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CR-128736

USER'S MANUAL

SPACE SHUTTLE ENVIRONMENTAL AND THERMAL CONTROL LIFE SUPPORT SYSTEM COMPUTER PROGRAM

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

CONTRACT NO. NAS 9-12411

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Hamilton Standard
DIVISION OF UNITED AIRCRAFT CORPORATION

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SECTION 1.0
INTRODUCTION

1.0 INTRODUCTION

1.1 Objective

The evaluation and ultimate definition of an integrated Shuttle ETC/LSS is an evolutionary process which reflects frequent changes in both technical and program related requirements. To support the NASA, Shuttle vehicle primes and in-house IRD, Hamilton Standard has developed an ETC/LSS computer program which provides accurate and rapid responses to these changing requirements. This design optimization tool has proven invaluable, saving countless hours of hand calculations and allowing the conceptual and preliminary design study phases to proceed in a comprehensive fashion. Two key features, which have made this computer model unique and of significant benefit to both Hamilton Standard and the people it supports, are:

a. Simplicity - ease of use/flexibility relative to schematics and requirement changes; and

b. Subroutines - unique models representing the "true" analytical descriptions of the mechanical and chemical processes under evaluation.

Under NASA sponsorship (NAS 9-12411), this program has been expanded and upgraded to meet the design evaluation demands of the forthcoming Shuttle phases. These demands include continuation of trade-off studies to further validate selections, expansion of these studies to include new requirements, and initial performance evaluations (steady state off-design transients) required to support development.

1.1 (Continued)

The objective of this document is to define this expanded computer program and provide the user with sufficient information for running and modifying the program as desired for the NASA-MSC computer facilities.

1.2 Outline

An outline of this document is presented in Table 1-1.

TABLE 1-1

USER'S MANUAL - OUTLINE

1.0 INTRODUCTION

- 1.1 Objective
- 1.2 Outline

2.0 BASIC OPTIMIZATION PROGRAM

3.0 PROGRAM CHANGES

- 3.1 Sizing Program Changes
- 3.2 Off Design Performance
- 3.3 Radiator/Evaporator Expendable Usage
- 3.4 Component Weights

4.0 OPERATING PROCEDURES

- 4.1 How to Set Up Deck
- 4.2 Program Input and Output
- 4.3 How to Vary Program

APPENDIX I

Logic Flow Diagrams of

1. Main Program
2. Condensing Heat Exchanger Subroutine
3. Sensible Heat Exchanger Subroutine
4. LiOH Subroutine

TABLE 1-1 (CONTINUED)

SECTION 2.0
BASIC OPTIMIZATION PROGRAM

2.0 BASIC OPTIMIZATION PROGRAM

A simplified logic diagram of the program is shown in Figure 2-1. The computer program consists of a "main line" program which does bookkeeping and a number of subroutines which calculate subsystem or component weights for the required performance. The "main line" program is "keyed" to select the desired subroutines (either condenser or solid amine for example) for the system under consideration. If other schematic arrangements are desired, it is a simple matter to change the "main line" program to select the subroutines in a different order or add other components.

There are three convergence loops in the program:

a. Condenser air outlet temperature/heat exchanger size

b. Interface heat exchanger outlet temperature

c. Radiator outlet temperature

When using a condenser, the air outlet temperature is initially set 2°F above the condenser coolant inlet temperature and the heat exchanger, fan, valve, and power equivalent weight calculated. The air outlet temperature is then increased in 1°F increments until the total equivalent weight is found to increase over the previous iteration. The previous iteration is then used as the condenser weight and performance.

The interface heat exchanger water loop outlet temperature for the first iteration is set by input data. For this value, the condenser and sensible heat exchanger are

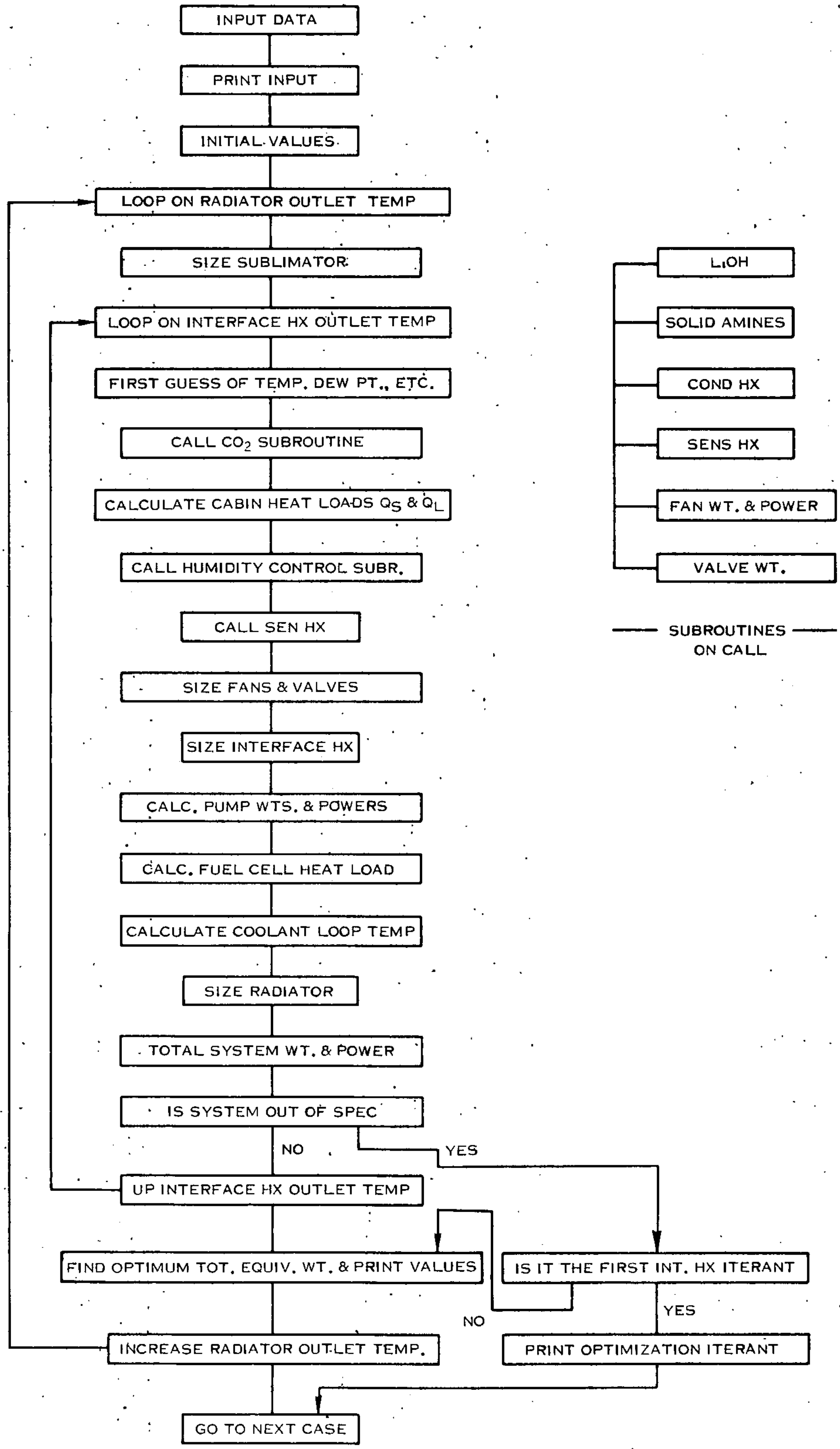


FIGURE 2-1. OPTIMIZATION COMPUTER PROGRAM LOGIC

2.0 (Continued)

optimized and the weight of pumps, fans, radiator, and other components are calculated and summed. The interface outlet temperature is then raised in 1°F increments until either the condenser or sensible heat exchanger can no longer provide the required cooling. The minimum total equivalent weights for various interface heat exchanger outlet temperatures are then compared and the minimum value stored.

The radiator outlet temperature is then raised by an input delta and the process repeated. When the cabin heat exchanger(s) cannot provide the required cooling (even at the lowest cabin loop temperatures), the minimum total equivalent weights for each radiator outlet temperature are compared and the minimum value selected. The case with lowest total equivalent weight is then recalculated and the weights, powers, flow rates and temperatures for the optimum case printed.

A simplified schematic of the ETC/LSS used by the computer program is shown in Figure 2-2. In the box labeled "Cabin Ventilation, CO_2 Removal, Humidity Control and Temperature Control" several different combinations of CO_2 removal and humidity control concepts can be used. A typical schematic of the LiOH/Condenser Approach is shown in Figure 2-3.

Items that can be varied when comparing optimized systems are:

a. Cabin conditions (temperature, pressure, maximum relative humidity, etc.)

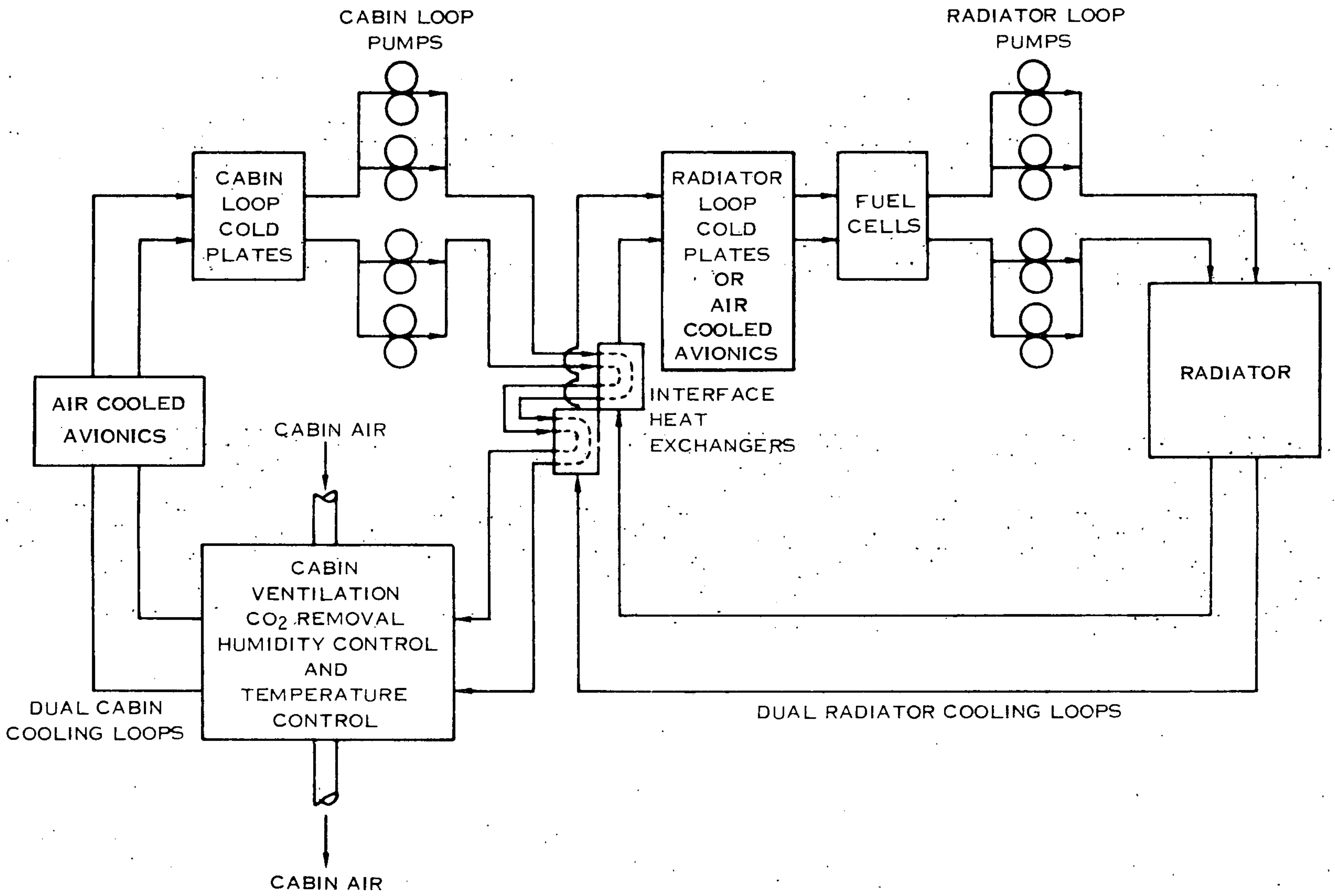


FIGURE 2–2. SYSTEM SCHEMATIC – SAMPLE CASE

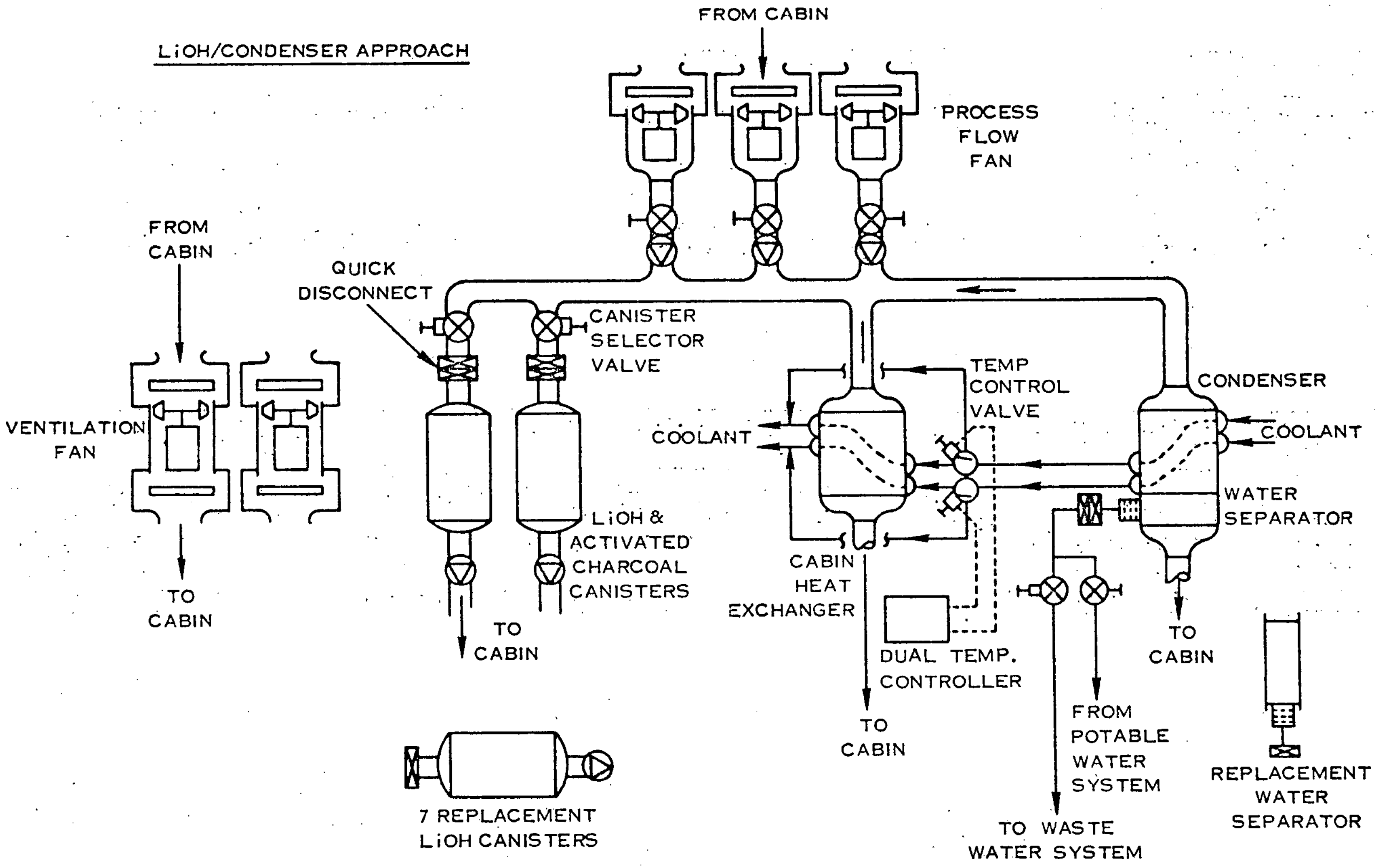


FIGURE 2–3. SAMPLE CASE – VENTILATION, CO_2, HUMIDITY &

2.0 (Continued)

b. Heat loads (metabolic sensible, metabolic latent, fuel cell, etc.)

c. Radiator loop flow rate and properties

d. Mission parameter (length, power penalty, etc.)

e. Which subsystems to use (LiOH or solid amine for CO_2; condenser or solid amine for humidity control, etc.)

f. Component data (pressure drops, fixed weights, structural weight factors, component weight factors, tables of optimization data, radiator influx, etc.)

SECTION 3.0
PROGRAM CHANGES

B

3.0 PROGRAM CHANGES

Program changes fall into four categories:

a. Changes to the sizing program (Basic Optimization Program)

b. Addition of "off design" performance calculations

c. Addition of loop to calculate the amount of water or cryogenic hydrogen required to supplement the radiator around an orbit

d. Addition of selected component weight calculations

3.1 Sizing Program Changes

Changes to the sizing program consist of additions, deletions, and a more detailed print out. The items deleted were the Desiccant, Hydrogen Depolarized Cell, and the Molecular Sieve Subroutines. As previous studies have shown these subsystems to be non-competitive, it was decided not to expand them to include "off design" performance calculations and, additionally, to delete them from the sizing program.

The additions made to the sizing program are:

a. A loop to calculate the optimum coolant flow rate

b. Additional components

    1. Flash Evaporator
    2. Fuel Cell Heat Exchanger
    3. GSE Heat Exchanger
    4. Separate Avionics Bay (with the capability to consider two bays in series using common hardware)
    5. Cryogenic Heat Exchanger

c. Ability to change component parameters by input data

    1. Input fan and pump overall efficiency
    2. Input the number of fans, check valves, and pumps

d. The radiator subroutine was changed to account for different delta temperatures between the fluid and wall at the inlet and outlet

In order to facilitate the running of the program, a convergence subroutine was added to optimize the coolant flow rate. If a flow rate is given in the input, the program will

3.1 (Continued)

use the input value as the first guess of flow rate. If the input value is zero or negative, the program will calculate a minimum coolant flow rate to be used for the first iteration. If the program does not converge with the original flow rate, the total equivalent weight is set to a large value and the flow rate is increased by an inputted factor. At the end of each radiator outlet temperature loop, the optimum total equivalent weight for that flow rate is compared to the optimum equivalent weight for the previous flow rate. If the weight is lower, the flow rate is again increased. If the weight is higher, the program goes back to recalculate the optimum condition (Wcoolant, Tradiator out, Tinterface hx out, Wair, etc.) and prints the optimum condition. It is also possible to run only one condition by setting an input key. The program will then use the input TRO and Wc and only optimize the heat exchangers.

The program has been changed to allow the radiator to be supplemented with:

a. Sublimator

b. Flash Evaporator

c. Cryogenic Hydrogen Heat Exchanger

If the maximum radiator area is too small to handle the required heat load, the excess heat load is rejected by the supplementary heat sink using an input expendable penalty. In addition, the supplementary heat sink will be used for a period of time (input) to handle the entire heat load. This simulates the time when the radiator is not

3.1 (Continued)

exposed to space. Three supplementary heat sinks are capable of being provided--cryogenic heat exchanger, sublimator or flash evaporator. If the cryogenic heat exchanger is desired, no additional input data is necessary except the expendable penalty. The cryogenic heat exchanger subroutine automatically calculates the heat exchanger weight and adds this value to the system total equivalent weight. If the cryogenic heat exchanger is not desired, then the component weight factors must be set to zero by input. The use of either a sublimator or flash evaporator must be selected and the necessary weight penalty factors included in the input data.

The fuel cell heat exchangers are sized to meet the input temperature requirements. The mass flow rate (W x Cp) of the fuel cell loop required, based on the fuel cell heat load and temperatures, is calculated and stored in the input data block. For off-design performance, the fuel cell loop temperatures are calculated based on Freon loop temperatures, heat exchanger size, and fuel cell loop flow rate. The heat exchanger is sized as a single unit capable of rejecting the entire heat load. If some type of parallel arrangement is used, the weight penalty would be equivalent to the single unit weight.

The GSE heat exchanger is sized to reject the maximum vehicle heat load. The GSE fluid inlet temperature is considered to be 0°F and the mass flow ratio is set at 2.

With the addition of air cooled avionics on the Shuttle, a special subroutine was developed that sizes a heat exchanger with the desired number of fans to remove the

3.1 (Continued)

heat from a separate compartment. The heat exchanger air flow rate is optimized to obtain the minimum total equivalent weight of the heat exchanger and fans. An initial air outlet temperature is assumed to be 2°F higher than the coolant inlet temperature. The required air flow, fan power, and component weights are calculated. The air outlet temperature is then increased 2°F and a new total equivalent weight is calculated. This process continues until the total equivalent weight is higher than the previous iteration. The values for the previous (lightest) iteration are used for system weight.

EBAY2 is a subroutine that sizes two avionics compartments in series. The compartments have the same ECLSS equipment. The subroutine calculates the equipment size (heat exchanger and fans) required to meet performance in the second (downstream) compartment. The air temperature of first (upstream) compartment is then calculated using the equipment sized for the downstream compartment. If the desired compartment temperatures are not met, the equipment is resized to meet the temperature requirements of the first compartment. The temperature of the downstream compartment is recalculated with the larger sized equipment. The optimization of the heat exchanger/fan air flow rate is similar to that explained in the paragraph above.

The basic program has the ability to change heat exchanger characteristics by changing the weight factors. It is also possible to now change other components such as the number of fans, number of pumps, number of HS-C canisters, etc., by changes to the input data. This is useful as several of prime contractors are using different numbers of components.

3.1 (Continued)

As heat loads change, flow rates and pressure losses also change. In order to better match the expected fan and pump efficiencies, these variables were made inputs to the computer program.

Recent radiator studies have shown that the difference in temperature between the fluid and the wall will vary considerably between the inlet and outlet of the radiator. The radiator subroutine was rewritten to account for this difference. At present, there is a predicted 15°F difference between the fluid and wall at the radiator inlet and a 5°F difference at the outlet.

3.2 Off-Design Performance

The inputs required for the "off-design" performance section of the computer program are:

a. Air volumetric flow rates

b. Heat exchanger sizes

c. Pump and fan powers

d. Coolant flow rates

e. Heat loads

f. Desired control temperatures

All of these parameters are calculated by the sizing program and stored in the input data block. If an "off-design" performance case is run after a "sizing" case, the only inputs required are the changes to heat loads, cabin temperature or cabin pressure desired. If an "off-design" case is to be run without a "sizing" case preceding it, the above parameters must be inputted.

The program first calculates the total vehicle heat loads and then the radiator inlet temperature. The program then goes to the desired heat rejection method:

a. Radiator/expendable (if required)

b. Expendable heat sink only

   1. Sublimator

   2. Flash evaporator

   3. Cryogenic heat exchanger

3.2 (Continued)

If a sublimator is used, the heat sink inlet and outlet temperatures must be iterated as the temperatures are a function of the sublimator size and vehicle heat load.

In calculating the total vehicle heat load, the sensible and latent heat of the LiOH must be included. The LiOH subroutine has been expanded to also calculate the CO_2 partial pressure resulting from both a new cartridge and the level at which the cartridge would normally be changed.

Once the interface heat exchanger heat load and radiator loop inlet temperature is known, the cabin loop outlet temperature is calculated by a subroutine called HX. This subroutine calculates the hot side outlet temperature based on the heat load, heat exchanger size, coolant flow rates, and cold side inlet temperature. This subroutine is used for all of the sensible heat exchangers.

The program then enters a loop on cabin temperature. This loop is needed only if there is a sensible heat exchanger. After entering the loop the program selects the water removal subroutine--either HS-C or a condenser. The HS-C subroutine calculates the cabin water vapor partial pressure or determines the air flow required for humidity control. Based on the flow through the beds, the CO_2 partial pressure is also calculated. The program then goes to the sensible heat exchanger.

If a condenser is used, a key is set to tell the condenser subroutine if there is a sensible heat exchanger also. If there is no sensible heat exchanger, the condenser

3.2 (Continued)

subroutine CX2 calculates the air flow required through the heat exchanger to meet the required cabin temperature and the cabin dew point. If the cabin temperature cannot be met, the cabin temperature is raised in 1°F increments, until the heat exchanger can remove the heat load. As the cabin temperature is raised, a subroutine QMET calculates a new latent/sensible metabolic heat load split for the new cabin temperature.

If there is also a sensible heat exchanger, the condenser subroutine calculates the sensible load removed by the condenser and the cabin dew point.

If there is a sensible heat exchanger, the Hx subroutine calculates the air flow through the heat exchanger required to reject the remaining sensible heat load. If the heat load is negative, a message is printed that a reheater is required and the program continues. If the heat exchanger cannot remove the required heat load, the cabin temperature is increased 1°F, the metabolic latent/sensible load split recalculated, and the program returns to the water removal subroutine. If the temperature is raised 15°F and the heat exchanger still cannot meet the load, a message is printed and the case continues.

If there is a water cooled avionics bay, the compartment temperature is calculated in a manner similar to that used for the interface heat exchanger.

Temperatures into and out of the other components (pump, fuel cell heat exchanger, etc.) are calculated in a similar manner and the results printed.

3.3 Radiator/Evaporator Expendable Usage

A section has been added to the program to determine the maximum nominal and minimum evaporating rates of expendables required to supplement the radiator over an entire orbit. The program calculates steady state performance at discrete orbital positions.

The inputs required are the vehicle heat loads, coolant flow rate, radiator characteristics (α, ϵ, Area, etc.), evaporator characteristics, and the radiator influx versus orbital position. It is assumed that the influx is modified to account for radiator mass.

The program sums the vehicle heat loads, finds the radiator influx for the orbital position, and calculates radiator outlet temperature. If the temperature is higher than the required temperature, a secondary sink is used:

a. Sublimator

b. Flash Evaporator

c. Cryogenic Heat Exchanger

If a sublimator is used, a convergence loop is used to find the proper load split between the radiator and sublimator.

The program prints the average rate of expendable usage as well as the radiator inlet and outlet temperatures and the rate of expendable usage for each orbital position. Up to 30 steps may be used for each orbit.

3.4 Component Weights

The weights printed for each subsystem are a buildup of the individual component weights within the subsystem. Generalized routines are used to calculate fan weights, as a function of flow and pressure rise; valve weights, as a function of type and flow; heat exchanger weights, as a function of UA, etc. In addition, fixed weights for items such as controllers, disconnects, accumulators, etc., are added. Finally, a structural weight factor is included to account for packaging consideration. Since heat exchangers usually include mounting provisions as an integral part of their design, structural weight factors are not applied to heat exchangers as the basic weight models include these mounting provisions. Table 3-1 shows the general weight equations used for the subsystem weights. Table 3-2 shows a breakdown of the subsystems, what components are included within each subsystem, and the source of weight values - F, for fixed weight that does not change with various conditions and P, for weight values calculated by the program as a part of the optimization process. All symbols are described in Appendix I.

TABLE 3-1
WEIGHT EQUATIONS

Subroutine		Weight Equations
FEVAP	WT =	(FWT(L)*CFT(L)+FXW(L))*SWT(L)
	WH2O =	QR/965
LIOH	WT =	(WL*FWT(J) +FXW(J)+2. *WTM)*SWT(J)
	WL =	WCO2*DAY*1.145
RAD	WT =	AR*SWT(J) + FXW (J)
CHX	WT =	FWT(J)*UA+(FXW(J)+WTV)*SWT(J)
EBAY	WTHX=	FWT(J)*UA+FXW(J)*SWT(J)
	WTFAN =	(FWT(J+1)*(WTF+WTK)+FXW(J+1))*SWT(J+1)
HSC	WTS =	(FWT(J)*(WBS+WTX+WTV)+FXW(J)+WVC)*SWT(J)
	WTF =	(WTF+3.*WTK)*SWT(12)
	WTV =	VACUUM VALVE WT.
	WTC =	CONTROL VALVE WT.
	WTX =	CANISTER WT.
	WUS =	83.4*RHO*DAY*WBS/CYCL
CONT	WT =	[WTB*FWT(J)+WTV)+FXW(J)] *SWT(J)
EBAY2	WTHX =	[FWT(J)*UA+FWX(J)*SWT(J)] *2.
	WTFAN =	[(FWT(J+1)*(WTF+WTK)+FXW(J+1))*SWT(J+1)] *2.
SHX	WT =	FWT(J)*UA+FXW(J)+WTV*SWT(J)
PUMP WT	WT =	$\left[(WC/RHO*.0748*DP)^{0.4}*FWT(J)+FXW(J)\right]$ *SWT(J)
INTER. HX WT	WT =	CFT(J)*FWT(J)+FXW(J)

TABLE 3-1 (CONT)
WEIGHT EQUATIONS

Subroutine			Weight Equations
SUBL. WT	WT	=	FWT(J)*UA+FXW(J)*SWT(J)
	WSUB	=	Q/1065.*TSUB
CRYO. HX	WT	=	FWT(J)*CFT(J)+FXW(J)*SWT(J)
	WHYD	=	Q/1440*TCRY
F/C HX&GSEHX	WT	=	UA*FWT(J)+FXW(J)*SWT(J)
EXPEND WT	WT	=	Q*FEXP
COND FAN	WT	=	(FWT(J)*(WCF+WCV)+.9*WCF+FXW(J))*SWT(J)
SENS FAN	WT	=	(FWT(J)*(WSF+WSV)+.9*WSF+FXW(J))*SWT(J)
VENT FAN	WT	=	FWT(J)*WTF

All Symbols Explained in Appendix 1.

TABLE 3-2
COMPONENT AND SUBSYSTEM LISTING

Subsystem Component	No. Required	Weight Source
Water Removal/Condenser		
HX	1	P
Temperature Control Valve (If no sens. HX)	1	P
Temperature Controller (Dual)	1	F
W/S Gutter/Duct	1	F
Sensible HX		
HX	1	P
Temperature Control Valve (Air)	1	P
Temperature Controller (Dual)	1	F
Water Separator		
W/S	1	F
Air Check Valves	2	F
H_2O Check Valves	2	F
Water Loop Pump Package		
Water Pump	3	P
Check Valves	3	F
Accumulator	3	F
Filters	2	F
Valve, Shutoff, Manual	2	F
Potable H_2O	1	F
Chiller	1	F

C

TABLE 3-2 (CONT)
COMPONENT AND SUBSYSTEM LISTING

Subsystem Component	No. Required	Weight Source
Disconnects, Liquid	5	F
Disconnects, Gas	3	F
Low Pressure Sensor	2	F
Pump Switchover	1	F
Interface HX		
HX's	2	P
Pumps Freon Loop		
Water Pump	3	P
Check Valves	3	F
Accumulator	3	F
Filter	2	F
Valve, Shutoff Solenoid	2	F
Disconnects, Liquid	5	F
Disconnects, Gas	3	F
Low Pressure Sensor	2	F
Pump Switchover	1	F
Water Evaporator - Sublimator		
HX	2	P
Shutoff Valves, Solenoid	4	F

TABLE 3-2 (CONT)
COMPONENT AND SUBSYSTEM LISTING

Subsystem/Component	No. Required	Weight Source
Shutoff Valves, Manual	5	F
Pressure Regulators	3	F
CO_2 Control - LiOH		
Cartridges	P	P
Valves, Shutoff, Manual	2	P
Ventilation Fans		
Fans	2	P
Silencer/Screen	1	P
Condenser Fans		
Fan	3	P
Check Valve	3	P
Silencer/Screen (.9 Fan)	1	P
Sensible Fans		
Fan	3	P
Check Valve	3	P
Silencer/Screen (.9 Fan)	1	P
Contaminate Control		
Cartridge	1	P
Check Valve	1	P

TABLE 3-2 (CONT)
COMPONENT AND SUBSYSTEM LISTING

Subsystem Component	No. Required	Weight Source
Avionics Bay - Water Cooled		
HX	1	P
Fan	3	P
Check Valve	3	P
Fan Speed Sensor		
Avionics Bay - Freon Cooled		
HX	1	P
Fan	3	P
Valve Check	3	P
Fan Speed Sensor	3	F
Fuel Cell HX		
HX	3	P
Cryo Hx		
HX	2	P
Valve, Shutoff Solenoid	6	F
Valve, Control	3	F
Temperature Controller	2	F
Water Evaporator - Flash		
HX	2	P
Solenoid Shutoff Valves	4	F

TABLE 3-2 (CONT)
COMPONENT AND SUBSYSTEM LISTING

Subsystem/Component	No. Required	Weight Source
Manual Valves	4	F
Temperature Controllers	2	F
Other		
Chiller (with water pumps)	1	F
Cooler (with water pumps)	1	F
GSE Cooling		
HX	1	P
Disconnects	2	F
Cold Plates		
HS-C Subsystem		
Beds & Canisters	4	P
Valves, Cycling	4	P
Valves, Vacuum	4	F
Timer (triple)	1	F
Humidity Control Valve	1	P
Humidity Controller (Dual)	2	F
Humidity Sensor	3	F
Gas Actuator Valves	8	F
Radiator		
Panels	1	P
Hinge, Valves, Controls, Orifices, Etc.	1	F

3.4 (Continued)

In order to run the HS-C or the orbital transient programs, tables of input data must be stored in the computer. Tables are set up in accordance with the following format.

X ~ Name of data block where table is stored

I ~ Location of first item in table within X

X(1) ~ Table or curve number

X(I+1) ~ Degree Interpolation choice (1, 2 or 3)

X(I+2) = NX Number of X values

X(I+3) = NY Number of Y values

X(I+4) "X" Values in ascending order

X(I+4+NX) "Y" Values in ascending order

X(I+4+NX+NY) "Z" Values in the following order

Z(1,1), Z(1,2), Z(1,3), --------------- Z(1,NY)

Z(2,1), Z(2,2), Z(2,3), --------------- Z(2,NY)

Z(NX,1), Z(NX,2), Z(NX, 3)----------- Z(NX,NY)

SECTION 4.0
OPERATING PROCEDURES

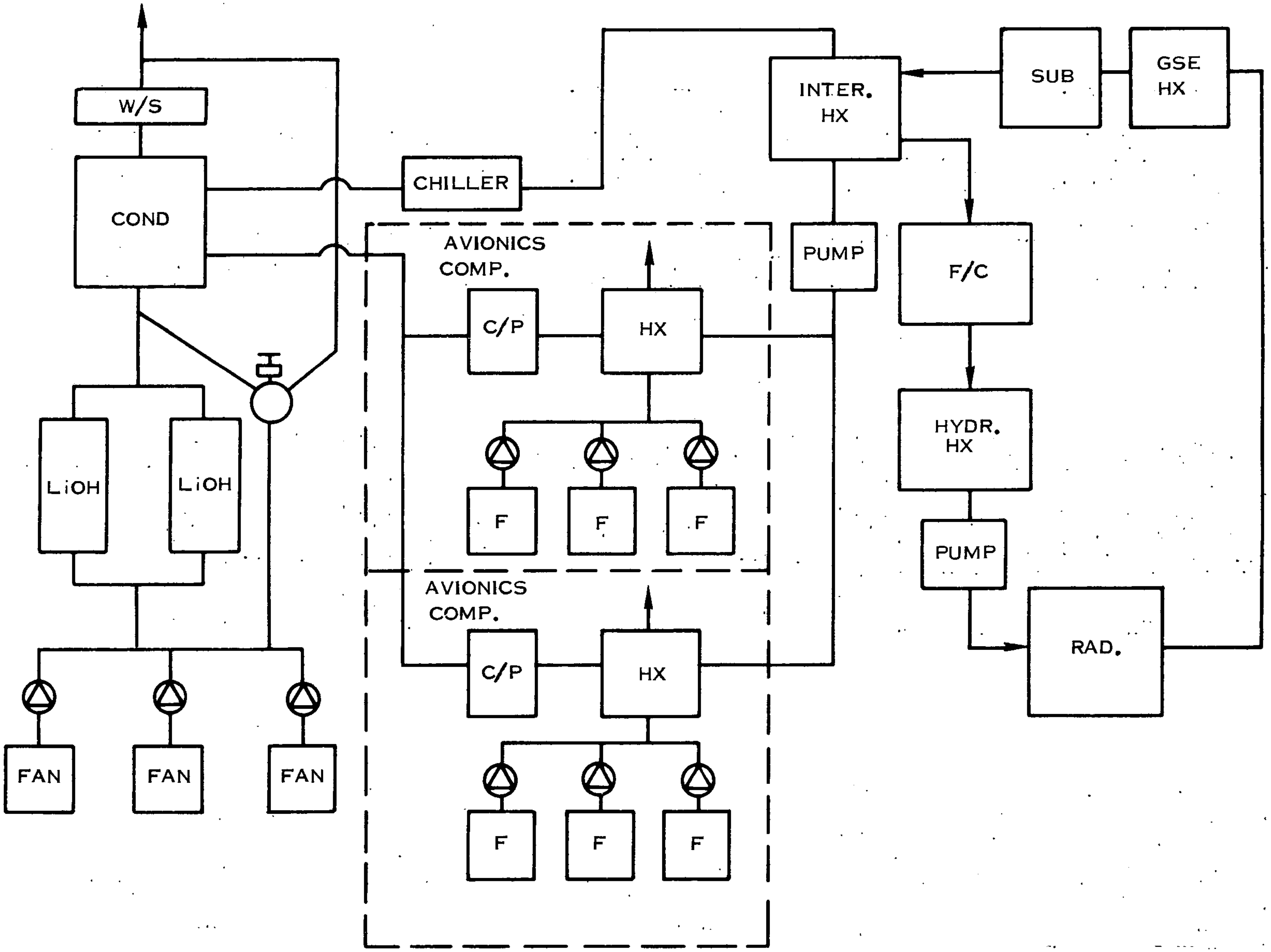
4.0 OPERATING PROCEDURES

4.1 How To Set Up The Deck

The data cards are set up as shown in Figure 4-1. The object of source deck with the system control cards are denoted by (1). The next card (2), the first data card, is a "comment" card. This card will be printed with the case. It must not be blank. The rest of the data for the first case is denoted by (3). The last card of (3) has a "minus" in the second field. This denotes the fact that this is the last data card for a particular case. The next case consists of another comment card (4) and what ever data it is desirable to change from the previous case. This is shown as (5). Again the last card in (5) has a "minus" in the second field. A run is ended by putting a blank card (6) at the end of the last case.

All of the data cards with the exception of the "comment" card, are set up according to the format shown in Figure 4-2. A card is divided into 8 fields. The first field is one (1) digit long. In this field a number is noted telling the load routine how many pieces of input are on this card. The digit will be between 0 and 5. The second field is the location in the input data block into which the first piece of information will be loaded. This field extends from the second digit to the 12th digit. A minus sign in this field will terminate a case.

Field 3 contains the first piece of input data which is loaded into the location given in the second field. The number may be punched anywhere within the field and must contain a decimal point. Data in fields 4, 5, 6, and 7 are loaded into sequential locations in the data block. The last field, locations 73 and 80 may be used as a



NR SCHEMATIC

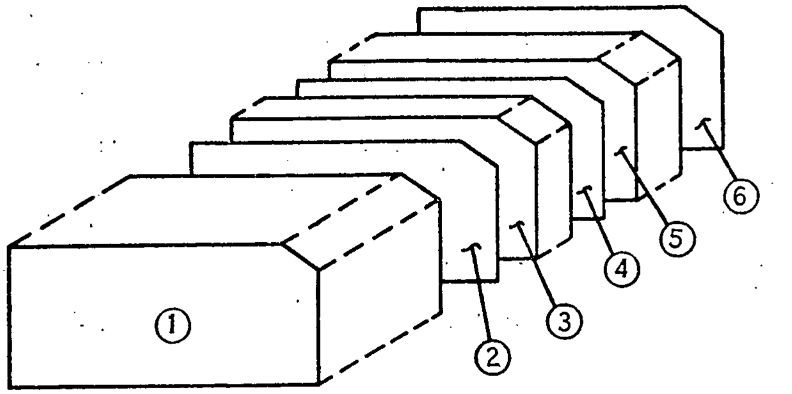


FIGURE 4–1 DECK SET UP

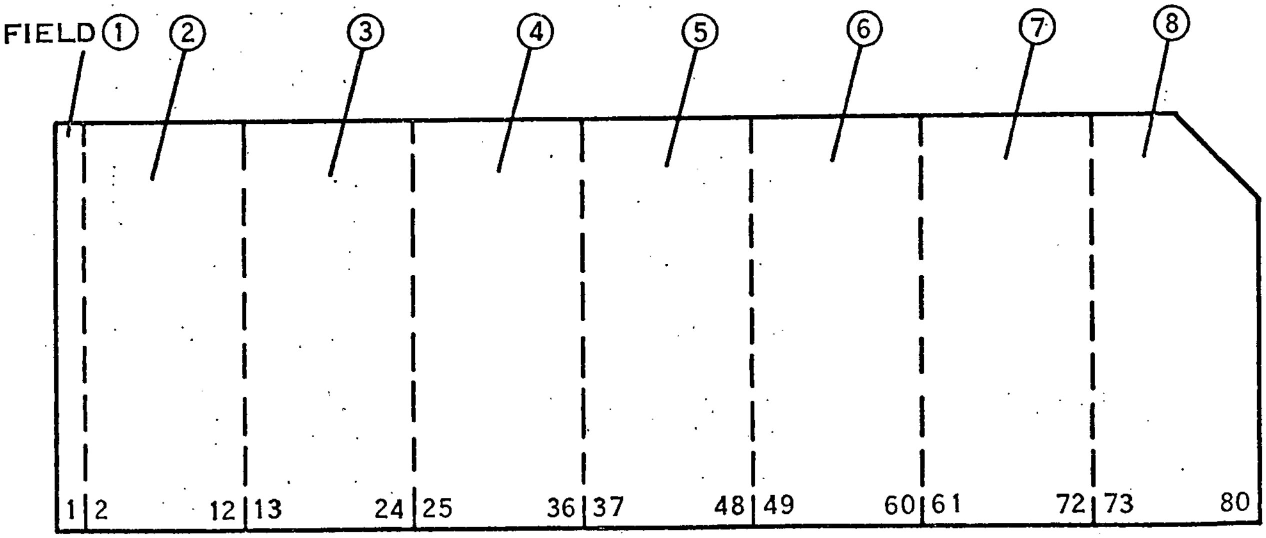


FIGURE 4–2 COMPUTER CARD SETUP

4.1 (Continued)

label. It is not examined by the computer and may contain any alpha-numeric character desired.

If a number does not appear in the second field, the data will be loaded into sequential locations from the previous piece of data input. The first data card in the case must have a location to place the data in the second field.

Definition of input data including location and units are described in the next Section 4.2. Input required for a typical case is shown in Figure 4-3. If a second case is added after the first case, the only input data that must be inputed is that desired to be changed. In the case shown in Figure 4-3, the cabin temperature is changed from 65°F to 70°F.

4.2 Program Input and Output

4.2.1 Input Definition

The following information provides the input definition for operating the program. Information includes location, symbols, the printed label, description, and unit. An explanation of all symbols is presented in Appendix I. Typical printouts of the input data are shown in Figures 4-4, 4-5, and 4-6 for a sizing case, performance case, and an orbital transient case, respectively.

HSF – 1199A 9 63

INPUT DATA SHEET

NAME R. Balinskas MAIL ADDRESS ______ TEL. EXT. ______

PROGRAM NO. H247 TITLE ______ ESTIMATED COMPUTER TIME ______ SHEET 1 OF 2

JOB NO. ______ KEYPUNCHER: 1. Do not verify title cards. COMPUTER MODEL ______

2. Observe dotted lines only for numbers containing "E."

PROGRAM INFO		INPUT DATA					LABEL
n	LOCATION NO.	1	2	3	4	5	
1	3	13 · 21	25 · 33	37 · 45	49 · 57	61 · 69	73 · 80
	MULSS SIZING CASE MAX HEAT LOAD TCAB = 65						
5	1.	65.	14.5	53.3	34.	1600.	
5	6.	1.	.25	62.4	85.	13.2	
5	11.	7.	2070.	6700.	1230.	17500.	
5	16.	0.	23000.	4200.	1.	2.	
5	21.	2.	.01	24000.	2.	15.	
5	26.	15.	1.	1.	.73	1.	
5	31.	2.	0.	.16	.0013	0.	
5	36.	0.	20.	1.04	0.	0.	
5	41.	2.25	1.3	40.	60.	2.25	
5	46.	.5	459.	.24	900.	.16	
5	51.	0.	0.	0.	0.	120.	
5	56.	120.	1.3	1.3	0.	1.19	
5	61.	2.	120.	.16	0.	30.	
5	66.	0.	0.	.04	0.	2.	
5	71.	0.	0.	4.	0.	115.	
5	76.	150.	1.	.9	0.	0.	
1	100.	1.					
5	101.	.0632	.0432	0.	3.	.022	
5	106.	3.	5.22	.08	1.785	2.5	
5	111.	3.	2.	1.	4.	1.	
5	116.	.0432	3.	.052	3.	.0231	
5	121.	.011	.001	0.	.08	.0082	

SP 01T72

HSF – 1199A 9 63

INPUT DATA SHEET

NAME R. Balinskas MAIL ADDRESS TEL. EXT.

PROGRAM NO. H247 TITLE ESTIMATED COMPUTER TIME SHEET 2 OF 2

JOB NO. KEYPUNCHER: 1. Do not verify title cards. 2. Observe dotted lines only for numbers containing "E." COMPUTER MODEL

PROGRAM INFO n	LOCATION NO.	INPUT DATA 1	2	3	4	5	LABEL
1	3	13 – 21	25 – 33	37 – 45	49 – 57	61 – 69	73 – 80
5	126.	0.	0.	0.	0.	0.	
5	131.	18.3	10.5	12.3	45.55	0.	
5	136.	44.0	999.	22.1	0.	0.	
5	141.	0.	0.	0.	44.3	0.	
5	146.	0.	0.	0.	0.	0.	
5	151.	.8	30.	0.	0.	26.6	
5	156.	0.	0.	0.	0.	0.	
5	161.	1.25	1.25	1.25	1.25	1.0	
5	166.	1.25	1.35	1.25	1.15	1.0	
5	171.	1.25	1.25	1.25	1.15	1.15	
5	176.	1.25	1.25	1.25	1.25	1.0	
5	181.	1.0	1.25	1.0	1.25	1.25	
5	186.	1.	1.	1.	1.	1.	
5	221.	0.	0.	0.	.20	0.	
5	226.	.22	0.	0.	.6	.35	
5	231.	.35	.35	0.	0.	0.	
5	236.	0.	.35	0.	.35	.0	
0	-1.						
	MULSS SIZING CASE TCAB = 70						
1	1.	70.					
0	-1.						

