UNITED TECHNOLOGIES
HAMILTON STANDARD

CR-171 817

SVHSER 7236

DEVELOPMENT OF A PREPROTOTYPE
TIMES
WASTEWATER RECOVERY SUBSYSTEM

BY

GEORGE J. ROEBELEN, JR.

AND GERARD F. DEHNER

PREPARED UNDER CONTRACT NO. NAS 9-15471

BY

HAMILTON STANDARD

DIVISION OF UNITED TECHNOLOGIES CORPORATION

WINDSOR LOCKS, CONNECTICUT

FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LYNDON B. JOHNSON SPACE CENTER

HOUSTON, TEXAS

APPENDICES

JULY, 1984

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Unclas 24452

APPENDIX A

MASTER TEST PLAN

HAMILTON STANDARD

Windsor Locks, Connecticut 06096

August 21, 1978
TIMES-12

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Crew Systems Division
2101 NASA Boulevard
Houston, Texas 77058

Attention: Mr. E. Winkler
Mail Code EC3

Subject: Contract NAS 9-15471, TIMES
Master Test Plan

Gentlemen:

In accordance with DRL Line Item 3, TM-122TA, of subject contract two (2) copies of the Master Test Plan are forwarded herewith. This Plan includes the detailed test sections for Design Support Testing and Development Component Testing.

The Master Test Plan will be supplemented at a later date to incorporate the details of acceptance testing (reference Section 3.0). This action will be taken in sufficient time to permit NASA review before conducting this part of the test program.

Very truly yours,

HAMILTON STANDARD
Division of United Technologies Corporation

R. L. Simmons

R. L. Simmons
Contract Administrator

/dmm

Enclosure

cc: Mr. J. P. Festa DCAS/ACO
Mr. John Jones, NASA/JSC BC73(37)

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

SPACE SYSTEMS DEPARTMENT

HAMILTON STANDARD

MASTER TEST PLAN

URINE WATER RECOVERY SUBSYSTEM

CONTRACT NAS 9-15471

FOR

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

LYNDON B. JOHNSON SPACE CENTER

HOUSTON, TEXAS 77058

AUGUST, 1978

PREPARED BY: G. J. Roebelen

GEORGE J. ROEBELEN, JR.
PROJECT ENGINEERING MANAGER

APPROVED BY: H. F. Brose

HARLAN F. BROSE
PROGRAM MANAGER

HAMILTON STANDARD Division of United Technologies

1.0 SCOPE

This Master Test Plan outlines the test program to be performed by Hamilton Standard during the Urine Water Recovery Subsystem Program. Testing is divided into three phases:

- Design Support Testing
- Development Component Testing
- Acceptance Testing

Completion of this test program will verify subsystem operation.

2.0 TEST SEQUENCE

2.1 Design Support Testing

Design support testing is being performed at the scale model level to verify subsystem packaging configuration and to demonstrate corrosion resistance suitability of applicable metals, non-metals, metallurgical joining methods, and non-metallic joining methods not previously qualified for pretreated urine service.

2.2 Development Component Testing

Development component testing is being performed at the full scale level on items requiring development effort to verify satisfactory operation prior to incorporation into the subsystem. The following components will be tested during this phase:

- Thermoelectric Regenerator (TER) & Hollow Fiber Membrane Evaporator (EVAP)
- Urine Loop Recirculation Pump
- Controller
- Concentration Sensor

2.3 Acceptance Testing

The acceptance testing effort is broken down into two distinct phases: verification testing and baseline testing.

2.3.1 Verification Testing

Verification testing is being performed on the completed water recovery subsystem to verify subsystem functionality and to demonstrate that all contractual performance and design specifications are met.

2.3.2 Baseline Testing

A comprehensive baseline test is being performed on the completed water recovery subsystem to establish exact operating chacteristics in earth gravity conditions and to establish subsystem endurance, quantify component maintenance requirements, and determine subsystem suitability for inclusion in future flight systems.

3.0 TEST ENVIRONMENT

The test environment for all portions of this test will be room ambient temperature and pressure except for the indicated portions of the development component testing task that are preformed within an oven to eliminate the need for non-reusable insulation on the individual components.

4.0 TEST EQUIPMENT

All portions of this test program will be performed in the Hamilton Standard Advanced Engineering Laboratory. Tests producing noxious emissions will be conducted within a vented hood or other suitable enclosure. Portable equipment compatible with the test units and test requirements as defined by this master test plan will be utilized.

5.0 DEFINITION OF TESTS

5.1 Design Support Testing

5.1.1 Subsystem Packaging Configuration

5.1.1.1 Purpose

The purpose of this test is to ensure that the selected relative physical arrangement of the thermoelectric regenerator and the hollow fiber membrane evaporator will allow satisfactory one gravity, and by inference zero gravity, flow of the steam from the EVAP to the TER.

5.1.1.2 Test Setup

This test is to be performed in a vented oven. The test setup is schematically illustrated in Figure 1.

5.1.1.3 Test Procedure

a. Assemble the test setup as shown in Figure 1. Pay particular attention to insure that the vacuum line is absolutely leak tight.

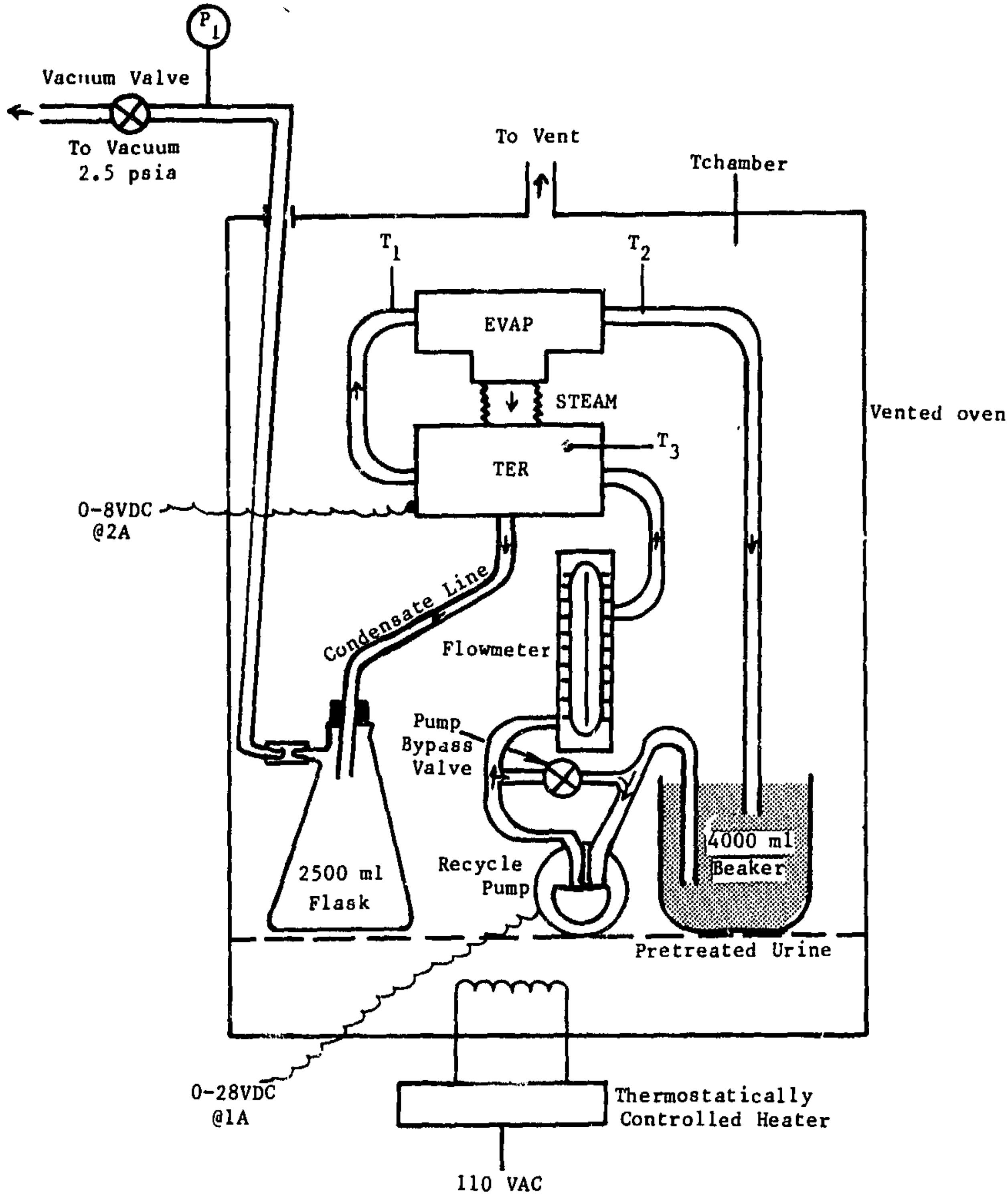


Figure 1: Subsystem Packaging Configuration Test Setup

b. Preheat the vented oven to 130°F. Preheat 3000 ml of pretreated urine to 140°F and place in the 4000 ml beaker. Open the vacuum valve. Energize the recycle pump and adjust the pump voltage and the pump bypass valve to obtain a flowmeter reading of 30 PPH.

c. Energize the thermoelectric regenerator (TER) to 8 VDC taking care to insure that the TER polarity is correct. The polarity can be checked by monitoring T_1 and T_3. T_1 must be higher than T_3; if T_3 is higher than T_1, reverse the TER polarity.

d. Close the vacuum valve. Manually control P_1 to 2.5 - 4.0 psia by opening the vacuum valve when P_1 rises to 4.0 psia and closing the vacuum valve when P_1 falls to 2.5 psia. It may be necessary to chill the flask to insure that the water does not revaporize in the flask.

e. Allow the test to run until T_1 stabilizes between 140°F and 150°F. When T_1 stabilizes, continue to run the test for 30 minutes and visually check for anomalies such as vapor lock, etc.

f. To terminate the test, follow the following procedure: De-energize the TER, the recycle pump, and the oven. Remove the pretreated urine beaker and replace with fresh water lines. Re-energize the recycle pump and flush until the water from the hollow fiber membrane evaporator (EVAP) is clear. De-energize the recycle pump.

5.1.1.4 Test Requirements

This test is being run to verify configuration of the recycle loop and the condensate line, and to verify vacuum purge duty cycle requirements. Satisfactory operation of this test setup is obtained when the pretreated urine temperature stabilizes at 140°F to 150°F as measured at T_1, the cold plate temperature T_3, stabilizes at a minimum of 10°F lower than T_1, steam from the EVAP flows continuously as water to the flask, and the pressure in the flask remains in the 2.5 - 4.0 psia range with the vacuum valve closed a minimum of 90% of the time at stabilized temperature.

5.1.1.5 Data Collection

Record the following data as a function of time (refer to Figure 1):

Parameter	Frequency	Accuracy
T_1, T_2, T_3, Tchamber	5 minute intervals	± 0.5°F
P_1	5 minute intervals and at low and high limits	± 0.2 psia
Flowmeter	5 minute intervals	± 2 PPH
Vacuum Valve On-Off	Every operation	---
Condensate collected	Every 30 minutes after stabilization	± 10%
Anomolies	As observed	---

5.1.2 Corrosion Testing

5.1.2.1 Purpose

The purpose of this test sequence is to demonstrate corrosion resistance suitability of applicable metals, non-metallics, metallurgical joint methods, and non-metallic joining methods not previously qualified for pretreated urine service. The following have been identified as requiring corrosion testing under this test definition:

- Titanium AMS 4901 Electron Beam Weld Joint
- Titanium AMS 4901 Fusion Weld Joint
- Stainless Steel AlSl 347 Nickel Braze Joint
- Stainless Steel AlSl 347 Fusion Weld Joint
- Polysulfone, annealed and non-annealed
- Viton V747-75 o-ring material
- T640 membrane potting compound

5.1.2.2 Test Setup

This test is to be performed in a vented hood and is schematically illustrated in Figure 2.

5.1.2.3 Test Procedure

a. Assemble the test setup as shown in Figure 2. Add 4000 ml of pretreated urine to the beaker. Set the controller to maintain the temperature of the pretreated urine at 150°F ± 5°F. Start the stirrer at a medium rate of stirring.

b. Attach lockwire hook to each sample and immerse each sample into the pretreated urine bath.

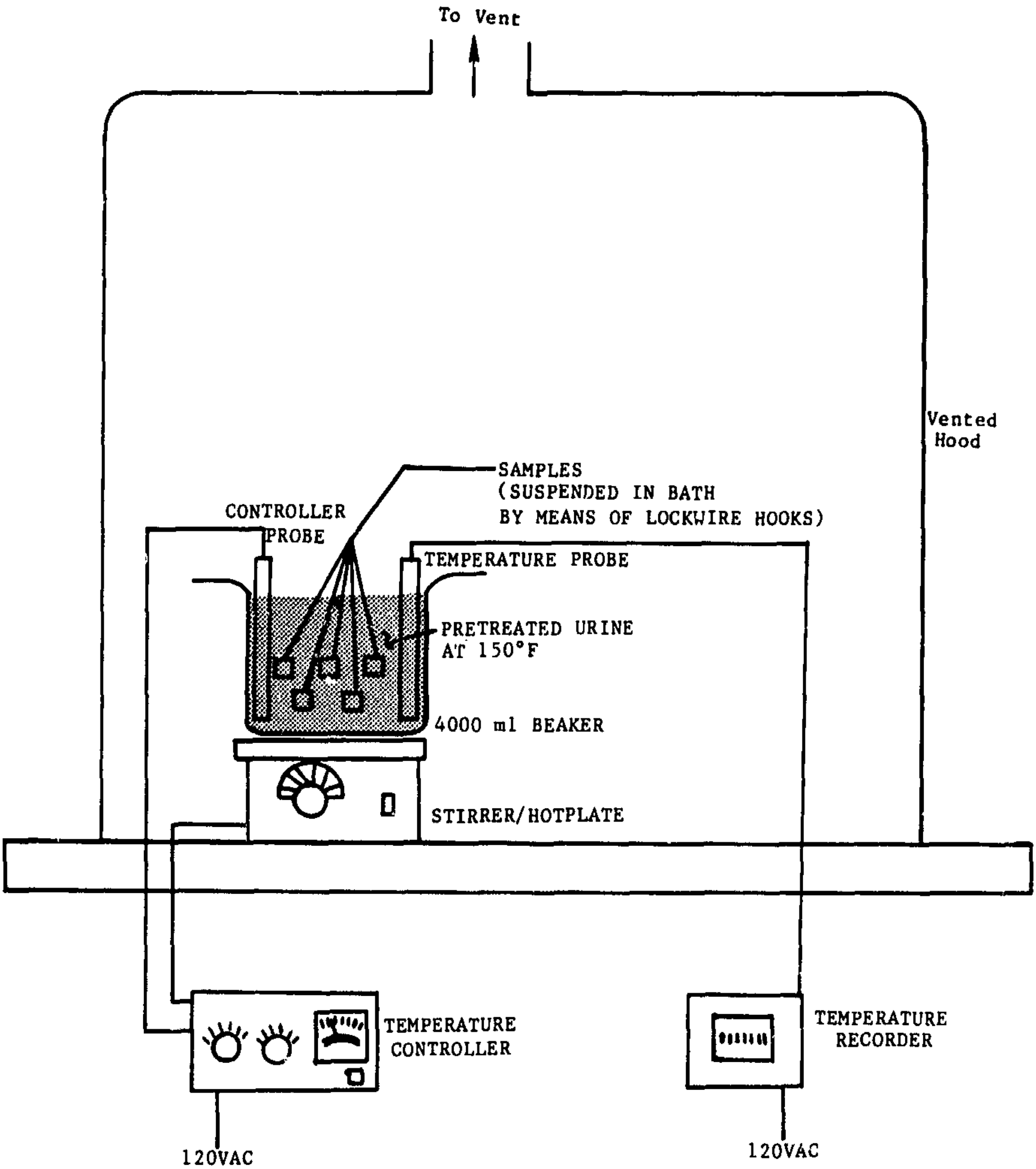


Figure 2: Corrosion Test Setup

c. Maintain the bath level by adding 1000 ml of pretreated urine when the beaker lowers the 3000 ml level. Keep a record of the quantity of pretreated urine added.

d. Examine the samples at 30 day intervals and record visual observations.

e. Discontinue the testing after 90 days.

5.1.2.4 Test Requirements

This test is being performed to verify the acceptability of each of the materials represented by the samples for prolonged exposure to 150°F urine pretreated with chromic acid. Completion of this test is achieved when each of the samples has been immersed for 90 days.

5.1.2.5 Data Collection

Record the following data as a function of time:

Parameter	Frequency	Accuracy
Sample condition	30 day intervals	Visual condition under 4X magnification
Bath temperature	Continual	$\pm$ 5°F
Makeup solution	As required	$\pm$ 25 ml

5.2 Development Component Testing

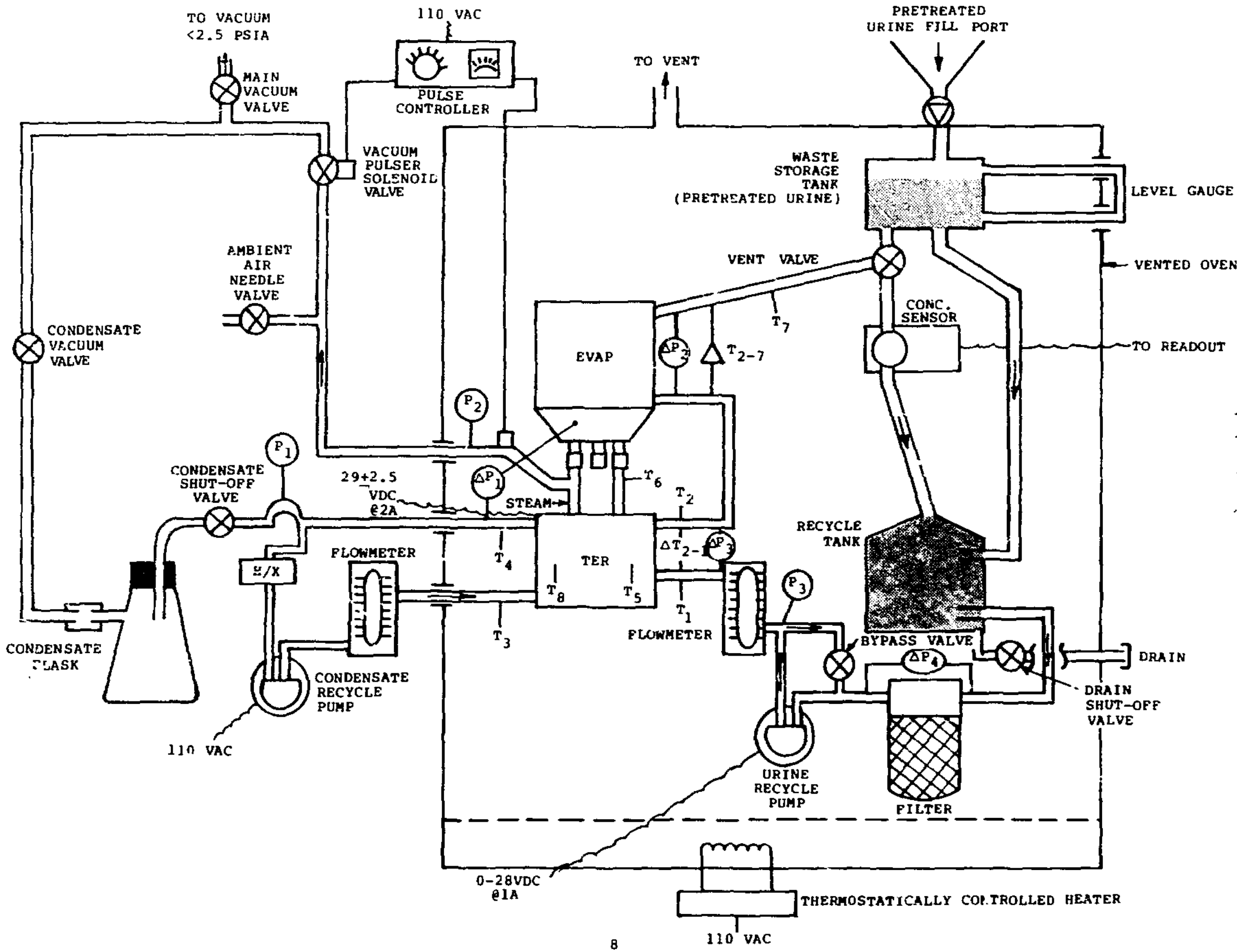
5.2.1 Thermoelectric Regenerator (TER)/Hollow Fiber Membrane Evaporator (EVAP)

5.2.1.1 Purpose

The purpose of this test sequence is to evaluate the performance of the TER/EVAP combination using hardware consisting of one full size TER module (three modules are required for the subsystem) coupled with a full size EVAP containing membrane surface areas equivalent to 1/3 of the anticipated subsystem requirement.

5.2.1.2 Test Setup

This test is to be performed in a vented oven. The test setup is schematically illustrated in Figure 3.


TO VACUUM
<2.5 PSIA
MAIN
VACUUM
VALVE
110 VAC
PULSE
CONTROLLER
TO VENT
PRETREATED
URINE FILL PORT
VACUUM
PULSER
SOLENOID
VALVE
WASTE
STORAGE
TANK
(PRETREATED URINE)
LEVEL GAUGE
AMBIENT
AIR
NEEDLE
VALVE
VENT VALVE
VENTED OVEN
CONDENSATE
VACUUM
VALVE
EVAP
T_7
ΔP_2
T_{2-7}
CONC.
SENSOR
TO READOUT
P_2
P_1
CONDENSATE
SHUT-OFF
VALVE
29+2.5
VDC
@2A
ΔP_1
STEAM
T_6
T_2
RECYCLE
TANK
M/X
FLOWMETER
T_4
TER
ΔT_{2-1}
ΔP_3
P_3
T_8
T_5
T_1
T_3
FLOWMETER
BYPASS VALVE
ΔP_4
DRAIN
CONDENSATE
FLASK
CONDENSATE
RECYCLE
PUMP
DRAIN
SHUT-OFF
VALVE
110 VAC
URINE
RECYCLE
PUMP
FILTER
0-28VDC
@1A
THERMOSTATICALLY CONTROLLED HEATER
110 VAC

5.2.1.3 Test Procedure

a. Assemble the test setup as shown in Figure 3. Fill the recycle tank and waste storage tank with pretreated urine. Keep the waste storage tank 1/2 full to full at all times. Open the vent valve to remove all gas from the recycle tank. With the vent valve open, energize the urine recycle pump to approximately 18VDC and adjust the bypass valve to obtain a flowmeter reading of 100 ± 5 PPH. When the gas has vented from the loop, close the vent valve. Turn on the vented oven and set the temperature to 130°F ± 5°F.

b. Close the ambient air needle valve and open the condensate vacuum valve and main vacuum valve. Set the pulse controller to maintain evaporator vacuum at 4.5 psia. If, during any phase of testing, the evaporator vacuum drops to 4.0 psia, open the ambient air needle valve to raise the pressure to 4.5 psia and close the needle valve fully. Manually adjust the condensate pressure by means of the condensate vacuum valve to maintain the Δp between the evaporator vacuum chamber and condensate line at 1 ± 0.25 psi.

c. Energize the thermoelectric regenerator at 29 VDC and run the system until the urine loop temperature exiting the thermoelectric regenerator reaches 150°F ± 2°F. Energize the condensate recycle pump and adjust the voltage level to control the condensate recycle rate thereby controlling the thermoelectric regenerator urine exiting temperature to 150°F ± 2°F.

d. Continue to run the subsystem for thirty (30) days. The following items require service:

Condensate flask: empty condensate flask daily. Record volume of condensate and prepare and refrigerate a 100 ml water sample.

Waste storage tank: maintain level at 1/2 full to full with pretreated urine.

Recycle tank: when concentration as sensed by the concentration sensor reaches 50% solids level drain recycle tank and refill with pretreated urine.

e. Repeat steps a through d except in step c, set the thermoelectric regenerator at 26.5 VDC and in step d run for 2 days.

f. Repeat step e except set thermoelectric regenerator at 31.5 volts.

g. Repeat steps a through d except in step b, set the evaporator vacuum at 3 psia and in step d run until equilibrium is reached.

h. Repeat step g except set the evaporator vacuum at 4 psia.

i. Repeat step g except set the evaporator vacuum at 5 psia.

j. Repeat step g except set the evaporator vacuum at 6 psia.

k. Repeat step g except set the evaporator vacuum at 7 psia.

l. Repeat steps a through d except in step a set the urine loop flow to 75 ± 5 PPH and in step d run until equilibrium is reached.

m. Repeat step i except set the urine loop flow to 125 ± 5 PPH.

n. Repeat steps a through d except in step a set the oven temperature to 110°F ± 5°F, in step c control the TER urine exit temperature to 130°F ± 2°F, and in step d run until equilibrium is reached.

5.2.1.4 <u>Test Requirements</u>

This test is being run to evaluate the performance of the thermoelectric regenerator/evaporator combination for design and off design conditions. Satisfactory completion of this test sequence is achieved when equilibrium data is obtained for all phases of the test sequence.

5.2.1.5 <u>Data Collection</u>

Record the following data as a function of time for each test sequence (refer to Figure 3):

Parameter	Frequency	Accuracy
T_1 thru T_8, $T_{chamber}$	5 minute intervals	± 0.5°F
ΔT_{2-1}, ΔT_{2-7}	5 minute intervals	± 0.5°F
P_1, P_2, P_3 ΔP_1, ΔP_2, ΔP_3, ΔP_4	5 minute intervals and at high and low limits	± 0.2psia.
Condensate flowrate	5 minute intervals	± 1 PPH
Urine flowrate	5 minute intervals	± 2 PPH
Urine concentration	5 minute intervals	± 2% solids
Condensate volume	Daily	± 10 ml
100 ml condensate sample	Daily	± 10 ml
TER voltage	5 minute intervals	± 0.1 V
TER amperage	5 minute intervals	± 0.05 A
Urine addition	As applicable	± 10 ml
Manual valve actuation	As applicable	---

5.2.2 Urine Loop Recirculation Pump

5.2.2.1 Purpose

The purpose of this test sequence is to performance and endurance test the urine loop recirculation pump prior to incorporation into the subsystem. The pump is to be run continuously in pre-treated urine at varying concentrations for a period of 90 days with pump performance tests accomplished at 30-day intervals.

5.2.2.2 Test Setup

This test is to be performed in a vented hood. The test setups are schematically illustrated in Figure 4 and 5.

5.2.2.3 Test Procedure

a. Leakage and performance check the pump using the setup shown in Figure 4.

   Leakage check: Lock the pump rotor and apply a source of H_2O pressurized at 10 psig to the inlet. Collect the through-put from the pump outlet in a graduated beaker for a period of 1 minute and record the volume in ml/min. Performance check: Plumb the pump as shown. Energize the pump at 27VCD and adjust the metering valve to obtain a pump Δp of 15 psi as indicated at P_1. Record the flowmeter reading in PPH and pump current draw in amperes.

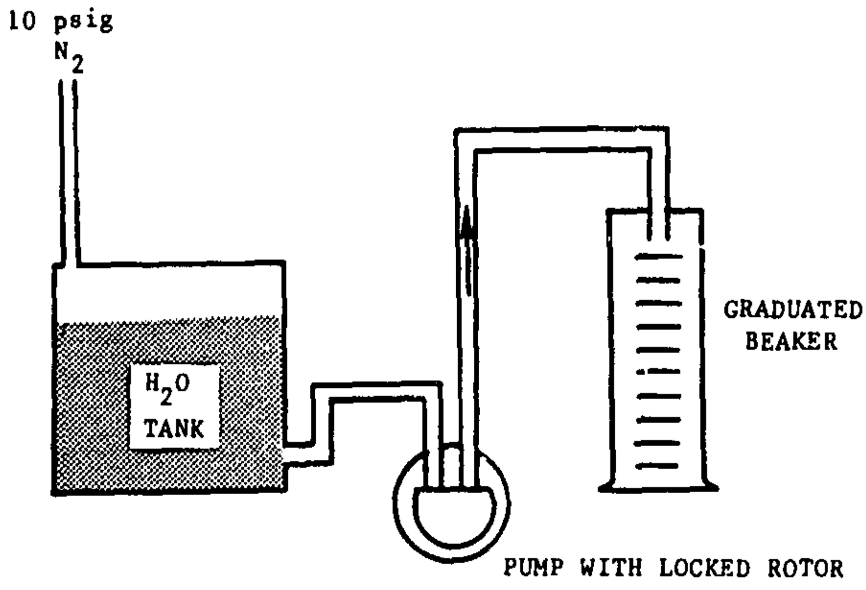
b. Assemble the test setup as shown in Figure 5. Add 4000 ml of pretreated urine to the beaker. Set the controller to maintain the temperature of the pretreated urine at 150°F ± 5°F. Start the stirrer at a medium rate of stirring.

c. Energize the urine loop recirculation pump using a 27 VDC @ 2A power supply. Adjust the bypass valve as required to obtain a flowmeter reading of 50% ± 5% and maintain this setting throughout the test.

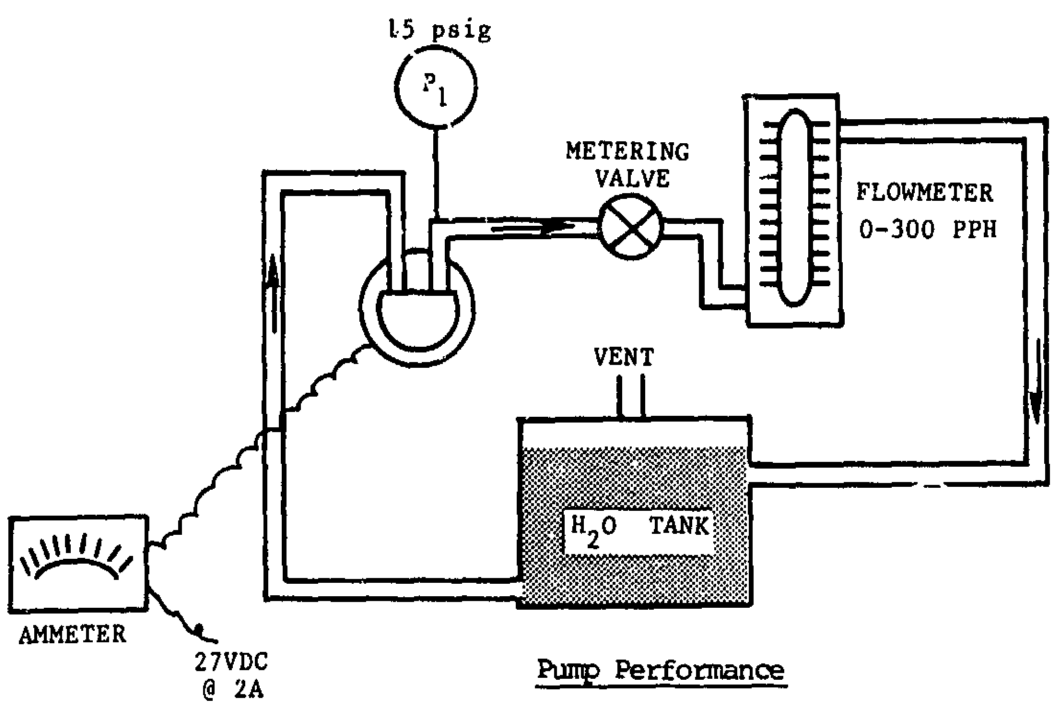
d. Maintain the bath level by adding 1000 ml of pretreated urine when the beaker lowers to the 3000 ml level. Keep a record of the quantity of pretreated urine added.

e. At 15 day intervals calculate the theoretical solids content of the beaker and withdraw a 100 ml sample. Evaporate the H_2O from the sample and measure and record the actual solids content. When 50% solids is reached, replace the solution with fresh pretreated urine and store the 50% solution in a refrigerator.

f. Leakage and performance check the pump per paragraph a. after 45, 60, and 90 days of endurance testing.



Pump Leakage



Pump Performance

Figure 4: Urine Loop Recirculation Pump Leakage and Performance Setup

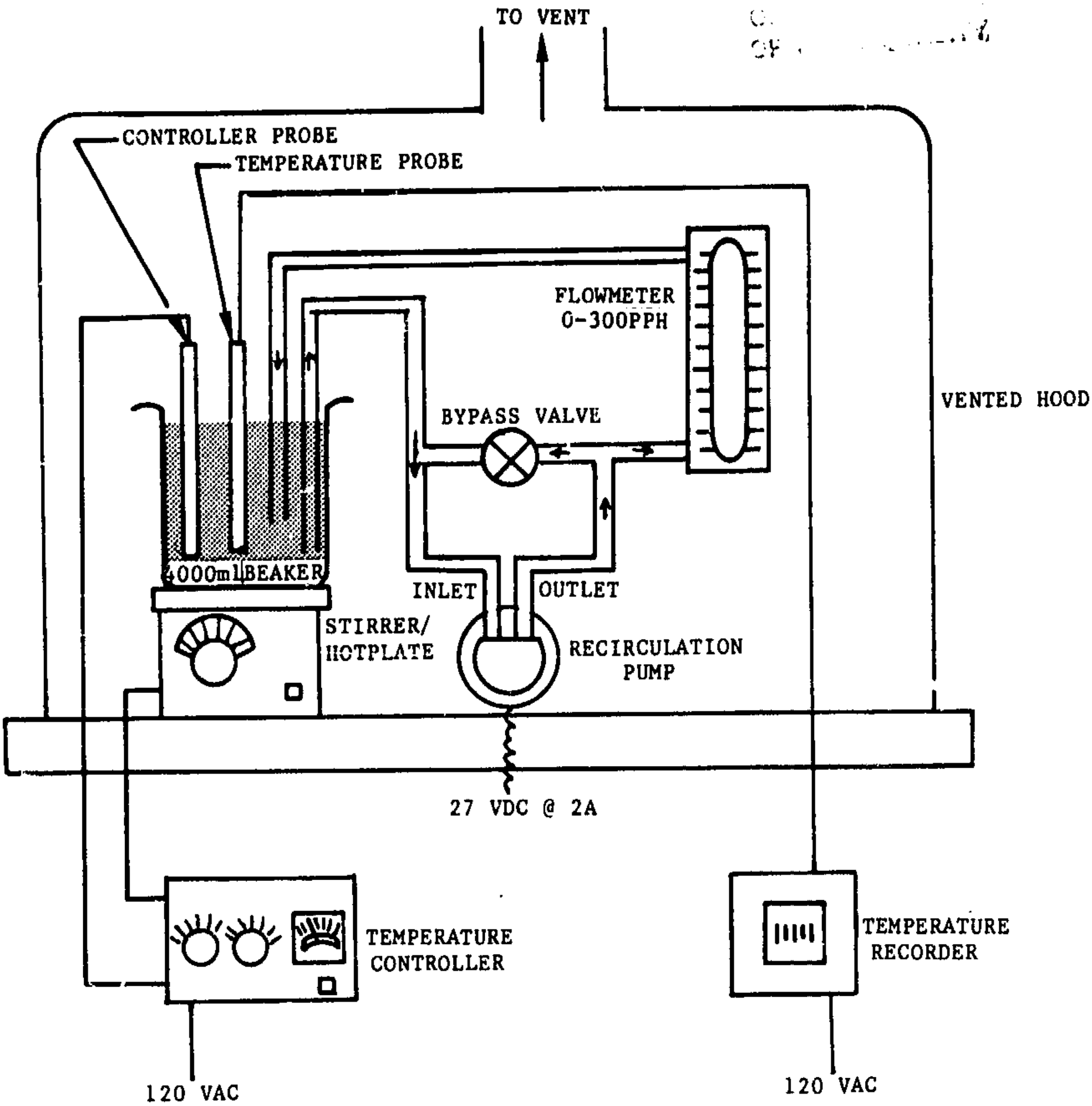


Figure 5: Urine Loop Recirculation Pump Test Setup

g. Terminate the test after 90 days. De-energize the recirculation pump, the instrumentation and controller. Remove the pretreated urine beaker and replace it with fresh water lines. Re-energize the recirculation pump and flush until the water from the pump is clear. De-energize the recirculation pump.

5.2.2.4 Test Requirements

This test is being performed to verify the durability of the selected Micropump P/N 12A-31-316-80647 for use in the TIMES subsystem. The pump is being run in pretreated urine at 150°F for a period of 90 days at which time the pump is to be leakage and performance tested, and subjected to disassembly and visual inspection to determine the 90 day degredation.

5.2.2.5 Data Collection

Record the following data as a function of time:

Leakage Test

Parameter	Frequency	Accuracy
N_2 pressure	0, 45, 60, 90 days	± 0.1 psi
H_2O throughput	0, 45, 60, 90 days	± 10 ml
Throughput time	0, 45, 60, 90 days	± 2 sec

Performance Test

Parameter	Frequency	Accuracy
Pump voltage	0, 45, 60, 90 days	± 0.5 VDC
Pump amperage	0, 45, 60, 90 days	± 0.05 A
Flowmeter reading	0, 45, 60, 90 days	± 6 PPH

Endurance Test

Parameter	Frequency	Accuracy
Pump voltage	Continuous	± 0.5 VDC
Bath temperature	Continuous	± 2°F
Pretreated urine addition	As required	± 10 ml
Pump cumulative time	Daily	---
Flowmeter reading	Continuous	± 5%

5.2.3 Controller

5.2.3.1 Purpose

The purpose of this test sequence is to verify the operational performance of the controller prior to incorporation into the subsystem. The controller is to be input with signals simulating the various subsystem inputs and tested for proper output signal sequences and levels.

5.2.3.2 Test Setup

This test is to be performed in the SSD Electronics Laboratory. The test setup is schematically illustrated in Figure 6. Block diagram drawing SVSK96638 (appendix) describes the specifics of the controller inputs, outputs, etc.

5.2.3.3 Test Procedure

The exact test procedure will be specified upon completion of the controller design.

5.2.3.4 Test Requirements

This test is being performed to verify the operational performance of the controller prior to incorporation into the subsystem. Simulated input signals corresponding to the conditioned signal from each of the input parameters are input over their operating ranges and the controller response as delivered by the output driver circuits for pump, valve, etc. control is monitored and compared to the required response. Further, the terminal/keyboard input capability and the monitor display capability is monitored and compared to the requirements. Successful completion of this test is accomplished when the actual controller responses for each of the simulated inputs corresponds to the required response.

5.2.3.5 Data Collection

Record the following data:

Parameter	Required Controller Response	Actual Controller Response
Variable input signal	To be specified	

5.2.4 Concentration Sensor

5.2.4.1 Purpose

The purpose of this test sequence is to verify the operational performance of the concentration sensor and provide a calibration curve of concentration versus sensor output for use in programming the controller.

5.2.4.2 Test Setup

This test is to be performed in a vented hood. The test setup is schematically illustrated in Figure 7.

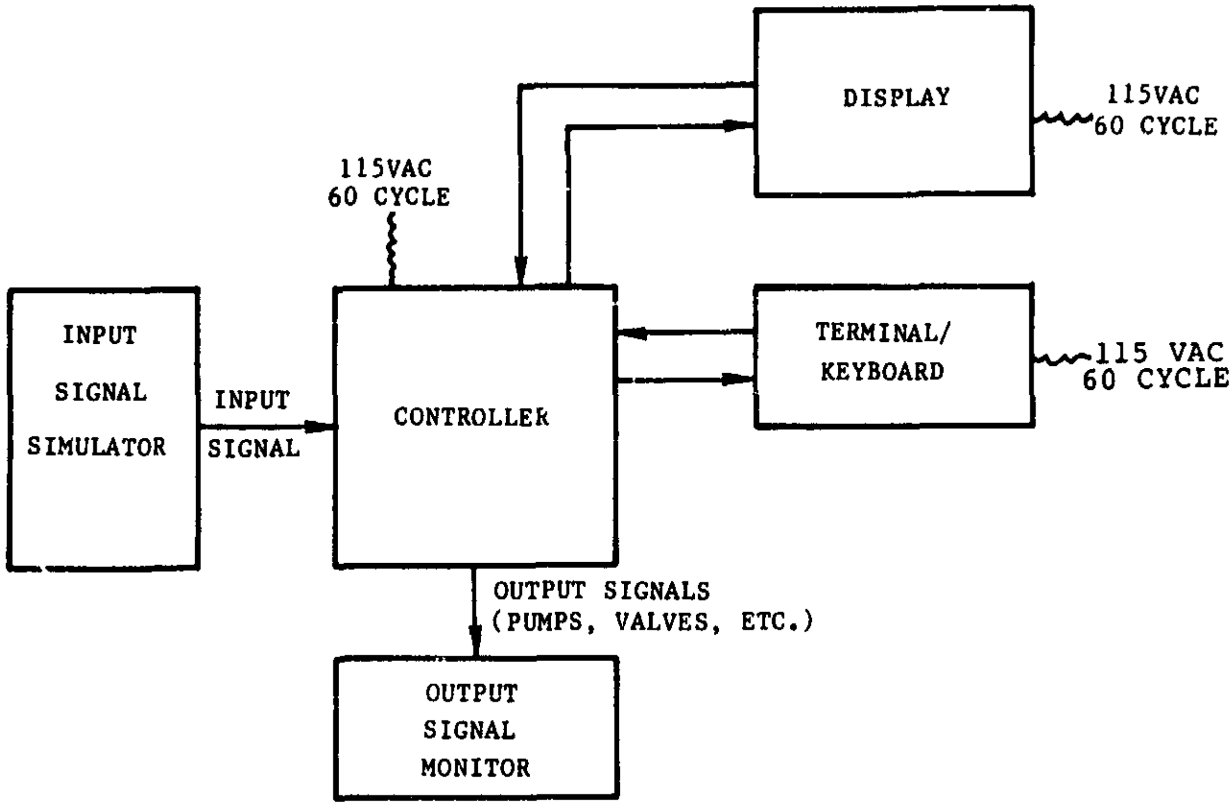


Figure 6: Controller Development Component Test Setup

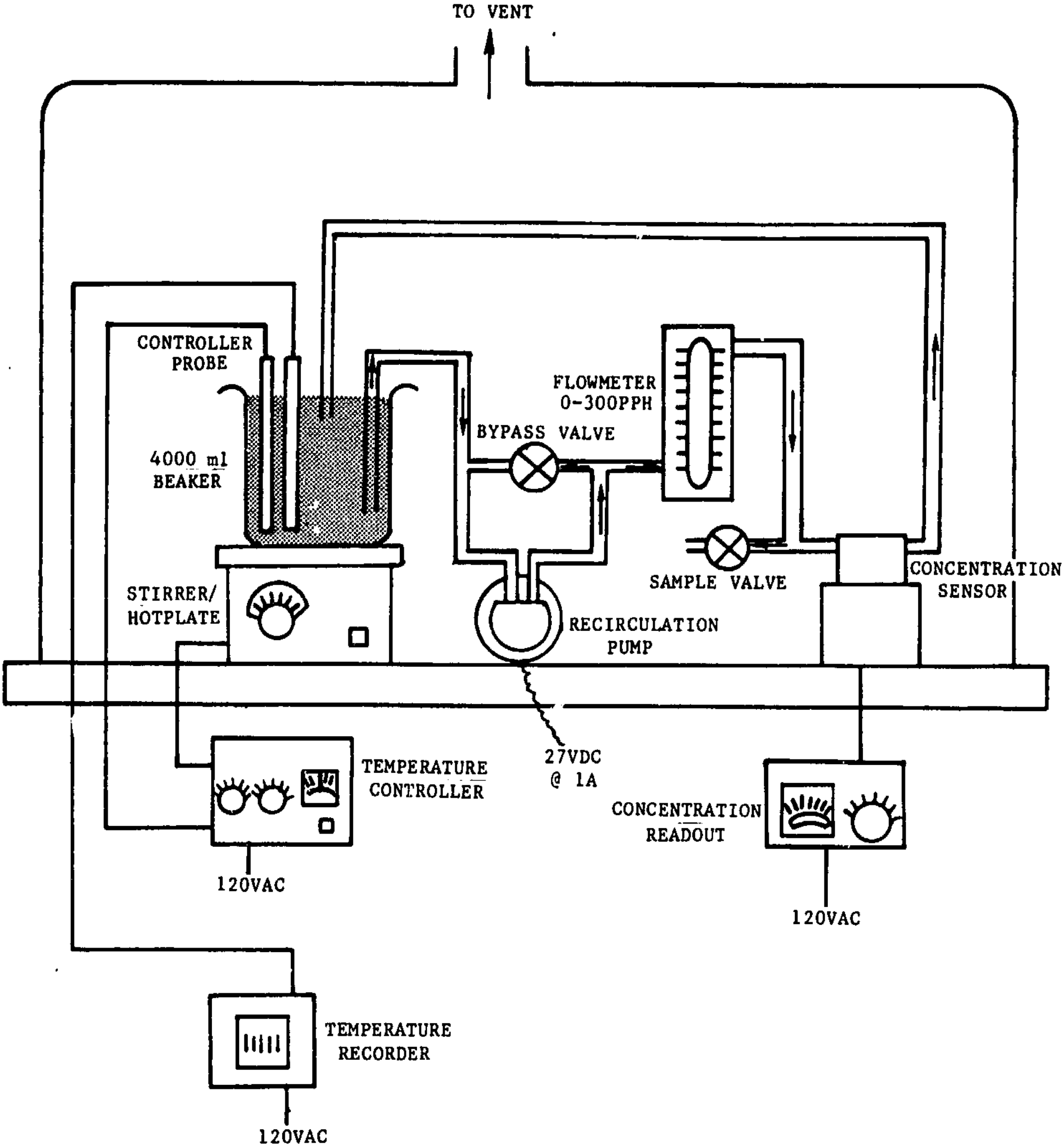


Figure 7: Concentration Sensor Development Test Setup

5.2.4.3 Test Procedure

a. Assemble the test setup as shown in Figure 7. Add 4000 ml of 60% solids pretreated concentrated urine to the beaker. Set the controller to maintain the temperature of the urine at 150°F. Start the stirrer at a medium rate of stirring.

b. Energize the pump with 27VDC and adjust the bypass valve to obtain a flowmeter reading of 300PPH ± 3PPH.

c. Obtain a concentration sensor reading and take a 100 ml sample from the sample valve port.

d. Reduce the flowmeter reading to 200PPH ± 3PPH and repeat c.

e. Reduce the flowmeter reading to 100PPH ± 3PPH and repeat c.

f. Reduce the flowmeter reading to 50PPH ± 3PPH and repeat c.

g. Replace the 60% solids pretreated concentrated urine with 40% solids urine and repeat b. thru f.

h. Replace the 40% solids pretreated concentrated urine with 20% solids urine and repeat b. thru f.

i. At the completion of the test, flush the lines with fresh water until the return line water is clear.

5.2.4.4 Test Requirements

This test is being performed to allow calibration of the concentration sensor reading as a function of pretreated urine solids concentration, and to determine if the concentration sensor is sensitive to changes in sample flow velocity. Satisfactory completion of this test is achieved upon completion of the data collection.

5.2.4.5 Data Collection

Record the following data and obtain a 100 ml urine sample for each point. Additonally, note any anomalies such as concentration sensor reading instability, etc.

Solids Concentration	Flowrate	Concentration Sensor Reading	Test Sample #
60%	300±3PPH		1
60%	200±3		2
60%	100±3		3
60%	50±3		4
40%	300±3		5
40%	200±3		6
40%	100±3		7
40%	50±3		8
20%	300±3		9
20%	200±3		10
20%	100±3		11
20%	50±3		12

5.3 Acceptance Testing

5.3.1 Verification Testing

5.3.1.1 Purpose

Post assembly verification testing is to be conducted on the completed water recovery subsystem to verify subsystem functionality and to demonstrate that all the contractual design, system performance, and fabrication specifications are met. Subsystem specific energy requirements, weight, volume, processing rate, water loss to vacuum, consumption of expendables, operation endurance, and product water quality are to be demonstrated to verify acceptability. In addition, product water samples are to be sent to JSC for corroborative analysis. Simulations of the reprocessing and automatic shutdown modes are to be made. As a minimum, the cumulative time at test conditions during this entire task is to be 30 eight-hour days.

5.3.1.2 Test Setup

5.3.1.3 Test Procedure

5.3.1.4 Test Requirements

5.3.1.5 Data Collection

5.3.2 Baseline Testing

5.3.2.1 Purpose

A comprehensive baseline test is to be conducted to establish exact operating characteristics in earth gravity conditions. This testing is to establish subsystem endurance, quantify component maintenance or replacement requirements, and determine subsystem suitability for inclusion in future flight systems. As a minimum, the cumulative time at test conditions during this entire task is to be equivalent of 30 eight-hour days. During this test sequence the system is to be veritified acceptable to the NASA by processing the equivalent of the urine, urinal rinse water and shower concentrated brine produced by three crewmen in 30 days with system maintenance permitted, except for the processing module. The processing module, including the hollow fiber membrane evaporator and the thermoelectric regenerator, are to operate for the 30-day equivalent period without maintenance. The water recovered shall necessarily be of the quality specified in Section 3.2.1.2.2.2 of the Statement of Work contained in Contract NAS 9-15471.

5.3.2.2 <u>Test Setup</u>

5.3.2.3 <u>Test Procedure</u>

5.3.2.4 <u>Test Requirements</u>

5.3.2.5 <u>Data Collection</u>

6.0 <u>TEST SCHEDULE</u>

7.0 <u>TEST REPORT</u>

APPENDIX A

BLOCK DIAGRAM

TIMES CONTROLLER AND DISPLAY

Windsor Locks, Connecticut 06096

September 25, 1979
TIMES-34

National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Crew Systems Division
2101 NASA Boulevard
Houston, Texas 77058

Attention: Mr. E. Winkler
Mail Code EC3

Subject: Contract NAS9-15471, TIMES
Master Test Plan

Gentlemen:

Reference is made to Hamilton Standard letter TIMES-12 dated August 21, 1978 which transmitted the plan for Design Support Testing and Development Component Testing and TIMES-EM-10 which submitted a preliminary copy of the TIMES Acceptance Test Plan.

The Master Test Plan is being supplemented at this time by the presentation of the enclosed two (2) Addendum copies of the Master Test Plan for Acceptance Testing, completing the DRL Line Item 3, TM-122TA requirements.

The plan for Acceptance Testing has been reviewed by the Contract Technical Monitor. The plan as submitted reflects the comments that testing be accomplished with urine and urinal rinse water, without shower concentrated brine, in order that TIMES test data will be comparable with data obtained by NASA in other subsystem tests.

Very truly yours,

HAMILTON STANDARD
Division of United Technologies Corporation

R. L. Simmons

R. L. Simmons
Contract Administrator

RLS/dmm
Enclosure

cc: Mr. J. P. Testa, DCAS/ACO
Mr. J. W. Wilson, NASA/JSC BC72(23)

Division of

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

ADDENDUM TO

SPACE SYSTEMS DEPARTMENT

HAMILTON STANDARD

MASTER TEST PLAN

URINE WATER RECOVERY SUBSYSTEM

CONTRACT NAS 9-15471

FOR

NATIONAL AERONAUTICS & SPACE ADMINISTRATION

LYNDON B. JOHNSON SPACE CENTER

HOUSTON, TEXAS 77058

SEPTEMBER 1979

PREPARED BY: G Roebelen
GEORGE J. ROEBELEN
PROJECT ENGINEER

APPROVED BY: H Brose
HARLAN F. BROSE
PROGRAM MANAGER

5.3 Acceptance Testing

5.3.1 Verification Testing

5.3.1.1 Purpose

Post assembly verification testing is to be conducted on the completed water recovery subsystem to verify subsystem functionality and to demonstrate that all the contractual design, system performance, and fabrication specifications are met. Subsystem specific energy requirements, weight, volume processing rate, water loss to vacuum, consumption of expendables, operation, endurance and product water quality are to be demonstrated to verify acceptability. In addition, product water samples are to be sent to JSC for corroborative analysis. Simulations of the reprocessing and automatic shutdown modes are to be made. As a minimum, the cumulative time at test conditions during this entire task is to be equivalent to 30 eight-hour days.

5.3.1.2 Test Setup

The test setup is schematically illustrated in Fig. 8. Block diagram drawing SVSK 96638 (Appendix A) describes the specifics of the controller inputs, outputs, etc.

5.3.1.3 Test Procedure

a. Assemble the test setup as shown in Figure 8. Add a measured quantity of distilled water to fill the waste storage and holding tanks approximately 80% full. Fill the pretreat tank with a measured quantity of distilled water. Record nature and duration of any maintenance operations.

b. Apply 29 ± 0.5 VDC to the subsystem and place the subsystem control in the "Start" mode. Verify that the "Warming Up" and "Ready" sub-modes occur in accordance with the TIMES operating logic summary, Table 1.

c. Place the subsystem in the "Automatic" mode. Observe operation and verify the "processing", "transient flush", and "accumulating" sub-modes. Record system performance readings at least every 15 minutes and verify that steady state condensate production rate is 1.7 lb/hr minimum.

d. Place the subsystem in "Standby" mode and verify proper functioning per the operating logic summary.

e. Place the subsystem in "Sterilize" mode and verify proper functioning per the operating logic summary.

f. Add measured quantities of distilled water to the waste storage and holding tanks periodically to maintain a 40 to 85% charge. Record levels and production rates every 15 minutes to obtain a mass balance.

g. Start the subsystem and simulate a liquid breakthrough failure by biasing the signal at the liquid sensor, item 314, mating connector. The display shall indicate a failure and the subsystem shall shut down.

h. Restart the subsystem and simulate a stoppage of recycle flow by shutting off power to the recycle pump, item 400. The display shall indicate a failure and the subsystem shall shut down.

i. Restart the subsystem and simulate a stoppage of condensate production by biasing the signal at the condensate quantity sensor, item 312, mating connector. This display shall indicate a failure and the subsystem shall shut down.

j. Restart the subsystem. An HFM overtemperature failure shall be simulated by biasing the signal at the HFM inlet temperature sensor, item 308, mating connector to indicate temperature above 150°F. The display shall indicate a failure and the subsystem shall shut down.

k. Restart the subsystem and allow the waste storage tank, item 200, charge to drop to 60% or below. Slowly add distilled water to the waste water tank while monitoring quantity level. Above 70% full a white flag shall indicate over limit. Above 91% a yellow flag shall indicate waste tank full.

l. Add distilled water to the subsystem inlet while monitoring holding tank, item 202, liquid level. Above 95% charge a yellow flag shall be displayed indicating a full holding tank.

m. Allow the pretreat tank, item 201, to drain. Below a charge of 5% a white flag shall be displayed to indicate the pretreat tank level is low. Below 1% a yellow flag shall be displayed to indicate the pretreat tank is empty.

n. Refill the appropriate tanks and restart the subsystem. To simulate a clogged recycle filter, item 210, disconnect the electrical connector on the ΔP sensor, item 310, and apply a signal to item 310 mating connector equal to 2.5 psid. A white flag indicating a high pressure drop shall be displayed. Increase the signal to the equivalent of 3 psid and a yellow flag shall be displayed to indicate a clogged filter. Reconnect the electrical sensor and restart the subsystem.

o. In order to check the product water with the conductivity indication, supply progressively higher concentrations of NaCl through the septum, item 110. Withdraw samples of product water at four concentrations between 0 and 50 megohm-cm to correlate actual vs. indicated conductivities. Record indicated conductivity while withdrawing each sample and compare with independently measured concentrations of samples. At conductivities above 50 megohm-cm a white flag shall be displayed to indicate high conductivity water. Subsequent to this test the subsystem shall be placed in a flush system until the conductivity of the product water is below 0.5 megohm-cm.

p. In order to check the low water rate indicator shut off the "burping" valve until the production rate is 1.1 pph. When a production rate less than 1.1 pph occurs a white flag shall be displayed. Turn on the "burping" valve and resume normal operation.

q. Place the control in the normal shutdown mode and verify that a white flag is displayed and controls are in proper sequence as listed in the operating logic summary.

r. Review data from steady state runs to verify that production rate is at least 1.7 lb/hr. Calculate specific energy requirements excluding the controller, display or commercial instrumentation. Specific energy shall not exceed 152 watt-hours per pound of water at 26.5 VDC power supply. Subsystem operation may be resumed if necessary to verify this condition.

s. Calculate the number of eight-hour days accumulated during water operation.

t. Drain the distilled water from the holding, pretreat, waste storage and recycle tanks. Add a measured quantity of pretreat liquid (per Appendix B) to fill the pretreat tank. Add a measured quantity of urine and urinal rinse water (per Appenix C-1) to approximately reach the 50% level of the waste storage tank. Retain a 100 ml sample of urine mixture and determine its solid/liquid ratio to correlate recycle tank solids content during cumulative operation. Record the level in the waste storage tank and the total urine mix added to the subsystem. During operation add approximately 20.0 lb of urine mix per day and record the quantity. If the urine mix in the waste storage tank drops below 20% additional urine mix above the 20.0 lbs/day may be added to bring the tank up to the 50% level. Record time and quantity of added mix. Record any maintenance time throughout the test.

u. Place the control in the start position and record time. Upon attainment of ready status switch to the automatic mode and record time and waste storage tank level. This will determine warmup time with heaters. Shut down the system, allow to cool, disconnect the recycle tank heater and place control in the start position. Record time. Upon attainment of ready status switch to the automatic mode and record time and waste storage tank level. This will define warmup time without heaters. Reconnect the recycle tank heater and proceed with the test.

v. Continue testing until the concentration sensor recycle loop sampling, or the concentration as calculated from the input/output mass balance indicates 50% solids. At that time measure total time and calculate number of equivalent eight-hour days of urine testing. If less than 30 eight-hour days, drain recycle tank, refill with fresh urine mix and continue operation until the equivalent of 30 eight-hour days are completed. If 30 eight-hour days of urine testing is reached prior to completion of verification testing, shut down the subsystem, drain recycle tank and temporarily terminate testing. Complete the verification testing after completion of the test described by paragraph 5.3.2.3.b.

w. During testing the following shall be accomplished.

   1. Record all data at least hourly for the first eight hours of operation and at least twice daily thereafter.

   2. Maintain a mass balance between input and output.

   3. Obtain product water samples upstream and downstream of the multi-filter. Apportion samples for HS in-house evaluation and submittal to JSC. Analyze samples per Appendix D. Sample daily.

4. At least three samples of recycle liquid at various concentrations shall be taken for correlation of sensor and measurement of pH.

5. Measure and record power for specific energy calculation.

6. Determine ratio of product water produced to liquid input.

7. Vary voltage to the subsystem from 26.5 to 31.5 VDC and count pulses of the spoiler pump, item 404 at each voltage level.

8. Read all subsystem displayed readings.

5.3.1.4 Test Requirements

In general, specific operational requirements are included within the test procedures. However, the following overall requirements shall be satisified:

a. Recover 95% of the liquid mix as potable water.

b. Specific energy shall not exceed 152 watt-hours per lb of product water from non-concentrated raw urine at 26.5 VDC.

c. Expendables shall be less than 0.65 lbs to process 100 lbs of raw urine.

d. The subsystem shall process at least 1.7 lbs/hr of product water at 29 VDC nominal from unconcentrated urine mix after 30 eight-hour days of urine operation.

e. Water loss from vaccum purging shall be less than 0.03 lbs/hr.

f. Water quality is to exceed standards to NAS 9-15471, paragraph 3.2.1.3.3.3 (Appendix D) of this test plan.

5.3.1.5 Data Collection

Data collection is specified in the individual procedures.

5.3.2 Baseline Testing

5.3.2.1 Purpose

A comprehensive baseline test is to be conducted to establish exact operating characteristics in earth gravity conditions. This testing is to establish subsystem endurance, quantify component maintenance or replacement requirements, and determine subsystem suitability for inclusion in future flight systems. As a minimum, the cumulative time at test conditions during this entire task is to be equivalent to 30 eight-hours days. During this test sequence the system is to be verified acceptable to the NASA by processing the equivalent of the urine and urinal rinse water produced by three crewmen in 30 days with system maintenance permitted, except for the processing module. The processing module, including the hollow fiber membrane evaporator and the thermoelectric regenerator, are to operate for the 30-day equivalent period without maintenance. The water recovered shall necessarily be of the quality specified in Section 3.2.1.2.2.2 of the Statement of Work contained in Contract NAS 9-15471 (refer to Appendix D of this test plan).

5.3.2.2 Test Setup

The test setup is schematically illustrated in Figure 8. Block diagram drawing SVSK 96638 (Appendix A) describes the specifics of the controller inputs, outputs, etc.

5.3.2.3 Test Procedure

a. Assemble the test setup as shown in Figure 8. Drain the holding, pretreat, waste storage and recycle tanks of any residue from the verification test. Fill the pretreat tank with a measured quantity of pretreat liquid per Appendix B.

b. Fill the holding and waste storage tank with urine and urinal rinse water per Appendix C-1 to a level of approximately 50%. Record level in waste storage and holding tanks. Place the control in "Start" position. When ready, turn the controller to the automatic position and adjust power to 29 ± 0.5 VDC. Record waste and holding tanks quantity. Obtain a reading of water output quantity over a period of at least four hours of steady state operation at 29 ± 0.5 VDC. Record condensate produced per hour. This shall be a minimum of 1.7 lbs/hour. Resume and complete verification testing if verification testing has not been completed.

c. Continue baseline testing adding approximately 20.0 lbs/day of urine mix to simulate normal loading. Record time, quantity and waste storage and holding tank level before addition. If waste tank level drops below 20%, add a measured quantity of urine mix to raise level to approximately 50%. Continue operation until recycle concentration is 50% or 30 eight-hour days have been completed. If 50% concentration is attained before 30 equivalent days are completed the recycle tank should be drained, refilled with unconcentrated urine mix and testing continued to the end of 30 eight-hour days. The amounts drained and added should be measured to allow a mass balance.

d. Product water samples of 200 ml (100 each for HS and NASA) should be taken on the following schedule and examined for purity per Appendix D:

Sample (Number)	Time (Hours)
1	8
2	16
3	32
4	48
5	64
6	80
7	96
8	112
9	128
10	144
11	160
12	176
13	192
14	208
15	224
16	240

Readings shall be taken at least once per hour during the first eight hours and at least twice daily during the remainder of the test. Further, readings should be taken whenever adding to or drawing samples from the subsystem.

e. Record any anomalies or failures during testing as well as any maintenance time.

