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GENERALIZED ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM COMPUTER PROGRAM (G189A) CONFIGURATION CONTROL

PHASE I FINAL REPORT

Contract NAS9-13404

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

MCDONNELL DOUGLAS CORPORATION

MCDONNELL DOUGLAS

GENERALIZED ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM COMPUTER PROGRAM (G189A) CONFIGURATION CONTROL

PHASE I FINAL REPORT

Contract NAS9-13404

31 DECEMBER 1973

MDC G5084

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I

FOREWORD

The work described in this report was performed by the Biotechnology and Space Sciences Subdivision of the Engineering Division, McDonnell Douglas Astronautics Company - Western Division, Huntington Beach, California. J. R. Jaax, Crew Systems Division, National Aeronautics and Space Administration, Johnson Space Center (JSC) was the contract technical monitor. R. S. Barker was the project manager for McDonnell Douglas. R. L. Blakely was responsible for performing the G189A computer program configuration control effort.

SUMMARY

This final report documents the work performed during Phase I of contract NAS9-13404, Generalized Environmental and Life Support System Computer Program (G189A) Configuration Control. Phase I of the contract covers the period from 2 April 1973 to 31 October 1973. During this period the following items of significance were accomplished:

1. A G189A simulation of the Shuttle Orbiter EC/LSS was prepared and used to study payload support capabilities. (The current status of this simulation is documented in Attachment No. 1 of this report.)

2. Two master program libraries of the G189A computer program were prepared for the NASA/JSC computer system. An Exec 8 version of the program library is available as an operational SECURE file on the NASA/JSC UNIVAC 1110 computer and an Exec 2 version is available on magnetic tape for use on the NASA/JSC UNIVAC 1108 computers. Both program libraries have been checked out and are operational. A copy of the Exec 8 program library was sent to NASA/MSFC and is operational on their UNIVAC 1108 computers. A copy of the G189 program library Fortran symbolics was sent to NASA/Ames Research Center where it is intended to be made operational on their IBM 360/67 computer.

3. Several new component subroutines were added to the G189A program library and many existing subroutines were revised to improve their capabilities. (Addendum No. 1 of this report contains the required changes to the G189A Program Manual, Reference 1, which document the component subroutine additions and revisions.)

4. A number of special analyses were performed in support of a NASA/JSC Shuttle Orbiter EC/LSS Payload Support Capability Study.

1.0 INTRODUCTION

The G189 Generalized Environmental Control and Life Support System Computer Program was initially conceived and developed by MDAC in 1964. It was initially delivered to NASA/JSC in 1965 under contract NAS9-4090. Since this time a number of program revisions and developments have occurred as a result of work performed in-house and in conjunction with other NASA contracts. The Crew Systems Division of NASA/JSC has been instrumental in the development of this program into a valuable EC/LSS simulation tool. This contract, NAS9-13404 - Generalized Environmental Control and Life Supoort System Computer Program (G189A) Configuration Control, provides a method for updating and maintaining the G189A program library and documentation for all program users. The effort also involves (1) providing instruction and recommendations for the use and application of the program, (2) developing new subroutines and logic required for new simulations, and (3) supporting special analyses required by NASA/JSC. The following section describes in detail the progress made, during Phase I of the contract, under the various tasks described in contract NAS9-13404.

2.0 REPORT OF PHASE I PROGRESS

The Phase I progress on tasks 1-11 as described in contract NAS9-13404 is reported herein.

2.1 Task 1, Formulate Master Programs

Two master program libraries of the G189A computer program were prepared for the NASA/JSC computer system. An Exec 8 version of the program library was prepared for the NASA/JSC UNIVAC 1110 computer and is maintained as a SECURE file in permanent storage. An Exec 2 version of the program, suitable for use on the NASA/JSC UNIVAC 1108 computers, was prepared and placed on magnetic tape. The two program libraries are identical except for minor coding differences required by the Exec 8 or Exec 2 system. These program libraries are described in more detail in Section 2.2.

A survey of available master program tapes for previously prepared G189 simulators was made. The following table lists those simulators, their magnetic tape number, the person under whose name the tape is reserved, the approximate version data, and the operating system under which the tape was prepared.

TABLE 1 - MASTER PROGRAM TAPES FOR G189 SIMULATORS

Description	Tape No.	Reserved By	Approx. Version Date	Oper. System
Apollo Block II CM ECS Simulation:				
G189 Subroutine Elements	A13459	Dave Cook/LEC	9/69	Exce II
Basic Case Data - Earth Orbit	A00643	Dave Cook/LEC	9/69	Exec II
SSP 12 Man Simulation with Mol Sieve:				
G189 Subroutine Elements	A04141	Bill Ayotte/	7/71	Exec II
Restart Data	A05417	Boeing	7/71	Exec II
SSP Water Waste Management System Simulation:				
G189A Subroutine Elements	A12961	Bob Blakely/ MDAC	11/72	Exec II
Data Tape	A08553	Bill Ayotte/ Boeing	11/72	Exec II

In addition to these master program tapes, two new tapes and one permanent file were prepared for the new G189A Shuttle Orbiter EC/LSS Simulation. These items are described in Section 2.2.

2.2 Task 2, Maintain Library

In addition to the previously created G189 simulator master program tapes listed in Table 1, two new tapes and one permanent file for the G189A Shuttle Orbiter EC/LSS simulation were created. A G189A master program library for the Exec 8 operating system was created as a SECURE file on the NASA/JSC

UNIVAC 1110 computer. A similar library for the Exec 2 operating system, currently used on the NASA/JSC UNIVAC 1108 computers, was placed on magnetic tape. A set of basic case data for the Shuttle Orbiter EC/LSS simulation was also placed on magnetic tape for use on the Exec 2 operating system. The characteristics of these files are described in Table 2.

TABLE 2 - SHUTTLE G189A SIMULATOR MASTER PROGRAM FILES AND TAPES

File Name or Tape No.	Qualifier or Label	Description
G189AD	EC2-M22636	An Exec 8 SECURE file of the G189A program library which resides on the UNIVAC 1110 mass storage device. The file is cataloged for public access and as a read only file. It contains symbolic and relocatable elements for all G189A routines including a MAP collector element called SEGPRG which is used to provide program segmentation.
A07947	UPDAT	An Exec 2 tape containing two identical files of Fortran V source and relocatable elements of all G189A routines including a MAP element called SEGPRG which is to provide program segmentation.
A06583	NTOUT	An Exec 2 tape containing the basic case data for the current G189A Shuttle Orbiter EC/LSS Simulation.

The two program libraries, G189AD and A07947, contain the most recent changes and additions made to the G189A program by MDAC-W as of 17 July 1973. These libraries have also been updated several times at NASA/JSC as required for the Shuttle Orbiter EC/LSS simulation. The most recent JSC updates were made on 26 November 1973.

A magnetic tape of the Exec 8 master program library was made and modified to run on the NASA/MSFC UNIVAC 1108 computer system on 3 August 1973. This tape was sent to Sam Clonts, NASA/MSFC, S&E-ASTN-PLB, Bldg. 4666. An external BCD tape of the Exec 8 master program library Fortran subroutine symbolics was requested and sent to Dr. D. E. Cagliostro, NASA/Ames Research

Center on 24 September 1973. Dr. Cagliostro intends to implement the G189A program on an IBM 360/67 computer at Ames Research Center.

2.3 Task 3, Provide Recommendations

Contact has been maintained between active G189A program users at NASA/MSFC and MDAC-W to provide recommendations regarding use of master program library tapes, program subroutine modifications, and routine peculiarities or limitations.

2.4 Task 4, Provide Instruction

Contact has been maintained between active G189A users at NASA/MSFC and MDAC-W to provide briefings on new options and subroutines being developed and to aid in debugging program errors.

2.5 Task 5, Provide Program Modifications

Several component subroutine modifications have been made and several new subroutines have been prepared for use with the Shuttle Orbiter ETC/LSS simulation. These changes are briefly described below.

ALTCOM - Modified to calculate outlet temperature, as an option, if heat addition is specified.

F21 - New subroutine which will calculate the thermal properties (c_p, μ, k, ρ) of Freon 21 for a given temperature or the integrated value over a range of temperatures.

LIOH - New subroutine which calculates removal efficiency as a function of on-line time, carbon dioxide outlet pressure, water vapor generation, and heat dissipation.

SPLIT - Modified to calculate overall split ratio, as an option, if either primary or secondary exit flow is specified.

SSRAD - New subroutine which calculates effective sink temperature given solar and infra-red heat flux data, computes a fluid to root temperature drop, and determines the outlet fluid temperature. This is a simplified model based upon the equations in Reference 2.

In addition to these modifications many changes, not apparent to the user, have been incorporated into the new master program libraries which improve the efficiency and operation of the G189A program. Also many new subroutines and modifications have been incorporated into the program as a result of inhouse efforts and in conjunction with other NASA contracts. These changes are documented in Addendum No. 1 of this report.

2.6 Task 6 - Establish System Schematic Configurations on Master Programs

The current G189A Shuttle Orbiter EC/LSS simulation data are maintained on magnetic tape as described in Section 2.2. The G189A component schematic representation of the Shuttle Orbiter EC/LSS and a listing of the simulation data are presented in Attachment No. 1 of this report.

2.7 Task 7, Support Special Analyses

A number of special analyses were performed in conjunction with the NASA/JSC Shuttle Orbiter EC/LSS Payload Support Study. A summary list of these analyses is provided below.

1. Feasibility of providing separate high and low temperatures radiators to increase payload support capability, Reference 3.

2. Feasibility of placing a low temperature payload heat exchanger in parallel with the ARS interchanger in the freon loop. Determination of minimum cabin air flow and water loop flow requirements and the tradeoffs between flow requirements, heat exchanger size and pumping power, Reference 4.

4. Determination of minimum cabin air, water, and freon loop flow requirements as a function of mission phase. Parametric analyses of high and low temperature payload heat exchanger loop capabilities as a function

of freon flow rate, payload temperature requirements, and heat exchanger effectiveness, Reference 5.

2.8 Task 8, Maintain Status Reports

Weekly written status reports were prepared up through 1 June 1973 at which time this requirement was deleted. Their function was replaced with oral briefings and the monthly activity report. A list of interested G189A program users at key locations was determined and is presented below:

1. Bob Balinkas 203/623-8012
   Mail Stop 1A-2-6
   Hamilton Standard
   Windsor Locks, Connecticut 06096

2. Buford Beadle 205/632-1623
   Mail Stop 190
   Teledyne-Brown Engr.
   Research Park
   Huntsville, Alabama 35812

3. Dr. D. E. Cagliostro 415/965-6190
   NASA/Ames Research Center
   Moffett Field, California 94035

4. Sam Clonts 205/453-3828
   S&E-ASTN-PLB-Bldg. 4666
   NASA/MSFC
   Huntsville, Alabama 35812

5. John Coggi 714/896-3536
   A3-253-AJCO-M.S. 13/3
   MDAC-West
   Huntington Beach, California 92646

6. Ben Fulbright 713/483-6257
   Bldg. 16, Mail Code EZ
   NASA/JSC
   Houston, Texas 77058

7. Jim Jaax 713/483-4941
   Bldg. 7, Mail Code EC2
   NASA-JSC
   Houston, Texas 77058

8. Orin L. Murray 314/232-6742
Dept. E242-Bldg. 106, Level 1, M.S. 68
MDAC-E
Box 516
St. Louis, Mo. 63166

9. Stu Nicol 714/896-2310
A3-253-AJCO-M.S. 14/2
MDAC-West
Huntington Beach, California

10. Woodrow Ryan 205/453-2350
Computer Sciences
8300 Whitesburg Dr.
Huntsville, Alabama 35812

11. Wylie Ward 205/532-1623
Mail Stop 190
Teledyne - Brown Engr.
Research Park
Huntsville, Alabama 35812

2.9 Task 9, Provide Monthly Activity Report

Monthly activity reports documenting the current status of the G189A program and the work performed during each reporting period were prepared and distributed to all interested G189A program users.

2.10 Task 10, Provide Digital Computer Program Requirements

The G189 master program libraries and Shuttle Orbiter EC/LSS simulation data are maintained at NASA/JSC, Crew Systems Division, in the form of card decks, magnetic tapes, or permanent files (Section 2.2). Program listings are also maintained at NASA/JSC, Crew Systems Division.

2.11 Task 11, Provide Final Report

This document constitutes the final report for Phase I of this contract.

3.0 CONCLUSIONS

The G189A program configuration control concept has proven to be very effective in organizing and controlling the use and modification of the program and its simulations. Interested users have been determined and communications between these personnel have been established. This effort has resulted in the orderly development of the program and provides a central focal point for determining program inadequacies and errors, providing consultation and problem solutions, and distributing new updated versions of the program library.

A G189A Shuttle Orbiter EC/LSS simulation has been developed and executed satisfactorily (Attachment No. 1). The modelling in this simulation is consistent with the current state of development for the Orbiter EC/LSS. The simulation represents the active freon, water, and gas loops. The heat exchangers, cabins, and radiators currently use steady state solution techniques, however, these components can be easily transformed into transient models as the detailed component designs are established. The current simulation is capable of steady state or transient analysis with respect to heat load and environmental flux variations. Transport lag, thermal capacitance, or pressure drop effects are not included but will be added as the information becomes available. This initial simulation provides a basic building block model which can be easily developed into an accurate simulation of the Shuttle Orbiter EC/LSS as the hardware development and testing proceeds.

REFERENCES

1.0 Barker, R. S.; Blakely, R. L.; Hamill, T. D.; Nicol, S. W.; G189A Generalized Environmental/Thermal Control and Life Support Systems Computer Program Program Manual; McDonnell Douglas Astronautics Company Report MDAC-G2444, September 1971

2.0 Anderson, A. J., et. al., Radiator Design for Space Vehicles, AiResearch Report No. MS-AP-0069, 1963.

3.0 Status reports for the weeks ending 5/11, 5/18, 5/25 and 6/1/73 on contract NAS9-13404.

4.0 Fifth Monthly Activity Report, 2 September 1973, contract NAS9-13404.

5.0 Sixth Monthly Activity Report, 15 October 1973, contract NAS9-13404.

ATTACHMENT NO. 1

G189A SIMULATION OF THE SHUTTLE ORBITER EC/LSS

Attachment No. 1

1.0 INTRODUCTION

A G189A simulation of the Shuttle Orbiter EC/LSS was prepared under phase I of contract NAS9-13404, Generalized Environmental Control and Life Support System Computer Program (G189A) Configuration Control. This attachment describes the current status of the simulation model and presents some computed results obtained from the model.

2.0 SIMULATION MODEL DESCRIPTION

A G189A simulation of the Shuttle Orbiter EC/LSS has been developed and successfully executed. The simulation is being constantly modified to bring it into agreement with the current baseline or special study configuration. The model discussed in this attachment was prepared for a special payload support capability study.

The modelling detail used in this simulation is consistent with the current state of development for the Shuttle Orbiter EC/LSS. The simulation is being used to study the effects of varying heat loads, flow rates, heat exchanger sizes, and system configurations. Therefore, the current model simulates only the primary flow stream circuits for the cabin gas, avionic bay gas, water, and freon loops. The simulation is set up to run steady state or transient cases, however, steady state solutions are used for all components. The G189A program allows the option of using steady state solutions for each piece of equipment modelled. As the EC/LSS development evolves and the various equipment sizes and weights become well defined these data can be easily added to the simulation, without program modification, such that a true transient solution can be obtained.

A G189A simulation of an EC/LSS is prepared by representing each piece of equipment or system with a G189A component subroutine that is available in the G189A program library (Reference 1 of the Final Report). The flow path connections and order of solution are specified as input data to the program. Figures 1-4 present schematics of the G189A components used to represent a Shuttle Orbiter EC/LSS configuration used for a payload support capability study.

