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A Division of North American Aviation, Inc.

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NAA-SR-MEMO 10181

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ATOMICS INTERNATIONAL A Division of North American Aviation, Inc.		NAA-SR- TDR NO 10181	APPROVALS <i>W. N. Gallagher</i>
TECHNICAL DATA RECORD		PAGE 1 OF 25	
AUTHOR C. M. Quirk <i>c.m.2</i> T. M. Funakura <i>tmf.</i>		DEPT & GROUP NO 722-22 722-22	DATE 7-8-64 GO NO 7561 S A NO 2360 TWR 53273
TITLE SNAP 10A PbSnTe T/E Pump S/N-030 Acceptance Test		SECURITY CLASSIFICATION (CHECK ONE BOX ONLY)	
PROGRAM SNAP 10A	SUBACCOUNT TITLE T/E Pump and Emissivity Coatings	(CHECK ONE BOX ONLY) UNCL. ☒ AEC ☐ DOD CONF. ☐ SECRET ☐	(CHECK ONE BOX ONLY) RESTRICTED DATA ☐ DEFENSE INFO. ☐
DISTRIBUTION HQ-1 G. Alm HQ-2 J. V. Addison J. B. Brunings H. M. Dieckamp I. B. Sexton D. S. Thompson R. J. Smith HQ-5 J. B. Tathwell SS-036 K. A. Davis R. D. Keen M. A. Ferlow SS-038 S. R. Rocklin		AUTHORIZED CLASSIFIER SIGNATURE <i>W. N. Gallagher</i>	
STATEMENT OF PROBLEM Present the results of the Acceptance Test of the SNAP 10A PbSnTe T/E Pump S/N-030, in a NaK 78 Acceptance Test Loop, in accordance with Test Specification NAO204-005, Revision "A".		DATE 7-8-64	
ABSTRACT The SNAP 10A PbSnTe T/E Pump S/N-030 was Acceptance Tested in accordance with Test Specification NAO204-005, Revision "A", and data as obtained, is submitted with a short summary of the results. The maximum output obtained during the Orbital Full Flow Test was measured as 15.10 gpm of 1010°F NaK at a pressure of 1.062 psi. The maximum output obtained during the Pre-Reactor Startup Test was measured as .30 gpm of 90° NaK at a pressure of .0059 psi, with a startup current of 40 amperes D.C. Based on the results of the above tests, T/E Pump S/N-030 meets the requirements of the Test Specification with regards to the "Orbital Full Flow Test" but does not meet the "Pre-Reactor Startup Test" requirements.			

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Acceptance Test Report of T/E Pump S/N-030

Summary of Data and Performance

The SNAP 10A PbSnTe T/E Pump S/N-030 was Acceptance tested in accordance with Test Specification NA 0204-005, Revision "A", and data, as obtained is submitted with a short summary of the results.

Full Flow Test - With the test loop valve in the "open" position, the maximum output obtained at 1010°F NaK temperature was measured to be 15.10 gpm at a pressure of 1.062 psi.

Pressure vs. Flow measurements were obtained at 800°F, 900°F and 1010°F NaK Temperatures.

Pre-Reactor Startup Test - The maximum output obtained during this phase of the test was measured as .30 gpm at a pressure of .0059 psi with a startup current of 40 amperes D.C. and a NaK temperature of 90°F.

Pressure vs. Flow measurements were obtained at 90°F and 100°F NaK temperatures.

The pump was instrumented to measure T/E element voltages and hot and cold junction temperatures. The pump magnet was magnetized to a maximum obtainable field strength of 2540 gauss as measured at the center axis of the pump throat prior to delivery to the Environmental Test Unit. Upon its return from the Environmental Test Unit, the pump magnet field strength was measured to be 2490 gauss. The raw data, as obtained from the above tests, is contained in AI Log Notebook B 240001.

Based on the results of the above tests, the T/E Pump S/N-030 meets the requirements with regards to the Full Flow Test but does not meet the Pre-Reactor Startup requirements.

Included in this report are the data and results of the Environmental Acceptance Test performed by the Environmental Test Unit, Dept 722-22.