5.3.2.4 Test Requirements

The following specific requirements shall be satisfied during baseline testing:

a. Recover 95% of the liquid mix as potable water.

5.3.2.4 (Continued)

b. Specific energy shall not exceed 152 watt-hours per lb. of product water from non-concentrated raw urine at 26.5 VDC.

c. Expendables shall be less than 0.65 lbs. to process 100 lbs. of raw urine.

d. The subsystem shall process at least 1.7 lbs/hour of product water at 29 VDC nominal from unconcentrated urine mix after 30 eight-hour days of urine operation.

e. Water loss from vacuum purging shall be less than 0.03 lbs/hour.

f. Water quality is to exceed standards of contract NAS 9-15471 paragraph 3.2.1.2.2.2 (Appendix D of this test plan).

g. Test duration must be at least 30 eight-hour days or equivalent.

h. There shall be no maintenance of the processing equipment at any time during the baseline test.

i. Following baseline testing the subsystem shall be dismantled sufficiently to assure that any degradation in functional capability or condition is commensurate with life experience and adequate for a total of 180 days.

5.3.2.5 Data Collection

In addition to data requirements specified under test procedure the following subsystem readings shall be taken when indicated above:

Pretreat quantity
Mixing (holding) tank quantity
Waste storage tank quantity
Solids concentration
TER outlet temperature
Porous plate ΔP
Water conductivity
Recycle tank temperature
HFM inlet temperature
HFM outlet temperature
Filter ΔP
Condensate quantity
Steam pressure
Evaporator liquid

FIGURE 8: TEST SETUP

TIMES SCHEMATIC

Revised 9/14/79

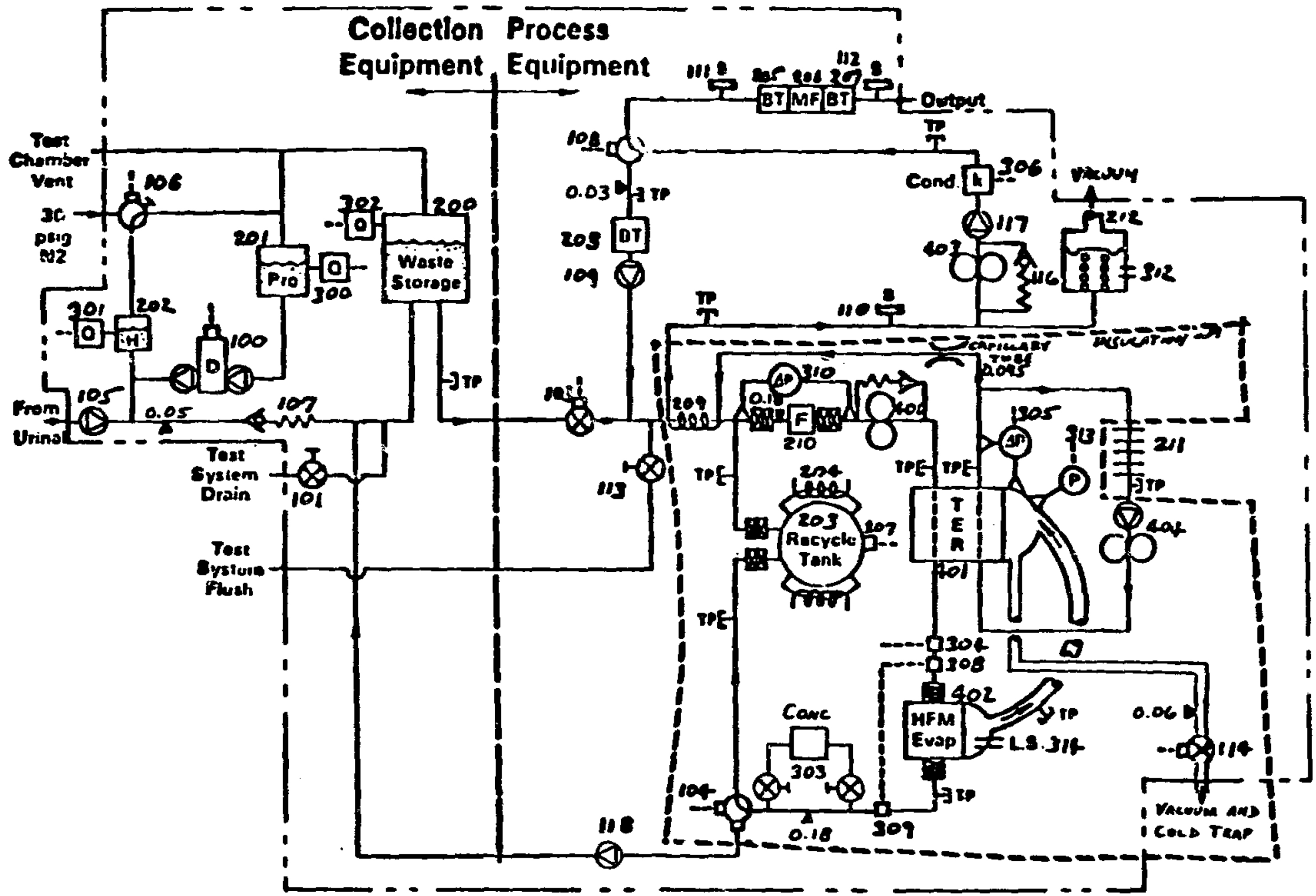


TABLE I

TIMES
Operating Logic Summary

Manually Selected Mode	Normal Shutdown	Start		Automatic			Standby	Sterilize	—
Controller Selected Sub-Mode	—	Warming-up	Ready	Processing	Transient Flush	Accumulating	—	—	Shutdown (Failure)
Sub-Mode Selection Parameter			HFM Temp	Waste Quantity	Waste Quantity	End of Flush			Malfunction
Functions									
· TER	Off	On	On	On	On	Off	Off	Reversed	Off
· Recycle pump	Off	On	On	On	On	Off	Off	Off	Off
· Heater Control	Off	On	Off	Off	Off	On	On	On (High)	Off
· Cooling temperature control	Off	Off	On	On	On	Off	Off	Off	Off
· Steam pressure control	Off	On	On	On	On	Off	Off	Val. Dump	Off
· Condensate pump control	Off	On	On	On	On	Off	Off	Off	Off
· Tank transfer control	Off	On	On	On	On	On	On	Off	Off
· Value position (latching)									
— Waste	Closed	Open	Open	Open	Open	Open	Open	Closed	Closed
— Flush	Flush	Recycle	Recycle	Recycle	Flush	Flush	Recycle	Recycle	Recycle
— Reject Recycle	Reject	Reject	Reject	S (Conductivity)	Reject	Reject	Reject	Reject	Reject
Malfunction Shutdowns									
· HFM Breakthrough	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
· No recycle flow	No	↓	↓	↓	↓	↓	↓	↓	↓
· HFM Inlet Overtemp	↓	↓	↓	↓	↓	↓	↓	↓	↓
· Accumulator Level High	↓	↓	↓	↓	↓	↓	↓	↓	↓

Revised 6/12/79

APPENDIX A

BLOCK DIAGRAM

TIMES CONTROLLER AND DISPLAY

DRAWING #SVSK96638

APPENDIX B

PRETREAT PROPORTION

& COMPOSITION

APPENDIX B

Pretreat proportion is 4 ml per 1000 ml of raw urine.

Composition of urine pretreat solution is:

44.7% by weight of H_2SO_4

11.0% by weight of CrO_3

44.3% by weight of H_2O

APPENDIX C-1

COMPOSITION OF URINE AND RINSE WATER

APPENDIX C-1

Composition and quantity of the urine/rinse water is as follows:

Pretreated urine: 4.53 lb per man day

Urinal rinse water: 1.27 lb per man day

Solids content of urine will be measured to determine effective water recovery ratio.

Urinal rinse water is composed of deionized distilled water.

APPENDIX C-2

COMPOSITION OF URINE,

RINSE WATER & SHOWER

BRINE

APPENDIX C-2

Composition and quantity of the urine/rinse/shower brine is as follows:

Pretreated urine: 4.53 lb per man day

Urinal rinse water: 1.27 lb per man day

Shower concentrated brine: 0.75 lb per man day

Urinal rinse water is composed of deionized distilled water.

Shower concentrated brine is water containing the following:

10,000 ppm	Rochester Germicide Co. ML 11 soap
5,000 ppm	NaCl
1,500 ppm	$NaSO_4$
1,000 ppm	$NaSO_4$
500 ppm	Urea

This results in a brine solids content of 0.018%.

APPENDIX D

PRODUCT WATER QUALITY

APPENDIX D

Product water samples will be sent to NASA/JSC for analysis.

The quality requirements are to exceed the standards recommended by the National Academy of Sciences - National Research Council Committee on Toxicology in the following report:

Appendix D

NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL

Committee on Toxicology

Report

of the

Panel on Potable Water Quality in Manned Spacecraft

August
1972

Committee on

Herbert E. Stokinger, Chairman
Arthur B. DuBois, Vice Chairman
Bertram D. Dinman
Seymour L. Friess
Harold M. Peck

Verald K. Rowe
C. Boyd Shaffer
Frank G. Standaert
James H. Sterner
Richard D. Stewart

Subcommittee on Air and Water Standards for Manned Spacecraft

Chairman, Herbert E. Stokinger
Seymour L. Friess
Riley D. Housewright
John Spizizen

Panel on Water Quality in Manned Spacecraft

Chairman, Riley D. Housewright
Marvin W. Skougstad
Robert G. Tardiff
Floyd B. Taylor
Charles M. Weiss

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ORIGINAL PAGE IS OF POOR QUALITY

NOTICE: The study reported herein was undertaken under the aegis of the National Research Council with the express approval of the Governing Board of the NRC. Such approval indicated that the Board considered that the problem is of national significance; that elucidation or solution of the problem required scientific or technical competence and that the resources of the NRC were particularly suitable to the conduct of the project. The institutional responsibilities of the NRC were then discharged in the following manner:

The members of the study committee were selected for their individual scholarly competence and judgment with due consideration for the balance and breadth of disciplines. Responsibility for all aspects of this report rests with the study committee, to whom we express our sincere appreciation.

Although the reports of our study committees are not submitted for approval to the Academy membership nor to the Council, each report is reviewed by a second group of appropriately qualified individuals according to procedures established and monitored by the Academy's Report Review Committee. Such reviews are intended to determine, inter alia, whether the major questions and relevant points of view have been addressed and whether the reported findings, conclusions, and recommendations arose from the available data and information. Distribution of the report is approved, by the President, only after satisfactory completion of this review process.

In response to a request from the National Aeronautics and Space Administration, the NAS-NRC Committee on Toxicology appointed a Panel on Water Quality in Manned Spacecraft in 1971 to study both potable water and nonpotable (wash) water contamination problems and to recommend permissible limits of the contaminants for 6-month and 3-year manned missions. (A report on the permissible limits for nonpotable water was submitted to NASA on 4 January 1972.)

An earlier report on potable water quality standards was prepared by the Academy's Space Science Board in September 1967.[1] In general, The Panel finds that report adequate in completeness of coverage and for application to missions of approximately 90-days duration. Data obtained from manned missions subsequent to 1967, mission simulations, and additional laboratory studies have resulted in extension of the list of contaminants, and in some cases have caused the present Panel to move to either a more conservative or more liberal position.

Potable water can be characterized by its physical properties, its inorganic and organic chemical composition, the presence of radionuclides, and its biological content. The Panel considered the problems of potability within the framework of each of these characterizations.

water are shown in the table below:

Table 1

Physical Standards for Potable Water in Spacecraft

	1967 SSB Report (90 days)	Mission Duration (6 Months)	(3 Years)
1. Turbidity (Jackson Units) Not to exceed	10	5	5
2. Color (platinum-cobalt units) Not to exceed	15	15	15
3. Taste	Unobjectionable	Unobjectionable	Unobjectionable
4. Odor	Unobjectionable	Unobjectionable	Unobjectionable
5. Foaming (allowable persistence in secs)	15	5	5
6. pH	-	7.0 to 8.0	7.0 to 8.0

Inorganic Chemical Standards

Table 2 is a listing of inorganic agents with proposed permissible limits in drinking water for 6-month and 3-year manned space flights. Since the primary objective of such limits is the health and well-being of the space crew on these flights, the maximum allowable concentrations of the inorganic materials in drinking water must provide not only assurance of safety to the health of the individuals under the unique conditions of their assignments, but also optimal mental activity and performance. Crews selected for space missions are in excellent physical condition and predictably should have above-average resistance to chemical insult. The USPHS Drinking Water Standards (2) have been set to protect a heterogenous population including extremes in susceptiblities (e.g., unborn and new-born children, elderly individuals) in a life-time exposure. Thus, for people in good health, the safety factor associated with each limit may be considered to be somewhat greater than average.

unlikely to jeopardize the [illegible]
those that produce direct biological changes (i.e., effects of health significance) some chemicals will affect the esthetic quality of the water and decrease its palatability. If water with poor taste and odor is the main source of fluid intake, the result may be a mild dehydration (due to lowered water consumption) which may in turn compromise the general health of the crew or alter their psychological well-being. Poor taste and odor would also serve as a crude warning signal of contamination.

Some of the limits are based mainly on organoleptic potential below health-related thresholds. Thus, substantially higher concentrations of these agents would be required to produce toxic effects directly. The limits proposed in Table 2 can safely have an excursion of two-fold; that is, the actual concentration on the average should be at or below the limit, but could occasionally, and for short periods of time, range as high as two times the limit.

Table 2
Proposed
Permissible Limits for Inorganic Chemical Agents (mg/l or ppm)
For Potable Water in Spacecraft

[illegible]	1967 SSB Report	Mission Duration (6 Months)	Mission Duration (3 Years)
Ammonium	ns	5.0	5.0
Arsenic	0.5	0.5	0.1
Barium	2.0	1.0	1.0
Bismuth	ns	0.05	0.01
Boron	5.0	1.0	1.0
Cadmium	0.05	0.01	0.01
Chloride	450	250	250
COD (dichromate method)	100	100	100
Chromium (hexavalent)	0.05	0.1	0.05
Cobalt	ns	0.02	0.01
Copper	3.0	1.0	1.0
Fluoride	2.0	2.0	2.0
Lead	0.2	0.05	0.05
Manganese	ns	0.1	0.05
Iron	ns	1.0	0.3
Mercury - Alkyl	ns	0.005	0.005
Mercury - other	ns	0.05	0.01
Nickel	ns	0.1	0.05
Nitrate (as N)	10.0	10.0	10.0
Nitrite	10.0	0.1	0.1
Selenium	0.05	0.05	0.01

	1967 SSB Report (90 days)	Mission Duration (6 Months)	(3 Years)
Silica	ns	10.0	10.0
Silver	0.5	0.1	0.05
Sulfate	250	250	250
Solids (Total) -	1000	500	500
Zinc	ns	5.0	5.0

ns - No standard

The following considerations led to the derivation of the limits:

Duration of exposure: The substantial difference in the length of the flights (6 months and 3 years) dictates the use of different limits in some instances. The longer flight compares closely to chronic exposure on earth; consequently, the chemical standards for inorganic materials in municipal drinking water [2] may be used as a guide for setting appropriate limits for the 3-year period. Greater latitude for some of the limits can be utilized for the shorter 6-month flight, after consideration of other factors.

For most of the chemicals listed in Table 2, the greatest threat is chronic, rather than acute, intoxication. Nitrate and nitrite ions are exceptions because they and their effects do not accumulate, and because the effects are readily reversed with the cessation of exposure.

Rationale: The USPHS Drinking Water Standards of 1962[2] were chosen as guides in the derivation of most of the limits. The rationales for these standards can be obtained from the official documents; but in addition, there are updated versions for arsenic, cadmium, lead, mercury, and selenium, which can be obtained upon request to EPA. However, for bismuth, boron, cobalt, nickel, nitrite, ammonium, and silicate, there are no official standards. Extensive experience with nitrite and silicate has been applied to determine the proposed limit with substantial confidence. For bismuth, boron, cobalt, nickel, and ammonium, there is more limited experience with these agents as chronic toxins. For these five agents, comparisons of known toxic manifestations permit the derivation of limits that possess a reasonable assurance of safety.

A proposed limit for alkyl mercury has been included because, if the water treatment and distribution systems were bacterially contaminated and simultaneously contained inorganic mercury, alkyl for the measurement of both forms of mercury, a dual standard is recommended.

Possible synergism and antagonism: The possibility of simultaneous exposure to two chemicals producing less than, or greater than, additive physiological effects is well known. The likelihood that the organic agents in the water would act as synergists with each other or with other chemicals (e.g., drugs) at these low concentrations appears remote with one exception, nitrite. Carbon monoxide and some drugs share with nitrite the ability to decrease the oxygen-carrying capacity of hemoglobin.

Unknown is the possible effect of weightlessness on the toxicity of these agents. There are no data available to the Panel on the effects of weightlessness on absorptive and excretory mechanisms, on detoxification systems, on mobilization of ions, and on immunologic responses during exposure to heavy metals.

Hypersensitivity: One parameter for which no prediction can be made confidently is hypersensitivity. Of the agents listed, hexavalent chromium is the only important sensitizer; however, the low concentrations proposed as permissible limits are expected to be sufficiently low to greatly diminish the probability of allergic reactions from exposure to the agent. Control of hexavalent chromium concentrations could perhaps involve chemical conversion to trivalent chromium, which, when incorporated into an organic molecule in the gastrointestinal tract, is essential in the "glucose tolerance factor" in man.

Exposure from other sources: It is anticipated that the concentrations of agents listed in Table 2 will be closely controlled in food and air so that the *total* exposure is well below the threshold for toxicity. (The USPHS Drinking Water Standards, the tolerances established by FDA for chemicals in foods, and EPA's ambient Air Quality Standards make allowances for exposure from sources other than those that they are limiting.)

Organic Contaminants

Water-quality criteria for organics in water used in extended manned space flight must be related to two sources of contamination. The assumption can be made that the initial water supply and water generated on board will be free of organic contamination initially. Sources of subsequent contamination following launch, and related to the operation of life-support systems, would include atmospheric contaminants entrained in condensate water as well as materials excreted in urine or feces and recycled due to carry-over from recovery systems.

It should be noted that in the 90-day Douglas Manned Life-Support System Evaluation (June 12, 1970 - September 10, 1970), water analyses indicated that the only significant build-up of undesirable materials was in organics, as indicated by undesirable tastes and odors, as well as in high total organic carbon (TOC) levels in samples taken from several of the holding tanks.

Of additional significance was the difference in quality between the system recycling potable water and that designed to recycle wash water. In the first instance, the level of TOC rose from initial values of 5-7 mg/l to a maximum of 33 mg/l and averaged 14.9 mg/l. In contrast, the wash-water system averaged 122 mg/l TOC by the tenth day and continued to rise to the peak value of 390 mg/l by the end of the test run. Aside from indicating the desirability of operating dual water supplies, these results also demonstrate that, for missions longer than 90 days, gross organic contamination will be a major water-quality problem.

It would appear from the observations made in the 1967 Water Quality Standards Report: "virtually nothing is known about the possible build-up of toxic, perhaps volatile, organic materials in water that has been recycled many times through the human system," that until additional information is generated, the conservative approach would be to remove and limit organic build-up as completely as possible by dialysis after distillation or by absorption on charcoal. This degree of purification may be entirely feasible for missions of 180 days. On longer missions lower levels of purification may have to be accepted due to limitations of material as well as inevitable carryover. Investigations leading to the development of additional information relating to the significance of organics that might accumulate in a water-recovery system should receive priority consideration. Procedures for such investigations should include animal experiments in which urine is collected and recycled through a water-recovery system such as that used in the 90-day test. The test should be conducted for at least 6 months, preferably longer, with careful monitoring of build-up of specific organic species.

Analytical procedures for the investigation of organics in water have substantially improved with the development of pyrolytic and gas-chromatographic techniques, with suitable detectors[3-10]. These procedures have reached a point which permits discrimination between very water-soluble substances, such as acetone and ethanol, and water itself. Similarly, other compounds of more complex nature can be defined, even those that are soluble to a limited degree in water. If the objective of the investigation of organic contamination in water is simply to determine whether organics have reached any prescribed level, other analytical methods would suffice. These techniques involve pyrolysis of the water sample and detection [illegible] suitable infra-red absorption system. Still other devices for investigation of organics, also using high-temperature pyrolysis, detect the yield of methane and hydrogen and other small molecular fragments with a flame-ionization detector. Where the organic contaminants may be contributing color, ultra-violet spectroanalysis may be used.

Radio Chemicals

Radionuclides that might accumulate in the potable-water supply of a manned spacecraft would be derived either from on-board radioactive materials or from proton activation of mineral salts in the water supply resulting either from cosmic radiation or proton flares from the sun. That cosmic radiation is of sufficient energy and abundance to activate ions with heavy nuclei and energy levels up to several hundred million electron volts has been documented by the cosmic-ray tracks left in the polycarbonate helmets of Apollo astronauts. However, cosmic radiation or proton flares energetic enough to cause significant activation of water contaminants are dangerous to living cells, and this danger could far outweigh that coming from the water. Moreover, activated elements or daughter products of such activation would normally not be carried over in water purification procedures employing distillation steps, and build-up in distillate residues could be shielded.

If necessary, water-quality standards for radionuclides could be applied to manned spaceflight at the same levels that are applied on earth. Water Quality Standards, USPHS 1962, note that an upper limit of 1,000 micro micro Ci per liter of gross beta activity (in the absence of alpha emitters and Strontium-90) should not be exceeded.

The instrumentation technology for alpha and beta activity measurements is extremely sensitive and highly developed; the preparation of the water sample for such measurements requires an evaporation to dryness in the presence of relatively strong hydrochloric and nitric acid. However, approximate total beta activity can be determined on samples by surface evaporation. If radiochemical levels will become an important aspect of water-quality criteria, simplification of analytical technique will have to be developed for extended manned space flight.

Biological Contamination

Toxins

Any component of the water-recovery system may harbor microbial contaminants. Such organisms, including fungi and bacteria, may proliferate and produce toxins. These toxins would then contaminate the water recovered and could be resistant to sterilizing procedures used. A well-known toxin is that produced under anaerobic conditions, by *Clostridium botulinum*, spores of which are found normally in the gastro-intestinal tract. Another toxin, an enterotoxin, produced by certain strains of *Staphylococcus*, is relatively heat-stable. Other non-pathogens, especially fungi, normally found in association with man, could produce toxins. One fungal toxin, aflatoxin, is known to be carcinogenic.

Microbiological

Microbial contamination of water resulting from build-ups on surfaces and adsorbents in the water-recovery system or in holding containers may be dangerous. Many different organisms (bacteria and fungi) are found in the intestinal tract, buccal cavity, and skin, which could find their way into the urine prior to recovery. Any of these organisms could proliferate to levels that would result in dangerously contaminated water. Even a final heat treatment would only serve to kill some, not necessarily all, of the organisms, and some killed products could be toxic, due to component endotoxins.

Although bacteria and fungi are generally the only organisms capable of proliferation outside the body, virus build-up could be significant. Ingestion of reclaimed water that is contaminated could produce acute and severe gastrointestinal disorders, respiratory infections, and septicemia.

Some procedures for estimating the bacterial contamination should be used. In addition, the water-recovery system should have component cleaning and sterilizing devices. The objective is to produce drinking water that is nearly sterile. With regard to its end use, wash water need not approach sterility, but it should be noted that contamination will readily spread in the cabin. Thus, certain organisms that survive and proliferate in water, e.g., *Pseudomonas*, can be pathogenic when skin openings occur, resulting in septicemia. Also, some fungal contaminants could spread and produce respiratory infections.)

The need for adequate sterilizing procedures, both in the recovery process and in the holding containers, cannot be overemphasized. As build-up of microbial populations may occur rapidly, routine surveillance of bacterial content is essential.

This Panel finds no reason to change the recommendation of the 1967 Report:[1] "For b[illegible]logical standards of drinking water for space use, the Panel specifically recommends that aliquots of water, cultured separately for total aerobic organisms, total anaerobic organisms and total cytopathic viruses, yield no more than a sum total of 10 organisms per milliliter."

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APPENDIX B

DEVELOPMENT COMPONENT TEST DATA

ORIGINAL PAGE IS
OF POOR QUALITY

TIMES - Single Module Test Data

Test Data - 11/6/78
(Data re-copied 11/17/78)

TIME (P.M)	V_{TER} (VOLTS) VDC	I_{TER} (AMPS)	P_{STEAM} (PSIA)	$P_{CONDENSATE}$ (PSIA)	T1 (°F)	T2 (°F)	T3 (°F)	T4 (°F)	T5 (°F)	T6 (°F)	T7 (°F)	T8 (°F)	T10 (°F)	
2:50	0	0			≈185	≈185	≈70	≈70	≈185	≈185	≈185	≈185	≈185	
	Bleeding air from within HFM thru HFM and steam chamber thru porous plate with vacuum system													
2:52	Starting recycle flow at 100 PPM													
	0	0	2.52	2.17	187.	187	70.5	102	166	131.8	132	185	132	Condensate outlet line hot
2:55	0	0			137	137	71	117	137	132	132	190	140	
2:57	26.5													
2:58	26.5	2	2.25	2.25	135	142	71	120	137	134	130	125	140	
2:59	↓ Have been sucking vacuum thru steam trap — now turned on condensate vacuum source													
3:01		2	2.18	1.85	132	138	71	120	134	135	130	126	141	
3:03	↓		2.18	1.78	131	137	71	118	132.5	135	130.	122	141	
3:05	26.3	1.8	2.18	1.66	130	136	71	112	132	135	130	119	140.3	
3:08		1.8	2.18	1.45	30	135	72	108	131	136	130	111	139.7	
3:10		1.7	2.18	1.39	130	134	72	106	130	136	131	102	140	
3:11	Start condensate recycle pump (cooling) — Turn off both vacuum pumps													
3:13			2.18	1.28	130	133	71	104	129	136	131	95	139	
3:16			2.15	1.68	130	130.5	78.5	87	128	136	129	82	137	
3:18	Turn off condensate cooling pump													
3:22			2.19	1.70	130	131	77	84	128	136	128.5	82	138	
3:26			2.22	1.80	130	132	76	80	128.5	135.5	131	89	138	
3:27	↓ Sucked down steam trap, P ≥ 2.0 psi, turned off, read increase, 5 sec ↗ 1 psi													
3:2?	SHUT DOWN													

THERMOCOUPLE	I.D.
1	- TER inlet (casing)
2	- TER outlet (casing)
3	- Condensate inlet
4	- Condensate outlet
5	- TED hot junction
6	- Steam
7	- HFM outlet (casing)
8	- TED cold junction
10	- Test chamber (oven)

Rig plumbed with condensate collection jug in series with pump & condensate cooler

Bubble Point Test - After shutdown, slowly pressurizing condensate side of porous plate while monitoring steam chamber pressure for breakthru

P_{COND} →	7.7	8.2	8.9	} Breakthru at ≈ 8.8 psia
P_{STM} →	2.0	2.0	2.2	

$\Rightarrow \Delta P_{BUBBLE\ PT} = 8.8 - 2.0 = 6.8$ psid

TIMES - 1/2 MODULE - POROUS PLATE FLOW DATA

TEST DATE: 11/10/78 (RECOPIED 11/17/78)

ΔP_{PLATE} (PSID)	TIME (MIN:SEC)	TIME (SEC)	COLLECTED WATER (ML)
2.0	0	0	0
	5:20	320	350
	8:35	515	550
	12:38	758	800
0.9	0	0	0
	10:55	655	300
	14:52	892	400

TEMP: 90°F

REVERSE FLOW THRU ONE (1) POROUS PLATE (1/2 MODULE)

CONDENSATE SIDE WAS PRESSURIZED AND FLOW COLLECTED ON STEAM SIDE

HSP-175.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: TE RESISTANCE CHECK

TEST ENGINEER: G. ROEBELEN

NAME OF RIG: 117

PROJECT & ENG. ORDER NO.: B41-100-200A

SHEET 1 OF 1 DATE 9/30/78

TEST PLAN NO.

MODEL NO. TIMES

PART NO.

SERIAL NO. 1 — 32

OPERATORS FAWCETT

TE #	RES. (Ω)	TE #	RES. (Ω)	TE #	RES. (Ω)	TE #	RES. (Ω)
1	.32	9	.33	17	.28	25	.28
2	.33	10	.32	18	.32	26	.30
3	.30	11	.32	19	.26	27	.31
4	.29	12	.30	20	31	28	.31
5	.29	13	.32	21	29	29	.32
6	32	14	.31	22	30	30	.29
7	.30	15	.28	23	.30	31	.29
8	.27	16	.30	24	.27	32	.30

REMARKS:
RESISTANCE SHOULD BE IN THE 0.25 — 0.35 RANGE.

15348

HSF-175.1A 1/66

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WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

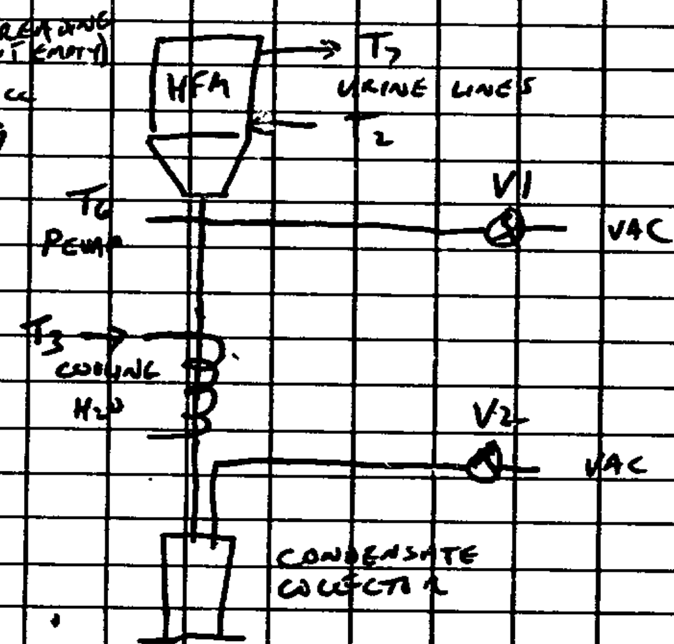
LOG OF TEST

TYPE OF TEST	
TEST ENGINEER	
NAME OF RIG	
PROJECT & ENG. ORDER NO.	
SHEET 1 OF	DATE 12/1/78
TEST PLAN NO.	
MODEL NO.	
PART NO.	
SERIAL NO.	
OPERATORS	

°F T_6	°F T_{10}	°F T_2	°F T_7	°F T_3	PSIA P_{EVAP}	V1	V2	TIME	COND VOL
URINE (H_2O) FLOW AT 100 PPH									
132	130	137.6 ~~128~~	122.1 ~~137.4~~	54	1.82	OFF	OPEN	1:36	NO READING (NOT EMPTY)
130	131	127	118	54	1.67	OFF	OFF ~~OPEN~~	1:40	53cc
129	129	119	116.5	54	1.58	OFF	OFF	1:45	79
128.8	127	116.6	116.8	54	1.58	OFF	OFF	1:50	91
128.7	126	116.5	116.5	54	1.60	OFF	OFF	1:55	91

END OF TEST

$T_{CHSE} = T_{10}$



REMARKS:

25659

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SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST	SHEET 2 OF 2 DATE 2/15/71
TEST ENGINEER	TEST PLAN NO.
	MODEL NO.
NAME OF RIG	PART NO.
	SERIAL NO.
PROJECT & ENG. ORDER NO.	OPERATORS

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_{Tc}	P_{co}		V_{cond}	
2 19		129.8	136.9			132.9	124.3	124.1	122.3	138.7	142.7		1.98	1.74		37	Added partial pressure of ~1 psia in cond
2 22		129.2	133.6			130.2	129.7	133.8	99.5	135.7	142.6		3.07	1.63		40	COND ACC'D 0 ON
2 28 30		129.6	131.9			129.0	130.0	131.2	89.9	141.1	142.6		2.66	1.58			COND ACC'D OFF
2 30		130.2	133.1			129.7	129.3	131.2	97.8	140.7	142.8		2.80	1.79			full vacuum bleed — what to ~~[illegible]~~ hold 3 psia

REMARKS:

25662

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HSF-175.1A 1/65

SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

HFM ΔT

TYPE OF TEST:
TEST ENGINEER: [illegible signature]
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.: B41 - 100 - 300A

SHEET 1 OF 2 DATE 12/15/78
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_{TG}	P_{COND}		(ml) V_{COND}	
PM				X	X	TEK ΔT							??				
1:00		144.0	150.1			144.2	139.3	134.2	132.0	139.2	139.4		2.08	2.57		Vaccum	sources off at 1:02
1:05		131.9	139.7			135.4	136.5	133.5	130.8	141.9	144.1		2.60	2.27		47	
1:10		128.4	134.1			129.7	135.7	130.9	117.4	136.6	142.4		2.43	2.00		53	
1:12 30		~~[illegible]~~	~~[illegible]~~			~~131.9~~	~~133.9~~	~~126.2~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~		~~[illegible]~~	~~[illegible]~~		54	2 ~~sec~~ sec vacuum shot x 2
1:13 30		127.8	135.6			131.4	133.9	126.2	124.8	138.2	142.8		2.09	1.89		[illegible]	
1:20		126.9	134.9			130.8	133.8	127.6	125.7	136.3	142.6		2.17	1.96		72	
1:25		127.1	133.8			130.2	134.6	128.1	126.8	136.6	142.4		2.22	2.02		75	
1:28													2.22	1.92			Condensate line va. on
1:31		127.5	133.2			130.1	135.1	128.3	123.0	137.4	142.2		2.23	1.80		107	va. off
1:34 1:35		127.7	132.9			129.9	135.2	128.6	116.2	137.3	142.2		2.24	1.77		112	
1:37 15		128.0	134.8			135.0	135.6	127.8	125.6	138.0	142.5		2.18	1.88		115	2 sec vac shot @ 1:35
1:45		128.0	133.8			130.5	136.0	128.0	124.8	137.5	142.5		2.22	1.93		143	
1:50		128.4	137.6			130.4	130.3	129.6	115.8	138.2	142.3		2.25	1.93		150	← 2 sec vac shot @ 1:50 30
2:00		128.7	135.8			132.3	136.6	129.5	125.0	137.3	142.6		2.24	2.03		174	
2:05																	cond flush 2 min
2:06		129.4	135.4			132.2	135.8	129.7	123.4	138.2	142.8		2.25	1.81		218	
2:11 30		129.9	135.2			131.9	133.9	130.7	113.5	138.9	142.6		2.30	1.82		228	
2:13 30																	2 sec vac shot
2:13		129.9	136.0			132.0	133.9	128.2	126.6	139.4	142.8		~~[illegible]~~ 2.23	1.97		232	

REMARKS:
AMB PRESS 14.67 PSI
RECYCLE FLOW 100 PPH

V_{TER} = 26.5 @ 22A

25661

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WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: CAPILLARY TUBE
TEST ENGINEER: [illegible]
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.

SHEET 1 OF
DATE 1/24/77
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_{EVAP}	P_{COND}		COND VOL	
		(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)	(°F)		(PSIA)	(PSIA)		(ml)	
9 13			HFA ΔT														ON 26.3 V @ 3A 100 RPM VAC [illegible] ON
9 15						TER ΔT											EVAP VAC PUMP OFF
9 17 30																	2 sec shut of evap vacuum
9 18		125.1	123.1	133.7	79.6	128.4	127.0	126.8	124.8	125.4	142.7		2.12	1.52		38	
9 23		122.0	129.2	131.3	83.2	125.2	127.0	125.0	122.0	117.9	140.6		2.02	1.52			
9 25																	4 sec shut of evap vac
9 27		121.9	129.2	129.6	84.4	125.6	125.0	122.9	121.2	119.1	139.8		2.02	1.52			
9 28																	URINE HTR ON

REMARKS:

25663

HSF-173.1A 1/65

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SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST
TEST ENGINEER
NAME OF RIG
PROJECT & ENG. ORDER NO.

SHEET OF DATE 1/24/78
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

Time		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}			P_{EVAP}	P_{COND}	V
3:50		137.9	145.2	128.8	50.6	141.5	134.7	134.7	135.0	133.0	146.1			~~[illegible]~~	0.62	103
														2.82		~~[illegible]~~
352		137.0	144.8	128.9	51.2	140.5	137.2	137.4	136.4	135.6	146.0			2.86	0.63	106
4:00		136.4	142.3	126.0	51.0	138.1	137.5	137.8	123.9	123.7	145.7			2.87	0.65	119
4:10		136.6	140.5	126.9	51.1	136.6	137.8	138.1	102.7	112.5	145.0			2.87	0.65	146
4:15		136.2	143.7	126.0	51.0	139.7	133.8	133.8	133.9	131.8	144.6			2.66	0.83	148

REMARKS:

25664

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SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST	
TEST ENGINEER	
NAME OF RIG	
PROJECT & ENG. ORDER NO.	

SHEET OF	DATE 1/25/79
TEST PLAN NO.	
MODEL NO.	
PART NO.	
SERIAL NO.	
OPERATORS	

Time		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_{EVAP}	P_{COND}		V_{COND}	V_{STM}	100 PPH FLOW			
2:20		138.4	145.0	138.6	54.7	140.4	139.9	140.3	130.7	136.0	149.4					43	550				
2:22		138.8	146.7	137.5	54.3	142.5	139.1	139.5	137.6	138.0	148.7		2.82	0.5		43	580	P_{atm} = 14.2 psia			
2:27		139.3	146.5	137.1	54.1	141.8	140.3	140.6	135.1	137.6	148.5	COND VAC	2.90	0.47		44	[illegible]				
2:32		140.2	145.8	134.2	54.0	141.3	141.3	141.5	119.4	132.0	147.5	10 SEC VAC	2.95	0.57		45	580				
2:35		140.8	148.5	132.2	54.3	144.5	139.9	140.1	139.7	138.0	147.8	AT STEAM	2.95	0.59		48	600				
2:38												COND VAC @ 2:40		0.50		51	640				
2:40		140.9	147.7	123.0	54.0	143.9	141.6	141.8	136.6	136.7	148.0		3.00	0.57		54	600				
2:45		141.5	147.6	130.1	54.1	144.0	142.2	142.5	121.9	134.5	147.8	5 SEC STEAM PURGE	3.02	0.65		62	600				
2:48		142.4	149.9	130.5	54.2	146.2	141.7	141.8	141.0	137.0	147.9		2.99	0.72		64	630				
2:55												10 SEC COND VAC PURGE									
256		143.1	149.5	132.2	54.4	145.6	143.6	143.8	123.9	132.1	147.8		304	0.62		82	630				
257												5 SEC STM PURGE									
258		143.6	151.0	132.2	54.2	147.3	142.3	142.6	142.1	137.9	148.4					85	650				
303		144.0	151.0	132.8	54.1	146.6	144.7	144.8	141.3	135.8	148.4		3.60	0.65		92	650				
308		145.1	151.0	133.4	54.6	146.8	145.6	145.7	123.4	136.4	149.0		3.825	0.66		96	650				
311							~~145.8~~					10 SEC VAC PURGE	3.875	0.60							
313		146.0	153.1	133.7	54.5	149.2	143.8	144.4	143.0	138.4	149.2	5/S VAC PURGE	3.525	0.62		122	690				
318		146.2	152.9	134.7	54.4	149.0	146.5	146.6	144.4	140.8	148.9		3.850	0.65		123	690				
323		146.8	152.8	135.2	54.4	148.8	147.2	147.3	141.2	137.0	149.0		390	0.80		142	690				
328		147.5	153.0	135.4	54.5	149.1	147.7	147.8	136.6	132.8	149.0		392	0.92		157	690				
333		148.0	153.2	135.6	54.3	149.2	148.2	148.3	130.2	134.4	149.2		394	0.97		170	690				

REMARKS:

25665

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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST	
TEST ENGINEER	
NAME OF RIG	
PROJECT & ENG. ORDER NO.	

SHEET	OF	DATE 1/29/79
TEST PLAN NO.		
MODEL NO.		
PART NO.		
SERIAL NO.		
OPERATORS		

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_1	P_2	P_{VAC}		V_{IER}		Flow PPM		COND ML	STEAM ML
TEST	STARTED		1:25 PM																			
230		144^{0}	152^{4}	128^{8}	51^{5}	148^{1}	143^{6}	144^{0}	142^{6}	140^{8}	150^{2}		3.15	3.15	.62		29		100		140	570 105
227		144^{1}	151^{3}	131^{2}	51^{5}	146^{9}	144^{4}	144^{8}	138^{7}	136^{6}	150^{0}		2.90	3.18	.72		29		100		147	
249															~~1.17~~			10 SEC	VENT		~~200~~	555
300		144^{0}	151^{6}	132^{8}	51^{2}	146^{9}	144^{5}	144^{8}	139^{5}	139^{2}	149^{0}		3.04	3.18	1.18		29		105		234	
302				?														5 SEC	VENT			555
303						BLOW		OUT		COND					.95						163	
324		145^{0}	150^{6}	132^{2}	50^{8}	145^{9}	145^{6}	145^{9}	116^{0}	131^{5}	148^{4}		3.10	3.22	2.45						239	
326							REMOVE		CONDENSATE				~~[illegible]~~		1.18		5 SEC	VENT			42	570

REMARKS:

25667

HSF-178.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST	
TEST ENGINEER	
NAME OF RIG	
PROJECT & ENG. ORDER NO.	
SHEET 1 OF	DATE 2/1/79
TEST PLAN NO.	
MODEL NO.	
PART NO.	
SERIAL NO.	
OPERATORS	

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_{EVAP}	$P_{COND\ PASSAGE}$	$P_{COLLECTION}$		V_{COLL}		$V_{STEAM\ PASSAGE}$			
905		START PURGE - STEAM PASSAGE & COND PASSAGE																				
		100 [illegible] RECIRC & 26.5 V [illegible] TE & HEATER ON																				
		CONDENSATE COOLANT WATER ON																				
[illegible]																						
921		135^1	138^4	130^7	63^9	135^4	135^0	138^1	98.8	116^3	145^1		3.06	1.95	1.1		10		690			

REMARKS:

26.5 V TE
0.040 LAM REST
AMB 14.4 PSI

25668

ORIGINAL PAGE IS
OF POOR QUALITY

HSF-175.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST	
TEST ENGINEER	
NAME OF RIG	
PROJECT & ENG. ORDER NO.	
SHEET 1 OF	DATE 2/2/79
TEST PLAN NO.	
MODEL NO.	
PART NO.	
SERIAL NO.	
OPERATORS	

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_{EVAP}	P_{COND} (PSI)	P_{CELL}		V_{CELL}	$V_{STEAM\ CMD}$				
950		PURGE STEAM & COND PASSAGES — STEAM OFF, COND ON																				
		100 PPM RECIRC & 26 V ON TE — HTR ON																				
		COND. COOLANT H_2O ON																				
1005				10 SEC STEAM PURGE																		
1006		139^{2}	147^{0}	129^{7}	52^{0}	143^{6}	137^{4}	137^{7}	135^{6}	136^{0}	149^{0}		2.86	2.55	0.46		22	800				
1009		140^{6}	147^{7}	131^{4}	52^{0}	144^{0}	140^{5}	140^{7}	134^{7}	138^{0}	150^{4}		3.02	2.57	0.47		25	—				
1012		142^{2}	148^{4}	131^{3}	52^{0}	144^{6}	142^{0}	142^{3}	119^{3}	137^{0}	151^{0}		3.14	2.53	0.46		31	—				
1015		143^{7}	149^{6}	130^{0}	52^{0}	146^{2}	142^{7}	143^{0}	122^{4}	137^{9}	151^{4}		3.16	2.62	0.46		35	—	LOWER HTR PWR			
1018		143^{7}	149^{9}	129^{5}	51^{8}	146^{2}	143^{7}	143^{5}	127^{9}	138^{7}	150^{1}		3.13	2.68	0.47		41	—				
1021		142^{2}	148^{6}	130^{2}	51^{6}	145^{3}	142^{2}	142^{5}	128^{2}	133^{7}	150^{6}		3.04	2.70	0.47		49	—	RAISE HTR PWR			
1024		142^{4}	148^{9}	131^{0}	52^{6}	145^{8}	142^{2}	142^{4}	123^{6}	138^{2}	151^{3}		3.03	2.80	0.47		54	—				
1027		146^{3}	152^{7}	132^{3}	51^{6}	149^{4}	144^{6}	145^{3}	123^{6}	141^{7}	152^{4}		3.37	3.20	0.47		62	—				
1030		148^{2}	154^{4}	134^{6}	51^{6}	150^{6}	146^{7}	147^{6}	124^{0}	143^{0}	153^{5}		3.45	3.25	0.47		73	—	LOWER HTR PWR			
1033		149^{2}	155^{4}	136^{6}	51^{5}	151^{4}	147^{8}	148^{4}	124^{6}	144^{4}	154^{0}		3.57	3.30	0.47		83	—				
1036		147^{6}	153^{6}	137^{6}	51^{6}	149^{5}	147^{4}	147^{8}	126^{1}	144^{4}	152.6		3.37	3.23	0.47		98	—				
1039		147^{6}	153^{4}	137^{4}	52^{7}	149^{5}	147^{1}	147^{6}	126^{2}	143^{9}	152.5		3.35	3.20	0.47		111		HTR OFF			
1042		147^{7}	153^{6}	136^{7}	52^{0}	149^{7}	147^{1}	147^{5}	126^{7}	144^{3}	152.2		3.35	3.19	0.47		124	—				
1045		146^{0}	152^{2}	136^{7}	51^{7}	148^{2}	146^{1}	146^{5}	125^{2}	143^{4}	152.2		3.28	3.14	0.47		137	—				
1048		145^{2}	151^{6}	136^{8}	51^{5}	147^{6}	145^{4}	145^{6}	123^{4}	142^{6}	152.4		3.24	3.10	0.47		150	—				
1051		145^{0}	151^{2}	136^{6}	51^{7}	147^{1}	145^{0}	145^{2}	123^{1}	142^{5}	152.0		3.21	3.05	0.47		162	—				
1054		144^{6}	150.7	136^{2}	51^{7}	146^{8}	144^{7}	145^{0}	123^{2}	142^{1}	152.0		3.20	3.00	0.47		174	—				

REMARKS:

26.5 TE
0.040 LAM RES
AMB 14.6 PSI

25669

HSF-175.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST	SHEET 2 OF	DATE 2/2/79
TEST ENGINEER	TEST PLAN NO.	
NAME OF RIG	MODEL NO.	
	PART NO.	
	SERIAL NO.	
PROJECT & ENG. ORDER NO.	OPERATORS	

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	G_{con}	P_{cav}	P_{cond}	P_{cm}		V_{cm}	V_{steam}				
1057		144.0	150.4	135.4	51.7	146.4	144.2	144.7	122.6	141.6	151.7		3.17	2.95	0.47		187	—				
1100		143.7	150.1	134.7	51.7	146.1	144.0	144.1	122.6	141.3	151.4		3.16	2.92	0.47		199	—				
1103																						
1106		143.8	149.4	133.6	51.8	145.2	143.2	143.5	120.6	140.4	150.7		3.04	2.88	0.47		223	—		HTR ON LOW		
1109		143.2	149.3	133.9	51.6	145.3	143.0	143.3	120.6	140.1	150.9		3.14	2.88	0.47		236	—				
1112						DUMP	CONDENSATE	—	236 ml								0					
1115		142.8	149.1	133.0	51.8	145.0	142.7	143.1	120.6	140.1	150.6		3.12	2.87	0.47		26	-				
1118		142.9	148.8	132.3	52.0	144.8	142.6	142.8	120.6	140.0	150.2		3.12	2.87	0.47		37	—				
1121				VENT		STEAM		PASSAGE	—		10	SEC					—	860				
1124		142.2	149.9	131.1	51.8	146.2	141.4	141.8	139.5	140.2	150.2		3.12	2.85	0.47		54	—				
1127		141.7	148.9	130.7	51.6	145.1	141.6	141.7	137.2	139.5	150.1		3.12	2.80	0.47		69	—				
1133		141.3	148.1	130.3	51.2	144.2	141.5	141.9	120.0	138.0	149.8		3.10	2.78	0.47		90	—		RAISE HTR		
1139		142.1	148.6	130.7	51.2	144.8	141.6	142.1	117.7	139.6	150.0		3.10	2.80	0.47		109	—				
1145		142.7	149.0	131.8	51.4	145.0	142.4	142.8	117.7	140.4	150.2		3.13	2.83	0.47		132	-				
1200		143.8	150.0	131.1	51.6	145.6	143.2	143.6	117.7	141.4	147.8		3.16	2.88	0.47		192	-				
1201					DUMP	CONDENSATE				-	192 ml						0	-				
1246		143.9	149.4	131.0	51.7	145.2	143.0	143.8	113.4	141.0	146.8		3.18	2.88	0.47		200	-				
1251				VENT		STEAM	PASSAGE		-	10	SEC						—	880				
1255		143.6	150.7	130.2	51.9	147.3	142.8	143.2	140.2	141.6	148.3		3.23	2.92	0.47		232	—				
1257					DUMP	CONDENSATE	—	232 ml									0					
1300		143.3	150.2	131.0	51.8	146.5	142.9	143.2	135.4	140.5	148.0		3.20	2.90	0.51		22	—				

REMARKS:

25670

HSF-175.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST	SHEET 3 OF	DATE 2/2/79
TEST ENGINEER	TEST PLAN NO.	
NAME OF RIG	MODEL NO.	
PROJECT & ENG. ORDER NO.	PART NO.	
	SERIAL NO.	
	OPERATORS	

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_{evap}	$P_{cond\ pass}$	P_{cell}		V_{cell}	$V_{steam\ pass}$				
1305		143^5	149^6	130^2	51^7	146^2	143^0	143^5	122^1	138^9	147^8		3.18	2.88	0.47		44	—				
~~40~~																						
1409		148^9	155^1	136^4	50^7	151^1	147^3	148^2	125^9	142^6	149^8		3.50	3.20	0.65		246+	—				
					DUMPED COND. - 246+ ml (full at 246 - [illegible] 0 [illegible])														HTR OFF			
1414					VENT STEAM PASSAGE				10 - SEC — CHANGED COLLECTION PUMP									900				
1416		149^0	156^7	134^9	51^0	153^0	147^7	147^8	146^2	146^4	150^5		3.42	3.38	1.30		~~25~~	—				
1424		148^6	155^6	132^9	51^3	151^8	148^1	148^4	133^1	145^7	150^5		3.45	3.30	1.47		~~38~~	—				
1436		149^3	155^9	125^2	51^6	151^9	148^7	148^9	127^9	147^0	150^4		3.46	3.35	1.72		~~25~~	—				
1451		142^3	148^5	125^3	52^0	143^0	144^0	144^6	116^7	139^3	149.9		3.25	2.18	1.35		54	—	refilled water supply			
1500			VENTED STEAM PASSAGE						10 SEC - REMOVE NONCOND FROM ADDED H_2O									925				
1525			VENTED STEAM PASSAGE						10 SEC - REMOVE NONCONDENSATE								0	925				
1527		139^2	146^0	119^8	51^2	142^8	136^5	137^0	135^0	137^9	148^1		2.68	2.48	1.40		10	—				
1533		138^2	143^9	114^6	51^2	139^9	138^8	139^2	119^2	124^8	149^0		2.80	2.48	1.24		33	—				
1551		140^1	144^0	118^0	50^8	140^6	140^0	140^2	102^4	117^3	148^5		2.77	2.44	1.21		83	—				
1553				VENTED STEAM PASSAGE - 10 SEC														940				
1555		140^9	148^1	121^3	50^5	144^6	138^4	138^4	137^7	135^5	148^6		2.92	2.64	1.17		91	—				
1610		142^6	146^2	126^7	51^1	144^6	142^2	142^7	119^4	132^8	150^7		3.03	2.66	1.26		158	—				
1615		143^1	148^8	127^3	51^2	144^8	142^7	143^2	119^6	133^4	150.7		3.03	2.69	1.26		178					

REMARKS:

25671

HSF-178.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

UA

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST

TEST ENGINEER

NAME OF RIG

PROJECT & ENG. ORDER NO.

SHEET 1 OF DATE 2/12/79

TEST PLAN NO.

MODEL NO.

PART NO.

SERIAL NO.

OPERATORS

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		4.0 P_{EVAP}	3.0 P_{COND}		ml V_{COND}		F_{RECIRC}				
1040		145^{1}	149^{3}			145^{5}	139^{2}	145^{2}	115^{8}	124^{4}	150^{7}		3.9	2.75				~6				
1042																80						
1048		146^{2}	150^{5}			146^{8}	140^{3}	146^{7}	117^{1}	125^{4}	151^{0}		3.95	2.75		92		~6				
1052		146^{4}	150^{7}			147^{0}	141^{5}	147^{0}	118^{2}	126^{3}	151^{0}		3.95	2.75		103		water in flowmeter				

REMARKS:

Flow = 100PPH
V_{TC} = 26.5 VDC
ATM PRESS = 14.60

25672

HSF-175.1A 1/68

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST:
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET 1 OF 1 DATE 2/21/79
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9		P_{EVAP}	$P_{COND\ PASS}$	P_{COLL}		V_{COLL}		$V_{STEAM\ COND}$	
255																			VENTED STEAM PASS
256		141^{2}	149^{1}	142^{0}	142^{4}	145^{4}	144^{4}	139^{6}	139^{9}	135^{0}		2.98	1.62	2.78		37		350	
300		141^{2}	148^{2}	143^{2}	143^{6}	146^{0}	143^{6}	138^{4}	138^{0}	136^{1}		3.16	1.72	2.85		42		—	
304		141^{2}	147^{1}	143^{6}	143^{6}	145^{3}	142^{3}	131^{4}	132^{5}	136^{1}		3.18	1.80	2.80		50		—	
308		139^{9}	145^{2}	142^{5}	142^{5}	145^{4}	140^{5}	111^{3}	118^{6}	135^{6}		3.04	1.83	2.75		58		—	
310																		375	VENTED 10 SEC
312		140^{2}	147^{8}	141^{2}	141^{6}	145^{1}	143^{1}	138^{8}	138^{2}	135^{5}		3.00	1.86	2.75		70		—	
316		140^{4}	147^{3}	142^{2}	142^{6}	144^{4}	142^{3}	134^{0}	134^{0}	132^{6}		3.02	1.96	2.82		78		—	
318																			VENTED COLLECTION LINE
320		141^{2}	147^{1}	142^{9}	143^{0}	145^{3}	142^{0}	119^{0}	124^{0}	134^{4}		3.03	1.63	2.78		96		—	
324																		408	VENTED 5 SEC
326		141^{6}	149^{2}	142^{7}	143^{0}	145^{9}	144^{4}	138^{7}	139^{1}	136^{0}		3.10	1.82	2.85		108		—	
353		146^{4}	150^{0}	148^{2}	148^{6}	149^{5}	145^{7}	108^{1}	115^{1}	145^{1}		3.42	2.98	3.30		157		—	
		TER INLET	TER OUTLET/HFM INLET	HFM OUTLET	STEAM PASSAGE (WALL TC)	CHAMBER TEMP	TE HOT JUNCT	TE COLD JUNCT	TER STEAM PASS	CAPILLARY									

REMARKS:

26.5 VDC T.E.
2 - .040 CAP REST
AMB - 14.75 PSIA

25673

HSF-178.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

UA

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST

TEST ENGINEER

NAME OF RIG

PROJECT & ENG. ORDER NO.

SHEET 1 OF DATE 2/28/79

TEST PLAN NO.

MODEL NO.

PART NO.

SERIAL NO.

OPERATORS

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_{EVAP}	$P_{COND\ (ABS)}$	P_{CELL}		V_{CELL}	V_{STOR}			H_2O
337					STEAM		VENT			2 SEC	/ 5 MIN										
240		145^6	152^0	146^5	146^7	148^0	148^2	141^0	143^2	135^2	112^3		3.38	2.94	1.35		151	58			0
243																		60			
300																	247	68	EMPTIED		896
302																	0				
318																		66			
320		144^2	151^1	145^3	145^6	150^2	147^3	141^6	142^7	134^6	112^2		3.28	2.94	1.34		86				
323		CHANGED TO		STEAM		VENT			2 SEC	/ 10 MIN								68			
407																	246+				160+
																	~~246~~	68			

REMARKS:

26.5 V
1.87 A

25675

Gauge set at 14.70*
ATMOS = 14.76
* Added 0.06 to readings

HSF-175.1A 1/65

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST
TEST ENGINEER
NAME OF RIG
PROJECT & ENG. ORDER NO.

SHEET OF DATE 2/26/79
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	P_{EVAP}	P_{COLL}	$P_{COND\ PASS}$	V_{COLL}	$V_{STEAM\ PASS}$
149				VENTED			NON	- COND							
150	150^3	142^3	142^1	142^6	146^0	146^1	140^8	140^2	132^9	112.5	2.94	1.35	2.75	67	475
2	149^7	142^4	143^6	143^9	145^8	145^8	140^6	140^6	133^2	110.9	3.10	1.35	2.80	76	-
154				VENTED	2 SEC										480
155	150^1	142^5	142^5	142^9	145^8	146^2	140^9	140^4	132^9	111.7	3.20	1.35	2.75	94	-
157	149^5	142^5	143^6	143^9	145^8	145^5	139^7	140^3	133^0	110.4	3.12	1.35	2.80	101	-
159				VENTED		2 SEC									480
200	150^2	142^5	142^3	142^7	145^5	146^3	140^9	140^3	132^7	111.6	2.98	1.35	2.75	119	-
202	149^9	142^5	143^5	143^9	145^6	145^9	140^9	140^8	133^2	110^7	3.10	1.35	2.80	127	-
204				VENTED		2 SEC									485
205	150^4	142^6	142^4	143^0	145^7	146^4	141^2	140^7	132^7	111^2	3.00	1.35	2.80	143	-
208				SHUT OFF			COND	VAC SOURCE						157	[illegible]
209				VENT		2 SEC									485
210											3.07	1.55	2.82	165	[illegible]
214						VENTED		2 SEC							481
218	149^1			145^2							3.20	2.87	2.88	193	-
219				VENTED		2 SEC									490
~~220~~															
220												3.10	2.84	Flow stopped	
221						OPENED		COND VAC							
224						VENTED		2 SEC							500
225	150^7	143^6	143^6	144^1	146^5	146^9	142^9	141^7	133^6	110^2	3.08	1.32	2.84	228	

REMARKS:
227 150^1 143^4 144^4 144^7 146^5 146^7 142^0 142^0 133^6 109^2 3.18 1.32 2.84 238

25674

HSF-175.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: URINE TEST
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET 1 OF
DATE 3/1/79
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P EVAP	P COND PASS.	P COLL		V COLL	V STEAM	
126		TER ON - START DEGASSING SYSTEM											VENT 2SEC/[illegible]MIN						
242		142^3	148^9	141^8	142^2	148^3	145^0	137^0	137^0	132^5	111^2		3.0	2.58	1.22		50	42	VENT 3SEC/[illegible] SEC
									RANGE 133^3 → 138^7										
252		142^2	148^9	141^8	142^2	148^5	144^8	138^0	137^5	132^1	111^1		3.02	2.58	1.22		98		
				RANGE 143^8 → 141^1									RANGE 3.14 → 2.72						
302		141^9	148^4	142^0	142^2	147^8	144^4	137^4	137^6	131^6	110^4		3.02		1.22		144	50	
312		141^3	148^0	140^7	140^4	145^7	144^1	137^4	131^1	131^2	110^3		2.90	2.58	1.22		192		
322																	242	58	
									RANGE 139^0 — 141^0								EMPTY CONDENSATE		
402		141^0	150^9	141^8	144^8	150^5	146^6	139^6	141^1	133^9	111^0						196	64	
				RANGE			145^4 →		143^9										

REMARKS:
ATMUS PRESS 14.8 FLOW = 100 PPH
TE VOLT = 26.5
TE AMP = 1.85

25676

HSF-178.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: URINE TEST - 26.5V
TEST ENGINEER:
NAME OF RIG:
PROJECT & ENG. ORDER NO.:

SHEET 1 OF   DATE 3/2/79
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_1	P_2	P_3		V_c	V_s	
800		ON		TE: 26.5V @ 1.85 A													VENT 3SEC/140 SEC		
815		143^5	149^8	144^5	144^3	147^5	145^6	134^2	137^2	133^5	113^4		3.05	2.62	1.25		24	5	
	142^5 →	145^5		→				←	138^6 →	130^0									
845		Added additional condensate collection volume															156	50	
		Dumped some non-condensible with steam passage - purged and got																	REMOVED (500 ml) SAMPLE
1100																		65	
1258																			
100		142^9	148^9	144^4	143^7	150^5	144^9	139^0	138^9	133^7	113^0		3.10	2.75	1.20		19.	~~58~~	REMOVED (250 ml) SAMPLE
	142^7 →	144^6		→				←	140^7 →	137^0									
140																	190	68	
400		143^1	150^2	143^3	141^6	150^8	145^5	140^4	140^5	133^8	115^8								
	143^0 →	144^4		→				←		140^4 - 137^8			3.00	2.72	1.25			77	REMOVED (1434 ml)
																			2184 ml

REMARKS:
ATMOS PRESS: 14.85   26.5V @ [illegible]
100 PPH FLOW

25678

HSF-178.1A 1/68

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: URINE TEST 29.0V
TEST ENGINEER:
NAME OF RIG:
PROJECT & ENG. ORDER NO.:

SHEET 1 OF
DATE 3/5/79 THRU 3/7/79
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_1	P_2	P_3		V_c	V_s				
900AM																						
915																	15	10			removed Hw 15 because it was [illegible]	
1000																	212	32			removed	212
																	~~212~~					
																	232				removed	232
130		144^{1}	151^{8}	144^{1}	143^{6}	144^{4}	147^{0}	139^{9}	139^{7}	133^{6}	111^{1}		3.20	2.75	1.08		417	72			removed	237
	143^{6}	→	145^{5}	↑				2	136^{8}	→ 139^{9}												
220																					removed	238
320																					removed	236
400								3 SEC/65 SEC													removed	796
		System chilled and saturated with cold, [illegible]																				
900PM		149^{6} System OK.						3 SEC/140 SEC									1140/0	/0				1966
900AM 3/6/79																	3285	→ 4.56 ml/min				
900AM 3/7/79																	5385	- 4.08 ml/min				
4:30PM 3/7/79			SHUT DOWN		WITH	URINE		IN	MEMBRANE								1610	> 3.83 ml/min				

REMARKS:
ATMOS PRESS = 14.85
29.0 V@
100 PPH

25677

HSF-175.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: URINE TEST 26,5 V
TEST ENGINEER:
NAME OF RIG:
PROJECT & ENG. ORDER NO.:

SHEET 1 OF DATE 3/8/79
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

SYSTEM SHUT DOWN ON 3/7/79 - 400 PM AS FOLLOWS:
TER & CIRC POWER OFF — STEAM VENT & COLLECTOR LINES SHUT OFF
VENT HFM TO AMBIENT & SHUT OFF ~~[illegible]~~ URINE IN AND OUT LINES TO HFM - SHUT OFF HFM VENT
LEAVE HFM HTR ON AT 20 V (200W AT 115 V)

SYSTEM STARTUP ON 3/8/79 AT 8:30 AM:
NO URINE VISIBLE IN HFM - NORMAL STARTUP WITH 15 MINUTE STEAM VENT PURGE

TIME																	
845	START CYCLIC OPERATION																
853	RE START PURGING - TOO MUCH NON-COND. IN SYST																
900	RESTART CYCLIC OPERATION 3 SEC PURGE/44 SEC CYCLE																
909	PURGE AGAIN																
919	RESTART CYCLE																
~~[illegible]~~	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_1	P_2	P_3	V_C	V_S	
1108															0	0	3 SEC/140 SEC
~~[illegible]~~ 1150															0	0	
} 18 hrs															~~[illegible]~~		
10^20 3/9/79															4018		= 3.72 ml/min
4^30 stop test															1020		

REMARKS:

15369

HSF-178.1A 1/68

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST
TEST ENGINEER
NAME OF RIG
PROJECT & ENG. ORDER NO.