SP 01T72

MULSS SIZING CASE MAX HEAT LOAD TCAB = 65   DATE 10/11/72   TIME 18-54-57

INPUT DATA

65.00	TCAB	14.50	PCAB	53.30	PGAS	34.000	TRADO	1600.00	WRAD	1.00	CPCOOL	0.25	CPRAD	62.40	RHOC
85.00	RHOR	13.20	WCO2	7.00	DAYS	2070.0	QSMET	6700.0	QSENE	1230.0	QLMET	17500.0	QCP1	0.0	QCP2
23000.0	QFCELL	4200.0	QSUBL	1.0	KEY CO2	2.0	KEY H2O	2.00	DTIHX	0.010	TOLP	24000.0	TVENT	2.000	DAYEM
15.00	NO TRAD	15.00	NO TIHO	1.00	BLANK	1.00	NO QLAT	0.730	RHMAX	1.00	WC/WR	2.0000	DT RADO	0.0	EF FC
0.1600	PPFIX	0.00130	PPVAR	0.0	KEY HXS	0.0	KEY OPT	20.0000	NO WC	1.0400	FACT WC	0.0	KEY RAD	0.0	KEY CON
2.25	DP H2O	1.30	DP SHX	40.00	DP CP	60.00	DP RP	2.25	DP CO2	0.50	DP VENT	459.00	T SINK	0.24	CPA
900.00	AMAX	0.16	FEXP	0.0	QAMIN	0.0	QCPM	0.0	QE1	0.0	QE2	120.00	TE1	120.00	TE2
1.30	DPE1	1.30	DPE2	0.0	F RAD	1.19	F CO2	2.00	FN CO2	120.00	TCMAX	0.160	CO2L	0.0	EFH2O
30.0	CYCLE	0.0	QEB2												
0.0	QCHIL	0.040	TOLQ	0.0	WF/C	2.0	KEYSK	0.0	WCOOL	0.0	TIFXI	4.00	TIMECY	0.0	TIMESB
115.00	TFCI	150.00	TFCO	1.0	NUBFRH	0.9000	EMIS	20.0	STEP	0.0	TORBIT	1.0	PERF		

COMPONENT WEIGHT FACTORS

	COND	SENHX	W/S	PUMPC	HXINT	PUMPR	RAD	SUB	LIOH	VENT	FANC	FANS	C	HSC	CONTM
	0.0632	0.0432	0.0	3.0000	0.0220	3.0000	5.2200	0.0800	1.7850	2.5000	3.0000	2.0000	1.0000	4.0000	1.0000
SUBSYSTEM FIXED WT	18.30	10.50	12.30	45.55	0.0	44.00	959.00	22.10	0.0	0.0	0.0	0.0	0.0	44.30	0.0
STRUCTURAL WT FACTORS	1.2500	1.2500	1.2500	1.2500	1.0000	1.2500	1.3500	1.2500	1.1500	1.0000	1.2500	1.2500	1.2500	1.1500	1.1500

COMPONENT WEIGHT FACTORS

	EBHX1	EBFAN1	EBHX2	EBFAN2	FCHX	GSEHX	CRYHX	CHILL	SUBLT	FEVAP	A	B
	0.0432	3.0000	0.0520	3.0000	0.0231	0.0110	0.0010	0.0	0.0800	0.0082	0.0	0.0
SUBSYSTEM FIXED WT	0.0	0.0	0.0	0.0	0.0	0.8000	30.0000	0.0	0.0	26.6000	0.0	0.0
STRUCTURAL WT FACTORS	1.2500	1.2500	1.2500	1.2500	1.0000	1.0000	1.2500	1.0000	1.2500	1.2500	1.0000	1.0000

FIGURE 4–4. SIZING CASE INPUT

```
PERFORMANCE                                                            DATE 10/11/72     TIME 18-55-33

 INPUT DATA
    70.00 TCAB        14.50 PCAB         53.30 PGAS         34.000 TRADO     1600.00 WRAD          1.00 CPCOOL        0.25 CPRAD        62.40 RHOC
    85.00 RHOR        13.20 WCO2          7.00 DAYS        2070.0 QSMET      6700.0 QSENE      1230.0 QLMET      17500.0 QCP1           0.0 QCP2
 23000.0 QFCELL     4200.0 QSUBL          1.0 KEY CO2        2.0 KEY H2O       2.00 DTIHX        0.010 TOLP       24000.0 TVENT        2.000 DAYEM
    15.00 NO TRAD     15.00 NO TIHO       1.00 BLANK          1.00 NO QLAT     0.730 RHMAX         1.00 WC/WR       2.0000 DT RADO    0.0      EF FC
  0.1600 PPFIX     0.00130 PPVAR         0.0   KEY HXS   0.0      KEY OPT 20.0000 NO WC      1.0400 FACT WC    0.0      KEY RAD    0.0      KEY CON
     2.25 DP H2O       1.30 DP SHX       40.00 DP CP        60.00 DP RP        2.25 DP CO2        0.50 DP VENT    459.00 T SINK        0.24 CPA
   900.00 AMAX         0.16 FEXP          0.0  QAMIN         0.0  QCPM         0.0 QE1           0.0 QE2        120.00 TE1         120.00 TE2
     1.30 DPE1         1.30 DPE2          0.0  F RAD         1.19 F CO2        2.00 FN CO2      120.00 TCMAX        0.160 CO2L       0.0     EFH2O
     30.0 CYCLE         0.0 QEB2
     0.0  QCHIL       0.040 TOLQ         657.1 WF/C          2.0 KEYSK      1946.6 WCOOL         39.4 TIFXI         4.00 TIMECY       0.0   TIMESB
   115.00 TFCI       150.00 TFCO           1.0 NUBFRH    0.9000 EMIS          20.0 STEP          0.0  TORBIT        2.0 PERF

COMPONENT POWERS -WATTS
     0.0       0.0       0.0      84.54     0.0     338.53     0.0      0.0       0.0       0.0     411.60     0.0       0.0       0.0       0.0
     0.0       0.0       0.0       0.0      0.0      0.000     0.000********  0.000     0.000    -0.000     0.000*****************   -0.000

COMPONENT FACTORS-UA,EFF,ETC.
  2300.04      0.0       0.0       0.20 7504.62     0.22   889.83 1352.48    0.60      0.35      0.35      0.35      0.0       0.0       0.0
     0.0       0.35      0.0       0.35 3962.73   857.67   221.11********  649.60      0.00********  15.00      0.00-4165.94-3433.13

 COMPONENT FLOW RATES-CFH
32653.9 CONDF        0.0 SENF        0.0 AVFANH      0.0 AVFANR      0.0 VENTF     3960.0 LIDH
```

FIGURE 4–5. PERFORMANCE CASE INPUT

```
                                                                              DATE 10/11/72       TIME 18-55-34
H2O REQUIRED

INPUT DATA
    70.00 TCAB        14.50 PCAB       53.30 RGAS      34.000 TRADO    1600.00 WRAD        1.00 CPCOOL     0.25 CPRAD       62.40 RHOC
    85.00 RHOR        13.20 WCO2        7.00 DAYS     2070.0 QSMET     6700.0 QSENE     1230.0 QLMET   17500.0 QCP1          0.0 QCP2
 23000.0 QFCELL     4200.0 QSUBL        1.0 KEY CO2      2.0 KEY H2O      2.00 DTIHX       0.010 TOLP   24000.0 TVENT       2.000 DAYEM
    15.00 ND TRAD     15.00 NO TIHO     1.00 BLANK       1.00 NO QLAT     0.730 RHMAX      1.00 WC/WR     2.0000 DT RADO   0.0    EF FC
   0.1600 PPFIX    0.00130 PPVAR       0.0 KEY HXS   0.0    KEY OPT  20.0000 NO WC      1.0400 FACT WC   0.0    KEY RAD   0.0    KEY CON
     2.25 DP H2O       1.30 DP SHX     40.00 DP CP      60.00 DP RP       2.25 DP CO2      0.50 DP VENT  459.00 T SINK       0.24 CPA
   900.00 AMAX         0.16 FFXP       0.0 QAMIN       0.0 QCPM        0.0 QE1         0.0 QE2     120.00 TE1        120.00 TE2
     1.30 DPE1         1.30 DPE2       0.0 F RAD        1.19 F CO2        2.00 FN CO2   120.00 TCMAX     0.160 CO2L        0.0 EFH2O
     30.0 CYCLE        0.0 QEB2
      0.0 QCHIL      0.040 TOLQ     657.1 WF/C         2.0 KEYSK     1946.6 WCOOL        39.4 TIFXI      4.00 TIMECY      0.0 TIMESB
   115.00 TFCI      150.00 TFCO        1.0 NUBFRH    0.9000 EMIS        20.0 STEP         0.0 TORBIT     3.0 PERF
```

FIGURE 4–6. ORBITAL TRANSIENT CASE INPUT

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNIT
1	TCAB	TCAB	Cabin Temperature	°F
2	PCAB	PCAB	Cabin Pressure	psia
3	RA	RGAS	Cabin Atmosphere Gas Constant	ft/°F
4	TROIN	TRADO	Radiator Outlet Coolant Temp. a) If value is 0 and EX in location 36 is 0, program will find initial radiator outlet temp. b) If value is>0 and EX is 0, program will use input value as initial radiator outlet temp. c) If EX is>0, program will not optimize and will use input value for radiator outlet temp.	°F
5	WCIN	WRAD	Radiator Loop Coolant Flow Rate a) If value is>0 and EX in location 36 is 0, program will use input value as initial flow rate b) If EX is>0, program will not optimize and will use input value for flow rate	lb/hr
6	CPC	CPCOOL	Coolant Loop Specific Heat	BTU/lb/°R
7	CPR	CPRAD	Radiator Loop Specific Heat	BTU/lb/°R
8	RHOC	RHOC	Coolant Loop Density	lb/ft^3
9	RHOR	RHOR	Radiator Loop Density	lb/ft^3
10	WC02	WC02	CO_2 Generation Rate	lb/day
11	DAYN	DAYS	Normal Mission Length	days

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNITS
12	QSM	QSMET	Sensible Metabolic Heat Load	BTU/hr
13	QSE	QSENE	Cabin Air Heat Load (Q wall + Q elect)	BTU/hr
14	QLM	QLMET	Latent Metabolic Heat Load	BTU/hr
15	QCP1	QCP1	Coolant Loop Cold Plate Heat Load	BTU/hr
16	QCP2	QCP2	Radiator Loop Cold Plate Heat Load	BTU/hr
17	QFC	QFCELL	Fuel Cell Heat Load (Less Heat Load Due to EC/LSS Power)	BTU/hr
18	QSUBI	QSUBL	Heat Load Rejected by Flash Evaporator Sublimator Using Excess Fuel Cell Water	BTU/hr
19	M1	Key CO_2	CO_2 Removal Key a) 1 = LIOH b) 2 = Solid Amine (HS-C)	
20	M2	Key H_2O	Humidity Control Key b) 1 = Solid Amine c) 2 = Condenser	
21	DTX	DTIHX	Initial Temp. Difference Between Coolant and Radiator Loops	°F
22		TOLP	Not Used	
23	TVQL	TVENT	Minimum Cabin Ventilation Flow Req.	EHH
24	DAYE	DAYEM	Emergency Contingency Period	days

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNITS
25	RMAX	NO TRAD	Max. Times Thru Radiator Outlet Temp Loop	
26	HXIM	NO TIHO	Max. Times Thru Interface HX Outlet Temp Loop	
27		BLANK	Not Used	
28		NO QLAT	Not Used	
29	RHMAX	RHMAX	Max Allowable Cabin Relative Humidity	Decimal fraction
30	WRAT	WC/WR	Coolant/Radiator Loop Mass Flow (WC_P Coolant/WC_P Radiator)	
31	FW1	DT RADO	Increments of Radiator Outlet Temp (TRO Increased by this value each iteration)	°F
32	FW2	EFFC	Waste Heat Factor For Fuel Cell (Q waste heat/output power)	BTU/hr/watt
33	PPF	PPFIX	Fixed Power Penalty	lb/watt
34	PPV	PPVAR	Expendable Power Penalty	lb/watt hr
35	FW5	KEY HXS	Heat Exchanger Arrangement Key a) 0 = no sensible HX b) 1 = separate sensible HX	
36	EX	KEY OPT	Optimization Key a) 0 = optimize coolant flow rate and radiator outlet temp. b) 1 = no optimization - use input coolant flow rate and radiator outlet temp.	
37	EY	NO WC	Max Times Thru Coolant Flow Rate Loop	

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNITS
38	DWC	FACT WC	Factor Flow Rate is Increased by Every Iteration (new flow rate/ old flow rate)	
39	Not Used			
40	Not Used			
41	DP1	DP H_2O	ΔP Of Humidity Control Equip	In. H_2O
42	DP2	DP SHX	ΔP Of Sensible HX	In. H_2O
43	DP4	DP CP	ΔP Of Coolant Loop Pump	psi
44	DP6	DP RP	ΔP Of Radiator Loop Pump	psi
45	DP9	DP CO_2	ΔP Of CO_2 Removal Equip.	In. H_2O
46	DP10	DP VENT	ΔP Of Ventilation System	In. H_2O
47	TS	TSINK	Radiator Sink Temp.	°R
48	CPA	CPA	Cabin Atmosphere Specific Heat	ft/°R
49	AMAX	AMAX	Maximum Allowable Radiator Area	ft^2
50	FEXP	FEXP	Heat Rejection Expendable Weight Penalty Used to Top Radiator if Area Exceeds Max. Allowable	lb/BTU/hr
51	Not Used			
52	Not Used			
53	QE1	QE1	Air Cooled Electronic Bay in Coolant Loop Heat Load (less fan)total	BTU/hr
54	QE2	QE2	Air Cooled Electronic Bay in Radiator Loop Heat Load (less fan)	BTU/hr

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNITS
55	TE1	TE1	Air Cooled Electronic Bay In Coolant Loop Max. Air Temp.	°F
56	TE2	TE2	Air Cooled Electronic Bay In Radiator Loop Max. Air Temp.	°F
57	DPE1	DPE1	ΔP Of Fan In Coolant Loop Elect. Bay	in. H_2O
58	DPE2	DPE2	ΔP Of Fan In Radiator Loop Elect. Bay	in. H_2O
59	FRAD	FRAD	0. - Calculates RAD Area 1. - Uses RAD Area in 49.	
60	FCO2	FCO2	LiOH Heat Load Factor Acutal Production Rates / Ave. Production Rate	
61	FNCO2	FN CO2	No. of LiOH Cans on Line	
62	TCMAX	TCMAX	Max. Allowable Coolant Temp. Out Of Cold Plates	°F
63	CHSB	CO2L	HSC CO_2 Loading	lbs/lb
64	Not Used			
65	CYCL	CYCL	HSC 1/2 Cycl Time	minutes
66	QEB2	QEB2	Heat load of Second EBAY in series - Cabin Loop	BTU/Hr
67	QCHIL	QCHIL	Low Temp. Chiller Heat Load	BTU/Hr
68	TOLQ	TOLQ	Tolerance on Sensible Heat Load Converg	decimal fraction
69	WFC	WFC	Fuel Cell Coolant Mass Flow Rate	BTU/Hr-°F

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNITS
70	RN	NR	Heat Rejection Sink 1 - RAD + SUB 2 - RAD + CRY 3 - RAD + FLASH EVAP 4 - SUB 5 - CRYO 6 - FLASH EVAP	
71	WC	WC	Calculated Optimum Flow Rate (Used for off design Performance)	
72	TZ	TIFXI	Freon Loop Control Temp (into int HX)	°F
73	TCRY	TCRY	Time Cry. HX is Used @ Full Heat Load	hrs.
74	TSUB	TSUB	Time Sublimator or Flash Evaporator is Used that H_2O Must be Supplied	hrs.
75	TFCI	TFCI	Temp. of Fluid Entering F/C	°F
76	TFCO	TFCO	Temp. of Fluid Leaving F/C	°F
77	FRESH	NFREH	No. of Fresh LiOH Cart. On Line	
78	EMIS	EMIS	Radiator Emissivity	
79	STEP	STEP	No. of Steps Taken to Determine Radiator Topping Requirements	
80	TAU	TIME	Time Required for 1 Orbit	hrs.
100	PERF	PERF	1 - Sizing Program 2 - Performance Program 3 - Radiator/Evaporator Sizing	
101	FWT (1)	COND	Component Weight Factors Condenser - Weight/UA	lb/btu/hr/°F

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNITS
102	FWT (2)	SENHX	Sensible Heat Exchanger - Weight/UA	lb/btu/hr/°F
103	(3)	W/S	Water Separator	
104	(4)	PUMPC	Coolant Pump - No. of Pumps	
105	(5)	HXINT	Interface HX - Weight/UA	lb/btu/hr/°F
106	(6)	PUMPR	Radiator Pump - No. of Pumps	
107	(7)	RAD	Radiator - Area/WC_P (B-C)	ft^2/btu/hr/°F
108	(8)	SUB	Sublimator - Weight/UA	lb/btu/hr/°F
109	(9)	LiOH	LiOH - Packaging Factor For Canisters	
110	(10)	VENT	Ventilation Fans - No. of Fans	
111	(11)	FANC	Condenser Fan - Number	
112	(12)	FANS	Sens. HX Fan - Number	
113	(13)	MC	Molecular Sieve - Not Used	
114	(14)	HSC	Number of Canisters	lb
115	(15)	CONTM	Charcoal Canister - pkg Factor for Canister	
116	(16)	EBHXI	Coolant Loop Elect Bay HX Weight/UA	lb/btu/hr/°F
117	(17)	EBFANI	Coolant Loop Elect Bay Fan - Number of Fans	
118	(18)	EBHX2	Radiator Loop Elect Bay HX - weight/UA	lb/btu/hr/°F
119	(19)	EBFAN2	Radiator Loop Elect. Bay Fan Number of Fans	

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNITS
120	FWT (20)	FCHX	Fuel Cell HX	lbs/btu/hr/°F
121	(21)	GSEHX	GSE HX - Not Used	lbs/btu/hr/°F
122	(22)	CRYHX	Cryogenic H_2 HX	lbs/btu/hr/°F
123	(23)	CHILL	Low Temp Chiller - Not Used	
124	(24)	SUBLT	Topping Sublimator	lbs/btu/hr/°R
125	(25)	FLASH	Flash Evap	lbs/btu/hr/°R
131	FXW (1)	COND	Subsystem Fixed Weight Condenser	lb
132	(2)	SENHX	Sensible Heat Exchanger*	lb
133	(3)	W/S	Water Sep *	
134	(4)	PUMPC	Coolant Loop *	lb
135	(5)	HXINT	Interface HX	lb
136	(6)	PUMPR	Radiator Loop Pump *	lb
137	(7)	RAD	Radiator - Weight of Hinge For Fold Out	lb
138	(8)	SUB	Sublimator	lb
139	(9)	LiOH	LiOH *	lb
140	(10)	VENT	Ventilation Fans - Not Used	
141	(11)	FANC	Condenser Fan	lb
142	(12)	FANS	Sensible Fan	lb
143	(13)	C	Not Used	lb
144	(14)	HSC	HSC Fixed Wt.	lb

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNITS
145	FXW (15)	CONTM	Charcoal Canister	lb
146	(16)	EBHX1	Coolant Loop Elect. Bay HX*	lb
147	(17)	EBFAN	Coolant Loop Elect. Bay Fan*	lb
148	(18)	EXHX2	Radiator Loop Elect. Bay HX*	lb
149	(19)	EBFAN2	Radiator Loop Elect. Bay Fan*	lb
150	(20)	FCHX	Fuel Cell HX	lb
151	(21)	GSEHX	GSE HX	lb
152	(22)	CRYHX	Cryogenic HX	lb
153	(23)	CHILL	Not Used	
154	(24)	SUBLT	Not Used	
155	(25)	FLASH	Flash Evaporator	
161	SWT (1)	COND	Structural Weight Factors Condenser Fans	
162	(2)	SEN HX	Sensible HX & Process Flow Fans	
163	(3)	WS	Water Sep *	
164	(4)	PUMPC	Coolant Loop Pump	
165	(5)	HXINT	Interface HX	
166	(6)	PUMPR	Radiator Loop Pump	lb/ft^2
167	(7)	RAD	Radiator	
168	(8)	SUB	Sublimator	

* Program Factors Fixed wt by Structure wt Factor
FXW (n) * SWT (n)

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNIT
169	(9)	LIOH	LiOH	
170	(10)	VENT	Ven tilation Fans	
171	(11)	FANC	Condenser Fan	
172	(12)	HSB	Sensible Fan	
173	(13)	MS	Not Used	
174	(14)	H2DP	HSC	
175	(15)	CONTM	Charcoal Canister	
176	(16)	EBHX1	Coolant Loop Elect. Bay HX	
177	(17)	EBFAN1	Coolant Loop Elect. Bay Fan	
178	(18)	EBHX2	Radiator Loop Elect. Bay HX	
179	(19)	EBFAN2	Radiator Loop Elect. Bay Fan	
180	(20)	FCHX	Fuel Cell HX's	
181	(21)	GSEHX	Not Used	
182	(22)	CRYHX	Cryogenic HX	
183	(23)	CHILL	Not Used	
184	(24)	SUBLET	Not Used	
185	(25)	FLASH	Flash Evaporator	
191-220	PW (30)	PW (30)	Power Table For All Components	
221-250	CFT (30)	CFT (30)	Component Factors (UA, η, Etc.)	
426-500	T (75)	Not Printed	Table of HSC Performance (Water Loading VS Partial Press and Air Flow/lb Bed)	

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNITS
351-425	-	Not Printed	CO_2 Bed Loading Vs Air Flow LB Bed & PCO_2	
221	CFT (1)		Condenser UA	BTU/Hr-°F
222	(2)		Sens HX UA	BTU/Hr-°F
223	(3)		-	
224	CFT (4)		Coolant Pump EFF	
225	(5)		Inter HX UA	BTU/Hr-°F
226	(6)		Radiator Loop Pump EFF	
227	(7)		RAD Area	Ft^2
228	(8)		Sublimator UA	BTU/Hr-°F
229	(9)		LiOH Removal EFF of CO_2	
230	(10)		Vent Fan EFF	
231	(11)		Condenser Fan EFF	
232	(12)		Sensible Fan EFF	
233	(13)		-	
234	(14)		HSC Bed Size	Lbs
235	(15)		-	
236	(16)		EBHX UA	BTU/Hr-°F
237	(17)		EBFAN EFF	
238	(18)		EBHX2 UA	BTU/Hr-°F
239	(19)		EBFAN 2FF	
240	(20)		Fuel Cell HX UA	BTU/Hr-°F

LOCATION	PROGRAM SYMBOL	PRINTED LABEL	DESCRIPTION	UNITS
241	(21)		-	
242	(22)		CRY. HX UA	BTU/Hr-°F
243	(23)		-	
244	(24)		Topping Sub UA	BTU/Hr-°F
245	(25)		Flash Evap UA	BTU/Hr-°F
251	V11		Condenser Fan Air Low Rate	CFH
252	V12		Sensible Fan Air Flow Rate	CFH
253	V9		LiOH Air Flow Rate	CFH
254	V10		Ventilation Fan Air Flow Rate	CFH
255	V17		Cabin Loop Cooled Avion. Bay Fan Flow	CFH
256	V19		Radiator Loop Cooled Avion. Bay Fan Flow	CFH
301-350			Radiator Influx vs Orbit Position	
501-517			Qmetabolic Table	

4.2.2 Program Output

The program output can be separated by the type of case that is run:

a. Sizing

b. Off-Design Performance

c. Orbital Radiator/Evaporator Transient

For all cases, the input data in locations 1 - 100 (that are used) are printed. The labels are described in the table that describes the input data.

For the sizing program, the Weight factors (FWT, FXW, & SWT) are printed under the component name and in component order: from 1 to 15 and from 16 to 27. Tables of optimization results are printed in the following order:

1. Optimization of the interface heat exchanger outlet coolant temperature for each radiator outlet temperature.
2. A summary table of the optimum total equivalent weight for each radiator outlet temperature at a given flow rate.
3. A summary table of the optimum total equivalent weight for each flow rate.

Lastly, the results of the optimum condition are printed so that a flow chart can be produced.

E

4.2.2 (Continued)

The labels that are printed with the output data are described in the following tables:

Table 4-1	Sizing Program
Table 4-2	Off-Design Performance Program
Table 4-3	Orbital Transient Program

As with the input, all labels and symbols are explained in Appendix 1.

Typical computer output printouts are shown in Figure 4-7, 4-8, and 4-9. These outputs are for the respective inputs which are shown in Figures 4-4, 4-5, and 4-6.

OUTPUT DATA

TOTEQWT	TINHXO	TOTPW	TOTWT	1871.8 WC	34.00 TRO
5827.0	36.0	790.4	5478.5		
5744.1	37.0	808.0	5388.0		
5723.8	38.0	827.5	5359.0		
5740.4	39.0	849.3	5366.0		
5805.1	40.0	849.3	5430.7		
6182.5	41.0	827.5	5817.7		

TOTEQWT	TINHXO	TOTPW	TOTWT	1871.8 WC	36.00 TRO
5677.2	36.0	790.4	5328.8		
5594.4	37.0	808.0	5238.2		
5574.1	38.0	827.5	5209.3		
5590.6	39.0	849.3	5216.2		
5655.4	40.0	849.3	5281.0		
6032.7	41.0	827.5	5668.0		

TOTEQWT	TINHXO	TOTPW	TOTWT	1871.8 WC	38.00 TRO
5527.5	36.0	790.4	5179.0		
5444.7	37.0	808.0	5088.5		
5424.3	38.0	827.5	5059.5		
5440.9	39.0	849.3	5066.5		
5505.6	40.0	849.3	5131.2		
5883.0	41.0	827.5	5518.2		

TOTEQWT	TINHXO	TOTPW	TOTWT	1871.8 WC	40.00 TRO
5377.7	36.0	790.4	5029.3		
5294.9	37.0	808.0	4938.7		
5274.6	38.0	827.5	4909.8		
5291.1	39.0	849.3	4916.8		
5355.9	40.0	849.3	4981.5		
5733.3	41.0	827.5	5368.5		

TOTEQWT	TINHXO	TOTPW	TOTWT	1871.8 WC	42.00 TRO
5228.0	36.0	790.4	4879.6		
5145.2	37.0	808.0	4789.0		
5124.8	38.0	827.5	4760.1		
5141.4	39.0	849.3	4767.0		
5206.1	40.0	849.3	4831.8		
5583.5	41.0	827.5	5218.7		

TOTEQWT	TINHXO	TOTPW	TOTWT	1871.8 WC	44.00 TRO
5114.2	37.0	808.5	4757.8		
5040.5	38.0	828.0	4675.5		
5037.1	39.0	849.9	4662.5		
5092.7	40.0	849.9	4718.0		
5491.5	41.0	828.0	5126.5		

OPTIMUM CONDITION 1871.8 WC

TOTEQWT	TRO	TINHXO	TOTPW	TOTWT
5723.8	34.0	38.0	827.5	5359.0
5574.1	36.0	38.0	827.5	5209.3
5424.3	38.0	38.0	827.5	5059.5
5274.6	40.0	38.0	827.5	4909.8
5124.8	42.0	38.0	827.5	4760.1
5037.1	44.0	39.0	849.9	4662.5

TOTEQWT	TINHXO	TOTPW	TOTWT	1946.6 WC	34.00 TRO
5883.4	36.0	790.8	5534.8		
5796.2	37.0	806.7	5440.6		
5768.9	38.0	824.3	5405.6		
5771.9	39.0	843.8	5399.9		
5802.1	40.0	865.6	5420.6		
5886.7	41.0	890.2	5494.3		
6426.0	42.0	843.8	6054.0		

TOTEQWT	TINHXO	TOTPW	TOTWT	1946.6 WC	36.00 TRO
5727.6	36.0	790.8	5379.0		
5640.5	37.0	806.7	5284.9		
5613.2	38.0	824.3	5249.8		
5616.1	39.0	843.8	5244.2		
5646.4	40.0	865.6	5264.9		
5731.0	41.0	890.2	5338.6		
6270.2	42.0	843.8	5898.3		

TOTEQWT	TINHXO	TOTPW	TOTWT	1946.6 WC	38.00 TRO
5571.9	36.0	790.8	5223.3		
5484.8	37.0	806.7	5129.2		
5457.4	38.0	824.3	5094.1		
5460.4	39.0	843.8	5088.4		
5490.7	40.0	865.6	5109.1		
5575.3	41.0	890.2	5182.9		
6114.5	42.0	843.8	5742.6		

FIGURE 4–7. SIZING CASE OUTPUT (SHEET 1 OF 3)

TOTFQWT	TINHXO	TOTPW	TOTWT 1946.6 WC	40.00 TRO
5416.2	36.0	790.8	5067.6	
5329.0	37.0	806.7	4973.4	
5301.7	38.0	824.3	4938.4	
5304.7	39.0	843.8	4932.7	
5335.0	40.0	865.6	4953.4	
5419.5	41.0	890.2	5027.1	
5958.8	42.0	843.8	5586.8	

TOTFQWT	TINHXO	TOTPW	TOTWT 1946.6 WC	42.00 TRO
5260.4	36.0	790.8	4911.8	
5173.3	37.0	806.7	4817.7	
5146.0	38.0	824.3	4782.6	
5148.9	39.0	843.8	4777.0	
5179.2	40.0	865.6	4797.7	
5263.8	41.0	890.2	4871.4	
5803.0	42.0	843.8	5431.1	

TOTFQWT	TINHXO	TOTPW	TOTWT 1946.6 WC	44.00 TRO
5186.1	37.4	813.0	4827.7	
5106.7	38.4	831.3	4740.3	
5092.6	39.4	851.6	4717.2	
5123.1	40.4	874.3	4737.7	
5251.1	41.4	874.3	4865.7	

TOTFQWT	TINHXO	TOTPW	TOTWT 1946.6 WC	46.00 TRO
5116.6	39.4	851.6	4741.2	
5070.8	40.4	874.3	4685.4	
5165.7	41.4	874.3	4780.3	

TOTFQWT	TINHXO	TOTPW	TOTWT 1946.6 WC	48.00 TRO
5265.2	41.4	874.3	4879.8	

OPTIMUM CONDITION 1946.6 WC

TOTFQWT	TRO	TINHXO	TOTPW	TOTWT
5768.9	34.0	38.0	824.3	5405.6
5613.2	36.0	38.0	824.3	5245.8
5457.4	38.0	38.0	824.3	5094.1
5301.7	40.0	38.0	824.3	4938.4
5146.0	42.0	38.0	824.3	4782.6
5092.6	44.0	39.4	851.6	4717.2
5070.8	46.0	40.4	874.3	4685.4
5265.2	48.0	41.4	874.3	4879.8

OPTIMUM CONDITIONS SUMMARY

TOTFQWT	WC	TRO	TINHXO	TOTPW	TOTWT
999999.0	1600.0	34.0	36.0	0.0	0.0
999998.0	1664.0	34.0	36.0	0.0	0.0
999997.0	1730.6	34.0	36.0	0.0	0.0
999996.0	1799.8	34.0	36.0	0.0	0.0
5037.1	1871.8	44.0	39.0	849.9	4662.5
5070.8	1946.6	46.0	40.4	874.3	4685.4

CONDENSER WEIGHTS 183.27 WTHX 12.28 MVALVE

CONDENSER FAN 9.58 FANWT 1.56 WTVK

RADIATOR SUBROUTINE

610.51 TIN 503.60 TOUT 517.60 TOUTC 895.14 ARADC 900.00 ARMAX 2207.44 WTREQ

FIGURE 4—7. SIZING CASE OUTPUT (SHEET 2 OF 3)

```
SYSTEM ITERATION WEIGHTS
   35.0 TIHXI      39.02 TIHXO    5037.13 TECWT    4662.48 TOTWT     849.91 TOTPW      65.00 TAOS       48.02 TAOC
  0.1653 PDPO     1871.8 WCOOL    159.896 WBCO2        0.0 WBDES        0.0 ULLPEN     895.1 ARAD     1048.19 WTEXP
    0.0 ULLDES       0.0 ULLCO2      50.3 DEW PT      65.0 TAOF11      65.0 TAOE12      65.0 TEB1       65.0 TEB2
   65.0 TAOE2

 H2OREM  HXSENS   W/S      PUMPC    HXINTF   PUMPR   RADWT    SUBLIM   CO2REM   VENT     CONTC    FAN C    FAN A    FAN MS
 221.49    0.0    15.37    69.95   165.63    78.55  2207.44   165.07   333.67    0.0     16.60    52.55     0.0      0.0

 EBHX1    EBFAN1   EBHX2    EBFAN2   FCHX     CRYHX    WTH2O    WTHYD    FEVAP    GSE
   0.0      0.0     0.0       0.0    88.77    37.72     0.0    150.63     0.0    10.85

 COMPONENT POWERS (WATTS)
H2OREM  SENSE    PUMPC    PUMPR    CO2REM   VENTF    EBAY1    EBAY2
 443.11   0.0    81.29   325.51     0.0      0.0      0.0      0.0

COMPONENT FLOW RATES CFM
    519.9 H2OREM       66.0 CO2REM          0.0 SENHX           0.0 VENT            0.0 CONTM        585.9 FAN C           0.0 FAN A
      0.0 EBAY1         0.0 EBAY2

 CABIN LOOP  TEMPERATURES
 39.02   65.39   65.39   65.39   65.39   65.39  102.79  103.38

 RADIATOR LOOP TEMPERATURES
 35.02   99.38   99.38   99.38  148.53  150.91   58.00   44.00   35.02

 HEAT LOADS
  CONDHX      SENSHX   INTERHX  FUELCELL  RADIATOR    EXP HX    TOTLAT   SENSCO2    LATCO2  SENSH2DP   LATH2DP   QSINK
  12337.4       0.0    30115.0   23000.0   43475.0    6551.2    1504.9     549.8     274.9       0.0       0.0
  54226.2

   EBAY1      EBAY2     SUBLIM
     0.0        0.0     4200.0
```

FIGURE 4–7. SIZING CASE OUTPUT (SHEET 3 OF 3)

```
LIOH SUBROUTINE-CO2 PARTIAL PRESSURES
  3.557 PMAX       2.247 PMIN      549.8 QS        274.9 QL
 RADIATOR SUBROUTINE
 610.29 TIN    498.97 TOUT   519.97 TOUTC   882.66 ARADC   900.00 ARMAX 2190.59 WTREQ

CRYOGENIC HX PERFORMANCE
   39.36 THOTCAL     6.82 WHYD        60.34 THYDC
   2295.12    2300.04     509.41        72.41       51.37       70.00

CONDENSER PERFORMANCE
  70.00 TCAB       72.41 TAIRI     51.37 TAIRC     478.2 HXCFM    53.58 TOPCAB  10718.7 QSENS   2070.0 QSMET    1504.9 QLTOT
  69.99 TFANI      72.41 TFANO

FUEL CELL HX
23000.0 QFC      657.1 WFC     115.00 TF/CI    150.00 TF/CC

CABIN LOOP TEMPS
  43.37   43.37   68.49   68.49   68.49  104.45  105.04

RADIATOR LOOP TEMPS
 150.69  150.69   60.37   60.37   39.37   39.37  101.05  101.05  101.05  148.31
 HEAT LOADS
12223.6 QCOND      0.0 QSENS     288.6 QCPUMP  30018.5 QINTX   1155.7 QRPUMP  43954.3 QRAD
    0.0 QEVAP  10219.8 QPY      1504.9 QLAT
```

FIGURE 4-8. PERFORMANCE CASE OUTPUT

RADIATOR/EVAPORATOR EXPENDABLE USAGE

54174.2 QTOT   4.1 WEVAVG   20.0 NO.STEP

ORBIT STEP	1/16	2/17	3/18	4/19	5/20	6/21	7/22	8/23	9/24	10/25	11/26	12/27	13/28	14/29	15/30
WEVAPORANT	8.97	11.67	12.79	11.67	9.57	6.82	4.93	3.32	2.34	1.69	0.68	0.0	0.0	0.0	0.0
	0.0	0.0	1.02	2.34	4.61										
T RAD IN	150.69	150.69	150.69	150.69	150.69	150.69	150.69	150.69	150.69	150.69	150.69	150.69	150.69	150.69	150.69
	150.69	150.69	150.69	150.69	150.69										
T SINK	475.26	493.59	499.70	493.10	478.20	459.97	443.66	431.95	422.93	414.97	405.48	398.44	391.47	389.32	389.64
	391.95	398.53	409.09	423.23	441.48										
TEVAP OUT	39.37	39.37	39.37	39.37	39.37	39.37	39.37	39.37	39.37	39.37	39.37	39.37	39.37	39.37	39.37
	39.37	39.37	39.37	39.37	39.37										
OFF TABLES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	2										

FIGURE 4–9. ORBITAL TRANSIENT CASE OUTPUT

TABLE 4-1. OUTPUT DATA DESCRIPTION - SIZING

Label	Description	Unit
TOTEQWT	Total equivalent weight	lbs
TINHXO	Water temperature leaving the interface heat exchanger	°F
TOTPW	Total ECS power (thermal control)	watts
TOTWT	Total ECS weight (thermal control)	lbs
WC	Radiator loop flow rate	lbs/hr
TRO	Radiator outlet temperature	°F
WTHX	Heat Exchanger weight	lbs
MVALVE, WVALVE	Temperature Control Valve weight	lbs
WTFAN, FANWT	Fan Weight (one)	lbs
WTVK, WTCK	Check valve weight	lbs
QREJ	Total heat removed	BTU/hr
TCIN	Coolant loop inlet temperature	°F
TCOUT	Coolant loop outlet temperature	°F
WH20	Water usage rate	lbs/hr
WEIGHT	Flash evaporator subsystem weight	lbs
TIN	Radiator inlet temperature	°R
TOUT	Desired radiator outlet temperature	°R

TABLE 4-1. OUTPUT DATA DESCRIPTION - SIZING (CONTINUED)

Label	Description	Unit
TOUTC	Calculated outlet temperature	°R
ARADC	Calculated radiator area	ft^2
ARMAX	Maximum allowable radiator area	ft^2
WTREQ	Radiator weight	lbs
TIHXI	Radiator loop coolant temperature entering interface HX	°F
TIHXO	Cabin loop coolant temperature leaving interface HX	°F
TEQWT	SYSTEM total equivalent weight	lbs
TOTWT	System total weight	lbs
TOTPW	System total power	watts
TAOS	Sensible heat exchanger gas outlet temperature	°F
TAOC	Condenser gas outlet temperature	°F
PDPO	Water vapor pressure leaving the condenser	psia
WCOOL	Optimum coolant flow rate (radiator loop)	lbs/hr
WBCO2	Bed weight of the CO_2 removal system total LiOH wt.	lbs
WBDES	Weight of one HSC Bed	lbs
ULLPEN	Ullage penalty for the HSC subsystem	lbs
ARAD	Calculated radiator area	ft^2
WTEXP	Weight of expendables required to supplement radiator (does not include QSUBL)	lbs

TABLE 4-1. OUTPUT DATA DESCRIPTION - SIZING (CONTINUED)

Label	Description	Unit
ULLDES	Ullage penalty for the HSC subroutine	lbs
ULLCO2	Not used	
DEWPT	Cabin dew point	°F
TAOE11	Temperature of air leaving the HX of the first (or only) water cooled avionics bay in series	°F
TAOE12	Temperature of air leaving the HX of the second water cooled avionics bay in series	°F
TEB1	Temperature of the first (or only) water cooled avionic bag in series	°F
TEB2	Temperature of the second water cooled avionics bay in series	°F
TAOE2	Temperature of the gas leaving the heat exchanger of the radiator loop cooled avionics bay	°F
H_2OREM	Water removal (HSC or Condenser) subsystem weight	lbs
HXSENS	Sensible HX temperature control subsystem weight	lbs
W/S	Water separator subsystem weight	lbs
PUMPC	Cabin loop pump package weight	lbs
HXINTF	Interface HX's weight	lbs
PUMPR	Radiator loop pump package weight	lbs
RADWT	Radiator weight	lbs
SUBLIM	Sublimator package weight	lbs

TABLE 4-1. OUTPUT DESCRIPTION - SIZING (CONTINUED)

Label	Description	Unit
CO_2REM	LiOH Subsystem weight	lbs
VENT	Ventilation fan package weight	lbs
CONTC	Contaminant removal weight	lbs
FAN C	Condenser fan package weight or HSC fan weight increase	lbs
FAN A	Sensible fan package weight	lbs
FAN MS	Not used	
EBHX1	Water cooled avionics bay HX weight (total)	lbs
EBFAN1	Water cooled avionics bay HX package weight (total)	lbs
EBHX2	Radiator loop avionics bay HX weight	lbs
EBFAN2	Radiator loop avionics bay fan package weight	lbs
FCHX	Fuel cell heat exchanger package weight	lbs
CRYHX	Cryogenic HX package weight	lbs
WTH20	Weight of water required for period when radiator is inoperative	lbs
WTHYD	Weight of hydrogen required for period when radiator is inoperative	lbs
FEVAP	Flash evaporator package weight	lbs
GSE	Ground Support HX weight	lbs

TABLE 4-1. OUTPUT DESCRIPTION - SIZING (CONTINUED)

Label	Description	Unit
COMPONENT POWERS		
H20REM	Condenser fan or HSC fan power	watts
SENSF	Sensible HX fan power	watts
PUMPC	Cabin loop pump power	watts
PUMPR	Radiator loop pump power	watts
CO_2REM	Not used	
VENTF	Ventilation fan power	watts
EBAY1	Avionics bay (water cooled) fan power (total)	watts
EBAY2	Radiator loop avionics bay fan power	watts
COMPONENT FLOW RATES		
H20REM	Condenser or HSC gas flow rate	CFM
CO_2REM	LiOH gas flow rate	CFM
SENHX	Sensible heat exchanger gas flow rate	CFM
VENT	Ventilation fan flow rate	CFM
CONTM	Flow rate supplied by ECS fan through contaminate canister	CFM
FAN C	Condenser fan flow rate	CFM
FAN A	Sensible fan flow rate	CFM
EBAY1	Water Cooled avionics bay fan flow rate	CFM
EBAY2	Radiator loop avionics bay fan flow rate	CFM

TABLE 4-1. OUTPUT DESCRIPTION - SIZING (CONTINUED)

Label	Description	Unit
CABIN LOOP TEMPERATURES		°F
	Printed in order are:	
1st	Leaving the interface HX	
2nd	Leaving the condensing HX	
3rd	Leaving the sensible HX	
4th	Same as 3rd	
5th	Temperature entering the second avionics bay if two in series, otherwise same as 3rd	
6th	Temperature entering cold plates	
7th	Temperature leaving cold plates	
8th	Temperature leaving pump	
RADIATOR LOOP TEMPERATURES		
	Printed in order are:	°F
1st	Temperature entering interface HX	
2nd	Temperature leaving interface HX	
3rd	Temperature leaving avionics bay	
4th	Temperature leaving cold plates	
5th	Temperature leaving F/C HX's	
6th	Radiator inlet temperature	
7th	Radiator outlet temperature	

TABLE 4-1. OUTPUT DESCRIPTION - SIZING (CONTINUED)

Label	Description	Unit
8th	Temperature leaving that portion of the radiator topping HX that must pay for expendables	
9th	Temperature leaving topping heat exchanger	
HEAT LOADS		
CONDHX	Total heat removed by condensing HX	BTU/hr
SENSHX	Heat removed by sensible HX	BTU/hr
INTERHX	Heat transferred by the interface HX	BTU's/hr
FUELCELL	Heat removed from fuel cells	BTU's/hr
RADIATOR	Heat rejected by radiator	BTU's/hr
EXP HX	Portion of heat removed by topping HX for which expendables must be launched	BTU's/hr
TOTLATQ	Total latent heat load removed by condenser	BTU's/hr
SENSCO2	Sensible heat generated by LiOH	BTU's/hr
LATCO2	Latent heat generated by LiOH	BTU's/hr
SENSH2DP	Not used	
LATH2DP	Not used	
QSINK	Total heat rejected by all heat sinks	BTU/hr
EBAY1	Heat removed in cabin loop avionic bay	BTU/hr
EBAY2	Heat removed in radiator loop avionic bay	BTU/hr
SUBLIM	Heat removed with excess fuel cell H_2O	BTU/hr

TABLE 4-1. OUTPUT DESCRIPTION - SIZING (CONTINUED)

Label	Description	Unit
CONDENSER WEIGHTS		
WTHX	Condensing Hx weight	Lbs
MVALVE	Bypass air valve weight	Lbs
SENSIBLE HX		
WTHX	Sensible Hx weight	Lbs
WVALVE	Air bypass valve weight	Lbs
AVIONICS BAY		
WTHX	Weight of one heat exchanger	Lbs
WTFAN	Weight of one fan	Lbs
WTCK	Check valve weight	Lbs
BED LOADING		
1ST	Volumetric air flow per lb of HSC	cfm/lb HSC
2ND	Water vapor pressure	psia
3RD	Bed water loading	lb H_2O/lb HSC
4TH	Off Tables Indicator if non-zero	
	Next Line Printed in Order	
1ST	Weight of HSC canisters and valves	Lbs
2ND	Weight of fans and check valves	Lbs
3RD	Total Equivalent Weight (excluding ullage)	Lbs
4TH	Weight of HSC per canister	Lbs
	Next Line Printed in Order	
WTCAN	Canister weight	Lbs
WVVAL	Vacuum valve weight	Lbs
WCVAL	Humidity control valve weight	Lbs
WTFAN	Increase in fan weight	Lbs
WKVAL	Fan check valve weight	Lbs

TABLE 4.1. OUTPUT DESCRIPTION - SIZING (CONTINUED)

Label	Description	Unit
DOUBLE EBAY		
WTHX	Heat exchanger weight (1)	Lbs
WTFAN	Fan weight (1)	Lbs
WTKV	Fan check valve weight (1)	Lbs
FLASH EVAPORATOR SIZE		
QREJ	Heat rejected	BUT/hr
TCIN	Coolant circuit inlet temperature	°F
TCOUT	Coolant circuit outlet temperature	°F
WH_2O	Water used	Lbs
WEIGHT	F/E unit weight	Lbs
RADIATOR SUBROUTINE		
TIN	Coolant inlet temperature	°R
TOUT	Coolant outlet temperature	°R
TOUTC	Calculated outlet temperature	°R
ARADC	Radiator area required	Ft^2
ARMAX	Maximum available radiator area	Ft^2
WTREQ	Radiator weight	Lbs

TABLE 4-2. OUTPUT DATA DESCRIPTION OFF DESIGN PERFORMANCE CASES

Label	Description	Unit
COMPONENT POWERS-WATTS		
	The data in locations 191 - 220 are printed in order	
COMPONENT FACTORS - UA, EFF, Etc.		
	The data in locations 221 to 250 are printed in order	
COMPONENT FLOW RATES -CFH		
CONDF	Condenser or HSC flow rate	ft^3/hr
SENF	Sensible HX flow rate	ft^3/hr
AVFANH	Flow rate of cabin loop cooled avionics bay fan	ft^3/hr
AVFANR	Flow rate of radiator loop cooled avionics bay fan	ft^3/hr
VENTF	Ventilation fan flow rate	ft^3/hr
LiOH	LiOH flow rate	ft^3/hr
LiOH SUBROUTINE - CO_2 PARTIAL PRESSURES		
PMAX	Cabin CO_2 Pressure level at inputed removal efficiency	mm Hg
PMIN	Cabin CO_2 pressure level with fresh cartridge	mm Hg
QS	Sensible heat generated by LiOH	BTU/hr
QL	Latent heat generated by LiOH	BTU/hr
RADIATOR SUBROUTINE		
TIN	Radiator inlet temperature	°R
TOUT	Radiator outlet temperature desired	°R

TABLE 4-2. OUTPUT DATA DESCRIPTION OFF DESIGN PERFORMANCE CASES (CONTINUED)

Label	Description	Unit
TOUTC	Calculated outlet temperature	°R
ARADC	Calculated radiator area	ft^2
ARMAX	Maximum allowable radiator area	ft^2
WTREQ	Radiator weight	lbs
FLASH EVAPORATOR PERFORMANCE		
QREJ	Heat rejected	BTU/hr
TCIN	Coolant loop inlet temperature	°F
TCOUT	Coolant loop outlet temperature	°F
TOMAX	Maximum coolant loop outlet temperature	°F
TOMIN	Minimum coolant loop outlet temperature	°F
WH20	Water required to supplement radiator for TSUB hours	lbs
CRYOGENIC HX PERFORMANCE		
THOTCAL	Calculated coolant outlet temperature	°F
WHYD	Hydrogen flow rate	lbs/hr
THYDO	Hydrogen outlet temperature	°F
CONDENSER PERFORMANCE		
TCAB	Cabin temperature	°F
TAIRI	Heat exchanger air inlet temperature	°F
TAIRO	Heat exchanger air outlet temperature	°F
HXCFM	Gas flow rate through HX	CFM

TABLE 4-2. OUTPUT DATA DESCRIPTION OFF DESIGN PERFORMANCE CASES (CONTINUED)

Label	Description	Unit
TDPCAB	Cabin dew point	°F
QSENS	Sensible heat transferred by condenser	BTU/hr
QSMET	Crew sensible metabolic heat load	BTU/hr
QLMET	Crew latent metabolic heat load	BTU/hr
SENS HX PERFORMANCE		
QSENS	Heat transferred by HX	BTU/hr
VHX	Flow rate through HX	CFM
TXAI	Heat exchanger air inlet temperature	°F
TXAO	Heat exchanger air outlet temperature	°F
TCAB	Cabin temperature	°F
QMETS	Crew sensible metabolic heat load	BTU/hr
WATER COOLED AVIONICS BAY		
QHX	Rate of heat removal	BTU/hr
WCPAIR	Mass flow rate of air	BTU/hr-°F
TBAY	Compartment temperature	°F
TXO, THXAO	HX air outlet temperature	°F
THXCO	HX coolant outlet temperature	°F
RADIATOR COOLED AVIONICS BAY		
(Same as Water Cooled Avionics Bay)		

TABLE 4-2. OUTPUT DATA DESCRIPTION OFF DESIGN PERFORMANCE CASES (CONTINUED)

Label	Description	Unit
FUEL CELL HX		
QFC	Heat rejected by fuel cells	BTU/hr
WFC	Fuel cell coolant mass flow rate	BTU/hr-°F
TF/CI	Temperature entering fuel cells	°F
TF/CO	Temperature leaving fuel cells	°F
CABIN LOOP TEMPERATURES		°F
1st	Interface HX outlet temperature	
2nd	Chiller outlet temperature	
3rd	Condensing HX outlet temperature	
4th	Sensible HX outlet temperature	
5th	Temperature into cold plates	
6th	Temperature out of cold plates	
7th ω	Temperature into interface HX	
RADIATOR LOOP TEMPERATURES		°F
1st	Calculated temperature (around loop) into Radiator	
2nd	Radiator inlet temperature	
3rd	Radiator outlet temperature	
4th	Flash evaporator outlet temperature	
5th	Sublimator outlet temperature	

TABLE 4-2. OUTPUT DATA DESCRIPTION OFF DESIGN PERFORMANCE CASES (CONTINUED)

Label	Description	Unit
6th	Cryogenic HX coolant outlet temperature	
7th	Interface HX outlet temperature	
8th	Avionics bay HX outlet coolant temperature	
9th	Cold plate outlet temperature	
10th	Fuel Cell HX's outlet temperature	
HEAT LOADS		
QCOND	Total heat transferred by condenser	BTU/hr
QSENS	Heat transferred by sensible HX	BTU/hr
QCPUMP	Cabin loop pump heat load	BTU/hr
QINTX	Heat transferred by interface HX	BTU/hr
QRPUMP	Radiator loop pump heat generated	BTU/hr
QRAD	Heat rejected by radiator	BTU/hr
QEVAP	Heat rejected by water evaporation	BTU/hr
QRY	Heat rejected by cryogenic HX	BTU/hr
QLAT	Total latent heat load	BTU/hr

TABLE 4-3. OUTPUT DATA DESCRIPTION - ORBITAL TRANSIENT

Label	Description	Unit
QTOT	Average vehicle heat rejection around orbit	BTU/hr
WEVAVG	Average rate of evaporant usage	lbs/hr
NO. STEPS	Number of steps taken around orbit - 310 max.	-
ORBIT STEPS	Each step around the orbit - 2 rows of 15 steps per row	-
WEVAPORANT	Instantaneous rate of evaporant usage for each orbit step	lb/hr
TRAD IN	Radiator inlet temperature for each orbit step	°F
T SINK	Radiator adiabatic sink temperature for each orbit step	°R
TEVAP OUT	Coolant temperature leaving the evaporative sink for orbit step	°F
OFF TABLES	If other than "O", reading off curve - answers may not be good	

4.3 How to Vary the Program

One of the features of the computer program is the ease with which it can be changed to other schematic configurations. To demonstrate the ease of changing schematics, an example will be presented to optimize, calculate the off-design performance, and do an orbital transient to determine the amount of water evaporated for a schematic similar to Figure 4-1.

This schematic differs from the schematic already in the program in the following areas:

1. The cold plates are in front of the avionics bay heat exchanger rather than downstream of the avionics heat exchanger.
2. There are two sets of cold plates and avionics bays operating in parallel splitting the heat load equally between them rather than one of each.
3. The LiOH is in series with the condenser instead of in parallel.

To accomplish these changes, the following must be changed in the sizing program:

A. The heat and latent load of the LiOH are not circulated into the cabin but flow directly to the condensing heat exchanger.

B. The fan flow is only flow rate required by the heat exchanger for maximum cabin heat loads with no parallel LiOH path.

C. The arrangement of the cold plates and avionics bays must be changed.

D. The weights and powers must include the extra avionics compartment.

In making these changes, two approaches may be used:

4.3 (Continued)

a. Write the changes for the specific schematic and leave out the items that are not there.

b. Write the changes with the ability to add or delete items such as the sensible heat exchanger the avionics bays, etc.

The first approach is the quickest but program flexibility such as the ability to make continued changes is lost. For this example, the second approach will be described and this approach is recommended to the user for all changes of this nature.

To change the fan flow rate and the placement of the LiOH heat and latent load, cards 87 through 89:

```
87      QSH  =  0
88      QLH  =  0
89      QCH  =  0
```

are replaced with the following cards:

```
QSH   =   QS9 - PW9 * 3.414
QLH   =   QL9
QCH   =   0
QS9   =   0
QL9   =   0
PW9   =   0
```

The cold plates, even though split into two parallel groups are treated as one group. To change the location, the following cards are changed:

Replace card 276 with:

```
276     242  IF (QE1) 247, 247, 248
```

4.3 (Continued)

with:

242 T24 = T23 + QCP1/WCPC

IF (QE1) 247, 247, 248

Replace card 305

305 249 T25 = T24P = QCP1/WCPC

with:

249 CONTINUE

The parallel avionics bays are accomplished by splitting the heat load and coolant flow rate and adding in an extra set of fans and heat exchangers to account for the weight and doubling the fan power to account for the second set of fans. This is accomplished by the following changes:

Replace cards 292 and 293

292 253 Call EBAY (QE1, TE1, T24, WCPC, RHOE1, CPA, PP, DPE1,

WEHX1, WEF1, PW (17), V17

293 293 2, T24P, TAOE1, QET1, 16

with:

253 Call E6AY (QE1/2., TE1, T24, WCPC/2., RHOE1, CPA, PP,

DPE1, WEHX1, WEF1, PW (1 27), V17, T24P, TAOE1, QET1,

16)

Replace card 353

353 2 + PW (3)

with:

4.3 (Continued)

2 + PW (3) + PW (17)

After card 424

424 4 + WT21 + WT25

Add a card

5 + WEHX1 + WEF1

For the off design performance section of the program the same type of changes must be made. To account for the change in LiOH position the following cards must be changed:

Replace card 724

724 V1 = V11 - V9

with:

V1 = V11

QCABS = QCHBS - QS9

Replace card 744

744 642 Call CX2 (WHC, T22, QCABS, QCABL, TCAB, QSH, QLH,

V1, PW (11), 1, KY, T23

with:

642 Call CX2 (WHC, T22, QCABS, QLM, TCAB, QS9, QL9, V1,

PW (11), 1, KY, T23

To make the total heat load correct, after card 634

634 Q5 = QCABS + QCABL + QE1 + QCP1 + QCHIL + 3.414*

PW (4) + PW (17)

4.3 (Continued)

Add a card:

2 + PW (17) * 3.414

After card 636

636 PWT = PW (11) + PW (12) + PW (3) + PW (4) + PW (6) +

PW (10) + PW (17) + PW (19)

Insert the following card

2 + PW (17)

In order to change the location of the cold plates the following cards must be changed.

Replace card 823.