NOTE: Pump pressures are presented above using measured values plus a tare pressure which was calibrated and reported in the following reference:

IL to: R. M. Galentine from J. V. Addison

Dated: November 28, 1962

Subject: Pressure Drop Measurements in Pump Test Loop

Schedule of Events

June 15, 1964	Received pump from Emissivity Coating Unit
June 15, 1964	Visual inspection of the pump
June 15, 1964	Pressure test and Helium leak check of the pump.
June 15, 1964	Pump magnet magnetization
June 15, 1964	Pump delivered to Environmental Test Unit for Environmental Acceptance Test
June 19, 1964	Received pump from Environmental Test Unit
June 19, 1964	Visual inspection of the pump
June 19, 1964	Pump magnet field strength measurement
June 19, 1964	Pump installation into Acceptance Test Loop A-3
June 22, 1964	Helium leak check of pump test loop.
June 22, 1964	Installation and calibration of pump instrumentation
June 22-23, 1964	Vacuum Vessel and Test Loop Evacuation
June 23, 1964	Test system NaK loading
June 23, 1964	System heatup to 850°F
June 23, 1964	System cool down to 100° F
June 23-24, 1964	System heatup to 1010°F
June 24, 1964	Pressure vs. Flow at 1010°F
June 24, 1964	Pressure vs. Flow at 900°F
June 24, 1964	Pressure vs. Flow at 800°F
June 24-25, 1964	20 hours test at 1010°F
June 25, 1964	Pre-Reactor startup test at 90°F
June 26, 1964	Pre-Reactor startup test at 100°F
June 26, 1964	Test system shut down

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Component: SNAP 10A PbSnTe T/E Pump S/N-030
Drawing Number: 10FS-81001
Data Source: AI Log Notebook B-240001
Test Performed by: Liquid Metals Test Unit
Delivered to: Stored in Building 023, SS,
for FSM-4 spare.

Test Results:

Pages 5 to 7 - Environmental Test data and results
Figure 1 - Flow and Pressure vs. NaK temperature
Figure 2 - Flowmeter Output and Wall Voltage vs.
NaK temperature.
Figure 3 - Flowmeter Output and Wall Voltage vs.
NaK Flow
Figure 4 - Pressure vs. Flow at NaK temperatures
Indicated
Figure 5 - Pressure vs. Flow (Pre-Reactor Startup)
Figure 6 - Pump instrument call out
Page 14 - Instrument Calibration
Figure 7 - Pressure drop in pump loop without pump
Figure 8-13 - Test Flowmeter Calibration at 200°F,
400°F, 600°F, 800°F, 900°F and 1000°F
NaK Temperatures.
Pages 22 to 25- Raw Data

TO: K. A. Davis

DEPT. 722-22

DATE 6-23-64

ENVIRONMENTAL EVALUATION COMPONENT TEST REPORT #418

Component Identification SNAP 10A Thermoelectric NaK Pump #30

Responsible Engineer and/or Unit supplying component K. Davis date rec'd 6-15-64

Applicable environmental specifications NA024-005 "NaK Pump. Thermoelectric SNAP 10A
Acceptance Test." 11-26-63,

Tests requested Vibration Acceptance

TEST PLAN OF ACTION

Test assigned to A. L. Jones, ext 6463 date 6-15-64 scheduled test start 6-17-64

Test equipment to be utilized 246 Shaker System.

Instrumentation required Table input; control accelerometer on pump top, X-Y plotter

Measurements required Convertor element resistance and magnetic field measurement
after each pass. X-Y plot of table input and top response.

Specimen support fixture Pump was installed in the acceptance test fixture ETLA-1.
Struts were torqued per E.O. #45599, 4-21-64.

Test inputs: VIBRATION (constant octave sweep rate requiring 30 minutes)

Lateral and normal axes 5 to 14 cps@ 1/2 "DA
14 to 50 cps@ 5 g
5 to 100 cps@ 2.5 g
100 to 250 cps@ 1.0 g
to cps@ g

Longitudinal 5 to 11 cps@ 1/2 "DA
11 to 30 cps@ 3 g
30 to 80 cps@ 4 g
80 to 2000 cps@ 2.5 g
to cps@ g

Vibration (other) The response on the pump top was limited to 5 g in the lateral
and normal axes and to 4 g in the longitudinal tests per specification.

SHOCK

Lateral and g, 1/2 sine millisecc pulse;

Normal axes shocks in each direction of each axis

LONGITUDINAL

g, 1/2 sine,
millisecc pulse;
shocks in each
direction

ACCELERATION

Lateral and g, for a total
Normal axes of minutes

LONGITUDINAL

g, aft direction, for a total
of minutes.
g, forward direction, for a total
of minutes.

