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Lyndon B. Johnson Space Center
Houston, Texas 77058

NASA CR-160957

STS-2
SAIL NON-AVIONICS SUBSYSTEMS
MATH MODEL REQUIREMENTS

Job Order 22-109
Contract NAS 9-15800

(This revision supersedes LEMSCO-14524,
issued July 1980.)

Prepared By

Lockheed Engineering and Management Services Company, Inc.
Houston, Texas

For

SHUTTLE AVIONICS INTEGRATION DIVISION

November 1980

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16. Abstract

Simulation of the STS-2 Shuttle non-avionics subsystems in the Shuttle Avionics Integration Laboratory (SAIL) is necessary for verification of the integrated Shuttle avionics system. This report documents the math model (simulation) requirements for each of the ıon-avionics subsystems that interfaces with the Shuttle avionics system and provides a ˉingle source document for controlling approved changes (by the SAIL Change Control ınel) to the math models.

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SAIL NON-AVIONICS MATH MODEL CHANGE STATUS

The baselined SAIL non-avionics math model requirements are provided in Appendix A through N. Future approved SCR's will be identified on the Change Status Sheet which will be released with the revised math model pages and the title page (revision number change) for incorporation in this report.

SCR/ESCR NUMBER	DATE	MODEL/ PAGE(S)	CHANGE SUMMARY
1113	10/18		NOMENCLATURE CONVENTION: ● CHANGE GSIU TO STS NAS ● GTS NAS IMPLIES GTS RIG. ● NAS IMPLIES BOTH STS & GTS
1173	10/27	APU/HYD TABLE 2	● NOMINAL VALUE CHANGES TO V46T0222A V46T0184A V46T0284A V46T0384A V46P0290A
N/A	10/30	MPS TABLE 1	ADDED LDT-LO2 DUMP TIME PSEUDO HDT-LH2 DUMP TIME PSEUDO
N/A	10/30	MPS TABLE 2	VALUE CHANGES FOR ENGINE INLET PRESSURES, PLUS, LOGIC FLOW DIAGRAM CHANGE
N/A	11/20	MPS	DELETION OF MMES REFERENCE IN GTS, ie DELETION OF: VE_i VGH_i for i = 1, 2, 3 VGO_i
1184	10/20	MPS	ADDED 3 PRESSURE MEASUREMENTS TO THE HE SYSTEM: i.e. V41P1153A V41P1253A V41P1353A

ACKNOWLEDGEMENT

The SAIL non-avionics math model requirements contained in the appendices of this report resulted from the combined efforts of Lockheed Engineering and Management Services Company, Inc. (R. W. Herold and W. P. Bennett) and Rockwell/Downey (C. D. McPhail et. al.). These requirements are those baselined by the SAIL Change Control Panel.

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FIGURES

1. INTRODUCTION

The SAIL non-avionics math models are required to support verification of the Ascent Ops 1 Avionics Configuration, On-Orbit Ops 2 Avionics Configuration, Entry Ops 3 Configuration, and the Backup Flight System. The non-avionics subsystems math models resident in the GTS and/or the STS and their application to testing each of the Ops configurations are summarized in Table I.

This document defines non-avionic math model requirements for the STS and GTS that support GN&C tests, as well as the following GPC software functions: namely, Systems Management (SM), Fault Detection and Annunciation (FDA), Switch Scan, and Special Processing.

TABLE I. — NON-AVIONICS MATH MODEL APPLICATIONS

MATH MODEL	IMPLEMENTATION REQUIREMENT	PRIMARY					
		ASCENT OPS 1	ON-ORBIT OPS 2 GNC	ON-ORBIT OPS 2 SM	ENTRY OPS 3	BFS GNC	BFS SM
APU/ HYDRAULICS	STS/GTS	✓	✓	✓	✓	✓	✓
VENT DOORS	GTS	✓	✓		✓	✓	
UMBILICAL DOORS	GTS	✓				✓	
ET SEP PYROS	GTS	✓				✓	
MPS PLUMBING	STS/GTS	✓				✓	
FUEL CELL/CRYO	STS/GTS			✓			✓
ATMOS REVITALIZATION/H2O	STS/GTS			✓			✓
ATMOS REVITALIZATION/PCS-AIRLOCK	STS/GTS			✓			✓
ACTIVE THERMAL CONTROL	STS/GTS			✓			✓
SMOKE DETECTION SYSTEM	STS/GTS			✓			✓
WATER/WASTE MGMT	STS/GTS			✓			✓
RCS/OMS (DFI)	STS/GTS			✓			✓
SWITCH	GTS			✓			✓
RECORDER	GTS			✓			

2. PURPOSE

The purpose of this report is to provide a single source document for consistently controlling approved changes to the non-avionics math models. When changes are approved, change pages will be released and a change status page will accompany each change release. The change status page should be inporporated behind the signature page and will provide a history of all changes to this JSC report. The form of this change sheet is provided at the front of this document.

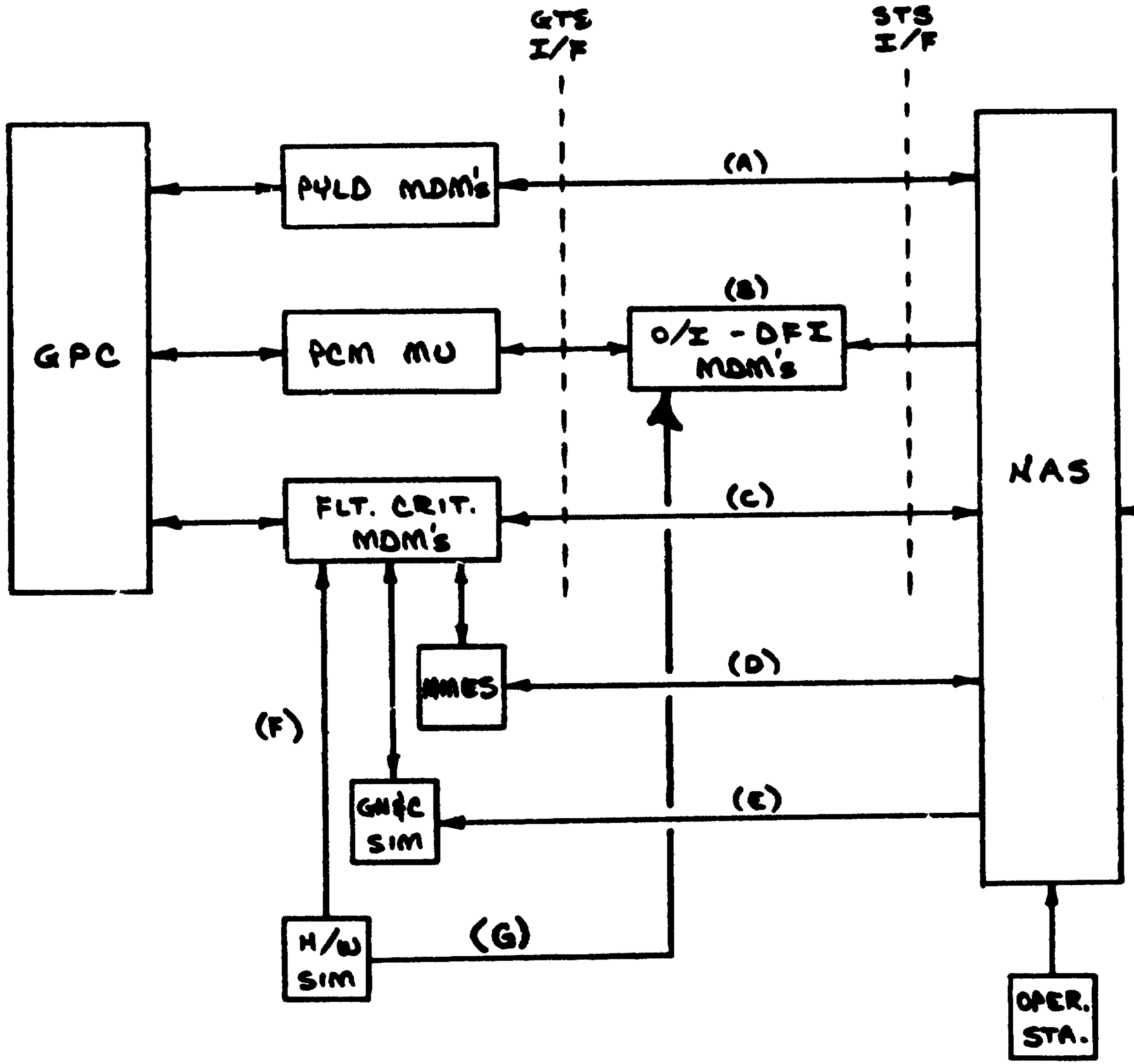
3. TEST STATION SIMULATOR CONFIGURATIONS

The purpose of this section is to describe the functional similarities and differences between the STS and the GTS simulators in order to give a basis for the statement of STS non-avionics math model requirements and GTS non-avionics math model requirements. The simulators are described only to the level of detail necessary to delineate the non-avionics math model requirements and are not considered definitive with respect to the details of actual simulator hardware implementations or modifications.

In the sections and appendices that follow, the non-avionics simulator for STS is referred to as STS NAS, the non-avionics simulator for GTS is referred to as GTS NAS, and a reference to both the STS and GTS simulators is referred to as NAS.

Figure 1 shows the major interfaces with the non-avionics simulator. Path A is used for bidirectional communication between the NAS and the GPC through payload MDM's. Path B is used by NAS for transmission of output measurements to the PCM master unit via O/I and DFI MDM's. Path C denotes bidirectional data transmission via flight critical MDM's. Bidirectional communication with the MMES is accomplished by Path D. Output to the GN&C simulator is accomplished by Path E. Path F interfaces mechanical hardware with the simulator. Path G interfaces the Flight Recorder output with the simulater.

Notice from figure 1 that while STS uses all the interfaces A thru G, GTS uses paths A, B, C and E.



MODEL	STS	GTS
APU/HYD	A,B,C	A,B,C
VENT DOORS	F	C
UMB DOORS	F	C
ET SEP PYRO	F	C
MPS	B,C,D,E	B,C,E
FC/CRYO	A,B	A,B
AR/H2O	A,B	A,B
AR/PCS	B	B
ATCS	A,B	A,B
SDS	B	B
W/WMS	B	B
RCS/OMS	B	B
SWITCH	NOTE 1	A,B
RCDR	F	G

NOTE 1 - GTS REQ'MT ONLY. SWITCH FUNCTION PROVIDED BY VARIOUS SOURCES IN STS.

FIGURE 1 - SAIL NON-AVIONICS SIMULATOR FUNCTIONAL INTERFACES

The table of figure 1 shows the similarities and differences between STS and GTS. For example, the vent doors, umbilical doors, ET separation pyros, and the recorder are simulated in STS by the use of mechanical hardware on interface paths F and G where as the lack of this hardware in GTS necessitates the requirement for math models to accomplish these functions. Therefore, the vents doors, umbilical doors, ET separation pyros and the recorder math models reside only in GTS.

The math models shown in the table on figure 1 reside in the STS and GTS non-avionic simulators (NAS) with the exception noted above.

The MPS is the only math model which has interfaces with other simulators. The MPS communicates with the MMES and the GN&C simulators.

Interfaces exist between some of the non-avionics math models within the NAS. The FC/CRYO generates output measurements which are required as inputs to the AR/PCS. The AR/PCS in turn generates output measurements which are required as inputs to the W/WMS. Therefore, in order to run the W/WMS model, the AR/PCS model is required to be run also. Similarly, in order to run the AR/PCS model, the FC/CRYO model is required to be run also. All other models may be executed independently.

Where the same model appears in the STS and the GTS, the flowcharts logic is the same with the exception of the MPS model. See Section 2.1.4 of appendix E. Differences in the test stations however necessitate front end processing for the GTS stimuli to obtain inputs to the model logic that are the same. This front end processing is accomplished by vehicle hardware in the STS.

The STS and GTS non-avionic models cycle once a second, in a serial manner, examining input stimuli and adjusting output measurements as defined by the flowchart logic. Timers in some of the models increment or decrement by one each cycle, or approximately one per second.

3.1 STS CONFIGURATION

The STS is a more complete test facility in terms of flight hardware. All cockpit switches along with LCA/PCA circuitry are available in the STS. For this reason the STS non-avionics math models form the basis for the GTS models. Within STS, only subsystem hardware such as pumps, heaters and valves are required to be simulated. This is due to the fact that, within STS, multiple MML's are channeled through LCA and PCA circuitry to produce single subsystem inputs, where as in GTS the LCA and PCA circuitry is not available.

Mechanical hardware and simulators for vent doors, umbilical doors, ET separation pyros and recorder are available in STS.

3.1.1 INPUT STIMULI IDENTIFICATION

The stimuli identification for those stimuli in the STS which have their sources at the flight system are coded in terms of reference Avionics Test Article (ATA) interface connector and pin number according to the following format.

The stimuli identification numbers used are coded to provide the following information at the SAIL flight cable/GSE/C70-1140 cable set interface.

```
K     40     PXXX  -  X
|     |      |        |
|     |      |        └──── PIN NUMBER (FLIGHT CABLE)
|     |      └───────────── CONNECTOR NUMBER (P FOLLOWED BY 3 or 4 DIGITS)
|     └──────────────────── AREA DESIGNATOR
└────────────────────────── STIMULI DESIGNATOR
```

Those stimuli which are uplinked to the model from the operator station are given unique alphanumeric variable names. The model output parameters whose destinations are the flight system are identified by their Master Measurement List numbers.

3.1.2 ANALOG MEASUREMENTS

Values shown in the math model flowcharts are in model counts outside the boxes and flight system engineering units inside the boxes for all analog measurements. The math model values are seen by the flight system as 0 to 5 VDC inputs. The flight system then converts these input voltages to engineering units using one of the two types of scaling discussed in the following paragraphs. The math model count values (or the count values by the test operator) must consider the scaling computation done later by the flight software, so that correct flight system engineering unit values are obtained for fault detection and annunciaiton (FDA), and for cockpit displays. The following paragraphs describe the scaling equations which apply to the models. Section 3.1.2.1 describes the scaling equation for measurements which require the polynomial conversion method. Section 3.1.2.2 describes the scaling equation for measurements which require the limit conversion method which was used on STS-1.

3.1.2.1 Polynomial Conversion Method

The scaling polynomial equation used by the flight system is defined in the SM FSSR, SD 76-SH-0027F. See Section 5, item 19. The general form of the equation is given as follows:

$$FS_{EU} = A_0 + A_1X + A_2X^2 + A_3X^3$$

where: FS_{EU} = flight system engineering units

X = flight system input voltage

A_0, A_1, A_2, A_3 = scaling polynomial coefficients

The following example shows the step by step procedure for converting analog measurements from flight system engineering units (FS_{EU}) to model counts.. This procedure may be used to calculate model count values for fault insertion.

Example:

For measurement no. V63R1100A, convert FS_{EU} value = 2288 to model counts.

Step 1:

In the SM FSSR, look up the measurement no. (V63R1100A) within the "SMM Data Requirements - Subsystems Displays" table. The measurement no. will appear on two consecutive pages as follows: page A will show engineering units, range low value and range high value, while page B will show the scaling polynomial coefficients (labelled A_0, A_1, A_2, A_3) followed by curve order, independent variable, and STS flight no. The values on page B will be of prime interest to do this example conversion, and will be referred to in the following discussion.

Step 2:

The coefficients will be used in the scaling polynomial:

$$FS_{EU} = A_0 + A_1X + A_2X^2 + A_3X^3$$

Solve the following scaling polynomial for X:

$$2288 = 443.167 + 851.956X - 143.904X^2 + 12.246X^3$$
$$\text{so } X = 3.846469$$

Step 3:

Notice the independent variable column labelled IND VR equals 2 for measurement no. V63R1100A. The 2 specifies that the independent variable X of the scaling polynomial is defined on a range of 0 to 5 VDC. So X = 3.846 VDC.

It is of interest to note that if IND VR had been equal to 0, X would have been defined on a range of 0 to 1023 PCM integer counts in which case X would be equal to 4 PCM counts, i.e. 3.846 rounded to the nearest integer.

However, in the example being worked, X is defined as VDC and X = 3.846 VDC.

Step 4:

Now to convert X VDC to model counts, evaluate the following equation which shows the relationship between X and model counts:

$$\text{model counts} = \left[X\left(\frac{1023}{K}\right)\right], \text{ rounded to the nearest integer}$$

where K = 5, for X defined as VDC (IND VR = 2) and

K = 500, for X defined as PCM counts (IND VR = 0).

For the example, evaluate:

$$\text{model counts} = \left[3.846\left(\frac{1023}{5}\right)\right], \text{ rounded to the nearest integer}$$

Therefore, model counts = 787 counts.

Note that since model counts are always rounded to the nearest integer, small changes will possibly occur in the values of X and consequently FS_{EU}, when the reverse calculations are made during test operations, as the following shows:

$$X = \text{model counts}\left(\frac{K}{1023}\right)$$

$$X = 787 \times \left(\frac{5}{1023}\right)$$

SO $X = 3.846529$

And

$$FS_{EU} = 443.167 + 851.956X - 143.904X^2 + 12.246X^3$$

$$FS_{EU} = 443.167 + 851.956(3.848) - 143.904(3.848)^2 + 12.246\,(3.848)^3$$

$$FS_{EU} = 2288.017$$

Hence when 787 model counts is inserted for measurement no. V63R1100A, a value of 2288.017 FS_{EU} will result.

3.1.2.2 Range Limit Conversion Method

Several analog measurements in the models are calculated according to the range limit conversion method, instead of the polynomial conversion method as described in the previous section of this document. The form of the scaling equation for these cases is given as follows:

$$FS_{EU} = \text{Low} + \frac{\text{Model}_{CTS}}{1023}(\text{High-Low})$$

where: FS_{EU} = flight system engineering units

Model_{CTS} = math model count values

Low = Range low limit

High = Range high limit

The measurement which use this method with an asterisk (*) in the Output Measurement List designated as Table 2 in Section 4.2 of each appendix which follows.

3.2 GTS CONFIGURATION

The GTS is not as complete a test facility as STS in terms of flight hardware availability. Only the related cockpit switches from the Commander station at the left side of the cockpit are available to GTS. All other switches must be simulated by operator entries at the NAS keyboard. The LCA/PCA circuitry which occurs between the cockpit switches and subsystems is not available in GTS, therefore GTS pre-processor logic is required prior of the model in order to accomplish the function. Models which apply only to GTS contain the GTS pre-processor logic implicitly within the model. However, for models adapted from STS to GTS, the GTS pre-processor logic is called out explicitly prior to the model flow diagram.

In GTS, additional models are required where mechanical hardware and simulators are not available. This is the case for vent door, umbilical doors, ET separation pyros, and the recorder.

The GTS NAS will adjust the math model analog output values, based on the latest calibration coefficients defined in the Space Shuttle OFT Level C SM FSSR, SD 76-SH-0027F so that once the GPC makes its calibration calculations, the resulting flight system values are the same as those specified inside the boxes of the logic flow diagrams in these requirements.

GTS models do not respond to EPD & C bus failures as in the STS. BUS states are not monitored and failure simulations must be handled by the operator at the NAS keyboard.

4. MATH MODEL DESIGN

4.1 DESIGN GROUNDRULES

The purpose of the NAS math models is to provide the responses to flight system commands such that flight software and hardware components can be tested. The purpose is not to test the performance of the system being simulated, but rather the system's external interfaces. The exact characteristics of the system are not simulated in the model. For example, the output values are static until the system configuration changes, and the transients that occur with configuration changes are not reflected in the model outputs, e.g. pressure build-ups and decays associated with pressurization or venting, and temperature ramps associated with system heating or cooling.

In preparing the requirements for the non-avionic system math models, the following ground rules were observed:

- Output all measurements addressed to flight critical MDM's.
- Output those measurements used in dedicated displays, systems management, or caution and warning.
- Output those measurements needed for operation by other systems.
- Output those measurements needed during pre-launch operations, starting at T-20 minutes.
- Respond to stimuli inputs in a discrete manner (no timed transients simulating pressure or temperature build-up and decay, for example).
- Do not account for depletion of expendables during a mission.

These ground rules are intended to simplify the math models without compromising the avionics testing in SAIL. Where required, specific ground rules may be waived.

4.2 CHANNELIZATION

The output values are unique, as much as possible, to permit channelization checks where the outputs are followed through the flight circuitry to the GPC, CRT displays, and out the telemetry link to ground recording. The actual system output values would probably have negligible differences for similar measurements, such as the temperature values for cryo tanks 1, 2 and 3.

4.3 FAULT INSERTION

Data values for out of limits conditions may be entered through the operators console when required for testing system management limits or caution and warning alarms. Any value may be entered within the transducer range of the measurement.

5. APPLICABLE DOCUMENTS

1. LA-B-10100-1/JSC-11174, Space Shuttle Systems Handbook OV-102
2. LEC-9510, Orbiter 102 Simulation Requirements for SMFS/APU-HYD
3. LEC-6992 Rev. A, Space Shuttle APU Controller Study
4. LEC-Memo #77-2109-055, GSIU Math Model Requirements for APU/HYD
5. VS70-580102, Hydraulic Control Subsystem Schematic
6. VS70-460102, Auxiliary Power Unit Schematic
7. VL70-000137G, Hydraulic Subsystem, Orbiter MCR1750 Baseline Schematic
8. ICD-3-1603-5, Flight Test System to SAIL Elements/Facility Non-Avionics Interface Control Document
9. GNCTS-02 - GNCTS Crew Station to GTS ICD
10. GNCTS-06 - GTS Non-Avionics Simulator ICD, dated 8/2/78
11. LEC Memo no. 78-GNC-254, NAS Functional Logic by N. Bauer, 8/18/78
12. LEC Memo no. 78-GNC-260, NAS CRT Formats by N. Bauer, 8/30/78
13. VS70-415001, Main Propulsion System Schematic
14. 382-240-CDM/76-062, Rockwell Preliminary Requirements
15. 382-240-CDM/76-064, Preliminary Requirements Update
16. LEC-7827, MPS Simulation Requirements
17. VS70-450102, Schematic Diagram - Fuel Cells
18. VS70-450202, Schematic Diagram - Cryo Subsystem
19. SD76-SH-0027F, Functional Subsystem Software Requirements (Level C), 16 June 1980
20. SD72-SH-0104-1, System Definition Manual, paragraph 5.0, Fuel Cell/Cryogenic System
21. LEC-9485, Orbiter 102 Subsystem Simulation Requirements
22. VS70-610102, 5/20/77, Schematic Diagram Atmospheric Revitalization Subsystem

23. VS70-610202, Schematic Diagram-Atmosphere Revitalization/Pressure Control System

24. LEC Memo #77-2109-060, GSIU Math Model Requirements

25. Shuttle Operational Data Book, Section 4.6, ECLSS

26. VS70-630102, Schematic Diagram - Active Thermal Control System

27. VS70-620102, Smoke Detection Schematic

28. LEC-9361, Smoke Detection Subsystem Simulation Software Specification

29. Potable Water Storage OV-102 Space Shuttle Dwg. 6.4 (6-15-77)

30. Waste Management OV-102 Space Shuttle Dwg. 6.5 (6-1-77)

31. Schematic Diagram Waste Mgm't Subsystem Dwg. VS70-620202 (8-24-77)

32. Schematic Diagram Water Mgm't Subsystem Dwg. VS70-620302 (7-26-77)

33. Rockwell Internal Letter No. 382-460-JTK-78-012 subject; Justification for Adding DFI MDM (DC02) to SAIL in Support of Mission Profile Tests

34. Backup Flight System Management/Special Processes and Sequencing Program Requirements Document, pp. 9, 20 & 128, document number MG038103 Rev. B, dated 9/21/79, by Rockwell International Space Division

6. ACRONYM LIST

APU/HYD	- Auxiliary Power Unit/Hydraulics
AR/H2O	- Atmosphere Revitalization/Water Loops
AR/PCS	- Atmosphere Revitalization/Pressurization Control System-Airlock.
ATA	- Avionics Test Article
ATCS	- Active Thermal Control System
BFS	- Back-up Flight System
CMDS	- Commands
CP	- Connector-pin number
CRT	- Cathode Ray Tube
CTS	- Counts
DCM	- Display and Control Module
DFI	- Development Flight Instrumentation
ECLSS	- Environmental Control and Life Support System
EPR	- Engine Prevalve Routine
ET SEP PYRO	- External Tank/Orbiter Forward Separation Pyro
EU	- Engineering Units
FC/CRYO	- Fuel Cell/Cryogenic
FDA	- Fault Detection and Annunciation
FS	- Flight System
FSSR	- Functional Subsystem Software Requirements
GN&C	- Guidance, Navigation and Control
GND	- Ground
GPC	- General Purpose Computer
GSE	- Ground Support Equipment
GTS	- GN&C Test Station
HDT	- LH2 Dump Time
IC	- Initial Condition
JSC	- Lyndon B. Johnson Space Center
KYBD	- Keyboard
LCA	- Load Control Assembly
LCG	- Liquid Cooling Garmet
LDT	- LO2 Dump Time

LVR	- Latching Valve Routine
MDM	- Multiplexer/Demultiplexer
MEC	- Mission Events Controller
MMES	- Marshall Mated Element System
MML	- Master Measurement List
MPS	- Main Propulsion System
NAS	- Non-Avionics Simulator
NCVR	- Normally Closed Valve Routine
NOVR	- Normally Open Valve Routine
OFT	- Orbital Flight Test
O/I	- Operational Instrumentation
PCA	- Power Control Assembly
PCM	- Pulse Code Modulation
PCMMU	- PCM Master Unit
PYLD	- Payload
RCDR	- Recorder
RCS/OMS	- Reaction Control System/Orbiter Maneuvering System
ROS	- RCS/OMS Simulator
SAIL	- Shuttle Avionics Integration Laboratory
SDS	- Smoke Detection System
SM	- Systems Management
STS	- Shuttle Test Station
STS-2	- Space Transportation System Flight No. 2
UMB	- Umbilical
VDC	- Volts, Direct Current
VDS	- Vehicle Dynamics Simulator
W/WMS	- Water/Waste Management System

APPENDIX A

APU/HYDRUALICS MATH MODEL REQUIREMENTS

CONTENTS

FIGURES

1. INTRODUCTION

This model simulates those functions of the Auxiliary Power Unit (APU) and the Hydraulics (HYD) subsystems that are in the Orbiter. To simplify the model, only those subsystem functions needed to support testing of the Shuttle avionics system are provided.

Internal to the model is considerable "cross-talk" between the APU and the HYD areas. An attempt was made to keep these two areas separate for modular simplicity. The "cross-talk" involved here is transparent to the user and requires no special conditioning.

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in table 1 to produce values for the output measurements listed in table 2 that simulate the operation of the APU/HYD subsystem.

2.1 MATH MODEL DESCRIPTION

2.1.1 APU SUBSYSTEM

The APU subsystem consists of three APU packages providing the mechanical power necessary to drive the main hydraulic pumps. Inputs from the flight system (FS) drive the model to simulate a dedicated control unit for each APU, which will maintain the selected speed and, in the event of the limiting conditions being exceeded, will automatically shut the unit down. Override control is provided by a crew switch. The APU turbine drives the gearbox which in turn drives the main hydraulic pump. Figure 1 is a functional diagram of the APU system.

2.1.2 HYD SUBSYSTEM

The hydraulic pump is driven by the APU, and the speed is dependent upon whether input stimuli is selected to Normal or High speed mode. Hydraulic power is supplied to aerosurface controls (elevons, rudder, body flap, and speedbrake), landing gear, wheel brakes, and nosewheel steering. Figure 2 is a functional diagram of the HYD system.

Hydraulic fluid must be cooled during main pump operation; and, therefore, the model simulates a water boiler which removes heat from the system fluid.

When the APU's are shut down (idle), a circulation pump maintains fluid circulation to prevent freezing.

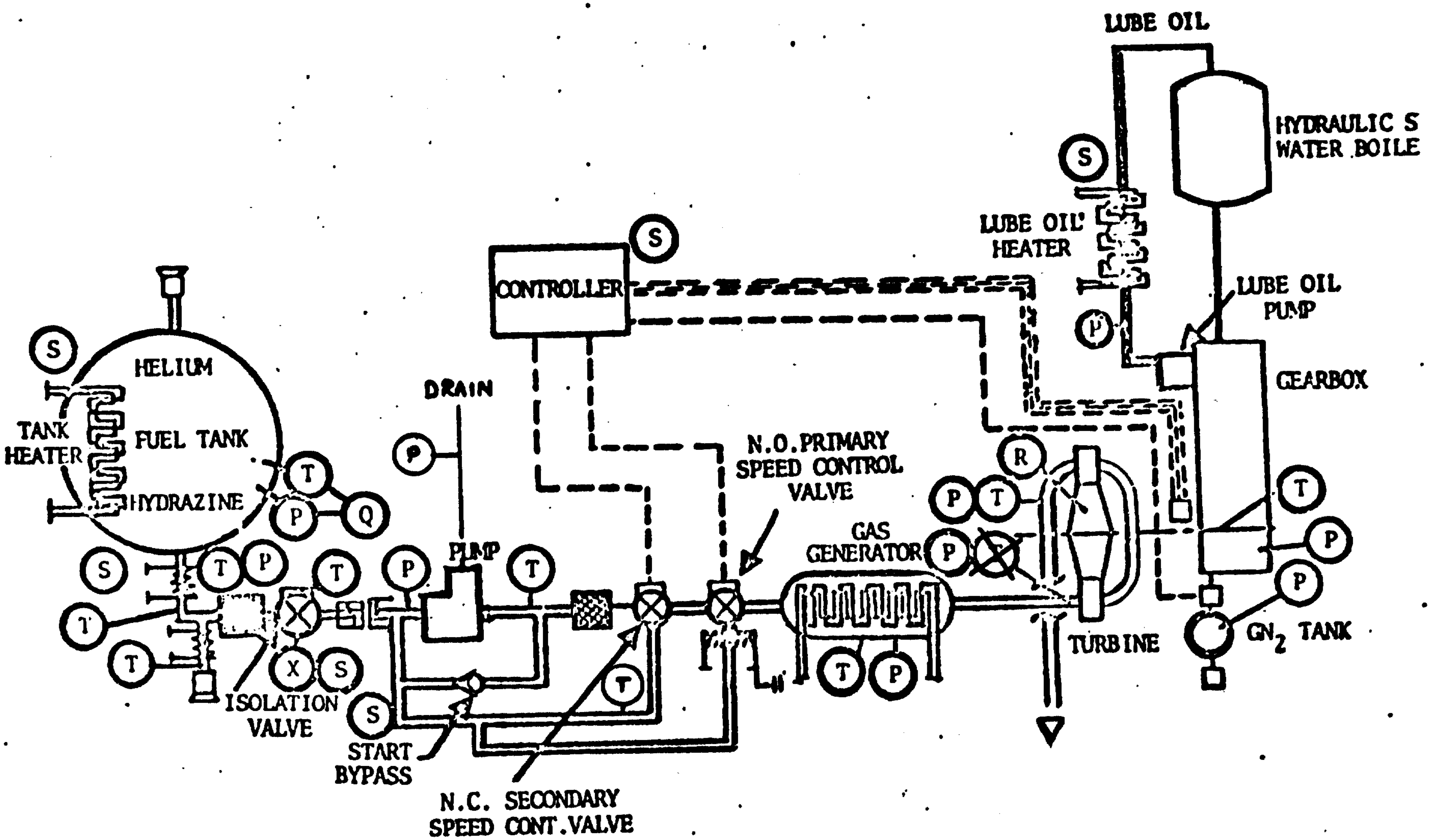


Figure 1 – Auxiliary power unit block diagram.

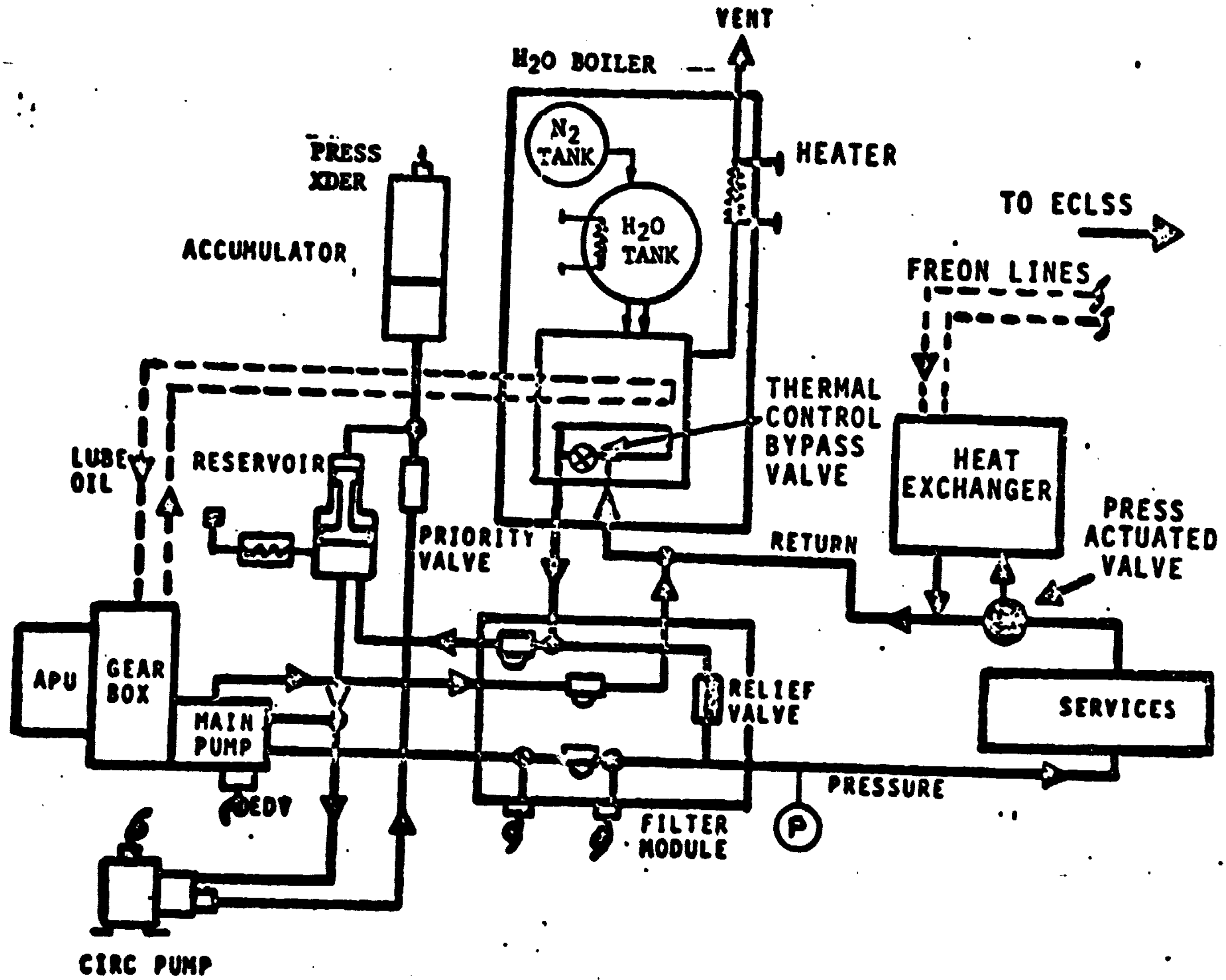


Figure 2 – Hydraulic system (typical for systems 1, 2, and 3).

A reservoir and nitrogen pressurized accumulator are also a part of the system, and the model simulates these I/O parameters also.

The hydraulic subsystem incorporates functional redundancy. This redundancy is obtained by switching valves which provide the capability for any one of the subsystems connected to the switching valves to supply the function in the event of failure of the other connected subsystems.

2.1.3 UNIQUE REQUIREMENTS

There exists a requirement for some measurements within the model to reflect a nominal, Hi/Low, and off condition. The condition is determined by (a) the system running normally, (b) the system being idle, but the circulation pumps running, and (c) all functions in an off mode. There is also the requirement for the model to be capable of functioning in a triple-redundant mode.

In order to best show these requirements, the following criteria were set up and are used throughout this document.

1. $i = 1, 2, 3$
   Where (i) represents the system; APU1, APU2, or APU3, respectively.
2. $\alpha = i + 3, \gamma = i - 1$
   These relationships were established for simplicity and ease of representing logic flow diagrams within this requirements package.
3. $K = 1, 2, 3$
   Where (K) represents the condition existing for the system, i.e.:
   - 1 = Nominal
   - 2 = Circulation Pumps On
   - 3 = Idle Mode

   The value K is then used to find the correct measurement value needed to reflect the proper conditions. These measurement values will be found in table 2 entitled, "Measurement Output from APU/HYD Model".

NOTE: The flow diagrams refer to the value tables in the following manner:

MEAS. = Value (K)

Where MEAS. is the output measurement.

VALUE is one of three possible values for that particular MEAS.

(K) is a pointer that shows which of the three values is applied.

EXAMPLE: V58T0101A = VALUE (2) = 40°F

4. TURBINE SPEED (V46R0135A)>0 = APU 1 RUN MODE
   TURBINE SPEED (V46R0135A)≤0 = APU 1 IDLE MODE

2.1.4 APU TURBINE OVERSPEED OR UNDERSPEED CONDITIONS

APU turbine overspeed or underspeed is a common test condition. To simplify the simulation of APU turbine overspeed or underspeed, the model incorporates a set of six pseudos that are controllable by the test operator. These pseudos automatically produce the appropriate changes in output measurements when the test operator sets the pseudo(s) to 1. The pseudos are listed in table 1.

2.1.5 BFS MEASUREMENTS

The hydraulic measurements listed below are used by the Back-up Flight System (BFS). The calculations required to convert these analog measurements from FS_{EU} to model counts is slightly different than the usual polynomial conversion method discussed in the front document. The value for model counts is multiplied by a factor of 64 in order to shift the least significant bit of the counts from the low order bit (bit 24) of the Data Response Word to bit 18. See pp. 9, 20, and 128 of the "Backup Flight System Management/Special Processes and Sequencing Program Requirements Document", document number MG038103 Rev. B, dated 9/21/79, by Rockwell International Space Division for information pertaining to this type of conversion. After multiplying the model counts by 64, the polynomial conversion is employed with K = 500. See Section 3.1.2.1 of the front document. The polynomial coefficients are shown on page 128 of the referenced BFS document. The measurements are:

V58T0830A
V58T0880A
V58T0930A
V58T0980A
V57T0014A
V57T0018A

2.1.6 INITIAL CONDITIONS

Note that initial conditions for STS are the same as those listed for GTS; see GTS PREPROCESSOR LOGIC.

2.2 STS UNIQUE REQUIREMENTS

2.2.1 APU HEATER THERMAL SWITCHES

Certain APU heaters are controlled by thermal switches in the APU controller. For simplification of the APU math model, the operation of the thermal switches and the cycling of heater temperatures are not simulated, but instead the thermal switches are simulated closed and heater temperatures are a function of heater power only. The control logic for the thermal switches resides in the flight system Load Controller Assembly (LCA) hardware; therefore, the APU math model must send "thermal switch on" signals to the LCA. The LCA then transmits a heater power signal to the APU math model whenever the heater power switch is "ON". Since the thermal switch signals to the LCA from the math model do not have MML ID numbers, pseudo numbers have been assigned, reference table 2.

2.3 GTS UNIQUE REQUIREMENTS

2.3.1 PREPROCESSOR LOGIC

The simplified GTS model is being replaced by the complete STS model. The math model input stimuli symbols referred to in the logic flow diagram, Section 3.2, are ATA Reference connector and pin numbers. Due to the lack of flight hardware circuitry in the GTS simulator, logic functions that bridge the gap between the payload MDM's and the APU/HYD are required in a

GTS preprocessor in order to evaluate values for the input stimuli coming from the GPC prior to execution of the model.

2.3.2 APU HEATER THERMAL SWITCHES

The APU heater thermal switch outputs listed in table 2, reference pseudos FP1A through GG3B, are required for STS only and do not apply to GTS.

2.3.3 HYDRAULIC SUPPLY PRESSURE

Hydraulic supply pressure B has two MML identifications, one for the value sent to the GPC (V58P0115C), and another for the value sent to the PCM master unit (V58P0115A). Both values are equal since they originate from the same pressure transducer, but as the measurements leave the signal conditioner they become two distinct measurements. In STS, the math model must supply only one measurement because the signal conditioner is part of the flight system being tested, and the signal conditioner will generate the duplicate measurement. In GTS however, the math model must supply both measurements because the signal conditioner is not present.

3. MATH MODEL LOGIC

This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

The basic input stimuli to the model are identified by ATA reference system connector-pin (CP) numbers. A logical combination of one or more MML numbers is used to derive the proper input stimulus for each CP. Within the STS, the logical combination is accomplished via hardware circuitry. However, within the GTS, due to the absence of the required circuitry, the logical relations between CP and MML must be effected by software. The following logical equations are required as a preprocessor within GTS in order to calculate the correct CP stimuli which are then input to the model. Most equations are merely a direct one-for-one correspondence between CP and MML. However, some equiations may require more than one MML to be combined by the logical product (AND) and the inclusive logical sum (OR). In these instances, "AND" denotes the logical product and "OR" denotes the inclusive logical sum.

The SOURCE columns contain an entry for the MDM, connector end pin from which the MML is received. In the absnece of an entry in these columns, the operator must make the entry via the NAS keyboard.

The final column lists the input stimuli initialization values required. Notice that inputs containing an entry for SOURCE do not have an initialization value, since they are updated at the GTS simulator cycle rate by the source connection.

GTS MATH MODEL STIMULI - APU/HYD
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN		MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
APU					
K54P106-J	=	V46K0097E			0
5P106-J	=	98E			0
6P106-J	=	99E			0
K50SP441	=	103E			1
423	=	109E			1
493	=	203E			1
474	=	209E			1
545	=	303E			1
527	=	309E			1
K50P9909-A	=	114E			0
10-B	=	121E			0
19-A	=	214E			0
20-B	=	221E			0
29-A	=	314E			0
30-B	=	321E			0
K50SP452	=	116E			1
457	=	117E			1
505	=	216E			1
510	=	217E			1
556	=	316E			1
561	=	317E			1
K50P9911-B	=	118E			1
12-B	=	119E			1
21-B	=	218E			1
22-B	=	219E			1
31-B	=	318E			1
32-B	=	319E			1
K54P107-C	=	124E			0
4P106-C	=	144E			0

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

GTS MATH MODEL STIMULI - APU/HYD
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN		MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
K55P107-C	=	V46K0224E			0
5P106-C	=	244E			0
6P107-C	=	324E			0
6P106-C	=	344E			0
4P106-R	=	126E			0
4P107-R	=	146E			0
4P106-S	=	127E			0
4P107-S	=	147E			0
K55P106-R	=	226E			0
107-R	=	246E			0
106-S	=	227E			0
107-S	=	247E			0
K56P106-R	=	326E			0
107-R	=	346E			0
106-S	=	327E			0
107-S	=	347E			0
K54P106-E	=	129E			0
107-E	=	149E			0
K55P106-E	=	229E			0
107-E	=	249E			0
K56P106-E	=	329E			0
107-E	=	349E			0
HYD					
K50PP1-E1	=	V58K0142Y	PF01	J08/039	
		OR 143Y	PF02	J08/039	
2-E1	=	V58K0242Y	PF01	J08/051	
		OR 243Y	PF02	J08/051	
3-E1	=	V58K0342Y	PF01	J08/053	
		OR 343Y	PF02	J08/053	
K50P9007-A	=	V58K0195X	FA01	J08/104	

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

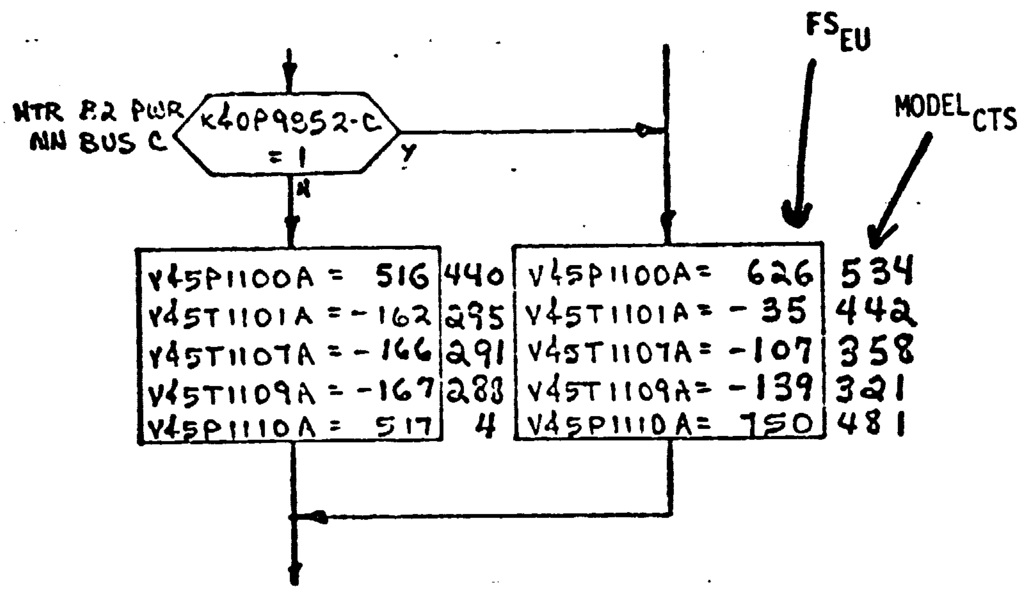
GTS MATH MODEL STIMULI - APU/HYD
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN		MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
K50P9008-A	=	V58K0295X	FA02	J08/104	
9-A	=	395X	FA03	J08/104	
K50P9022-A	=	V58K0149E			0
25-A	=	150E			0
28-A	=	249E			0
31-A	=	250E			0
34-A	=	349E			0
37-A	=	350E			0
24-4	=	151E			0
27-4	=	151E			0
30-4	=	251E			0
33-4	=	251E			0
36-4	=	351E			0
39-4	=	351E			0
K50P9004-1	=	V58K0171E			0
5-1	=	0271E			0
6-1	=	0371E			0
7-C	=	0191E			0
8-C	=	0291E			0
9-C	=	0391E			0
K50P38-A	=	1134E			0
38-C	=	1135E			1
39-A	=	1234E			0
39-C	=	1235E			1
40-A	=	1334E			0
40-C	=	1335E			1
9001-C	=	**			1
9002-C	=				1
9003-C					1

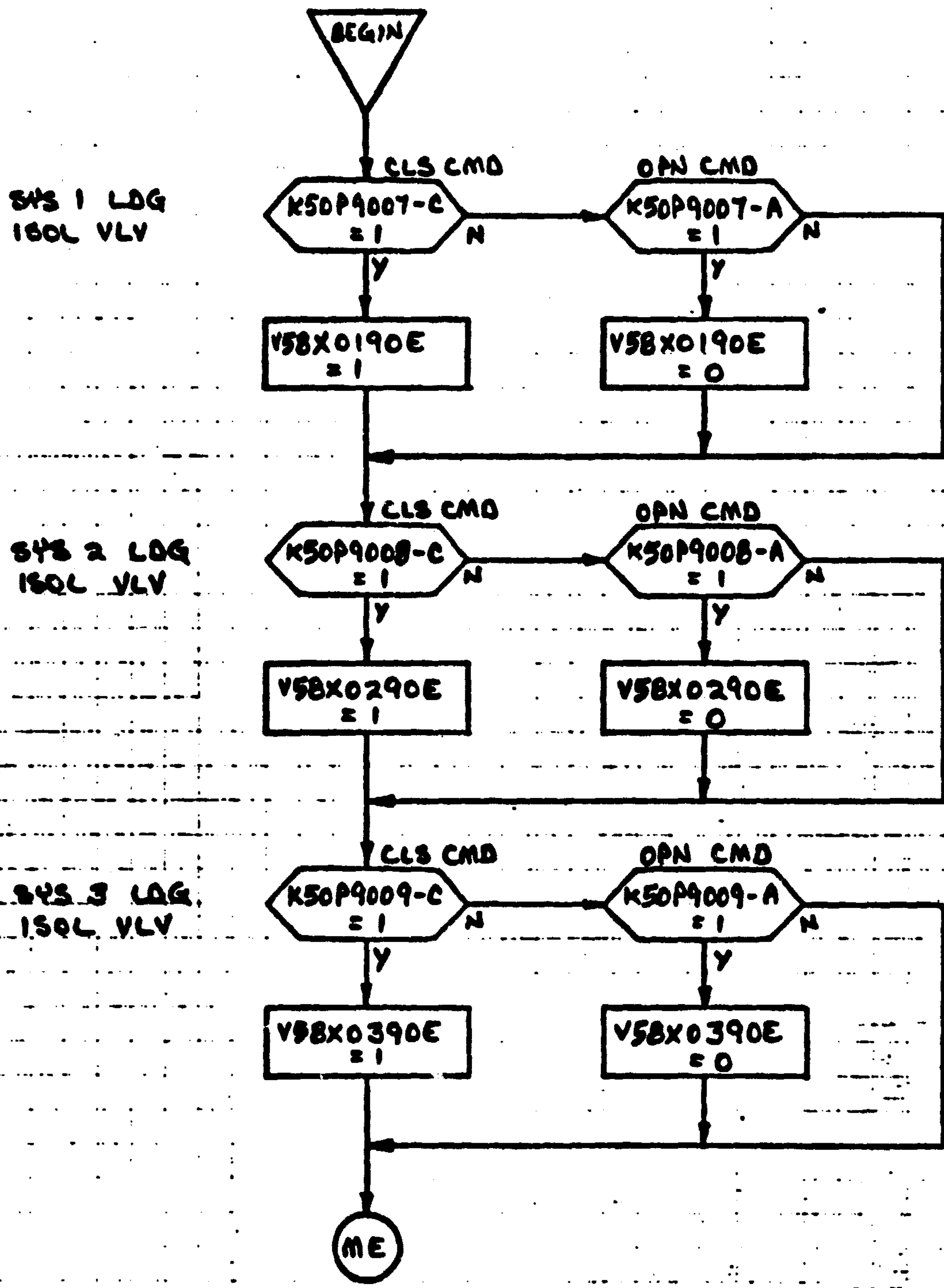
*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

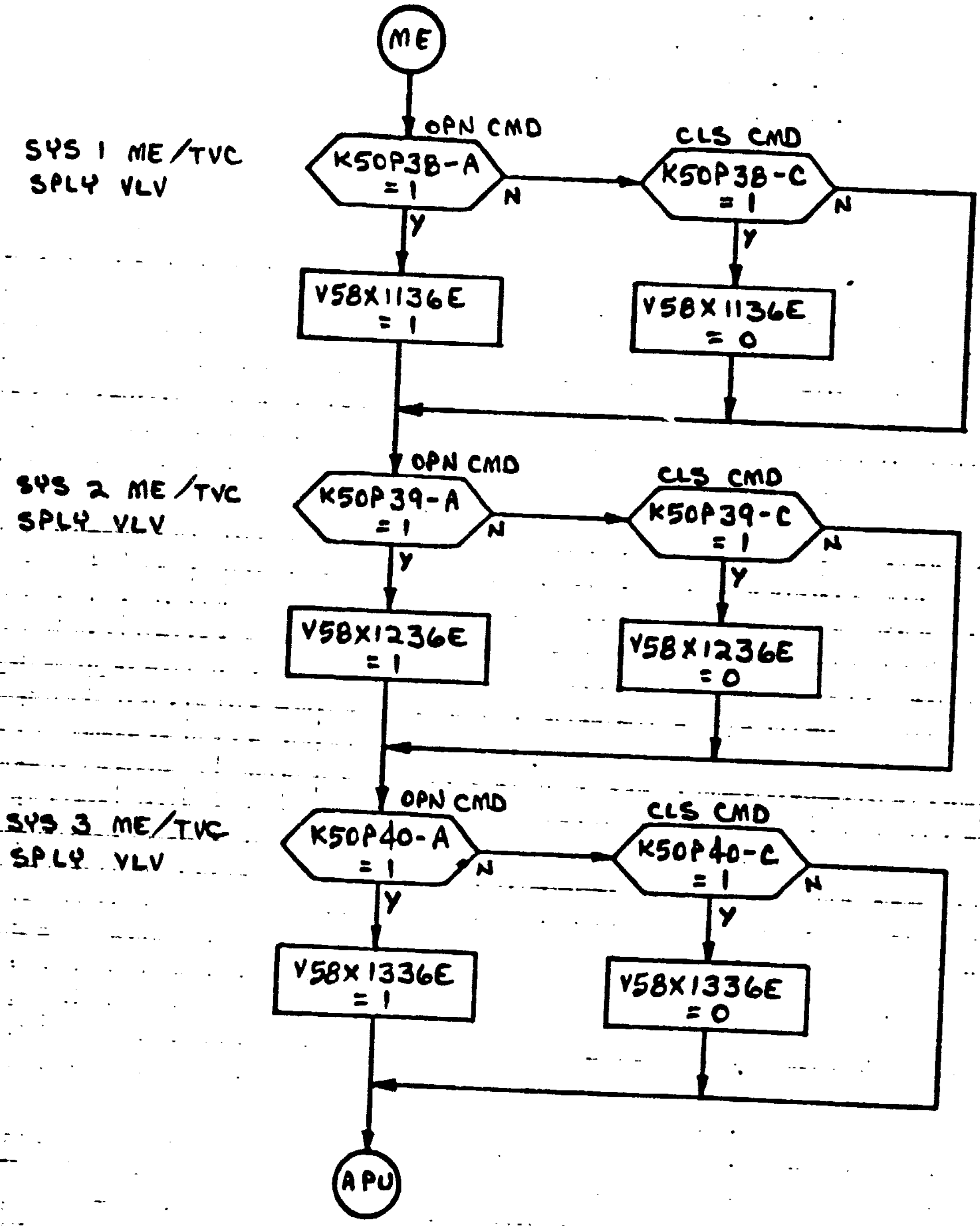
3.2 LOGIC FLOW DIAGRAM

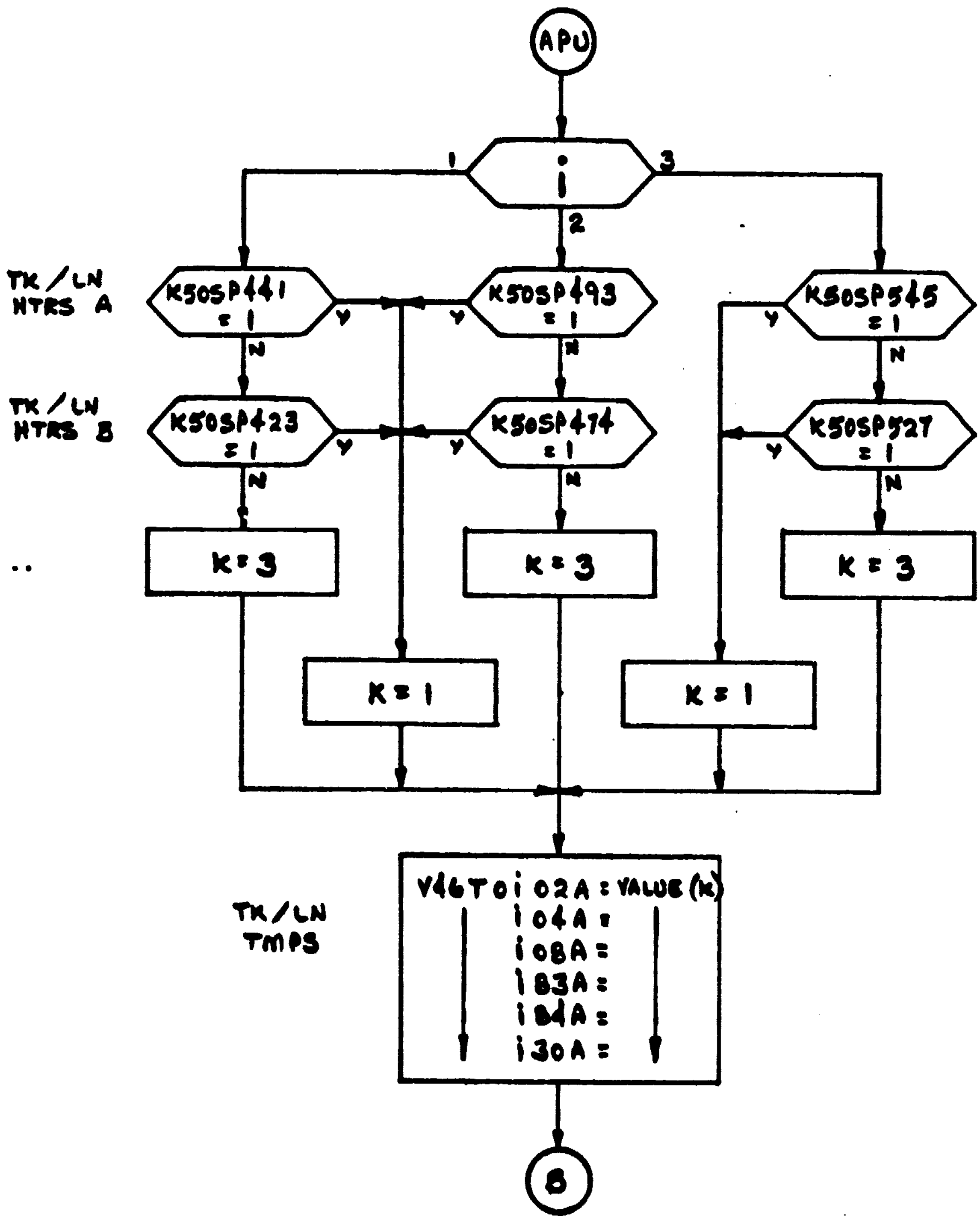
The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;



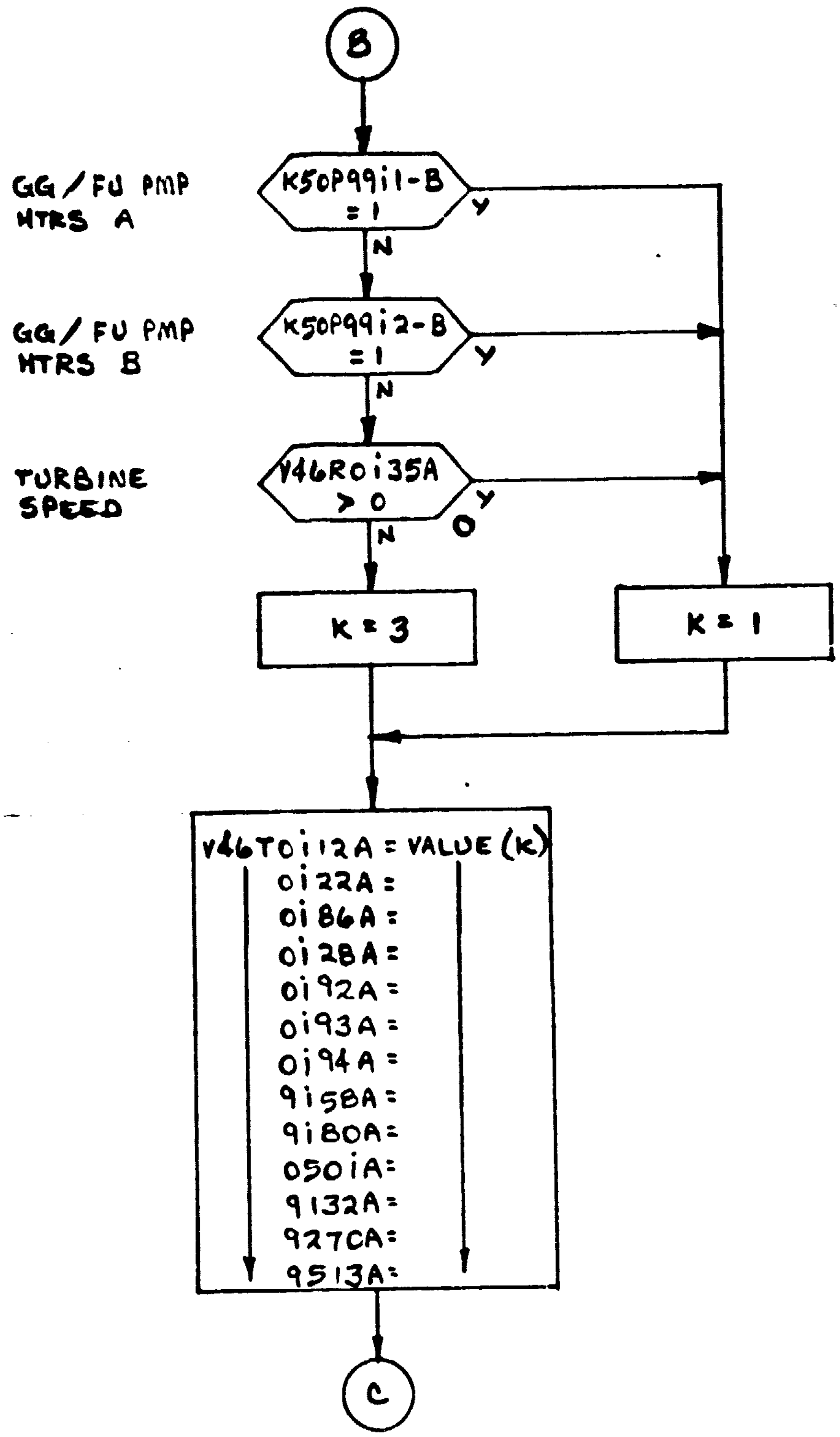
shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.

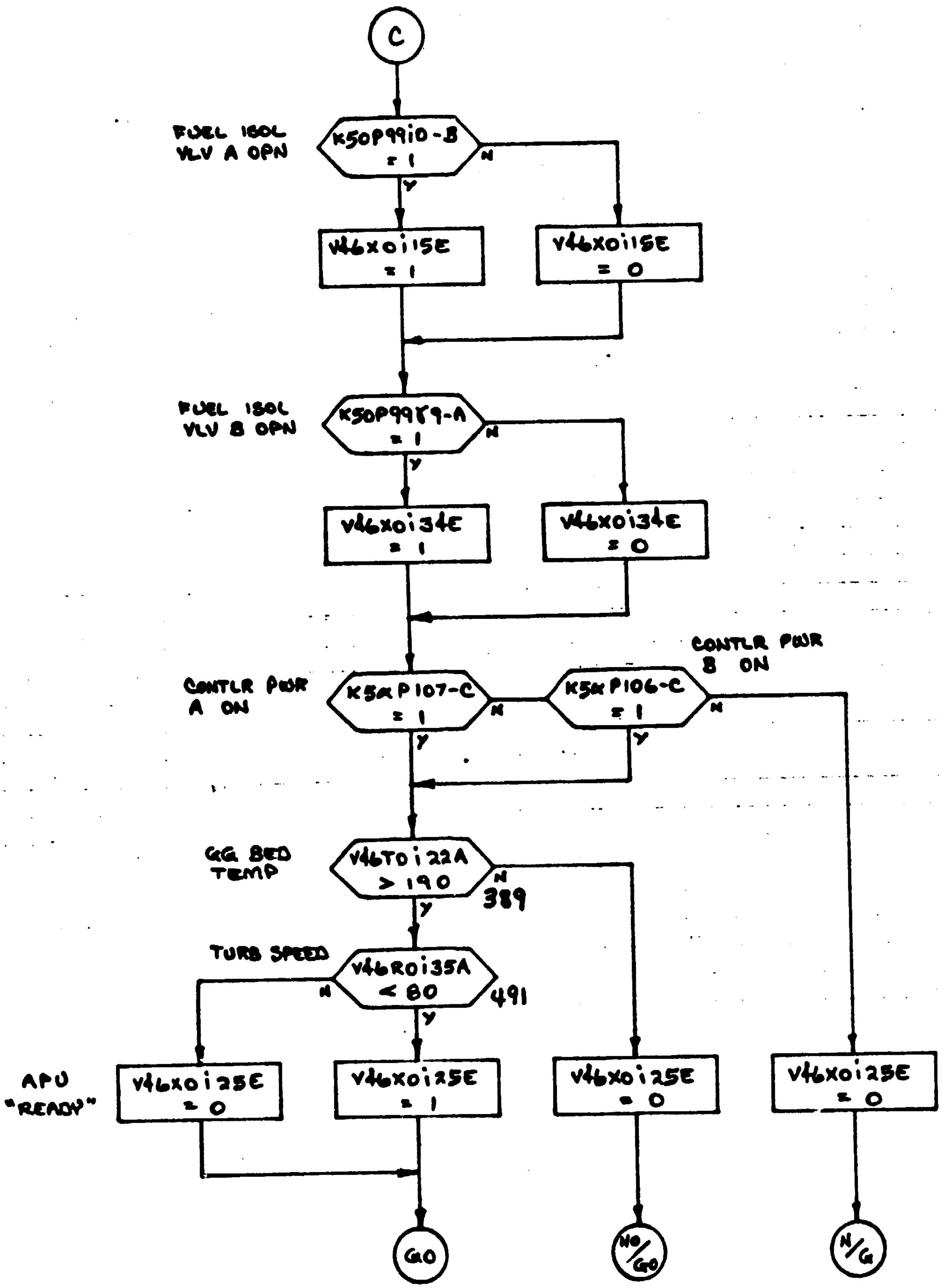

BEGIN
SYS 1 LOG
ISOL VLV
CLS CMD
K50P9007-C
= 1
N
Y
OPN CMD
K50P9007-A
= 1
V58X0190E
= 1
V58X0190E
= 0
SYS 2 LOG
ISOL VLV
CLS CMD
K50P9008-C
= 1
OPN CMD
K50P9008-A
= 1
V58X0290E
= 1
V58X0290E
= 0
SYS 3 LOG
ISOL VLV
CLS CMD
K50P9009-C
= 1
OPN CMD
K50P9009-A
= 1
V58X0390E
= 1
V58X0390E
= 0
ME

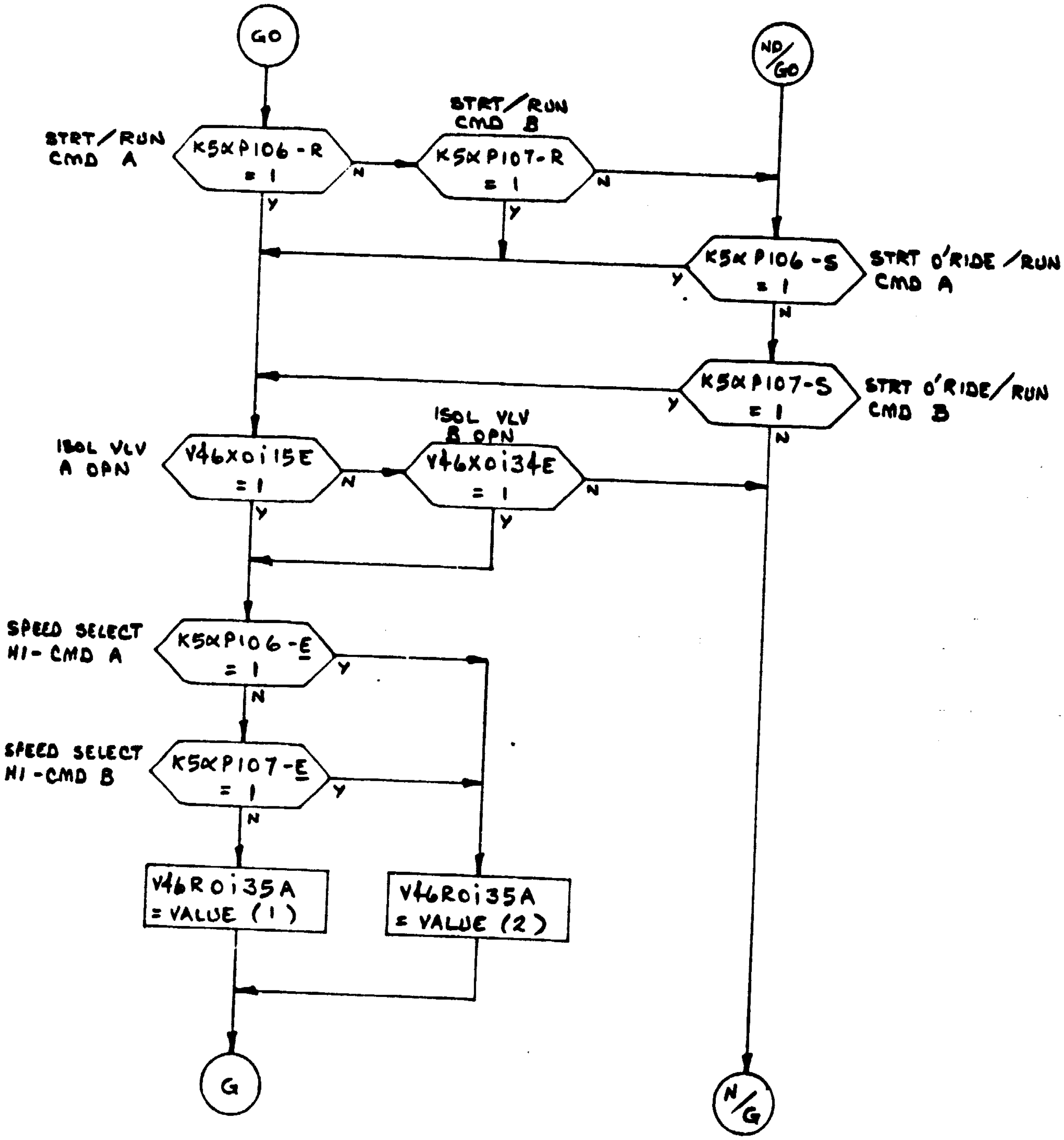

ME
SYS 1 ME/TVC SPLY VLV
OPN CMD
K50P38-A = 1
N
Y
V58X1136E = 1
CLS CMD
K50P38-C = 1
V58X1136E = 0
SYS 2 ME/TVC SPLY VLV
K50P39-A = 1
V58X1236E = 1
K50P39-C = 1
V58X1236E = 0
SYS 3 ME/TVC SPLY VLV
K50P40-A = 1
V58X1336E = 1
K50P40-C = 1
V58X1336E = 0
APU

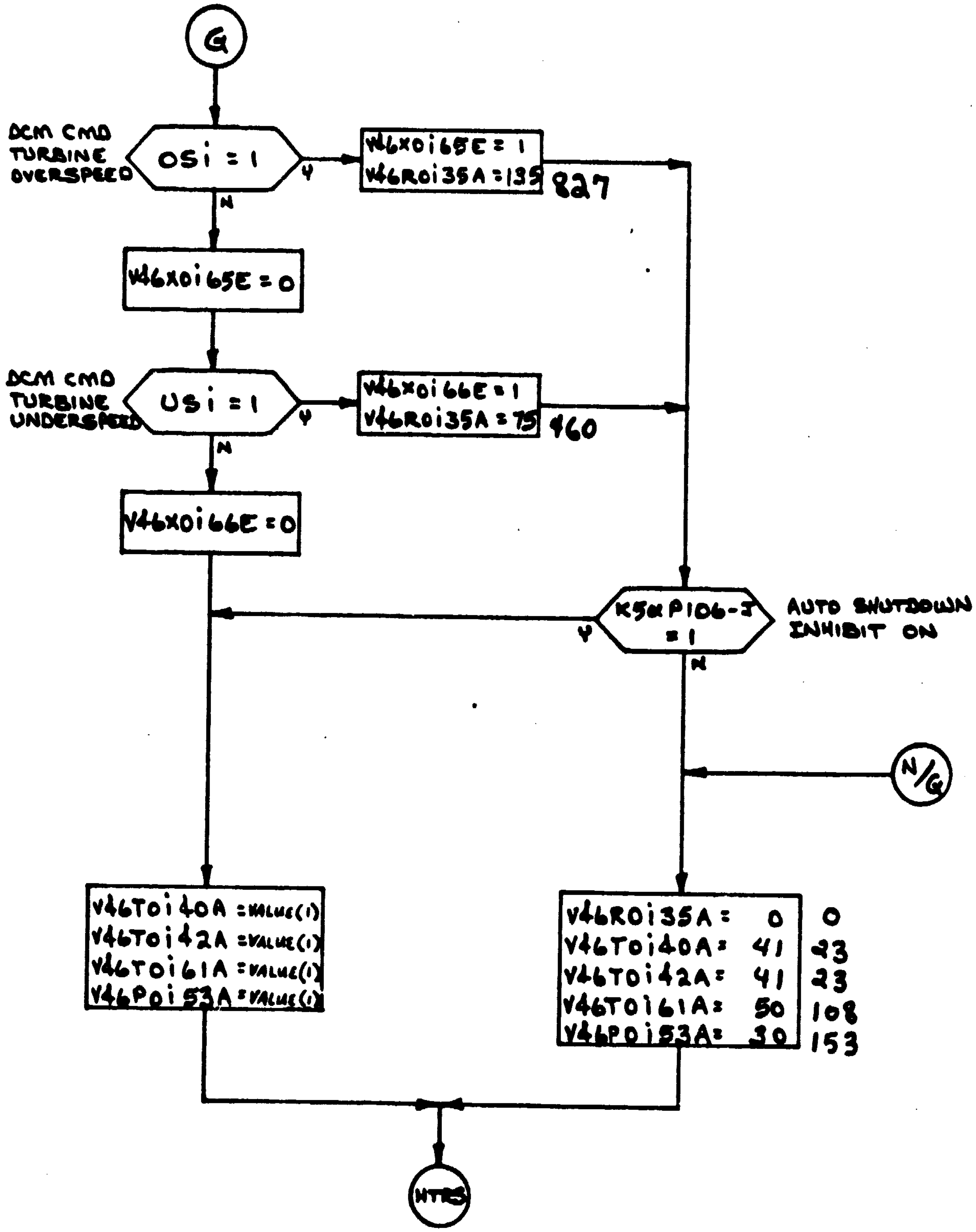


APU
i
1
2
3
TK/LN HTRS A
K50SP441 = 1
K50SP493 = 1
K50SP545 = 1
TK/LN HTRS B
K50SP423 = 1
K50SP474 = 1
K50SP527 = 1
Y
N
K = 3
K = 1
TK/LN TMPS
V46T0i 02A = VALUE (K)
i 04A =
i 08A =
i 83A =
i 84A =
i 30A =
B

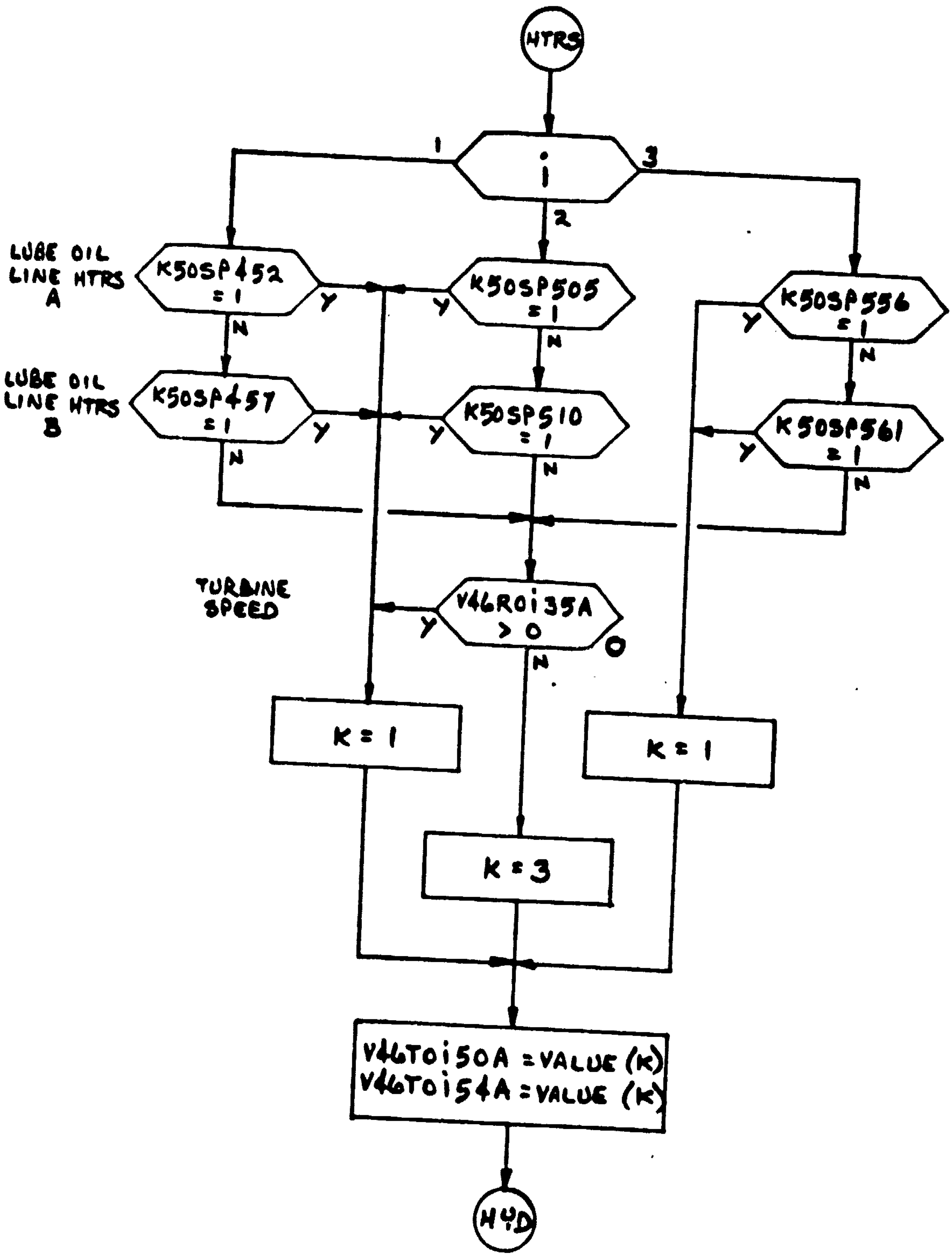

B
GG / FU PMP HTRS A
K50P9911-B = 1
Y
N
GG / FU PMP HTRS B
K50P9912-B = 1
Y
N
TURBINE SPEED
V46R0135A > 0
Y
N
K = 3
K = 1
V46T0112A = VALUE (K)
0122A =
0186A =
0128A =
0192A =
0193A =
0194A =
9158A =
9180A =
0501A =
9132A =
927CA =
9513A =
C

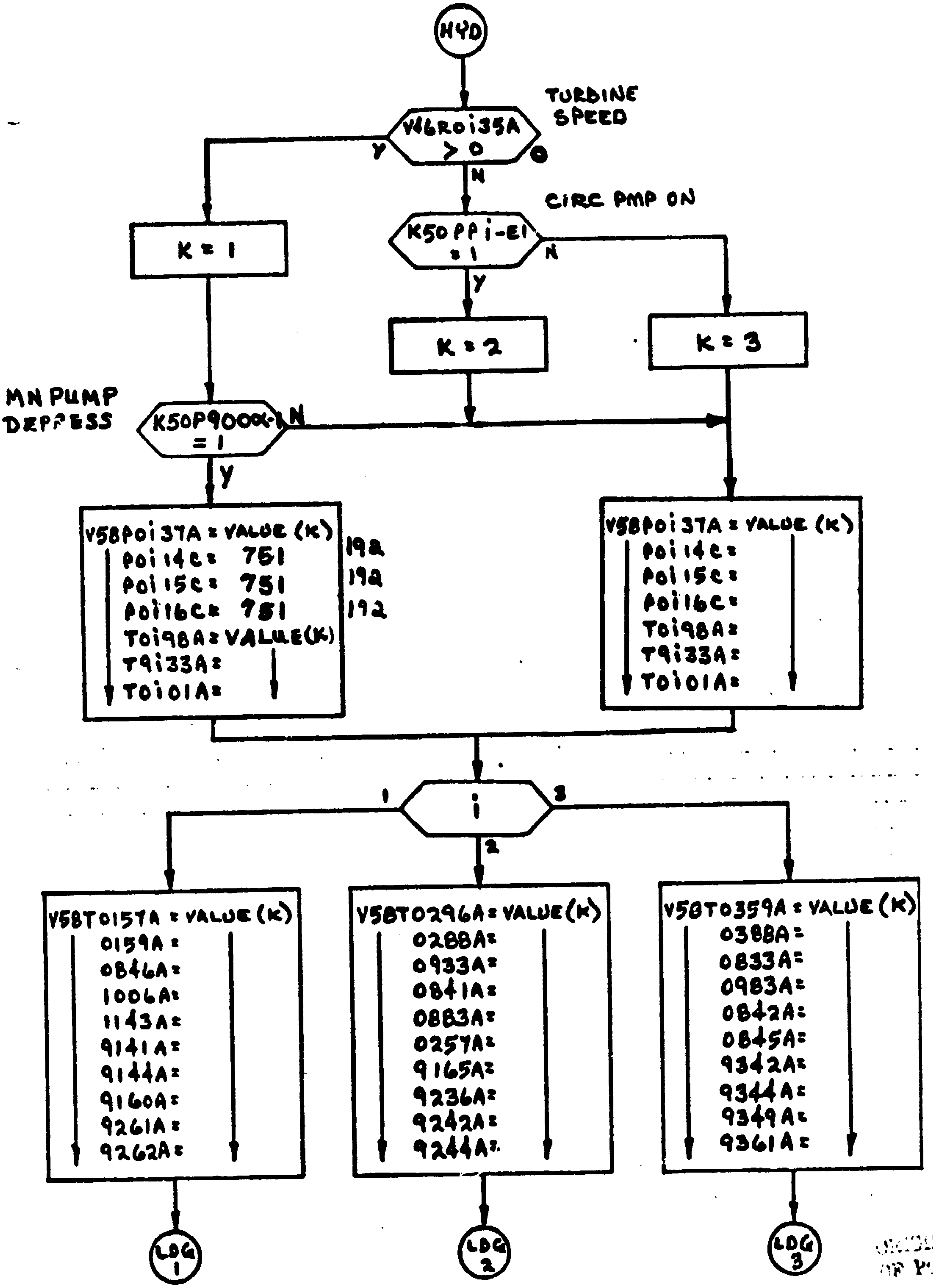

C
FUEL ISOL VLV A OPN
K50P9910-B = 1
V46X0115E = 1
V46X0115E = 0
FUEL ISOL VLV B OPN
K50P9989-A = 1
V46X0134E = 1
V46X0134E = 0
CONTLR PWR A ON
K5xP107-C = 1
CONTLR PWR B ON
K5xP106-C = 1
GG BED TEMP
V46T0122A > 190
389
TURB SPEED
V46R0135A < 80
491
APU "READY"
V46X0125E = 0
V46X0125E = 1
V46X0125E = 0
V46X0125E = 0
GO
NO/GO
N/G

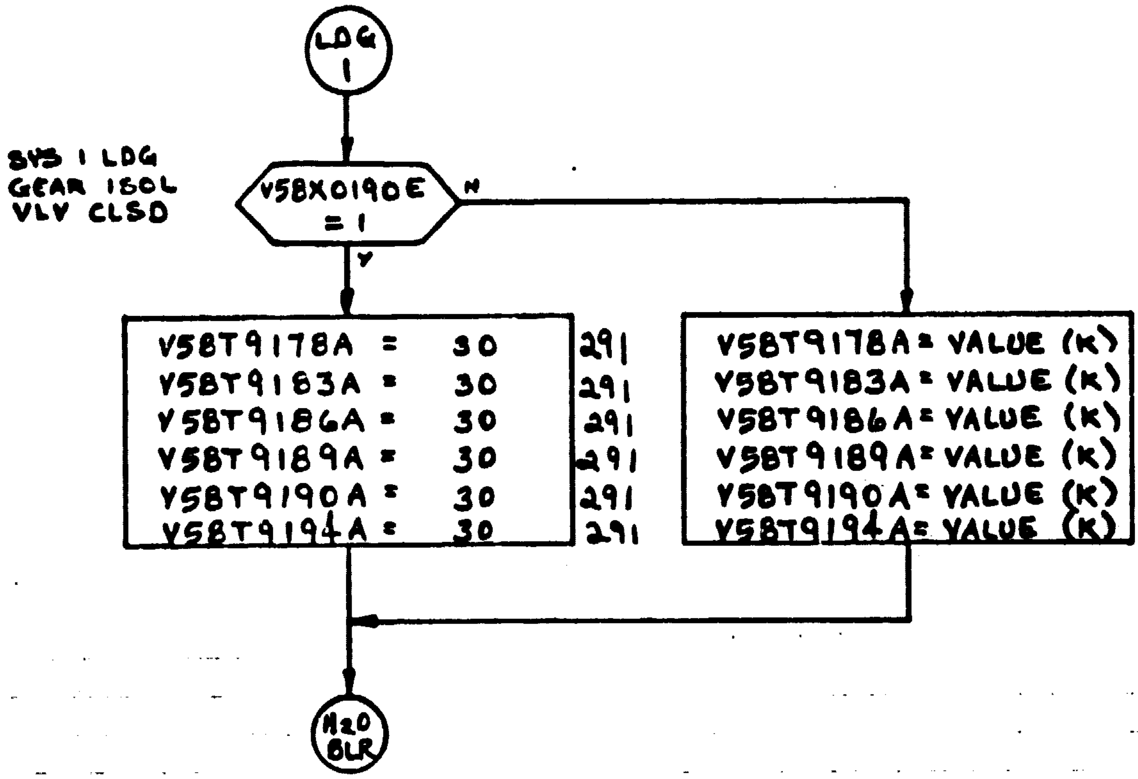

GO
NO/GO
STRT/RUN CMD A
K5αP106-R = 1
STRT/RUN CMD B
K5αP107-R = 1
K5αP106-S = 1
STRT O'RIDE/RUN CMD A
K5αP107-S = 1
STRT O'RIDE/RUN CMD B
ISOL VLV A OPN
V46X0115E = 1
ISOL VLV B OPN
V46X0134E = 1
SPEED SELECT HI-CMD A
K5αP106-E = 1
SPEED SELECT HI-CMD B
K5αP107-E = 1
V46R0135A = VALUE (1)
V46R0135A = VALUE (2)
G
N/G

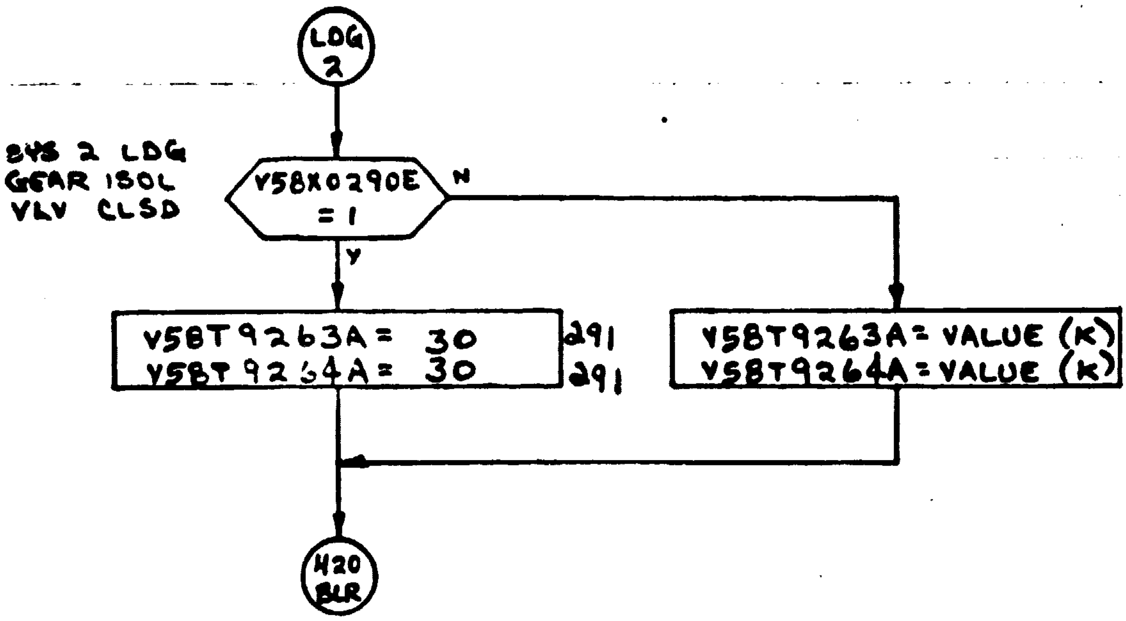


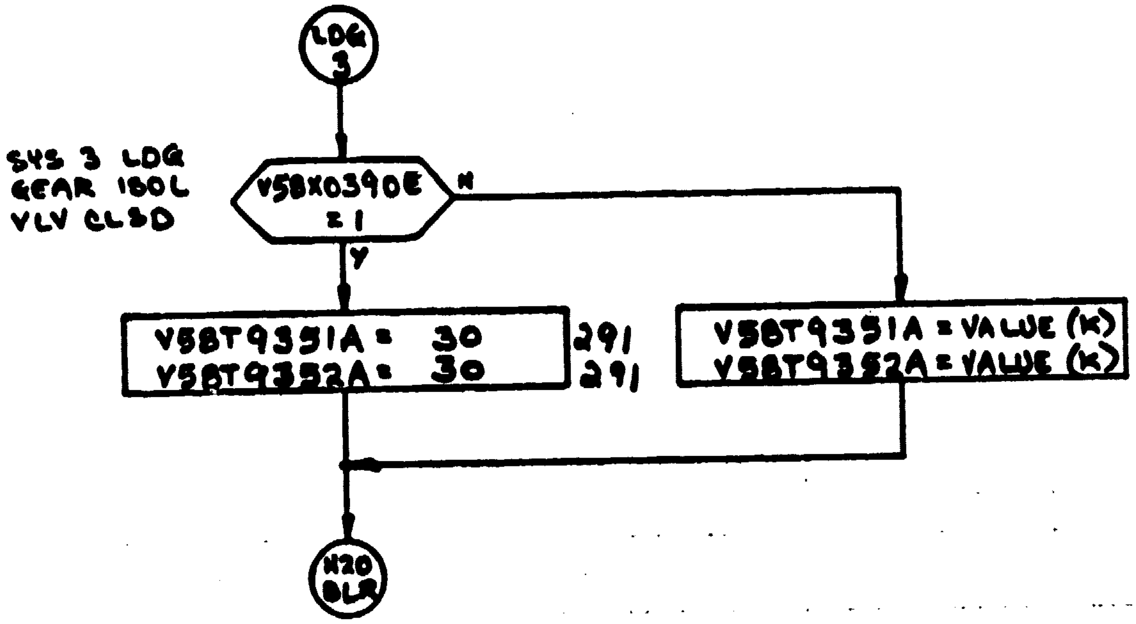
G
DCM CMD TURBINE OVERSPEED
OSi = 1
V46X0i65E = 1
V46R0i35A = 135
827
V46X0i65E = 0
DCM CMD TURBINE UNDERSPEED
USi = 1
V46X0i66E = 1
V46R0i35A = 75
460
V46X0i66E = 0
K5αP106-J = 1
AUTO SHUTDOWN INHIBIT ON
N/G
V46T0i40A = VALUE(I)
V46T0i42A = VALUE(I)
V46T0i61A = VALUE(I)
V46P0i53A = VALUE(I)
V46R0i35A = 0 0
V46T0i40A = 41 23
V46T0i42A = 41 23
V46T0i61A = 50 108
V46P0i53A = 30 153
HTRS

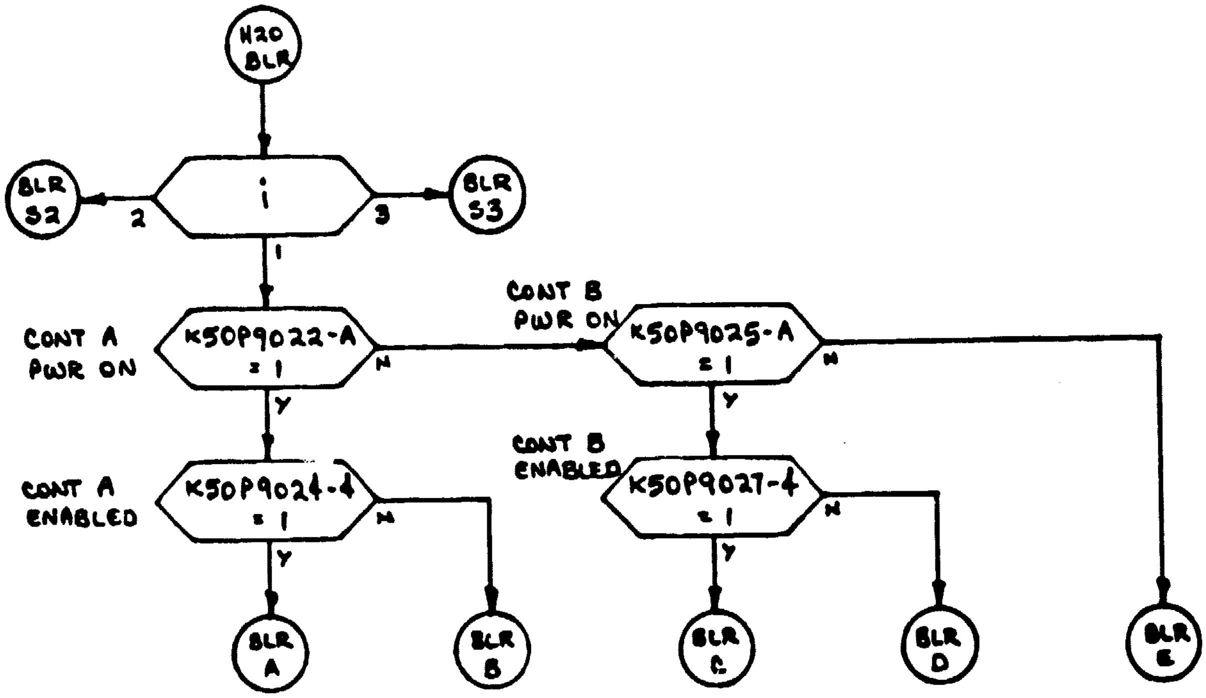

HTRS
i
1
2
3
LUBE OIL LINE HTRS A
K50SP452 = 1
LUBE OIL LINE HTRS B
K50SP457 = 1
K50SP505 = 1
K50SP510 = 1
K50SP556 = 1
K50SP561 = 1
TURBINE SPEED
V46R0i35A > 0
K = 1
K = 3
K = 1
V46T0i50A = VALUE (K)
V46T0i54A = VALUE (K)
H4D

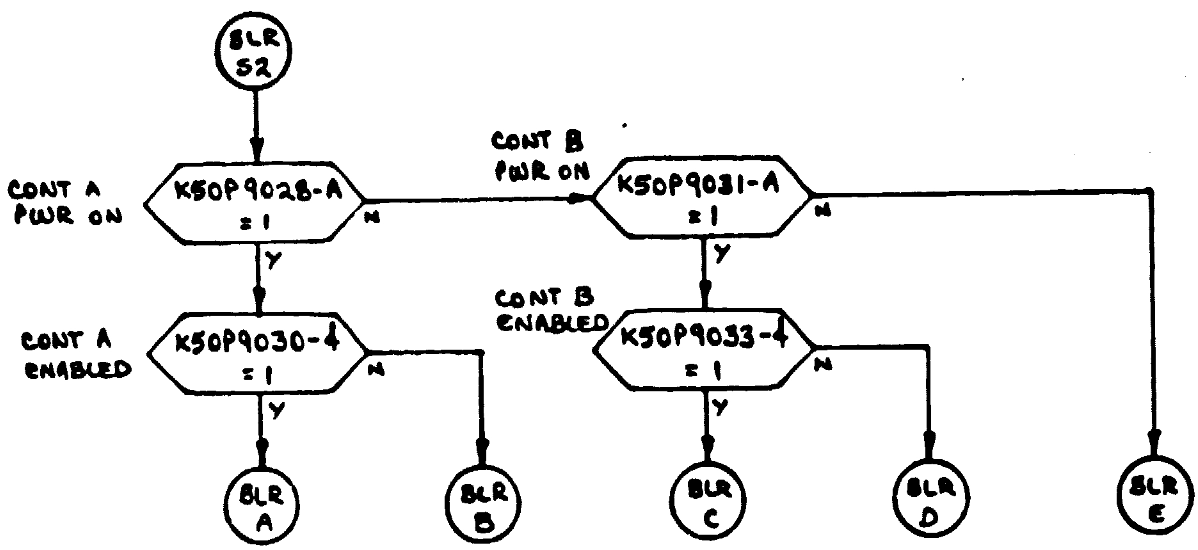

HYD
TURBINE SPEED
V46R0135A > 0
Y
N
CIRC PMP ON
K50PP1-E1 = 1
N
Y
K = 1
K = 2
K = 3
MN PUMP DEPRESS
K50P9000X-1 = 1
N
Y
V58P0137A = VALUE (K)
P0114C = 751
P0115C = 751
P0116C = 751
T0198A = VALUE(K)
T9133A =
T0101A =
192
192
192
V58P0137A = VALUE (K)
P0114C =
P0115C =
P0116C =
T0198A =
T9133A =
T0101A =
i
1
2
3
V58T0157A = VALUE (K)
0159A =
0846A =
1006A =
1143A =
9141A =
9144A =
9160A =
9261A =
9262A =
V58T0296A = VALUE (K)
0288A =
0933A =
0841A =
0883A =
0257A =
9165A =
9236A =
9242A =
9244A =
V58T0359A = VALUE (K)
0388A =
0833A =
0983A =
0842A =
0845A =
9342A =
9344A =
9349A =
9361A =
LDG 1
LDG 2
LDG 3

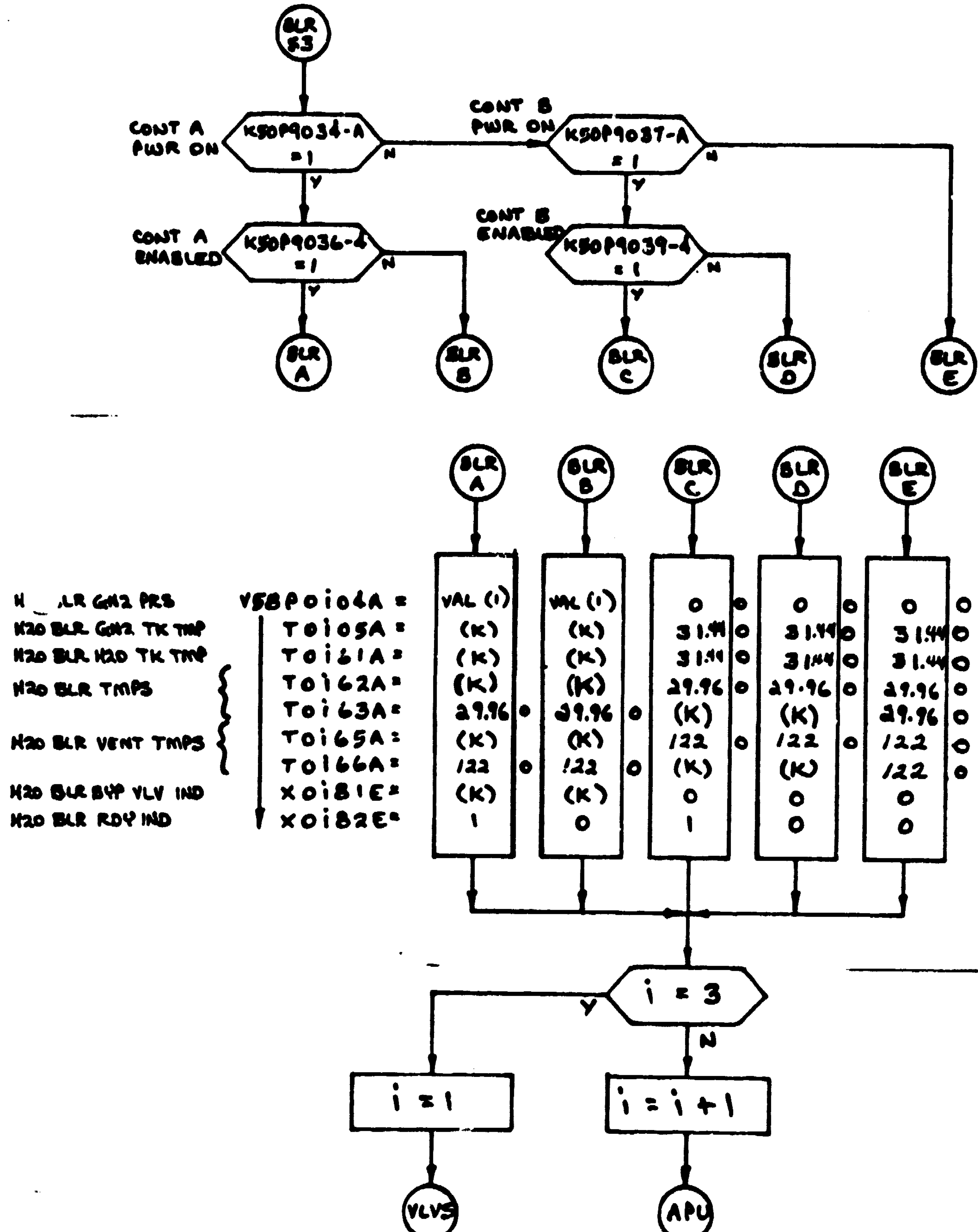

LDG 1
SYS 1 LDG GEAR ISOL VLV CLSD
V58X0190E = 1
N
Y
V58T9178A = 30 291
V58T9183A = 30 291
V58T9186A = 30 291
V58T9189A = 30 291
V58T9190A = 30 291
V58T9194A = 30 291
V58T9178A = VALUE (K)
V58T9183A = VALUE (K)
V58T9186A = VALUE (K)
V58T9189A = VALUE (K)
V58T9190A = VALUE (K)
V58T9194A = VALUE (K)
H2O BLR

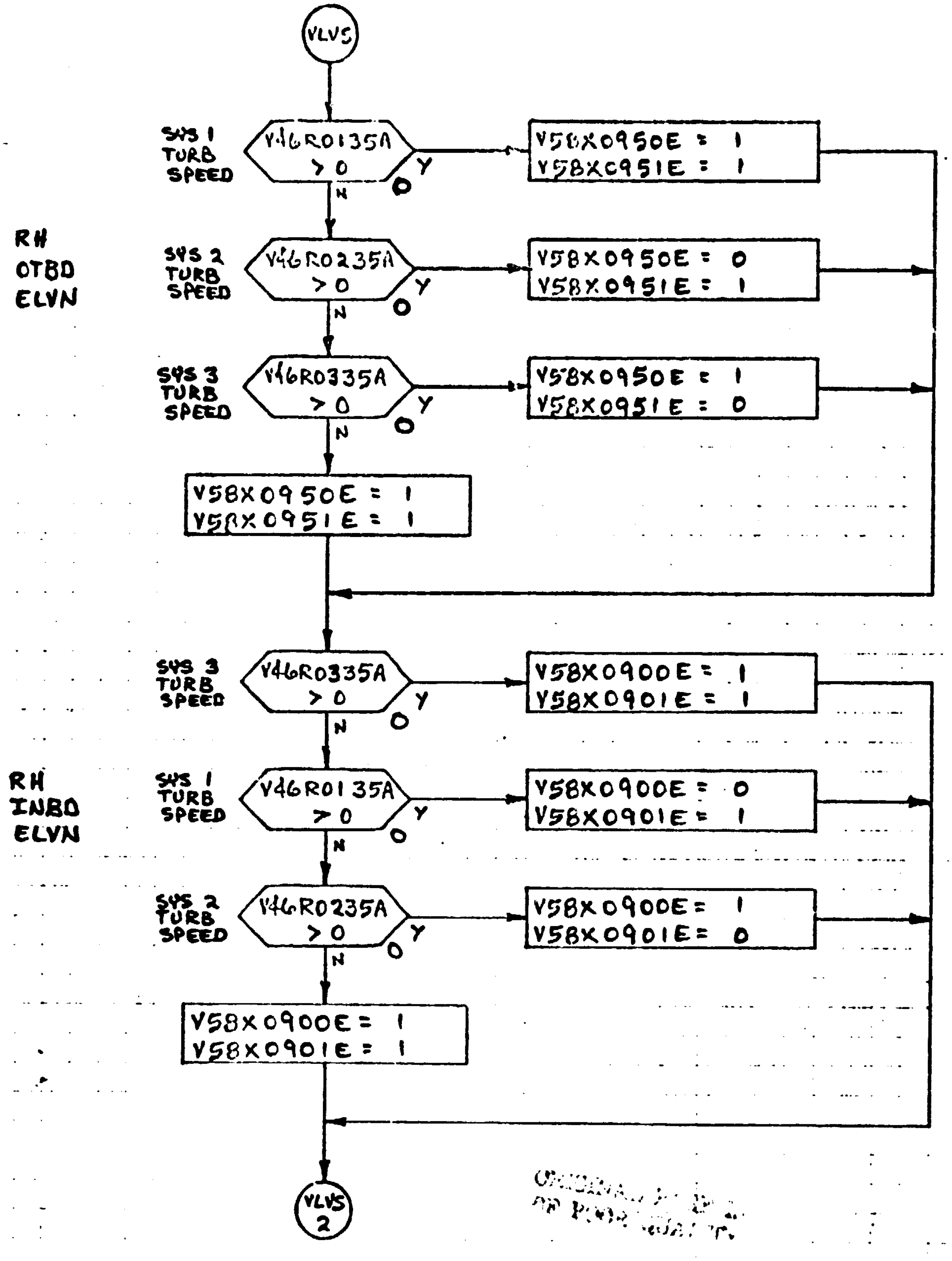

LDG 2
SYS 2 LDG GEAR ISOL VLV CLSD
V58X0290E = 1
N
Y
V58T9263A = 30 291
V58T9264A = 30 291
V58T9263A = VALUE (K)
V58T9264A = VALUE (K)
H2O BLR


LDG 3
SYS 3 LDG GEAR ISOL VLV CLSD
V58X0390E = 1
N
Y
V58T9351A = 30
V58T9352A = 30
291
291
V58T9351A = VALUE (K)
V58T9352A = VALUE (K)
H20 BLR


H2O BLR
i
BLR S2
BLR S3
2
3
1
CONT A PWR ON
K50P9022-A = 1
CONT B PWR ON
K50P9025-A = 1
CONT A ENABLED
K50P9024-4 = 1
CONT B ENABLED
K50P9027-4 = 1
Y
N
BLR A
BLR B
BLR C
BLR D
BLR E


BLR S2
CONT A PWR ON
K50P9028-A = 1
CONT B PWR ON
K50P9031-A = 1
CONT A ENABLED
K50P9030-4 = 1
CONT B ENABLED
K50P9033-4 = 1
Y
N
BLR A
BLR B
BLR C
BLR D
BLR E


BLR 53
CONT A PWR ON
K50P9034-A =1
CONT B PWR ON
K50P9037-A =1
CONT A ENABLED
K50P9036-A =1
CONT B ENABLED
K50P9039-A =1
Y
N
BLR A
BLR B
BLR C
BLR D
BLR E
H _ LR GN2 PRS
H2O BLR GN2 TK TMP
H2O BLR H2O TK TMP
H2O BLR TMPS
H2O BLR VENT TMPS
H2O BLR BYP VLV IND
H2O BLR RDY IND
V58P0104A =
T0105A =
T0161A =
T0162A =
T0163A =
T0165A =
T0166A =
X0181E =
X0182E =
VAL (1)
(K)
29.96
122
1
0
31.44
i = 3
i = 1
i = i + 1
VLVS
APU



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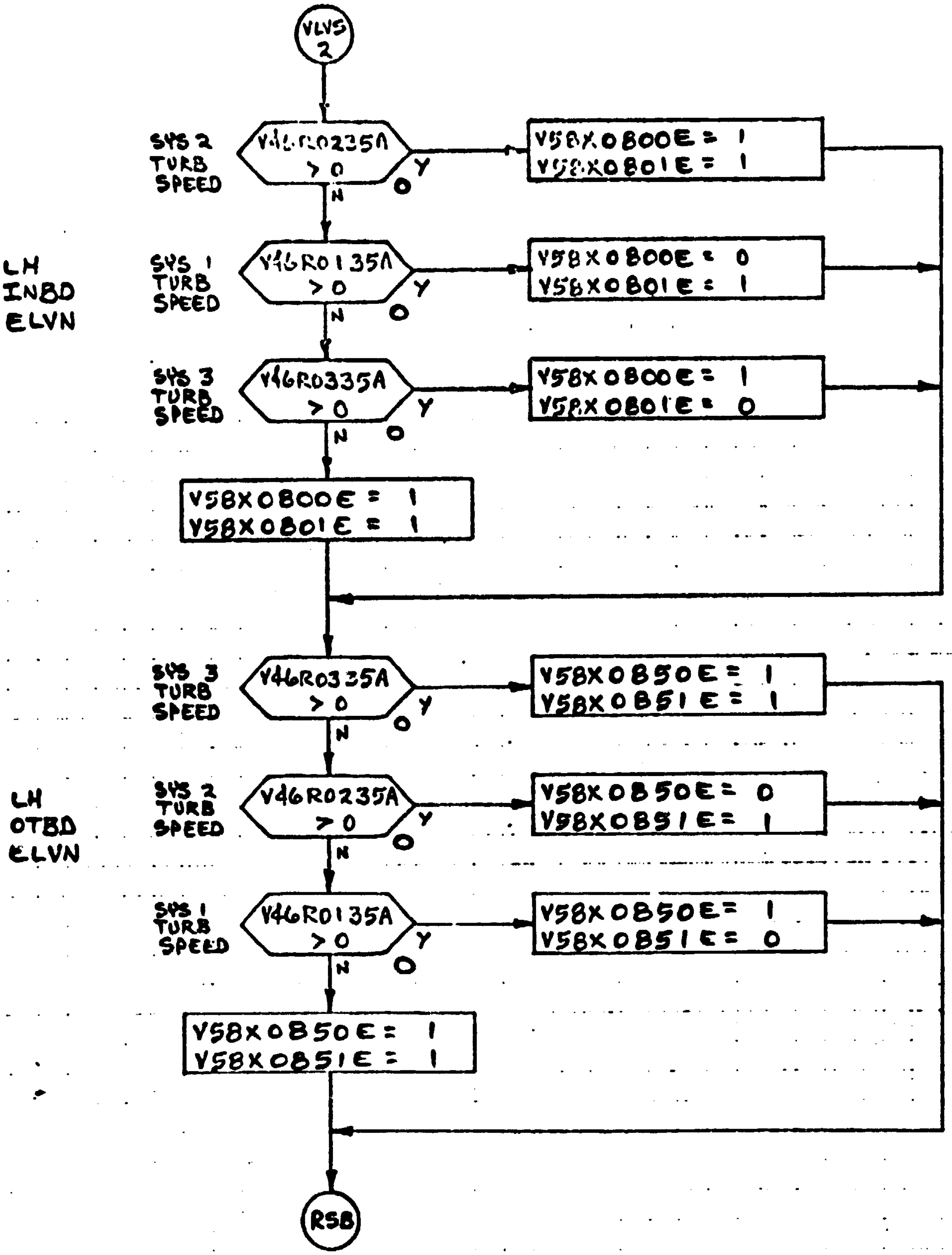
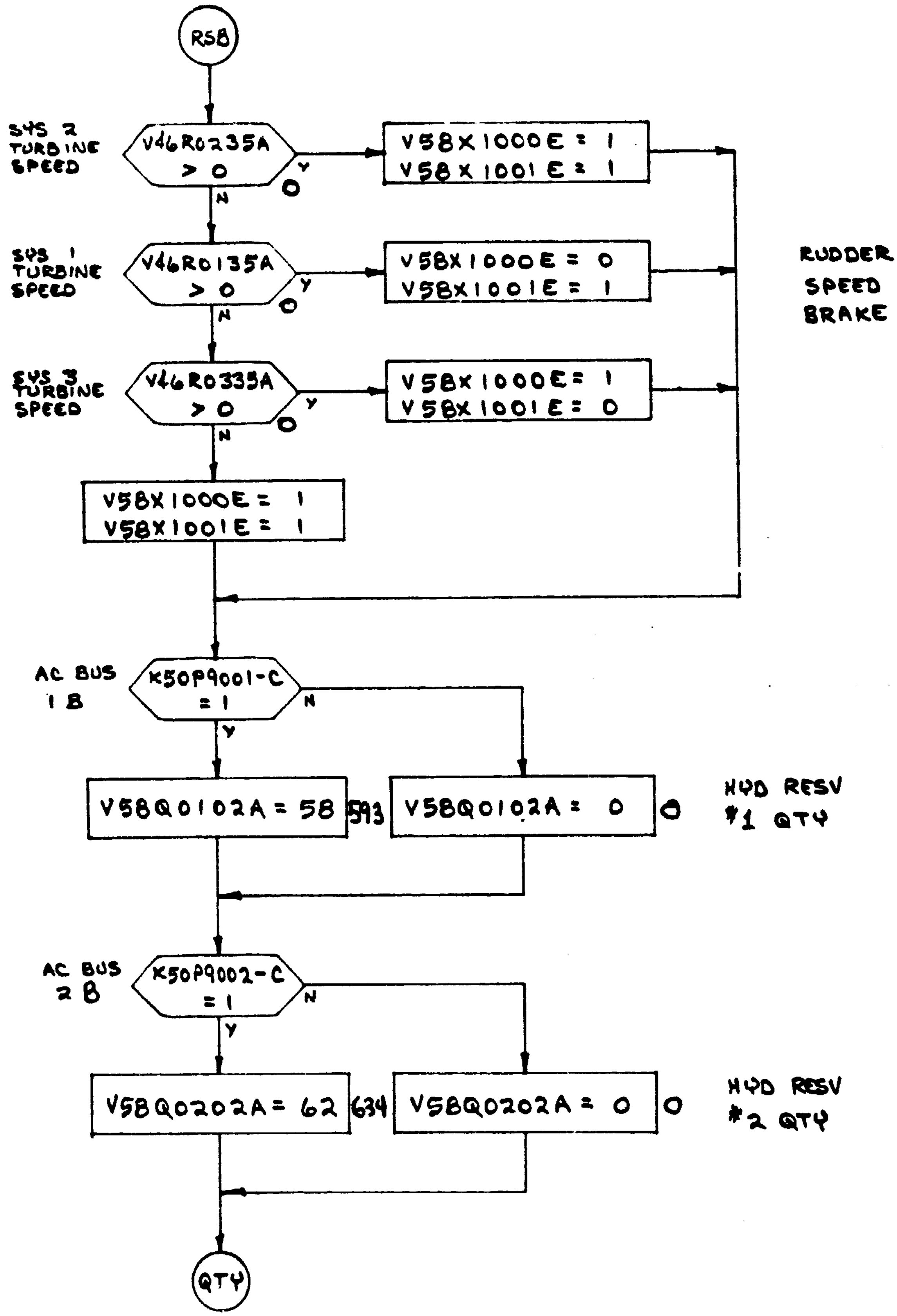
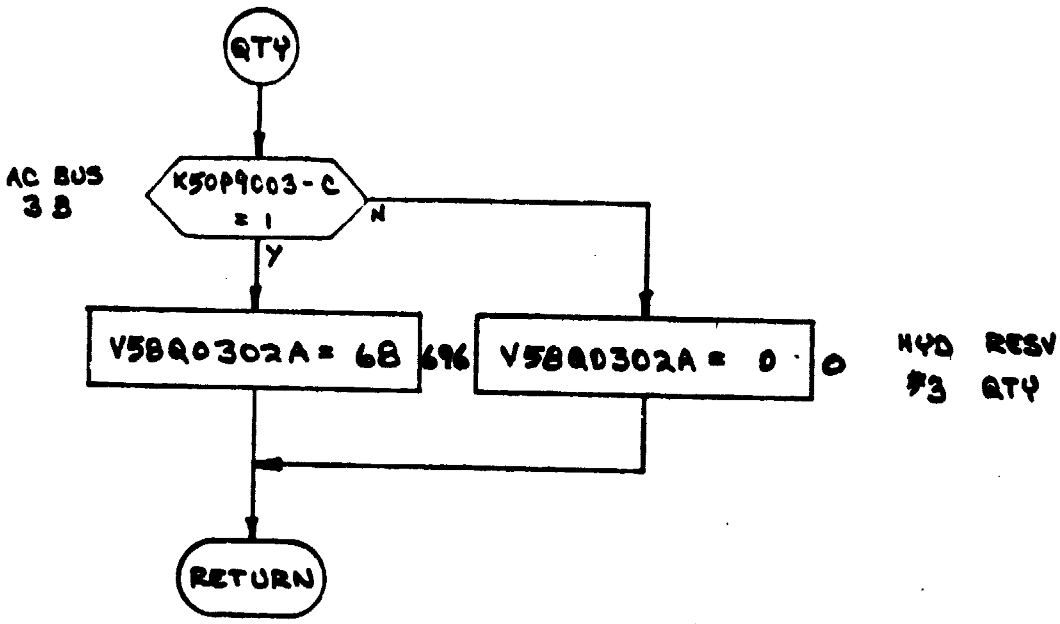

VLVS 2
SYS 2 TURB SPEED
V46R0235A > 0
Y
N
V58X0800E = 1
V58X0801E = 1
LH INBD ELVN
SYS 1 TURB SPEED
V46R0135A > 0
V58X0800E = 0
V58X0801E = 1
SYS 3 TURB SPEED
V46R0335A > 0
V58X0800E = 1
V58X0801E = 0
V58X0800E = 1
V58X0801E = 1
SYS 3 TURB SPEED
V46R0335A > 0
V58X0850E = 1
V58X0851E = 1
LH OTBD ELVN
SYS 2 TURB SPEED
V46R0235A > 0
V58X0850E = 0
V58X0851E = 1
SYS 1 TURB SPEED
V46R0135A > 0
V58X0850E = 1
V58X0851E = 0
V58X0850E = 1
V58X0851E = 1
RSB


RSB
SYS 2 TURBINE SPEED
V46R0235A > 0
V58X1000E = 1
V58X1001E = 1
SYS 1 TURBINE SPEED
V46R0135A > 0
V58X1000E = 0
V58X1001E = 1
SYS 3 TURBINE SPEED
V46R0335A > 0
V58X1000E = 1
V58X1001E = 0
RUDDER SPEED BRAKE
V58X1000E = 1
V58X1001E = 1
AC BUS 1 B
K50P9001-C = 1
V58Q0102A = 58
593
V58Q0102A = 0
0
HYD RESV #1 QTY
AC BUS 2 B
K50P9002-C = 1
V58Q0202A = 62
634
V58Q0202A = 0
0
HYD RESV #2 QTY
QTY



QTY
AC BUS
3 B
K50P9C03-C
= 1
Y
N
V58Q0302A = 68
696
V58Q0302A = 0
0
HYD RESV
#3 QTY
RETURN

4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

4.1.2 PSEUDO VARIABLE INITIALIZATION

The following pseudos are initialized as following:

VAIABLE	INITIAL CONDITION
OS1	0
US1	0
OS2	0
US2	0
OS3	0
US3	0

TABLE 1 - STIMULI IN . APU/HYD

PANEL/ SWITCH	NOMENCLATURE -APU-	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
A12/S7	TK/LN HTRS A SYS 1	5	V46K0103E	K50SP441	1-ON/0-OFF
A12/S8	TK/LN HTRS B SYS 1	5	V46K0109E	K50SP423	1-ON/0-OFF
A12/S9	TK/LN HTRS A SYS 2	5	V46K0203E	K50SP493	1-ON/0-OFF
A12/S10	TK/LN HTRS B SYS 2	5	V46K0209E	K50SP474	1-ON/0-OFF
A12/S11	TK/LN HTRS A SYS 3	5	V46K0303E	K50SP545	1-ON/0-OFF
AJ2/S12	TK/LN HTRS B SYS 3	5	V46K0309E	K50SP527	1-ON/0-OFF
A12/S4	LUBE OIL LINE HTRS - A AUTO SYS 1	5	V46K0116E	K50SP452	1-ON/0-OFF
	LUBE OIL LINE HTRS - B AUTO SYS 1	5	V46K0117E	K50SP457	1-ON/0-OFF
A12/S5	LUBE OIL LINE HTRS - A AUTO SYS 2	5	V46K0216E	K50SP505	1-ON/0-OFF
	LUBE OIL LINE HTRS - B AUTO SYS 2	5	V46K0217E	K50SP510	1-ON/0-OFF
A12/S6	LUBE OIL LINE HTRS - A AUTO SYS 3	5	V46K0316E	K50SP556	1-ON/0-OFF
	LUBE OIL LINE HTRS - B AUTO SYS 3	5	V46K0317E	K50SP561	1-ON/0-OFF
A12/S1	GG/FU PMP HTRS - A AUTO SYS 1	5	V46K0118E	K50P9911-B	1-ON/0-OFF
	GG/FU PMP HTRS - B AUTO SYS 1	5	V46K0119E	K50P9912-B	1-ON/0-OFF
A12/S2	GG/FU PMP HTRS - A AUTO SYS 2	5	V46K0218E	K50P9921-B	1-ON/0-OFF
	GG/FU PMP HTRS - B AUTO SYS 2	5	V46K0219E	K50P9922-B	1-ON/0-OFF
A12/S3	GG/FU PMP HTRS - A AUTO SYS 3	5	V46K0318E	K50P9931-B	1-ON/0-OFF
	GG/FU PMP HTRS - B AUTO SYS 3	5	V46K0319E	K50P9932-B	1-ON/0-OFF

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R2/S35	FUEL ISOL VLV A SYS 1	5	V46K0121E	K50P9910-B	1-OPN/0-CLS
	FUEL ISOL VLV B SYS 1	5	V46K0114E	K50P9909-A	1-OPN/0-CLS
R2/S36	FUEL ISOL VLV A SYS 2	5	V46K0221E	K50P9920-B	1-OPN/0-CLS
	FUEL ISOL VLV B SYS 2	5	V46K0214E	K50P9919-A	1-OPN/0-CLS
R2/S37	FUEL ISOL VLV A SYS 3	5	V46K0321E	K50P9930-B	1-OPN/0-CLS
	FUEL ISOL VLV B SYS 3	5	V46K0314E	K50P9929-A	1-OPN/0-CLS
R2/S32	APU CNTRL PWR A - SYS 1	5	V46K0124E	K54P107-C	1-ON/0-OFF
	APU CNTRL PWR B - SYS 1	5	V46K0144E	K54P106-C	1-ON/0-OFF
R2/S33	APU CNTRL PWR A - SYS 2	5	V46K0224E	K55P107-C	1-ON/0-OFF
	APU CNTRL PWR B - SYS 2	5	V46K0244E	K55P106-C	1-ON/0-OFF
R2/S34	APU CNTRL PWR A - SYS 3	5	V46K0324E	K56P107-C	1-ON/0-OFF
	APU CNTRL PWR B - SYS 3	5	V46K0344E	K56P106-C	1-ON/0-OFF
R2/S16	APU CNTRL - START/RUN CMD A SYS 1	5	V46K0126E	K54P106-R	1-RUN/0-OFF
	APU CNTRL - START/RUN CMD B SYS 1	5	V46K0146E	K54P107-R	1-RUN/0-OFF
	APU CNTRL - O'RIDE/RUN CMD A SYS 1	5	V46K0127E	K54P106-S	1-RUN/0-OFF
	APU CNTRL - O'RIDE/RUN CMD B SYS 1	5	V46K0147E	K54P107-S	1-RUN/0-OFF
R2/S17	APU CNTRL - START/RUN CMD A SYS 2	5	V46K0226E	K55P106-R	1-RUN/0-OFF
	APU CNTRL - START/RUN CMD B SYS 2	5	V46K0246E	K55P107-R	1-RUN/0-OFF
	APU CNTRL - O'RIDE/RUN CMD A SYS 2	5	V46K0227E	K55P106-S	1-RUN/0-OFF

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R2/S17 CONTINUED	APU CNTRL - O'RIDE/RUN CMD B SYS 2	5	V46K0247E	K55P107-S	1-RUN/0-OFF
R2/S18	APU CNTRL - START/RUN CMD A SYS 3	5	V46K0326E	K56P106-R	1-RUN/0-OFF
	APU CNTRL - START/RUN CMD B SYS 3	5	V46K0346E	K56P107-R	1-RUN/0-OFF
	APU CNTRL - O'RIDE/RUN CMD A SYS 3	5	V46K0327E	K56P106-S	1-RUN/0-OFF
	APU CNTRL - O'RIDE/RUN CMD B SYS 3	5	V46K0347E	K56P107-S	1-RUN/0-OFF
R2/S22	AUTO SHUTDOWN INHIBIT A - SYS 1 & 3	5	V46K0097E	K54P106-J	1-ON/0-OFF
	AUTO SHUTDOWN INHIBIT B - SYS 1 & 2	5	V46K0098E	K55P106-J	1-ON/0-OFF
	AUTO SHUTDOWN INHIBIT C - SYS 2 & 3	5	V46K0099E	K56P106-J	1-ON/0-OFF
R2/S19	SPEED SELECT HI - CMD A SYS 1	5	V46K0129E	K54P106-E	1-HI/0-NORM
	SPEED SELECT HI - CMD B SYS 1	5	V46K0149E	K54P107-E	1-HI/0-NORM
R2/S20	SPEED SELECT HI - CMD A SYS 2	5	V46K0229E	K55P106-E	1-HI/0-NORM
	SPEED SELECT HI - CMD B SYS 2	5	V46K0249E	K55P107-E	1-HI/0-NORM
R2/S21	SPEED SELECT HI - CMD A SYS 3	5	V46K0329E	K56P106-E	1-HI/0-NORM
	SPEED SELECT HI - CMD B SYS 3	5	V46K0349E	K56P107-E	1-HI/0-NORM
	TURBINE OVERSPEED CMD - SYS 1			OS1	1-OS/0-OFF
	TURBINE UNDERSPEED CMD - SYS 1			US1	1-US/0-OFF
	TURBINE OVERSPEED CMD - SYS 2	7		OS2	1-OS/0-OFF
	TURBINE UNDERSPEED CMD - SYS 2			US2	1-US/0-OFF
	TURBINE OVERSPEED CMD - SYS 3			OS3	1-OS/0-OFF
	TURBINE UNDERSPEED CMD - SYS 3			US3	1-US/0-OFF

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
	-HYD-				
R2/S29	CIRC PUMP SYS 1	2	V58K0142Y V58K0143Y	K50PP1-E1	1-ON/0-OFF
R2/S30	CIRC PUMP SYS 2	2	V58K0242Y V58K0243Y	K50PP2-E1	1-ON/0-OFF
R2/S31	CIRC PUMP SYS 3	2	V58K0342Y V58K0343Y	K50PP3-E1	1-ON/0-OFF
R2/S26	MN PUMP DEPR ON SYS 1	5	V58K0171E	K50P9004-1	1-LOW/0-NORM
R2/S27	MN PUMP DEPR ON SYS 2	5	V58K0271E	K50P9005-1	1-LOW/0-NORM
R2/S28	MN PUMP DEPR ON SYS 3	5	V58K0371E	K50P9006-1	1-LOW/0-NORM
R4/S22	LG ISLN VLV OPEN SYS 1	2	V58K0195X	K50P9007-A	1-OPN/0-OFF
	LG ISLN VLV CLOSED SYS 1	5	V58K0191E	K50P9007-C	1-CLS/0-OFF
R4/S23	LG ISLN VLV OPEN SYS 2	2	V58K0295X	K50P9008-A	1-OPN/0-OFF
	LG ISLN VLV CLOSED SYS 2	5	V58K0291E	K50P9008-C	1-CLS/0-OFF
R4/S24	LG ISLN VLV OPEN SYS 3	2	V58K0395X	K50P9009-A	1-OPN/0-OFF
	LG ISLN VLV CLOSED SYS 3	5	V58K0391E	K50P9009-C	1-CLS/0-OFF
R4/S25	ME/TVC SPLY VLV OPEN SYS 1	5	V58K1134E	K50P38-A	1-OPN/0-OFF
	ME/TVC SPLY VLV CLOSED SYS 1	5	V58K1135E	K50P38-C	1-CLS/0-OFF
R4/S26	ME/TVC SPLY VLV OPEN SYS 2	5	V58K1234E	K50P39-A	1-OPN/0-OFF
	ME/TVC SPLY VLV CLOSED SYS 2	5	V58K1235E	K50P39-C	1-CLS/0-OFF

TABLE 1 - STIMULI FOR APU/HYD

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R4/S27	ME/TVC SPLY VLV OPEN SYS 3	5	V58K1334E	K50P40-A	1-OPN/0-OFF
	ME/TVC SPLY VLV CLOSED SYS 3	5	V58K1335E	K50P40-C	1-CLS/0-OFF
R2/S41	H20 BLR CNTLR PWR/HTR A SYS 1	5	V58K0149E	K50P9022-A	1-ON/0-OFF
	H20 BLR CNTLR PWR/HTR B SYS 1	5	V58K0150E	K50P9025-A	1-ON/0-OFF
R2/S42	H20 BLR CNTLR PWR/HTR A SYS 2	5	V58K0249E	K50P9028-A	1-ON/0-OFF
	H20 BLR CNTLR PWR/HTR B SYS 2	5	V58K0250E	K50P9031-A	1-ON/0-OFF
R2/S43	H20 BLR CNTLR PWR/HTR A SYS 3	5	V58K0349E	K50P9034-A	1-ON/0-OFF
	H20 BLR CNTLR PWR/HTR B SYS 3	5	V58K0350E	K50P9037-A	1-ON/0-OFF
R2/S38	H20 BLR CNTLR A ENABLE SYS 1	5	V58K0151E	K50P9024-4	1-ENABLE/0-OFF
	H20 BLR CNTLR B ENABLE SYS 1			K50P9027-4	1-ENABLE/0-OFF
R2/S39	H20 BLR CNTLR A ENABLE SYS 2	5	V58K0251E	K50P9030-4	1-ENABLE/0-OFF
	H20 BLR CNTLR B ENABLE SYS 2			K50P9033-4	1-ENABLE/0-OFF
R2/S40	H20 BLR CNTLR A ENABLE SYS 3	5	V58K0351E	K50P9036-4	1-ENABLE/0-OFF
	H20 BLR CNTLR B ENABLE SYS 3			K50P9039-4	1-ENABLE/0-OFF
L4/CB57	AC BUS 1B PWR HYD RESV QTY #1	5,6		K50P9001-C	1-ON/0-OFF
L4/CB60	AC BUS 2B PWR HYD RESV QTY #2	5,6		K50P9002-C	1-ON/0-OFF
L4/CB63	AC BUS 3B PWR HYD RESV QTY #3	5,6		K50P9003-C	1-ON/0-OFF

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the initial condition value for the output. Measurement I. D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I. C. indicates initial condition values. VALUE 1 typically indicates nominal values. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

Note that table 2 includes all output measurement values except those dealing with turbine overspeed and underspeed which are not related to VALUE (K) for K = 1, 2, 3. The turbine overspeed and underspeed values not included in table 2 are as follows:

When OSi = 1, V46R0i35A = 135 PCT (827 CNTS)
and USi = 1, V46R0i35A = 75 PCT (460 CNTS)

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
	- APU -									
V46P0100A	FUEL TK. PRESS SYSTEM 1	340	695	340	696	NA		340	696	PSIA
V46P0200A	FUEL TK. PRESS SYSTEM 2	335	685	335	685	NA		335	685	PSIA
V46P0300A	FUEL TK. PRESS SYSTEM 3	346	708	346	708	NA		346	706	PSIA
V46T0102A	TK. SURFACE TEMP SYSTEM 1	56	360	56	360	NA		47	303	°F
V46T0202A	TK. SURFACE TEMP SYSTEM 2	64	411	64	411	NA		47	303	°F
V46T0302A	TK. SURFACE TEMP SYSTEM 3	48	309	48	309	NA		47	303	°F
V46T0104A	FUEL LN TEMP NO. 2 SYSTEM 1	80	331	80	331	NA		47	195	°F
V46T0204A	FUEL LN TEMP NO. 2 SYSTEM 2	90	372	90	372	NA		47	196	°F
V46T0304A	FUEL LN TMEP NO. 2 SYSTEM 3	105	434	105	434	NA		47	196	°F
V46P0105A	FUEL TK OUT PRESS SYSTEM 1	330	675	330	675	NA		330	675	PSIA
V46P0205A	FUEL TK OUT PRESS SYSTEM 2	335	685	335	685	NA		335	685	PSIA
V46P0305A	FUEL TK OUT PRESS SYSTEM 3	338	692	338	692	NA		338	692	PSIA
V46T0108A	FUEL LN TEMP NO. 1 SYSTEM 1	85	352	85	352	NA		48	201	°F
V46T0208A	FUEL LN TEMP NO. 1 SYSTEM 2	92	381	92	381	NA		50	209	°F
V46T0308A	FUEL LN TEMP NO. 1 SYSTEM 3	98	405	98	405	NA		52	217	°F
V46T0112A	FUEL PUMP DISCHARGE TEMP SYSTEM 1	157.6	409	157.6	409	NA		60	158	°F
V46T0212A	FUEL PUMP DISCHARGE TEMP SYSTEM 2	153	397	153	397	NA		60	158	°F
V46T0312A	FUEL PUMP DISCHARGE TEMP SYSTEM 3	142	368	142	368	NA		60	158	°F
V46X0115E	FUEL ISOL. VALVE POS. SYSTEM 1	0	0							STATE
V46X0215E	FUEL ISOL. VALVE POS. SYSTEM 2	0	0							STATE
V46X0315E	FUEL ISOL. VALVE POS. SYSTEM 3	0	0							STATE

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
	APU Continued									
V46T0122A	G.G. BED TEMP. SYSTEM 1	325	665	325	665	NA		160	327	°F
V46T0222A	G.G. BED TEMP. SYSTEM 2	350	716	350	716			160	327	°F
V46T0322A	G.G. BED TEMP. SYSTEM 3	300	614	300	614			160	327	°F
V46X0125E	APU "READY" SYSTEM 1	0	0							STATE
V46X0225E	APU "READY" SYSTEM 2	0	0							STATE
V46X0325E	APU "READY" SYSTEM 3	0	0							STATE
V46T0128A	APU 1 FUEL LINE TEMP NO. 3	156	405	156	405	NA		70	184	DEGF
V46T0228A	APU 2 FUEL LINE TEMP NO. 3	160	415	160	415			70	184	DEGF
V46T0328A	APU 3 FUEL LINE TEMP NO. 3	164	426	164	426			70	184	DEGF
V46T0130A	APU 1 FUEL TANK SURF TEMP AT HTR	87	663	87	663			50	509	DEGF
V46T0230A	APU 2 FUEL TANK SURF TEMP AT HTR	95	696	95	696			50	509	DEGF
V46T0330A	APU 3 FUEL TANK SURF TEMP AT HTR	102	724	102	724			50	509	DEGF
V46X0134E	APU 1 FUEL ISOL VALVE B POSITION	0	0							STATE
V46X0234E	APU 2 FUEL ISOL VALVE B POSITION	0	0							STATE
V46X0334E	APU 3 FUEL ISOL VALVE B POSITION	0	0							STATE
V46R0135A	TURBINE SPEED SYSTEM 1	0	0	83.5	512	113	692	0	0	PCT
V46R0235A	TURBINE SPEED SYSTEM 2	0	0	100.2	614	113	692	0	0	PCT
V46R0335A	TURBINE SPEED SYSTEM 3	0	0	96.86	593	113	692	0	0	PCT
V46T0140A	TURBINE E.G. TEMP. NO. 2 SYSTEM 1	631	421	631	421	NA		41	23	°F
V46T0240A	TURBINE E.G. TEMP. NO. 2 SYSTEM 2	749	501	749	501	NA		41	23	°F
V46T0340A	TURBINE E.G. TEMP. NO. 2 SYSTEM 3	1199	806	1199	806	NA		41	23	°F

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V46T0142A	TURBINE E.G. TEMP. NO. 1 SYSTEM 1	601	401	601	401	NA		41	23	°F
V46T0242A	TURBINE E.G. TEMP. NO. 1 SYSTEM 2	900	604	900	604			41	23	°F
V46T0342A	TURBINE E.G. TEMP. NO. 1 SYSTEM 3	1051	706	1051	706			41	23	°F
V46T0150A	G.B. LUBE OIL RTN. TEMP. SYSTEM 1	145	303	145	303			50	108	°F
V46T0250A	G.B. LUBE OIL RTN. TEMP. SYSTEM 2	140	293	140	293			50	108	°F
V46T0350A	G.B. LUBE OIL RTN. TEMP. SYSTEM 3	225	466	225	466			50	108	°F
V46P0151A	G.B. GN_2 PRESS SYSTEM 1	25	851	25	851			25	851	PSIA
V46P0251A	G.B. GN_2 PRESS SYSTEM 2	20	685	20	685			20	685	PSIA
V46P0351A	G.B. GN_2 PRESS SYSTEM 3	15	509	15	509			15	509	PSIA
V46P0152A	APU 1 GN_2 BOTTLE PRESS	50	170	50	170			50	170	PSIA
V46P0252A	APU 2 GN_2 BOTTLE PRESS	40	137	40	137			40	137	PSIA
V46P0352A	APU 3 GN_2 BOTTLE PRESS	45	153	45	153			45	153	PSIA
V46P0153A	G.B. LUBE OIL OUT. PRESS. SYSTEM 1	76	389	76	389			30	153	PSIA
V46P0253A	G.B. LUBE OIL OUT. PRESS. SYSTEM 2	78	399	78	399			30	153	PSIA
V46P0353A	G.B. LUBE OIL OUT. PRESS. SYSTEM 3	81	415	81	415			30	153	PSIA
V46T0154A	G.B. LUBE OIL OUT. TEMP. SYSTEM 1	180	466	180	466			60	158	°F
V46T0254A	G.B. LUBE OIL OUT. TEMP. SYSTEM 2	172	446	172	446			60	158	°F
V46T0354A	G.B. LUBE OIL OUT. TEMP. SYSTEM 3	168	436	168	436			60	158	°F
V46T0161A	G.B. BRING. TEMP. NO. 1 SYSTEM 1	200	415	200	415			50	108	°F
V46T0261A	G.B. BRING. TEMP. NO. 1 SYSTEM 2	190	395	190	395			50	108	°F
V46T0361A	G.B. BRING. TEMP. NO. 1 SYSTEM 3	260	538	260	538			50	108	°F
V46X0165E	TURBINE OVERSPEED (1 = overspeed) SYSTEM 1	0	0							STATE

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V46X0265E	TURBINE OVERSPEED (1 = overspeed) SYSTEM 2	0	0							STATE
V46X0365E	TURBINE OVERSPEED (1 = overspeed) SYSTEM 3	0	0							STATE
V46X0166E	TURBINE UNDERSPEED (1 = underspeed) SYSTEM 1	0	0							STATE
V46X0266E	TURBINE UNDERSPEED (1 = underspeed) SYSTEM 2	0	0							STATE
V46X0366E	TURBINE UNDERSPEED (1 = underspeed) SYSTEM 3	0	0							STATE
V46T0183A	FUEL TEST LN. TEMP. 1 SYSTEM 1	66	274	66	274	NA		50	209	°F
V46T0283A	FUEL TEST LN. TEMP. 1 SYSTEM 2	63	262	63	262			50	209	°F
V46T0383A	FUEL TEST LN. TEMP. 1 SYSTEM 3	74	307	74	307			50	209	°F
V46T0184A	FUEL TEST LN. TEMP. 2 SYSTEM 1	54	224	54	224			50	208	°F
V46T0284A	FUEL TEST LN. TEMP. 2 SYSTEM 2	65	269	65	269			50	208	°F
V46T0384A	FUEL TEST LN. TEMP. 2 SYSTEM 3	70	290	70	290			50	208	°F
V46T0186A	FUEL PUMP DRAIN LN. TEMP. 1 SYSTEM 1	60	250	60	250			50	209	°F
V46T0286A	FUEL PUMP DRAIN LN. TEMP. 1 SYSTEM 2	55	229	55	229			50	209	°F
V46T0386A	FUEL PUMP DRAIN LN. TEMP. 1 SYSTEM 3	52	217	52	217			50	209	°F
V46P0190A	APU 1 FUEL PUMP DRAIN LINE PRESS 1	13	264	13	264			13	264	PSIA
V46P0290A	APU 2 FUEL PUMP DRAIN LINE PRESS 1	17	348	17	348			17	348	PSIA
V46P0390A	APU 3 FUEL PUMP DRAIN LINE PRESS 1	10	205	10	205			10	205	PSIA

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C. FS	I.C. CTS	VALUE 1 (NOMINAL) K=1 FS	VALUE 1 (NOMINAL) K=1 CTS	VALUE 2 (HI/LOW) K=2 FS	VALUE 2 (HI/LOW) K=2 CTS	VALUE 3 (OFF) K=3 FS	VALUE 3 (OFF) K=3 CTS	UNITS
V46T0192A	APU 1 FU PUMP TEMP	185	385	185	385	NA		65	139	°F
V46T0292A	APU 2 FU PUMP TEMP	176	366	176	366			67	143	°F
V46T0392A	APU 3 FU PUMP TEMP	125	262	125	262			69	147	°F
V46T0193A	APU 1 PUMP H20 LINE TEMP - PRI	61	393	61	393			43	276	°F
V46T0293A	APU 2 PUMP H20 LINE TEMP - PRI	67	430	67	430			45	291	°F
V46T0393A	APU 3 PUMP H20 LINE TEMP - PRI	88	667	88	667			47	497	°F
V46T0194A	APU 1 PUMP H20 LINE TEMP - SEC	91	679	91	679			51	514	°F
V46T0294A	APU 2 PUMP H20 LINE TEMP - SEC	94	692	94	692			53	522	°F
V46T0394A	APU 3 PUMP H20 LINE TEMP - SEC	99	712	99	712			55	532	°F
V46T0501A	H20 LINE TEMP 1	48	340	48	340			41	321	°F
V46T0502A	H20 LINE TEMP 2	53	354	53	354			43	327	°F
V46T0503A	H20 LINE TEMP 3	58	368	58	368			45	331	°F
V46T9158A	APU 1 FU VLV TEMP	120	276	120	276			71	162	°F
V46T9258A	APU 2 FU VLV TEMP	115	264	115	264			73	166	°F
V46T9358A	APU 3 FU VLV TEMP	110	252	110	252			75	172	°F
* V46T9180A	APU 1 INJECTOR TUBE TEMP	419	286	419	286			130	89	°F
* V46T9280A	APU 2 INJECTOR TUBE TEMP	479	327	479	327			135	92	°F
* V46T9380A	APU 3 INJECTOR BUTE TEMP	540	368	540	368			141	96	°F
* V46T9132A	APU 1 CAVITY DRAIN LINE TEMP	56	266	56	266			49	254	°F
* V46T9270A	APU 2 FU PUMP DRAIN LINE TEMP	86	352	86	352			57	233	°F
* V46T9513A	APU 3 CAVITY DRAIN LINE TEMP	69	393	69	393			59	366	°F

* NOTE: This measurement uses the range limit conversion method of calculating FS_{EU}.

