MASTER

EN-77-C-02-4299

KILOWATT ISOTOPE

POWER SYSTEM

COMPONENT TEST REPORT FOR THE

GROUND DEMONSTRATION

SYSTEM PUMP

Sundstrand Energy Systems

ROCKFORD, ILLINOIS
unit of Sundstrand Corporation

77-KIPS-99

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REPORT NO. AER 1504- 3
 DATE 11/7/77
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SUNDSTRAND AVIATION
 DIVISION OF SUNDSTRAND CORPORATION
 ROCKFORD, ILLINOIS

ENGINEERING REPORT

REPORT OF THE
 PUMP TEST FOR
 THE KILOWATT ISOTOPE POWER SYSTEM
 MODEL NUMBER ORC1A3A01
 GROUND DEMONSTRATION SYSTEM

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QUALITY ASSURANCE MANAGER	DATE

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1.0

PURPOSE

The purpose of this test was to demonstrate that the System Pump utilized for the developmental program to be conducted on the Kilowatt Isotope Power System (KIPS) fulfilled the requirements of Test Procedure 398, Component Test Procedure for the GDS System Pump.

This report, one of a series, presents the results of the testing performed on the System Pump.

2.0

CONCLUSION

The System Pump for the Kilowatt Isotope Power System has satisfactorily completed the requirements of Sundstrand Pump Test Procedure, TP 398. Test requirements of TP 398 were extracted from the Kilowatt Isotope Power System, Phase I Test Plan.

3.0 TEST DESCRIPTION

The System Pump, prior to assembly, in the CRU, was subjected to a visual inspection, testing per TP 398 and then another visual inspection.

Upon completion of the test, the parts were packaged per CP 14.57-01 and then stored.

3.1 Applicable Documents

All referenced documents used in the performance of the testing specified herein were to their latest approved version.

AER 1342	Kilowatt Isotope Power System Ground Demonstration Test Plan
CP 14.57-01	General Precision Cleaning (KIPS)
720838	Drawing Number of the Combined
723713	Rotating Unit (CRU) Assembly
723298	
Document 8.01	Quality Assurance-Instrumentation Calibration Procedure
M-005	Quality Assurance-Instrument Calibration Frequency Schedule
QA5-107335	Sundstrand Corporation Quality Assurance Program Plan, Applicable to KIPS

3.2 Facilities

3.2.1 Instrumentation

The instrumentation used in the performance of the tests is listed in Table I, Page 11 of Appendix I.

3.2.2 Test Equipment

Test equipment was shown in Table II, Page 12 of Appendix I.

None of the test equipment was considered as being under test requirements.

4.0

TEST PROCEDURE

The test procedure was as shown within TP 398, which is reproduced as Appendix I of this document.

5.0

TEST RESULTS

Testing of S/N 001 and 002 pumps was completed without incident.

All parameters were recorded. Test data sheets are reproduced as pages 15 through 22 of Appendix I of this document.

Examination of Product prior to test and prior to cleaning and storage data sheets are shown as pages 18 and 22 of Appendix I.

SUNDSTRAND
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OPERATIONS

TEST TITLE
PUMP TEST REPORT

AER 1504-3

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APPENDIX I
TEST PROCEDURE 398
WITH TEST DATA SHEETS

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Advanced Technology Group

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- SUNDSTRAND AVIATION MECHANICAL
- SUNDSTRAND ENERGY SYSTEMS
- SUNDSTRAND OPERATIONS
- SUNDSTRAND MACHINE TOOL

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Test Procedure Number: 398 A

DEVELOPMENT TEST PROCEDURE FOR

PUMP

KILOWATT ISOTOPE POWER SYSTEM

MODEL NUMBER ORC1A3A01

GROUND DEMONSTRATION SYSTEM

Date: 9 June 1977

Approved:

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CHANGE RECORD

REVISION	TPC NO.	DATE	AFFECTED PAGES
A	483	10/31/77	2,10,11,12

TEST TITLE

KIPS-GROUND
 DEMONSTRATION UNIT
 DEVELOPMENT TESTS

TP 398

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TEST TITLE

KIPS-GROUND
DEMONSTRATION UNIT
DEVELOPMENT TESTS

TP 398

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1.0 GENERAL

1.1 Scope

This test procedure provides a detailed description of the verification methods which shall be used in the development program to be conducted on the Kilowatt Isotope Power System (KIPS) Main System Pump,
of the Combined Rotating Unit (CRU), Assembly
, to fulfill the requirements of the Ground Demonstration Test Plan, Section 6.8.

1.2 Test Objectives

To characterize pump performance so that data can be used for Turbine performance evaluation during Combined Rotating Unit (CRU) and Ground Demonstration System (GDS) Testing.

A

A

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DEMONSTRATION UNIT
DEVELOPMENT TESTS

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2.0

APPLICABLE DOCUMENTS

All referenced documents used in the performance of the testing specified herein shall be to their latest approved revision.

AER 1342
(Sundstrand)

Kilowatt Isotope Power System
Ground Demonstration Test Plan

CP14.57-01
(Sundstrand)

General Precision Cleaning, KIPS

720838
723713
723298

Sundstrand Drawing Number for
Combined Rotating Unit (CRU)
Assembly

Document 8.01

Sundstrand Aviation Quality
Assurance Instrumentation
Calibration Procedure

M-005

Sundstrand Aviation Instrument
Calibration Frequency Schedule

QA5-107335

Sundstrand Corporation
Quality Assurance Program Plan
Applicable to KIPS

A
A

3.0 FACILITIES

3.1 Instrumentation

The instrumentation used in the performance of the tests specified herein shall be in accordance with Table I, page 10.