823 613 IF (V17) 614, 614, 6151

with:

613 T2C = T24 + QCP1/WHC

IF (V17) 614, 614, 6151

and replace cards 866 and 867

866 616 T26 = T25 + QCP1/WHC

867 T27 = T26 + PW (4) * 3.414/WHC

with:

616 T26 = T2C

T27 = T25 + PW (4) * 3.414/WHC

For the double avionics bays the following cards must be changed:

Replace card 850

4.3 (Continued)

```
850   615      Q16  =  QE1 + PW (17) * 3.414

               with:

      615      Q16  =  QE1 + PW (17) * 6.828

               Replace cards 855 to 859

855            Call HX (Q16, WE1, WHC, T24, 16 TE1O)
856      C     EBAY TEMPERATURE
857            TE1I  =  TE1O + QE1/WE1
858      C     COOLANT TEMPERATURE
859            T25  +  T24 + Q16/WHC

               with:

               Call HX (Q16/2., WE1, WHC/2., T2C, 16, TE1O)
         C     EBAY TEMPERATURE
               TE1I  =  TE1O + QE1/2./WE1
         C     COOLANT OUTLET TEMPERATURE
               T25  =  T2C + Q16/WHC
```

For the radiator/evaporator orbital transient, only the heat load due to the second bay fan must be corrected. This can be done by inserting a card after card 933.

```
               After card 933

933            QPW  =  (PW (11) + PW (12) + PW (17) + PW (19) +
               PW (4) + PW (6) + PW (10) + PW (3)) * 3.414

               Insert:

               2 + PW (17) * 3.414
```

4.3 (Continued)

These are the changes needed to change the program to the new schematic. Following the completion of these changes, the sizing program, the off-design performance program, and the orbital transient program could be run with the new schematic.

APPENDIX I
DEFINITION OF SYMBOLS

SYMBOL DESCRIPTION - MAIN PROGRAM

Symbol	Description	Units
LA	Key to Subroutines IF = 2, Print; IF = 1, Do Not Print	-
NPER	Same as "Perf"	-
PP	Power Penalty	Lbs/Watt
J	Counter - Index	-
NR	Same as "RN" - Heat Rejection Sink Key	-
KR	Same as "RMAX" - Max. Radiator Loop Count	-
KI	Same as "HXIM" - Max. Interface HX Loop Count	-
KS	Not Used	-
KC	Not Used	-
WEXP	Expendable Weight Penalty Required to Supplement Radiator	Lbs
WT13	Not Used	-
M1	Same as "A1" - CO_2 Removal Key	-
M2	Same as "A2" - Humidity Control Key	-
KEYC	Same as "FW5" - HX Arrangement Key	-
QSH	Sensible Heat Upstream of Condenser	BTU/Hr
QLH	Latent Heat Upstream of Condenser	BTU/Hr
I	Convergence Key - IF = 0, Subroutines Converged	-
RHOA	Cabin Gas Density	Lbs/Ft^3
PX	Saturation Pressure @ Cabin Temperature	PSIA
PMAX	Maximum Allowable Cabin Vapor Pressure	PSIA
DAY	Total Mission Length Including Emergency	DAYS
WTCH	Contaminant Removal Weight	Lbs
VCH	Contaminant Removal Flow Rate	Ft^3/Hr
QCH	Contaminant Removal Heat Generated	BTU/Hr
WBC	CO_2 Removal Bed Weight (Lbs LiOH Total	Lbs
WT9	CO_2 Removal Subsystem Weight	Lbs
PW9	CO_2 Removal Subsystem Power	Watts
QS9	CO_2 Removal Subsystem Sensible Heat Generated	BTU/Hr
QL9	CO_2 Removal Subsystem Latent Heat Generated	BTU/Hr
WUC	CO_2 Removal Subsystem Ullage Penalty	Lbs
ND	Flow Rate Iteration Count	-
NT	Same as "EY" - Max. Times Through Flow Rate Loop	-
NQ	Flow Rate Loop Index Counter	-
WCPC	Radiator Loop Thermal Mass Flow Rate	BTU/Hr-°F
NC	Radiator Temperature Loop Count	-
TB	Adiabatic Sink Temperature - Radiator	°F

SYMBOL DESCRIPTION - MAIN PROGRAM (CONT)

Symbol	Description	Units
KTS	Truncated TB	°F
TBI	KTS + 2	°F
TRO	Radiator Outlet Temperature	°F
N1	Radiator Loop Index Counter	-
T1	Radiator Loop Temperature Into Interface HX	°F
QSUB	Topping Water Evaporator Heat Load	BTU/Hr
KT	Interface HX Loop Max. Index Count	-
T21	Cabin Loop Interface HX Outlet Temperature	°F
NB	Interface HX Outlet Temperature Loop Count	-
N2	Interface HX Outlet Temperature Loop Index Counter	-
PDPI	Not Used	-
PVI	Control Value of Cabin Vapor Pressure	PSIA
TDPT	Cabin Dew Point	°F
WT1	Water Removal Subsystem Weight	Lbs
V1	Water Removal Subsystem Gas Flow Rate	CFH
WBD	Water Removal Bed Weight (HSC)	Lbs
WUD	Water Removal Ullage Penalty	Lbs
WT11	Water Removal Subsystem Fan Package Weight	Lbs
QS1	Sensible Heat Removed by Water Removal Subsystem	BTU/Hr
T22	Coolant Temperature Leaving H_2O Removal Subsystem	°F
QLT	Total Latent Heat Load	BTU/Hr
QST	Total Cabin Sensible Heat Load	BTU/Hr
TAOC	Condenser Air Outlet Temperature	°F
VX	Same as V1	Ft^3/Hr
QS2	Cabin Heat Load to be Removed by Sens. HX	BTU/Hr
WT2	Sens. HX Package Weight	Lbs
V2	Sens. HX Flow Rate	Ft^3/Hr
T23	Sens. HX Outlet Coolant Temperature	°F
TAOS	Sens. HX Gas Outlet Temperature	°F
T24	Same as "T23"	°F
WT3	Water Separator Weight	Lbs
WT10	Ventilation Fan Package Weight	Lbs
WTF	Fan Weight	Lbs
WTK	Check Valve Weight	Lbs
WT12	Sensible Fan Package Weight	Lbs
PW1	Fan Power Required For Cond. HX Fan Flow Rate	Watts

SYMBOL DESCRIPTION - MAIN PROGRAM (CONT)

Symbol	Description	Units
PDPO	Condenser Air Outlet Dew Point Pressure	PSIA
XX	Not Used	-
VFC	M/S Fan Flow Rate - Not Used	-
WCF	Condenser Fan Weight	Lbs
WCV	Condenser Fan Check Valve Wt.	Lbs
VT	Same as "V2"	Ft^3/Hr
WSF	Sensible Fan Wt.	Lbs
WSV	Sensible Fan Check Valve Wt.	Lbs
T24P	Coolant Loop Temperature Entering C/P	°F
WEHX1	Cabin Loop Cooled Avionic's HX Wt. (Total)	Lbs
WEF1	Cabin Loop Cooled Avionic's Fan Package Wt. (Total)	Lbs
TAOE1	Air Temperature Leaving First Avionic's HX	°F
QET1	First Avionic's HX Load	BTU/Hr
T24PP	Coolant Temperature Leaving First Avionic's HX	°F
TEB1	Compartment Temperature 1st Avionic's Bay	°F
TEB2	Compartment Temperature 2nd Avionic's Bay	°F
TAOB2	Air Temperature Leaving 2nd Avionic's HX	°F
QEBT2	2nd Avionic's HX Load	BTU/Hr
RHOE1	Gas Density in Cabin Loop Cooled Avioinic's Compt.	Lbs/Ft^3
QEB1	Heat Load to be Removed from 1st Avionic's Bay	BTU/Hr
T25	Cold Plate Outlet Coolant Temperature	°F
WT4	Pump Package Weight	Lbs
T26	Pump Outlet Temperature-Interface HX Inlet Temperature	°F
T2	Interface HX Outlet Temperature Radiator Loop	°F
WT5	Interface HX Wt.	Lbs
DTLM	HX Log-Mean Temperature Difference	°F
T2P	Temperature Leaving Radiator Loop Cooled Avionic's HX	°F
WEHX2	Radiator Loop Cooled Avionic's HX Wt.	Lbs
WEF2	Radiator Loop Cooled Avionic's Fan Package Wt.	Lbs
TAOE2	Radiator Loop Cooled Avionic's HX Air Outlet Temperature	°F
QET2	Radiator Loop Cooled Avionic's HX Heat Load	BTU/Hr
RHOE2	Gas Density in Radiator Loop Cooled Avionic's Compt.	Lbs/Ft^3
T3	Radiator Loop C/P Outlet Temperature	°F
TPW	Total ECS Power (As calculated by program)	Watts
QFCT	Total F/C Heat Load	BTU/Hr
T4	F/C Coolant Leaving Temperature	°F

SYMBOL DESCRIPTION - MAIN PROGRAM (CONT)

Symbol	Description	Units
WT6	Radiator Loop Pump Package Wt.	Lbs.
TRI	Radiator Inlet Temperature	°F
TI	Radiator Inlet Temperature	°R
TO	Radiator Outlet Temperature	°R
QF	Total ECS Heat Rejection	BTU/Hr
T1A	Interface HX Inlet Temperature - Calculated	°F
WT25	Flash Evaporator Subsystem Weight	Lbs
WSUB	Weight of H_2O Stored for Periods When No Radiator	Lbs
WT8	Sublimator Subsystem Wt.	Lbs
WHYD	Weight of H_2 Stored for Periods When No Radiator	Lbs
WT22	Hydrogen HX Package Wt.	Lbs
EFF	Heat Exchanger Temperature Effectiveness	-
WT21	GSE HX Weight	Lbs
WT20	F/C HX Weight	Lbs
WT7	Radiator Panel Weight	Lbs.
ARAD	Required Radiator Area	Ft^2
TORAD	Calculated Radiator Leaving Temperature	°F
QEXP	Heat Load That Must Supplement Radiator	BTU/Hr
WUT	Total Ullage Penalty	Lbs
TWT	Total Fixed Weight	Lbs
TEWT	Total Equivalent Weight	Lbs
TMIN	Minimum Total Equivalent Wt. (Interface HX Loop)	Lbs
NJ	Index Counter	-
JJ	Index Counter	-
TMIN1	Minimum Total Equivalent Wt. (Radiator Temperature Loop)	Lbs
NK	Index Counter	-
JK	Index Counter	-
WQ	Float Number of Times Through Flow Rate Loop	-
J1	Index Counter	-
J2	Index Counter	-
Q1	Condenser Total Heat Load	BTU/Hr
Q2	Sensible HX Total Heat Load	BTU/Hr
Q5	Interface HX Total Heat Load	BTU/Hr
Q6	Total F/C Heat Load (Same "QFCT")	BTU/Hr
Q7	Heat Rejected by Radiator	BTU/Hr
Q8	Expendable Heat to Supplement Radiator	BTU/Hr

SYMBOL DESCRIPTION - MAIN PROGRAM (CONT)

Symbol	Description	Units
	TABLES	
TRA(N)	Optimum Cond. Air Outlet Temperature for each Coolant Flow Rate	°F
TRB(N)	Optimum Cond. Air Outlet Temperature for each Radiator Outlet Temp.	°F
TEO(N)	Optimum Cond. Air Outlet Temperature for each Interface HX Outlet Temp.	°F
WEV(N)	Rate of Expendable Usage for each Orbit Step	Lbs/Hr
L(N)	Off Tables for each Orbit Step	-
TQ(N)	Total Equivalent Wt. for each T-Interface HX Out	Lbs
TXO(N)	Interface HX Outlet Temperature	°F
PT(N)	Total Power for each TXO	Watts
WTT(N)	Total Weight for each TXO	Lbs
T41(N)	F/C Outlet Temperature for each TXO	°F
TQ1(N)	Optimum TEQWT for each TRO	Lbs
TRDO(N)	Radiator Outlet Temperature	°F
TXO1(N)	Optimum TXO for each TRDO	°F
PT1(N)	Optimum PT for each TRDO	Watts
WTT1(N)	Optimum WTT for each TRDO	Lbs
T42(N)	Optimum T4 for each TRDO	°F
WC1(N)	Table of Coolant Flow Rates	Lbs/Hr
TQ2(N)	Optimum TEQWT for each Coolant Flow Rate	Lbs
TRDO1(N)	Optimum Radiator Outlet Temperature for each WC	°F
TXO2(N)	Optimum TXO for each WC	°F
PT2(N)	Total Power at Optimum TEQWT for each WC	Watts
WTT2(N)	Total Weight at Optimum TEQWT for each WC	Lbs
T43(N)	F/C Outlet Temperature @ Optimum TEQWT for each WC	°F
	SUBROUTINE LiOH	
WL	Weight of LiOH Required for Mission	Lbs
DAY	Total Mission Length	DAYS
TN	Number of LiOH Canisters	-
IN	Truncate "TN"	-
WN	Float "IN"	-
PW	Fan Power for LiOH	Watts
DPF	Fan Pressure Rise	In-H_2O
QS	LiOH Sensible Heat	BTU/Hr
QL	LiOH Latent Heat	BTU/Hr
V	Volume Flow Rate Required/Available	Ft^3/Hr

SYMBOL DESCRIPTION - MAIN PROGRAM (CONT)

Symbol	Description	Units
QCRY	Excess Expendable H_2O Used	BTU/Hr
QLAT	Latent Heat Rejected	BTU/Hr
VC	LiOH Flow Rate (V9/60)	CFM
VV	Ventilation Flow Rate (V10/60)	CFM
VE1	Same as "V17"	Ft^3/Hr
VE2	Same as "V19"	Ft^3/Hr
WHC	Cabin Loop Thermal Mass Flow Rate	BTU/Hr-°F
NA	Cabin Temperature Loop Index Register	-
QCABL	Total Cabin Latent Load	BTU/Hr
QCABS	Total Cabin Sensible Load	BTU/Hr
PWT	Total ECS Power	Watts
QFT	Total F/C Heat Load	BTU/Hr
QTOT	Total Heat to be Rejected	BTU/Hr
T6	Radiator Inlet Temperature	°R
N	Radiator Loop (Performance) Index Register	-
WR	Radiator Wt. (Not Used)	Lbs
WE	Not Used	-
T7	Calculated Radiator Outlet Temperature	°R-°F
T8	Sublimator Outlet Temperature (Flash Evap.)	°F
T9	GSE Outlet Temperature	°F
QR	Calculated Total Heat Rejection	BTU/Hr
Q22	Cryogenic HX Heat Rejected	BTU/Hr
Q25	Flash Evap. Heat Rejected	BTU/Hr
RHO	Dummy Variable	-
QCDS	Sensible Heat Removed by Condensing HX	BTU/Hr
KY	Key to Tell Cond. if there is a Sens. HX O - NO Sensible HX; 1 - Followed by Sensible HX	-
WHOT	Sensible HX Thermal Mass Flow Rate	BTU/Hr-°F
WMX	Maximum "WHOT"	BTU/Hr-°F
TAI	HX Air Inlet Temperature	°F
TAOR	HX Air Outlet Temperature	°F
TAO	Calculated HX Air Outlet Temperature	°F
QSN	New Sensible Metabolic Heat Load	BTU/Hr
KA	Off Tables If > 0 in QMET Subroutine	-
VHX	Volumetric Flow Rate Through HX	Ft^3/Hr
QEE1	Heat to be Removed from First Cabin Loop Avionic's HX	BTU/Hr

SYMBOL DESCRIPTION - MAIN PROGRAM (CONT)

Symbol	Description	Units
QEE2	Heat to be Removed from Second Cabin Loop Avionic's HX	BTU/Hr
WE1	Avionics (Cabin Loop) Thermal Mass Flow Rate	BTU/Hr-°F
TEE1	1st Avionic's HX Air Inlet Temperature	°F
T25A	Coolant Loop Temperature Into Second Avionic's HX	°F
TAE2	Air Temperature Leaving 2nd Avionic's HX	°F
TEE2	2nd Avionic's HX Air Inlet Temperature	°F
TEIC	Same as "TE1"	°F
Q16	Single Avionic's HX Heat Load	BTU/Hr
TE1O	Single Avionic's HX Air Outlet Temperature	°F
TE1I	Single Avionic's HX Air Inlet Temperature	°F
T27	Pump Outlet Temperature (Performance)	°F
Q18	Radiator Loop Avionic's HX Load	BTU/Hr
WHX	Radiator Loop Avionic's HX Thermal Mass Flow Rate	BTU/Hr-°F
TE2O	Radiator Loop Avionic's HX Air Outlet Temperature	°F
TE2B	Radiator Loop Avionic's HX Air Inlet Temperature	°F
T5	F/C Coolant Loop Outlet Temperature	°F
T6C	Calculated Radiator Inlet Temperature	°F
Q4	Cabin Loop Pump Heat Load	BTU/Hr
QLTOT	Total Latent Load	BTU/Hr
DTHEA	Degrees of Orbit for Each Step	°
TAUS	Time for Each Orbit Step	Hr
A	Orbital Position	°
WA	Average Expendable Use Rate	Lbs/Hr
NS	Orbital Transient Loop No. of Steps	-
QPW	Total ECS Power Heat Load	BTU/Hr
DT	Radiator Loop Delta T	°F
T1O	Actual Interface HX Coolant Inlet Temperature	°F
FK	Radiator Ambient Heat Load	BTU/Hr-Ft^2
NN	Evaporator Loop Temperature Index Register	-
AR	Dummy Variable	-
TOR	Radiator Outlet Temperature	°R
TR	Same as "TOR"	°F
QE	Evaporator Heat Load	BTU/Hr
WT	Dummy Variable	-
TR2	Sublimator Outlet Temperature	°F

SYMBOL DESCRIPTION - MAIN PROGRAM (CONT)

Symbol	Description	Units
WTM	Manual Valve Weight	Lbs
WT	Total Subsystem Weight	Lbs
J	Component Number	-
PMIN	Minimum CO_2 Partial Pressure (R = .95)	mm Hg
PMAX	CO_2 Partial Pressure Before Cartridge is Replaced (R = CFT (9))	mm Hg
	SUBROUTINE CHX	
PMAX	Max. Allowable Cabin H_2O Vapor Pressure	PSIA
TMAX	Max. Allowable Cabin Dew Point Temperature	°R/°F
WH2O	Rate of H_2O Removal from Cabin Atmosphere	Lbs/Hr
QL	Cabin Latent Load	BTU/Hr
QL3	Total HX Latent Load	BTU/Hr
QL2	Latent Heat Downstream of Cabin	BTU/Hr
K	IF = 0; No Sensible HX; I 0; Sensible HX	-
L	Set to 1 If No Sensible HX, Set to 2 If Sensible HX	-
QT	Cabin Sensible and Latent Load	BTU/Hr
QS	Cabin Sensible Load	BTU/Hr
TCO	Coolant HX Outlet Temperature	°F
QC	Calculated HX Total Heat Load	BTU/Hr
WCPC	Coolant Thermal Mass Flow Rate	BTU/Hr-°F
TCI	Coolant Inlet Temperature	°F
TAO	HX Gas Outlet Temperature	°F
NT	Maximum Number of Times Through Optimization Loop	-
I	Set = 0; If Subroutine Converged	-
N	Index Register	-
V	Gas Volume Flow Rate	Ft^3/Hr
TC	Cabin Temperature	°F
RHO	Gas Density	Lbs/Ft^3
CPA	Gas Specific Heat	BTU/Lb-°F
PXO	H_2O Vapor Pressure of Gas Leaving HX	PSIA
WWO	Water Flow Rate in Gas Leaving HX	Lbs/Hr
WWI	Water Flow Rate in Gas Entering HX	Lbs/Hr
TCCO	Calculated Coolant Outlet Temperature	°F
QCDT	Minimum Total Heat Load for Humidity Control	BTU/Hr
VMIN	Minimum Volume Flow Rate for Humidity Control	Ft^3/Hr
PPF	Fan Pressure Rise	In-H_2O

SYMBOL DESCRIPTION - MAIN PROGRAM (CONT)

Symbol	Description	Units
J	Component Number	-
PXI	Inlet Water Vapor Pressure	PSIA
TDP	Cabin Dew Point	°F
TWTS	Total Equivalent Weight-Stored	Lbs
WT	Total Weight	Lbs
PW	Total Power	Watts
WTF	Fan Weight	Lbs
TAI	HX Gas Inlet Temperature	°F
QS2	Heat Load Downstream of Cabin	BTU/Hr
QCS	Sensible Heat Removed by Condenser	BTU/Hr
PDPI	Dew Point Pressure Where Condensing Starts	PSIA
TDPI	Dew Point Temperature Where Condensing Starts	°F
TY	Coolant Temperature Where Condensing Starts	°F
QW	Heat in Wet Section of Condenser	BTU/Hr
QD	Heat in Dry Section of Condenser	BTU/Hr
TAOD	Gas Temperature Where Condensing Starts	°F
DTLM	Log-Mean-Temperature Difference	
UAD	Dry Section UA	BTU/Hr-°F
UAW	Wet Section UA	BTU/Hr-°F
WTM	Not Used	-
WTK	Check Valve Weight	Lbs
WTV	Temperature Control Bypass Valve Weight	Lbs
TWT	Total Equivalent Weight	Lbs
WTS	Total Weight Stored	Lbs
PWS	Total Power Stored	Watts
UAS	HX UA Stored	BTU/Hr-°F
TDPS	Cabin Dew Point Stored	°F
VS	Volume Flow Rate Stored	Ft^3/Hr
PXOS	HX Outlet Dew Point Pressure	PSIA
QSS	Sensible Heat Removed - Stored	BTU/Hr
WHX	Heat Exchanger Weight	Lbs

SUBROUTINE SHX

Symbol	Description	Units
DTF	Fan Temp. Rise	°F
DP	Fan Pressure Rise	In-H_2O
RHO	Cabin Gas Density	Lbs/Ft^3
CPA	Cabin Gas Specific Heat	BTU/Lb-°F
J	Component Number	-
TAI	HX Gas Inlet Temp	°F
TCAB	Cabin Gas Temp	°F
DTM	Maximum Gas To Coolant Temp Difference	°F
TCI	Coolant Inlet Temp	°F
TAO	Gas Outlet Temp	°F
N	Index Register	-
V	Gas Volumetric Flow Rate	Ft^3/Hr
QS	Sensible Heat Load To Be Removed From Cabin	BTU/Hr
PW	Fan Power	Watts
TCO	Coolant Outlet Temp	°F
WCPC	Coolant Thermal Mass Flow Rate	BTU/Hr-°F
DTLM	Log-Mean-Temperature Difference	°F
UA	Thermal Conductance x Area	BTU/Hr-°F
WTF	Fan Weight	Lbs
WTM	Not Used	-
WTK	Check Valve Weight	Lbs.
WTV	Temp Control Valve Weight	Lbs.
WT	Total Weight	Lbs.
TWT	Total Equivalent Weight	Lbs.
PP	Power Penalty	Lbs./Watts
TWTS	Total Equivalent Weight Stored	Lbs.
WTS	Total Weight Stored	Lbs.
PWS	Total Power Stored	Watts
UAS	Thermal Conductance x Area Stored	BTU/Hr-°F
TCOS	Coolant Outlet Temp Stored	°F
VS	Volumetric Flow Rate Stored	Ft^3/Hr
WTX	Heat Exchanger Weight	Lbs.

SYMBOL DESCRIPTION - EBAY

DTF	Fan Temp Rise	°F
DP	Fan Pressure Rise	In-H_2O
RHO	Gas Density	Lbs/Ft^3
CPA	Gas Specific Heat	BTU/Lb-°F

SYMBOL DESCRIPTION - EBAY (CONT)

Symbol	Description	Units
LF	Component Number	-
TAI	Gas Inlet Temp	°F
TE	Compartment Temp	°F
TAO	HX Gas Outlet Temp	°F
TCI	Coolant Inlet Temp	°F
N	Index Resister	-
V	Volumetric Flow Rate	Ft^3/Min
QE	Compartment Heat Load (Excluding Fan)	BTU/Hr
PW	Fan Power	Watts
QT	HX Total Load	BTU/Hr
TCO	Coolant Outlet Temp	°F
WCPC	Flow Stream Capacity Rate	BTU/Hr-°F
DTLM	Log-Mean-Temperature-Difference	°F
UA	Thermal Conductance x Area	BTU/Hr-°F
WTF	Fan Weight	Lbs.
WTK	Check Valve Weight	Lbs.
WTHX	Heat Exchanger Weight (Package)	Lbs.
WTFAN	Fan Package Weight	Lbs.
TWT	Total Equivalent Weight	Lbs.
PP	Power Penalty	Lbs/Watt
TWTS	Total Equivalent Weight Stored	Lbs.
WTHXS	Heat Exchanger Weight Stored (Package)	Lbs.
UAS	Thermal Conductance x Area Stored	BTU/Hr-°F
WTFS	Fan Package Weight Stored	Lbs.
PWS	Fan Power Stored	Watts
TCOS	Coolant Outlet Temp Stored	°F
QTS	HX Total Load Stored	BTU/Hr
VS	Volumetric Flow Rate Stored	Ft^3/Min
WTX	Heat Exchanger Weight	Lbs.

SUBROUTINE HSC

Symbol	Description	Units
VB	Gas Flow Rate Per Lb of Bed	CFM/LbHSC
WH2O	Water Removed Per Cycle	Lbs/Cycle
QLAT	Latent Heat Removal Rate From Cabin	BTU/Hr
WBC	Bed Size Required For CO_2 Control	Lbs.
WCO2	CO_2 Generation Rate	Lbs./DAY
NC	Loop Counter	-

SUBROUTINE HSC (CONT)

Symbol	Description	Units
N	Index Register - Bed Sizing Loop H_2O	-
PVI	Cabin Water Vapor Pressure Level	PSIA
BL	Bed Water Loading	Lbs/Lb
K	Off Tables IF ≠ O	-
V	Volumetric Flow Rate Required/Available	Ft^3/Hr
WTV	Vacuum Valve Weight	Lbs
DP	Fan Pressure Rise	In-H_2O
PD	System Pressure Loss - Excluding Bed	In-H_2O
WTF	Fan Weight	Lbs
WTK	Check Valve Weight	Lbs
WVC	Humidity Control Valve Weight	Lbs
RHO	Gas Density	Lbs/Ft^3
DAY	Mission Length	DAYS
WTX	Canister Weight (Excluding HSC)	Lbs
L	Component Weight	Lbs
WT	System Total Weight	Lbs
WF	Fan Weight Increase	Lbs
PW	Fan Power	Watts
WB	Bed Weight	Lbs
WU	Ullage Penalty Weight	Lbs
VBM	Maximum Volumetric Flow Rate	Ft^3/Hr
WH2OC	Calculated Amount of H_2O Removed Per Cycle	Lbs/Cycle
WC	Same As "WBC"	Lbs/Cycle
VC	Volumetric Flow Rate	Ft^3/Hr
WCR	Required CO_2 Bed Loading	Lbs/Lb
PCO2	First Guess of CO_2 Cabin Partial Pressure Level	MMHG
J	CO_2 Performance Index Register	-
BLS	Calculated CO_2 Bed Loading	Lbs/Lb
KC	Off Tables IFϕO	-
TDP	Cabin Dew Point	°F
VCH	Dummy - Not Used	-
PWS(N)	Same As "PW" - Stored	Watts
WTS(N)	Same As "WT" - Stored	Lbs
WBS(N)	Same As "WB" - Stored	Lbs
WUS(N)	Same As "WU" - Stored	Lbs
WFS(N)	Same As "WF" - Stored	Lbs
VS(N)	Same As "V" - Stored	Ft^3/Hr

SUBROUTINE HSC (CONT)

Symbol	Description	Units
WTSYS(N)	System Total Equivalent Weight	Lbs

SUBROUTINE (CONT)

Symbol	Description	Units
V	Volumetric Flow Rate	Ft^3/Hr
WTB	Bed Weight (Chemical)	Lbs
DAY	Mission Length	DAYS
WTV	Check Valve Weight	Lbs
WT	Total Weight	Lbs
J	Component Number	-
QSC	Heat Generated	BTU/Hr
DP	Fan Pressure Rise	$In-H_2O$

SUBROUTINE EBAY2

Symbol	Description	Units
DTF	Fan Temp Rise	°F
DP	Fan Pressure Rise	$In-H_2O$
RHO	Gas Density	Lbs/Ft^3
CPA	Gas Specific Heat	BTU/Lb-°F
LF	Component Number	-
TAI2	Gas Inlet Temp - 2nd HX In Series	°F
TE	Compartment Temp - Design	°F
TB2	Compartment Temp - 2nd Bay	°F
TCI2	Coolant Inlet Temp - 2nd HX	°F
TCI	Coolant Inlet Temp - 1st HX	°F
QB1	Compartment Heat Load - 1st Bay	BTU/Hr
TAO2	Gas Outlet Temp - 2nd HX	°F
N	Index Register	-
V	Volumetric Flow Rate	Ft^3/Hr
QB2	Compartment Heat Load - 2nd Bay	BTU/Hr
PW	Fan Power	Watts
QT2	2nd HX Total Heat Load	BTU/Hr
QTI	1st HX Total Heat Load	BTU/Hr
TCO1	Same As "TCI2"	°F
TCO2	Coolant Temp Leaving 2nd HX	°F
DTLM2	Log-Mean-Temp-Difference: 2nd HX	°F
UA2	Thermal Conductance x Area: 2nd HX	BTU/Hr-°F
WTF	Fan Weight	Lbs
WTK	Check Valve Weight	Lbs

SUBROUTINE EBAY2 (CONT)

Symbol	Description	Units
WTHX	HX Package Weight	Lbs
WTFAN	Fan Package Weight	Lbs
TWT	Total Equivalent Weight	Lbs
PP	Power Penalty	Lbs/Watt
TWTS	Total Equivalent Weight Stored	Lbs
WTHXS	HX Package Weight Stored	Lbs
WTFS	Fan Package Weight Stored	Lbs
PWS	Power - Stored	Watts
TCO1S	Coolant Temp Leaving 1st HX Stored	°F
TCO2S	Coolant Temp Leaving 2nd HX Stored	°F
UA2S	Thermal Conductance x Area Stored	BTU/Hr-°F
QT1S	Total Heat Removed 1st HX Stored	BTU/Hr
QT2S	Total Heat Removed 2nd HX Stored	BTU/Hr
VS	Volumetric Flow Rate - Stored	Ft^3/Min
TAO1	Gas Outlet Temp - 1st HX	°F
EFF	Temp Effectiveness	-
TBI	1st Compartment Temp	°F
M	Index Register	-
TAI1	1st HX Gas Inlet Temp	°F
DTLM1	Log-Mean-Temp-Difference 1st HX	°F
UA1	Thermal Conductance x Area 1st HX	BTU/Hr-°F
UA1S	Thermal Conductance x Area 1st HX Stored	BTU/Hr-°F

SUBROUTINE FEVAP

TCO	Coolant Outlet Temp	°F
TCI	Coolant Inlet Temp	°F
Q	Heat Load Desired	BTU/Hr
WCP	Flow Stream Capacity - Rate	BTU/Hr-°F
QR	Heat Load Rejected	BTU/Hr
L	Component Number	-
WT	Subsystem Weight	Lbs
WH2O	Water Usage Rate	Lbs/Hr
TOMIN	Minimum Coolant Outlet Temp	°F
TOMAX	Maximum Coolant Outlet Temp	°F

SUBROUTINE FANWT

Symbol	Description	Units
CFM	Volumetric Flow Rate	FT^3/Min
CFH	Volumetric Flow Rate	Ft^3/Min
A	Specific Speed	-
DP	Fan Pressure Rise	In-H_2O
WT	Fan Weight	Lbs

SUBROUTINE CRY

Symbol	Description	Units
THO	Coolant Outlet Temp-Assummed	°F
TIN	Coolant Inlet Temp	°F
Q	Heat Rejected	BTU/Hr
WH	Flow Stream Capacity-Rate	BTU/Hr-°F
TH2O	Hydrogen Outlet Temp	°F
N	Index Register	-
WC	Hydrogen Flow Stream Capacity-Rate	BTU/Hr-°F
NC	Component Number	-
TOC	Calculated Coolant Outlet Temp	°F
WH2	Hydrogen Flow Rate	Lbs/Hr

SUBROUTINE HX

Symbol	Description	Units
R	Mass Flow Ratio (Cold/Hot)	-
WC	Cold Side Flow Stream Capacity-Rate	BTU/Hr-°F
WH	Hot Side Flow Stream Capacity-Rate	BTU/Hr-°F
THO	Hot Side Outlet Temp	BTU/Hr-°F
TCI	Cold Side Inlet Temp	°F
Q	Heat Rate To Be Transferred	BTU/Hr
NCOMP	Component Number	-
EFF	Temperature Effectiveness (Hot Side)	-

SUBROUTINE WTV2

Symbol	Description	Units
N	Type of Valve 1- Manual Valve 2- Check Valve 3- Elec. Solenoid Valve 4- Gas Disconnect	-
WT	Component Weight	Lbs

SUBROUTINE WTV2 (CONT)

Symbol	Description	Units
V	Gas Flow Rate	Ft^3/Hr

SUBROUTINE RAD

Symbol	Description	Units
TY	Calculated Coolant Outlet Temp	°R
T2	Desired Coolant Outlet Temp	°R
B	Number (2.0×10^{-10})	-
TI	Wall Temp At Inlet	°R
T1	Inlet Coolant Temp	°R
ZETA	Function of TI	BTU/Hr
ALPHA	$\delta \epsilon T_S{}^3$	BTU/Hr
TO	Wall Temp At Outlet	BTU/Hr
BETA	$B*Ts^3$	°R
I	Index Register	-
QA	Heat Rejected Per Unit Area	$BTU/Hr\text{-}Ft^3$
AR	Required Radiator Area	Ft^2
WCP	Flow Stream Capacity-Rate	BTU/Hr °F
WR	Radiator Wt.	Lbs
J	Component Number	-
WE	Dummy - Not Used	-

SUBROUTINE CX2

Symbol	Description	Units
RHO	Gas Density	Lbs/Ft^3
TC	Cabin Temp	°F
WAM	Max Gas Flow Stream Capacity-Rate-HX	BTU/Hr-°F
V	Volumetric Flow Rate - HX	Ft^3/Hr
WF	Gas Flow Stream Capacity-Rate Through Fan	BTU/Hr-°F
V11	Fan Volumetric Flow Rate	Ft^3/Hr
WH	Assummed HX Gas Flow Stream Capacity-Rate	BTU/Hr-°F
WH2O	Water Condensing Rate	Lbs/Hr
QL	Cabin Latent Load	BTU/Hr
QL2	Latent Load Downstream of Cabin	BTU/Hr
TAMIN	Minimum Gas Outlet Temp	°F
TCI	Coolant Inlet Temp	°F
QF	Fan Heat Load	BTU/Hr
P	Fan Power	Watts

SUBROUTINE CX2 (CONT)

Symbols	Description	Units
QSMAX	Maximum Sensible Heat Load	BTU/Hr
QS	Cabin Sensible Heat Load (Includes Fan)	BTU/Hr
QS2	Sensible Heat Downstream of Cabin	BTU/Hr
K	IF = 0, Single HX, 70 - Has Sensible HX Also	-
TAO	Gas Outlet Temp-Assummed	°F
TAI	Gas Inlet Temp-Assummed	°F
QSX	HX Sensible Load	BTU/Hr
TCN	New Cabin Temp	°F
QSN	New Crew Sensible Load	BTU/Hr
KL	Off Tables IF = 0	-
NP	Index Register	-
PXO	H_2O Vapor Pressure At HX Exit	PSIA
WWO	H_2O Vapor Leaving HX In Gas Stream	Lbs/Hr
PXI	Vapor Pressure of H_2O At HX Inlet	PSIA
TDP	Inlet Dew Point	°F
TY	Coolant Temp Where Condensing Starts	°F
QT	HX Total Load	BTU/Hr
TCO	Coolant Outlet Temp	°F
WC	Coolant Flowstream Capacity Rate	BTU/Hr-°F
QW	Heat Removed In Wet Section	BTU/Hr
QD	Heat Removed In Dry Section	BTU/Hr
TAOD	Gas Temp Where Condensing Starts	°F
DT	Log-Mean-Temp-Difference	°F
UAD	Dry Section Thermal Conductance x Area	BTU/Hr-°F
UAW	Wet Section Thermal Conductance x Area	BTU/Hr-°F
UAR	Required Thermal Conductance x Area	BTU/Hr-°F
NL	Component Number	-
I	IF = O, Converged	-
WHX	Volumetric Flow Rate Through HX	FT^3/Min
PXC	Cabin H_2O Vapor Pressure	PSIA
TDPC	Cabin Dew Point Temp.	°F

SUBROUTINE QMET

T2	New Cabin Temp	°F
Q2	New Sensible Metabolic Load	BTU/Hr
K	IF ≠ O, Off Tables	-

SUBROUTINE QMET (CONT)

Symbols	Description	Units
T1	Original Cabin Temp	°F
QO	Original Metabolic Heat Rate	BTU/Hr/Min
K1	Same As "K"	-
QN	New Metabolic Heat Rate	BTU/Hr/Min
K2	Same As "K"	-
Q1	Original Cabin Heat Load-Metabolic	BTU/Hr

SENSIBLE HX SUBROUTINE — SHX

INPUTS

QS2	CABIN SENSIBLE HEAT TO BE REMOVED	BTU/HR
TCAB	CABIN TEMPERATURE	°F
T22	COOLANT INLET TEMP	°F
WCPC	COOLANT MASS FLOW	BTU/LB–°F
RHOA	CABIN GAS DENSITY	LBS/FT^3
CPA	CABIN GAS SPECIFIC HEAT	BTU/LB –°F
PP	POWER PENALTY	LBS/WATT
DP2	FAN PRESSURE RISE	IN–H_2O
N	COMPONENT NUMBER	—
FWT(N)	HX WEIGHT FACTOR	LBS/UA
FXW(N)	SYSTEM FIXED WEIGHT	LBS
SWT(N)	PACKAGING WEIGHT FACTOR	LBS/LB
CFT(N+10)	FAN EFFICIENCY	—

OUTPUTS

WT2	HX & FIXED WEIGHT	LBS
PW(12)	FAN POWER FOR SENS. HX FLOW	WATTS
V12	HX FLOW RATE	CFH
T23	COOLANT OUTLET TEMP	°F
TAOS	HX GAS OUTLET TEMP	°F
CFT(N)	HX UA	BTU/HR–°F
WTHX	HX WEIGHT	LBS
WVALVE	AIR BYPASS VALVE WEIGHT	LBS

SUBROUTINE EBAY 2 (QB1, QB2, TE, TCI, WCPC, RHO, CPA, PP, DP, WTHX, WTFAN, PW, V, TCO1, TCO2, TB1, TB2, TAO1, TAO2, QT1, QT2, LF)

INPUT

QB1	– HEAT LOAD IN FIRST SERIES BAY	BTU/HR
QB2	– HEAT LOAD IN SECOND SERIES BAY	BTU/HR
TE	– MAXIMUM COMPACTMENT TEMP	°F
TCI	– COOLANT TEMP INTO FIRST BAY	°F
WCPC	– COOLANT MASS FLOW RATE	BTU/HR–°F
RHO	– COMPARTMENT DENSITY AT TE	LBS/FT^3
CPA	– GAS SPECIFIC HEAT	BTU/LB–°F
PP	– POWER PENALTY	LBS/WATT
DP	– FAN PRESSURE RISE	IN – H_2O
LF	– HX COMPONENT NUMBER	–
	FAN COMPONENT NUMBER=LF+1	–
FWT(LF)	–HEAT EXCHANGER WEIGHT FACTOR	LBS/UA
FWT(LF+1)	–NUMBER OF FANS & CHECK VALVES	–
FXW(LF)	–FIXED WEIGHT ADDED TO HX	LBS
FXW(LF+1)	–FIXED WEIGHT ADDED TO FANS	LBS
SWT(LF)	–STRUCTURAL WEIGHT FACTOR-HX	LBS/LB
SWT(LF+1)	–STRUCTURAL WEIGHT FACTOR – FANS	LBS/LB
CFT(LF+1)	–OVERALL FAN EFFICIENCY	–

OUTPUT

WTHX	– TOTAL HX WT–BOTH BAYS	LBS
WTFAN	– TOTAL FAN WT–BOTH BAYS	LBS
PW	– TOTAL POWER – BOTH BAYS	WATTS
V	– FAN VOLUME FLOW RATE	CFM
TCO1	– COOLANT OUTLET TEMP–1ST BAY	°F
TCO2	– COOLANT OUTLET TEMP–2ND BAY	°F
TB1	– 1ST COMPARTMENT TEMP	°F
TB2	– 2ND COMPARTMENT TEMP	°F
TAO1	– AIR OUTLET TEMP 1ST JX	°F
TAO2	– AIR OUTLET TEMP 2ND HX	°F
QT1	– TOTAL HEAT REMOVED BY HX 1ST BAY	BTU/HR
QT2	– TOTAL HEAT REMOVED BY HX 2ND BAY	BTU/HR

SUBROUTINE RAD (T1, T2, WCP, WR, AR, WE, TY, J)

INPUTS

T1	– RADIATOR INLET TEMP.	°R
T2	– DESIRED RADIATOR OUTLET TEMP	°R
WCP	– COOLANT FLOW RATE	BTU/HR–°F
J	– COMPONENT NUMBER	–
TS	– EQUIVALENT SINK TEMP (DUE TO ENVIRONMENT)	°R
AMAX	– MAXIMUM ALLOWABLE RADIATOR SURFACE AREA	FT^2
EMIS	– RADIATOR EMISSIVITY	–
SWT (J)	– RADIATOR WEIGHT FACTOR	LBS/FT^2

OUTPUTS

TY	– RADIATOR OUTLET TEMP	°R
WR	– RADIATOR PANEL WEIGHT	LBS
AR	– RADIATOR AREA REQUIRED FOR TY	FT^2

SUBROUTINE F E VAP (Q, WCP, TCI, L, TCO, WT)

INPUTS

Q	– HEAT TO BE REJECTED	BTU/HR
WCP	– COOLANT MASS FLOW RATE	BTU/HR–°F
TCI	– COOLANT INLET TEMP	°F
L	– COMPONENT NUMBER	–
FWT(L)	– HEAT EXCHANGER WT. FACTOR	LBS/UA
FXW(L)	– SUBSYSTEM FIXED WT	LBS
SWT(L)	– STRUCTURAL WT. FACTOR	LBS
CFT(L)	– HEAT EXCHANGER UA	BTU/HR–°F
PP	– POWER PENALTY	LBS/WATT

OUTPUTS

TCO	– COOLANT OUTLET TEMP	°F
WT	– SUBSYSTEM WEIGHT	LBS
QR	– ACTUAL HEAT REJECTED	BTU/HR
WH2O	– WATER USAGE RATE	LBS/HR
TOMAX	– MAX. COOLANT OUTLET TEMP POSSIBLE	°F
TO MIN	– MIN. COOLANT OUTLET TEMP POSSIBLE	°F

SUBROUTINE QMET (Q1, T1, T2,Q2, K)

INPUTS

Q1	– METABOLIC SENSIBLE HEAT LOAD AT T1	BTU/HR
T1	– ORIGINAL CABIN TEMPERATURE	°F
T2	– NEW CABIN TEMPERATURE	°F
–	– TABLE OF QS VS TCABIN FOR ONE MAN (LOC 501)	–

OUTPUTS

Q2	– METABOLIC SENSIBLE HEAT LOAD AT T2	BTU/HR
K	– IF ≠O, OFF TABLES	–

SUBROUTINE CRY (Q, WH, TIN, NC, WH2)

INPUTS

Q	HEAT TO BE REJECTED	BTU/HR
WH	COOLANT MASS FLOW RATE	BTU/HR–°F
TIN	COOLANT INLET TEMP	°F
NC	COMPONENT NUMBER	–
CFT (NC)	HEAT EXCHANGER UA	BTU/HR–°F

OUTPUTS

WH2	HYDROGEN FLOW RATE	(WHYD)	LBS/HR
TOC	COOLANT OUTLET TEMP	(THOTCAL)	°F
TH2O	HYDROGEN OUTLET TEMP	(THYDO)	°F

SUBROUTINE EBAY (QE, TE, TCI, WCPC, RHO, CPA, PP, DP, WTHX
WTFAN, PW, V, TCO, TAO, QT, LF)

INPUTS

QE	— COMPARTMENT HEAT LOAD	BTU/HR
TE	— DESIRED COMPARTMENT TEMP	°F
TCI	— INLET COOLANT TEMP TO HX	°F
WCPC	— COOLANT MASS FLOW	BTU/HR—°F
RHO	— COMPARTMENT GAS DENSITY	LBS/FT3
CPA	— GAS SPECIFIC HEAT	BTU/LB—°F
PP	— POWER PENALTY	LBS/WATT
DP	— FAN PRESSURE RISE	IN — H_2O
LF	— COMPONENT NUMBER OF HX	—
FWT(N)	— WEIGHT FACTOR HX	LBS/UA
FXW(N)	— FIXED WEIGHT ADDED TO COMPONENT	LBS
SWT(N)	— STRUCTURAL WEIGHT FACTOR (USED FOR FAN, VALVE, & FIXED WEIGHT)	—

OUTPUTS

WTHX	— HEAT EXCHANGER & FIXED WEIGHT	LBS
WTFAN	— FANS & CHECK VALVES WEIGHT	LBS
PW	— FAN POWER	WATTS
V	— FAN VOLUMETRIC FLOW RATE	CFM
TCO	— COOLANT OUTLET TEMP	°F
TAO	— AIR OUTLET TEMP LEAVING HX	°F
QT	— TOTAL HEAT REMOVED BY HX	BTU/HR

SUBROUTINE CX2 (WC, TCI, QS, QL, TC, QS2, QL2, V, P, NL, K, TCO, V11, I, QSX)

INPUTS

WC	— COOLANT MASS FLOW RATE	BTU/HR —°F
TCI	— COOLANT INLET TEMP	°F
QS	— TOTAL SENS. HEAT TO BE REMOVED FROM CABIN (INCLUDES FAN)	BTU/HR
QL	— LATENT HEAT TO BE REMOVED FROM CABIN	BTU/HR
TC	— CABIN TEMPERATURE	°F
QS2	— SENSIBLE HEAT DOWNSTREAM OF FAN	BTU/HR
QL2	— LATENT HEAT DOWNSTREAM OF FAN	BTU/HR
V	— HEAT EXCHANGER MAX FLOW RATE	CFH
P	— FAN POWER	WATTS
NL	— COMPONENT NUMBER	—
K	— IF 0, SINGLE HX IF 1, ALSO SENS. HX	—
V11	— FAN FLOW RATE	FT^3/HR
TOLQ	— TOLERANCE ON HX UA CONVERGENCE	DEC. FRAC.
PCAB	— CABIN PRESSURE	PSIA
RA	— CABIN GAS CONSTANT	FT/°R
CPA	— CABIN GAS SPECIFIC HEAT	BTU/LB—°R
QSM	— METABOLIC SENSIBLE HEAT	BTU/HR

OUTPUT

TCAB	— CABIN TEMP (MAY BE RAISED IF SYSTEM NOT CAPABLE)	°F
HXCFM	— AIR FLOW THROUGH HX	CFM
TDPCAB	— CABIN DEW POINT	°F
TAIRO	— HX AIR OUTLET TEMP	°F
TCO	— COOLANT OUTLET TEMP	°F
QSX	— SENSIBLE HEAT REMOVED BY CONDENSER	BTU/HR
I	— IF 0, SUBROUTINE CONVERGED	—

SUBROUTINE CHX (QS, QL, TC, TCI, WCPC, RHO, CPA, PMAX, DPF, TAO, J, QCS, V, PW, WT, TCCO, PXO, I, QS2, QL2, K, TDP)

INPUT

QS	–	CABIN SENS. HEAT LOAD	BTU/HR
QL	–	CABIN LATENT HEAT LOAD	BTU/HR
TC	–	CABIN TEMP HEAT LOAD	°F
TCI	–	COOLANT INLET TEMP	°F
WCPC	–	COOLANT MASS FLOW RATE	BTU/HR–°F
RHO	–	CABIN GAS DENSITY	LB / FT^3
CPA	–	CABIN GAS SPECIFIC HEAT	BTU/LB–°F
PMAX	–	MAXIMUM CABIN H_20 VAPOR PRESS.	PSIA
DPF	–	FAN PRESSURE RISE	IN–H_2O
J	–	COMPONENT NO.	–
QS2	–	SENS. HEAT ADDED DOWN STREAM OF FAN	BTU/HR
QL2	–	LATENT HEAT ADDED DOWN STREAM OF FAN	BTU/HR
K	–	{(IF O, NO SENS HX (IF 1, SENS HX ALSO	–
CFT(J+10)	–	FAN OVERALL EFFICIENCY	–
FWT(J)	–	HX WEIGHT FACTOR	LBS/UA
FXW(J)	–	FIXED WEIGHT ADDED TO SUBSYSTEM	LBS
SWT(J)	–	STRUCTURAL WEIGHT FACTOR	LBS/LB

OUTPUT

TAO	–	HX AIR OUTLET TEMP	°F
TDP	–	CABIN DEW POINT	°F
QCS	–	SENSIBLE HEAT REMOVED BY COND.	BTU/HR
V	–	HX AIR FLOW RATE	FT^3/HR
PW	–	POWER REQUIRED BY COND. FLOW	WATTS
WT	–	HX+VALVE WEIGHT	LBS
TCCO	–	COOLANT OUTLET TEMP.	°F
PXO	–	HX OUTLET VAPOR PRESS.	PSIA
I	–	CONVERGENCE KEY –IFO, O.K.	–
WTHX	–	HX WEIGHT	LBS
MVALVE	–	AIR BYPASS VALVE WEIGHT	LBS
CFT(J)	–	HX UA	BTU/HR–°F

SUBROUTINE HSC (WCO2, QLAT, DAY, RHO, PVI, PD, L, WT, V, WB, WU, VCH, WF)

INPUTS

WCO2	– CO_2 REMOVAL RATE	LBS/DAY
QLAT	– LATENT HEAT REMOVAL RATE	BTU/HR
DAY	– MISSION LENGTH	DAYS
RHO	– CABIN GAS DENSITY	LBS/FT^3
PVI	– REQUIRED MAX. H_20 VAPOR PRESS LEVEL	PSIA
PD	– SYSTEM PRESSURE LOSS EXTERNAL TO CANISTER	IN–H2O
L	– COMPONENT NUMBER	–
FCO2	– RATIO OF PEAK PRODUCTION RATE TO AVG RATE	–
CO2L	– CO_2 DESIGN BED LOADING	LBS/LB
CYCL	– 1/2 CYCLE TIME	MIN
TCAB	– CABIN TEMP	°F
FWT(L)	– NUMBER OF CANISTERS	–
FXW(L)	– SYSTEM FIXED WEIGHT	LBS
SWT(L)	– STRUCTURAL WEIGHT FACTOR	LBS/LB
X(426)	– TABLE H_2O LOADING	–
X(351)	– TABLE OF CO_2 LOADING	–
VCH	– NOT USED	–

OUTPUTS

WT	– SUBSYSTEM WEIGHT (EXCLUDING FAN)	LBS
V	– SUBSYSTEM FLOW RATE	FT^3/HR
WB	– HSC BED WEIGHT	LBS
WU	– ULLAGE PENALTY	LBS
WF	– FAN WEIGHT INCREASE FOR HSC	LBS
WTCAN	– EMPTY CANISTER WT	LBS
WVVAL	– VACUUM CYCLING VALVE WT	LBS
WCVAL	– CONTROL VALVE WT	LBS
WKVAL	– CHECK VALVE WT (FAN FLOW)	LBS

SUBROUTINE LIOH (J, DAY, DPF, WL, WT PW, V, QS, QL)

INPUTS

J	– COMPONENT NUMBER	–
DAY	– MISSION LENGTH	DAYS
DPF	– FAN ΔP	IN – H_2O
WCO2	– AVERAGE CO_2 REMOVAL RATE	LBS/DAY
TCAB	– CABIN TEMPERATURE	°F
FCO2	– RATIO OF ACTUAL PRODUCTION RATE/AVG.	–
FNCO	– NUMBER OF CANISTERS ON LINE	–
FRESH	– NUMBER OF FRESH CANISTERS ON LINE	–
CFT (11)	– FAN EFFICIENCY	–
CFT (J)	– CO_2 REMOVAL EFFICIENCY	–
FWT (J)	– CANISTER WEIGHT FACTOR (TOTAL WT.)	LBS/LB

OUTPUTS

WT	– SUBSYSTEM TOTAL FIXED WEIGHT	LBS
WL	– MINIMUM WT OF LIOH REQUIRED FOR MISSION	LBS
PW	– FAN POWER REQUIRED FOR LIOH	WATTS
V	– VOLUME FLOW RATE	FT^3/HR
QS	– (SIZING PROGRAM–SENS & FAN HEAT LOAD	BTU/HR
	(OFF DESIGN–SENS HEAT OF REACTION	BTU/HR
Q L	– LATENT HEAT LOAD	BTU/HR
PMAX	– CO_2 PARTIAL PRESSURE AT 60% ηREM	MM HG
PMIN	– CO_2 PARTIAL PRESSURE AT 95% ηREM	MM HG

APPENDIX II
SUBROUTINE DESCRIPTION

APPENDIX II

SUBROUTINE DESCRIPTIONS

Listed below is a short description of what each of the subroutines does:

START - Reads a comment card and prints it. A blank card terminates a run.

