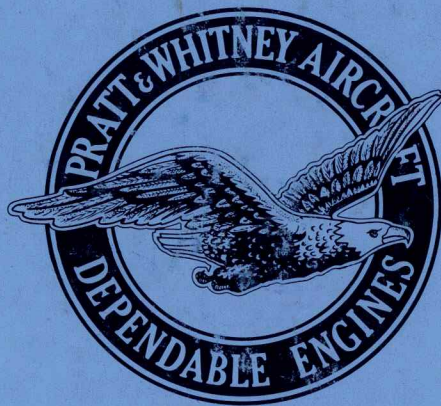


W. CARROLL

APOLLO FUEL CELL POWERPLANT
END-ITEM INSPECTION AND
TEST PROCEDURES
PWA-2399D



Pratt & Whitney Aircraft

DIVISION OF UNITED AIRCRAFT CORPORATION

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EAST HARTFORD, CONNECTICUT

Pratt & Whitney Aircraft

DIVISION OF UNITED AIRCRAFT CORPORATION

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In reply please refer to:
JML:I:1 - SWEF Building
Reference: 2-84

2 April 1968

To: North American Rockwell Corporation
Space Division
12214 Lakewood Boulevard
Downey, California 90241

Attention: Subcontract Data Management
Department 0960523, Mail Code CA99

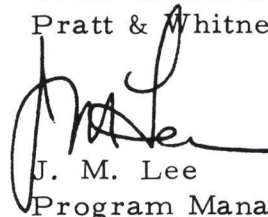
Subject: Transmittal of revised pages to Document PWA-2399D, Apollo
Fuel Cell Powerplant End Item Inspection and Test Procedures;
Purchase Order No. M6J7XAA-400003A

References: (A) P&WA TWX OD-2860 dated 25 March 1968
(B) P&WA TWX OD-2872 dated 28 March 1968
(C) TELCON Mr. J. Anderson (NR) and Mr. J. K. Ingram (P&WA)
26 March 1968

Enclosed are 10 copies, plus one reproducible copy, of revised pages to the Apollo Fuel Cell Powerplant End Item Inspection and Test Procedures, submitted in accordance with Paragraph 3.6.1.5 of NR specification MC 999-0025B, dated 12 November 1965, and Attachment No. 3 to the subject purchase order. The changes transmitted to NR by References (A) and (B) and discussed in Reference (C) are hereby submitted for final approval. These changes have been approved through 1 May 1968 by the NR Quality Control Resident Representative at P&WA. To avoid delay in the acceptance testing of Block II Apollo Fuel Cell Powerplants, NR's final approval of the subject procedure, as modified herein, is required by 30 April 1968.

Any inquiries concerning this subject should be directed to Mr. R. F. Lohneiss, Chief - Program Operations, Apollo Fuel Cell Program at Area Code 203, Telephone Number 565-8349.

UNITED AIRCRAFT CORPORATION
Pratt & Whitney Aircraft Division



J. M. Lee
Program Manager
Apollo Fuel Cell System

cc: D. V. Ovist, Administrative Buyer
Apollo Material Department 41-653
Building No. 1 AA 90

Revision Notice

The following pages of the Apollo Fuel Cell Powerplant End Item Inspection and Test Procedures, PWA-2399D, have been revised:

<u>Page</u>	<u>Page</u>	<u>Page</u>
Title Page		
12	43	62
15	44	63
17	45	64
25	48	65
26	49	66
41	50	67
42	61	A-2
		A-13

Please replace the indicated pages in your copies of PWA-2399D.

Revised 2 April 1968

APOLLO FUEL CELL POWERPLANT
END-ITEM INSPECTION AND
TEST PROCEDURES
PWA-2399D

29 August 1967



APPROVED BY J.M. Lee by Robert F. Schmitt
PROGRAM MANAGER

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Pratt & Whitney Aircraft DIVISION OF UNITED AIRCRAFT CORPORATION

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Pratt & Whitney Aircraft

DIVISION OF UNITED AIRCRAFT CORPORATION

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In reply please refer to:
JML:H:l - SWEF Building
Reference: 2-83

11 December 1967

To: North American Rockwell Corporation
Space Division
12214 Lakewood Boulevard
Downey, California 90241

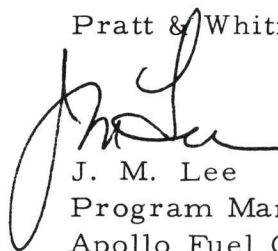
Attention: Subcontract Data Management
Department 0960523, Mail Code CA99

Subject: Transmittal of revised pages to Document PWA-2399D,
Apollo Fuel Cell Powerplant End Item Inspection and Test
Procedures; Purchase Order No. M6J7XAA-400003A

Reference: NAA/SD Letter M8MA4-3-2022 dated 15 November 1967

Enclosed are 10 copies, plus one reproducible copy, of revised pages to the Apollo Fuel Cell Powerplant End Item Inspection and Test Procedures, submitted in accordance with Paragraph 3.6.1.5 of NAR/SD specification MC 999-0025B, dated 12 November 1965, and Attachment No. 3 to the subject purchase order. The changes requested by NAR/SD in the referenced letter, are included. In addition, "red-line" changes incorporated during acceptance testing and approved by the NAR/SD Quality Control Resident Representative have also been incorporated.

UNITED AIRCRAFT CORPORATION
Pratt & Whitney Aircraft Division


J. M. Lee
Program Manager
Apollo Fuel Cell System

cc: D. V. Ovist, Administrator
Apollo Material Department 41-653
Building No. 1 AA 90

Pratt & Whitney Aircraft

DIVISION OF UNITED AIRCRAFT CORPORATION

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In reply please refer to:

JML:H:c - SWEF

Reference: 2-82

29 August 1967

To: North American Aviation, Inc.
Space Division
12214 Lakewood Boulevard
Downey, California 90241

Attention: Data Requirements
Department 41-096-704

Subject: Transmittal of Document PWA-2399D Apollo
Fuel Cell Powerplant End Item Inspection and
Test Procedures; Purchase Order No. M6J7XAA-
400003A

References: (A) NAA/SD Letter M7MA5-22-3083 dated
21 March 1967
(B) NAA/SD Letter M7MA5-22-3094 dated
30 March 1967
NAA/SD P& WA Negotiations held at NAA/SD
23 August 1967
(C) P& WA Letter OD-2335 dated 23 February 1967

Enclosed are 10 copies plus one reproducible copy of PWA-2399D, Apollo Fuel Cell Powerplant End Item Inspection and Test Procedures, submitted in accordance with Paragraph 3.6.1.5 of NAA/SD specification MC-999-0025B, dated 12 November 1965, and Attachment No. 3 to the subject purchase order. This document, describing the End Item Inspection and Test Procedures to be used for delivery powerplants, is hereby submitted for final approval. The changes requested by NAA/SD in the Referenced (A), (B), and (C) letters have been incorporated into the subject document. In addition, this revision includes changes necessary to update and clarify certain procedural items in accordance with current practices.

For your convenience in reviewing the changes, there are two attachments to this letter. Attachment I lists those changes which have been incorporated

Pratt & Whitney Aircraft

-2-

and in each case includes the affected pages and paragraphs as well as the NAA/SD comment contained in the Reference (A) letter where applicable. Attachment II lists those few changes which have not been incorporated and explains in each case why it has not been included.

UNITED AIRCRAFT CORPORATION
Pratt & Whitney Aircraft Division

R. F. Schmeiss for

J. M. Lee
Program Manager
Apollo Fuel Cell System

cc: E. S. Young, Jr., Administrative Buyer
Apollo Material Department 41-653
Building No. 1, AA88

Attachment I

CHANGES INCORPORATED IN PWA-2399D

Page	Paragraph	Sub Paragraph	Appearing In PWA-2399C	PWA-2399D Change	Comments
iii	3		TEST ADMINISTRATION	TEST PROGRAM ADMINISTRATION	
iii	3.4		Documentation	Documentation Acceptance Test	Requested In Reference (A)
iii	6.1		Description	Deleted	
IV	-		No Page Numbers	Page Numbers Added	Requested In Reference (A)
IV	-		Illustrations Changed To Include Up-To-Date Photographs		Requested in Reference (B)
2	2.1.1		Apollo Spacecraft Fuel Cell Electrical Powerplant	Apollo Spacecraft, Fuel Cell, Electrical Powerplant	
2	2.1.1		Ethylene Glycol, Water Solution	Ethylene Glycol - Water Solution	Requested In Reference (A)
3	3.3		0 to 60 amperes	zones 1 & 3 0-5 amps zone 2 0-50 amps	Requested In Reference (A) & (C)
7	-		No Page Number	Page Number Added	Requested In Reference (A)
11	5.2		"...denoted by the entry of the applicable underlined paragraph number..."	"...denoted by the entry of the applicable paragraph number..."	Requested In Reference (A)
11	5.2.1.2		H ₂ S/O F/M ISOLATION	H ₂ S/O HP F/M ISOLATION	
14	5.2.1.8	i	correct	connect	Requested In Reference (A)
15	5.2.2.1	d	GLYCOL S/O P/P FILL	GLYCOL S/O P/P FILL (test stand)	
15	5.2.2.3	a	"...28 volt VOLTAGE CONTROL RHEOSTAT..."	"...stand 28 volt VOLTAGE CONTROL RHEOSTAT..."	Requested In Reference (A)
15	5.2.2.3	a	"...DC VOLTMETER..."	"...stand DC VOLTMETER..."	
15	5.2.2.3	b	"...28 VOLT POWER SUPPLY..."	"...stand 28 VOLT POWER SUPPLY..."	
16	5.2.2.3	c	"...following switches..."	"...following stand switches..."	
16	5.2.2.3	f	"...with the N ₂ REG AUX..."	"...with the stand N ₂ REG AUX..."	Requested In Reference (A)
16	5.2.2.3	k	"...OPEN the GLYCOL S/O P/P FILL..."	"...OPEN the stand GLYCOL S/O P/P FILL..."	
16	5.2.2.3	i	"After a pressure of at least 1 inch Hg. absolute is obtained, as read on the VACUUM MANOMETER, ..."	"After a pressure of 1 inch Hg. absolute or less is obtained, as read on the VACUUM GAGE, ..."	
16	5.2.2.3	k	"...Establish a pressure of at least 1 inch Hg. absolute and record observed and absolute values as read on the VACUUM MANOMETER. ..."	"... Establish a pressure of 1 inch Hg. absolute or less and record observed and absolute values as read on the VACUUM GAGE. ..."	Requested In Reference (B)
17	5.2.2.4	c	VACUUM MANOMETER	VACUUM GAGE	
17	5.2.2.4	c	"...allowable decay is..."	"...allowable pressure rise is..."	Requested In Reference (B)

Page	Paragraph	Sub-Paragraph	Appearing In PWA-2399C	PWA-2399D Change	Comments
17	5.2.2.5	a	OPEN the N ₂ S/O GLYCOL FILL valve.	OPEN the stand N ₂ S/O GLYCOL FILL valve.	
17	5.2.2.5	b	Set the N ₂ PRESS-GLYCOL RESERVOIR to 15 ± 2 psig with the N ₂ REG-GLYCOL RESERVOIR	Set the N ₂ PRESS-GLYCOL RESERVOIR GAGE to 15 ± 2 psig by adjusting the N ₂ REG-GLYCOL RESERVOIR.	
17	5.2.2.5	d	OPEN the two following valves:	OPEN the two following stand valves:	
17	5.2.2.5	e	ATMOS VENT S/O GLYCOL Δ P P/P interface	Stand ATMOS VENT S/O Stand GLYCOL Δ P P/P INTERFACE	Requested In Reference (A)
17	5.2.2.5	f	"...S/O No. 1" "...S/O No. 1" GLYCOL S/O P/P FILL N ₂ S/O GLYCOL FILL	"...S/O No. 1 (test stand)" "...S/O No. 2 (test stand)" GLYCOL S/O P/P FILL (test stand) N ₂ S/O GLYCOL FILL (test stand)	
17	5.2.2.5	g	"...N ₂ PRESS-GLYCOL RESERVOIR..."	"...N ₂ PRESS-GLYCOL RESERVOIR GAGE..."	
17	5.2.2.5	h	"...from the GLYCOL S/O P/P FILL..."	"...from the stand GLYCOL S/O P/P FILL..."	
18	5.2.2.6	a	"...N ₂ REG ZUX..."	"...N ₂ REG AUX..."	Requested In Reference (A)
19	5.2.3.1	h	Record the powerplant regulated pressures...	<u>Record the powerplant regulated pressures...</u>	Standard In PWA-2399
20	5.2.3.1	j	purgine	purgine	Typographical Error
21	5.2.3.2	d	"...120 minutes..."	"...120 minutes..."	Only Recorded Items Are Underlined
21	5.2.3.2	c & d	"...0-1 psia vacuum..."	"...0-1 psia pressure..."	Nomenclature Clarification
21	5.2.3.3	c	"Record the stabilized gas pressure transducer readings..."	<u>"Record the stabilized gas pressure transducer readings..."</u>	Standard in PWA-2399
22	5.2.3.4	d	"...51.45-55.45 psia..."	"...51.45-55.45 psia (Block II) and 47.8-52.9 psia (Block I)..."	Requested In Reference (A)
23	5.2.3.6	b	powerplane	powerplant	Typographical Error
24	5.2.4.1	f	By adjusting the HEATER POWERSTAT <u>set and maintain the following heater voltages as indicated on the HEATER VOLTMETER:</u> Zone 1 70 ± 2 volts Zone 2 70 ± 2 volts Zone 3 70 ± 2 volts	By adjusting the HEATER POWERSTAT <u>set and maintain the following heater amperages as indicated on the HEATER AMMETER:</u> Zone 1 2.8 to 3.2 amps Zone 2 38.0 to 42.0 amps Zone 3 2.8 to 3.2 amps	Requested In Reference (A)
23	5.2.4.1.1	a	"...Channel 1-1 and 2-1..."	"...Channel 1-1 and 1-2..."	Typographical Error

Page	Paragraph	Sub-Paragraph	Appearing In PWA-2399C	PWA-2399D Change	Comments
25	5.2.4.1.1	d	watts	power	Improved Terminology
25	5.2.4.1.2	a	"... Channel 1-1 and 2-1."	"... Channel 1-1 and 1-2."	Typographical Error
25	5.2.4.1.3	a	"... Channel 1-1 and 2-1."	"... Channel -1- and 1-2."	Typographical Error
26	5.2.4.1.4	a	"... Channel 1-1 and 2-1."	"... Channel 1-1 and 1-2."	Typographical Error
26	5.2.4.1.4	b	By adjusting the HEATER POWERSTAT set the following heater voltages as indicated on the HEATER VOLTMETER: Zone 1 24 \pm 10 volts Zone 2 0 + 10-0 volts Zone 3 10 \pm 10 volts	By adjusting the HEATER POWERSTAT set the following heater amperages as indicated on the HEATER AMMETER: Zone 1 0.6 to 1.0 amps Zone 2 HEATER POWER TO OFF POSITION Zone 3 0.2 to 0.6 amps	Requested In Reference (A)
28	5.2.5.2	g	When the powerplant voltage, as read on Channel 7 is below 30.6 volts, set and maintain heater-power by adjusting the HEATER POWER-STAT to the voltages indicated below on the HEATER VOLTMETER and record heater volts and amps. Zone 1 40 \pm volts Zone 2 20 \pm volts Zone 3 40 \pm volts"	When the powerplant voltage, as read on Channel 7 is below 30.6 volts, set and maintain the following heater amperages as indicated on the HEATER AMMETER by adjusting the HEATER POWERSTAT. Record the voltage and current as indicated on the HEATER VOLTMETER and HEATER AMMETER. Zone 1 1.2 to 1.6 amps Zone 2 8.0 to 12.0 amps Zone 3 1.2 to 1.6 amps	Requested in Reference (A)
28	5.2.5.3	(note: 3) 2nd sent.	"Therefore, the last full data point for five of the six load points during the acceptance test approaches stabilization and will be used for fuel consumption demonstration."	"Therefore, the last full data point for five of the six load points during the acceptance test which most closely approaches stabilization will be used for fuel consumption demonstration."	Improved Meaning
29	5.2.5.3.2	b	"... 100 minutes..."	"... 100 minutes..."	Not A Recorded Item
30	5.2.5.3.3	a	"... In-Line Heater Control Ammeter Reading."	"... In-Line Heater Control Ammeter Reading."	Recorded Item
30	5.2.5.3.3	c	"... 65 minutes..."	"... 65 minutes..."	
30	5.2.5.3.4	b	"... 1.5 minutes..."	"... 1.5 minutes..."	
30	5.2.5.3.5	a	"... not less than 2195 watts."	"... not less than 2195 watts."	Not A Recorded Item
30	5.2.5.3.4	a	"... record powerplant volts and amps."	"... record powerplant volts and amps."	Recorded Item
31	5.2.5.3.6	b	"... thirty 0 one..."	"... thirty-one..."	Requested In Reference (A)

Page	Paragraph	Sub-Paragraph	Appearing In PWA-2399C	PWA-2399D Change	Comments
31	5.2.5.3.6	b (last sent.)	Also record the thirty 0 one individual cell output voltages on the powerplant log sheet as part of the last Full Data Reading.	Also record the thirty-one individual cell output voltages on the powerplant log sheet as part of the last Full Data Reading.	Recorded Item - Also correct Typographical Error
32	5.2.6.2	a	Start 7.5 hour \pm 10 minutes powerplant conditioning period by turning the H ₂ PURGE and O ₂ PURGE switches to ON - opening the powerplant reactant purge valves. Set and maintain heater power by adjusting the HEATER POWERSTAT to the voltages indicated below on the HEATER VOLTMETER. Record heater volts and amps. Zone 1 53 \pm 2 volts Zone 2 53 \pm 2 volts Zone 3 53 \pm 2 volts	Start the 7.5 hour \pm 10 minutes powerplant conditioning period by turning the H ₂ PURGE and O ₂ PURGE switches to ON - opening the powerplant reactant purge valves. Set and maintain heater amperages by adjusting the HEATER POWERSTAT as indicated on the HEATER AMMETER. Record the voltage and current as indicated on the HEATER VOLTMETER and the HEATER AMMETER. Zone 1 1.9 to 2.05 amps Zone 2 25.0 to 26.5 amps Zone 3 1.9 to 2.05 amps	Requested In Reference (A)
32	5.2.6.2	c	"...turn the O ₂ PURGE switch to OFF..."	"...turn the O ₂ PURGE switch to OFF..."	Recorded Item
32	5.2.6.2	c	"...O ₂ PURGE VALVE."	"...O ₂ PURGE VALVE."	Not A Recorded Item
33	5.2.6.2	gl changes to i	After not less than 3 hours of the 7.5 hour conditioning period remove and replace the generated H ₂ O Collection Bottle. This water will be used for quantitative analysis.	i. Remove the generated H ₂ O Collection Bottle. This water will be used for quantitative analysis.	Unnecessary Step
33	5.2.6.2	i, j, & k	i., j., k.	j., k., l.	To Correct Sequence (As a result of above change)
33	5.2.6.2.1	a	"At open circuit, record the following..."	"At open circuit, record the following..."	Unnecessary Underlining
34	5.2.6.2.1	f	"...18 \pm 2 amperes..."	"...18 \pm 2 amperes..."	Unnecessary Underlining
34	5.2.6.2.1	h	"...52 \pm 2 amperes..."	"...52 \pm 2 amperes..."	
34	5.2.6.2.1	i	"...65 \pm 2 amperes..."	"...65 \pm 2 amperes..."	
34	5.2.6.2.1	f	"...set on..."	"...set an..."	
34	5.2.6.2.1	g	"...set on..."	"...set an..."	
34	5.2.6.2.1	h	"...set on..."	"...set an..."	Typographical Error
34	5.2.6.2.1	i	"...set on..."	"...set an..."	
35	5.2.6.2.1	l	"At open circuit, record the following..."	"At open circuit, record the following..."	Unnecessary Underlining
35	5.2.6.3	e	Record full data reading as defined by Figure 1 every 30 minutes.	Record full data readings as defined by Figure 1 every 30 minutes.	Recorded Item

Attachment I (Cont.)

Page 5

<u>Page</u>	<u>Paragraph</u>	<u>Sub-Paragraph</u>	<u>Appearing in PWA-2399C</u>	<u>PWA-2399D Change</u>	<u>Comments</u>
37	5.2.6.4.1		"Start depressurizing the N ₂ blanket in 1 psi steps at 15 minute intervals down to 30 ± 2 psia as read on the Digital Voltmeter Channel 2, ..."	"Start depressurizing the N ₂ blanket in steps of 1 psi nominal, not to exceed 1.2 psi per 15 minute intervals to 28 ± 2 psia as read on the Digital Voltmeter Channel 2, ..."	Requested in Reference (A) and Outlined Specific Limits For Depressurization
37	5.2.6.4.1		"NOTE:..."	Delete entire note.	Unnecessary
37	5.2.6.4.2		"...at 30 ± 2 psia..."	"...at 28 ± 2 psia..."	Requested In Reference (A)
37	5.2.6.3.4	g	"Turn the LO REACT DIFF switch to OFF,..."	"Turn the <u>LO REACT DIFF</u> switch to <u>OFF</u> ,..."	Recorded Item
38	5.2.6.4.3	-	H ₂ PURGE	<u>H₂ PURGE</u>	Recorded Item
	5.2.6.4.3	c	O ₂ PURGE	<u>O₂ PURGE</u>	
39	5.2.6.4.4		"...at 15 minute intervals down to..."	"...at 15 minute intervals to..."	Superfluous Word
39	5.2.6.4.4		"...and record full data reading..."	"...and <u>record full data reading</u> ..."	Recorded Item
39	5.2.6.4.4	"Notes"	NOTE: Depressurization greater or less than 1 psi decrements at 15 minute intervals is not cause for rejection. Depressurization must not exceed a rate of 4 psi in 60 minutes.	NOTES: (1) Complete depressurization of the N ₂ blanket in steps of 1 psi nominal, not to exceed 1.2 psi per 15 minute intervals. Depressurization must not exceed a rate of 1.2 psi in 15 minutes. (2) A slight negative pressure on one or both reactant systems at this time is normal and is not cause for rejection.	Requested in Reference (A) and Outlined Specific Limits For Depressurization Normal Cooldown Phenomena
42	5.2.7.2.1	j	"Replace the protective cap on the F5 fitting."	"Replace the protective cap on the F5 fitting using P/N 601531 seal."	Requested In Reference (A)
44	5.2.7.3.1	f (Note)	NOTE: The total power must not exceed 90 watts.	NOTE: The total power must not exceed 90 watts (Block II), 122 watts (Block I).	Requested In Reference (A)
44	5.2.7.3.1	i	"...DISCHARGE FLOWMETER..."	"... <u>DISCHARGE FLOWMETER</u> ..."	Recorded Item
45	5.2.7.3.1	m	"...20 minutes..."	"...20 minutes..."	Not A Recorded Item
45	5.2.7.3.1	m3	SUPPLY PRESS DISCHARGE PRESS N ₂ PRESS AUX (stand)	<u>SUPPLY PRESS</u> <u>DISCHARGE PRESS</u> <u>N₂ PRESS AUX (stand)</u>	Recorded Item

<u>Page</u>	<u>Paragraph</u>	<u>Sub-Paragraph</u>	<u>Appearing In PWA-2399C</u>	<u>PWA-2399D Change</u>	<u>Comments</u>
45	5.2.7.3.1	n	"... valve to limit the water pressure to a maximum of 50 psig..."	"... valve to set the water pressure to 45-50 psig..."	Requested In Reference (A)
46	5.2.7.3.2	a	"... <u>20 minutes</u> ..."	"... 20 minutes..."	Not A Recorded Item
46	5.2.7.3.2	b	"... valve to limit the water pressure to a maximum of 50 psig..."	"... valve to set the water pressure to 45-50 psig..."	Requested In Reference (A)
47	5.2.7.3.3	a	"... <u>80 minutes</u> ..."	"... 80 minutes..."	Not A Recorded Item
47	5.2.7.3.3	a1	"... DISCHARGE FLOWMETER."	"... <u>DISCHARGE FLOWMETER</u> ."	Recorded Item
47	5.2.7.3.3	a3	SUPPLY PRESS DISCHARGE PRESS N ₂ PRESS AUX (stand)	<u>SUPPLY PRESS</u> <u>DISCHARGE PRESS</u> <u>N₂ PRESS AUX (stand)</u>	Recorded Item
48	5.2.7.4.1	c	"Start the powerplant glycol system N ₂ purge by using the N ₂ REG AUX to set 25 ± 5 psig..."	"Start the powerplant glycol system N ₂ purge by using the N ₂ REG AUX to set 25 ± 5 psig..."	Not A Recorded Item
49	5.2.7.4.1	c4	<u>Minimum purge duration is 30 minutes.</u>	<u>Continue purge for a minimum of 30 minutes.</u>	Clarification
51	5.2.7.5.2	i	"... DISCHARGE FLOWMETER."	"... <u>DISCHARGE FLOWMETER</u> ."	Recorded Item
51	5.2.7.5.2	f (Note)	NOTE: The total power must not exceed 90 watts.	NOTE: The total power must not exceed 90 watts (Block II), 122 watts (Block I).	Requested In Reference (A)
51	5.2.7.5.2	k	"... value on the PRESS gage."	"... value on the SUPPLY PRESS gage."	Requested In Reference (A)
52	5.2.7.5.2	l	"... to not more than 1/2 ± 1/4..."	"... to 1/2 ± 1/4..."	Requested In Reference (A)
52	5.2.7.5.2	m	"... <u>10 minutes</u> ..."	"... 10 minutes..."	Not A Recorded Item
52	5.2.7.5.2	m1	DISCHARGE FLOWMETER (F7) ACCUMULATOR DISCHARGE FLOWMETER SECONDARY BYPASS LINE DISCHARGE FLOWMETER	<u>DISCHARGE FLOWMETER (F7)</u> <u>ACCUMULATOR DISCHARGE FLOWMETER</u> <u>SECONDARY BYPASS LINE DISCHARGE FLOWMETER</u>	Recorded Item
52	5.2.7.5.2	m3	SUPPLY PRESS DISCHARGE PRESS N ₂ PRESS AUX (stand)	<u>SUPPLY PRESS</u> <u>DISCHARGE PRESS</u> <u>N₂ PRESS AUX (stand)</u>	Recorded Item
52	5.2.7.5.3	a	"... <u>20 minutes</u> ..."	"... 20 minutes..."	Not A Recorded Item

<u>Page</u>	<u>Paragraph</u>	<u>Sub- Paragraph</u>	<u>Appearing In PWA-2399C</u>	<u>PWA-2399Change</u>	<u>Comments</u>
53	5.2.7.5.3	a1	DISCHARGE FLOWMETER (F7) ACCUMULATOR DISCHARGE FLOWMETER	<u>DISCHARGE FLOWMETER (F7)</u> <u>ACCUMULATOR DISCHARGE FLOWMETER</u>	Recorded Item
53	5.2.7.5.3	a2	"Record the total motor and conductivity probe powers, currents and voltages..."	<u>"Record the total motor and conductivity probe powers, currents and voltages..."</u>	Recorded Item
53	5.2.7.5.3	a3	SUPPLY PRESS DISCHARGE PRESS N ₂ PRESS AUX (stand)	<u>SUPPLY PRESS</u> <u>DISCHARGE PRESS</u> <u>N₂ PRESS AUX (stand)</u>	Recorded Item
54	5.2.7.5.4	g1	DISCHARGE FLOWMETER (F7) ACCUMULATOR DISCHARGE FLOWMETER	<u>DISCHARGE FLOWMETER (F7)</u> <u>ACCUMULATOR DISCHARGE FLOWMETER</u>	Recorded Item
54	5.2.7.5.4	g3	SUPPLY PRESS DISCHARGE PRESS N ₂ PRESS AUX (stand)	<u>SUPPLY PRESS</u> <u>DISCHARGE PRESS</u> <u>N₂ PRESS AUX (stand)</u>	Recorded Item
54	5.2.7.5.4	g	"... 30 minutes..."	"... 30 minutes..."	Not A Recorded Item
54	5.2.7.5.4	f	"... to not more than 1/2 ± 1/4..."	"... to 1/2 ± 1/4..."	Requested In Reference (A)
55	5.2.7.5.5	a	"... 30 minutes..."	"... 30 minutes..."	Not A Recorded Item
55	5.2.7.5.5	a1	DISCHARGE FLOWMETER(F7)	<u>DISCHARGE FLOWMETER(F7)</u>	Recorded Item
55	5.2.7.5.5	a3	SUPPLY PRESS DISCHARGE PRESS N ₂ PRESS AUX (stand)	<u>SUPPLY PRESS</u> <u>DISCHARGE PRESS</u> <u>N₂ PRESS AUX (stand)</u>	Recorded Item
56	5.2.7.5.6	f	"... 30 minutes..."	"... 30 minutes..."	Not A Recorded Item
56	5.2.7.5.6	f1	DISCHARGE FLOWMETER (F7)	<u>DISCHARGE FLOWMETER (F7)</u>	Recorded Item
56	5.2.7.5.6	f3	SUPPLY PRESS DISCHARGE PRESS N ₂ PRESS AUX (stand)	<u>SUPPLY PRESS</u> <u>DISCHARGE PRESS</u> <u>N₂ PRESS AUX (stand)</u>	Recorded Item
57	5.2.7.5.7	f	"... 30 minutes..."	"... 30 minutes..."	Not A Recorded Item
57	5.2.7.5.7	f (note)	"... the cart flush PUMP BYPASS switch..."	"... the cart PUMP BYPASS switch..."	Requested In Reference (A)
58	5.2.7.5.7	f1	DISCHARGE FLOWMETER (F7)	<u>DISCHARGE FLOWMETER (F7)</u>	Recorded Item

Page	Paragraph	Sub-Paragraph	Appearing In PWA-2399C	PWA-2399D Change	Comments
58	5.2.7.5.7	f3	SUPPLY PRESS DISCHARGE PRESS N ₂ PRESS AUX (stand)	<u>SUPPLY PRESS</u> <u>DISCHARGE PRESS</u> <u>N₂ PRESS AUX (stand)</u>	Recorded Item
59	5.2.7.5.8	f	"...to not more than 1/2 of 1/4..."	"...to 1/2 ± 1/4..."	Requested In Reference (A)
59	5.2.7.5.8	g	"... 30 minutes..."	"... 30 minutes..."	Not A Recorded Item
60	5.2.7.5.8	g1	DISCHARGE FLOWMETER (F7) ACCUMULATOR DISCHARGE FLOWMETER	<u>DISCHARGE FLOWMETER (F7)</u> <u>ACCUMULATOR DISCHARGE FLOWMETER</u>	Recorded Item
60	5.2.7.5.8	g3	SUPPLY PRESS DISCHARGE PRESS N ₂ PRESS AUX (stand)	<u>SUPPLY PRESS</u> <u>DISCHARGE PRESS</u> <u>N₂ PRESS AUX (stand)</u>	Recorded Item
61	5.2.7.5.8	m	New Paragraph	Turn the stand 400 CPS SUPPLY switch to OFF <u>deactivating the powerplant pumps and conductivity probe.</u>	Shutting off pumps at the end of flush prevents unnecessary splashing of alcohol and reduces total run time of pumps. This becomes important if personnel cannot immediately attend change lines.
62	5.2.7.6.2	b	New Sub-Paragraph b replacing old sub-paragraph b	Turn the stand 400 CPS SUPPLY switch to ON <u>activating the powerplant pumps and conductivity probe.</u>	To Turn Pump Back On After Previous Step
62	5.2.7.6.2	c	Previously appeared as sub-paragraph b, renumbered to accommodate new step.		To Maintain Sequential Order
62	5.2.7.6.2	c1	"... deactivating the powerplant pumps and conductivity probe."	<u>"... deactivating the powerplant pumps and conductivity probe."</u>	Requested In Reference (A)
62	5.2.7.6.2	c5	<u>Minimum purge duration is 1 hour.</u>	Minimum purge duration is 1 hour.	Not A Recorded Item
63	5.2.7.6.2	c & d	Previously appeared as sub-paragraphs c & d now appear as d & e respectively		To Maintain Sequential Order
63	5.2.7.6.3	b4	<u>Minimum purge duration is 1 hour.</u>	Minimum purge duration is 1 hour.	Not A Recorded Item
	5.2.7.7.1	a	VACUUM TANK S/O ISOLATION VENT S/O VACUUM TANK COLD TRAP S/O NEW	VACUUM DECAY S/O ISOLATION VACUUM GAGE ISOLATION S/O POWERPLANT ISOLATION S/O COLD TRAP S/O ISOLATION	Requested In References (A) & (B)

Attachment I (Cont.)