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
*FP1A	FUEL PUMP 1A THERMO	1	1							STATE
*FP1B	FUEL PUMP 1B THERMO	1	1							STATE
*FP2A	FUEL PUMP 2A THERMO	1	1							STATE
*FP2B	FUEL PUMP 2B THERMO	1	1							STATE
*FP3A	FUEL PUMP 3A THERMO	1	1							STATE
*FP3B	FUEL PUMP 3B THERMO	1	1							STATE
*AT1A	APU 1 TANK A THERMO	1	1							STATE
*AF1A	APU F/LINE A THERMO	1	1							STATE
*AO1A	APU O/LINE A THERMO	1	1							STATE
*AS1A	APU SER LINE A THERMO	1	1							STATE
*AT1B	APU TANK B THERMO	1	1							STATE
*AF1B	APU F/LINE 3 THERMO	1	1							STATE
*AO1B	APU O/LINE B THERMO	1	1							STATE
*AS1B	APU SER LINE B THERMO	1	1							STATE
*AT2A	APU 2 TANK A THERMO	1	1							STATE
*AF2A	APU F/LINE A THERMO	1	1							STATE
*AO2A	APU O/LINE A THERMO	1	1							STATE
*AS2A	APU SER LINE A THERMO	1	1							STATE
*AT2B	APU TANK B THERMO	1	1							STATE
*AF2B	APU F/LINE B THERMO	1	1							STATE
*AO2B	APU O/LINE B THERMO	1	1							STATE
*AS2B	APU SER LINE B THERMO	1	1							STATE
*AT3A	APU 3 TANK A THERMO	1	1							STATE

*ALL PSEUDOS ON THIS PAGE DO NOT APPLY TO GTS.

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
*AF3A	APU F/LINE A THERMO	1	1							STATE
*AO3A	APU O/LINE A THERMO	1	1							STATE
*AS3A	APU SER LINE A THERMO	1	1							STATE
*AT3B	APU TANK B THERMO	1	1							STATE
*AF3B	APU F/LINE B THERMO	1	1							STATE
*AO3B	APU O/LINE B THERMO	1	1							STATE
*AS3B	APU SER LINE B THERMO	1	1							STATE
*GG1A	PUMP/GG HTR	1	1							STATE
*GG1B	PUMP/GG HTR	1	1							STATE
*GG2A	PUMP/GG HTR	1	1							STATE
*GG2B	PUMP/GG HTR	1	1							STATE
*GG3A	PUMP/GG HTR	1	1							STATE
*GG3B	PUMP/GG HTR	1	1							STATE

*ALL PSEUDOS ON THIS PAGE DO NOT APPLY TO GTS.

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 K=1 (NOMINAL)		VALUE 2 K=2 (HI/LOW)		VALUE 3 K=3 (OFF)		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
	-HYD-									
V58T0101A	RESVR FLUID TEMP. SYSTEM 1	120	536	120	536	40	319	35	305	°F
V58T0201A	RESVR FLUID TEMP. SYSTEM 2	124.2	548	124.2	548	40	319	35	305	°F
V58T0301A	RESVR FLUID TEMP. SYSTEM 3	117	528	117	528	40	319	35	305	°F
V58Q0102A	RESVR FLUID VOLUME SYSTEM 1	58	593	58	593	0	0			PCT
V58Q0202A	RESVR FLUID VOLUME SYSTEM 2	62	634	62	634	0	0			PCT
V58Q0302A	RESVR FLUID VOLUME SYSTEM 3	68	696	68	696	0	0			PCT
V58P0104A	H_2O BLR GN_2 REG. OUT. PRESS. SYSTEM 1	0	[illegible]	25	342	25	342	25	342	PSIA
V58P0204A	H_2O BLR GN_2 REG. OUT. PRESS. SYSTEM 2	0	0	28	383	28	383	28	383	PSIA
V58P0304A	H_2O BLR GN_2 REG. OUT. PRESS. SYSTEM 3	0	0	27	368	27	368	27	368	PSIA
V58T0105A	H_2O BLR GN_2 TK. TEMP. SYSTEM 1	31.44	0	70.04	278	70.04	278	70.04	278	°F
V58T0205A	H_2O BLR GN_2 TK. TEMP. SYSTEM 2	31.44	0	103.05	589	103.05	589	103.05	539	°F
V58T0305A	H_2O BLR GN_2 TK. TEMP. SYSTEM 3	31.44	0	106.94	616	106.94	616	106.94	616	°F
*V58P0114C	SUPPLY PRESS. A SYSTEM 1	3022	773	3022 751	773 192	375	96	78	20	PSIA
*V58P0214C	SUPPLY PRESS. A SYSTEM 2	3124	799	3124 751	799 192	375	96	78	20	PSIA
*V58P0314C	SUPPLY PRESS. A SYSTEM 3	3226	825	3226 751	825 192	375	96	78	20	PSIA
V58P0115C V58P0115A	SUPPLY PRESS. B SYSTEM 1 **	3200	818	3200 751	818 192	376	96	80	20	PSIA
V58P0215C V58P0215A	SUPPLY PRESS. B SYSTEM 2 **	3000	767	3000 751	767 192	376	96	80	20	PSIA

*NOTE: This measurement uses the range limit conversion method of calculating FS_{EU}.

** Unique to GTS. Measurement values are equivalent to Supply Pressure B.

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V58P0315C	SUPPLY PRESS B SYSTEM 3	2896	741	2896	741	376	96	80	20	PSIA
V58P0315A	**			751	192					
*V58P0116C	HYD SYS 1 SUPPLY PRESS C	3300	844	3300 751	844 192	375	96	78	20	PSIA
*V58P0216C	HYD SYS 2 SUPPLY PRESS C	3402	870	3402 751	870 192	375	96	78	20	PSIA
*V58P0316C	HYD SYS 3 SUPPLY PRESS C	3152	806	3152 751	806 192	375	96	78	20	PSIA
V58T0120A	HYD SYS 1 FLUID HTR OUT TMP	102	487	102	487	102	487	35	305	DEGF
V58T0220A	HYD SYS 2 FLUID HTR OUT TMP	90	454	90	454	90	454	35	305	DEGF
V58T0320A	HYD SYS 3 FLUID HTR OUT TMP	81	430	81	430	81	430	35	305	DEGF
V58P0137A	CIRC. PUMP PRESS. SYSTEM 1	50	63	50	63	374	479	80	102	PSIA
V58P0237A	CIRC. PUMP PRESS. SYSTEM 2	54	70	54	70	374	479	80	102	PSIA
V58P0337A	CIRC. PUMP PRESS. SYSTEM 3	61	78	61	78	374	479	80	102	PSIA
V58P0147A	H_2O BLR. GN_2 TK. PRESS SYSTEM 1	2471	722	2471	722	2471	722	2471	722	PSIA
V58P0247A	H_2O BLR. GN_2 TK. PRESS SYSTEM 2	2429	710	2429	710	2429	710	2429	710	PSIA
V58P0347A	H_2O BLR. GN_2 TK. PRESS SYSTEM 3	2513	735	2513	735	2513	735	2513	735	PSIA
V58T0157A	HYD SYS 1 LH INBD ELEV ACT RTN LN TMP	141	593	141	593	30	291	30	291	DEGF
V58T0257A	HYD SYS 2 LH INBD ELEV ACT RTN LN TMP	132	569	132	569	30	291	30	291	DEGF
V58T0159A	HYD SYS 1 RH INBD ELEV ACT RTN LN TMP	147	610	147	610	30	291	30	291	DEGF
V58T0359A	HYD SYS 3 RH INBD ELEV ACT RTN LN TMP	78	421	78	421	30	291	30	291	DEGF
V58T0161A	H_2O BLR. TK. TEMP. SYSTEM 1	31.44	0	100.08	567	55.89	152	55.89	152	°F
V58T0261A	H_2O BLR. TK. TEMP. SYSTEM 2	31.44	0	105.03	603	55.89	152	55.89	152	°F

*NOTE: This measurement uses the range limit conversion method of calculating FS_{EU}.

** Unique to GTS. Measurement values are equivalent to Supply Pressure B.

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V58T0361A	H_2O BLR. TK. TEMP. SYSTEM 3	31.44	0	110.01	636	55.89	152	55.89	152	°F
V58T0162A	H_2O BLR. TEMP. NO. 1 SYSTEM 1	29.96	0	82.00	405	55.86	159	55.86	159	°F
V58T0262A	H_2O BLR. TEMP. NO. 1 SYSTEM 2	29.96	0	76.90	352	55.86	159	55.86	159	°F
V58T0362A	H_2O BLR. TEMP. NO. 1 SYSTEM 3	29.96	0	71.00	292	55.86	159	55.86	159	°F
V58T0163A	H_2O BLR. TEMP. NO. 2 SYSTEM 1	29.96	0	104.95	610	55.86	159	55.86	159	°F
V58T0263A	H_2O BLR. TEMP. NO. 2 SYSTEM 2	29.96	0	95.98	539	55.86	159	55.86	159	°F
V58T0363A	H_2O BLR. TEMP. NO. 2 SYSTEM 3	29.96	0	86.03	446	55.86	159	55.86	159	°F
V58T0165A	H_2O BLR. VENT TEMP. NO. 1 SYSTEM 1	150	454	150	454	122	0	122	0	°F
V58T0265A	H_2O BLR. VENT TEMP. NO. 1 SYSTEM 2	153	503	153	503	122	0	122	0	°F
V58T0365A	H_2O BLR. VENT TEMP. NO. 1 SYSTEM 3	160	618	160	618	122	0	122	0	°F
V58T0166A	H_2O BLR. VENT TEMP. NO. 2 SYSTEM 1	155	536	155	536	122	0	122	0	°F
V58T0266A	H_2O BLR. VENT TEMP. NO. 2 SYSTEM 2	157	569	157	569	122	0	122	0	°F
V58T0366A	H_2O BLR. VENT TEMP. NO. 2 SYSTEM 3	165	698	165	698	122	0	122	0	°F
V58X0181E	H_2O BLR. BYPASS CL. IND. SYSTEM 1	0	0	1	1	0	0	0	0	STATE
V58X0281E	H_2O BLR. BYPASS CL. IND. SYSTEM 2	0	0	1	1	0	0	0	0	STATE
V58X0381E	H_2O BLR. BYPASS CL. IND. SYSTEM 3	0	0	1	1	0	0	0	0	STATE
V58X0182E	H_2O BLR. OK SYSTEM 1	0	0							STATE
V58X0282E	H_2O BLR. OK SYSTEM 2	0	0							STATE
V58X0382E	H_2O BLR. OK SYSTEM 3	0	0							STATE

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V58X0190E	LDG. GR. ISLN. VLV. CL. IND. SYSTEM 1	0	0							STATE
V58X0290E	LDG. GR. ISLN. VLV. CL. IND. SYSTEM 2	0	0							STATE
V58X0390E	LDG. GR. ISLN. VLV. CL. IND. SYSTEM 3	0	0							STATE
V58T0198A	HYD SYS 1 RSB RETURN LINE TEMP	136.2	581	136.2	581	30	291	30	291	DEGF
V58T0298A	HYD SYS 2 RSB RETURN LINE TEMP	69	397	69	397	30	291	30	291	DEGF
V58T0398A	HYD SYS 3 RSB RETURN LINE TEMP	63	381	63	381	30	291	30	291	DEGF
V58T0288A	HYD SYS 2 BODY FLAP RTN LINE TEMP	75	413	75	413	30	291	30	291	DEGF
V58T0388A	HYD SYS 3 BODY FLAP RTN LINE TEMP	66	389	66	389	30	291	30	291	DEGF
V58T0296A	HYD SYS 2 RH BRAKE VLV RTN LN TMP	72	405	72	405	30	291	30	291	DEGF
V58X0800E	LH INBD ELVN ACTR. SW. VLV. ACTV. POSN.	0	0							STATE
V58X0801E	LH INBD ELVN ACTR. SW. VLV. PS2 POSN.	0	0							STATE
V58T0833A	LH INBD ELVN SW. VALVE LN TEMP.	40	319	40	319	30	291	30	291	°F
V58T0841A	LH OTBD BRAKE SW. VALVE LN TEMP.	57	364	57	364	30	291	30	291	°F
V58T0842A	LH INBD BRAKE SW. VALVE LN TEMP.	54	356	54	356	30	291	30	291	°F
V58T0845A	RH OTBD BRAKE SW. VALVE LN TEMP.	51	348	51	348	30	291	30	291	°F
V58T0846A	RH INBD BRAKE SW. VALVE LN TEMP.	48	340	48	340	30	291	30	291	°F
V58X0850E	LH OTBD ELVN ACTR. SW. VLV. ACTV. POSN.	0	0							STATE
V58X0851E	LH OTBD ELVN ACTR. SW. VLV. PS2 POSN.	0	0							STATE
V58T0883A	LH OTBD ELVN SW. VALVE LN TEMP.	45	331	45	331	30	291	30	291	°F

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V58X0900E	RH INBD ELVN ACTR. SW. VLV. ACTV. POSN.	0	0							STATE
V58X0901E	RH INBD ELVN ACTR. SW. VLV. PS2 POSN.	0	0							STATE
V58T0933E	RH INBD ELVN SW. VALVE LN TEMP.	42	323	42	323	30	291	30	291	°F
V58X0950E	RH OTBD ELVN ACTR. SW. VLV. ACTV. POSN	0	0							STATE
V58X0951E	RH OTBD ELVN ACTR. SW. VLV. PS2 POSN	0	0							STATE
V58T0983A	RH OTBD ELVN SW. VALVE LN TEMP.	39	315	39	315	30	291	30	291	°F
V58X1000E	RDR/SPDBK SW. VLV ACTV. POSN.	0	0							STATE
V58X1001E	RDR/SPDBK SW. VLV. PS2 POSN.	0	0							STATE
V58T1006A	RUDDER SW. VALVE LN TEMP. A	36	307	36	307	30	291	30	291	°F
V58X1136E	HYD SYS 1 ME/TVC SPLY VLV OPN IND	0	0							STATE
V58T1143A	MID FUSLG. RTN. LN TEMP A	33	299	33	299	30	291	30	291	°F
V58X1236E	HYD SYS 2 ME/TVC SPLY VLV OPN IND	0	0							STATE
V58X1336E	HYD SYS 3 ME/TVC SPLY VLV OPN IND	0	0							STATE
V58P9116A	HYD SYS 1 GN2 ACCUMULATOR PRESS	2560	655	2560	655	2560	655	2560	655	PSIA
V58P9216A	HYD SYS 2 GN2 ACCUMULATOR PRESS	2400	614	2400	614	2400	614	2400	614	PSIA
V58P9316A	HYD SYS 3 GN2 ACCUMULATOR PRESS	2600	665	2600	665	2500	665	2600	665	PSIA

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V58T9133A	HYD SYS 1 FLUID HTR INLET TMP	108	503	108	503	70	401	70	401	DEGF
V58T9233A	HYD SYS 2 FLUID HTR INLET TMP	125	550	125	550	70	401	70	401	DEGF
V58T9333A	HYD SYS 3 FLUID HTR INLET TMP	170	673	170	673	70	401	70	401	DEGF
V58T9141A	HYD SYS 1 CIRC PUMP OUTLET TEMP	112.2	516	112.2	516	70	401	70	401	DEGF
V58T9242A	HYD SYS 2 CIRC PUMP OUTLET TEMP	127.2	557	127.2	557	70	401	70	401	DEGF
V58T9342A	HYD SYS 3 CIRC PUMP OUTLET TEMP	165	659	165	659	70	401	70	401	DEGF
V58T9144A	HYD SYS 1 RETURN LINE RSB TMP	93	462	93	462	30	291	30	291	DEGF
V58T9244A	HYD SYS 2 RETURN LINE RSB TMP	117	528	117	528	30	291	30	291	DEGF
V58T9344A	HYD SYS 3 RETURN LINE RSB TMP	175	687	175	687	30	291	30	291	DEGF
V58T9160A	HYD SYS 1 RTN LN BODY FLAP TMP	99	479	99	479	30	291	30	291	DEGF
V58T9165A	HYD SYS 2 RTN LN R OTBD ELEV ACT TEMP	85	442	85	442	30	291	30	291	DEGF
V58T9178A	HYD SYS 1 RTN LN LMG UPLK ACT TMP	27	282	27	282	30	291	30	291	DEGF
V58T9183A	HYD SYS 1 NLG UPLK ACT LINE TMP	24	274	24	274	30	291	30	291	DEGF
V58T9186A	HYD SYS 1 RTN LN NLG TEMP 3	87	446	87	446	30	291	30	291	DEGF
V58T9189A	HYD SYS 1 RTN LN RMG UPLK ACT TMP	21	266	21	266	30	291	30	291	DEGF
V58T9190A	HYD SYS 1 RTN LN RMG ORIFICE TMP	18	258	18	258	30	291	30	291	DEGF
V58T9194A	HYD SYS 1 RTN LN R BRK SW VLV TMP	96	471	96	471	30	291	30	291	DEGF
V58T9236A	HYD SYS 2 RTN LN BODY FLAP TMP	115	524	115	524	30	291	30	291	DEGF
V58T9261A	HYD SYS 1 RTN LN L OTBD ELEV ACT	84	438	84	438	30	291	30	291	DEGF
V58T9262A	HYD SYS 1 RTN LN R OTBD ELEV ACT	144	602	144	602	30	291	30	291	DEGF
V58T9263A	HYD SYS 2 LH BRAKE VLV RTN LN TMP	30	291	30	291	30	291	30	291	DEGF
V58T9264A	HYD SYS 2 RH BRAKE SW VLV RTN LN TMP	30	291	30	291	30	291	30	291	DEGF
V58T9349A	HYD SYS 3 RTN LN BODY FLAP TMP	160.2	647	160.2	647	30	291	30	291	DEGF

MEASUREMENT OUTPUT FROM APU/HYD MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V58T9351A	HYD SYS 3 RH BRAKE VLV RTN LN TMP	30	291	30	291	30	291	30	291	DEGF
V58T9352A	HYD SYS 3 LH BRAKE VLV RTN LN TMP	30	291	30	291	30	291	30	291	DEGF
V58T9361A	HYD SYS 3 RTN LN L OTBD ELEV ACT TMP	156	634	156	634	30	291	10	237	DEGF
V58T0830A	HYD SYS LH INBD ELEV ACT	120	532							DEGF
V58T0880A	HYD SYS LH OTBD ELEV ACT	126	548							DEGF
V58T0930A	HYD SYS RH INBD ELEV ACT	132	565							DEGF
V58T0980A	HYD SYS RH OTBD ELEV ACT	138	581							DEGF
V57T0014A	RUDDER/SPEEDBRAKE PDU	144	597							DEGF
V57T0018A	BODY FLAP PDU	150	614							DEGF

APPENDIX B

VENT DOORS MATH MODEL REQUIREMENTS

CONTENTS

1. INTRODUCTION

The GN&C Test Station (GTS) uses math models to simulate many of the Shuttle systems for which hardware has not been provided. A group of these models are termed "non-avionic" models since they do not simulate the Shuttle's "avionic" systems. The "non-avionic" models are needed to supply data for on-board software processing and to respond to Shuttle commands, whether they be from cockpit switches, the General Purpose Computers (GPC's) or the Non-Avionic Simulator (NAS) console.

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in table 1 to produce values for the output measurements listed in table 2 that simulate the operation of the Vent Doors.

2.1 MATH MODEL DESCRIPTION

This model simulates those functions of the vent doors in the Orbiter, namely: OPEN, CLOSE, and PURGE. The vent doors permit equalization of pressures between the ambient and the unpressurized areas within the Orbiter during ascent and descent. The PURGE function expels toxic or explosive gas mixtures that may accumulate within the unpressurized areas.

2.2 STS UNIQUE REQUIREMENTS

This model is not required for STS.

2.3 GTS UNIQUE REQUIREMENTS

This model is required for GTS only.

3. MATH MODEL LOGIC

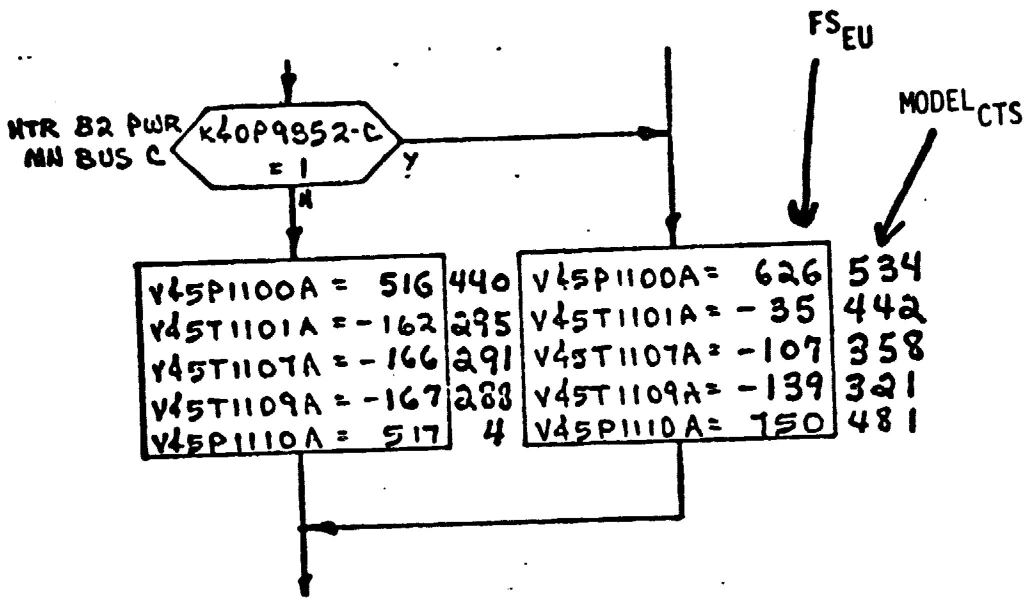
This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

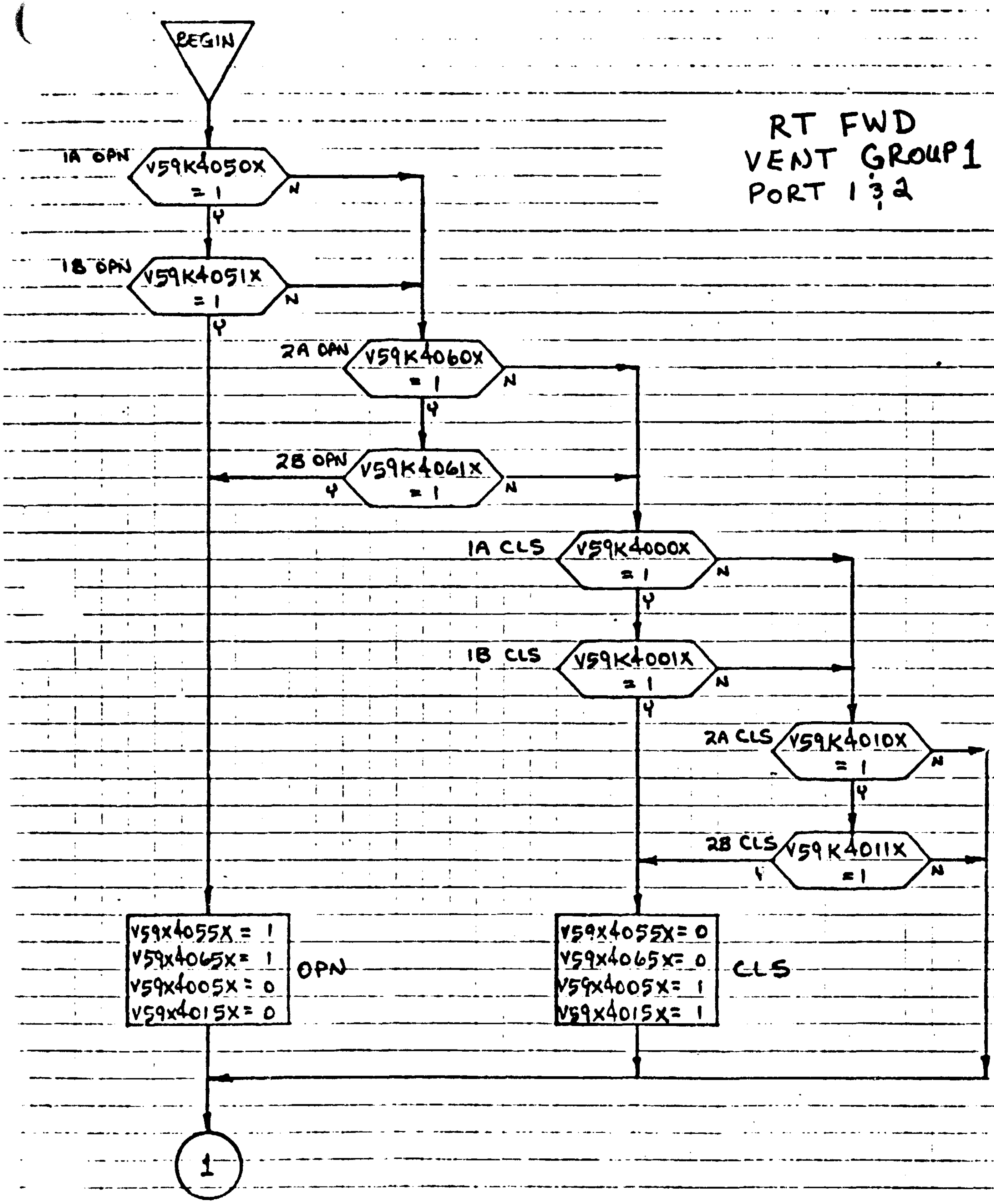
NONE

3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;



shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.



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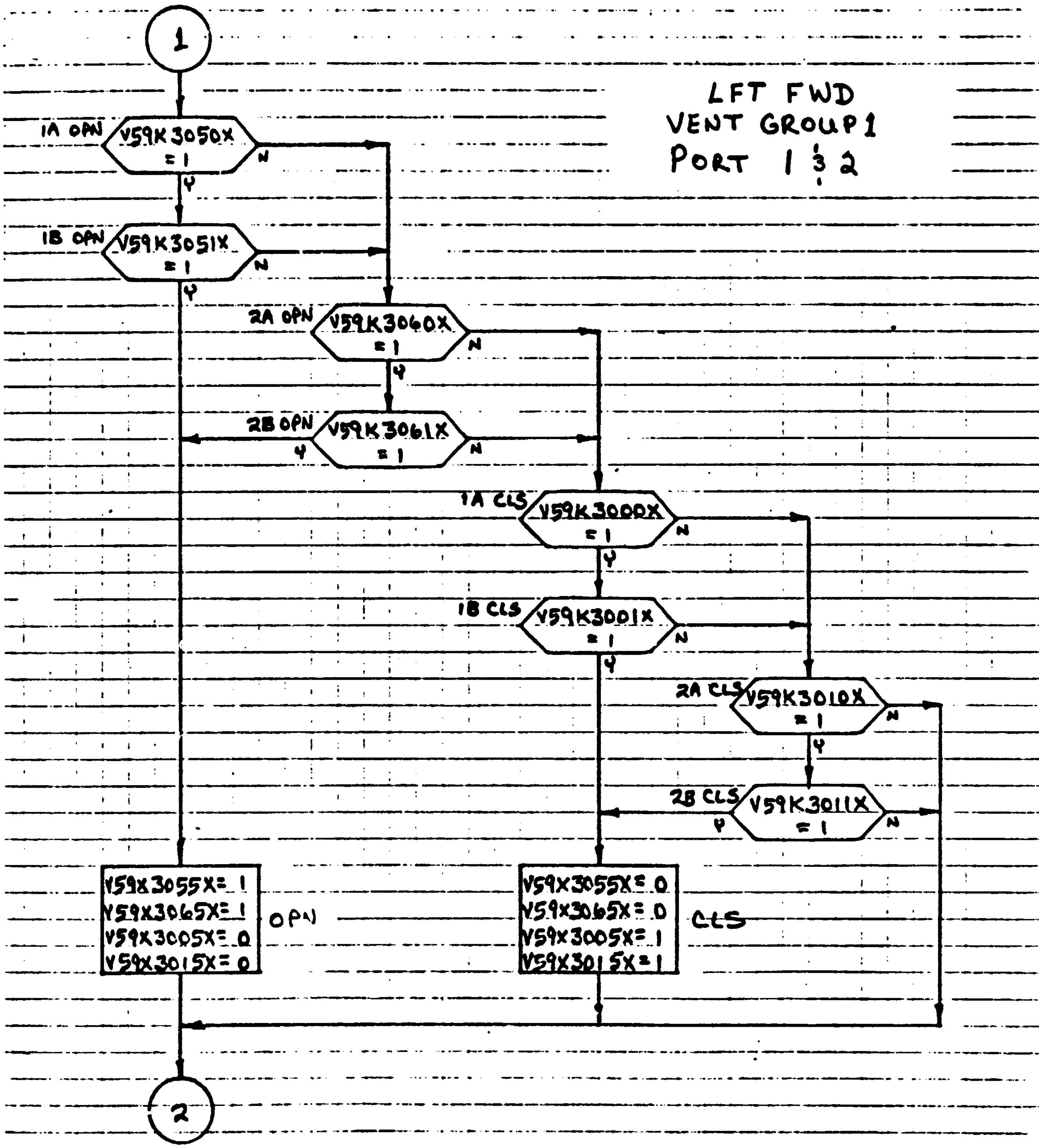
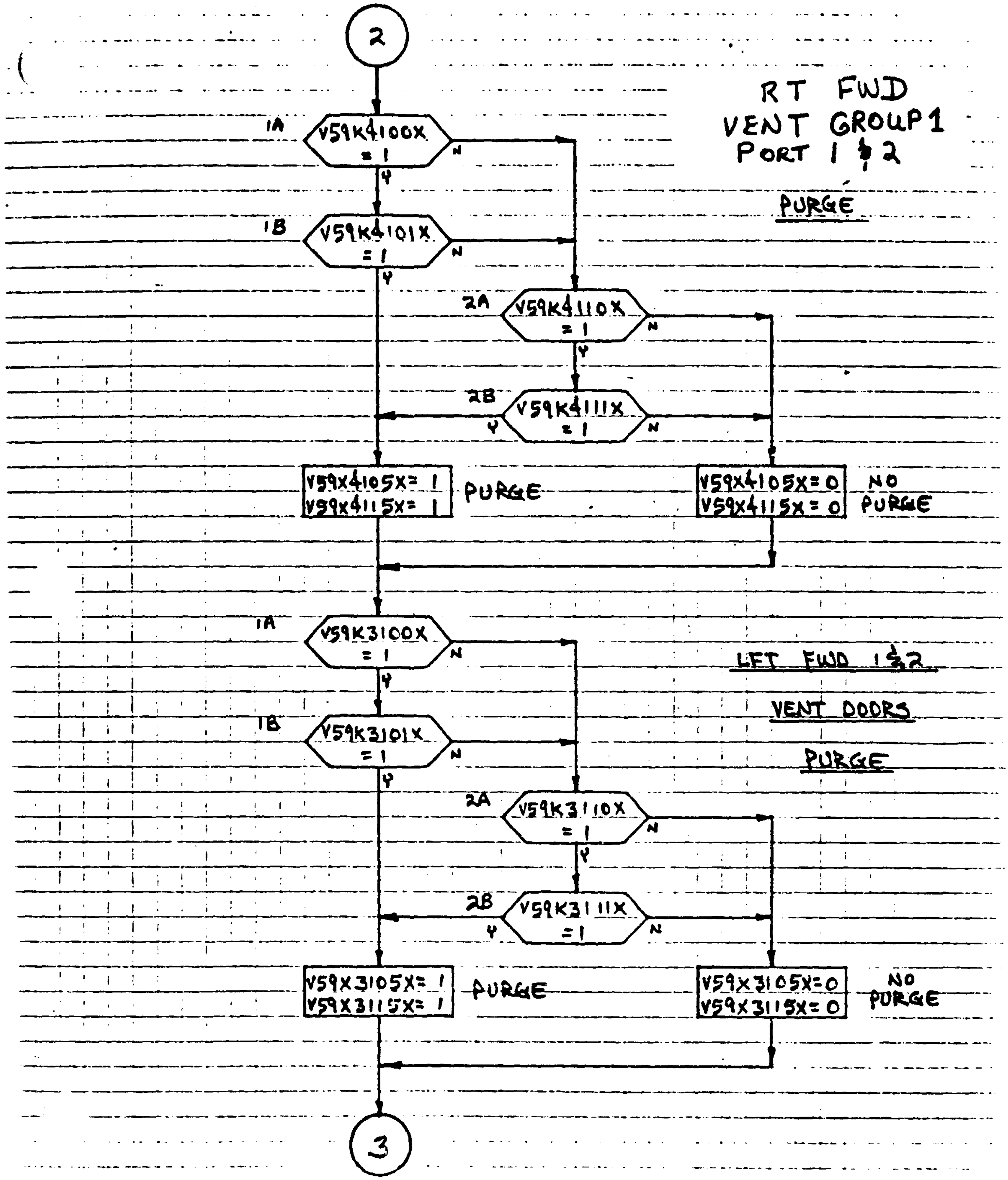
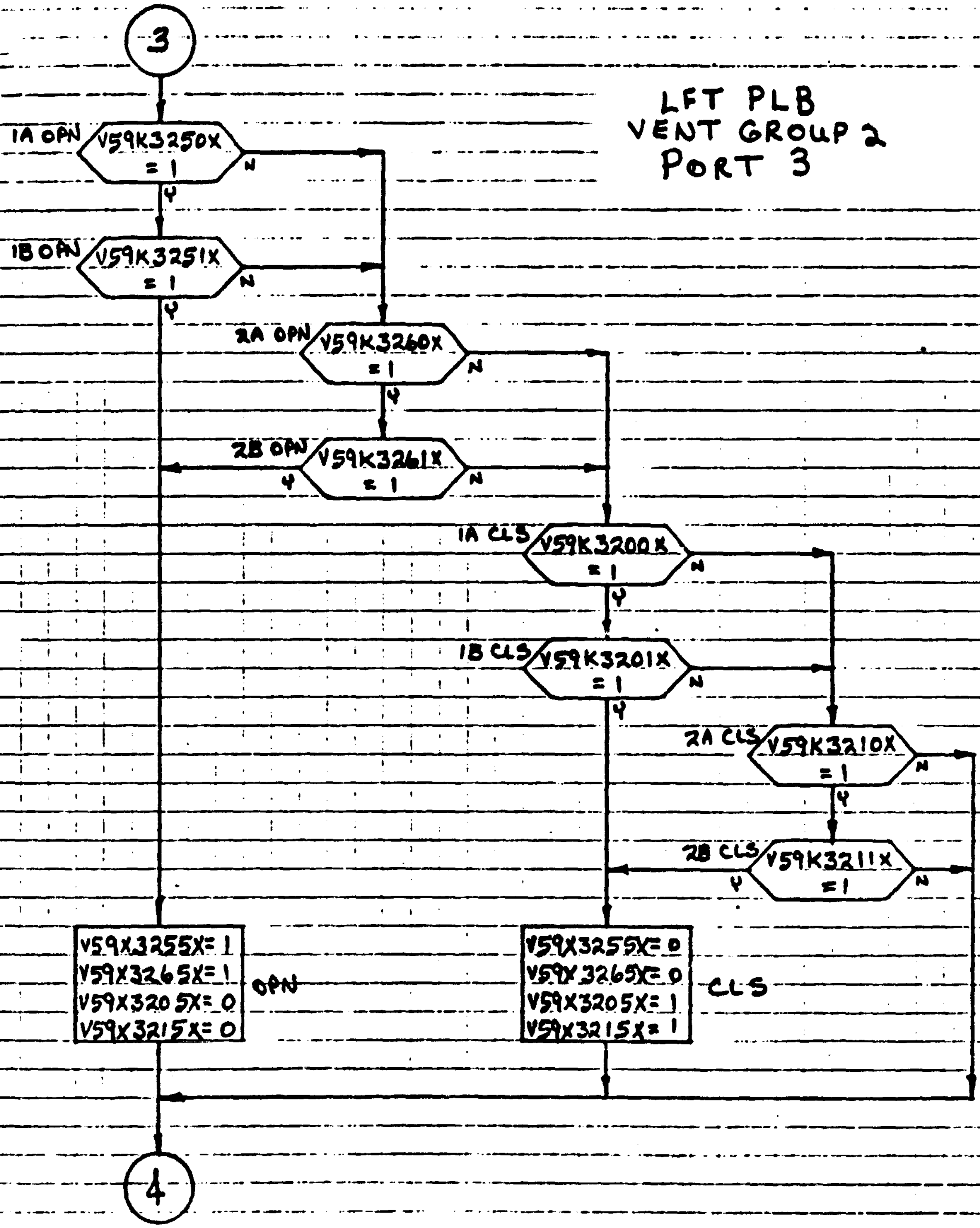
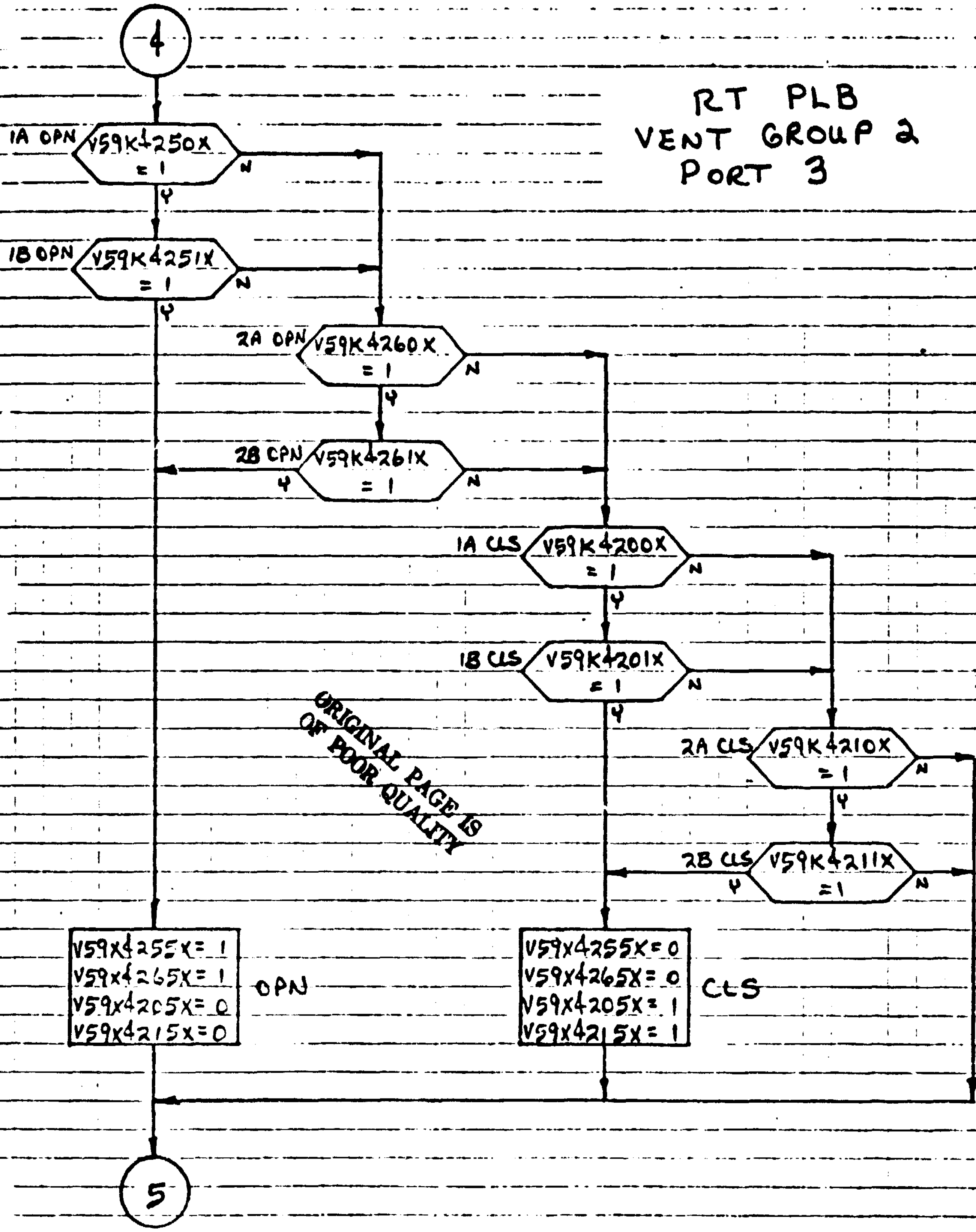

LFT FWD
VENT GROUP 1
PORT 1 ⅓ 2
1
1A OPN
V59K3050X = 1
1B OPN
V59K3051X = 1
2A OPN
V59K3060X = 1
2B OPN
V59K3061X = 1
1A CLS
V59K3000X = 1
1B CLS
V59K3001X = 1
2A CLS
V59K3010X = 1
2B CLS
V59K3011X = 1
Y
N
V59X3055X = 1
V59X3065X = 1
V59X3005X = 0
V59X3015X = 0
OPN
V59X3055X = 0
V59X3065X = 0
V59X3005X = 1
V59X3015X = 1
CLS
2

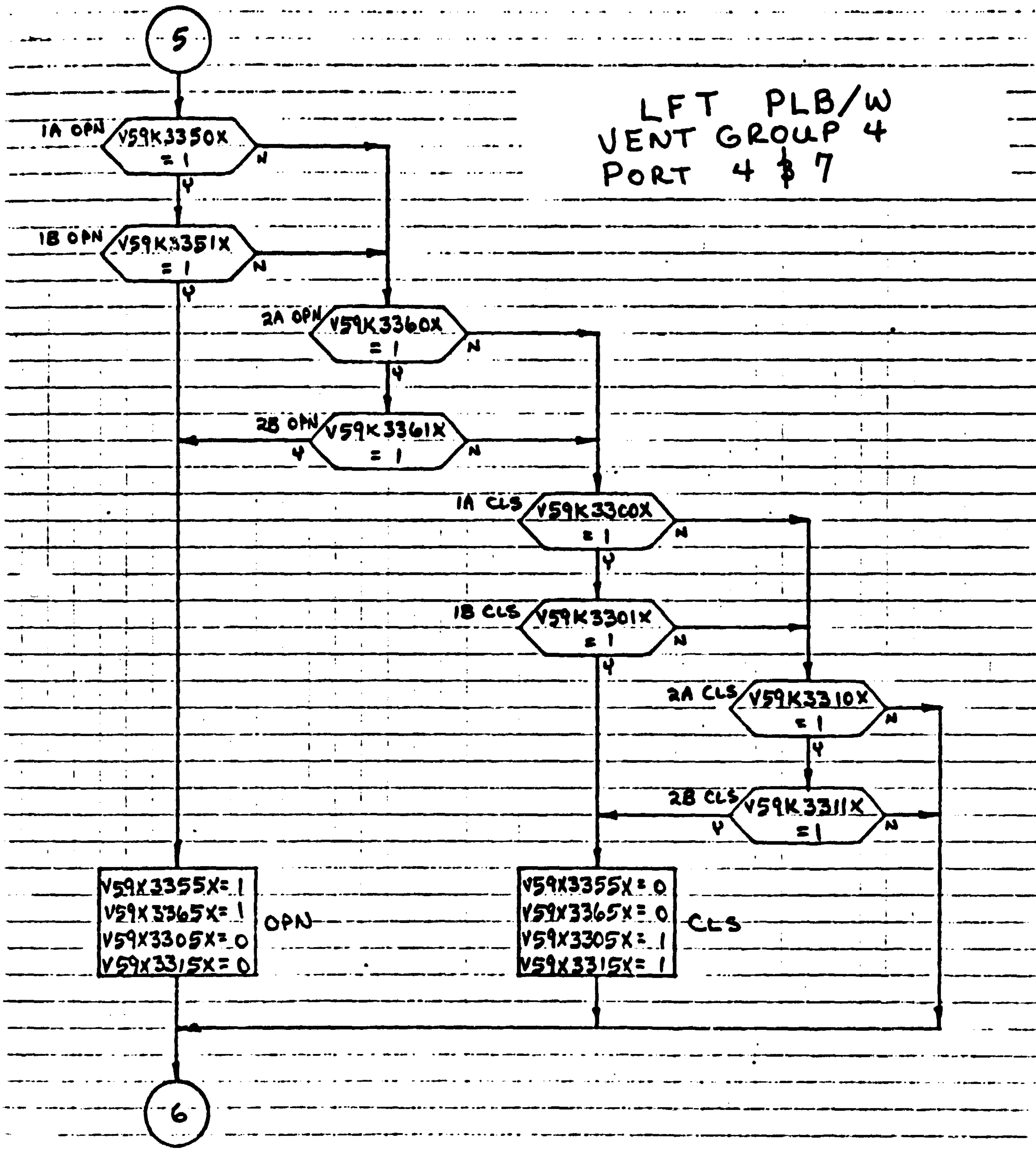


RT FWD
VENT GROUP 1
PORT 1 & 2
PURGE
2
1A
V59K4100X = 1
1B
V59K4101X = 1
2A
V59K4110X = 1
2B
V59K4111X = 1
Y
N
V59X4105X = 1
V59X4115X = 1
PURGE
V59X4105X = 0
V59X4115X = 0
NO PURGE
LFT FWD 1 & 2
VENT DOORS
PURGE
1A
V59K3100X = 1
1B
V59K3101X = 1
2A
V59K3110X = 1
2B
V59K3111X = 1
V59X3105X = 1
V59X3115X = 1
PURGE
V59X3105X = 0
V59X3115X = 0
NO PURGE
3

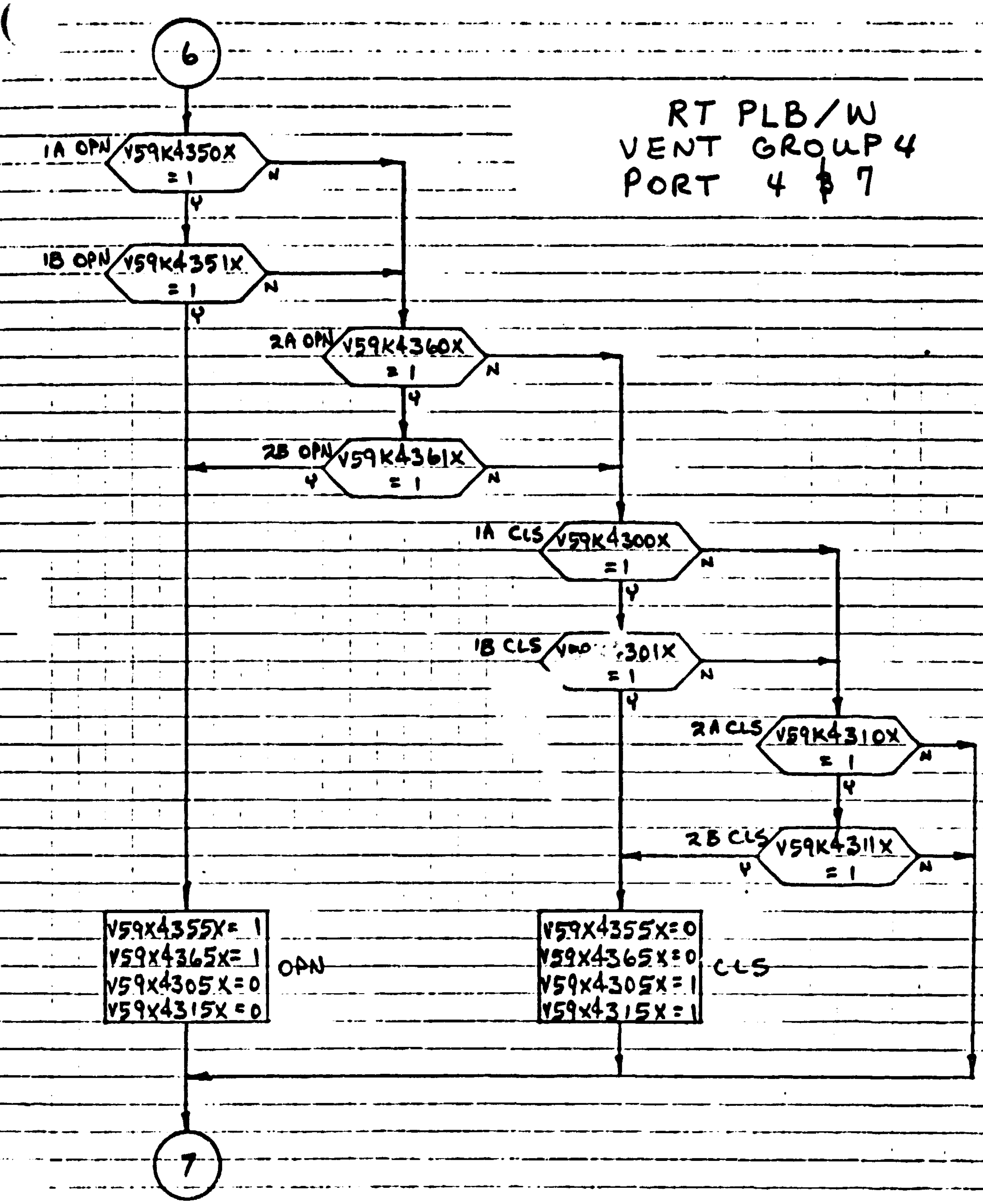

LFT PLB
VENT GROUP 2
PORT 3
3
1A OPN
V59K3250X = 1
1B OPN
V59K3251X = 1
2A OPN
V59K3260X = 1
2B OPN
V59K3261X = 1
1A CLS
V59K3200X = 1
1B CLS
V59K3201X = 1
2A CLS
V59K3210X = 1
2B CLS
V59K3211X = 1
Y
N
V59X3255X= 1
V59X3265X= 1
V59X3205X= 0
V59X3215X= 0
OPN
V59X3255X= 0
V59X3265X= 0
V59X3205X= 1
V59X3215X= 1
CLS
4

RT PLB
VENT GROUP 2
PORT 3

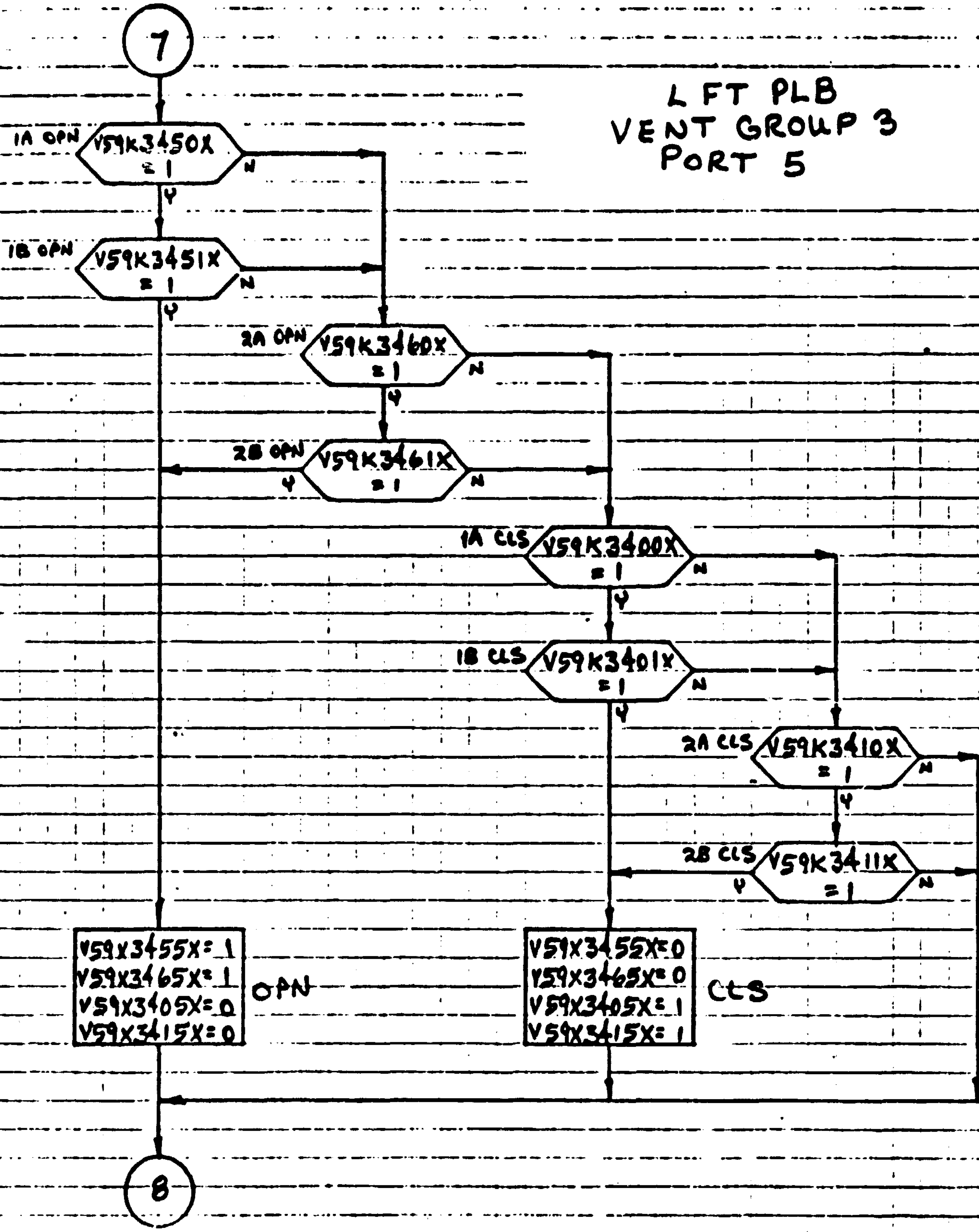


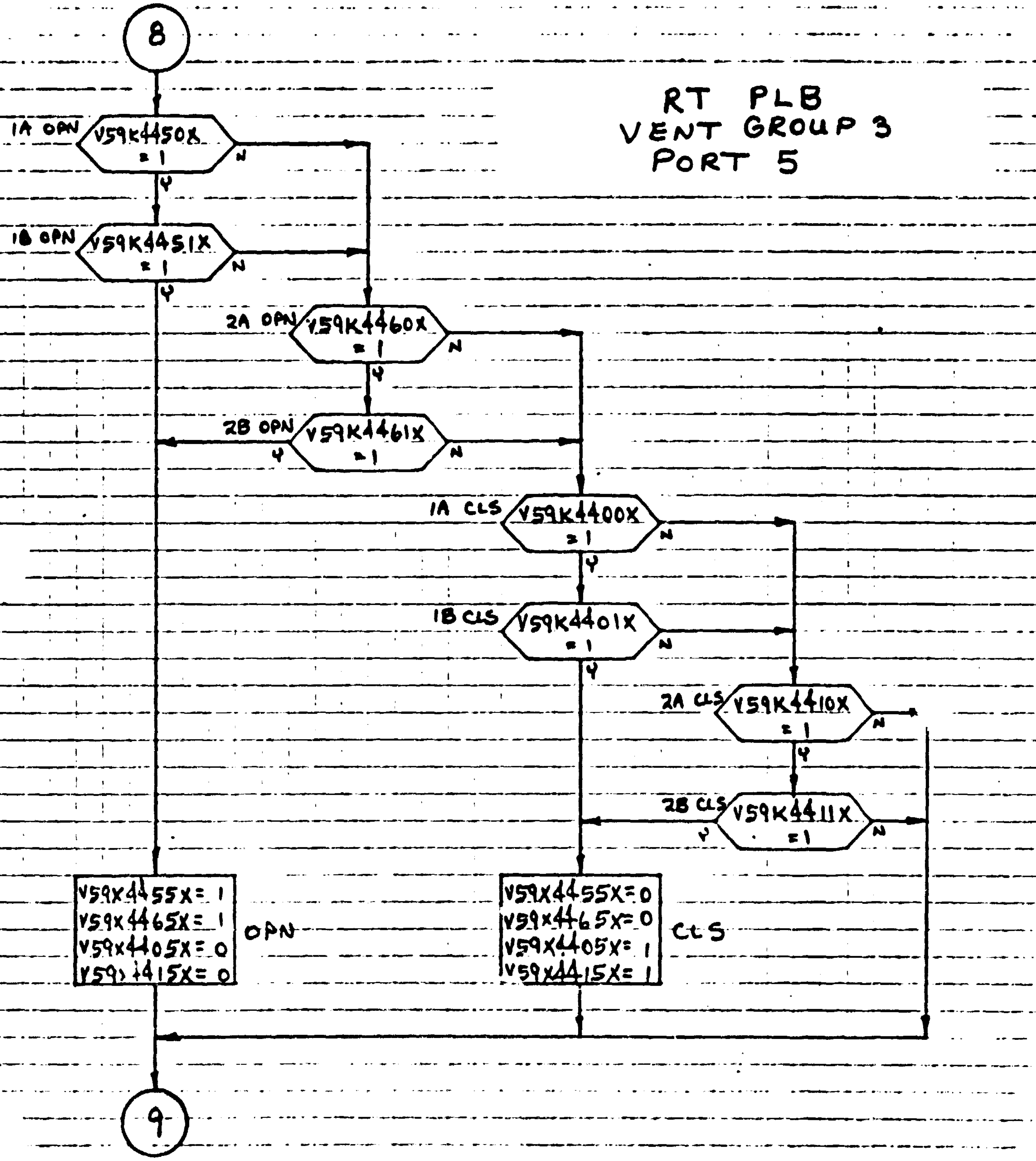

LFT PLB/W
VENT GROUP 4
PORT 4 $ 7
5
1A OPN
V59K3350X = 1
1B OPN
V59K3351X = 1
2A OPN
V59K3360X = 1
2B OPN
V59K3361X = 1
1A CLS
V59K33C0X = 1
1B CLS
V59K3301X = 1
2A CLS
V59K3310X = 1
2B CLS
V59K3311X = 1
Y
N
V59X3355X= 1
V59X3365X= 1
V59X3305X= 0
V59X3315X= 0
OPN
V59X3355X = 0
V59X3365X = 0
V59X3305X = 1
V59X3315X = 1
CLS
6

RT PLB/W VENT GROUP 4 PORT 4 & 7

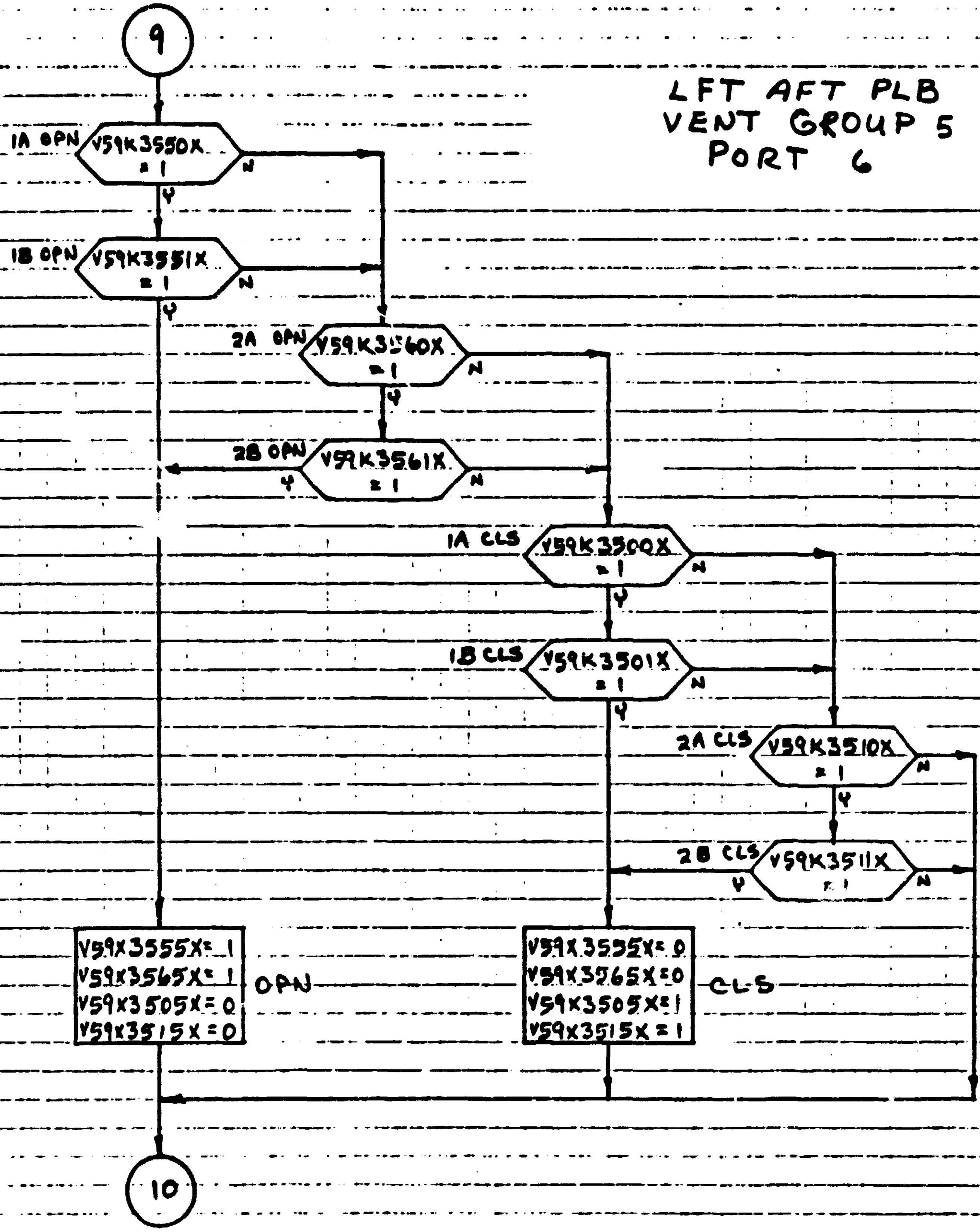


LFT PLB
VENT GROUP 3
PORT 5

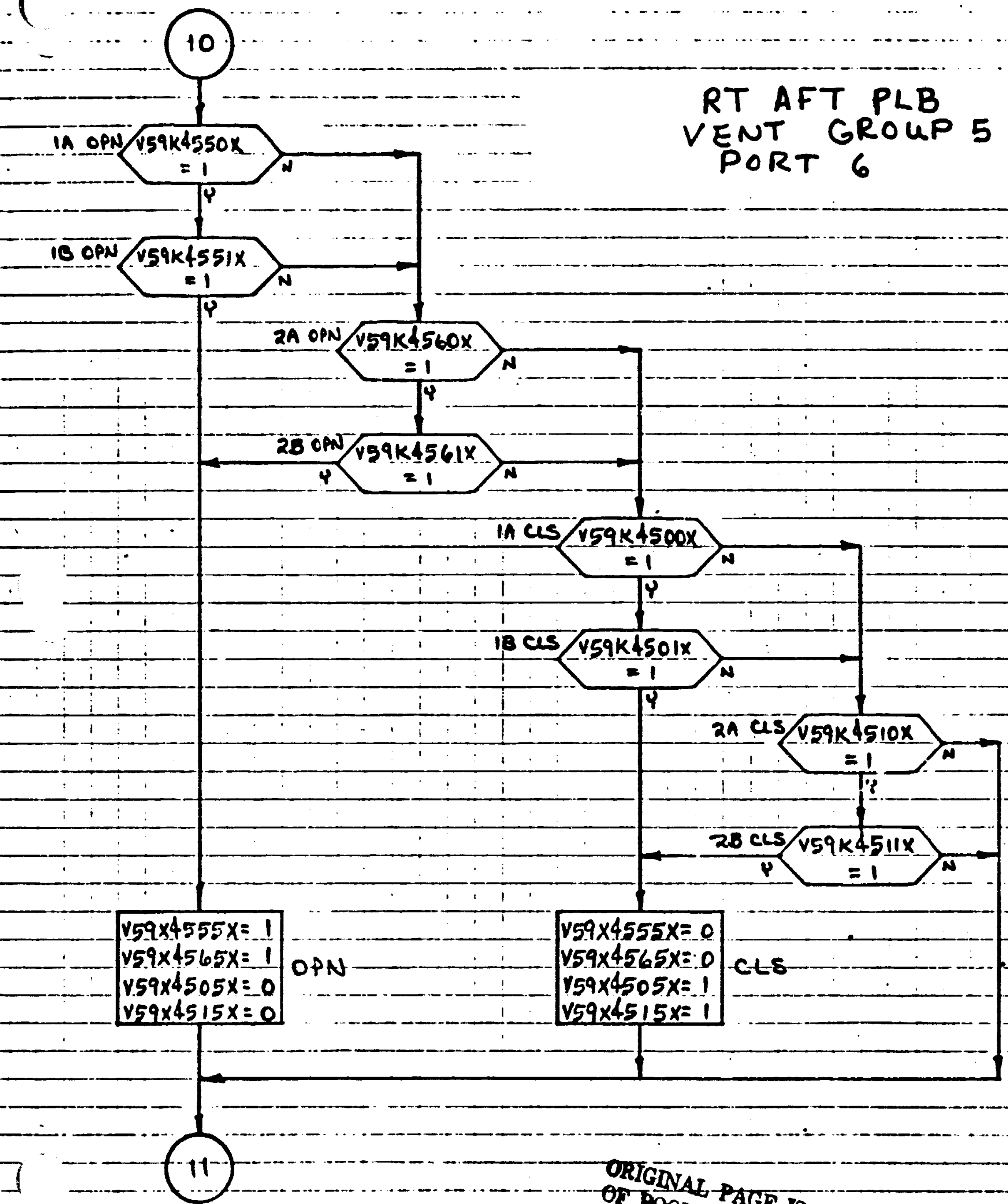



8
RT PLB
VENT GROUP 3
PORT 5
1A OPN
V59K4450X = 1
1B OPN
V59K4451X = 1
2A OPN
V59K4460X = 1
2B OPN
V59K4461X = 1
1A CLS
V59K4400X = 1
1B CLS
V59K4401X = 1
2A CLS
V59K4410X = 1
2B CLS
V59K4411X = 1
Y
N
V59X4455X = 1
V59X4465X = 1
V59X4405X = 0
V59X4415X = 0
OPN
V59X4455X = 0
V59X4465X = 0
V59X4405X = 1
V59X4415X = 1
CLS
9

LFT AFT PLB VENT GROUP 5 PORT 6



RT AFT PLB VENT GROUP 5 PORT 6



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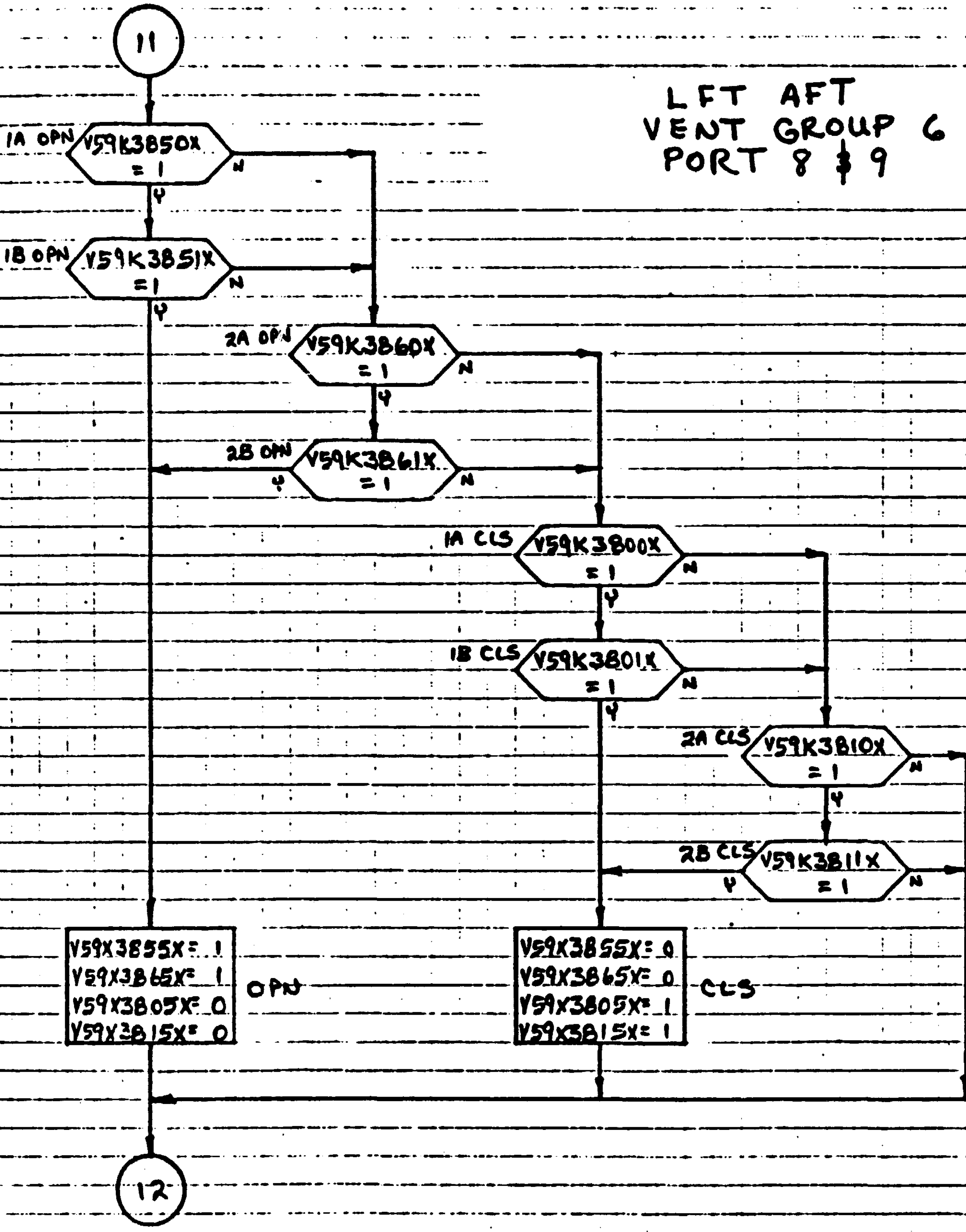
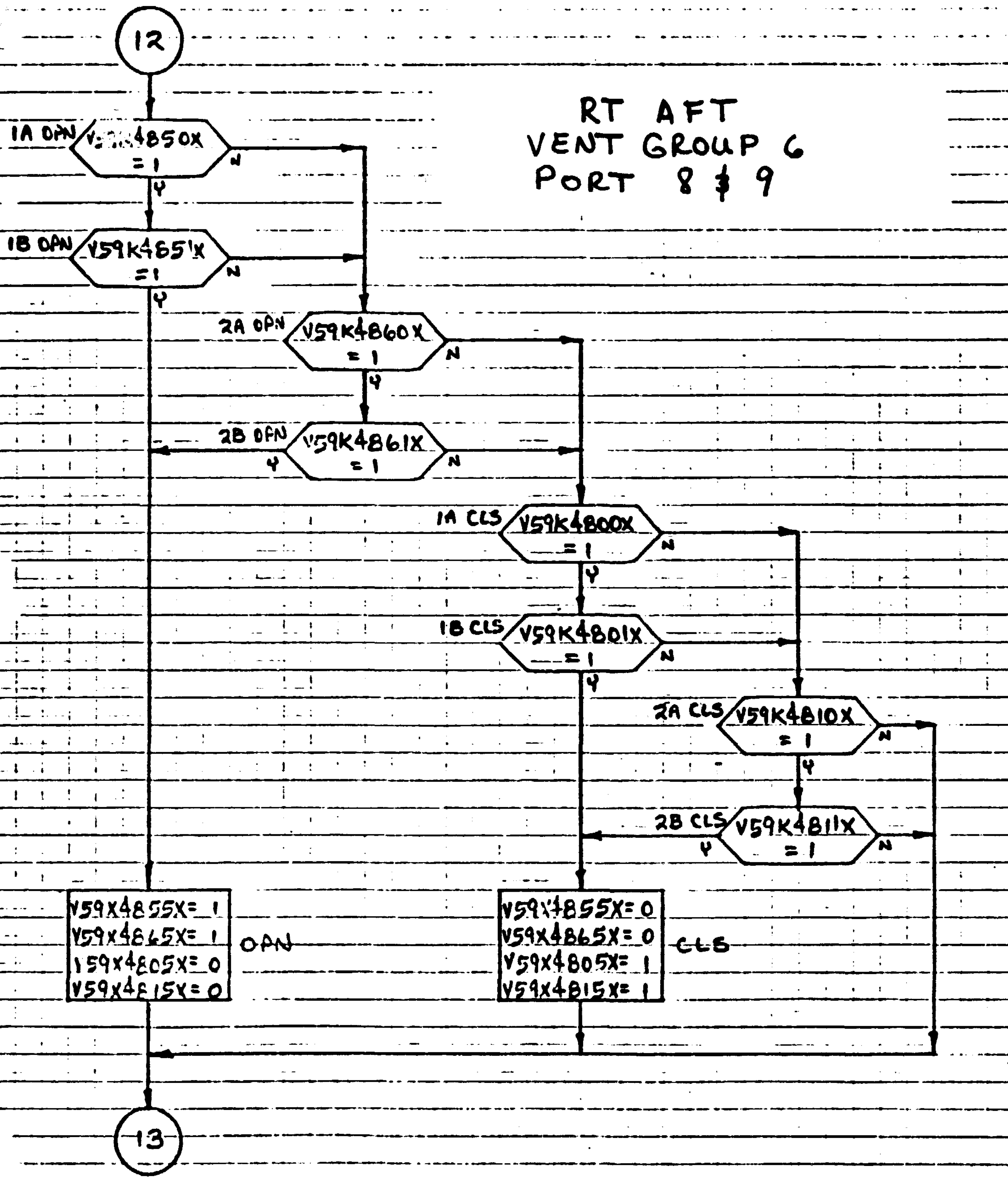
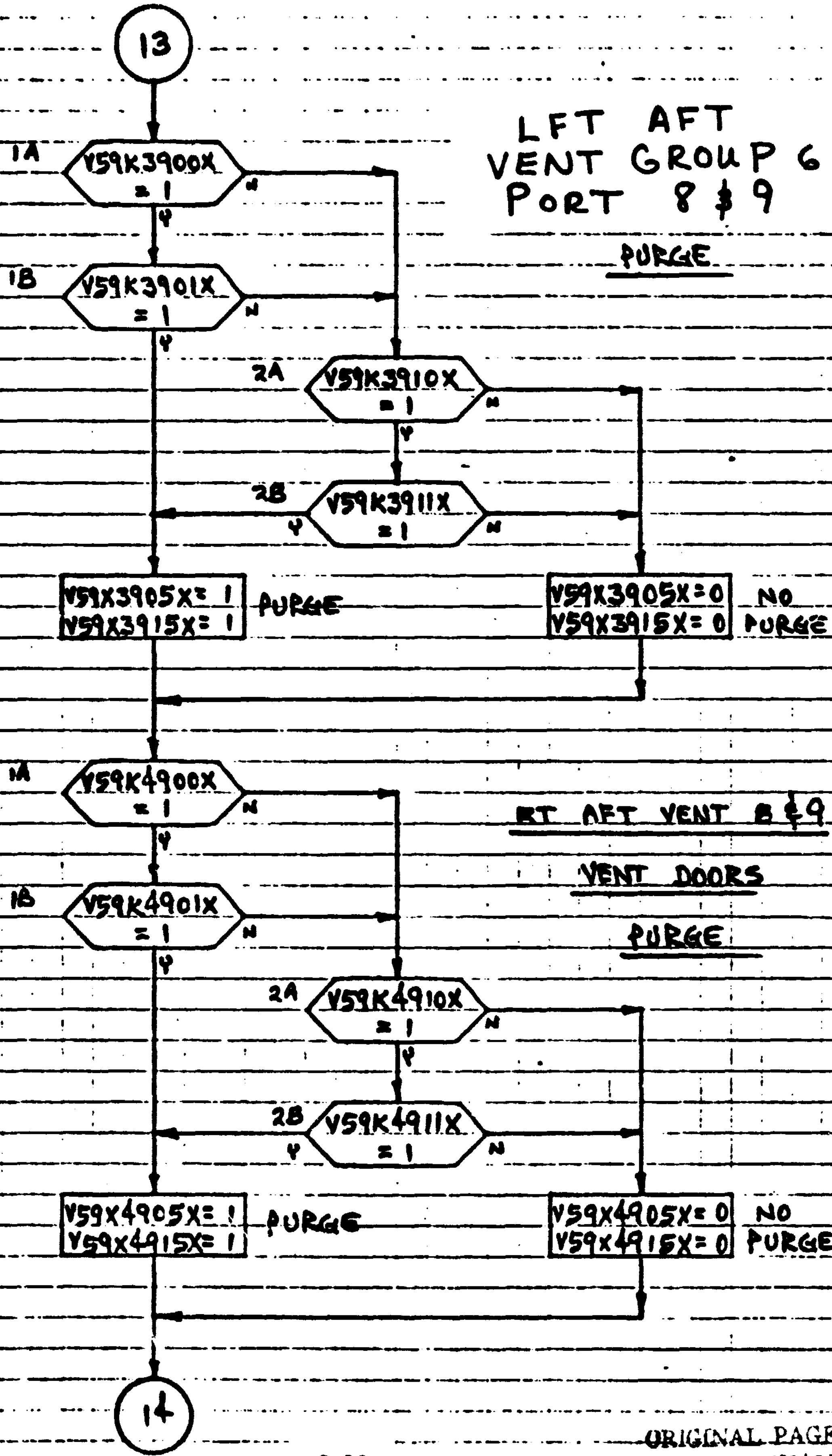
LFT AFT
VENT GROUP 6
PORT 8 & 9



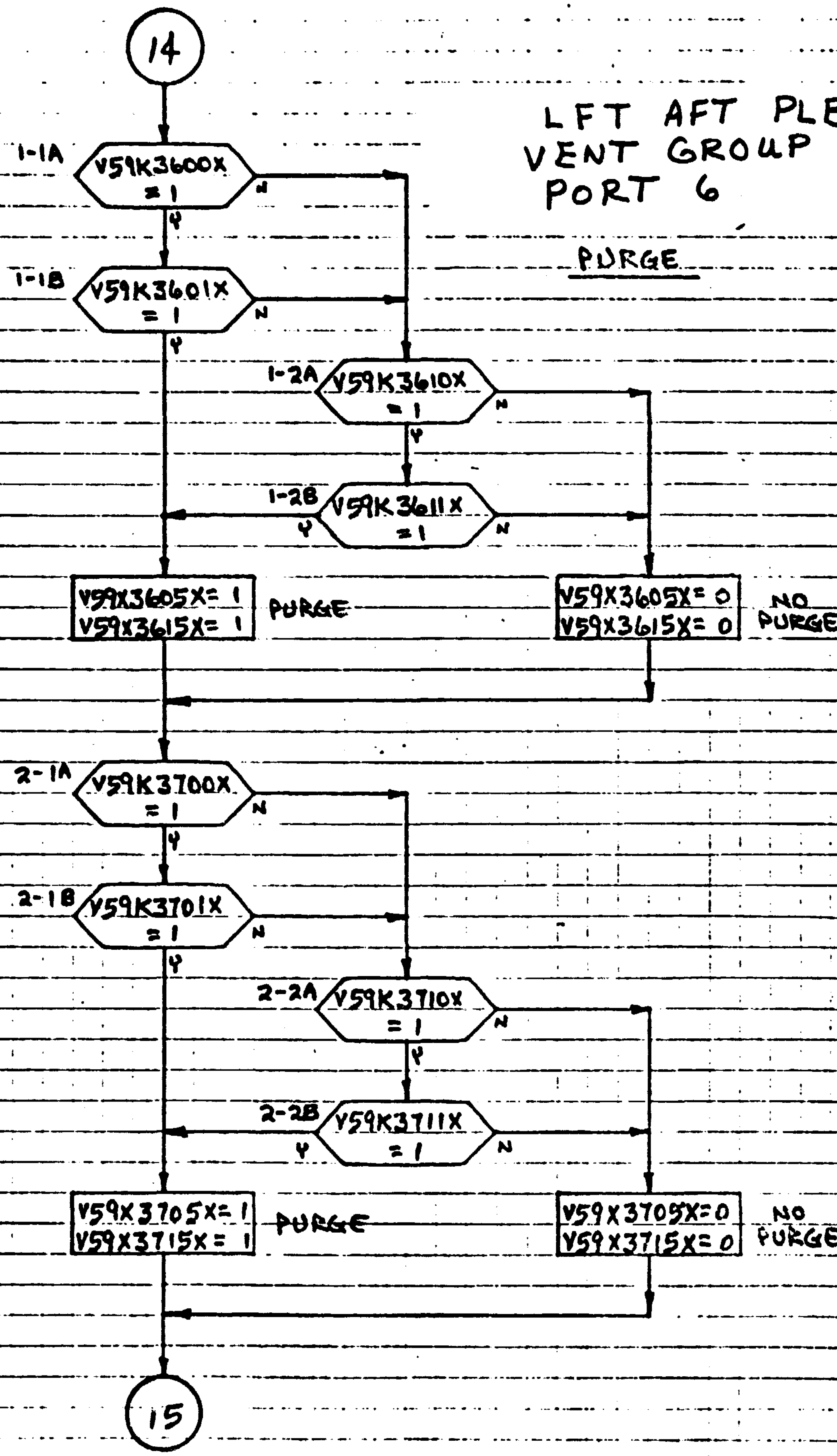


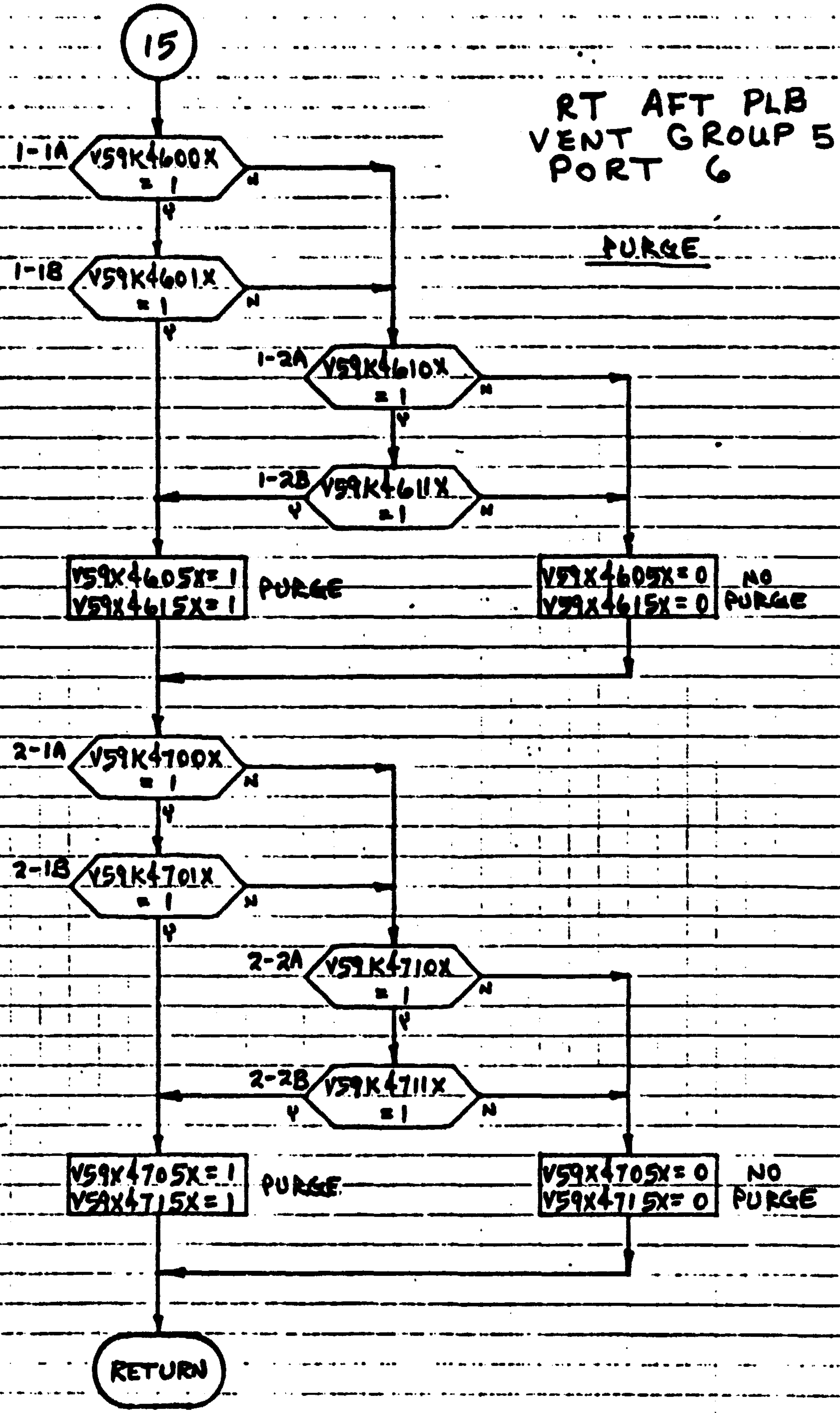
RT AFT
VENT GROUP 6
PORT 8 & 9
12
1A OPN
V59K4850X = 1
1B OPN
V59K4851X = 1
2A OPN
V59K4860X = 1
2B OPN
V59K4861X = 1
1A CLS
V59K4800X = 1
1B CLS
V59K4801X = 1
2A CLS
V59K4810X = 1
2B CLS
V59K4811X = 1
Y
N
V59X4855X = 1
V59X4865X = 1
V59X4805X = 0
V59X4815X = 0
OPN
V59X4855X = 0
V59X4865X = 0
V59X4805X = 1
V59X4815X = 1
CLS
13


LFT AFT
VENT GROUP 6
PORT 8 & 9
PURGE
13
1A
V59K3900X = 1
1B
V59K3901X = 1
2A
V59K3910X = 1
2B
V59K3911X = 1
V59X3905X = 1
V59X3915X = 1
PURGE
V59X3905X = 0
V59X3915X = 0
NO PURGE
RT AFT VENT 8 & 9
VENT DOORS
PURGE
1A
V59K4900X = 1
1B
V59K4901X = 1
2A
V59K4910X = 1
2B
V59K4911X = 1
V59X4905X = 1
V59X4915X = 1
PURGE
V59X4905X = 0
V59X4915X = 0
NO PURGE
14

LFT AFT PLB
VENT GROUP 5
PORT 6

PURGE





15
RT AFT PLB
VENT GROUP 5
PORT 6
PURGE
1-1A
V59K4600X = 1
1-1B
V59K4601X = 1
1-2A
V59K4610X = 1
1-2B
V59K4611X = 1
V59X4605X = 1
V59X4615X = 1
PURGE
V59X4605X = 0
V59X4615X = 0
NO PURGE
2-1A
V59K4700X = 1
2-1B
V59K4701X = 1
2-2A
V59K4710X = 1
2-2B
V59K4711X = 1
V59X4705X = 1
V59X4715X = 1
PURGE
V59X4705X = 0
V59X4715X = 0
NO PURGE
RETURN

4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SOURCE		STATE
				MDM	CONN-PIN	
(NONE)	L FWD VENTS 1 & 2 CLOSE CMD 1A	2	V59K3000X	FF03	J04-094	1-CLS/0-$\overline{\text{CLS}}$
	L FWD VENTS 1 & 2 CLOSE CMD 1B		V59K3001X	FF03	J02-079	
	L FWD VENTS 1 & 2 CLOSE CMD 2A		V59K3010X	FF02	J04-094	
	L FWD VENTS 1 & 2 CLOSE CMD 2B		V59K3011X	FF02	J02-094	
	L FWD VENTS 1 & 2 OPEN CMD 1A		V59K3050X	FF03	J04-096	1-OPN/0-$\overline{\text{OPN}}$
	L FWD VENTS 1 & 2 OPEN CMD 1B		V59K3051X	FF03	J02-096	
	L FWD VENTS 1 & 2 OPEN CMD 2A		V59K3060X	FF02	J04-096	
	L FWD VENTS 1 & 2 OPEN CMD 2B		V59K3061X	FF02	J02-096	
	L FWD VENTS 1 & 2 PURGE CMD 1A		V59K3100X	FF03	J04-079	1-PURGE/0-$\overline{\text{PURGE}}$
	L FWD VENTS 1 & 2 PURGE CMD 1B		V59K3101X	FF03	J02-072	
	L FWD VENTS 1 & 2 PURGE CMD 2A		V59K3110X	FF02	J04-072	
	L FWD VENTS 1 & 2 PURGE CMD 2B		V59K3111X	FF02	J02-072	
	L PB VENT 3 CLOSE CMD 1A		V59K3200X	FF03	J04-091	1-CLS/0-$\overline{\text{CLS}}$
	L PB VENT 3 CLOSE CMD 1B		V59K3201X	FF03	J02-091	
	L PB VENT 3 CLOSE CMD 2A		V59K3210X	FF02	J04-091	
	L PB VENT 3 CLOSE CMD 2B		V59K3211X	FF02	J02-091	
	L PB VENT 3 OPEN CMD 1A		V59K3250X	FF03	J04-072	1-OPN/0-$\overline{\text{OPN}}$
	L PB VENT 3 OPEN CMD 1B		V59K3251X	FF03	J02-094	
	L PB VENT 3 OPEN CMD 2A		V59K3260X	FF02	J04-079	
	L PB VENT 3 OPEN CMD 2B		V59K3261X	FF02	J02-079	
	L PB/W VENTS 4 & 7 CLOSE CMD 1A		V59K3300X	FF03	J03-054	1-CLS/0-$\overline{\text{CLS}}$
	L PB/W VENTS 4 & 7 CLOSE CMD 1B		V59K3301X	FF03	J01-060	
	L PB/W VENTS 4 & 7 CLOSE CMD 2A		V59K3310X	FF02	J03-054	
	L PB/W VENTS 4 & 7 CLOSE CMD 2B		V59K3311X	FF02	J01-054	
	L PB/W VENTS 4 & 7 OPEN CMD 1A		V59K3350X	FF03	J03-042	1-OPN/0-$\overline{\text{OPN}}$

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SOURCE		STATE
				MDM	CONN-PIN	
(NONE)	L PB/W VENTS 4 & 7 OPEN CMD 1B	2	V59K3351X	FF03	J01-042	1-OPN/0-$\overline{\text{OPN}}$
	L PB/W VENTS 4 & 7 OPEN CMD 2A		V59K3360X	FF02	J03-042	
	L PB/W VENTS 4 & 7 OPEN CMD 2B		V59K3361X	FF02	J01-042	
	L PB VENT 5 CLOSE CMD 1A		V59K3400X	FF03	J03-055	1-CLS/0-$\overline{\text{CLS}}$
	L PB VENT 5 CLOSE CMD 1B		V59K3401X	FF03	J01-055	
	L PB VENT 5 CLOSE CMD 2A		V59K3410X	FF04	J03-055	
	L PB VENT 5 CLOSE CMD 2B		V59K3411X	FF04	J01-060	
	L PB VENT 5 OPEN CMD 1A		V59K3450X	FF03	J03-041	1-OPN/0-$\overline{\text{OPN}}$
	L PB VENT 5 OPEN CMD 1B		V59K3451X	FF03	J01-041	
	L PB VENT 5 OPEN CMD 2A		V59K3460X	FF04	J03-041	
	L PB VENT 5 OPEN CMD 2B		V59K3461X	FF04	J01-041	
	L PB VENT 6 CLOSE CMD 1A		V59K3500X	FF01	J03-044	1-CLS/0-$\overline{\text{CLS}}$
	L PB VENT 6 CLOSE CMD 1B		V59K3501X	FF01	J01-044	
	L PB VENT 6 CLOSE CMD 2A		V59K3510X	FF04	J03-044	
	L PB VENT 6 CLOSE CMD 2B		V59K3511X	FF04	J01-044	
	L PB VENT 6 OPEN CMD 1A		V59K3550X	FF01	J03-056	1-OPN/0-$\overline{\text{OPN}}$
	L PB VENT 6 OPEN CMD 1B		V59K3551X	FF01	J01-056	
	L PB VENT 6 OPEN CMD 2A		V59K3560X	FF04	J03-056	
	L PB VENT 6 OPEN CMD 2B		V59K3561X	FF04	J01-056	
	L PB VENT 6 PURGE 1 CMD 1A		V59K3600X	FF01	J03-057	1-PURGE/0-$\overline{\text{PURGE}}$
	L PB VENT 6 PURGE 1 CMD 1B		V59K3601X	FF01	J01-057	
	L PB VENT 6 PURGE 1 CMD 2A		V59K3610X	FF04	J03-057	
	L PB VENT 6 PURGE 1 CMD 2B		V59K3611X	FF04	J01-057	
	L PB VENT 6 PURGE 2 CMD 1A		V59K3700X	FF01	J03-045	
	L PB VENT 6 PURGE 2 CMD 1B		V59K3701X	FF01	J01-045	

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SOURCE		STATE
				MDM	CONN-PIN	
(NONE)	L PB VENT 6 PURGE 2 CMD 2A	2	V59K3710X	FF04	J03-045	1-PURGE/0-$\overline{\text{PURGE}}$
	L PB VENT 6 PURGE 2 CMD 2B		V59K3711X	FF04	J01-045	↓
	L AFT VENTS 8 & 9 CLOSE CMD 1A		V59K3800X	FA01	J06-019	1-CLS/0-$\overline{\text{CLS}}$
	L AFT VENTS 8 & 9 CLOSE CMD 1B		V59K3801X	FA01	J08-010	
	L AFT VENTS 8 & 9 CLOSE CMD 2A		V59K3810X	FA04	J06-019	
	L AFT VENTS 8 & 9 CLOSE CMD 2B		V59K3811X	FA04	J08-010	↓
	L AFT VENTS 8 & 9 OPEN CMD 1A		V59K3850X	FA01	J06-030	1-OPN/0-$\overline{\text{OPN}}$
	L AFT VENTS 8 & 9 OPEN CMD 1B		V59K3851X	FA01	J08-019	
	L AFT VENTS 8 & 9 OPEN CMD 2A		V59K3860X	FA04	J06-030	
	L AFT VENTS 8 & 9 OPEN CMD 2B		V59K3861X	FA04	J08-019	↓
	L AFT VENTS 8 & 9 PURGE CMD 1A		V59K3900X	FA01	J06-008	1-PURGE/0-$\overline{\text{PURGE}}$
	L AFT VENTS 8 & 9 PURGE CMD 1B		V59K3901X	FA01	J08-030	
	L AFT VENTS 8 & 9 PURGE CMD 2A		V59K3910X	FA04	J06-008	
	L AFT VENTS 8 & 9 PURGE CMD 2B		V59K3911X	FA04	J08-030	↓
	R FWD VENTS 1 & 2 CLOSE CMD 1A		V59K4000X	FF01	J04-094	1-CLS/0-$\overline{\text{CLS}}$
	R FWD VENTS 1 & 2 CLOSE CMD 1B		V59K4001X	FF01	J02-094	
	R FWD VENTS 1 & 2 CLOSE CMD 2A		V59K4010X	FF04	J04-094	
	R FWD VENTS 1 & 2 CLOSE CMD 2B		V59K4011X	FF04	J02-079	↓
	R FWD VENTS 1 & 2 OPEN CMD 1A		V59K4050X	FF01	J04-096	1-OPN/0-$\overline{\text{OPN}}$
	R FWD VENTS 1 & 2 OPEN CMD 1B		V59K4051X	FF01	J02-096	
	R FWD VENTS 1 & 2 OPEN CMD 2A		V59K4060X	FF04	J04-096	
	R FWD VENTS 1 & 2 OPEN CMD 2B		V59K4061X	FF04	J02-096	↓
	R FWD VENTS 1 & 2 PURGE CMD 1A		V59K4100X	FF01	J04-072	1-PURGE/0-$\overline{\text{PURGE}}$
	R FWD VENTS 1 & 2 PURGE CMD 1B		V59K4101X	FF01	J02-072	
	R FWD VENTS 1 & 2 PURGE CMD 2A		V59K4110X	FF04	J04-079	↓

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SOURCE		STATE
				MDM	CONN-PIN	
(NONE)	R FWD VENTS 1 & 2 PURGE CMD 2B	2	V59K4111X	FF04	J02-072	1-PURGE/0-$\overline{\text{PURGE}}$
	R PB VENT 3 CLOSE CMD 1A		V59K4200X	FF01	J03-054	1-CLS/0-$\overline{\text{CLS}}$
	R PB VENT 3 CLOSE CMD 1B		V59K4201X	FF01	J01-054	
	R PB VENT 3 CLOSE CMD 2A		V59K4210X	FF04	J04-091	
	R PB VENT 3 CLOSE CMD 2B		V59K4211X	FF04	J02-091	
	R PB VENT 3 OPEN CMD 1A		V59K4250X	FF01	J03-042	1-OPN/0-$\overline{\text{OPN}}$
	R PB VENT 3 OPEN CMD 1B		V59K4251X	FF01	J01-042	
	R PB VENT 3 OPEN CMD 2A		V59K4260X	FF04	J04-072	
	R PB VENT 3 OPEN CMD 2B		V59K4261X	FF04	J02-094	
	R PB/W VENT 4 & 7 CLOSE CMD 1A		V59K4300X	FF04	J03-054	1-CLS/0-$\overline{\text{CLS}}$
	R PB/W VENTS 4 & 7 CLOSE CMD 1B		V59K4301X	FF04	J01-054	
	R PB/W VENTS 4 & 7 CLOSE CMD 2A		V59K4310X	FF01	J04-091	
	R PB/W VENTS 4 & 7 CLOSE CMD 2B		V59K4311X	FF01	J02-089	
	R PB/W VENTS 4 & 7 OPEN CMD 1A		V59K4350X	FF04	J03-042	1-OPN/0-$\overline{\text{OPN}}$
	R PB/W VENTS 4 & 7 OPEN CMD 1B		V59K4351X	FF04	J01-042	
	R PB/W VENTS 4 & 7 OPEN CMD 2A		V59K4360X	FF01	J04-079	
	R PB/W VENTS 4 & 7 OPEN CMD 2B		V59K4361X	FF01	J02-079	
	R PB VENT 5 CLOSE CMD 1A		V59K4400X	FF01	J03-055	1-CLS/0-$\overline{\text{CLS}}$
	R PB VENT 5 CLOSE CMD 1B		V59K4401X	FF01	J01-055	
	R PB VENT 5 CLOSE CMD 2A		V59K4410X	FF02	J03-055	
	R PB VENT 5 CLOSE CMD 2B		V59K4411X	FF02	J01-060	
	R PB VENT 5 OPEN CMD 1A		V59K4450X	FF01	J03-041	1-OPN/0-$\overline{\text{OPN}}$
	R PB VENT 5 OPEN CMD 1B		V59K4451X	FF01	J01-041	
	R PB VENT 5 OPEN CMD 2A		V59K4460X	FF02	J03-041	
	R PB VENT 5 OPEN CMD 2B		V59K4461X	FF02	J01-041	

TABLE 1 - STIMULI INP FOR VENT DOORS

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SOURCE		STATE
				MDM	CONN-PIN	
(NONE)	R PB VENT 6 CLOSE CMD 1A	2	V59K4500X	FF03	J03-044	1-CLS/0-$\overline{CLS}$
	R PB VENT 6 CLOSE CMD 1B		V59K4501X	FF03	J01-044	
	R PB VENT 6 CLOSE CMD 2A		V59K4510X	FF02	J03-044	
	R PB VENT 6 CLOSE CMD 2B		V59K4511X	FF02	J01-044	
	R PB VENT 6 OPEN CMD 1A		V59K4550X	FF03	J03-056	1-OPN/0-$\overline{OPN}$
	R PB VENT 6 OPEN CMD 1B		V59K4551X	FF03	J01-056	
	R PB VENT 6 OPEN CMD 2A		V59K4560X	FF02	J03-056	
	R PB VENT 6 OPEN CMD 2B		V59K4561X	FF02	J01-056	
	R PB VENT 6 PURGE 1 CMD 1A		V59K4600X	FF03	J03-057	1-PURGE/0-$\overline{PURGE}$
	R PB VENT 6 PURGE 1 CMD 1B		V59K4601X	FF03	J01-057	
	R PB VENT 6 PURGE 1 CMD 2A		V59K4610X	FF02	J03-057	
	R PB VENT 6 PURGE 1 CMD 2B		V59K4611X	FF02	J01-057	
	R PB VENT 6 PURGE 2 CMD 1A		V59K4700X	FF03	J03-045	
	R PB VENT 6 PURGE 2 CMD 1B		V59K4701X	FF03	J01-045	
	R PB VENT 6 PURGE 2 CMD 2A		V59K4710X	FF02	J03-045	
	R PB VENT 6 PURGE 2 CMD 2B		V59K4711X	FF02	J01-045	
	R AFT VENTS 8 & 9 CLOSE CMD 1A		V59K4800X	FA03	J06-019	1-CLS/0-$\overline{CLS}$
	R AFT VENTS 8 & 9 CLOSE CMD 1B		V59K4801X	FA03	J08-010	
	R AFT VENTS 8 & 9 CLOSE CMD 2A		V59K4810X	FA02	J06-019	
	R AFT VENTS 8 & 9 CLOSE CMD 2B		V59K4811X	FA02	J08-010	
	R AFT VENTS 8 & 9 OPEN CMD 1A		V59K4850X	FA03	J06-030	1-OPN/0-$\overline{OPN}$
	R AFT VENTS 8 & 9 OPEN CMD 1B		V59K4851X	FA03	J08-019	
	R AFT VENTS 8 & 9 OPEN CMD 2A		V49K4860X	FA02	J06-030	
	R AFT VENTS 8 & 9 OPEN CMD 2B		V59K4861X	FA02	J08-019	
	R AFT VENTS 8 & 9 PURGE CMD 1A		V59K4900X	FA03	J06-008	1-PURGE/0-$\overline{PURGE}$

TABLE 1 - STIMULI I[illegible]R VENT DOORS

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SOURCE		STATE
				MDM	CONN-PIN	
(NONE)	R AFT VENTS 8 & 9 PURGE CMD 1B	2	V59K4901X	FA03	J08-030	1-PURGE/0-$\overline{\text{PURGE}}$
	R AFT VENTS 8 & 9 PURGE CMD 2A		V59K4910X	FA02	J06-008	
	R AFT VENTS 8 & 9 PURGE CMD 2B		V59K4911X	FA02	J08-030	

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM VENT DOORS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V59X3555X	LFT AFT PLB 6ACT/B1 OPEN	0	0	1	1					STATE
V59X3505X	LFT AFT PLB 6ACT/B1 CLOSE	1	1	0	0					
V59X3605X	LFT AFT PLB 6ACT/B1 PURGE 1	0	0	1	1					
V59X3705X	LFT AFT PLB 6ACT/B1 PURGE 2	0	0	1	1					
V59X3565X	LFT AFT PLB 6ACT/B2 OPEN	0	0	1	1					
V59X3515X	LFT AFT PLB 6ACT/B2 CLOSE	1	1	0	0					
V59X3615X	LFT AFT PLB 6ACT/B2 PURGE 1	0	0	1	1					
V59X3715X	LFT AFT PLB 6ACT/B2 PURGE 2	0	0	1	1					
V59X4555X	RT AFT PLB 6ACT/B1 OPEN	0	0	1	1					
V59X4505X	RT AFT PLB 6ACT/B1 CLOSE	1	1	0	0					
V59X4605X	RT AFT PLB 6ACT/B1 PURGE 1	0	0	1	1					
V59X4705X	RT AFT PLB 6ACT/B1 PURGE 2	0	0	1	1					
V59X4565X	RT AFT PLB 6ACT/B2 OPEN	0	0	1	1					
V59X4515X	RT AFT PLB 6ACT/B2 CLOSE	1	1	0	0					
V59X4615X	RT AFT PLB 6ACT/B2 PURGE 1	0	0	1	1					
V59X4715X	RT AFT PLB 6ACT/B2 PURGE 2	0	0	1	1					
V59X3855X	LFT AFT VENT 8&9 ACT/B1 OPEN	0	0	1	1					
V59X3805X	LFT AFT VENT 8&9 ACT/B1 CLOSE	1	1	0	0					
V59X3905X	LFT AFT VENT 8&9 ACT/B1 PURGE	0	0	1	1					
V59X3865X	LFT AFT VENT 8&9 ACT/B2 OPEN	0	0	1	1					
V59X3815X	LFT AFT VENT 8&9 ACT/B2 CLOSE	1	1	0	0					
V59X3915X	LFT AFT VENT 8&9 ACT/B2 PURGE	0	0	1	1					STATE

MEASUREMENT OUTPUT FROM VENT DOORS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V59X4855X	RT AFT VENT 8&9 ACT/B1 OPEN	0	0	1	1					STATE
V59X4805X	RT AFT VENT 8&9 ACT/B1 CLOSE	1	1	0	0					
V59X4905X	RT AFT VENT 8&9 ACT/B1 PURGE	0	0	1	1					
V59X4865X	RT AFT VENT 8&9 ACT/B2 OPEN	0	0	1	1					
V59X4815X	RT AFT VENT 8&9 ACT/B2 CLOSE	1	1	0	0					
V59X4915X	RT AFT VENT 8&9 ACT/B2 PURGE	0	0	1	1					
V59X4055X	RT FWD 1&2 ACT/B1 OPEN	0	0	1	1					
V59X4005X	RT FWD 1&2 ACT/B1 CLOSE	1	1	0	0					
V59X4105X	RT FWD 1&2 ACT/B1 PURGE	0	0	1	1					
V59X4065X	RT FWD 1&2 ACT/B2 OPEN	0	0	1	1					
V59X4015X	RT FWD 1&2 ACT/B2 CLOSE	1	1	0	0					
V59X4115X	RT FWD 1&2 ACT/B2 PURGE	0	0	1	1					
V59X3055X	LFT FWD 1&2 ACT/B1 OPEN	0	0	1	1					
V59X3005X	LFT FWD 1&2 ACT/B1 CLOSE	1	1	0	0					
V59X3105X	LFT FWD 1&2 ACT/B1 PURGE	0	0	1	1					
V59X3065X	LFT FWD 1&2 ACT/B2 OPEN	0	0	1	1					
V59X3015X	LFT FWD 1&2 ACT/B2 CLOSE	1	1	0	0					
V59X3115X	LFT FWD 1&2 ACT/B2 PURGE	0	0	1	1					
V59X3255X	LFT PLB/WING 3ACT/B1 OPEN	0	0	1	1					
V59X3205X	LFT PLB/WING 3ACT/B1 CLOSE	1	1	0	0					
V59X3265X	LFT PLB/WING 3ACT/B2 OPEN	0	0	1	1					
V59X3215X	LFT PLB/WING 3ACT/B2 CLOSE	1	1	0	0					
V59X4255X	RT PLB/WING 3ACT/B1 OPEN	0	0	1	1					STATE

MEASUREMENT OUTPUT FROM VENT DOORS MODEL-TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V59X4205X	RT PLB/WING 3ACT/B1 CLOSE	1	1	0	0					STATE
V59X4265X	RT PLB/WING 3ACT/B2 OPEN	0	0	1	1					
V59X4215X	RT PLB/WING 3ACT/B2 CLOSE	1	1	0	0					
V59X3355X	LFT PLB/WING 4&7 ACT/B1 OPEN	0	0	1	1					
V59X3305X	LFT PLB/WING 4&7 ACT/B1 CLOSE	1	1	0	0					
V59X3365X	LFT PLB/WING 4&7 ACT/B2 OPEN	0	0	1	1					
V59X3315X	LFT PLB/WING 4&7 ACT/B2 CLOSE	1	1	0	0					
V59X4355X	RT PLB/WING 4&7 ACT/B1 OPEN	0	0	1	1					
V59X4305X	RT PLB/WING 4&7 ACT/B1 CLOSE	1	1	0	0					
V59X4365X	RT PLB/WING 4&7 ACT/B2 OPEN	0	0	1	1					
V59X4315X	RT PLB/WING 4&7 ACT/B2 CLOSE	1	1	0	0					
V59X3455X	LFT PLB/WING 5ACT/B1 OPEN	0	0	1	1					
V59X3405X	LFT PLB/WING 5ACT/B1 CLOSE	1	1	0	0					
V59X3465X	LFT PLB/WING 5ACT/B2 OPEN	0	0	1	1					
V59X3415X	LFT PLB/WING 5ACT/B2 CLOSE	1	1	0	0					
V59X4455X	RT PLB/WING 5ACT/B1 OPEN	0	0	1	1					
V59X4405X	RT PLB/WING 5ACT/B1 CLOSE	1	1	0	0					
V59X4465X	RT PLB/WING 5ACT/B2 OPEN	0	0	1	1					
V59X4415X	RT PLB/WING 5ACT/B2 CLOSE	1	1	0	0					STATE

APPENDIX C

ET UMBILICAL DOORS
NAS MATH MODEL REQUIREMENTS

CONTENTS

1. INTRODUCTION

The GN&C Test Station (GTS) uses math models to simulate many of the Shuttle systems for which hardware has not been provided. A group of these models are termed "non-avionic" models since they do not simulate the Shuttle's "avionic" systems. The "non-avionic" models are needed to supply data for on-board software processing and to respond to Shuttle commands, whether they be from cockpit switches, the General Purpose Computers (GPC's) or the Non-Avionic Simulator (NAS) console.

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in table 1 to produce values for the output measurements listed in table 2 that simulate the operation of the ET Umbilical Doors.

2.1 MATH MODEL DESCRIPTION

This model simulates the functions of the ET Umbilical Doors, namely: OPEN, CLOSED, LATCHED, RELEASED, LOCKED, and STOWED. The doors seal Orbiter umbilical penetrations following ET separation to ensure a unified heat shield for entry.

2.2 STS UNIQUE REQUIREMENTS

This model is not required for STS.

2.3 GTS UNIQUE REQUIREMENTS

This model is required for GTS only.

3. MATH MODEL LOGIC

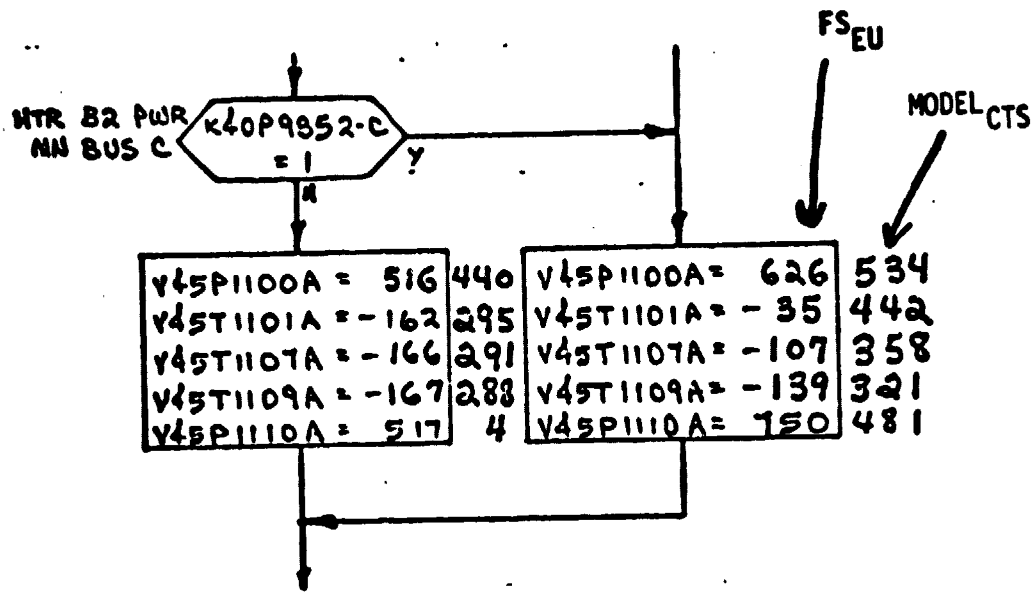
This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

NONE

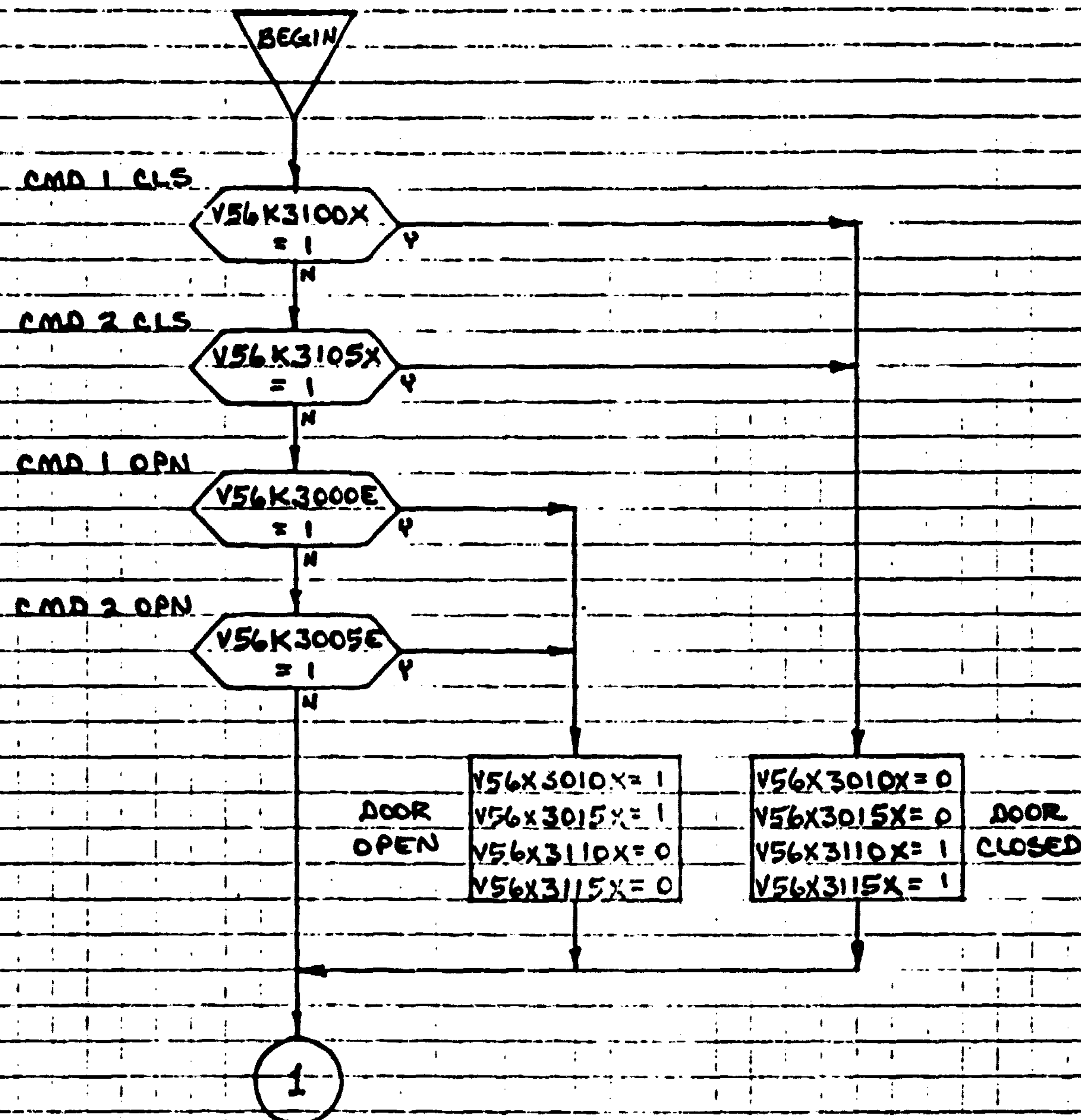
3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;



shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.