SHEET OF DATE 3/12/75
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME		
830	START UP DRAW VACUUM BEFORE STARTING CIRC	
845	START CYCLE 3 SEC / 40 SEC	
930	3 SEC / 80 SEC	
1050	3 SEC / 130 SEC	0 ml
410		1405 ml
		$\}$ 4.39 ml/min

REMARKS:

15385

ORIGINAL PAGE IS OF POOR QUALITY

HSF-175.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST
TEST ENGINEER
NAME OF RIG
PROJECT & ENG. ORDER NO.

SHEET OF DATE 3/13/79
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_1	D_2	P_3		COND	STEAM				
904				TER ON 26.5V, 10 GPM FLOW FULL PURGE																		
909				3 SEC / 31 SEC PURGE																		
914				3 SEC / 60 SEC PURGE																		
919				3 SEC / 90 SEC													20	40				
956				3 SEC / 120 SEC													145					
350																	1440					
																	1295					
				SHUT DOWN WITH MEMBRANES																4 hr 54 min		
				FLUSHED AND VENTED —																	294 min	
				NO HFM HTR												4.4 ml/min						
3/14/79				CONDENSATION ON HFA SHELL																		
900	STARTED UP																					
115				PUT BLEED INTO COND VACUUM SOURCE											2.08		40 ml					
215															2.08		210 ml	3.48 ml/min				
234															2.08/2.27		315 ml					
357															2.27		625 ml	3.73 ml/min				

REMARKS:

15386

HSF-175.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: UN CONC URINE 29.0 VDC @ 1.88 A

TEST ENGINEER:

NAME OF RIG:

PROJECT & ENG. ORDER NO.:

SHEET 1 OF

DATE 3/16/79

TEST PLAN NO.:

MODEL NO.:

PART NO.:

SERIAL NO.:

OPERATORS:

TIME		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}		P_1	P_2	P_3		Cond	Stem				
830/		DRAINED SUBSYSTEM - REFILLED WITH																				
1000		FRESH URINE																				
1015		START SUBSYSTEM - BRING TO TEMP.																	3 sec / 70 sec			
115		START MEASUREMENTS															0	0	3 sec / 70 sec			
125		143.3	149.8	144.5	141.9	147.3	145.6	136.0	137.0	135.0	126.0		2.76/2.92	2.65	2.06							
				← 144.9 → 144.2				← 136.8 → 135.8														
132																			3 sec / 130 sec			
400																	676					
400																	0		165 min = 4.10			
3/17/79													@ 2.93									
840 AM		147.0	153.0	148.0	145.1	146.2	149.0	138.8	138.4	137.2	126.0		2.93/3.18	2.77	2.06		3985					
																		1000 minutes = 3.99 ml/min				

REMARKS:

SPEC 4.28 ml/min.

15387

APPENDIX C

SUBSYSTEM ANALYSIS MEMOS

HAMILTON STANDARD

Internal Correspondence

May 22, 1978

Analysis 78-92
File: 6.3
6.5
9.0
2.14

Memorandum to: Mr. E. O'Connor

cc: Messrs. J. Lovell
G. Roebelen
R. Trusch

From: M. Heldmann

Subject: TIMES Computer Math Model Usage

Summary

A mathematical computer model was written to simulate the operation of the "TIMES" water reclamation system. It assumes the usage of an integral controller so that only steady state responses from the system are attained. The model is flexible enough to incorporate changes in major design parameters as well as environmental conditions with little difficulty. It can be run batch or interactive on the Hamilton Standard TSO terminals. All files have been saved in the G15 tape and disc libraries. Figure 1 shows the file listings tree for the interactive program package and Figure 2 presents the program and subroutine tree utilized by both the interactive and batch command lists. Procedures for program usage for both batch and interactive running are given step by step to allow operators who are unfamiliar with the program to run it. Appendix A contains individual program descriptions while Appendix B contains listings of the individual programs and subroutines.

Running the "TIMES" Model

Interactive

The model can be run interactive from the user's catalogue by performing the following operations:

(1) Lib Get

a) TIMECL CLIST
b) TIMES FORT
c) SBTIME FORT
d) SUBTH FORT
e) SUBTER FORT
f) SUBTERN FORT
g) SUBTED FORT
h) SUBHFM FORT
i) URINPP FORT
j) TANK FORT
k) PUMP1 FORT
l) TIN DATA

(2) FORT(COMPILE) the fortran files to create the object decks.

(3) Modify the input data set, TIN, to simulate the desired case. The READ statement, in free format, is in the main program. TIMES, and the information inputted is, in order.

a)	NUMMOD	integer number of TER modules (nominally 3)
b)	UTANK	UA heat transfer coefficient for system (Btu/hr-°F)
c)	VOLTIN	voltage inputted to TER (29 ± 2.5 VDC)
d)	TAMBTK	ambient temperature for system
e)	XTANK	fraction solids in urine within recirculating tank (.03 - .5)
f)	TFEED	temperature of feed urine
g)	XFEED	fraction solids of feed urine (nominally .03)
h)	AREA	HFM area (presently 3.75 ft^2)
i)	KPERM	permeability constant for HFM (.5 - 1.0 #/hr-psid)
j)	FFAM	TED Seebeck coefficient multiplier
k)	FFKM	TED thermal conductivity coefficient multiplier
l)	FFRM	TED electrical resistance coefficient multiplier
m)	CONTMF	set point temperature by controller for urine entering HFM
n)	ECOOLR	effectiveness of coolant loop heat exchanger
o)	TAMBCL	cooler heat exchanger's ambient temperature
p)	N	max number of interactions to converge on CONTMP

(4) Execute the TIMECL C list.

All links and printoffs are done in the c list. For subsequent runs if new links are required on the same logon, the abridged version TMCL.CLIST can be executed. For subsequent runs with no links required (i.e., no recompilation of programs during same logon) a simple "CALL TIMES" with printoffs of TIN.DATA and TIM.OUTPUT can be done with equal results while saving the time necessary to relink

Batch

The program can be run batch by using a different c list. The following steps are required:

(1) Lib Get a) TIMECLB.CLIST
b) TIN.DATA

(2) Execute TIMECLB using TIN as the input data set. TIN can be modified to generate the desired case.

A load module has been created using the file TIMESJOB.CNTL and the program in TIMESB.FORT and is available for use in TIMECLB.CLIST.

Using this same procedure the program can be run interactive. During the TIMECLB.CLIST execution the question is asked whether batch or interactive running is desired. IF interactive is chosen then only the input date set is asked for. This is actually a simpler method than the previous interactive set of commands and should be attempted first.

Prepared by: M Heldmann
M. Heldmann

Reviewed by: E.W.O.C.

/sa
Attachments

FIGURE 1

File Listing Tree for TIMES

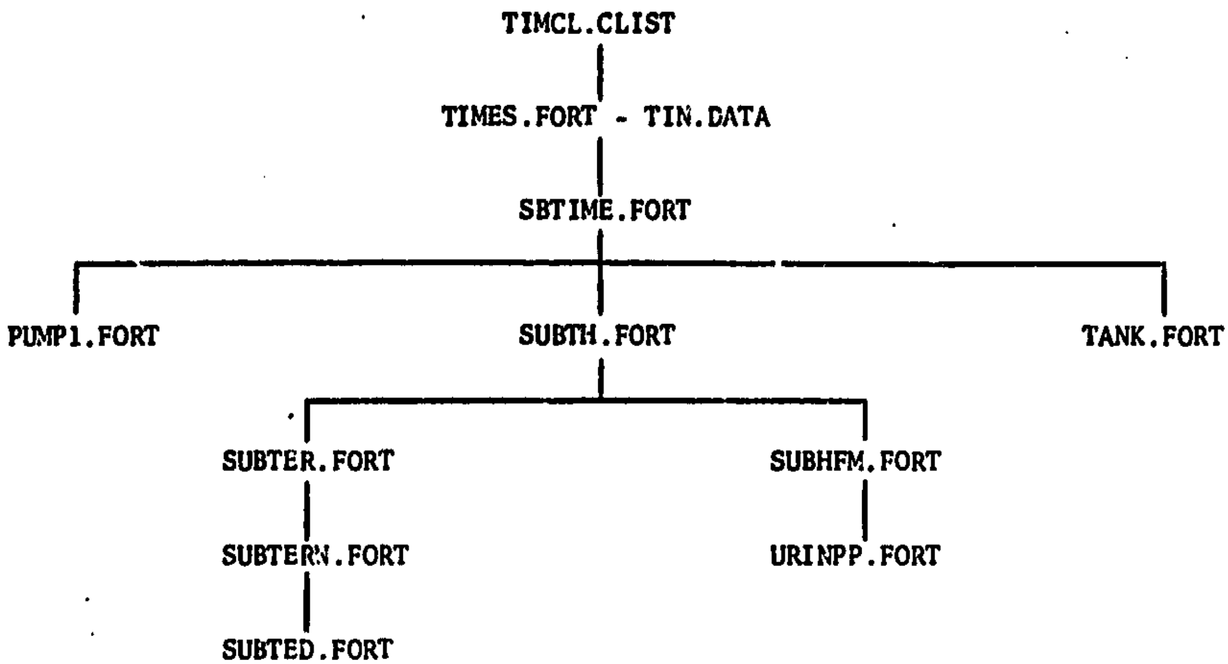
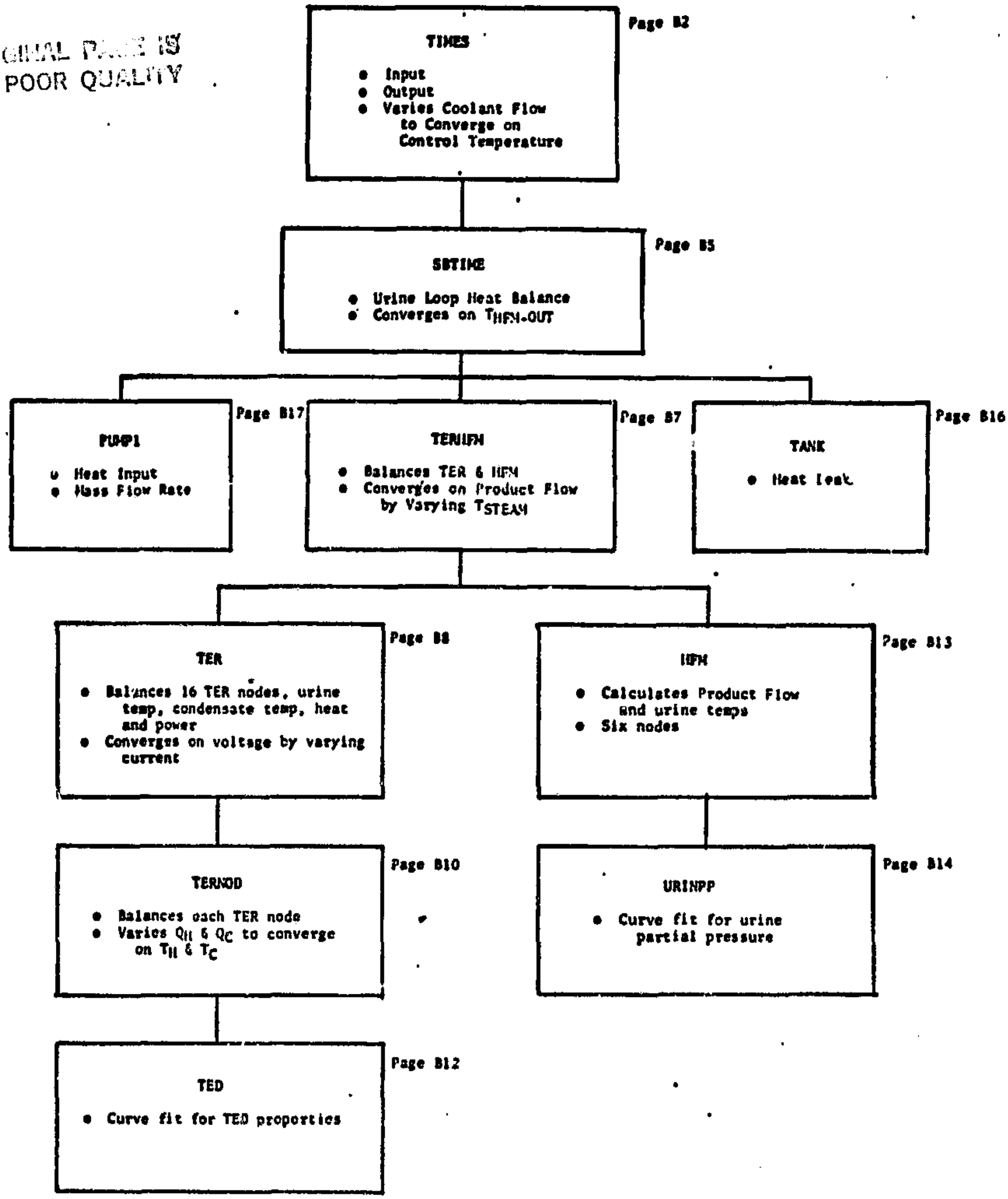


Figure 2

Program Listing Tree for TIMES



APPENDIX A

Program Descriptions

TIMES.FORT is the file name of the main program TIMES for the interactive model. It handles all I/O commands and contains the control scheme. Presently, this is accomplished by varying coolant flow through the TER until the desired HFM urine inlet temperature is reached. It calls the subroutine SBTIME.FORT which solve the urine loop subsystem.

SBTIME.FORT is the file name of the subroutine SBTIME which solves for the equilibrium parameters within the urine recycle loop. The iteration process involves solving for the urine temperature leaving the HFM. First, a guess is made of this temperature, TOUT, and the loop parameters are calculated around the subsystem. Then the calculated TOUT is compared to the guessed TOUT and a subsequent new value of temperature is assumed. This process is completed until the calculated value of TOUT agrees with the assumed value. The subroutine files PUMP1.FORT, SUBTH.FORT and TANK.FORT are called by this listing.

SUBTH.FORT is the file name for the subroutine TERHFM which calculates the equilibrium steam temperature within the TER and HFM subsystem. It does this by guessing a steam temperature then calculates the heat input to the steam in the HFM and the heat loss in the TER. Then by requiring that these two Q's sum to zero at equilibrium reguesses and tests for a new steam temperature. This subroutine calls the subroutine files SUBTER.FORT and SUBHFM.FORT.

SUBTER.FORT is the file name for the subroutine TER. It calculates the TER current at equilibrium by converging on the inputted valve of voltage. The subroutine TERNOD in file SUBTERN.FORT is called in this program.

SUBTERN.FORT stores the subroutine TERNOD. It uses the Cambion* equations of Q_C and Q_H for the heat pumped at the cold and hot sides, respectively, of the TEDS. It uses these, in conjunction with the temperature and heat transfer relationships for the TER to calculate outlet conditions for each TER node. There are 16 nodes, one for each unique TED per TER module. The file SUBTED.FORT is assessed to calculate the TED coefficients for the given hot and cold side temperatures.

SUBTED.FORT contains the subroutine TED which uses the Cambion curve fit equations for TED parameters Am, Rm and Km.

SUBHFM.FORT is the file name of subroutine HFM. It breaks the HFM into six nodes of lumped capacity parameters and solves for mass flow of reclaimed water It uses the permeability equation:

$$\dot{W}_{H_2O} = KA(P_{urine} - P_{steam})$$

URINPP.FORT calculates the water vapor partial pressure of urine at any fraction solids and temperature. This is based on the curve fit equation:

$$P_{vap} = P_{sat} * \frac{P_{vap}\ 144°F}{3.144} + \frac{X_{solids}^{1.696}}{750}\ (T-144)$$

It uses the Hamilton Standard routine KANDK to calculate P_{sat} of H_2O as a function of temperature. It inputs an array of P_{vap} of urine at 144°F for different solid fractions. The HS program BIQUAD is used to interpolate between the inputted valves of P_{vap} @ 144°F for different fraction solids.

TANK.FORT is the file name of the subroutine that calculates the temperature and mass flow rate out of the recirculating tank. It accomplishes this by doing a heat balance between the change of enthalpy of the brine and the heat loss to the environment.

PUMP1.FORT contains the subroutine that calculates mass flow and power into the fluid at the pump. It models the constant displacement pump in the recirculating loop.

---

*From the Cambion Thermoelectric Handbook, 2nd Edition.

APPENDIX B

Program Listings

-B1-

TIMECL. CLIST

```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=TSOG15Q.TIMECL.CLIST

PROC 0                                                            00000010
FREE F(FT05F001)                                                  00000020
FREE F(FT08F001)                                                  00000022
DELETE TIM.OUT                                                    00000030
FREE ATTRLIST(BLOCK6)                                             00000032
 ATTRIB BLOCK6 BLKSIZE(2744) LRECL(137) RECFM(V B A)              00000040
ALLOC F(FT06F001) DA(TIM.OUT)  NEW SPACE(500,200) BLOCK(1330)    -00000060
  USING(BLOCK6) RELEASE                                           00000070
ALLOC DA(TIM.DATA) F(FT05F001)                                    00000100
FREE ATTRLIST(BLOCK6)                                             00000104
SEEP1   DEEPN61                                                   00000106
LINK (TIMES SBTIME SUBTH SUBTER SUBTERN SUBTED SUBHFM URINPP TANK PUMP1)00000120
CALL TIMES                                                        00000125
TIME                                                              00000130
PRINTOFF (TIM.DATA TIM.OUT)                                       00000135
END                                                               00000140
```

- B2 -

TIMES

TIMES. FORT


```
                C       *** PROGRAM TIMES ***
                C
                C      THIS PROGRAM ACTS AS THE THE CONTROLER FOR THE "TIMES"
                C      SUBROUTINE PACKAGE.  IT CALLS THE SUBROUTINE SBTIME WHICH
                C      SOLVES THE SYSTEM FOR A GIVEN COOLANT TEMP AND FLOW.  THIS
                C      PROGRAM USES A COOLANT CONTROL SCHEME WHICH ITERATES ON
                C      COOLANT FLOW AND CALCULATES NEW COOLANT TEMPERATURES.
                C
0001                REAL MCOLIN(99), KPERM
0002                COMMON/TED1/ FFAM, FFKM, FFRM
0003                COMMON/TER1/ TURNI, TURNO, TCOOLI, TCOOLO, MCOOLI, MCOOLO,
                   1 V, TC, TH, QC, QH
0004                COMMON/HFM1/ PSTEAM, DHURN, TURN, PVPURN, XSOLDS, DHVAP, KPERM,
                   1 AREA
0005                COMMON/TIME1/ TOUT2, XOUT, DHOUT, TBULK, XTANK, DHOUT2, TURMIX,
                   1 XSOLD, AMUR, TURNIN, QLEAK, AMURIN, TSTEAM, AMCLD, AMPS
0006                DIMENSION TURNI(17),TURNO(17),TCOOLI(17),TCOOLO(17),MCOOLO(17),
                   1 V(17), TC(17), TH(17), QC(17), GH(17), DHURN(7), TURN(7),
                   2 PVPURN(7), XSOLDS(7), DHVAP(7), MCOOLI(17), TINHFM(99)
0007                READ(7,*) NUMMOD, UTANK, VOLTIN, TAMBTK, XTANK, TFEED, XFEED,
                   1 AREA, KPERM, FFAM, FFKM, FFRM, CONTMP, ECOOLR, TAMBCL, N
0008                WRITE(6,2009) NUMMOD, UTANK, VOLTIN, TAMBTK, XTANK, TFEED, XFEED,
                   1 AREA, KPERM, FFAM, FFKM, FFRM, CONTMP, ECOOLR, TAMBCL, N
0009                WRITE(8,2009) NUMMOD, UTANK, VOLTIN, TAMBTK, XTANK, TFEED, XFEED,
                   1 AREA, KPERM, FFAM, FFKM, FFRM, CONTMP, ECOOLR, TAMBCL, N
0010           2009 FORMAT(//,9X,'- SYSTEM DESCRIPTION -',//,
                   1 5X,'NUMBER OF TER MODULES IS ',I1,/,
                   2 5X,'TANK HEAT TRANSFER COEFFICIENT, UA = ',F6.2,/,
                   3 5X,'VOLTAGE INPUT TO TER IS ',F6.1,/,
                   4 5X,'AMBIENT TEMPERATURE IS ',F6.1,/,
                   5 5X,'FRACTION SOLIDS IN TANK IS ',F6.3,/,
                   6 5X,'TEMPERATURE OF FEED URINE IS ',F6.1,/,
                   7 5X,'FRACTION SOLIDS OF FEED URINE IS ',F6.3,/,
                   A 5X,'MEMBRANE AREA IS ',F7.3,/,
                   B 5X,'PERMEABILITY CONSTANT IS ',F7.3,/,
                   C 5X,'AM MULTIPLIER IS ',F7.3,/,
                   D 5X,'KM MULTIPLIER IS ',F7.3,/,
                   E 5X,'RM MULTIPLIER IS ',F7.3,/,
                   F 5X,'CONVERGING HFM TEMP IS ',F7.1,/,
                   G 5X,'EFFECTIVENESS OF COOLER IS ',F8.4,/,
                   H 5X,'COOLER AMBIENT TEMP IS ',F7.1,/,
                   I 5X,'MAX NUMBER OF ITERATIONS IS ',I2,// )
0011                MCOLIN(1) = 0.
0012                MCOLIN(2) = 1.
0013                TPCLO = 135.
0014                CFCOOL = 1.0
                C
                C       BEGINNING OF ITERATIVE LOOP
                C
0015                DO 99 I = 1, N
0016                DO 98 J = 1,4
0017                TCOLIN = TPCLO - ECOOLR*(TPCLO - TAMBCL)
                C
                C      CALL THE SUBROUTINE SBTIME TO SOLVE THE SYSTEM FOR GIVEN FLOWS
                C
0018                CALL SBTIME( NUMMOD, UTANK, VOLTIN, TAMBTK,
                   1 TFEED, XFEED, MCOLIN(I), TCOLIN, TINHFM(I), TPCLO )
                C
```

```
0019          WRITE(6,2102) TINHFM(I), MCOLIN(I)
0020          WRITE(8,2102) TINHFM(I), MCOLIN(I)
0021     2102 FORMAT(3X,'TINHFM = ',F7.2,4X,'MCOLIN = ',F7.3,/ )
0022          IF(I .EQ. 1) GO TO 99
0023          DTEMP = CONTMP - TINHFM(I)
0024          WRITE(6,2101) DTEMP
0025          WRITE(8,2101) DTEMP
0026     2101 FORMAT(3X,'IN MAIN PROGRAM, DTEMP = ',F12.3,/ )
0027          IF(ABS(DTEMP) .LT. 0.2) GO TO 100
0028          MCOLIN(I+1) = MCOLIN(I) + (MCOLIN(I) - MCOLIN(I-1)) /
             1 (TINHFM(I) - TINHFM(I-1)) * DTEMP
0029          IF(MCOLIN(I+1) .GT. MCOLIN(I) + 1. .AND. I .GT. 4 )
             1 MCOLIN(I+1) = MCOLIN(I) + 1.
0030          IF(MCOLIN(I+1) .LT. MCOLIN(I) - 1. .AND. I .GT. 4 )
             1 MCOLIN(I+1) = MCOLIN(I) - 1.
0031          IF (I .EQ. N) WRITE(6,2100)
0032          IF (I .EQ. N) WRITE(8,2100)
0033     2100 FORMAT(//,3X,'** TINHFM DID NOT CONVERGE **',//)
0034       98 CONTINUE
0035       99 CONTINUE
        C
        C         * END OF ITERATION *
        C
0036      100 WRITE(6,2000)
0037          WRITE(8,2000)
0038     2000 FORMAT(//,7X,'***** RUN HAS BEEN COMPLETED *****',//,
             1 12X,'ENGLISH UNITS ARE USED',/)
0039          WRITE(6,2001) TOUT2, XOUT, DMOUT
0040          WRITE(8,2001) TOUT2, XOUT, DMOUT
0041     2001 FORMAT(5X,'PROPERTIES OF URINE LEAVING HFM',/,10X,
             1 'TEMPERATURE = ',F8.2,/,10X,'FRACTION SOLIDS = ',F8.5,/,
             2 10X,'MASS FLOW URINE = ',F8.2,/)
0042          WRITE(6,2002) TBULK, XTANK, DMOUT2
0043          WRITE(8,2002) TBULK, XTANK, DMOUT2
0044     2002 FORMAT(5X,'PROPERTIES OF URINE LEAVING RECIRCULATING TANK',/,10X,
             1 'TEMPERATURE = ',F8.2,/,10X,'FRACTION SOLIDS = ',F8.5,/,
             2 10X,'MASS FLOW URINE = ',F8.2,/ )
0045          WRITE(6,2003) TURMIX, XSOLD, AMUR
0046          WRITE(8,2003) TURMIX, XSOLD, AMUR
0047     2003 FORMAT(5X,'PROPERTIES OF URINE ENTERING PUMP',/,10X,
             1 'TEMPERATURE = ',F8.2,/,10X,'FRACTION SOLIDS = ',F8.5,/,
             2 10X,'MASS FLOW URINE = ',F8.2,/)
0048          WRITE(6,2004) TURNIN, XSOLD, AMURIN
0049          WRITE(8,2004) TURNIN, XSOLD, AMURIN
0050     2004 FORMAT(5X,'PROPERTIES OF URINE ENTERING TER',/,10X,
             1 'TEMPERATURE = ',F8.2,/,10X,'FRACTION SOLIDS = ',F8.5,/,
             2 10X,'MASS FLOW URINE = ',F8.2,/)
0051          WRITE(6,2005) TINHFM(I), TSTEAM
0052          WRITE(8,2005) TINHFM(I), TSTEAM
0053     2005 FORMAT(5X,'TEMPERATURES OF URINE AND STEAM FLOWS BETWEEN TER ',
             1'AND HFM',/,10X,'URINE TEMP = ',F8.2,/,10X,'STEAM TEMP = ',F8.2,/)
0054          WRITE(6,2006) MCOLIN(I), TCOLIN, AMCLO, TPCLO
0055          WRITE(8,2006) MCOLIN(I), TCOLIN, AMCLO, TPCLO
0056     2006 FORMAT(5X,'COOLANT OR CONDENSATE FLOWS THROUGH TER',/,7X,
             1 'MASS FLOW OF COOLANT IN = ',F8.3,3X,'TEMPERATURE = ',F8.2,/,7X,
             2 'MASS FLOW OF COOLANT OUT = ',F8.3,3X,'TEMPERATURE = ',F8.2,/)
0057          POWER = AMPS*VOLTIN*FLOAT(NUMMOD)
0058          WRITE(6,2007) POWER
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0059          WRITE(8,2007) POWER                                                  00001130
0060     2007 FORMAT(5X,'ELECTRICAL POWER TO TER = ',F8.1,' WATTS',/)              00001140
0061          WRITE(6,2008) QLEAK                                                  00001150
0062          WRITE(8,2008) QLEAK                                                  00001160
0063     2008 FORMAT(5X,'HEAT LEAK FROM THE UNIT = ',F8.1,' BTU/HR',/)             00001170
0064          QDEF = 3.4121*POWER + 90.4 + (TFEED*(AMCLO - MCOLIN(I))              00001180
            1 + TCOLIN*MCOLIN(I) - TPCLO*AMCLO)*CPCOOL - QLEAK                     00001190
0065          WRITE(6,2013) QDEF                                                   00001200
0066          WRITE(8,2013) QDEF                                                   00001210
0067     2013 FORMAT(5X,'NET HEAT INTO SYSTEM = ',F8.2,// )                         00001220
0068          WRITE(6,2016) AMPS                                                   00001230
0069          WRITE(8,2016) AMPS                                                   00001240
0070     2016 FORMAT(5X,'CURRENT INTO TEDS = ',F7.4,' AMPS',/// )                   00001250
0071          WRECL = AMCLO - MCOLIN(I)                                            00001260
0072          WRITE(6,2015) WRECL                                                  00001270
0073          WRITE(8,2015) WRECL                                                  00001280
0074     2015 FORMAT(15X,'***** WATER RECLAIMED FROM URINE IS ',F6.3,              00001290
            1 ' LBS PER HOUR *****',// )                                           00001300
0075          POW = POWER/WRECL                                                    00001310
0076          WRITE(6,2017) POW                                                    00001320
0077          WRITE(8,2017) POW                                                    00001330
0078     2017 FORMAT(5X,'POWER / PRODUCT WATER RATE = ',F8.2,///// )                00001340
0079          WRITE(6,2014)(I, TURNI(I), TURNO(I), TCOOLI(I), TCOOLO(I),           00001350
            1 MCOOLI(I), MCOOLO(I), V(I), TC(I), TH(I), QC(I), QH(I),              00001360
            2 I = 1,16 )                                                           00001370
0080          WRITE(8,2014)(I, TURNI(I), TURNO(I), TCOOLI(I), TCOOLO(I),           00001380
            1 MCOOLI(I), MCOOLO(I), V(I), TC(I), TH(I), QC(I), QH(I),              00001390
            2 I = 1,16 )                                                           00001400
0081     2014 FORMAT(9X,'- PARAMETERS OF NODES WITHIN TER -',//,                   00001410
            1 16( 5X,'NODE(',I2,')',/,                                             00001420
            2 5X,'TEMP OF URINE IN IS ',F8.2,3X,'TEMP OF URINE OUT IS ',F8.2,/,00001430
            3 5X,'TEMP OF COOLANT IN IS ',F8.2,3X,                                 00001440
            4     'TEMP OF COOLANT OUT IS ',F8.2,/,                                00001450
            5 5X,'MASS FLOW OF COOLANT IN IS ',F8.4,3X,                            00001460
            6     'MASS FLOW OF COOLANT OUT IS ',F8.4,/,                           00001470
            7 5X,'VOLTAGE ACROSS TED IS ',F8.4,/,                                  00001480
            8 5X,'TC = ',F8.2,6X,'TH = ',F8.2,/,                                   00001490
            9 5X,'QC = ',F8.4,6X,'QH = ',F8.4,/// ) )                              00001500
0082          WRITE(6,2012) PSTEAM, (I, DWURN(I), TURN(I), PVPURN(I), XSOLDS(I),00001510
            1 DWVAP(I), I = 1,6 ), DWURN(7), TURN(7), XSOLDS(7)                    00001520
0083          WRITE(8,2012) PSTEAM, (I, DWURN(I), TURN(I), PVPURN(I), XSOLDS(I),00001530
            1 DWVAP(I), I = 1,6 ), DWURN(7), TURN(7), XSOLDS(7)                    00001540
0084     2012 FORMAT(9X,'- HFM NODAL DESCRIPTION -',//,                            00001550
            1 5X,'STEAM PRESSURE = ',F8.4,//,                                      00001560
            2 6( 5X,'NODE(',I1,')',/,                                              00001570
            3      5X,'MASS FLOW OF URINE IN IS ',F8.2,/,                          00001580
            4      5X,'TEMPERATURE OF URINE IN IS ',F8.2,/,                        00001590
            5      5X,'VAPOR PRESSURE URINE IS ',F8.4,/,                           00001600
            6      5X,'FRACTION SOLIDS IS ',F7.4,/,                                00001610
            7      5X,'FLOW OF DIFFUSED WATER VAPOR IS ',F8.5,/// ),               00001620
            8      5X,'MASS FLOW OF URINE OUT IS ',F9.4,/,                         00001630
            9      5X,'TEMPERATURE OF URINE OUT IS ',F8.2,/,                       00001640
            A      5X,'FRACTION SOLIDS IS ',F8.5,// )                              00001650
0085          STOP                                                                 00001660
0086          END                                                                  00001670
```

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SBTIMES
SBTIME.FORT

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```
0001         SUBROUTINE SBTIME( NUMMOD, UTANK, VOLTIN, TAMBTK,
            1 TFEED, XFEED, MCOLIN, TCOLIN, TINHFM, TPCLO )
       C
       C
       C           ***   SUBROUTINE SBTIME   ***
       C
       C       THIS SUBROUTINE COMBINES THE 'TIMES' SUBROUTINES:
       C                 TERHFM
       C                 TER
       C                 TERMOD
       C                 TED
       C                 HFM
       C                 URINPP
       C                 PUMP1
       C                 TANK
       C    INTO A CLOSED LOOP SYSTEM WHICH CALCULATES A QUASI-STEADY STATE
       C    FOR THE 'TIMES' URINE LOOP.  GIVEN INLET FLOWS AND PROPERTIES,
       C    TOTAL VOLTAGE AND URINE SOLIDS FRACTION IN THE RECYCLE TANK,
       C    CALCULATE PREFORMANCE.
       C
0002         REAL MCOLIN, KFERM
0003         DIMENSION TOUT(99), TOUTG(99)
0004         COMMON/TED1/ FFAM, FFKM, FFRM
0005         COMMON/TER1/ TURNI, TURNO, TCOOLI, TCOOLO, MCOOLI, MCOOLO,
            1 V, TC, TH, QC, QH
0006         COMMON/HFM1/ PSTEAM, DWURN, TURN, PVPURN, XSOLDS, DWVAP, KPERM,
            1 AREA
0007         COMMON/TIME1/ TOUTF, XOUT, DMOUT, TBULK, XTANK, DMOUT2, TURMIX,
            1 XSOLD, AMUR, TURNIN, QLEAK, AMURIN, TSTEAM, AMCLO, AMPS
0008         DIMENSION TURNI(17),TURNO(17),TCOOLI(17),TCOOLO(17),MCOOLO(17),
            1 V(17), TC(17), TH(17), QC(17), QH(17), DWURN(7), TURN(7),
            2 PVPURN(7), XSOLDS(7), DWVAP(7), MCOOLI(17)
0009         XSOLD = XTANK
0010         TOUTG(1) = 150.
0011         TURMIX = TOUTG(1) - 1.
0012         CPCOOL = 1.0
       C
       C       BEGINNING OF ITERATIVE LOOP
       C    SOLVE THE FLOW THROUGH THE RECIRCULATING PUMP FIRST
       C
0013         DO 99 I = 1,20
       C     WRITE(6,2003) TURMIX, XSOLD
0014         CALL PUMP1(XSOLD, DM, DTRISE)
0015         AMURIN = DM
0016         TURNIN = TURMIX + DTRISE
0017         XIN = XSOLD
       C
       C    SOLVE THE FLOW THROUGH THE TER-HFM SYSTEM
       C
       C     WRITE(6,2004) TURNIN, XIN
0018         CALL TERHFM(AMURIN, TURNIN, MCOLIN, TCOLIN, CPCOOL, VOLTIN,
            1 NUMMOD, XIN, AMPS, DMOUT, TOUT(I), POUT, XOUT, AMCLO, TPCLO,
            2 TSTEAM, TINHFM)
0019         DEN = (.4775*XOUT + .99325)*62.43
0020         DVOL = DMOUT/DEN
0021         XIN = XOUT
0022         IF(I .EQ. 1) GO TO 98
0023         TOUTG(I+1) = TOUTG(I) + (TOUTG(I) - TOUTG(I-1))/
```

```
                  1 ((TOUTG(I) - TOUT(I)) - (TOUTG(I-1) - TOUT(I-1)))
                  2 * (TOUT(I) - TOUTG(I))
0024                IF(TOUTG(I+1)-TOUTG(I) .GT. 10.) TOUTG(I+1) = TOUT(I) + 10.
0025                IF(TOUTG(I+1)-TOUTG(I) .LT. -10.) TOUTG(I+1) = TOUT(I) - 10.
0026             98 TOUTG(2) = 145.
0027                TINT = TOUTG(I+1)
                C
                C     SOLVE THE FLOW THROUGH THE RECIRCULATING TANK
                C
                C     WRITE(6,2001) TOUTG(I+1), XOUT
                C2001 FORMAT(3X,'TOUTG = ',F7.2,4X,'XOUT = ',F7.3,/)
0028                CALL TANK(DVOL, XIN, TINT,XTANK,TBULK,TAMBTK,QLEAK,DMOUT2,UTANK)
                C     WRITE(6,2002) TBULK, XTANK
0029                FEEDUR = AMCLO - MCOLIN
0030                AMUR = FEEDUR + DMOUT2
0031                XSOLD = (FEEDUR*XFEED + DMOUT*XTANK)/AMUR
                C     WRITE(6,2011) FEEDUR, AMCLO, MCOLIN, AMUR, XSOLD
                C2011 FORMAT(2X,'FEEDUR =',E9.3,3X,'AMCLO =',E9.3,3X,'MCOLIN =',E9.3,/,
                C    1 6X,'AMUR =',E9.3,4X,'XSOLD =',E9.3,/)
0032                TURMIX = (FEEDUR*TFEED + DMOUT*TBULK)/AMUR
                C
                C     TEST TO SEE IF TEMPERATURE OF THE URINE LEAVING THE HFM HAS
                C     CONVERGED TO A STEADY-STATE SOLUTION.
                C
                C     WRITE(6,2010) TOUT(I)
                C2010 FORMAT(5X,'COMPLETED TIMES ITERATION, TOUT =',F9.2,/)
0033                IF (ABS(TOUT(I) - TOUTG(I)) .LE. .01) GO TO 100
0034             99 CONTINUE
0035            100 CONTINUE
0036                TCUTF = TOUT(I)
                C
                C          * END OF ITERATION *
                C
0037                RETURN
0038                END
```

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TERHFM

SUBTH.FORT


```
0001          SUBROUTINE TERHFM(AMURIN, TURNIN, MCOLIN, TCOLIN, CPCOOL,        00002610
             / VOLTIN, NUMMOD, XIN, AMPS, DMOUT, TOUT, POUT, XOUT,             00002620
             / AMCLO, TFCLO, TSNOW, TIN)                                        00002630
         C      SUBROUTINE WHICH EVALUATES TER AND HFM SUBSYSTEMS              00002650
         C                                                                      00002660
0002          REAL MCOLIN, MSTMTL                                               00002670
0003          U13 = 14.                                                         00002680
0004          U1COOL = 6.                                                       00002690
0005          TSNOW = 140.                                                      00002700
0006          USTM = U1COOL + U13                                               00002710
0007          CPURN = 1. - .7*XIN                                               00002720
0008          CALL TER(MCOLIN, TCOLIN, CPCOOL, AMURIN, TURNIN, TSNOW,           00002730
             / VOLTIN, CPURN, AMPS, QSTMTL, MSTMTL, TPURNO, TPCLO,AMCLO,NUMMOD) 00002740
0009          TIN = TFURNO                                                      00002750
0010          DMIN = AMURIN                                                     00002760
0011          CALL HFM(TIN,XIN,TOUT,POUT,XOUT,DMIN,DMOUT,TDQ,TSNOW )            00002770
0012          DT1 = QSTMTL/USTM                                                 00002780
0013          DT2 = TDQ/USTM                                                    00002790
0014          DTNOW = (DT2-DT1)/2.                                              00002800
         C    WRITE(6,700)  DT1, DT2, DTNOW                                     00002810
0015          TSNEW = 130.                                                      00002820
0016          DO 99 I = 2,20                                                    00002830
0017          TSOLD = TSNOW                                                     00002840
0018          DTOLD = DTNOW                                                     00002850
0019          TSNOW = TSNEW                                                     00002860
0020          CALL TER(MCOLIN, TCOLIN, CPCOOL, AMURIN, TURNIN, TSNOW,           00002870
             / VOLTIN, CPURN, AMPS, QSTMTL, MSTMTL, TPURNO, TPCLO,AMCLO,NUMMOD) 00002880
0021          TIN = TFURNO                                                      00002890
0022          DMIN = AMURIN                                                     00002900
0023          CALL HFM(TIN,XIN,TOUT,POUT,XOUT,DMIN,DMOUT,TDQ,TSNOW )            00002910
0024          DT1 = QSTMTL/USTM                                                 00002920
0025          DT2 = TDQ/USTM                                                    00002930
0026          DTNOW = (DT2-DT1)/2.                                              00002940
         C    WRITE(6,700)  DT1, DT2, DTNOW                                     00002950
         C 700 FORMAT(2X, 'DT1 =',E9.3,3X,'DT2 =',E9.3,3X,'DT =',E9.3  )        00002960
0027          TSNEW = TSNOW - (TSNOW - TSOLD)/(DTNOW - DTOLD) * DTNOW           00002970
0028          IF(TSNEW .GT. TSNOW + 10.) TSNEW = TSNOW + 10.                    00002973
0029          IF(TSNEW .LT. TSNOW - 10.) TSNEW = TSNOW - 10.                    00002974
         C    WRITE(6,600) TSNOW                                                00002980
         C 600 FORMAT(/ ,2X,'*** USING NEW VALUE OF TSTEAM =',F6.1,' ***',/ )   00002990
0030          IF(ABS(DTNOW) .LE. .005) GO TO 100                                00003000
0031       99 CONTINUE                                                          00003010
0032      100 CONTINUE                                                          00003020
0033          RETURN                                                            00003030
0034          END                                                               00003040
```

```
                C      THIS SUBROUTINE SOLVES THE TER (THERMOELECTRIC REGENERATOR)    00003050
                C    IN THE TIMES SYSTEM                                              00003060
                C                                                                     00003070
0001                 SUBROUTINE TER(MCOLIN, TCOLIN, CPCOOL ,AMURIN, TURNIN, TSTEAM,   00003080
                    / VOLTIN, CPURN, ANOW, QSTMTL, MSTMTL, TPURNO    ,                00003090
                    / TPCLO, AMCLO, NUMMOD )                                          00003100
0002                 DIMENSION TURNI(17), TURNO(17), V(17), TCOOLI(17), TCOOLO(17),   00003110
                    1 TC(17), TH(17), QC(17), QH(17)                                  00003120
0003                 REAL MCOOLI(17), MURIN, MCOLIN, MSTEAM(17), MCOOLO(17), MSTMTL   00003130
0004                 COMMON/TER1/ TURNI, TURNO, TCOOLI, TCOOLO, MCOOLI, MCOOLO,       00003140
                    1 V, TC, TH, QC, QH                                               00003150
0005                 ANUM = NUMMOD                                                    00003160
0006                 ANEW = 2.                                                        00003170
0007                 ANOW = 0.                                                        00003171
0008                 VNOW = -30.                                                      00003172
0009            20   VOLTS = 0.                                                       00003180
0010                 AOLD = ANOW                                                      00003184
0011                 ANOW = ANEW                                                      00003185
0012                 VOLD = VNOW                                                      00003186
0013                 TURNI(1) = TURNIN                                                00003190
0014                 MURIN = AMURIN/ANUM/2.                                           00003200
0015                 QSTMTL = 0.                                                      00003210
0016                 MSTMTL = 0.                                                      00003220
                C                                                                     00003230
0017                 DO 10 I = 1,16                                                   00003240
                C                                                                     00003250
                C    VALUES OF TCOOLI TO TERMOD                                       00003260
                C                                                                     00003270
0018                 IF(I .LE. 4) TCOOLI(I) = TCOLIN                                  00003280
0019                 IF(I .EQ.  5) TCOOLI( 5) = TCOOLO( 4)                            00003290
0020                 IF(I .EQ.  6) TCOOLI( 6) = TCOOLO( 3)                            00003300
0021                 IF(I .EQ.  7) TCOOLI( 7) = TCOOLO( 2)                            00003310
0022                 IF(I .EQ.  8) TCOOLI( 8) = TCOOLO( 1)                            00003320
0023                 IF(I .EQ.  9) TCOOLI( 9) = TCOOLO( 8)                            00003330
0024                 IF(I .EQ. 10) TCOOLI(10) = TCOOLO( 7)                            00003340
0025                 IF(I .EQ. 11) TCOOLI(11) = TCOOLO( 6)                            00003350
0026                 IF(I .EQ. 12) TCOOLI(12) = TCOOLO( 5)                            00003360
0027                 IF(I .EQ. 13) TCOOLI(13) = TCOOLO(12)                            00003370
0028                 IF(I .EQ. 14) TCOOLI(14) = TCOOLO(11)                            00003380
0029                 IF(I .EQ. 15) TCOOLI(15) = TCOOLO(10)                            00003390
0030                 IF(I .EQ. 16) TCOOLI(16) = TCOOLO( 9)                            00003400
                C                                                                     00003410
                C    VALUES OF MCOOLI TO TERMOD                                       00003420
                C                                                                     00003430
0031                 IF (I .LE. 4) MCOOLI(I) = MCOLIN/ANUM/2./4.                      00003440
0032                 IF (I .EQ.  5) MCOOLI( 5) = MCOOLO( 4)                           00003450
0033                 IF (I .EQ.  6) MCOOLI( 6) = MCOOLO( 3)                           00003460
0034                 IF (I .EQ.  7) MCOOLI( 7) = MCOOLO( 2)                           00003470
0035                 IF (I .EQ.  8) MCOOLI( 8) = MCOOLO( 1)                           00003480
0036                 IF (I .EQ.  9) MCOOLI( 9) = MCOOLO( 8)                           00003490
0037                 IF (I .EQ. 10) MCOOLI(10) = MCOOLO( 7)                           00003500
0038                 IF (I .EQ. 11) MCOOLI(11) = MCOOLO( 6)                           00003510
0039                 IF (I .EQ. 12) MCOOLI(12) = MCOOLO( 5)                           00003520
0040                 IF (I .EQ. 13) MCOOLI(13) = MCOOLO(12)                           00003530
0041                 IF (I .EQ. 14) MCOOLI(14) = MCOOLO(11)                           00003540
0042                 IF (I .EQ. 15) MCOOLI(15) = MCOOLO(10)                           00003550
0043                 IF (I .EQ. 16) MCOOLI(16) = MCOOLO( 9)                           00003560
                C                                                                     00003570
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TER

SUBTER.FORT

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                C    NOW SOLVE THE I-TH NODE WITH SUBROUTINE TERNOD                00003580
                C                                                                  00003590
  0044               CALL TERNOD(TURNI(I), TCOOLI(I), ANOW, TSTEAM, TURNO(I),      00003600
                     / TCOOLO(I), QSTEAM, MSTEAM(I), MCOOLI(I), MURIN, CPURN,      00003610
                     / CPCOOL, MCOOLO(I), V(I), TC(I), TH(I), QC(I), QH(I) )       00003620
                C                                                                  00003630
  0045               VOLTS = VOLTS + V(I)                                          00003640
  0046               TURNI(I+1) = TURNO(I)                                         00003650
  0047               QSTMTL = QSTMTL + QSTEAM*FLOAT(NUMMOD)*2.                     00003660
  0048               MSTMTL = MSTMTL + MSTEAM(I)*FLOAT(NUMMOD)*2.                  00003670
  0049               TPURND = TURNO(16)                                            00003680
  0050          10   CONTINUE                                                      00003690
                C                                                                  00003700
                C    WRITE(6,500) ANOW                                             00003710
                C 500 FORMAT(//,3X,'**** HAVE COMPLETED ITERATION WITH VALUE OF AMPS =',00003720
                C    / F6.3,' ****',//)                                            00003730
  0051               VNOW = VOLTS * 2.                                             00003740
  0052               ANEW = ANOW + (ANOW - AOLD)/(VNOW - VOLD) * (VOLTIN - VNOW)   00003770
  0053               TPCLO = (MCOOLO(13)*TCOOLO(13) +                              00003850
                     / MCOOLO(14)*TCOOLO(14) + MCOOLO(15)*TCOOLO(15) +             00003860
                     / MCOOLO(16)*TCOOLO(16) )/                                    00003870
                     / (MCOOLO(13) + MCOOLO(14) + MCOOLO(15) + MCOOLO(16) )        00003880
  0054               IF( ABS(VOLTIN - VNOW) .GT. .05 ) GO TO 20                    00003890
  0055               AMCLO = (MCOOLO(13) + MCOOLO(14) + MCOOLO(15) + MCOOLO(16))   00003900
                     / *FLOAT(NUMMOD)*2.                                           00003910
  0056               RETURN                                                        00003920
  0057               END                                                           00003930
```

B9.

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TERNOD

SUBTERN.FORT

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```
0001          SUBROUTINE TERNOD(TURNI, TCOOLI, AMPS, TSTEAM, TURNO, TCOOLO,    00003940
             1 QSTEAM, MSTEAM, MCOOLI, MURIN, CPURN, CPCOOL, MCOOLO, V,         00003950
             2 TC, TH, QCIN, QHIN )                                             00003960
        C                                                                       00003970
        C       THIS SUBROUTINE EVALUATES THE SYSTEM THERMAL RESPONCE OF        00003980
        C     ONE THERMOELECTRIC DEVICE IN THE "TIMES" TER PACKAGE              00003990
        C                                                                       00004000
0002          REAL MCOOLI, MSTEAM, MURIN, MCOOLO, KM                            00004010
0003          TH = TURNI + 1.5                                                  00004020
0004          TC = TCOOLI - 2.                                                  00004030
0005          HFG = 1000.                                                       00004040
0006          U13 = 14.                                                         00004050
0007          U1COOL = 6.                                                       00004060
0008          UCOOL3 = 6.                                                       00004070
0009          U45 = 13.                                                         00004080
0010          MCOOLO = MCOOLI + .05                                             00004090
0011          MSTEAM = .05                                                      00004100
0012          IFLAG = 1                                                         00004110
0013          TC2 = 0.                                                          00004120
0014          TH2 = 0.                                                          00004130
        C                                                                       00004140
        C     NOW ITERATE TO OBTAIN TC & TH                                     00004150
        C                                                                       00004160
0015       10 Q13 = U13*(TSTEAM - TC)                                           00004170
0016          TCOOLO = (TC + TSTEAM)/2.                                         00004180
0017          QCOOL = MCOOLO*TCOOLO - MCOOLI*TCOOLI - MSTEAM*TSTEAM             00004190
0018          TAVE = TCOOLO                                                     00004200
0019          QCOOL3 = UCOOL3*(TAVE - TC) - QCOOL/2.                            00004210
0020          Q1COOL = U1COOL*(TSTEAM - TAVE) + QCOOL/2.                        00004220
0021          QHOUT = U45*(TH - TURNI)                                          00004230
        C                                                                       00004240
        C     NOW CALL A SUBROUTINE TO EVALUATE TED PROPERTIES                  00004250
        C                                                                       00004260
0022          CALL TED(TH, TC, KM, RM, AM)                                      00004270
        C                                                                       00004280
0023          TCK = (TC + 460.)/1.8                                             00004290
0024          THK = (TH + 460.)/1.8                                             00004300
0025          QCIN = (AM*TCK*AMPS - AMPS**2*RM/2.)*3.4121 - KM*(THK - TCK)      00004310
0026          QHIN = (AM*THK*AMPS + AMPS**2*RM/2.)*3.4121 - KM*(THK - TCK)      00004320
0027          TH2 = TURNI + QHIN/U45                                            00004330
0028          TC2 = (U13*TSTEAM + UCOOL3*TCOOLO - QCOOL/2. - QCIN)/(U13+UCOOL3) 00004340
        C     WRITE(6,101) QCIN, QHIN, TH2, TC2                                 00004350
        C 101 FORMAT(2X,'QCIN =',E10.4,3X,'QHIN =',E10.4,5X,'TH2 =',F6.2,3X,    00004360
        C    / 'TC2 =',F6.2,/)                                                  00004370
0029          IF(IFLAG .EQ. 1) TC = (TC+TC2)/2.                                 00004380
0030          IF(IFLAG .EQ. 2) TH = (TH+TH2)/2.                                 00004390
0031          IF(IFLAG .EQ. 1 .AND. ABS(TC-TC2) .LT. .02) IFLAG = 2             00004400
0032          IF(IFLAG .EQ. 2 .AND. ABS(TH-TH2) .LT. .02) IFLAG = 1             00004410
        C     WRITE(6,102) TC, TH                                               00004420
        C 102 FORMAT(3X,'TC =',F7.2,4X,'TH =',F7.2,/)                           00004430
0033          QSTEAM = Q13 + Q1COOL                                             00004440
0034          MSTEAM = QSTEAM/HFG                                               00004450
0035          MCOOLO = MCOOLI + MSTEAM                                          00004460
0036          IF (ABS(TH - TH2) .GT. .02 .OR. ABS(TC - TC2) .GT. .02) GO TO 10  00004470
        C                                                                       00004480
        C     NOW EVALUATE FINAL SYSTEM PROPERTIES                              00004490
        C                                                                       00004500
0037          TURNO = TURNI + QHIN/MURIN/CPURN                                  00004510
```

```
0038    V = AM*(THK - TCK) + AMPS*RM        00004520
0039    RETURN                              00004530
0040    END                                 00004540
```

```
C     SUBROUTINE FOR EVALUATING TED PROPERTIES
C
      SUBROUTINE TED(TH, TC, KM, RM, AM)
      REAL KM
      T = ( (TH + TC)/2. + 460. )*5./9.
C
C     LIST TED PROPERTY CONSTANTS FOR "CURVE FIT" FORMULAS
C
      A1 = 1.9275E-03
      B1 = 2.7811E-05
      C1 = 3.3049E-08
      D1 = 9.7356E-11
      E1 =-5.0474E-13
      A2 = 2.0320E-01
      B2 =-1.2194E-03
      C2 = 8.5366E-07
      D2 = 2.7204E-08
      E2 =-4.3563E-11
      A3 =-5.7999E-01
      B3 = 1.3023E-02
      C3 =-7.4861E-05
      D3 = 1.7322E-07
      E3 =-1.3305E-10
C
      AM =(A1 + B1*T + C1*T**2 + D1*T**3 + E1*T**4)
      RM = A2 + B2*T + C2*T**2 + D2*T**3 + E2*T**4
      KM =(A3 + B3*T + C3*T**2 + D3*T**3 + E3*T**4)*3.4121
      RETURN
      END
```

-B12-

TED

SUBTED.FORT

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-B13-

HFM

SUBHFM.FORT


```
0001          SUBROUTINE HFM(TIN,XIN,TOUT,POUT,XOUT,DMIN,DMOUT,TDQ,TSTEAM)
        C
        C     SUBROUTINE HOLLOW FIBER MEMBRANE
        C
        C     THIS SUBROUTINE CALCULATES THE OUTLET CONDITIONS OF THE "TIMES"
        C  HFM GIVEN THE INLET PARAMETERS TIN, XIN, DMIN, TSTEAM WHERE:
        C             TIN = INLET BRINE TEMP - DEG F
        C             XIN = INLET BRINE FRACTION SOLIDS - DIMENSIONLESS
        C             DMIN = INLET BRINE MASS FLOW - #/HR
        C             TSTEAM = VAPORIZED STEAM TEMP
        C
0002          REAL KPERM
0003          DIMENSION DWVAP(7),DWURN(7),DWH2O(7),XSOLDS(7),TURN(7),PVPURN(7),
             / CP(7)
0004          COMMON/HEM1/ PSTEAM, DWURN, TURN, PVPURN, XSOLDS, DWVAP, KPERM,
             1 AREA
0005          T =TSTEAM + 460.
0006          TURN(1)=TIN
0007          N=2
        C
        C     SUBROUTINE "URINPP" DETERMINES H2O VAPOR PRESSURE OF URINE
        C
0008          CALL URINPP(TURN(1),XIN,PVPURN(1))
        C
        C     KANDK IS A CANNED PROGRAM FOR VAPOR PRESSURE OF STEAM
        C
0009          CALL KANDK(PSTEAM,T,N)
0010          XSOLDS(1)=XIN
0011          DWURN(1)=DMIN
0012          HFG=1000.
0013          TDQ=0.
0014          AMEM = AREA/6.
0015          DWH2O(1) =DWURN(1)*(1.-XSOLDS(1))
        C
0016          DO 10 I=1,6
0017          DWVAP(I)=KPERM*AMEM*(PVPURN(I)-PSTEAM)
0018          CP(I)=1.-.7*XSOLDS(I)
0019          DWURN(I+1) =DWURN(I)-DWVAP(I)
0020          DWH2O(I+1) =DWH2O(I)-DWVAP(I)
0021          XSOLDS(I+1) =(DWURN(I+1)-DWH2O(I+1))/DWURN(I+1)
0022          DQ =DWVAP(I)*HFG
0023          TDQ =TDQ+DQ
        C     WRITE(6,1000) TDQ, DQ, I, DWVAP(I), PSTEAM, I, PVPURN(I)
        C1000 FORMAT(2X,'TDQ =',E9.3,3X,'DQ =',E9.3,3X,'DWVAP(',I1,') =',E9.3,
        C    1 /,4X,'PSTEAM =',E9.3,4X,'PVPURN(',I1,') =',E9.3,/)
0024          DT =-DQ/DWURN(I)/CP(I)
0025          TURN(I+1) =TURN(I)+DT
0026          CALL URINPP(TURN(I+1),XSOLDS(I+1),PVPURN(I+1))
0027       10 CONTINUE
        C
0028          TOUT =TURN(7)
0029          POUT =PVPURN(7)
0030          XOUT =XSOLDS(7)
0031          DMOUT =DWURN(7)
0032          RETURN
0033          END
```

-B14-

URINPP

URINPP.FORT

```
                C    SUBROUTINE URINPP CALCULATES THE PARTIAL PRESSURE OF H2O VAPOR    00005400
                C  OF URINE GIVEN ITS TEMPERATURE AND MASS FRACTION OF SOLIDS          00005410
                C                                                                      00005420
0001                 SUBROUTINE URINPP(TEMP,XSOLDS,PVAP)                               00005430
0002                 IF(XSOLDS .LT. .01) XSOLDS = .01                                  00005435
0003                 DIMENSION A(50)                                                   00005440
0004                 N = 2                                                             00005450
0005                 TABS = TEMP + 460.                                                00005460
                C                                                                      00005470
                C    KANDK IS A CANNED PROGRAM WHICH CALCULATES VAPOR PRESSURE OF WATER 00005480
                C                                                                      00005490
0006                 CALL KANDK(PSAT,TABS,N)                                           00005500
                C                                                                      00005510
                C     THIS ARRAY IS A LIST OF VAPOR PRESSURE OF URINE AT 144 DEG F     00005520
                C    FOR FRACTION SOLIDS FROM .05 TO .50 IN INCREMENTS OF .05 TO       00005530
                C    BE INPUTTED INTO "BIQUAD" INTERPOLATION ROUTINE                   00005540
                C                                                                      00005550
0007                 A( 1) = 1.                                                        00005560
0008                 A( 2) = 19.                                                       00005570
0009                 A( 3) = 0.                                                        00005580
0010                 A( 4) = 0.                                                        00005590
0011                 A( 5) = .05                                                       00005600
0012                 A( 6) = .1                                                        00005610
0013                 A( 7) = .15                                                       00005620
0014                 A( 8) = .2                                                        00005630
0015                 A( 9) = .25                                                       00005640
0016                 A(10) = .3                                                        00005650
0017                 A(11) = .35                                                       00005660
0018                 A(12) = .4                                                        00005670
0019                 A(13) = .45                                                       00005680
0020                 A(14) = .5                                                        00005690
0021                 A(15) = .55                                                       00005700
0022                 A(16) = .6                                                        00005710
0023                 A(17) = .65                                                       00005720
0024                 A(18) = .7                                                        00005730
0025                 A(19) = .75                                                       00005740
0026                 A(20) = .8                                                        00005750
0027                 A(21) = .85                                                       00005760
0028                 A(22) = .9                                                        00005770
0029                 A(23) = 3.1990                                                    00005780
0030                 A(24) = 3.1357                                                    00005790
0031                 A(25) = 3.0923                                                    00005800
0032                 A(26) = 3.0499                                                    00005810
0033                 A(27) = 2.9976                                                    00005820
0034                 A(28) = 2.9285                                                    00005830
0035                 A(29) = 2.8448                                                    00005840
0036                 A(30) = 2.7407                                                    00005850
0037                 A(31) = 2.6257                                                    00005860
0038                 A(32) = 2.5030                                                    00005870
0039                 A(33) = 2.3640                                                    00005880
0040                 A(34) = 2.2210                                                    00005890
0041                 A(35) = 2.0767                                                    00005900
0042                 A(36) = 1.9318                                                    00005910
0043                 A(37) = 1.7989                                                    00005920
0044                 A(38) = 1.6698                                                    00005930
0045                 A(39) = 1.5295                                                    00005940
0046                 A(40) = 1.3340                                                    00005950
0047                 A(41) = 1.0660                                                    00005960
```

```
              C                                                      00005970
0048                I = 1                                            00005980
0049                CALL BIQUAD(A,I,XSOLDS,Y,PVP144,Z)               00005990
0050                PVAP = PSAT*(PVP144/3.199 + XSOLDS**1.696/750.*(TEMP-144.))  00006000
0051                RETURN                                           00006010
0052                END                                              00006020
```

