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PRELIMINARY DESIGN OF AN AUXILIARY POWER UNIT FOR THE SPACE SHUTTLE

Volume V - Selected System Cycle Performance Data

by M. L. Hamilton and W. L. Burriss

Prepared by
AIRESEARCH MANUFACTURING COMPANY
Los Angeles, Calif.
for Lewis Research Center



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16. Abstract This study has considered numerous candidate APU concepts, each meeting the Space Shuttle APU problem statement. Evaluation of these concepts indicates that the optimum concept is a hydrogen-oxygen APU incorporating a recuperator to utilize the exhaust energy and using the cycle hydrogen flow as a means of cooling the component heat loads. The initial portion of the study (Phase I) was concerned with evaluation of the candidate concepts; this information is presented in Volume II. The Phase II work accomplished preliminary design of the selected APU concept, placing primary emphasis on the cycle thermal management and the controls (to maintain desired turbine inlet temperature and rotational speed). The Phase II work is presented in Volumes III, IV, and V. Volumes III, IV, and V also present results for both steady-state and transient APU performance, based on digital computer programs developed during the study. The selected APU provides up to 400 hp out of the gearbox, has a fixed weight of about 277 lb, and requires about 2 lb/shp-hr of propellants.			
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FOREWORD

This report is the fifth volume of a series that comprises the following:

- Volume I - Summary
- Volume II - Component and System Configuration Screening
Analysis
- Volume III - Details of System Analysis, Engineering, and
Design for Selected System
- Volume IV - Selected System Supporting Studies
- Volume V - Selected System Cycle Performance Data

Volume II summarizes the Phase I portion of the program, in which the various component and system concepts were compared and evaluated. Volumes III, IV, and V contain the Phase II work, in which preliminary design of the selected APU system concept was performed.

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SECTION I

INTRODUCTION AND SUMMARY

INTRODUCTION

The Phase II work performed under Contract NAS3-14408, "Preliminary Design of an Auxiliary Power Unit (APU) for the Space Shuttle," was primarily concerned with detail system analysis, engineering, and design of an APU system concept selected during Phase I. The Phase II work is reported in three volumes:

Volume III Details of System Analysis, Engineering, and Design for Selected System

Volume IV Selected System Supporting Studies

Volume V Selected System Cycle Performance Data

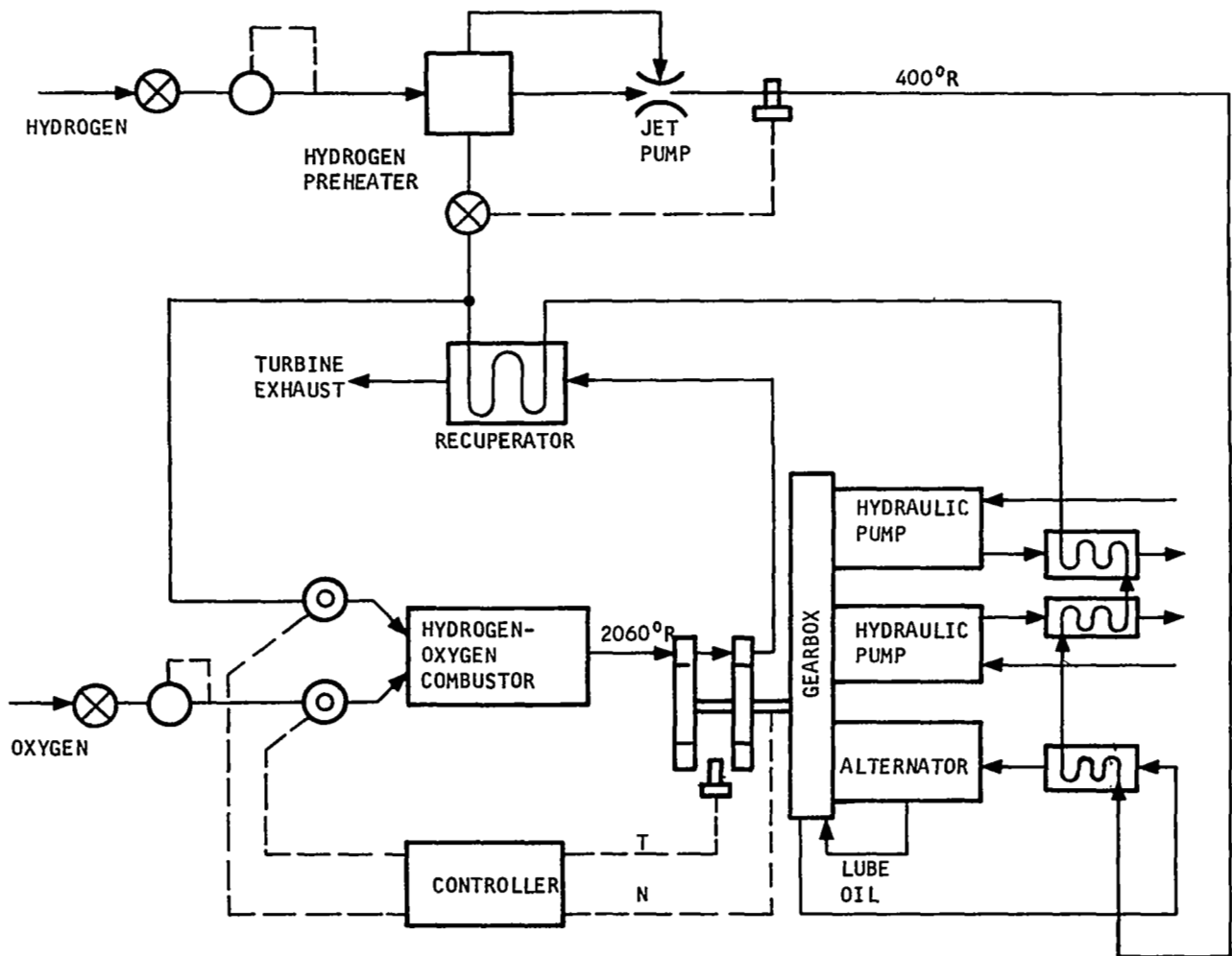
Volume V contains detailed cycle steady-state performance data for the final APU system configuration for the range of input/output parameters specified by NASA. These data provide the following:

1. Verification of the adequacy of the design to meet the NASA problem statement for steady-state performance (transient performance is given in Volume III).
2. Overall system performance data for the vehicle systems analyst to determine propellant consumption and hydraulic fluid temperature as a function for varying mission profiles, propellant inlet conditions, etc.
3. Detailed component performance and cycle state point data to show what is happening in the cycle as a function of the external forcing functions (output power, ambient pressure, propellant inlet temperature, and hydraulic fluid temperature).

These data are given in the form of the computer printout, which presents a large amount of data (for 144 cases) in a compact form with high precision. An approximate correlation is given in Volume III, showing overall system performance as a function of the relevant forcing functions with sufficient accuracy (± 2 percent) for many purposes.

SYSTEM SCHEMATIC

The performance data presented herein are applicable to the baseline system configuration described in detail in Volume III and shown schematically in Figure 1-1.



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Figure 1-1. APU Baseline System Schematic

DATA UTILIZATION

In addition to the previously mentioned functions of system performance verification and providing system and component performance, the data presented here has additional uses for systems analysis, alternative systems studies, and insurance of system compatibility during development.

Systems Analysis

The vehicle systems analyst will be required to establish system performance for varying vehicle mission profiles. The data presented here permit the systems analyst to determine propellant consumption and hydraulic fluid temperature for specific mission profiles, varying propellant inlet conditions, hydraulic system arrangements, etc.

Alternative System Studies

By appropriate cross-plotting of data given in this volume and supplemental hand calculations, estimates can be made of alternative system arrangements that will be sufficiently accurate for preliminary comparison purposes.

Insuring System Performance Compatibility During Development

In terms of the eventual hardware program, this use is probably the most important. The computer program itself can be used during the development program to establish system performance as actual component test data are obtained and thereby insure performance compatibility with the vehicle requirements. This approach has been successfully used at AiResearch with comparable computer programs for aircraft air cycle systems. For example, a turbine performance map based on test data would replace the analytically derived map and system performance would be checked over the entire operating range of the system, which in the case of aircraft systems might encompass several hundred points. In this way, any variation in component performance that would lead to deficiency in system performance could be detected at an early date and appropriate remedial action (in that or another component, as identified by program analysis) taken before the problem becomes critical during expensive complete system tests or still more expensive flight tests.

It should be noted that it is not always possible to identify trouble-causing performance deviations from component test data by itself. This is due to the complex nature of the interactions within the system and the difficulty in identifying critical design points in high-performance systems that operate over a wide range of conditions. In the Space Shuttle vehicles, the entire operating envelope can be considered to be critical, assuming high incentive for being able to accurately predict and minimize propellant weight. Therefore, it can be concluded that an APU system performance program of the type developed in the present program will be highly desirable to the Space Shuttle vehicles.

SELECTED PARAMETERS

As shown in Figure 1-1, the APU may be required to operate over a range of steady-state input and output variables that will influence system operation and performance. The parameters selected for detailed performance evaluation are inlet hydraulic fluid temperature, inlet hydrogen temperature, hydraulic output power, and ambient pressure.

Oxygen temperature variations will not greatly influence system performance and consequently were not included. Under the NASA component performance ground rules (constant component losses, regardless of output), hydraulic output power is interchangeable with electrical output power. Therefore, the hydraulic output power is used to indicate the net output power (hydraulic and electric) from the APU system.

DATA MATRIX

This volume presents calculated APU system performance for a matrix comprised of 144 representative operating conditions. Steady-state performance at the various operating conditions was obtained by using a computer program that outputs the component performance (efficiency, effectiveness, pressure drop, etc.) and the state points (flows, pressures, and temperatures) throughout the system for a given net output power, hydrogen inlet temperature, ambient pressure, and hydraulic fluid inlet temperature. Table 1-1 is a numerical tabulation of the individual cases of the data matrix as related to the respective boundary conditions of each. Table 1-1 also keys each subsequent section of this book to the specific cases (Section 2, 75°R inlet hydrogen cases; Section 3, 300°R inlet hydrogen cases; and Section 4, 500°R inlet hydrogen cases).

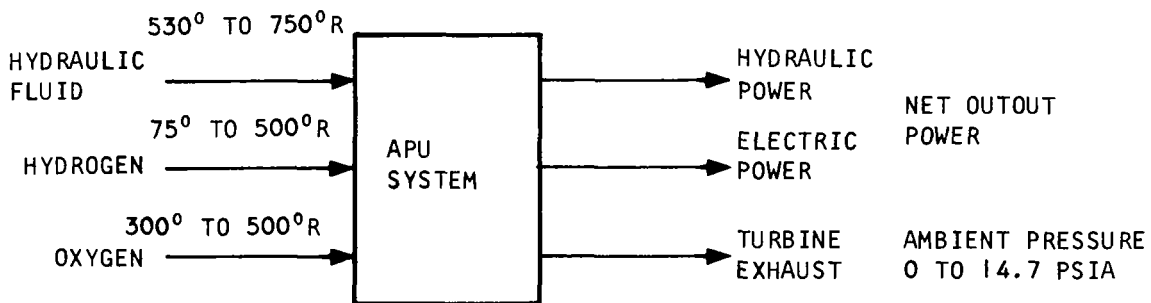


Figure 1-2. APU System Input/Output Parameters

TABLE I-1.

DATA MATRIX

Hydrogen Inlet Temperature, °R	Hydraulic Fluid Inlet Temperature to Heat Exchanger, °R	Ambient Pressure, psia	Data Case No.			
			Hydraulic Power Output, hp			
			0	100	200	360
75 (See Section 2)	550	0.0	1	2	3	4
		5.0	5	6	7	8
		10.0	9	10	11	12
		14.7	13	14	15	16
	650	0.0	17	18	19	20
		5.0	21	22	23	24
		10.0	25	26	27	28
		14.7	29	30	31	32
	750	0.0	33	34	34	36
5.0		37	38	39	40	
10.0		41	42	43	44	
14.7		45	46	47	48	
300 (See Section 3)	550	0.0	49	50	51	52
		5.0	53	54	55	56
		10.0	57	58	59	60
		14.7	61	62	63	64
	650	0.0	65	66	67	68
		5.0	69	70	71	72
		10.0	73	74	75	76
		14.7	77	78	79	80
	750	0.0	81	82	83	84
		5.0	85	86	87	88
		10.0	89	90	91	92
		14.7	93	94	95	96
500 (See Section 4)	550	0.0	97	98	99	100
		5.0	101	102	103	104
		10.0	105	106	107	108
		14.7	109	110	111	112
	650	0.0	113	114	115	116
		5.0	117	118	119	120
		10.0	121	122	123	124
		14.7	125	126	127	128
	750	0.0	129	130	131	132
		5.0	133	134	135	136
		10.0	137	138	139	140
		14.7	141	142	143	144

DESCRIPTION OF ANALYTICAL METHOD

The digital computer program used for system steady-state performance analysis was written in Fortran V for the Univac 1108 computer. It uses 13 subroutines, 50 component off-design performance maps, and real fluid thermodynamic properties (pressure, temperature, enthalpy, and density) for hydrogen, oxygen, and water vapor (each fluid map uses about 10,000 bytes of computer storage). The program uses an iterative analytical procedure using 5 nested iteration loops with approximate equations to establish first guesses. Initially, the first-guess system flows are obtained by calculating the approximate output power and using the flow relationship through the turbine nozzle and the relationship between turbine throughflow, pressure ratio, O/F ratio, and turbine output work to calculate approximate flows for the guessed O/F ratio. Then a series of nested convergence loops are applied to make the system meet the various boundary conditions imposed upon it.

FEATURES OF ANALYTICAL METHOD

The principal feature of this program is that it allows determination of exact system performance (within the accuracy of the performance maps) throughout the complete operating regime of the APU. Such variables as ducting losses, component pressure losses, and overboard expansion losses are all accounted for in the program. Additionally, by using actual fluid thermodynamic properties the program accounts for the large changes in cryogenic fluid specific heats. It should be noted that such analytical sophistication would be virtually impossible on an analog computer because of the large number of variables.

In addition, system analysis by hand calculations would be extremely difficult and tedious because of the iterations required with the recycle loop, jet pump, and variable O/F ratio. It is estimated that a minimum of 4 to 6 man-hours would be required with hand calculations to solve a point requiring 8 to 15 sec of computer time with the program. The program has been used during the study to evaluate various system concepts and optimize system and component design on a detailed level. Furthermore, it has been possible to perform several iterations on component design and alternative approaches during Phase II. Volume IV describes results of some of these studies, which involved modification of the program for different system concepts (such as fixed O/F systems, variable T_{it} systems, and purely passive controlless systems).

OUTPUT DATA FORMAT

The steady-state program output is contained on two computer printout sheets. The input data is summarized at the heading of the first sheet and includes pressure loss coefficients (representing the ducting between the components; heat exchanger scale factors (which permit "rubberizing" the system); specific system design parameters such as turbine nozzle area, turbine inlet temperature, and recycle loop control temperature; and point input data such as hydraulic power, electrical power, ambient pressure, hydraulic system pressure, inlet hydrogen temperature, and inlet hydraulic fluid temperature. The output data include the oxygen and hydrogen flows to the system, component performance data, and state points throughout the system.

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SSAPU PHASE II, TURB 16.75 R H2, T20=400, 8 JUNE 1971 15:54:04 PAGE 1 OF 2

• CONDITION • 0.0 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OSGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P. AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER			
HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.35 O/F = .649 SPC = 1.542

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	.862	.560
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	499.2	500.0
PRESSURE OUT	50.2	53.9
TEMPERATURE IN	932.5	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, 8 JUNE 1971 15:54:04 PAGE 2 OF 2

• CONDITION • 0.0 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW
.862	.560
PRESSURE IN	PRESSURE OUT
49.9	49.9
TEMPERATURE IN H2	TEMPERATURE IN O2
932.5	300.0

TURBINE INFORMATION

INLET FLOW	SPECIFIC HEAT RATIO
1.422	1.367
PRESSURE IN	PRESSURE OUT
49.8	.7
TEMPERATURE IN	TEMPERATURE OUT
2060.0	1318.3
ENTHALPY IN	ENTHALPY OUT
4811.4	3165.0
PRESSURE RATIO	EFFICIENCY
68.74	.531

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.433	499.3	499.2	548.2	932.5	1842.6	3185.4	.499
HOT SIDE 1.422	.7	.4	1318.3	690.3	3165.0	1811.8	.819

• TURBINE EXHAUST OVERBOARD PRESSURE = .28

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.571	.198

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE .862	500.0	500.0	75.0	399.0	54.3	1296.8	.378
HOT SIDE .571	499.1	499.1	932.5	401.8	3185.4	1307.4	.619

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	17.23	.86	499.99	399.04
RESULTANT	11.44	.57	499.08	401.83
FLOW PARA RATIO		1.43	499.36	400.15
JET PUMP RISE	1.0006	PRI FLOW PARA	.0345	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.433	499.4	499.3	400.2	522.6	1304.0	1751.9	.573
HOT SIDE 30.000	200.0	196.9	613.8	570.4	.0	.0	.203

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.8	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.433	499.3	499.3	522.6	548.2	1752.0	1842.6	.933
HOT SIDE 29.0	100.0	99.8	550.0	540.2	.0	.0	.360

HEAT REJECTED 129.91

DATA CASES 1 TO 48

% GARRETT - AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, 8 JUNE 1971 15:54:16 PAGE 1 OF 2

% CONDITION % 100 HP, 0.0 PAMB, 3000 PSI HYOSYS

% UNITS % AREA=SQ IN, H=BTU/LB, P=PSIA, Q=STU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				2.74

SFT	TUR DN F	SF JP P	SF JP W	TUR OB CA	JP PR CA	TURB NO Z
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LMH O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

% POINT INPUT DATA %

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 159.80 O/F = .659 SPC = 1.645

PROPELLANT

	HYDROGEN	OXYGEN
FLOW RATE	2.641	1.741
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	492.4	499.9
PRESSURE OUT	152.5	163.7
TEMPERATURE IN	913.4	300.0

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SSAPU PHASE II, TURB 16.75 R H2, T20=400, 8 JUNE 1971 15:54:16 PAGE 2 OF 2

% CONDITION % 100 HP, 0.0 PAMB, 3000 PSI HYOSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW
2.641	1.741
PRESSURE IN	PRESSURE OUT
151.5	151.5
TEMPERATURE IN H2	TEMPERATURE IN O2
913.4	300.0

TURBINE INFORMATION

INLET FLOW	SPECIFIC HEAT RATIO
4.382	1.366
PRESSURE IN	PRESSURE OUT
151.3	2.3
TEMPERATURE IN	TEMPERATURE OUT
2060.0	1362.1
ENTHALPY IN	ENTHALPY OUT
4790.3	3247.3
PRESSURE RATIO	EFFICIENCY
67.18	.501

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.460	493.1	492.8	540.6	913.6	1816.0	3119.7
HOT SIDE	4.382	2.2	1.3	1362.1	743.3	3247.3	1920.4

* TURBINE EXHAUST OVERBOARD PRESSURE * .88

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.819	1.166

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.641	500.0	500.0	75.0	399.4	54.3	1298.1
HOT SIDE	1.819	491.6	491.6	913.6	403.1	3119.7	1312.3

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	52.79	2.64	499.95
SECONDARY JET	36.52	1.82	491.53
RESULTANT		4.46	493.84
FLOW PARA RATIO	.692	P PRI/P SEC	1.0171
JET PUMP RISE	1.0047	PRI FLOW PARA	.1056
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.460	493.8	493.5	400.9	452.3	1303.9	1496.3
HOT SIDE	30.000	200.0	196.9	540.2	475.7	.0	.0

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL

509.1	323.7	25.5	858.3
-------	-------	------	-------

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.460	493.5	493.1	452.3	540.6	1496.3	1816.0
HOT SIDE	423.7	100.0	97.8	550.0	542.6	.0	.0

HEAT REJECTED 1426.03

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 SSAPU PHASE II, TURB 16.75 R H2, T20=400,
 8 JUNE 1971 15:54:30 PAGE 1 OF 2

* CONDITION * 200 HP, 0.0 PAMB, 3000 PSI HYDSYS
 * UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4
 .00 .00 1110.00 70000.00 .00 .00 10.00
 3.64 .00 1.18 1.44 .00 .66 3.50 20.80
 19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
 .12 .00

SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRICA TURB NOZ
 1.000 .000 1.000 1.000 12.560 .2000 .1210
 TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HHX IN T LHX O
 .0002 .98 .30 .5 2060.00 400.00 1500.00
 ETA CORF O/F BASE
 .0925 .600

HEAT EXCHANGER SCALE FACTORS
 H2 PREHEATER 2.00 .50 2.00 .50 1.00
 HYD O COOLER 1.00 1.00 1.00 1.00 1.00
 LUB O COOLER 1.00 1.00 1.00 1.00 1.00
 RECUPERATOR 1.00 1.00 1.00 1.00 1.00

* POINT INPUT DATA *
 HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
 200.00 .00 .00 3000.0 35.0

* OUTPUT DATA *

DRIVE POWER HP LOSS
 HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
 240.00 12.00 .60 12.63

TURBINE OUTPUT POWER = 265.06 O/F = .681 SPC = 1.658

PROPELLANT HYDROGEN OXYGEN
 FLOW RATE 4.359 2.966
 PRESSURE 500.00 500.00
 TEMPERATURE 75.00 300.00
 ENTHALPY 54.3 52.8

CONTROL VALVE YES YES
 IS IT IN CONTROL 478.9 499.8
 PRESSURE IN 259.0 273.6
 PRESSURE OUT 877.4 300.0
 TEMPERATURE IN

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16.75 R H2, T20=400,
 8 JUNE 1971 15:54:30 PAGE 2 OF 2

* CONDITION * 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION
 HYDROGEN FLOW 4.359 OXYGEN FLOW 2.966
 PRESSURE IN 253.4 PRESSURE OUT 253.4
 TEMPERATURE IN H2 877.4 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
 INLET FLOW 7.325 SPECIFIC HEAT RATIO 1.365 ✓
 PRESSURE IN 253.0 PRESSURE OUT 3.8
 TEMPERATURE IN 2060.0 TEMPERATURE OUT 1359.3
 ENTHALPY IN 4745.2 ENTHALPY OUT 3213.5
 PRESSURE RATIO 66.13 ✓ EFFICIENCY .505

RECUPERATOR INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 7.568 480.5 479.6 528.2 877.4 1771.7 2993.5 .420
 HOT SIDE 7.325 3.7 2.2 1359.3 763.2 3213.5 1951.2 .717
 * TURBINE EXHAUST OVERBOARD PRESSURE * 1.49

HOT BYPASS VALVE INFORMATION
 FLOW PRESSURE DROP
 3.210 2.752

H2 PREHEATER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 4.359 500.0 500.0 75.0 396.4 54.3 1286.6 .400
 HOT SIDE 3.210 476.8 476.7 877.4 405.2 2993.5 1320.0 .589

JET PUMP PERFORMANCE
 FLOW PARA FLOW PRESSURE TEMPERATURE
 PRIMARY JET 86.78 4.36 499.87 396.37
 SECONDARY JET 64.61 3.21 476.61 405.17
 RESULTANT 7.57 482.29 400.12
 FLOW PARA RATIO .744 P PRI/P SEC 1.0488
 JET PUMP RISE 1.0119 PRI FLOW PARA .1736 JPSF 2.30

LUBE OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 7.568 482.2 481.5 400.1 437.7 1300.8 1442.2 .270
 HOT SIDE 30.000 200.0 196.9 939.4 457.9 .0 .0 .589

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
 509.1 535.9 25.5 1070.4

HYDRAULIC OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 7.568 481.4 480.6 437.7 528.2 1442.0 1771.7 .806
 HOT SIDE 818.4 100.0 95.4 550.0 543.3 .0 .0 .060

HEAT REJECTED 2495.41

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, 6 JUNE 1971 15:54:45 PAGE 1 OF 2

* CONDITION * 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4	
.00	.00
3.64	.00
19.00	13.85
.12	.00

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 432.56 O/F = .703 SPC = 1.676

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.093	4.989
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	447.7	499.6
PRESSURE OUT	416.2	445.8
TEMPERATURE IN	836.0	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, 6 JUNE 1971 15:54:45 PAGE 2 OF 2

* CONDITION * 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW	PRESSURE IN	PRESSURE OUT	TEMPERATURE IN H2	TEMPERATURE IN O2
7.093	4.989	413.7	413.7	836.0	300.0

TURBINE INFORMATION

INLET FLOW	SPECIFIC HEAT RATIO	PRESSURE IN	PRESSURE OUT	TEMPERATURE IN	TEMPERATURE OUT	ENTHALPY IN	ENTHALPY OUT	PRESSURE RATIO	EFFICIENCY
12.081	1.364	413.1	413.7	2060.0	1358.2	4699.5	3182.7	60.23	.512

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 12.778	453.1	450.7	510.2	836.0	1706.6	2848.8	.384
HOT SIDE 12.081	6.7	3.6	1358.2	780.4	3182.6	1974.6	.681

* TURBINE EXHAUST OVERBOARD PRESSURE * 2.47

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
5.685	3.369

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.093	500.0	499.9	75.0	391.7	54.3	1268.8	.416
HOT SIDE 5.685	447.3	446.9	836.0	408.8	2848.8	1333.5	.561

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	140.38	7.09	499.68	391.70
RESULTANT	114.95	5.69	446.63	408.82
FLOW PARA RATIO		12.78	457.81	399.34
JET PUMP RISE	.819	P PRI/P SEC		1.1188
	1.0250	PRI FLOW PARA	.2809 JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 12.778	457.5	455.6	399.3	428.6	1297.6	1407.9	.187
HOT SIDE 30.000	200.0	196.9	955.6	448.8	.0	.0	.684

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 12.778	455.3	453.3	428.6	510.2	1408.0	1706.6	.672
HOT SIDE 1450.0	100.0	91.5	950.0	544.2	.0	.0	.048

HEAT REJECTED 3816.39

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400,
8 JUNE 1971 15:54:57 PAGE 1 OF 2

• CONDITION • 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TUR NOZ
1.000	.000	1.000	1.000	12.560	.2030	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHDDP COLD	RHDDP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	5.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
40.00	12.00
	.60
	2.63

TURBINE OUTPUT POWER = 55.58 O/F = .594 SPC = 1.943

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.129	.671
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	498.7	500.0
PRESSURE OUT	64.6	68.7
TEMPERATURE IN	1028.8	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400,
8 JUNE 1971 15:54:57 PAGE 2 OF 2

• CONDITION • 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.129	OXYGEN FLOW	.671
PRESSURE IN	64.2	PRESSURE OUT	64.2
TEMPERATURE IN H2	1028.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.800	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	64.1	PRESSURE OUT	5.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1492.2
ENTHALPY IN	4935.9	ENTHALPY OUT	3629.2
PRESSURE RATIO	12.63	EFFICIENCY	.559

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.763	498.8	498.8	544.1	1028.8	1828.3	3520.1
HOT SIDE	1.800	5.1	5.0	1492.2	749.9	3629.2	1971.9
• TURBINE EXHAUST OVERBOARD PRESSURE •							4.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.634	.259

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.129	500.0	500.0	75.0	398.8	54.3	1295.7
HOT SIDE	.634	498.5	498.5	1028.8	402.6	3520.1	1310.5

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
22.54	1.13	499.99	398.76		
SECONDARY JET	12.73	.63	498.49	402.63	
RESULTANT		1.76	498.99	400.15	
FLOW PARA RATIO		.565	P PRI/P SEC	1.0030	
JET PUMP RISE	1.0010	PRI FLOW PARA	.0451	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.763	499.0	498.9	400.2	499.2	1301.0	1667.3
HOT SIDE	30.000	200.0	196.9	581.7	536.4	.0	.0

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.763	498.9	498.8	499.1	544.1	1667.3	1828.3
HOT SIDE	29.0	100.0	99.8	550.0	528.3	.0	.0

HEAT REJECTED 283.91

% GARRETT % AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II;TURB 16.75 R H2,T20=400,
8 JUNE 1971 15:55:09 PAGE 1 OF 2

% CONDITION % 100 HP,5.0 PAMB,3000 PSI HYDSYS

% UNITS % AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.9	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* % POINT INPUT DATA %

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
MYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX
140.00	12.00	.60
		7.63

TURBINE OUTPUT POWER = 160.36 O/F = .650 SPC = 1.725

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.794	1.817
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	491.6	499.9
PRESSURE OUT	161.2	172.7
TEMPERATURE IN	930.7	300.0

% GARRETT % AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II;TURB 16.75 R H2,T20=400,
8 JUNE 1971 15:55:09 PAGE 2 OF 2

% CONDITION % 100 HP,5.0 PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	2.794	OXYGEN FLOW	1.817
PRESSURE IN	160.1	PRESSURE OUT	160.1
TEMPERATURE IN H2	930.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.611	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	159.9	PRESSURE OUT	5.5
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1398.4
ENTHALPY IN	4809.8	ENTHALPY OUT	3338.2
PRESSURE RATIO	29.14	EFFICIENCY	.540

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.651	492.4	492.0	930.6	1811.9	3178.8	.455
HOT SIDE	4.611	5.4	5.1	1398.4	759.2	3338.2	1959.5
* TURBINE EXHAUST OVERBOARD PRESSURE *					5.00		

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.857	1.394

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.794	500.0	500.0	75.0	398.7	54.3	1295.4
HOT SIDE	1.857	490.6	490.6	930.6	402.8	3178.8	1310.9

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	55.79	2.79	499.95
SECONDARY JET	37.26	1.86	490.56
RESULTANT		4.65	493.18
FLOW PARA RATIO	.668	P PRI/P SEC	1.0191
JET PUMP RISE	1.0053	PRI FLOW PARA	.1116 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.651	493.1	492.9	400.3	449.5	1301.6	1486.1
HOT SIDE	30.000	200.0	196.9	536.9	472.1	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.651	492.8	492.4	449.5	539.4	1485.8	1811.9
HOT SIDE	423.7	103.0	97.8	550.0	542.1	.0	.0

HEAT REJECTED 1516.48

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16.75 R H2, T20=400,
8 JUNE 1971 15:55:21 PAGE 1 OF 2

* CONDITION * 200 HP.5. PAMB.3000 PSI HYOSYS

* UNITS * AREA=SQ IN, M=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4								
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.00	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T MHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0923	.000					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAMA COLD	ETAMA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP 240.00	ALTERNATOR 12.00
	LUBE PUMP .60
	GEAR BOX 12.63

TURBINE OUTPUT POWER = 265.19 O/F = .677 SPC = 1.692

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.462	3.019
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	32.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	477.4	499.8
PRESSURE OUT	260.8	279.6
TEMPERATURE IN	884.0	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16.75 R H2, T20=400,
8 JUNE 1971 15:55:21 PAGE 2 OF 2

* CONDITION * 200 HP.5. PAMB.3000 PSI HYOSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.462	OXYGEN FLOW	3.019
PRESSURE IN	259.1	PRESSURE OUT	259.1
TEMPERATURE IN H2	884.0	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.480	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	258.8	PRESSURE OUT	6.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1375.3
ENTHALPY IN	475.8	ENTHALPY OUT	3253.1
PRESSURE RATIO	41.24	EFFICIENCY	.528

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.704	479.6	478.6	327.5	884.0	1769.1	3016.4	.421
HOT SIDE 7.480	6.2	5.4	1375.3	770.4	3253.1	1968.6	.714

* TURBINE EXHAUST OVERBOARD PRESSURE * 5.08

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
3.242	3.042

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.462	500.0	500.0	75.0	396.3	54.3	1286.4	.397
HOT SIDE 3.242	475.5	475.4	884.0	405.4	3016.4	1320.9	.592

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET 88.82	4.46	499.87	396.30
SECONDARY JET 65.28	3.24	475.33	405.42
RESULTANT 7.70	481.39	400.15	
FLOW PARA RATIO .739	P PRI/P SEC		1.0516
JET PUMP RISE 1.0128	PRI FLOW PARA	.1777	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.704	481.3	480.6	400.2	437.1	1300.9	1439.8	.267
HOT SIDE 30.000	200.0	196.9	338.6	437.0	.0	.0	.589

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.704	480.4	479.6	437.0	527.5	1439.6	1769.1	.801
HOT SIDE 818.4	100.0	95.4	350.0	543.2	.0	.0	.060

HEAT REJECTED 2538.79

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400,
8 JUNE 1971 15:55:33 PAGE 1 OF 2

* CONDITION * 360 HP, 5.0 PAMB, 3000 HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, G=BTU/MIN, T=JEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE	110.00	LOSS COEFFICIENTS	*10E+4	.00	.00	10.00
.00	.00	.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50
19.00	13.85	54.00	.00	2.02	50.00	2.74
.12	.00					.023

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAMA COLD	ETAMA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS	GEAR BOX
400.00	12.00	.60	20.63	

TURBINE OUTPUT POWER = 431.96 O/F = .703 SPC = 1.690

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.147	5.022
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

IS IT IN CONTROL	CONTROL VALVE	YES	YES
PRESSURE IN	447.0	499.6	
PRESSURE OUT	418.8	448.5	
TEMPERATURE IN	838.3	300.0	

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400,
8 JUNE 1971 15:55:33 PAGE 2 OF 2

* CONDITION * 360 HP, 5.0 PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.147	OXYGEN FLOW	5.022
PRESSURE IN	416.2	PRESSURE OUT	416.2
TEMPERATURE IN H2	838.3	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	12.169	SPECIFIC HEAT RATIO	1.364
PRESSURE IN	415.6	PRESSURE OUT	8.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1364.6
ENTHALPY IN	4701.0	ENTHALPY OUT	3197.2
PRESSURE RATIO	49.46	EFFICIENCY	.522

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 12.862	452.6	450.1	510.0	838.3	1706.0	2856.7	.384
HOT SIDE 12.169	8.2	6.0	1364.6	783.2	3197.2	1980.8	.680

* TURBINE EXHAUST OVERBOARD PRESSURE = 5.28

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
5.715	3.432

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.147	500.0	499.9	75.0	392.1	54.3	1270.5	.415
HOT SIDE 5.715	446.6	446.3	838.3	409.4	2856.7	1335.8	.562

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	141.53	7.15	499.67
SECONDARY JET	115.65	5.72	445.97
RESULTANT		12.86	457.32
FLOW PARA RATIO		.817	P PRI/P SEC
JET PUMP RISE	1.0254	PRI FLOW PARA	.2833 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 12.862	457.0	455.1	399.8	428.9	1299.5	1409.1	.187
HOT SIDE 30.000	200.0	196.9	555.8	449.0	.0	.0	.685

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 12.862	454.7	452.7	428.9	510.0	1409.0	1706.0	.670
HOT SIDE 1450.0	100.0	91.5	550.0	544.2	.0	.0	.048

HEAT REJECTED 3820.06

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II: TURB 16.75 R H2.T20=400,
8 JUNE 1971 15:55:50 PAGE 1 OF 2

* CONDITION * 0.0 HP, 10. PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.025
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.400					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAMA COLD	ETAMA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	10.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.17 O/F = .567 SPC = 2.309

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.355	.768
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	498.1	500.0
PRESSURE OUT	76.9	81.2
TEMPERATURE IN	1079.6	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II: TURB 16.75 R H2.T20=400,
8 JUNE 1971 15:55:50 PAGE 2 OF 2

* CONDITION * 0.0 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	1.355	OXYGEN FLOW	.768
PRESSURE IN	76.3	PRESSURE OUT	76.3
TEMPERATURE IN H2	1079.6	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	2.123	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	76.2	PRESSURE OUT	10.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1591.2
ENTHALPY IN	5002.6	ENTHALPY OUT	3901.7
PRESSURE RATIO	7.58	EFFICIENCY	.544

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.060	498.3	498.2	539.3	1079.5	1811.5	3696.5 .514
HOT SIDE	2.123	10.0	10.0	1591.2	787.1	3901.7	2072.9 .764
* TURBINE EXHAUST OVERBOARD PRESSURE *					9.99		

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.705	.486

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.355	500.0	500.0	75.0	398.6	54.3	1295.3 .322
HOT SIDE	.705	497.7	497.7	1079.5	402.5	3696.5	1310.0 .674

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
27.06	1.36	499.99	398.64	
SECONDARY JET	14.14	.70	497.69	402.52
RESULTANT		2.06	498.49	399.97
FLOW PARA RATIO		.523	P PRI/P SEC	1.0046
JET PUMP RISE	1.0016	PRI FLOW PARA	.0541	JSPF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.060	498.5	498.4	400.0	484.4	1300.3	1614.0 .517
HOT SIDE	30.000	200.0	196.9	563.3	516.8	.0	.0 .289

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.060	498.4	498.3	484.5	539.3	1614.2	1811.5 .837
HOT SIDE	29.0	100.0	99.8	550.0	516.8	.0	.0 .477

HEAT REJECTED 406.56

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, 8 JUNE 1971 15:56:01 PAGE 1 OF 2

* CONDITION * 100 HP, 10. PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT		PRESSURE	LOSS	COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS	GEAR BOX
140.00	12.00	.60		7.63

TURBINE OUTPUT POWER = 161.20 O/F = .638 SPC = 1.848

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.033	1.933
PRESSURE	500.00	300.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	490.1	499.9
PRESSURE OUT	174.6	186.5
TEMPERATURE IN	952.5	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, 8 JUNE 1971 15:56:01 PAGE 2 OF 2

* CONDITION * 100 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	3.033	OXYGEN FLOW	1.933
PRESSURE IN	173.4	PRESSURE OUT	173.4
TEMPERATURE IN H2	952.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.966	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	173.1	PRESSURE OUT	10.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1447.7
ENTHALPY IN	4838.1	ENTHALPY OUT	3464.2
PRESSURE RATIO	16.85	EFFICIENCY	.561

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.966	491.1	490.7	537.5	952.5	1805.1	3294.6	.456
HOT SIDE 4.966	10.2	10.0	1447.7	780.7	3464.2	2013.6	.733

* TURBINE EXHAUST OVERBOARD PRESSURE * 9.97

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.937	1.769

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.033	500.0	500.0	75.0	398.5	54.3	1294.8	.369
HOT SIDE 1.937	488.9	488.9	952.5	403.2	3294.6	1312.5	.628

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
60.54	3.03	499.94	398.50		
SECONDARY JET	38.89	1.94	488.84	403.20	
RESULTANT		4.97	491.97	400.34	
FLOW PARA RATIO		.642	P PRI/P SEC	1.0227	
JET PUMP RISE	1.0064	PRI FLOW PARA	.1211	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.966	491.9	491.6	400.3	446.4	1301.7	1474.4	.347
HOT SIDE 30.000	200.0	196.9	933.0	467.8	.0	.0	.492

HEAT REJECTED ALTERNATOR 509.1 GEAR BOX 323.7 LUBE PUMP 25.5 TOTAL 858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.966	491.6	491.2	446.3	537.5	1474.0	1805.1	.880
HOT SIDE 423.7	100.0	97.8	550.0	541.5	.0	.0	.062

HEAT REJECTED 1645.32

16

12

Case 10

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400,
8 JUNE 1971 15:56:13 PAGE 1 OF 2

• CONDITION • 200 HP, 10. PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T MHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	10.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX
240.00	12.00	.60
		12.63

TURBINE OUTPUT POWER = 266.23 O/F = .669 SPC = 1.763

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.686	3.137
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	475.1	499.8
PRESSURE OUT	273.3	292.7
TEMPERATURE IN	896.1	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400,
8 JUNE 1971 15:56:13 PAGE 2 OF 2

• CONDITION • 200 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.686	OXYGEN FLOW	3.137
PRESSURE IN	271.7	PRESSURE OUT	271.7
TEMPERATURE IN H2	896.1	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.824	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	271.3	PRESSURE OUT	10.7
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1405.9
ENTHALPY IN	4769.2	ENTHALPY OUT	3328.6
PRESSURE RATIO	25.33	EFFICIENCY	.549

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.011	477.4	476.4	525.9	896.0	1763.2	3058.1
HOT SIDE	7.824	10.7	10.1	1405.9	784.4	3328.6	2002.6
• TURBINE EXHAUST OVERBOARD PRESSURE •					9.96		

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
3.325	3.618

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.686	500.0	500.0	75.0	396.1	54.3	1285.6
HOT SIDE	3.325	472.7	472.6	896.0	405.9	3058.1	1322.7

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
93.27	4.69	499.86	396.11		
SECONDARY JET	66.99	3.32	472.54	405.92	
RESULTANT		8.01	479.40	400.19	
FLOW PARA RATIO		.718	P PRI/P SEC	1.0578	
JET PUMP RISE	1.0145	PRI FLOW PARA	.1866	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.011	479.3	478.5	400.2	435.7	1301.0	1434.6
HOT SIDE	30.000	200.0	196.9	536.9	455.0	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.011	478.4	477.5	435.6	525.9	1434.2	1763.2
HOT SIDE	818.4	100.0	95.4	550.0	542.9	.0	.0

HEAT REJECTED 2635.15

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,75 R H2, T20=400,
8 JUNE 1971 15:56:46 PAGE 1 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 HYDSYS

• UNITS • AREA SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				2.74
					10.00
					20.80
					.023

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX
400.00	12.00	.60
		20.63

TURBINE OUTPUT POWER = 431.66 O/F * .701 SPC = 1.736

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.343	5.145
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	444.9	499.5
PRESSURE OUT	424.5	455.1
TEMPERATURE IN	845.7	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,75 R H2, T20=400,
8 JUNE 1971 15:56:46 PAGE 2 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.343	OXYGEN FLOW	5.145
PRESSURE IN	421.8	PRESSURE OUT	421.8
TEMPERATURE IN H2	845.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	12.488	SPECIFIC HEAT RATIO	1.364
PRESSURE IN	421.2	PRESSURE OUT	12.2
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1383.9
ENTHALPY IN	4705.2	ENTHALPY OUT	3240.7
PRESSURE RATIO	34.51	EFFICIENCY	.537

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	13.113	450.8	448.2	509.0	845.8	1702.2	2882.8
HOT SIDE	12.488	12.1	10.5	1383.9	792.3	3240.7	2001.1
* TURBINE EXHAUST OVERBOARD PRESSURE *							10.11

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
5.770	3.848

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.343	500.0	499.9	75.0	391.7	54.3	1268.9
HOT SIDE	5.770	444.3	443.9	845.8	409.7	2882.8	1336.6

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
145.35	7.34	499.65	391.71	
SECONDARY JET	116.77	5.77	443.63	409.65
RESULTANT		13.11	455.69	399.62
FLOW PARA RATIO		.804	P PRI/P SEC	1.1263
JET PUMP RISE	1.0272	PRI FLOW PARA	.2909	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	13.113	455.4	453.4	399.6	428.2	1298.7	1406.2
HOT SIDE	30.000	200.0	196.9	554.9	448.0	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	13.113	453.0	450.9	428.2	509.0	1406.4	1702.2
HOT SIDE	1450.0	103.0	91.5	550.0	544.1	.0	.0

HEAT REJECTED 3879.26

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Case 12

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, 8 JUNE 1971 15:57:05 PAGE 1 OF 2

• CONDITION • 0.0 HP, 14.7PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		TURB OBCA		JP PRICA		TURB NOZ	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.45	54.00	.00	2.02	30.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.500	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS
HYD PUMP 40.00	ALTERNATOR 12.00
LUBE PUMP .60	GEAR BOX 2.63

TURBINE OUTPUT POWER = 55.13 O/F = .549 SPC = 2.680

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.590	.873
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

IS IT IN CONTROL	CONTROL VALVE	YES	NO
PRESSURE IN	YES	497.3	500.0
PRESSURE OUT	YES	89.7	94.4
TEMPERATURE IN	YES	1111.4	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, 8 JUNE 1971 15:57:05 PAGE 2 OF 2

