FINAL REPORT

MSC AIR EVAPORATION WATER RECLAMATION SYSTEM

Contract No. NAS-9-3796

August 11, 1965

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ABSTRACT

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This report describes the air evaporation process for the reclamation of potable water from urine and the system built under contract number NAS-9-3796 for NASA-MSC, Houston to automatically carry out the process. System operation and performance in both preliminary and acceptance testing are discussed.

1.0 PROCESS DESCRIPTION

The air evaporation process for the reclamation of water from urine consists of a chemical treatment of the urine as collected, introduction of the treated urine into a felt wick evaporator, evaporation of the water into a heated air stream, charcoal filtration of the saturated air, condensation of the water from the air and charcoal filtration of the condensed water. In this process, the chemical treatment reacts with the urine to prevent the breakdown of the urine into volatile compounds, ensuring the evaporation of practically pure water from the wick. The few volatiles that do evaporate along with the water are almost completely removed by the charcoal filtrations of the water vapor and the final condensate. The product water possesses no objectionable color, odor or taste and contains only trace impurities well below the limits established by the United States Public Health Service for drinking water.

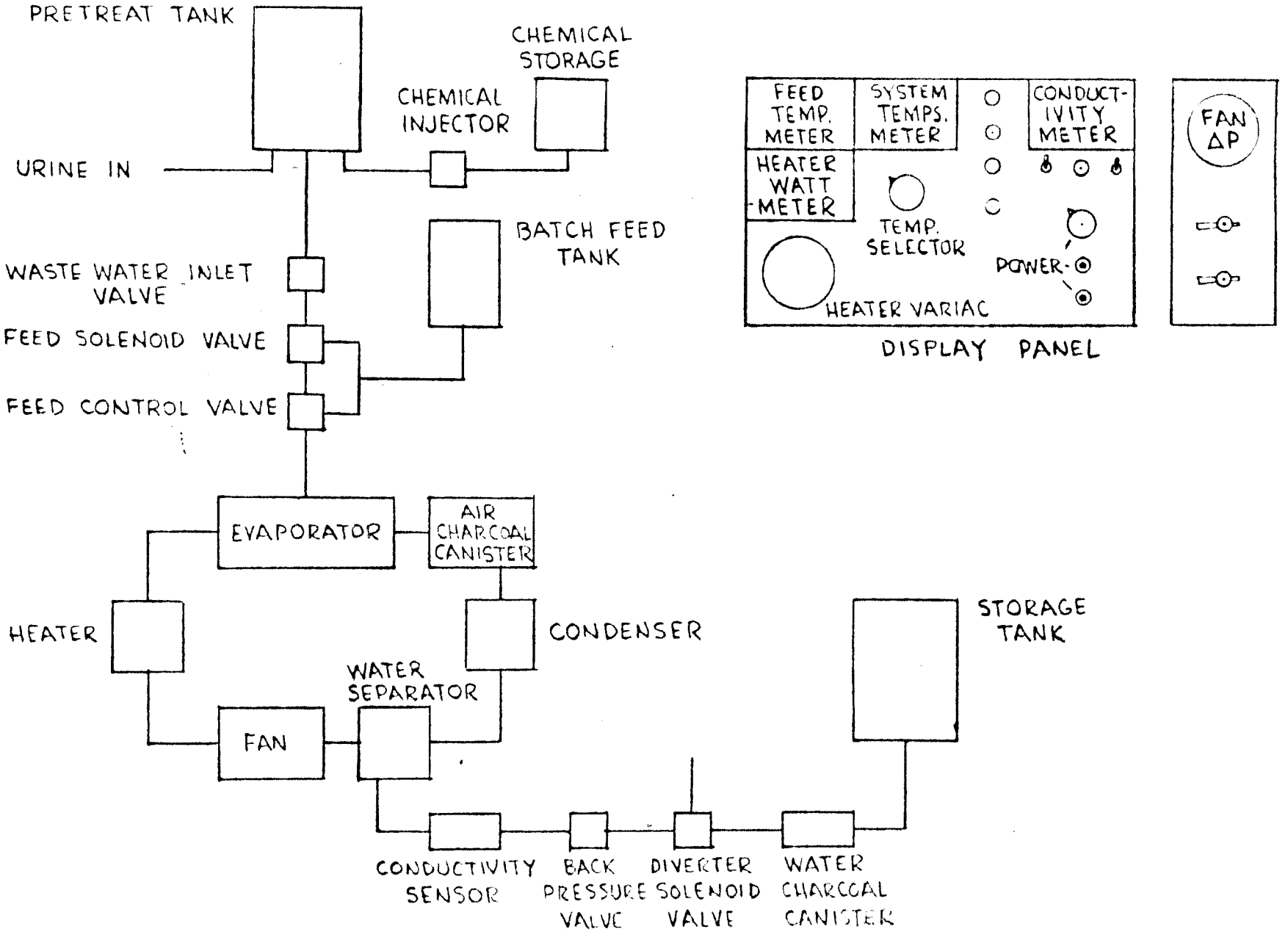
2.0 SYSTEM

2.1 Unit Description

The air evaporation unit designed to automatically carry out the process described in Section 1.0, consists of a closed loop air circulation system for the evaporation and condensation of the urine-contained water; a pretreatment and feed system for the introduction of the urine into the air loop; a collection system for the removal and storage of processed water and a display panel containing all controls and indicators necessary to the operation of the unit.

Urine, as collected, is introduced into the unit pretreatment tank and treated by the manual injection of the treatment chemical. It is then introduced into the evaporating wick, either manually, directly from the pretreatment tank or automatically, through a batch feed tank. Air, within ±4 inches of water of ambient pressure at the fan inlet, is driven by the fan through an electric heater, increasing its temperature and ability to absorb moisture. This heated air passes into the evaporator and through the urine-filled rayon felt wick package, causing the evaporation of water and small amounts of impurities into the air stream, lowering the air temperature and increasing its relative humidity. Passage of this nearly saturated air through a charcoal filter removes most of the impurities before introduction into the water-cooled condensing heat exchanger, where a temperature reduction causes the condensation of the water vapor into droplets. These water droplets are entrained by the air stream and carried into the air-driven centrifugal water separator. The water is pumped by the separator through a final charcoal filter to storage. The air, free of entrained water, passes into the fan for recirculation through the loop.

A schematic diagram of the unit is shown in Figure 2.1. Physical dimensions of the unit are:



AIR EVAPORATION SYSTEM SCHEMATIC

FIGURE 2.

2.1 (Continued)

Length	20 3/4 inches
Width	34 1/8 inches
Height	24 inches
Height (evaporator cover open)	35 7/8 inches
Weight	109.85 pounds

2.2 Unit Operation

Manual operations required are:

Introduction of treatment chemical
Installation and replacement of wicks
Initial filling of wick
Setting of automatic controls

All other unit operations are automatic.

Treatment chemical introduction consists of the operation of the chemical injector plunger once for every 1.5 liters of urine introduced into the pretreat tank, supplying the required chemical concentration of 4 ml per liter of urine. The installation of the wick package is described in the operating instructions and is required at approximately eight day intervals. Each new wick must be initially filled with urine directly from the pretreat tank by the manual operation of the feed control and waste water inlet valves on the control panel. The automatic controls to be set are the conductivity and wick feed temperature meter set points, the diverter valve selector switch and the electric heater variac.

When these operations have been carried out and the unit started, the unit will, under normal conditions, run automatically and unattended. Urine is fed to the wick in measured batches, triggered by a rise in the wick's internal temperature. This temperature, a function of wick wetness, is sensed by an imbedded thermistor and displayed on a panel-mounted meter. When the wick temperature reaches a predetermined value, contact with the meter set point activates a solenoid valve permitting the discharge of the spring loaded batch feed tank into the wick. A microswitch, activated by the batch feed tank as it empties, deactivates the solenoid valve and permits the refilling of the batch tank from the pressurized pretreat tank. The introduction of urine into the wick lowers the wick's internal temperature and drives the contacts below the set point to begin another cycle. The processed water leaving the centrifugal separator passes through a conductivity sensing cell which displays the water conductivity in micromhos per centimeter on a panel-mounted set point meter. If the conductivity rises above a predetermined level, contact with the set point activates a solenoid valve to divert the contaminated water directly to a discharge line for collection for reprocessing. Uncontaminated water, with conductivities lower than the meter set point, passes through a charcoal filter in the normal collection line and into the storage tank. The solenoid diverter valve is further controlled by a panel-mounted switch, providing for automatic operation as described, manual diversion of all product water, or no diversion. Panel-mounted signal lights indicate high conductivity and diverter valve operation.

Air flow through the loop is monitored by a differential pressure gauge across the fan, the ΔP reading being converted to CFM air flow via the fan calibration curve in the operating instructions. A signal light indicates low ΔP. Unit air loop temperatures are sensed by duct-mounted thermocouples

2.2 (Continued)

and displayed, through the temperature selector switch, on the panel pyrometer. Signal lights indicate excessive evaporator and condenser outlet temperature, each monitored by a duct-mounted thermal switch. Heater power is controlled and monitored by a panel-mounted variac and wattmeter.

Prior to the removal of a spent wick, the unit is placed in the "DRY" mode of operation, which permits the continued evaporation of water from the wick while disconnecting the automatic feed system from the circuit. All other automatic functions remain operative during this time.

2.3 Unit Manufacture

The air evaporation unit delivered under this contract was manufactured almost entirely from existing HSD designs. Minor modifications were made to the designs of the evaporator, water separator, and mounting brackets. A new design was required for the electric heater and an extensive modification was required to the display panel design to accommodate the heater variac and wattmeter. The addition of these items also required the relocation of minor components within the unit.

No efforts were made to minimize the size or weight of this prototype unit which utilized, wherever possible, readily available commercial off-the-shelf hardware. Studies based on the original designs of this unit indicate possible savings of approximately 50% in weight and 40% in volume through extensive redesign and optimization.

All component and unit assembly work was accomplished at HSD. Component calibrations and leak and pressure tests, where required, were performed during the component assembly phase prior to final unit assembly.

3.0 PERFORMANCE

3.1 Preliminary Testing

Tests to determine the proper operation of all components and to establish nominal processing rates were run at the completion of assembly. Test runs were made initially with distilled water and later with pretreated urine. Results of these tests are shown in Figures 3.1 to 3.4.

3.2 Acceptance Testing

The unit acceptance test, consisting of an eight hour continuous run, a twelve hour simulated earth-orbital cyclic run and a four hour dry down run in accordance with contractual requirements, was performed from July 22 to July 26, 1965 at HSD. The attached plan of test (Appendix) outlines the procedures of this test. Data recorded during this test and results of the analyses of product water samples collected during the test are presented in the Appendix.

4.0 ACCEPTANCE TEST RESULTS AND DISCUSSION

Plots of processing rate, system temperatures and wick temperatures are presented in Figures 4.1, 4.2 and 4.3 respectively, for the eight hour continuous running test. A tabulation of the processed water analyses for this test is presented in Table 4.1.

FIGURE 3.1

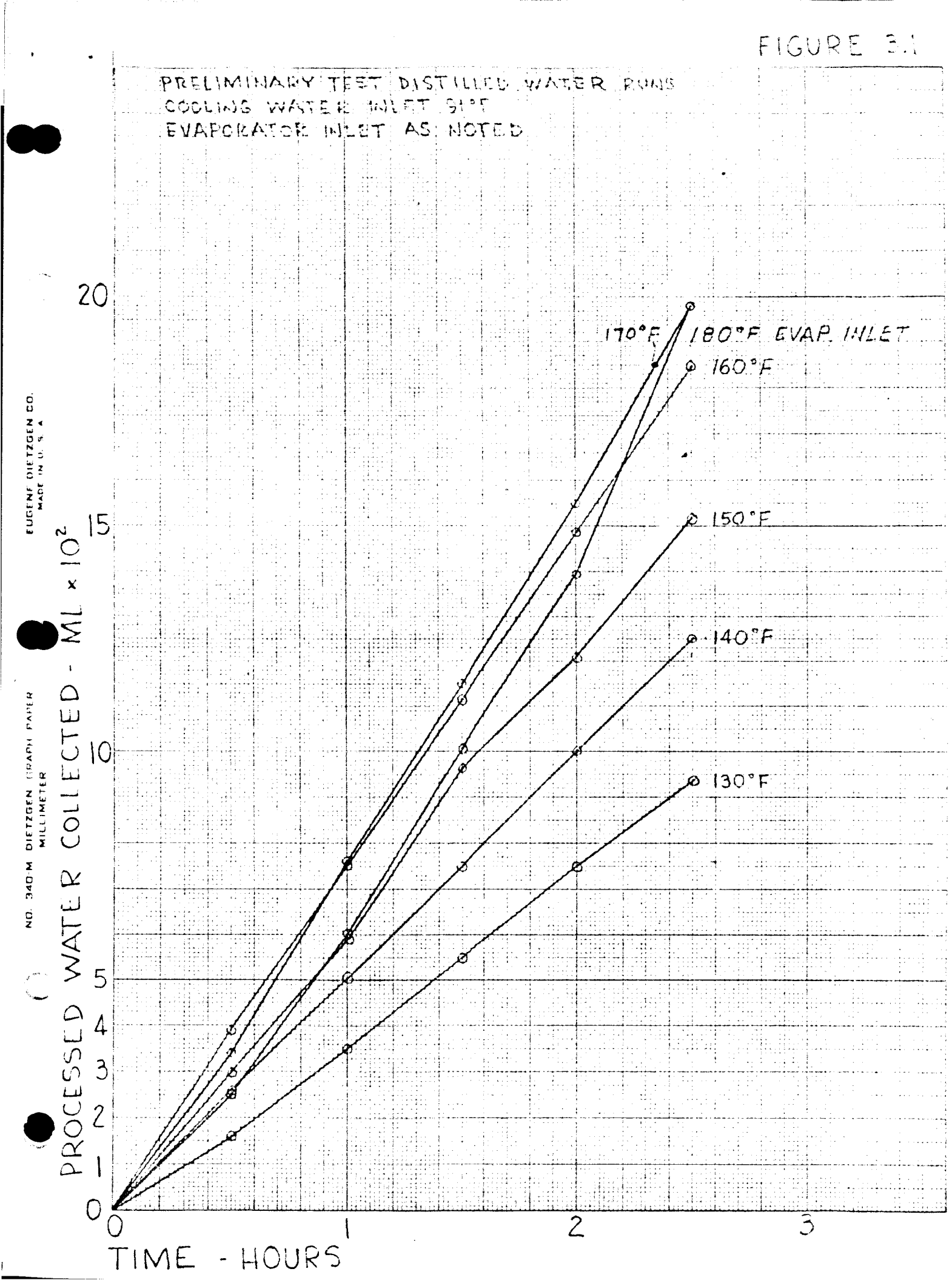
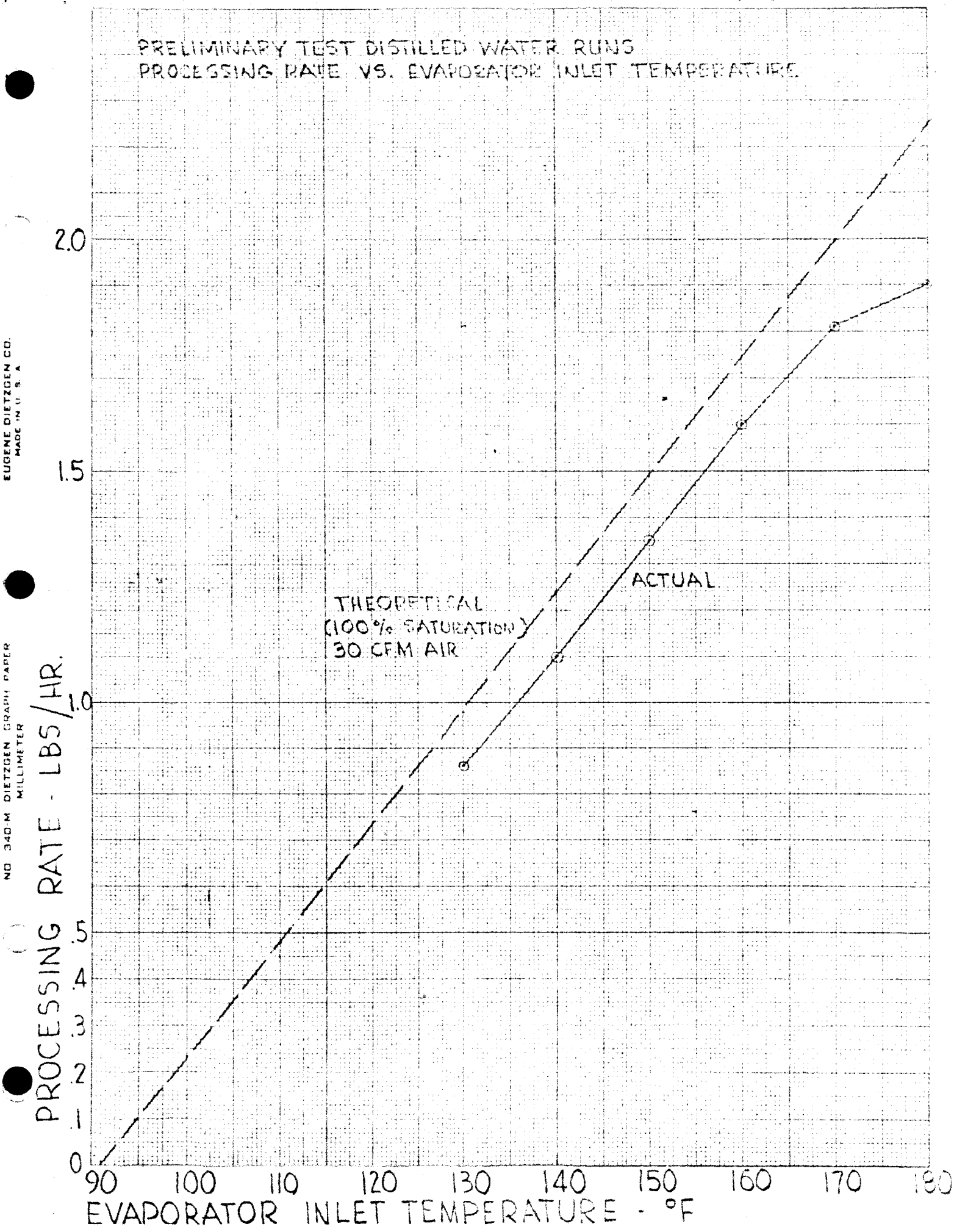

