2	
10*	C		5=PRESSURE LINE SYS 3, 6=RETURN SYS 3	
11*	C	LLL	NUMBER OF LINES ON ACTUATOR NN	
12*	C	NN	ACTUATOR NUMBER ON SYS IS	
13*	C			
14*		COMMON K,L,DELT,TIME,TSTOP,NNODES		
15*		COMMON P(300,2),F(300,2),C(300,20)		
16*		COMMON DUM(100),IDUM(100)		
17*		COMMON/LINES/ LINUM(260),KNOE(260),LTH(260),IBIG(260),FLOWL(260),		
18*	1	TEMPIN(260),TEMPOT(260),LDGF(260),SPACE(20,2),		
19*	2	NOOLIN(50,76),NLCNT(50),QDOTL(260),SHAPE,EMISS,		
20*	3	TEMPB(11,2),FLACUM(260),FLOWT(260)		
21*		COMMON /ACT/ NHYD(3,50),NHOUT(3,50),NACT,FLW(50)		
22*		KEY1 = 2*IS -1		
23*		KEY2 = 2*IS		
24*		JK= IDUM(10+IS)		
25*		DO 1 ND=1,JK		
26*		NN= NHYD(1S,ND)		
27*		LLL=NLCNT(NN)		
28*		DO 2 LL=1,LLL		
29*		ID =NOOLIN(NN,LL)		
30*		LINE= LINUM(ID)		
31*		INTG1 = LINE/100		
32*		INTG2 = LINE/1000		
33*		INTG2 = 10*INTG2		
34*		INTG3 = INTG1 -INTG2		
35*		IF(LDGF(ID).GT.0) INTG3 = 2		
36*		IF(INTG3.EQ.KEY1) FLOWL(ID) = FLOWL(ID) + FLW(NN)		
37*		IF(INTG3.EQ.KEY2) FLOWL(ID) = FLOWL(ID) + FLW(NN)		
38*	2	CONTINUE		
39*	1	CONTINUE		
40*		RETURN		
41*		END		

END OF COMPILATION: NO DIAGNOSTICS.

LINE	CHARACTER	VARIABLE NAME	DESCRIPTION	UNITS
1		SUBROUTINE LUBOIL(I,N)		
2	C			
3	C			
4	C			
5	C	C(N+1,4)	HEAT LOAD ON GEARBOX	BTU/HR
6	C	C(N+1,3)	LUBE OIL FLOWRATE	LBM-BTU/HR-LBM-R
7	C	C(N+2,2)	HEAT TRANSFER COEFFICIENT FOR LUBE OIL	BTU/HR-DEG
8	C		HEAT EXCHANGER	
9	C	TBAR	AVERAGE OF INLET AND OUTLET TEMPS	DEG
10	C			
11		DIMENSION SPHL(3),DENSL(3)		
12		COMMON K,L,DELT,TIME,TSTOP,NNODES		
13		COMMON P(300,2),F(300,2),C(300,20)		
14		COMMON DUM(100),IDUM(100)		
15		COMMON/HYD/IPDC(27,3),LMMTRX(50,4),POWER(3),ISPD(3),IFLAG,IFLW(3)		
16	C			
17		TBAR=(F(N+1,K)+F(N+2,K))/2.		
18		SPHL(1)=.0004*TBAR+.228		
19		DENSL(1)=-.019008*TBAR+.70.69		
20		IF(ISPD(1).EQ.2)GO TO 10		
21		C(N+1,4) = 19987.2 + 26.214 * POWER(1)		
22		C(N+1,3)= SPHL(1) * DENSL(1) * 26.468		
23		GO TO 20		
24	10	HP=4.946+.024*POWER(1)		
25		C(N+1,3)=SPHL(1)*DENSL(1)*33.668		
26	20	CONTINUE		
27	C			
28		TBAR=TBAR-460.		
29		FLRL=(520./134.) * C(N+1,3)/SPHL(1)		
30		UA1L=391.354*(FLRL+.29819)		
31		AOL= 4.88993795*TBAR-1355.651		
32		A1L=-2.1668348 *TBAR+603.35074		
33		A2L=.2395562 * TBAR - 66.919291		
34		ALFLR = ALOG10(FLRL)		
35		ALUA2L= AOL+A1L+ALFLR + A2L*(ALFLR+.2)		
36		UA2L = 10.**ALUA2L		
37		USE = AMAX1(UA1L,UA2L)		
38		C(N+2,2) =(134./1040.) * USE		
39		RETURN		
40		END		


```

10 SUBROUTINE MOD(N,I,J,M,TC,R,MIN,MAX)
11 C
12 C
13 C      N = NODE TO SPLIT
14 C      I = SPLIT N INTO I, FLOW XM
15 C      J = SPLIT N INTO J, FLOW 1-XM
16 C      M = CONTROL NODE
17 C      TC = CONTROL TEMP.
18 C      R = XM CHANGE PER DEGREE
19 C      MAX = MAX. VAL. OF XM
20 C      MIN = MIN. VAL. OF XM
21 C
22 REAL MAX, MIN
23 COMMON K, L, DELT, TIME, TSTOP, NNODES
24 COMMON P(300,2), F(300,2), C(300,20)
25 COMMON DUM(100), IDUM(100)
26 GO TO 101
27 ENTRY GMOD(N,I,J,M,TC,R,MIN,MAX)
28 BAD1= C(I,10)
29 BAD2= C(J,10)
30 DO 102 11=5,14
31 C(I,11)=C(N,11)
32 C(J,11)=C(N,11)
33 102 CONTINUE
34 C(I,10)= BAD1
35 C(J,10)= BAD2
36 101 CONTINUE
37 IF(F(N,L).LT.TC)XM=0.
38 IF(F(N,L).LT.TC)GO TO 18
39
40 IF(F(I+1,L).GT.TC)XM=1.
41 IF(F(I+1,L).GT.TC) GO TO 18
42 XM=(TC-F(N,L))/(F(I+1,L)-F(N,L))
43 FOO=(TC-F(M,L))*R
44 XM=XM-FOO
45 10 HH=MIN+.005
46 GG=MAX+.005
47 IF(XM.GE.HH) GO TO 15
48 XM=HH
49 GO TO 18
50 15 IF(XM.LE.GG) GO TO 18
51 XM=GG
52 18 C(I,3)=XM*C(N,3)
53 C(J,3)=C(N,3)-C(I,3)
54 30 F(I,L)=F(N,L)
55 F(J,L)=F(N,L)
56 RETURN
57 END

```

END OF COMPILATION;

NO DIAGNOSTICS.

```

1* SUBROUTINE PLATE(M,N)
2*
3* M = INLET
4* N = OUTLET
5*
6*
7* VARIABLE NAME DESCRIPTION UNITS
8*
9* ICUP FLAG TO SIGNAL THAT PLATO WAS CALLED
10* F(N,L) OUTLET FLUID TEMPERATURE
11* P(N,L) COMPONENT TEMPERATURE
12*
13* COMMON K, L, DELT, TIME, TSTOP, NNODES
14* COMMON P(300,2), F(300,2), C(300,20)
15* COMMON DUM(100), IDUM(100)
16* EQUIVALENCE (DELT02,DUM(1))
17* C(N,3) = C(M,3)
18* GO TO 100
19* ENTRY PLATO(M,N)
20* C(N,3) = C(M,3)
21* SAVEQ = C(M,4)
22* SAVET = F(M,L)
23* ICUP = 1
24* IF (C(M,3).LE.0) GO TO 100
25* F(M,L) = C(M,4)/C(M,3)/2.*SAVET
26* C(M,4) = 0
27* GO TO 100
28* ENTRY GPLT(M,N)
29* C(N,5) = C(M,5)
30* PM = C(M,12)*DUM(17) + C(M,13)*DUM(18)
31* DO 101 IX=11,14
32* C(N,IX) = C(M,IX)
33* 101 C(N,IX-5) = C(N,IX)*DUM(IX+5)/PM
34* C(N,3) = C(M,3)
35* C(M,3) = (C(N,6)*DUM(21) + C(N,9)*DUM(24) + C(M,5))*C(M,3)/C(M,5)
36* 100 CONTINUE
37* TRM1 = 0.
38* IF (C(M,3).LE.0) GO TO 78
39* UAWCP = C(M,2)/C(M,3)
40* IF (ABS(UAWCP).GT.60.) GO TO 78
41* TRM1 = EXP(-UAWCP)
42* 78 TRM2 = 1. - TRM1
43* TRM3 = DELT02*TRM2*C(M,3)
44* TRM5 = TRM2/2.
45* TOFML = 2.*F(M,L)
46* CMTRM3 = C(M,1) + TRM3
47* P(M,L) = (C(M,4)*DELT + (P(M,K) - TOFML)*TRM3 + C(M,1)*P(M,K))/CMTRM3
48* PMLMK = P(M,L) + P(M,K)
49* F(N,L) = TRM5*PMLMK + TRM1*F(M,L)
50* C(M,3) = C(N,3)
51* IF (ICUP.EQ.0) RETURN
52* C(M,4) = SAVEQ
53* F(M,L) = SAVET
54* IF (C(M,3).LE.0) GO TO 102
55* F(N,L) = F(N,L) + C(M,4)/C(M,3)/2.
56* 102 ICUP = 0
57* RETURN
58* END

```


		VARIABLE NAME	DESCRIPTION	UNITS
1*		SUBROUTINE PLATEC(II,JJ)		
2*	C			
3*	C			
4*	C			
5*	C	NSTRT	LOCATION OF FIRST NODE IN IBIG COUPLED TO	
6*	C		NODE M	
7*	C	NTRY	LOCATION OF LAST NODE IN IBIG COUPLED TO	
8*	C		NODE M	
9*	C	SUM	TOTAL HEAT LOSED TO STRUCTURE OR OTHER	
10*	C		COMPONENTS	
11*	C			
12*		COMMON K, L, DELT, TIME, TSTOP, NNODES		
13*		COMMON P(300,2), F(300,2), C(300,20)		
14*		COMMON DUM(100), IDUM(100)		
15*		COMMON/ GLOB/ KEEP(300), IBIG(2000), VAL(2000),		
16*		LEEP(300), JBIG(2000), RVAL(2000)		
17*		AA=C(II,4)		
18*		GO TO 44		
19*		ENTRY PLATOC(II,JJ)		
20*		AA=C(II,4)		
21*		ICUP=1		
22*		GO TO 44		
23*		ENTRY GPLTC(II,JJ)		
24*		BAD= C(JJ,10)		
25*		DO 45 IX=5,14		
26*	45	C(JJ,IX) = C(II,IX)		
27*		C(JJ,10)= BAD		
28*	44	CONTINUE		
29*		NSTRT=KEEP(II)/1000		
30*		NTRY=KEEP(II)-NSTRT*1000+NSTRT-1		
31*		IF(NSTRT.EQ.0) GO TO 150		
32*		SUM=0.		
33*		DO 100 I=NSTRT,NTRY		
34*		NOW=IBIG(I)		
35*		TEMP=P(II,K)-P(NOW,K)		
36*		SUM=SUM+VAL(I)*TEMP		
37*	100	CONTINUE		
38*		C(II,4)=C(II,4)-SUM		
39*	150	NSTRT=LEEP(II)/1000		
40*		NTRY=LEEP(II)-NSTRT*1000+NSTRT-1		
41*		IF(NSTRT.EQ.0) GO TO 200		
42*		SUM=0.		
43*		T4=P(II,K)*.4		
44*		DO 175 I=NSTRT,NTRY		
45*		NOW=JBIG(I)		
46*		TEMP=T4-P(NOW,K)*.4		
47*		SUM=SUM+RVAL(I)*TEMP		
48*	175	CONTINUE		
49*		C(II,4)=C(II,4)-SUM		
50*	200	IF(ICUP.EQ.1)CALL PLATO(II,JJ)		
51*		IF(ICUP.EQ.1) GO TO 202		
52*		CALL PLATE(II,JJ)		
53*	202	ICUP=0		
54*		C(II,4)=AA		
55*		RETURN		
56*		END		

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1*		SUBROUTINE PLOOT		
2*	C			
3*	C	SUBROUTINE PLOOT PUTS THE INFORMATION FROM EACH		
4*	C	COMP CYCLE FOR EACH DESIRED PLOT ONTO HIGH SPEED		
5*	C	DRUM TO BE RETRIEVED LATER BY THE ROUTINE DRAW		
6*	C			
7*	C	VARIABLE NAME	DESCRIPTION	UNITS
8*	C			
9*	C	IPLT	NODE NUMBER OF PLOT	
10*	C	IWRADR	ADDRESS ON DRUM AT WHICH TO WRITE DATA	
11*	C	JPLT	TYPE OF PLOT	
12*	C	NIX	COUNTER FOR NUMBER OF PLOTS	


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13*      C      NNPLTS      NUMBER OF PLOTS PLUS 1 FOR X
14*      C      NPLPTS      COUNTER FOR NUMBER OF POINTS ON EACH
15*      C      PLOT
16*      C      PLANET      ARRAY OF VALUES TO PUT ON ONE RECORD OF
17*      C      DRUM (1)=TIME (1), I=2, NNPLTS=ONE
18*      C      POINT FOR EACH PARAMETER BEING PLOTTED
19*      C      XX      VALUE TO PUT IN PLANET ARRAY
20*      C
21*      DIMENSION PLANET(25)
22*      COMMON K, L, DELT, TIME, TSTOP, NNODES
23*      COMMON P(300,2), F(300,2), C(300,20)
24*      COMMON DUM(100), IDUM(100)
25*      COMMON /ARRAY/ G(300,10), TINIT(300), FLAG, IITER
26*      COMMON /PSST/ NPLTS, IPLT(25), JPLT(25), PLTSEQ, TSTP(5), XAXIS(5),
27*      YAXIS(5), NOPLOT(5), NPLPTS, NTR(25), IWRADR, IRDADR
28*      COMMON/DAMMIT/ IERG(12), ERG(12), DH(12)
29*      COMMON /ALTD / ALT
30*      COMMON /COMEPV/ IWAT(10), XAT(10), DW(10), WATLFT(3)
31*      EQUIVALENCE (NERG, IDUM(16))
32*      DATA CONV/220./
33*      NIX=0
34*      NPLPTS=NPLPTS+1
35*      PLANET(1)=TIME
36*      S CONTINUE
37*      NIX = NIX + 1
38*      MUG=JPLT(NIX)
39*      MUG=IPLT(NIX)
40*      GO TO 110,20,30,40,50,60,70,80,90,100,110,120,130,140,150,160,170,
41*      180,190,200,210,220,230), MUG
42*      C *** FLUID TEMPERATURE (DEGREES R)
43*      10 XX = F(MUG,L) - 460.
44*      GO TO 400
45*      C *** COMPONENT TEMPERATURE (DEGREES R).
46*      20 XX = P(MUG,L) - 460.
47*      GO TO 400
48*      30 CONTINUE
49*      IF (ABS(C(MUG,5)) .LT. .000001) GO TO 35
50*      C *** FLOW RATE (LBS/HR)
51*      XX = C(MUG,3)/C(MUG,5)
52*      GO TO 400
53*      C *** FLOW RATE (GPM)
54*      35 XX = C(MUG,3)/CONV
55*      GO TO 400
56*      C *** HEAT (BTU/HR)
57*      40 XX = C(MUG,4)
58*      GO TO 400
59*      C *** WATER REMAINING (LBS)
60*      50 DO 54 I = 1,10
61*      IF ( MUG .EQ. IWAT(I) ) GO TO 56
62*      54 CONTINUE
63*      56 XX = WATLFT(I)
64*      GO TO 400
65*      C *** CONC. OF H2O (LB/LB DRY GAS)
66*      60 XX = C(MUG,6)
67*      GO TO 400
68*      C *** CONC. OF O2 (LB/LB DRY GAS)
69*      70 XX = C(MUG,7)
70*      GO TO 400