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<u>Page</u>	<u>Paragraph</u>	<u>Sub-Paragraph</u>	<u>Appearing In PWA-2399C</u>	<u>PWA-2399D Change</u>	<u>Comments</u>
64	5.2.7.7.1	e	"... VACUUM SERVICE PORT to..."	"... VACUUM SERVICE PORT NO. 1 to..."	Requested In Reference (A)
64	5.2.7.7.1	h	New	Connect lines from the HELIUM BOTTLE to the cart PURGE PORT NO. 3 and to the cart COLD TRAP ATMOS. VENT. PORT.	Requested In Reference (A)
64	5.2.7.7.1	g	New	Set and maintain 2-10 psig as indicated on the HELIUM PRESS gage by using the HELIUM REG.	Requested In Reference (A)
65	5.2.7.7.2	a	COLD TRAP S/O VACUUM TANK S/O ISOLATION	POWERPLANT ISOLATION S/O COLD TRAP S/O ISOLATION	Requested In Reference (A)
65	5.2.7.7.2	d	New	Slowly OPEN the cart VACUUM GAGE ISOLATION S/O VALVE.	Requested In Reference (A) & To Maintain Sequential Order
		e f	"... VACUUM MANOMETER." Renumbered to accommodate paragraph addition	"... VACUUM GAGE."	
65	5.2.7.7.2	f	"... maintain the vacuum for 7.0 hours..."	"... maintain the vacuum for 7.0 hours..."	Not A Recorded Item
65	5.2.7.7.2	fla	"a. Slowly OPEN..."	Delete entire paragraph	Unnecessary with New Vacuum Pump
66	5.2.7.7.2	fl b-f	Renumber sub-paragraph b-f to a-g to accommodate above deletion		Maintain Sequential Order
66	5.2.7.7.2	fla	New	VACUUM GAGE ISOLATION S/O	Requested In Reference (A) & (B)
		flf	COLD TRAP S/O New	POWERPLANT ISOLATION S/O Slowly OPEN the cart VACUUM GAGE ISOLATION S/O valve	
66	5.2.7.7.2	flb	OPEN the following cart valve allowing the pressure to reach ambient.	Slowly OPEN the following cart valve allowing the system to be back-filled with Helium.	Requested In Reference (A)
		fle	COLD TRAP S/O	POWERPLANT ISOLATION S/O	
66	5.2.7.7.2	flg	"At the end of the 7.0 hour \pm 10 minutes vacuum dryout..."	"At the end of the 7.0 hour \pm 10 minutes vacuum dryout..."	Not A Recorded Item
66	5.2.7.7.2	flg	"... turn the following cart switch to OFF." VACUUM PUMP	"... turn the following cart switch to OFF." <u>VACUUM PUMP</u>	Recorded Item
66	5.2.7.7.2	flg	Renumbered from f to accommodate previously mentioned changes		Maintain Sequential Order
66	5.2.7.7.3	b & c	"Connect a..." "Set 2-10 psig..."	Delete entire paragraph in both cases	Requested In Reference (A)

Page	Paragraph	Sub-Paragraph	Appearing In PWA-2399C	PWA-2399D Change	Comments
67	5.2.7.7.3	d-g	Renumbered from d - g to b - e to accommodate above deletions		Maintain Sequential Order
67	5.2.7.7.3	b	"... VACUUM MANOMETER."	"... VACUUM GAGE."	Requested In Reference (B)
68	5.2.8.1	d & h	H ₂ PURGE O ₂ PURGE	H ₂ PURGE O ₂ PURGE	Recorded Items
68	5.2.8.1	c	New item, Part of d in PWA-2399C. Set N ₂ Press Purge - N ₂ to 8 ± 2 with the N ₂ REG PURGE - H ₂ and set N ₂ PRESS PURGE - O ₂ to 8 ± 2 PSIG with the N ₂ REG PURGE - O ₂ .	Set N ₂ PRESS PURGE - N ₂ to 100 ± 10 psig with the N ₂ REG PURGE - H ₂ and set N ₂ PRESS PURGE - O ₂ to 100 ± 10 psig with the N ₂ REG PURGE - O ₂ .	Improved Procedure
		d	c..., opening...	d..., opening...	Not A Recorded Item, Lettering Change
		e	Set N ₂ PRESS PURGE - N ₂ to 8 ± 2 psig with the N ₂ REG PURGE - H ₂ and set N ₂ PRESS PURGE - O ₂ to 8 ± 2 psig with the N ₂ REG PURGE - O ₂ . Start purging the reactant systems with N ₂ purge for a period no less than 10 minutes.	<u>Start purging the reactant systems</u> with N ₂ purge for a period no less than 10 minutes.	Part of Item "d" Became Item "c"
		f & g & h & i	Lettering Changes		Necessary Lettering Changes
		h	Turn the following switches to OFF, <u>closing</u> the corresponding powerplant valves.	When the O ₂ and H ₂ pressures reach ambient as indicated on Digital Voltmeter Channels 3 and 4, turn the following switches to OFF, <u>closing</u> the corresponding powerplant valves.	Allows time for residual pressure to dissipate after shutting off supply pressure.
69	5.2.9.3	a	"... cap on J4..."	"... cap P/N P604803, on J4..."	Requested In Reference (A)
		b	"... cap on J3..."	"... cap P/N P603802, on J3..."	
		c	"... cap on J2..."	"... cap P/N P602658, on J2..."	
		d	"... cap on J1..."	"... cap P/N P602659, on J1..."	
69	5.2.9.4	a	"... cap on F6."	"... cap on F6 using P/N 601531 seal."	Requested In Reference (A)
70	5.2.9.4	b	"... cap on F4."	"... cap on F4 using P/N 601531 seal."	Requested In Reference (A)
		c	"... cap on F3."	"... cap on F3 using P/N 601531 seal."	
		d	"... cap on F2."	"... cap on F2 using P/N 601531 seal."	
		e	"... cap on F1."	"... cap on F1 using P/N 601531 seal."	
70	5.3.1.1		"...test fixture..."	"...test cart..."	Requested In Reference (A) The Word Cart Used To Agree With Fig. 6

<u>Page</u>	<u>Paragraph</u>	<u>Sub-Paragraph</u>	<u>Appearing In PWA-2399C</u>	<u>PWA-2399D Change</u>	<u>Comments</u>
71	5.3.1.1	a	New	He S/O HP REG SUPPLY He S/O LP REG SUPPLY	Requested In Reference (A) To Agree With Figure 6
71	5.3.1.1	a - f	"...fixture..." c "...F5..." d "...F1..." e "...F2..." f "...F7 and F8..."	"...cart..." "...F5 using P/N 601531 seal..." "...F1 using P/N 601531 seal..." "...F2 using P/N 601531 seal..." "...F7 using P/N 601531 seal and F8 using P/N 601577 seal..."	Requested In Reference (A)
71	5.3.1.1	g	New	Remove P/N 602914 dust cover from N ₂ sampling valve.	Identification and Clarification on the Removal of Item h, pp 5.3.1.1
71	5.3.1.1		Renumber Subparagraph g to h		Maintain Sequential Order
71 & 72	5.3.1.1	h	g. Leave the following powerplant fluid fittings OPEN to ambient: C (N ₂ sampling) (This valve is in the closed position when uncapped.) F4 (water outlet) F6 (H ₂ vent) F3 (O ₂ vent)	h. Leave the following powerplant fluid fittings OPEN to ambient: F4 (water outlet) F6 (H ₂ vent) F3 (O ₂ vent)	Requested In Reference (A) and "Leave Open" means that the dust cover should be removed for Veeco sniffing. The valve remains <u>closed</u> .
72	5.3.1.1	i & j	Renumber From Subparagraphs h and i to i and j		Maintain Sequential Order
72	5.3.1.1	j	New Addition to j	Note: This activates the H ₂ , O ₂ and N ₂ ELECTRONIC PRESSURE gages on the Pressure Test Cart. Those gages are to be used only to monitor powerplant pressures, no recordings required.	Defines The Use Of Cart Gages Not Previously Mentioned.
72	5.3.1.1	j	"connect the fixture..."	"connect the cart..."	To Agree With Figure 6
72	5.3.1.1	k	New	k. Adjust power supply to 28 volts.	Defines A Previously Implied Step
72	5.3.1.2	c	"...He PRESS LP SUPPLY to 50 ± 10 psig..."	"...He PRESS LP SUPPLY gage to 50 ± 5 psig..."	Requested In Reference (A)
72	5.3.1.2	d	"...fixture valves..."	"...cart valves..."	To Agree With Figure 6
72	5.3.1.2	e (note)	"...will pressurizing."	"while pressurizing."	Requested In Reference (A)
73	5.3.1.3	b	"Adjust the He PRESS HP SUPPLY valve to a..."	"...Set the He PRESS HP SUPPLY gage at a..."	Requested In Reference (A) and the Gage is not Adjusted with the REGULATOR

Attachment I (Cont.)

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<u>Page</u>	<u>Paragraph</u>	<u>Sub-Paragraph</u>	<u>Appearing In PWA-2399C</u>	<u>PWA-2399D Change</u>	<u>Comments</u>
73	5.3.1.3	d	"...He S/O HP SUPPLY..."	"...He S/O HP SUPPLY valve..."	Requested In Reference (A)
73	5.3.1.3	e	Last sentence in subparagraph taken to create a new subparagraph - designated as e.	e. CLOSE the He S/O HP SUPPLY valve.	Further Breakdown Of One Step
73	5.3.1.3	g	"...test stand to decrease to 45-50 psig as recorded on..."	"...cart to decrease the 45-50 psig as indicated on..."	To Agree With Figure 6 and to Improve Terminology
73	5.3.1.3	h	New	CLOSE the He S/O HP VENT valve.	Requested In Reference (A)
73 & 74	5.3.1.3	e - o	Renumber Subparagraphs e-m to e-o		Maintain Sequential Order
74	5.3.1.3	k	Addition To Present Statement "...leaking)."	Record the variation in pressure as registered on the <u>DIFF PRESS GAGE</u>	Clarification of Procedure
74	5.3.1.3	l - o	Renumber subparagraphs j - m to l - o		Maintain Sequential Order
74	5.3.1.4	•	"20 minutes and record the variation in pressure as registered on the DIFF PRESS gage."	"20 minutes and <u>record the variation in pressure as registered on the DIFF PRESS gage.</u> "	Recorded Item
74	5.3.1.4	g	"pressure in the test stand to decrease to 45-50 psig as recorded on the He PRESS HP SUPPLY gages."	"pressure in the cart to decrease to 45-50 psig as indicated on the He PRESS HP SUPPLY gage."	Improved Terminology
74	5.3.1.4	h	New	h. CLOSE the He S/O HP VENT valve.	Requested In Reference (A)
75	5.3.1.4	i, j	Renumber Subparagraphs h & i to i & j		Maintain Sequential Order
75	5.3.1.5	e	20 minutes and record the variation in pressure as registered on the DIFF PRESS gage.	20 minutes and <u>record the variation in pressure as registered on the DIFF PRESS gage.</u>	Recorded Item
75	5.3.1.5	f	OPEN the He S/O HP decay isolation valve	OPEN the He S/O HP DECAY ISOLATION valve	Requested In Reference (A)
76	5.3.1.6	f	Allow the nitrogen tank on the engine to cool to room temperature.	Allow the powerplant nitrogen tank to cool to room temperature.	Improved Terminology
76	5.3.1.6	f k	"...to cool ro room..." New	"...to cool to room..." CLOSE the He S/O HP VENT valve.	Requested In Reference (A)
76	5.3.1.6	h	"...record the variation in pressure as registered on the DIFF PRESS gage."	"...record the variation in pressure as registered on the <u>DIFF PRESS gage.</u> "	Recorded Item

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Page	Paragraph	Sub-Paragraph	Appearing In PWA-2399C	PWA-2399D Change	Comments								
76	5.3.1.6	j	"...test stand..." "...45-50 psig as recorded..." Add Note	"...cart..." "...45-50 psig as indicated..." Note: Depressurize over a period of at least 5 minutes	To Agree With Figure 6 Improved Terminology Prevents Frost From Forming On N ₂ Tank								
76	5.3.1.6	n	New	OPEN He S/O HP VENT valve.	Improved Procedure								
76	5.3.1.6	o	"...fixture..." "...He REG HP."	"...cart..." "...He REG HP closing the REG HP."	To Agree With Figure 6 Improved Terminology								
76	5.3.1.6	k, l, m, n, o, p	Renumber subparagraphs k - n to k - p to include new additions		Maintain Sequential Order								
77	5.3.1.7	e	"...N ₂ system to 32 ± 1 psig as indicated by the N ₂ transducer (62.7 ± 1.3 mv)."	"...N ₂ system to 64 ± 1 inches Hg as indicated on the He PRESS LP SUPPLY - N ₂ gage.	Requested In Reference (A)								
77	5.3.1.7	e2 e3	"...GLYCOL pressure together." "...bled the blanket..."	"...GLYCOL pressures together." "...bleed the blanket..."	Typographical Error Requested In Reference (A)								
78	5.3.1.7	k	"...record results."	"... <u>record results</u> ."	Recorded Item								
79 & 80	5.3.1.8 5.3.1.9	k1 - a b c d f	"...fixture..." "...Fixture" "...fixture..." "...fixture..." "...fixture..." "...fixture..." "Disconnect the digital voltmeter instrumentation cable..."	"...cart..." "...Cart" "...cart..." "...cart..." "...cart..." "...cart..." "Disconnect the instrumentation cable..."	To Agree With Figure 6 The Digital Voltmeter is no longer in use								
81	5.4.1.2	j	"...readings on megohmmeter."	"... <u>readings on megohmmeter</u> ."	Recorded Item								
81	5.4.1.2	g & h	New	g. Place multi-meter (Simpson) in "+DC" position on 1000 vdc. h. Plug programmer connector into checkout unit, push test button and take reading on multi-meter.	Additional Checks of Equipment Before and After a Sequence Prevents Errors Due to Instrument Drift								
<table><tr><th>Programmer</th><th>Description</th><th>Meter Voltage</th><th>Min. Readings</th></tr><tr><td>No. 55</td><td>Test Voltage Check</td><td>1000</td><td>450 vdc</td></tr></table>						Programmer	Description	Meter Voltage	Min. Readings	No. 55	Test Voltage Check	1000	450 vdc
Programmer	Description	Meter Voltage	Min. Readings										
No. 55	Test Voltage Check	1000	450 vdc										
81	5.4.1.2	g - j	Renumber Subparagraphs g - h to g - j To Include New Additions		Maintain Sequential Order								

Attachment I (Cont.)

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<u>Page</u>	<u>Paragraph</u>	<u>Sub-Paragraph</u>	<u>Appearing In PWA-2399C</u>	<u>PWA-2399D Change</u>	<u>Comments</u>												
82	5.4.1.2	k	New	Repeat item h													
		l	New	Place multi-meter (Simpson) in "+DC" position on 250 vdc.													
		m	New	Plug programmer connector into checkout unit, push test button and take reading on multi-meter.	Improve Procedure												
				<table> <tr> <th><u>Programmer</u></th><th><u>Description</u></th><th><u>Meter</u></th><th><u>Max.</u></th><th><u>Voltage</u></th><th><u>Reading</u></th></tr> <tr> <td>No. 56</td><td>Test Voltage</td><td>250</td><td>60 vdc</td><td></td><td></td></tr> </table>	<u>Programmer</u>	<u>Description</u>	<u>Meter</u>	<u>Max.</u>	<u>Voltage</u>	<u>Reading</u>	No. 56	Test Voltage	250	60 vdc			
<u>Programmer</u>	<u>Description</u>	<u>Meter</u>	<u>Max.</u>	<u>Voltage</u>	<u>Reading</u>												
No. 56	Test Voltage	250	60 vdc														
		0	New	Check													
				Repeat item m													
82	5.4.1.2	k - o	Renumber subparagraph i to k - o to include new additions		Maintain Sequential Order												
83	5.4.2.2	b	"...take readings on the multi-meter."	"...take readings on the multi-meter."	Recorded Item												
83	5.4.2.2	c	"...the following resistive continuity readings."	"...the following resistive continuity readings."	Recorded Item												
84	5.4.2.2		44 Primary Condensor Exit Temp. 0 2 Common Leads (Check 2) New	44 Primary Condensor Exit Temp 0 2 Common Leads (Check 2) 57 Low Power Heater Control 0 2 Common Leads	Requested In Reference (A)												
85	5.5.1		*Latest Accepted Revision Letter	Delete	Requested In Reference (A)												
85	5.5.1		Contract No. M3J3XAA-406009A (Block I) M6J7XAA-400003A (Block II)	Contract No. NAS 9-150	Actual Contract Number												
86	5.7	Note	"...receipt of plant water analysis."	"...receipt of powerplant water analysis."	Requested In Reference (A)												

<u>Figure Number</u>	<u>Page</u>	<u>Description Or Change</u>	<u>Comments</u>
2	A-2	Remove Manometer	Requested In Reference (B)
2	A-2	Valve Title Changes	Requested In Reference (A)
2	A-3	New Photograph	Requested In Reference (B)
3	A-5	Wrong Figure No., etc.	Requested In Reference (A)
4	A-6	Minor Changes To Schematic	Updated
4	A-7	New Photograph	Updated
5	A-8	New Schematic	Requested In Reference (A) & (B)
5	A-9	New Photograph	Requested In Reference (A) & (B)
5	A-10	Add Page No.	Requested In Reference (A)
6	A-11	Minor Changes	Previously Omitted
6	A-12	Minor Changes	Previously Omitted
7	A-13	Minor Changes	Requested In Reference (A)
7	A-14	New Pictures	Updated
8	A-15	To Agree With A-14	Updated
9	A-16	Omitted In PWA-2399C	Requested In Reference (A)

ATTACHMENT II

<u>Page</u>	<u>Paragraph</u>	<u>Appearing in PWA-2399C</u>	<u>Requested Change</u>	<u>Reason for Noncompliance</u>
5	3.5	"Should a deviation to this procedure occur which does not affect the end-item performance as defined by NAA/S&ID Procurement Specification..., the deviation may be evaluated and accepted by the subcontractor through approval of resident NAA/S&ID representative(s)."	"... the deviation may be evaluated and accepted by the subcontractor through approval of NAA/S&ID."	When this was written, NAA/SD's resident representative was leaving making the statement in PWA-2399C obsolete. However, since a new resident representative is here, no need for this change now exists.
21	5.2.3.4 sub. para. c & d	c. <u>"Establish a 0-1 psia vacuum on the powerplant H₂ and O₂ systems..."</u> d. "Maintain the 0-1 psia vacuum for a period of not less than <u>120 minutes.</u> "	In steps c and d to change the vacuum range on the reactant systems from 0-1 psia to 0-1 in H _g in accordance with that presented in the Field Operations Manual.	Previous experience indicates that the specified vacuum is more than sufficient to produce a clean system. The service manual may be revised to this vacuum level.
39 & 78	5.2.6.4.4 and 5.3.1.8 sub. para. e	"Depressurization greater or less than 1 psi decrements at 15 min. intervals..." "Depressurization may be accomplished in 10 inch H _g decrements."	Change the word "decrements" to "increments"	Decrements is grammatically correct.
78	5.3.1.8 sub. para. e	"Depressurize at a rate not to exceed 10 inches H _g per 30-minute period."	Change so the depressurization rate is consistent with the requirements of paragraph 5.2.6.4 and Field Operations Manual.	At assembly the two hour hold at 30 inches H _g accomplishes the same results as a much slower depressurization rate without a hold as is done at test.

FOREWORD

This End-Item Test and Inspection procedure establishes the sequence, methods, and equipment to be used in conducting End-Item Tests and Inspection of the PC3A-2 Fuel Cell Powerplant for the Apollo Command and Service Module. This document is submitted by Pratt & Whitney Aircraft Division of United Aircraft Corporation, East Hartford, Connecticut in accordance with the requirements of paragraph 3.6.1.5 of MC 999-0025B, dated 12 November 1963, and Attachment No. 3 to Purchase Order No. M 6J7XAA-400003A.

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7	Plumbing and Electrical Schematic - Sea Level Test Stand	A-13
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1. SCOPE

1.1 General

This procedure establishes the sequence, methods, and equipment to be used in conducting End-Item Tests and Inspection of the PC3A-2 Fuel Cell powerplant for the Apollo Command and Service Module. The tests and inspections will be conducted in accordance with ME 464-0007 and with Procurement Specification MC 464-0015 and applicable amendments.

2. APPLICABLE DOCUMENTS

2.1 General

The following specifications, publications, and drawings as implemented under this Purchase Order form a part of these procedures to the extent specified herein.

2.1.1 Specifications

MC 464-0015F	23 June 1966	Apollo Spacecraft, Fuel Cell, Electrical Powerplant
MC 999-0025B	12 Nov. 1963	Documentation Requirements for Project Apollo Major Subcontractors
MB 0110-006E	17 May 1966	Ethylene Glycol-Water Solution

2.1.2 Drawings

ME 464-0007*	Power Supply, Electrical Fuel Cell Specification Control Drawing
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* For purposes of preparing this procedure, the revision of the specification control drawing considered to be applicable is that shown in the then currently applicable delivery schedule of the purchase order.

3. TEST PROGRAM ADMINISTRATION

3.1 Notification

The contractor will be advised not less than 48 hours in advance of a scheduled acceptance test. No test will be delayed if the contractor's representative fails to appear.

3.2 Witnessing

Representatives of the contractor, or representatives of government agencies who have a need to know will be granted the right to witness any acceptance test.

3.3 Data to be Recorded

The data listed below will be recorded using PWA Form G.O. 338, Log of Powercel[®] Test, as shown in Figure 1. Additional instrumentation may be used and data recorded at the discretion of the subcontractor to monitor powerplant or facility operation during the specified testing.

<u>Parameter</u>	<u>Instrument Range</u>	<u>Instrument Accuracy</u>
Elapsed Time	-	±5 minutes
Fuel Flow	0.04 to 1.50 pph	±3% of reading
Oxidizer Flow	0.02 to 2.5 pph	±3% of reading
Heater Voltage	0 to 100 volts	±2% of full scale
Heater Current	Zones 1 & 3 0-5 amps	±2% of full scale
	Zone 2 0-50 amps	
Total Motor & Conductivity Probe		
Power	0 to 150 watts	±5 watts
Glycol External Differential Pressure	0 to 15 psi	±1% of full scale
Water Generation	0 to 15 lbs.	±2% of reading
Water pH	-	±0.2 pH
Powerplant Voltage	0 to 50 volts (7)*	±0.5% of reading
Powerplant Current	0 to 200 amperes (5 or 6)*	±0.5% of reading
Regulated Fuel Pressure	0 to 75 psia (3)*	±0.75 psi
Regulated Oxidizer Pressure	0 to 75 psia (4)*	±0.75 psi

Regulated Nitrogen Pressure	0 to 75 psia	(2)*	±0.75 psi
Powerplant Surface Temperature	0 to 550 °F	(1-1)*	±2 °F
Glycol Interface Temperature (Inlet and Outlet)	-40 to 200 °F		±5 °F
Condenser Exit Temperature	-60 to 250 °F	(1-2)*	±2 °F
Voltage (Pump Motor Power Factor)	0 to 130 volts		±0.5% of full scale
Current (Pump Motor Power Factor)	0 to 1.5 amperes		±0.5% of full scale
Water Analysis	Standard quantitative analysis, including bacteria count, on one sample at completion of the Performance Run Cycle.		

* Digital Voltmeter Readout Channel

3.4 Documentation Acceptance Test

Documentation will be submitted to the contractor in accordance with the requirements of MC 999-0025. The End-Item Data Book shall contain the following:

Cover
Foreword
Index
Mechanical Test
Start Summary
Shutdown Summary
Pressure Test
Electrical Test
Final Inspection
Operating Time
Configuration and Serialization Record
Failure, Malfunction, and Replacement Record
Corrective Action Record
Waiver and Deviation Record
Preservation Record
Summary of Material Review Actions
Certification

ATTACHMENTS

Acceptance Test Log Sheets
Manufacturing Data Sheets
Shipping Data
Interface Inspection Report
Powerplant Parts List
Gas Purity Analysis
Powercel® Instrumentation Calibration Data

3.5 Acceptance Criteria

Successful completion of all the acceptance tests specified herein will constitute criteria for powerplant acceptance.

Should a deviation to this procedure occur which does not affect the end item performance as defined by the NAA/SD Procurement Specification or alter the procedure to the extent of jeopardizing the performance, durability or acceptability of the fuel cell, the deviation may be evaluated and accepted by the subcontractor through approval of resident NAA/SD representative(s).

3.6 Rejection and Retest

Starts made by the fuel cell powerplant during the course of acceptance testing shall not exceed a total of four. A start is defined as a heatup from ambient temperature to an excess of 300°F as indicated by the powerplant surface temperature. If any production fuel cell powerplant requires more than 24 hours of load time to successfully complete the standard acceptance test run, the particular fuel cell module shall be rejected. Also if any production fuel cell powerplant requires more than 100 hours of operation at a temperature greater than 300°F to successfully complete the standard acceptance test run, the particular fuel cell module shall be rejected. Should a failure occur in any of the tests, continuation or termination of acceptance testing will be at the discretion of the subcontractor with approval of the contractor's resident quality assurance representative. Upon correction of the fault or faults, subject to the approval of the contractor's resident quality assurance representative, the powerplant may be resubmitted for acceptance. The extent of additional acceptance testing will be at the option of the contractor's resident quality assurance representative.

4. POWERPLANT DESCRIPTION

4.1 General

The Pratt & Whitney Aircraft PC3A-2 Fuel Cell Powerplant, Part Number 606100 (Block I - Part Number 602600), is an electrical power source which converts into direct current the energy derived from the chemical reaction of hydrogen and oxygen. Potable water is generated as a by-product of the process. The powerplant utilizes dual-porosity nickel electrodes with a potassium hydroxide electrolyte.

The Apollo Fuel Cell Powerplant PC3A-2 consists of a power, or energy conversion section, a reactant control system, a waste heat and water removal system, and flight instrumentation. A schematic diagram of an Apollo Fuel Cell Powerplant follows. The power section consists of 31 Bacon type fuel cells having dual-porosity nickel electrodes and using highly concentrated aqueous potassium hydroxide as the electrolyte. The cells operate at temperatures up to 500°F combining hydrogen and oxygen to produce electrical energy, water, and waste heat. Gaseous hydrogen and oxygen are provided to the power section through reactant regulators which maintain the pressure of the reactants in the fuel cell at desired levels independent of electrical power demand. Preheaters in the reactant supply system utilize a portion of the waste heat to warm the reactants before they enter the pressure regulators.

A flow of hydrogen in excess of the instantaneous demand of the fuel cells is maintained to carry water and waste heat away from the cells. If the cell temperature is too low at a given operating condition, the return flow of hydrogen passes through a regenerator. In this primary regenerator the hydrogen supplied to the cells is heated to maintain the temperature of the cells at the desired level. The proportion of the hydrogen return flow passing through the regenerator is controlled by the primary regenerator bypass valve.

The return flow of hydrogen bearing water vapor then passes through a condenser where the water vapor is condensed to a liquid. The condenser is cooled by an ethylene glycol/water mixture which is pumped through the spacecraft radiator. A portion of the return flow from the radiator is bypassed to the secondary regenerator to maintain a constant temperature at the condenser. The proportion of coolant bypassed to the regenerator is controlled by the secondary regenerator bypass valve.

