MASTER

EN-77-C-02-4299

KILOWATT ISOTOPE

POWER SYSTEM

COMPONENT TEST PROCEDURE FOR THE

GROUND DEMONSTRATION

SYSTEM RADIATOR BYPASS VALVE

Sundstrand Energy Systems

ROCKFORD, ILLINOIS
unit of Sundstrand Corporation

77-KIPS-58

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Sundstrand Corporation Advanced Technology Group

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

4747 HARRISON AVENUE • ROCKFORD ILLINOIS 61101
(815) 226 6000 • TWX 910-631 4255 • TELEX 257-440

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof nor any of their employees makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Test Procedure Number: 403 A

DEVELOPMENT TEST PROCEDURE

RADIATOR BYPASS VALVE

KILOWATT ISOTOPE POWER SYSTEM

MODEL NUMBER ORC1A3A01

GROUND DEMONSTRATION SYSTEM

Date: 14 July 1977

CONTINUATION OF TPC NO. 403 IS UNLIMITED

Approved:

Edwin L. Brinson
Coordinator 7-18-77 Date

Harry W. Johard
Project Eng.

M. Keltner 8-16-77
Quality Assurance

Ed H. Kinneman
Rel. Eng.

Ed Sorenson
KIPS Project Eng.

CHANGE RECORD

REVISION	TPC NO.	DATE	AFFECTED PAGES
A	465	9/27/77	7,8,14,16,19

NOTICE

"This document was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Energy Research & Development Administration, nor any of their employees, nor any of their contractors, subcontractors, or their employees, make any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately-owned rights".

KIPS TEST PROCEDURE

Distribution

R. C. Brouns (3 copies)

N. R. Thielke

F. M. Dieringer

T. Dobry

A. Schock

M. A. Langsam

TABLE OF CONTENTS

<u>PARAGRAPH</u>		<u>PAGE</u>
1.0	GENERAL	2
2.0	APPLICABLE DOCUMENTS	3
3.0	FACILITIES	4
4.0	EXAMINATION OF PRODUCT	6
5.0	PERFORMANCE TEST	7
6.0	CLEANING AND STORAGE	10
FIGURE 1	TEST SCHEMATIC	11
TABLE I	INSTRUMENTATION	12
TABLE II	TEST EQUIPMENT	13
	TEST DATA SHEETS	14
FIGURE 2	RADIATOR BYPASS VALVE ACCEPTANCE CRITERIA	19

TEST TITLE
KIPS-GROUND
DEMONSTRATION SYSTEM
RADIATOR B/P VALVE

TP 403

PAGE 2

1.0 GENERAL

1.1 Scope

This test procedure provides a detailed description of the verification methods which shall be used in the developmental program to be conducted on the Kilowatt Isotope Power System (KIPS) Radiator Bypass Valve, P/N 720990, to fulfill the requirements of the Ground Demonstration System Design Criteria.

1.2 Test Objective

To demonstrate the bypass flow characteristics of the valve as a function of the Jet Condensor Inlet Temperature.

1.3 Description of Test

To accomplish Paragraph 1.2, the pump discharge temperature (TPO) will be varied by adjusting the temperature control (T/C) on the rig heaters. Heat will be rejected by adjusting the cooling rate through the heat exchanger.

As the Jet Condenser inlet temperature changes, the bypass flow rate and the radiator flow rate will change.

These parameters shall be recorded for evaluation.

2.0 APPLICABLE DOCUMENTS

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

AER 1342 (Sundstrand)	Kilowatt Isotope Power System Ground Demonstration System (GDS) Test Plan
CP14.57-01 (Sundstrand)	General Precision Cleaning (KIPS)
720990 (Sundstrand)	Drawing Number of the Radiator Bypass Valve
Document 8.01 (Sundstrand)	Quality assurance-Instrumentation Calibration Procedure
M-005 (Sundstrand)	Quality Assurance-Instrument Calibration Frequency Schedule
QA5-107335	Sundstrand Corporation Quality Assurance Program Plan, Applicable to KIPS

TEST TITLE

KIPS-GROUND
DEMONSTRATION SYSTEM
RADIATOR B/P VALVE

TP 403

PAGE 4

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 12.

The test engineer may, at the time of test, substitute an equivalent instrument with similar characteristics and with equal, or better, accuracy. Substitutions shall be documented in the Test Engineering Log.

3.2 Test Equipment

Test equipment shall be in accordance with Table II, page 13.

Equivalent equipment with similar characteristics may be utilized. Substitutions shall be documented in the Test Engineering Log.

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.