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```
               C      THIS SUBROUTINE MODELS THE RECIRCULATING TANK THAT IS IN       00006030
               C     THE URINE LOOP.                                                 00006040
               C                                                                     00006050
      0001             SUBROUTINE TANK(DVOL, XIN, TIN, XTANK, TBULK, TAMB, QLEAK, DMOUT, 00006060
                      1 UTANK)                                                       00006070
      0002              CPURN = 1. - .7*XIN                                          00006080
      0003              DENIN = (.4775*XIN + .99325)*62.43                           00006090
      0004              DEN = (.4775*XTANK + .99325)*62.43                           00006100
      0005              DMOUT = DVOL*DEN                                             00006110
      0006              UIN = DVOL*DENIN*CPURN                                       00006120
      0007              QLEAK = 1./(1./UIN + 1./UTANK)*(TIN - TAMB)                  00006130
      0008              TBULK = TIN - QLEAK/UIN                                      00006140
      0009              RETURN                                                       00006150
      0010              END                                                          00006160
```


-B16-
TANK
TANK.FORT

```
0001          SUBROUTINE PUMP1(XSOLDS, DM, DTRISE)                      00006170
         C                                                              00006180
         C    THIS SUFFOUTINE MODELS THE CONSTANT VOLUME DISPLACEMENT  00006190
         C  RECIRCULATING PUMP IN THE URINE LOOP.                      00006200
         C                                                              00006210
0002          DENS = (.4775*XSOLDS + .99325)*62.43                      00006220
0003          DVOL = 4.7692                                             00006230
0004          DM = DENS*DVOL                                            00006240
0005          QIN = 90.4                                                00006250
0006          CP = 1.-.7*XSOLDS                                         00006260
0007          DTRISE = QIN/DM/CP                                        00006270
0008          RETURN                                                    00006280
0009          END                                                       00006290
```

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- B17 -
PUMP1
PUMP1 . FORT

HAMILTON STANDARD

Internal Correspondence

May 24, 1978

Analysis 78-93
File: 2.14
6.5

Memorandum to: Messrs. J. Lovell
R. Trusch

cc: Messrs. R. Balinskas
M. Hultman
E. O'Connor
G. Roebelen
F. Sribnik
E. Tepper

From: M. Heldmann

Subject: Physical Properties of Urine

Reference: Putnam, David F.,"Composition and Concentrative Properties of Human Urine", June, 1970

Summary

For studying systems that handle urine, three properties are generally required. They are specific heat, density and vapor pressure. The first two are basically functions of the fraction of solids in the brine while vapor pressure is also a strong function of temperature. Techniques which predict these properties are shown below.

Specific Heat

Figure 42 from Putnam's report is a plot of nominal valves of specific heat in Btu/lb_m. A simple curve fit is

$$Cp = 1 - .7X$$

Cp = Specific heat, Btu per pound
X = Solute weight fraction, grams of solute per gram of urine

Density

Putnam gives an equation for density good to within ± 1 1/2 percent. It is

$$\rho = 0.4775\ x + 0.99326$$

ρ = density, grams of urine per ml of urine

This is for chemically treated urine.

Vapor Pressure

A chart of vapor pressure as a function of solute weight fraction (from 0 to 1.0) and temperature (from 80 to 144°F) is given in Putnam's report as Table VIII. This table is nondimensionalized by dividing each urine vapor pressure by the vapor pressure of pure water at any temperature. This results in an expression for urine vapor pressure as a function of its solids weight fraction and temperature. For each solute weight fraction there is a straight line fit of the nondimensional vapor pressure and temperature. The slope and an intercept of these lines is then approximated as a function of solids weight fraction.

The intercept point is taken at 144°F for any solids weight fraction, as this is the highest temperature for which urine partial pressure information is available. This program was developed to predict properties at around 150°F for the TIMES water reclamation system. The slope is assumed proportional to the solute weight fraction raised to a power. The resulting equation is:

$$\frac{P_{UR}}{P_W} = \frac{P_{UR-144}}{P_{W-144}} + \frac{X^{1.696}}{750}(T - 144)$$

where:

P_{UR} = Urine partial pressure at:
Solids weight fraction = X, and
temperature = T °F

P_W = Water partial pressure at:
Temperature = T °F

P_{UR-144} = Urine partial pressure at:
Solids weight fraction = X, and
temperature = 144°F

P_{W-144} = Water partial pressure at:
temperature = 144°F

As is easily shown, at T = 144°F and at X=0, exact solutions are attained. To calculate these values, vapor pressure of pure water at any temperature and urine at 144°F for any solids fraction must be known.

Results

Comparisons of random values of urine partial pressure in terms of % error and psi error are given in Tables 1 and 2. These numbers were generated by the subroutine URINPP developed for the TIMES program.

Partial pressure of water was inputted by the HS canned subroutine KANDK and the vapor pressure of urine at 144°F was inputted as a one-dimensional array utilizing the BIQUAD interpolation routine.

Errors are introduced in the equation and in the KANDK values inputted to the equation. In general, they are less than 1 percent or .025 psi in magnitude.

Prepared by: Michael Heldmann
M. Heldmann

Reviewed by: E. W. O'Connor
E. O'Connor

/sa
Attachment

TABLE 1

% Error

Temperature	Solute Weight Fraction							
	0	0.05	0.10	0.15	0.20	0.30	0.40	0.50
120°F		0.7		0.5		-0.08		-1.8
125°F								
130°F	0.8	0.7		0.6			-0.2	-0.8
135°F		0.8	0.7			0.5	-0.6	-0.2
140°F		0.8			0.7		0.5	0.3
144°F					1.1			

TABLE 2

ΔPressure Error ~ psi

Temperature	Solute Weight Fraction							
	0	0.05	0.10	0.15	0.20	0.30	0.40	0.50
120°F		0.012		0.009		-0.001		-0.023
125°F								
130°F	0.018	0.016		0.014			-0.003	-0.012
135°F		0.019	0.018			0.016		-0.004
140°F		0.022			0.019		0.012	0.007
144°F					0.024			

HAMILTON STANDARD

Internal Correspondence

Please address answer to
Mail Stop No. 1a-2-5

June 2, 1978
Analysis 78-104
File 2.14
6.3
6.5

Memorandum to: E. O'Connor

cc: G. Kleiner
M. Hultman
J. Lovell
G. Roebelen
R. Trusch

From: M. Heldmann

Subject: TIMES Computer Math Model Results

References: Program Plan for Contract No. NAS 9-15471
January, 1978, "Statement of Work"

Analysis Memorandum 78-92, "TIMES Computer
Math Model Usage", M. Heldmann, May 22, 1978

150°F HFM Temp., 3 TEI Modules A_{HFM} = 3.75 in^2

The results from the TIMES computer math model, as described in analysis memo 78-92, are presented here in graphical form. It is predicted that the specific energy and water processing rate requirements, as specified in the statement of work, will be met by the present system. At 26.5 VDC for non-concentrated raw urine, a system specific energy requirement of 165 watt-hours per pound is set. We predict less than 80 watt-hours per pound will be required for the thermoelectric regenerator subsystem. When the power estimates for the remaining components are added, the total specific energy is less than the 165 watt hours per pound required. The processing rate requirement of 1.7 lbs/hr of product water at 29 VDC for non-concentrated raw urine has also been met. For a HFM, permeability of 1.0 pound per hour per psid, a margin of 27% is predicted, for a degraded permeability of 0.5 pound per hour per psid, a margin of 9% is shown. These margins represent flows of 2.16 and 1.86 pounds of process water per hour, respectively.

The first set of graphs show various system properties for the present system design as of function of HFM permeability. The range of K is given between 1.0 and 0.5 pound per hour per psid. These 2 numbers represent our current predictions of the membrane performance when new and after degradation from use. Since the product of membrane area and permeability constant is actually the controlling parameter, the same curves also shown changes in system performance against membrane area. With a range of 3.75 to 7.5 ft^2 for a permeability of 0.5 pounds per hour per psid.

150°F HFM Temp., 3 TER Modules (Continued)

Figures 1 through 3 show process water recovery rate, Figures 4 through 6 show specific energy of the TER assembly, and Figures 7 through 9 show TER electrical power all as functions of the permeability constant. Figures 10 through 12 show the steam temperature and Figures 13 through 15 show coolant, again as functions of permeability constant.

Each parameter is presented for 3 voltages, 26.5, 29, and 31.5 VDC, and for 3 different fraction solids in recirculating urine of 3, 30, and 50%. The system used has 3 TER modules of 32 TED's per module., a membrane area of 3.75 ft^2, and is controlled to a urine temperature entering the HFM of 150°F. The heat transfer coefficient for the system is 40 Btu/hr °F, which is an estimate for the system, mounted with 2" of insulation. The environment is 70°F and the feed urine is at 3% solids and 110°F. The coolant heat exchanger has an effectiveness of 0.5 to a 70°F ambient temperature. The coolant flow is varied to maintain the 150°F urine temperature.

160°F HFM Temp., 3 TER Modules

The effects on the system performance by raising the urine entrance temperature to 160°F in the HFM is presented in Figures 16 and 17. Figure 16 shows process water recovery rate while 17 shows specific energy both as functions of fraction solids of urine in the recycle loop. This would increase the recovery rate to 1.9 pounds per hour and the lower the specific energy to 76 watt-hours per pound. This would give us performance increases of 2% and 5%, respectively. These graphs, also, show very clearly the deterioration in performance that occurs when the fraction solids in the recycle loop is allowed to exceed the 0.3 point. This same effect occurs for the 150°F HFM temperature system.

150°F HFM Temp., 2 TER Modules

Table 1 shows the effect on performance of reducing the number of TER modules from 3 to 2. The specific energy is reduced by 4%, but the water produced at specified conditions is only 1.32 pounds per hour, which does not meet the 1.7 pounds per hour minimum.

Minimum Insulation Study

The higher the heat transfer coefficient, the lower the amount of coolant flow that is required and thus the more heat that must be pumped by the TED's per pound of water processed. This would represent a lower performance design. For a system designed with no coolant flow required at minimum power input (i.e. min. voltage of 26.5 VDC) would be the lowest performance system that could be controlled by the present coolant, thermal subsystem. Four combinations of area and number of modules are shown in Table 2. Each one's insulation is sized for zero coolant flow at 26.5 VDC. This approach, more fairly, shows the effects of adding an additional module or changing HFM area. Note the 8% increase in specific energy requirement when an additional module is added to the 3.75 ft^2 HFM area system. This verifies the optimization of the 3 TER module system.