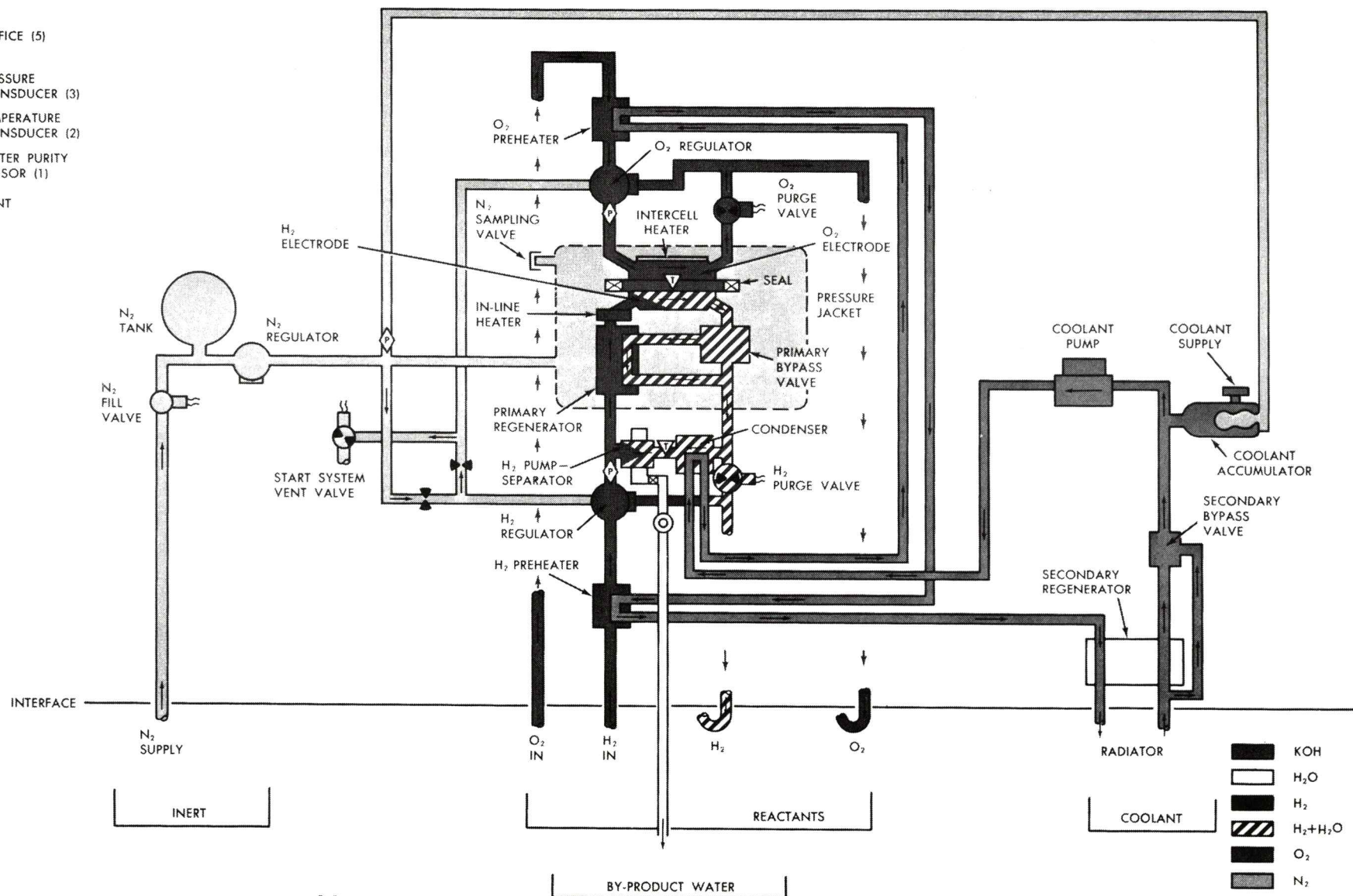
BLOCK I

APOLLO FUEL CELL POWERPLANT MODEL PC3A-2

FLOW SCHEMATIC

PRATT & WHITNEY AIRCRAFT

- ORIFICE (5)
- PRESSURE TRANSDUCER (3)
- TEMPERATURE TRANSDUCER (2)
- WATER PURITY SENSOR (1)
- VENT



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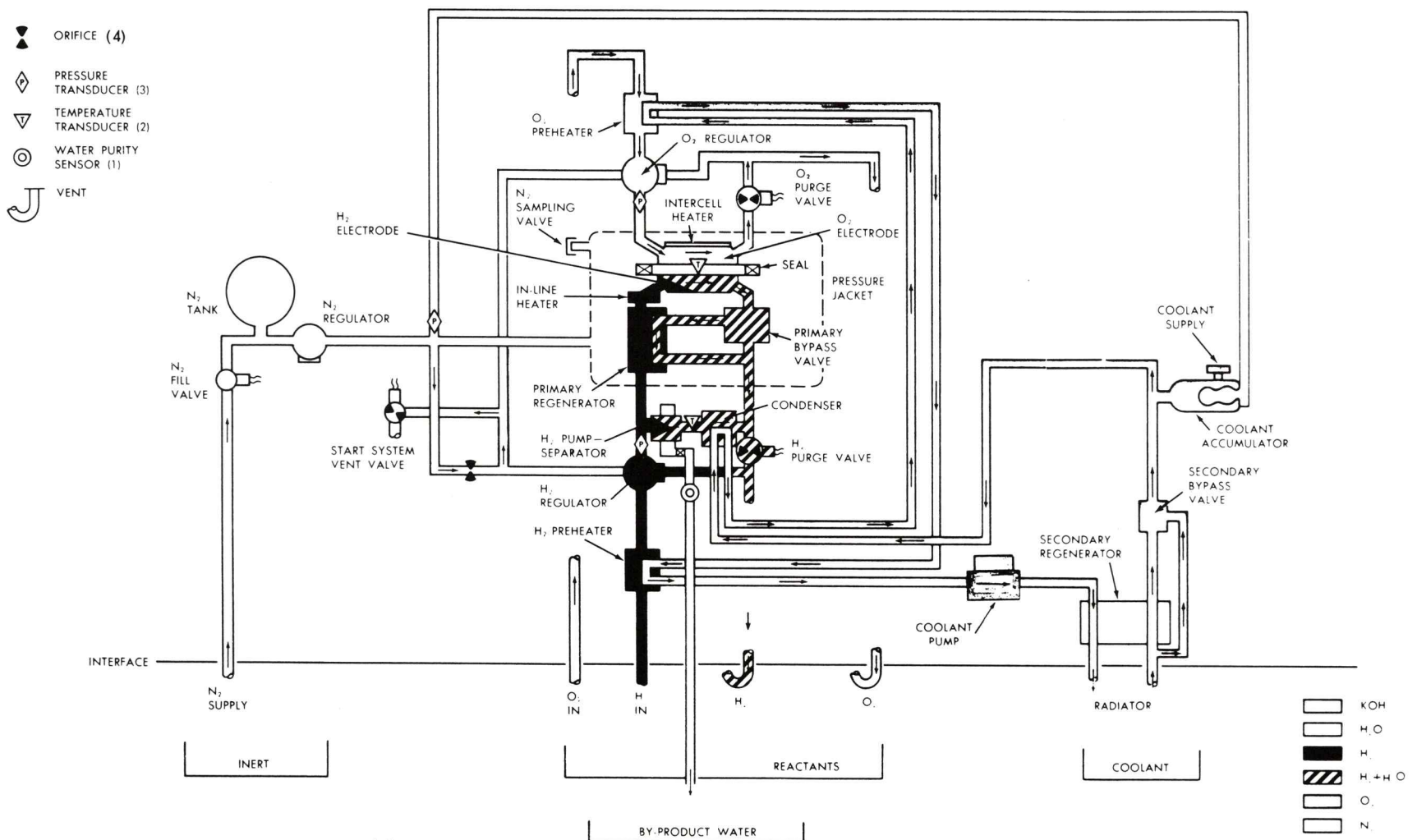
Pratt & Whitney Aircraft

DIVISION OF UNITED AIRCRAFT CORPORATION

APOLLO POWERCELL
PWA-2399D

M-19799
R641011

BLOCK II

APOLLO FUEL CELL POWERPLANT MODEL PC3A-2
FLOW SCHEMATIC


PAGE NO. 8

Hydrogen and water leaving the condenser pass through a centrifugal separator where the water is removed from the cool hydrogen and discharged to the spacecraft water system. A redundant water discharge valve ensures that no free hydrogen enters the water manifold. The dry hydrogen exiting from the separator is pumped back to the fuel cell through the primary regenerator.

Reactant purge valves are included in the powerplant to permit venting of the reactant systems and fuel cells. This is necessary to remove inert constituents of the reactant gases which are concentrated by the removal of hydrogen and oxygen in the fuel cells. Instrumentation is included to permit significant operating variables to be monitored during checkout and operation of the powerplant.

5. INSPECTION AND TEST PROCEDURES

5.1 EXAMINATION OF PRODUCT PROCEDURE

5.1.1. Assembly Record Sheets

Review current Assembly Record Sheets in effect on date of the test to verify that all prescribed operations have been successfully completed and approved (signed off) by Assembly, Quality Control and Navy.

Component Assembly Fuel Cell, Assembly Record Sheets.
(PC-02)

Fuel Cell Assembly, Assembly Record Sheets. (PC-03)

Fuel Cell Stack Sub-assembly, Assembly Record
Sheets. (PC-04)

Powerplant Assembly Fuel Cell, Assembly Record
Sheets. (PC-05)

Powerplant Assembly (Support Assembly) Assembly
Record Sheets. (PC-05A)

Sensor and Signal Conditioner Assembly-Conductivity,
Assembly Record Sheets. (PC-21)

Sensor & Signal Conditioner Conductivity Assembly,
Assembly Record Sheets. (PC-21A)

Coolant Accumulator Assembly, Assembly Record
Sheets. (PC-22)

Motor Pump Assembly, Circulating Fuel, Assembly
Record Sheets. (PC-23)

5.1.2 Powerplant Inspection Record Cards

Review Powerplant Inspection Record Cards (Hard cards).

Review Powerplant Component Inspection Records. (G.O. #174)

Review Powerplant & Component Inspection Record. (G.O. #176)

Review Powercel Inspection Record. (G.O. #175)

5.1.3 Visual Inspection

Visually inspect the powerplant for good workmanship by re-checking the exterior condition of the completed assembly to assure that nothing detrimental has occurred during the assembly operations. (Magnification may be used to evaluate indications of defects found with normal corrected vision).

- 5.1.4 Present the powerplant to Navy for Acceptance and Signoff permitting the powerplant to go to test for the Performance Run Cycle.

5.2 PERFORMANCE RUN CYCLE

NOTE: In Section 5.2 all sequences, valve operations or data that is underlined will appear on the Powercel® Log Sheet (PWA Form G.O. 338), either in the column provided or by written entry. Any sequences, valve operations, data, etc., not underlined will be complied with and the compliance will be denoted by the entry of the applicable paragraph number and the time at which the last paragraph sequence was accomplished in the log sheet column provided.

5.2.1 INSTALLATION OF POWERPLANT IN A SEA LEVEL TEST STAND

NOTE: The following steps are necessary to mount a powerplant and they need not be continuous nor consecutive but should be accomplished prior to filling the powerplant glycol system.

- 5.2.1.1 The Test Department will accept the powerplant, mounted in the test stand adapter, from the Assembly Department after completion of a visual inspection, and then start mounting the powerplant in the sea level test stand.

- 5.2.1.2 Ascertain that the following valves are in the CLOSED position.

H₂ S/O HP F/M ISOLATION
H₂ S/O HP SUPPLY
H₂ S/O LP SUPPLY
H₂ S/O VACUUM
O₂ S/O HP SUPPLY
O₂ S/O LP SUPPLY
O₂ S/O - LP F/M ISOLATION
O₂ S/O - VACUUM
N₂ S/O - PURGE H₂
N₂ S/O - PURGE O₂

N₂ S/O P/P SUPPLY
N₂ S/O - AUX P/P SUPPLY
N₂ S/O - SAMPLING
H₂ S/O - VENT
O₂ S/O - VENT
N₂ S/O - BLANKET VENT
H₂O S/O-VENT CONDENSER
N₂ S/O LP SUPPLY

5.2.1.3 Ascertain that the following stand regulators are turned out:

H₂ REG - HP
H₂ REG - LP
O₂ REG - HP
O₂ REG - LP
N₂ REG P/P SUPPLY
N₂ REG PURGE - H₂
N₂ REG PURGE - O₂
N₂ REG - AUX
N₂ REG - LP

5.2.1.4 Ascertain that the following stand switches are in the OFF position.

H₂ PURGE
O₂ PURGE
N₂ FILL
LO REACT DIFF
H₂ VACUUM PUMP
O₂ VACUUM PUMP
DVM
DCVM
28 VOLT POWER SUPPLY
400 CPS SUPPLY
60 CPS SUPPLY

5.2.1.5 Ascertain that the following stand isolation valves are in the OPEN position.

N₂ S/O AUX STAND ISOLATION
O₂ S/O HP STAND ISOLATION
O₂ S/O LP ISOLATION
O₂ S/O HP ISOLATION
N₂ S/O HP STAND ISOLATION
N₂ S/O PURGE O₂ ISOLATION
N₂ S/O LP STAND ISOLATION

N₂ S/O P/P ISOLATION
N₂ S/O PURGE H₂ ISOLATION
H₂ S/O HP STAND ISOLATION
H₂ S/O HP ISOLATION
H₂ S/O LP ISOLATION

5.2.1.6 Turn the IND/TOT selector switch to TOTAL.

5.2.1.7 Turn the VTVM switch to VOLTS.

5.2.1.8 Make the following Plumbing Connections:

NOTE: Prior to the removal of each protective cap inspect for and remove any residual fluid on the interface fittings.

- a. Remove interface adapter protective cap from fitting F1 and connect H₂ SUPPLY stand line to powerplant interface fitting F1 using nickel seal P/N 601531.
- b. Remove interface adapter protective cap from fitting F2 and connect the O₂ SUPPLY stand line to powerplant interface fitting F2 using nickel seal P/N 601531.
- c. Remove interface adapter protective cap from fitting F3 and connect the O₂ VENT stand line to powerplant interface fitting F3 using nickel seal P/N 601531.
- d. Remove interface adapter protective cap from fitting F4 and connect the WATER OUTLET line to powerplant interface fitting F4 using nickel seal P/N 601531. Do not connect water collection bottle at this point.
- e. Remove interface adapter protective cap from fitting F5 and connect N₂ SUPPLY stand line to powerplant interface fitting F5 using nickel seal P/N 601531.
- f. Remove interface adapter protective cap from fitting F6 and connect H₂ VENT stand line to powerplant interface fitting F6 using nickel seal P/N 601531.

- g. Remove interface adapter protective cap from fitting F7 and connect GLYCOL TO RADIATOR stand line to powerplant interface fitting F7 using nickel seal P/N 601531.

Note: Collect any fluid noted when the protective cap is removed.

- h. Remove interface adapter protective cap from fitting F8 and connect GLYCOL FROM RADIATOR stand line to powerplant interface fitting F8 using nickel seal P/N 601577.

Note: Collect any fluid noted when the protective cap is removed.

- i. Remove the protective cap from the powerplant N₂ SAMPLING VALVE connector and connect N₂ SAMPLING stand line to the powerplant N₂ SAMPLING VALVE connector.

5.2.1.9 Make the following Electrical Connections:

- a. Remove protective cap from connector J1 and connect the POWER OUTPUT stand cable to powerplant interface connector J1.
- b. Remove protective cap from connector J2 and connect the HEATER POWER SUPPLY stand cable to powerplant interface connector J2.
- c. Remove protective cap from connector J3 and connect the CONTROL POWER SUPPLY stand cable to powerplant interface connector J3.
- d. Remove protective cap from connector J4 and connect the INSTRUMENTATION stand cable to the powerplant interface connector J4.

- 5.2.1.10 Install generated water collection equipment and attach to tube installed on F4 interface connector

- 5.2.1.11 Ascertain that the following valves are in the CLOSED position.

ATMOS VENT H₂O SAMPLE COLLECTION
H₂O S/O SAMPLE COLLECTION

- 5.2.1.12 Obtain quality control validation that installation of power-plant is complete.

5.2.2 GLYCOL SYSTEM FILL PROCEDURE

5.2.2.1 Glycol Filling Cart Hook-Up

- a. Connect a line from the GLYCOL SERVICE PORT of the glycol filling cart, Figure 2, to the test stand GLYCOL S/O P/P FILL valve.
- b. Turn OUT the N₂ REG-GLYCOL RESERVOIR.
- c. Connect a line from the N₂ SERVICE PORT of the glycol filling cart to the test stand N₂ S/O LP SUPPLY valve.
- d. Ascertain that the following valves are CLOSED.

GLYCOL RESERVOIR S/O FILL
GLYCOL RESERVOIR S/O ISOLATION
VACUUM TANK S/O ISOLATION
VACUUM PUMP S/O ISOLATION
VENT S/O VACUUM TANK
GLYCOL S/O P/P FILL (test stand)
VENT S/O GLYCOL RESERVOIR

5.2.2.2 Glycol Reservoir Filling

- a. OPEN the GLYCOL RESERVOIR S/O FILL and VENT S/O GLYCOL RESERVOIR valves and fill the GLYCOL RESERVOIR with an aqueous solution of inhibited ethylene glycol meeting the requirements of MB 0110-006, Type III.
- b. CLOSE the GLYCOL RESERVOIR S/O FILL and VENT S/O GLYCOL RESERVOIR valves.

5.2.2.3 Glycol System Evacuation

- a. By adjusting the stand 28 volt VOLTAGE CONTROL RHEOSTAT set 28 volts as indicated on the stand DC VOLTMETER and maintain.
- b. Turn the stand 28 VOLT POWER SUPPLY switch ON.

- c. Turn the following stand switches to ON, opening the corresponding powerplant valves.

O₂ PURGE
H₂ PURGE
N₂ FILL

- d. OPEN the following stand valves:

H₂ S/O VENT
O₂ S/O VENT

- e. OPEN the N₂ S/O AUX P/P SUPPLY stand valve.

- f. Pressurize the N₂ BLANKET to 20 ± 2 psia with the stand N₂ REG AUX and record as read on the Digital Voltmeter Channel 2.

- g. Turn the VAC PUMP switch to ON.

- h. OPEN the following valves:

VACUUM PUMP S/O ISOLATION
VACUUM TANK S/O ISOLATION

- i. After a pressure of 1 inch Hg. absolute or less is obtained, as read on the VACUUM GAGE, CRACK OPEN the GLYCOL RESERVOIR S/O ISOLATION valve.

- j. When the glycol level in the GLYCOL RESERVOIR LEVEL sight gage decreases slightly, CLOSE the GLYCOL RESERVOIR S/O ISOLATION valve.

- k. With the vacuum pump still running OPEN the stand GLYCOL S/O P/P FILL valve.

- l. OPEN the ATMOS. VENT S/O valve and PULSE THE VACUUM from 24-28 inch Hg to 14-18 inch Hg, as read on the VACUUM GAGE, at least 12 times.

- m. Establish a pressure of 1 inch Hg absolute or less and record observed and absolute values as read on the VACUUM GAGE. Maintain pressure for a period not less than 10 minutes.

5.2.2.4 Glycol Systems Decay Checking

- a. CLOSE the VACUUM PUMP S/O ISOLATION valve.
- b. Turn the VAC PUMP switch to OFF.

- c. Record the VACUUM GAGE reading at the start and end of a period of not less than 15 minutes. The maximum allowable pressure rise is 0.2 inch Hg. in 15 minutes.
- d. CLOSE the VACUUM TANK S/O ISOLATION valve.

5.2.2.5 Glycol System Filling

- a. OPEN the stand N₂ S/O LP SUPPLY valve.
- b. Set the N₂ PRESS LP SUPPLY to 50 ± 10 psig by adjusting the N₂ REG LP.
- c. Set the N₂ PRESS-GLYCOL RESERVOIR GAGE to 15 ± 2 psig by adjusting the N₂ REG-GLYCOL RESERVOIR.
- d. OPEN the GLYCOL RESERVOIR S/O ISOLATION valve, and keep OPEN until the glycol level in the GLYCOL RESERVOIR LEVEL sight gage stops falling.
- e. OPEN the two following stand valves:

GLYCOL Δ P GAGE EQUALIZATION S/O No. 1
GLYCOL Δ P GAGE EQUALIZATION S/O No. 2
- f. Slowly OPEN the stand ATMOS VENT S/O valve until the discharge from the stand GLYCOL Δ P P/P INTERFACE gage is free of air bubbles then CLOSE the valve.
- g. CLOSE the following valves:

GLYCOL Δ P GAGE EQUALIZATION S/O No. 1 (TEST STAND)
GLYCOL Δ P GAGE EQUALIZATION S/O No. 2 (TEST STAND)
GLYCOL RESERVOIR S/O ISOLATION
GLYCOL S/O P/P FILL (TEST STAND)
N₂ S/O LP SUPPLY (TEST STAND)
- h. Decrease the N₂ PRESS-GLYCOL RESERVOIR GAGE to zero with the N₂ REG-GLYCOL RESERVOIR.
- i. Disconnect the line from the GLYCOL SERVICE PORT and from the stand GLYCOL S/O P/P FILL valve.
- j. Disconnect the line from the N₂ SERVICE PORT.
- k. Turn OUT the N₂ REG LP.
- l. CLOSE the stand N₂ S/O LP SUPPLY valve.

5.2.2.6 Glycol System Bleeding

- a. Pressurize the N₂ BLANKET to 30 ± 2 psia and record with the N₂ REG AUX as read on the Digital Voltmeter Channel 2.
- b. OPEN the GLYCOL S/O P/P FILL valve and Bleed 320 ± 10cc from the glycol system.
- c. CLOSE the GLYCOL S/O P/P FILL valve.

5.2.2.7 Glycol System Fill Evaluation

- a. By adjusting the 400 CPS POWERSTAT set 115 ± 2 volts as indicated on the 400 CPS VOLTMETER and maintain.
- b. Turn the 400 CPS SUPPLY switch to ON - Activating the powerplant pumps and conductivity probe and record the total motor and conductivity probe power, current and the glycol external ΔP.
- c. Record the maximum glycol pressure fluctuation observed on the GLYCOL PRESS P/P DISCH gage.

NOTE: If the fluctuation exceeds 6 psi repeat the Glycol Filling Procedure.

- d. Turn the 400 CPS SUPPLY switch to OFF, deactivating the powerplant pumps and conductivity probe.

5.2.2.8 Powerplant N₂ Blanket Depressurization

- a. Depressurize the Powerplant N₂ Blanket by turning OUT the N₂ REG AUX and turning the LO REACT DIFF switch to ON until the Digital Voltmeter Channel 2 indicates ambient and record.
- b. Turn the following switches to OFF, closing the corresponding powerplant valves.

N₂ FILL
H₂ PURGE
O₂ PURGE
LO REACT DIFF

- c. CLOSE the following valve.

N₂ S/O AUX P/P SUPPLY

5.2.2.9 Protection Shield Installation

- a. Install the test stand protection shield.

5.2.3 REACTANT SYSTEM EVACUATION AND PRESSURIZATION PROCEDURE

5.2.3.1 Reactant System Purge

- a. Ascertain that 150 ± 10 psig is indicated on the H₂ PRESS-LP PRESS LIMITING pressure gage.
- b. Ascertain that 180 ± 10 psig is indicated on the O₂ PRESS-LP PRESS LIMITING pressure gage.
- c. OPEN the following valves
- O₂ S/O LP SUPPLY
H₂ S/O HP SUPPLY
- d. Set and record 100 ± 10 psig oxygen supply pressure on the O₂ PRESS LP SUPPLY gage with the O₂ REG LP.
- e. Set and record 100 ± 10 psig hydrogen supply pressure on the H₂ PRESS HP SUPPLY gage with the H₂ REG HP.
- f. Simultaneously crack the H₂ S/O HP F/M ISOLATION valve and the O₂ S/O LP F/M ISOLATION valve and start flowing reactants into the reactant systems.
- g. Allow reactant systems to pressurize and stabilize.
- h. Record the powerplant regulated pressures as indicated by Digital Voltmeter Channels 2, 3 and 4.

NOTE: Verify that the powerplant differential pressures have stabilized at a $H_2 \Delta P$ of 8.5 ± 1.5 psi and an $O_2 \Delta P$ of 9.5 ± 1.5 psi (Block I - 11.0 ± 1.5 psi) as indicated on the Digital Voltmeter, Channels 2, 3 and 4.

- i. Turn the following switches to ON, opening the corresponding powerplant valves:

H_2 PURGE
 O_2 PURGE

- j. After purging for not less than 10 minutes turn the following switches to OFF, closing the corresponding powerplant valves.

H_2 PURGE
 O_2 PURGE

- k. CLOSE the following valves:

H_2 S/O HP F/M ISOLATION
 O_2 S/O LP F/M ISOLATION

- l. Depressurize the powerplant reactant systems to ambient as read on the Digital Voltmeter Channels 3 and 4 by simultaneously turning the following switches to ON, opening the corresponding powerplant valves:

H_2 PURGE
 O_2 PURGE

- m. CLOSE the following valves:

H_2 S/O VENT
 O_2 S/O VENT

5.2.3.2 Evacuation of the Powerplant Reactant Systems

- a. OPEN the following valves:

H_2 S/O VACUUM
 O_2 S/O VACUUM

- b. Simultaneously turn ON the following switches:

H₂ VACUUM PUMP
O₂ VACUUM PUMP
LO REACT DIFF

NOTE: If the vacuum pump is in operation servicing the adjacent stand, paragraph 5.2.3.2a will supply vacuum to the test stand.

- c. Establish a 0-1 psia pressure on the powerplant H₂ and O₂ systems, as indicated on the Digital Voltmeter Channels 3 and 4.
- d. Maintain the 0-1 psia pressure for a period of not less than 120 minutes, Record the powerplant regulated pressures as indicated on Digital Voltmeter Channels 2, 3 and 4 (vacuum data) every 30 minutes.
- e. CLOSE the following valves:

H₂ S/O VACUUM
O₂ S/O VACUUM

- f. Turn the following switches to OFF:

H₂ VACUUM PUMP
O₂ VACUUM PUMP

NOTE: If the vacuum pump is servicing the adjacent stand, paragraph 5.2.3.2f should be omitted.

- g. Turn the following switches OFF, closing the corresponding powerplant valves.

H₂ PURGE
O₂ PURGE

5.2.3.3 Pressurization of the Powerplant Evacuated Reactant Systems

- a. Simultaneously crack the H₂ S/O HP F/M ISOLATION and the O₂ S/O LP F/M ISOLATION valves and start flowing reactants into the evacuated reactant systems.
- b. Allow the reactant systems to pressurize and stabilize.
- c. Record the stabilized gas pressure transducer readings as read on the Digital Voltmeter Channels 2, 3 and 4.

NOTE: Verify that the powerplant differential pressures have stabilized at a $H_2 \Delta P$ of 8.5 ± 1.5 psi and an $O_2 \Delta P$ of 9.5 ± 1.5 psi (Block I - 11.0 ± 1.5 psi) as indicated on the Digital Voltmeter, Channels 2, 3 and 4.

- d. OPEN the following valves:

H_2 S/O LP SUPPLY
 O_2 S/O HP SUPPLY
 H_2 S/O VENT
 O_2 S/O VENT

- e. Set 100 ± 10 psig oxygen supply pressure on the O_2 PRESS HP SUPPLY gage with the O_2 REG HP
- f. Set and record 145 ± 5 psig hydrogen supply pressure on the H_2 PRESS HP SUPPLY gage with the H_2 REG HP.
- g. Set 100 ± 10 psig hydrogen supply pressure on the H_2 PRESS LP SUPPLY gage with the H_2 REG LP.
- h. Set and record 145 ± 5 psig oxygen supply pressure on the O_2 PRESS LP SUPPLY gage with O_2 REG LP.
- i. Record powerplant regulated pressures as read on the Digital Voltmeter, Channels 2, 3 and 4.

5.2.3.4 Pressurizing the Powerplant Nitrogen System:

- a. OPEN the N_2 S/O P/P SUPPLY valve.
- b. Set and record 1450 ± 50 psig nitrogen supply pressure on the N_2 PRESS P/P SUPPLY gage with the N_2 REG P/P supply.
- c. Turn the N_2 FILL switch to ON, opening the corresponding powerplant valve.
- d. Allow the powerplant N_2 blanket to pressurize and stabilize. Verify that the N_2 blanket has stabilized between 51.45-55.45 psia (Block II) and 47.8-52.9 psia (Block I) as indicated on Digital Voltmeter Channel 2.
- e. Record the powerplant regulated pressures as indicated on Digital Voltmeter Channels 2, 3 and 4.

NOTE: Verify that the reactant differential pressures have stabilized between 2 and 6 psi as indicated on the Digital Voltmeter, Channels 2, 3 and 4.

- f. OPEN the N₂ S/O SAMPLING valve.

5.2.3.5 Reactant System Purge

- a. Turn the following switches to ON, opening the corresponding powerplant valves.

H₂ PURGE

O₂ PURGE

- b. Record the light indication of both valves.

- c. After purging for not less than 5 minutes record the reactant flow rates as indicated on the O₂ F/M LP and on the H₂ F/M.

- d. Turn the following switches to OFF, closing the corresponding powerplant valves.

H₂ PURGE

O₂ PURGE

- e. Record the light indication of both valves.

5.2.3.6 Evaluation of Powerplant Pumps

- a. By adjusting the 400 CPS POWERSTAT set 115 ± 2 volts as indicated on the 400 CPS VOLTMETER and maintain.
- b. Turn the 400 CPS SUPPLY switch to ON - activating the powerplant pumps and conductivity probe and record the total motor and conductivity probe power, current and the glycol external ΔP .
- c. Record the maximum pressure fluctuation observed on GLYCOL PRESS P/P DISCH gage.

NOTE: If fluctuation exceeds 6 psi repeat the Glycol Fill Procedure.

- d. Turn the 400 CPS SUPPLY switch to OFF - deactivating the powerplant pumps and conductivity probe.

5.2.4 STARTING PROCEDURE

5.2.4.1 Powerplant Heat-up

- a. Ascertain that the following switches are turned OFF.
DVM
DCVM
In-line Heater Control
- b. Ascertain that the VTVM switch is in the VOLTS position.
- c. Ascertain that the power cables are removed from the load box.
- d. Plug the Vacuum Tube Voltmeter into the VTVM connector.
- e. Turn the 60 CPS HEATER POWER SUPPLY switch to ON.
- f. By adjusting the HEATER POWERSTAT set and maintain the following heater amperages as indicated on the HEATER AMMETER:

Zone 1	2.8 to 3.2 amps
Zone 2	38.0 to 42.0 amps
Zone 3	2.8 to 3.2 amps

- g. Record the voltage and current as indicated on the HEATER VOLTMETER and the HEATER AMMETER and record the powerplant surface temperature as indicated on the Digital Voltmeter Channel 1-1.
 - h. Record powerplant surface and condenser exit temperatures as read on Digital Voltmeter, Channel 1-1 and 1-2, every 20 minutes up to 300°F.
- 5.2.4.1.1 Perform the following after reaching a powerplant surface temperature of 300°F as read on the Digital Voltmeter Channel 1-1. Discontinue 20 minute readings.
- a. Record the powerplant surface and condenser exit temperatures, Channel 1-1 and 1-2.
 - b. By adjusting the 400 CPS POWERSTAT set and record 115 ± 2 volts as indicated on the 400 CPS VOLTMETER and maintain.
- NOTE: Maintain 115 ± 2 volts for the duration of power-plant pump operation.
- c. Turn the 400 CPS SUPPLY switch to ON - Activating the power-plant pumps and conductivity probe.

- d. Record the pump and probe power and currents as read on the 400 CPS WATTMETER and the 400 CPS AMMETER.
 - e. OPEN the H₂O RAD HEAT EXCHANGER valve.
- 5.2.4.1.2 Perform the following after reaching a powerplant surface temperature of 360°F as read on the Digital Voltmeter Channel 1-1.
- a. Record the powerplant surface and condenser exit temperatures, Channel 1-1 and 1-2.
 - b. Turn the LO REACT DIFF switch to OFF, closing the corresponding powerplant valve.
 - c. Record the stabilized gas pressure transducer readings as read on the Digital Voltmeter Channels 2, 3 and 4.