The test engineer may, at the time of test, substitute an equivalent instrument with similar characteristics and with equal, or better, accuracy.

3.2 Test Equipment

Test equipment shall be in accordance with Table II, page 11. Equivalent equipment with similar characteristics may be utilized. The slave turbine and air bearing rig is shown on Figure 2, Page 13. None of the test equipment will be considered as being under test requirements. Repair, or replacement, of test equipment shall not invalidate testing accomplished prior to such repair or replacement.

3.3 Monitored Parameters

The following data shall be monitored and recorded at appropriate intervals to verify unit performance.

3.3 Monitored Parameters (Continued)

<u>PARAMETER</u>	<u>UNITS</u>	<u>ACRONYM</u>
1. Pump Inlet Pressure	PSIG	PPI
2. Pump Discharge Pressure	PSIG	PPO
3. Pump Inlet Temperature	°F	TPI
4. Pump Discharge Temperature	°F	TPO
5. Pump Inlet Flow	GPM	QI
6. Pump Discharge Flow	GPM	QO
7. Reservoir Pressure	PSIG	PR
8. Slave Turbine Torque	GRMS	T
9. Pump Speed	RPM	NS

3.4 Test Conditions

Unless otherwise specified in the individual test paragraph, testing shall be conducted at existing test lab ambient conditions.

The test fluid shall be tap water which has been filtered to remove harmful particulate.

Test fluid temperature shall be $80 \pm 15^{\circ}\text{F}$.

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KIPS-GROUND
DEMONSTRATION UNIT
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4.0

EXAMINATION OF PRODUCT

Examination of product shall consist of a revision inspection per the applicable drawing prior to any testing and a final visual inspection after completion of all testing.

As components of a Combined Rotating Unit, the items to be tested are:

<u>ITEM</u>	<u>SUNDSTRAND P/N</u>
1. Impeller	720768
2. Housing	720764
3. Seal	719129
4. Seal	719130
5. Retainer	720766
6. Plate	720762

Record inspection results on test data sheet, page 17.

5.0 PERFORMANCE TEST

1. Make test setup as shown in Figure 1, page 12.

Operate the slave turbine and pump support bearings (which are part of the test equipment defined as EP2605-5001) at 33,700, 45,000, and 57,000 RPM.

Record data on the appropriate data sheet, page 13, 14, and 15. The duration of the operation at each speed shall be such that bearing loss readings within ± 0.2 Gram, are obtained over a minimum period of three minutes.

2. Assemble pump and install in test fixture. Connect plumbing as shown in Figure 1, page 12. Close pump outlet valve and open pump inlet valve. Adjust reservoir pressure until pump inlet pressure (PPI) reads 25 ± 2 PSIG.

Start pump rotation by driving the slave turbine and then opening the pump outlet valve. Increase pump speed to $33,700 \pm 300$ RPM.

Record data on data sheet, page 14.

5.0 PERFORMANCE TEST (Continued)

3. Increase pump speed to 45,000 $\pm$ 300 RPM.

Adjust inlet flows as shown on the test data sheet, page 15. Record data.

4. Increase pump speed to 57,000 $\pm$ 300 RPM. Adjust inlet flows as shown on the test data sheet, page 16. Record data.

5. During Steps 2, 3 and 4 above, place beaker under seal drain port for tabulated time period and collect seal leakage.

Record time and amount of leakage on data sheet, pages 14, 15 and 16.

TEST TITLE

KIPS-GROUND
DEMONSTRATION UNIT
DEVELOPMENT TESTS

TP

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6.0

CLEANING AND STORAGE

When testing has been completed, disassemble pump parts and follow instructions in Sundstrand Cleaning Procedure 14.57-01.

Pump can then be assembled into balance assembly. The balance assembly shall then be properly packaged and stored.

INSTRUMENTATION

TYPE	PURPOSE	MANUFACTURER	MODEL, S/N, P/N	RANGE	ACCURACY
Gauge	Pump Inlet Pressure			0-60 PSIG	$\pm 1\%$ F.S. A
	Pump Discharge Pressure			0-300 PSIG 0-500 PSIG	$\pm 1\%$ F.S. A A
	Reservoir Pressure			0-100 PSIG	Reference Only A
Flowmeter	Pump Inlet Flow			0-8 GPM Min. 0-10 GPM Max.	$\pm 1\%$ of full reading A
	Pump Outlet Flow			0-8 GPM Min. 0-10 GPM Max.	$\pm 1\%$ of full reading A
Temperature Readout	Pump Inlet Temperature			32-100°F	$\pm 1\%$ F.S. A
	Pump Discharge Temperature			32-100°F	$\pm 1\%$ F.S. A
Torque Meter	Slave Turbine Torque			5-250 GRAMS	$\pm 2\%$ F.S. A
Mag. Pickup	Turbine Speed			0-60,000 RPM	$\pm 1\%$ of reading

TABLE I

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- SUNDSRAND ENERGY SYSTEMS
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SUNDSTRAND
AVIATION

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KIPS GDS SYSTEM PUMP
TEST SCHEMATIC