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71*   C *** CONC. OF N2 (LB/LB DRY GAS)
72*       80 XX = C(MUG,8)
73*       GO TO 400
74*   C *** CONC. OF CO2 (LB/LB DRY GAS)
75*       90 XX = C(MUG,9)
76*       GO TO 400
77*   C *** HEATER POWER (BTU/HR)
78*       100 XX = C(MUG,10)
79*       GO TO 400
80*   C *** PARTIAL PRESSURE OF H2O (PSI)
81*       110 XX = C(MUG,11)
82*       GO TO 400
83*   C *** PARTIAL PRESSURE OF O2 (PSI)
84*       120 XX = C(MUG,12)
85*       GO TO 400
86*   C *** PARTIAL PRESSURE OF N2 (PSI)
87*       130 XX = C(MUG,13)
88*       GO TO 400
89*   C *** PARTIAL PRESSURE OF CO2 (MMHG)
90*       140 XX = C(MUG,14) *51.70068
91*       GO TO 400
92*   C *** HEATER ENERGY (BTU)
93*       150 DO 155 I=1,NERG
94*           IF(MUG,EQ,1,ERG(I)) GO TO 156
95*       155 CONTINUE
96*       156 XX = ERG(I) * DH(I)
97*       GO TO 400
98*       160 XX = C(MUG,16)
99*       GO TO 400
100*  C *** ACCUM FUEL (LBS)
101*       170 XX = C(MUG,17)
102*       GO TO 400
103*  C *** ACCUM ENERGY (HP-HR)
104*       180 XX = C(MUG,18)
105*       GO TO 400
106*  C *** FUEL REMAINING (PERCENT USABLE)
107*       190 XX=C(MUG,19)
108*       GO TO 400
109*  C *** AMBIENT PRESSURE (PSIA)
110*       200 XX=G(MUG,2)
111*       GO TO 400
112*  C *** BOILER PRESSURE (PSIA)
113*       210 XX= G(MUG,1)
114*       GO TO 400
115*  C *** MISCELLANEOUS PLOT
116*       220 XX= G(MUG,3)
117*           IF(MUG,EQ,35) XX=ALT
118*       GO TO 400
119*  C *** MISCELLANEOUS PLOT
120*       230 XX=G(MUG,7)
121*       400 CONTINUE
122*       PLANET(NIX+1) = XX
123*       IF(NIX,LT,NNPLTS) GO TO 5
124*       NNPLTS=NNPLTS+1
125*       CALL RWRITE(IWRADR,PLANET,NNPLTS,ISTAT)
126*       450 IF(ISTAT,EQ,1) GO TO 450
127*       IWRADR = IWRADR + NNPLTS
128*       END

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		SUBROUTINE PRINT		
		VARIABLE NAME	DESCRIPTION	UNITS
1*	C			
2*	C			
3*	C			
4*	C			
5*	C	AERROR	ARRAY OF TITLES FOR HEAT BALANCE VALUES	
6*	C	G(1,7)	ARRAY OF HEAT BALANCE VALUES	
7*	C	G(1,J)	I=1,3,J=1,2,3,8,9 - OUTPUT FROM BOILP	
8*	C	IALT	FLAG TO LIMIT PRINTING OF ALT OUTPUT	
9*	C		ALT MISSIONS	
10*	C	ICNT	COUNTER FOR NUMBER OF COMP CYCLES BETWEEN PRINT CYCLES	
11*	C	IP	FLAG TO SIGNAL WHICH ROUTINE WAS CALLED	
12*	C		IP=1=PRINT IP=2=SELECT	
13*	C	IPRNT	NUMBER OF COMP CYCLES PER PRINT CYCLE	
14*	C	ISKP	FLAG TO PREVENT WRITING NODE DATA	
15*	C	IWAT	NODE NUMBER OF BOILER	
16*	C	NAD	ARRAY OF INLET NODES ON EACH SYSTEM	
17*	C	NADE	ARRAY OF OUTLET NODES ON EACH SYSTEM	
18*	C	NMP	NUMBER OF NP FOR WHICH TO PRINT THERMAL DATA	
19*	C			
20*	C	NMP1	FIRST NODE NUMBER USED FOR FUEL USAGE	
21*	C	NMP6	LAST NODE NUMBER USED FOR ENERGY USAGE	
22*	C	NNODES	TOTAL NUMBER OF NODES IN MODEL	
23*	C	NP	TOTAL NUMBER OF NODES IN IPART ARRAY	
24*	C	NUP	COMPUTATION CYCLE COUNTER	
25*	C	NWAT	NUMBER OF BOILERS	
26*	C	TTINIT	START TIME	
27*	C	WAT	AMOUNT OF WATER USED	LBM
28*	C			
29*	C			
30*		COMMON K,L,DELT,TIME,TSTOP,NNODES		
31*		COMMON P(300,2),F(300,2),C(300,20)		
32*		COMMON DUM(100),IDUM(100)		
33*		COMMON /DAMMIT/ IERG(12),ERG(12),DH(12)		
34*		COMMON /TIME/ TMSUM(3),AMSNTM,FUDGE,SUMARY(20,3)		
35*		COMMON /ARRAY/ G(300,10),TINIT(300),FLAG,ITER		
36*		COMMON /PRT/ IPRNT,ICNT,ANAME(300,2),AERROR(8,2)		
37*		COMMON /ACT/ NHYD(3,50),NHOUT(3,50),NACT,FLW(50)		
38*		COMMON /ALT/ BH2O(3),BH2CF(3),IALT		
39*		COMMON /COMVP/ IWAT(10),WAT(10),DW(10),WATLFT(3)		
40*		DIMENSION NAD(37),NADE(37)		
41*		DIMENSION IO(11),IPART(1)		
42*		DIMENSION ICON(5),CON(5),DC(5)		
43*		EQUIVALENCE (IDUM(10),NTURBN)		
44*		EQUIVALENCE (IDUM(16),NERG),(IDUM(17),NUP),(DUM(25),TTINIT)		
45*		EQUIVALENCE (ICON,IDUM(22)),(ICON,IDUM(23)),(DC,DUM(46))		
46*		EQUIVALENCE (CON,DUM(56)),(IDUM(6),NWAT)		
47*		DATA ISKP/0/		
48*		IP=1		
49*		GO TO 199		
50*		ENTRY SELECT(NP,NMP,IPART,IO)		
51*		IP=2		
52*		199 CONTINUE		

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53*      DO 96 I=1,NERG
54*      ERG(I)=ERG(I)+DH(I)
55*      DH(I)=0.
56*      96 CONTINUE
57*      DO 106 I=1,NCON
58*      CON(I)=CON(I)+DC(I)
59*      DC(I)=0.
60*      106 CONTINUE
61*      ICNT=ICNT+1
62*      IF(C(300,20).GT.10.) GO TO 108
63*      IF(ABS(TIME-TSTOP).LE.DELT) GO TO 108
64*      IF(ICNT/IPRNT.LT.1) GO TO 36
65*      108 CONTINUE
66*      C(300,20) = 0.0
67*      ICNT=0
68*      IF(1SKP.EQ.0) GO TO 81
69*      IF(1ALT.NE.1) GO TO 110
70*      WRITE(6,6)(BH2O(I),I=1,3),(BH2OF(I),I=1,3)
71*      6 FORMAT(1H0,16X,15HWATER IN BOILER,24X,17HWATER TRANSFERRED/6X,
72*      *6(F4,1,10X))
73*      110 CONTINUE
74*      WRITE(6,7)((AERROR(IERROR,J),J=1,2),IERROR=1,8)
75*      7 FORMAT(1H0,8(2X,2A6)/)
76*      I=100
77*      WRITE(6,8)(G(I,7),I=1,8)
78*      8 FORMAT(2X,8(1PE10,3,4X)/)
79*      I=102
80*      WRITE(6,13)
81*      13 FORMAT(7X,2HP1,12X,2HP2,11X,3HP12,9X,8HSAT TEMP,6X,8HH2O RATE,7X,
82*      *4HFLAG,10X,5HITTER/)
83*      DO 310 N=1,NTURBN
84*      WRITE(6,9)(G(I,J),J=1,2),(G(I,J),J= 8, 9),G(I,3),FLAG,1TTER
85*      9 FORMAT(2X,8(1PE10,3,4X))
86*      I=1+50
87*      310 CONTINUE
88*      DO 125 I=1,NTURBN
89*      JM= IDUM(10+I)
90*      DO 120 J=1,JM
91*      IF(JM.EQ.0) GO TO 126
92*      NAD(J)=NHYD(I,J)
93*      NADE(J)=NHYOUT(I,J)
94*      120 CONTINUE
95*      WRITE(6,11) I,(NAD(J),J=1,JM)
96*      WRITE(6,12) I,(NADE(J),J=1,JM)
97*      125 CONTINUE
98*      11 FORMAT(1H0,4HIN ,11,37(14))
99*      12 FORMAT(1X,4HOUT ,11,37(14))
100*      126 CONTINUE
101*      IHR = TIME
102*      HMIN=(TIME-IHR)*60.
103*      IMIN =HMIN
104*      SEC =(HMIN-IMIN)*60.
105*      WRITE(6,1) TIME,IHR,IMIN,SEC
106*      1 FORMAT(1H0,7HTIME =,F10,3,10X,13,13,F6,2/25X4HCOMP12X5HFLUID/2X,
107*      *4HNODE19X4HTEMP12X4HTEMP12X1HC13X2HUA12X3HWC13X1HQ/)
108*      GO TO (401,402),IP
109*      401 IEND=14
110*      DO 10 I=1,NNODES

```

@ PRINT NODE NUMBERS ON EACH SYSTEM

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```

111*      WRITE(6,2)I,P(I,L),F(I,L),(C(I,M),M=3,IEND)
112*      2 FORMAT(1X,14,3(2X,F10.5,2X),2X,F7.1,5(2X,1PE11.5),/
113*      *58X,5(2X,1PE11.5))
114*      10 CONTINUE
115*      GO TO 82
116*      402 N=1
117*      DO 83 I=1,NMP
118*      INDEX=IPART(I)
119*      IEND=4
120*      IF(INDEX.NE.10(N)) GO TO 403
121*      IEND=14
122*      N=N+1
123*      403 CONTINUE
124*      P(INDEX,L)=P(INDEX,L)-460.
125*      F(INDEX,L)=F(INDEX,L)-460.
126*      WRITE(6,49)INDEX,(ANAME(INDEX,J),J=1,2),P(INDEX,L),F(INDEX,L),
127*      * (C(INDEX,M),M=1,IEND)
128*      49 FORMAT(1X,14,3H - ,2A5,2X,F10.2,2X,4(2X,F12.2,2X),2X,F8.1,
129*      *5(2X,1PE11.5),/58X,5(2X,1PE11.5))
130*      P(INDEX,L) = P(INDEX,L) + .460.
131*      F(INDEX,L) = F(INDEX,L) + .460.
132*      83 CONTINUE
133*      GO TO 82
134*      81 CONTINUE
135*      ISKP = 1
136*      82 IF(IDUM(8).EQ.1) GO TO 75
137*      IF(INWAT.LE.0) GO TO 75
138*      DO 40 I=1,NWAT
139*      WRITE(6,3) IWAT(I),WAT(I)
140*      3 FORMAT(10X,4HNODE,13,5X,26HACCUMULATED CONSUMABLES = ,1PE11.4)
141*      40 CONTINUE
142*      75 CONTINUE
143*      IF(IDUM(8).EQ.1) GO TO 20
144*      SUM=0.
145*      NMP1 = NMP+1
146*      NMP3 = NMP+3
147*      DO 60 I=NMP1,NMP3
148*      INDEX=IPART(I)
149*      WRITE(6,4) INDEX,C(INDEX,17)
150*      4 FORMAT(10X,4HNODE,13,5X,26HACCUMULATED FUEL (LBM) = ,1PE11.4)
151*      60 CONTINUE
152*      NMP4 = NMP+4
153*      NMP6 = NMP+6
154*      DO 61 I=NMP4,NMP6
155*      INDEX=IPART(I)
156*      WRITE(6,5) INDEX,C(INDEX,18)
157*      5 FORMAT(10X,4HNODE,13,5X,26HACCUM ENERGY (HP-HR) = ,1PE11.4)
158*      61 CONTINUE
159*      IF(NERG.LE.0) GO TO 20
160*      DO 80 I=1,NERG
161*      SUM=SUM+ERG(I)
162*      IF(NERG.EQ.1) GO TO 80
163*      WRITE(6,33) I,ERG(I),ERG(I)
164*      33 FORMAT(10X,4HNODE,13,4X,9HENERGY = ,1PE11.4)
165*      80 CONTINUE
166*      85 WRITE(6,44) SUM
167*      44 FORMAT(13X,15HTOTAL ENERGY = ,1PE11.4)
168*      20 CONTINUE

```

```

169*      IF(IDUM(8).EQ.1) GO TO 36
170*      IF(NCON.LE.0) GO TO 36
171*      DO 55 I=1,NCON
172*      WRITE(6,53) I,CON(I),CON(I)
173*      53 FORMAT(10X,4HNODE,13,5X,21HCONSUB CONSUMABLES = ,1PE11.4)
174*      55 CONTINUE
175*      36 CONTINUE
176*      NUP=NUP+1
177*      X=NUP
178*      TIME = TTINIT + X*DELT
179*      100 CONTINUE
180*      IDUM(100) = ICNT
181*      RETURN
182*      END

```

END OF COMPILATION: NO DIAGNOSTICS.