• CONDITION • 0.0 HP, 14.7PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.590	OXYGEN FLOW	.873
PRESSURE IN	88.9	PRESSURE OUT	88.9
TEMPERATURE IN H2	1111.4	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.463	SPECIFIC HEAT RATIO	1.364
PRESSURE IN	88.8	PRESSURE OUT	14.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1661.0
ENTHALPY IN	5045.9	ENTHALPY OUT	4095.7
PRESSURE RATIO	6.02	EFFICIENCY	.509

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.300	497.7	497.5	533.6	1111.3	1791.1	3807.1	.512
HOT SIDE	2.463	14.7	14.7	1661.0	814.7	4095.7	2147.7	.751

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.69

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.790	.699

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	1.590	500.0	500.0	75.0	398.7	54.3	1295.5	.312
HOT SIDE	.790	496.8	496.8	1111.3	402.3	3807.1	1309.3	.684

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	31.74	1.59	499.98	398.70
RESULTANT	15.84	.79	496.81	402.32
FLOW PARA RATIO		2.38	497.91	399.91
JET PUMP RISE	1.0022	PRI FLOW PARA	.0635	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.300	497.9	497.8	399.9	472.8	1300.1	1571.6	.489
HOT SIDE	30.000	200.0	196.9	546.9	501.5	.0	.0	.318

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	111.6	25.5	646.2	

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.300	497.8	497.7	472.9	533.6	1571.8	1791.1	.787
HOT SIDE	29.0	100.0	99.8	550.0	509.7	.0	.0	.523

HEAT REJECTED 521.69

19

19

Case 13

• GARRETT • AIRRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400,
8 JUNE 1971 15:57:15 PAGE 1 OF 2

• CONDITION • 100 HP, 14.7 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER			HP LOSS
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 161.72 O/F = .627 SPC = 1.970

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.264	2.047
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	488.7	499.9
PRESSURE OUT	187.6	199.9
TEMPERATURE IN	970.7	300.0

• GARRETT • AIRRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400,
8 JUNE 1971 15:57:15 PAGE 2 OF 2

• CONDITION • 100 HP, 14.7 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	3.264	OXYGEN FLOW	2.047
PRESSURE IN	186.2	PRESSURE OUT	186.2
TEMPERATURE IN H2	970.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	5.310	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	186.0	PRESSURE OUT	14.9
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1489.6
ENTHALPY IN	4861.7	ENTHALPY OUT	3572.4
PRESSURE RATIO	12.46	EFFICIENCY	.585

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.283	489.8	489.3	535.6	970.7	1798.3	3317.9 .456
HOT SIDE	5.310	14.9	14.7	1489.6	799.3	3572.4	2060.6 .724
* TURBINE EXHAUST OVERBOARD PRESSURE					14.67		

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
2.019	2.186

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.264	500.0	500.0	75.0	398.3	54.3	1294.0 .361
HOT SIDE	2.019	487.1	487.1	970.7	403.6	3317.9	1314.2 .633

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	65.14	3.26	499.93
SECONDARY JET	40.57	2.02	487.05
RESULTANT		5.28	490.76
FLOW PARA RATIO		.623	P PRI/P SEC
JET PUMP RISE	1.0076	PRI FLOW PARA	.1303 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.283	490.7	490.4	400.3	443.6	1301.7	1464.2 .335
HOT SIDE	30.000	200.0	196.9	529.5	464.0	.0	.0 .507

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.283	490.3	489.9	443.5	535.6	1463.8	1798.3 .865
HOT SIDE	423.7	100.0	97.8	550.0	540.8	.0	.0 .086

HEAT REJECTED 1767.17

11

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Case 14

* GARRETT * AIRRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE 11, TURB 16.75 R H2, T20*400,
 8 JUNE 1971 15:57:27 PAGE 1 OF 2
 * CONDITION * 200 HP, 14.7 PAMB, 3000 PSI HYDRYS
 * UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4
 .00 .00 1.18 1.44 .00 .66 3.50 20.80
 19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
 .12 .00
 SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRCA TURB NOZ
 1.000 .000 1.000 1.000 12,560 2.000 .1210
 TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HNX IN T LHX O
 .0002 .98 .30 .3 2060.00 400.00 1300.00
 ETA CORF O/F BASE
 .0925 .600

HEAT EXCHANGER SCALE FACTORS
 H2 PREHEATER ETAMA COLD ETAMA HOT RHODP COLD RHODP HOT
 2.00 2.00 .90 1.00
 HYD O COOLER 1.00 1.00 1.00 1.00
 LUB O COOLER 1.00 1.00 1.00 1.00
 RECUPERATOR 1.00 1.00 1.00 1.00

* POINT INPUT DATA *
 HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
 200.00 .00 14.70 3000.0 35.0

* OUTPUT DATA *
 DRIVE POWER HP LOSS
 HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
 240.00 12.00 .60 12.63
 TURBINE OUTPUT POWER = 267.26 O/F = .663 SPC = 1.832

PROPELLANT HYDROGEN OXYGEN
 FLOW RATE 4.906 3.255
 PRESSURE 500.00 500.00
 TEMPERATURE 75.00 300.00
 ENTHALPY 54.3 52.8

CONTROL VALVE
 IS IT IN CONTROL YES YES
 PRESSURE IN 472.8 499.8
 PRESSURE OUT 283.9 305.5
 TEMPERATURE IN 906.3 300.0

* GARRETT * AIRRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE 11, TURB 16.75 R H2, T20*400,
 8 JUNE 1971 15:57:27 PAGE 2 OF 2
 * CONDITION * 200 HP, 14.7 PAMB, 3000 PSI HYDRYS

COMBUSTOR INFORMATION
 HYDROGEN FLOW 4.906 OXYGEN FLOW 3.255
 PRESSURE IN 284.1 PRESSURE OUT 284.1
 TEMPERATURE IN H2 906.3 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
 INLET FLOW 8.161 SPECIFIC HEAT RATIO 1.364
 PRESSURE IN 283.6 PRESSURE OUT 15.2
 TEMPERATURE IN 2060.0 TEMPERATURE OUT 1433.0
 ENTHALPY IN 4782.4 ENTHALPY OUT 3395.6
 PRESSURE RATIO 18.63 EFFICIENCY .561

RECUPERATOR INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 8.318 475.4 474.2 524.2 906.3 1757.3 3093.6 .420
 HOT SIDE 8.161 15.2 14.8 1433.0 797.2 3395.6 2033.5 .700
 * TURBINE EXHAUST OVERBOARD PRESSURE * 14.65

HOT BYPASS VALVE INFORMATION
 FLOW PRESSURE DROP
 3.412 4.166

H2 PREHEATER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 4.906 500.0 499.9 75.0 395.9 54.3 1284.8 .386
 HOT SIDE 3.412 470.1 469.9 906.3 408.4 3093.6 1324.5 .601

JET PUMP PERFORMANCE
 FLOW PARA FLOW PRESSURE TEMPERATURE
 PRIMARY JET 97.61 4.91 499.84 395.90
 SECONDARY JET 68.79 3.41 469.84 406.39
 RESULTANT 8.32 477.48 400.22
 FLOW PARA RATIO .705 P PRI/P SEC 1.0639
 JET PUMP RISE 1.0163 PRI FLOW PARA .1953 JPSF 2.30

LUBE OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 8.318 477.4 476.5 400.2 434.4 1301.1 1429.8 .253
 HOT SIDE 30.000 200.0 196.9 535.3 453.3 .0 .0 .607

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
 509.1 535.0 25.5 1070.4

HYDRAULIC OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 8.318 476.4 475.4 434.3 524.2 1429.3 1757.3 .777
 HOT SIDE 818.4 100.0 95.4 550.0 542.7 .0 .0 .063

HEAT REJECTED 2727.98

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, 8 JUNE 1971 15:57:42 PAGE 1 OF 2

* CONDITION * 360 HP, 14.7PAMB, 3000 WYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		SF JP P		SF JP W		TUR OBCA		JP PRICA		TURB NOZ	
.00	.00	.00	1110.00	.00	7000.00	.00	.00	.00	10.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00				
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023				
.12	.00										

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1300.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	14.70	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
400.00	12.00	20.63

TURBINE OUTPUT POWER = 434.53 O/F = .696 SPC = 1.769

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.555	5.254
PRESSURE	500.00	300.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE		
NO	YES	
PRESSURE IN	442.7	499.5
PRESSURE OUT	442.7	470.6
TEMPERATURE IN	850.4	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, 8 JUNE 1971 15:57:42 PAGE 2 OF 2

* CONDITION * 360 HP, 14.7PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION		TURBINE INFORMATION	
HYDROGEN FLOW	7.555	OXYGEN FLOW	5.254
PRESSURE IN	439.8	PRESSURE OUT	439.8
TEMPERATURE IN H2	850.4	TEMPERATURE IN O2	300.0
INLET FLOW		SPECIFIC HEAT RATIO	
PRESSURE IN	12.809	PRESSURE OUT	1.364
TEMPERATURE IN	439.1	TEMPERATURE OUT	16.3
ENTHALPY IN	2060.0	ENTHALPY OUT	1398.6
PRESSURE RATIO	4716.1	EFFICIENCY	3278.6
	26.89		.549

RECUPERATOR INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	13.429	448.9	446.1	507.7	850.3	1697.6	2898.6	.385
HOT SIDE	12.809	16.2	15.0	1398.6	799.6	3278.5	2019.4	.672
% TURBINE EXHAUST OVERBOARD PRESSURE %					14.70			

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
5.875	4.089

H2 PREHEATER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.555	500.0	499.9	75.0	391.4	54.3	1267.9	.408
HOT SIDE	5.875	442.0	441.7	850.3	410.1	2898.6	1338.1	.968

JET PUMP PERFORMANCE					
PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
SECONDARY JET	149.47	7.55	499.63	391.44	
RESULTANT	118.96	5.87	441.34	410.05	
FLOW PARA RATIO		13.43	454.01	399.60	
JET PUMP RISE	1.0287	.796	P PRI/P SEC	1.1321	
			.2992	JPSF	2.30

LUBE OIL COOLER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	13.429	453.7	451.6	399.6	427.5	1298.6	1403.5	.180
HOT SIDE	30.000	200.0	196.9	554.1	447.1	.0	.0	.693

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	13.429	451.2	449.0	427.4	507.7	1403.4	1697.6	.655
HOT SIDE	1450.0	100.0	91.5	550.0	544.0	.0	.0	.049

HEAT REJECTED 3950.71

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16:38:46 PAGE 1 OF 2

• CONDITION • 0.0 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		SFT		TUR DN F		SF JP P		SF JP W		TUR OBCA		JP PRICA		TURB NOZ	
.00	.00	1.000	.000	1.000	.000	1.000	1.000	1.000	1.000	12.560	.2000	.1210			
3.64	.00	TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O							
19.00	13.85	.0002	.98	.30	.5	2060.00	400.00	1500.00							
.12	.00	ETA CORF	O/F BASE												
		.0925	.600												

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* P O I N T I N P U T D A T A *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.39 O/F = .615 SPC = 1.526

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	.872	.537
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	499.1	300.0
PRESSURE OUT	50.3	53.6
TEMPERATURE IN	992.4	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16:38:46 PAGE 2 OF 2

• CONDITION • 0.0 HP, 0.0 PAMB, 3000 PSI HYDSYS

HYDROGEN FLOW		COMBUSTOR INFORMATION	
PRESSURE IN	TEMPERATURE IN H2	OXYGEN FLOW	PRESSURE OUT
.872	992.4	.537	49.9
		TEMPERATURE IN O2	300.0

INLET FLOW		TURBINE INFORMATION	
PRESSURE IN	TEMPERATURE IN	SPECIFIC HEAT RATIO	PRESSURE OUT
1.409	2060.0	1.367	.8
4887.2	66.44	TEMPERATURE OUT	1324.9
		ENTHALPY OUT	3223.2
		EFFICIENCY	.528

FLOW		PRE IN		P OUT		T IN		T OUT		H IN		H OUT		EFF	
COLD SIDE	1.392	499.2	499.2	643.6	992.3	2176.9	3393.5	.512							
HOT SIDE	1.409	.7	.4	1324.9	778.0	3223.2	2021.4	.803							

* TURBINE EXHAUST OVERBOARD PRESSURE = .30

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.920	.122

H2 PREHEATER INFORMATION

FLOW		PRE IN		P OUT		T IN		T OUT		H IN		H OUT		EFF	
COLD SIDE	.872	500.0	500.0	75.0	399.0	54.3	1296.5	.353							
HOT SIDE	.920	499.1	499.1	992.3	402.0	3393.5	1308.1	.644							

JET PUMP PERFORMANCE

FLOW PARA		FLOW		PRESSURE		TEMPERATURE	
PRIMARY JET	17.42	.87	499.99	398.95			
SECONDARY JET	10.42	.52	499.05	402.01			
RESULTANT		1.39	499.35	400.09			
FLOW PARA RATIO		.598	P PRI/P SEC	1.0019			
JET PUMP RISE	1.0006	PRI FLOW PARA	.0348	JPSF	2.30		

LUBE OIL COOLER INFORMATION

FLOW		PRE IN		P OUT		T IN		T OUT		H IN		H OUT		EFF	
COLD SIDE	30.000	499.3	499.3	400.1	526.3	1300.8	1765.0	.577							
HOT SIDE	30.000	200.0	196.9	618.9	575.7	.0	.0	.197							

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW		PRE IN		P OUT		T IN		T OUT		H IN		H OUT		EFF	
COLD SIDE	1.392	499.3	499.2	526.3	643.6	1765.0	2176.9	.948							
HOT SIDE	29.0	100.0	99.8	650.0	610.9	.0	.0	.316							

HEAT REJECTED 573.34

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650, 8 JUNE 1971 16138158 PAGE 1 OF 2

• CONDITION • 100 HP, 0.0 PAMB, 3000 PSI HYDSYS
 • UNITS • AREA*SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4	.00	.00	.00	1110.00	70000.00	.00	.00	10.00
	3.64	.00	1.18	1.44	.00	.66	3.50	20.00
	19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
	.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2000.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.80

• • POINT INPUT DATA • •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 159.02 O/F = .624 SPC = 1.625

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.668	1.665
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	492.3	500.0
PRESSURE OUT	152.5	142.7
TEMPERATURE IN	976.7	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650, 8 JUNE 1971 16138158 PAGE 2 OF 2

• CONDITION • 100 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	2.668	OXYGEN FLOW	1.665
PRESSURE IN	151.4	PRESSURE OUT	151.4
TEMPERATURE IN H2	976.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.332	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	151.2	PRESSURE OUT	2.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1367.2
ENTHALPY IN	4868.5	ENTHALPY OUT	3305.5
PRESSURE RATIO	65.27	EFFICIENCY	.499

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.303	493.1	492.7	633.7	976.9	2142.0	3339.6	.460
HOT SIDE 4.332	2.2	1.4	1367.2	823.9	3305.5	2115.8	.741

• TURBINE EXHAUST OVERBOARD PRESSURE • .92

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.636	1.489

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.668	500.0	500.0	75.0	399.1	54.3	1297.0	.359
HOT SIDE 1.636	491.3	491.2	976.9	403.0	3339.6	1311.7	.636

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	32.83	1.64	491.20	402.96
RESULTANT		4.30	493.81	400.57
FLOW PARA RATIO		.616	P PRI/P SEC	1.0170
JET PUMP RISE	1.0053	PRI FLOW PARA	.1066	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.303	493.8	493.5	400.6	453.9	1302.6	1502.0	.370
HOT SIDE 30.000	200.0	196.9	542.3	477.9	.0	.0	.454

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.303	493.5	493.1	453.0	633.7	1502.0	2142.0	.917
HOT SIDE 423.7	100.0	97.8	650.0	637.3	.0	.0	.068

HEAT REJECTED 2754.14

24

13

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16:39:12 PAGE 1 OF 2

• CONDITION • 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4	110.00	7000.00	.00	.00	10.00
.00	.00	.00	.00	.00	.00
3.64	.00	1.18	1.44	.00	3.50
19.00	13.85	54.00	.00	2.02	50.00
.12	.00			2.74	.023

SFT	TUR DN F	SF JP P	SF JP W	TUR QBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP	ALTERNATOR
240.00	12.00
LUBE PUMP	GEAR BOX
.60	12.63

TURBINE OUTPUT POWER = 265.20 O/F * .645 SPC = 1.636

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.396	2.835
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	478.1	499.9
PRESSURE OUT	254.5	271.4
TEMPERATURE IN	938.6	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16:39:12 PAGE 2 OF 2

• CONDITION • 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.396	OXYGEN FLOW	2.835
PRESSURE IN	252.8	PRESSURE OUT	252.8
TEMPERATURE IN H2	938.6	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.231	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	252.4	PRESSURE OUT	3.9
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1363.6
ENTHALPY IN	4822.5	ENTHALPY OUT	3269.0
PRESSURE RATIO	64.52	EFFICIENCY	.503

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.274	480.3	479.3	613.2	938.7	2070.2	3206.5	.434
HOT SIDE 7.231	3.8	2.3	1363.6	835.1	3269.0	2126.0	.704

* TURBINE EXHAUST OVERBOARD PRESSURE * 1.55

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
2.878	3.773

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.396	500.0	500.0	75.0	396.7	54.3	1288.1	.373
HOT SIDE 2.878	475.5	475.5	938.7	405.7	3206.5	1321.8	.617

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	87.56	4.40	499.87
SECONDARY JET	57.97	2.88	475.39
RESULTANT		7.27	482.01
FLOW PARA RATIO		.662	P PRI/P SEC
JET PUMP RISE	1.0139	PRI FLOW PARA	.1752 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.274	481.9	481.3	400.3	439.5	1301.4	1448.6	.277
HOT SIDE 30.000	200.0	196.9	541.4	460.2	.0	.0	.576

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.274	481.1	480.3	439.4	613.2	1448.6	2070.2	.825
HOT SIDE 818.4	100.0	95.4	650.0	639.2	.0	.0	.051

HEAT REJECTED 4522.03

25

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Case 19

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,75 R H2, T20=400, T60=650.
8 JUNE 1971 16139123 PAGE 1 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, G=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HWX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	.00	3000.0	39.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
400.00	12.00	.60
		20.63

TURBINE OUTPUT POWER = 432.27 O/F = .671 SPC = 1.657

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.143	4.796
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	92.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	448.5	499.6
PRESSURE OUT	414.6	441.9
TEMPERATURE IN	893.1	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,75 R H2, T20=400, T60=650.
8 JUNE 1971 16139123 PAGE 2 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.143	OXYGEN FLOW	4.796
PRESSURE IN	411.9	PRESSURE OUT	411.9
TEMPERATURE IN H2	893.1	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.939	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	411.3	PRESSURE OUT	7.0
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1362.4
ENTHALPY IN	4766.8	ENTHALPY OUT	3231.9
PRESSURE RATIO	59.07	EFFICIENCY	.510

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 12.227	454.1	491.6	582.9	893.1	1963.6	3047.3	.398
HOT SIDE 11.939	6.8	3.8	1362.4	841.4	3231.9	2122.0	.668

• TURBINE EXHAUST OVERBOARD PRESSURE = 2.56

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
5.084	5.497

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.143	500.0	499.9	75.0	392.4	54.3	1271.4	.388
HOT SIDE 5.084	446.1	445.8	893.1	409.8	3047.3	1337.1	.591

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
SECONDARY JET	141.49	7.14	499.67	392.37	
RESULTANT	102.91	5.08	445.60	409.79	
FLOW PARA RATIO		12.23	456.55	399.63	
JET PUMP RISE	1.0291	.727	P PRI/P SEC	1.1213	
		PRI FLOW PARA	.2832	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 12.227	458.3	456.5	399.6	430.2	1298.7	1414.0	.194
HOT SIDE 30.000	200.0	196.9	957.4	450.9	.0	.0	.675

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 12.227	456.2	454.2	430.3	582.9	1414.0	1963.6	.695
HOT SIDE 1450.0	100.0	91.5	650.0	641.0	.0	.0	.041

HEAT REJECTED 6719.06

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16:39:35 PAGE 1 OF 2

• CONDITION • 0.0 HP, 5.0 PAMB, 3000 PSI HYOSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBSCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LXH O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER			
HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.49 O/F * .563 SPC = 1.919

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.135	.639
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	498.7	500.0
PRESSURE OUT	64.4	68.0
TEMPERATURE IN	1082.7	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16:39:35 PAGE 2 OF 2

• CONDITION • 0.0 HP, 5.0 PAMB, 3000 PSI HYOSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.135	OXYGEN FLOW	.639
PRESSURE IN	63.8	PRESSURE OUT	63.8
TEMPERATURE IN H2	1082.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.775	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	63.8	PRESSURE OUT	5.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1495.4
ENTHALPY IN	5011.0	ENTHALPY OUT	3686.9
PRESSURE RATIO	12.56	EFFICIENCY	.556

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	1.724	498.8	498.7	636.0	1082.7	2150.2	3707.5	.520
HOT SIDE	1.775	5.1	5.0	1495.4	830.7	3686.9	2173.8	.773
* TURBINE EXHAUST OVERBOARD PRESSURE * 4.99								

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.589	.270

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	1.135	500.0	500.0	75.0	398.9	54.3	1296.1	.321
HOT SIDE	1.589	498.5	498.5	1082.7	403.6	3707.5	1314.2	.674

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	22.67	1.14	499.99
SECONDARY JET	11.83	.59	498.47
RESULTANT		1.72	498.99
FLOW PARA RATIO	.522	P PRI/P SEC	1.0031
JET PUMP RISE	1.0010	PRI FLOW PARA	.0453 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	1.724	499.0	498.9	430.5	501.8	1302.3	1677.0	.549
HOT SIDE	30.000	200.0	196.9	585.2	540.1	.0	.0	.244

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	1.724	498.9	498.8	501.9	636.0	1677.2	2150.2	.905
HOT SIDE	29.0	100.0	99.8	650.0	593.8	.0	.0	.380

HEAT REJECTED 815.62

11

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Case 21

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650,
8 JUNE 1971 16:39:46 PAGE 1 OF 2

• CONDITION • 100 HP, 5.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4			
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
140.00	12.00
ALTERNATOR	LUBE PUMP
	.60
	7.63

TURBINE OUTPUT POWER = 160.20 O/F = .615 SPC = 1.702

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.813	1.731
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

IS IT IN CONTROL	CONTROL VALVE
PRESSURE IN	YES
PRESSURE OUT	YES
TEMPERATURE IN	YES
	491.5
	160.7
	992.5
	499.9
	171.0
	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650,
8 JUNE 1971 16:39:46 PAGE 2 OF 2

• CONDITION • 100 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	2.813	OXYGEN FLOW	1.731
PRESSURE IN	159.5	PRESSURE OUT	159.5
TEMPERATURE IN H2	992.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	4.544	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	159.2	PRESSURE OUT	5.5
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1402.2
ENTHALPY IN	4888.4	ENTHALPY OUT	3395.5
PRESSURE RATIO	28.91	EFFICIENCY	.537

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.489	492.4	492.0	631.8	992.5	2135.5	3393.9	.468
HOT SIDE 4.544	5.5	5.1	1402.2	837.9	3395.5	2152.3	.733
* TURBINE EXHAUST OVERBOARD PRESSURE *						5.00	

HOT BYPASS VALVE INFORMATION		
FLOW	PRESSURE DROP	
1.676	1.704	

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.813	500.0	500.0	75.0	398.6	54.3	1295.1	.353
HOT SIDE 1.676	490.3	490.3	992.5	402.8	3393.9	1310.9	.643

JET PUMP PERFORMANCE					
PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
56.16	2.81	499.95	398.59		
SECONDARY JET	33.63	1.68	490.27	402.76	
RESULTANT		4.49	493.17	400.16	
FLOW PARA RATIO	.599	P PRI/P SEC	1.0197		
JET PUMP RISE	1.0059	PRI FLOW PARA	.1123	JPSF	2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.489	493.1	492.9	400.2	451.2	1301.0	1492.2	.367
HOT SIDE 30.000	200.0	196.9	539.1	474.4	.0	.0	.465

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.489	492.8	492.5	451.1	631.8	1492.0	2135.5	.908
HOT SIDE 423.7	100.0	97.8	650.0	636.7	.0	.0	.067

HEAT REJECTED 2884.27

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SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16:39:57 PAGE 1 OF 2

* CONDITION * 200 HP, 5. PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

.00	DUCT	PRESSURE	LOSS	COEFFICIENTS	*10E+4	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR ON F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 264.99 O/F = .642 SPC = 1.671

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.494	2.885
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	477.2	499.9
PRESSURE OUT	260.1	277.1
TEMPERATURE IN	945.1	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16:39:57 PAGE 2 OF 2

* CONDITION * 200 HP, 5. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.494	OXYGEN FLOW	2.885
PRESSURE IN	258.3	PRESSURE OUT	258.3
TEMPERATURE IN H2	945.1	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.379	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	257.9	PRESSURE OUT	6.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1379.5
ENTHALPY IN	4829.0	ENTHALPY OUT	3307.8
PRESSURE RATIO	40.80	EFFICIENCY	.925

RECUPERATOR INFORMATION

FLOW PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.399	479.4	478.4	612.0	945.1	2066.0	3228.7 .434
HOT SIDE 7.379	6.2	5.4	1379.5	841.6	3307.8	2142.0 .701

* TURBINE EXHAUST OVERBOARD PRESSURE * 5.09

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
2.905	4.055

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.494	500.0	500.0	75.0	396.5	54.3	1287.0	.369
HOT SIDE 2.905	474.3	474.3	945.1	405.7	3228.7	1321.9	.620

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	89.48	4.49	499.87
SECONDARY JET	58.51	2.90	474.19
RESULTANT		7.40	481.17
FLOW PARA RATIO	.654	P PRI/P SEC	1.0542
JET PUMP RISE	1.0147	PRI FLOW PARA	.1790 JPSF

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.399	481.1	480.4	400.1	438.6	1300.7	1445.4	.274
HOT SIDE 30.000	200.0	196.9	540.4	459.1	.0	.0	.580

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
509.1 535.9 25.5 1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.399	480.3	479.5	438.5	612.0	1445.1	2066.0	.820
HOT SIDE 818.4	100.0	95.4	650.0	639.1	.0	.0	.052

HEAT REJECTED 4593.61

12

29

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SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650,
8 JUNE 1971 16:40:09 PAGE 1 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 WYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4				
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.00	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TUR OBSC	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210

TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00

ETA CORF	O/F BASE
.0925	.600

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 432.32 O/F = .671 SPC = 1.670

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.204	4.831
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	447.8	499.6
PRESSURE OUT	419.1	446.4
TEMPERATURE IN	895.0	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650,
8 JUNE 1971 16:40:09 PAGE 2 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW	TEMPERATURE IN H2	TEMPERATURE IN O2
7.204	4.831	895.0	300.0

TURBINE INFORMATION

INLET FLOW	PRESSURE IN	TEMPERATURE IN	ENTHALPY IN	PRESSURE RATIO	SPECIFIC HEAT RATIO	PRESSURE OUT	TEMPERATURE OUT	ENTHALPY OUT	EFFICIENCY
12.035	415.8	2060.0	4768.8	49.03	1.365	8.5	1368.3	3245.9	.519

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	12.319	453.6	451.0	582.4	895.0	1961.6	3053.9	.398
HOT SIDE	12.035	8.3	6.1	1368.3	843.9	3245.9	2127.8	.667

* TURBINE EXHAUST OVERBOARD PRESSURE = 5.29

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
5.115	5.569

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.204	500.0	499.9	75.0	392.6	54.3	1272.2	.387
HOT SIDE	5.115	445.5	445.2	895.0	410.2	3053.9	1338.7	.591

JET PUMP PERFORMANCE

PRIMARY JET	SECONDARY JET	RESULTANT	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
142.74	103.61	12.32	.726	499.66	392.60	399.93

FLOW PARA RATIO = .726 P PRI/P SEC = 1.1230
JET PUMP RISE = 1.0295 PRI FLOW PARA = .2857 JPSF = 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	12.319	457.8	456.0	399.9	430.3	1299.8	1414.3	.193
HOT SIDE	30.000	200.0	196.9	557.4	450.9	.0	.0	.676

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL

509.1	875.3	25.5	1409.8
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HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	12.319	455.7	453.7	430.3	582.4	1414.1	1961.6	.692
HOT SIDE	1450.0	100.0	91.5	650.0	640.9	.0	.0	.041

HEAT REJECTED 6745.22

30

11

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I; TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16:40:21 PAGE 1 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	10.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
40.00	12.00	.60
		2.63

TURBINE OUTPUT POWER = 55.72 O/F = .538 SPC = 2.273

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.373	.738
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	498.0	500.0
PRESSURE OUT	77.2	81.1
TEMPERATURE IN	1128.8	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I; TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16:40:21 PAGE 2 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.373	OXYGEN FLOW	.738
PRESSURE IN	76.6	PRESSURE OUT	76.6
TEMPERATURE IN H2	1128.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.111	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	76.4	PRESSURE OUT	10.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1591.8
ENTHALPY IN	5074.7	ENTHALPY OUT	3955.4
PRESSURE RATIO	7.60	EFFICIENCY	.542

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.039	498.3	627.0	1128.8	2118.7	3867.9	.520
HOT SIDE	2.111	10.1	1591.8	862.5	3955.4	2265.7	.756

• TURBINE EXHAUST OVERBOARD PRESSURE = 9.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.666	.910

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.373	500.0	75.0	398.5	54.3	1294.6	.307
HOT SIDE	.666	497.6	1128.8	403.2	3867.9	1312.6	.689

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
27.40	1.37	499.99	398.47		
SECONDARY JET	13.38	.67	497.61	403.19	
RESULTANT	2.04	498.44	400.01		
FLOW PARA RATIO	.488	P PRI/P SEC	1.0048		
JET PUMP RISE	1.0017	PRI FLOW PARA	.0548	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.039	498.4	498.4	400.0	485.4	1300.5	1617.4	.519
HOT SIDE	30.000	200.0	196.9	564.4	518.0	.0	.0	.282

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.039	498.4	485.3	627.0	1617.2	2118.7	.860
HOT SIDE	29.0	100.0	99.8	650.0	578.9	.0	.432

HEAT REJECTED 1022.44

31

12

% GARRETT % AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650, 8 JUNE 1971 16:40:33 PAGE 1 OF 2

* CONDITION * 100 HP, 10. PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, G=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				2.74
					10.00
					20.00

SFT	TUR DN F	SF JP P	SF JP W	TUR OB CA	JP PR CA	TURB NO Z
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LK CA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETA HA COLD	ETA HA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

HYDRA HP	ELECT HP	% POINT P AMB	% HYDRA OIL	ALT SIZE(KW)
100.00	.00	10.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 160.72 O/F = .403 SPC = 1.825

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.048	1.839
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	490.1	499.9
PRESSURE OUT	173.8	184.4
TEMPERATURE IN	1013.1	300.0

% GARRETT % AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650, 8 JUNE 1971 16:40:33 PAGE 2 OF 2

* CONDITION * 100 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	3.048	OXYGEN FLOW	1.839
PRESSURE IN	172.5	PRESSURE OUT	172.5
TEMPERATURE IN H2	1013.1	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.888	SPECIFIC HEAT RATIO	1.364
PRESSURE IN	172.2	PRESSURE OUT	10.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1451.5
ENTHALPY IN	4916.1	ENTHALPY OUT	3523.4
PRESSURE RATIO	16.70	EFFICIENCY	.958

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.805	491.2	490.7	628.6	1013.1	2124.3	3465.4
HOT SIDE	4.888	10.3	10.1	1451.5	858.1	3523.4	2205.2
% TURBINE EXHAUST OVERBOARD PRESSURE							10.00

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.756	2.100

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.048	500.0	500.0	75.0	398.5	54.3	1294.7
HOT SIDE	1.756	488.6	488.5	1013.1	403.2	3465.4	1312.4

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	60.85	3.05	499.94
SECONDARY JET	35.26	1.76	488.52
RESULTANT		4.80	491.97
FLOW PARA RATIO	.580	PRI/P SEC	1.0234
JET PUMP RISE	1.0071	PRI FLOW PARA	.1217
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.805	491.6	491.6	400.2	447.8	1301.1	1479.8
HOT SIDE	30.000	200.0	196.9	534.8	469.8	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.805	491.6	491.2	447.8	628.6	1479.5	2124.3
HOT SIDE	423.7	100.0	97.8	650.0	635.7	.0	.0

HEAT REJECTED 3098.08

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,75 R H2, T20=400, T60=650,
8 JUNE 1971 16:40:44 PAGE 1 OF 2

* CONDITION * 200 HP, 10. PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4			
.00	.00	.00	1110.00
3.64	.00	1.18	1.44
19.00	13.85	54.00	.00
.12	.00		

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	19.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER	HP LOSS
MYD PUMP	GEAR BOX
240.00	12.63

TURBINE OUTPUT POWER = 265.73 O/F = .636 SPC = 1.740

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.713	2.995
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	474.9	499.8
PRESSURE OUT	272.3	289.8
TEMPERATURE IN	956.2	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,75 R H2, T20=400, T60=650,
8 JUNE 1971 16:40:44 PAGE 2 OF 2

* CONDITION * 200 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	4.713	OXYGEN FLOW	2.995
PRESSURE IN	270.4	PRESSURE OUT	270.4
TEMPERATURE IN H2	956.2	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	7.708	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	270.0	PRESSURE OUT	10.7
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1409.6
ENTHALPY IN	4843.8	ENTHALPY OUT	3383.2
PRESSURE RATIO	25.15	EFFICIENCY	.546

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.700	477.4	476.3	609.3	956.2	2056.3	3267.3	.433
HOT SIDE 7.708	10.7	10.2	1409.6	854.1	3383.2	2173.5	.694

* TURBINE EXHAUST OVERBOARD PRESSURE * 9.97

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
2.987	4.613

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.713	500.0	499.9	75.0	396.3	54.3	1286.2	.365
HOT SIDE 2.987	471.7	471.6	956.2	406.2	3267.3	1323.8	.624

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	93.81	4.71	499.85
SECONDARY JET	60.20	2.99	471.52
RESULTANT		7.70	479.29
FLOW PARA RATIO	.642	P PRI/P SEC	1.0601
JET PUMP RIBE	1.0165	PRI FLOW PARA	.1877
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.700	479.2	478.5	406.1	437.1	1300.8	1439.8	.267
HOT SIDE 30.000	200.0	196.9	538.6	457.0	.0	.0	.589

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.700	478.3	477.5	437.0	609.3	1439.5	2056.3	.809
HOT SIDE 818.4	100.0	95.4	650.0	638.7	.0	.0	.053

HEAT REJECTED 4749.19

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650,
8 JUNE 1971 16:41:18

PAGE 1 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 WYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OB CA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETA	TA	COLD	ETA	MOT	RHODP	COLD	RHODP	HOT
H2 PREHEATER	2.00			2.00			.50		1.00
HYD O COOLER	1.00			1.00			1.00		1.00
LUB O COOLER	1.00			1.00			1.00		1.00
RECUPERATOR	1.00			1.00			1.00		1.00

* P O I N T I N P U T D A T A *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 431.89 O/F = .669 SPC = 1.714

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.393	4.947
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	446.0	499.6
PRESSURE OUT	425.2	453.3
TEMPERATURE IN	901.6	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650,
8 JUNE 1971 16:41:18

PAGE 2 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION		OXYGEN FLOW	
HYDROGEN FLOW	7.393	OXYGEN FLOW	4.947
PRESSURE IN	422.4	PRESSURE OUT	422.4
TEMPERATURE IN H2	901.6	TEMPERATURE IN O2	300.0

TURBINE INFORMATION		SPECIFIC HEAT RATIO	
INLET FLOW	12.341	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	421.7	PRESSURE OUT	12.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1307.0
ENTHALPY IN	4771.8	ENTHALPY OUT	3288.2
PRESSURE RATIO	34.39	EFFICIENCY	.534

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	12.341	452.1	449.4	580.6	901.6	1955.4	3077.0	.398
HOT SIDE	12.341	12.1	10.6	1387.0	851.9	3288.2	2145.8	.664
* TURBINE EXHAUST OVERBOARD PRESSURE *							10.13	

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
5.176	5.889

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.393	500.0	499.9	75.0	392.2	54.3	1270.6	.384
HOT SIDE	5.176	443.6	443.3	901.6	410.4	3077.0	1339.3	.594

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
146.41	7.39	499.65	392.16		
SECONDARY JET	104.85	5.18	443.01	410.38	
RESULTANT		12.57	456.75	399.68	
FLOW PARA RATIO		.716	P PRI/P SEC	1.1278	
JET PUMP RISE	1.0310	PRI FLOW PARA	.2930	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	12.369	458.5	454.6	399.7	429.5	1298.9	1411.0	.190
HOT SIDE	30.000	200.0	196.9	556.5	449.8	.0	.0	.687

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	12.369	454.3	452.2	429.5	580.6	1411.2	1955.4	.685
HOT SIDE	1450.0	100.0	91.5	650.0	640.8	.0	.0	.042

HEAT REJECTED 6841.23

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650,
8 JUNE 1971 16:41:35 PAGE 1 OF 2

• CONDITION • 0.0 HP, 14.7 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2030	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
40.00	12.00	2.63

TURBINE OUTPUT POWER = 55.10 O/F = .522 SPC = 2.652

PROPELLANT FLOW RATE	HYDROGEN	OXYGEN
1.600	.835	
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	497.3	500.0
PRESSURE OUT	89.6	93.8
TEMPERATURE IN	1160.5	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650,
8 JUNE 1971 16:41:35 PAGE 2 OF 2

• CONDITION • 0.0 HP, 14.7 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.600	OXYGEN FLOW	.835
PRESSURE IN	88.7	PRESSURE OUT	88.7
TEMPERATURE IN H2	1160.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.435	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	88.6	PRESSURE OUT	14.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1663.3
ENTHALPY IN	5115.8	ENTHALPY OUT	4154.7
PRESSURE RATIO	6.01	EFFICIENCY	.506

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.345	497.6	497.5	617.5	1160.0	2085.6	3976.1	.519
HOT SIDE 2.435	14.7	14.7	1663.3	886.5	4154.7	2334.3	.743
• TURBINE EXHAUST OVERBOARD PRESSURE • 14.69							

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.745	.725

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.600	500.0	500.0	75.0	398.6	54.3	1295.1	.298
HOT SIDE .745	496.8	496.8	1160.0	403.0	3976.1	1311.7	.698

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	31.95	1.60	499.98	398.59
RESULTANT	14.95	.74	496.75	402.96
FLOW PARA RATIO		2.34	497.88	399.98
JET PUMP RISE	1.0023	PRI FLOW PARA	.0639	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.345	497.9	497.8	400.0	474.0	1300.4	1575.9	.492
HOT SIDE 30.000	200.0	196.9	550.3	503.0	.0	.0	.319

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.345	497.8	497.6	474.0	617.5	1576.0	2085.6	.819
HOT SIDE 29.0	100.0	99.8	650.0	566.3	.0	.0	.476

HEAT REJECTED 1191.94

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16.75 R H2,T20=400,T60=650.
8 JUNE 1971 16:41:45 PAGE 1 OF 2

• CONDITION • 100 HP,14.7PAMB,3000 PSI HYDSYS
• UNITS • AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •
DUCT PRESSURE LOSS COEFFICIENTS *10E+4

.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHDDP COLD	RHDDP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS
HYD PUMP ALTERNATOR LUBE PUMP	GEAR BOX
140.00 12.00 .60	7.63
TURBINE OUTPUT POWER =	O/F = .594 SPC = 1.945

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.275	1.944
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE	YES	YES
IS IT IN CONTROL	YES	YES
PRESSURE IN	488.7	499.9
PRESSURE OUT	186.4	197.4
TEMPERATURE IN	1030.3	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16.75 R H2,T20=400,T60=650.
8 JUNE 1971 16:41:45 PAGE 2 OF 2

• CONDITION • 100 HP,14.7PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	3.275	OXYGEN FLOW	1.944
PRESSURE IN	185.0	PRESSURE OUT	185.0
TEMPERATURE IN H2	1030.3	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	5.220	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	184.7	PRESSURE OUT	14.9
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1493.1
ENTHALPY IN	4939.1	ENTHALPY OUT	3632.3
PRESSURE RATIO	12.37	EFFICIENCY	.562

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.111	489.9	489.3	625.5	1030.3	2113.2	3525.3	.467
HOT SIDE 5.220	14.9	14.7	1493.1	874.8	3632.3	2249.6	.713

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.68

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.836	2.930

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.275	500.0	500.0	75.0	398.3	54.3	1294.0	.338
HOT SIDE 1.836	486.8	486.8	1030.3	403.6	3525.3	1314.0	.654

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	65.36	3.28	499.93
SECONDARY JET	36.89	1.84	486.76
RESULTANT		5.11	490.79
FLOW PARA RATIO		.564	P PRI/P SEC
JET PUMP RISE	1.0083	PRI FLOW PARA	.1307 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.111	490.8	490.4	400.2	445.0	1301.2	1469.1	.342
HOT SIDE 30.000	200.0	196.9	531.2	465.9	.0	.0	.499

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.111	490.4	489.9	444.9	625.5	1468.9	2113.2	.880
HOT SIDE 423.7	130.0	97.8	650.0	634.8	.0	.0	.074

HEAT REJECTED 3293.61

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16141156 PAGE 1 OF 2

* CONDITION * 200 HP, 14.7 PAMB, 3000 PSI HYOSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		SFT		TUR DN F		SF JP P		SF JP W		TUR OBSCA		JP PRICA		TURB NOZ	
.00	.00	1.000	.000	1.000	.000	1.000	1.000	1.000	1.000	12,560	.2000	.1210	.1210	.0002	.98
19.00	13.85	.0002	.98	.30	.9	2060.00	400.00	1500.00							
.12	.00	ETA CORF	O/F BASE												
		.0925	.600												

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	14.70	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 266.58 O/F = .630 SPC = 1.809

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.930	3.106
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	472.7	499.8
PRESSURE OUT	284.5	302.3
TEMPERATURE IN	965.7	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=650.
8 JUNE 1971 16141156 PAGE 2 OF 2

* CONDITION * 200 HP, 14.7 PAMB, 3000 PSI HYOSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.930	OXYGEN FLOW	3.106
PRESSURE IN	282.5	PRESSURE OUT	282.5
TEMPERATURE IN H2	965.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	8.036	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	282.1	PRESSURE OUT	15.2
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1436.6
ENTHALPY IN	4856.5	ENTHALPY OUT	3450.8
PRESSURE RATIO	18.50	EFFICIENCY	.550

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.004	475.4	474.2	606.5	965.6	2046.5	3300.0 .433
HOT SIDE	8.036	15.2	14.8	1436.6	865.6	3450.8	2202.3 .688
* TURBINE EXHAUST OVERBOARD PRESSURE *				14.65			

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
3.074	5.139

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.930	500.0	499.9	75.0	396.1	54.3	1285.5 .360
HOT SIDE	3.074	469.1	469.0	965.6	406.7	3300.0	1325.6 .628

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	98.12	4.93	499.84
SECONDARY JET	61.99	3.07	468.90
RESULTANT		8.00	477.42
FLOW PARA RATIO		.632	P PRI/P SEC
JET PUMP RISE	1.0182	PRI FLOW PARA	.1963 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.004	477.3	476.5	400.2	435.7	1300.9	1434.6 .260
HOT SIDE	30.000	200.0	196.9	536.9	455.1	.0	.0 .598

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
509.1 535.9 25.5 1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.004	476.4	475.5	435.6	606.5	1434.2	2046.5 .797
HOT SIDE	818.4	100.0	95.4	650.0	638.3	.0	.0 .054

HEAT REJECTED 4901.02

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I1,TURB 16.75 R H2,T20=400,T60=650.
8 JUNE 1971 16:42:10 PAGE 1 OF 2

* CONDITION * 360 HP,14.7PAMB,3000 HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		TURBINE LOSS COEFFICIENTS *10E+4	
.00	.00	.00	.00
3.64	.00	1.18	1.44
19.00	13.85	54.00	.00
.12	.00	2.02	50.00
		2.74	.023

SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRICA TURB NOZ
1.000 .000 1.000 1.000 12.560 .2000 .1210
TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HMX IN T LHX O
.0002 .98 .30 .5 2060.00 400.00 1500.00
ETA CORF O/F BASE
.0925 .600

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAMA COLD	ETAMA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	14.70	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	AP LOSS GEAR BOX
403.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 434.94 O/F = .664 SPC = 1.746

PROPELLANT FLOW RATE	HYDROGEN	OXYGEN
PRESSURE	7.605	5.053
TEMPERATURE	500.00	500.00
ENTHALPY	75.00	300.00
	54.3	52.8

IS IT IN CONTROL	CONTROL VALVE	
	NO	YES
	PRESSURE IN	499.5
	PRESSURE OUT	469.3
TEMPERATURE IN	905.4	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I1,TURB 16.75 R H2,T20=400,T60=650.
8 JUNE 1971 16:42:10 PAGE 2 OF 2

* CONDITION * 360 HP,14.7PAMB,3000 HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.605	OXYGEN FLOW	5.053
PRESSURE IN	440.8	PRESSURE OUT	440.8
TEMPERATURE IN H2	905.4	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	12.658	SPECIFIC HEAT RATIO	1.365
PRESSURE IN	440.2	PRESSURE OUT	16.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1401.2
ENTHALPY IN	4782.3	ENTHALPY OUT	3325.3
PRESSURE RATIO	26.91	EFFICIENCY	.546

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	12.891	450.3	447.5	578.4	905.3	1947.8	3089.8
HOT SIDE	12.658	16.3	15.0	1401.2	858.1	3325.3	2162.3
* TURBINE EXHAUST OVERBOARD PRESSURE *							14.69

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
5.286	6.094

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.605	500.0	499.9	75.0	392.0	54.3	1269.8
HOT SIDE	5.286	441.4	441.1	905.3	410.9	3089.8	1341.1

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	150.56	7.60	499.63	391.96
RESULTANT	107.15	5.29	440.86	410.85
FLOW PARA RATIO		12.89	455.19	399.72
JET PUMP RISE	1.0325	P PRI/P SEC		1.1333
		PR1 FLOW PARA	.3013	JPSF
				2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	12.891	454.9	453.0	399.7	428.8	1299.0	1408.4
HOT SIDE	30.000	200.0	196.9	555.6	448.8	.0	.0

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	12.891	452.6	450.4	428.7	578.4	1408.2	1947.8
HOT SIDE	1450.0	100.0	91.5	650.0	640.7	.0	.0

HEAT REJECTED 6955.93

38

15

• GARRETT • AIRRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 1; TURB 16.75 R H2,T20=400,T60=750.
8 JUNE 1971 16:59:23 PAGE 1 OF 2

• CONDITION • D.O HP,D.O PAMB,3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		TURBINE LOSS COEFFICIENTS *10E+4	
.00	.00	.00	.00
3.64	.00	1.18	1.44
19.00	13.85	54.00	.00
.12	.00	2.02	50.00
		2.74	.083

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T MHX IN	T LHX O
.0002	.98	.30	.9	2080.00	400.00	1900.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAMA COLD	ETAMA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
40.00	12.00	.60
		2.63

TURBINE OUTPUT POWER = 55.43 O/F = .583 SPC = 1.511

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	.882	.514
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	499.1	500.0
PRESSURE OUT	50.3	53.4
TEMPERATURE IN	1049.2	300.0

• GARRETT • AIRRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 1; TURB 16.75 R H2,T20=400,T60=750.
8 JUNE 1971 16:59:23 PAGE 2 OF 2

• CONDITION • D.O HP,D.O PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	.882	OXYGEN FLOW	.514
PRESSURE IN	49.9	PRESSURE OUT	49.9
TEMPERATURE IN H2	1049.2	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.396	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	49.9	PRESSURE OUT	.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1331.0
ENTHALPY IN	4961.7	ENTHALPY OUT	3280.1
PRESSURE RATIO	64.41	EFFICIENCY	.525

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.362	499.2	740.7	1049.2	2516.9	3991.0	.923
HOT SIDE	1.396	.7	.5	1331.0	863.8	2232.7	.791
• TURBINE EXHAUST OVERBOARD PRESSURE •					.31		

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.480	.132

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	.882	500.0	500.0	75.0	398.9	54.3	1296.3
HOT SIDE	.480	499.0	1049.2	402.2	3591.0	1308.9	.664

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	17.61	.88	499.99
SECONDARY JET	9.62	.48	499.03
RESULTANT		1.36	499.34
FLOW PARA RATIO	.546	P PRI/P SEC	1.0019
JET PUMP RISE	1.0006	PRI FLOW PARA	.0352
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.362	499.3	499.3	400.1	529.1	1300.7	1775.3
HOT SIDE	30.000	200.0	196.9	622.8	579.8	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.362	499.3	499.2	529.2	740.7	1775.3	2516.9
HOT SIDE	29.0	100.0	99.8	750.0	687.5	.0	.0

HEAT REJECTED 1009.86

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,75 R H2, T20=400, T60=750,
8 JUNE 1971 16:59:31 PAGE 1 OF 2

• CONDITION • 100 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.30	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR QBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 159.20 O/F = .591 SPC = 1.603

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.674	1.580
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	492.3	500.0
PRESSURE OUT	153.5	162.4
TEMPERATURE IN	1036.4	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,75 R H2, T20=400, T60=750,
8 JUNE 1971 16:59:31 PAGE 2 OF 2

• CONDITION • 100 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION		
HYDROGEN FLOW	2.674	OXYGEN FLOW 1.580
PRESSURE IN	152.3	PRESSURE OUT 152.3
TEMPERATURE IN H2	1036.4	TEMPERATURE IN O2 300.0

TURBINE INFORMATION		
INLET FLOW	4.254	SPECIFIC HEAT RATIO 1.367
PRESSURE IN	152.1	PRESSURE OUT 2.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT 1370.8
ENTHALPY IN	4945.4	ENTHALPY OUT 3359.8
PRESSURE RATIO	64.34	EFFICIENCY .497

RECUPERATOR INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.159	493.2	492.8	728.1	1036.3	2472.7	3546.1	.480
HOT SIDE	4.254	2.3	1.4	1370.8	901.4	3359.8	2310.5	.730

• TURBINE EXHAUST OVERBOARD PRESSURE • .97

HOT BYPASS VALVE INFORMATION		
FLOW	PRESSURE DROP	
1.485	1.694	

H2 PREHEATER INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.674	500.0	500.0	75.0	398.7	54.3	1295.6	.337
HOT SIDE	1.485	491.1	491.1	1036.3	402.6	3546.1	1310.3	.659

JET PUMP PERFORMANCE				
	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	53.40	2.67	499.95	398.72
SECONDARY JET	29.79	1.48	491.05	402.65
RESULTANT		4.16	493.85	400.12
FLOW PARA RATIO		.558	P PRI/P SEC	1.0181
JET PUMP RISE	1.0057	PRI FLOW PARA	.1068	JPSF 2.30

LUBE OIL COOLER INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.159	493.8	493.6	400.1	455.3	1300.9	1307.2	.383
HOT SIDE	30.000	200.0	196.9	544.2	480.0	.0	.0	.445

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.159	493.5	493.2	455.0	728.1	1506.2	2472.7	.926
HOT SIDE	423.7	100.0	97.8	750.0	733.4	.0	.0	.056

HEAT REJECTED 4019.34

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 16:59:39 PAGE 1 OF 2

* CONDITION * 200 HP, 0.0 PAMB, 3000 PSI HYD SYS

* UNITS * AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		SF JP P		SF JP W		TUR OBCA		JP PRICA		TURB NOZ	
.00	.00	.00	1110.00	.00	70000.00	.00	.00	.00	10.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00	19.00	13.85	54.00	.00
.12	.00			2.02	50.00	2.74	.023				

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.3	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.000					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 262.97 O/F = .613 SPC = 1.615

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.388	2.690
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE	
IS IT IN CONTROL	YES
PRESSURE IN	478.3
PRESSURE OUT	253.5
TEMPERATURE IN	997.5

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 16:59:39 PAGE 2 OF 2

* CONDITION * 200 HP, 0.0 PAMB, 3000 PSI HYD SYS

COMBUSTOR INFORMATION		OXYGEN FLOW	
HYDROGEN FLOW	4.388		2.690
PRESSURE IN	251.7	PRESSURE OUT	251.7
TEMPERATURE IN H2	997.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION		SPECIFIC HEAT RATIO	
INLET FLOW	7.077		1.367
PRESSURE IN	251.3	PRESSURE OUT	4.0
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1367.0
ENTHALPY IN	4895.0	ENTHALPY OUT	3320.0
PRESSURE RATIO	63.52	EFFICIENCY	.501

RECUPERATOR INFORMATION						
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT
COLD SIDE 6.980	480.6	479.6	700.7	997.5	2376.5	3410.8
HOT SIDE 7.077	3.8	2.4	1367.0	904.6	3320.0	2299.9
* TURBINE EXHAUST OVERBOARD PRESSURE *						1.60

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
2.593	4.472

H2 PREHEATER INFORMATION						
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT
COLD SIDE 4.388	500.0	500.0	75.0	396.9	54.3	1288.7
HOT SIDE 2.593	475.1	475.0	997.5	405.7	3410.8	1321.9

JET PUMP PERFORMANCE				
PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	87.42	4.39	499.87	396.91
RESULTANT	52.22	2.59	474.97	405.69
FLOW PARA RATIO		6.98	482.19	400.18
JET PUMP RISE	1.0152	.597	P PRI/P SEC	1.0524
		1.749	JPSF	2.30

LUBE OIL COOLER INFORMATION						
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT
COLD SIDE 6.980	482.1	481.5	400.2	441.0	1301.0	1454.3
HOT SIDE 30.000	200.0	196.9	543.4	462.4	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION						
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT
COLD SIDE 6.980	481.4	480.6	440.8	700.7	1453.5	2376.5
HOT SIDE 818.4	100.0	95.4	750.0	736.2	.0	.0

HEAT REJECTED 6443.11

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 16:59:150 PAGE 1 OF 2

* CONDITION * 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				2.74
					.023

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS	GEAR BOX
400.00	12.00	.60		20.63

TURBINE OUTPUT POWER = 432.42 O/F = .641 SPC = 1.639

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.198	4.617
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	448.6	499.6
PRESSURE OUT	413.2	438.4
TEMPERATURE IN	947.0	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 16:59:50 PAGE 2 OF 2

* CONDITION * 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.198	OXYGEN FLOW	4.617
PRESSURE IN	410.3	PRESSURE OUT	410.3
TEMPERATURE IN H2	947.0	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.815	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	409.7	PRESSURE OUT	7.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1366.4
ENTHALPY IN	4832.6	ENTHALPY OUT	3280.0
PRESSURE RATIO	58.02	EFFICIENCY	.508

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	11.829	454.5	452.0	657.7	947.1	2225.6	3234.9
HOT SIDE	11.815	6.9	3.9	1366.4	900.6	3280.0	2269.4
* TURBINE EXHAUST OVERBOARD PRESSURE *							2.64

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
4.631	7.100

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.198	500.0	499.9	75.0	392.9	54.3	1273.4
HOT SIDE	4.631	444.9	444.6	947.1	410.6	3234.9	1340.1

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	142.67	7.20	499.67
SECONDARY JET	93.84	4.63	444.42
RESULTANT		11.83	458.79
FLOW PARA RATIO		.658	P PRI/P SEC
JET PUMP RISE	1.0323	PRI FLOW PARA	.2855 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	11.829	458.5	456.9	399.8	431.5	1299.5	1418.7
HOT SIDE	30.000	200.0	196.9	558.8	452.6	.0	.0

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	11.829	456.6	454.6	431.5	657.7	1418.7	2225.6
HOT SIDE	1450.0	100.0	91.5	750.0	738.5	.0	.0

HEAT REJECTED 9544.25

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Case 36

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750,
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* CONDITION * 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4	
.00	.00
3.64	.00
19.00	13.85
.12	.00

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.800					

HEAT EXCHANGER SCALE FACTORS			
HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD
H2 PREHEATER	2.00	2.00	.50
HYD O COOLER	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00

* POINT INPUT DATA *			
HYDRA HP	ELECT HP	P AMB	P HYDRA OIL
.00	.00	5.00	3000.0
			ALT SIZE(KW)
			35.0

* OUTPUT DATA *

DRIVE POWER			
HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS
40.00	12.00	.60	2.63
TURBINE OUTPUT POWER = 54.97 O/F = .534 SPC = 1.897			

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.133	.605
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	498.7	500.0
PRESSURE OUT	64.0	67.1
TEMPERATURE IN	1136.3	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750,
8 JUNE 1971 16:59:57 PAGE 2 OF 2

* CONDITION * 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	1.133	OXYGEN FLOW	.605
PRESSURE IN	63.4	PRESSURE OUT	63.4
TEMPERATURE IN H2	1136.3	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	1.738	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	63.3	PRESSURE OUT	5.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1498.7
ENTHALPY IN	5083.2	ENTHALPY OUT	3743.2
PRESSURE RATIO	12.46	EFFICIENCY	.554

RECUPERATOR INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	1.677	498.8	498.7	730.7	1136.3	2482.1	3893.8	.928
HOT SIDE	1.738	5.1	5.0	1498.7	911.5	3743.2	2380.9	.765
* TURBINE EXHAUST OVERBOARD PRESSURE *							4.99	

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.545	.271

H2 PREHEATER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	1.133	500.0	500.0	75.0	398.5	54.3	1294.6	.305
HOT SIDE	.545	498.5	498.5	1136.3	403.4	3893.8	1313.4	.691

JET PUMP PERFORMANCE					
FLOW PARA	FLOW	PRESSURE	TEMPERATURE		
PRIMARY JET	22.61	1.13	499.99	398.46	
SECONDARY JET	10.94	.54	498.47	403.39	
RESULTANT		1.68	498.99	400.06	
FLOW PARA RATIO		.484	P PRI/P SEC	1.0031	
JET PUMP RISE	1.0011	PRI FLOW PARA	.0452	JPSF	2.30

LUBE OIL COOLER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	1.677	499.0	498.9	400.1	504.3	1300.7	1685.9	.552
HOT SIDE	30.000	200.0	196.9	588.7	543.8	.0	.0	.238

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	1.677	498.9	498.9	504.1	730.7	1685.3	2482.1	.922
HOT SIDE	29.0	100.0	99.8	750.0	666.3	.0	.0	.340

HEAT REJECTED 1336.48

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750,
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* CONDITION * 100 HP, 5.0 PAMB, 3000 PSI HYDSYS
* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4	
.03	.00
3.64	.00
19.00	13.85
.12	.00

SF	JP	P	SF	JP	W	TUR	OB	CA	JP	PR	CA	TURB	NOZ
1.00J	.000	1.000	1.000	1.000	12.560	.2000	.1210						
TUR LKCA	ETA	COMB	LUBE	P	HP	ETA	LQPP	T	TUR	IN	T	HHX	IN
.0002	.98		.30		.5			2060.00		400.00		1500.00	

ETA	CORF	O/F	BASE
.0925		.600	

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA	COLD	ETAHA	HOT	RHODP	COLD	RHODP	HOT
H2 PREHEATER	2.00		2.00		.50		1.00	
HYD O COOLER	1.00		1.00		1.00		1.00	
LUB O COOLER	1.00		1.00		1.00		1.00	
RECUPERATOR	1.00		1.00		1.00		1.00	

* POINT INPUT DATA *

HYDRA	HP	ELECT	HP	P	AMB	P	HYDRA	OIL	ALT	SIZE(KW)
100.00		.00		5.00		3000.0			35.0	

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP 140.00	ALTERNATOR 12.00
LUBE PUMP .60	GEAR BOX 7.63

TURBINE OUTPUT POWER = 160.25 O/F * .582 SPC = 1.679

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.835	1.649
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

IS IT IN CONTROL	CONTROL VALVE
PRESSURE IN	YES 491.4
PRESSURE OUT	YES 160.3
TEMPERATURE IN	YES 1050.5

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750,
8 JUNE 1971 17:00:07 PAGE 2 OF 2

* CONDITION * 100 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	2.835	OXYGEN FLOW	1.649
PRESSURE IN	159.1	PRESSURE OUT	159.1
TEMPERATURE IN H2	1050.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.484	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	158.8	PRESSURE OUT	5.5
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1406.0
ENTHALPY IN	4967.6	ENTHALPY OUT	3453.1
PRESSURE RATIO	28.70	EFFICIENCY	.534

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.378	492.4	491.9	725.2	1050.6	2462.5	3595.9	.478
HOT SIDE 4.484	5.5	5.2	1406.0	914.1	3453.1	2346.5	.722

* TURBINE EXHAUST OVERBOARD PRESSURE * 5.01

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.543	1.917

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.835	500.0	500.0	75.0	399.0	54.3	1296.7	.332
HOT SIDE 1.543	490.0	490.0	1050.6	403.3	3595.9	1312.9	.663

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	56.63	2.83	499.95
SECONDARY JET	30.99	1.54	489.99
RESULTANT		4.38	493.12
FLOW PARA RATIO		.547	P PRI/P SEC
JET PUMP RISE	1.0064	PRI FLOW PARA	.1133 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.378	493.1	492.8	400.5	452.9	1302.4	1498.4	.373
HOT SIDE 30.000	200.0	196.9	541.1	476.6	.0	.0	.458

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.378	492.8	492.4	452.9	725.2	1498.4	2462.5	.916
HOT SIDE 423.7	100.0	97.8	750.0	732.5	.0	.0	.059

HEAT REJECTED 4220.70

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750,
8 JUNE 1971 17:00:18 PAGE 1 OF 2

* CONDITION * 200 HP, 5. PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.30	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAMA COLD	ETAMA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 265.14 O/F = .610 SPC = 1.650

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.530	2.762
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE	
IS IT IN CONTROL	YES
PRESSURE IN	476.9
PRESSURE OUT	259.7
TEMPERATURE IN	1002.7
	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750,
8 JUNE 1971 17:00:18 PAGE 2 OF 2

* CONDITION * 200 HP, 5. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.530	OXYGEN FLOW	2.762
PRESSURE IN	257.8	PRESSURE OUT	257.8
TEMPERATURE IN H2	1002.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.292	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	257.4	PRESSURE OUT	6.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1383.3
ENTHALPY IN	4902.7	ENTHALPY OUT	3361.2
PRESSURE RATIO	40.42	EFFICIENCY	.522

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.182	479.3	476.2	698.1	1002.7	2367.3	3428.8	.444
HOT SIDE	7.292	6.3	5.4	1383.3	910.5	3361.2	2315.6	.690

* TURBINE EXHAUST OVERBOARD PRESSURE * 5.09

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
2.652	4.806

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	4.530	500.0	500.0	75.0	396.6	54.3	1287.6	.347
HOT SIDE	2.652	473.4	473.3	1002.7	405.9	3428.8	1322.6	.643

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	90.21	4.53	499.86
SECONDARY JET	53.44	2.65	473.26
RESULTANT		7.18	480.97
FLOW PARA RATIO	.592	P PRI/P SEC	1.0562
JET PUMP RISE	1.0163	PRI FLOW PARA	.1805 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.182	480.9	480.2	400.1	439.7	1300.5	1449.6	.280
HOT SIDE	30.000	200.0	196.9	541.9	460.7	.0	.0	.373

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.182	480.1	479.3	439.7	698.1	1449.4	2367.3	.833
HOT SIDE	818.4	100.0	95.4	750.0	735.9	.0	.0	.043

HEAT REJECTED 6592.74

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
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* CONDITION * 360 HP, 5.0 PAMB, 3000 HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP 400.00	GEAR BOX 20.63
ALTERNATOR 12.00	LUBE PUMP .60

TURBINE OUTPUT POWER = 432.10 O/F = .640 SPC = 1.652

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.254	4.644
PRESSURE	500.00	503.00
TEMPERATURE	75.00	303.00
ENTHALPY	54.3	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	448.0	499.6
PRESSURE OUT	417.4	442.6
TEMPERATURE IN	949.0	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 17:00:29 PAGE 2 OF 2

* CONDITION * 360 HP, 5.0 PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.254	OXYGEN FLOW	4.644
PRESSURE IN	414.5	PRESSURE OUT	414.5
TEMPERATURE IN H2	949.0	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.898	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	413.8	PRESSURE OUT	8.6
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1372.3
ENTHALPY IN	4835.4	ENTHALPY OUT	3294.7
PRESSURE RATIO	48.36	EFFICIENCY	.517

RECUPERATOR INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	11.908	454.0	451.4	657.0	948.9	2222.9	3241.5	.408
HOT SIDE	11.898	8.4	6.1	1372.3	902.8	3294.7	2275.3	.656

* TURBINE EXHAUST OVERBOARD PRESSURE * 5.33

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
4.655	7.188

H2 PREHEATER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.254	500.0	499.9	75.0	393.0	54.3	1273.7	.364
HOT SIDE	4.655	444.3	444.0	948.9	410.8	3241.5	1341.1	.616

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	143.80	7.25	499.66
SECONDARY JET	94.35	4.65	443.81
RESULTANT		11.91	458.35
FLOW PARA RATIO		.656	P PRI/P SEC
JET PUMP RISE	1.0328	PRI FLOW PARA	.2878 JPSF
			2.30

LUBE OIL COOLER INFORMATION

	FLOW	PRE IN	F OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	11.908	458.1	456.4	400.0	431.4	1300.1	1418.4	.198
HOT SIDE	30.000	200.0	196.9	558.7	452.4	.0	.0	.670

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	11.908	456.1	454.2	431.4	657.0	1418.3	2222.9	.708
HOT SIDE	1450.0	100.0	91.5	750.0	738.4	.0	.0	.036

HEAT REJECTED 9582.36

94

10

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 17:00:34 PAGE 1 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYD SYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, G=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT	PRESSURE	LOSS	COEFFICIENTS	*10E+4				
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.80	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NO2
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETA MA COLD	ETA MA HOT	RHO DP COLD	RHO DP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER	HP LOSS
HYD PUMP 40.00	ALTERNATOR 12.00
LUBE PUMP .60	GEAR BOX 2.63

TURBINE OUTPUT POWER = 55.05 O/F = .508 SPC = 2.255

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.372	.697
PRESSURE	500.00	500.00
TEMPERATURE	75.00	303.00
ENTHALPY	54.3	52.8

IS IT IN CONTROL	CONTROL VALVE	YES	YES
PRESSURE IN	498.0	500.0	
PRESSURE OUT	76.5	79.9	
TEMPERATURE IN	1181.2	300.0	

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 17:00:34 PAGE 2 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYD SYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.372	OXYGEN FLOW	.697
PRESSURE IN	75.7	PRESSURE OUT	75.7
TEMPERATURE IN H2	1181.2	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.069	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	75.6	PRESSURE OUT	10.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1596.3
ENTHALPY IN	5151.0	ENTHALPY OUT	4021.8
PRESSURE RATIO	7.52	EFFICIENCY	.539

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.993	498.3	498.1	718.5	1181.1	2433.3	4049.8	.527
HOT SIDE 2.069	10.1	10.0	1596.3	939.8	4021.8	2470.3	.748

• TURBINE EXHAUST OVERBOARD PRESSURE • 9.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.621	.514

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.372	500.0	500.0	75.0	398.1	54.3	1293.2	.292
HOT SIDE .621	497.6	497.6	1181.1	403.9	4049.8	1315.4	.703

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	27.36	1.37	499.99
SECONDARY JET	12.49	.62	497.60
RESULTANT	1.99	498.45	399.91
FLOW PARA RATIO	.456	P PRI/P SEC	1.0048
JET PUMP RISE	1.0017	PRI FLOW PARA	.0547 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.993	498.4	498.4	399.9	487.3	1300.1	1624.3	.523
HOT SIDE 30.000	200.0	196.9	566.8	520.6	.0	.0	.277

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	111.8	25.5	646.2	

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.993	498.4	498.3	487.3	718.5	1624.4	2439.3	.880
HOT SIDE 29.0	100.0	99.8	750.0	647.3	.0	.0	.391

HEAT REJECTED 1624.01

47

5

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750, 8 JUNE 1971 17:00:46 PAGE 1 OF 2

• CONDITION • 100 HP, 10. PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE	LOSS COEFFICIENTS	*10E+4					
.00	.00	.00	110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	10.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
140.00	12.00
	.60
	7.63

TURBINE OUTPUT POWER = 160.54 O/F = .571 SPC = 1.801

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.067	1.751
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE	YES	YES
IS IT IN CONTROL		
PRESSURE IN	490.0	499.9
PRESSURE OUT	173.2	182.7
TEMPERATURE IN	1070.6	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750, 8 JUNE 1971 17:00:46 PAGE 2 OF 2

• CONDITION • 100 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW	1.751
3.067		
PRESSURE IN	PRESSURE OUT	171.8
171.8		
TEMPERATURE IN H2	TEMPERATURE IN O2	300.0
1070.6		

TURBINE INFORMATION

INLET FLOW	SPECIFIC HEAT RATIO	1.367
4.818		
PRESSURE IN	PRESSURE OUT	10.3
171.5		
TEMPERATURE IN	TEMPERATURE OUT	1454.8
2060.0		
ENTHALPY IN	ENTHALPY OUT	3580.8
4993.1		
PRESSURE RATIO	EFFICIENCY	.555
16.62		

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.683	491.1	490.6	720.8	1070.6	2447.3	3665.4	.477
HOT SIDE 4.818	10.3	10.1	1454.8	932.6	3580.8	2396.8	.711

* TURBINE EXHAUST OVERBOARD PRESSURE • 10.00

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.617	2.351

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.067	500.0	500.0	75.0	398.5	54.3	1294.6	.325
HOT SIDE 1.617	488.3	488.3	1070.6	403.3	3665.4	1312.8	.676

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	61.22	3.07	499.94
SECONDARY JET	32.47	1.62	488.23
RESULTANT	4.68	491.95	400.13
FLOW PARA RATIO	.530	P PRI/P SEC	1.0240
JET PUMP RISE	1.0076	PRI FLOW PARA	.1224 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.683	491.9	491.6	400.1	449.0	1300.9	1484.1	.359
HOT SIDE 30.000	200.0	196.9	536.3	471.5	.0	.0	.476

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.683	491.6	491.2	449.0	720.8	1484.0	2447.3	.903
HOT SIDE 423.7	100.0	97.8	750.0	731.3	.0	.0	.062

HEAT REJECTED 4511.76

87

12

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
 8 JUNE 1971 17:00:56 PAGE 1 OF 2

* CONDITION * 200 HP, 10. PAMB, 3000 PSI HYDSYS
 * UNITS * AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4
 .00 .00 1110.00 70000.00 .00 .00 10.00
 3.64 .00 1.18 1.44 .00 .66 3.50 20.00
 19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
 .12 .00

SFT TUR DN F SF JP P SF JP W TUR OBSCA JP PRICA TURB NOZ
 1.000 .000 1.000 1.000 12.560 .2000 .1210
 TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HHX IN T LHX O
 .0002 .98 .30 .5 2060.00 400.00 1500.00
 ETA CORF O/F BASE
 .0925 .600

HEAT EXCHANGER SCALE FACTORS
 HEAT EXCHANGER ETAMA COLD ETAMA HOT RHODP COLD RHODP HOT
 H2 PREHEATER 2.00 2.00 .50 1.00
 HYD O COOLER 1.00 1.00 1.00 1.00
 LUB O COOLER 1.00 1.00 1.00 1.00
 RECUPERATOR 1.00 1.00 1.00 1.00

* POINT INPUT DATA *
 HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
 200.00 .00 10.00 3000.0 35.0

* OUTPUT DATA *

DRIVE POWER HP LOSS
 HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
 240.00 12.00 .60 12.63

TURBINE OUTPUT POWER = 265.40 O/F * .604 SPC = 1.719

PROPELLANT HYDROGEN OXYGEN
 FLOW RATE 4.740 2.861
 PRESSURE 500.00 500.00
 TEMPERATURE 75.00 300.00
 ENTHALPY 54.3 52.8

CONTROL VALVE
 IS IT IN CONTROL YES YES
 PRESSURE IN 474.7 499.9
 PRESSURE OUT 271.4 287.1
 TEMPERATURE IN 1013.2 300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
 8 JUNE 1971 17:00:56 PAGE 2 OF 2

* CONDITION * 200 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION
 HYDROGEN FLOW 4.740 OXYGEN FLOW 2.861
 PRESSURE IN 269.3 PRESSURE OUT 269.3
 TEMPERATURE IN H2 1013.2 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
 INLET FLOW 7.601 SPECIFIC HEAT RATIO 1.366
 PRESSURE IN 268.9 PRESSURE OUT 10.8
 TEMPERATURE IN 2060.0 TEMPERATURE OUT 1413.1
 ENTHALPY IN 4917.1 ENTHALPY OUT 3436.9
 PRESSURE RATIO 24.99 EFFICIENCY .543

RECUPERATOR INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 7.470 477.3 476.2 694.3 1013.2 2354.3 3465.3 .444
 HOT SIDE 7.601 10.7 10.2 1413.1 921.7 3436.9 2345.2 .684
 * TURBINE EXHAUST OVERBOARD PRESSURE * 9.97

HOT BYPASS VALVE INFORMATION
 FLOW PRESSURE DROP
 2.729 5.350

H2 PREHEATER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 4.740 500.0 499.9 75.0 396.4 34.3 1286.9 .343
 HOT SIDE 2.729 470.8 470.8 1013.2 406.4 3465.3 1324.4 .647

JET PUMP PERFORMANCE
 FLOW PARA FLOW PRESSURE TEMPERATURE
 PRIMARY JET 94.38 4.74 499.85 396.44
 SECONDARY JET 55.02 2.73 470.70 406.35
 RESULTANT 7.47 479.17 400.00
 FLOW PARA RATIO .583 P PRI/P SEC 1.0619
 JET PUMP RISE 1.0180 PRI FLOW PARA .1888 JPSF 2.30

LUBE OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 7.470 479.1 478.4 400.1 438.2 1300.6 1443.9 .273
 HOT SIDE 30.000 200.0 196.9 540.0 458.5 .0 .0 .582

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
 509.1 535.9 25.5 1070.4

HYDRAULIC OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 7.470 478.3 477.4 438.1 694.3 1443.7 2354.3 .822
 HOT SIDE 818.4 100.0 95.4 750.0 735.4 .0 .0 .047

HEAT REJECTED 6801.56

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 17:01:31 PAGE 1 OF 2

* CONDITION * 360 HP, 10. PAMB, 3000 WYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4	
.00	.30
3.64	.00
19.00	13.85
.12	.00

SFT	TUR DN F	SF JP P	SF JP W	TUR OB CA	JP PR CA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAH COLD	ETAH HOT	RHDP COLD	RHDP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	10.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP	ALTERNATOR
400.00	12.00
LUBE PUMP	GEAR BOX
.60	20.63

TURBINE OUTPUT POWER = 432.20 O/F = .641 SPC = 1.695

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.440	4.766
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	446.2	499.6
PRESSURE OUT	426.3	452.1
TEMPERATURE IN	954.5	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 17:01:31 PAGE 2 OF 2

* CONDITION * 360 HP, 10. PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.440	OXYGEN FLOW	4.766
PRESSURE IN	423.3	PRESSURE OUT	423.3
TEMPERATURE IN H2	954.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	12.207	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	422.7	PRESSURE OUT	12.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1389.8
ENTHALPY IN	4834.5	ENTHALPY OUT	3332.5
PRESSURE RATIO	34.32	EFFICIENCY	.532

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	12.161	452.5	449.8	654.5	954.6	2214.1	3261.1	.408
HOT SIDE	12.207	12.2	10.6	1389.8	909.6	3332.5	2289.5	.653
* TURBINE EXHAUST OVERBOARD PRESSURE *							10.14	

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
4.720	7.496

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.440	500.0	499.9	75.0	392.5	54.3	1272.0	.361
HOT SIDE	4.720	442.3	442.0	954.6	411.0	3261.1	1341.5	.618

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	147.41	7.44	499.64
SECONDARY JET	95.69	4.72	441.83
RESULTANT		12.16	456.98
FLOW PARA RATIO		.649	P PRI/P SEC
JET PUMP RISE	1.0343	PRI FLOW PARA	.2950 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	12.161	456.7	455.0	399.7	430.5	1298.9	1414.9	.195
HOT SIDE	30.000	200.0	196.9	557.7	451.2	.0	.0	.674

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	12.161	454.6	452.6	430.5	654.5	1415.0	2214.1	.701
HOT SIDE	1450.0	100.0	91.5	750.0	738.3	.0	.0	.037

HEAT REJECTED 9718.29

50

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16.75 R H2,T20=400,T60=750.
8 JUNE 1971 17:01:39 PAGE 1 OF 2

• CONDITION • 0.0 HP,14.7PAMB,3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		HYDROGEN FLOW		OXYGEN FLOW	
.00	.00	1.610	.795	88.2	88.2
3.64	.00	1110.00	7000.00	1208.5	300.0
19.00	13.85	1.18	1.44	2060.0	1665.9
.12	.00	.00	.66	5190.2	4218.0
		2.02	50.00	5.97	.503

SFT	TUR DN F	SF JP P	SF JP W	TUR QBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS
HYD PUMP 40.00	ALTERNATOR 12.00
LUBE PUMP .60	GEAR BOX 2.63
TURBINE OUTPUT POWER = 55.01 O/F = .494 SPC = 2.623	

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.610	.795
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	497.2	300.0
PRESSURE OUT	89.1	92.9
TEMPERATURE IN	1208.5	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16.75 R H2,T20=400,T60=750.
8 JUNE 1971 17:01:39 PAGE 2 OF 2

• CONDITION • 0.0 HP,14.7PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.610	OXYGEN FLOW	.795
PRESSURE IN	88.2	PRESSURE OUT	88.2
TEMPERATURE IN H2	1208.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.405	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	88.1	PRESSURE OUT	14.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1665.9
ENTHALPY IN	5190.2	ENTHALPY OUT	4218.0
PRESSURE RATIO	5.97	EFFICIENCY	.503

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.315	497.6	497.4	704.9	1208.4	2391.5	4144.8	.524
HOT SIDE 2.405	14.7	14.7	1665.9	959.2	4218.0	2530.1	.735
• TURBINE EXHAUST OVERBOARD PRESSURE • 14.69							

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.705	.745

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.610	500.0	500.0	75.0	398.3	54.3	1294.1	.289
HOT SIDE .705	496.7	496.7	1208.4	403.5	4144.8	1313.9	.710

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET 32.14	1.61	499.98	398.33
SECONDARY JET 14.17	.71	496.69	403.53
RESULTANT 2.32	1.61	497.86	399.92
FLOW PARA RATIO .441	P PRI/P SEC		1.0066
JET PUMP RISE 1.0024	PRI FLOW PARA .0643	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.315	497.9	497.8	399.9	474.9	1300.1	1579.2	.495
HOT SIDE 30.000	200.0	196.9	551.5	504.2	.0	.0	.312

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.315	497.6	497.6	475.0	704.9	1579.5	2391.5	.836
HOT SIDE 29.0	100.0	99.8	750.0	630.0	.0	.0	.436

HEAT REJECTED 1880.18

51

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,75 R H2, T20*400, T60=750, PAGE 1 OF 2
8 JUNE 1971 17:01:49

• CONDITION • 100 HP, 14.7 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, G=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4	
.00	.00
3.64	.00
19.00	13.85
.12	.00

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAH COLD	ETAH HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
140.00	12.00
	.60
	7.63

TURBINE OUTPUT POWER = 160.65 O/F = .562 SPC = 1.921

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.292	1.850
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	488.6	499.9
PRESSURE OUT	185.6	195.4
TEMPERATURE IN	1086.9	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,75 R H2, T20*400, T60=750, PAGE 2 OF 2
8 JUNE 1971 17:01:49

• CONDITION • 100 HP, 14.7 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW	1.850
3.292		
PRESSURE IN	184.1	PRESSURE OUT 184.1
TEMPERATURE IN H2	1086.9	TEMPERATURE IN O2 300.0

TURBINE INFORMATION

INLET FLOW	5.142	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	183.8	PRESSURE OUT	14.9
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1496.3
ENTHALPY IN	5015.6	ENTHALPY OUT	3691.0
PRESSURE RATIO	12.30	EFFICIENCY	.559

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.987	489.9	489.3	716.5	1086.9	2432.0	3722.1 .475
HOT SIDE	5.142	14.9	14.7	1496.3	948.1	3691.0	2439.8 .703

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.68

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.695	2.791

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.292	500.0	500.0	75.0	398.3	54.3	1294.0 .319
HOT SIDE	1.695	486.5	486.5	1086.9	403.6	3722.1	1314.2 .675

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
65.70	3.29	499.93	398.31	
SECONDARY JET	34.05	1.69	486.47	403.64
RESULTANT		4.99	490.78	400.13
FLOW PARA RATIO		.518	P PRI/P SEC	1.0277
JET PUMP RISE	1.0089	PRI FLOW PARA	.1314	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.987	490.7	490.4	400.1	446.0	1300.9	1473.0 .346
HOT SIDE	30.000	200.0	196.9	532.6	467.3	.0	.0 .493

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3	

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.987	490.4	489.9	446.0	716.5	1472.8	2432.0 .890
HOT SIDE	423.7	100.0	97.8	750.0	730.2	.0	.0 .065

HEAT REJECTED 4783.28

52

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750,
8 JUNE 1971 17101159 PAGE 1 OF 2

* CONDITION * 200 HP, 14.7PAMB, 3000 PSI HYD SYS

* UNITS * AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		*10E+4			
.00	.00	.00	1110.00	70000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				

SFT	TUR ON F	SF JP P	SF JP W	TUR OBSCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.960	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LMX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.400					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	14.70	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 265.88 O/F = .598 SPC = 1.786

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.953	2.964
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	472.5	499.8
PRESSURE OUT	283.2	299.3
TEMPERATURE IN	1022.1	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750,
8 JUNE 1971 17101159 PAGE 2 OF 2

* CONDITION * 200 HP, 14.7PAMB, 3000 PSI HYD SYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.953	OXYGEN FLOW	2.964
PRESSURE IN	281.0	PRESSURE OUT	281.0
TEMPERATURE IN H2	1022.1	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.916	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	280.6	PRESSURE OUT	15.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1440.1
ENTHALPY IN	4929.4	ENTHALPY OUT	3505.2
PRESSURE RATIO	18.38	EFFICIENCY	.556

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.764	475.4	474.2	690.6	1022.1	2341.0	3496.3 .442
HOT SIDE	7.916	15.2	14.8	1440.1	931.9	3505.2	2372.1 .678

* TURBINE EXHAUST OVERBOARD PRESSURE * 14.66

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
2.811	5.882

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.953	500.0	499.9	75.0	396.2	54.3	1286.2 .339
HOT SIDE	2.811	468.3	468.2	1022.1	406.9	3496.3	1326.2 .650

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
SECONDARY JET	56.71	2.81	468.13	406.85	
RESULTANT		7.76	477.37	400.10	
FLOW PARA RATIO		.575	P PRI/P SEC	1.0677	
JET PUMP RISE	1.0197	PRI FLOW PARA	.1972	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.764	477.3	476.5	400.1	436.8	1300.7	1438.5 .265
HOT SIDE	30.000	200.0	196.9	538.2	456.5	.0	.0 .591

HEAT REJECTED ALTERNATOR 509.1 GEAR BOX 535.9 LUBE PUMP 25.5 TOTAL 1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.764	476.4	475.5	436.7	690.6	1438.3	2341.0 .810
HOT SIDE	818.4	100.0	95.4	750.0	735.0	.0	.0 .048

HEAT REJECTED 7008.46

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 17:02:20

PAGE 1 OF 2

• CONDITION • 360 HP, 14.7PAMB, 3000 WYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR ORCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.567	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T H4X IN	T LHX 0
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	14.70	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 429.96 O/F = .636 SPC = 1.735

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.600	4.832
PRESSURE	500.00	500.00
TEMPERATURE	75.00	300.00
ENTHALPY	54.3	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	444.6	439.6
PRESSURE OUT	430.3	456.4
TEMPERATURE IN	960.5	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16.75 R H2, T20=400, T60=750.
8 JUNE 1971 17:02:20

PAGE 2 OF 2

• CONDITION • 360 HP, 14.7PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.600	OXYGEN FLOW	4.832
PRESSURE IN	427.2	PRESSURE OUT	427.2
TEMPERATURE IN H2	960.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	12.433	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	426.5	PRESSURE OUT	16.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1407.5
ENTHALPY IN	4845.4	ENTHALPY OUT	3378.2
PRESSURE RATIO	26.01	EFFICIENCY	.544

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	12.367	451.2	448.4	652.4	960.6	2206.9	3281.9 .400
HOT SIDE	12.433	16.3	15.1	1407.5	916.9	3378.2	2308.9 .650

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.73

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
4.767	7.795

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.600	500.0	499.9	75.0	392.2	54.3	1270.6 .350
HOT SIDE	4.767	440.6	440.3	960.6	411.1	3281.9	1342.0 .620

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	150.51	7.60	499.63	392.16
RESULTANT	96.65	4.77	440.12	411.10
FLOW PARA RATIO		12.37	455.81	399.48
JET PUMP RISE	1.0356	.642	P PRI/P SEC	1.1352
			1.3013	JPSF
				2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	12.367	455.5	453.8	399.5	429.7	1298.1	1412.1 .192
HOT SIDE	30.000	200.0	196.9	556.9	450.3	.0	.0 .677

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
539.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	12.367	453.4	451.3	429.8	652.4	1412.3	2207.0 .695
HOT SIDE	1450.0	100.0	91.5	750.0	738.1	.0	.0 .037

HEAT REJECTED 9827.71

21

45

Case 48

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T60 = 550,
9 JUNE 1971 15:46:17 PAGE 1 OF 2

• CONDITION • 0.0 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT	PRESSURE	LOSS	COEFFICIENTS	*10E+4			
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT TUR DN F SF JP P SF JP W TUR ORCA JP PRICA TURB NOZ
1.000 .000 1.000 1.000 12,560 .2050 .1210
TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T H-X IN T LHX O
.0002 .98 .30 .5 2060.03 400.00 1500.00
ETA CORF O/F BASE
.0925 .600

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP ALTERNATOR LUBE PUMP	GEAR BOX
40.00 12.00 .60	2.63

TURBINE OUTPUT POWER = 55.45 O/F = .597 SPC = 1.515

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	.877	.523
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

IS IT IN CONTROL	CONTROL VALVE	YES	YES
PRESSURE IN	499.2	500.0	
PRESSURE OUT	50.2	53.4	
TEMPERATURE IN	1024.8	300.0	

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T60 = 550,
9 JUNE 1971 15:46:17 PAGE 2 OF 2

• CONDITION • 0.0 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION		
HYDROGEN FLOW	.877	OXYGEN FLOW .523
PRESSURE IN	49.8	PRESSURE OUT 49.8
TEMPERATURE IN H2	1024.8	TEMPERATURE IN O2 300.0

TURBINE INFORMATION		
INLET FLOW	1.400	SPECIFIC HEAT RATIO 1.368
PRESSURE IN	49.8	PRESSURE OUT .7
TEMPERATURE IN	2060.0	TEMPERATURE OUT 1327.0
ENTHALPY IN	4930.0	ENTHALPY OUT 3252.7
PRESSURE RATIO	66.40	EFFICIENCY .526

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.032	499.3	499.3	550.5	1024.7	1850.7	3506.0	.611
HOT SIDE 1.400	.7	.4	1327.0	777.5	3252.7	2031.8	.708

* TURBINE EXHAUST OVERBOARD PRESSURE * .30

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.156	.253

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE .877	500.0	500.0	300.0	399.8	908.5	1299.6	.138
HOT SIDE .156	499.0	499.0	1024.7	401.5	3506.0	1306.3	.860