PRELIMINARY TEST DISTILLED WATER RUNS
COOLING WATER INLET 91°F
EVAPORATOR INLET AS NOTED
170°F
180°F EVAP. INLET
160°F
150°F
140°F
130°F
PROCESSED WATER COLLECTED - ML x 10²
TIME - HOURS
0
1
2
3
0
1
2
3
4
5
10
15
20
EUGENE DIETZGEN CO.
MADE IN U.S.A.
NO. 340 M DIETZGEN GRAPH PAPER
MILLIMETER

FIGURE 3.2



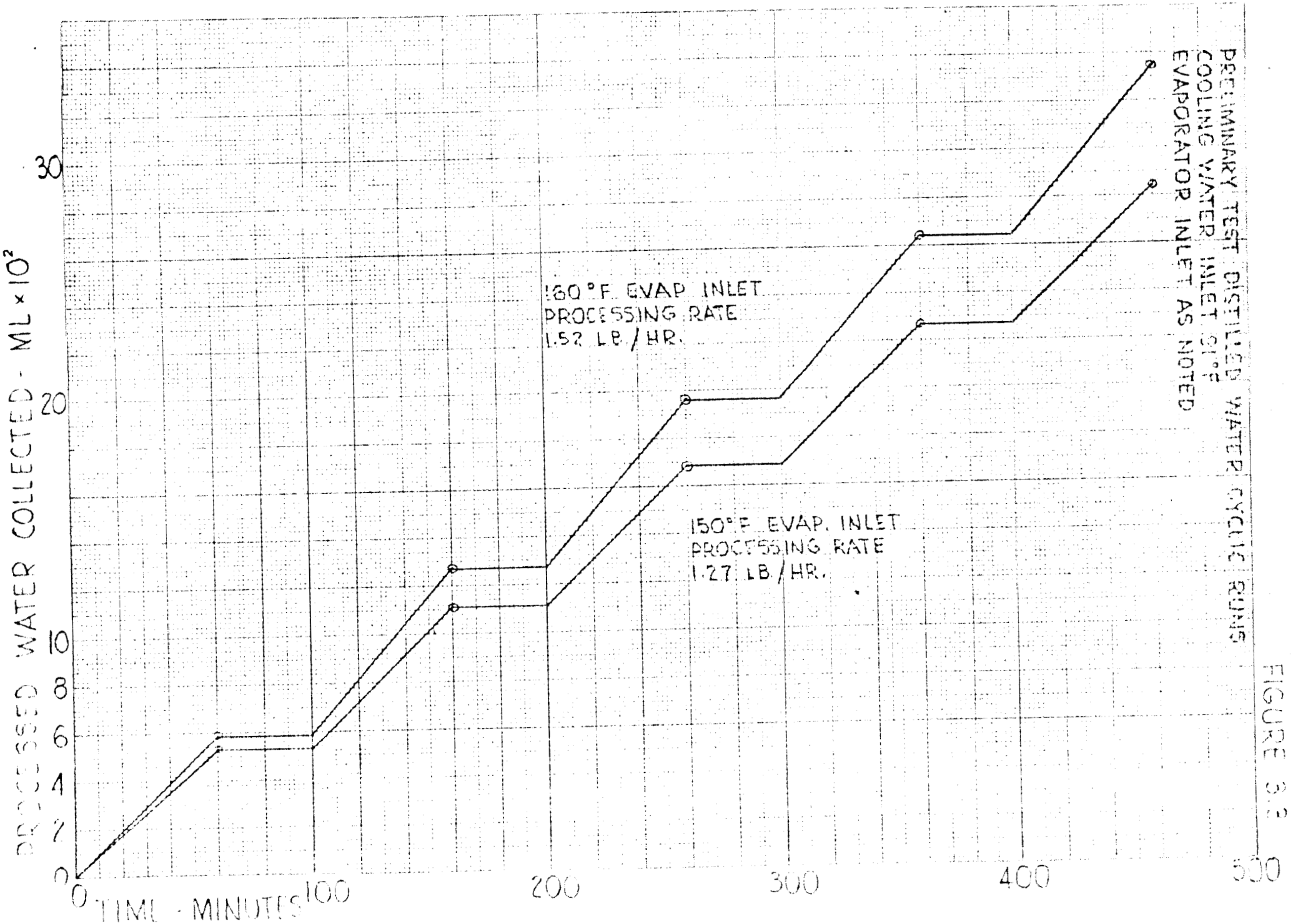


FIGURE 3.2

FIGURE 3.4

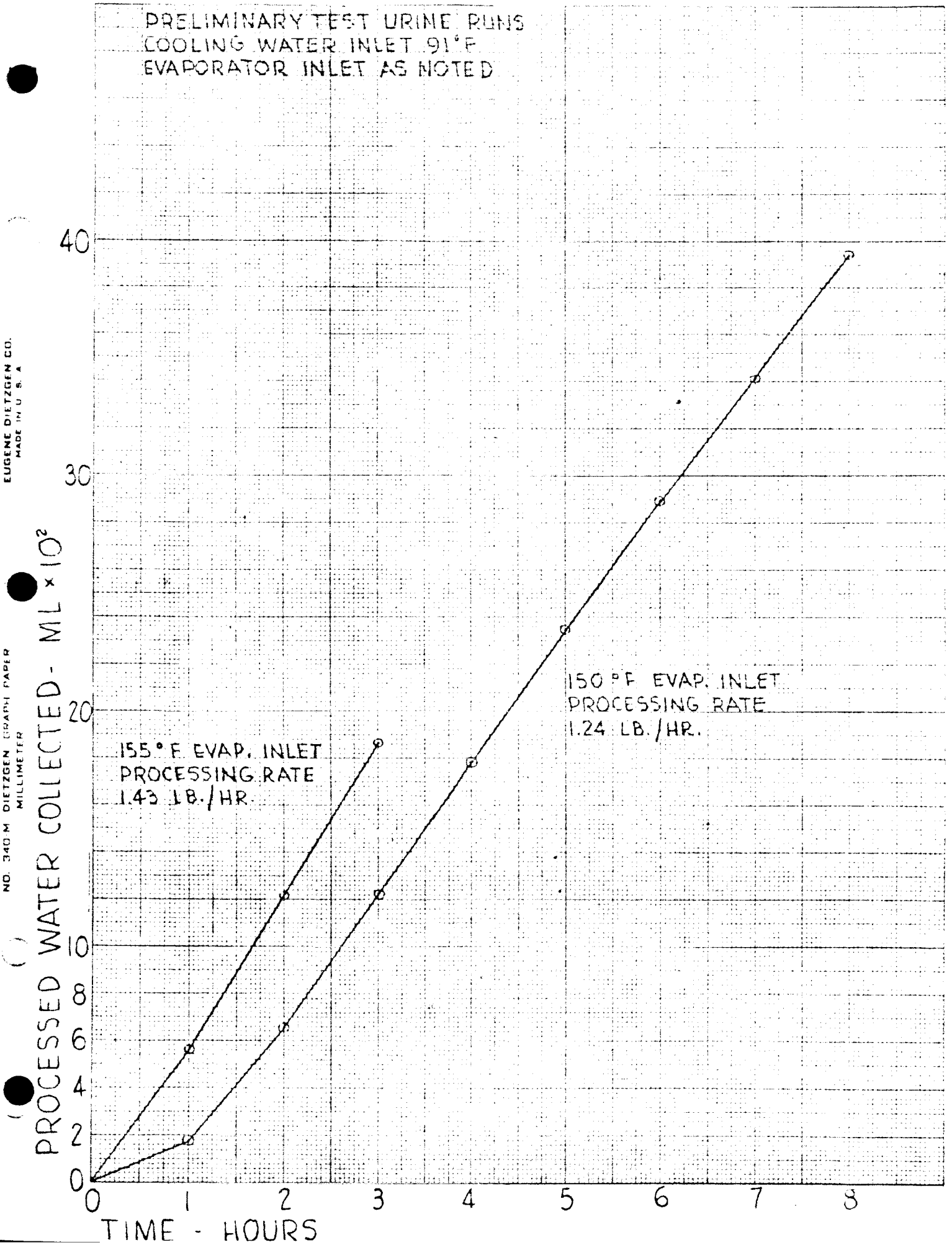


FIGURE 4.1

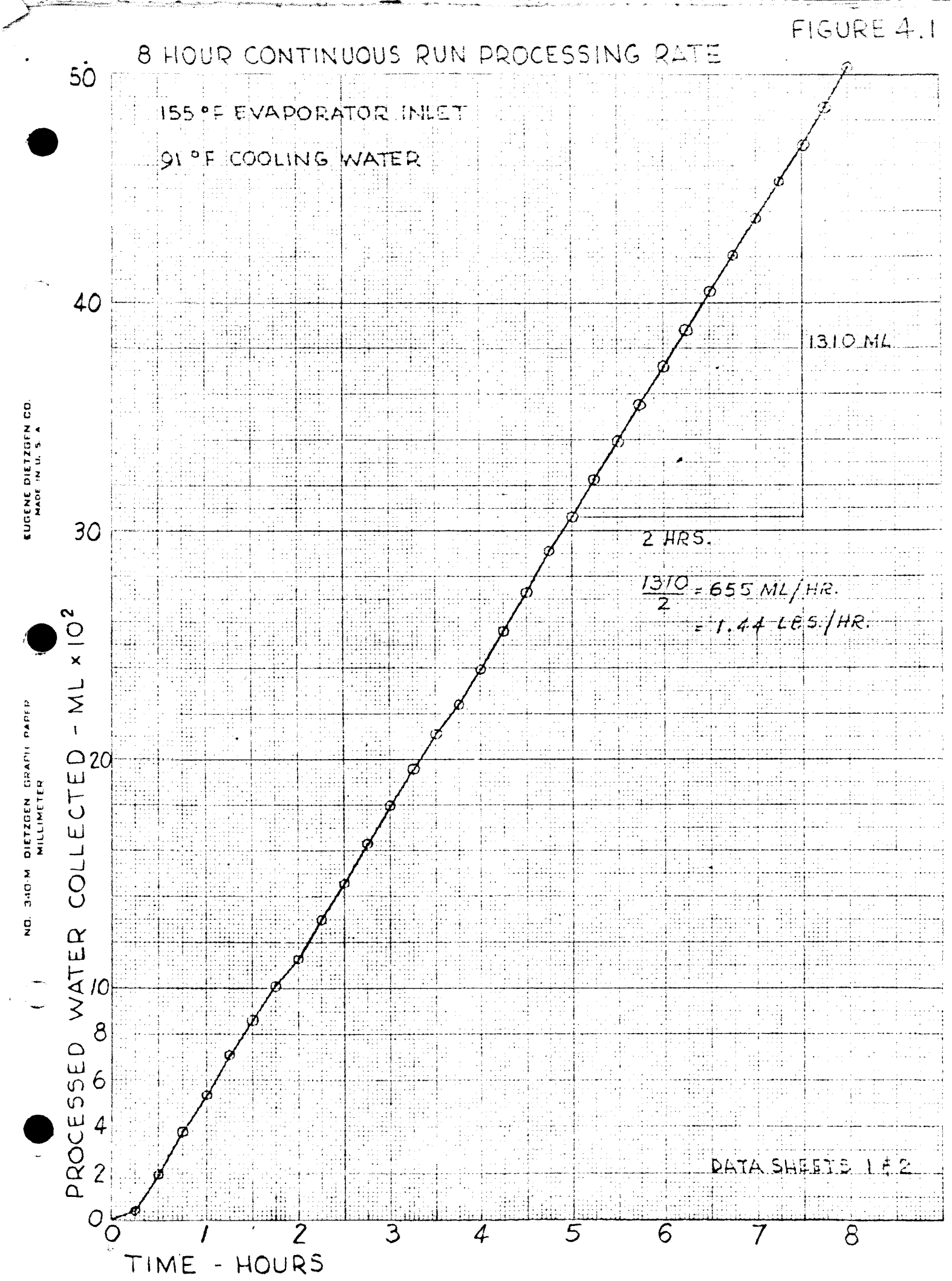

8 HOUR CONTINUOUS RUN PROCESSING RATE
155 °F EVAPORATOR INLET
91 °F COOLING WATER
1310 ML.
2 HRS.
1310/2 = 655 ML/HR.
= 1.44 LBS./HR.
DATA SHEETS 1 & 2
PROCESSED WATER COLLECTED - ML x 10²
TIME - HOURS
0
2
4
6
8
10
20
30
40
50
1
2
3
4
5
6
7
8
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FIGURE 7.

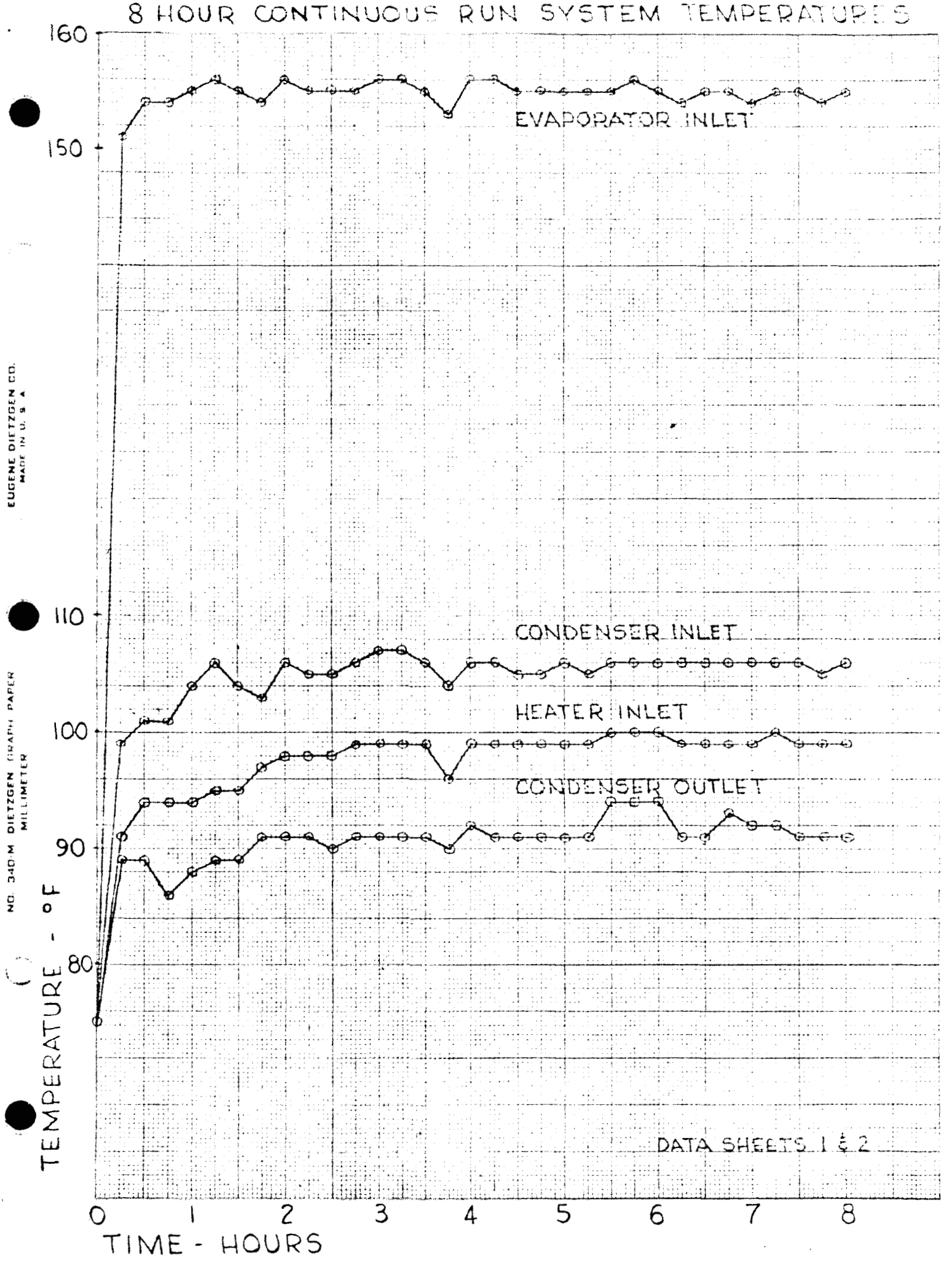
8 HOUR CONTINUOUS RUN SYSTEM TEMPERATURES
160
150
110
100
90
80
EVAPORATOR INLET
CONDENSER INLET
HEATER INLET
CONDENSER OUTLET
DATA SHEETS 1 & 2
TEMPERATURE - °F
0
1
2
3
4
5
6
7
8
TIME - HOURS
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FIGURE 4.3