Parameter	Units	Figure 1, Acronym
1. Pressure, Radiator Out	PSIG	PRO
2. Temperature, Radiator Out	°F	TRO
3. Pressure, Pump Out	PSIG	PPO
4. Temperature, Pump Out	°F	TPO
5. Pressure, Jet Condenser In	PSIG	PJCI
6. Temperature, Jet Condenser In	°F	TJCI
7. Radiator Flow	GPM	QR
8. Bypass Flow	GPM	QB

3.4 Test Conditions

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

Test fluid shall be Dowtherm A.

Dowtherm A, as specified in this test procedure, shall be interpreted as commercial grade DIPHENYL ETHER-DIPHENYL EUTECTIC (73.5%, 26.5%).

TEST TITLE

KIPS-GROUND
DEMONSTRATION SYSTEM
RADIATOR B/P VALVE

TP 403

PAGE 6

4.0 EXAMINATION OF PRODUCT

Examination of Product shall consist of a revision inspection and visual examination for damage of the Radiator Bypass Valve prior to any testing and a final visual inspection after completion of all testing.

5.0 PERFORMANCE TEST

5.1 Complete the test setup as shown in Figure 1, page 11.
Add sufficient Dowtherm A to the reservoir to raise the fluid level to the full mark on the sight glass. Mount the Radiator Bypass Valve on the support fixture before installation into the test setup.

5.2 Connect instrumentation. Open the hot flow valve (HFV), the cold flow valve (CFV), mix flow valve (MFV) and the pump outlet valve (POV).

Direct fluid flow through the high (0-5 GPM) flowmeter. Start system pump and check all connections for leaks.

5.3 To simulate the Ground Demonstration System, calibrate the Radiator Bypass Valve by first closing the hot flow valve. Adjust the cold and mix flow valves until pump pressure out (PPO) reads 102 ± 1 PSIG, radiator pressure out (PRO) reads 75 ± 1 PSIG, and radiator flow (QR) reads 1.89 ± 0.02 GPM (radiator design flow).

Record parameters on the Test Data Sheet, page 13.

A

TEST TITLE

KIPS-GROUND
DEMONSTRATION SYSTEM
RADIATOR B/P VALVE

TP 403

PAGE 8

5.4 Open the hot flow valve. Set the temperature control dial to 160°F. Turn the heaters on.

Adjust the coolant flow through the heat exchanger until a Jet Condenser inlet temperature (TJCI) of 145 ± 1°F is maintained.

Add heat by adjusting the setting on the temperature control until a Jet Condenser inlet temperature of 151 ± 0.5°F is maintained.

Record parameters on the Test Data Sheet, page 14.

5.5 Continue in this manner (incrementing the setting on the temperature control), varying the jet condenser inlet temperature in 2°F increments, until a TJCI of 163 ± .5°F is reached. Record data for when the bypass flow decreases to 0 GPM on Test Data Sheet, page 18.

After each new jet condenser inlet temperature stabilizes, record the parameters on the appropriate Test Data Sheet.

NOTE: WHEN BYPASS FLOW DECREASES BELOW 0.2 GPM ON THE HIGH (0-5 GPM) FLOWMETER, SWITCH FLUID FLOW THROUGH THE LOW (0-1 GPM) FLOWMETER.

5.6 Test Criteria

From the data collected in Paragraph 5.5,
plot a curve of Bypass Flow versus Jet Condenser
inlet temperature on the graph, Figure 2, page 19.

If all points fall within the tolerance limits specified,
the Radiator Bypass Valve is acceptable.

TEST TITLE

KIPS-GROUND
DEMONSTRATION SYSTEM
RADIATOR B/P VALVE

TP 403

PAGE 10

6.0

CLEANING AND STORAGE

When testing has been completed, disassemble radiator bypass valve and clean parts per Sundstrand Drawing 720990. When final assembly has been completed, cap-off all open ports per Sundstrand Drawing 720990. Package radiator bypass valve per CP14.57-01 and store.