LEFT UMB CLOSEOUT DOOR



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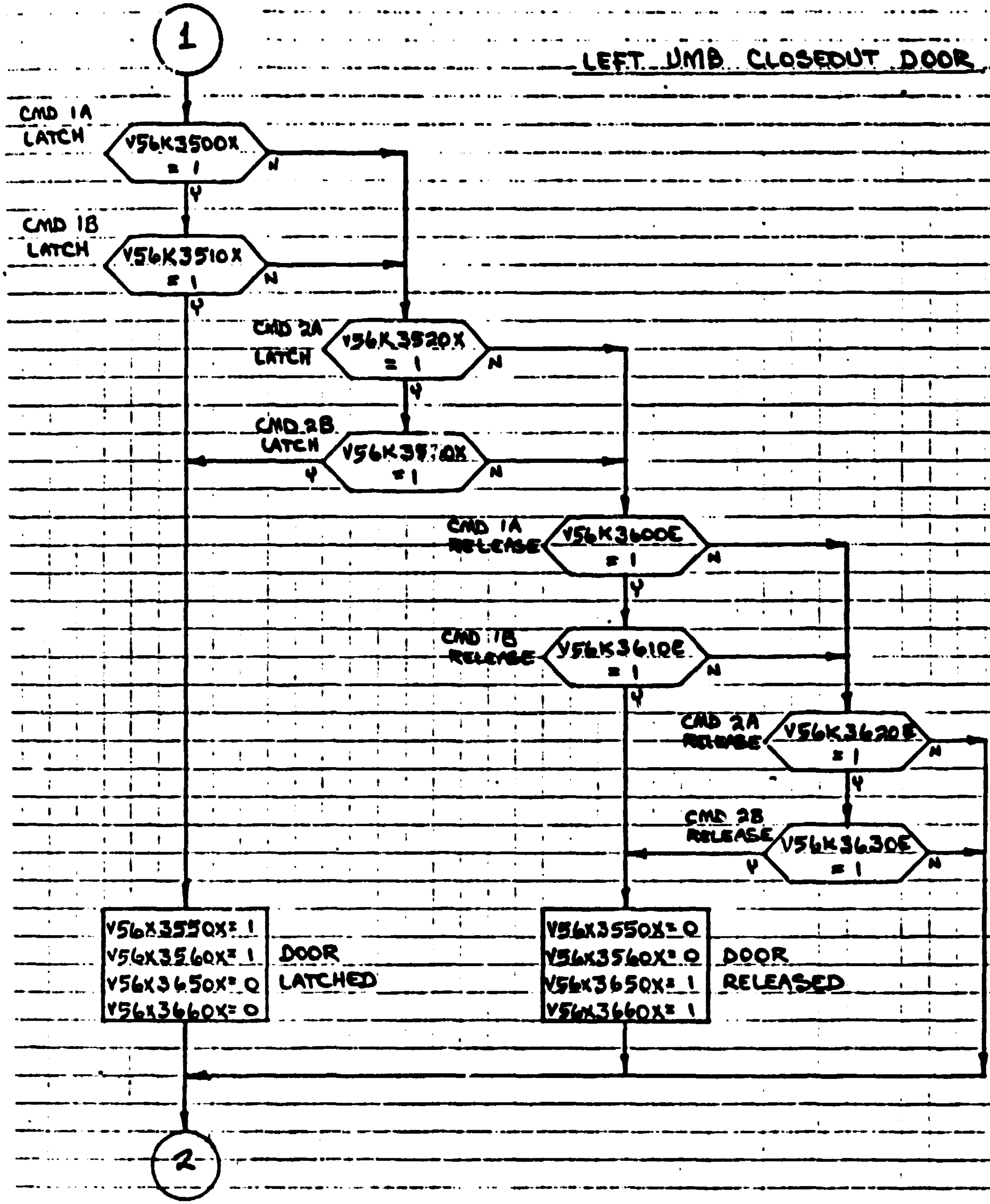
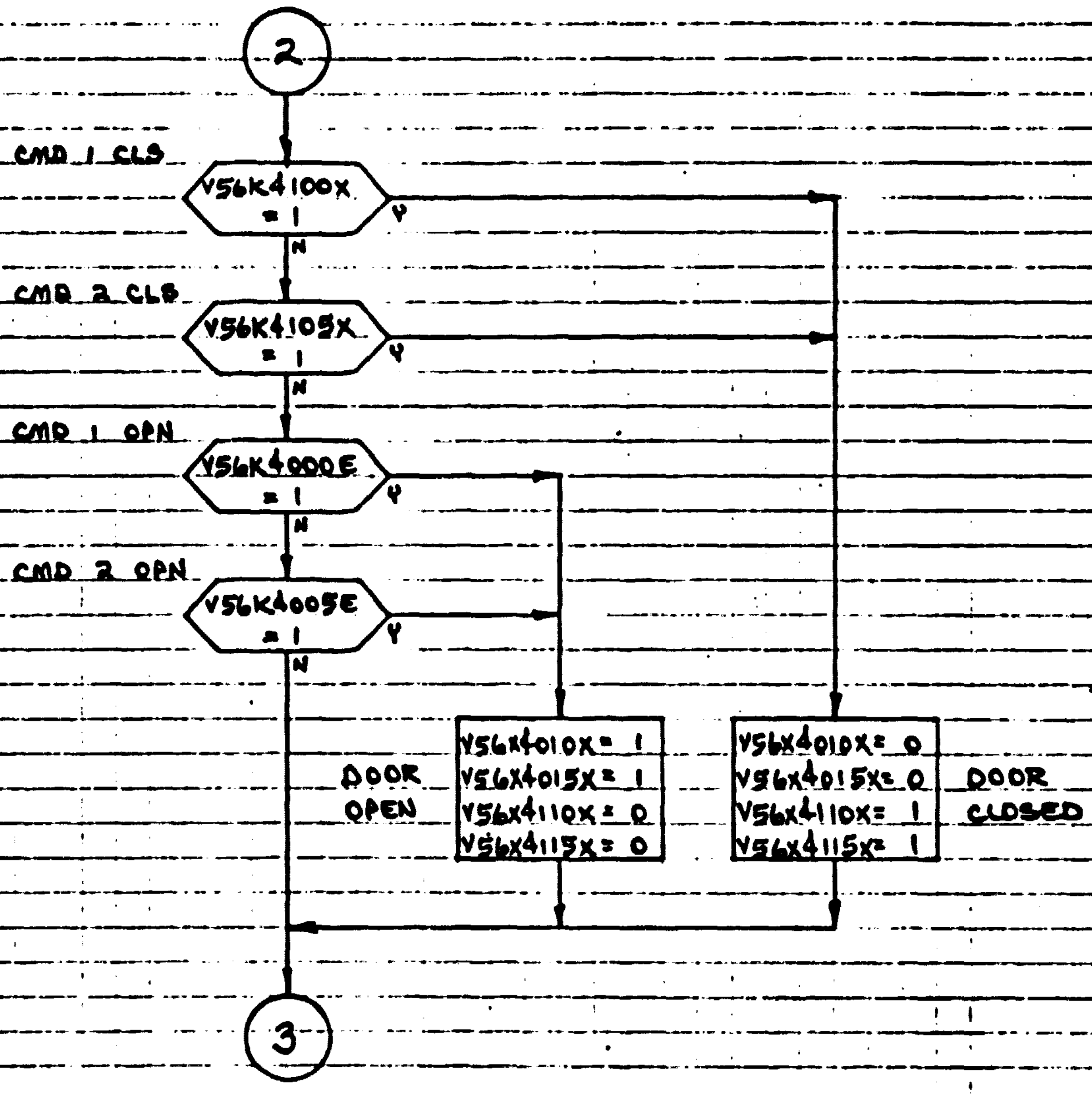
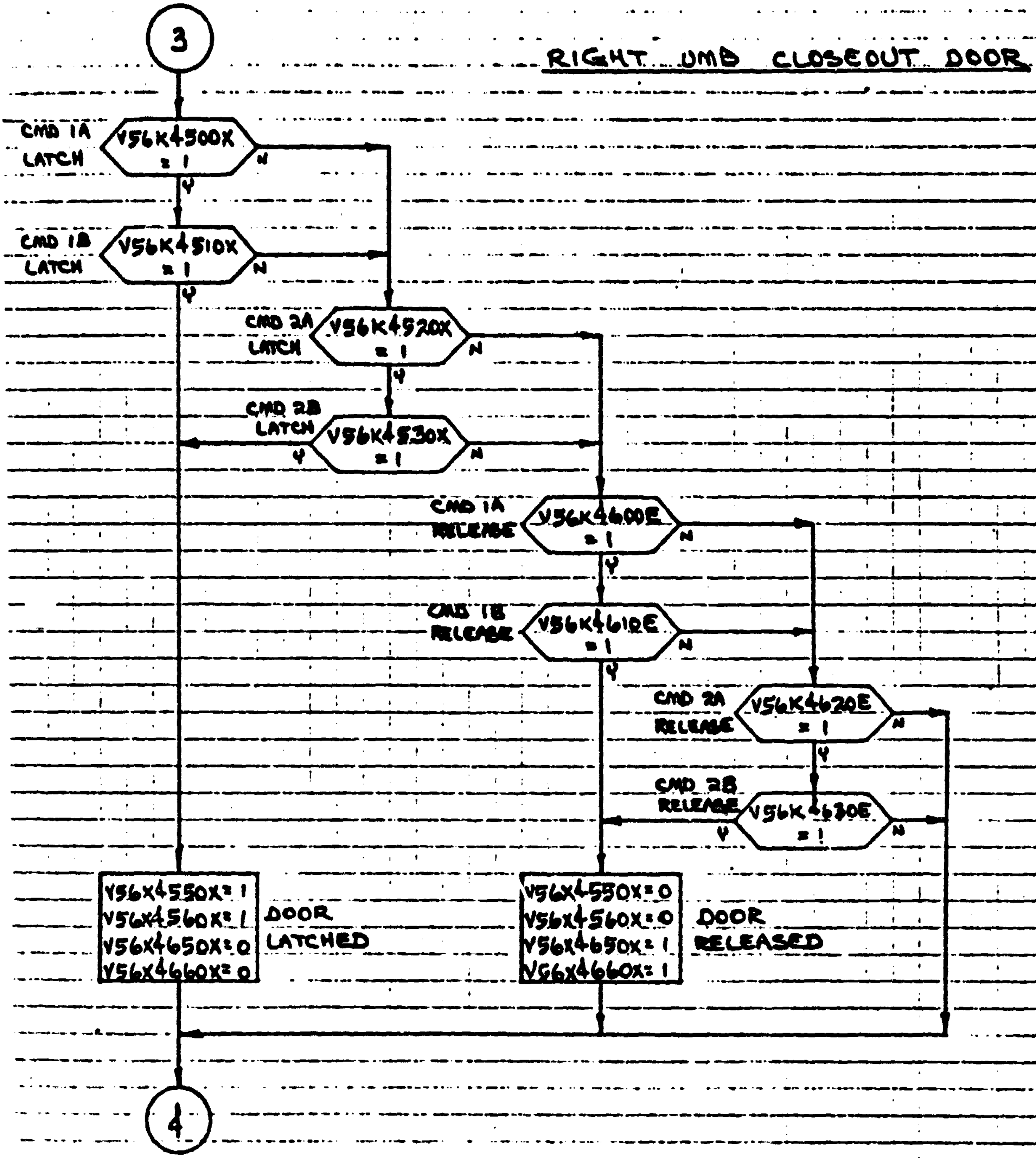


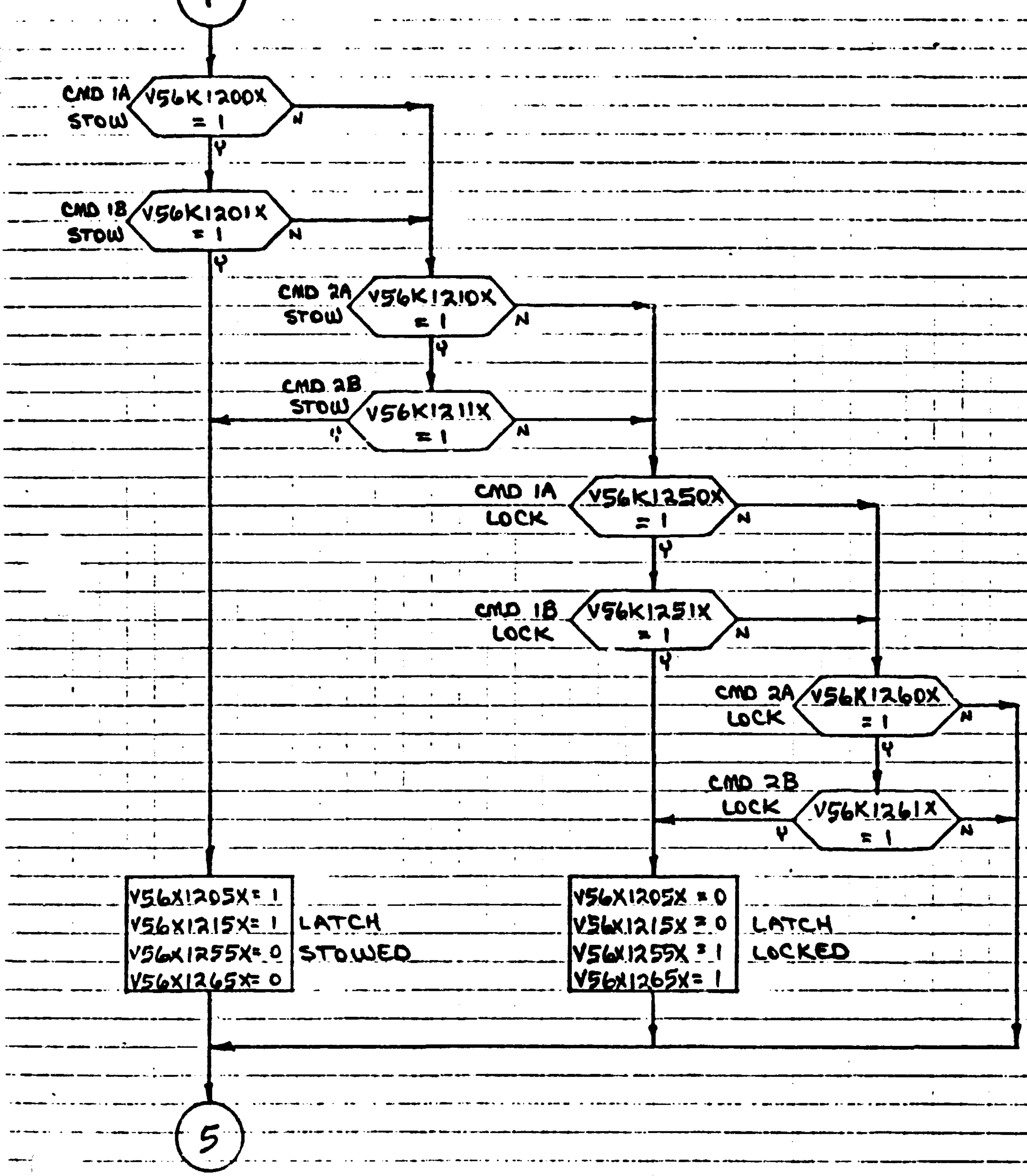
1
LEFT UMB CLOSEOUT DOOR
CMD 1A LATCH
V56K3500X = 1
CMD 1B LATCH
V56K3510X = 1
CMD 2A LATCH
V56K3520X = 1
CMD 2B LATCH
CMD 1A RELEASE
V56K3600E = 1
CMD 1B RELEASE
V56K3610E = 1
CMD 2A RELEASE
V56K3620E = 1
CMD 2B RELEASE
V56K3630E = 1
V56X3550X = 1
V56X3560X = 1
V56X3650X = 0
V56X3660X = 0
DOOR LATCHED
V56X3550X = 0
V56X3560X = 0
V56X3650X = 1
V56X3660X = 1
DOOR RELEASED
Y
N
2

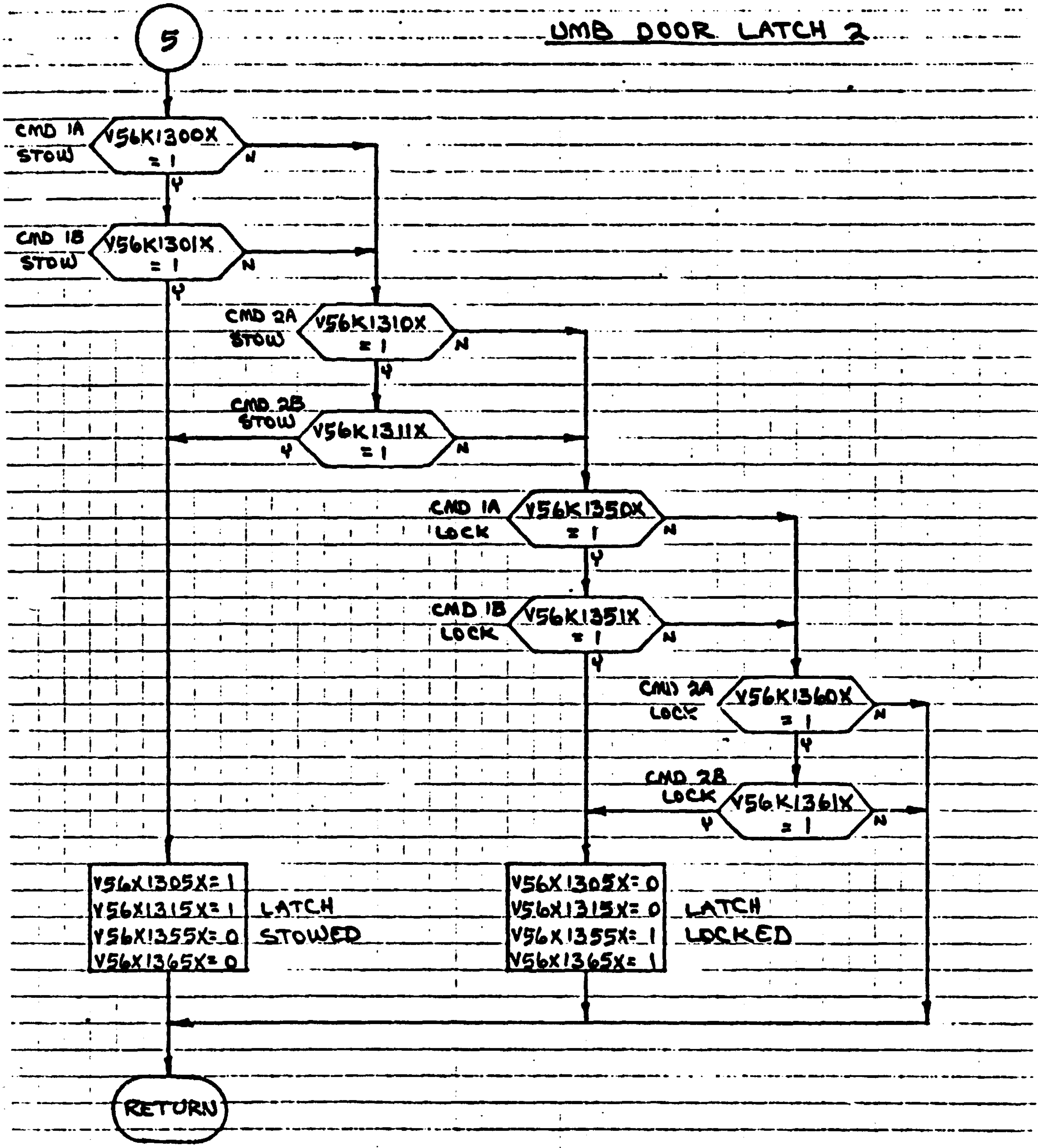
RIGHT UMB CLOSEOUT DOOR




3
RIGHT UMB CLOSEOUT DOOR
CMD 1A LATCH
V56K4500X = 1
CMD 1B LATCH
V56K4510X = 1
CMD 2A LATCH
V56K4520X = 1
CMD 2B LATCH
V56K4530X = 1
CMD 1A RELEASE
V56K4600E = 1
CMD 1B RELEASE
V56K4610E = 1
CMD 2A RELEASE
V56K4620E = 1
CMD 2B RELEASE
V56K4630E = 1
Y
N
V56X4550X = 1
V56X4560X = 1
V56X4650X = 0
V56X4660X = 0
DOOR LATCHED
V56X4550X = 0
V56X4560X = 0
V56X4650X = 1
V56X4660X = 1
DOOR RELEASED
4

UMB DOOR LATCH 1





5
UMB DOOR LATCH 2
CMD 1A STOW
V56K1300X = 1
CMD 1B STOW
V56K1301X = 1
CMD 2A STOW
V56K1310X = 1
CMD 2B STOW
V56K1311X = 1
CMD 1A LOCK
V56K1350X = 1
CMD 1B LOCK
V56K1351X = 1
CMD 2A LOCK
V56K1360X = 1
CMD 2B LOCK
V56K1361X = 1
Y
N
V56X1305X = 1
V56X1315X = 1
V56X1355X = 0
V56X1365X = 0
LATCH STOWED
V56X1305X = 0
V56X1315X = 0
V56X1355X = 1
V56X1365X = 1
LATCH LOCKED
RETURN

4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

4.1.2 VARIABLE INITIALIZATION

The following stimuli are initialized as follows:

MML ID.	INITIAL CONDITION
V56K3000E	0
3005E	0
4000E	0
4005E	0
3600E	0
3610E	0
3620E	0
3630E	0
4600E	0
4610E	0
4620E	0
4630E	0

TABLE 1 - STIM .PUT FOR UMB DOORS

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	NAS SOURCE MDM	CONN-PIN	STATE
R2/S48	ET UMB DOOR LATCH 1 STOW CMD 1A	2	V56K1200X	FA01	J06-013	1-STOW/0-$\overline{\text{STOW}}$
	↓ 1B		1201X	FA01	J08-026	↓
	↓ 2A		1210X	FA02	J06-013	↓
	↓ 2B		1211X	FA02	J08-026	↓
	ET UMB DOOR LATCH 1 LOCK CMD 1A		1250X	FA01	J06-015	1-DPLY/0-$\overline{\text{DPLY}}$
	↓ 1B	2	1251X	FA01	J08-013	↓
	↓ 2A		1260X	FA02	J06-015	↓
	↓ 2B		1261X	FA02	J08-013	↓
	ET UMB DOOR LATCH 2 STOW CMD 1A		1300X	FA04	J06-013	1-STOW/0-$\overline{\text{STOW}}$
	↓ 1B	2	1301X	FA04	J08-026	↓
	↓ 2A		1310X	FA03	J06-013	↓
	↓ 2B		1311X	FA03	J08-026	↓
	ET UMB DOOR LATCH 2 LOCK CMD 1A		1350X	FA04	J06-015	1-DPLY/0-$\overline{\text{DPLY}}$
	↓ 1B	2	1351X	FA04	J08-013	↓
	↓ 2A		1360X	FA03	J06-015	↓
	↓ 2B		1361X	FA03	J08-013	↓
R2/S49	ET LF UMB CLS-OUT DR OPN CMD 1	5	3000E			1-OPN/0-$\overline{\text{OPN}}$
	↓ OPN CMD 2		3005E			↓
	↓ CLOSE CMD 1	2	3100X	FA01	J06-010	1-CLS/0-$\overline{\text{CLS}}$
	↓ CLOSE CMD 2		3105X	FA03	J06-010	↓
R2/S51	ET RT UMB CLS-OUT DR OPN CMD 1	5	4000E			1-OPN/0-$\overline{\text{OPN}}$
	↓ OPN CMD 2		↓ 4005E			↓

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	NAS SOURCE MDM	NAS SOURCE CONN-PIN	STATE
R2/S51 (cont)	ET RT UMB CLS-OUT DR CLOSE CMD 1	2	V56K4100X	FA04	J06-010	1-CLS/0-$\overline{\text{CLS}}$
	↓ CLOSE CMD 2		4105X	FA02	J06-010	↓
R2/S50	ET LF UMB CLS-OUT DR LATCH CMD 1A		3500X	FA01	J06-017	1-LCH/0-$\overline{\text{LCH}}$
	1B	2	3510X	FA01	J08-017	↓
	2A		3520X	FA04	J06-017	
	↓ 2B		3530X	FA04	J08-017	
	ET LF UMB CLS-OUT DR REL CMD 1A		3600E			1-REL/0-$\overline{\text{REL}}$
	1B	5	3610E			↓
	2A		3620E			
	↓ 2B		3630E			
R2/S52	ET RT UMB CLS-OUT DR LATCH CMD 1A		4500X	FA03	J06-017	1-LCH/0-$\overline{\text{LCH}}$
	1B	2	4510X	FA03	J08-017	↓
	2A		4520X	FA02	J08-017	
	↓ 2B		4530X	FA02	J06-017	
	ET RT UMB CLS-OUT DR REL CMD 1A		4600E			1-REL/0-$\overline{\text{REL}}$
	1B	5	4610E			↓
	2A		4620E			
	↓ 2B		4630E ↓			

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM ET UMB MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V56X1205X	ET UMB DOOR LATCH 1 STOWED 1	0	0	1	1					STATE
V56X1215X	ET UMB DOOR LATCH 1 STOWED 2	0	0	1	1					
V56X1255X	ET UMB DOOR LATCH 1 LOCKED 1	0	0	1	1					
V56X1265X	ET UMB DOOR LATCH 1 LOCKED 2	0	0	1	1					
V56X1305X	ET UMB DOOR LATCH 2 STOWED 1	0	0	1	1					
V56X1315X	ET UMB DOOR LATCH 2 STOWED 2	0	0	1	1					
V56X1355X	ET UMB DOOR LATCH 2 LOCKED 1	0	0	1	1					
V56X1365X	ET UMB DOOR LATCH 2 LOCKED 2	0	0	1	1					
V56X3010X	ET LF UMB CLOSEOUT DOOR OPEN 1	1	1	0	0					
V56X3015X	ET LF UMB CLOSEOUT DOOR OPEN 2	1	1	0	0					
V56X3110X	ET LF UMB CLOSEOUT DOOR CLOSED 1	0	0	1	1					
V56X3115X	ET LF UMB CLOSEOUT DOOR CLOSED 2	0	0	1	1					
V56X3550X	ET LF UMB CLOSEOUT DOOR LATCHED 1	0	0	1	1					
V56X3560X	ET LF UMB CLOSEOUT DOOR LATCHED 2	0	0	1	1					
V56X3650X	ET LF UMB CLOSEOUT DOOR RELEASED 1	1	1	0	0					
V56X3660X	ET LF UMB CLOSEOUT DOOR RELEASED 2	1	1	0	0					
V56X4010X	ET RT UMB CLOSEOUT DOOR OPEN 1	1	1	0	0					
V56X4015X	ET RT UMB CLOSEOUT DOOR OPEN 2	1	1	0	0					
V56X4110X	ET RT UMB CLOSEOUT DOOR CLOSED 1	0	0	1	1					
V56X4115X	ET RT UMB CLOSEOUT DOOR CLOSED 2	0	0	1	1					
V56X4550X	ET RT UMB CLOSEOUT DOOR LATCHED 1	0	0	1	1					
V56X4560X	ET RT UMB CLOSEOUT DOOR LATCHED 2	0	0	1	1					
V56X4650X	ET RT UMB CLOSEOUT DOOR RELEASED 1	1	1	0	0					
V56X4660X	ET RT UMB CLOSEOUT DOOR RELEASED 2	1	1	0	0					STATE

APPENDIX D

ET SEP PYROS MATH MODEL REQUIREMENTS

CONTENTS

1. INTRODUCTION

The GN&C Test Station (GTS) uses math models to simulate many of the Shuttle systems for which hardware has not been provided. A group of these models are termed "non-avionic" models since they do not simulate the Shuttle's "avionic" systems. The "non-avionic" models are needed to supply data for on-board software processing and to respond to Shuttle commands, whether they be from cockpit switches, the General Purpose Computers (GPC's) or the Non-Avionic Simulator (NAS) console.

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in table 1 to produce values for the output measurements listed in table 2 that simulate the operation of the ET SEP PYROS.

2.1 MATH MODEL DESCRIPTION

This model simulates the functions of the ET/Orbiter Forward Separation Pyro, namely: ARM and FIRE. The rear separation pyros are not part of this model because they exist in the Mission Events Controller (MEC) in the Flight System.

2.2 STS UNIQUE REQUIREMENTS

This model is not required for STS.

2.3 GTS UNIQUE REQUIREMENTS

This model is required for GTS only.

3. MATH MODEL LOGIC

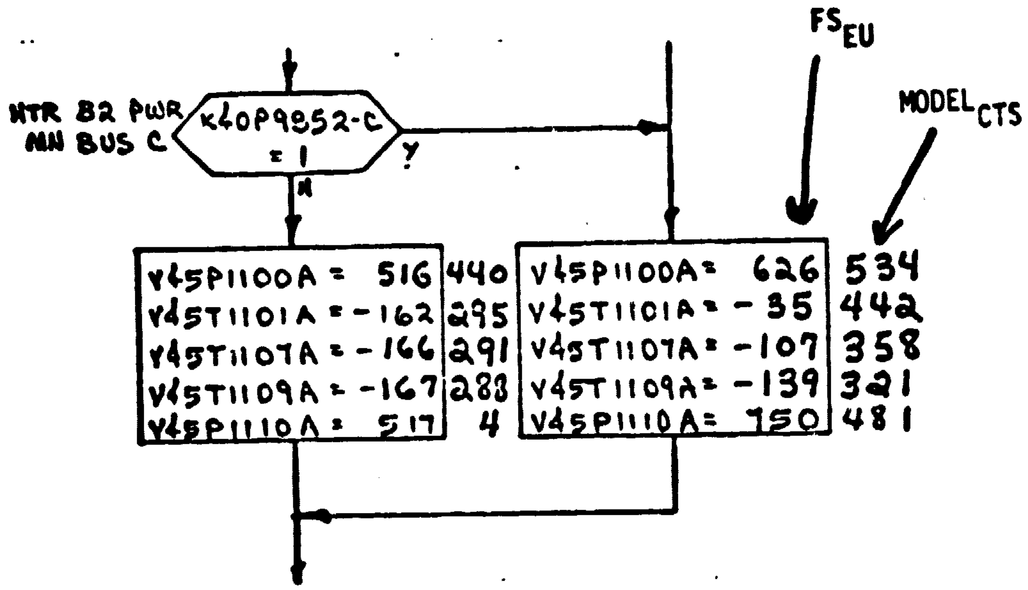
This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

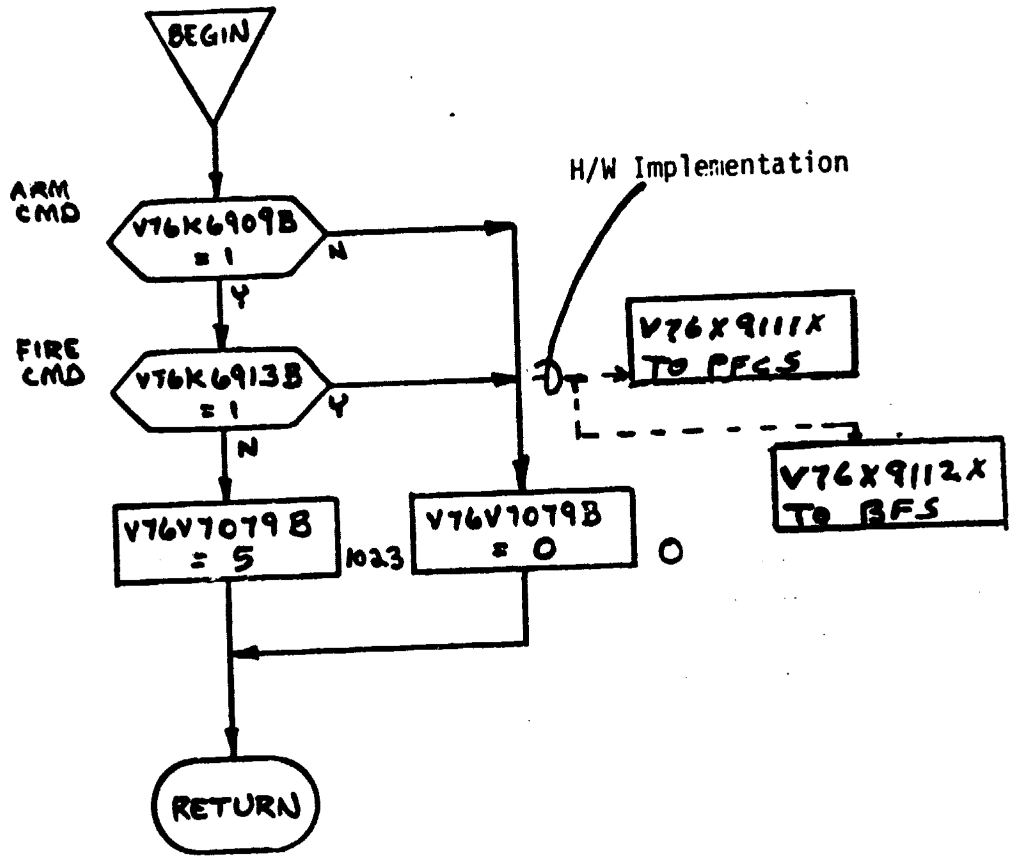
NONE

3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;



shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.



NOTE: Pyro math model output of Pyro System A is also routed to the BFS to satisfy Pyro System B interface with the BFS.

4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

TABLE 1 - STIMULI INPUT FOR ET

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	NAS SOURCE	STATE
C3A7/S3	ET/ORB FWD SEP ARM CMD	2	V76K6909B	MEC 1	1-ARM/0-$\overline{\text{ARM}}$
C3A7/S4	ET/ORB FWD SEP FIRE 1 CMD	2	V76K6913B	MEC 1	1-FIRE/0-$\overline{\text{FIRE}}$

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM ET SEP MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 K=1 (NOMINAL)		VALUE 2 K=2 (HI/LOW)		VALUE 3 K=3 (OFF)		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
*V76V7079B	ET/ORB FWD PIC SEP A CAP VOLT	0	0	5	1023					VDC

*NOTE: This measurement uses the range limit conversion method of calculating FS_{EU}.

APPENDIX E

MPS PLUMBING MATH MODEL REQUIREMENTS

CONTENTS

FIGURES

1. INTRODUCTION

This model simulates those functions of the Main Propulsion System (MPS) components that are in the Orbiter, namely valve positions, system pressures, and system temperatures. To simplify the model, only those component functions needed to support testing of the Shuttle Avionics System are provided.

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in table 1 to produce values for the output measurements listed in table 2 that simulate the operation of the MPS. Figures 1 and 2 are simplified schematics of the Orbiter portion of the MPS and are included in this requirements document for reference.

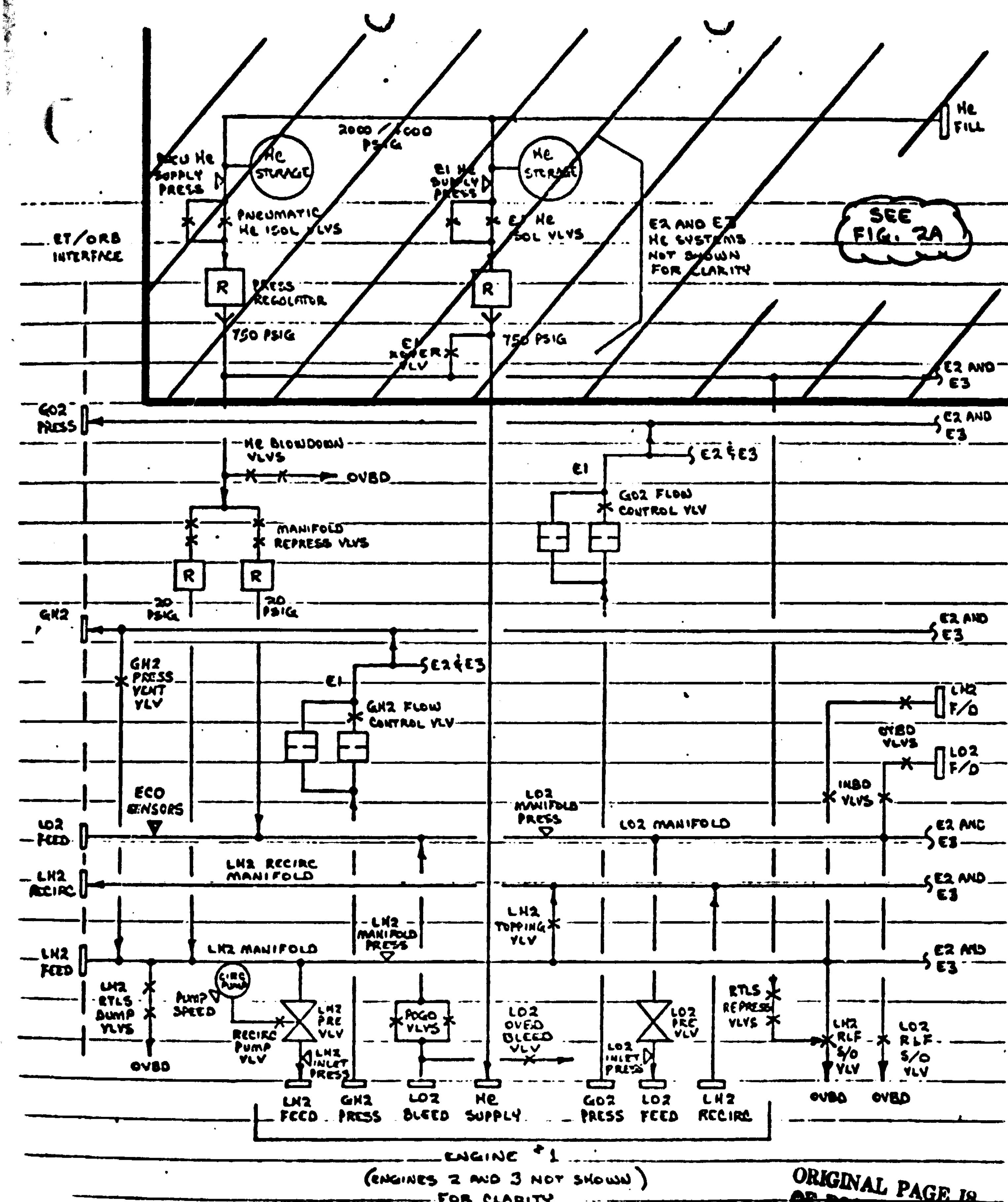
2.1 MATH MODEL DESCRIPTION

The helium supply pressures (HE1, HE2, HE3, and HE4) are used to establish the pressure levels in the helium system. These pressures are transmitted to the Flight System as well as used in the model to determine if pneumatic valves can or cannot be activated.

The valves in the model are of three types: normally open, normally closed, and latching. The normally open valve remains open unless there is pneumatic pressure and a close command present in which case the valve closes. The normally closed valve remains closed unless there is pneumatic pressure and an open command present in which case the valve opens. The latching valve remains in either the open or close state depending on its last command, unless there is pneumatic pressure and a command for it to go to its opposite state. These three types of valve actions are shown in the logic flow chart routines titled, Normally Open Valve Routine (NOVR), Normally Closed Valve Routine (NCVR), and Latching Valve Routine (LVR).

2.1.1 HELIUM SUPPLY PRESSURE

A mission phase dependent variable in the Orbiter portion of the MPS is helium supply pressure. To avoid complexity in the model, the change of helium pressure to account for the operation of pneumatic valves and engine purging was not incorporated into the flowchart logic. Instead, it is intended that the test operator transmit new pressure values to the model at



ORBITER PART OF MAIN PROPULSION SYSTEM

FIGURE 1

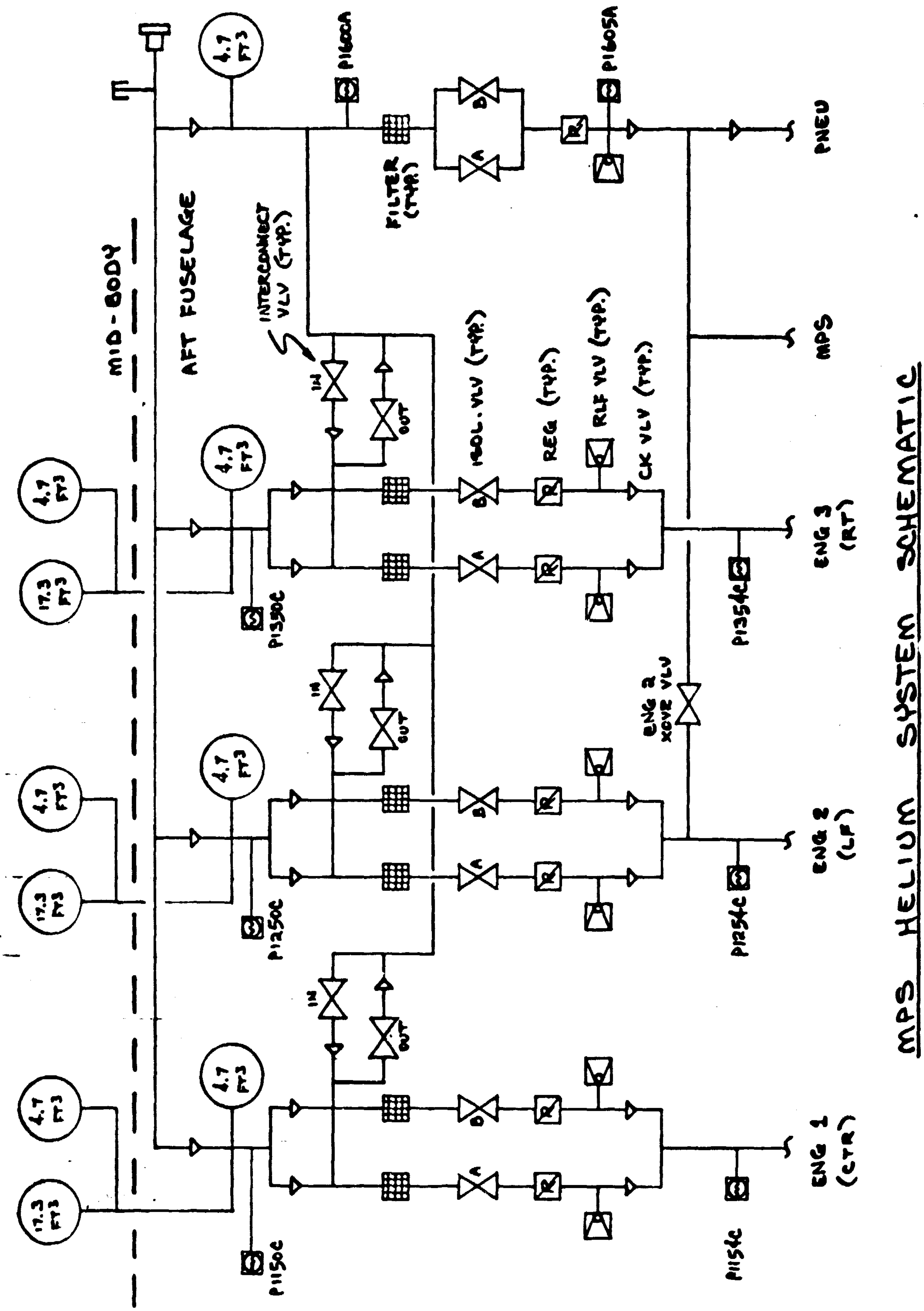

MPS HELIUM SYSTEM SCHEMATIC
MID-BODY
AFT FUSELAGE
4.7 FT3
17.3 FT3
P1600A
P1605A
FILTER (TYP.)
INTERCONNECT VLV (TYP.)
ISOL. VLV (TYP.)
REG (TYP.)
RLF VLV (TYP.)
CK VLV (TYP.)
IN
OUT
A
B
R
P1150C
P1250C
P1350C
P1154C
P1254C
P1354C
ENG 2 XOVR VLV
ENG 1 (CTR)
ENG 2 (LF)
ENG 3 (RT)
MPS
PNEU

FIGURE 2

appropriate times. A suggested set of pressure values for a nominal mission are as follows:

PHASE	PRESSURE VALUE (PSIA)
Prelaunch	2,000
Launch	4,000
Orbit	1,500
Reentry	1,000
Landing	500

Accounting for pressure usage during the mission is more for data realism than to satisfy avionics test requirements. The helium supply pressure might just as well remain fixed at 4,000 psia.

2.1.2 MODEL INITIALIZATION

The initial conditions column in the measurements table indicates the state of the model prior to configuring for LH2 and LO2 fill operations and is for reference only. The output measurement values of the model shall reflect the state of the input stimuli when the model is made active.

2.1.3 TIMERS

Two timers called "COUNTER" and "KOUNTER" are used in the LO2 and LH2 manifold pressure subroutines. The timers provide a delay before manifold pressures are set to zero. This simulates the time interval during which 20 psig helium pressure is forcing residual liquid propellants out of the manifolds following external tank separation.

The timer limits are LDT (LO2 Dump Time) and HDT (LH2 Dump Time) which are initialized, but may be changed by the test operator.

2.1.4 FLAGS

The variable in the flow diagram named TST is a unique type of variable since it's function is to convey which part of the flow diagram applies to the STS configuration and which part applies to the GTS configuration. TST is not to be implemented in the model, but is to be interpreted by the implementer as to which paths of the flow diagram are unique to STS and which paths are unique to GTS.

Logic flows unique to STS are indicated by TST=1, while logic flows unique to GTS are indicated by TST=0.

Flags or pseudos that are used for purposes internal to the model are defined as follows:

D - Indicates valve position of the designated valve in the LVR, NCVR, and NOVR subroutines.

A,B - Indicate valve stimuli for the designated valve in the LVR, NCVR, and NOVR subroutines.

D1 thru D13 - Indicates the latching valve position for:

D1 - LO2 Feed Disconnect Valve
D2 - LH2 Feed Disconnect Valve
D3 - LH2 Recirculation Disconnect Valve
D4 - LO2 Outboard Fill and Drain Valve
D5 - LO2 Inboard Fill and Drain Valve
D6 - LH2 Outboard Fill and Drain Valve
D7 - LH2 Inboard Fill and Drain Valve
D8 - Engine 1 LO2 Prevalve
D9 - Engine 2 LO2 Prevalve
D10 - Engine 3 LO2 Prevalve
D11 - Engine 1 LH2 Prevalve
D12 - Engine 2 LH2 Prevalve
D13 - Engine 3 LH2 Prevalve

2.1.5 MPS PROPELLANT DUMP SIGNALS

Following Main Engine Cut-Off or External Tank separation, an LO2 signal, an LH2 signal, and an RTLS signal are needed by the Vehicle Dynamics Math Models to compute the changes in vehicle forces and mass properties while MPS residual propellants are discharged overboard. The three signals are generated in the MPS math model and are identified as follows:

LO2DP	LO2 DUMP SIGNAL
LH2DP	LH2 DUMP SIGNAL
RTLSDP	RTLS DUMP SIGNAL

A state of (1) indicates a dump is in progress. These signals will be output by the MPS model and will be transmitted to the VDS math models.

2.1.5 INITIAL CONDITIONS

Note that initial conditions for STS are the same as those listed for GTS; see GTS PREPROCESSOR LOGIC.

2.2 STS UNIQUE REQUIREMENTS

2.2.1 PREVALVE INHIBIT

In order to properly configure the logic flow diagram for STS, the value for the variable named TST should be 1.

2.2.2 EXTERNAL INPUTS AND OUTPUTS

The model receives stimuli from three sources: (1) the Flight System; (2) the Marshall Mated Elements Simulator (MMES); and (3) the test operator. The model transmits parameter values to the Flight System and the MMES. Tables 1 and 2 list the input stimuli and the output measurements, respectively.

The model generates three engines ready for firing discretes (one per engine) which are transmitted to the MMES as a valve status signal prior to engine firing.

2.3 GTS UNIQUE REQUIREMENTS

2.3.1 PREPROCESSOR LOGIC

The MPS math model was originally written for the STS simulator. The math model input stimuli symbols referred to the logic flow diagram, Section 3.2, are ATA Reference connector and pin numbers. Due to the lack of flight hardware circuitry in the GTS simulator, logic functions that bridge the gap between the payload MDM's and the MPS are required in a GTS preprocessor in order to evaluate values for the input stimuli coming from the GPC prior to execution of the model.

2.3.2 PREVALVE INHIBIT

In order to properly configure the logic flow diagram for GTS, the value for the variable named TST should be 0. A subroutine called Engine Prevalve Routine (EPR) was added to the math model to accommodate the Mainstage stimuli provided by the Flight System in GTS. The Mainstage stimuli prevent closing of the engine prevalves while the engine is ignited.

2.3.3 DISCRETE STIMULI MONITORING

The following discrete stimuli from the Flight System are not used in the GTS logic flow diagrams but are to be displayed to the NAS console operator for monitoring:

MML NUMBER	NOMENCLATURE
V41K1700X	REPLACE LH2 ULLAGE PRESS XDCR #1
V41K1701X	REPLACE LH2 ULLAGE PRESS XDCR #2
V41K1702X	REPLACE LH2 ULLAGE PRESS XDCR #3
V41K1750X	REPLACE LO2 ULLAGE PRESS XDCR #1
V41K1751X	REPLACE LO2 ULLAGE PRESS XDCR #2
V41K1752X	REPLACE LO2 ULLAGE PRESS XDCR #3

2.3.4 EXTERNAL INPUTS AND OUTPUTS

The model receives stimuli from two sources: (1) the Flight System; (2) the test operator. Tables 1 and 2 list the input stimuli and the output measurements, respectively.

Discrete stimulus K50P721-A shall be generated by the Non-Avionic Simulator (NAS) console operator to simulate a ground command to the LH2 RECIRC PUMPS during prelaunch checkout. In STS this signal comes from the flight system.

3. MATH MODEL LOGIC

This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

The basic input stimuli to the model are identified by ATA reference system connector-pin (CP) numbers. A logical combination of one or more MML numbers is used to derive the proper input stimulus for each CP. Within the STS, the logical combination is accomplished via hardware circuitry. However, within the GTS, due to the absence of the required circuitry, the logical relations between CP and MML must be effected by software. The following logical equations are required as a preprocessor within GTS in order to calculate the correct CP stimuli which are then input to the model. Most equations are merely a direct one-for-one correspondence between CP and MML. However, some equiations may require more than one MML to be combined by the logical product (AND) and the inclusive logical sum (OR). In these instances, "AND" denotes the logical product and "OR" denotes the inclusive logical sum.

The SOURCE columns contain an entry for the MDM, connector end pin from which the MML is received. In the absnece of an entry in these columns, the operator must make the entry via the NAS keyboard.

The final column lists the input stimuli initialization values required. Notice that inputs containing an entry for SOURCE do not have an initialization value, since they are updated at the GTS simulator cycle rate by the source connection.

GTS MATH MODEL STIMULI - MPS

MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN	MML ID	SOURCE* MDM/NAS	SOURCE* CONN/PIN	INITIALIZATION VALUES
REFER TO FLOW DIAGRAM WHICH FOLLOWS, FOR CONN-PIN LOGIC.	V41K1119X	FA03	J06 001	
	V41K1119E	(NAS)	J21 A	
	V41K1120X	FA01	J06 001	
	V41K1120E	(NAS)	J21 B	
	V41K1121X	FA02	J06 001	
	V41K1121E	(NAS)	J21 C	
	V41K1122X	FA03	J06 001	
	V41K1122E	(NAS)	J21 D	
	V41K1123X	FA01	J06 009	
	V41K1123E	(NAS)	J21 E	
	V41K1124X	FA02	J06 009	
	V41K1124E	(NAS)	J21 F	
	V41K1125X	FA01	J06 016	
	V41K1126X	FA02	J06 016	
	V41K1136X	FA03	J06 025	
	V41K1136E	(NAS)	J20 c	
	V41K1137X	FA01	J06 025	
	V41K1137E	(NAS)	J20 d	
	V41K1138X	FA02	J06 025	
	V41K1138E	(NAS)	J20 e	
	V41K1139X	FA03	J06 018	
	V41K1139E	(NAS)	J20 f	
	V41K1140X	FA01	J06 018	
	V41K1140E	(NAS)	J20 g	
	V41K1141X	FA02	J06 018	
	V41K1141E	(NAS)	J20 h	
	V41K1155E	(NAS)	J14 N	
	V41K1156E	(NAS)	J14 R	
	V41K1157E	(NAS)	J14 T	
	V41K1165E	(NAS)	J14 P	
	V41K1166E	(NAS)	J14 S	

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.

**ARTIFICAL MML ID's ARE TO BE SUPPLIED BY PROGRAMMER.

SYSTEM CONN-PIN	MML ID	SOURCE*			INITIALIZATION VALUES
		MDM/NAS	CONN/PIN		
REFER TO FLOW DIAGRAM WHICH FOLLOWS, FOR CONN-PIN LOGIC.	V41K1167E	(NAS)	J14	U	
	V41K1219X	FA01	J08	001	
	V41K1219E	(NAS)	J21	G	
	V41K1220X	FA02	J08	001	
	V41K1220E	(NAS)	J21	H	
	V41K1221X	FA04	J08	001	
	V41K1221E	(NAS)	J21	J	
	V41K1222X	FA01	J08	009	
	V41K1222E	(NAS)	J21	K	
	V41K1223X	FA02	J08	009	
	V41K1223E	(NAS)	J21	L	
	V41K1224X	FA04	J08	009	
	V41K1224E	(NAS)	J21	M	
	V41K1225X	FA02	J08	016	
	V41K1226X	FA03	J08	016	
	V41K1236X	FA01	J08	025	
	V41K1236E	(NAS)	J20	i	
	V41K1237X	FA02	J08	025	
	V41K1237E	(NAS)	J20	j	
	V41K1238X	FA03	J08	025	
	V41K1238E	(NAS)	J20	k	
	V41K1239X	FA01	J08	018	
	V41K1239E	(NAS)	J20	m	
	V41K1240X	FA02	J08	018	
	V41K1240E	(NAS)	J20	n	
	V41K1241X	FA03	J08	018	
	V41K1241E	(NAS)	J20	p	
	V41K1255E	(NAS)	J14	V	
	V41K1256E	(NAS)	J14	X	
	V41K1257E	(NAS)	J14	Z	

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.

**ARTIFICAL MML ID's ARE TO BE SUPPLIED BY PROGRAMMER.

GTS MATH MODEL STIMULI - MPS

MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN	MML ID	SOURCE* MDM/NAS	SOURCE* CONN/PIN		INITIALIZATION VALUES
REFER TO FLOW DIAGRAM WHICH FOLLOWS, FOR CONN-PIN LOGIC.	V41K1265E	(NAS)	J14	W	
	V41K1266E	(NAS)	J14	Y	
	V41K1267E	(NAS)	J14	a	
	V41K1319X	FA02	J08	099	
	V41K1319E	(NAS)	J21	N	
	V41K1320X	FA04	J08	099	
	V41K1320E	(NAS)	J21	P	
	V41K1321X	FA01	J08	099	
	V41K1321E	(NAS)	J21	R	
	V41K1322X	FA02	J08	109	
	V41K1322E	(NAS)	J21	S	
	V41K1323X	FA04	J08	109	
	V41K1323E	(NAS)	J21	T	
	V41K1324X	FA01	J08	109	
	V41K1324E	(NAS)	J21	U	
	V41K1325X	FA04	J08	116	
	V41K1326X	FA01	J08	116	
	V41K1336X	FA02	J08	115	
	V41K1336E	(NAS)	J20	q	
	V41K1337X	FA04	J08	115	
	V41K1337E	(NAS)	J20	r	
	V41K1338X	FA01	J08	115	
	V41K1338E	(NAS)	J20	s	
	V41K1339X	FA02	J08	097	
	V41K1339E	(NAS)	J20	t	
	V41K1340X	FA04	J08	097	
	V41K1340E	(NAS)	J20	u	
	V41K1341X	FA01	J08	097	
	V41K1341E	(NAS)	J20	v	
	V41K1355E	(NAS)	J14	b	

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.

**ARTIFICAL MML ID's ARE TO BE SUPPLIED BY PROGRAMMER.

GTS MATH MODEL STIMULI - MPS
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN	MML ID	SOURCE* MDM/NAS	SOURCE* CONN/PIN		INITIALIZATION VALUES
REFER TO FLOW DIAGRAM WHICH FOLLOWS, FOR CONN-PIN LOGIC.	V41K1356E	(NAS)	J14	d	
	V41K1357E	(NAS)	J14	f	
	V41K1365E	(NAS)	J14	c	
	V41K1366E	(NAS)	J14	e	
	V41K1367E	(NAS)	J14	g	
	V41K1391X	FA02	J08	110	
	V41K1391E	(NAS)	J20	T	
	V41K1393X	FA02	J08	098	
	V41K1393E	(NAS)	J20	U	
	V41K1401X	FA02	J08	031	
	V41K1401E	(NAS)	J20	V	
	V41K1402X	FA03	J08	031	
	V41K1408E	*			0
	V41K1411X	FA01	J06	021	
	V41K1412X	FA01	J08	021	
	V41K1412E	(NAS)	J20	Y	
	V41K1413X	FA03	J06	032	
	V41K1414X	FA04	J06	032	
	V41K1415X	FA02	J06	032	
	V41K1416X	FA03	J06	021	
	V41K1417X	FA04	J06	021	
	V41K1418X	FA02	J06	021	
	V41K1421X	FA04	J06	009	
	V41K1422X	FA04	J06	031	
	V41K1431E	(NAS)	J20	G	
	V41K1432E	*			0
	V41K1435X	FA01	J06	027	
	V41K1435E	(NAS)	J20	E	
	V41K1437X	FA02	J06	027	
	V41K1443E	(NAS)	J21	Z	

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.

**ARTIFICAL MML ID's ARE TO BE SUPPLIED BY PROGRAMMER.

SYSTEM CONN-PIN	MML ID	SOURCE* MDM/NAS	SOURCE* CONN/PIN	INITIALIZATION VALUES
REFER TO FLOW DIAGRAM WHICH FOLLOWS, FOR CONN-PIN LOGIC.	V41K1447X	FA03	J08 008	
	V41K1447E	(NAS)	J21 b	
	V41K1448X	FA04	J08 008	
	V41K1465E	*		1
	V41K1501X	FA01	J08 018	
	V41K1501E	(NAS)	J20 P	
	V41K1502X	FA04	J08 031	
	V41K1512X	FA02	J08 105	
	V41K1512E	(NAS)	J20 S	
	V41K1515X	FA04	J08 018	
	V41K1515E	(NAS)	J20 N	
	V41K1518X	FA04	J08 025	
	V41K1518E	(NAS)	J20 M	
	V41K1521X	FA03	J08 032	
	V41K1522X	FA04	J08 032	
	V41K1523X	FA02	J08 032	
	V41K1524X	FA03	J08 021	
	V41K1525X	FA04	J08 021	
	V41K1526X	FA02	J08 021	
	V41K1531E	(NAS)	J20 C	
	V41K1532E	*		0
	V41K1535X	FA03	J08 027	
	V41K1535E	(NAS)	J20 E	
	V41K1537X	FA04	J08 027	
	V41K1543E	(NAS)	J21 V	
	V41K1547X	FA02	J08 008	
	V41K1547E	(NAS)	J21 X	
	V41K1548X	FA01	J08 008	
	V41K1584X	FA03	J08 106	

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICAL MML ID's ARE TO BE SUPPLIED BY PROGRAMMER.

SYSTEM CONN-PIN	MML ID	SOURCE* MDM/NAS	SOURCE* CONN/PIN	INITIALIZATION VALUES
REFER TO FLOW DIAGRAM WHICH FOLLOWS, FOR CONN-PIN LOGIC.	V41K1585X	FA04	J08 106	
	V41K1586X	FA02	J08 106	
	V41K1607E	(NAS)	J14 j	
	V41K1609E	(NAS)	J14 k	
	V41K1613X	FA02	J08 126	
	V41K1613E	(NAS)	J14 h	
	V41K1619E	(NAS)	J14 i	
	V41K1700X	FA01	J06 031	
	V41K1701X	FA02	J06 031	
	V41K1702X	FA03	J06 031	
	V41K1750X	FA01	J08 125	
	V41K1751X	FA02	J08 125	
	V41K1752X	FA04	J08 125	
	V41K1815X	FA01	J08 122	
	V41K1816X	FA03	J08 122	
	V41K1825X	FA02	J08 122	
	V41K1826X	FA04	J08 122	
	V41K1905X	FA03	J08 105	
	V41K1906X	FA04	J08 016	
	V41K1907X	FA01	J08 105	
	V41K1908X	FA01	J08 016	
	V41K1913X	FA03	J08 098	
	V41K1914X	FA04	J08 098	
	V41K1915X	FA01	J08 098	
	V41K1923X	FA03	J08 110	
	V41K1924X	FA04	J08 110	
	V41K1925X	FA01	J08 110	
	V41K1155X	FA01	J07 029	
	V41K1156X	FA02	J07 029	
	V41K1157X	FA03	J07 029	

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.

**ARTIFICAL MML ID's ARE TO BE SUPPLIED BY PROGRAMMER.

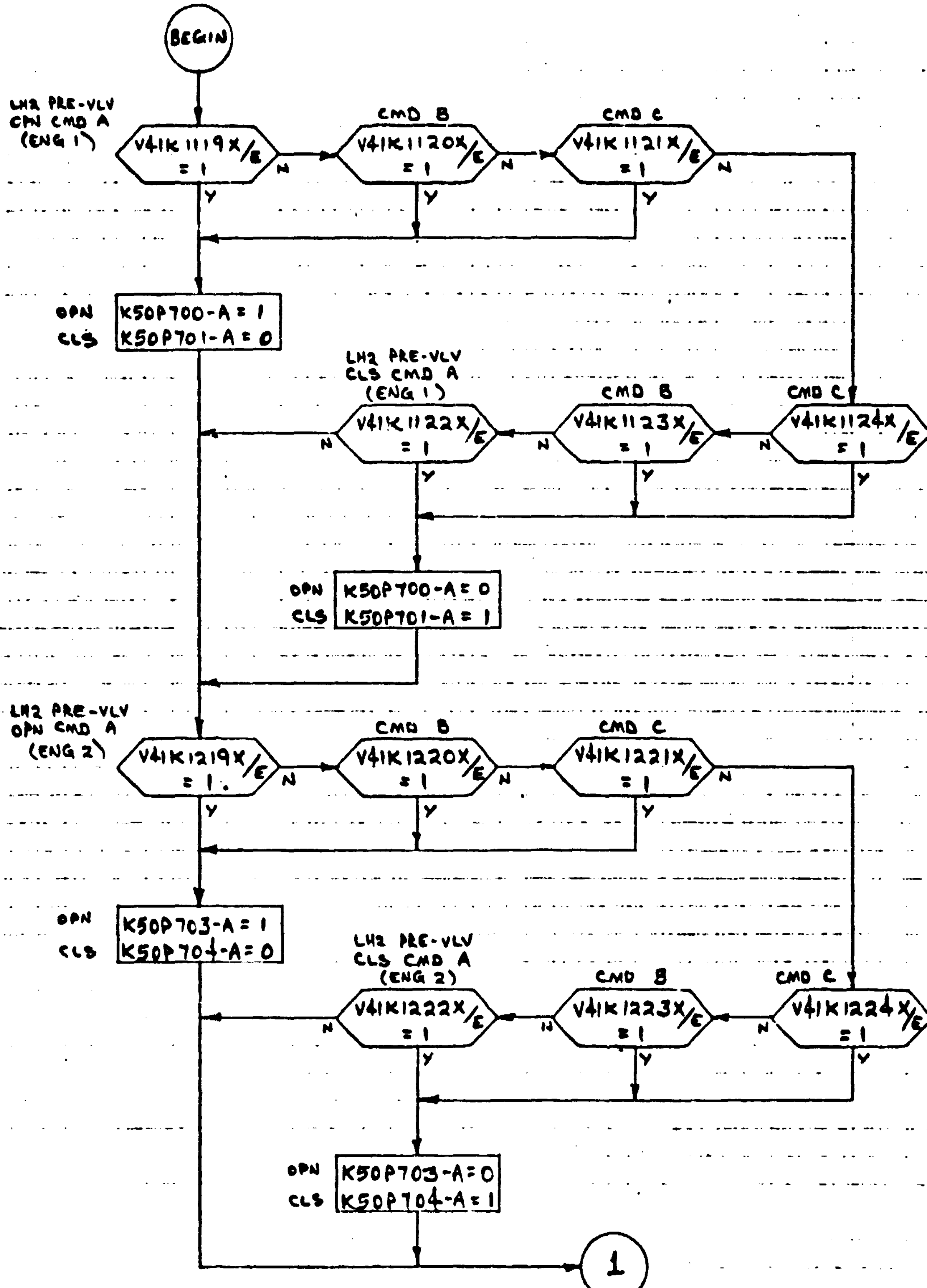
GTS MATH MODEL STIMULI - MPS
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN	MML ID	SOURCE* MDM/NAS	SOURCE* CONN/PIN	INITIALIZATION VALUES
REFER TO FLOW DIAGRAM WHICH FOLLOWS, FOR CONN-PIN LOGIC.	V41K1162X	FA01	J07 014	
	V41K1162E	(NAS)	J14 A	
	V41K1163X	FA02	J07 007	
	V41K1163E	(NAS)	J14 C	
	V41K1168X	FA01	J07 024	
	V41K1168E	(NAS)	J14 B	
	V41K1169E	(NAS)	J14 D	
	V41K1255X	FA02	J07 016	
	V41K1256X	FA04	J07 016	
	V41K1257X	FA01	J07 016	
	V41K1262X	FA02	J07 014	
	V41K1262E	(NAS)	J14 E	
	V41K1263X	FA03	J07 007	
	V41K1263E	(NAS)	J14 G	
	V41K1268X	FA02	J07 024	
	V41K1268E	(NAS)	J14 F	
	V41K1269E	(NAS)	J14 H	
	V41K1355X	FA03	J07 009	
	V41K1356X	FA01	J07 009	
	V41K1357X	FA02	J07 009	
	V41K1362X	FA03	J07 014	
	V41K1362E	(NAS)	J14 J	
	V41K1363X	FA01	J07 007	
	V41K1363E	(NAS)	J14 L	
	V41K1368X	FA04	J07 024	
	V41K1368E	(NAS)	J14 K	
	V41K1369E	(NAS)	J14 M	
	V41K1607X	FA01	J07 028	
	V41K1608X	FA04	J07 029	
	V41K1111N	*		0

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.

**ARTIFICAL MML ID's ARE TO BE SUPPLIED BY PROGRAMMER.

GTS PREPROCESSOR LOGIC



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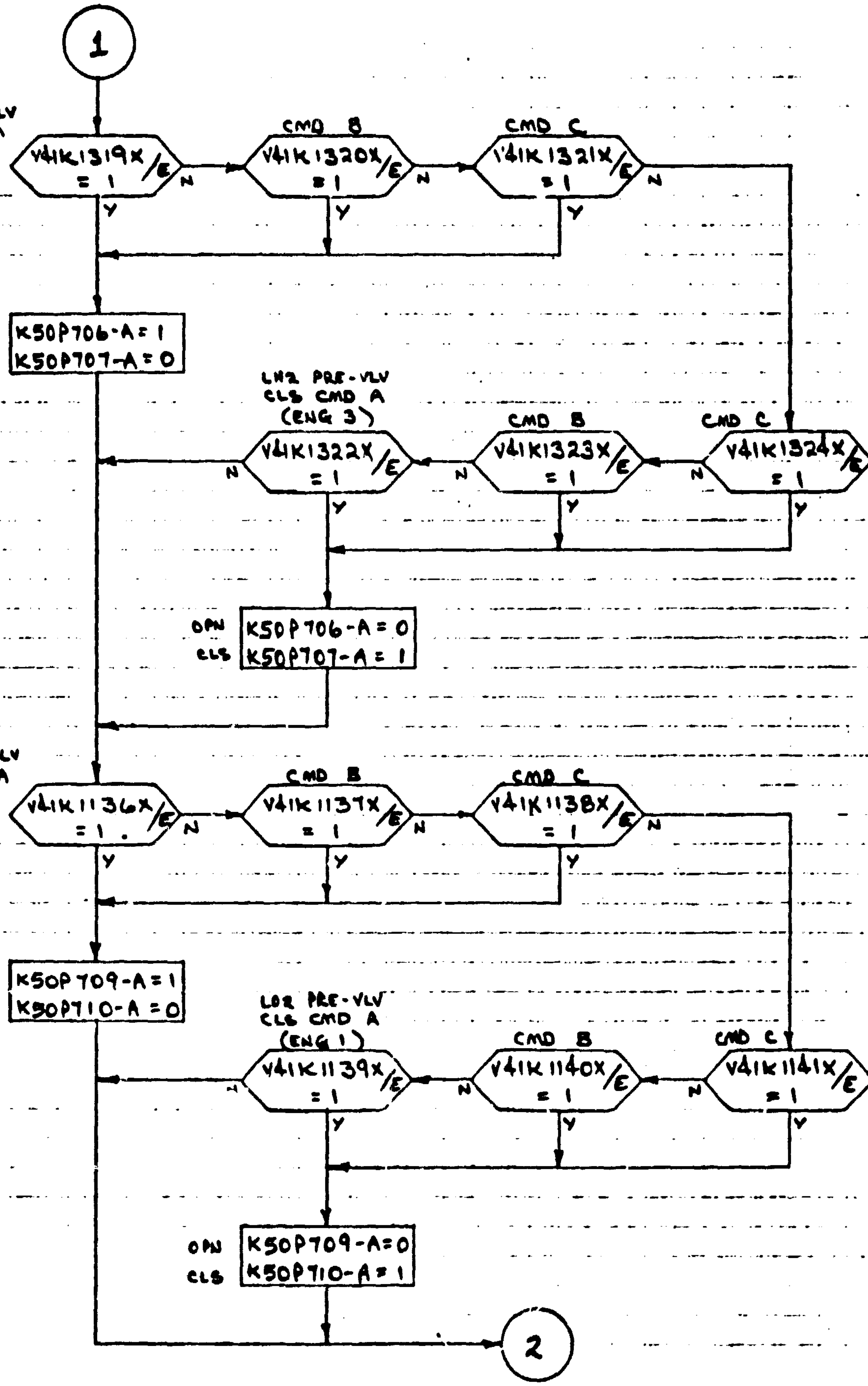
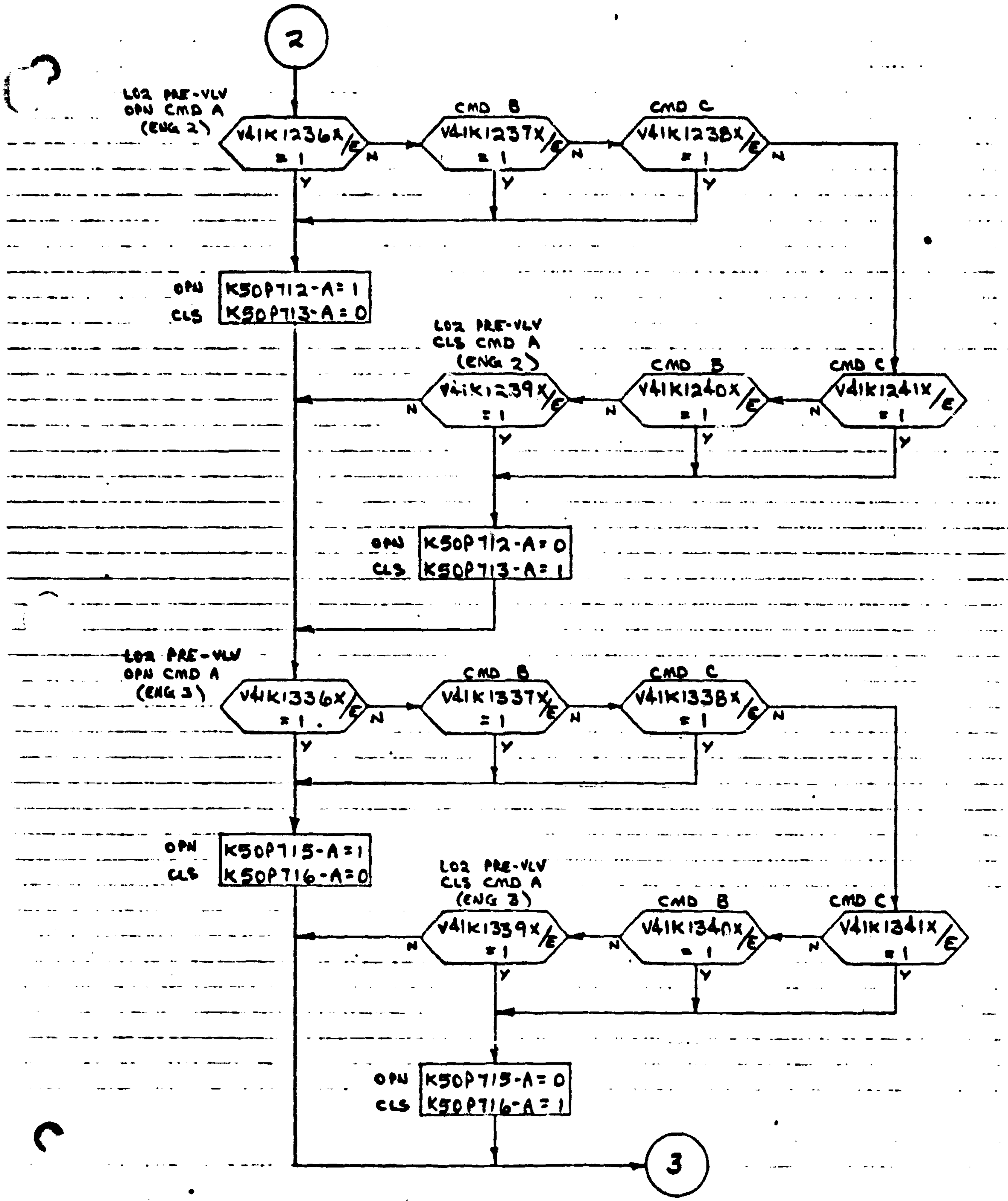
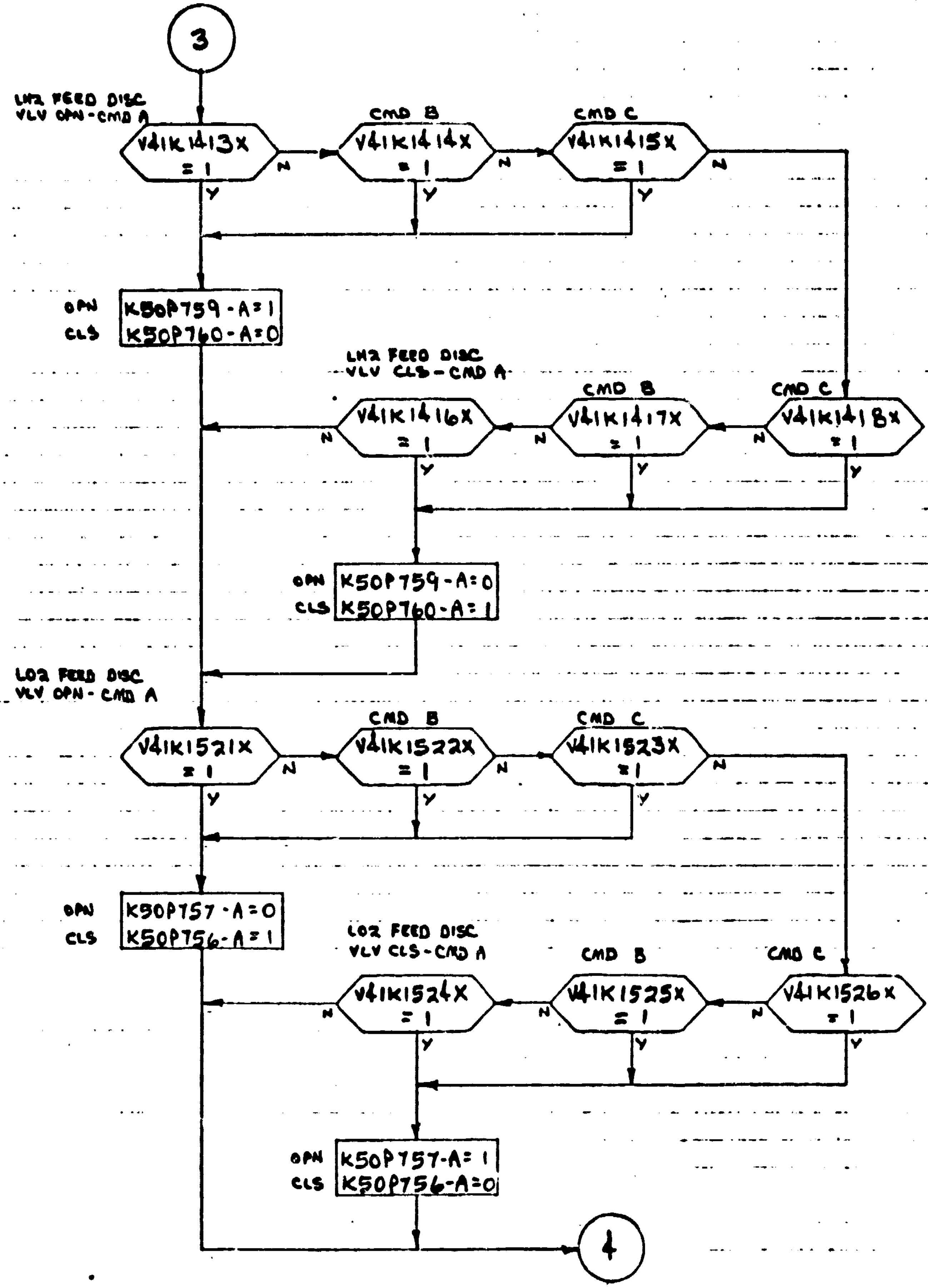
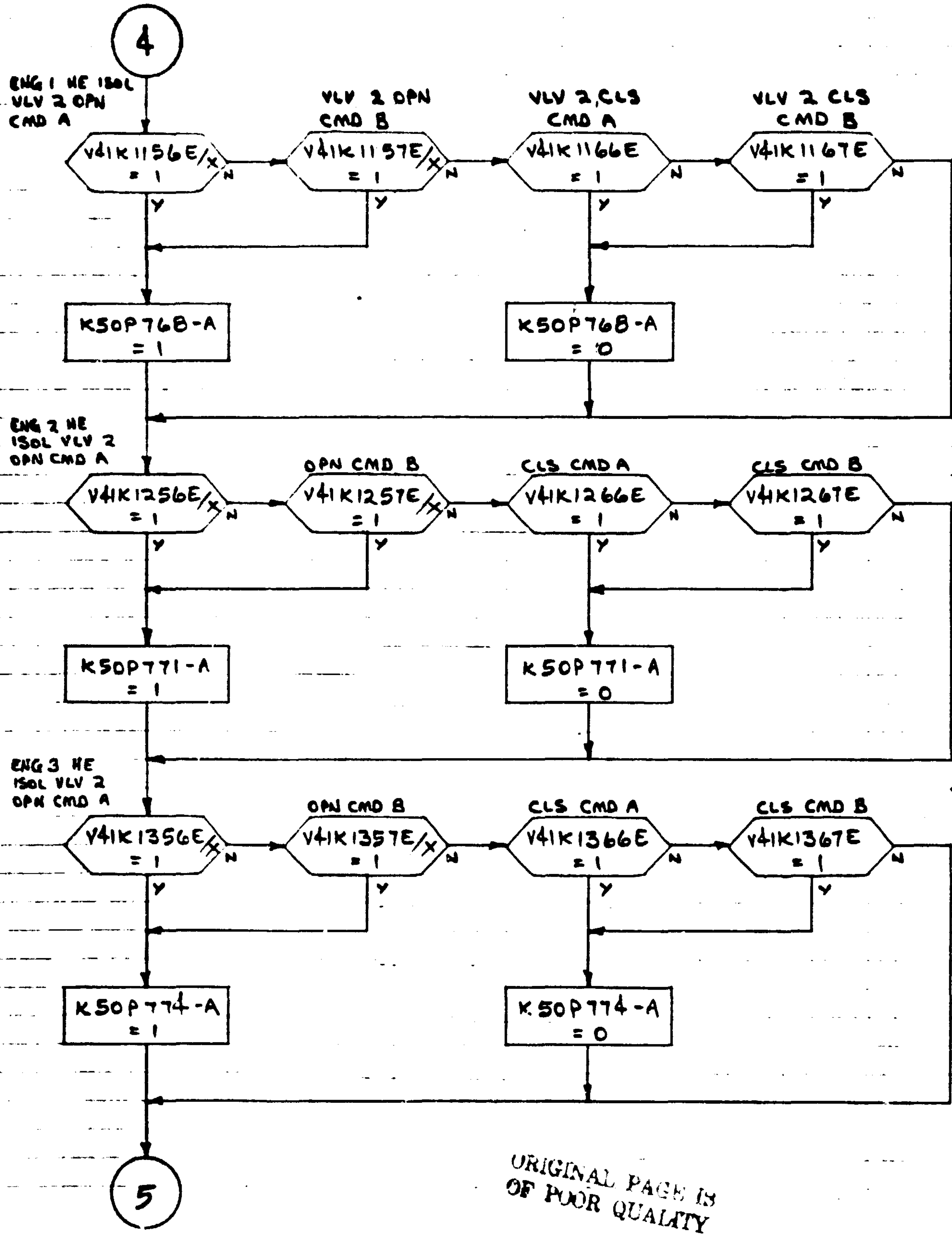

1
LH2 PRE-VLV OPN CMD A (ENG 3)
V41K1319X = 1 /E
CMD B
V41K1320X = 1 /E
CMD C
V41K1321X = 1 /E
N
Y
OPN K50P706-A = 1
CLS K50P707-A = 0
LH2 PRE-VLV CLS CMD A (ENG 3)
V41K1322X = 1 /E
CMD B
V41K1323X = 1 /E
CMD C
V41K1324X = 1 /E
OPN K50P706-A = 0
CLS K50P707-A = 1
LO2 PRE-VLV OPN CMD A (ENG 1)
V41K1136X = 1 /E
CMD B
V41K1137X = 1 /E
CMD C
V41K1138X = 1 /E
OPN K50P709-A = 1
CLS K50P710-A = 0
LO2 PRE-VLV CLS CMD A (ENG 1)
V41K1139X = 1 /E
CMD B
V41K1140X = 1 /E
CMD C
V41K1141X = 1 /E
OPN K50P709-A = 0
CLS K50P710-A = 1
2



2
LO2 PRE-VLV OPN CMD A (ENG 2)
V41K1236X = 1
CMD B
V41K1237X = 1
CMD C
V41K1238X = 1
OPN K50P712-A = 1
CLS K50P713-A = 0
LO2 PRE-VLV CLS CMD A (ENG 2)
V41K1239X = 1
CMD B
V41K1240X = 1
CMD C
V41K1241X = 1
OPN K50P712-A = 0
CLS K50P713-A = 1
LO2 PRE-VLV OPN CMD A (ENG 3)
V41K1336X = 1
CMD B
V41K1337X = 1
CMD C
V41K1338X = 1
OPN K50P715-A = 1
CLS K50P716-A = 0
LO2 PRE-VLV CLS CMD A (ENG 3)
V41K1339X = 1
CMD B
V41K1340X = 1
CMD C
V41K1341X = 1
OPN K50P715-A = 0
CLS K50P716-A = 1
3



3
LH2 FEED DISC VLV OPN-CMD A
V41K1413X = 1
CMD B
V41K1414X = 1
CMD C
V41K1415X = 1
N
Y
OPN K50P759-A=1
CLS K50P760-A=0
LH2 FEED DISC VLV CLS-CMD A
V41K1416X = 1
CMD B
V41K1417X = 1
CMD C
V41K1418X = 1
OPN K50P759-A=0
CLS K50P760-A=1
LO2 FEED DISC VLV OPN-CMD A
V41K1521X = 1
CMD B
V41K1522X = 1
CMD C
V41K1523X = 1
OPN K50P757-A=0
CLS K50P756-A=1
LO2 FEED DISC VLV CLS-CMD A
V41K1524X = 1
CMD B
V41K1525X = 1
CMD C
V41K1526X = 1
OPN K50P757-A=1
CLS K50P756-A=0
4



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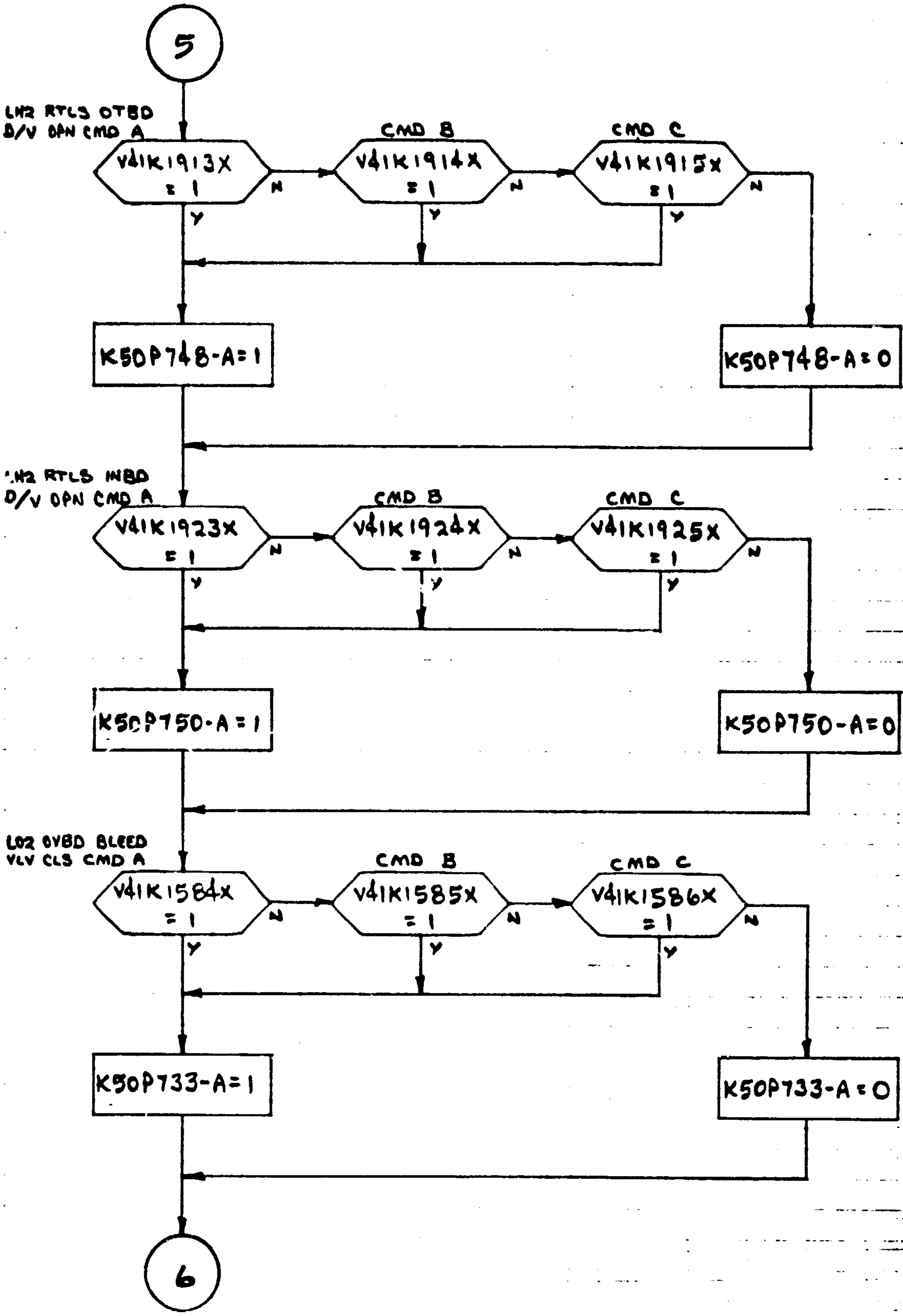
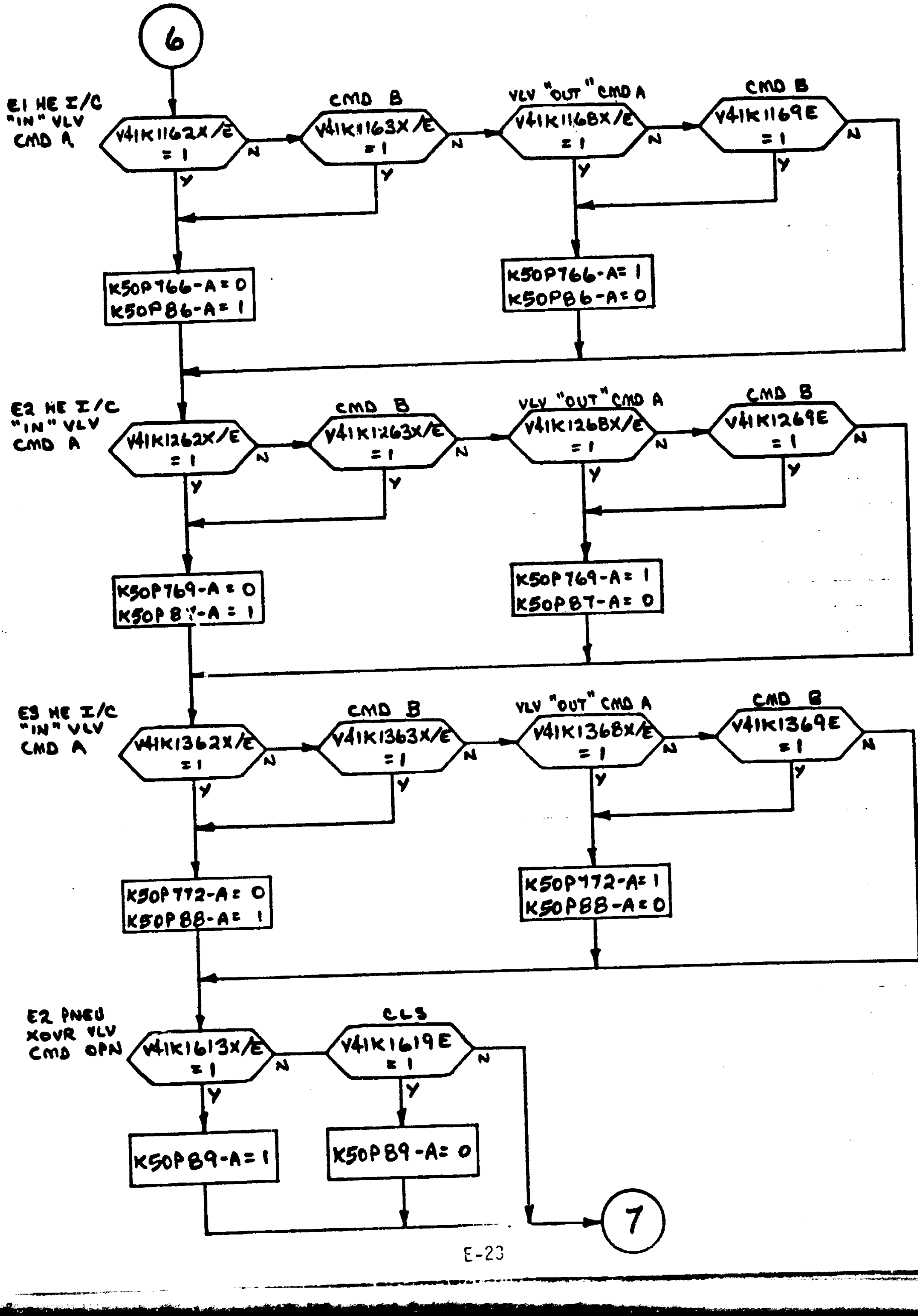
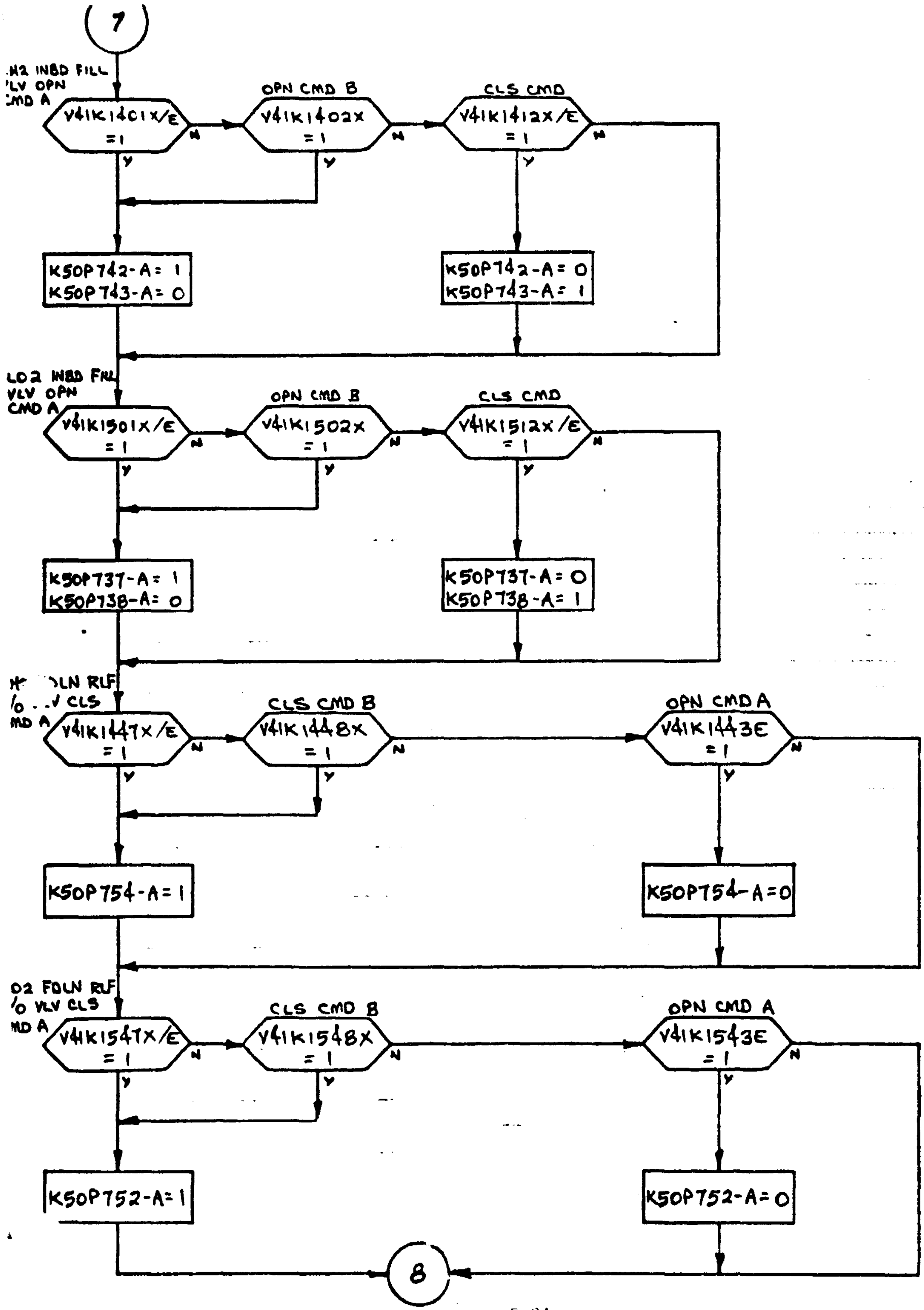
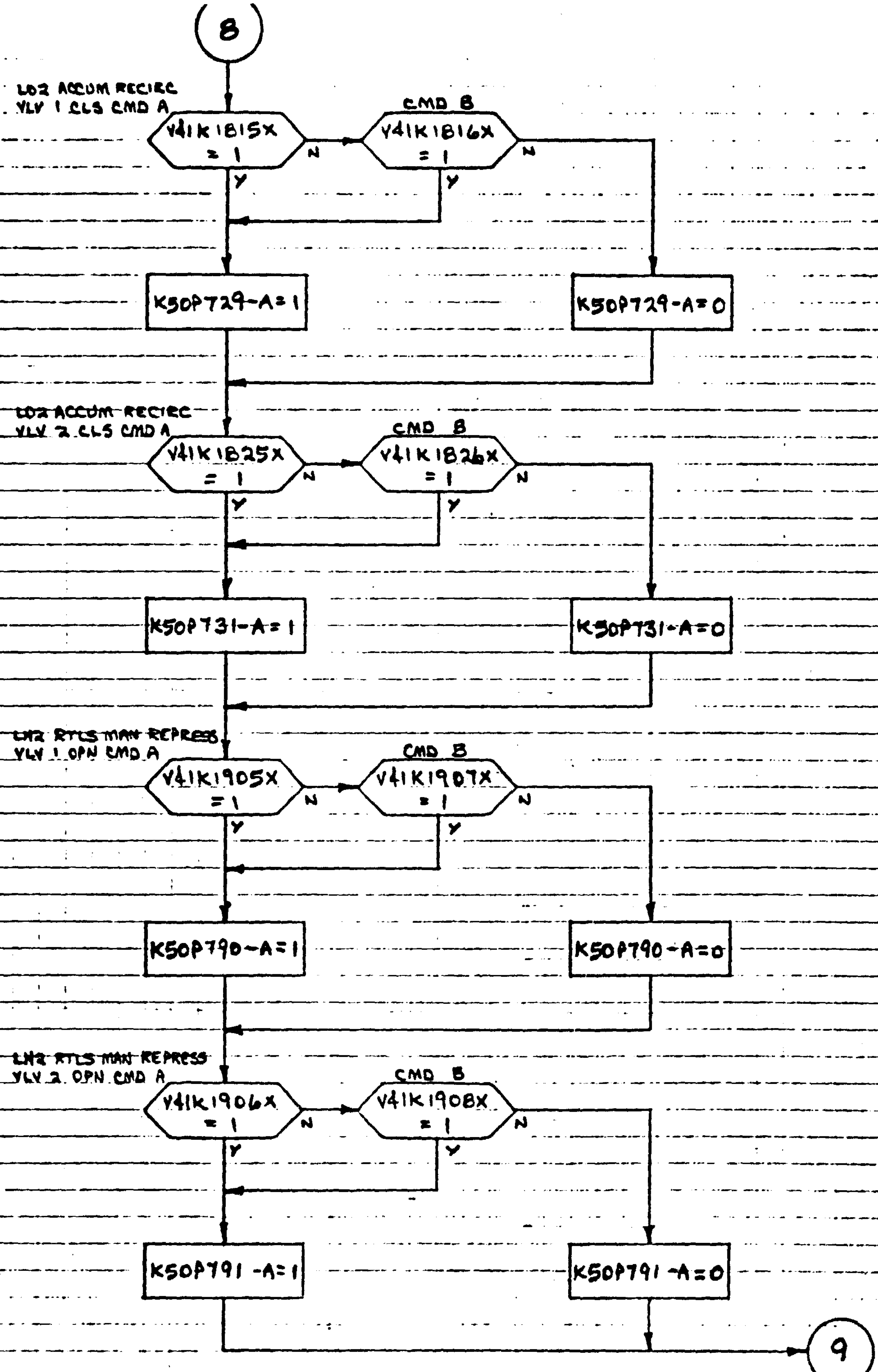
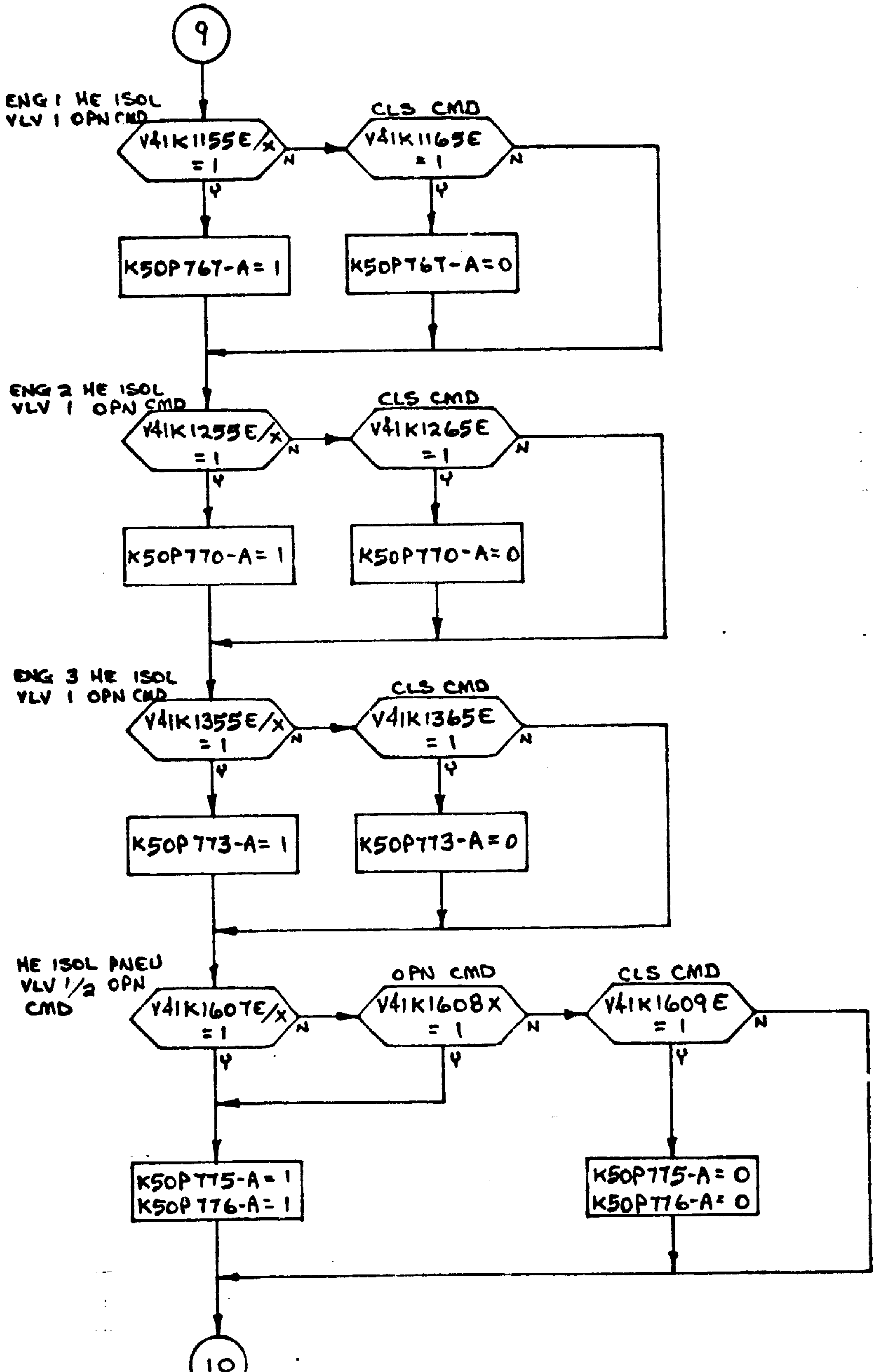
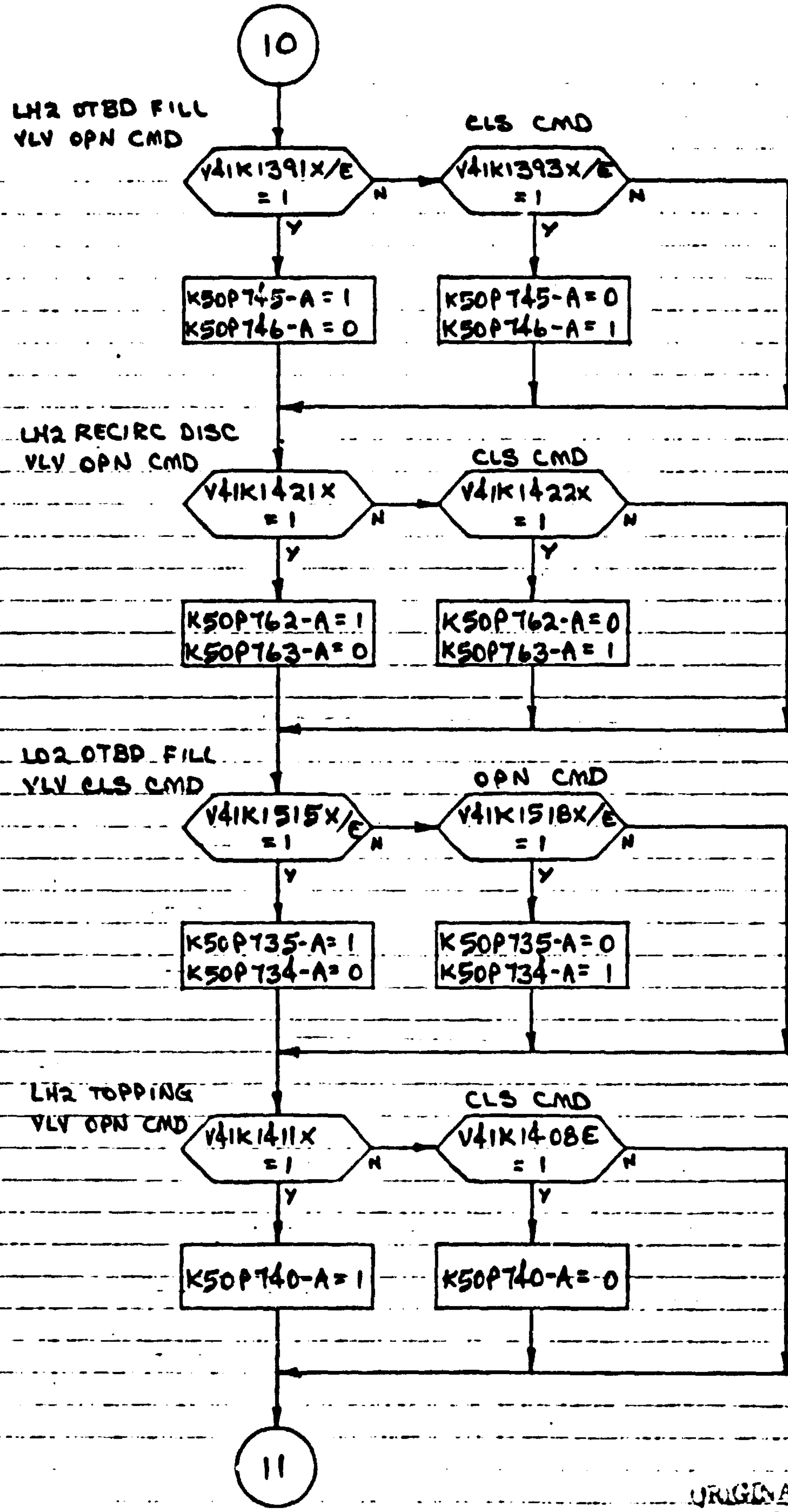

5
LH2 RTLS OTBD
D/V OPN CMD A
V41K1913X = 1
CMD B
V41K1914X = 1
CMD C
V41K1915X = 1
N
Y
K50P748-A=1
K50P748-A=0
LH2 RTLS INBD
D/V OPN CMD A
V41K1923X = 1
CMD B
V41K1924X = 1
CMD C
V41K1925X = 1
K50P750-A=1
K50P750-A=0
LO2 OVBD BLEED
VLV CLS CMD A
V41K1584X = 1
CMD B
V41K1585X = 1
CMD C
V41K1586X = 1
K50P733-A=1
K50P733-A=0
6


6
E1 HE I/C "IN" VLV CMD A
V41K1162X/E = 1
CMD B
V41K1163X/E = 1
VLV "OUT" CMD A
V41K1168X/E = 1
CMD B
V41K1169E = 1
K50P766-A = 0
K50P86-A = 1
K50P766-A = 1
K50P86-A = 0
E2 HE I/C "IN" VLV CMD A
V41K1262X/E = 1
CMD B
V41K1263X/E = 1
VLV "OUT" CMD A
V41K1268X/E = 1
CMD B
V41K1269E = 1
K50P769-A = 0
K50P87-A = 1
K50P769-A = 1
K50P87-A = 0
E3 HE I/C "IN" VLV CMD A
V41K1362X/E = 1
CMD B
V41K1363X/E = 1
VLV "OUT" CMD A
V41K1368X/E = 1
CMD B
V41K1369E = 1
K50P772-A = 0
K50P88-A = 1
K50P772-A = 1
K50P88-A = 0
E2 PNEU XOVR VLV CMD OPN
V41K1613X/E = 1
CLS
V41K1619E = 1
K50P89-A = 1
K50P89-A = 0
7


7
H2 INBD FILL VLV OPN CMD A
V41K1401X/E = 1
OPN CMD B
V41K1402X = 1
CLS CMD
V41K1412X/E = 1
K50P742-A= 1
K50P743-A= 0
K50P742-A= 0
K50P743-A= 1
LO2 INBD FILL VLV OPN CMD A
V41K1501X/E = 1
OPN CMD B
V41K1502X = 1
CLS CMD
V41K1512X/E = 1
K50P737-A= 1
K50P738-A= 0
K50P737-A= 0
K50P738-A= 1
OPN CMD B
CLS CMD B
V41K1447X/E = 1
V41K1448X = 1
OPN CMD A
V41K1443E = 1
K50P754-A= 1
K50P754-A=0
O2 FDLN RLF I/O VLV CLS CMD A
V41K1547X/E = 1
CLS CMD B
V41K1548X = 1
OPN CMD A
V41K1543E = 1
K50P752-A= 1
K50P752-A= 0
8


8
LO2 ACCUM RECIRC
VLV 1 CLS CMD A
V41K1815X
= 1
CMD B
V41K1816X
= 1
N
Y
K50P729-A=1
K50P729-A=0
LO2 ACCUM RECIRC
VLV 2 CLS CMD A
V41K1825X
= 1
CMD B
V41K1826X
= 1
K50P731-A=1
K50P731-A=0
LH2 RTLS MAN REPRESS
VLV 1 OPN CMD A
V41K1905X
= 1
CMD B
V41K1907X
= 1
K50P790-A=1
K50P790-A=0
LH2 RTLS MAN REPRESS
VLV 2 OPN CMD A
V41K1906X
= 1
CMD B
V41K1908X
= 1
K50P791-A=1
K50P791-A=0
9


9
ENG 1 HE ISOL
VLV 1 OPN CMD
V41K1155E/X
= 1
N
Y
CLS CMD
V41K1165E
= 1
N
Y
K50P767-A = 1
K50P767-A = 0
ENG 2 HE ISOL
VLV 1 OPN CMD
V41K1255E/X
= 1
N
Y
CLS CMD
V41K1265E
= 1
N
Y
K50P770-A = 1
K50P770-A = 0
ENG 3 HE ISOL
VLV 1 OPN CMD
V41K1355E/X
= 1
N
Y
CLS CMD
V41K1365E
= 1
N
Y
K50P773-A = 1
K50P773-A = 0
HE ISOL PNEU
VLV 1/2 OPN
CMD
V41K1607E/X
= 1
N
Y
OPN CMD
V41K1608X
= 1
N
Y
CLS CMD
V41K1609E
= 1
N
Y
K50P775-A = 1
K50P776-A = 1
K50P775-A = 0
K50P776-A = 0
10



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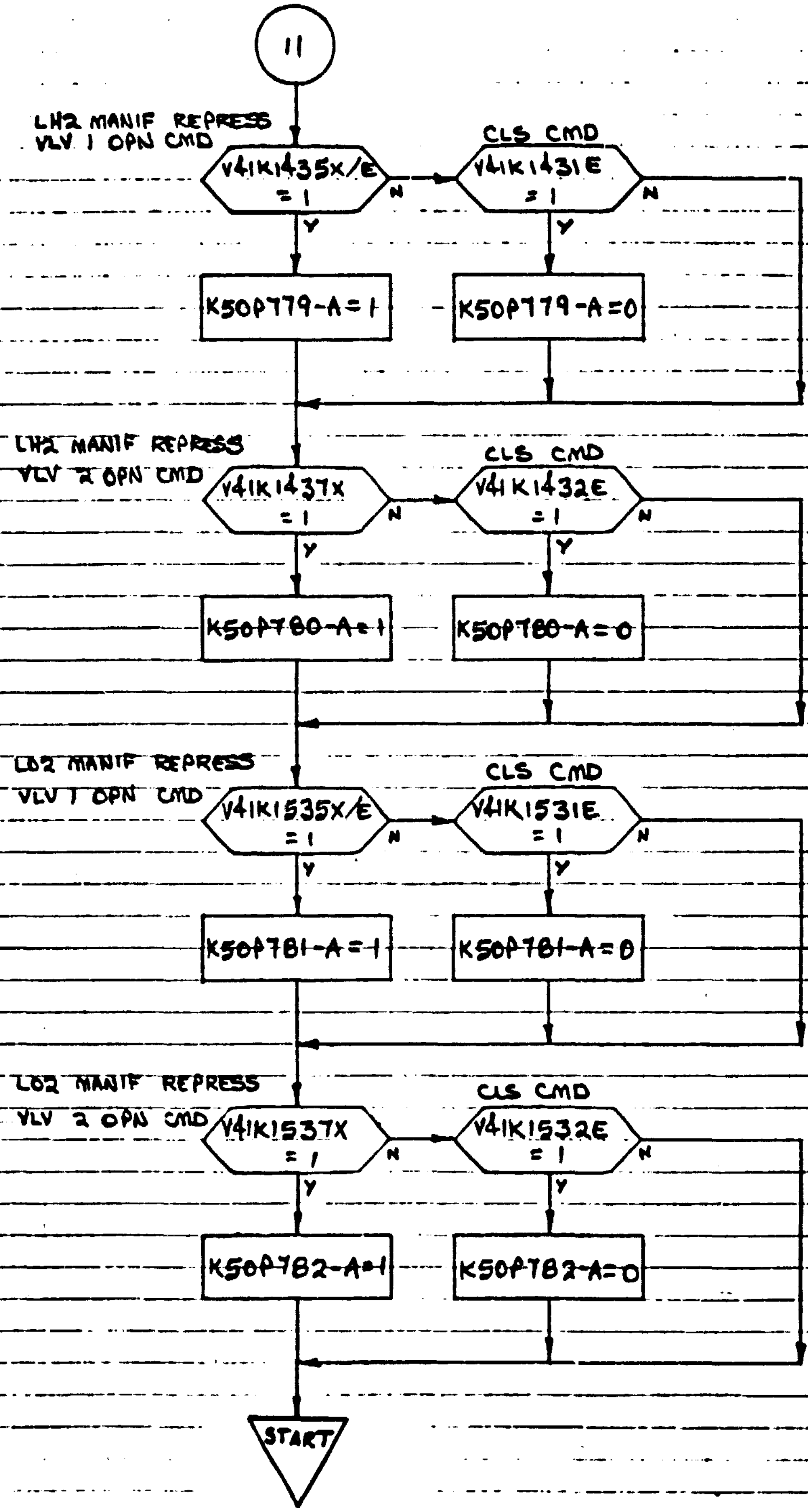
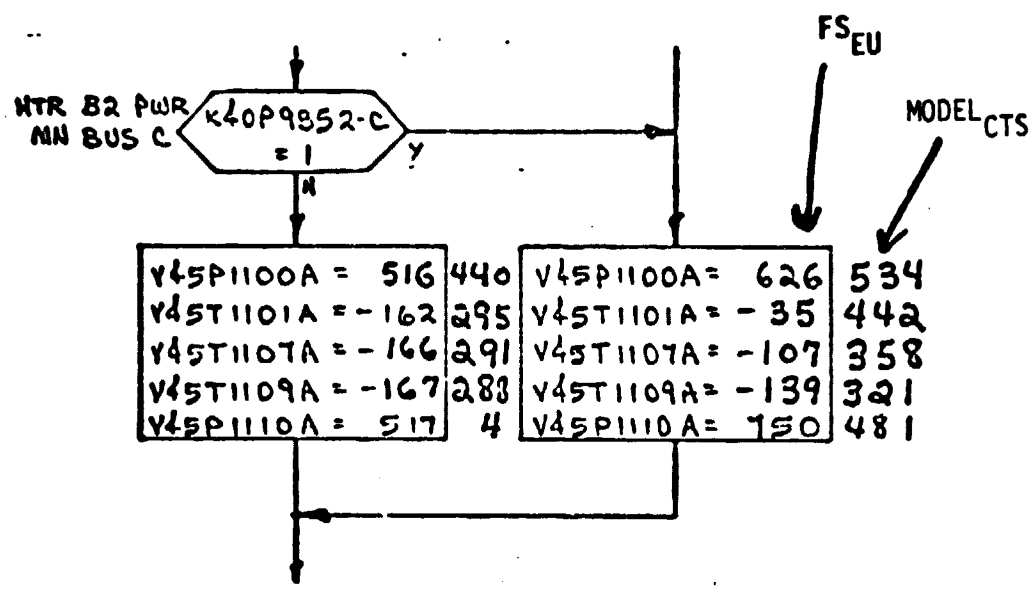

11
LH2 MANIF REPRESS VLV 1 OPN CMD
V41K1435X/E = 1
CLS CMD
V41K1431E = 1
K50P779-A=1
K50P779-A=0
LH2 MANIF REPRESS VLV 2 OPN CMD
V41K1437X = 1
CLS CMD
V41K1432E = 1
K50P780-A=1
K50P780-A=0
LO2 MANIF REPRESS VLV 1 OPN CMD
V41K1535X/E = 1
CLS CMD
V41K1531E = 1
K50P781-A=1
K50P781-A=0
LO2 MANIF REPRESS VLV 2 OPN CMD
V41K1537X = 1
CLS CMD
V41K1532E = 1
K50P782-A=1
K50P782-A=0
START

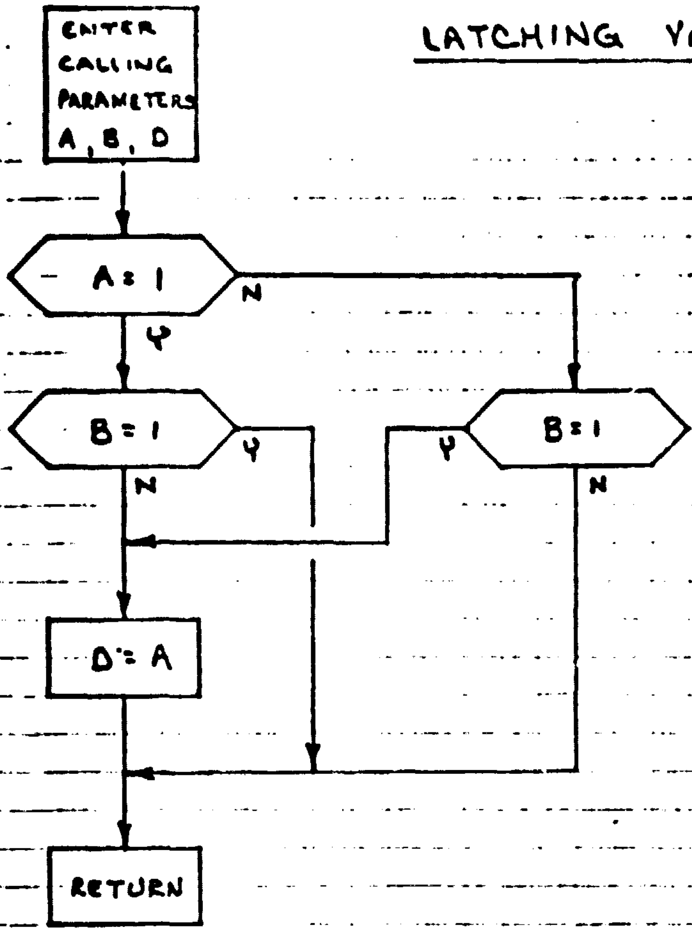
3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;

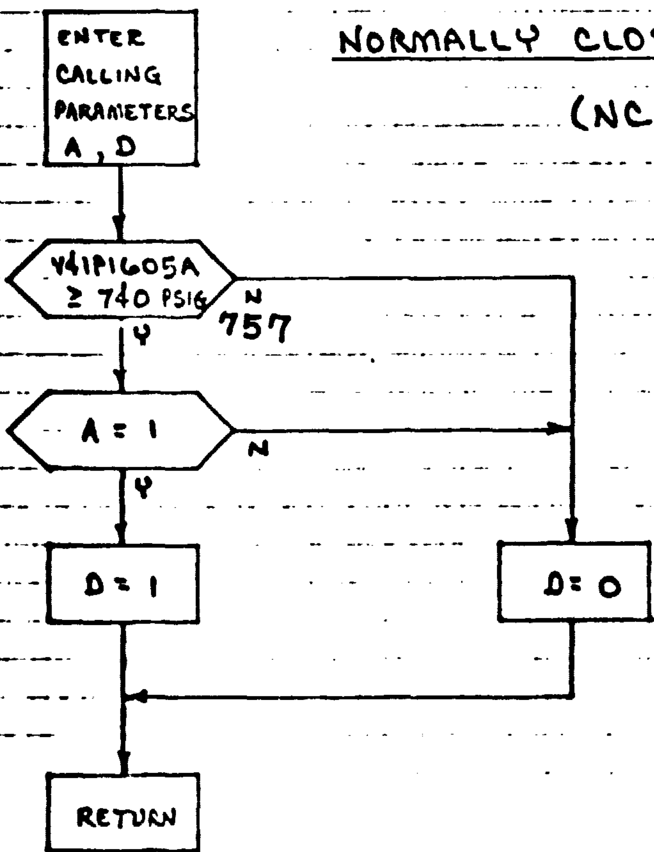


shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.