Figure 1 presents the G189A component schematic used to simulate the cabin gas and avionic bays gas loops. Each piece of equipment (heat exchanger, compartment, fan, duct tee, etc.) is represented by a component and assigned an arbitrary but unique component number. Each G189A component is allowed to have two separate flow stream connections: (1) a primary flow stream, indicated by a "P" on the schematics, and (2) a secondary flow stream, indicated by an "S" on the schematics. These designations are required for preparation of the G189A simulation model data.

Figure 2 presents the G189A component schematic used to represent the Atmospheric Revitalization System (ARS) water loop; Figure 3, the freon loop exclusive of the radiator system; and Figure 4, the radiator system. Figure 4 contains a G189A component, 113, which does not represent a physical piece of hardware. This component subroutine, FLØMET, is used to determine the integrated average heat rejection rate and outlet temperature provided by the radiator system during a transient run.

The G189A simulation data required for the Shuttle Orbiter EC/LSS is presented as Card Listing No. 1 of this attachment. The first page of this listing contains case data required for this simulation model which was prepared to represent a seven man on-orbit simulation with maximum payload heat input (8.5 kw). The second page begins with a listing of G189A comment (IDXX) cards for component number 1 which were used to document pertinent design data for the Shuttle Orbiter EC/LSS and their references. These cards are followed by the detailed component and table data required for the G189A simulation. The component data are grouped by component number which appears in the second column of the card listing data. Table data are grouped in a similar manner by table number which is arbitrarily assigned by the user. The input data cards are annotated so that the user can easily identify the required input data. (Reference 1 of the Final Report describes the input data requirements and formats in detail.)

The G189A program allows the user an opportunity to modify his input basic case simulation data (Card Listing No. 1) during the system analysis solution. Two subroutines, GPØLY1 and GPØLY2, provide this capability. The G189A program proceeds through its system analysis by solving components in a given order (the solution path) specified by the user. Subroutine GPØLY1 is called prior to a component's solution and subroutine GPØLY2 is called after a component's solution but before its computed data are stored. These subroutines allow the user an opportunity to modify and examine a components' input data prior to its solution and also an opportunity to modify and examine the computed results before they are stored. Card Listing No. 2 of the attachment contains the GPØLY1 Fortran statements used for the Shuttle Orbiter EC/LSS simulation under discussion. Card Listing No. 3 contains the required GPØLY2 Fortran statements. Comment cards have been inserted to describe the operations being performed.

The GPØLY1 logic is used to set up the component heat loads, to specify the gas leakage rate to the avionics bay, and to simulate the operation of the cabin temperature control valve. The heat load data for each component are input as table data with heat load being a function of mission phase. A table of mission phase versus mission time is also input in the basic case simulation data (Card Listing No. 1). The first block of GPØLY1 logic determines the current mission phase. If this phase is identical to the previously determined mission phase then the heat load data do not require updating and that logic is skipped. As mentioned previously, the simulation model discussed in this attachment has been modified to perform a special payload capability analysis for a seven man crew (3 men in the payload compartment) on-orbit case with maximum payload heat production (8.5 kw). Therefore, the heat load logic of GPØLY1 has been modified to override the table data heat load values and to store the heat load data specified for the special payload capability case. An example of this modification can be observed by examining the second block of GPØLY1 logic labelled "FIND MAIN CABIN HEAT LOAD". The first Fortran statement in this logic reads table 1002 to determine the cabin heat load, QCAB. This value is subsequently modified to the correct value for the special study case, QCAB=5306. The last statement in the logic block stores this value in the V array reference location number 66 of component number 2. The remaining heat load calculations are modified in a similar manner.

The GPØLY1 logic block following Fortran statement lable number 3, near the end of the listing, is entered when the current component being solved is component number 3, N=3. This logic block determines the total outboard gas leakage rate from the main cabin to the avionics bay which is set to 0.125 lb/hr for this case. The next logic block determines the payload compartment gas flow requirement which is set to 48 cfm. The last block of logic simulates the cabin temperature control valve operation and determines the split ratio for component number 86 (Figure 1) required to control the cabin temperature to TSET=70°F. This logic was overridden for this simulation such that all of the gas flow would be directed through the cabin heat exchanger and the minimum cabin temperature could be determined.

The GPØLY2 logic (Card Listing No. 3) consists of only one card for this simulation. When the current component number being solved is the payload compartment, N=82, then the gas temperature leaving the payload compartment, R(2), is set to 75.0°F. This logic was required for the special payload capability study and is not used normally.

The combination of the basic case simulation data (Card Listing No. 1), the Fortran subroutine GPØLY1 logic (Card Listing No. 2), and the Fortran subroutine GPØLY2 logic (Card Listing No. 3) comprises the special payload capability study simulation model of the Shuttle Orbiter EC/LSS used for the seven man, on-orbit, maximum payload heat case. The results of this case and three others set up for a payload capability study are discussed in the following section.

3.0 COMPUTED RESULTS

The seven-man, on-orbit, maximum payload heat simulation model described in Section 2.0 was run and the computed results are summarized in Figure 5. Figure 5 contains a schematic drawing of the cabin and avionics bays gas loops, the ARS water loop (shown as dotted lines), and a portion of the freon loop. For this simulation the freon inlet temperature to the ARS interchanger and low temperature payload was set to 40°F as a boundary condition and the radiator system portion of the simulation model was excluded from the solution path. Figure 1 indicates the heat loads, flows, and heat exchanger UA's used to compute the fluid temperatures indicated on the schematic. The sensible and latent heat generated by the crew and the operation of the lithium hydroxide beds were computed by the metabolic man and lithium hydroxide component subroutines present in the G189A program library. The other heat loads, exclusive of the computed heat exchanger heat transfer rates, were input via component simulation model data or GPØLY logic. The cabin gas fan flow was set at 317 cfm and avionics bay fan flows were set at 200 cfm each.

The purpose of running the seven man, on-orbit, maximum payload heat case shown in Figure 1 was to determine if the main cabin temperature could be controlled to 75°F, to determine the freon supply and return temperatures for the high and low temperature payload loops, and to determine any other temperature critical components for the set of imposed heat loads and flows. The simulation model predicted a cabin temperature of 74.5°F with a dew point of 56.0°F, a low temperature payload coolant supply temperature of 45.3°F with a return temperature of 103.8°F, and a high temperature payload coolant supply temperature of 96.0°F with a return temperature of 106.6°F.

The computed results for three other cases are summarized in a similar manner on Figures 6, 7, and 8. The payload gas flow is set to zero cfm for all of these cases. Figure 6 shows the results of a four man, on-orbit, no space lab case with the total freon flow set at 2903 lb/hr and a water loop flow of 600 lb/hr. The cabin air temperature could be lowered to 68.5°F if desired and the low temperature payload coolant supply temperature of 41.1°F could be maintained with a return temperature of 88.9°F.

Figure 7 depicts the results of a seven man launch/reentry case with the total freon flow set to 3301 lb/hr and a water flow of 700 lb/hr. The results indicate that the main cabin could be lowered to 71.2°F and the low temperature payload coolant supply and return temperatures would be 41.1°F and 82.2°F respectively. These payload coolant temperatures are different from those in Figure 6 due to the difference in freon flows through the low temperature payload heat exchanger.

Figure 8 presents the results of a case similar to that shown in Figure 7 except that there are only four men present in the cabin. These results indicate that the main cabin temperature could be lowered to 68.1°F if desired.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The basic case simulation model of the Shuttle Orbiter EC/LSS was developed and successfully used in a series of payload capability studies during phase I of contract NAS9-13404. The simulation provides a valuable analytical tool which can be easily used to study component placement or substitution, heat load variations and timelines, fluid flow variations, etc. Only the primary fluid circuits of the Shuttle Orbiter EC/LSS and the steady state characteristics of the components are currently modelled. As the EC/LSS development proceeds the simulation should be expanded to represent the transient characteristics of each component, to incorporate their pressure drop characteristics, and to incorporate the secondary fluid circuits.