FIGURE 1

SUNDSTRAND
AVIATION

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FIGURE 2

SUNDSTRAND
AVIATION

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PUMP TEST DATA SHEET

TEST OPERATOR 1593

UNIT S/N 001

TEST SURVEILLANCE:

DATE: 9.28-77

NS - Speed (RPM) Required	33700 ± 300	33700 ± 300	33700 ± 300	33700 ± 300	33700 ± 300	33700 ± 300	33700 ± 300	33700 ± 300
NS - Speed (RPM) Actual	33660	33660	33660	33690	33690	33660	33660	33690
PPI - Inlet Pressure (PSIG) Req.	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2
PPI - Inlet Pressure (PSIG) Actual	25	25	25	25	25	25	25	25
PPO - Outlet Pressure (PSIG) Actual	156	156	154	151	144	135	126	114
QI - Inlet Flow (GPM) Required	± 1.0 ±.1	± 1.5 ±.1	± 2.0 ±.1	± 2.5 ±.1	± 3.0 ±.1	± 3.5 ±.1	± 4.0 ±.1	± 4.5 ±.1
QI - Inlet Flow (GPM) Actual	1.0	1.5	2.0	2.5	2.98	3.5	4.0	4.5
QO - Outlet Flow (GPM) Actual	1.0	1.5	2.03	2.52	3.03	3.55	4.03	4.52
TPI - Inlet Temperature (°F) Req.	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15
TPI - Inlet Temperature (°F) Actual	81	80.5	81	81.5	82	82	82	82
TOP - Outlet Temperature (°F) Actual	81	80.5	81	81.5	82	82	82	82
T - Torque Load (GRAMS) Actual	50.0	57.45	65.15	72.45	79.4	85.6	90.9	95.7
Moment Arm (Inches) Required	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00

Pump Support Bearing Loss = 13.35 GRAMS
Seal Leakage = 375 cc's in 47 minutes.

SUNDSTRAND
AVIATIONTEST FILE
KIPS-GROUND
DEMONSTRATION UNIT
DEVELOPMENT TESTSTP
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PUMP TEST DATA SHEET

TEST OPERATOR 1593UNIT S/N 001

TEST SURVEILLANCE:

DATE: 9-28-77

NS - Speed (RPM) Required	45000 ± 300	45000 ± 300	45000 ± 300	45000 ± 300	45000 ± 300	45000 ± 300	45000 ± 300	45000 ± 300
NS - Speed (RPM) Actual	45030	45000	45030	45030	45030	45000	45000	45000
PPI - Inlet Pressure (PSIG) Req.	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2
PPI - Inlet Pressure (PSIG) Actual	25	25	25	25	25	25	25	25
PPO - Outlet Pressure (PSIG) Actual	261	262	260	255	249	241	231	218
QI - Inlet Flow (GPM) Required	± 1.5 ±.1	± 2.0 ±.1	± 2.5 ±.1	± 3.0 ±.1	± 3.5 ±.1	± 4.0 ±.1	± 4.5 ±.1	± 5.0 ±.1
QI - Inlet Flow (GPM) Actual	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
QO - Outlet Flow (GPM) Actual	1.52	2.03	2.5	3.01	3.52	4.05	4.53	5.04
TPI - Inlet Temperature (°F) Req.	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15
TPI - Inlet Temperature (°F) Actual	82	82	82	82.5	82.5	82.5	82.5	82.5
TOP - Outlet Temperature (°F) Actual	82	82	82	82.5	82.5	82.5	82.5	82.5
T - Torque Load (GRAMS) Actual	17.2	87.7	97.1	107.2	116.6	125.8	134.5	141.8
Moment Arm (Inches) Required	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00

Pump Support Bearing Loss = 12.45 GRAMS
Seal Leakage = 1015 cc's in 75 minutes

SUNDSTRAND
AVIATION

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PUMP TEST DATA SHEET

TEST OPERATOR 1593

UNIT S/N 001

TEST SURVEILLANCE:

DATE: 7-28-77

NS - Speed (RPM) Required	57000 ± 300	57000 ± 300	57000 ± 300	57000 ± 300	57000 ± 300	57000 ± 300	57000 ± 300	57000 ± 300
NS - Speed (RPM) Actual	57060	57030	56970	57000	57060	57000	57000	57000
PPI - Inlet Pressure (PSIG) Req.	± 25 ± 2	± 25 ± 2	± 25 ± 2	± 25 ± 2	± 25 ± 2	± 25 ± 2	± 25 ± 2	± 25 ± 2
PPI - Inlet Pressure (PSIG) Actual	25	25	25	25	25	25	25	25
PPO - Outlet Pressure (PSIG) Actual	400	402	398	396	388	379	371	362
QI - Inlet Flow (GPM) Required	2.0 ±.1	2.5 ±.1	3.0 ±.1	3.5 ±.1	4.0 ±.1	4.5 ±.1	5.0 ±.1	5.5 ±.1
QI - Inlet Flow (GPM) Actual	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.4
QO - Outlet Flow (GPM) Actual	2.0	2.5	3.02	3.52	4.03	4.52	5.02	5.42
TPI - Inlet Temperature (°F) Req.	± 80 ± 15	± 80 ± 15	± 80 ± 15	± 80 ± 15	± 80 ± 15	± 80 ± 15	± 80 ± 15	± 80 ± 15
TPI - Inlet Temperature (°F) Actual	83.5	83.5	84.5	85	85	85	85	85
TOP - Outlet Temperature (°F) Actual	83.5	83.5	84.5	85	85	85	85	84
T - Torque Load (GRAMS) Actual	117.7	130.3	142.0	155.1	166.95	179.6	191.8	199.8
Moment Arm (Inches) Required	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00