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```

1* SUBROUTINE PRITAB
2* C
3* C SUBROUTINE PRITAB GATHERS THE SUMMARY TABLE
4* C INFORMATION PREPARED IN OTHER ROUTINES, COMPUTES
5* C THE OTHER NECESSARY VALUES, AND PRINTS OUT THE
6* C CONSUMABLES SUMMARY TABLE
7* C
8* COMMON /TYME/TIMSUM(3),AMSNTM,FUDGE,SUMARY(20,3)
9* DO 938 J=1,3
10* SUMARY(8,J)=SUMARY(5,J)
11* SUMARY(18,J)=SUMARY(8,J)
12* PART1=0.
13* PART2=0.
14* DO 939 I=5,8
15* PART1=PART1+SUMARY(I,J)
16* PART2=PART2+SUMARY(I+10,J)
17* 939 CONTINUE
18* SUMARY(9,J) = PART1 /10.
19* SUMARY(19,J)= PART2 /10.
20* SUMARY(10,J)=SUMARY(4,J) - (PART1 + SUMARY(9,J))
21* SUMARY(20,J)= SUMARY(14,J) - (PART2 + SUMARY(19,J))
22* 938 CONTINUE
23* WRITE(6,1000)((IJK,IJK=1,3),(JKI,JKI=1,3)
24* 1000 FORMAT(11H1,44X,9HFUEL, LBM;22X,10HWATER, LBM//35X,3(2X,7HSYSTEM ,1
25* *1),2X,3(2X,7HSYSTEM ,11)/)
26* WRITE(6,1001)((SUMARY(I,J),J=1,3),(SUMARY(I+10,J),J=1,3),I=1,10)
27* 1001 FORMAT(17H PRESENT LOADING ,17X,3F10.1,2X,3F10.1//10H UNUSABLES//4
28* *X,23HMEASUREMENT ERROR (RSS),6X,3F10.1,2X,3F10.1//4X,9HRESIDUALS,
29* *20X,3F10.1,2X,3F10.1//16H MINIMUM USABLE ,17X,3F10.1,2X,3F10.1//19
30* *H USABLE REQUIREMENTS//3X,22H PRELAUNCH REQUIREMENT,8X,3F10.1,2X,
31* *3F10.1//3X,19H FLIGHT REQUIREMENT,11X,3F10.1,2X,3F10.1//4X,24HPOST
32* * LANDING REQUIREMENT,5X,3F10.1,2X,3F10.1//4X,27H24 HOUR LAUNCH HOL
33* *D RECYCLE/4X,11HREQUIREMENT,18X,3F10.1,2X,3F10.1//4X,17HDISPERSION
34* *S (10%),12X,3F10.1,2X,3F10.1//14H USABLE MARGIN,19X,3F10.1,2X,3F10
35* *1//)
36* RETURN
37* END

```

END OF COMPILATION:

NO DIAGNOSTICS.

LINE	CHARACTER	VARIABLE NAME	DESCRIPTION	UNITS
1*		SUBROUTINE QBAL		
2*	C			
3*	C	VARIABLE NAME	DESCRIPTION	UNITS
4*	C			
5*	C	G(1,7)	I=1,3 HEAT IN	BTU
6*	C		I=4,7 HEAT OUT	BTU
7*	C		I=8 BTU'S ERROR	
8*	C	IBIG	ARRAY OF CONDUCTION/CONVECTION COUPLING	
9*	C		NODES	
10*	C	JBIG	ARRAY OF RADIATION COUPLING NODES	
11*	C	NSTRT	LOCATION OF FIRST NODE IN IBIG OR JBIG	
12*	C		ARRAYS COUPLED TO NODE (N+1)	
13*	C	NTRY	LOCATION OF LAST NODE IN IBIG OR JBIG	
14*	C		ARRAYS COUPLED TO NODE (N+1)	
15*	C	RVAL	ARRAY OF RADIATION COUPLING COEFFICIENTS	
16*	C	TCCUP	TOTAL HEAT OUT VIA COUPLING TO STRUCTURE	BTU/HR
17*	C		FOR ONE SYSTEM FOR ONE COMP CYCLE	
18*	C	TOTCUP	TOTAL HEAT OUT VIA COUPLING TO STRUCTURE	BTU/HR
19*	C		FOR ALL THREE SYSTEMS PLUS LINE AND	
20*	C		COMPONENT LOSSES FOR ONE COMP CYCLE	
21*	C	VAL	ARRAY OF CONDUCTION/CONVECTION COUPLING	
22*	C		COEFFICIENTS	
23*	C			
24*		COMMON K,L,DELT,TIME,TSTOP,NNODES		
25*		COMMON P(300,2),F(300,2),C(300,20)		
26*		COMMON DUM(100),IDUM(100)		
27*		COMMON /ACT/ NHYD(3,50),NHOUT(3,50),NACT,FLW(50)		
28*		COMMON /ARRAY/ G(300,10),TINIT(300),FLAG,ITER		
29*		COMMON /GLOB/ KEEP(300),IBIG(2000),VAL(2000),		
30*		LEEP(300),JBIG(2000),RVAL(2000)		
31*		COMMON /EXTRA/ ICUP(300)		
32*		EQUIVALENCE(NTURBN,IDUM(10))		
33*		G(5,7)=0.		
34*		DO 15 M=1,NACT		
35*	15	G(5,7)=G(5,7) + C(M,1) * (P(M,L)-TINIT(M)) @ OF ACTUATORS -ADD IN LATER		
36*		N=100		
37*		DO 100 I=1,NTURBN		
38*	C			
39*	C	POWER HEAT IN		
40*	C			
41*		G(1,7)= G(1,7)+(C(N+1,4) + C(N+4,4) + C(N+7,4))* DELT		
42*		C(249+I,2)=C(249+I,2) + (C(N+1,4)*DELT) @ APU HEAT PER SYSTEM		
43*	C			
44*	C	TURBINE HEAT IN		
45*	C			
46*		G(2,7) = 0.		
47*	C			
48*	C	TOTAL HEAT IN		
49*	C			
50*		G(3,7)=G(1,7)+G(2,7)		
51*	C			

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52* C HEAT OUT BY H2O
53* C
54* G(4,7)=G(4,7)+G(N+2,4)*DELT*(G(N+2,5)+(P(N+2,L)-TINIT(N+2)))
55* C(252+1,2)=C(252+1,2)+G(N+2,4)*DELT*(G(N+2,5)+(P(N+2,L)-
56* TINIT(N+2))) @ WATER HEAT PER SYSTEM
57* C
58* C HEAT STORED IN CAPACITANCE.
59* C
60* DUMM1=0.
61* DO 25 N1=1,14
62* 25 DUMM1=DUMM1+C(N+N1,1)*(P(N+N1,L)-TINIT(N+N1))
63* DUMM2 = C(N+10,1)*(P(N+10,L)-TINIT(N+10))
64* G(5,7)=G(5,7)+DUMM1-DUMM2
65* C
66* C HEAT OUT VIA CONDUCTANCE TO STRUCTURE
67* C
68* DO 75 N1=1,12
69* NSTRT=KEEP(N+N1)/1000
70* NTRY=KEEP(N+N1)-NSTRT*1000+NSTRT-1
71* SUM=0.
72* IF(NSTRT.EQ.0) GO TO 65
73* DO 50 J=NSTRT,NTRY
74* NOW=JBIG(J)
75* TEMP=P(N+N1,L)-P(NOW,L)
76* 50 SUM=SUM+VAL(J)*TEMP*ICOUPL(J)
77* 65 CONTINUE
78* NSTRT= LEEP(N+N1)/1000
79* NTRY = LEEP(N+N1)-NSTRT*1000 + NSTRT -1
80* SUMR = 0.
81* IF(NSTRT.EQ.0) GO TO 80
82* T4 = P(N+N1,L)*.4
83* DO 85 M= NSTRT,NTRY
84* NOW = JBIG(M)
85* TEMP=T4-P(NOW,L)*.4
86* SUMR = SUMR + RVAL(M) * TEMP * ICOUPL(M)
87* 85 CONTINUE
88* 80 CONTINUE
89* TCCUP = TCCUP + SUM + SUMR
90* C(255+1,2)=C(255+1,2)+C(250+1,4)*60.*DELT @ LINE LOSS
91* C(258+1,2)=C(258+1,2)+(C(256+1,4)*60.+TCCUP)*DELT @ COMPONENT LOSS
92* TOTCUP= TCCUP + (C(1+250,4)+C(1+256,4))*60.
93* TCCUP=0.
94* G(6,7)=G(6,7)+TOTCUP*DELT
95* TOTCUP=0.
96* C
97* C TOTAL HEAT OUT
98* C
99* G(7,7) = G(4,7) + G(5,7) + G(6,7)
100* C
101* C HEAT IN-HEAT OUT
102* C
103* G(8,7)=G(3,7)-G(7,7)
104* N=N+50
105* 100 CONTINUE
106* RETURN
107* END

```

LINE	CHARACTER	VARIABLE NAME	DESCRIPTION	UNITS
1		SUBROUTINE QBAL		
2	C			
3	C	VARIABLE NAME	DESCRIPTION	UNITS
4	C			
5	C	IBIG	ARRAY OF CONDUCTION/CONVECTION COUPLING	
6	C		NODES	
7	C	JBIG	ARRAY OF RADIATION COUPLING NODES	
8	C	G(1,7)	1=1,3 HEAT IN	BTU
9	C		1=4,7 HEAT OUT	BTU
10	C		1=8 BTU'S ERROR	
11	C	NSTRT	LOCATION OF FIRST NODE IN IBIG OR JBIG	
12	C		ARRAYS COUPLED TO NODE (N+1)	
13	C	NTRY	LOCATION OF LAST NODE IN IBIG OR JBIG	
14	C		ARRAYS COUPLED TO NODE (N+1)	
15	C	RVAL	ARRAY OF RADIATION COUPLING COEFFICIENTS	
16	C	TCCUP	TOTAL HEAT OUT VIA COUPLING TO STRUCTURE	BTU/HR
17	C		FOR ONE SYSTEM FOR ONE COMP CYCLE	
18	C	TOTCUP	TOTAL HEAT OUT VIA COUPLING TO STRUCTURE	BTU/HR
19	C		FOR ALL THREE SYSTEMS PLUS LINE AND	
20	C		COMPONENT LOSSES FOR ONE COMP CYCLE	
21	C	VAL	ARRAY OF CONDUCTION/CONVECTION COUPLING	
22	C		COEFFICIENTS	
23	C			
24	C			
25	C	COMMON K,L,DELT,TIME,TSTOP,NNODES		
26	C	COMMON P(300,2),F(300,2),C(300,20)		
27	C	COMMON DUM(100),IDUM(100)		
28	C	COMMON /ARRAY/ G(300,10),TINIT(300),FLAG,ITERR		
29	C	COMMON /GLOB/KEEP(300),IBIG(2000),VAL(2000),		
30	C	LEEP(300),JBIG(2000),RVAL(2000)		
31	C	COMMON /EXTRA/ ICUP(300)		
32	C	COMMON /ACT/ NHYD(3,50),NHOUT(3,50),NACT,FLW(50)		
33	C	EQUIVALENCE (NTURBN,IDUM(10))		
34	C	G(5,7)=0		
35	C	DO 15 M=1,NACT		
36	C	15 G(5,7)=G(5,7) + C(M,1) * (P(M,L)-TINIT(M))	W HEAT STORED IN CAPACITANCE	
37	C	N=100	W OF ACTUATORS -ADD IN LATER	
38	C	DO 100 I=1,NTURBN		
39	C			
40	C	POWER HEAT IN		
41	C			
42	C	G(1,7)= G(1,7)+(C(N+1,4) * C(N+4,4) + C(N+7,4)) * DELT		
43	C	C(249+1,2)=C(249+1,2) + (C(N+1,4)*DELT)	W APU HEAT PER SYSTEM	
44	C			
45	C	TURBINE HEAT IN		
46	C			
47	C	G(2,7) = 0		
48	C			
49	C	TOTAL HEAT IN		
50	C			
51	C	G(3,7)=G(1,7)+G(2,7)		

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52* C HEAT OUT BY H2O
53* C
54* G(4,7)=G(4,7)+G(N+2,4)*DELTA*(G(N+2,5)+(P(N+2,L)-TINIT(N+2)))
55* C(252+1,2)=C(252+1,2)+G(N+2,4)*DELTA*(G(N+2,5)+(P(N+2,L)-
56* TINIT(N+2)))
57* C
58* C HEAT STORED IN CAPACITANCE.
59* C
60* DUMM1=0.
61* DO 25 N1=1,14
62* 25 DUMM1=DUMM1+C(N+N1,1)*(P(N+N1,L)-TINIT(N+N1))
63* DUMM2 = C(N+10,1)*(P(N+10,L)-TINIT(N+10))
64* G(5,7)=G(5,7)+DUMM1-DUMM2

65* C
66* C HEAT OUT VIA CONDUCTANCE TO STRUCTURE
67* C
68* DO 75 N1=1,12
69* NSTRT=KEEP(N+N1)/1000
70* NTRY=KEEP(N+N1)-NSTRT*1000+NSTRT-1
71* SUM=0.
72* IF(NSTRT.EQ.0) GO TO 65
73* DO 50 J=NSTRT,NTRY
74* NOW=JBIG(J)
75* TEMP=P(N+N1,L)-P(NOW,L)
76* SUM=SUM+VAL(J)*TEMP*ICOUPL(J)
77* 65 CONTINUE
78* NSTRT=KEEP(N+N1)/1000
79* NTRY=KEEP(N+N1)-NSTRT*1000+NSTRT-1
80* SUMR=0.
81* IF(NSTRT.EQ.0) GO TO 80
82* T4=P(N+N1,L)**4
83* DO 85 M=NSTRT,NTRY
84* NOW=JBIG(M)
85* TEMP=T4-P(NOW,L)**4
86* SUMR=SUMR+RVAL(M)*TEMP*ICOUPL(M)
87* 85 CONTINUE
88* 80 CONTINUE
89* 75 TCCUP=TCCUP+SUM+SUMR
90* TOTCUP=TCCUP
91* TCCUP=0.
92* G(6,7)=G(6,7)+TOTCUP*DELTA
93* TOTCUP=0.
94* C
95* C TOTAL HEAT OUT
96* C
97* G(7,7)=G(4,7)+G(5,7)+G(6,7)
98* C
99* C HEAT IN=HEAT OUT
100* C
101* G(8,7)=G(3,7)-G(7,7)
102* N=N+50
103* 100 CONTINUE
104* RETURN
105* END

```

SUBROUTINE RSTAR(IICHECK)

VARIABLE NAME

DESCRIPTION

UNITS

VARIABLE NAME	DESCRIPTION	UNITS
I	NODE NUMBER AT WHICH TO START DO-LOOP FOR EACH SYSTEM	
IICHECK	FLAG SHOWING THAT RSTAR HAS BEEN CALLED	
III	NODE NUMBER AT WHICH TO STOP DO-LOOP FOR EACH SYSTEM	
IRST	FLAG FOR TYPE OF REINITIALIZATION 1=DEFINE NEW VALUE -2=READ IN NEW VALUE	

```

COMMON K,L,DELT,TIME,TSTOP,NNODES
COMMON P(300,2),F(300,2),C(300,20)
COMMON DUM(100),IDUM(100)
COMMON /TIME/TIMSUM(3),AMSNM,FUDGE,SUMARY(20,3)
COMMON /ARRAY/ G(300,10),TINIT(300),FLAG,ITEX
EQUIVALENCE (IDUM(10),NTURBN)

```

```

EQUIVALENCE(IDUM(14),IRST)
GO TO(2,402),IRST

```

REINITIALIZE ACTUATOR TEMPERATURES

```

2 CONTINUE
DO 102 M=1,50
P(M,K)=560.
P(M,L)=560.
TINIT(M)=560.

```

102 CONTINUE

REINITIALIZE THERMAL NODE TEMPERATURES