LOAD - Loads the input data into the proper storage locations.

UNBAR - A table interpolation routine.

KANDK - Calculates the vapor pressure or dew point temperature of water vapor. Given one property it will calculate the corresponding property.

LIOH - Calculates the heat loads, flow required, and weight of LiOH required for CO_2 removal.

CHX - Calculates the optimum volume flow required and the heat exchanger weight to remove a given sensible and latent heat load. If a sensible heat exchanger is also used, the coolant leaving temperature will be kept at or below the cabin dew point.

SHX - Sensible heat exchanger subroutine calculates optimum volume flow rate and heat exchanger size.

EBAY - Calculates the optimum heat exchanger size and volume flow rate to remove an air heat load from a separate compartment. Also calculates fan weight and power.

APPENDIX II (CONT)

SUBROUTINE DESCRIPTIONS

EBAY2 - Does the same as EBAY for two compartments in series. Calculates which compartment controls the sizing of the equipment and uses the same equipment in each compartment.

HSC - This routine calculates the optimum flow rate and bed size for HSC. This material absorbs both CO_2 and H_2O vapor. During the off design performance, the water vapor partial pressure and CO_2 partial pressure are calculated as well as the air flow required for humidity control.

CONT - Calculates the contaminant canister weight and volume flow rate required for contaminant control.

FEVAP - Calculated the subsystem weight required to remove the input heat load. For off design performance it will remove as much heat as possible up to the desired heat load.

FANWT - Calculates fan weight as a function of volume flow rate and pressure rise.

CRY - Calculates the cryogen flow rate required to meet the given heat load. (Off design performance only).

HX - Calculates the hot side leaving temperature giving the flow rates, heat rejected, and the cold side inlet temperatures. Used for sensible heat transfer only.

APPENDIX II

SUBROUTINE DESCRIPTIONS

WTV2 - Calculates valve weight as a function of volume flow rate for:

a) Check valves

b) Solenoid valves

c) Manual shut off valves

d) Gas disconnects

RAD - Calculated radiator area and weight required to reject a given heat load at a given inlet temperature. If the area required exceeds the maximum area available, the routine will calculate the outlet temperature that can be reached at the maximum area.

CX2 - Calculates condenser air outlet temperature and cabin dew point for a given sensible and latent load. It also calculates the heat exchanger volume flow rate required to meet the heat load. If the heat load can not be met at maximum air flow, the cabin temperature will be raised in 1°F increments until it can be met.

QMET - Calculates the metabolic sensible/latent heat load ratio as the cabin temperature is varied.

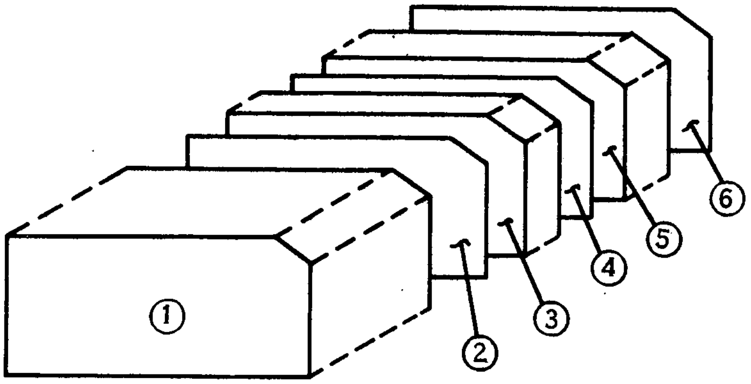


FIGURE 4–1 DECK SET UP

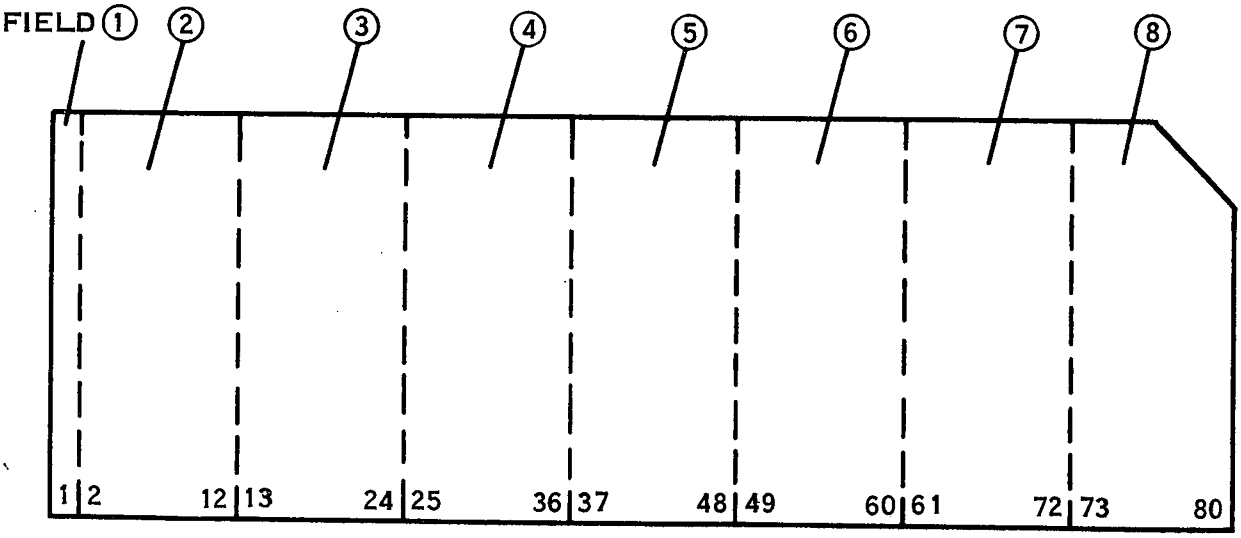


FIGURE 4–2 COMPUTER CARD SETUP

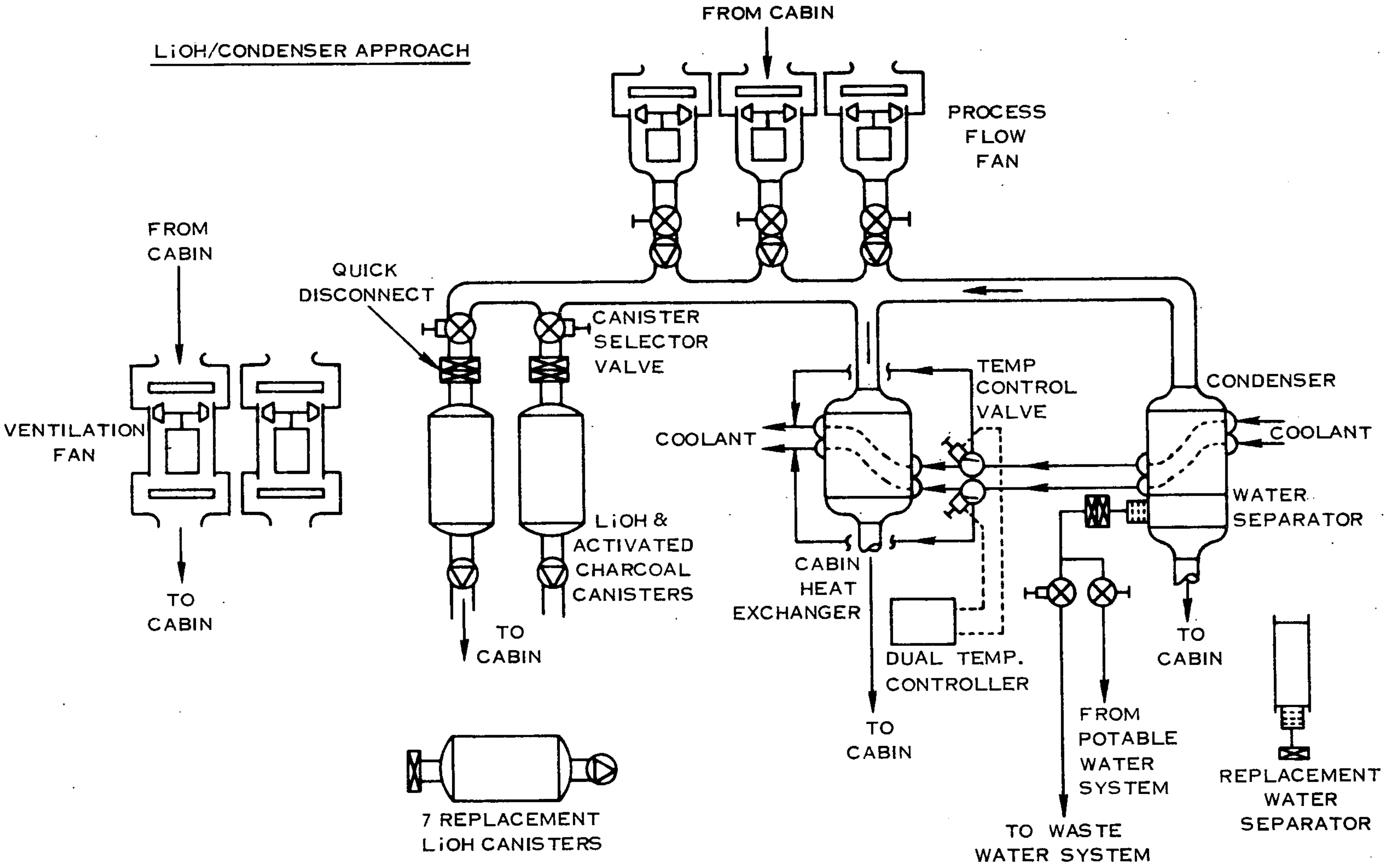


FIGURE 2–3. SAMPLE CASE – VENTILATION, CO_2, HUMIDITY &

APPENDIX III
LOGIC FLOW DIAGRAM

CHART TITLE - INTRODUCTORY COMMENTS

H247 SHUTTLE EC/LSS SIZING PROGRAM

LOAD DATA

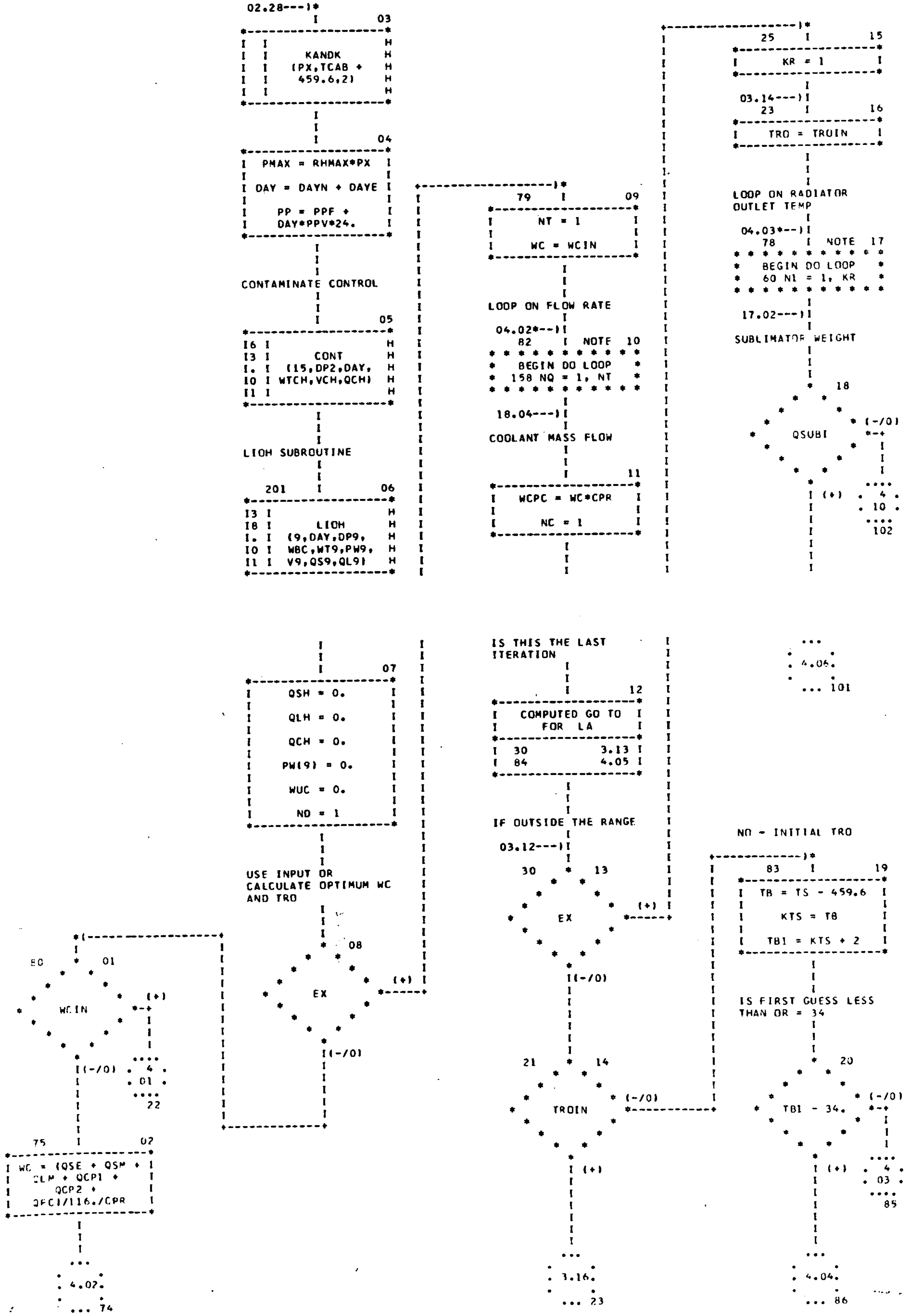
CHART TITLE - PROCEDURES

```
     -----------
    /  800     /
   -----------
         I
14.10*--)I
         I          01
*--------------------*
I I                  H
I I     START        H
I I                  H
I I                  H
I I                  H
*--------------------*
         I
         I
         I          02
*--------------------*
I I                  H
I I      LOAD        H
I I      (X)         H
I I                  H
I I                  H
*--------------------*
         I
         I
         I
PRINT INPUT DATA
         I
         I
         I          03
     ----------------
    / WRITE TO DEV  /
   /      6        /
  /  VIA FORMAT   /
 /       910     /
/ FROM THE LIST /
----------------
         I
         I
         I NOTE  04
* * * * * * * * * * *
* LIST = (X(J),J =  *
*       1,64)       *
* * * * * * * * * * *
         I
         I
         I          05
     ----------------
    / WRITE TO DEV  /
   /      6        /
  /  VIA FORMAT   /
 /       915     /
/ FROM THE LIST /
----------------
         I
         I
         I NOTE  06
* * * * * * * * * * *
* LIST = CYCL, QEB2 *
* * * * * * * * * * *
         I
         I
         I          07
     ----------------
    / WRITE TO DEV  /
   /      6        /
  /  VIA FORMAT   /
 /       982     /
/ FROM THE LIST /
----------------
         I
         I
         I NOTE  08
* * * * * * * * * * *
* LIST = (X(J),J =  *
*  67,80), PERF     *
* * * * * * * * * * *
         I
         I
         I
OFF DESIGN
PERFORMANCE
         I
         I
         I          09
*--------------------*
I      NR = RN       I
I                    I
I    NPER = PERF     I
*--------------------*
         I
         I
         +-------------+
```

```
+------------------)*
         I          10
*--------------------*
I  COMPUTED GO TO    I
I     FOR  NPER      I
*--------------------*
I 802          2.11  I
I 801         20.01  I
I 805         31.19  I
*--------------------*
         I
         I
         I
IF OUTSIDE THE RANGE
         I
02.10---)I
  802    I          11
     ----------------
    / WRITE TO DEV  /
   /      6        /
  /  VIA FORMAT   /
 /       930     /
/ FROM THE LIST /
----------------
         I
         I
         I NOTE  12
* * * * * * * * * * *
* LIST = (X(J),J =  *
*     101,115)      *
* * * * * * * * * * *
         I
         I
         I          13
     ----------------
    / WRITE TO DEV  /
   /      6        /
  /  VIA FORMAT   /
 /       931     /
/ FROM THE LIST /
----------------
         I
         I
         I NOTE  14
* * * * * * * * * * *
* LIST = (X(J),J =  *
*     131,145)      *
* * * * * * * * * * *
         I
         I
         I          15
     ----------------
    / WRITE TO DEV  /
   /      6        /
  /  VIA FORMAT   /
 /       932     /
/ FROM THE LIST /
----------------
         I
         I
         I NOTE  16
* * * * * * * * * * *
* LIST = (X(J),J =  *
*     161,175)      *
* * * * * * * * * * *
         I
         I
         I          17
     ----------------
    / WRITE TO DEV  /
   /      6        /
  /  VIA FORMAT   /
 /       933     /
/ FROM THE LIST /
----------------
         I
         I
         I NOTE  18
* * * * * * * * * * *
* LIST = (X(J),J =  *
*     116,127)      *
* * * * * * * * * * *
         I
         I
         I          19
     ----------------
    / WRITE TO DEV  /
   /      6        /
  /  VIA FORMAT   /
 /       934     /
/ FROM THE LIST /
----------------
         I
         I
         +-------------+
```

```
+------------------)*
         I NOTE  20
* * * * * * * * * * *
* LIST = (X(J),J =  *
*     146,157)      *
* * * * * * * * * * *
         I
         I
         I          21
     ----------------
    / WRITE TO DEV  /
   /      6        /
  /  VIA FORMAT   /
 /       935     /
/ FROM THE LIST /
----------------
         I
         I
         I NOTE  22
* * * * * * * * * * *
* LIST = (X(J),J =  *
*     176,187)      *
* * * * * * * * * * *
         I
         I
         I          23
     ----------------
    /               /
   / WRITE TO DEV  /
  /       6       /
 /   VIA FORMAT  /
/       960     /
----------------
         I
         I
         I
SET UP MAXIME LOOP
COUNTS
         I
         I
         I          24
*--------------------*
I     KR = RMAX      I
I                    I
I     KI = HXIM      I
I                    I
I     KS = SPLITM    I
I                    I
I     KC = CONDM     I
I                    I
I     WEXP = 0.      I
I                    I
I     WT13 = 0.      I
*--------------------*
         I
         I
         I          25
*--------------------*
I      M1 = A1       I
I                    I
I      M2 = A2       I
I                    I
I    KEYC = FW5      I
I                    I
I     QSH = 0.       I
I                    I
I     QLH = 0.       I
I                    I
I       I = 0        I
*--------------------*
         I
         I
         I          26
*--------------------*
I       LA = 1       I
*--------------------*
         I
         I
         I
CALCULATE AIR DENSITY
         I
         I
         I          27
*--------------------*
I     RHOA =         I
I  PCAB*144./RA/     I
I  (TCAB + 459.6)    I
*--------------------*
         I
         I
         I
MAXIMUM  DEW PT
         I
         I
         I
         I  /
      -----
     / 3.03
```

CHART TITLE - PROCEDURES



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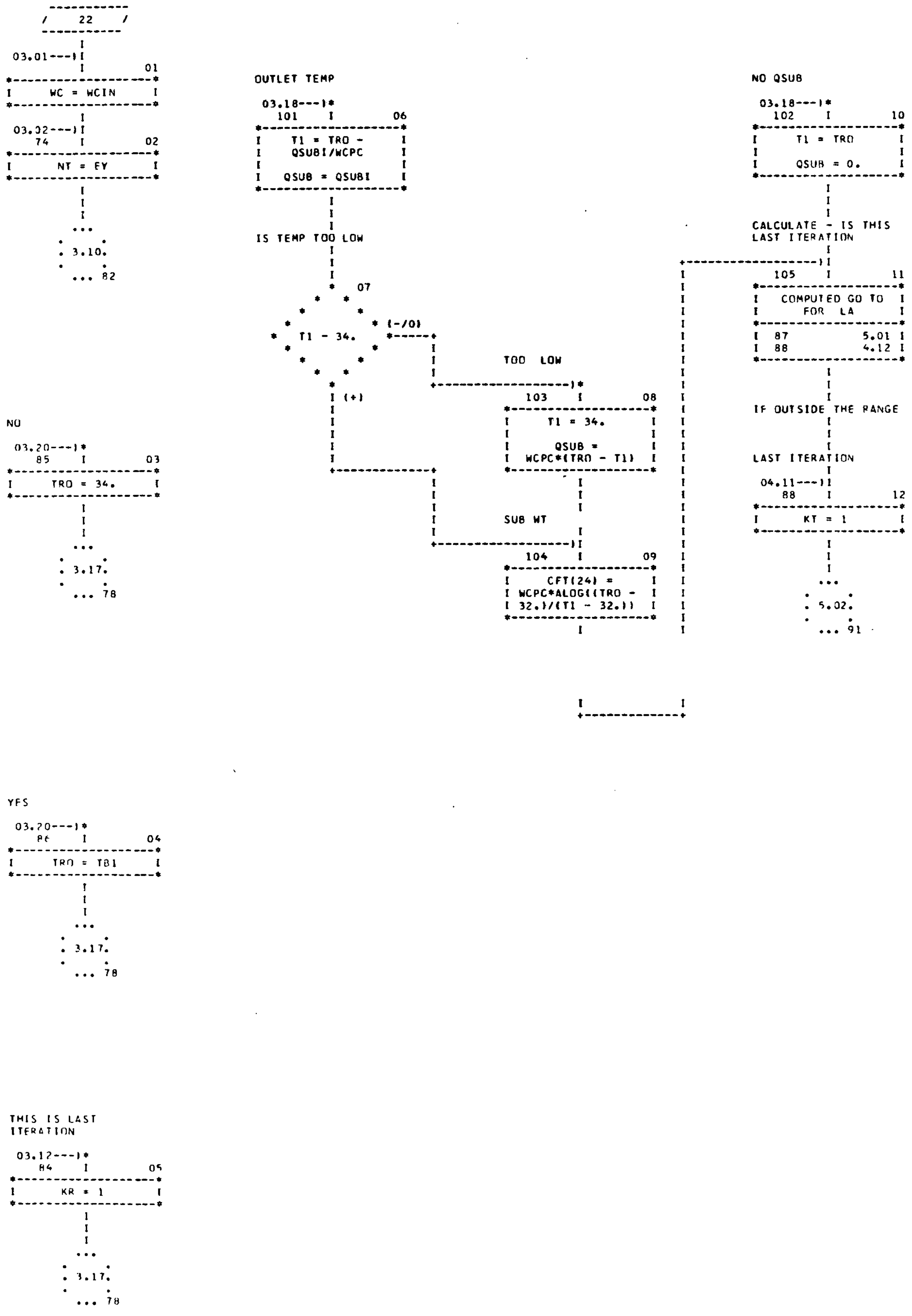

CHART TITLE - PROCEDURES

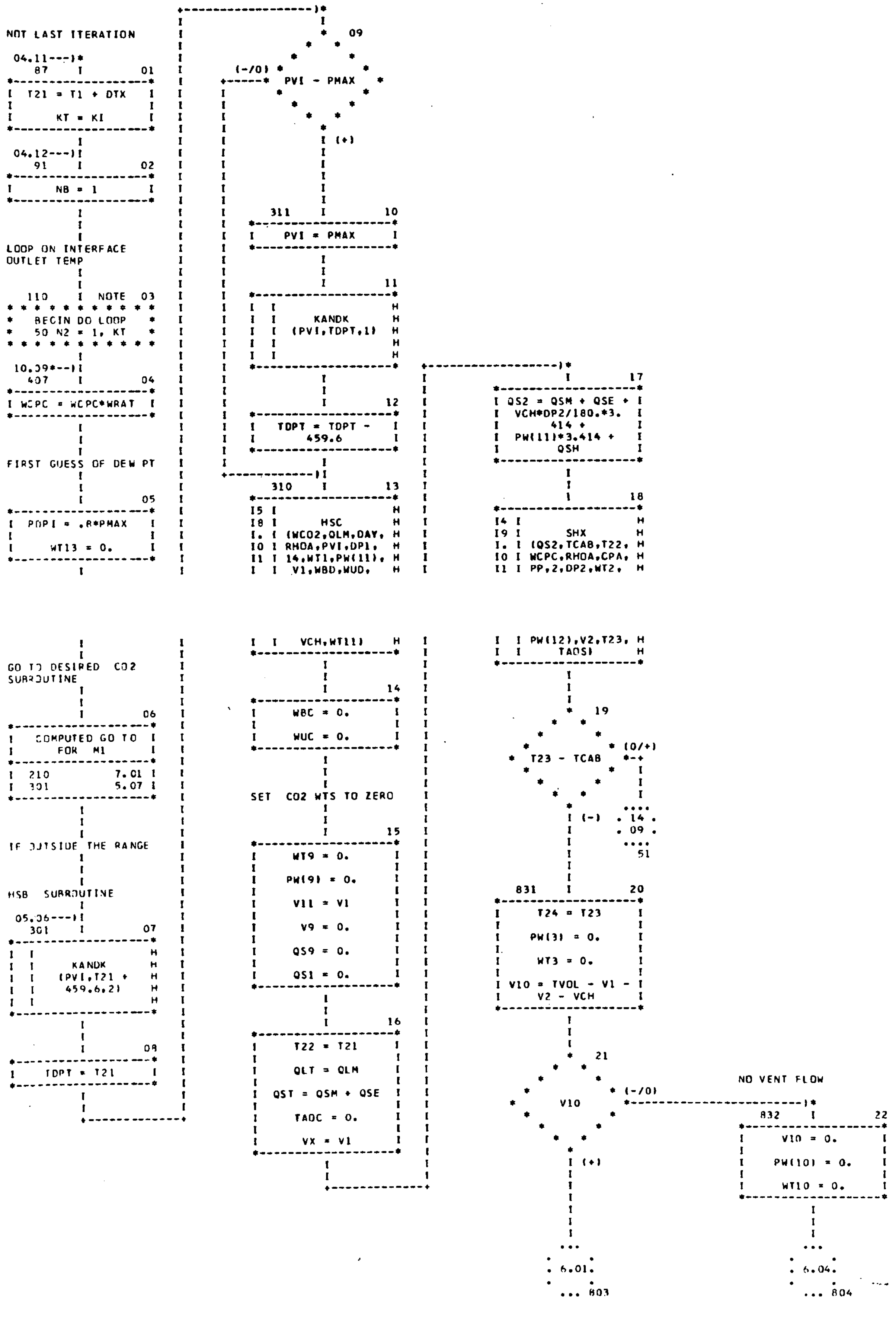

CHART TITLE - PROCEDURES

```
             -----------
            /   803    /
            -----------
                I
 05.21---)I
                I          01
*--------------------*
I     PW(10) =       I
I  V10*DP10/510./    I
I      CFT(10)       I
*--------------------*
          I
          I
          I          02
*--------------------*
I7 I                 H
I4 I     FANWT       H
I. I (V10,DP10,WTF)  H
I0 I                 H
I1 I                 H
*--------------------*
          I
          I
          I          03
*--------------------*
I     WT10 =         I
I    WTF*FWT(10)     I
*--------------------*
          I
 05.22---)I
   804    I          04
*--------------------*
I  V12 = V2 + VCH    I
*--------------------*
          I
          I
          I
SENS FAN WT
          I
          I
          I          05
*--------------------*
I     PW(12) =       I
I V12*DP2/510./CFT   I
I       (12)         I
*--------------------*
          I
          I
          I          06
*--------------------*
I7 I                 H
I4 I     FANWT       H

I. I (V12,DP2,WTF)   H
I0 I                 H
I1 I                 H
*--------------------*
          I
          I
          I          07
*--------------------*
I8 I                 H
I1 I     WTV2        H
I. I  (V12,2,WTK)    H
I0 I                 H
I1 I                 H
*--------------------*
          I
          I
          I          08
*--------------------*
I     WT12 =         I
I  (FWT(12)*(WTF +   I
I  WTK) + .9*WTF +   I
I FXW(12))*SWT(12)   I
*--------------------*
          I
          I
          I          09
*--------------------*
I   COMPUTED GO TO   I
I      FOR  LA       I
*--------------------*
I  242          9.11 I
I  2422         6.11 I
*--------------------*
          I             +----------06.09*--)*
          I             I            2422   I         11
          I             I              ----------------
IF OUTSIDE THE RANGE    I             / WRITE TO DEV  /
          I             I            /       6       /
          I             I           /  VIA FORMAT   /
          +-------------+          /      2423     /
                                  / FROM THE LIST /
                                  ----------------
                                            I
                                            I
                                            I  NOTE  12
                                  * * * * * * * * * * *
                                  *  LIST = WTF, WTK  *
                                  * * * * * * * * * * *
                                            I
                                            I
                                            I
                                           ...
                                          .     .
                                          . 9.11.
                                          .     .
                                           ... 242
```

CHART TITLE - PROCEDURES

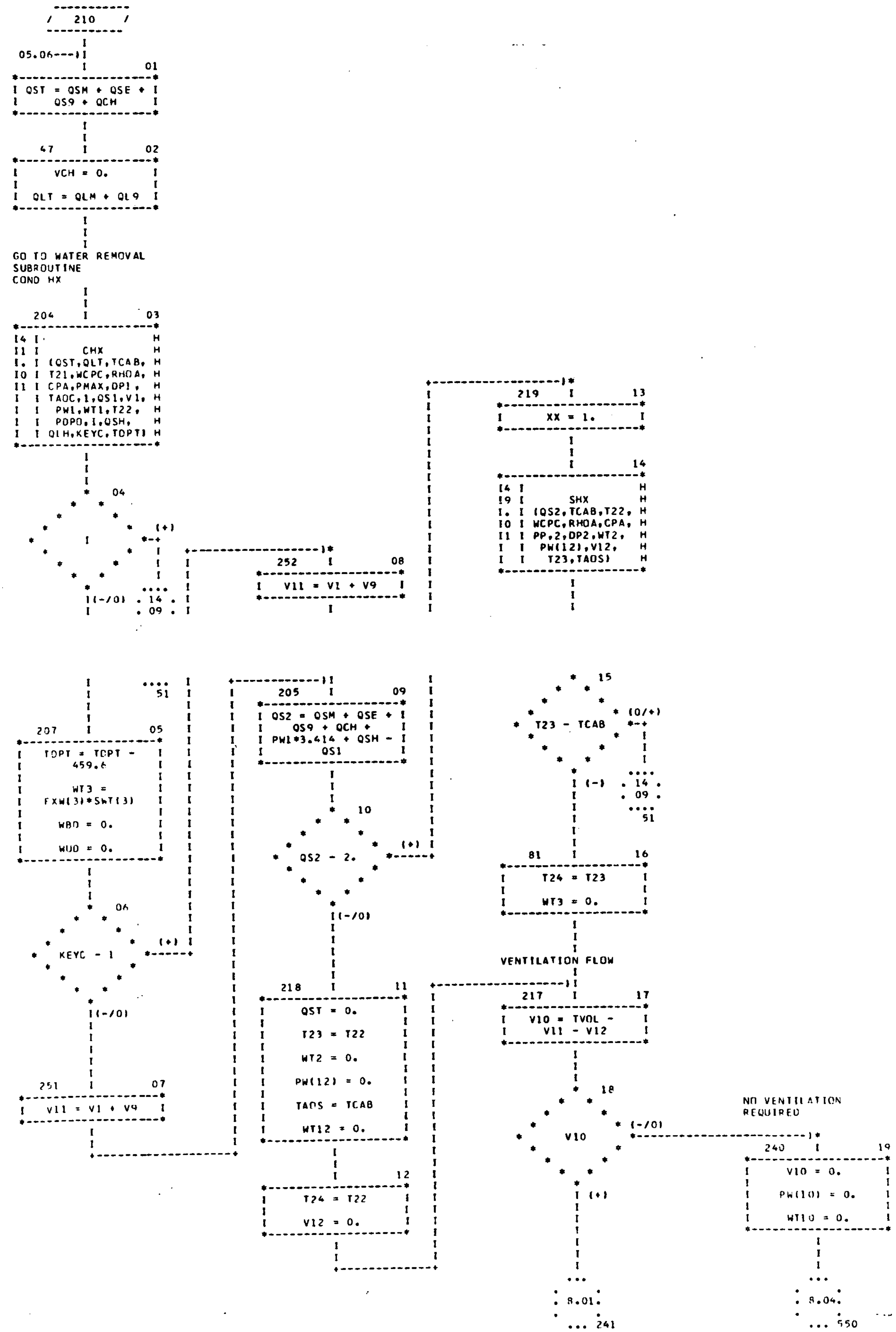

CHART TITLE - PROCEDURES

```
VENTILATION REQUIRED

 07.18---)*
   241     I          01
*--------------------*
I     PW(10) =       I
I  V10*DP10/510./    I
I      CFT(10)       I
*--------------------*
           I
           I
           I          02
*--------------------*
I7 I                 H
I4 I     FANWT       H
I. I (V10,DP10,WTF)  H
I0 I                 H
I1 I                 H
*--------------------*
           I
           I
           I
VENT -WT
           I
           I
           I          03
*--------------------*
I      WT10 =        I
I    FWT(10)*WTF     I
*--------------------*
           I
 07.19---)I
   550     I          04
*--------------------*
I      VX = V1       I
I                    I
I      VFC = 0.      I
*--------------------*
           I
           I
   245     I          05
*--------------------*
I7 I                 H
I4 I     FANWT       H
I. I (V11,DP1,WCF)   H
I0 I                 H

I1 I                 H
*--------------------*
           I
           I
           I          06
*--------------------*
I8 I                 H
I1 I     WTV2        H
I. I  (V11,2,WCV)    H
I0 I                 H
I1 I                 H
*--------------------*
           I
           I
           I          07
*--------------------*
I      WT11 =        I
I  (FWT(11)*(WCF +   I
I  WCV) + .9*WCF +   I
I FXW(11))*SWT(11)   I
I                    I
I     PW(11) =       I
I V11*DP1/510./CFT   I
I       (11)         I
*--------------------*
           I
           I
           I          08
*--------------------*
I  COMPUTED GO TO    I
I     FOR  LA        I
*--------------------*
I  1001        9.03  I
I  1002        9.01  I
*--------------------*
           I
           I
           I
IF OUTSIDE THE RANGE
           I
           I
           I
           I  /
         -----
        / 9.01
```

CHART TITLE - PROCEDURES

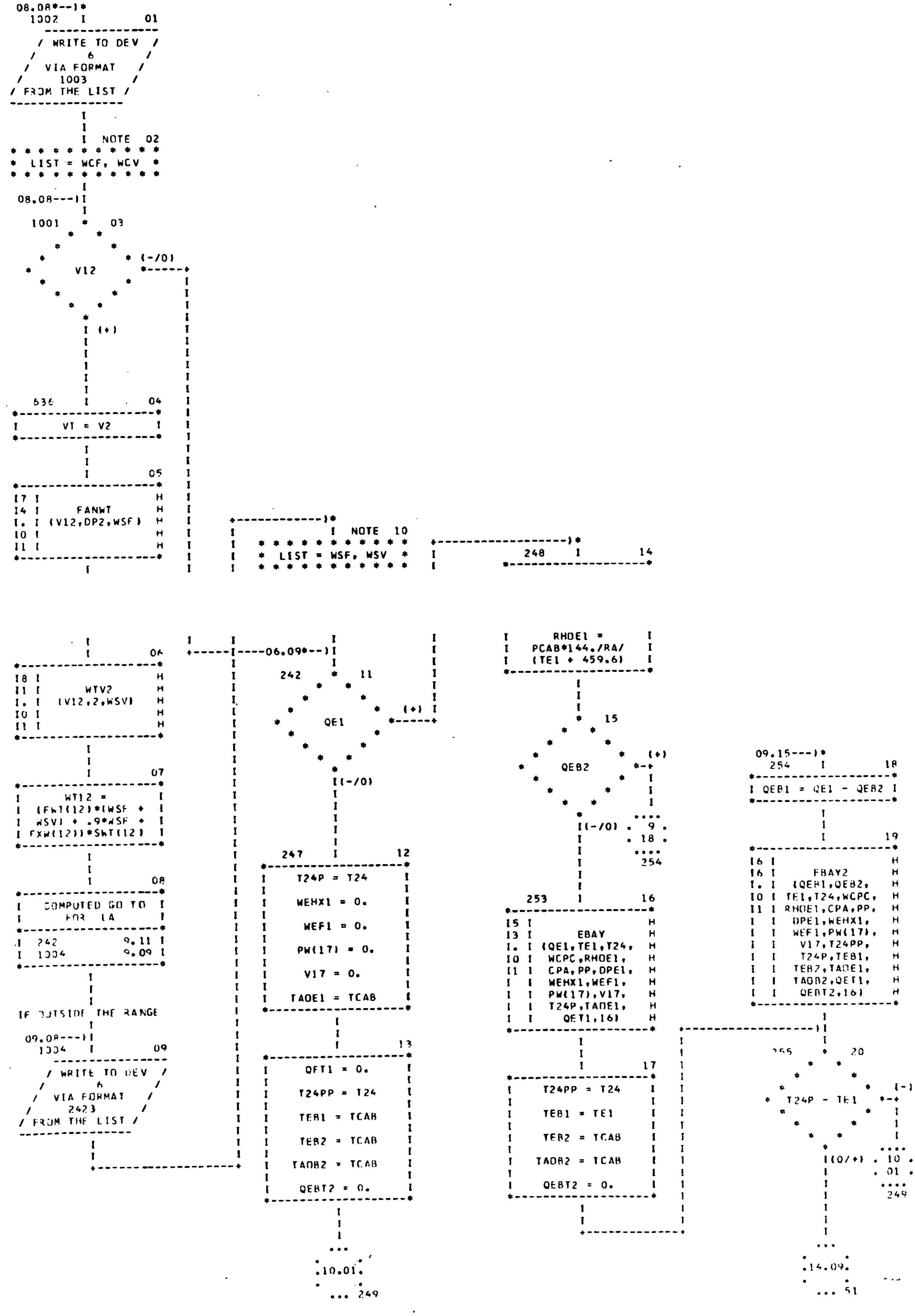

CHART TITLE - PROCEDURES

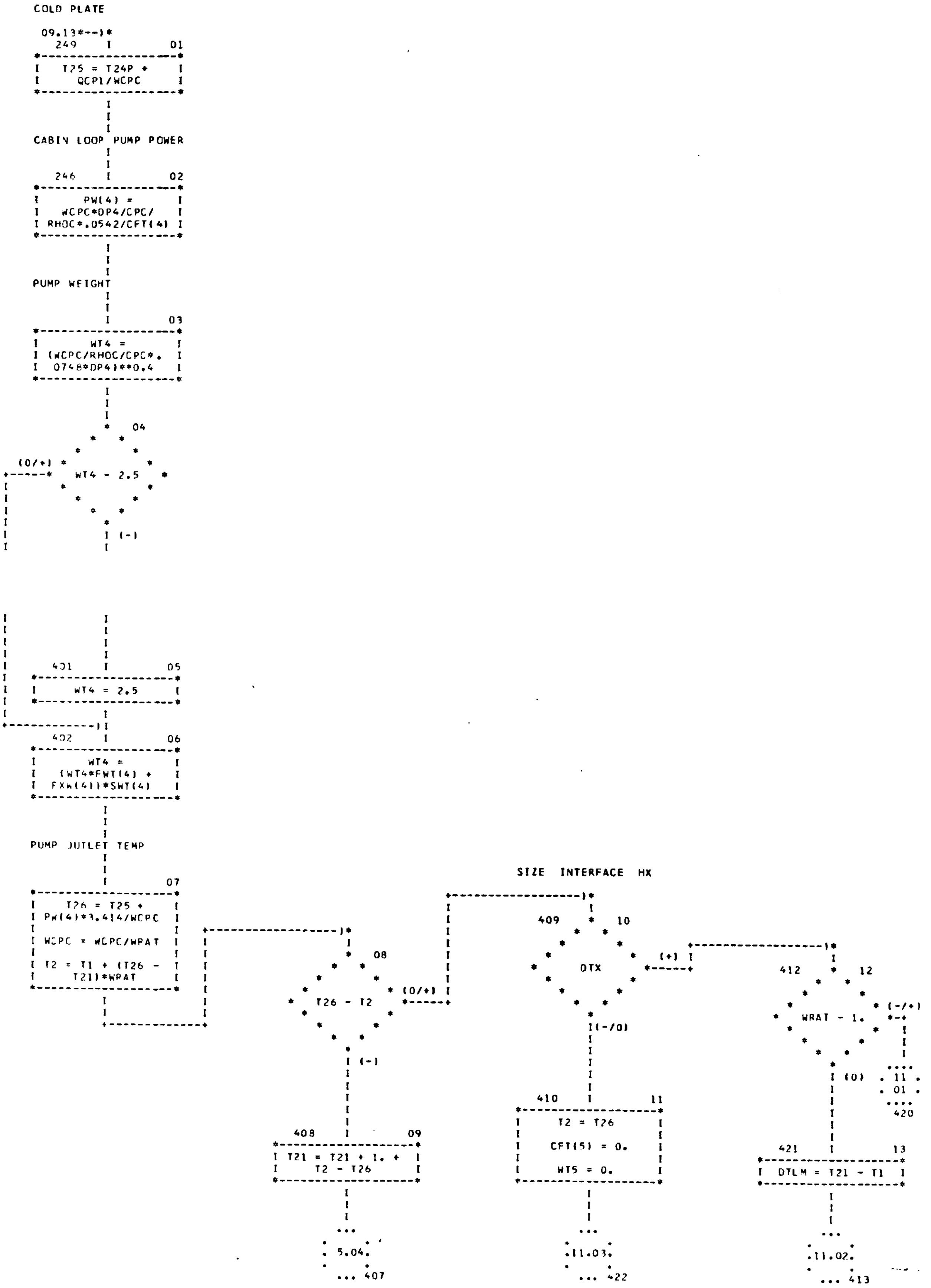

CHART TITLE - PROCEDURES

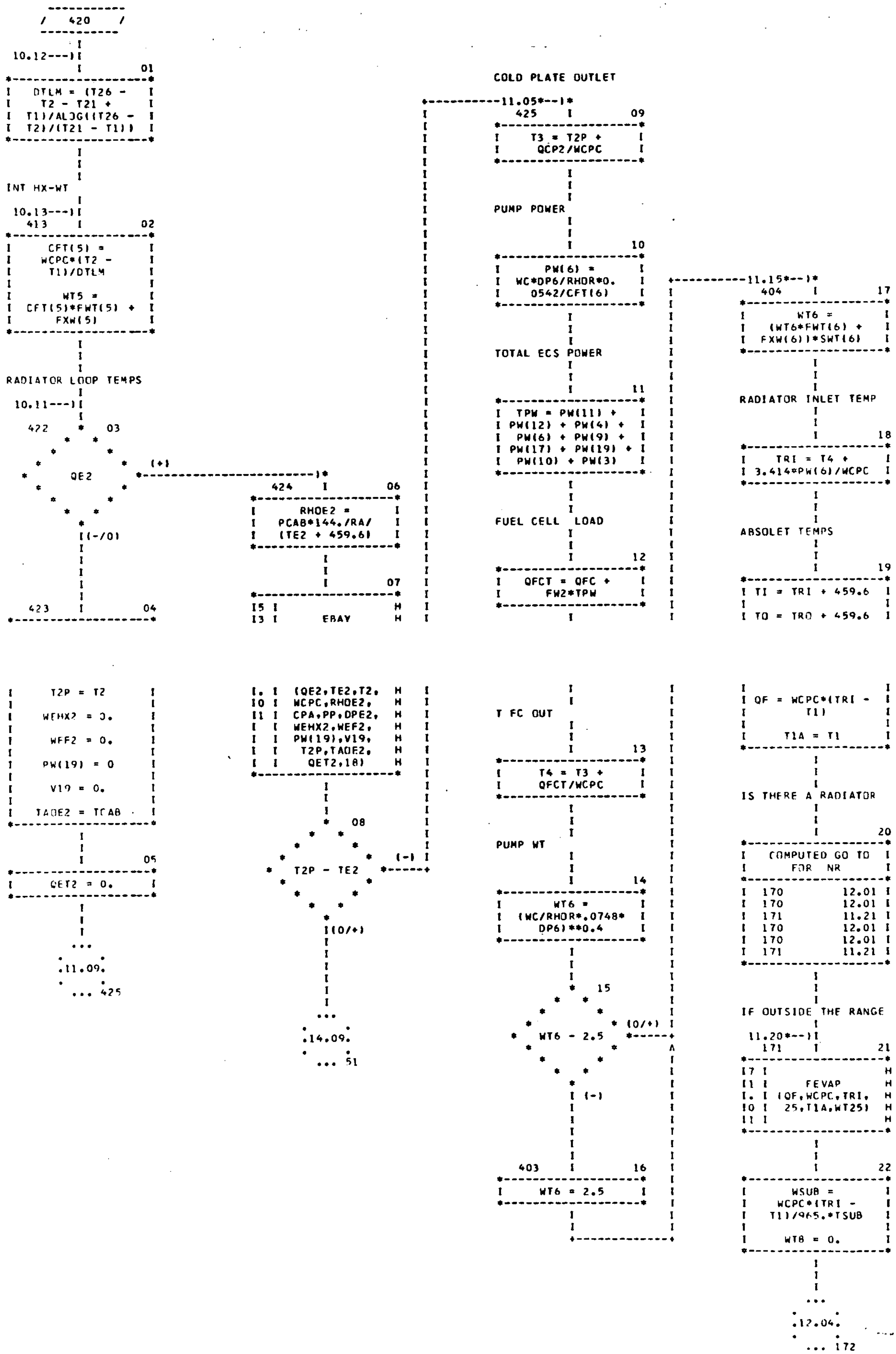

CHART TITLE - PROCEDURES

```
SIZE SUBL FOR TOTAL Q

 11.20*--)*
  170    I          01
*------------------*
I     CFT(8) =     I
I WCPC*ALOG((TRI - I
I 32.)/(T1 - 32.)) I
*------------------*
          I
          I
          I
SUBL  WT
          I
          I
          I         02
*------------------*
I      WT8 =       I
I  FWT(8)*CFT(8) + I
I   FXW(8)*SWT(8)  I
I                  I
I     WT25 = 0.    I
*------------------*
          I
          I
          I
WATER STORED
          I
          I
          I         03
*------------------*
I      WSUB =      I
I    WCPC*(TRI -   I
I  T1)/1065.*TSUB  I
*------------------*
          I
          I
          I
SIZE CRYO HX
          I
 11.22---)I
  172    I          04
*------------------*
I       WHYD =     I
I    WCPC*(TRI -   I
I  T1)/(1440)*TCRY I



I                  I
I   DTLM = (TRI -  I
I      460. -      I
I  T1)/ALOG((TRI - I
I 40.)/(T1 + 420.)) I
*------------------*
          I
          I
          I         05
*------------------*
I     CFT(22) =    I
I    WCPC*(TRI -   I
I     T1)/DTLM     I
I                  I
I      WT22 =      I
I FWT(22)*CFT(22) + I
I  FXW(22)*SWT(22) I
*------------------*   +------------------)*
          I            I                   I
          I            I                   *   08
          I            I                 *   *
SIZE GSE HX  MFR=2     I               *       *
TCI=0                  I             *           * (-/0)
          I            I           *   TFCO - T4   *-----+
          I            I             *           *       I
          I         06 I               *       *         I        CAN NOT BUILD HX
*------------------*   I                 *   *           I
I EFF = 1. - T1/TRI I  I                   *             +-----------12.08*--)*
I                  I   I                   I (+)         A         710    I         10
I     CFT(21) =    I   I                   I             I       *------------------*
I WCPC*2.*ALOG((1. I   I                   I             I       I   WT20 = 2000.   I
I  - EFF/2.)/(1. - I   I                   I             I       I                  I
I       EFF))      I   I                   I             I       I CFT(20) = 10000. I
I                  I   I                   I             I       *------------------*
I      WT21 =      I   I            711    *   09        I                 I
I FWT(21)*CFT(21) + I  I                 *   *           I                 I
I  FXW(21)*SWT(21) I   I               *       *         I                 I
*------------------*   I             *           * (-/0) I                ...
          I            I           *   TFCI - T3   *-----+              .     .
          I            I             *           *                      .14.09.
          I            I               *       *                        .     .
SIZE F/C HX -CHECK     I                 *   *                            ... 51
FLUID TEMPS            I                   *
          I            I                   I (+)
          I            I                   I
          +------------+                   I
                                           I
                                           I
                                           I
                                           I
                                          ...
                                        .     .
                                        .13.01.
                                        .     .
                                          ... 712
```

CHART TITLE - PROCEDURES

```
SIZE HX                                                                      MFR=1

12.09---)*                                                                    13.01---)*
         I                                                                     715     I            06
 712     *     01                                                            *---------------------*
       *   *                                                                 I DTLM = TFCO - T4   I
     *       *                                                               *---------------------*
   *  (TFCO -   * (-/+)                                                                 I
 *  TFCI)/(T4 -   *-------------------------)*                                          I
   * T3) - 1.   *                714     I           02               *-----------------*
     *       *                  *---------------------*               I
       *   *                    I  DTLM = (TFCO -     I               I
         *                      I    T4 - TFCI +      I               I
         I (0)                  I T3)/ALOG((TFCO -    I               I
         I                      I T4)/(TFCI - T3))    I               I
         I                      *---------------------*               I
         I                               I                            I
         I                               I(---------------------------*
         I                       716     I           03
         I                      *---------------------*
        ...                     I      CFT(20) =      I
      .     .                   I      QFCT/DTLM      I
      .13.06.                   I                     I
      .     .                   I       WT20 =        I
        ... 715                 I CFT(20)*FWT(20) +   I
                                I  FXW(20)*SWT(20)    I
                                I                     I                YES
                                I        WFC =        I
                                I    QFCT/(TFCO -     I      *----------------------)*
                                I        TFCI)        I      I          841     I            07
                                *---------------------*      I         *---------------------*
                                         I                   I         I     WEXP = 0.       I
                                         I                   I         *---------------------*
                                         I                   I                   I
                              RADIATOR  WT                   I                   I
                                         I                   I                   I
                                         I                   I                  ...
                                 820     I           04      I                .     .
                                *---------------------*      I                .14.02.
                                I8 I                  H      I                .     .
                                I2 I      RAD         H      I                  ... 822
                                I. I  (TI,TO,WCPC,    H      I
                                I0 I WT7,ARAD,WEXP,   H      I
                                I2 I    TORAD,7)      H      I
                                *---------------------*      I
                                         I                   I


                                         I                   I
                                         I                   I
                              DID RAD DO TOTAL JOB           I
                                         I                   I
                                         I                   I
                                         I                   I
                                         *     05            I
                                       *   *                 I
                                     *       *               I
                                   *           *   (-)       I
                                 * TO - TORAD +  *-+         I
                                   *    .5     *   I         I
                                     *       *     I         I
                                       *   *       I         I
                                         *        ....       I
                                         I(0/+)  . 14 .      I
                                         I       . 01 .      I
                                         I        ....       I
                                         I        842        I
                                         I                   I
                                         I                   I
                                         *-------------------*
```