JET PUMP PERFORMANCE				
PRIMARY JET	FLOW PARA 17.53	FLOW .88	PRESSURE 499.99	TEMPERATURE 399.77
SECONDARY JET	3.12	.16	499.03	401.54
RESULTANT		1.03	499.39	400.04
FLOW PARA RATIO		.178	P PRI/P SEC	1.0019
JET PUMP RISE	1.0007	PRI FLOW PARA	.0351	JPSF 2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.032	499.4	499.4	400.0	572.1	1306.6	1926.5	.612
HOT SIDE 30.000	200.0	196.9	661.4	641.4	.0	.0	.142

HEAT REJECTED			
ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.032	499.4	499.3	572.1	550.5	1926.5	1850.7	.979
HOT SIDE 29.0	100.0	99.8	500.0	555.9	.0	.0	.266

HEAT REJECTED -76.19

SECTION 3
DATA CASES 49 TO 96

55

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,300 R H2, T20=400,
 8 JUNE 1971 16:18:28 PAGE 1 OF 2
 • CONDITION • 100 HP, 0.0 PAMB, 3000 PSI HYDSYS
 • UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4

.90	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.30	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.300	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 158.69 O/F = .603 SPC = 1.609

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.654	1.600
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE	YES	YES
IS IT IN CONTROL	YES	YES
PRESSURE IN	493.1	500.0
PRESSURE OUT	153.1	162.4
TEMPERATURE IN	1014.9	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,300 R H2, T20=400,
 8 JUNE 1971 16:38:28 PAGE 2 OF 2
 • CONDITION • 100 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	2.654	OXYGEN FLOW	1.600
PRESSURE IN	152.0	PRESSURE OUT	152.0
TEMPERATURE IN H2	1014.9	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.254	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	151.8	PRESSURE OUT	2.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1368.2
ENTHALPY IN	4917.0	ENTHALPY OUT	3336.9
PRESSURE RATIO	66.16	EFFICIENCY	.497

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.134	493.8	493.6	547.0	1014.9	1838.3	3471.6	.370
HOT SIDE 4.254	2.2	1.4	1368.2	825.5	3336.9	2133.8	.661

• TURBINE EXHAUST OVERBOARD PRESSURE • .95

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.480	3.217

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.654	500.0	499.9	300.0	399.2	908.5	1297.4	.139
HOT SIDE .480	490.3	490.3	1014.9	405.1	3471.6	1319.7	.893

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	53.03	2.65	499.89
SECONDARY JET	9.65	.48	490.34
RESULTANT		3.13	494.17
FLOW PARA RATIO		.182	P PRI/P SEC
JET PUMP RISE	1.0078	PRI FLOW PARA	.1061 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.134	494.2	494.0	400.1	473.7	1300.8	1574.7	.448
HOT SIDE 30.000	200.0	196.9	567.1	505.1	.0	.0	.372

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.134	494.0	493.8	473.7	547.0	1574.7	1838.3	.960
HOT SIDE 423.7	100.0	97.8	550.0	545.7	.0	.0	.056

HEAT REJECTED 826.20

56

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:08:41 PAGE 1 OF 2

• CONDITION • 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1900.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
240.00	12.00	.60
		12.63

TURBINE OUTPUT POWER = 265.07 O/F = .621 SPC = 1.621

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.417	2.743
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	479.9	499.9
PRESSURE OUT	254.0	269.7
TEMPERATURE IN	982.7	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:08:41 PAGE 2 OF 2

• CONDITION • 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION	
HYDROGEN FLOW	4.417
PRESSURE IN	252.1
TEMPERATURE IN H2	982.7
OXYGEN FLOW	2.743
PRESSURE OUT	252.1
TEMPERATURE IN O2	300.0

TURBINE INFORMATION	
INLET FLOW	7.160
PRESSURE IN	251.7
TEMPERATURE IN	2060.0
ENTHALPY IN	4876.8
PRESSURE RATIO	64.22
SPECIFIC HEAT RATIO	1.367
PRESSURE OUT	3.9
TEMPERATURE OUT	1366.4
ENTHALPY OUT	3307.8
EFFICIENCY	.501

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.258	481.6	481.1	540.4	982.8	1815.3	3359.7	.536
HOT SIDE 7.160	3.8	2.3	1366.4	849.4	3307.8	2173.6	.626
• TURBINE EXHAUST OVERBOARD PRESSURE •					1.56		

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.841	9.404

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.417	500.0	499.8	300.0	399.3	908.5	1297.8	.145
HOT SIDE .841	471.7	471.7	982.8	403.5	3359.7	1313.6	.848

JET PUMP PERFORMANCE			
FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	88.27	4.42	499.70
SECONDARY JET	16.88	.84	471.68
RESULTANT		5.26	482.58
FLOW PARA RATIO	.191	P PRI/P SEC	1.0594
JET PUMP RISE	1.0231	PRI FLOW PARA	.1766 JPSF
			2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.258	482.5	482.2	400.0	454.4	1300.3	1503.9	.340
HOT SIDE 30.000	200.0	196.9	560.1	481.0	.0	.0	.494

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	935.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.258	482.1	481.6	454.4	540.4	1503.9	1815.3	.900
HOT SIDE 818.4	100.0	95.4	550.0	545.6	.0	.0	.046

HEAT REJECTED 1636.98

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400,
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• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDSYS
• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, G=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TUR NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* P O I N T I N P U T D A T A *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 432.34 O/F = .642 SPC = 1.639

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.192	4.616
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE	
IS IT IN CONTROL	YES
PRESSURE IN	455.8
PRESSURE OUT	413.4
TEMPERATURE IN	947.1
	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:08:51 PAGE 2 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.192	OXYGEN FLOW	4.616
PRESSURE IN	410.5	PRESSURE OUT	410.5
TEMPERATURE IN H2	947.1	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.808	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	409.9	PRESSURE OUT	7.0
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1366.0
ENTHALPY IN	4831.8	ENTHALPY OUT	3278.7
PRESSURE RATIO	58.63	EFFICIENCY	.507

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.647	460.4	459.1	528.7	947.1	1773.0	3235.3	.508
HOT SIDE 11.000	6.8	3.8	1366.0	872.1	3278.7	2207.0	.598

* TURBINE EXHAUST OVERBOARD PRESSURE * 2.59

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.455	18.357

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.192	500.0	499.5	300.0	399.1	908.5	1296.9	.153
HOT SIDE 1.455	440.7	440.7	947.1	403.9	3235.3	1314.9	.839

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	143.68	7.19	499.23
SECONDARY JET	29.24	1.45	440.68
RESULTANT		8.65	462.74
FLOW PARA RATIO		.203	P PRI/P SEC
JET PUMP RISE	1.0501	PRI FLOW PARA	.2878
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.647	462.6	461.7	399.9	443.4	1299.9	1463.0	.251
HOT SIDE 30.000	200.0	196.9	573.2	469.1	.0	.0	.601

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.647	461.5	460.4	443.4	528.7	1463.0	1773.0	.800
HOT SIDE 1450.0	100.0	91.5	550.0	546.0	.0	.0	.038

HEAT REJECTED 2680.60

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400,
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• CONDITION • 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT	PRESSURE	LOSS	COEFFICIENTS	*10E+4				
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.00	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR ON F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1300.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• • P O I N T I N P U T D A T A • •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	5.00	3000.0	35.0

• O U T P U T D A T A •

DRIVE POWER	HP LOSS
HYD PUMP ALTERNATOR LUBE PUMP	GEAR BOX
40.00 12.00 .60	2.63

TURBINE OUTPUT POWER = 54.81 O/F = .540 SPC = 1.903

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.129	.610
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE	YES	YES
IS IT IN CONTROL	YES	YES
PRESSURE IN	498.8	500.0
PRESSURE OUT	63.9	67.1
TEMPERATURE IN	1125.8	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:08158 PAGE 2 OF 2

• CONDITION • 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.129	OXYGEN FLOW	.610
PRESSURE IN	63.3	PRESSURE OUT	63.3
TEMPERATURE IN H2	1125.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.738	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	63.2	PRESSURE OUT	5.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1498.3
ENTHALPY IN	5068.0	ENTHALPY OUT	3732.1
PRESSURE RATIO	12.46	EFFICIENCY	.554

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.302	498.9	549.3	1125.8	1846.5	3857.3	.607
HOT SIDE	1.738	5.1	5.0	1498.3	846.3	3732.1	.687

* TURBINE EXHAUST OVERBOARD PRESSURE = 4.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.173	.482

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.129	500.0	500.0	300.0	399.7	908.5	.121
HOT SIDE	.173	498.4	498.4	1125.8	402.1	3857.3	.876

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	22.56	1.13	499.98
SECONDARY JET	3.47	.17	498.40
RESULTANT	1.30	499.04	400.02
FLOW PARA RATIO	.154	P PRI/P SEC	1.0032
JET PUMP RISE	1.0013	PRI FLOW PARA	.0491 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.302	499.0	499.0	400.0	535.2	1300.5	.589
HOT SIDE	30.000	200.0	196.9	631.2	988.6	.0	.184

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.4	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.302	499.0	498.9	535.2	549.3	1796.7	.951
HOT SIDE	29.0	100.0	99.8	950.0	945.1	.0	.338

HEAT REJECTED 64.80

59

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:09:08 PAGE 1 OF 2

• CONDITION • 100 HP, 5.0 PAMB, 3000 PSI HYD SYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4			
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBSCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER	HP LOSS		
MYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 160.26 O/F = .591 SPC = 1.685

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.828	1.673
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	492.2	500.0
PRESSURE OUT	160.4	170.0
TEMPERATURE IN	1033.8	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:09:08 PAGE 2 OF 2

• CONDITION • 100 HP, 5.0 PAMB, 3000 PSI HYD SYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	2.828	OXYGEN FLOW	1.673
PRESSURE IN	159.1	PRESSURE OUT	159.1
TEMPERATURE IN H2	1033.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.501	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	158.9	PRESSURE OUT	5.5
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1404.7
ENTHALPY IN	4944.1	ENTHALPY OUT	3435.7
PRESSURE RATIO	28.84	EFFICIENCY	.933

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.324	493.0	492.7	546.2	1033.9	1835.7	3938.0
HOT SIDE	4.801	5.5	5.1	1404.7	842.1	3435.7	2178.7

* TURBINE EXHAUST OVERBOARD PRESSURE * 5.01

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.496	3.684

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.828	500.0	499.9	300.0	399.1	908.5	1297.0
HOT SIDE	.496	489.0	489.0	1033.9	405.4	3538.0	1320.8

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	56.50	2.83	499.87
SECONDARY JET	9.98	.50	489.03
RESULTANT		3.32	493.39
FLOW PARA RATIO		.177	P PRI/P SEC
JET PUMP RISE	1.0089	PRI FLOW PARA	.1130 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.324	493.4	493.2	400.0	469.3	1300.5	1558.7
HOT SIDE	30.000	200.0	196.9	561.7	499.2	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.324	493.2	493.0	469.3	546.2	1558.7	1835.7
HOT SIDE	423.7	100.0	97.8	550.0	545.2	.0	.0

HEAT REJECTED 920.60

69

10

Case 54

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II;TURB 16,300 R H2,T20=400, 16:09:19 PAGE 1 OF 2
8 JUNE 1971

* CONDITION * 200 HP,5. PAMB,3000 PSI WYDSYS

* UNITS * AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4			
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T MHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 265.25 O/F = .616 SPC = 1.653

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.524	2.786
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

IS IT IN CONTROL	CONTROL VALVE	
	YES	YES
PRESSURE IN	478.9	499.9
PRESSURE OUT	259.7	275.5
TEMPERATURE IN	990.1	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II;TURB 16,300 R H2,T20=400, 16:09:19 PAGE 2 OF 2
8 JUNE 1971

* CONDITION * 200 HP,5. PAMB,3000 PSI WYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	4.524	OXYGEN FLOW	2.786
PRESSURE IN	257.8	PRESSURE OUT	257.8
TEMPERATURE IN H2	990.1	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	7.309	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	257.4	PRESSURE OUT	6.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1382.4
ENTHALPY IN	4888.7	ENTHALPY OUT	3350.6
PRESSURE RATIO	40.69	EFFICIENCY	.522

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.374	480.8	480.2	539.9	990.3	1813.2	3385.8 .535
HOT SIDE	7.309	6.2	5.4	1382.4	857.3	3350.6	2194.5 .623

* TURBINE EXHAUST OVERBOARD PRESSURE * 5.08

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.850	9.771

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.524	500.0	499.8	300.0	399.3	908.5	1297.8 .144
HOT SIDE	.850	470.5	470.5	990.3	403.5	3385.8	1313.6 .850

JET PUMP PERFORMANCE				
PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	17.08	.85	470.45	403.51
RESULTANT		5.37	481.78	400.00
FLOW PARA RATIO		.189	P PRI/P SEC	1.0621
JET PUMP RISE	1.0241	PRI FLOW PARA	.1809	JPSF 2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.374	481.7	481.3	400.0	453.2	1300.3	1499.5 .536
HOT SIDE	30.000	200.0	196.9	558.6	479.3	.0	.0 .500

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.374	481.3	480.8	453.2	539.9	1499.5	1813.2 .895
HOT SIDE	818.4	100.0	95.4	550.0	545.5	.0	.0 .047

HEAT REJECTED 1686.08

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:09:28 PAGE 1 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 WYDSYS

• UNITS • AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	7000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.800					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	5.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
400.00	12.00	.60
		20.63

TURBINE OUTPUT POWER = 432.49 O/F = .639 SPC = 1.651

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.260	4.640
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	455.2	499.6
PRESSURE OUT	417.5	442.6
TEMPERATURE IN	949.7	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:09:28 PAGE 2 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION		OXYGEN FLOW	
HYDROGEN FLOW	7.260	OXYGEN FLOW	4.640
PRESSURE IN	414.6	PRESSURE OUT	414.6
TEMPERATURE IN H2	949.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION		SPECIFIC HEAT RATIO	
INLET FLOW	11.899	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	413.9	PRESSURE OUT	8.5
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1372.2
ENTHALPY IN	4837.8	ENTHALPY OUT	3295.9
PRESSURE RATIO	46.64	EFFICIENCY	.516

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.719	459.9	458.6	528.3	949.7	1771.7	3244.3 .499
HOT SIDE	11.899	8.3	6.1	1372.2	875.4	3295.9	2216.8 .589
* TURBINE EXHAUST OVERBOARD PRESSURE *					5.31		

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
1.460	18.557

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.260	500.0	499.4	300.0	399.0	908.5	1296.5 .152
HOT SIDE	1.460	440.0	440.0	949.7	403.9	3244.3	1314.6 .848

JET PUMP PERFORMANCE				
PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	145.00	7.26	499.22	398.96
SECONDARY JET	29.33	1.46	439.99	403.85
RESULTANT		8.72	462.31	399.83
FLOW PARA RATIO		.202	P PRI/P SEC	1.1346
JET PUMP RISE	1.0507	PRI FLOW PARA	.2905	JPSF 2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.719	462.2	461.2	399.8	442.9	1299.5	1461.2 .249
HOT SIDE	30.000	200.0	196.9	572.6	468.5	.0	.0 .603

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.719	461.0	460.0	442.9	528.3	1461.2	1771.7 .797
HOT SIDE	1450.0	100.0	91.5	550.0	545.9	.0	.0 .038

HEAT REJECTED 2706.88

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20#400,
8 JUNE 1971 16:09:33 PAGE 1 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, G=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT	PRESSURE	LOSS	COEFFICIENTS	*10E+4				
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.80	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T MHX IN	T LMX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETA	COLD	ETA	HOT	RHOOP	COLD	RHOOP	HOT
H2 PREHEATER	2.00		2.00		.50		1.00	
HYD O COOLER	1.00		1.00		1.00		1.00	
LUB O COOLER	1.00		1.00		1.00		1.00	
RECUPERATOR	1.00		1.00		1.00		1.00	

• • POINT INPUT DATA • •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	10.00	3000.0	35.0

• O U T P U T D A T A •

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.02 O/F = .509 SPC = 2.256

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.371	.698
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	498.1	500.0
PRESSURE OUT	76.4	79.9
TEMPERATURE IN	1179.2	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20#400,
8 JUNE 1971 16:09:33 PAGE 2 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.371	OXYGEN FLOW	.698
PRESSURE IN	75.7	PRESSURE OUT	75.7
TEMPERATURE IN H2	1179.2	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.069	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	75.6	PRESSURE OUT	10.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1396.3
ENTHALPY IN	5148.1	ENTHALPY OUT	4019.6
PRESSURE RATIO	7.92	EFFICIENCY	.939

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.366	498.4	498.3	546.7	1179.2	1837.5	4043.1 .603
HOT SIDE	2.069	10.1	10.0	1396.3	888.5	4019.6	2349.5 .676

* TURBINE EXHAUST OVERBOARD PRESSURE = 9.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.196	.851

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.371	500.0	500.0	300.0	399.6	908.5	1299.0 .113
HOT SIDE	.196	497.4	497.4	1179.2	402.7	4043.1	4310.7 .883

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	27.40	1.37	499.97
SECONDARY JET	3.93	.20	497.42
RESULTANT		1.57	498.47
FLOW PARA RATIO		.143	P PRI/P SEC
JET PUMP RISE	1.0021	PRI FLOW PARA	.0546 JPSF

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.366	498.5	498.4	400.0	511.8	1300.5	1713.0 .562
HOT SIDE	30.000	200.0	196.9	399.0	554.7	.0	.0 .223

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.366	498.4	498.4	511.8	546.7	1712.9	1837.5 .914
HOT SIDE	29.0	100.0	99.8	550.0	535.2	.0	.0 .388

HEAT REJECTED 195.13

63

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:09:44 PAGE 1 OF 2

* CONDITION * 100 HP, 10. PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		TURBINE LOSS COEFFICIENTS *10E+4	
.00	.00	1110.00	70000.00
3.64	.00	1.18	1.44
19.00	13.85	.00	2.02
.12	.00		50.00

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	10.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 160.66 O/F = .577 SPC = 1.804

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.063	1.766
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.8	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	490.8	499.9
PRESSURE OUT	173.2	182.9
TEMPERATURE IN	1059.3	300.8

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:09:44 PAGE 2 OF 2

* CONDITION * 100 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	3.063	OXYGEN FLOW	1.766
PRESSURE IN	171.8	PRESSURE OUT	171.8
TEMPERATURE IN H2	1059.3	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.829	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	171.5	PRESSURE OUT	10.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1453.9
ENTHALPY IN	4979.9	ENTHALPY OUT	3570.0
PRESSURE RATIO	16.68	EFFICIENCY	.555

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.980	491.7	491.5	545.1	1059.3	1831.8	3626.2	.566
HOT SIDE 4.829	10.3	10.0	1453.9	864.6	3570.0	2239.8	.648

* TURBINE EXHAUST OVERBOARD PRESSURE * 9.97

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.517	4.402

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.063	500.0	499.9	300.0	399.1	908.5	1297.1	.131
HOT SIDE .917	487.1	487.1	1059.3	486.0	3626.2	1323.1	.868

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	61.20	3.06	499.85	399.13
RESULTANT	10.42	.52	487.05	405.97
FLOW PARA RATIO		3.58	492.22	400.13
JET PUMP RISE	1.0106	.170	P PRI/P SEC	1.0263
			.1224	JPSF
				2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.980	492.2	492.0	400.1	464.3	1300.9	1540.6	.413
HOT SIDE 30.000	200.0	196.9	559.5	492.4	.0	.0	.406

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.980	492.0	491.7	464.3	545.1	1540.6	1831.8	.943
HOT SIDE 423.7	130.0	97.8	550.0	544.6	.0	.0	.063

HEAT REJECTED 1042.33

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, 16109157 PAGE 1 OF 2
8 JUNE 1971

* CONDITION * 200 HP, 10. PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR QBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETA MA COLD	ETA MA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	10.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
240.00	12.63
ALTERNATOR	LUBE PUMP
12.00	.60

TURBINE OUTPUT POWER = 265.79 O/F = .609 SPC = 1.722

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.741	2.886
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

IS IT IN CONTROL	CONTROL VALVE
	YES
PRESSURE IN	477.0
PRESSURE OUT	271.7
TEMPERATURE IN	1004.1
	YES
	499.9
	287.8
	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, 16109157 PAGE 2 OF 2
8 JUNE 1971

* CONDITION * 200 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	4.741	OXYGEN FLOW	2.886
PRESSURE IN	269.7	PRESSURE OUT	269.7
TEMPERATURE IN H2	1004.1	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	7.627	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	269.3	PRESSURE OUT	10.7
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1412.4
ENTHALPY IN	4904.8	ENTHALPY OUT	3427.6
PRESSURE RATIO	25.08	EFFICIENCY	.544

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.611	479.1	478.5	538.7	1004.1	1809.0	3433.8
HOT SIDE	7.627	10.7	10.2	1412.4	872.1	3427.6	2232.1
* TURBINE EXHAUST OVERBOARD PRESSURE *							9.97

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.871	10.578

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.741	500.0	499.8	300.0	399.3	908.5	1297.9
HOT SIDE	.871	467.9	467.9	1004.1	403.5	3433.8	1313.6

JET PUMP PERFORMANCE							
PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE			
SECONDARY JET	94.73	4.74	499.66	399.34			
RESULTANT	17.49	.87	467.91	403.51			
FLOW PARA RATIO		5.61	480.17	400.02			
JET PUMP RISE	1.0262	PRI FLOW PARA	.1896	JPSF	2.30		1.0679

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.611	480.1	479.7	400.0	450.9	1300.4	1491.1
HOT SIDE	30.000	200.0	196.9	555.8	476.2	.0	.0

HEAT REJECTED			
ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.611	479.6	479.1	450.9	538.7	1491.1	1809.0
HOT SIDE	818.4	100.0	95.4	550.0	545.2	.0	.0

HEAT REJECTED 1784.02

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65

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400;
8 JUNE 1971 16:10:08 PAGE 1 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 HYOSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0802	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER				HP LOSS
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX	
400.00	12.00	.60	20.63	

TURBINE OUTPUT POWER = 433.04 O/F = .636 SPC = 1.690

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.455	4.740
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	453.5	499.6
PRESSURE OUT	428.0	453.3
TEMPERATURE IN	956.8	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400;
8 JUNE 1971 16:10:08 PAGE 2 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 HYOSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.455	OXYGEN FLOW	4.740
PRESSURE IN	425.0	PRESSURE OUT	425.0
TEMPERATURE IN H2	956.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	12.195	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	424.3	PRESSURE OUT	12.2
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1389.8
ENTHALPY IN	4845.3	ENTHALPY OUT	3330.7
PRESSURE RATIO	34.64	EFFICIENCY	.931

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.938	458.5	457.1	927.3	956.8	1768.1	3269.0	.498
HOT SIDE 12.195	12.1	10.6	1389.6	884.3	3330.7	2238.6	.986

* TURBINE EXHAUST OVERBOARD PRESSURE = 10.09

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.483	19.123

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.455	500.0	499.4	300.0	399.1	908.5	1897.1	.151
HOT SIDE 1.483	438.0	438.0	956.8	404.2	3269.0	1315.8	.841

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	148.93	7.45	499.18
SECONDARY JET	29.81	1.48	437.94
RESULTANT		8.94	461.00
FLOW PARA RATIO	.200	P PRI/P SEC	1.1398
JET PUMP RISE	1.0527	PRI FLOW PARA	.2983 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.938	460.9	459.9	400.0	442.0	1300.2	1457.9	.245
HOT SIDE 30.000	200.0	196.9	371.5	467.2	.0	.0	.600

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.938	459.7	458.6	442.0	527.3	1457.8	1768.1	.798
HOT SIDE 1450.0	100.0	91.5	550.0	545.8	.0	.0	.039

HEAT REJECTED 2772.66

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Case 60

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:10:15 PAGE 1 OF 2

• CONDITION • 0.0 HP, 14.7PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, G=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.14 O/F = .491 SPC = 2.617

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.614	.792
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	497.4	500.0
PRESSURE OUT	89.2	92.9
TEMPERATURE IN	1213.8	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I, TURB 16,300 R H2, T20=400,
8 JUNE 1971 16:10:15 PAGE 2 OF 2

• CONDITION • 0.0 HP, 14.7PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.614	OXYGEN FLOW	.792
PRESSURE IN	88.3	PRESSURE OUT	88.3
TEMPERATURE IN H2	1213.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.405	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	88.1	PRESSURE OUT	14.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1665.7
ENTHALPY IN	5198.6	ENTHALPY OUT	4224.0
PRESSURE RATIO	5.97	EFFICIENCY	.503

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.834	497.7	497.6	543.0	1213.7	1024.5	4163.6 .597
HOT SIDE	2.405	14.7	14.7	1665.7	919.7	4224.0	2440.0 .664

* TURBINE EXHAUST OVERBOARD PRESSURE * 14.69

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.221	1.204

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.814	500.0	500.0	300.0	399.5	908.5	1298.6 .109
HOT SIDE	.221	496.4	496.4	1213.7	403.2	4163.6	1312.7 .887

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
SECONDARY JET	32.25	1.61	499.95	399.52	
RESULTANT	4.43	.22	496.39	403.22	
FLOW PARA RATIO		1.83	497.86	399.97	
JET PUMP RISE	.137	P PRI/P SEC		1.0072	
	1.0030	PRI FLOW PARA	.0645	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.834	497.9	497.8	400.0	495.1	1300.3	1652.6 .539
HOT SIDE	30.000	200.0	196.9	576.4	530.8	.0	.0 .259

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.834	497.8	497.7	495.1	543.0	1652.7	1824.5 .872
HOT SIDE	29.0	100.0	99.8	550.0	525.9	.0	.0 .439

HEAT REJECTED 315.12

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400;
8 JUNE 1971 16:10:25 PAGE 1 OF 2

• CONDITION • 100 HP, 14.7PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• I N P U T D A T A •
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4
 .00 .00 .00 1110.00 70000.00 .00 .00 10.00
 3.64 .00 1.18 1.44 .00 .66 3.50 20.00
 19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
 .12 .00
 SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRICA TURB NOZ
 1.000 .000 1.000 1.000 12.560 .2000 .1210
 TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HHX IN T LHX O
 .0002 .98 .30 .5 2060.00 400.00 1300.00
 ETA CORF O/F BASE
 .0925 .600

HEAT EXCHANGER SCALE FACTORS
 H2 PREHEATER ETAHA COLD ETAHA HOT RHODP COLD RHODP HOT
 2.00 2.00 .50 1.00
 HYD O COOLER 1.00 1.00 1.00 1.00
 LUB O COOLER 1.00 1.00 1.00 1.00
 RECUPERATOR 1.00 1.00 1.00 1.00

• • POINT INPUT DATA • •
 HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
 100.00 .00 14.70 3000.0 35.0

• O U T P U T D A T A •

DRIVE POWER HP LOSS
 HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
 140.00 12.00 .60 7.63

TURBINE OUTPUT POWER = 160.70 O/F = .566 SPC = 1.924

PROPELLANT HYDROGEN OXYGEN
 FLOW RATE 3.289 1.863
 PRESSURE 500.00 500.00
 TEMPERATURE 300.00 300.00
 ENTHALPY 908.5 52.8

CONTROL VALVE
 IS IT IN CONTROL YES YES
 PRESSURE IN 489.5 499.9
 PRESSURE OUT 185.7 195.7
 TEMPERATURE IN 1078.9 300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400;
8 JUNE 1971 16:10:25 PAGE 2 OF 2

• CONDITION • 100 HP, 14.7PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION
 HYDROGEN FLOW 3.289 OXYGEN FLOW 1.863
 PRESSURE IN 184.1 PRESSURE OUT 184.1
 TEMPERATURE IN H2 1078.9 TEMPERATURE IN O2 300.0
 TURBINE INFORMATION
 INLET FLOW 5.153 SPECIFIC HEAT RATIO 1.366
 PRESSURE IN 183.9 PRESSURE OUT 14.9
 TEMPERATURE IN 2060.0 TEMPERATURE OUT 1495.8
 ENTHALPY IN 5004.7 ENTHALPY OUT 3682.6
 PRESSURE RATIO 12.31 EFFICIENCY .559

RECUPERATOR INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.828 490.5 490.2 543.9 1078.9 1827.5 3694.0 .568
 HOT SIDE 5.153 14.9 14.7 1495.8 886.0 3682.6 2295.9 .641
 • TURBINE EXHAUST OVERBOARD PRESSURE = 14.68

HOT BYPASS VALVE INFORMATION
 FLOW PRESSURE DROP
 .539 5.101

H2 PREHEATER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.289 500.0 499.9 300.0 399.0 908.5 1294.6 .127
 HOT SIDE .839 485.1 485.1 1078.9 406.4 3694.0 1324.5 .863

JET PUMP PERFORMANCE
 FLOW PARA FLOW PRESSURE TEMPERATURE
 PRIMARY JET 65.70 3.29 499.83 398.98
 SECONDARY JET 10.86 .54 485.10 406.36
 RESULTANT 3.83 491.06 400.03
 FLOW PARA RATIO .165 P PRI/P SEC 1.0304
 JET PUMP RISE 1.0123 PRI FLOW PARA .1315 JPSF 2.30

LUBE OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.828 491.0 490.8 400.0 460.0 1300.5 1524.7 .400
 HOT SIDE 30.000 200.0 196.9 550.1 486.6 .0 .0 .424

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
 509.1 323.7 25.5 858.3

HYDRAULIC OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.828 490.8 490.5 460.0 543.9 1524.6 1827.5 .932
 HOT SIDE 423.7 100.0 97.8 550.0 544.0 .0 .0 .067

HEAT REJECTED 1159.53

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Case 62

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, 16:10:39 PAGE 1 OF 2
8 JUNE 1971

* CONDITION * 200 HP, 14.7 PAMB, 3000 PSI HYDSYS
* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		SFT		TUR DN F		SF JP P		SF JP W		TUR OBCA		JP PRICA		TURB NOZ	
.00	.00	1.000	.000	1.000	.000	1.000	1.000	1.000	12.560	.2000	.1210	2060.00	400.00	1500.00	
3.64	.00	TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LHX O							
19.00	13.85	.0002	.98	.30	.5										
.12	.00	ETA CORF	O/F BASE												
		.0925	.800												

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	14.70	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
240.00	12.63
ALTERNATOR	LUBE PUMP
12.00	.60

TURBINE OUTPUT POWER = 266.01 O/F = .602 SPC = 1.790

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.954	2.981
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

IS IT IN CONTROL	CONTROL VALVE
PRESSURE IN	475.2
PRESSURE OUT	283.5
TEMPERATURE IN	1016.5
	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, 16:10:39 PAGE 2 OF 2
8 JUNE 1971

* CONDITION * 200 HP, 14.7 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION	
HYDROGEN FLOW	4.954
PRESSURE IN	281.4
TEMPERATURE IN H2	1016.5
OXYGEN FLOW	2.981
PRESSURE OUT	281.4
TEMPERATURE IN O2	300.0

TURBINE INFORMATION	
INLET FLOW	7.935
PRESSURE IN	280.9
TEMPERATURE IN	2060.0
ENTHALPY IN	4921.7
PRESSURE RATIO	18.33
SPECIFIC HEAT RATIO	1.366
PRESSURE OUT	15.3
TEMPERATURE OUT	1440.1
ENTHALPY OUT	3500.3
EFFICIENCY	.556

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.846	477.5	476.9	537.5	1016.5	1804.7	3477.0	.531
HOT SIDE 7.935	15.3	14.9	1440.1	886.1	3500.3	2260.3	.614

* TURBINE EXHAUST OVERBOARD PRESSURE * 14.73

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.892	11.442

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.954	500.0	499.7	300.0	399.4	908.5	1298.0	.139
HOT SIDE .892	465.4	465.4	1016.5	403.5	3477.0	1313.4	.856

JET PUMP PERFORMANCE			
FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	99.01	4.95	499.62
SECONDARY JET	17.92	.89	465.40
RESULTANT		5.85	478.65
FLOW PARA RATIO	.181	P PRI/P SEC	1.0735
JET PUMP RISE	1.0285	PRI FLOW PARA	.1982 JPSF
			2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.846	478.6	478.1	400.0	448.9	1300.4	1483.5	.319
HOT SIDE 30.000	200.0	196.9	553.2	473.3	.0	.0	.521

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.846	478.1	477.5	448.9	537.5	1483.4	1804.7	.876
HOT SIDE 818.4	100.0	95.4	550.0	545.0	.0	.0	.050

HEAT REJECTED 1878.48

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11-TURB 16,300 R H2-T20=400,
8 JUNE 1971 16111115 PAGE 1 OF 2

• CONDITION • 360 HP,14.7PAMB,3000 WYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• I N P U T D A T A •
DUCT PRESSURE LOSS COEFFICIENTS *10E+4
.00 .00 .00 1110.00 70000.00 .00 .00 10.00
3.64 .00 1.18 1.44 .00 .66 3.50 20.80
19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
.12 .00

SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRCA TURB NOZ
1.000 .000 1.000 1.000 12.560 .2000 .1210
TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HX IN T LMH O
.0002 .98 .30 .5 2060.00 400.00 1500.00
ETA CORF O/F BASE
.0925 .600

HEAT EXCHANGER SCALE FACTORS
ETAMA COLD ETAMA HOT RHODP COLD RHODP HOT
H2 PREHEATER 2.00 2.00 .50 1.00
HYD O COOLER 1.00 1.00 1.00 1.00
LUB O COOLER 1.00 1.00 1.00 1.00
RECUPERATOR 1.00 1.00 1.00 1.00

• • POINT INPUT DATA • •
HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
360.00 .00 14.70 3000.0 35.0

• O U T P U T D A T A •

DRIVE POWER HP LOSS
HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
400.00 12.00 .60 20.63
TURBINE OUTPUT POWER = 431.70 O/F = .634 SPC = 1.731

PROPELLANT HYDROGEN OXYGEN
FLOW RATE 7.625 4.831
PRESSURE 500.00 500.00
TEMPERATURE 300.00 300.00
ENTHALPY 908.5 52.8

CONTROL VALVE
IS IT IN CONTROL YES YES
PRESSURE IN 452.1 499.6
PRESSURE OUT 434.1 459.9
TEMPERATURE IN 964.3 300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11-TURB 16,300 R H2-T20=400,
8 JUNE 1971 16111115 PAGE 2 OF 2

• CONDITION • 360 HP,14.7PAMB,3000 WYDSYS

COMBUSTOR INFORMATION
HYDROGEN FLOW 7.625 OXYGEN FLOW 4.831
PRESSURE IN 431.0 PRESSURE OUT 431.0
TEMPERATURE IN H2 964.3 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
INLET FLOW 12.456 SPECIFIC HEAT RATIO 1.366
PRESSURE IN 430.3 PRESSURE OUT 16.4
TEMPERATURE IN 2060.0 TEMPERATURE OUT 1406.9
ENTHALPY IN 4850.5 ENTHALPY OUT 3380.0
PRESSURE RATIO 26.20 EFFICIENCY .544

RECUPERATOR INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 9.117 457.3 455.9 526.4 964.4 1764.8 3295.4 .497
HOT SIDE 12.456 16.3 15.1 1406.9 893.3 3380.0 2259.7 .503
• TURBINE EXHAUST OVERBOARD PRESSURE • 14.77

HOT BYPASS VALVE INFORMATION
FLOW PRESSURE DROP
1.492 19.624

H2 PREHEATER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 7.625 500.0 499.4 300.0 398.8 908.5 1295.9 .149
HOT SIDE 1.492 436.3 436.2 964.4 404.0 3295.4 1315.1 .843

JET PUMP PERFORMANCE
FLOW PARA FLOW PRESSURE TEMPERATURE
PRIMARY JET 152.28 7.63 499.14 398.80
SECONDARY JET 29.98 1.49 436.22 403.97
RESULTANT 9.12 459.92 399.71
FLOW PARA RATIO .197 P PRI/P SEC 1.1443
JET PUMP RISE 1.0544 PRI FLOW PARA .3051 JPSF 2.30

LUBE OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 9.117 459.8 458.7 399.7 440.9 1299.0 1453.7 .242
HOT SIDE 30.000 200.0 196.9 570.2 465.7 .0 .0 .613

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
509.1 875.3 25.5 1409.8

HYDRAULIC OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 9.117 458.5 457.4 440.9 526.4 1453.7 1764.8 .784
HOT SIDE 1450.0 100.0 91.5 550.0 545.7 .0 .0 .039

HEAT REJECTED 2836.52

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2=300 R .T(60)=650 R
15JUN71 09:20:00 PAGE 1 OF 2

• CONDITION • CASE 1

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		TURBINE LOSS COEFFICIENTS *10E+4	
.00	.00	1110.00	70000.00
3.64	.00	1.18	1.44
19.00	13.85	54.00	.00
.12	.00	2.02	50.00
		2.74	.023

SFT	TUR DN F	SF JP P	SF JP W	TUR OSCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.360	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.46 O/F = .573 SPC = 1.504

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	.884	.506
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.6

IS IT IN CONTROL

	CONTROL VALVE	YES	YES
PRESSURE IN	499.2	500.0	
PRESSURE OUT	50.3	53.2	
TEMPERATURE IN	1067.8	300.0	

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2=300 R .T(60)=650 R
15JUN71 09:20:00 PAGE 2 OF 2

• CONDITION • CASE 1

COMBUSTOR INFORMATION

HYDROGEN FLOW	.884	OXYGEN FLOW	.506
PRESSURE IN	49.9	PRESSURE OUT	49.9
TEMPERATURE IN H2	1067.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.390	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	49.8	PRESSURE OUT	.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1331.9
ENTHALPY IN	4988.0	ENTHALPY OUT	3297.5
PRESSURE RATIO	64.64	EFFICIENCY	.524

RECUPERATOR INFORMATION

COLD SIDE	1.031	PRE IN	499.3	P OUT	499.3	T IN	648.6	T OUT	1067.7	H IN	2194.5	H OUT	3655.6	EFF	.613
HOT SIDE	1.390	.7	.5	1331.9	851.6	3297.5	2213.7	.703							

• TURBINE EXHAUST OVERBOARD PRESSURE • .31

HOT BYPASS VALVE INFORMATION

FLOW	.147	PRESSURE DROP	.257
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H2 PREHEATER INFORMATION

COLD SIDE	1.031	PRE IN	500.0	P OUT	500.0	T IN	300.0	T OUT	399.8	H IN	908.5	H OUT	1299.6	EFF	.130
HOT SIDE	.147	499.0	499.0	1067.7	401.6	3655.6	1306.5	.868							

JET PUMP PERFORMANCE

PRIMARY JET	17.67	FLOW PARA	.88	PRESSURE	499.99	TEMPERATURE	399.78
SECONDARY JET	2.95	.15	499.02	401.58			
RESULTANT		1.03	499.38	400.03			
FLOW PARA RATIO	.167	P PRI/P SEC	1.0019				
JET PUMP RISE	1.0007	PRI FLOW PARA	.0353	JPSF	2.30		

LUBE OIL COOLER INFORMATION

COLD SIDE	1.031	PRE IN	499.4	P OUT	499.4	T IN	400.0	T OUT	572.3	H IN	1300.6	H OUT	1927.3	EFF	.612
HOT SIDE	30.000	200.0	196.9	681.7	641.7	.0	.0	.142							

HEAT REJECTED

ALTERNATOR	509.1	GEAR BOX	111.6	LUBE PUMP	25.5	TOTAL	646.2
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HYDRAULIC OIL COOLER INFORMATION

COLD SIDE	1.031	PRE IN	499.4	P OUT	499.3	T IN	572.3	T OUT	648.6	H IN	1927.3	H OUT	2194.5	EFF	.982
HOT SIDE	29.0	100.0	99.8	650.0	631.4	.0	.0	.239							

HEAT REJECTED 275.47

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650, PAGE 1 OF 2
 8 JUNE 1971 16:43:19

* CONDITION * 100 HP, 0.0 PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT	PRESSURE	LOSS	COEFFICIENTS	*10E+4				
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.80	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TJR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
140.00	12.00
	.60
	7.63

TURBINE OUTPUT POWER = 160.04 O/F = .577 SPC = 1.595

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.697	1.557
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE	YES	YES
IS IT IN CONTROL	YES	YES
PRESSURE IN	492.8	500.0
PRESSURE OUT	153.8	162.4
TEMPERATURE IN	1060.5	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650, PAGE 2 OF 2
 8 JUNE 1971 16:43:19

* CONDITION * 100 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	2.697	OXYGEN FLOW	1.557
PRESSURE IN	152.6	PRESSURE OUT	152.6
TEMPERATURE IN H2	1060.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	4.254	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	152.4	PRESSURE OUT	2.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1372.6
ENTHALPY IN	4977.8	ENTHALPY OUT	3383.4
PRESSURE RATIO	64.31	EFFICIENCY	.495

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.151	493.6	643.4	1060.4	2176.1	3629.9	.572
HOT SIDE	4.254	2.3	1.4	1372.6	894.8	3383.4	.655

* TURBINE EXHAUST OVERBOARD PRESSURE * .97

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.454	3.333

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.697	500.0	499.9	300.0	399.1	908.5	1297.2
HOT SIDE	.454	490.0	490.0	1060.4	405.2	3629.9	1320.1

JET PUMP PERFORMANCE				
PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	53.89	2.70	499.88	399.13
RESULTANT	9.13	.45	490.00	405.18
FLOW PARA RATIO		3.15	493.98	400.02
JET PUMP RISE	.170	P PRI/P SEC		1.0202
	1.0081	PRI FLOW PARA	.1078	JPSF
				2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.151	494.0	493.8	400.0	473.2	1300.5	1572.9
HOT SIDE	30.000	200.0	196.9	566.6	504.4	.0	.0

HEAT REJECTED				
ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL	
509.1	323.7	25.5	858.3	

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.151	493.8	493.6	473.0	643.4	1572.5	2176.1
HOT SIDE	423.7	100.0	97.8	650.0	641.3	.0	.0

HEAT REJECTED 1902.16

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16:43:27 PAGE 1 OF 2

• CONDITION • 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT		PRESSURE		LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00		
3.64	.00	1.18	1.44	.00	.66	3.50	20.80		
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023		
.12	.00								

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 264.96 O/F = .596 SPC = 1.603

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.436	2.642
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	479.6	499.9
PRESSURE OUT	255.7	270.1
TEMPERATURE IN	1028.5	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16:43:27 PAGE 2 OF 2

• CONDITION • 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.436	OXYGEN FLOW	2.642
PRESSURE IN	253.8	PRESSURE OUT	253.8
TEMPERATURE IN H2	1028.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.077	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	253.4	PRESSURE OUT	4.0
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1368.6
ENTHALPY IN	4935.6	ENTHALPY OUT	3348.0
PRESSURE RATIO	63.55	EFFICIENCY	.499

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.219	481.5	480.9	631.8	1028.4	2135.2	3518.3 .530
HOT SIDE	7.077	3.9	2.4	1368.6	911.0	3348.0	2328.0 .621

• TURBINE EXHAUST OVERBOARD PRESSURE • 1.62

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.784	9.912

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.436	500.0	499.8	300.0	399.2	908.5	1297.6 .136
HOT SIDE	.784	471.4	471.4	1028.4	404.3	3518.3	1316.7 .857

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	88.63	4.44	499.70
SECONDARY JET	15.76	.78	471.40
RESULTANT		5.22	482.47
FLOW PARA RATIO		.178	P PRI/P SEC
JET PUMP RISE	1.0235	PRI FLOW PARA	.1774 JPSF

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.219	482.4	482.1	400.0	454.9	1300.5	1505.6 .341
HOT SIDE	30.000	200.0	196.9	560.6	481.6	.0	.0 .492

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.219	482.0	481.5	454.8	631.8	1505.2	2135.2 .907
HOT SIDE	818.4	100.0	95.4	650.0	642.2	.0	.0 .040