```

I=100
III=120
DO 302 N=1,NTURBN
DO 202 M=1,III
P(M,K)=560.
P(M,L)=560.
TINIT(M)=560.

```

202 CONTINUE

```

I=I+50
III=I+20

```

302 CONTINUE

```

IICHECK=1
RETURN

```

READ NEW INITIALIZATION TEMPS

```

402 DO 602 I=1,NNODES
READ(5,502)NODE,P(NODE,1),F(NODE,1)
502 FORMAT(15,5X,2F10.0)
P(NODE,1)=P(NODE,1)+460.
F(NODE,1)=F(NODE,1)+460.
P(NODE,2)=P(NODE,1)
F(NODE,2)=F(NODE,1)

```

602 CONTINUE

```

IICHECK = 1
RETURN
END

```

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SUBROUTINE SPRAY(M1,M2,M11,M22)

VARIABLE NAME

DESCRIPTION

UNITS

VARIABLE NAME	DESCRIPTION	UNITS
BTUH	HEAT TO BOIL OFF TO BRING HYDRAULIC FLUID TO CONTROL TEMP	
BTUL	HEAT TO BOIL OFF TO BRING LUBE OIL TO CONTROL TEMP	
DELW	AMOUNT OF WATER USED THIS COMP CYCLE FOR CURRENT SYSTEM	
TCH	CONTROL TEMPERATURE FOR HYDRAULIC FLUID	
TCL	CONTROL TEMPERATURE FOR	

M1 = LUBE OIL INLET NODE
M2 = HYDRAULIC FLUID INLET NODE
TCL = LUBE OIL CONTROL TEMPERATURE
TCH = HYDRAULIC FLUID CONTROL TEMPERATURE

DIMENSION COEF(4)

COMMON K,L,DELT,TIME,TSTOP,NNODES

COMMON P(300,2),F(300,2),C(300,20)

COMMON DUM(100),IDUM(100)

COMMON /COMEVP/ IWAT(10),WAT(10),DW(10)

DATA TCH/680./TCL/705./

DATA COEF/ 1.4952841 E-03, -1.3875411E-06,
1.5867400 E-03, -1.0192200E-06 /

H = COEF(1)

DO 10 I=2,4

10 H = H + COEF(I) * P(M1,K)**(I-1)

DELW = 0

DIFFL = F(M1,K) - TCL

IF(DIFFL.LE.0) GO TO 20

BTUL = DIFFL * C(M1,3)

DELW = BTUL*DELT/H

20 DIFFH = F(M2,K) - TCH

IF(DIFFH.LE.0) GO TO 40

BTUH = DIFFH * C(M2,3)

DELW = DELW + (BTUH*DELT/H)

DO 30 I=1,3

IF(M1.NE.IWAT(I)) GO TO 30

GO TO 40

30 CONTINUE

40 DW(I) = DELW

WAT(I) = WAT(I) + DW(I)

C(M11,3)=C(M1,3)

C(M22,3)=C(M2,3)

IF(DIFFL.LE.0) GO TO 50

F(M11,L) = TCL

GO TO 60

50 F(M11,L) = F(M1,L)

60 CONTINUE

IF(DIFFH.LE.0) GO TO 70

F(M22,L) = TCH

GO TO 80

70 F(M22,L) = F(M2,L)

80 CONTINUE

RETURN

END

END OF COMPILATION:

NO DIAGNOSTICS.

SUBROUTINE START

VARIABLE NAME

DESCRIPTION

UNITS

PART
1 of 5

VARIABLE NAME	DESCRIPTION	UNITS
AERROR	ARRAY OF TITLES FOR ERROR CALCULATIONS	
AMSNM	LENGTH OF MISSION	HR
BIG	MAX VALUE DESIRED ON PLOT	
DX	DELTA VALUE OF PARAMETER PER INCH	
FUDGE	TIME FUDGE FOR LONG MISSIONS	
IBIG	ARRAY OF CONDUCTION/CONVECTION COUPLING NODES	
IDUM(8)	FLAG USED TO RESTRICT PRINTING DONE IN FIRST CALL TO PRINT	
IFLAG	SYSTEM CONFIGURATION CODE	
IPDO	SYSTEM CONFIGURATION MATRIX	
IPLT	NODE NUMBER FOR PLOT DESIRED	
IRADR	INITIAL DRUM ADDRESS FOR READING	
IWORK	PAIR OF NODES COUPLED (READ IN)	
IWRADR	INITIAL DRUM ADDRESS FOR WRITING	
JBIG	ARRAY OF RADIATION COUPLING NODES	
JPLT	TYPE OF PLOT DESIRED FOR IPLT	
LMMTRX	LOSS MANAGEMENT MATRIX	
NSC	NUMBER OF NODE COUPLING CARDS	
NTR	NUMBER OF TRACES ON THIS PLOT	
RVAL	ARRAY OF RADIATION COUPLING COEFFICIENTS	
TIMSUM	TIMES FOR DIVISION OF ACCUMULATED CONSUMABLES VALUES PER PHASE IN SUMMARY TABLE	HR
VAL	ARRAY OF CONDUCTION/CONVECTION COUPLING COEFFICIENTS	
WEE	MIN VALUE DESIRED ON PLOT	
WORDS	ARRAY OF ALPHA CHARACTERS USED FOR GREETING	
WORK	COUPLING COEFFICIENTS FOR NODES IN IWORK	
XI	LENGTH OF AXIS	
XE	ERROR VALUE (USED INTERNALLY)	
XO	STARTING VALUE OF PARAMETER ON PLOT	
XAXIS	LENGTH OF XAXIS	IN
XMAX	MAX VALUE OF PARAMETER	
XMIN	MIN VALUE OF PARAMETER	
YAXIS	LENGTH OF YAXIS	IN

```

INTEGER PLTSEQ
DIMENSION IWORK(100,2),WORK(100,2),ICOUPL(100)
DIMENSION WORDS(7,9),IZERO(7406)
COMMON K, L, DELT, TIME, TSTOP, NNODES
COMMON P(300,2), F(300,2), C(300,20)
COMMON DUM(100), IDUM(100)
COMMON /EXTRA/ ICOUN(300)
COMMON /HYD/ IPDO(27,3), LMMTRX(50,4), POWER(3), ISPD(3), IFLAG, TFLW(3)
COMMON /ACT/ NHYD(3,50), NHYOUT(3,50), NACT, FLW(50)
COMMON /TIME/ TIMSUM(3), AMSNM, FUDGE, SUMMARY(20,3)
COMMON /PRT/ IPRNT, CNT, ANAME(300,2), AERROR(8,2)
COMMON /GLOB/ KEEP(300), IBIG(2000), VAL(2000),
LEEP(300), JBIG(2000), RVAL(2000)
COMMON /LUMP2/ TITLE(12), BIG(25), WEE(25)
COMMON /PSST/ NPLTS, IPLT(25), JPLT(25), PLTSEQ, TSTP(5), XAXIS(5),
YAXIS(5), NOPLT(5), NPLPTS, NTR(25), IWRADR, IRADR
EQUIVALENCE (DELT02, DUM(1))
EQUIVALENCE (IDUM(35), IPFREQ)

```

K - PREVIOUS VALUE
 L - PRESENT VALUE
 NNODES - NO. OF NODES
 TIME - START TIME INITIALLY, CURRENT TIME THEREAFTER


```

67*      TSTOP - STOP TIME
68*      DELT - TIME STEP
69*      PRNT - PRINT AT THIS INCREMENT
70*      P(1,J) - PLATE TEMPERATURE      I=NODE      J=PREVIOUS OR PRESENT
71*      F - FLUID TEMPERATURE
72*      C(1,1) - C
73*      C(1,2) - UA
74*      C(1,3) - MCP
75*      C(1,4) - Q
76*      EQUIVALENCE (IZERO,K)
77*      DATA WORDS/378HHIP BOQUICK DIGITAECS DOKIT ECTOM SWECS PRCKET EDRA
78*      *W EL ECS IT YOS PROGIFT ANOGRAM CS PROCS PROPROGRAUKSELFAM PRO M
79*      *IS TO ENOGRAM PGRAM PM SLID PROGRESNTECS PR ALL ERLESENTE K
80*      *ULEAN PRE UGRAM CS PROS S SIMULSENTE PRESENTE K
81*      *MS ATOR P TS PRESEN RESENT
82*      *
83*      DO 24 I=1,7406
84*      24 IZERO(I)=0
85*      CALL CLOCK(CLOCK)
86*      LOCK=CLOCK*1000.
87*      LOCK=MOD(LOCK,7)*1
88*      READ(5,1) TITLE
89*      1 FORMAT(12A6)
90*      WRITE(6,2) (WORDS(LOCK,I),I=1,9),CLICK,TITLE
91*      READ(5,3) NNODES,DELT,TIME,TSTOP,PRNT,NPLTS,NSC,MOREV,IDUM(19)
92*      3 FORMAT(15,5X,4F10.0,4I5)
93*      READ(5,19) PLTSEQ,TSTP(1),XAXIS(1),YAXIS(1),NOPLOT(1)
94*      19 FORMAT(15,5X,3F10.0,110)
95*      DUM(25)=TIME
96*      READ(5,20) (TIMSUM(I),I=1,3),AMSNM,FUDGE
97*      20 FORMAT(5F10.3)
98*      IDUM(20) = NPLTS
99*      IF(NSC.LT.1) GO TO 707
100*      NCON=0
101*      NRAD=0
102*      MAX=-1
103*      DO 300 I=1,NSC
104*      READ(5,26) (IWORK(I,J),J=1,2),(WORK(I,J),J=1,2),ICOUPL(1)
105*      26 FORMAT(215,F10.0,10X,F10.0,110)
106*      NJ=IWORK(I,1)
107*      NK=IWORK(I,2)
108*      IF(ABS(WORK(I,1)).LT.1.E-25) GO TO 310
109*      KEEP(NJ)=KEEP(NJ)+1
110*      KEEP(NK)=KEEP(NK)+1
111*      NCON=NCON+1
112*      310 IF(ABS(WORK(I,2)).LT.1.E-25) GO TO 300
113*      LEEP(NJ)=LEEP(NJ)+1
114*      LEEP(NK)=LEEP(NK)+1
115*      NRAD=NRAD+1
116*      300 MAX=MAX0(MAX,NJ,NK)
117*      JJ=1
118*      LL=1
119*      DO 360 I=1,MAX
120*      IF(KEEP(I).EQ.0) GO TO 370
121*      MESS=KEEP(I)
122*      KEEP(I)=KEEP(I)+JJ*1000
123*      MM=0
124*      DO 350 J=1,NSC

```

```

125* IF (ABS(WORK(J,1)).LT.1.E-25) GO TO 350
126* DO 340 M=1,2
127* IF (1.E.1WORK(J,M)) GO TO 340
128* NN=MOD(M,2)+1
129* IBIG(JJ)=WORK(J,NN)
130* VAL(JJ)=WORK(J,1)
131* ICOUPL(JJ)=ICOUPL(J)
132* JJ=JJ+1
133* MM=MM+1
134* IF (MM.EQ.MESS) GO TO 370
135* CONTINUE
136* CONTINUE
137* IF (LEEP(1).EQ.0) GO TO 360
138* MESS=LEEP(1)
139* LEEP(1)=LEEP(1)+LL*1000
140* MM=0
141* DO 380 J=1,NSC
142* IF (ABS(WORK(J,2)).LT.1.E-25) GO TO 380
143* DO 390 M=1,2
144* IF (1.E.1WORK(J,M)) GO TO 390
145* NN=MOD(M,2)+1
146* JBIG(LL)=WORK(J,NN)
147* RVAL(LL)=WORK(J,2)
148* LL=LL+1
149* MM=MM+1
150* IF (MM.EQ.MESS) GO TO 360
151* CONTINUE
152* CONTINUE
153* CONTINUE
154* IF (INCON.EQ.0) GO TO 627
155* WRITE(6,727)
156* 727 FORMAT(1H0,15X,18HCOND/CONV COUPLING / 15X,19HNODE HOOKED TO NODE
157* / 1)
158* DO 600 I=1,MAX
159* IF (KEEP(1).EQ.0) GO TO 600
160* NSTRT=KEEP(1)/1000
161* NTRY=KEEP(1)-NSTRT*1000-1
162* WRITE(6,602) 1,IBIG(NSTRT),VAL(NSTRT)
163* 602 FORMAT(15X,15,5X,15,5X,1P2E15.6)
164* IF (NTRY.EQ.0) GO TO 600
165* DO 610 J=1,NTRY
166* M=NSTRT+J
167* WRITE(6,603) IBIG(M),VAL(M)
168* 603 FORMAT(25X,15,5X,1P2E15.6)
169* CONTINUE
170* 627 IF (INRAD.EQ.0) GO TO 629
171* WRITE(6,729)
172* 729 FORMAT(1H0,15X,12HHRAD COUPLING / 15X,19HNODE HOOKED TO NODE / 1)
173* DO 620 I=1,MAX
174* IF (LEEP(1).EQ.0) GO TO 620
175* NSTRT=LEEP(1)/1000
176* NTRY=LEEP(1)-NSTRT*1000-1
177* WRITE(6,602) 1,JBIG(NSTRT),RVAL(NSTRT)
178* IF (NTRY.EQ.0) GO TO 620
179* DO 615 J=1,NTRY
180* M=NSTRT+J
181* 615 WRITE(6,603) JBIG(M),RVAL(M)
182* 620 CONTINUE

```



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183* 629 CONTINUE
184* 707 DO 126 I=1,100
185* DO 125 J=1,2
186* 125 IWORK(I,J)=0
187* DO 126 J=1,2
188* 126 WORK(I,J)=0.
189* WRITE(6,122) NNODES,DELT,TIME,TSTOP,FRNT
190* 122 FORMAT(1H0,4X,14,13H NODE PROBLEM / 5X,10HDELTA T = ,F10.4,4H HRS
191* * / 5X, 9HSTART AT ,F10.4, 4H HRS / 5X, 8HSTOP AT ,F10.4,4H HRS/
192* * 5X, 9HPRINT AT ,F10.4, 4H HRS/)
193* WRITE(6,22)
194* 2 FORMAT(1H1,9A6,8X,6H(AT T=,F10.3,1H) / 3H *12A6,2H**/ )
195* 22 FORMAT(63X,9HCOMPONENT,5X,13HINITIAL FLUID / 7X,4HNODE,17X,1HC,
196* * 14X,2HUA,11X,3HWCP,14X,1HQ, 7X,12HINITIAL TEMP,5X,10HINLET TEMP/)
197* DELT02=DELT/2.
198* DO 100 I=1,NNODES
199* READ(5,10) NODE,MORE,(C(NODE,J),J=1,4),P(NODE,1), F(NODE,1),
200* * (ANAME(NODE,J),J=1,2)
201* 10 FORMAT (15,12,3X,6F10.0,2A5)
202* WRITE(6,4) NODE,(ANAME(NODE,J),J=1,2),(C(NODE,J),J=1,4),P(NODE,1),
203* * F(NODE,1)
204* 4 FORMAT(12X,14,3H - ,2A5,6F15.3)
205* P(NODE,1) = P(NODE,1) + 460.
206* F(NODE,1) = F(NODE,1) + 460.
207* P(NODE,2)=P(NODE,1)
208* F(NODE,2) = F(NODE,1)
209* IF(MORE.LT.1) GO TO 100
210* READ(5,5) (C(NODE,J),J=5,9)
211* 5 FORMAT(10X,5F10.0)
212* WRITE(6,6) (C(NODE,J),J=5,9)
213* 6 FORMAT(9X,1P5E15.5)
214* IF(MORE.LT.2) GO TO 100
215* READ(5,5) (C(NODE,J),J=10,14)
216* WRITE(6,6) (C(NODE,J),J=10,14)
217* 100 CONTINUE
218* IF(NPLTS.LT.1) GO TO 102
219* IPFREQ=(TSTOP-TIME)/DELT
220* IPFREQ=IPFREQ/990
221* IF(IPFREQ.LT.1) IPFREQ=1
222* READ(5,7)(IPLT(I),JPLT(I),BIG(I),WEE(I),NTR(I),I=1,NPLTS)
223* 7 FORMAT(215,2F10.0,15)
224* WRITE(6,8)(IPLT(I),JPLT(I),BIG(I),WEE(I),NTR(I),I=1,NPLTS)
225* 8 FORMAT(1H0,15X,9HPLOT INFO / (5X,215,2F11.4,15) )
226* CALL RINIT(INIADR,NWDS)
227* IRADR= INIADR
228* IWRADR= INIADR
229* 102 CONTINUE
230* DO 400 IERROR=1,8
231* READ(5,11)(AERROR(IERROR,J),J=1,2)
232* 11 FORMAT(2A6)
233* 400 CONTINUE
234* DO 410 IFLAG=1,27
235* READ(5,12)(IPDO(IFLAG,I),I=1,3)
236* WRITE(6,12)(IPDO(IFLAG,I),I=1,3)
237* 12 FORMAT(315)
238* 410 CONTINUE
239* DO 420 NSYSUP=1,NACT
240* READ(5,13)(LMNTRX(NSYSUP,I),I=1,4)