CHART TITLE - PROCEDURES

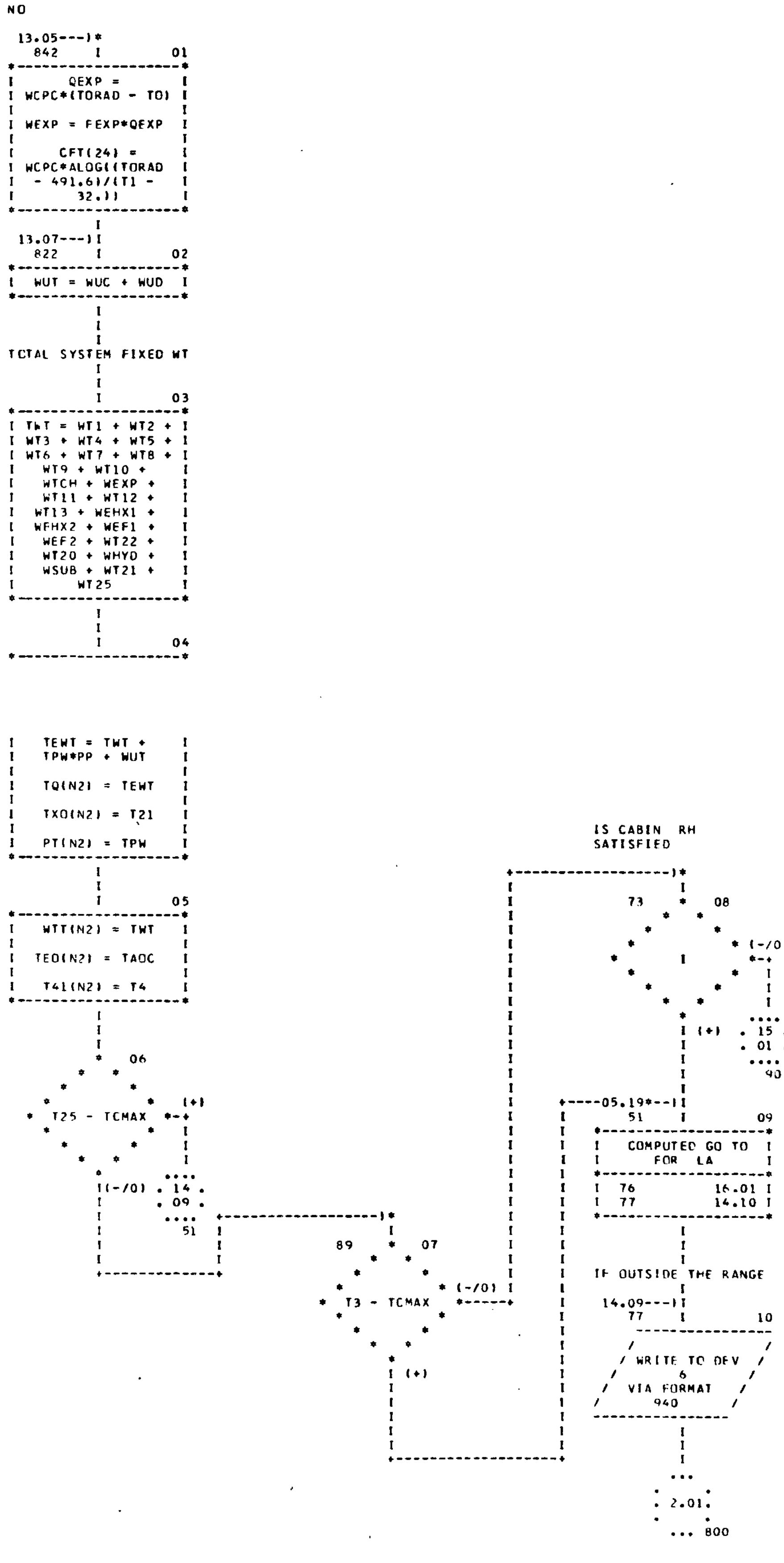

CHART TITLE - PROCEDURES

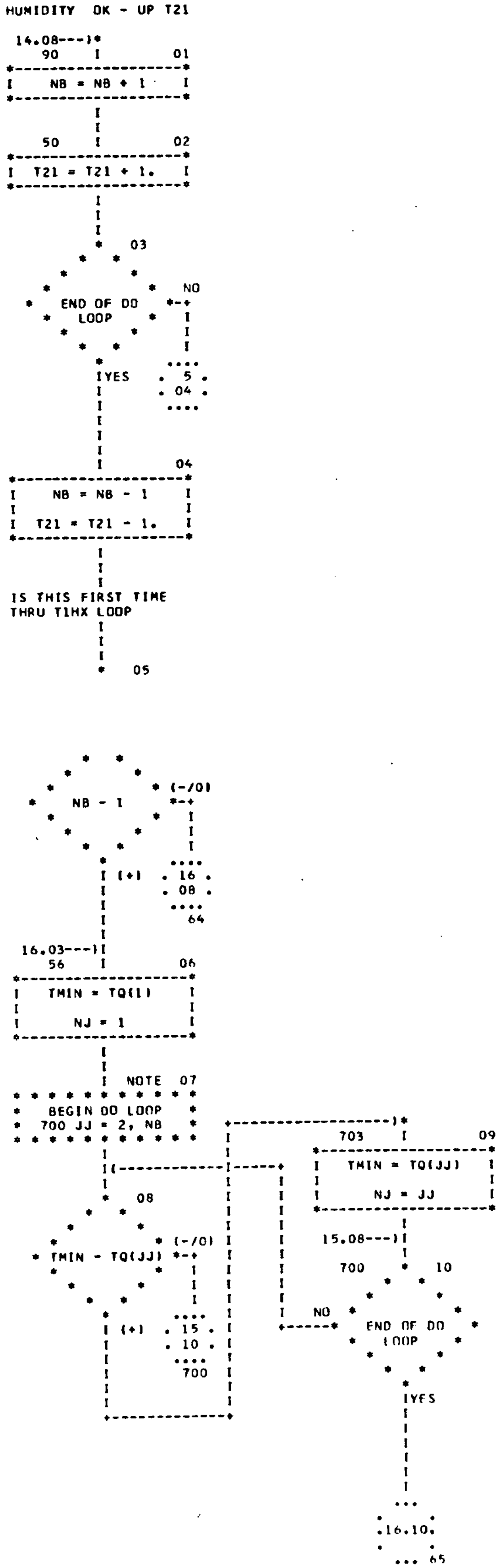

CHART TITLE - PROCEDURES

```
 ------------
 /   76    /
 ------------
        I
 14.09---)I
        I
        *  01
     *     *
  *           *        (+)
(0) *   NB - 2   *------------------------)*
+-*                                   63  I           03
I   *          *                    *--------------------*
I      *    *                       I   NB = NB - 1      I
I         *                         I                    I
 ....     I (-)                     I WCPC = WCPC/WRAT   I
. 16 .    I                         *--------------------*
. 09 .    I                                  I
 ....     I                                  I
62        I                                 ...
          I                               .15.06.
     27   *  02                             ... 56
      *       *
   *            * (-/0)
*      EX        *------+
   *            *       I
      *       *         I
          *             I
          I (+)         I
          I             I
         ...            I     HOW MANY TIMES THRU
        . 2.01.         I     TRO LOOP
         ... 800        +-------------------)*
                                             I
                                       61    *  04
                                          *     *
                                   (0) *           *  (-)
                                   +-*   NC - 2     *-----+
                                   I   *          *       I
                                   I      *    *          I     FIRST TIME THRU TRO
                                   I         *            I     LOOP
                                   ....      I (+)        +--------------------)*
                                   . 17 .    I                          153   I        06
                                   . 09 .

                                   ....      I                  *---------------------*
                                   150       I                  I     WQ = NQ         I
                                             I                  I                     I
                                     155     I       05         I   WC1(NQ) = WC      I
                                   *--------------------*       I                     I
                                   I   NC = NC - 1      I       I    TQ2(NQ) =        I
                                   *--------------------*       I  1000000. - WQ      I
                                             I                  I                     I
                                             I                  I  TRDO1(NQ) = TRO    I
                                            ...                 I                     I
                                          .17.05.               I  TXO2(NQ) = T21     I
                                            ... 151             *---------------------*
                                                                         I
                                                                         I          07
                                                                *---------------------*
                                                                I   PT2(NQ) = 0.      I
                                                                I                     I
                                                                I   WTT2(NQ) = 0.     I
                                                                I                     I
                                                                I   T43(NQ) = 0.      I
                                                                *---------------------*
                                                                         I
                                                                        ...
                                                                      .17.21.
                                                                        ... 156
```

```
 ------------
 /   64    /
 ------------
        I
 15.05---)I
        I              08
*---------------------*
I  COMPUTED GO TO     I
I     FOR  LA         I
*---------------------*
I 62          16.09   I
I 59          16.16   I
*---------------------*
        I
IF OUTSIDE THE RANGE
        I
 16.01*--)I
   62   I              09
*---------------------*
I      NB = 1         I
I                     I
I WCPC = WCPC/WRAT    I
I                     I
I      NJ = 1         I
*---------------------*
        I
STORE VALUES
        I
 15.10---)I
   65   I              10
*---------------------*
I TQ1(N1) = TQ(NJ)    I
I                     I
I  TRDO(N1) = TRO     I
I                     I
I   TXO1(N1) =        I
I    TXO(NJ)          I
I                     I
I PT1(N1) = PT(NJ)    I
*---------------------*
        I
        I              11
*---------------------*
I   WTT1(N1) =        I
I    WTT(NJ)          I
I                     I
I T42(N1) = T41(NJ)   I

I                     I
I TRB(N1) = TEO(NJ)   I
*---------------------*
        I
        I              12
   ------------------
   / WRITE TO DEV   /
  /      6         /
 /  VIA FORMAT    /
/      954       /
/ FROM THE LIST /
------------------
        I
        I  NOTE   13
* * * * * * * * * * *
*  LIST = WC, TRO   *
* * * * * * * * * * *
        I
        I              14
   ------------------
   / WRITE TO DEV   /
  /      6         /
 /  VIA FORMAT    /
/      941       /
/ FROM THE LIST /
------------------
        I
        I  NOTE   15
* * * * * * * * * * *
*      LIST =       *
*  (TQ(J),TXO(J),   *
* PT(J),WTT(J),J =  *
*       1,NB)       *
* * * * * * * * * * *
        I
 16.08---)I
   59   I              16
*---------------------*
I    NC = NC + 1      I
*---------------------*
        I
        I  /
      -----
     /17.01
```

CHART TITLE - PROCEDURES

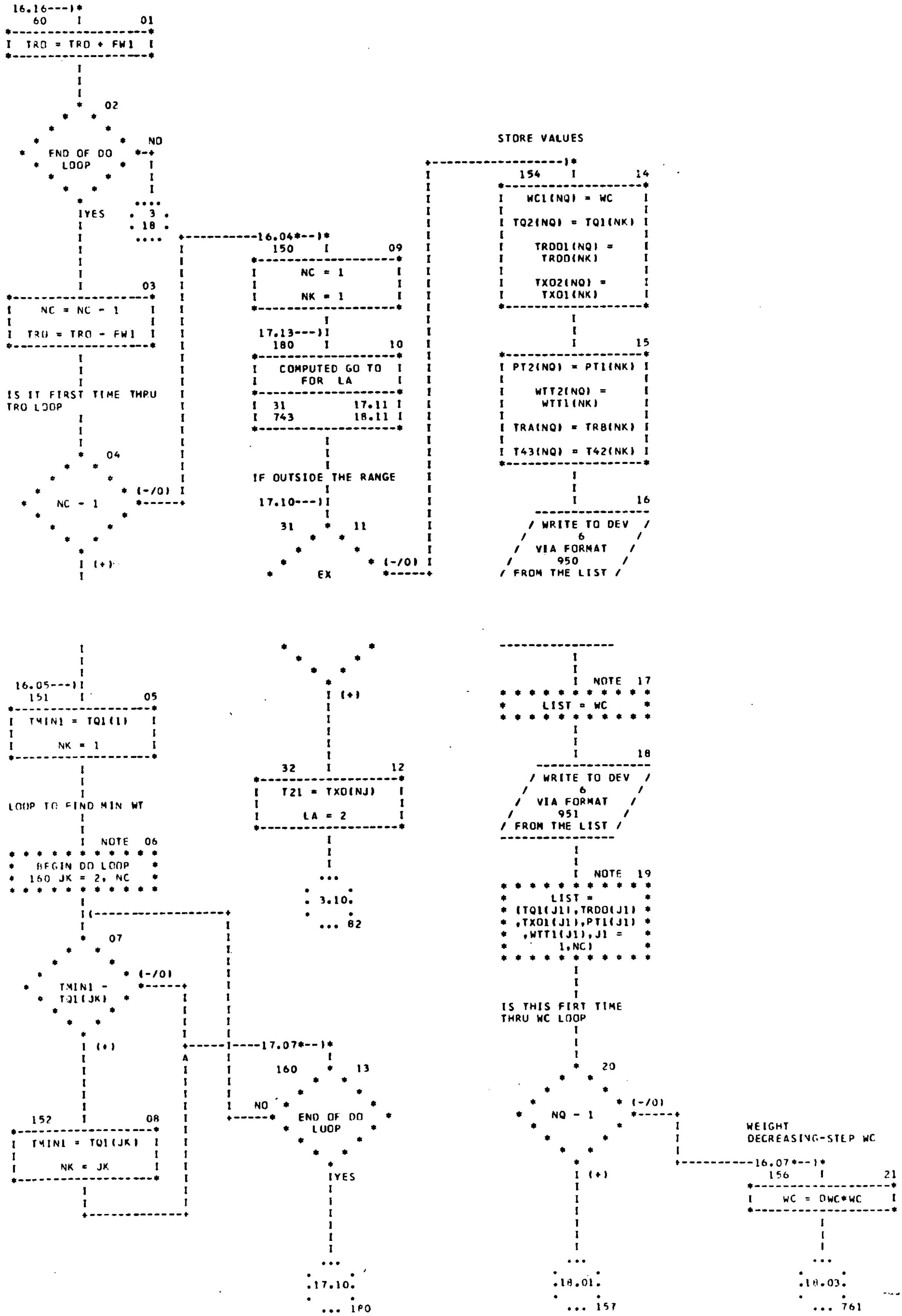

CHART TITLE - PROCEDURES

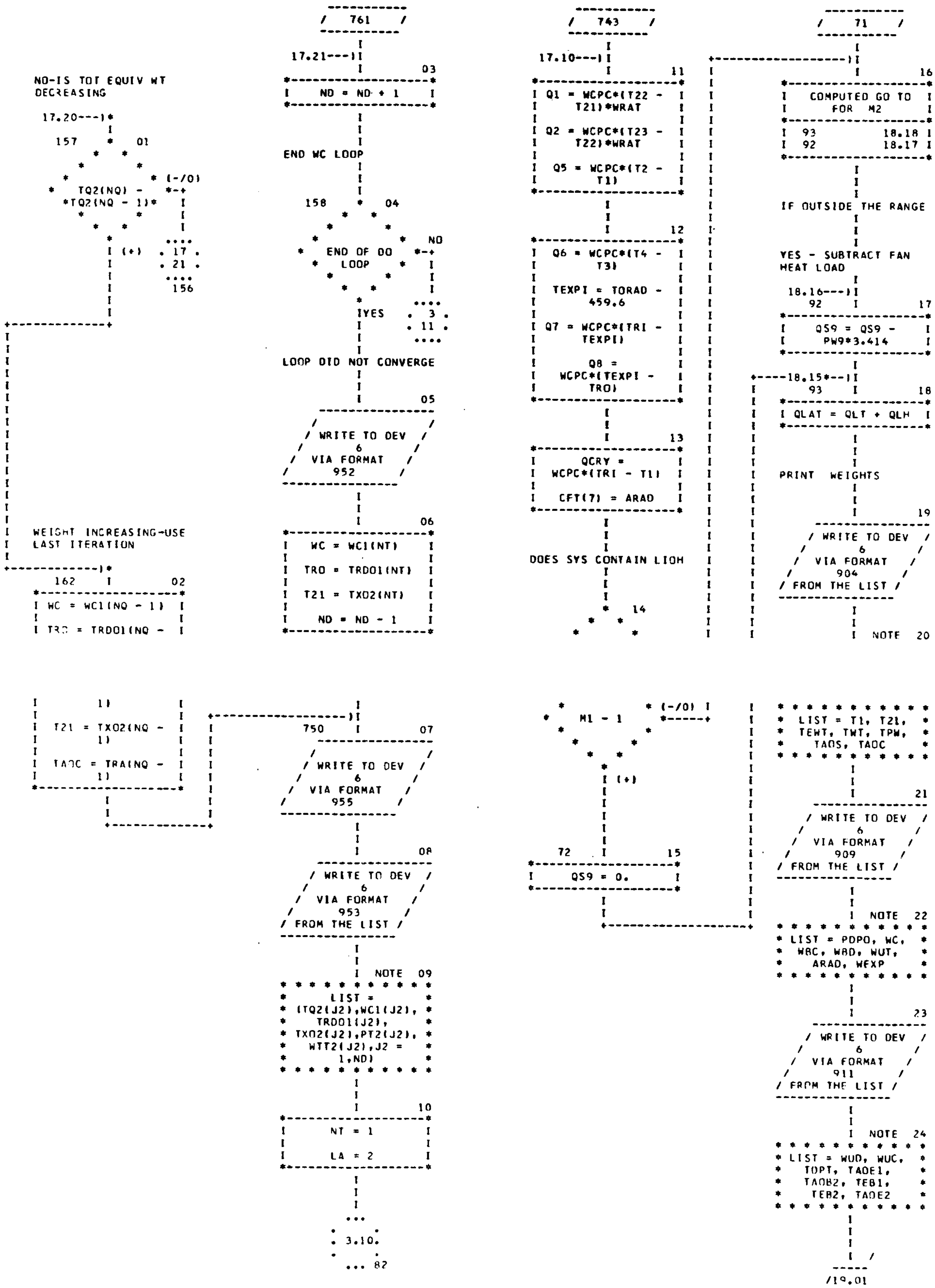

CHART TITLE - PROCEDURES

```
18.24---)*
01  WRITE TO DEV 6 VIA FORMAT 905
02  WRITE TO DEV 6 VIA FORMAT 906 FROM THE LIST
03  NOTE  LIST = WT1, WT2, WT3, WT4, WT5, WT6, WT7, WT8,
          WT9, WT10, WTCH, WT11, WT12, WT13
04  WRITE TO DEV 6 VIA FORMAT 912
05  WRITE TO DEV 6 VIA FORMAT 906 FROM THE LIST
06  NOTE  LIST = WEHX1, WEF1, WEHX2, WEF2, WT20, WT22,
          WSUB, WHYD, WT25, WT21
07  WRITE TO DEV 6 VIA FORMAT 907
08  WRITE TO DEV 6 VIA FORMAT 906 FROM THE LIST
09  NOTE  LIST = PW(11), PW(12), PW(4), PW(6), PW(9),
          PW(10), PW(17), PW(19)

10  V1 = V1/60.
    VC = V9/60.
    V2 = V12/60.
    VV = V10/60.
    VFC = V11/60.
11  VCH = VCH/60.
    VT = V12/60.
    VE1 = V17
    VE2 = V19
12  WRITE TO DEV 6 VIA FORMAT 908 FROM THE LIST
13  NOTE  LIST = V1, VC, V2, VV, VCH, VFC, VT, VE1, VE2
14  V17 = V17*60.
    V19 = V19*60.
15  WRITE TO DEV 6 VIA FORMAT 937
16  WRITE TO DEV 6 VIA FORMAT 906 FROM THE LIST
17  NOTE  LIST = T21, T22, T23, T24, T24PP, T24P, T25, T26
18  WRITE TO DEV 6 VIA FORMAT 936

19  WRITE TO DEV 6 VIA FORMAT 906 FROM THE LIST
20  NOTE  LIST = T1, T2, T2P, T3, T4, TRI, TEXPI, TRO, T1A
21  WRITE TO DEV 6 VIA FORMAT 975
22  WRITE TO DEV 6 VIA FORMAT 970 FROM THE LIST
23  NOTE  LIST = Q1, Q2, Q5, Q6, Q7, Q8, QLAT, QS9, QL9,
          QSH, QLH, QF
24  WRITE TO DEV 6 VIA FORMAT 938
25  WRITE TO DEV 6 VIA FORMAT 970 FROM THE LIST
26  NOTE  LIST = QET1, QET2, QSUB
27  T7 = T1
    2.01.
    ... 800
```

CHART TITLE - PROCEDURES

```
OFF DESIGN
PERFORMANCE-PRINT
POWERS

 02.10---)*
   801    I          01
      ----------------
     / WRITE TO DEV  /
    /       6       /
   /  VIA FORMAT   /
  /      988      /
 / FROM THE LIST /
 ----------------
          I
          I
          I  NOTE  02
 * * * * * * * * * * *
 * LIST = (X(J),J =  *
 *     191,205)      *
 * * * * * * * * * * *
          I
          I
          I          03
      ----------------
     / WRITE TO DEV  /
    /       6       /
   /  VIA FORMAT   /
  /      981      /                 *-------------------)*
 / FROM THE LIST /                  I                   I          10
 ----------------                   I         *--------------------*
          I                         I         I    KEYC = FW5      I
          I                         I         I                    I
          I  NOTE  04               I         I     QSH = 0.       I
 * * * * * * * * * * *              I         I                    I
 * LIST = (X(J),J =  *              I         I     QLH = 0.       I
 *     206,220)      *              I         I                    I
 * * * * * * * * * * *              I         I      I = 0         I
          I                         I         I                    I
          I                         I         I  WCPC = WC*CPR     I
          I                         I         *--------------------*
 PRINT COMPONENT                    I                   I
 FACTORS                            I                   I
          I                         I                   I          11
          I                         I         *--------------------*
          I          05             I         I  WHC = WCPC*WRAT   I
      ----------------              I

     / WRITE TO DEV  /              I         I                    I
    /       6       /               I         I      LA = 2        I
   /  VIA FORMAT   /                I         I                    I
  /      976      /                 I         I TRO = TZ + 459.6   I
 / FROM THE LIST /                  I         I                    I
 ----------------                   I         I      T1 = TZ       I
          I                         I         *--------------------*
          I                         I                   I
          I  NOTE  06               I                   I
 * * * * * * * * * * *              I                   I
 * LIST = (X(J),J =  *              I         LOOP ON CABIN TEMP
 *     221,250)      *              I                   I
 * * * * * * * * * * *              I                   I
          I                         I                   I  NOTE  12
          I                         I         * * * * * * * * * * * *
          I                         I         *   BEGIN DO LOOP     *
 COMPONENT FLOW RATES               I         *  6123 NA = 1, 15    *
          I                         I         * * * * * * * * * * * *
          I                         I                   I
          I          07             I          28.12---)I
      ----------------              I                   I
     / WRITE TO DEV  /              I         GET LIGH  HEAT LOADS
    /       6       /               I                   I
   /  VIA FORMAT   /                I                   I
  /      977      /                 I                   I          13
 / FROM THE LIST /                  I         *--------------------*
 ----------------                   I         I   COMPUTED GO TO   I
          I                         I         I      FOR  M!       I
          I                         I         *--------------------*
          I  NOTE  08               I         I  655        21.01  I
 * * * * * * * * * * *              I         I  656        20.14  I
 * LIST = V11, V12,  *              I         *--------------------*
 * V17, V19, V10, V9 *              I                   I
 * * * * * * * * * * *              I                   I
          I                         I                   I
          I                         I         IF OUTSIDE THE RANGE
          I                         I                   I
 SET VARIABLES                      I                   I
          I                         I                   I
          I                         I         HSC -NO LATENT LOADS
          *--------------------------*                  I
                                               20.13---)I
                                                656     I          14
                                              *--------------------*
                                              I    QCABL = 0.      I
                                              I                    I
                                              I     QS9 = 0.       I
                                              *--------------------*
                                                        I
                                                        I
                                                        I
                                                       ...
                                                      .   .
                                                      .21.03.
                                                      .   .
                                                       ... 657
```

CHART TITLE - PROCEDURES

```
CABIN LATENT LOAD

20.13---)*
 655    I          01
I3 I                H
I9 I      LIOH      H
I. I  (9,DAY,DP9,   H
I0 I  WBC,WT9,PW9,  H
I1 I  V9,QS9,QL9)   H
                   02
I   QCABL = QL9 +   I
I     QLH + QLM     I

TOTAL HEAT
LOADS-CABIN SENS
20.14---)I
 657    I          03
I   QCABS = QSM +   I
I QSE + QS9 + QSH + I
I  3.414*(PW(11) +  I
I PW(12) + PW(10) + I
I      PW(3))       I

INTERFACE HX LOAD
                   04
I   Q5 = QCABS +    I
I   QCABL + QE1 +   I
I   QCP1 + QCHIL +  I
I   3.414*(PW(4) +  I
I      PW(17))      I

TOTAL POWER
                   05
I  PWT = PW(11) +   I
I PW(12) + PW(3) +  I
I  PW(4) + PW(6) +  I
I PW(10) + PW(17) + I
I      PW(19)       I

FUEL CELL HEAT LOAD
                   06
I    QFT = QFC +    I
I      FW2*PWT      I

TOTAL HEAT REJECTED
                   07
I   QTOT = Q5 +     I
I   QCP2 + QF2 +    I
I       QFT +       I
I  3.414*(PW(6) +   I
I      PW(19))      I

HEAT SINK INLET TEMP
```

```
                   09
I   T6 = TRO +      I
I   QTOT/WCPC       I

GO TO DESIRED HEAT
REJECTION METHOD
                   10
I  COMPUTED GO TO   I
I     FOR  NR       I
I  620       21.11  I
I  620       21.11  I
I  620       21.11  I
I  621       22.07  I
I  622       23.01  I
I  623       23.06  I

IF OUTSIDE THE RANGE

RADIATOR  LOOP
21.10*--)I
 620    I  NOTE 11
*  BEGIN DO LOOP   *
*  650 N = 1, 30   *
22.04---)I
                   12
I8 I                H
I2 I      RAD       H
I. I (T6,TRO,WCPC,  H
I0 I WR,ARAD,WE,T7, H
I2 I       7)       H
                   13
I  T6 = T6 - 459.6  I

DID RAD DO TOTAL  JOB
                14
*  ABS(TRO -  *  (-/0)
*  T7) - .5   *
(+)
.21.18.
... 626
```

```
RAD  DID  TOTAL JOB
-SET TEMPS
 625    I          15
I  T7 = T7 - 459.6  I
I                   I
I      T8 = T7      I
21.23*--)I
 630    I          16
I      T9 = T8      I
I                   I
I      T1 = T9      I

GO TO INT HX
I 17
.24.02.
... 651
```

```
RAD CAN NOT DO TOTAL
Q -GO TO SECONDARY
HEAT SINK
21.14---)*
 626    I          18
I  T7 = T7 - 459.6  I
                   19
I  COMPUTED GO TO   I
I     FOR  NR       I
I  627       21.20  I
I  628       23.02  I
I  629       23.07  I

IF OUTSIDE THE RANGE

SUBLIMATOR HEAT SINK
-SET TEMPS
21.19---)I
 627    I          20
I   EFF = 1. -      I
I  1./EXP(CFT(24)   I
I     /WCPC)        I

OUTLET TEMP
                   21
I      T8 = T7 -    I
I  EFF*(T7 - 32.)   I

TOTAL HEAT REJECTED
                   22
I  QR = WCPC*(T6 -  I
I       T8)         I

IS Q WITHIN TOL
                23
(-/0) * ABS(QR -  *
*  QTOT) -  *
*  .5*WCPC  *
(+)
.22.01.
... 631
```

CHART TITLE - PROCEDURES

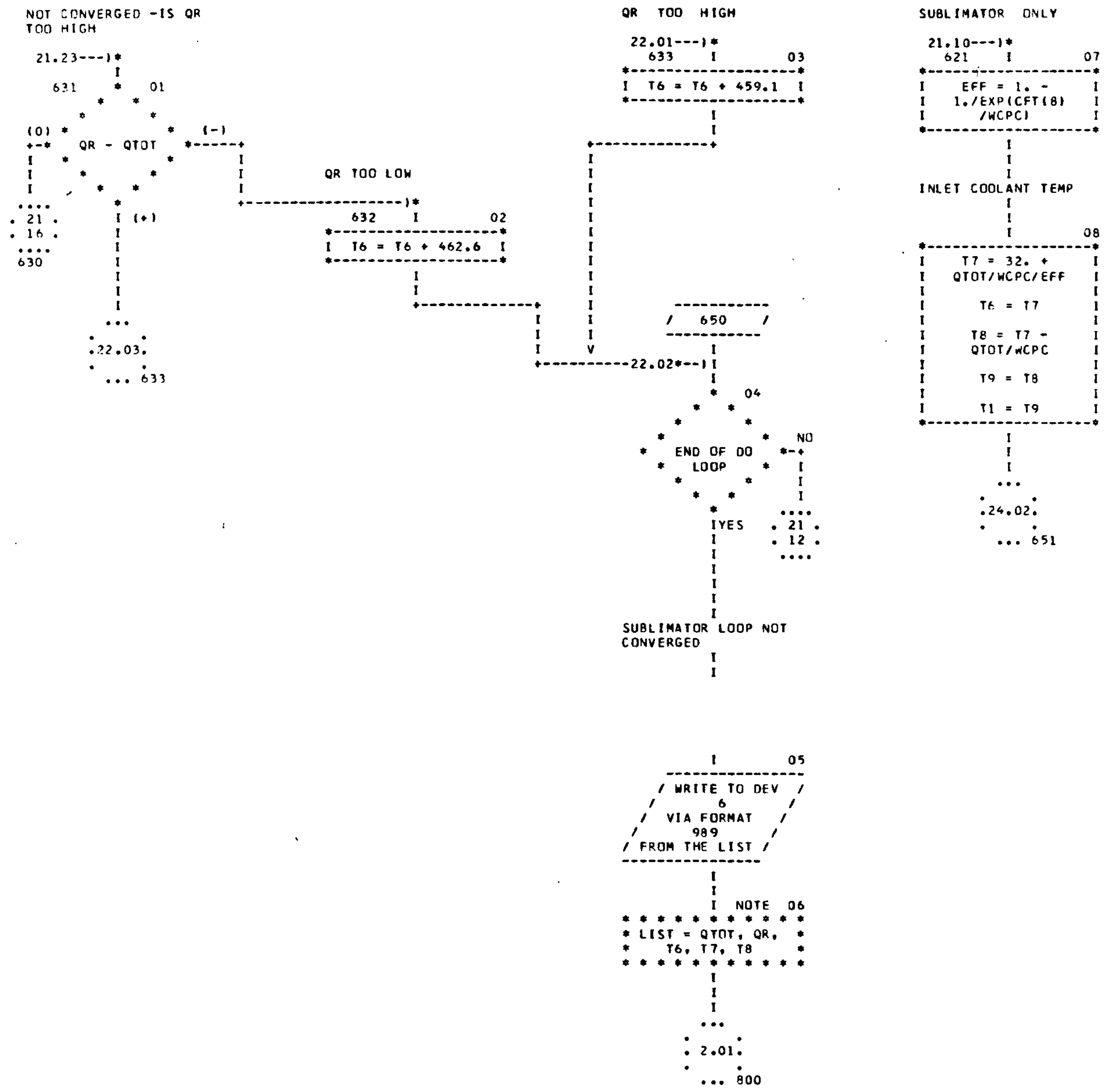

CHART TITLE - PROCEDURES

```
CRYOGENIC HX -SET             FLASH EVAP -SET
TEMPS                         TEMPS

 21.10---)*                    21.10---)*
  622     I          01         623     I          06
*--------------------*        *--------------------*
I  T6 = T6 - 459.6   I        I  T6 = T6 - 459.6   I
I                    I        I                    I
I       T7 = T6      I        I       T7 = T6      I
*--------------------*        *--------------------*
          I                             I
          I                             I
          I                             I
HEAT REJECTION                HEAT REJECTION
          I                             I
 21.19---)I                    21.19---)I
  628     I          02         629     I          07
*--------------------*        *--------------------*
I Q22 = WCPC*(T7 -   I        I Q25 = WCPC*(T7 -   I
I         T1)        I        I         T1)        I
*--------------------*        *--------------------*
          I                             I
          I                             I
          I          03                 I          08
*--------------------*        *--------------------*
I7 I                 H        I7 I                 H
I6 I       CRY       H        I1 I      FEVAP      H
I. I (Q22,WCPC,T7,   H        I. I (Q25,WCPC,T7,   H
I0 I       22)       H        I0 I  25,T8,WT25)    H
I1 I                 H        I1 I                 H
*--------------------*        *--------------------*
          I                             I
          I                             I
          I          04                 I
*--------------------*        CAN FLASH EVAP DO JOB
I      T9 = T1       I                  I
*--------------------*                  I
          I                             I
          I                             *   09
          I                          *     *
TO TO INT HX                      *           * (-/0)
          I                    *     T1 - T8     *------+
          I                       *           *         I
          I          05              *     *            I        CAN MEET TEMP
*--------------------*                  *               I
I      T8 = T7       I


*--------------------*                  *           +------------------)*
          I                             I (+)          634      I          10
          I                             I             *--------------------*
          I                             I             I      T8 = T1       I
         ...                            I             I                    I
        .   .                           I             I      T9 = T1       I
       .24.02.                          I             *--------------------*
        .   .                           I                       I
         ... 651                       ...                      I
                                      .   .                     I
                                     .24.01.                   ...
                                      .   .                   .   .
                                       ... 635               .24.02.
                                                              .   .
                                                               ... 651
```

CHART TITLE - PROCEDURES

```
UNIT CAN NOT MEET Q
-UP TEMPS

 23.09---)*
   635    I            01
*--------------------*
I     T7 = T8 +       I
I     Q22/WCPC        I
I                     I
I     T6 = T7         I
I                     I
I     T9 = T8         I
I                     I
I     T1 = T8         I
*--------------------*
          I
          I
          I
INTER HX
          I
 21.17*--)I
   651    I            02
*--------------------*
I7 I                  H
I9 I      HX          H
I. I  (Q5,WHC,WCPC,   H
I0 I    T1,5,T21)     H
I1 I                  H
*--------------------*
          I
          I
          I
CHILLER OUTLET TEMP
          I
          I
          I            03
*--------------------*
I    T22 = T21 +      I
I     QCHIL/WHC       I
*--------------------*
          I
          I
          I
COND AIR FLOW RATE
          I
          I


          I            04
*--------------------*
I   V1 = V11 - V9     I
*--------------------*
          I
          I
          I
LOOP  ON  CABIN TEMP
          I
          I
          I  NOTE  05
* * * * * * * * * * * *
*    BEGIN DO LOOP     *
*   612 NI = 1, 15     *
* * * * * * * * * * * *
          I
 28.06---)I
          I            06
*--------------------*
I   COMPUTED GO TO    I
I      FOR  NI        I
*--------------------*
I 660         24.11 I
I 661         24.07 I
*--------------------*
          I
          I
          I
IF OUTSIDE THE RANGE     I         +------------------)*
          I              I                            I             09
          I              I         *----------------------*
HSC-NO CONDENSER         I         I5 I                    H
          I              I         I8 I        HSC         H
 24.06---)I              I         I. I (WCO2,QLM,DAY,     H
   661    I            07I         I0 I  RHO,PVI,DP1,      H
*--------------------*   I         I1 I 14,WT1,PW(11),     H
I  I                  H  I         I  I  V1,WBD,WUD,       H
I  I     KANDK        H  I         I  I   VCH,WT11)        H
I  I   (PVI,T22 +     H  I         *----------------------*
I  I    459.6,2)      H  I                    I
I  I                  H  I                    I
*--------------------*   I                    I             10
          I              I         *----------------------*
          I              I         I     T23 = T22        I
          +--------------+         I                      I
                                   I     QCDS = 0.        I
                                   I                      I
                                   I     QS9 = 0.         I
                                   *----------------------*
                                              I
                                              I
                                              I
```

```
IS THERE A SENS HX

24.06---)*
         I
  660    *    11
       *   *
     *       *  (-/0)
   *    V12    *------+
     *       *        I
       *   *          I          NO
         *            I
         I (+)        +----------------------)*
         I                          640       I        12
         I                   *---------------------*
         I                   I       KY = 0         I
         I                   *---------------------*
         I                                I
         I                                I
        ...                              ...
      .25.01.                          .25.02.
        ... 641                          ... 642
```

CHART TITLE - PROCEDURES

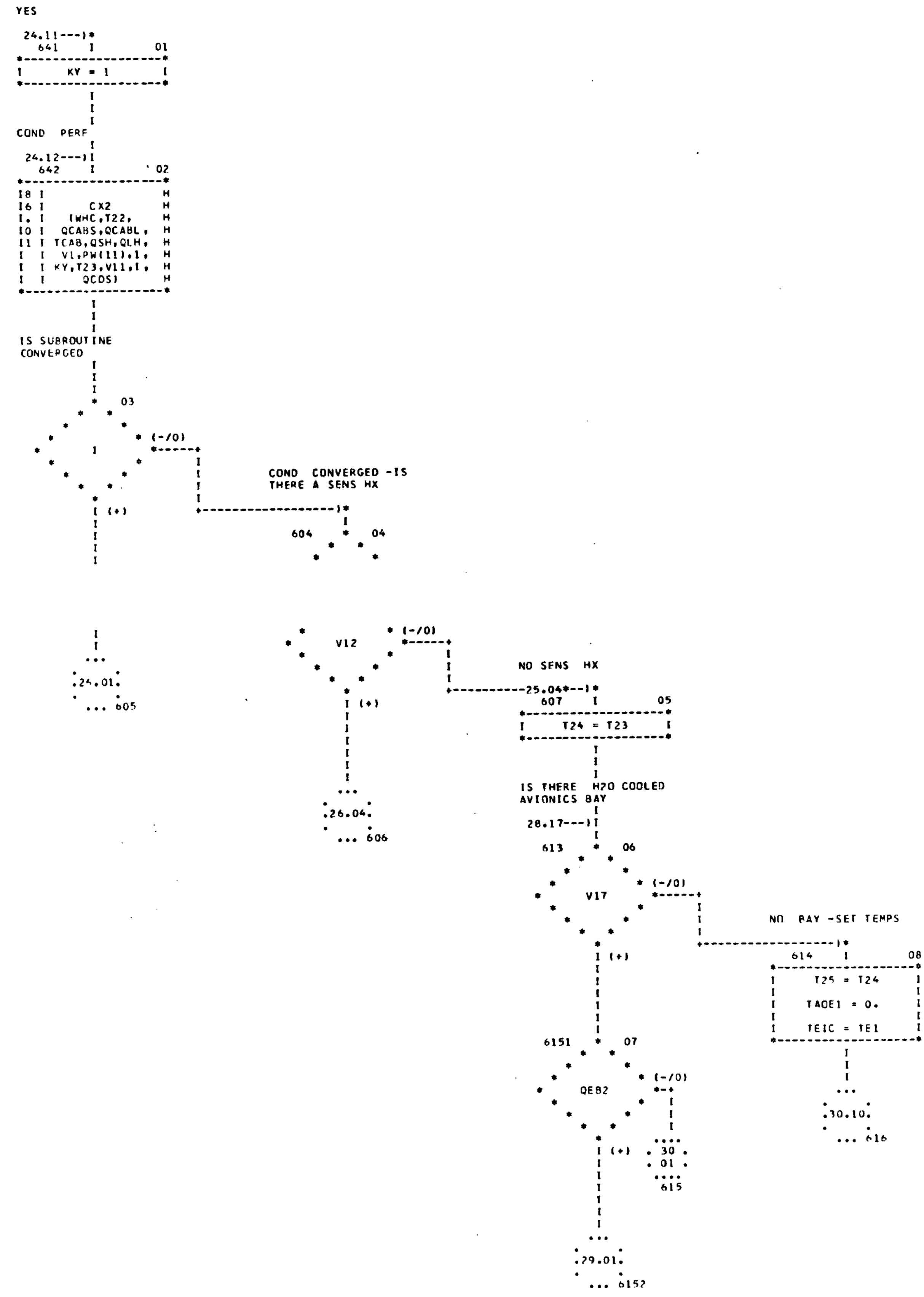

CHART TITLE - PROCEDURES

```
CHX2 NOT CONVERGED                          YES -SET UP FOR SENS
                                            HX
 25.03---)*
  605     I         01                       24.10*--)*
       -----------------                       606     I         04
      / WRITE TO DEV  /                     *--------------------*
     /      6        /                      I       WHOT =       I
    /  VIA FORMAT   /                       I V12*PCAB*144./RA/  I
   /       961     /                        I      (TCAB +       I
  / FROM THE LIST /                         I    459.6)*CPA      I
  -----------------                         *--------------------*
          I                                            I
          I                                            I
          I  NOTE  02                                  I
* * * * * * * * * * * *                     MAX AIR FLOW
* LIST = WHC, T22,    *                                I
*   QCABS, QCABL,     *                                I
*  TCAB, QSH, QLH,    *                                I         05
*     V1, PW(11)      *                     *--------------------*
* * * * * * * * * * * *                     I    WMX = WHOT      I
          I                                 *--------------------*
          I                                            I
          I                                            I
NEXT CASE                                              I
          I                                 HX INLET AIR TEMP
          I                                            I
          I 03                                         I
         ...                                           I         06
        .   .                               *--------------------*
        . 2.01.                             I  TAI = TCAB +      I
        .   .                               I PW(12)*3.414/WMX   I
         ... 800                            *--------------------*
                                                       I
                                                       I
                                                       I
                                            HX HEAT LOAD
                                                       I
                                                       I
                                                       I         07
                                            *--------------------*
                                            I Q2 = QCABS - QCDS  I
                                            *--------------------*
                                                       I
                                                       I
                                                       I
                                                       *    08
```

```
             *   *
          *         *
       *               * (-/0)
     *       Q2          *------+
       *               *        I
          *         *           I              REHEATER REQUIRED
             *   *              I
               *                +--------------------)*
               I (+)                             637     I         09
               I                                 -----------------
               I                                / WRITE TO DEV  /
               I                               /       6       /
               I                              /  VIA FORMAT   /
               I                             /      980      /
               I                            / FROM THE LIST /
              ...                           -----------------
             .   .                                   I
            .27.01.                                  I
             .   .                                   I  NOTE  10
              ... 638                       * * * * * * * * * * * *
                                            * LIST = Q2, TCAB,    *
                                            *     V12, T23        *
                                            * * * * * * * * * * * *
                                                     I
                                                     I
                                                    ...
                                                   .   .
                                                   .25.05.
                                                   .   .
                                                    ... 607
```

CHART TITLE - PROCEDURES

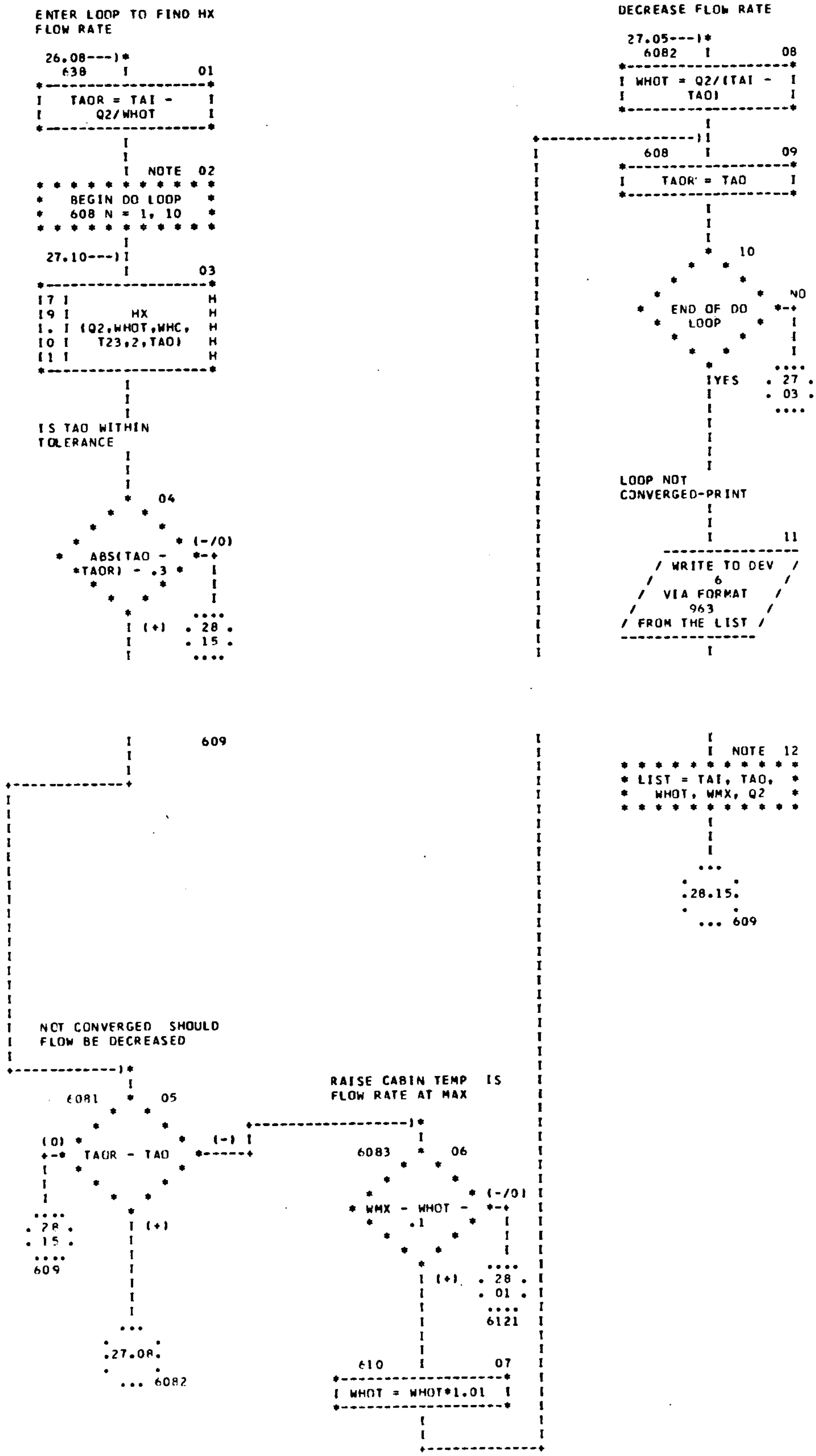

CHART TITLE - PROCEDURES

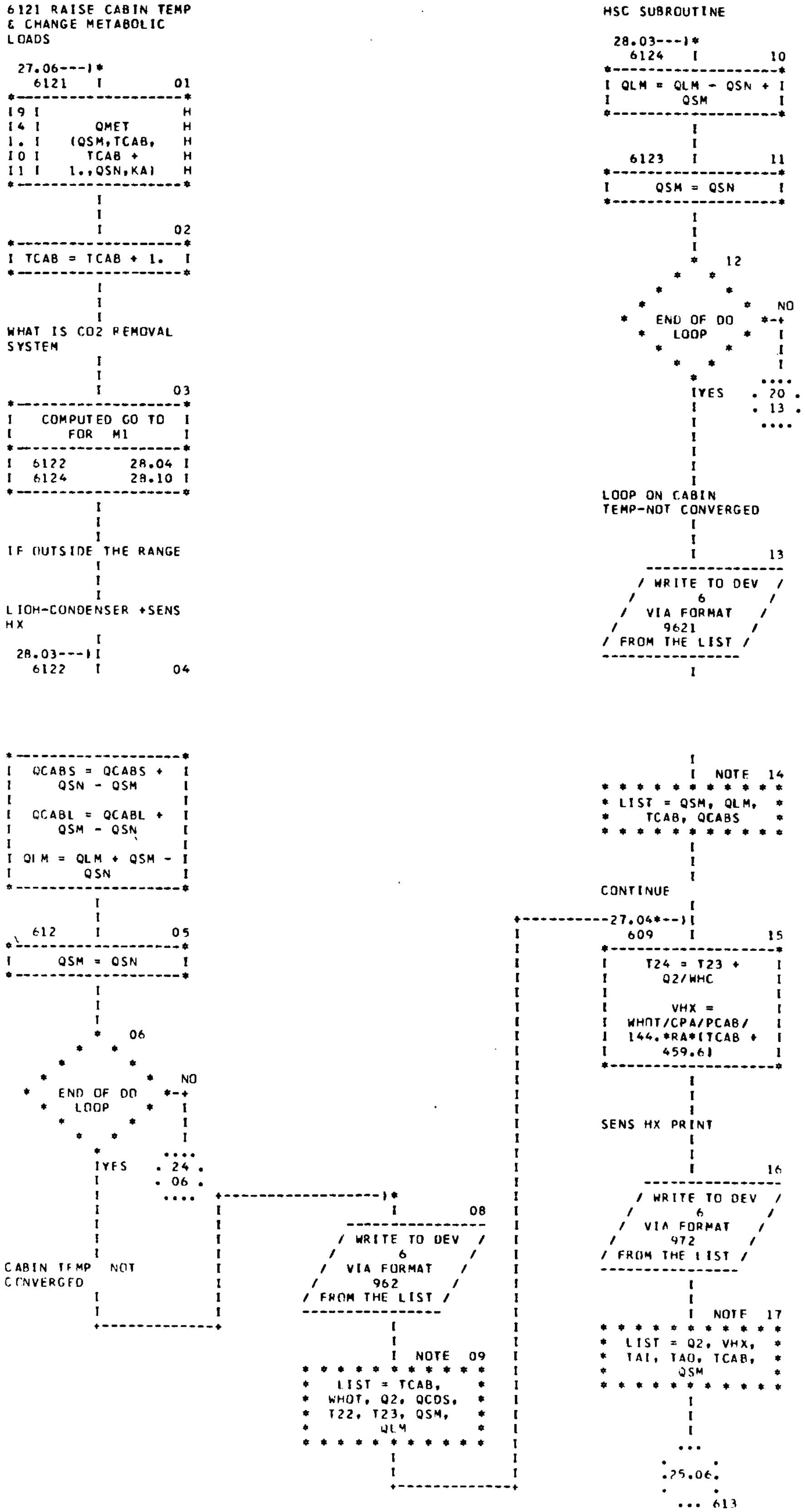

CHART TITLE - PROCEDURES

```
DOUBLE  EBAY

 25.07---)*
  6152   I            01
*--------------------*
I  QEE1 = QE1 -       I
I      QEB2 +         I
I  PW(17)*1.707       I
I                     I
I  QEE2 = QEB2 +      I
I  PW(17)*1.707       I
I                     I
I      RHOE1 =        I
I  PCAB*144./RA/      I
I  (TE1 + 459.6)      I
*--------------------*
          I
          I
          I           02
*--------------------*
I       WE1 =         I
I   V17*RHOE1*CPA     I
*--------------------*
          I
          I
          I
FIRST BAY
          I
          I
          I           03
*--------------------*
I7 I                  H
I9 I        HX        H
I, I (QEE1,WE1,WHC,   H
I0 I T24,16,TAOE1)    H
I1 I                  H
*--------------------*
          I
          I
          I           04
*--------------------*
I  TEE1 = TAOE1 +     I
I     QEE1/WE1        I
I                     I
I   T25A = T24 +      I
I     QEE1/WHC        I


*--------------------*
          I
          I
          I           05
   -----------------
  / WRITE TO DEV   /
 /       6        /
/  VIA FORMAT    /
/     9641       /
/ FROM THE LIST  /
-----------------
          I
          I
          I  NOTE  06
* * * * * * * * * * *
* LIST = QEE1, WE1,  *
* TEE1, TAOE1, T25A  *
* * * * * * * * * * *
          I
          I
          I
SECOND BAY
          I
          I
          I           07
*--------------------*  *------------------)*
I7 I                  H I                  I          10
I9 I        HX        H I          *--------------------*
I, I (QEE2,WE1,WHC,   H I          I   T25 = T25A +     I
I0 I T25A,16,TAE2)    H I          I     QEE2/WHC       I
I1 I                  H I          *--------------------*
*--------------------*  I                  I
          I             I                  I
          I             I                  I          11
          I           08I             -----------------
*--------------------*  I            / WRITE TO DEV    /
I  TEE2 = TAE2 +      I I           /       6         /
I     QEE2/WE1        I I          /  VIA FORMAT     /
*--------------------*  I         /     9641        /
          I             I        / FROM THE LIST   /
          I             I        -----------------
          I             I                  I
COOLANT OUTLET TEMP     I                  I
          I             I                  I  NOTE  12
          I             I          * * * * * * * * * * *
          *-------------*          * LIST = QEE2, WE1, *
                                   *  TEE2, TAE2, T25  *
                                   * * * * * * * * * * *
                                           I
                                           I
                                           I
                                          ...
                                         .   .
                                        .30.10.
                                         .   .
                                          ... 616
```