NOTE: Verify that the reactant differential pressures have stabilized at H₂ ΔP of 8.5 ± 1.5 psi and an O₂ ΔP of 9.5 ± 1.5 psi (Block I, 11.0 ± 1.5 psi) as indicated on the Digital Voltmeter, Channels 2, 3 and 4.

- d. Turn the IN-LINE HEATER CONTROL switch to ON - activating the IN-LINE HEATER CONTROL and record the current as read on the IN-LINE HEATER AMMETER.

NOTE: The IN-LINE HEATER CONTROL amperage should be 5 to 8 amperes.

- e. Plug the power cables into the load box.
- f. When the IN-LINE HEATER CONTROL de-energizes the IN-LINE HEATER (as indicated by a decrease in current to 0-0.2 amps on the IN-LINE HEATER CONTROL ammeter), record the powerplant surface temperature as read on the Digital Voltmeter Channel 1-1. Then turn the IN-LINE HEATER CONTROL switch to off, deactivating the in-line heater control. If the IN-LINE HEATER CONTROL does not de-energize the IN-LINE HEATER before 390°F, proceed to step e and continue in sequence until IN-LINE HEATER CONTROL de-energizes. At this time, record the powerplant surface temperature and turn the IN-LINE HEATER CONTROL switch to OFF.

- g. Turn the following switches to ON:

DCVM
DVM

- h. Ascertain that the IND/TOT selector switch is turned to TOTAL.

- i. Unplug the Vacuum Tube Voltmeter from the VTVM Connector.

5.2.4.1.3 Perform the following after reaching a powerplant surface temperature of 390°F as read on the Digital Voltmeter Channel 1-1.

- a. Record the powerplant surface and condenser exit temperatures, Channel 1-1 and 1-2.
- b. By adjusting the HEATER POWERSTAT set the following heater amperages as indicated on the HEATER AMMETER.

Zone 1	0.6 to 1.0 amps
Zone 2	Heater Power to OFF Position
Zone 3	0.2 to 0.6 amps

- c. Record the voltage and current as indicated on the HEATER VOLTMETER and the HEATER AMMETER.

5.2.5 OPERATION ON LOAD

NOTE: Data specified in paragraph 3.3 will be recorded no less frequently than at 20 minute intervals unless otherwise specified.

5.2.5.1 Pre-Performance Run Load Operation

- a. Turn the LOAD CONTROL RHEOSTAT fully COUNTER CLOCKWISE.
- b. Turn the LOAD BANK CONTROL switch to AC POWER ON.
- c. Turn the LOAD BANK CONTROL switch to 150 VAR.
- d. Ascertain that the AIRFLOW INDICATOR and the REVERSE POLARITY lights are OUT.

- e. By adjusting the LOAD CONTROL RHEOSTAT, set pre-performance external load of 50 ± 2 amperes as read on the Digital Voltmeter Channel 6 and record powerplant volts and amps.
- f. Maintain this 50 ampere load for 120 ± 10 minutes. Record full data reading as defined in Figure 1 every 20 minutes.

5.2.5.2 Pre-Performance Run Open Circuit Operation

- a. CLOSE the H₂O S/O RAD HEAT EXCHANGER valve.
- b. Remove External Load from powerplant by turning the LOAD CONTROL RHEOSTAT fully COUNTERCLOCKWISE, record-ing powerplant volts and amps.
- c. OPEN the powerplant H₂ and O₂ Purge Valves by turning the following switches to ON.

H₂ PURGE
O₂ PURGE
- d. After purging for not less than 2 minutes, CLOSE the power-plant H₂ and O₂ Purge Valves by turning the following switches to OFF.

H₂ PURGE
O₂ PURGE
- e. Maintain open circuit conditioning period until the powerplant output voltage is below 31.0 volts, as read on Channel 7, when the LOAD CONTROL RHEOSTAT is adjusted to a check point load of 17.5 - 18.5 amperes as read on Channel 6. Record open circuit full data points every 20 minutes. Record power-plant volts and amps and powerplant surface temperature Channel 6, 7 and 1-1, during each periodic check load point. Record load time during checks to nearest minute.
- f. When powerplant voltage, as read on Channel 7, is between 30.4 and 31.0 volts as determined by the check load points, maintain 17.5 - 18.5 amperes external load by adjusting the LOAD CONTROL RHEOSTAT. Record powerplant volts, amps and surface temperature, Channels 6, 7 and 1-1, every 10 minutes.

- g. When the powerplant voltage, as read on Channel 7 is below 30.6 volts, set and maintain the following heater amperages as indicated on the HEATER AMMETER by adjusting the HEATER POWERSTAT.

Record the voltage and current as indicated on the HEATER VOLTMETER and HEATER AMMETER.

Zone 1	1.2 to 1.6 amps
Zone 2	8.0 to 12.0 amps
Zone 3	1.2 to 1.6 amps

- h. Maintain 17.5 - 18.5 amperes, as read on Channel 6, until the powerplant observed output voltage is within 30.4 - 30.6 volts, as read on Channel 7, and observed to be increasing. Record full data reading.

5.2.5.3 Performance Run Operation

- NOTES:
1. The acceptance operation shall be run in the sequence indicated but the sequence need not be continuous.
 2. The powerplant temperature sensor shall indicate a temperature greater than 330°F for the first 3 hours of the performance run and indicate a temperature greater than 385°F thereafter.
 3. Representative fuel consumption as defined in the specification occurs after powerplant stabilization is reached. Therefore, the last full data point for five of the six load points during the acceptance test which most closely approaches stabilization will be used for fuel consumption demonstration. If the fuel consumption at the last programmed data point is not acceptable, the load condition may be continued until consumption at that load level is demonstrated. Demonstration of fuel consumption will be acceptable if the following condition is satisfied: In order to take into account the limitation of the accuracy of the flow rate and power measurements, two but not more than two, specific fuel consumption points for either hydrogen or oxygen may exceed the specification maximum by as much as the accuracy of the measurement.

5.2.5.3.1 First Load Point

- a. OPEN the H₂O S/ORAD HEAT EXCHANGER valve.
- b. Set First Load Point by adjusting the LOAD CONTROL RHEOSTAT to an external load of 16.2 - 18.2 amperes as read on the Digital Voltmeter Channel 6 and record powerplant volts and amps.
- c. Maintain 16.2 - 18.2 amperes for a period not less than 120 minutes. Record Full Data Readings every 20 minutes.

NOTE: Powerplant output voltage must be 27.0 - 31.0 volts as read on Digital Voltmeter Channel 7 at 563 watts.

5.2.5.3.2 Second Load Point

- a. Set Second Load Point by adjusting the LOAD CONTROL RHEOSTAT to an external load of 38-42 amperes as read on the Digital Voltmeter Channel 6 and record powerplant volts and amps.
- b. Maintain 38-42 amperes for a period not less than 100 minutes. Record Full Data Reading every 20 minutes.

NOTES:

1. Powerplant output voltage must be 27.0 - 31.0 volts as read on Digital Voltmeter Channel 7.
2. After generating between 600-800 grams of water, change the H₂O COLLECTION BOTTLE, OPEN the ATMOS VENT H₂O SAMPLE COLLECTION and the H₂O S/O SAMPLE COLLECTION valves allowing at least a 50 gram flush to flow out. Take a sample of generated water before closing the H₂O S/O SAMPLE COLLECTION and the ATMOS VENT H₂O SAMPLE valves. Process the sample for pH analysis per AP-26. Record the water sample weight and the pH before and after N₂ bubbling.

5.2.5.3.3 Third Load Point

- a. Turn the IN-LINE HEATER CONTROL switch to ON, Activating In-Line Heater Control. Record In-Line Heater Control Ammeter Reading.
- b. Set Third Load Point by adjusting the LOAD CONTROL RHEOSTAT to an external load of 51-54.5 amperes as read on the Digital Voltmeter Channel 6 and record powerplant volts and amps.
- c. Maintain 51-54.5 amperes for a period not less than 65 minutes. Record two 20 minute Full Data Readings and one final 25 minute Full Data Reading.

NOTE: Powerplant output voltage must be 27.0-31.0 volts as read on Digital Voltmeter Channel 7 at 1420 watts.

5.2.5.3.4 Fourth Load Point

- a. Set Fourth Load Point by adjusting the LOAD CONTROL RHEOSTAT to an external load of not less than 2295 watts (Digital Voltmeter Channels 5 or 6 x 7) and record powerplant volts and amps.
- b. Maintain not less than 2295 watts for a period not less than 1.5 minutes. Record powerplant volts and amps at the end of the 1.5 minute period.

NOTE: Powerplant output voltage must be not less than 20.5 volts as read on the Digital Voltmeter Channel 7.

5.2.5.3.5 Fifth Load Point

- a. Set Fifth Load Point by adjusting the LOAD CONTROL RHEOSTAT to an external load of not less than 2195 watts. (Digital Voltmeter Channels 5 or 6 x 7) and record powerplant volts and amps.

- b. Maintain not less than 2195 watts for a period not less than 13.5 minutes. Record Full Data Reading after 5.0 minutes and at the end of the 13.5 minute period. Also record the thirty-one individual cell output voltages on the powerplant log sheet as part of the last Full Data Reading.

NOTES: 1. Powerplant output voltage must not be less than 20.5 volts as read on the Digital Voltmeter Channel 7.

2. Individual cell output voltages must not be less than 0.64 volts as read on the DCVM.

5.2.5.3.6 Sixth Load Point

- a. Set Sixth Load Point by adjusting the LOAD CONTROL RHEOSTAT to an external load of 48-52 amperes as read on the Digital Voltmeter Channel 6 and record power-plant volts and amps.
- b. Maintain 48-52 amperes for a period not less than 60 minutes. Record Full Data Reading every 20 minutes. Before the end of this load period OPEN the ATMOS VENT H₂O SAMPLE COLLECTION and the H₂O S/O SAMPLE COLLECTION valves allowing at least a 50 gram flush to flow out. Take a sample of generated water before closing the H₂O S/O SAMPLE COLLECTION and the ATMOS VENT H₂O SAMPLE COLLECTION valves. Process the sample for pH analysis per AP-26. Record the water sample weight and the pH before and after N₂ bubbling. Also record the thirty-one individual cell output voltages on the powerplant log sheet as part of the last Full Data Reading.

NOTES: 1. Powerplant output voltage must be 27.0-31.0 volts as read on the Digital Voltmeter Channel 7.

2. Individual cell output voltages must not be less than 0.83 volts as read on the DCVM.

5.2.6 SHUTDOWN PROCEDURE

5.2.6.1 Removal of Load

- a. Remove external load from powerplant by turning the LOAD CONTROL RHEOSTAT fully COUNTERCLOCKWISE.
- b. Turn the LOAD BANK CONTROL switch to OFF.
- c. Record powerplant volts and amps.

5.2.6.2 Powerplant Conditioning

- a. Start the 7.5 hour \pm 10 minutes powerplant conditioning period by turning the H₂ PURGE and O₂ PURGE switches to ON - opening the powerplant reactant purge valves. Set and maintain heater amperages by adjusting the HEATER POWERSTAT as indicated on the HEATER AMMETER.

Record the voltage and current as indicated on the HEATER VOLTMETER and the HEATER AMMETER.

BLOCK II

Zone 1	1.9 to 2.05 amps
Zone 2	25.0 to 26.5 amps
Zone 3	1.9 to 2.05 amps

BLOCK I

Zone 1	1.8 - 2.0 amps
Zone 2	24.0 - 25.5 amps
Zone 3	1.8 - 2.0 amps

- b. Record the H₂ and O₂ purge flow rates and light indication, after stabilizing, as indicated on the H₂ FLOWMETER and O₂ FLOWMETER LP.
- c. After a purge period of not less than 20 minutes, turn the O₂ PURGE switch to OFF closing the powerplant O₂ Purge Valve. Combine c, d, e and f into first 30 minute Full Data Reading.
- d. Increase powerplant H₂ supply pressure by increasing the H₂ PRESS HP SUPPLY to 280 \pm 10 psig with the H₂ REG HP and record.
- e. Increase powerplant O₂ supply pressure by increasing the O₂ PRESS HP SUPPLY to 980 \pm 20 psig with O₂ REG HP and record.

- f. Ascertain 1450 ± 50 psig is indicated on the N₂ PRESS HP SUPPLY pressure gage and record.
- g. Continue Conditioning Period for a total of 7.5 hours ± 10 minutes, recording Full Data Readings, as defined by Figure 1, every 30 minutes.
 1. Not after less than 3 hours of the 7.5 hour conditioning period, remove and replace the generated H₂O Collection Bottle. This water will be used for quantitative analysis.
- h. At the completion of the 7.5 hour (± 10 minutes) conditioning period, turn the H₂ PURGE switch to OFF closing the power-plant H₂ purge valve. Combine h, j, and l data into one reading.
- i. Remove the generated H₂O Collection Bottle.
- j. Decrease the powerplant H₂ supply pressure by decreasing the H₂ PRESS HP SUPPLY to 145 ± 5 psig with H₂ REG HP and record.
- k. Decrease the O₂ PRESS HP SUPPLY to $100 \pm$ psig with O₂ REG HP.
- l. Readjust the powerplant O₂ supply pressure by adjusting the O₂ PRESS LP SUPPLY to 145 ± 5 psig with the O₂ REG LP and record.

5.2.6.2.1 Perform the Following Powerplant Calibration

- a. At open circuit, record the following as read on the Digital Voltmeter. Discontinue 30 minute Full Data Reading.

<u>Surface Temperature</u>	Channel 1-1
<u>Current</u>	Channel 6
<u>Voltage</u>	Channel 7

- b. Turn the LOAD CONTROL RHEOSTAT fully COUNTER-CLOCKWISE.
- c. Turn the LOAD BANK CONTROL switch to AC POWER ON.
- d. Turn the LOAD BANK CONTROL switch to 150 VAR.

- e. Ascertain that the AIRFLOW INDICATOR and the REVERSE POLARITY lights are OUT.
- f. By adjusting the LOAD CONTROL RHEOSTAT set an external load of 18 ± 2 amperes as read on Digital Voltmeter Channel 6.

Allow one minute for stabilization and record the following as read on the Digital Voltmeter.

<u>Surface Temperature</u>	Channel 1-1
<u>Current</u>	Channel 6
<u>Voltage</u>	Channel 7

- g. By adjusting the LOAD CONTROL RHEOSTAT set an external load of 30 ± 2 amperes as read on Digital Voltmeter Channel 6.

Allow one minute for stabilization and record the following as read on the Digital Voltmeter.

<u>Surface Temperature</u>	Channel 1-1
<u>Current</u>	Channel 6
<u>Voltage</u>	Channel 7

- h. By adjusting the LOAD CONTROL RHEOSTAT, set an external load of 52 ± 2 amperes as read on the Digital Voltmeter Channel 6.

Allow one minute for stabilization and record the following as read on the Digital Voltmeter.

<u>Surface Temperature</u>	Channel 1-1
<u>Current</u>	Channel 6
<u>Voltage</u>	Channel 7

- i. By adjusting the LOAD CONTROL RHEOSTAT set an external load of 65 ± 2 amperes as read on Digital Voltmeter Channel 6.

Allow one minute for stabilization and record the following as read on the Digital Voltmeter.

<u>Surface Temperature</u>	Channel 1-1
<u>Current</u>	Channel 6
<u>Voltage</u>	Channel 7

- j. Turn the LOAD CONTROL RHEOSTAT fully COUNTER-CLOCKWISE.
- k. Turn the LOAD BANK CONTROL switch to OFF.
- l. At open circuit, record the following as read on the Digital Voltmeter.

<u>Surface Temperature</u>	Channel 1-1
<u>Current</u>	Channel 6
<u>Voltage</u>	Channel 7

5.2.6.3 Cooldown

- a. Start cooldown by removing heater power, adjusting the HEATER POWERSTAT for the three zones to zero as indicated on the HEATER VOLTMETER and record heater power volts and amps.
- b. Turn the following switches to OFF.
DCVM
DVM
IND. DCVM
- c. Ascertain that the VTVM switch is in the VOLTS position.
- d. Plug the Vacuum Tube Voltmeter into the VTVM connector.
- e. Record full data reading as defined by Figure 1 every 30 minutes.
- f. When the IN-LINE HEATER CONTROL automatically energizes the in-line heater (as indicated by an increase in current of 5 to 8 amperes on the IN-LINE HEATER CONTROL ammeter), record the powerplant surface temperature as read on the Digital Voltmeter Channel 1-1 and discontinue 30 minute full data readings.

- g. Turn the IN-LINE HEATER CONTROL switch to OFF, deactivating the IN-LINE HEATER CONTROL.

5.2.6.3.1 After reaching a powerplant surface temperature of 360°F as read on the Digital Voltmeter Channel 1-1, perform the following:

NOTE: The low reactant differential valve may be opened any time after the in-line heater is deactivated but must be opened before the powerplant cools down to below 330°F powerplant surface temperature.

- a. Record the powerplant surface temperature, Channel 1-1.
- b. Turn the LO REACT DIFF switch to ON, opening the corresponding powerplant valve.

NOTE: Verify that the reactant differential pressures have stabilized between 2 and 6 psi as indicated on the Digital Voltmeter, Channels 2, 3 and 4.

- c. Remove the power cables from the load box.
- d. Record full data reading every 30 minutes.

5.2.6.3.2 Record the time when the powerplant surface temperature as read on the Digital Voltmeter Channel 1-1 reaches 300°F.

5.2.6.3.3 After reaching a powerplant surface temperature of 220°F as read on the Digital Voltmeter Channel 1-1, perform the following:

- a. Record the powerplant surface temperature, Channel 1-1.
- b. Turn OFF the powerplant pumps and conductivity probe by turning the 400 CPS SUPPLY switch to OFF.

5.2.6.3.4 Perform the following after reaching a powerplant surface temperature of 150°F as read on the Digital Voltmeter Channel 1-1.

- a. Record the powerplant surface temperature Channel 1-1 discontinuing 30 minute full data readings.
- b. Decrease the N₂ PRESS P/P SUPPLY to 125-175 psig with the N₂ REG P/P SUPPLY.
- c. Adjust the N₂ PRESS AUX to 150 ± 10 psig with the N₂ REG AUX.
- d. OPEN the N₂ S/O AUX P/P SUPPLY valve.
- e. CLOSE the N₂ S/O P/P SUPPLY valve.
- f. Turn OUT the N₂ REG P/P SUPPLY.
- g. Turn the LO REACT DIFF switch to OFF, closing the corresponding powerplant valve.

5.2.6.4 Depressurization

- 5.2.6.4.1 Start depressurizing the N₂ blanket in steps of 1 psi nominal not to exceed 1.2 psi per 15 minute intervals to 28 ± 2 psia as read on the Digital Voltmeter Channel 2, by adjusting the N₂ REG AUX and record full data reading every 15 minutes.

NOTE: Depressurization at a rate in excess of 1.2 psi per 15 minutes is not cause for rejection. Depressurization must not exceed a rate of 4.8 psi in 60 minutes.

- 5.2.6.4.2 Stabilize the powerplant N₂ blanket pressure at 28 ± 2 psia as read on the Digital Voltmeter Channel 2.

- a. Record full data reading. Discontinue 15 minute data readings.
- b. Turn OUT the following regulators:

H₂ REG LP
O₂ REG HP

- c. CLOSE the following valves:

H₂ S/O LP SUPPLY
O₂ S/O HP SUPPLY
N₂ S/O SAMPLING

- d. Reduce the H₂ HP and O₂ LP supply pressures to 15 ± 5 psig with the use of the H₂ REG HP and O₂ REG LP.

- e. CLOSE the following valves:

H₂ S/O HP SUPPLY
O₂ S/O LP SUPPLY

- f. Turn OUT the following regulators:

H₂ REG HP
O₂ REG LP

- 5.2.6.4.3 Depressurize the powerplant reactant systems to ambient as read on the Digital Voltmeter Channels 3 and 4 by simultaneously turning the following switches to ON, opening the corresponding powerplant valves.

H₂PURGE
O₂PURGE

- a. Record full data reading.
- b. CLOSE the following valves:

H₂ S/O HP F/M ISOLATION
O₂ S/O LP F/M ISOLATION

- c. Turn the following switches to OFF, closing the corresponding powerplant valves.

H₂PURGE
O₂PURGE

- 5.2.6.4.4 Continue depressurizing the N₂ blanket in 1 psi steps at 15 minute intervals to ambient as read on the Digital Voltmeter Channel 2 by adjusting the N₂ REG AUX and record full data reading every 15 minutes.

NOTES: (1) Depressurization at a rate in excess of 1.2 psi per 15 minutes is not cause for rejection. Depressurization must not exceed a rate of 4.8 psi in 60 minutes.

(2) A pressure slightly below ambient on one or both reactant systems at this time is normal and is not cause for rejection.

- a. Record full data reading after the N₂ BLANKET is stabilized at ambient. Discontinue 15 minute readings.
- b. Ascertain that the N₂ PRESS AUX is zero and CLOSE the N₂ S/O AUX P/P SUPPLY valve.
- c. Turn the following switch to OFF, closing the corresponding powerplant valve.

N₂ FILL

- d. Close the H₂O S/O RAD Heat Exchanger valve.

5.2.7 GLYCOL SYSTEM DRAIN AND FLUSH PROCEDURE

5.2.7.1 Glycol System Drain

- a. Start establishing operating conditions on the stand Simulated Space Radiator per the operations manual.
- b. Start to drain the powerplant glycol system by opening the following stand valves.

H₂ S/O VENT
O₂ S/O VENT
GLYCOL FILL
GLYCOL ΔP GAGE EQUALIZATION S/O No. 1
GLYCOL ΔP GAGE EQUALIZATION S/O No. 2
ATMOS VENT S/O

- c. Disconnect the stand lines from the F7 and F8 powerplant interface adapter fittings and drain the powerplant glycol system into an appropriate container.

- d. CLOSE the following stand valves.

GLYCOL FILL
GLYCOL ΔP GAGE EQUALIZATION S/O NO. 1
GLYCOL ΔP GAGE EQUALIZATION S/O NO. 2
ATMOS VENT S/O

5.2.7.2 Glycol System Purge

5.2.7.2.1 Water Flush Cart Hook-Up

- a. Ascertain that the following Water Flush Cart (Figure 3) valves are in the CLOSED position.

WATER SUPPLY
BYPASS THROTTLE
PURGE S/O
SUPPLY TOGGLE
DISCHARGE TOGGLE
WATER SUPPLY ISOLATION
WATER DISCHARGE ISOLATION
DISCHARGE THROTTLE
ACCUMULATOR S/O
SECONDARY BYPASS LINE S/O

- b. Ascertain that the following cart switches are in the OFF position.

FLUSH PUMP
PUMP BYPASS
- c. Ascertain that the following stand switch is in the OFF position.

400 CPS SUPPLY
- d. Ascertain that the following stand valves are in the CLOSED position.

N₂ S/O P/P SUPPLY
N₂ S/O AUX P/P SUPPLY
N₂ S/O LP SUPPLY
- e. Ascertain that the following stand regulators are turned OUT.

N₂ REG AUX
N₂ REG LP
- f. Have assembly personnel remove the P/N 605207 plug from the glycol side of the powerplant Glycol Accumulator and install a AKN 7931 fitting with a P/N 605208 seal.
- g. Have assembly personnel disconnect and cap the powerplant N₂ lines from the top of the Glycol Accumulator and from the N₂ Transducer.
- h. Have assembly personnel remove the P/N 606411 fitting from the N₂ side of the powerplant Glycol Accumulator and install a AKN 7931 fitting with a P/N 605208 seal. Install a protective cap.
- i. Have assembly personnel disconnect the powerplant Secondary Regenerator Bypass Line from the Secondary Regenerator Bypass Valve.

NOTE: Use caution to prevent damage to powerplant tubing.
Cap the Secondary Regenerator Bypass Valve fitting.
Use a drip pan to catch leakage.

- j. Connect the stand N₂ LP SUPPLY line to the fitting on the glycol side of the powerplant Glycol Accumulator.
- k. Connect the WATER DISCHARGE LINE of the cart to the F7 powerplant interface fitting.
- l. Connect the WATER SUPPLY LINE of the cart to the F8 powerplant interface fitting.
- m. Connect the SECONDARY BYPASS LINE DISCHARGE LINE of the cart to the powerplant Secondary Regenerator Bypass Line.
- n. Connect a line from the stand demineralized WATER SUPPLY to the cart WATER SUPPLY PORT.

5.2.7.2.2 Glycol System N₂ Purge

- a. OPEN the following cart valves.

PURGE S/O
SUPPLY TOGGLE
DISCHARGE TOGGLE
- b. OPEN the following stand valve.

N₂ S/O LP SUPPLY
- c. Start the powerplant glycol system N₂ purge by using the N₂ REG LP to set 25 ± 5 psig, as indicated on the N₂ PRESS LP gage. Perform the following during the purge.
 - 1. During the valve manipulations which follow, readjust the N₂ REG LP, if necessary, to limit N₂ pressure to 30 psig maximum during pressure excursions.
 - 2. Alternately CLOSE and OPEN cart SUPPLY TOGGLE and DISCHARGE TOGGLE valves to alternately channel the N₂ flow through the powerplant glycol system.
 - 3. Minimum purge duration is 30 minutes.

- d. Reduce the N₂ pressure as indicated on the N₂ PRESS LP GAGE to 0-2 psig by turning OUT the N₂ REG LP, completing the glycol system N₂ purge.
- e. CLOSE the following cart valves.

PURGE S/O
SUPPLY TOGGLE
DISCHARGE TOGGLE
- f. Disconnect the stand N₂ LP SUPPLY line from the fitting on the glycol side of the powerplant Glycol Accumulator.
- g. Disconnect the stand INERT GAS SUPPLY line from the F5 powerplant interface adapter fitting. Replace the protective cap on the F5 fitting using P/N 601531 seal.
- h. Connect the stand INERT GAS SUPPLY line to the powerplant Glycol Accumulator N₂ fitting.
- i. Connect the cart ACCUMULATOR DISCHARGE LINE to the fitting on the glycol side of the powerplant Glycol Accumulator.

5.2.7.3 Glycol System Demineralized Water Flush

5.2.7.3.1 Water Flush Cycle No. 1

- a. OPEN the cart WATER SUPPLY valve and fill the Water Reservoir with demineralized water (AP-2) as indicated on the WATER RESERVOIR SIGHT GAGE.

NOTE: Throughout the water flushing insure that the Water Reservoir does not run dry.

- b. OPEN the following stand valve
N₂ S/O AUX P/P SUPPLY
- c. Apply 25±3 psig as indicated on the stand N₂ PRESS AUX gage to the N₂ side of the powerplant Glycol Accumulator using the stand N₂ REG AUX.
- d. OPEN the following cart valves.

BYPASS THROTTLE (Full Open)
DISCHARGE THROTTLE (Full Open)
WATER SUPPLY ISOLATION
WATER DISCHARGE ISOLATION
- e. Set and maintain 115 ± 2 volts, as indicated on the stand 400 CPS VOLTMETER, by adjusting the stand 400 CPS POWERSTAT

- f. Turn the stand 400 CPS SUPPLY switch to ON, activating the powerplant pumps and conductivity probe.
- g. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.

NOTE: The total power must not exceed 90 watts, (Block II), 122 watts (Block I).

- h. Turn the cart FLUSH PUMP switch to ON.
- i. Slowly ADJUST the cart BYPASS THROTTLE valve to set and maintain water pressure at 45 - 50 psig as indicated on the cart SUPPLY PRESS gage.
- j. Record the scale reading as read on the cart DISCHARGE FLOWMETER. This scale reading will be an indication of the maximum water flow through the powerplant F7 interface fitting.
- k. OPEN the following cart valves.

ACCUMULATOR S/O
SECONDARY BYPASS LINE S/O

- l. Adjust the following cart valve to obtain the maximum pressure value on the SUPPLY PRESS gage.

BYPASS THROTTLE

NOTE: Water pressure as indicated on the cart SUPPLY PRESS gage must not exceed 50 psig. If necessary ADJUST the cart BYPASS THROTTLE valve to set and maintain water pressure at 25-50 psig.

- m. Slowly ADJUST the cart DISCHARGE THROTTLE valve to set the water flow as indicated on the cart DISCHARGE FLOWMETER to $1/2 \pm 1/4$ of the flowmeter scale reading recorded in step 5.2.7.3.1 i.

NOTE: Water pressure as indicated on the cart SUPPLY PRESS gage must not exceed 50 psig. If necessary ADJUST the cart BYPASS THROTTLE valve to set and maintain water pressure at 25 - 50 psig.

- n. Flush water through the powerplant glycol system for a minimum of 20 minutes for the purpose of flushing the powerplant Secondary Regenerator Bypass Line. Perform the following during the flush.

NOTE: Take readings at the beginning and just prior to the completion of the flush with the cart flush PUMP BYPASS switch in the OFF position.

1. Record the scale reading as read on the cart DISCHARGE FLOWMETER.
2. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.
3. Record the pressures as indicated on the following cart gages.

SUPPLY PRESS
DISCHARGE PRESS
N₂ PRESS AUX (stand)

4. Throughout this flush duration, cycle the water pressure, as indicated on the cart SUPPLY PRESS gage, from the maximum of 50 psig to the minimum value by alternately OPENING for 30 ± 10 seconds, then CLOSING for 30 ± 10 seconds the cart Pump Bypass valve with the PUMP BYPASS switch.

NOTE: Minimum water pressure is obtained with the cart PUMP BYPASS switch in the ON position. Variations in cycle times are not cause for rejection.

5. Terminate the flush with the cart PUMP BYPASS switch in the OFF position.
- o. CLOSE the cart SECONDARY BYPASS LINE S/O valve while adjusting the cart BYPASS THROTTLE valve to set the water pressure to 45 - 50 psig as indicated on the cart SUPPLY PRESS gage.

5. 2. 7. 3. 2 Water Flush Cycle No. 2

- a. Flush water through the powerplant glycol system for a minimum of 20 minutes for the purpose of flushing the powerplant Glycol Accumulator. Perform the following during the flush.

NOTE: Take readings at the beginning and just prior to the completion of the flush with the cart flush PUMP BYPASS switch in the OFF position.

1. Record the scale reading as read on the cart DISCHARGE FLOWMETER.
2. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.
3. Record the pressures as indicated on the following cart gages.

SUPPLY PRESS
DISCHARGE PRESS
N₂ PRESS AUX (stand)

4. Throughout this flush duration, cycle the water pressure, as indicated on the cart SUPPLY PRESS gage, from the maximum of 50 psig to the minimum value by alternately OPENING for 30 ± 10 seconds, then CLOSING for 30 ± 10 seconds the cart Pump Bypass valve with the PUMP BYPASS switch.

NOTE: Minimum water pressure is obtained with the cart PUMP BYPASS switch in the ON position.
Variations in cycle times are not cause for rejection.