Minimum Insulation Study (Continued)

Figures 18 through 25 use the same systems as described in the previous paragraph to show urine temperature against coolant flow and water recovery rate against membrane area. These curves are based on minimum insulation (i.e. zero coolant flow at 26.5 VDC).

These figures show that very little coolant flow is required during average and peak voltages. Less than 2 pounds per hour is required at 29 VDC and less than 4 is needed to maintain the 150°F urine temperature at 31.5 VDC. Also, the increase in performance with increased membrane area is presented in Figures 24 and 25. These studies were done with 3 and 4 TER modules to verify that 3 TER modules would be optimum.

Prepared by M. Heldmann
M. Heldmann

Reviewed by E. W. O'C
E. O'Connor

MH/nrc

TABLE 1

2 Module TER @ 150°F HFM Inlet Temp.

Voltage	$\mathbb{P}$ (Power)	$\dot{W}$prod.	$\mathbb{P}$ / $\dot{W}$prod.	Tsteam
26.5v	90.8w	1.179 #/hr	76.99	139.96°F
29v	108.7w	1.317 #/hr	82.52	138.70°F

P = Power to TER in watts

$\dot{W}$prod. = Water process rate in lbs/hr

P/Wprod. = Specific energy of TER in watt-hours/lb of water produced

Tsteam = Steam temperature in °F

From TIMES' Runs #192 and #193

TABLE 2

TIMES SUMMARY

$T_{HPM} = 150°F \pm 1°F$ 3% Solids 300 pph
$K_{perm} = .5\ lbm/hr\ psid$

A = 3 ft² N = 3 modules

Voltage	Case	$\dot{W}$recl.	UA	$\dot{W}$cool	P	P/$\dot{W}$recl.
26.5v	102	1.465	6.45	0	132.0	90.10
29v	141	1.627	6.45	1.950	157.8	97.01

A = 3.75 ft² N = 3

Voltage	Case	$\dot{W}$recl.	UA	$\dot{W}$cool	P	P/$\dot{W}$recl.
26.5v	106	1.565	6.55	0	134.0	85.65
29v	142	1.744	6.55	1.900	160.3	91.93

A = 3 ft² N = 4

Voltage	Case	$\dot{W}$recl.	UA	$\dot{W}$cool	P	P/$\dot{W}$recl.
26.5	111	1.746	8.45	0	172.7	98.92
29	144	1.937	8.45	2.400	206.2	106.44

A = 3.75 ft² N = 4

Voltage	Case	$\dot{W}$recl.	UA	$\dot{W}$cool	P	P/$\dot{W}$recl.
26.5	114	1.902	8.55	0	175.7	92.32
29	146	2.121	8.55	2.300	209.9	98.95

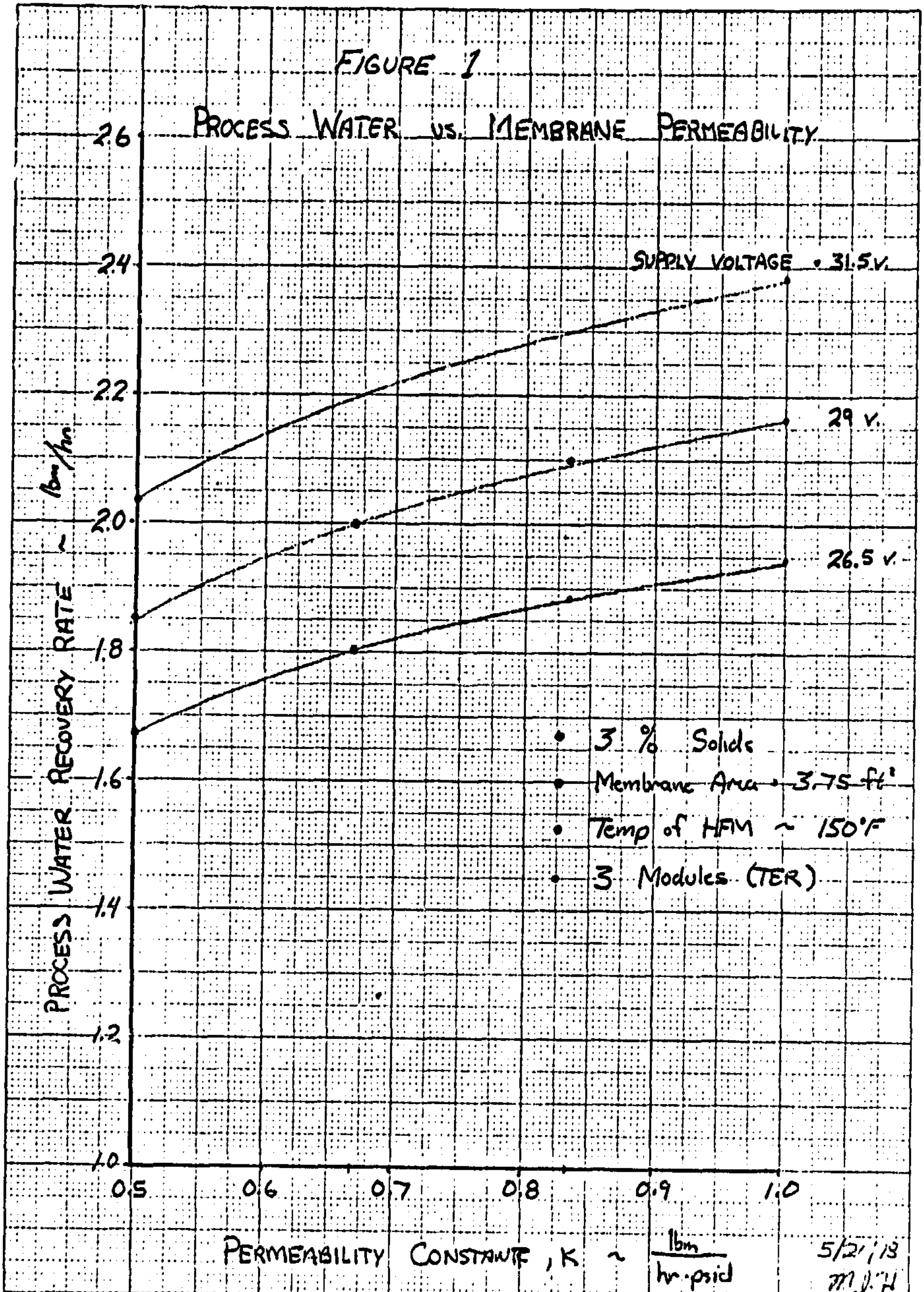
$\dot{W}$recl = Water process rate in lbs/hour

UA = Heat transfer coefficient of package in Btu/hr °F

$\dot{W}$cool = Coolant flow in lbs/hour

P = Power to TER in watts

P/$\dot{W}$recl. = Specific energy of TER in watt-hours/lb of water produced



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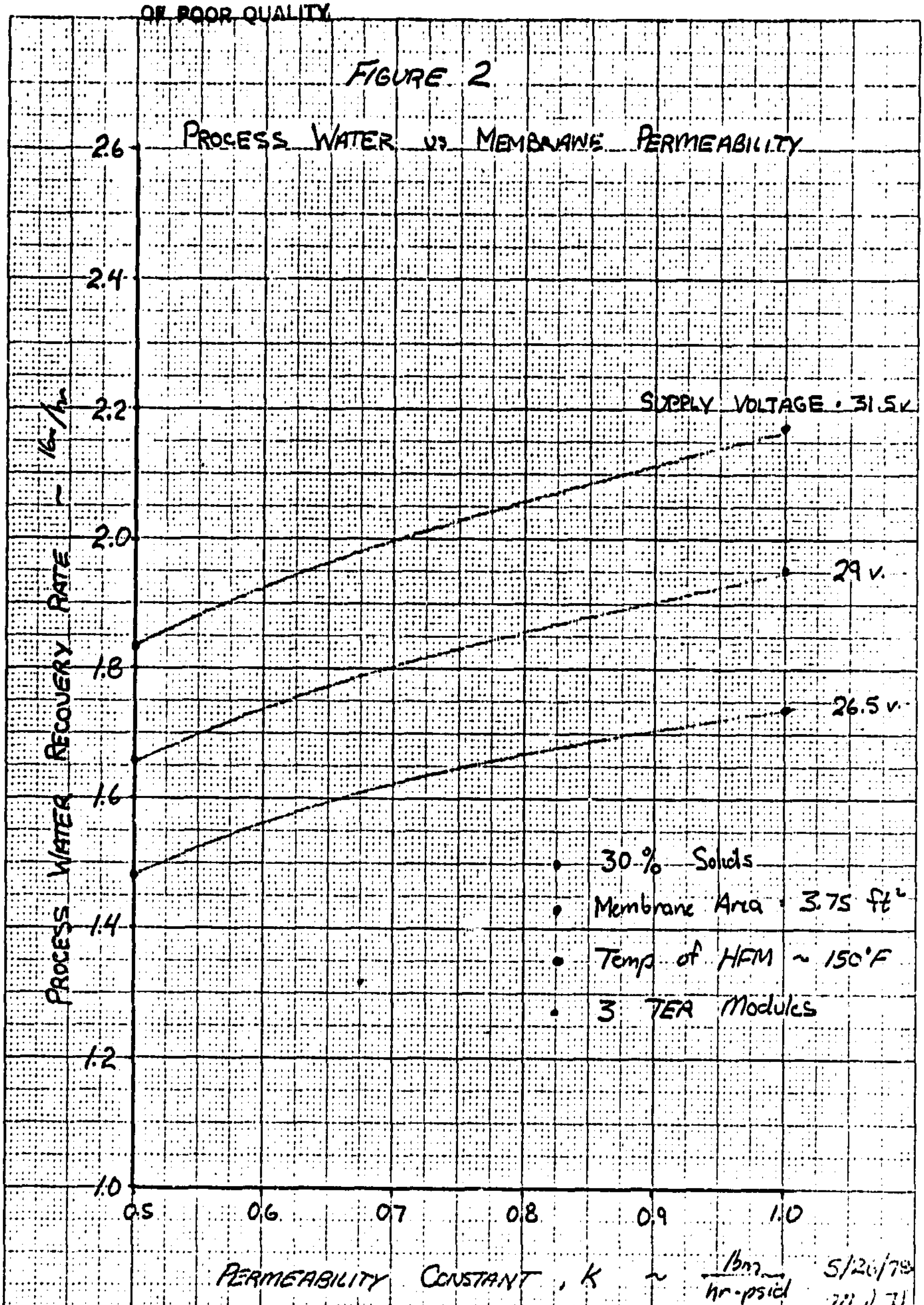

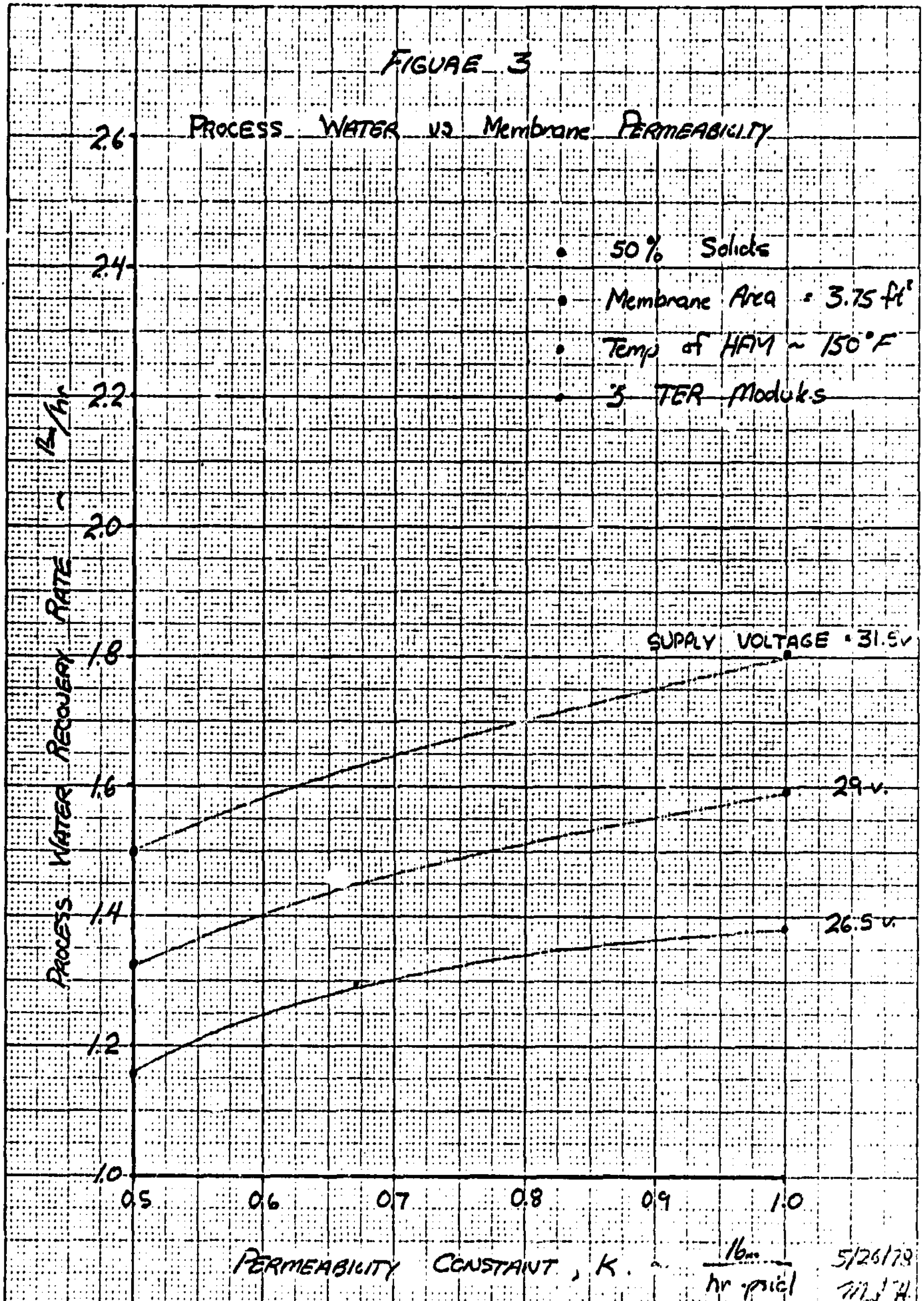
FIGURE 3
PROCESS WATER vs Membrane PERMEABILITY
• 50% Solids
• Membrane Area = 3.75 ft²
• Temp of HAM ~ 150°F
• 3 TER Modules
SUPPLY VOLTAGE = 31.5v
29 v.
26.5 v.
PROCESS WATER RECOVERY RATE, lb/hr
PERMEABILITY CONSTANT, K ~ lb / hr·psid
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.5
0.6
0.7
0.8
0.9
1.0
5/26/78

FIGURE 4

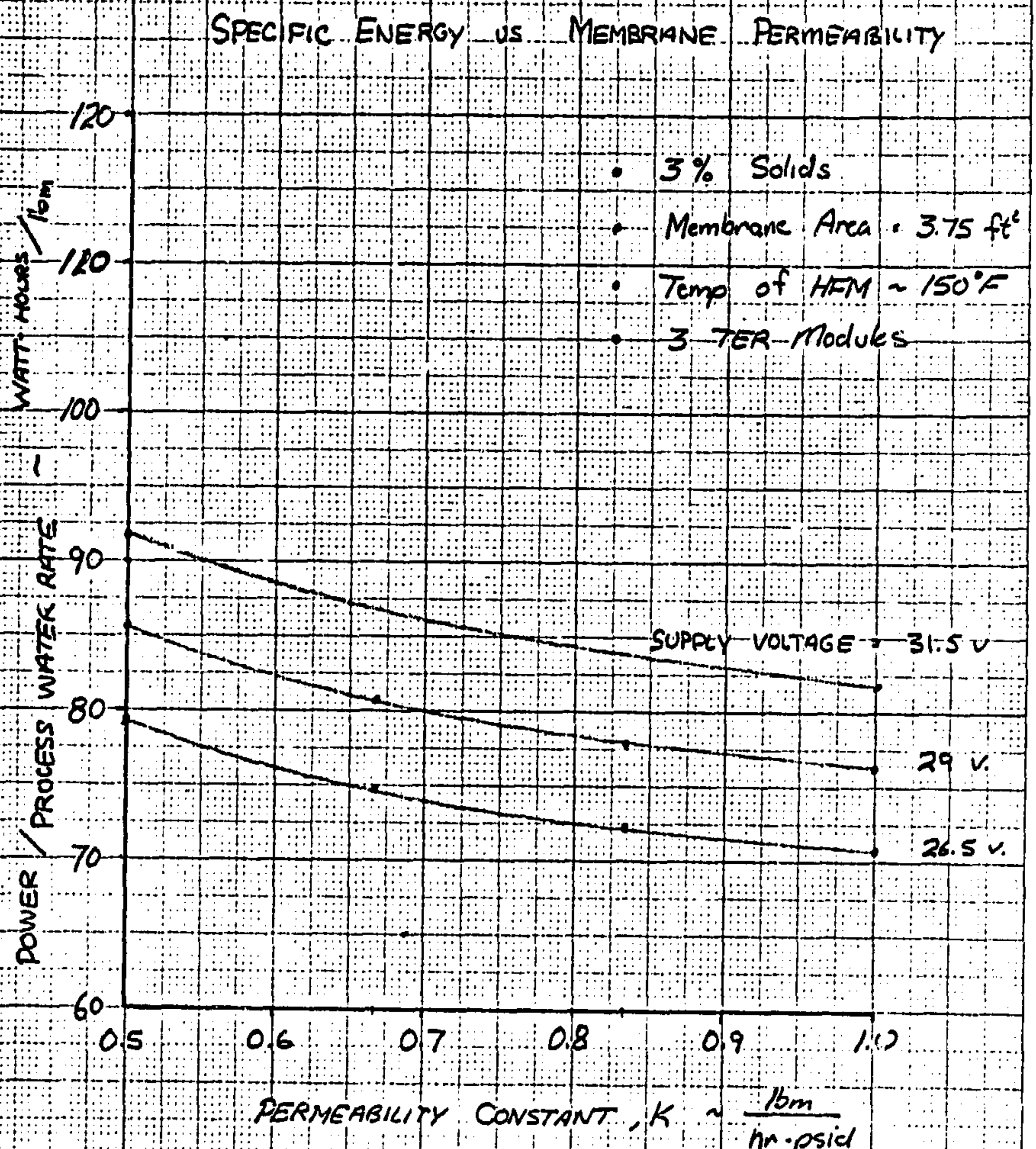

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FIGURE 5

SPECIFIC ENERGY vs MEMBRANE PERMEABILITY

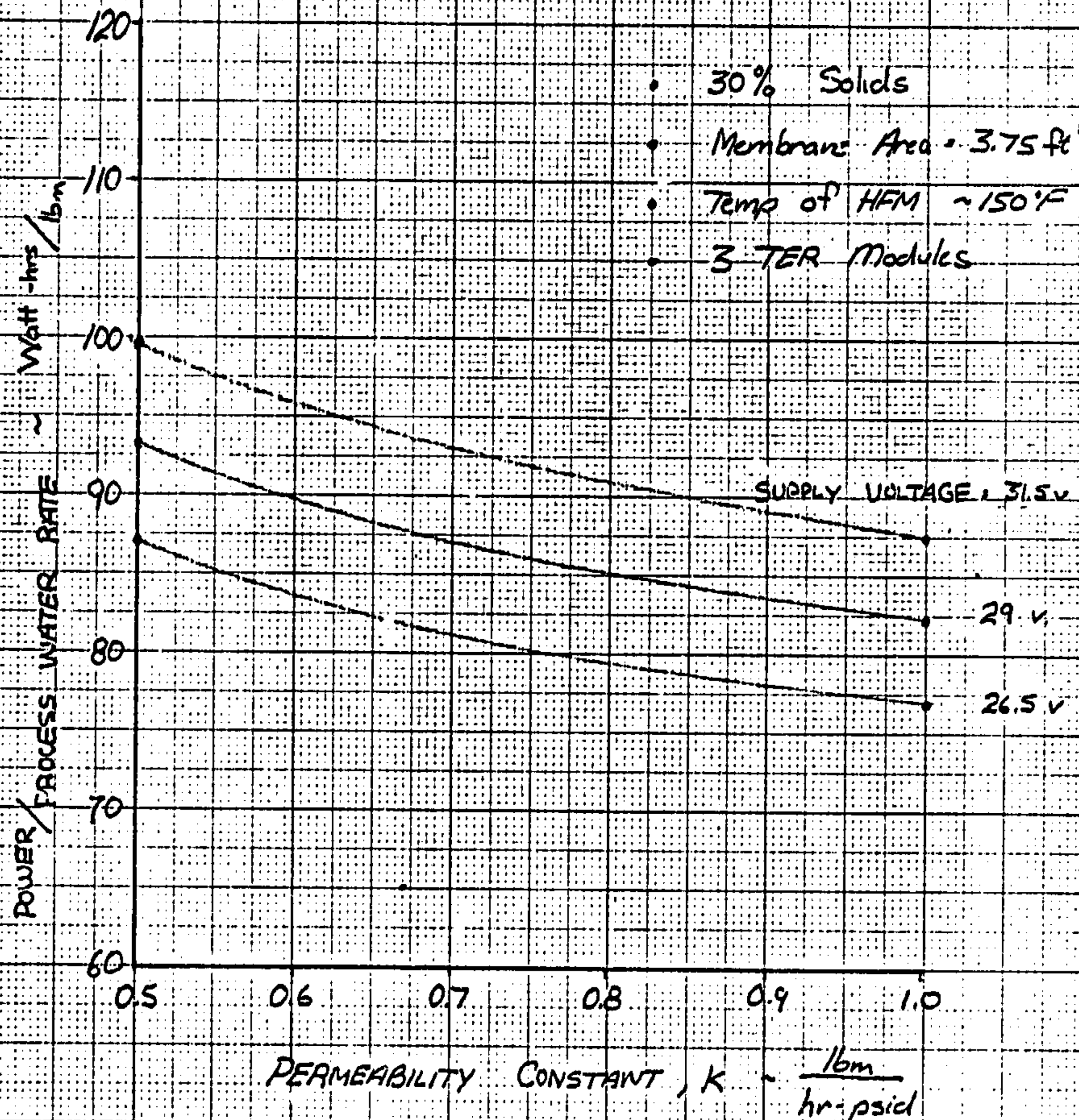

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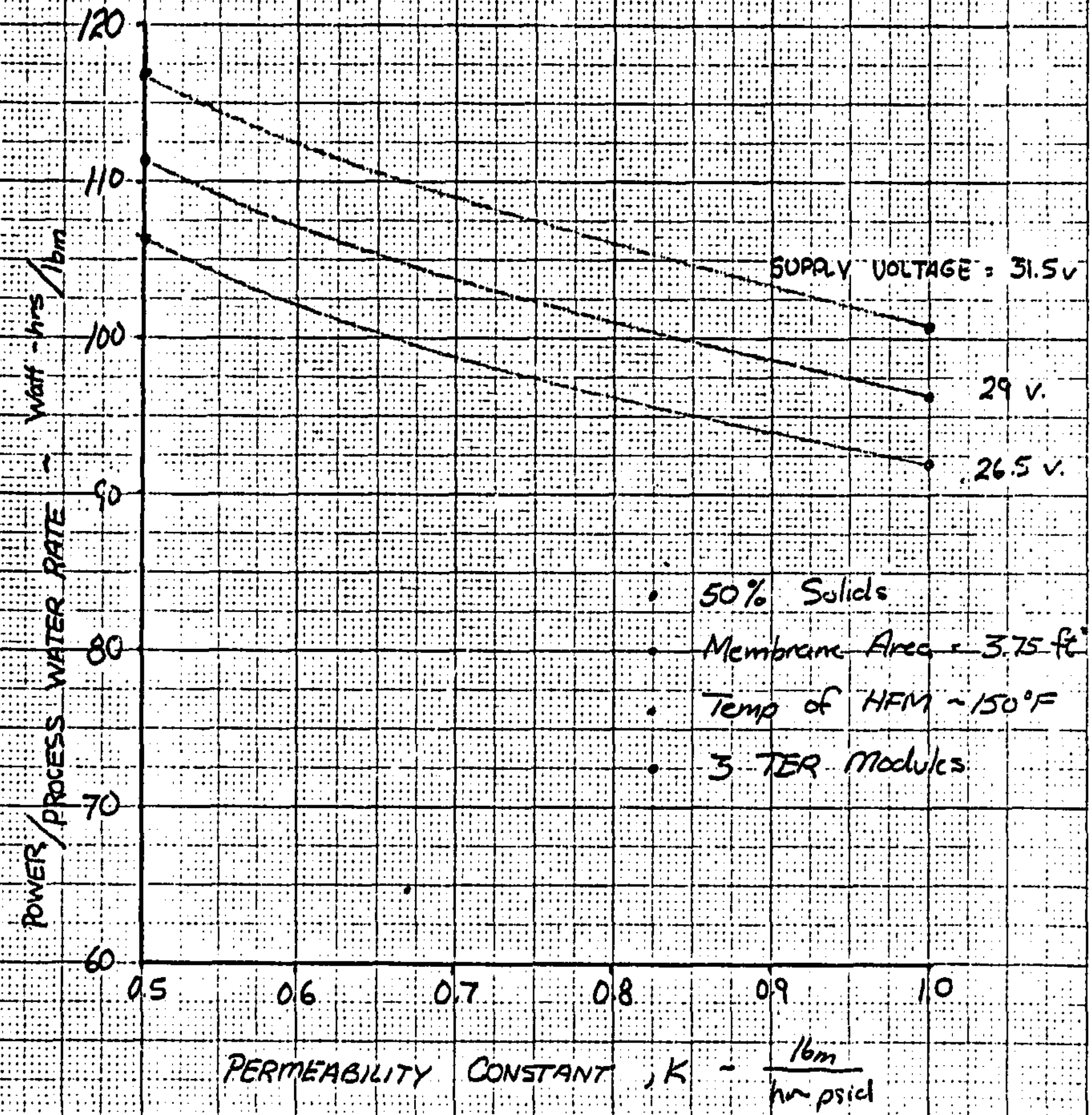
FIGURE 6

SPECIFIC ENERGY vs. MEMBRANE PERMEABILITY



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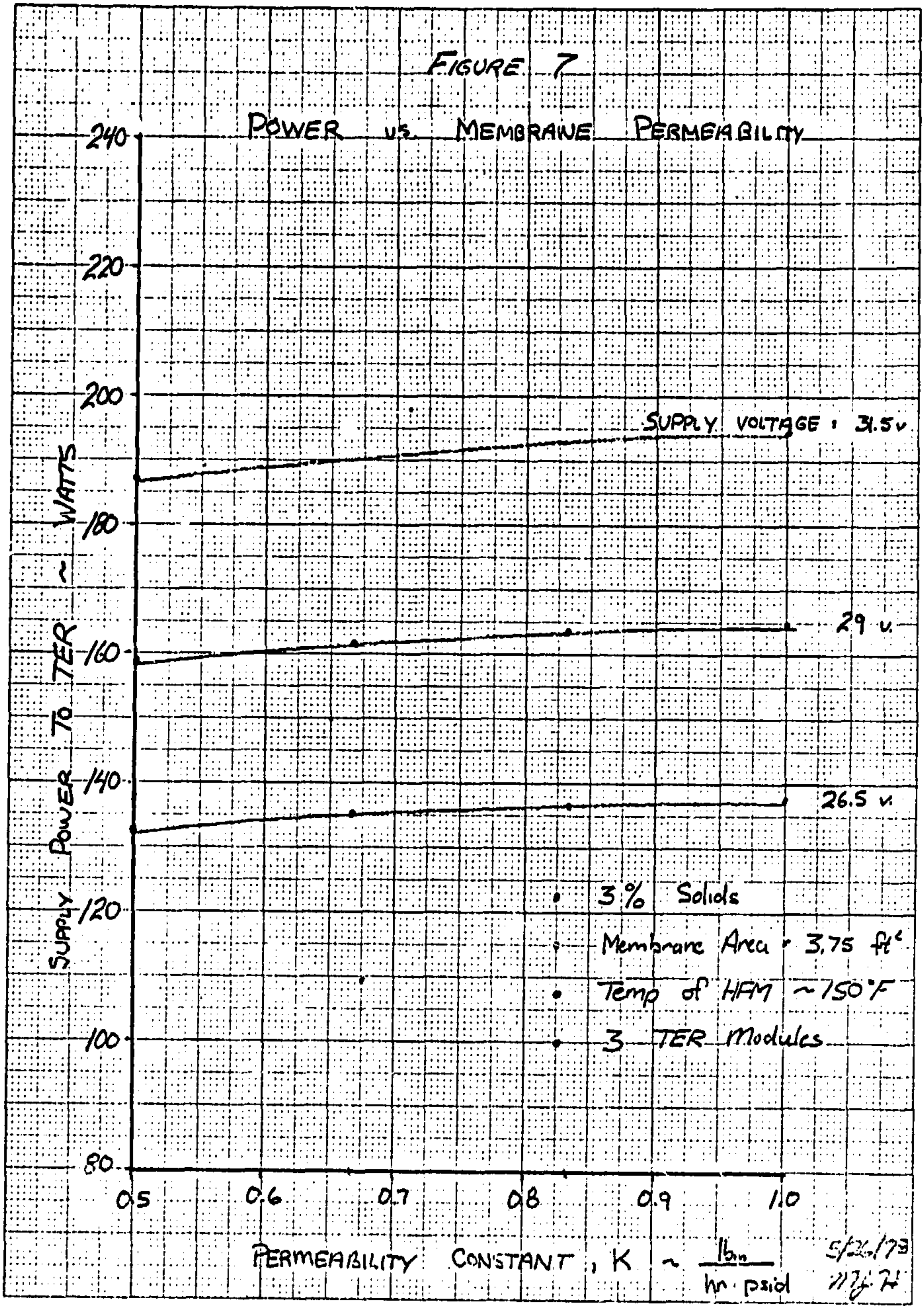

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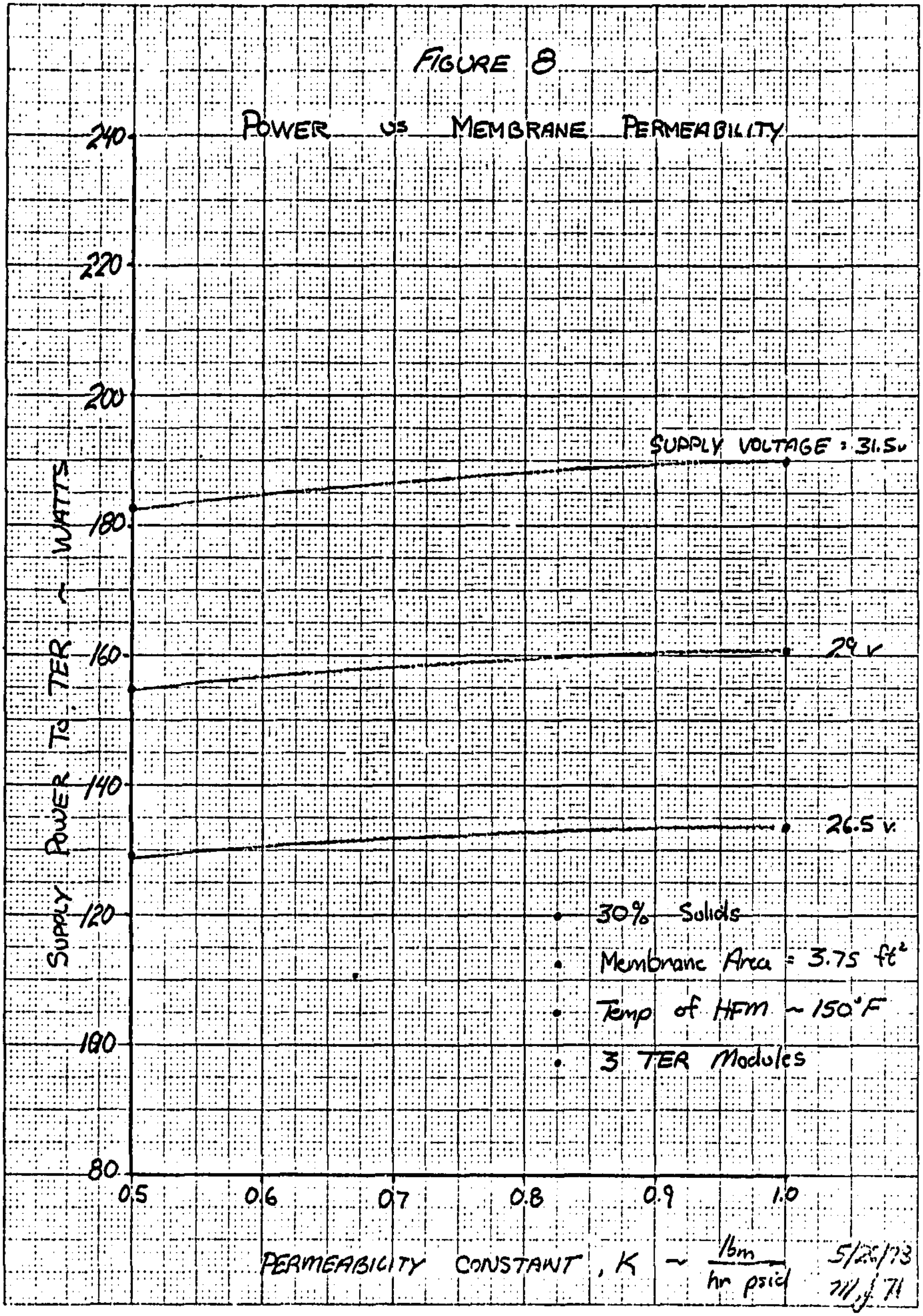
FIGURE 8
POWER vs MEMBRANE PERMEABILITY
240
220
200
180
160
140
120
100
80
SUPPLY POWER TO TER ~ WATTS
SUPPLY VOLTAGE = 31.5v
29 v
26.5 v
30% Solids
Membrane Area = 3.75 ft²
Temp of HFM ~ 150°F
3 TER Modules
0.5
0.6
0.7
0.8
0.9
1.0
PERMEABILITY CONSTANT, K ~ lbm / hr psid
5/25/73

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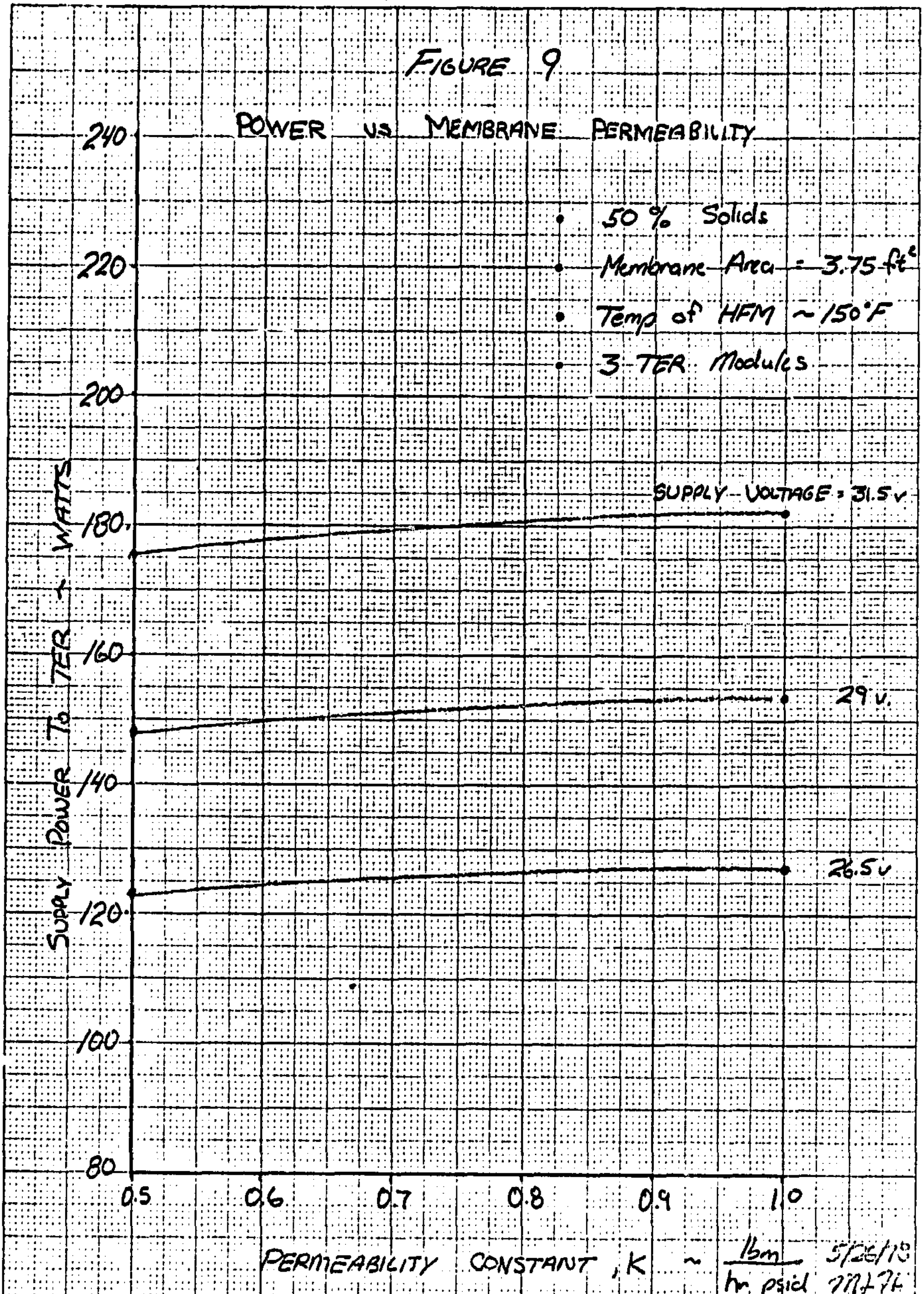

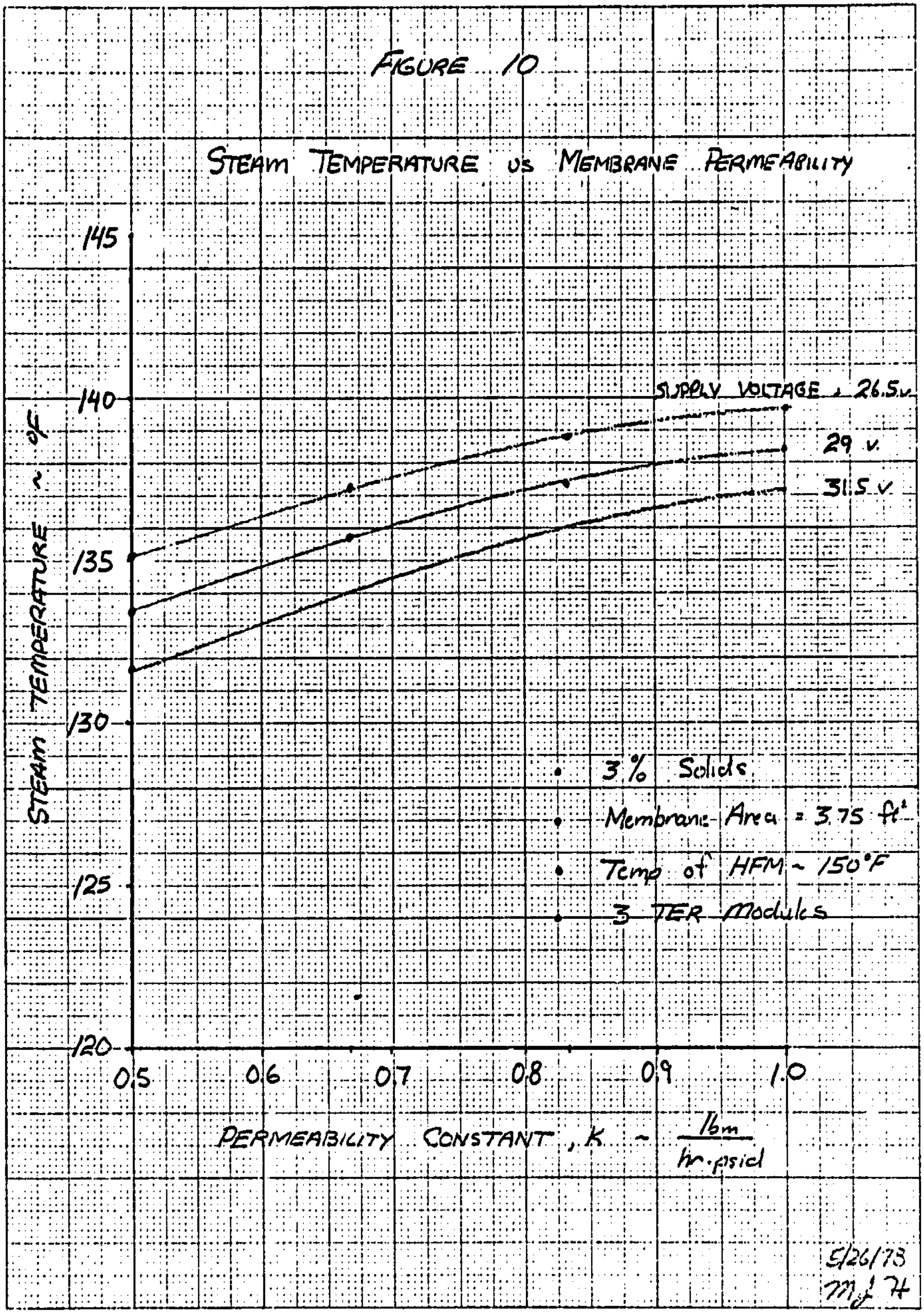

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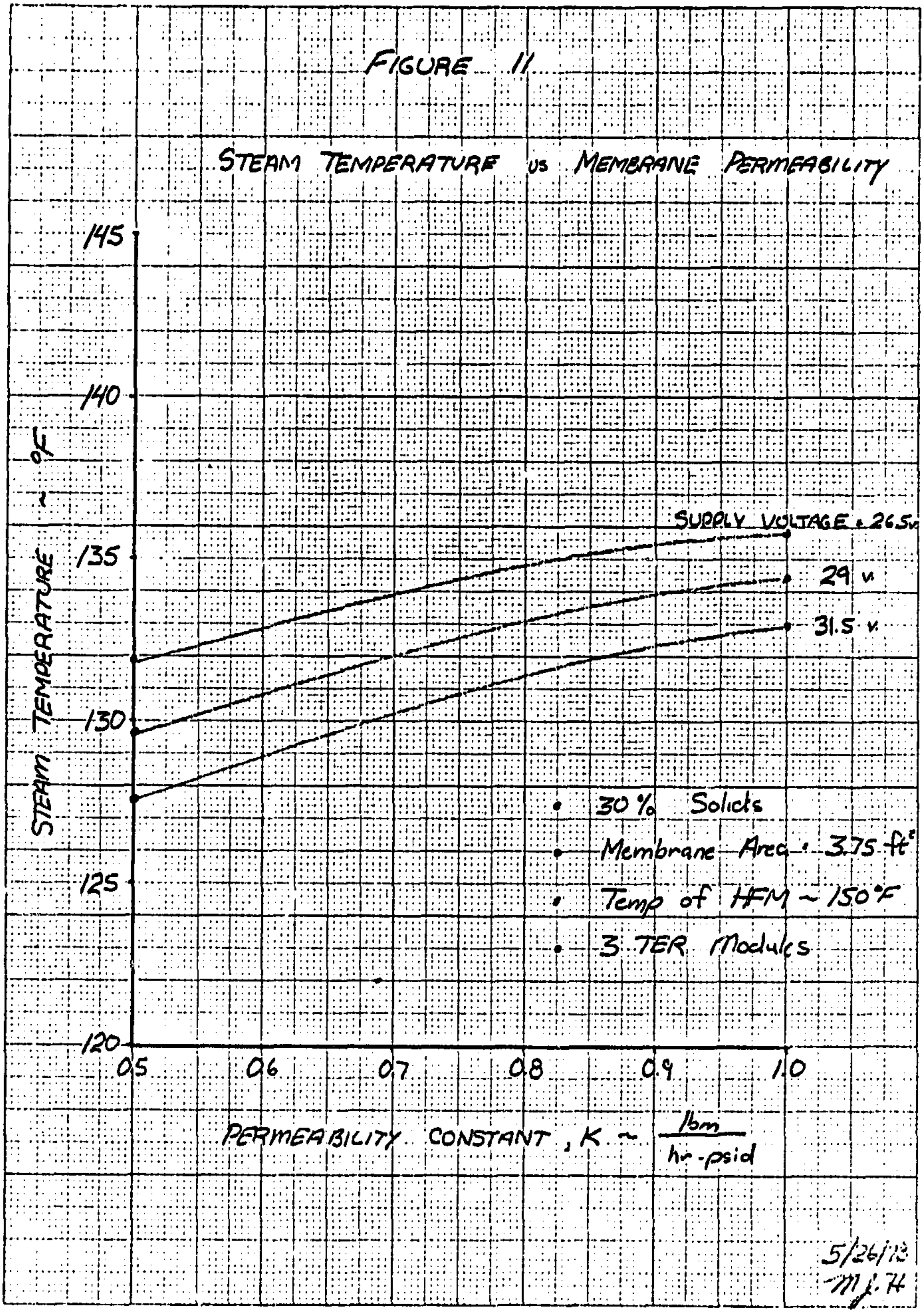

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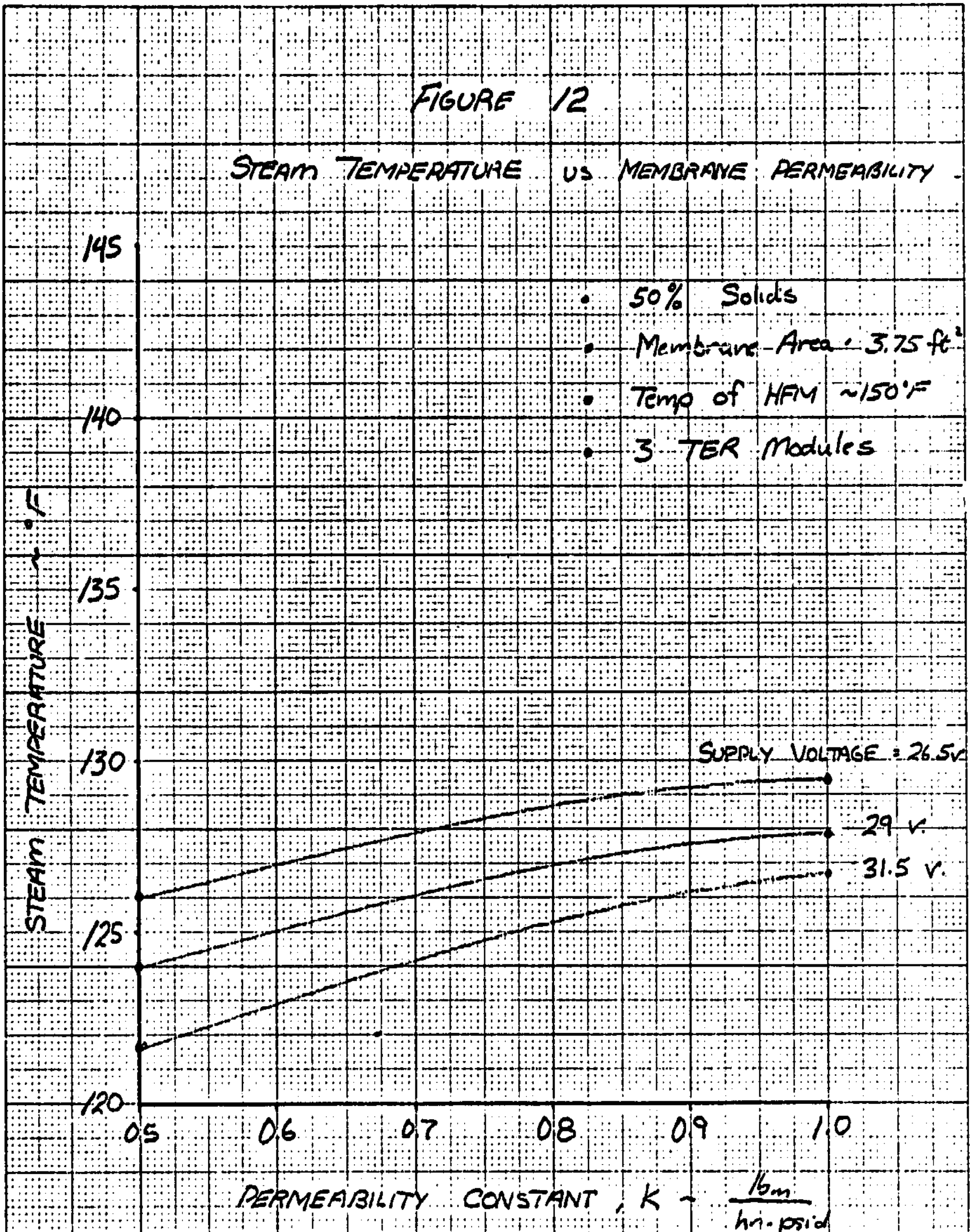

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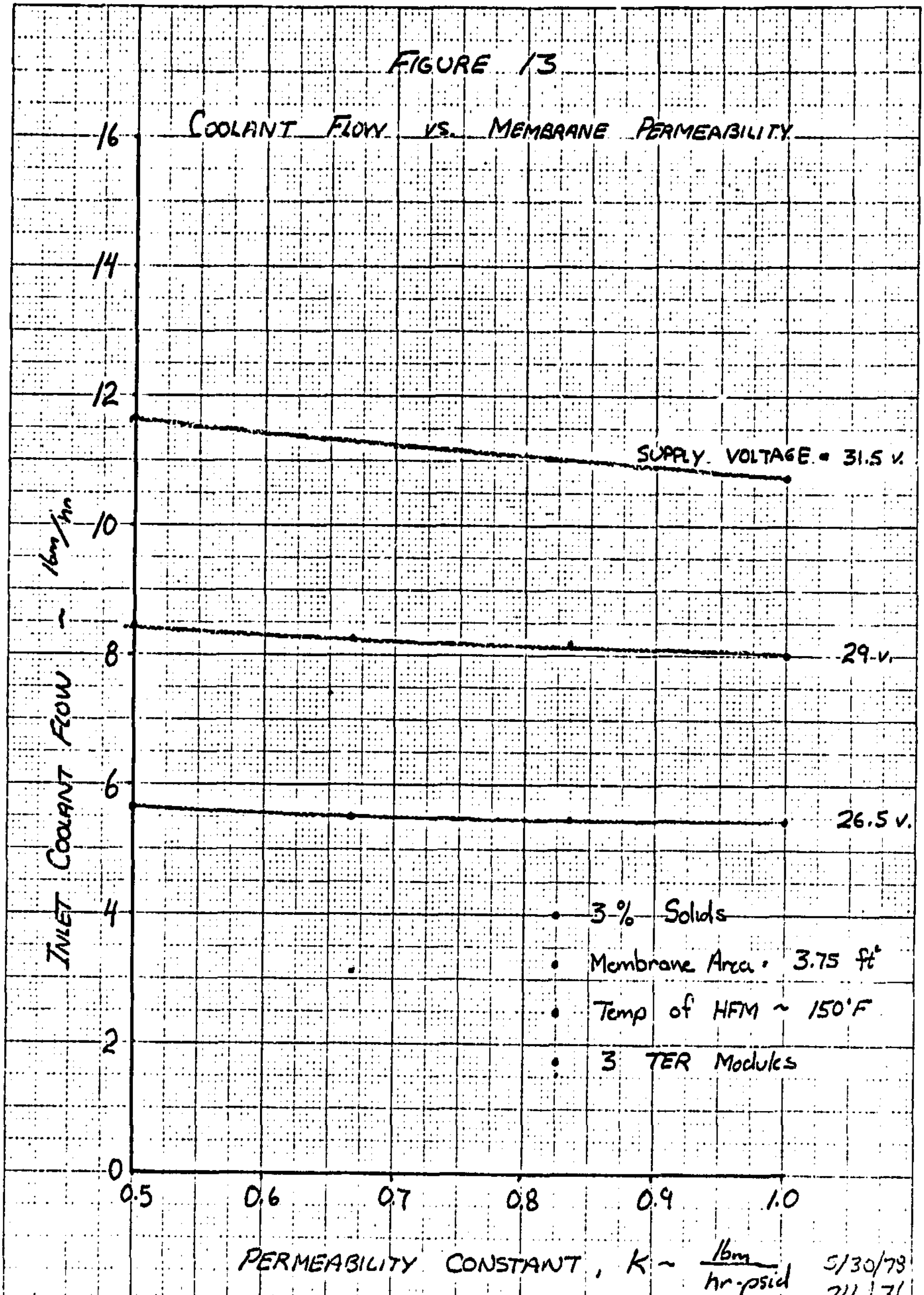

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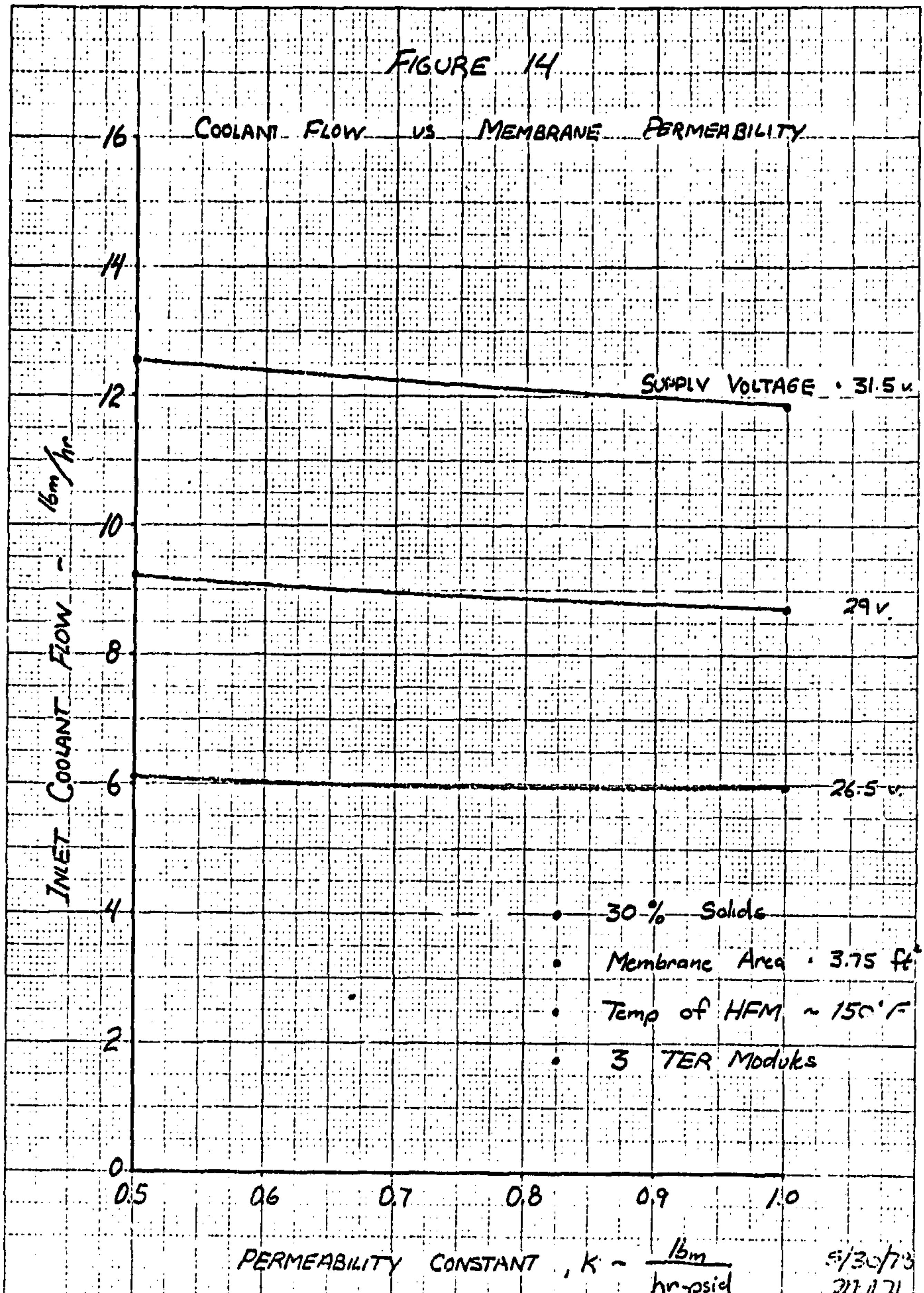

FIGURE 14
COOLANT FLOW vs MEMBRANE PERMEABILITY
16
14
12
10
8
6
4
2
0
INLET COOLANT FLOW ~ lbm/hr
SUPPLY VOLTAGE · 31.5 v.
29 v.
26.5 v.
30 % Solids
Membrane Area · 3.75 ft²
Temp of HFM ~ 150°F
3 TER Modules
0.5
0.6
0.7
0.8
0.9
1.0
PERMEABILITY CONSTANT, K ~ lbm / hr-psid
5/30/73
M.J.H.

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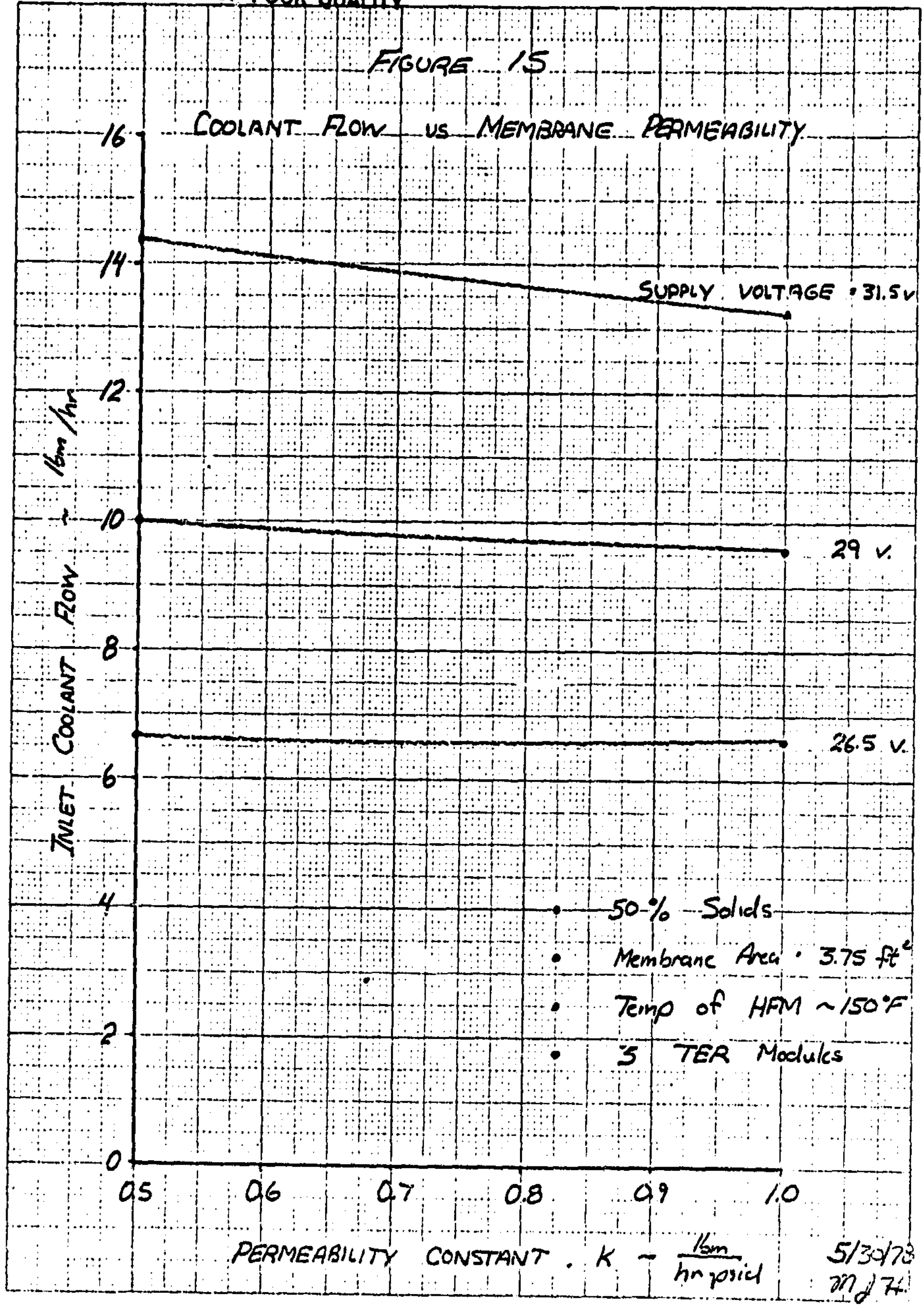

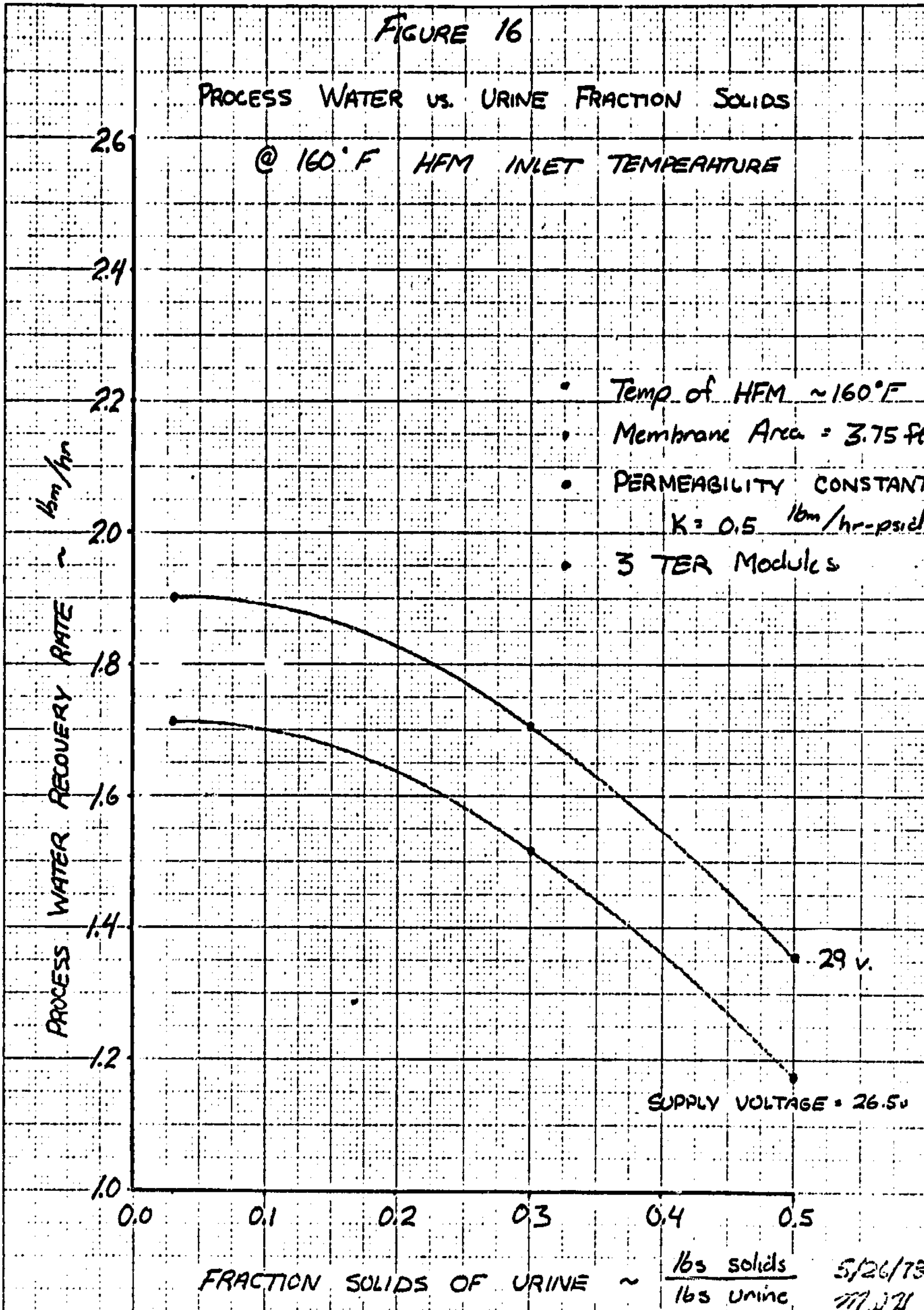

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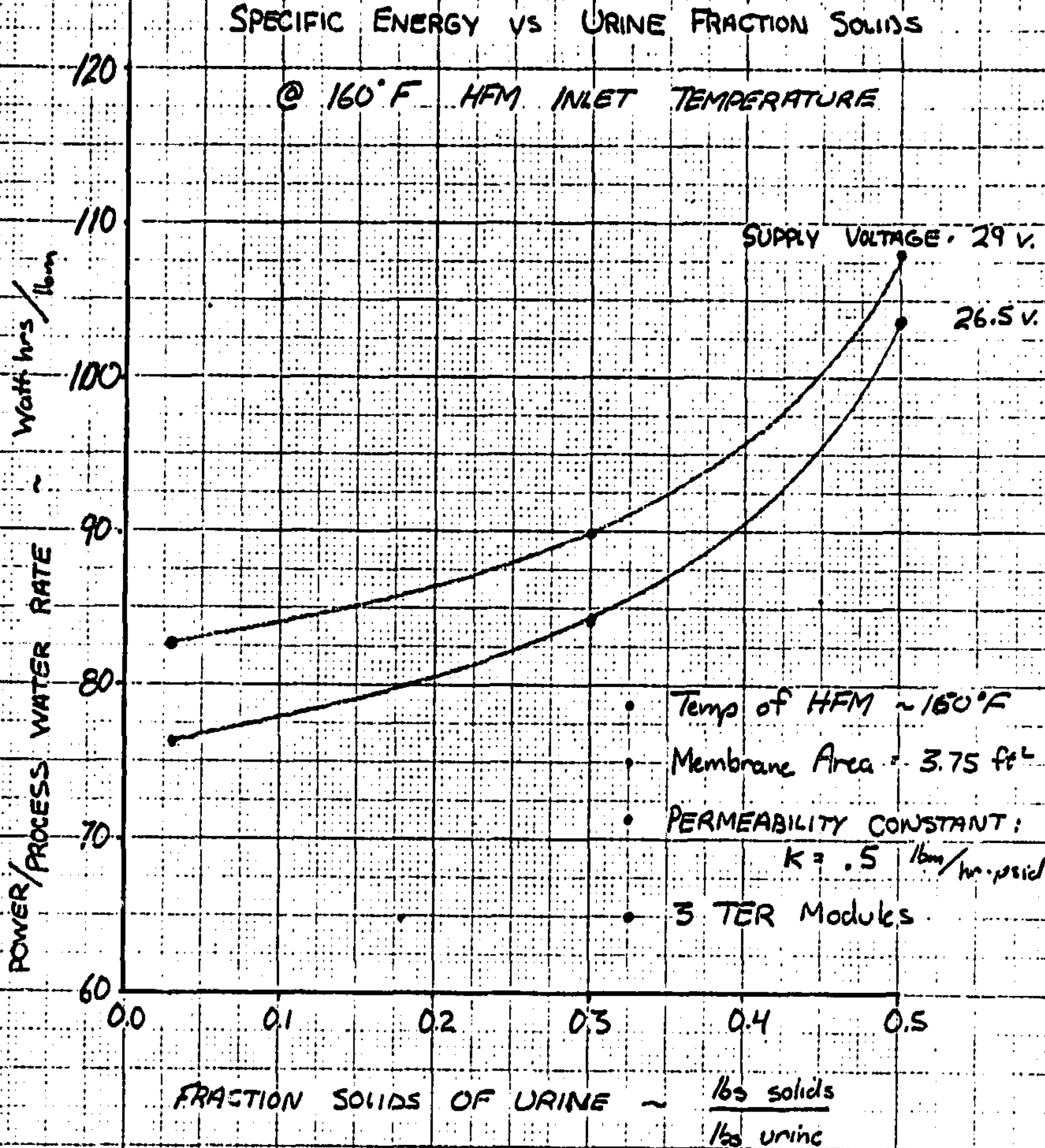
FIGURE 17


SPECIFIC ENERGY VS URINE FRACTION SOLIDS
@ 160°F HFM INLET TEMPERATURE
POWER/PROCESS WATER RATE ~ Watt hrs/lbm
120
110
100
90
80
70
60
0.0
0.1
0.2
0.3
0.4
0.5
FRACTION SOLIDS OF URINE ~ lbs solids / lbs urine
SUPPLY VOLTAGE - 29 v.
26.5 v.
• Temp of HFM ~ 160°F
• Membrane Area - 3.75 ft²
• PERMEABILITY CONSTANT: K = .5 lbm/hr·psid
• 3 TER Modules
5/26/78
M.J. H

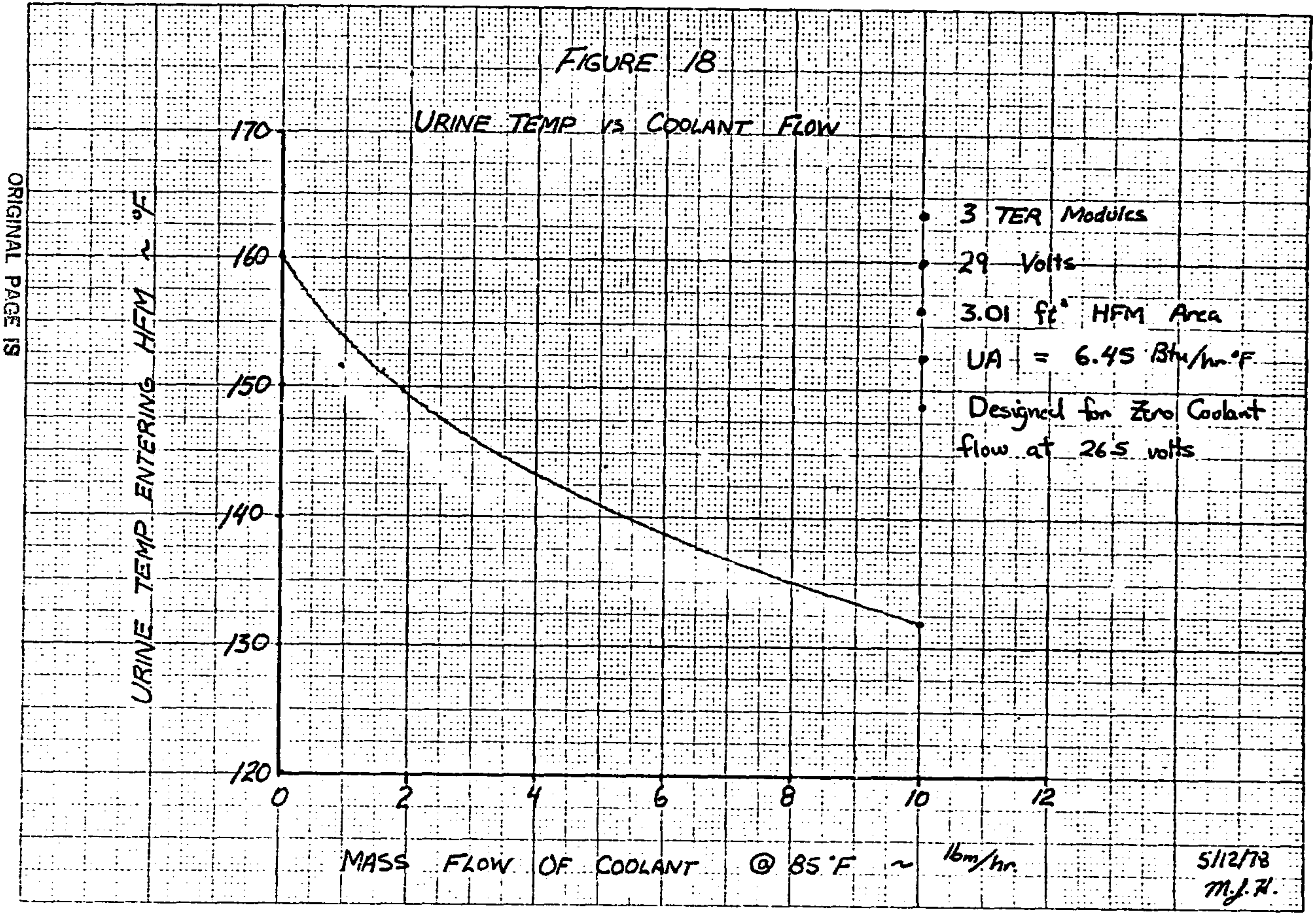
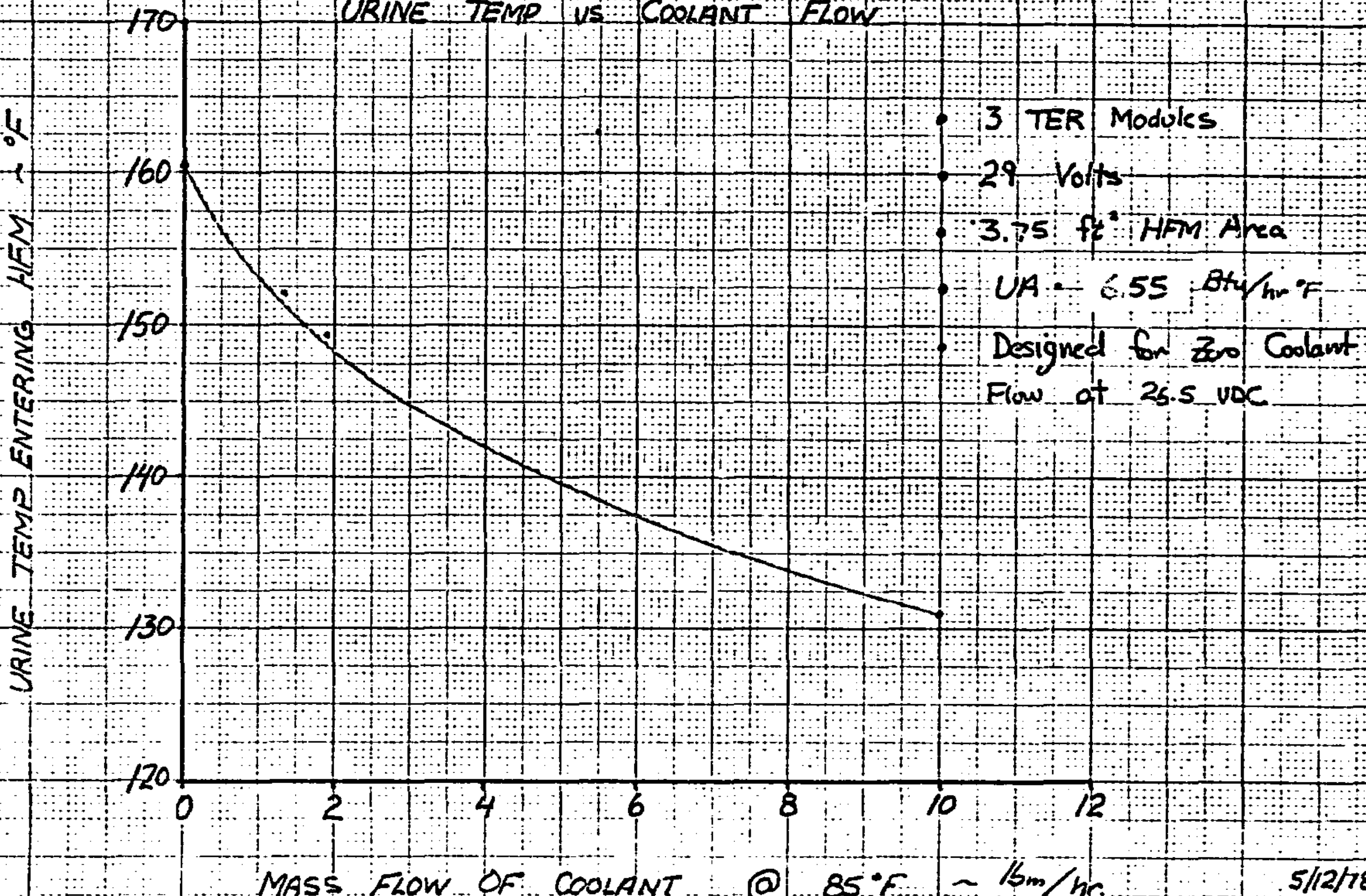


FIGURE 18
URINE TEMP vs COOLANT FLOW
170
160
150
140
130
120
0
2
4
6
8
10
12
URINE TEMP ENTERING HFM ~ °F
MASS FLOW OF COOLANT @ 85°F ~ lbm/hr.
3 TER Modules
29 Volts
3.01 ft² HFM Area
UA = 6.45 Btu/hr-°F
Designed for Zero Coolant flow at 26.5 volts
5/12/78
M.J.H.

FIGURE 19

URINE TEMP VS COOLANT FLOW



5/12/78
M.J.H.

FIGURE 20

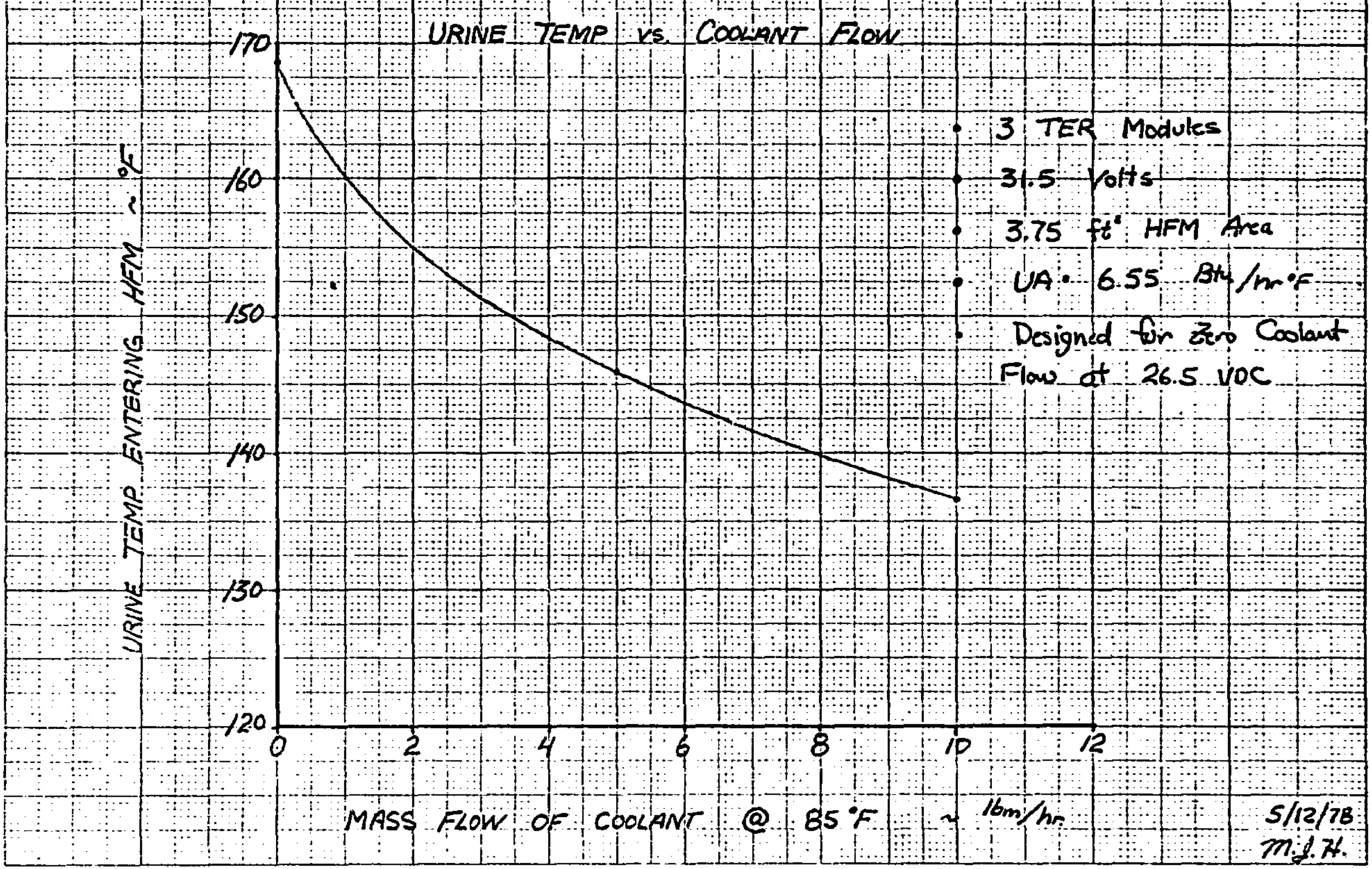
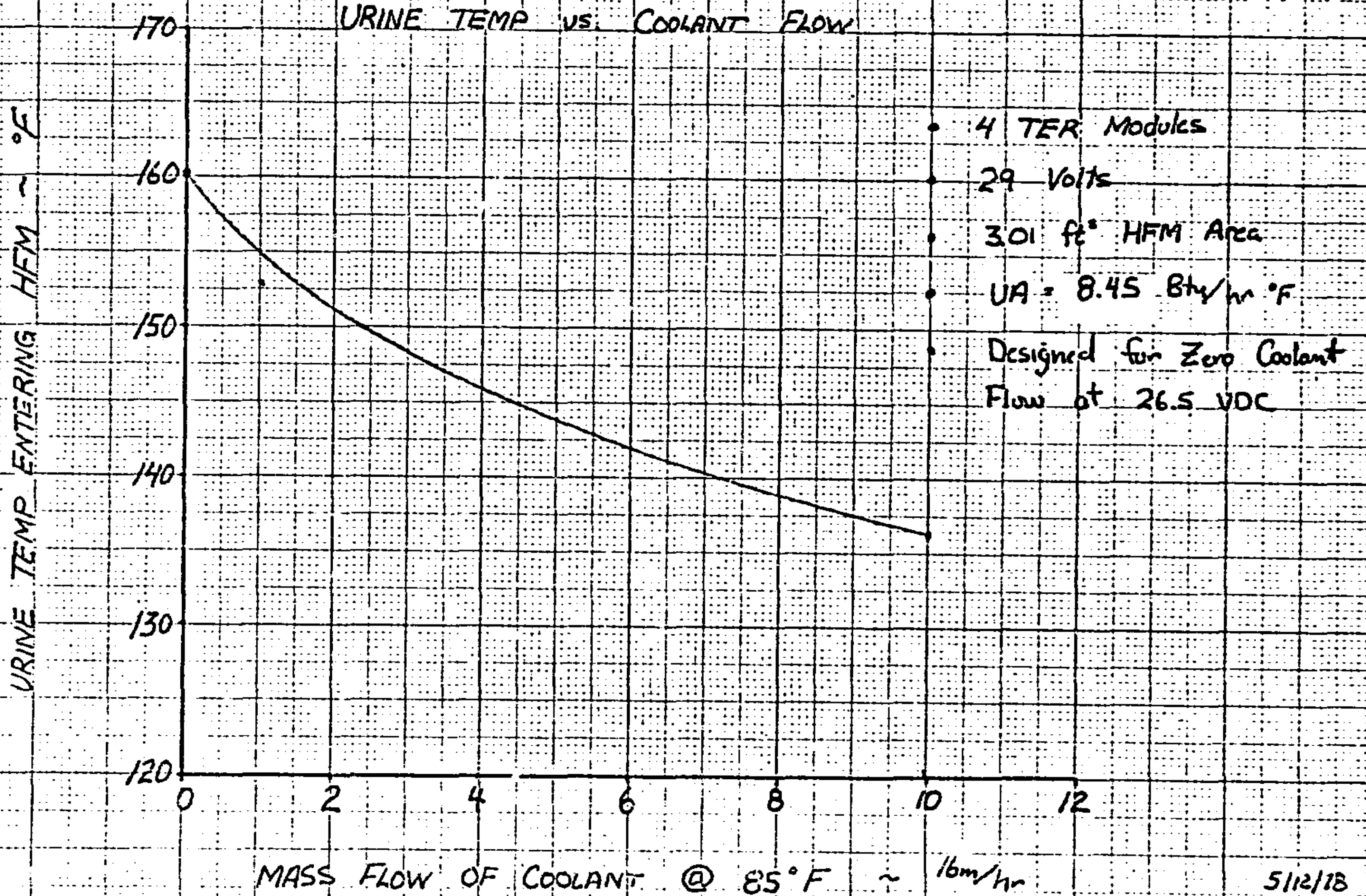

URINE TEMP vs. COOLANT FLOW
170
160
150
140
130
120
0
2
4
6
8
10
12
URINE TEMP ENTERING HFM ~ °F
MASS FLOW OF COOLANT @ 85 °F ~ lbm/hr.
• 3 TER Modules
• 31.5 Volts
• 3.75 ft² HFM Area
• UA • 6.55 Btu/hr·°F
• Designed for Zero Coolant Flow at 26.5 VDC
5/12/78
M.J.H.

FIGURE 21

URINE TEMP vs. COOLANT FLOW



5/12/78
M.J.H.

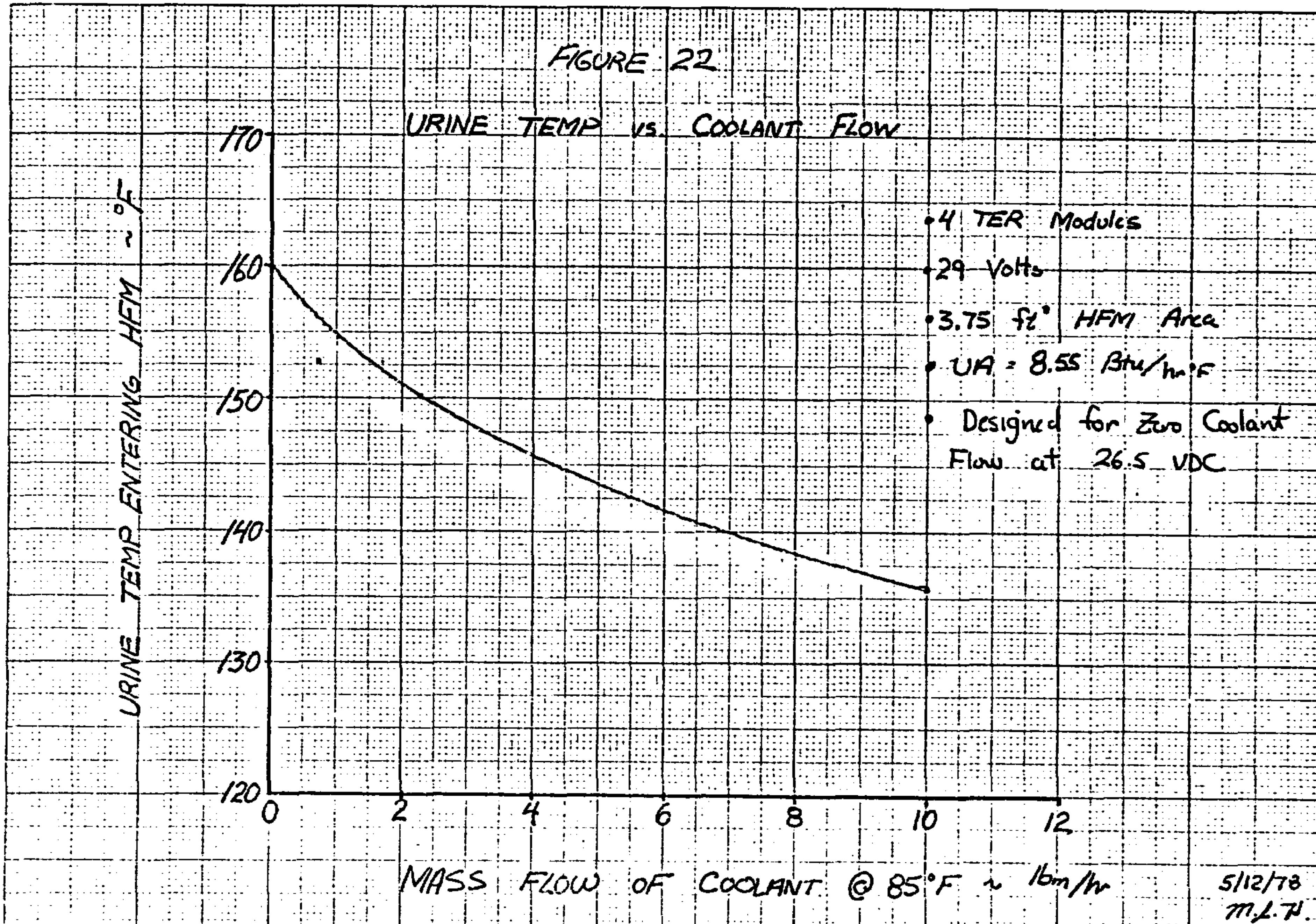


FIGURE 22
URINE TEMP vs. COOLANT FLOW
• 4 TER Modules
• 29 Volts
• 3.75 ft² HFM Area
• UA = 8.55 Btu/hr·°F
• Designed for Zero Coolant Flow at 26.5 VDC
URINE TEMP ENTERING HFM ~ °F
170
160
150
140
130
120
0
2
4
6
8
10
12
MASS FLOW OF COOLANT @ 85°F ~ lbm/hr
5/12/78
M.L.H.

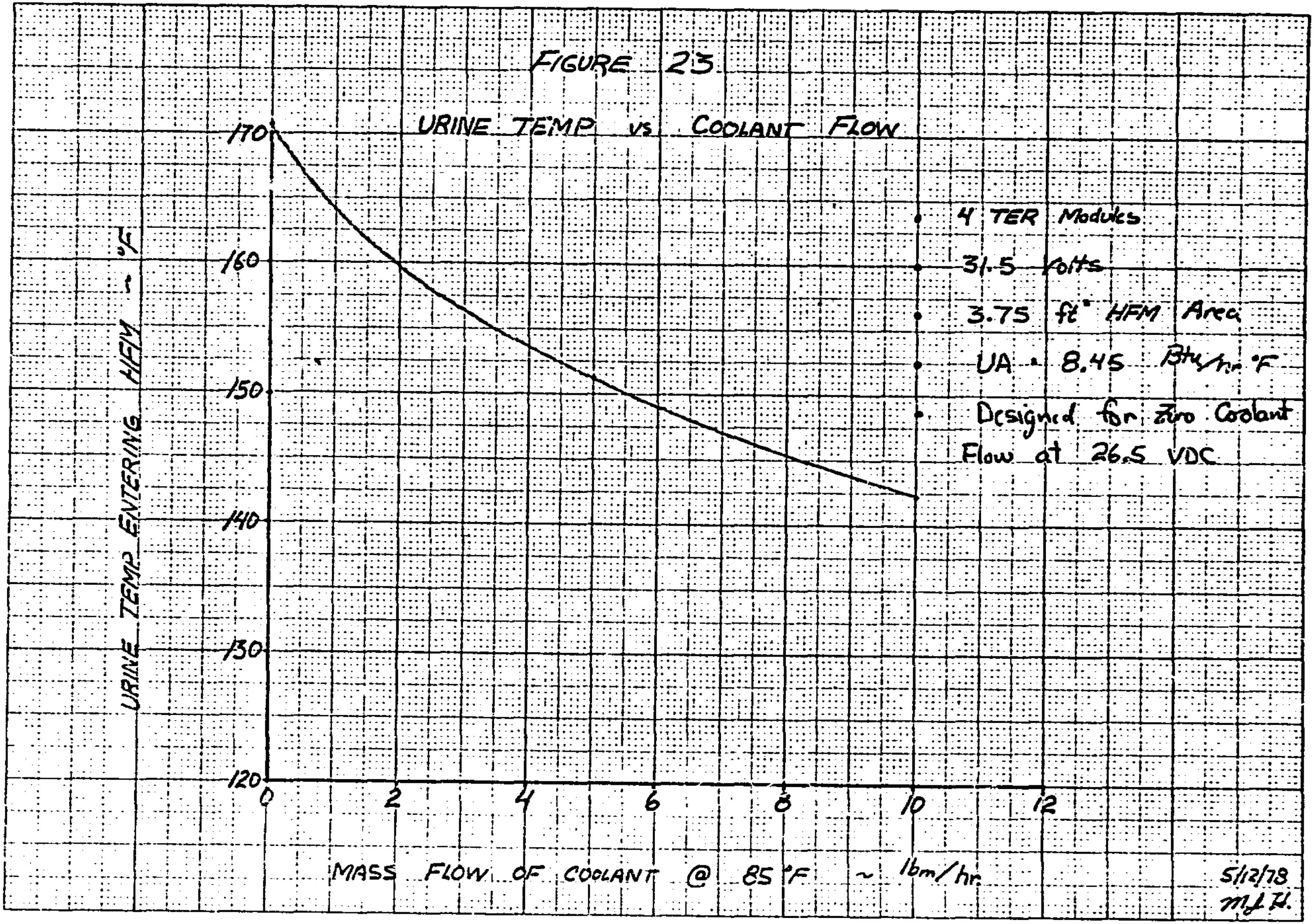


FIGURE 23
URINE TEMP vs COOLANT FLOW
170
160
150
140
130
120
0
2
4
6
8
10
12
URINE TEMP ENTERING HFM ~ °F
MASS FLOW OF COOLANT @ 85 °F ~ lbm/hr.
4 TER Modules
31.5 Volts
3.75 ft² HFM Area
UA = 8.45 Btu/hr °F
Designed for Zero Coolant Flow at 26.5 VDC
5/12/78
MJH.

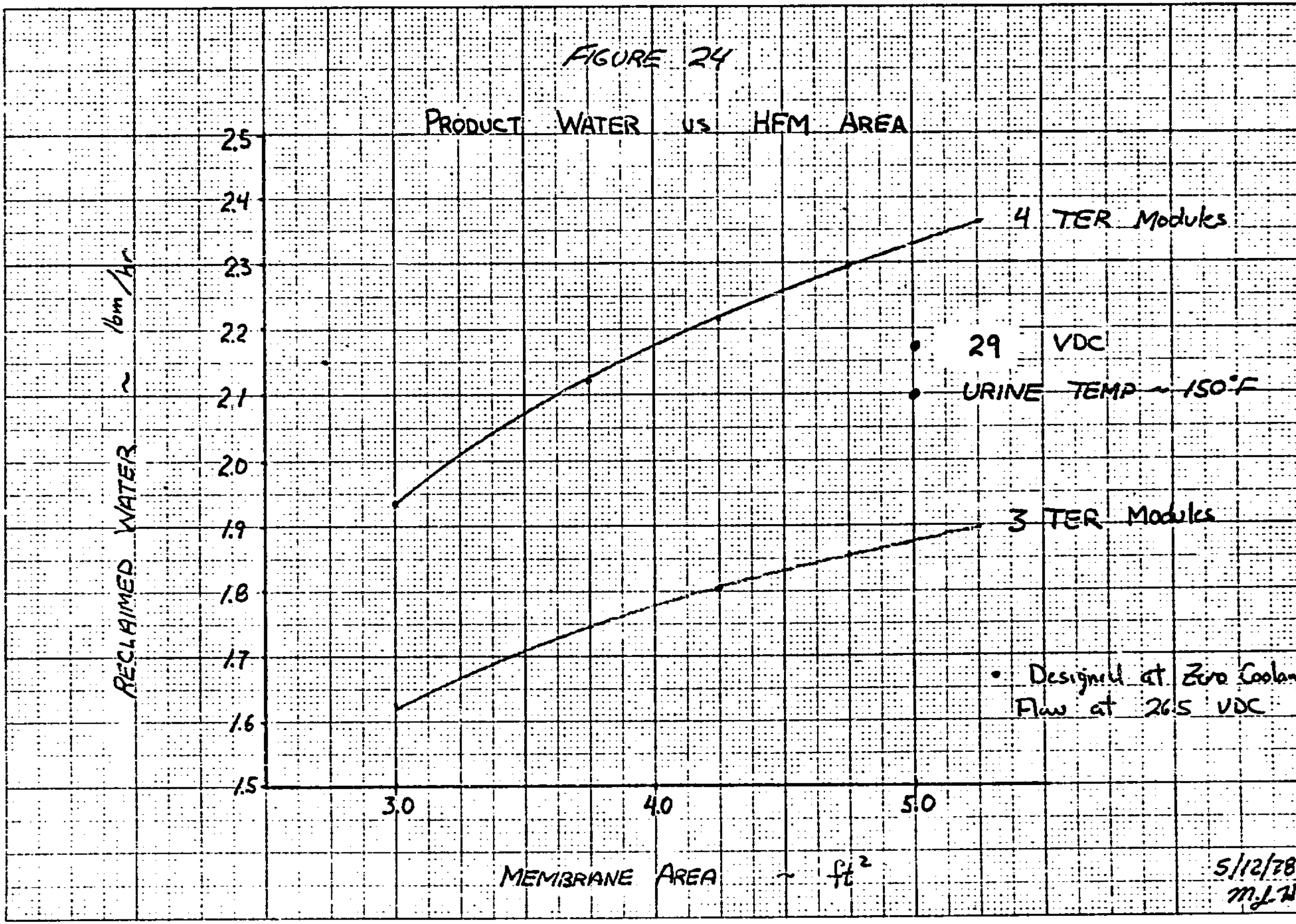
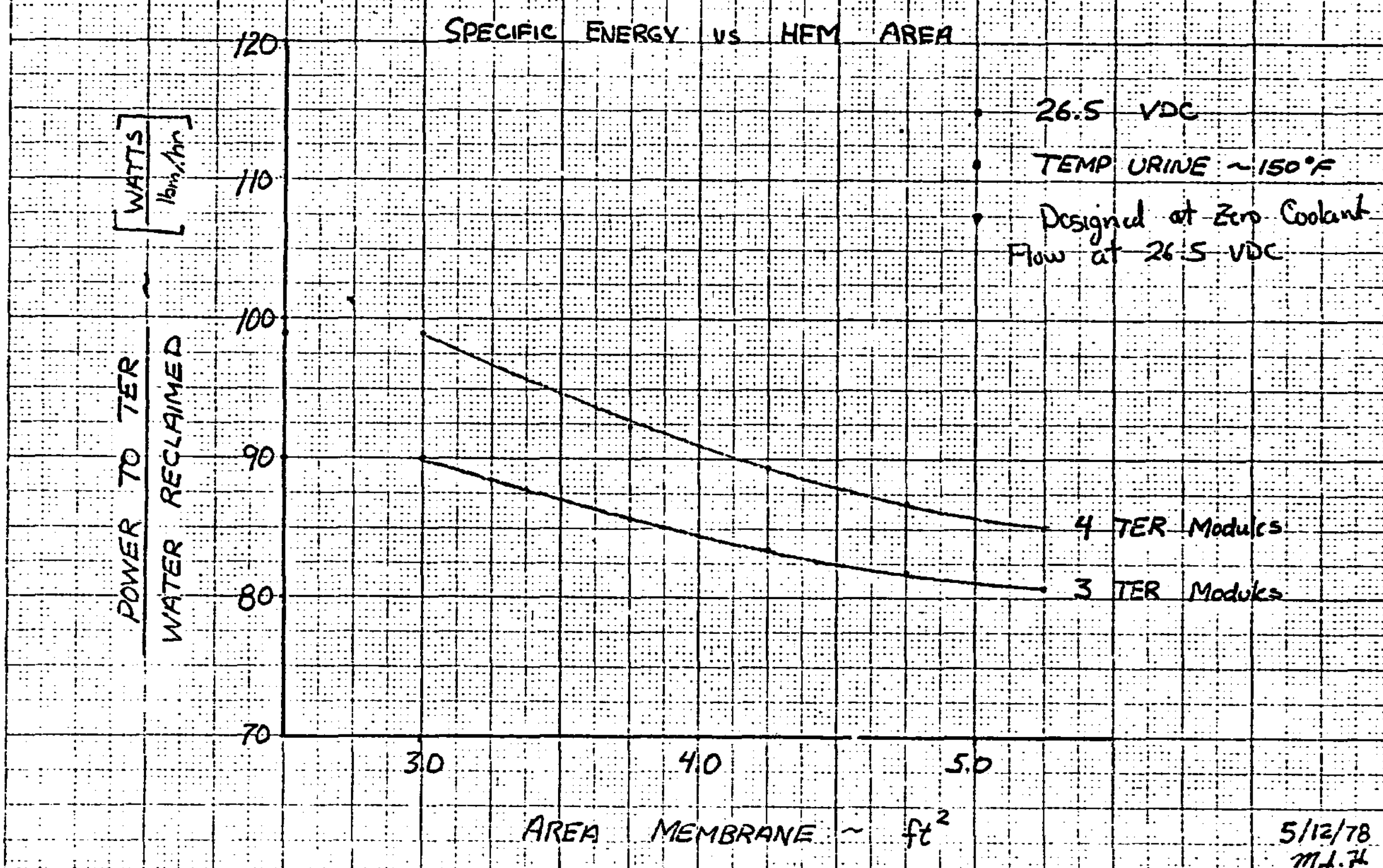


FIGURE 24
PRODUCT WATER vs HFM AREA
4 TER Modules
3 TER Modules
29 VDC
URINE TEMP ~ 150°F
• Designed at Zero Coolant Flow at 26.5 VDC
RECLAIMED WATER ~ lbm/hr
2.5
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
3.0
4.0
5.0
MEMBRANE AREA ~ ft²
5/12/78
M.J.H.

FIGURE 25


SPECIFIC ENERGY vs HEM AREA
26.5 VDC
TEMP URINE ~ 150°F
Designed at Zero Coolant Flow at 26.5 VDC
4 TER Modules
3 TER Modules
POWER TO TER / WATER RECLAIMED [WATTS / lbm/hr]
120
110
100
90
80
70
3.0
4.0
5.0
AREA MEMBRANE ~ ft²
5/12/78
MJ.H

HAMILTON STANDARD

Internal Correspondence

June 7, 1978
Analysis 78-107
File 2.14
6.3
6.5

Memorandum to: Mr. E O'Connor*

cc: Messrs. M. Hultman
J. Lovell
G. Roebelen*
R. Trusch

From: Mr. M. Heldmann*

Subject: TIMES Computer Math Model Runs

References: Analysis memo 78-92, TIMES Computer Math Model Usage by M. Heldmann

Analysis memo 78-104, TIMES Computer Math Model Results by M. Heldmann

*Only these people should receive copies of the appendix.

Summary

The actual computer printoffs of the various runs using the TIMES program as described in Analysis memo 78-92 are presented. These results were previously reduced and vital parameters graphed in Analysis memo 78-104. Task 1 lists the run number with input parameters used for that run. There are gaps in the run number sequence resulting from changes from the estimation of program running time. The nodalization for the TER results are shown in Figure 1. Figure 2 presents the nodalization for the HFM assembly. They may be helpful in interpretting the computer printoffs.

The two design point run numbers 150 and 154 for 26.5 and 29 volts, respectively, 3% solids, 3.75 ft^2 of HFM, a UA of 4.0 Btu per hour per degree F and 3 modules at a urine temperature of 150°F are given in Tables 2 and 3. All other runs are presented in the appendix.

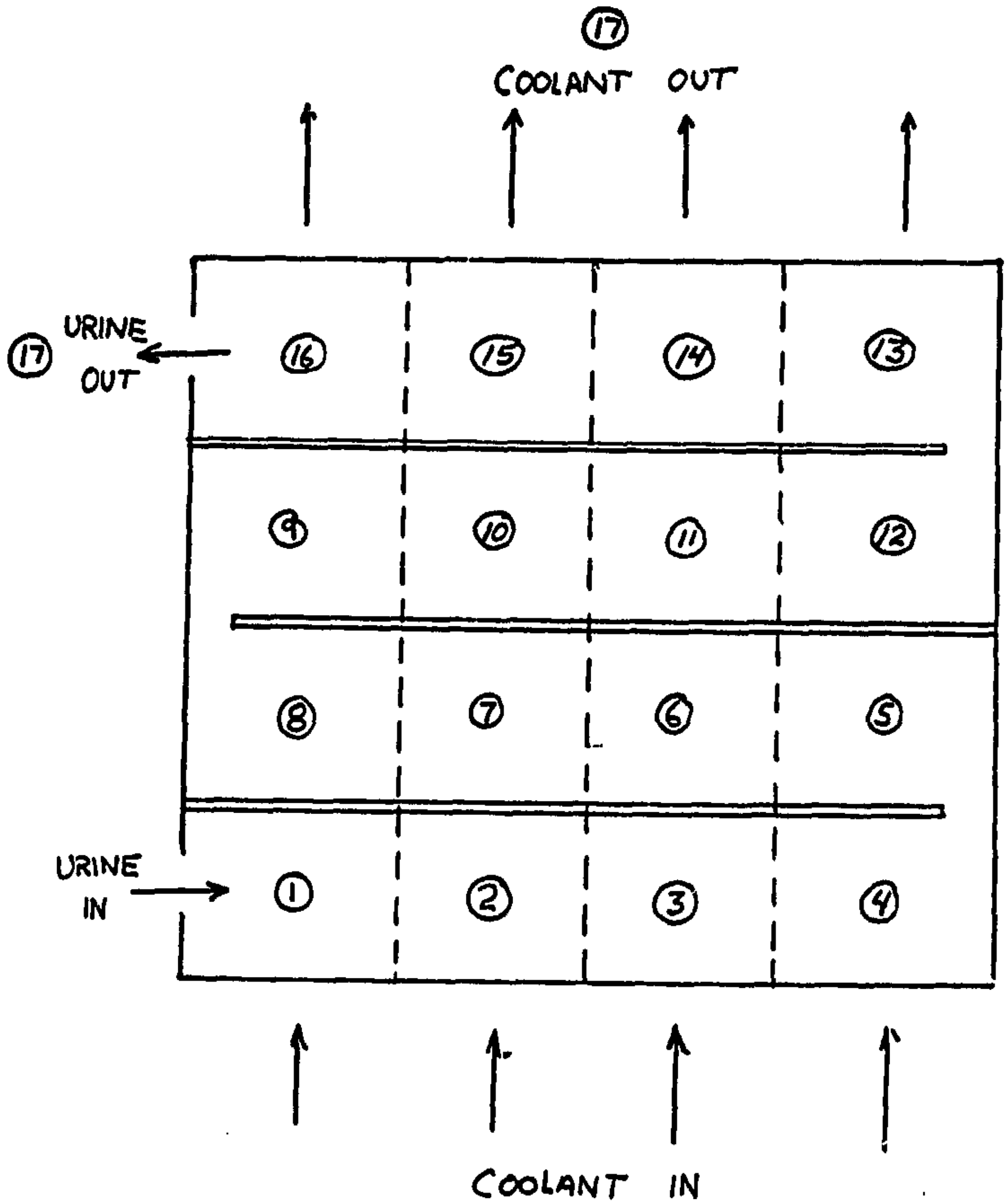
M. Heldmann

M. Heldmann

/cak

FIGURE 1

TIMES TER Module Nodes

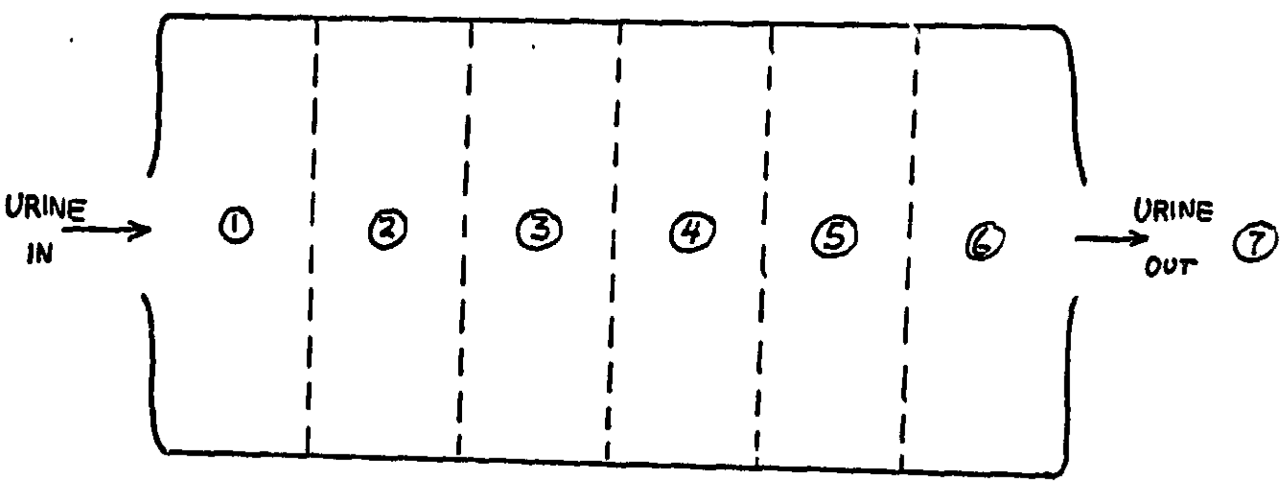


These numbers correspond to the computer output numbering of the TER.

FIGURE 2

HOLLOW FIBER MEMBRANE ASSEMBLY

"TIMES" NODALIZATION



These numbers correspond to the computer output numbering of the HFM

TABLE 1

Listing of TIMES Program Runs

Run No.	% Solids	Membrane Area	Flow From Pump	Voltage	Coolant Flow in	UA Tank	No. of TER Modules	Temp. Enter HFM
101	3	3.01 ft^2	300.00 lbm/hr	26.5v	0 lbm/hr	5.828 Btu/hr°F	3	156.44°F
102	"	"	"	"	"	6.45	"	150.77
103	"	"	"	29	"	"	"	160.34
104	"	"	"	"	10	"	"	131.99
105	"	3.75	"	26.5	0	"	"	151.09
106	"	"	"	"	"	6.55	"	150.27
107	"	"	"	29	"	"	"	159.74
108	"	"	"	"	10	"	"	131.03
109	"	3.01	"	26.5	0	7.2	4	159.31
110	"	"	"	"	"	8.2	"	151.89
111	"	"	"	"	"	8.45	"	150.22
112	"	"	"	29	"	"	"	160.37
113	"	"	"	"	10 "	"	"	136.42
114	"	3.75	"	26.5	0	8.55	"	150.16
115	"	"	"	29	"	"	"	160.12
116	"	"	"	"	10	"	"	135.76
117	"	"	"	31.5	0	6.55	3	168.63
118	"	"	"	"	5	"	"	145.97
119	"	"	"	"	10	"	"	136.60
120	"	"	"	"	0	8.45	4	170.71
121	"	"	"	"	5	"	"	151.25
122	"	"	"	"	10	"	"	142.25
123	"	4.25	"	26.5	0	6.6	"	150.04
124	"	4.75	"	"	"	6.75	3	149.00
125	"	"	"	"	"	6.65	"	149.78
126	"	5.25	"	"	"	6.70	"	149.53
127	"	4.25	"	"	"	8.6	4	150.10
128	"	4.75	"	"	"	8.65	"	150.04
129	"	5.25	"	"	"	8.70	"	149.95
130	"	4.25	"	29	2	6.6	3	148.70
131	"	"	"	"	1.5	"	"	150.95
132	"	"	"	"	1.7	"	"	150.02
133	"	4.75	"	"	"	6.65	"	149.76
134	"	5.25	"	"	1.6	6.70	"	149.94
135	"	4.25	"	"	1.7	8.6	4	152.64
136	"	"	"	"	2.3	"	"	150.54
137	"	4.75	"	"	"	8.65	"	150.39
138	"	5.25	"	"	"	8.70	"	150.26
139	"	3.01	"	"	1.6	5.828	3	155.71
140	"	"	"	"	"	6.45	"	151.30
141	"	"	"	"	1.95	"	"	149.75
142	"	3.75	"	"	1.9	6.55	"	149.40
143	"	3.01	"	"	2.4	7.2	4	157.39
144	"	"	"	"	"	8.45	"	150.21
145	"	3.75	"	"	1.7	8.55	"	152.75
146	"	"	"	"	2.3	"	"	150.66
147	"	3.01	"	26.5	0	5.44	3	160.35
148	"	"	"	29	2	"	"	156.47
149	"	"	"	"	1.5	"	"	159.33
150	"	3.75	"	26.5	5.618	4.00	"	150± .1

TABLE 1 (Continued)

Listing of TIMES Program Runs

Run No.	% Solids	Membrane Area	Flow From Pump	Voltage	Coolant Flow in	UA Tank	No. of TER Modules	Temp. Enter HFM
151	3	5	300.00	26.5	-	4.00	3	150+.1
152	"	6.25	"	"	-	"	"	"
153	"	7.5	"	"	-	"	"	"
154	"	3.75	"	29	-	"	"	"
155	"	5	"	"	8.261	"	"	"
156	"	6.25	"	"	-	"	"	"
157	"	7.5	"	"	-	"	"	"
158	"	3.75	"	31.5	-	"	"	"
161	"	7.5	"	"	-	"	"	"
162	30	3.75	"	26.5	-	"	"	"
165	"	7.5	"	"	-	"	"	"
166	"	3.75	"	29	-	"	"	"
169	"	7.5	"	"	-	"	"	"
170	"	3.75	"	31.5	-	"	"	"
173	30	7.5	"	"	-	"	"	"
174	50	3.75	"	26.5	-	"	"	"
177	"	7.5	"	"	-	"	"	"
178	"	3.75	"	29	-	"	"	"
181	"	7.5	"	"	-	"	"	"
182	"	3.75	"	31.5	-	"	"	"
185	"	7.5	"	"	-	"	"	"
186	3	3.75	"	26.5	-	"	"	160
187	30	"	"	"	-	"	"	"
188	50	"	"	"	-	"	"	"
189	3	"	"	29	-	"	"	"
190	30	"	"	"	-	"	"	"
191	50	"	"	"	-	"	"	"
192	3	"	"	26.5	-	"	2	150
193	"	"	"	29	"	"	"	"

TABLE 2

Design Point Run for 26.5 VDC