Pump Support Bearing Loss = 12.75 GRAMS
Seal Leakage = 1190 cc's in 53 minutes

TEST TITLE
KIPS-GROUND
DEMONSTRATION UNIT
DEVELOPMENT TEST

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4.0 EXAMINATION OF PRODUCT DATA SHEET - FOR UNIT S/N 001

PRIOR TO TEST

ITEM	SUNDSTRAND P/N	REV.	S/N
1. Impeller	720768	<u>A</u>	<u>2</u>
2. Housing	720764	<u>C</u>	<u>001</u>
3. Seal	719129	<u>*</u>	<u>001</u>
4. Seal	719130	<u>*</u>	<u>001</u>
5. Retainer	720766	<u>C</u>	<u>001</u>
6. Plate	720762	<u>*</u>	<u>001</u>

TEST SURVEILLANCE DATE 9-27-77

PRIOR TO CLEANING AND STORAGE

ITEM	SUNDSTRAND P/N	REV.	S/N
1. Impeller	720768	<u>A</u>	<u>2</u>
2. Housing	720764	<u>C</u>	<u>001</u>
3. Seal	719129	<u>*</u>	<u>001</u>
4. Seal	719130	<u>*</u>	<u>001</u>
5. Retainer	720766	<u>C</u>	<u>001</u>
6. Plate	720762	<u>*</u>	<u> </u>

TEST SURVEILLANCE DATE 9-28-77

SUNDSTRAND
AVIATION

TEST OPERATOR 1593

PUMP TEST DATA SHEET

UNIT S/N 002

TEST SURVEILLANCE: 289

DATE: 9-23-77

NS - Speed (RPM) Required	33700 ± 300	33700 ± 300	33700 ± 300	33700 ± 300	33700 ± 300	33700 ± 300	33700 ± 300	33700 ± 300
NS - Speed (RPM) Actual	33720	33690	33660	33660	33660	33690	33720	33690
PPI - Inlet Pressure (PSIG) Req.	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2
PPI - Inlet Pressure (PSIG) Actual	25	25	25	25	25	25	25	25
PPO - Outlet Pressure (PSIG) Actual	154	156	154	149	141	131	122	108
QI - Inlet Flow (GPM) Required	1.0 ±.1	1.5 ±.1	2.0 ±.1	2.5 ±.1	3.0 ±.1	3.5 ±.1	4.0 ±.1	4.5 ±.1
QI - Inlet Flow (GPM) Actual	1.0	1.5	2.0	2.48	3.0	3.5	4.0	4.5
QO - Outlet Flow (GPM) Actual	1.0	1.5	2.0	2.5	3.0	3.52	4.0	4.5
TPI - Inlet Temperature (°F) Req.	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15
TPI - Inlet Temperature (°F) Actual	84	84	83.5	83	83	82.5	82	81
TOP - Outlet Temperature (°F) Actual	84	84	83.5	83	83	82.5	82	81
T - Torque Load (GRAMS) Actual	48.35	56.0	63.95	70.45	77.1	83.5	88.6	92.5
Moment Arm (Inches) Required	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00

Pump Support Bearing Loss = 13.25 GRAMS
Seal Leakage = 210 cc's in 40 minutes.

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KIPS-GROUND
DEMONSTRATION UNIT
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PUMP TEST DATA SHEET

TEST OPERATOR 1593

UNIT S/N 002.

TEST SURVEILLANCE:

DATE: 9-26-77

NS - Speed (RPM) Required	45000 ± 300	45000 ± 300	45000 ± 300	45000 ± 300	45000 ± 300	45000 ± 300	45000 ± 300	45000 ± 300
NS - Speed (RPM) Actual	45060	45000	45000	45000	44970	45030	45000	45000
PPI - Inlet Pressure (PSIG) Req.	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2
PPI - Inlet Pressure (PSIG) Actual	25	25	25	25	25	25	25	25
PPO - Outlet Pressure (PSIG) Actual	261	262	260	255	246	235	224	209
QI - Inlet Flow (GPM) Required	± 1.5 ±.1	± 2.0 ±.1	± 2.5 ±.1	± 3.0 ±.1	± 3.5 ±.1	± 4.0 ±.1	± 4.5 ±.1	± 5.0 ±.1
QI - Inlet Flow (GPM) Actual	1.5	2.0	2.5	2.98	3.5	4.0	4.5	5.0
QO - Outlet Flow (GPM) Actual	1.5	2.02	2.52	3.02	3.53	4.05	4.55	5.05
TPI - Inlet Temperature (°F) Req.	± 80 - 15	± 80 - 15	± 80 - 15	± 80 - 15	± 80 - 15	± 80 - 15	± 80 - 15	± 80 - 15
TPI - Inlet Temperature (°F) Actual	81.5	81.5	81.5	82	82	82	82	82
TOP - Outlet Temperature (°F) Actual	81.5	81.5	81.5	82	82	82	82	82
T - Torque Load (GRAMS) Actual	76	87.2	96.4	105.5	115.1	123.6	131.3	138.2
Moment Arm (Inches) Required	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00