LATCHING VALVE ROUTINE (LVR)

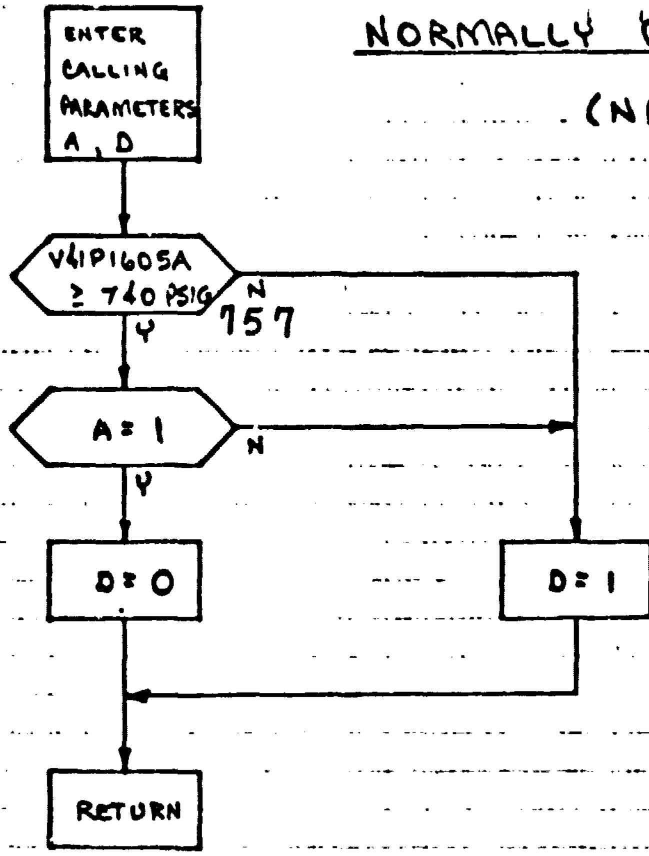


NORMALLY CLOSED VALVE ROUTINE (NCVR)

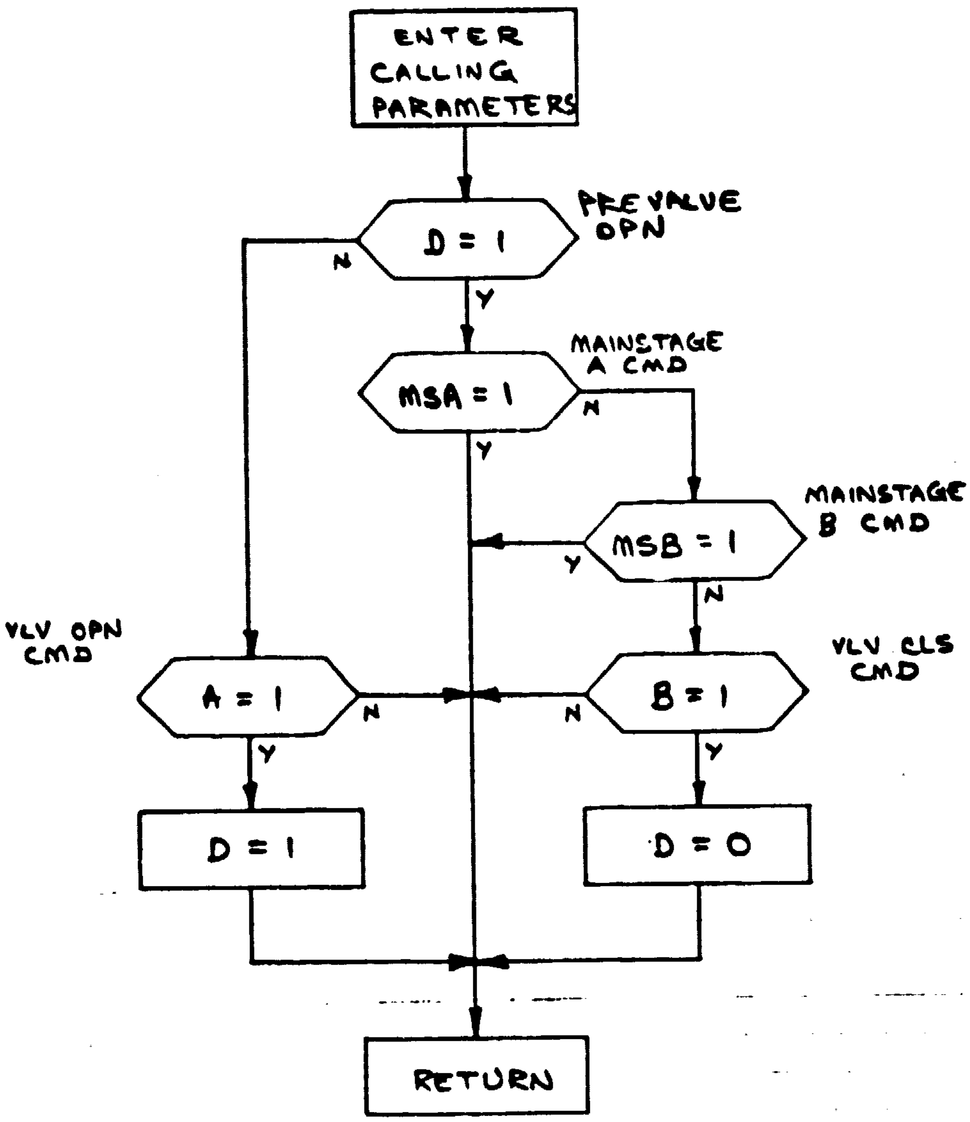


NORMALLY OPEN VALVE ROUTINE

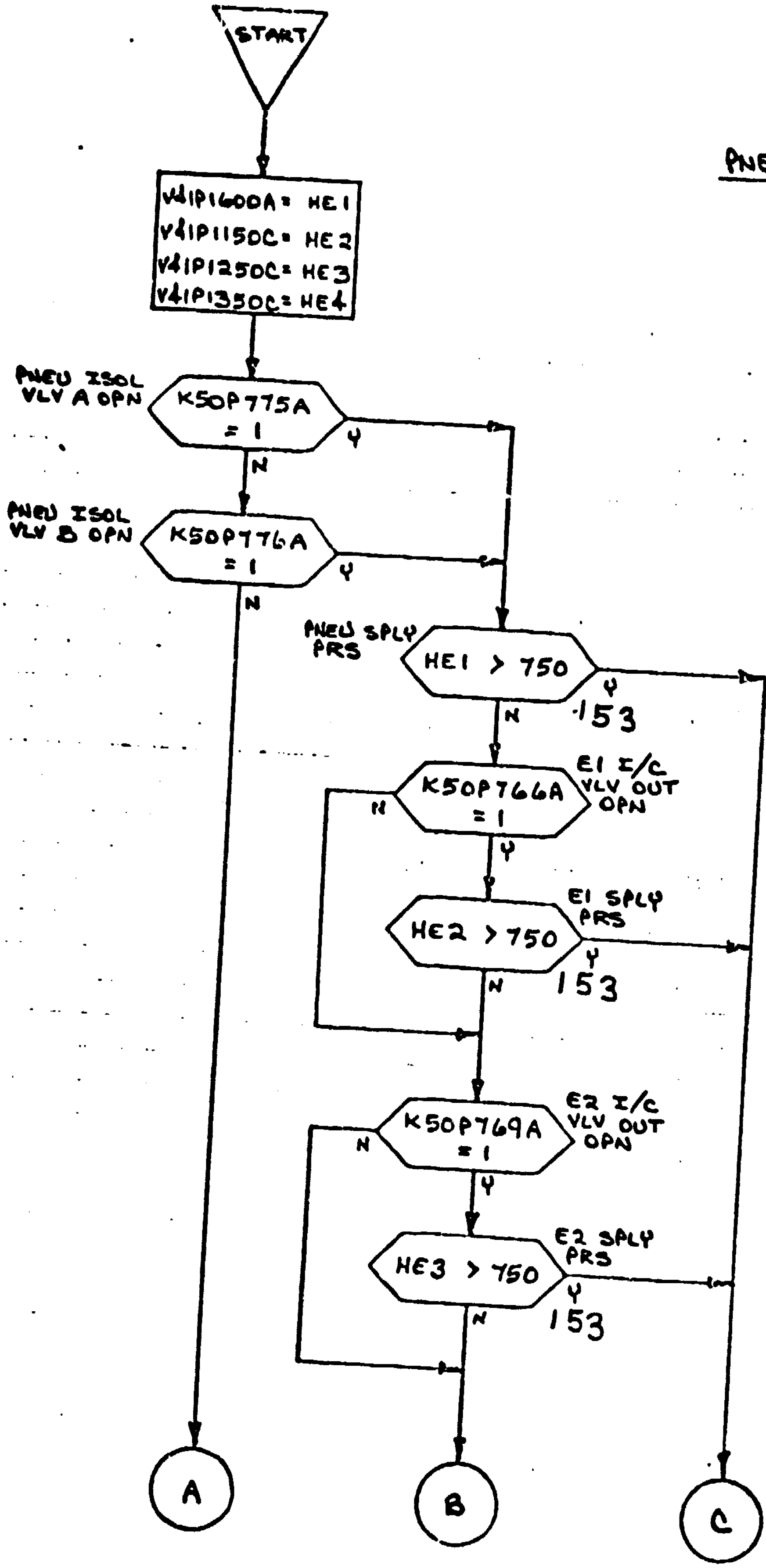
(NØVR)

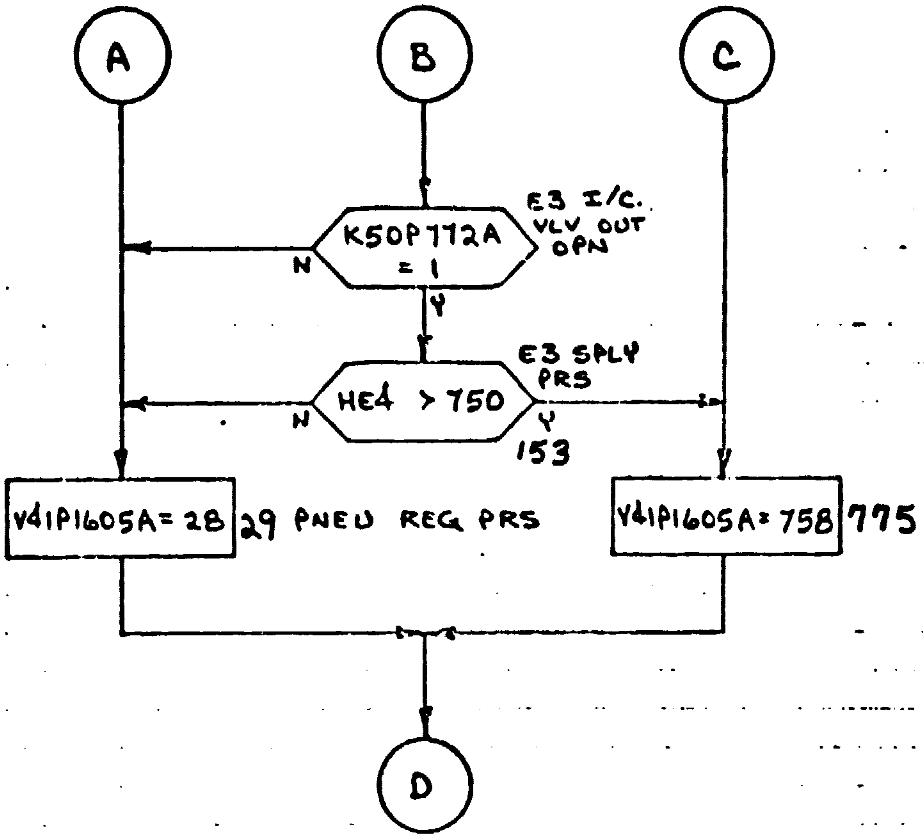


ENGINE PREVALVE ROUTINE (EPR)

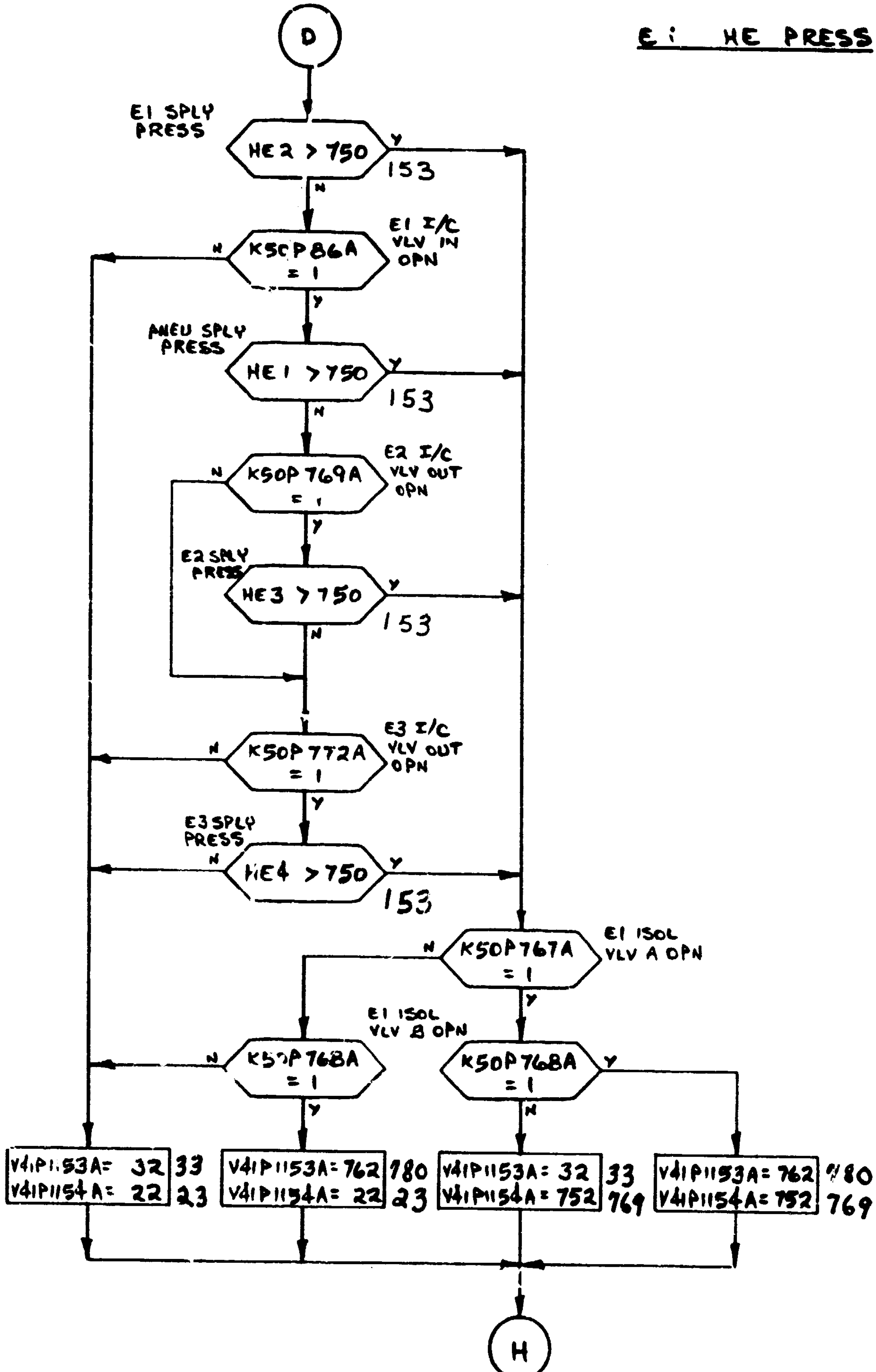


PNEU HE PRESS

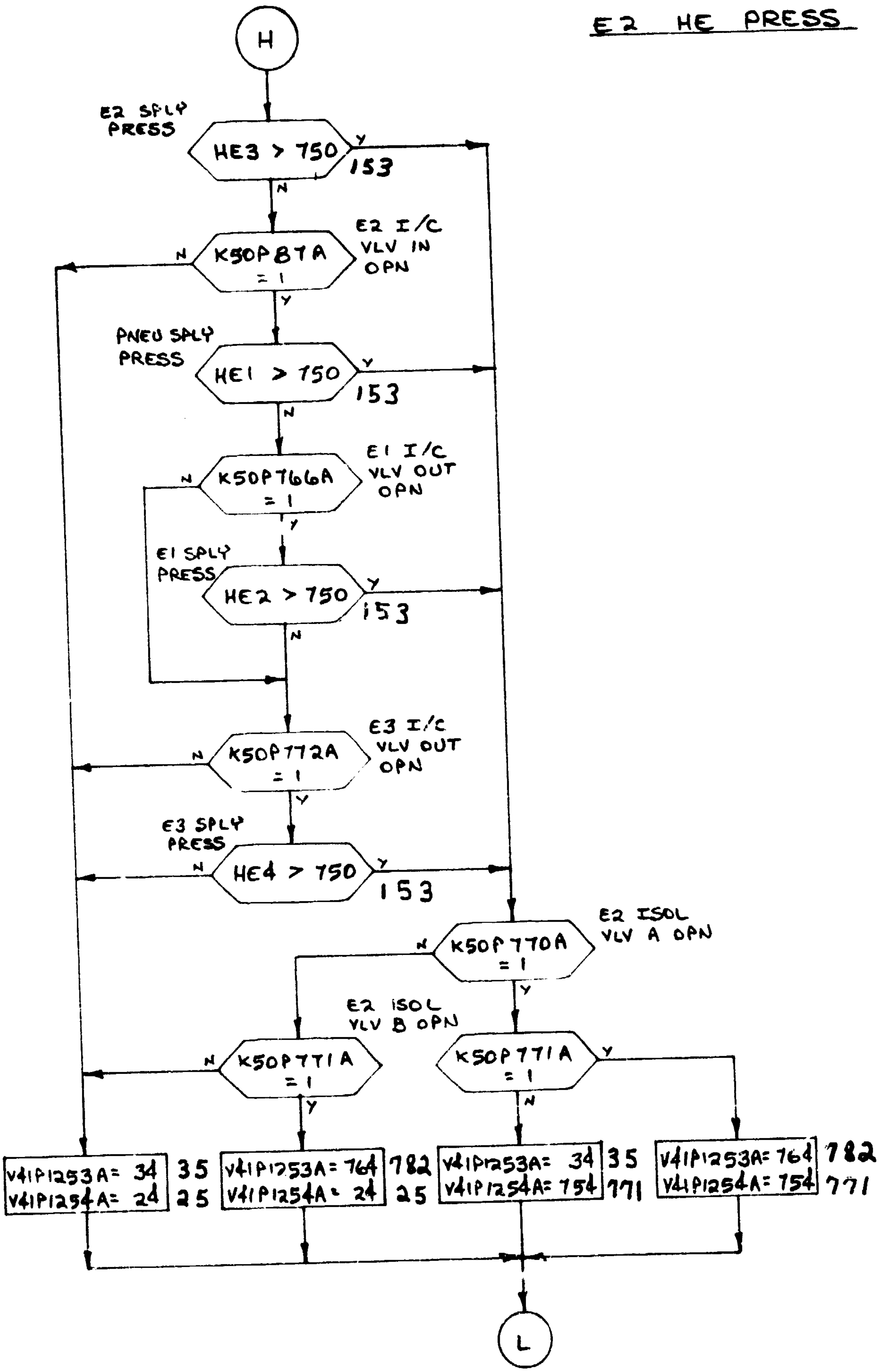



A
B
C
K50P772A = 1
N
Y
E3 I/C. VLV OUT OPN
HE4 > 750
N
Y
E3 SPLY PRS
153
V41P1605A = 28
29 PNEU REG PRS
V41P1605A = 758
775
D

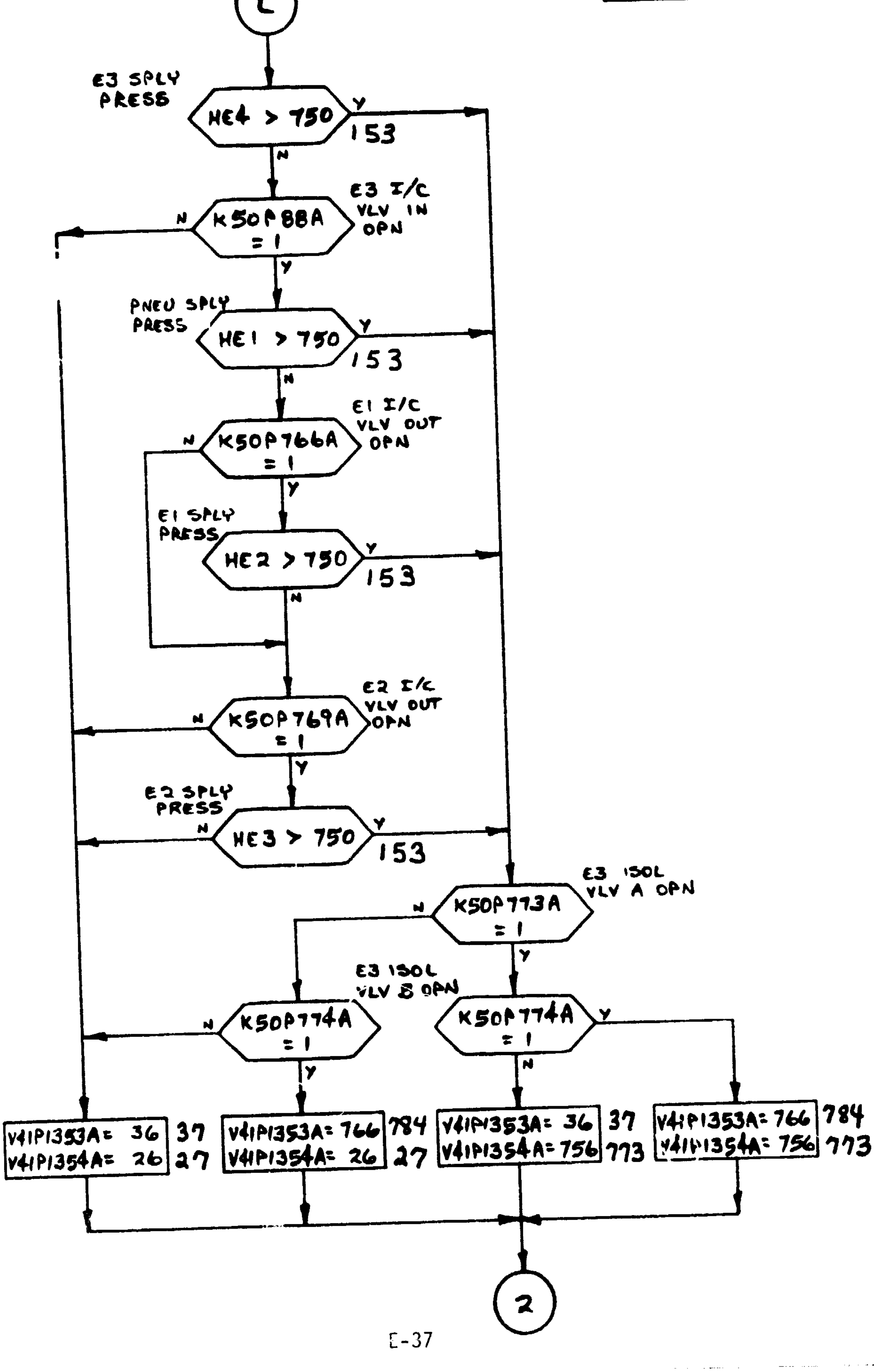
E: HE PRESS

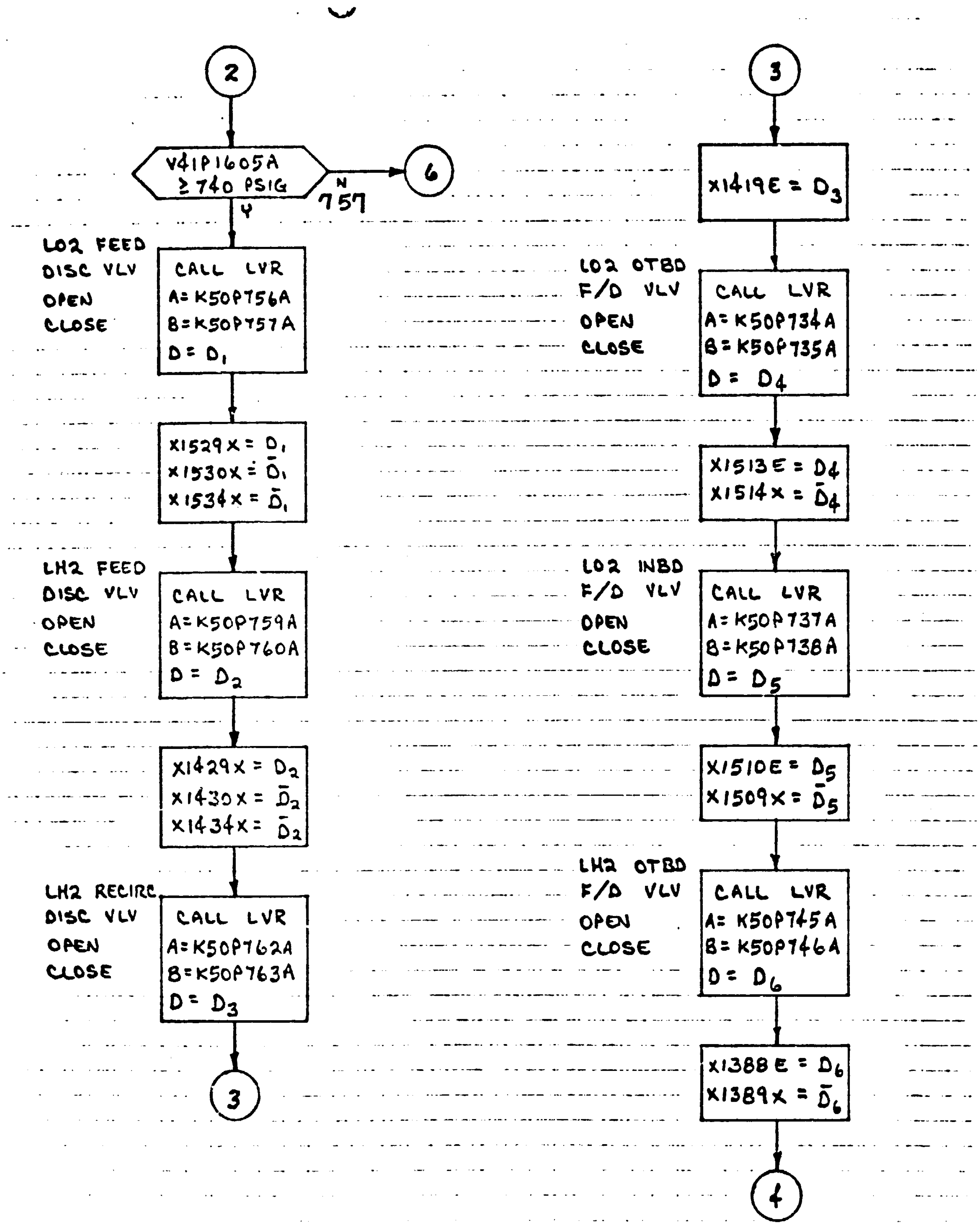

D
E1 SPLY PRESS
HE2 > 750
153
E1 I/C VLV IN OPN
K50P86A = 1
PNEU SPLY PRESS
HE1 > 750
153
E2 I/C VLV OUT OPN
K50P769A = 1
E2 SPLY PRESS
HE3 > 750
153
E3 I/C VLV OUT OPN
K50P772A = 1
E3 SPLY PRESS
HE4 > 750
153
E1 ISOL VLV A OPN
K50P767A = 1
E1 ISOL VLV B OPN
K50P768A = 1
K50P768A = 1
V41P1153A= 32 33
V41P1154A= 22 23
V41P1153A= 762 780
V41P1154A= 22 23
V41P1153A= 32 33
V41P1154A= 752 769
V41P1153A= 762 780
V41P1154A= 752 769
H

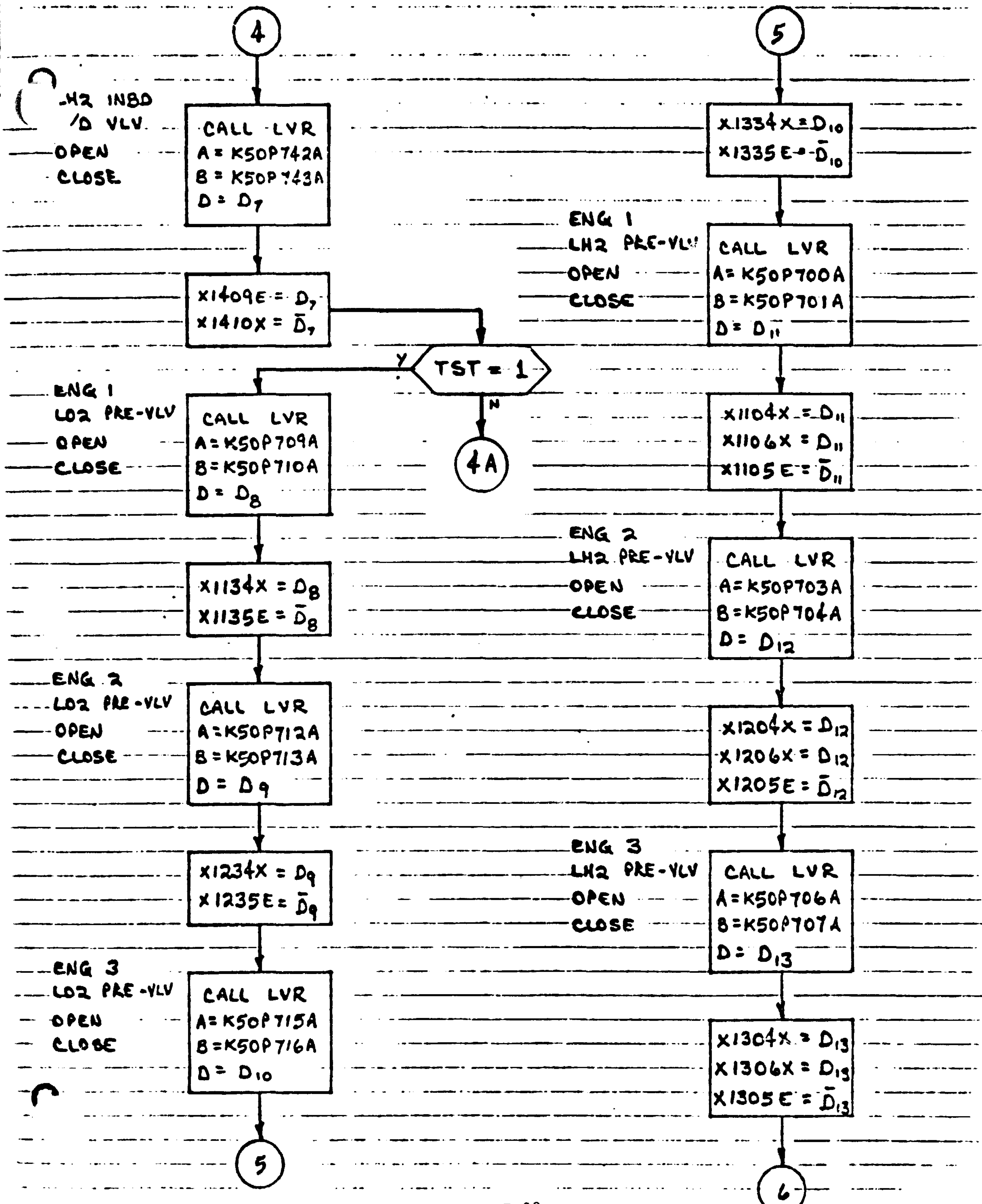
E2 HE PRESS

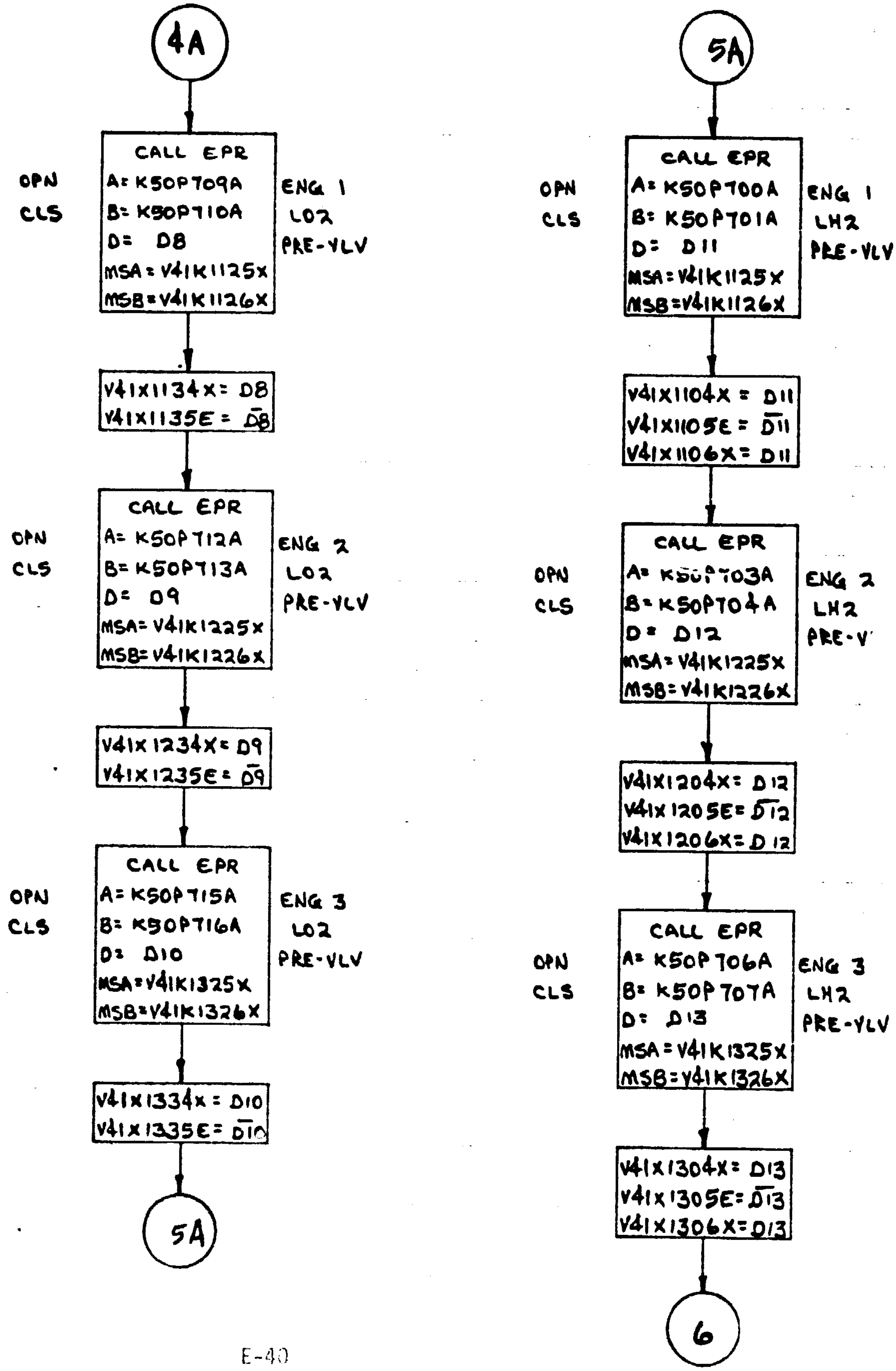

H
E2 SPLY PRESS
HE3 > 750
153
K50P87A = 1
E2 I/C VLV IN OPN
PNEU SPLY PRESS
HE1 > 750
153
K50P766A = 1
E1 I/C VLV OUT OPN
E1 SPLY PRESS
HE2 > 750
153
K50P772A = 1
E3 I/C VLV OUT OPN
E3 SPLY PRESS
HE4 > 750
153
K50P770A = 1
E2 ISOL VLV A OPN
E2 ISOL VLV B OPN
K50P771A = 1
K50P771A = 1
V41P1253A= 34 35
V41P1254A= 24 25
V41P1253A= 764 782
V41P1254A= 24 25
V41P1253A= 34 35
V41P1254A= 754 771
V41P1253A= 764 782
V41P1254A= 754 771
L

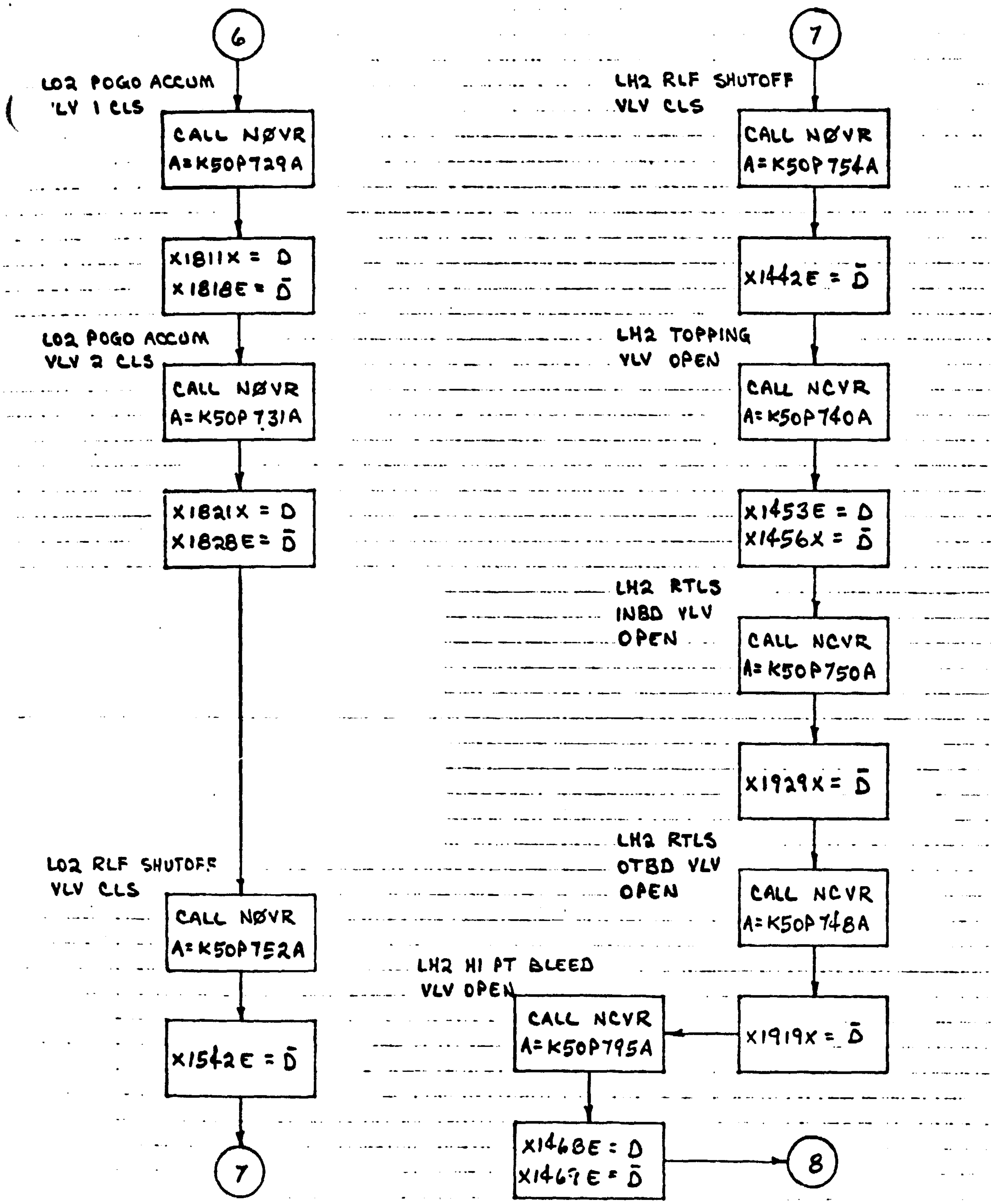
E3 HE PRESS


L
E3 SPLY PRESS
HE4 > 750
Y
153
N
E3 I/C VLV IN OPN
K50P88A = 1
N
Y
PNEU SPLY PRESS
HE1 > 750
Y
153
N
E1 I/C VLV OUT OPN
K50P766A = 1
N
Y
E1 SPLY PRESS
HE2 > 750
Y
153
N
E2 I/C VLV OUT OPN
K50P769A = 1
N
Y
E2 SPLY PRESS
HE3 > 750
N
Y
153
E3 ISOL VLV A OPN
K50P773A = 1
N
Y
E3 ISOL VLV B OPN
K50P774A = 1
N
Y
K50P774A = 1
Y
N
V41P1353A= 36 37
V41P1354A= 26 27
V41P1353A= 766 784
V41P1354A= 26 27
V41P1353A= 36 37
V41P1354A= 756 773
V41P1353A= 766 784
V41P1354A= 756 773
2

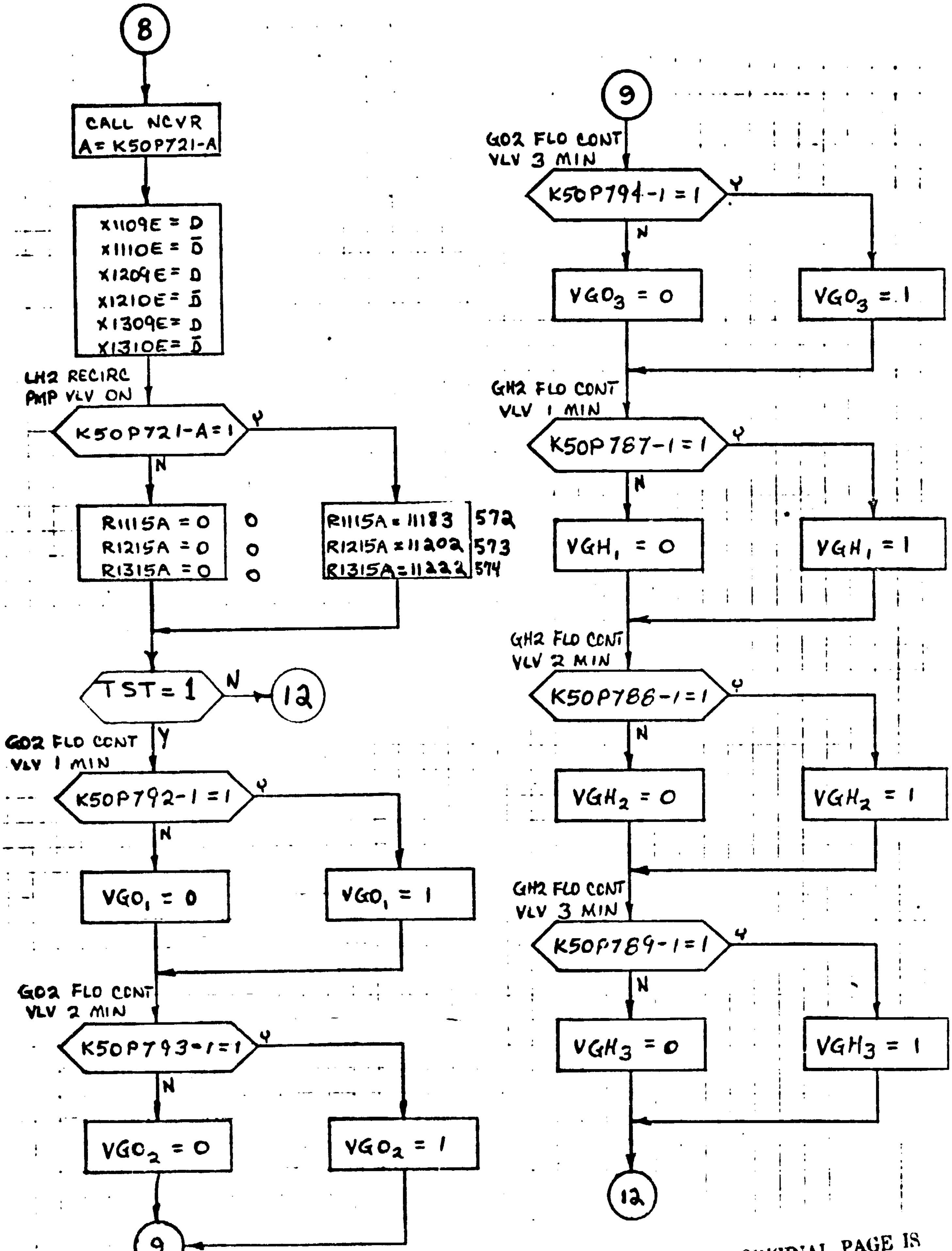

2
V41P1605A
≥ 740 PSIG
N
757
6
Y
LO2 FEED
DISC VLV
OPEN
CLOSE
CALL LVR
A = K50P756A
B = K50P757A
D = D1
X1529X = D1
X1530X = D̄1
X1534X = D̄1
LH2 FEED
DISC VLV
OPEN
CLOSE
CALL LVR
A = K50P759A
B = K50P760A
D = D2
X1429X = D2
X1430X = D̄2
X1434X = D̄2
LH2 RECIRC
DISC VLV
OPEN
CLOSE
CALL LVR
A = K50P762A
B = K50P763A
D = D3
3
3
X1419E = D3
LO2 OTBD
F/D VLV
OPEN
CLOSE
CALL LVR
A = K50P734A
B = K50P735A
D = D4
X1513E = D4
X1514X = D̄4
LO2 INBD
F/D VLV
OPEN
CLOSE
CALL LVR
A = K50P737A
B = K50P738A
D = D5
X1510E = D5
X1509X = D̄5
LH2 OTBD
F/D VLV
OPEN
CLOSE
CALL LVR
A = K50P745A
B = K50P746A
D = D6
X1388E = D6
X1389X = D̄6
4


4
-H2 INBD
/D VLV
OPEN
CLOSE
CALL LVR
A = K50P742A
B = K50P743A
D = D7
X1409E = D7
X1410X = D̄7
TST = 1
Y
N
4A
ENG 1
LO2 PRE-VLV
OPEN
CLOSE
CALL LVR
A=K50P709A
B=K50P710A
D = D8
X1134X = D8
X1135E = D̄8
ENG 2
LO2 PRE-VLV
OPEN
CLOSE
CALL LVR
A=K50P712A
B=K50P713A
D = D9
X1234X = D9
X1235E = D̄9
ENG 3
LO2 PRE-VLV
OPEN
CLOSE
CALL LVR
A=K50P715A
B=K50P716A
D = D10
5
5
X1334X = D10
X1335E = D̄10
ENG 1
LH2 PRE-VLV
OPEN
CLOSE
CALL LVR
A=K50P700A
B=K50P701A
D = D11
X1104X = D11
X1106X = D11
X1105E = D̄11
ENG 2
LH2 PRE-VLV
OPEN
CLOSE
CALL LVR
A=K50P703A
B=K50P704A
D = D12
X1204X = D12
X1206X = D12
X1205E = D̄12
ENG 3
LH2 PRE-VLV
OPEN
CLOSE
CALL LVR
A=K50P706A
B=K50P707A
D = D13
X1304X = D13
X1306X = D13
X1305E = D̄13
6


4A
CALL EPR
A= K50P709A
B= K50P710A
D= D8
MSA= V41K1125X
MSB= V41K1126X
OPN
CLS
ENG 1
LO2
PRE-VLV
V41X1134X= D8
V41X1135E= $\overline{D8}$
CALL EPR
A= K50P712A
B= K50P713A
D= D9
MSA= V41K1225X
MSB= V41K1226X
OPN
CLS
ENG 2
LO2
PRE-VLV
V41X1234X= D9
V41X1235E= $\overline{D9}$
CALL EPR
A= K50P715A
B= K50P716A
D= D10
MSA= V41K1325X
MSB= V41K1326X
OPN
CLS
ENG 3
LO2
PRE-VLV
V41X1334X= D10
V41X1335E= $\overline{D10}$
5A
5A
CALL EPR
A= K50P700A
B= K50P701A
D= D11
MSA= V41K1125X
MSB= V41K1126X
OPN
CLS
ENG 1
LH2
PRE-VLV
V41X1104X= D11
V41X1105E= $\overline{D11}$
V41X1106X= D11
CALL EPR
A= K50P703A
B= K50P704A
D= D12
MSA= V41K1225X
MSB= V41K1226X
OPN
CLS
ENG 2
LH2
PRE-V
V41X1204X= D12
V41X1205E= $\overline{D12}$
V41X1206X= D12
CALL EPR
A= K50P706A
B= K50P707A
D= D13
MSA= V41K1325X
MSB= V41K1326X
OPN
CLS
ENG 3
LH2
PRE-VLV
V41X1304X= D13
V41X1305E= $\overline{D13}$
V41X1306X= D13
6

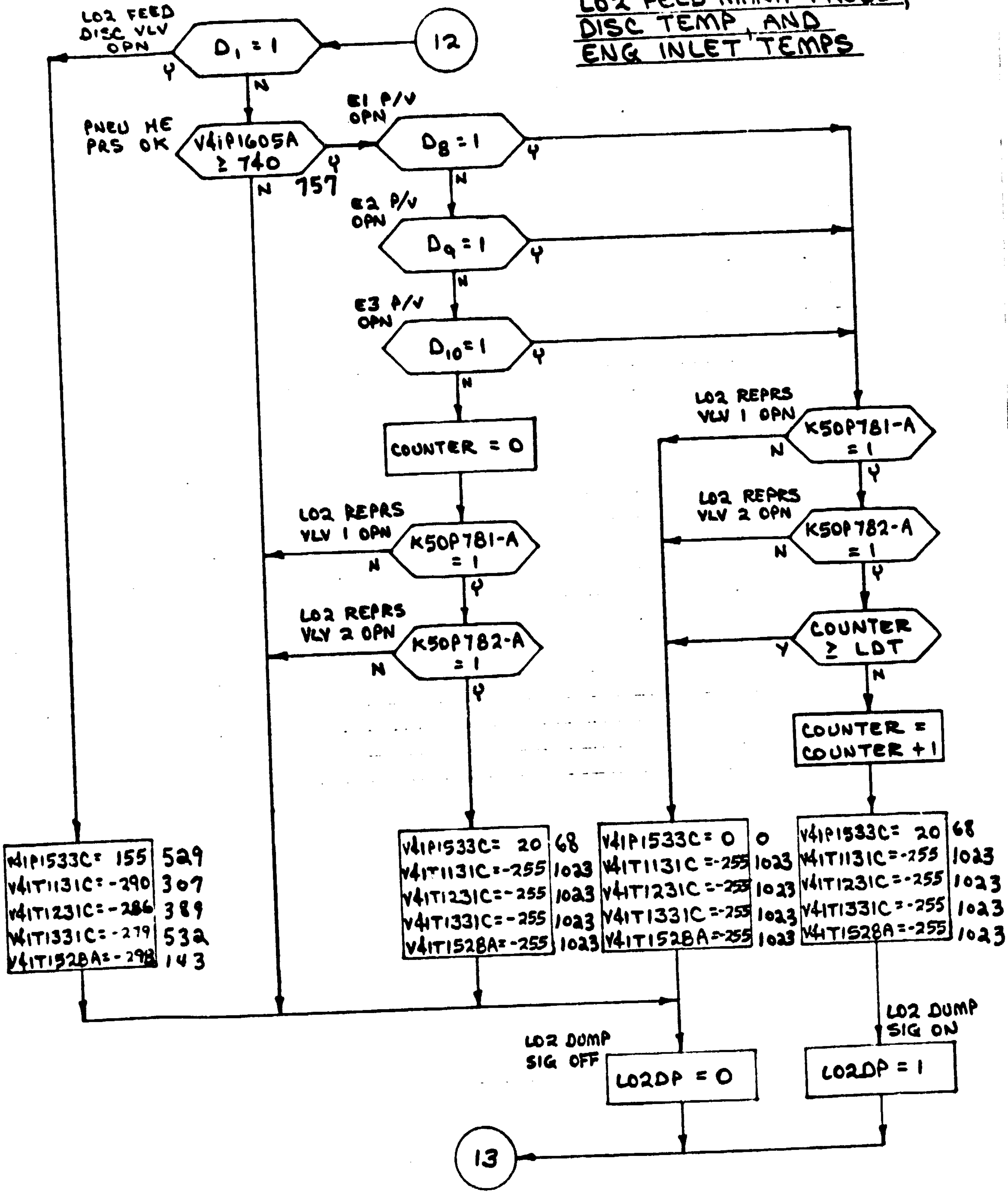


6
LO2 POGO ACCUM
VLV 1 CLS
CALL NØVR
A=K50P729A
X1811X = D
X1818E = D̄
LO2 POGO ACCUM
VLV 2 CLS
CALL NØVR
A=K50P731A
X1821X = D
X1828E = D̄
LO2 RLF SHUTOFF
VLV CLS
CALL NØVR
A=K50P752A
X1542E = D̄
7
7
LH2 RLF SHUTOFF
VLV CLS
CALL NØVR
A=K50P754A
X1442E = D̄
LH2 TOPPING
VLV OPEN
CALL NCVR
A=K50P740A
X1453E = D
X1456X = D̄
LH2 RTLS
INBD VLV
OPEN
CALL NCVR
A=K50P750A
X1929X = D̄
LH2 RTLS
OTBD VLV
OPEN
CALL NCVR
A=K50P748A
X1919X = D̄
LH2 HI PT BLEED
VLV OPEN
CALL NCVR
A=K50P795A
X1468E = D
X1469E = D̄
8



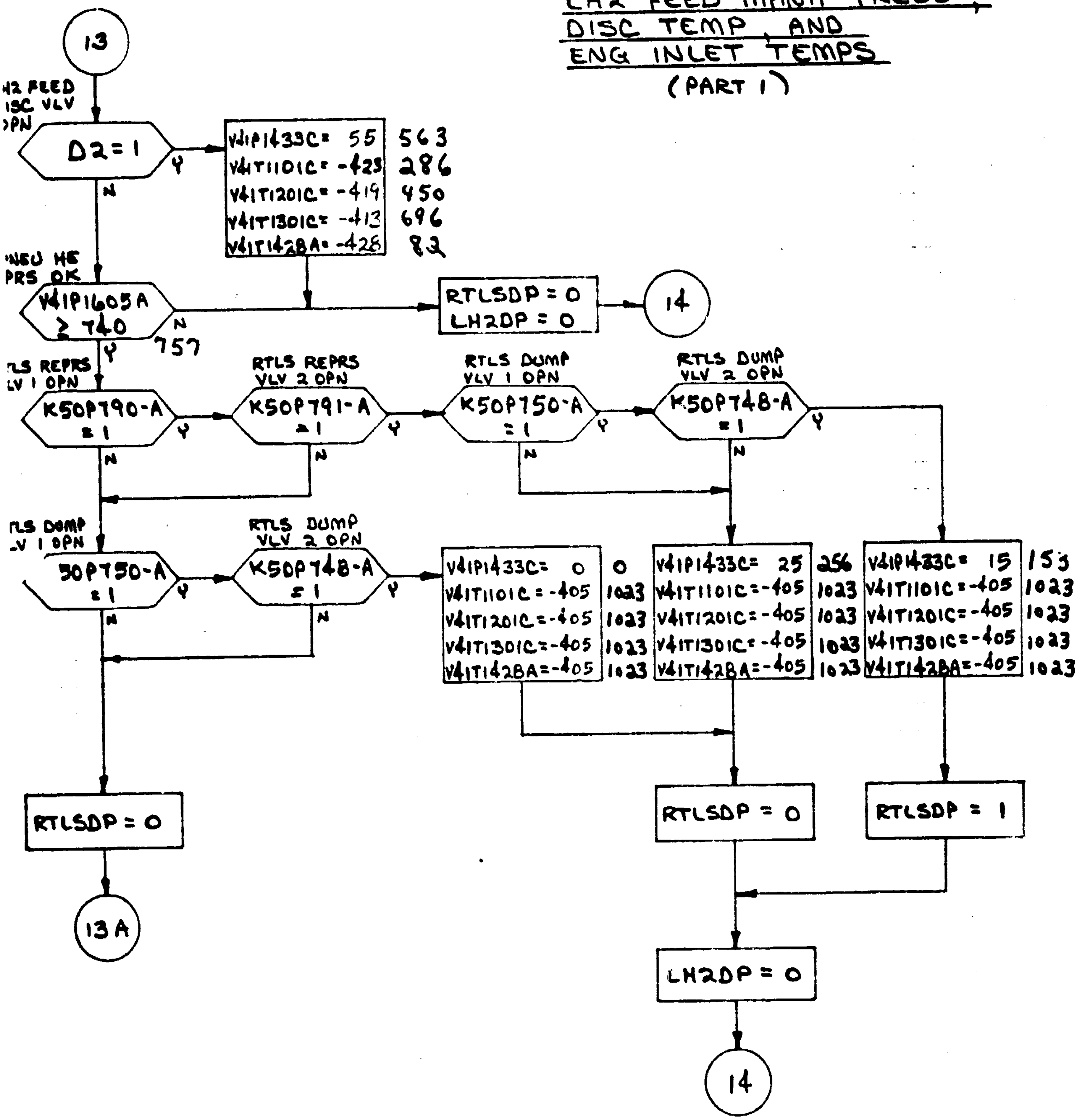
8
CALL NCVR
A= K50P721-A
X1109E = D
X1110E = D̄
X1209E = D
X1210E = D̄
X1309E = D
X1310E = D̄
LH2 RECIRC
PMP VLV ON
K50P721-A=1
Y
N
R1115A = 0
R1215A = 0
R1315A = 0
0
0
0
R1115A = 11183
R1215A = 11202
R1315A = 11222
572
573
574
TST = 1
N
12
Y
GO2 FLO CONT
VLV 1 MIN
K50P792-1 = 1
Y
N
VGO1 = 0
VGO1 = 1
GO2 FLO CONT
VLV 2 MIN
K50P793-1 = 1
Y
N
VGO2 = 0
VGO2 = 1
9
9
GO2 FLO CONT
VLV 3 MIN
K50P794-1 = 1
Y
N
VGO3 = 0
VGO3 = 1
GH2 FLO CONT
VLV 1 MIN
K50P787-1 = 1
Y
N
VGH1 = 0
VGH1 = 1
GH2 FLO CONT
VLV 2 MIN
K50P788-1 = 1
Y
N
VGH2 = 0
VGH2 = 1
GH2 FLO CONT
VLV 3 MIN
K50P789-1 = 1
Y
N
VGH3 = 0
VGH3 = 1
12

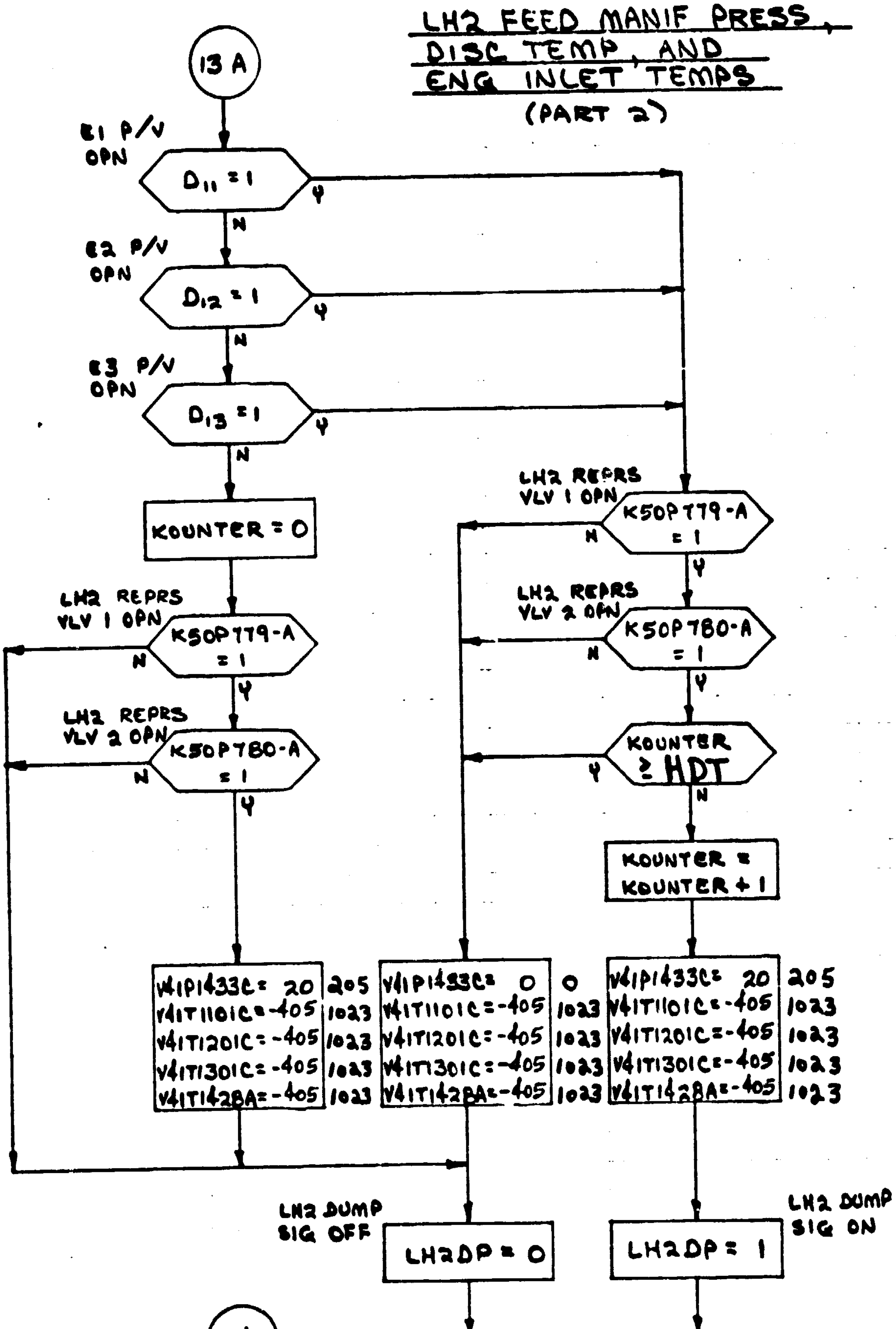
LO2 FEED MANIF PRESS, DISC TEMP, AND ENG INLET TEMPS



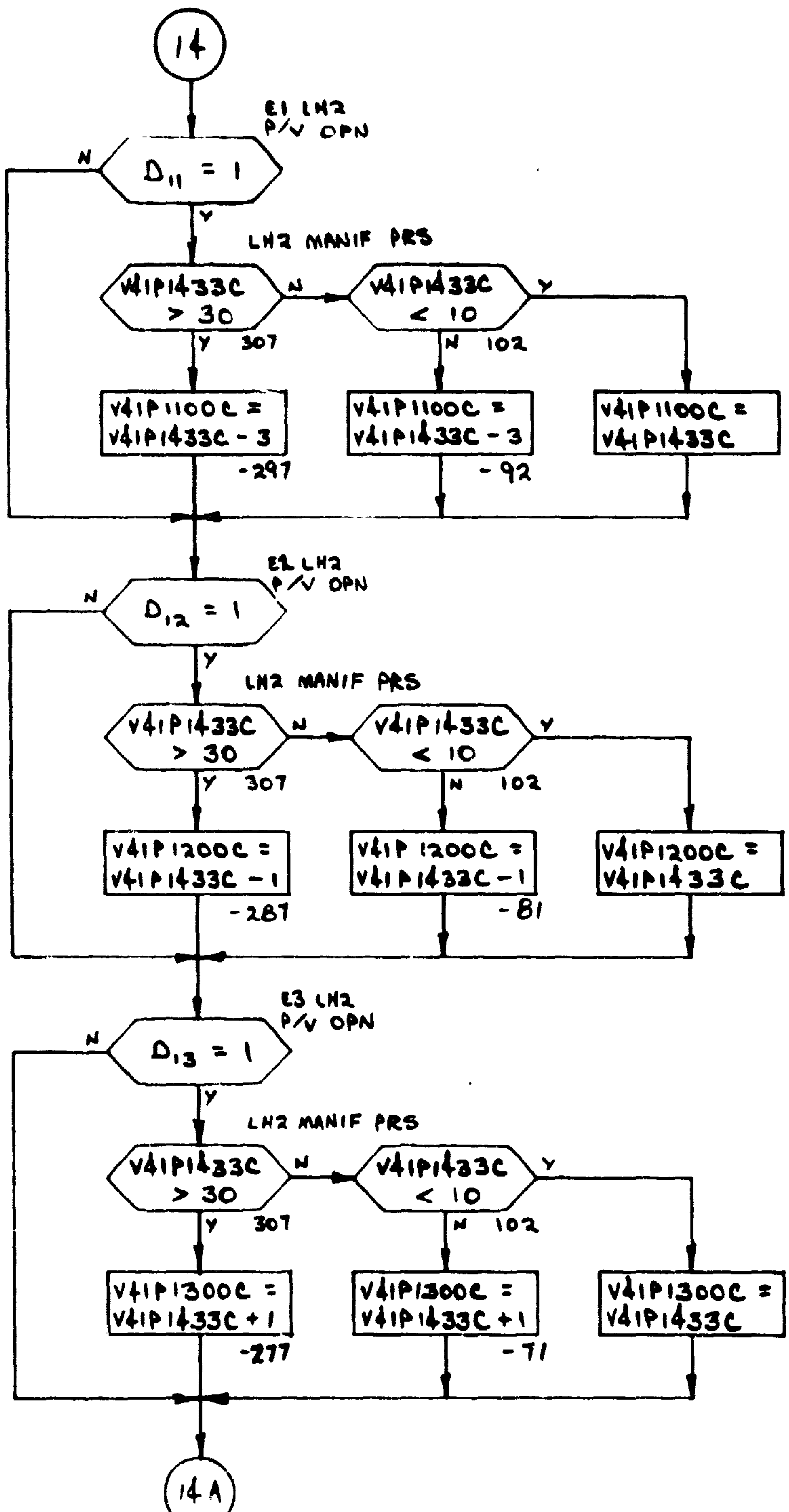
LHR FEED MANIF PRESS, DISC TEMP, AND ENG INLET TEMPS

(PART 1)

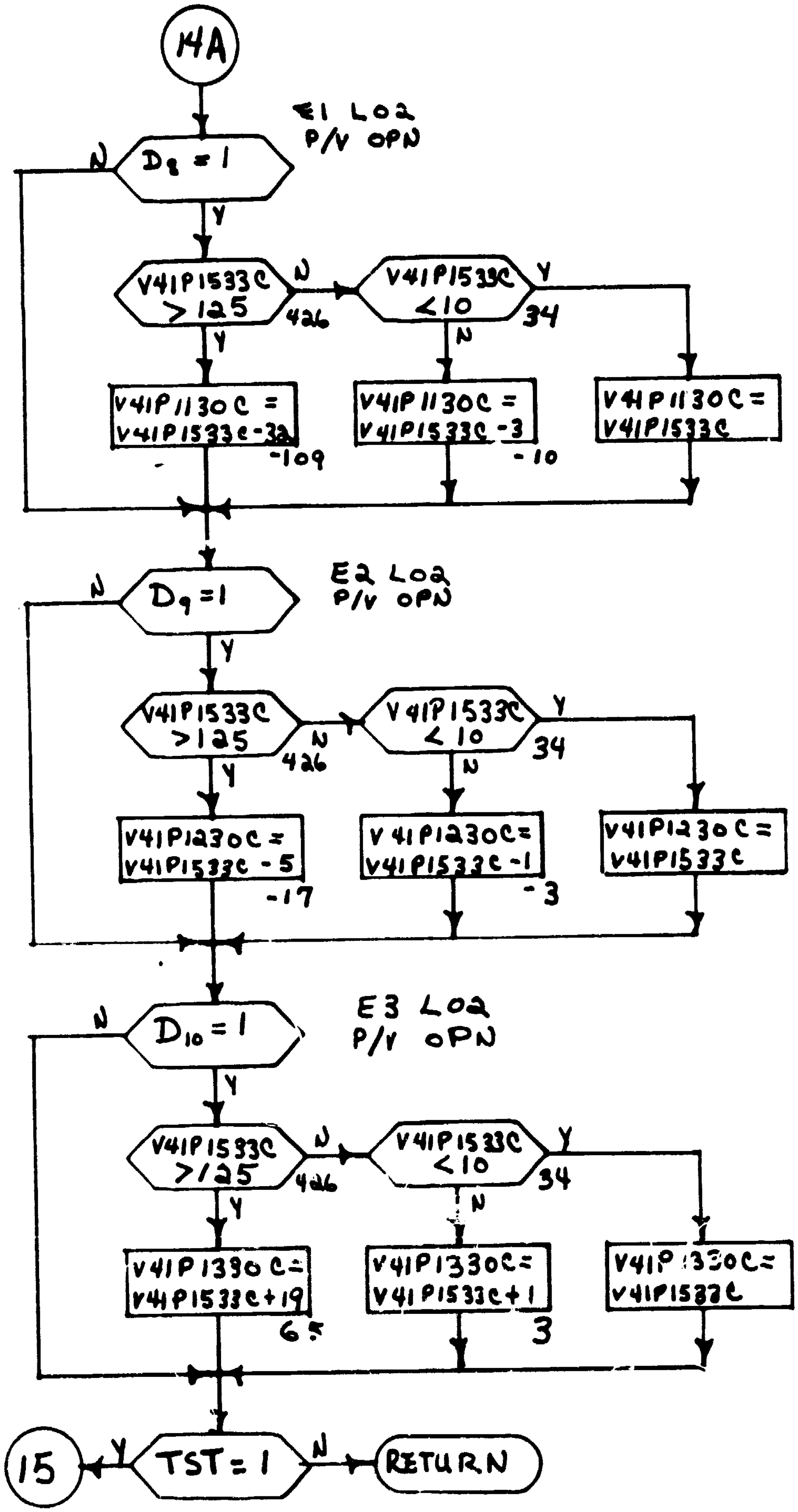



LH2 FEED MANIF PRESS, DISC TEMP, AND ENG INLET TEMPS
(PART 2)
13 A
E1 P/V OPN
D11 = 1
E2 P/V OPN
D12 = 1
E3 P/V OPN
D13 = 1
Y
N
KOUNTER = 0
LH2 REPRS VLV 1 OPN
K50P779-A = 1
LH2 REPRS VLV 2 OPN
K50P780-A = 1
KOUNTER ≥ HDT
KOUNTER = KOUNTER + 1
V41P1433C = 20 205
V41T1101C = -405 1023
V41T1201C = -405 1023
V41T1301C = -405 1023
V41T1428A = -405 1023
V41P1433C = 0 0
LH2 DUMP SIG OFF
LH2DP = 0
LH2 DUMP SIG ON
LH2DP = 1
14

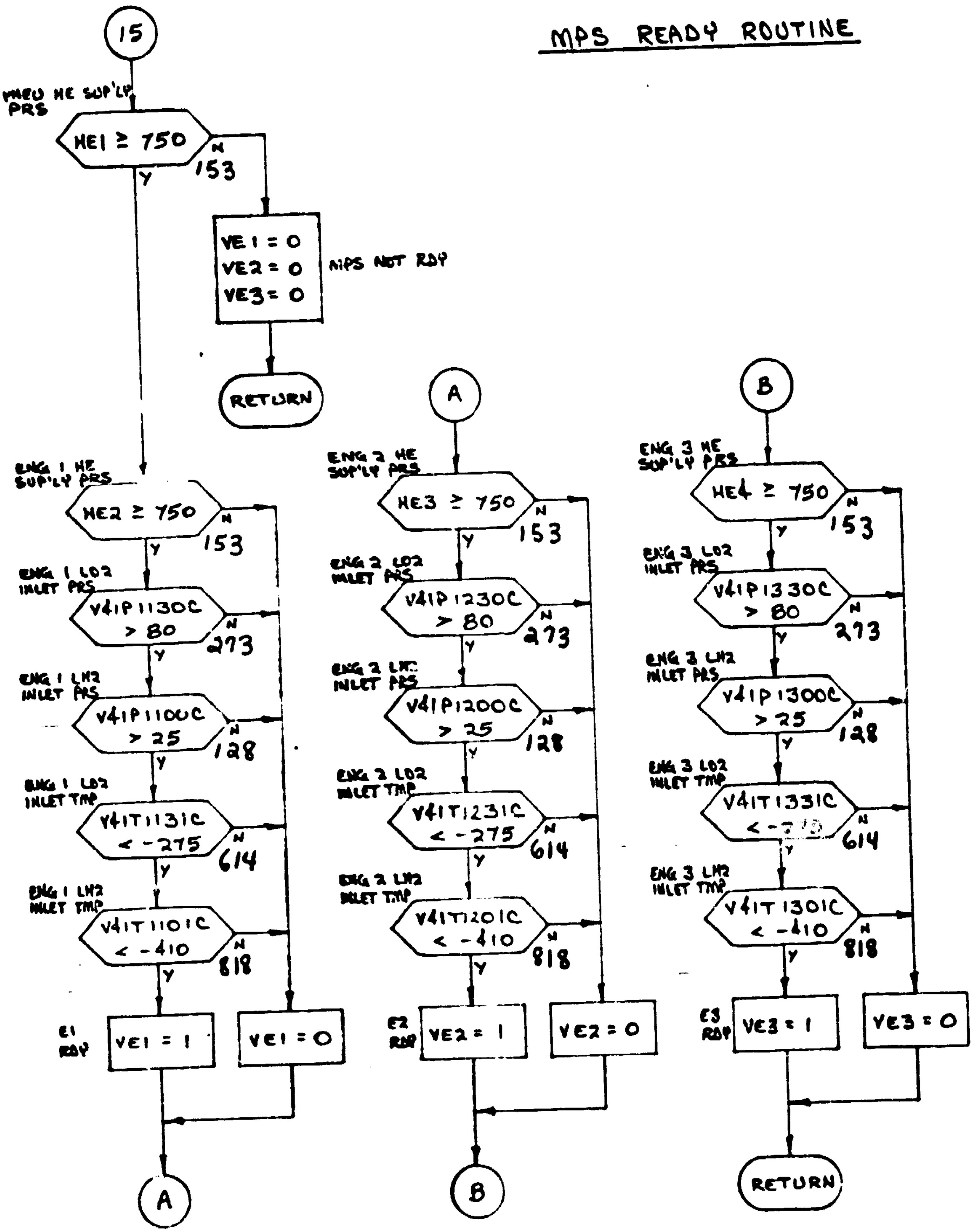
ENGINE LH2 INLET PRESSURES



ENGINE LO2 INLET PRESSURES



MPS READY ROUTINE



4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

C-3

4.1.2 PSEUDO VARIABLE INITIALIZATION

The following pseudos are initialized as follows:

VARIABLE	INITIAL CONDITION
HE1	4052
HE2	4198
HE3	3998
HE4	4101
LDT	95
HDT	37

TABLE 1 - STIMULI ... TO MPS MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R4/S14	ENG 1 LH2 PRE-VLV OPEN	2	V41K1119X 1119E 1120X 1120E 1121X 1121E	K50P700-A	1-OPN/0-$\overline{\text{OPN}}$
	ENG 1 LH2 PRE-VLV CLOSE	2	1122X 1122E 1123X 1123E 1124X 1124E	K50P701-A	1-CLS/0-$\overline{\text{CLS}}$
R4/S11	ENG 1 LO2 PRE-VLV OPEN	2	1136X 1136E 1137X 1137E 1138X 1138E	K50P709-A	1-OPN/0-$\overline{\text{OPN}}$
	ENG 1 LO2 PRE-VLV CLOSE	2	1139X 1139E 1140X 1140E 1141X 1141E	K50P710-A	1-CLS/0-$\overline{\text{CLS}}$

TABLE 1 - STIMULI INPUT TO MPS MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R4/S15	ENG 2 LH2 PRE-VLV OPEN	2	V41K1219X	K50P703-A	1-OPN/0-$\overline{OPN}$
			1219E		
			1220X		
			1220E		
			1221X		
			1221E		
	ENG 2 LH2 PRE-VLV CLOSE	2	1222X	K50P704-A	1-CLS/0-$\overline{CLS}$
			1222E		
			1223X		
			1223E		
			1224X		
			1224E		
R4/S12	ENG 2 LO2 PRE-VLV OPEN	2	1236X	K50P712-A	1-OPN/0-$\overline{OPN}$
			1236E		
			1237X		
			1237E		
			1238X		
			1238E		
	ENG 2 LO2 PRE-VLV CLOSE	2	1239X	K50P713-A	1-CLS/0-$\overline{CLS}$
			1239E		
			1240X		
			1240E		
			1241X		
			1241E		

TABLE 1 - STIMULI TO MPS MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R4/S16	ENG 3 LH2 PRE-VLV OPEN	2	V41K1319X 1319E 1320X 1320E 1321X 1321E	K50P706-A	1-OPN/0-$\overline{\text{OPN}}$
	ENG 3 LH2 PRE-VLV CLOSE	2	1322X 1322E 1323X 1323E 1324X 1324E	K50P707-A	1-CLS/0-$\overline{\text{CLS}}$
R4/S13	ENG 3 LO2 PRE-VLV OPEN	2	1336X 1336E 1337X 1337E 1338X 1338E	K50P715-A	1-OPN/0-$\overline{\text{OPN}}$
	ENG 3 LO2 PRE-VLV CLOSE	2	1339X 1339E 1340X 1340E 1341X 1341E	K50P716-A	1-CLS/0-$\overline{\text{CLS}}$

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R2/S55	ENG 1 HE SPLY ISOL VLV 1 OPEN	2	V41K1155X 1155E	K50P767-A	1-OPN/0-$\overline{\text{OPN}}$
	ENG 1 HE SPLY ISOL VLV 1 CLOSE		1165E		1-CLS/0-$\overline{\text{CLS}}$
R2/S12	ENG 1 HE SPLY ISOL VLV 2 OPEN	2	1156X 1156E 1157X 1157E	K50P768-A	1-OPN/0-$\overline{\text{OPN}}$
	ENG 1 HE SPLY ISOL VLV 2 CLOSE		1166E 1167E		1-CLS/0-$\overline{\text{CLS}}$
R2/S56	ENG 2 HE SPLY ISOL VLV 1 OPEN	2	1255X 1255E	K50P770-A	1-OPN/0-$\overline{\text{OPN}}$
	ENG 2 HE SPLY ISOL VLV 1 CLOSE		1265E		1-CLS/0-$\overline{\text{CLS}}$
R2/S13	ENG 2 HE SPLY ISOL VLV 2 OPEN	2	1256X 1256E 1257X 1257E	K50P771-A	1-OPN/0-$\overline{\text{OPN}}$
	ENG 2 HE SPLY ISOL VLV 2 CLOSE		1266E 1267E		1-CLS/0-$\overline{\text{CLS}}$
R2/S57	ENG 3 HE SPLY ISOL VLV 1 OPEN	2	1355X 1355E	K50P773-A	1-OPN/0-$\overline{\text{OPN}}$
	ENG 3 HE SPLY ISOL VLV 1 CLOSE		1365E		1-CLS/0-$\overline{\text{CLS}}$

TABLE 1 - STIMULI [illegible] TO MPS MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R2/S14	ENG 3 HE SPLY ISOL VLV 2 OPEN	2	V41K1356X 1356E 1357X 1357E	K50P774-A	1-OPN/0-$\overline{\text{OPN}}$
	ENG 3 HE SPLY ISOL VLV 2 CLOSE		1366E 1367E		1-CLS/0-$\overline{\text{CLS}}$
R2/S9	ENG 1 HE I/C "IN" VLV OPEN	2	V41K1162X 1162E 1163X 1163E	K50P86-A	1-OPN/0-CLS
	ENG 1 HE I/C "OUT" VLV OPEN		1168X 1168E 1169E	K50P766-A	
R2/S10	ENG 2 HE I/C "IN" VLV OPEN	2	1262X 1262E 1263X 1263E	K50P87-A	1-OPN/0-CLS
	ENG 2 HE I/C "OUT" VLV OPEN		1268X 1268E 1269E	K50P769-A	
R2/S11	ENG 3 HE I/C "IN" VLV OPEN	2	1362X 1362E 1363X 1363E	K50P88-A	1-OPN/0-CLS

TABLE 1 - STIMILI [illegible]UT TO MPS MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R2/S11 cont.	ENG 3 HE I/C "OUT" VLV OPEN	2	V41K1368X 1368E 1369E	K50P772-A	1-OPN/0-CLS
R2/S54	ENG 2 HE PNEU XOVR VLV OPN	2	1613X 1613E 1619E	K50P89-A	1-OPN/0-CLS
R2/S15	PNEU HE SPLY ISOL VLV 1 OPEN	2	V41K1607X 1607E 1608X	K50P775-A	1-OPN/0-CLS
	PNEU HE SPLY ISOL VLV 1 CLOSE		1609E		
	PNEU HE SPLY ISOL VLV 2 OPEN	2	1607X 1607E 1608X	K50P776-A	1-OPN/0-CLS
	PNEU HE SPLY ISOL VLV 2 CLOSE		1609E		
(NONE)	LO2 POGO ACCUM VLV 1 CLOSE	2	1815X 1816X	K50P729-A	1-CLS/0-OPN
	LO2 POGO ACCUM VLV 2 CLOSE	2	1825X 1826X	K50P731-A	1-CLS/0-OPN
(NONE)	LO2 OVBD BLEED VLV CLOSE	2	1584X 1585X 1586X	K50P733-A	1-CLS/0-OPN

TABLE 1 - STIMULI I ... O MPS MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R4/S6	LO2 OTBD FILL VLV OPEN	2	V41K1518X 1518E	K50P734-A	1-OPN/O-CLS
	LO2 OTBD FILL VLV CLOSE	2	1515X 1515E	K50P735-A	1-CLS/O-OPN
R4/S7	LO2 INBD FILL VLV OPEN	2	1501X 1501E 1502X	K50P737-A	1-OPN/O/CLS
	LO2 INBD FILL VLV CLOSE	2	1512X 1512E	K50P738-A	1-CLS/O-OPN
R4/S9	LH2 TOPPING VLV OPEN	2	1411X	K50P740-A	1-OPN/O-CLS
	LH2 TOPPING VLV CLOSE	5	1408E		
	LH2 INBD FILL VLV OPEN	2	1401X 1401E 1402X	K50P742-A	1-OPN/O-CLS
	LH2 INBD FILL VLV CLOSE	2	1412X 1412E	K50P743-A	1-CLS/O-OPN
	LH2 HI POINT BLEED VLV OPEN	5	1465E	K50P795-A	1-OPN/O-CLS
R4/S8	LH2 OTBD FILL VLV OPEN	2	1391X 1391E	K50P745-A	1-OPN/O-CLS
	LH2 OTBD FILL VLV CLOSE	2	1393X 1393E	K50P746-A	1-CLS/O-OPN

TABLE 1 - STIMULI INPUT TO MPS MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
(NONE)	LH2 FEED RTLS OTBD VLV OPEN	2	V41K1913X 1914X 1915X	K50P748-A	1-OPN/0-CLS
	LH2 FEED RTLS INBD VLV OPEN	2	1923X 1924X 1925X	K50P750-A	1-OPN/0-CLS
R4/S17	LO2 RELIEF SHUT-OFF VLV CLOSE	2	1547X 1547E 1548X	K50P752-A	1-CLS/0-OPN
	LO2 RELIEF SHUT-OFF VLV OPEN	2	1543E		
R4/S18	LH2 RELIEF SHUT-OFF VLV CLOSE	2	1447X 1447E 1448X	K50P754-A	1-CLS/0-OPN
	LH2 RELIEF SHUT-OFF VLV OPEN	2	1443E		
(NONE)	LO2 FEED DISC VLV OPEN	2	1521X 1522X 1523X	K50P756-A	1-OPN/0-CLS
	LO2 FEED DISC VLV CLOSE	2	1524X 1525X 1526X	K50P757-A	1-CLS/0-OPN
(NONE)	LH2 FEED DISC VLV OPEN	2	1413X 1414X	K50P759-A	1-OPN/0-CLS

TABLE 1 - STIMULI I O MPS MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
(NONE)	LH2 FEED DISC VLV OPEN	2	V41K1415X	K50P759-A	1-OPN/0-CLS
	LH2 FEED DISC VLV CLOSE	2	1416X 1417X 1418X	K50P760-A	1-CLS/0-OPN
(NONE)	LH2 RECIRC DISC VLV OPEN	2	1421X	K50P762-A	1-OPN/0-CLS
	LH2 RECIRC DISC VLV CLOSE	2	1422X	K50P763-A	1-CLS/0-OPN
R4/S2	LH2 MANIFOLD REPRESS VLV 1 OPEN	2	1435X 1435E	K50P779-A	1-OPN/0-CLS
	LH2 MANIFOLD REPRESS VLV [illegible] LOSE	2	1431E		
	LH2 MANIFOLD REPRESS VLV 2 OPEN	2	1437X	K50P780-A	1-OPN/0-CLS
	LH2 MANIFOLD REPRESS VLV 2 CLOSE	5	1432E		
R4/S1	LO2 MANIFOLD REPRESS VLV 1 OPEN	2	1535X 1535E	K50P781-A	1-OPN/0-CLS
	LO2 MANIFOLD REPRESS VLV 1 CLOSE	2	1531E		
	LO2 MANIFOLD REPRESS VLV 2 OPEN	2	1537X	K50P782-A	1-OPN/0-CLS
	LO2 MANIFOLD REPRESS VLV 2 CLOSE	5	1532E		
(NONE)	RTLS REPRESS VLV 1 OPEN	2	1905X 1907X	K50P790-A	1-OPN/0-CLS
	RTLS REPRESS VLV 2 OPEN	2	1906X 1908X	K50P791-A	1-OPN/0-CLS

TABLE 1 - STIMULI INPUT TO MPS MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
(NONE)	LH2 RECIRC PUMP VLV OPEN	4,5	V41K1111N	K50P721-A	1-OPN/0-CLS
(NONE)	PNEU HE SUPPLY PRESS			HE1	0/5000 PSIA
	ENG 1 HE SUPPLY PRESS	7		HE2	0/5000 PSIA
	ENG 2 HE SUPPLY PRESS			HE3	0/5000 PSIA
	ENG 3 HE SUPPLY PRESS			HE4	0/5000 PSIA
(NONE)	GO2 FLOW CONTROL VLV - ENG 1	14		K50P792-1	1-MIN/0-MAX
	GO2 FLOW CONTROL VLV - ENG 2			93-1	1-MIN/0-MAX
	GO2 FLOW CONTROL VLV - ENG 3			94-1	1-MIN/0-MAX
	GH2 FLOW CONTROL VLV - ENG 1			87-1	1-MIN/0-MAX
	GH2 FLOW CONTROL VLV - ENG 2			88-1	1-MIN/0-MAX
	GH2 FLOW CONTROL VLV - ENG 3			89-1	1-MIN/0-MAX
(NONE)	ENG 1 PRE-VLV INHIBIT CMD A	15	V41K1125X		1-INHIB/0-$\overline{\text{INHIB}}$
	ENG 1 PRE-VLV INHIBIT CMD B		1126X		
	ENG 2 PRE-VLV INHIBIT CMD A		1225X		
	ENG 2 PRE-VLV INHIBIT CMD B		1226X		
	ENG 3 PRE-VLV INHIBIT CMD A		1325X		
	ENG 3 PRE-VLV INHIBIT CMD B		1326X		
(NONE)	LO2 DUMP TIME	7		LDT	0/500 SEC
	LH2 DUMP TIME	7		HDT	0/500 SEC

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUT FROM MPS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
*V41P1100C	ENG 1 LH2 INLET PRESS	0	0	12 52	61 266	32	164	22	113	PSIA
*V41T1101C	ENG 1 LH2 INLET TEMP	-423	286	-405	1023					DEGF
V41X1104X	ENG 1 LH2 PRE-VLV OPEN - A	1	1	0	0					STATE
V41X1105E	ENG 1 LH2 PRE-VLV CLOSED	0	0	1	1					STATE
V41X1106X	ENG 1 LH2 PRE-VLV OPEN - B	1	1	0	0					STATE
V41X1109E	ENG 1 LH2 RECIRC VLV OPEN	1	1	0	0					STATE
V41X1110E	ENG 1 LH2 RECIRC VLV CLOSED	0	0	1	1					STATE
*V41R1115A	ENG 1 LH2 RECIRC PUMP SPEED	11183	572	0	0					RPM
*V41P1130C	ENG 1 LO2 INLET PRESS	0	0	17	58	123	419			PSIA
*V41T1131C	ENG 1 LO2 INLET TEMP	-290	307	-255	1023					DEGF
V41X1134X	ENG 1 LO2 PRE-VLV OPEN	1	1	0	0					STATE
V41X1135E	ENG 1 LO2 PRE-VLV CLOSED	0	0	1	1					STATE
*V41P1150C	ENG 1 HE SUPPLY PRESS	4198	859							PSIA
*V41P1153A	ENG 1 HE I/F B	762	780	32	33					PSIG
*V41P1154A	ENG 1 HE I/F A	752	769	22	23					PSIG
*V41P1200C	ENG 2 LH2 INLET PRESS	0	0	14 54	72 276	34	175	24	123	PSIA
*V41T1201C	ENG 2 LH2 INLET TEMP	-419	450	-405	1023					DEGF
V41X1204X	ENG 2 LH2 PRE-VLV OPEN - A	1	1	0	0					STATE
V41X1205E	ENG 2 LH2 PRE-VLV CLOSED	0	0	1	1					STATE
V41X1206X	ENG 2 LH2 PRE-VLV OPEN - B	1	1	0	0					STATE
V41X1209E	ENG 2 LH2 RECIRC VLV OPEN	1	1	0	0					STATE
V41X1210E	ENG 2 LH2 RECIRC VLV CLOSED	0	0	1	1					STATE

*NOTE: This measurement uses the range limit conversion method of calculating FS_{EU}.

MEASUREMENT OUTPUT FROM MPS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
*V41R1215A	ENG 2 LH2 RECIRC VLV PUMP SPEED	11202	573	0	0					RPM
*V41P1230C	ENG 2 LO2 INLET PRESS	0	0	19	65	150	512			PSIA
*V41T1231C	ENG 2 LO2 INLET TEMP	-286	389	-255	1023					DEGF
V41X1234X	ENG 2 LO2 PRE-VLV OPEN	1	1	0	0					STATE
V41X1235E	ENG 2 LO2 PRE-VLV CLOSED	0	0	1	1					STATE
*V41P1250C	ENG 2 HE SUPPLY PRESS	3998	818							PSIA
*V41P1253A	ENG 2 HE I/F B	764	782	34	35					PSIG
*V41P1254A	ENG 2 HE I/F A	754	771	24	25					PSIG
*V41P1300C	ENG 3 LH2 INLET PRESS	0	0	16 56	82 286	26	133	36	185	PSIA
*V41T1301C	ENG 3 LH2 INLET TEMP	-413	696	-405	1023					DEGF
V41X1304X	ENG 3 LH2 PRE-VLV OPEN - A	1	1	0	0					STATE
V41X1305E	ENG 3 LH2 PRE-VLV CLOSED	0	0	1	1					STATE
V41X1306X	ENG 3 LH2 PRE-VLV OPEN - B	1	1	0	0					STATE
V41X1309E	ENG 3 LH2 RECIRC VLV OPEN	1	1	0	0					STATE
V41X1310E	ENG 3 LH2 RECIRC VLV CLOSED	0	0	1	1					STATE
*V41R1315A	ENG 3 LH2 RECIRC PUMP SPEED	11222	574	0	0					RPM
*V41P1330C	ENG 3 LO2 INLET PRESS	0	0	21	72	174	593			PSIA
*V41T1331C	ENG 3 LO2 INLET TEMP	-279	532	-255	1023					DEGF
V41X1334X	ENG 3 LO2 PRE-VLV OPEN	1	1	0	0					STATE
V41X1335E	ENG 3 LO2 PRE-VLV CLOSED	0	0	1	1					STATE

*NOTE: This measurement uses the range limit conversion method of calculating FS_{EU}.

MEASUREMENT OUTPL FROM MPS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
*V41P1350C	ENG 3 HE SUPPLY PRESS	4101	839							PSIA
*V41P1353A	ENG 3 HE I/F B	766	784	36	37					PSIG
*V41P1354A	ENG 3 HE I/F A	756	773	26	27					PSIG
V41X1388E	LH2 OTBD FILL VLV OPEN	0	0	1	1					STATE
V41X1389X	LH2 OTBD FILL VLV CLOSED	1	1	0	0					STATE
V41X1409E	LH2 INBD FILL VLV OPEN	0	0	1	1					STATE
V41X1410X	LH2 INBD FILL VLV CLOSED	1	1	0	0					STATE
V41X1419E	LH2 RECIRC DISC VLV OPEN	1	1	0	0					STATE
*V41T1428A	LH2 FEED MANIFOLD DISC TEMP	-428	82	-405	1023					DEGF
V41X1429X	LH2 FEED DISC VLV OPEN	1	1	0	0					STATE
V41X1430X	LH2 FEED DISC VLV CLOSED - A	0	0	1	1					STATE
*V41P1433C	LH2 ENG MANIFOLD PRESS	55	563	150	1530	20	205	25	256	PSIA
V41X1434X	LH2 FEED DISC VLV CLOSED - B	0	0	1	1					STATE
V41X1442E	LH2 FEED LINE RLF SHUT-OFF VLV CLOSED	0	0	1	1					STATE
V41X1453E	LH2 TOPPING VLV OPEN	1	1	0	0					STATE
V41X1456X	LH2 TOPPING VLV CLOSED	0	0	1	1					STATE
V41X1468E	LH2 HI POINT BLEED VLV OPEN	1	1	0	0					STATE
V41X1469E	LH2 HI POINT BLEED VLV CLOSED	0	0	1	1					STATE
V41X1509X	LO2 INBD FILL VLV CLOSED	1	1	0	0					STATE
V41X1510E	LO2 INBD FILL VLV OPEN	0	0	1	1					STATE
V41X1513E	LO2 OTBD FILL VLV OPEN	0	0	1	1					STATE
V41X1514X	LO2 OTBD FILL VLV CLOSED	1	1	0	0					STATE

MEASUREMENT OUTPUT FR. MPS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
*V41T1528A	LO2 FEED MANIFOLD DISC TEMP	-298	143	-255	1023					DEGF
V41X1529X	LO2 FEED DISC VLV OPEN	1	1	0	0					STATE
V41X1530X	LO2 FEED DISC VLV CLOSED - A	0	0	1	1					STATE
*V41P1533C	LO2 ENG MANIFOLD PRESS	155	529	20	68	0	0			PSIA
V41X1534X	LO2 FEED DISC VLV CLOSED - B	0	0	1	1					STATE
V41X1542E	LO2 FEED LINE RLF SHUT-OFF VLV CLOSED	0	0	1	1					STATE
V41X1580X	LO2 OVBD BLEED VLV CLOSED - A	1	1	0	0					STATE
V41X1581X	LO2 OVBD BLEED VLV CLOSED - B	1	1	0	0					STATE
V41X1587E	LO2 OVBD BLEED VLV OPEN	0	0	1	1					STATE
*V41P1600A	PNEU VLV HE SUPPLY PRESS	4052	829							PSIA
*V41P1605A	PNEU HE REG OUT PRESS	758	775	28	29					PSIG
V41X1811X	LO2 ACCUM RECIRC VLV 1 OPEN	1	1	0	0					STATE
V41X1818E	LO2 ACCUM RECIRC VLV 1 CLOSED	0	0	1	1					STATE
V41X1821X	LO2 ACCUM RECIRC VLV 2 OPEN	1	1	0	0					STATE
V41X1828E	LO2 ACCUM RECIRC VLV 2 CLOSED	0	0	1	1					STATE
V41X1919X	LH2 RTLS OTBD DRAIN VLV CLOSED	1	1	0	0					STATE
V41X1929X	LH2 RTLS INBD DRAIN VLV CLOSED	1	1	0	0					STATE
†VGH1	ENG 1 GH2 FLOW CONTROL VLV POSN - LO	0	0	1	1					STATE
†VGH2	ENG 2 GH2 FLOW CONTROL VLV POSN - LO	0	0	1	1					STATE
†VGH3	ENG 3 GH2 FLOW CONTROL VLV POSN - LO	0	0	1	1					STATE
†VGO1	ENG 1 GO2 FLOW CONTROL VLV POSN - LO	0	0	1	1					STATE
†VGO2	ENG 2 GO2 FLOW CONTROL VLV POSN - LO	0	0	1	1					STATE
†VGO3	ENG 3 GO2 FLOW CONTROL VLV POSN - LO	0	0	1	1					STATE

*NOTE: This measurement uses the range limit conversion method of calculating FS_{EU}.
†THESE PSEUDO OUTPUTS DO NOT APPLY TO GTS.

MEASUREMENT OUTPUT FROM MPS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
+VE1	ENG 1 PLUMBING READY DISCRETE	0	0	1	1					STATE
+VE2	ENG 2 PLUMBING READY DISCRETE	0	0	1	1					STATE
+VE3	ENG 3 PLUMBING READY DISCRETE	0	0	1	1					STATE
LO2DP	LO2 DUMP SIGNAL	0	0	1	1					STATE
LH2DP	LH2 DUMP SIGNAL	0	0	1	1					STATE
RTLSDP	RTLS DUMP SIGNAL	0	0	1	1					STATE

† THESE PSEUDO OUTPUTS DO NOT APPLY TO GTS.

APPENDIX F

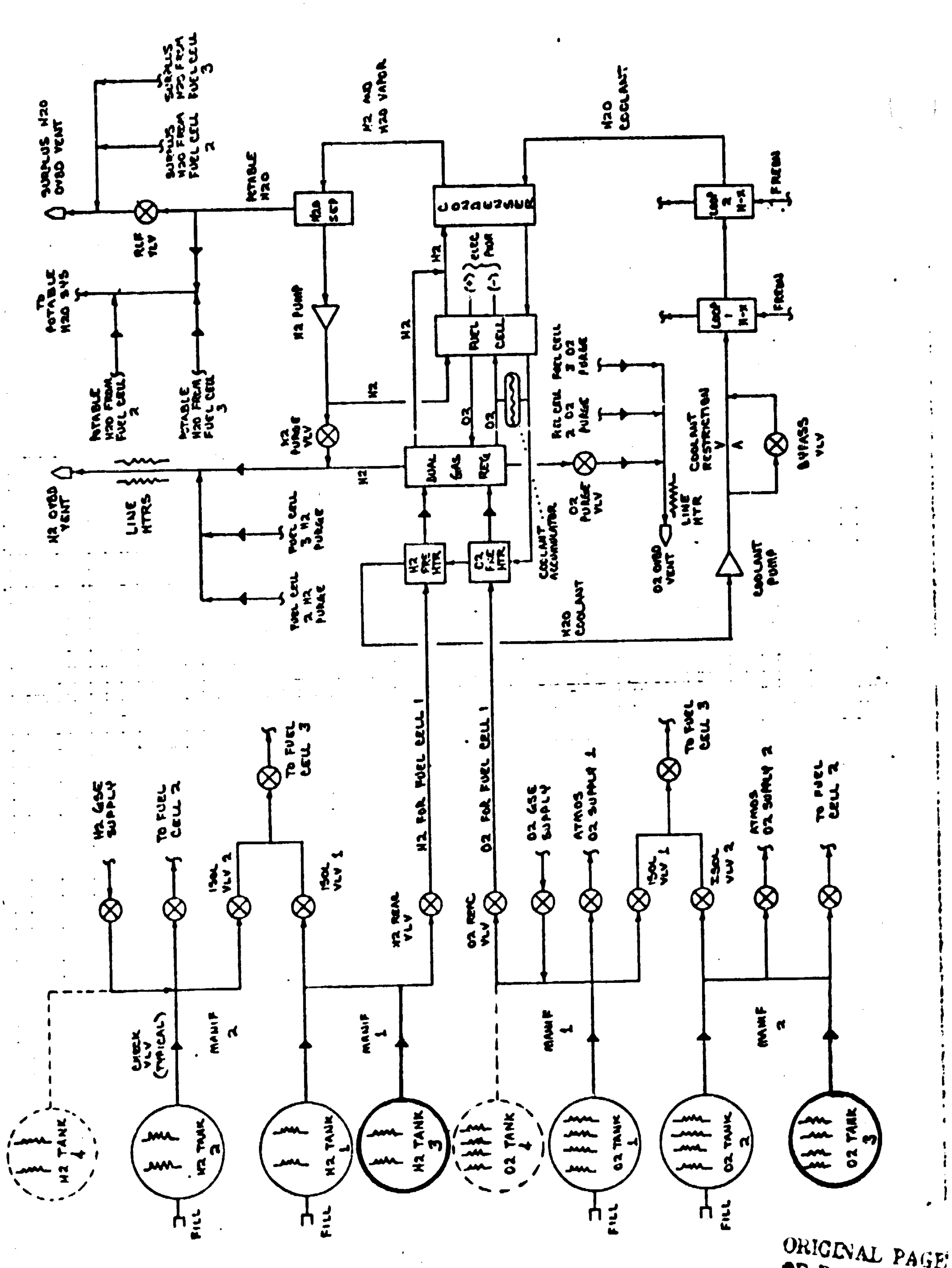
FUEL CELL/CRYO MATH MODEL REQUIREMENTS

CONTENTS

FIGURES

1. INTRODUCTION

The FC/CRYO system provides the Orbiter with electrical power and can be divided into two major systems, 1) the fuel cell power plants where reactants are converted into electrical energy, and 2) the reactant storage and distribution system where reactants are stored in a cryogenic state, then heated to a gas and supplied to the fuel cell power plants. Gaseous oxygen is also provided for the Environmental Control and Life Support System (ECLSS) as well as potable water, a by-product of the fuel cell energy reaction. Figure 1 is a simplified schematic of the FC/CRYO system. Hydrogen and oxygen tanks 4 are not planned for use in STS-1 or STS-2 flights. Consequently only tanks 1, 2 and 3 are simulated in the math model, and tank 4 is shown in dashed lines in figure 1 for reference purposes. There are three fuel cells although figure 1 shows only one for clarity. Each fuel cell has a water coolant loop to transport heat from heat exchangers. To improve the performance of the fuel cells, purge valves are provided to flush impurities overboard. The purge operation may be performed manually or automatically by the GPC but must be initiated by the crew. Each fuel cell has a power rating of 2 to 7 KW continuous duty, or 12 KW peak duty for not more than 15 minutes. Output voltage is 28 to 32 volts DC.



FUEL CELL / CRYO SUBSYSTEM SCHEMA

FIGURE 1 F-2

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2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in Table 1 to produce values for the output measurements listed in Table 2 that simulate the operation of the FC/CRYO subsystem.

2.1 MATH MODEL DESCRIPTION

The FC/CRYO flow diagram begins with the cryogenic system and ends with the fuel cell system.

2.1.1 LATCHING VALVE ROUTINE (LVR)

To simplify the logic, a subroutine called LVR is used repetitively to determine the position of the various latching valves in the system. If a valve OPEN command is received, an internal variable "A" is set to 1. If a valve CLOSE command is received, an internal variable "B" is set to 1. The LVR then checks the values of A and B and sets a third variable "V", to 1 or 0, indicating an OPEN or CLOSED valve, respectively. The value of "V" is then used to set the output measurement which indicates the position of the valve. If both an OPEN and a CLOSE command are received due to error, i.e. "A" and "B" both = 1, the LVR will not set "V" and the output measurement indicating the valve's position will remain unchanged from its previous value. The same is true when neither an OPEN or CLOSE command is received.

2.1.2 INTERNAL VARIABLES

The internal variables used in the flow diagram are described below along with their state definition.

NAME	FUNCTION	STATE 0	STATE 1
FLAG	Indicates the state of 02 pressure on the fuel cell coolant accumulator.	PRESS LO	PRESS OK
OP	Indicates the state of 02 pressure at fuel cell 3 supply valve inlet.	PRESS LO	PRESS OK
HP	Indicates the state of H2 pressure at fuel cell 3 supply valve inlet.	PRESS LO	PRESS OK
A	Represents an OPEN command in the Latching Valve Routine (LVR).	OFF	ON
B	Represents a CLOSE command in the Latching Valve Routine (LVR).	OFF	ON
V	Indicates the valve position in the Latching Valve Routine (LVR).	CLSD	OPN
V1	02 GSE supply valve position.	OPN	CLSD
V2	H2 GSE supply valve position.	OPN	CLSD
V3	02 isolation valve 1.	CLSD	OPN
V4	02 isolation valve 2.	CLSD	OPN
V5	H2 isolation valve 1.	CLSD	OPN
V6	H2 isolation valve 2.	CLSD	OPN
V7	02 ECLSS supply valve 1.	CLSD	OPN
V8	02 ECLSS supply valve 2.	CLSD	OPN
V9	FC 1 02 reactant supply valve.	CLSD	OPN
V10	FC 1 H2 reactant supply valve.	CLSD	OPN
V11	FC 2 02 reactant supply valve.	CLSD	OPN
V12	FC 2 H2 reactant supply valve.	CLSD	OPN
V13	FC 3 02 reactant supply valve.	CLSD	OPN
V14	FC 3 H2 reactant supply valve.	CLSD	OPN

2.1.3 FUEL CELL ROUTINE OVERVIEW

To clarify the fuel cell logic, which extends over several pages, an overview is provided which depicts the various logic flow paths possible for an individual fuel cell. The dotted lines on the overview define page boundaries. Output measurement values shown in the overview are for information only. The detailed logic for a specific fuel cell designates the required output measurement values.

2.1.4 INPUT PSEUDOS FROM THE OPERATOR KEYBOARD

Three pseudos (L1, L2 and L3) are used as operator inputs to the FC/CRYO model. These inputs permit the model to simulate O2 and H2 flow rates that occur when the fuel cells are either ON-LINE and supplying BUS power, or are OFF-LINE on standby or off.

L1 represents FC1, and 1 = ON-LINE, 0 = OFF-LINE

L2 represents FC2, and 1 = ON-LINE, 0 = OFF-LINE

L3 represents FC3, and 1 = ON-LINE, 0 = OFF-LINE

2.1.5 INITIAL CONDITIONS

Note that initial conditions for STS are the same as those listed for GTS; see GTS PREPROCESSOR LOGIC.

2.2 STS UNIQUE REQUIREMENTS

Since fuel cell substitutes are actually providing the vehicle power during SAIL tests, it is necessary that the DCM operator signal the FC/CRYO model when a particular fuel cell is supposed to be supplying power. This allows the proper O2 and H2 flow rates to be determined. The actual current flowing in the vehicle busses is not visible to the math model, so when a fuel cell is simulating supplying power, the O2 and H2 flow rates provided by the model will be either at their maximum or minimum value, depending on whether or not a purge is in progress. This prevents vehicle software from calculating an erroneous position for the O2 and H2 purge valves. There is no position indication measurement on the purge valves so flight software monitors the total reactant flow (provided by the model) and subtracts a calculated amount based on the current in the bus (provided by the fuel cell substitutes). This difference will then indicate the purge valve is open or closed.

The heaters in the O2 and H2 cryogenic tanks are controlled by a three position switch: 1-Off, 2-AUTO, 3-ON, and by a heater controller. The math model does not know the position of the switch. The math model will see only power or no power to the heaters as provided by the heater controller.

Using a tank pressure value that is less than the low limit will cause the heater controller to provide power whenever the switch is in AUTO or ON. When no power is supplied, the switch will be assumed OFF and the tank pressure value will then reflect a heaters OFF condition.

2.3 GTS UNIQUE REQUIREMENTS

2.3.1 PREPROCESSOR LOGIC

The FC/CRYO math model was originally required in the STS simulator. The math model input stimuli symbols referred to in the logic flow diagram, section 3.2, are ATA Reference connector and pin numbers. Due to the lack of flight hardware circuitry in the GTS simulator, logic functions that bridge the gap between the payload MDM's and the fuel cell subsystem are required in a GTS preprocessor in order to evaluate values for the input stimuli coming from the GPC prior to execution of the model. This is the case for the H2/O2 Purge Heaters command, the Fuel Cells 1, 2, 3 O2 Purge Valve Open commands, and the Fuel Cells 1, 2, 3 H2 Purge Valve Open commands. See section 3.1 for a listing of the required logic functions.

2.3.2 FUEL CELL CURRENT AND VOLTAGE

Fuel cell current and voltage are not provided by facility fuel cell substitute units as in the STS. These parameters are required to support the FC Purge special processes in the GPC. Rather than add these parameters to the FC/CRYO model in GTS and make it different from the one in STS, FC current and voltage are provided as part of the SWITCH model.

3. MATH MODEL LOGIC

This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

The basic input stimuli to the model are identified by ATA reference system connector-pin (CP) numbers. A logical combination of one or more MML numbers is used to derive the proper input stimulus for each CP. Within the STS, the logical combination is accomplished via hardware circuitry. However, within the GTS, due to the absence of the required circuitry, the logical relations between CP and MML must be effected by software. The following logical equations are required as a preprocessor within GTS in order to calculate the correct CP stimuli which are then input to the model. Most equations are merely a direct one-for-one correspondence between CP and MML. However, some equiations may require more than one MML to be combined by the logical product (AND) and the inclusive logical sum (OR). In these instances, "AND" denotes the logical product and "OR" denotes the inclusive logical sum.

The SOURCE columns contain an entry for the MDM, connector end pin from which the MML is received. In the absnece of an entry in these columns, the operator must make the entry via the NAS keyboard.

The final column lists the input stimuli initialization values required. Notice that inputs containing an entry for SOURCE do not have an initialization value, since they are updated at the GTS simulator cycle rate by the source connection.

GTS MATH MODEL STIMULI - FC/CRYO
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN	(V45K-----) MML ID	SOURCE*		INITIALIZATION VALUES
		MDM	CONN/PIN	
K40TB100-KC	= 0604Y	PF02	J07/072	
	OR 0605Y	PF02	J07/082	
K40TB101-KC	= 0604Y	PF02	J07/072	
	OR 0605Y	PF02	J07/082	
K40P862-D	= 0815Y	PF01	J05/117	
	AND 0816Y	PF01	J05/115	
K40P862-E	= 0815Y	PF01	J05/117	
	AND 0816Y	PF01	J05/115	
K40P872-D	= 0825Y	PF01	J07/072	
	AND 0826Y	PF01	J07/082	
K40P872-E	= 0825Y	PF01	J07/072	
	AND 0826Y	PF01	J07/082	
K40P882-D	= 0835Y	PF02	J05/117	
	AND 0836Y	PF02	J05/115	
K40P882-E	= 0835Y	PF02	J05/117	
	AND 0836Y	PF02	J05/115	
K40P862-B	= V45K0109E			1
872-B	= 0209E			1
882-B	= 0309E			1
862-M	= 0112E			0
872-M	= 0212E			0
882-M	= 0312E			0
862-V	= 0180E			0
872-V	= 0280E			0
882-V	= 0380E			0
862-C	= 0191E			0
872-C	= 0291E			0
882-C	= 0391E			0

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

GTS MATH MODEL STIMULI - FC/CRYO

MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN		(V45K-----) MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
K40TB11-KC	=	V45K0601E			0
K40TB12-KC	=	0601E			0
K40P9875-1	=	1084E			1
75-2	=	1085E			0
76-1	=	1086E			1
76-2	=	1087E			0
K40P9851-A	=	1131E			1
K40P9831-A	=	1231E			1
KJ5-A	=	1331E			1
K40P9851-C	=	1131E			1
K40P9831-C	=	1231E			1
KJ5-C	=	1331E			1
K40P9852-A	=	V45K1136E			1
K40P9832-A	=	1236E			1
KJ6-A	=	1336E			1
K40P9852-C	=	1136E			1
K40P9832-C	=	1236E			1
KJ6-C	=	1336E			1
K40P9871-1	=	1143E			1
71-2	=	1144E			0
72-1	=	1148E			1
72-2	=	1149E			0
77-1	=	1151E			1
78-1	=	1151E			1
77-2	=	1152E			0
78-2	=	1152E			0
79-1	=	1156E			1
80-1	=	1156E			1
79-2	=	1157E			0
80-2	=	1157E			0

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.

**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

GTS MATH MODEL STIMULI - FC/CRYO
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN	(V45K-----) MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
K40P9881-1 =	V45K1161E			1
82-1 =	1161E			1
81-2 =	1162E			0
82-2 =	1162E			0
11-B =	2131E			1
41-B =	2231E			1
KJ3-A =	2331E			1
K40P9812-A =	2136E			1
K40P9842-A =	2236E			1
KJ4-A =	2336E			1
K40P9873-1 =	2239E			1
73-2 =	2241E			0
74-1 =	2243E			1
74-2 =	2245E			0
K40P862-F =	V45K1121N			0
72-F =	1124N			0
82-F =	1127N			0
K40P9853-A =	1128N			0
9833-A =	1228N			0
9520-A =	1328N			0
K40P9869-1 =	1191N			0
9869-2 =	1196N			1
9813-A =	2128N			0
9843-A =	2228N			0
9547-A =	2328N			0
9870-1 =	2191N			0
9870-2 =	2196N			1
K40P863-12 =	**			1
73-12 =	**			1
83-12 =	**			1

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

GTS MATH MODEL STIMULI - FC/CRYO

MML TO CONN-PIN CONVERSION LOGIC

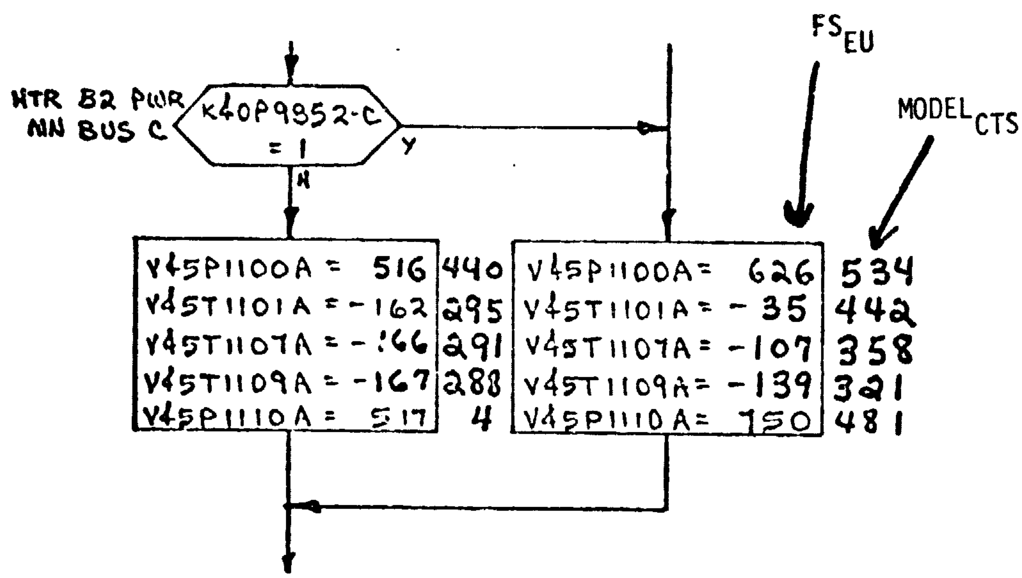
SYSTEM CONN-PIN	(V45K-----) MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
K40P864-A	= **			1
74-A	= **			1
84-A	= **			1
K40P9853-W	= **			1
9833-W	= **			1
9520-W	= **			1
9813-W	= **			1
9843-W	= **			1
9547-W	= **			1

**ARTIFICAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.

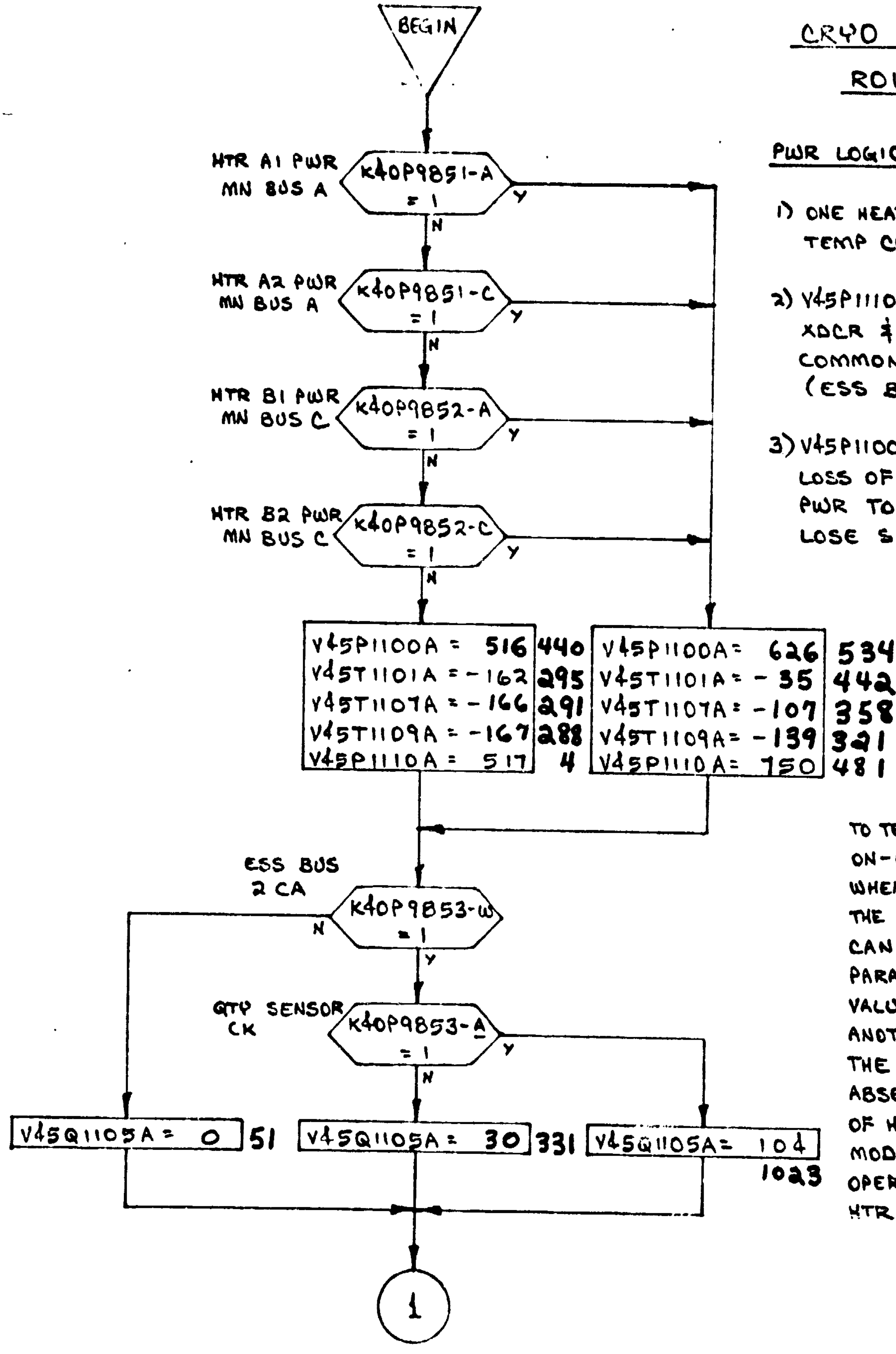
3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;



shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.

CRYO O2 TANK 1 ROUTINE



PWR LOGIC:

1) ONE HEATER GIVES POSITIVE TEMP CONTROL.

2) V45P1110A PRESS PWR TO XDCR & SIGNAL AMP IS COMMON IN SC A2. (ESS BUS 2 CA)

3) V45P1100A PRESS REQUIRES LOSS OF MNA AND MNB PWR TO SC OF1 TO LOSE SIGNAL.

TO TEST THE HTR CONT ON-OFF CAPABILITY WHEN HTR SW ARE IN THE AUTO POSN, TDC CAN INHIBIT THIS PARAMETER'S OUTPUT VALUE AND CAN ENTER ANOTHER VALUE FROM THE DCM. THEN THE ABSENCE OR PRESENCE OF HTR PWR TO THE MODEL WILL INDICATE OPERATION OF THE HTR CONT.

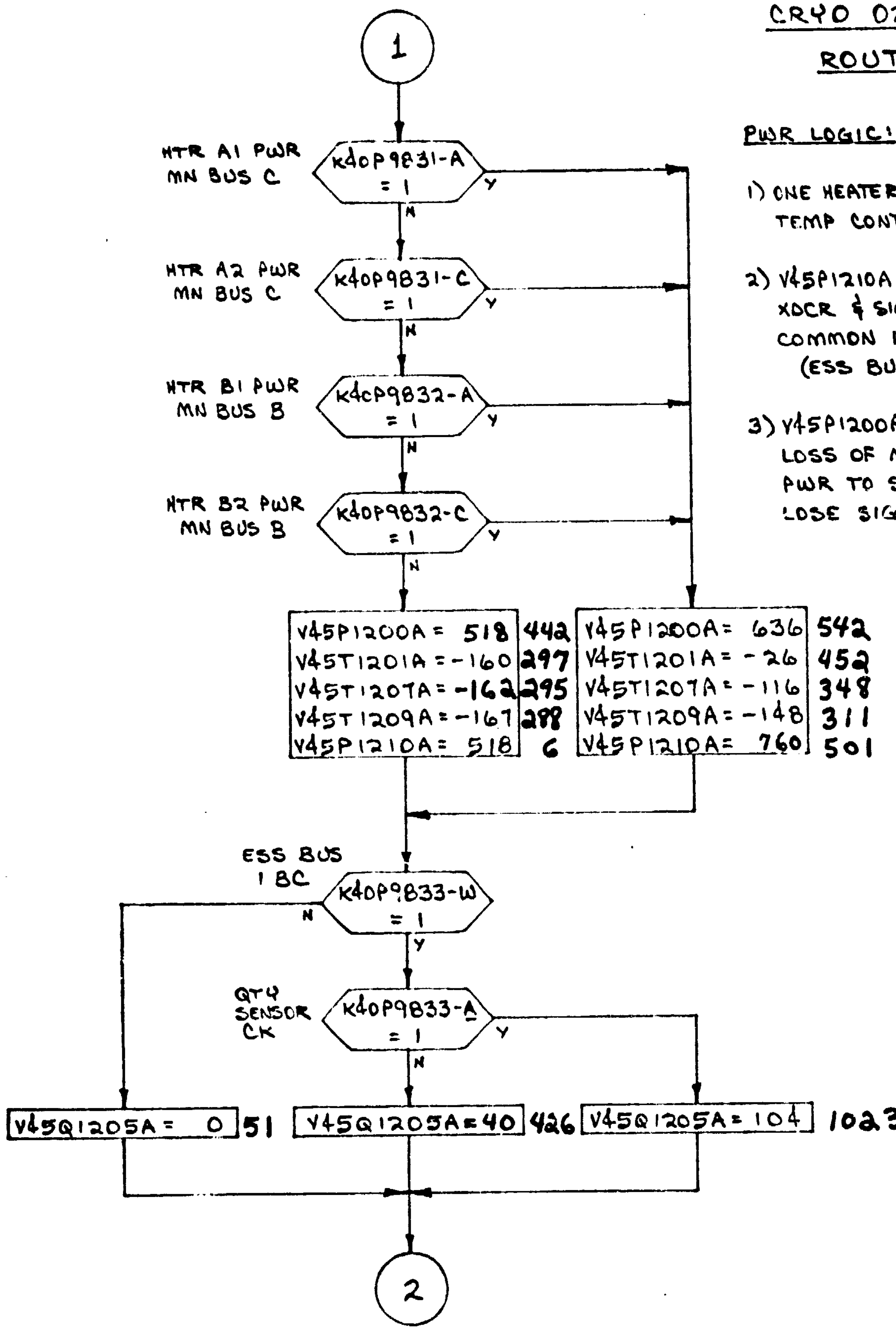
CRYO O2 TANK 2 ROUTINE

PWR LOGIC:

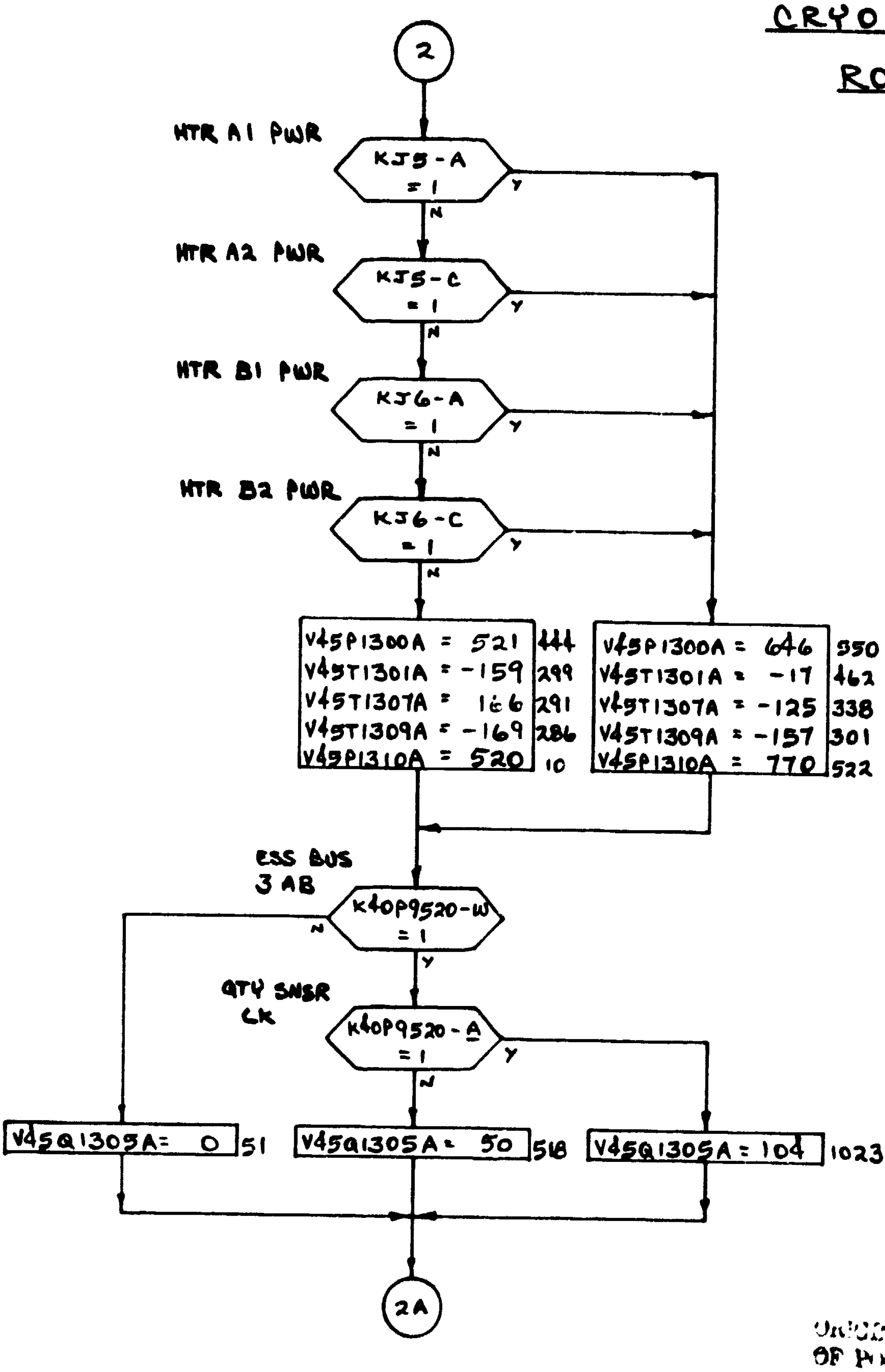
1) ONE HEATER GIVES POSITIVE TEMP CONTROL.

2) V45P1210A PRESS PWR TO XDCR & SIGNAL AMP IS COMMON IN SC A2. (ESS BUS 1BC)

3) V45P1200A PRESS REQUIRES LOSS OF MNC AND MNB PWR TO SC OF3 TO LOSE SIGNAL.



CRYO O2 TANK 3 ROUTINE



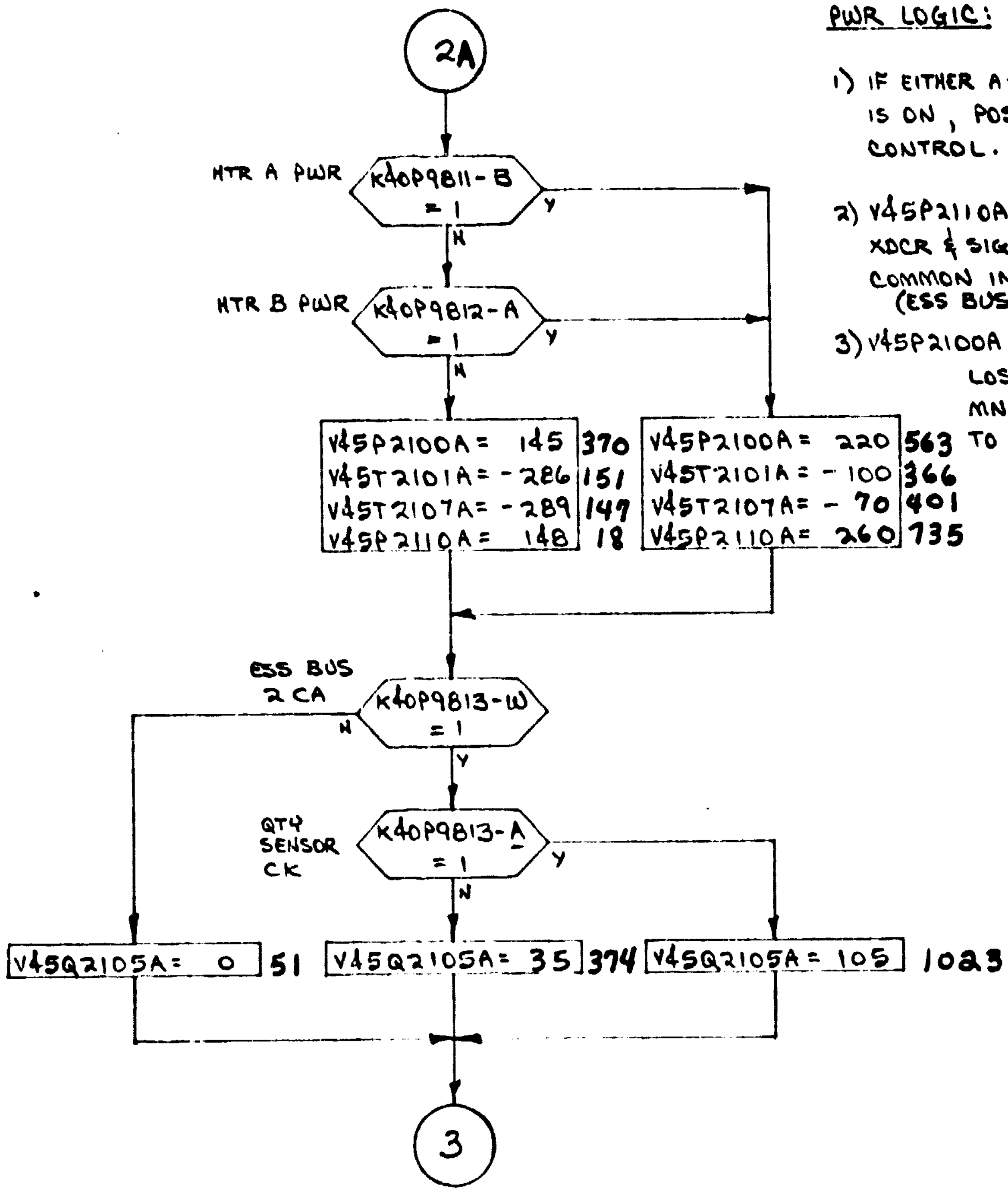
CRYO H2 TANK 1 ROUTINE

PWR LOGIC:

1) IF EITHER A-PWR OR B-PWR IS ON, POSITIVE TEMP CONTROL.

2) V45P2110A PRESS PWR TO XDCR & SIGNAL AMP IS COMMON IN SC A1. (ESS BUS 2CA)

3) V45P2100A PRESS REQUIRES LOSS OF MNA AND MNB PWR TO SC OF1 TO LOSE SIGNAL.



CRYO H2 TANK 2

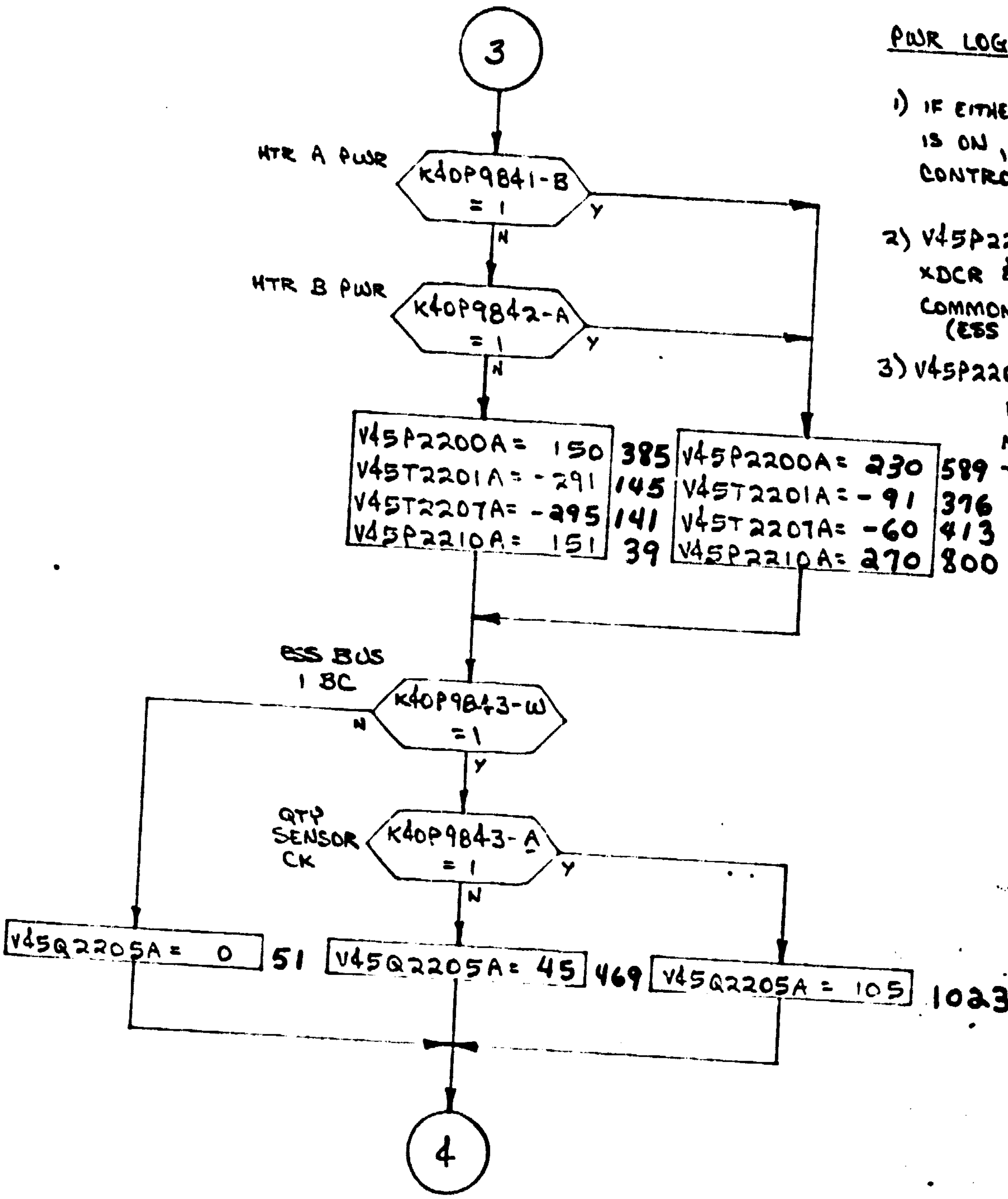
ROUTINE

PWR LOGIC:

1) IF EITHER B-PWR OR C-PWR IS ON, POSITIVE TEMP CONTROL.

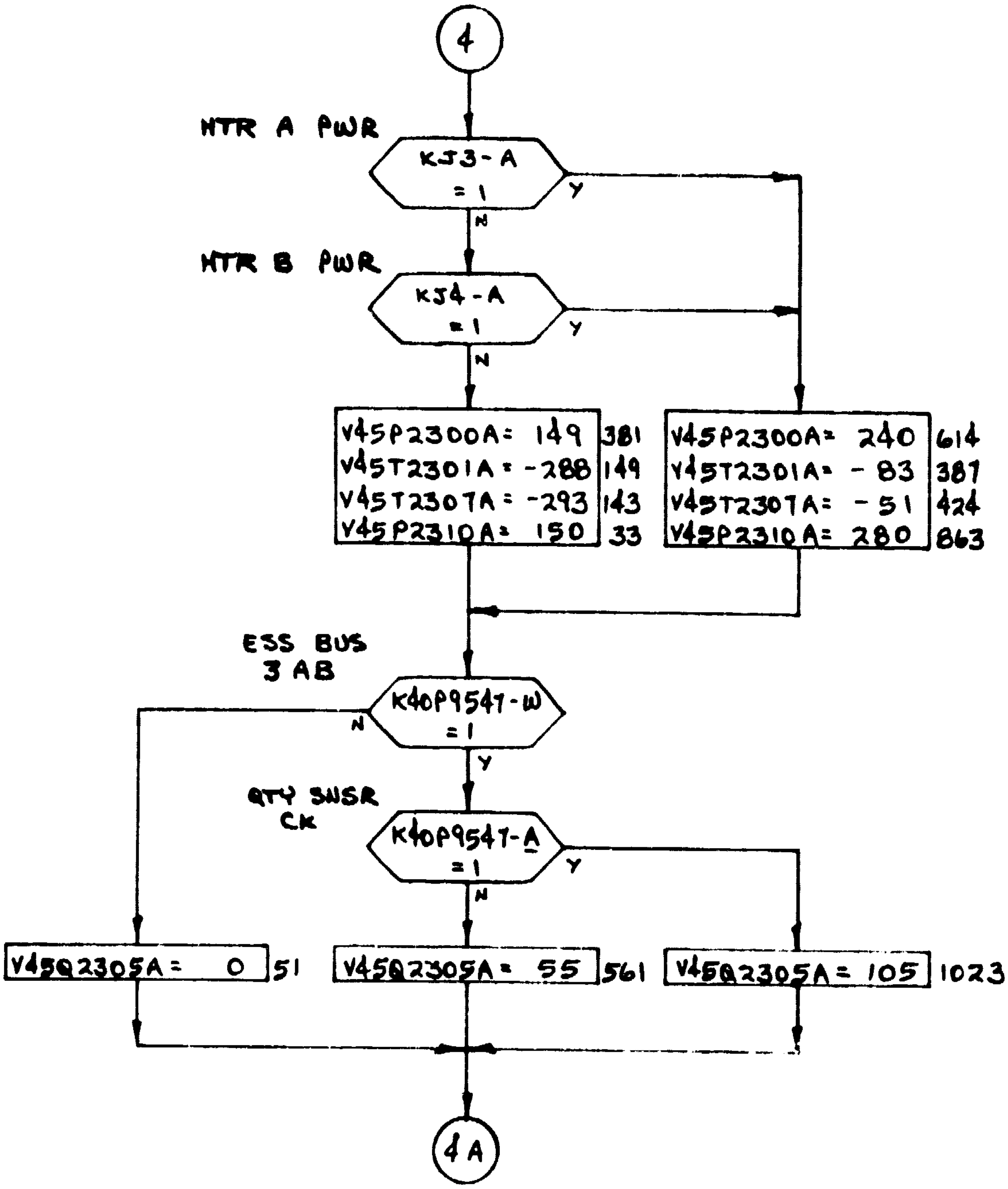
2) V45P2210A PRESS PWR TO XDCR & SIGNAL AMP IS COMMON IN SC A1. (ESS BUS 1BC)

3) V45P2200A PRESS REQUIRES LOSS OF MNB AND MNC PWR TO SC OF3 TO LOSE SIGNAL.