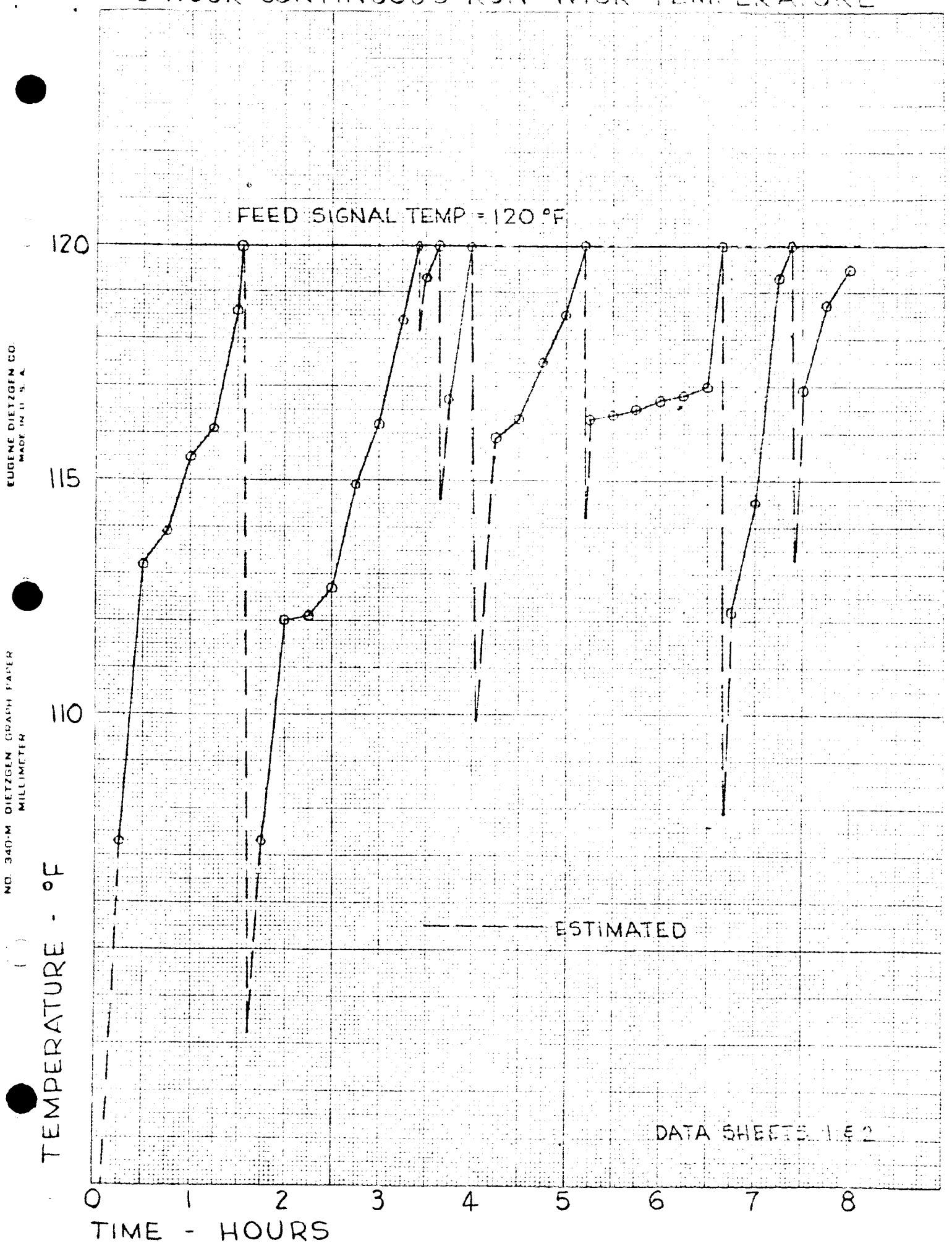
8 HOUR CONTINUOUS RUN WICK TEMPERATURE
FEED SIGNAL TEMP = 120 °F
120
115
110
ESTIMATED
DATA SHEETS 1 & 2
TEMPERATURE - °F
0
1
2
3
4
5
6
7
8
TIME - HOURS
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TABLE 4.1

Processed Water Analysis - 8 hour continuous run

ITEM	SAMPLE 1	2	3	4	USPHS LIMITS (2)
p H	7.0	6.9	6.9	6.9	<10.5
Color, Apparent	0	2	1	2	15
Turbidity	1	1	0	1	5
Solids, Volatile	2	4	12	12	N.S.
Solids, Fixed	18	6	0	6	N.S.
Solids, Total	20	10	12	18	500
Alkalinity	8.0	5.0	6.0	5.0	N.S.
Hardness	6	0	0	0	N.S.
Oxygen Consumed	0.92	1.0	0.85	1.0	N.S.
Nitrogen, Ammonia	0.75	0.84	0.96	0.78	N.S.
Nitrogen, Albuminoid	<0.03	<0.03	0.03	<0.03	N.S.
Nitrogen, Nitrite	0.010	0.004	0.006	0.008	N.S.
Nitrogen, Nitrate	0.032	0.042	<.01	0.032	10
Nitrogen, Urea	0	0	10	20	N.S.
Chloride	<0.5	<0.5	<0.5	<0.5	250
Sulfate (SO_4)	<0.8	<0.8	0	0	250
Copper	<0.01	<0.01	0.11	<0.01	1.0
Iron	<0.022	0.022	0.022	0.038	0.3
Fluoride (F)	0	0	0	0	3.4
Manganese	0.112	0	0.062	0.05	0.3
Phosphate (PO_4)	0.129	0	0	0	N.S.
Anionic Detergent	-	0	0	0	0.5
Hexavalent Chromium	<0.01	<0.01	<0.01	<0.01	0.05
Conductivity	15.1	11.2	15.1	9.6	N.S.

Bacteriological Analysis:

	SAMPLE 1	2	USPHS LIMITS
Standard plate count (bacteria/ml)	46,800	117,000	N.S.
Coliform organisms detected	0	0	N.S.
Most probable number of coliform organism per 100 ml	<2.2	<2.2	

The letters N.S. in the "USPHS LIMITS" column indicate that no limits for these items have been specified.

All quantities except p H, Color, turbidity and conductivity are parts per million. p H, color and turbidity are scale numbers, while conductivity is expressed in micromhos per centimeter.

Samples referenced to data sheets 1 and 2 reading numbers:

SAMPLE	READING NUMBERS
1	1-7
2	8-15
3	16-21
4	21-32
Bacteria 1	17
Bacteria 2	32

4.0 (Continued)

The evaporator inlet temperature of 155°F used for this test was determined in preliminary testing, initially with water and later with urine, to be the most efficient temperature consistent with the fixed cooling water temperature of 91°F to guarantee the specified processing rate of 1.25 lbs/hr.

Comparison of the analyses of the processed water from this test with the values established for acceptable drinking water by the United States Public Health Service (both shown in Table 4.1) indicates that in every case the processed water is well within the established limits. The bacteriological analyses of the sample taken after four and eight hours running show no coliform bacteria present and total bacteria/ml levels below those normally found in untreated well water considered acceptable for consumption.(1) It should be noted that while the samples were collected in sterilized vessels, neither the product water nor the water reclamation system were treated with any bacteriacidal agent.

Plots of processing rate and system temperatures for the twelve hour, 60 minutes on, 40 minutes off cyclic test are presented in Figures 4.4 and 4.5. A tabulation of the processed water analyses for this test is presented in Table 4.2.

Conditions for this test were, by contractual requirement, set the same as those for the eight hour continuous test and yielded a processing rate of 92% of the continuous rate. The repeatability of the processing rate (Figure 4.4) during this test, with a yield of 585 ml each hour after the initial cold start hour for the duration of the test, indicates the feasibility of developing completely automatic control and time-based feed systems for cyclic operation with only minor modifications to the existing continuous running automatic controls.

Processed water quality (Table 4.2) for this test equaled that for the eight hour continuous run, remaining well within the USPHS established limits.

Operating points of the system controls and indicators are presented in Table 4.3. No difficulties were encountered in the operation of the system in this test or in the previous preliminary testing.

Plots of processing rates, wick wetness and water conductivity for the four hour dry down run are presented in Figures 4.6 and 4.7. Though no analyses were made of the water processed during the test, the conductivity readings indicate that all water processed was of acceptable quality.

5.0 CONCLUSIONS

The Air Evaporation Water Reclamation System has been completed on schedule and has successfully met all performance requirements of the contract.

It should be noted that while the system has been designed for "zero g" operation, the evaporating wick remains gravity dependent and will not necessarily perform properly in all attitudes in a gravity field. All other system components are gravity independent.

FIGURE 4.4

12 HOUR CYCLIC RUN PROCESSING RATE

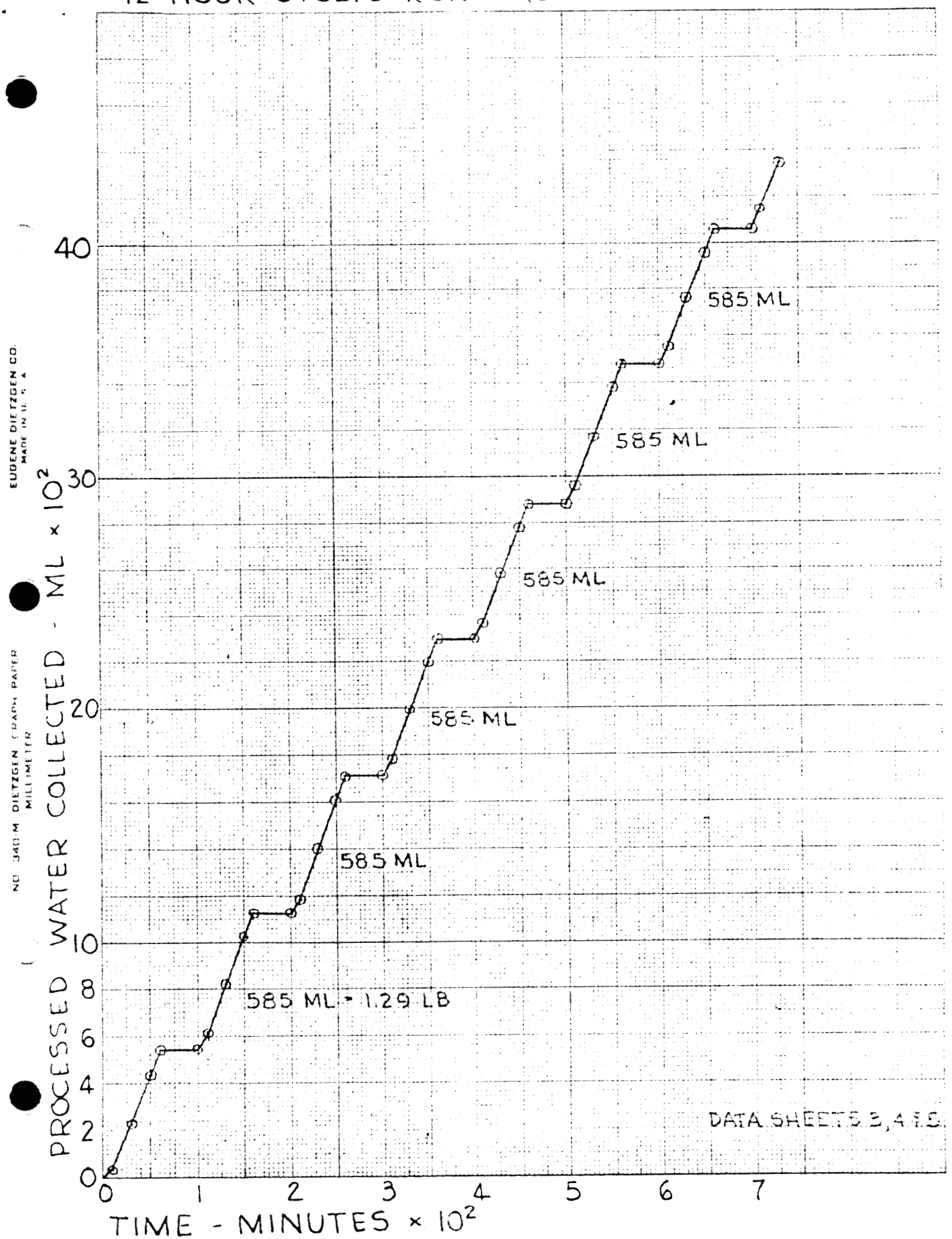

FIGURE 4.5

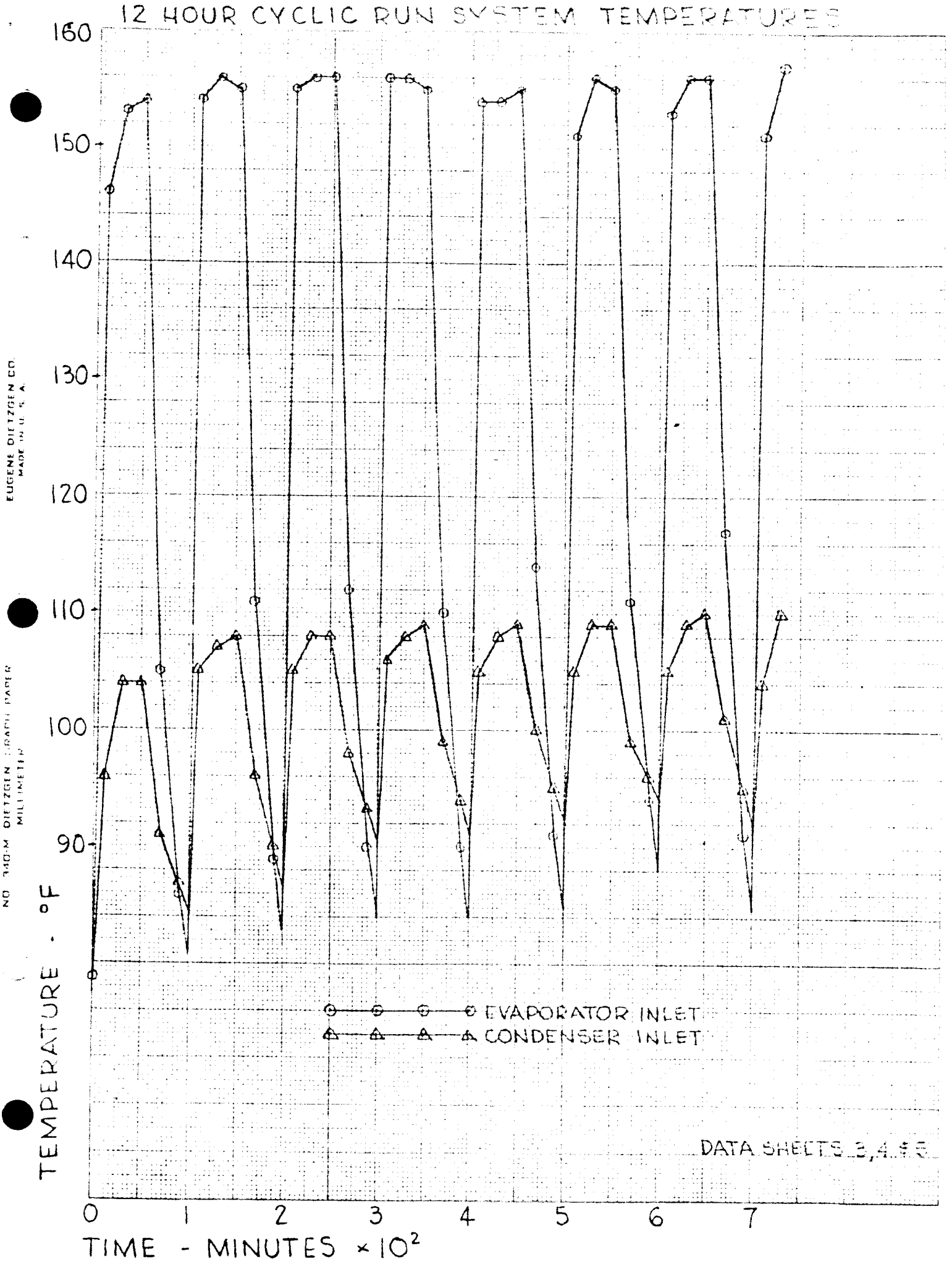
12 HOUR CYCLIC RUN SYSTEM TEMPERATURES
160
150
140
130
120
110
100
90
TEMPERATURE - °F
EVAPORATOR INLET
CONDENSER INLET
DATA SHEETS 3, 4, & 5
0
1
2
3
4
5
6
7
TIME - MINUTES × 10²
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TABLE 4.2

Processed Water Analyses - 12-Hour Cyclic Run

Item	Sample 5	6	7	8	USPHS Limits
pH	7.0	6.9	6.9	7.0	< 10.5
Color, apparent	2	0	1	1	15
Turbidity	0	0	0	0	5
Solids, volatile	16	6	8	4	N.S.
Solids, fixed	10	12	6	4	N.S.
Solids, total	26	18	14	8	500
Alkalinity	7.0	8.0	7.0	8.0	N.S.
Hardness	4	0	0	0	N.S.
Oxygen consumed	0.8	0.8	0.75	0.9	N.S.
Nitrogen, ammonia	0.90	1.05	1.32	1.32	N.S.
Nitrogen, albuminoid	< 0.03	0	< 0.03	< 0.03	N.S.
Nitrogen, nitrite	0.006	0.006	0.006	0.006	N.S.
Nitrogen, nitrate	0.056	0.036	0.032	0.042	10
Nitrogen, urea	0	10	10	0	N.S.
Chloride	< 0.5	< 0.5	< 0.5	< 0.5	250
Sulfate (SO_4)	0	0	0	0	250
Copper	0.02	< 0.01	< 0.01	< 0.01	1.0
Iron	0.022	0.022	0.022	0.038	0.3
Fluoride (F)	0	0	0	0	3.4
Manganese	0.075	0.05	0.05	0.05	0.3
Phosphate (PO_4)	0	0	0	0	N.S.
Anionic detergent	0	0	-	0	0.5
Hexavalent chromium	< 0.01	< 0.01	< 0.01	< 0.01	0.05
Conductivity	13.5	14.3	15.2	15.5	N.S.