Pump Support Bearing Loss = 12.35 GRAMS
Seal Leakage = 390 cc's in 40 minutes

SUNOSTRAND
AVIATION

PUMP TEST DATA SHEET

TEST OPERATOR 1593

UNIT S/N 002

TEST SURVEILLANCE:

DATE: 9-26-77

NS - Speed (RPM) Required	57000 ± 300	57000 ± 300	57000 ± 300	57000 ± 300	57000 ± 300	57000 ± 300	57000 ± 300	57000 ± 300
NS - Speed (RPM) Actual	57060	57060	56970	57060	56970	56976	57030	57060
PPI - Inlet Pressure (PSIG) Req.	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2	± 25 2
PPI - Inlet Pressure (PSIG) Actual	25	25	25	25	25	25	25	25
PPO - Outlet Pressure (PSIG) Actual	398	402	398	392	385	373	360	346
QI - Inlet Flow (GPM) Required	2.0 ±.1	2.5 ±.1	3.0 ±.1	3.5 ±.1	4.0 ±.1	4.5 ±.1	5.0 ±.1	5.5 ±.1
QI - Inlet Flow (GPM) Actual	2.0	2.48	3.0	3.5	3.99	4.5	5.0	5.5
QO - Outlet Flow (GPM) Actual	2.02	2.5	3.03	3.54	4.04	4.54	5.05	5.55
TPI - Inlet Temperature (°F) Req.	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15	± 80 15
TPI - Inlet Temperature (°F) Actual	83.5	84	84	84	84	84	84	84
TOP - Outlet Temperature (°F) Actual	83.5	84	84	84	84	84	84	84
T - Torque Load (GRAMS) Actual	117.5	129.1	141.1	152.8	163.5	174.4	185.0	194.2
Moment Arm (Inches) Required	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00

TEST TITLE
KIPS-GROUND
DEMONSTRATION UNIT
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Pump Support Bearing Loss = 12.65 GRAMS
Seal Leakage = 830 cc's in 75 minutes

4.0 EXAMINATION OF PRODUCT DATA SHEET - FOR UNIT S/N 002

PRIOR TO TEST

ITEM	SUNDSTRAND P/N	REV.	S/N
1. Impeller	720768	<u>A</u>	<u>1</u>
2. Housing	720764	<u>C</u>	<u>002</u>
3. Seal	719129	<u>*</u>	<u>003</u>
4. Seal	719130	<u>*</u>	<u>002</u>
5. Retainer	720766	<u>C</u>	<u>002</u>
6. Plate	720762	<u>*</u>	<u>002</u>

TEST SURVEILLANCE DATE 9-22-77

PRIOR TO CLEANING AND STORAGE

ITEM	SUNDSTRAND P/N	REV.	S/N
1. Impeller	720768	<u>A</u>	<u>1</u>
2. Housing	720764	<u>C</u>	<u>002</u>
3. Seal	719129	<u>*</u>	<u>003</u>
4. Seal	719130	<u>*</u>	<u>002</u>
5. Retainer	720766	<u>C</u>	<u>002</u>
6. Plate	720762	<u>*</u>	<u>002</u>

TEST SURVEILLANCE DATE 9-22-77

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COMPUTER DATA PRINTOUTS

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COMPUTER DATA PRINTOUTS

FOR S/N 001 UNIT

TYPE OF PUMP -- KIPS-6.DIGIT NO. 2.

PUMP CONFIGURATION -- NO. 2 SWEPT VANE IMPELLER

BEARING LOAD (GRAMS) -- 13.350

IMPELLER THROAT (DIAMETER IN.) 0.0420

-IMPELLER RADIUS (INLET CENTER LINE IN.) 0.4427

INPUT DATA *****

	1	2	3	4	5	6	7	8
COUNTER (1/1500 RPM)	1123.0	1122.0	1122.0	1123.0	1123.0	1122.0	1122.0	1122.0
INPUT PRESSURE (PSIG)	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
OUTPUT PRESSURE (PSIG)	114.0	126.0	135.0	144.0	151.0	154.0	156.0	156.0
FLOW (GPM)	4.510	4.010	3.520	3.000	2.510	2.010	1.500	1.000
TORQUE LOAD (GRAMS)	95.70	90.90	85.60	79.40	72.45	65.15	57.45	50.00
MOMENT ARM (IN)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
VAPOR PRESSURE (PSIA)	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54