```

```

241*      WRITE(6,13)(LMMTRX(NSYSUP,I),I=1,4)
242*      13 FORMAT(4I5)
243*      420 CONTINUE
244*      READ(5,14)((SUMARY(1,J),J=1,3),I=1,3)
245*      READ(5,15)((SUMARY(11,J),J=1,3),(SUMARY(13,J),J=1,3)
246*      14 FORMAT(3F10.1,6F5.1)
247*      15 FORMAT(6F10.1)
248*      DO 430 J=1,3
249*      SUMARY(4,J)=SUMARY(1,J)-(SUMARY(2,J)+ SUMARY(3,J))
250*      SUMARY(14,J)= SUMARY(11,J)-SUMARY(13,J)
251*      430 CONTINUE
252*      107 WRITE(6,2)(WORDS(LOCK,I),I=1,9),CLICK,TITLE
253*      K=2
254*      L=1
255*      IPRNT=(PRNT+.0000001)/DELT
256*      IF(IPRNT.LE.0) IPRNT=2
257*      ICNT=IPRNT-1
258*      TSTOP=TSTOP+DELT/TSTOP
259*      IDUM(8)=1
260*      DUM(16) = 18.015 @ LB/LB-MOLE OF H2O
261*      DUM(17) = 28.013 @ LB/LB-MOLE OF N2
262*      DUM(18) = 31.999 @ LB/LB-MOLE OF O2
263*      DUM(19) = 44.009 @ LB/LB-MOLE OF CO2
264*      DUM(21) = .4454 @ BTU/LB H2O/DEG R AT 77 DEG F
265*      DUM(22) = .2485 @ BTU/LB N2 /DEG R AT 77 DEG F
266*      DUM(23) = .2193 @ BTU/LB O2 /DEG R AT 77 DEG F
267*      DUM(24) = .2017 @ BTU/LB CO2/DEG R AT 77 DEG F
268*      CALL PRINT
269*      IDUM(8)=2
270*      RETURN
271*      END

```

END OF COMPILATION: NO DIAGNOSTICS.

ORIGINAL PAGE IS
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SUBROUTINE THERMP(IS, NI, PAM

ERMP

1 of 3

		VARIABLE NAME	DESCRIPTION	UNITS
1*				
2*	C			
3*	C			
4*	C			
5*	C	AREA	AREA OF LINE SEGMENT	
6*	C	FLACUM	ACCUMULATOR OF FLOWRATE IN LINE FROM EACH ACTUATOR SERVICING IT	
7*	C			
8*	C	IBIG	NUMBER OF 16THS IN. IN DIAMETER	
9*	C	ID	LINE INDEX OF LINE BEING SOLVED	
10*	C	ILTH	LENGTH OF LINE SEGMENT	IN
11*	C	INN	NUMBER OF LINE SEGMENTS IN LINE(ID)	
12*	C	INTG3	SECOND DIGIT OF LINE NUMBER, TELLS WHETHER LINE IS PRESSURE OR RETURN AND ON WHICH SYSTEM	
13*	C			
14*	C			
15*	C	JK	TOTAL NUMBER OF ACTUATORS SERVICING SYSTEM 1	
16*	C			
17*	C	KNODE	BOUNDARY NODE NUMBER	
18*	C	LDGF	FLAG TO DISTINGUISH BETWEEN FORWARD AND REVERSE FLOW IN SYSTEM 1 LANDING GEAR CIRCUIT	
19*	C			
20*	C			
21*	C	LTHEND	LENGTH OF LINE SEGMENT REMAINING AFTER EVEN DIVISION INTO STANDARD LENGTH SEGMENT	IN
22*	C			
23*	C	NAL	NUMBER OF LINES SERVICING ACTUATOR NN	
24*	C	NN	ACTUATOR NUMBER SERVICING SYSTEM 1	
25*	C	QDOTL	HEAT LOSS RATE IN LINE ID	BTU/HR
26*	C	TBEFF	EFFECTIVE BOUNDARY TEMPERATURE	DEG R
27*	C	TU	LINE OUTLET TEMPERATURE	DEG R
28*	C	UA	COMBINED HEAT TRANSFER COEFFICIENT	BTU/MIN-R
29*	C			
30*	C			
31*	C			
32*		THIS S/R COMPUTES THE INLET AND OUTLET TEMP OF SYSTEM(IS) PRESSURE LINES		
33*		COMMON K, L, DELT, TIME, TSTOP, NNODES		
34*		COMMON P(300,2), F(300,2), C(300,20)		
35*		COMMON DUM(100), IDUM(100)		
36*		COMMON /LINES/ LINUM(260), KNODE(260), LTH(260), IBIG(260), FLWL(260),		
37*	1	TEMPIN(260), TEMPOT(260), LDGF(260), SPACE(20,2),		
38*	2	NODLIN(50,76), NLCNT(50), QDOTL(260), SHAPE, EMISS,		
39*	3	TEMPB(11,2), FLACUM(260), FLOWT(260)		
40*		COMMON /ACT/ NHYD(3,50), NHYOUT(3,50), NACT, FLW(50)		
41*		COMMON /PRT/ IPRNT, ICNT, ANAME(300,2), AERROR(8,2)		
42*		DATA ILTH/ID/		
43*		DUM(4)=530. W TEMPORARY		
44*		KEY1= 2*IS-1		
45*		KEY2 = 0		
46*		YP = 1.42*ALOG10(PAMB) -1.45759		
47*		JK= IDUM(10+IS)		
48*		DO 1 ND=1, JK		
49*		NN= NHYD(IS, ND)		
50*		IF(FLW(NN).LT.1.E-4) GO TO 1		
51*		NAL= NLCNT(NN)		
52*		DO 2 LL=1, NAL		
53*		ID= NODLIN(NN, LL)		
54*		LINE = LINUM(ID)		
55*		INTG1 = LINE/100		
56*		INTG2 = LINE/1000		
57*		INTG2 = 10*INTG2		
58*		INTG3 = INTG1-INTG2		
59*		IF(LDGF(ID).GT.0) INTG3 = 2		
60*		IF(INTG3.NE.KEY1) GO TO 2		
61*		IF(TEMPOT(ID).GT.390.)GO TO 3		
62*		IF(KEY2.EQ.0) TEMPIN(ID)= F(NI+6, L)		
		IF(KEY2.NE.0) TEMPIN(ID) = TEMPOT(LASTID)		

```

63* C COMPUTE CONDUCTION UA/INCH
64* K1 = 1816(ID)
65* K2 = KNODE(ID)
66* C ASSUME .01 BTU/HR-DEGF/SUPPORT. SPACE = SUPPORT DENSITY PER IL SSP/Y+A-74-16
67* UACOND=.01*ILTH/SPACE(K1,1)
68* AREA=.19634953*ILTH*K1
69* WCP = 220. * FLOWL(ID)
70* INN=LTH(ID)/ILTH
71* LTHEND = LTH(ID) -ILTH*INN
72* IF(LTHEND.GT.0) INN = INN + 1
73* IF(INN.LT.1) INN=1
74* DO 4 IN=1,INN
75* IF(IN.NE.INN) GO TO 29
76* IF(LTHEND.EQ.0) GO TO 29
77* AREA = AREA*LTHEND/ILTH
78* UACOND = UACOND*LTHEND/ILTH
79* 29 CONTINUE
80* IF(IN.EQ.1) T1 = TEMPIN(ID)
81* IF(IN.EQ.1) TC = T1
82* IF(IN.NE.1) TC =(TO-T1)/2. + TO
83* IF(IN.NE.1) T1 =TO
84* C CALCULATE RADIATION UA/IN -BOLTZMAN =1.1897E-11(BTU/HR/IN**2/DEGR**4)
85* C LINEARIZE TEMPERATURE TO CENTER POINT FORWARD DIFFERENCE PREDICTION
86* T1= TC
87* T2= P(K2,L)
88* TEMPZ =T1**3 +T1**2*T2 +T1*T2**2 + T2**3
89* UARAD =SHAPE*AREA*TEMPZ*1.1897E-11*EMISS
90* C CALCULATE CONVECTION UA/INCH .. FILM COEFFICIENTS BASED ON TABLE 10-5, PERRY'S
91* C CHEMICAL ENGINEERING HANDBOOK, FOURTH EDITION. BASE FACTOR FOR AIR IS
92* C LINEARLY INTERPOLATED BETWEEN 0 AND 200 F. NOMOGRAPH MAPPING FUNCTIONS ARE
93* C WITHIN EYEBALL RESOLUTION FOR DT/DO FROM 10 TO 400 AND FOR PRESS FROM 14.7 TO
94* C 34.7 PSIA.
95* TFILM=(TC+F(K2,L))/2.
96* RATIO=(TC-F(K2,L))/K1*16.
97* IF(RATIO.LE.1.E-5) RATIO = 1.E-5
98* YUTDO =.9686*ALOG10(RATIO) + 3.22/(22.04+RATIO) -.6493
99* FLOG = .2227*YUTDO + .3655*YP -.11765
100* CFACT= 10.**FLOG
101* BASE=.89-(TFILM-460.)* 1.E-4
102* FILMH = CFACT*BASE
103* UA CONV= FILMH*AREA/144.
104* UA= UA COND +UARAD + UA CONV
105* TBEFF=(UA COND+UARAD)*P(K2,L) +UA CONV*F(K2,L))/UA
106* TO=(T1-TBEFF)*EXP(-UA/WCP)+TBEFF
107* IF(IN.EQ.INN)TEMPOT(ID) =TO
108* QDOTL(ID)=QDOTL(ID)+UA/60.*(T1+TO)/2.-TBEFF)
109* 4 CONTINUE
110* C(IIS+250,4)=C(IIS+250,4)+QDOTL(ID)
111* IF(IICNT+1.NE.IPRNT) GO TO 300
112* TEMPIN(ID)= TEMPIN(ID)-460.
113* TEMPOT(ID)= TEMPOT(ID)-460.
114* TBEFF= TBEFF -460.
115* IF(IICNT+1.EQ.IPRNT) WRITE(6,199)NN,LINE,KNODE(ID),LTH(ID),
116* TEMPIN(ID),TEMPOT(ID),TBEFF, QDOTL(ID),FLOWL(ID),NLCNT(NN)
117* 199 FORMAT(2X,I3,1X,I7,5X,I5,2X,I5,5F10.3,15)
118* TEMPIN(ID)= TEMPIN(ID)+460.
119* TEMPOT(ID)= TEMPOT(ID)+460.
120* TBEFF= TBEFF +460.

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ORIGINAL PAGE 13
OF POOR QUALITY