5. Terminate the flush with the cart PUMP BYPASS switch in the OFF position.
- b. CLOSE the cart ACCUMULATOR S/O valve while adjusting the cart BYPASS THROTTLE valve to set the water pressure to 45-50 psig as indicated on the cart SUPPLY PRESS gage.

- c. ADJUST the cart DISCHARGE THROTTLE valve to set 30 ± 3 psig as indicated on the cart DISCHARGE PRESS gage.

NOTE: Water pressure as indicated on the cart SUPPLY PRESS gage must not exceed 50 psig. If necessary ADJUST the cart BYPASS THROTTLE valve to set and maintain water pressure at 45 - 50 psig.

5. 2. 7. 3. 3 Water Flush Cycle No. 3

- a. Flush water through the powerplant glycol system for a minimum of 80 minutes for the purpose of flushing the powerplant Glycol Pump. Perform the following during the flush.

NOTE: Take readings at the beginning, during and just prior to the completion of the flush with the cart flush PUMP BYPASS switch in the OFF position.

1. Record the scale reading as read on the cart DISCHARGE FLOWMETER.
2. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.
3. Record the pressures as indicated on the following cart gages.

SUPPLY PRESS
DISCHARGE PRESS
N₂ PRESS AUX (stand)

4. Throughout this flush duration, cycle the water pressure, as indicated on the cart SUPPLY PRESS gage, from the maximum of 50 psig to the minimum value by alternately OPENING for 30 ± 10 seconds, then CLOSING for 30 ± 10 seconds the cart Pump Bypass valve with the PUMP BYPASS switch.

NOTE: Minimum water pressure is obtained with the cart PUMP BYPASS switch in the ON position. Variations in cycle times are not cause for rejection.

5. Terminate the flush with the cart PUMP BYPASS switch in the OFF position.
- b. Turn the cart FLUSH PUMP switch to OFF.

- c. Turn OUT the stand N₂ REG AUX to reduce the pressure as indicated on the stand N₂ PRESS AUX to 0-2 psig to remove the pressure from the N₂ side of the powerplant Glycol Accumulator.

5. 2. 7. 4 Glycol System Purge

- a. Disconnect the cart ACCUMULATOR DISCHARGE LINE from the fitting on the glycol side of the powerplant Glycol Accumulator.
- b. Connect the stand N₂ LP SUPPLY line to the fitting on the glycol side of the powerplant Glycol Accumulator.
- c. CLOSE the following cart valves.

WATER SUPPLY ISOLATION
WATER DISCHARGE ISOLATION

5. 2. 7. 4. 1 Glycol System N₂ Purge

- a. OPEN the following cart valves.

PURGE S/O
SUPPLY TOGGLE
DISCHARGE TOGGLE

- b. Start the powerplant glycol system N₂ purge by using the N₂ REG LP to set 25 ± 5 psig, as indicated on the N₂ PRESS LP gage. Perform the following during the purge.
 - 1. After purging for not less than 10 minutes turn the stand 400 CPS SUPPLY switch to OFF, deactivating the powerplant pumps and conductivity probe.
 - 2. During the valve manipulations which follow, readjust the N₂ REG LP, if necessary, to limit N₂ pressure to 30 psig maximum during pressure excursions.

3. Alternately CLOSE and OPEN cart SUPPLY TOGGLE and DISCHARGE TOGGLE valves to alternately channel the N₂ flow through the powerplant glycol system.
4. Continue purge for a minimum of 30 minutes.
- c. Reduce the N₂ pressure as indicated on the N₂ PRESS LP GAGE to 0-2 psig by turning OUT the N₂ REG LP, com-
pleting the glycol system N₂ purge.
- d. CLOSE the following cart valves.

PURGE S/O
SUPPLY TOGGLE
DISCHARGE TOGGLE

5.2.7.4.2 Disconnection of Water Flush Cart

- a. Disconnect the cart WATER SUPPLY LINE from the F8 powerplant interface adapter fitting. Use a drip pan to catch drippings.
- b. Disconnect the cart WATER DISCHARGE LINE from the F7 powerplant interface adapter fitting. Use a drip pan to catch drippings.
- c. Disconnect the cart SECONDARY BYPASS LINE DISCHARGE LINE from the Secondary Regenerator Bypass Line. Use a drip pan to catch drippings.
- d. Disconnect the stand N₂ LP SUPPLY line from the fitting on the glycol side of the powerplant Glycol Accumulator.

5.2.7.5 Glycol System Alcohol Flush

5.2.7.5.1 Alcohol Flush Cart Hook-Up

- a. Ascertain that the following Alcohol Flush Cart (Figure 4) valves are in the CLOSED position.

TOGGLE VALVE D
TOGGLE VALVE E
TOGGLE VALVE G
TOGGLE VALVE H
SECONDARY BYPASS LINE S/O

BYPASS THROTTLE
DISCHARGE THROTTLE

- b. Ascertain that the following Alcohol Flush Cart switch is in the OFF position.
Timer, SOLENOID BYPASS VALVE
FLUSH PUMP
- c. Ascertain that the following stand switch is in the OFF position.
400 CPS SUPPLY
- d. Connect cart ACCUMULATOR DISCHARGE LINE to the fitting on the glycol side of the powerplant Glycol Accumulator.
- e. Connect the cart ALCOHOL DISCHARGE LINE to the F7 powerplant interface adapter fitting.
- f. Connect the cart ALCOHOL SUPPLY LINE to the F8 powerplant interface adapter fitting.
- g. Connect the cart SECONDARY BYPASS LINE DISCHARGE LINE to the powerplant Secondary Regenerator Bypass Line.

5.2.7.5.2 Alcohol Flush Cycle No. 1

- a. Fill ALCOHOL RESERVOIR A of the cart with 2 gallons of fresh Isopropyl Alcohol.
- b. Apply 25 ± 3 psig as indicated on the stand N₂ PRESS AUX gage to the N₂ side of the powerplant Glycol Accumulator using the stand N₂ REG AUX.
- c. OPEN the following cart valves.
TOGGLE VALVE D
TOGGLE VALVE G
BYPASS THROTTLE (Full Open)
DISCHARGE THROTTLE (Full Open)

- d. Set and maintain 115 ± 2 volts, as indicated on the stand 400 CPS VOLTMETER, by adjusting the stand 400 CPS POWERSTAT.
- e. Turn the stand 400 CPS SUPPLY switch to ON, activating the powerplant pumps and conductivity probe.
- f. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.

NOTE: The total power must not exceed 90 watts. (Block II),
122 watts (Block I).

- g. Turn the cart FLUSH PUMP switch to ON
- h. Slowly ADJUST the cart BYPASS THROTTLE valve to set and maintain alcohol pressure at 45-50 psig as indicated on the cart SUPPLY PRESS gage.
- i. Record the scale reading as read on the cart DISCHARGE FLOWMETER. This scale reading will be an indication of the maximum alcohol flow through the powerplant F7 inter-face fitting.
- j. OPEN the following cart valves.

TOGGLE VALVE E
SECONDARY BYPASS LINE S/O
- k. Adjust the following cart valve to obtain the maximum pressure value on the SUPPLY PRESS gage.

BYPASS THROTTLE

NOTE: Alcohol pressure, as indicated on the cart SUPPLY PRESS gage, must not exceed 50 psig. If necessary, ADJUST the cart BYPASS THROTTLE valve to set and maintain alcohol pressure at 25-50 psig.

1. Slowly ADJUST the cart DISCHARGE THROTTLE valve to set the alcohol flow, as indicated on cart DISCHARGE FLOW-METER to $1/2 \pm 1/4$ of the flowmeter scale reading recorded in step 5.2.7.5.2, i.

NOTE: Alcohol pressure, as indicated on the cart SUPPLY PRESS gage, must not exceed 50 psig. If necessary ADJUST the cart BYPASS THROTTLE valve to set and maintain alcohol pressure at 25-50 psig.

- m. Circulate alcohol through the powerplant glycol system for a minimum of 10 minutes for the purpose of flushing the power-plant Secondary Regenerator Bypass Line. Perform the following at the beginning of the flush and just prior to the completion of the flush.

1. Record the scale readings as read on the following cart flowmeters.

DISCHARGE FLOWMETER (F7)
ACCUMULATOR DISCHARGE FLOWMETER
SECONDARY BYPASS LINE DISCHARGE FLOWMETER

2. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.
3. Record the pressures as indicated on the following cart gages.

SUPPLY PRESS
DISCHARGE PRESS
N₂ PRESS AUX (stand)

- n. CLOSE the cart SECONDARY BYPASS LINE S/O valve while adjusting the cart BYPASS THROTTLE valve to set the alcohol pressure at 45 - 50 psig as indicated on the cart SUPPLY PRESS gage.

5.2.7.5.3 Alcohol Flush Cycle No. 2

- a. Circulate alcohol through the powerplant glycol system for a minimum of 20 minutes for the purpose of flushing the power-plant Glycol Accumulator. Perform the following during the flush and just prior to the completion of the flush.

1. Record the scale readings as read on the following cart flowmeters.

DISCHARGE FLOWMETER (F7)

ACCUMULATOR DISCHARGE FLOWMETER

2. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.
3. Record the pressures as indicated on the following cart gages.

SUPPLY PRESS

DISCHARGE PRESS

N₂ PRESS AUX (stand)

- b. OPEN the following cart valves.

TOGGLE VALVE H

DISCHARGE THROTTLE (Full Open)

- c. CLOSE the following cart valve.

TOGGLE VALVE G

- d. Allow the used alcohol to flow from ALCOHOL RESERVOIR A to ALCOHOL RESERVOIR B of the cart.

- e. Turn the cart FLUSH PUMP switch to OFF.

5.2.7.5.4 Alcohol Flush Cycle No. 3

- a. Fill RESERVOIR A of the cart with 2 gallons of fresh Isopropyl Alcohol.

- b. OPEN the following cart valves.

TOGGLE VALVE G

BYPASS THROTTLE (Full Open)

- c. CLOSE the following cart valve.

TOGGLE VALVE H

- d. Turn the cart FLUSH PUMP switch ON.
- e. Slowly ADJUST the cart BYPASS THROTTLE valve to set and maintain alcohol pressure at 45-50 psig as indicated on the cart SUPPLY PRESS gage.
- f. Slowly ADJUST the cart DISCHARGE THROTTLE valve to set the alcohol flow as indicated on the cart DISCHARGE FLOWMETER (F7) to $1/2 \pm 1/4$ of the flowmeter scale reading recorded in step 5.2.7.5.2, i.

NOTE: Alcohol pressure, as indicated on the cart SUPPLY PRESS gage, must not exceed 50 psig. If necessary, ADJUST the cart BYPASS THROTTLE valve to set and maintain alcohol pressure at 45-50 psig.

- g. Circulate alcohol through the powerplant glycol system for a minimum of 30 minutes for the purpose of flushing the power-plant Glycol Accumulator. Perform the following at the beginning, during and just prior to the completion of the flush.

- 1. Record the scale readings as read on the following cart flowmeters.

DISCHARGE FLOWMETER (F7)
ACCUMULATOR DISCHARGE FLOWMETER

- 2. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.
- 3. Record the pressures as indicated on the following cart gages.

SUPPLY PRESS
DISCHARGE PRESS
N₂ PRESS AUX (stand)

- h. CLOSE the cart TOGGLE VALVE E while adjusting the cart BYPASS THROTTLE valve to set the alcohol pressure at 45 - 50 psig as indicated on the SUPPLY PRESS gage.

- i. ADJUST the cart DISCHARGE THROTTLE valve to set 30 ± 3 psig as read on the DISCHARGE PRESS gage while adjusting the cart BYPASS THROTTLE valve to set the alcohol pressure at 45 - 50 psig as indicated on the SUPPLY PRESS gage.

5.2.7.5.5 Alcohol Flush Cycle No. 4

- a. Circulate alcohol through the powerplant glycol system for a minimum of 30 minutes for the purpose of flushing the powerplant Glycol Pump. Perform the following at the beginning, during and just prior to the completion of the flush.

1. Record the scale reading as read on the following cart flowmeter.

DISCHARGE FLOWMETER (F7)

2. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.

3. Record the pressures as indicated on the following cart gages.

SUPPLY PRESS
DISCHARGE PRESS
N₂ PRESS AUX (stand)

- b. OPEN the following cart valve.

TOGGLE VALVE H

- c. CLOSE the following cart valve.

TOGGLE VALVE G

- d. Allow the used alcohol to flow from ALCOHOL RESERVOIR A to ALCOHOL RESERVOIR B of the cart.

- e. Turn the cart FLUSH PUMP switch to OFF.

5.2.7.5.6 Alcohol Flush Cycle No. 5

- a. Fill RESERVOIR A of the cart with 2 gallons of fresh Isopropyl Alcohol.
- b. OPEN the following cart valves.

TOGGLE VALVE G
BYPASS THROTTLE (Full Open)
- c. CLOSE the following cart valve.

TOGGLE VALVE H
- d. Turn the cart FLUSH PUMP switch to ON.
- e. ADJUST the cart DISCHARGE THROTTLE valve to set 30 + 3 psig as read on the DISCHARGE PRESS gage while ADJUSTING the cart BYPASS THROTTLE valve to set alcohol pressure at 45-50 psig as indicated on the cart SUPPLY PRESS gage.
- f. Circulate alcohol through the powerplant glycol system for a minimum of 30 minutes for the purpose of flushing the powerplant Glycol Pump. Perform the following at the beginning, during and just prior to the completion of the flush.
 1. Record the scale reading as read on the following cart flowmeter.

DISCHARGE FLOWMETER (F7)

2. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.
3. Record the pressures as indicated on the following cart gages.

SUPPLY PRESS
DISCHARGE PRESS
N₂ PRESS AUX (stand)

- g. OPEN the following cart valve.

TOGGLE VALVE H

- h. CLOSE the following cart valve.

TOGGLE VALVE G

- i. Allow the used alcohol to flow from ALCOHOL RESERVOIR A to ALCOHOL RESERVOIR B of the cart.

- j. Turn the cart FLUSH PUMP switch to OFF.

5.2.7.5.7 Alcohol Flush Cycle No. 6

- a. Fill RESERVOIR A of the cart with 2 gallons of fresh Isopropyl Alcohol.

- b. OPEN the following cart valves.

TOGGLE VALVE G

BYPASS THROTTLE (Full Open)

- c. CLOSE the following cart valve.

TOGGLE VALVE H

- d. Turn the cart FLUSH PUMP Switch to ON.

- e. ADJUST the cart DISCHARGE THROTTLE valve to set 30 ± 3 psig as read on the DISCHARGE PRESS gage while ADJUSTING the cart BYPASS THROTTLE valve to set alcohol pressure at 45-50 psig as indicated on the cart SUPPLY PRESS gage.

- f. Circulate alcohol through the powerplant glycol system for a minimum of 30 minutes for the purpose of flushing the powerplant Glycol Pump. Perform the following during the flush.

NOTE: Take the readings at the beginning, during and just prior to the completion of the flush with the cart PUMP BYPASS switch in the OFF position.

1. Record the scale reading as read on the following cart flowmeter.

DISCHARGE FLOWMETER (F7)

2. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.
3. Record the pressures as indicated on the following cart gages.

SUPPLY PRESS
DISCHARGE PRESS
N₂ PRESS AUX (stand)

4. Turn the cart SOLENOID BYPASS VALVE TIMER switch to ON, thereby cycling the alcohol pressure as indicated on the SUPPLY PRESSURE gage.
 5. Terminate the flush by turning the cart solenoid bypass valve timer switch to the OFF position.
- g. OPEN the following cart valve.
- TOGGLE VALVE H
- h. CLOSE the following cart valve.
- TOGGLE VALVE G
- i. Allow the used alcohol to flow from RESERVOIR A to RESERVOIR B of the cart.
- j. Turn the cart FLUSH PUMP switch to OFF.

5.2.7.5.8 Alcohol Cycle No. 7

- a. Fill ALCOHOL RESERVOIR A of the cart with 2 gallons of fresh Isopropyl Alcohol.
- b. OPEN the following cart valves.

TOGGLE VALVE E
TOGGLE VALVE G
BYPASS THROTTLE (Full Open)
DISCHARGE THROTTLE (Full Open)
- c. CLOSE the following cart valve.

TOGGLE VALVE H
- d. Turn the cart FLUSH PUMP switch to ON.
- e. Slowly ADJUST the cart BYPASS THROTTLE valve to set and maintain alcohol pressure at 45-50 psig as indicated on the SUPPLY PRESSURE gage.
- f. Slowly ADJUST the cart DISCHARGE THROTTLE valve to set the alcohol flow, as indicated on the cart DISCHARGE FLOWMETER, to $1/2 \pm 1/4$ of the flowmeter scale reading recorded in step 5.2.7.5.2, i.

NOTE: Alcohol pressure, as indicated on the cart SUPPLY PRESSURE gage, must not exceed 50 psig. If necessary, ADJUST the cart BYPASS THROTTLE valve to set and maintain alcohol pressure at 45-50 psig.

- g. Circulate alcohol through the powerplant glycol system for a minimum of 30 minutes for the purpose of flushing the powerplant Glycol Accumulator. Perform the following during the flush.

NOTE: Take the readings at the beginning, during and just prior to the completion of the flush with the cart flush PUMP BYPASS switch in the OFF position.

1. Record the scale readings as read on the following cart flowmeters.

DISCHARGE FLOWMETER (F7)
ACCUMULATOR DISCHARGE FLOWMETER

2. Record the total motor and conductivity probe powers, currents and voltages as read on the stand 400 CPS WATTMETER, the stand 400 CPS AMMETER and the stand 400 CPS VOLTMETER.
3. Record the pressures as indicated on the following cart gages.

SUPPLY PRESS
DISCHARGE PRESS
N₂ PRESS AUX (stand)

4. Turn the cart SOLENOID BYPASS VALVE TIMER switch to ON, thereby cycling the alcohol pressure as indicated on the SUPPLY PRESSURE gage.
 5. Terminate the flush by turning the cart solenoid bypass valve timer switch to the OFF position.
- h. OPEN the following cart valves.
- TOGGLE VALVE H
DISCHARGE THROTTLE (Full Open)
- i. CLOSE the following cart valve.
- TOGGLE VALVE E
TOGGLE VALVE G
- j. Allow the used alcohol to flow from ALCOHOL RESERVOIR A to ALCOHOL RESERVOIR B of the cart.
- k. Turn the cart FLUSH PUMP switch to OFF.

1. Turn OUT the stand N₂ REG AUX to reduce pressure as indicated on the stand N₂ PRESS AUX to 0-2 psig to remove the pressure from the N₂ side of the powerplant Glycol Accumulator.
 - m. Turn the stand 400 CPS SUPPLY switch to OFF deactivating the powerplant pumps and conductivity probe.
- 5.2.7.5.9 Disconnection of the Alcohol Flush Cart
- a. Disconnect the ACCUMULATOR DISCHARGE LINE of the cart from the fitting on the glycol side of the powerplant Glycol Accumulator. Use a drip pan to catch drippings.
 - b. Disconnect the ALCOHOL DISCHARGE LINE of the cart from the F7 powerplant interface adapter fitting. Use a drip pan to catch drippings.
 - c. Disconnect the ALCOHOL SUPPLY LINE of the cart from the F8 powerplant interface adapter fitting. Use a drip pan to catch drippings.
 - d. Disconnect the stand INERT GAS SUPPLY line from the powerplant Glycol Accumulator N₂ fitting and cap off the N₂ fitting.
 - e. Disconnect the cart SECONDARY BYPASS LINE DISCHARGE LINE from the powerplant Secondary Regenerator Bypass Line. Use a drip pan to catch drippings.
 - f. Have assembly personnel disconnect and remove the powerplant Secondary Regenerator Bypass Line from the powerplant. Use a drip pan to collect drippings.
 - g. Clean the powerplant Secondary Regenerator Bypass Line and dry it by purging N₂ through the tube.
 - h. Have assembly personnel reinstall the powerplant Secondary Regenerator Bypass Line in the powerplant.
- 5.2.7.6 Glycol System Purge
- 5.2.7.6.1 Glycol System Purge and Vacuum Cart Hook-Up
- a. Connect the stand N₂ LP SUPPLY line to the fitting on the glycol side of the powerplant Glycol Accumulator.

- b. Connect a line from the PURGE PORT NO. 1 on the Glycol System Purge and Vacuum Cart, Figure 5, to the F8 powerplant interface adapter fitting.
- c. Connect a line from the PURGE PORT NO. 2 on the cart to the F7 powerplant interface adapter fitting.
- d. Connect a line from the supply side of the stand Simulated Space Radiator to the cart IN PORT on the Cold Trap.
- e. Connect a line from the return side of the stand Simulated Space Radiator to the cart OUT PORT on the Cold Trap.

5.2.7.6.2 Glycol System N₂ Purge

- a. OPEN the following cart valves.

TOGGLE VALVE A
TOGGLE VALVE B
TOGGLE VALVE C
PURGE S/O

- b. Turn the stand 400 CPS SUPPLY switch to ON activating the powerplant pumps and conductivity probe.
- c. Start the powerplant glycol system N₂ purge by using the N₂ REG LP to set 25 ± 5 psig, as indicated on the stand N₂ PRESS LP gage.
 - 1. After purging for not less than 10 minutes turn the stand 400 CPS SUPPLY switch to OFF deactivating the powerplant pumps and conductivity probe.
 - 2. During the valve manipulations which follow, readjust N₂ REG LP, if necessary, to limit N₂ pressure to 30 psig maximum during pressure excursions.
 - 3. Alternately CLOSE and OPEN the cart TOGGLE VALVES B and C to alternately channel the N₂ flow through both cart PURGE PORT NO. 1 and PURGE PORT NO. 2 until the alcohol flow is reduced to not more than 15 drops per minute out of the cart PURGE PORT NO. 3.
 - 4. To make the purge most effective, CLOSE and OPEN cart TOGGLE VALVE A quickly several times during the purge through each drain port.

5. Minimum purge duration is 1 hour.

- d. Reduce the N₂ pressure to 0-2 psig, as indicated on the N₂ PRESS LP gage, by turning OUT the N₂ REG LP completing the glycol system N₂ purge.
- e. Disconnect the stand N₂ LP SUPPLY line from the fitting on the glycol side of the powerplant Glycol Accumulator.

5.2.7.6.3 Glycol System Helium Purge

- a. Connect a line from the HELIUM BOTTLE (Figure 5) to the fitting on the glycol side of the powerplant Glycol Accumulator.
- b. Start the powerplant glycol system helium purge by using the HELIUM REG to set 25 ± 5 psig as indicated on the HELIUM PRESS gage.
 - 1. During the valve manipulations which follow, readjust the HELIUM REG, if necessary, to limit helium pressure to 30 psig maximum during pressure excursions.
 - 2. Alternately CLOSE and OPEN the cart TOGGLE VALVES B and C to alternately channel the Helium flow through cart PURGE PORT NO. 1 and PURGE PORT NO. 2.
 - 3. To make purge most effective, CLOSE and OPEN the cart TOGGLE VALVE A quickly several times during the purge through each drain port.
 - 4. Minimum purge duration is 1 hour.
- c. Reduce the Helium pressure to 0-2 psig, as indicated on the HELIUM PRESS gage, by turning OUT the HELIUM REG, completing the glycol system Helium purge.
- d. Disconnect the line from the PURGE PORT NO. 1 of the cart from the F8 powerplant interface adapter fitting.
- e. Disconnect the line on the HELIUM BOTTLE from the fitting on the glycol side of the powerplant Glycol Accumulator.
- f. Cap the fitting on the glycol side of the powerplant Glycol Accumulator to ensure that the system is pressure tight.

5.2.7.7 Glycol System Heat and Vacuum

5.2.7.7.1 Glycol System Purge and Vacuum Cart Hook-Up

- a. Ascertain that the following valves on the Glycol System Purge and Vacuum Cart, Figure 5, are in the CLOSED position:

VACUUM DECAY S/O ISOLATION
VACUUM GAGE ISOLATION S/O
POWERPLANT ISOLATION S/O
COLD TRAP DRAIN S/O
COLD TRAP ATMOS VENT
VACUUM PUMP S/O ISOLATION
PURGE S/O
TOGGLE VALVE A
TOGGLE VALVE B
TOGGLE VALVE C
COLD TRAP S/O ISOLATION

- b. Ascertain that the following cart switch is in the OFF position.

VACUUM PUMP

- c. Install skin thermocouples on the following powerplant components.

GLYCOL PUMP
GLYCOL ACCUMULATOR
SECONDARY REGENERATOR
REACTANT PREHEATER (H₂ OR O₂)
SECONDARY REGENERATOR BYPASS LINE
H₂ PUMP - MOTOR ASSEMBLY
2 T/C's ON PUMP SECTION
1 T/C ON MOTOR

- d. Remove the top portion of the stand protective shield and install the Heat Rig, Figure 5, around the powerplant accessory section.
- e. Connect a line from the cart VACUUM SERVICE PORT No. 1 to the F8 powerplant interface adapter fitting.
- f. Cap off the cart PURGE PORT No. 1.
- g. Connect lines from the HELIUM BOTTLE to the cart PURGE PORT No. 3 and to the cart COLD TRAP ATMOS. VENT. PORT.
- h. Set and maintain 2-10 psig as indicated on the HELIUM PRESS gage by using the HELIUM REG.

5.2.7.7.2 Glycol System Heat and Vacuum Cycle

- a. OPEN the following cart valves

TOGGLE VALVE A
TOGGLE VALVE C
VACUUM PUMP S/O ISOLATION
POWERPLANT ISOLATION S/O
COLD TRAP S/O ISOLATION

- b. Using the HEAT RIG, start heating the powerplant accessory section.

NOTE: No powerplant component skin temperature may exceed a maximum of 150°F as indicated on the thermocouples.

- c. When the COLD TRAP temperature is below +5°F, turn the cart VACUUP PUMP switch to ON.
- d. Slowly OPEN the cart VACUUM GAGE ISOLATION S/O VALVE.
- e. Ascertain that the following stand valves are CLOSED.

H₂ S/O LP SUPPLY
N₂ S/O PURGE-H₂

- f. CLOSE the following stand valves:

H₂ S/O HP F/M ISOLATION
H₂ S/O VENT

- g. Turn the following stand switches to ON, opening the corresponding powerplant valves:

H₂ PURGE
LO REACT DIFF

- h. OPEN the following stand valve:

H₂ S/O VACUUM

- i. Establish and maintain a pressure of 0-1 inch Hg absolute as read on the cart VACUUM GAGE.

- j. Turn the following stand switch to ON:

H₂ VACUUM PUMP

NOTE: If the vacuum pump is in operation servicing the adjacent stand, paragraph 5.2.7.7.2h will supply vacuum to the test stand.

- k. Establish a 0-1 psia vacuum on the powerplant H₂ system, as indicated on the Digital Voltmeter, Channel 3.
- l. After reaching a temperature of 145°F on any one of the powerplant components, maintain the vacuum on the H₂ and Glycol systems for 7.0 hours ± 10 minutes. Perform the following during vacuuming.

NOTE: Record the temperatures of the powerplant components, condenser exit temperature (channel 1-2) the vacuum levels and the Cold Trap temperature every 30 minutes throughout the vacuuming.

1. The cart COLD TRAP COLLECTION TANK should be drained at intervals of 1.0 hour ± 15 minutes as follows.
- (a) CLOSE the following cart valves.
VACUUM GAGE ISOLATION S/O
VACUUM PUMP S/O ISOLATION
POWERPLANT ISOLATION S/O
- (b) Slowly OPEN the following cart valve allowing the system to be back-filled with Helium.
- COLD TRAP ATMOS VENT
- (c) OPEN the following cart valve and allow the collected alcohol to drain out.
- COLD TRAP DRAIN S/O
- (d) CLOSE the following cart valves.
- COLD TRAP DRAIN S/O
COLD TRAP ATMOS VENT
- (e) OPEN the following cart valves.
- VACUUM PUMP S/O ISOLATION
POWERPLANT ISOLATION S/O
- (f) Slowly OPEN the cart VACUUM GAGE ISOLATION S/O valve.

- m. At the end of the 7.0 hour ± 10 minutes vacuum dryout period turn the following cart switch to OFF.

VACUUM PUMP

- n. Close the following stand valve:

H₂ S/O VACUUM

- o. Turn the following stand switch to OFF:

H₂ VACUUM PUMP

NOTE: If the vacuum pump is servicing the adjacent stand paragraph 5.2.7.7.2 should be omitted.

- p. Turn the following stand switches to OFF, closing the corresponding powerplant valves:

H₂ PURGE

No REACT DIFF

- q. OPEN the following stand valve:

H₂ S/O VENT

NOTE: The H₂ system must be repressurized in accordance with paragraph 5.2.8, the Reactant System Purge, prior to removal of the powerplant from the test stand.

5.2.7.7.3 Disconnection of the Glycol System Purge and Vacuum Cart

- a. Turn OFF the Heat Rig and remove it from around the powerplant accessory section.
- b. Slowly OPEN the cart PURGE S/O valve and allow the powerplant glycol system to be bled to ambient as read on the cart VACUUM GAGE.
- c. CLOSE the following cart valve.

PURGE S/O

NOTE: Prior to the disconnection of each cart line and the installation of each protective cap, inspect for and remove any residual fluid on the interface fittings.

- d. Disconnect the line from the F8 adapter fitting on the powerplant to the VACUUM SERVICE PORT on the cart. Install a protective cap on the powerplant F8 fitting using nickel seal P/N 601577. Install finger tight.
- e. Disconnect the line from the F7 adapter fitting on the powerplant to the PURGE PORT NO. 2 on the cart. Install protective cap on the powerplant F7 fitting using nickel seal P/N 601531. Install finger tight.

5.2.8 REACTANT SYSTEM PURGE

5.2.8.1 Purging the Reactant System with N₂

- a. Ascertain the following valves are closed.

H₂ S/O LP SUPPLY
H₂ S/O HP SUPPLY
O₂ S/O LP SUPPLY
O₂ S/O HP SUPPLY

- b. OPEN the following valves.

N₂ S/O PURGE - H₂
N₂ S/O PURGE - O₂

- c. Set N₂ PRESS PURGE - N₂ to 100 ± 10 psig with the N₂ REG PURGE - H₂ and set N₂ PRESS PURGE - O₂ to 100 ± 10 psig with the N₂ REG PURGE - O₂.

- d. Turn the following switches to ON, opening the corresponding powerplant valves.

H₂ PURGE
O₂ PURGE

- e. Start purging the reactant systems with N₂ purge for a period no less than 10 minutes.

- f. After completing N₂ purge period, CLOSE the following valves.

N₂ S/O PURGE - H₂
N₂ S/O PURGE - O₂

- g. Turn OUT the following regulators.

N₂ REG PURGE - H₂
N₂ REG PURGE - O₂

- h. When the O₂ and H₂ pressures reach ambient as indicated on Digital Voltmeter Channels 3 and 4, turn the following switches to OFF, closing the corresponding powerplant valves.