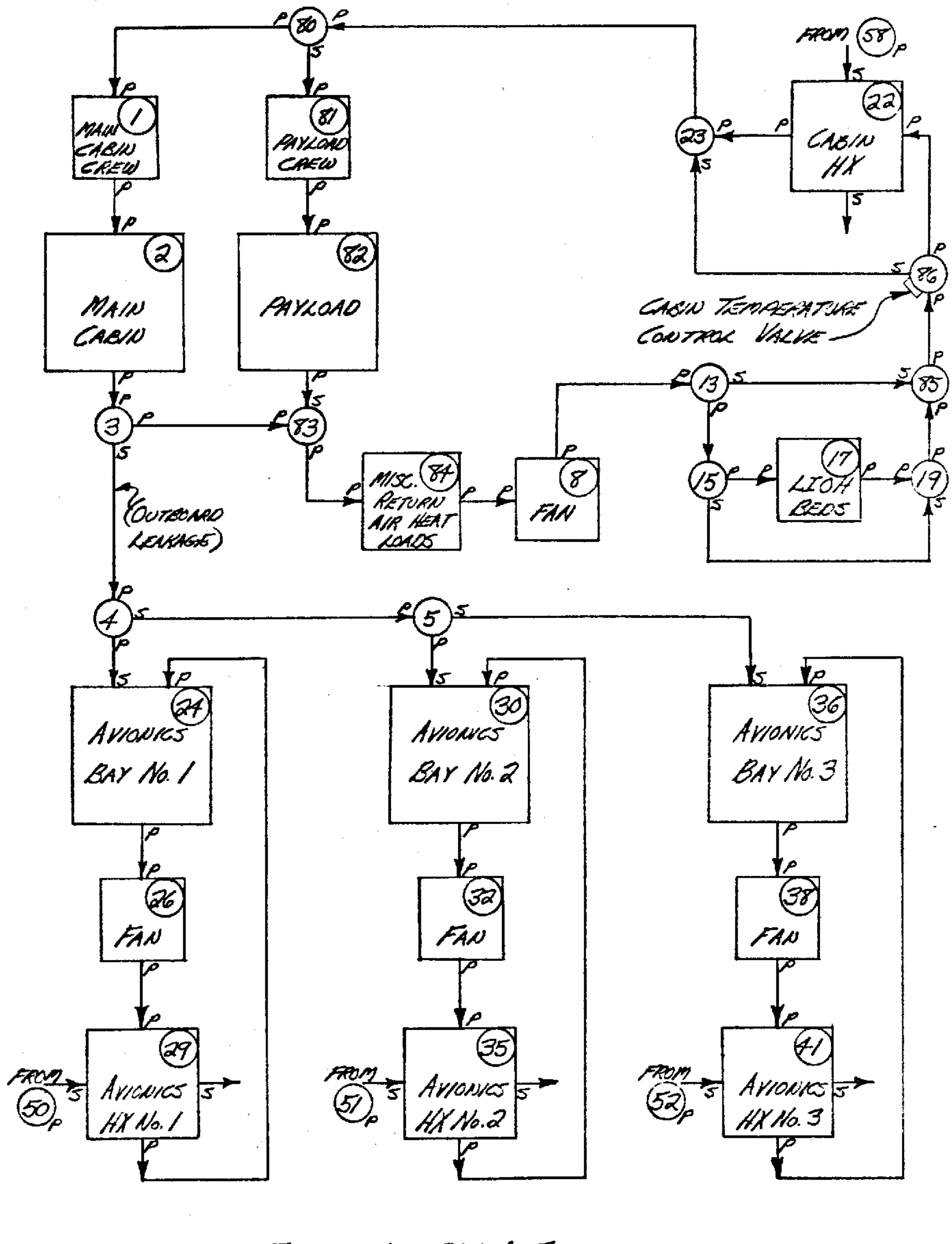

FIGURE 1, G189A SIMULATION - CABIN AND AVIONICS BAY GAS LOOPS

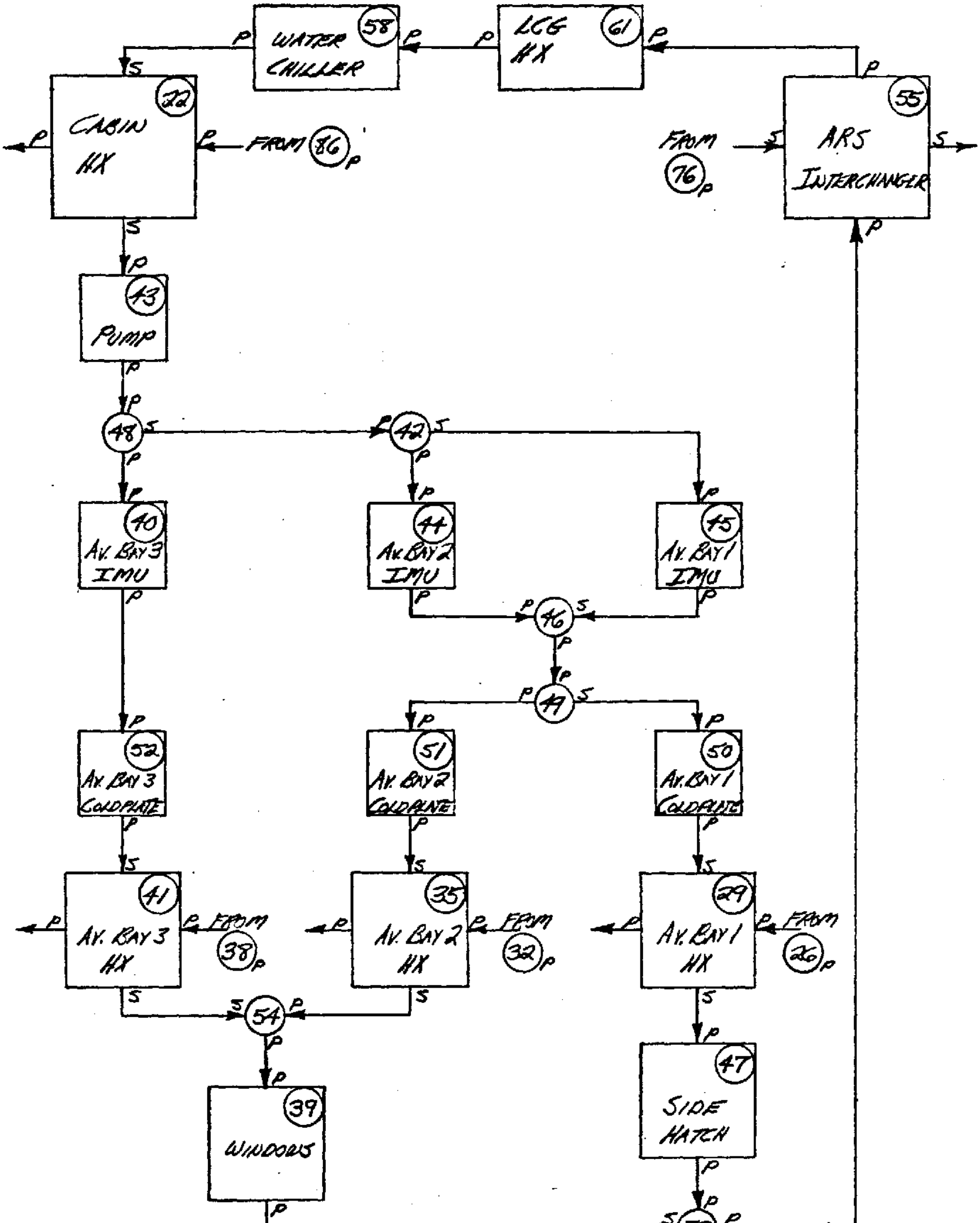

FIGURE 2, G189A SIMULATION - ARS COOLANT WATER LOOP

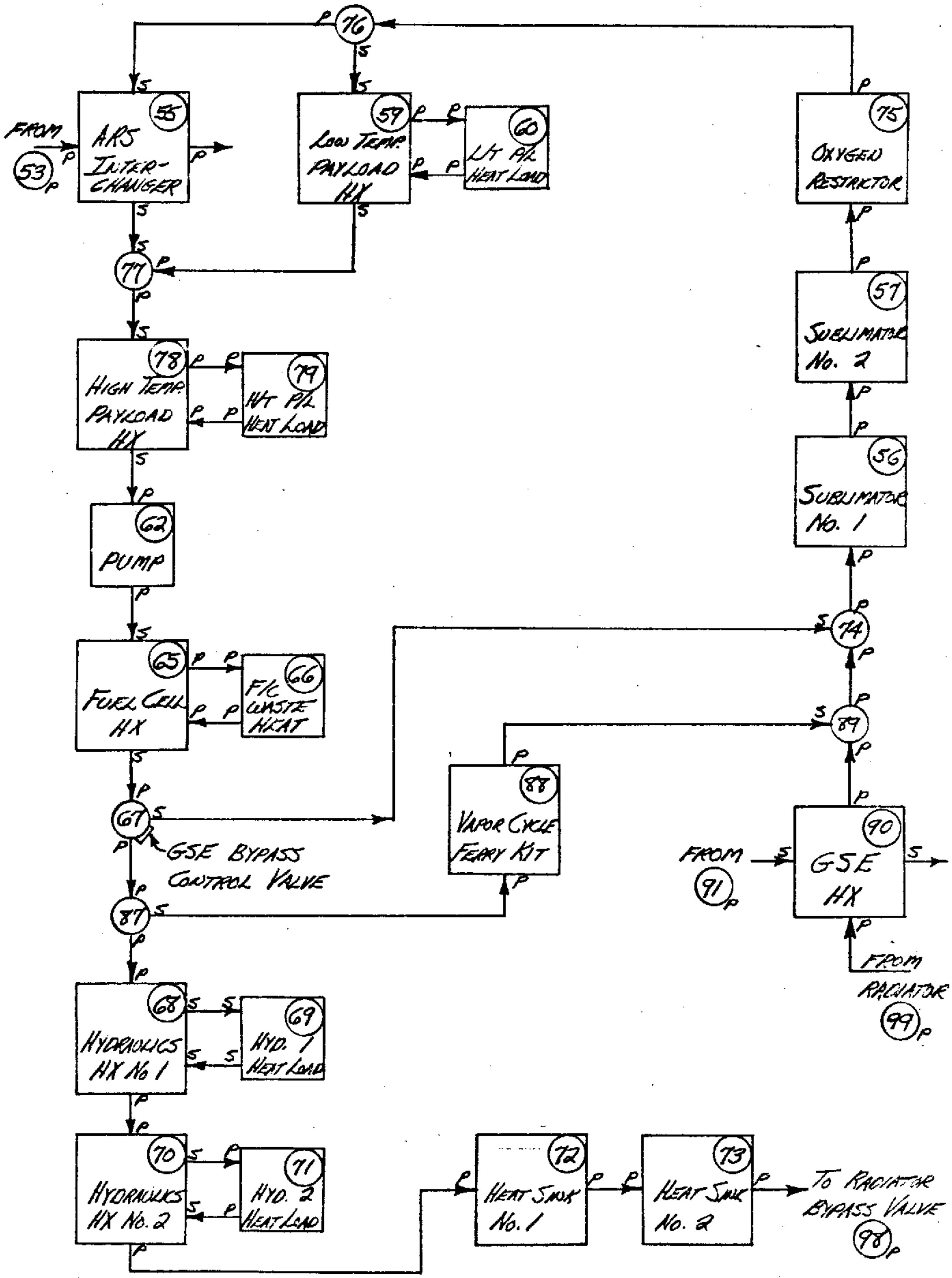

FIGURE 3, G189A SIMULATION - FREON LOOP

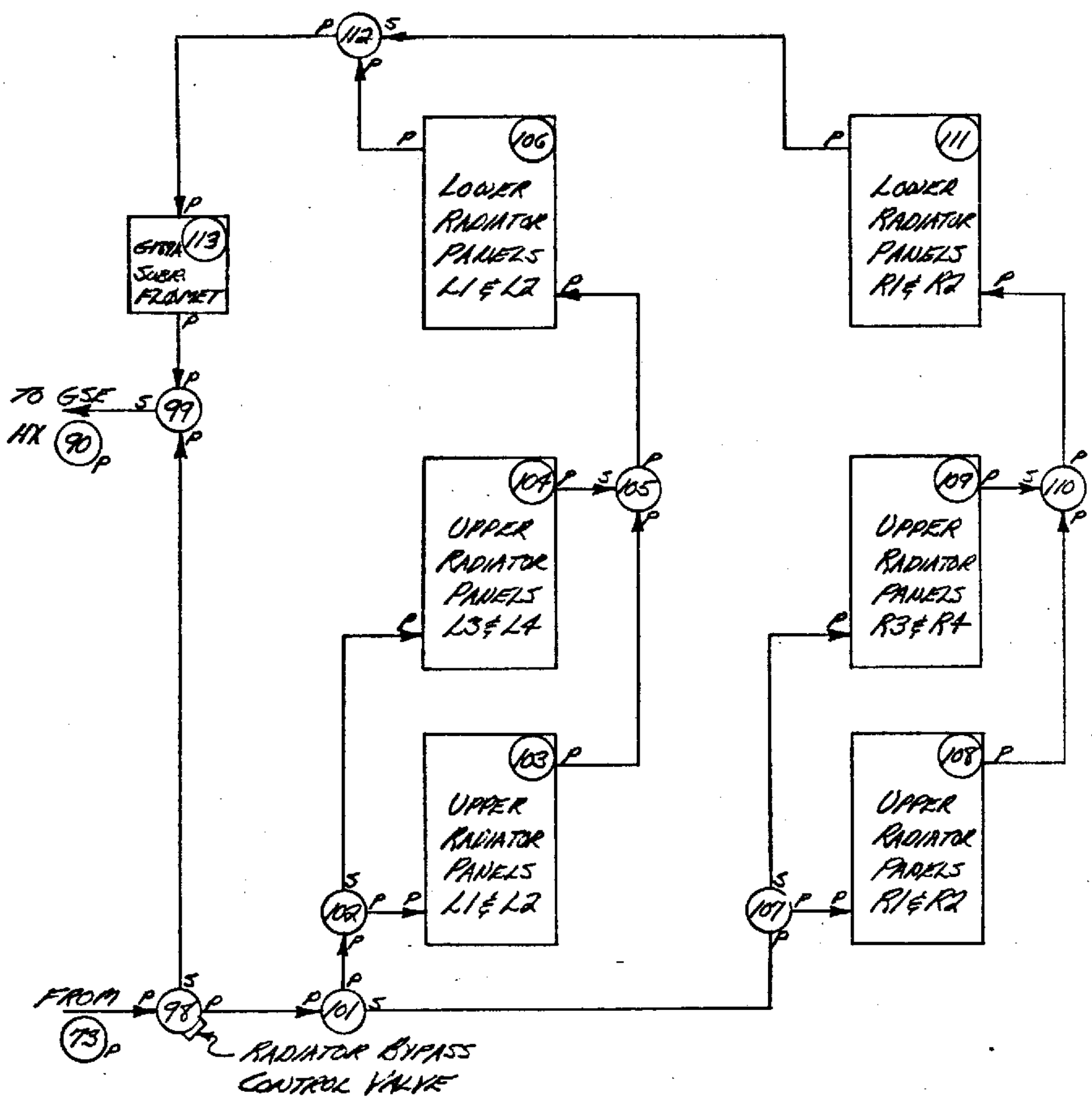

FIGURE 4, G189A SIMULATION - RADIATOR SYSTEM

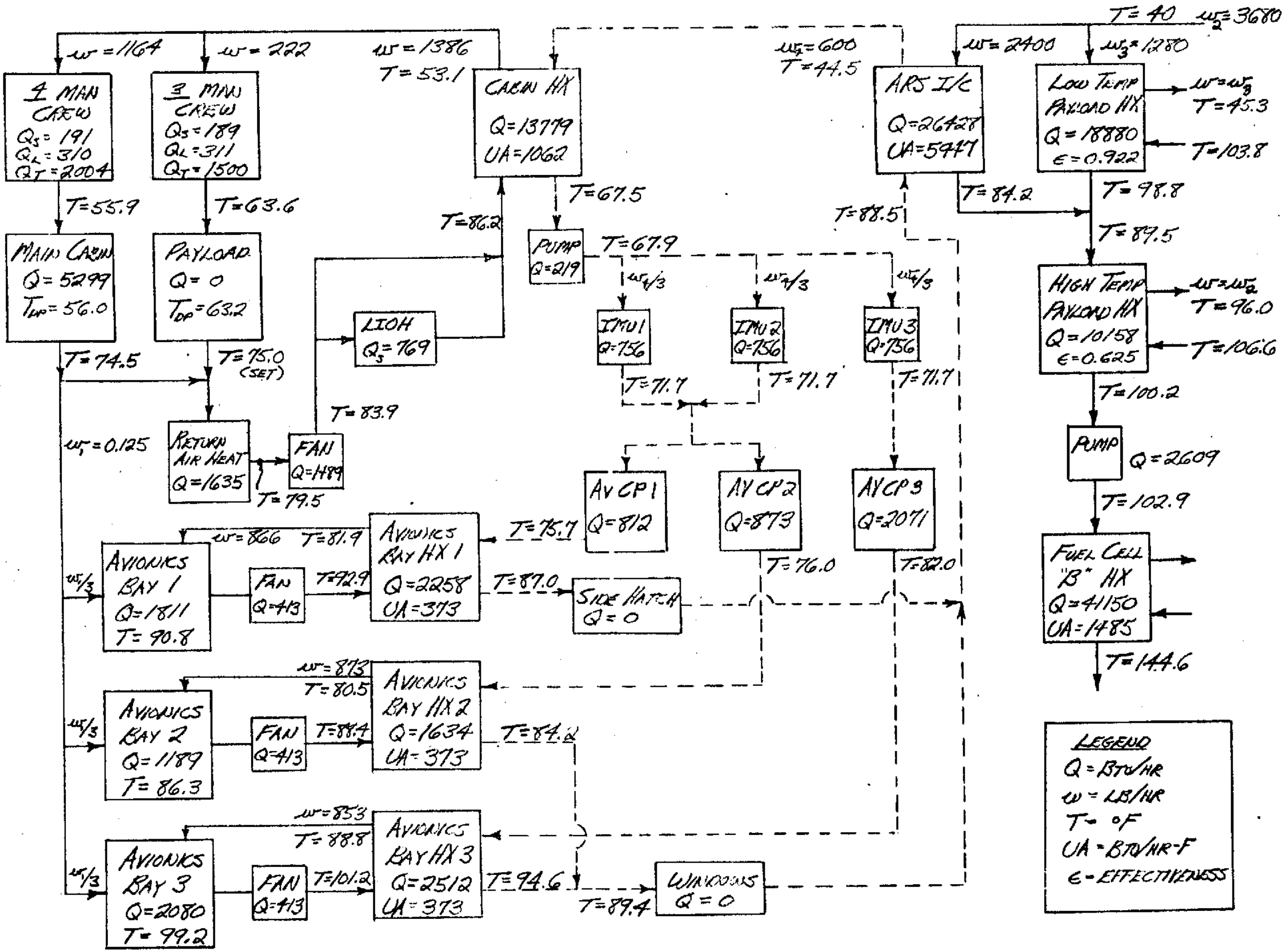

FIGURE 5 – 7 MAN ON-ORBIT, MAX PAYLOAD HEAT

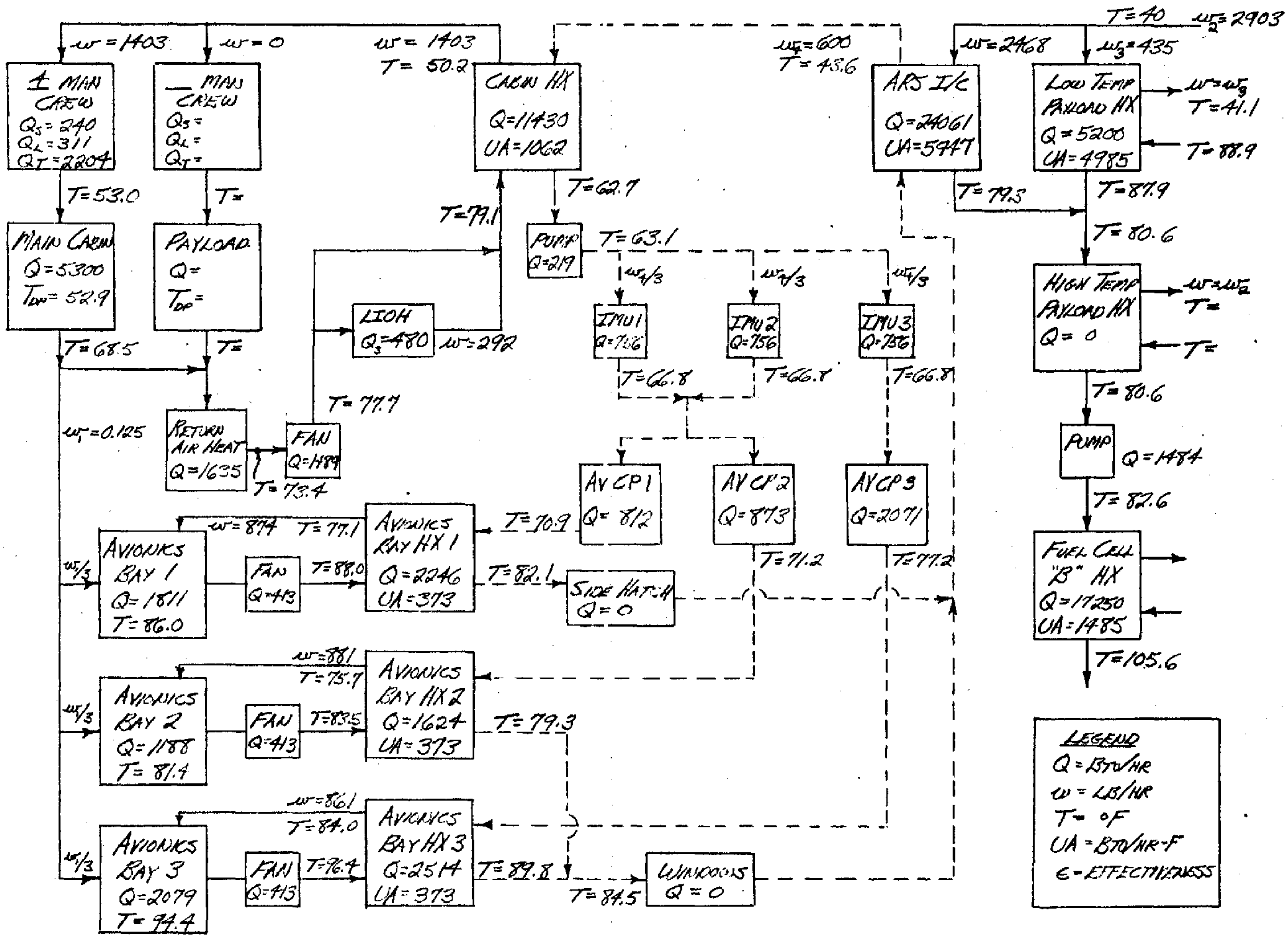

FIGURE 6 - 4 MAN ON-ORBIT, NO SPACE LAB

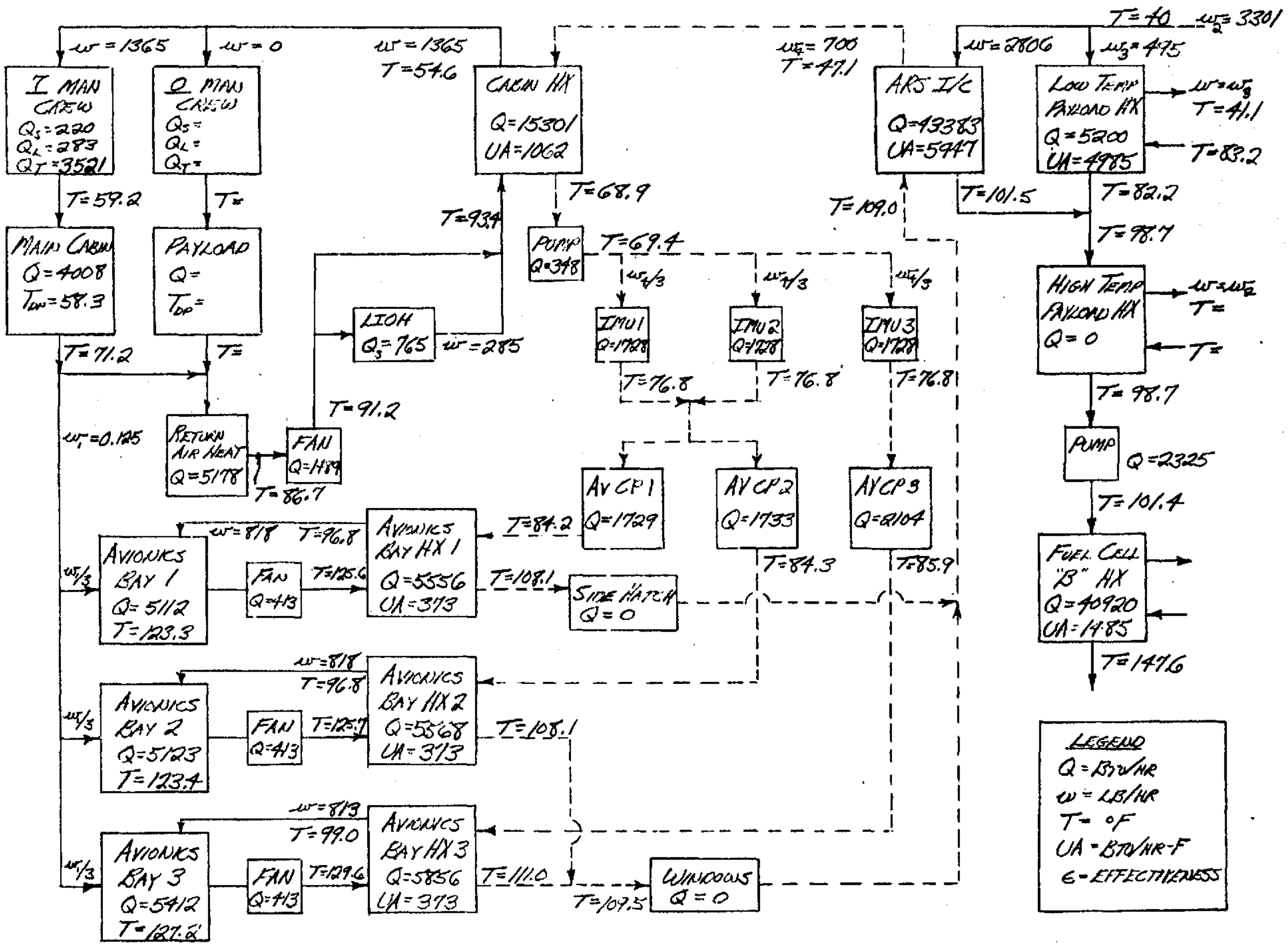

FIGURE 7 - 7 MAN LAUNCH/REENTRY

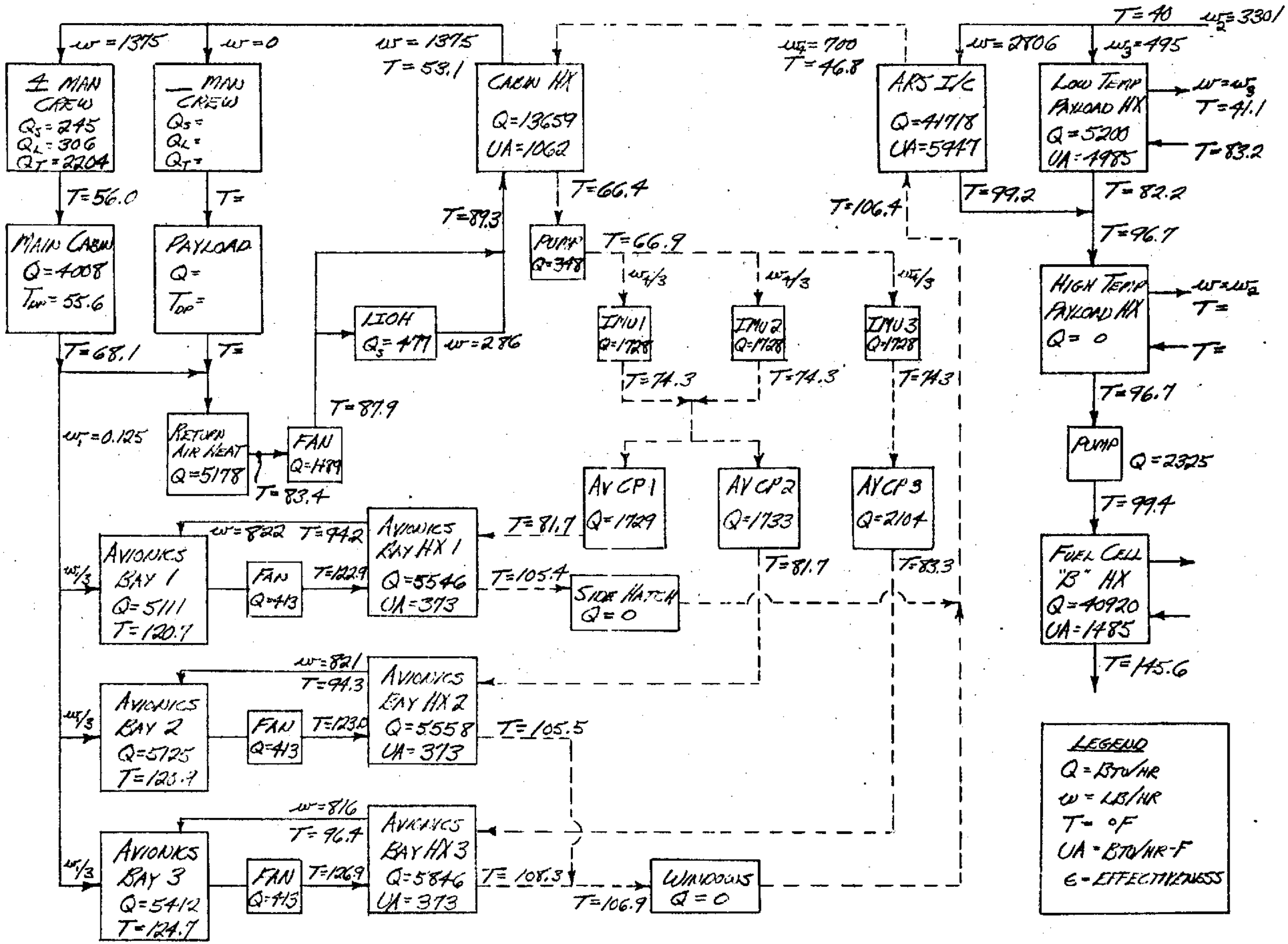

FIGURE 8 - 4 MAN LAUNCH/REENTRY

CARD LISTING NO. 1

DATA DECK FOR G189A SHUTTLE

ORBITER EC/LSS SIMULATION

INPUT CARD IMAGES LISTED BELOW

```
TAPE            TOUT
BASIC            1      117       76                    YEA       NAY
CASE            G189A SHUTTLE ECLSS AND ATCS SIMULATION  7 MAN ON ORBITMAX P/L Q
 $CASE1
  KRUN=4,
  KCHOUT=1, KPRNT=6, KPTINV(1)=1, MAXSLP=4, MINSSI=2, KRUN=1, DTIME=30.,
  TIMEMX=360., MAXSSI=5, TMAX=250., TMIN=-20.,WTMAX=1.E6,
       TIMEMX =3600.0,
       DTIME =60.0  ,
  TMIN = -200.0,
       KPTINV(2) =5 ,
  DTIME=235.8, TIMEMX=107524.8,
  TIMEMX=6000.,  DTIME=120.,
 KRUN=0,
  MAXSSI=12, MINSSI=4,
  KCHOUT=0,
  TMAX = 250.0   $
 $PROP1
  CP(1)=1., RHO(1)=62.4, VISC(1)=2,42, WTM(1)=18., XK(1)=0.34,
  CP(2)=.248, RHO(2)=86.8, VISC(2)=.822, WTM(2) =102.9, XK(2)=.0612,
 CP(3)=0.27, RHO(3)=116.0, VISC(3)=5.81, WTM(3)=000.0, XK(3)=0.038,
 CP(4)=0.56, RHO(4)=51.8,  VISC(4)=10.2, WTM(4)=000.0, XK(4)=0.066,
  CP(5)=0.72,  RHO(5)=68.4,  VISC(5)=0.007,  WTM(5)=000.0,  XK(5)=0.275,
  CPCONL=1., CPCONV=0.44, CPCO2=0.2, CPDIL=0.25, CPOXY=0.22, CPTC=0.2,
  GAMGAS=1.4, VISGAS=0.44, WTMCON=18., WTMDIL=28., WTMTC=20.,
  XKGAS=0.146 $
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ID**    1  50 FLUID TYPE CODES --
ID**    1  51            1 = WATER
ID**    1  52            2 = FREON 21
ID**    1  53            3 = FC-40
ID**    1  54            4 = HYDRAULIC FLUID
ID**    1  55            5 = GSE GLYCOL/WATER
ID**    1  99
ID**    1 100 RISD - ATMOSPHERIC REVITALIZATION REQUIREMENTS - SRR CONFG- 7/23/73
ID**    1 101      1. CABIN AIR TEMPS,  65-80 F DB,  39-61 F DP
ID**    1 102          A. TMAX=70 F DB, 61 F DP FOR 4 MEN AT MAX METABOLIC RATES
ID**    1 103             AND MAX HEAT LOADS  (EXCEPT FOR REENTRY PHASE)
ID**    1 104          B. TMAX=80 F DB, 61 F DP FOR 10 MEN AT NOMINAL METABOLIC
ID**    1 105             RATES AND MAX HEAT LOADS (EXCEPT FOR REENTRY PHASE)
ID**    1 106          C. TMAX=90F DB DURING ENTRY, TOUCHDOWN, AND TD+15 MIN.
ID**    1 107          D. TEMP SELECTABLE WITHIN + OR - 2 F DURING ORBITAL
ID**    1 108             PHASES WITH 4 MEN
ID**    1 120      2. CABIN GAS PRESSURES
ID**    1 121          A. 14.7 PSIA +-2  TOTAL PRESSURE  (13.9 PSIA DURING AIRL)
ID**    1 122                MAKEUP GAS= 7 LB/DAY FOR STURTURE AND METABOLIC
ID**    1 123                         = 3 LB/DAY FOR AVIONICS BAY PURGE
ID**    1 124          B. OXYGEN PRESSURE = 3.1 PSIA +-1  (MINIMUM OF 2.75 PSIA
ID**    1 125             DURING REPRESSURIZATION)
ID**    1 126          C. CO2 PRESSURE = 0-7.6 MM HG  (5.0 MM HG NOMINAL)
ID**    1 130      3. COLD PLATE EQUIPMENT TEMP =  35-120 F
ID**    1 140      4. AIR COOLED AVIONICS HX GAS TEMP = 100 F IN OR 130 F OUT
ID**    1 150      5. PAYLOAD SUPPORT
ID**    1 151          A.CABIN
ID**    1 152                1000 BTU/HR FROM PAYLOAD CONSOLE
ID**    1 153                METABOLIC HEAT AND CO2 FOR 4 MEN
ID**    1 154          B.PAYLOAD MODULE
ID**    1 155                48 CFM NOMINAL AT 50 F NOMINAL
ID**    1 156                MAINTAIN HABITABLE PRESSURE AND GAS COMPOSITION
ID**    1 160      6.STRUCTURAL HEAT LOSS/GAIN
ID**    1 161          MAX GAIN = 1700 BTU/HR DURING NON-ORBIT PHASES
ID**    1 162                   = 6500 BTU/HR DURING ENTRY TO TD + 15 MIN
ID**    1 163          MAX LOSS =-4600 BTU/HR DURING ORBITAL PHASES
ID**    1 170      7. AVIONICS BAY
ID**    1 171          PRESSURE = CABIN P - 0.4 PSIA
ID**    1 172                   (= CABIN P + 0.6 PSIA DURING FIRE SUPPRESSION OR
ID**    1 173                      AIR LOCK PRESSURIZATION)
ID**    1 180      8. LIOH CAPABILITY
ID**    1 181          10 MEN AT 2.11 LB CO2/DAY   OR
ID**    1 182           4 MEN AT 2.58 LB CO2/DAY  TO MAINTAIN PPCO2 LIMITS
ID**    1 190      9. CABIN HX GAS SUPPLY = 50 F DB, 50 F DP
ID**    1 200     10. CABIN WALL TEMP .GT. CABIN GAS TEMP FOR ALL PRESSURIZED COMP
ID**    1 210     11. ON-ORBIT STURTURAL HEAT LOSS SHALL BE ACCOMODATED FOR BY
ID**    1 211         A 1.0 KW HEATER
ID**    1 299
ID**    1 300 RISD - ACTIVE THERMAL CONTROL REQUIREMENTS- SRR CONFG-  7/23/73
ID**    1 310      1. RADIATORS  (12 MODULAR STAGNATION TYPE PANELS, 8 UP, 4 DOWN)
ID**    1 311           QREJECT = 7000-75000 BTU/HR FOR ANY ATTITUDE  FROM
ID**    1 312           100000 FT  TO  100-270 NAUTICAL MILE ORBIT
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ID**    1 320      2. HEAT SINKS
ID**    1 321           AMMONIA BOILER - 20000 FT TO TOUCHDOWN + 17 MIN (40+-5F)
ID**    1 322           NONE - ASCENT TO 100000 FT, REENTRY 100000-20000 FT
ID**    1 323           VAPOR CYCLE - FERRY OPERATIONS, 40000 BTU/HR  (42 +-3F)
ID**    1 330      3. PAYLOAD HEAT LOAD = 21500 BTU/HR MAX
ID**    1 340      4. HX UA VALUES
ID**    1 341              7398  FREON-WATER INTERCHANGER
ID**    1 342              1027  FUEL CELL HX (TYPE A, 2LOOPS OPERATING)
ID**    1 343              1508  FUEL CELL HX (TYPE B, 2LOOPS OPERATING)
ID**    1 344              1644  GSE HX
ID**    1 345               563  HYDRAULIC HX (1 LOOP OPERATING)
ID**    1 346              1429  PAYLOAD HX
ID**    1 350      5. FREON PUMP--CENTRIFUGAL, EFFICIENCY= 0.291
ID**    1 360      6. HYDRAULICS HEATING = 0-15000 BTU/AR  (.GT.40 F HYDRAULIC FL)
ID**    1 370      7. SUBLIMATOR OPERATION
ID**    1 371           ASCENT TO 100000 FT, ON-ORBIT DOORS CLOSED, AND DURING
ID**    1 372           RENTRY FROM DOOR CLOSURE TO 100000 FT
ID**    1 380      8. INTERCHANGER LOAD = 40000 BTU/HR AT 40 F FREON SUPPLY
ID**    1 399
ID**    1 400 HSD-FREON COOLANT LOOP PROPOSAL   5-29-73
ID**    1 410      1. 0.75 IN OD AL TUBES, 0.028 IN WALL
ID**    1 420      2. FREON PUMP DELTA P = 41 PSI AT 2200 LB/HR
ID**    1 430      3. HX'S ARE STAINLESS STELL WITH NICKEL FINS EXCEPT FOR TYPE A
ID**    1 431         FUEL CELL HX WHICH IS ALUMINUM
ID**    1 997
ID**    1 998
ID**    1 999 SHUTTLE CREW METABOLIC SIMULATION
KBAS    1    0  3              80 2                                         2    2
NSTR    1    00                        SOLVE FOR TYP CREWMAN AND MULTIPLY BY TOTAL NO
KARY    1   16          4       4 CREWMEN
KARY    1   17          990     AVG. MAN, 500 BTU/HR METABOLIC RATE, CLO=.99
VARY    1   71 25.0             AVG. CABIN GAS VELOCITY  (FT/MIN)                PRR
VARY    1   72 300.             MAX HEAT STORAGE/MAN (BTU)                        PRR

ID**    2    0 SHUTTLE MAIN CABIN
ID**    2    1 WALL TEMPERATURES.GT. CABIN GAS TEMPERATURE                     RDD/SRR
ID**    2    2                      .LT. 113 DEG F  CREW ACESSIBLE             RDD/SRR
ID**    2    3                      .LT. 120 DEG F  CREW NON-ACESSIBLE
KBAS    2    0  1              1 2                                        43    2
NSTR    2    0021000010              2 RESETS,CARRY ENTRAINED WATER
VARY    2    2 72.5             CABIN TEMP  (F)                                RDD/SRR
VARY    2    3 14.7           4 CABIN PRESSURE  (PSIA)                         RDD/SRR
VARY    2    6 9.4              H2O VAPOR FLOW  (LB/HR)
VARY    2   10 272.0            OXYGEN FLOW  (LB/HR)
VARY    2   11 875.8            NITROGEN FLOW  (LB/HR)
VARY    2   12 9.4              CO2 FLOW  (LB/HR)
VARY    2   66                  CABIN HEAT LOAD - CALC IN GPOLY
VARY    2   87 72.5             CABIN GAS DESIGN TEMP  (F)   (4 MEN)           RDD/SRR
VARY    2   88 7.5              CABIN GAS DESIGN TEMP TOL (F)  (4 MEN)         RDD/SRR
VARY    2   90 14.7             DESIGN TOTAL PRESSURE (PSIA)                   RDD/SRR
VARY    2   91 0.2              DESIGN TOTAL PRESSURE TOL  (PSIA)              RDD/SRR
VARY    2   92 3.1              DESIGN OXYGEN PRESSURE  (PSIA)                 RDD/SRR
VARY    2   93 0.1              DESIGN OXYGEN PRESSURE TOL (PSIA)              RDD/SRR
VARY    2   96 50.0             DESIGN DEW POINT (F)                           RDD/SRR
VARY    2   97 11.0             DESIGN DEW POINT TOL (F)                       RDD/SRR
VARY    2   99 7.6              MAX ALLOWABLE CO2 PRESSURE  (MM HG)            RDD/SRR
VARY    2  101 250.             MAX ALLOWABLE TRACE CONTAMINANT LEVEL (PPM)
VARY    2  122 0.25             TOTAL OUTBOARD LEAKAGE (LB/HR), 6 LB/DAY       RDD/SRR
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VARY    2 127                   N-C ADDITION RATE  (LB/HR)
VARY    2 128                   COND. VAPOR ADDITION RATE (LB/HR)
VARY    2 129                   COND ENTRAINED LIQUID ADDITION RATE (LB/HR)
VARY    2 134 0.2               SPECIFIC HEAT OF N-C ADDED  (BTU/LB-F)

ID**    3    0 SPLIT - MAIN CABIN LEAKAGE TO AVIONICS BAYS
KBAS    3    0 10           2 2                     2                 4     2
NSTR    3    002                   SPECIFY R(20) IN GPOLY - CALC R(65)
VARY    3    20                 MAX LEAKAGE TO AV BAYS 1-3 (LB/HR)- 3 LB/DAY ROD/SRR

ID**    4    0 SPLIT -(AVIONICS BAY NO. 1 GAS SUPPLY)
KBAS    4    0 10          -3 2                     2                 5     2
NSTR    4    00                    INPUT UNIVERSAL SPLIT RATIO