```
121*      300 CONTINUE
122*      3 CONTINUE
123*      LASTID = 10
124*      KEY2 = 10
125*      2 CONTINUE
126*      C CALCULATE ACTUATOR INLET AND OUTLET EQUILIBRIUM TEMPERATURES CONSIDERING TOTAL
127*      C PRESSURE DROP AT ACTUATOR - NO ACTUATOR HEAT LOSS OR INERTIA.
128*      F(INN,L) = TEMPOT(LASTID)
129*      1 CONTINUE
130*      RETURN
131*      END
```

END OF COMPILATION: NO DIAGNOSTICS.

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OF POOR QUALITY

SUBROUTINE THERMR(1S,NI,PAMB)

LINE	CHARACTER	VARIABLE NAME	DESCRIPTION	UNITS
1*				
2*	C			
3*	C			
4*	C			
5*	C	AREA	AREA OF LINE SEGMENT	
6*	C	FLACUM	ACCUMULATOR OF FLOWRATE IN LINE FROM EACH ACTUATOR SERVICING IT	
7*	C			
8*	C	IBIG	NUMBER OF 16THS IN. IN DIAMETER	
9*	C	ID	LINE INDEX OF LINE BEING SOLVED	
10*	C	ILTH	LENGTH OF LINE SEGMENT	IN
11*	C	INN	NUMBER OF LINE SEGMENTS IN LINE(ID)	
12*	C	INTG3	SECOND DIGIT OF LINE NUMBER, TELLS WHETHER LINE IS PRESSURE OR RETURN AND ON WHICH SYSTEM	
13*	C			
14*	C	JK	TOTAL NUMBER OF ACTUATORS SERVICING SYSTEM 1	
15*	C			
16*	C	KNODE	BOUNDARY NODE NUMBER	
17*	C	LDGF	FLAG TO DISTINGUISH BETWEEN FORWARD AND REVERSE FLOW IN SYSTEM 1 LANDING GEAR CIRCUIT	
18*	C			
19*	C			
20*	C			
21*	C	LTHEND	LENGTH OF LINE SEGMENT REMAINING AFTER EVEN DIVISION INTO STANDARD LENGTH SEGMENT	IN
22*	C			
23*	C			
24*	C	NAL	NUMBER OF LINES SERVICING ACTUATOR NN	
25*	C	NN	ACTUATOR NUMBER SERVICING SYSTEM 1	
26*	C	QDOTL	HEAT LOSS RATE IN LINE ID	BTU/HR
27*	C	TBEFF	EFFECTIVE BOUNDARY TEMPERATURE	DEG R
28*	C	TO	LINE OUTLET TEMPERATURE	DEG R
29*	C	UA	COMBINED HEAT TRANSFER COEFFICIENT	BTU/MIN-R

THIS S/R COMPUTES THE INLET AND OUTLET TEMP OF SYSTEM(1S) RETURN LINES STARTING AT THE ACTUATOR OUTLETS AND GOING TO THE WATER BOILER

COMMON K,L,DELT,TIME,TSTOP,NNODES

COMMON P(300,2),F(300,2),C(300,20)

COMMON DUM(100),IDUM(100)

COMMON/LINES/ LINUM(260),KNODE(260),LTH(260),IBIG(260),FLUWL(260),

TEMPIN(260),TEMPOT(260),LDGF(260),SPACE(20,2),

NODLIN(50,76),NLCNT(50),QDOTL(260),SHAPE,EMISS,

TEMPB(11,2),FLACUM(260),FLOWT(260)

COMMON /ACT/ NHYD(3,50),NHYYOUT(3,50),NACT,FLW(50)

COMMON /PRT/ IPRNT,ICNT,ANAME(300,2),AERROR(3,2)

COMMON /PRESR/ SPH(3),DENS(3),PDRP(3)

COMMON /HYD/ IPDO(27,3),LMMTRX(50,4),POWER(3),ISPD(3),ILLAG

DATA ILTH/10/

CAPHR=0.

YP= 1.42*ALOG10(PAMB) - 1.45759

KEY1 = 2*IS

JK= IDUM(10+IS)

DO 1 ND=1,JK

KEY2=0

KEY3 =0

NN= NHYD(1S,ND)

IF(FLW(NN).LT.1.E-4) GO TO 1

NAL =NLCNT(NN)

DO 2 LL=1,NAL

ID = NODLIN(NN,LL)

LINE = LINUM(ID)

INTG1 =LINE/100

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59*      INTG2 = LINE/1000
60*      INTG2 = 10*INTG2
61*      INTG3 = INTG1-INTG2
62*      IF(LDGF(ID).GT.0) INTG3 = 2
63*      IF(INTG3.NE.KEY1) GO TO 2
64*      IF(KEY3.EQ.0) GO TO 100
65*      FLACUM(ID) = FLACUM(ID) + FLW(INN)
66*      GO TO 3
67*      100 CONTINUE
68*      IF(KEY2.EQ.0) TEMPIN(ID) = F(INN+50,L)
69*      FLACUM(ID) = FLACUM(ID) + FLW(INN)
70*      IF(FLACUM(ID).LT.FLOWL(ID)) KEY3 = 10
71*      IF(KEY2.EQ.0) FLOWT(ID) = FLOWT(ID) + FLW(INN)*F(INN+50,L)
72*      IF(KEY2.NE.0) FLOWT(ID) = FLOWT(ID) + FLOWL(LASTID)*TEMPOT(LASTID)
73*      IF(KEY3.GT.0) GO TO 2
74*      TEMPIN(ID) = FLOWT(ID)/FLOWL(ID)
75*      K1 = IBIG(ID)
76*      K2 = KNODE(ID)
77*      UACOND = .01*ILTH/SPACE(K1,1)
78*      AREA = .19634953*ILTH*K1
79*      INN = LTH(ID)/ILTH
80*      LTHEND = LTH(ID) - ILTH*INN
81*      IF(LTHEND.GT.0) INN = INN + 1
82*      IF(INN.LT.1) INN = 1
83*      DO 4 IN=1,INN
84*      IF(IN.NE.INN) GO TO 29
85*      IF(LTHEND.EQ.0) GO TO 29
86*      AREA = AREA*LTHEND/ILTH
87*      UACOND = UACOND*LTHEND/ILTH
88*      29 CONTINUE
89*      IF(IN.EQ.1) T1 = TEMPIN(ID)
90*      IF(IN.EQ.1) TC = T1
91*      IF(IN.NE.1) TC = (T0-T1)/2. + T0
92*      IF(IN.NE.1) T1 = T0
93*      T1 = TC
94*      T2 = P(K2,L)
95*      TEMPZ = T1**3 + T1**2*T2 + T1*T2**2 + T2**3
96*      UARAD = SHAPE*AREA*EMISS*TEMPZ*1.1897E-11
97*      RATIO = (TC-F(K2,L))/K1*16.
98*      TFILM = (TC+F(K2,L))/2.
99*      IF(RATIO.LE.1.E-5) RATIO = 1.E-5
100*      YDIDO = .9686*ALOG10(RATIO)-3.22/(22.04+RATIO) -.6493
101*      FLOG = .2227*YDIDO +.3655*YP -.11765
102*      CFACT = 10.**FLOG
103*      BASE = .89-(TFILM-460.)*1.E-4
104*      FILMH = CFACT*BASE
105*      UACONV = FILMH*AREA/144.
106*      UA = UACOND + UARAD + UACONV
107*      WCP = 220.*FLOWL(ID)
108*      TBEFF = ((UACOND+UARAD)*P(K2,L) + UACONV*F(K2,L))/UA
109*      T0 = (T1-TBEFF)*EXP(-UA/WCP) + TBEFF
110*      QDOTL(ID) = QDOTL(ID) + UA/60.*(T1+T0)/2.-TBEFF)
111*      IF(IN.EQ.INN) TEMPOT(ID) = T0
112*      4 CONTINUE
113*      C(15+250,4) = C(15+250,4) + QDOTL(ID)
114*      IF(1CNT+1.NE.1PRNT) GO TO 300
115*      TEMPIN(ID) = TEMPIN(ID) - 460.
116*      TEMPOT(ID) = TEMPOT(ID) - 460.

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117*      TBEFF = TBEFF - 460.
118*      IF (ICNT+1.EQ.IPRNT) WRITE(6,199)NN,LINE,KNODE(ID),LYH(ID),
119*          TEMPIN(ID),TEMPOT(ID),TBEFF, QDOTL(ID),FLOWL(ID),NLCONT(NN)
120*      199 FORMAT(2X,I3,1X,I7,5X,I5,2X,I5,5F10.3,15)
121*      TEMPIN(ID) = TEMPIN(ID) + 460.
122*      TEMPOT(ID) = TEMPOT(ID) + 460.
123*      TBEFF = TBEFF + 460.
124*      300 CONTINUE
125*      KEY2 = 10
126*      3 CONTINUE
127*      LASTID = 10
128*      2 CONTINUE
129*      CAPHR = CAPHR + (P(NN,L) - P(NN,K)) * C(NN,1) / 60. / DELT
130*      C(IS+259,4) = CAPHR
131*      1 CONTINUE
132*      C *** CAPHR = SYSTEM(IS) CAPACITANCE HEAT SOAK RATE (BTU/MIN) (+ = WARMUP)
133*      C *** C(IS+250,4) = SYSTEM(IS) LINE HEAT LOSS RATE (BTU/MIN)
134*      C *** C(IS+253,4) = SYSTEM(IS) TOTAL HEAT LOSS RATE
135*      C *** C(IS+256,4) = SYSTEM(IS) ACTUATOR COUPLING HEAT LOSS RATE (BTU/MIN)
136*      ICNFIG = 1PDO(IFLAG,15)
137*      C(IS+253,4) = FLOWL(LASTID) * ((F(NI+6,L) - TEMPOT(LASTID)) * 3.0667 +
138*      * PDRP(ICNFIG) * 2.4745E-2)
139*      C(IS+256,4) = C(IS+253,4) - C(IS+250,4) - CAPHR
140*      IF (ICNT+1.EQ.IPRNT) WRITE(6,200)IS,C(IS+250,4),C(IS+256,4),CAPHR,
141*      * C(IS+253,4)
142*      200 FORMAT(10X,10H$$$ SYSTEM,12,36H HEAT LOSS RATES (BTU/MIN) - LINES
143*      * =,F8.3,12H COUPLING =,F8.3,8H SOAK =,F8.3,9H TOTAL =,F8.3/)
144*      F(NI+7,L) = TEMPOT(LASTID)
145*      C(NI+7,3) = WCP
146*      RETURN
147*      END

```

END OF COMPILATION: NO DIAGNOSTICS.

APPENDIX E. SAMPLE OUTPUT

The following are examples of the tabular data printout and plot output from TAHAP.

Node Coupling Data

COND/CONV COUPLING
NODE HOOKED TO NODE

10	255	2.000000-01
11	255	2.000000-01
12	255	2.000000-01
13	255	1.400000+00
14	255	2.000000-01
15	255	2.000000-01
16	255	2.000000-01
17	255	1.400000+00
18	252	1.000000+00
19	252	1.800000+00
20	253	1.800000+00
21	253	1.800000+00
22	256	3.000000-01
23	256	3.000000-01
24	257	3.000000-01
25	258	1.500000+00
26	258	1.500000+00
27	257	1.500000+00
28	257	1.500000+00
29	258	3.000000-01
30	257	3.000000-01
31	258	4.700000+00
32	257	4.700000+00
33	260	2.000000-01
34	260	8.000000-01
35	260	1.600000+00
36	260	1.000000-01
37	257	1.000000-01
100	250	2.500000-01
101	250	8.500000-02
-	104	1.996000+00
102	103	8.000000+00
-	250	1.250000+00
103	102	8.000000+00
-	250	1.000000+00
104	101	1.996000+00
-	250	8.230000+00
112	250	8.830000+00
114	261	1.000000-01
150	250	2.500000-01
151	250	8.500000-02
-	154	1.996000+00
152	153	8.000000+00
-	250	1.250000+00
153	152	8.000000+00
-	250	1.000000+00
154	151	1.996000+00
-	250	8.030000+00
162	250	1.000000+01
164	261	1.000000-01
200	250	2.500000-01
201	250	8.500000-02
-	204	1.996000+00
202	203	8.000000+00
-	250	1.250000+00
203	202	8.000000+00
-	250	1.000000+00
204	201	1.996000+00
-	250	7.380000+00
212	250	1.500000+00
214	261	1.000000-01

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Cond/Convection
Coupling (Cont.)

Node	Node	Coefficient
250	100	2.500000-01
	101	8.500000-02
	102	1.250000+00
	103	1.000000+00
	104	8.230000+00
	112	8.630000+00
	150	2.500000-01
	151	8.500000-02
	152	1.250000+00
	153	1.000000+00
	154	8.030000+00
	162	1.000000+01
	200	2.500000-01
	201	8.500000-02
	202	1.250000+00
	203	1.000000+00
	204	7.380000+00
	212	6.450000+00
252	18	1.000000+00
	19	1.800000+00
253	20	1.800000+00
	21	1.800000+00
255	10	2.000000-01
	11	2.000000-01
	12	2.000000-01
	13	1.400000+00
	14	2.000000-01
	15	2.000000-01
	16	2.000000-01
	17	1.400000+00
256	22	3.000000-01
	23	3.000000-01
257	24	3.000000-01
	27	1.500000+00
	28	1.500000+00
	30	3.000000-01
	32	4.700000+00
	37	1.000000-01
258	25	1.500000+00
	26	1.500000+00
	29	3.000000-01
	31	4.700000+00
260	33	2.000000-01
	34	8.000000-01
	35	1.600000+00
	36	1.000000-01
261	114	1.000000-01
	164	1.000000-01
	214	1.000000-01

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RAD COUPLING
NODE HOOKED TO NODE

10	255	1.220000-10
11	255	1.220000-10
12	255	1.220000-10
13	255	9.770000-10
14	255	1.220000-10
15	255	1.220000-10
16	255	1.220000-10
17	255	9.770000-10
18	252	1.232000-09
19	252	1.232000-09
20	253	1.232000-09
21	253	1.232000-09
22	256	1.820000-10
23	256	1.820000-10
24	257	1.820000-10
25	258	1.027000-09
26	258	1.027000-09
27	257	1.027000-09
28	257	1.027000-09
29	258	2.140000-10
30	257	2.140000-10
31	258	2.821000-09
32	257	2.821000-09
33	260	1.330000-10
34	260	5.190000-10
35	260	1.063000-09
36	260	2.900000-11
37	257	2.900000-11
101	250	7.537900-10
104	250	5.563500-09
112	250	5.965000-09
151	250	7.537900-10
154	250	4.871900-09
162	250	6.717700-09
201	250	7.537900-10
204	250	4.433900-09
212	250	4.174300-09

Radiation coupling
(Cont.)

Node	Node	Coeffieient
250	101	7.537900-10
	104	5.563500-09
	112	5.965000-09
	151	7.537900-10
	154	4.871900-09
	162	6.717700-09
	201	7.537900-10
	204	4.433900-09
252	212	4.174300-09
	18	1.232000-09
	19	1.232000-09
253	20	1.232000-09
	21	1.232000-09
255	10	1.220000-10
	11	1.220000-10
	12	1.220000-10
256	13	9.770000-10
	14	1.220000-10
	15	1.220000-10
	16	1.220000-10
	17	9.770000-10
	22	1.820000-10
257	23	1.820000-10
	24	1.820000-10
	27	1.027000-09
	28	1.027000-09
	30	2.140000-10
	32	2.821000-09
258	37	2.900000-11
	25	1.027000-09
	26	1.027000-09
	29	2.140000-10
260	31	2.821000-09
	33	1.330000-10
	34	5.190000-10
	35	1.063000-09
	36	2.900000-11

Node Thermal Data Initial Values

NODE	C	UA	WCP	Q	COMPONENT INITIAL TEMP	INITIAL FLUID INLET TEMP
1 - PITCH 1	39.400	200.000	.000	.000	50.000	50.000
2 - YAW 1	38.600	200.000	.000	.000	50.000	50.000
3 - ENG CTRL 1	23.500	200.000	.000	.000	50.000	50.000
4 - PITCH 2	39.400	200.000	.000	.000	50.000	50.000
5 - YAW 2	38.800	200.000	.000	.000	50.000	50.000
6 - ENG CTRL 2	23.500	200.000	.000	.000	50.000	50.000
7 - PITCH 3	39.400	200.000	.000	.000	50.000	50.000
8 - YAW 3	38.600	200.000	.000	.000	50.000	50.000
9 - ENG CTRL 3	23.500	200.000	.000	.000	50.000	50.000
10 - RDR MTR 1	2.294	200.000	.000	.000	24.000	24.000
11 - RDR MTR 2	2.585	200.000	.000	.000	24.000	24.000
12 - RDR MTR 3	.389	200.000	.000	.000	24.000	24.000
13 - RDR SERVO	6.317	200.000	.000	.000	24.000	24.000
14 - SB MTR 1	2.294	200.000	.000	.000	24.000	24.000
15 - SB MTR 2	2.585	200.000	.000	.000	24.000	24.000
16 - SB MTR 3	.389	200.000	.000	.000	24.000	24.000
17 - SB SERVO	6.317	200.000	.000	.000	24.000	24.000
18 - LO ELEVON	15.548	200.000	.000	.000	20.000	20.000
19 - LI ELEVON	20.380	200.000	.000	.000	20.000	20.000
20 - RO ELEVON	17.358	200.000	.000	.000	20.000	20.000
21 - RI ELEVON	15.596	200.000	.000	.000	20.000	20.000
22 - BF MTR 1	2.534	200.000	.000	.000	18.000	18.000
23 - BF MTR 2	2.524	200.000	.000	.000	18.000	18.000
24 - BF MTR 3	2.661	200.000	.000	.000	18.000	18.000
25 - LO BRK MOD	10.792	200.000	.000	.000	22.000	22.000
26 - LI BRK MOD	6.512	200.000	.000	.000	22.000	22.000
27 - RO BRK MOD	10.561	200.000	.000	.000	22.000	22.000