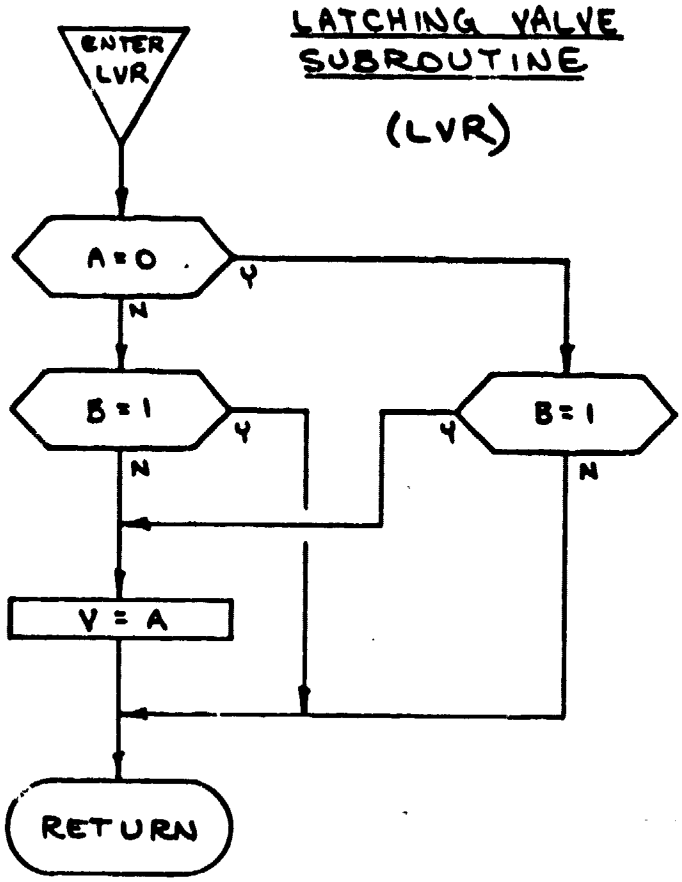
CRYO H2 TANK 3

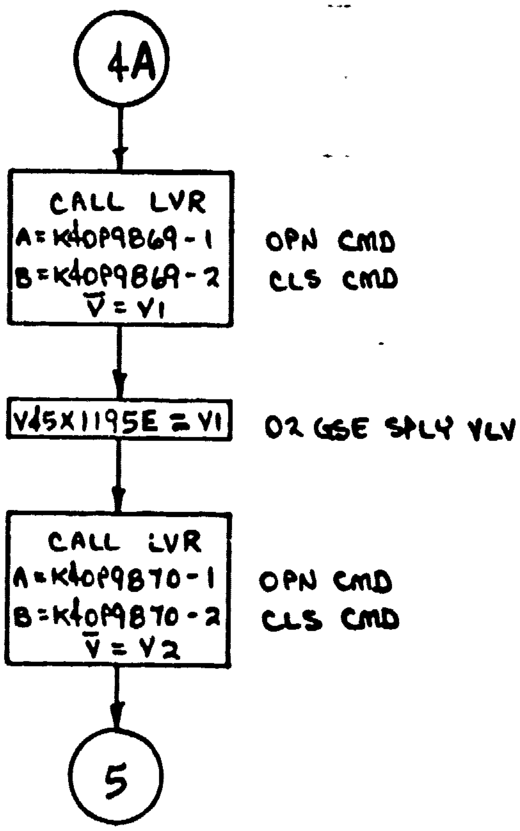
ROUTINE

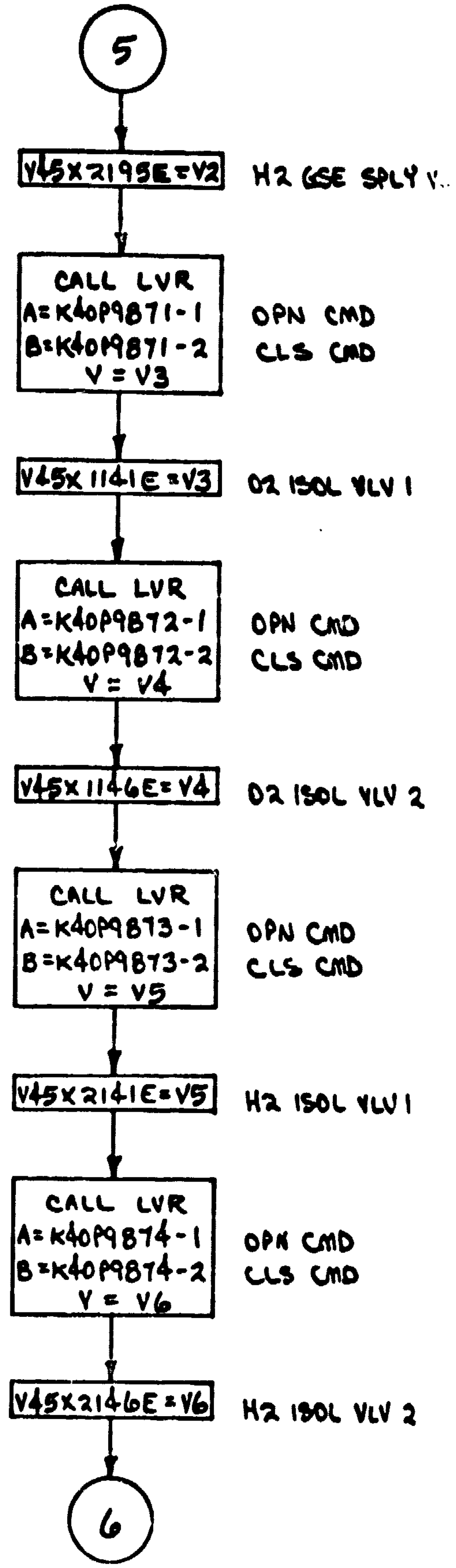


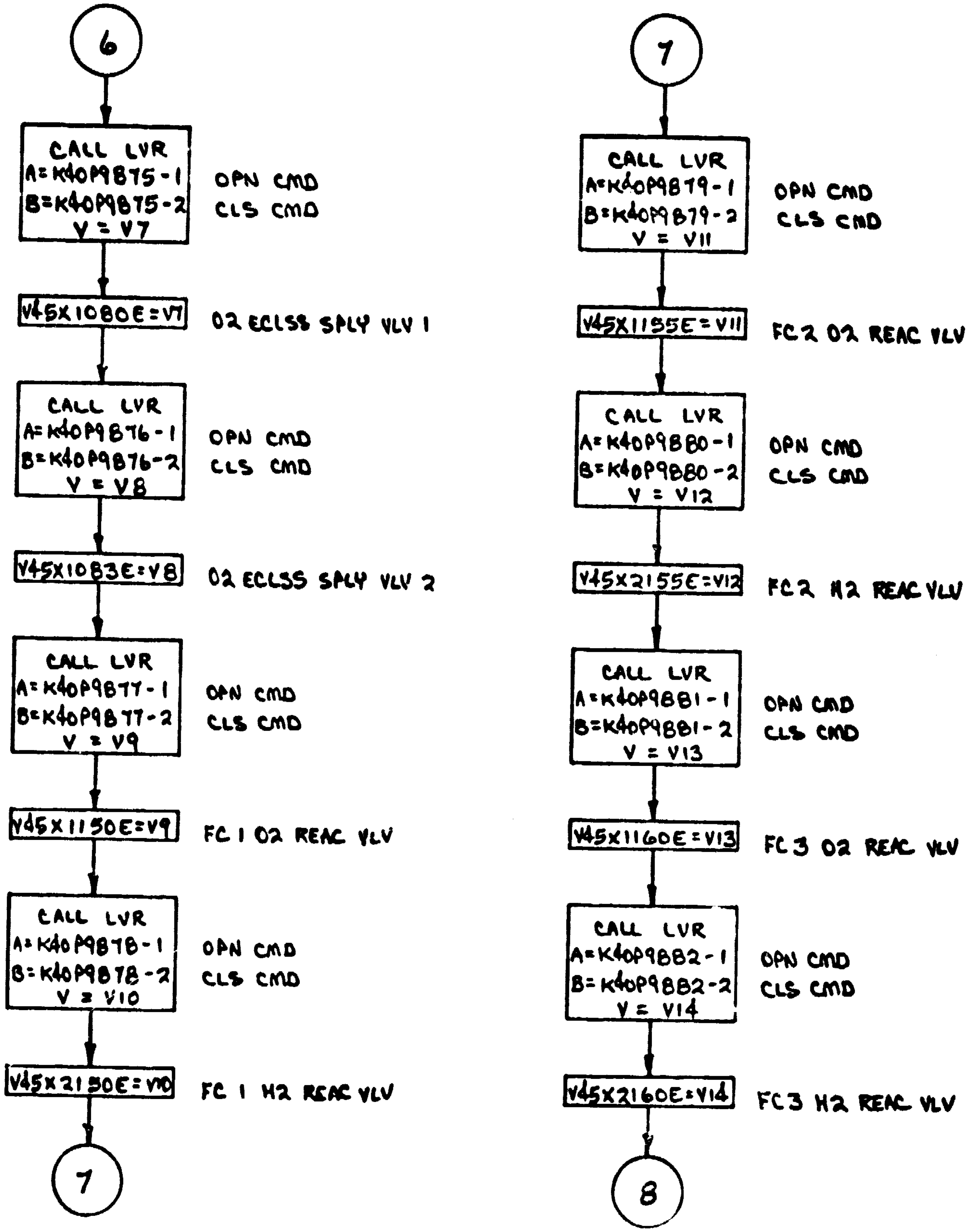
LATCHING VALVE SUBROUTINE

(LVR)

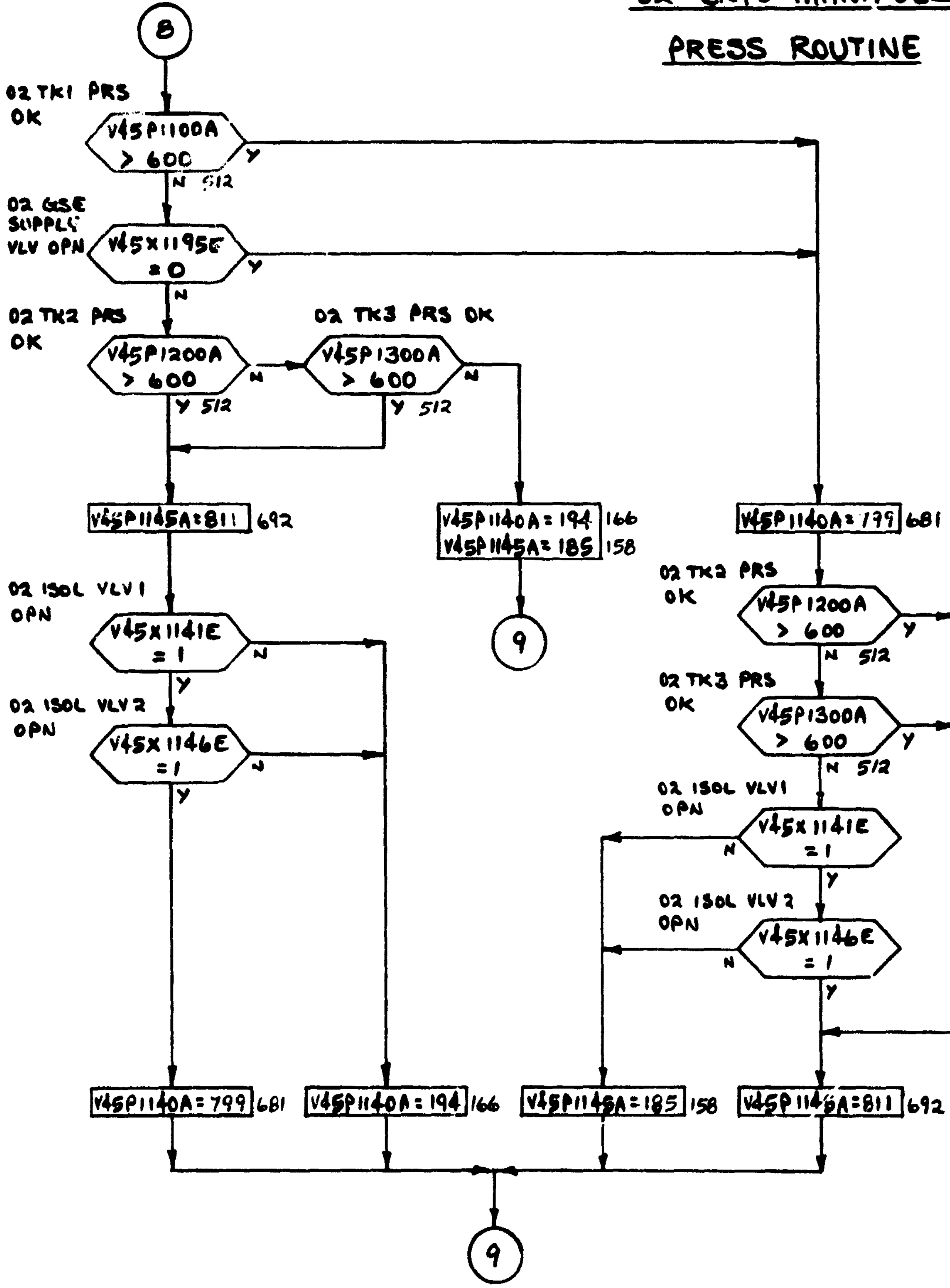




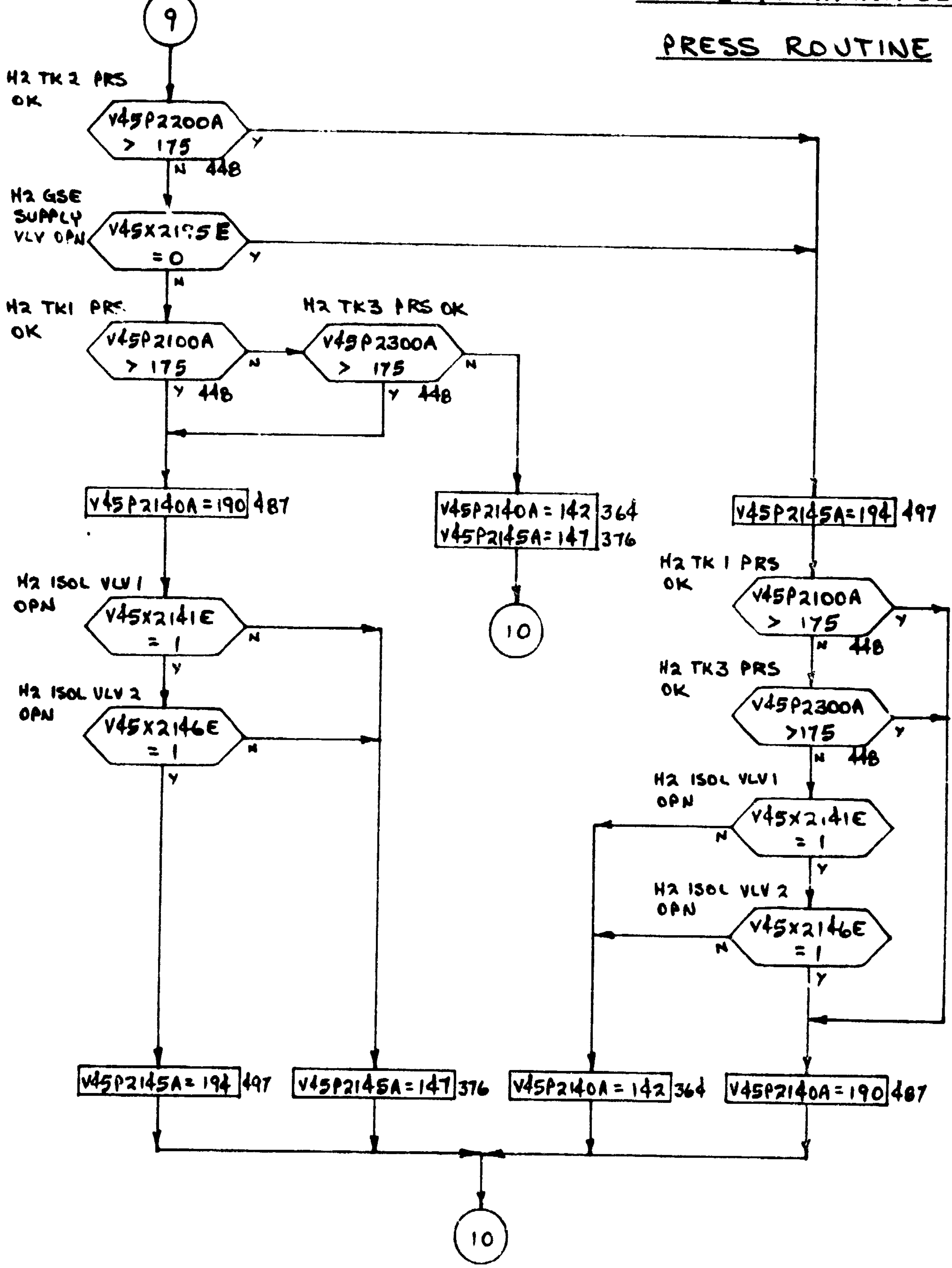


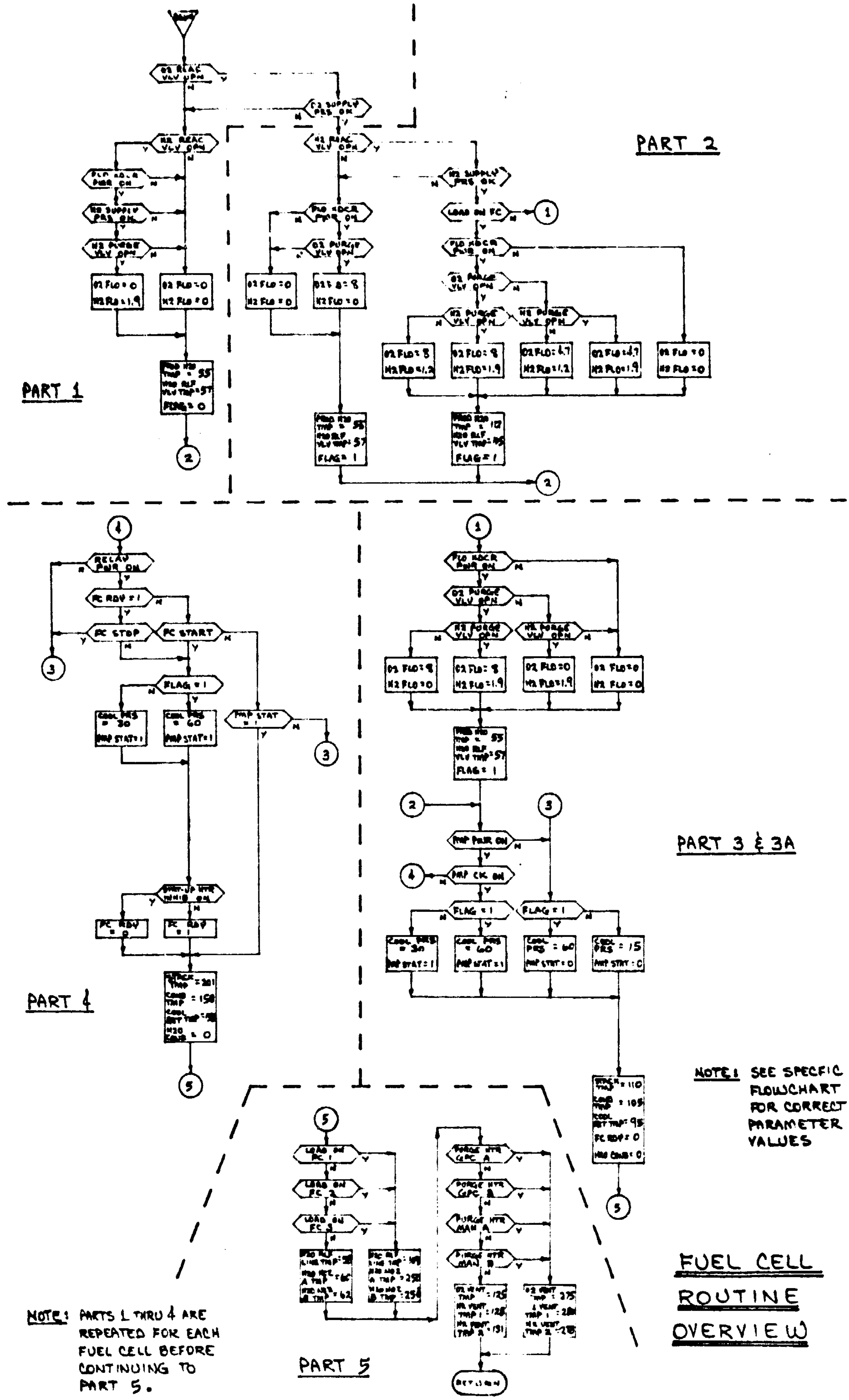

6
CALL LVR
A=K40P9B75-1
B=K40P9B75-2
V = V7
OPN CMD
CLS CMD
V45X1080E=V7
O2 ECLSS SPLY VLV 1
CALL LVR
A=K40P9B76-1
B=K40P9B76-2
V = V8
OPN CMD
CLS CMD
V45X1083E=V8
O2 ECLSS SPLY VLV 2
CALL LVR
A=K40P9B77-1
B=K40P9B77-2
V = V9
OPN CMD
CLS CMD
V45X1150E=V9
FC 1 O2 REAC VLV
CALL LVR
A=K40P9B78-1
B=K40P9B78-2
V = V10
OPN CMD
CLS CMD
V45X2150E=V10
FC 1 H2 REAC VLV
7
7
CALL LVR
A=K40P9B79-1
B=K40P9B79-2
V = V11
OPN CMD
CLS CMD
V45X1155E=V11
FC2 O2 REAC VLV
CALL LVR
A=K40P9B80-1
B=K40P9B80-2
V = V12
OPN CMD
CLS CMD
V45X2155E=V12
FC2 H2 REAC VLV
CALL LVR
A=K40P9B81-1
B=K40P9B81-2
V = V13
OPN CMD
CLS CMD
V45X1160E=V13
FC3 O2 REAC VLV
CALL LVR
A=K40P9B82-1
B=K40P9B82-2
V = V14
OPN CMD
CLS CMD
V45X2160E=V14
FC3 H2 REAC VLV
8

O2 CRYO MANIFOLD PRESS ROUTINE



H2 CRYO MANIFOLD PRESS ROUTINE

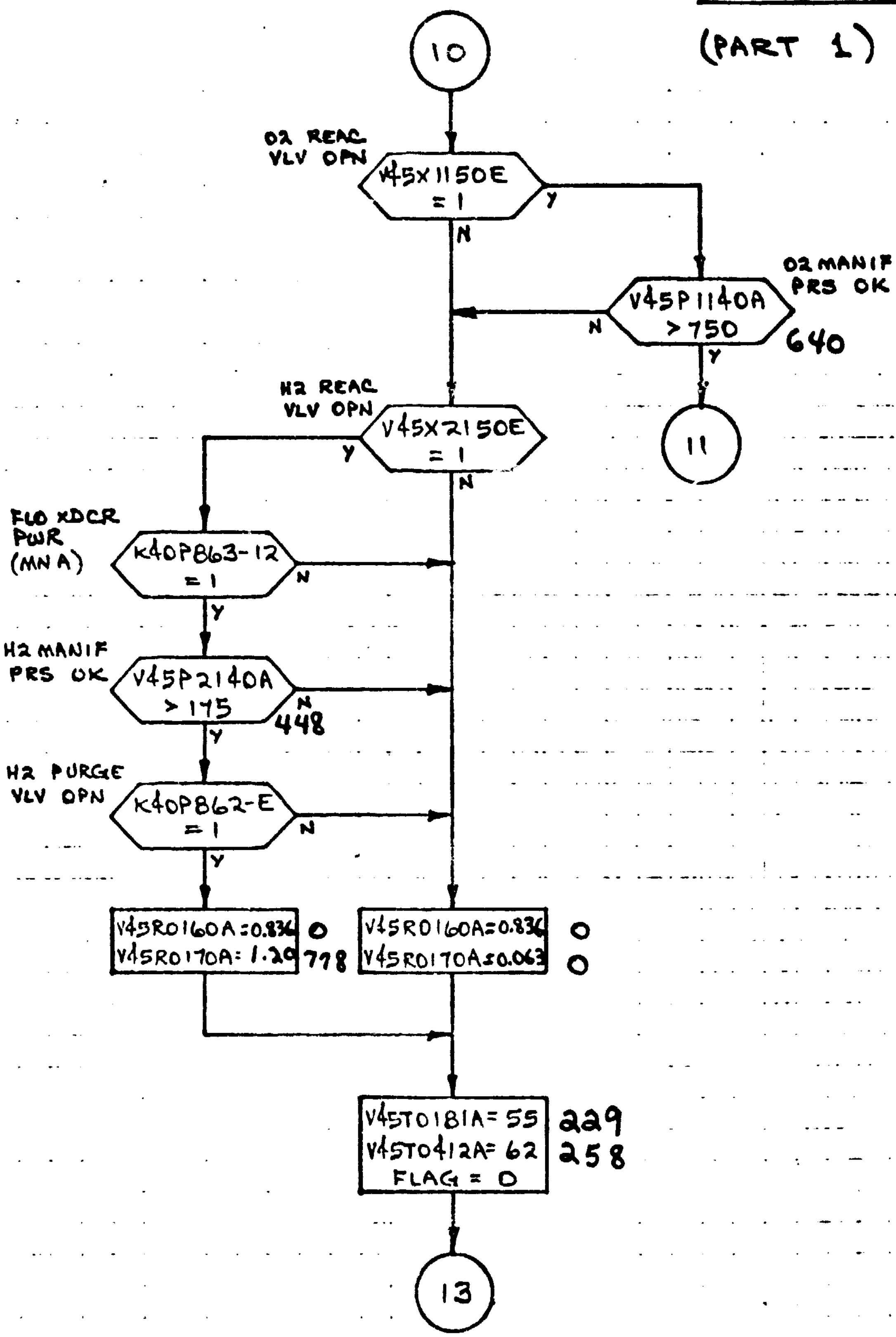




FUEL CELL ROUTINE OVERVIEW

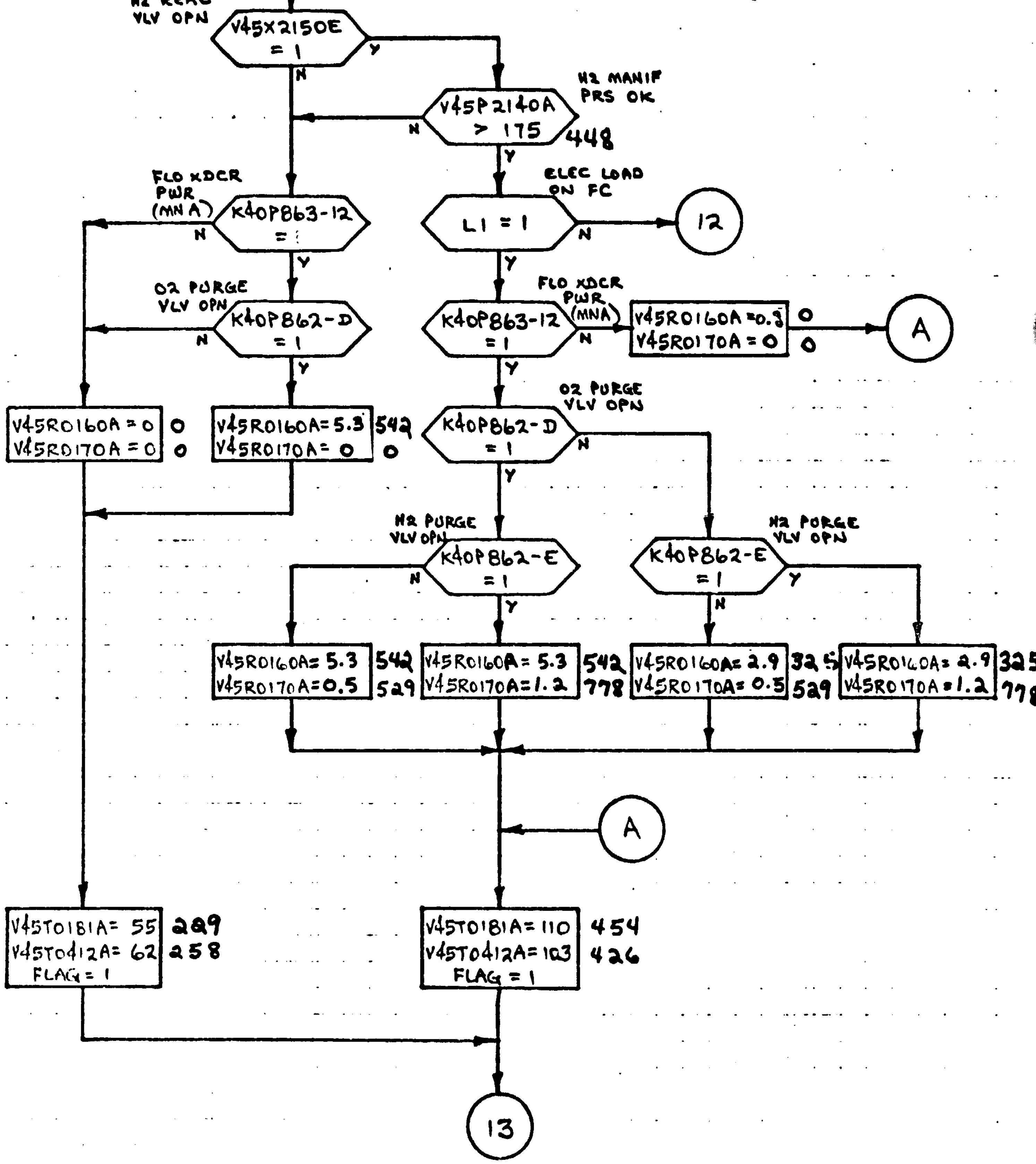
FUEL CELL 1 ROUTINE

(PART 1)

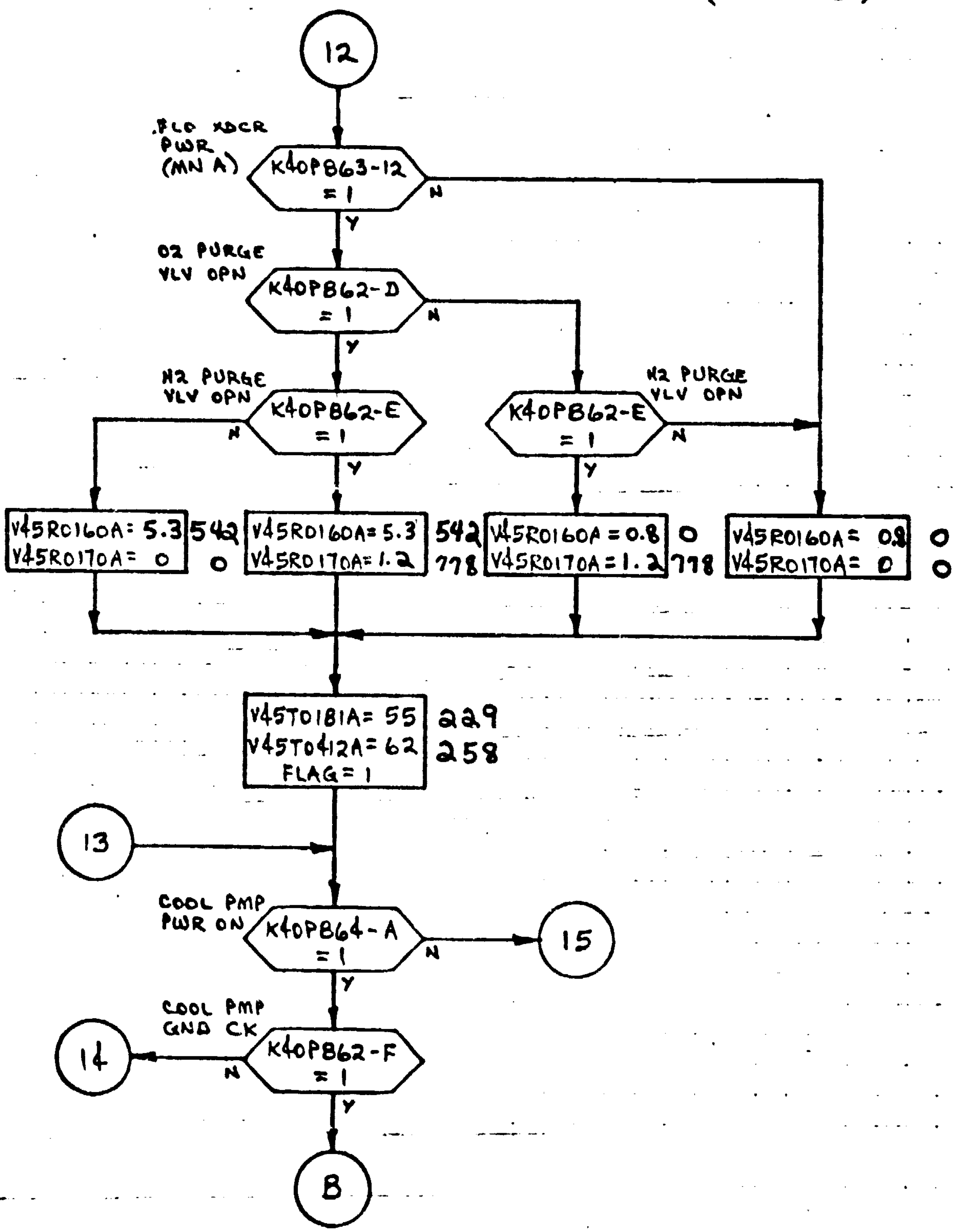


FUEL CELL 1 ROUTINE

(PART 2)

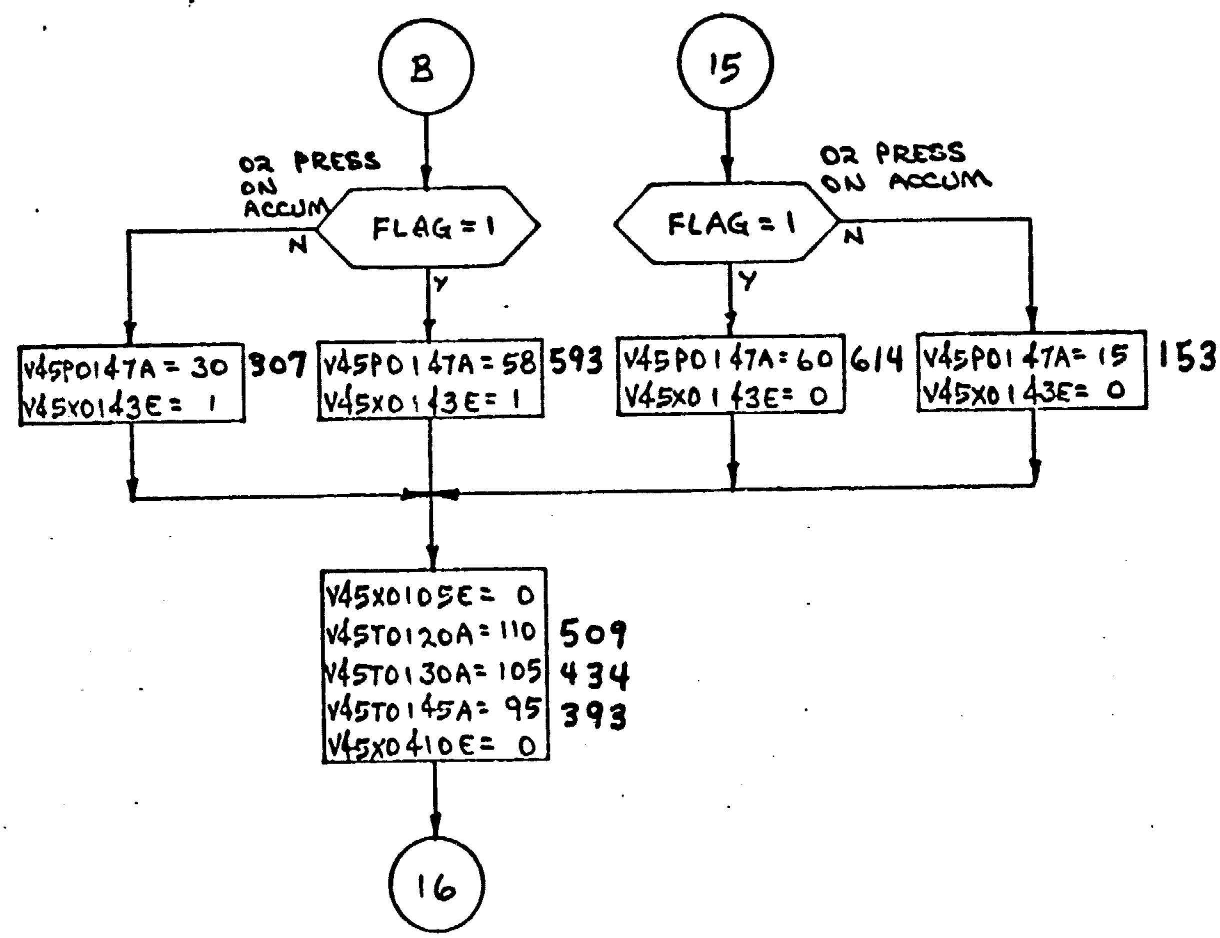


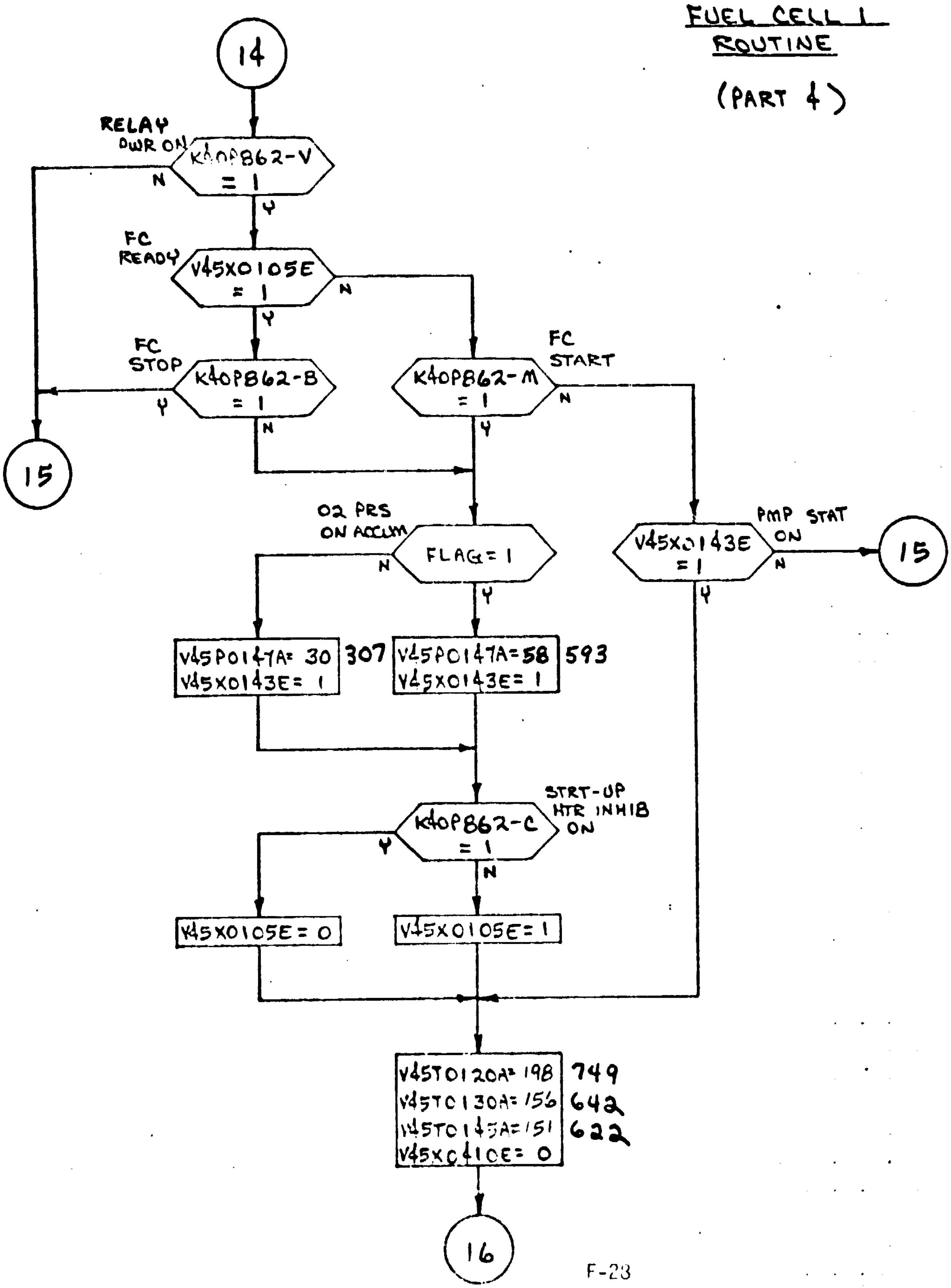
FUEL CELL 1
ROUTINE
(PART 3)



FUEL CELL 1
ROUTINE

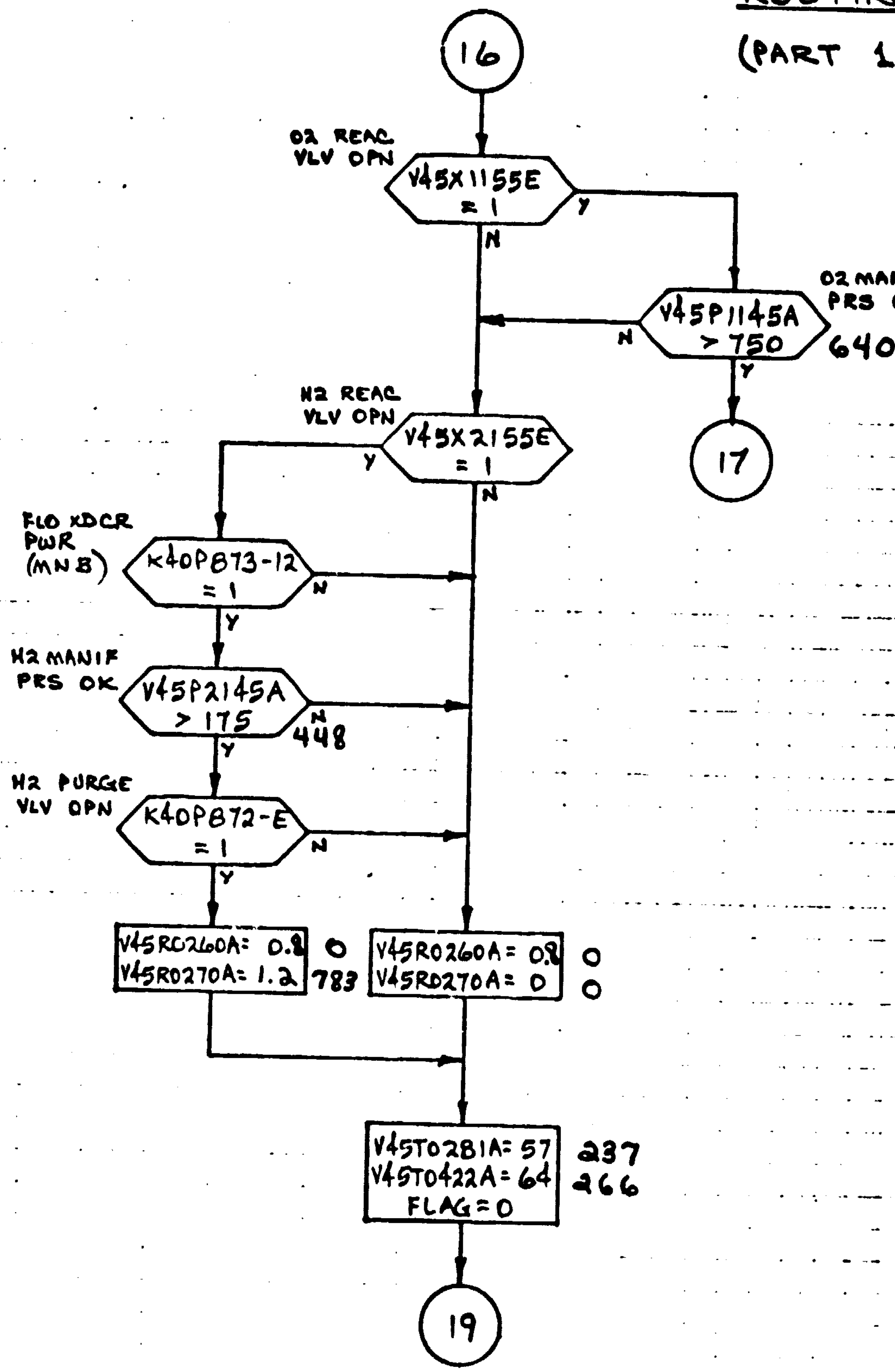
(PART 3A)




FUEL CELL 1
ROUTINE
(PART 4)
14
RELAY
PWR ON
K40P862-V
= 1
N
Y
FC
READY
V45X0105E
= 1
N
Y
FC
STOP
K40P862-B
= 1
Y
N
FC
START
K40P862-M
= 1
N
Y
15
O2 PRS
ON ACCUM
FLAG = 1
N
Y
PMP STAT
ON
V45X0143E
= 1
N
Y
15
V45P0147A = 30
V45X0143E = 1
307
V45P0147A = 58
V45X0143E = 1
593
STRT-UP
HTR INHIB
ON
K40P862-C
= 1
Y
N
V45X0105E = 0
V45X0105E = 1
V45T0120A = 198
V45T0130A = 156
V45T0145A = 151
V45X0410E = 0
749
642
622
16

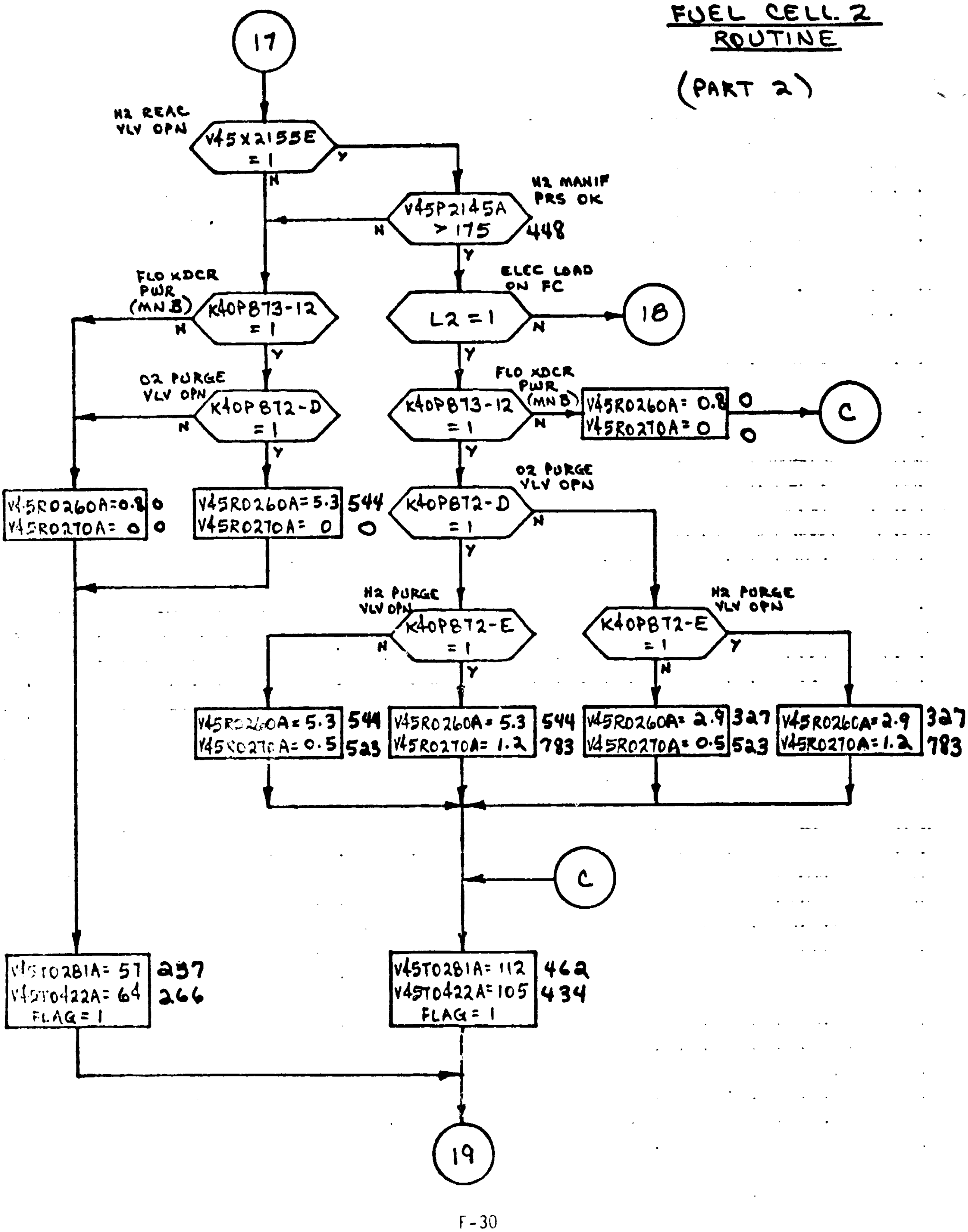
FUEL CELL 2 ROUTINE

(PART 1)



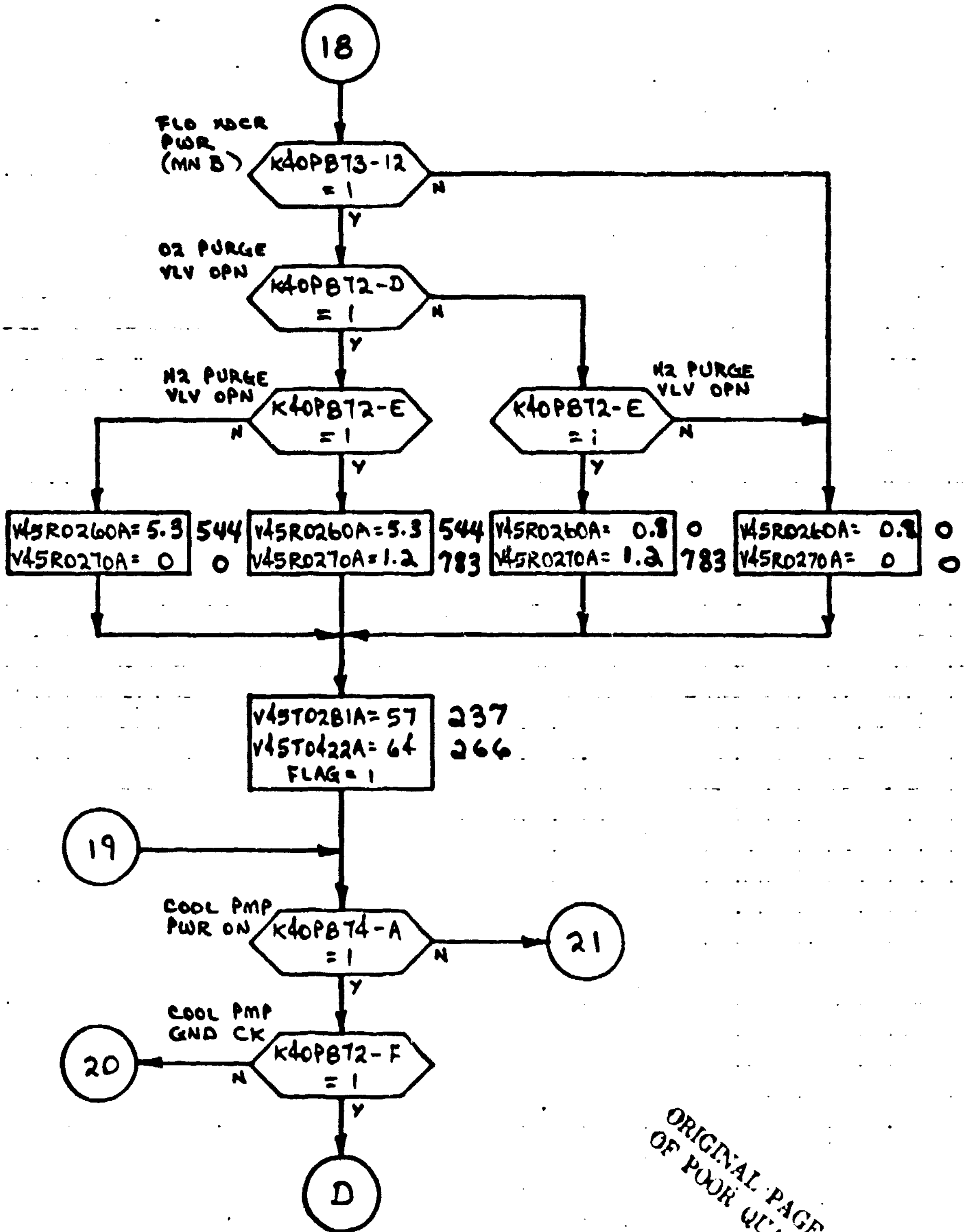
FUEL CELL 2 ROUTINE

(PART 2)



FUEL CELL 2 ROUTINE

(PART 3)



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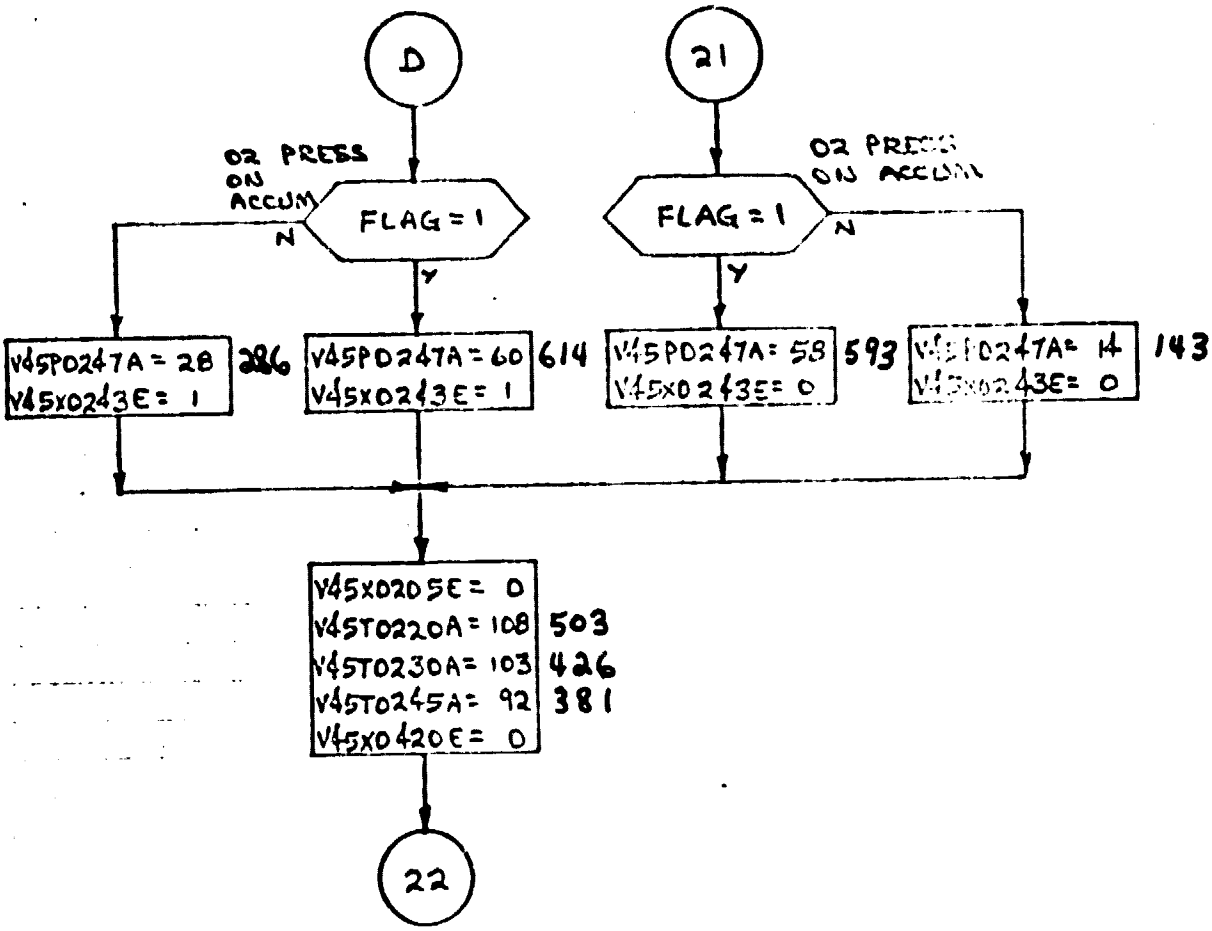
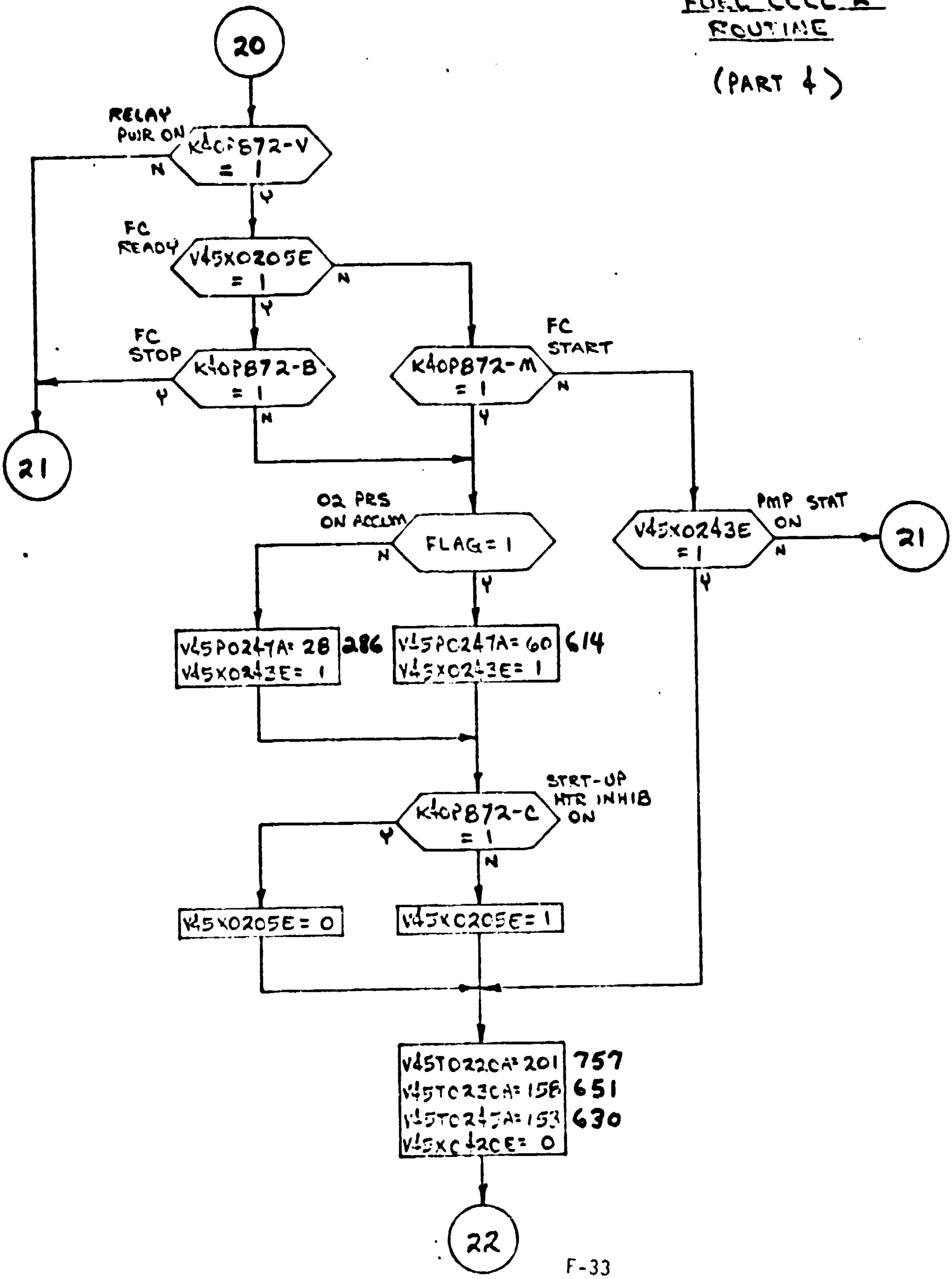
FUEL CELL 2
ROUTINE

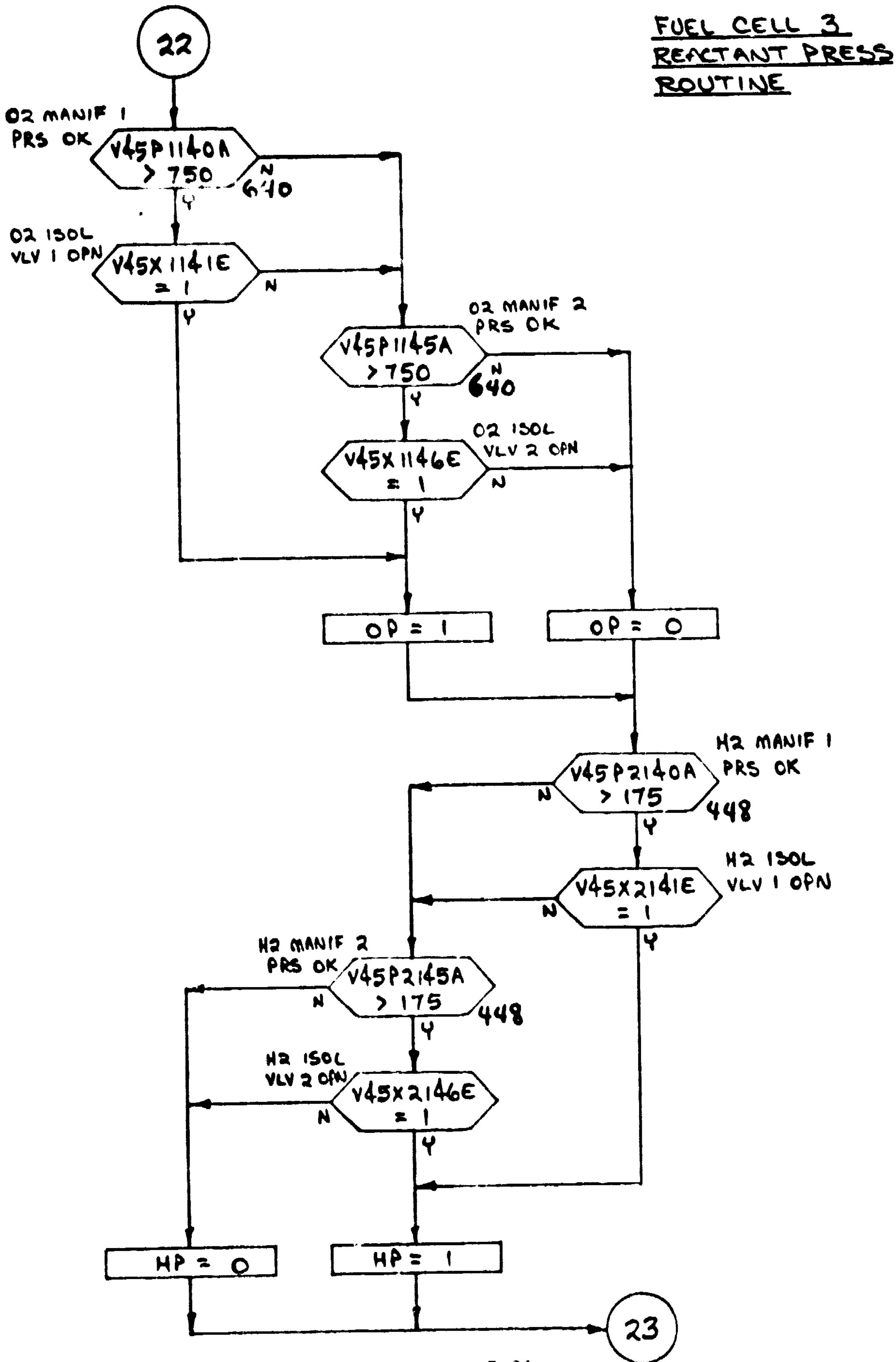
(PART 3A)



FUEL CELL 2
ROUTINE

(PART 4)

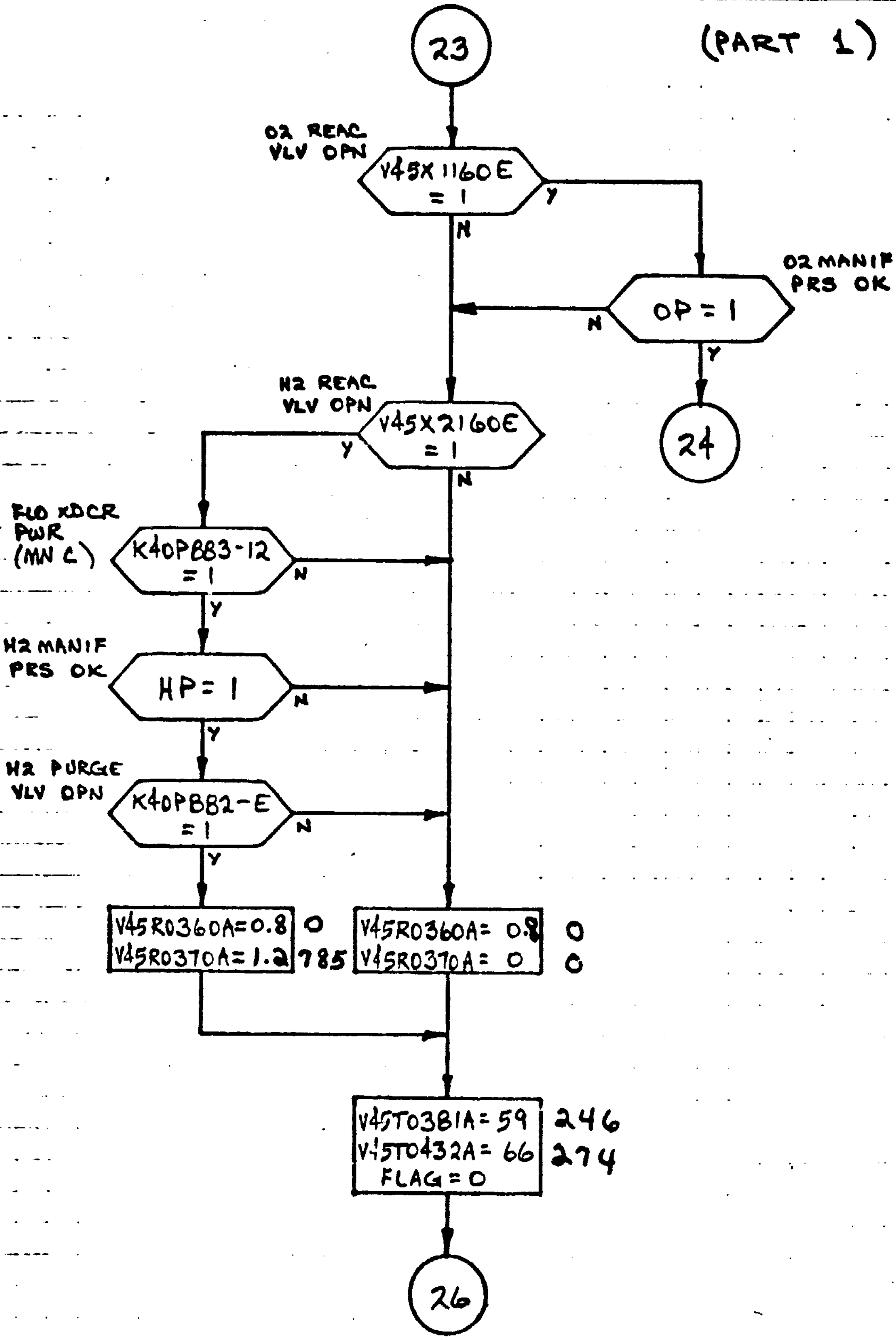




FUEL CELL 3
REACTANT PRESS
ROUTINE
22
O2 MANIF 1
PRS OK
V45P1140A
> 750
N
640
Y
O2 ISOL
VLV 1 OPN
V45X1141E
= 1
N
Y
O2 MANIF 2
PRS OK
V45P1145A
> 750
N
640
Y
O2 ISOL
VLV 2 OPN
V45X1146E
= 1
N
Y
OP = 1
OP = 0
H2 MANIF 1
PRS OK
V45P2140A
> 175
N
448
Y
H2 ISOL
VLV 1 OPN
V45X2141E
= 1
N
Y
H2 MANIF 2
PRS OK
V45P2145A
> 175
N
448
Y
H2 ISOL
VLV 2 OPN
V45X2146E
= 1
N
Y
HP = 0
HP = 1
23

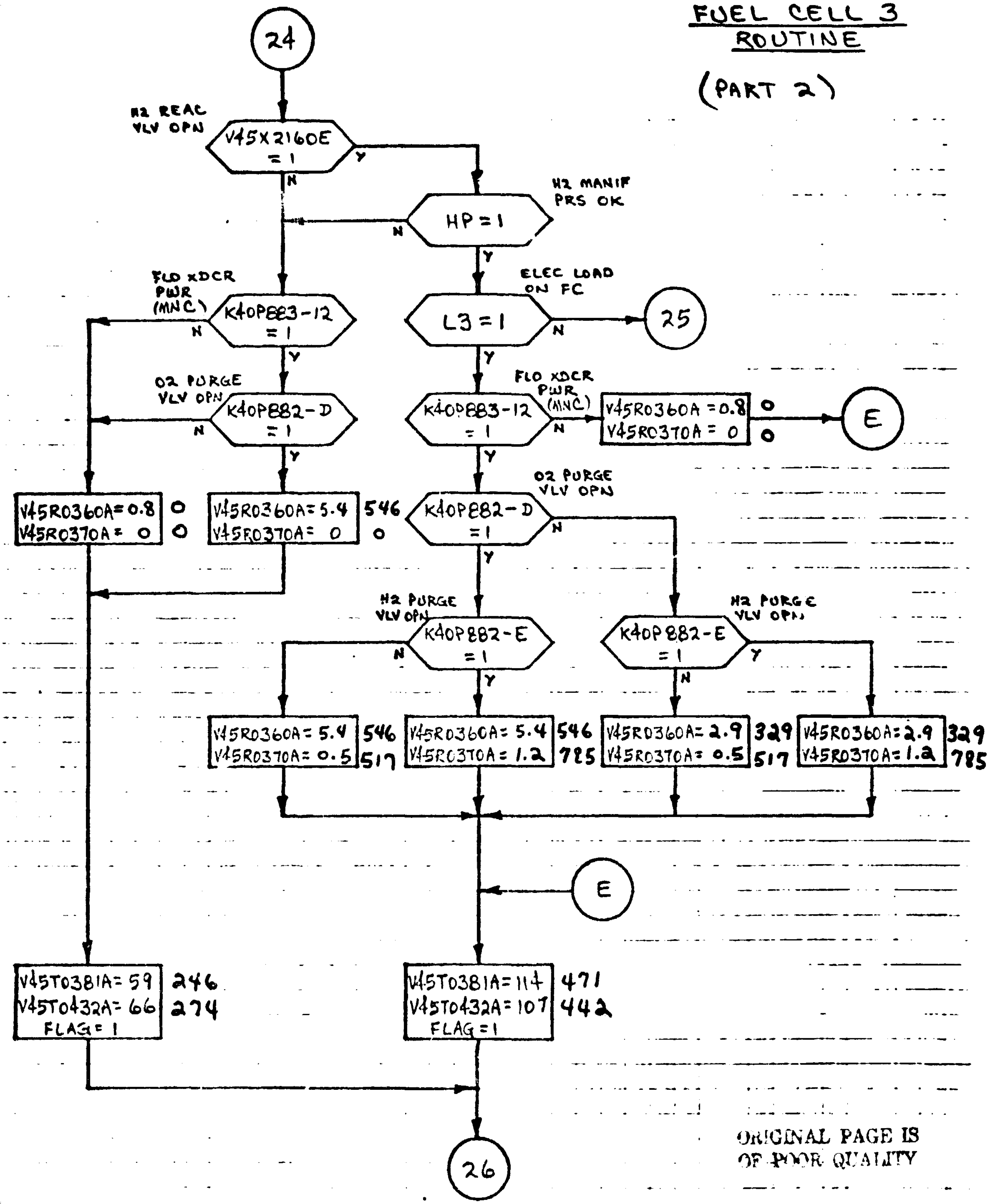
FUEL CELL 3 ROUTINE

(PART 1)



FUEL CELL 3 ROUTINE

(PART 2)



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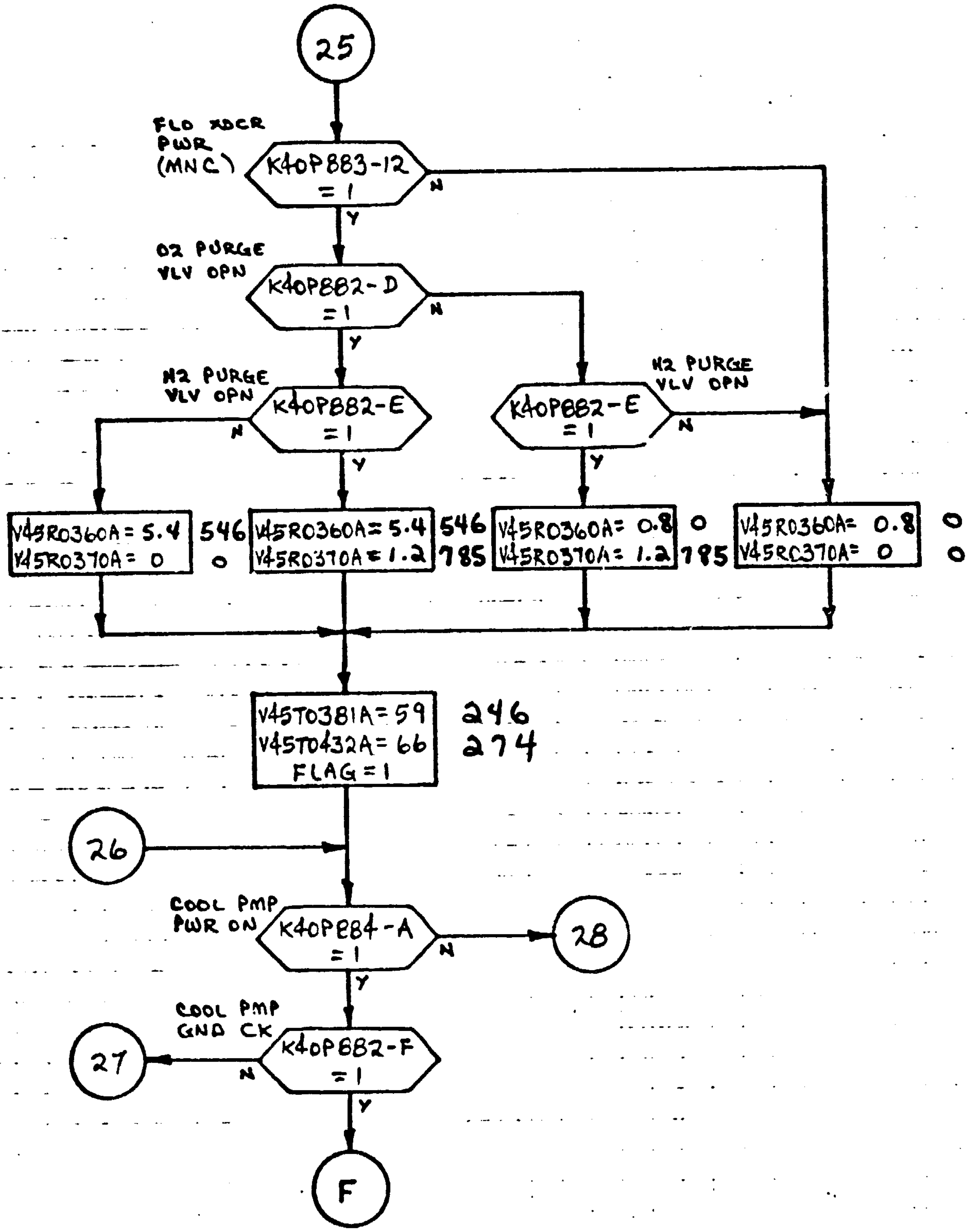
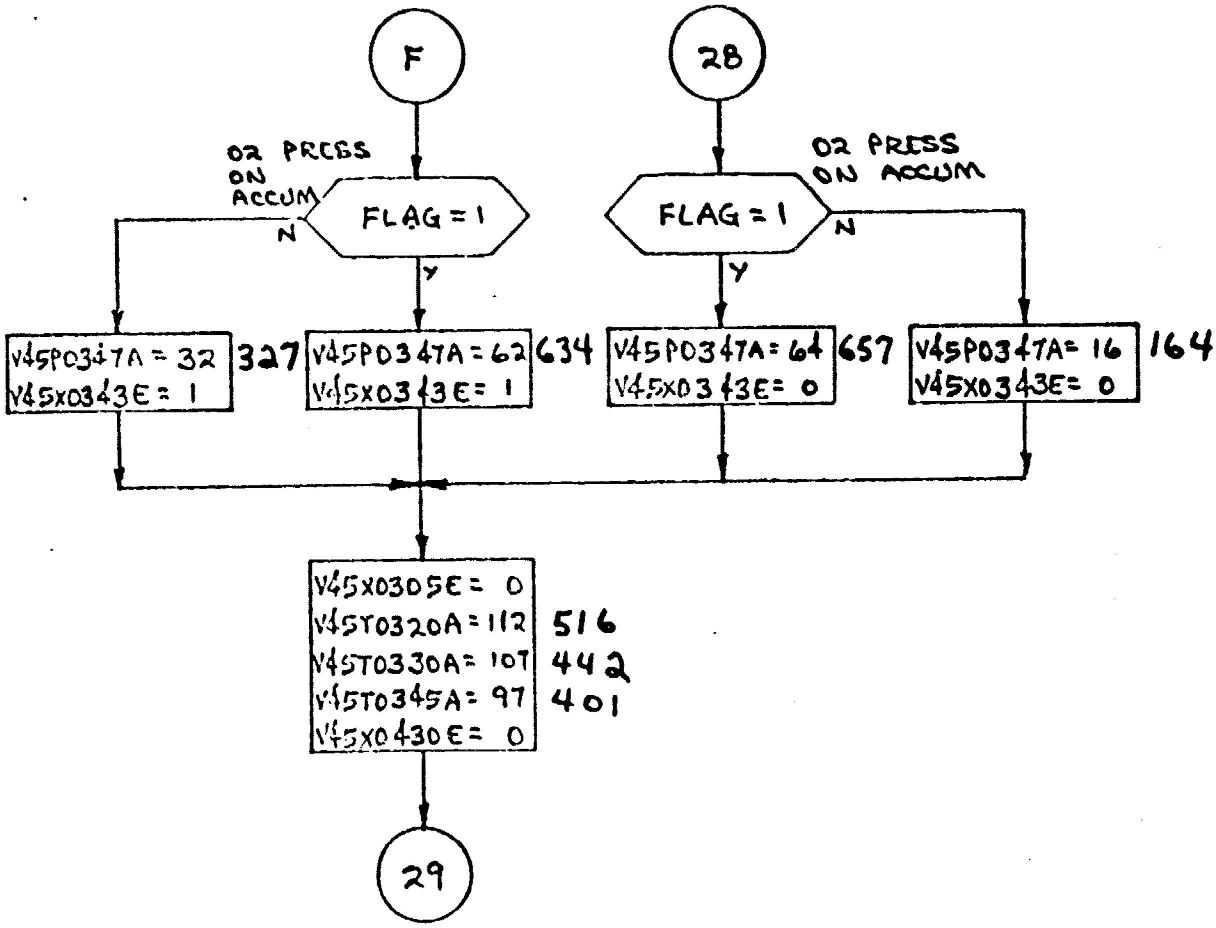
FUEL CELL 3
ROUTINE

(PART 3)



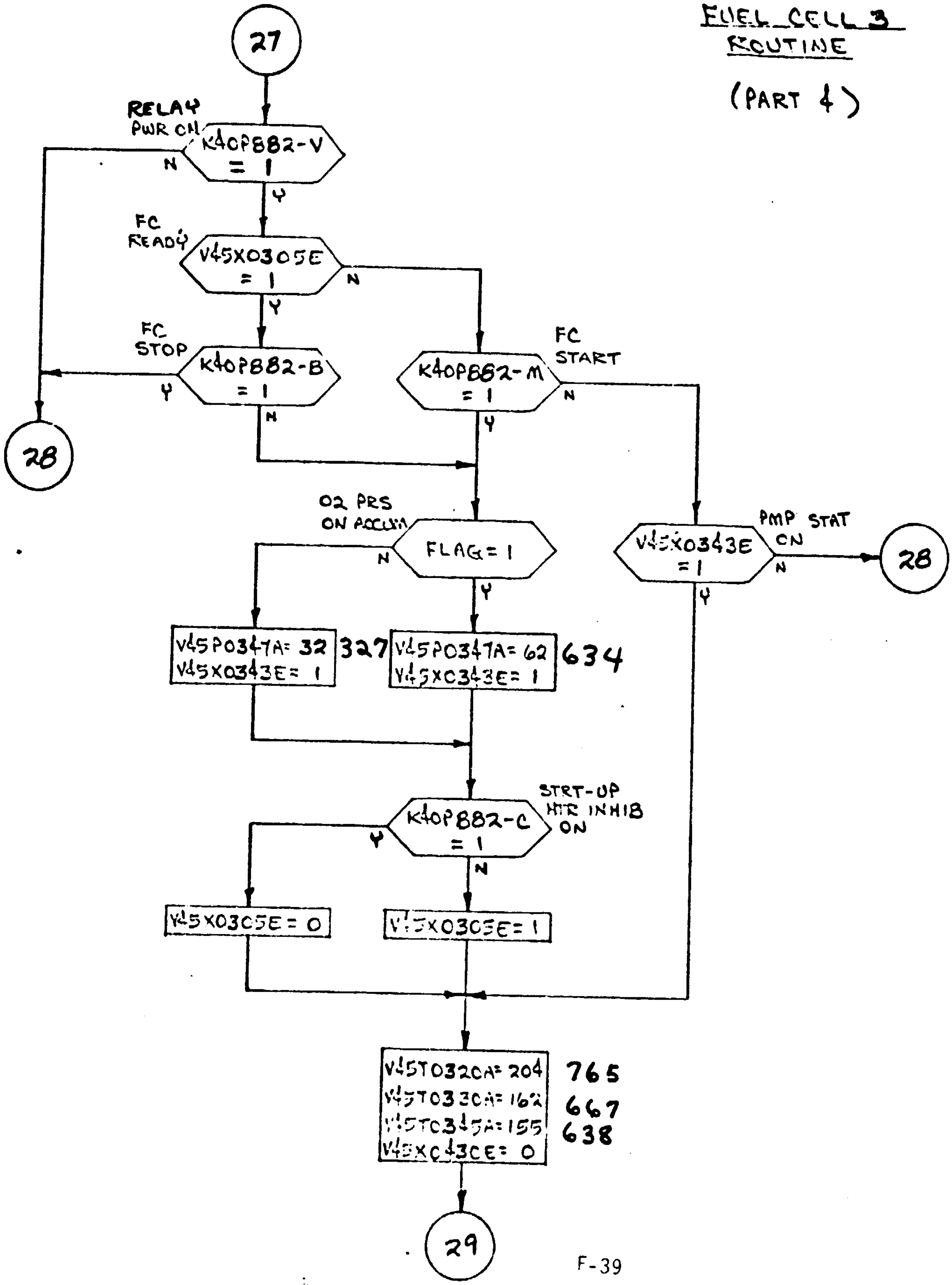
FUEL CELL 3 ROUTINE

(PART 3A)



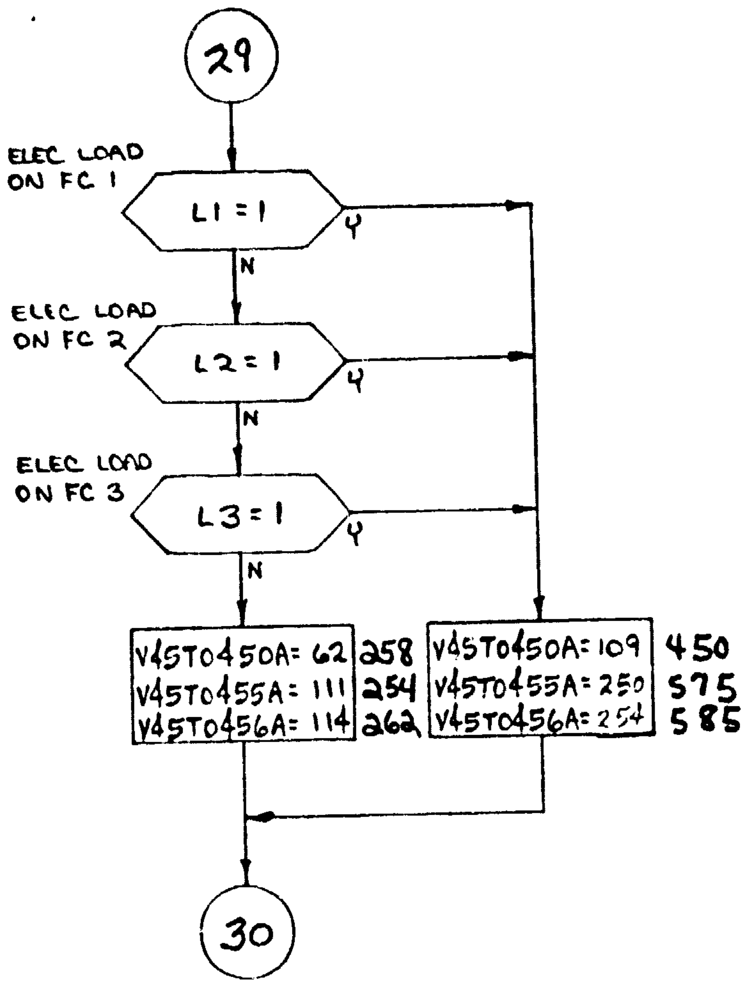
FUEL CELL 3
ROUTINE

(PART 4)

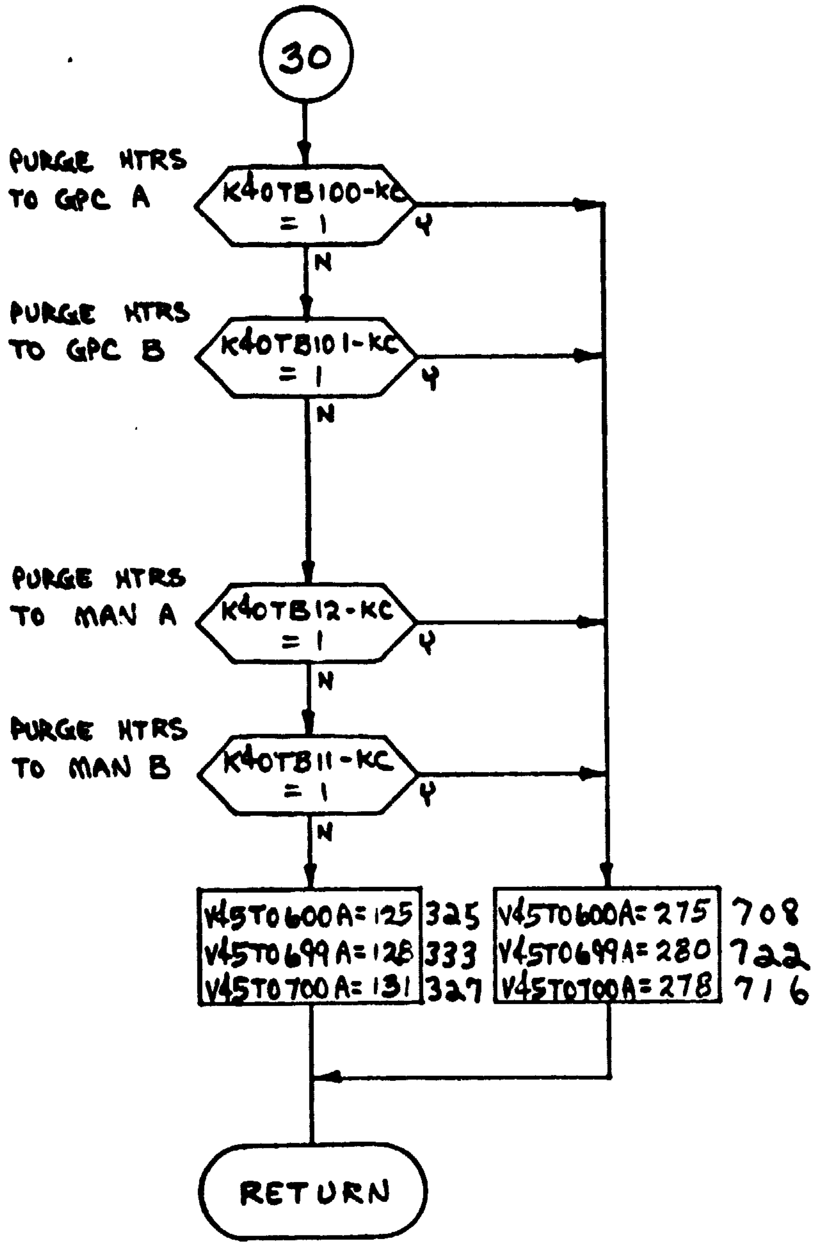


FUEL CELL ROUTINE

(PART 5)



PURGE HEATERS ROUTINE



4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

4.1.2 PSEUDO VARIABLE INITIALIZATION

The following pseudos are initialized as follows:

VARIABLE	INITIAL CONDITION
L1	0
L2	0
L3	0

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R1A2/S8	O2 TANK 1 HTR A1 POWER	5	V45K1131E	K40P9851-A	1-ON/0-OFF
	O2 TANK 1 HTR A2 POWER	5	1131E	↓ -C	1-ON/0-OFF
R1A2/S9	O2 TANK 1 HTR B1 POWER	5	1136E	K40P9852-A	1-ON/0-OFF
	O2 TANK 1 HTR B2 POWER	5	1136E	↓ -C	1-ON/0-OFF
R1A2/S13	O2 TANK 2 HTR A1 POWER	5	1231E	K40P9831-A	1-ON/0-OFF
	O2 TANK 2 HTR A2 POWER	5	1231E	↓ -C	1-ON/0-OFF
R1A2/S14	O2 TANK 2 HTR B1 POWER	5	1236E	K40P9832-A	1-ON/0-OFF
	O2 TANK 2 HTR B2 POWER	5	1236E	↓ -C	1-ON/0-OFF
R1A2/S21	O2 TANK 3 HTR A1 POWER	5	1331E	KJ5-A	1-ON/0-OFF
	O2 TANK 3 HTR A2 POWER	5	1331E	↓ -C	1-ON/0-OFF
R1A2/S22	O2 TANK 3 HTR B1 POWER	5	1336E	KJ6-A	1-ON/0-OFF
	O2 TANK 3 HTR B2 POWER	5	1336E	↓ -C	1-ON/0-OFF
R1A2/S11	H2 TANK 1 HTR A POWER	5	2131E	K40P9811-B	1-ON/0-OFF
R1A2/S12	H2 TANK 1 HTR B POWER	5	2136E	K40P9812-A	1-ON/0-OFF
R1A2/S19	H2 TANK 2 HTR A POWER	5	2231E	K40P9841-B	1-ON/0-OFF
R1A2/S20	H2 TANK 2 HTR B POWER	5	2236E	K40P9842-A	1-ON/0-OFF
R1A2/S24	H2 TANK 3 HTR A POWER	5	2331E	KJ3-A	1-ON/0-OFF
R1A2/S25	H2 TANK 3 HTR B POWER	5	2336E	KJ4-A	1-ON/0-OFF

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R1A2/S2	02 MANIFOLD 1 VLV OPEN	5	V45K1143E	K40P9871-1	1-OPN/0-$\overline{\text{OPN}}$
	02 MANIFOLD 1 VLV CLOSE	5	44E	K40P9871-2	1-CLS/0-$\overline{\text{CLS}}$
R1A2/S5	02 MANIFOLD 2 VLV OPEN	5	48E	K40P9872-1	1-OPN/0-$\overline{\text{OPN}}$
	02 MANIFOLD 2 VLV CLOSE	5	49E	K40P9872-2	1-CLS/0-$\overline{\text{CLS}}$
R1A2/S3	H2 MANIFOLD 1 VLV OPEN	5	V45K2239E	K40P9873-1	1-OPN/0-$\overline{\text{OPN}}$
	H2 MANIFOLD 1 VLV CLOSE	5	41E	K40P9873-2	1-CLS/0-$\overline{\text{CLS}}$
R1A2/S6	H2 MANIFOLD 2 VLV OPEN	5	43E	K40P9874-1	1-OPN/0-$\overline{\text{OPN}}$
	H2 MANIFOLD 2 VLV CLOSE	5	45E	K40P9874-2	1-CLS/0-$\overline{\text{CLS}}$
L2A1/S11	ECLSS 02 SUPPLY VLV 1 OPEN	5	V45K1084E	K40P9875-1	1-OPN/0-$\overline{\text{OPN}}$
	ECLSS 02 SUPPLY VLV 1 CLOSE	5	85E	K40P9875-2	1-CLS/0-$\overline{\text{CLS}}$
L2A1/S20	ECLSS 02 SUPPLY VLV 2 OPEN	5	86E	K40P9876-1	1-OPN/0-$\overline{\text{OPN}}$
	ECLSS 02 SUPPLY VLV 2 CLOSE	5	87E	K40P9876-2	1-CLS/0-$\overline{\text{CLS}}$
R1A2/S1	02 SUPPLY VLV OPEN - FC1	5	V45K1151E	K40P9877-1	1-OPN/0-$\overline{\text{OPN}}$
	H2 SUPPLY VLV OPEN - FC1			K40P9878-1	1-OPN/0-$\overline{\text{OPN}}$
	02 SUPPLY VLV CLOSE - FC1	5	V45K1152E	K40P9877-2	1-CLS/0-$\overline{\text{CLS}}$
	H2 SUPPLY VLV CLOSE - FC1			K40P9878-2	1-CLS/0-$\overline{\text{CLS}}$
R1A2/S7	02 SUPPLY VLV OPEN - FC2	5	V45K1156E	K40P9879-1	1-OPN/0-$\overline{\text{OPN}}$
	H2 SUPPLY VLV OPEN - FC2			K40P9880-1	1-OPN/0-$\overline{\text{OPN}}$

TABLE 1 - STIMULI INPUT T UEL CELL/CRYO MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R1A2/S7 (CONTINUED)	O2 SUPPLY VLV CLOSE - FC2	5	V45K1157E	K40P9879-2	1-CLS/0-$\overline{\text{CLS}}$
	H2 SUPPLY VLV CLOSE - FC2			K40P9880-2	1-CLS/0-$\overline{\text{CLS}}$
R1A2/S4	O2 SUPPLY VLV OPEN - FC3	5	V45K1161E	K40P9881-1	1-OPN/0-$\overline{\text{OPN}}$
	H2 SUPPLY VLV OPEN - FC3			K40P9882-1	1-OPN/0-$\overline{\text{OPN}}$
	O2 SUPPLY VLV CLOSE - FC3	5	V45K1162E	K40P9881-2	1-CLS/0-$\overline{\text{CLS}}$
	H2 SUPPLY VLV CLOSE - FC3			K40P9882-2	1-CLS/0-$\overline{\text{CLS}}$
R12/S3	FC 1 O2 PURGE VLV OPN	2,10	V45K0815Y ↓ 16Y	K40P862-D	1-OPN/0-CLS
	FC 1 H2 PURGE VLV OPN	2,10	↓ 15Y ↓ 16Y	K40P862-E	1-OPN/0-CLS
R12/S4	FC 2 O2 PURGE VLV OPN	2,10	↓ 25Y ↓ 26Y	K40P872-D	1-OPN/0-CLS
	FC 2 H2 PURGE VLV OPN	2,10	↓ 25Y ↓ 26Y	K40P872-E	1-OPN/0-CLS
R12/S5	FC 3 O2 PURGE VLV OPN	2,10	↓ 35Y ↓ 36Y	K40P882-D	1-OPN/0-CLS
	FC 3 H2 PURGE VLV OPN	2,10	↓ 35Y ↓ 36Y	K40P882-E	1-OPN/0-CLS

TABLE 1 - STIMULI INPUT T[illegible] CELL/CRYO MODEL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R1A2/S16	FC 1 START	5	V45K0112E	K40P862-M	1-STRT/0-$\overline{\text{STRT}}$
	FC 1 STOP A/STOP B	5	↓ 09E	K40P862-B	1-STOP/0-$\overline{\text{STOP}}$
R1A2/S17	FC 2 START	5	V45K0212E	K40P872-M	1-STRT/0-$\overline{\text{STRT}}$
	FC 2 STOP A/STOP B	5	↓ 09E	K40P872-B	1-STOP/0-$\overline{\text{STOP}}$
R1A2/S18	FC 3 START	5	V45K0312E	K40P882-M	1-STRT/0-$\overline{\text{STRT}}$
	FC 3 STOP A/STOP B	5	↓ 09E	K40P882-B	1-STOP/0-$\overline{\text{STOP}}$
R12/S2	H2/02 PURGE HTRS-MAN	5	V45K0601E	K40TB11-KC K40TB12-KC	1-ON/0-OFF
	H2/02 PURGE HTRS-GPC	2	V45K0604Y ↓ 05Y	K40TB100-KC K40TB101-KC	1-ON/0-OFF
	02 GSE SUPPLY VLV OPEN	4,5	V45K1191N	K40P9869-1	1-OPN/0-$\overline{\text{OPN}}$
	02 GSE SUPPLY VLV CLOSE	4,5	↓ 96N	K40P9869-2	1-CLS/0-$\overline{\text{CLS}}$
	H2 GSE SUPPLY VLV OPEN	4,5	V45K2191N	K40P9870-1	1-OPN/0-$\overline{\text{OPN}}$
	H2 GSE SUPPLY VLV CLOSE	4,5	↓ 96N	K40P9870-2	1-CLS/0-$\overline{\text{CLS}}$
L4C/CB65	FC 1 COOLANT PUMP-PHASE A	5,6		K40P864-A	1-ON/0-OFF
L4C/CB68	FC 2 ↓	5,6		↓ 74-A	↓
L4C/CB71	FC 3 ↓	5,6		↓ 84-A	↓
014/S12	FC 1 CONTROLLER (RELAY) POWER	5	V45K0180E	K40P862-V	↓
015/S11	FC 2 ↓	5	↓ 280E	K40P872-V	↓
016/S11	FC 3 ↓	5	↓ 380E	K40P882-V	↓

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
	FC 1 H2 PUMP CHECK	4,5	V45K1121N	K40P862-F	1-ON/0-OFF
	FC 2	4,5	24N	72-F	
	FC 3	4,5	27N	82-F	
013/CB22	O2 TANK 1 QTY XDCR PWR (ESS BUS 2CA)	5,6		K40P9853-W	1-ON/0-OFF
013/CB20	O2 2 1BC)			9833-W	
ML86B/CB55	O2 3 3AB)			9520-W	
013/CB23	H2 1 2CA)			9813-W	
013/CB22	H2 2 1BC)			9843-W	
ML86B/CB56	H2 3 3AB)			9547-W	
	FLO XDCR PWR - FC1 (MN A)	5,6		863-12	
	- FC2 (MN B)			873-12	
	- FC3 (MN C)			883-12	
	O2 TANK 1 QTY CK SIGNAL	4,5,6	V45K1128N	9853-A	
	O2 2		1228N	9833-A	
	O2 3		1328N	9520-A	
	H2 1		2128N	9813-A	
	H2 2		2228N	9843-A	
	H2 3		2328N	9547-A	
R12A1/S6	FC 1 START-UP HTR INHIBIT	5	V45K0191E	K40P862-C	1-INHIBIT/ 0-ENABLE
R12A1/S7	2	5	291E	72-C	
R12A1/S8	3	5	391E	82-C	

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
	FC 1 LOAD - ON/OFF	7		L1	1-ON/0-OFF
	2			L2	
	3			L3	

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM FC/CRYO MODEL - TABLE 2

MEASUREMENT I.D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V45X0105E	FC 1 READY	0	0	1	1					STATE
V45T0120A	FC 1 STACK COOLANT OUT TEMP	110	509	198	749					DEGF
V45T0130A	FC 1 CONDENSER EXIT TEMP	105	434	156	642					DEGF
V45X0143E	FC 1 COOLANT PUMP STATUS	0	0	1	1					STATE
V45T0145A	FC 1 COOLANT RETURN TEMP	95	393	151	622					DEGF
V45P0147A	FC 1 COOLANT PRESS	60	614	15	153	30	307	58	593	PSIA
V45R0160A	FC 1 O2 FLOW	0.836	0	2.86	325	5.31	542			LB/HR
V45R0170A	FC 1 H2 FLOW	0.063	0	0.50	529	1.20	776			LB/HR
V45T0181A	FC 1 PRODUCT H2O LINE TEMP	55	229	110	454					DEGF
V45X0205E	FC 2 READY	0	0	1	1					STATE
V45T0220A	FC 2 STACK COOLANT OUT TEMP	108	503	201	757					DEGF
V45T0230A	FC 2 CONDENSER EXIT TEMP	103	426	158	651					DEGF
V45X0243E	FC 2 COOLANT PUMP STATUS	0	0	1	1					STATE
V45T0245A	FC 2 COOLANT RETURN TEMP	92	381	153	630					DEGF
V45P0247A	FC 2 COOLANT PRESS	58	593	14	143	28	286	60	614	PSIA
V45R0260A	FC 2 O2 FLOW	0.836	0	2.88	327	5.34	544			LB/HR
V45R0270A	FC 2 H2 FLOW	0.063	0	0.49	523	1.22	783			LB/HR
V45T0281A	FC 2 PRODUCT H2O LINE TEMP	57	237	112	462					DEGF
V45X0305E	FC 3 READY	0	0	1	1					STATE
V45T0320A	FC 3 STACK COOLANT OUT TEMP	112	516	204	765					DEGF
V45T0330A	FC 3 CONDENSER EXIT TEMP	107	442	162	667					DEGF
V45X0343E	FC 3 COOLANT PUMP STATUS	0	0	1	1					STATE

MEASUREMENT OUTPUT FROM FC/CRYO MODEL - TABLE 2

[illegible] I.D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V45T0345A	FC 3 COOLANT RETURN TEMP	97	401	155	538					DEGF
V45P0347A	FC 3 COOLANT PRESS	62	634	16	164	32	327	64	657	PSIA
V45R0360A	FC 3 O2 FLOW	0.836	0	2.90	329	5.37	546			LB/HR
V45R0370A	FC 3 H2 FLOW	0.063	0	0.48	417	1.23	785			LB/HR
V45T0381A	FC 3 PRODUCT H2O LINE TEMP	59	246	114	471					DEGF
V45X0410E	FC 1 H2O CONDITION	0	0	1	1					STATE
V45T0412A	FC 1 H2O RELIEF VLV TEMP	62	253	103	426					DEGF
V45X0420E	FC 2 CONDITION	0	0	1	1					STATE
V45T0422A	FC 2 H2O RELIEF VLV TEMP	64	256	105	434					DEGF
V45X0430E	FC 3 H2O CONDITION	0	0	1	1					STATE
V45T0432A	FC 3 H2O RELIEF VLV TEMP	66	274	107	442					DEGF
V45T0450A	H2O RELIEF LINE TEMP	62	253	109	450					DEGF
V45T0455A	H2O RELIEF NOZZLE TEMP A	111	254	250	575					DEGF
V45T0456A	H2O RELIEF NOZZLE TEMP B	114	262	254	585					DEGF
V45T0600A	FC O2 VENT LINE TEMP	125	325	275	708					DEGF
V45T0699A	FC H2 VENT LINE TEMP 1	128	333	280	722					DEGF
V45T0700A	FC H2 VENT LINE TEMP 2	131	327	278	716					DEGF
V45X1080E	PRSD O2 ECS PRI SUPPLY VLV - OPEN	1	1	0	0					STATE
V45X1083E	PRSD O2 ECS SEC SUPPLY VLV - OPEN	1	1	0	0					STATE
V45P1100A	PRSD O2 TANK 1 PRESS	626	534	516	440					PSIA
V45T1101A	PRSD O2 TANK 1 FLUID TEMP	-35	442	-162	295					DEGF

MEASUREMENT OUTPUT FROM FC/CRYO MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V45Q1105A	PRSD 02 TANK 1 QUANTITY	30	331	104	1023	0	51			PCNT
V45T1107A	PRSD 02 TANK 1 HTR ASSY 1 TEMP	-107	358	-166	291					DEGF
V45T1109A	PRSD 02 TANK 1 HTR ASSY 2 TEMP	-139	321	-167	288					DEGF
V45P1110A	PRSD 02 TANK 1 HTR CONTROL PRESS	750	481	517	4					PSIA
V45P1140A	PRSD 02 MANIF 1 PRESS	799	681	194	166					PSIA
V45X1141E	PRSD 02 MANIF 1 ISOL VLV - OPEN	1	1	0	0					STATE
V45P1145A	PRSD 02 MANIF 2 PRESS	811	692	185	158					PSIA
V45X1146E	PRSD 02 MANIF 2 ISOL VLV - OPEN	1	1	0	0					STATE
V45X1150E	PRSD FC 1 02 REAC VLV - OPEN	1	1	0	0					STATE
V45X1155E	PRSD FC 2 02 REAC VLV - OPEN	1	1	0	0					STATE
V45X1160E	PRSD FC 3 02 REAC VLV - OPEN	1	1	0	0					STATE
V45X1195E	PRSD 02 GSE SUPPLY VLV - CLSD	0	0	1	1					STATE
V45P1200A	PRSD 02 TANK 2 PRESS	636	542	518	442					PSIA
V45T1201A	PRSD 02 TANK 2 FLUID TEMP	-26	452	-160	297					DEGF
V45Q1205A	PRSD 02 TANK 2 QUANTITY	40	426	104	1023	0	51			PCNT
V45T1207A	PRSD 02 TANK 2 HTR ASSY 1 TEMP	-116	348	-162	295					DEGF
V45T1209A	PRSD 02 TANK 2 HTR ASSY 2 TEMP	-148	311	-167	288					.GF
V45P1210A	PRSD 02 TANK 2 HTR CONTROL PRESS	760	501	518	6					PSIA
V45P1300A	PRSD 02 TANK 3 PRESS	646	550	521	444					PSIA
V45T1301A	PRSD 02 TANK 3 FLUID TEMP	-17	462	-159	299					DEGF
V45Q1305A	PRSD 02 TANK 3 QUANTITY	50	518	104	1023	0	51			PCNT
V45T1307A	PRSD 02 TANK 3 HTR ASSY 1 TEMP	-125	338	-166	291					DEGF
V45T1309A	PRSD 02 TANK 3 HTR ASSY 2 TEMP	-157	301	-169	286					DEGF

MEASUREMENT OUTPUT FROM FC/CRYO MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1 (NOMINAL) K=1		VALUE 2 (HI/LOW) K=2		VALUE 3 (OFF) K=3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V45P1310A	PRSD O2 TANK 3 HTR CONTROL PRESS	770	522	520	10					PSIA
V45P2100A	PRSD H2 TANK 1 PRESS	220	563	145	370					PSIA
V45T2101A	PRSD H2 TANK 1 FLUID TEMP	-100	366	-286	151					DEGF
V45Q2105A	PRSD H2 TANK 1 QUANTITY	35	374	105	1023	0	5[illegible]			PCNT
V45T2107A	PRSD H2 TANK 1 HTR ASSY TEMP	-70	401	-289	147					DEGF
V45P2110A	PRSD H2 TANK 1 HTR CONTROL PRESS	260	735	148	13					PSIA
V45P2140A	PRSD H2 MANIF 1 PRESS	190	487	142	364					PSIA
V45X2141E	PRSD H2 MANIF 1 ISOL VLV - OPEN	1	1	0	0					STATE
V45P2145A	PRSD H2 MANIF 2 PRESS	194	497	147	376					PSIA
V45X2146E	PRSD H2 MANIF 2 ISOL VLV - OPEN	1	1	0	0					STATE
V45X2150E	PRSD FC 1 H2 REAC VLV - OPEN	1	1	0	0					STATE
V45X2155E	PRSD FC 2 H2 REAC VLV - OPEN	1	1	0	0					STATE
V45X2160E	PRSD FC 3 H2 REAC VLV - OPEN	1	1	0	0					STATE
V45X2195E	PRSD H2 GSE SUPPLY VLV - CLSD	0	0	1	1					STATE
V45P2200A	PRSD H2 TANK 2 PRESS	230	589	150	385					PSIA
V45T2201A	PRSD H2 TANK 2 FLUID TEMP	-91	376	-291	145					DEGF
V45Q2205A	PRSD H2 TANK 2 QUANTITY	45	469	105	1023	0	51			PCNT
V45T2207A	PRSD H2 TANK 2 HTR ASSY TEMP	-60	413	-295	141					DEGF
V45P2210A	PRSD H2 TANK 2 HTR CONTROL PRESS	270	800	151	39					PSIA
V45P2300A	PRSD H2 TANK 3 PRESS	240	614	149	381					PSIA
V45T2301A	PRSD H2 TANK 3 FLUID TEMP	-83	387	-288	149					DEGF
V45Q2305A	PRSD H2 TANK 3 QUANTITY	55	561	105	1023	0	51			PCNT
V45T2307A	PRSD H2 TANK 3 HTR ASSY TEMP	-51	424	-293	143					DEGF
V45P2310A	PRSD H2 TANK 3 HTR CONTROL PRESS	280	863	150	33					PSIA

APPENDIX G

ATMOSPHERE REVITALIZATION/H20 MATH MODEL REQUIREMENTS

ACKNOWLEDGEMENTS:

The mathematical model flow chart appearing in Section 3 was based on one prepared by Rockwell/Downey, California and provided the basic information from which this requirements document was prepared.

CONTENTS

FIGURES

1. INTRODUCTION

Thermal control within the cabin area and the avionics bays (1, 2 and 3) is accomplished by two parallel water coolant loops. For OV-102, both water coolant loops will be operated simultaneously during launch and entry. During orbital operations, only one water coolant loop will be operated. The water coolant locps (fig. 1) remove crew and equipment generated heat, and transport it to the active thermal control subsystem (ATCS) interchanger for heat rejection. Each coolant loop is identical with the exception that the primary loop contains two parallel mounted pumps and a shuttle check valve, while the secondary has only one pump and no shuttle check valve.

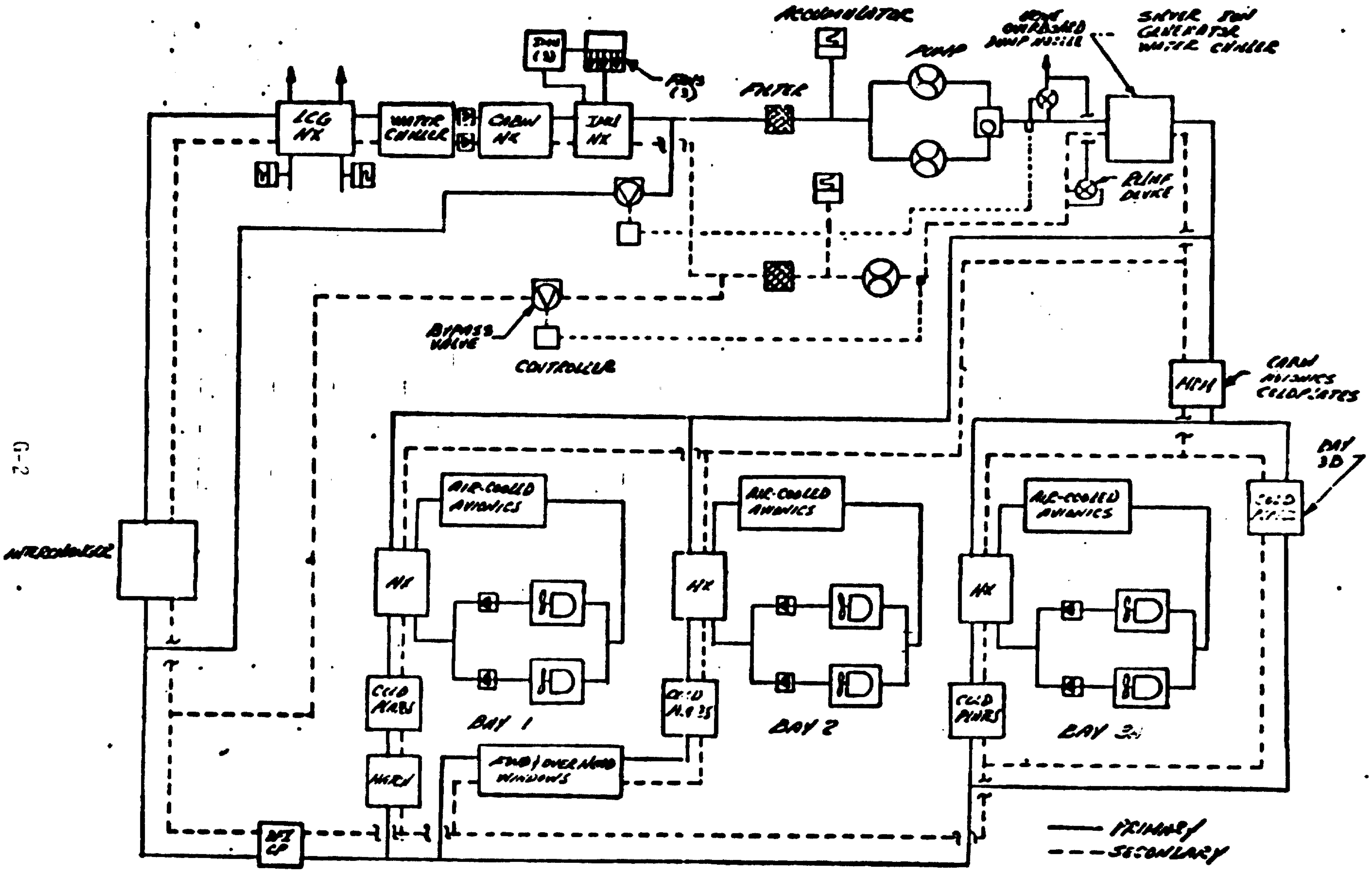


Figure 1 – ARS ~ water coolant loops - Orbiter 102.

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in table 1 to produce values for the output measurements listed in table 2 that simulate the operation of the AR/H2O.

2.1 MATH MODEL DESCRIPTION

2.1.1 WATER COOLANT LOOPS

As depicted in figure 1 water flow leaving the pump first passes through a shuttle check valve (primary coolant loop only) to prevent flow around the inactive pump. On leaving the valve, the water coolant encounters a relief device. After this, the water coolant enters the silver ion generator (SIG) water chiller which cools fuel cell water to allow the water management subsystem SIG to provide proper water purification. From the SIG water chiller, the water coolant divides into two different paths.

- One path provides water coolant to the cabin (MDM) avionics coldplates to pick up heat generated by the MDM's. From the coldplates, the flow divides into two parallel paths. One path directs water coolant through avionics bay 3A heat exchanger to abosrb heat generated by various avionics equipment and then through the avionics bay coldplates. The second path provides water coolant to avionics bay 3B coldplates. From this point, the water coolant merges with coolant exiting bay 3A into a single path.
- The second path divides into two parallel paths, thus entering in-cabin avionics bays 1 and 2. In these avionics bays, the water coolant flows through the avionics bay heat exchanger, and then the avionics bay coldplates. The water coolant leaving avionics bay 1 coldplates enters the hatch coolant loop, and the water coolant exiting avionics bay 2 enters the forward and overhead windows coolant loops. After leaving the hatch and windows, the water coolant merges with coolant exiting bays 3A and 3B into a single path.

Downstream of this point, the water coolant encounters the DFI coldplates and then the water bypass valve line. The bypass valve can be either automatically or manually controlled. In the auto mode, the bypass valve controls the water temperature in the water coolant pump package to 63 $\pm$ 2.5°F by bypassing coolant around the water/freon interchanger. For different phases of the mission, the bypass valve will be controlled as follows:

- Launch and Entry - The bypass valve will be driven manually to the full flow through interchanger position, then the valve will be left in the manual mode.
- Orbital - The bypass valve will be manually set to a predetermined position to match the required freon flow through the interchanger.

The water coolant that is bypassed around the interchanger then passes through the main loop filter. Downstream of the filter is the loop accumulator which maintains a constant pump inlet pressure and compensates for thermal expansion and contraction of the coolant loop. From here, the water coolant returns to the pump for recirculation. The water coolant not bypassed continues through the interchanger for heat rejection. After this, the water coolant travels through the liquid cooling garment (LCG) heat exchanger, whose function is to supply chilled water to the airlock support subsystem for crewmen LCG cooling prior to EVA. From the LCG heat exchanger, the water coolant passes through a water chiller to cool water for crewman consumption. Then the water coolant goes through a check valve and the cabin condensing heat exchanger, whose function is to remove sensible and latent heat from the cabin atmosphere. After leaving the cabin condensing heat exchanger, the water coolant is directed to the IMU heat exchanger where heat is abosrbed by a convective/conductive process. From the IMU heat exchanger, the water coolant returns to the coolant pump and accumulator assembly.

2.1.2 INTERNAL VARIABLES

The following internal variables were introduced into the logic to facilitate computations.

T_1 - Cabin H_x in TEMP - LOOP 1

T_2 - Cabin H_x in TEMP - LOOP 2

R_1 - H_2O INTCHGR flow rate - LOOP 1

R_2 - H_2O INTCHGR flow rate - LOOP 2

F1 - Internal logic flag

T_c - Cabin TEMP

L1 - Internal counter

L2 - Internal counter

The following initial conditions are required:

Internal Variable	Initial Value	Model Counts
T1	44	137
T2	47	172
R1	118	0
R2	659	276
L1	1	1
L2	1	1

2.1.3 INITIAL CONDITIONS

Note that inital conditions for STS are the same as those listed for GTS; see GTS PREPROCESSOR LOGIC.

2.2 STS UNIQUE REQUIREMENTS

None

2.3 GTS UNIQUE REQUIREMENTS

2.3.1 PREPROCESSOR LOGIC

The AR/H20 math model was originally required in the STS simulator. The math model input stimuli symbols referred to in the logic flow diagram, section 3.2, are ATA Reference connector and pin numbers. Due to the lack of flight hardware circuitry in the GTS simulator, logic functions that bridge the gap between the payload MDM's and the AR/H20 are required in a GTS preprocessor in order to evaluate values for the input stimuli coming from the GPC prior to execution of the model.

3. MATH MODEL LOGIC

This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

T basic input stimuli to the model are identified by ATA reference system connector-pin (CP) numbers. A logical combination of one or more MML numbers is used to derive the proper input stimulus for each CP. Within the STS, the logical combination is accomplished via hardware circuitry. However, within the GTS, due to the absence of the required circuitry, the logical relations between CP and MML must be effected by software. The following logical equations are required as a preprocessor within GTS in order to calculate the correct CP stimuli which are then input to the model. Most equations are merely a direct one-for-one correspondence between CP and MML. However, some equiations may require more than one MML to be combined by the logical product (AND) and the inclusive logical sum (OR). In these instances, "AND" denotes the logical product and "OR" denotes the inclusive logical sum.

The SOURCE columns contain an entry for the MDM, connector end pin from which the MML is received. In the absnece of an entry in these columns, the operator must make the entry via the NAS keyboard.

The final column lists the input stimuli initialization values required. Notice that inputs containing an entry for SOURCE do not have an initialization value, since they are updated at the GTS simulator cycle rate by the source connection.

GTS MATH MODEL STIMULI - AR/H20

MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN		MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
K90P13-1	=	V61K2611Y	PF01	J06/009	
15-1	=	2613Y	PF01	J06/031	
23-1	=	2711Y	PF02	J06/021	
27-7	=	2120E			0
33-7	=	2121E			0
39-1	=	2450E			1
41-1	=	2455E			1
31-4	=	2566A			5
37-4	=	2567A			5
18-A	=	2585E			0
20-A	=	2590E			0
17-1	=	2747E			0
17-3	=	2748E			0
1-1	=	2770E			0
3-1	=	2775E			0
2-1	=	2780E			1
4-1	=	2785E			1
10-1	=	2790E			1
12-1	=	2795E			1
25-1	=	2847E			0
25-3	=	2848E			0
K81P157-1	=	2849E			1
158-1	=	2852E			1
159-1	=	2855E			1
K80P32-F	=	**			1
K81P155-1	=				1
K90P5-1	=				1
6-1	=				1
14-1	=				1

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

GTS MATH MODEL STIMULI - AR/H2O

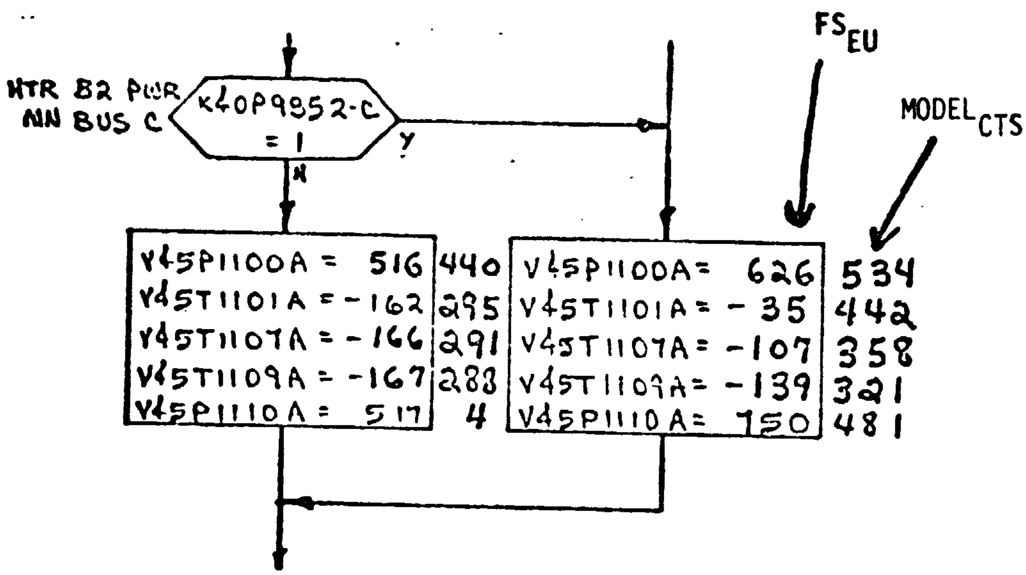
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN		MML ID	SOURCE*		INITIALIZATION VALUES
			MDM	CONN/PIN	
K90P9-1	=	**			1
19-1	=				1
22-1	=				1
27-1	=				1
33-1	=				1
43-1	=				1
96-F	=				0
95-F	=				1

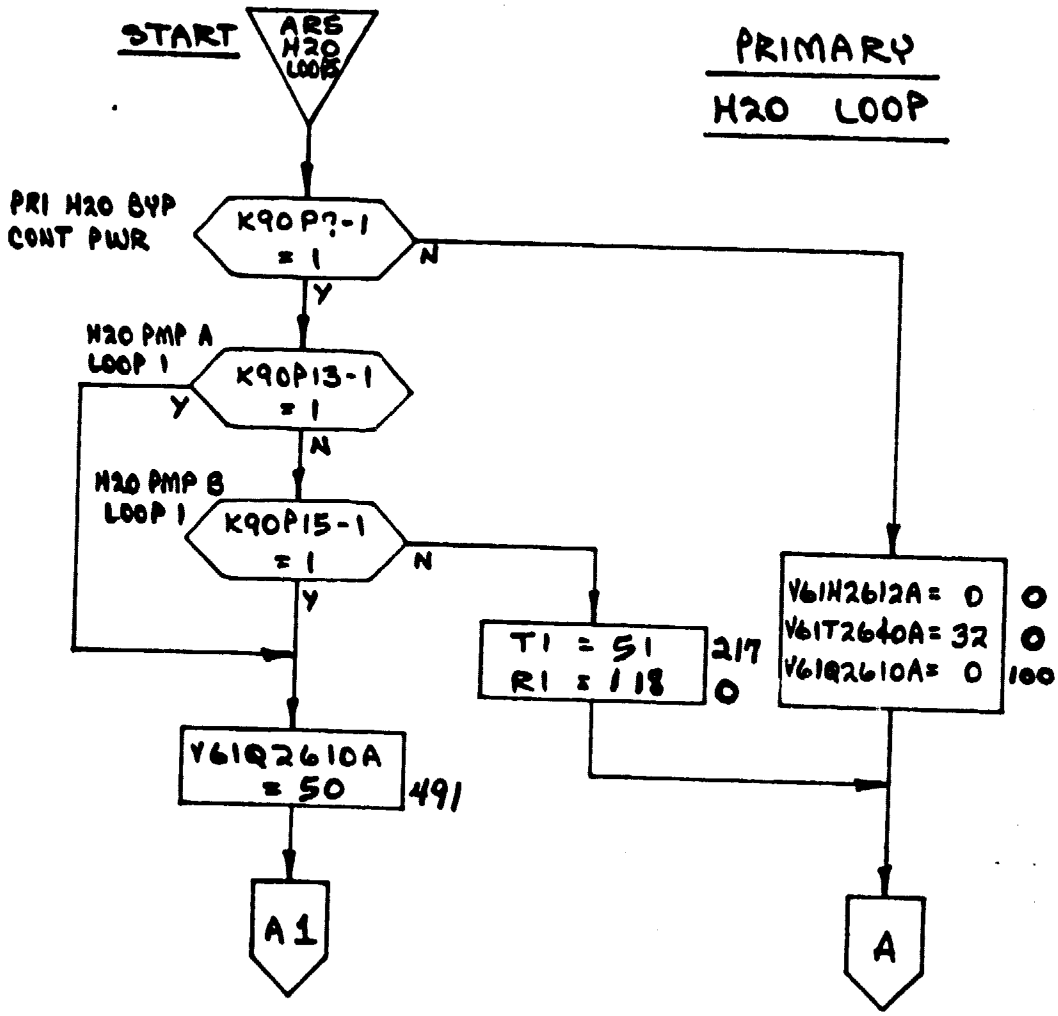
*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;

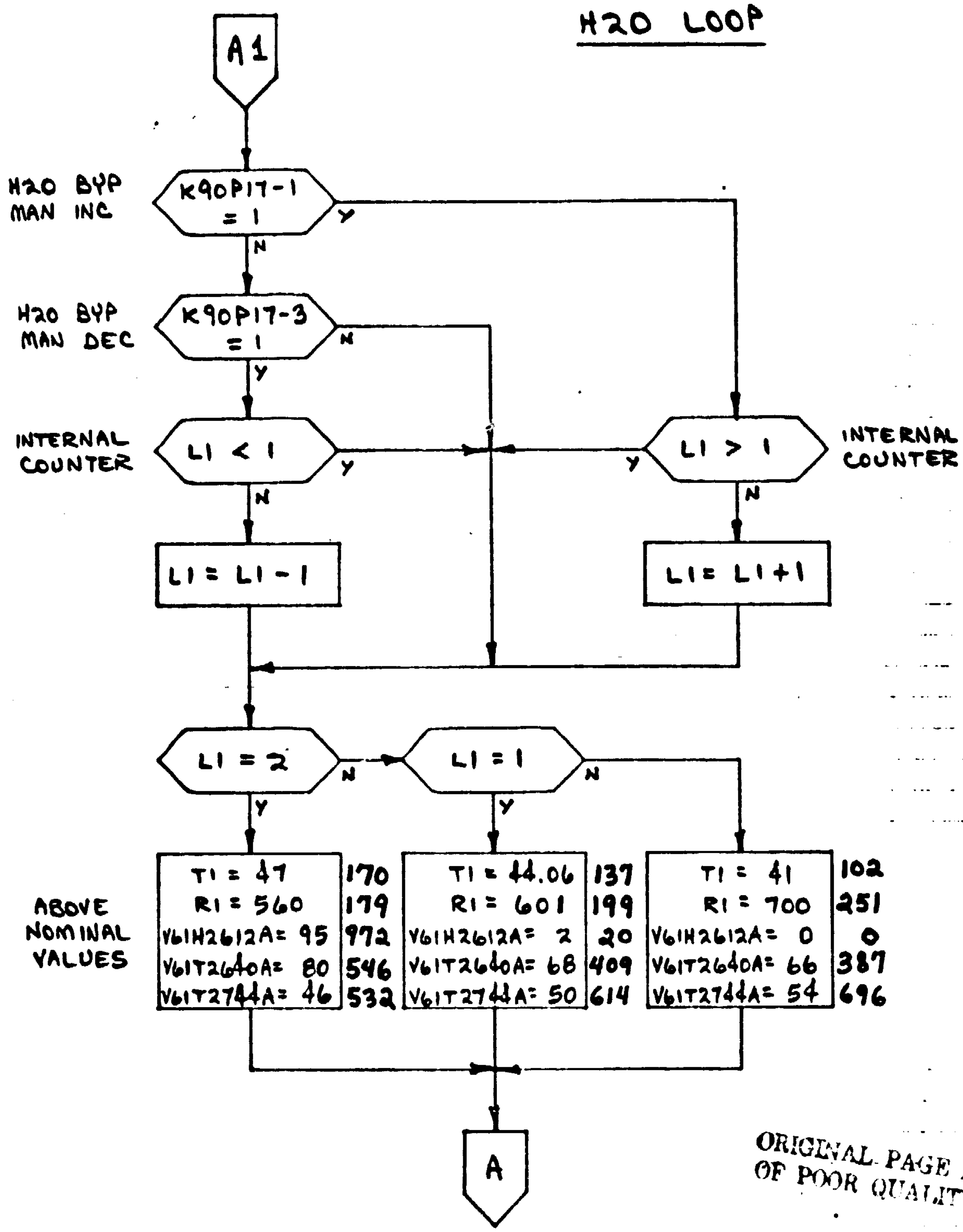


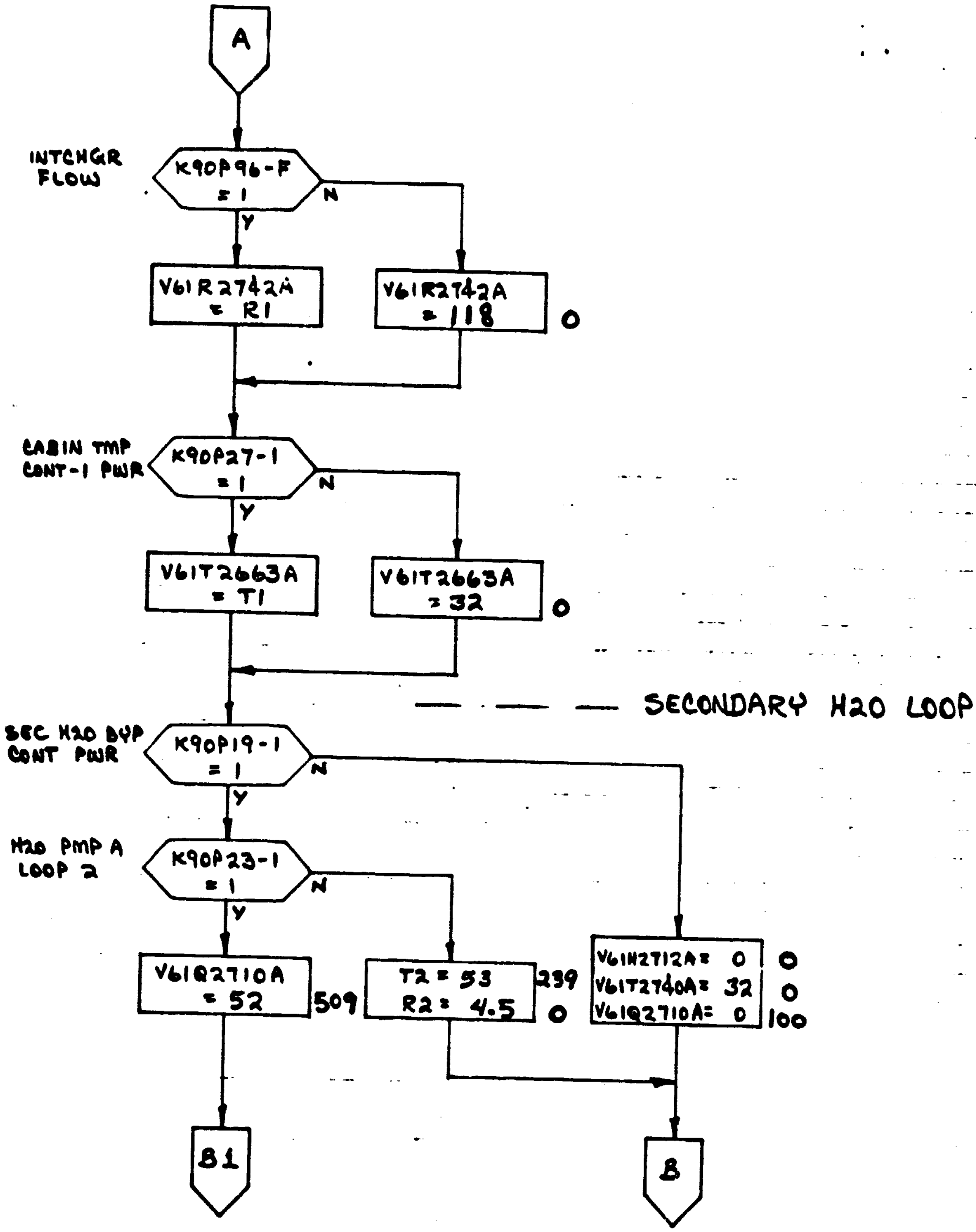
shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.