VARY    4    65 .666666666      SPLIT RATIO TO AVIONICS BAYS 2 AND 3

ID**    5    0 SPLIT -(AVIONICS BAY NOS. 2 AND 3 GAS SUPPLIES)
KBAS    5    0 10          -4 2                     2                83     2
NSTR    5    00                    INPUT UNIVERSAL SPLIT RATIO
VARY    5    65 .5              SPLIT RATIO TO AVIONIC BAY 3

ID**    8    0 MAIN CABIN FANS (3)
KBAS    8    0 23          84 2                                      13     2
NSTR    8    01                    INPUT HEAT ADDITION DUE TO FAN + CFM
VARY    8    76 317.0            FAN VOLUMETRIC FLOW (CFM)
VARY    8    91 436.3           FAN HEAT ADDITION (WATTS)                      FE

ID**   13    0 SPLIT - (LIOH BEDS BYPASS)
KBAS   13    0 10           8 2                     2                15     2
NSTR   13    00                    INPUT UNIV SPLIT RATIO
VARY   13    65 0.792           LIOH BEDS BYPASS GAS FLOW RATIO

ID**   15    0 SPLIT - (LIOH BED INTERNAL BYPASS)
KBAS   15    0 10          13 2                     2                17     2
NSTR   15    00                    INPUT UNIV SPLIT RATIO
VARY   15    65 0.0             SPLIT RATIO - LIOH 1 BYPASS

ID**   17    0 LIOH BEDS
KBAS   17    0 63          15 2                                      19     2
NSTR   17    01                 1  REMOVE ALL TRACE CONTAMINANTS  - SS SOLUTION
VARY   17    66 0.95            CO2 REMOVAL EFFICIENCY CONSTANT - C1
VARY   17    67 0.0             CO2 REMOVAL EFFICIENCY CONSTANT - C2
VARY   17    68 875.0           HEAT OF REACTION FOR CO2  (BTU/LB CO2)

ID**   19    0 GASMIX - (LIOH BED INTERNAL BYPASS)
KBAS   19    0  6          17 2                    15                85     2

ID**   22    0 MAIN CABIN CONDENSING HX
KBAS   22    0  4          86 2                   -58 0   1          23     2
NSTR   22    0200000100         1  COUNTERFLOW,REMOVE ALL COND H2O, SS MODEL
VARY   22    66 1062.           OVERALL UA  (BTU/HR-F)

ID**   23    0 GASMIX - (CABIN TEMP CONTROL VALVE BYPASS)
KBAS   23    0  6          22 2                    86                80     2

ID**   24    0 AVIONICS BAY 1 - AIR COOLED AVIONICS COMPARTMENT
KBAS   24    0  1 20       29 2                    -4                32    24
NSTR   24    0021100010            2 RESETS, CARRY ENTRAINED WATER
VARY   24    2 85.0             AVIONICS BAY 1 - TEMP (F)
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VARY   24    3 14.3          4 AVIONICS BAY 1 - PRES (PSIA)                        RDD/SRR
VARY   24    6 7.5             AVIONICS BAY 1 - COND VAPOR (LB/HR)                     PRR
VARY   24   10 749.7           AVIONICS BAY 1 - O2 FLOW (LB/HR)                        PRR
VARY   24   11 749.7           AVIONICS BAY 1 - N2 FLOW  (LB/HR)                       PRR
VARY   24   12 10.0            AVIONICS BAY 1 - CO2 FLOW (LB/HR)                       PRR
VARY   24   66                 HEAT LOAD (BTU/HR) - CALC IN GPOLY
VARY   24   87 85.0            AVIONICS BAY 1 - DESIGN GAS TEMP (F)
VARY   24   88 45.0            AVIONICS BAY 1 - DESIGN GAS TEMP TOL (F)
VARY   24   90 14.3            AVIONICS BAY 1 - DESIGN TOTAL PRESS     (PSIA)
VARY   24   91 14.3            AVIONICS BAY 1 - DESIGN TOTAL PRESS TOL.(PSIA)
VARY   24   92 3.0             AVIONICS BAY 1 - DESIGN O2 PRESS (PSIA)
VARY   24   93 3.0             AVIONICS BAY 1 - DESIGN O2 PRESS (TOL (PSIA)
VARY   24   96 50.0            AVIONICS BAY 1 - DESIGN DEW POINT TEMP (F)
VARY   24   97 11.0            AVIONICS BAY 1 - DESIGN DEW POINT TEMP TOL (F)
VARY   24   99 7.6             AVIONICS BAY 1 - MAX CO2 PRES (MM HG)
VARY   24  101 250.0           AVIONICS BAY 1 - MAX TRACE CONT LEVEL (PPM)
VARY   24  122 0.04167         AVIONICS BAY 1 - LEAKAGE (LB/HR) - 1 LB/DAY  RDD/SRR

ID**   26    0 AVIONICS BAY 1 - FANS (2)
KBAS   26    0 23            24 2                                           29    24
NSTR   26    01                        INPUT HEAT ADDITION DUE TO FAN + CFM
VARY   26   76 200.0            FAN VOLUMETRIC FLOW (CFM)
VARY   26   91 121.0           FAN HEAT ADDITION (WATTS)                                FE

KBAS   29    0  4            26 2                  -50 0    1                24    24
NSTR   29    0200000100                COUNTERFLOW, SS MODEL
VARY   29   66 373.0           OVERALL UA  (BTU/HR-F)                                   FE

ID**   30    0 AVIONICS BAY 2 - AIR COOLED AVIONICS COMPARTMENT
KBAS   30    0  1 20         35 2                  -5                        36    30
NSTR   30    0021100010                2 RESETS, CARRY ENTRAINED WATER
VARY   30    2 85.0            AVIONICS BAY 2 - TEMP (F)
VARY   30    3 14.3          4 AVIONICS BAY 2 - PRES (PSIA)                        RDD/SRR
VARY   30    6 7.5             AVIONICS BAY 2 - COND VAPOR (LB/HR)                     PRR
VARY   30   10 749.7           AVIONICS BAY 2 - O2 FLOW (LB/HR)                        PRR
VARY   30   11 749.7           AVIONICS BAY 2 - N2 FLOW  (LB/HR)                       PRR
VARY   30   12 10.0            AVIONICS BAY 2 - CO2 FLOW (LB/HR)                       PRR
VARY   30   66                 HEAT LOAD (BTU/HR) - CALC IN GPOLY
VARY   30   87 85.0            AVIONICS BAY 2 - DESIGN GAS TEMP (F)
VARY   30   88 45.0            AVIONICS BAY 2 - DESIGN GAS TEMP TOL (F)
VARY   30   90 14.3            AVIONICS BAY 2 - DESIGN TOTAL PRESS     (PSIA)
VARY   30   91 14.3            AVIONICS BAY 2 - DESIGN TOTAL PRESS TOL.(PSIA)
VARY   30   92 3.0             AVIONICS BAY 2 - DESIGN O2 PRESS (PSIA)
VARY   30   93 3.0             AVIONICS BAY 2 - DESIGN O2 PRESS (TOL (PSIA)
VARY   30   96 50.0            AVIONICS BAY 2 - DESIGN DEW POINT TEMP (F)
VARY   30   97 11.0            AVIONICS BAY 2 - DESIGN DEW POINT TEMP TOL (F)
VARY   30   99 7.6             AVIONICS BAY 2 - MAX CO2 PRES (MM HG)
VARY   30  101 250.0           AVIONICS BAY 2 - MAX TRACE CONT LEVEL (PPM)
VARY   30  122 0.04167         AVIONICS BAY 2 - LEAKAGE (LB/HR) - 1 LB/DAY  RDD/SRR

ID**   32    0 AVIONICS BAY 2 - FANS (2)
KBAS   32    0 23            30 2                                           35    30
NSTR   32    01                        INPUT HEAT ADDITION DUE TO FAN + CFM
VARY   32   76 200.0            FAN VOLUMETRIC FLOW (CFM)
VARY   32   91 121.0           FAN HEAT ADDITION (WATTS)                                FE

ID**   35    0 AVIONICS BAY 2 - GAS/LIQ HX
KBAS   35    0  4            32 2                  -51 0    1                30    30
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NSTR  35   0200000100              COUNTERFLOW, SS MODEL
VARY  35  66 373.0           OVERALL UA  (BTU/HR-F)                                    FE

ID**  36   0 AVIONICS BAY 3 - AIR COOLED AVIONICS COMPARTMENT
KBAS  36   0  1 20           41 2                       5                       54    36
NSTR  36   0021100010              2 RESETS, CARRY ENTRAINED WATER
VARY  36   2 85.0            AVIONICS BAY 3 - TEMP (F)
VARY  36   3 14.3          4 AVIONICS BAY 3 - PRES (PSIA)                         RDD/SRR
VARY  36   6 7.5             AVIONICS BAY 3 - COND VAPOR (LB/HR)                      PRR
VARY  36  10 749.7           AVIONICS BAY 3 - O2 FLOW (LB/HR)                         PRR
VARY  36  11 749.7           AVIONICS BAY 3 - N2 FLOW  (LB/HR)                        PRR
VARY  36  12 10.0            AVIONICS BAY 3 - CO2 FLOW (LB/HR)                        PRR
VARY  36  66                 HEAT LOAD (BTU/HR) - CALC IN GPOLY
VARY  36  87 85.0            AVIONICS BAY 3 - DESIGN GAS TEMP (F)
VARY  36  88 45.0            AVIONICS BAY 3 - DESIGN GAS TEMP TOL (F)
VARY  36  90 14.3            AVIONICS BAY 3 - DESIGN TOTAL PRESS     (PSIA)
VARY  36  91 14.3            AVIONICS BAY 3 - DESIGN TOTAL PRESS TOL.(PSIA)
VARY  36  92 3.0             AVIONICS BAY 3 - DESIGN O2 PRESS (PSIA)
VARY  36  93 3.0             AVIONICS BAY 3 - DESIGN O2 PRESS (TOL (PSIA)
VARY  36  96 50.0            AVIONICS BAY 3 - DESIGN DEW POINT TEMP (F)
VARY  36  97 11.0            AVIONICS BAY 3 - DESIGN DEW POINT TEMP TOL (F)
VARY  36  99 7.6             AVIONICS BAY 3 - MAX CO2 PRES (MM HG)
VARY  36 101 250.0           AVIONICS BAY 3 - MAX TRACE CONT LEVEL (PPM)
VARY  36 122 0.04167         AVIONICS BAY 3 - LEAKAGE (LB/HR) - 1 LB/DAY  RDD/SRR

ID**  38   0 AVIONICS BAY 3 - FANS (2)
KBAS  38   0 23              36 2                                               41    36
NSTR  38   01                      INPUT HEAT ADDITION DUE TO FAN + CFM
VARY  38  76 200.0            FAN VOLUMETRIC FLOW (CFM)
VARY  38  91 121.0           FAN HEAT ADDITION (WATTS)

ID**  39   0 WINDOW PANELS
KBAS  39   0 49              54       1                                         47
NSTR  39   02                      INPUT HEAT LOAD
VARY  39  65                 HEAT LOAD (BTU/HR) - CALC IN GPOLY

ID**  40   0 IMU - BAY 3 CIRCUIT
KBAS  40   0 49              48       1                                         52
NSTR  40   02                      INPUT HEAT LOAD
VARY  40  65                 HEAT LOAD (BTU/HR) - CALC IN GPOLY

ID**  41   0 AVIONICS BAY 3 - GAS/LIQ HX
KBAS  41   0  4              38 2                      -52 0    1               36    36
NSTR  41   0200000100              COUNTERFLOW, SS MODEL
VARY  41  66 373.0           OVERALL UA  (BTU/HR-F)                                    FE

ID**  42   0 SPLIT - (IMU BAY 1 AND IMU BAY 2 CIRCUIT)
KBAS  42   0 10             -48       1                                         44
VARY  42  65 .5              SPLIT RATIO TO IMU BAY 1 CIRCUIT

ID**  43   0 WATER LOOP PUMPS (2)
KBAS  43   0 22             -22       1                                         48     2
NSTR  43   00002                   INPUT HEAT ADDITION DUE TO PUMP
VARY  43  80                 PUMP VOLUMETRIC FLOW (CFM)