28

262

Line Data

Line Number	Boundary Node	Actuators Being Serviced																				
1105	250 22 18	19	21	20	10	14	13	17	28	26	29	31	30	37	32	34	35	36	33			
1100	250 22 18	19	21	20	10	14	13	17	28	26	29	31	30	37	32	34	35	36	33			
1101	250 22 18	19	21	20	10	14	13	17	28	26	29	31	30	37	32	34	35	36	33			
2120	250 22 18	19	21	20	10	14	13	17	28	26	29	31	30	37	32	34	35	36	33			
2123	250 10 14	13	17																			
2118	250 10 14	13	17																			
6123	250 10 14	13	17																			
6124	255 10 14	13	17																			
2121	250 22 18	19	21	20	33	36	35	34	32	37	30	31	29	26	28							
8133	256 22 18	19	21	20	33	36	35	34	32	37	30	31	29	26	28							
2122	250 18 19	21	20	33	36	35	34	32	37	30	31	29	26	28								
5131	250 18 19																					
5132	252 18 19																					
5136	252 18																					
5137	252 19																					
2119	250 21 20	33	36	35	34	32	37	30	31	29	26	28										
5133	250 20 21																					
5134	253 20 21																					
5138	253 21																					
5139	253 20																					
2127	250 33 36	35	34	32	37	30	31	29	26	28												
2136	250 29 31	30	37	32	34	35	36	33	26	28												
2126	250 29 31	30	37	32	34	35	36	33	26	28												
2128	254 29 31	30	37	32	34	35	36	33	26	28												
4165	254 28																					
4198	257 28																					
4168	254 29 26	31	30	37	32	34	35	36	33													
4162	258 29 26	31	30	37	32	34	35	36	33													
4164	258 26																					
4163	258 29 31	30	37	32	34	35	36	33														
4151	258 29 31	30	37	32	34	35	36	33														
4132	258 29 31	30	37	32	34	35	36	33														
4133	258 29																					
4135	258 29																					
4130	258 31 30	37	32	34	35	36	33															
4131	258 31 30	37	32	34	35	36	33															
4161	258 31																					
4156	258 31																					
4199	258 30 27	32	34	35	36	33																
4159	254 30 37	32	34	35	36	33																
4181	254 32 30	37																				
4177	257 37 30																					
4178	257 30																					
4186	257 30																					
4146	257 30																					
4184	257 32																					
4175	257 32																					
3100	254 34 35	36	33																			
3101	259 34 35	36	33																			
3104	260 34 35	36	33																			
3114	260 34																					
3117	260 34																					
3130	260 35 36	33																				
3127	260 35																					
3129	260 35																					

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Line Data (Cont.)

2220	250	19	18	22	21	20	33	36	35	34	32	37	30	31	29	26	28	10	14	13	17
1207	250	19	18	22	21	20	33	36	35	34	32	37	30	31	29	26	28	10	14	13	17
1206	250	19	18	22	21	20	33	36	35	34	32	37	30	31	29	26	28	10	14	13	17
1305	250	11	15	13	17	23	18	19	21	20	27	30	25	29							
1301	250	11	15	13	17	23	18	19	21	20	27	30	25	29							
2320	250	11	15	13	17	23	18	19	21	20	27	30	25	29							
2313	250	11	15	13	17																
2318	250	11	15	13	17																
6323	250	11	15	13	17																
6324	255	11	15	13	17																
2321	250	23	18	19	21	20	27	30	25	29											
6333	256	23																			
2322	250	18	19	21	20	27	30	25	29												
5331	250	18	19																		
5332	252	18	19																		
5336	252	18																			
5337	252	19																			
2319	250	21	20	27	30	25	29														
5333	250	21	20																		
5334	253	21	20																		
5338	253	21																			
5339	253	20																			
2327	250	27	30	25	29																
2326	250	29	25	30	27																
2328	254	29	25	30	27																
4378	254	27	30																		
4379	257	27	30																		
4385	257	27																			
4388	257	30																			
4380	257	30																			
4381	257	30																			
4374	254	25	29																		
4367	256	25	29																		
4375	258	25																			
4382	258	29																			
4377	258	29																			
4373	258	29																			
4476	258	25																			
4475	258	25																			
4473	254	25																			
4485	257	27																			
4486	257	27																			
4483	254	27																			
2428	254	27	25																		
2426	250	27	25																		
2427	250	27	25																		
5438	253	21																			
5439	253	20																			
5434	253	21	20																		
5433	250	21	20																		
2419	250	21	20	27	25																
5436	252	18																			
5437	252	19																			
5432	252	18	19																		
5431	250	18	19																		
2422	250	18	19	21	20	27	25														
8434	256	23																			
8433	256	23																			

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Line Data (Cont.)

2423	250	23	18	19	21	20	27	25											
2421	250	23	18	19	21	20	27	25											
6424	255	11	15	13	17														
6423	250	11	15	13	17														
2420	250	11	15	13	17	23	18	19	21	20	27	25							
1407	250	11	15	13	17	23	18	19	21	20	27	25							
1406	250	11	15	13	17	23	18	19	21	20	27	25							
1505	250	12	16	13	17	24	20	21	19	18	28	27	30	26	25	29			
1501	250	12	16	13	17	24	20	21	19	18	28	27	30	26	25	29			
2520	250	12	16	13	17	24	20	21	19	18	28	27	30	26	25	29			
2516	250	12	16	13	17	24	20	21	19	18	28	27	30	26	25	29			
2513	250	12	16	13	17														
6523	250	12	16	13	17														
6524	255	12	16	13	17														
2521	250	24	20	21	19	18	28	27	30	26	25	29							
6533	256	24																	
2522	250	20	21	19	18	28	27	30	26	25	29								
5533	250	20	21																
5534	253	20	21																
5538	253	21																	
5539	253	20																	
2519	250	19	18	28	27	30	26	25	29										
5531	250	19	18																
5532	252	19	18																
5536	252	18																	
5537	252	19																	
2527	250	28	27	30	26	25	29												
2526	250	29	25	26	30	27	28												
2528	254	29	25	26	30	27	28												
4580	257	28	27	30															
4571	257	28	27	30															
4565	257	28																	
4569	257	27	30																
4567	257	27																	
4568	257	30																	
4563	257	30																	
4564	257	30																	
4581	257	26	25	29															
4578	258	26	25	29															
4574	256	26																	
4579	258	29	25																
4567	258	25																	
4576	258	29																	
4577	258	29																	
4575	258	29																	
4678	259	25																	
4680	258	25																	
4661	258	26																	
4671	258	25	26																
4670	254	25	26																
4682	257	27																	
4686	257	27																	
4686	257	28																	
4684	257	28	27																
4683	254	28	27																
2628	254	27	25	26	28														
2626	250	28	27	26	25														
2627	250	28	27	26	25														

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SKIP = .20069803E+02, .16296820E+02, .19229250E+02,
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ALT = .22949985E+04,
IFLAG = +1,
ISPD = +1, +1, +1,
SEND
    
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Boiler Water Level, Heat Balance, and BOILP Output

62.4		WATER IN BOILER 62.4		.0		WATER TRANSFERRED .0		.0	
POWER IN	TURBINE IN	TOTAL IN	OUT BY H2O	STORED	CONDUCTED	TOTAL OUT	ERROR		
1.385+04	0.000	1.385+04	0.000	1.324+04	7.293+02	1.397+04	-1.171+02		
P1	P2	P12	SAT TEMP	H2O RATE	FLAG	ITTER			
1.334+01	1.334+01	0.000	0.000	0.000	0.000	0.000			
1.334+01	1.334+01	0.000	0.000	0.000	0.000	0.000			
1.334+01	1.334+01	0.000	0.000	0.000	0.000	0.000			

Output from THERMP and THERMR

Actuator Number	Line Number	Boundary Node	Line Length	Inlet Temp	Outlet Temp	Boundary Temp	Heat Loss Rate	Flow Rate	NLCNT
10	1105	250	52	52.617	52.582	31.479	.645	4.975	13
10	1100	250	54	52.582	52.545	31.479	.668	4.975	13
10	1101	250	146	52.545	52.446	31.479	1.801	4.975	13
10	2120	250	44	52.446	52.417	31.479	.541	4.975	13
10	2123	250	74	52.417	51.214	31.479	.882	.200	13
10	2118	250	35	51.214	50.675	31.475	.395	.200	13
10	6123	250	194	50.675	49.069	31.509	1.179	.200	13
10	6124	255	49	49.069	48.406	20.892	.486	.200	13
20	2121	250	218	52.417	52.264	31.479	2.666	4.775	59
20	2122	250	16	52.264	52.253	31.478	.195	4.775	59
20	2119	250	83	52.253	52.210	31.500	.755	4.775	59
20	5133	250	79	52.210	52.033	31.500	.715	1.100	59
20	5134	253	96	52.033	51.674	20.000	1.447	1.100	59
20	5139	253	243	51.674	50.991	20.000	2.755	1.100	59
26	2127	250	15	52.210	52.202	31.514	.104	3.675	55
26	2136	250	7	52.202	52.199	31.514	.049	3.675	55
26	2126	250	95	52.199	52.150	31.514	.659	3.675	55
26	2128	254	120	52.150	52.103	36.275	.625	3.675	55
26	4168	254	193	52.103	52.029	36.262	.841	3.094	55
26	4162	258	9	52.029	52.022	22.000	.081	3.094	55
26	4164	258	13	52.022	51.978	22.000	.094	.581	55
26	4165	254	154	52.103	51.852	36.263	.535	.581	54
26	4198	257	16	51.852	51.798	22.000	.115	.581	54
35	4163	258	16	52.022	52.006	22.000	.145	2.513	51
35	4151	258	12	52.006	51.997	22.000	.087	2.513	51
35	4132	258	8	51.997	51.991	22.000	.058	2.513	51
35	4130	258	13	51.991	51.980	22.000	.094	2.513	51
35	4131	258	12	51.980	51.971	22.000	.087	2.513	51
35	4199	258	2	51.971	51.969	22.000	.014	2.513	51
35	4159	254	100	51.969	51.932	36.264	.346	2.513	51
35	3100	254	633	51.932	51.496	36.269	2.154	1.349	51
35	3101	259	197	51.496	51.377	36.826	.589	1.349	51
35	3104	260	56	51.377	51.304	24.000	.364	1.349	51
35	3130	260	18	51.304	51.280	24.000	.117	1.349	51
35	3127	260	26	51.280	51.032	24.000	.168	.185	51
35	3129	260	18	51.032	50.863	24.000	.115	.185	51
35	3128	260	60	50.863	50.305	24.000	.378	.185	51
36	3102	260	65	51.280	51.181	24.000	.421	1.164	49
36	3118	260	3	51.181	51.177	24.000	.019	1.164	49
37	4181	254	220	51.932	51.755	36.264	.756	1.164	41
37	4177	257	4	51.755	51.748	22.000	.029	1.164	41
14	6224	255	49	35.375	35.075	20.971	.220	.200	13
14	6223	250	95	35.075	34.960	31.358	.084	.200	13
20	5239	253	248	48.852	48.228	20.000	2.514	1.100	59
20	5234	253	99	48.228	47.910	20.000	1.283	1.100	59
20	5233	250	60	47.910	47.608	31.484	.412	1.100	59
26	4274	258	18	42.361	42.333	22.000	.103	.581	55
26	4284	257	8	42.129	42.108	22.000	.045	.581	54
28	4282	257	8	42.108	42.087	22.000	.045	.581	54

Output from THERMP and THERMR (Cont.)

28	4283	254	157	42.087	41.972	38.452	.246	.581	54
35	3113	260	57	36.741	36.718	24.000	.151	.185	51
35	3111	260	20	36.718	36.641	24.000	.052	.185	51
35	3116	260	25	36.641	36.545	24.000	.065	.185	51
35	3112	260	2	52.251	52.248	24.000	.014	1.164	49
36	3107	260	66	52.248	52.143	24.000	.446	1.164	49
36	3131	260	41	50.004	49.978	24.000	.129	1.349	49
36	3119	260	47	49.978	49.920	24.000	.287	1.349	49
36	3115	259	197	49.920	49.816	36.754	.515	1.349	49
36	3123	254	633	49.816	49.449	36.293	1.815	1.349	49
37	4178	257	4	51.809	51.802	22.000	.029	1.164	41
37	4180	254	216	51.802	51.630	36.266	.736	1.164	41
37	4169	254	100	50.459	50.426	36.261	.307	2.513	41
37	4170	258	5	50.426	50.422	22.000	.034	2.513	41
37	4166	258	7	50.422	50.417	22.000	.048	2.513	41
37	4271	258	6	50.417	50.410	22.000	.066	2.513	41
37	4272	258	11	50.410	50.399	22.000	.093	2.513	41
37	4269	258	13	46.885	46.883	22.000	.024	3.094	41
37	4270	254	186	46.883	46.818	36.313	.737	3.094	41
37	4228	254	120	47.735	47.699	36.348	.490	3.675	41
37	2226	250	101	47.699	47.654	31.491	.605	3.675	41
37	2227	250	20	47.654	47.645	31.490	.119	3.675	41
37	2219	250	105	47.645	47.642	31.483	.711	4.775	41
37	2223	250	37	47.642	47.623	31.460	.334	4.775	41
37	2222	250	161	47.623	47.530	31.460	1.627	4.775	41
37	2221	250	100	47.530	47.479	31.460	.894	4.775	41
37	2220	250	13	46.976	46.970	31.457	.112	4.975	41
37	1207	250	26	46.970	46.957	31.457	.223	4.975	41
37	1206	250	50	46.957	46.934	31.457	.429	4.975	41
SYSTEM 1 HEAT LOSS RATES (BTU/MIN) - LINES = 40.220 COUPLING = .105 SOAK = 432.580 TOTAL = 472.984									
11	1305	250	55	50.249	50.193	31.471	.592	2.862	12
11	1301	250	88	50.193	50.103	31.471	.943	2.862	12
11	2320	250	40	50.103	50.062	31.471	.427	2.862	12
11	2313	250	78	50.062	48.963	31.470	.806	.200	12
11	2318	250	50	48.963	48.300	31.466	.486	.200	12
11	6323	250	211	48.300	46.811	31.500	1.093	.200	12
11	6324	255	45	46.811	46.259	20.901	.405	.200	12
19	2321	250	130	50.062	49.921	31.470	1.379	2.662	57
19	2322	250	20	49.921	49.899	31.470	.211	2.662	57
19	5331	250	30	49.899	49.856	31.492	.237	1.500	57
19	5332	252	118	49.856	49.559	20.000	1.636	1.500	57
19	5337	252	76	49.559	49.347	20.000	1.185	1.500	57
25	2319	250	110	49.899	49.697	31.492	.863	1.162	55
25	2327	250	13	49.697	49.682	31.510	.065	1.162	55
25	2326	250	92	49.682	49.574	31.510	.459	1.162	55
25	2328	254	154	49.574	49.446	36.292	.545	1.162	55
25	4374	254	192	49.446	49.133	36.293	.667	.581	55
25	4387	258	13	49.133	49.084	22.000	.104	.581	55
25	4375	258	4	49.084	49.069	22.000	.032	.581	55
27	4378	254	168	49.446	49.172	36.293	.564	.581	55
27	4379	257	12	49.172	49.126	22.000	.096	.581	55
27	4385	257	3	49.126	49.115	22.000	.024	.581	55
19	6424	255	46	35.178	34.900	20.973	.204	.200	12
19	6423	250	76	34.900	34.790	31.352	.080	.200	12
19	5437	252	87	52.211	51.999	20.000	1.171	1.500	57
19	5432	252	126	51.999	51.648	20.000	1.926	1.500	57
19	5431	250	24	51.648	51.610	31.498	.211	1.500	57

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Output from THERMP and THERMR (Cont.)