H₂ PURGE
O₂ PURGE

- i. Turn the 28 VOLT POWER SUPPLY switch to OFF.

5.2.9 REMOVAL OF POWERPLANT FROM SEA LEVEL TEST STAND

NOTE: The following steps are necessary to remove a powerplant and they need not be continuous nor consecutive but should be accomplished prior to returning the powerplant to Assembly.

5.2.9.1 Remove the Stand Protective Shield

5.2.9.2 Remove water collection equipment connected to tube installed on F4 interface.

5.2.9.3 Disconnect the following Electrical Connections:

- a. Disconnect the INSTRUMENTATION stand cable from the powerplant interface connector J4. Replace the protective cap, P/N P603803, on J4 connector.
- b. Disconnect the CONTROL POWER SUPPLY stand cable from the powerplant interface connector J3. Replace the protective cap, P/N P603802, on J3 connector.
- c. Disconnect the HEATER POWER SUPPLY stand cable from the powerplant interface connector J2. Replace the protective cap, P/N P602658, on J2 connector.
- d. Disconnect the POWER OUTPUT stand cable from the powerplant interface connector J1. Replace the protective cap P/N P602659, on J1 connector.

5.2.9.4 Disconnect the following Plumbing Connections:

NOTE: Prior to the disconnection of each stand line and the installation of each protective cap, inspect for and remove any residual fluid on the interface fittings.

- a. Disconnect the FUEL VENT stand line from the powerplant interface fitting adapter F6. Replace the protective cap on F6 using P/N 601531 seal.

- b. Disconnect the WATER OUTLET stand line from the power-plant interface fitting adapter F4. Replace protective cap on F4 using P/N 601531 seal.
 - c. Disconnect the OXIDIZER VENT stand line from the power-plant interface fitting adapter F3. Replace protective cap on F3 using P/N 601531 seal.
 - d. Disconnect the OXIDIZER SUPPLY stand line from the power-plant interface fitting adapter F2. Replace protective cap on F2 using P/N 601531 seal.
 - e. Disconnect the FUEL SUPPLY stand line from the powerplant interface fitting adapter F1. Replace protective cap on F1 using P/N 601531 seal.
 - f. Disconnect the N₂ - SAMPLING stand line from the power-plant N₂ SAMPLING valve connector. Replace protective cap on the powerplant N₂ SAMPLING valve connector.
- 5.2.9.5 Remove the powerplant and adapter assembly from the test stand.
- 5.2.9.6 Install the powerplant in transport stand.
- 5.2.9.7 Present Log Sheets to Quality Control for final approval (Review discontinuity) and deliver powerplant to Assembly Department.
- 5.3 FINAL LEAK CHECK PROCEDURE - Performed on Production Assembly Floor with Helium.
- 5.3.1 Decay checking the complete powerplant assembly.
- 5.3.1.1 Connect the pressure test cart (Figure 6) to the powerplant.

- a. Ascertain that the following cart valves are CLOSED.

He S/O LP SUPPLY
He S/O LP VENT
He S/O LP ISOLATION
He S/O LP - O₂
He S/O LP - H₂
He S/O LP - N₂
He S/O LP - GLYCOL
He S/O LP SEPARATION - O₂
He S/O LP SEPARATION - H₂
He S/O LP SEPARATION - N₂
GLYCOL TRAP DRAIN
He S/O HP ISOLATION - O₂
He S/O HP ISOLATION - H₂
He S/O HP ISOLATION - N₂
He S/O HP VENT
He S/O HP DECAY ISOLATION
He S/O HP SUPPLY
He S/O HP REG SUPPLY
He S/O LP REG SUPPLY

- b. Ascertain that the following cart switches are OFF.

H₂ PURGE
O₂ PURGE
N₂ FILL
LO REACT DIFF

- c. Connect the cart N₂ SUPPLY line to the powerplant F5 using P/N 601531 Seal interface adapter.
- d. Connect the cart H₂ SUPPLY line to the powerplant F1 using P/N 601531 seal interface adapter.
- e. Connect the cart O₂ SUPPLY line to the powerplant F2 using P/N 601531 seal interface adapter.
- f. Connect the interconnected cart GLYCOL SUPPLY line to the powerplant F7 using P/N 601531 seal and F8 using P/N 601577 seal interface adapter fittings.
- g. Remove PWA P/N 602914 dust cover from N₂ sampling valve.
- h. Leave the following powerplant fluid fittings OPEN to ambient:

F4 (water outlet)

F6 (H₂ vent)

F3 (O₂ vent)

- i. Connect the 28 VOLT POWER SUPPLY cable (valve actuation box) to the powerplant J3 interface connector.
- j. Connect the cart INSTRUMENTATION cable to the powerplant J4 interface connector.

NOTE: This activates the H₂, O₂, and N₂ ELECTRONIC PRESSURE Gages on the Pressure Test Cart. These gages are to be used only to monitor powerplant pressures, no recordings required.

- k. Adjust power supply to 28 volts.

5.3.1.2 Pressurize the powerplant O₂, N₂, H₂ and GLYCOL systems.

- a. Turn the N₂ FILL switch to ON.
- b. OPEN the He S/O LP REG SUPPLY valve.
- c. Adjust the He PRESS LP SUPPLY gage to 50 ± 5 psig with the He REG LP on the LP He Tank.
- d. OPEN the following cart valves:

He S/O LP - O₂

He S/O LP - H₂

He S/O LP - N₂

He S/O LP - GLYCOL

He S/O LP SEPARATION - O₂

He S/O LP SEPARATION - H₂

He S/O LP SEPARATION - N₂

He S/O LP SUPPLY

- e. Slightly OPEN the He S/O LP ISOLATION valve and adjust the He S/O LP ISOLATION valve and the He S/O LP O₂, H₂, N₂ and GLYCOL valves as necessary to simultaneously pressurize all systems to 67 ± 1 inches Hg., as indicated in the He PRESS LP SUPPLY H₂, O₂, N₂ and GLYCOL gages.

NOTE: Avoid pressurizing at a rate in excess of 5 inches Hg. per minute. Do not allow the pressure difference between O₂, H₂ and N₂ to exceed 8 inches Hg. while pressurizing.

- f. CLOSE the He S/O LP ISOLATION valve.
- g. When the O₂, H₂, N₂ and GLYCOL systems have stabilized at 67 ± 1 inches Hg., CLOSE the He S/O LP - GLYCOL.
- h. Adjust the He S/O LP ISOLATION valve and the He S/O LP - H₂, O₂ and N₂ valves as necessary to simultaneously pressurize the O₂, H₂ and N₂ gages.
- i. When the O₂, H₂ and N₂ gages stabilize at 100 ± 10 inches Hg., CLOSE the following valves:

He S/O LP - O₂
He S/O LP - H₂
He S/O LP - N₂
He S/O LP ISOLATION
He S/O LP SUPPLY
He S/O LP SEPARATION - N₂

5.3.1.3 Nitrogen System Fill and Nitrogen Fill Valve Check

- a. OPEN the He S/O HP REG SUPPLY valve.
- b. Set the He PRESS HP SUPPLY gage at a minimum of 1600 psig with the He REG HP on the HP He Tank.
- c. OPEN the following valves:

He S/O HP DECAY ISOLATION
He S/O HP ISOLATION - N₂
- d. Slowly OPEN the He S/O HP SUPPLY valve and monitor the pressure increase on He PRESS HP SUPPLY gages. Increase the pressure to 1600 ± 50 psig.
- e. CLOSE the He S/O HP SUPPLY valve.
- f. Turn the N₂ FILL switch to OFF.
- g. Slowly OPEN the He S/O HP VENT valve and allow the pressure in the cart to decrease to 45-50 psig as indicated on the H3 PRESS HP SUPPLY gages.
- h. CLOSE the He S/O HP VENT valve.
- i. CLOSE the He S/O HP DECAY ISOLATION valve.

- j. Slowly CRACK the He S/O HP VENT valve to allow the DIFF PRESS gage to increase to 2 ± 0.5 psi. CLOSE the He S/O HP VENT valve.
- k. Decay check the system for 20 minutes. (If the reading decreases below the preset value in step j, the N₂ FILL valve could be leaking). Record the variations in pressure as registered on the DIFF PRESS gage.
- l. OPEN the He S/O HP DECAY ISOLATION valve.
- m. Readjust the HP supply pressure to 45-50 psig as read on the He PRESS HP SUPPLY gages by opening the He S/O HP SUPPLY valve to increase pressure or opening the He S/O VENT valve to decrease pressure.
- n. CLOSE the He S/O HP ISOLATION - N₂ valve.
- o. OPEN the He S/O LP SEPARATION - N₂ valve.

5.3.1.4 Hydrogen System High Pressure Check

- a. CLOSE the He S/O LP SEPARATION - H₂ valve.
- b. OPEN the He S/O HP ISOLATION - H₂ valve.
- c. OPEN the He S/O HP SUPPLY valve to allow 300 ± 20 psig to be supplied to the system as registered on the He PRESS HP SUPPLY gages. CLOSE the He S/O HP SUPPLY valve.
- d. CLOSE the He S/O HP DECAY ISOLATION valve.
- e. Decay check the hydrogen system for a period not less than 20 minutes and record the variation in pressure as registered on the DIFF PRESS gage.

NOTE: Decay is not to exceed limit in paragraph 5.3.1.10.

- f. OPEN the He S/O HP DECAY ISOLATION valve.
- g. Slowly OPEN the He S/O HP VENT valve and allow the pressure in the cart to decrease to 45-50 psig as indicated on the H₂ PRESS HP SUPPLY gages.
- h. CLOSE the He S/O HP VENT valve.

- i. CLOSE the He S/O HP ISOLATION - H₂ valve.
- j. OPEN the He S/O LP SEPARATION - H₂ valve.

5.3.1.5 Oxygen System High Pressure Check

- a. CLOSE the He S/O LP SEPARATION - O₂ valve.
- b. OPEN the He S/O HP ISOLATION - O₂ valve.
- c. OPEN the He S/O HP SUPPLY valve to allow 1050 ± 50 psig to be supplied to the system as registered on the He PRESS HP SUPPLY gages. CLOSE the He S/O HP SUPPLY valve.
- d. CLOSE the He S/O HP DECAY ISOLATION valve.
- e. Decay check the oxygen system for a period not less than 20 minutes and record the variation in pressure as registered on the DIFF PRESS gage.

NOTE: Decay not to exceed limit in paragraph 5.3.1.10.

- f. OPEN the He S/O HP DECAY ISOLATION valve
- g. Slowly OPEN the He S/O HP VENT valve and allow the pressure in the cart to decrease to 45-50 psig as recorded on the He PRESS HP SUPPLY gages.
- h. CLOSE the He S/O HP VENT valve
- i. CLOSE the He S/O HP ISOLATION - O₂ valve.
- j. OPEN the He S/O LP SEPARATION - O₂ valve.

5.3.1.6 Nitrogen System High Pressure Check

- a. CLOSE the He S/O LP SEPARATION - N₂ valve.
- b. OPEN the He S/O HP ISOLATION - N₂ valve.
- c. OPEN the He S/O HP SUPPLY valve to allow 1500 ± 50 psig to be supplied to the system as registered on the He PRESS HP SUPPLY gages. CLOSE the He S/O HP SUPPLY valve.

- d. Turn the N₂ FILL switch to ON.
- e. Readjust, if necessary, the He PRESS HP SUPPLY gages to 1500 ± 50 psig by filling through the He S/O HP SUPPLY valve.
- f. Allow the powerplant nitrogen tank to cool to room temperature
- g. CLOSE the He S/O HP DECAY ISOLATION valve.
- h. Decay check the nitrogen system for a period not less than 20 minutes and record the variation in pressure as registered on the DIFF PRESS gage.

NOTE: Decay not to exceed limit per paragraph 5.3.1.10.

- i. OPEN the He S/O HP DECAY ISOLATION valve.
- j. Slowly OPEN the He S/O HP VENT valve and allow the pressure in the cart to decrease to 45-50 psig as indicated on the He PRESS HP SUPPLY gages.

NOTE: Depressurize over a period of at least 5 minutes.

- k. CLOSE the He S/O HP VENT valve.
- l. CLOSE the He S/O HP ISOLATION - N₂ valve.
- m. OPEN the He S/O LP SEPARATION - N₂ valve.
- n. OPEN He S/O HP VENT valve
- o. SHUT OFF the HP supply to the cart by adjusting the He REG HP closing the He REG HP.
- p. OPEN the He S/O HP Supply Valve.

5.3.1.7 Leak Check the Engine at Low Pressure

- a. Ascertain that the following valves are closed:

He S/O LP SUPPLY
He S/O LP ISOLATION

- b. OPEN the following valves:

He S/O LP - O₂
He S/O LP - H₂
He S/O LP - N₂
He S/O LP VENT

- c. Slowly OPEN the He S/O LP ISOLATION valve and depressurize the H₂, O₂ and N₂ systems to 90 ± 1 inches Hg. as shown on the He PRESS LP SUPPLY gages.

- d. CLOSE the following valves:

He S/O LP - O₂
He S/O LP - H₂

- e. Slowly OPEN the He S/O LP ISOLATION valve and depressurize the N₂ system to 64 ± 1 inches Hg as indicated on the He PRESS LP SUPPLY - N₂ gage.

NOTES: 1. Monitor the H₂ and O₂ transducer readout to insure they follow the decreased blanket pressure.

2. OPEN the GLYCOL TRAP DRAIN as necessary to depressurize the N₂ and GLYCOL pressures together.

3. If the transducer readout indicates the N₂ internal pressure is not dropping as the supply is decreased, bleed the blanket through the N₂ sampling valve using ET 61253 or equivalent release mechanism.

- f. CLOSE the He S/O LP - N₂ valve.
- g. Readjust the H₂ and O₂ pressures as shown on the He PRESS LP SUPPLY gages to 83 ± 1 inches Hg by slowly opening the HE S/O LP-02 and He S/O LP-H₂ valves.
- h. CLOSE the He S/O LP - O₂ and He S/O LP - H₂ valves.
- i. Readjust the N₂ and GLYCOL pressures as shown on the He PRESS LP SUPPLY gages to 67 ± 1 inches Hg by slowly opening the HE S/O LP-N₂ valve.

- j. CLOSE the following valves:

He S/O LP - N₂
He S/O LP - GLYCOL

- k. Decay check for one hour and record results.

NOTE: Decay not to exceed limit per paragraph 5.3.1.10.

5.3.1.8 Depressurize the powerplant H₂, O₂, N₂ and GLYCOL systems.

- a. OPEN the He S/O LP VENT valve about 6 turns.
- b. Slightly OPEN the He S/O LP - H₂ and O₂ valves.
- c. Slightly OPEN the He S/O LP ISOLATION valve and depressurize the O₂ and H₂ systems at a rate not to exceed 1.5 inch Hg. per minute down to the level of the N₂ system, then CLOSE the He S/O LP ISOLATION valve.
- d. After the O₂ and H₂ systems are within 2 inches Hg. of the N₂ system, OPEN the He S/O LP - N₂ valve and allow the three systems to equalize.
- e. Slightly OPEN the He S/O LP ISOLATION valve and the GLYCOL TRAP DRAIN valve and start to depressurize the powerplant O₂, H₂, N₂ and GLYCOL systems.

NOTES: 1. Depressurize at a rate not to exceed 10 inches Hg. per 30-minute period. Depressurization may be accomplished in 10-inch Hg. decrements.

2. Do not allow the pressure difference between the O₂, H₂, N₂ and GLYCOL systems to exceed 8-inches hg., adjusting the individual shutoff valves as required.

- f. When the H₂, O₂, N₂ and GLYCOL systems are depressurized to 30 ± 2 inches Hg., simultaneously CLOSE the He S/O LP ISOLATION valve and the GLYCOL TRAP DRAIN valve.

- g. CLOSE the following fixture valves:

He S/O LP - O₂
He S/O LP - H₂

- h. Simultaneously turn the O₂ PURGE and H₂ PURGE switches to ON and allow the reactant system to depressurize to ambient.
- i. Maintain the N₂ and GLYCOL system pressure at 29 ± 3 inches Hg. for a period of not less than 2 hours.
- j. After the 2-hour period, OPEN the S/O LP ISOLATION valve and the GLYCOL TRAP DRAIN valve and depressurize the N₂ and GLYCOL system to ambient.

NOTES: 1. Do not allow the pressure difference between the N₂ and GLYCOL systems to exceed 8 inches Hg. Regulate by adjusting the individual low pressure shutoff valves as required.

2. Avoid depressurizing the N₂ and GLYCOL systems at a rate in excess of 5 inches Hg. per minute.

- k. Turn the following switches to OFF.

N₂ FILL
O₂ PURGE
H₂ PURGE

1. CLOSE the following cart valves:

He S/O LP - N₂
He S/O LP VENT
He S/O LP ISOLATION
GLYCOL TRAP DRAIN
He S/O LP SEPARATION - O₂
He S/O LP SEPARATION - H₂
He S/O LP SEPARATION - N₂

5.3.1.9 Disconnect the Powerplant from Pressure Test cart

- a. Disconnect the cart N₂ SUPPLY line from the powerplant F5 interface adapter. Replace the protective cap on F5 using P/N 601531 seal.
- b. Disconnect the cart H₂ SUPPLY line from the powerplant F1 interface adapter. Replace the protective cap on F5 using P/N 601531 seal.
- c. Disconnect the cart O₂ SUPPLY line from the powerplant F2 interface adapter. Replace the protective cap on F2 using P/N 601531 seal.
- d. Disconnect the cart interconnection from the powerplant F7 and F8 interface adapters. Replace the protective caps on F7 and F8 using P/N 601531 seal.
- e. Disconnect the 28 VOLT POWER SUPPLY (valve actuation box) from the powerplant J3 connector. Replace the protective cap on the J3 connector.
- f. Disconnect the instrumentation cable from the powerplant J4 interface connector. Replace the protective cap on the J4 interface connector.

5.3.1.10 Decay limits for Post-Test Check of Complete Powerplant

	<u>High Press</u>	<u>Low Press</u>
H ₂	at 300 psig*	at 83" Hg - 0.3" Hg/20 min (Gage)
O ₂	at 1050 psig*	at 83" Hg - 0.3" Hg/20 min (Gage)
Glycol		at 67" Hg - 0.1" Hg/20 min (Gage)
N	at 1500 psig 0.66 psi/20 min	at 67" Hg - 0.1" Hg/20 min (Gage)

* Record for Engineering Evaluation

5.4 ELECTRICAL TEST PROCEDURES

5.4.1 Insulation resistance check procedure

5.4.1.1 Equipment Requirement

- a. Powerplant component checking fixture No. ED-1438-3 (Figure 9) and cables.
- b. Freed model 1020-C D.C. megohmmeter and 5 pin cable (megohmmeter modified to PWA ED 1398-1.)

5.4.1.2 Procedure

- a. Connect four test cables (power, heaters, accessories and instrumentation) from the checkout unit to the powerplant.
- b. Connect the ground line to the nut on the F-1 fitting (H₂ Inlet) on the powerplant interface.
- c. Disconnect P-171 connector from J-171 at fuel cell pressure vessel.
- d. Connect the megohmmeter to the checkout unit.
- e. Disconnect jumper bar from output terminals of megohmmeter and calibrate.
- f. Push test voltage switch up on megohmmeter in lock position.
- g. Place multi-meter(Simpson) in "+DC" position on 1000 vdc.
- h. Plug programmer connector into checkout unit, push test button and take reading on multi-meter.

<u>Programmer</u>	<u>Description</u>	<u>Meter Voltage</u>	<u>Min. Reading</u>
No. 55	Test Voltage Check	1000	450 vdc

- i. All resistance readings taken on megohmmeter must be no less than stated minimum.
- j. Plug programmer connector into checkout unit, push test button and take readings on megohmmeter.

<u>Programmer</u>	<u>Description</u>	<u>Meter Voltage</u>	<u>Min. Reading</u>
No. 1	Meter Resistance Check	500	1.2 ± 0.1 Meg. ohm
2	Power Output (-)	500	1 Meg.
3	Power Output (+)	500	1 Meg.
4	Reduced Delta P Valve	500	1 Meg.
5	Heaters	500	1 Meg.
6	Motors & H ₂ O Sensor Input	500	1 Meg.
7	H ₂ Press Switch (+)	500	1 Meg.
8	H ₂ Press Switch (-)	500	1 Meg.
9	H ₂ Purge Valve	500	1 Meg.
10	O ₂ Purge Valve	500	1 Meg.
11	O ₂ Press Switch (+)	500	1 Meg.
12	O ₂ Press Switch (-)	500	1 Meg.
13	N ₂ Fill Valve	500	1 Meg.

- k. Plug programmer connector into checkout unit, push test button and take reading on multi-meter.

<u>Programmer</u>	<u>Description</u>	<u>Meter Voltage</u>	<u>Min. Reading</u>
No. 55	Test Voltage Check	1000	450 vdc

- l. Place multi-meter (simpson) in "+DC" position on 250 vdc.
- m. Plug programmer connector into checkout unit, push test button and take reading on multi-meter

<u>Programmer</u>	<u>Description</u>	<u>Meter Voltage</u>	<u>Max. Reading</u>
No. 56	Test Voltage Check	250	60 vdc

- n. Reconnect and safety wire P-171 with J-171.

<u>Programmer</u>	<u>Description</u>	<u>Meter Voltage</u>	<u>Min. Reading</u>
No. 14	In-line Heater Control	50	1 Meg.
15	Water Condition Sensor Output	50	1 Meg.
16	P5-02 Pressure Outputs	50	1 Meg.
17	P5-02 Pressure Input	50	1 Meg.
18	P4-H2 Pressure Output	50	1 Meg.
19	P4-H2 Pressure Input	50	1 Meg.
20	P3-N2 Pressure Input	50	1 Meg.
21	P3-N2 Pressure Output	50	1 Meg.
22	T6 Cond. Exit Temp.	50	1 Meg.
23	To Stack Temperature	50	1 Meg.

- o. Plug programmer connector into checkout unit, push test button and take reading on multi-meter

<u>Programmer</u>	<u>Description</u>	<u>Meter Voltage</u>	<u>Max. Reading</u>
No. 56	Test Voltage Check	250	60 vdc

5.4.2 Electrical Continuity Check Procedure

5.4.2.1 Equipment Requirement

- a. Powerplant component checking fixture No. ED-1438-3 (Figure 9) and cables.

5.4.2.2 Continuity Test Procedure

- a. Place multi-meter (Simpson) in "+D.C." position on 10 VDC scale.
- b. Plug programmer connector into checkout unit, push test button and take readings on the multi-meter.

			Voltage Reading	
<u>Programmer</u>	<u>Description</u>	<u>Scale</u>	<u>Min.</u>	<u>Max.</u>
No. 24	Battery Check	10V	4.8	
25	Reduced Differential Pressure Valve Coil Resistance	10V	4	7
26	Reduced Differential Pressure Valve Diode Resistance	10V	.25	2 Block I 7 Block II
27	Hydrogen Purge Valve Coil Resistance	10V	4	7
28	Hydrogen Purge Valve Diode Resistance	10V	.25	2 Block I 7 Block II
29	Oxygen Purge Valve Coil Resistance	10V	4	7
30	Oxygen Purge Valve Diode Resistance	10V	.25	2 Block I 7 Block II
31	Nitrogen Fill Valve Coil Resistance	10V	3	6 Block I 3.5 Block II
32	Nitrogen Fill Valve Diode Resistance	10V	.25	2 Block I 3.5 Block II

- c. Place the multi-meter to the appropriate resistance scale X1, X100 or X10 K to take the following resistive continuity readings.

			Measured Resistance ohms	
<u>Programmer</u>	<u>Description</u>		<u>Min.</u>	<u>Max.</u>
Set Meter to X1 Scale				
No. 33	Zero Meter Check		Set to zero	
34	Resistance Meter Check		9	11
35	Heaters Zone 2		1	3
36	Heaters Zone 3		15	30
37	Heaters Zone 1		15	30
38	Pump Motors Phase A (Heater Control)		6	19
No. 39	Pump Motors Phase B		6	19
40	Pump Motors Phase C		6	19
41	Stack Surface Temperature Sensor Common Leads (Check 1)		0	2
42	Stack Surface Temperature Sensor Common Leads (Check 2)		0	2
43	Primary Condensor Exit Temp. Common Leads (Check 1)		0	2

44	Primary Condensor Exit Temp. Common Leads (Check 2)	0	2
----	--	---	---

57	Low Power Heater Control Common Leads	0	2
----	--	---	---

Set Meter to X100 Scale

No.	33	Zero Meter Check	Set to zero	
	45	Stack Surface Temperature Sensor Resistance	200	350
	46	Primary Condensor - Exit Temp. Sensor Resistance	200	350
No.	47	Nitrogen Regulated Pressure Sensor Output Resistance	1K	10K
	48	Hydrogen Regulated Pressure Sensor Output Resistance	1K	10K
	49	Oxygen Regulated Pressure Sensor Output Resistance	1K	10K
	50	Water Condition Sensor Output Resistance	500	1500
	51	In-Line Heater Control Input Resistance	1K	5K

Set Meter to X10K Scale

No.	33	Zero Meter Check	Set to zero	
	52	Nitrogen Regulated Pressure Sensor Input Resistance	20K	50K
	53	Hydrogen Regulated Pressure Sensor Input Resistance	20K	50K
	54	Oxygen Regulated Pressure Sensor Input Resistance	20K	50K

5.5 DATA PLATE INFORMATION

5.5.1 Verification

Quality Control will verify that the data plate information conforms to the following unless otherwise specified by NAA/S& ID.

NAA/S& ID SCD NO. ME464-0007-0001 (Block I)
ME464-0007-1000 (Block II)

Contract No. NAS 9-150

Stock No. **

**** Leave Blank**

MFR PART NO. 602600 (Block I)
606100 (Block II)

MFR SERIAL NO. 06763P6507--

-- Last Two Digits of Applicable Powerplant

5.5.2 Installation

The data plate will be installed per ARS PC-06.

5.6 FINAL INSPECTION PROCEDURE

5.6.1 Assembly Inspector Responsibilities - PC3A-2 Powerplant Checkout

5.6.1.1 Review Assembly Record Sheets to verify that all prescribed operations are completed and signed off by Assembly, Quality Control and Navy.

- a. Powerplant Assembly Post-Test Requirements - Assembly Record Sheets (PC-06)
- b. Powerplant End Item Data - Assembly Record Sheets (PC-08)
- c. Review Specification Check List and Bill of Material

5.6.1.2 Review Powerplant Inspection Records (Hard Cards).

5.6.1.3 Visually inspect the powerplant for good workmanship by re-checking the exterior condition of the completed assembly to assure that nothing detrimental has occurred during test and subsequent reassembly operations. (Magnification may be used to evaluate indications of defects found with normal corrected vision).

5.6.1.4 Upon completion of the above check points, place final inspection stamp on Powerplant Data Plate.

5.6.1.5 Present the complete Powerplant and Assembly Record Sheets to NAA and Navy for final acceptance and permission to install Powerplant into Shipping Container.

5.6.2 Present the Shipping Document (DD 250) and the End Item Data Book to NAA and Navy for Final Acceptance and Signatures.

5.7 PREPARATION FOR SHIPPING PROCEDURE

NOTE: Powerplant may be shipped prior to receipt of powerplant water analysis.

5.7.1 Assembly Inspector Responsibilities - PC3A-2 Powerplant Check Out

5.7.1.1 Witness Assembly of Powerplant into Shipping Container per ARS PC-07.

5.7.1.2 Review Assembly Record Sheets to verify that all prescribed operations have been successfully completed and signed off by Assembly, Quality Control and Navy.

a. Powerplant Check Off - Assembly Record Sheets (PC-01)

b. Powerplant Packing - Assembly Record Sheets (PC-07*)

* PC-07 will not be complete at this point.

- 5.7.1.3 Upon completion of the above check points, install lead security seal on the shipping container.
- 5.7.1.4 Review Shipping Document (DD 250) for completeness and verify that the information such as delivery point, Powerplant identification and shipping weight marked on the shipping container agrees with the shipping document.
- 5.7.1.5 Review End Item Data Book for Completeness and Accuracy.
- 5.7.1.6 Witness installation of PC-07 Directed Documentation into the Shipping Container Documentation tube.
- 5.7.1.7 Complete PC-07 and Retire all Applicable Documentation to the Pratt & Whitney Aircraft Quality Control files.

6. SEA LEVEL TEST STAND

6.1 DESCRIPTION

The Sea Level Test Stands were designed by Pratt & Whitney Aircraft for operation and performance testing of the powerplant in an ambient atmospheric environment. They consist of a control and instrumentation panel and a hooded and vented enclosure to accommodate the powerplant under test. The ventilated enclosure is provided to meet safety requirements for operation with hydrogen and oxygen.

The control and instrumentation panel includes the pressure regulators, valves, pressure gages, and flowmeters necessary to control the gas supplies to the powerplant and to measure the gas flows and various pressures. Also included are the variable voltage transformers required to energize the powerplant heaters, the heater fuse box, the ammeters, voltmeters, and wattmeters required to measure heater and pump motor power input and powerplant output, and all required associated switches. A self-balancing potentiometer is included to measure thermocouple temperatures. Vacuum pumps are provided for purging the reactant systems prior to powerplant starting.

All gases will meet the purity requirements as described by the specification MC464-0015. Electrical supplies to the stands include 115 volt 60 cycle single phase alternating current, 115 volt 400 cycle three phase alternating current, and 28 volt direct current. Supporting equipment and systems for these stands includes a load bank capable of providing variable resistive loads to absorb the output of the powerplant and a heat rejection system to dissipate powerplant waste heat. The heat rejection system permits temperature of the glycol returned to the powerplant to be controlled over the entire operating range of the powerplant.

APPENDIX
ILLUSTRATIONS

PC3 A

PC3A

POWERCEL NO. _____

STAND NO. _____

TYPE OF TEST _____

TEST STAND CALIBRATION

DUE DATE _____

INSPECTION _____

FLOW METER

FLOAT

SERIAL NO.

Pratt & Whitney Aircraft

LOG OF POWERCEL TEST

TIME OBS.

PROD.

INSP.

GOV.

PROD. APPROVAL

INSP. APPROVAL

GOV. APPROVAL

DATE

OPERATOR

ASST. OPERATOR

WATTMETER CORRECTION

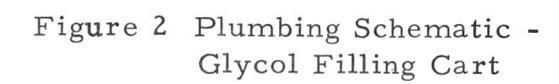
PAGE NO.