Sample referenced to data sheets 3, 4, and 5 reading numbers:

Sample	Reading Numbers
5	1 - 9
6	10 - 18
7	19 - 27
8	28 - 36

FIGURE 4.6

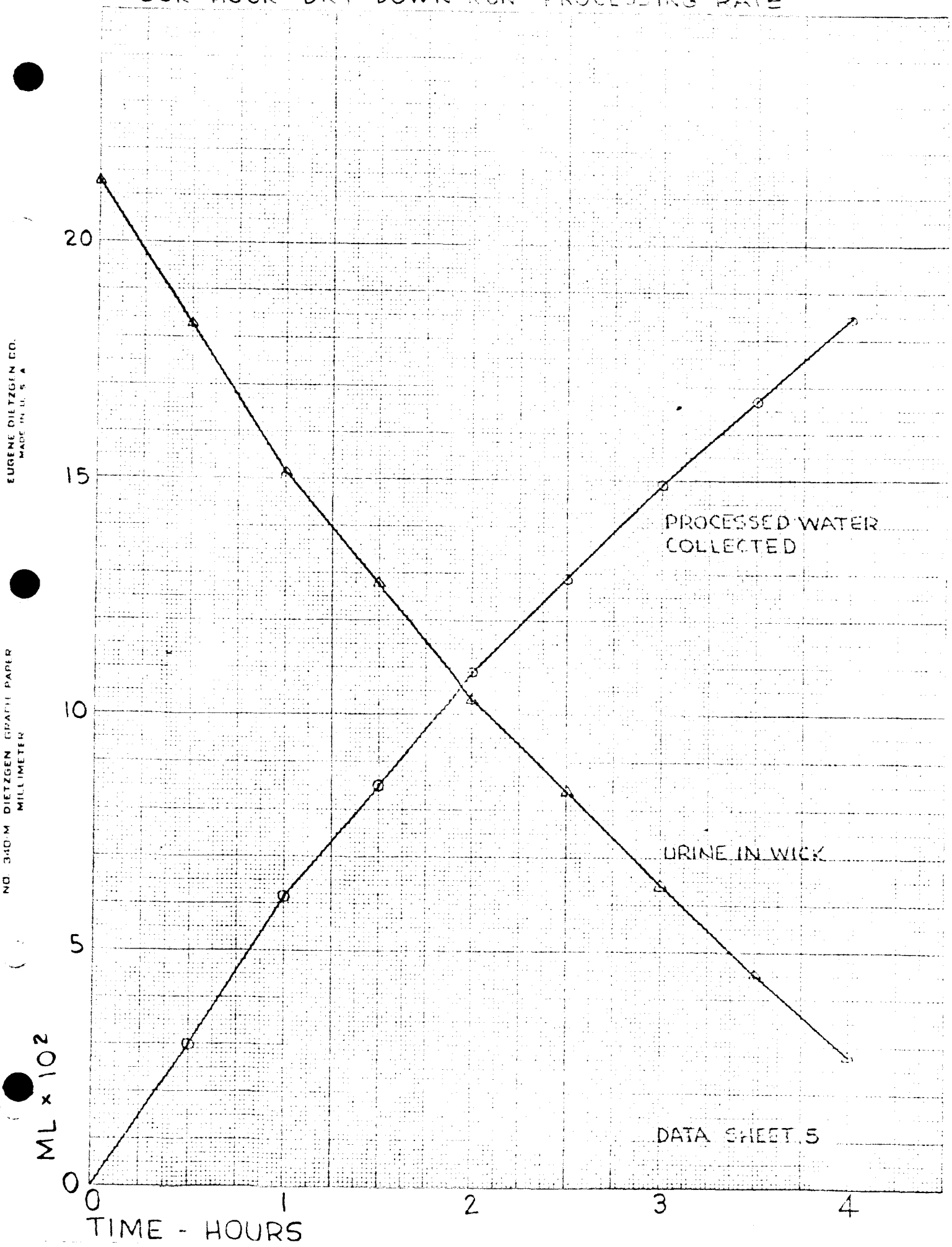
FOUR HOUR DRY DOWN RUN PROCESSING RATE
20
15
10
5
0
ML x 10²
0
1
2
3
4
TIME - HOURS
PROCESSED WATER COLLECTED
URINE IN WICK
DATA SHEET 5
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FIGURE 4.7

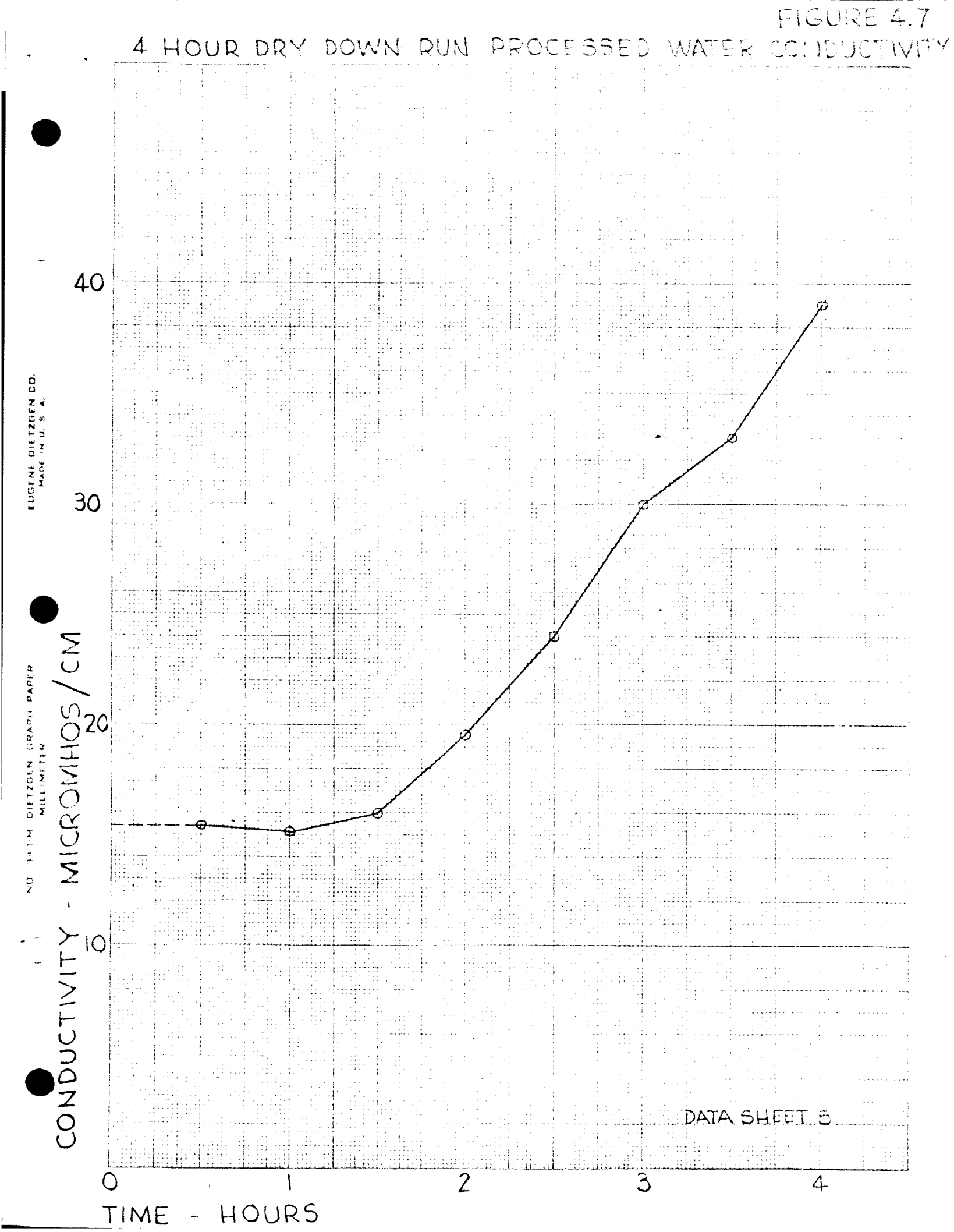
4 HOUR DRY DOWN RUN PROCESSED WATER CONDUCTIVITY
40
30
20
10
CONDUCTIVITY - MICROMHOS/CM
0
1
2
3
4
TIME - HOURS
DATA SHEET 5
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TABLE 4.3

SYSTEM OPERATING POINTS - REFERENCE DATA SHEET 6

Fan ΔP low indicating light - off at 1.9 inches H_2O

Evaporator temperature out high indicating light - on at 206°F
off at 140°F condenser inlet temp.

Condenser temperature out high indicating light - on at 131°F
off at 126°F

Diverter valve on indicating light -

Switch in "Manual" - Light on
Switch in "Auto",

Conductivity below set point - light off
Conductivity at set point - light on

Conductivity high indicating light -

Conductivity below set point - light off
Conductivity at set point - light on

REFERENCES

1. "Chemical Aspects of Urine Distillation" by David F. Putnam, ASME Paper 65-AV-24, January, 1965.

2. "Public Health Service Drinking Water Standards" U. S. Department of Health, Education and Welfare, Washington, D. C., 1962.

APPENDIX

ACCEPTANCE TEST

MSC-AE PACKAGE

June 28, 1965

Prepared by: H. Kolnsberg
H. Kolnsberg

Approved by: W. Coe
W. Coe

1.0 The item being tested is the Air Evaporation Water Reclamation System, serial number 3, manufactured under contract number NAS 9-3796 for the NASA Manned Spacecraft Center, Houston.

2.0 The purpose of the tests is to evaluate the performance of the unit consistent with contractual requirements. Tests will demonstrate the operation of system controls and indicators and the ability of the unit to produce potable water at prescribed rates.

3.0 The test set-up is shown schematically in Figure 1. Instrumentation required is:

3 Pressure regulators	(0-8 psig)
3 Pressure gages	(0-8 psig)
1 Flow meter	(1-4 GPM water)
2 Thermocouples	
2' of 2" ID flex hose	
1 urine supply tank	(~6 liters)
Shop air or nitrogen	
Cooling water	(4 GPM at 60°-95°F)
28 Volt DC power	(1 amp)
120/208 Volt, 3Ø, 400 cycle power	(2.5 KW)
Power analyzer for AC and DC power	
6 Water manometers	

4.0 TEST DESCRIPTIONS

4.1 Dry run to check operation of indicating lights, thermal switches, solenoid valves and meter set point relays - one hour.

4.2 Urine reclamation run - 8 hours continuous at conditions determined in preliminary testing to yield a processing rate of 1.25 lbs/hr.

4.3 Urine reclamation run - 12 hours cyclic, 60 minutes on, 40 minutes off at conditions of 4.2.

4.4 Data to be recorded for urine reclamation runs:

Evaporator inlet temperature	Unit pyrometer
Evaporator outlet temperature	Unit pyrometer
Condenser outlet temperature	Unit pyrometer
Heater inlet temperature	Unit pyrometer
Fan ΔP	Unit ΔP gage
Heater power	Unit wattmeter
Processed water conductivity	Unit cond. meter
Wick feed temperature	Unit. temp. meter
Pretreat tank level	Unit sight gage
Cooling water flow rate	External flow meter
Cooling water inlet temperature	External TC
Cooling water outlet temperature	External TC
Processed water volume	Graduated beaker
AC power	External Analyzer
DC power	External analyzer
6 Component ΔP's	External manometers

5.0 TEST PROCEDURE

With unit set-up as in Figure 1:

5.1 Install evaporator wick bypass hose with cooling water flow off, turn system mode selector switch to "run", press DC power switch and AC power "press to start" switch. Note fan ΔP on fan pressure rise gage when "fan ΔP low" indicator light goes out.

Turn heater power variac to maximum setting (100). Note evaporator and condenser outlet temperatures when corresponding "high" indicator lights come on. Turn heater power variac to minimum setting (0). Note evaporator and condenser outlet temperatures when indicator lights go out.

Turn conductivity meter set point to maximum. Place diverter valve switch in "manual" position. Note operation of "Diverter valve on" indicator light. Place diverter valve switch in "auto" position. Note operation of "DVO" indicator light. Turn conductivity meter set point below "test" value on meter. Hold meter test switch in "test" position and note operation of "DVO" indicator light. Release test switch.

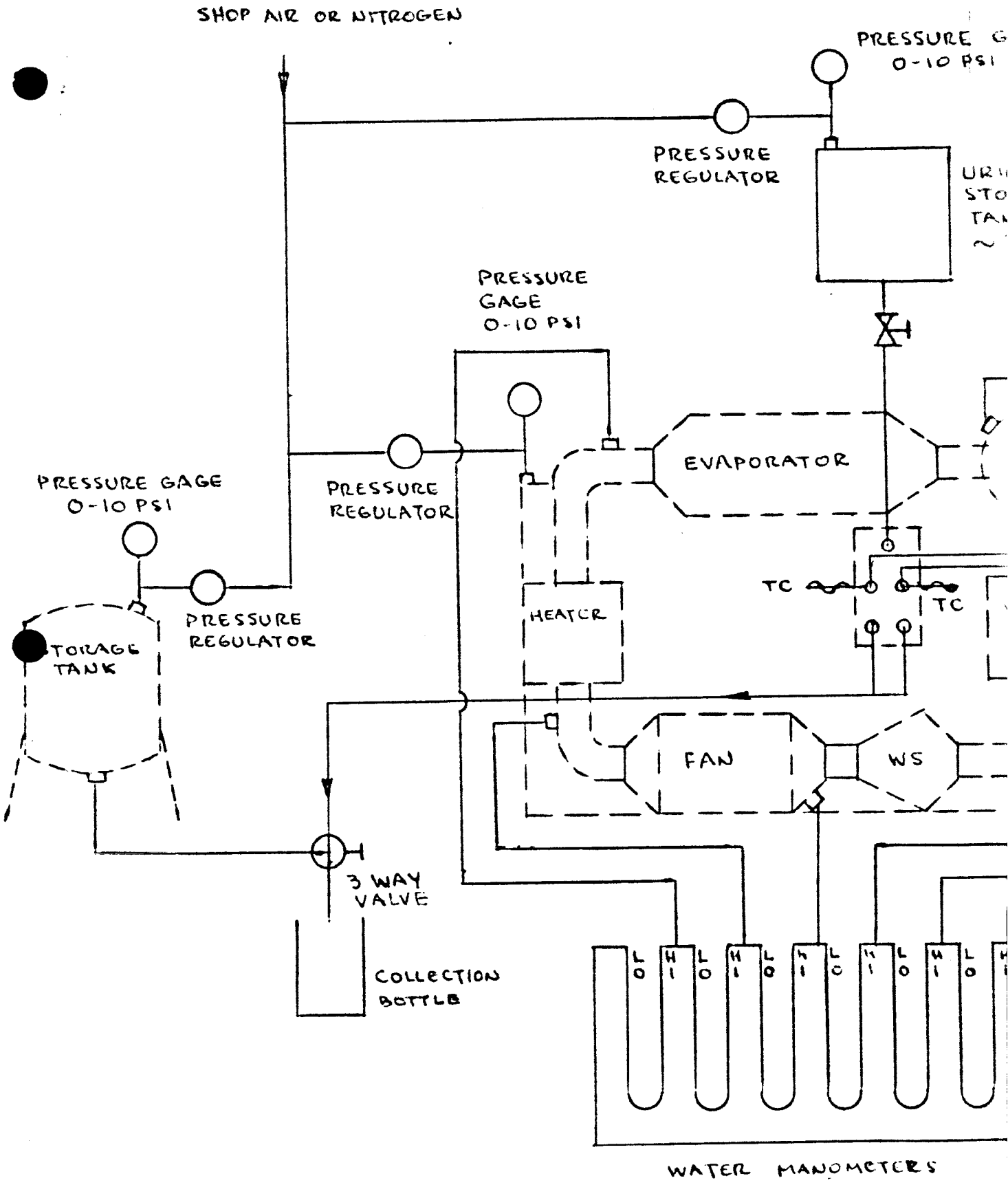
Turn system mode selector switch to "off".

5.2 Fill urine supply tank with pretreated urine and pressurize tank to 4 psig. Turn waste water inlet valve to "off", transfer urine from supply tank to pretreat tank and pressurize pretreat tank to 8 psig.

Install wick package and connect feed valve and thermistor. Turn feed control valve to "manual". Note level of pretreat tank sight gage. Turn waste water inlet valve to "on", permitting urine to feed from the pretreat tank. When sight gage level drops by 3.0 liters, turn waste water inlet valve to "off". Note time. Refill urine supply and pretreat tanks as required. Two hours after filling of wick, turn cooling water flow on and adjust as directed. Set wick feed temperature and conductivity meters set point indicators at 120^{0}F and 100 micromhos/cm respectively. Turn system mode selector switch to "run", press DC power switch and AC "press to start" switch. Adjust heater variac as directed. Record data of 4.4 at 15 minute intervals for 8 hours. Store collected water in one liter bottles for chemical analysis. Label bottles as to contents, referencing data sheet collection numbers. Draw sterile samples of processed water after 4 and 8 hours of running as directed for bacteriological analysis.

5.3 Continue running at conditions of 5.2, cycling 60 minutes on, 40 minutes off. To turn unit off, turn system mode selector switch to "off". To turn unit on, turn system mode selector switch to "run", press DC power and AC "press to start" switches. Record data of 4.4 at 20 minute intervals, beginning 10 minutes after start of initial on cycle, for an elapsed time of 12 hours. Store collected water for analysis as in 5.2 as directed. Turn system mode selector switch to "dry" and record data of 4.4 at 30 minute intervals for 4 hours. Turn system mode selector switch to "off". Shut off cooling water flow and depressurize all tanks.

6.0 Data will be reduced to yield operating parameters and processing rates and delivered, with water analyses, to NASA-MSC.