25	4476	258	13	40.980	40.948	22.000	.068	.581	55
25	4475	258	9	40.948	40.926	22.000	.047	.581	55
25	4473	254	190	40.926	40.820	36.492	.227	.581	55
27	4485	257	5	41.014	41.001	22.000	.026	.581	55
27	4486	257	13	41.001	40.969	22.000	.068	.581	55
27	4483	254	164	40.969	40.876	36.490	.198	.581	55
27	2428	254	153	40.848	40.799	36.512	.207	1.162	55
27	2426	250	101	40.799	40.726	31.446	.314	1.162	55
27	2427	250	20	40.726	40.711	31.445	.062	1.162	55
27	2419	250	105	40.711	40.626	31.437	.365	1.162	55
27	2422	250	39	46.815	46.781	31.456	.331	2.662	55
27	2423	250	168	46.781	46.636	31.456	1.415	2.662	55
27	2421	250	110	46.636	46.542	31.455	.918	2.662	55
27	2420	250	28	45.721	45.700	31.450	.218	2.662	55
27	1407	250	33	45.700	45.676	31.450	.256	2.662	55
27	1406	250	48	45.676	45.640	31.450	.371	2.662	55
*** SYSTEM 2 HEAT LOSS RATES (BTU/MIN) - LINES = 21.503 COUPLING = .006 SOAK = 236.237 TOTAL = 260.827									
12	1505	250	43	52.328	52.296	31.478	.525	4.500	14
12	1501	250	72	52.296	52.243	31.478	.876	4.500	14
12	2520	250	43	52.243	52.211	31.478	.522	4.500	14
12	2516	250	5	52.211	52.207	31.478	.061	4.500	14
12	2513	250	66	52.207	52.093	31.478	.798	1.900	14
12	6523	250	174	52.093	51.901	31.514	1.333	1.900	14
12	6524	255	56	51.901	51.811	20.883	.630	1.900	14
18	2521	250	146	52.207	52.022	31.478	1.763	2.600	57
18	2522	250	24	52.022	51.992	31.477	.268	2.600	57
18	2519	250	77	51.992	51.822	31.499	.688	1.100	57
18	5531	250	101	51.822	51.600	31.499	.892	1.100	57
18	5532	252	111	51.600	51.193	20.000	1.645	1.100	57
18	5516	252	229	51.193	50.560	20.000	2.550	1.100	57
21	5533	250	34	51.992	51.937	31.499	.305	1.500	59
21	5534	253	100	51.937	51.727	20.000	1.154	1.500	59
21	5539	253	92	51.727	51.506	20.000	1.215	1.500	59
17	6524	255	57	48.176	48.097	20.896	.550	1.900	39
17	6523	250	216	48.097	47.933	31.499	1.198	1.900	39
18	5636	252	236	48.741	48.150	20.000	2.383	1.100	57
18	5632	252	114	48.150	47.765	20.000	1.471	1.100	57
18	5631	250	103	47.765	47.612	31.483	.700	1.100	57
18	2619	250	53	47.612	47.524	31.482	.356	1.100	57
21	5638	253	86	53.586	53.364	20.000	1.217	1.500	59
21	5634	253	101	53.364	53.073	20.000	1.601	1.500	59
21	5633	250	33	53.073	53.016	31.503	.314	1.500	59
21	2622	250	46	50.692	50.639	31.473	.509	2.600	59
21	2623	250	92	50.639	50.533	31.473	1.013	2.600	59
21	2621	250	45	50.533	50.481	31.472	.493	2.600	59
21	2620	250	104	49.405	49.341	31.468	1.060	4.500	59
21	1600	250	59	49.341	49.305	31.468	.599	4.500	59
21	1622	250	2	49.305	49.303	31.467	.020	4.500	59
21	1607	250	40	49.303	49.279	31.467	.405	4.500	59
21	1606	250	22	49.279	49.265	31.467	.223	4.500	59
*** SYSTEM 3 HEAT LOSS RATES (BTU/MIN) - LINES = 29.307 COUPLING = .211 SOAK = 352.069 TOTAL = 384.587									

Node Thermal Data

TIME =, --12000

0-7-12:00

NODE	COMP TEMP	FLUID TEMP	C	UA	WCP	Q
10 - RDR MTR 1	50.61	68.40	2.29	200.00	50.60	1024.5
60 - RDR MTR1 OUT	.00	60.45	.00	.00	50.60	.0
11 - RDR MTR 2	47.51	66.34	2.59	200.00	50.60	1024.5
61 - RDR MTR2 OUT	.00	57.43	.00	.00	50.60	.0
12 - RDR MTR 3	82.66	75.71	.39	200.00	50.60	1024.5
62 - RDR MTR3 OUT	.00	92.13	.00	.00	50.60	.0
13 - RDR SERVO	61.39	75.71	6.32	200.00	187.00	3786.3
63 - RDR SR OUT	.00	79.26	.00	.00	187.00	.0
14 - SB MTR 1	53.09	68.40	2.29	200.00	22.00	445.4
64 - SB MTR1 OUT	.00	62.74	.00	.00	22.00	.0
15 - SB MTR 2	49.92	66.34	2.59	200.00	22.00	445.4
65 - SB MTR2 OUT	.00	59.61	.00	.00	22.00	.0
16 - SB MTR 3	80.87	75.71	.39	200.00	22.00	445.4
66 - SB MTR3 OUT	.00	90.30	.00	.00	22.00	.0
17 - SB SERVO	61.39	75.71	6.32	200.00	187.00	3786.3
67 - SB SRV OUT	.00	79.26	.00	.00	187.00	.0
18 - LO ELEVON	43.31	73.74	15.55	200.00	302.52	6125.4
68 - LO ELV OUT	.00	74.05	.00	.00	302.52	.0
19 - LI ELEVON	39.68	70.99	20.38	200.00	427.09	8647.6
69 - LI ELV OUT	.00	75.51	.00	.00	427.09	.0
20 - RO ELEVON	41.08	71.73	17.36	200.00	302.52	6125.4
70 - RO ELV OUT	.00	71.92	.00	.00	302.52	.0
21 - RI ELEVON	45.67	75.41	15.60	200.00	427.09	8647.6
71 - RI ELV OUT	.00	80.45	.00	.00	427.09	.0
22 - BFT MTR 1	32.14	68.29	2.53	200.00	.00	.0
72 - BFT MTR1 OUT	.00	32.15	.00	.00	.00	.0
23 - BFT MTR 2	31.81	66.29	2.52	200.00	.00	.0
73 - BFT MTR2 OUT	.00	31.81	.00	.00	.00	.0
24 - BFT MTR 3	31.95	69.94	2.66	200.00	.00	.0
74 - BFT MTR3 OUT	.00	31.95	.00	.00	.00	.0
25 - LO BRK MOD	44.05	69.52	10.79	200.00	127.82	2588.1
75 - LO BRK OUT	.00	61.09	.00	.00	127.82	.0
26 - LI BRK MOD	55.10	73.03	6.51	200.00	127.82	2588.1
76 - LI BRK OUT	.00	70.35	.00	.00	127.82	.0
27 - RO BRK MOD	44.45	69.65	10.56	200.00	127.82	2588.1
77 - RO BRK OUT	.00	61.42	.00	.00	127.82	.0
28 - RI BRK MOD	52.42	72.54	7.37	200.00	127.82	2588.1
78 - RI BRK OUT	.00	68.18	.00	.00	127.82	.0
29 - L MLG UPLK	22.00	22.00	1.47	200.00	.00	.0
79 - L MLGUP OUT	.00	22.00	.00	.00	.00	.0
30 - R MLG UPLK	22.00	22.00	1.49	200.00	.00	.0
80 - R MLGUP OUT	.00	22.00	.00	.00	.00	.0
31 - L MLG STRT	22.00	22.00	11.87	200.00	.00	.0
81 - L MLGST OUT	.00	22.00	.00	.00	.00	.0
32 - R MLG STRT	22.00	22.00	11.84	200.00	.00	.0
82 - R MLGST OUT	.00	22.00	.00	.00	.00	.0
33 - NLG UPLOCK	24.00	24.00	.48	200.00	.00	.0
83 - NLG UP OUT	.00	24.00	.00	.00	.00	.0
34 - NLG STRUT	24.00	24.00	2.51	200.00	.00	.0
84 - NLGSTT OUT	.00	24.00	.00	.00	.00	.0
35 - NLG STRNG	57.98	69.33	2.07	200.00	40.70	824.1

Actuator Assignments

IN	1	1	2	3	10	14	20	22	26	28	29	30	31	32	33	34	35	36	37
OUT	1	51	52	53	60	64	70	72	76	78	79	80	81	82	83	84	85	86	87
IN	2	4	5	6	11	15	19	23	25	27									
OUT	2	54	55	56	61	65	69	73	75	77									
IN	3	7	8	9	12	13	16	17	18	21	24								
OUT	3	57	58	59	62	63	66	67	68	71	74								

Accumulated Consumables

NODE102	ACCUMULATED CONSUMABLES	==	0.0000
NODE152	ACCUMULATED CONSUMABLES	==	0.0000
NODE202	ACCUMULATED CONSUMABLES	==	0.0000
NODE275	ACCUMULATED FUEL (LBM)	==	1.1214+01
NODE276	ACCUMULATED FUEL (LBM)	==	9.9783+00
NODE277	ACCUMULATED FUEL (LBM)	==	1.0984+01
NODE275	ACCUM ENERGY (HP-HR)	==	1.3678+00
NODE276	ACCUM ENERGY (HP-HR)	==	1.1230+00
NODE277	ACCUM ENERGY (HP-HR)	==	1.3222+00

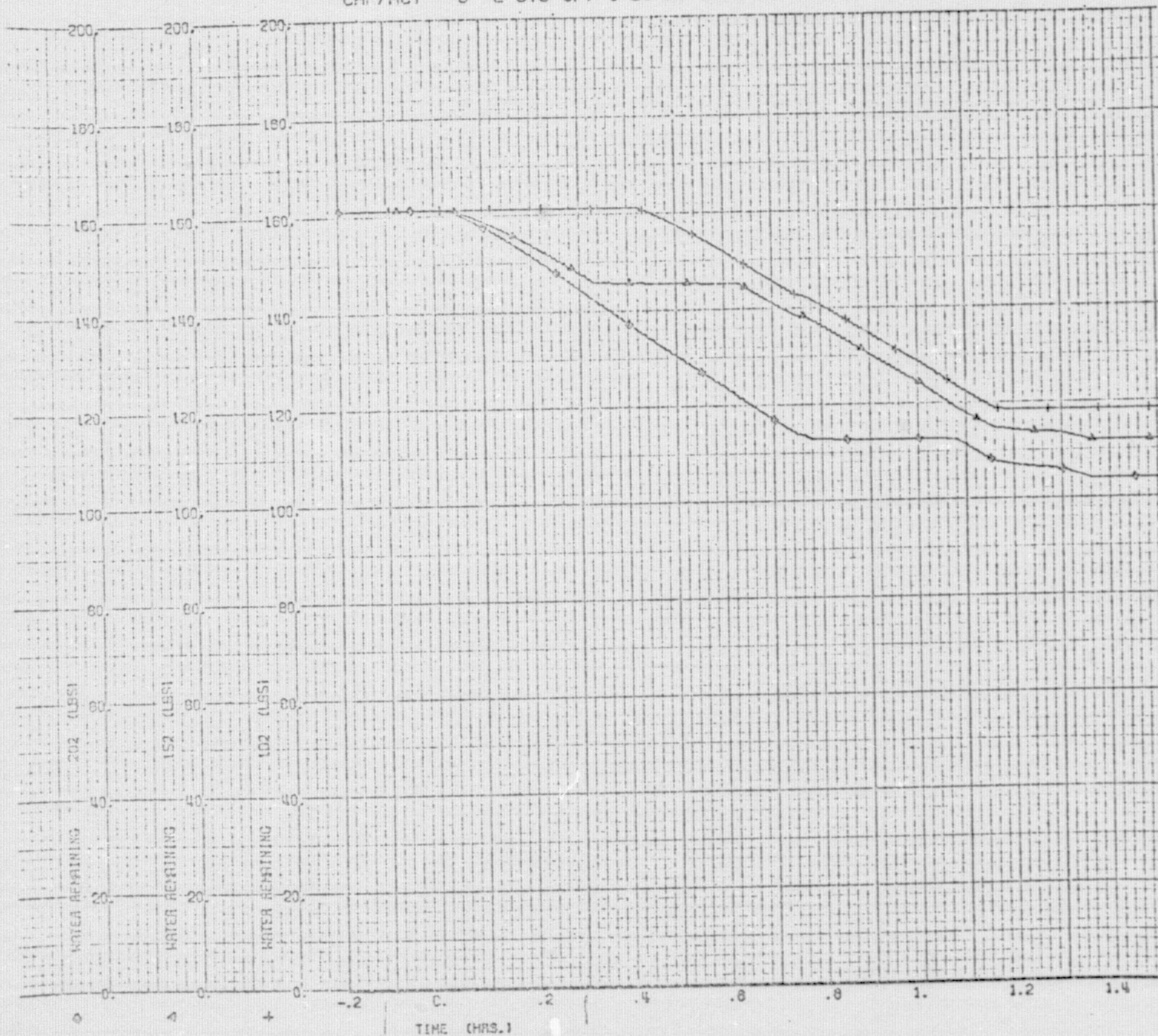
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Summary Table

	FUEL, LBM			WATER, LBM		
	SYSTEM 1	SYSTEM 2	SYSTEM 3	SYSTEM 1	SYSTEM 2	SYSTEM 3
PRESENT LOADING	295.0	295.0	295.0	161.4	161.4	161.4
UNUSABLES						
MEASUREMENT ERROR (RSS)	25.0	25.0	25.0	.0	.0	.0
RESIDUALS	5.4	5.4	5.4	25.0	25.0	25.0
MINIMUM USABLE	264.6	264.6	264.6	136.4	136.4	136.4
USABLE REQUIREMENTS						
PRELAUNCH REQUIREMENT	31.3	27.8	30.6	.0	.0	.0
FLIGHT REQUIREMENT	210.6	182.6	204.4	41.2	41.8	54.3
POST LANDING REQUIREMENT	7.8	6.9	7.6	.8	1.1	1.5
24 HOUR LAUNCH HOLD RECYCLE REQUIREMENT	31.3	27.8	30.6	.0	.0	.0
DISPERSIONS (10%)	28.1	24.5	27.3	4.2	4.3	5.6
USABLE MARGIN	-44.5	-5.0	-35.9	90.1	89.2	75.0

CAP/ACT - 3 2 SYS UP, 1 DOWN, EAFB HOT DAY

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ORIGINAL PAGE IS
OF POOR QUALITY

REFERENCE

1. FORTRAN Environmental Analysis Routines (FEAR) User's Guide,
28 December 1973.