DATE 7-8-64PAGE 6 of 25TEST RESULTSTest conducted by A. L. Jones ext 6463 date 6-19-64 IN page NoB-196685B-196686B-196687

Results A detailed visual inspection showed no apparent physical damage as a result of the test. Thermoelectric resistance readings of the telluride elements were recorded. To counteract the effect of emf generated in the telluride material, readings were taken in each direction through each element as noted in the table of results. It is extremely difficult to make accurate resistance measurements in the low micro-ohm range because the thermal emf from the telluride and the thermal emf present in the junctions between the test leads and the copper bars and/or radiators are of the same order magnitude as the IR drop of the telluride material. Since the trend of readings for each element from test to test did not vary significantly, it is assumed that within the resolution of the measuring device employed no appreciable damage to the telluride material and/or interfaces occurred.

Specimen disposal Pump returned to the Pumps and Emissivity Unit, 722-22

Report prepared by A. L. Jones date 6-19-64 approved _____ date _____

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RESULTS

Read Out Location	Resistance Readings in Micro-ohms			
	Before Test	X Axis	Y Axis	Z Axis
1 to 2	26 (16)	24 (19)	24 (12)	24 (16)
1 to 3	25 (17)	25 (20)	24 (17)	25 (19)
1 to 5	21 (18)	20 (20)	18 (20)	19 (18)
4 to 5	21 (8)	19 (7)	20 (8)	18 (10)
5 to 6	20 (7)	16 (6)	18 (7)	19 (8)
Gauss	2550	2550	2550	2550

*Magnetic flux at internal center of lump throat () leads Reversed

Figure 1

T/E PUMP S/N-030
PRESSURE and FLOW
vs.
NAK TEMPERATURE

Figure 2

T/E PUMP 5/N-030
FLOWMETER OUTPUT and WALL VOLTAGE
VS.
NAK FLOW

Figure 4

Figure 5

T/E PUMP S/N-030
PRESSURE VS. FLOW
(PRE REACTOR STARTUP)

SNAP 10A T/E Pump S/N 030Front View + Copper.Calibrated T/C's

1 - 5361

2 - 5366

3 - 5359

4 - 5370

○ Thermocouples

10 in Neg copper opposite # 9

□ Voltage Probes

5 on Neg Copper opposite # 1

4 on Neg Radiator opposite # 2

6 on Neg Radiator opposite # 3

7 on Neg side opposite # 8

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Instrument Calibration

<u>Instrument</u>	<u>Calibration Date</u>
Robertshaw Gage-----	June 6, 1964
Leak Detector-----	Prior to each test
Temperature Recorder-----	June 17, 1964
Flow Recorder-----	June 17, 1964
Temperature Controller-----	May 12, 1964
Rubicon Potentiometer-----	June 18, 1964 (#169179)
Immersion Thermocouples-----	January 8, 1964 (#5361)
	January 8, 1964 (#5366)
	January 8, 1964 (#5359)
	January 8, 1964 (#5370)
Level Probe Meter-----	June 19, 1964
Level Probe-----	June 19, 1964
D.C. Power Supply-----	May 2, 1964

Note: All calibrations were made by the Instrumentation Unit, Department 744-42, Santa Susana, with the exception of the FM Flowmeter, the Immersion Thermocouples and the RFL Gaussmeter.

A. The test loop Flowmeter was calibrated over a flow range of 1-12 gpm against a calibrated Venturi Meter at Santa Susana by the Liquid Metals Test Unit, Department 722-22, Lab Notebook B222251.

B. Immersion Thermocouples were fabricated by the Liquid Metals Test Unit, and calibrated by the AI Standards Lab at HQ, DeSoto.

C. The pump magnet was magnetized with the RFL Electronic Magnetizer, Model LG 5. The magnet field strength was measured at the center axis of the pump throat with the RFL Gaussmeter, Model 1890. The Gaussmeter was calibrated prior to each magnet field strength measurement and accuracy of measurements were in the order of $\pm 0.75^\circ$ as specified in the Manufacturer's manual.

Figure 7

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PRESSURE DROP BETWEEN PRESSURE TAPS
IN ACCEPTANCE TEST LOOP WITHOUT PUMP

1000°F CURVE BY HENDERSON AND ADDISON
106 T.O.R. GALANTINE FROM J. ADDISON, 11-28-62
"PRESSURE DROP MEASUREMENT IN PUMP LOOP"

Figure 8

SNAP-10 ACCEPTANCE LOAD-A-3.

FLOWMETER SIN FM-23.

NAK TEMPERATURE - 200°F.

FIELD STRENGTH - 1625 gauss at 75°F.

DATA SOURCE L.N.B-222265.

ESTIMATED ACCURACY 14% FOR $Q' > 1.0 \text{ gpm}$.

MILLIVOLTS.