```
**** TSO FOREGROUND HARDCOPY ****
DSNAME=TSOG15Q.TIM.OUT

        - SYSTEM DESCRIPTION -

  NUMBER OF TER MODULES IS 3
  TANK HEAT TRANSFER COEFFICIENT, UA =   4.00
  VOLTAGE INPUT TO TER IS   26.5
  AMBIENT TEMPERATURE IS   70.0
  FRACTION SOLIDS IN TANK IS  0.030
  TEMPERATURE OF FEED URINE IS  110.0
  FRACTION SOLIDS OF FEED URINE IS  0.030
  MEMBRANE AREA IS   3.750
  PERMEABILITY CONSTANT IS   0.500
  AM MULTIPLIER IS   1.000
  KM MULTIPLIER IS   1.000
  RM MULTIPLIER IS   1.000
  CONVERGING HFM TEMP IS   150.0
  EFFECTIVENESS OF COOLER IS   0.5000
  COOLER AMBIENT TEMP IS   70.0
  MAX NUMBER OF ITERATIONS IS 10
```

150-1

150+2

```
***** RUN HAS BEEN COMPLETED *****

      ENGLISH UNITS ARE USED

   PROPERTIES OF URINE LEAVING HFM
        TEMPERATURE =   144.22
        FRACTION SOLIDS =  0.03017
        MASS FLOW URINE =   298.32

   PROPERTIES OF URINE LEAVING RECIRCULATING TANK
        TEMPERATURE =   143.21
        FRACTION SOLIDS =  0.03000
        MASS FLOW URINE =   298.30

   PROPERTIES OF URINE ENTERING PUMP
        TEMPERATURE =   143.04
        FRACTION SOLIDS =  0.03000
        MASS FLOW URINE =   299.97

   PROPERTIES OF URINE ENTERING TER
        TEMPERATURE =   143.35
        FRACTION SOLIDS =  0.03000
        MASS FLOW URINE =   300.00

   TEMPERATURES OF URINE AND STEAM FLOWS BETWEEN TER AND HFM
        URINE TEMP =   149.93
        STEAM TEMP =   135.14

   COOLANT OR CONDENSATE FLOWS THROUGH TER
     MASS FLOW OF COOLANT IN =     5.618   TEMPERATURE =   102.50
     MASS FLOW OF COOLANT OUT =    7.292   TEMPERATURE =   134.72

   ELECTRICAL POWER TO TER =    132.8 WATTS

   HEAT LEAK FROM THE UNIT =    292.8 BTU/HR

   NET HEAT INTO SYSTEM =    28.20

   CURRENT INTO TEDS =  1.6699 AMPS

          ***** WATER RECLAIMED FROM URINE IS  1.674 LBS PER HOUR *****

   POWER / PRODUCT WATER RATE =    79.31

      - PARAMETERS OF NODES WITHIN TER -

   NODE( 1)
   TEMP OF URINE IN IS   143.35   TEMP OF URINE OUT IS   143.78
   TEMP OF COOLANT IN IS   102.50   TEMP OF COOLANT OUT IS   134.54
   MASS FLOW OF COOLANT IN IS   0.2341   MASS FLOW OF COOLANT OUT IS   0.2504
```

```
VOLTAGE ACROSS TED IS   0.8061
TC =   133.94        TH =   144.54
QC =  16.5600        QH =  21.1833

NODE( 2)
TEMP OF URINE IN IS   143.78   TEMP OF URINE OUT IS   144.21
TEMP OF COOLANT IN IS   102.50   TEMP OF COOLANT OUT IS   134.55
MASS FLOW OF COOLANT IN IS   0.2341   MASS FLOW OF COOLANT OUT IS   0.2592
VOLTAGE ACROSS TED IS   0.8094
TC =   133.95        TH =   144.97
QC =  16.4165        QH =  21.0301

NODE( 3)
TEMP OF URINE IN IS   144.21   TEMP OF URINE OUT IS   144.64
TEMP OF COOLANT IN IS   102.50   TEMP OF COOLANT OUT IS   134.55
MASS FLOW OF COOLANT IN IS   0.2341   MASS FLOW OF COOLANT OUT IS   0.2580
VOLTAGE ACROSS TED IS   0.8124
TC =   133.96        TH =   145.38
QC =  16.2545        QH =  20.8854

NODE( 4)
TEMP OF URINE IN IS   144.64   TEMP OF URINE OUT IS   145.06
TEMP OF COOLANT IN IS   102.50   TEMP OF COOLANT OUT IS   134.56
MASS FLOW OF COOLANT IN IS   0.2341   MASS FLOW OF COOLANT OUT IS   0.2578
VOLTAGE ACROSS TED IS   0.8156
TC =   133.97        TH =   145.80
QC =  16.0851        QH =  20.7341

NODE( 5)
TEMP OF URINE IN IS   145.06   TEMP OF URINE OUT IS   145.48
TEMP OF COOLANT IN IS   134.56   TEMP OF COOLANT OUT IS   134.67
MASS FLOW OF COOLANT IN IS   0.2578   MASS FLOW OF COOLANT OUT IS   0.2740
VOLTAGE ACROSS TED IS   0.8175
TC =   134.19        TH =   146.22
QC =  16.0104        QH =  20.6704

NODE( 6)
TEMP OF URINE IN IS   145.48   TEMP OF URINE OUT IS   145.90
TEMP OF COOLANT IN IS   134.55   TEMP OF COOLANT OUT IS   134.67
MASS FLOW OF COOLANT IN IS   0.2580   MASS FLOW OF COOLANT OUT IS   0.2740
VOLTAGE ACROSS TED IS   0.8206
TC =   134.20        TH =   146.63
QC =  15.8425        QH =  20.5203

NODE( 7)
TEMP OF URINE IN IS   145.90   TEMP OF URINE OUT IS   146.32
TEMP OF COOLANT IN IS   134.55   TEMP OF COOLANT OUT IS   134.68
MASS FLOW OF COOLANT IN IS   0.2582   MASS FLOW OF COOLANT OUT IS   0.2740
VOLTAGE ACROSS TED IS   0.8237
TC =   134.21        TH =   147.04
QC =  15.6751        QH =  20.3707

NODE( 8)
```

150-3

ORIGINAL PAGE IS
OF POOR QUALITY

```
TEMP OF URINE IN IS   146.32   TEMP OF URINE OUT IS   146.73
TEMP OF COOLANT IN IS   134.54   TEMP OF COOLANT OUT IS   134.68
MASS FLOW OF COOLANT IN IS   0.2504   MASS FLOW OF COOLANT OUT IS   0.2740
VOLTAGE ACROSS TED IS   0.8268
TC =   134.22        TH =   147.45
QC =  15.5091        QH =  20.2224

NODE( 9)
TEMP OF URINE IN IS   146.73   TEMP OF URINE OUT IS   147.14
TEMP OF COOLANT IN IS   134.68   TEMP OF COOLANT OUT IS   134.69
MASS FLOW OF COOLANT IN IS   0.2740   MASS FLOW OF COOLANT OUT IS   0.2895
VOLTAGE ACROSS TED IS   0.8299
TC =   134.24        TH =   147.86
QC =  15.3449        QH =  20.0756

NODE(10)
TEMP OF URINE IN IS   147.14   TEMP OF URINE OUT IS   147.55
TEMP OF COOLANT IN IS   134.68   TEMP OF COOLANT OUT IS   134.70
MASS FLOW OF COOLANT IN IS   0.2740   MASS FLOW OF COOLANT OUT IS   0.2893
VOLTAGE ACROSS TED IS   0.8329
TC =   134.25        TH =   148.26
QC =  15.1811        QH =  19.9292

NODE(11)
TEMP OF URINE IN IS   147.55   TEMP OF URINE OUT IS   147.95
TEMP OF COOLANT IN IS   134.67   TEMP OF COOLANT OUT IS   134.70
MASS FLOW OF COOLANT IN IS   0.2740   MASS FLOW OF COOLANT OUT IS   0.2892
VOLTAGE ACROSS TED IS   0.8360
TC =   134.25        TH =   148.66
QC =  15.0177        QH =  19.7931

NODE(12)
TEMP OF URINE IN IS   147.95   TEMP OF URINE OUT IS   148.35
TEMP OF COOLANT IN IS   134.67   TEMP OF COOLANT OUT IS   134.70
MASS FLOW OF COOLANT IN IS   0.2740   MASS FLOW OF COOLANT OUT IS   0.2890
VOLTAGE ACROSS TED IS   0.8390
TC =   134.26        TH =   149.06
QC =  14.8557        QH =  19.6382

NODE(13)
TEMP OF URINE IN IS   148.35   TEMP OF URINE OUT IS   148.75
TEMP OF COOLANT IN IS   134.70   TEMP OF COOLANT OUT IS   134.71
MASS FLOW OF COOLANT IN IS   0.2890   MASS FLOW OF COOLANT OUT IS   0.3038
VOLTAGE ACROSS TED IS   0.8420
TC =   134.27        TH =   149.45
QC =  14.6948        QH =  19.4944

NODE(14)
TEMP OF URINE IN IS   148.75   TEMP OF URINE OUT IS   149.15
TEMP OF COOLANT IN IS   134.70   TEMP OF COOLANT OUT IS   134.71
MASS FLOW OF COOLANT IN IS   0.2892   MASS FLOW OF COOLANT OUT IS   0.3038
VOLTAGE ACROSS TED IS   0.8449
TC =   134.28        TH =   149.84
QC =  14.5346        QH =  19.3511
```

150-4

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OF POOR QUALITY

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NODE(15)
TEMP OF URINE IN IS   149.15   TEMP OF URINE OUT IS   149.5
TEMP OF COOLANT IN IS   134.70   TEMP OF COOLANT OUT IS   134.72
MASS FLOW OF COOLANT IN IS   0.2893   MASS FLOW OF COOLANT OUT IS   0.3038
VOLTAGE ACROSS TED IS   0.8479
TC =   134.29      TH =   150.23
QC =  14.3755      QH =  19.2087

NODE(16)
TEMP OF URINE IN IS   149.54   TEMP OF URINE OUT IS   149.93
TEMP OF COOLANT IN IS   134.69   TEMP OF COOLANT OUT IS   134.72
MASS FLOW OF COOLANT IN IS   0.2895   MASS FLOW OF COOLANT OUT IS   0.3038
VOLTAGE ACROSS TED IS   0.8508
TC =   134.30      TH =   150.61
QC =  14.2173      QH =  19.0672

     - HFM NODAL DESCRIPTION -

STEAM PRESSURE =   2.5673

NODE(1)
MASS FLOW OF URINE IN IS   300.00
TEMPERATURE OF URINE IN IS   149.93
VAPOR PRESSURE URINE IS   3.6926
FRACTION SOLIDS IS  0.0300
FLOW OF DIFFUSED WATER VAPOR IS  0.35163

NODE(2)
MASS FLOW OF URINE IN IS   299.64
TEMPERATURE OF URINE IN IS   148.73
VAPOR PRESSURE URINE IS   3.5845
FRACTION SOLIDS IS  0.0300
FLOW OF DIFFUSED WATER VAPOR IS  0.31786

NODE(3)
MASS FLOW OF URINE IN IS   299.33
TEMPERATURE OF URINE IN IS   147.65
VAPOR PRESSURE URINE IS   3.4890
FRACTION SOLIDS IS  0.0301
FLOW OF DIFFUSED WATER VAPOR IS  0.28802

NODE(4)
MASS FLOW OF URINE IN IS   299.04
TEMPERATURE OF URINE IN IS   146.67
VAPOR PRESSURE URINE IS   3.4043
FRACTION SOLIDS IS  0.0301
FLOW OF DIFFUSED WATER VAPOR IS  0.26154

NODE(5)
MASS FLOW OF URINE IN IS   298.78
TEMPERATURE OF URINE IN IS   145.77
```

150.5

```
VAPOR PRESSURE URINE IS   3.3288
FRACTION SOLIDS IS  0.0301
FLOW OF DIFFUSED WATER VAPOR IS  0.23795

NODE(6)
MASS FLOW OF URINE IN IS   298.54
TEMPERATURE OF URINE IN IS   144.96
VAPOR PRESSURE URINE IS   3.2613
FRACTION SOLIDS IS  0.0301
FLOW OF DIFFUSED WATER VAPOR IS  0.21685

MASS FLOW OF URINE OUT IS  298.3220
TEMPERATURE OF URINE OUT IS   144.22
FRACTION SOLIDS IS  0.03017
```

150-6

ORIGINAL PAGE IS
OF POOR QUALITY

HAMILTON STANDARD

Internal Correspondence

June 12, 1978

Analysis 78-109
File: 2.14
6.3
6.5

Memorandum to: Mr. G. Roebelen

cc: Messrs. D. Faye
P. Gaffney
M. Heldmann
M. Hultman
J. Lovell
R. Trusch

From: E. W. O'Connor

Subject: TIMES - Heat Leak and Heater Study

The attached document describes the results of a study to determine insulation thickness and to determine system thermal control when the waste tank is empty. The heater study portion answers an action item from the April 12, 1978 NASA meeting.

E.W.O'C

HEAT LEAK AND HEATER STUDY

The TIMES thermal aspects were studies to determine insulation thickness, warm-up heater power and heater operating technique with the following conclusions:

1. The recycle tank, TER, HFM, urine pump and all components packaged with those components should be covered with three (3) inches of insulation.

2. Heaters should be placed on the recycle tank for start-up or dormant mode heating.

3. The heaters should be sized at 150 watts at 26.5 VDC and should have an overtemperature cut-out at a tank temperature of 200°F.

4. During heating modes the urine recycle pump should be operational.

5. With Solar Cell power when installed power (WATTS/PPH) is the critical criteria, the system should be maintained at operations temperature during dormant periods.

6. With Fuel Cell power when specific energy (WATT-HRS/CB) is the critical criteria the system should be allowed to cool down during dormant periods. Heat-up is accomplished by powering the thermoelectrics and the heaters and tanks less than 2.5 hours.

Figure 1 presents the heat loss from the system as a function of insulation thickness. The insulation weighs approximately 5 LBS/IN thickness. Thus, considering a power penalty of 0.25 LBS/WATT, the optimum thickness is approximately 2 1/2 inches. To allow for short circuits and tolerances the insulation will be sized at 3 inches and the heat leak will be quoted at a 2 inch thickness. Thus, the overall system UA is approximately 4.0 BTU/HR-°F. For transient studies, the system thermal time constant and thermal inertia become important.

Estimates of the TIMES thermal inertia are:

Component	Thermal Inertia (BTU/°F)
TER-HFM	5.0
Filled Recycle Tank*	19.0
Pumps & Pipes	1.0
TOTAL	25.0

This yields a time constant of 25.0 ÷ 4.0 = 6.25 hours. Per it' normal operations scheme the TIMES processes approximately 50 lbs of water and then shuts down until another 30 lbs are collected. With a nominal processing rate of 1.8 PPH and a collection rate of 19.65 lbs/day, the system operates for 28 hours and then shuts down for 37 hours. The system is shut down for 37 ÷ 6.25 = 5.9 time constants. If power is turned off the system will have cooled down to ambient temperature in that time. Figure 2 shows the time to reach operating temperature as a function of heater power. Total power available for heat up includes the heater power, urine recycle pump power and TER power. At 26.5 VDC, pump power plus TER power amounts to approximately 160 watts. Without any additional power, warm-up time is 5.5 hours. The addition of 150 watts heater power shortens the warm-up time considerably to 2.25 hours. With increasingly higher powers the decrease in warm-up time is not as significant. Figure 3 shows the total energy required for warm-up. Increasing heater power decreases total energy requirements but above 150 watts the improvement is insignificant. At 150 watts the total energy required for warm-up is 700 watt-hrs. If the system is maintained at temperature for the 37 dormant hours, heat leak is 94 watts and total energy expended is 3480 watt-hrs. Thus, if energy consumption is the governing criteria, as would be the case with a fuel cell power supply, the system should be turned off and allowed to cool down during dormant phases. When averaged over the 50 lb water production after each heat-up, the 700 watt-hrs amounts to a specific energy consumption of 14 watt-hrs/lb. If installed, power is the governing criteria, as would be the case with a solar cell power supply, it's desirable not to have the heaters and thermoelectrics powered at the same time. It than makes more sense to maintain operating temperature during dormant periods and avoid the 5.5 hour warm-up time. Since a 150 watt heater has less current draw than the thermoelectrics plus coolant pump (160 watts total), there is no penalty for utilizing dormant period heating with a solar cell power supply. To maintain uniform temperature throughout the loop and to provide convection currents within the recycle tank to improve heat transfer the urine recycle pump should be operating whenever the heaters are active. The pump power helps heat the fluid and reduces heater duty cycle. With the pump running, the heater control sensor can be placed at the HFM inlet. Not only is this the critical temperature, but the fluid is well mixed so that point yielding a good bulk average temperature. To prevent local boiling in the recycle tank, the tank wall temperature must not exceed 212°F. A quite conservative heat transfer analysis of the heating process established 150°F as the maximum wall temperature required to transfer the heater thermal energy when powered with 31.5 VDC. Thus, setting the tank overtemperature cut-off at 200°F allows the full range of normal heating without interruption but prevents flashing in the recycle tank.

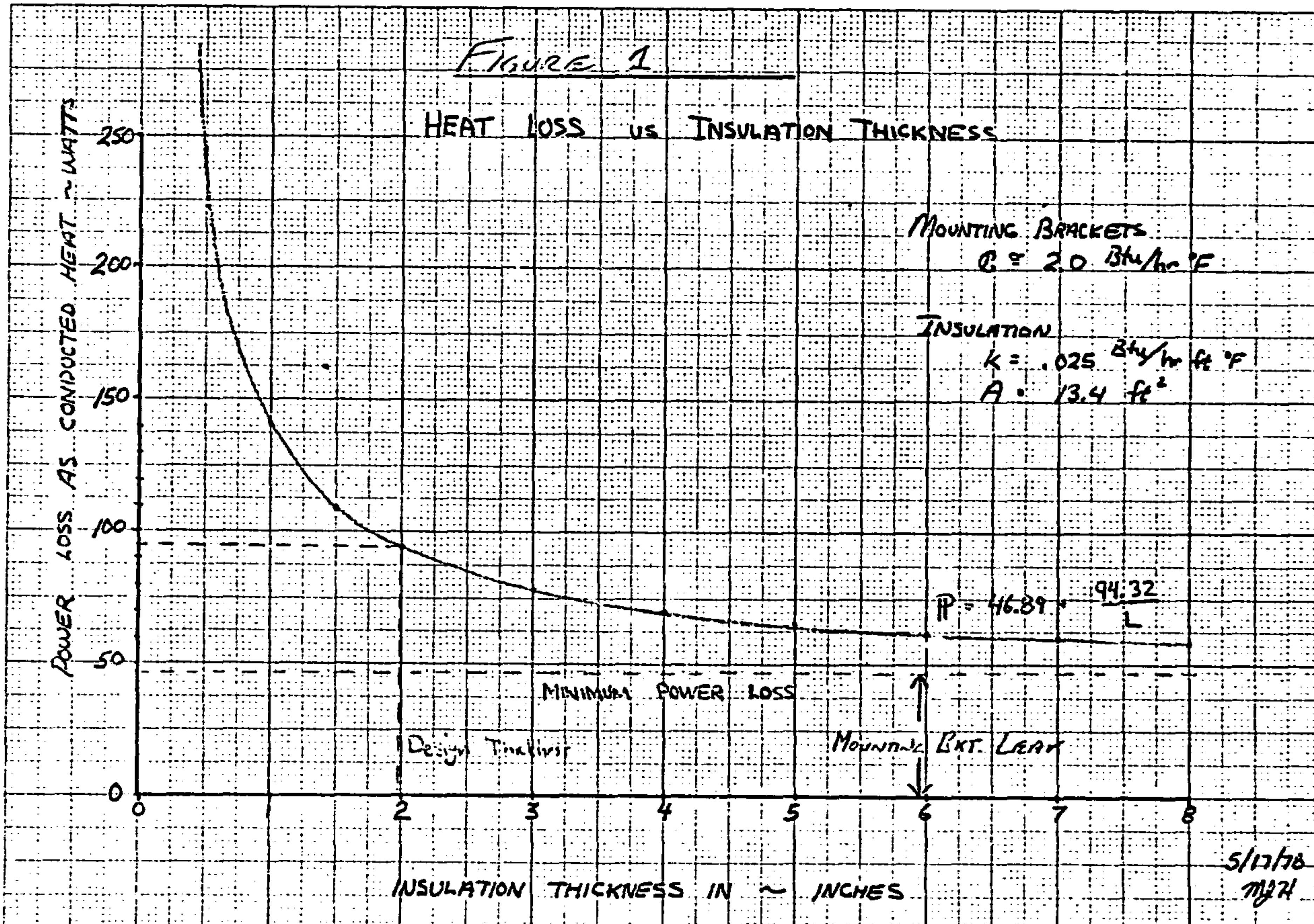
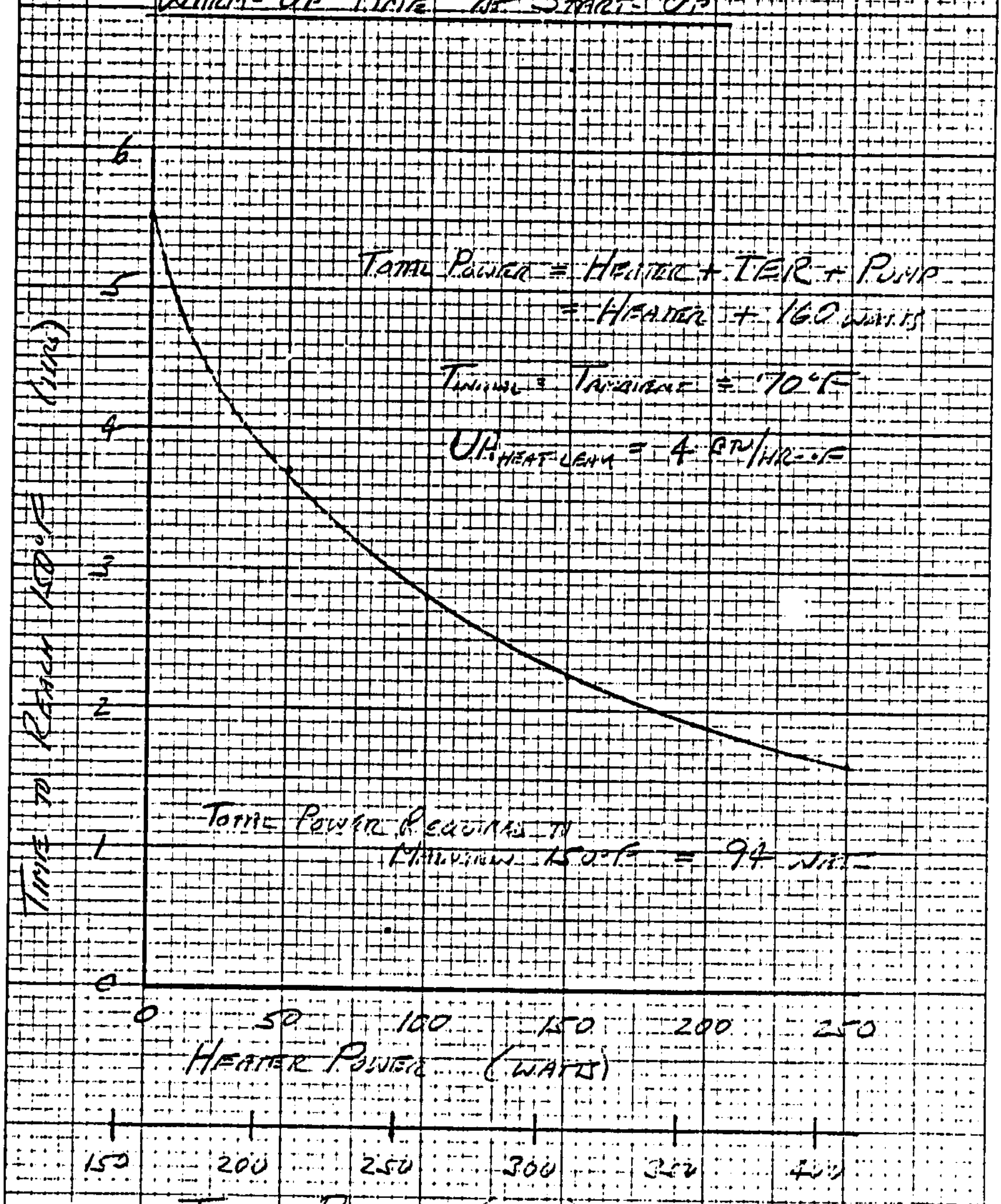


FIGURE 1
HEAT LOSS vs INSULATION THICKNESS
MOUNTING BRACKETS
C = 2.0 Btu/hr °F
INSULATION
k = .025 Btu/hr ft °F
A = 13.4 ft²
P = 46.89 + 94.32/L
MINIMUM POWER LOSS
Design Thickness
Mounting Bkt. Leak
POWER LOSS AS CONDUCTED HEAT ~ WATTS
INSULATION THICKNESS IN ~ INCHES
0
50
100
150
200
250
2
3
4
5
6
7
8
5/17/78

FIGURE 2

TIMES

WARM-UP TIME AT START-UP



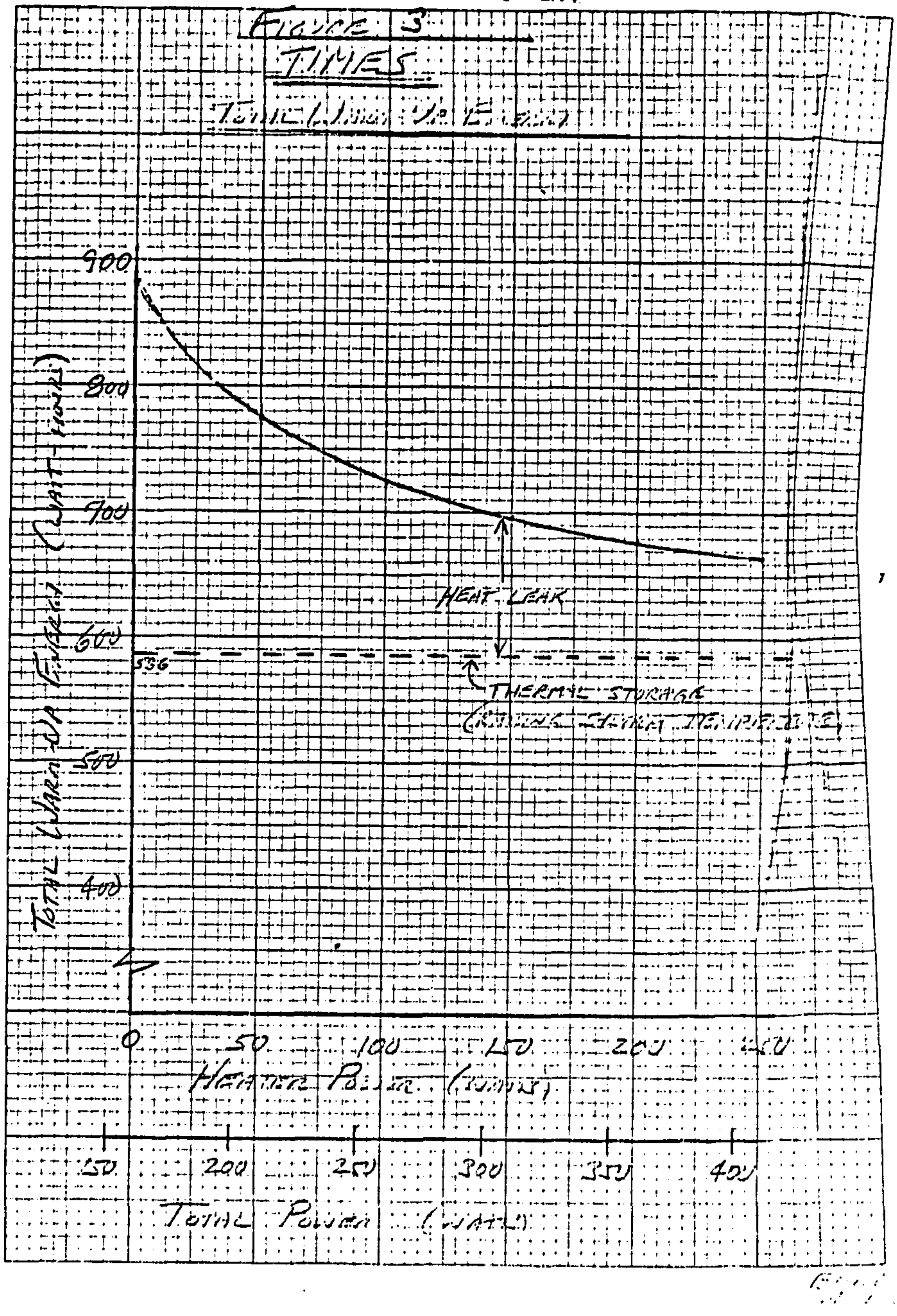


FIGURE 3
TIMES
TOTAL WARM UP ENERGY
TOTAL WARM-UP ENERGY (WATT-HOURS)
900
800
700
600
536
500
400
HEAT LEAK
THERMAL STORAGE
0
50
100
150
200
250
HEATER POWER (WATTS)
150
200
250
300
350
400
TOTAL POWER (WATTS)

HAMILTON STANDARD

Internal Correspondence

June 26, 1978

Analysis 78-117
File: 2.14
6.3
6.5

Memorandum to: Mr. G. Roebelen

cc: Messrs. W. Bogert
M. Heldmann
M. Hultman
J. Lovell
W. Perkins
M. Sheehan
R. Trusch

From: E. W. O'Connor

Subject: TIMES - Controller Logic

Reference: Analysis Memorandum 78-110, Same Subject, Dated 6/20/78

This document supersedes the referenced memorandum. The attached document describes the operating logic to be programmed into the TIMES microprocessor. In addition, the controller should have approximately the same analog outputs and control panel discrete signals as described in the proposal.

E.W.O'C

E. W. O'Connor

/sa
Attachment

CONTROLLER OPERATING LOGIC

In a broad sense system operation is directed by selection of the operating mode on a control panel switch. Then the system functions automatically according to the logic associated with that selection. The six (6) positions on the Operational Mode switch are:

OFF	-	All power to the system is off and the urinal is inhibited.
STANDBY	-	Instruments are powered, all other components are passive and the urinal is inhibited.
START	-	Power applied to TERs and heaters. Tank transfer, pressure control and heater control logic activated. Product water recycled.
AUTO	-	System is functioning automatically, delivering product water as dictated by the logic circuits. Shutdown and control logic is active.
READY	-	System in a readiness state but not processing water. Heaters operating to maintain system temperature. TER and pressure control inhibited.
STERILIZATION	-	High temperature sterilization mode. Not processing water.

The system operational logic keyed to the operating mode switch is described in the following sections. Those elements which are common to several modes are described in detail under "NORMAL".

The "OFF" and "STANDBY" modes of operation are self-explanatory.

The "START" mode is utilized to evacuate the steam passages and to bring the system up to operating temperature. This provides a 2½ hour startup. In this mode the following control logic applies:

- The waste inlet valve is opened and remains opened until the "OFF" or "STANDBY" is selected or unless a failure shutdown closes the valve.
- The urine recycle loop diverter valve is positioned to the recycle tank inlet.
- The urine recycle pump is activated.
- The product water reject recycle valve is directed to the recycle position.
- The condensate delivery pump operates normally.
- The pretreat and holding tank transfer logic and inhibit logic operates normally.

- Steam chamber pressure control operates normally.
- Power is applied to the thermoelectric devices.
- The condensate cooling pump is inhibited.
- The recycle tank heater logic operates normally.
- The shutdown sequences operate normally.
- When the HFM inlet temperature exceeds 155°F, the recycle tank heater operation is terminated and normal cooling utilizing coolant pump modulation is enabled.

The AUTOMATIC mode provides completely hands-off operation of the TIMES. It provides normal control, startup and shutdown of the system based on urine quantities, reconfigures the system as required based on water condition sensors and maintains appropriate thermal control during shutdown periods. In this mode the following control logic applies:

- The pretreat and holding tank transfer logic and inhibit logic operates normally.
- Normal subsystem startup and shutdown is controlled by the waste tank quantity sensor. Startup begins when the sensor indicates 68 percent full (30 lbs H_2O) and the normal shutdown cycle is initiated when the sensor reads three (3) percent full (1.3 lbs H_2O). Startup and shutdown relates to processing, not to collection or tank transfer logic.
- When the shutdown cycle is initiated, the recycle loop diverter valve is positioned to the waste tank position. At the end ot ten (10) minutes in this position, the valve returns to the recycle position. Simultaneously, (or slightly earlier) power is removed from the thermoelectric devices, pressure control logic is inhibited, the condensate and coolant pumps are inhibited and the recycle tank heater control logic is enabled.
- When startup is signaled, the recycle tank heater logic is inhibited and power is applied to the thermoelectrics. The subsystem then operates normally. This includes steam chamber pressure control, HFM temperature control and condensate delivery control.
- The shutdown sequences operate normally.

The "READY" mode of operation is utilized to maintain the system at operating temperature when processing is not desired (e.g. overnight during testing). In this mode the following control logic applies:

- The pretreat and holding tank transfer logic and inhibit logic operate normally.
- Power is removed from the thermoelectric devices, pressure control logic is inhibited, the condensate and coolant pumps are inhibited and the recycle tank heater control logic is enabled.
- The shutdown sequences operate normally.

The STERILIZATION mode of operation is available for exposing the steam and condensate sections of the TER to 200+°F temperatures. In this mode the following control logic applies:

- Reverse voltage polarity of the thermoelectrics and apply power.
- Inhibit coolant, condensate and recycle pumps.
- Enable vacuum purge portion of the pressure control logic but inhibit air bleed portion.
- Operate heaters per normal heater control logic except that the set point temperature is 195-200°F and the overtemperature limits are 205-210°F.
- Direct product water recycle valve to recycle tank position.

The "NORMAL" operating functions are as follows:

Tank Transfer Logic - A normal holding tank discharge cycle initiates when the quantity indicator reaches the "FULL" level. The expulsion valve is switched to the pressurant supply and remains there until the quantity measurement indicates "EMPTY" at which point the valve reverts to the vent position. When the valve has returned to vent, the pretreat dispenser meters five (5) ml. of pretreat solution into the holding tank to complete the cycle.

Steam Chamber Pressure Control - When the delta-P transducer (steam chamber minus condensate) indicates a pressure greater than 2.0 psid the vacuum purge valve remains open. When the delta-P falls below 2.0 psid a slower control mode is initiated in which a nominal pressure of 1.0 ± 0.25 psid is maintained. In this mode when the delta-P exceeds 1.20 psid the purge valve is opened for a period of one second. It then closes and waits one second for transients to decay before opening again, if necessary. If the delta-P falls below 0.80 psid the air bleed valve is opened for a period of one second. Again, it closes for a period of one second for transients to decay before opening again if necessary.

HFM Temperature Control - In normal operation the HFM inlet temperature is controlled to 150°F by varying coolant pump speed. Speed is varied as a proportional plus integral function of the temperature error. The proportional gain constant is 0.02 PPH/°F and the integral gain constant is 0.004 PPH/°F/sec. The selected pump is a solenoid dispensing pump with a maximum flow of 24 PPH. Applying power to the pump coil will give 1/2 of the pumping cycle. It must be de-energized in order to return to its starting position. "ON-OFF" results in the pumping action. At maximum flow the pumping rate is 120 strokes per minute.

Condensate Delivery - This comprises two functions: operation of the delivery pump and control of the product water valve.

- The condensate delivery pump is activated when the condensate accumulator quantity indicator reads "HIGH" and is inhibited when the quantity indicator reads "LOW". It is constrained from operating while divertor valves or the pretreat pump are drawing power. This limits system maximum current.

- The product water reject recycle valve position is a function of product water conductivity. For conductivities of 0.33 micromhos/cm or less the valve shall be in the "Good Water" position. For higher conductivities it shall be positioned to "Reject Recycle". In some mode there may be an override command to "Reject Recycle" regardless of conductivity.

Recycle Tank Heater Logic - This is an on/off heater control to maintain a urine temperature of 140-145°F at the HFM inlet control sensor. Temperature sensors on the recycle tank provide an overtemp cutout whenever the skin temperature exceeds 200°F. This cutout is automatically reset and normal control commences when the skin temperature falls below 195°F. The recycle pump is operating whenever this logic is enabled.

Transfer Logic Inhibit - The pretreat and holding tank logic operates normally until the waste tank is 91 percent full. At that point the holding tank is inhibited from starting any new discharge cycles. Any discharge cycle in process may be completed. This is the "HI LIMIT" signal and when this is present, a "URINAL INHIBIT" signal is generated.

HFM Breakthrough Shutdown - If the liquid sensor in the HFM indicates the presence of water for more than five (5) seconds, the product water reject recycle valve will switch to the recycle position and the system will be shut down. The system will revert to the condition described in the "STANDBY". It may be started up again only by manually switching the operational mode selector switch to "STANDBY" and then to "START".

No-Flow Shutdown - If the filter delta-P transducer indicates a pressure drop less than 0.5 psid for more than one (1) minute, the system will be shut down. It may be started up again only by manually switching the operational mode selector switch to "STANDBY" and then to "START".

Filter Replacement Signal - If the filter delta-P transducer indicates a pressure drop greater than 3.0 psid, a message to change the filter will be generated.

APPENDIX D

ACCEPTANCE TESTING TEST DATA

HSF-175.18 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: TIMES SUBSYSTEM WEIGHT	SHEET 1 OF 1	DATE 9/21/79
TEST ENGINEER: G. ROEBELEN	TEST PLAN NO. —	
NAME OF RIG: CERTIFIED BENCH SCALE	MODEL NO. TIMES	
PROJECT & ENG. ORDER NO.: B41-500-001A	PART NO.	
	SERIAL NO. 001	
	OPERATORS G. ROEBELEN	

ITEM	WEIGHT (LBS)	
PROCESS PKG (DRY)	132.8	203 RECYCLE TANK (DRY) (+204, 307) 10.70 LBS
		210 FILTER (DRY WITH CARTRIDGE) 3.14 LBS
COLLECTION PKG (DRY)	96.1	
		11/27/79
CONTROLLER PKG	39.2	ADD 113 VALVE + FILTER + FITTINGS + ELECT CONN + PLUMBING — +1.21#
		REMOVE 114 VALVE REVERSE LOOP PLUMBING — −0.54#
DRIVER PKG	27.5	PROCESS PKG ΔWT = +0.67, WT = 133.5
CONTROLLER/DRIVER INTERCONNECTING CABLES (4)	1.1	NEW SUBSYSTEM WT = 298.9 + 0.67 = 299.6#
CONTROLLER/~~DRIVER~~ PROCESS PKG/COLLECTOR PKG INTERCONNECTING CABLE	2.2	
TOTAL	~~298.9~~ *	

REMARKS:

* TOTAL DRY WEIGHT OF DISTILLATION UNIT, PRETREAT AND POSTTREATMENT UNITS, CONTROLLER, TANKS, AND FRAME SUPPORT TO BE LESS THAN 300 LBS.

29576

HSF-179.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES®
Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST	TIMES SUBSYSTEM TANK CAL.
TEST ENGINEER	G. ROEBELEN
NAME OF RIG	
PROJECT & ENG. ORDER NO.	B41-500-001A
SHEET	1 OF 1
DATE	12/5/79
TEST PLAN NO.	
MODEL NO.	TIMES
PART NO.	
SERIAL NO.	001
OPERATORS	G. ROEBELEN

ITEM — LOW LEVEL (%) — ADDED VOL (ML) — ACTUATION LEVEL (%) — ADDED VOL (ML) — WARNING LEVEL (%)

MIXING TANK — 9.5 (10% TRIP POINT) — 1233 — 86.5 (85% T.P.) — 154 — 96.0 (95% T.P.) YELLOW MX TANK FULL

15 SEC AFTER DUMP SHUT OFF PRETREAT

ACTUATOR DELIVERS 11 STROKES OF PRETREAT @ .44 ML = 4.84

PRETREAT RATIO: 4.84/1233 = 3.9 ml/l

EMPTY — ΔV — FLUSH ACT — ΔV — PROCESS TRIP — ΔV — WHITE WARN — ΔV — YEL WARN

WASTE TANK — 0 — 565 ml — 2 (3%) — 12060 ml — 65.0 (65%) — 495 — 72.5 (70%) — 3560 ml — 91.5 (91% TP)

TANK ULLAGE BELOW 0 READING 4300 ml

EMPTY ~~YELLOW WARN~~ — ΔV — LOW LEVEL ~~WHITE~~ — ΔV — FULL

PRETREAT TANK — 0 — 317 ml — 4.5 (5.0%) — 7207 ml — 100%

TANK ULLAGE BELOW 0 READING 440 ml

6430 ml REQ'D FOR 3 MAN - 180 DAY MISSION; 35.72 ml/DAY

REMARKS:

29577

HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: TIMES SUBSYSTEM TEMP. CONTROL	SHEET 1 OF 2	DATE 12/7/79	
TEST ENGINEER: G. ROEBELEN	TEST PLAN NO.		
NAME OF RIG	MODEL NO. TIMES		
PROJECT & ENG. ORDER NO. B41-500-001A	PART NO.		
	SERIAL NO. 001		
	OPERATORS G. ROEBELEN		

RECYCLE TANK TEMP AND OVER TEMP CONTROL

RECYCLE TANK T(°F)	CRT ANNUNCIATOR SIGNAL	TANK POWER	MODE		HFM INLET TEMP (°F)	TEST CONCLUSION
<145	NONE	ON	AUTO-ACCUMULATE		82	TEMP CONTROL OPERATION PER SPECIFICATION
145	NONE	OFF	"	"	82	
>134	NONE	OFF	"	"	82	
134	NONE	ON	"	"	82	
155°F	NONE	OFF	"	"	118	OVER TEMP SHUTDOWN PER SPEC. (RECYCLE TANK TEMP SIMULATED TO PRODUCE DESIRED SHUTDOWN)
156°F	AUTOMATIC SHUTDOWN FAILED	OFF	FAILURE SHUTDOWN		118	

RECYCLE TANK/HFM INLET TEMPERATURE SENSOR FAILURE (TEMP DIFFERENCE >±70°F)

RECYCLE TANK (°F)	HFM INLET (°F)	ΔT(°F)	CRT ANNUNCIATOR SIGNAL	MODE	
152	82	70	NONE	AUTO-ACCUM.	SENSOR FAILURE SHUTDOWN PER SPEC (RECYCLE TANK TEMP SIMULATED TO PRODUCE DESIRED ΔT)
153	82	71	TEMPERATURE SENSOR FAILURE	FAILURE SHUTDOWN	
12	82	70	NONE	AUTO-ACCUM	
11	82	71	TEMPERATURE SENSOR FAILURE	FAILURE SHUTDOWN	

REMARKS:

29578

HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES®

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: TIMES SUBSYSTEM TEMP CONTROL

TEST ENGINEER: G ROEBELEN

NAME OF RIG:

PROJECT & ENG. ORDER NO.: 841-500-001A

SHEET 2 OF 2 DATE 12/7/79

TEST PLAN NO.:

MODEL NO.: TIMES

PART NO.:

SERIAL NO.: 001

OPERATORS: G ROEBELEN

HFM INLET TEMP – OVERTEMP CONTROL

HFM INLET (°F)	TIME (MIN)	RECYCLE TANK (°F)	TANK POWER	CRT ANOMALY SIGNAL	MODE
149	–	105	ON	NONE	AUTO-ACCUM
156	–	105	OFF	NONE	" "
~~159~~ 160	6 MIN	105	OFF	NONE	" "
~~155~~ 161	5 MIN	105	OFF		FAILURE SHUTDOWN

REMARKS:

29579

HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: TIMES VERIFICATION TEST	SHEET 1 OF	DATE 2/12/80
TEST ENGINEER: G. ROEBELEN	TEST PLAN NO.	
NAME OF RIG	MODEL NO. TIMES	
PROJECT & ENG. ORDER NO. B41-500-001A	PART NO.	
	SERIAL NO. 001	
	OPERATORS G. ROEBELEN	

START OF URINE TESTING

INTRODUCED 20 LITERS PRETREATED URINE INTO WASTE TANK (SOLIDS CONC 3.7%)
(FILLS FROM EMPTY - BELOW "0" BY 4L - TO 79.5%)
AT 20% LEVEL OF WASTE TANK MODE CHANGED FROM ~~man~~ AUTOMATIC (ACCUM. URINE)
TO

TIME	REACHED 135 DURING INITIAL STARTUP	HFM IN(°F)	HFM ΔT	RECYC TANK(°F)	STEAM PRESS(PSIA)	SYST VOLTAGE	SYST AMP	HTR PWR	PP ΔP	RESS SCALE	ACC %	FILT ΔP		AMB PRESS
8:22		88	0	144	14.2	29.0	0	.9W	0		99	0		14.68
8:27		130	1.7	130	2.1	29.0	10.0	"	.10	33.0	70.5	2.85		
8:33		132	2.4	130	2.1	29.0	10.0	"	.13		49.0	2.81		
8:40		135	2.9	132	2.2	29.0	10.0	"	.32	33.0	41.0	2.81		
8:50		139	2.9	136	2.5	29	10	"	.37		41.0	2.81		
9:00		142	2.0	140	2.7	29	10	"	.39		53.5	2.8		
9:10		146	2.0	144	3.1	29	10		.40		67.0	2.8		
9:14		ACC	PUMP											
9:18	CHANGE TO AUTO	148	4.0	145	3.0	29	6.6		.48		30.0	2.84	BURP VOLUME 626 ml	
9:30		LIQUID BREAKTHROUGH		CHAT DOWN -		RESTART WITH	6.0	SECOND DISC						
9:45		151	4.6	147	3.3	29	6.6		.62		56.5	2.86		
9:59													SAMPLE	COND 37
1:21		150	5.0	146	3.1	29.1	6.5	6	.69		25	2.86	RATE	1.98 PPH
3:23		150	4.9	146	3.1	29.1	6.4	6.0	.65		25	2.84		

REMARKS:

9:30 → 1:21; 2.05 PPH AVG PROD; 0.020 PPH AVG BURP

INTRODUCED 5 LITERS PRETREATED URINE (SOLID CONC 3.9 %)

1433 ml product

29580

3792 ml product
36 ml burp

D-5

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HSF-178.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST	
TEST ENGINEER	
NAME OF RIG	
PROJECT & ENG. ORDER NO.	
SHEET OF	DATE 12/13/80
TEST PLAN NO.	
MODEL NO.	
PART NO.	
SERIAL NO.	
OPERATORS	

Date	Time										
	9:44	150	4.2	147	3.1	29.1	6.2	6.0	.87	25	2.89
	10:27	150	4.9	147	3.1	29.1	6.4	6.0	.81		2.91
2/13/81									.66		2.90
	8:04	150	3.7	147	3.1	29.1	6.1	6.			
	12:49										
	4:13	150	2.9	147	3.1	29.1		6.2	.90	25	2.89
	4:53	153	4.0	150	3.2	29.0	6.6	6.0	1.03	25	2.88

9:44 —

WETNESS INDICATOR READS DRY

INTRODUCED 10 LITERS (SOLID CONC 3.9%)

CALCULATED RATE: 1.76 PPH

3:23 → 9:44; 5361 ml product

1:31 → 9:44; 220 ml bump; 0.058 PPH

27 μƱ/cm conductivity

8:04 —

INTRODUCED 5 LITERS (S.C. 3.9%)

WETNESS IND READS DRY

CALCULATED RATE = 1.54 PPH

RECYCLE SOLIDS CONCENTRATION 6.47%

9:44 → 8:04; 6983 ml product

394 ml bump ← 32 μƱ/cm

35 μƱ/cm prod cond

12:49 —

8:04 → 12:49 3283 ml product

178 ml bump

4:13 —

INTRODUCED 5 LITERS (S.C. 3.8%)

12:49 → 4:13 2737 ml product

193 ml bump

REMARKS:

INTRODUCED 7 LITERS (S.C. 3.8%)

4692 ml product

16 37 152 4.1 148 3.1 29.0 6.2 .92 36 μƱ/cm prod cond

29581

HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES®

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST

TEST ENGINEER

NAME OF RIG

PROJECT & ENG. ORDER NO.

SHEET OF DATE 2/14/80

TEST PLAN NO.

MODEL NO.

PART NO.

SERIAL NO.

OPERATORS

2/14/80									~~69.5~~	
8:52	152	35	149	3.1	29.0	6.1	6.0	.34	64.5	2.95

INTRODUCED 3 LITERS (S.C. 3.8%) PROD COND 35 μ℧/cm

9:53P → 8:52A PROD WATER REMOVED 7915 ml

RECYCLE SOLIDS CONC 12.1% 4:13P 8:52A BURP WATER 239 ml cond 51 μ℧/cm

1:03	153	3.7	149	3.2	29.0	6.1	6.0	.85	70	2.92

PROD H2O 2908 ml 1.

BURP 58 ml

REMARKS:

29582

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HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES®

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: H_2O

TEST ENGINEER: G. Dewer

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.:

SHEET 1 OF 1 DATE 2/27/81

TEST PLAN NO.:

MODEL NO. NAFION

PART NO.:

SERIAL NO.:

OPERATORS:

TIME	RUN TIME	T_{HM}	T_{RECY}	ΔT	STEAM P	PP ΔP	FILTER ΔP	VOLT.	AMPS	SPEC P	CONC P	ACCUM LINE	ACCUM P	CONDUC	PROD RATE	
1318	1447.4	122	144		4.7								'START' ON @ > 20.0 % WASTE TANK			
1322		132	133		2.1	1.60	2.52									
1330	1447.7	135	134	2.7	2.2	1.58	2.50						.38	20		
1340		139	136													
1342		140	137	5.0	2.2	1.76	2.45	28.2	10.0							
1350		142	139	5.3	2.4	1.70	2.45									
1355		145	141	5.4	2.6	1.62	2.48									
1407		148	143	5.6	2.8	1.48	2.58	28.6	7.0					24		
1417		POWER	OUT -													'AUTO PROCESSING'
1423		146	143	2.6	3.0	1.53	1.59									
1425														28		
														255		ACCUM DUMP.

REMARKS: AMB. PRESS. = 14.76 psia

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HSF-175.18 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: H_2O

TEST ENGINEER: OPD

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.:

SHEET 1 OF 1 DATE 3/5/81

TEST PLAN NO.

MODEL NO. NAFION

PART NO.

SERIAL NO.

OPERATORS

TIME	RUN TIME	T_{HTM}	T_{RECIR}	ΔT	STEAM P	PP ΔP	FILTER ΔP	V	A	SPEC ENERGY	CALC ENERGY	ACCUM TIME	ACCUM P	COND	PROD RATE	TOTAL POWER	TEC POWER	
1300	160%	89	145	0	15.5			29.2					.25	28				
1305		131	133	6.2	4.9			28.5	10									START
1310		130	130	3.4	1.7	1.61	2.53	29.0										3/4" HG. IN SHELL
1330		137	134	5.7	1.9	1.59	2.53											
1345		142	139	5.8	2.2	1.40	2.53											AUX VAC 2.0" HG 1/2'
1400		147	143	5.9	2.6	1.30	2.56											
1401		148	144					29.2	7.2							212	180	READY – PUT IN 'AUTO'
1415		150	144	5.7	2.7	1.29	2.62											1/4" HG.
1422		151	145	5.8	2.8	1.36	2.62											COOLANT PUMP ON
1430		152																DEGAS HEX
1445		150	145	6.1	2.7	1.56	2.66											AUX VAC 2.48
1500		150	145	6.3	2.7	1.63	2.66							28				
1515		151	146	6.1	2.8	1.62	2.66						.35	2		[illegible]	[illegible]	
1530		151	146	6.0	2.8	1.70	2.62							24		212	150	
1536		151			2.8	1.72	2.64					8.72	.45	22	1.72			
1545		151	146	6.1	2.8	1.80	2.61					—		21	2.41			
1554		151	146	6.0	2.8	1.80	2.62			70.0	83.9	8.62	.45	20	2.41	212	180	
1558		151								76.5	71.5	[illegible]			2.88			
1603												8.52						
1611		151	146	5.9	2.8	1.8	2.62					8.78			2.74			
1615	PUT IN 'FLUSH' — 1640 – PUT IN STANDBY'																	

REMARKS:

1. AMB PRESS = 14.80 psia
2. INITIAL PREHEAT USING AUX VAC ON PP EXIT HYDR

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HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: URINE - PERFORMANCE

TEST ENGINEER: G.F. DEHNER

NAME OF RIG: TIMES

PROJECT & ENG ORDER NO.

SHEET 1 OF 3 DATE 3/10/81

TEST PLAN NO.

MODEL NO. NAFION

PART NO.

SERIAL NO.

OPERATORS

TIME	RUN TIME	T HTM	T RECYC	ΔT HTM	STEAM P	PP ΔP	FILTER ΔP		V	SPEC POWER	CORR POWER	TOTAL POWER	TER POWER		ACCUM	ACCUM TIME	CALC RATE	PROD RATE	COND	SPEC COND	WASTE TANK	
1015	1620.2	96	145	0	15.1	0	0		29.6			13.5			.25				34	32	STANDBY	
1028																					START	
1030	1620.5	129	130	1.4	3.4	1.61	2.62		29.0			289.2	173									
1031					FAILURE	S/D																
1034		126	126	3.2	5.1	1.79	2.62		— NO EXTRA LIQ	IN SHELL – RESET —		INDICATES —									LIQ. BREAK. 0 START	
1054		NORMAL	SHUTDOWN	– CAUSE BY µP RESET –	LEAK AT URINE TAP – TOP OF EVAP.																	
1105		132	130	9.7	2.1	1.10	2.64					LEAK FIXED								0	START	
1120		136	135	3.2	2.4	1.17	2.59								.45				59			
1135		142	139	5.8	2.6	1.16	2.56								.45				44			
1150		148	144	5.9	2.9	1.07	2.58												32	0	AUTO	
1155		149	143	5.6	3.0	1.07	2.58								.45	8.	2.80	.29	34	31	49	
1204		153	145	5.7	3.1	1.09	2.58									9.35	2.44	.29	32	31	49	
1214		151	146	6.1	3.1	1.23	2.58			227	211	208	179		.45	10.05	2.27	.92	32	31	49	
1223		151	146	6.1	3.1	1.32	2.58			133	124				.45	8.55	2.67	1.57	32	31	46.5	
1231		150			3.0	1.41	2.56								.45	8.67	2.64	1.57	32	31	46.5	
1241	✓	152	145	5.9	2.9	1.48	2.56			93.6	87.6				.45			2.27	32	31	46.5	
1249		150			2.9	1.50	2.58								.45	8.	2.86	2.27	32	31.5	44.5	
1258	✓	150			2.9	1.49	2.58								.45	8.6	2.60	2.68	32	31.5	44.5	
1315			S/D	DUE	TO	LINE RUPTURE	POST –		CONC. SENSOR										32.	32.5		←
1330		144	141	5.7	2.6	.98	2.62														37.5	START
1340		148			3.0	.87	2.62												34	31.5	37.5	

REMARKS:

1. AMB PRESS - 14.76
2. HOLD TANK - 0, WASTE - 2, PRE - 2
3. CHARGE 1015 W/ 10 ℓ URINE — 'B' - 3.77% SOLIDS

MICROPROCESSOR RESET – PREVIOUS PROD RATE & CONDUCT. ERASED

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HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST: URINE PERFORMANCE
TEST ENGINEER: G. F. DEHNER
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET 2 OF 3 DATE 3/11/81
TEST PLAN NO.:
MODEL NO. NAFION
PART NO.:
SERIAL NO.:
OPERATORS:

TIME	RUN TIME	T HFM	T STYC	ΔT HFM	STRM P	PP ΔP	FILTER ΔP	% ACCUM	V	SPEC ~~POWER~~	COMB ~~POWER~~	TGA POWER	TER POWER		ACCUM P	ACCUM TIME	CALC RATE	PROD RATE	COND.	SOLIDS CONC	WASTE TANK	BURP VOLUME
1348		149	146	4.4	2.9	1.33	2.62		29.0			158	159		.45				33	31.5	37.5	
1353		150	145	5.9	2.9	1.14	2.59								.45	[illegible]			36	31.5	37.5	
1402	1635.0	151			2.9	1.20	2.59								.45	7.75	2.95	.95	36	31.5	35.0	
1409		150	145	6.2	2.9	1.42	2.59			222	207	208	178		.45	7.92	2.89	.95	36	31.5	35.0	
1417		150	145	5.6	2.9	1.39	2.60			126	116				.45	8.62	2.65	1.68	36	31.5	35.0	
1435		150	145	5.9	2.9	1.50	2.59			89.2	82.5				.45			2.37	39	31.5	32.5	
1444	✓	150	145	6.0	2.9	1.55	2.58			89.2	82.4				.45	8.67	2.64	2.37	40	31.5	32.5	
1453		150			2.9	1.61	2.58								.45	8.77	[illegible]	2.93	40	31.0	30.0	
1501		150													.45	8.77	2.61	2.93	41	31.0	30.0	
1503		150															[illegible]	2.81				
1518		150														8.5	2.6?	2.78	41	31.0	28.0	
[illegible]		150	145	6.1	2.9	1.65	2.56			76.2	71.0					8.5	2.69	2.78	42	31.5	28.0	
1536		150			2.9					75.9	70.0			AMB PRESS		8.7	2.63	2.80	43	31.0	25.5	
1620		150	145	5.9	2.9	1.74	2.55			75.0	69.2			14.72				2.83	45	31.0	21.0	
1645		150	145	6.0	2.9	1.77	2.58			74.2	68.4				.55			2.83	48	31.0	18.5	
1700						1.80		75														204 ml
1701						1.78		25														
1800		150	145	5.9	2.9	1.79	2.58	60		75.2	69.8			14.73	.55			2.79	50	31.0	11.5	24 ml
1825			8 HR URINE SAMPLE TAKEN pH 2.35 (meter) 2 (paper)																			
1830			8 HR PRODUCT WATER CHECK pH 4.9 (meter) 5-5.5 (paper) 50 μmho cond																			
1835		150	146	6.2	2.9	1.77	2.58			75.9	70.3			14.73	.55				52	31.0	7.0	

REMARKS:
1. 8 hr SAMPLE - RECYCLE URINE - 1.45% SOLIDS

pH ~~2.35~~

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HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: Urine Performance
TEST ENGINEER: G.F. Dehner
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET 3 OF 3 DATE 3/16/81
TEST PLAN NO.:
MODEL NO.: Nafion
PART NO.:
SERIAL NO.:
OPERATORS:

TIME	RUN TIME	T HFM	T RECYK	ΔT HFM	STEAM P	PP ΔP	FILTER ΔP	% ACC	V	SPEC. RATE	CORRE POWER	TOTAL POWER	TEC POWER		ACCUM P	ACCUM TIME	CALC RATE	PROC RATE	COND	SOLIDS CONC	WASTE TANK	BURP vol
1836	HFM		SMELL		BURNE		DRY															
1840		150	145	6.2	2.9	1.75	2.6	40		766	71.1	209	171		.55			2.77	52	31.0	4.5	-BLIPPED
1846		151	146	5.7				[illegible]	FLOPPY DISK WILL NOT PUT UP SCHEMATIC CO- BLIPPED													[illegible]
1850		151	146	5.9	29/30			99														
1859		HFM	SMELL		BURNE		DRY															
1859		153	146																			
1900		FLUSH			STARTED																	
1903					14.2	1/4" WATER IN HFM SHELL																
1905		WET SENSOR			RESIST		3.64 meg Ω (2 meg scale)								WET SENSOR PROCEED — DRY							
1909							3.32															
1910		SHUT OFF			1/4" WATER IN HFM SHELL									PICTURE OF PAGE 2								8 ml
1918	Burp valve closed / pump off - put into standby mode																					
					CONDENSATE COLLECTED 8547 - 1115 = 7432 gms																	
1921		WET SENSOR				2.41 meg Ω			SENSOR "DRY"													

REMARKS:
~~[illegible]~~
1. CALCULATED WASTE TANK USAGE: 49-4.5% = 44.5% , 20 ℓ = 8.9 liters
2. ~~TOTAL~~ Run time - 8.5 hrs. - ~~[illegible]~~

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HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: URINE PERFORMANCE
TEST ENGINEER: G.F. DEHNER
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET 1 OF 1 DATE 3/11/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME	RUN TIME	T HTR	T RECYC	ΔT	STEAM P	PP ΔP	FILTER ΔP		V	SPEC E POWER	COMP POWER	TOTAL POWER	TEST POWER		ACCUM P	ACCUM TIME	CALC RATE	PROD RATE	COND	S..G CONC	WASTE TANK	
0800		98	145		15.9														40		2.0	
0820	1652.1	139	137	7.8	2.7	1.72	2.66		29.9										53	32.0		1st START
0849		148	145	5.2	3.4	1.40	2.64												55	32.0		READY
0900		149	145	4.9	2.5	1.30	2.62		29.1	—	—	205	173		.45			0	55	31.5	53.5	
0930		150	148	2.6	3.7	1.16	2.61											.66	54			
1003		152	149	4.7	3.6	1.98	2.62												52		←	COND. OVERBOARD TO FLASK
1030	8:10	150	145	5.9	3.4	1.74	2.62		29.1						•				51	31.5	49	
1035		150	145	6.0	3.4	1.74	2.62								.25				57	31.5	49	ACCUM BACK ON
1100		151	146	5.7	3.4	1.65	2.59					205	179		.45	8.25	2.77		59	31.5	46.5	
4 1200		150	145	5.8	3.4	1.70	2.62			76.6	71.4				.45			2.77	62	31.0	39.5	
1400		151	146	5.8	3.6	1.77	2.58			76.1	71.0				.50			2.81	67	30.5	28.0	
8 1500		150	146	6.2	3.5	1.84	2.61								.50			2.81	69	30.5	37.5	→ 6
1630	FOUND SYSTEM IN FAILURE S/D - TEMP 148 148 - NO MESSAGE - ACCUM - 100% — RESET + FLUSH																					
1701		105	147		15.2	1.99																ACCUM START OVERBOARD
1800		141	139	3.7	3.1	1.69	2.61															
1900		150	149	6.5	4.1	1.27	2.61												75		37.5	
2000	5:10	150	146	6.1	3.7	1.50	2.61								.55			1.46	75	30.5	32.5	
12 2100		151	146	6.1	3.7	1.77	2.61			71.7	71.7				.55			2.69	79	30.5	23.5	TOOK REC + COND [illegible]
2200	1665.1	151	146	5.9	3.7	1.86	2.61								.55			2.71	79	30.5	18.5	
2300		152	147	5.9	3.8	1.86	2.62		29.0	78.0	72.1	205	174		.60			2.67	89	30.0	11.5	SOLIDS
2304	GOT FAILURE S/D — NO MESSAGE — PUT IN NORM S/D TO GET FLUSH																					4.5%

REMARKS:
1. Fans P = 14.7 PSIA
2. CHARGE 0800 w/ 10 l URINE - δ' - 3.77%
3. 0850 BLEED COLLECT 70 cc = .154 lb
4. RUN BLEED VOL - 25 cc/hr = .055 pph
5. RUN BLEED VOL 13cc/1.5hr = .019 pph
6. ADDED URINE @ 21% - 6 l. (⇒ [illegible])
7. TOTAL CONDENSATE 14537 g 31246
8. 13.5 hrs RUN TIME, 22.0 SUBTOTAL

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HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: URINE TESTING

TEST ENGINEER: G. Roebelen

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.