SUNDSTRAND
AVIATION

TEST TITLE
KIPS-GROUND
DEMONSTRATION SYSTEM
RADIATOR B/P VALVE

TP 403

PAGE 11

FIGURE 1 - RADIATOR BYPASS VALVE TEST LOOP

INSTRUMENTATION

Sundstrand Corporation
Advanced Technology Group
 • SUNDSTRAND AVIATION ELECTRIC POWER
 • SUNDSTRAND AVIATION MECHANICAL
 • SUNDSTRAND ENERGY SYSTEMS
 • SUNDSTRAND ENGINEERING
 • SUNDSTRAND MACHINE TOOL
 4247 HARRISON AVENUE • ROCKFORD, ILLINOIS 61101
 (815) 398-4200 • FAX 910 631-4203 • TELETYPE 287 440

TEST TITLE
 KIPS-GROUND
 DEMONSTRATION SYSTEM
 RADIATOR B/P VALVE

TP 403
PAGE 12

TYPE	PURPOSE	MANUFACTURER	MODEL, S/N, P/N	RANGE	ACCURACY
Thermocouples	Pump outlet temperature	Gorden	Type "K"	0-2500°F	.5 of 1% from 0°F-800°F
	Radiator outlet temperature				
	Jet Condenser Inlet temperature				
Digital Readout	Thermocouple pickup for Digital display of temperatures	Gorden	Model 5050		
Counter	Flowmeter pickup- displaying Flow Rates as Frequencies	Anadex	Model CF-600R		
Flowmeters	Radiator Flow	Flow Tech.	S/N 860345	0-5 GPM	+1% of full reading
	Bypass Flow	Flow Tech.	S/N 860346	0-5 GPM	+1% of full reading
	Bypass Flow	Fisher-Porter		0-1 GPM	+1% of full reading
Temperature Control	Regulate Heater Temperature	L.F.E.	Series 230	0°F to 999°F	
Gauge	Pump Outlet Pressure	Master Gauge Co.	S/N P-230	0-300 PSIG	+1% F.S.
	Radiator Outlet Pressure		S/N P-1123	0-300 PSIG	+1% F.S.
	Jet Condenser Inlet Pressure		S/N P-390	0-160 PSIG	+1% F.S.

TABLE I

TEST EQUIPMENT

Sundstrand Corporation
Advanced Technology Group

 • SUNDSTRAND AVIATION ELECTRIC POWER
 • SUNDSTRAND ENERGY SYSTEMS
 • SUNDSTRAND AVIATION MECHANICAL
 • SUNDSTRAND AVIATION TOOLING
 • SUNDSTRAND MACHINE TOOL
 4347 HANBURY AVENUE - HANCOCK, MD 21076-1000
 (301) 284-1100 FAX (301) 284-1101

TEST TITLE
 KIPS-GROUND
 DEMONSTRATION SYSTEM
 RADIATOR B/P VALVE

TP 403
 PAGE 13

ITEM	PURPOSE	MANUFACTURER	MODEL, S/N, P/N	RANGE, CAPACITY, RESPONSE, ACCURACY
Test Stand	Mount Hardware	Sundstrand		
Heaters	Heat Input	Wells Mfg. Co.	Type COAQ2 5442	5000 WATTS @ 440 VOLTS
Cooler	Heat Rejection			
Pump	Circulate Dowtherm	Burks	S/N 900689	1/3 HP, 3450 RPM @ 60 Hz
Hydraulic Filters	Filter contaminants from working fluid	Purolator Products Inc.	Type PR-412-13	500-3000 PSI

TABLE II

TEST TITLE
 KIPS-GROUND
 DEMONSTRATION SYSTEM
 RADIATOR B/P VALVE

TP 403

PAGE 14

PARAGRAPH 4.0 EXAMINATION OF PRODUCT - P/N 720990, REV. _____

TEST DATA SHEET

ACCEPT _____

REJECT _____

RADIATOR BY-PASS VALVE S/N _____

Paragraph 5.3	Acronym	Req'd	Actual
Pressure, Pump Out	PPO	102 ⁺¹ PSIG	_____ PSIG
Pressure, Radiator Out	PRO	75 ⁺¹ PSIG	_____ PSIG
Radiator Flow	QR	1.89 ^{+0.02} GPM	_____ GPM

A

Paragraph 5.4

Pressure, Radiator Out	PRO		_____ PSIG
Temperature, Radiator Out	TRO		_____ °F
Pressure, Pump Out	PPO		_____ PSIG
Temperature, Pump Out	TPO		_____ °F
Pressure, Jet Condenser In	PJCI		_____ PSIG
Temperature, Jet Condenser In	TJCI	151 ^{+0.5} °F	_____ °F
Bypass Flow	QB		_____ GPM
			_____ Hz
Radiator Flow	QR		_____ GPM
			_____ Hz