OUTPUT DATA *****

RPM	33690.	33660.	33660.	33690.	33690.	33660.	33660.	33660.
INPUT HEAD (FT. H2O)	57.75	57.75	57.75	57.75	57.75	57.75	57.75	57.75
OUTPUT HEAD (FT. H2O)	263.3	291.1	311.8	332.6	348.8	355.7	360.4	360.4
TOTAL HEAD (FT. H2O)	205.6	233.3	254.1	274.9	291.1	298.0	302.6	302.6
TOTAL TORQUE (IN-OZ)	13.501	12.824	12.076	11.202	10.221	9.191	8.105	7.054
TOTAL TORQUE (FT-LB)	0.070	0.067	0.063	0.058	0.053	0.048	0.042	0.037
SY	0.391	0.444	0.484	0.523	0.553	0.567	0.576	0.576
PHI	0.095	0.085	0.074	0.063	0.053	0.042	0.032	0.021
BEARING HP	0.063	0.063	0.063	0.063	0.063	0.063	0.063	0.063
PUMP HP	0.388	0.365	0.340	0.311	0.279	0.244	0.208	0.173
TOTAL HP	0.451	0.428	0.403	0.374	0.341	0.307	0.271	0.235
PUMP EFFICIENCY	60.323	64.691	66.384	66.892	66.227	62.004	55.193	44.275
SPECIFIC SPEED	1317.77	1129.11	992.27	864.35	757.45	665.37	568.19	463.93
SUCTION SPECIFIC SPEED	3471.8	3270.8	3064.4	2831.5	2590.0	2315.7	2000.4	1633.3
BEARING WATTS	46.94	46.90	46.90	46.94	46.94	46.90	46.90	46.90
PUMP WATTS	289.6	272.4	253.8	232.2	207.8	182.0	154.9	128.8
TOTAL WATTS	336.5	319.3	300.7	279.2	254.8	228.9	201.8	175.7

TYPE OF PUMP -- KIPS-6.DIGIT NO. 2.

PUMP CONFIGURATION -- NO. 2, SWEEP VANE IMPELLER

BEARING LOAD (GRAMS) -- 12.450

IMPELLER THROAT (DIAMETER IN.) 0.0420

IMPELLER RADIUS (INLET CENTER LINE IN.) 0.4427

INPUT DATA *****

	1	2	3	4	5	6	7	8
COUNTER (1/1500 RPM)	1500.0	1500.0	1500.0	1501.0	1501.0	1501.0	1500.0	1501.0
INPUT PRESSURE (PSIG)	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
OUTPUT PRESSURE (PSIG)	218.0	231.0	241.0	249.0	255.0	260.0	262.0	261.0
FLOW (GPM)	5.020	4.510	4.020	3.510	3.000	2.500	2.010	1.510
TORQUE LOAD (GRAMS)	141.80	134.50	125.80	116.60	107.20	97.10	87.70	77.20
MOMENT ARM (IN)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
VAPOR PRESSURE (PSIA)	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54

OUTPUT DATA *****

RPM	45000.	45000.	45000.	45030.	45030.	45030.	45000.	45030.
INPUT HEAD (FT. H2O)	57.75	57.75	57.75	57.75	57.75	57.75	57.75	57.75
OUTPUT HEAD (FT. H2O)	503.6	533.6	556.7	575.2	589.0	600.6	605.2	602.9
TOTAL HEAD (FT. H2O)	445.8	475.9	499.0	517.4	531.3	542.8	547.5	545.2
TOTAL TORQUE (IN-OZ)	20.005	18.975	17.748	16.450	15.124	13.699	12.373	10.891
TOTAL TORQUE (FT-LB)	0.104	0.099	0.092	0.086	0.079	0.071	0.064	0.057
SY	0.475	0.507	0.532	0.551	0.565	0.578	0.583	0.580
PHI	0.079	0.071	0.063	0.055	0.047	0.039	0.032	0.024
BEARING HP	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078
PUMP HP	0.814	0.768	0.714	0.656	0.597	0.533	0.474	0.408
TOTAL HP	0.893	0.847	0.792	0.735	0.675	0.612	0.552	0.486
PUMP EFFICIENCY	69.400	70.530	70.978	69.899	67.429	64.262	58.655	50.959
SPECIFIC SPEED	1039.17	937.98	854.63	777.61	704.79	633.08	563.69	490.45
SUCTION SPECIFIC SPEED	4892.5	4637.3	4378.1	4093.7	3784.6	3454.9	3095.8	2685.1
BEARING WATTS	58.47	58.47	58.47	58.51	58.51	58.51	58.47	58.51
PUMP WATTS	607.5	573.2	532.4	489.5	445.3	397.8	353.4	304.3
TOTAL WATTS	666.0	631.7	590.8	548.0	503.8	456.4	411.9	362.8

TYPE OF MP -- KIPS - 6. DIGIT NO. 2.

PUMP CONFIGURATION -- NO. 2. SWEEP VANE IMPELLER

BEARING LOAD (GRAMS) -- 12.750

IMPELLER THROAT (DIAMETER IN.) 0.0420

-IMPELLER RADIUS (INLET CENTER LINE IN.) 0.4427

INPUT DATA *****

	1	2	3	4	5	6	7	8
COUNTER (1/1500 RPM)	1902.0	1901.0	1899.0	1900.0	1902.0	1900.0	1900.0	1900.0
INPUT PRESSURE (PSIG)	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
OUTPUT PRESSURE (PSIG)	362.0	371.0	379.0	388.0	396.0	398.0	402.0	400.0
FLOW (GPM)	5.410	5.010	4.510	4.010	3.510	3.010	2.500	2.000
TORQUE LOAD (GRAMS)	199.80	191.80	179.60	166.95	155.10	142.00	130.30	117.70
MOMENT ARM (IN)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
VAPOR PRESSURE (PSIA)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60