SHEET 1 OF 1 DATE 3/12/81

TEST PLAN NO.

MODEL NO.

PART NO.

SERIAL NO.

OPERATORS

TIME	RUN TIME	THEA	TRECK	ΔT	STEAM P	PP ΔP	FILT ΔP		V	SPEC ~~ENERGY~~	CURR	AVG TOT POW	TEA POW		ACC P	ACC ΔT	COOL RATE	PROD RATE	COND	SOLIDS CONC	WASTE TANK	WET/DRY COND
7:46		STARTED - ACC. FULL OF GAS - WETNESS SENSOR CAUSED SHUTDOWN																				
7:50	0:12	RESTART AFTER RESET TO GET OUT OF FLUSH - METER WETNESS SENSOR																				
8:26	0'	UP TO TEMP (148) - TRANSFERRED TO AUTO. PRODUCT WATER BYPASSING ACC (AMX SUCTION)																				
8:32		FAILURE SHUTDOWN (DUE TO NOISE ON 307 - RECYC TANK - SENSOR)																				
		FLUSHED AND GOT PROGRAM REWRITTEN TO PUT 5 CYCLE ANOMALY REQUIREMENT																				
		ON 307 TO STOP NOISE SHUTDOWN. - ALSO INCREASED 404 PUMP TIME TO 800 MS.																				
		TO GIVE MORE CYCLING																				
11:20		MICROPROCESSOR START UP - 1677.4 - FILLED WASTE TANK ADDED 10 L (PREVIOUSLY ADDED SOME)																				
11:26		PUT IN START MODE																	63%				
11:27		ACCUM DUMP																				
11:28		138	138	8.6	3.3	1.62	2.61		286						.50				83	30.0	30.0	
11:53		SWITCHED TO AUTO																				
11:58		148	145	5.7	4.1	1.4	2.58		21.9						.50				85	29.5	63.0	
12:00	11:35	EMPTIED BURP TANK ≈ 10cc (NO REFRIG. SO NOT SIGNIFICANT NUMBER)																				
12:18		151	146	5.7	4.2	1.37	2.60		29.0						.50				83	29.5	63.0	
13:32		150	145	6.1	4.2	1.80	2.62		28.9	77.6	72.0	205	168		.65			2.67	83	29.0	53.5	.25 MAX
15:12		150	146	6.1	4.2	1.82	2.62		29.0	71.3	66.0	207	168		.65			2.90	87	29.0	44.5	.13
17:50		150	146	5.8	4.2	1.90	2.61		29.0	77.8	71.4	207	167		.65			2.72	81	29.0	28.0	.15
18:58		150	146	6.0	4.2	1.91	2.62		29.0	76.9	71.0	205	167		.65			2.67	91	29.5	21.0	.23
21:20		150	146	6.0	4.2	1.91	2.62		29.0	77.6	71.3	206	168		.65			2.65	93	29.5	7.4	.32 *
22:30		149	145	5.6	4.1	1.77	2.66		29.0	76.5	70.3	204	168		.65	BURP VOL 75 ml/hr		2.67	95	29.5	9.5	
22:3_		FLUSH - HIT FLUSH WITH ACCUMULATOR EMPTYING - ACC STOPPED EMPTYING IN MID STREAM AND FAILED TO GO OK																				
22:55		SHUT OFF - PUT ON STANDBY - SHELL DRY, LIQUID SENSOR WET																				

REMARKS:

WASTE TANK SAMPLE BEFORE START = ~~2~~ 2.3 pH

AMB PRESS 758 = 14.66 psi

TOTAL CONDENSATE = 12333 } TOTAL URINE IN ≈ 11L NOT TOO GOOD BALANCE EXCEPT HOLDING TANK WAS ALMOST FULL TO START

TOTAL TIME - ~~[illegible]~~ 12.5 hrs

SUBTOTAL 38.5 hrs

~~LIQUID~~ SENSOR WET!! (POLARIZED FLUIDS?)

7.5 ml/hr .017 PPH

* ADDED 1L TOTAL 11L

31251

SOLIDS SAMPLE - ~~12~~ 28

D-14

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HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST	URINE TESTING – ACCEPTANCE VERIFICATION	SHEET 1 OF 1	DATE 3/13/81
TEST ENGINEER	G. F. DEHNER	TEST PLAN NO.	
NAME OF R G	TIMES	MODEL NO.	
PROJECT & ENG. ORDER NO.		PART NO.	
		SERIAL NO.	
		OPERATORS	

TIME	RUN TIME	T_{HTR}	T_{RECUP}	ΔT_{HTR}	STEAM P	PP ΔP	FILT ΔP		V	SPEC ENERGY	CONC FEED	TOT POW	TER POW		ACCUM P	ACCUM TIME	CALC RATE	PROD RATE	COND	SOLIDS CONC	WASTE TANK	WETNESS
0750			START – FILLING WASTE WITH 9 l URINE – from 4.5% to																			
0800	1698.0	141	140	4.1	3.8	1.73	2.61		28.6			288	147		.65				93	29.5	49.0	
0830		150	145	5.1	4.4	1.65	2.64		29.0			202	170						91			.003
0900		151	146	5.7	4.3	1.69	2.64			124	115				.65			1.65	91	29.5	46.5	
1000		151	147	5.8	4.4	1.81	2.64			81.4	75.2				.65			2.51	91	29.0	42.0	.04
1100		152	147	5.8	4.4	1.88	2.66			80.3	73.8							2.58	91	29.0	35.0	
1200		152	147	5.9	4.4	1.87	2.66			83.0	76.1							2.48	94	29.0	82.0	
1300		151	146	5.6	4.3	1.73	2.67			81.6	75.4							2.52	95	29.0	77.5	
1400		152	147	5.9	4.5	1.84	2.67			80.7	74.6							2.54	95	29.0	70.0	
1500		151	146	5.8	4.4	1.60	2.70			83.0	76.1							2.51	95	29.0	65.0	
1630		153	148	5.8	4.5	1.84	2.69											2.50	95	28.5	56.0	
1800		151	146	5.7	4.4	1.67	2.70		29.0	84.0	77.3	204.1	164		(RECYC) .65/.70			2.43	95	29.0	46.5	
		REMOVED: 68 ml burp, 10,437 g condensate pH 3.25 Temp(?) 53.05 # delivered																				
2000		151	145	5.6	4.4	1.58	2.68			84.1	77.7	203.4	164		.70			2.41	95	29.0/27.5	35.0	
2130		TOOK RECYC SAMPLE pH=2.75 – REMOVED 24 ml burp, 3514 g condensate pH E 3.3 water delivery (203)																		60	21	
~~2130~~		~~151~~	~~145~~	~~5.6~~	~~4.4~~	~~1.58~~	~~2.68~~			~~84.1~~	~~77.7~~	~~203.4~~	~~164~~		~~.70~~			~~2.41~~	~~95~~	~~29.0/27.5~~	~~35.0~~	
2200		150	145	5.7	4.4	1.65	2.70		28.9	83.6	76.6	201	164		.70			2.41	95	29.0	25.5	

REMARKS:

1. AMB P = 14.6 PSIA
2. 0740 – FILL WITH 9 l URINE TO 49.%
3. 1100 – ADD 10 l – 35 → 82%
4. 2310 – ADD 12 l 18.5 → 79.5
5. 2130 Recycle Sample – 12.3 % solids – 48 total hrs (13.5 FOR DAY TO THAT POINT)

31249

HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE TEST - VERIFICATION

TEST ENGINEER:

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.:

SHEET 1 OF 1 DATE 3/14/81

TEST PLAN NO.:

MODEL NO.:

PART NO.:

SERIAL NO.:

OPERATORS:

TIME	RUN TIME	T_{HFM}	T_{RECY}	ΔT_{HFM}	P_{STEAM}	ΔP_{PP}	ΔP_F	V	A	PROD RATE	PWR AVG	TER PWR	SPEC ENGY	CORR SP ENGY	COND	SOL CONC	WASTE TANK	ACCUM WASTE	PROD pH	BURP VOL	ACTUAL PROD WATER	WATER DEL
		(219)	(220)	(221)	(222)	(223)	(224)	(225)	(226)	(201)	(205)	(206)	(208)	(209)	(213)	(214)	(217)	[illegible]		ML	GRAMS	(203)
00:00		150.	145.	5.7	4.4	1.72	2.68	28.9	6.9	2.39	203.1	166.5	84.64	78.60	95.	28.8	79.5					
02.00		150.	145.	5.5	4.4	1.62	2.72	29.0	7.1	2.35	201.5	165.8	85.75	78.80	95.	29.	67.5					
0358		150.	144.	5.6	4.3	1.42	2.71	28.7	6.9	2.27	202.8	166.5	89.03	81.5	95.	29.	58.5					
0530																			3.5		7252	80.2
0800		150	145	6.0	4.4	1.36	2.78	28.9	7.0	2.17	205.0	166	94.64	87.0	95	28.5	44.5	.70				
1000		150	145	5.7	4.4	1.71	2.75	28.9	6.9	2.32	204.5	166	88.14	81.5	95	29.0	65.0	.70				
1145		150	144	5.6	4.4	1.66	2.73	28.9	6.9	2.27	202.7	163	89.29	81.3	91	29.0/28.5	56.0	.70				
																	pH 3.6					
1330																	100 ML		3.2	100	7770	97.11
1400		150	145	5.1	4.4	1.39	2.75	28.9	6.9	2.11	201.4	163	94.11	86.6	89	29.0	44.5	.70		(16 HRS)		
1600		150	145	5.6	4.4	1.55	2.81	28.9	6.8	2.16	201.0	163	93.05	86.0	87	28.5	35.0	.70				
1800		150	144	5.6	4.4	1.56	2.80	29.0	6.8	2.12	201.3	166	94.96	87.7	83	29.0	23.5	.68				
2000		150	145	5.1	4.4	1.45	2.80	29.0	7.1	2.12	213.7	167	100.8	93.2	79	29.0	58.5	.65				
2130	TAKE RECYCLE LOOP SAMPLE — pH = 3.5 WEIGH, MAKE & PUT IN OVEN																		3.3	55	7548	113.91
2200		150	145	4.9	4.4	1.61	2.83	29.0	6.7	1.89	198.7	164	105.1	97.2	79	29.5	56.0	.65				

REMARKS:

AMB PRESS: [mm Hg]
0000
0800 751.6
1600 751.1
2300 754.5

ADDED URINE:

TIME	QUAN	READINGS	
0755	8 ℓ	37.5	72.5
1935	10 ℓ	16.0	65.0
2230	5 ℓ	53.5	77.5

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HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE TEST - VERIFICATION

TEST ENGINEER:

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.:

SHEET OF | DATE 3/15/87

TEST PLAN NO. | MODEL NO. | PART NO. | SERIAL NO. | OPERATORS

TIME	RUN TIME	T_{HTM}	T_{RECYC}	ΔT_{HTM}	P_{STEAM}	ΔP_{PP}	ΔP_F	V	A	PROD RATE	PWR AVG	TOT PWR	SPEC ENGY	CORR ENGY	PROD COND	SOL CONC	WASTE TANK	ρ ACCUM	PROD pH	BURP VOL	ACTUAL PROD H_2O	WATER DEL
		(219)	(220)	(221)	(222)	(223)	(224)	(225)	(226)	(201)	(205)	(206)	(208)	(209)	(213)	(214)	(217)			Ml	GRAMS	(205)
00:00		150.	145.	5.4	4.4	1.70	2.80	28.9	6.7	1.92	197.6	157.5	103.12	95.5	76.	28.	72.5					
02:00		150.	145.	5.3	4.4	1.72	2.80	28.9	7.0	1.93	198.5	158.	103.	95.2	73.	28.5	65.0					
04:00		150.	145.	5.1	4.4	1.62	2.83	28.8	6.7	1.88	195.3	158.1	105.	96.8	71.	28.5	56.0					
~~0530~~		~~150.~~	~~145.~~	~~5.4~~	~~4.4~~	~~1.65~~	~~2.84~~	~~28.9~~	~~6.8~~	~~1.88~~	~~199.2~~	~~157.~~	~~105.8~~	~~97.9~~	~~71.~~	~~29.0~~	~~46.5~~		3.5	X	6721	128.9
0600		150.	145.	5.4	4.4	1.65	2.84	28.9	6.8	1.88	199.2	157.	[illegible]	97.9	71.	29.0	46.5					
0800		150	145	4.6	4.3	1.48	2.84	29.0	6.8	1.95	208.6	161	106.95	98.8	75	29.5	63.0	.70				
1000		150.	145	4.8	4.4	1.47	2.86	29.0	6.8	1.92	197.4	163	102.8	95.00	83	29.5	53.5	.70				
1200		150	145	4.8	4.4	1.53	2.87	29.0	6.7	1.83	197.4	163	107.88	99.6	91	29.0	46.5	.70				
1330																			4.5	90	6705	143.33
1400		150	145	5.3	4.4	1.48	2.89	29.0	6.8	1.91	197.0	158	103.14	95.3	107	29.0	37.5	.72				
1600		150	144	5.4	4.4	1.52	2.89	29.0	6.7	1.86	196.8	159	105.94	97.9	127	28.5	28.0	.78	6.5	{ conductivity and		
1639		CONDUCTIVITY PROBLEM; WASTE TANK pH 4.5, RECYC TANK pH 4.5, NEW PRET URINE pH = 2.15*																		@ (14.4)		
2000		150	145	5.5	4.4	1.60	2.88	28.9	6.7	(.92)	207.2	159	(225)	(207)	159	[illegible]	67.5	.65				
2130		pH recycle 4.6													220				5.9	46	5992	156.89
2200		151	146	4.1	4.5	1.80	2.67	29.0	6.5	1.41	195.2	154	138	128	[illegible]	[illegible]	58.5	.65				

Demineralizer wrong sensor (cond sensor)

Did night one 10:30

REMARKS:

AMB PRESS 0000 754.7
0800 753.7
1600 748.0 (14.47)

ADDED URINE:

TIME	QUANT	READINGS
0730	5 l	39.5 - 63.0
Added urine after pretreat 1639	10 l	25.5 - 75.0
2030	4 l	72.5

* CONDUCTIVITY PROBLEM MAY BE DUE TO NEGLECTING TO FULLY DISSOLVE A TANK OF NEW URINE.

31262

1930 COND. HIGH - SENSOR DISCONNECTED - SWITCH VALVE

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HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE TEST – VERIFICATION

TEST ENGINEER:

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 3/16/81

TEST PLAN NO:

MODEL NO.:

PART NO.:

SERIAL NO.:

OPERATORS:

TIME	RUN TIME	THFM	TRECK	ΔTHFM	PSTEAM	ΔPP	ΔPF	V	A	PROD RATE	PWR AVG	TEL PWR	SPEC ENGY	CORR SP ENGY	PROD COND	SIL CONC	WASTE TANK	PACC	PROD pH	BARO VOL (ml)	ACTUAL PROD H2O (gm)	WATER DEC
		(219)	(220)	(221)	(222)	(223)	(224)	(225)	(226)	(201)	(205)	(206)	(208)	(209)	~~(213)~~ ACTUAL	(214)	(217)					(203)
0000		150.	145.	5.3	4.4	1.74	2.90	28.9	6.8	1.92	202.	157.	104.85	96.9	X	X	67.5	X	X	X	X	X
0200		150.	145.	5.4	4.4	1.76	2.93	28.9	7.1	1.92	199.1	156.	103.76	95.8	X	X	60.5	X	X	X	X	X
0400		150.	145.	5.0	4.4	1.70	2.93	28.9	7.3	1.89	197.7	157.	104.54	96.6	X	X	51.5	X	6.2	X	6391	170.23
0530		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
0600		151.	145.	5.2	4.4	1.73	2.92	28.9	7.0	1.94	196.5	158.	104.29	93.6	X	X	42.	X	6.9	X	X	X
0800		150	145	5.2	4.3	1.66	2.92	29.0	6.7	1.89	197.5	160	104.5	96.0	290	30.0	32.5	.62	X	X	X	X
1030		REPLACED PROCESS PKG. OPEN TOP WITH NEATLY CUT OPEN TOP																	6.9	X	X	X
1200		150	145	5.1	4.4	1.66	2.91	28.9	6.8	1.97	208.5	156	105.8	98.3	320	29.5	51.5	.62	6.95	79	6635	185.56
1330		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
1400		150	145	5.0	4.3	1.85	2.90	28.9	6.7	1.98	198.0	160	100.0	92.5	340	29.5	37.5	.60	7.1	X	X	X
1600		150	145	5.3	4.3	1.86	2.91	28.9	6.6	1.92	207.4	158	108.0	99.0	340	29.5	34.0	.60	X	X	X	X
1800																			6.6	X	X	X
2000		150	145	4.7	4.2	1.83	2.96	29.0	6.7	1.84	198.9	155	108.1	99.0	320	29.5	30.0	.6	6.70	47	6795	201.14
2130		RECYCLE LOOP SAMPLE — SOLIDS CONC + pH 4.75													305				X	X	X	X
2200		150	146	5.1	4.3	1.77	2.96	28.9	6.6	1.88	195.3	156	105.0	96.6	290	29.5	77.5	.6				

pH 6.6

NOTE: pH and conductivity going down

REMARKS: AMB PRESS 0000 745.9 mmHg
0800 744.5
1600 744.0

ADDED URINE: 0015 – 6l – 28→ pH 2.4 (waste 3.2)
1610 – 3l 34→44.5
2130 – 25.5→79.5 pH 1.7 (waste 1.6)

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HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE TEST - VERIFICATION

TEST ENGINEER:

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.:

SHEET OF DATE 3/17/81

TEST PLAN NO.:

MODEL NO.:

PART NO.:

SERIAL NO.:

OPERATORS:

TIME	RUN TIME	T_{HFA}	T_{RECYC}	ΔT_{HEAT}	P_{STEAM}	P_{Pr}	ΔP_F	V	A	PROD RATE	PWR AVG	TER PWR	SPEC ENGY	CORR SP ENGY	PROD COND	SOL CONC	WASTE TANK	P_{ACC}	PROD pH	BURP VOL	ACTUAL PROD H_2O	WATER DEC
		(219)	(220)	(221)	(222)	(223)	(224)	(225)	(226)	(201)	(205)	(206)	(208)	(209)	(ACTUAL)	(214)	(217)			(ml)	(gm)	(203)
0000		150.	145.	5.1	4.2	1.84	2.96	28.9	6.7	1.89	196.6	155.5	164.03	96.	X	29.	67.5	X	X	X	X	X
0200		150.	145.	5.2	4.2	1.85	2.98	28.9	6.7	1.82	196.4	156.	107.92	98.6	X	29.	60.5	X	X	X	X	X
0400		150.	145.	5.2	4.2	1.82	3.00	28.9	6.7	1.82	196.8	155.8	108.07	99.90	X	29.	51.5	X	X	X	X	X
0530		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	6.35	X	6464	215.9
0600		150.	145.	5.1	4.3	1.73	3.0	28.9	7.0	1.80	194.7	156.	108.16	99.8	X	29.5	42.0	.6	X	X	X	X
0800		150	145	5.2	4.2	1.80	3.00	29.0	7.0	1.79	197.1	160.	109.59	101.2	255	29.5	35.0	.56	6.08	X	X	X
1000		150	146	4.7	4.5	1.87	3.00	29.0	6.7	1.83	199.0	158	108.75	101.2	265	29.5	56	.65	6.15	X	X	X
1200		150	145	5.2	4.2	1.83	3.02	28.9	6.6	1.83	197.6	159	107.4	99.2	260	29.5	49.0	.60	6.25	X	X	X
1330		X	X	X	X	X	X	X	X	X	X	X	X	X	275	X	X	X	6.25	80	6461	230.29
1400		150	145	4.9	4.2	1.84	3.02	29.0	6.6	1.82	201.6	156	113.52	104.9	—	29.5	42.0	.60	—	X	X	X
1600		151	146	5.2	4.2	1.87	3.02	29.0	6.6	1.77	205.0	156	115.82	107.0	275	29.5	32.5	.65	6.35	X	X	X
1800		151	146	4.9	4.2	1.90	3.02	29.0	6.7	1.78	198.2	156	111.34	102.9	275	29.0	75.0	.65	6.35	X	X	X
2000		150	146	4.9	4.2	1.87	3.03	29.0	6.6	1.76	194.7	156	110.61	102.3	280	29.5	67.5	.65	6.45	X	X	X
2130		RECYCLE LOOP SAMPLE - SOLIDS CONC + pH 4.70 ALSO COND 390 SENSOR SAMPLE																	6.45	40	6279	244.26
2200		151	146	5.1	4.2	1.86	3.03	29.0	6.9	1.68	196.9	157	117.25	108.40	—	30.0	72.5	.60	—	X	X	X

NOTE @ 1000 hrs. Recycle pH = 4.75

REMARKS:

AMB PRESS 0000 746 mm Hg
0900 745.5
1600 739.6

URINE FILL

TIME	pH	QUANT.	READINGS
0450	2.25	5 l	25 - 56%
1730	1.80	10 l	25.5 - 75.0
2145	1.80	2.5 l	60.5 - 72.5

WASTE pH
1.90
2.15
—

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HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE TEST - VERIFICATION	SHEET 1 OF V DATE 3/18/81
TEST ENGINEER	TEST PLAN NO.
NAME OF RIG: TIMES	MODEL NO.
PROJECT & ENG. ORDER NO.	PART NO.
	SERIAL NO.
	OPERATORS

TIME	RUN TIME	T_{HTM}	T_{RECYC}	ΔT_{HTM}	P_{STEAM}	ΔP_{PP}	ΔP_F	V	A	PROD RATE	PWR AVG	TER PWR	SPEC ENGY	CORR SP ENGY	PROD COND	SOL CONC	WASTE TANK	P_{ACC}	PROD pH	BLEED VOL	ACTUAL PROD H2O	WATER DEL
		(219)	(220)	(221)	(222)	(223)	(224)	(225)	(226)	(201)	(205)	(206)	(208)	(209)	(ACTUAL)	(214)	(217)			(ML)	(GMS)	(203)
0000		150.	146.	4.8	4.2	1.77	3.05	28.9	6.7	1.69	200.7	155.	118.25	108.9	X	29.5	65.0	X	X	X	X	X
0200		150.	146.	4.8	4.2	1.80	3.08	28.9	6.9	1.77	193.9	154.	109.4	101.2	X	29.25	56.0	X	X	X	X	X
0400		150.	146.	5.0	4.2	1.80	3.08	28.9	6.7	1.74	206.3	153.	117.01	108.2	X	29.0	49.0	X	X	X	X	X
0530															X	X	X	X	6.7	X	5971	257.7
0600		150.	145.	4.9	4.2	1.51	3.09	28.9	6.7	1.60	194.7	155.	121.68	112.50	X	29.5	39.5	X	X	X	X	X
0800		150	146	4.2	4.2	1.84	3.11	28.9	6.7	1.65	195.0	153.	118.41	109.4	300	30.0	14.0	.50	6.56	51	1759	161.83

~~[illegible]~~ 0800 RECYC LOOP SAMPLE 4.6 pH — P_{ACC} 4.5

~~[illegible]~~ 840 SWITCHED TO FLUSH MODE —

~~[illegible]~~ 853 ACC AT 99.5

~~[illegible]~~ 907 STARTED FLUSH — WASTE TANK pH = 2.0

~~[illegible]~~ 917 SUBSYSTEM OFF — STEAM PRESS READS 15.8/15.9 SHOULD BE 14.47

~~[illegible]~~ PUT IN SHUTDOWN — NO LIQUID IN MEMBRANES — BLEED 11 ml

~~[illegible]~~ 948 CHANGEOUT COMPLETE — PUT IN STANDBY — TANK TEMP 12°

~~[illegible]~~ ~~RECYCLE LOOP SAMPLE~~ 14.47 AMO — RECALED ITEM 222 STEAM SENSOR

~~[illegible]~~ ADDED 12 l waste tank vol 4.5 → 60.5, pH = 2.3

REMOVED RECYCLE FLUID WT = 10866 g — ABSOLUTELY NO PRECIPITATE IN TANK

DRY WT OF RECYC TANK = 4899 g

FULLY RECHARGED RECYC TANK WT = 14375 g — VOL = 9476 cc

REMARKS: AMB PRESS 0000 745.8
0800 747.4
1600 747.5

31258

HSF-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES®

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE TEST - VERIFICATION

TEST ENGINEER:

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.:

SHEET 2 OF 2 DATE 3/12/81

TEST PLAN NO.:

MODEL NO.:

PART NO.:

SERIAL NO.:

OPERATORS:

TIME	RUN TIME	T_{HFM}	T_{RECYC}	ΔT_{HFM}	P_{STEAM}	ΔP_{11}	ΔP_F	V	A	PROD RATE	~~AVG~~ PWR	TER PWR	SPEC EFFICY	CELL EFFICY	PROD COND	SOL COND	WASTE TANK (and pH)	P_{ACC}	PROD pH	BUMP VOL	ACT PROD H_2O	WATER DEL	RECYC TANK pH
		(219)	(220)	(221)	(222)	(223)	(224)	(225)	(226)	(201)	(207)	(206)	(207)	(209)	(213)	(214)	(217)			(ml)	(gms)	(203)	
←	917	PUT INTO START						TRECYC 145°F															
←	918	GOOD ACCUMULATOR DUMP							(THFM UP TO TEMP TEMPORARILY)								ACCUMULATOR REFILLING OK						
←	921	CONDENSATE ON HFM SHELL - NO VISIBLE LIQUID																	ΔP_{11} @ 1.12				
1110	SWITCH [illegible]	149	144	4.8	3.1	.98	2.70	29.0	6.9	—	—	—	—	—	127	30.5 / 30.0	63.0	.60		15			
1200		150	145	5.8	3.1	1.12	2.67	29.0	7.0	1.89	207.8	170	109.94	101.0	103	30.5	63	.60					
1400	*	150	145	5.7	3.1	1.41	2.72	29.0	7.0	2.45	206.1	168	84.12	78.1	95	30.0	51.5	.60					
1430		150	145	5.4	3.1	1.34	2.35	26.5	6.3	2.31	170.5	139.38	73.81	70.9	95	30.0	49.0 / 2.8	.60	3.55	22	3488	2708	2.85
1600		150	145	5.6	3.1	1.42	2.40	26.5	6.3	2.16	174.3	138	80.40	77.6	103	29.5	42 / 2.1	.60					
1800		150	145	5.4	3.1	1.30	2.40	26.5	6.4	2.13	169.4	137	79.53	77.0	107	30.0	72.5	.60					
2000		150	145	5.5	3.1	1.36	2.41	26.5	6.4	2.10	170.6	139	81.23	78.5	111	30.0 / 30.5	60.5	.55					
2230		150	145	5.4	3.1	1.27	2.44	26.5	6.2	2.07	168.7	139	81.49	79.0	119	30.0	45 / 1.95 pH	.55	3.10	51	7315	281.69	2.45

REMARKS:

1115 added 1.3 l and 40 ml nutrient

1700 added 8.7 l pH 1.7

1748 added 12 l waste tank 71.5 pH 2.3

2235 added 6 l " 77.5 pH 1.7

* VOLTAGE RESET TO 26.5

31257

ORIGINAL PAGE IS OF POOR QUALITY

HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST: ACCEPTANCE/VERIFICATION
TEST ENGINEER
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.

SHEET 1 OF 1 DATE 5/19/81
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME	RUN TIME	T_{HFA}	$T_{RECYCLE}$	ΔT_{HFA}	A_{STEAM}	ΔP_{PP}	ΔP_F	V	A	PROD RATE	PWR AVG	TEC PWR	SPEC ENGY	CORR SP ENGY	PROD COND	SOL CONC	WATER TANK	ρ ACC	PROD pH	BURET VOL	ACT PROD H_2O	WATER DEL	RECIR TANK pH
		(219)	(220)	(221)	(222)	(223)	(224)	(225)	(226)	(201)	(205)	(206)	(208)	(209)	(213)	(214)	(217)			(ml)	(gm)	(203)	
																		X	X	X	X	X	
0000		150.	145.	5.4	3.1	1.39	2.46	26.5	6.3	2.08	176.5	139.	81.86	79.5	X	30.	72.5	X	X	X	X	X	
0200		150.	145.	5.6	3.1	1.33	2.55	26.5	6.2	2.01	168.9	138.	83.73	82.0	X	30.	63.0	X	X	X	X	X	
0400		150.	145.	5.4	3.1	1.40	2.55	26.5	6.6	2.03	169.4	137.5	83.45	81.8	X	29.75	53.5	X	X	X	X	X	
0600		150.	145.	5.4	3.1	1.35	2.67	26.5	6.3	2.0	168.8	136.	84.4	82.4	X	30.	44.5	X	X	X	X	X	
0630		X																X	3.15	X	7316	303.8	X
0800		150	145	5.2	3.1	1.42	3.02	26.5	6.3	2.00	168.0	140	84.0	81.2	145	30.	35.0	.5	3.1				
1000	*	150	144	5.5	3.0	1.27	3.98	26.6	6.3	1.96	168.4	138	85.9	85.9		30	23.5	.55					
1230		141	137	5.6	2.4	.80	2.34	26.2	10.0	0								.70	WASTE TANK pH				
1400		150	145	5.4	3.1	1.15	2.42	26.5	6.3	1.54	172.1	142	112.14	108.4	140	30.	60.5	.70	3.2	INCLUDES STARTUP			
1430		~~150~~	~~144~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~	~~[illegible]~~		~~[illegible]~~			3.2	125	4923	314.63	2.75
1600		150	144	4.9	2.9	1.23	2.45	26.6	6.3	2.08	167.0	142	80.28	79.50	150	29.5	57.5 ~~34~~	.70	3.15				
1800		150	145	5.7	3.0	1.40	2.58	26.5	6.3	2.03	170.1	140	83.80	85.4		30.0	67.5	.65					
2000		150	144	5.6	3.0	1.20	2.98	26.5	6.3	2.03	167.6	142	82.57	82.7	150	30.0	58.5	.65					
2200		150	145	5.7	3.0	1.22	216 3.14 3.30	26.5	7.0	1.86	168.5	142	90.57	90.2		30.0	49.0	.60					
2230				5.6			3.36								150		92.? 2.8		3.10	50	6989	330.44	2.80

TIGHTENED DIAPHRAGMS W/ LARGE PARTICLES

FILTER WET WT 423.22 g.

REMARKS: AMB PRESS 0000 749.1
0800 748.0
1930 747.5

URWE FILL 1220 8 L 219.65
1645 5 L 49-72.5
2215 5 L 49-72.5

URWE	VAC
2.4	2.15
2.55	2.4
1.90	2.5

* 1030 hrs.
PUT INTO NORMAL S/D IN ORDER TO CHANGE FILTER. 31256
FOUND PIECE OF FILTER IN CURRENT LINE
WET WT. 432.70 g.
OFF 45 MIN. - 1110-1155
READY @1305

HSF-175.1B 11/76

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE / VERIFICATION

TEST ENGINEER:

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.

SHEET 1 OF 1 DATE 3/20/81

TEST PLAN NO.

MODEL NO.

PART NO.

SERIAL NO.

OPERATORS

TIME		T_{HTR}	T_{REC}	ΔT_{HTR}	P_{STEAM}	ΔP_{PP}	ΔP_F	V	A	PROD RATE	AVG AVL	TEK AVL	SPEC ENGY	CORR SP ENGY	PROD COND	SOL CONC	WASTE TANK	P_{ACC}	P_{PROD} pH	BULK VOL	ACC PROD H_2O	WATER DEL	RE TK pH
		(219)	(220)	(221)	(222)	(223)	(224)	(225)	(226)	(201)	(205)	(206)	(208)	(209)	(213)	(214)	(217)			(ml)	(gms)	(203)	
0000		150.	145.	5.1	2.9	1.23	3.46	26.5	6.3	2.0	169.3	137.	84.65	82.2	X	30.5	65.0	X					
0200		150.	145.	5.4	2.9	1.38	3.66	26.5	6.3	1.87	168.	136.5	90.16	86.2	X	30.0	56.0	X					
0400		150.	145.	5.4	2.9	1.36	3.82	26.5	6.3	1.95	167.8	138.0	86.3	82.0	X	30.5	46.5	X					
0600		150.	145.	5.9	2.9	1.36	3.97	26.5	6.2	1.91	168.	136.	88.1	84.5	X	30.0	37.5	X					
0630		X																	3.6	X	7022	345.9	2.9
0800		150	145	5.2	2.9	1.33	3.98 MAX	26.5	6.2	1.91	167.9	137	87.91	87.5	145	30.5	28.0	0.60	3.05				
1000		150	145	5.8	2.9	1.52	3.98	26.5	6.2	1.91	168.5	137	88.22	85.1		–	70.0	0.60					
1230		150	145	5.2	3.0	1.41	3.98	26.5	6.3	1.91	167.3	132.5	87.5	87.2	140	–	58.5	0.60	3.20				
1400		150	145	5.6	2.9	1.27	3.98	26.5	6.2	1.93	168.2	137	87.15	84.4		–	53.5	0.60					
1430	*	PUT INADVERTENTLY INTO STERILIZATION — PUT BACK INTO AUTO – STAYED ACCIDENTALLY IN FLUSH – GOT FLUSH																					
1500	‡	1505 – PUT INTO START																					
	—	@ 1745 – PUT ON ACCUM. SUCTION. WASTE 1745 – 4.5 MUST HAVE SLIGHT LEAK IN ACC LINE, PUT IN AUTO																					
1800		150	145	5.0	3.0	.80	3.98	26.5	6.2	0	166.9	136	0	0	93	–	44.5	.70	→ ACCUM OFF 1945				
2000		150	146	5.2	3.1	.93	3.98	26.5	6.8	–	164.5	137	–	–	–		30.0	.95	PUT ACCUM BACK ON				
2200		150	146	5.1	3.0	1.09	3.98	29.0	6.6	1.59	165.9	157	106.22	98.10	107	–	28.0	.70	3.25				
2230		150						26.5		1.62					111			.70	3.20	[illegible]	8907	36233	3.0

+ 23 ... in ... OVERBOARD

* ACS. BLEW CB. – HAVE TO RESTART BY ... SEQUENCE ... & ACCUM.

REMARKS:
AMB PRESS 0000 748.2, 0800 748.9, 1600 749.0

URINE FILL 0230 10.2, 2220 12L

28–75% 28.5 77.5

ΔP URINE 2.20 ... 2.18

ΔP WASTE TANK 2.30 2.40

FLUSH OFF 1501, START 1505

31263

D-23

ORIGINAL PAGE IS OF POOR QUALITY

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE / VERIFICATION

TEST ENGINEER:

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.:

SHEET 1 OF 1 DATE 3/21/87

TEST PLAN NO.:

MODEL NO.:

PART NO.:

SERIAL NO.:

OPERATORS:

TIME		T_{HTR} (219)	T_{TRAY} (220)	ΔT_{HTR} (221)	P_{STEAM} (222)	ΔP_{PP} (223)	ΔP_F (224)	V (225)	A (226)	PROD RATE (201)	AVG PWR (205)	TER PWR (206)	SPEC ENGY (208)	GEN SP ENGY (209)	PROD COND (213)	SOL CONC (214)	WASTE TANK (217)	P_{REC}	PROD pH	PURP VOL (ml)	ACT PROD H2O (GMS)	WATER DEL (203)	REC TK PH
0000		150.	146.	5.1	2.9	1.20	3.98	26.5	6.2	1.75	165.8	134.	94.66	92.5	X	30.	75.0	X					
0200		150.	145.	5.1	3.0	1.16	3.98	26.5	6.2	1.65	165.9	135.	95.	93.	X	30.	67.5	X					
0400		150.	145.	5.5	2.9	1.39	3.98	26.5	6.2	1.50	166.6	136.	91.5	90.6	X	30.	58.5	X					
0600		150.	145.	5.4	2.9	1.30	3.98	26.5	6.2	1.15	165.9	134.	89.5	87.5	X	30.	49.0	X					
0630		X																	3.6	X	6298	369.92	X
0800		150	145	5.1	2.9	1.27	3.98	26.5	6.1	—	165.4	133	—	—	—	30	39.5	—					
1000		150	145	5.6	2.9	1.14	3.98	26.5	6.2	—	167.5	133	—	—	—	30	32.5	—					
1200		150	145	5.3	2.9	1.06	3.98	26.5	6.2	—	164.5	133	—	—	—	29.5	70.0	—					
1400		151	145	5.4	2.9	1.16	3.98	26.5	6.2	—	163.9	133	—	—	—	29.5	63.0	—					
1430								8 HR AVG RATE:		1.655					110		~~63~~ 2.5		3.3	119	6005	—	3.2
1435		KNOCKED CIRCUIT BREAKER WHEN CHECKING CONDUCTIVITY SENSOR —																					
		HAD TO RESET TO GET BACK ON LINE																					
1600		150	145	5.2	2.9	1.20	3.98	26.5	6.2	—	165.5	132	—	—	—	29.5	53.5	—					
1800		150	145	5.2	2.9	1.20	3.98	26.5	6.2	—	174.1	132	—	—	—	30.0	46.5	—					
2000		150	145	5.4	2.9	1.21	3.98	26.5	6.1	—	163.7	133	—	—	—	30.0	38.0	—					
2200		150	145	5.2	2.9	1.22	3.98	26.5	6.1	—	162.2	133	—	—	—	30.0	30.0	—					
2315		subsystem shut down - subsystem put in "standby"													108		~~25.5~~ 2.5		3.0	49	5935	—	3.2
		Time on clock - 1905.1																					
		NOTE — HOLDING TANK LEVEL SENSOR HAS OPEN SWITCH AT ~ 50%.																					
		Flush started at 2305																					

REMARKS:

AMB. PRESS MM Hg: 756.1 @ 00:00 HRS. 752.8 @ 08:00 HRS 757.0 @ 16:00 HRS

URINE FILL 1055 6l, pH 1.6, 28.0 → 72.5 waste tank

31264

D-14

ORIGINAL PAGE IS OF POOR QUALITY

C-3

HSP-176.T8 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES®
Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: Acceptance / ~~Verification~~

TEST ENGINEER: Baseline - Urine

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.

SHEET OF

DATE 3/24/81

TEST PLAN NO.

MODEL NO.

PART NO.

SERIAL NO.

OPERATORS

0900 REASSEMBLE H/X AND CHECK OUT SYSTEM
1300 PUT INTO -START-
1400 IN AUTO PROCESSING - GETTING LOTS OF GAS OVERBOARD FLASK
1430 PUT INTO NORMAL S/D
1450 PUT INTO STANDBY

RUN TIME 1.5 hrs

ORIGINAL PAGE IS OF POOR QUALITY

REMARKS:

31277

HAMILTON STANDARD Division of UNITED TECHNOLOGIES®
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE / ~~VERIFICATION~~
TEST ENGINEER: BASELINE-URINE
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.

SHEET 1 OF 1 DATE 3/23/81
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME	T_{HTM}	T_{RECY}	ΔT_{HTM}	P_{STEAM}	ΔP_{PP}	✓	PROD RATE pph	PROD COND	PROD pH	BUFF VOL cc	ACT H_2O lb	REC TK P..
0900	— IN STANDBY. — 0930 — PUT INTO START — RAN WITH OUTBOARD COLLECTION FLASK DUE TO HIGH GAS.											
1000	151	139	11.0	2.5	1.0	29.0						
1400	START MEASURED COLLECTION									0	0	
1500							1.89	125	6.2		1.89	3.0
1600							2.00			16	2.00	
	GO ONTO ACCUMULATOR											
1730	INITIATE FLUSH BY DRAINING WASTE TANK TO 0.0%. AFTER GET AUTO FLUSH MODE, INPUT 10 ℓ OF METERED DI H_2O INTO WASTE TANK FOR ACTUAL FLUSH LIQUID.											
1800	AUTO / ACCUM — PUT INTO STANDBY OVERNITE											
	TOTAL RUN TIME 8.5 hrs.											

ORIGINAL PAGE IS OF POOR QUALITY

REMARKS: RECYCLE SOLIDS — 9.65 %

31266

HSP-175.1B 11/78

HAMILTON STANDARD Division of **UNITED TECHNOLOGIES**

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE / VERIFICATION

TEST ENGINEER: BASELINE - URINE

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.

SHEET 1 OF

DATE 3/26/81

TEST PLAN NO.

MODEL NO.

PART NO.

SERIAL NO.

OPERATORS

TIME		T_{HTR}	T_{RECYC}	ΔT_{HTR}	P_{STEAM}	ΔP_{PRO}	ΔP_F	V	A	PROD RATE	AVG PWR	TER AVE	SPEC ENGY	CORR SP ENGY	PROD COND *	SOL CONC	WASTE TANK **	P_{ACC}	PROD PH	BUFF VOL	ACT PROD H_2O	WATER DEL	REC TK PH
0850		PUT INTO START					—		GROO	READY		—	1ST ACCUM		QUAL		OK.	2ND	CAL.				
0900		150	142	2.9	2.9	.91	—	29.2	6.4	.26	232.7	158	239.6	225	260	—	35.0	1.3					
1000		152	143	9.3	3.1	1.07	—	29.2	7.2	1.40	198.7	167	141.9	133	220	—	32.5	1.2	4.8				
1030		PUT INTO AUTO/FLUSH BY DRAINING WASTE TANK TO 4.5%																					
1120		AUTO/ACCUM. REACHED - PUT INTO S/B. REMOVE RECYCLE TANK. 1145 PUT INTO STANDBY.																					
1400		SYSTEM @ READY. GO TO AUTO PROCESSING																					
1535		152	142	11.2	3.1	.90		29.2	6.7	1.57	197	167	126	118	200	—	18.5	1.30					
1600	—	GO TO SHUTDOWN, THEN AUTO TO GET AUTO FLUSH																					
1652		PUT IN STANDBY																					
		DAILY TOTAL RUN TIME 6.5 HRS																					
		TOTAL TO DATE 16.5 hrs.																					

REMARKS: 0900 - 770 mmHg

* COND. READINGS HIGH BY X2

** INITIALLY FILLED WITH PRETREATED DI H_2O

31265

HSF-178.18 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE / ~~VERIFICATION~~
TEST ENGINEER: BASELINE-URINE
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET 1 OF 1
DATE: 5/27/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME		T_{HTM}	T_{REZ}	ΔT_{HS}	P_{STEAM}	ΔP_{PP}	ΔP_F	V	A	PROD RATE	AVG PWR	TEX PWR	SPEC ENGY	CORR SP ENGY	PROD COND	SOL CONC	WASTE TANK	P_{ACC}	PROD PH	BLEED VOL	ACT H_2O DEL	W.ASSR DEL	REC TO PH
															*								
0845	START. — MODIFIED 1ST ACCUM. DUMP TO ACTUATE @ 143°F. 0855 READY																						
0900		149	142	8.4	3.0	.76	—	29.0							200		21.0						
1000		150	136	9.8	2.9	.73	—	29.0	6.5	1.89	192.7	163	101.95	95.0	200	—	16.0	1.35	POST TREATED				
1200		151	140	10.4	3.0	.86	—	29.0	6.6	2.00	201.8	163	100.9	94.0	200	—	25.5	1.35					
1415		150	138	11.2	2.9	.77	—	29.0	6.6	1.96	197.8	162	101.17	94.0	200	—	16.0	1.35	NON-POST TREATED				
1500		151	138	11.4	2.9	.73	—	29.1	6.6	1.95	196.0	169	100.5	94	200	—	14.0	1.35					
1525	GO TO NORM S/D																						
1610	PUT INTO STANDBY																						
	DAILY TOTAL TIME 7.5 hrs.																						
	TO DATE TOTAL 24.0 hrs																						

REMARKS:
1200 ADDED 4 gal urine PH = 1.7 wash Col 9.5 → 25.5

* COND. STILL READING ~ 2X HIGH
POST TREATED 1300 hrs COND 31 ph 5.65
NON POST-TREATED 1430 hrs COND 74 ph - 3.70

31267

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HAMILTON STANDARD Division of UNITED TECHNOLOGIES®
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST: H_2O - RESTART
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 7/3/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME		T_{HTR}	T_{RECL}	ΔT_{HX}	P_{STEAM}	ΔP_{PP}	ΔP_F	V	A	PROD RATE	AVG PWR	TOTAL PWR	SPEC ENGY	CORR SP ENGY	PROD COND	SCC CONC	WASTE TANK	P_{ACCUM}		WATER DEL.
0825		91	145	0	15.9	0	—	28.0	5						0		25.5			
0845		136	135	3.1	2.2	.77	—	27.5	10.0									AUX 1.8	— START —	
0900		142	138	5.6	2.4	.93	—	27.5	10.0									AUX 2.0		
1010		152	PULLED GAS FROM EXTING OF H/X @ [illegible].																	
1100		150	145	5.7	3.1	.85	—	27.6	7.1	1.66	195.2	162	215.1	203.5	0	—	16.0	0.8		
1136		DROPPED ACC PRESS FROM .85 TO .65																		
1200		150	145	6.0	3.1	1.09	—	27.6	7.1	2.70	194.3	160	73.4	70.0			11.5	.65	COND-[illegible] 0.8 BARO VOL 36 ml	
1300		151	146	6.1	3.1	1.16	—	27.6	7.0	2.67	200.9	160	75.2	71.7	0	—	30.0	.65		
1400		150	145	6.1	3.1	1.16	—	28.7	7.3	2.85	209.8	172	74.4	67.6	0	—	23.5	.65	RAISE VOLTS - 29.0 ACTUAL - READS 28.7 ON UNIT	
1500		151	146	6.1	3.1	1.14	—	28.6	7.3	2.89	211.8	170	73.4	66.6	0	—	16.0	.65		
1545		151	146	6.0	3.1	1.12	—	28.6	7.3	2.86	212.8	172	74.4	68.1	0	—	11.5	.65		21.22
1550		PUT INTO NORMAL S/D																		
1619		PUT INTO STANDBY																		

REMARKS:
mmHg 764.7 mm Hg

0900 • BURP + COLL LIQ YELLOWISH
• LIQ BOILED OFF IN SHELL

1500 TOTAL AMPS 1 1.93
2 2.07
3 1.95

31268

HSP-175.1B 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE / BASELINE / ~~VERIFICATION~~ - URINE

TEST ENGINEER:

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.:

SHEET OF

DATE 4/16/81

TEST PLAN NO.:

MODEL NO.:

PART NO.:

SERIAL NO.:

OPERATORS:

TIME		T_{HTR}	T_{RECY}	ΔT_{HTR}	P_{STEAM}	ΔP_{FT}	ΔP_F	V	A	PROD RATE	AVG PWR	TER PWR	SPEC ENGY	CORR SP ENGY	PROD COND	SOL COND	WASTE TANK	P_{ACCUM}	PROD pH	BURP VOL	ACT H2O DEL	WATER DEL	RECY pH
0835		98	147	0	15.9	0	—	29.1	.1			—	START —					.65					
0840	FAIL S/D DUE TO 'COND. DEL. STOPPED' — SOFTWARE MUST NOT BE CORRECT. RESET μP - PUT TO STANDBY																						
				STEAM P = 13.6																			
0958	-	CHANGE SOFTWARE T_{min} = 136 SETPT - START																					
* 1100		151	146	6.0	3.2	.90	—	28.7	7.3	1.87	212.9	170	113.8	104	20	—	23.5	0.7					
1200		150	145	5.9	3.1	1.10	—	28.7	7.2	2.75	218.6	170	79.48	73	20		16.0	0.6					
1300		151	146	6.1	3.2	1.20	—	28.7	7.2	2.85	212.0	169	74.00	67.0	30	—	11.5	0.6					
1420		151	146	5.9	3.2	1.21	—	28.7	7.2	2.68	208.8	169	77.9	71.4	30	—	63.0	0.6					
1500		150	145	6.0	3.1	1.23	—	28.7	7.2	2.68	207.8	170	78.3	71.7	40	—	58.5	0.6					
1600		150	145	5.6	3.2	1.15	—	28.7	7.2	2.65	209.3	170	79.0	72.4	40	—	53.5	0.6					
2000		150	145	5.6	3.2	1.17	—	28.7	7.2	2.65	205.4	170	76.6	72.0	60	—	25.5	0.6					
2100		150	145	5.8	3.1	1.26	—	28.7	7.5	2.63	227.9	170	86.7	78.5	60	—	22.0	0.6		175ml			2191

REMARKS:

PRESS 0800 - 759.4

0800 - STANDBY - 1 1/4" LIQ IN SHELL
1000 - BURP LIQ. YELLOW.
1110 - DUMP BURP. LIQ -

0830 FILL 8L, 0-23.5% pH = 1.9
1330 12L, 9.5-65.0
2100 14L, 22.0-84.0' pH = 1.4

* 1145 - WENT TO POSTTREAT OF RECY H2O - DOWNSTREAM BACT TRAP PLUGGED REMOVED FROM LINE FOR INVESTIGATION

31269

HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TITLE OF TEST: ACCEPTANCE / BASELINE - URINE
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 4/7/81, 4/8/81, 4/9/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME		T_{HFM}	T_{RECC}	ΔT_{HFM}	P_{ST}	ΔP_{ST}	ΔP_F	V (PERTS)	A	PROD RATE	AVG PWR	TCL PWR	SPEC ENGY	CORR SP ENGY	SOL CONC	WASTE TANK	P ACC	PROD pH	BURF VOL	ACT H_2O DEL	H_2O DEL	PROD COND TV/MEAS	REC TANK pH
																RECALIB AT 800							
800		150	145	5.2	3.1	1.30	–	28.7	7.1	2.56	207.4	167	81.01	74.0	—	21.0	0.6	[illegible]	–			100	
1000		150	145	5.7	3.1	1.47	–	28.7	7.1	2.50	206.7	167	82.68	75.0		42.0	0.7	3.5 / 5.1	177 ml	2514 / 7.53	60.56	110 / 92	2.3
1100		150	146	5.2	3.2	1.30	–	26.2	6.4	2.52	169.5	137	67.24	67.8	–	25.0	0.7	–				27 [illegible]	
1600		151	146	5.4	3.1	1.36	–	26.1	6.4	2.16	167.9	137	77.71	78.5	–	63.0	0.7	–				120	
22 [illegible]		150	146	5.4	3.1	1.36	–	26.2	6.7	2.18	170.2	137	78.07	78.5	–	32.5	0.7	–	159 ml	11,896 / 26.11	8359 / 6056 / 27.03	130	
4/8 0800		150	145	5.2	2.9	1.42	–	26.2	6.4	2.12	169.8	137	80.09	81.2	–	35.0	0.7						
0815		Go to 31.5 VDC						31.[illegible]	7.8														
1000		151	146	5.6	2.9	1.66	–	31.1	7.7	2.59	242.7	191	93.85	82.46		23.5	0.7	POST 5.5	146	11340	114.15	156 / 160	2.5
1600		152	147	5.3	2.9	1.78		31.1	7.6	2.63	263.5	192	101.34	88.8	–	58.5	0.7					150	
1730		Go to 29.0 VDC						28.6	7.3														
1800		151	146	5.3	2.9	1.74	–	28.6	6.9	2.56	200.2	159	78.20	71.0	–	49.0	0.7					150	
2200		151	146	5.2	2.9	1.68	–	28.6	6.9	2.29	199.0	162	86.93	78.9	–	67.5	0.7	4.7	139	12472	193.52	150 / 115	
4/9 0800		THFM AT 152 FIRM – PUT IN PARTIAL COVER																					
1000		150	145	5.1	2.9	1.34	--	28.6	6.9	2.12	200.0	160	94.3	86.0		25.5	0.7	3.4 / 3.9	129	12809 / [illegible]	169.76	160 / 110	2.3
1105		ACC VAC PUMP RAN LOW ON OIL – ACC PRESS UP – NO DELIVERY – 132 ml [illegible] removed																					
1110		Back to normal																					
1600		151	146	5.1	2.9	1.50	–	28.6	6.8	2.19	198.9	158	90.81	82.4		86.5	0.7					150	
1630		Reduced accumulator suction to 0.9 to get rid of gas bubble																0.9					
2200		151	146	5.1	2.8	1.12	–	28.6	6.1	1.80	195.5	156	108.51	98.4		60.5	.85	4.15 / 4.2	210	9189 / [illegible]	193.71	152 / 120	

REMARKS:

PRESS	800	770.2	4/7/81
	0800	769.4	4/8/81
	2200	765.9	
	800	763.0	4/9/81
	1200	763.3	

4/7/81 840 FILLED: 16 l → 46.5 pH = 1.4
1520 10 l: 14 → 63 pH = 1.8
2200 10 l 32.5 → 86 pH = 1.8

1020	13 l	21.0 – 85.5	pH 1.85	2.35
2020	7 l	35.0 – 72	1.96	2.30
2200	3 l	67.5 – 84.0	1.9	2.5
4/9 1030	13 l	23.5 – 84.0	1.75	2.0
1310	4 l	72.0 – 96.5	1.75	
2200	6 l	60.5 – 88.5	1.96	

10:45 went to 26.5 VDC

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HSP-175.18 11/78

HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: Acceptance / ~~Verification~~ - Urine
TEST ENGINEER: BASELINE
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 4/10/81, 4/11/81, 4/12/81, 4/13/81, 4/14/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

Date	TIME		T_{HFM}	T_{RECY}	ΔT_{HFM}	P_{STEAM}	ΔP_{PP}		V	A	PROD RATE	AVG PWR	TER PWR	SPEC ENGY	CORR SP ENGY		WASTE TANK	ρ_{ACC}	PROD pH	BURP VOL	ACT H_2O DEL	H_2O DEL	PILOT COND	PRE TR pH
4/10	0800		151	146	4.9	2.8	.96	—	28.6	6.7	1.59	214.4	155	134.83	123.3	—	46.5	1.0					150	
	1000		150	146	4.2	2.8	1.21	—	28.6	6.7	1.63	198.0	153	121.48	111.3	—	39.5	.95	3.85	580	8432	230.7	150/100	2.80
	1515		152	148	4.7	2.9	1.23		— OPEN	BACK	MORE	TO	COOL —					1.1						
	1630		150	145	5.4	2.7	.70				1.49							.90						
	1800		151	146	4.4	2.7	1.00		28.6	6.7	1.63	195.8	152	120.31	109.2		84.0	.95					150	
	2200		150	146	4.6	2.7	.70		28.6	6.7	1.50	192.7	153	128.46	117.7		67.5	1.0	4.4	450	8344	231.6	150/110	
	2210												(GAUGE		CORRECTED)			.95						
4/11	1000		150	148	4.4	2.6	.37		28.6	7.0	1.40	193.1	152	137.25	125.5		28.0	.85	3.3/2.5	495	7381	249.43	130/90	2.8
	2200		150	146	4.6	2.6	.59		28.6	6.5	1.35	206.7	149	152.64	139.0		93.5	.90	3.95	555	6684	265.14	120/100	
4/12	1000		150	146	4.5	2.6	.51		28.6	6.4	1.19	185.9	148	156.21	142.0		53.0	.75 @ 78.5	3.3/3.4	670	6250	279.96	90/80	3.6
	1800		150	146	4.2	2.5	.55		28.6	6.6	1.17	166.1	146.0	159.64	145.0			.70 @ 78.5		475	4110	289.35	80	
4/13	1000		150	146	5.2	2.4	.83		28.6	6.4	1.02	183.9	148.0	180.36	164.0		35.0	.75 @ 78.5	4.0	1025	8049	307.5	140/140	
	1600		151	145	6.3	2.4	.89		28.6	6.2	1.09	182.3	147.	167.24	153.		70.0	.75 @ 79.7		355			200	

~2000 – 2030 HRS SHUT DOWN DUE TO OVERTEMP – PUT INTO SHUTDOWN – THEN HAD COOLED SO WENT TO FLUSH – FIRST 10 MIN ACCUM THEN 10 MIN FLUSH – HIGH ΔP (LOW FLOW) DURING FIRST PART OF FLUSH – CLEARED UP OK. 248 9507

4/14 0800 REMOVED FILTER & RECYCLE TANK – CHANGE FILTER – ADD NEW URINE TO BOTH. PUT EPROM IN WITH T_{HFM} 143°F S.PT. FOR WARMUP. FIXED BAD CONNECTOR ON V104. PUT INTO STANDBY 1130 hrs 1600 hrs 1st wk in SHELL – OSD DRY

REMARKS:

4/10 0800 767.5 T=73°F FILL 1430 13 ℓ 24–91.5 to pH 1.75 WASH 2.1
2200 767.9 1630 2 ℓ 84–88.5
4/11 0800 763.3 T=76°F (AT TIMES) 1600 12 ℓ 28–84.0 pH 1.8
2200 761.2 2130 8 ℓ 44.5 – 93.5
1000 767.5 T=75°F

4/12 1000 5 ℓ 53 – 79.5 pH 2.9 – wash tank – 2.3
1800 5 ℓ 53.5 – 84.0
4/13 1130 10 ℓ – 75 pH 1.2 waste 2.75
1530

31272

HAMILTON STANDARD — Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE / ~~[illegible]~~ · URINE BASELINE
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET 1 OF
DATE 4/15/81 4/16/81
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

	TIME		T_{HFM}	T_{RECYC}	ΔT_{HFM}	P_{STEAM}	ΔP_{PP}		V	A	PROD RATE	AVG PWR	TEE PWR	SPEC ENGY	CORR SP ENGY		WASTE TANK	P_{ACC}	PROD pH	BURP VOL	ACT H_2O DEL	H_2O DEL	PROD COND	REC TK pH
																	60.5							
4/15	0752		95	146	0	15.9	0		28.1	0														
	0821		95	145					28.5	10.0			START USING OFF LINE COLLECTION											
	0832		S/D BY FILLING ACCUM MANUALLY. HAVE URINE OVERBOARD IN BURP. DISASSEMBLE																					
			EVAP. BOTTOM - PUT NEW O-RINGS IN LOWER Ti COVER. WASH SHELL, FILL TUBES DI H_2O.																					
			PRESSURIZE TUBES TO 15 PSIG TO CHECK LIQ LEAK. SEE NO LEAKS. WASH OUT																					
			PP. THROUGH STEAM CONE UNTIL CONDUCTIVITY = 70 µmho/cm. LEAVE SOME LIQ IN																					
			CONE TO CLEAN BURP LINE UPON STARTUP. SYSTEM IN STANDBY.																					
																	39.5	.70	— STARTING WITH NO ACCUM					
	1403		82	146	0	14.9	0		29.0	0											— START —			
	1416		82	145		PUT			INTO								(HEATER ON)				— READY —			
	1536		148	145	5.4	2.9	.94		28.5	6.7							37.5							
	1549		150	145	4.7	3.1	.87																	
	1555		151	146	5.3	3.2	.87										RUN TIME 2 HRS							
	1600		PUT INTO NORMAL S/D. MANUALLY FILL ACCUM TO 100%.														TOTAL TO DATE 2+[illegible]2 = 204 hrs.							
4/16	0735		100	146		HFM WERE CLOSED, NO LIQ. IN SHELL - WETNESS INDICATION THOUGH. DISCONNECT RAPID BURP VALVE																		
	0803		125	145	15.4	15.9	0		28.9				OPEN HFM 5 MIN. BEFORE											
	0807					→ BURPER DOWN <5 IN ≥ 15 SEC											— START —							
	0849		148	145	4.9	2.8	.88		28.6	6.8							— READY —							
	0913		151	145	5.3	3.2	.87																	
	0916		152	146					OPEN BACK A LITTLE.															
	0934		153			DEGAS BOTTOM OF H/X																		

REMARKS:
4/15 - 773
4/16 - 776
0800 - 10.2 0-42.2 pH 1.45
0800 - WASTE 39.5
4/16 0800 1" LIQ IN SHELL
SET 29.0 ACCUM [illegible]

31274

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HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE/~~VERIFICATION~~ - URINE
TEST ENGINEER: BASELINE
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET 6 OF
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS
DATE 4/16/81, 4/20/81, 4/21/81

	TIME		T_{FEED}	T_{RECYC}	ΔT_{HTR}	P_{STEAM}	ΔP_{PP}		V	A	PROD RATE	AVG PWR	TEK PWR	SPEC ERGY	CORR SP ERGY		WASTE TANK	P_{ACC}	PROD pH	BULK VOL	ACT H_2O DEL	W. ATEN DEL	PROD COND	REC TK pH
																				•	GMs	lbs		
4/16	1322			CONDUCTIVITY 80,				pH		4.05														
	1400		150	145	5.1	2.9	1.45		28.6	6.8	2.15	144.7	163		84.7									
	1540	DECREASE WASTE TANK TO 0% - GO IN AUTO FLUSH - FILL WITH H_2O TO 23.5%																						
	1550	FILL ACCUM. MANUALLY TO 10%																						
	1610	PUT INTO SHUTDOWN. ~~[illegible]~~. PULL PLUG. CLOSE [illegible]																						
		RUN 8 hrs. - TOTAL TIME 212 hrs.																						
4/20	1325		82	145	0	14.4	0		29	0		NO SHELL HEAT; NO RATIO BULK; DUMPING TO OVERBOARD FLASK — START —												
	1330			. -																				
	1440		134	133	2.9	1.8	.56		28.4	10.0									— READY — 60					
	1515		151	147	5.0	2.6	.80		28.5	6.9														
	[illegible]										PUT INTO S/D													
											RUN - 8 hrs TOTAL TIME 215 hrs.													
	16[illegible]			STANDBY																				
																		.9	NO LIQ IN SHELL (NO HEATER)					
4/21	[illegible]		1[illegible]	145	[illegible]	14.9	[illegible]		21.1	0		NO RECYCLE HEATER → START / AUTO PROCESS												
	[illegible]								24.6															
	[illegible]		141	13[illegible]	4.1	2.1	.52		23.6	5.9			750 ml FROM BULK + FILL [illegible]											
	[illegible]		143						[illegible]	[illegible]	TREAT [illegible] AFTER [illegible] DRAINS													
	[illegible]		14[illegible]	[illegible]	[illegible]	-	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	1.3				[illegible]	.7			[illegible]			
	1[illegible]		15[illegible]	14[illegible]	[illegible].2	[illegible]	.21		[illegible].6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	77.1		57.5	.9						[illegible]

REMARKS:
4/20 P=757.6 [illegible] FALL 82 0-21% pH 1.65
4/21 [illegible] 91 [illegible] pH 2.5

11:15 STANDBY MODE
RUN TIME - 8.25 ; TOTAL 223.25 hrs

31275

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HAMILTON STANDARD Division of UNITED TECHNOLOGIES

Windsor Locks, Connecticut 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: ACCEPTANCE / ~~VERIFICATION~~

TEST ENGINEER: BASELINE - URINE

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.