VARY  43  85 64.17           PUMP HEAT ADDITION (WATTS)

ID**  44   0 IMU - BAY 2 CIRCUIT
KBAS  44   0 49              42       1                                         45
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NSTR  44   02                          INPUT HEAT LOAD
VARY  44   65                   HEAT LOAD (BTU/HR) - CALC IN GPOLY

ID**  45   0 IMU - BAY 1 CIRCUIT
KBAS  45   0 49           -42       1                                  46
NSTR  45   02                          INPUT HEAT LOAD
VARY  45   65                   HEAT LOAD (BTU/HR) - CALC IN GPOLY

ID**  46   0 LIQMIX - (IMU BAY 1 AND IMU BAY 2 CIRCUITS)
KBAS  46   0  7            44       1              -45                 49

ID**  47   0 SIDE HATCH PANELS
KBAS  47   0 49           -29       1                                  53     2
NSTR  47   02                          INPUT HEAT LOAD
VARY  47   65                   HEAT LOAD (BTU/HR) - CALC IN GPOLY

ID**  48   0 SPLIT - (IMU BAY 3 CIRCUIT)
KBAS  48   0 10            43       1                    1             40
NSTR  48   00                          INPUT UNIV SPLIT RATIO
VARY  48   65 .666666667        SPLIT RATIO - FLOW TO COLDPLATES AV-1, AV-2

ID**  49   0 SPLIT - (AVIONICS COLDPLATES AV-1 AND AV-2)
KBAS  49   0 10            46       1                    1             50
NSTR  49   00                          INPUT UNIV SPLIT RATIO
VARY  49   65 .5                SPLIT RATIO TO AVIONIC BAY 1 COLDPLATES

ID**  50   0 AVIONICS BAY 1 COLDPLATES, AV-1
KBAS  50   0  8           -49       1                                  51
NSTR  50   00                          NO TEMP TEST FOR FAILURES
VARY  50   51 60.0              ELEC TEMP (F)
VARY  50   66                   ELEC HEAT DISP - CALC IN GPOLY   (WATTS)
VARY  50   67 1.0      E6       CP ELEC - CP CONTACT COND  (BTU/HR-F)

ID**  51   0 AVIONICS BAY 2 COLDPLATES, AV-2
KBAS  51   0  8            49       1                                  26
NSTR  51   00                          NO TEMP TEST FOR FAILURES
VARY  51   51 60.0              ELEC TEMP (F)
VARY  51   66                   ELEC HEAT DISP - CALC IN GPOLY   (WATTS)
VARY  51   67 1.0      E6       CP ELEC - CP CONTACT COND  (BTU/HR-F)

ID**  52   0 AVIONICS BAY 3 COLDPLATES, AV-3
KBAS  52   0  8            40       1                                  42
NSTR  52   00                          NO TEMP TEST FOR FAILURES
VARY  52   51 60.0              ELEC TEMP (F)
VARY  52   66                   ELEC HEAT DISP - CALC IN GPOLY   (WATTS)
VARY  52   67 1.0      E6       CP ELEC - CP CONTACT COND  (BTU/HR-F)

ID**  53   0 LIQMIX - AVIONIC BAY HXS 1, 2, AND 3
KBAS  53   0  7            47       1              -39                 55

ID**  54   0 LIQMIX - AVIONIC BAY HXS 2 AND 3
KBAS  54   0  7           -35       1               41                 39

ID**  55   0 WATER/FREON INTERCHANGER HX
KBAS  55   0  4            53       1              -76     2           61
NSTR  55   0200020100                  COUNTERFLOW, LIQ-LIQ, SS MODEL
VARY  55   66 5947.0            OVERALL UA  (BTU/HR-F)                       FE
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ID**  56   0 WATER SUBLIMATOR 1
KBAS  56   0 49            74      2                                          57
NSTR  56   00                        PASS TEMP AND FLOW

ID**  57   0 WATER SUBLIMATOR 2
KBAS  57   0 49            56      2                                          75
NSTR  57   00                        PASS TEMP AND FLOW

ID**  58   0 POTABLE WATER CHILLER
KBAS  58   0 49            61      1                                          60
NSTR  58   00                        PASS TEMP AND FLOW
VARY  58   1 600.0           H2O FLOW  (LB/HR)
VARY  58   2 45.0            TEMP (F)
VARY  58   3 80.0          4 PRESSURE (PSIA)                                      OFCL

ID**  59   0 LOW TEMP PAYLOAD HX
KBAS  59   0  4            60      2                 76      2                77
NSTR  59   0000020100                CNTRFLOW, LIQ-LIQ, SS MODEL
VARY  59   1 1280.           FREON FLOW (LB/HR)
VARY  59   2 45.0            TEMP (F)
VARY  59   3 90.0          4 PRESS (PSIA)
VARY  59  67 0.922           HX EFFECTIVENESS

ID**  60   0  LOW TEMP P/L HEAT LOAD SIMULATOR
KBAS  60   0 49            59      2                                          59
NSTR  60   02                          INPUT HEAT LOAD IN GPOLY
VARY  60  65                 HEAT LOAD (BTU/HR) - INPUT IN GPOLY

ID**  61   0 LIQUID COOLED GARMENT HX
KBAS  61   0 49            55      1                                          58

ID**  62   0 FREON 21 PUMPS (2)
KBAS  62   0 22          -78       2                                          66
NSTR  62   00002                     INPUT PUMP HEAT ADDITION
VARY  62  85 765.2           PUMP HEAT ADDITION (WATTS)

ID**  65   0 FUEL CELL HX
KBAS  65   0  4            66      3                -62      2                67
NSTR  65   0200020100                CNTRFLOW, LIQ-LIQ, SS MODEL
VARY  65   1 14741.0         FC-40 FLOW (LB/HR)
VARY  65   2 130.0           TEMP (F)
VARY  65   3 70.0          4 PRESS (PSIA)
VARY  65  66 1485.           OVERALL UA  (BTU/HR-F)                               FL

ID**  66   0 FUEL CELL WASTE HEAT SIMULATOR
KBAS  66   0 49            65      3                                          65
NSTR  66   02                        INPUT HEAT LOAD
VARY  66  65                 FUEL CELL WASTE HEAT (BTU/HR) - CALC IN GPOLY

ID**  67   0 SPLIT -   GSE HX BYPASS CONTROL VALVE
KBAS  67   0 10          -65       2                         2                87
NSTR  67   00                        INPUT UNIV SPLIT RATIO
VARY  67  65 0.0             SPLIT RATIO - ALL FLOW TO GSE HX

ID**  68   0 HYDRAULICS HX 1
KBAS  68   0  4            87      2                -69      4                71
NSTR  68   0200020100                CNTRFLOW, LIQ-LIQ, SS MODEL
VARY  68  20 0.0             FLOW (LB/HR)
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VARY  68   21 20.0            TEMP (F)                                              HSD/PRO
VARY  68   22 500.         23 PRESS (PSIA)
VARY  68   66 200.            OVERALL UA  (BTU/HR-F)

ID**  69    0 HYDRAULIC HX NO. 1 COOLING LOAD SIMULATOR
KBAS  69    0 49          -68      4                                        68
NSTR  69    02                        INPUT HEAT LOAD
VARY  69   65                 HYD HX NO. 1 HEAT LOAD (BTU/HR) - CALC IN GPOLY

ID**  70    0 HYDRAULICS HX 2
KBAS  70    0  4           68      2                   -71      4           72
NSTR  70    0200020100                CNTRFLOW, LIQ-LIQ, SS MODEL
VARY  70    1 0.0             FLOW (LB/HR)                                         OFCL
VARY  70    2 0.0             TEMP (F)                                             OFCL
VARY  70    3 500.0         4 PRES (PSIA)                                          RDD/SRR
VARY  70   66 200.            OVERALL UA  (BTU/HR-F)

ID**  71    0 HYDRAULIC HX NO. 2 COOLING LOAD SIMULATOR
KBAS  71    0 49          -70      4                                        70
NSTR  71    02                        INPUT HEAT LOAD
VARY  71   65                 HYD HX NO. 2 HEAT LOAD (BTU/HR) - CALC IN GPOLY

ID**  72    0 HEAT SINK 1
KBAS  72    0 49           70      2                                        73
NSTR  72    00                        PASS FLOW AND TEMP

ID**  73    0 HEAT SINK 2
KBAS  73    0 49           72      2                                        90
NSTR  73    00                        PASS FLOW AND TEMP

ID**  74    0 LIQMIX - FROM GSE HX AND GSE HX BYPASS
KBAS  74    0  7           89      2                    67                  56

ID**  75    0 OXYGEN RESTRICTOR
KBAS  75    0 49           57      2                                        76
NSTR  75    00                        PASS FLOW AND TEMP

ID**  76    0 SPLIT - FREON FLOW TO ARS I/C AND LOW TEMP P/L HX
KBAS  76    0 10           75      2                             2           3
NSTR  76    001                        SPECIFY PRI OUTFLOW - CALC SPLIT RATIO
VARY  76    1 2400.0          ARS I/C FLOW (LB/HR)
VARY  76    2 40.0            TEMP (F)
VARY  76    3 260.0         4 PRESS (PSIA)
VARY  76   20 1280.0          LOW TEMP P/L HX FLOW (LB/HR)
VARY  76   21 40.0            TEMP (F)
VARY  76   22 260.0        23 PRESS (PSIA)

ID**  77    0 LIQMIX - FREON FLOW FROM ARS I/C AND LOW TEMP P/L HX
KBAS  77    0  7          -59      2                    55                  79

ID**  78    0 HIGH TEMP P/L HX
KBAS  78    0  4           79      2                   -77      2           62
NSTR  78    0000020100                CNTRFLOW, LIQ-LIQ, SS MODEL
VARY  78    1 3680.           FREON FLOW (LB/HR)
VARY  78    2 75.0            TEMP (F)
VARY  78    3 90.0          4 PRESS (PSIA)
VARY  78   67 0.625           HX EFFECTIVENESS
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ID**   79    0 HIGH TEMP P/L HEAT LOAD SIMULATOR
KBAS   79    0 49           78      2                                           78
NSTR   79    02                          INPUT HEAT LOAD
VARY   79   65                      HEAT LOAD (BTU/HR) - INPUT IN GPOLY

ID**   80    0 SPLIT - (SEC FLOW TO PAYLOAD, PRI FLOW TO MAIN CABIN)
KBAS   80    0 10           23 2                           2                    81     2
NSTR   80    002                         SPECIFY SEC FLOW
VARY   80   20                      PAYLOAD GAS FLOW - INPUT IN GPOLY FROM TABLE 1080

ID**   81    0 PAYLOAD CREW METABOLIC SIMULATION
KBAS   81    0  3          -80 2                                                82    82
KARY   81   16             3        3 CREWMEN
KARY   81   17           990        AVG. MAN, 500 BTU/HR METABOLIC RATE, CLO=.99