OUTPUT DATA *****

RPM	57060.	57030.	56970.	57000.	57060.	57000.	57000.	57000.
INPUT HEAD (FT. H2O)	57.75	57.75	57.75	57.75	57.75	57.75	57.75	57.75
OUTPUT HEAD (FT. H2O)	836.2	857.0	875.5	896.3	914.8	919.4	928.6	924.0
TOTAL HEAD (FT. H2O)	778.5	799.3	817.7	838.5	857.0	861.6	870.9	866.2
TOTAL TORQUE (IN-OZ)	28.188	27.059	25.338	23.553	21.882	20.033	18.383	16.605
TOTAL TORQUE (FT-LB)	0.147	0.141	0.132	0.123	0.114	0.104	0.096	0.086
SY	0.516	0.530	0.544	0.557	0.568	0.572	0.578	0.575
PHI	0.067	0.062	0.056	0.050	0.044	0.038	0.031	0.025
BEARING HP	0.102	0.102	0.102	0.102	0.102	0.102	0.102	0.102
PUMP HP	1.493	1.429	1.330	1.230	1.136	1.031	0.937	0.837
TOTAL HP	1.595	1.530	1.432	1.331	1.238	1.132	1.039	0.939
PUMP EFFICIENCY	71.222	70.781	70.030	69.051	66.845	63.540	58.649	52.274
SPECIFIC SPEED	900.53	849.19	791.18	732.50	674.91	621.82	562.19	504.84
SUCTION SPECIFIC SPEED	6451.0	6204.6	5880.7	5548.1	5196.1	4806.8	4380.7	3918.2
BEARING WATTS	75.93	75.89	75.81	75.85	75.93	75.85	75.85	75.85
PUMP WATTS	1114.0	1065.8	992.1	917.4	847.7	768.9	699.3	624.4
TOTAL WATTS	1189.9	1141.6	1067.9	993.2	923.7	844.8	775.2	700.2

SUNDSTRAND
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OPERATIONS

TEST TITLE
PUMP TEST REPORT

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COMPUTER DATA PRINTOUTS
FOR S/N 002 UNIT

TYPE PUMP -- KIPS 6. DIGIT NO. 1.

PUMP CONFIGURATION -- NO. 1. SWEEP VANE IMPELLER

BEARING LOAD (GRAMS) -- 13.250

IMPELLER THROAT (DIAMETER IN.) 0.0420

-IMPELLER RADIUS (INLET CENTER LINE IN.) 0.4428

INPUT DATA *****

1 2 3 4 5 6 7 8

COUNTER (1/1500 RPM)	1123.0	1124.0	1123.0	1122.0	1121.0	1122.0	1123.0	1124.0
INPUT PRESSURE (PSIG)	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
OUTPUT PRESSURE (PSIG)	108.0	122.0	131.0	141.0	149.0	154.0	156.0	154.0
FLOW (GPM)	4.500	4.000	3.510	3.000	2.490	2.000	1.500	1.000
TORQUE LOAD (GRAMS)	92.50	88.60	83.50	77.10	70.45	63.95	56.00	48.35
MOMENT ARM (IN)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
VAPOR PRESSURE (PSIA)	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56

OUTPUT DATA *****

RPM	33690.	33720.	33690.	33660.	33630.	33660.	33690.	33720.
INPUT HEAD (FT. H2O)	57.75	57.75	57.75	57.75	57.75	57.75	57.75	57.75
OUTPUT HEAD (FT. H2O)	249.5	281.8	302.6	325.7	344.2	355.7	360.4	355.7
TOTAL HEAD (FT. H2O)	191.7	224.1	244.9	268.0	286.4	298.0	302.6	298.0
TOTAL TORQUE (IN-OZ)	13.050	12.500	11.780	10.877	9.939	9.022	7.900	6.821
TOTAL TORQUE (FT-LB)	0.068	0.065	0.061	0.057	0.052	0.047	0.041	0.036
SY	0.364	0.425	0.465	0.510	0.546	0.567	0.575	0.565
PHI	0.095	0.084	0.074	0.063	0.053	0.042	0.032	0.021
BEARING HP	0.062	0.063	0.062	0.062	0.062	0.062	0.062	0.063
PUMP HP	0.374	0.355	0.331	0.301	0.269	0.239	0.202	0.166
TOTAL HP	0.436	0.418	0.394	0.363	0.331	0.301	0.264	0.228
PUMP EFFICIENCY	58.327	63.670	65.545	67.512	66.923	63.034	56.886	45.444
SPECIFIC SPEED	1387.041	1164.481	1019.69	880.28	762.17	663.71	568.70	470.15
SUCTION SPECIFIC SPEED	3469.8	3274.3	3064.5	2830.6	2576.5	2311.2	2003.3	1637.2
BEARING WATTS	46.59	46.63	46.59	46.55	46.51	46.55	46.59	46.63
PUMP WATTS	278.7	265.2	247.0	224.3	200.8	178.1	150.3	123.5
TOTAL WATTS	325.3	311.8	293.6	270.9	247.3	224.7	196.9	170.2

TYPE PUMP -- KIPS 6 DIGIT NO. 1.