SHOP AIR OR NITROGEN
PRESSURE G
0-10 PSI
PRESSURE
REGULATOR
PRESSURE
GAGE
0-10 PSI
EVAPORATOR
PRESSURE GAGE
0-10 PSI
PRESSURE
REGULATOR
HEATER
TC
TC
PRESSURE
REGULATOR
STORAGE
TANK
FAN
WS
3 WAY
VALVE
COLLECTION
BOTTLE
LO HI LO HI LO HI LO HI LO HI LO
WATER MANOMETERS

AGE

JE
RAGE
JK
3 GAL

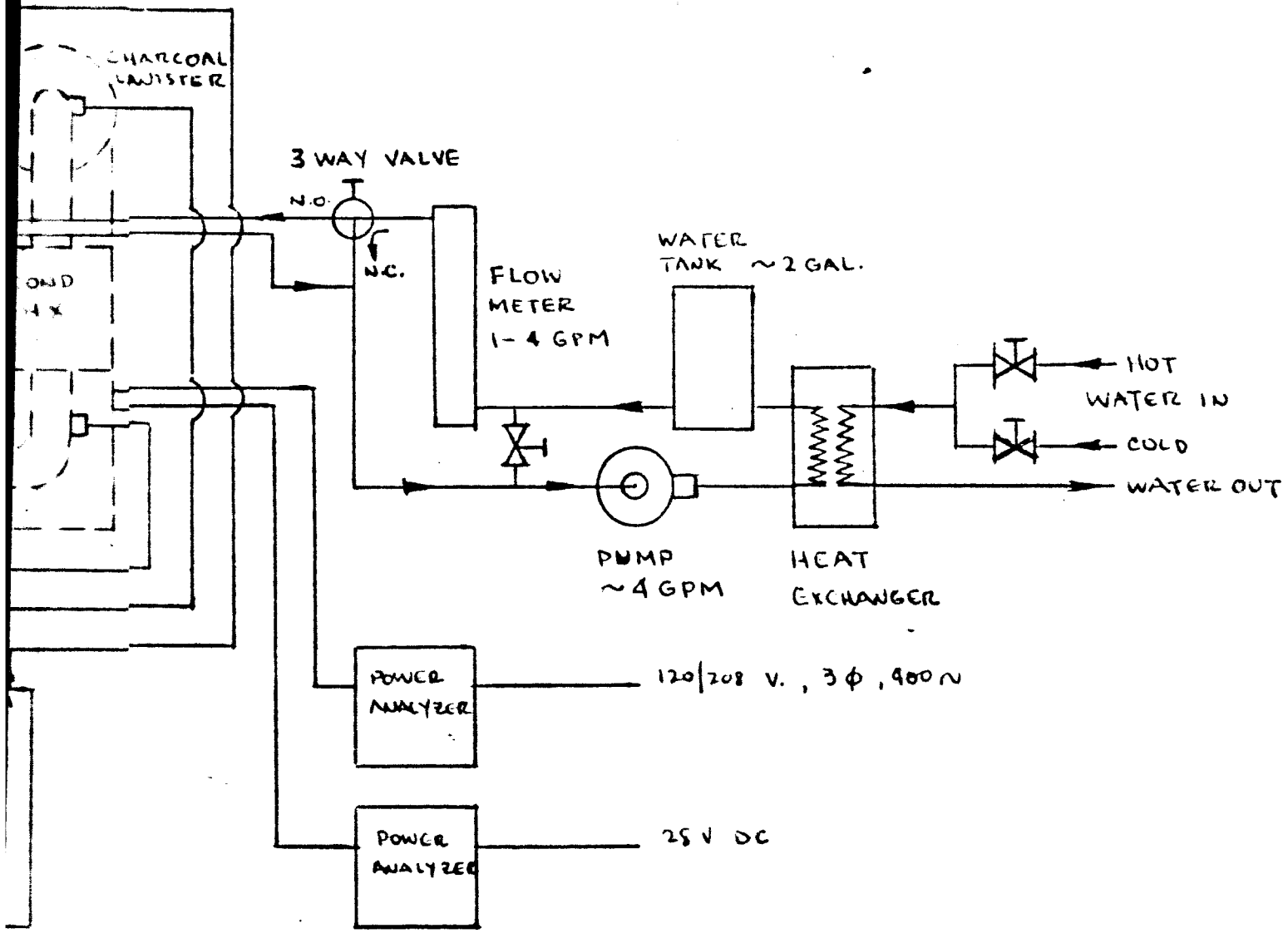


FIGURE 1 - TEST SET UP SCHEMATIC

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT

BOOTH No. ______ TYPE OF TEST MSC - AE PACKAGE ACC
UNIT ______ SERIAL No. 3 ______ ASSEMBLY No. ______ TEST SPEC. ______
HEAT EXCHANGER SER. No. ______ (PRIMARY) ______ (SECONDARY)

				— TEMP °F —								— "H₂O —			"Hg
TEMPERATURES °F →				ΔP	EVAP		HTR	COND		HTR		H_2O	WICK		KOOL
SWITCH No. →				FAN	1	3	5	7		PWR		K	FEED		H_2O
READING NO.	TIME	RUNNING TIME	SPEED RPM		IN	OUT	IN	OUT		WATTS			TEMP		FLOW
	0820			TURN ON											
1	0835			5.32	151	99	91	89		220		21.7	11.9		12.4
2	0850			5.35	154	101	94	89		225		21.9	22.0		12.4
3	0905			5.35	154	101	94	86		215		21.5	23.1		12.4
4	0920			5.35	155	104	94	88		220		19.8	25.8		12.4
5	0935			5.35	156	106	95	89		228		20.1	29.9		12.4
6	0950			5.35	156	104	95	89		222		21.5	31		12.4
7	1005			5.35	154	103	97	91		215		20.5	11.9		12.4
8	1020			5.35	156	106	98	91		220		19.9	20		12.4
9	1035			5.35	155	105	98	91		215		20.0	20.1		12.4
10	1050			5.35	155	105	98	90		220		19.5	21.2		12.4
11	1105			5.35	155	106	99	91		221		19.9	24.9		12.4
12	1120			5.36	156	107	99	91		220		20.2	27.0		12.4
13	1135			5.36	156	107	99	91		218		21.0	30.6		12.4
14	1150			5.36	155	106	99	91		220		21.5	32.1		12.4
15	1205			5.35	153	104	96	90		220		21.2	27.9		12.4

REMARKS: WT. OF WICK 4480
ΔP INLET TEMP SET FOR 155°F, WICK FEED SET FOR 120

TEMPERATURE LOG OF REFRIGERATION UNIT TEST
TURBINE ACCESSORY DEVELOPMENT GROUP

EPTANCE TEST

ENG. PROJECT AND PLAN No. ______

ENGINEERING INSTRUCTION No. ______

E.W.I. No ______ WRITTEN BY ______

" H_2O ΔT

Cooling H_2O IN (2)	OUT (1)	ΔT (3)	ML Transfer	ML Total		Evap	Mtr	Con	W	H Y	Amb
			~~40~~								
1.290	1.330	.043	40	40		.7	.5	5.4	1.8	1.0	1.3
1.325	1.371	.054	155	195		.7	.5	5.4	1.7	1.0	1.3
1.290	1.335	.054	160	375		.7	.5	5.4	1.75	1.0	1.3
1.286	1.350	.055	160	535		.7	.5	5.4	1.8	1.0	1.4
1.294	1.343	.059	170	705		.7	.5	5.4	1.9	.9	1.4
1.293	1.335	.050	155	860		.7	.5	5.4	1.75	1.0	1.4
1.317	1.336	.049	150	1010		.7	.5	5.4	1.75	1.0	1.4
1.285	1.330	.055	115	1125		.7	.5	5.4	1.7	1.0	1.4
1.300	1.346	.055	175	1300		.7	.5	5.4	1.7	1.0	1.4
1.311	1.361	.061	155	1455		.7	.5	5.4	1.7	1.0	1.35
1.320	1.369	.055	170	1625 / 1725		.7	.5	5.4	1.7	1.0	1.4
1.300	1.350	.052	170	1795 / 1895		.7	.5	5.4	1.75	1.05	1.4
1.286	1.335	.055	160	1955 / 2055		.7	.5	5.35	1.85	1.0	1.4
1.255	1.302	.030	155	2110 / 2210		.7	.5	5.35	1.9	.95	1.4
1.283	1.332	.051	130	2240 / 2340		.7	.5	5.4	1.75	1.0	1.4

°F Cooling H_2O INLET TEMP 91°F.

J

SHEET No. 1

DATE 7/22/65

OPERATORS GROOM

ENGINEER SUPERVISING TEST KOLNSBERG

	WET BULB	DRY BULB	WICK FEED			BEARINGS		
	—	—	TIME	TFB	TTB	P.T. TANK LEVEL	TFB	TTB
	DC VOLTS	DC AMPS		FED	FED	LITERS	REF TEMP	RPM
						4.2	75.2	
2.5	28	.10				4.2	/	615
2.5	28	.10				4.2	78.6	777
2.5	28	.10				4.2	/	639
2.5	28	.10				4.2	71.7	776
2.5	28	.10				4.2	/	628
2.5	28	.10	0950	600	600	3.7	80.6	611
2.5	28	.10	1005	600	1200	3.2	/	620
2.5	28	.10				3.2	83.4	800
2.5	28	.10				3.2	/	762
2.5	28	.10				3.2	84.2	754
2.5	28	.10				3.2	/	731
2.5	28	.10				3.2	84.3	756
2.5	28	.10				3.2	/	682
2.5	28	.10	1145	600	1800	2.5	86.0	662
2.5	28	.10	1158	600	2400	1.8	/	666

INSPECTION

OPERATOR

INSPECTOR WITNESSED 7/22/65 EHO.

NAVY

TEST ACCEPTED

REJECTED

MARK INSPECTION STAMP

3

ISF-50.1C 2/62

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT

UA

BOOTH No. _____ TYPE OF TEST MSC-AC PACKAGE ACCEP
UNIT _____ SERIAL No. 3 ASSEMBLY No. _____ TEST SPEC. _____
HEAT EXCHANGER SER. No. _____ (PRIMARY) _____ (SECON

					°F Temp								
TEMPERATURES °F →				ΔP	EVAP		AIR	COND					
SWITCH No. →				From	1	3	5	7					
READING NO.	TIME	RUNNING TIME	SPEED RPM		IN	OUT	IN	OUT					
16	1220			5.36	156	106	99	92		222	21	33½	
17	1235			5.39	156	106	99	91		220	19.0	26.5	
18	1250			5.4	155	105	99	91		215	20	27.2	
19	1305			5.4	155	105	99	91		210	20.2	29.1	
20	1320			5.4	155	106	99	91		210	20	30.9	
21	1335			5.4	155	105	99	91		210	18.9	27.2	
22	1350			5.4	155	106	100	94		210	18.8	27.3	
23	1405			5.39	156	106	100	94		210	18.2	27.4	
24	1420			5.39	155	106	100	94		210	18.5	27.8	
25	1435			5.39	154	106	99	91		208	18.2	28.0	
26	1450			5.39	155	106	99	91		212	19.0	28.2	
27	1505			5.39	155	106	99	93		215	21.0	20.4	
28	1520			5.39	154	106	99	92		212	19.9	24.1	
29	1535			5.39	155	106	100	92		210	20.9	22.1	
30	1550			5.39	155	106	99	91		212	20.8	28.1	
31	1605			5.39	154	105	99	91		210	19.5	31.2	
32	1620			5.39	155	106	99	91		210	19.9	32.5	

REMARKS: FILLED P-T TANK TO 2.3 LITERS
TANK MATRIX SAMPLE #1 @ 1235 BOTLE WT. 203 g
" " " " #2 @ 1620 " " " 205

SHUT DOWN 1622

TEMPERATURE LOG OF REFRIGERATION UNIT TEST
TURBINE ACCESSORY DEVELOPMENT GROUP

RANGE TEST

ENG. PROJECT AND PLAN No.

DARY) ENGINEERING INSTRUCTION No.

E.W.I. No. WRITTEN BY

		2	1	3									
				ΔT									
2.4		1.280	1.324	.051	150	2490		.7	.5	5.4	1.75	1.05	1.4	2.5
2.4		1.290	1.346	.056	170	2660	120	.7	.5	5.4	1.75	1.05	1.4	2.5
2.4		1.300	1.350	.050	170	2830		.7	.5	5.4	1.7	1.0	1.4	2.5
2.6		1.290	1.339	.049	180	3010		.7	.5	5.35	1.9	.9	1.4	2.5
2.6		1.285	1.333	.048	150	3160		.7	.5	5.35	1.85	.9	1.4	2.5
2.6		1.289	1.338	.049	165	3325		.7	.5	5.35	1.85	1.05	1.4	2.5
2.5		1.304	1.355	.052	165	3490		.7	.5	5.35	1.75	1.05	1.4	2.5
2.5		1.306	1.354	.057	160	3650		.7	.5	5.35	1.75	1.0	1.4	2.5
2.5		1.299	1.349	.054	170	3820		.7	.5	5.35	1.75	1.0	1.4	2.5
2.5		1.280	1.326	.050	160	3980		.7	.5	5.35	1.75	.95	1.4	2.5
2.5		1.286	1.341	.053	170	4150		.7	.5	5.35	1.8	1.0	1.4	2.5
2.5		1.300	1.350	.060	155	4305		.7	.5	5.4	1.7	1.0	1.4	2.45
2.5		1.280	1.330	.054	165	4470		.7	.5	5.4	1.75	1.05	1.4	2.45
2.5		1.290	1.358	.059	160	4630		.7	.5	5.4	1.7	1.0	1.4	2.45
2.5		1.261	1.313	.059	160	4790		.7	.5	5.4	1.75	1.0	1.4	2.45
2.5		1.276	1.329	.056	165	4955		.7	.5	5.4	1.7	1.0	1.4	2.45
2.5		1.309	1.344	.051	174	5129	119	.7	.5	5.4	1.7	1.0	1.4	2.45

Empty - 325 g f.u. = 22 ml } THESE ARE INCLUDED IN THE
334 g f.u. = 119 ml } Total ml Process Fig.

SHEET No 2

DATE 7/22/65

OPERATORS Groom

ENGINEER SUPERVISING TEST Kolnsberg

~~WET BULB~~	~~DRY BULB~~	BEARINGS					
—	—	TIME	~~TFB~~	TTB	TIME	TFB	TTB
DC VOLTS	DC AMPS	Watch Feed	ml FED	Total ml FED	PT Tank [illegible]	Ref. [illegible]	E Put
28	.10	1220	600	3000	1.2	86.9	757
28	.10				1.2	/	763
28	.10				* 9.3	87.8	768
28	.10				9.3	/	764
28	.10				7.3	87.8	772
28	.10	1332	600	3600	8.7	/	776
28	.10				8.7	87.3	751
28	.10				8.7	/	800
28	.10				8.7	87.8	820
28	.10				8.7	/	816
28	.10	1500	600	4200	8.7	87.8	749
28	.10				8.1	87.3	757
28	.10				8.1	/	778
28	.10				8.1	87.3	700
28	.10	1543	600	4800	7.6	/	737
28	.10				7.6	87.6	773
28	.10				7.6	/	771

INSPECTION

OPERATOR

INSPECTOR Witnessed 7/22/65 [illegible]

NAVY

TEST ACCEPTED

REJECTED

MARK INSPECTION STAMP

HSF-50.1C 2/62

Hamilton Standard
WINDSOR LOCKS, CONNECTICUT
DIVISION OF UNITED AIRCRAFT CORPORATION

BOOTH No. ________ TYPE OF TEST MSC-AG PACKAGE ACCEPT
UNIT ________ SERIAL No. 3 ASSEMBLY No. ________ TEST SPEC. ________
HEAT EXCHANGER SER. No. ________ (PRIMARY) ________ (SECONDARY)

READING NO	TIME	RUNNING TIME	SPEED RPM	ΔP	EVAP 1 IN (°F)	EVAP 3 OUT (°F)	HTR 5 IN (°F)	COND 7 OUT (°F)		HTR PWR WATTS		H_2O K (-VA)		COOL H_2O FLOW ("Hg)
	0810	TURN		ON										
1	0820			5.41	146	96	90	84		215		19.1		12.7
2	0840			5.41	153	104	85	89		218		21.0		12.75
3	0900	STOP 0910		5.41	154	104	85	87		225		19.3		12.7
4	0920			/	105	91	98	83		/		/		12.7
5	0940	START 0950		/	86	87	85	81		/		/		12.5
6	1000			5.45	154	105	95	89		225		20.9		12.8
7	1020			5.43	156	107	96	90		210		20.7		12.8
8	1040	STOP 1050		5.43	155	108	96	90		210		21		12.8
9	1100			/	111	96	100	84		/		/		12.8
10	1120	START 1130		/	89	90	89	84		/		/		12.8
11	1140			5.43	155	105	95	90		210		23.2		13.0
12	1200			5.43	156	108	98	91		210		22.5		13.1
13	1220	STOP 1230		5.43	156	108	97	91		210		22.8		12.9
14	1240			/	112	98	101	86		/		/		12.9
15	1300	START 1310		/	90	93	91	85		/		/		12.9

REMARKS: CYCLING RUN PER PARA 5.3 EVAP INLET
[illegible]ICK @ START 3025 ML

TEMPERATURE LOG OF REFRIGERATION UNIT TEST

TURBINE ACCESSORY DEVELOPMENT GROUP

...NER TEST

ENG. PROJECT AND PLAN No.

...Y) ENGINEERING INSTRUCTION No.

E.W.I. No. WRITTEN BY

− millivolts −			M L		" H_2O ΔP						
COOL H_2O Temp											
2	1	3									
IN	OUT	ΔT	P	T	EVAP	HTR	FAN	WS	HX	CHNG CAN	MTR ...
1.278	1.320	.042	35	35	.7	.5	5.4	1.75	1.0	1.41	1.[illegible]
1.315	1.364	.050	190	225	.7	.5	5.4	1.75	1.0	1.4	1.9
1.302	1.350	.056	210	435	.7	.5	5.4	1.7	1.0	1.4	1.[illegible]
1.190	1.190	.005	105	640							
1.187	1.186	.010		"							
1.300	1.342	.051	70	610	.7	.5	5.35	1.7	1.0	1.4	1.9
1.312	1.358	.058	210	820	.7	.5	5.4	1.7	1.0	1.35	2.
1.308	1.352	.057	205	1025	.7	.5	5.4	1.85	1.0	1.4	2.
1.195	1.192	.007	100	1125							
1.260	1.259	.006		"							
1.324	1.363	.055	60	1185	.7	.5	5.4	1.8	1.0	1.4	1.9
1.313	1.363	.056	215	1400	.7	.5	5.4	1.8	1.0	1.4	1.
1.299	1.348	.055	210	1610	.7	.5	5.4	1.75	1.0	1.4	1.
1.212	1.208	.006	100	1710							
1.187	1.187	.005		"							

...ET TEMP 155°F + H_2O COOLING INLET 91°F.