VARY   81   71 25.0                 AVG. CABIN GAS VELOCITY  (FT/MIN)
VARY   81   72 300.                 MAX HEAT STORAGE/MAN (BTU)

ID**   82    0 PAYLOAD COMPARTMENT SIMULATION
KBAS   82    0  1           81 2                                                 1    82
NSTR   82    0021000010                 2 RESETS,CARRY ENTRAINED WATER
VARY   82    2 72.5                 PAYLOAD CABIN TEMP  (F)
VARY   82    3 14.7               4 PAYLOAD CABIN PRESSURE  (PSIA)
VARY   82    6 1.8                  H2O VAPOR FLOW  (LB/HR)
VARY   82   10 51.8                 OXYGEN FLOW  (LB/HR)
VARY   82   11 166.8                NITROGEN FLOW  (LB/HR)
VARY   82   12 1.8                  CO2 FLOW  (LB/HR)
VARY   82   66                      CABIN HEAT LOAD - CALC IN GPOLY
VARY   82   87 72.5                 CABIN GAS DESIGN TEMP  (F)
VARY   82   88 7.5                  CABIN GAS DESIGN TEMP TOL (F)
VARY   82   90 14.7                 DESIGN TOTAL PRESSURE (PSIA)
VARY   82   91 0.2                  DESIGN TOTAL PRESSURE TOL  (PSIA)
VARY   82   92 3.1                  DESIGN OXYGEN PRESSURE  (PSIA)
VARY   82   93 0.1                  DESIGN OXYGEN PRESSURE TOL (PSIA)
VARY   82   96 50.0                 DESIGN DEW POINT (F)
VARY   82   97 11.0                 DESIGN DEW POINT TOL (F)
VARY   82   99 7.6                  MAX ALLOWABLE CO2 PRESSURE  (MM HG)
VARY   82  101 250.                 MAX ALLOWABLE TRACE CONTAMINANT LEVEL (PPM)
VARY   82  122                      TOTAL OUTBOARD LEAKAGE (LB/HR)
VARY   82  127                      N-C ADDITION RATE  (LB/HR)
VARY   82  128                      COND. VAPOR ADDITION RATE (LB/HR)
VARY   82  129                      COND ENTRAINED LIQUID ADDITION RATE (LB/HR)
VARY   82  134 0.2                  SPECIFIC HEAT OF N-C ADDED  (BTU/LB-F)

ID**   83    0 GASMIX - (PAYLOAD AND MAIN CABIN GAS RETURNS)
KBAS   83    0  6            3 2                         -82 2                  84     2

ID**   84    0 ALTCOM - (SIMULATE HEAT LOAD ADDITIONS TO CABIN HX RETURN GAS)
KBAS   84    0 49           83 2                                                 8     2
NSTR   84    02                          INPUT HEAT LOAD IN GPOLY
VARY   84   65                      MISC RETURN GAS HEAT  INPUT IN GPOLY FROM TABLE1084

ID**   85    0 GASMIX - (LIOH BEDS BYPASS)
KBAS   85    0  6           19 2                          13                    86     2

ID**   86    0 SPLIT - (CABIN TEMPERATURE CONTROL VALVE)
KBAS   86    0 10           85 2                           2                    22     2
NSTR   86    00                          CALC UNIV SPLIT RATIO
VARY   86   65                      SPLIT RATIO - CALC IN GPOLY TO CONTROL CABIN TEMP
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ID**  87   0 SPLIT - (VAPOR CYCLE BYPASS VALVE)
KBAS  87   0 10              67     2                    2              88
NSTR  87   00                        INPUT UNIV SPLIT RATIO
VARY  87  65 0.0                 SPLIT RATIO - NO FLOW TO VAPOR CYCLE FERRY KIT

ID**  88   0 VAPOR CYCLE FERRY KIT
KBAS  88   0 49             -87     2                                   69

ID**  89   0 LIQMIX - (GSE HX AND VAPOR CYCLE RETURNS)
KBAS  89   0  7              90     2               -88                 74

ID**  90   0 GSE HX
KBAS  90   0  4              99     2               -91      5          89
NSTR  90   0200020100                CNTRFLOW, LIQ-LIQ, SS MODEL
VARY  90  66 2107.               OVERALL UA (BTU/HR-F)

ID**  91   0 GSE HX COOLANT SUPPLY CONDITIONS
KBAS  91   0 49                     5
VARY  91   1 3375.               FLOW (LB/HR)
VARY  91   2 40.0                TEMP (F)
VARY  91   3 50.0              4 PRESS (PSIA)

ID**  98   0 SPLIT - RADIATOR BYPASS CONTROL VALVE
KBAS  98   0 10              73     2                    2             101
VARY  98  65 0.0                 SPLIT RATIO - ALL FLOW TO RADIATOR

ID**  99   0 LIQMIX - FROM RADIATOR AND RADIATOR BYPASS
KBAS  99   0  7             113     2               98                  90
VARY  99   1 3680.0              FREON FLOW (LB/HR)
VARY  99   2 40.0                TEMP (F)
VARY  99   3 260.0             ↑ PRESSURE (PSIA)

ID** 101   0 SPLIT TO SIDE 1 AND SIDE 2 PANELS
KBAS 101   0 10              98     2                    2             102
VARY 101  65 0.5                 SPLIT RATIO

ID** 102   0 SPLIT TO FORE AND AFT TOP PANELS OF SIDE 1
KBAS 102   0 10             101     2                    2             103
VARY 102  65 0.5                 SPLIT RATIO

ID** 103   0 SIDE 1 FORE TOP RADIATOR PANELS
KBAS 103   0 62             102     2                                  104
NSTR 103   011                  1     USE STEADY STATE SOLUTION
KARY 103  16          103        SOLAR HEAT FLUX TABLE NO.
KARY 103  17          104        IR HEAT FLUX TABLE NO.
VARY 103  66 .25                 SOLAR ABSORPTIVITY
VARY 103  67 .92                 IR EMMISSIVITY
VARY 103  68 .934                OVERALL FIN RADIATOR EFFECTIVENESS  (NO PRIME TUBE)
VARY 103  69 1.0                 SCRIPT F
VARY 103  70 249.4               RADIATING AREA (FT2)                (NO PRIME TUBE)
VARY 103  71 3655.5              UA AT  550 LB/HR  (BTU/HR-F)
VARY 103  72 550.                FLOW AT CALCULATED UA, R(71)    (LB/HR)
VARY 103  73 0.8                 UA FLOW PROPORTIONALITY EXPONENT
VARY 103  74 0.00001             TAU CONVERGENCE CRITERION
VARY 103  75 0.01                FLUID OUTLET TEMP CONVERGENCE CRITERION (F)
VARY 103  87 151.6               RADIATOR + TUBE MASS  (LB)
VARY 103  88 0.22                RADIATOR + TUBE SPECIFIC HEAT, AL6061-T6  (BTU/LB-F)
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ID** 104   0 SIDE 1 AFT TOP RADIATOR PANELS
KBAS 104   0 62          -102     2                                      105
NSTR 104   011                   1     USE STEADY STATE SOLUTION
KARY 104   16          103     SOLAR HEAT FLUX TABLE NO.
KARY 104   17          104     IR HEAT FLUX TABLE NO.
VARY 104   66 .25              SOLAR ABSORPTIVITY
VARY 104   67 .92              IR EMMISSIVITY
VARY 104   68 .934             OVERALL FIN RADIATOR EFFECTIVENESS  (NO PRIME TUBE)
VARY 104   69 1.0              SCRIPT F
VARY 104   70 249.4            RADIATING AREA (FT2)                (NO PRIME TUBE)
VARY 104   71 3655.5           UA AT  550 LB/HR  (BTU/HR-F)
VARY 104   72 550.             FLOW AT CALCULATED UA, R(71)   (LB/HR)
VARY 104   73 0.8              UA FLOW PROPORTIONALITY EXPONENT
VARY 104   74 0.00001          TAU CONVERGENCE CRITERION
VARY 104   75 0.01             FLUID OUTLET TEMP CONVERGENCE CRITERION (F)
VARY 104   87 151.6            RADIATOR + TUBE MASS  (LB)
VARY 104   88 0.22             RADIATOR + TUBE SPECIFIC HEAT, AL6061-T6  (BTU/LB-F)

ID** 105   0 LIQMIX FROM SIDE 1 FORE AND AFT TOP RADIATOR PANELS
KBAS 105   0  7          103      2             -103                      106

ID** 106   0 SIDE 1 CAVITY RADIATOR PANELS
KBAS 106   0 62          105      2                                      111
NSTR 106   011                   1     USE STEADY STATE SOLUTION
KARY 106   16          106     SOLAR HEAT FLUX TABLE NO.
KARY 106   17          107     IR HEAT FLUX TABLE NO.
VARY 106   66 .45              SOLAR ABSORPTIVITY
VARY 106   67 .92              IR EMMISSIVITY
VARY 106   68 .944             OVERALL FIN RADIATOR EFFECTIVENESS  (NO PRIME TUBE)
VARY 106   69 1.0              SCRIPT F
VARY 106   70 175.12           RADIATING AREA  (FT2)               (NO PRIME TUBE)
VARY 106   71 3655.5           UA AT  550 LB/HR  (BTU/HR-F)
VARY 106   72 550.             FLOW AT CALCULATED UA, R(71)   (LB/HR)
VARY 106   73 0.8              UA FLOW PROPORTIONALITY EXPONENT
VARY 106   74 0.00001          TAU CONVERGENCE CRITERION
VARY 106   75 0.01             FLUID OUTLET TEMP CONVERGENCE CRITERION (F)
VARY 106   87 151.6            RADIATOR + TUBE MASS  (LB)
VARY 106   88 0.22             RADIATOR + TUBE SPECIFIC HEAT, AL6061-T6  (BTU/LB-F)

ID** 107   0 SPLIT TO FORE AND AFT TOP PANELS OF SIDE 2
KBAS 107   0 10          -101     2                       2
VARY 107   65 0.5              SPLIT RATIO

ID** 108   0 SIDE 2 FORE TOP RADIATOR PANELS
KBAS 108   0 62          107      2
NSTR 108   011                   1     USE STEADY STATE SOLUTION
KARY 108   16          103     SOLAR HEAT FLUX TABLE NO.
KARY 108   17          104     IR HEAT FLUX TABLE NO.
VARY 108   66 .25              SOLAR ABSORPTIVITY
VARY 108   67 .92              IR EMMISSIVITY
VARY 108   68 .934             OVERALL FIN RADIATOR EFFECTIVENESS  (NO PRIME TUBE)
VARY 108   69 1.0              SCRIPT F
VARY 108   70 249.4            RADIATING AREA (FT2)                (NO PRIME TUBE)
VARY 108   71 3655.5           UA AT  550 LB/HR  (BTU/HR-F)
VARY 108   72 550.             FLOW AT CALCULATED UA, R(71)   (LB/HR)
VARY 108   73 0.8              UA FLOW PROPORTIONALITY EXPONENT
VARY 108   74 0.00001          TAU CONVERGENCE CRITERION
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VARY 108  75 0.01                FLUID OUTLET TEMP CONVERGENCE CRITERION (F)
VARY 108  87 151.6               RADIATOR + TUBE MASS  (LB)
VARY 108  88 0.22                RADIATOR + TUBE SPECIFIC HEAT, AL6061-T6  (BTU/LB-F)

ID** 109   0 SIDE 2 AFT TOP RADIATOR PANELS
KBAS 109   0 62           -107      2
NSTR 109   011                     1      USE STEADY STATE SOLUTION
KARY 109  16           103       SOLAR HEAT FLUX TABLE NO.
KARY 109  17           104       IR HEAT FLUX TABLE NO.
VARY 109  66 .25                 SOLAR ABSORPTIVITY
VARY 109  67 .92                 IR EMMISSIVITY
VARY 109  68 .934                OVERALL FIN RADIATOR EFFECTIVENESS  (NO PRIME TUBE)
VARY 109  69 1.0                 SCRIPT F