PUMP CONFIGURATION -- NO. 1. SWEEP VANE IMPELLER

BEARING LOAD (GRAMS) -- 12.350

IMPELLER THROAT (DIAMETER IN.) 0.0420

-IMPELLER RADIUS (INLET CENTER LINE IN.) 0.4428

INPUT DATA *****

	1	2	3	4	5	6	7	8
COUNTER (1/1500 RPM)	1500.0	1500.0	1501.0	1499.0	1500.0	1500.0	1500.0	1502.0
INPUT PRESSURE (PSIG)	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
OUTPUT PRESSURE (PSIG)	209.0	224.0	235.0	246.0	255.0	260.0	262.0	261.0
FLOW (GPM)	5.020	4.520	4.020	3.510	3.000	2.510	2.010	1.500
TORQUE LOAD (GRAMS)	138.20	131.30	123.60	115.10	105.50	96.40	87.20	76.00
MOMENT ARM (IN)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
VAPOR PRESSURE (PSIA)	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54

OUTPUT DATA *****

RPM	45000.	45000.	45030.	44970.	45000.	45000.	45000.	45060.
INPUT HEAD (FT. H2O)	57.75	57.75	57.75	57.75	57.75	57.75	57.75	57.75
OUTPUT HEAD (FT. H2O)	482.8	517.4	542.8	568.3	589.0	600.6	605.2	602.9
TOTAL HEAD (FT. H2O)	425.0	459.7	485.1	510.5	531.3	542.8	547.5	545.2
TOTAL TORQUE (IN-OZ)	19.497	18.524	17.437	16.238	14.884	13.600	12.302	10.722
TOTAL TORQUE (FT-LB)	0.102	0.096	0.091	0.085	0.078	0.071	0.064	0.056
SY	0.453	0.490	0.516	0.544	0.566	0.578	0.583	0.579
PHI	0.079	0.071	0.063	0.055	0.047	0.040	0.032	0.024
BEARING HP	0.078	0.078	0.078	0.078	0.078	0.078	0.078	0.078
PUMP HP	0.792	0.749	0.701	0.646	0.586	0.529	0.471	0.401
TOTAL HP	0.870	0.827	0.779	0.724	0.664	0.607	0.549	0.479
PUMP EFFICIENCY	68.004	70.064	70.262	69.996	68.633	65.023	58.968	51.462
SPECIFIC SPEED	1077.07	963.68	873.46	784.46	704.32	633.93	563.69	489.15
SUCTION SPECIFIC SPEED	4892.5	4642.4	4381.0	4088.3	3782.1	3459.5	3095.8	2677.9
BEARING WATTS	58.00	58.00	58.04	57.97	58.00	58.00	58.00	58.08
PUMP WATTS	591.1	558.7	522.9	482.3	437.5	394.8	351.5	299.3
TOTAL WATTS	649.1	616.7	580.9	540.2	495.5	452.8	409.5	357.4

TYPE OF PUMP -- KIPS 6 DIGIT NO. 1.

PUMP CONFIGURATION -- NO. 1. SWEEP VANE IMPELLER

BEARING LOAD (GRAMS) -- 12.650

IMPELLER THROAT (DIAMETER IN.) 0.0420

-IMPELLER RADIUS (INLET CENTER LINE IN.) 0.4428

INPUT DATA *****

	1	2	3	4	5	6	7	8
COUNTER (1/1500 RPM)	1902.0	1901.0	1899.0	1899.0	1902.0	1899.0	1902.0	1902.0
INPUT PRESSURE (PSIG)	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
OUTPUT PRESSURE (PSIG)	346.0	360.0	373.0	385.0	392.0	398.0	402.0	398.0
FLOW (GPM)	5.500	5.000	4.500	4.000	3.500	3.000	2.490	2.000
TORQUE LOAD (GRAMS)	194.20	185.00	174.40	163.50	152.80	141.10	129.10	117.50
MOMENT ARM (IN)	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
VAPOR PRESSURE (PSIA)	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58

OUTPUT DATA *****

RPM	57060.	57030.	56970.	56970.	57060.	56970.	57060.	57060.
INPUT HEAD (FT. H2O)	57.75	57.75	57.75	57.75	57.75	57.75	57.75	57.75
OUTPUT HEAD (FT. H2O)	799.3	831.6	861.6	889.3	905.5	919.4	928.6	919.4
TOTAL HEAD (FT. H2O)	741.5	773.8	803.9	831.6	847.8	861.6	870.9	861.6
TOTAL TORQUE (IN-OZ)	27.398	26.100	24.604	23.067	21.557	19.906	18.213	16.577
TOTAL TORQUE (FT-LB)	0.143	0.136	0.128	0.120	0.112	0.104	0.095	0.086
SY	0.491	0.513	0.534	0.553	0.562	0.572	0.577	0.571
PHI	0.068	0.062	0.056	0.050	0.044	0.037	0.031	0.025
BEARING HP	0.101	0.101	0.101	0.101	0.101	0.101	0.101	0.101
PUMP HP	1.449	1.375	1.289	1.202	1.119	1.024	0.930	0.837
TOTAL HP	1.550	1.476	1.390	1.303	1.220	1.125	1.031	0.938
PUMP EFFICIENCY	71.059	71.052	70.856	69.863	66.971	63.757	58.904	51.990
SPECIFIC SPEED	941.73	869.15	800.50	735.77	679.45	620.46	561.65	507.41
SUCTION SPECIFIC SPEED	6500.6	6194.8	5870.8	5535.0	5185.7	4793.5	4373.9	3920.0
BEARING WATTS	75.34	75.30	75.22	75.22	75.34	75.22	75.34	75.34
PUMP WATTS	1081.2	1025.9	961.8	897.0	834.6	763.8	693.5	624.4
TOTAL WATTS	1156.5	1101.2	1037.0	972.2	910.0	839.0	768.8	699.8