SHEET No. 3

DATE 7/23/65

OPERATORS Groom

ENGINEER SUPERVISING TEST Kolnsberg

	WET BULB	DRY BULB	BEARINGS					
			WICK FEED TIME	TFB	TTB	P.F. TAIL	°F TFB	TTB
	DC VOLTS	DC AMPS		ML	TOTAL [illegible]	LEVEL	REF JCT	LEVEL
						7.6	78.4	
5	28	.10				"	/	632
5	28	.10				"	/	661
5	28	.10				"	80.6	683
/	28	/				"	/	/
	28	/				"	/	/
1	28	.10				"	80.8	666
2	28	.10	Witnessed McDuffitt 7-23-65			"	/	816
2	28	.10				"	/	815
/	28	/	Witnessed McDuffitt			"	82.4	/
/	28	/			7-23-65	"	/	/
1	28	.10	1230	600	602	6.9	6.9	664
1	28	.10			"	"	82.4	776
1	28	.10			"	"	/	771
/	28	/	1230	600	1200	6.2	/	/
/	28	/			"		/	/

INSPECTION

OPERATOR 7-23-65

INSPECTOR Witnessed McDuffitt

NAVY

TEST ACCEPTED

REJECTED

MARK INSPECTION STAMP 3

HSF-50.1C 2/62

Hamilton Standard

DIVISION OF UNITED AIRCRAFT CORPORATION

WINDSOR LOCKS, CONNECTICUT

BOOTH No. _____ TYPE OF TEST MSC - AE PACKAGE ACC

UNIT _____ SERIAL No. 3 ASSEMBLY No. _____ TEST SPEC.

HEAT EXCHANGER SER. No. _____ (PRIMARY) _____ (SECO

TEMPERATURES °F →				ΔP	EVAP		HTR	COND		HTR PWR		-ug H2O		
SWITCH No. →				FAN	1	3	5	7				K		
READING NO	TIME	RUNNING TIME	SPEED RPM		IN	OUT	IN	OUT		WATTS				
16	1320			5.41	156	106	97	91		210		25.0		
17	1340			5.42	156	108	99	91		205		23.0		
18	1400	STOP 1410		5.42	155	109	99	91		210		22.5		
19	1420			/	110	99	101	86		/		/		
20	1440	START 1450		/	90	94	91	86		/		/		
21	1500			5.42	154	105	96	91		210		25.0		
22	1520			5.42	154	108	98	91		210		23.1		
23	1540	STOP 1550		5.42	155	109	99	91		215		23.0		
24	1600			/	114	100	104	86		/		/		
25	1620	START 1630		/	91	95	94	86		/		/		
26	1640			5.41	151	105	95	89		220		24.2		
27	1700			5.42	156	109	99	91		215		23.0		
28	1720	STOP 1730		5.53	155	109	99	91		210		22.9		
29	1740			/	111	99	102	86		/		/		
30	1800	START 1810		/	94	96	94	86		/		/		
31	1820			5.42	153	105	96	90		210		25		

REMARKS: PARA 5.3 CYCLING RUN E.V.E. TEMP 1

CONTI

TEMPERATURE LOG OF REFRIGERATION UNIT TEST

TURBINE ACCESSORY DEVELOPMENT GROUP

EPTANCE TEST

ENG PROJECT AND PLAN No

(NDARY) ENGINEERING INSTRUCTION No

E.W.I. No WRITTEN BY

"Hg — Millivolts — mL "H_2O ΔP

T_{oil}	H_2O Flow	Cool H_2O Temp 2 IN	1 OUT	3 ΔT	P_{in}	T_{out}	E_{vap}	H_{TR}	F_{an}	W_S	H
13.0		1.315	1.364	.033	70	1780	.7	.5	5.4	1.8	1.
13.1		1.309	1.357	.056	215	1995	.7	.5	5.4	1.9	.9
13.1		1.280	1.328	.053	200	2195	.7	.5	5.4	2.0	.9
13.0		1.224	1.224	.006	100	2295					
13.1		1.196	1.196	.007		"					
13.0		1.314	1.362	.050	70	2365	.7	.5	5.4	1.8	1
13.0		1.295	1.341	.056	215	2580	.7	.5	5.4	1.75	1
13.0		1.282	1.311	.057	200	2780	.7	.5	5.4	1.8	1
13.1		1.160	1.160	.005	100	2880					
13.3		1.156	1.156	.006		"					
13.1		1.286	1.331	.050	80	2960	.7	.5	5.4	1.8	1
13.1		1.301	1.350	.052	205	3165	.7	.5	5.35	2.0	.
13.1		1.276	1.337	.057	210	3375	.7	.5	5.4	2.0	.9
13.1		1.223	1.223	.008	100	3475					
13.2		1.175	1.175	.004		"					
13.2		1.275	1.319	.035	75	3550	.7	.5	5.4	2.0	1.

55°F H_2O COOLING TIMES 91°F.

(CONTI)NUED FROM SHT. #3

SHEET No 4
DATE 7/23/65
OPERATORS Geom[illegible]

ENGINEER SUPERVISING TEST Kolnsberg

				WET BULB	DRY BULB	BEARINGS Wick Feed TIME	TFB	TTB	[illegible] ~~TIME~~	TFB	TTB
K	Char Kan	Ht Ref		DC Volts	DC Amps		ML	Total ML Feed	[illegible]	[illegible]	[illegible]
0	1.4	1.8		28	.10			1200	6.2	84.0	851
5	1.4	1.8		28	.10			"	"	/	824
[illegible]	1.4	1.8		28	.10	1410	600	1800	5.6	86.[illegible]	819
/	/	/		28	/			"	"	/	/
/	/	/		28	/			"	"	/	/
.0	1.4	1.8		28	.10			"	"	86.4	780
0	1.4	1.8		28	.10			"	"	/	770
.0	1.4	1.8		28	.10	1550	600	2400	5.0	/	767
/	/	/		28	/			"	"	87.6	/
/	/	/		28	[illegible] 7-23-65			"	"	/	/
.0	1.4	1.8		28	.10			"	"	/	760
75	1.4	1.8		28	.10			"	"	87.8	777
15	1.4	1.8		28	.10	1732	600	3000	4.4	/	795
/	/	/		28	/			"	"	/	/
/	/	/		28	/			"	"	87.8	/
0	1.4	1.8		28	.10			"	"	/	834

INSPECTION

OPERATOR

INSPECTOR [illegible] 7/23/65

NAVY

TEST ACCEPTED 3

REJECTED

MARK INSPECTION STAMP

Hamilton Standard
DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT

U A

BOOTH No. _____ TYPE OF TEST M35-A6 PACKAGE ACCEPT

UNIT _____ SERIAL No. 3 ASSEMBLY No. _____ TEST SPEC. _____

HEAT EXCHANGER SER. No. _____ (PRIMARY) _____ (SECONDAR

					← °F →													"Hg
TEMPERATURES °F →				ΔP	EVAP		HTR	COND		H_{TL}		H_2O	DRY	DRY	C_{OOL}			
SWITCH No. →				F_{AN}	1	3	5	7		P_{WR}		K	DOWN	RUN	H_2O			
READING NO	TIME	RUNNING TIME	SPEED RPM		IN	OUT	IN	OUT		WATTS			K	psi	F_{LOW}			
32	1840			5.43	156	109	99	91		218		22.9			13.3			
33	1900	START 1910		5.43	156	110	100	91		220		23.5			13.3			
34	1920			/	117	101	105	87		/		/			13.2			
35	1940	START 1950		/	91	95	93	85		/		/			13.3			
36	2000	2010*		5.3	151	104	95	89		216		26			13.3			
37	2020			5.3	157	110	100	94		220		24			13.3			
38	2040	~~START~~		5.3	156	110	100	91		220		22	15.4	7.65	13.1			
39	2110			5.3	156	113	99	92		220		25.4	15.1	7.6	13.3			
40	2140			5.3	156	117	99	92		220		26.1	16.0	7.6	13.3			
41	2210			5.3	156	121	99	94		220		27.1	19.5	7.7	13.3			
42	2240			+ 5.3	156 ~~156~~	126 ~~130~~	99 ~~103~~	91 ~~96~~		220		32.1	24.0	7.6	13.3			
43	2310			5.3	156	131	99	92		220		32.1	30.0	7.65	13.1			
44	2340			5.3	156	134	100	92		220		34.1	33.0	7.58	13.1			
45	2410			SHUT DOWN - END 4 HOUR DRY								DOWN	39	27 RUN				

REMARKS: ~~Rapid~~ 5.3 cyclic Run EVI Temp 113°F H_2O c

* END 12 HOUR CYCLIC RUN - BEGIN FOUR HOUR DRY DOW

† PT TANK EMPTIED & SYSTEM FLUSHED WITH DISTILLED WA

CONTINUED F

TEMPERATURE LOG OF REFRIGERATION UNIT TEST

TURBINE ACCESSORY DEVELOPMENT GROUP

...ANCE TEST

ENG. PROJECT AND PLAN No. ______

...Y) ENGINEERING INSTRUCTION No. ______

E.W.I. No. ______ WRITTEN BY ______

Millivolts – Cool H_2O Temp – 2 – IN	1 – OUT	3 – ΔT		ML – Freon 4	Total Freon – F 3550	Freon ... 4	" H_2O ΔP – Evap.	Mtr.	Fan	W.S.	H.X.	Chamber ...	Atm ...
1.291	1.340	.057		210	3760		7	5	5.35	1.75	1.0	1.4	1.85
1.300	1.350	.059		200	3980		.7	.5	5.4	1.75	1.0	1.4	1.9
1.202	1.200	.009		100	4060		/	/	/	/	/	/	/
1.124	1.124	.006		/	"		/	/	/	/	/	/	/
1.286	1.330	.051		85	4145		.7	.5	5.35	1.75	1.0	1.4	1.9
1.302	1.359	.064		200	4345		.7	.5	5.35	1.8	1.0	1.4	1.9
1.309	1.357	.054		200	4545		.7	.5	5.35	1.8	1.0	1.4	1.9
1.284	1.335	.059		315	4860		.7	.5	5.4	1.8	1.0	1.4	1.9
1.291	1.340	.059		235	5095		.7	.5	5.4	1.7	1.1	1.4	1.9
1.309	1.354	.056		240	5335		.7	.5	5.4	1.75	1.0	1.4	1.9
1.294	1.339	.060		202	5535		.7	.5	5.4	1.8	1.0	1.4	1.9
1.271	1.314	.056		200	5735		.7	.5	5.4	1.8	1.0	1.4	2.0
1.285	1.350	.051		180	5915		.7	.5	5.4	1.8	1.0	1.4	2.0
				175	6090								

...cooling temp 9... F.
...on run
...ter.

* Hit H_2O cooling valve by accident & ... had to be re-set to 9?°F.

from SHT. # 4

SHEET No 5

DATE 7/23/65

OPERATORS Groom

ENGINEER SUPERVISING TEST Kobnsborg

	WET BULB	DRY BULB	BEARINGS					
			TIME	TFB	TTB	TIME	TFB	TTB
	DC volts	DC amp		ML	Tot ML	Level	Rff	Fr
	28	.10		~~3000~~	3000	4.4	87.8	817
	28	.10	1910	600	3600	3.8	87.8	826
	28	/			"	"	/	/
	28	/			"		/	/
	28	.10			"		87.4	832
	28	.10			"		87.4	829
	28	.10			"		/	800
	28	.10			"	0+	/	821
	28	.10			"		/	819
	28	.10			"		86.0	832
	28	.10			"		/	826
	28	.10			"		/	829
	28	.10					/	829

INSPECTION

Emp

OPERATOR

INSPECTOR E.C. Hodge 7/23/65

NAVY

TEST

ACCEPTED 3

REJECTED

MARK INSPECTION STAMP

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT

UA

BOOTH No. _____ TYPE OF TEST MK-AE PACKAGE
UNIT _____ SERIAL No. 2 ASSEMBLY No. _____
HEAT EXCHANGER SER No. _____ (PRIMARY) _____

						LIGHT ON		X			LIG				
TEMPERATURES °F →				ΔT		HTR	EVAP		COND			HTR	EVAP		
SWITCH No. →				FAN		PWR	3		1			PWR	3		
READING NO	TIME	RUNNING TIME	SPEED RPM	LIGHT OFF		WATTS	OUT		OUT			WATTS	OUT		
				1.9		600	206		131			0	124		

PARA 5.1 SECTION 3;

DIVERTER SWITCH IN MANUAL - DIVER

DIVERTER SWITCH IN AUTO - DIVE

CONDUCTIVITY METER POINTER ON S

CONDUCTIVITY METER POINTER ON

PARA 5.1 COMPLETED. √ SYSTEM

REMARKS: _____

TEMPERATURE LOG OF REFRIGERATION UNIT TEST

TURBINE ACCESSORY DEVELOPMENT GROUP

ACCEPTANCE TEST

TEST SPEC. ____ ENG. PROJECT AND PLAN No. ____

____ (SECONDARY) ENGINEERING INSTRUCTION No. ____

E.W.I. No ____ WRITTEN BY ____

HT OUT | COND 7 OUT

140 PARA 5.1 SECTIONS 1 + 2

...ER LIGHT ON.

...TER LIGHT OFF.

...ET POINT - CONDUCTIVITY HIGH LIGHT ON.

SET POINT + DIVERTER SWITCH IN AUTO - DIVER...

MODE SELECTOR OFF. [signature] 525...

SHEET No 6

DATE 7/26/65

OPERATORS Graham

ENGINEER SUPERVISING TEST Robinson

					WET BULB	DRY BULB	BEARINGS					
					—	—	TIME	TFB	TTB	TIME	TFB	TTB
TEA LIGHT ON.												
A 7/26/65												
②												

INSPECTION

OPERATOR

INSPECTOR

NAVY

TEST ACCEPTED

REJECTED

MARK INSPECTION STAMP

3

THE NEWLANDS SANITARY LABORATORY

THE HENRY SOUTHER ENGINEERING CO., PROPRIETOR

SANITARY, CHEMICAL AND BACTERIOLOGICAL INVESTIGATIONS

HARTFORD, CONNECTICUT

I. LAIRD NEWELL, DIRECTOR
STATE CHEMIST
[redacted] BAMPTON
CHIEF ENGINEER
H. P. SACHS
BACTERIOLOGIST

P.O. 16724NM

REPORT ON EXAMINATION OF WATER

Client Hamilton Standard, Div. United Aircraft Corp. Sample No. 574504
Windsor Locks, Conn., Att: Mr. Kolnsberg

Collected by Date Reported 7-30-65

Source #1 - Urine Distillate at reading 1-7

Received 7-23-65 Hour Temp.

Color (true) (apparent) 0 Odor pH 7.0

Turbidity 1 Sediment Foaming

1. Solids, Volatile	2	9. Chloride	Less than 0.5
2. Fixed	18	10. Alkalinity	8.0
3. Total	20	11. Total Hardness	6
4. Effect on heating	no charring	12. Free CO_2 (Calculated)	
5. Ammonia Nitrogen	0.75	13. Iron	
6. Albuminoid Nitrogen	Less than 0.03	14. Manganese	
7. Nitrite Nitrogen	0.010	15. Oxygen Consumed	0.92
8. Nitrate Nitrogen	0.032	16. Anionic Detergent	insufficient sample

17. Standard Agar Plate Count at 35°C.

Test for Coliform Organisms:

Quantity of sample, ml.	.1 ml.	1.0 ml.	10.0 ml. portion
Gas in lactose broth in 24 hrs.			
Gas in lactose broth in 48 hrs.			
Coliform Organisms			

Most Probable Number Coliform Organisms per 100 ml.

(All chemical data given in parts per million.)

GENERAL CONCLUSIONS:

Hexavalent Chromium	Present - less than 0.01	parts per mill
Sulfate (SO_4)	Trace - less than 0.8	"
Fluoride (F)	0	
Urea Nitrogen	0	
Iron	0.022	"
Copper	less than 0.01	"
Manganese	0.112	"
Phosphate (PO_4)	0.129	"
Conductivity at 25°C	15.1	micromhos per cm.

I. Laird Newell State Chemist

FORM 61

I. LAIRD NEWELL, DIRECTOR
STATE CHEMIST
[redacted] SAMPTON
CHIEF ENGINEER
H. V. SACHS
BACTERIOLOGIST

THE NEWLANDS SANITARY LABORATORY

THE HENRY SOUTHER ENGINEERING CO., PROPRIETOR
SANITARY, CHEMICAL AND BACTERIOLOGICAL INVESTIGATIONS
HARTFORD, CONNECTICUT

P.O. 16724NM

REPORT ON EXAMINATION OF WATER

Client Hamilton Standard, Div. United Aircraft Corp. Sample No. 574505
Collected by Windsor Locks, Conn., Att: Mr. Kolnsberg Date Reported 7-30-65
Source #2 - Urine Distillate - reading 8-15 Received 7-23-65 Hour Temp.
Color (true) (apparent) 2 Odor pH 6.9
Turbidity 1 Sediment Foaming

1. Solids, Volatile	4	9. Chloride	Less than 0.5
2. Fixed	6	10. Alkalinity	5.0
3. Total	10	11. Total Hardness	0
4. Effect on heating	slight charring	12. Free CO_2 (Calculated)	
5. Ammonia Nitrogen	0.84	13. Iron	
6. Albuminoid Nitrogen	Less than 0.03	14. Manganese	
7. Nitrite Nitrogen	0.004	15. Oxygen Consumed	1.0
8. Nitrate Nitrogen	0.042	16. Anionic Detergent	none

17. Standard Agar Plate Count at 35°C.

Test for Coliform Organisms:

Quantity of sample, ml.	.1 ml.	1.0 ml.	10.0 ml. portion
Gas in lactose broth in 24 hrs.			
Gas in lactose broth in 48 hrs.			
Coliform Organisms			

Most Probable Number Coliform Organisms per 100 ml.

(All chemical data given in parts per million.)