VARY 109  70 249.4               RADIATING AREA (FT2)                 (NO PRIME TUBE)
VARY 109  71 3655.5              UA AT  550 LB/HR  (BTU/HR-F)
VARY 109  72 550.                FLOW AT CALCULATED UA, R(71)   (LB/HR)
VARY 109  73 0.8                 UA FLOW PROPORTIONALITY EXPONENT
VARY 109  74 0.00001             TAU CONVERGENCE CRITERION
VARY 109  75 0.01                FLUID OUTLET TEMP CONVERGENCE CRITERION (F)
VARY 109  87 151.6               RADIATOR + TUBE MASS  (LB)
VARY 109  88 0.22                RADIATOR + TUBE SPECIFIC HEAT, AL6061-T6  (BTU/LB-F)

ID** 110   0 LIQMIX FROM SIDE 2 FORE AND AFT TOP RADIATOR PANELS
KBAS 110   0  7           108       2               -109

ID** 111   0 SIDE 2 CAVITY RADIATOR PANELS
KBAS 111   0 62           105       2                                   112
NSTR 111   011                     1      USE STEADY STATE SOLUTION
KARY 111  16           111       SOLAR HEAT FLUX TABLE NO.
KARY 111  17           112       IR HEAT FLUX TABLE NO.
VARY 111  66 .45                 SOLAR ABSORPTIVITY
VARY 111  67 .92                 IR EMMISSIVITY
VARY 111  68 .944                OVERALL FIN RADIATOR EFFECTIVENESS  (NO PRIME TUBE)
VARY 111  69 1.0                 SCRIPT F
VARY 111  70 175.12              RADIATING AREA  (FT2)                (NO PRIME TUBE)
VARY 111  71 3655.5              UA AT  550 LB/HR  (BTU/HR-F)
VARY 111  72 550.                FLOW AT CALCULATED UA, R(71)   (LB/HR)
VARY 111  73 0.8                 UA FLOW PROPORTIONALITY EXPONENT
VARY 111  74 0.00001             TAU CONVERGENCE CRITERION
VARY 111  75 0.01                FLUID OUTLET TEMP CONVERGENCE CRITERION (F)
VARY 111  87 151.6               RADIATOR + TUBE MASS  (LB)
VARY 111  88 0.22                RADIATOR + TUBE SPECIFIC HEAT, AL6061-T6  (BTU/LB-F)

ID** 112   0 LIQMIX FROM SIDE 1 AND SIDE 2 RADIATOR PANELS
KBAS 112   0  7           106       2               -111                113

ID** 113   0   CALCULATE TIME AVERAGED OUTLET TEMPERATURE
KBAS 113   0 29  4        112       2                                   101
NSTR 113   00                       6   METER MAIN FLOW ONLY

TABL    1  10   2              5              LIN    STP
TITL    1  20RADIATOR RETURN FLOW (LB/HR)  VS   HRS
VALU    1 10021 0.0          6.288        12.576       18.864       25.152
VALU    1 11020 2200.        2400.        2800.        3200.        3800.

TABL    2  10   2              19             LIN    STP
TITL    2  20RADIATOR RETURN TEMPERATURE (F)  VS.  HRS
VALU    2 10021 0.0          1.572        3.144        4.716        6.288        7.860
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VALU    2 11020 125.          150.          175.          200.          125.          150.
VALU    2 12021 9.432         11.004        12.576        14.148        15.720        17.292
VALU    2 13020 175.          200.          100.          125.          150.          175.
VALU    2 14021 18.864        20.436        22.008        23.580        25.152        26.724
VALU    2 15020 100.          125.          150.          175.          100.          125.
VALU    2 16021 28.296
VALU    2 17020 150.

TABL 103   10    2            18             LIN   LIN
TITL 103   20SOLAR FLUX, BETA=78 DEG, SOLAR ORIENTED, TOP PNLS, BTU/HR-FT2 VS HRS
VALU 103 10021 0.0            .0655         .131          .1965         .262          .3275
VALU 103 11020 452.87         452.79        452.53        451.96        451.03        449.23
VALU 103 12021 .393           .4585         .524          1.040         1.1135        1.179
VALU 103 13020 446.83         444.01        443.0         443.0         444.01        446.85
VALU 103 14021 1.2455         1.31          1.3755        1.441         1.5065        1.572
VALU 103 15020 449.29         451.03        451.96        452.53        452.79        452.87

TABL 104   10    2            25             LIN   LIN
TITL 104   20IR FLUX, BETA=78 DEG, SOLAR ORIENTED, TOP PANELS, BTU/HR- FT2 VS HRS
VALU 104 10021 0.0            .0655         .131          .1965         .262          .3275
VALU 104 11020 14.2           14.38         14.9          15.72         16.79         18.03
VALU 104 12021 .393           .4585         .524          .5895         .655          .7205
VALU 104 13020 19.36          21.07         22.66         24.03         25.09         25.76
VALU 104 14021 .786           .8515         .917          .9825         1.040         1.1135
VALU 104 15020 25.99          25.76         25.09         24.03         22.66         21.07
VALU 104 16021 1.179          1.2455        1.31          1.3755        1.441         1.5065
VALU 104 17020 19.36          18.03         16.79         15.72         14.9          14.38
VALU 104 18021 1.572
VALU 104 19020 14.2

TABL 106   10    2            16             LIN   LIN
TITL 106   20SOLAR FLUX, BETA=78, SOLAR ORIENTED, SIDE 1 CAV, BTU/HR-FT2  VS  HRS
VALU 106 10021 0.0            .0655         .131          .1965         .262          .3275
VALU 106 11020 .39            .51           .68           .87           1.16          1.09
VALU 106 12021 .393           .4585         1.1135        1.179         1.2455        1.31
VALU 106 13020 .41            0.0           0.0           .41           1.09          1.16
VALU 106 14021 1.3755         1.441         1.5065        1.572
VALU 106 15020 .87            .68           .51           .39

TABL 107   10    2            25             LIN   LIN
TITL 107   20IR FLUX, BETA=78, SOLAR ORIENTED, SIDE 1 CAVITY,  BTU/HR-FT2  VS HRS
VALU 107 10021 0.0            .0655         .131          .1965         .262          .3275
VALU 107 11020 2.48           2.89          4.03          5.65          9.6           14.4
VALU 107 12021 .393           .4585         .524          .5895         .655          .7205
VALU 107 13020 19.36          25.0          31.9          37.56         42.26         45.54
VALU 107 14021 .786           .8515         .917          .9825         1.040         1.1135
VALU 107 15020 46.74          45.54         42.26         37.56         31.9          25.0
VALU 107 16021 1.179          1.2455        1.31          1.3755        1.441         1.5065
VALU 107 17020 19.36          14.5          9.6           5.65          4.03          2.89
VALU 107 18021 1.572
VALU 107 19020 2.48

TABL 111   10    2            16             LIN   LIN
TITL 111   20SOLAR FLUX, BETA=78, SOLAR ORIENTED, SIDE 2 CAVITY,  BTU/HR-FT2 VSHR
VALU 111 10021 0.0            .0655         .131          .1965         .262          .3275
VALU 111 11020 22.3           20.81         16.78         11.27         5.43          2.49
VALU 111 12021 .393           .4585         1.1135        1.179         1.2455        1.31
VALU 111 13020 .41            0.0           0.0           .41           2.49          5.93
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VALU 111 1402I 1.3755       1.441        1.5065       1.572
VALU 111 1502D 11.27        16.78        20.81        22.3

TABL 112   10    2           25           LIN    LIN
TITL 112   20IR FLUX, BETA=78, SOLAR ORIENTED, SIDE 2 CAVITY,  BTU/HR-FT2  VS HRS
VALU 112 100    0.0          .0655        .131         .1965        .262         .3275
VALU 112 110    56.54        55.05        50.56        43.26        35.55        27.48
VALU 112 120    .393         .4585        .524         .5895        .655         .7205
VALU 112 130    19.36        13.04        6.77         3.68         1.16         .19
VALU 112 140    .786         .8515        .917         .9825        1.040        1.1135
VALU 112 150    .15          .19          1.16         3.68         6.77         13.04
VALU 112 160    1.179        1.2455       1.31         1.3755       1.441        1.5065
VALU 112 170    19.36        27.48        35.53        43.26        50.56        55.05
VALU 112 180    1.572
VALU 112 190    56.54

TABL1000   10    2           24           LIN    STP
TITL1000   20MISSION PHASE VS. MISSION TIME (SEC)  FOR SORTIE MISSION 2A
VALU1000 1102I -600.        0.0          596.         1459.        2203.        69161.
VALU1000 1202D 1.0          2.0          3.0          4.0          5.0          6.0
VALU1000 1302I 83232.       89075.       94200.       166200.      176350.      184200.
VALU1000 1402D 7.0          8.0          9.0          10.0         11.0         12.0
VALU1000 1502I 270600.      357000.      443400.      529800.      537000.      595225.
VALU1000 1602D 13.0         14.0         15.0         16.0         17.0         18.0
VALU1000 1702I 597833.      599645.      599841.      600000.      600120.      600900.
VALU1000 1802D 19.0         20.0         21.0         22.0         23.0         24.0

TABL1002   10    2           11           LIN    STP
TITL1002   20CABIN HEAT LOAD (-METABOLIC) VS. MISSION PH. (SORTIE 2A)  (BTU/HR)
VALU1002 1102I 1.0          3.0          5.0          6.0          8.0          9.0
VALU1002 1202D 3938.        2688.        5362.        2438.        2585.        5112.
VALU1002 1302I 10.0         11.0         12.0         18.0         21.0
VALU1002 1402D 2585.        2438.        5112.        3938.        6238.

TABL1024   10    2           17           LIN    STP
TITL1024   20AVIONIC BAYS AIR LOAD VS. MISSION PH (SORTIE 2A)  (BTU/HR)
VALU1024 1102I 1.0          3.0          4.0          5.0          6.0          9.0
VALU1024 1202D 11818.       11761.       7499.        5159.        7749.        8050.
VALU1024 1302I 10.0         11.0         12.0         16.0         17.0         18.0
VALU1024 1402D 8219.        7749.        5296.        5352.        6071.        11915.
VALU1024 1502I 19.0         20.0         21.0         22.0         23.0