NAK FLOW RATE - gpm

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Figure 9

SNAP-10 ACCEPTANCE LOOP A-3
FLOWMETER SIN FM-23
NAK TEMPERATURE - 400°F.
E FIELD STRENGTH - 1625 gauss at 25°F.
DATA SOURCE L.N.B-222265.
ESTIMATED ACCURACY ±4% FOR $Q^2 = 1.0$ gpm.

MILLIVOLTS.

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Figure 10

SNAP-10 ACCEPTANCE LOOP A-3

FLOWMETER S/N FM-23

NAK TEMPERATURE - 600°F

E FIELD STRENGTH - 1625 gauss at 25 g.

DATA SOURCE L/N B-222264

ESTIMATED ACCURACY $\pm 4\%$ FOR $Q \geq 1.0$ gpm

MILLIVOLTS

NAK FLOW RATE - gpm

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OKEN

Figure 11

SNAP-10 ACCEPTANCE LOOP A-3.
FLOWMETER SIN FM-23.
NAK TEMPERATURE - 800° F.
FIELD STRENGTH - 1625 gauss at 75° F.
DATA SOURCE L.N. B-222264.
ESTIMATED ACCURACY ± 4% FOR "Q" > 1.0 gpm.

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Figure 12

SHEATH ACCEPTANCE TEST LAP A-B
FLOWMETER S/N - FM-23
WATER TEMPERATURE - 70.0°F
FIELD STRENGTH - 1525 gpm at 75°F
DATA SOURCE - INTERPOLATED FROM 800°F & 1000°F DATA
ESTIMATED ACCURACY ± 6% FOR "Q" > 1.0 gpm

WATER FLOW RATE

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WATER FLOW RATE gpm

Figure 13

Pump No. S/N 030

Test Acceptance

Date	Running Time Hrs	ΔP			FLOWMETERS			T_{NaK}		FIN TEMPERATURE				T_{sink}
		"NaK	$T_{NaK}^{\circ}F$	ΔP psi	Loop MV/GPM	FT-1T MV	FT-2T MV	$T_{in}^{\circ}F$	$T_{out}^{\circ}F$	TC24 $^{\circ}F$	TC25 $^{\circ}F$	RT17 $^{\circ}F$	RT18 $^{\circ}F$	
6/23		.375	110	.0118	.01 .05	.040	.032	98	98	95	96	96	95	82
		.375	110	.0118	.27 .32	.480	.527	140	136	118	117	119	115	80
		.50	126	.0154	.252 .63	.809	1.085	180	178	144	141	144	140	81
		.813	162	.0251	.428 1.05	1.363	1.885	220	216	165	162	166	160	83
		1.188	199	.0368	.598 1.47	1.941	2.679	260	257	190	185	191	185	86
		1.875	215	.0573	.829 2.05	2.665	3.755	300	298	214	207	214	206	87
		3.563	250	.1084	1.463 3.60	4.775	7.20	400	399	274	266	275	264	88
		6.50	270	.197	2.21 5.68	7.34	11.10	499	498	311	302	311	300	88
		10.25	280	.3155	3.0 7.68	10.01	15.80	600	599	359	350	360	346	93
		14.875	300	.4495	3.78 9.65	12.78	20.73	704	700	405	396	407	390	90
		19.312	315	.582	4.41 11.62	15.02	25.48	799	795	445	437	449	431	99
		24.188	350	.725	5.02 13.50	17.28	30.45	900	897	484	476	488	470	88
		28.938	440	.854	5.56 14.94	19.41	35.50	1008	1005	530	526	535	517	88

Pump No. S/N 030

Test Acceptance

Date	Running Time Hrs	ΔP			FLOWMETERS			T_{NaK}		FIN TEMPERATURE				T_{sink}
		T_{NaK}	$T_{NaK}^{\circ}F$	ΔP psi	Loop MV/GPM	FT-1T MV	FT-2T MV	$T_{in}^{\circ}F$	$T_{out}^{\circ}F$	TC24 $^{\circ}F$	TC25 $^{\circ}F$	RT17 $^{\circ}F$	RT18 $^{\circ}F$	
		Pressure Vs Flow at 1010 $^{\circ}F$												
6/24		29.0	450	.86	5.58 / 15.0	19.46	35.55	1011	1003	532	529	536	519	87
		33.812	450	1.00	5.20 / 14.0	18.54	34.47	1014	1008	532	529	537	520	88
		38.938	450	1.15	4.83 / 13.0	17.55	33.29	1012	1008	532	529	537	520	87
		43.562	450	1.29	4.46 / 12.0	16.64	32.19	1012	1006	533	529	537	520	87
		48.188	450	1.42	4.09 / 11.0	15.66	30.96	1011	1005	532	529	536	520	86
		Pressure Vs Flow at 900 $^{\circ}F$												
		24.875	450	.734	5.06 / 13.63	17.38	30.75	905	900	495	491	500	485	93
		28.188	450	.832	4.82 / 13.0	16.77	30.09	907	902	496	492	500	485	93
		33.25	450	.980	4.45 / 12.0	15.84	29.00	907	903	496	493	501	485	93
		38.25	450	1.129	4.08 / 11.0	14.90	27.90	908	903	497	493	501	485	94
		43.875	450	1.295	3.72 / 10.0	13.95	26.80	909	902	498	493	502	485	92
		48.312	450	1.425	3.35 / 9.0	13.03	25.70	910	903	497	493	502	485	91