GENERAL CONCLUSIONS:

Hexavalent Chromium	Present - Less than 0.01	parts per million
Sulfate (SO_4)	Trace - less than 0.8	"
Fluoride (F)	0	
Urea Nitrogen	0	
Iron	0.022	"
Copper	Less than 0.01	"
Manganese	None detected	
Phosphate (PO_4)	none	

Conductivity at 25°C 11.2 micromhos per cm.

I. Laird Newell State Chemist.

FORM 61

THE NEWLANDS SANITARY LABORATORY

THE HENRY SOUTHER ENGINEERING CO., PROPRIETOR

SANITARY, CHEMICAL AND BACTERIOLOGICAL INVESTIGATIONS

HARTFORD, CONNECTICUT

I. LAIRD NEWELL, DIRECTOR
STATE CHEMIST
NORMAN BAMPTON
CHIEF ENGINEER
M. V. SACHS
BACTERIOLOGIST

P.O. 16724NM

REPORT ON EXAMINATION OF WATER

Client Hamilton Standard, Div. United Aircraft Corp. Sample No. 574506
Windsor Locks, Conn. Att: Mr. Kolnsberg

Collected by Date Reported 7-30-65

Source #3 - Urine Distillate - Received 7-23-65 Hour Temp.

Color (true) reading 16-21 (apparent) 1 Odor pH 6.9

Turbidity 0 Sediment Foaming

1. Solids, Volatile	12	9. Chloride	less than 0.5
2. Fixed	0	10. Alkalinity	6.0
3. Total	12	11. Total Hardness	0
4. Effect on heating	no charring	12. Free CO_2 (Calculated)	
5. Ammonia Nitrogen	0.96	13. Iron	
6. Albuminoid Nitrogen	0.030	14. Manganese	
7. Nitrite Nitrogen	0.006	15. Oxygen Consumed	0.85
8. Nitrate Nitrogen	Less than .01	16. Anionic Detergent	none

17. Standard Agar Plate Count at 35°C.

Test for Coliform Organisms:

Quantity of sample, ml.	.1 ml.	1.0 ml.	10.0 ml. portion
Gas in lactose broth in 24 hrs.			
Gas in lactose broth in 48 hrs.			
Coliform Organisms			

Most Probable Number Coliform Organisms per 100 ml.

(All chemical data given in parts per million.)

GENERAL CONCLUSIONS:

Hexavalent Chromium	Present - less than 0.01	parts per million
Sulfate (SO_4)	0	
Fluoride (F)	0	
Urea Nitrogen	10	"
Iron	0.022	"
Copper	0.11	"
Manganese	0.062	"
Phosphate (PO_4)	none	
Conductivity at 25°C	15.1	micromhos per cm.

I. Laird Newell State Chemist

FORM 61

THE NEWLANDS SANITARY LABORATORY

THE HENRY SOUTHER ENGINEERING CO., PROPRIETOR

SANITARY, CHEMICAL AND BACTERIOLOGICAL INVESTIGATIONS

HARTFORD, CONNECTICUT

I. LAIRD NEWELL, DIRECTOR
STATE CHEMIST
[illegible] BAMPTON
CHIEF ENGINEER
H. P. BACHS
BACTERIOLOGIST

P.O. 16724NM

REPORT ON EXAMINATION OF WATER

Client Hamilton Standard, Div. United Aircraft Corp. Att: Mr. Kolnsberg Windsor Locks, Conn. Sample No. 574507

Collected by ..... Date ..... Reported 7-30-65

Source #4 - Urine Distillate Readings 21-32 Received 7-23-65 Hour ..... Temp. .....

Color (true) ..... (apparent) 2 Odor ..... pH 6.9

Turbidity 1 Sediment ..... Foaming .....

1. Solids, Volatile	12	9. Chloride	less than 0.5
2. Fixed	6	10. Alkalinity	5.0
3. Total	18	11. Total Hardness	0
4. Effect on heating	no charring	12. Free CO_2 (Calculated)	
5. Ammonia Nitrogen	0.78	13. Iron	
6. Albuminoid Nitrogen	less than 0.03	14. Manganese	
7. Nitrite Nitrogen	0.008	15. Oxygen Consumed	1.0
8. Nitrate Nitrogen	0.032	16. Anionic Detergent	none

17. Standard Agar Plate Count at 35°C. - - - - - - - - - - - - -

Test for Coliform Organisms:

Quantity of sample, ml.	.1 ml.	1.0 ml.	10.0 ml. portion
Gas in lactose broth in 24 hrs.			
Gas in lactose broth in 48 hrs.			
Coliform Organisms			

Most Probable Number Coliform Organisms per 100 ml. - - - - - - -

(All chemical data given in parts per million.)

GENERAL CONCLUSIONS:

Hexavalent Chromium	Present - less than 0.01	parts per million
Sulfate (SO_4)	0	
Fluoride (F)	0	
Urea Nitrogen	20	"
Iron	0.038	"
Copper	Less than 0.01	"
Manganese	0.05	"
Phosphate (PO_4)	none	
Conductivity at 25°C	9.6	micromhos per cm.

I. Laird Newell

State Chemist.

FORM 61

THE HENRY SOUTHER ENGINEERING CO.

CONSULTING ENGINEERS
ESTABLISHED 1898
11 LAUREL STREET
HARTFORD. CONN.

L. LAIRD NEWELL
PRESIDENT
NORMAN BAMPTON
VICE PRESIDENT
ARTHUR SOLOMON
SECRETARY-TREASURER

CIVIL SANITARY
CHEMICAL AND METALLURGICAL
ENGINEERING
DESIGN-SUPERVISION-VALUATION
CHEMICAL-BACTERIOLOGICAL AND
METALLURGICAL MATERIALS
TESTING LABORATORIES

July 28, 1965

Hamilton Standard
Division of United Aircraft
Windsor Locks, Conn.

Att: Mr. Kolnsberg

Gentlemen:

We have the following to report on the sample submitted to this laboratory on July 23, 1965.

Sample No.	574508
Marks	#1 Urine Distillate reading at 17-7/22 P.O. 16724 NM
Standard Plate Count at 35°C (Bacteria per ml.)	46,000
Coliform Organisms	absent in five-10 ml. volumes
Most Probable Number of Coliform Organisms per 100 ml.	Less than 2.2

The bacterial count at 35°C is very high but coliform organisms were absent in five 10 ml. volumes. The absence of coliform organisms meets the requirements of the United States Public Health Service for bacteria in drinking water.

Very truly yours,

THE HENRY SOUTHER ENGINEERING CO.

Darrell L. Moody

DLM:cak

THE HENRY SOUTHER ENGINEERING CO.

CONSULTING ENGINEERS
ESTABLISHED 1898
11 LAUREL STREET
HARTFORD, CONN.

F. LAIRD NEWELL
PRESIDENT
NORMAN BAMPTON
VICE PRESIDENT
ARTHUR SOLOMON
SECRETARY TREASURER

CIVIL SANITARY
CHEMICAL AND METALLURGICAL
ENGINEERING
DESIGN-SUPERVISION-VALUATION
CHEMICAL BACTERIOLOGICAL AND
METALLURGICAL MATERIALS
TESTING LABORATORIES

July 23, 1965

Hamilton Standard
Division of United Aircraft
Windsor Locks, Conn.

Att: Mr. Kolnsberg

Gentlemen:

We have the following to report on the sample submitted to this laboratory on July 23, 1965.

Sample No.	57h509
Marks	#2 Urine Distillate requisition 32-T/22 P.O. #16724 NM
Standard Plate Count at 35°C (Bacteria per ml.)	117,000
Coliform Organisms	absent in five-10 ml. volumes
Most Probable Number of Coliform Organisms per 100 ml.	Less than 2.2

The bacterial count at 35°C is very high but coliform organisms were absent in five 10 ml. volumes. The absence of coliform organisms meets the requirements of the United States Public Health Service for bacteria in drinking water.

Very truly yours,

THE HENRY SOUTHER ENGINEERING CO.

Darrell L. Moody

DLM:cak

THE NEWLANDS SANITARY LABORATORY

THE HENRY SOUTHER ENGINEERING CO., PROPRIETOR

SANITARY, CHEMICAL AND BACTERIOLOGICAL INVESTIGATIONS

HARTFORD, CONNECTICUT

I. LAIRD NEWELL, DIRECTOR
STATE CHEMIST
NORMAN SAMPTON
CHIEF ENGINEER
[redacted] SACKS
BACTERIOLOGIST

REPORT ON EXAMINATION OF WATER

Client Hamilton Standard, Div. United Aircraft Corp. Sample No. 574524
Windsor Locks, Conn., Att: Mr. Kolnsberg
Collected by Date Reported 7-30-65
Source #5 - Urine Distillate - Received 7-27-65 Hour Temp.
Color (true) 7-23 - Reading 1-9 (apparent) 2 Odor pH 7.0
Turbidity 0 Sediment Foaming

1. Solids, Volatile	16	9. Chloride	less than 0.5
2. Fixed	10	10. Alkalinity	7.0
3. Total	26	11. Total Hardness	4
4. Effect on heating	no charring	12. Free CO_2 (Calculated)	
5. Ammonia Nitrogen	0.90	13. Iron	
6. Albuminoid Nitrogen	less than 0.03	14. Manganese	
7. Nitrite Nitrogen	0.006	15. Oxygen Consumed	0.8
8. Nitrate Nitrogen	0.056	16. Anionic Detergent	none

17. Standard Agar Plate Count at 35°C.

Test for Coliform Organisms:

Quantity of sample, ml.	.1 ml.	1.0 ml.	10.0 ml. portion
Gas in lactose broth in 24 hrs.			
Gas in lactose broth in 48 hrs.			
Coliform Organisms			

Most Probable Number Coliform Organisms per 100 ml.

(All chemical data given in parts per million.)

GENERAL CONCLUSIONS:

Hexavalent Chromium	Present - less than 0.01 parts per million	
Sulfate (SO_4)	0	
Fluoride (F)	0	
Urea Nitrogen	0	
Iron	0.022	"
Copper	0.020	"
Manganese	0.075	"
Phosphate (PO_4)	none	
Conductivity at 25°C	13.5	micromhos per cm.

I. Laird Newell State Chemist.

FORM 61

I. LAIRD NEWELL, DIRECTOR
STATE CHEMIST
NORMAN BAMPTON
CHIEF ENGINEER
. SACHS
BACTERIOLOGIST

THE NEWLANDS SANITARY LABORATORY

THE HENRY SOUTHER ENGINEERING CO., PROPRIETOR
SANITARY, CHEMICAL AND BACTERIOLOGICAL INVESTIGATIONS
HARTFORD, CONNECTICUT

REPORT ON EXAMINATION OF WATER

Client Hamilton Standard, Div. United Aircraft Corp. Sample No. 574525
Windsor Locks, Conn. Att: Mr. Kolnsberg
Collected by Date Reported 7-30-65
Source #6 - Urine Distillate - Received 7-26-65 Hour Temp.
ATC Readings 10-18
Color (true) (apparent) 0 Odor pH 6.9
Turbidity 0 Sediment Foaming

1.	Solids, Volatile	6	9.	Chloride	less than 0.5
2.	Fixed	12	10.	Alkalinity	8.0
3.	Total	18	11.	Total Hardness	0
4.	Effect on heating	no charring	12.	Free CO_2 (Calculated)	
5.	Ammonia Nitrogen	1.05	13.	Iron	
6.	Albuminoid Nitrogen	0	14.	Manganese	
7.	Nitrite Nitrogen	0.006	15.	Oxygen Consumed	0.8
8.	Nitrate Nitrogen	0.036	16.	Anionic Detergent	none
17.	Standard Agar Plate Count at 35°C.				

Test for Coliform Organisms:

Quantity of sample, ml.	.1 ml.	1.0 ml.	10.0 ml. portion
Gas in lactose broth in 24 hrs.			
Gas in lactose broth in 48 hrs.			
Coliform Organisms			

Most Probable Number Coliform Organisms per 100 ml.

(All chemical data given in parts per million.)

GENERAL CONCLUSIONS:

Hexavalent Chromium	Present - less than	0.01	parts per million
Sulfate (SO_4)		0	
Fluoride (F)		0	
Urea Nitrogen		10	"
Iron		0.022	"
Copper	less than	0.01	"
Manganese		0.05	"
Phosphate		none	

Conductivity at 25°C 14.3 micromhos per cm.

I. Laird Newell State Chemist.

I. LAIRD NEWELL, DIRECTOR
STATE CHEMIST
NORMAN BAMPTON
CHIEF ENGINEER
[illegible] BACHS
BACTERIOLOGIST

THE NEWLANDS SANITARY LABORATORY

THE HENRY SOUTHER ENGINEERING CO., PROPRIETOR
SANITARY, CHEMICAL AND BACTERIOLOGICAL INVESTIGATIONS
HARTFORD, CONNECTICUT

REPORT ON EXAMINATION OF WATER

Client Hamilton Standard, Div. United Aircraft Corp. Sample No. 574526
Windsor Locks, Conn. Att: Mr. Kolnsberg
Collected by Date Reported 7-30-65
Source #7 - Urine Distillate - Received 7-26-65 Hour Temp.
Color (true) 7-23 - ATC Readings 19-27 (apparent) 1 Odor pH 6.9
Turbidity 0 Sediment Foaming

1. Solids, Volatile	8	9. Chloride	less than 0.5
2. Fixed	6	10. Alkalinity	7.0
3. Total	14	11. Total Hardness	0
4. Effect on heating	no charring	12. Free CO_2 (Calculated)	
5. Ammonia Nitrogen	1.32	13. Iron	
6. Albuminoid Nitrogen	less than 0.03	14. Manganese	
7. Nitrite Nitrogen	0.006	15. Oxygen Consumed	0.75
8. Nitrate Nitrogen	0.032	16. Anionic Detergent	insufficient sample

17. Standard Agar Plate Count at 35°C.

Test for Coliform Organisms:

Quantity of sample, ml.	.1 ml.	1.0 ml.	10.0 ml. portion
Gas in lactose broth in 24 hrs.			
Gas in lactose broth in 48 hrs.			
Coliform Organisms			

Most Probable Number Coliform Organisms per 100 ml.

(All chemical data given in parts per million.)

GENERAL CONCLUSIONS:

Hexavalent Chromium	Present - less than	0.01	parts per million
Sulfate (SO_4)		0	
Fluoride (F)		0	
Urea Nitrogen		10	"
Iron		0.022	"
Copper	less than	0.01	"
Manganese		0.05	"
Phosphate		none	
Conductivity at 25°C		15.2	micromhos per cm.

I. Laird Newell State Chemist.

FORM 61

I. LAIRD NEWELL, DIRECTOR
STATE CHEMIST
[redacted] SAMPTON
CHIEF ENGINEER
M. F. SACHS
BACTERIOLOGIST

THE NEWLANDS SANITARY LABORATORY

THE HENRY SOUTHER ENGINEERING CO., PROPRIETOR

SANITARY, CHEMICAL AND BACTERIOLOGICAL INVESTIGATIONS

HARTFORD, CONNECTICUT

REPORT ON EXAMINATION OF WATER

Client Hamilton Standard, Div. United Aircraft Corp. Sample No. 574527
Windsor Locks, Conn., Att: Mr. Kolnsberg
Collected by ..... Date ..... Reported 7-30-65
Source #8 - Urine Distillate - 7-23 Received 7-26-65 Hour ..... Temp. .....
Color (true) ATC Readings 28-36 (apparent) 1 Odor ..... pH 7.0
Turbidity 0 Sediment ..... Foaming .....

1.	Solids, Volatile	4	9.	Chloride	less than 0.5
2.	Fixed	4	10.	Alkalinity	8.0
3.	Total	8	11.	Total Hardness	0
4.	Effect on heating	no charring	12.	Free CO_2 (Calculated)	
5.	Ammonia Nitrogen	1.32	13.	Iron	
6.	Albuminoid Nitrogen	less than 0.03	14.	Manganese	
7.	Nitrite Nitrogen	0.006	15.	Oxygen Consumed	0.9
8.	Nitrate Nitrogen	0.042	16.	Anionic Detergent	none

17. Standard Agar Plate Count at 35°C. - - - - - - - - - - - - -

Test for Coliform Organisms:

Quantity of sample, ml.	.1 ml.	1.0 ml.	10.0 ml. portion
Gas in lactose broth in 24 hrs.			
Gas in lactose broth in 48 hrs.			
Coliform Organisms			

Most Probable Number Coliform Organisms per 100 ml. - - - - - - -

(All chemical data given in parts per million.)

GENERAL CONCLUSIONS:

Hexavalent Chromium	Present - less than 0.01	parts per million	
Sulfate (SO_4)	0		
Fluoride (F)	0		
Urea Nitrogen	0		
Iron	0.038	"	
Copper	less than 0.01	"	
Manganese	0.05	"	
Phosphate (PO_4)	none		

Conductivity at 25°C 15.5 micromhos per cm.

I. Laird Newell State Chemist.

FORM 61

MSC AIR EVAPORATION

WATER RECLAMATION UNIT

OPERATING AND ROUTINE MAINTENANCE INSTRUCTIONS

Contract Number NAS-9-3796

August 12, 1965

Prepared by: H. Kolnsberg

H. Kolnsberg, Senior Experimental Engineer

Approved by: W. B. Coe

W. B. Coe, Program Manager

OPERATING PROCEDURES

AIR EVAPORATION WATER RECLAMATION SYSTEM

It is the function of this system to reclaim potable water from chemically pretreated urine by evaporation from an enclosed wick into a circulating air stream, charcoal filtration of the saturated air, condensation into air-entrained droplets, centrifugal separation of air and water and a final charcoal filtration of the processed water. This is accomplished in a closed loop system with all operations save an initial filling and periodic replacements of expendables being fully automatic.

1.0 OPERATING PROCEDURES

1.1 Before starting system (with new wick)

1.1.1 Ensure that flow control and waste water inlet valves on right panel are in "AUTO" and "CLOSED" positions, respectively; and that system mode selector and electric power switches on left panel are in "OFF" position.