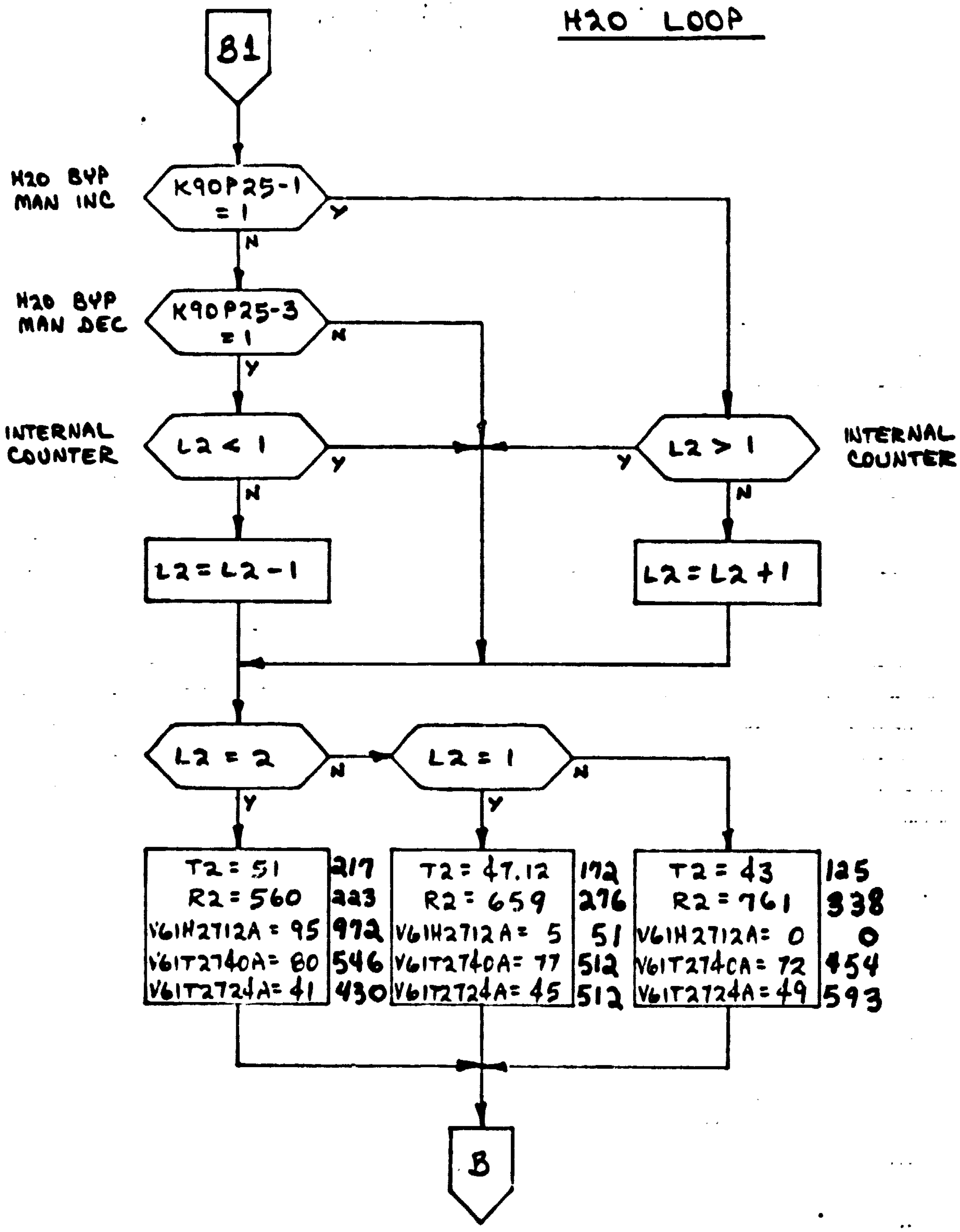
START
ARS H2O LOOPS
PRIMARY H2O LOOP
PRI H2O BYP CONT PWR
K90P7-1 = 1
N
Y
H2O PMP A LOOP 1
K90P13-1 = 1
Y
N
H2O PMP B LOOP 1
K90P15-1 = 1
N
Y
T1 = 51
R1 = 118
217
0
V61N2612A = 0
V61T2640A = 32
V61Q2610A = 0
0
0
100
V61Q2610A = 50
491
A1
A

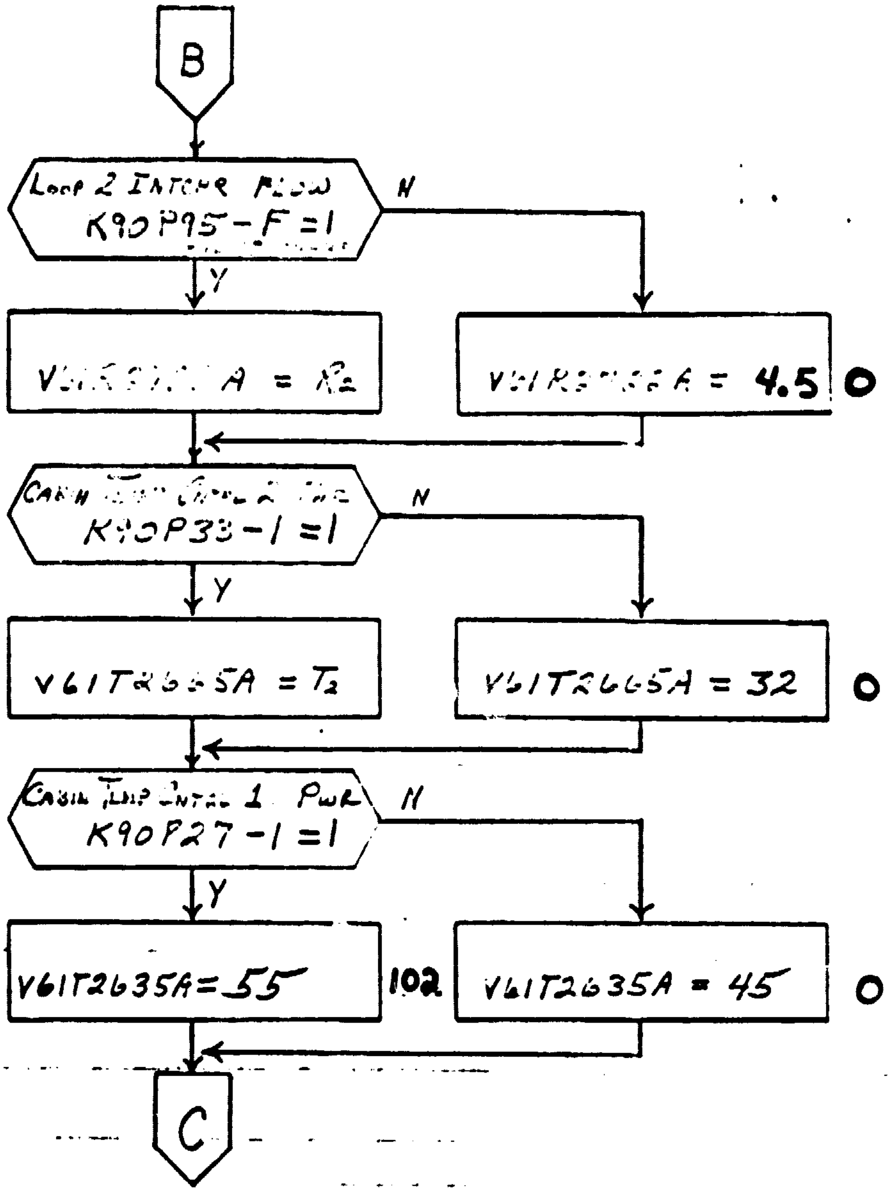
PRIMARY H2O LOOP

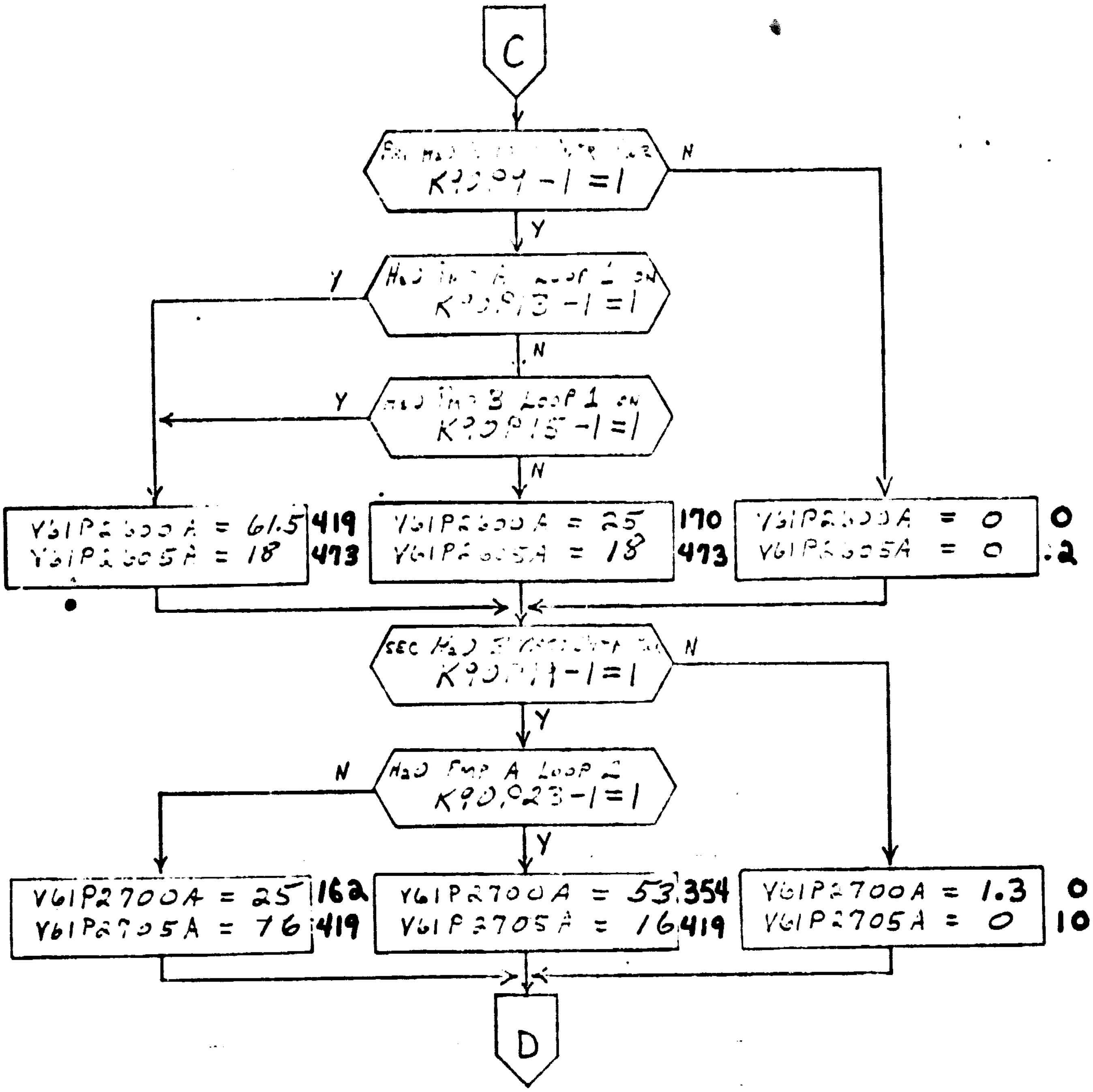


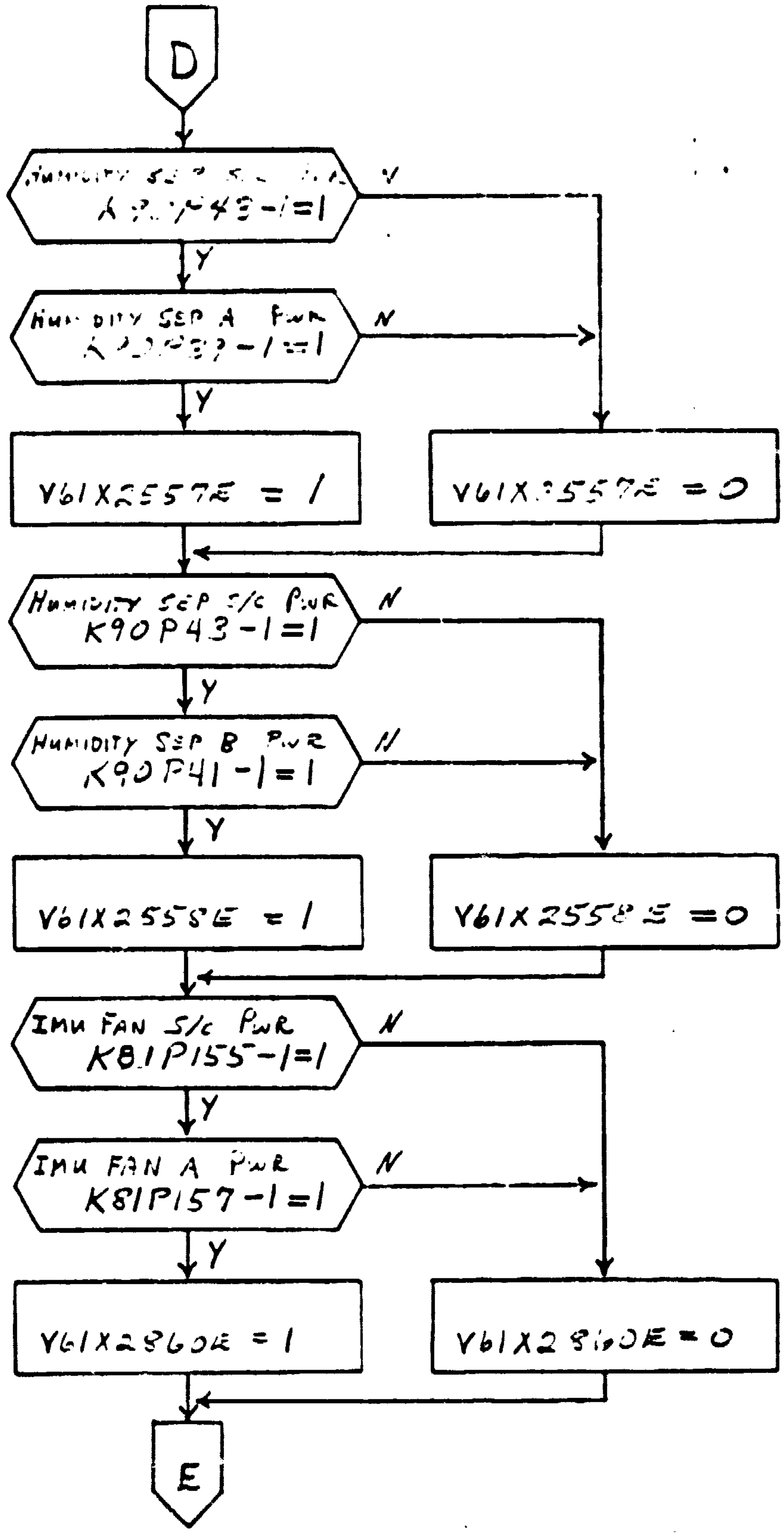

A
INTCHGR FLOW
K90P96-F = 1
Y
N
V61R2742A = R1
V61R2742A = 118
0
CABIN TMP CONT-1 PWR
K90P27-1 = 1
V61T2663A = T1
V61T2663A = 32
SECONDARY H2O LOOP
SEC H2O BYP CONT PWR
K90P19-1 = 1
H2O PMP A LOOP 2
K90P23-1 = 1
V61Q2710A = 52
509
T2 = 53
R2 = 4.5
239
V61H2712A = 0
V61T2740A = 32
V61Q2710A = 0
100
B1
B

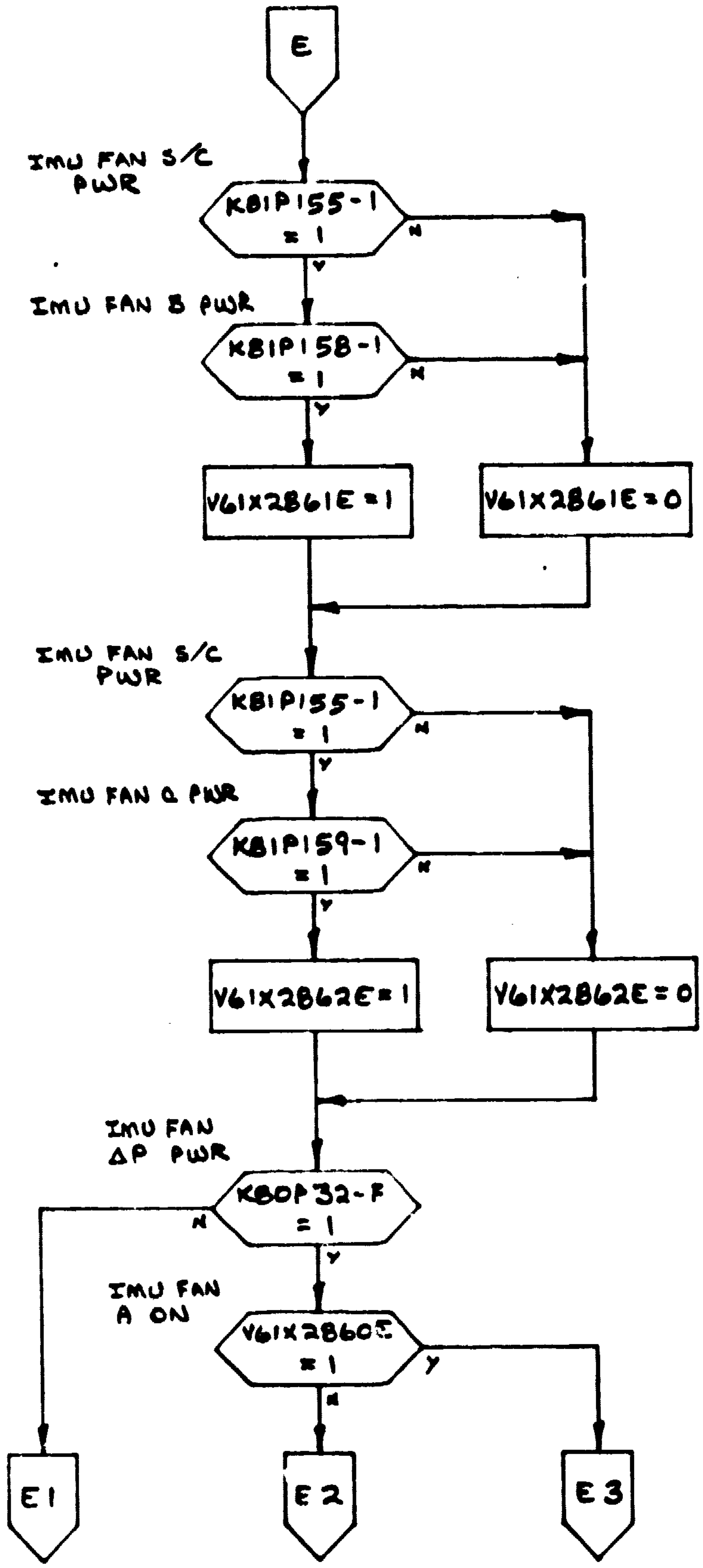
SECONDARY H2O LOOP



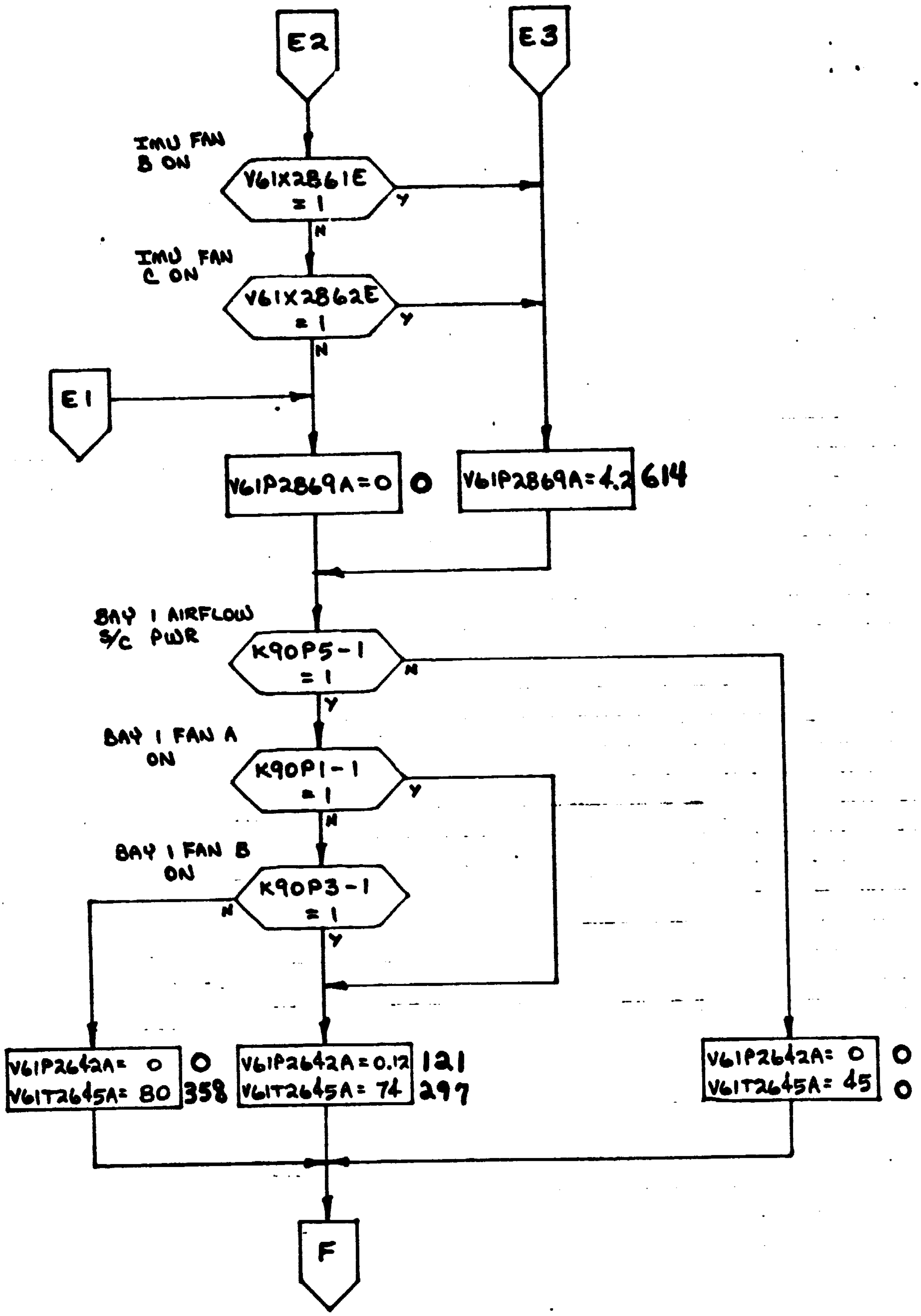

B
K90P95-F=1
N
Y
4.5
0
K90P33-1=1
N
Y
V61T2665A = 32
0
Cabin Temp Cntrl 1 Pwr
K90P27-1=1
N
Y
V61T2635A=55
102
V61T2635A = 45
0
C


C
Y
N
Y61P2600A = 61.5
Y61P2605A = 18
419
473
Y61P2600A = 25
Y61P2605A = 18
170
473
Y61P2600A = 0
Y61P2605A = 0
0
.2
H2O Pmp A Loop 2
Y61P2700A = 25
Y61P2705A = 76
162
419
Y61P2700A = 53
Y61P2705A = 16
354
419
Y61P2700A = 1.3
Y61P2705A = 0
0
10
D

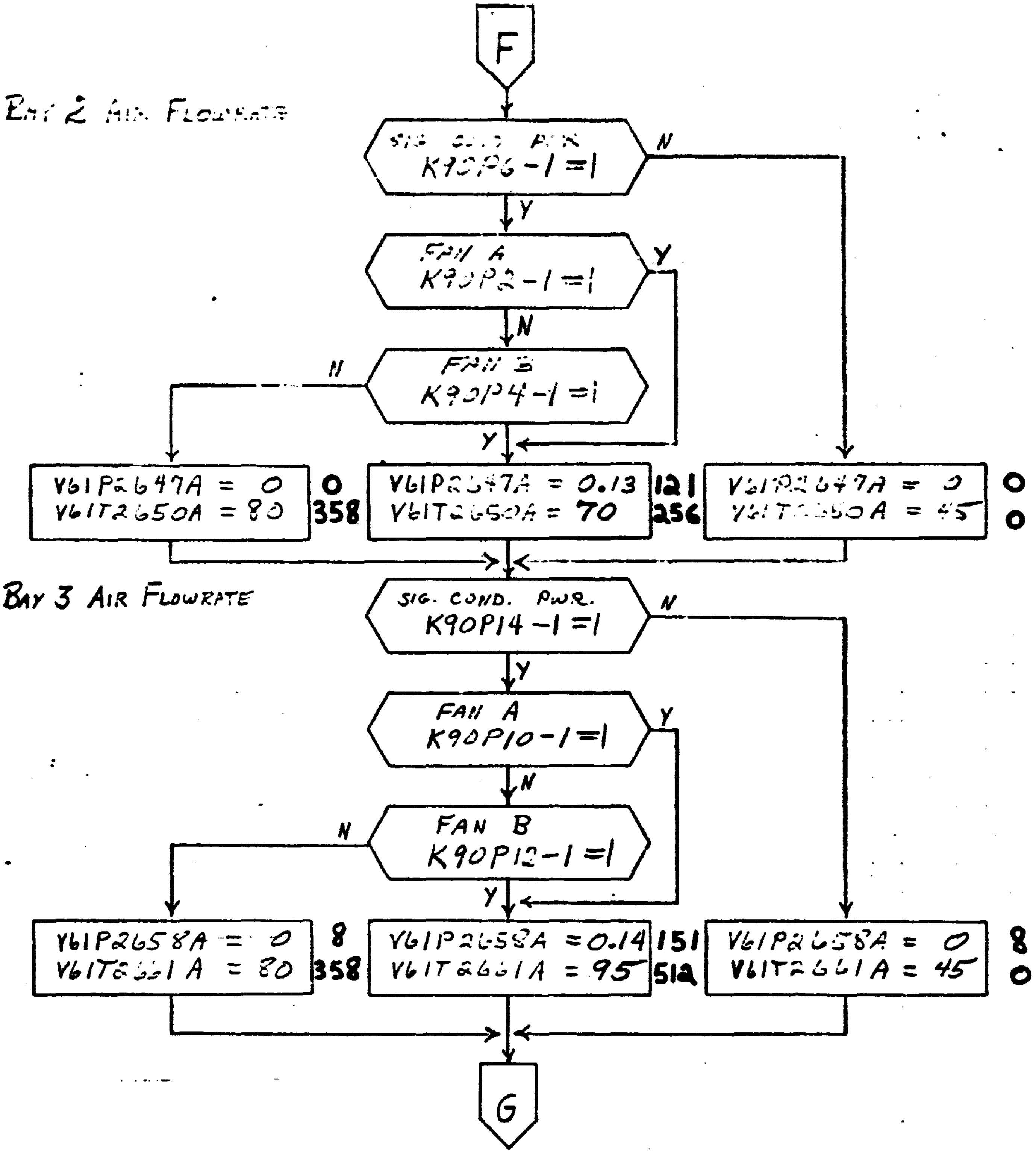

D
HUMIDITY SEP S/C PWR
K90P43-1=1
Y
N
HUMIDITY SEP A PWR
K90P39-1=1
V61X2557E = 1
V61X2557E = 0
HUMIDITY SEP S/C PWR
K90P43-1=1
HUMIDITY SEP B PWR
K90P41-1=1
V61X2558E = 1
V61X2558E = 0
IMU FAN S/C PWR
K81P155-1=1
IMU FAN A PWR
K81P157-1=1
V61X2860E = 1
V61X2860E = 0
E



E
IMU FAN S/C PWR
KBIP155-1 = 1
IMU FAN B PWR
KBIP158-1 = 1
V61X2B61E = 1
V61X2B61E = 0
IMU FAN S/C PWR
KBIP155-1 = 1
IMU FAN C PWR
KBIP159-1 = 1
V61X2B62E = 1
V61X2B62E = 0
IMU FAN ΔP PWR
KBOP32-F = 1
IMU FAN A ON
V61X2B60E = 1
E1
E2
E3


E2
E3
IMU FAN B ON
V61X2861E = 1
Y
N
IMU FAN C ON
V61X2862E = 1
Y
N
E1
V61P2869A=0
0
V61P2869A=4.2
614
BAY 1 AIRFLOW S/C PWR
K90P5-1 = 1
N
Y
BAY 1 FAN A ON
K90P1-1 = 1
Y
N
BAY 1 FAN B ON
K90P3-1 = 1
N
Y
V61P2642A= 0
0
V61T2645A= 80
358
V61P2642A=0.12
121
V61T2645A= 74
297
V61P2642A= 0
0
V61T2645A= 45
0
F

C-4



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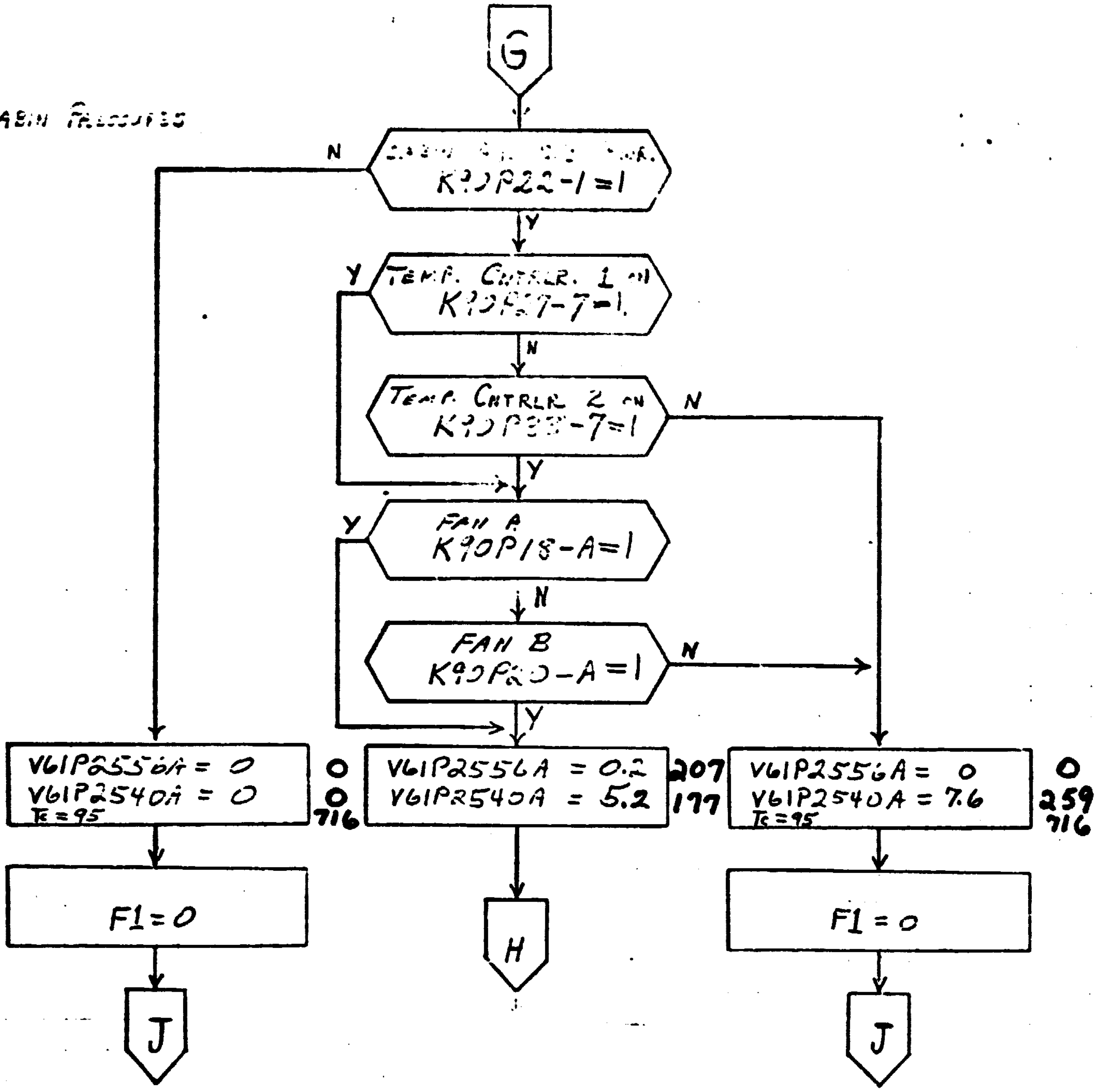
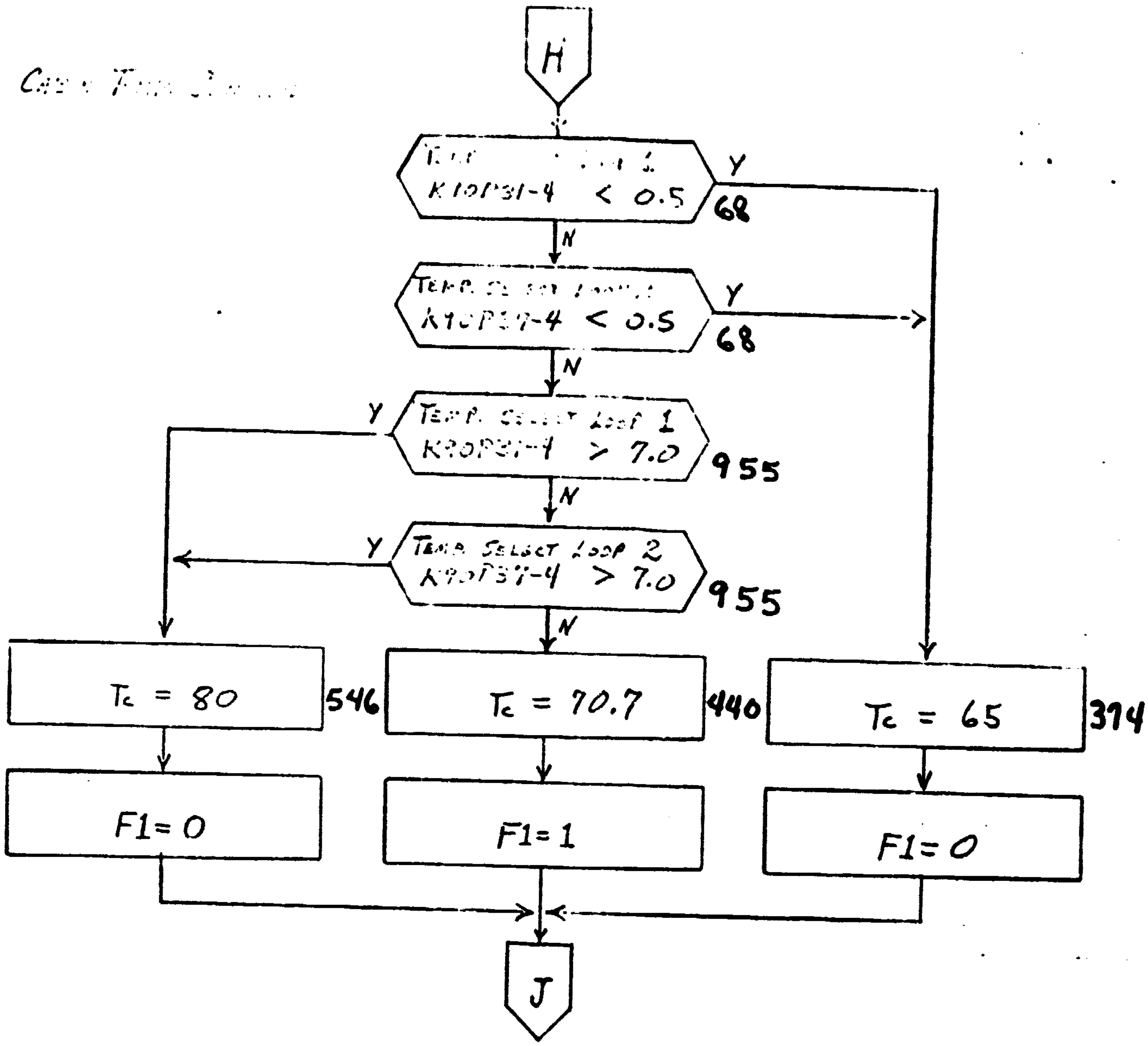
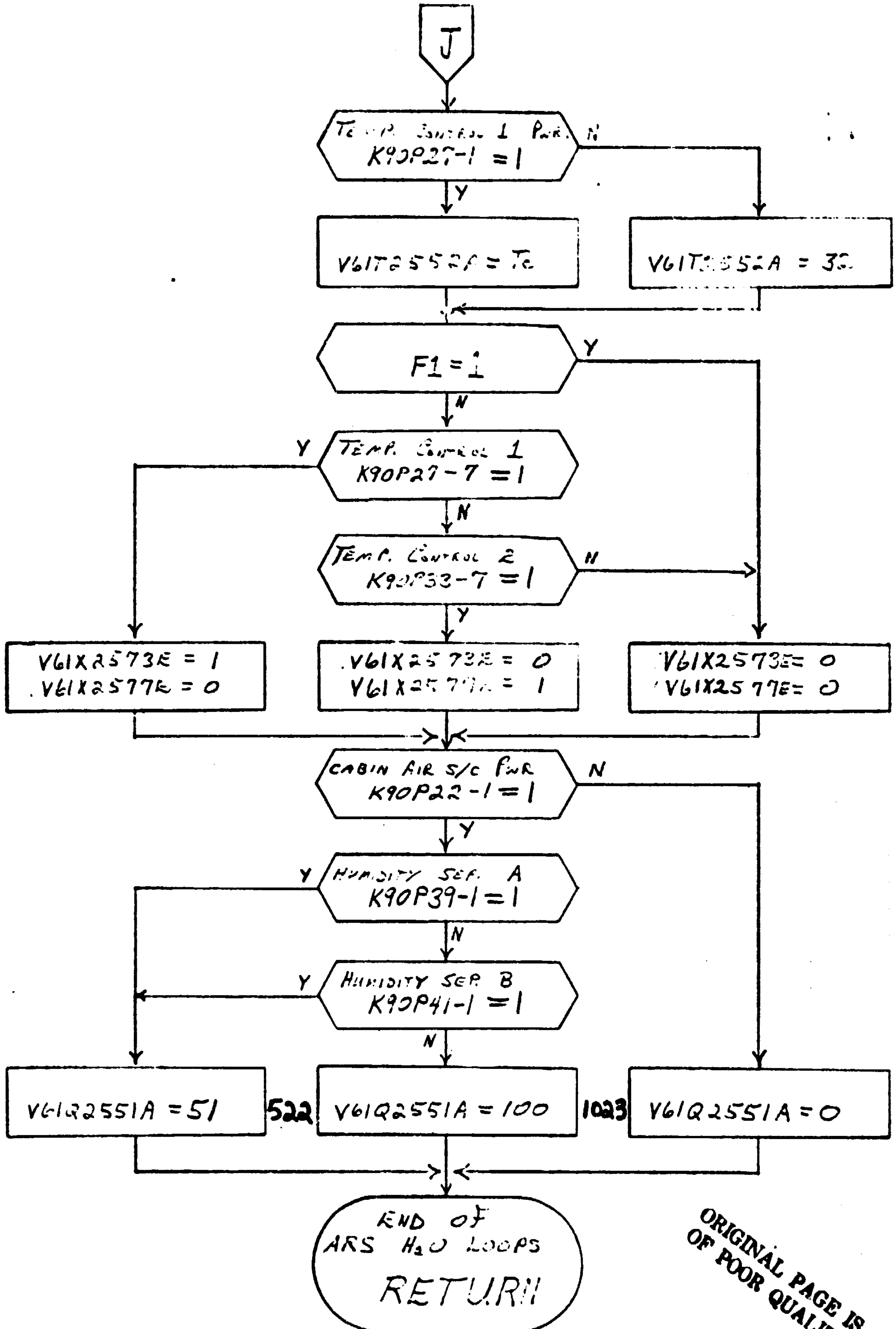
CABIN PRESSURES





H
K10P31-4 < 0.5
Y
N
68
K10P37-4 < 0.5
Y
N
68
TEMP. SELECT LOOP 1
K90P31-4 > 7.0
Y
N
955
TEMP. SELECT LOOP 2
K90P37-4 > 7.0
Y
N
955
Tc = 80
546
Tc = 70.7
440
Tc = 65
374
F1= 0
F1= 1
F1= 0
J



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4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
L4/CB117	CABIN TEMP CNTRLR 1 PWR	5,6		K90P27-1	1-ON/0-OFF
L4/CB119	CABIN TEMP CNTRLR 2 PWR	5,6		K90P33-1	1-ON/0-OFF
L4/CB127	AV BAY 1 S/C PWR	5,6		K90P5-1	1-ON/0-OFF
L4/CB118	AV BAY 2 S/C PWR	5,6		K90P6-1	1-ON/0-OFF
L4/CB120	AV BAY 3 S/C PWR	5,6		K90P14-1	1-ON/0-OFF
L4/CB121	H20 BYPASS CNTRLR - PRI	5,6		K90P9-1	1-ON/0-OFF
L4/CB93	H20 BYPASS CNTRLR - SEC	5,6		K90P19-1	1-ON/0-OFF
L4/CB81	IMU FAN S/C PWR	5,6		K81P155-1	1-ON/0-OFF
L4/CB94	CABIN AIR S/C PWR	5,6		K90P22-1	1-ON/0-OFF
L4/CB80	HUMIDITY SEP S/C PWR	5,6		K90P43-1	1-ON/0-OFF
014/CB35	INTCHGR. FLOW - H20 LOOP 1 PWR	5,6		K90P96-F	1-ON/0-OFF
015/CB35	INTCHGR FLOW - H20 LOOP 2 PWR	5,6		K90P95-F	1-ON/0-OFF
L1A2/S3	H20 PUMP A - LOOP 1 ON	2	V61K2611Y	K90P13-1	1-ON/0-OFF
	H20 PUMP B - LOOP 1 ON	2	V61K2613Y	K90P15-1	1-ON/0-OFF
L1A2/S6	H20 PUMP - LOOP 2 ON	2	V61K2711Y	K90P23-1	1-ON/0-OFF
L1A2/S4	H20 BYPASS MAN- INCR - LOOP 1	5	V61K2747E	K90P17-1	1-ON/0-OFF
	H20 BYPASS MAN - DECR - LOOP 1	5	V61K2748E	K90P17-3	1-ON/0-OFF
L1A2/S7	H20 BYPASS MAN - INCR - LOOP 2	5	V61K2847E	K90P25-1	1-ON/0-OFF
	H20 BYPASS MAN - DECR - LOOP 2	5	V61K2848E	K90P25-3	1-ON/0-OFF

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
L1A2/S12	IMU FAN A	5	V61K2849E	K81P157-1	1-ON/0-OFF
L1A2/S13	IMU FAN B	5	V61K2852E	K81P158-1	1-ON/0-OFF
L1A2/S14	IMU FAN C	5	V61K2855E	K81P159-1	1-ON/0-OFF
L1/S11	CABIN TEMP CNTRLR - LOOP 1 ON	5	V61K2120E	K90P27-7	1-ON/0-OFF
	CABIN TEMP CNTRLR - LOOP 2 ON	5	V61K2121E	K90P33-7	1-ON/0-OFF
L1A2/S1	HUMIDITY SEP A ON	5	V61K2450E	K90P39-1	1-ON/0-OFF
L1A2/S2	HUMIDITY SEP B ON	5	V61K2455E	K90P41-1	1-ON/0-OFF
L1A2/S17	CABIN FAN A ON	5	V61K2585E	K90P18-A	1-ON/0-OFF
L1A2/S18	CABIN FAN B ON	5	V61K2590E	K90P20-A	1-ON/0-OFF
L1/R1	CABIN TEMP SELECTOR - LOOP 1	5	V61K2566A	K90P31-4	>7(WARM)/≤ 7(COOL)
	CABIN TEMP SELECTOR - LOOP 2	5	V61K2567A	K90P37-4	>7(WARM)/≤ 7(COOL)
L1A2/S9	AVIONICS BAY 1 - FAN A ON	5	V61K2770E	K90P1-1	1-ON/0-OFF
L1A2/S10	AVIONICS BAY 1 - FAN B ON	5	V61K2785E	K90P3-1	1-ON/0-OFF
L1A2/S15	AVIONICS BAY 2 - FAN A ON	5	V61K2780E	K90P2-1	1-ON/0-OFF
L1A2/S16	AVIONICS BAY 2 - FAN B ON	5	V61K2785E	K90P4-1	1-ON/0-OFF
L1A2/S19	AVIONICS BAY 3 - FAN A ON	5	V61K2790E	K90P10-1	1-ON/0-OFF
L1A2/S20	AVIONICS BAY 3 - FAN B ON	5	V61K2795E	K90P12-1	1-ON/0-OFF
	IMU FAN ΔP POWER	5,6		K80P32-F	1-ON/0-OFF

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM AR/H_2O MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
*V61P2540A	CO_2 PARTIAL PRESSURE	5.2	177	0	0	7.6	259			MMHG
*V6102551A	CABIN HUMIDITY	51	522	0	0	100	1023			PERCENT
V61T2552A	CABIN TEMP.	70.7	440	32 95	0 716	65	374	80	546	DEG.F
V61P2556A	CABIN FAN DELTA PRESSURE	0	0	0.2	207					PSID
V61X2557E	HUMIDITY SEP A SPEED	0	0	1	1					STATE
V61X2558E	HUMIDITY SEP B SPEED	0	0	1	1					
V61X2573E	CABIN TEMP CTL FULL HX-LOOP 1	0	0	1	1					
V61X2577E	CABIN TEMP CTL FULL HX-LOOP 2	0	0	1	1					
V61P2600A	H_2O PUMP OUT PRESS - PRI	61.5	419	0	0	25	170			PSIA
V61P2605A	H_2O PUMP IN PRESS-PRI	18	473	0	12					PSIA
V61Q2610A	H_2O ACCUM QTY-PRI	50	491	0	100					PERCENT
*V61H2612A	H_2O BYPASS VLV. POS.-PRI	2	20	0	0	95	972			PERCENT
V61T2635A	CABIN HX OUT TEMP.	55	102	45	0					DEG.F.
V61T2640A	H_2O PUMP OUT TEM.-LOOP 1	68	409	32	0	66	387	80	546	DEG.F.
V61P2642A	AV. BAY 1 DELTA PRESS.	0	0	0.12	121					PSID
V61T2645A	AV. BAY 1 OUT AIR TEMP.	74	297	45	0	80	358			DEG.F.
V61P2647A	AV. BAY 2 DELTA PRESS.	0.13	121	0	0					PSID
V61T2650A	AV. BAY 2 OUT AIR TEMP.	70	256	45	0	80	358			DEG.F.
V61P2658A	AV. BAY 3 DELTA PRESS.	0.14	151	0	8					PSID
V61T2661A	AV. BAY 3 OUT AIR TEMP.	95	512	45	0	80	358			DEG. F.
V61T2663A	CABIN HX IN. TEMP.-LOOP 1	44.06	137	32 51	0 217	41	102	47	170	DEG.F.

*NOTE: This measurement uses the range limit conversion method of calculating FS_{EU} .

MEASUREMENT OUTPUT FROM AR/H_2O MODEL - TABLE 2

MEASUREMENT I.D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V61T2665A	CABIN HX IN. TEMP.-LOOP 2	47.12	172	32 53	0 239	43	125	51	217	DEG.F.
V61P2700A	H_2O PUMP OUT PRESS-SEC.	53	354	1.3	0	25	162			PSIA
V61P2705A	H_2O PUMP IN. PRESS-SEC.	16	419	0	10					PSIA
V61Q2710A	H_2O ACCUM. QTY-SEC.	52	509	0	100					PERCENT
*V61H2712A	H_2O BYPASS VLV. POS.-SEC	95	972	0	0	5	51			PERCENT
V61R2722A	H_2O INTCHGR. FLOW - LOOP 2	659	276	4.5	0	560	223	761	338	PPH
V61T2724A	H_2O INTCHGR. OUT TEMP.-LOOP 2	45	512	41	430	49	593			DEG.F.
V61T2740A	H_2O PUMP OUT TEMP - LOOP 2	77	512	32	0	72	454	80	546	DEG.F.
V61R2742A	H_2O INTCHGR. FLOW - LOOP 1	118	0	560	179	601	199	700	251	PPH
V61T2744A	H_2O INTCHGR. OUT TEMP. - LOOP 1	50	614	46	532	54	696			DEG.F.
V61X2860E	IMU FAN A SPEED	0	0	1	1					STATE
V61X2861E	IMU FAN B SPEED	0	0	1	1					
V61X2862E	IMU FAN C SPEED	0	0	1	1					
V61P2869A	IMU FAN ΔP	4.2	614	0	0					INCHES H_2O

*NOTE: This measurement uses the range limit conversion method of calculating FS_{EU} .

APPENDIX H

ATMOSPHERE REVITALIZATION/PCS MATH MODEL REQUIREMENTS

CONTENTS

FIGURES

1. INTRODUCTION

This model simulates the Orbiter Atmosphere Revitalization/Pressurization and Control-Airlock System (AR/PCS-Airlock) by representing the stimulus/response relationships which exist at the power and signal interfaces between the Orbiter Avionics System and the AR/PCS-Airlock. The model has been simplified by including only those output signals which are needed to support the type of testing which will be accomplished in the Shuttle Avionics Integration Laboratory (SAIL).

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in Table 1 to produce values for the output measurements listed in Table 2 that simulate the operation of the AR/PCS.

2.1 MATH MODEL DESCRIPTION

2.1.1 AR/PCS MODEL OVERVIEW

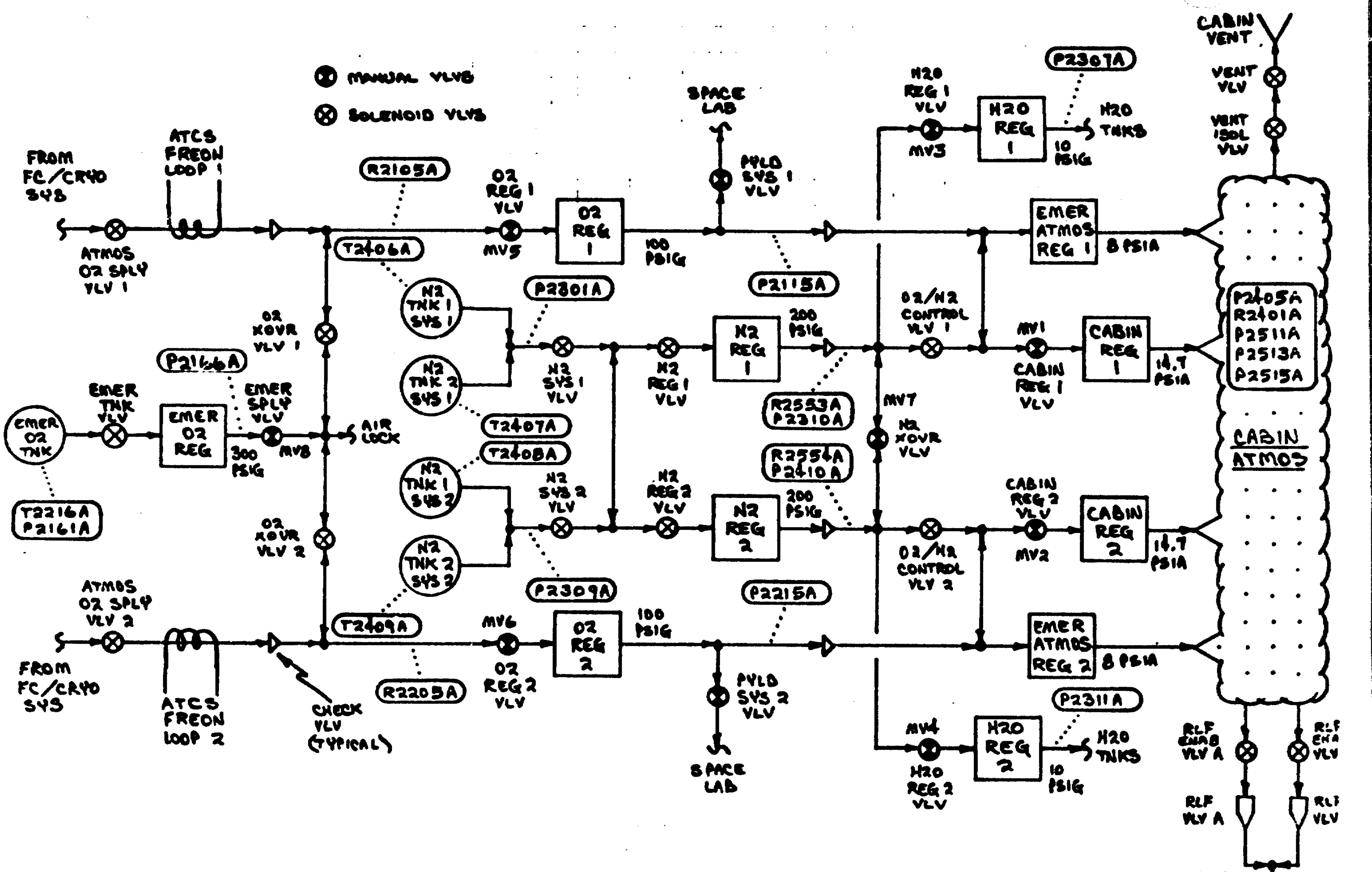
The AR/PCS provides the Orbiter with a pressurized atmosphere of oxygen and nitrogen, and supplies nitrogen for pressurization of the Orbiters' potable and waste water system. Two lines from the Fuel Cell/Cryogenic System (FC/CRYO) supply oxygen to the AR/PCS, which are backed up by an emergency oxygen tank in the AR/PCS. Four nitrogen tanks in the AR/PCS supply the necessary nitrogen. For reliability, two independent systems control the atmosphere and water pressurization, with crossover valves providing additional reliability. Figure 1 and figure 2 are simplified schematics of the AR/PCS and airlock, respectively, showing the various tanks, regulators and valves.

In the AR/PCS-Airlock math model, the OPEN or CLOSED position of the manual values must be entered by the test operator when cockpit valves are changed, so that the AP/PCS-Airlock math model will generate realistic data.

Fixed values are provided for the pressure and temperature of the oxygen and nitrogen tanks. Tank quantities, as calculated by the flight system GPC based on tank pressures and temperatures, will remain unchanged unless different pressure and temperature values are sent by the test operator while the math model's output for these parameters is inhibited.

2.1.2 LATCHING VALVE ROUTINE (LVR)

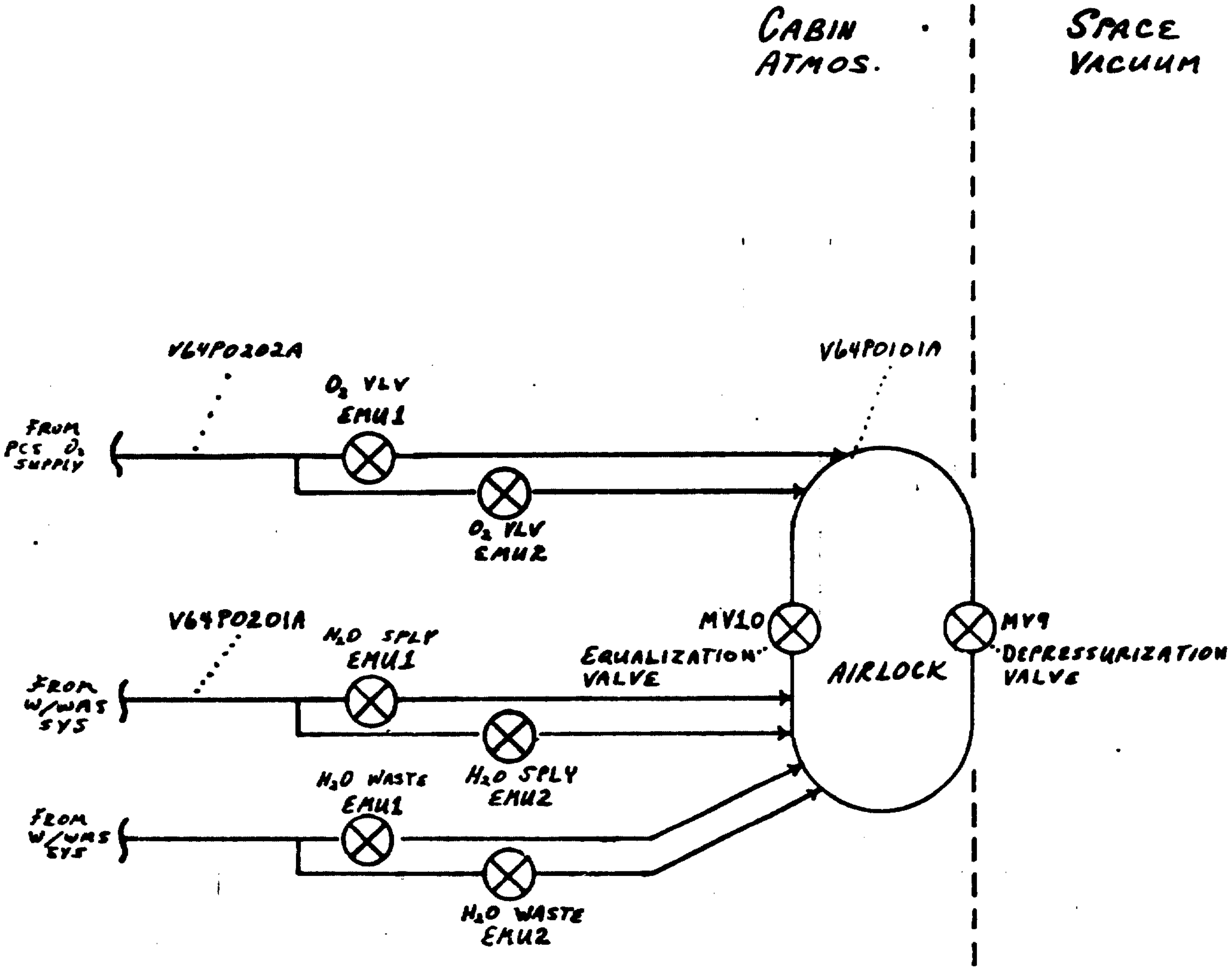
The math model uses three internal variables (A, B, and V) in subroutine called Latching Valve Routine (LVR). A and B represent the state of CLOSE and OPEN stimuli, respectively, to a valve. V represents the OPENED or CLOSED state of the valve based on A and B values.



ATMOS PRESSURIZATION AND CONTROL SYSTEM

SIMPLIFIED SCHEMATIC

FIGURE 1



AIRLOCK
SIMPLIFIED SCHEMATIC

FIGURE 2

2.1.3 INITIAL CONDITIONS

Note that initial conditions for STS are the same as those listed for GTS; see GTS PREPROCESSOR LOGIC.

2.2 STS UNIQUE REQUIREMENTS

None.

2.3 GTS UNIQUE REQUIREMENTS

2.3.1 PREPROCESSOR LOGIC

The AR/PCS math model was originally required in the STS simulator. The math model input stimuli symbols referred to in the logic flow diagram, section 3.2, are ATA Reference connector and pin numbers. Due to the lack of flight hardware circuitry in the GTS simulator, logic functions that bridge the gap between the payload MDM's and the AR/PCS subsystem are required in a GTS preprocessor in order to evaluate values for the input stimuli coming from the GPC prior to execution of the model.

3. MATH MODEL LOGIC

This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

The basic input stimuli to the model are identified by ATA reference system connector-pin (CP) numbers. A logical combination of one or more MML numbers is used to derive the proper input stimulus for each CP. Within the STS, the logical combination is accomplished via hardware circuitry. However, within the GTS, due to the absence of the required circuitry, the logical relations between CP and MML must be effected by software. The following logical equations are required as a preprocessor within GTS in order to calculate the correct CP stimuli which are then input to the model. Most equations are merely a direct one-for-one correspondence between CP and MML. However, some equiations may require more than one MML to be combined by the logical product (AND) and the inclusive logical sum (OR). In these instances, "AND" denotes the logical product and "OR" denotes the inclusive logical sum.

The SOURCE columns contain an entry for the MDM, connector end pin from which the MML is received. In the absnece of an entry in these columns, the operator must make the entry via the NAS keyboard.

The final column lists the input stimuli initialization values required. Notice that inputs containing an entry for SOURCE do not have an initialization value, since they are updated at the GTS simulator cycle rate by the source connection.

GTS MATH MODEL STIMULI - AR/PCS/AL

MML TO CONN-PIN CONVERSION LOGIC

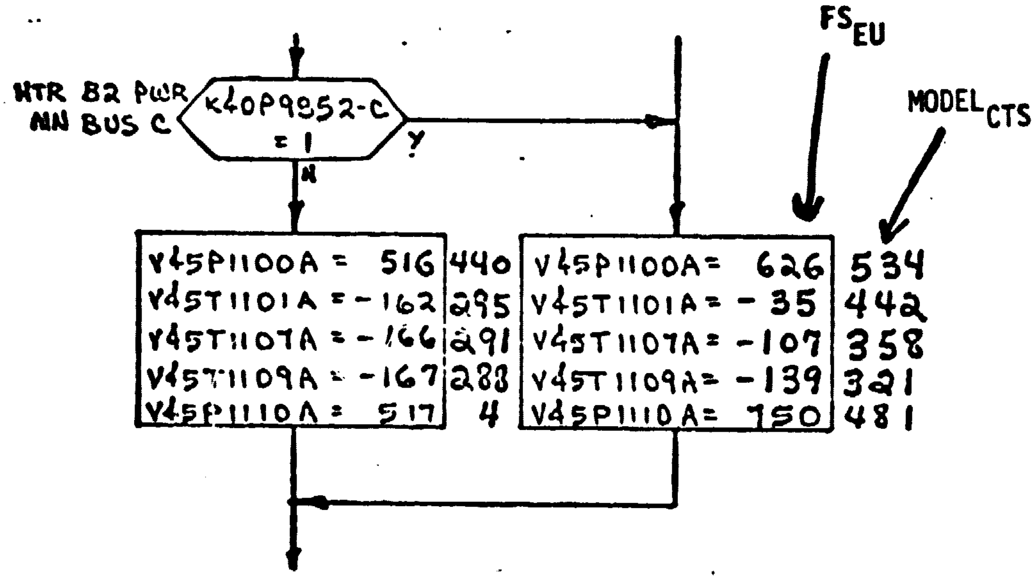
SYSTEM CONN-PIN		MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
K80P31-10	=	V61K2000E			1
31-12	=	2020E			0
30-10	=	2040E			1
30-12	=	2060E			0
27-30	=	2100E			1
28-30	=	2200E			1
25-10	=	2133E			0
25-12	=	2134E			1
26-10	=	2137E			0
26-12	=	2138E			1
34-32	=	2162E			0
34-5	=	2164E			1
33-5	=	2304E			1
33-3	=	2305E			0
34-36	=	2314E			0
34-17	=	2315E			1
34-34	=	2317E			0
34-11	=	2318E			1
33-11	=	2322E			1
33-9	=	2325E			0
27-29	=	2370E			1
28-29	=	2375E			0
KAW82D P6-S	=	V64K0500E			0
P6-T	=	0501E			1
P4-13	=	0510E			0
P4-11	=	0511E			1
P6-B	=	0520E			0
P6-C	=	0521E			1
P5-13	=	0530E			0
P5-11	=	0531E			1
K80P27-37	=	**			1
28-37	=				1
29-22	=				1

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.

**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

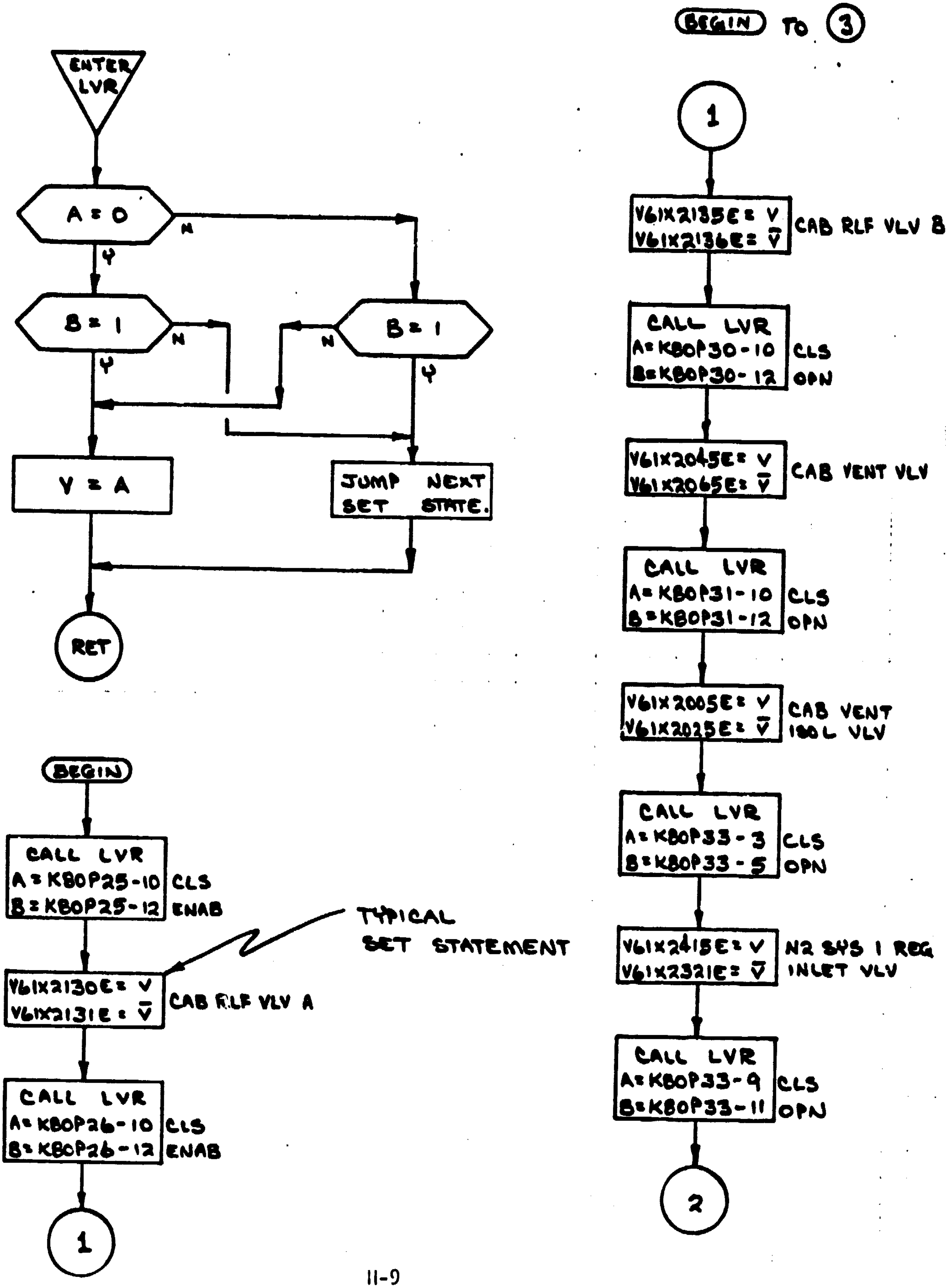
3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;

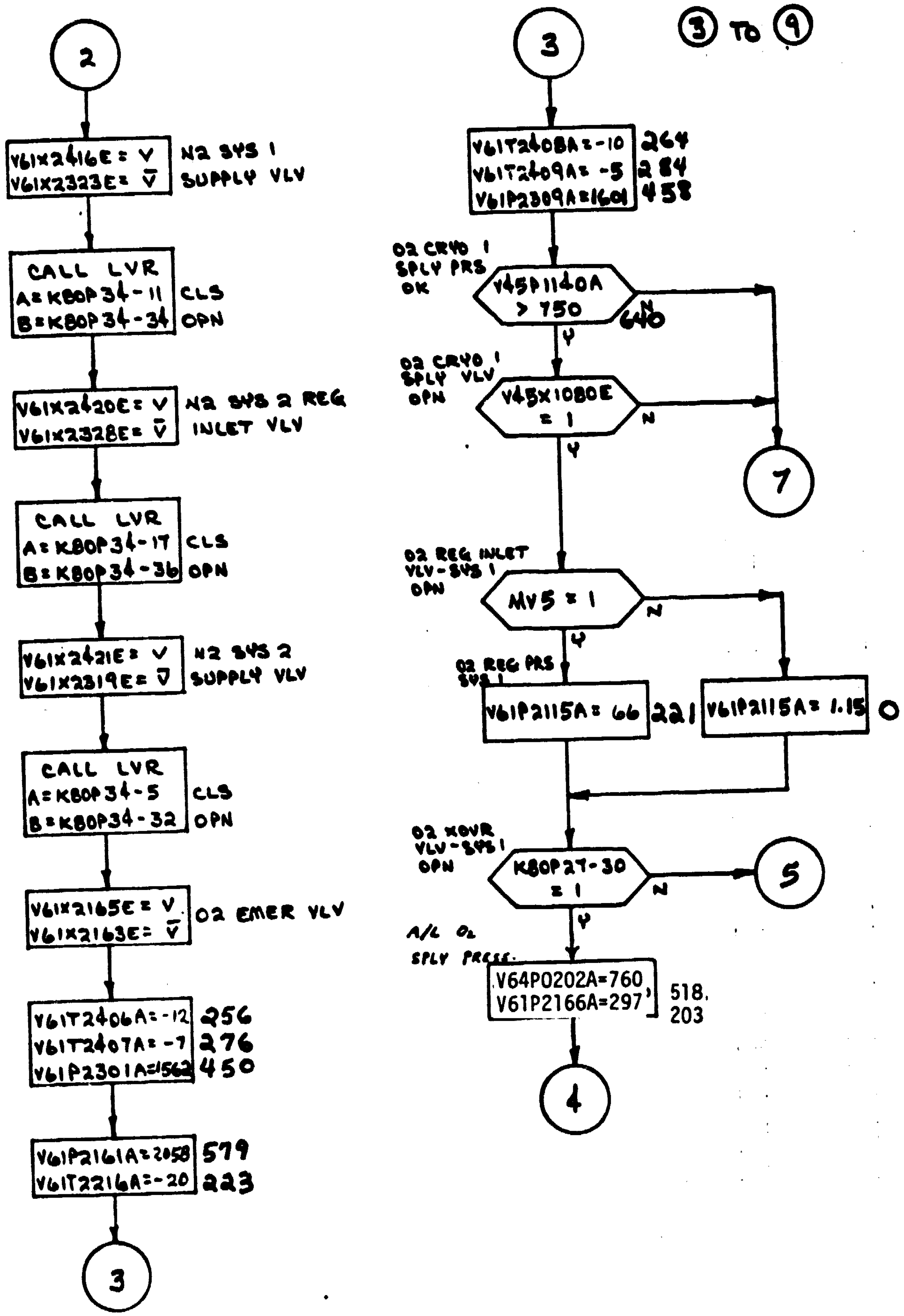


shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.

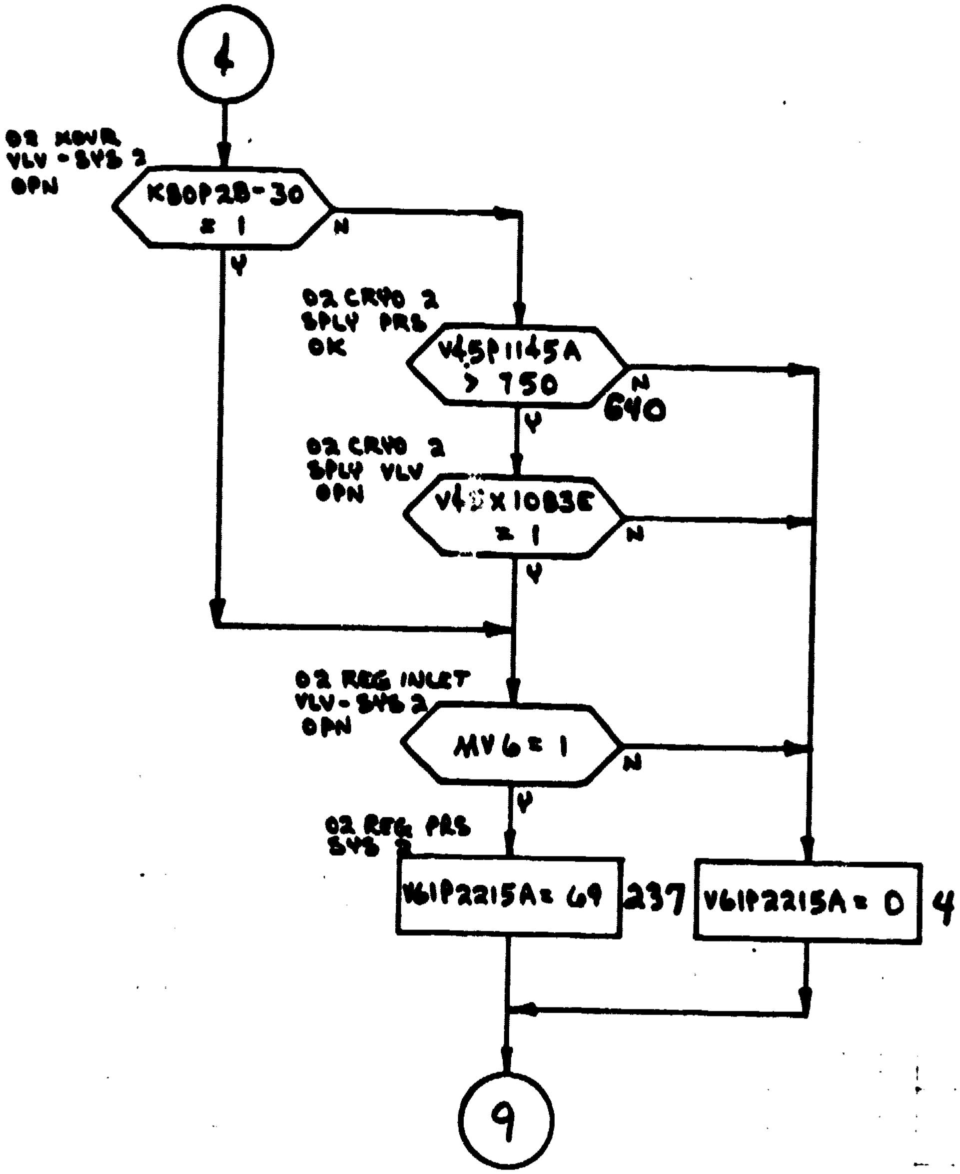
LVR


BEGIN TO 3
ENTER LVR
A = 0
N
Y
B = 1
N
Y
B = 1
N
Y
Y = A
JUMP NEXT SET STATE.
RET
BEGIN
CALL LVR
A = KBOP25-10 CLS
B = KBOP25-12 ENAB
TYPICAL SET STATEMENT
V61X2130E = V
V61X2131E = V̄
CAB RLF VLV A
CALL LVR
A = KBOP26-10 CLS
B = KBOP26-12 ENAB
1
1
V61X2135E = V
V61X2136E = V̄
CAB RLF VLV B
CALL LVR
A = KBOP30-10 CLS
B = KBOP30-12 OPN
V61X2045E = V
V61X2065E = V̄
CAB VENT VLV
CALL LVR
A = KBOP31-10 CLS
B = KBOP31-12 OPN
V61X2005E = V
V61X2025E = V̄
CAB VENT ISOL VLV
CALL LVR
A = KBOP33-3 CLS
B = KBOP33-5 OPN
V61X2415E = V
V61X2321E = V̄
N2 SYS 1 REG INLET VLV
CALL LVR
A = KBOP33-9 CLS
B = KBOP33-11 OPN
2

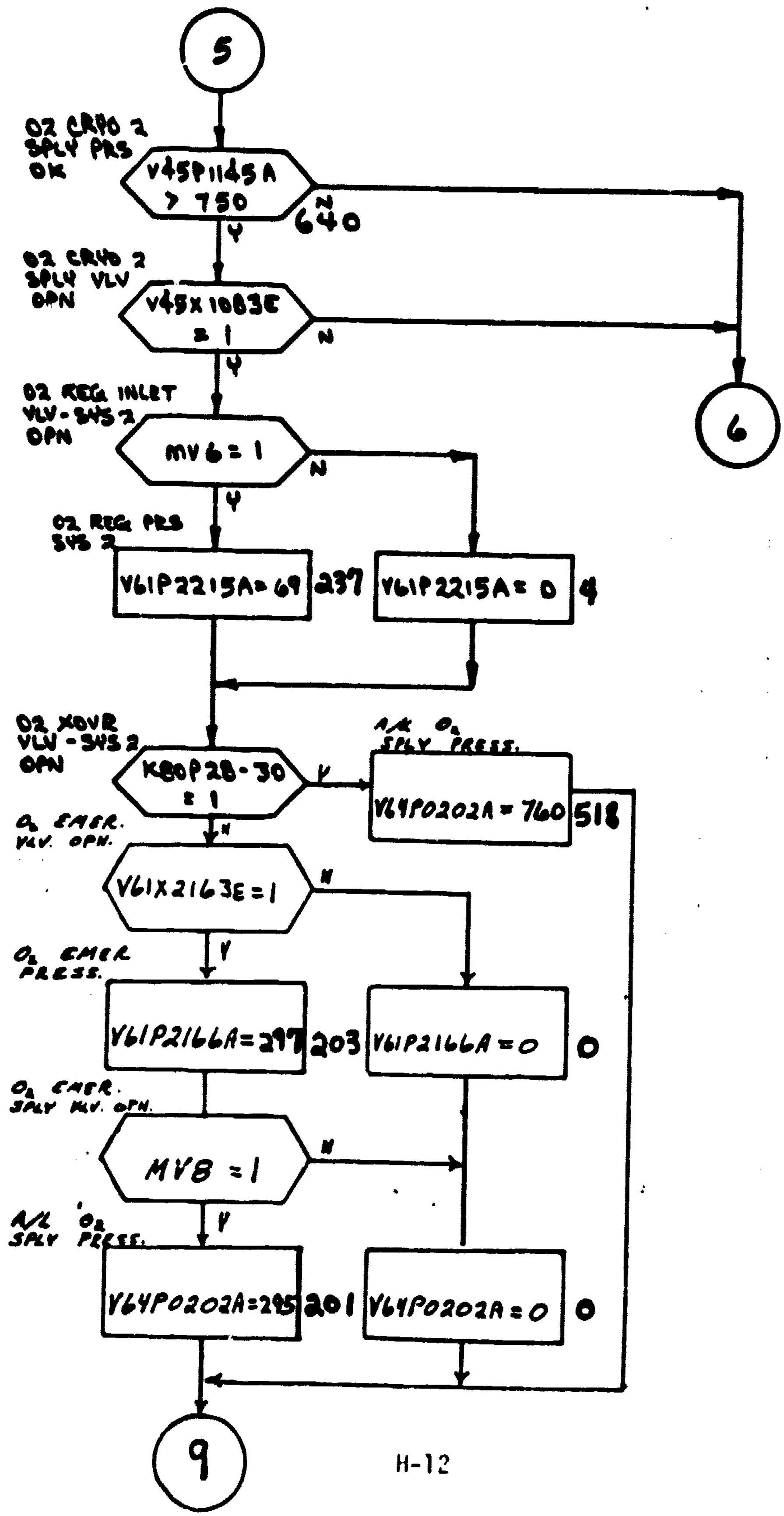
O2 PRESSURES 3 TO 9



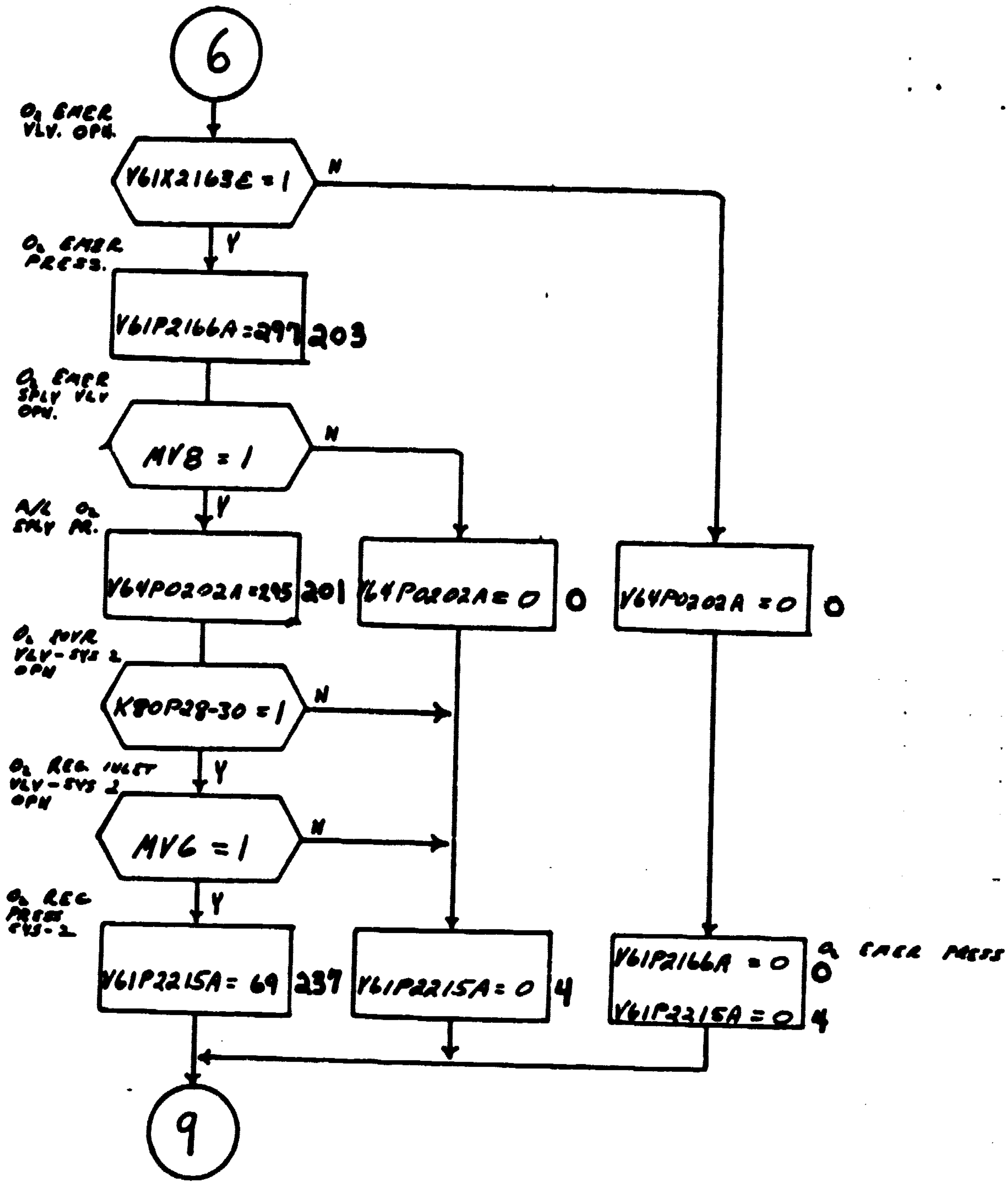
O2 PRESSURES
(3) TO (9).



O2 PRESSURES
3 TO 9

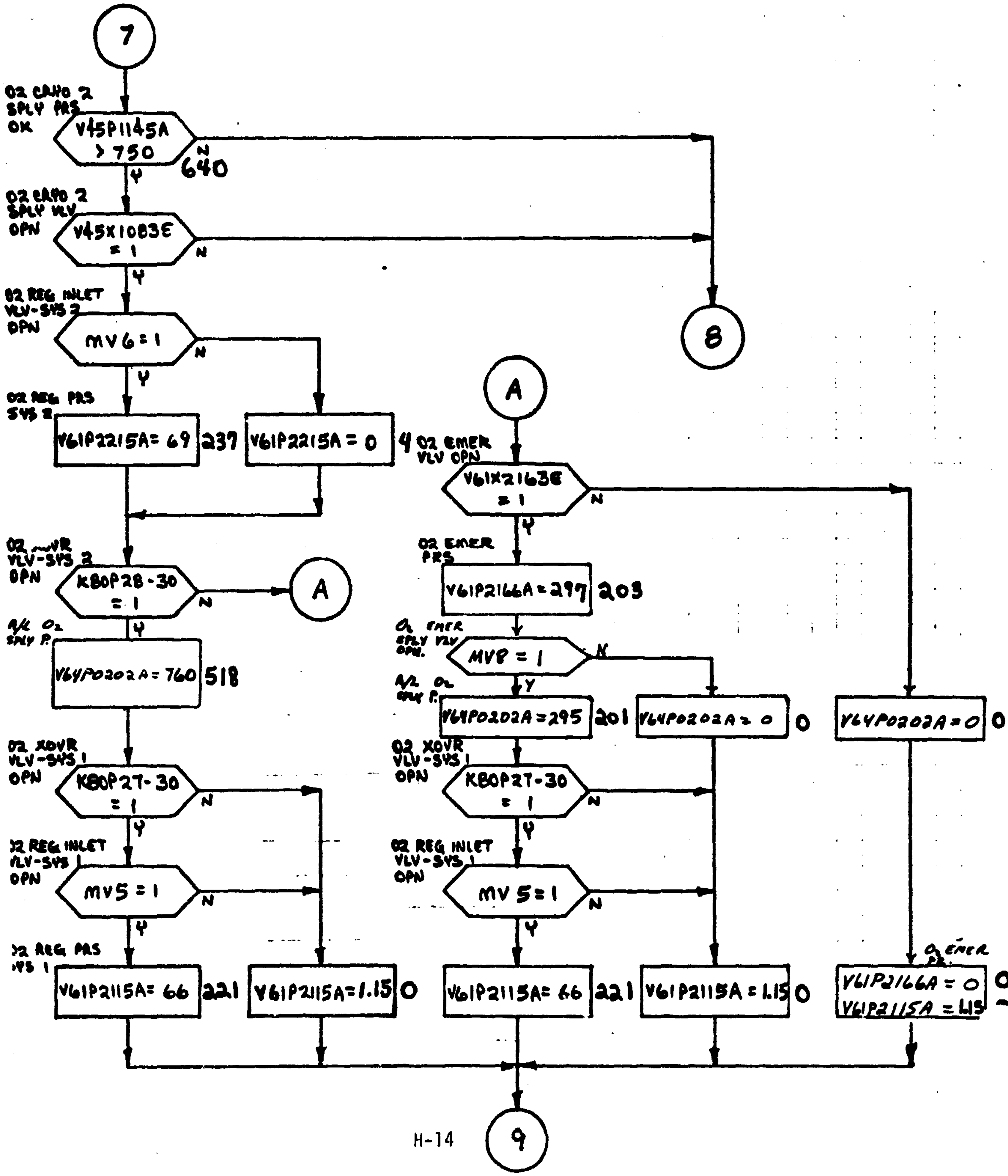


O_2 PRESSURES



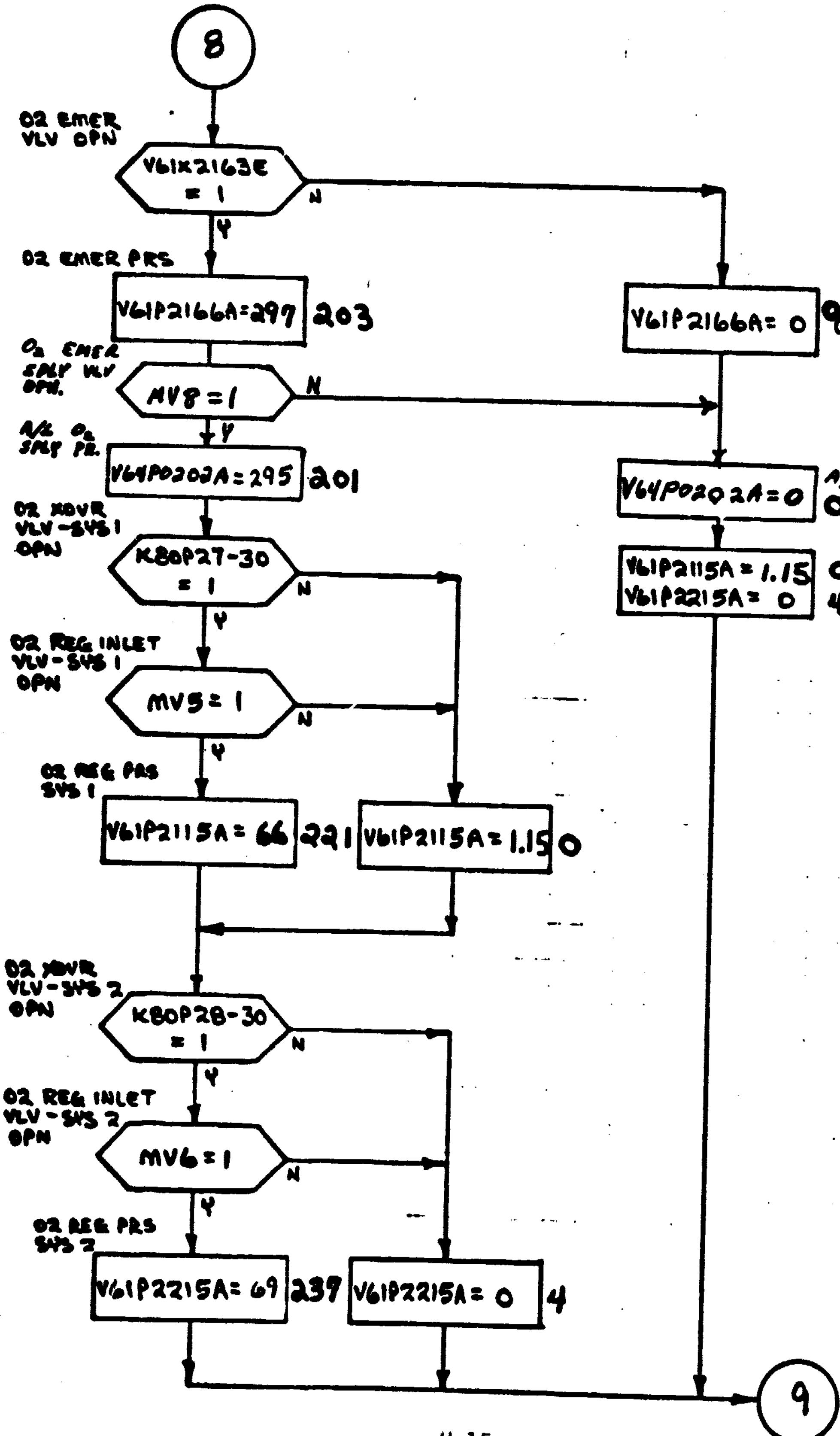
O2 PRESSURES

3 TO 9



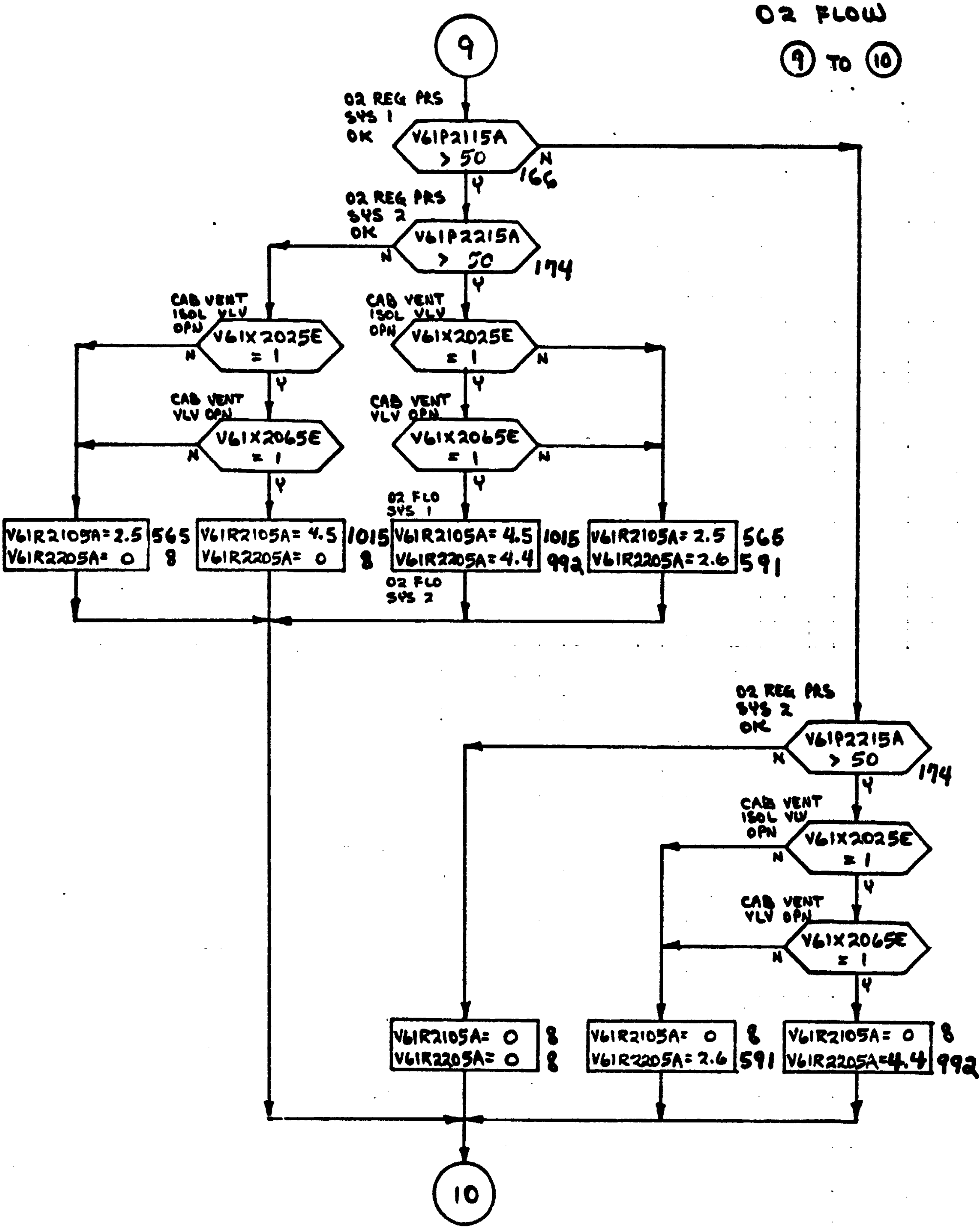
O2 PRESSURES

3 TO 9

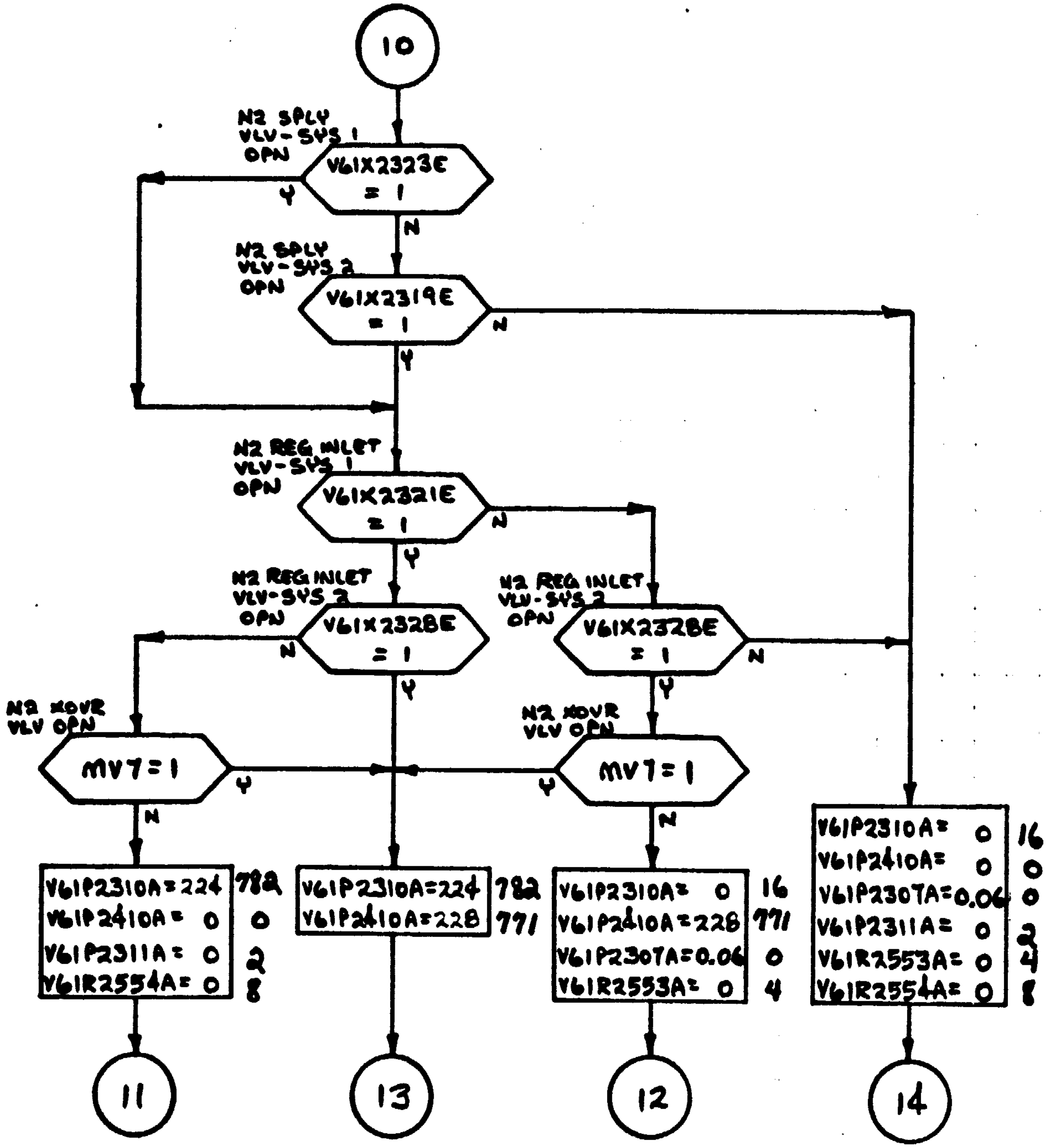


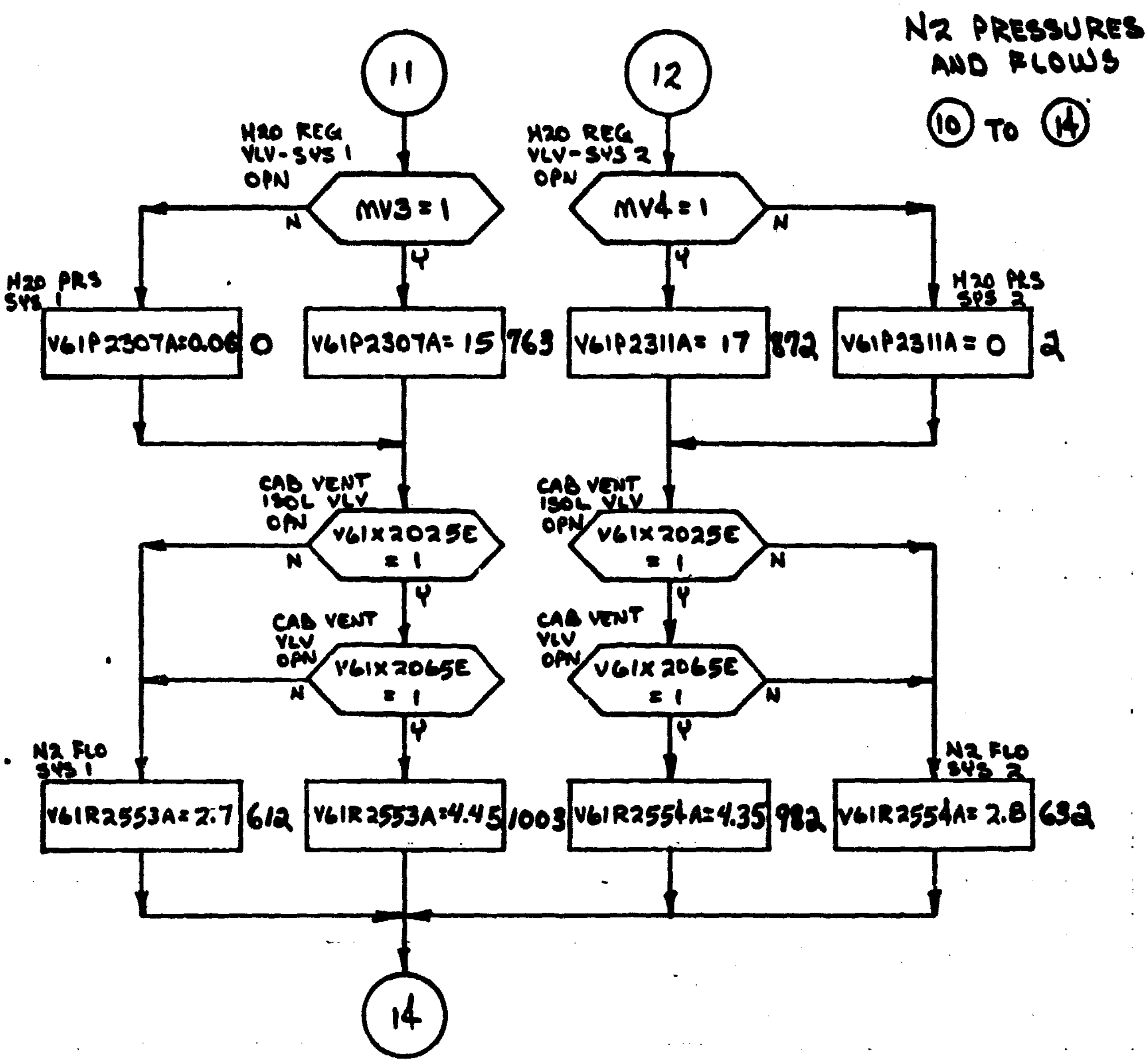
O2 FLOW

9 TO 10



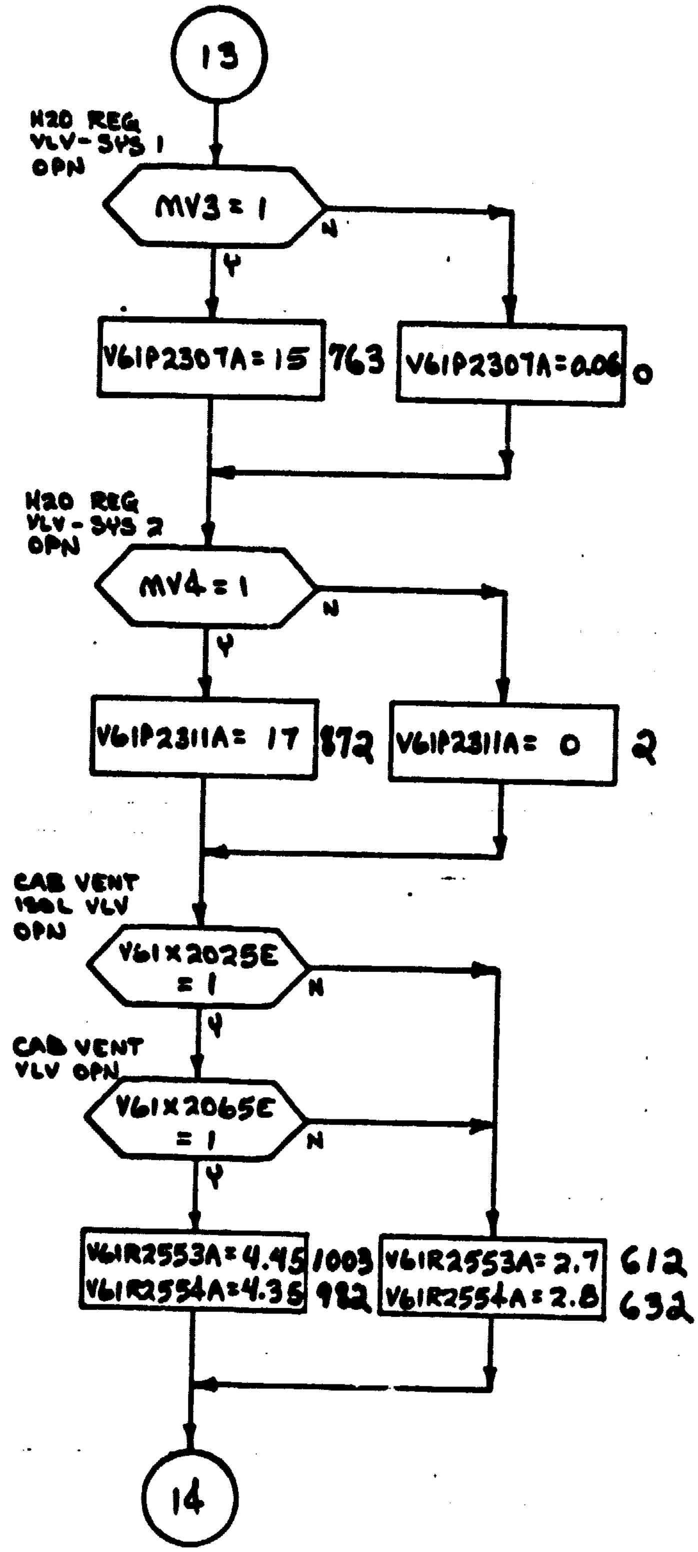
N2 PRESSURES
AND FLOWS
(10) TO (14)

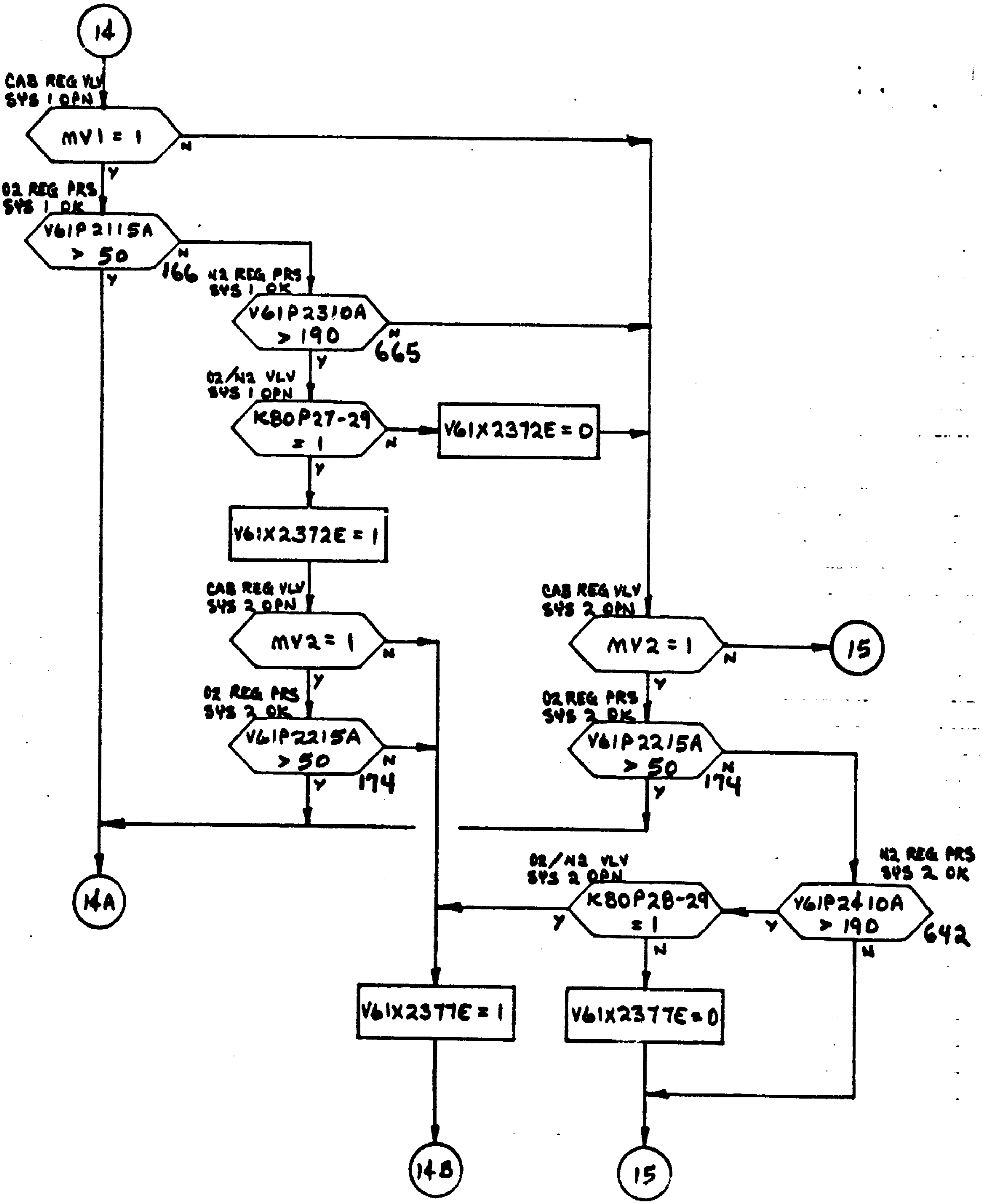



N2 PRESSURES
AND FLOWS
10 TO 14
11
12
H2O REG VLV-SYS 1 OPN
MV3 = 1
H2O REG VLV-SYS 2 OPN
MV4 = 1
N
Y
H2O PRS SYS 1
V61P2307A=0.06
0
V61P2307A= 15
763
V61P2311A= 17
872
H2O PRS SYS 2
V61P2311A= 0
2
CAB VENT ISOL VLV OPN
V61X2025E = 1
CAB VENT VLV OPN
V61X2065E = 1
N2 FLO SYS 1
V61R2553A=2.7
612
V61R2553A=4.45
1003
V61R2554A=4.35
982
N2 FLO SYS 2
V61R2554A= 2.8
632
14

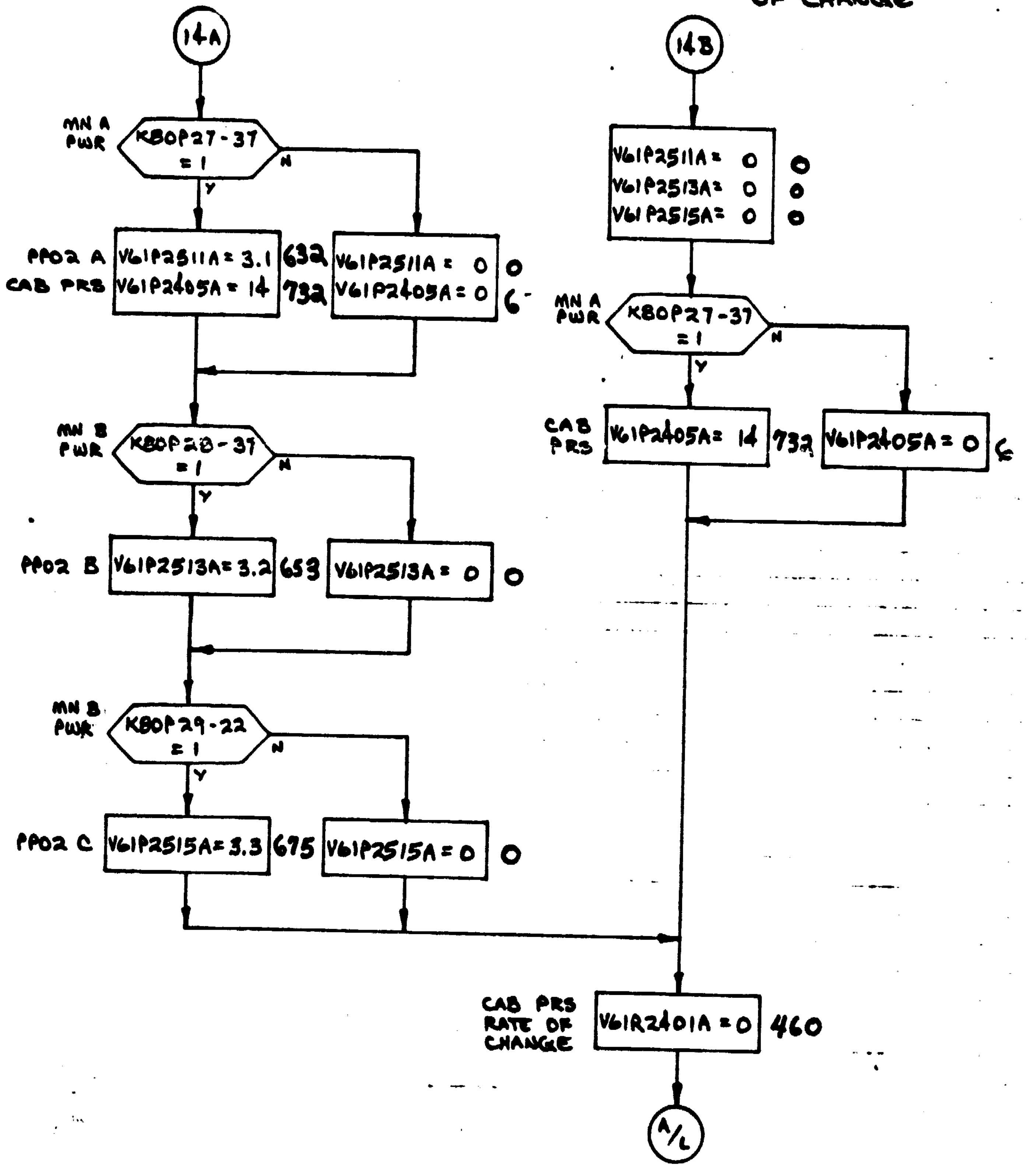
N2 PRESSURES AND FLOWS

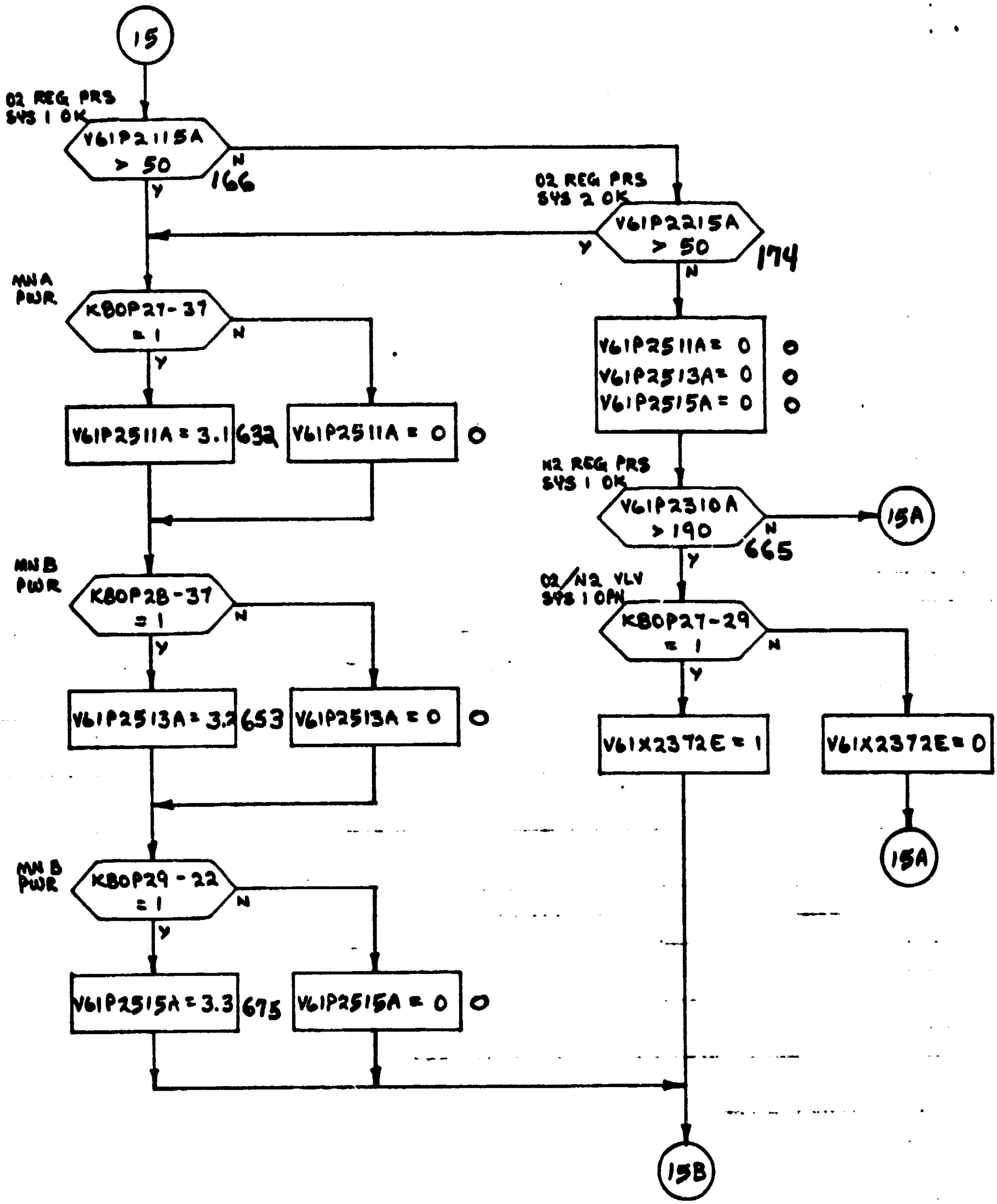
(10) TO (14)




14
CAB REG VLV SYS 1 OPN
MV1 = 1
N
Y
O2 REG PRS SYS 1 OK
V61P2115A > 50
N
166
Y
N2 REG PRS SYS 1 OK
V61P2310A > 190
N
665
Y
O2/N2 VLV SYS 1 OPN
K80P27-29 = 1
N
V61X2372E = 0
Y
V61X2372E = 1
CAB REG VLV SYS 2 OPN
MV2 = 1
N
Y
O2 REG PRS SYS 2 OK
V61P2215A > 50
N
174
Y
CAB REG VLV SYS 2 OPN
MV2 = 1
N
15
Y
O2 REG PRS SYS 2 OK
V61P2215A > 50
N
174
Y
14A
N2 REG PRS SYS 2 OK
V61P2410A > 190
642
Y
N
O2/N2 VLV SYS 2 OPN
K80P28-29 = 1
Y
N
V61X2377E = 1
V61X2377E = 0
14B
15

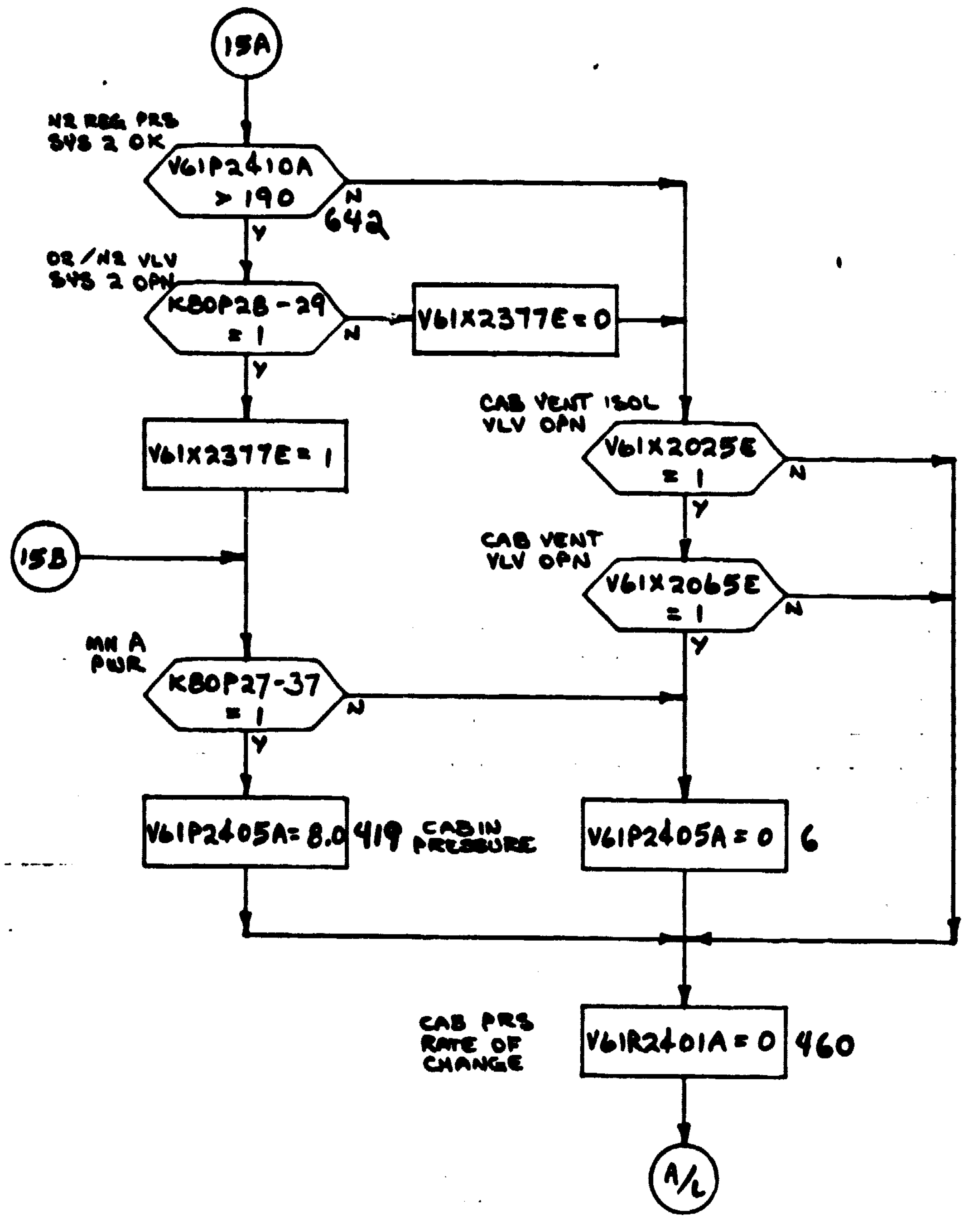
CABIN PRESS, PARTIAL O2 PRESS, & CABIN PRESS RATE OF CHANGE



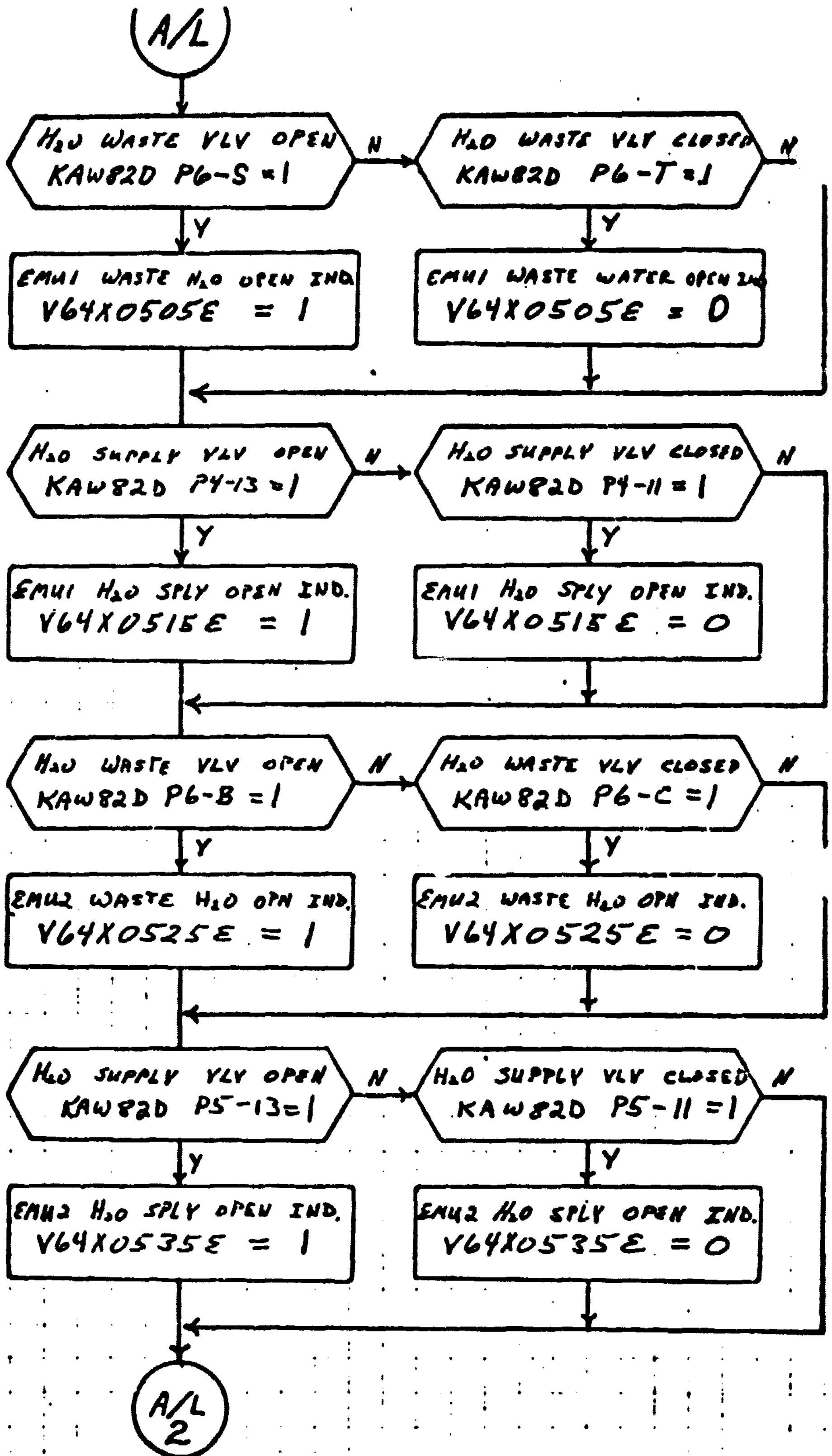

15
O2 REG PRS SYS 1 OK
V61P2115A > 50
166
O2 REG PRS SYS 2 OK
V61P2215A > 50
174
V61P2511A = 0
V61P2513A = 0
V61P2515A = 0
0
0
0
MN A PWR
KBOP27-37 = 1
V61P2511A = 3.1
632
V61P2511A = 0
0
N2 REG PRS SYS 1 OK
V61P2310A > 190
665
15A
MN B PWR
KBOP28-37 = 1
O2/N2 VLV SYS 1 OPN
KBOP27-29 = 1
V61P2513A = 3.2
653
V61P2513A = 0
0
V61X2372E = 1
V61X2372E = 0
15A
MN B PWR
KBOP29-22 = 1
V61P2515A = 3.3
675
V61P2515A = 0
0
15B
Y
N

EMERGENCY
CABIN PRESS,

& PRESS RATE OF
CHANGE



AIRLOCK EMU1

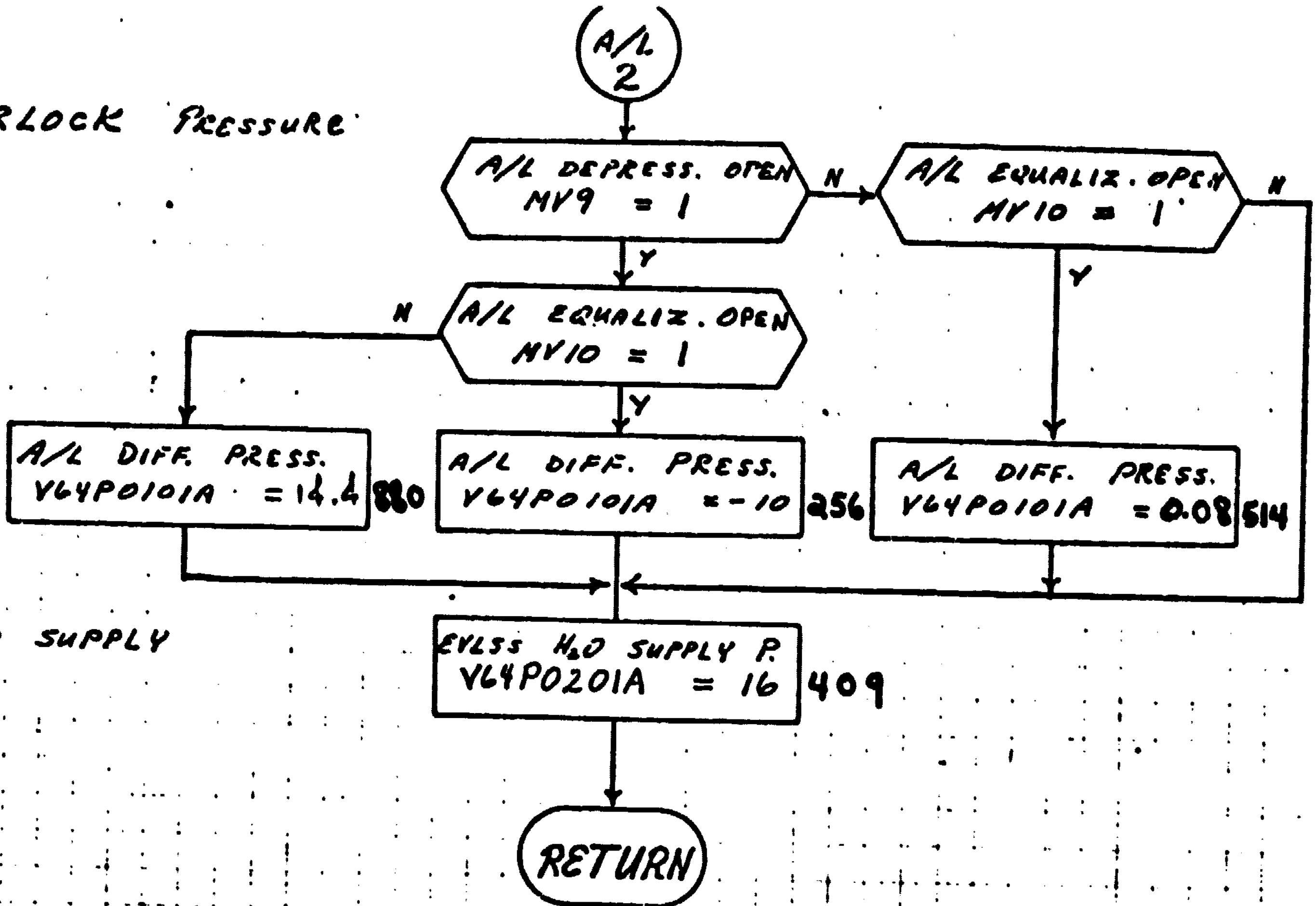


AIRLOCK EMU2

ORIGINAL PAGE IS
OF POOR QUALITY

AIRLOCK PRESSURE

H2O SUPPLY



4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

4.1.2 PSEUDO VARIABLE INITIALIZATION

The following pseudos are initialized as follows:

VARIABLE	INITIAL CONDITION
MV1	1
MV2	0
MV3	1
MV4	0
MV5	1
MV6	0
MV7	0
MV8	0
MV9	1
MV10	0

TABLE 1 - STIMULI LIST FOR AR/PCS/AL

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
L2/S15	02/SYS 1 XOVR VLV CMD - OPN	5	V61K2100E	K80P27-30	1-OPN/0-CLS
L2/S18	02/SYS 2 XOVR VLV CMD - OPN	5	V61K2200E	K80P28-30	1-OPN/0-CLS
L2/S3	CABIN VENT ISOL VLV CMD - CLS	5	V61K2000E	K80P31-10	1-CLS/0-OFF
	CABIN VENT ISOL VLV CMD - OPN	5	V61K2020E	K80P31-12	1-OPN/0-OFF
L2/S4	CABIN VENT VLV CMD - CLS	5	V61K2040E	K80P30-10	1-CLS/0-OFF
	CABIN VENT VLV CMD - OPN	5	V61K2060E	K80P30-12	1-OPN/0-OFF
L2/S13	N2 SYS 1 SPLY CMD - CLS	5	V61K2325E	K80P33-9	1-CLS/0-OFF
	N2 SYS 1 SPLY CMD - OPN	5	V61K2322E	K80P33-11	1-OPN/0-OFF
L2/S21	N2 SYS 2 SPLY CMD - CLS	5	V61K2315E	K80P34-17	1-CLS/0-OFF
	N2 SYS 2 SPLY CMD - OPN	5	V61K2314E	K80P34-36	1-OPN/0-OFF
L2/S14	N2 SYS 1 REG INLET CMD - CLS	5	V61K2305E	K80P33-3	1-CLS/0-OFF
	N2 SYS 1 REG INLET CMD - OPN	5	V61K2304E	K80P33-5	1-OPN/0-OFF
L2/S22	N2 SYS 2 REG INLET CMD - CLS	5	V61K2318E	K80P34-11	1-CLS/0-OFF
	N2 SYS 2 REG INLET CMD - OPN	5	V61K2317E	K80P34-34	1-OPN/0-OFF
L2/S1	CABIN RLF VLV A CMD - CLS	5	V61K2133E	K80P25-10	1-CLS/0-OFF
	CABIN RLF VLV A CMD - ENABLE	5	V61K2134E	K80P25-12	1-ENABLE/0-OFF
L2/S2	CABIN RLF VLV B CMD - CLS	5	V61K2137E	K80P26-10	1-CLS/0-OFF
	CABIN RLF VLV B CMD - ENABLE	5	V61K2138E	K80P26-12	1-ENABLE/0-OFF

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
L2/S16	02/N2 CONT VLV SYS 1 - OPN, AUTO	5	V61K2370E	K80P27-29	1-OPN/0-CLS
L2/S19	02/N2 CONT VLV SYS 2 - OPN, AUTO	5	V61K2375E	K80P28-29	1-OPN/0-CLS
L2/S12	02 EMER CMD - CLS	5	V61K2164E	K80P34-5	1-CLS/0-OFF
	02 EMER CMD - OPN	5	V61K2162E	K80P34-32	1-OPN/0-OFF
014/CB19	CABIN PRESS SENSOR PWR MNA	5,6		K80P27-37	1-ON/0-OFF
015/CB18	02 PARTIAL PRESS CONT PWR - MNB	5,6		K80P28-37	1-ON/0-OFF
015/CB16	CABIN PRESS DECAY SENSOR PWR - MNB	5,6		K80P29-22	1-ON/0-OFF
M010W	SYS 1 CAB REG INLET VLV CMD - OPN	7		MV1	1-OPN/0-CLS
M010W	SYS 2 CAB REG INLET VLV CMD - OPN	7		MV2	1-OPN/0-CLS
M010W	SYS 1 H20 TK REG INLET VLV CMD - OPN	7		MV3	1-OPN/0-CLS
M010W	SYS 2 H20 TK REG INLET VLV CMD - OPN	7		MV4	1-OPN/0-CLS
M010W	SYS 1 02 REG INLET VLV CMD - OPN	7		MV5	1-OPN/0-CLS
M010W	SYS 2 02 REG INLET VLV CMD - OPN	7		MV6	1-OPN/0-CLS
M010W	N2 XOVR VLV CMD - OPN	7		MV7	1-OPN/0-CLS
M010W	02 EMER SUPPLY VLV CMD - OPN	7		MV8	1-OPN/0-CLS
AIRLOCK	A/L DEPRESS VLV - OPN	7		MV9	1-OPN/0-CLS
AIRLOCK	A/L EQUAL VLV - OPN	7		MV10	1-OPN/0-CLS
AW82D/S2	EMU 1 WASTE H20 VLV - OPN	5	V64K0500E	KAW82D P6-S	1-OPN/0-OFF
	EMU 1 WASTE H20 VLV - CLS	5	V64K0501E	KAW82D P6-T	1-CLS/0-OFF

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
AW82D/S4	EMU 2 WASTE H2O VLV - OPN	5	V64K0520E	KAW82D P6-B	1-OPN/0-OFF
	EMU 2 WASTE H2O VLV - CLS	5	V64K0521E	KAW82D P6-C	1-CLS/0-OFF
AW82D/S1	EMU 1 H2O SUPPLY VLV - OPN	5	V64K0510E	KAW82D P4-13	1-OPN/0-OFF
	EMU 1 H2O SUPPLY VLV - CLS	5	V64K0511E	KAW82D P4-11	1-CLS/0-OFF
AW82D/S3	EMU 2 H2O SUPPLY VLV - OPN	5	V64K0530E	KAW82D P5-13	1-OPN/0-OFF
	EMU 2 H2O SUPPLY VLV - CLS	5	V64K0531E	KAW82D P5-11	1-CLS/0-OFF
	PRSD O2 ECS PRI SUPPLY VLV - OPEN		V45X1080E		1-OPN/0-CLS
	PRSD O2 ECS SEC SUPPLY VLV - OPEN	11	V45X1083E		1-OPN/0-CLS
	PRSD O2 MANIF 1 PRESS		V45P1140A		0-1200 PSIA
	PRSD O2 MANIF 2 PRESS		V45P1145A		0-1200 PSIA

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM AR/PCS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V61X2321E	N2 SYS 1 Reg Inlet VLV-Open	1	1	0	0					STATE
V61X2323E	N2 SYS 1 Supply VLV-Open	1	1	0	0					STATE
V61X2328E	N2 SYS 2 Reg Inlet VLV-Open	0	0	1	1					STATE
V61X2372E	02/N2 CNTLR VLV-SYS 1 Open	1	1	0	0					STATE
V61X2377E	02/N2 CNTLR VLV-SYS 2 Open	0	0	1	1					STATE
V61R2401A	Cabin Press Rate of Change	0	460							PSI/MIN
V61P2405A	Cabin Press	14	732	0	6	8	419			PSIA
V61T2406A	SYS 1 N2 Tank 1 Temp	-12	256							DEGF
V61T2407A	SYS 1 N2 Tank 2 Temp	-7	276							DEGF
V61T2408A	SYS 2 N2 Tank 1 Temp	-10	264							DEGF
V61T2409A	SYS 2 N2 Tank 2 Temp	-5	284							DEGF
V61P2410A	SYS 2 N2 200 PSI Press	0	0	228	771					PSIA
V61X2415E	N2 SYS 1 Reg Inlet VLV-Closed	0	0	1	1					STATE
V61X2416E	N2 SYS 1 Supply VLV-Closed	0	0	1	1					STATE
V61X2420E	N2 SYS 2 Reg Inlet VLV-Closed	1	1	0	0					STATE
V61X2421E	N2 SYS 2 Supply VLV-Closed	1	1	0	0					STATE
V61P2511A	02 Partial Press-A	3.1	632	0	0					PSIA
V61P2513A	02 Partial Press-B	3.2	653	0	0					PSIA
V61P2515A	02 Partial Press-C	3.3	675	0	0					PSIA
V61R2553A	SYS 1 N2 Flowrate	2.7	512	0	4	4.45	1003			LB/HR
V61R2554A	SYS 2 N2 Flowrate	0	8	2.8	632	4.35	982			LB/HR

MEASUREMENT OUTPUT FROM AR/PCS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V61X2005E	Cabin Vent ISOL VLV-CLOSED	1	1	0	0					STATE
V61X2025E	Cabin Vent ISOL VLV-OPEN	0	0	1	1					STATE
V61X2045E	Cabin Vent VLV-CLOSED	1	1	0	0					STATE
V61X2065E	Cabin Vent VLV-OPEN	0	0	1	1					STATE
V61R2105A	SYS 1 02 Flowrate	2.5	565	0	8	4.5	1015			LB/HR
V61P2115A	02 Reg Press Sys 1	66	221	1.15	0					PSIA
V61X2130E	Cabin Press RLF VLV A- CLOSED	0	0	1	1					STATE
V61X2131E	Cabin Press RLF VLV A-Enabled	1	1	0	0					STATE
V61X2135E	Cabin Press RLF VLV B-CLOSED	0	0	1	1					STATE
V61X2136E	Cabin Press RLF VLV B-ENABLED	1	1	0	0					STATE
V61P2161A	EMER 02 Tank Press	2058	579							PSIA
V61X2163E	02 EMER VLV-Open	0	0	1	1					STATE
V61X2165E	02 EMER VLV-Close	1	1	0	0					STATE
V61P2166A	EMER 02 Supply Press	297	203	0	0					PSIA
V61R2205A	SYS 2 02 Flowrate	0	8	2.6	591	4.4	992			LB/HR
V61P2215A	02 REG Press SYS 2	0	4	69	237					PSIA
V61T2216A	EMER 02 Tank Temp	-20	223							DEGF
V61P2301A	SYS 1 N2 Supply Press	1562	450							PSIA
V61P2307A	SYS 1 N2 17 PSI Press	15	763	0.06	0					PSIG
V61P2309A	SYS 2 N2 Supply Press	1601	458							PSIA
V61P2310A	SYS 1 N2 200 PSI Press	224	782	0	16					PSIA
V61P2311A	SYS 2 N2 17 PSI Press	0	2	17	872					PSIG
V61X2319E	N2 SYS 2 Supply VLV-Open	0	0	1	1					STATE

MEASUREMENT OUTPUT FROM AR/PCS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C. FS	I.C. CTS	VALUE 1 FS	VALUE 1 CTS	VALUE 2 FS	VALUE 2 CTS	VALUE 3 FS	VALUE 3 CTS	UNITS
	-AIRLOCK-									
V64P0101A	AIRLOCK DIFFERENTIAL PRESS	14.4	880	-10	256	0.08	514			PSID
*V64P0201A	EVLSS H2O SUPPLY PRESS	16	409							PSIG
*V64P0202A	EVLSS O2 SUPPLY PRESS	760	518	295	201	0	0			PSIA
V64X0505E	EMU 1 H2O WASTE-OPEN	0	0	1	1					STATE
V64X0515E	EMU 1 H2O SUPPLY-OPEN	0	0	1	1					STATE
V64X0525E	EMU 2 H2O WASTE-OPEN	0	0	1	1					STATE
V64X0535E	EMU 2 H2O SUPPLY-OPEN	0	0	1	1					STATE

*NOTE: This measurement uses the range limit conversion method of calculating FS_{EU} .