HEAT REJECTED 3288.0R

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16:43:34 PAGE 1 OF 2

* CONDITION * 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		HYDROGEN FLOW		OXYGEN FLOW	
.00	.00	1110.00	70000.00	.00	10.00
3.64	.00	1.18	1.44	.66	3.50
19.00	13.85	54.00	.00	2.02	50.00
.12	.00			2.74	.023

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER		HEAT EXCHANGER SCALE FACTORS		RHODP COLD		RHODP HOT	
H2 PREHEATER	2.00	ETAHA COLD	ETAHA HOT	.50	1.00		
HYD O COOLER	1.00	1.00	1.00	1.00	1.00		
LUB O COOLER	1.00	1.00	1.00	1.00	1.00		
RECUPERATOR	1.00	1.00	1.00	1.00	1.00		

* P O I N T I N P U T D A T A *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS	
MYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 432.17 O/F = .617 SPC = 1.621

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.222	4.455
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	455.5	499.6
PRESSURE OUT	416.7	439.7
TEMPERATURE IN	991.5	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16:43:34 PAGE 2 OF 2

* CONDITION * 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.222	OXYGEN FLOW	4.455
PRESSURE IN	413.7	PRESSURE OUT	413.7
TEMPERATURE IN H2	991.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.677	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	413.1	PRESSURE OUT	7.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1368.2
ENTHALPY IN	4888.3	ENTHALPY OUT	3317.4
PRESSURE RATIO	58.50	EFFICIENCY	.505

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.577	460.4	459.0	610.7	991.4	2060.8	3389.2
HOT SIDE	11.677	6.9	3.9	1368.2	925.1	3317.4	2341.7
* TURBINE EXHAUST OVERBOARD PRESSURE *							2.67

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.355	18.544

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.222	500.0	499.5	300.0	399.2	908.5	1297.5
HOT SIDE	1.355	440.4	440.4	991.4	404.1	3389.2	1315.4

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	144.30	7.22	499.22
SECONDARY JET	27.23	1.35	440.40
RESULTANT		8.58	462.76
FLOW PARA RATIO		.189	P PRI/P SEC
JET PUMP RISE	1.0508	PRI FLOW PARA	.2890
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.577	462.6	461.7	400.1	443.9	1307.4	1464.8
HOT SIDE	30.000	200.0	196.9	573.7	469.7	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.577	461.5	460.4	443.8	610.7	1464.5	2060.8
HOT SIDE	1450.0	100.0	91.5	650.0	643.1	.0	.0

HEAT REJECTED 5114.58

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE 11, TURB 16,300 R H2, T20=400, T60=650,
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• CONDITION • 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS
 • UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4
 .00 .00 1.00 1110.00 70000.00 .00 .00 10.00
 3.84 .00 1.18 1.44 .00 .66 3.90 20.00
 19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
 .12 .00

SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRCA TURB NOZ
 1.000 .000 1.000 1.000 12.560 .2000 .1210
 TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HMX IN T LHX Q
 .0002 .98 .30 .5 2060.00 400.00 1500.00
 ETA CORF O/F BASE
 .0925 .000

HEAT EXCHANGER SCALE FACTORS
 ETAMA COLD ETAMA HOT RHODP COLD RHODP HOT
 H2 PREHEATER 2.00 2.00 .50 1.00
 HYD O COOLER 1.00 1.00 1.00 1.00
 LUB O COOLER 1.00 1.00 1.00 1.00
 RECUPERATOR 1.00 1.00 1.00 1.00

• POINT INPUT DATA •
 HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
 .00 .00 5.00 3000.0 35.0

• OUTPUT DATA •

DRIVE POWER HP LOSS
 HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
 40.00 12.00 .60 2.63

TURBINE OUTPUT POWER = 55.48 O/F = .516 SPC = 1.880

PROPELLANT HYDROGEN OXYGEN
 FLOW RATE 1.146 .592
 PRESSURE 500.00 500.00
 TEMPERATURE 300.00 300.00
 ENTHALPY 908.5 52.8

CONTROL VALVE
 IS IT IN CONTROL YES YES
 PRESSURE IN 498.8 500.0
 PRESSURE OUT 64.2 67.1
 TEMPERATURE IN 1165.3 300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE 11, TURB 16,300 R H2, T20=400, T60=650,
 8 JUNE 1971 16:43:40 PAGE 2 OF 2

• CONDITION • 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION
 HYDROGEN FLOW 1.146 OXYGEN FLOW .592
 PRESSURE IN 63.6 PRESSURE OUT 63.6
 TEMPERATURE IN H2 1165.3 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
 INLET FLOW 1.738 SPECIFIC HEAT RATIO 1.368
 PRESSURE IN 63.5 PRESSURE OUT 5.1
 TEMPERATURE IN 2060.0 TEMPERATURE OUT 1499.6
 ENTHALPY IN 5129.6 ENTHALPY OUT 3776.0
 PRESSURE RATIO 12.50 EFFICIENCY .552

RECUPERATOR INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 1.313 498.9 498.9 645.0 1165.3 2181.9 3994.7 .609
 HOT SIDE 1.738 5.1 5.0 1499.6 916.0 3776.0 2407.4 .683
 • TURBINE EXHAUST OVERBOARD PRESSURE • 4.99

HOT BYPASS VALVE INFORMATION
 FLOW PRESSURE DROP
 .167 .494

H2 PREHEATER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 1.146 500.0 500.0 300.0 399.7 908.5 1299.3 .115
 HOT SIDE .167 498.4 498.4 1165.3 402.2 3994.7 1308.8 .882

JET PUMP PERFORMANCE
 FLOW PARA FLOW PRESSURE TEMPERATURE
 PRIMARY JET 22.92 1.15 499.98 399.69
 SECONDARY JET 3.34 .17 498.36 402.19
 RESULTANT 1.31 499.01 400.01
 FLOW PARA RATIO .146 P PRI/P SEC 1.0033
 JET PUMP RISE 1.0013 PRI FLOW PARA .0458 JPSF 2.30

LUBE OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 1.313 499.0 499.0 400.0 534.0 1300.5 1792.6 .584
 HOT SIDE 30.000 200.0 196.9 629.5 566.8 .0 .0 .186

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
 509.1 111.6 25.5 646.2

HYDRAULIC OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 1.313 499.0 498.9 533.9 645.0 1792.4 2181.9 .957
 HOT SIDE 29.0 100.0 99.8 650.0 615.2 .0 .0 .300

HEAT REJECTED 511.46

75

6

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
 8 JUNE 1971 16:43:50 PAGE 1 OF 2

• CONDITION • 100 HP, 5.0 PAMB, 3000 PSI HYDSYS
 • UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4
 .00 .00 .00 1110.00 70000.00 .00 .00 10.00
 3.64 .00 1.18 1.44 .00 .66 3.50 20.80
 19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
 .12 .00

SFT TUR DN F SF JP P SF JP W TUR OBGA JP PRICA TURB NOZ
 1.000 .000 1.000 1.000 12.560 .2000 .1210
 TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HHX IN T LHX Q
 .0002 .98 .30 .5 2060.00 400.00 1500.00
 ETA CORF O/F BASE
 .0925 .600

HEAT EXCHANGER SCALE FACTORS
 HEAT EXCHANGER ETAMA COLD ETAMA HOT RHODP COLD RHODP HOT
 H2 PREHEATER 2.00 2.00 .50 1.00
 HYD O COOLER 1.00 1.00 1.00 1.00
 LUB O COOLER 1.00 1.00 1.00 1.00
 RECUPERATOR 1.00 1.00 1.00 1.00

* POINT INPUT DATA *
 HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
 100.00 .00 5.00 3000.0 35.0

* O U T P U T D A T A *
 DRIVE POWER HP LOSS
 HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
 140.00 12.00 .60 7.63

TURBINE OUTPUT POWER = 160.23 O/F = .567 SPC = 1.668

PROPELLANT HYDROGEN OXYGEN
 FLOW RATE 2.844 1.611
 PRESSURE 500.00 500.00
 TEMPERATURE 300.00 300.00
 ENTHALPY 908.5 52.8

CONTROL VALVE
 IS IT IN CONTROL YES YES
 PRESSURE IN 492.1 500.0
 PRESSURE OUT 160.1 168.9
 TEMPERATURE IN 1078.7 300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
 8 JUNE 1971 16:43:50 PAGE 2 OF 2

• CONDITION • 100 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION
 HYDROGEN FLOW 2.844 OXYGEN FLOW 1.611
 PRESSURE IN 158.8 PRESSURE OUT 158.8
 TEMPERATURE IN H2 1078.7 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
 INLET FLOW 4.455 SPECIFIC HEAT RATIO 1.368
 PRESSURE IN 158.6 PRESSURE OUT 5.5
 TEMPERATURE IN 2060.0 TEMPERATURE OUT 1407.5
 ENTHALPY IN 5004.1 ENTHALPY OUT 3479.9
 PRESSURE RATIO 28.66 EFFICIENCY .533

RECUPERATOR INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.309 492.9 492.6 642.3 1078.8 2172.1 3693.9 .570
 HOT SIDE 4.455 5.5 5.2 1407.5 909.6 3479.5 2349.0 .651
 • TURBINE EXHAUST OVERBOARD PRESSURE • 5.01

HOT BYPASS VALVE INFORMATION
 FLOW PRESSURE DROP
 .466 3.725

H2 PREHEATER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 2.844 500.0 499.9 300.0 399.1 908.5 1296.9 .127
 HOT SIDE .466 488.9 488.9 1078.8 405.5 3693.9 1321.2 .868

JET PUMP PERFORMANCE
 FLOW PARA FLOW PRESSURE TEMPERATURE
 PRIMARY JET 56.81 2.84 499.87 399.08
 SECONDARY JET 9.38 .47 488.89 405.47
 RESULTANT 3.31 493.32 399.99
 FLOW PARA RATIO .165 P PRI/P SEC 1.0225
 JET PUMP RISE 1.0091 PRI FLOW PARA .1136 JPSF 2.30

LUBE OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.309 493.3 493.1 400.0 469.6 1300.4 1559.7 .429
 HOT SIDE 30.000 200.0 196.9 562.1 499.6 .0 .0 .386

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
 509.1 323.7 25.5 858.3

HYDRAULIC OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.309 493.1 492.9 469.6 642.3 1559.7 2172.1 .957
 HOT SIDE 423.7 103.0 97.8 650.0 640.7 .0 .0 .052

HEAT REJECTED 2024.51

76

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SSAPU PHASE II, TURB 16,300 R H2-T20=400, T60=650,
8 JUNE 1971 16:44:00 PAGE 1 OF 2

• CONDITION • 200 HP, 5. PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		TURBINE LOSS COEFFICIENTS *10E+4	
.00	.00	1110.00	70000.00
3.64	.00	1.18	1.44
19.00	13.05	54.00	.00
.12	.00	2.02	50.00
		3.50	20.00
		2.74	.023

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOFP	T TUR IN	T HHX IN	T LHX 0
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE	.0925	.600			

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA MP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 265.09 O/F = .590 SPC = 1.637

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.548	2.685
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	478.6	499.9
PRESSURE OUT	259.2	273.7
TEMPERATURE IN	1036.0	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2-T20=400, T60=650,
8 JUNE 1971 16:44:00 PAGE 2 OF 2

• CONDITION • 200 HP, 5. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW	2.685
4.548		
PRESSURE IN	PRESSURE OUT	257.2
257.2		
TEMPERATURE IN H2	TEMPERATURE IN O2	300.0
1036.0		

TURBINE INFORMATION

INLET FLOW	SPECIFIC HEAT RATIO	1.367
7.233		
PRESSURE IN	PRESSURE OUT	6.4
256.8		
TEMPERATURE IN	TEMPERATURE OUT	1385.5
2060.0		
ENTHALPY IN	ENTHALPY OUT	3393.8
4948.0		
PRESSURE RATIO	EFFICIENCY	.520
40.33		

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.342	480.6	480.0	630.7	1036.2	2131.5	3545.4	.937
HOT SIDE 7.233	6.3	5.4	1385.5	918.8	3393.8	2349.6	.618

• TURBINE EXHAUST OVERBOARD PRESSURE • 5.09

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.794	9.892

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.548	500.0	499.8	300.0	399.2	908.5	1297.4	.139
HOT SIDE .794	470.1	470.1	1036.2	404.3	3545.4	1316.4	.858

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET 90.87	4.55	499.68	399.20
SECONDARY JET 15.96	.79	470.12	404.25
RESULTANT	5.34	481.63	399.98
FLOW PARA RATIO	.176	P PRI/P SEC	1.0629
JET PUMP RISE 1.0245	PRI FLOW PARA	.1819	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.342	481.6	481.2	400.0	453.5	1300.2	1500.6	.337
HOT SIDE 30.000	200.0	196.9	559.0	479.8	.0	.0	.498

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	535.8	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.342	481.1	480.6	453.5	630.7	1500.6	2131.5	.902
HOT SIDE 818.4	100.0	95.4	650.0	642.0	.0	.0	.041

HEAT REJECTED 337.10

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650.
8 JUNE 1971 16:44:08

PAGE 1 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1900.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX
400.00	12.00	20.63

TURBINE OUTPUT POWER = 432.30 O/F = .614 SPC = 1.636

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.299	4.484
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	900.5	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	454.8	499.6
PRESSURE OUT	416.3	439.6
TEMPERATURE IN	994.3	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650.
8 JUNE 1971 16:44:08

PAGE 2 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	7.299	OXYGEN FLOW	4.484
PRESSURE IN	413.1	PRESSURE OUT	413.1
TEMPERATURE IN H2	994.3	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	11.784	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	412.5	PRESSURE OUT	8.6
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1375.4
ENTHALPY IN	4894.1	ENTHALPY OUT	3337.0
PRESSURE RATIO	48.17	EFFICIENCY	.514

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.660	459.8	458.4	610.0	994.3	2058.4	3399.3 .502
HOT SIDE	11.784	8.4	6.1	1375.4	928.6	3337.0	2351.5 .584

• TURBINE EXHAUST OVERBOARD PRESSURE • 5.32

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.360	18.767

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.299	580.0	499.4	300.0	399.1	908.5	1296.9 .143
HOT SIDE	1.360	439.6	439.6	994.3	404.0	3399.3	1315.0 .850

JET PUMP PERFORMANCE

	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
PRIMARY JET	145.82	7.30	499.21	399.08	
SECONDARY JET	27.34	1.36	439.61	403.95	
RESULTANT		8.66	462.26	399.90	
FLOW PARA RATIO		.188	P PRI/P SEC	1.1356	
JET PUMP RISE	1.0515	PRI FLOW PARA	.2921	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.660	462.1	461.2	399.9	443.3	1299.8	1462.6 .251
HOT SIDE	30.000	200.0	196.9	573.0	469.0	.0	.0 .601

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.660	461.0	459.9	443.3	610.0	1462.6	2058.4 .806
HOT SIDE	1450.0	100.0	91.5	650.0	643.1	.0	.0 .033

HEAT REJECTED 5159.64

78

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,300 R H2, T20=400, T60=650.
8 JUNE 1971 16:44:15 PAGE 1 OF 2

• CONDITION • 0.0 HP.10. PAMB,3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, G=BTU/MIN, T=DEC R, W=LB/MIN

• INPUT DATA •

DUCT	PRESSURE	LOSS	COEFFICIENTS	*10E+4				
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.00	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210

TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00

ETA CORF	O/F BASE
.0925	.600

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	10.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS	GEAR BOX
40.00	12.00	.60	2.63	

TURBINE OUTPUT POWER = 55.72 O/F = .489 SPC = 2.227

PROPELLANT

FLOW RATE	HYDROGEN	OXYGEN
PRESSURE	1.390	.679
TEMPERATURE	500.00	500.00
ENTHALPY	300.00	300.00
	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	498.1	500.0
PRESSURE OUT	76.7	79.9
TEMPERATURE IN	1217.0	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,300 R H2, T20=400, T60=650.
8 JUNE 1971 16:44:15 PAGE 2 OF 2

• CONDITION • 0.0 HP.10. PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.390	OXYGEN FLOW	.679
PRESSURE IN	75.9	PRESSURE OUT	75.9
TEMPERATURE IN H2	1217.0	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.069	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	75.8	PRESSURE OUT	10.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1596.2
ENTHALPY IN	5203.3	ENTHALPY OUT	4059.9
PRESSURE RATIO	7.54	EFFICIENCY	.538

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.979	498.3	498.2	639.6	1216.9	2162.8	4175.0 .604
HOT SIDE	2.069	10.1	10.0	1596.2	954.5	4059.9	2324.0 .671

• TURBINE EXHAUST OVERBOARD PRESSURE • 9.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.189	.871

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.390	500.0	500.0	300.0	399.6	908.5	1298.9 .109
HOT SIDE	.189	497.3	497.3	1216.9	402.7	4175.0	1310.9 .888

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	27.78	1.39	499.97	399.60
RESULTANT	3.80	.19	497.33	402.73
FLOW PARA RATIO		1.58	498.42	399.98
JET PUMP RISE	1.0022	.137	P PRI/P SEC	1.0053
			PRI FLOW PARA	.0556
			JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.979	498.4	498.4	400.0	510.8	1300.4	1709.6 .561
HOT SIDE	30.000	200.0	196.9	597.8	553.4	.0	.0 .224

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.2	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.979	498.4	498.3	510.9	639.6	1709.8	2162.8 .925
HOT SIDE	29.0	100.0	99.8	650.0	600.9	.0	.0 .353

HEAT REJECTED 715.27

79

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650, 8 JUNE 1971 16:44:26 PAGE 1 OF 2

• CONDITION • 100 HP, 10. PAMB, 3000 PSI HYDSYS

• UNITS • AREA*SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OB CA	JP PR CA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LK CA	ETA COMB	LUBE P HP	ETA LO PP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETA HA COLD	ETA HA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE (KW)
100.00	.00	10.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX	
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 160.48 O/F = .552 SPC = 1.785

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.077	1.698
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	490.7	499.9
PRESSURE OUT	172.7	181.6
TEMPERATURE IN	1103.8	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650, 8 JUNE 1971 16:44:26 PAGE 2 OF 2

• CONDITION • 100 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION		
HYDROGEN FLOW	3.077	OXYGEN FLOW 1.698
PRESSURE IN	171.2	PRESSURE OUT 171.2
TEMPERATURE IN H2	1103.8	TEMPERATURE IN O2 300.0

TURBINE INFORMATION		
INLET FLOW	4.775	SPECIFIC HEAT RATIO 1.367
PRESSURE IN	171.0	PRESSURE OUT 10.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT 1496.4
ENTHALPY IN	5040.1	ENTHALPY OUT 3615.0
PRESSURE RATIO	16.61	EFFICIENCY .553

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.563	491.6	491.3	640.3	1103.8	2165.1	3780.7	.968
HOT SIDE 4.775	10.3	10.1	1456.4	930.8	3615.0	2409.5	.844

* TURBINE EXHAUST OVERBOARD PRESSURE = 9.97

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.487	4.444

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.077	500.0	499.9	300.0	399.1	908.5	1297.1	.823
HOT SIDE .487	486.9	486.9	1103.8	406.1	3780.7	1323.9	.868

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	61.46	3.08	499.85
SECONDARY JET	9.80	.49	486.90
RESULTANT		3.56	492.15
FLOW PARA RATIO	.160	P PRI/P SEC	1.0266
JET PUMP RISE	1.0108	PRI FLOW PARA	.1230 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.563	492.1	491.9	400.1	464.6	1300.7	1541.6	.414
HOT SIDE 30.000	200.0	196.9	555.9	492.8	.0	.0	.403

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.563	491.9	491.7	464.6	640.3	1541.6	2165.1	.947
HOT SIDE 423.7	100.0	97.8	650.0	639.8	.0	.0	.059

HEAT REJECTED 2221.70

80

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16144:37 PAGE 1 OF 2

• CONDITION • 200 HP, 10. PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •
DUCT PRESSURE LOSS COEFFICIENTS *10E+4
.00 .00 .00 1110.00 70000.00 .00 .00 10.00
3.64 .00 1.18 1.44 .00 .66 3.50 20.80
19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
.12 .00

SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRICA TURB NOZ
1.000 .000 1.000 1.000 12,560 .2000 .1210
TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HHX IN T LHX O
.0002 .98 .30 .5 2060.00 400.00 1900.00
ETA CORF O/F BASE
.0925 .600

HEAT EXCHANGER SCALE FACTORS
HEAT EXCHANGER ETAMA COLD ETAMA HOT RHODP COLD RHODP HOT
H2 PREHEATER 2.00 2.00 .50 1.00
HYD O COOLER 1.00 1.00 1.00 1.00
LUB O COOLER 1.00 1.00 1.00 1.00
RECUPERATOR 1.00 1.00 1.00 1.00

• POINT INPUT DATA •
HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
200.00 .00 10.00 3000.0 35.0

• OUTPUT DATA •

DRIVE POWER HP LOSS
HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
240.00 12.00 .60 12.63
TURBINE OUTPUT POWER = 265.52 O/F = .582 SPC = 1.704

PROPELLANT FLOW RATE PRESSURE TEMPERATURE ENTHALPY
HYDROGEN 4.766 500.00 300.00 908.5
OXYGEN 2.775 500.00 300.00 52.8

CONTROL VALVE
IS IT IN CONTROL YES YES
PRESSURE IN 476.8 499.9
PRESSURE OUT 271.0 285.7
TEMPERATURE IN 1049.6 300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16144:37 PAGE 2 OF 2

• CONDITION • 200 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION
HYDROGEN FLOW 4.766 OXYGEN FLOW 2.775
PRESSURE IN 268.9 PRESSURE OUT 268.9
TEMPERATURE IN H2 1049.6 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
INLET FLOW 7.541 SPECIFIC HEAT RATIO 1.367
PRESSURE IN 268.5 PRESSURE OUT 10.8
TEMPERATURE IN 2060.0 TEMPERATURE OUT 1415.6
ENTHALPY IN 4967.4 ENTHALPY OUT 3474.0
PRESSURE RATIO 24.86 EFFICIENCY .541

RECUPERATOR INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 5.980 478.9 478.3 628.7 1049.7 2124.2 3592.3 .538
HOT SIDE 7.541 10.7 10.2 1415.6 932.8 3474.0 2387.6 .613
• TURBINE EXHAUST OVERBOARD PRESSURE • 10.01

HOT BYPASS VALVE INFORMATION
FLOW PRESSURE DROP
.815 10.715

H2 PREHEATER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 4.766 500.0 499.8 300.0 399.2 908.5 1297.6 .132
HOT SIDE .815 467.6 467.6 1049.7 404.2 3592.3 1316.3 .861

JET PUMP PERFORMANCE
FLOW PARA FLOW PRESSURE TEMPERATURE
PRIMARY JET 95.23 4.77 499.65 399.24
SECONDARY JET 16.38 .81 467.57 404.22
RESULTANT 5.58 480.04 400.00
FLOW PARA RATIO .172 # PRI/P SEC 1.0686
JET PUMP RISE 1.0267 PRI FLOW PARA .1906 JPSF 2.30

LUBE OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 5.580 480.0 479.6 400.0 451.2 1300.3 1492.1 .328
HOT SIDE 30.000 200.0 196.9 556.1 476.6 .0 .0 .509

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
509.1 535.9 25.5 1070.4

HYDRAULIC OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 5.580 479.5 479.0 451.2 628.7 1492.1 2124.2 .893
HOT SIDE 818.4 100.0 95.4 650.0 641.6 .0 .0 .042

HEAT REJECTED 3527.69

81

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16144:48 PAGE 1 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 WYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• • P O I N T I N P U T D A T A • •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	10.00	3000.0	35.0

• O U T P U T D A T A •

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 433.32 O/F = .611 SPC = 1.672

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.497	4.581
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE	
IS IT IN CONTROL	YES
PRESSURE IN	453.1
PRESSURE OUT	428.6
TEMPERATURE IN	1000.8

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16:44:48 PAGE 2 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	7.497	OXYGEN FLOW	4.581
PRESSURE IN	425.4	PRESSURE OUT	425.4
TEMPERATURE IN H2	1000.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	12.078	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	424.8	PRESSURE OUT	12.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1392.1
ENTHALPY IN	4902.0	ENTHALPY OUT	3379.0
PRESSURE RATIO	34.54	EFFICIENCY	.529

RECUPERATOR INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.882	458.4	456.9	608.2	1000.8	2052.2	3421.7	.501
HOT SIDE	12.078	12.2	10.6	1392.1	936.7	3379.0	2371.9	.581
• TURBINE EXHAUST OVERBOARD PRESSURE •								10.10

HOT BYPASS VALVE INFORMATION			
FLOW	PRESSURE DROP		
1.384	19.333		

H2 PREHEATER INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.497	500.0	499.4	300.0	399.2	908.5	1297.3	.142
HOT SIDE	1.384	437.6	437.6	1000.8	404.2	3421.7	1315.9	.851

JET PUMP PERFORMANCE					
	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
PRIMARY JET	149.79	7.50	499.17	399.17	
SECONDARY JET	27.83	1.38	437.54	404.20	
RESULTANT		8.88	460.95	400.01	
FLOW PARA RATIO	.186		P PRI/P SEC	1.1408	
JET PUMP RISE	1.0535	PRI FLOW PARA	.3001	JPSF	2.30

LUBE OIL COOLER INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.882	460.8	459.8	400.0	442.3	1300.2	1458.9	.246
HOT SIDE	30.000	200.0	196.9	571.8	467.6	.0	.0	.607

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	8.882	459.6	458.5	442.3	608.2	1458.9	2052.2	.799
HOT SIDE	1450.0	100.0	91.5	650.0	642.9	.0	.0	.034

HEAT REJECTED 5269.55

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16:44:55 PAGE 1 OF 2

• CONDITION • 0.0 HP, 14.7 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	14.70	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
40.00	12.00	.60
		2.63

TURBINE OUTPUT POWER = 55.99 O/F = .470 SPC = 2.577

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.636	.769
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	497.3	500.0
PRESSURE OUT	89.5	92.9
TEMPERATURE IN	1249.7	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16:44:55 PAGE 2 OF 2

• CONDITION • 0.0 HP, 14.7 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.636	OXYGEN FLOW	.769
PRESSURE IN	88.5	PRESSURE OUT	88.5
TEMPERATURE IN H2	1249.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.405	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	88.4	PRESSURE OUT	14.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1664.6
ENTHALPY IN	5254.3	ENTHALPY OUT	4264.1
PRESSURE RATIO	5.99	EFFICIENCY	.504

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.850	497.6	497.5	632.5	1249.4	2138.0	4289.5
HOT SIDE	2.405	14.7	14.7	1664.6	982.2	4264.1	2609.0

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.69

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.214	1.228

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.636	500.0	500.0	300.0	399.5	908.5	1298.6
HOT SIDE	.214	496.3	496.3	1249.4	403.3	4289.5	1312.9

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	32.70	1.64	499.95
SECONDARY JET	4.30	.21	496.29
RESULTANT		1.85	497.80
FLOW PARA RATIO	.132	P PRI/P SEC	1.0074
JET PUMP RISE	1.0030	PRI FLOW PARA	.0654
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.850	497.8	497.7	399.9	494.2	1300.2	1649.5
HOT SIDE	30.000	200.0	196.9	575.4	529.6	.0	.0

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.850	497.7	497.6	474.3	632.5	1649.8	2138.0
HOT SIDE	29.0	100.0	99.8	600.0	587.5	.0	.0

HEAT REJECTED

903.22

83

8

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16145:01 PAGE 1 OF 2

• CONDITION • 100 HP, 14.7PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.565	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	14.70	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS	GEAR BOX
140.00	12.00	.60	7.63	

TURBINE OUTPUT POWER = 158.65 O/F = .541 SPC = 1.907

PROPELLANT

	HYDROGEN	OXYGEN
FLOW RATE	3.272	1.771
PRESSURE	300.00	300.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	32.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	489.5	499.9
PRESSURE OUT	183.9	192.8
TEMPERATURE IN	1124.6	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16145:01 PAGE 2 OF 2

• CONDITION • 100 HP, 14.7PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	3.272	OXYGEN FLOW	1.771
PRESSURE IN	182.3	PRESSURE OUT	182.3
TEMPERATURE IN H2	1124.6	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	5.042	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	182.0	PRESSURE OUT	14.9
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1499.2
ENTHALPY IN	5067.6	ENTHALPY OUT	3732.9
PRESSURE RATIO	12.18	EFFICIENCY	.557

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF.
COLD SIDE 3.774	490.6	490.3	638.5	1124.6	2158.8	3852.9	.565
HOT SIDE 5.042	14.9	14.8	1499.2	950.8	3732.9	2464.9	.637

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.68

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.502	5.051

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.272	500.0	499.9	300.0	399.0	908.5	1296.7	.120
HOT SIDE .908	485.2	485.2	1124.6	406.5	3852.9	1324.9	.871

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	65.35	3.27	499.83
SECONDARY JET	10.13	.50	485.22
REGULANT		3.77	491.15
FLOW PARA RATIO	.155	P PRI/P SEC	1.0301
JET PUMP RISE	1.0122	PRI FLOW PARA	.1308
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.774	491.1	490.9	480.0	460.9	1300.5	1527.8	.939
HOT SIDE 38.800	280.0	196.9	551.2	487.8	.0	.0	.420

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.774	490.9	490.6	460.9	638.5	1527.8	2158.8	.939
HOT SIDE 423.7	100.0	97.8	650.0	639.1	.0	.0	.058

HEAT REJECTED 2381.72

84

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16:45:14 PAGE 1 OF 2

• CONDITION • 200 HP, 14.7 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		SFT		TUR DN F		SF JP P		SF JP W		TUR OBGA		JP PRICA		TURB NOZ	
.00	.00	1.000	.000	1.000	.000	1.000	.000	1.000	.000	12.560	.2000	.1210	.1210	.1210	.1210
3.64	.00	1.18	1.44	.30	.5	.30	.5	.30	.5	2060.00	400.00	1500.00	1500.00	1500.00	1500.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023								
.12	.00														

TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00

ETA CORF	O/F BASE
.0925	.600

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	14.70	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
240.00	12.00	.60
		12.63

TURBINE OUTPUT POWER = 265.93 O/F = .575 SPC = 1.771

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.982	2.866
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	474.9	499.9
PRESSURE OUT	282.8	297.7
TEMPERATURE IN	1061.5	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650,
8 JUNE 1971 16:45:14 PAGE 2 OF 2

• CONDITION • 200 HP, 14.7 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.982	OXYGEN FLOW	2.866
PRESSURE IN	280.5	PRESSURE OUT	280.5
TEMPERATURE IN H2	1061.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.848	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	280.1	PRESSURE OUT	15.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1442.8
ENTHALPY IN	4984.6	ENTHALPY OUT	3546.9
PRESSURE RATIO	18.26	EFFICIENCY	.553

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.819	477.3	476.6	626.6	1061.5	2116.9	3633.4 .533
HOT SIDE	7.848	15.3	14.9	1442.8	945.7	3546.9	2422.8 .607

* TURBINE EXHAUST OVERBOARD PRESSURE * 14.73

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.837	11.580

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.982	500.0	499.7	300.0	399.3	908.5	1297.8 .130
HOT SIDE	.837	465.1	465.1	1061.5	404.2	3633.4	1316.1 .863

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	99.55	4.98	499.62
SECONDARY JET	16.82	.84	465.05
RESULTANT		5.82	478.52
FLOW PARA RATIO	.169	P PRI/P SEC	1.0743
JET PUMP RISE	1.0290	PRI FLOW PARA	.1992 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.819	478.5	478.0	400.0	449.1	1300.4	1484.4 .320
HOT SIDE	30.000	200.0	196.9	553.5	473.7	.0	.0 .520

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.819	477.9	477.4	449.1	626.6	1484.4	2116.9 .883
HOT SIDE	818.4	100.0	95.4	650.0	641.3	.0	.0 .044

HEAT REJECTED 3680.28

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650.
8 JUNE 1971 16:45:51 PAGE 1 OF 2

• CONDITION • 360 HP, 14.7PAMB, 3000 WYDSYS

• UNITS • AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00
3.64	.00	1.18	1.44
19.00	13.85	54.00	.00
.12	.00	.00	2.02
			50.00
			2.74
			.023

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.400					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• • POINT INPUT DATA • •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	14.70	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
400.00	12.00	.60
		20.63

TURBINE OUTPUT POWER = 431.95 O/F = .609 SPC = 1.714

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.668	4.669
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE	
IS IT IN CONTROL	YES
PRESSURE IN	451.7
PRESSURE OUT	434.3
TEMPERATURE IN	1007.9

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=650.
8 JUNE 1971 16:45:51 PAGE 2 OF 2

• CONDITION • 360 HP, 14.7PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.668	OXYGEN FLOW	4.669
PRESSURE IN	431.0	PRESSURE OUT	431.0
TEMPERATURE IN H2	1007.9	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	12.337	SPECIFIC HEAT RATIO	1.366
PRESSURE IN	430.5	PRESSURE OUT	16.5
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1409.3
ENTHALPY IN	4906.9	ENTHALPY OUT	3420.6
PRESSURE RATIO	26.14	EFFICIENCY	.542

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 9.063	457.2	455.7	606.7	1008.0	2046.8	3446.9	.500
HOT SIDE 12.337	16.4	15.1	1409.3	945.0	3420.6	2392.1	.578

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.78

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.395	19.824

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.668	500.0	499.4	300.0	398.9	908.5	1296.2	.140
HOT SIDE 1.395	435.9	435.0	1008.0	404.0	3446.9	1315.3	.853

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	153.15	7.67	499.13
SECONDARY JET	28.04	1.39	435.82
RESULTANT		9.06	459.87
FLOW PARA RATIO		.183	P PRI/P SEC
JET PUMP RISE	1.0552	PRI FLOW PARA	.3068 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 9.063	459.7	458.7	399.7	441.2	1299.2	1454.7	.243
HOT SIDE 30.000	200.0	196.9	570.5	466.1	.0	.0	.612

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 9.063	458.5	457.3	441.2	606.7	1454.7	2046.8	.793
HOT SIDE 1450.0	106.0	91.5	650.0	642.8	.0	.0	.034

HEAT REJECTED 5365.25

98

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2 = 300. R ; T(60)=750 R
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* CONDITION * CASE 2

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE		LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS	GEAR BOX
40.00	12.00	.60		2.63

TURBINE OUTPUT POWER = 55.48 O/F = .549 SPC = 1.492

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	.891	.489
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	906.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	499.2	500.0
PRESSURE OUT	50.3	53.0
TEMPERATURE IN	1110.3	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2 = 300. R ; T(60)=750 R
15JUN71 09:19:31 PAGE 2 OF 2

* CONDITION * CASE 2

COMBUSTOR INFORMATION

HYDROGEN FLOW	.891	OXYGEN FLOW	.489
PRESSURE IN	49.9	PRESSURE OUT	49.9
TEMPERATURE IN H2	1110.3	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.380	SPECIFIC HEAT RATIO	1.369
PRESSURE IN	49.8	PRESSURE OUT	.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1336.7
ENTHALPY IN	5047.1	ENTHALPY OUT	3342.9
PRESSURE RATIO	63.04	EFFICIENCY	.522

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.031	499.3	499.3	747.3	1110.3	2540.2	3803.6 .616
HOT SIDE	1.380	.8	.5	1336.7	925.1	3342.9	2399.3 .698

* TURBINE EXHAUST OVERBOARD PRESSURE *

.32

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.140	.258

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	.891	500.0	500.0	300.0	399.8	908.5	1299.6 .123
HOT SIDE	.140	499.0	499.0	1110.3	401.6	3803.6	1306.6 .875

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	17.82	.89	499.99	399.78
RESULTANT	2.80	.14	499.00	401.62
FLOW PARA RATIO		1.03	499.37	400.03
JET PUMP RISE	1.0008	PRI FLOW PARA	.0356	JPSF
				2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.031	499.4	499.4	400.0	572.4	1300.6	1927.5 .612
HOT SIDE	30.000	200.0	196.9	681.8	641.8	.0	.0 .142

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.031	499.4	499.3	572.4	747.3	1927.5	2540.2 .985
HOT SIDE	29.0	100.0	99.8	750.0	711.4	.0	.0 .217

HEAT REJECTED 631.48

87

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
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• CONDITION • 100 HP, 0.0 PAMB, 3000 PSI WYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1300.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAH COLD	ETAH HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* P O I N T I N P U T D A T A *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 161.47 O/F = .552 SPC = 1.581

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.741	1.513
PRESSURE	300.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.9	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	492.6	500.0
PRESSURE OUT	134.5	142.4
TEMPERATURE IN	1105.3	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:55:15 PAGE 2 OF 2

• CONDITION • 100 HP, 0.0 PAMB, 3000 PSI WYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	2.741	OXYGEN FLOW	1.513
PRESSURE IN	153.2	PRESSURE OUT	153.2
TEMPERATURE IN H2	1105.3	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.254	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	152.9	PRESSURE OUT	2.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1376.8
ENTHALPY IN	5040.1	ENTHALPY OUT	3430.7
PRESSURE RATIO	62.62	EFFICIENCY	.494

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF.
COLD SIDE	3.173	493.4	493.1	739.9	1105.2	2514.0	3785.7 .574
HOT SIDE	4.254	2.4	1.5	1376.8	962.8	3430.7	2482.0 .650

• TURBINE EXHAUST OVERBOARD PRESSURE • 1.02

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.432	3.439

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF.
COLD SIDE	2.741	500.0	499.9	300.0	399.1	908.5	8297.2 .123
HOT SIDE	.432	489.6	489.6	1105.2	405.4	3785.7	1320.8 .869

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
SECONDARY JET	8.70	.43	489.64	405.37	
RESULTANT		3.17	493.78	400.00	
FLOW PARA RATIO		.159	P PRI/P SEC	1.0209	
JET PUMP RISE	1.0085	PR; FLOW PARA	.1096	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF.
COLD SIDE	3.173	493.8	493.6	400.0	472.6	1300.4	1370.9 .438
HOT SIDE	30.000	200.0	196.9	565.9	503.7	.0	.0 .379

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF.
COLD SIDE	3.173	493.6	493.4	472.5	739.9	1570.6	2514.0 .963
HOT SIDE	423.7	100.0	97.8	750.0	737.6	.0	.0 .045

HEAT REJECTED 2993.76

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:55:23

PAGE 1 OF 2

* CONDITION * 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				2.74

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LNX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 267.39 O/F = .570 SPC = 1.588

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.508	2.569
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	478.9	499.9
PRESSURE OUT	256.8	270.1
TEMPERATURE IN	1073.7	300.0

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:55:23

PAGE 2 OF 2

* CONDITION * 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.508	OXYGEN FLOW	2.569
PRESSURE IN	254.7	PRESSURE OUT	254.7
TEMPERATURE IN H2	1073.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.077	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	254.3	PRESSURE OUT	4.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1372.6
ENTHALPY IN	4997.1	ENTHALPY OUT	3394.1
PRESSURE RATIO	62.02	EFFICIENCY	.498

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.252	480.9	480.3	722.7	1073.6	2453.8	3675.5
HOT SIDE	7.077	4.0	2.5	1372.6	972.6	3394.1	2487.6

* TURBINE EXHAUST OVERBOARD PRESSURE * 1.68

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.744	9.761

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.508	500.0	499.8	300.0	399.2	908.5	1297.2
HOT SIDE	.744	470.5	470.5	1073.6	405.1	3675.5	1319.6

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	14.97	.74	470.53	405.08
RESULTANT		5.25	481.95	400.02
FLOW PARA RATIO		.166	P PRI/P SEC	1.0620
JET PUMP RISE	1.0243	PRI FLOW PARA	.1802	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.252	481.9	481.5	400.0	454.5	1300.4	1504.2
HOT SIDE	30.000	200.0	196.9	560.2	481.1	.0	.0

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.252	481.5	481.0	454.4	722.7	1504.0	2453.8
HOT SIDE	818.4	100.0	95.4	750.0	739.4	.0	.0

HEAT REJECTED 4987.93

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:55:29 PAGE 1 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT	PRESSURE	LOSS	COEFFICIENTS	*10E+4				
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.00	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LHX 0
.0002	.98	.30	.5	2060.00	400.00	1300.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
400.00	20.63
ALTERNATOR	LUBE PUMP
12.00	.60

TURBINE OUTPUT POWER = 436.05 O/F = .592 SPC = 1.607

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.333	4.343
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

IS IT IN CONTROL	CONTROL VALVE	YES	YES
PRESSURE IN	454.5	499.7	
PRESSURE OUT	418.3	439.8	
TEMPERATURE IN	1034.8	300.0	

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:55:29 PAGE 2 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	7.333	OXYGEN FLOW	4.343
PRESSURE IN	415.0	PRESSURE OUT	415.0
TEMPERATURE IN H2	1034.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	11.677	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	414.4	PRESSURE OUT	7.2
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1371.7
ENTHALPY IN	4945.6	ENTHALPY OUT	3399.8
PRESSURE RATIO	57.29	EFFICIENCY	.504

RECUPERATOR INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE 8.616	459.7	458.2	692.1	1034.7	2346.1	3539.9	.904	
HOT SIDE 11.677	7.0	4.1	1371.7	977.8	3359.8	2478.9	.500	
• TURBINE EXHAUST OVERBOARD PRESSURE •								2.77

HOT BYPASS VALVE INFORMATION		
FLOW	PRESSURE DROP	
1.283	18.892	

H2 PREHEATER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE 7.333	500.0	499.4	300.0	399.3	908.5	1297.6	.135	
HOT SIDE 1.283	439.3	439.3	1034.7	404.1	3539.9	1315.6	.850	

JET PUMP PERFORMANCE					
PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
146.53	7.33	499.20	399.26		
SECONDARY JET	25.79	1.28	439.27	404.11	
RESULTANT		8.62	462.21	400.04	
FLOW PARA RATIO		.176	P PRI/P SEC	1.1364	
JET PUMP RISE	1.0522	PRI FLOW PARA	.2935	JPSF	2.30

LUBE OIL COOLER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE 8.616	462.1	461.1	400.0	443.7	1300.3	1463.9	.252	
HOT SIDE 30.000	200.0	196.9	573.5	469.5	.0	.0	.600	

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	875.3	25.5	1409.8	

HYDRAULIC OIL COOLER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE 8.616	461.0	459.8	443.6	692.1	1463.8	2346.1	.811	
HOT SIDE 1450.0	100.0	91.5	750.0	740.8	.0	.0	.030	

HEAT REJECTED 7601.69

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Case 84

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16155136 PAGE 1 OF 2

* CONDITION * 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS		COEFFICIENTS *10E+4					
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LMH O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER	HEAT EXCHANGER SCALE FACTORS			
	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX
40.00	12.00	.60
		2.63

TURBINE OUTPUT POWER = 56.06 O/F = .496 SPC = 1.860

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.162	.576
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

IS IT IN CONTROL	CONTROL VALVE	
	YES	YES
PRESSURE IN	498.7	500.0
PRESSURE OUT	64.4	67.2
TEMPERATURE IN	1204.8	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16155136 PAGE 2 OF 2

* CONDITION * 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.162	OXYGEN FLOW	.576
PRESSURE IN	63.8	PRESSURE OUT	63.8
TEMPERATURE IN H2	1204.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.738	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	63.7	PRESSURE OUT	5.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1500.0
ENTHALPY IN	5184.3	ENTHALPY OUT	3816.6
PRESSURE RATIO	12.53	EFFICIENCY	.950

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.323	498.9	498.8	741.7	1204.9	2520.4	4132.5
HOT SIDE	1.738	5.1	5.0	1500.0	985.4	3816.6	2589.6
* TURBINE EXHAUST OVERBOARD PRESSURE *							4.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.161	.908

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.162	500.0	500.0	300.0	399.7	908.5	1299.2
HOT SIDE	.161	498.3	498.3	1204.9	482.2	4132.5	1309.0