LIMITS LOW - HIGH				MODULE				SUPPLY PRESS. TO ENGINE REG.			FLOW METERS								HEATER POWER				MODULE SURFACE TEMP.		COND. EXIT TEMP.		BLANKET PRESS.		H ₂ PRESS. (REGULATED)		O ₂ PRESS. (REGULATED)		COOLANT PRESS.		PURGE VALVES				MOTOR AND CONDUCTIVITY PROBE POWER								WATER				BAR TEMP.		TRAP H ₂ TEMP.		TEMP. RAI COOL.																								
C	O	D	E	TIME	TOTAL HOURS	PARA. NO.	AMPS		VOLTS		H ₂ PSIG	O ₂ PSIG	N ₂ PSIG	H ₂				O ₂				ZONE 1		ZONE 2		ZONE 3		LOW POWER HEATER OFF AMPS	M.V.	TEMP. °F	M.V.	TEMP. °F	C	O	D	E	M.V.	PRESS. PSIA	M.V.	PRESS. PSIA	M.V.	PRESS. PSIA	ΔP INTER-FACE PSI	H ₂ O	H ₂ O	H ₂ O	H ₂ O	WATTS				AMPS				VOLTS	POWER FACTOR	PURITY		GEN. GRAMS	TRAP SAMPLE	INCH HG.	°F	°F															
							X1	X2	M.V.	VOLTS				L - LOW H - HIGH FLOW	PRESS. PSIG	TEMP. °F	COR. READING RPH	L - LOW H - HIGH FLOW	PRESS. PSIG	TEMP. °F	COR. READING RPH	VOLTS	AMPS	VOLTS	AMPS	VOLTS	AMPS																					LEG. A	LEG. B	LEG. C	TOTAL WATTS	LEG. A	LEG. B	LEG. C	TOTAL AMPS			PH	VOLTS																				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
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1	2	3																																																																													

NOTES -

1. If the powerplant heaters and/or pumps are turned off, entries need not be made in the "Heater Power" and/or the "Motor and Conductivity Probe Power" columns.
2. If the powerplant is not on load (open circuit), entries need not be made in the "Flowmeters" columns.
3. If the generated H₂O Collection Bottle has been removed, entries need not be made in the "Purity Volts" and in the "Gen. Grams" columns. The voltage of the Conductivity Probe should be periodically monitored and any variations recorded on the data sheet.

Figure 1 Log of Powercel® Test



Page No. A-2

Revised 2 April 1968

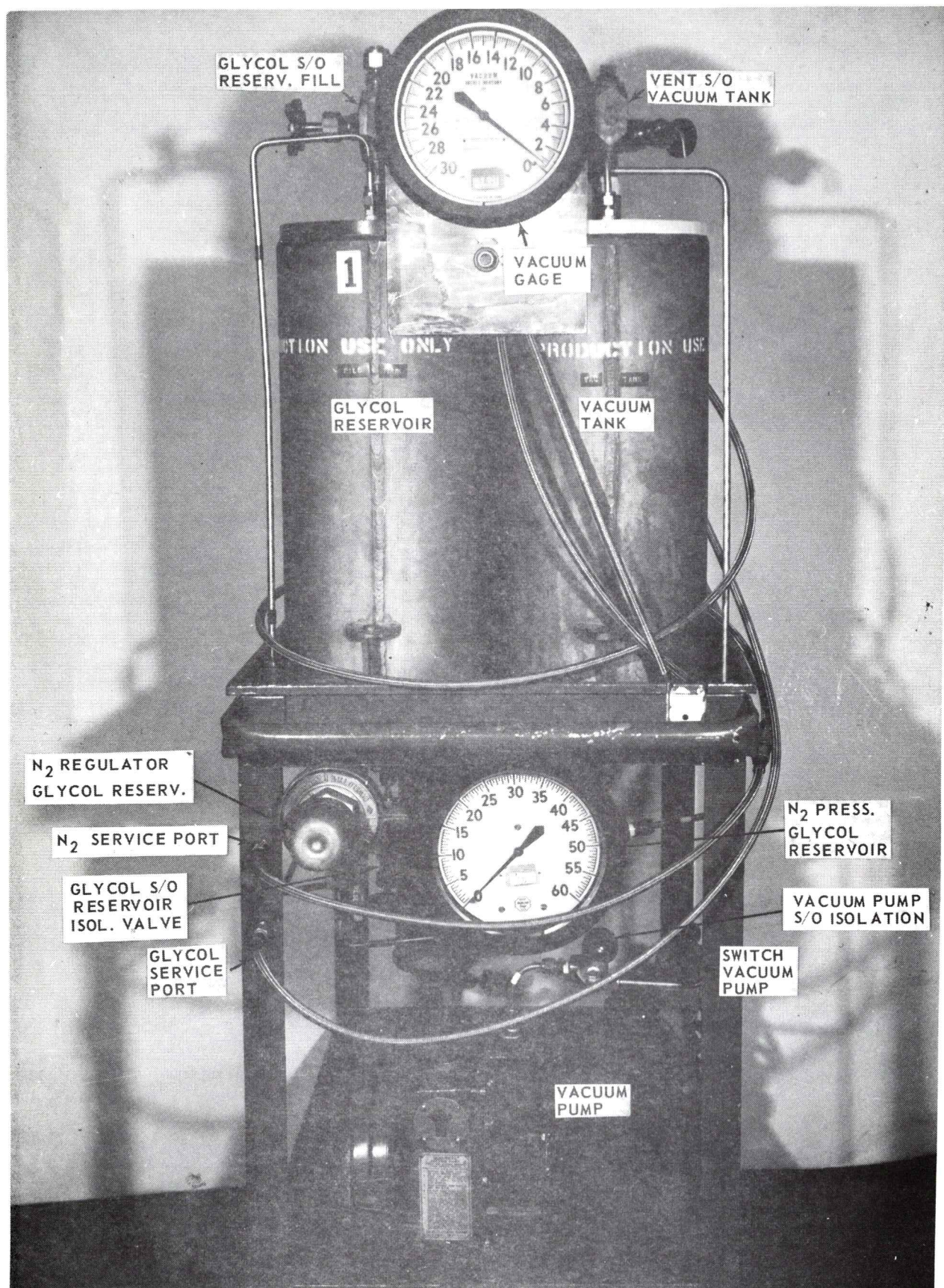


Figure 2 (Cont'd) Glycol Filling Cart

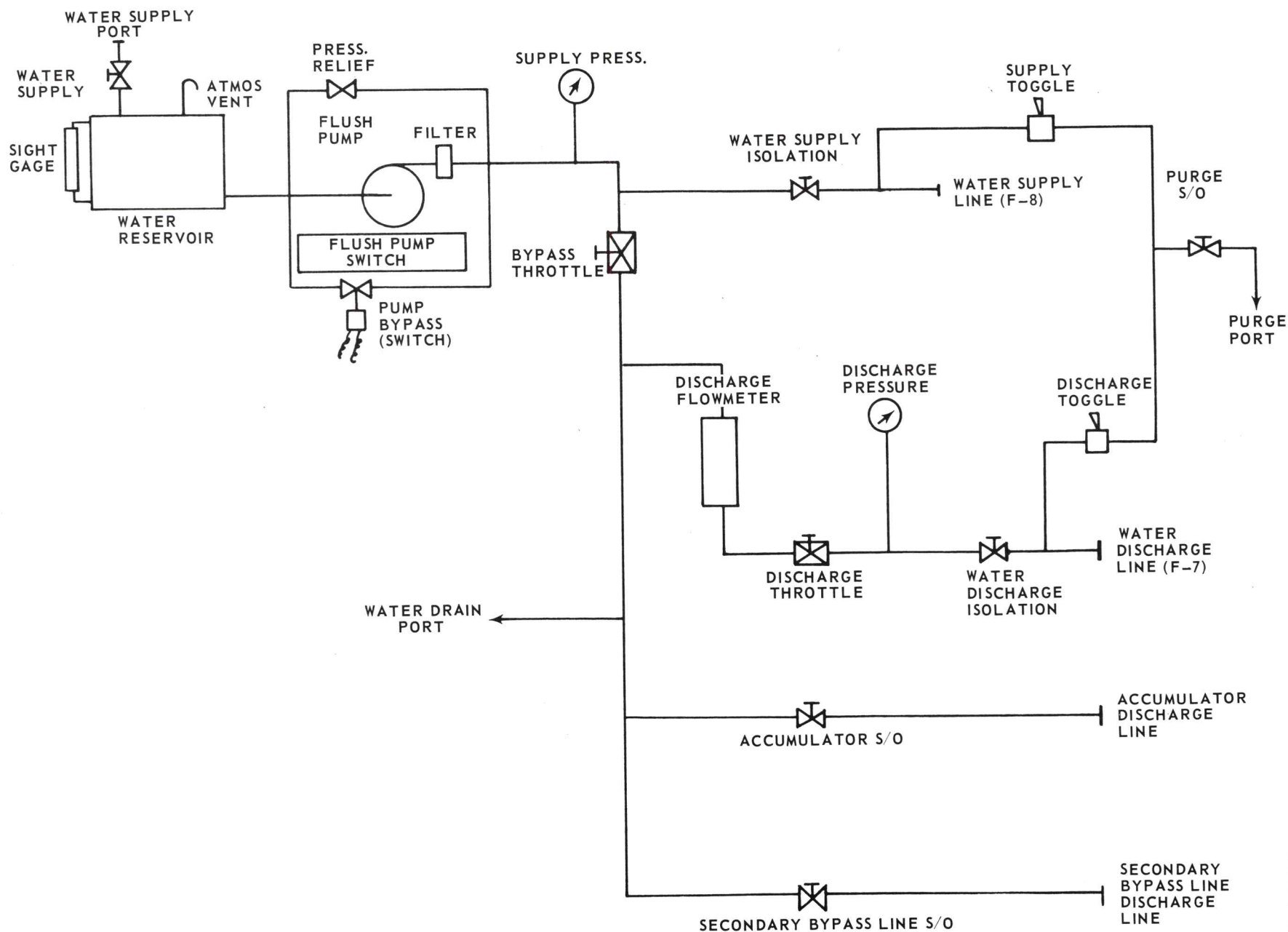


Figure 3 Plumbing Schematic - Water Flush Cart

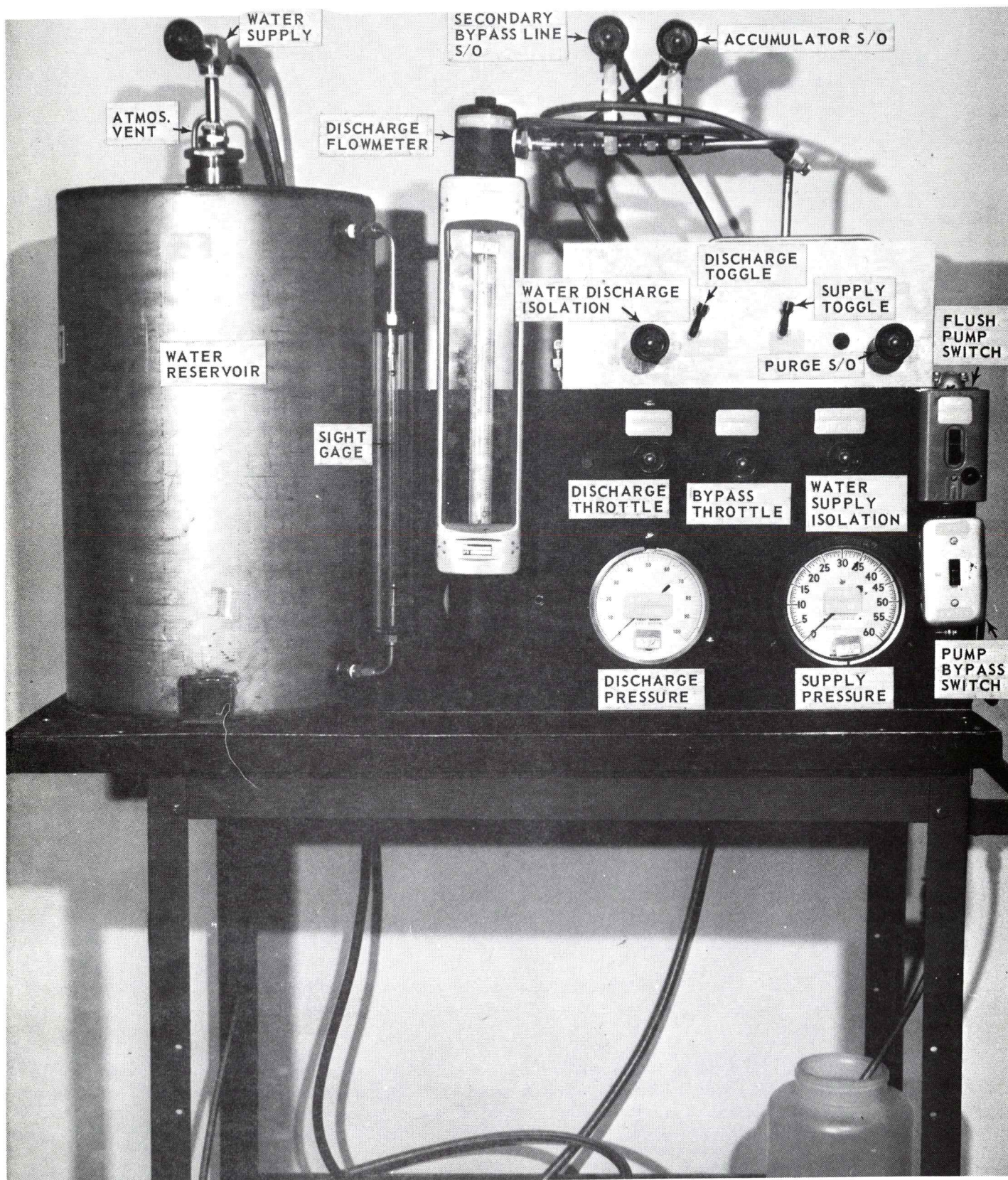


Figure 3 (Cont'd)