VALU1024 1602D 13133.       14338.       14276.       12536.       6937.

TABL1050   10    2           20           LIN    STP
TITL1050   20AVIONIC BAYS CP LOAD VS. MISSION PH (SORTIE 2A)  (BTU/HR)
VALU1050 1102I 1.0          2.0          3.0          4.0          5.0          6.0
VALU1050 1202D 11083.       9903.        8351.        6748.        5631.        6408.
VALU1050 1302I 7.0          8.0          9.0          10.0         11.0         12.0
VALU1050 1402D 7638.        7109.        6174.        6649.        6597.        5436.
VALU1050 1502I 16.0         17.0         18.0         19.0         20.0         21.0
VALU1050 1602D 5406.        5713.        8477.        9780.        10148.       10210.
VALU1050 1702I 22.0         23.0
VALU1050 1802D 9768.        7084.

TABL1060   10    2            3           LIN    STP
TITL1060   20LOW TEMP.  PAYLOAD HX LOAD VS. MISSION PH (SORTIE 2A)  (BTU/HR)
VALU1060 1102I 1.0          12.0         18.0
VALU1060 1202D 5200.        21500.       5200.
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TABL1066  10   3              3      4    LIN   LIN   LIN
TITL1066  20FUEL CELL -A- WASTE HEAT (BTU/HR) VS. NO. CELLS VS. ELEC OUTPUT (KW)
VALU1066 11031                3.2        10.0       12.0       14.0
VALU1066 12030 1.0            5000.      20800.     25400.     30000.
VALU1066 13030 2.0            5000.      18200.     22600.     27000.
VALU1066 14030 3.0            5000.      17200.     21000.     25400.

TABL1069  10   2              5               LIN   STP
TITL1069  20HYDRAULIC LOOP HEAT LOSS (BTU/HR) VS. MISSION PH (SORTIE 2A)
VALU1069 11021 1.0            5.0        6.0        12.0       18.0
VALU1069 12020 0.0            -15000.    0.0        -15000.    0.0

TABL1075  10   2              2               LIN   STP
TITL1075  2002 RESTRICTOR HEAT LOSS (BTU/HR) VS. MISSION PH (SORTIE 2A)
VALU1075 11021 1.0            23.0
VALU1075 12020 0.0            0.0

TABL1079  10   2              2               LIN   STP
TITL1079  20HIGH TEMP PAYLOAD HX HEAT LOAD (BTU/HR)  VS. MISSION PH (SORTIE 2A)
VALU1079 11021 1.0            23.0
VALU1079 12020 0.0            0.0

TABL1080  10   2              3               LIN   STP
TITL1080  20PAYLOAD GAS FLOW (CFM) VS. MISSION PH (SORTIE 2A)
VALU1080 11021 1.0            12.0       18.0
VALU1080 12020 0.0            48.0       0.0

TABL1082  10   2              2               LIN   STP
TITL1082  20PAYLOAD AIR LOAD VS. MISSION PH FOR 48CFM  (SORTIE 2A)  (BTU/HR)
VALU1082 11021 1.0            23.0
VALU1082 12020 0.0            0.0

TABL1084  10   2              18              LIN   STP
TITL1084  20HX IN LOADS (-LIOH QS, QL)   VS. MISSION PH (SORTIE 2A)  (BTU/HR)
VALU1084 11021 1.0            3.0        4.0        5.0        6.0        7.0
VALU1084 12020 6473.          6386.      5862.      3434.      4995.      4978.
VALU1084 13021 8.0            9.0        10.0       11.0       12.0       13.0
VALU1084 14020 5756.          4436.      5024.      5343.      3293.      3170.
VALU1084 15021 16.0           17.0       18.0       19.0       20.0       23.0
VALU1084 16020 3293.          3251.      5934.      6514.      6524.      3286.

TABL1566  10   3              3      4    LIN   LIN   LIN
TITL1566  20FUEL CELL -B- WASTE HEAT (BTU/HR) VS. NO. CELLS VS. ELEC OUTPUT (KW)
VALU1566 11031                5.0        10.0       12.0       14.0
VALU1566 12030 1.0            11000.     26600.     33400.     40400.
VALU1566 13030 2.0            11000.     23400.     29000.     34300.
VALU1566 14030 3.0            11000.     22200.     27200.     32000.

TABL2066  10   2              23              LIN   STP
TITL2066  20FUEL CELL OUTPUT REQ'D VS. MISSION PH (SORTIE 2A)   (KW)
VALU2066 11021 1.0            2.0        3.0        4.0        5.0        6.0
VALU2066 12020 17.86          15.86      11.90      11.42      7.29       8.06
VALU2066 13021 7.0            8.0        9.0        10.0       11.0       12.0
VALU2066 14020 8.87           9.43       9.75       9.50       9.24       8.25
VALU2066 15021 13.0           14.0       15.0       16.0       17.0       18.0
VALU2066 16020 8.18           8.65       8.66       9.20       9.40       11.95
VALU2066 17021 19.0           20.0       21.0       22.0       23.0
VALU2066 18020 13.90          16.03      16.10      15.25      10.06

ENDC
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      SUBROUTINE GPOLY1
      COMMON  /COMP/ DS(15),N,NA1,NB1,NC,NCAB,NCFL,NEXT,NEXV,NK,
     1  NKEX,NKS,NKT,NLFL,NP,NPASS,NPF,NPFT(6),NQ,NS,NSF,NSFT(6),
     2  NSTR(18),NSUBR,NV,NVT,Y(12)
      COMMON  /RARRAY/  IMAXR,R(1)
      COMMON  /ECLSTI/  KCHOUT,KPRNT,KPTINV(4),KWIT,KWIT1,KWIT2,
     1  KWIT3,KWIT4,NUFF
      COMMON  /KANDV/ K
      COMMON  /MISC/  DTIME,GRAV,KFLSYS,KOUTPT,KPDROP,KSYPAS,KTRANS,
     1  LPSUM(5),MAXCI,MAXLP,MAXSLP,MAXSSI,NCOMPS,NEWDT,NLAST,NPASPD,
     2  MINSSI,PGMIN,PLMIN,START,STEADY,TIME,TIMEMX,TMAX,TMIN,WTMAX
      COMMON  /CASE/ NCASE,NRSCS
      COMMON  /F21P/  CPF,RHOF,VISCF,WTMF,XKF
      COMMON  /PROPTY/  CPO,CP(99),CPCONL,CPCONV,CPCO2,CPOIL,CPOXY,CPTC,
     1  GAMGAS,RHOO,RHO(99),VISCO,VISC(99),VISGAS,WTMO,WTM(99),WTMCON,
     2  WTMOIL,WTMTC,XKO,XK(99),XKGAS,XKLIQ,VISLIQ
      COMMON  /SOURCE/  A(19),B(19),CPA,CPB,IA1,IB1,NA,NB,NPFS,NPFST(6),
     1  NSFS,NSFST(6),RHOA,RHOB,VISCA,VISCB,WTMA,WTMB,XKA,XKB
      COMMON /POW/ POWER
      COMMON /VLOC/ IP,IS,IC,IQ,IV,IVT,IEX,INEXK
      COMMON /SHUTLE/ PH
      LOGICAL POWER
      DIMENSION V(1),K(1)
      EQUIVALENCE (V,K)
      LOGICAL  STEADY

C           DETERMINE MISSION PHASE
      PH=VALUE(1000,TIME,0.0) + 0.00001
      IF(PH.EQ.OLPH)  GO TO 999
      OLPH=PH
C           FIND MAIN CABIN HEAT LOAD  (DOES NOT INCLUDE METABOLIC)
      QCAB=VALUE(1002,PH,0.0)
      QCAB=5306.
      CALL SV(QCAB,2,66)
C           FIND AVIONICS BAY AIR HEAT LOADS (DOES NOT INCLUDE FAN)
      QAV=VALUE(1024,PH,0.0) - 938.0
      QAV1=QAV/3.0
      QAV2=QAV1
      QAV3=QAV1
      QAV1=1812.
      QAV2=1189.
      QAV3=2080.
      CALL SV(QAV1,24,66)
      CALL SV(QAV2,30,66)
      CALL SV(QAV3,36,66)
C           FIND AVIONICS BAY COLDPLATE HEAT LOADS  (CONVERT TO WATTS)
      QAVCP=VALUE(1050,PH,0.0)/3.413
      QAVCP1=QAVCP/3.0
      QAVCP2=QAVCP1
      QAVCP3=QAVCP1
      QAVCP1=812. /3.413
      QAVCP2=873. /3.413
      QAVCP3=2071./3.413
      CALL SV(QAVCP1,50,66)
      CALL SV(QAVCP2,51,66)
      CALL SV(QAVCP3,52,66)
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C          FIND LOW TEMP PAYLOAD HEAT LOAD
      QLTPL=VALUE(1060,PH,0.0)
      QLTPL=18880.0
      CALL SV(QLTPL,60,65)
C          FIND FUEL CELL ELEC OUTPUT REQD.
      FCKW=VALUE(2066,PH,0.0)
C          DETERMINE NO. OF FUEL CELLS OPERATING
      NFC=IFIX(FCKW/7.15) +1
      XFC=FLOAT(NFC) + .00001
C          DETERMINE FUEL CELL WASTE HEAT
C           - TYPE A -
      QFCWH=VALUE(1066,XFC,FCKW)
      QFCWH=41150.
      CALL SV(QFCWH,66,65)
C          FIND HYDRAULIC LOOP HEAT LOSS
      QHYD1=VALUE(1069,PH,0.0)
      QHYD1=0.0
      CALL SV(QHYD1,69,65)
      QHYD2=0.0
      CALL SV(QHYD2,71,65)
C          FIND O2 RESTRICTOR HEAT LOSS
      QO2R=VALUE(1075,PH,0.0)
      QO2R=0.0
      CALL SV(QO2R,75,65)
C          FIND HIGH TEMP PAYLOAD HX HEAT LOAD
      QHTPL=VALUE(1079,PH,0.0)
      QHTPL=10120.0
      CALL SV(QHTPL,79,65)
C          FIND HEAT LOAD FOR PAYLOAD AIR FROM MAIN CABIN
      QPLAIR=VALUE(1082,PH,0.0)
      QPLAIR=0.0
      CALL SV(QPLAIR,82,66)
C          FIND MAIN CABIN HEAT LOADS TO BE ADDED BEFORE HX INLET
C          INCLUDES CABIN COLDPLATE LOADS
C           (DOES NOT INCLUDE LIOH OR FAN LOADS)
      QHXIN=VALUE(1084,PH,0.0) -1489.
      QHXIN=1635.
      CALL SV(QHXIN,84,65)
C          FIND IMU LOAD FOR EACH WATER LOOP CIRCUIT
      QIMU=2269.
      QIMU1=QIMU/3.0
      QIMU2=QIMU1
      QIMU3=QIMU1
      CALL SV(QIMU1,45,65)
      CALL SV(QIMU2,44,65)
      CALL SV(QIMU3,40,65)
  999 CONTINUE
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  3    IF(N.NE.3)  GO TO 305
C            SPECIFY TOTAL LEAKAGE RATE TO AVIONICS BAYS 1-3 AS R(20) FOR COMP 3
C            MAX LEAKAGE = 3 LB/DAY = 0.125 LB/HR  PER  RDU/SRR
       R(20)=0.125
  305  CONTINUE
 80    IF(N.NE.80)  GO TO 8050
C            FIND PAYLOAD GAS FLOW FROM MAIN CABIN
       PLCFM=VALUE(1080,PH,0.0)
       PLCFM=48.0
       R(20)=PLCFM*RHOA*60.0
 8050  CONTINUE
 86    IF(N.NE.86)  GO TO 8650
C            FIND SPLIT RATIO FOR CABIN TEMP CONTROL VALVE
       IF(KSYPAS.EQ.0)  GO TO 8650
       TCAB=VV(2,104)
       TSET=70.0
       IF(ABS(TCAB-TCABO).LE.0.1)  GO TO 8650
       CALL ESTIM(R(65),TCAB,TSET,R650,TCABO,TSETO,1.0,ITER1,NSTR(1))
       R(65)=0.0
 8650  CONTINUE


       RETURN
       END
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      SUBROUTINE GPOLY2
      COMMON  /COMP/ DS(15),N,NA1,NB1,NC,NCAB,NCFL,NEXT,NEXV,NK,
     1  NKEX,NKS,NKT,NLFL,NP,NPASS,NPF,NPFT(6),NW,NS,NSF,NSFT(6),
     2  NSTR(18),NSUBR,NV,NVT,Y(12)
      COMMON  /RARRAY/  IMAXR,R(1)
      COMMON  /KANDV/ K
      COMMON  /MISC/  DTIME,GRAV,KFLSYS,KOUTPT,KPDROP,KSYPAS,KTRANS,
     1  LPSUM(5),MAXCI,MAXLP,MAXSLP,MAXSSI,NCOMPS,NEWDT,NLAST,NPASPD,
     2  MINSSI,PGMIN,PLMIN,START,STEADY,TIME,TIMEMX,TMAX,TMIN,WTMAX
      COMMON  /CASE/ NCASE,NRSCS
      COMMON  /PROPTY/  CP0,CP(99),CPCONL,CPCONV,CPCO2,CPDIL,CPOXY,CPTC,
     1  GAMGAS,RHO0,RHO(99),VISC0,VISC(99),VISGAS,WTM0,WTM(99),WTMCON,
     2  WTMDIL,WTMTC,XK0,XK(99),XKGAS,XKLIQ,VISLIQ
      COMMON  /SOURCE/  A(19),B(19),CPA,CPB,IA1,IB1,NA,NB,NPFS,NPFST(6),
     1  NSFS,NSFST(6),RHOA,RHOB,VISCA,VISCB,WTMA,WTMB,XKA,XKB
      COMMON /POW/ POWER
      LOGICAL POWER
      DIMENSION V(1),K(1)
      EQUIVALENCE (V,K)
      LOGICAL  STEADY
      IF(N.EQ.82)  R(2)=75.0
      RETURN
      END
```