1.1.2 Check pretreat tank for proper (8 psig) pressure and liquid level. Sight glass should show at least 4.5 liters in tank.

1.1.3 Install wick as per wick replacement procedure (Section 2.0).

1.1.4 Turn waste water inlet valve on right panel to "OPEN".

1.1.5 Note pretreat tank level indicator position and turn feed control valve on right panel to "MANUAL".

1.1.6 When pretreat tank level drops by 2.5 liters, turn feed control valve to "AUTO".

These steps have introduced the initial charge of urine into the wick. Before starting the system, a waiting period of four hours must be allowed to permit this charge to distribute evenly through the wick to assure proper evaporation.

1.2 To start system

1.2.1 Ensure that diverter valve switch on left panel is in "AUTO" position.

1.2.2 Set wick feed temperature meter set point indicator at 120°F.

1.2.3 Set water conductivity meter set point indicator at 100 micromhos per centimeter.

1.2.4 Turn electric power switches on left panel to "ON".

1.2.5 Turn on condenser cooling water flow.

1.2.6 Turn system mode selector switch on left panel to "RUN". Fan pressure signal light will go out as air flow rate reaches proper operating range.

1.2 (Continued)

System is now in normal operating mode. Temperature signal from wick thermistor will operate solenoid feed valve, controlling the flow of urine from the batch tank to the evaporator, maintaining a proper and sufficient supply of waste water to the system.

1.3 To shut down system

1.3.1 Turn system mode selector switch on left panel to "OFF".

1.3.2 Turn off condenser cooling water flow.

1.3.3 Turn electric power switches on left panel to "OFF".

System may be restarted, when no wick replacement is required as in 1.2 above.

1.4 To dry wick prior to removal with system in normal operating mode

1.4.1 Turn system mode selector switch to "DRY".

1.4.2 Turn waste water inlet valve to "CLOSED". Wick temperature sensing circuit is now inoperative and no flow of waste water to the evaporator is possible. Conductivity sensor will automatically divert flow of processed water to collection tank for reprocessing and light high conductivity signal when conductivity reaches 100 micromhos per centimeter. Dry down cycle should, under normal operating conditions, continue for at least four hours.

1.4.3 Shut down system as per 1.3.1 and 1.3.3.

1.4.4 Remove wick as per wick replacement procedures (Section 2.0).

1.5 Back Pressure Valve Adjustment

On initial installation, the unit will require adjustment of the back pressure valve in the processed water line to compensate for variations in external processed water line pressure losses. This one-time adjustment is made as described below with the unit running in the normal operating mode.

The back pressure valve is located to the left of, behind and below pretreat tank. Turn large back up nut clockwise to seat against valve body. Turn capped adjusting nut clockwise as far as it will go. Back off adjusting nut as required until bubbles appear in processed water line, then turn adjusting nut clockwise until bubbles no longer appear. Hold adjusting nut and turn back up nut counterclockwise to seal and lock adjusting nut. Back pressure valve is now set for minimum pressure to prevent pumping of air from system to collection tanks.

2.0 WICK REPLACEMENT PROCEDURE

Normal useful wick life for urine processing is approximately 88 hours of operating time (110 pounds of urine processed). At the end of this period, or when a continuing high conductivity signal is observed, the system should run for at least 4 hours in the dry down mode of operation (Section 1.4, above) and the wick replaced as in the procedure outlined below.

2.1 To remove wick

2.1.1 Remove feed valve from wick feed cup.

2.1.2 Insert plug in wick feed cup.

2.1.3 Disconnect thermistor.

2.1.4 Open cover latches.

2.1.5 Lift cover and pass thermistor through port.

2.1.6 Loosen clamp on inlet side, slide away from evaporator.

2.1.7 Roll rubber sleeve on inlet side away from evaporator.

2.1.8 Slide header off duct.

2.1.9 Loosen clamp on outlet side, slide away from evaporator.

2.1.10 Roll rubber sleeve on outlet side away from evaporator.

2.1.11 Slide header off duct.

2.1.12 Lift wick from evaporator.

2.2 To insert wick

2.2.1 Place wick package in evaporator.

2.2.2 Slide headers over duct ends.

2.2.3 Roll rubber sleeves over headers toward evaporator.

2.2.4 Slide clamps over sleeves and tighten.

2.2.5 Pass thermistor through cover port.

2.2.6 Connect thermistor.

2.2.7 Close and latch cover.

2.2.8 Remove plug from wick feed cup.

2.2.9 Insert feed valve in wick feed cup.

3.0 CHARCOAL REPLACEMENT PROCEDURES

3.1 Air charcoal canister replacement procedure

3.1.1 Remove canister cover by loosening V-band clamp with 3/8" wrench.

3.1.2 Slide out used cartridge.

3.1.3 Slide new cartridge into canister, ensuring that end is properly seated. (Cover will not close if improperly seated).

3.1.4 Replace canister cover and V-band clamp. Tighten clamp.

3.2 Water Charcoal Canister Replacement Procedure

3.2.1 Disconnect inlet and outlet water lines at canister.

3.2.2 Remove screws holding canister to mounting bracket.

3.2.3 Replace canister with freshly charged canister.

3.2.4 Install screws to mounting bracket.

3.2.5 Connect inlet and outlet water lines.

4.0 URINE COLLECTION AND TREATMENT

4.1 Procedures

Raw urine is introduced to the system through the waste water inlet port on the interface panel at the rear of the unit. The urine is treated as it enters the pretreat tank by mixing with the treatment chemicals injected just before the introduction of the urine. The required procedure is outlined below.

4.1.1 Turn waste water inlet valve to "CLOSED".

4.1.2 Depressurize and vent pretreat tank.

4.1.3 Pull and push, to limit of stroke, chemical injector handle once for each 1.5 liters of urine to be introduced.

4.1.4 Open waste water inlet line and introduce urine, under approximately 4 psig pressure, through interface panel port.

4.1.5 Close waste water inlet line.

4.1.6 Pressurize pretreat tank.

4.1.7 Open waste water inlet valve.

4.2 Treatment Chemicals

The treatment chemical composition and mixing procedure is specified on HSD drawing 137X-390, found at the end of this report.

5.0 HEATER CONTROLS

The evaporator inlet temperature is controlled by the heater variac on the left panel. Increasing the variac setting will increase the power to the heater and the inlet temperature for a given air flow. Heater power is indicated on the wattmeter directly above the variac control. Actual power consumed by the balanced three-phase heater is three times that indicated by the single phase wattmeter. Heater variac calibration curves are presented in Figure 5.1.

6.0 WARNING LIGHT OPERATION

Five lights, each indicative of a possible requirement for corrective action, are incorporated on the left panel. The specific function of each light is tabulated below.

Light	Function
Water Conductivity Low	Signal when conductivity reaches 100 micromhos per centimeter. Activate diverter solenoid valve.
Fan ΔP Low	Signal if fan ΔP drops below 2 inches H_2O, indicating low air flow rate.
Evaporator Temperature Out High	Signal if evaporator air outlet temperature rises above 145±5°F, indicating low evaporating rate.
Condenser Temperature Out High	Signal if condenser air outlet temperature rises above 145±5°F, indicating low condensing rate.
Diverter Valve On	Signal when diverter solenoid valve is activated.

7.0 DIVERTER VALVE OPERATION

A switch for the manual overriding of the automatic processed water diverter valve (actuated by a high conductivity signal) is provided beneath the water conductivity meter on the left panel. This switch should be in the "AUTO" position in the normal operating mode, in the "MANUAL" position for continuous diversion and in the "OFF" position for diverter valve deactivation.

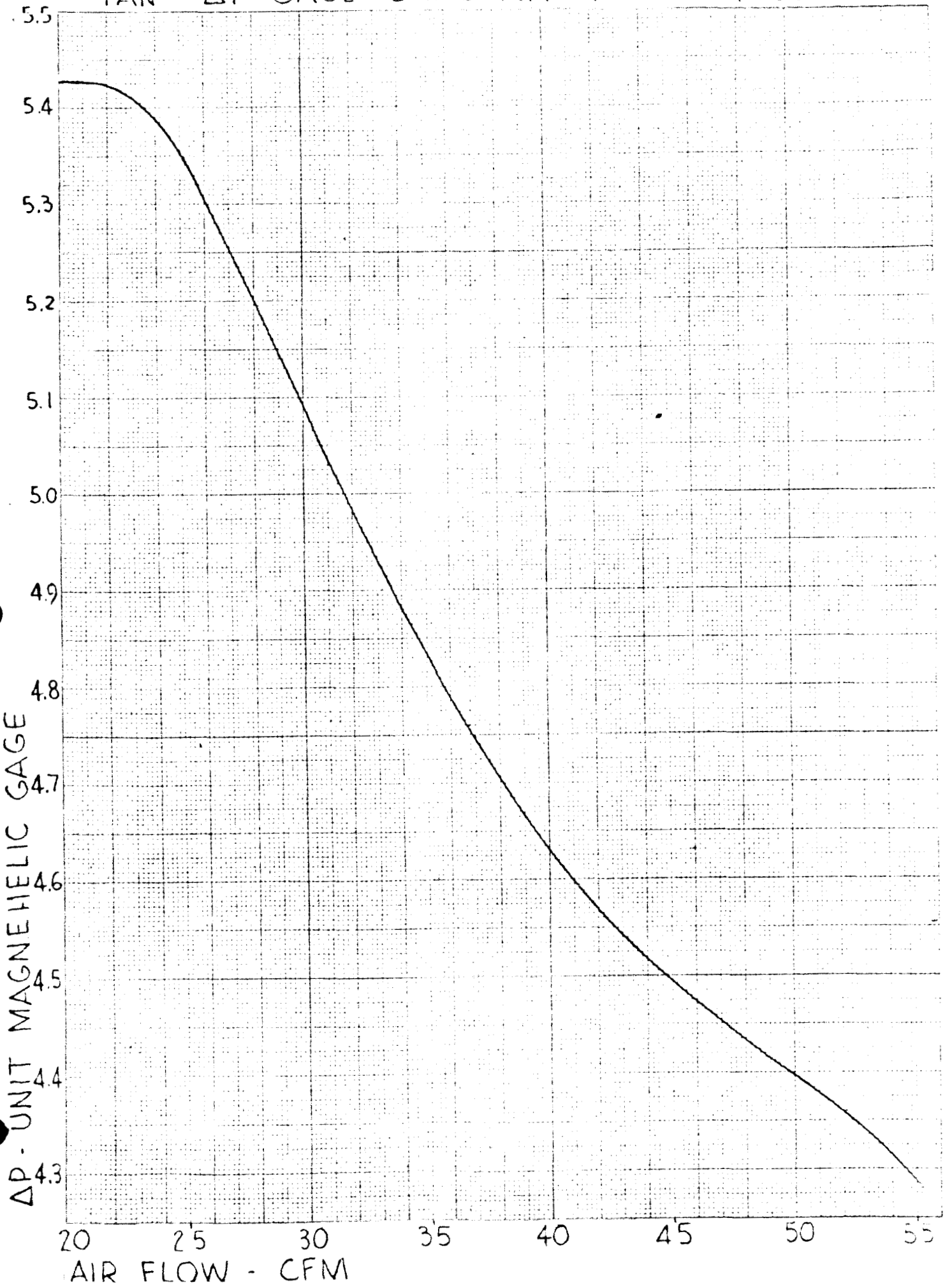
8.0 WATER CONDUCTIVITY METER TEST

To test the water conductivity sensing probe and meter circuit for proper operation, depress, with 400 ~ AC electrical power on, the "TEST" switch located beneath the water conductivity meter. Proper operation is indicated by a steady meter reading of 30 micromhos/cm.

9.0 AIR FLOW

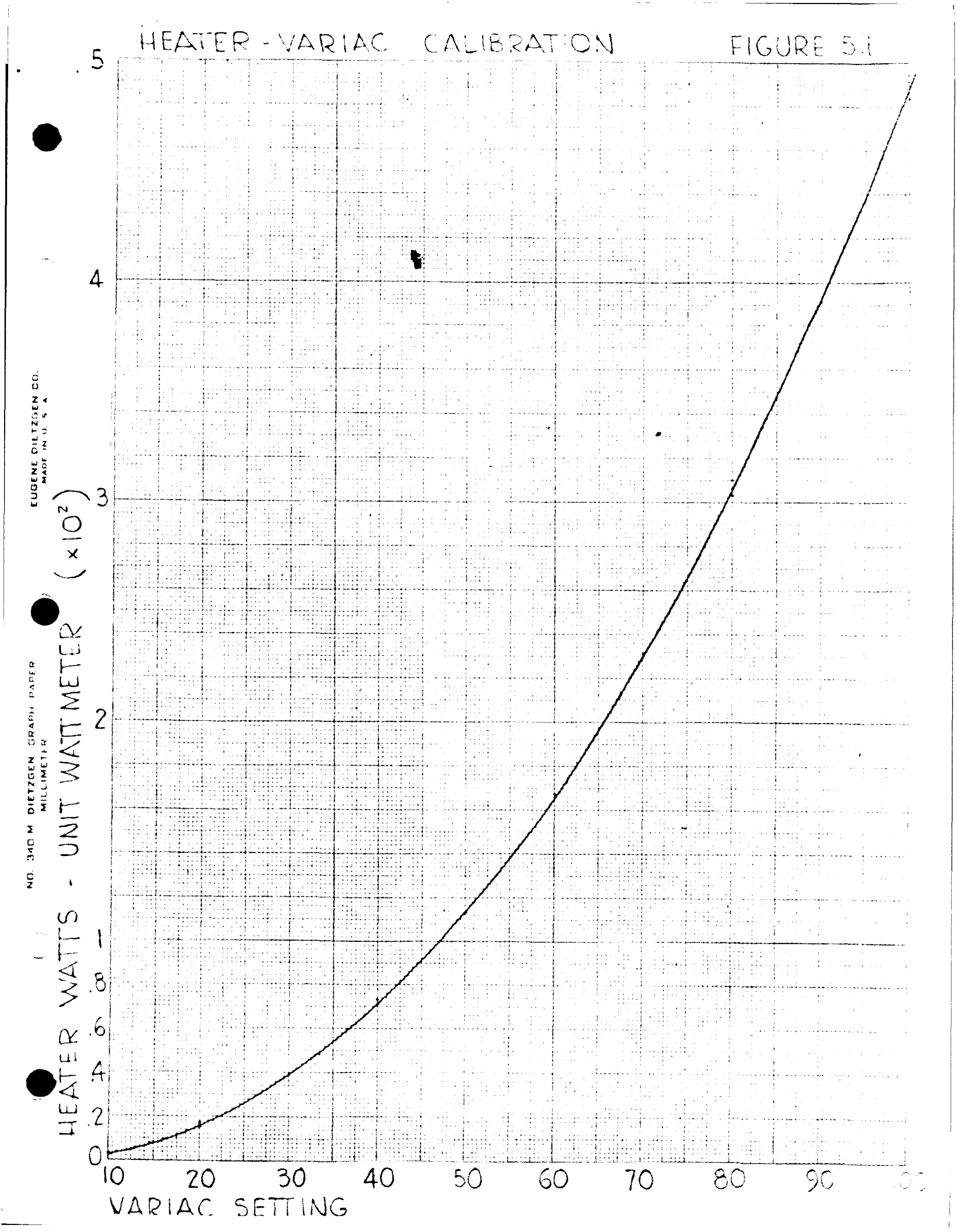
A curve of air flow versus fan ΔP is presented in Figure 9.1.

FAN - ΔP GAGE CALIBRATION FIGURE 9.1



EUGENE DIETZGEN CO.
MADE IN U. S. A.

NO 340-M DIETZGEN GRAPH PAPER
MILLIMETER


HEATER - VARIAC CALIBRATION
FIGURE 5.1
HEATER WATTS - UNIT WATTMETER (×10²)
VARIAC SETTING
0
.2
.4
.6
.8
1
2
3
4
5
10
20
30
40
50
60
70
80
90
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CHEMICAL COMPOSITION (BY WEIGHT)

CHROMIUM TRIOXIDE, A.R. (CrO_3)

SULFURIC ACID, A.R. (H_2SO_4)

WATER, DISTILLED

MIXING INSTRUCTIONS:

DISSOLVE CrO_3 IN WATER.

SLOWLY ADD H_2SO_4.

CAUTION: REACTION PRODUCES TE
IN EXCESS OF 200°F. USE
RESISTANT GLASS OR
VESSELS.

INSPECT – TEST DESIGNATED AREA(S) PER	
DES	SPECIFICATION (S)
A	
B	
C	
ALL AREAS	
ALL AREAS	✓

137X390

SYM

11%
44%
45%

ADD 40 ML
OF URINE T

MPERATURES
ONLY HEAT
EARTHENWARE

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ± _____ ANGLES ± _____.
EXCEPT FOR DRILL END FORM : FILLET RADII
_____ TO _____. SURFACES HAVING A COMMON AXIS
CONCENTRIC WITHIN _____ T.I.R. _____.

Δ MARK PART IDE
DRAWING INTERF
PRESERVATION A

MATERIAL		DRAWN	H. KOLNSBERG	8/5/65
		CHECKED	HK	8/5
		DRAFTING		
		DESIGN		
		MATERIALS		
HARDNESS		PROJECT	HK	8/5
HEAT TREAT		COST		
SPEC		FACTORY		
SURFACE COATING				
		EXP MFG	PRELIM PROD	PROD.
MFG SPEC				
MAKE FROM				
PROD. CODE				

REVISIONS		
DESCRIPTION	DATE	APPROVAL

OF SOLUTION TO EACH LITER
O BE TREATED

NTIFICATION: MIL-STD-130 PER HS333.
RETATION PER HS1360. CLEANING,
ND HANDLING PER HS1550-C___P___

NEXT ASSY	USED ON
APPLICATION	

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION
WINDSOR LOCKS, CONNECTICUT • U.S.A.

CHEMICAL, URINE TREATMENT

CODE IDENT NO.	SIZE	
73030	B	137X390
SCALE:	WEIGHT: LB	SHEET

5