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	23.23	1.16	499.98
SECONDARY JET	3.23	.16	498.29
RESULTANT		1.32	498.98
FLOW PARA RATIO		.139	P PRI/P SEC
JET PUMP RISE	1.0014	PRI FLOW PARA	.0465 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.323	499.0	498.9	400.0	532.9	1300.4	1788.8
HOT SIDE	30.000	200.0	196.9	628.0	585.3	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.323	498.9	498.9	533.0	741.7	1789.0	2520.4
HOT SIDE	29.0	100.0	99.8	750.0	690.2	.0	.0

HEAT REJECTED 967.76

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750.
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* CONDITION * 100 HP, 5.0 PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4	
.00	.00
3.64	.00
19.00	13.85
.12	.00

INLET	COMP	TURB	EXHAUST
1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
.0002	.98	.30	.5	2060.00	400.00	1300.00

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAH COLD	ETAH HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUBE O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 199.90 O/F = .542 SPC = 1.651

PROPELLANT

	HYDROGEN	OXYGEN
FLOW RATE	2.846	1.542
PRESSURE	500.00	900.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

	YES	YES
IS IT IN CONTROL	YES	YES
PRESSURE IN	492.0	500.0
PRESSURE OUT	159.7	167.4
TEMPERATURE IN	1123.3	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750.
8 JUNE 1971 16:55:42 PAGE 2 OF 2

* CONDITION * 100 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW	PRESSURE IN	PRESSURE OUT	TEMPERATURE IN H2	TEMPERATURE IN O2
2.846	1.542	158.3	158.3	1123.3	300.0

TURBINE INFORMATION

INLET FLOW	PRESSURE IN	TEMPERATURE IN	ENTHALPY IN	PRESSURE RATIO	SPECIFIC HEAT RATIO	TEMPERATURE OUT	ENTHALPY OUT	EFFICIENCY
4.388	158.0	2060.0	5065.6	28.46	1.368	1410.1	3524.0	.531

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.284	492.9	492.6	738.7	1123.3	2510.0	3848.5	.573
HOT SIDE 4.388	5.5	5.2	1410.1	976.2	3524.0	2522.3	.646

* TURBINE EXHAUST OVERBOARD PRESSURE = 5.02

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.438	3.721

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.846	500.0	499.9	300.0	399.1	908.5	1297.2	.120
HOT SIDE .438	488.8	488.8	1123.3	409.6	3848.5	1321.7	.872

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	56.86	2.85	499.87
SECONDARY JET	8.82	.44	488.84
RESULTANT	3.28	493.31	400.01
FLOW PARA RATIO	.155	P PRI/P SEC	1.0226
JET PUMP RISE	1.0091	PRI FLOW PARA	.1137 JPBF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.284	493.3	493.1	400.0	470.1	1300.4	1981.8	.431
HOT SIDE 30.000	200.0	196.9	962.8	500.3	.0	.0	.384

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.284	493.1	492.9	470.1	738.7	1561.7	2510.0	.960
HOT SIDE 423.7	100.0	97.8	750.0	737.1	.0	.0	.046

HEAT REJECTED 3113.74

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 SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
 8 JUNE 1971 16:55:52 PAGE 1 OF 2

• CONDITION • 200 HP, 5. PAMB, 3000 PSI HYDSYS
 • UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •
 PRESSURE LOSS COEFFICIENTS *10E+4
 .00 .00 1110.00 70000.00 .00 .00 10.00
 3.64 .00 1.18 1.44 .00 .66 3.50 20.00
 19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
 .12 .00

SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRICA TURB NOZ
 1.000 .000 1.000 1.000 12.560 .2000 .1210
 TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HMX IN T LHX O
 .0002 .98 .30 .5 2060.00 400.00 1900.00
 ETA CORF O/F BASE
 .0925 .600

HEAT EXCHANGER SCALE FACTORS
 HEAT EXCHANGER ETAMA COLD ETAMA HOT RHODP COLD RHODP HOT
 H2 PREHEATER 2.00 2.00 .50 1.00
 HYD O COOLER 1.00 1.00 1.00 1.00
 LUB O COOLER 1.00 1.00 1.00 1.00
 RECUPERATOR 1.00 1.00 1.00 1.00

• POINT INPUT DATA •
 HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
 200.00 .00 5.00 3000.0 35.0

• OUTPUT DATA •
 DRIVE POWER HP LOSS
 HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
 240.00 12.00 .60 12.63
 TURBINE OUTPUT POWER = 265.22 O/F = .565 SPC = 1.620

PROPELLANT HYDROGEN OXYGEN
 FLOW RATE 4.577 2.586
 PRESSURE 500.00 500.00
 TEMPERATURE 300.00 300.00
 ENTHALPY 908.5 52.8

CONTROL VALVE
 IS IT IN CONTROL YES YES
 PRESSURE IN 478.3 499.9
 PRESSURE OUT 258.9 272.2
 TEMPERATURE IN 1081.4 300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
 8 JUNE 1971 16:55:52 PAGE 2 OF 2

• CONDITION • 200 HP, 5. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION
 HYDROGEN FLOW 4.577 OXYGEN FLOW 2.586
 PRESSURE IN 256.8 PRESSURE OUT 256.8
 TEMPERATURE IN H2 1081.4 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
 INLET FLOW 7.163 SPECIFIC HEAT RATIO 1.368
 PRESSURE IN 256.4 PRESSURE OUT 6.4
 TEMPERATURE IN 2060.0 TEMPERATURE OUT 1380.5
 ENTHALPY IN 5009.0 ENTHALPY OUT 3438.0
 PRESSURE RATIO 40.06 EFFICIENCY .518

RECUPERATOR INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 5.323 480.4 479.8 721.9 1081.4 2450.7 3702.7 .539
 HOT SIDE 7.163 6.3 5.5 1388.5 979.5 3438.0 2507.6 .614
 • TURBINE EXHAUST OVERBOARD PRESSURE • 5.09

HOT BYPASS VALVE INFORMATION
 FLOW PRESSURE DROP
 .746 9.997

H2 PREHEATER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 4.577 500.0 499.8 300.0 399.1 908.5 1297.0 .127
 HOT SIDE .746 469.8 469.8 1081.4 405.1 3702.7 1319.5 .866

JET PUMP PERFORMANCE
 FLOW PARA FLOW PRESSURE TEMPERATURE
 PRIMARY JET 91.43 4.58 499.68 399.11
 SECONDARY JET 15.02 .75 469.75 405.07
 RESULTANT 5.32 481.45 399.97
 FLOW PARA RATIO .164 P PRI/P SEC 1.0637
 JET PUMP RISE 1.0249 PRI FLOW PARA .1830 JPSF 2.30

LUBE OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 5.323 481.4 481.0 400.0 453.7 1300.2 1501.3 .337
 HOT SIDE 30.000 200.0 196.9 559.2 480.0 .0 .0 .497

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
 509.1 535.9 25.5 1070.4

HYDRAULIC OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 5.323 481.0 480.4 453.7 721.9 1501.3 2450.7 .905
 HOT SIDE 818.4 100.3 95.4 750.0 739.2 .0 .0 .036

HEAT REJECTED 5053.84

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750.
8 JUNE 1971 16:56:00 PAGE 1 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS *10E+4					
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.16	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1900.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* P O I N T I N P U T D A T A *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 432.72 O/F = .590 SPC = 1.619

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.346	4.332
PRESSURE	900.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	434.4	499.7
PRESSURE OUT	417.0	438.4
TEMPERATURE IN	1038.0	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750.
8 JUNE 1971 16:56:00 PAGE 2 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW	4.332
7.346	413.7	413.7
PRESSURE IN	PRESSURE OUT	
413.0	300.0	
TEMPERATURE IN H2	TEMPERATURE IN O2	
1038.0		

TURBINE INFORMATION

INLET FLOW	SPECIFIC HEAT RATIO	1.367
11.678	8.6	
PRESSURE IN	TEMPERATURE OUT	
413.0	1378.2	
TEMPERATURE IN	ENTHALPY IN	
2060.0	4951.7	3378.1
ENTHALPY IN	EFFICIENCY	.512
4951.7		
PRESSURE RATIO		
47.92		

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.623	459.7	458.1	692.0	1038.0	2345.7	3351.2	.904
HOT SIDE 11.678	8.5	6.2	1378.2	980.9	3378.1	2488.0	.379
• TURBINE EXHAUST OVERBOARD PRESSURE •		5.33					

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.277	18.940

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.346	500.0	499.4	300.0	399.2	908.5	1297.2	.134
HOT SIDE 1.277	439.2	439.2	1038.0	404.0	3351.2	1315.2	.859

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	146.76	7.35	499.20
SECONDARY JET	25.67	1.28	439.15
RESULTANT		8.62	462.15
FLOW PARA RATIO	.175	P PRI/P SEC	1.1367
JET PUMP RISE	1.0524	PRI FLOW PARA	.2940
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.623	462.0	461.1	399.9	443.5	1299.9	1463.4	.251
HOT SIDE 30.000	200.0	196.9	573.3	469.3	.0	.0	.608

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.623	460.9	459.7	443.5	692.0	1463.4	2345.7	.811
HOT SIDE 1450.0	100.0	91.5	750.0	740.8	.0	.0	.030

HEAT REJECTED 7608.26

46

7

Cast 88

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:56:12

PAGE 1 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •
DUCT PRESSURE LOSS COEFFICIENTS *10E+4
.00 .00 .00 1110.00 70000.00 .00 .00 10.00
3.64 .00 1.18 1.44 .00 .66 3.50 20.80
19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
.12 .00

SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRICA TURB NOZ
1.000 .000 1.000 1.000 12.560 .2000 .1210
TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HHX IN T LHX O
.0002 .98 .30 .5 2000.00 400.00 1500.00
ETA CORF O/F BASE
.0925 .600

HEAT EXCHANGER SCALE FACTORS
ETAHA COLD ETAHA HOT RHODP COLD RHODP HOT
H2 PREHEATER 2.00 2.00 .50 1.00
HYD O COOLER 1.00 1.00 1.00 1.00
LUB O COOLER 1.00 1.00 1.00 1.00
RECUPERATOR 1.00 1.00 1.00 1.00

• POINT INPUT DATA •
HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
.00 .00 10.00 3000.0 35.0

• OUTPUT DATA •

DRIVE POWER HP LOSS
HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
40.00 12.00 .60 2.63

TURBINE OUTPUT POWER = 54.78 O/F = .466 SPC = 2.217

PROPELLANT HYDROGEN OXYGEN
FLOW RATE 1.381 .643
PRESSURE 500.00 500.00
TEMPERATURE 300.00 300.00
ENTHALPY 908.5 52.8

CONTROL VALVE
IS IT IN CONTROL YES YES
PRESSURE IN 498.1 500.0
PRESSURE OUT 75.9 78.7
TEMPERATURE IN 1258.5 300.0

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:56:12

PAGE 2 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION
HYDROGEN FLOW 1.381 OXYGEN FLOW .643
PRESSURE IN 75.1 PRESSURE OUT 75.1
TEMPERATURE IN H2 1258.5 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
INLET FLOW 2.024 SPECIFIC HEAT RATIO 1.367
PRESSURE IN 75.0 PRESSURE OUT 10.1
TEMPERATURE IN 2060.0 TEMPERATURE OUT 1600.6
ENTHALPY IN 5265.9 ENTHALPY OUT 4118.4
PRESSURE RATIO 7.46 EFFICIENCY .935

RECUPERATOR INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 1.960 498.3 498.2 734.8 1258.5 2496.2 4321.5 .608
HOT SIDE 2.024 10.1 10.0 1600.6 1022.3 4116.4 2709.8 .668
• TURBINE EXHAUST OVERBOARD PRESSURE • 9.99

HOT BYPASS VALVE INFORMATION
FLOW PRESSURE DROP
.179 .849

H2 PREHEATER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 1.381 500.0 500.0 300.0 399.6 908.5 1299.0 .104
HOT SIDE .179 497.4 497.4 1258.5 402.8 4321.5 1311.0 .893

JET PUMP PERFORMANCE
FLOW PARA FLOW PRESSURE TEMPERATURE
PRIMARY JET 27.60 1.38 499.97 399.63
SECONDARY JET 3.59 .18 497.37 402.77
RESULTANT .136 498.45 399.99
FLOW PARA RATIO .130 P PRI/P SEC 1.0052
JET PUMP RISE 1.0022 PRI FLOW PARA .0592 JPSF 2.30

LUBE OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 1.560 498.4 498.4 400.0 512.3 1300.4 1714.7 .562
HOT SIDE 30.000 200.0 196.9 599.7 555.4 .0 .0 .222

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
509.1 111.6 25.5 646.2

HYDRAULIC OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 1.560 498.4 498.3 512.3 734.8 1714.7 2496.2 .936
HOT SIDE 29.0 100.0 99.8 750.0 674.0 .0 .0 .320

HEAT REJECTED 1219.01

95

12

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SSAPU PHASE I],TURB 16,300 R H2,T20=400,T60=750,
8 JUNE 1971 16:56:19 PAGE 1 OF 2

• CONDITION • 100 HP,10. PAMB,3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* • POINT INPUT DATA • *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER			HP LOSS
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 159.85 O/F = .526 SPC = 1.767

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.084	1.623
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	490.6	500.0
PRESSURE OUT	171.9	179.9
TEMPERATURE IN	1148.2	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16,300 R H2,T20=400,T60=750,
8 JUNE 1971 16:56:19 PAGE 2 OF 2

• CONDITION • 100 HP,10. PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION		
HYDROGEN FLOW	3.084	OXYGEN FLOW 1.623
PRESSURE IN	170.3	PRESSURE OUT 170.3
TEMPERATURE IN H2	1148.2	TEMPERATURE IN O2 300.0

TURBINE INFORMATION		
INLET FLOW	4.707	SPECIFIC HEAT RATIO 1.368
PRESSURE IN	170.1	PRESSURE OUT 10.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT 1459.3
ENTHALPY IN	5105.3	ENTHALPY OUT 3664.4
PRESSURE RATIO	16.90	EFFICIENCY .551

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.542	491.6	491.3	735.8	1148.2	2499.8	3935.0 .570
HOT SIDE	4.707	10.3	10.1	1459.3	996.5	3664.4	2584.3 .640

* TURBINE EXHAUST OVERBOARD PRESSURE = 9.98

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.459	4.454

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.084	500.0	499.9	300.0	399.1	908.5	1297.0 .117
HOT SIDE	.459	486.8	486.8	1148.2	406.1	3935.0	1323.7 .875

JET PUMP PERFORMANCE			
FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	61.60	3.08	499.85
SECONDARY JET	9.25	.46	486.81
RESULTANT		3.54	492.11
FLOW PARA RATIO	.150	P PRI/P SEC	1.0268
JET PUMP RISE	1.0109	PRI FLOW PARA	.1232 JPSF
			2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.542	492.1	491.9	400.0	464.9	1300.5	1542.7 .415
HOT SIDE	30.000	200.0	196.9	556.3	493.3	.0	.0 .403

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.542	491.9	491.6	464.9	735.8	1542.6	2499.8 .950
HOT SIDE	423.7	100.0	97.8	750.0	736.0	.0	.0 .049

HEAT REJECTED 3391.83

96

6

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750, 8 JUNE 1971 16:56:30 PAGE 1 OF 2

• CONDITION • 200 HP, 10. PAMB, 3000 P61 HYOSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		TURBINE LOSS COEFFICIENTS *10E+4	
.00	.00	.00	.00
3.64	.00	1.18	1.44
19.00	13.85	54.00	.00
.12	.00	2.02	50.00

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.360	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LMH O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAMA COLD	ETAMA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	10.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS
HYD PUMP ALTERNATOR LUBE PUMP	GEAR BOX
240.00 12.00 .60	12.63

TURBINE OUTPUT POWER = 265.43 O/F = .557 SPC = 1.687

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.790	2.671
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	476.4	499.9
PRESSURE OUT	270.5	283.9
TEMPERATURE IN	1094.5	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750, 8 JUNE 1971 16:56:30 PAGE 2 OF 2

• CONDITION • 200 HP, 10. PAMB, 3000 P61 HYOSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.790	OXYGEN FLOW	2.671
PRESSURE IN	268.2	PRESSURE OUT	268.2
TEMPERATURE IN H2	1094.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.461	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	267.8	PRESSURE OUT	10.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1418.3
ENTHALPY IN	5028.0	ENTHALPY OUT	3918.2
PRESSURE RATIO	24.75	EFFICIENCY	.539

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF.
COLD SIDE 5.557	478.8	478.1	719.0	1094.4	2440.6	3748.4	.537
HOT SIDE 7.461	10.8	10.2	1418.3	992.4	3518.2	2544.2	.609

* TURBINE EXHAUST OVERBOARD PRESSURE = 10.01

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.767	10.819

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF.
COLD SIDE 4.790	500.0	499.7	300.0	399.1	908.5	1297.2	.125
HOT SIDE .767	467.3	467.3	1094.6	405.0	3748.4	1319.2	.888

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	95.71	4.79	499.65
SECONDARY JET	15.43	.77	467.25
RESULTANT		5.56	479.91
FLOW PARA RATIO	.161	P PRI/P SEC	1.0693
JET PUMP RISE	1.0271	PRI FLOW PARA	.1915 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF.
COLD SIDE 5.557	479.9	479.4	400.0	451.4	1300.2	1492.9	.329
HOT SIDE 30.000	200.0	196.9	556.4	476.9	.0	.0	.508

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF.
COLD SIDE 5.557	479.4	478.8	451.4	719.0	1492.9	2440.6	.896
HOT SIDE 818.4	100.0	95.4	750.0	738.8	.0	.0	.038

HEAT REJECTED 5265.79

97

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20*400, T60=750.
 8 JUNE 1971 16:56:39 PAGE 1 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 WYDSYS

• UNITS • AREA*SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE		LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR ON F	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T MHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 433.45 O/F = .586 SPC = 1.656

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.545	4.418
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	452.6	499.7
PRESSURE OUT	427.1	448.7
TEMPERATURE IN	1044.4	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20*400, T60=750.
 8 JUNE 1971 16:56:39 PAGE 2 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.545	OXYGEN FLOW	4.418
PRESSURE IN	423.7	PRESSURE OUT	423.7
TEMPERATURE IN H2	1044.4	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.963	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	423.1	PRESSURE OUT	12.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1395.2
ENTHALPY IN	4961.9	ENTHALPY OUT	3423.0
PRESSURE RATIO	34.27	EFFICIENCY	.526

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
GOLD SIDE 8.842	458.3	456.6	689.5	1044.4	2336.9	3573.3	.503
HOT SIDE 11.963	12.2	10.6	1395.2	988.6	3423.0	2509.1	.576

* TURBINE EXHAUST OVERBOARD PRESSURE * 10.11

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.297	19.505

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.545	500.0	499.4	300.0	399.0	908.5	1296.7	.133
HOT SIDE 1.297	437.1	437.1	1044.4	404.0	3573.3	1313.3	.060

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
150.72	7.55	499.16	399.03	
SECONDARY JET	26.08	1.30	437.11	404.02
RESULTANT		8.84	460.86	399.82
FLOW PARA RATIO		.173	P PRI/P SEC	1.1420
JET PUMP RISE	1.0543	PRI FLOW PARA	.3019	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.842	460.7	459.7	399.8	442.3	1299.5	1458.9	.247
HOT SIDE 30.000	200.0	196.9	571.9	467.6	.0	.0	.606

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 8.842	459.6	458.3	442.3	689.5	1458.9	2336.9	.803
HOT SIDE 1450.0	168.0	91.5	750.0	740.7	.0	.0	.030

HEAT REJECTED 7765.27

96

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II: TURB 16,300 R H2, T20=400, T60=750.
8 JUNE 1971 16:56:58

PAGE 1 OF 2

• CONDITION • 0.0 HP, 14.7 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX 0
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	14.70	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER				HP LOSS
MYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX	
40.00	12.00	.60	2.63	

TURBINE OUTPUT POWER = 55.42 O/F = .446 SPC = 2.558

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.634	.729
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	497.3	500.0
PRESSURE OUT	89.3	92.2
TEMPERATURE IN	1289.7	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II: TURB 16,300 R H2, T20=400, T60=750.
8 JUNE 1971 16:56:58

PAGE 2 OF 2

• CONDITION • 0.0 HP, 14.7 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.634	OXYGEN FLOW	.729
PRESSURE IN	88.3	PRESSURE OUT	88.3
TEMPERATURE IN H2	1289.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.363	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	88.2	PRESSURE OUT	14.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1667.7
ENTHALPY IN	5323.0	ENTHALPY OUT	4324.9
PRESSURE RATIO	5.98	EFFICIENCY	.500

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.839	497.6	497.5	724.7	1289.2	2460.9	4429.5	.599
HOT SIDE 2.363	14.8	14.7	1667.7	1047.0	4324.9	2793.0	.658

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.69

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.204	1.215

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.634	500.0	500.0	300.0	399.5	908.5	1298.5	.101
HOT SIDE .204	496.3	496.3	1289.2	403.3	4429.5	1313.0	.896

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	32.66	1.63	499.95
SECONDARY JET	4.10	.20	496.29
RESULTANT		1.84	497.80
FLOW PARA RISE	1.0030	.126	P PRI/P SEC
		.0653	JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.839	497.8	497.7	399.9	494.8	1300.2	1651.6	.530
HOT SIDE 30.000	200.0	196.9	576.1	530.4	.0	.0	.259

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.839	497.7	497.6	494.8	724.7	1651.6	2460.9	.901
HOT SIDE 29.0	100.0	99.8	750.0	656.3	.0	.0	.367

HEAT REJECTED 1488.04

66

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750.
8 JUNE 1971 16:57:03 PAGE 1 OF 2

• CONDITION • 100 HP, 14.7 PAMB, 3000 PSI HYD SYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=3TU/MIN, T=DEG R, W=LB/MIN

• I N P U T D A T A •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		TUR ORCA		JP PRICA		TURB NOZ	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.70	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR ORCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00

HEAT EXCHANGER SCALE FACTORS		RHODP COLD		RHODP HOT	
HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT	
H2 PREHEATER	2.00	2.00	.50	1.00	
HYD O COOLER	1.00	1.00	1.00	1.00	
LUB O COOLER	1.00	1.00	1.00	1.00	
RECUPERATOR	1.00	1.00	1.00	1.00	

• • POINT INPUT DATA • •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	14.70	3000.0	35.0

• O U T P U T D A T A •

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 160.47 O/F = .518 SPC = 1.885

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.321	1.721
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE	
IS IT IN CONTROL	YES
PRESSURE IN	489.1
PRESSURE OUT	184.6
TEMPERATURE IN	1167.0

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750.
8 JUNE 1971 16:57:03 PAGE 2 OF 2

• CONDITION • 100 HP, 14.7 PAMB, 3000 PSI HYD SYS

COMBUSTOR INFORMATION		OXYGEN FLOW	
HYDROGEN FLOW	3.321	OXYGEN FLOW	1.721
PRESSURE IN	182.9	PRESSURE OUT	182.9
TEMPERATURE IN H2	1167.0	TEMPERATURE IN O2	300.0

TURBINE INFORMATION		SPECIFIC HEAT RATIO	
INLET FLOW	5.042	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	182.6	PRESSURE OUT	14.9
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1500.5
ENTHALPY IN	5126.2	ENTHALPY OUT	3775.6
PRESSURE RATIO	12.22	EFFICIENCY	.555

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.803	490.3	490.0	732.7	1167.1	2488.8	4000.6
HOT SIDE	5.042	14.9	14.8	1500.5	1015.0	3775.6	2635.4

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.68

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.482	5.182

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.321	500.0	499.9	300.0	399.0	908.5	1296.7
HOT SIDE	.482	484.8	484.8	1167.1	406.6	4000.6	1325.5

JET PUMP PERFORMANCE			
FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	66.34	3.32	499.83
SECONDARY JET	9.72	.48	484.76
RESULTANT		3.80	490.90
FLOW PARA RATIO	.146	P PRI/P SEC	1.0311
JET PUMP RISE	1.0127	PRI FLOW PARA	.1327
		JPSF	2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.803	490.9	490.7	400.0	460.4	1300.4	1526.1
HOT SIDE	30.000	200.0	196.9	550.6	487.1	.0	.0

HEAT REJECTED			
ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.803	490.6	490.3	460.4	732.7	1526.1	2488.8
HOT SIDE	423.7	100.0	97.8	730.0	734.9	.0	.0

HEAT REJECTED 366.83

100

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:57:116 PAGE 1 OF 2

• CONDITION • 200 HP, 14.7PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4						
.00	.00	.00	1110.00	70000.00	.00	.00
3.64	.00	1.18	1.44	.00	.66	3.50
19.00	13.85	54.00	.00	2.02	50.00	2.74
.12	.00					

SFT	TUR ON F	SF JP P	SF JP W	TUR OBGA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMH IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.000					

HEAT EXCHANGER SCALE FACTORS			
HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD
H2 PREHEATER	2.00	2.00	.50
HYD O COOLER	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER			
HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 265.48 O/F = .551 SPC = 1.753

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	5.000	2.755
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	474.7	499.9
PRESSURE OUT	281.9	295.5
TEMPERATURE IN	1106.2	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:57:116 PAGE 2 OF 2

• CONDITION • 200 HP, 14.7PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	5.000	OXYGEN FLOW	2.755
PRESSURE IN	279.5	PRESSURE OUT	279.5
TEMPERATURE IN H2	1106.2	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	7.755	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	279.1	PRESSURE OUT	15.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1445.4
ENTHALPY IN	5044.6	ENTHALPY OUT	3591.6
PRESSURE RATIO	16.17	EFFICIENCY	.551

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.788	477.2	476.5	716.1	1106.2	2430.5	3788.7	.939
HOT SIDE 7.753	15.3	14.9	1445.4	1004.4	3591.6	2577.9	.609
• TURBINE EXHAUST OVERBOARD PRESSURE • 14.73							

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.787	11.656

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.000	500.0	499.7	300.0	399.2	908.5	1297.4	.123
HOT SIDE .787	464.8	464.8	1106.2	404.9	3788.7	1319.0	.870

JET PUMP PERFORMANCE					
FLOW PARA	FLOW	PRESSURE	TEMPERATURE		
PRIMARY JET	99.91	5.00	499.62	399.21	
SECONDARY JET	15.85	.79	464.81	404.94	
RESULTANT		5.79	478.44	400.02	
FLOW PARA RATIO		.159	P PRI/P SEC	1.0749	
JET PUMP RISE	1.0293	PRI FLOW PARA	.2000	JPSF	2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.788	478.4	477.9	400.0	449.4	1300.4	1485.3	.321
HOT SIDE 30.000	200.0	196.9	553.8	474.0	.0	.0	.519

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 5.788	477.9	477.3	449.3	716.1	1485.2	2430.5	.887
HOT SIDE 818.4	100.0	95.4	750.0	738.3	.0	.0	.039

HEAT REJECTED 5471.41

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SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:57:52 PAGE 1 OF 2

* CONDITION * 360 HP, 14.7 PAMB, 3000 WYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		SFT		TUR DN F		SF JP P		SF JP W		TUR OBCA		JP PRICA		TURB NOZ	
.00	.00	1.000	.000	1.000	1.000	12,560	.2000	.1210							
3.64	.00	.0002	.98	.30	.5	2060.00	400.00	1500.00							
19.00	13.85	.0925	.600												
.12	.00														

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	14.70	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 432.26 O/F = .585 SPC = 1.696

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.712	4.509
PRESSURE	500.00	500.00
TEMPERATURE	300.00	300.00
ENTHALPY	908.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	451.2	499.6
PRESSURE OUT	434.5	456.4
TEMPERATURE IN	1050.9	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,300 R H2, T20=400, T60=750,
8 JUNE 1971 16:57:52 PAGE 2 OF 2

* CONDITION * 360 HP, 14.7 PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.712	OXYGEN FLOW	4.509
PRESSURE IN	431.0	PRESSURE OUT	431.0
TEMPERATURE IN H2	1050.9	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	12.221	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	430.3	PRESSURE OUT	16.5
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1411.7
ENTHALPY IN	4964.1	ENTHALPY OUT	3461.7
PRESSURE RATIO	26.08	EFFICIENCY	.540

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 9.024	457.1	455.4	687.4	1051.0	2329.6	3596.2	.502
HOT SIDE 12.221	16.4	15.2	1411.7	996.0	3461.7	2526.4	.574

* TURBINE EXHAUST OVERBOARD PRESSURE * 14.79

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
1.312	19.975

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.712	500.0	499.4	300.0	399.0	908.5	1296.5	.132
HOT SIDE 1.312	435.4	435.4	1051.0	404.1	3596.2	1315.5	.861

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
154.04	7.71	499.12	398.97		
SECONDARY JET	26.38	1.31	435.41	404.09	
RESULANT		9.02	459.79	399.78	
FLOW PARA RATIO	.171	P PRI/P SEC		1.1463	
JET PUMP RISE	1.0560	PRI FLOW PARA	.3086	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 9.024	459.6	458.6	399.8	441.4	1299.3	1455.5	.243
HOT SIDE 30.000	260.0	196.9	570.8	466.4	.0	.0	.611

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	875.3	25.5	1409.8	

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 9.024	458.4	457.2	441.4	687.4	1455.5	2329.6	.797
HOT SIDE 1450.0	160.0	91.5	750.0	740.5	.0	.0	.031

HEAT REJECTED 788.72

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TH2=500 R , T(60)= 550 R
15JUN71

09:18:28

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• CONDITION • CASE 3

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, G=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		TURBINE LOSS COEFFICIENTS *10E+4	
.00	.00	.00	.00
3.64	.00	1.18	1.44
19.00	13.85	54.00	.00
.12	.00	.00	2.02
			50.00
			2.74
			.023

6FT	TUR DN P	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T WHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.46 O/F = .573 SPC = 1.503

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	.883	.506
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	499.1	500.0
PRESSURE OUT	50.2	53.1
TEMPERATURE IN	1065.9	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2=500 R , T(60)= 550 R
15JUN71

09:18:28

PAGE 2 OF 2

• CONDITION • CASE 3

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW
.883	.504
PRESSURE IN	PRESSURE OUT
49.8	49.8
TEMPERATURE IN H2	TEMPERATURE IN O2
1065.9	300.0

TURBINE INFORMATION

INLET FLOW	SPECIFIC HEAT RATIO
1.389	1.368
PRESSURE IN	PRESSURE OUT
49.7	49.8
TEMPERATURE IN	TEMPERATURE OUT
2060.0	1331.2
ENTHALPY IN	ENTHALPY OUT
4986.2	3294.7
PRESSURE RATIO	EFFICIENCY
65.24	.924

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE .883	499.2	499.2	551.7	1066.2	1855.0	3690.3	.668
HOT SIDE 1.389	.7	.4	1331.2	825.0	3294.7	2153.6	.649

* TURBINE EXHAUST OVERBOARD PRESSURE = .30

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE .883	500.0	500.0	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	499.2	499.2	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET 19.74	.88	499.98	500.00
SECONDARY JET .00	.00	498.75	.00
RESULTANT .00	.88	499.25	500.00
FLOW PARA RATIO	P PRI/P SEC		
JET PUMP RISE 1.0010	.0395	JPSF 2.30	1.0025

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE .883	499.3	499.2	500.0	708.0	1670.5	2402.4	.640
HOT SIDE 30.000	200.0	196.9	824.9	790.7	.0	.0	.105

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE .883	499.2	499.2	708.0	551.7	2402.4	1855.0	.989
HOT SIDE 29.0	100.0	99.8	550.0	585.6	.0	.0	.225

HEAT REJECTED -483.25

SECTION 4
DATA CASES 97 TO 144

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Case 97

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T20=400,
8 JUNE 1971 16:21:41 PAGE 1 OF 2

• CONDITION • 100 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 160.07 O/F = .578 SPC = 1.595

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.696	1.558
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	491.4	500.0
PRESSURE OUT	153.8	162.4
TEMPERATURE IN	1059.4	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T20=400,
8 JUNE 1971 16:21:41 PAGE 2 OF 2

• CONDITION • 100 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	2.696	OXYGEN FLOW	1.558
PRESSURE IN	152.6	PRESSURE OUT	152.6
TEMPERATURE IN H2	1059.4	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.254	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	152.3	PRESSURE OUT	2.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1372.2
ENTHALPY IN	4976.3	ENTHALPY OUT	3381.7
PRESSURE RATIO	64.78	EFFICIENCY	.495

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.696	492.1	491.9	550.9	1059.3	1852.2	3625.9	.619
HOT SIDE	4.254	2.3	1.4	1372.2	873.0	3381.7	2257.6	.600

* TURBINE EXHAUST OVERBOARD PRESSURE = .96

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.696	500.0	499.9	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	491.9	491.9	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
60.29	2.70	499.84	500.00	
SECONDARY JET	.00	.00	486.92	.00
RESULTANT	2.70	492.44	500.03	
FLOW PARA RATIO	.000	P PRI/P SEC	1.0265	
JET PUMP RISE	1.0113	PRI FLOW PARA	.1206	JPSF
			2.30	

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.696	492.4	492.3	500.0	589.9	1670.5	1988.8	.496
HOT SIDE	30.008	200.0	196.9	681.2	627.7	.0	.0	.296

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.696	492.3	492.1	589.9	550.9	1988.8	1852.2	.977
HOT SIDE	423.7	100.0	97.8	550.0	551.9	.0	.0	.048

HEAT REJECTED -368.40

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16,500 R H2,T20=400, 16:21:47 PAGE 1 OF 2
 8 JUNE 1971

* CONDITION * 200 HP,0.0 PAMB,3000 PSI HYDSYS

* UNITS * AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00
3.84	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				2.74

SFT	TUR DN F	SF JP P	SF JP W	TUR OBSCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER HP LOSS

HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 265.28 O/F = .593 SPC = 1.601

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.444	2.634
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	476.0	499.9
PRESSURE OUT	255.0	270.1
TEMPERATURE IN	1033.4	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16,500 R H2,T20=400, 16:21:47 PAGE 2 OF 2
 8 JUNE 1971

* CONDITION * 200 HP,0.0 PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.444	OXYGEN FLOW	2.634
PRESSURE IN	253.9	PRESSURE OUT	253.9
TEMPERATURE IN H2	1033.4	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.077	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	253.5	PRESSURE OUT	4.0
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1368.9
ENTHALPY IN	4942.5	ENTHALPY OUT	3353.0
PRESSURE RATIO	63.83	EFFICIENCY	.499

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.444	478.5	478.1	551.1	1033.3	1052.7	3555.4
HOT SIDE	7.077	3.8	2.4	1368.9	895.7	3353.0	2296.4

* TURBINE EXHAUST OVERBOARD PRESSURE * 1.61

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.444	500.0	499.7	500.0	500.0	1670.5	1670.5
HOT SIDE	.000	478.1	478.1	.0	.0	.0	.0

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	.00	.00	464.55	.00
RESULTANT		4.44	479.36	500.09
FLOW PARA RATIO	.000	P PRI/P SEC		1.0754
JET PUMP RISE	1.0319	PRI FLOW PARA	.1989	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.444	479.3	479.0	500.1	567.9	1670.5	1911.4
HOT SIDE	30.000	200.0	196.9	669.6	601.2	.0	.0

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL

509.1	535.9	25.5	1070.4
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HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.444	478.9	478.5	567.9	551.1	1911.4	1852.7
HOT SIDE	818.4	100.0	95.4	550.0	550.7	.0	.0

HEAT REJECTED -260.67

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,500 R H2, T20=400,
8 JUNE 1971 16:21:51 PAGE 1 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •
DUCT PRESSURE LOSS COEFFICIENTS *10E+4
.00 .00 .00 1110.00 70000.00 .00 .00 10.00
3.64 .00 1.18 1.44 .00 .66 3.50 20.00
19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
.12 .00

SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRCA TURB NOZ
1.000 .000 1.000 1.000 12.560 .2000 .1210
TUR LKCA ETA COMB LUBE P HP ETA LQPP T TUR IN T HHX IN T LHX O
.0002 .98 .30 .5 2060.00 400.00 1500.00
ETA CORF O/F BASE
.0925 .600

HEAT EXCHANGER SCALE FACTORS
HEAT EXCHANGER ETAMA COLD ETAMA HOT RHDDP COLD RHDDP HOT
H2 PREHEATER 2.00 2.00 .50 1.00
HYD O COOLER 1.00 1.00 1.00 1.00
LUB O COOLER 1.00 1.00 1.00 1.00
RECUPERATOR 1.00 1.00 1.00 1.00

• POINT INPUT DATA •
HYDRA HP ELECT HP P AMB B HYDRA OIL ALT SIZE(KW)
360.00 .00 .00 3000.0 35.0

• OUTPUT DATA •

DRIVE POWER HP LOSS
HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
400.00 12.00 .60 20.63

TURBINE OUTPUT POWER = 433.38 O/F = .609 SPC = 1.617

PROPELLANT HYDROGEN OXYGEN
FLOW RATE 7.256 4.421
PRESSURE 500.00 500.00
TEMPERATURE 500.00 300.00
ENTHALPY 1670.5 52.8

CONTROL VALVE
IS IT IN CONTROL YES YES
PRESSURE IN 453.7 499.7
PRESSURE OUT 416.7 439.3
TEMPERATURE IN 1004.8 300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16,500 R H2, T20=400,
8 JUNE 1971 16:21:51 PAGE 2 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION
HYDROGEN FLOW 7.256 OXYGEN FLOW 4.421
PRESSURE IN 413.6 PRESSURE OUT 413.6
TEMPERATURE IN H2 1004.8 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
INLET FLOW 11.677 SPECIFIC HEAT RATIO 1.367
PRESSURE IN 413.0 PRESSURE OUT 7.1
TEMPERATURE IN 2060.0 TEMPERATURE OUT 1369.2
ENTHALPY IN 4905.7 ENTHALPY OUT 3330.1
PRESSURE RATIO 58.41 EFFICIENCY .505

RECUPERATOR INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 7.256 458.2 457.2 550.7 1004.7 1650.7 1670.5 .558
HOT SIDE 11.677 6.9 3.8 1369.2 923.9 3330.1 2345.4 .544
• TURBINE EXHAUST OVERBOARD PRESSURE • 2.66

HOT BYPASS VALVE INFORMATION
FLOW PRESSURE DROP
.000 .000

H2 PREHEATER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 7.256 500.0 499.2 500.0 500.0 1670.5 1670.5 .008
HOT SIDE .000 457.2 457.8 .0 .0 .0 .000

JET PUMP PERFORMANCE
FLOW PARA FLOW PRESSURE TEMPERATURE
PRIMARY JET 162.24 7.28 498.91 500.00
SECONDARY JET .00 .00 431.95 .00
RESULTANT 7.26 460.30 500.16
FLOW PARA RATIO .000 P PRI/P SEC 1.1550
JET PUMP RISE 1.0656 PRI FLOW PARA .3252 JPBF 2.30

LUBE OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 7.256 460.2 459.3 500.2 554.7 1670.5 1664.8 .307
HOT SIDE 30.000 200.0 196.9 677.9 987.6 .0 .0 .308

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
509.1 875.3 25.5 1409.8

HYDRAULIC OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 7.256 459.2 458.3 554.7 550.7 1664.8 1650.7 .859
HOT SIDE 1450.0 100.0 91.5 550.0 550.2 .0 .0 .033

HEAT REJECTED -102.18

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2=500 R , T(60)= 550 R
15JUN71

09:18:33

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* CONDITION * CASE 4

* UNITS * AREA*SQ IN, H*BTU/LB, P*PSIA, Q*BTU/MIN, T*DEG R, W*LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR ORCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX
40.00	12.00 .60	2.63

TURBINE OUTPUT POWER = 55.51 O/F = .515 SPC = 1,879

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.147	.591
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.6

CONTROL VALVE	
IS IT IN CONTROL	YES
PRESSURE IN	498.5 500.0
PRESSURE OUT	64.2 67.1
TEMPERATURE IN	1167.7 300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2=500 R , T(60)= 550 R
15JUN71

09:18:33

PAGE 2 OF 2

* CONDITION * CASE 4

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.147	OXYGEN FLOW	.591
PRESSURE IN	63.6	PRESSURE OUT	63.6
TEMPERATURE IN H2	1167.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.738	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	63.5	PRESSURE OUT	5.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1499.6
ENTHALPY IN	5132.5	ENTHALPY OUT	3778.8
PRESSURE RATIO	12.50	EFFICIENCY	.552

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.147	498.6	498.6	553.4	1167.7	1860.9	4003.0 .649
HOT SIDE	1.738	5.1	5.0	1499.6	897.4	3778.8	2365.1 .636

* TURBINE EXHAUST OVERBOARD PRESSURE * 4.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.147	500.0	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	498.6	498.6	.0	.0	.0	.000

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
25.65	1.15	499.97	500.00	
SECONDARY JET	.00	.00	497.73	.00
RESULTANT		1.15	498.69	500.01
FLOW PARA RATIO	.000	P PRI/P SEC		1.0045
JET PUMP RISE	1.0019	PRI FLOW PARA	.0513 JPSF	2.30

LURE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.147	498.7	498.7	500.0	659.8	1670.5	2233.7 .617
HOT SIDE	30.000	200.0	196.9	758.8	722.1	.0	.0 .142

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.147	498.7	498.6	659.8	553.4	2233.7	1860.9 .969
HOT SIDE	29.0	100.0	99.8	550.0	581.6	.0	.0 .288

HEAT REJECTED -427.76

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Case 101

4

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II.TURB 16.500 R H2.T20=400,
8 JUNE 1971 16:22:36 PAGE 1 OF 2

• CONDITION • 100 HP,5.0 PAMB,3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• I N P U T D A T A •
DUCT PRESSURE LOSS COEFFICIENTS *10E+4
.00 .00 .00 1110.00 70000.00 .00 .00 10.00
3.64 .00 1.18 1.44 .00 .66 3.50 20.00
19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
.12 .00

SFT TUR DN F SF JP P SF JP W TUR OBGA JP PRCA TURB NOZ
1.000 .000 1.000 1.000 12.560 .2000 .1210
TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HHX IN T LHX O
.0002 .98 .30 .5 2060.00 400.00 1500.00
ETA CORF O/F BASE
.0925 .600

HEAT EXCHANGER SCALE FACTORS
HEAT EXCHANGER ETAHA COLD ETAHA HOT RHODP COLD RHODP HOT
H2 PREHEATER 2.00 2.00 .50 1.00
HYD O COOLER 1.00 1.00 1.00 1.00
LUB O COOLER 1.00 1.00 1.00 1.00
RECUPERATOR 1.00 1.00 1.00 1.00

• • POINT INPUT DATA • •
HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
100.00 .00 5.00 3000.0 35.0

• O U T P U T D A T A •

DRIVE POWER HP LOSS
HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
140.00 12.00 .60 7.63

TURBINE OUTPUT POWER = 160.28 O/F = .567 SPC = 1.667

PROPELLANT HYDROGEN OXYGEN
FLOW RATE 2.843 1.611
PRESSURE 500.00 500.00
TEMPERATURE 500.00 300.00
ENTHALPY 1670.5 52.8

CONTROL VALVE
IS IT IN CONTROL YES YES
PRESSURE IN 490.5 500.0
PRESSURE OUT 160.1 168.9
TEMPERATURE IN 1080.0 300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II.TURB 16.500 R H2.T20=400,
8 JUNE 1971 16:22:36 PAGE 2 OF 2

• CONDITION • 100 HP,5.0 PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION
HYDROGEN FLOW 2.843 OXYGEN FLOW 1.611
PRESSURE IN 158.8 PRESSURE OUT 158.8
TEMPERATURE IN H2 1080.0 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
INLET FLOW 4.454 SPECIFIC HEAT RATIO 1.367
PRESSURE IN 158.5 PRESSURE OUT 5.5
TEMPERATURE IN 2060.0 TEMPERATURE OUT 1407.2
ENTHALPY IN 5003.9 ENTHALPY OUT 3478.5
PRESSURE RATIO 28.74 EFFICIENCY .533