TEST TITLE
 KIPS-GROUND
 DEMONSTRATION SYSTEM
 RADIATOR B/P VALVE

TP 403

PAGE 15

TEST DATA SHEET

Paragraph 5.5	Acronym (Figure 1)	Req'd	Actual
Pressure, Radiator Out	PRO		_____ PSIG
Temperature, Radiator Out	TRO		_____ °F
Pressure, Pump Out	PPO		_____ PSIG
Temperature, Pump Out	TPO		_____ °F
Pressure, Jet Condenser In	PJCI		_____ PSIG
Temperature, Jet Condenser In	TJCI	153 [±] 0.5 °F	_____ °F
Bypass Flow	QB		_____ GPM
			_____ Hz
Radiator Flow	QR		_____ GPM
			_____ Hz
Pressure, Radiator Out	PPO		_____ PSIG
Temperature, Radiator Out	TRO		_____ °F
Pressure, Pump Out	PPO		_____ PSIG
Temperature, Pump Out	TPO		_____ °F
Pressure, Jet Condenser In	PJCI		_____ PSIG
Temperature, Jet Condenser In	TJCI	155 [±] 0.5 °F	_____ °F
Bypass Flow	QB		_____ GPM
			_____ Hz
Radiator Flow	QR		_____ GPM
			_____ Hz

TEST TITLE
 KIPS-GROUND
 DEMONSTRATION SYSTEM
 RADIATOR B/P VALVE

TP 403

PAGE 16

TEST DATA SHEET

Paragraph 5.5	Acronym (Figure 1)	Req'd	Actual
Pressure, Radiator Out	PRO		_____ PSIG
Temperature, Radiator Out	TRO		_____ °F
Pressure, Pump Out	PPO		_____ PSIG
Temperature, Pump Out	TPO		_____ °F
Pressure, Jet Condenser In	PJCI		_____ PSIG
Temperature, Jet Condenser In	TJCI	157 ± 0.5 °F	_____ °F
Bypass Flow	QB		_____ GPM
			_____ Hz
Radiator Flow	QR		_____ GPM
			_____ Hz
Pressure, Radiator Out	PPO		_____ PSIG
Temperature, Radiator Out	TRO		_____ °F
Pressure, Pump Out	PPO		_____ PSIG
Temperature, Pump Out	TPO		_____ °F
Pressure, Jet Condenser In	PJCI		_____ PSIG
Temperature, Jet Condenser In	TJCI	159 ± 0.5 °F	_____ °F
Bypass Flow	QB		_____ GPM
			_____ Hz
Radiator Flow	QR		_____ GPM
			_____ Hz

A

A

Paragraph 5.5	Acronym (Figure 1)	Req'd	Actual
Pressure, Radiator Out	PRO		_____ PSIG
Temperature, Radiator Out	TRO		_____ °F
Pressure, Pump Out	PPO		_____ PSIG
Temperature, Pump Out	TPO		_____ °F
Pressure, Jet Condenser In	PJCI		_____ PSIG
Temperature, Jet Condenser In	TJCI	161 [±] 0.5 °F	_____ °F
Bypass Flow	QB		_____ GPM
			_____ Hz
Radiator Flow	QR		_____ GPM
			_____ Hz
Pressure, Radiator Out	PPO		_____ PSIG
Temperature, Radiator Out	TRO		_____ °F
Pressure, Pump Out	PPO		_____ PSIG
Temperature, Pump Out	TPO		_____ °F
Pressure, Jet Condenser In	PJCI		_____ PSIG
Temperature, Jet Condenser In	TJCI	163 [±] 0.5 °F	_____ °F
Bypass Flow	QB		_____ GPM
			_____ Hz
Radiator Flow	QR		_____ GPM
			_____ Hz

TEST TITLE

KIPS-GROUND
 DEMONSTRATION SYSTEM
 RADIATOR B/P VALVE

TP 403

PAGE 18

TEST DATA SHEET

Paragraph 5.5	Acronym (Figure 1)	Req'd	Actual
Pressure, Radiator Out	PRO		_____ PSIG
Temperature, Radiator Out	TRO		_____ °F
Pressure, Pump Out	PPO		_____ PSIG
Temperature, Pump Out	TPO		_____ °F
Pressure, Jet Condenser In	PJCI		_____ PSIG
Temperature, Jet Condenser In	TJCI		_____ °F
Bypass Flow	QB	0 GPM	_____ GPM
		0 Hz	_____ Hz
Radiator Flow	QR		_____ GPM
			_____ Hz

Paragraph 5.6

Data/Graph Review Accept _____ Reject _____

Tested by: _____ Date: _____

Test Surveillance: _____ Date: _____

Paragraph 4.0

Final Visual Inspection Accept _____ Reject _____

SUNDSTRAND
AVIATION

TEST TITLE
KIPS-GROUND
DEMONSTRATION SYSTEM
RADIATOR B/P VALVE

TP 403
PAGE 19

FIGURE 2