Water Flush Cart

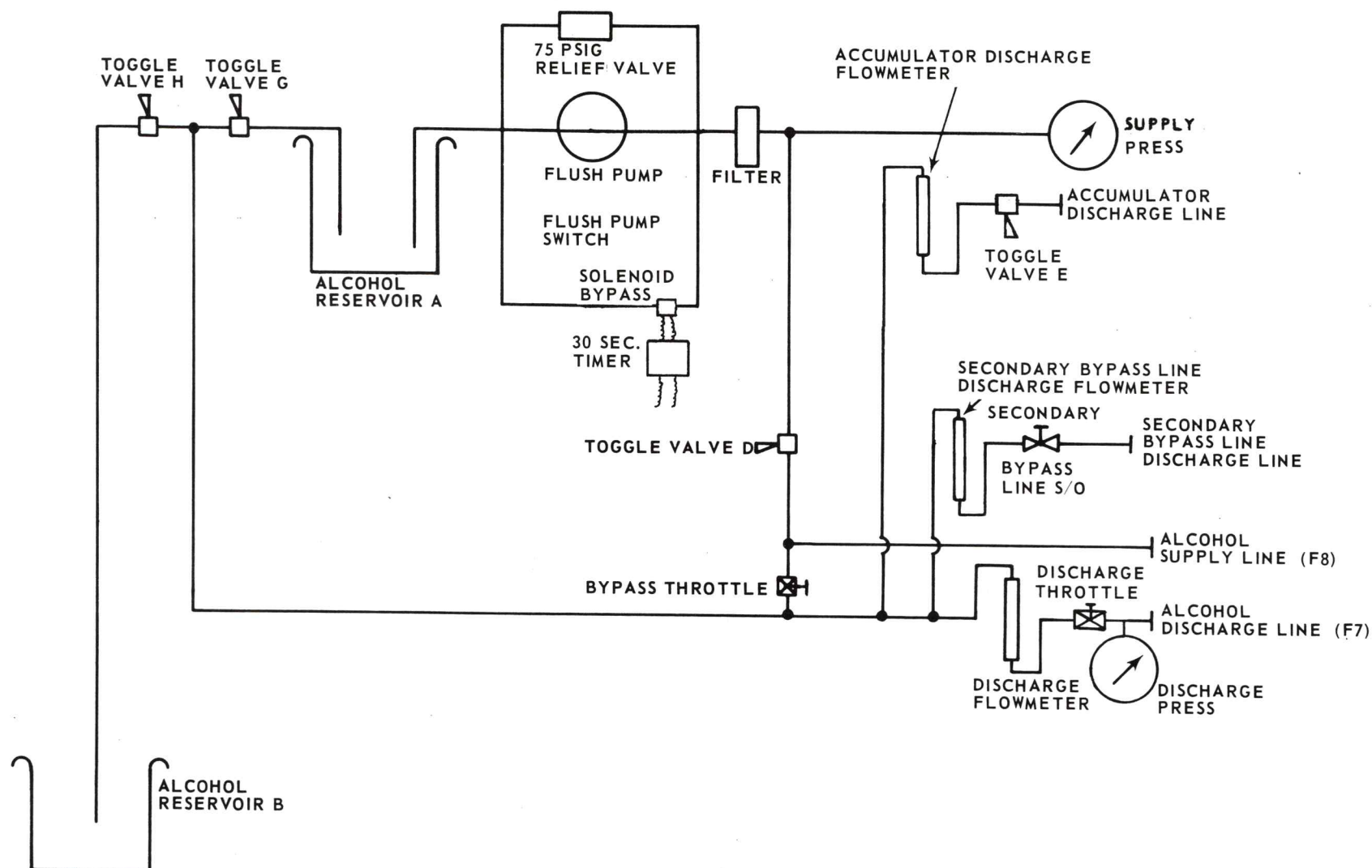


Figure 4 Plumbing Schematic - Alcohol Flush Cart

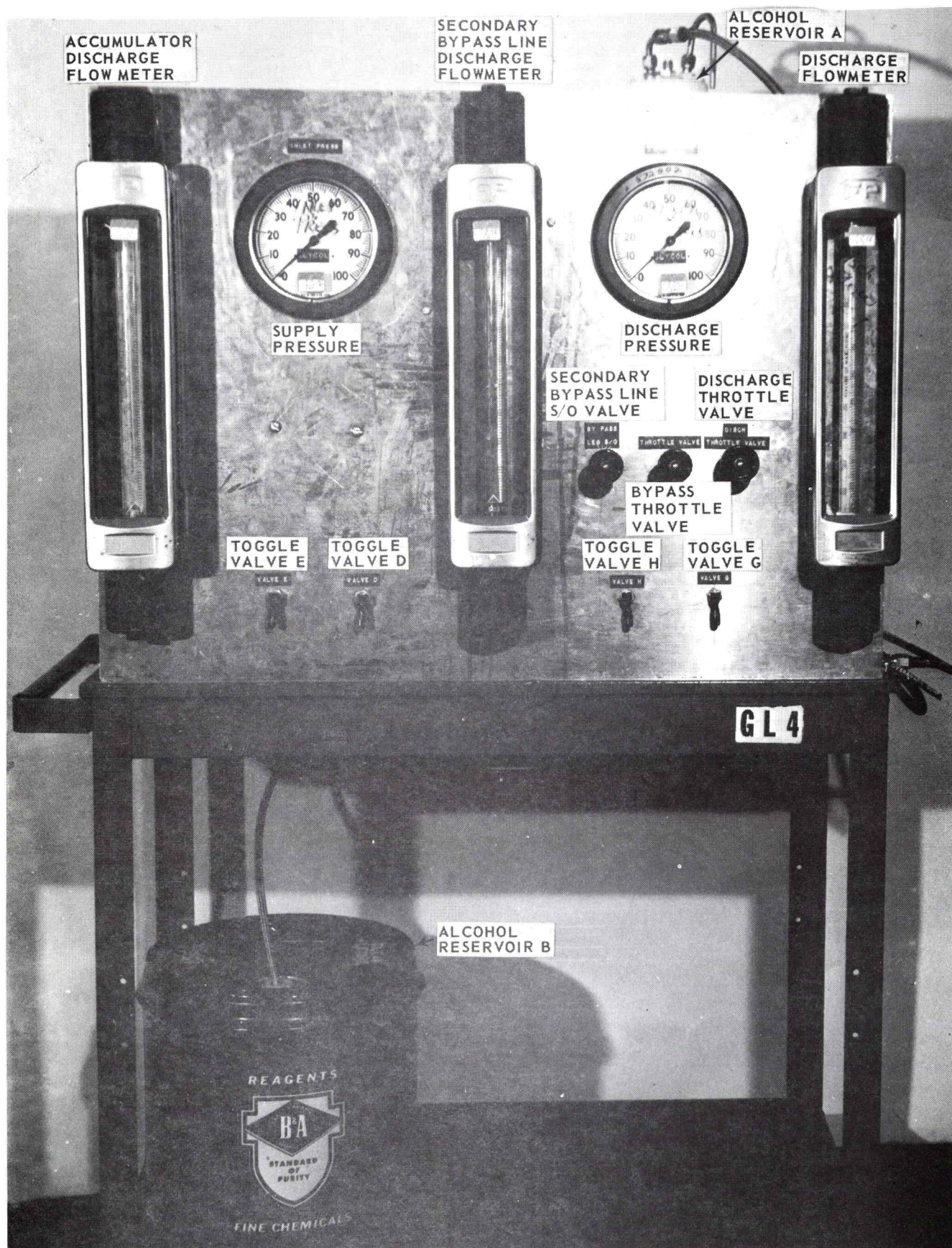


Figure 4 (Cont'd) Alcohol Flush Cart

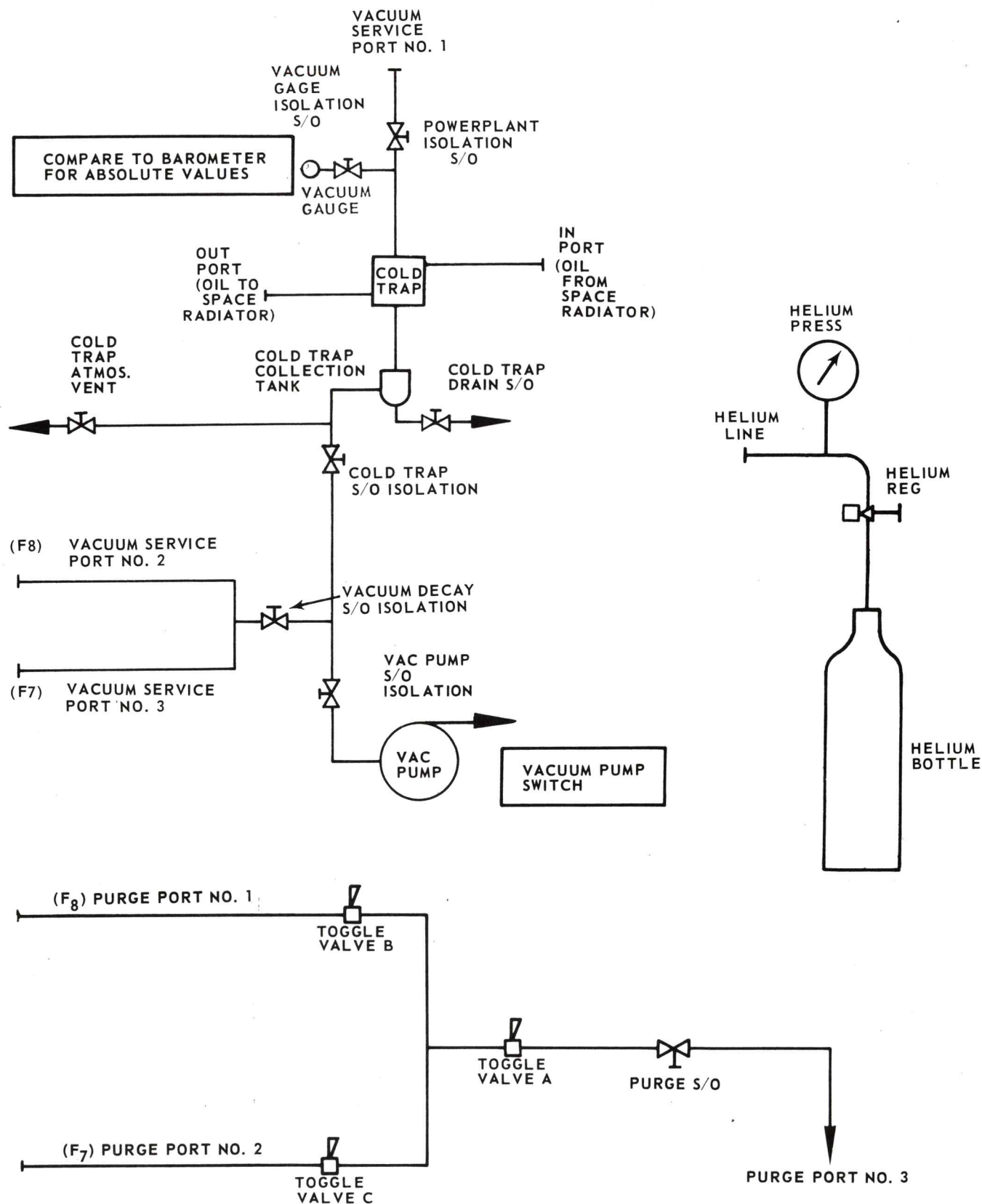


Figure 5 Plumbing Schematic - Glycol System Purge and Vacuum Cart

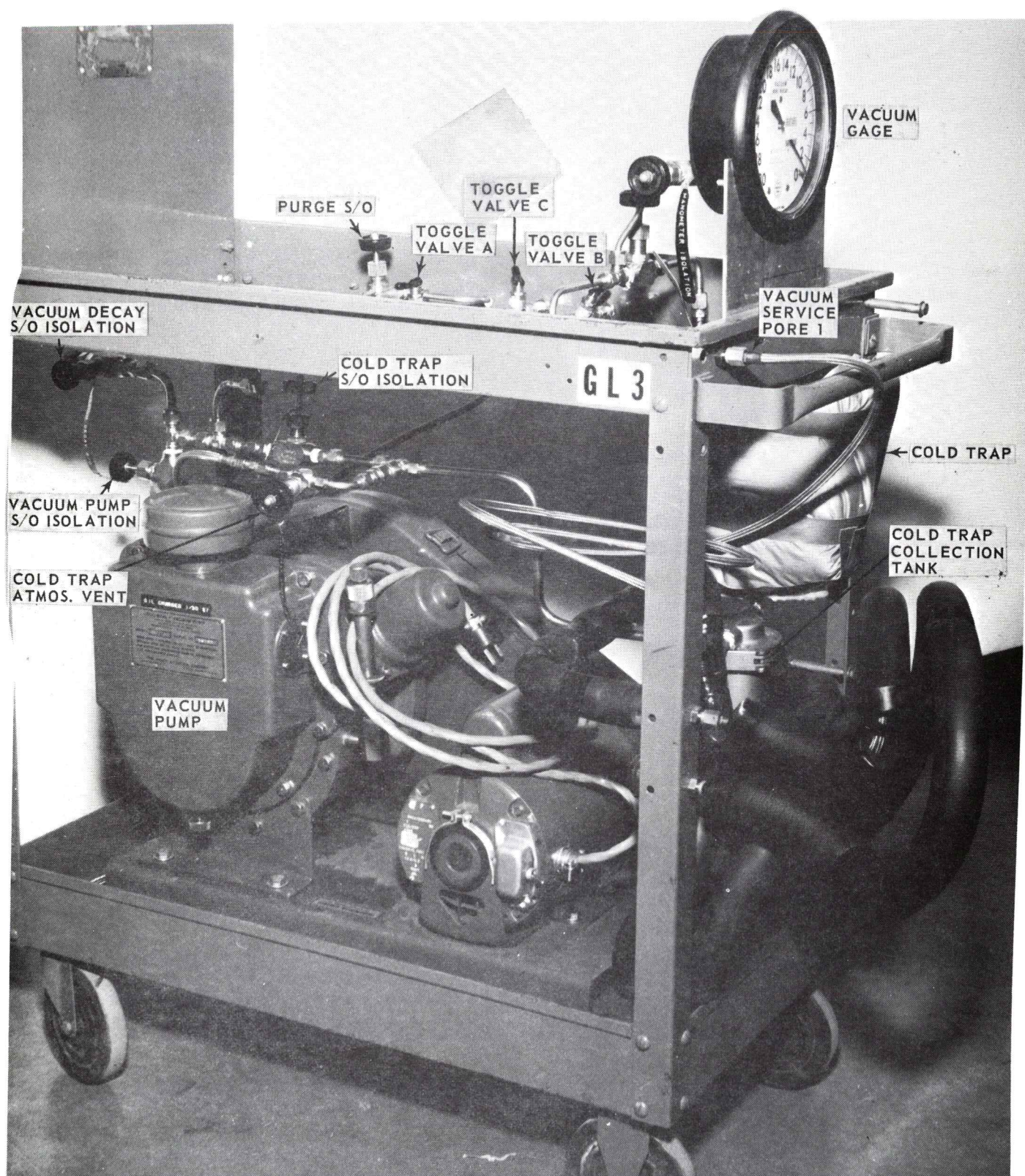


Figure 5(Cont'd)Glycol System Purge and Vacuum Cart

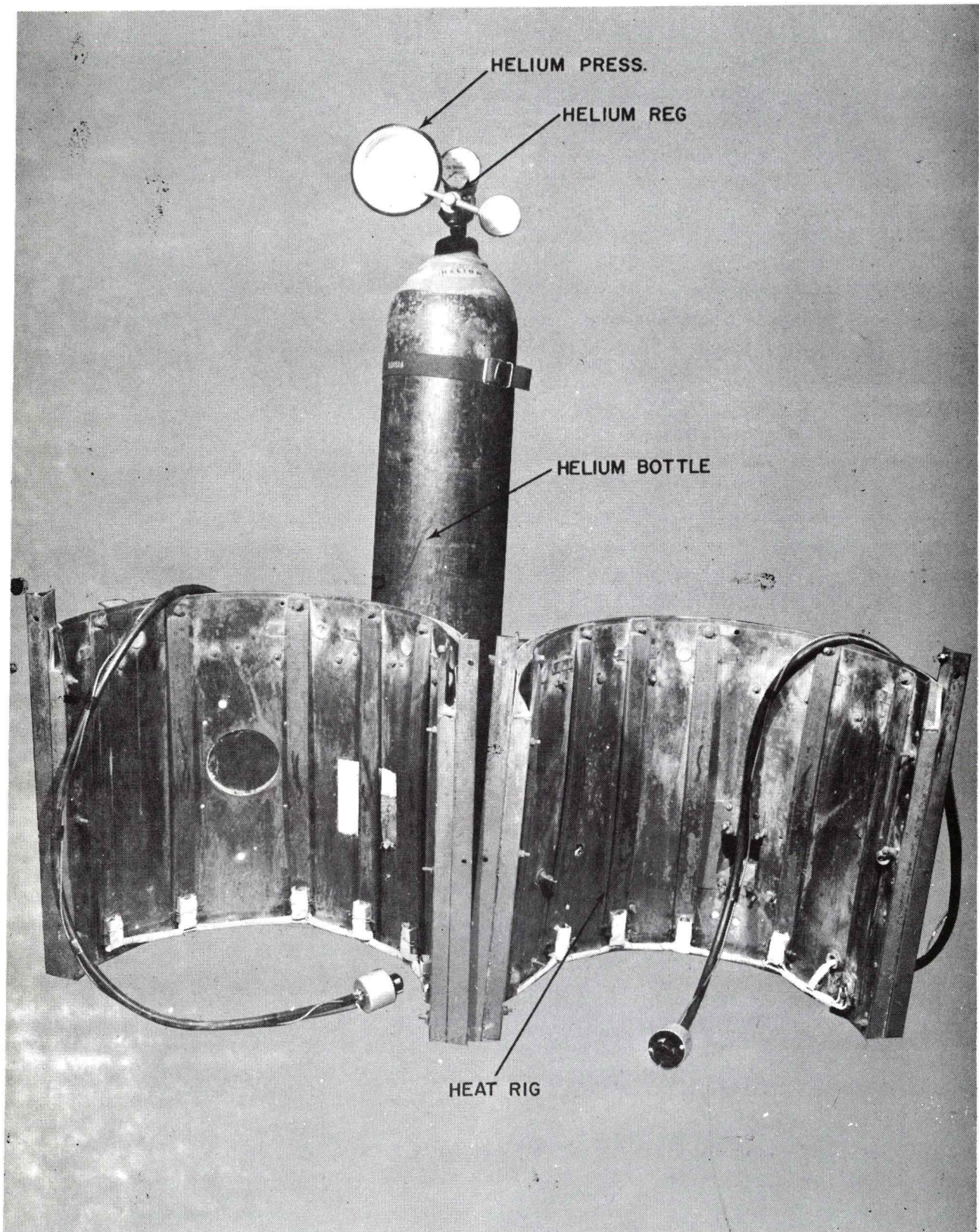


Figure 5

Heat Rig and Helium Bottle

X-24030

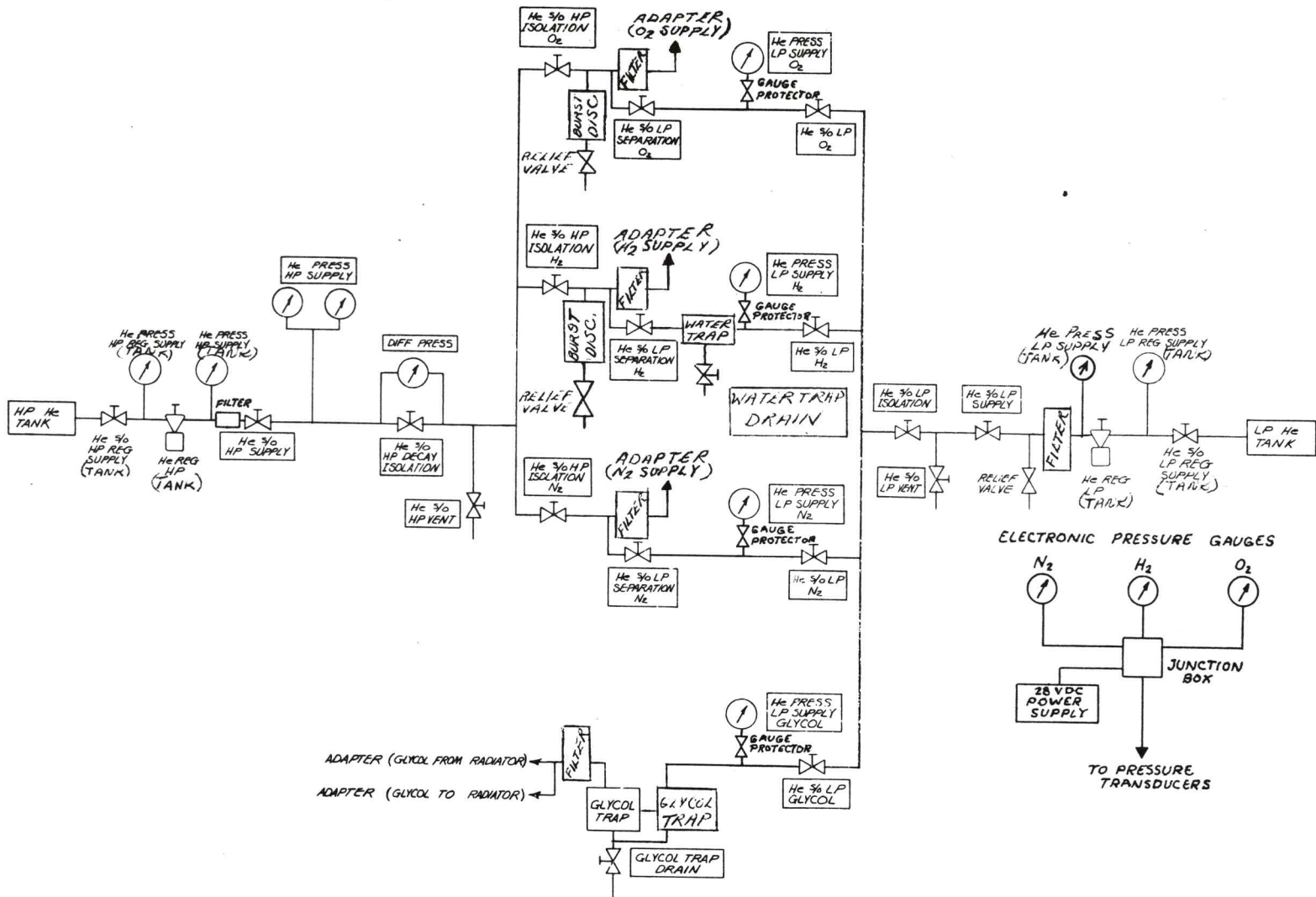
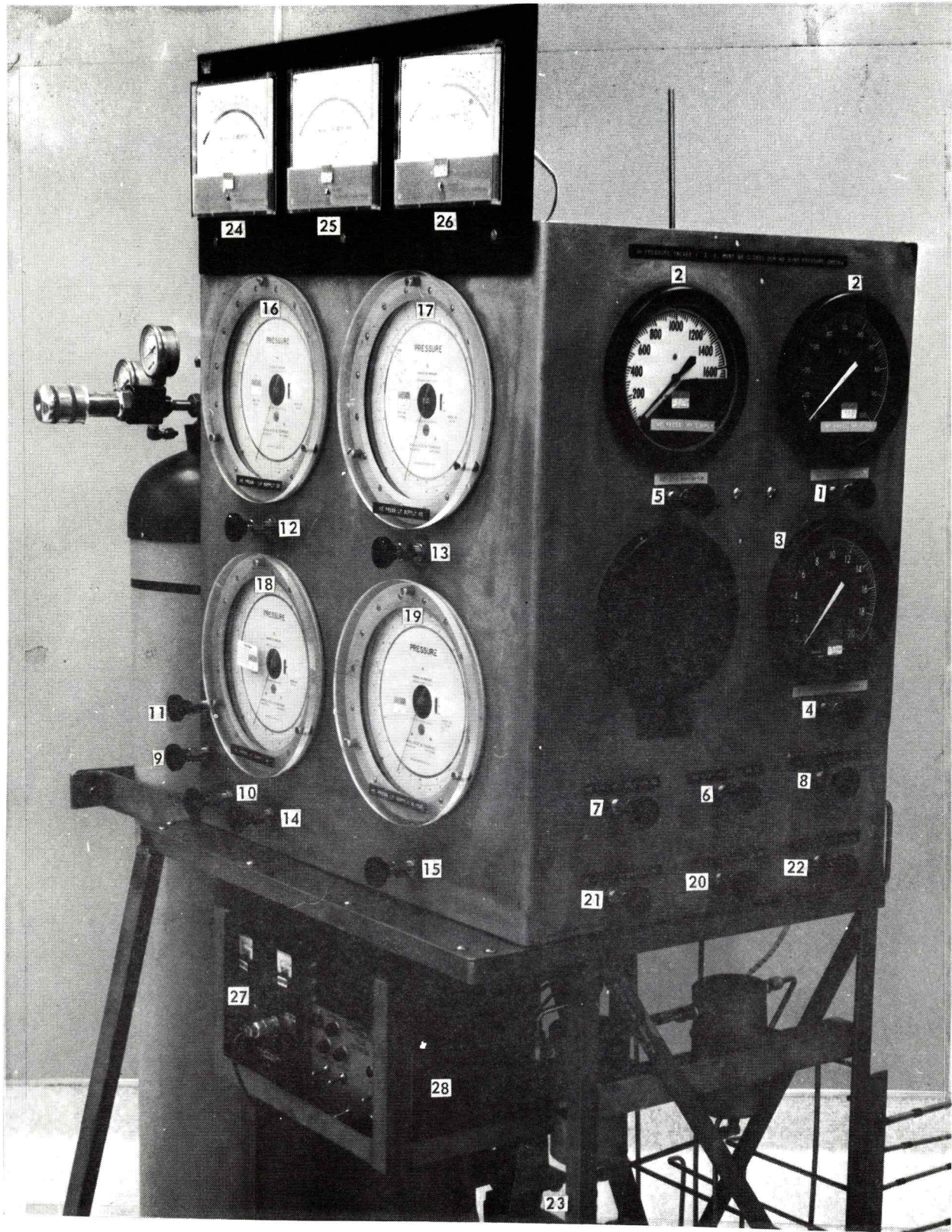


Figure 6

Plumbing Schematic - Pressure Test Cart



1. He S/O HP SUPPLY Valve
2. He PRESS HP SUPPLY Gage
3. DIFF PRESS Gage
4. He S/O HP DECAY ISOLATION Valve
5. He S/O HP VENT Valve
6. He S/O HP ISOLATION - O₂ Valve
7. He S/O HP ISOLATION - H₂ Valve
8. H₂ S/O HP ISOLATION - N₂ Valve
9. He S/O LP SUPPLY Valve
10. He S/O LP VENT Valve
11. He S/O LP ISOLATION Valve
12. He S/O LP - O₂ Valve
13. He S/O LP - H₂ Valve
14. He S/O LP - N₂ Valve
15. He S/O LP - GLYCOL Valve
16. He PRESS LP SUPPLY - O₂ Gage
17. He PRESS LP SUPPLY - H₂ Gage
18. He PRESS LP SUPPLY - N₂ Gage
19. He PRESS LP SUPPLY - GLYCOL Gage
20. He S/O LP SEPARATION - O₂ Valve
21. He S/O LP SEPARATION - H₂ Valve
22. He S/O LP SEPARATION - N₂ Valve
23. GLYCOL TRAP DRAIN Valve
24. H₂ ELECTRONIC PRESSURE Gage
25. O₂ ELECTRONIC PRESSURE Gage
26. N₂ ELECTRONIC PRESSURE Gage
27. 28 VDC POWER SUPPLY
28. PURGE - VALVE ACTUATOR

Figure 6 (Cont'd) Pressure Test Cart

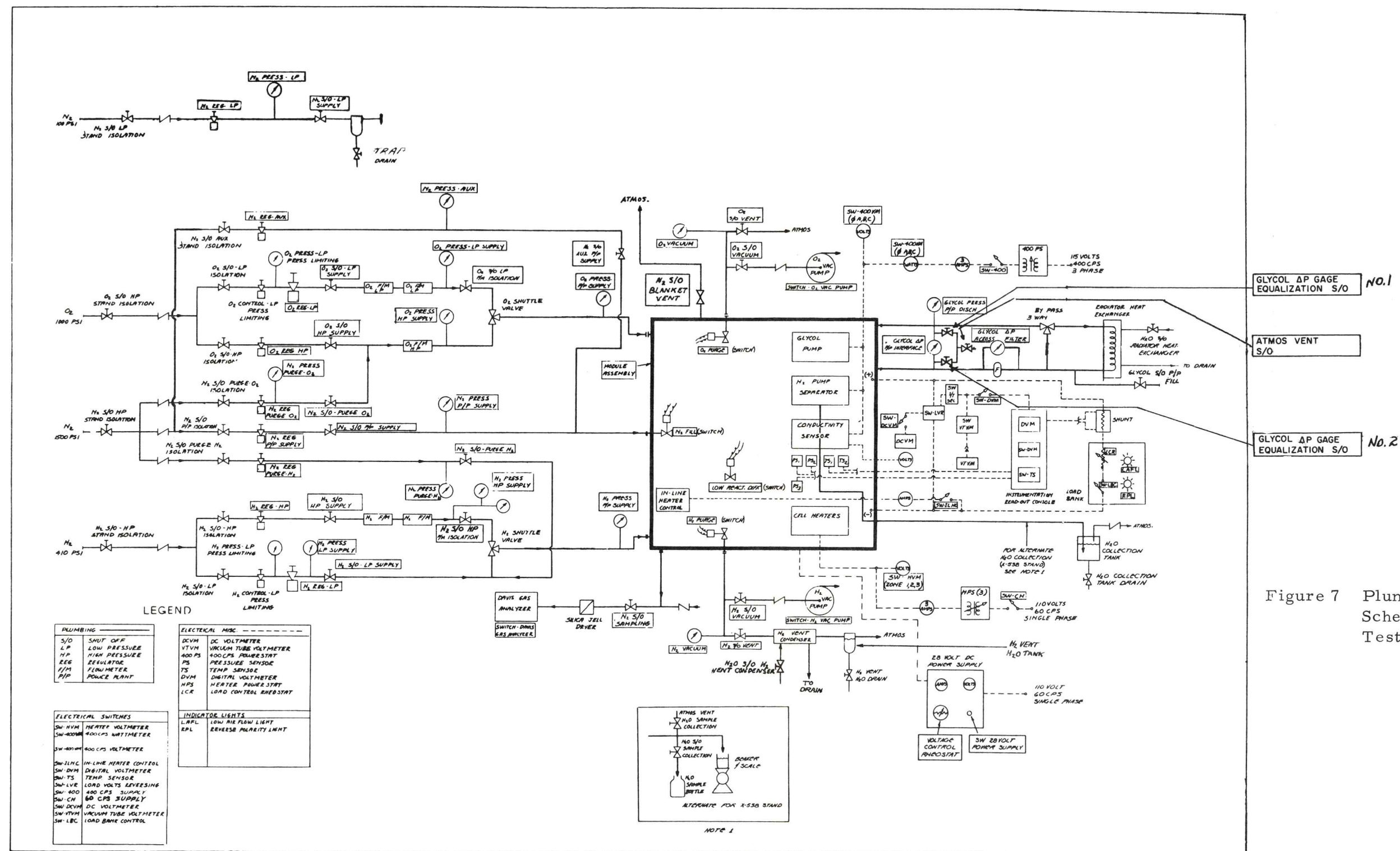
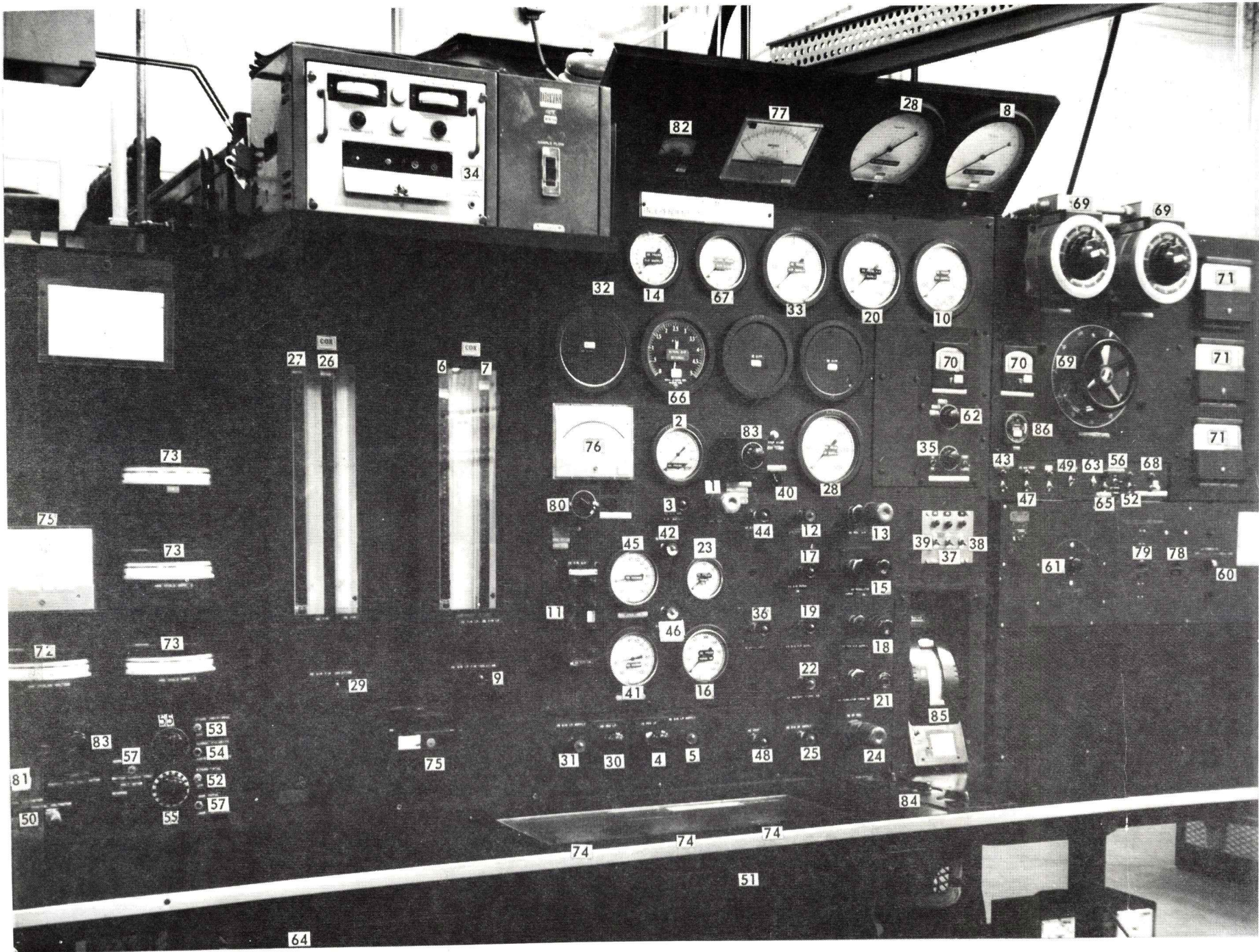
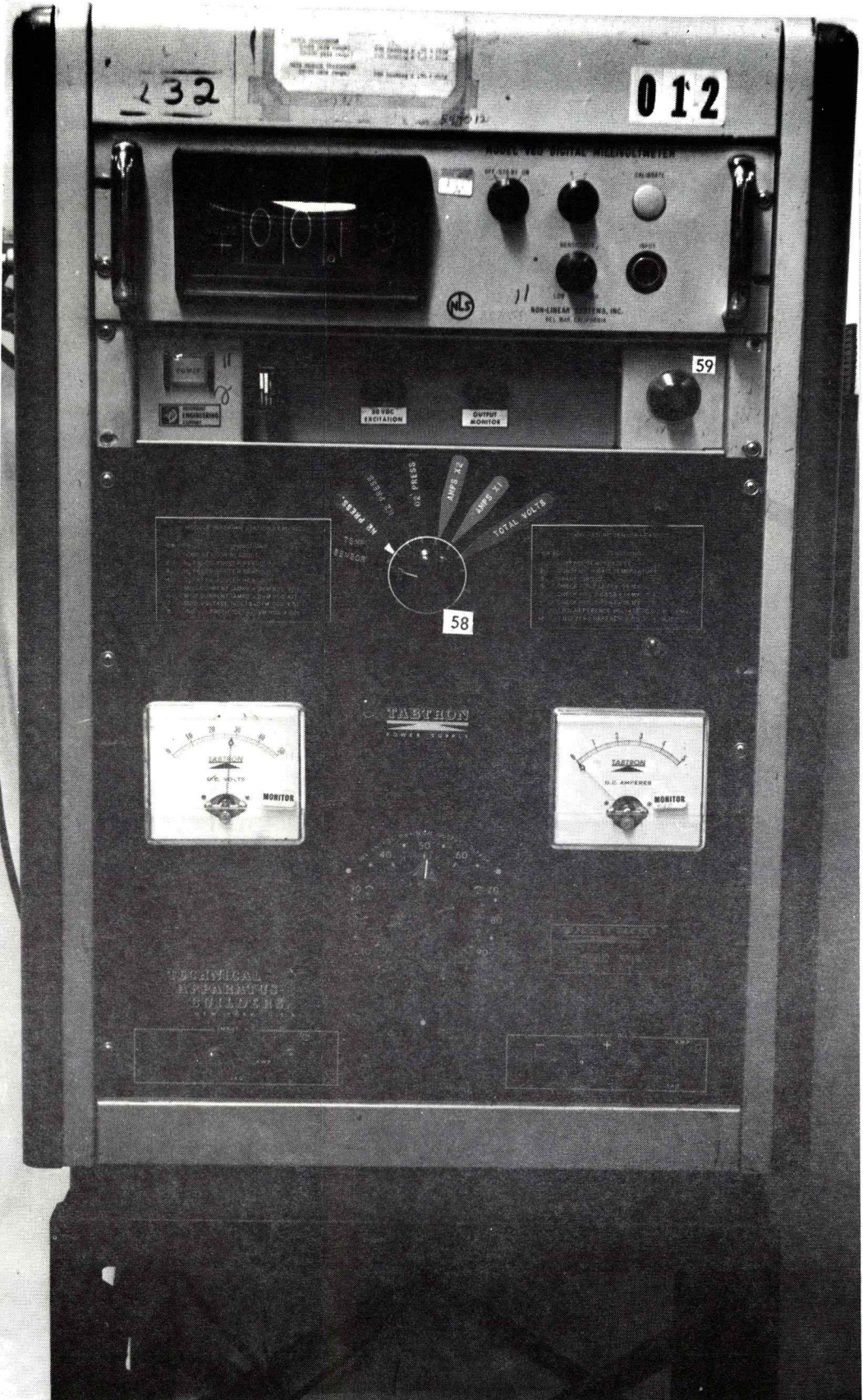


Figure 7 Plumbing and Electrical Schematic - Sea Level Test Stand



X-25206



X-25205

Figure 7 (Cont'd) Typical Sea-Level
Test Stand and Digital Voltmeter

- | | |
|--|---|
| 1. N ₂ PRESS REG AUX | 44. O ₂ S/O VALVE - VENT |
| 2. N ₂ PRESS GAGE AUX | 45. H ₂ VACUUM GAGE |
| 3. N ₂ S/O VALVE AUX P/P SUPPLY | 46. H ₂ S/O VALVE - VACUUM |
| 4. O ₂ PRESS REG - LP | 47. SWITCH - H ₂ VAC PUMP |
| 5. O ₂ S/O VALVE - LP SUPPLY | 48. H ₂ S/O VALVE - VENT |
| 6. O ₂ F/M LP | 49. SWITCH - HOOD LIGHT |
| 7. O ₂ F/M LP | 50. SW-400 VM (A, B, C) - 400 CPS VOLTMETER |
| 8. O ₂ PRESS GAGE - LP SUPPLY | 51. SW-400 WM (A, B, C) - 400 CPS WATTMETER |
| 9. O ₂ S/O VALVE LP F/M ISOLATION | 52. SW-400 - 400 CPS SUPPLY |
| 10. O ₂ PRESS GAGE HP SUPPLY | 53. SW-DCVM - D.C. VOLTMETER |
| 11. O ₂ F/M HP | 54. SW-LVR - LOAD VOLTS REVERSING |
| 12. O ₂ S/O VALVE HP SUPPLY | 55. SW-I/T - SEL - INDIVIDUAL/TOTAL SELECTOR |
| 13. O ₂ PRESS REG HP | 56. SW-ILHC - IN LINE HEATER CONTROL |
| 14. O ₂ PRESS GAGE P/P SUPPLY | 57. SW-VTVM - VACUUM TUBE VOLTMETER |
| 15. N ₂ PRESS REG PURGE O ₂ | 58. SW-DVM - DIGITAL VOLTMETER (2) |
| 16. N ₂ PRESS GAGE - PURGE O ₂ | 59. SW-TS - TEMP SENSOR |
| 17. N ₂ S/O VALVE - PURGE O ₂ | 60. SW-LBC - LOAD BANK CONTROL |
| 18. N ₂ PRESS REG P/P SUPPLY | 61. LCR - LOAD CONTROL RHEOSTAT |
| 19. N ₂ S/O VALVE P/P/ SUPPLY | 62. SW-HVM (ZONES 1, 2, 3) - HEATER VOLTMETER |
| 20. N ₂ PRESS GAGE P/P SUPPLY | 63. SWITCH - F/M LIGHT |
| 21. N ₂ PRESS REG - PURGE H ₂ | 64. VOLTAGE CONTROL RHEOSTAT |
| 22. N ₂ S/O VALVE - PURGE H ₂ | 65. SW-28 VOLT POWER SUPPLY |
| 23. N ₂ PRESS GAGE - PURGE H ₂ | 66. GLYCOL ΔP GAGE - P/P INTERFACE |
| 24. H ₂ PRESS REG - HP | 67. GLYCOL PRESS GAGE - P/P DISCH |
| 25. H ₂ S/O VALVE HP SUPPLY | 68. SWITCH - HEATER VOLTMETER SELECTOR |
| 26. H ₂ F/M | 69. HPS (3) HEATER POWERSTAT |
| 27. H ₂ F/M | 70. CELL HEATER VOLTMETER |
| 28. H ₂ PRESS GAGE - HP SUPPLY (2) | 71. CELL HEATER AMMETER |
| 29. H ₂ S/O VALVE F/M ISOLATION | 72. 400 CPS VOLTMETER |
| 30. H ₂ PRESS REG - LP | 73. 400 CPS AMMETER |
| 31. H ₂ S/O VALVE - LP SUPPLY | 74. 400 CPS WATTMETER |
| 32. H ₂ PRESS GAGE - LP SUPPLY | 75. DC VOLTMETER |
| 33. H ₂ PRESS GAGE - P/P SUPPLY | 76. P/P AMMETER |
| 34. DAVIS GAS ANALYZER | 77. IN-LINE HEATER AMMETER |
| 35. SWITCH - CURRENT LEAKAGE MEASUREMENT | 78. LOW AIRFLOW LIGHT |
| 36. N ₂ BLANKET VENT | 79. REVERSED POLARITY LIGHT |
| 37. O ₂ PURGE (SWITCH) | 80. SWITCH - SELECTOR P/P AMMETER |
| 38. N ₂ FILL (SWITCH) | 81. SWITCH - DC VOLTMETER - STAND |
| 39. H ₂ PURGE (SWITCH) | 82. WATER PURITY VOLTMETER |
| 40. LOW REACT. DIFF. (SWITCH) | 83. PHASE SELECTOR |
| 41. O ₂ VACUUM GAGE | 84. SWITCH - T/C SELECTOR |
| 42. O ₂ S/O VALVE - VACUUM | 85. TEMPERATURE - T/C |
| 43. SWITCH - O ₂ VAC PUMP | 86. TIMER |

Figure 8 Key to Sea Level Photographs

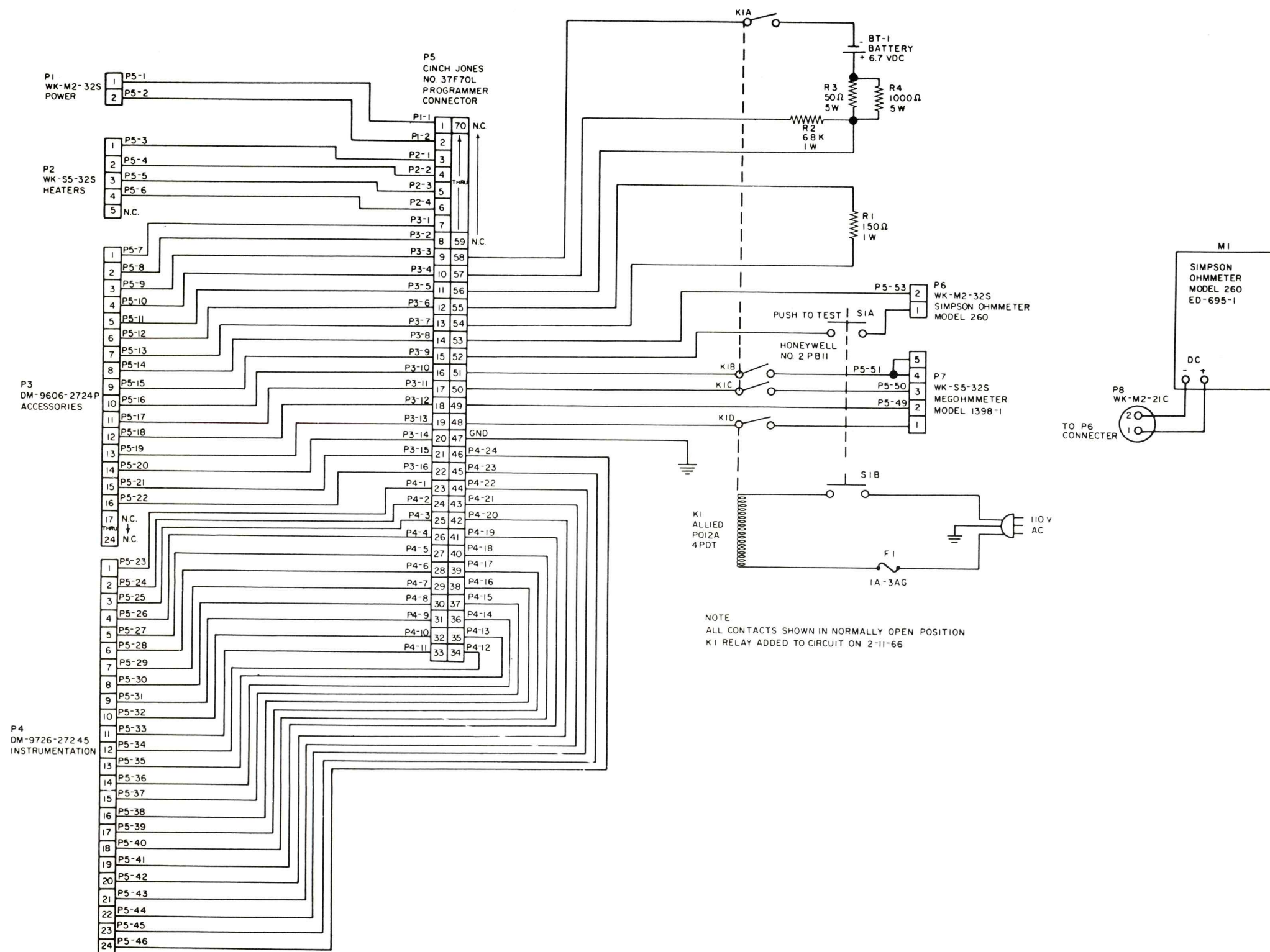


Figure 9 Electrical Diagram -
Powerplant Component
Checking Fixture