RECUPERATOR INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 2.843 491.2 491.0 551.0 1078.7 1852.3 3693.3 .616
HOT SIDE 4.454 5.5 5.1 1407.2 889.4 3478.5 2303.4 .605
• TURBINE EXHAUST OVERBOARD PRESSURE • 5.00

HOT BYPASS VALVE INFORMATION
FLOW PRESSURE DROP
.300 .000

H2 PREHEATER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 2.843 500.0 499.9 500.0 500.0 1670.5 1670.5 .000
HOT SIDE .000 491.0 491.0 .0 .0 .0 .000

JET PUMP PERFORMANCE
FLOW PARA FLOW PRESSURE TEMPERATURE
PRIMARY JET 63.57 2.84 499.82 500.00
SECONDARY JET .00 .00 485.45 .00
RESULTANT 2.84 491.60 500.03
FLOW PARA RATIO .000 P PRI/P SEC 1.0296
JET PUMP RISE 1.0127 PRI FLOW PARA .1272 JPSF 2.30

LUBE OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 2.843 491.6 491.4 500.0 585.2 1670.5 1972.4 .486
HOT SIDE 30.000 200.0 196.9 675.4 621.5 .0 .0 .308

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
509.1 323.7 25.5 858.3

HYDRAULIC OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 2.843 491.4 491.2 585.2 551.0 1972.4 1852.3 .973
HOT SIDE 423.7 100.0 97.8 550.0 551.8 .0 .0 .050

HEAT REJECTED -341.35

108

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T20=400, 16:22:43 PAGE 1 OF 2
8 JUNE 1971

• CONDITION • 200 HP, 5. PAMB, 3000 PSI HYDYSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4								
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.00	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.000					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 265.08 O/F = .587 SPC = 1.635

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.550	2.673
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	475.9	499.9
PRESSURE OUT	259.1	273.5
TEMPERATURE IN	1041.9	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T20=400, 16:22:43 PAGE 2 OF 2
8 JUNE 1971

• CONDITION • 200 HP, 5. PAMB, 3000 PSI HYDYSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.550	OXYGEN FLOW	2.673
PRESSURE IN	257.1	PRESSURE OUT	257.1
TEMPERATURE IN H2	1041.9	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.223	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	256.7	PRESSURE OUT	6.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1385.7
ENTHALPY IN	4954.9	ENTHALPY OUT	3398.5
PRESSURE RATIO	40.38	EFFICIENCY	.520

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.950	477.7	477.3	551.1	1041.4	1852.5	3563.6	.587
HOT SIDE 7.223	6.3	5.4	1385.7	904.7	3398.5	2320.7	.976

• TURBINE EXHAUST OVERBOARD PRESSURE = 5.09

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.950	500.0	499.7	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	477.3	477.3	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
101.74	4.55	499.56	500.00	
SECONDARY JET	.00	.00	463.24	.00
RESULTANT		4.55	478.62	500.09
FLOW PARA RATIO	.000	P PRI/P SEC		1.0784
JET PUMP RISE	1.0332	PRI FLOW PARA	.2037	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.550	478.6	478.2	500.1	566.3	1670.5	1905.7	.399
HOT SIDE 30.000	200.0	196.9	667.6	599.1	.0	.0	.409

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	935.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.550	478.2	477.8	566.3	551.1	1905.7	1852.5	.933
HOT SIDE 818.4	100.0	95.4	550.0	550.6	.0	.0	.040

HEAT REJECTED -241.99

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T20=400,
 8 JUNE 1971 16:22:49 PAGE 1 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 WYDSYS
 • UNITS • AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• I N P U T D A T A •
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4

.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LMH O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• • POINT INPUT DATA • •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	5.00	3000.0	35.0

• O U T P U T D A T A •

DRIVE POWER	HP LOSS		
MYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 432.49 O/F = .607 SPC = 1.631

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.314	4.439
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE	YES	YES
IS IT IN CONTROL	YES	YES
PRESSURE IN	453.2	499.7
PRESSURE OUT	416.0	438.8
TEMPERATURE IN	1008.0	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T20=400,
 8 JUNE 1971 16:22:49 PAGE 2 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 WYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	7.314	OXYGEN FLOW	4.439
PRESSURE IN	412.8	PRESSURE OUT	412.8
TEMPERATURE IN H2	1008.0	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	11.753	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	412.2	PRESSURE OUT	8.6
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1376.2
ENTHALPY IN	4911.2	ENTHALPY OUT	3349.1
PRESSURE RATIO	48.19	EFFICIENCY	.513

RECUPERATOR INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE 7.314	457.8	456.8	550.6	1008.0	1850.5	3446.9	.554	
HOT SIDE 11.753	8.4	6.1	1376.2	927.8	3349.1	2355.7	.543	
• TURBINE EXHAUST OVERBOARD PRESSURE •						5.31		

HOT BYPASS VALVE INFORMATION			
FLOW	PRESSURE	DROP	
.000	.000		

H2 PREHEATER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE 7.314	500.0	499.2	500.0	500.0	1670.5	1670.5	.000	
HOT SIDE .000	456.8	456.8	.0	.0	.0	.0	.000	

JET PUMP PERFORMANCE					
FLOW PARA	FLOW	PRESSURE	TEMPERATURE		
PRIMARY JET	163.55	7.31	498.89	500.00	
SECONDARY JET	.00	.00	431.32	.00	
RESULTANT		7.31	459.92	500.17	
FLOW PARA RATIO	.000	P PRI/P SEC		1.1567	
JET PUMP RISE	1.0663	PRI FLOW PARA	.3278	JPSF	2.30

LUBE OIL COOLER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE 7.314	459.8	458.9	500.2	554.2	1670.5	1863.2	.309	
HOT SIDE 30.000	200.0	196.9	677.3	587.0	.0	.0	.510	

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION								
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE 7.314	458.8	457.9	554.2	550.6	1863.2	1850.5	.857	
HOT SIDE 1450.0	100.0	91.5	550.0	550.1	.0	.0	.033	

HEAT REJECTED -93.06

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SSAPU PHASE II, TURB 16,500 R H2, T20=400,
8 JUNE 1971 16:22:154 PAGE 1 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYOSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT	PRESSURE	LOSS	COEFFICIENTS	*10E+4				
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.80	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.9	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.83 O/F = .486 SPC = 2.223

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.392	.676
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	497.7	500.0
PRESSURE OUT	74.8	79.9
TEMPERATURE IN	1222.6	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T20=400,
8 JUNE 1971 16:22:154 PAGE 2 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYOSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	1.392	OXYGEN FLOW	.676
PRESSURE IN	74.0	PRESSURE OUT	76.0
TEMPERATURE IN H2	1222.6	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	2.069	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	75.9	PRESSURE OUT	10.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1396.2
ENTHALPY IN	5211.8	ENTHALPY OUT	4066.0
PRESSURE RATIO	7.54	EFFICIENCY	.538

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.392	497.9	497.8	554.7	1222.5	1865.4	4194.7	.641
HOT SIDE 2.069	10.1	10.0	1596.2	942.3	4066.0	2498.1	.628
* TURBINE EXHAUST OVERBOARD PRESSURE *					9.99		

HOT BYPASS VALVE INFORMATION			
FLOW	PRESSURE DROP		
.000	.000		

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.392	500.0	500.0	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	497.8	497.8	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE					
FLOW PARA	FLOW	PRESSURE	TEMPERATURE		
PRIMARY JET 31.14	1.39	499.95	500.00		
SECONDARY JET .00	.00	496.52	.00		
RESULTANT	1.39	497.99	500.01		
FLOW PARA RATIO	.000	P PRI/P SEC	1.0069		
JET PUMP RISE	1.0030	PRI FLOW PARA	.0623	JPSF	2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.392	498.0	497.9	500.0	631.5	1670.5	2134.5	.598
HOT SIDE 30.000	200.0	196.9	720.1	681.8	.0	.0	.174

HEAT REJECTED				
ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL	
509.1	111.6	25.5	646.2	

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 1.392	497.9	497.9	631.5	554.7	2134.5	1865.4	.943
HOT SIDE 29.0	100.0	99.8	550.0	577.7	.0	.0	.340

HEAT REJECTED -374.68

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SSAPU PHASE II, TURB 16,500 R H2, T20=400, 16:23:01 PAGE 1 OF 2
8 JUNE 1971

• CONDITION • 100 HP, 10. PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4
 .00 .00 .00 1110.00 7000.00 .00 .00 10.00
 3.64 .00 1.18 1.44 .00 .66 3.50 20.00
 19.00 13.85 54.00 .00 2.02 50.00 2.74 .023
 .12 .00

SFT TUR DN F SF JP P SF JP W TUR O9CA JP PRICA TURB NOZ
 1.000 .000 1.000 1.000 12.561 .2000 .1210
 TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HHX IN T LHX O
 .0002 .98 .30 .5 2060.00 460.00 1500.00
 ETA CORF O/F BASE
 .0925 .600

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER ETAMA COLD ETAMA HOT RHODP COLD RHODP HOT
 H2 PREHEATER 2.00 2.00 .50 1.00
 HYD O COOLER 1.00 1.00 1.00 1.00
 LUB O COOLER 1.00 1.00 1.00 1.00
 RECUPERATOR 1.00 1.00 1.00 1.00

• POINT INPUT DATA •

HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
 100.00 .00 10.00 3000.0 35.0

• OUTPUT DATA •

DRIVE POWER HP LOSS
 HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
 140.00 12.00 .60 7.63

TURBINE OUTPUT POWER = 160.49 O/F = .551 SPC = 1.785

PROPELLANT HYDROGEN OXYGEN
 FLOW RATE 3.077 1.696
 PRESSURE 500.00 500.00
 TEMPERATURE 500.00 300.00
 ENTHALPY 1670.5 52.8

CONTROL VALVE

IS IT IN CONTROL YES YES
 PRESSURE IN 489.0 499.9
 PRESSURE OUT 172.7 181.6
 TEMPERATURE IN 1106.0 300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T20=400, 16:23:01 PAGE 2 OF 2
8 JUNE 1971

• CONDITION • 100 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW 3.077 OXYGEN FLOW 1.696
 PRESSURE IN 171.2 PRESSURE OUT 171.2
 TEMPERATURE IN H2 1106.0 TEMPERATURE IN O2 300.0

TURBINE INFORMATION

INLET FLOW 4.773 SPECIFIC HEAT RATIO 1.367
 PRESSURE IN 171.0 PRESSURE OUT 10.3
 TEMPERATURE IN 2060.0 TEMPERATURE OUT 1456.4
 ENTHALPY IN 5041.9 ENTHALPY OUT 3616.3
 PRESSURE RATIO 16.61 EFFICIENCY .553

RECUPERATOR INFORMATION

FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.077 489.8 489.6 551.0 1105.4 1852.4 3786.3 .612
 HOT SIDE 4.773 10.3 10.1 1456.4 913.1 3616.3 2369.8 .608
 • TURBINE EXHAUST OVERBOARD PRESSURE • 9.97

HOT BYPASS VALVE INFORMATION

FLOW PRESSURE DROP
 .000 .000

H2 PREHEATER INFORMATION

FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.077 500.0 499.8 500.0 500.0 1670.5 1670.5 .000
 HOT SIDE .000 489.6 489.6 .0 .0 .0 .0 .000

JET PUMP PERFORMANCE

FLOW PARA FLOW PRESSURE TEMPERATURE
 PRIMARY JET 68.80 3.08 499.79 500.00
 SECONDARY JET .00 .00 483.11 .00
 RESULTANT 3.08 490.28 508.04
 FLOW PARA RATIO .000 P PRI/P SEC 1.0345
 JET PUMP RISE 1.0148 PRI FLOW PARA .1377 JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.077 490.3 490.1 500.0 578.7 1670.5 1949.4 .470
 HOT SIDE 30.000 200.0 196.9 667.3 612.8 .0 .0 .326

HEAT REJECTED

ALTERNATOR GEAR BOX LUBE PUMP TOTAL
 509.1 323.7 25.5 858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 3.077 490.3 489.9 578.7 551.0 1949.4 1852.4 .965
 HOT SIDE 423.7 1570.0 97.8 550.0 551.0 .0 .0 .054

HEAT REJECTED -298.49

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16.500 R H2, T20=400,
8 JUNE 1971 16:23:08 PAGE 1 OF 2

• CONDITION • 200 HP, 10. PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX D
.0002	.98	.30	.5	2060.00	400.00	1900.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	10.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
240.00	12.00	.60
		12.63

TURBINE OUTPUT POWER = 265.53 O/F = .579 SPC = 1.701

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.766	2.761
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	474.1	499.9
PRESSURE OUT	270.0	285.4
TEMPERATURE IN	1055.9	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 11, TURB 16.500 R H2, T20=400,
8 JUNE 1971 16:23:08 PAGE 2 OF 2

• CONDITION • 200 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION		
HYDROGEN FLOW	4.766	OXYGEN FLOW 2.761
PRESSURE IN	260.7	PRESSURE OUT 260.7
TEMPERATURE IN H2	1055.9	TEMPERATURE IN O2 300.0

TURBINE INFORMATION		
INLET FLOW	7.527	SPECIFIC HEAT RATIO 1.367
PRESSURE IN	260.2	PRESSURE OUT 10.0
TEMPERATURE IN	2060.0	TEMPERATURE OUT 1415.9
ENTHALPY IN	4974.8	ENTHALPY OUT 3478.6
PRESSURE RATIO	24.93	EFFICIENCY .541

RECUPERATOR INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.766	476.2	475.7	551.0	1055.4	1892.2	3612.0	.983
HOT SIDE	7.527	10.7	10.2	1415.5	921.2	3478.6	2344.2	.572

• TURBINE EXHAUST OVERBOARD PRESSURE • 9.97

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.766	500.0	499.6	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	475.7	475.7	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	106.58	4.77	499.51	500.00
SECONDARY JET	.00	.00	460.59	.00
RESULTANT		4.77	477.11	500.09
FLOW PARA RATIO	.000	P PRI/P SEC		1.0845
JET PUMP RISE	1.0359	PRI FLOW PARA	.2134	JPSF 2.30

LUBE OIL COOLER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.766	477.1	476.7	500.1	563.2	1670.5	1895.1	.388
HOT SIDE	30.000	200.0	196.9	663.8	594.9	.0	.0	.420

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.766	476.6	476.2	563.2	551.0	1895.1	1852.2	.925
HOT SIDE	818.4	100.0	95.4	550.0	550.5	.0	.0	.041

HEAT REJECTED -204.44

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T20=400,
8 JUNE 1971 16:23:16 PAGE 1 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •
DUCT PRESSURE LOSS COEFFICIENTS *10E+4
.00 .00 .00 1110.00 70000.00 .00 .00 10.00
3.64 .00 1.18 1.44 .00 .66 3.50 20.80
19.30 13.85 54.00 .00 2.32 50.00 2.74 .023
.12 .00

SFT TUR DN F SF JP P SF JP W TUR O9CA JP PRICA TURB NOZ
1.000 .000 1.000 1.000 12.560 .2000 .1210
TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HX IN T LHX O
.0002 .98 .30 .5 2060.00 400.00 1500.00
ETA CORF O/F BASE
.0925 .600

HEAT EXCHANGER SCALE FACTORS
ETAHA COLD ETAHA HOT RHODP COLD RHODP HOT
H2 PREHEATER 2.00 2.00 .50 1.00
HYD O COOLER 1.00 1.00 1.00 1.00
LUB O COOLER 1.00 1.00 1.00 1.00
RECUPERATOR 1.00 1.00 1.00 1.00

• POINT INPUT DATA •
HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
360.00 .00 10.00 3000.0 35.0

• OUTPUT DATA •

DRIVE POWER HP LOSS
HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
400.00 12.00 .60 20.63

TURBINE OUTPUT POWER = 433.60 O/F = .602 SPC = 1.667

PROPELLANT HYDROGEN OXYGEN
FLOW RATE 7.518 4.525
PRESSURE 500.00 500.00
TEMPERATURE 500.00 300.00
ENTHALPY 1670.5 52.8

CONTROL VALVE
IS IT IN CONTROL YES YES
PRESSURE IN 451.5 499.6
PRESSURE OUT 428.1 450.8
TEMPERATURE IN 1015.4 300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T20=400,
8 JUNE 1971 16:23:16 PAGE 2 OF 2

• CONDITION • 360 HP, 10. PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION
HYDROGEN FLOW 7.518 OXYGEN FLOW 4.525
PRESSURE IN 424.8 PRESSURE OUT 424.8
TEMPERATURE IN H2 1015.4 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
INLET FLOW 12.043 SPECIFIC HEAT RATIO 1.367
PRESSURE IN 424.1 PRESSURE OUT 12.3
TEMPERATURE IN 2060.0 TEMPERATURE OUT 1393.2
ENTHALPY IN 4923.0 ENTHALPY OUT 3394.4
PRESSURE RATIO 34.49 EFFICIENCY .528

RECUPERATOR INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 7.518 456.4 455.3 550.4 1015.4 1849.8 3472.7 .552
HOT SIDE 12.043 12.2 10.6 1393.2 937.5 3394.4 2301.3 .541
• TURBINE EXHAUST OVERBOARD PRESSURE • 10.10

HOT BYPASS VALVE INFORMATION
FLOW PRESSURE DROP
.000 .000

H2 PREHEATER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 7.518 500.0 499.1 500.0 500.0 1670.5 1670.5 .000
HOT SIDE .000 455.3 455.3 .0 .0 .0 .0 .000

JET PUMP PERFORMANCE
FLOW PARA FLOW PRESSURE TEMPERATURE
PRIMARY JET 168.10 7.52 498.83 500.00
SECONDARY JET .00 .00 429.12 .00
RESULTANT 7.52 458.61 500.17
FLOW PARA RATIO .000 P PRI/P SEC 1.1625
JET PUMP RISE 1.0687 PRI FLOW PARA .3370 JPSF 2.30

LUBE OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 7.518 458.5 457.6 500.2 552.7 1670.5 1858.0 .300
HOT SIDE 30.000 200.0 196.9 675.5 584.9 .0 .0 .517

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
509.1 875.3 25.5 1409.8

HYDRAULIC OIL COOLER INFORMATION
FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
COLD SIDE 7.518 457.4 456.5 552.7 550.4 1858.0 1849.8 .050
HOT SIDE 1450.0 160.0 91.5 590.0 550.1 .0 .0 .034

HEAT REJECTED -61.63

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Case 108

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I; TURB 16,500 R H2, T20=400, 16:23:21 PAGE 1 OF 2
8 JUNE 1971

• CONDITION • 0.0 HP, 14.7 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

.00	DUCT	PRESSURE	LOSS	COEFFICIENTS	*10E+4	.00	10.00
3.64	.00	.00	110.00	70000.00	.00	3.50	20.00
19.00	13.85	1.18	1.44	.00	.66	2.74	.023
.12	.00	54.00	.00	2.02	50.00		

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	Q/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	14.70	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 56.20 O/F * .465 SPC = 2.568

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.642	.763
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	496.8	500.0
PRESSURE OUT	89.6	92.9
TEMPERATURE IN	1258.9	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I; TURB 16,500 R H2, T20=400, 16:23:21 PAGE 2 OF 2
8 JUNE 1971

• CONDITION • 0.0 HP, 14.7 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.642	OXYGEN FLOW	.763
PRESSURE IN	88.6	PRESSURE OUT	88.6
TEMPERATURE IN H2	1258.9	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.405	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	88.5	PRESSURE OUT	14.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1664.4
ENTHALPY IN	5269.3	ENTHALPY OUT	4275.3
PRESSURE RATIO	6.00	EFFICIENCY	.503

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.642	497.1	497.0	555.5	1258.6	1664.4	4321.8
HOT SIDE	2.405	14.7	14.7	1664.4	976.2	4275.3	2600.4

* TURBINE EXHAUST OVERBOARD PRESSURE * 14.69

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.642	500.0	499.9	500.0	500.0	1670.5	1670.5
HOT SIDE	.000	497.0	497.0	.0	.0	.0	.0

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
36.71	1.64	499.93	500.00	
SECONDARY JET	.00	.00	495.20	.00
RESULTANT	1.64	497.23	500.01	
FLOW PARA RATIO	.000	P PRI/P SEC	1.0096	
JET PUMP RISE	1.0041	PRI FLOW PARA	.0734	JPSF
			2.30	

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.642	497.2	497.2	500.0	611.4	1670.5	2064.0
HOT SIDE	30.000	200.0	196.9	692.6	653.1	.0	.0

HEAT REJECTED ALTERNATOR 509.1 GEAR BOX 111.6 LUBE PUMP 25.5 TOTAL 646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.642	497.2	497.1	611.4	555.5	2064.0	1668.4
HOT SIDE	29.0	100.0	99.8	550.0	573.8	.0	.0

HEAT REJECTED -321.23

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Case 109

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16,500 R H2,T20*400,
8 JUNE 1971 16:23:26 PAGE 1 OF 2

* CONDITION * 100 HP,14.7PAMB,3000 PSI HYOSYS

* UNITS * AREA*SQ IN, H*BTU/LB, P*PSIA, Q*BTU/MIN, T*DEG R, W*LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		SFT		TUR DN F		SF JP P		SF JP W		TUR OBCA		JP PRICA		TURB NOZ	
.00	.00	.00	110.00	70000.00	.00	.00	10.00								
3.64	.00	1.18	1.44	.00	.66	3.50	20.80								
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023								
.12	.00														

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
130.00	.00	14.70	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
140.00	7.63
ALTERNATOR	LUBE PUMP
12.00	.60

TURBINE OUTPUT POWER = 158.84 O/F = .539 SPC = 1.905

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.277	1.766
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

IS IT IN CONTROL	CONTROL VALVE
PRESSURE IN	487.0
PRESSURE OUT	184.0
TEMPERATURE IN	1128.7
	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16,500 R H2,T20*400,
8 JUNE 1971 16:23:26 PAGE 2 OF 2

* CONDITION * 100 HP,14.7PAMB,3000 PSI HYOSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	3.277	OXYGEN FLOW	1.766
PRESSURE IN	182.3	PRESSURE OUT	182.3
TEMPERATURE IN H2	1128.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	5.042	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	182.1	PRESSURE OUT	14.9
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1499.3
ENTHALPY IN	5073.4	ENTHALPY OUT	3737.1
PRESSURE RATIO	12.19	EFFICIENCY	.557

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.277	488.0	487.8	551.0	1128.7	1852.4	3867.1 .609
HOT SIDE	5.042	14.9	14.7	1499.3	933.7	3737.1	2427.8 .596

* TURBINE EXHAUST OVERBOARD PRESSURE * 14.68

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.277	500.0	499.8	500.0	500.0	1670.5	1670.5 .000
HOT SIDE	.000	487.8	487.8	.0	.0	.0	.0 .000

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
73.27	3.28	499.76	500.00	
SECONDARY JET	.00	479.99	.00	
RESULTANT	3.28	488.54	500.05	
FLOW PARA RATIO	.000	P PRI/P SEC	1.0412	
JET PUMP RISE	1.0178	PRI FLOW PARA	.1466	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.277	488.5	488.3	500.0	573.8	1670.5	1932.4 .458
HOT SIDE	30.000	200.0	196.9	661.2	606.4	.0	.0 .341

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
539.1	323.7	25.5	858.3	

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.277	488.3	488.1	573.8	551.0	1932.4	1852.4 .959
HOT SIDE	423.7	100.0	97.8	550.0	551.4	.0	.0 .057

HEAT REJECTED -262.33

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II; TURB 16,500 R H2; T20=400;
8 JUNE 1971 16:23:33 PAGE 1 OF 2

• CONDITION • 200 HP, 14.7PAMB, 3000 PSI HYDSYS

• UNITS • AREA#60 IN, H#BTU/LB, P#PSIA, Q#BTU/MIN, T#DEG R, W#LB/MIN

* I N P U T D A T A *

DUCT PRESSURE	110.00	70000.00	.00	.00	10.00
LOSS COEFFICIENTS	1.18	1.44	.00	.66	3.50
	54.00	.00	2.02	50.00	2.74
	.00	.00			.023

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURS NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	14.70	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
240.00	12.63
ALTERNATOR	LUBE PUMP
12.00	.60

TURBINE OUTPUT POWER = 265.87 O/F = .572 SPC = 1.767

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.980	2.848
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

IS IT IN CONTROL	CONTROL VALVE	YES	YES
PRESSURE IN	472.4	499.9	
PRESSURE OUT	282.4	297.1	
TEMPERATURE IN	1068.6	300.0	

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II; TURB 16,500 R H2; T20=400;
8 JUNE 1971 16:23:33 PAGE 2 OF 2

• CONDITION • 200 HP, 14.7PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	4.980	OXYGEN FLOW	2.848
PRESSURE IN	280.1	PRESSURE OUT	280.1
TEMPERATURE IN H2	1068.6	TEMPERATURE IN O2	300.0
TURBINE INFORMATION			
INLET FLOW	7.828	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	279.7	PRESSURE OUT	15.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1442.6
ENTHALPY IN	4992.7	ENTHALPY OUT	3551.8
PRESSURE RATIO	18.32	EFFICIENCY	.593

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.980	474.6	474.1	550.9	1068.3	1851.7	3656.9	.580
HOT SIDE 7.828	15.2	14.8	1442.6	935.9	3551.8	2403.4	.568
* TURBINE EXHAUST OVERBOARD PRESSURE * 14.66							

HOT BYPASS VALVE INFORMATION			
FLOW	PRESSURE DROP		
.000	.000		

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.980	500.0	499.6	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	474.1	474.1	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE				
PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	111.36	4.98	499.47	500.00
RESULTANT	.00	.00	458.00	.00
FLOW PARA RATIO	.000	4.98	475.64	500.10
JET PUMP RISE	1.0385	PRI FLOW PARA	.2230	JPSF
				2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.980	475.6	475.2	500.1	560.5	1670.5	1885.4	.377
HOT SIDE 30.000	200.0	196.9	660.3	591.2	.0	.0	.431

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.980	475.1	474.6	560.5	550.9	1885.4	1851.7	.918
HOT SIDE 818.4	100.0	95.4	500.0	550.4	.0	.0	.043

HEAT REJECTED -167.90

117

Case 111

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T20=400,
8 JUNE 1971 16:23:57 PAGE 1 OF 2

• CONDITION • 360 HP, 14.7PAMB, 3000 HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• I N P U T D A T A •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• • POINT INPUT DATA • •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	14.70	3000.0	35.0

• O U T P U T D A T A •

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 431.58 O/F = .600 SPC = 1.707

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.676	4.605
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	450.1	499.6
PRESSURE OUT	433.6	456.7
TEMPERATURE IN	1023.3	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T20=400,
8 JUNE 1971 16:23:57 PAGE 2 OF 2

• CONDITION • 360 HP, 14.7PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	7.676	OXYGEN FLOW	4.605
PRESSURE IN	430.2	PRESSURE OUT	430.2
TEMPERATURE IN H2	1023.3	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	12.281	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	429.5	PRESSURE OUT	16.5
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1410.2
ENTHALPY IN	4927.8	ENTHALPY OUT	3435.8
PRESSURE RATIO	26.11	EFFICIENCY	.541

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.676	455.3	454.2	550.3	1023.4	1849.2	3500.5	.550
HOT SIDE 12.281	16.4	15.1	1410.2	946.8	3435.8	2403.7	.539
• TURBINE EXHAUST OVERBOARD PRESSURE •				14.77			

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.676	500.0	499.1	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	454.2	454.2	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	171.65	7.68	498.78
SECONDARY JET	.00	.00	427.43
RESULTANT		7.68	457.61
FLOW PARA RATIO	.000	P PRI/P SEC	1.1669
JET PUMP RISE	1.0706	PRI FLOW PARA	.3441 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.676	457.5	456.5	500.2	551.6	1670.5	1054.1	.296
HOT SIDE 30.000	200.0	196.9	674.1	583.4	.0	.0	.522

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.676	456.4	455.4	551.6	550.3	1854.1	1849.2	.844
HOT SIDE 1450.0	100.0	74.5	550.0	550.1	.0	.0	.034

HEAT REJECTED -37.53

118

Case 112

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 15:38:17 PAGE 1 OF 2

• CONDITION • 0.0 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2070	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS	GEAR BOX
40.00	12.00	.60		2.63

TURBINE OUTPUT POWER = 55.47 O/F = .553 SPC = 1.493

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	.889	.492
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	499.1	500.0
PRESSURE OUT	50.3	53.0
TEMPERATURE IN	1102.1	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 15:38:17 PAGE 2 OF 2

• CONDITION • 0.0 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	.889	OXYGEN FLOW	.492
PRESSURE IN	49.8	PRESSURE OUT	49.8
TEMPERATURE IN H2	1102.1	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.381	SPECIFIC HEAT RATIO	1.369
PRESSURE IN	49.8	PRESSURE OUT	.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1335.4
ENTHALPY IN	5036.3	ENTHALPY OUT	3333.4
PRESSURE RATIO	63.74	EFFICIENCY	.522

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	.889	499.2	499.2	650.5	1102.4	2201.2	3776.0	.660
HOT SIDE	1.381	.8	.5	1335.4	891.5	3333.4	2319.3	.648

• TURBINE EXHAUST OVERBOARD PRESSURE • .32

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	.889	500.0	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	499.2	499.2	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	19.88	.89	499.98
SECONDARY JET	.00	.00	498.73
RESULTANT	.89	.89	499.24
FLOW PARA RATIO	.000	P PRI/P SEC	1.0025
JET PUMP RISE	1.0010	PRI FLOW PARA	.0398
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	.889	499.2	499.2	500.0	706.5	1670.5	2397.3	.639
HOT SIDE	30.000	200.0	196.9	822.9	788.6	.0	.0	.106

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
509.1 111.6 25.5 646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	.889	499.2	499.2	706.5	650.5	2397.3	2201.2	.991
HOT SIDE	29.0	100.0	99.8	650.0	661.6	.0	.0	.205

HEAT REJECTED -174.34

119

9

Case 113

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971

18:02:09

PAGE 1 OF 2

• CONDITION • 100 HP, 0.0 PAMB, 3000 PSI HYOSYS

• UNITS • AREA*SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	7000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				2.74

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAH COLD	ETAH HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 161.27 O/F = .556 SPC = 1.583

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.734	1.520
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	491.1	500.0
PRESSURE OUT	154.4	162.4
TEMPERATURE IN	1098.2	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971

18:02:09

PAGE 2 OF 2

• CONDITION • 100 HP, 0.0 PAMB, 3000 PSI HYOSYS

HYDROGEN FLOW		COMBUSTOR INFORMATION	
PRESSURE IN	153.1	OXYGEN FLOW	1.520
TEMPERATURE IN H2	1098.2	PRESSURE OUT	153.1
		TEMPERATURE IN O2	300.0

INLET FLOW		TURBINE INFORMATION	
PRESSURE IN	152.8	SPECIFIC HEAT RATIO	1.368
TEMPERATURE IN	2060.0	PRESSURE OUT	2.4
ENTHALPY IN	5029.7	TEMPERATURE OUT	1375.9
PRESSURE RATIO	63.21	ENTHALPY OUT	3422.4
		EFFICIENCY	.494

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.734	491.8	491.6	648.6	1098.0	2194.3	3760.7
HOT SIDE	4.254	2.3	1.5	1375.9	935.2	3422.4	2415.7
• TURBINE EXHAUST OVERBOARD PRESSURE •							1.00

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.734	500.0	499.9	500.0	500.0	1670.5	1670.5
HOT SIDE	.000	491.6	491.6	.0	.0	.0	.0

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	61.13	2.73	499.83	500.00
RESULTANT	.00	.00	486.54	.00
FLOW PARA RATIO		2.73	492.22	500.03
JET PUMP RISE	1.0117	PRI FLOW PARA	.1223	JPSF
				2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.734	492.2	492.1	500.0	588.7	1670.5	1984.4
HOT SIDE	30.000	200.0	196.9	679.7	626.0	.0	.0

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.734	492.0	491.9	588.7	648.6	1984.4	2194.3
HOT SIDE	423.7	100.0	97.8	650.0	647.4	.0	.0

HEAT REJECTED 573.68

120

Case 114

6

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 18:02:15 PAGE 1 OF 2

* CONDITION * 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

* UNITS * AREA*SQ IN, H=BTU/LB., P=PSIA, G=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HMX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX
240.00	12.00	.60
		12.63

TURBINE OUTPUT POWER = 267.39 O/F = .571 SPC = 1.588

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.506	2.572
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	476.2	499.9
PRESSURE OUT	256.8	270.1
TEMPERATURE IN	1072.5	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 18:02:15 PAGE 2 OF 2

* CONDITION * 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION		
HYDROGEN FLOW	4.506	OXYGEN FLOW 2.572
PRESSURE IN	254.7	PRESSURE OUT 254.7
TEMPERATURE IN H2	1072.5	TEMPERATURE IN O2 300.0

TURBINE INFORMATION		
INLET FLOW	7.077	SPECIFIC HEAT RATIO 1.368
PRESSURE IN	254.3	PRESSURE OUT 4.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT 1372.2
ENTHALPY IN	4995.2	ENTHALPY OUT 3392.3
PRESSURE RATIO	62.41	EFFICIENCY .498

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.506	478.0	477.6	644.7	1072.5	2180.3	3671.5	.588
HOT SIDE 7.077	3.9	2.4	1372.2	953.0	3392.3	2442.9	.576

* TURBINE EXHAUST OVERBOARD PRESSURE * 1.67

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.506	500.0	499.7	500.0	503.3	1670.5	1670.5	.000
HOT SIDE .000	477.6	477.6	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	100.75	4.51	499.56	500.00
SECONDARY JET	.00	.00	463.78	.00
RESULTANT		4.51	478.93	500.09
FLOW PARA RATIO	.000		P PRI/P SEC	1.0771
JET PUMP RISE	1.0327	PRI FLOW PARA	.2017 JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.506	478.9	478.5	500.1	566.9	1670.5	1908.0	.397
HOT SIDE 30.000	200.0	196.9	668.4	599.9	.0	.0	.407

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.506	478.5	478.1	566.9	644.7	1908.0	2180.3	.936
HOT SIDE 818.4	100.0	95.4	650.0	647.1	.0	.0	.036

HEAT REJECTED 1225.57

121

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Case 115

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 18:02:19 PAGE 1 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDYSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	7000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* P O I N T I N P U T D A T A *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX
402.00	12.00	.60
TURBINE OUTPUT POWER = 436.83		O/F = .588
		SPC = 1.604

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.355	4.321
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	452.5	499.7
PRESSURE OUT	418.1	439.3
TEMPERATURE IN	1043.4	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 18:02:19 PAGE 2 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDYSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.355	OXYGEN FLOW	4.321
PRESSURE IN	414.7	PRESSURE OUT	414.7
TEMPERATURE IN H2	1043.4	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.677	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	414.1	PRESSURE OUT	7.2
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1372.4
ENTHALPY IN	4957.0	ENTHALPY OUT	3368.2
PRESSURE RATIO	57.28	EFFICIENCY	.503

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.355	457.5	456.4	636.3	1043.4	2150.5	3569.8	.953
HOT SIDE 11.677	7.0	4.1	1372.4	973.8	3368.2	2474.2	.542

* TURBINE EXHAUST OVERBOARD PRESSURE * 2.75

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.355	500.0	499.2	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	456.4	456.4	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	164.47	7.36	498.88
SECONDARY JET	.00	.00	430.87
RESULTANT	7.36	459.66	500.17
FLOW PARA RATIO	.000	P PRI/P SEC	1.1578
JET PUMP RISE	1.0668	PRI FLOW PARA	.3297 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.355	459.5	458.7	500.2	553.9	1670.5	1862.2	.304
HOT SIDE 30.000	200.0	196.9	676.9	586.5	.0	.0	.511

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF.
COLD SIDE 7.355	458.5	457.5	553.9	636.3	1862.2	2150.5	.857
HOT SIDE 1450.0	100.0	91.5	650.0	647.2	.0	.0	.030

HEAT REJECTED 2121.16

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
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• CONDITION • 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		TURBINE LOSS COEFFICIENTS *10E+4		TURBINE LOSS COEFFICIENTS *10E+4	
.00	.00	.00	1110.00	7000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				2.74

SFT	TUR DN F	SF JP P	SF JP W	TUR QBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	LUBE PUMP
40.00	12.00	.60
		2.63

TURBINE OUTPUT POWER = 56.02 O/F = .497 SPC = 1.862

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.161	.577
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE	
IS IT IN CONTROL	YES
PRESSURE IN	498.4
PRESSURE OUT	64.4
TEMPERATURE IN	1201.8

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 15:38:27 PAGE 2 OF 2

• CONDITION • 0.0 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.161	OXYGEN FLOW	.577
PRESSURE IN	63.7	PRESSURE OUT	63.7
TEMPERATURE IN H2	1201.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.738	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	63.7	PRESSURE OUT	5.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1500.6
ENTHALPY IN	5179.7	ENTHALPY OUT	3813.1
PRESSURE RATIO	12.93	EFFICIENCY	.550

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.161	498.6	650.2	1201.8	2200.1	4121.8	.649
HOT SIDE	1.738	5.1	5.0	1500.6	960.7	3813.1	.635

• TURBINE EXHAUST OVERBOARD PRESSURE • 4.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.161	500.0	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	498.5	498.5	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	25.96	1.16	499.97
SECONDARY JET	.00	.00	497.66
RESULTANT		1.16	498.65
FLOW PARA RATIO	.000	P PRI/P SEC	1.0046
JET PUMP RISE	1.0020	PRI FLOW PARA	.0519
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.161	498.7	498.6	500.0	657.9	1670.5	.616
HOT SIDE	30.000	200.0	196.9	756.2	719.4	.0	.144

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.161	498.6	498.6	657.9	650.2	2227.1	.973
HOT SIDE	29.0	100.0	99.8	650.0	652.1	.0	.264

HEAT REJECTED -31.32

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Case 117

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II-TURB 16,500 R H2,T60 = 650.
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• CONDITION • 100 HP,5.0 PAMB,3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		SF JP P		SF JP W		TUR OBSCA		JP PRICA		TURB NOZ	
.00	.00	.00	1110.00	.00	7000.00	.00	.00	.00	10.00		
3.64	.00	1.18	1.44	.00	.66	3.50	20.80				
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023				
.12	.00										

SFT	TUR DN F	SF JP P	SF JP W	TUR OBSCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	5.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
140.00	12.00
	.60
	7.63

TURBINE OUTPUT POWER = 159.30 O/F = .545 SPC = 1.653

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.839	1.548
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

IS IT IN CONTROL	CONTROL VALVE	YES	YES
PRESSURE IN	490.4	500.0	
PRESSURE OUT	159.6	167.6	
TEMPERATURE IN	1117.3	300.0	

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II-TURB 16,500 R H2,T60 = 650.
8 JUNE 1971 18:03:03 PAGE 2 OF 2

• CONDITION • 100 HP,5.0 PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	2.839	OXYGEN FLOW	1.548
PRESSURE IN	158.2	PRESSURE OUT	158.2
TEMPERATURE IN H2	1117.3	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.388	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	158.0	PRESSURE OUT	5.5
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1409.6
ENTHALPY IN	5056.9	ENTHALPY OUT	3517.3
PRESSURE RATIO	28.54	EFFICIENCY	.531

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.839	491.2	491.0	648.3	1117.3	2193.3	3827.6	.616
HOT SIDE	4.388	5.5	5.2	1409.6	950.2	3517.3	2459.7	.603

* TURBINE EXHAUST OVERBOARD PRESSURE * 5.01

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.839	500.0	499.9	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	491.0	491.0	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	63.49	2.84	499.82
SECONDARY JET	.00	.00	485.48
RESULTANT	2.84	491.62	500.03
FLOW PARA RATIO	.000	P PRI/P SEC	1.0295
JET PUMP RISE	1.0126	PRI FLOW PARA	.1270 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.839	491.6	491.5	500.0	585.3	1670.5	1972.7	.486
HOT SIDE	30.000	200.0	196.9	675.5	621.6	.0	.0	.307

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	2.839	491.4	491.2	585.3	648.3	1972.7	2193.3	.974
HOT SIDE	100.0	100.0	97.8	650.0	647.1	.0	.0	.044

HEAT REJECTED 626.25

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 * 650.
8 JUNE 1971

18:03:09

PAGE 1 OF 2

• CONDITION • 200 HP, 5. PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				2.74

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 265.17 O/F * .566 SPC = 1.621

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.575	2.588
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	475.6	499.9
PRESSURE OUT	258.9	272.2
TEMPERATURE IN	1081.3	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 * 650.
8 JUNE 1971

18:03:09

PAGE 2 OF 2

• CONDITION • 200 HP, 5. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.575	OXYGEN FLOW	2.588
PRESSURE IN	256.7	PRESSURE OUT	256.7
TEMPERATURE IN H2	1081.3	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.163	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	256.3	PRESSURE OUT	6.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1388.4
ENTHALPY IN	5007.7	ENTHALPY OUT	3437.0
PRESSURE RATIO	40.08	EFFICIENCY	.518

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.575	477.5	477.1	644.4	1080.8	2179.3	3700.5
HOT SIDE	7.163	6.3	5.5	1388.4	961.0	3437.0	2465.4

* TURBINE EXHAUST OVERBOARD PRESSURE * 5.10

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.575	500.0	499.7	500.0	500.0	1670.5	1670.5
HOT SIDE	.000	477.1	477.1	.0	.0	.0	.0

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
102.30	4.58	499.55	500.00	
SECONDARY JET	.00	.00	462.93	.00
RESULTANT		4.58	478.44	500.09
FLOW PARA RATIO		.000	P PRI/P SEC	1.0791
JET PUMP RISE	1.0335	PRI FLOW PARA	.2048	JPSF

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.575	478.4	478.0	500.1	565.9	1670.5	1904.5
HOT SIDE	30.000	200.0	196.9	667.1	598.6	.0	.0

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.575	478.0	477.5	565.9	644.4	1904.5	2179.3
HOT SIDE	818.4	100.0	95.4	650.0	647.0	.0	.0

HEAT REJECTED 1257.53

125

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Case 119

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
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• CONDITION • 360 HP, 5.0 PAMB, 3000 HYDSYS

• UNITS • AREA*SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				2.74

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	5.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
400.00	20.63
ALTERNATOR	LUBE PUMP
12.00	.60

TURBINE OUTPUT POWER = 432.84 O/F = .585 SPC = 1.616

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.355	4.304
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	452.5	499.7
PRESSURE OUT	416.6	437.7
TEMPERATURE IN	1046.8	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 18:03:15 PAGE 2 OF 2

• CONDITION • 360 HP, 5.0 PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.355	OXYGEN FLOW	4.304
PRESSURE IN	413.2	PRESSURE OUT	413.2
TEMPERATURE IN H2	1046.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.659	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	412.6	PRESSURE OUT	8.6
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1378.7
ENTHALPY IN	4962.7	ENTHALPY OUT	3386.0
PRESSURE RATIO	47.93	EFFICIENCY	.512

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.355	457.5	456.4	636.3	1046.8	2150.5	3581.7	.553
HOT SIDE 11.659	8.4	6.2	1378.7	976.8	3386.0	2483.1	.541
• TURBINE EXHAUST OVERBOARD PRESSURE % 5.33							

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.355	500.0	499.2	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	456.4	456.4	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	164.47	7.36	498.88
SECONDARY JET	.00	.00	430.87
RESULTANT	7.36	459.65	500.17
FLOW PARA RATIO	.000	P PRI/P SEC	1.1578
JET PUMP RISE	1.0668	PRJ FLOW PARA	.3297 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.355	459.5	458.7	500.2	553.9	1670.5	1862.2	.304
HOT SIDE 30.000	200.0	196.9	676.9	586.5	.0	.0	.511

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.355	458.5	457.5	553.9	636.3	1862.1	2150.5	.857
HOT SIDE 1450.0	190.0	91.5	650.0	647.2	.0	.0	.030