Pump No. S/N 030

Test Acceptance

Date	Running Time Hrs	ΔP			FLOWMETERS			T_{NaK}		FIN TEMPERATURE				T_{sink}
		T_{NaK}	$T_{NaK}^{\circ}F$	ΔP psi	Loop MV/GPM	FT-1T MV	FT-2T MV	$T_{in}^{\circ}F$	$T_{out}^{\circ}F$	TC24 $^{\circ}F$	TC25 $^{\circ}F$	RT17 $^{\circ}F$	RT18 $^{\circ}F$	
6/24		Pressure Vs Flow at 800°F												
					4.46									
		20.0	450	.59	11.75	15.11	25.77	802	800	456	451	460	445	91
					4.17									
		23.813	450	.702	11.0	14.39	24.89	802	798	456	450	459	445	92
					3.79									
		29.25	450	.863	10.0	13.35	23.74	802	798	456	451	460	445	93
					3.40									
		34.125	450	1.006	9.0	12.37	22.59	801	798	456	451	460	445	92
					3.02									
		38.875	450	1.148	8.0	11.40	21.48	800	795	456	451	460	445	91
					2.64									
		43.562	450	1.285	7.0	10.37	20.34	801	795	456	450	460	444	89
20 hour Test at 1010°F														
					5.59									
6/24	0	29.375	450	.866	15.0	19.65	35.75	1012	1008	535	530	539	521	92
					5.60									
	4 hrs	29.50	450	.870	15.03	19.57	35.64	1010	1005	535	530	540	522	98
					5.60									
6/25	8 hrs	29.50	450	.870	15.03	19.66	35.84	1009	1005	535	530	539	521	83
					5.61									
	12 hrs	29.56	450	.872	15.09	19.65	35.82	1010	1006	535	530	540	521	81
					5.57									
	16 hrs	29.25	450	.863	15.0	19.48	35.49	1006	1001	534	530	539	521	95
					5.62									
	20 hrs	29.688	450	.876	15.10	19.62	35.77	1010	1005	535	531	540	523	90

Pump No. S/N 030

Test Acceptance

Date	Running Time Hrs	ΔP			FLOWMETERS			T_{NaK}		FIN TEMPERATURE				T_{sink}
		H_{NaK}	$T_{NaK}^{\circ F}$	ΔP psi	Loop MV/GPM	FT-1T MV	FT-2T MV	$T_{in}^{\circ F}$	$T_{out}^{\circ F}$	TC24 $^{\circ F}$	TC25 $^{\circ F}$	RT17 $^{\circ F}$	RT18 $^{\circ F}$	
		Pre Reactor Startup Test at 90°F												
6/25		.188	98	.0059	$\frac{.120}{.30}$	.345	.345	90	92	93	93	91	93	88
		.625	98	.0195	$\frac{.100}{.25}$	.300	.308	90	92	93	92	91	92	88
		1.00	98	.0312	$\frac{.08}{.20}$	.251	.255	90	93	93	93	92	93	88
		1.875	98	.0585	$\frac{.04}{.10}$	.148	.162	90	93	93	93	92	93	88
		2.813	96	.0877	$\frac{0}{0}$	.040	.065	93	93	93	93	93	93	89
		Pre Reactor Startup Test at 100°F												
		.188	95	.0058	$\frac{.143}{.35}$	.405	.395	100	101	100	100	100	100	95
		.562	95	.0175	$\frac{.120}{.30}$	.360	.345	100	101	100	100	100	100	95
		1.375	95	.0429	$\frac{.08}{.20}$	.259	.245	100	101	100	100	100	100	95
		2.125	95	.0669	$\frac{.04}{.10}$	.155	.151	100	101	100	100	100	100	95
		2.813	95	.877	$\frac{0}{0}$	.049	.051	100	101	100	100	100	100	95