CHART TITLE - PROCEDURES

```
AVION  BAY -HEAT LOAD
 25.07---)*
  615     I          01
*--------------------*
I    Q16 = QE1 +     I
I   PW(17)*3.414     I
*--------------------*
          I
MINIMUM AIR DENSITY
          I          02
*--------------------*
I      RHOE1 =       I
I   PCAB*144./RA/    I
I   (TE1 + 459.6)    I
*--------------------*
          I
MIN FLOW RATE
          I          03
*--------------------*
I       WE1 =        I
I   V17*RHOE1*CPA    I
*--------------------*
          I          04
*--------------------*
17 I                 H
19 I       HX        H
I. I (Q16,WE1,WHC,   H
10 I  T24,16,TE10)   H
11 I                 H
*--------------------*
          I
EBAY TEMP
          I

          I          05
*--------------------*
I  TE11 = TE10 +     I
I     QE1/WE1        I
*--------------------*
          I
COOLANT OUTLET TEMP
          I          06
*--------------------*
I   T25 = T24 +      I
I     Q16/WHC        I
*--------------------*
          I
PRINT OUTPUT
          I          07
   / WRITE TO DEV  /
  /       6       /
 /  VIA FORMAT   /
/      964      /
/ FROM THE LIST /
          I
          I  NOTE  08
* * * * * * * * * * *
* LIST = Q16, WE1,  *
*    TE11, TE10     *
* * * * * * * * * * *
          I
PUMP OUTLET TEMP
COLD PLATE OUTLET
TEMP
          I
          *-------------* (to 25.08)

*-----------25.08*--)*
         616     I            10
*----------------------*
I     T26 = T25 +      I
I      QCP1/WHC        I
I                      I
I     T27 = T26 +      I
I  PW(4)*3.414/WHC     I
*----------------------*
          I
RAD  LOOP -INTER HX
OUTLET TEMP
          I            11
*----------------------*
I T2 = T1 + Q5/WCPC    I
*----------------------*
          I
AVIONICS  BAY -RAD
LOOP
          I
          *  12
       *     *
    *           * (-/0)
  *     V19       *------*
    *           *        I
       *     *           I      NO BAY-SET TEMPS
          *              *-----------------)*
          I (+)                   617   I        13
          I                 *----------------------*
          I                 I      T3 = T2         I
          I                 *----------------------*
          I                             I
         ...                           ...
       .30.14.                       .31.01.
         ... 618                       ... 619

BAY- HEAT LOAD HX
 30.12---)*
  618     I          14
*--------------------*
I    Q18 = QE2 +     I
I   PW(19)*3.414     I
*--------------------*
          I
MIN AIR DENSITY
          I          15
*--------------------*
I      RHOE2 =       I
I   PCAB*144./RA/    I
I   (TE2 + 459.6)    I
*--------------------*
          I
MIN AIR MASS FLOW
          I          16
*--------------------*
I       WHX =        I
I   V19*RHOE2*CPA    I
*--------------------*
          I          17
*--------------------*
17 I                 H
19 I       HX        H
I. I (Q18,WHX,WCPC,  H
10 I  T2,18,TE20)    H
11 I                 H
*--------------------*
          I
AIR TEMP
          I

          I          18
*--------------------*
I  TE2B = TE20 +     I
I     QE2/WHX        I
*--------------------*
          I
COOLANT TEMP
          I          19
*--------------------*
I     T3 = T2 +      I
I     Q18/WCPC       I
*--------------------*
          I
PRINT DATA
          I          20
   / WRITE TO DEV  /
  /       6       /
 /  VIA FORMAT   /
/      965      /
/ FROM THE LIST /
          I
          I  NOTE  21
* * * * * * * * * * *
* LIST = Q18, WHX,  *
*    TE2B, TE20     *
* * * * * * * * * * *
          I
COLD PLATE  TEMP
          I
          I  /
        -----
       /31.01
```

CHART TITLE - PROCEDURES

```
30.13*--)*
 619    I          01
T4 = T3 +
QCP2/WCPC

F/C HXS
                   02
I7 I       HX        H
I9 I (QFT,WFC,WCPC,  H
I. I  T4,20,TFCI)    H
I0 I                 H
I1 I                 H

F/C INLET TEMP
                   03
TFCO = TFCI +
QFT/WFC

PRINT F/C TEMPS
                   04
/ WRITE TO DEV /
      6
/ VIA FORMAT /
     966
/ FROM THE LIST /

NOTE 05
* LIST = QFT, WFC, *
*   TFCI, TFCO     *
                   06
T5 = T4 +
QFT/WCPC

PUMPS
                   07
T6C = T5 +
PW(6)*3.414/WCPC

PRINT WATER LOOP
TEMPS
                   08
/ WRITE TO DEV /
      6
/ VIA FORMAT /
     967
```

```
                   09
/ WRITE TO DEV /
      6
/ VIA FORMAT /
     906
/ FROM THE LIST /

NOTE 10
* LIST = T21, T22, *
* T23, T24, T25,   *
*   T26, T27       *

PRINT RADIATOR LOOP
TEMPS
                   11
/ WRITE TO DEV /
      6
/ VIA FORMAT /
     968
                   12
/ WRITE TO DEV /
      6
/ VIA FORMAT /
     906
/ FROM THE LIST /

NOTE 13
* LIST = T6C, T6,  *
* T7, T8, T9, T1,  *
* T2, T3, T4, T5   *

CALCULATE HEAT LOADS
                   14
Q1 = WHC*(T23 -
   T21)
Q4 = PW(4)*3.414
Q6 = PW(6)*3.414
Q7 = WCPC*(T6 -
   T7)
                   15
Q8 = WCPC*(T7 -
   T8)
Q22 = WCPC*(T8 -
   T9)
Q2 = WHC*(T24 -
   T23)
QLTOT = QCABL +
   QLH

PRINT HEAT LOADS
```

```
                   17
/ WRITE TO DEV /
      6
/ VIA FORMAT /
     971
/ FROM THE LIST /

NOTE 18
* LIST = Q1, Q2,   *
* Q4, Q5, Q6, Q7,  *
* Q8, Q22, QLTOT   *

. 2.01.
... 800
```

```
RADIATOR/EVAPORATOR
EXPENDABLE USAGE -SET
VARIABLES

02.10---)*
 805    I          19
DTHEA = 360./STEP
T1 = T2
WCPC = WC*CPR
TAUS = TAU/STEP
A = 0.
                   20
WA = 0.
NS = STEP
LA = 1

TOTAL POWER HEAT LOAD
                   21
QPW = (PW(11) +
PW(12) + PW(17) +
PW(19) + PW(4) +
PW(6) + PW(10) +
PW(3))*3.414

TOTAL HEAT LOAD
                   22
COMPUTED GO TO
FOR  M1
8051          31.23
8052          32.01

IF OUTSIDE THE RANGE

LIOH-ADD LATENT LOADS
31.22---)I
 8051   I          23
I3 I      LIOH       H
I8 I 19,7.,0.,WBC,   H
I. I WT9,PW9,V9,     H
I0 I  QS9,QL9)       H
I1 I                 H
                   24
QSH = 0.
QLH = 0.
QLT = QL9 + QLM +
   QLH

.32.02.
... 8053
```

CHART TITLE - PROCEDURES

```
HSC- NO LATENT LOADS
 31.22---)*
  8052   I           01
*--------------------*
I     QLT = 0.       I
*--------------------*
         I
 31.24---)I
  8053   I           02
*--------------------*
I   QTOT = QPW +     I
I QSE + QSM + QS9 +  I
I QSH + QE1 + QE2 +  I
I   QCP1 + QCP2 +    I
I QCHIL + QFC + QLT  I
I                    I
I  DT = QTOT/WCPC    I
*--------------------*
         I
         I
         I
ENTER LOOP TO GO
AROUND  ORBIT
         I
         I
         I  NOTE  03
* * * * * * * * * * *
*   BEGIN DO LOOP   *
*   810 N = 1, NS   *
* * * * * * * * * * *
         I
 33.10---)I
         I           04
*--------------------*
I     T10 = T1       I
*--------------------*
         I
         I
         I           05
*--------------------*
I  I                 H
I  I     UNBAR       H
I  I (S,1,A,0.,FK,   H
I  I     L(N))       H
I  I                 H

 --------------------*
         I
         I
         I
SINK TEMP
         I
         I
         I           06
*--------------------*
I       TS =         I
I (FK/(EMIS*.1714E-  I
I     8))**.25       I
I                    I
I    TRR(N) = TS     I
*--------------------*
         I
         I
         I
INLET RAD TEMP
         I
         I
         I           07
*--------------------*
I TRA(N) = T1 + DT   I
*--------------------*
         I
         I
         I
TEMP RATIOS
         I
         I
         I           08
*--------------------*
I   T1 = TRA(N) +    I
I       459.6        I
I                    I
I  T1 = T1 + 459.6   I
*--------------------*
         I
         I
         I
ENTER LOOP TO FIND
EVAP OUTLET TEMP
         I
         I
         +--------------
```

```
+-------------------)*
I                 I  NOTE  10
I   * * * * * * * * * * *
I   *   BEGIN DO LOOP   *
I   *  815 NN = 1, 10   *
I   * * * * * * * * * * *
I                 I
I    33.03---)I
I                 I
I    RAD PERFORMANCE
I                 I
I                 I
I                 I          11
I   *--------------------*
I   I8 I                 H
I   I2 I       RAD       H
I   I. I  (T1,TO,WCPC,   H
I   I0 I  WT7,AP,WEXP,   H
I   I2 I     TOR,7)      H
I   *--------------------*
I                 I
I                 I
I                 I
I    DID RADIATOR DO TOTAL
I    JOB
I                 I
I                 I
I                 I
I                 *   12
I              *     *
I           *           *
I        *                 * (-/0)
I     * TOR - TO - .5 *-+
I        *                 *   I
I           *           *      I
I              *     *         I
I                 *            I
I                 I (+)     . 33 .
I                 I         . 07 .
I                 I          ....
I                 I           819
I                 I
I                 I
I                 +--------------
```

```
RADIATOR CAN NOT DO
JOB -CHANGE TEMP
+-------------------)*
I       811      I          13
I  *--------------------*
I  I TR = TOR - 459.6   I
I  *--------------------*
I                I
I                I
I                I
I  EVAPORATOR HEAT LOAD
I                I
I                I
I                I          14
I  *--------------------*
I  I  QE = WCPC*(TR -   I
I  I       T10)         I
I  *--------------------*
I                I
I                I
I                I
I  GO TO SUPPLIMENTRY
I  HEAT SINK
I                I
I                I
I                I          15
I  *--------------------*
I  I  COMPUTED GO TO    I
I  I      FOR  NR       I
I  *--------------------*
I  I 813         32.20  I
I  I 812         32.16  I
I  I 814         32.18  I
I  *--------------------*
I                I
I                I
I                I
I  IF OUTSIDE THE RANGE
I                I
I                I
I                I
I  CRYOGENIC HX
I                I
I   32.15---)I
I     812      I            16

I  *--------------------*
I  I7 I                 H
I  I6 I       CRY       H
I  I. I  (QE,WCPC,TR,   H
I  I0 I   22,WEV(N))    H
I  I1 I                 H
I  *--------------------*
I                I
I                I
I                I          17
I  *--------------------*
I  I    TEO(N) = T1     I
I  *--------------------*
I                I
I                I
I               ...
I              .   .
I             .33.08.
I              .   .
I               ... 816
I
+--------------
```

```
FLASH EVAPORATOR
 32.15---)*
   814     I            18
*--------------------*
I7 I                 H
I1 I       FEVAP     H
I. I  (QE,WCPC,TR,   H
I0 I 25,TEO(N),WT)   H
I1 I                 H
*--------------------*
           I
           I
           I            19
*--------------------*
I WEV(N) = QE/965.   I
*--------------------*
           I
           I
           I
          ...
         .   .
        .33.08.
         .   .
          ... 816

SUBLIMATOR  HEAT SINK
 32.15---)*
   813     I            20
*--------------------*
I    EFF = 1. -      I
I  1./EXP(CFT(24)    I
I      /WCPC)        I
I                    I
I    TR2 = TR -      I

I  EFF*(TR - 32.)    I
*--------------------*
           I
           I
           I
HEAT REJECTED
           I
           I
           I            21
*--------------------*
I      WEV(N) =      I
I    WCPC*(TR -      I
I    TR2)/1060.      I
I                    I
I    TEO(N) = TR2    I
*--------------------*
           I
           I
           I
IS TEMP WITHIN
TOLERENCE
           I
           I
           I
           *   22
        *     *
     *           *
  *                 * (-/0)
*  ABS(T10 -    *-+
  *  TR2) - .5 *    I
     *           *  I
        *     *     I
           *        I
           I (+)  . 33 .
           I      . 08 .
           I       ....
           I        816
           I
           I
           I
          ...
         .   .
        .33.01.
         .   .
          ... 817
```

E

CHART TITLE - PROCEDURES

```
NOT IN TOLERENCE

 32.22---)*
  817     I          01
*--------------------*
I      T10 = TR2     I
I                    I
I TRA(N) = T10 + DT  I
I                    I
I   TI = TRA(N) +    I
I       459.6        I
*--------------------*
          I
          I
  815     I          02
*--------------------*
I TO = T10 + 459.6   I
*--------------------*
          I
          I
          I
          *   03
        *   *
      *       *
    *           *   NO
  *   END OF DO   *--+
    *   LOOP    *    I
      *       *      I
        *   *        I
          *         ....
          IYES     . 32 .
          I        . 11 .
          I         ....
          I
          I
          I
LOOP NOT CONVERGED
          I
          I
          I               04
     ----------------
    / WRITE TO DEV  /
   /       6       /
  /   VIA FORMAT  /
 /       983     /
/ FROM THE LIST /
----------------
          I
          I
          I  NOTE  05
* * * * * * * * * * *
*  LIST = TRA(N),   *
* TR2, CE, TP, QTOT *
* * * * * * * * * * *
          I
          I
          I
NEXT CASE
          I
          I
          I 06
         ...
        .   .
        . 2.01.
        .   .
         ... 800
```

```
RADIATOR DID TOTAL
JOB

 32.12---)*
  819     I          07
*--------------------*
I      QE = 0.       I
I                    I
I     WEV(N) = 0.    I
I                    I
I   TEO(N) = TOR -   I
I       459.6        I
*--------------------*
          I
          I
          I
AVG FLOW RATE
          I
 32.17*--)I
  816     I          08
*--------------------*
I      WA = WA +     I
I    WEV(N)/STEP     I
*--------------------*
          I
          I
  810     I          09
*--------------------*
I   A = A + DTHEA    I
*--------------------*
          I
          I
          I
          *   10
        *   *
      *       *
    *           *   NO
  *   END OF DO   *--+
    *   LOOP    *    I
      *       *      I
        *   *        I
          *         ....
          IYES     . 32 .
          I        . 04 .
          I         ....
          I
          I
          I
END LOOP -PRINT
VALUES
          I
          I
          I               11
     ----------------
    / WRITE TO DEV  /
   /       6       /
  /   VIA FORMAT  /
 /       984     /
/ FROM THE LIST /
----------------
          I
          I
          I  NOTE  12
* * * * * * * * * * *
* LIST = QTOT, WA,  *
*       STEP        *
* * * * * * * * * * *
          I
          I
          I               13
     ----------------
    /               /
   / WRITE TO DEV  /
  /       6       /
 /   VIA FORMAT  /
/       985     /
----------------
          I
          I
          I               14
     ----------------
    / WRITE TO DEV  /
   /       6       /
  /   VIA FORMAT  /
 /       986     /
/ FROM THE LIST /
----------------
          I
          I
          +-------------------+
```

```
+-------------------)*
I                    I  NOTE  15
I          * * * * * * * * * * *
I          *      LIST =       *
I          * (WEV(J),J = 1,NS) *
I          * * * * * * * * * * *
I                    I
I                    I
I                    I               16
I               ----------------
I              / WRITE TO DEV  /
I             /       6       /
I            /   VIA FORMAT  /
I           /       9861    /
I          / FROM THE LIST /
I          ----------------
I                    I
I                    I
I                    I  NOTE  17
I          * * * * * * * * * * *
I          *      LIST =       *
I          * (TRA(J),J = 1,NS) *
I          * * * * * * * * * * *
I                    I
I                    I
I                    I               18
I               ----------------
I              / WRITE TO DEV  /
I             /       6       /
I            /   VIA FORMAT  /
I           /       9862    /
I          / FROM THE LIST /
I          ----------------
I                    I
I                    I
I                    I  NOTE  19
I          * * * * * * * * * * *
I          *      LIST =       *
I          * (TRB(J),J = 1,NS) *
I          * * * * * * * * * * *
I                    I
I                    I               20
I               ----------------
I              / WRITE TO DEV  /
I             /       6       /
I            /   VIA FORMAT  /
I           /       9863    /
I          / FROM THE LIST /
I          ----------------
I                    I
I                    I
I                    I  NOTE  21
I          * * * * * * * * * * *
I          *      LIST =       *
I          * (TEO(J),J = 1,NS) *
I          * * * * * * * * * * *
I                    I
I                    I               22
I               ----------------
I              / WRITE TO DEV  /
I             /       6       /
I            /   VIA FORMAT  /
I           /       987     /
I          / FROM THE LIST /
I          ----------------
I                    I
I                    I
I                    I  NOTE  23
I          * * * * * * * * * * *
I          * LIST = (L(J),J =  *
I          *       1,NS)       *
I          * * * * * * * * * * *
I                    I
+                    I
                     I
           NEXT CASE
                     I
                     I
                     I 24
                    ...
                   .   .
                   . 2.01.
                   .   .
                    ... 800
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      DIMENSION  S(100),T(100)
      DIMENSION TRA(30),TRB(30),TEO(30),WEV(30),L(30)
      DIMENSION  FWT(30),FXW(30),SWT(30)
      DIMENSION TQ(20),TXO(20),PT(20),WTT(20)
      DIMENSION T41(20),TQ1(20),TRDO(20),TXO1(20),PT1(20),WTT1(20),
      T42(20),WC1(50),TQ2(50),TRDO1(50),TXO2(50),PT2(50),WTT2(50),
      T43(50)
      ,CFT(30),PW(30)
       COMMON X(700),LA,NPER,PP
      EQUIVALENCE
      (X(101),FWT(1)),(X(131),FXW(1)),(X(161),SWT(1))
      ,(X(191),PW(1)),(X(221),CFT(1))
      EQUIVALENCE
      (X( 1),TCAB  ),(X( 2),PCAB  ),(X( 3),RA    ),(X( 4),TROIN ),
      (X( 5),WCIN  ),(X( 6),CPC   ),(X( 7),CPR   ),(X( 8),RHOC  ),
      (X( 9),RHOR  ),(X(10),WCO2  ),(X(11),DAYN  ),(X(12),QSM   ),
      (X(13),QSE   ),(X(14),QLM   ),(X(15),QCP1  ),(X(16),QCP2  ),
      (X(17),QFC   ),(X(18),QSUBI ),(X(19),A1    ),(X(20),A2    ),
      (X(21),DTX   ),(X(22),TOLP  ),(X(23),TVOL  ),(X(24),DAYE  ),
      (X(25),RMAX  ),(X(26),HXIM  ),(X(27),SPLITM),(X(28),CONDM ),
      (X(29),RHMAX ),(X(30),WRAT  )
      EQUIVALENCE
      (X(31),FW1   ),(X(32),FW2   ),(X(33),PPF   ),(X(34),PPV   ),
      (X(35),FW5   ),(X(36),EX    ),(X(37),EY    ),(X(38),DWC   ),
      (X(39),FW9   ),(X(40),FW10  ),(X(41),DP1   ),(X(42),DP2   ),

      (X(43),DP4   ),(X(44),DP6   ),(X(45),DP9   ),(X(46),DP10  ),
      (X(47),TS    ),(X(48),CPA   ),(X(49),AMAX),(X(50),FEXP)
      EQUIVALENCE
      (X(51),QAMIN),(X(52),QCPM ),(X(53),QE1  ),(X(54),QE2  ),
      (X(55),TE1  ),(X(56),TE2  ),(X(57),DPE1 ),(X(58),DPE2 )
      EQUIVALENCE (X(59),FRAD),(X(60),FCO2),(X(61),FNCO2),(X(62),TCMAX)
      EQUIVALENCE
      (S(1),X(301)),(T(1),X(401))
      ,(X(63),CHSB),(X(64),EH2O ),(X(65),CYCL),(X(66),QEB2)
      ,(X(77),FRESH ),(X(67),QCHIL ),(X(68),TOLQ  ),(X(69),WFC   )
      ,(X(70),RN    ),(X(71),WC    ),(X(72),TZ    ),(X(73),FACT  )
      ,(X(100),PERF ),(X(191),PW(1)),(X(221),CFT(1))
      ,(X(251),V11  ),(X(252),V12  ),(X(253),V9    ),(X(254),V10 )
      ,(X(255),V17  ),(X(256),V19  )
      ,(X(73),TCRY ),(X(74),TSUB ),(X(75),TFCI),(X(76),TFCO )
      ,(X(100),PERF)
      ,(X(78 ),FMIS ),(X(79 ),STEP ),(X(80),TAU )
2423  FORMAT(1HO'SENSIBLE FAN ',F8.2,8H FANWT  F8.2,8H WTVK    )
1003  FORMAT(1HO'CONDENSER FAN ',F8.2,8H FANWT  F8.2,8H WTVK    )
977   FORMAT(1HO' COMPONENT FLOW RATES-CFH'/F8.1,' CONDF  ',F8.1,' SENF
       ',F8.1,' AVFANH ',F8.1,' AVFANR ',F8.1,' VENTF  ',F8.1,' LIOH  ')
976   FORMAT(1HO'COMPONENT FACTORS-UA,EFF,ETC.'/1H 15F8.2/1H 15F8.2 )
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
999     FORMAT(1H0'SUBLIMATOR LOOP NOT CONVERGED'/1H F8.1,8H QTOT    F8.1,
        8H QREJ   F8.2,8H TRI     F8.2,8H TRO     F8.2,8H TSUBO    )
961     FORMAT(1H0'CONDESER PERFORMANCE NOT CONVERGED'/F8.1,' WCOOL ',
        F8.2,' TCI  ',F8.1,' QCABS ',F9.1,' QCABL  ',F8.2,' TCAB  ',F8.1,'
         QSH   ',F8.1,' QLH  '/F8.1,'VAIR  ',F8.2,' PWFAN  ')
980     FORMAT(1H0'REHEATER REQUIRED'/ F8.1,' QSENS ',F8.2,' TCAB  ',F8.1,
        ' VSENS ',F8.2,' TCIN '  )
963     FORMAT(1H0'SENS HX FLOW LOOP NOT CONVG'/F8.2,' TAI   ',F8.2,'TAO
        ',F8.1,' WAIR  ',F8.1,' WAIRMAX ' )
962     FORMAT(1H0'CABIN TEMP NOT CONVERGED'/F8.2,' TCAB  ',F8.1,' WASEN',
        F8.1,' QSENSX ',F8.1,' QCSEN  ',F8.2,' TCDI  ',F8.2,' TSI  '
        ,F8.1,8H QSMET  F8.1,8H QLMET      )
9621    FORMAT(1H0'HSC-CABIN TEMP LOOP NOT CONVERGED'/1H F8.2,8H QSM
        F8.2,8H QLM     F8.2,8H TCAB     F8.2,8H QCABS   )
9641    FORMAT(1H0'WATER COOLED AVIONICS BAY'/1H F8.1,8H QHX     F8.2,8H WC
        PAIR F8.2,8H TBAY   F8.2,8H THXAO  F8.2,8H THXCO    )
964     FORMAT(1H0'WATER COOLED AVIONICS BAY'/F8.1,' QHX  ',F8.1,' WCPAIR'
        ,F8.2,' TBAY  ',F8.2,' TXO  ')
965     FORMAT(1H0'RADIATOR LOOP COOLED AVIONIC BAY'/
         F8.1,' QHX  ',F8.1,' WCPAIR ',F8.2,' TBAY  ',F8.2,' TXO   ')
966     FORMAT(1H0'FUEL CELL HX '/
         F8.1,' QFC  ',F8.1,' WFC  ',F8.2,' TF/CI ',F8.2,' TF/CO  ')
967     FORMAT(1H0'CABIN LOOP TEMPS ')
968     FORMAT(1H0'RADIATOR LOOP TEMPS ')
971     FORMAT(1H0' HEAT LOADS '/



        F8.1,' QCOND  ',F8.1,' QSENS   ',F8.1,' QCPUMP ',F8.1,' QINTX  ',
        F8.1,' QRPUMP ',F8.1,' QRAD   '/F8.1,' QEVAP  ',F8.1,' QRY    ',
        F8.1,' QLAT   ' )
972     FORMAT(1H0'SENS HX PERFORMANCE '/
        F8.1,8H QSENS  F8.1,8H VHX     F8.2,8H TXAI    F8.2,8H TXAO    F8.2,
         8H TCAB    F8.1,8H QMETS   )
901     FORMAT(20H QLAT NOT CONVERGED  /1H F8.2,8H TRO     F8.2,8H TIHXO
         F8.4,8H PH2OI  F8.4,8H PH2OO    )
902     FORMAT(20H CANNOT MEET QSENS   /1H F8.2,8H TRO     F8.2,8H TIHXO  )
903     FORMAT(1H F8.1,8H QHXS   F8.2,8H TEQWT  F8.2,8H HXWT   F8.2,8H WAL
        LWT F8.2,8H FANPW   F8.2,8H  TAOX     )
904     FORMAT(26H1SYSTEM ITERATION WEIGHTS /1H F8.1,8H TIHXI  F8.2,8H TIH
        XO  F8.2,8H TEQWT  F8.2,8H TOTWT  F8.2,8H TOTPW  F8.2,8H TAOS
        F8.2,8H TAOC    )
905     FORMAT(114H0 H2OREM  HXSENS  W/S      PUMPC    HXINTF  PUMPR    RADWT
           SUBLIM  CO2REM  VENT     CONTC    FAN C    FAN A    FAN MS  )
906     FORMAT(14F8.2)
907     FORMAT(27H0 COMPONENT POWERS (WATTS) /65H H2OREM  SENSF    PUMPC
        PUMPR    CO2REM  VENTF    EBAY1    EBAY2    )
908     FORMAT(30H0COMPONENT FLOW RATES CFM         /
        1H F10.1,8H H2OREM F9.1,8H CO2REM F9.1,8H SENHX  F10.1,8H VENT
           F10.1,8H CONTM  F10.1,8H FAN C  F10.1,8H FAN A  /
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
         1H F10.1,8H EBAY1  F10.1,8H EBAY2  )
909      FORMAT(1H F8.4,8H PDPO    F8.1,8H WCOOL  F8.3,8H WBCO2  F8.3,8H WBD
         ES  F8.2,8H ULLPEN F8.1,8H ARAD    F8.2,8H WTEXP  )
910      FORMAT(13HO INPUT DATA /
         1H F8.2,8H TCAB    F8.2,8H PCAB    F8.2,8H RGAS    F8.3,8H TRADO
            F8.2,8H WRAD    F8.2,8H CPCOOL F8.2,8H CPRAD  F8.2,8H RHOC     /
         1H F8.2,8H RHOR    F8.2,8H WCO2    F8.2,8H DAYS    F8.1,8H QSMET
            F8.1,8H QSENE  F8.1,8H QLMET  F8.1,8H QCP1    F8.1,8H QCP2     /
         1H F8.1,8H QFCELL F8.1,8H QSUBL  F8.1,8H KEY CO2F8.1,8H KEY H2O
            F8.2,8H DTIHX  F8.3,8H TOLP    F8.1,8H TVENT  F8.3,8H DAYEM    /
         1H F8.2,8H NO TRADF8.2,8H NO TIHOF8.2,8H BLANK  F8.2,8H NO QLAT
            F8.3,8H PHMAX  F8.2,8H WC/WR  F8.4,8H DT RADUF8.4,8H EF FC    /
         1H F8.4,8H PPFIX  F8.5,8H PPVAR  F8.2,8H KEY HXSF8.4,8H KEY OPT
            F8.4,8H NO WC  F8.4,8H FACT WCF8.4,8H KEY RADF8.4,8H KEY CON /
         1H F8.2,8H DP H2O F8.2,8H DP SHX F8.2,8H DP CP  F8.2,8H DP RP
            F8.2,8H DP CO2 F8.2,8H DP VENTF8.2,8H T SINK F8.2,8H CPA      /
         1H F8.2,8H AMAX    F8.2,8H FEXP    F8.2,8H QAMIN  F8.2,8H QCPM
            F8.1,8H QE1     F8.1,8H QE2     F8.2,8H TE1     F8.2,8H TE2      /
         1H F8.2,8H DPE1    F8.2,8H DPE2    F8.2,8H F RAD  F8.2,8H F CO2
            F8.2,8H FN CO2 F8.2,8H TCMAX  F8.3,8H  CO2L  F8.3,8H EFH2O  )
911      FORMAT(1H F8.1,8H ULLDES F8.1,8H ULLCO2 F8.1,8H DEW PT F8.1,8H TAO
         E11 F8.1,8H TAOE12 F8.1,8H TEB1    F8.1,8H TEB2   /1H F8.1,8H TAOE2
          )
912      FORMAT(1HO' EBHX1   EBFAN1  EBHX2   EBFAN2  FCHX    CRYHX   WTH2O
          WTHYO   FEVAP   GSE  ')

930      FORMAT(26HOCOMPONENT WEIGHT FACTORS /
         122H  COND     SENHX    W/S      PUMPC    HXINT    PUMPR    RAD      SUB
             LIOH     VENT     FANC     FANS     C        HSC      CONTM    /
         1H 15F8.4 )
931      FORMAT(20H SUBSYSTEM FIXED WT  / 1H 15F8.2 )
932      FORMAT(23H STRUCTURAL WT FACTORS  /1H 15F8.4 )
933      FORMAT(1HO'COMPONENT WEIGHT FACTORS'/' EBHX1   EBFAN1  EBHX2   EB
         FAN2  FCHX    GSEHX   CRYHX   CHILL   SUBLT   FEVAP   A        B'
          /15F8.4  )
934      FORMAT(20H SUBSYSTEM FIXED WT  /1H 15F8.4)
935      FORMAT(23H STRUCTURAL WT FACTORS  /1H  15F8.4)
936      FORMAT(29HO RADIATOR LOOP TEMPERATURES  )
937      FORMAT(29HO CABIN LOOP  TEMPERATURES     )
938      FORMAT(32HO      EBAY1      EBAY2      SUBLIM  )
940      FORMAT(18H CASE DID NOT RUN )
941      FORMAT(1H 4F10.1)
950      FORMAT(20HO OPTIMUM CONDITION F8.1,5H WC  /50H    TOTEQWT         TRO
             TINHXO      TOTPW      TOTWT)
951      FORMAT(1H 5F10.1)
952      FORMAT(32H FLOW RATE LOOP DID NOT CONVERGE)
953      FORMAT(1H 6F10.1)
954      FORMAT(40HO   TOTEQWT     TINHXO      TOTPW      TOTWTF8.1,5H WC  F8.2
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
         ,4H TRO)
955      FORMAT(28H0 OPTIMUM CONDITIONS SUMMARY/60H   TOTEQWT        WC
            TRO    TINHXO      TOTPW      TOTWT)
960      FORMAT(13H0 OUTPUT DATA)
970      FORMAT(1H 11F10.1)
975      FORMAT(12H0 HEAT LOADS/119H    CONDHX    SENSHX   INTERHX  FUELCEL
         L  RADIATOR    EXP HX    TOTLAT   SENSCO2    LATCO2  SENSH2OP   LA
         TH2OP   QSINK   )
915      FORMAT(1H F8.1,8H CYCLE  F8.1,8H QEB2   )
981       FORMAT(1H 15F8.3)
982      FORMAT(1H F8.2,8H QCHIL  F8.3,8H TOLQ   F8.1,8H WF/C   F8.1,8H KEY
         SK  F8.1,8H WCOOL  F8.1,8H TIFXI  F8.2,8H TIMECY F8.2,8H TIMESB  /
         1H F8.2,8H TFCI   F8.2,8H TFCO   F8.1,8H NUBFRH F8.4,8H EMIS
         F8.1,8H STEP   F8.2,8H TORBIT F8.1,8H PERF    )
983      FORMAT(1H0'RADIATOR/EVAPORATOR EXPENDABLE USAGE NOT CONVERGED'/1H
         F8.1,8H TRADIN F8.1,8H TEVAPO F8.1,8H QEVAP  F8.1,8H TRADO
         F8.1,8H QTOT    )
984      FORMAT(1H1'RADIATOR/EVAPORATOR EXPENDABLE USAGE'/1H F8.1,8H QTOT
           F8.1,8H WEVAVG F8.1,8H NO.STEP  )
985      FORMAT(12H0 ORBIT STEP  '   1/16     2/17     3/18     4/19     5/20
           6/21     7/22     8/23     9/24    10/25    11/26    12/27    13/28    1
         4/29    15/30')
986      FORMAT(11H WEVAPORANT    15F8.2/11H              15F8.2 )
9861     FORMAT(11H T RAD IN      15F8.2/11H             15F8.2 )
9862     FORMAT(11H T SINK        15F8.2/11H             15F8.2 )


9863     FORMAT(11H TEVAP OUT     15F8.2/11H             15F8.2 )
997      FORMAT(11H OFF TABLES    15I8 /11H              15I8   )
989      FORMAT(1H0'COMPONENT POWERS -WATTS'/1H 15F8.2 )
```

CHART TITLE - SUBROUTINE LIOH(J,DAY,DPF,WL,WT,PW,V,QS,QL)

```
 / LIOH /
03.06*--)I
          01
 COMPUTED GO TO
   FOR NPER
 11          38.02
 12          38.14

IF OUTSIDE THE RANGE

PERFORMANCE
CALCULATIONS
WT OF LIOH + CHARCOAL
38.01---)I
 11       02
      WL =
  WCO2*DAY*1.263
      TN =
  WCO2*DAY/8.44
     IN = TN
     WN = IN

          03
(-/0)  TN - WN -
         .001
          (+)

 15       04
  WN = WN + 1.

 14       05
  WL = WL*WN/TN

FAN POWER
          06
  V = WCO2*300.
      PW =
  V*DPF/510./CFT
      (11)

IS POWER TOO LOW
HEAT LOADS
          07
      QS =
  35.*WCO2*FCO2 +
    PW*3.414
      QL =
  17.5*WCO2*FCO2

LIOH  M-VALVES
          08
 I8 I
 I1 I      WTV2
 I. I   (V,1,WTM)
 I0 I
 I1 I

          09
 WT = (WL*FWT(J) +
      FXW(J) +
   2.*WTM)*SWT(J)

          10
  COMPUTED GO TO
     FOR LA
 21          38.13
 22          38.11

IF OUTSIDE THE RANGE
38.10---)I
 22         11
 / WRITE TO DEV /
 /      6       /
 /  VIA FORMAT  /
 /      23      /
 / FROM THE LIST /

     NOTE 12
 LIST = WN, WTM,
       WL

38.10*--)I(---------
 21       13
     * EXIT *

 / 12 /
38.01---)I
          14
      QS =
  35.*WCO2*FCO2
      QL =
  17.5*WCO2*FCO2

CO2 PARTIAL PRES
          15
     PMIN =
  WCO2*(TCAB +
     459.6)
  *FNCO2*FCO2/
  FRESH/V/1.870
     PMAX =
  PMIN*.95/CFT(J)

PRINT DATA
          16
 / WRITE TO DEV /
 /      6       /
 /  VIA FORMAT  /
 /      20      /
 / FROM THE LIST /

     NOTE 17
  LIST = PMAX,
  PMIN, QS, QL
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      DIMENSION  FWT(15),FXW(15),SWT(15)
     DIMENSION
     CFT(30)
      COMMON X(700),LA,NPER,PP
     EQUIVALENCE
      (X(101),FWT(1)),(X(131),FXW(1)),(X(161),SWT(1))
     EQUIVALENCE (X(60),FCO2),(X(61),FNCO2) ,
     (X(221),CFT(1)) ,(X(100),PERF) ,(X(10),WCO2)
     ,(X(1),TCAB ),(X(77),FRESH)
23   FORMAT(1HOF8.1,8H NO.CAR F8.2,8H MVALVE F8.2,8H LIOHWT  )
20   FORMAT(1H1 'LIOH SUBROUTINE-CO2 PARTIAL PRESSURES'/F8.3,' PMAX   '
     ,F8.3,' PMIN  ',F8.1,' QS    ',F8.1,' QL  ' )
```