APPENDIX I

ACTIVE THERMAL CONTROL MATH MODEL REQUIREMENTS

CONTENTS

FIGURES

Figure | Page

1. INTRODUCTION

The ATCS transports thermal energy in the unpressurized area of the Orbiter, provides temperature control of selected onboard equipment and rejects excess heat overboard. The ATCS consists of two freon 21 coolant loops which flow in parallel through similar components, and have redundant centrifugal pumps. The ATCS cools the water coolant loops through an interchanger, heats the Orbiter's hydraulic fluid and crew compartment cryogenic makeup oxygen, and transports the heat generated by the payload, fuel cell power plants, and various cold plate electronics. The ATCS rejects the excess heat overboard during different phases of the mission by means of its radiator subsystem, flash evaporators, ammonia boiler, and GSE heat exchanger. During on-orbit operations, whenever the payload bay doors are opened, heat is rejected to space by the radiator subsystem with the flash evaporator subsystem on standby to provide supplemental cooling when needed. Whenever the payload bay doors are closed, heat is rejected by the flash evaporator subsystem. The flash evaporator also provides cooling above 140,000 feet during ascent and above 100,000 feet during entry. The ammonia boiler system provides cooling during entry starting at 100,000 feet and continuing for 15 minutes after landing. The GSE heat exchanger provides thermal control during ground operations; no overboard heat rejection is provided during the period from lift-off until the vehicle reaches 140,000 feet.

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in Table 1 to produce values for the output measurements listed in Table 2 that simulate the operation of the ATCS.

2.1 MATH MODEL DESCRIPTION

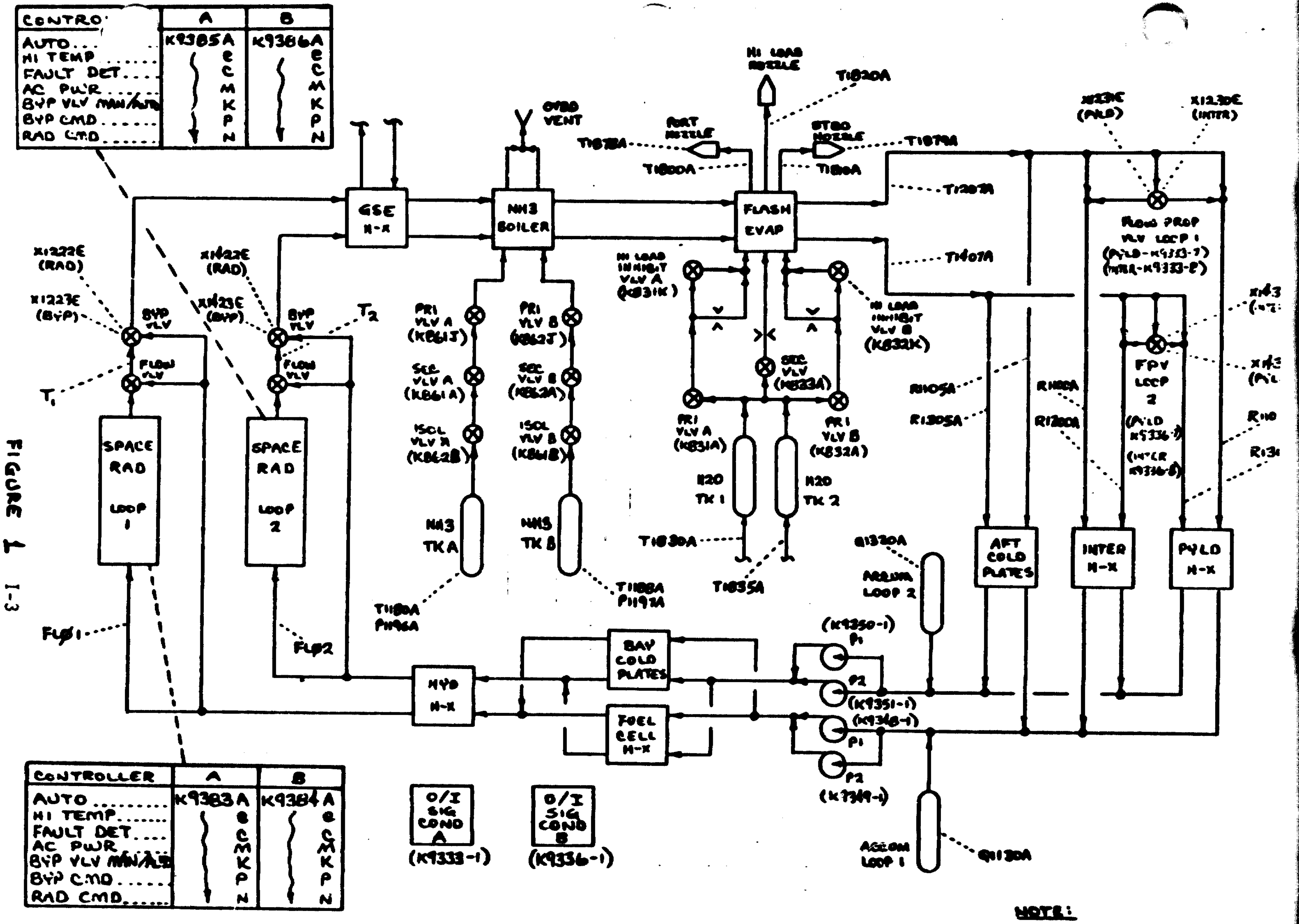
The model generates values for quantity, flow, temperature, pressure, and valve positions for each of the two freon coolant loops. The values are dependent upon input stimuli from the flight system and upon mission phase indicators uplinked by the test operator. A static set of nominal values are generated for the flash evaporator heater temperatures and for the parameters from the ammonia boiler supply tanks. These static values are sufficient to meet test objectives and they greatly simplify the model.

Referring to the schematic of the ATCS, figure 1, the flowchart starts at the flow proportioning valves and progresses around the coolant loops in a clockwise manner, ending at the flash exporator. Once a complete cycle has been made and values have been assigned to the output parameters, the values are transmitted to the flight system.

2.1.1 MISSION PHASE FLAGS

Mission phase flags for the ATCS model are uplinked by the test operator to assure that the model response is appropriate for the mission phase/segment or Orbiter configuration being simulated. The following definitions explain the mission phase flags:

- GSE - When equal to one, ground support equipment provides cooling for the ATCS. Zero indicates no ground cooling.
- P1 - When equal to one, the payload doors are open and the radiator panel for ATCS loop one is deployed. Zero indicates the loop one radiator panel is not deployed and cannot provide cooling.



NOTE:
K DESIGNATES A STIMULUS

FREON COOLANT LOOPS

- P2 - When equal to one, the payload doors are open and the radiator panel for ATCS loop two is deployed. Zero indicates the loop two radiator panel is not deployed and cannot provide cooling.

Appropriate values for the mission flags in each mission phase are tabulated below:

	FLAGS		
PHASE	GSE (b)	P1	P2
Prelaunch	1	0	0
Ascent to 140K	0	0	0
Ascent above 140K	0	0	0
On-Orbit	0	(a)	(a)
Entry above 100K	0	0	0
Entry below 100K	0	0	0
Landing +15 minutes	1	0	0

(a) Value of flag depends on Orbit configuration.

(b) Briefly setting GSE to one during phase transitions will prevent transient alarms for V63T1207A and V63T1407A.

2.1.2 INTERNAL VARIABLES

The model uses four internal variables to determine the values of output parameters.

ID#	DESCRIPTIONS
FLO 1	A discrete which represents loop 1 flow through the radiator (1), or flow bypassing the radiator (0).
FLO 2	A discrete which represents loop 2 flow through the radiator (1), or flow bypassing, the radiator (0).
T1	An analog which represents loop 1 evaporator outlet temperature.
T2	An analog which represents loop 2 evaporator outlet temperature.

2.1.3 INITIAL CONDITIONS

Note that inital conditions for STS are the same as those listed for GTS; see GTS PREPROCESSOR LOGIC.

2.2 STS UNIQUE REQUIREMENTS

None

2.3 GTS UNIQUE REQUIREMENTS

2.3.1 PREPROCESSOR LOGIC

The ATCS math model was originally required in the STS simulator. The math model input stimuli symbols referred to in the logic flow diagram, section 3.2, are ATA Reference connector and pin numbers. Due to the lack of flight hardware circuitry in the GTS simulator, logic functions that bridge the gap between the payload MDM's and the ATCS are required in the GTS preprocessor in order to evaluate values for the input stimuli coming from the GPC prior to execution of the model.

2.3.2 OPERATOR SUPPLIED INPUTS

Notice that several of the operator supplied inputs within the GTS preprocessor logic are combined by logical operators to derive the proper value.

3. MATH MODEL LOGIC

This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

The basic input stimuli to the model are identified by ATA reference system connector-pin (CP) numbers. A logical combination of one or more MML numbers is used to derive the proper input stimulus for each CP. Within the STS, the logical combination is accomplished via hardware circuitry. However, within the GTS, due to the absence of the required circuitry, the logical relations between CP and MML must be effected by software. The following logical equations are required as a preprocessor within GTS in order to calculate the correct CP stimuli which are then input to the model. Most equations are merely a direct one-for-one correspondence between CP and MML. However, some equiations may require more than one MML to be combined by the logical product (AND) and the inclusive logical sum (OR). In these instances, "AND" denotes the logical product and "OR" denotes the inclusive logical sum.

The SOURCE columns contain an entry for the MDM, connector end pin from which the MML is received. In the absnece of an entry in these columns, the operator must make the entry via the NAS keyboard.

The final column lists the input stimuli initialization values required. Notice that inputs containing an entry for SOURCE do not have an initialization value, since they are updated at the GTS simulator cycle rate by the source connection.

GTS MATH MODEL STIMULI - ATCS
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN	(V63K-----) MML ID	SOURCE*		INITIALIZATION VALUES
		MDM	CONN/PIN	
K40P9349-1 =	V63K1124Y	PF02	J08/042	
9351-1 =	1324Y	PF01	J08/054	
K50P832-A =	1501Y	PF01	J02/087	
833-A =	1505Y	PF02	J06/009	
831-A =	1509Y	PF02	J02/087	
862-J =	1551Y	PF02	J02/089	
AND	1559Y	PF02	J06/031	
862-B =	1551Y	PF02	J02/089	
AND	1559Y	PF02	J06/031	
861-J =	1555Y	PF01	J02/089	
AND	1559Y	PF02	J06/031	
861-B =	1555Y	PF01	J02/089	
AND	1559Y	PF02	J06/031	
K40P9348-1 =	V63K1111E			0
9350-1 =	1311E			0
K50P861-A =	1186E			0
862-A =	1190E			0
K40P9385-A =	1211E			1
K40P9385-M =	V63K1211E			1
	OR 1212E			1
K40P9386-M =	V63K1211E			1
	OR 1212E			1
9386-C =	1211E			1
9386-A =	1212E			0
9385-C =	1212E			0
9383-A =	1411E			1
K40P9383-M =	V63K1411E			1
	OR 1412E			1
K40P9384-M =	V63K1411E			1
	OR 1412E			1

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

GTS MATH MODEL STIMULI - ATCS

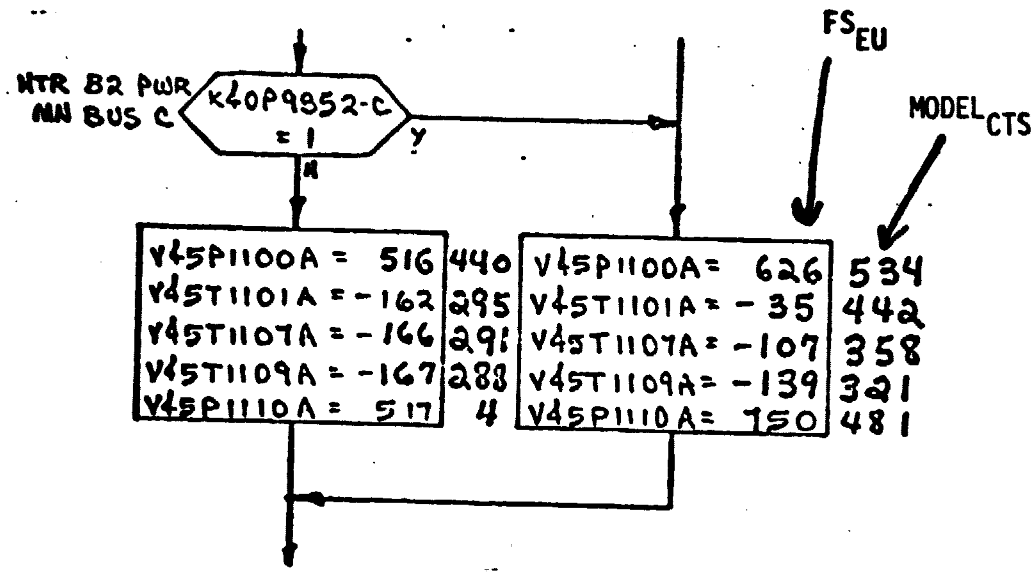
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN	(V63K-----) MML ID	SOURCE*		INITIALIZATION VALUES
		MDM	CONN/PIN	
K40P9384-C =	V63K1411E			1
9384-A =	1412E			0
9383-C =	1412E			0
9385-E =	1214E			1
9386-E =	1214E			0
9383-E =	1414E			0
9384-E =	1414E			0
K40P9385-K =	V63K1221E			0
9386-K =	1221E			0
9383-K =	1421E			1
9384-K =	1421E			1
9333-8 =	1228E			1
9333-7 =	1238E			0
9336-8 =	1428E			1
9336-7 =	1438E			0
K50P831-K =	1670E			0
832-K =	1670E			0
K40P9333-1 =	2000E			1
9336-1 =	2050E			1
9385-P =	**			0
9385-N =				1
9386-P =				0
9386-N =				1
9383-P =				0
9383-N =				1
9384-P =				0
9384-N =				1

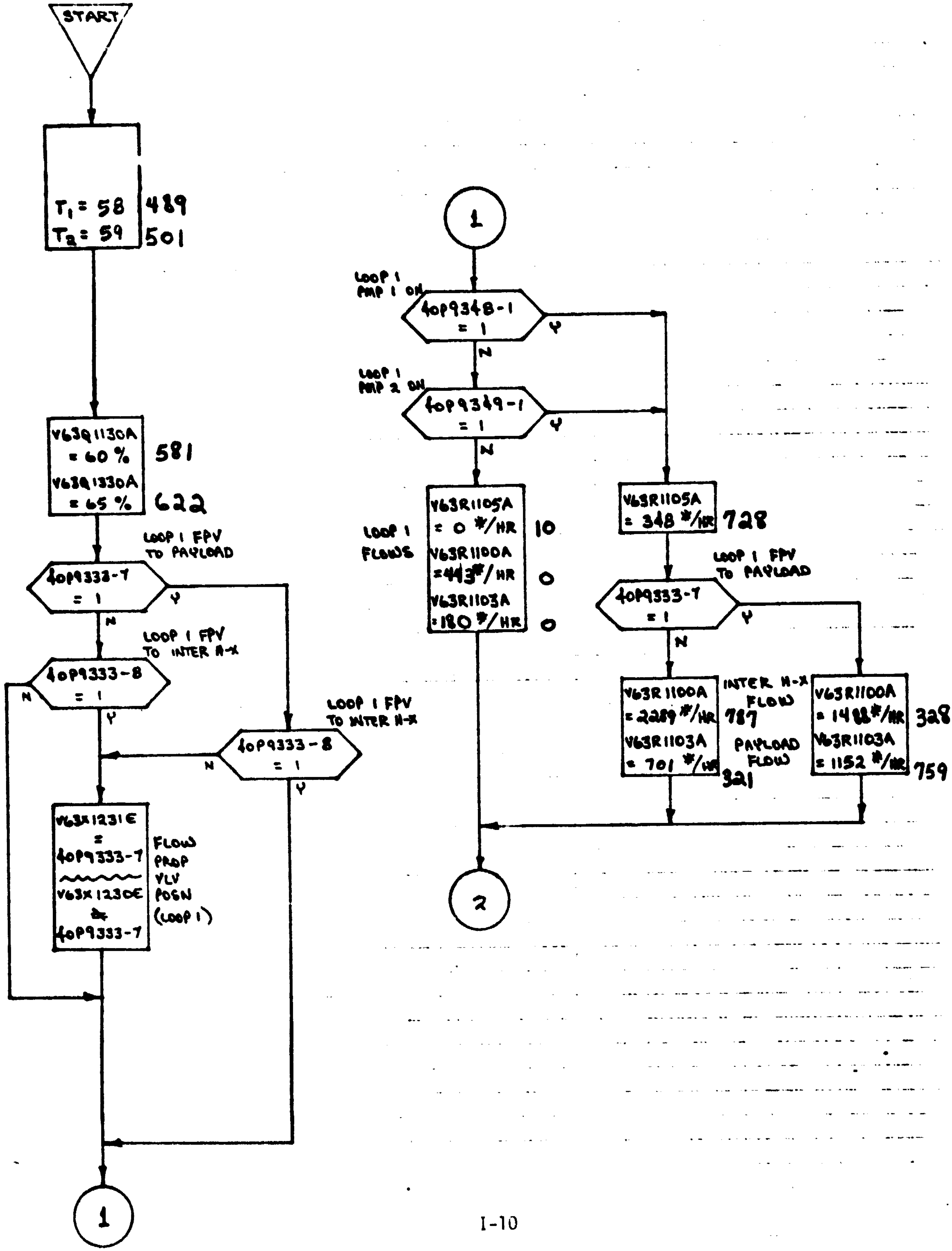
*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

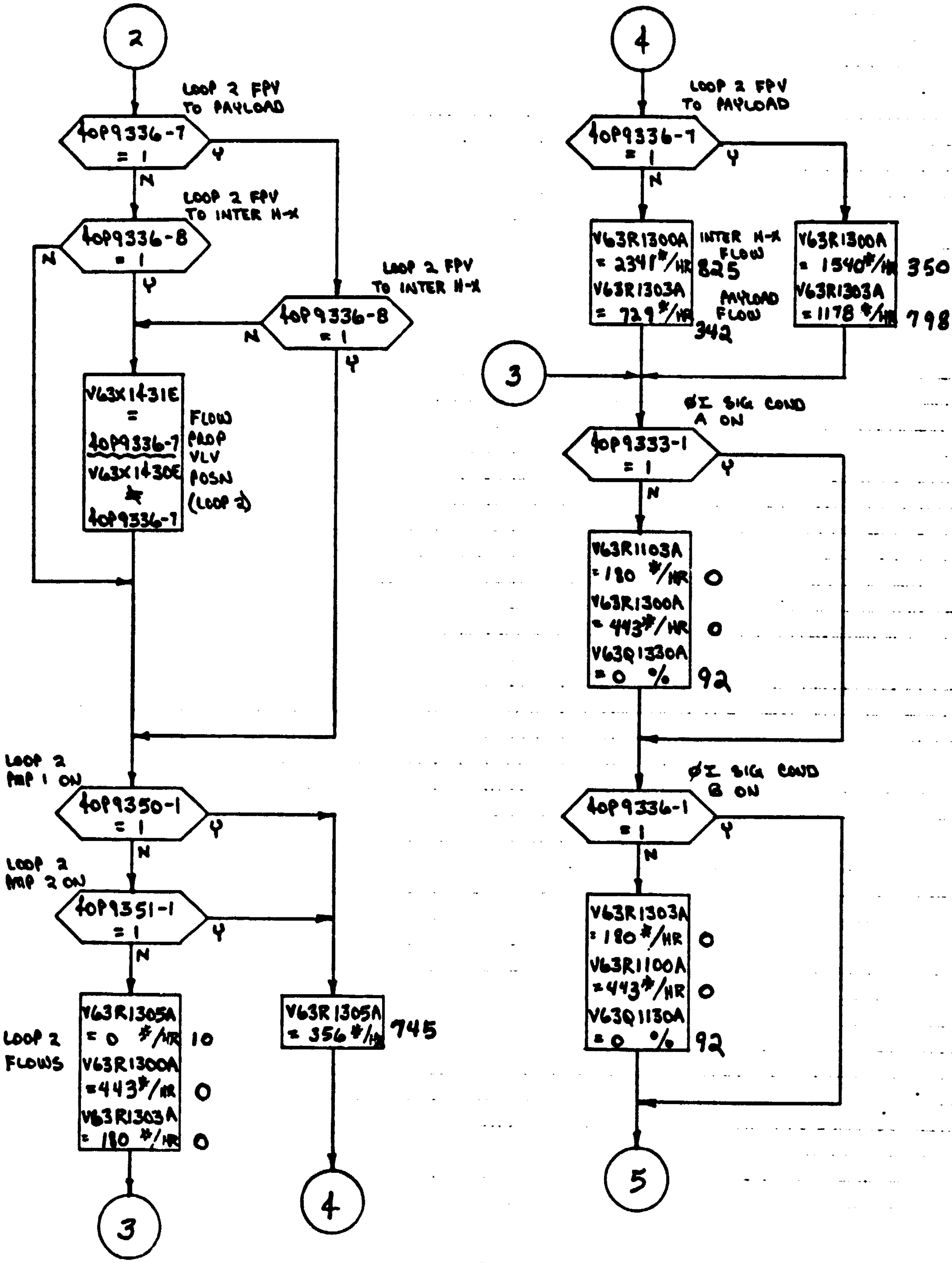
3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;

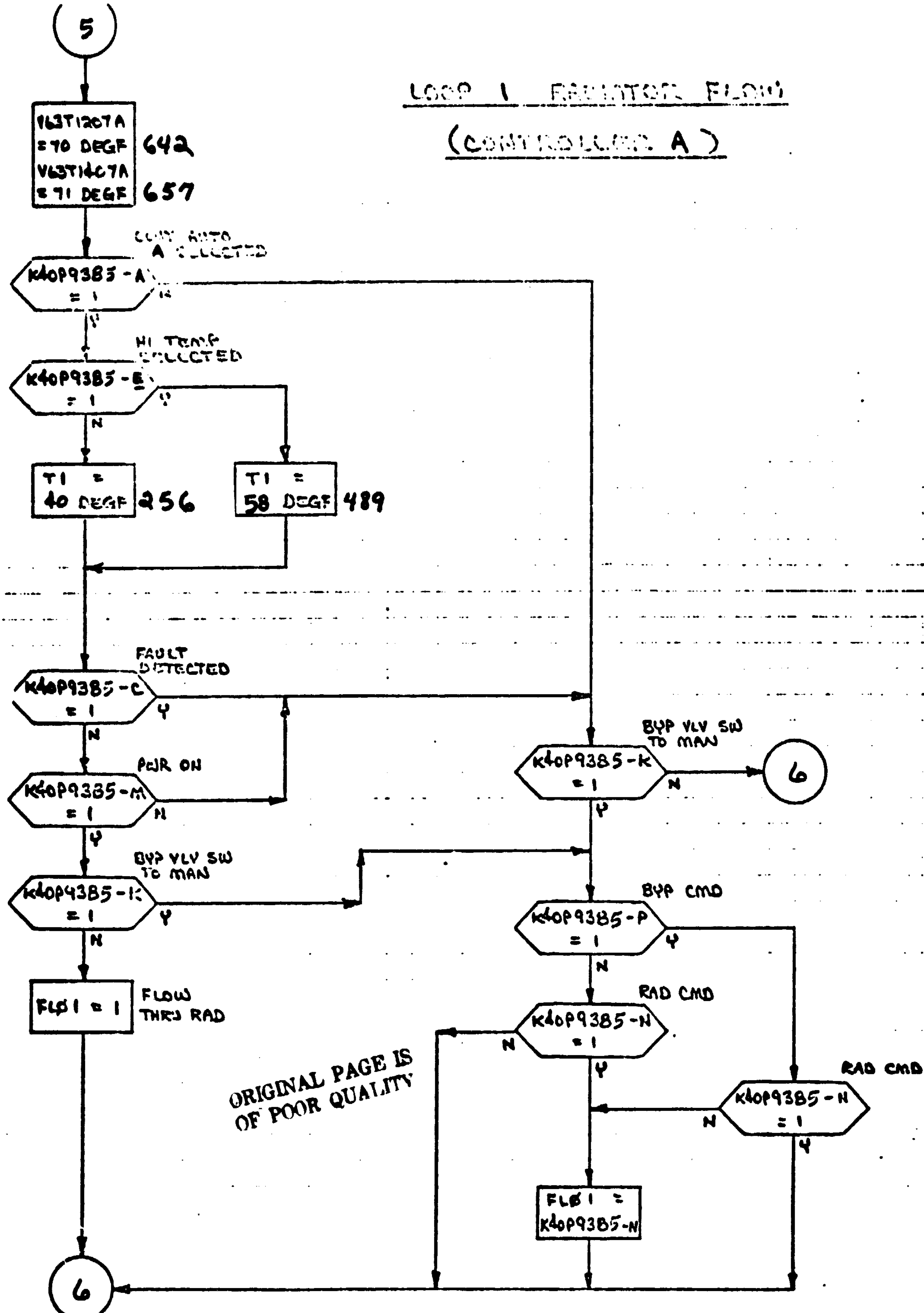


shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.


START
T1 = 58
T2 = 59
489
501
V63Q1130A = 60 %
581
V63Q1330A = 65 %
622
LOOP 1 FPV TO PAYLOAD
40P9333-7 = 1
Y
N
LOOP 1 FPV TO INTER H-X
40P9333-8 = 1
N
Y
LOOP 1 FPV TO INTER H-X
40P9333-8 = 1
N
Y
V63X1231E = 40P9333-7
V63X1230E 40P9333-7
FLOW PROP VLV POSN (LOOP 1)
1
1
LOOP 1 PMP 1 ON
40P9348-1 = 1
Y
N
LOOP 1 PMP 2 ON
40P9349-1 = 1
Y
N
LOOP 1 FLOWS
V63R1105A = 0 #/HR
10
V63R1100A = 443 #/HR
0
V63R1103A = 180 #/HR
0
V63R1105A = 348 #/HR
728
LOOP 1 FPV TO PAYLOAD
40P9333-7 = 1
Y
N
V63R1100A = 2289 #/HR
787
INTER H-X FLOW
V63R1103A = 701 #/HR
321
PAYLOAD FLOW
V63R1100A = 1488 #/HR
328
V63R1103A = 1152 #/HR
759
2

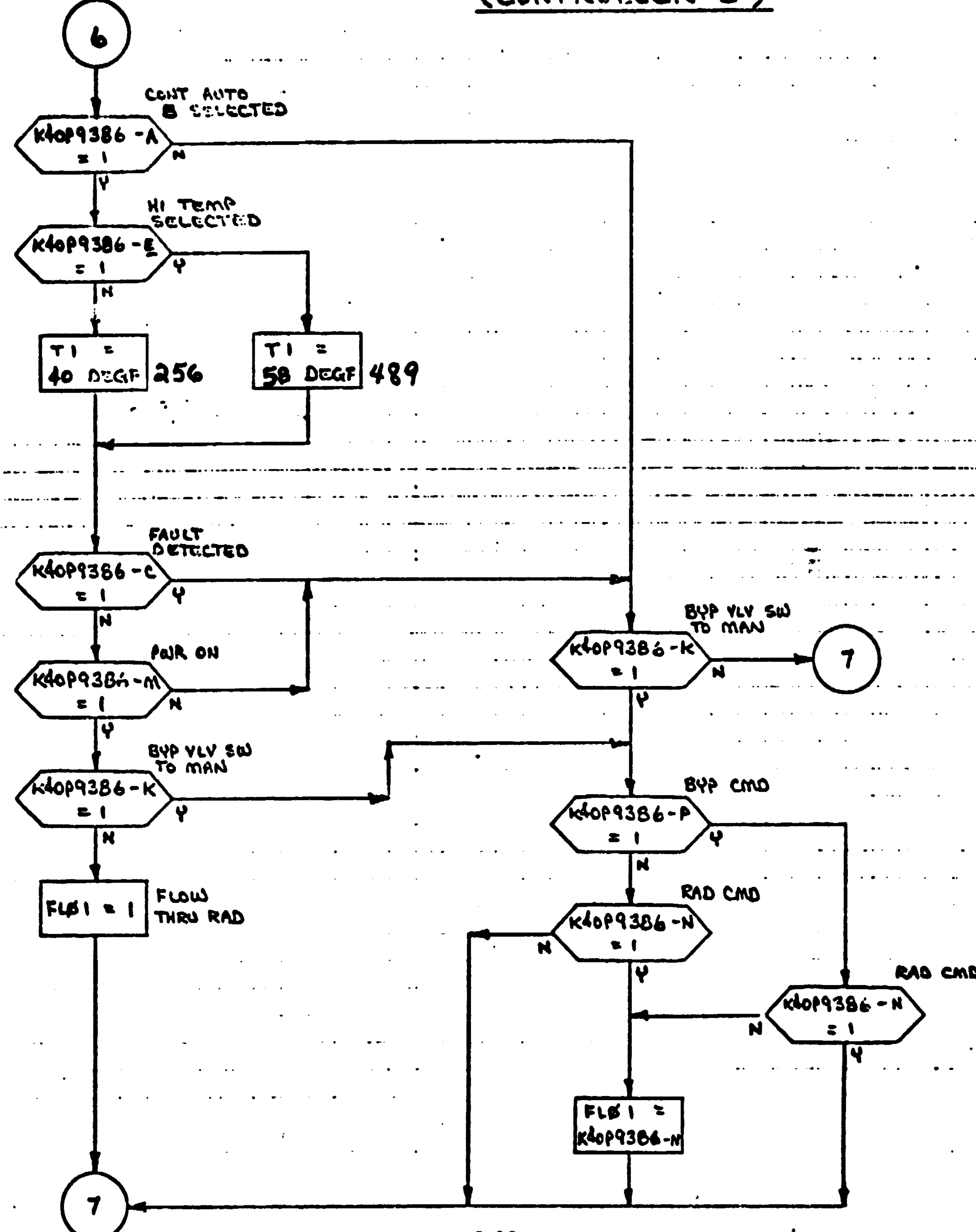

2
LOOP 2 FPV TO PAYLOAD
40P9336-7 = 1
Y
N
LOOP 2 FPV TO INTER H-X
40P9336-8 = 1
N
Y
LOOP 2 FPV TO INTER H-X
40P9336-8 = 1
N
Y
V63X1431E = 40P9336-7 V63X1430E = 40P9336-7
FLOW PROP VLV POSN (LOOP 2)
LOOP 2 PMP 1 ON
40P9350-1 = 1
Y
N
LOOP 2 PMP 2 ON
40P9351-1 = 1
Y
N
LOOP 2 FLOWS
V63R1305A = 0 #/HR
10
V63R1300A = 443#/HR
0
V63R1303A = 180 #/HR
0
V63R1305A = 356#/HR
745
3
4
4
LOOP 2 FPV TO PAYLOAD
40P9336-7 = 1
Y
N
V63R1300A = 2341#/HR
INTER H-X FLOW
825
V63R1303A = 729#/HR
PAYLOAD FLOW
342
V63R1300A = 1540#/HR
350
V63R1303A = 1178#/HR
798
3
ØI SIG COND A ON
40P9333-1 = 1
Y
N
V63R1103A = 180 #/HR
0
V63R1300A = 443#/HR
0
V63Q1330A = 0 %
92
ØI SIG COND B ON
40P9336-1 = 1
Y
N
V63R1303A = 180#/HR
0
V63R1100A = 443#/HR
0
V63Q1130A = 0 %
92
5

LOOP 1 RADIATOR FLOW (CONTROLLER A)



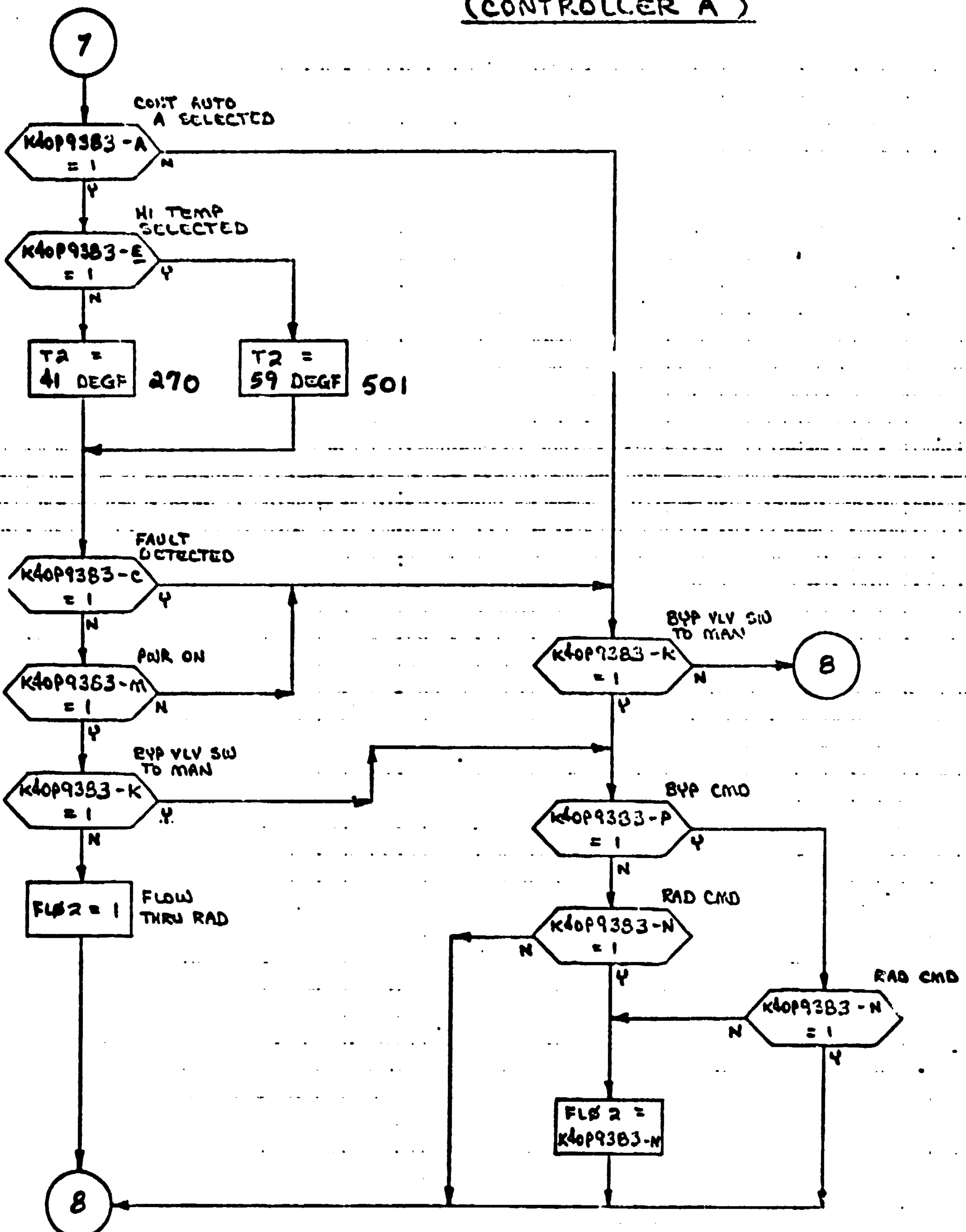
LOOP 1 RADIATOR FLOW

(CONTROLLER B)



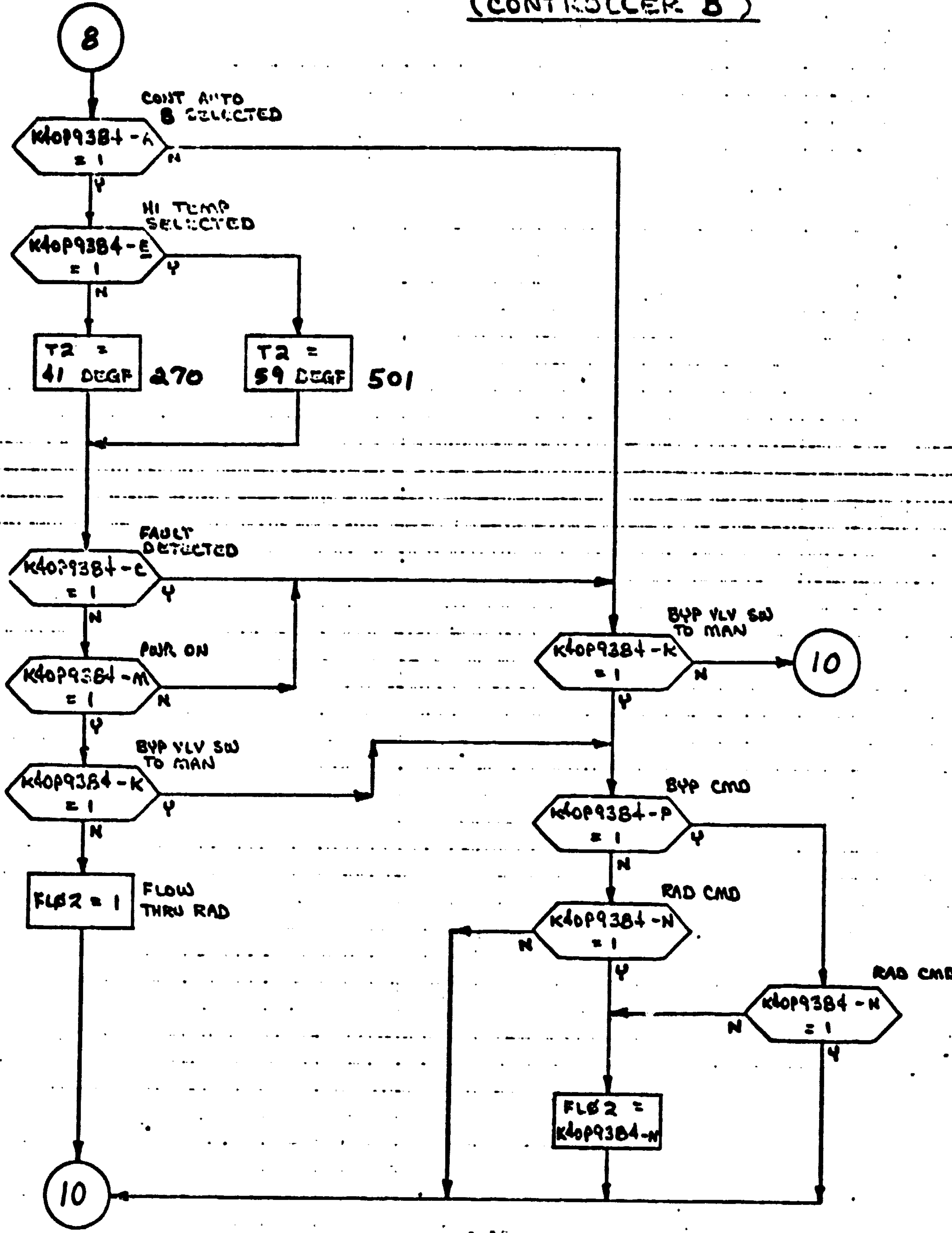
LOOP 2 RADIATOR FLOW

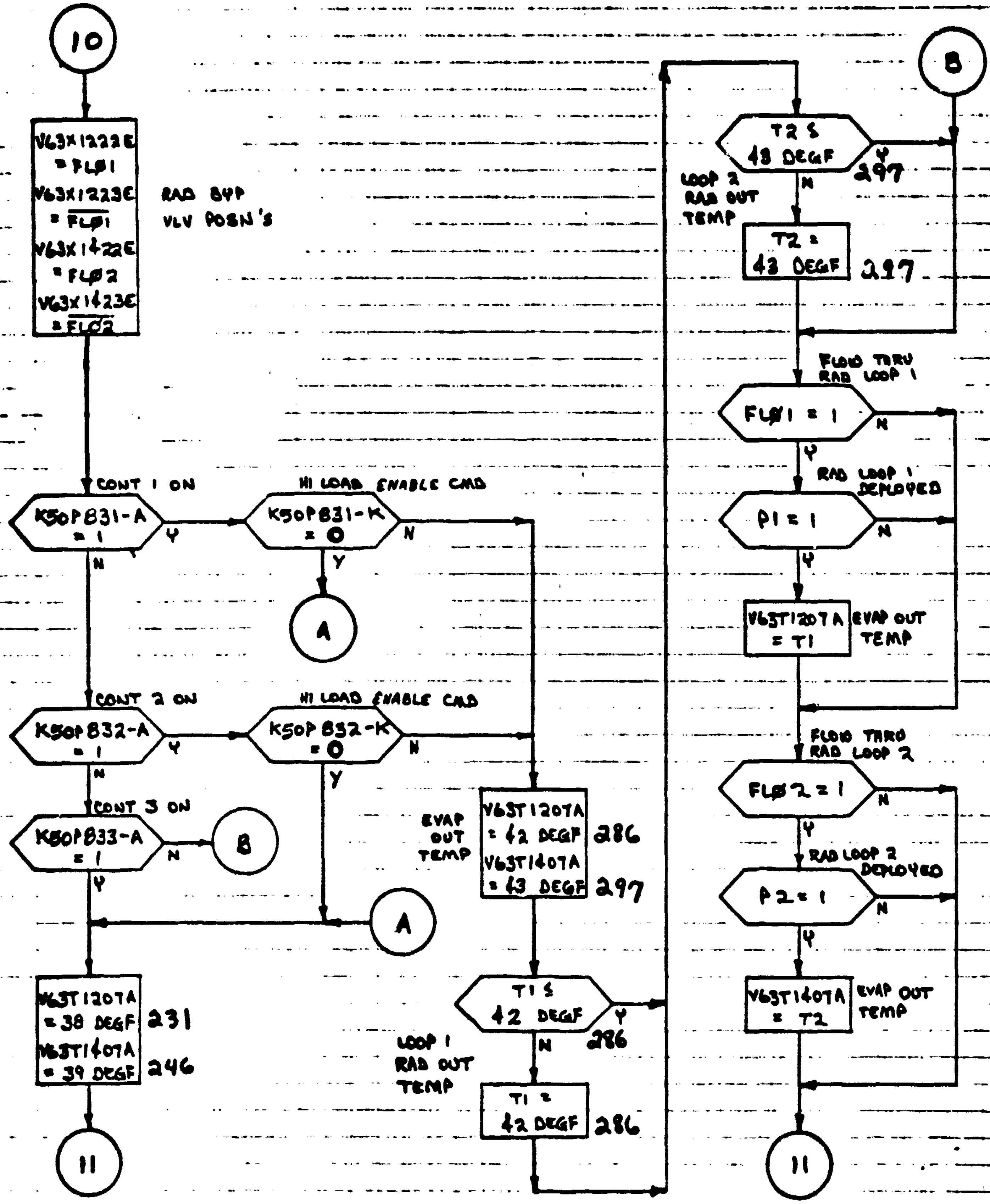
(CONTROLLER A)



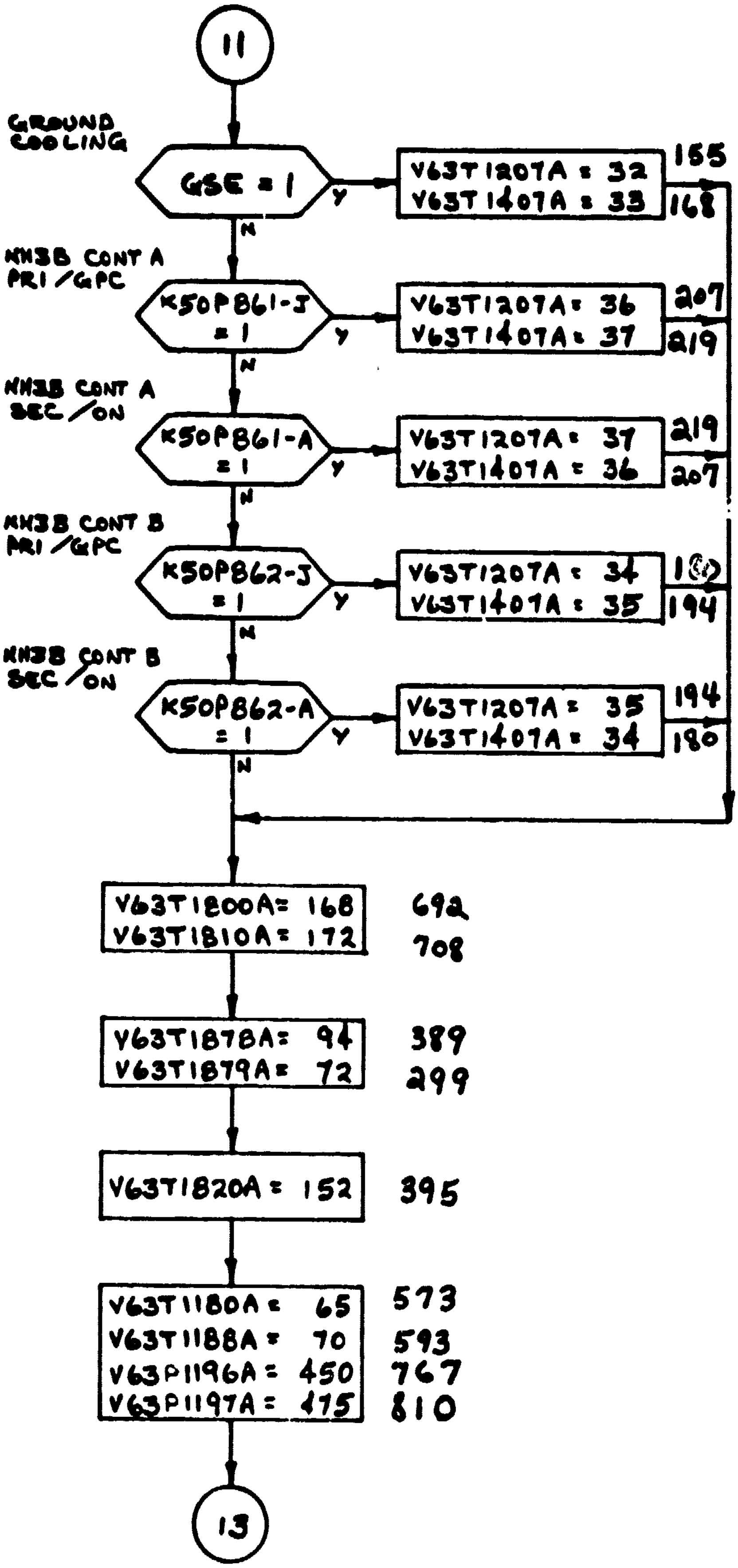
LOOP 2 RADIATOR FLOW

(CONTROLLER 8)





10
V63X1222E = FLØ1
V63X1223E = $\overline{FLØ1}$
V63X1422E = FLØ2
V63X1423E = $\overline{FLØ2}$
RAD BYP VLV POSN'S
CONT 1 ON
K50P831-A = 1
HI LOAD ENABLE CMD
K50P831-K = 0
A
CONT 2 ON
K50P832-A = 1
HI LOAD ENABLE CMD
K50P832-K = 0
CONT 3 ON
K50P833-A = 1
B
A
V63T1207A = 38 DEGF 231
V63T1407A = 39 DEGF 246
11
EVAP OUT TEMP
V63T1207A = 42 DEGF 286
V63T1407A = 43 DEGF 297
T1 ≤ 42 DEGF 286
LOOP 1 RAD OUT TEMP
T1 = 42 DEGF 286
B
T2 ≤ 43 DEGF 297
LOOP 2 RAD OUT TEMP
T2 = 43 DEGF 297
FLOW THRU RAD LOOP 1
FLØ1 = 1
RAD LOOP 1 DEPLOYED
P1 = 1
V63T1207A = T1
EVAP OUT TEMP
FLOW THRU RAD LOOP 2
FLØ2 = 1
RAD LOOP 2 DEPLOYED
P2 = 1
V63T1407A = T2
EVAP OUT TEMP
11
Y
N


11
GROUND COOLING
GSE = 1
Y
V63T1207A = 32
V63T1407A = 33
155
168
N
NH3B CONT A PRI / GPC
K50P861-J = 1
Y
V63T1207A = 36
V63T1407A = 37
207
219
N
NH3B CONT A SEC / ON
K50P861-A = 1
Y
V63T1207A = 37
V63T1407A = 36
219
207
N
NH3B CONT B PRI / GPC
K50P862-J = 1
Y
V63T1207A = 34
V63T1407A = 35
180
194
N
NH3B CONT B SEC / ON
K50P862-A = 1
Y
V63T1207A = 35
V63T1407A = 34
194
180
N
V63T1800A = 168
V63T1810A = 172
692
708
V63T1878A = 94
V63T1879A = 72
389
299
V63T1820A = 152
395
V63T1180A = 65
V63T1188A = 70
V63P1196A = 450
V63P1197A = 475
573
593
767
810
13

13

V63T1208A	=	100.7	739
V63T1209A	=	80	514
V63T1408A	=	109	820 DFI MEAS.
V63T1409A	=	96	616 ADDED BY
V63T1801A	=	160	415 REV. A.
V63T1802A	=	164	426
V63T1821A	=	156	405
V63T1870A	=	85	546
V63T1871A	=	89	571
V63T1872A	=	86	552
V63T1873A	=	90	577
V63T1874A	=	87	559
V63T1875A	=	91	583
V63T1876A	=	88	565
V63T1877A	=	92	591
V63T1890A	=	256	661
V63R9159A	=	420	878

RETURN

4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

4.1.2 PSEUDOS VARIABLE INITIALIZATION

The following pseudos are initialized as following:

VARIABLE	INITIAL CONDITION
GSE	1
P1	0
P2	0

TABLE 1 - S INPUT FOR ATCS

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
L1A2/S21	FCL 1 FLO PROP VLV (PYLD H-X) CMD	5	V63K1238E	K40P9333-7	1-ON/0-OFF
	FCL 1 FLO PROP VLV (INTER H-X) CMD	5	V63K1228E	K40P9333-8	1-ON/0-OFF
L1A2/S22	FCL 2 FLO PROP VLV (PYLD H-X) CMD	5	V63K1438E	K40P9336-7	1-ON/0-OFF
	FCL 2 FLO PROP VLV (INTER H-X) CMD	5	V63K1428E	K40P9336-8	1-ON/0-OFF
L1A2/S23	FCL 1 PMP 1 PWR ON CMD	5	V63K1111E	K40P9348-1	1-ON/0-OFF
	FCL 1 PMP 2 PWR ON CMD	2	↓ 24Y	K40P9349-1	1-ON/0-OFF
L1A2/S24	FCL 2 PMP 1 PWR ON CMD	5	V63K1311E	K40P9350-1	1-ON/0-OFF
	FCL 2 PMP 2 PWR ON CMD	2	↓ 24Y	K40P9351-1	1-ON/0-OFF
O17/S10	OI SIG COND A PWR ON CMD	5	V63K2000E	K40P9333-1	1-AC2/0-OFF
O17/S11	OI SIG COND B PWR ON CMD	5	V63K2050E	K40P9336-1	1-AC2/0-OFF
L1A2/S26	FCL 1 RAD TEMP CONT VLV AUTO A CMD	5	V63K1211E	K40P9385-A	1-AUTO A/0-OFF
	FCL 1 RAD TEMP CONT VLV AUTO B CMD	5	↓ 12E	K40P9386-A	1-AUTO B/0-OFF
	FCL 1 RAD TEMP CONT A PWR ON CMD	5	V63K1211E 1212E	K40P9385-M	1-ON/0-OFF
	FCL 1 RAD TEMP CONT B PWR ON CMD	5	1211E ↓ 1212E	K40P9386-M	1-ON/0-OFF
	FCL 1 RAD TEMP CONT AUTO A-FAULT DET B	5,12	V63K1211E	K40P9386-C	1-AUTO A/0-OFF
	FCL 1 RAD TEMP CONT AUTO B-FAULT DET A		V63K1212E	K40P9385-C	1-AUTO B/0-OFF
L1A2/S27	FCL 2 RAD TEMP CONT VLV AUTO A CMD	5	V63K1411E	K40P9383-A	1-AUTO A/0-OFF
	FCL 2 RAD TEMP CONT VLV AUTO B CMD	5	V63K1412E	K40P9384-A	1-AUTO B/0-OFF
	FCL 2 RAD TEMP CONT A PWR ON CMD	5	V63K1411E ↓ 1412E	K40P9383-M	1-ON/0-OFF

TABLE 1 - STIM[illegible] INPUT FOR ATCS

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
L1A2/S27 (cont.)	FCL 2 RAD TEMP CONT B PWR ON CMD	5	V63K1411E ↓ 1412E	K40P9384-M	1-ON/0-OFF
	FCL 2 RAD TEMP CONT AUTO A-FAULT DET B	5,12	V63K1411E	K40P9384-C	1-AUTO A/0-OFF
	FCL 2 RAD TEMP CONT AUTO B-FAULT DET A		V63K1412E	K40P9383-C	1-AUTO B/0-OFF
L1A2/S35	FCL 1 BYP VLV (MAN/CONT A AUTO) CMD	5	V63K1221E	K40P9385-K	1-MAN/0-AUTO
	FCL 1 BYP VLV (MAN/CONT B AUTO)CMD			K40P9386-K	
L1A2/S36	FCL 2 BYP VLV (MAN/CONT A AUTO) CMD	5	V63K1421E	K40P9383-K	1-MAN/0-AUTO
	FCL 2 BYP VLV (MAN/CONT B AUTO) CMD			K40P9384-K	
L1A2/S29	FCL 1 RAD MAN BYP A CMD	5		K40P9385-P	1-BYP/0-OFF
	FCL 1 RAD MAN FLOW A CMD	5		85-N	1-RAD/0-OFF
	FCL 1 RAD MAN BYP B CMD	5		86-P	1-BYP/0-OFF
	FCL 1 RAD MAN FLOW B CMD	5		86-N	1-RAD/0-OFF
L1A2/S30	FCL 2 RAD MAN BYP A CMD	5		K40P9383-P	1-BYP/0-OFF
	FCL 2 RAD MAN FLOW A CMD	5		83-N	1-RAD/0-OFF
	FCL 2 RAD MAN BYP B CMD	5		84-P	1-BYP/0-OFF
	FCL 2 RAD MAN FLOW B CMD	5		84-N	1-RAD/0-OFF
L1A2/S42	NH3 BOILER CONT A (SEC/ON) CMD	5	V63K1186E	K50P861-A	1-SEC-ON/0-OFF
	NH3 BOILER CONT A (PRI/GPC) CMD	2	1555Y	861-J	1-PRI-GPC/0-OFF
	NH3 BOILER ISOL VLV (SYS A) CMD		1559Y	K50P861-B	1-OPN/0-CLS

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
L1A2/S43	NH3 BOILER CONT B (SEC/ON) CMD	5	V63K1190E	K50P862-A	1-SEC-ON/0-OFF
	NH3 BOILER CONT B (PRI/GPC) CMD	2	1551Y	862-J	1-PRI-GPC/0-OFF
	NH3 BOILER ISOL VLV (SYS B) CMD		1559Y	K50P862-B	1-OPN/0-CLS
L1A2/S31	FLASH EVAP PRI A CONT CMD	2	V63K1509Y	K50P831-A	1-ON/0-OFF
L1A2/S32	FLASH EVAP PRI B CONT CMD	2	V63K1501Y	K50P832-A	1-ON/0-OFF
L1A2/S33	FLASH EVAP SEC CONT CMD	2	V63K1505Y	K50P833-A	1-ON/0-OFF
L1A2/S34	FLASH EVAP PRI A HI LOAD ENABLE CMD	5	V63K1670E	K50P831-K	0-ENABLE/ 1-OFF
	FLASH EVAP PRI B HI LOAD ENABLE CMD			K50P832-K	
L1A2/S25	FCL 1 RAD TEMP CONT A-HI TEMP CMD	5	V63K1214E	K40P9385-E	1-HI/0-NORM
	FCL 1 RAD TEMP CONT B-HI TEMP CMD	5	V63K1214E	K40P9386-E	
	FCL 2 RAD TEMP CONT A-HI TEMP CMD	5	V63K1414E	K40P9383-E	
	FCL 2 RAD TEMP CONT B-HI TEMP CMD	5	V63K1414E	K40P9384-E	
	GSE COOLING FLAG FCL 1-SPACE RAD DEPLOYED FLAG FCL 2-SPACE RAD DEPLOYED FLAG	7		GSE P1 P2	1-ON/0-OFF

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM ATCS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V63R1100A	FCL 1 INTER H-X FLOWRATE	2288	787	443	0	1488	328			lb/hr
V63R1103A	FCL 1 PYLD H-X FLOWRATE	701	321	180	0	1152	759			lb/hr
V63R1105A	FCL 1 COLDPLATE NETWORK FLOWRATE	348	728	0	10					lb/hr
V63Q1130A	FCL 1 ACCUMULATOR QUANTITY	60	581	0	92					PCNT
*V63T1180A	NH3 SYS A TANK TEMP	65	573							DEGF
*V63T1188A	NH3 SYS B TANK TEMP	70	593							DEGF
*V63P1196A	NH3 SYS A TANK PRESS	450	767							PSIA
*V63P1197A	NH3 SYS B TANK PRESS	475	810							PSIA
V63T1207A	FCL 1 EVAP OUT TEMP.	32	155	38 40 35	231 256 194	42 34 36	286 180 207	70 58 37	642 489 219	DEGF
V63T1208A	FCL 1 RAD OUTLET TEMP	100.7	739							DEGF
V63T1209A	FCL 1 RAD INLET TEMP	80	514							DEGF
V63X1222E	FCL 1 RAD BYP VLV POSN-RAD	0	0	1	1					STATE
V63X1223E	FCL 1 RAD BYP VLV POSN-BYP	1	1	0	0					STATE
V63X1230E	FCL 1 FLO PROP VLV POSN-INTER H-X	1	1	0	0					STATE
V63X1231E	FCL 1 FLO PROP VLV POSN-PYLD H-X	0	0	1	1					STATE
V63R1300A	FCL 2 INTER H-X FLOWRATE	2341	825	443	0	1540	350			lb/hr
V63R1303A	FCL 2 PYLD H-X FLOWRATE	729	342	180	0	1178	798			lb/hr
V63R1305A	FCL 2 COLDPLATE NETWORK FLOWRATE	356	745	0	10					lb/hr
V63Q1330A	FCL 2 ACCUMULATOR QUANTITY	65	622	0	92					PCNT
V63T1407A	FCL 2 EVAP OUT TEMP	33	168	39 41 34	246 270 180	43 35 36	297 194 207	71 59 37	657 501 219	DEGF
V63T1408A	FCL 2 RAD OUTLET TEMP	109	820							DEGF

*NOTE: This measurement uses the range limit conversion method of calculating FS_{EU}.

MEASUREMENT OUTPUT FROM ATCS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V63T1409A	FCL 2 RAD INLET TEMP	96	616							DEGF
V63X1422E	FCL 2 RAD BYP VLV POSN-RAD	0	0	1	1					STATE
V63X1423E	FCL 2 RAD BYP VLV POSN-BYP	1	1	0	0					STATE
V63X1430E	FCL 2 FLO PROP VLV POSN-INTER H-X	1	1	0	0					STATE
V63X1431E	FCL 2 FLO PROP VLV POSN-PYLD H-X	0	0	1	1					STATE
V63T1800A	FLASH EVAP TOPPING DUCT-PORT TEMP	168	692							DEGF
V63T1801A	FL EVAP TOPPING DUCT TEMP D	160	415							DEGF
V63T1802A	FL EVAP TOPPING DUCT TEMP E	164	426							DEGF
V63T1810A	FLASH EVAP TOPPING DUCT-STBD TEMP	172	708							DEGF
V63T1820A	FLASH EVAP HI LOAD DUCT TEMP	152	395							DEGF
V63T1821A	FL EVAP HI LOAD DUCT TEMP B	156	405							DEGF
V63T1870A	FLASH EVAP H_2O FDLN TEMP 1-L	85	546							DEGF
V63T1871A	FLASH EVAP H_2O FDLN TEMP 1-R	89	571							DEGF
V63T1872A	FLASH EVAP H_2O FDLN TEMP 2-L	86	552							DEGF
V63T1873A	FLASH EVAP H_2O FDLN TEMP 2-R	90	577							DEGF
V63T1874A	FLASH EVAP H_2O FDLN TEMP 3-L	87	559							DEGF
V63T1875A	FLASH EVAP H_2O FDLN TEMP 3-R	91	583							DEGF
V63T1876A	FLASH EVAP H_2O FDLN TEMP 4-L	88	565							DEGF
V63T1877A	FLASH EVAP H_2O FDLN TEMP 4-R	92	591							DEGF
V63T1878A	FLASH EVAP NOZZLE TEMP - LEFT	94	389							DEGF
V63T1879A	FLASH EVAP NOZZLE TEMP - RIGHT	72	299							DEGF
V63T1890A	FL EVAP HI LOAD NOZ TEMP C	256	661							DEGF
V63R9159A	MID-BODY DFI LOOP FLOWRATE	420	878							lb/hr

APPENDIX J

SMOKE DETECTION MATH MODEL REQUIREMENTS

CONTENTS

FIGURES

1. INTRODUCTION

The model simulates those functions of the Smoke Detection (SD) subsystem in the Orbiter. To simplify the model, only those subsystem functions needed to support testing of the Shuttle avionics system are provided.

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of the input stimuli listed in Table 1 to produce values for the output measurements listed in Table 2 that simulate the operation of the SDS.

2.1 MATH MODEL DESCRIPTION

2.1.1 SDS FUNCTIONAL CHARACTERISTICS

The SDS consists of several detector head (detector) assemblies. Each detector head shall sense any significant increase in the gaseous or particulate products of combustion or decomposition within the cabin or avionics bays. The logic device shall use the input and send a signal to appropriate warning lights on the detection and fire suppression control panel. The detector shall be designed to provide a warning during the incipient stage (the starting phase or pre-smoke stage) of a potential fire condition to permit certain cabin or avionics system evaluation and troubleshooting prior to an overheat condition or outbreak of an open flame. Figure 1 presents the SDS functional diagram.

A. The detector function is to sense a predetermined concentration or rate of increase of concentration of gaseous or particulate products of combustion or decomposition and then, through a built-in logic unit, send a signal to the smoke detection and fire suppression control panel. The signal turns on the "smoke warning" light for the affected area.

B. The crew, alerted by this warning may monitor the concentration level and start a systematic investigation of the equipment in the affected area and take appriopriate action.

C. When the smoke (incipient fire) condition exists, the "reset" button on the panel may be pressed to verify the smoke condition. If the incipient fire condition has been corrected, the "smoke warning" light will remain off. The detector is now ready to sense a new incipient fire. In the event that the smoke or incipient fire condition still exists, the warning light will come on again. The concentration level may be monitored

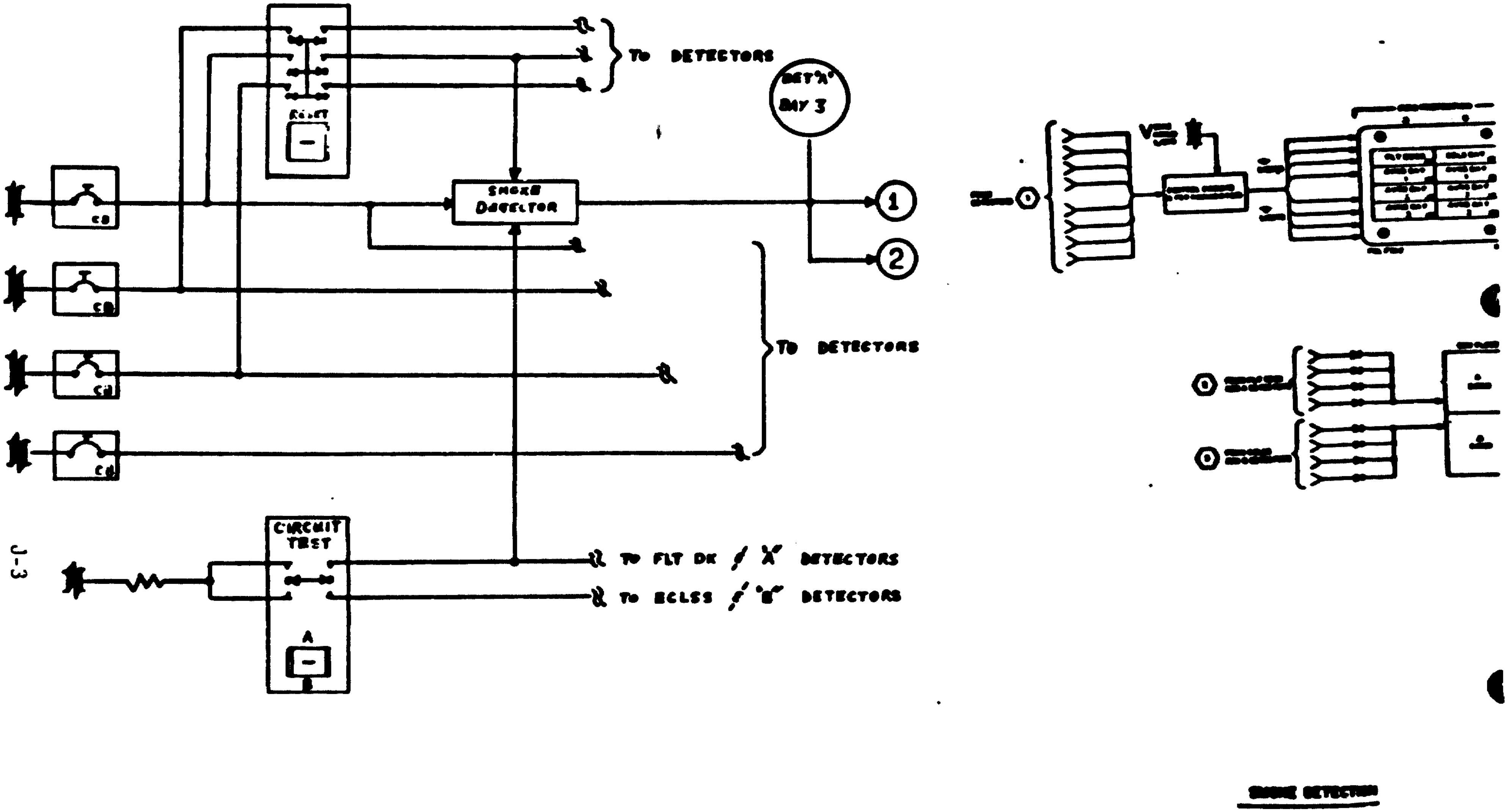


Figure 1 - Smoke detection system functional diagram.

to verify if the level is increasing or decreasing during the trouble-shooting period.

D. The detector can be interrogated in flight or on ground for an electrical operability check, by depressing a "circuit-test" button on the panel.

2.1.2 SMOKE CONCENTRATION VALUES

Particle concentration values are input to the model by the test operator. Once set, they remain constant until another value is uplinked.

2.1.3 INITIAL CONDITIONS

Note that initial conditions for STS are the same as those listed for GTS; see <u>GTS PREPROCESSOR LOGIC</u>.

2.2 <u>STS UNIQUE REQUIREMENTS</u>

None.

2.3 <u>GTS UNIQUE REQUIREMENTS</u>

2.3.1 PREPROCESSOR LOGIC

The SDS math model was originally required in the STS simulator. The math model input stimuli symbols referred to in the logic flow diagram, section 3.2, are ATA Reference connector and pin numbers. Due to the lack of flight hardware circuitry in the GTS simulator, logic functions that bridge the gap between the payload MDMs and the SDS are required in a GTS preprocessor in order to evaluate values for the input stimuli coming from the GPC prior to execution of the model.

3. MATH MODEL LOGIC

This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

The basic input stimuli to the model are identified by ATA reference system connector-pin (CP) numbers. A logical combination of one or more MML numbers is used to derive the proper input stimulus for each CP. Within the STS, the logical combination is accomplished via hardware circuitry. However, within the GTS, due to the absence of the required circuitry, the logical relations between CP and MML must be effected by software. The following logical equations are required as a preprocessor within GTS in order to calculate the correct CP stimuli which are then input to the model. Most equations are merely a direct one-for-one correspondence between CP and MML. However, some equiations may require more than one MML to be combined by the logical product (AND) and the inclusive logical sum (OR). In these instances, "AND" denotes the logical product and "OR" denotes the inclusive logical sum.

The SOURCE columns contain an entry for the MDM, connector end pin from which the MML is received. In the absnece of an entry in these columns, the operator must make the entry via the NAS keyboard.

The final column lists the input stimuli initialization values required. Notice that inputs containing an entry for SOURCE do not have an initialization value, since they are updated at the GTS simulator cycle rate by the source connection.

GTS MATH MODEL STIMULI - SDS

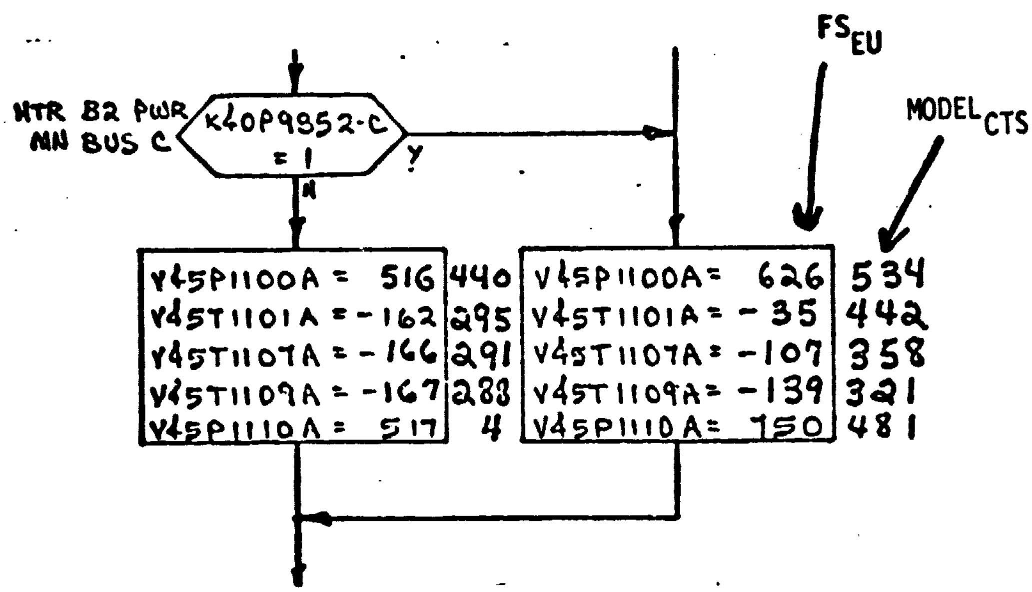
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN	MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
K30P139-8				
K81P120-8				
K82P108-8	= V62K0802E			0
K83P63-8				
K90P28-8				
K30[illegible]2-8				
K81P121-8	= 806E			0
K82P109-8				
K83P64-8				
K81P121-7	= 815E			1
K83P63-7				
K30P122-7				
K30P139-7	= 816E			1
K82P108-7				
K83P64-7				
K81P120-7				
K82P109-7	= 817E			1
K90P28-7				
K30P122-4	= **			0
K30P139-4	=			0
K81P120-4	=			0
K81P121-4	=			0
K82P108-4	=			0
K82P109-4	=			0
K83P63-4	=			0
K83P64-4	=			0
K90P28-4	=			0

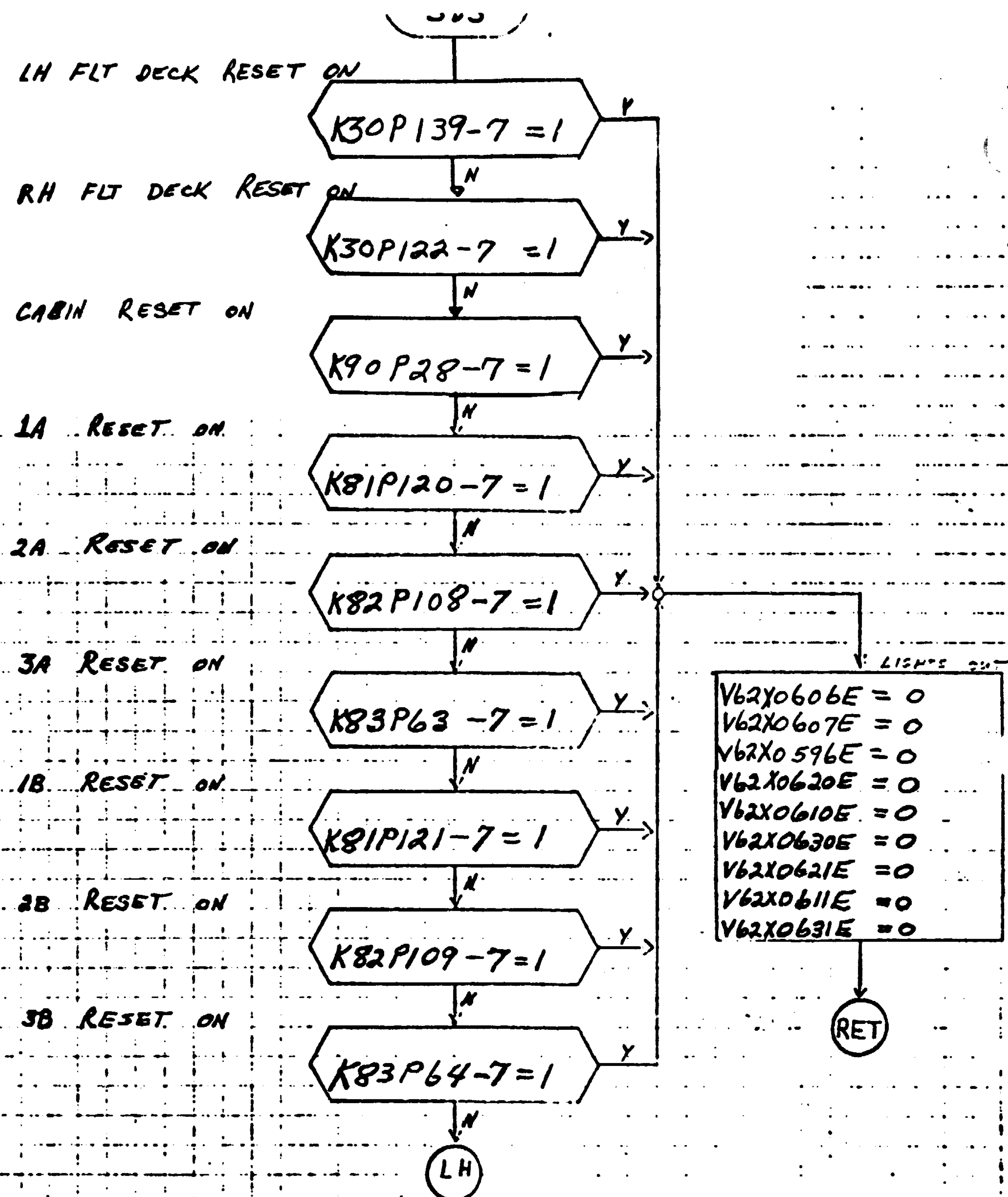
*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

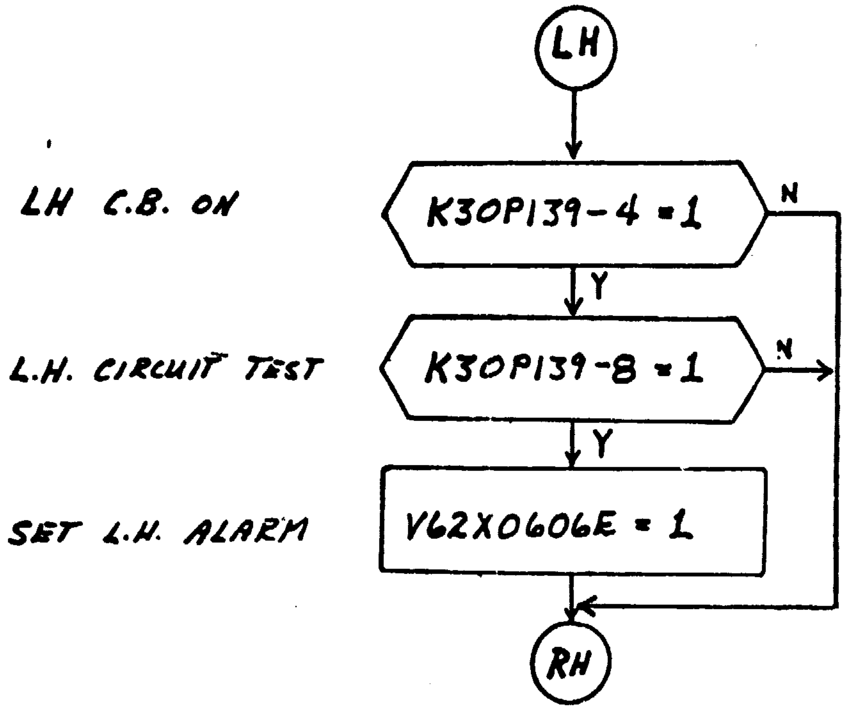
3.2 LOGIC FLOW DIAGRAM

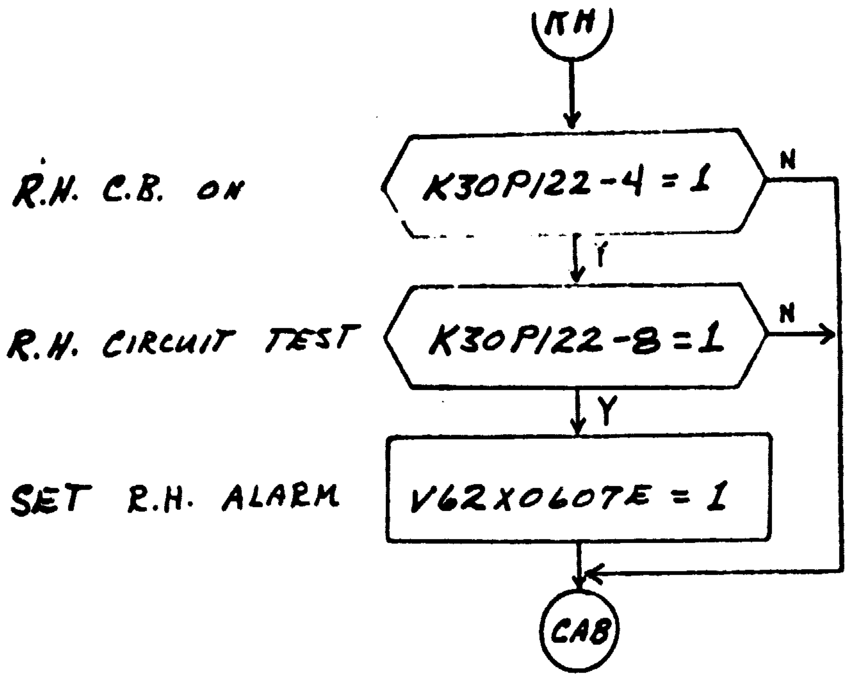
The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;

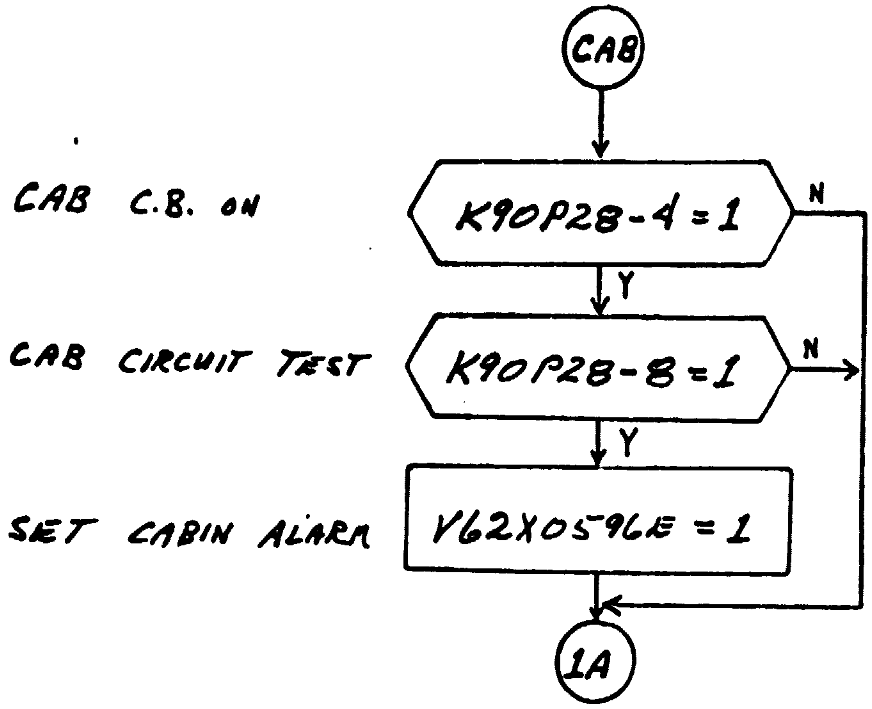


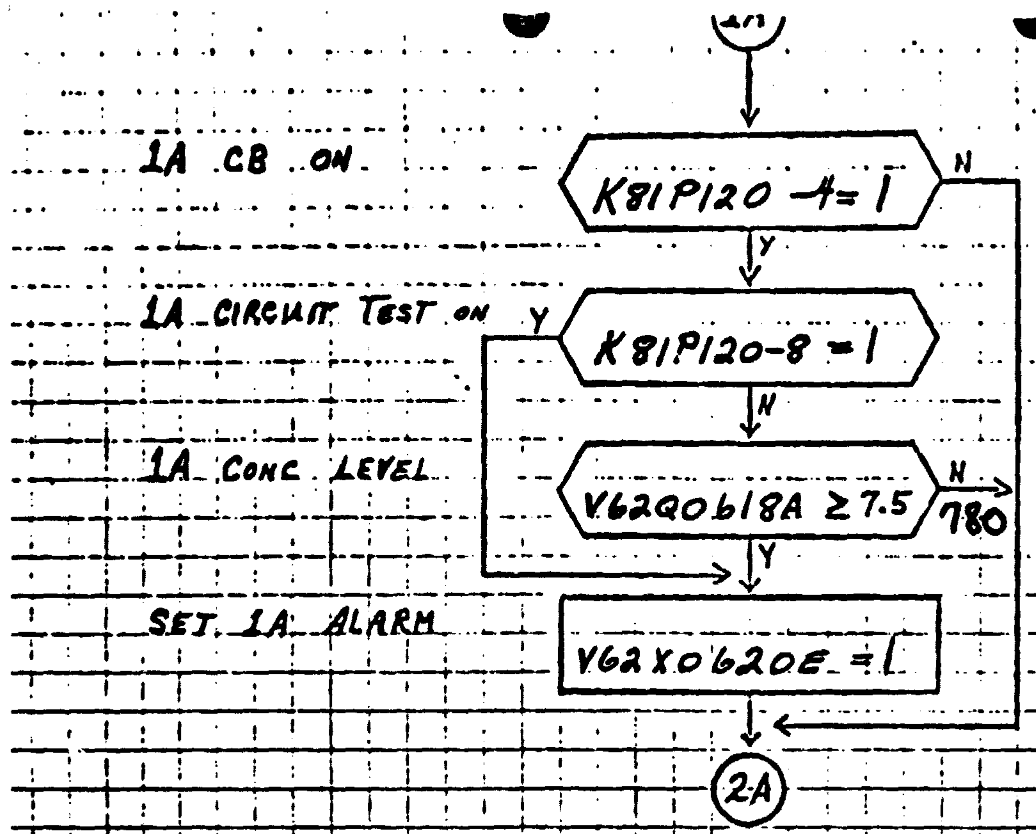
shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.


LH FLT DECK RESET ON
K30P139-7 =1
RH FLT DECK RESET ON
K30P122-7 =1
CABIN RESET ON
K90P28-7=1
1A RESET ON
K81P120-7=1
2A RESET ON
K82P108-7=1
3A RESET ON
K83P63 -7=1
1B RESET ON
K81P121-7=1
2B RESET ON
K82P109-7=1
3B RESET ON
K83P64-7=1
Y
N
LH
LIGHTS OUT
V62X0606E = 0
V62X0607E = 0
V62X0596E = 0
V62X0620E = 0
V62X0610E = 0
V62X0630E = 0
V62X0621E = 0
V62X0611E = 0
V62X0631E = 0
RET


LH
LH C.B. ON
K30P139-4 = 1
N
Y
L.H. CIRCUIT TEST
K30P139-8 = 1
N
Y
SET L.H. ALARM
V62X0606E = 1
RH


RH
R.H. C.B. ON
K30P122-4 = 1
N
Y
R.H. CIRCUIT TEST
K30P122-8 = 1
N
Y
SET R.H. ALARM
V62X0607E = 1
CAB


CAB
CAB C.B. ON
K90P28-4 = 1
N
Y
CAB CIRCUIT TEST
K90P28-8 = 1
N
Y
SET CABIN ALARM
V62X0596E = 1
1A



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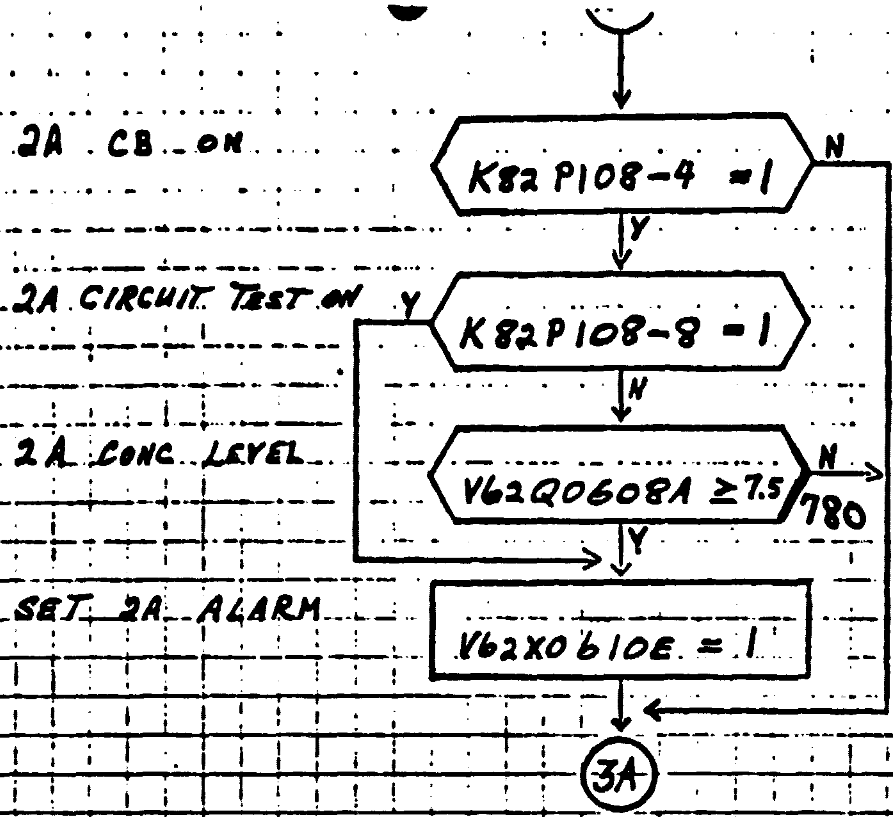
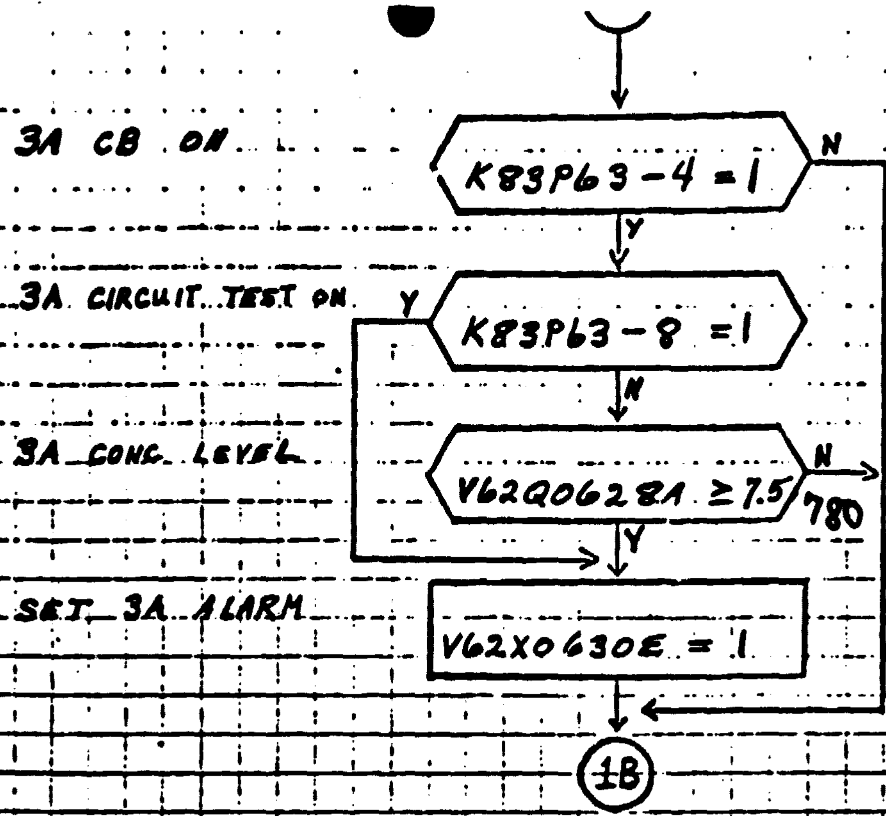
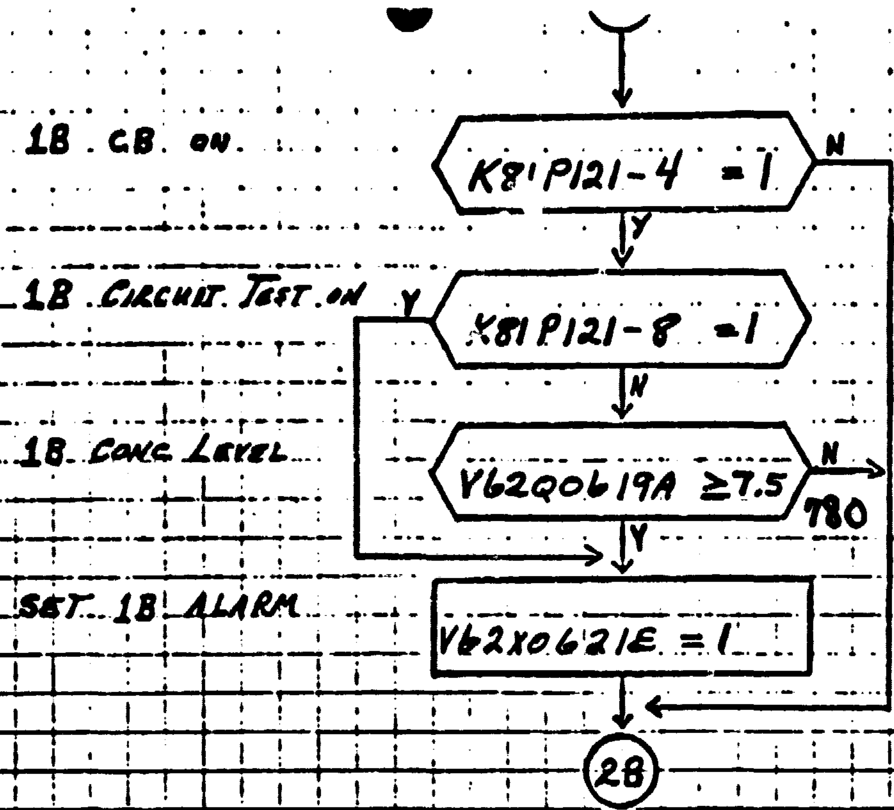
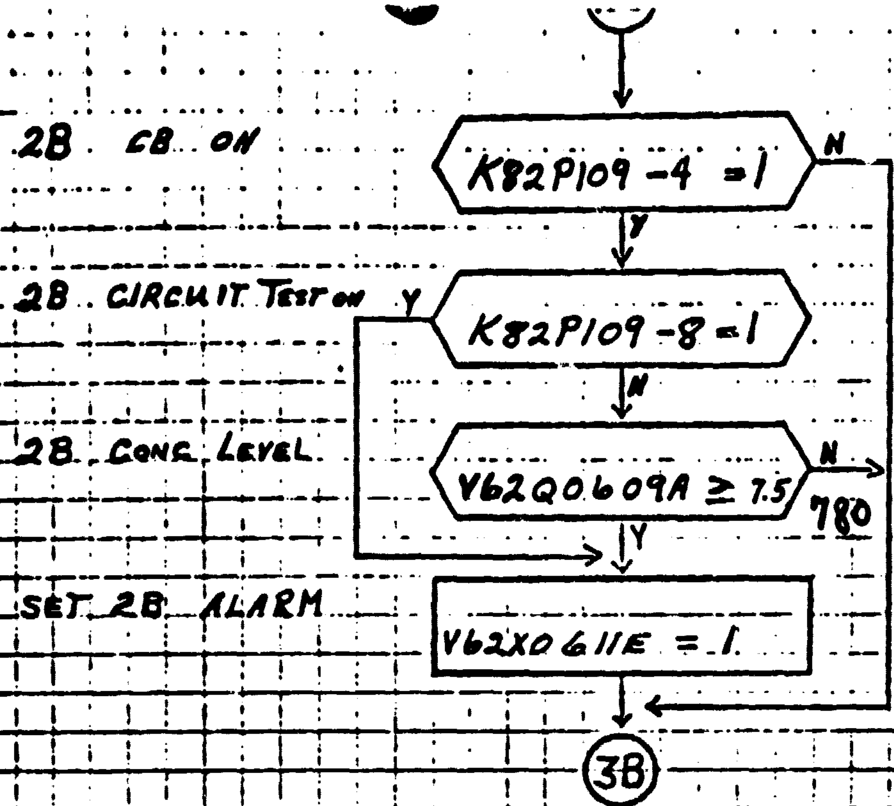
OF POOR QUALITY

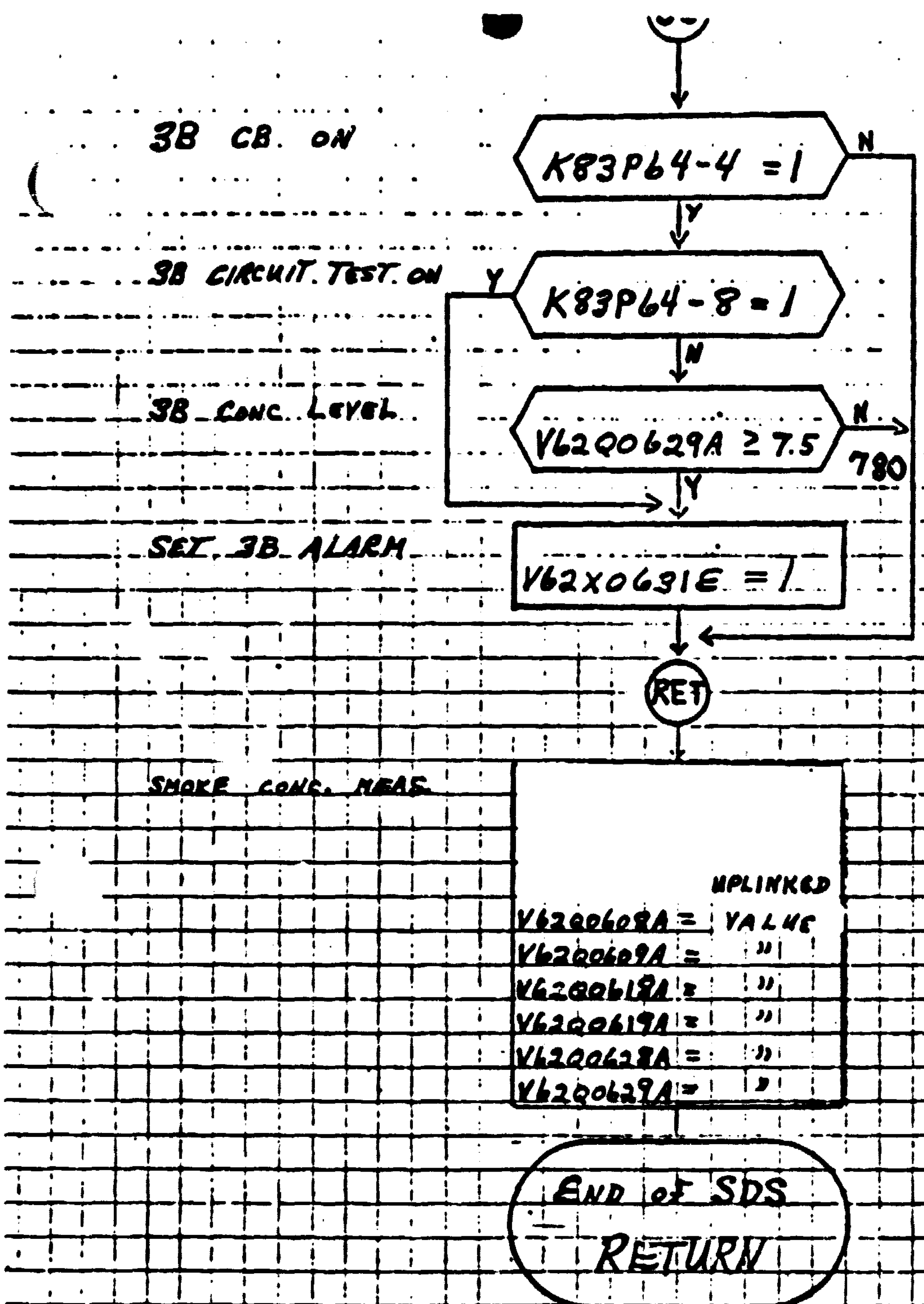

2A CB ON
K82P108-4 =1
N
Y
2A CIRCUIT TEST ON
Y
K82P108-8 =1
N
2A CONC LEVEL
V62Q0608A ≥7.5
N
780
Y
SET 2A ALARM
V62X0610E =1
3A


3A CB ON
K83P63-4 = 1
N
Y
3A CIRCUIT TEST ON
Y
K83P63-8 = 1
N
3A CONC. LEVEL
V62Q06281 ≥ 7.5
N
780
Y
SET 3A ALARM
V62X0630E = 1
1B


1B CB ON
K8'P121-4 = 1
N
Y
1B CIRCUIT TEST ON
Y
K81P121-8 = 1
N
1B CONC LEVEL
V62Q0619A ≥7.5
N
780
Y
SET 1B ALARM
V62X0621E = 1
28



2B CB ON
K82P109 -4 =1
N
Y
2B CIRCUIT TEST ON
Y
K82P109 -8 =1
N
2B CONC LEVEL
V62Q0609A ≥ 7.5
N
780
Y
SET 2B ALARM
V62X0611E = 1
3B


3B CB. ON
K83P64-4 = 1
N
Y
3B CIRCUIT TEST ON
K83P64-8 = 1
Y
N
3B CONC. LEVEL
V62Q0629A ≥ 7.5
N
780
Y
SET 3B ALARM
V62X0631E = 1
RET
SMOKE CONC. MEAS.
UPLINKED
V62Q0608A = VALUE
V62Q0609A = "
V62Q0618A = "
V62Q0619A = "
V62Q0628A = "
V62Q0629A = "
END OF SDS
RETURN

4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

C-5

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
L1A1/S8	BAY 1/DETECTOR A		V62K0802E	K81P120-8	1-TST/0-NO TST
	BAY 2/DETECTOR A			K82P108-8	1-TST/0-NO TST
	BAY 3/DETECTOR A	5		K83P63-8	1-TST/0-NO TST
	LEFT FLT DECK			K30P139-8	1-TST/0-NO TST
	CABIN			K90P28-8	1-TST/0-NO TST
	BAY 1/DETECTOR B		V62K0806E	K81P121-8	1-TST/0-NO TST
	BAY 2/DETECTOR B	5		K82P109-8	1-TST/0-NO TST
	BAY 3/DETECTOR B			K83P64-8	1-TST/0-NO TST
	RIGHT FLT DECK			K30P122-8	1-TST/0-NO TST
L1A1/S7	BAY 1/DETECTOR B	5	V62K0815E	K81P121-8	1-RESET/0-OFF
	BAY 3/DETECTOR A			K83P63-7	1-RESET/0-OFF
	BAY 3/DETECTOR B		V62K0816E	K83P64-7	1-RESET/0-OFF
	BAY 2/DETECTOR A	5		K82P108-7	1-RESET/0-OFF
	LEFT FLT DECK			K30P139-7	1-RESET/0-OFF
	RIGHT FLT DECK			K30P122-7	1-RESET/0-OFF
	BAY 1/DETECTOR A	5	V62K0817E	K81P120-7	1-RESET/0-OFF
	BAY 2/DETECTOR B			K82P109-7	1-RESET/0-OFF
	CABIN			K90P28-7	1-RESET/0-OFF

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
014/CB7	LEFT FLT DECK MN A PWR	5,6		K30P139-4	1-ON/0-OFF
	RIGHT FLT DECK MN A PWR			K30P122-4	1-ON/0-OFF
016/CB6	CABIN MN C PWR	5,6		K90P28-4	1-ON/0-OFF
016/CB7	BAY 1/DETECTOR A MN C PWR	5,6		K81P120-4	1-ON/0-OFF
	BAY 2/DETECTOR B MN C PWR			K82P109-4	1-ON/0-OFF
014/CB8	BAY 2/DETECTOR A MN A PWR	5,6		K82P108-4	1-ON/0-OFF
	BAY 3/DETECTOR B MN A PWR			K83P64-4	1-ON/0-OFF
015/CB7	BAY 3/DETECTOR A MN B PWR	5,6		K83P63-4	1-ON/0-OFF
	BAY 1/DETECTOR B MN B PWR	5,6		K81P121-4	1-ON/0-OFF

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM SDS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V62Q0608A	SMOKE DET. CONC. A AV. BAY 2	0.71	620							MG/M^3
V62Q0609A	SMOKE DET. CONC. B. AV. BAY 2	1.00	667							MG/M^3
V62Q0618A	SMOKE DET. CONC. A AV. BAY 1	1.29	698							MG/M^3
V62Q0619A	SMOKE DET. CONC. B AV. BAY 1	1.60	723							MG/M^3
V62Q0628A	SMOKE DET. CONC. A AV. BAY 3	1.91	743							MG/M^3
V62Q0629A	SMOKE DET. CONC. B AV. BAY 3	2.20	760							MG/M^3
V62X0606E	LH FLT DECK SM DET SIG	0	0	1	1					STATE
V62X0607E	RH FLT DECK SM DET SIG	0	0	1	1					
V62X0596E	SM DET SIG CABIN	0	0	1	1					
V62X0620E	SM DET SIG 1A	0	0	1	1					
V62X0610E	SM DET SIG 2A	0	0	1	1					
V62X0630E	SM DET SIG 3A	0	0	1	1					
V62X0621E	SM DET SIG 1B	0	0	1	1					
V62X0611E	SM DET SIG 2B	0	0	1	1					
V62X0631E	SM DET SIG 3B	0	0	1	1					STATE

APPENDIX K

WATER/WASTE MANAGEMENT MATH MODEL REQUUIREMENTS

CONTENTS

FIGURES

1. INTRODUCTION

This model simulates those functions of the Water/Waste Management (W/WMS) subsystem that are in the Orbiter. To simplify the model, only those subsystem functions needed to support testing of the Shuttle avionics system are provided. Figure 1 shows an overview of the W/WMS. Figure 2 shows the waste collector of the Waste Management System.

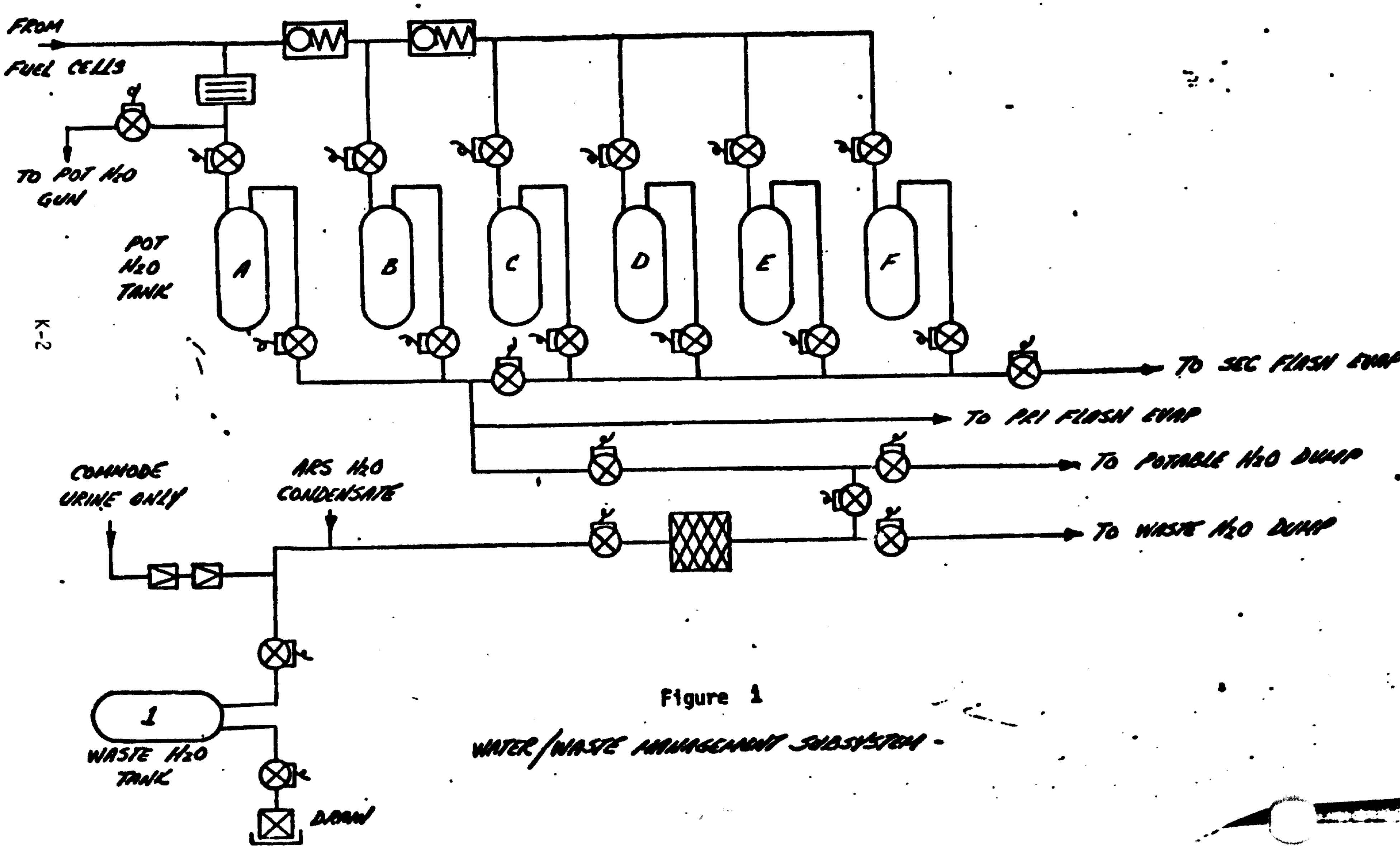


Figure 1

WATER/WASTE MANAGEMENT SUBSYSTEM -

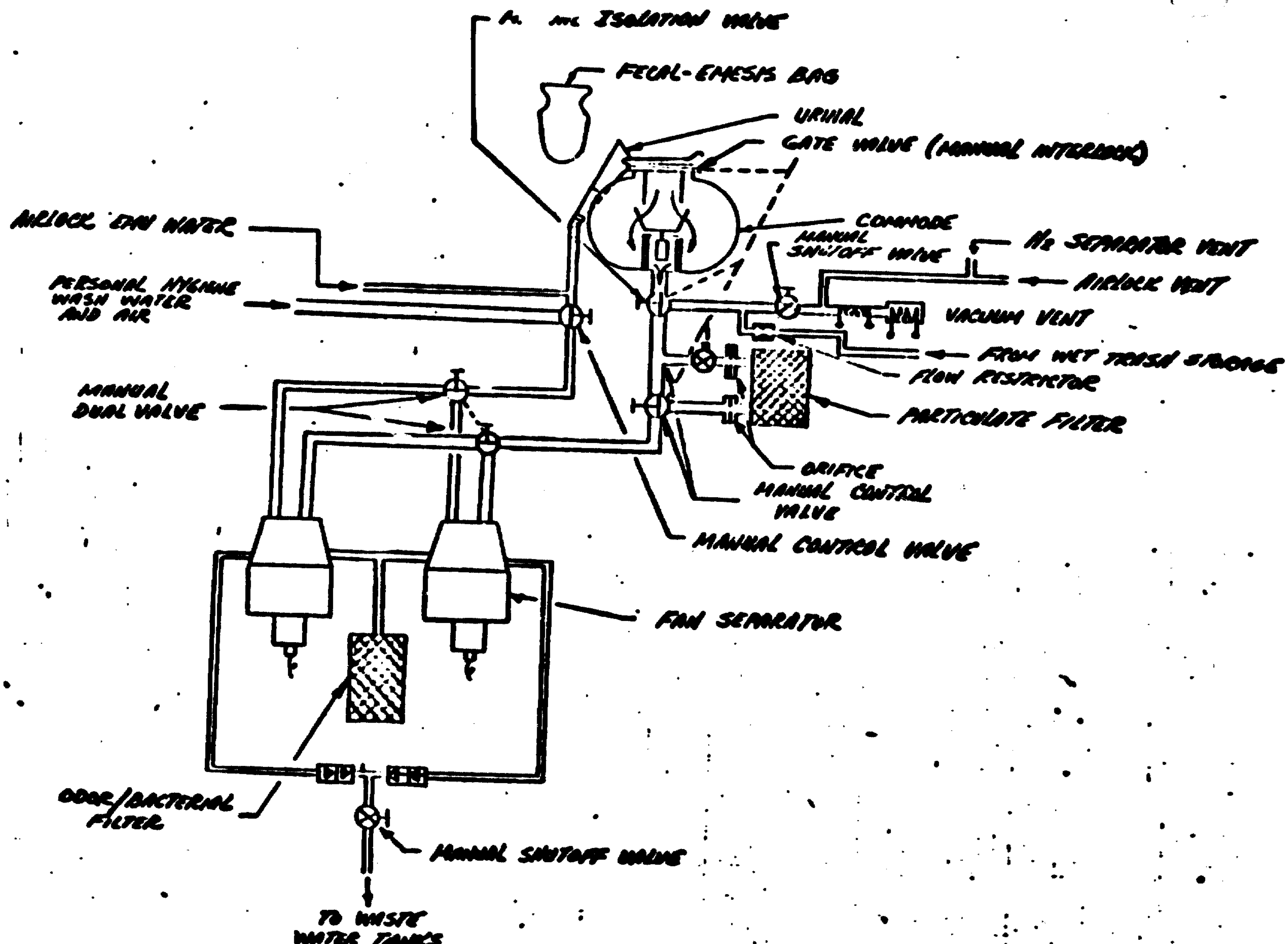


Figure 2

WASTE MANAGEMENT SUBSYSTEM - WASTE COLLECTOR

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in Table 1 to produce values for the output measurements listed in Table 2 that simulate the operation of the W/WMS.

2.1 MATH MODEL DESCRIPTION

2.1.1 WATER MANAGEMENT SUBSYSTEM

The water management subsystem performs the primary functions of supplying potable water to the crew for metabolic consumption, to the ATCS flash evaporators for vehicle thermal control purposes, and to the airlock support subsystem for recharging the extravehicular life suport system. The water management subsystem achieves these objectives be collecting and processing water produced at a rate of approximately 0.8 pound per kwhr by the Oriter fuel cells before distributing the water to the various sources.

After the water is properly treated, the potable water is stored in four tanks containing metallic bellows. The water is expelled from the tank by nitrogen gas supplied at approximately 10 psig by the atmospheric revitalization pressure control subsystem (ARPCS) or in contingency conditions by cabin atmospheric pressure. Should the fuel cell production rates exceed the water usage requirement and storage capability, the water management subsystem provides the capability to dump the excess potable water overboard.

2.1.2 WASTE MANAGEMENT SUBSYSTEM

The waste management subsystem provides for collecting, treating, and storing fecal, urine, cabin humidity condensate, personal hygiene, and airlock waste water. To accomplish these task, the waste management subsystem employs a waste collection system which handles solid and liquid waste separately.

Solid wastes, such as fecal material and toilet paper, are collected in a commode or fecal collection system. Fecal material is directed into the collector by air flow and the air is passed through a bacteria filter before returning to the cabin. The fecal material entering the collector is impinged on the inside surface of the collector by a slinger device. The waste material is vacuum dried for reduction of mass and bacteria control. In the event the commode malfunctions, a backup collection system is provided. The backup system consists of using fecal collection bags.

Liquid waste are collected by a urine/waste water collection system which is comprised primarily of a urinal collector, water separators and waste storage tanks. The urinal collector, used in conjunction with a fan/water separator, collects and transfers the urine into the waste storage tanks.

2.1.3 INITIAL CONDITIONS

Note that initial conditions for STS are the same as those listed for GTS; see GTS PREPROCESSOR LOGIC.

2.2 STS UNIQUE REQUIREMENTS

NONE

2.3 GTS UNIQUE REQUIREMENTS

2.3.1 PREPROCESSOR LOGIC

The W/WMS math model was originally required in the STS simulator. The math model input stimuli symbols referred to in the logic flow diagram, section 3.2, are ATA Reference Connector and pin numbers. Due to the lack of flight hardware circuitry in the GTS simulator, logic functions that bridge the gap between the payload MDM's and the W/WMS subsystem are required in a GTS preprocessor in order to evaluate values for the input stimuli coming from the GPC prior to execution of the model.

3. MATH MODEL LOGIC

This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

The basic input stimuli to the model are identified by ATA reference system connector-pin (CP) numbers. A logical combination of one or more MML numbers is used to derive the proper input stimulus for each CP. Within the STS, the logical combination is accomplished via hardware circuitry. However, within the GTS, due to the absence of the required circuitry, the logical relations between CP and MML must be effected by software. The following logical equations are required as a preprocessor within GTS in order to calculate the correct CP stimuli which are then input to the model. Most equations are merely a direct one-for-one correspondence between CP and MML. However, some equiations may require more than one MML to be combined by the logical product (AND) and the inclusive logical sum (OR). In these instances, "AND" denotes the logical product and "OR" denotes the inclusive logical sum.

The SOURCE columns contain an entry for the MDM, connector end pin from which the MML is received. In the absnece of an entry in these columns, the operator must make the entry via the NAS keyboard.

The final column lists the input stimuli initialization values required. Notice that inputs containing an entry for SOURCE do not have an initialization value, since they are updated at the GTS simulator cycle rate by the source connection.

GTS MATH MODEL STIMULI - W/WMS
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN		MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
K90P412-13	=	V62K0200E			0
412-11	=	0201E			1
401-13	=	0401E			0
401-11	=	0402E			1
402-13	=	0405E			0
402-11	=	0406E			1
403-13	=	0421E			0
403-11	=	0422E			1
404-13	=	0425E			0
404-11	=	0426E			1
411-13	=	0450E			0
411-11	=	0452E			1
K40P98-13	=	0460E			0
98-11	=	0462E			1
K90P415-13	=	0530E			0
415-11	=	0531E			1
99-13	=	0535E			0
99-11	=	0536E			1
K40SP182	=	0541E			1
SP181	=	0549E			1
K90P416-13	=	0710E			0
416-11	=	0711E			1
417-11	=	0714E			1
417-13	=	0715E			0
408-13	=	0750E			0
408-11	=	0751E			1
407-11	=	0754E			1
407-13	=	0755E			0
405-13	=	0770E			0
405-11	=	0771E			1

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

GTS MATH MODEL STIMULI - W/WMS

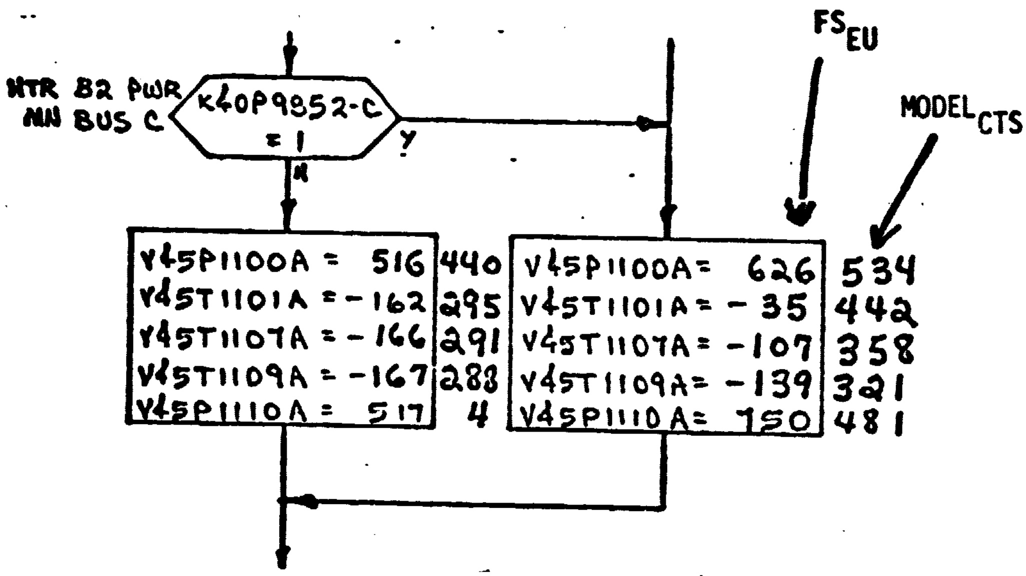
MML TO CONN-PIN CONVERSION LOGIC

SYSTEM CONN-PIN		MML ID	SOURCE* MDM	SOURCE* CONN/PIN	INITIALIZATION VALUES
K90P406-13	=	V62K0774E			0
406-11	=	0775E			1
413-13	=	1000E			0
413-11	=	1002E			1
409-13	=	1100E			0
↓ 409-11	=	↓ 1102E			1
K40SP185	=	**			1
↓ SP186	=	↓			1

*UNLESS SPECIFIED, STIMULI ARE TO BE ENTERED BY OPERATOR AT THE NAS KYBD.
**ARTIFICIAL MML ID'S ARE TO BE SUPPLIED BY PROGRAMMER.