SHEET OF

DATE 4/22/81 4/23/81

TEST PLAN NO.

MODEL NO.

PART NO.

SERIAL NO.

OPERATORS

TIME		T_{ITM}	T_{RECY}	ΔT_{HTR}	P_{SEAM}	ΔP_{PP}		V	A	PROD RATE	AVG PWR	TER PWR	SPEC ENGY	COMP OF ENGY		WASTE TANK	P_{ACC}	PROD pH	BURP VOL	ACT ...	WATER DEL	PROD COND
																			ml	gms	lbs	
4/22 0820		97	145	0	15.1	0		29.1	0		(NO LIQ. IN SHELL)					35.0	(STANDBY)					
0826				— START —				28.1	10.0		RECY. HEATER ON, NO SHELL HEATER, NO RAPID BURP											
0917		148	145	4.6	2.6	.84		28.5	6.2							35.0	0.9		— READY —			100
0918				AUTO PROCESSING						(X ... = 3%)									330	AUTO —		
1302		151	146	5.2	2.5	1.00	—	28.6	6.3	2.20	184.1	161	8568	76.0		18.5		—(1230 CAME BACK)—				80
1540				FOUND SYSTEM IN FLUSH							WASTE < 4.5%									5740	27.62	
1615			PUT IN STANDBY								RUN TIME - 8 hrs						TOTAL		231.25		hrs.	
4/23 0734		99	149	0	15.1	0		29	0							28	1.0	— START —				
0821		148	145	3.9	2.7	.42		28.6	5.9								1.1	— READY —				
0827				(10 ... - ... HTR)															364			
1542		150	145	4.9	2.6	.84		28.6	6.2	1.90	121.2	159	9536	86.6		42	1.1	—	72	S/D	—	70
1615				END OF FLUSH PUT INTO STANDBY															172			
	FINAL % = 11.5 %										RUN TIME 8.75 hrs.					TOTAL		240 hrs.				
																			GOOD CALCU.			

REMARKS:

4/22 P = 765.1 1020 hrs - FINAL CONC. SAMPLE & PIPET ≥ 8% SOLIDS (225 TOTAL HRS) 1215 hr WASTE TK pH 3.1 1230 TOPFAN = 112 ... 1600 FILL 5 l 25-25 % pH 2.8

4/23 P = 760.1 0832 FILL 10 l 28-72.5%, pH = 3.4 1543 hrs - FINAL SAMPLE PIPET = 11.5% SOLIDS (240 hrs)

31276

D-35

ORIGINAL PAGE IS OF POOR QUALITY

HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TITLE OF TEST: TIMES - WASH WATER
TEST ENGINEER:
NAME OF RIG:
PROJECT & ENG. ORDER NO.

SHEET OF
DATE 7/28/81
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME		T_{HTR}	T_{REC}	ΔI_{HTR}	P_{ST}	N_{PE}		V	A	PROD RATE	AVG PWR	TER PWR	SPEC ENGY	CORR SPEC ENGY		WATER TANK	P_{ACC}	PERM pH	BURA VOL	ACT H_2O SEL	WATER DEL	[illegible]	[illegible]
		4 ml/A DIST H_2O BASELINE TEST																					
1300		ON - RECYC TANK T = 145°F										PUT IN AUTO MODE											
1342		148	145	5.4	2.2 (4.6)	.64		28.6	6.4														
1356		150	145	5.1	2.3	.58		28.6	6.5														
1500		150	146	5.4	2.2	1.08		28.6	6.4														
1540		CALCULATED RATE: 103 ml dump ÷ 9.867 min; 16.05												Rate =			2.32 PPH						
1550				"													2.28 PPH						
1600																	2.29 PPH						
1610																	2.18						
1620																	2.30 PPH						
1635		150	146	5.6	2.2	.73		28.6	6.4	2.17	177	165.0	16.44	73.30									
										THESE TAKEN AFTER UPDATE WITH ACCUMULATOR 96%													
										i.e., NOT REPRESENTATIVE OF ~2.30 RATE													
1636		ACC = 100%.																					
1656		SHUT DOWN - LEFT IN STANDBY																					
		STEAM PRESSURE AT SHUT DOWN = 14.0 (SHOULD BE 14.7, ≈ .7 SHIFT)																					

31278

REMARKS:

HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST: WASH WATER
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 4/24/81
TEST PLAN NO. 4/13/81
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME		THFM	TRE	ΔTHFM	Pst	ΔPpp		V	A	PROD RATE	AVG PWR	TER PWR	SPEC ENGY	CORR SP ENGY	CONC.	WASTE TANK	PACC	PROD pH	BURP VOL	ACT H2O DEL	WATER DEL	PRES COND	REC pH
																			ml	GMS	lb		
4/1 0730		11.5% H2O/PRETREAT IN WASTE ⇒ 2.5l + 4l = 6.5l. ADD 650 ml SOAP MIX FOR THIS VOLUME INTO 10l OF SOAP/PRETREAT/H2O SO THAT STARTING WITH HOMOGENEOUS MIX IN TANK.																					
0755		101	149	0	14.2	0		*28.7	4.8						1.0	58.5	0.9					30	
0800			START				*(ACTUAL 29.0 VDC)																
0841		148	144	5.5	2.1	.77	–	28.6	6.4	— AUTO —					1.0	60.5	0.9					50	
0900		150	146	5.4	2.2	.92	–	28.6	6.4	.74	185.9	165	251.22	225.0	1.0	58.5	0.9	4.0	300			60	
1300		150	146	5.1	2.0	1.40		28.6	6.3	2.31	183.8	162.6	74.56	72.30	1.0	39.5	0.9				COMPUTED 4/28	60	
1700		151	147	4.9	1.9	1.51		28.6	6.2	2.22	181.9	159.9	81.94	74.4	1.5	18.5	0.9					70	
2100		151	146	4.8	2.1	1.27		28.6	6.3	2.13	185.6	161.6	87.13	79.10	1.5	77.5	0.9	3.9	78	12060	34.38	70	
4/2																	(MIST COLLECTED)						
0400		150	146	4.7	2.0	1.04		28.6	6.3	2.00	180.7	161.0	90.35	81.85	1.5	[illegible]	0.7	3.9	62	10773	60.98	80	
1440		SHUT DOWN TO SEE EFFECT OF FLUSH ON T.C. READINGS - REF T.C. LOG SHEET																					
1530		150	145	46	2.2	.99		28.6	6.3										235				
2100		150	145	4.5	2.2	1.02		28.6	6.3	2.04	182.3	161.0	94.44	81.10	1.5	37.5	0.7		51	9415	81.55	80	

2020 OPEN TOP SLIGHTLY

REMARKS:
4/1 0730 P = 754.7 mm, T = 75°F — FILL 1000 10l 11.5 → 58.5% ~~pH 1.65~~ — NO LIQ. IN SHELL, NO POST TREAT.
1700 10l 16.0 → 65.0
2100 6l 49.0 → 77.5
4/2 0930 P = 757.2, T = 75°F — 830 4l 23.5 → 46.5
1600 10l 18.5 → 60.5
2100 10l 37.5 → 88.5

31279

HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TITLE OF TEST: WASH WATER - TEMPS
TEST ENGINEER: —
NAME OF RIG: TIME S
PROJECT & ENG. ORDER NO.:

SHEET OF
DATE 4/29/81 4/30/81
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

	TIME	TER 1 AMPS	TER 2 AMPS	TER 3 AMPS	TC 1 (TERS OUT)	TC 2 (TERS OUT)	TC 3 (TERS OUT)	TC 4 (IN)	TC 5 (COND)	TC 6 (COOL)	T_{HFM}	P_{ST}	V
4/29	0802	1.45	1.56	1.50	122.8	121.0	117.0	126.4	104.5	95.6	135	—	28.6 (29.0 VDC SERIES)
	0830	1.52	1.60	1.58	135.7	135.0	133.3	135.7	114.9	103.2	143	2.1	
	0900	1.87	2.01	1.91	145.4	145.6	144.0	141.6	119.4	107.2	150	2.4	
	1000	1.86	1.99	1.87	145.4	145.8	144.2	141.6	131.7	96.7	150	2.1	
	1100	1.84	1.97	1.87	146.4	146.6	145.1	142.4	132.2	96.8	150	2.1	
	1300	1.84	1.97	1.86	146.3	146.6	145.1	142.7	131.3	99.9	150	2.0	
	1700	1.82	1.95	1.82	146.2	146.5	145.0	142.8	130.3	103.3	151	1.9	
	2100	1.80	1.93	1.84	146.0	146.2	144.4	142.3	130.9	106.6	151	2.1	
4/30	0900	1.80	1.93	1.82	145.4	145.6	143.9	142.0	128.0	97.1	150	2.0	
	1330	1.80	1.91	1.84	144.9	145.2	143.7	141.7	126.7	98.7	150	2.0	
	1339	DISCONNECTED COOLING H/X PUMP											
	1354	1.82	1.93	1.86	145.8	145.8	143.9	142.4	124.8	107.7	151	2.2	
	1409	1.82	1.93	1.86	146.6	146.4	144.7	143.0	124.0	115.4	151	2.2	
	1424	1.82	1.93	1.86	147.1	146.9	145.1	143.5	122.9	116.3	152	2.4	
	1433	1.68	1.80	1.74	113.4	113.4	114.8	106.7			112	14.1	
	1436	1.64	1.76	1.70	111.4	111.4	112.1	107.5	118.6	112.1	113	14.1	
					110.85	110.85	111.05						
	2100	1.84	1.95	1.86	145.4	145.6	143.9	141.6	130.6	97.7	150	2.2	

TEM OPEN SLIGHTLY

REMARKS:

31280

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HAMILTON STANDARD Division of UNITED TECHNOLOGIES
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASH WATER	SHEET	OF	DATE 5/1/81
TEST ENGINEER	TEST PLAN NO.		
	MODEL NO.		
NAME OF RIG: TIMES	PART NO.		
	SERIAL NO.		
PROJECT & ENG. ORDER NO.	OPERATORS		

	TIME	THFM	TREC	ΔT_{HEAT}	P_{ST}	ΔP_{PP}	V	A	PROD RATE	AVG PWR	TER PWR	SPEC ENGY	CORR SP ENGY	CONC	WASTE TANK	P_{ACC}	PROD PH	BURP VOL	ACC H_2O DEL	WATER DEL	PROD COND	PREC TK PH
5/1	0900	150	146	5.1	2.2	1.12	28.6	6.4	1.14	184.0	163.3	86.0	78.0	1.5	30.0	0.7	3.85	90	96.8 / 11335	INCLUDES 10.5 / 106.6	90	
	1500	150	145	— CONNECTED COOLANT PUMP CONTINUOUS — TOOK ≈ 5 MINUTES TO GET THFM TO 148° AND TER INLINE EXIT TEMPS ONLY DROP ≈ 1.5°. CONNECT PUMP BACK NORMAL @ T=148°F																		
	1525	149	145	5.1	2.2	1.05			2.30			(TOP CLOSED TIGHT)										
	1700	150	146	5.3	2.2	1.42	28.6	6.3	2.26	182.6	163.3	80.80	73.4	1.5	39.5	0.65	— BACK OPEN —			123.38	100	
	2100	150	146	5.3	2.2	1.22	28.6	6.3	2.20	184.3	165.3	83.77	76.0	1.5	84.0	0.65	3.8	108	11465	132.47	100	
5/2	0900	150	146	5.6	2.4	1.04	28.6	7.4	2.26	202.1	163.0	89.28	81.1	1.5	86.0	0.60		118	11790	158.96	110	

1730 DISCOVERED HIGH TEMP SHUTDOWN — DISCONNECTED HFM SENSOR — IT WAS OK, CHECKED EXTERNAL TEMPS - HIGH ALSO, TRIED RESTART WITH DUMMY HFM SENSOR — NO PUMP, KEPT IN SHUTDOWN. PUMP MUST HAVE FAILED, LACK OF FILTER ΔP SENSOR LET SYSTEM NOT SENSE PUMP FAILURE AND THUS OVERHEATED.

ONE STRANGE NOTE: TER CURRENTS WERE ON EVEN AFTER SHUTDOWN WHICH WAS DUE TO SENSOR FAILURE, NOT HIGH HFM TEMP.

collected - 595 ml
TOTAL ≈ 52.5 lbs
TOTAL: HRS - UNTIL 1600 hrs - 80
TOTAL TO DATE 148.5 lb

REMARKS:
5/1 0900 P=757.6 FILL 100 102 28-75.2
1700 P=754.6 200 102 23.5-77.5
2100 205 73-84
5/2 0900 P=757.8 0900 13.5 23.5-86.5

31281

D-39

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HAMILTON STANDARD Division of **UNITED TECHNOLOGIES**
Windsor Locks, Connecticut 06096
SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST: WASH WATER - TEMPS
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.

SHEET / OF
DATE 5/1/81, 5/2/81
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

TIME		TER 1 AMPS	TER 2	TER 3		TC 1 OUT	TC 2 OUT	TC 3 OUT	TC 4 IN	TC 5 COND	TC 6 COOL		THEM	PST	V	
5/1 0900		1.84	1.97	1.86		145.4	145.4	143.3	141.7	130.6	96.0		150	2.2	28.6	o COOLANT PUMP CONTINUOUSLY SAW-
1500		1.80	1.93	1.80		144	144	142		125	100		148	1.9		
1700		1.84	1.97	1.87		145.6	145.8	143.8	142.0	131.4	100.6		150	2.2		
2100		1.84	1.97	1.87		145.5	145.6	143.5	141.8	131.0	99.2		150	2.2		
5/2 0900		1.86	1.99	1.87		145.8	145.9	143.8	142.0	131.9	96.5		150	2.3		
1730						205.0	208.0	205.6	198.1	112.3	107.8					

TER

31282

REMARKS:

HSP-178.1A 1/68

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASH WATER
TEST ENGINEER: T
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET: OF: DATE: 5/5/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME		T_{HFA}	T_{RECYC}	ΔT_{HFA}	P_{ST}	ΔP_{PP}		V	A	DELD RATE	AVG PWR	TEL PWR	SPEC ENGY	CURR SP ENGY	CONC	WASTE TANK	P_{ACC}	PROD pH	BULK VOL	H-T FLOW DEL	WATER DEL	PROD COND	REC TK pH
																		ml	ml				
0805		PUT IN WARM UP																					
0850		T_{HFA} = 149 °F – PUT IN AUTOMATIC – MUCH GAS IN DELIVERY LINE																					
		EXTERNAL FLASK USED FOR COLLECTION																					
0935		TOOK BACK COVER OFF TO STABILIZE ~~[illegible]~~ T_{HFA} AT 150 – 157																					
1100		151	145	5.4	2.7	.22		28.7	7.3										240				
1200																		~~2258~~	166	2258			
1500		150	148	3.6	2.9	.22		27.7	7.3	1.95								~~1900~~	750	1900			
1600		PUT INTO SHUTDOWN MODE ACC = 100 %																					
1620		SUBSYSTEM IN STANDBY								1.98								~~700~~	200	700			

SUB HRS – 8.5
TOTAL HRS – 88.5

TOTAL 6214 g → 13.7 #
TOTAL TODATE = 162.2 #

REMARKS: 5/5 1150 ADDED 4 L C26 → 845 NEW ~~L~~ TANK

23654

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASH WATER
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 5/6/81
TEST PLAN NO. 5/7
MODEL NO. 5/8
PART NO.
SERIAL NO.
OPERATORS

TIME		THFM	TREC	ΔTHFM	PST	ΔPPP		V	A	PROD RATE	AVG AMP	TOT AMP	SPEC ENGY	CORR SP ENGY	CONC	WASTE TK	PACC	PROD PH	BLEED VOL	ACT H2O DEL	WATER DEL	PROD COND
5/6 0835		99	— START —		14.9			28.5	10.0							67.5						
0900		142	140	3.7	2.2	.29		28.5	10.0							65.0						40
0920		148	144	4.6	2.6	.44		28.5	10.0						1.5	65.0	0.9	—	30¢ READY		—	40
1050		151	147	3.9	2.7	.66				—	ON FLASK —					58.5	AUX 2.8		300	935		100
1320		150	145	4.7	2.6	.47				2.05	(CALC)						AUX 2.0		400	1423		
96 hr 1600		150	146	4.9	2.7	.55		28.6	6.3	1.91	(CALC)					35.0	AUX 2.0		655	1650	12009 g	
1730		151	146	4.7	2.7	.65		28.6	6.3	1.90	(CALC)					21.0	1.9		993	2043	= 26.5#	
2300		150	145	4.9	2.6	.64		28.7	6.2	1.78	(CALC)					77.5	1.85		1135	1695	SUBTOTAL 188.7#	
5/7 0730		157	152	4.7	3.3	.33		28.7	6.4	1.84	(CALC)				2.0	42.0			3470	3630		
0900		SHUT DOWN — REMOVED CONDENSATE LINE CAPILLARY — TIGHTENED COND LINE FITTINGS																				
1340		STARTUP																			13398 g	
1450		REACHED THFM = 148, PUT INTO AUTO																			= 29.5#	
1500		149	145	4.1	2.7	.65		28.7	6.1							63.0	AUX 2.8		192	466	SUBTOTAL	
120 hr 1700		150	145	4.4	2.7	.47		28.7	6.1	1.59	(CALC)					53.5	2.6		520	920	218.2	
2300		149	145	4.1	2.7	.39		28.7	6.1	1.54	(CALC)		— (BACK OPEN TILT — NO TOP) —						2170	2030		
5/8 0730		146	142	3.4	2.5	.36		28.7	5.8	1.53	(CALC)		— IN AUTO FLASH —			44.5	AUX 2.4		3490	2404	— SLIGHTLY CLOSE UP BACK + TOP	
1030		150	146	4.7	2.4	.68		28.7		1.38	(CALC)	—					1.6		1175	740		
1100		148	144	5.0	2.4	.76		28.7		2.05	(CALC)						1.6		215	250		
1130		147	142	4.9	2.4	.79		28.7									1.6		225	205		

REMARKS:
5/6 0835 P = 758.0 — ON FLASK —
2230 P = 758.4
1930 FILL 10 l — 21 – 67.5 %
2245 5 l — 56 – 77.5 %
5/7 1350 5 l — 42 → 65.0
2230 ~8 l — 32.5 → 75.0
5/8 FILL 1315 10 l 21 – 92 %

23656

D-42

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HSF-175.1A 1/66

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST

TEST ENGINEER

NAME OF RIG

PROJECT & ENG. ORDER NO.

SHEET 2 OF   DATE 3/8

TEST PLAN NO.

MODEL NO.

PART NO.

SERIAL NO.

OPERATORS

TIME	THEM	TREC	ΔTHEM	PST	ΔPPP	V	A	PROD RATE		WASTE TK	PRL		RUAP VOL	H2O DEL
1300	147	142	4.9	2.4	.47	28.6			(PULLING OUT BOTTOM H/X)		1.6	CONTROL LEAK MONITOR TO		
1315	147	142							(PUT ON LOWER VAC PUMP)		0.5	– BLOW BUMPER WITH 5 PSIA		
1350	144	139	5.6	2.1	.84			(GOOD BOX)	(BACK ON VANE PUMP) – HW	122	1.6			
1500	146	141	5.5	2.2	1.11	28.6	6.4	2.1 (CALC)		75.0	1.6		1411	1915
1532	147	143	3.4	2.5	.98				– S/D –					

144 / 66

TOTAL 12000 = 26.43#

TOTAL TO DATE = 244.6#

SUBTOTAL TIME 55.5 HRS

TOTAL ~~144~~.0 HRS

REMARKS:

23661

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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

HSF-175.1A 1/66

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASH WATER - TEMPS

TEST ENGINEER:

NAME OF RIG: TIMES

PROJECT & ENG. ORDER NO.:

SHEET __ OF __

DATE 5/5/81, 5/6/81, 5/7, 5/8

TEST PLAN NO.:

MODEL NO.:

PART NO.:

SERIAL NO.:

OPERATORS:

	TIME		TEA 1 AAC	TEA 2	TEA 3		TC_1	TC_2	TC_3	TC_4	TC_5	TC_6		THEM	P_{ST}	V
5/5											•				(.3 um)	
	1100		1.89	2.05	1.93		145.3	145.6	143.5	141.0	123.4	111.6		151	2.7	28.6
5/6	0930		1.62 ~~134.3~~	1.78 ~~134.2~~	1.76 ~~132.4~~		134.3	134.2	132.4	133.4	110.9	101.8		142	2.2	28.5
	1600		1.82	1.97	1.87		145.5	145.1	142.6	142.0	127.0	104.1		150	2.7	28.6
	1730		1.78	1.91	1.84		145.1	144.9	142.8	141.8	129.6	97.9		152	2.6	28.6
	2300		1.78	1.91	1.89		145.6	144.8	142.9	141.7	131.0	97.5		150	2.6	28.7
5/7	0730						152.6	152.0	150.0	147.4	139.9	124.0		157	3.3	28.4
	1500		1.70	1.78	1.82		143.6	142.3	140.8	141.2	121.0	101.5		149	2.7	28.7
	1700		1.76	1.87	1.87		145.1	144.4	142.3	141.6	132.1	109.6		150	2.7	28.7
	2300		1.76	1.87	1.80		143.9	143.6	142.0	140.6	128.0	110.0		149	2.7	28.7
5/8	0730		1.72	1.80	1.74		[illegible]	[illegible]	138.9	137.3	130.2	101.0		146	2.5	28.7
	1030		1.72	1.87	1.86						132			150		
	1100		1.76	1.89	1.89		142.9	142.0	140.2	139.4	128.5	109.7		148	2.4	28.7
	1130		1.76	1.89	1.91		142.0	141.2	139.3	135.6	128.4	111.4				
	1500		1.87	2.03	1.91		140.6	140.7	136.8	137.2	127.4	109.7		146	2.2	28.6

REMARKS:

23655

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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASH WATER
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET   OF   DATE 5/12/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME		THFM	TREC	ΔT HFM	PST	ΔP PP		V	A	PROD RATE	AVG PWR	TEX PWR	SPEC ENGY	CORR SP ENGY	CAL	WASTE TK	PACC	PROD ΔH	BURP VOL	ACT H2O DEL	WATER DEL	PROD COND
0920		90	148		14.6			29.0	4.8		— START					21.0						
1015		148	140	8.7	2.1	.62		28.6	6.2		— READY → AUTO					32.5	.5		800			60
1200		150	143	5.6	2.4	.84		28.8	6.5	2.43	191.3	169	78.85	72.50	1.5	65.0	0.6		25	1900	4.06	110
1300		151	145	5.7	2.4	.96		28.8	6.4	2.36	188.2	169.8	79.73	73.00	1.5	58.5	0.6					110
1340		152	145	5.7	2.4	.93				2.32							0.5					110
1630		153	147	5.3	2.6	1.09		28.8	6.3	2.03	184.4	166	90.90	83.70	1.5	39.5	0.4		420		13.92	100
2030		DISCOVERED "FAILURE SHUTDOWN" NO MESSAGE - TRECYC TANK = 153																				
		MUST HAVE BEEN HFM OVERTEMP BUT NO MESSAGE OR RED FLAG OR BEEP																				
		TOOK TOP OFF AND RESTARTED - ACC = 100% WENT TO WARMUP DUMPED ACC (WITH HELP																				
		AND AVOIDED FLUSH (NOT AT ACCUMULATE = 100% LONG ENOUGH?)																				
2100		153	140	6.1	2.6	.69		28.7	6.4													
2130		151	144	4.7	2.6	.70		28.7	6.3										780	6515	20.56	130
2136		PAT INM SHUT DOWN - WENT IMMEDIATELY - NO WAITING PERIOD.																				

SUBTOTAL TIME — 12.5 HRS
TOTAL 156.5

TOTAL 10440 g ⇒ 23.0#
SUBTOTAL 267.6 #

REMARKS:
0900 P=758 FILL 10 l 0-32.5 2110 5 l 49.5 → 70.0
1145 10 l 21.0-65.0
1700 5 l 35.0-58.5

NO H/X COOLING FOR RUNS
NO CAPILLARY

23657

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST: WASH WATER
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET OF — DATE 5/13/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME		T_{HFA}	T_{REC}	ΔT_{HFA}	P_{ST}	ΔP_{PP}		V	A	PROD RATE						WASTE TE	P_{ACC}	PROD PH	BURP VOL	ACT H_2O DEL	WATER DEL	PROD COND
0805		101	147		14.4			28.9	4.8		— START —						0.3					
0930		148	143	5.2	2.3	.57		28.7	6.4		— READY/AUTO —						0.3	(GREEN - SOAPY FLUID IN BURP + FLASK)				
0950		151	146	5.1	2.5	.53					ON ACCUMULATOR						0.3					
1000		150	145	6.1	2.4	.71		28.7	6.4													
1020		150	145	5.8	2.4	[illegible]	FLASK THRU TOP OF H/X - NO REGEN. H/X PMAX = 1.8									58.5	0.3		350	1747		7.0
1100		148	144	5.0	2.2	1.03										53.5						
1230		152	148	4.7	2.7	.83																
1300		154	150	5.0	2.8	.96										44.5	AUX 1.45		570	1915		
1315		155	151	4.2	2.7	.60		CHANGE TO HV/122 CONNECTION —									AUX 0.6	— NO COOL. PUMP				
1325		153	148	5.9	2.6	.98											0.6					
1345		150	146	5.4	2.4	1.24											0.5					
1500		145	141	5.4	2.0	1.28				2.51 (CALC)							~~1.0~~		623	1665		
1540	BLOW BACKWARDS WITH DI H_2O @ 14.7 PSIA - OPEN BLEED TO STEAM CONE TO ALLOW PC ≤ 5 PSIA AND GET RAPID BURPING - GET CRUD IN BURP FLASK - COLLECT ≈ 1 L H_2O FLUSH - REPLUMB AGAIN CORRECTLY TO HV/122.																					
1550		147	142	6.1	2.1	.70																
1600		147	142	5.3	2.1	.82											1.0					
1643		148	144	4.9	2.3	.98	— COOLANT PUMP CONNECTED —										1.37					
1702		149	144	5.0	2.3	1.01				1.58 (CALC)						72.0	1.15 / 1.00		343	1088		
2100		147	143	4.9	2.2	1.15				2.08 (CALC)						53.5	0.90		1470	2315		

TOTAL 12056 ⇒ 26.56 #
SUBTOTAL = 294.2 #

REMARKS:
0800 - P > 761 FILL 1650 10 L 23.5 - 72.0
2100 5 L 53.5 - 88.5

0800 H/X CONNECTED IN.
NO CAPILLARY

23659

ORIGINAL PAGE IS OF POOR QUALITY

168

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TYPE OF TEST: WASH WATER
TEST ENGINEER: [illegible]
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 5/14/81 5/15/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

	TIME	T_{HFA}	T_{RECYC}	ΔT_{HFA}	P_{ST}	ΔP_{PP}	V	A	PROD RATE	ACT PROD	WASTE TANK	P_{ACC}	PROD pH	BUFF VOL	ACT KW DEL		PROD COND
5/14	0900	152	147	5.1	2.5	.80	28.7	6.2	1.99	(CALC)	25.0	0.9	3.9	4377	6465		112
	1520	REORIENTED COPPER COIL - TOOK VACUUM FROM OIL PUMP TO VANE PUMP							2.14	(CALC)				2455	3195		
	1730	148	143	5.2	2.2	1.05	28.7	6.2			63.0	1.8					
[illegible]	2100	148	143	5.1	2.2	1.09	28.7	6.2	2.15	(CALC)		1.9		2500	3020		
													TOTAL	22512	⇒ 49.57#	SUBS = 393.8#	
5/15	0800	152	148	5.1	2.6	1.04	28.7	6.2	2.11	(CALC)	39.5	1.9		4945	5616		
	1050	154	150	3.6	2.9	.45	—	PUT IN S/D - CAN'T PULL ΔP_{PP} LOWER						1730	1455		
													TOTAL	13746	⇒ 30.3		
						SUBTOTAL	51.0 HRS						SUBTOTAL		= 374.1#		
						TOTAL	207.5 HRS										

REMARKS:
P = 763.0 @ 0900

ADDED WASHWATER 5/14 1100 5 l 18.0 → 39.5
1630 13 l 24.0 → 65.0
2045 10 l 46.5 → 91.5

23660

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASHWATER TEMPS
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 5/12/81, 5/13/81, 5/14/81, 5/15/81
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

	TIME		TER AMB	TER 2	TER 3	TC_1	TC_2	TC_3	TC_4 (H/X IN)	TC_5	TC_6	TC_7 (H/X)	TC_8 (H/X OUT)	Flow	T_{HTR}	P_{ST}	V
5/12/81	0930		1.43	1.56	1.48	118.8	118.8	115.8	121.1	97.7	84.4	58.8	57.8		129	3.7	28.6
	1015		1.87	2.01	1.91	141.7	142.8	140.2	136.0	118.3	100.8	56.8	56.3		148	2.1	
	1200		1.87	2.05	1.95	145.6	145.9	144.9	141.4	132.6	116.[illegible]	56.5	57.4		150	2.4	28.8
	1300		1.87	2.03	1.93	146.6	146.4	144.2	142.9	134.2	119.4	57.0	57.8		151	2.4	
	1630		1.84	1.97	1.89	147.9	147.8	145.5	144.7	133.6	121.4	56.7	56.1		153	2.6	28.8
	2100		1.87	2.03	1.91	148.5	148.5	146.0	144.0	134.6	110.3	57.4	57.2		153	2.6	28.7
	2130		1.82	1.95	1.91	146.1	145.7	143.6	142.4	132.2	109.2				151	2.6	28.7
5/13/81	1000		1.84	1.95	1.95	145.6	145.0	143.1	141.5	126.2	90.6	56.0	55.3		150	2.4	28.7
	1115		1			143.2	142.8	140.8	139.5	129.4	109.7				148	2.3	28.6
	1230		1.80	1.93	1.91												
	1345		1.82	1.97	1.89	145.2	145.0	143.0	141.9	130.6	117.0						
	2100		1.80	1.95	1.93	142.8	142.2	140.4	139.3	129.2	117.4				147	2.2	
5/14	0900		1.78	1.93	1.91	147.0	146.6	144.2	143.6	133.5	120.7	55.4	57.0		152	2.5	28.6
	1730		1.82	1.95	1.93	142.6	142.7	140.7	139.6	130.0	115.4	58.4	60.9		148	2.2	28.6
	2100		1.80	1.93	1.93	143.6	142.4	140.6	134.5	130.2	116.8	59.6	61.3		148	2.2	28.6
5/15	0800		1.78	1.93	1.91	147.6	146.8	145.0	143.9	134.4	119.6	58.2	60.0				

REMARKS:

23658

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASH WATER
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET OF DATE 5/19/81
TEST PLAN NO. 7/20/81
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

	TIME		T_{HFM}	T_{RECK}	ΔT_{HFM}	P_{ST}	ΔP_{PP}		V	A	PROD RATE	AUG PWR	TER PWR	TREC ENGY	CORR SPEC ENGY	CONC	WASTE TANK	P_{ACC}	PROD pH	BURP VOL	ACT H_2O	T.T H_2O	PROD CON
5/19	0805		PUT INTO START MODE + AUX BOTTLE ON PRODUCT H_2O LINE																				
	0900		148	144	5.2	2.7	.44		27.6	6.5			PUT IN AUTOMATIC							639 (used)	572 (spec)		
	1030		WENT TO ACCUMULATOR								1.98 (CALC)						21.0	0.9	3.7	74	1350		200
	1130		150	145	5.4	2.6	.46		27.6	6.3	1.98 (ACT)	196.8	165	99.69	91.1	1.5	16.0	0.9		151	695	2.04	120
	1135		WENT OFF ACCUMULATOR								(160 ml dumps)												
	1400		150	145	5.1	2.7	.30				1.81 (CALC)						46.5	2.7		432	1685		
216	1700		150	145	4.6	2.7	.60		27.6	6.2	1.81 (CALC)						91.5	2.75		770	1690		
	2100		151	146	4.5	2.7	.55		27.6	6.2	1.80 (CALC)						91.5	2.65 (749.7ml)		1345	1925		
																				TOT 9462.5 →		20.75#	
5/20	0800		151	146	3.7	2.9	.34		26.6	5.9	1.72 → SET 2.0 AUX P @ 0805						49	2.66		4320	4205		
	0805		150	145	4.1	2.7	.51		28.6	6.1	ΔP_{PP} → .84, AT 5.1							2.00					
	1600		150	146	4.4	2.9	.44		28.7	6.0	1.73 — S/D —						44.5	2.04		3470	2800 R		
240																					ON + RAPIDS EV. OUNT		
					SUBTOTAL				32.5 HRS											TOTAL 14845 = 32.7#			
					TOTAL				- 240 HRS											SUBTOTAL 427.5 #			

REMARKS:
5/19 ADDED 10 l 0 → 24.0 5/20 0730 52 49-75
5/19 1130 10 l 12.5 → 56.0
1700 10 l 35.0 → 91.5
2100 4 l 71.5 → 91.5

23662

D-49

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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: H2O w/ PRETREAT
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 5/22/81 5/26/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

TIME		T_{HTM}	T_{REG}	ΔT_{HTM}	P_{ST}	ΔP_{P}		V	A	PROD RATE	AVG PWR	TCL PWR	SPEC ENGY	COMP SP ENGY		WASTE TK	P_{ACC}		RECP VOL	ACT H2O	WATER DEL	PROD COND
5/22 0820		93		0	15.9	0		29.0	0							32.5	.25					20
0810		93	145					28.6	4.7	— START —												
0900		148	144	4.7	2.9	.33		28.5	6.4	— READY/AUTO —						32.5	.25		EMPTIED			
1000		150	145	4.9	3.0	.62		28.5	6.2	1.81	183.9	166	101.6	92.2		28.0	.50		80	→ CLOUDY w/ FLAKES		
1300		151	147	4.2	3.1	.96		28.5	6.4	1.61						16.0	.50		550			0
1530		151	147	4.4	3.1	1.05		28.5	5.9	1.37	173.6	156	126.7	115.1		63.0	.5		600	480 ↓ 10.8	10.9	
					— PUT			INTO	S/D —													
5/26 1300		96	145	0	15.9	0		29.0	0							56.0	0.3					0
1303									4.7	— START —												
1350		148	144	5.2	2.4	.32		29.0	7.0	— READY/AUTO —						53.5	0.3					
1400																			670			
1500		150	146	5.4	2.6	.74		28.5	6.2	1.29	179.1	162.6	135.8	126.0		49.0	0.2					0
1530		150								1.32 S/D —												

REMARKS:
5/22 0820 P = 750.3 (P_{ST} off 0.6 HIGH) FILL 0820 - 1.2 0-32.5 1:30 - 1.2 -115-70 / 5/26 P = 700.6

23664

D-50

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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASH WATER TEMPS
TEST ENGINEER:
NAME OF RIG:
PROJECT & ENG. ORDER NO.:

SHEET OF
DATE 5/19/81
TEST PLAN NO. 5/20/81
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

	TIME	TCA AMPS 1	TCA AMPS 2	TCA AMPS 3	TC_1	TC_2	TC_3	TC_4	TC_5	TC_6	T_{HFA}	P_{SI}	✓
5/19	0900	1.92	2.07	1.97	143.0	143.3	141.2	139.0	123.9	102.8	148	2.7	28.6
	1130	1.82	1.97	1.95	145.0	143.6	142.0	140.8	123.4	95.7	150	2.6	28.6
	1400	1.78	1.91	1.93	145.2	147.5	142.2	141.4	126.4	95.6	150	2.7	28.6
	1700	1.80	1.59	1.89	145.4	144.8	143.2	141.6	131.2	95.4	150	2.7	28.6
	2100	1.78	1.59	1.86	145.4	144.7	143.3	142.0	130.4	99.2	151	2.7	28.6
5/20	0800	1.78	1.57	1.87	144.4	143.4	142.2	140.7	130.9	95.6	150	2.7	28.6
5/21	0800	0	0	0	89.2	89.0	88.9	98.0	100.1	90.8	—	—	
	0900	1.91	2.07	1.97	142.7	142.9	140.7	138.7	116.6	102.6			
	1300	1.74	1.89	1.91	146.3	144.6	143.1	142.8	123.7	97.0			
	1530	1.70	1.86	1.89	145.9	144.4	143.4	142.8	121.6	98.6			

REMARKS:

23663

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HSF-175.1A 1/68

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: H2O CHECKOUT
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 6/3/8
TEST PLAN NO. 6/4
MODEL NO. 6/5
PART NO. 6/8
SERIAL NO.
OPERATORS

	TIME		T_{HM}	T_{REC}	ΔT_{HEM}	P_{ST}	ΔP_{PP}		V	A	PROD RATE	AVG PWR	TOT PWR			WASTE TANK	P_{ACC}		BURP VOL	ACT H2O DEL	WATER DEL	PROD CUM
6/3	1420		81	145	–	14.7	–		29.0	4.7	— START —					23.5	AUX 1.58					
	1550		149	144	5.6	2.2	.18		28.6	6.3						18.5	2.30					0
	1600		150	145	5.6	2.3	.20	–	NORMAL		1.45 GAL — S/D —						1.6		–	1100		
6/4	0815		100	146		14.2			29.1	0	— START —					16.0						
			WOULDN'T GO INTO START — USED AUTO + WASTE SENSOR LIFTOFF (NOT 20% FULL)																			
	0830		135	130	5.7	1.3	.55		28.5	6.6							AUX 1.9					
	0925		FOUND IN FAILURE S/D — FORGOT TO DUMP ACCUM — RESET µP + RESTARTED																			
	1000		147	141	5.7	2.0	.40		28.6	6.4									200	1500		
	1300		147	141	5.9	2.0	.04		28.6	6.7									375	2550		
6/5	1345		84	148	–	14.4	–		28.6	4.7	— START —					300						
	1350		124	124	3.2	.9	0				(CAPILLARY IN TOP)											
	1500		147	149	5.2	2.1	0		28.2	10.0							AUX 2.0		400	320		
	1600		153	148	5.2	2.5	.02				— S/D —					23.5	2.2		260	550		
6/8	1300		81	149	–	13.1	–		28.7	4.7	— START —					23.5						
	1400		143	141	5.9	1.8	.18		28.2	10.0	(CAPILLARY OUT)						2.45		380	550		
	1545		145	140	5.9	1.9	.31				— S/D —						1.9		280	1600		
											182% 172											

REMARKS:
1400 6/3 P = 752.6 RH = 60%
0800 6/4 P = 747.1 RH = 72% T = 73
1345 6/5 P = 747.6 RH = 62% T = 74
1300 6/8 P = 747.6 RH 40% T = 74

23672

D-52

1000 TO 1300 NO FAULT

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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASH WATER - H_2O CIRCUIT
TEST ENGINEER: + WASH WATER
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET OF | DATE 8/17 / 8/18
TEST PLAN NO.
MODEL NO.
PART NO.
SERIAL NO.
OPERATORS

	TIME	T_{HEA}	T_{REC}	ΔT_{HEA}	P_{ST}	ΔP_{PP}	$\Delta P / \Delta F$	V	A	PROD RATE	AVG PWR	TER PWR	SPEC ENGY	CORR SP ENGY	WASTE TK	P_{ACC}	ACC COND	ACT H_2O DEL	T_1	T_2	T_3	T_5	BUG
					H_2O																		
8/17	1310	82	146		15.0			28.7	0		— START —												
	1348	139	137	4.7	2.2	.14	2.30	30.0	10														
	1410	148	144	5.7	2.7	.10	2.31												128.4	127.4	119.1	132.6	680
	1419	149	144	5.7	2.8	.06	2.42	31.0	6.9		— READY —					2.35			139.2	137.7	134.6	140.0	
	1600	151	146	6.2	2.8	.37	2.41									2.65			141.2	140.6	140.5	142	104
					WASHWATER						— SHUTDOWN —					2.30		2500	140.9	139.8	141.2	141.6	55
8/18	0800	FOUND	SYSTEM	DOWN —	RESET	— T_{REC} = 106													TER_1	TER	TER_3	T_{STEAM}	
	0835	FOUND	S/D	AGAIN	— HARD	TO RESET	— PUT IN STANDBY												T_1	T_2	T_3	T_5	
	0945	94	149	0	13.6	0	.12	31.4	5.1		— START —				(3114.0 [illegible])								
	1037	148	144	5.9	2.6	.19	2.70	31.1	7.0		— READY —					1.74		800	2.11 / 138.6	2.27 / 137.4	2.05 / 135.6	140.1	134
	1300	151	145	6.4	2.7	.58	2.70	31.1	7.0	2.68						1.83		3050	2.19 / 141.0	2.27 / 140.2	2.2 / 141.0	141.8	36
	1400				PUT ON	ACCUMULATOR				2.70						.40		1225					
	1600	150	145	6.3	2.7	.73	2.70	31.1	7.0	2.85	245.3	202	86.1	75.6		.70	0	2650	2.17 / 140.0	2.23 / 139.0	2.03 / 140.0	140.9	76
	1723				66 OFF	ACCUM.				3.23	(HIGH → AIR IN ACCUM)				Aux →	2.35		1450					
	1833	151			2.8	.55	2.67			2.64	(CALC)				ACCUM →	1.52		1300	(LITTLE	SUCKING	— N.G.)		
	1900	151	146	5.5	2.8	.53	2.67	31.2	6.8		215.0	195.9			Aux →	2.35		—	2.13 / 142.2	2.17 / 139.2	1.97 / 141.4	142.9	170
	2100	151	146	5.7	2.7	.61	2.67	31.1	6.8	2.73	212.8	197.7				2.30		2475	2.13 / 144.5	2.21 / 140.4	1.97 / 141.2	142.1	106
	2200	151	147	5.4	2.9	.68	2.69		FOUND	BURP	VALVE	CLOSED			84.0	2.22			142.9	144.5	142.6	144.0	—
	2230	151	145	5.5	2.8	.60	2.69	31.1	6.9	2.14	216.3	199.6			Aux →	2.25		1460	2.15 / 142.2	2.21 / 141.6	2.03 / 141.6	143.2	48
																		$\boxed{31.1^{\#}}$					

REMARKS:
8/17 0800 - P = 748.4
8/18 0800 P = 747.6
2070 P = 756.7

1085 WASTE 2535 H_2O - 400 $\Rightarrow$ WASHWATER 10 l
12.0%

1900 10 C - 28.0 → 15 %
1945 7 C 49 → 86.5 %

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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASH WATER
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 8/19/81 8/20/81
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

	TIME	THFA	TREC	ΔTHEAT	PST	ΔPDC	ΔPF	V	A	PROD RATE	AVG PWR	TEA PWR	SPEC ENGY	CARR SP ENGY	WASH TANK	PACC	BASE DH COND	ACT SEC	T1	T2	T3	TC	BURP VOL
8/19	0730	— FIRST CHECK AFTER OVERNITE RUN - SUCTION TO LOW TO DRAIN CONDENSATE INTO COLLECTION																					
		FLASKS - BURP VOLUME HIGH AS RESULT - READJUSTED SUCTION																					
	0800	150	145	5.9	2.7	.77	2.66	31.1	6.9	2.58 w/burp	215.9	199.6	83.6		23.5	1.95		9020	139.9	139.1	139.8	141.5	2100
	1100	151	145	6.3	2.7	.73	2.69	31.1	7.0	2.83	218.2	200.1	77.1		69.5	1.85	66/40	3850	140.4	139.5	140.9	141.9	42
	1400	150	145	6.2	2.7	.78	2.70	31.1	6.9	2.85	217.6	199.1	76.4		49.0	1.80		3890	139.8	138.8	140.2	141.6	42
	1700	150	145	6.4	2.6	.76	2.69	31.1	6.9	2.77	218.1	200.6	78.7		32.5	1.75		3770	139.6	138.6	139.9	141.2	39
	2200	151	145	6.1	2.7	.66	2.69	31.1	6.9	2.73	216.7	200.6	79.4		93.5	1.00		6290	141.4	140.6	141.6	143	69
																		58.9 #	TOTAL - 90.0 #				
8/20	0720	106	123		1.6		— SYSTEM DOWN — PUT IN STANDBY - 2½" LIQ. IN SHELL																
			LIQ SENSOR WET -				— SUCTION ON ALL NIGHT								86.5			450					—
	0810	106	148		START -		LIQ YELLOW IN BURP - USING NO SUCTION											RUN TIME 3148.5 (0835)					
	0840	— SHUTDOWN - BY POWER INTERRUPT - FOR CLEANING OF EVAP, THROAT & PLATES (BACKFLOW)																					
	1305	84	148		14.7			— START —								1.78							
	1400	148	144	5.9	2.6	0.9	2.61	31.1	7.0		— READY —					1.72			139.2	138.2	139.4	140.8	
	1500	150	145	5.6	2.7	.38	2.55	31.1	7.0		221.9	204.0			77.5	MAXIM .25		1750	141.6	140.4	141.6	143.0	138
	2000	151	145	6.2	2.7	.77	2.55	31.1	7.0	3.23	224.5	204.0	69.5	61.6	42.0	.25	70	6150	140.8	139.7	141.0	142.3	70
	2200	150	145	6.2	2.6	.78	2.58	31.1	7.0	3.24	224.8	202.4	70.0	62.0	93.5	1.80	70	2475	140.2	139.0	140.6	141.8	27
	3161.9						TEA 1,2,3 —			2.19, 2.25, 2.05						CONC SENSOR - 2.5%							
8/21	0730	FLAMEOUT LAST NITE @ 3170.8 ON CLOCK — @2200: 8.9 HRS AFTER 2200 = 0654																					
		TRIED RESTART - MICROPROCESSOR WOULD NOT RESET																					
	0730						2.94											11880					126
																		49.1#	TOTAL - 139.1#				

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REMARKS:

8/19 0800 758.7 — 0800 ADD WATER 23.5 → 84.0 = 13 l
1115 756.6 — 1600 ADD 22.5 → 75.0 = 10 l
2200 ADD 42.0 → 93.5 = 10 l

8/20 0800 P = 757.5
1900 RUN 3153.9 hrs
2130 FILL 12 l 32 — 93.5%
P > 756.0

SUBTOTAL TIME - 52 hrs
TOTAL = 296 hrs

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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TYPE OF TEST: WASH WATER
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET: OF:
DATE: 5/24/8_ 5/25/8_
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

	TIME	T_{HFM}	T_{REC}	ΔT_{HFM}	P_{ST}	ΔP_{PP}	ΔP_F	V	A	PROD RATE	AVG PWR	TER PWR	SPEC ENGY	COMP OF ENGY	WASTE TANK	P_{ACC}	AMP PSI / COND	ACT H2O DEL	T_1	T_2	T_3	T_5	BURP VOL
		AIR COOLING LOGIC INSTALLED. SPARE FILTER ON LINE. SAFETY SOLENOIDS INSTALLED FOR ONE-SITE OPERATION																					
5/24	1440	82	138		14.3			31.5	5.1		— START —												
	1602	148	144	5.8	2.6	.14	2.58	31.1	7.1							1.7			140.0	138.9	140.4	141.4	—
	1620	151	—	COOLING FAN DID NOT CAME ON – WENT TO MANUAL														(10 VDC)					
	1800	152	146	5.7	2.9	.11	2.59	31.1	7.0		221.9	200.5			58.5	1.7		2770	143.3	142.2	143.4	144.1	31
	2000	151	145	5.7	2.8	.10	2.59	31.1	7.0	2.45	228.2	201.4	93.2		46.5	1.6		2220	142.7	141.6	142.9	143.9	30
	2200	150	144	5.8	2.8	.08	2.56	31.1	7.0	2.56	219.5	202.2	85.7		35.0	1.6		2320	142.1	140.9	142.2	143.7	32
	2200	PUT INTO SHUTDOWN MODE – (TRIPPED ACCUMULATOR TO 127 & CLOSED CONDENSATE LINE)																					
	2220	PUT INTO STANDBY + ~~FAN~~ CLOSED HFM VALVES – ~~[illegible]~~																					
		MICROPROCESSOR CLOCK 3183.65																7310	$\boxed{16.1\#}$	$\boxed{\text{TOTAL } 155.2\#}$			
8/25	0840	101	149		14.4			31.1	5.0		— START —				32.5	1.78		(1/4" LIQ IN SHELL)					
	0920	148	143	5.7	2.7	.17	2.58	31.0	7.0		— READY —		(1/4" LIQ)		82	1.78			140.8	139.8	141.0	142.0	140
	0935	151	145	5.7	2.8	.18	2.52				–FANS ON 10VDC, ACCUM. ON					.25	60	825					
	1100	151	145	5.7	2.9	.08	2.56	31.1	7.0	2.73	221.9	203.2	81.24	71.3	72.0	.25	80	1625	143.2	141.8	143.3	144.8	26
	1400	151	145	5.7	2.9	.07	2.61	31.1	7.0	2.69	220.6	203.2	82.00	72.10	53.5	.25	39 / 80	3375	143.2	142.0	143.4	144.6	48
	1650	151	145	5.7	2.8	.05	2.58	31.1	7.0	2.81	221.0	203.2	80.40	70.40	37.5	.25	80		142.9	141.9	143.0	144.1	39
	1900	151	144	5.7	2.8	.07	2.58	31.1	7.0	2.78	223.4	203.2	80.82	71.00		.25	80		142.6	141.2	142.8	144.0	36
	1900	SWITCHED PROD H2O TO BYPASS POST FILTRATION																					
	2200	150	144	5.7	2.7	.06	2.58	31.1	7.0	2.69	220.6	202.4	82.00	72.1		.25	80	8800	142.2	140.7	142.1	143.4	42
	2400	—	SYSTEM SHUTDOWN —							(2 HR CALC)	FLAMEOUT —							2050					30

Left margin: 3194.4 @ 0920 hrs; 3201.3 @ 1900 hrs (1022)

REMARKS:

8/24 1430 FULL 7λ 32–72
P = 750.3 H.S

SUBTOTAL HRS – 23 hrs
TOTAL – 319 hrs

8/25 0800 P = 757.4 HS
0900 FILL 10λ 30–82%
1000 · BUF TEMP 123°F
1330 AIR EXHAUST 110°F
1400 SHELL 132°F

1645 FILL 5λ 37.5–60.5
1900 " 5λ 49.0–82.0
2200 " 7λ – 93.5

16675 $\boxed{36.7\#}$
TOTAL $\boxed{191.9\#}$

23668

D-55

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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY

LOG OF TEST

TITLE OF TEST: WASH WATER
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 8/26/87 8/27/87
TEST PLAN NO.:
MODEL NO.:
PART NO.:
SERIAL NO.:
OPERATORS:

8/26

TIME	T_{TEN}	T_{REC}	ΔT_{TEN}	P_{ST}	ΔP_{PP}	ΔP_F	V	A	PROD RATE	AVG PWR	TER PWR	SPEC ENGY	CORR SP ENGY	WASTE TK	P_{ACC}	pH / COND	ACT H2O DEL	T_1	T_2	T_3	T_5	REQ VOL
0800	- EDGE CONNECTORS MOVED AROUND TO START UP MP. RUN TIME - 3209.2 - NO LIQ IN SHELL																					
1300	85			14.5			31.7	0	— START —					86.5	1.55	— LIQ IN SHELL AFTER START						
1415	150	144	5.8	2.7	.17	2.56	31.1	7.0		229.2	203.5				.25		1150	141.4	140.1	141.4	143.0	—
	— AUTO FAN COOLING WITH AIR WORKING - FOAM PARTITION BETWEEN RECY. TANK + EVAP. —																					
1500	150	144	5.9	2.8	.11	2.53	31.0	7.0	1.09	224.0	201.6	205.5	180.0	75.0	.30	/ 240	750	142.0	140.8	141.9	143.3	15
1800	150	144	5.9	2.7	.09	2.56	31.0	7.0	2.67	221.9	200.6	83.1	73.0	58.5	.30	/ 80	3225	142.2	140.8	141.9	143.5	40
2200	150	144	6.0	2.7	.09	2.50	31.0	7.0	2.66	253.4	200.6	95.25	83.10	84.0	.30	/ 80	4400	141.9	140.6	141.8	143.3	60
																	21.0	TOTAL 212.9 #				
0740	150	145	4.7	2.8	.01	2.52	31.0	7.3	RECYC	231.6	188.6	0	0	65.0	.30	/ 2550		141.0	137.4	128.5	144.2	1100
0750	PUT INTO SHUTDOWN — THEN DISCOVERED → ACC PUMP ON - WOULD NOT PUMP OUT ACC																					
0755	TOOK OUT OF SHUTDOWN BY RESETTING CONTROLLER																					
	DISCONNECTED COND SENSOR TO BYPASS BACT FILT, TOOK CONDENSATE THRU POST TREATMENT																					
	BED BY PASS - ACC DUMP WORKED OK																					
0900	PUT INTO SHUTDOWN																					
0910	ACC = 100%.																					
0920	STARTED FLUSH, FILTER ΔP WENT TO .00 CHECKED TO MAKE SURE WE HAD FLOW OK																					
0930	SHUT DOWN - TURNED OFF																					

3221.5 @ 2200 hrs

8/27

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REMARKS:
8/24 P=759.3 0900
P-757.3 1300
420 hrs - Conc. solids 6.0%
- 136°F TER 1,2,3 217, 225, 205
35-84%

SUBTOTAL hrs - 19 h
TOTAL - 338 h

23671

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Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT 06096

SPACE & LIFE SYSTEMS LABORATORY
LOG OF TEST

TITLE OF TEST: WASH WATER
TEST ENGINEER:
NAME OF RIG: TIMES
PROJECT & ENG. ORDER NO.:

SHEET ___ OF ___ DATE 9/1/81 9/2/81
TEST PLAN NO.
MODEL NO. — AIR COOL
PART NO.
SERIAL NO.
OPERATORS

	TIME	T_{HFM}	T_{REC}	ΔT_{HFM}	P_{ST}	ΔP_{PP}	ΔP_F	V	A	PROD RATE	AVG PWR	TER PWR	SPEC ENGY	CORR SP ENGY	WASTE TK	P_{ACC}	PH/COND	ACT H2O DEL	T_1	T_2	T_3	T_4/T_5	BUBL VOL
	1425	82	150		14.4			31.0		— START —						1.6			LIQ. IN SHELL			1/4"	
	1530	148	143	5.9	2.6	.15	2.6	31.1	7.1	— AUTOMATIC —						.3		900	139.6	135.6	139.7	141.3	—
	1800	150	143	6.1	2.8	.11	2.56	31.1	7.1	2.70	250	205.0	94.4	83.6	30.0	.3			141.3	140.0	141.4	143.0	30 CLEAR
	2200	150	143	5.9	2.8	.10	2.56	31.1	7.1	2.71	229.9	205.9	84.8	75.1	79.5	.3	320	7400	141.8	140.4	141.9	143.4	60
	~~2400~~	LIQ-GREEN		BRAKE THRU — PULLED PLUG TO POWER INTERRUPT. REPRESS & CLOSED HFM VALVES																			
				1/2" LIQ IN SHELL.														183#	~~231~~ # TOTAL 231				
9/2	1310	TURNED ON SUBSYSTEM - START —											12 W HTR ON SHELL										
	1401	148	143	5.8	2.6	.29	2.67	31.1	7.5	— AUTO —								870	~~[illegible]~~				14
	1412	150	143	5.6	2.7	.30	2.67	31.1	7.5							.2			140.9	140.0	141.2	126.? / 102.4 / 99.2	
	1419	150/149		— COOLING BLOWER SHUT OFF —																			
	1600	UPPED SHELL PWR TO 24 W (ON AUX PWR)																					
	1700	150	143	5.8	2.8	.12	2.59	31.1	7.5	2.74	227.4	205.1	83.0	73.6	65.0	.2	4.0/120	3180	141.9	140.8	142.2	MIN 105.4 / 142.?	16
	2000	150	144	5.7	2.7	.24	2.59	31.1	7.0	2.67	228.1	205.9	88.8	75.1	46.5	.2	(SHELL HTR PWR TO 40W)		141.9	140.9	142.0	NO. ? / 143.?	
	2200	150	142	5.7	2.7	.27	2.61	31.1	7.5	2.71 (2.45 ACTUAL)	231.2	205.9	85.5	75.6	67.5	.2	3.9/85	5565	141.6	140.6	141.6	142.2 / 142.9	71
																		21.2#	~~256~~ # TOTAL 252.4				
9/3	0800	150	143	5.8	2.7	.27	2.61	31.1	7.5	2.74	232.4	205.8	84.68	75.0	25.5	.2	GREEN	11400	141.2	140.9	141.6	142.0	160
																		25.2#	277.6# TOTAL				
	1000	150	144	6.0	2.7	1.35	2.56	31.1	7.0	3.35	250.5	204.0	74.76	66.2	70.0	.4	400	2500	139.1	138.8	140.2	141.8	30
	1300	150	145	5.9	2.7	1.30	2.62	31.1	7.0	3.20	226.6	205.6	70.81	62.2	49.0	.7	GREEN	140.1	[illegible]	137.7	139.2	140.6	
	1430	150	145	5.6	2.7	1.51	2.62	31.1	7.0	3.17	225.1	224.0	—	S/D	—		GREEN	6150	139.2	137.4	138.8	140.8	

LIQ. COOLING DUE TO 336

REMARKS:
9/1 P = 752.1 @1400; 9/1 FILL 15 ℓ 16–86.5 @ 2000; 2200 2.0 ℓ 79.5; 9/2 FILL 6.5 ℓ 46.5–77.5 @ 2000; 2200 3.5 ℓ 67.5–84.0; 9/3 FILL 12.5 ℓ 23.5–77.5 0830

9/2 P = 756.4 @1400

1400 COOLANT 6200 ml PUMPED — ADDED IN TO END OF TEST

19.1# SUB

141.3# TOTAL

SUBTOTAL HRS – 33 hrs
TOTAL HRS – 37

TOTAL 296.6#

23673

D-57

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