CHART TITLE - INTRODUCTORY COMMENTS

COND HX SUBROUTINE

CHART TITLE - SUBROUTINE CHX(QS,QL,TC,TCI,WCPC,RHO,CPA,PMAX,DPF,TAO,J,QCS,V,PW,

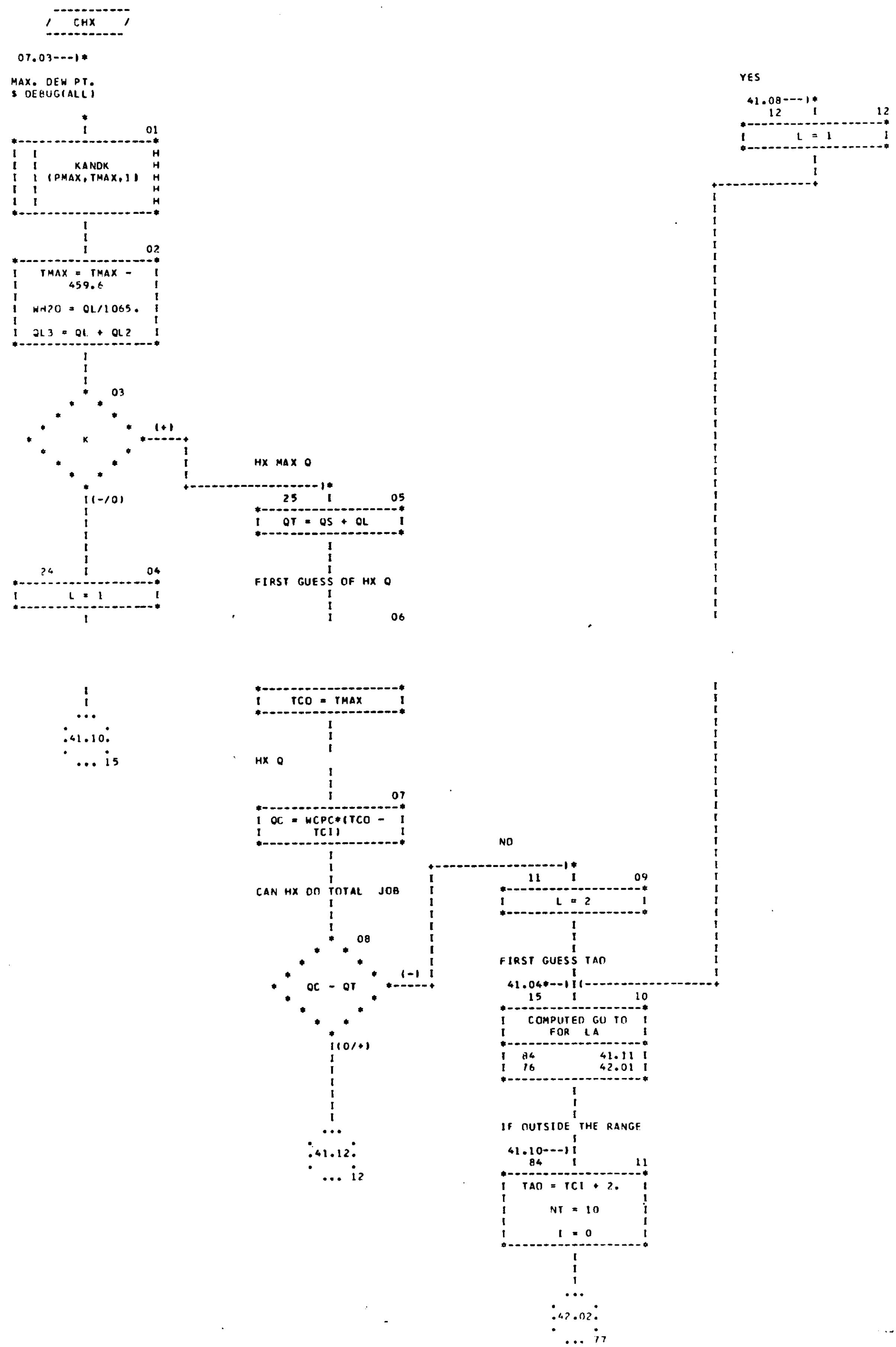

CHART TITLE - SUBROUTINE CHX(QS,QL,TC,TCI,WCPC,RHO,CPA,PMAX,DPF,TAO,J,QCS,V,PW,

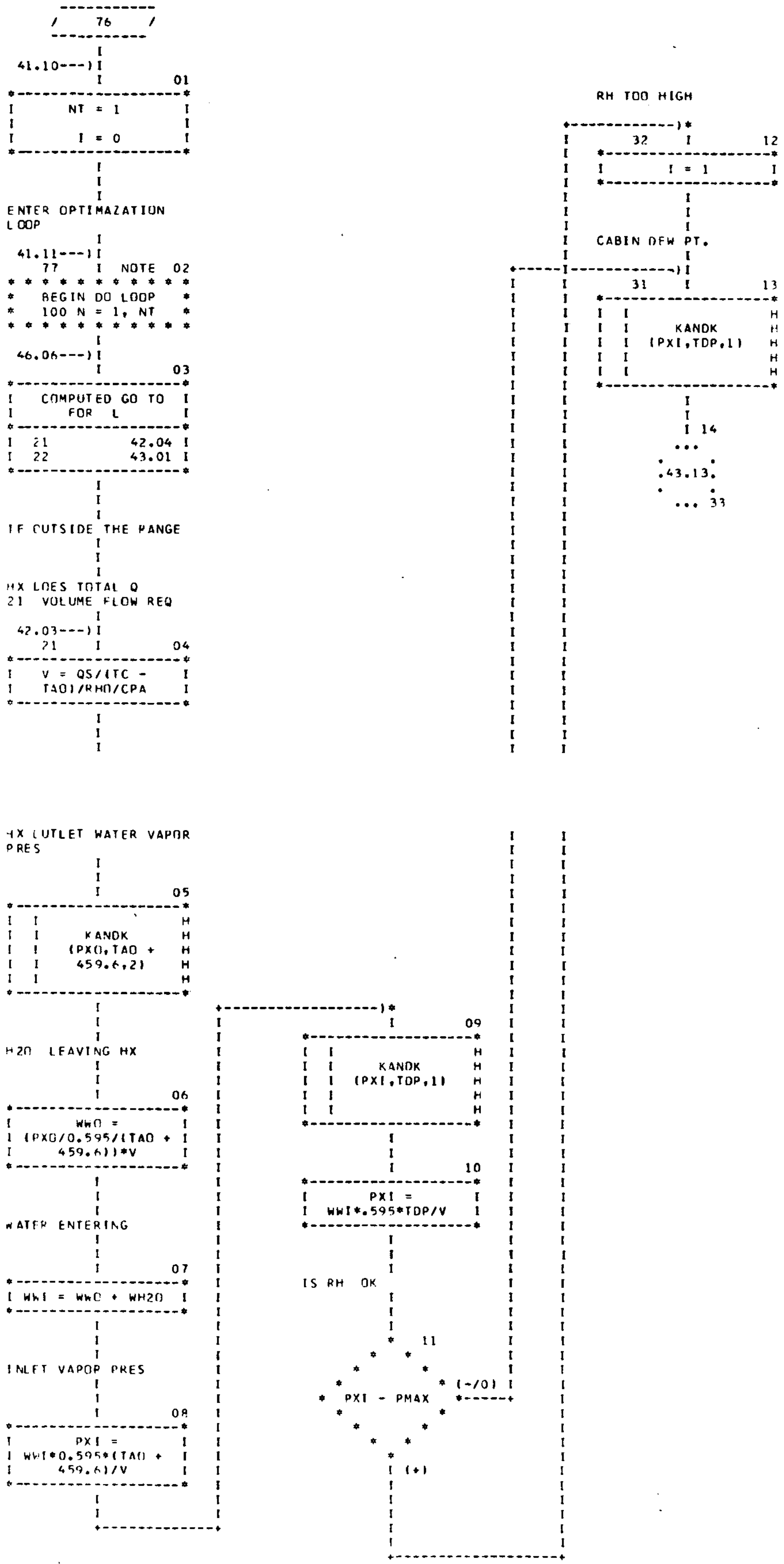

CHART TITLE - SUBROUTINE CHX(QS,QL,TC,TCI,WCPC,RHO,CPA,PMAX,DPF,TAO,J,QCS,V,PW,

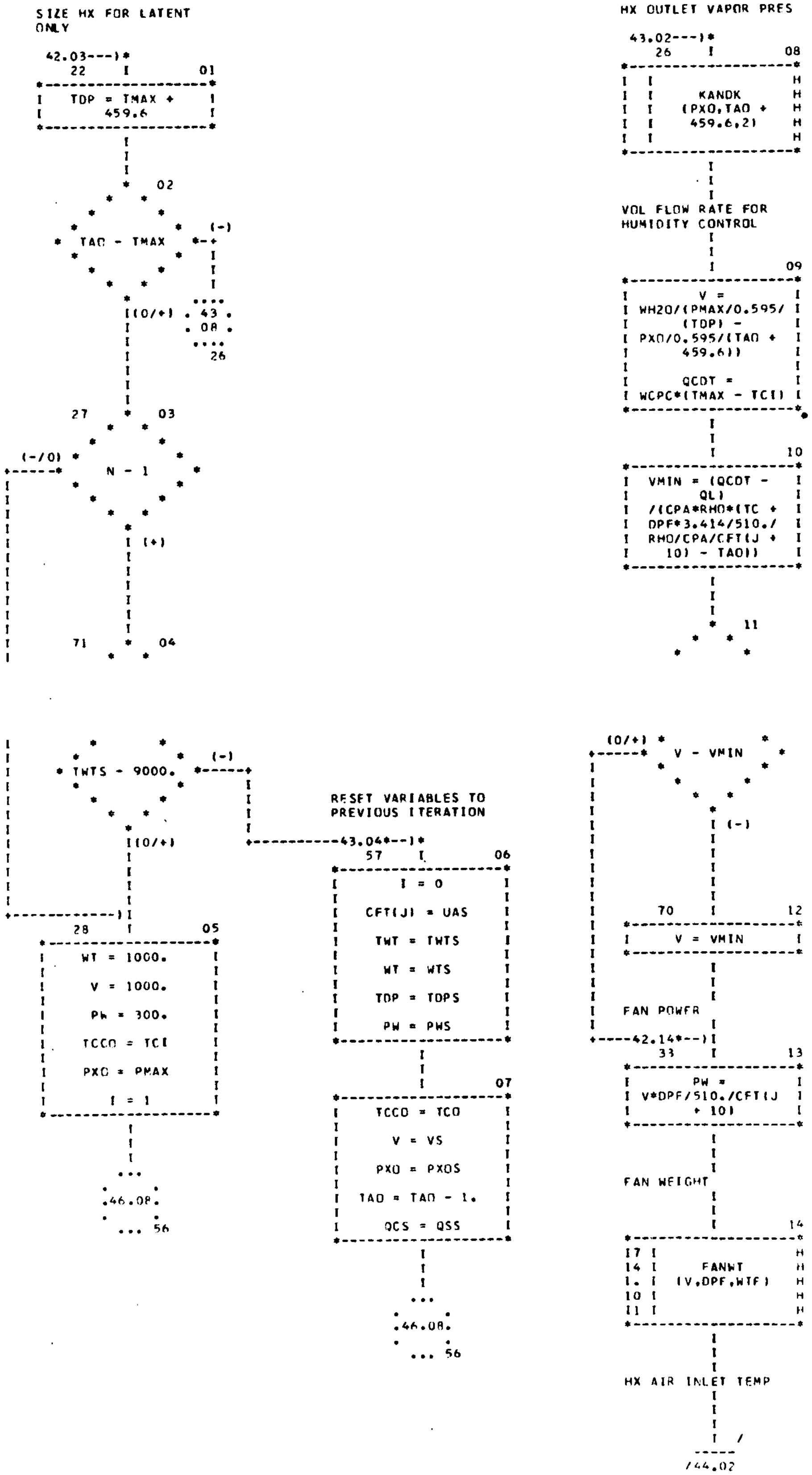

CHART TITLE - SUBROUTINE CHX(QS,QL,TC,TCI,WCPC,RHO,CPA,PMAX,DPF,TAO,J,QCS,V,PW,

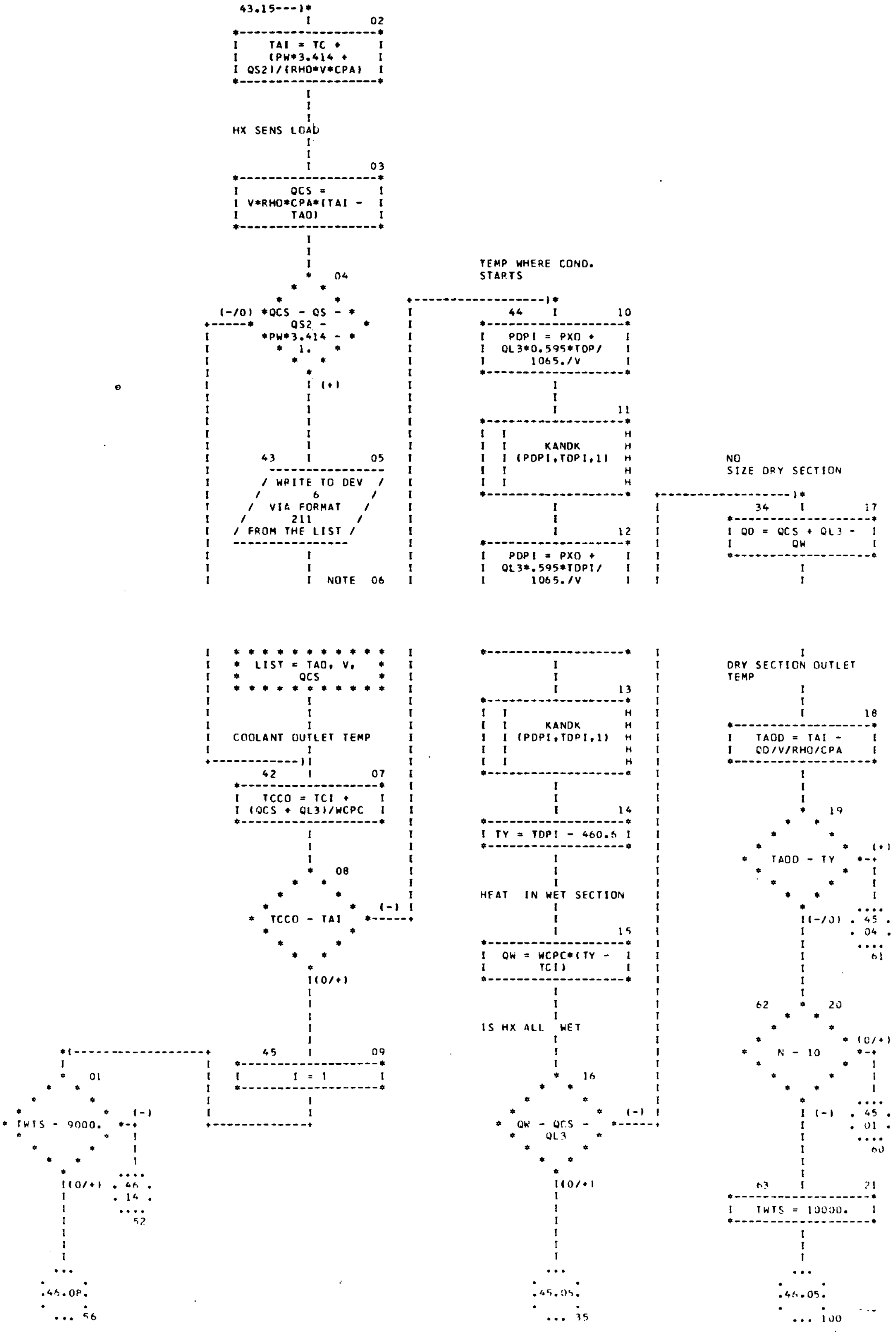

CHART TITLE - SUBROUTINE CHX(QS,QL,TC,TCI,WCPC,RHO,CPA,PMAX,DPF,TAO,J,QCS,V,PW,

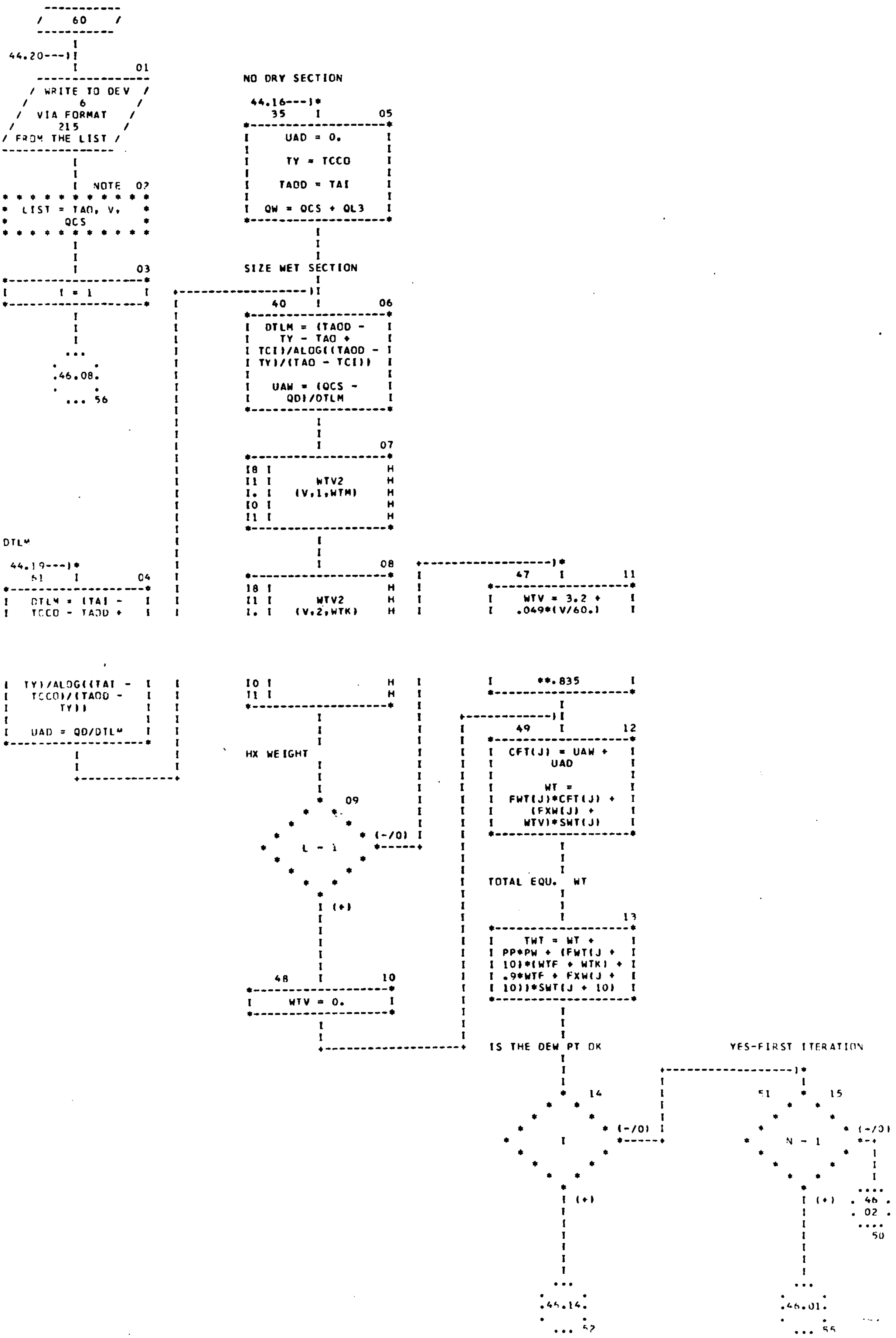

CHART TITLE - SUBROUTINE CHX(QS,QL,TC,TCI,WCPC,RHO,CPA,PMAX,DPF,TAO,J,QCS,V,PW,

```
                                       ------------
                                      /   50     /
                                      ------------
                                           I
                                 +----45.15*--)I
                                 I         I            02
  IS WT OPIMIZED                 I   *--------------------*
                                 I   I   COMPUTED GO TO   I
   45.15---)*                    I   I      FOR  LA       I
            I                    I   *--------------------*
     55     *     01             I   I  78          46.03 I
          *   *                  I   I  81          46.10 I
       *         *               I   *--------------------*
 (-) *             *    (0)      I              I
 +-*   TWTS - TWT   *------+     I              I
 I   *             *       I     I              I
 I      *       *          I     I   IF OUTSIDE THE RANGE
 I         *  *            I     I              I
 ....        *             I     I   46.02---)I
. 43 .       I (+)         I     I     78       I         03
. 06 .       I             I     I   *--------------------*
 ....        I             I     I   I    TWTS = TWT      I
 57          I             I     I   I                    I
             I             I     I   I     WTS = WT       I
             I             I     I   I                    I
             +-------------I-----+   I     PWS = PW       I
                           I         I                    I
                           I         I   UAS = CFT(J)     I
                           I         I                    I
                           I         I    TDPS = TDP      I
                           I         I                    I
                           I         I    TCO = TCCO      I
                           I         *--------------------*
                           I                    I
                           I                    I
                           I                    I         04
                           I         *--------------------*
                           I         I     VS = V         I
                           I         I                    I
                           I         I    PXOS = PXO      I
                           I         I                    I
                           I         I     QSS = QCS      I
                           I         *--------------------*
                           I                    I
                           I                    I
                           I                    I
                           I         NEXT  ITER
                           I                    I
                           I          44.21---)I
                           I           100      I         05
                           I         *--------------------*
                           I         I  TAO = TAO + 1.    I

                           I         *--------------------*
                           I                    I
                           I                    I
                           I                    I
                           I                    *    06
                           I                 *     *
                           I              *           *      NO
                           I           *   END OF DO    *--+
                           I              *  LOOP     *    I
                           I                 *     *       I
                           I                    *         ....
                           I                    IYES     . 42 .
                           I                    I        . 03 .
                           I                    I         ....
                           I                    I
                           I                    I
                           I                    I
                           I         NOT OPIMIZED
                           I                    I
                           I                    I
                           I                    I         07
                           I            -----------------
                           I           /                /
                           I          / WRITE TO DEV   /
                           I         /       6        /
                           I        /  VIA FORMAT    /    +-----------46.02*--)*
                           I       /     210        /     I              81    I            10
                           I       -----------------      I           *---------------------*
                           I                    I         I           I       WHX =         I
                           +-----------43.05*--)I         I           I   FWT(J)*CFT(J)     I
                                     56         I    08   I           *---------------------*
                                     *--------------------*                    I
                                     I   COMPUTED GO TO   I I                  I
                                     I      FOR  LA       I I                  I             11
                                     *--------------------* I          ------------------
                                     I  80          46.13 I I         / WRITE TO DEV   /
                                     I  81          46.10 I I        /       6        /
                                     *--------------------* I       /  VIA FORMAT    /
                                                I           I      /     212        /
                                                I           I     / FROM THE LIST  /
                                     IF OUTSIDE THE RANGE   I     ------------------
                                                I           I                  I
                                                I           I                  I  NOTE  12
                                                +-----------+     * * * * * * * * * * * * *
                                                                  *  LIST = WHX, WTV     *
                                                                  * * * * * * * * * * * * *
                                                                               I
                                                                     46.08---)I
                                                                        80     I 13
                                                                          ---------
                                                                          *  EXIT  *
                                                                          ---------
```

```
DEW PT TOO HIGH
IS THIS FIRST
ITERATION

44.01*--)*
         I
   52    *    14
       *   *
     *       *
   *           *  (-/0)
 *     N - 1     *--+
   *           *    I
     *       *      I
       *   *        I
         *         ....
         I (+)    . 46 .
         I        . 08 .
         I         ....
         I          56
         I
         I
   75    *    15
       *   *
     *       *
   *           *  (-)
 *  TWTS - 9000.  *--+
   *           *    I
     *       *      I
       *   *        I
         *         ....
         I(0/+)   . 43 .
         I        . 06 .
         I         ....
         I          57
         I
         I
        ...
      .     .
      .46.08.
      .     .
        ... 56
```

f

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      DIMENSION  FWT(30),FXW(30),SWT(30)
     ,CFT(30)
      COMMON X(700),LA,NPER ,PP
     EQUIVALENCE
      (X(101),FWT(1)),(X(131),FXW(1)),(X(161),SWT(1))
     ,(X(221),CFT(1))
211  FORMAT(20H REHEATER REQUIRED  /1H F8.1,8H TAO     F8.1,8H VOL
      F8.1,8H QSENS      )
215  FORMAT(20H TEMPERATURE PINCH  /1H F8.1,8H TAO     F8.1,8H V
      F8.1,8H QCS       )
212  FORMAT(1HO'CONDENSER WEIGHTS',F8.2,8H WTHX   F8.2,8H MVALVE    )
210  FORMAT(29H  NOT OPIMIZED -TAO TOO LOW   )
```

CHART TITLE - INTRODUCTORY COMMENTS

DRY HX SUBROUTINE

CHART TITLE - SUBROUTINE SHX(QS,TCAB,TCI,WCPC,RHO,CPA,PP,J,DP,WT,PW,V,TCO,TAO)

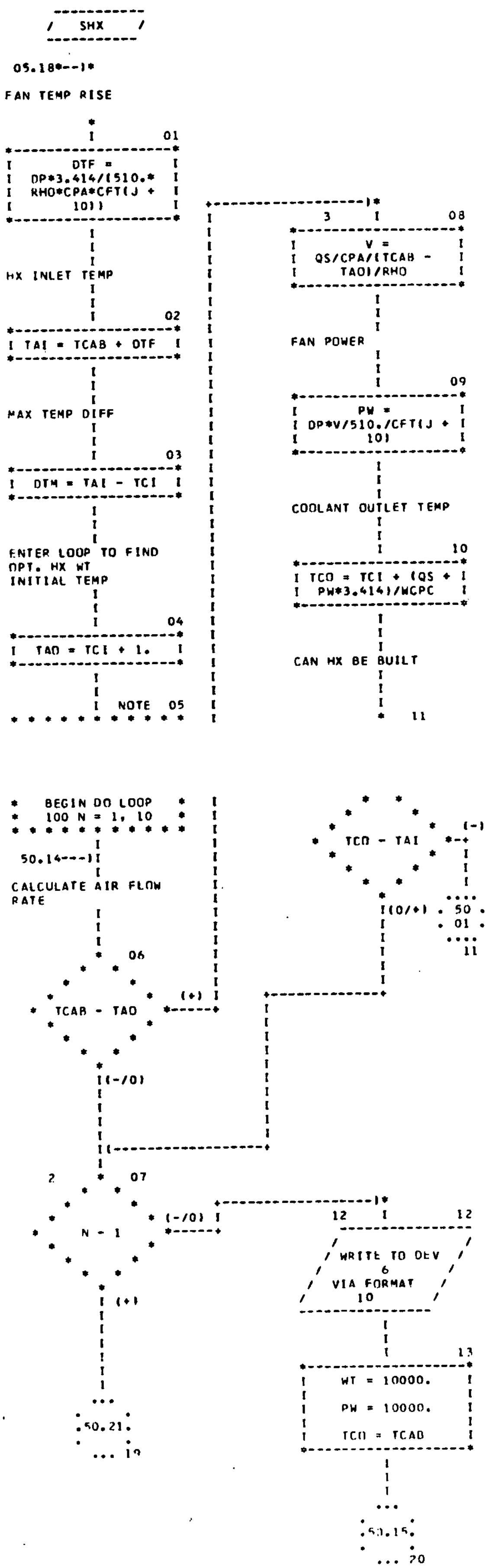

CHART TITLE - SUBROUTINE SHX(QS,TCAB,TCI,WCPC,RHO,CPA,PP,J,DP,WT,PW,V,TCO,TAO)

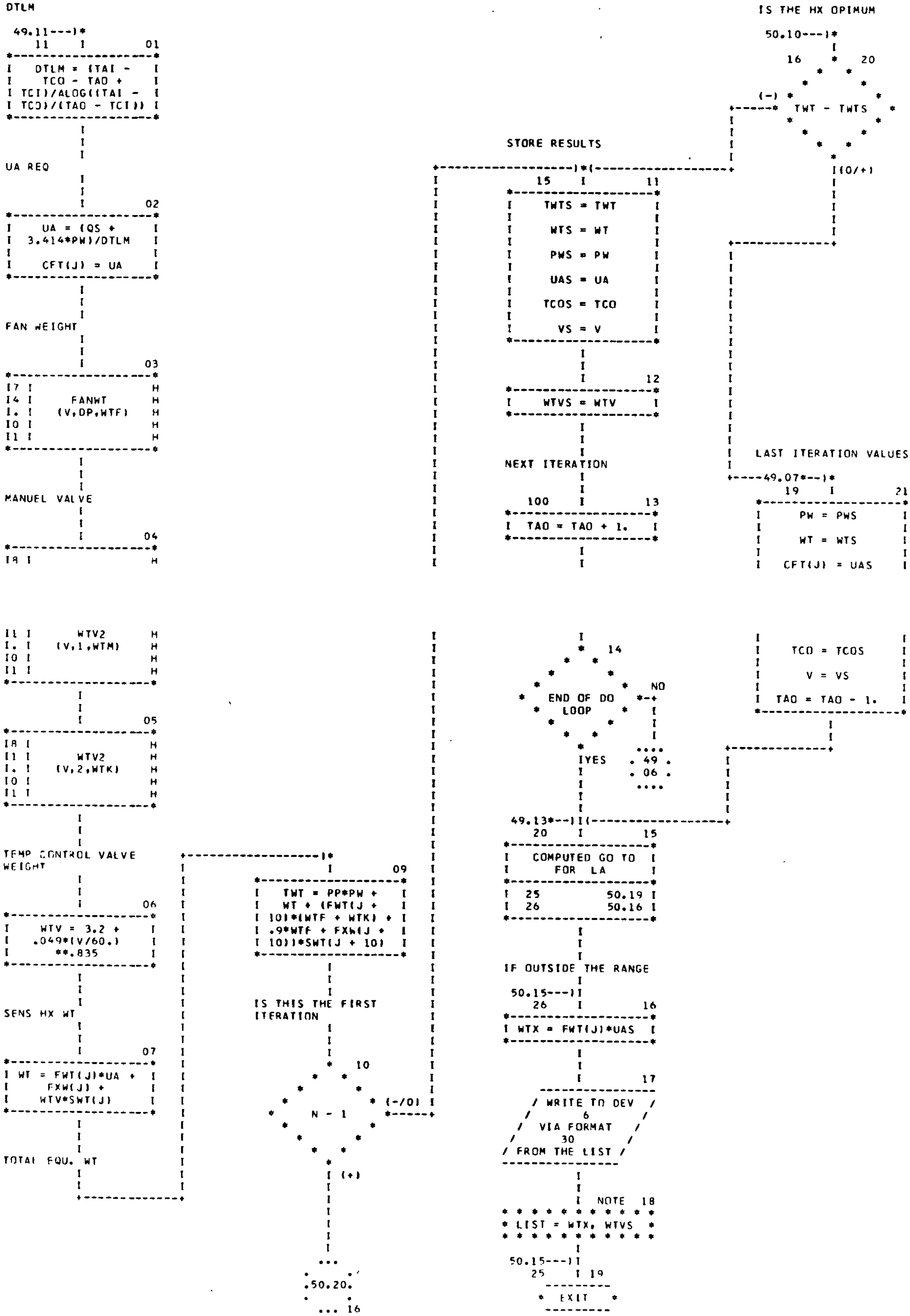

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
          DIMENSION  FWT(15),FXW(15),SWT(15)
         ,CFT(30)
          COMMON X(700),LA,NPER
         EQUIVALENCE
          (X(101),FWT(1)),(X(131),FXW(1)),(X(161),SWT(1))
         ,(X(221),CFT(1))
30       FORMAT(1H0'SENSIBLE HX ',F8.2,8H WTHX   F8.2,8H WVALVE  )
10          FORMAT(22H HX CANNOT BE BUILT   )
```

CHART TITLE - INTRODUCTORY COMMENTS

ELECTRONIC BAY COOLING SUBROUTINE

CHART TITLE - SUBROUTINE EBAY(QE,TE,TCI,WCPC,RHO,CPA,PP,DP,WTHX,WTFAN,PW,V,TCO,

```
   -----------
  /  EBAY   /
 -----------

 09.16*--)*

FAN TEMP RISE
            *
            I              01
*-------------------------*
I          DTF =           I
I  DP*3.414/(510.*         I
I  RHO*CPA*CFT(LF +        I
I          1))             I
*-------------------------*
            I
            I
            I
AIR INLET TEMP
            I
            I
            I              02
*-------------------------*
I   TAI = TE + DTF         I
*-------------------------*
            I
            I
            I
INITIAL AIR OUTLET
TEMP
            I
            I
            I              03
*-------------------------*
I   TAO = TCI + 1.         I
*-------------------------*
            I
            I
            I
OPTIMIZATION LOOP
            I
            I
            I  NOTE  04
* * * * * * * * * * * *
*    BEGIN DO LOOP     *
*    100 N = 1, 20     *
* * * * * * * * * * * *
            I
  55.04---)I
            I
CAN HX BE BUILT

            I
            I
            I
            *   05
          *   *
        *       *  (-/0)
  *   TE - TAO    *------+
        *       *        I
          *   *          I      HX CANNOT BE BUILT IS
            *            I      THIS FIRST TIME THRU
            I (+)        I      LOOP
            I            +-----------53.05*--)*
            I                            I
            I                      2     *    06
            I                          *   *
           ...                       *       *  (-/0) I
          .   .                  *     N - 1    *------+
          .53.10.                    *       *
          .   .                        *   *
           ... 3                         *
                                         I (+)
                                         I
                                         I
                                        ...
                                       .   .
                                      .55.10.
                                       .   .
                                        ... 19

FIRST TIME THRU - USE
LARGE VALUES AND
PRINT MESSAGE
  +----------------)*
            12      I              07
         ----------------------
        /                     /
       / WRITE TO DEV        /
      /       6             /
     /  VIA FORMAT         /
    /        10           /
    ----------------------
                I
                I
                I              08
*-------------------------*
I    WTHX = 10000.         I
I                          I
I    WTFAN = 10000.        I
I                          I
I    PW = 10000.           I
I                          I
I    TCO = TF              I
I                          I
I    QT = 100000.          I
*-------------------------*
                I
                I
                I              09
*-------------------------*
I    V = 10000.            I
I                          I
I    TAO = TCI             I
*-------------------------*
                I
                I
                I
               ...
              .   .
             .55.05.
              .   .
               ... 20

HX CAN BE BUILT - AIR
FLOW RATE

 53.05---)*
     3       I              10
*-------------------------*
I  V = QE/CPA/(TE -        I
I      TAO)/RHO            I
*-------------------------*
             I
             I
             I
FAN POWER
             I
             I
             I              11
*-------------------------*
I          PW =            I
I  DP*V/510./CFT(LF        I
I        + 1)              I
*-------------------------*
             I
             I
             I
TOTAL HEAT LOAD
             I
             I
             I              12
*-------------------------*
I     QT = QE +            I
I     PW*3.414             I
*-------------------------*
             I
             I
             I
COOLANT OUTLET TEMP
             I
             I
             I              13
*-------------------------*
I     TCO = TCI +          I
I     QT/WCPC              I
*-------------------------*
             I
             I
             I

CAN HX BE BUILT
             I
             I
             I
             *   14
           *   *
         *       *   (-)
   *   TCO - TAI   *--+
         *       *    I
           *   *      I
             *        I
             I(0/+)  ....
             I      . 54 .
             I      . 01 .
             I       ....
             I        11
             I
             I
            ...
           .   .
          .53.06.
           .   .
            ... 2
```

CHART TITLE - SUBROUTINE EBAY(QE,TE,TCI,WCPC,RHO,CPA,PP,DP,WTHX,WTFAN,PW,V,TCO,

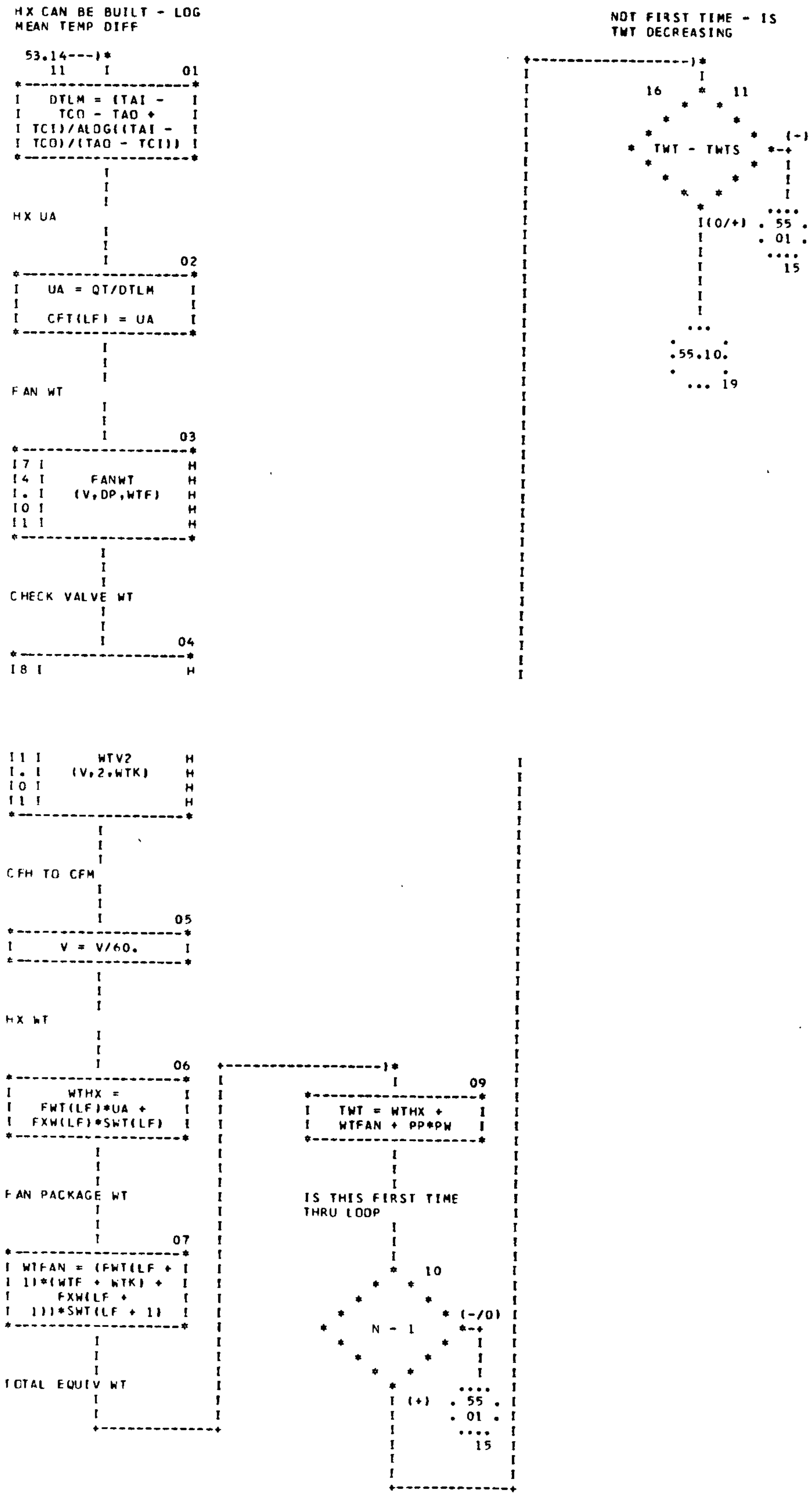

CHART TITLE - SUBROUTINE EBAY(QE,TE,TCI,WCPC,RHO,CPA,PP,OP,WTHX,WTFAN,PW,V,TCO,

```
IS FIRST TIME OR TWT                               NOT FIRST TIME THRU
DECREASING - STORE                                 OR TWT INCREASING -
VALUES                                             USE PREVIOUS VALUES

 54.10*--)*                                         53.06*--)*
   15     I           01                              19    I           10
*--------------------*                             *--------------------*
I     TWTS = TWT     I                             I      PW = PWS      I
I                    I                             I                    I
I    WTHXS = WTHX    I                             I    WTHX = WTHXS    I
I                    I                             I                    I
I      UAS = UA      I                             I    WTFAN = WTFS    I
I                    I                             I                    I
I    WTFS = WTFAN    I                             I   CFT(LF) = UAS    I
I                    I                             I                    I
I      WFS = WTF     I                             I     TCO = TCOS     I
I                    I                             I                    I
I      WKS = WTK     I                             I      QT = QTS      I
*--------------------*                             *--------------------*
          I                                                  I
          I                                                  I
          I           02                                     I           11
*--------------------*                             *--------------------*
I      PWS = PW      I                             I       V = VS       I
I                    I                             I                    I
I     TCOS = TCO     I                             I  TAO = TAO - 2.    I
I                    I                             *--------------------*
I      QTS = QT      I                                       I
I                    I                                       I
I       VS = V       I                                       I
*--------------------*                                      ...
          I                                               .     .
          I                                               .55.05.
          I                                               .     .
END LOOP - STEP AIR                                         ... 20
OUTLET TEMP
          I
          I
   100    I           03
*--------------------*
I  TAO = TAO + 2.    I
*--------------------*
          I
          I
          I
          *    04


        *     *
     *           *
   *               *   NO
 *    END OF DO     *--+
   *    LOOP       *   I
     *           *     I
        *     *        I
           *          ....
          IYES        . 53 .
          I           . 05 .
          I           ....
          I
          I
 53.09*--)I
   20     I           05
*--------------------*
I   COMPUTED GO TO   I
I       FOR  LA      I
*--------------------*
I  21          55.09 I
I  22          55.06 I
*--------------------*
          I
          I
          I
IF OUTSIDE THE RANGE
          I
 55.05---)I
   22     I           06
*--------------------*
I WTX = FWT(LF)*UAS  I
*--------------------*
          I
          I
          I           07
      ----------------
     / WRITE TO DEV  /
    /      6        /
   /  VIA FORMAT   /
  /      23       /
 / FROM THE LIST /
----------------
          I
          I
          +--------------------------------)*
                                           I  NOTE  08
                              * * * * * * * * * * * *
                              * LIST = WTX, WFS,    *
                              *        WKS          *
                              * * * * * * * * * * * *
                                           I
                               55.05---)I
                                  21    I 09
                                     ---------
                                     * EXIT  *
                                     ---------
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
         DIMENSION FWT(30),FXW(30),SWT(30)
         ,CFT(30)
          COMMON X(700),LA,NPER
         EQUIVALENCE (X(101),FWT(1)),(X(131),FXW(1)),(X(161),SWT(1))
         ,(X(221),CFT(1))
23       FORMAT(1HO'AVIONICS BAY ',F8.2,8H WTHX   F8.2,8H WTFAN  F8.2,8H WT
         CK    )
10       FORMAT(22H HX CANNOT BE BUILT    )
```

CHART TITLE - INTRODUCTORY COMMENTS

HSC ROUTINE

CHART TITLE - SUBROUTINE HSC(WCO2,QLAT,DAY,RHO,PVI,PD,L,WT,PW,V,WB,WU,VCH,WF)

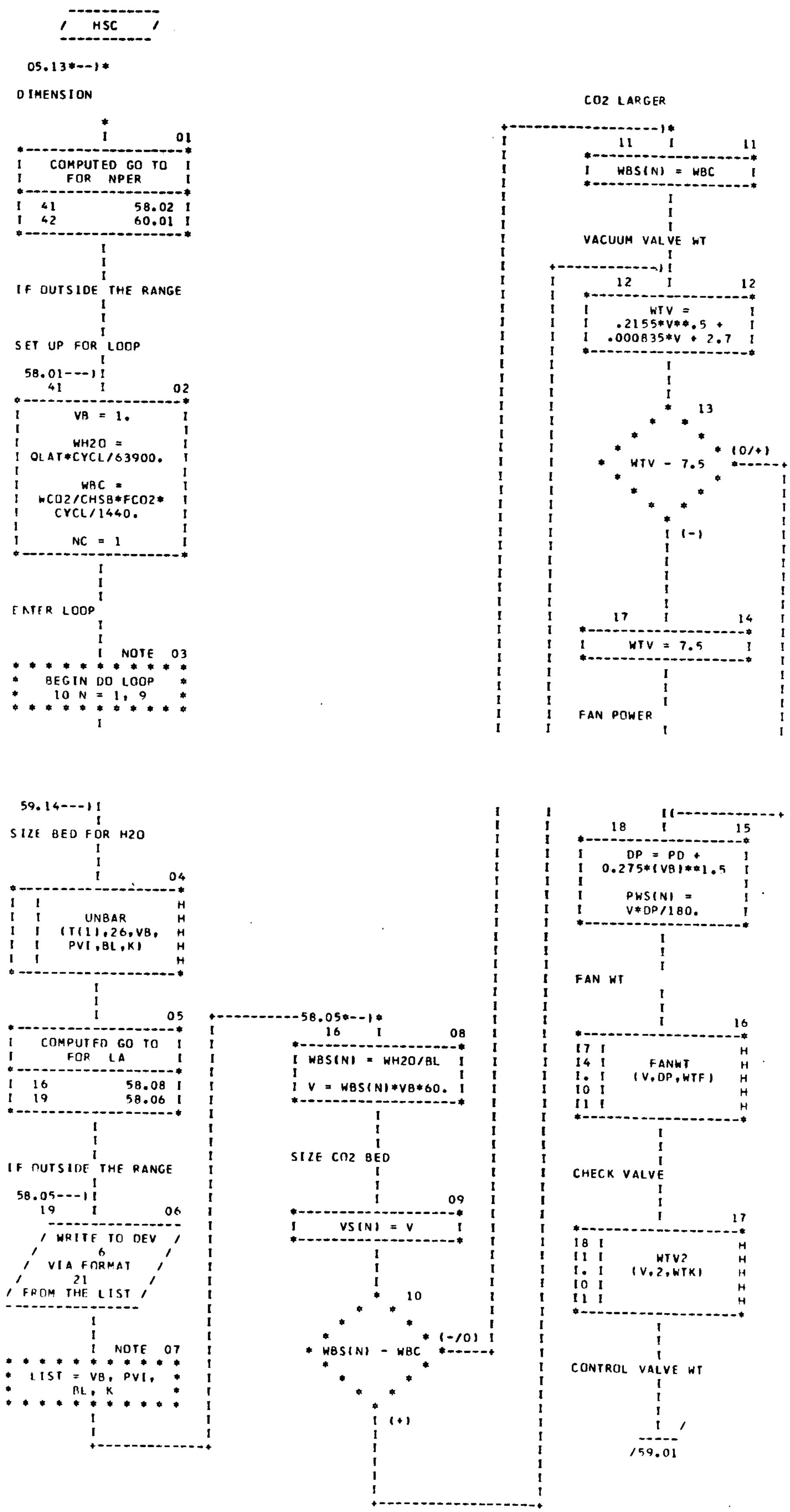

CHART TITLE - SUBROUTINE HSC(WCO2,QLAT,DAY,RHO,PVI,PD,L,WT,PW,V,WB,WU,VCH,WF)

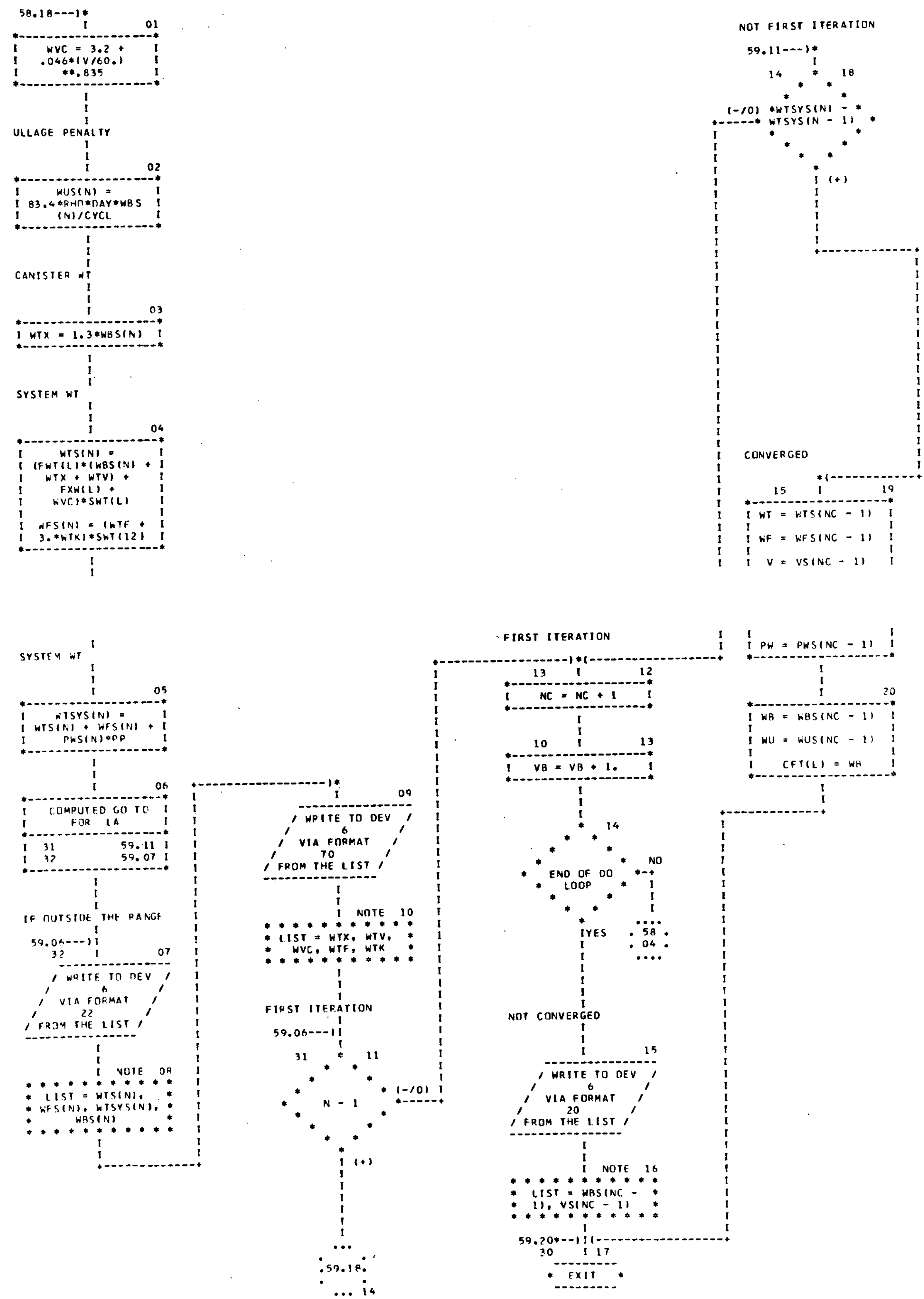

CHART TITLE - SUBROUTINE HSC(WCO2,QLAT,DAY,RHO,PVI,PD,L,WT,PW,V,WB,WU,VCH,WF)

```
 OFF DESIGN                              H2O NOT
                                         CONVERGED-SHOULD AIR
  58.01---)*                             BE BYPASSED
   42    I           01
*-------------------*     *-----------------)*
I       WH2O =      I     I                  I
I  QLAT*CYCL/63900. I     I        43        *     06
I                   I     I               *     *
I     WB = CFT(L)   I     I            *           *
I                   I     I      (0) *                 *   (-)
I     VB = V/WB/60. I     I      +-* WH2OC  -  WH2O   *------+
I                   I     I      I   *                 *     I
I      VBM = VB     I     I      I      *           *        I        UP CABIN DEWPOINT-IS
*-------------------*     I      I         *     *           I        FLOW AT MAX FLOW RATE
          I               I     ....          *              I
          I               I    . 61 .         I (+)          +------------------)*
          I               I    . 05 .         I                                 I
 ENTER LOOP TO FIND       I     ....          I                       44        *     07
 AIR FLOW REQUIRED FOR    I     50            I                              *     *
 HUMIDITY CONTROL         I                   I                           *           *
          I               I                   I                        *                 *  (-)
          I               I                   I                      *     VB  -  VBM      *-+
          I  NOTE  02     I                   I                        *                 *   I
* * * * * * * * * * * *   I                  ...                          *           *      I
*    BEGIN DO LOOP    *   I                 .   .                            *     *         I
*    47 N = 1, 15     *   I                 .61.01.                             *           ....
* * * * * * * * * * * *   I                 .   .                               I(0/+)    . 61 .
          I               I                  ... 45                             I         . 01 .
 61.02---)I               I                                                     I          ....
          I               I                                                     I           45
 FIND WATER LOADING       I                                                     I
          I               I                                                     I
          I               I                                          46         I          08
          I          03   I                                       *-------------------------*
*--------------------*    I                                       I         PVI =           I
I  I                 H    I                                       I  PVI*(WH2O/WH2OC)       I
I  I      UNBAR      H    I                                       *-------------------------*
I  I  (T(1),26,VB,   H    I                                                     I
I  I   PVI,BL,K)     H    I                                                     I
I  I                 H    I                                                     I
*--------------------*    I                                                    ...
          I               I                                                   .   .
          I               I                                                   .61.02.
          I               I                                                   .   .
 H2O REMOVED              I                                                    ... 47
          I               I


          I               I
          I          04   I
*--------------------*    I
I    WH2OC = WB*BL   I    I
*--------------------*    I
          I               I
          I               I
          I               I
 IS WATER WITHIN          I
 TOLERENCE                I
          I               I
          I               I
          I               I
          *    05         I
       *     *            I
    *           *         I
  *               * (-/0) I
*  ABS(WH2OC -    *-+     I
  *WH2O) - .05*     I     I
    *           *   I     I
       *     *      I     I
          *        ....   I
          I (+)   . 61 .  I
          I       . 05 .  I
          I        ....   I
          I         50    I
          I               I
          I               I
          +---------------+
```

G

CHART TITLE - SUBROUTINE HSC(WCO2,QLAT,DAY,RHO,PVI,PD,L,WT,PW,V,WB,WU,VCH,WF)

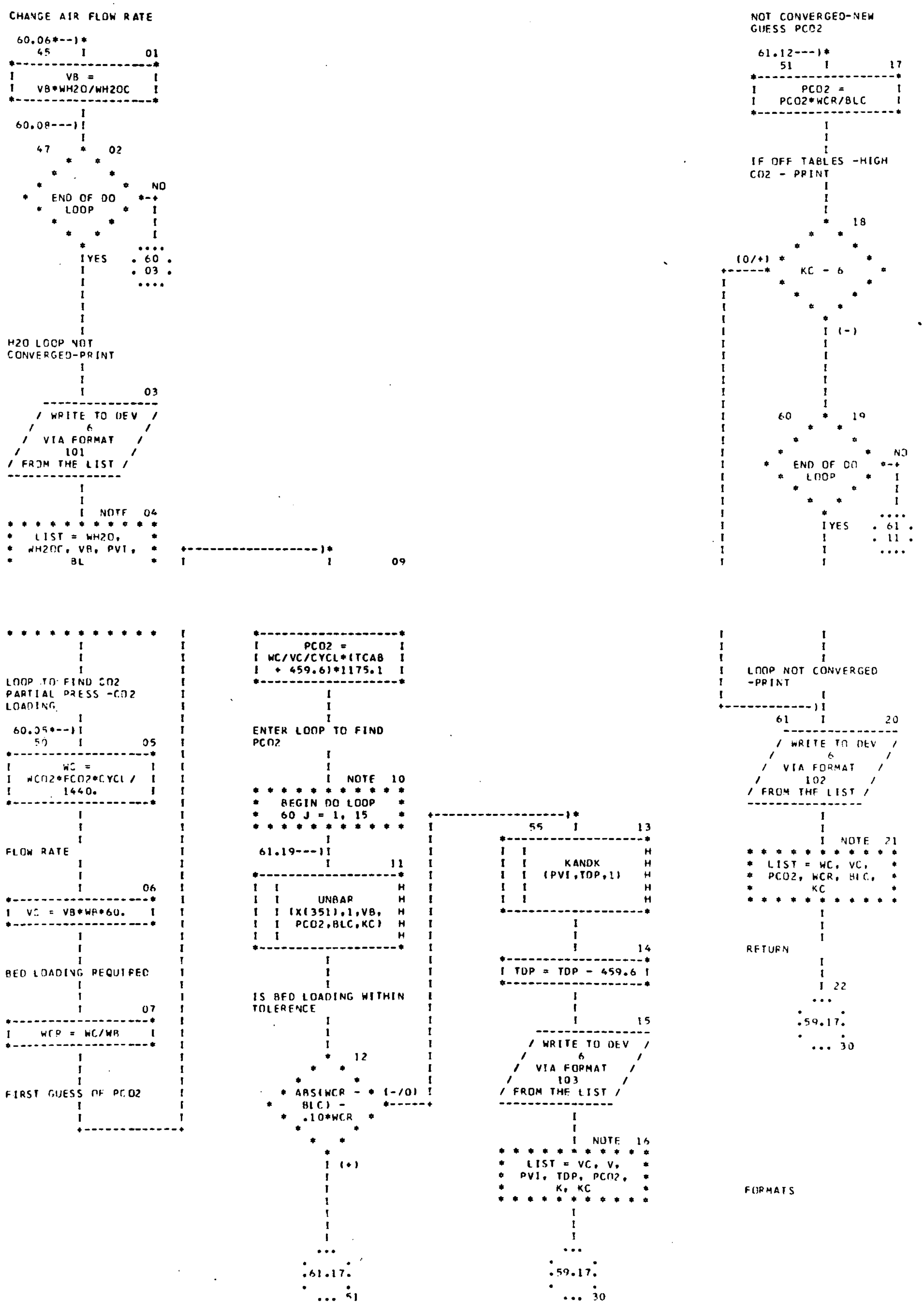

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      DIMENSION  FWT(30),FXW(30),SWT(30)
       ,PWS(10),WTS(10),WBS(10),WUS(10),WFS(10),VS(10),WTSYS(10)
      ,T(100),CFT(30)
       COMMON X(700),LA,NPER,PP
      EQUIVALENCE
       (X(101),FWT(1)),(X(131),FXW(1)),(X(161),SWT(1)),(X(63 ),CHSB)
      ,(X(64 ),EH2O  ),(X(60),FCO2 ),(X(65),CYCL)
      ,(X(401),T(1)),(X(1),TCAB),(X(221),CFT(1))
21    FORMAT(14H BED LOADING  3F10.3,I2   )
70    FORMAT(1H F8.2,8H WTCAN  F8.2,8H WVVAL  F8.2,8H WCVAL  F8.2,8H WTF
      AN  F8.2,8H WKVAL    )
22    FORMAT(1H  6F10.2)
101   FORMAT(1HO'HSC WATER LOOP NOT CONVERGED'/1H F8.2,8H WH2O   F8.2,8H
       WH2OC  F8.2,8H VOLF   F8.4,8H PVI    F6.4,8H BEDLD     )
102   FORMAT(1HO'CO2 LOOP NOT CONVERGED'/1H F8.3,8H WCO2CY F8.1,8H FLOW
        F8.3,8H PCO2   F8.3,8H BLOADR F8.3,8H BLOADC I3,8H OFFTAB  )
103   FORMAT(1HO'HSC PERFORMANCE '/1H F8.1,8H VREQ   F8.1,8H VAVAIL F8.4
      ,8H PVI    F8.2,8H TDEWPT F8.3,8H PCO2   I2,I2,8H OFFTAB  )
20    FORMAT(19H NOT CONVERGED HSC / 2F8.2  )
```

CHART TITLE - SUBROUTINE CONT(J,DP,DAY,WT,V,QSC)

```
                 -----------
                /   CONT    /
                -----------

              03.05---)*
              VOL  FLOW RATE

                     *
                     I          01
              *--------------------*
              I   V = WCO2*300.    I
              *--------------------*
                     I
                     I
                     I
              BED WEIGHT
                     I
                     I
                     I          02
              *--------------------*
              I       WTB =        I
              I   DAY*WCO2*.118    I
              *--------------------*
                     I
                     I
                     I
              VALVE WEIGHT
                     I
                     I
                     I          03
              *--------------------*
              I8 I                 H
              I1 I       WTV2      H
              I. I    (V,2,WTV)    H
              I0 I                 H
              I1 I                 H
              *--------------------*
                     I
                     I
                     I
              TOTAL WT
                     I
                     I
                     I          04
              *--------------------*
              I       WT =         I
              I   (WTB*FWT(J) +    I
              I       WTV +        I
              I  FXW(J))*SWT(J)    I
              *--------------------*
                     I



                     I
                     I
              FAN HEAT LOAD
                     I
                     I
                     I          05
              *--------------------*
              I     QSC = 0.       I
              *--------------------*
                     I
                     I
                     I 06
                 ---------
                 *  EXIT  *
                 ---------
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
DIMENSION FWT(15),FXW(15),SWT(15)
,CFT(30)
 COMMON X(700),LA,NPER,PP
 EQUIVALENCE
 (X(101),FWT(1)),(X(131),FXW(1)),(X(161),SWT(1))
,(X(221),CFT(1)),(X(10),WCO2)
```

CHART TITLE - INTRODUCTORY COMMENTS

DOUBLE ELECTRONIC BAY COOLING SUBROUTINE

CHART TITLE - SUBROUTINE EBAY2(QB1,QB2,TE,TCI,WCPC,RHO,CPA,PP,DP,WTHX,WTFAN,PW,

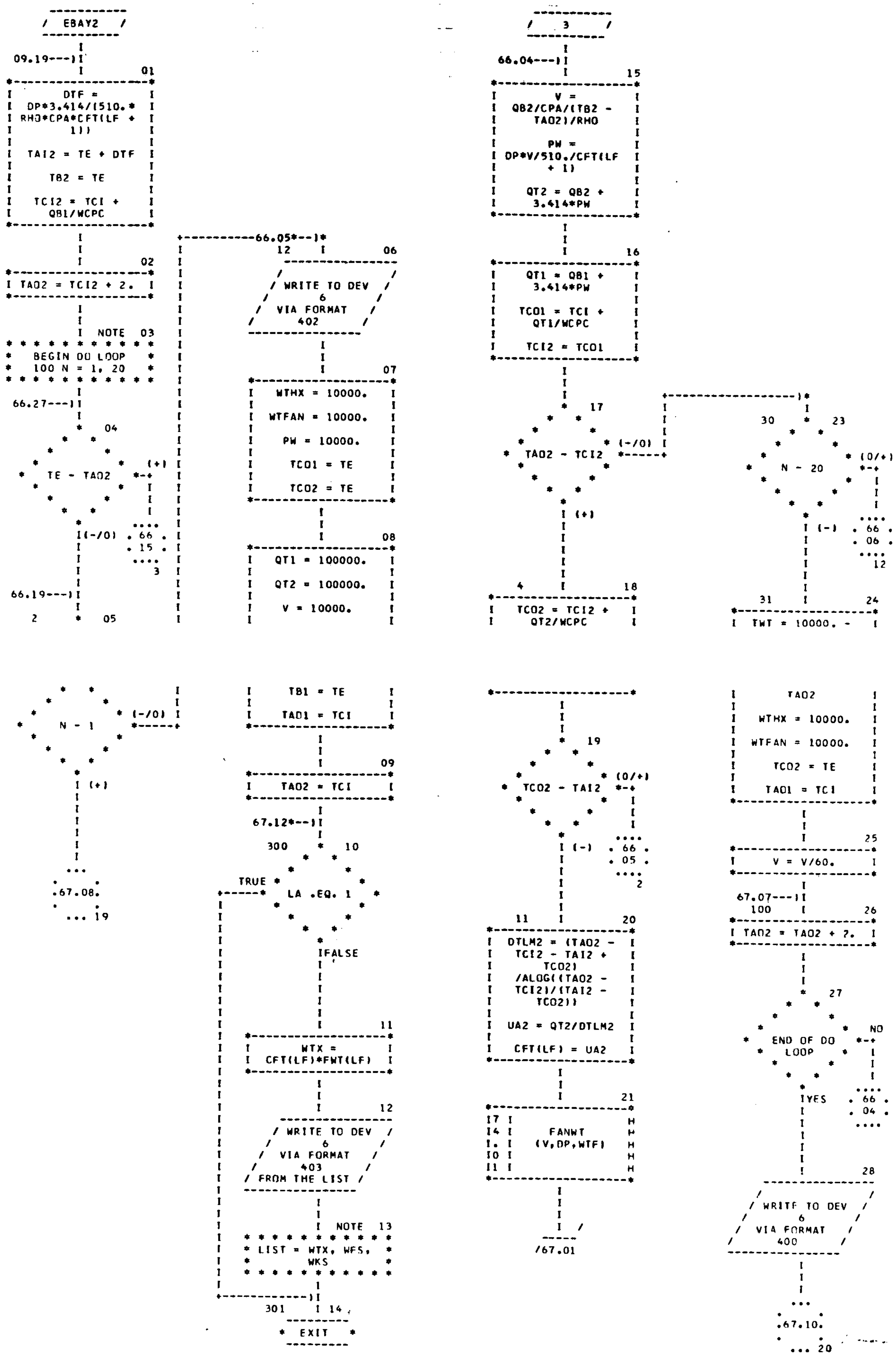

CHART TITLE - SUBROUTINE EBAY2(QB1,QB2,TE,TCI,WCPC,RHO,CPA,PP,DP,WTHX,WTFAN,PW,

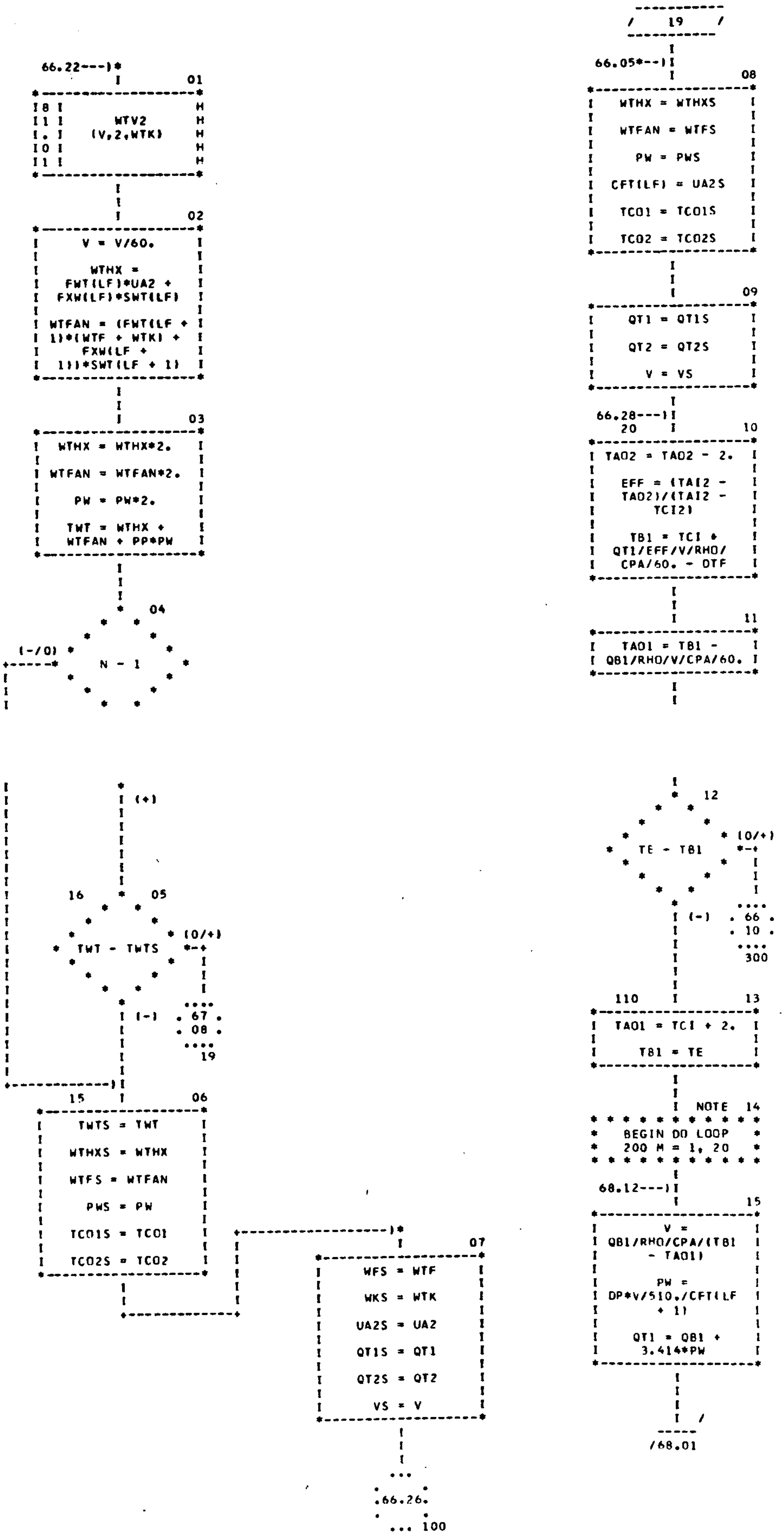

CHART TITLE - SUBROUTINE EBAY2(QB1,QB2,TE,TCI,WCPC,RHO,CPA,PP,DP,WTHX,WTFAN,PW,

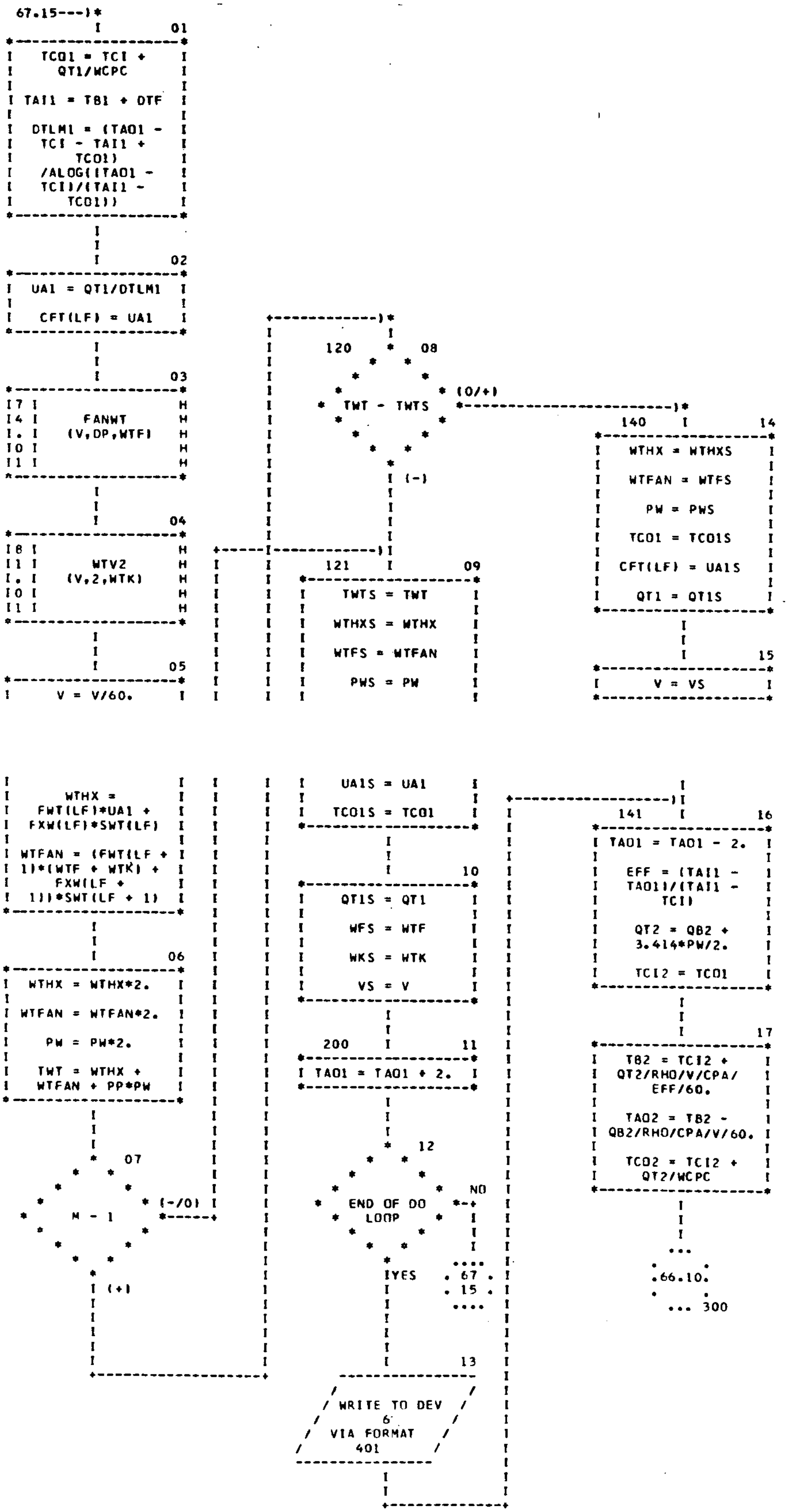

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
          DIMENSION FWT(30),FXW(30),SWT(30)
          ,CFT(30)
           COMMON X(700),LA,NPER
          EQUIVALENCE (X(101),FWT(1)),(X(131),FXW(1)),(X(161),SWT(1))
          ,(X(221),CFT(1))
403       FORMAT(1H 'DOUBLE EBAY ',F8.2,' WTHX ',F8.2,' WTFAN ',F8.2,' WTKV
           ' )
400       FORMAT(22H EBAY2 NOT OPTIMIZED   )
401       FORMAT(22H EBAY1 NOT OPTIMIZED   )
402       FORMAT(26H EBAY HX CANNOT BE BUILT   )
```