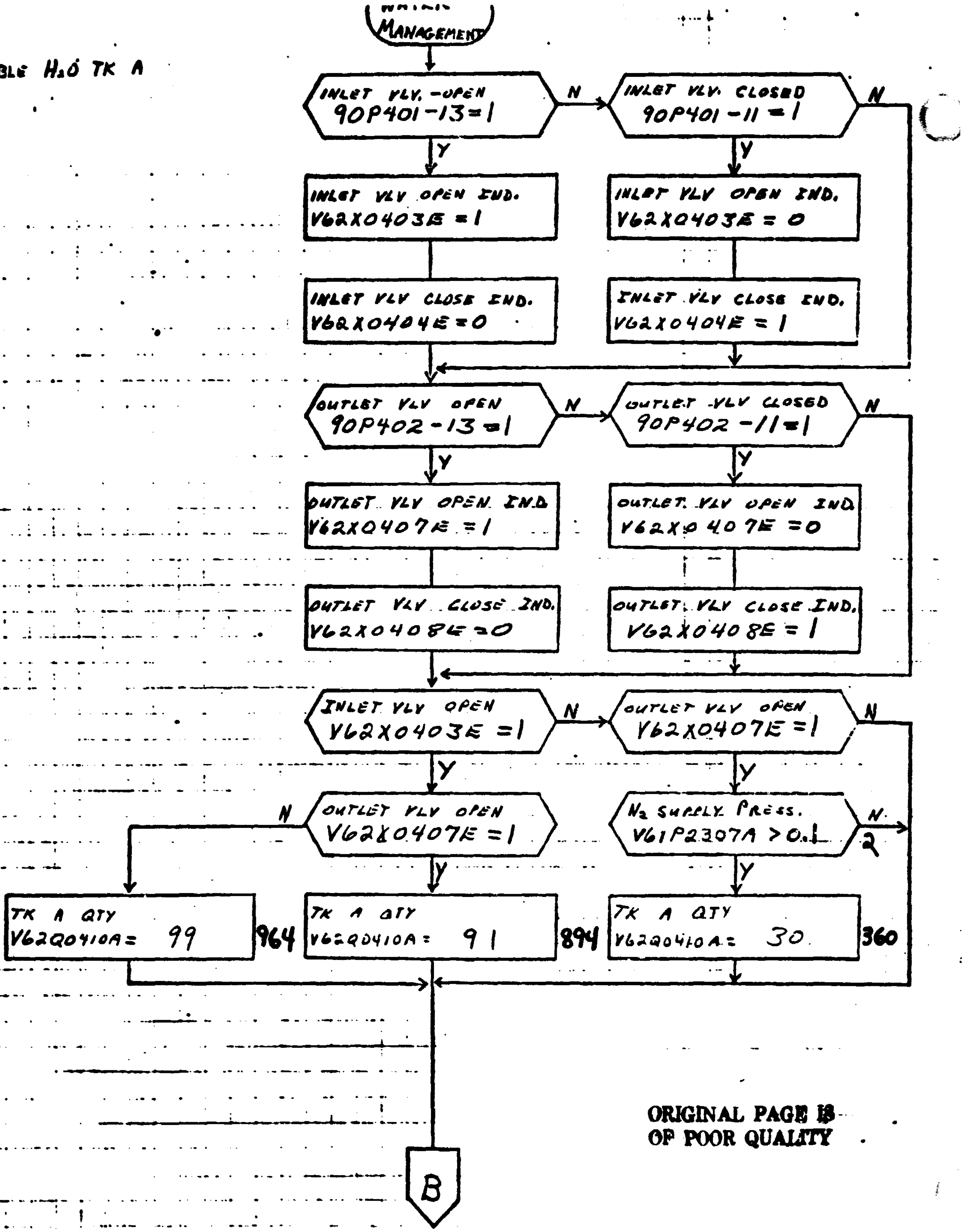
3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;



shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.

POTABLE H_2O TK A



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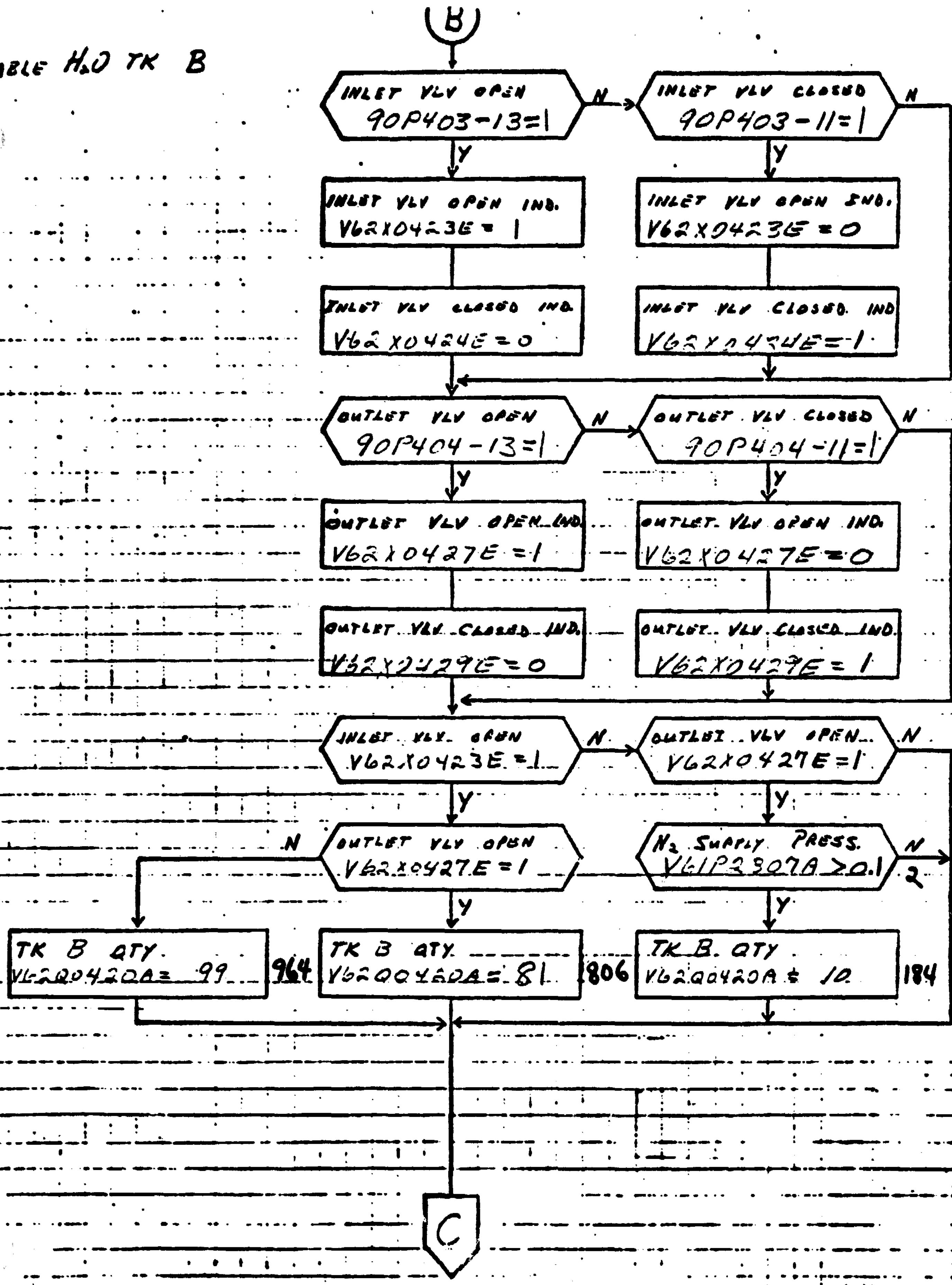
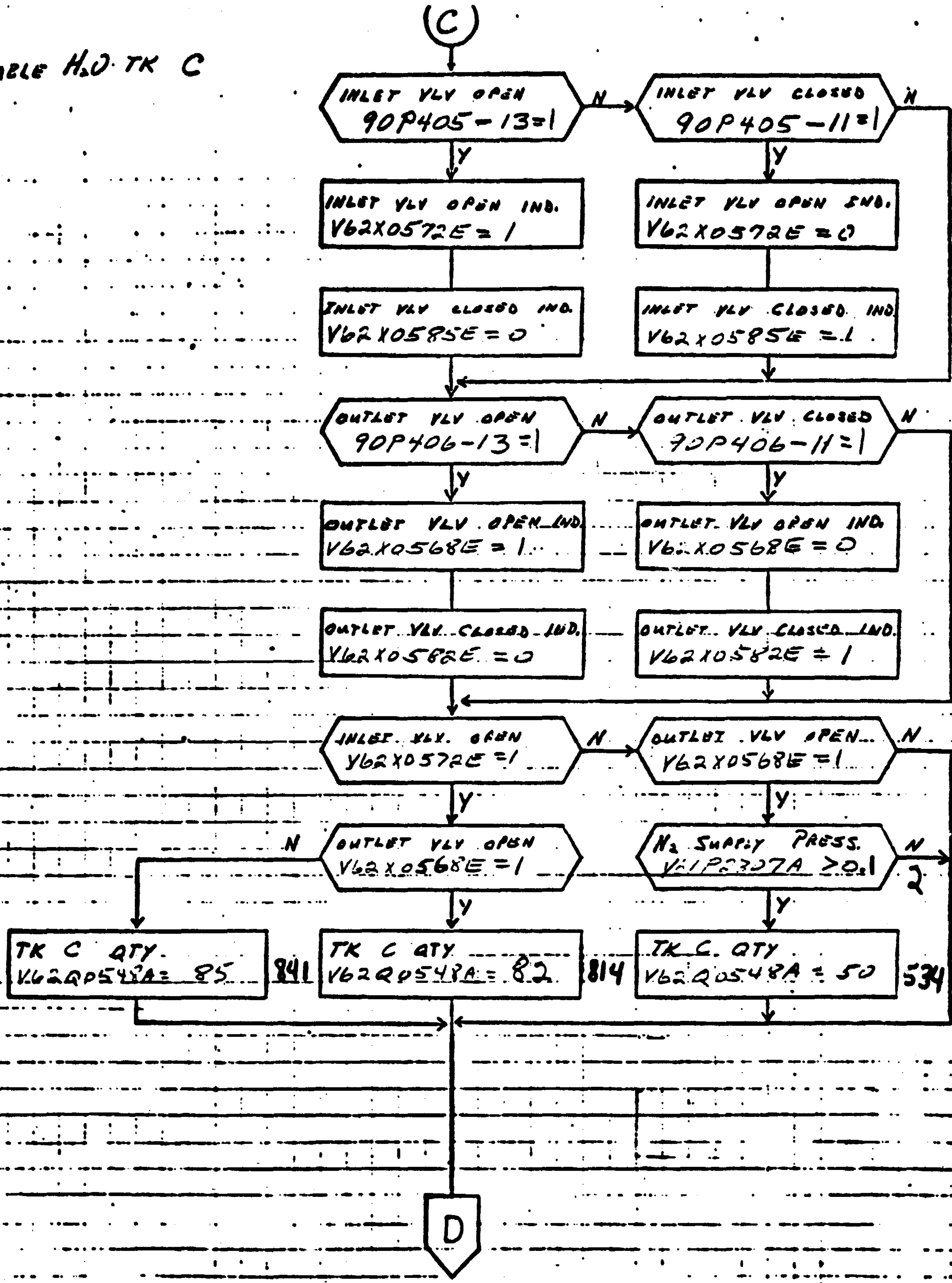
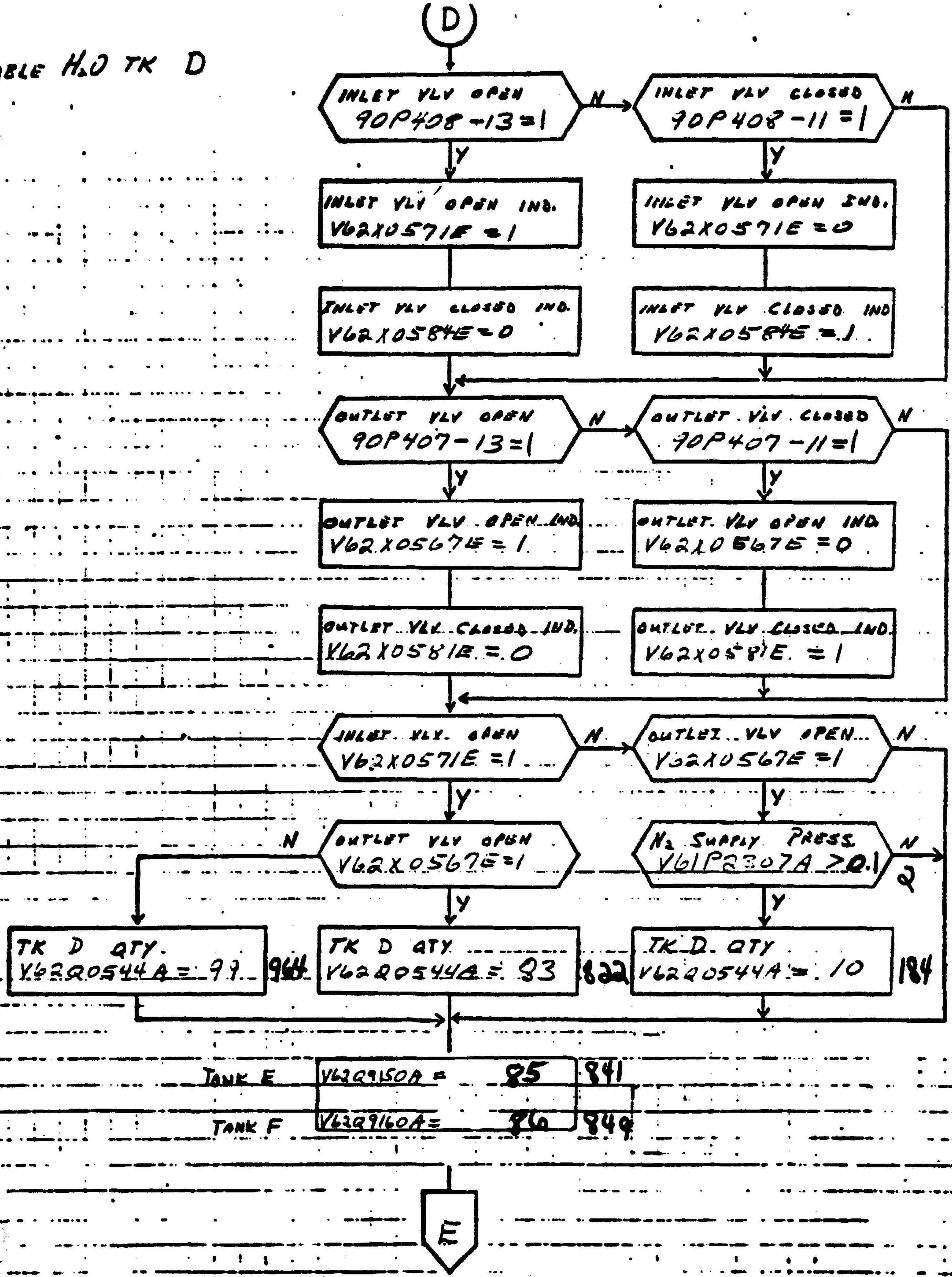
POTABLE H_2O TK B

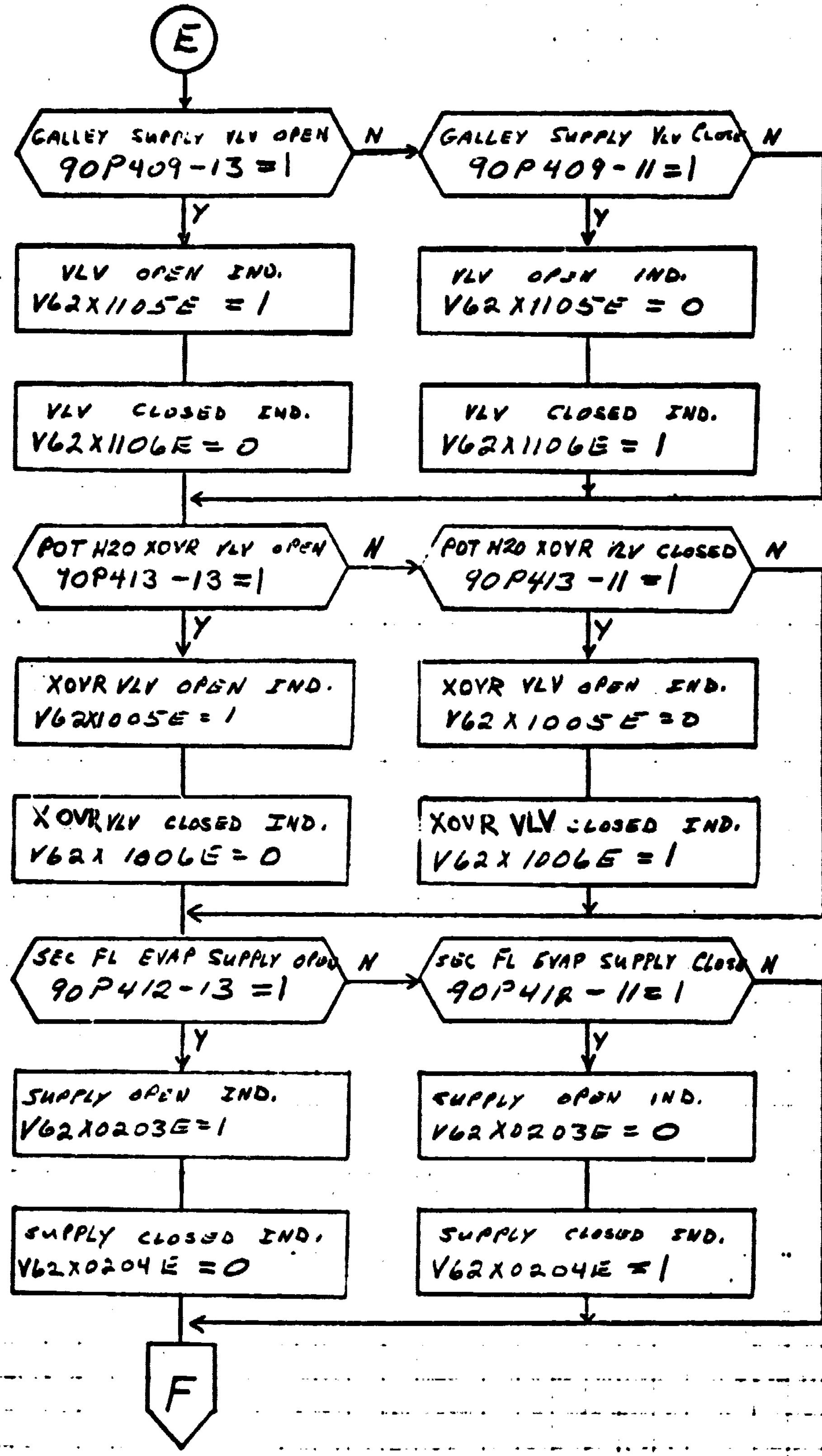


POTABLE H_2O TK C



POTABLE H_2O TK D





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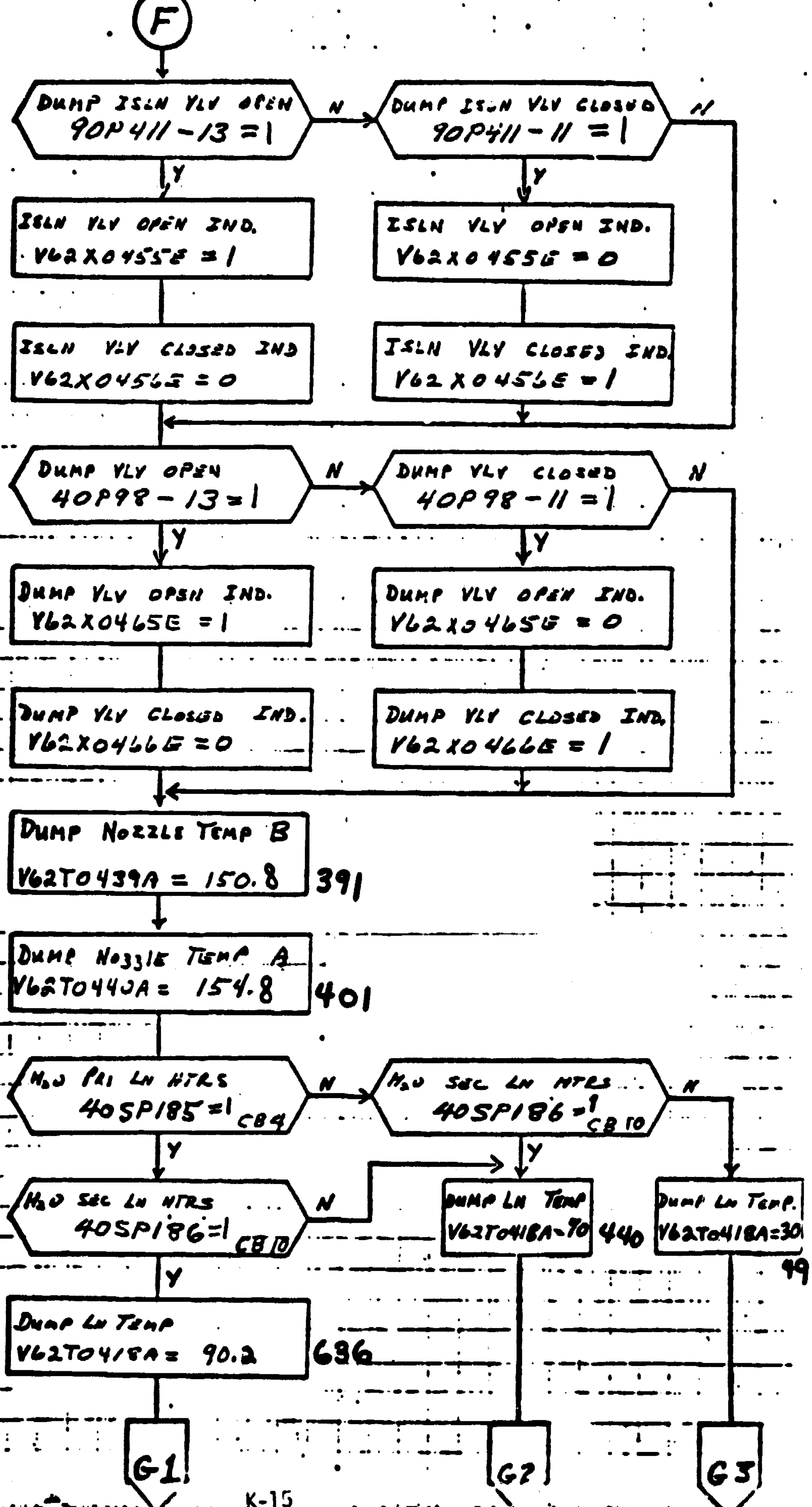
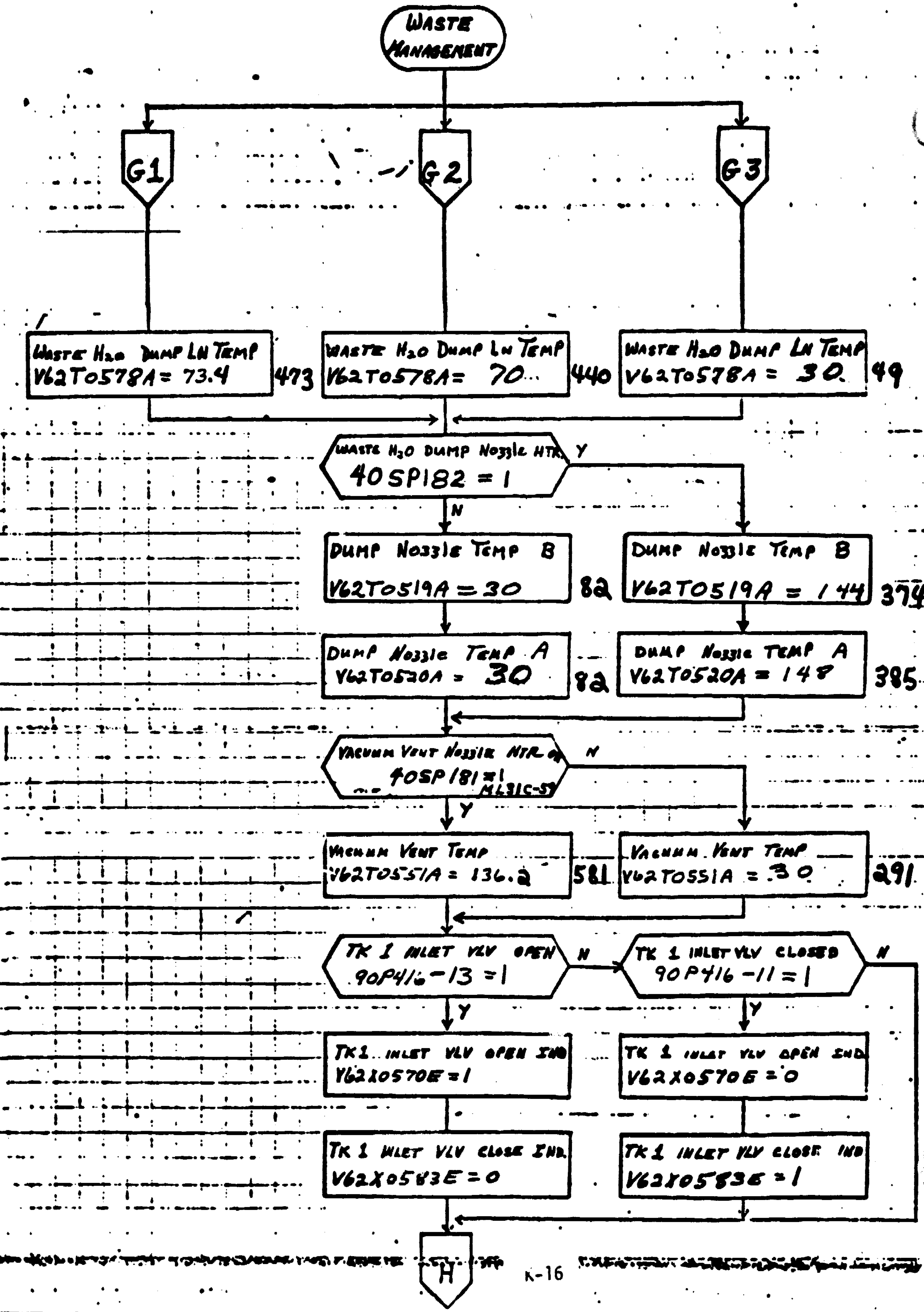
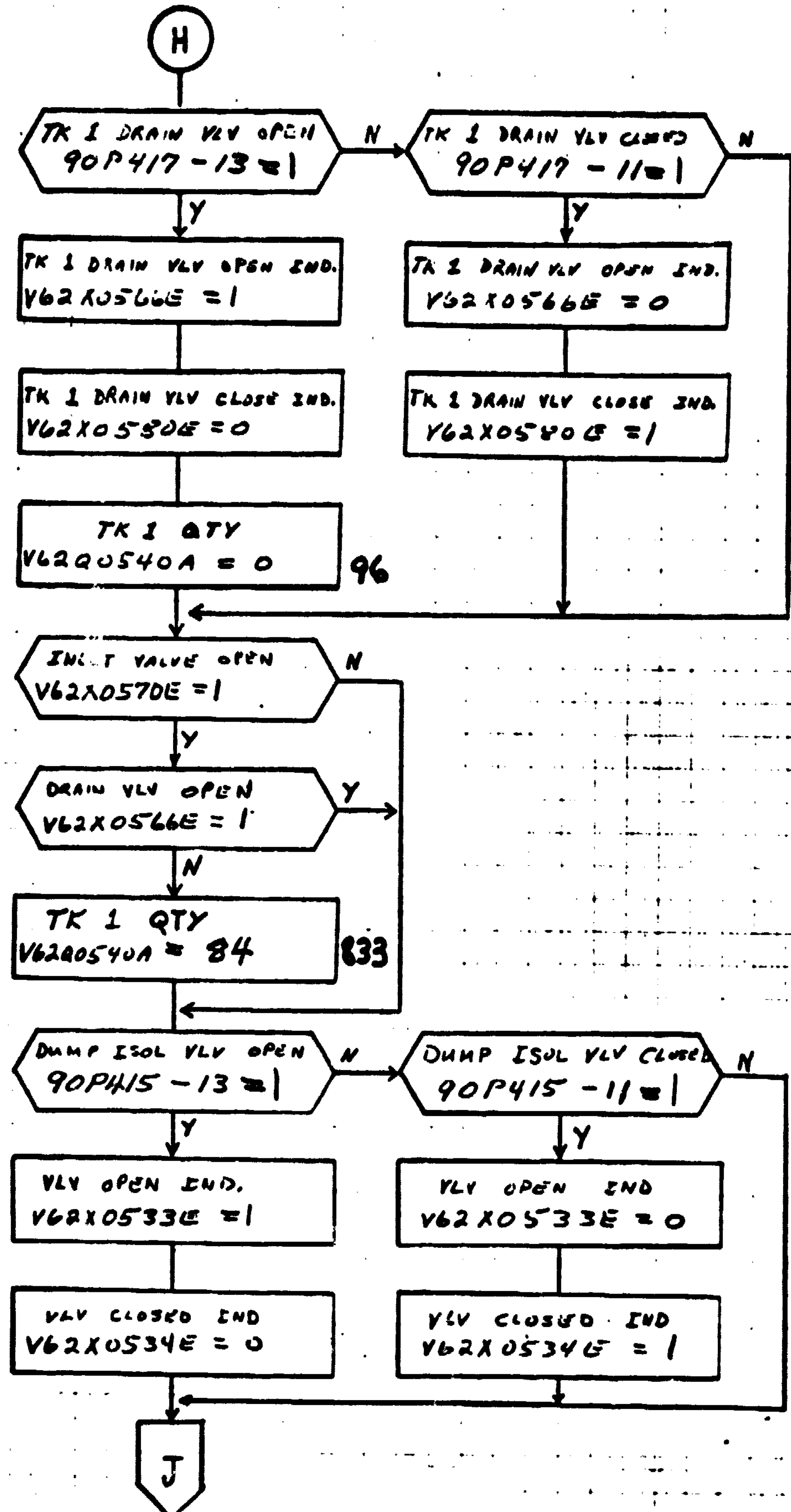
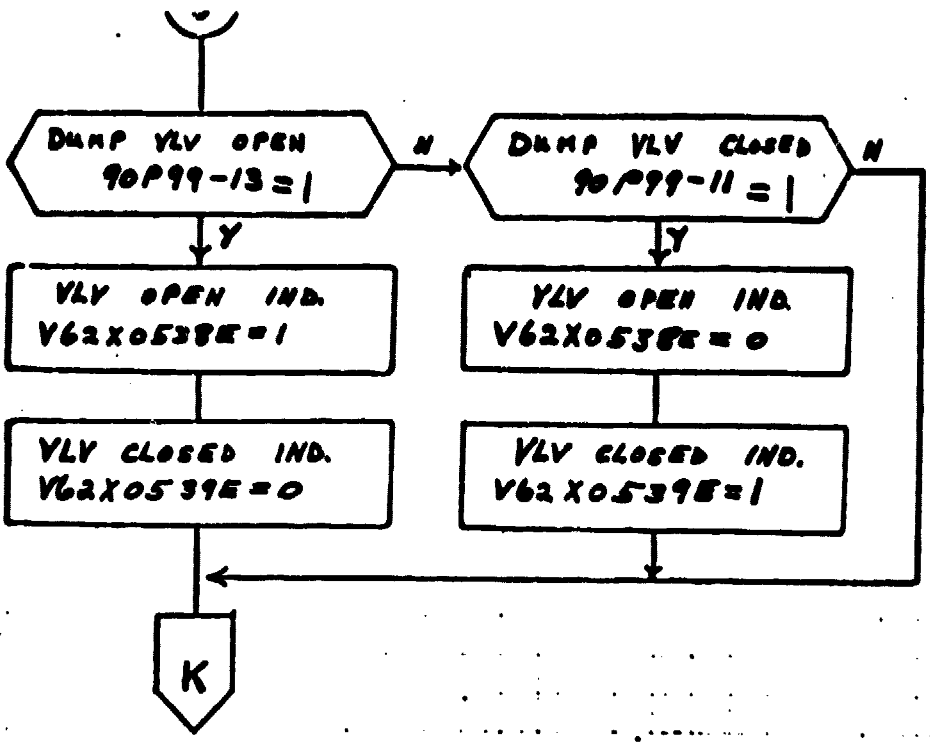
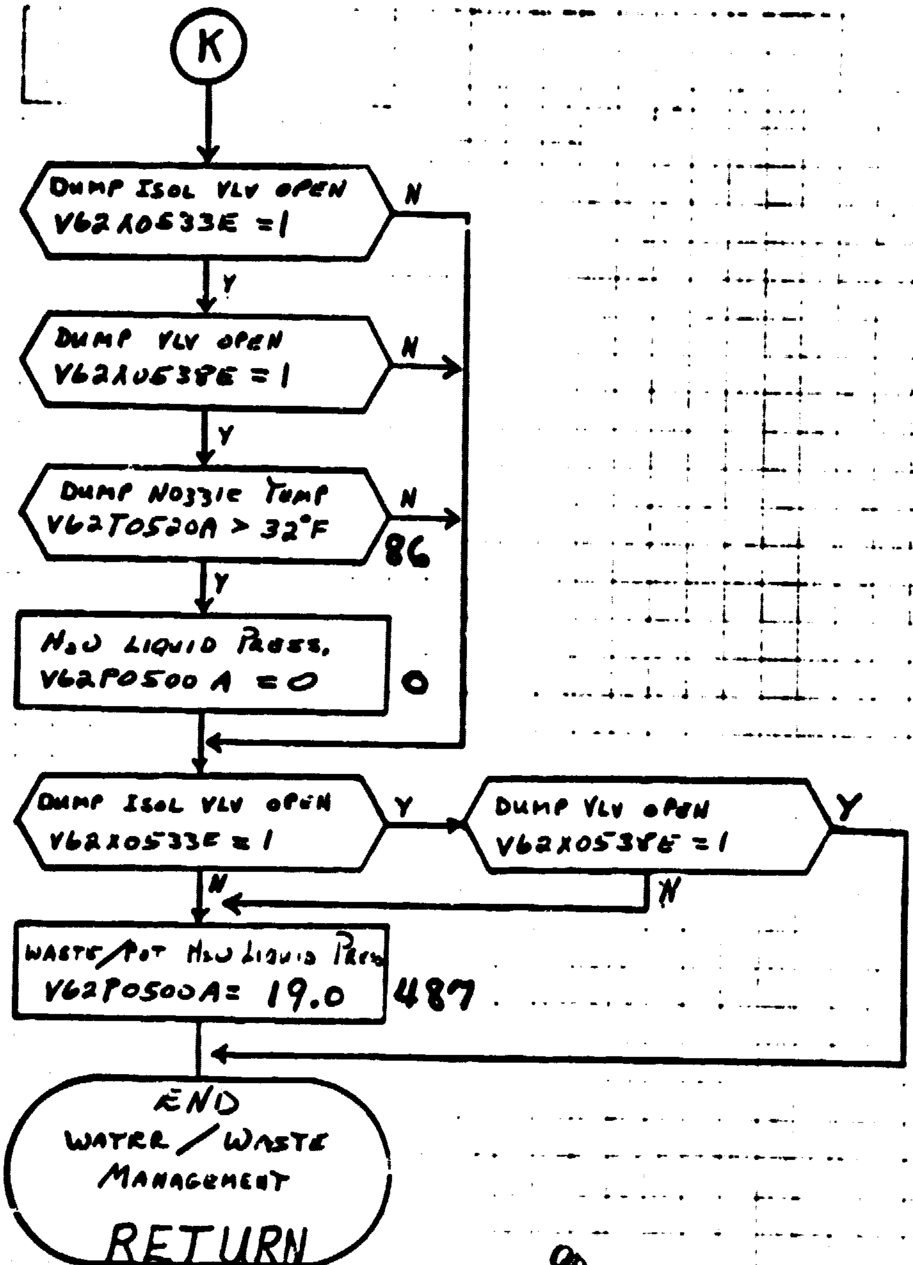

F
DUMP ISLN VLV OPEN
90P411-13=1
N
DUMP ISLN VLV CLOSED
90P411-11=1
N
Y
Y
ISLN VLV OPEN IND.
V62X0455E=1
ISLN VLV OPEN IND.
V62X0455E=0
ISLN VLV CLOSED IND
V62X0456E=0
ISLN VLV CLOSED IND
V62X0456E=1
DUMP VLV OPEN
40P98-13=1
N
DUMP VLV CLOSED
40P98-11=1
N
Y
Y
DUMP VLV OPEN IND.
V62X0465E=1
DUMP VLV OPEN IND.
V62X0465E=0
DUMP VLV CLOSED IND.
V62X0466E=0
DUMP VLV CLOSED IND.
V62X0466E=1
DUMP NOZZLE TEMP B
V62T0439A = 150.8
391
DUMP NOZZLE TEMP A
V62T0440A = 154.8
401
H2O PRI LN HTRS
40SP185=1 CB9
N
H2O SEC LN HTRS
40SP186=1 CB10
N
Y
Y
H2O SEC LN HTRS
40SP186=1 CB10
N
DUMP LN TEMP
V62T0418A=70
440
DUMP LN TEMP.
V62T0418A=30
49
Y
DUMP LN TEMP
V62T0418A= 90.2
686
G1
G2
G3


WASTE MANAGEMENT
G1
G2
G3
WASTE H2O DUMP LN TEMP V62T0578A = 73.4
473
WASTE H2O DUMP LN TEMP V62T0578A = 70
440
WASTE H2O DUMP LN TEMP V62T0578A = 30
49
WASTE H2O DUMP NOZZLE HTR 40SP182 = 1
Y
N
DUMP NOZZLE TEMP B V62T0519A = 30
82
DUMP NOZZLE TEMP B V62T0519A = 144
374
DUMP NOZZLE TEMP A V62T0520A = 30
82
DUMP NOZZLE TEMP A V62T0520A = 148
385
VACUUM VENT NOZZLE HTR 40SP181 = 1 ML31C-57
N
Y
VACUUM VENT TEMP V62T0551A = 136.2
581
VACUUM VENT TEMP V62T0551A = 30
291
TK 1 INLET VLV OPEN 90P416-13 = 1
N
Y
TK 1 INLET VLV CLOSED 90P416-11 = 1
N
Y
TK1 INLET VLV OPEN IND V62X0570E = 1
TK 1 INLET VLV OPEN IND V62X0570E = 0
TK 1 INLET VLV CLOSE IND. V62X0583E = 0
TK 1 INLET VLV CLOSE IND V62X0583E = 1
H


H
TK 1 DRAIN VLV OPEN
90P417 - 13 = 1
N
Y
TK 1 DRAIN VLV CLOSED
90P417 - 11 = 1
TK 1 DRAIN VLV OPEN IND.
V62X0566E = 1
TK 1 DRAIN VLV OPEN IND.
V62X0566E = 0
TK 1 DRAIN VLV CLOSE IND.
V62X0580E = 0
TK 1 DRAIN VLV CLOSE IND.
V62X0580E = 1
TK 1 QTY
V62Q0540A = 0
96
INLET VALVE OPEN
V62X0570E = 1
DRAIN VLV OPEN
V62X0566E = 1
TK 1 QTY
V62Q0540A = 84
833
DUMP ISOL VLV OPEN
90P415 - 13 = 1
DUMP ISOL VLV CLOSED
90P415 - 11 = 1
VLV OPEN IND.
V62X0533E = 1
VLV OPEN IND
V62X0533E = 0
VLV CLOSED IND
V62X0534E = 0
VLV CLOSED IND
V62X0534E = 1
J


DUMP VLV OPEN
90P99-13=1
N
Y
DUMP VLV CLOSED
90P99-11 = 1
N
Y
VLV OPEN IND.
V62X0538E=1
VLV OPEN IND.
V62X0538E = 0
VLV CLOSED IND.
V62X0539E=0
VLV CLOSED IND.
V62X0539E=1
K


K
DUMP ISOL VLV OPEN
V62X0533E = 1
N
Y
DUMP VLV OPEN
V62X0538E = 1
N
Y
DUMP NOZZLE TEMP
V62T0520A > 32°F
N
86
Y
H2O LIQUID PRESS.
V62P0500 A = 0
0
DUMP ISOL VLV OPEN
V62X0533E = 1
Y
DUMP VLV OPEN
V62X0538E = 1
Y
N
N
WASTE/POT H2O LIQUID PRESS
V62P0500A = 19.0
487
END
WATER / WASTE
MANAGEMENT
RETURN

4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

TABLE 1 - STIMULI : JI FOR W/WMS PAGE 1 OF 3

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R12A2/S3	POT H2O TK A INLET VLV OPEN	5	V62K0401E	K90P401-13	1-OPN/0-OFF
	POT H2O TK A INLET VLV CLOSE	5	V62K0402E	K90P401-11	1-CLS/0-OFF
R12A2/S4	POT H2O TK A OUTLET VLV OPEN	5	V62K0405E	K90P402-13	1-OPN/0-OFF
	POT H2O TK A OUTLET VLV CLOSE	5	V62K0406E	K90P402-11	1-CLS/0-OFF
R12A2/S9	POT H2O TK B INLET VLV OPEN	5	V62K0421E	K90P403-13	1-OPN/0-OFF
	POT H2O TK B INLET VLV CLOSE	5	V62K0422E	K90P403-11	1-CLS/0-OFF
R12A2/S10	POT H2O TK B OUTLET VLV OPEN	5	V62K0425E	K90P404-13	1-OPN/0-OFF
	POT H2O TK B OUTLET VLV CLOSE	5	V62K0426E	K90P404-11	1-CLS/0-OFF
R12A2/S14	POT H2O TK C INLET VLV OPEN	5	V62K0770E	K90P405-13	1-OPN/0-OFF
	POT H2O TK C INLET VLV CLOSE	5	V62K0771E	K90P405-11	1-CLS/0-OFF
R12A2/S15	POT H2O TK C OUTLET VLV OPEN	5	V62K0774E	K90P406-13	1-OPN/0-OFF
	POT H2O TK C OUTLET VLV CLOSE	5	V62K0775E	K90P406-11	1-CLS/0-OFF
ML31C/S2	WASTE TK 1 INLET VLV OPEN	5	V62K0710E	K90P416-13	1-OPN/0-OFF
	WASTE TK 1 INLET VLV CLOSE	5	V62K0711E	K90P416-11	1-CLS/0-OFF
ML31C/S1	WASTE TK 1 DRAIN VLV OPEN	5	V62K0715E	K90P417-13	1-OPN/0-OFF
	WASTE TK 1 DRAIN VLV CLOSE	5	V62K0714E	K90P417-11	1-CLS/0-OFF
ML31C/S6	WASTE TK 2 INLET VLV OPEN	5	V62K0750E	K90P408-13	1-OPN/0-OFF
	WASTE TK 2 INLET VLV CLOSE	5	V62K0751E	K90P408-11	1-CLS/0-OFF

TABLE 1 - STIMULI INPUT FOR [illegible] MS

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
ML31C/S7	WASTE TK 2 DRAIN VLV OPEN	5	V62K0755E	K90P407-13	1-OPN/0-OFF
	WASTE TK 2 DRAIN VLV CLOSE	5	V62K0754E	K90P407-11	1-CLS/0-OFF
R12A2/S16	SEC FLASH EVAP SUPPLY OPEN	5	V62K0200E	K90P412-13	1-OPN/0-OFF
	SEC FLASH EVAP SUPPLY CLOSE	5	V62K0201E	K90P412-11	1-CLS/0-OFF
R12A2/S6	POT H20 DUMP ISLN VLV OPEN	5	V62K0450E	K90P411-13	1-OPN/0-OFF
	POT H20 DUMP ISLN VLV CLOSE	5	V62K0452E	K90P411-11	1-CLS/0-OFF
R12A2/S7	POT H20 DUMP VLV OPEN	5	V62K0460E	K40P98-13	1-OPN/0-OFF
	POT H20 DUMP VLV CLOSE	5	V62K0462E	K40P98-11	1-CLS/0-OFF
ML31C/S3	WASTE H20 DUMP ISLN VLV OPEN	5	V62K0530E	K90P415-13	1-OPN/0-OFF
	WASTE H20 DUMP ISLN VLV CLOSE	5	V62K0531E	K90P415-11	1-CLS/0-OFF
ML31C/S4	WASTE H20 DUMP VLV OPEN	5	V62K0535E	K90P99-13	1-OPN/0-OFF
	WASTE H20 DUMP VLV CLOSE	5	V62K0536E	K90P99-11	1-CLS/0-OFF
ML31C/S8	WASTE H20 DUMP NOZZLE	5	V62K0541E	K40SP182	1-ON/0-OFF
ML31C/S9	VACUUM VENT HTR ON	5	V62K0549E	K40SP181	1-ON/0-OFF
R12A2/S5	POT H20 XOVR VLV OPEN	5	V62K1000E	K90P413-13	1-OPN/0-OFF
	POT H20 XOVR VLV CLOSE	5	V62K1002E	K90P413-11	1-CLS/0-OFF
R12A2/S11	GALLEY SUPPLY VLV OPEN	5	V62K1100E	K90P409-13	1-OPN/0-OFF
	GALLEY SUPPLY VLV CLOSE	5	V62K1102E	K90P409-11	1-CLS/0-OFF

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
ML86B/CB4	H20 LN HTRS - PRI	5,6		K40SP185	1-ON/0-OFF
ML86B/CB10	H20 LN HTRS - SEC	5,6		K40SP186	1-ON/0-OFF
	N2 REG PRESS	11	V61P2307A		0-20 PSIG

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM W/WMS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V62X0203E	SEC FLASH EVAP SUPPLY OPEN IND	0	0	1	1					STATE
V62X0204E	SEC FLASH EVAP SUPPLY CLOSE IND	1	1	0	0					STATE
V62X0403E	POT. H_2O TK A INLET VLV OPEN IND	0	0	1	1					STATE
V62X0404E	POT. H_2O TK A INLET VLV CLOSE IND	1	1	0	0					STATE
V62X0407E	POT. H_2O TK A OUTLET VLV OPEN IND	0	0	1	1					STATE
V62X0408E	POT. H_2O TK A OUTLET VLV CLOSE IND	1	1	0	0					STATE
V62Q0410A	POT. H_2O TK A QTY	91	894	30	360	99	964			PCT
V62T0418A	POT. H_2O DUMP LINE TEMP	90.2	636	30	49	70	440			DEGF
V62Q0420A	POT. H_2O TK B QTY	81	806	10	184	99	964			PCT
V62X0423E	POT. H_2O TK B INLET VLV OPEN IND	0	0	1	1					STATE
V62X0424E	POT. H_2O TK B INLET VLV CLOSE IND	1	1	0	0					STATE
V62X0427E	POT. H_2O TK B OUTLET VLV OPEN IND	0	0	1	1					STATE
V62X0429E	POT. H_2O TK B OUTLET VLV CLOSE IND	1	1	0	0					STATE
V62P0430A	POT. H_2O STORAGE INLET PRESS.	35	716							PSIA
V62T0439A	POT. H_2O DUMP NOZZLE TEMP. B.	150.8	391							DEGF
V62T0440A	POT. H_2O DUMP NOZZLE TEMP	154.8	401							DEGF
V62X0455E	POT. H_2O DUMP ISOL VLV OPEN IND	0	0	1	1					STATE
V62X0456E	POT. H_2O DUMP ISOL VLV CLOSE IND	1	1	0	0					STATE
V62X0465E	POT. H_2O DUMP VLV OPEN IND.	0	0	1	1					STATE
V62X0466E	POT. H_2O DUMP VLV CLOSE IND.	1	1	0	0					STATE
V62P0500A	WASTE/POT. H_2O LIQUID PRESS	19.0	487	0	0					PSIG
V62T0519A	WASTE H_2O DUMP NOZZLE TEMP. B.	144	374	30	82					DEGF
V62T0520A	WASTE H_2O DUMP NOZZLE TEMP.	148	385	30	82					DEGF

MEASUREMENT OUTPUT FROM W/WMS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V62X0533E	WASTE H_2O DUMP ISOL VLV OPEN IND	0	0	1	1					STATE
V62X0534E	WASTE H_2O DUMP ISOL VLV CLOSED IND	1	1	0	0					STATE
V62X0538E	WASTE H_2O DUMP VLV OPEN IND	0	0	1	1					STATE
V62X0539E	WASTE H_2O DUMP VLV CLOSED IND	1	1	0	0					STATE
V62Q0540A	WASTE H_2O TK 1 QTY	84	833	0	96					PCT
V62Q0544A	POT. TK D OR WASTE TK 2 QTY.	83	822	10	184	99	964			PCT
V62Q0548A	POT. H_2O TK C QTY	82	814	50	534	85	841			PCT
V62T0551A	VACUUM VENT TEMP	136.2	581	30	291					DEGF
V62X0566E	WASTE H_2O TK 1 DRAIN OPEN IND	0	0	1	1					STATE
V62X0567E	POT. TK D OR WASTE TK 2 OUT. VLV OPEN IND	0	0	1	1					STATE
V62X0568E	POT. H_2O TK C OUTLET VLV OPEN IND	0	0	1	1					STATE
V62X0570E	WASTE TK 1 INLET VLV OPEN IND	0	0	1	1					STATE
V62X0571E	POT. TK D OR WASTE TK 2 INLET VLV OPEN IND	0	0	1	1					STATE
V62X0572E	POT H_2O TK C INLET VLV OPEN IND	0	0	1	1					STATE
V62T0578A	WASTE H_2O DUMP LINE TEMP	73.4	473	30	49	70	440			DEGF
V62X0580E	WASTE TK 1 DRAIN VLV CLOSE IND	1	1	0	0					STATE
V62X0581E	WASTE H_2O TK 2 OUTLET VLV CLOSE IND	1	1	0	0					STATE
V62X0582E	POT. H_2O TK C OUTLET VLV CLOSE IND	1	1	0	0					STATE
V62X0583E	WASTE TK 1 INLET VLV CLOSE IND	1	1	0	0					STATE
V62X0584E	POT. TK D OR WASTE TK 2 INLET VLV CLOSE IND	1	1	0	0					STATE

MEASUREMENT OUTPUT FROM W/WMS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V62X0585E	POT. H_2O TK C INLET VLV CLOSE IND	1	1	0	0					STATE
V62X1005E	POT. H_2O XOVR VLV OPEN IND	0	0	1	1					STATE
V62X1006E	POT. H_2O XOVR VLV CLOSE IND	1	1	0	0					STATE
V62X1105E	POT. H_2O GALLEY SUPPLY VLV OPEN IND	0	0	1	1					STATE
V62X1106E	POT. H_2O GALLEY SUPPLY VLV CLOSE IND	1	1	0	0					STATE
V62Q9150A	POT. H_2O TANK E QTY	85	841							PERCENT
V62Q9160A	POT. H_2O TANK F QTY	86	849							PERCENT

APPENDIX L
RCS/OMS MATH MODEL REQUIREMENTS

CONTENTS

1. INTRODUCTION

The RCS/OMS model is a Rockwell application requirement. This model outputs those DFI parameters not found in the RCS/OMS simulator (ROS) avionics model. The model receives input from one source, the test operator. The model provides output parameter values to the flight system. Table 2 lists the output measurements.

2. DETAILED REQUIREMENTS

2.1 MATH MODEL DESCRIPTION

This RCS/OMS model is a special case function to provide the Developmental Flight Instrumentation (DFI) measurements found in table 1 to the flight system. These instrumentation measurements could not be output by the RCS/OMS Vehicle Dynamics model because of the absense of a hardware interface.

This model, therefore, does none of the RCS/OMS logic functions. It merely outputs the aforementioned measurements as static values.

2.2 STS UNIQUE REQUIREMENTS

NONE

2.3 GTS UNIQUE REQUIREMENTS

NONE

3. MATH MODEL LOGIC

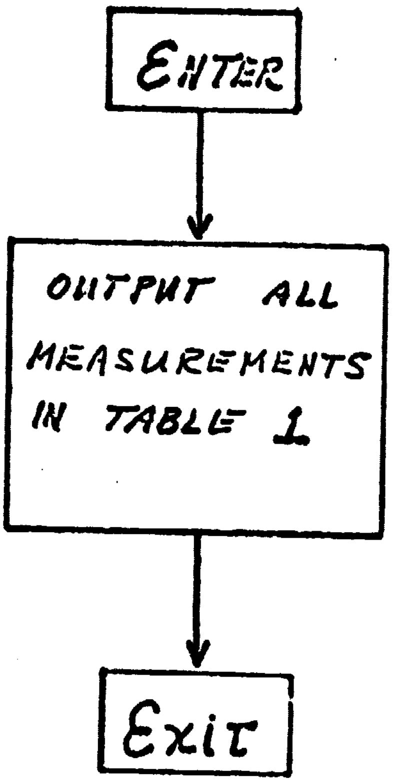
This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

NONE

3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors.



RCS/OMS
FLOW DIAGRAM

4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

TABLE 1 - STIMULI INPUT FOR RCS/OMS

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SOURCE		STATE
				MDM	CONN-PIN	
	NONE					

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM RCS/OMS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
	- RCS -									
V42T2305A	RCS-L AFT HSG THERM SW TEMP 2	104.0	732							DEGF
V42T3305A	RCS-R AFT HSG THERM SW TEMP 2	105.0	737							DEGF
V42T9044A	FRCS FU TK FILL MANIF LOC 2 THERMO	98.22	630							DEGF
V42T9045A	FRCS OX TK FILL MANIF LOC 2 THERMO	99.2	636							DEGF
V42T9432A	RCS-L OX/HE TEST PORT LN. TEMP	106.23	681							DEGF
V42T9442A	RCS-L OX TK OTBD UPR SKIN TEMP	45.41	293							DEGF
V42T9449A	RCS-L OX VLV TEMP Y WEB OTBD	108.15	694							DEGF
V42T9561A	RCS-R OX/HE TEST PORT LN. TEMP	107.2	687							DEGF
	- OMS -									
V43T4700A	OMS-L POD RCS PRESS PNL SUPT TEMP 1	58.21	374							DEGF
V43T4706A	OMS-L POD GSE SERVICE PNL TEMP	78.2	323							DEGF
V43T4707A	OMS-L POD ENG SERVICE PNL TEMP	74.22	477							DEGF
V43T4710A	OMS-L POD RCS PRESS PNL SUPT TEMP 2	60.2	552							DEGF
V43T4711A	OMS-L POD RCS HSG VERNIER CMPT TEMP 2	111.2	458							DEGF
V43T4718A	OMS-L POD OX/HE TEST PORT FTG TEMP 2	82.1	642							DEGF
V43T5710A	OMS-R POD RCS PRESS PNL SUPT TEMP 2	61.2	557							DEGF
V43T5711A	OMS-R POD RCS HSG VERNIER CMPT TEMP 2	112.2	462							DEGF
V43T5718A	OMS-R POD OX/HE TEST PORT FTG TEMP 2	83.1	647							DEGF
V43T6234A	OMS BHD FU HI PT BLEED LN TEMP	94.0	692							DEGF
V43T6235A	OMS BHD OX HI PT BLEED LN TEMP	95.0	696							DEGF
V43T6236A	OMS-AFT FUSLG LO PT OX DRN LN TEMP-L	90.22	579							DEGF
V43T6237A	OMS-AFT FUSLG LO PT OX DRN LN TEMP-R	91.18	585							DEGF

MEASUREMENT OUTPUT FROM RCS/OMS MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V43T6238A	OMS-AFT FU HI PT BLEED LN TEMP	92.0	683							DEGF
V43T6239A	OMS-AFT OX HI PT BLEED LN TEMP	93.0	687							DEGF
V43T6240A	OMS-AFT FULSG XFD FU FLX LN-L TEMP	88.30	567							DEGF
V43T6241A	OMS-AFT FULSG XFD FU FLX LN-R TEMP	89.26	573							DEGF
V43T6242A	OMS-AFT FUSLG OX LN CTR TEMP	87.34	561							DEGF
V43T6243A	OMS-AFT FUSLG OX XFD LINE L TEMP	85.42	548							DEGF
V43T6244A	OMS-AFT FUSLG OX XFD LINE R TEMP	86.38	554							DEGF
V43T9002A	OMS-L POD OX ISLN VLV TEMP	50.21	323							DEGF
V43T9290A	OMS-R XFD/POD OX COUPLING TEMP	56.29	362							DEGF
V43T9459A	OMS-L ENG COVER THERMOSTAT TEMP	72.29	464							DEGF
V43T9464A	OMS-L FU/HE TEST PORT LN. TEMP	84	651							DEGF
V43T9467A	OMS-L OXIDIZER DRAIN LN. TEMP	66	577							DEGF
V43T9470A	OMS-L OX FLG TEMP POD/ORBR INTFC	55.33	356							DEGF
V43T9471A	OMS-L FU FLG TEMP POD/ORBR INTFC	57.25	368							DEGF
V43T9551A	OMS-R OXIDIZER DRAIN LN. TEMP.	67	581							DEGF
V43T9553A	OMS-R ENG COVER THERMOSTAT TEMP.	73.26	471							DEGF

APPENDIX M

SWITCH MATH MODEL REQUIREMENTS

CONTENTS

1. INTRODUCTION

The GN&C Test Station (GTS) uses math models to simulate many of the Shuttle systems for which hardware has not been provided. A group of these models are termed "non-avionic" models since they do not simulate the Shuttle's "avionic" systems. The "non-avionic" models are needed to supply data for on-board software processing and to respond to Shuttle commands, whether they be from cockpit switches, the General Purpose Computers (GPC's) or the Non-Avionic Simulator (NAS) console.

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in table 1 to produce values for the output measurements listed in table 2 that simulate the operation of the Vent Doors.

2.1 MATH MODEL DESCRIPTION

This model simulates those functions of the vent doors in the Orbiter, namely: OPEN, CLOSE, and PURGE. The vent doors permit equalization of pressures between the ambient and the unpressurized areas within the Orbiter during ascent and descent. The PURGE function expels toxic or explosive gas mixtures that may accumulate within the unpressurized areas.

2.2 STS UNIQUE REQUIREMENTS

This model is not required for STS.

2.3 GTS UNIQUE REQUIREMENTS

This model is required for GTS only.

3. MATH MODEL LOGIC

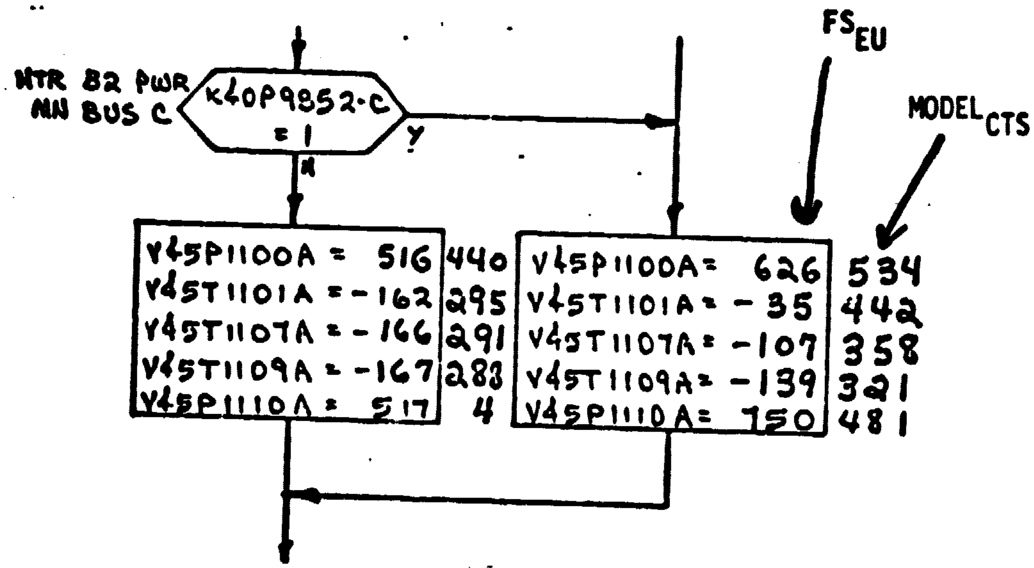
This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

NONE

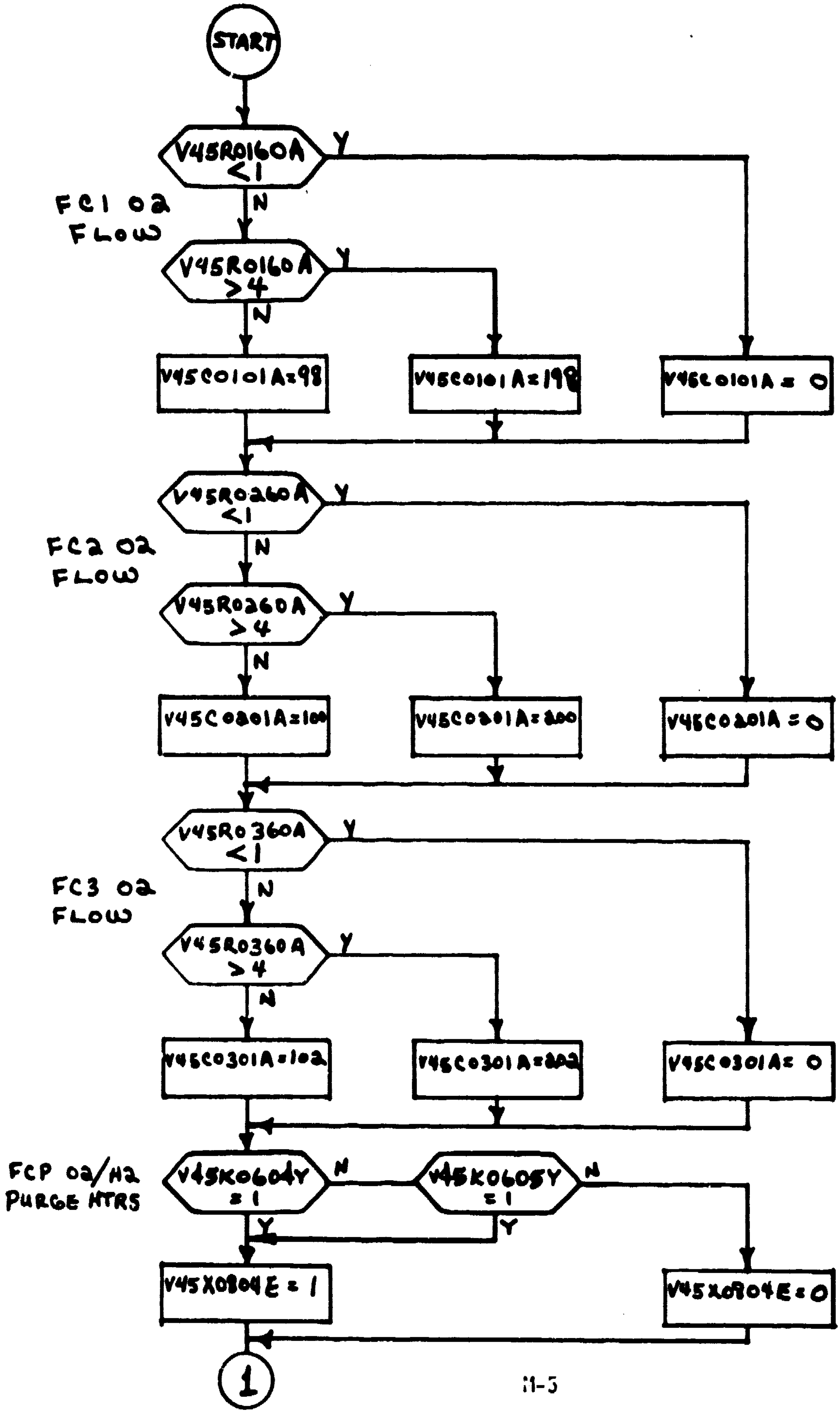
3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors. Notice that where analog measurements are listed in boxes and decisions, the value inside the box is in flight system engineering units (FS_{EU}) while the corresponding model count value is listed outside the box. For example, the box on the right hand below;

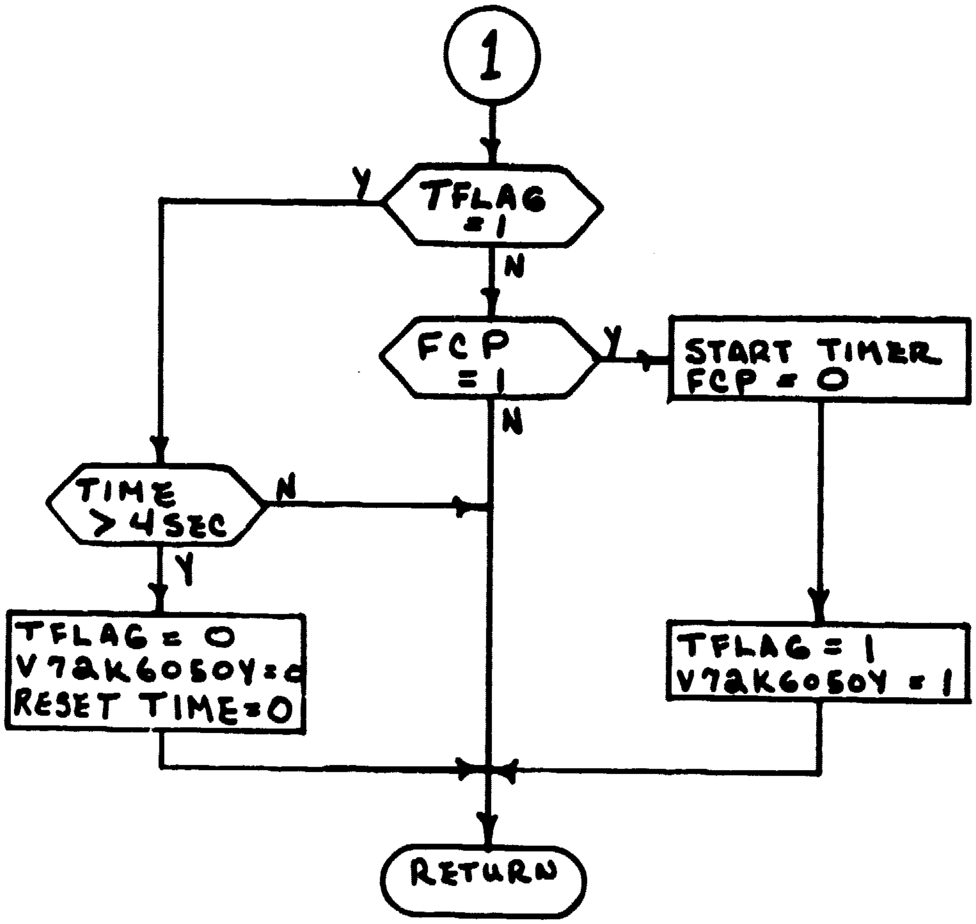


shows that V45P1100A is set equal to 626 FS_{EU} which is equivalent to 534 $MODEL_{CTS}$ shown outside the box.

SWITCH MODEL



SWITCH MODEL
(CONTINUED)



4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

4.1.2 PSEUDO VARIABLE INITIALIZATION

The following pseudos are initialized as follows:

VARIABLE	INITIAL CONDITION
FCP	0
T_{FLAG}	0

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SYSTEM CONN-PIN	STATE
R12/S1	FC GPC PURGE SEQ START	7		FCP	1-ON/0-OFF
R12/S2	FCP O2/H2 PURGE HTRS GPC-A ON	2	V45K0604Y	(PF02)J07-072	1-ON/0-OFF
	FCP O2/H2 PURGE HTRS GPC-B ON		V45K0605Y	(PF02)J07-082	1-ON/0-OFF
(NONE)	FC1 O2 FLOW	11	V45R0160A		0-15 PPH
	FC2 O2 FLOW		V45R0260A		0-15 PPH
	FC3 O2 FLOW		V45R0360A		0-15 PPH

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM SWITCH MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V72K6050Y	FC GPC PURGE SEQ START	0		1						STATE
V45X0804E	FC AUTO PURGE-ON	0		1						STATE
V45C0101A	FC 1 CURRENT	0		98		198				AMPS-DC
V45C0201A	FC 2 CURRENT	0		100		200				AMPS-DC
V45C0301A	FC 3 CURRENT	0		102		202				AMPS-DC

The following table contains switch scan measurements which are to be output.

MML NO.	NOMENCLATURE	I.C.
V42S1151E	RCS-FWD HE PRESS VLV-A OP B	0
V42S1154E	RCS-FWD HE PRESS VLV-A CL A	0
V42S1153E	RCS-FWD HE PRESS VLV-B OP B	0
V42S1156E	RCS-FWD HE PRESS VLV-B CL A	0
V42S1344E	RCS-FWD TANK ISLN VLV-1/2 OP A	0
V42S1352E	RCS-FWD TANK ISLN VLV-1/2 CL A	0
V42S1348E	RCS-FWD TANK ISLN VLV-3/4/5 OP A	0
V42S1357E	RCS-FWD TANK ISLN VLV-3/4/5 CL A	0
V42S1362E	RCS-FWD MANF ISLN VLV-1 OP	0
V42S1372E	RCS-FWD MANF ISLN VLV-1 CL	0
V42S1364E	RCS-FWD MANF ISLN VLV-2 OP	0
V42S1374E	RCS-FWD MANF ISLN VLV-2 CL	0
V42S1366E	RCS-FWD MANF ISLN VLV-3 OP	0
V42S1376E	RCS-FWD MANF ISLN VLV-3 CL	0
V42S1368E	RCS-FWD MANF ISLN VLV-4 OP	0
V42S1378E	RCS-FWD MANF ISLN VLV-4 CL	0
V42S1371E	RCS-FWD MANF ISLN VLV-5 OP B	0
V42S1380E	RCS-FWD MANF ISLN VLV-5 CL A	0
V42S1580E	RCS-FWD THRSTR HEAT-1 AUTO	1
V42S1584E	RCS-FWD THRSTR HEAT-2 AUTO	1
V42S1588E	RCS-FWD THRSTR HEAT-3 AUTO	1
V42S1592E	RCS-FWD THRSTR HEAT-4 AUTO	1
V42S1596E	RCS-FWD THRUSTER HEAT-5 AUTO	1
V42S1910E	RCS-FWD MODULE HEAT-1 AUTO	1
V42S1912E	RCS-FWD MODULE HEAT-1A AUTO	0
V42S2151E	RCS-L AFT HE PRESS VLV-A OP B	0
V42S2154E	RCS-L AFT HE PRESS VLV-A CL A	0
V42S2153E	RCS-L AFT HE PRESS VLV-B OP B	0
V42S2156E	RCS-L AFT HE PRESS VLV-B CL A	0
V42S2340E	RCS-L AFT TANK ISLN VLV-1/2 OP A	0
V42S2351E	RCS-L AFT TANK ISLN VLV-1/2 CL A	0
V42S2345E	RCS-L AFT TANK ISLN V-3/4/5 A OP	0
V42S2356E	RCS-L AFT TANK ISLN VLV-3/4/5 A CL	0

MML NO.	NOMENCLATURE	I.C.
V42S2348E	RCS-L AFT TANK ISLN VLV-3/4/5 B OP	0
V42S2359E	RCS-L AFT TANK ISLN VLV-3/4/5 B CL	0
V42S2362E	RCS-L AFT MANF ISLN VLV-1 OP	0
V42S2372E	RCS-L AFT MANF ISLN VLV-1 CL	0
V42S2364E	RCS-L AFT MANF ISLN VLV-2 OP	0
V42S2374E	RCS-L AFT MANF ISLN VLV-2 CL	0
V42S2366E	RCS-L AFT MANF ISLN VLV-3 OP	0
V42S2376E	RCS-L AFT MANF ISLN VLV-3 CL	0
V42S2368E	RCS-L AFT MANF ISLN VLV-4 OP	0
V42S2378E	RCS-L AFT MANF ISLN VLV-4 CL	0
V42S2371E	RCS-L AFT MANF ISLN VLV-5 OP B	0
V42S2380E	RCS-L AFT MANF ISLN VLV-5 CL A	0
V42S2400E	RCS-L AFT XFD VLV-1/2 OP A	0
V42S2412E	RCS-L AFT XFD VLV-1/2 CL A	0
V42S2406E	RCS-L AFT XFD VLV-3/4/5 OP A	0
V42S2424E	RCS-L AFT XFD VLV-3/4/5 CL A	0
V42S3151E	RCS-R AFT HE PRESS VLV-A OP B	0
V42S3154E	RCS-R AFT HE PRESS VLV-A CL A	0
V42S3153E	RCS-R AFT HE PRESS VLV-B OP B	0
V42S3156E	RCS-R AFT HE PRESS VLV-B CL A	0
V42S3340E	RCS-R AFT TANK ISLN VLV-1/2 OP A	0
V42S3351E	RCS-R AFT TANK ISLN VLV-1/2 CL A	0
V42S3345E	RCS-R AFT TANK ISLN V-3/4/5 A OP	0
V42S3356E	RCS-R AFT TANK ISLN VLV-3/4/5 A CL	0
V42S3348E	RCS-R AFT TANK ISLN VLV-3/4/5 B OP	0
V42S3359E	RCS-R AFT TANK ISLN VLV-3/4/5 B CL	0
V42S3362E	RCS-R AFT MANF ISLN VLV-1 OP	0
V42S3372E	RCS-R AFT MANF ISLN VLV-1 CL	0
V42S3364E	RCS-R AFT MANF ISLN VLV-2 OP	0
V42S3374E	RCS-R AFT MANF ISLN VLV-2 CL	0
V42S3366E	RCS-R AFT MANF ISLN VLV-3 OP	0
V42S3376E	RCS-R AFT MANF ISLN VLV-3 CL	0
V42S3368E	RCS-R AFT MANF ISLN VLV-4 OP	0

MML NO.	NOMENCLATURE	I.C.
V42S3378E	RCS-R AFT MANF ISLN VLV-4 CL	0
V42S3371E	RCS-R AFT MANF ISLN VLV-5 OP B	0
V42S3380E	RCS-R AFT MANF ISLN VLV-5 CL A	0
V42S3400E	RCS-R AFT XFD VLV-1/2 OP A	0
V42S3412E	RCS-R AFT XFD VLV-1/2 CL A	0
V42S3406E	RCS-R AFT XFD VLV-3/4/5 OP A	0
V42S3424E	RCS-R AFT XFD VLV-3/4/5 CL A	0
V42S4580E	RCS-R/L AFT THRSTR HEAT-1 AUTO	1
V42S4584E	RCS-R/L AFT THRSTR HEAT-2 AUTO	1
V42S4588E	RCS-R/L AFT THRSTR HEAT-3 AUTO	1
V42S4592E	RCS-R/L AFT THRSTR HEAT-4 AUTO	1
V42S4596E	RCS-R/L AFT THRSTR HEAT-5 AUTO	1
V43S4184E	OMS-L POD HE ISLN VLV A CL	1
V43S4186E	OMS-L POD HE A AND VAP ISO VLVS OP	0
V43S4185E	OMS-L POD HE ISLN VLV B CL	1
V43S4187E	OMS-L POD HE B AND VAP ISO VLVS OP	0
V43S4470E	OMS-L POD TANK ISLN VLV A CMD 1 OP	1
V43S4471E	OMS-L POD TANK ISLN VLV A CMD 1 CL	0
V43S4474E	OMS-L POD TANK ISLN VLV B CMD 1 OP	1
V43S4475E	OMS-L POD TANK ISLN VLV B CMD 1 CL	0
V43S4482E	OMS-L POD XFD VLV A CMD 1 OP	0
V43S4483E	OMS-L POD XFD VLV A CMD 1 CL	1
V43S4486E	OMS-L POD XFD VLV B CMD 1 OP	0
V43S4487E	OMS-L POD XFD VLV B CMD 1 CL	1
V43S4575E	OMS-L ENG VLVS PWR ENABLE COILS 1	1
V43S5184E	OMS-R POD HE ISLN VLV A CL	1
V43S5186E	OMS-R POD HE A AND VAP ISO VLVS OP	0
V43S5185E	OMS-R POD HE ISLN VLV B CL	1
V43S5187E	OMS-R POD HE B AND VAP ISO VLVS OP	0
V43S5470E	OMS-R POD TANK ISLN VLV A CMD 1 OP	1
V43S5471E	OMS-R POD TANK ISLN VLV A CMD 1 CL	0
V43S5474E	OMS-R POD TANK ISLN VLV B CMD 1 OP	1
V43S5475E	OMS-R POD TANK ISLN VLV B CMD 1 CL	0

MML NO.	NOMENCLATURE	I.C.
V43S5482E	OMS-R POD XFD VLV A CMD 1 OP	0
V43S5483E	OMS-R POD XFD VLV A CMD 1 CL	1
V43S5486E	OMS-R POD XFD VLV B CMD 1 OP	0
V43S5487E	OMS-R POD XFD VLV B CMD 1 CL	1
V43S5575E	OMS-R ENG VLVS PWR ENABLE COILS 1	1
V43S7410E	OMS-L POD HTR A1 ON	1
V43S7414E	OMS-L POD HTR B1 ON	1
V43S7510E	OMS-R POD HTR A1 ON	1
V43S7514E	OMS-R POD HTR B1 ON	1
V43S7710E	OMS-XFD LINES HTR A ON	1
V43S7712E	OMS-XFD LINES HTR B ON	0
V45S0191E	FCP NO 1 STARTUP HEATER - INHIBIT	0
V45S0291E	FCP NO 2 STARTUP HEATER - INHIBIT	0
V45S0391E	FCP NO 3 STARTUP HEATER - INHIBIT	0
V45S0441E	FCP H20 LINE HTRS A-ON	1
V45S0442E	FCP H20 LINE HTRS B-ON	0
V45S0445E	FCP H20 RELIEF HTRS A-ON	1
V45S0446E	FCP H20 RELIEF HTRS B-ON	0
V45S0601E	FCP 02/H2 PURGE HTRS MNL A	0
V45S0604E	FCP 02/H2 PURGE HTRS GPC-A ON	1
V45S0811E	FCP 1 PURGE VLVS MNL OPEN-A	0
V45S0815E	FCP 1 PURGE VLVS GPC-A OPEN	1
V45S0821E	FCP 2 PURGE VLVS MNL OPEN-A	0
V45S0825E	FCP 2 PURGE VLVS GPC-A OPEN	1
V45S0831E	FCP 3 PURGE VLVS MNL OPEN-A	0
V45S0835E	FCP 3 PURGE VLVS GPC-A OPEN	1
V45X1080E	PRSD 02 ECS PRIM SUP VLV-OPEN	1
V45X1083E	PRSD 02 ECS SEC SUP VLV-OPEN	0
V45S1131E	PRSD 02 TK 1 HTR A-ON A/B	0
V45S1133E	PRSD 02 TK 1 HTR A-AUTO A/B	1
V45S1136E	PRSD 02 TK 1 HTR B-ON A/B	0
V45S1138E	PRSD 02 TK 1 HTR B-AUTO A/B	1
V45S1231E	PRSD 02 TK 2 HTR A-ON A/B	0

MML NO.	NOMENCLATURE	I.C.
V45S1233E	PRSD 02 TK 2 HTR A-AUTO A/B	1
V45S1236E	PRSD 02 TK 2 HTR B-ON A/B	0
V45S1238E	PRSD 02 TK 2 HTR B-AUTO A/B	1
V45S1331E	PRSD 02 TK 3 HTR A-ON A/B (MBK)	0
V45S1333E	PRSD 02 TK 3 HTR A-AUTO A/B (MBK)	1
V45S1336E	PRSD 02 TK 3 HTR B-ON A/B (MBK)	0
V45S1338E	PRSD 02 TK 3 HTR B-AUTO A/B (MBK)	1
V45S2131E	PRSD H2 TK 1 HTR A-ON A/B	0
V45S2133E	PRSD H2 TK 1 HTR A-AUTO A/B	1
V45S2136E	PRSD H2 TK 1 HTR B-ON A/B	0
V45S2138E	PRSD H2 TK 1 HTR B-AUTO A/B	1
V45S2231E	PRSD H2 TK 2 HTR A-ON A/B	0
V45S2233E	PRSD H2 TK 2 HTR A-AUTO A/B	1
V45S2236E	PRSD H2 TK 2 HTR B-ON A/B	0
V45S2338E	PRSD H2 TK 2 HTR B-AUTO A/B	1
V45S2331E	PRSD H2 TK 3 HTR A-ON A/B (MBK)	0
V45S2333E	PRSD H2 TK 3 HTR A-AUTO A/B (MBK)	1
V45S2336E	PRSD H2 TK 3 HTR B-ON A/B (MBK)	0
V45S2338E	PRSD H2 TK 3 HTR B-AUTO A/B (MBK)	1
V46S0099E	APU AUTO SHUTDOWN INHIBIT CMD-C	0
V46S0106E	APU 1 TANK AND LINE HTRS-A AUTO 2	1
V46S0109E	APU 1 TANK AND LINE HTRS-B AUTO 1	0
V46S0114E	APU 1 FUEL ISLN VLV B OPEN CMD	0
V46S0116E	APU 1 LUBE OIL LINE HTR - A AUTO 1	1
V46S0117E	APU 1 LUBE OIL LINE HTR-B AUTO 1	0

MML NO.	NOMENCLATURE	I.C.
V46S0118E	APU 1 GAS GEN/FU PUMP HTR-A AUTO 1	1
V46S0119E	APU 1 GAS GEN/FU PUMP HTR-B AUTO 1	0
V46S0124E	APU NO 1 CONTROLLER POWER ON CMD-A	0
V46S0126E	APU 1 START/RUN CMD-A	0
V46S0127E	APU 1 START OVERRIDE/RUN CMD-A	0
V46S0129E	APU NO 1 SPEED SELECT-HIGH CMD-A	0
V46S0206E	APU 2 TANK AND LINE HTRS-A AUTO 2	1
V46S0209E	APU 2 TANK AND LINE HTRS-B AUTO 1	0
V46S0214E	APU 2 FUEL ISLN VLV B OPEN CMD	0
V46S0216E	APU 2 LUBE OIL LINE HTR-A AUTO 1	1
V46S0217E	APU 2 LUBE OIL LINE HTR-B AUTO 1	0
V46S0218E	APU 2 GAS GEN/FU PUMP HTR-A AUTO 1	1
V46S0219E	APU 2 GAS GEN/FU PUMP HTR-B AUTO 1	0
V46S0224E	APU NO 2 CONTROLLER POWER ON CMD-A	0
V46S0226E	APU 2 START/RUN CMD-A	0
V46S0227E	APU 2 START OVERRIDE/RUN CMD-A	0
V46S0229E	APU NO 2 SPEED SELECT HIGH CMD-A	0
V46S0306E	APU 3 TANK AND LINE HTRS-A AUTO 2	1
V46S0309E	APU 3 TANK AND LINE HTRS-B AUTO 1	0
V46S0314E	APU 3 FUEL ISLN VLV B OPEN CMD	0
V46S0316E	APU 3 LUBE OIL LINE HTR-A AUTO 1	1
V46S0317E	APU 3 LUBE OIL LINE HTR-B AUTO 1	0
V46S0318E	APU 3 GAS GEN/FU PUMP HTR-A AUTO 1	1
V46S0319E	APU 3 GAS GEN/FU PUMP HTR-B AUTO 1	0
V46S0324E	APU NO 3 CONTROLLER POWER ON CMD-A	0
V46S0326E	APU 3 START/RUN CMD-A	0
V46S0327E	APU 3 START OVERRIDE/RUN CMD-A	0
V46S0329E	APU NO 3 SPEED SELECT HIGH-A	0
V57S0010E	RUDDER/SPEEDBRAKE PDU HEATER-ON A	1
V57S0011E	RUDDER/SPEEDBRAKE PDU HEATER-ON B	1
V57S0015E	BODY FLAP PDU HEATER-ON A	1
V57S0016E	BODY FLAP PDU HEATER-ON B	1
V58S0060E	LANDING GEAR BRAKE A HEATERS AUTO	0

MML NO.	NOMENCLATURE	I.C.
V58S0061E	LANDING GEAR BRAKE B HEATERS AUTO	0
V58S0062E	LANDING GEAR BRAKE C HEATERS AUTO	0
V58S0070E	HYD SYS AFT FUS A HEATERS AUTO	1
V58S0071E	HYD SYS AFT FUS B HEATERS AUTO	1
V58S0086E	HYD SYS ELEVON ACTUATOR HTRS-ON A	1
V58S0087E	HYD SYS ELEVON ACTUATOR HTRS-ON B	1
V58S0108E	HYDR SYS GEAR UP/CIRC VALVE-OPEN A	0
V58S0110E	HYDR SYS GEAR UP/CIRC VALVE-AUTO A	1
V58S0138E	HYDR SYS 1 CIRC PUMP-ON A	0
V58S0140E	HYDR SYS 1 CIRC PUMP-AUTO ENABLE A	1
V58S0149E	HYD 1 H20 BLR CONT A AC DC PWR ON	1
V58S0150E	HYD 1 H20 BLR CONT B AC DC PWR ON	0
V58S0151E	HYDR SYS 1 H20 BLR CONTLR A ON	0
V58S0153E	HYDR SYS 1 H20 BLR N2 SUPPLY ON A	1
V58S0172E	HYDR SYS 1 MN PUMP DEPRESS-ENBL A	0
V58X0190E	HYDR SYS 1 LDG GR ISLN VLV CL IND	0
V58S0238E	HYDR SYS 2 CIRC PUMP-ON A	0
V58S0240E	HYDR SYS 2 CIRC PUMP-AUTO ENABLE A	1
V58S0249E	HYD 2 H20 BLR CONT A AC DC PWR ON	1
V58S0250E	HYD 2 H20 BLR CONT B AC DC PWR ON	0
V58S0251E	HYDR SYS 2 H20 BLR CONTLR A ON	0
V58S0253E	HYDR SYS 2 H20 BLR N2 SUPPLY ON A	1
V58S0272E	HYDR SYS 2 MN PUMP DEPRESS-ENBL A	0
V58X0290E	HYDR SYS 2 LDG GR ISLN VLV CL IND	0
V58S0338E	HYDR SYS 3 CIRC PUMP-ON A	0
V58S0340E	HYDR SYS 3 CIRC PUMP-AUTO ENABLE A	1
V58S0349E	HYD 3 H20 BLR CONT A AC DC PWR ON	1
V58S0350E	HYD 3 H20 BLR CONT B AC DC PWR ON	0
V58S0351E	HYDR SYS 3 H20 BLR CONTLR A ON	0
V58S0353E	HYDR SYS 3 H20 BLR N2 SUPPLY ON A	1
V58S0372E	HYDR SYS 3 MN PUMP DEPRESS-ENBL A	0
V58X0390E	HYDR SYS 3 LDG GR ISLN VLV CL IND	0
V58X1136E	HYD SYS 1 ME/TVC SPLY V OP IND	0

MML NO.	NOMENCLATURE	I.C.
V58X1236E	HYD SYS 2 ME/TVC SPLY V OP IND	0
V58X1336E	HYD SYS 3 ME/TVC SPLY V OP IND	0
V61X2005E	CABIN VENT ISOL-CLOSE	1
V61X2045E	CABIN VENT-CLOSE	1
V61X2100E	O2 XOVR SYS 1 OPEN	0
V61S2120E	CABIN TEMP CNTLR LOOP 1 ON	1
V61S2121E	CABIN TEMP CNTLR LOOP 2 ON	0
V61X2131E	CABIN PRESS RELIEF VLV A IND ENBL	1
V61X2136E	CABIN PRESS RELIEF VLV B IND ENBL	1
V61S2140E	SYS 1 PPO2 MODE SELECT-NORMAL	1
V61S2142E	SYS 2 PPO2 MODE SELECT-NORMAL	1
V61X2163E	O2 EMERGENCY-OPEN	1
V61S2200E	O2 XOVR SYS 2 OPEN	0
V61S2308E	H2O ALTERNATE PRESS-OPEN	0
V61X2321E	N2 SYS 1 REG INLET-OPEN	1
V61X2323E	N2 SYS 1 SUPPLY-OPEN	1
V61S2350E	SYS 1/2 PPO2 SNSB/VLV-NORMAL	1
V61S2371E	O2/N2 CNTLR VLV-SYS 1 AUTO	1
V61S2370E	O2/N2 CNTLR VLV-SYS 1 OPEN	0
V61S2376E	O2/N2 CNTLR VLV-SYS 2 AUTO	1
V61S2375E	O2/N2 CNTLR VLV-SYS 2 OPEN	0
V61X2420E	N2 SYS 2 REG INLET-CLOSE	1
V61X2421E	N2 SYS 2 SUPPLY-CLOSE	1
V61S2450E	HUMIDITY SEPARATOR A PHASE A ON	1
V61S2455E	HUMIDITY SEPARATOR B PHASE A ON	0
V61S2585E	CABIN FAN A-PHASE A ON	1
V61S2590E	CABIN FAN B-PHASE A ON	0
V61S2604E	H2O LOOP 1 PUMP A CONT ON	0
V61S2609E	H2O LOOP 1 PUMP B CONT ON-GPC CMD	1
V61S2606E	H2O LOOP 1 PUMP B CONTROL-PH A ON	1
V61S2704E	H2O LOOP 2 PUMP CONT ON-GPC CMD	0
V61S2709E	H2O LOOP 2 PUMP CONT ON	1
V61S2745E	H2O LOOP 1 BYPASS MODE-MNL	1

MML NO.	NOMENCLATURE	I.C.
V61S2770E	AVIONICS BAY 1 FAN A PHASE A ON	1
V61S2775E	AVIONICS BAY 1 FAN B PHASE A ON	0
V61S2780E	AVIONICS BAY 2 FAN A PHASE A ON	1
V61S2785E	AVIONICS BAY 2 FAN B PHASE A ON	0
V61S2790E	AVIONICS BAY 3 FAN A PHASE A ON	1
V61S2795E	AVIONICS BAY 3 FAN B PHASE A ON	0
V61S2845E	H2O LOOP 2 BYPASS MODE-MNL	1
V61S2849E	ARS IMU FAN A ON PHASE A	1
V61S2852E	ARS IMU FAN B ON PHASE A	0
V61S2855E	ARS IMU FAN C ON PHASE A	0
V62X0403E	POTABLE H2O TK A INLET VLV-OPEN	1
V62X0407E	POTABLE H2O TK A OUTLET VLV-OPEN	0
V62X0423E	POTABLE H2O TK B INLET VLV-OPEN	1
V62X0427E	POTABLE H2O TK B OUTLET VLV-OPEN	1
V62S0442E	POTABLE H2O DUMP V ENA/NOZ HTR-ON	0
V62X0455E	POTABLE H2O DUMP ISLN VLV-OPEN	1
V62X0465E	POTABLE H2O DUMP VLV-OPEN	0
V62X0533E	WASTE H2O DUMP ISLN VLV-OPEN	1
V62X0538E	WASTE H2O DUMP VLV-OPEN	0
V62S0541E	WASTE H2O DUMP VLV ENA/NOZ HTR-ON	0
V62S0549E	VACUUM VENT HEATER ON	1
V62X0566E	WASTE TK 1 DRAIN VLV-OPEN	0
V62X0567E	POT TK D OR WASTE TK 2 OUT VLV-OP	1
V62X0568E	POTABLE H2O TK C OUTLET VLV-OPEN	1
V62X0570E	WASTE TK 1 INLET VLV-OPEN	1
V62X0571E	POT TK D OR WASTE TK 2 INLT VLV-OP	1
V62X0572E	POTABLE H2O TK C INLET VLV-OPEN	1
V62X1005E	POTABLE H2O OUTLET ISLN VLV-OPEN	0
V62X1105E	GALLEY SUPPLY VLV-OPEN	1
V63S1111E	FCL 1 PUMP A-PHASE A ON	1
V63S1121E	FCL 1 PUMP B-PHASE A ON	0
V63S1178E	NH3 CONTROLLER A-PRI/GPC CMD	0
V63S1186E	NH3 CONTROLLER A SEC ON	0

MML NO.	NOMENCLATURE	I.C.
V63S1182E	NH3 CONTROLLER B-PRI/GPC CMD	0
V63S1190E	NH3 CONTROLLER B SEC ON	0
V63S1211E	FCL 1 RDTR TEMP CNTLR-AUTO A	1
V63S1212E	FCL 1 RDTR TEMP CNTLR-AUTO B	0
V63S1220E	FCL 1 RDTR BYP VLV-AUTO	1
V63X1222E	FCL 1 RDTR BYPASS VLV POSN-RDTR	1
V63X1230E	FCL 1 FLOW PROP VALVE-INTERCHANGER	1
V63S1311E	FCL 2 PUMP A-PHASE A ON	1
V63S1321E	FCL 2 PUMP B-PHASE A ON	0
V63S1411E	FCL 2 RDTR TEMP CNTLR-AUTO A	1
V63S1412E	FCL 2 RDTR TEMP CNTLR-AUTO B	0
V63S1420E	FCL 2 RDTR BYP VLV-AUTO	1
V63X1422E	FCL 2 RDTR BYPASS VLV POSN-RDTR	1
V63X1430E	FCL 2 FLOW PROP VALVE-INTERCHANGER	1
V63S1600E	FLASH EVAP CNTLR PRI A-GPC CMD	0
V63S1610E	FLASH EVAP CNTLR PRI A CMD-ON	1
V63S1620E	HI LOAD EVAP-ENABLE	0
V63S1650E	FLASH EVAP CNTLR PRI B-GPC CMD	0
V63S1660E	FLASH EVAP CNTLR PRI B CMD-ON	0
V63S1700E	FLASH EVAP CNTLR SEC-GPC CMD	0
V63S1710E	FLASH EVAP CNTLR SEC CMD-ON	0
V63S2501E	HI LOAD FLASH EVAP DUCT HTR A ON	0
V63S2521E	HI LOAD FLASH EVAP DUCT HTR B ON	0

MML NO.	NOMENCLATURE	I.C.
V73S0689E	LH R,P,Y PANEL TRIM POWER ON A	0
V73S0696E	RH R,P,Y PANEL TRIM POWER ON A	0
V74S0109E	MSBLS NO 1 POWER ON	0
V74S0119E	MSBLS NO 2 POWER ON	0
V74S0129E	MSBLS NO 3 POWER ON	0
V74S0140E	TACAN NO 1 POWER ON	0
V74S0150E	TACAN NO 2 POWER ON	0
V74S0160E	TACAN NO 3 POWER ON	0
V74S0175E	RADAR ALT NO 1-ON	0
V74S0185E	RADAR ALT NO 2-ON	0
V76X0106E	MAIN BUS A TIE BUS ON	0
V76S0134E	MAIN BUS C TO ESS BUS-1BC-ON	1
V76S0163E	FUEL CELL 1 TO ESS BUS 1BC-ON	0
V76X0206E	MAIN BUS B TIE BUS ON	0
V76S0234E	MAIN BUS A TO ESS BUS-2CA-ON	1
V76S0263E	FUEL CELL 2 TO ESS BUS 2CA-ON	1
V76X0306E	MAIN BUS C TIE BUS ON	0
V76S0334E	MAIN BUS B TO ESS BUS-3AB-ON	1
V76S0363E	FUEL CELL 3 TO ESS BUS 3AB-ON	0
V76S0801E	KU BAND ANT JTSN ARM A CMD	0
V76S0901E	REND RDR ANT JTSN ARM A CMD	0
V76S1503E	AC BUS 1 VOLTAGE SENSOR AUTO	1
V76S1504E	AC BUS 1 VOLTAGE SENSOR MONITOR	0
V76X1537E	AC BUS 1 PHASE A INPUT ON	1
V76X1538E	AC BUS 1 PHASE B INPUT ON	1
V76X1539E	AC BUS 1 PHASE C INPUT ON	1

MML NO.	NOMENCLATURE	I.C.
V76S1603E	AC BUS 2 VOLTAGE SENSOR AUTO	1
V76S1604E	AC BUS 2 VOLTAGE SENSOR MONITOR	0
V76X1637E	AC BUS 2 PHASE A INPUT ON	1
V76X1638E	AC BUS 2 PHASE B INPUT ON	1
V76X1639E	AC BUS 2 PHASE C INPUT ON	1
V76S1703E	AC BUS 3 VOLTAGE SENSOR AUTO	1
V76S1704E	AC BUS 3 VOLTAGE SENSOR MONITOR	0
V76X1737E	AC BUS 3 PHASE A INPUT ON	1
V76X1738E	AC BUS 3 PHASE B INPUT ON	1
V76X1739E	AC BUS 3 PHASE C INPUT ON	1
V76S2851E	PAYLOAD CABIN-MAIN BUS A ON	1
V76S2853E	PAYLOAD CABIN-MAIN BUS B ON	0
V76S2861E	PAYLOAD AUXILIARY-MAIN BUS A ON	1
V76S4601E	MEC 1 BUS A PWR ON	0
V76S4605E	MEC 2 BUS B PWR ON	0
V76S7301E	LH RMS JTSN ARM A CMD	0
V76S7401E	RH RMS JTSN ARM A CMD	0
V79S2004E	ACCEL ASSY 1 PWR ON CMD A	0
V79S2007E	ACCEL ASSY 2 PWR ON CMD B	0
V79S2010E	ACCEL ASSY 3 PWR ON CMD C	0
V79S2015E	ACCEL ASSY 4 PWR ON CMD D	0
V79S4126E	ASA 1 PWR ON CMD A	0
V79S4132E	ASA 2 PWR ON CMD B	0
V79S4138E	ASA 3 PWR ON CMD C	0
V79S4143E	ASA 4 PWR ON CMD D	0

The following table contains measurements to be output since they are required by the GPC SM:

SM ADDITIONAL INPUTS

MML. NO.	NOMENCLATURE	I.C.
V43T4215A	OMS-L POD OXDZR TANK TEMP LOWER	50
V43T4216A	OMS-L POD OXDZR ENG INLET TEMP	61
V43T4315A	OMS-L POD FUEL TANK TEMP-LOWER	52
V43T4641A	OMS-L ENG OX VLV TEMP	63
V43T4642A	OMS-L ENG FU FEEDLINE TEMP	65
V43T4643A	OMS-L ENG FUEL INJECTOR TEMP	71
V43T4701A	OMS-L POD RCS HSG VERNIER CMPT T 1	67
V43T4702A	OMS-L POD UPPER Y-WEB OTBD TEMP	69
V43T4703A	OMS-L POD UPPER Y-WEB INBD TEMP	73
V43T4704A	OMS-L POD OX DRAIN PNL TEMP 1	75
V43T4705A	OMS-L POD OX DRAIN PNL TEMP 2	77
V43T4708A	OMS-L POD OX/HE TEST PORT FIG T 1	56
V43T5215A	OMS-R POD OXDZR TANK TEMP-LOWER	58
V43T5216A	OMS-R POD OXDZR ENG INLET TEMP	79
V43T5315A	OMS-R POD FU TANK TEMP-LOWER	81
V43T5641A	OMS-R ENG OX VLV TEMP	82
V43T5642A	OMS R ENG FU FEEDLINE TEMP	83
V43T5643A	OMS-R ENG FUEL INJECTOR TEMP	84
V43T5700A	OMS-R POD RCS PRESS PNL SPRT TMP 1	85
V43T5701A	OMS-R POD RCS HSG VERNIER CMPT T 1	86
V43T5702A	OMS R POD UPPER Y-WEB OTBD TEMP	87
V43T5703A	OMS R POD UPPER Y-WEB INBD TEMP	88
V43T5704A	OMS-R POD OX DRAIN PNL TEMP 1	89
V43T5705A	OMS-R POD OX DRAIN PNL TEMP 2	90
V43T5706A	OMS R POD GSE SERVICE PNL TEMP	91
V43T5707A	OMS R POD ENG SERVICE PNL TEMP	92
V43T5708A	OMS-R POD OX/HE TEST PORT FIG T 1	54
V45V0100A	FUEL CELL NO. 1 VOLTAGE	29
V45V0200A	FUEL CELL NO. 2 VOLTAGE	30
V45V0300A	FUEL CELL NO. 3 VOLTAGE	31
V45X1185E	PRSD 02 TK 1 HTR CUR SNSR 1A-TRIP	0
V45X1186E	PRSD 02 TK 1 HTR CUR SNSR 2A-TRIP	0
V45X1187E	PRSD 02 TK 1 HTR CUR SNSR 1B-TRIP	0

MML NO.	NOMENCLATURE	I.C.
V45X1188E	PRSD 02 TK 1 HTR CUR SNSR 2B-TRIP	0
V45X1285E	PRSD 02 TK 2 HTR CUR SNSR 1A-TRIP	0
V45X1286E	PRSD 02 TK 2 HTR CUR SNSR 2A-TRIP	0
V45X1287E	PRSD 02 TK 2 HTR CUR SNSR 1B-TRIP	0
V45X1288E	PRSD 02 TK 2 HTR CUR SNSR 2B-TRIP	0
V45X1385E	PRSD 02 TK 3 HTR CUR SNSR 1A-TRIP	0
V45X1386E	PRSD 02 TK 3 HTR CUR SNSR 2A-TRIP	0
V45X1387E	PRSD 02 TK 3 HTR CUR SNSR 1B-TRIP	0
V45X1388E	PRSD 02 TK 3 HTR CUR SNSR 2B-TRIP	0
V54X0131E	PLD NO 1 LATCH 1A RELEASED IND	0
V54X0132E	PLD NO 1 LATCH 1B RELEASED IND	0
V54X0133E	PLD NO 1 LATCH 2A RELEASED IND	0
V54X0134E	PLD NO 1 LATCH 2B RELEASED IND	0
V54X0135E	PLD NO 1 LATCH 3A RELEASED IND	0
V54X0136E	PLD NO 1 LATCH 3B RELEASED IND	0
V54X0141E	PLD NO 1 LATCH 1A LATCHED IND	1
V54X0142E	PLD NO 1 LATCH 1B LATCHED IND	1
V54X0143E	PLD NO 1 LATCH 2A LATCHED IND	1
V54X0144E	PLD NO 1 LATCH 2B LATCHED IND	1
V54X0145E	PLD NO 1 LATCH 3A LATCHED IND	1
V54X0146E	PLD NO 1 LATCH 3B LATCHED IND	1
V54X0151E	PLD NO 1 IN-POSITION 1A INDICATION	1
V54X0152E	PLD NO 1 IN-POSITION 1B INDICATION	1
V54X0153E	PLD NO 1 IN-POSITION 2A INDICATION	1
V54X0154E	PLD NO 1 IN-POSITION 2B INDICATION	1
V54X0155E	PLD NO 1 IN-POSITION 3A INDICATION	1
V54X0156E	PLD NO 1 IN-POSITION 3B INDICATION	1
V54X0231E	PLD NO 2 LATCH 1A RELEASED IND	0
V54X0232E	PLD NO 2 LATCH 1B RELEASED IND	0
V54X0233E	PLD NO 2 LATCH 2A RELEASED IND	0
V54X0234E	PLD NO 2 LATCH 2B RELEASED IND	0
V54X0235E	PLD NO 2 LATCH 3A RELEASED IND	0
V54X0236E	PLD NO 2 LATCH 3B RELEASED IND	0

MML NO.	NOMENCLATURE	I.C.
V54X0241E	PLD NO 2 LATCH 1A LATCHED IND	1
V54X0242E	PLD NO 2 LATCH 1B LATCHED IND	1
V54X0243E	PLD NO 2 LATCH 2A LATCHED IND	1
V54X0244E	PLD NO 2 LATCH 2B LATCHED IND	1
V54X0245E	PLD NO 2 LATCH 3A LATCHED IND	1
V54X0246E	PLD NO 2 LATCH 3B LATCHED IND	1
V54X0251E	PLD NO 2 IN-POSITION 1A INDICATION	1
V54X0252E	PLD NO 2 IN-POSITION 1B INDICATION	1
V54X0253E	PLD NO 2 IN-POSITION 2A INDICATION	1
V54X0254E	PLD NO 2 IN-POSITION 2B INDICATION	1
V54X0255E	PLD NO 2 IN-POSITION 3A INDICATION	1
V54X0256E	PLD NO 2 IN-POSITION 3B INDICATION	1
V54X0331E	PLD NO 3 LATCH 1A RELEASED IND	0
V54X0332E	PLD NO 3 LATCH 1B RELEASED IND	0
V54X0333E	PLD NO 3 LATCH 2A RELEASED IND	0
V54X0334E	PLD NO 3 LATCH 2B RELEASED IND	0
V54X0335E	PLD NO 3 LATCH 3A RELEASED IND	0
V54X0336E	PLD NO 3 LATCH 3B RELEASED IND	0
V54X0341E	PLD NO 3 LATCH 1A LATCHED IND	1
V54X0342E	PLD NO 3 LATCH 1B LATCHED IND	1
V54X0343E	PLD NO 3 LATCH 2A LATCHED IND	1
V54X0344E	PLD NO 3 LATCH 2B LATCHED IND	1
V54X0345E	PLD NO 3 LATCH 3A LATCHED IND	1
V54X0346E	PLD NO 3 LATCH 3B LATCHED IND	1
V54X0351E	PLD NO [illegible] IN-POSITION 1A INDICATION	1
V54X0352E	PLD NO 3 IN-POSITION 1B INDICATION	1
V54X0353E	PLD NO 3 IN-POSITION 2A INDICATION	1
V54X0354E	PLD NO 3 IN-POSITION 2B INDICATION	1
V54X0355E	PLD NO 3 IN-POSITION 3A INDICATION	1
V54X0356E	PLD NO 3 IN-POSITION 3B INDICATION	1
V54X0431E	PLD NO 4 LATCH 1A RELEASED IND	0
V54X0432E	PLD NO 4 LATCH 1B RELEASED IND	0
V54X0433E	PLD NO 4 LATCH 2A RELEASED IND	0

MML NO.	NOMENCLATURE	I.C.
V54X0434E	PLD NO 4 LATCH 2B RELEASED IND	0
V54X0435E	PLD NO 4 LATCH 3A RELEASED IND	0
V54X0436E	PLD NO 4 LATCH 3B RELEASED IND	0
V54X0441E	PLD NO 4 LATCH 1A LATCHED IND	1
V54X0442E	PLD NO 4 LATCH 1B LATCHED IND	1
V54X0443E	PLD NO 4 LATCH 2A LATCHED IND	1
V54X0444E	PLD NO 4 LATCH 2B LATCHED IND	1
V54X0445E	PLD NO 4 LATCH 3A LATCHED IND	1
V54X0446E	PLD NO 4 LATCH 3B LATCHED IND	1
V54X0451E	PLD NO 4 IN-POSITION 1A INDICATION	1
V54X0452E	PLD NO 4 IN-POSITION 1B INDICATION	1
V54X0453E	PLD NO 4 IN-POSITION 2A INDICATION	1
V54X0454E	PLD NO 4 IN-POSITION 2B INDICATION	1
V54X0455E	PLD NO 4 IN-POSITION 3A INDICATION	1
V54X0456E	PLD NO 4 IN-POSITION 3B INDICATION	1
V54X0531E	PLD NO 5 LATCH 1A RELEASED IND	0
V54X0532E	PLD NO 5 LATCH 1B RELEASED IND	0
V54X0533E	PLD NO 5 LATCH 2A RELEASED IND	0
V54X0534E	PLD NO 5 LATCH 2B RELEASED IND	0
V54X0535E	PLD NO 5 LATCH 3A RELEASED IND	0
V54X0536E	PLD NO 5 LATCH 3B RELEASED IND	0
V54X0541E	PLD NO 5 LATCH 1A LATCHED IND	1
V54X0542E	PLD NO 5 LATCH 1B LATCHED IND	1
V54X0543E	PLD NO 5 LATCH 2A LATCHED IND	1
V54X0544E	PLD NO 5 LATCH 2B LATCHED IND	1
V54X0545E	PLD NO 5 LATCH 3A LATCHED IND	1
V54X0546E	PLD NO 5 LATCH 3B LATCHED IND	1
V54X0551E	PLD NO 5 IN-POSITION 1A INDICATION	1
V54X0552E	PLD NO 5 IN-POSITION 1B INDICATION	1
V54X0553E	PLD NO 5 IN-POSITION 2A INDICATION	1
V54X0554E	PLD NO 5 IN-POSITION 2B INDICATION	1
V54X0555E	PLD NO 5 IN-POSITION 3A INDICATION	1
V54X0556E	PLD NO 5 IN-POSITION 3B INDICATION	1

MML NO.	NOMENCLATURE	I.C.
V54S0600E	RMS PWR MCIU MN A/SEL-ENBL ON CMD	0
V54S0601E	RMS PWR MCIU MN B/SEL-ENBL ON CMD	0
V54X0810E	PORT RMS SHLD POS MECH DEPL IND 1	0
V54X0811E	PORT RMS SHLD POS MECH DEPL IND 2	0
V54X0820E	PORT RMS SHLD POS MECH STOWED IND 1	1
V54X0821E	PORT RMS SHLD POS MECH STOWED IND 2	1
V54X0840E	PORT RMS FWD RETNN RDY-FOR-LCH 1	0
V54X0841E	PORT RMS FWD RETNN RDY-FOR-LCH 2	0
V54X0842E	PORT RMS MID RETNN RDY-FOR-LCH 1	0
V54X0843E	PORT RMS MID RETNN RDY-FOR-LCH 2	0
V54X0844E	PORT RMS AFT RETNN RDY-FOR-LCH 1	0
V54X0845E	PORT RMS AFT RETNN RDY-FOR-LCH 2	0
V54X0860E	PORT RMS FWD RETNN LCH-LCH IND 1	1
V54X0861E	PORT RMS FWD RETNN LCH-LCH IND 2	1
V54X0862E	PORT RMS MID RETNN LCH-LCH IND 1	1
V54X0863E	PORT RMS MID RETNN LCH-LCH IND 2	1
V54X0864E	PORT RMS AFT RETNN LCH-LCH IND 1	1
V54X0865E	PORT RMS AFT RETNN LCH-LCH IND 2	1
V54X0870E	PORT RMS FWD RETNN LCH-REL IND 1	0
V54X0871E	PORT RMS FWD RETNN LCH-REL IND 2	0
V54X0872E	PORT RMS MID RETNN LCH-REL IND 1	0
V54X0873E	PORT RMS MID RETNN LCH-REL IND 2	0
V54X0874E	PORT RMS AFT RETNN LCH-REL IND 1	0
V54X0875E	PORT RMS AFT RETNN LCH-REL IND 2	0
V54X1010E	STBD RMS SHLD POS MECH DEPL IND 1	0
V54X1011E	STBD RMS SHLD POS MECH DEPL IND 2	0
V54X1020E	STBD RMS SHLD POS MECH STOWED IND 1	1
V54X1021E	STBD RMS SHLD POS MECH STOWED IND 2	1
V54X1040E	STBD RMS FWD RETNN RDY-FOR-LCH 1	0
V54X1041E	STBD RMS FWD RETNN RDY-FOR-LCH 2	0
V54X1042E	STBD RMS MID RETNN RDY-FOR-LCH 1	0
V54X1043E	STBD RMS MID RETNN RDY-FOR-LCH 2	0
V54X1044E	STBD RMS AFT RETNN RDY-FOR-LCH 1	0

MML NO.	NOMENCLATURE	I.C.
V54X1045E	STBD RMS AFT RETNN RDY-FOR-LCH 2	0
V54X1060E	STBD RMS FWD RETNN LCH-LCH IND 1	1
V54X1061E	STBD RMS FWD RETNN LCH-LCH IND 2	1
V54X1062E	STBD RMS MID RETNN LCH-LCH IND 1	1
V54X1063E	STBD RMS MID RETNN LCH-LCH IND 2	1
V54X1064E	STBD RMS AFT RETNN LCH-LCH IND 1	1
V54X1065E	STBD RMS AFT RETNN LCH-LCH IND 2	1
V54X1070E	STBD RMS FWD RETNN LCH-REL IND 1	0
V54X1071E	STBD RMS FWD RETNN LCH-REL IND 2	0
V54X1072E	STBD RMS MID RETNN LCH-REL IND 1	0
V54X1073E	STBD RMS MID RETNN LCH-REL IND 2	0
V54X1074E	STBD RMS AFT RETNN LCH-REL IND 1	0
V54X1075E	STBD RMS AFT RETNN LCH-REL IND 2	0
V58S0139E	HYDR SYS 1 CIRC PUMP-ON B	0
V58S0239E	HYDR SYS 2 CIRC PUMP-ON B	0
V58S0339E	HYDR SYS 3 CIRC PUMP-ON B	0
V63S2511E	HI LOAD DUCT HTR A/B ON	0
V63S2531E	HI LOAD DUCT HTR C ON	0
V74X0847E	CCTV CAMERA OUT OF TEMP	0
V74E4080A	S-BD PM XPNDR 1 AGC SIG STRENGTH	2.5
V74E4081A	S-BD PM XPNDR 2 AGC SIG STRENGTH	2.6
V74X4745E	GCIL-S-BAND PM-XPNDR 1 (ON)	0
V74X4746E	GCIL-S-BAND PM-XPNDR 2 (ON)	0
V47X4747E	GCIL-S-BAND PM-PWR AMPL 1-STBY	0
V74X4749E	GCIL-S-BAND PM-PWR AMPL 2-STBY	0
V74X4753E	GCIL-NSP DATA RATE-XMIT HIGH	0

MML NO.	NOMENCLATURE	I.C.
V74X4754E	GCIL-NSP DATA RATE-XMIT LOW	0
V74X4756E	GCIL-NSP DATA RATE-RCV LOW	0
V74X4758E	GCIL-NSP UPLINK DATA-KU	0
V74X4776E	GCIL-S-BAND PREAMP 1 ON	0
V74X4777E	GCIL-S-BAND PREAMP 2 ON	0
V74X4784E	GCIL-S-BAND POWER AMPL 1 OPERATE	0
V74X4785E	GCIL-S-BAND POWER AMPL 2 OPERATE	0
V74X4787E	GCIL-S-BAND PM LOW XPNDR STDN	0
V74X4788E	GCIL-S-BAND PM HI XPNDR STDN	0
V74X4789E	GCIL-S-BAND PM XPNDR-SGLS MODE	0
V74X4790E	GCIL-S-BD XPNDR SPRD SPECTRUM DSBL	0
V74X4791E	GCIL-S-BAND XPNDR RANGING OFF	0
V74X4792E	GCIL-S-BAND XPNDR FREQ LOW	0
V74X4793E	GCIL S-BAND XPNDR FREQ HIGH	0
V74X4794E	GCIL-NSP DATA RATE-RECEIVE HIGH	0
V74X4795E	GCIL-NSP UPLINK DATA SOURCE-S BAND	0
V74X4796E	GCIL-NSP CODING RECEIVE-ON	0
V74X4797E	GCIL-NSP CODING TRANSMIT-ON	0
V74X4798E	GCIL-NSP RCDR VOICE CHAN 1/2-OFF	0
V74X4799E	GCIL-NSP RCDR VOICE CHAN 1/2-ON	0
V74X4880E	GCIL-CCTV REMOTE CONTROL UNIT MN A	0
V74X4881E	GCIL-CCTV REMOTE CONTROL UNIT MN B	0
V74X5052E	GCIL ACTIVE	0
V74X5176E	NSP FRAME SYNC LOCK 1	1
V74X5177E	NSP FRAME SYNC LOCK 2	1
V74T9220A	S-BAND PWR AMP 1 TEMPERATURE	145
V74T9221A	S-BAND PWR AMP 2 TEMPERATURE	148
V76V0100A	MAIN BUS A VOLTAGE	28.0
V76V0120A	CONTROL BUS AB1 VOLTAGE	28.3
V76V0121A	CONTROL BUS AB2 VOLTAGE	28.6

MML NO.	NOMENCLATURE	I.C.
V76V0122A	CONTROL BUS AB3 VOLTAGE	28.9
V76V0130A	ESS BUS 1BC VOLTAGE	29.2
V76V0200A	MAIN BUS B VOLTAGE	29.0
V76V0220A	CONTROL BUS BC1 VOLTAGE	29.3
V76V0221A	CONTROL BUS BC2 VOLTAGE	29.6
V76V0222A	CONTROL BUS BC3 VOLTAGE	29.9
V76V0230A	ESS BUS 2CA VOLTAGE	30.2
V76V0300A	MAIN BUS C VOLTAGE	30.0
V76V0320A	CONTROL BUS CA1 VOLTAGE	30.3
V76V0321A	CONTROL BUS CA2 VOLTAGE	30.6
V76V0322A	CONTROL BUS CA3 VOLTAGE	30.9
V76V0330A	ESS BUS 3AB VOLTAGE	31.2
V76V1500A	AC BUS 1 PHASE A VOLT	110
V76V1501A	AC BUS 1 PHASE B VOLT	113
V76V1502A	AC BUS 1 PHASE C VOLT	116
V76X1505E	INVERTER BUS NO 1 0/V-0/V	0
V76X1506E	AC BUS 1 OVERLOAD	0
V76C1540A	AC BUS 1 PHASE A CURRENT	4.3
V76C1541A	AC BUS 1 PHASE B CURRENT	4.6
V76C1542A	AC BUS 1 PHASE C CURRENT	4.9
V76V1600A	AC BUS 2 PHASE A VOLT	111
V76V1601A	AC BUS 2 PHASE B VOLT	114
V76V1602A	AC BUS 2 PHASE C VOLT	117
V76X1605E	INVERTER BUS NO 2 0/V-0/V	0
V76X1606E	AC BUS 2 OVERLOAD	0
V76C1640A	AC BUS 2 PHASE A CURRENT	6.3
V76C1641A	AC BUS 2 PHASE B CURRENT	6.6
V76C1642A	AC BUS 2 PHASE C CURRENT	6.9
V76V1700A	AC BUS 3 PHASE A VOLT	112
V76V1701A	AC BUS 3 PHASE B VOLT	115
V76V1702A	AC BUS 3 PHASE C VOLT	118
V76X1705E	INVERTER BUS NO 3 0/V-0/V	0
V76X1706E	AC BUS 3 OVERLOAD	0

MML NO.	NOMENCLATURE	I.C.
V76C1740A	AC BUS 3 PHASE A CURRENT	8.3
V76C1741A	AC BUS 3 PHASE B CURRENT	8.6
V76C1742A	AC BUS 3 PHASE C CURRENT	8.9
V76C2811A	PAYLOAD AFT MAIN B CURRENT	12
V76C2822A	PAYLOAD AFT MAIN C CURRENT	15
V76V3071A	FWD PCA-1 VOLTAGE	32.0
V76V3072A	FWD PCA-2 VOLTAGE	32.1
V76V3073A	FWD PCA-3 VOLTAGE	32.2
V76C3075A	FWD PCA MAIN BUS A AMPS	55
V76C3076A	FWD PCA MAIN BUS B AMPS	60
V76C3077A	FWD PCA MAIN BUS C AMPS	65
V76C3085A	MID PCA MAIN BUS A AMPS	35
V76C3086A	MID PCA MAIN BUS B AMPS	40
V76C3087A	MID PCA MAIN BUS C AMPS	45
V76V3091A	AFT PCA-4 VOLTAGE	31.0
V76V3092A	AFT PCA-5 VOLTAGE	31.1
V76V3093A	AFT PCA-6 VOLTAGE	31.2
V76C3095A	AFT PCA MAIN BUS A AMPS	15
V76C3096A	AFT PCA MAIN BUS B AMPS	18
V76C3097A	AFT PCA MAIN BUS C AMPS	21
V78X9017E	RCDR DFI PCM-BITE	0
V78X9028E	RCDR WB ASCENT DFI-BITE	1
V78X9463E	PCM MASTER BITE GOOD-DFI 1	1
V78X9464E	PCM MASTER BITE GOOD-DFI 2	1
V78X9508E	RCDR WB MISSION DFI-BITE	0

APPENDIX N

RECORDER MATH MODEL REQUIREMENTS

CONTENTS

1. INTRODUCTION

The GN&C Test Station (GTS) uses math models to simulate many of the Shuttle systems for which hardware has not been provided. A group of these models are termed "non-avionic" models since they do not simulate the Shuttle's "avionic" systems. The "non-avionic" models are needed to supply data for on-board software processing and to respond to Shuttle commands, whether they be from cockpit switches, the General Purpose Computers (GPC's) or the Non-avionic Simulator (NAS) console.

2. DETAILED REQUIREMENTS

These requirements specify the logical processing of input stimuli listed in table 1 to produce values for the output measurements listed in table 2 that stimulate the operation of the flight recorder.

2.1 MATH MODEL DESCRIPTION

This model simulates the output of the flight recorder. No logic is involved. The model merely outputs all of table 2 as static values.

2.2 STS UNIQUE REQUIREMENTS

This model is not required for STS.

2.3 GTS UNIQUE REQUIREMENTS

This model is required for GTS only.

3. MATH MODEL LOGIC

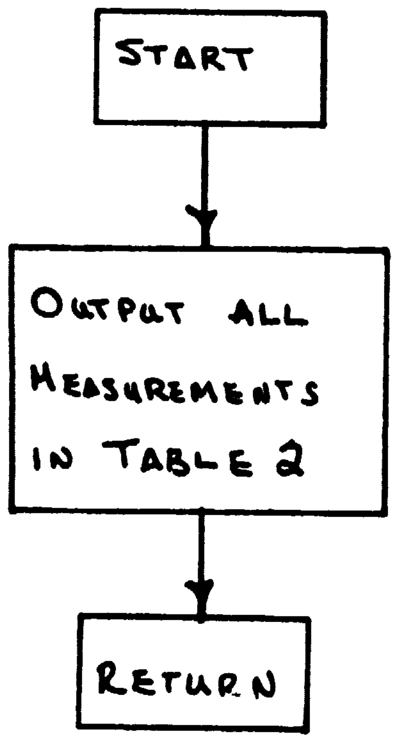
This section presents the logic which is the basis for the math model. The section is divided into two parts. The first part applies to GTS, while the second part applies to both STS and GTS.

3.1 GTS PREPROCESSOR LOGIC

NONE

3.2 LOGIC FLOW DIAGRAM

The logic flow diagram is made up of interconnected lines, boxes, decisions, and offpage connectors.


START
OUTPUT ALL MEASUREMENTS IN TABLE 2
RETURN

4. TABLES

4.1 INPUT STIMULI LIST

Table 1 contains a list of all model input stimuli. The first column shows the cockpit panel and switch designation followed by a descriptive nomenclature. Entries in the "NOTES" column are explained in subsection 4.1.1 which follows. Applicable MML numbers are listed next, designating their connection to input stimuli shown in the column marked "SYSTEM CONN-PIN". The final column indicates the states which the input stimuli may attain.

4.1.1 NOTES DEFINITION FOR TABLE 1

1. Both GND commands req'd to open valve.
2. Flt. System CMDS to STS or GTS NAS.
3. Unique to GTS - stimulus from NAS Kybd to GPC.
4. GND commands only - no onboard switch or GPC CMDS.
5. Will be entered at NAS Kybd for GTS.
6. Power connections are not identified by MML no.
7. Pseudo entered by operator at DCM or NAS Kybd.
8. Conn-pin designation uses same MML ID as line above.
9. Both switch commands req'd to open valve.
10. Both GPC commands req'd to open valve.
11. Stimulus provided by other model.
12. These commands are mutually exclusive.
13. Stimuli from MMES, for GTS NAS only.
14. Flight System commands to STS NAS only.
15. Flight System commands to GTS NAS only.

TABLE 1 - ST? .NPUT FOR RCDR

PANEL/ SWITCH	NOMENCLATURE	NOTES	MML ID.	SOURCE		STATE
				MDM	CONN-PIN	
	NONE					

4.2 OUTPUT MEASUREMENT LIST

Table 2 lists all model outputs along with the inital condition value for the output. Measurement I.D. and Measurement Name precede pairs of numeric columns. The first of each pair is labeled FS indicating flight system engineering units. The second of each pair is labeled CTS indicating the model count value corresponding to the FS value. I.C. indicates initial condition values. VALUE 1 typically indicates nominal vlaues. VALUE 2 and VALUE 3 columns indicate off nominal conditions. The CTS columns indicate the count value to be used within the STS NAS. For the GTS, automatic conversion from FS engineering unit values to CTS will be done by the NAS.

MEASUREMENT OUTPUT FROM RCDR MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V75X2540E	RCDR OPS 1 PERCENT TAPE BIT 1	0	0							STATE
V75X2541E	RCDR OPS 1 PERCENT TAPE BIT 2	1	1							STATE
V75X2542E	RCDR OPS 1 PERCENT TAPE BIT 3	1	1							STATE
V75X2543E	RCDR OPS 1 PERCENT TAPE BIT 4	1	1							STATE
V75X2544E	RCDR OPS 1 PERCENT TAPE BIT 5	0	0							STATE
V75X2640E	RCDR OPS 2 PERCENT TAPE BIT 1	0	0							STATE
V75X2641E	RCDR OPS 2 PERCENT TAPE BIT 2	1	1							STATE
V75X2642E	RCDR OPS 2 PERCENT TAPE BIT 3	0	0							STATE
V75X2643E	RCDR OPS 2 PERCENT TAPE BIT 4	0	0							STATE
V75X2644E	RCDR OPS 2 PERCENT TAPE BIT 5	1	1							STATE
V75X2740E	RCDR PL PERCENT TAPE BIT 1	0	0							STATE
V75X2741E	RCDR PL PERCENT TAPE BIT 2	0	0							STATE
V75X2742E	RCDR PL PERCENT TAPE BIT 3	1	1							STATE
V75X2743E	RCDR PL PERCENT TAPE BIT 4	0	0							STATE
V75X2744E	RCDR PL PERCENT TAPE BIT 5	1	1							STATE
V75X2505E	RCDR OPS 1 DIRECTION	0	0							STATE
V75T2517A	RCDR OPS 1 HEAD TEMPERATURE	82	591							DEGF
V75X2523E	RCDR OPS 1 TAPE MOTION	1	1							STATE
V75X2529E	RCDR OPS 1 BITE	1	1							STATE
V75X2547E	RCDR OPS 1 ACTIVE TRACK BIT 1	0	0							STATE
V75X2548E	RCDR OPS 1 ACTIVE TRACK BIT 2	0	0							STATE
V75X2549E	RCDR OPS 1 ACTIVE TRACK BIT 3	0	0							STATE
V75X2550E	RCDR OPS 1 ACTIVE TRACK BIT 4	1	1							STATE

MEASUREMENT OUTPUT FROM RCDR MODEL - TABLE 2

MEASUREMENT I. D.	MEASUREMENT NAME	I.C.		VALUE 1		VALUE 2		VALUE 3		UNITS
		FS	CTS	FS	CTS	FS	CTS	FS	CTS	
V75X2555E	RCDR OPS 1 FUNCTION MODE BIT 1	1	1							STATE
V75X2556E	RCDR OPS 1 FUNCTION MODE BIT 2	0	0							STATE
V75X2557E	RCDR OPS 1 FUNCTION MODE BIT 3	0	0							STATE
V75X2605E	RCDR OPS 2 DIRECTION	0	0							STATE
V75T2617A	RCDR OPS 2 HEAD TEMPERATURE	84	608							DEGF
V75X2623E	RCDR OPS 2 TAPE MOTION	1	1							STATE
V75X2629E	RCDR OPS 2 BITE	1	1							STATE
V75X2647E	RCDR OPS 2 ACTIVE TRACK BIT 1	1	1							STATE
V75X2648E	RCDR OPS 2 ACTIVE TRACK BIT 2	1	1							STATE
V75X2649E	RCDR OPS 2 ACTIVE TRACK BIT 3	1	1							STATE
V75X2650E	RCDR OPS 2 ACTIVE TRACK BIT 4	0	0							STATE
V75X2655E	RCDR OPS 2 FUNCTION MODE BIT 1	0	0							STATE
V75X2656E	RCDR OPS 2 FUNCTION MODE BIT 2	0	0							STATE
V75X2647E	RCDR OPS 2 FUNCTION MODE BIT 3	0	0							STATE
V75X2705E	RCDR PL DIRECTION	1	1							STATE
V75T2717A	RCDR PL HEAD TEMPERATURE	86	626							DEGF
V75X2723E	RCDR PL TAPE MOTION	0	0							STATE
V75X2729E	RCDR PL BITE	1	1							STATE
V75X2747E	RCDR PL ACTIVE TRACK BIT 1	0	0							STATE
V75X2748E	RCDR PL ACTIVE TRACK BIT 2	1	1							STATE
V75X2749E	RCDR PL ACTIVE TRACK BIT 3	0	0							STATE
V75X2750E	RCDR PL ACTIVE TRACK BIT 4	0	0							STATE
V75X2755E	RCDR PL FUNCTION MODE BIT 1	0	0							STATE
V75X2756E	RCDR PL FUNCTION MODE BIT 2	1	1							STATE
V75X2757E	RCDR PL FUNCTION MODE BIT 3	0	0							STATE