CHART TITLE - INTRODUCTORY COMMENTS

FLASH EVAP SUBROUTINE

CHART TITLE - SUBROUTINE FEVAP(Q,WCP,TCI,L,TCO,WT)

```
                   ------------
                   / FEVAP    /
                   ------------

             11.21*--)*

             SIZING OR PERFORMANCE

                        *
                        I            01
             *--------------------*
             I   COMPUTED GO TO   I
             I      FOR NPER      I
             *--------------------*
             I 10           71.02 I
             I 11           72.04 I
             I 11           72.04 I
             *--------------------*
                        I
                        I
                        I
             IF OUTSIDE THE RANGE
                        I
                        I
                        I
             SIZING-COOLANT OUTLET
             TEMP
                        I
              71.01---)I                    TOO  LOW
                 10     I            02
             *--------------------*   *------------------)*
             I TCO = TCI - Q/WCP  I   I             12    I            04
             *--------------------*   I          *--------------------*
                        I             I          I      TCO = 34.     I
                        I             I          *--------------------*
                        I             I                    I
             IS OUTLET  TEMP TOO      I                    I
             LOW                      I                    I
                        I             I          HEAT LOAD
                        I             I                    I
                        I             I      *-----------)I
                        *    03       I      I      13    I            05
                     *     *          I      I   *--------------------*
                  *           *       I      I   I  QR = WCP*(TCI -   I
               *                 *  (-) I    I   I       TCO)         I
            *     TCO - 34.        *------*  I   *--------------------*
               *                 *           I             I
                  *           *              I             I
                     *     *                 I             I
                        *                    I   UA REQUIRED
                        I(0/+)               I             I
                        I                    I             I


                        I                    I             I            06
                        I                    I   *--------------------*
                        I                    I   I      CFT(L) =      I
                        I                    I   I  QR/(TCO - 30.)    I
                        *--------------------*   *--------------------*
                                                           I
                                                           I
                                                           I
                                                 WEIGHT
                                                           I
                                                           I
                                                           I            07
                                                 *--------------------*
                                                 I        WT =        I
                                                 I (FWT(L)*CFT(L) +   I
                                                 I  FXW(L))*SWT(L)    I
                                                 *--------------------*
                                                           I
                                                           I
                                                           I
                                                 WATER USAGE RATE
                                                           I
                                                           I
                                                           I            08
                                                 *--------------------*
                                                 I  WH2O = QR/965.    I
                                                 *--------------------*
                                                           I
                                                           I
                                                           I
                                                 IS THIS THE LAST
                                                 ITERATION
                                                           I
                                                           I
                                                           I
                                                           *    09
                                                        *     *
                                                     *           *
                                                  *                 * (-/0)
                                               *       LA - 1         *-+
                                                  *                 *   I
                                                     *           *      I
                                                        *     *         I
                                                           *           ....
                                                           I (+)      . 72 .
                                                           I          . 03 .
                                                           I           ....
                                                           I            14
                                                           I
                                                           I
                                                           I
                                                          ...
                                                         .   .
                                                        .72.01.
                                                         .   .
                                                          ... 15
```

CHART TITLE - SUBROUTINE FEVAP(Q,WCP,TCI,L,TCO,WT)

```
LAST ITERATION-PRINT

 71.09---)*
   15    I          01
   ----------------
  / WRITE TO DEV  /
 /       6       /
/  VIA FORMAT   /
      51
/ FROM THE LIST /
----------------
         I
         I
         I  NOTE  02
* * * * * * * * * * *
*  LIST = QR, TCI,  *
*   TCO, WH2O, WT   *
* * * * * * * * * * *
         I
 71.09*--)I
   14    I 03
     ---------
     *  EXIT  *
     ---------


PERFORMANCE -MINIMUM
OUTLET TEMP

 71.01*--)*
   11    I          04
*-------------------*
I   TOMIN = 30. +   I
I      Q/CFT(L)     I
*-------------------*
         I
         I

         I
IS TEMP TOO  LOW
         I
         I
         *  05
      *     *
   *           *    (-)
*  TOMIN - 34.   *-----+
   *           *       I          TOO LOW
      *     *          I
         *             +------------------)*
         I(0/+)                 16    I         06
         I                    *-------------------*
         I                    I   TOMIN = 34.     I
         I                    *-------------------*
         I                              I
         I                              I
         I                              I
         +-------------+      MAXIMUM OUTLET TEMP
                       I                I
                       +------------------)I
                                17     I        07
                              *-------------------*
                              I  TOMAX = TCI -    I
                              I       Q/WCP       I
                              *-------------------*
                                        I
                                        I
                                        I
                              USE LIMITING TEMP
                                        I
                                        I
                                        *  08
                                     *     *
                                  *           *  (-/0)
                              * TOMAX - TOMIN  *------+
                                  *           *       I
                                     *     *          I     USE MIN TEMP
                                        *             +-------------------)*
                                        I (+)                   19    I         09
                                        I                     *-------------------*
                                        I                     I   TCO = TOMIN     I
                                        I                     *-------------------*
                                        I                               I
                                        I                               I
                                       ...                              +--------------+
                                     .72.10.
                                       ... 18


USE MAX TEMP

 72.08---)*
   18    I          10
*-------------------*
I   TCO = TOMAX     I
*-------------------*
         I
         I
         I
HEAT LOAD REJECTED
         I
---------)I
   20    I          11
*-------------------*
I  QR = WCP*(TCI -  I
I       TCO)        I
*-------------------*
         I
         I
         I
WATER  USED
         I
         I
         I          12
*-------------------*
I      WH2O =       I
I   QR/965.*TSUB    I
*-------------------*
         I
         I
         I
PRINT
         I
         I
         I          13
   ----------------
  / WRITE TO DEV  /
 /       6       /
/  VIA FORMAT   /
      52
/ FROM THE LIST /
----------------
         I
         I
         I  NOTE  14

* * * * * * * * * * *
*  LIST = QR, TCI,  *
*    TCO, TOMAX,    *
*    TOMIN, WH2O    *
* * * * * * * * * * *
         I
         I
         I
RETURN
         I
         I
         I 15
        ...
      .72.03.
        ... 14


FORMATS
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      DIMENSION  FWT(30),FXW(30),SWT(30),CFT(30)
       COMMON X(700),LA,NPER,PP
      EQUIVALENCE
      (X(101),FWT(1)),(X(131),FXW(1)),(X(161),SWT(1)),(X(221),CFT(1))
      ,(X(100),PERF ),(X( 74),TSUB  )
51    FORMAT(1HO'FLASH EVAPORATOR  SIZE '/1H F8.1,8H QREJ   F8.2,8H TCIN
         F8.2,8H TCOUT  F8.1,8H WH2O   F8.2,8H WEIGHT  )
52    FORMAT(1HO'FLASH EVAPORATOR PERFORMANCE'/1H F8.1,8H QREJ   F8.2,8H
       TCIN   F8.2,8H TCOUT  F8.2,8H TOMAX  F8.2,8H TOMIN  F8.1,8H WH2O
        )
```

CHART TITLE - SUBROUTINE FANWT(CFH,DP,WT)

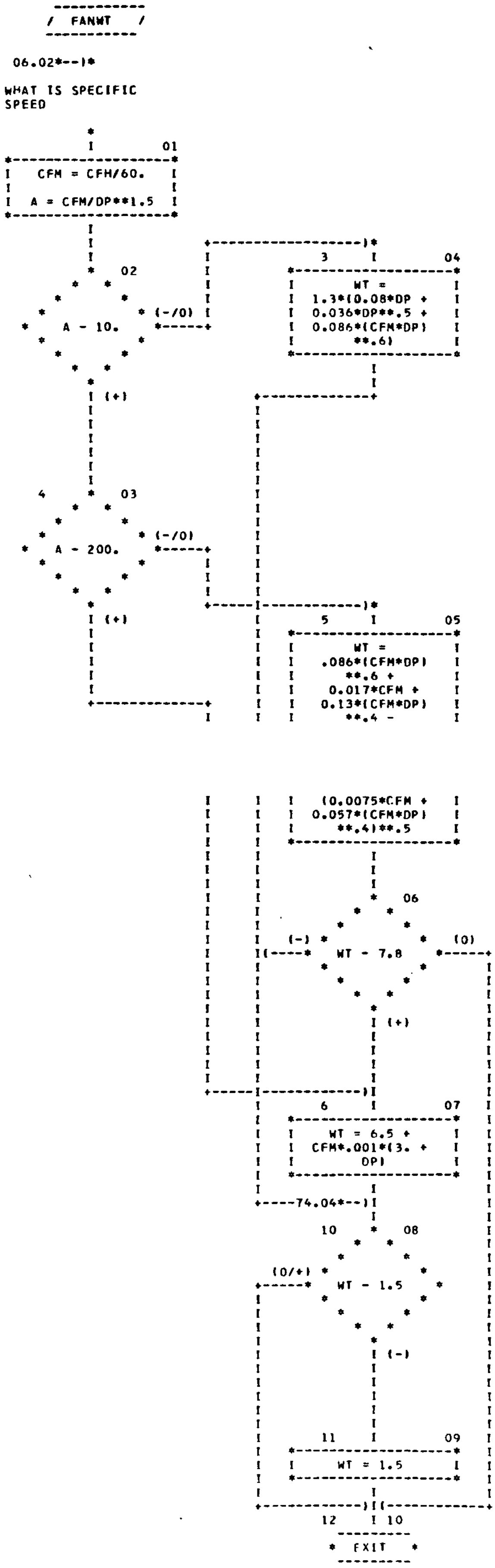

CHART TITLE - INTRODUCTORY COMMENTS

CRYOGENIC HX SUBROUTINE

CHART TITLE - SUBROUTINE CRY(Q,WH,TIN,NC,WH2)

```
        -----------
        /  CRY    /
        -----------

 23.03*--)*

OUTLET HOT TEMP

          *
          I          01
*--------------------*
I THO = TIN - Q/WH   I
*--------------------*
          I
          I
          I
FIRST GUESS OF H2
FLOW RATE-OUTLET TEMP
          I
          I
          I          02
*--------------------*
I  TH2O = (TIN +     I
I     THO)/2.        I
*--------------------*
          I
          I
          I
ENTER LOOP
          I
          I
          I  NOTE  03
* * * * * * * * * * * *
*   BEGIN DO LOOP     *
*   10 N = 1, 10      *
* * * * * * * * * * * *
          I
 76.13---)I
          I
FLOW RATE-MASS
          I
          I
          I          04
*--------------------*
I  WC = Q/(TH2O +    I
I     420.)          I
*--------------------*
          I
          I
          I
CALL HX SUB
          I

          I
          I          05
*--------------------*
I7 I                 H
I9 I      HX         H
I. I  (Q,WH,WC, -    H
I0 I  420.,NC,TOC)   H
I1 I                 H
*--------------------*
          I
          I
          I
IS TEMP CONVERGED
          I
          I
          I
          *   06
        *   *
      *       *
    *           * (-/0)
  *  ABS(THO -    *------+
    * TOC) - 3. *
      *       *
        *   *
          *
          I (+)
          I
          I
          I
          I
          I
         ...
        .76.12.
         ... 3


NO -H2 OUTLET TEMP

 76.06---)*
     3    I          12
*--------------------*
I   TH2O = TH2O -    I
I     TOC + THO      I
*--------------------*
          I
          I
          I
    10    *   13
        *   *
      *       *
    *           *    NO
  *   END OF DO   *--+
    *   LOOP    *    I
      *       *      I
        *   *        I
          *        ....
          IYES    . 76 .
          I       . 04 .
          I        ....
          I
          I
          I
          I
NOT CONVERGED
          I
          I
          I          14
    ----------------
   / WRITE TO DEV  /
  /       6       /
 /   VIA FORMAT  /
/       50      /
/ FROM THE LIST /
----------------
          I
          I
          I  NOTE  15
* * * * * * * * * * * *
* LIST = THO, TOC,    *
*   WC, Q, TIN        *
* * * * * * * * * * * *
          I

          I
+---------+
I
I

CONVERGED PRINT

+----------------)*
     2    I          07
*--------------------*
I   WH2 = WC/3.12    I
*--------------------*
          I
          I
          I
IS THIS LAST
ITERATION
          I
          I
          I          08
*--------------------*
I   COMPUTED GO TO   I
I      FOR  LA       I
*--------------------*
I  20        76.11   I
I  4         76.09   I
*--------------------*
          I
          I
          I
IF OUTSIDE THE RANGE
          I
          I
PRINT
          I
 76.08---)I
     4    I          09
    ----------------
   / WRITE TO DEV  /
  /       6       /
 /   VIA FORMAT  /
/       51      /
/ FROM THE LIST /
----------------
          I
          I
          I  NOTE  10
* * * * * * * * * * * *
* LIST = TOC, WH2,    *
*      TH2O           *
* * * * * * * * * * * *
          I
 76.08*--))(-------------------+
    20    I 11
      ---------
      *  EXIT  *
      ---------
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      DIMENSION CFT(30)
       COMMON X(700),LA,NPER,PP
      EQUIVALENCE (X(221),CFT(1))
50    FORMAT(1H0'CRYOGENIC HX NOT CONVERGED'/1H F8.2,8H THO    F8.2,8H T
      HOC   F8.2,8H WH2CP  F8.2,8H OCRY   F8.2,8H TIN     )
51    FORMAT(1H0'CRYOGENIC HX PERFORMANCE'/1H F8.2,8H THOTCAL F8.2,8H WH
      YO   F8.2,8H THYDO     )
```

CHART TITLE - INTRODUCTORY COMMENTS

HX OFF DESIGN PERFORMANCE -SENS HXS

CHART TITLE - SUBROUTINE HX(Q,WH,WC,TCI,NCOMP,THO)

```
           ------------
          /    HX    /
           ------------

      24.02*---)*

      IS THE MFR =1                                                MASS FLOW RATIO =1

                 *                                                  79.02---)*
                 I          01                                        23    I        06
      *---------------------*                                      *---------------------*
      I      R = WC/WH      I                                      I    THO = TCI +      I
      *---------------------*                                      I    Q/CFT(NCOMP)     I
                 I                                                 *---------------------*
                 I                                                          I
                 I                                                          I
                 *     02                                     *-------------*
              *     *                                         I
           *           *  (-/+)                               I
        *     R - 1.     *-------*                            I
           *           *         I                            I
              *     *            I      MFR NOT 1             I
                 *               I                            I
                 I (0)           *---------------------)*     I
                 I                          22    I      03   I
                 I                         *----------------* I
                 I                         I   EFF = (1. -  I I
                 I                         I   EXP((R -     I I
                 I                         I 1.)/R*CFT(NCOMP) I
                 I                         I  /WH))/(1./R - I I
                ...                        I   EXP((R -     I I
              .     .                      I 1.)/R*CFT(NCOMP) I
              .79.06.                      I      /WH))     I I
              .     .                      *----------------* I
                ... 23                            I           I
                                                  I           I
                                                  I           I
                                           HOT OUTLET TEMP    I
                                                  I           I
                                                  I           I
                                                  I      04   I
                                           *----------------* I
                                           I   THO = TCI +  I I
                                           I Q/WH*(1./EFF - I I
                                           I      1.)       I I
                                           *----------------* I
                                                  I           I
                                                  I(----------*
                                             30   I 05
                                               ----------
                                             *   EXIT   *
                                               ----------
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
DIMENSION CFT(30)
 COMMON X(700),LA,NPER,PP
EQUIVALENCE (X(221),CFT(1))
```

CHART TITLE - SUBROUTINE WTV2(V,N,WT)

```
     ------------
    /  WTV2    /
   ------------
         I
 06.07*--)I
         I              01
*--------------------*              MANUAL VALVES
I  COMPUTED GO TO    I
I     FOR  N         I              81.01---)*
*--------------------*                 3     I             08
I  3          81.08  I              *--------------------*
I  4          81.11  I              I WT = .0229*V**.56  I
I  11         81.02  I              *--------------------*
I  12         81.05  I                       I
*--------------------*                       I
         I                                   I
         I                                   *   09
         I                                *     *
IF OUTSIDE THE RANGE                   *           *
         I                   (0/+) *                 *
 81.01---)I               +-----*       WT - 1.       *
   11    I          02    I        *                 *
*--------------------*    I          *           *
I       WT =         I    I             *     *
I   .0768*V**.489    I    I                *
*--------------------*    I                I (-)
         I                I                I
         I                I                I
         *   03           I                I
      *     *             I                I
   *           *          I                I
 *               * (0/+)  I      5         I          10
*    WT - 2.2     *-----+ I     *--------------------*
 *               *      I I     I       WT = 1.      I
   *           *        I I     *--------------------*
      *     *           I I                I
         *              I I                I
         I (-)          I I(---------------+
         I              I I
         I              I I
         I              I I
   14    I         04   I I
*--------------------*  I I
I      WT = 2.2      I  I I
*--------------------*  I I
         I              I I
         I              I I
         +-------------)I I
                        I I

                        I I
                        I I     CHECK VALVES
                        I I
                        I I      81.01---)*
                        I I        4      I           11
                        I I     *--------------------*
                        I I     I       WT =         I
                        I I     I   .00275*V**.606   I
   ------------         I I     *--------------------*
  /    12    /          I I               I
 ------------           I I               I
         I              I I               I
 81.01---)I             I I               *   12
         I         05   I I            *     *
*--------------------*  I I         *           *
I       WT =         I  I I (0/+) *               *
I   .0053*V**.725    I  I I(----*     WT - .2      *
*--------------------*  I I       *               *
         I              I I         *           *
         I              I I            *     *
         *   06         I I               *
      *     *           I I               I (-)
   *           *        I I               I
 *               * (0/+)I I               I
*     WT - .2     *----)I I               I
 *               *      I I               I
   *           *        I I     6         I          13
      *     *           I I     *--------------------*
         *              I I     I      WT = 0.2      I
         I (-)          I I     *--------------------*
         I              I V               I
         I              +-----------81.03*--)I
         I              A            10    I 14
         I              I               ---------
         I              I              *  EXIT   *
   15    I          07  I               ---------
*--------------------*  I
I      WT = .2       I  I
*--------------------*  I
         I              I
         I              I
         +--------------+
```

CHART TITLE - SUBROUTINE RAD(T1,T2,WCP,WR,AR,WE,TY,J)

```
                 -----------
                /   RAD    /
                -----------

             13.04*--)*

            SET INITIAL VALUES

                         *
                         I          02
            *--------------------*
            I   COMPUTED GO TO   I
            I     FOR  NPER      I
            *--------------------*
            I  60          82.03 I
            I  61          82.04 I
            I  61          82.04 I
            *--------------------*
                         I
                         I
                         I
            IF OUTSIDE THE RANGE
                         I
             82.02---)I
                60       I          03
            *--------------------*
            I    AREA = AMAX     I
            *--------------------*
                         I
                         I
        +-------------+
        I
        I
        I
        I
        I
        I
        I
        I
        I
        I
        I         -----------
        I        /   61     /
        I        -----------
        I                I
        I    82.02*--)I
        I                I          04
        I   *--------------------*
        I   I AREA = AACT*1.002  I
        I   *--------------------*
        I                I
        +-----------)I


                62       I          05
            *--------------------*
            I       TY = T2      I
            I                    I
            I    B = 2.0E-10     I
            I                    I
            I     TI = (T1 -     I
            I       15.)/TS      I
            *--------------------*
                         I
                         I
                         I
                         *    06
                      *     *
                   *           *      (+)
                *   TI - 1.      *------------------------)*
                   *           *                  27   I          08
                      *     *                   *--------------------*
                         *                      I       ZETA =       I
                         I(-/0)                 I  .25*ALOG((TI +    I
                         I                      I 1.)/(TI - 1.)) +   I
                         I                      I     .5*ATAN(TI)    I
                         I                      I                    I
                         I                      I      ALPHA =       I
                         I                      I 1.712E-9*EMIS*.7*  I
                26       I          07          I       TS**3        I
            *--------------------*              *--------------------*
            I      T2 = TI       I                         I
            *--------------------*                         I
                         I                                 I
                         I                                 *    09
                         I                              *     *
                        ...                          *           * (-/0)
                      .     .                     *  TY - TS - 5.  *-+
                      .83.22.                        *           *   I
                      .     .                           *     *      I
                        ... 22                             *        ....
                                                           I (+)  . 83 .
                                                           I      . 01 .
                                                           I       ....
                                                           I         15
                                                           I
                                                           I
                                                          ...
                                                        .     .
                                                        .83.02.
                                                        .     .
                                                          ... 16
```

CHART TITLE - SUBROUTINE RAD(T1,T2,WCP,WR,AR,WE,TY,J)

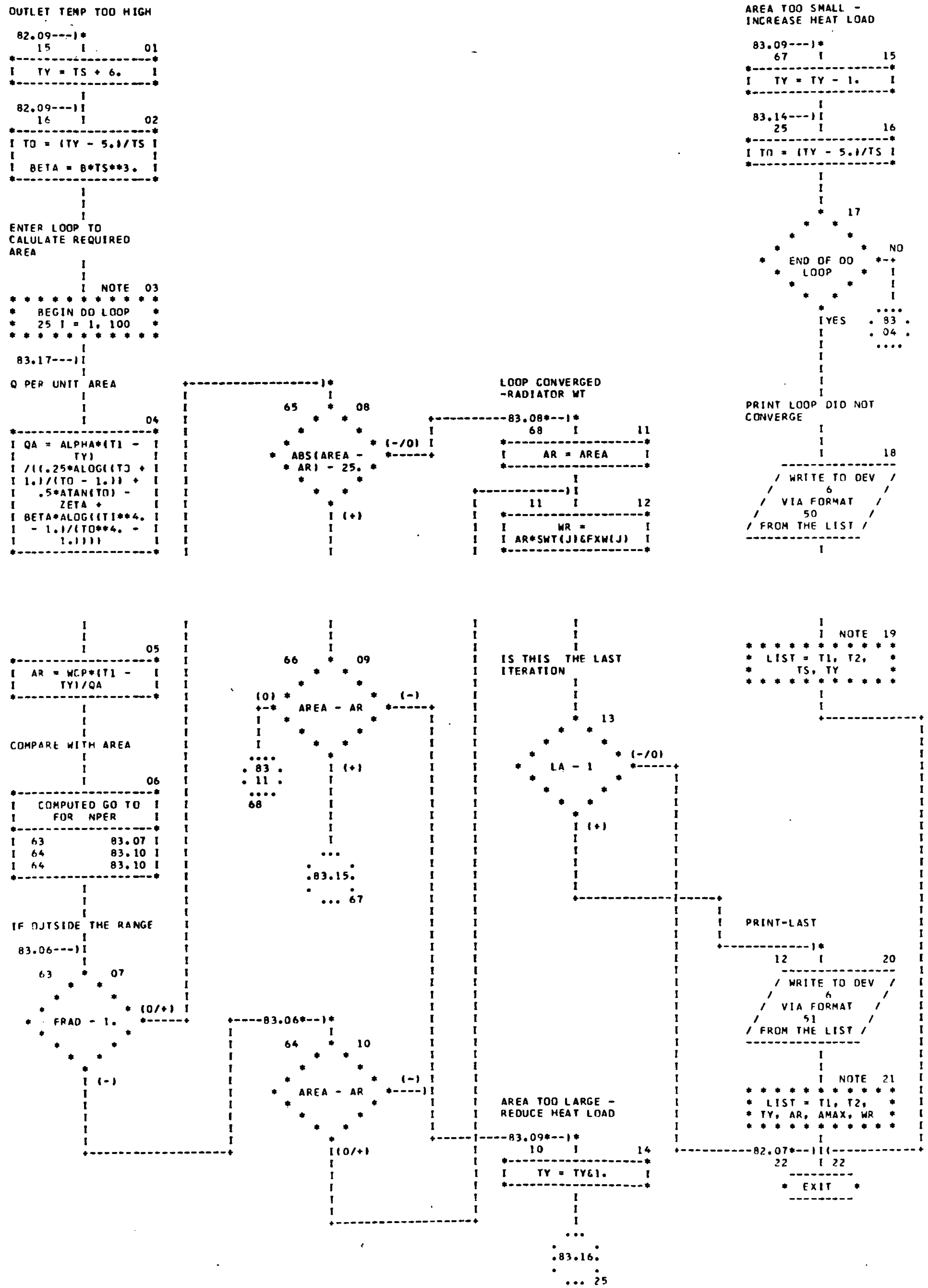

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
      DIMENSION FWT 15(,FXW 15(,SWT 15(
      ,CFT(30)
       COMMON X(700),LA,NPER,PP
      EQUIVALENCE
       (X(101),FWT(1)),(X(131),FXW(1)),(X(16)),SWT(1))
      , X 39(,FW9(, X 40(,FW10(, X 47(,TS(, X 49(,AMAX(, X 50(,FEXP(
      , X 221(,CFT 1((, X 78(,EMIS(, X 59(,FRAD(, CFT 7(,AACT(
51    FORMAT(1H0' RADIATOR SUBROUTINE '/F8.2,' TIN ',F8.2,' TOUT ',F8.2,
      ' TOUTC ',F8.2,' ARADC',F8.2,' ARMAX',F8.2,' WTREQ  ' )
50    FORMAT(1H0'RAD NOT CONVG'/F8.2,' TIN ',F8.2,' TOUT ',F8.2,' TSINK
       ',F8.2,' TOUTC ' )
```

CHART TITLE - INTRODUCTORY COMMENTS

CONDENSER PERFORMANCE SUBROUTINE

CHART TITLE - SUBROUTINE CX2(WC,TCI,QS,QL,TC,QS2,QL2,V,P,NL,K,TCO,V11,I,QSX)

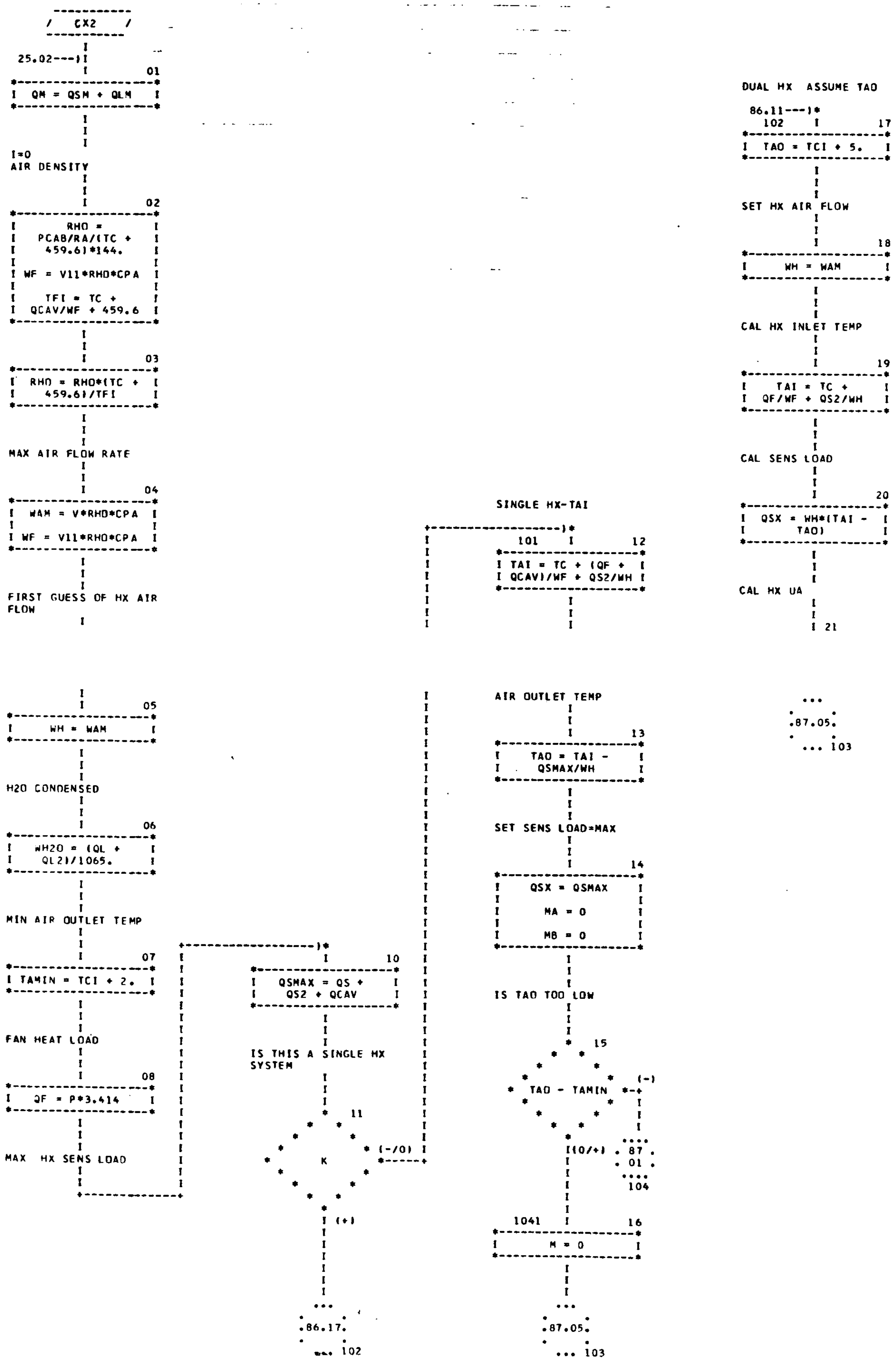

CHART TITLE - SUBROUTINE CX2(WC,TCI,QS,QL,TC,QS2,QL2,V,P,NL,K,TCO,V11,I,QSX)

TOO LOW -SET OUTLET TO MIN

86.15---)

104 — 01

TAO = TAMIN

M = 1

TAI = TAO + QSX/WH

TCN = TAI - (QF + QCAV)/WF - QS2/WH

02

19 14 I. 10 11 — QMET (QSM,TC,TCN, QSN,KL)

03

QSX = QSX + QSN - QSM

QSMAX = QSMAX + QSN - QSM

TAO = TAI - QSX/WH

TC = TCN

04

QL = QL + QSM - QSN

WH2O = (QL + QL2)/1065.

QSM = QSN

ENTER LOOP TO CAL UA/FLOW/TC

86.16*--)

103 — NOTE 05

BEGIN DO LOOP 200 NP = 1, 20

92.15---)

OUTLET DEWPOINT PRES

06

KANDK (PXO,TAO + 459.6,2)

WATER LEAVING HX

07

WWO = (PXO/0.595/(TAO + 459.6))*V*WH/WAM

INLET VAPOR PRESS

08

PXI = (WWO + WH2O)*.595*(TAO + 459.6)/V/WH*WAM

INLET DEW POINT

09

KANDK (PXI,TDP,1)

10

PXI = (WWO + WH2O) *.595*TDP/V/WH* WAM

11

KANDK (PXI,TDP,1)

COOLANT TEMP WHERE COND STARTS

12

TY = TDP - 460.6

HX TOTAL LOAD

13

QT = QSX + QL + QL2

COOLANT OUTLET TEMP

14

TCO = TCI + QT/WC

IS COOLANT OUTLET LOWER THAN TAI

16

TAI - TCO

(-/0)

(+)

88.01. ... 152

AIR TEMPS TOO LOW

151 — 17

TAI = TCO + 1.

TCN = TAI - (QF + QCAV)/WF - QS2/WH

18

19 14 I. 10 11 — QMET (QSM,TC,TCN, QSN,KL)

19

QSX = QSX + QSN - QSM

QSMAX = QSMAX + QSN - QSM

TAO = TAI - QSX/WH

TC = TCN

20

QL = QL + QSM - QSN

WH2O = (QL + QL2)/1065.

QSM = QSN

92.15. ... 200

B

CHART TITLE - SUBROUTINE CX2(WC,TCI,QS,QL,TC,QS2,QL2,V,P,NL,K,TCO,V11,I,QSX)

```
HEAT IN WET SECTION
 87.16---)*
   152    I          01
*--------------------*
I   QW = WC*(TY -    I
I        TC(I)       I
*--------------------*
          I
          I
          I
IS HX ALL WET
          I
          I
          I
          *   02
        *   *
      *       *
    *           *   (-)
  *    QW - QT    *------+
    *           *        I
      *       *          I      HX DRY- QDRY
        *   *            I
          *              +------------------)*
          I(0/+)                  153    I          03
          I                      *--------------------*
          I                      I   QD = QT - QW     I
          I                      *--------------------*
          I                              I
          I                              I
          I                              I
         ...                     AIR OUTLET TEMP
       .     .                           I
       .89.05.                           I
       .     .                           I          04
         ... 154                 *--------------------*
                                 I    TAOD = TAI -    I
                                 I        QD/WH       I
                                 *--------------------*
                                         I
                                         I
                                         I
                                 IS THERE A TEMP PINCH
                                 PROBLEM
                                         I
                                         I

                                         I
                                         *   05
                                       *   *
                                     *       *
                                   *           *  (-/0)
                                 *   TAOD - TY   *------+
                                   *           *        I
                                     *       *          I        HX TOO SMALL-HAS MAX
                                       *   *            I        FLOW BEEN REACHED
                                         *              I
                                         I (+)          +-----------88.05*--)*
                                         I                                  I
                                         I                          108     *   06
                                         I                                *   *
                                         I                              *       *
                                         I                            *           *   (-)
                                        ...                         *     MA - 1    *------------------------)*
                                      .     .                         *           *                          I
                                      .89.01.                           *       *                   1081     *   08
                                      .     .                             *   *                            *   *
                                        ... 156                             *                            *       *
                                                                            I(0/+)                     *           *   (-)
                                                                            I                        * WH - WAM + .1 *--+
                                                                            I                          *           *    I
                                                                            I                            *       *      I
                                                                            I                              *   *        I
                                                                            I                                *        ....
                                                                    1082    I          07                    I(0/+) . 91 .
                                                                   *--------------------*                    I      . 10 .
                                                                   I       MB = 1       I                    I       ....
                                                                   *--------------------*                    I       111
                                                                            I                                I
                                                                            I                                I
                                                                            I                                I
                                                                           ...                              ...
                                                                         .     .                          .     .
                                                                         .92.01.                          .92.01.
                                                                         .     .                          .     .
                                                                           ... 112                          ... 112
```

CHART TITLE - SUBROUTINE CX2(WC,TCI,QS,QL,TC,QS2,QL2,V,P,NL,K,TCO,V11,I,QSX)

```
LMTD
88.05---)*
156        01
DT = (TAI - TCO -
TAOD +
TY)/ALOG((TAI -
TCO)/(TAOD - TY))

DRY UA
           02
UAD = QD/DT

GO TO WET SECTION
03
.89.06.
... 157

1571   04
* ABS(UAR -
CFT(NL)) -
TOLQ*CFT
(NL) *
(-/0)  .89.
        .11.
        250
(+)
.90.01.
... 158

NO DRY SECTION
88.02---)*
154        05
UAD = 0.
QD = 0.
TY = TCO
TAOD = TAI
QW = QT

WET LMTD
89.03---)I
157        06
DT = (TAOD - TY -
TAO +
TCI)/ALOG((TAOD -
TY)/(TAO - TCI))
UAW = (QSX -
QD)/DT

TOTAL UA REQ
           07
UAR = UAD + UAW

           08
/ WRITE TO DEV /
/ 6
VIA FORMAT
703
/ FROM THE LIST /

NOTE 09
LIST = UAR,
CFT(NL), WH, TAI,
TAO, TC

IS UA WITHIN
TOLERENCE
           10
MB - I    (0/+)
(-)

SUBROUTINE
CONVERGED-PRINT-
HX FLOW RATE
--89.04*--)*
250        11
WHX =
WH/CPA/RHO/60.
TFANI = TC +
QCAV/WF
TFANO = TFANI +
QF/WF

CABIN DEW POINT
           12
PXC = (WWO +
QL/1065.)
*.595*(TAO +
459.6)/V/WH*WAM

           13
KANDK
(PXC,TDPC,1)

           14
PXC = (WWO +
QL/1065.)
*.595*TDPC/V/WH*
WAM

           15
KANDK
(PXC,TDPC,1)

           16
TDPC = TDPC -
459.6

           17
/ WRITE TO DEV /
6
/ VIA FORMAT
702
/ FROM THE LIST /

NOTE 18
LIST = TC, TAI,
TAO, WHX, TDPC,
QSX, QSM, QL,
TFANI, TFANO

92.18---)I
300        19
QLM = QM - QSM

20
* EXIT *
```

CHART TITLE - SUBROUTINE CX2(WC,TCI,QS,QL,TC,QS2,QL2,V,P,NL,K,TCO,V11,T,QSX)

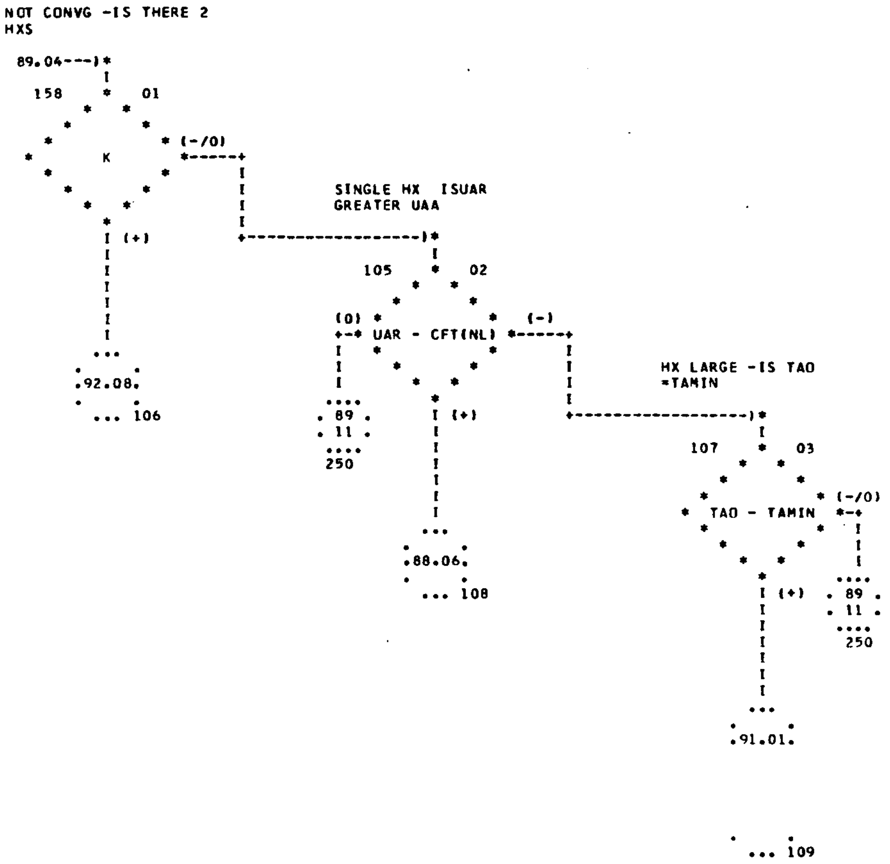

CHART TITLE - SUBROUTINE CX2(WC,TCI,QS,QL,TC,QS2,QL2,V,P,NL,K,TCO,V11,I,QSX)

REDUCE AIR FLOW

```
90.03---)*
109  01
   M - 1     (-) ---> 1091  06
   I(0/+)

1092  02
I9 I          H
I4 I   QMET   H
I. I (QSM,TC,TC -  H
I0 I  1.,QSN,KL)   H
I1 I          H

03
QS = QS + QSN -
 QSM

QL = QL + QSM -
 QSN

QSMAX = QSMAX +
 QSN - QSM

QSX = QSX + QSN -
 QSM

04
QSM = QSN

WH2O = (QL +
 QL2)/1065.

TC = TC - 1.

TAI = TC + (QF +
 QCAV)/WF +
 QS2/WAM

05
TAO = TAI -
 QSMAX/WAM

MA = 1

.92.15.
... 200
```

```
1091  06
TAO = TCI +
 (TAO -
TCI)*UAR/CFT(NL)

WH = QSX/(TAI -
 TAO)
```

CALCULATE TAI

```
07
TAI = TC + (QF +
QCAV)/WF + QS2/WH

TAO = TAI -
 QSX/WH
```

IS AIR OULET TOO LOW

```
08
TAO - TAMIN   (-)
I(0/+)
.92.15.
... 200
```

TAO TOO LOW

```
110  09
WH = (QSX -
QS2)/(TC + (QF +
QCAV)/WF - TAMIN)

TAO = TAMIN

TAI = QSX/WH +
 TAO

.92.15.
... 200
```

INCREASE AIR FLOW

```
88.08---)*
111  10
WH = QSX/(TAI -
 TAO - .2)

TAI = TC + (QF +
QCAV)/WF + QS2/WH

TAO = TAI -
 QSX/WH

.92.15.
... 200
```

CHART TITLE - SUBROUTINE CX2(WC,TCI,QS,QL,TC,QS2,QL2,V,P,NL,K,TCO,V11,I,QSX)

INCREASE CABIN TEMP
CHANGES TO CX2
SUBROUTINE

88.07 → 112 / 01
QMET (QSM,TC,TC + 1.,QSN,KL)

NEW SENSIBLE LOAD

02
QS = QS + QSN - QSM

NEW LATENT LOAD

03
QL = QL + QSM - QSN

NEW MAX HEAT LOAD
SENSIBLE

04
QSMAX = QSMAX + QSN - QSM
QSX = QSX + QSN - QSM
QSM = QSN

NEW H2O REMOVAL

05
WH2O = (QL + QL2)/1065.

UP CABIN TEMP

06
TC = TC + 1.

AIR INLET TEMP

07
TAI = TC + (QF + QCAV)/WF + QS2/WAM
TAO = TAI - QSMAX/WAM

92.15 / 200

TWO HXS IS HX TOO
SMALL

90.01 → 106 / 08
UAR - CFT(NL)
(0) → 89.11 / 250
(-) → 114
(+) → 113

HX TOO SMALL-LOWER QS

113 / 09
TAO = TCI + (TAO - TCI)*UAR/CFT(NL)
QSX = WH*(TAI - TAO)
→ 87.20

HX TOO LARGE -RAISE Q
IS TAO TOO LOW

114 / 10
TAO - TAMIN
(-/0) → 89.11 / 250
(+) → 116

116 / 11
TAO = TCI + (TAO - TCI)*UAR/CFT(NL)

IS OUTLET TEMP TOO
LOW

12
TAO - TAMIN
(0/+) → 119
(-) → 118

118 / 13
TAO = TAMIN

119 / 14
QSX = WH*(TAI - TAO)

END OF LOOP

87.20 → 200 / 15
END OF DO LOOP
NO → 87.06
YES

LOOP NOT
CONVERGED-PRINT

16
WRITE TO DEV 6 VIA FORMAT 701 FROM THE LIST

NOTE 17
LIST = UAR, CFT(NL), TAI, TAO, WH, WAM, QSX, QSM, QL

SET I

18
I = 1

89.19 / 300

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
        DIMENSION FWT(30),FXW(30),SWT(30),CFT(30)
         COMMON X(700),LA,NPER,PP
        EQUIVALENCE
        (X(101),FWT(1)),(X(131),FXW(1)),(X(161),SWT(1)),(X(221),CFT(1))
        ,(X(68),TOLQ),(X(2),PCAB),(X(3),RA),(X(48),CPA)
        ,(X(12),QSM),(X(14),QLM),(X(84),QCAV )
703     FORMAT(1H 6F10.2)
701     FORMAT(1H0 'CONDENSER NOT CONVERGED '/F8.1,'UAREQ  ',F8.1,' UAAVAI
        L ',F8.2,' TAI    ',F8.2,' TAO    ',F8.1,' WAIR   ',F8.1,' WAMAX
        ',F8.1,8H QSEN   /1H F8.1,8H QSMET  F8.1,8H QLMET    )
702     FORMAT(1H0'CONDENSER PERFORMANCE '/ F8.2,' TCAB   ',F8.2,' TAIRI
        ',F8.2,' TAIRO  ',F8.1,' HXCFM  ',F8.2,' TOPCAB ',F8.1,' QSENS '
        ,F8.1,8H QSMET  F8.1,8H QLTOT  /F8.2,8H TFANI  F8.2,8H TFANO  )
```

CHART TITLE - SUBROUTINE QMET(Q1,T1,T2,Q2,K)

```
  ------------
 /   QMET   /
------------

28.01*--)*

SUBROUTINE CALCULATES                                                NO SENSIBLE HEAT LOAD
NEW LATENT-SENSIBLE
SPLIT                                                                  94.01---)*
IS TEMP TOO HIGH                                                         3    I        05
                                                                       *------------------*
          *                                                            I      Q2 = 0.     I
          I                                                            I                  I
          *   01                                                       I       K = 0      I
        *   *                                                          *------------------*
      *       *                                                                I
    *           *  (-)                                     *-------------------)I
  *   T2 - 94.    *-----*                                  I               4    I 06
    *           *       I                                  I                  ----------
      *       *         I         ORIGINAL  QS             I                 *  EXIT   *
        *   *           I                                  I                  ----------
          *             *-------------------)*             I
          I(0/+)                  2    I        02         I
          I                      *-------------------*     I
          I                      I I                 H     I
          I                      I I     UNBAR       H     I
          I                      I I (X(501),1,T1,   H     I
          I                      I I   0.,Q0,K1)     H     I
          I                      I I                 H     I
         ...                     *-------------------*     I
        .   .                              I               I
        .94.05.                            I               I
        .   .                              I               I
         ... 3                   NEW QS                    I
                                           I               I
                                           I               I
                                           I        03     I
                                 *-------------------*     I
                                 I I                 H     I
                                 I I     UNBAR       H     I
                                 I I (X(501),1,T2,   H     I
                                 I I   0.,QN,K2)     H     I
                                 I I                 H     I
                                 *-------------------*     I
                                           I               I
                                           I               I
                                           I               I
                                 NEW SENSIBLE              I
                                           I               I
                                           I               I
                                           I        04     I
                                 *-------------------*     I


                                 I  Q2 = Q1*(1. -    I     I
                                 I  (Q0 - QN)/Q0)    I     I
                                 I                   I     I
                                 I   K = K1 + K2     I     I
                                 *-------------------*     I
                                           I               I
                                           I               I
                                           *---------------*
```

CHART TITLE - NON-PROCEDURAL STATEMENTS

```
COMMON X(700),LA,NPER,PP
```