HEAT REJECTED 2121.21

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 630.
8 JUNE 1971

18103124

PAGE 1 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYDSYS

• UNITS • AREA*SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		SF JP P		SF JP W		TUR OBCA		JP PRICA		TURB NOZ					
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210

TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00

ETA CORF	O/F BASE
.0925	.600

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAH COLD	ETAH HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	10.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
40.00	12.00	.60
		2.63

TURBINE OUTPUT POWER = 54.78 O/F = .466 SPC = 2.216

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.381	.643
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	497.7	500.0
PRESSURE OUT	75.9	78.7
TEMPERATURE IN	1259.0	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 630.
8 JUNE 1971

18103124

PAGE 2 OF 2

• CONDITION • 0.0 HP, 10. PAMB, 3000 PSI HYDSYS

HYDROGEN FLOW		COMBUSTOR INFORMATION	
PRESSURE IN	75.1	OXYGEN FLOW	.643
TEMPERATURE IN H2	1259.0	PRESSURE OUT	75.1
		TEMPERATURE IN O2	300.0

INLET FLOW		TURBINE INFORMATION	
PRESSURE IN	75.0	SPECIFIC HEAT RATIO	1.367
TEMPERATURE IN	2060.0	PRESSURE OUT	10.1
ENTHALPY IN	5267.1	TEMPERATURE OUT	1600.7
PRESSURE RATIO	7.46	ENTHALPY OUT	4117.3
		EFFICIENCY	.534

RECUPERATOR INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.381	497.9	497.8	649.2	1259.0	2196.4	4323.3	.641
HOT SIDE	2.024	10.1	10.0	1600.7	1003.9	4117.3	2666.0	.627

* TURBINE EXHAUST OVERBOARD PRESSURE * 9.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.381	500.0	500.0	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	497.8	497.8	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
PRIMARY JET	30.88	1.38	499.95	500.00	
SECONDARY JET	.00	.00	496.57	.00	
RESULTANT		1.38	498.03	500.01	
FLOW PARA RATIO		.000	PRI/P SEC	1.0068	
JET PUMP RISE	1.0029	PRI FLOW PARA	.0618	JPSF	2.30

LUBE OIL COOLER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.381	498.0	498.0	500.0	632.6	1670.5	2138.4	.598
HOT SIDE	30.000	200.0	196.9	721.6	683.4	.0	.0	.172

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.381	498.0	497.9	632.6	649.2	2138.4	2196.4	.951
HOT SIDE	29.0	100.0	99.8	650.0	644.6	.0	.0	.308

HEAT REJECTED

79.99

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 18:03:28 PAGE 1 OF 2

• CONDITION • 100 HP, 10. PAMB, 3000 PSI HYDSYS
• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOFP	T TUR IN	T WHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * P O I N T I N P U T D A T A * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
140.00	12.00	.60
		7.63

TURBINE OUTPUT POWER = 159.65 O/F = .529 SPC = 1.769

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.078	1.629
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	488.9	500.0
PRESSURE OUT	171.8	179.9
TEMPERATURE IN	1144.1	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 18:03:28 PAGE 2 OF 2

• CONDITION • 100 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION		
HYDROGEN FLOW	3.078	OXYGEN FLOW 1.629
PRESSURE IN	170.3	PRESSURE OUT 170.3
TEMPERATURE IN H2	1144.1	TEMPERATURE IN O2 300.0

TURBINE INFORMATION		
INLET FLOW	4.707	SPECIFIC HEAT RATIO 1.368
PRESSURE IN	170.0	PRESSURE OUT 10.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT 1459.1
ENTHALPY IN	5098.2	ENTHALPY OUT 3659.2
PRESSURE RATIO	16.50	EFFICIENCY .551

RECUPERATOR INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.078	489.8	489.6	647.6	1144.1	2190.8	3920.8	.612
HOT SIDE	4.707	10.3	10.1	1459.1	973.2	3659.2	2527.9	.599

* TURBINE EXHAUST OVERBOARD PRESSURE = 9.98

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.078	500.0	499.8	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	489.6	489.6	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	68.83	3.08	499.79	500.00
SECONDARY JET	.00	.00	483.10	.00
RESULTANT		3.08	490.28	500.04
FLOW PARA RATIO		.000	P PRI/P SEC	1.0345
JET PUMP RISE	1.0149	PRI FLOW PARA	.1377	JPSF 2.30

LUBE OIL COOLER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.078	490.3	490.1	500.0	578.7	1670.5	1949.3	.470
HOT SIDE	30.000	200.0	196.9	667.2	612.7	.0	.0	.328

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.078	490.1	489.8	578.7	647.6	1949.3	2190.8	.967
HOT SIDE	423.7	100.0	97.8	650.0	646.6	.0	.0	.048

HEAT REJECTED 743.39

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
 8 JUNE 1971 18:03:35 PAGE 1 OF 2
 * CONDITION * 200 HP, 10. PAMB, 3000 PSI HYDSYS
 * UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4
 .00 .00 .00 1110.00 70000.00 .00 .00 10.00
 3.64 .00 1.18 1.44 .00 .66 3.50 20.80
 19.00 13.85 54.00 .00 2.02 50.00 2.74 .025
 .12 .00

SFT TUR DN F SF JP P SF JP W TUR OBCA JP PRCA TURB NOZ
 1.000 .000 1.000 1.000 12.560 .2000 .1210
 TUR LKCA ETA COMB LUBE P HP ETA LOPP T TUR IN T HHX IN T LMN O
 .0002 .98 .30 .5 2060.00 400.00 1500.00
 ETA CORF O/F BASE
 .0925 .600

HEAT EXCHANGER SCALE FACTORS
 ETAMA COLD ETAMA HOT RHODP COLD RHODP HOT
 H2 PREHEATER 2.00 2.00 .50 1.00
 HYD O COOLER 1.00 1.00 1.00 1.00
 LUB O COOLER 1.00 1.00 1.00 1.00
 RECUPERATOR 1.00 1.00 1.00 1.00

* POINT INPUT DATA *
 HYDRA HP ELECT HP P AMB P HYDRA OIL ALT SIZE(KW)
 200.00 .00 10.00 3000.0 35.0

* OUTPUT DATA *

DRIVE POWER HP LOSS
 HYD PUMP ALTERNATOR LUBE PUMP GEAR BOX
 240.00 12.00 .60 12.63

TURBINE OUTPUT POWER = 265.46 O/F = .558 SPC = 1.686

PROPELLANT HYDROGEN OXYGEN
 FLOW RATE 4.788 2.670
 PRESSURE 500.00 500.00
 TEMPERATURE 500.00 300.00
 ENTHALPY 1670.5 52.8

CONTROL VALVE
 IS IT IN CONTROL YES YES
 PRESSURE IN 473.8 499.9
 PRESSURE OUT 270.3 283.8
 TEMPERATURE IN 1095.2 300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
 8 JUNE 1971 18:03:35 PAGE 2 OF 2
 * CONDITION * 200 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION
 HYDROGEN FLOW 4.788 OXYGEN FLOW 2.670
 PRESSURE IN 268.1 PRESSURE OUT 268.1
 TEMPERATURE IN H2 1095.2 TEMPERATURE IN O2 300.0

TURBINE INFORMATION
 INLET FLOW 7.458 SPECIFIC HEAT RATIO 1.368
 PRESSURE IN 267.7 PRESSURE OUT 10.8
 TEMPERATURE IN 2060.0 TEMPERATURE OUT 1417.9
 ENTHALPY IN 5027.8 ENTHALPY OUT 3517.3
 PRESSURE RATIO 24.82 EFFICIENCY .539

RECUPERATOR INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 4.788 476.0 475.5 643.5 1094.6 2176.3 3748.4 .582
 HOT SIDE 7.458 10.7 10.2 1417.9 976.5 3517.3 2508.0 .570
 * TURBINE EXHAUST OVERBOARD PRESSURE * 9.98

HOT BYPASS VALVE INFORMATION
 FLOW PRESSURE DROP
 .000 .000

H2 PREHEATER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EF.
 COLD SIDE 4.788 500.0 499.6 500.0 500.0 1670.5 1670.5 .006
 HOT SIDE .000 475.5 475.5 .0 .0 .0 .0 .000

JET PUMP PERFORMANCE
 FLOW PARA FLOW PRESSURE TEMPERATURE
 PRIMARY JET 107.07 4.79 499.51 500.00
 SECONDARY JET .00 .00 460.32 .00
 RESULTANT .00 4.79 476.96 500.10
 FLOW PARA RATIO .000 P PRI/P SEC 1.0851
 JET PUMP RISE 1.0361 PRI FLOW PARA .2143 JPSF 2.30

LUBE OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 4.788 476.9 476.5 500.1 562.9 1670.5 1894.0 .385
 HOT SIDE 30.000 200.0 196.9 663.4 594.6 .0 .0 .422

HEAT REJECTED ALTERNATOR GEAR BOX LUBE PUMP TOTAL
 509.1 535.9 25.5 1070.4

HYDRAULIC OIL COOLER INFORMATION
 FLOW PRE IN P OUT T IN T OUT H IN H OUT EFF
 COLD SIDE 4.788 476.5 476.0 562.9 643.5 1894.0 2176.3 .926
 HOT SIDE 818.4 100.0 95.4 650.0 646.8 .0 .0 .037

HEAT REJECTED 1351.63

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16,500 R H2,T60 = 650.
8 JUNE 1971 18:03:42 PAGE 1 OF 2

• CONDITION • 360 HP,10. PAMB,3000 HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• • POINT INPUT DATA • •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX
400.00	12.00	.60
TURBINE OUTPUT POWER = 433.45		O/F = .580
		SPC = 1.653

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.554	4.385
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	450.8	499.7
PRESSURE OUT	426.5	447.7
TEMPERATURE IN	1054.2	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE I],TURB 16,500 R H2,T60 = 650.
8 JUNE 1971 18:03:42 PAGE 2 OF 2

• CONDITION • 360 HP,10. PAMB,3000 HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.554	OXYGEN FLOW	4.385
PRESSURE IN	423.0	PRESSURE OUT	423.0
TEMPERATURE IN H2	1054.2	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.939	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	422.4	PRESSURE OUT	12.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1395.9
ENTHALPY IN	4974.2	ENTHALPY OUT	3432.0
PRESSURE RATIO	34.23	EFFICIENCY	.526

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.554	456.1	454.9	635.4	1054.2	2147.4	3607.6
HOT SIDE	11.939	12.2	10.6	1395.9	986.0	3432.0	2508.1
• TURBINE EXHAUST OVERBOARD PRESSURE •							10.11

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.554	500.0	499.1	500.0	500.0	1670.5	1670.5
HOT SIDE	.000	454.9	454.9	.0	.0	.0	.0

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	168.92	7.55	498.82
SECONDARY JET	.00	.00	428.73
RESULTANT		7.55	458.38
FLOW PARA RATIO		.000	P PRI/P SEC
JET PUMP RISE	1.0692	PRI FLOW PARA	.3386 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.554	458.3	457.3	500.2	552.5	1670.5	1857.1
HOT SIDE	30.000	200.0	196.9	675.2	584.6	.0	.0

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	7.554	457.2	456.1	552.5	635.4	1857.1	2147.5
HOT SIDE	1450.0	100.0	91.5	658.0	647.1	.0	.0

HEAT REJECTED 2195.46

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Case 124

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
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• CONDITION • 0.0 HP, 14.7PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00			2.74	.023

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• • P O I N T I N P U T D A T A • •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	14.70	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
40.00	12.00	.60
		2.63

TURBINE OUTPUT POWER = 55.48 O/F = .443 SPC = 2.553

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.635	.725
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE	
IS IT IN CONTROL	YES
PRESSURE IN	496.8
PRESSURE OUT	89.3
TEMPERATURE IN	1293.3

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
8 JUNE 1971 18:03:55 PAGE 2 OF 2

• CONDITION • 0.0 HP, 14.7PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION	
HYDROGEN FLOW	1.635
PRESSURE IN	88.3
TEMPERATURE IN H2	1293.3
OXYGEN FLOW	.725
PRESSURE OUT	88.3
TEMPERATURE IN O2	300.0

TURBINE INFORMATION	
INLET FLOW	2.360
PRESSURE IN	88.2
TEMPERATURE IN	2060.0
ENTHALPY IN	5330.3
PRESSURE RATIO	5.97
SPECIFIC HEAT RATIO	1.367
PRESSURE OUT	14.6
TEMPERATURE OUT	1667.5
ENTHALPY OUT	4329.8
EFFICIENCY	.500

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.635	497.1	497.0	647.0	1293.4	2188.8	4444.5
HOT SIDE	2.360	14.8	14.7	1667.5	1035.0	4329.8	2767.0

* TURBINE EXHAUST OVERBOARD PRESSURE = 14.69

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.635	500.0	499.9	500.0	500.0	1670.5	1670.5
HOT SIDE	.000	497.0	497.0	.0	.0	.0	.0

JET PUMP PERFORMANCE

	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	36.56	1.64	499.93	500.00
SECONDARY JET	.00	.00	495.24	.00
RESULTANT		1.64	497.25	500.01
FLOW PARA RATIO	.000	P PRI/P SEC		1.0095
JET PUMP RISE	1.0041	PRI FLOW PARA	.0731	JPSF
			2.30	

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.635	497.2	497.2	500.0	611.8	1670.5	2065.6
HOT SIDE	30.000	200.0	196.9	693.2	653.8	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.635	497.2	497.1	611.8	647.0	2065.6	2188.8
HOT SIDE	29.0	100.0	99.8	650.0	636.5	.0	.0

HEAT REJECTED 201.33

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Case 125

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
 8 JUNE 1971 18103159 PAGE 1 OF 2

• CONDITION • 100 HP, 14.7 PAMB, 3000 PSI HYD SYS
 • UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR ON F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T MHX IN	T LMX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	14.70	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP	ALTERNATOR
140.00	12.00
LUBE PUMP	GEAR BOX
.60	7.63

TURBINE OUTPUT POWER = 160.43 O/F = .519 SPC = 1.886

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.320	1.723
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

IS IT IN CONTROL	CONTROL VALVE
PRESSURE IN	YES
PRESSURE OUT	486.5
TEMPERATURE IN	184.6
	1165.9
	499.9
	192.9
	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
 8 JUNE 1971 18103159 PAGE 2 OF 2

• CONDITION • 100 HP, 14.7 PAMB, 3000 PSI HYD SYS

COMBUSTOR INFORMATION			
HYDROGEN FLOW	3.320	OXYGEN FLOW	1.723
PRESSURE IN	182.9	PRESSURE OUT	182.9
TEMPERATURE IN H2	1165.9	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	5.042	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	182.6	PRESSURE OUT	14.9
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1500.5
ENTHALPY IN	5124.8	ENTHALPY OUT	3774.5
PRESSURE RATIO	12.22	EFFICIENCY	.555

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.320	487.6	487.3	646.8	1165.9	2187.9	3996.7	.608
HOT SIDE 5.042	14.9	14.8	1500.5	992.9	3774.5	2583.7	.595
• TURBINE EXHAUST OVERBOARD PRESSURE •						14.68	

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.320	500.0	499.8	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	487.3	487.3	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE				
FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
PRIMARY JET	74.23	3.32	499.76	500.00
SECONDARY JET	.00	.00	479.31	.00
RESULTANT		3.32	488.14	500.05
FLOW PARA RATIO	.000	P PRI/P SEC		1.0427
JET PUMP RISE	1.0184	PRI FLOW PARA	.1485	JPSF 2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.320	488.1	487.9	500.0	572.9	1670.5	1929.0	.455
HOT SIDE 30.000	200.0	196.9	660.0	605.1	.0	.0	.344

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 3.320	487.9	487.6	572.9	646.8	1929.0	2187.9	.958
HOT SIDE 423.7	100.0	97.8	650.0	646.1	.0	.0	.051

HEAT REJECTED 859.45

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• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
 8 JUNE 1971 18:04:06 PAGE 1 OF 2

• CONDITION • 200 HP, 14.7PAMB, 3000 PSI HYDSYS
 • UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4

.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OB CA	JP PR CA	TURB NO Z
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LK CA	ETA COM B	LUBE P HP	ETA LOPP	T TUR IN	T HM X IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 265.46 O/F = .550 SPC = 1.751

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.997	2.749
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	472.1	499.9
PRESSURE OUT	281.6	295.1
TEMPERATURE IN	1107.6	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
 8 JUNE 1971 18:04:06 PAGE 2 OF 2

• CONDITION • 200 HP, 14.7PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.997	OXYGEN FLOW	2.749
PRESSURE IN	279.2	PRESSURE OUT	279.2
TEMPERATURE IN H2	1107.6	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.746	SPECIFIC HEAT RATIO	1.367
PRESSURE IN	278.8	PRESSURE OUT	15.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1445.0
ENTHALPY IN	5046.6	ENTHALPY OUT	3592.0
PRESSURE RATIO	18.24	EFFICIENCY	.551

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.997	474.4	473.9	642.7	1107.6	2173.2	3793.4	.579
HOT SIDE 7.746	15.2	14.8	1445.0	990.3	3592.0	2546.7	.567

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.67

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.997	500.0	499.6	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	473.9	473.9	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET 111.74	5.00	499.47	500.00
SECONDARY JET .00	.00	457.79	.00
RESULTANT	5.00	475.52	500.10
FLOW PARA RATIO	.000	P PRI/P SEC	1.0910
JET PUMP RISE	1.0387	PRI FLOW PARA	.2237 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.997	475.5	475.0	500.1	560.3	1670.5	1884.7	.376
HOT SIDE 30.000	200.0	196.9	660.1	590.9	.0	.0	.432

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.997	475.0	474.5	560.3	642.7	1884.7	2173.2	.918
HOT SIDE 818.4	100.0	95.4	650.0	646.6	.0	.0	.038

HEAT REJECTED 1441.96

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
 8 JUNE 1971 18:04:29 PAGE 1 OF 2

* CONDITION * 360 HP, 14.7PAMB, 3000 HYDSYS
 * UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4								
.00	.00	.00	1110.00	7000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.80	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	14.70	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 431.77 O/F = .578 SPC = 1.692

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.715	4.458
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	449.5	499.6
PRESSURE OUT	433.7	455.0
TEMPERATURE IN	1061.7	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T60 = 650.
 8 JUNE 1971 18:04:29 PAGE 2 OF 2

* CONDITION * 360 HP, 14.7PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION		
HYDROGEN FLOW	7.715	OXYGEN FLOW 4.458
PRESSURE IN	430.1	PRESSURE OUT 430.1
TEMPERATURE IN H2	1061.7	TEMPERATURE IN O2 300.0

TURBINE INFORMATION		
INLET FLOW	12.173	SPECIFIC HEAT RATIO 1.367
PRESSURE IN	429.4	PRESSURE OUT 16.5
TEMPERATURE IN	2060.0	TEMPERATURE OUT 1412.4
ENTHALPY IN	4980.6	ENTHALPY OUT 3473.7
PRESSURE RATIO	26.05	EFFICIENCY .539

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.715	455.0	453.8	634.7	1061.8	2144.9	3633.7	.549
HOT SIDE 12.173	16.4	15.2	1412.4	994.8	3473.7	2530.1	.537

* TURBINE EXHAUST OVERBOARD PRESSURE * 14.78

HOT BYPASS VALVE INFORMATION		
FLOW	PRESSURE	DROP
.000	.000	

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.715	500.0	499.1	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	453.8	453.8	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE				
FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
PRIMARY JET	172.51	7.71	498.77	500.00
SECONDARY JET	.00	.00	427.01	.00
RESULTANT		7.71	457.36	500.18
FLOW PARA RATIO	.000	P PRI/P SEC		1.1680
JET PUMP RISE	1.0711	PRI FLOW PARA	.3459	JPSF 2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.715	457.2	456.3	500.2	551.4	1670.5	1853.2	.295
HOT SIDE 30.000	200.0	194.9	673.8	583.0	.0	.0	.523

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.715	456.1	455.0	551.4	634.7	1853.2	2144.9	.845
HOT SIDE 1450.0	130.0	91.5	650.0	647.3	.0	.0	.031

HEAT REJECTED 2250.66

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Case 128

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2= 500 R , T(60)=750 R
15JUN71

09:18:56

PAGE 1 OF 2

• CONDITION • CASE 5

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, G=STU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4									
.00	.00	.00	1110.00	70000.00	.00	.00	10.00		
3.64	.00	1.18	1.44	.00	.66	3.50	20.80		
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023		
.12	.00								

SFT	TUR ON F	SF JP P	SF JP W	TUR QBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00

ETA CORF	O/F BASE
.0925	.600

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.53 O/F = .532 SPC = 1.483

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	.896	.477
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.6

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	499.1	500.0
PRESSURE OUT	50.3	52.8
TEMPERATURE IN	1138.5	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2= 500 R , T(60)=750 R
15JUN71

09:18:56

PAGE 2 OF 2

• CONDITION • CASE 5

COMBUSTOR INFORMATION

HYDROGEN FLOW	.896	OXYGEN FLOW	.477
PRESSURE IN	49.9	PRESSURE OUT	49.9
TEMPERATURE IN H2	1138.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	1.373	SPECIFIC HEAT RATIO	1.370
PRESSURE IN	49.8	PRESSURE OUT	.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1339.5
ENTHALPY IN	5088.5	ENTHALPY OUT	3373.7
PRESSURE RATIO	62.34	EFFICIENCY	.520

RECUPERATOR INFORMATION

COLD SIDE	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
	.896	499.1	499.1	749.6	1138.5	2548.4	3902.7	.640
HOT SIDE	1.373	.8	.5	1339.5	958.1	3373.7	2489.8	.647

• TURBINE EXHAUST OVERBOARD PRESSURE • .33

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

COLD SIDE	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
	.896	500.0	500.0	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	499.1	499.1	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
	20.03	.90	499.98	500.00
SECONDARY JET	.00	.00	498.71	.00
RESULTANT		.90	499.23	500.00
FLOW PARA RATIO		.000	P PRI/P SEC	1.0025
JET PUMP RISE	1.0010	PRI FLOW PARA	.0401 JPSF	2.30

LUBE OIL COOLER INFORMATION

COLD SIDE	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
	.896	499.2	499.2	500.0	704.9	1670.5	2391.7	.639
HOT SIDE	30.000	200.0	196.9	820.7	786.3	.0	.0	.107

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

COLD SIDE	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
	.896	499.2	499.2	704.9	749.6	2391.7	2548.4	.992
HOT SIDE	29.0	100.0	99.8	750.0	741.5	.0	.0	.167

HEAT REJECTED 140.42

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II; TURB 16,500 R H2,T60 = 750.
8 JUNE 1971 17:03:58 PAGE 1 OF 2

* CONDITION * 100 HP,0.0 PAMB,3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TUR NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOFF	T TUR IN	T HMX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 160.22 O/F = .534 SPC = 1.571

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.734	1.460
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	491.1	500.0
PRESSURE OUT	152.4	159.8
TEMPERATURE IN	1138.6	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II; TURB 16,500 R H2,T60 = 750.
8 JUNE 1971 17:03:58 PAGE 2 OF 2

* CONDITION * 100 HP,0.0 PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	2.734	OXYGEN FLOW	1.460
PRESSURE IN	151.0	PRESSURE OUT	151.0
TEMPERATURE IN H2	1138.6	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.194	SPECIFIC HEAT RATIO	1.369
PRESSURE IN	150.8	PRESSURE OUT	2.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1379.5
ENTHALPY IN	5085.1	ENTHALPY OUT	3464.5
PRESSURE RATIO	61.70	EFFICIENCY	.493

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.734	491.8	491.6	746.4	1137.5	2536.8	3098.0	.618
HOT SIDE 4.194	2.4	1.5	1379.5	996.9	3464.5	2577.2	.604
* TURBINE EXHAUST OVERBOARD PRESSURE *					1.01		

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.734	500.0	499.9	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	491.6	491.6	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
61.13	2.73	499.83	500.00	
SECONDARY JET	.00	486.54	.00	
RESULTANT	2.73	492.22	500.03	
FLOW PARA RATIO	.000	P PRI/P SEC	1.0273	
JET PUMP RISE	1.0117	PRI FLOW PARA	.1223	JPSF
			2.30	

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.734	492.2	492.1	500.0	588.7	1670.5	1984.4	.493
HOT SIDE 30.000	200.0	196.9	679.7	626.0	.0	.0	.299

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3	

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 2.734	492.0	491.8	568.7	746.4	1984.4	2536.8	.978
HOT SIDE 423.7	100.0	97.8	750.0	743.8	.0	.0	.039

HEAT REJECTED 1510.06

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Case 130

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE 11, TURB 16,500 R H2, T60 = 790.
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* CONDITION * 200 HP, 0.0 PAMB, 3000 PSI HYDSYS
 * UNITS * AREA=SQ IN, W=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *
 DUCT PRESSURE LOSS COEFFICIENTS *10E+4

.00	.00	1.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.00
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBGA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HX IN	T LHX 0
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
240.00	12.00	.60	12.63

TURBINE OUTPUT POWER = 265.25 O/F = .547 SPC = 1.574

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.499	2.461
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

IS IT IN CONTROL	CONTROL VALVE	YES	YES
PRESSURE IN	476.1	499.9	
PRESSURE OUT	253.2	265.3	
TEMPERATURE IN	1113.5	300.0	

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE 11, TURB 16,500 R H2, T60 = 790.
 6 JUNE 1971 17:04:05 PAGE 2 OF 2

* CONDITION * 200 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.499	OXYGEN FLOW	2.461
PRESSURE IN	251.0	PRESSURE OUT	251.0
TEMPERATURE IN H2	1113.5	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	6.960	SPECIFIC HEAT RATIO	1.369
PRESSURE IN	250.6	PRESSURE OUT	4.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1375.9
ENTHALPY IN	5053.8	ENTHALPY OUT	3436.2
PRESSURE RATIO	61.07	EFFICIENCY	.496

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.499	478.1	477.5	738.4	1113.1	2508.7	3812.7 .380
HOT SIDE	6.960	4.0	2.5	1375.9	1009.6	3436.2	2593.4 .575

* TURBINE EXHAUST OVERBOARD PRESSURE * 1.69

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.499	500.0	499.7	500.0	500.0	1670.5	1670.5 .000
HOT SIDE	.000	477.5	477.5	.0	.0	.0	.0 .000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	100.61	4.50	499.57
SECONDARY JET	.00	.00	463.87
RESULTANT		4.50	478.97
FLOW PARA RATIO	.000	P PRI/P SEC	1.0770
JET PUMP RISE	1.0326	PRI FLOW PARA	.2014 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.499	478.9	478.6	500.1	567.0	1670.5	1908.4 .397
HOT SIDE	30.000	200.0	196.9	668.5	600.1	.0	.0 .406

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	4.499	478.5	478.1	567.0	738.4	1908.4	2508.7 .937
HOT SIDE	618.4	100.0	95.4	750.0	744.2	.0	.0 .031

HEAT REJECTED 2701.05

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Case 131

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
8 JUNE 1971

17:04:10

PAGE 1 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.30	13.85	54.00	.00	2.92	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER	HEAT EXCHANGER SCALE FACTORS			
	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	.00	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER			HP LOSS
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 433.44 O/F = .565 SPC = 1.590

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.338	4.146
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	452.4	499.7
PRESSURE OUT	414.0	433.4
TEMPERATURE IN	1083.4	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
8 JUNE 1971

17:04:10

PAGE 2 OF 2

• CONDITION • 360 HP, 0.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.338	OXYGEN FLOW	4.146
PRESSURE IN	410.5	PRESSURE OUT	410.5
TEMPERATURE IN H2	1083.4	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.483	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	409.9	PRESSURE OUT	7.2
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1375.3
ENTHALPY IN	5011.5	ENTHALPY OUT	3407.7
PRESSURE RATIO	56.70	EFFICIENCY	.502

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.338	457.5	456.3	722.3	1083.2	2451.9	3708.1	.553
HOT SIDE 11.483	7.0	4.1	1375.3	1022.6	3407.7	2605.0	.540
• TURBINE EXHAUST OVERBOARD PRESSURE •							2.79

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.338	500.0	499.2	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	456.3	456.3	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
164.08	7.34	498.88	500.00	
SECONDARY JET	.00	.00	431.06	.00
RESULTANT		7.34	459.77	500.17
FLOW PARA RATIO	.000	P PRI/P SEC		1.1573
JET PUMP RISE	1.0666	PRI FLOW PARA	.3289	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.338	459.7	458.8	500.2	554.1	1670.5	1862.6	.305
HOT SIDE 30.000	200.0	196.9	677.1	596.7	.0	.0	.511

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.338	453.6	457.6	554.1	722.3	1862.6	2451.9	.859
HOT SIDE 1450.0	100.0	91.5	750.0	744.8	.0	.0	.027

HEAT REJECTED 4323.67

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2= 500 R , T(60)=750 R
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* CONDITION * CASE 6

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN #	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

	ETAHA COLD	ETAHA HOT	RHDP COLD	RHDP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER

HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 54.95 O/F = .478 SPC = 1.852

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.148	.548
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

IS IT IN CONTROL	CONTROL VALVE	
	YES	YES
PRESSURE IN	498.4	500.0
PRESSURE OUT	63.4	65.9
TEMPERATURE IN	1238.8	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

TH2= 500 R , T(60)=750 R
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* CONDITION * CASE 6

COMBUSTOR INFORMATION			
HYDROGEN FLOW	1.148	OXYGEN FLOW	.548
PRESSURE IN	62.7	PRESSURE OUT	62.7
TEMPERATURE IN H2	1238.8	TEMPERATURE IN O2	300.0

TURBINE INFORMATION			
INLET FLOW	1.696	SPECIFIC HEAT RATIO	1.369
PRESSURE IN	62.7	PRESSURE OUT	5.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1504.6
ENTHALPY IN	5233.0	ENTHALPY OUT	3858.8
PRESSURE RATIO	12.32	EFFICIENCY	.549

RECUPERATOR INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.148	498.6	498.5	747.9	1238.8	2542.4	4252.0	.649
HOT SIDE	1.696	5.1	5.0	1504.6	1024.6	3858.8	2701.9	.634
* TURBINE EXHAUST OVERBOARD PRESSURE *								4.99

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.148	500.0	500.0	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	498.5	498.5	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE				
	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	25.67	1.15	499.97	500.00
SECONDARY JET	.00	.00	497.72	.00
RESULTANT		1.15	498.69	500.01
FLOW PARA RATIO		.000	P PRI/P SEC	1.0045
JET PUMP RISE	1.0019	PRI FLOW PARA	.0513 JPSF	2.30

LUBE OIL COOLER INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.148	498.7	498.7	500.0	659.7	1670.5	2233.3	.617
HOT SIDE	30.000	200.0	196.9	758.7	722.0	.0	.0	.142

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION								
	FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.148	498.7	498.6	659.7	747.9	2233.3	2542.4	.977
HOT SIDE	29.0	100.0	99.8	750.0	728.5	.0	.0	.238

HEAT REJECTED 354.88

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Case 133

8

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
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• CONDITION • 10 HP, 5.0 PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *							
DUCT		PRESSURE LOSS		COEFFICIENTS *10E+4			
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS					
HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT	
H2 PREHEATER	2.00	2.00	.50	1.00	
HYD O COOLER	1.00	1.00	1.00	1.00	
LUB O COOLER	1.00	1.00	1.00	1.00	
RECUPERATOR	1.00	1.00	1.00	1.00	

* POINT INPUT DATA *				
HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER			HP LOSS
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 160.83 O/F = .524 SPC = 1.637

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	2.879	1.509
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE		
IS IT IN CONTROL	YES	YES
PRESSURE IN	490.1	500.0
PRESSURE OUT	160.2	167.6
TEMPERATURE IN	1156.7	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
8 JUNE 1971 17:04:52 PAGE 2 OF 2

• CONDITION • 100 HP, 5.0 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION		
HYDROGEN FLOW	2.879	OXYGEN FLOW 1.509
PRESSURE IN	158.7	PRESSURE OUT 158.7
TEMPERATURE IN H2	1156.7	TEMPERATURE IN O2 300.0

TURBINE INFORMATION		
INLET FLOW	4.388	SPECIFIC HEAT RATIO 1.369
PRESSURE IN	158.5	PRESSURE OUT 5.6
TEMPERATURE IN	2060.0	TEMPERATURE OUT 1411.7
ENTHALPY IN	5111.0	ENTHALPY OUT 3556.1
PRESSURE RATIO	28.53	EFFICIENCY .529

RECUPERATOR INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.879	491.0	490.7	745.6	1155.4	2534.1	3960.0 .615
HOT SIDE	4.388	5.5	5.2	1411.7	1011.1	3556.1	2620.5 .601

* TURBINE EXHAUST OVERBOARD PRESSURE = 5.01

HOT BYPASS VALVE INFORMATION	
FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.879	500.0	499.9	500.0	500.0	1670.5	1670.5 .000
HOT SIDE	.000	490.7	490.7	.0	.0	.0	.0 .000

JET PUMP PERFORMANCE				
PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	.00	.00	445.08	.00
RESULTANT		2.88	491.39	500.04
FLOW PARA RATIO	.000		P PRI/P SEC	1.0304
JET PUMP RISE	1.0130	PRI FLOW PARA	.1288	JPSF 2.30

LUBE OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.879	491.4	491.2	500.0	584.2	1670.5	1968.6 .483
HOT SIDE	30.000	200.0	196.9	674.1	620.0	.0	.0 .311

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION							
FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	2.879	491.2	491.0	584.2	745.6	1968.6	2534.1 .973
HOT SIDE	423.7	100.0	97.8	750.0	743.3	.0	.0 .040

HEAT REJECTED 1627.99

140

Case 134

3

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 * 750.
8 JUNE 1971 17:04:55 PAGE 1 OF 2

• CONDITION • 200 HP, 5, PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP 240.00	ALTERNATOR 12.00
LUBE PUMP .60	GEAR BOX 12.63

TURBINE OUTPUT POWER = 264.80 O/F = .542 SPC = 1.605

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.593	2.489
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	475.3	499.9
PRESSURE OUT	258.2	270.3
TEMPERATURE IN	1120.6	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 * 750.
8 JUNE 1971 17:04:55 PAGE 2 OF 2

• CONDITION • 200 HP, 5, PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.593	OXYGEN FLOW	2.489
PRESSURE IN	255.9	PRESSURE OUT	255.9
TEMPERATURE IN H2	1120.6	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.083	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	255.5	PRESSURE OUT	6.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1391.2
ENTHALPY IN	5066.8	ENTHALPY OUT	3479.7
PRESSURE RATIO	39.81	EFFICIENCY	.516

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.593	477.4	476.8	737.8	1120.5	2506.3	3838.5	.586
HOT SIDE 7.083	6.3	5.5	1391.2	1017.1	3479.7	2615.7	.573
* TURBINE EXHAUST OVERBOARD PRESSURE = 5.10							

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.593	500.0	499.7	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	476.8	476.8	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
102.71	4.59	499.55	500.00		
SECONDARY JET	.00	.00	462.71	.00	
RESULTANT	4.59	478.32	500.09		
FLOW PARA RATIO	.000	P PRI/P SEC	1.0796		
JET PUMP RISE	1.0337	PRI FLOW PARA	.2056	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.593	478.3	477.9	500.1	565.6	1670.5	1903.5	.393
HOT SIDE 30.000	200.0	196.9	666.8	598.2	.0	.0	.411

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.593	477.8	477.4	565.6	737.8	1903.5	2506.3	.934
HOT SIDE 818.4	100.0	95.4	750.0	744.1	.0	.0	.032

HEAT REJECTED

2769.89

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
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* CONDITION * 360 HP, 5.0 PAMB, 3000 HYDSYS
 * UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=3TU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4								
.00	.00	.00	1110.00	70000.00	.00	.00	10.00	
3.64	.00	1.18	1.44	.00	.66	3.50	20.80	
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023	
.12	.00							

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	5.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS		
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
400.00	12.00	.60	20.63

TURBINE OUTPUT POWER = 429.78 O/F = .564 SPC = 1.602

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.338	4.137
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE	YES	YES
IS IT IN CONTROL	YES	YES
PRESSURE IN	452.3	499.7
PRESSURE OUT	413.9	433.3
TEMPERATURE IN	1086.4	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
 8 JUNE 1971 17:04:58 PAGE 2 OF 2

* CONDITION * 360 HP, 5.0 PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.338	OXYGEN FLOW	4.137
PRESSURE IN	410.4	PRESSURE OUT	410.4
TEMPERATURE IN H2	1086.4	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.474	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	409.8	PRESSURE OUT	8.6
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1381.1
ENTHALPY IN	5014.6	ENTHALPY OUT	3423.1
PRESSURE RATIO	47.62	EFFICIENCY	.510

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.338	457.5	456.3	722.3	1086.4	2451.8	3719.3	.553
HOT SIDE 11.474	8.4	6.2	1381.1	1025.4	3423.1	2612.6	.540
* TURBINE EXHAUST OVERBOARD PRESSURE *							5.34

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.338	500.0	499.2	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	456.3	456.3	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	164.08	7.34	498.88
SECONDARY JET	.00	.00	431.06
RESULTANT		7.34	459.77
FLOW PARA RATIO		.000	P PRI/P SEC
JET PUMP RISE	1.0666	PRI FLOW PARA	.3289 JPSF
			2.30
			1.1573

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.338	459.7	458.8	500.2	554.1	1670.5	1862.6	.305
HOT SIDE 30.000	200.0	196.9	677.1	586.7	.0	.0	.511

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.338	458.6	457.6	554.1	722.3	1862.6	2451.9	.859
HOT SIDE 1450.0	100.0	91.5	750.0	744.8	.0	.0	.027

HEAT REJECTED 4323.79

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 1],TURB 16,500 R H2,T60 = 790.
8 JUNE 1971

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PAGE 1 OF 2

* CONDITION * 0.0 HP,10. PAMB,3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA GORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* * POINT INPUT DATA * *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER			
HYD PUMP	ALTERNATOR	LUBE PUMP	HP LOSS GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 54.36 O/F * .446 SPC = 2.203

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.381	.615
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	497.7	500.0
PRESSURE OUT	75.4	77.9
TEMPERATURE IN	1294.9	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE 1],TURB 16,500 R H2,T60 = 790.
8 JUNE 1971

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PAGE 2 OF 2

* CONDITION * 0.0 HP,10. PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION		
HYDROGEN FLOW	1.381	OXYGEN FLOW .615
PRESSURE IN	74.6	PRESSURE OUT 74.6
TEMPERATURE IN H2	1294.9	TEMPERATURE IN O2 300.0

TURBINE INFORMATION		
INLET FLOW	1.996	SPECIFIC HEAT RATIO 1.368
PRESSURE IN	74.5	PRESSURE OUT 10.1
TEMPERATURE IN	2060.0	TEMPERATURE OUT 1603.6
ENTHALPY IN	5323.8	ENTHALPY OUT 4166.3
PRESSURE RATIO	7.40	EFFICIENCY .532

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.381	497.8	744.9	1294.8	2531.9	4449.6	.640
HOT SIDE	1.996	10.1	10.0	1603.6	1066.0	4166.3	2839.7 .626

* TURBINE EXHAUST OVERBOARD PRESSURE * 9.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.381	500.0	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	497.8	497.8	.0	.0	.0	.000

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
30.87	1.38	499.95	500.00	
SECONDARY JET	.00	496.58	.00	
RESULTANT		498.03	500.01	
FLOW PARA RATIO	.000	P PRI/P SEC		1.0068
JET PUMP RISE	1.0029	PR1 FLOW PARA	.0618 JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.381	498.0	498.0	500.0	632.6	1670.5	2138.5 .598
HOT SIDE	30.000	200.0	196.9	721.6	683.4	.0	.0 .172

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.381	498.0	497.9	632.6	744.9	2138.5	2531.9 .957
HOT SIDE	29.0	100.0	99.8	750.0	716.9	.0	.0 .282

HEAT REJECTED 543.20

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* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.

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PAGE 1 OF 2

* CONDITION * 100 HP, 10. PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.30	.00	.30	1110.00	70000.00	.00	.00	10.00
3.44	.00	1.18	1.44	.00	.66	3.50	20.00
19.90	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR ON F	SF JP P	SF JP W	TUR OBCA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1900.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHOOP COLD	RHOOP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUR O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	10.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR LUBE PUMP	GEAR BOX
140.00	12.00	.60
		7.63

TURBINE OUTPUT POWER = 161.21 O/F = .509 SPC = 1.752

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.119	1.587
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	488.4	500.0
PRESSURE OUT	172.5	179.9
TEMPERATURE IN	1181.9	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.

8 JUNE 1971

17:05:12

PAGE 2 OF 2

* CONDITION * 100 HP, 10. PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	3.119	OXYGEN FLOW	1.587
PRESSURE IN	170.8	PRESSURE OUT	170.8
TEMPERATURE IN H2	1181.9	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.707	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	170.5	PRESSURE OUT	10.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1460.6
ENTHALPY IN	5151.0	ENTHALPY OUT	3697.4
PRESSURE RATIO	16.53	EFFICIENCY	.549

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.119	489.4	489.2	744.2	1181.9	2529.0	4052.2
HOT SIDE	4.707	10.3	10.1	1460.6	1033.1	3697.4	2687.8
* TURBINE EXHAUST OVERBOARD PRESSURE = 9.97							

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.119	500.0	499.8	500.0	500.0	1670.5	1670.5
HOT SIDE	.000	489.2	489.2	.0	.0	.0	.0

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
SECONDARY JET	69.75	3.12	499.79	500.00
RESULTANT	.00	.00	482.48	.00
FLOW PARA RATIO		3.12	489.93	500.04
JET PUMP RISE	1.0154	PRI FLOW PARA	.1396	JPSF
				2.30

LOBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.119	489.9	489.7	500.0	577.6	1670.5	1945.6
HOT SIDE	30.000	200.0	196.9	665.9	611.3	.0	.0

HEAT REJECTED

ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.119	489.7	489.5	577.6	744.2	1945.6	2529.0
HOT SIDE	423.7	160.0	97.8	750.0	742.5	.0	.0

HEAT REJECTED 1819.77

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5

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II TURB 16,500 R H2,T60 = 750,
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* CONDITION * 200 HP,10. PAMB,3000 PSI HYDSYS
 * UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* I N P U T D A T A *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4		*10E+4		*10E+4		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAMA COLD	ETAMA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	10.00	3000.0	35.0

* O U T P U T D A T A *

DRIVE POWER	HP LOSS
HYD PUMP 240.00	ALTERNATOR 12.00
LUBE PUMP .60	GEAR BOX 12.63

TURBINE OUTPUT POWER = 264.30 O/F = .937 SPC = 1.672

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	4.792	2.974
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

IS IT IN CONTROL	CONTROL VALVE	YES	YES
PRESSURE IN	473.6	499.9	
PRESSURE OUT	268.8	281.2	
TEMPERATURE IN	1134.6	300.0	

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.
 SSAPU PHASE II TURB 16,500 R H2,T60 = 750,
 8 JUNE 1971 17105115 PAGE 2 OF 2

* CONDITION * 200 HP,10. PAMB,3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	4.792	OXYGEN FLOW	2.974
PRESSURE IN	266.4	PRESSURE OUT	266.4
TEMPERATURE IN H2	1134.6	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	7.366	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	266.0	PRESSURE OUT	10.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1420.6
ENTHALPY IN	8079.1	ENTHALPY OUT	3555.9
PRESSURE RATIO	24.62	EFFICIENCY	.537

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.792	475.9	475.3	736.3	1134.6	2501.1	3887.5	.582
HOT SIDE 7.366	10.7	10.2	1420.6	1031.5	3555.9	2653.9	.569

* TURBINE EXHAUST OVERBOARD PRESSURE * 9.99

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.792	500.0	499.6	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	475.3	475.3	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET 107.16	4.79	499.51	500.00
SECONDARY JET .00	.00	460.27	.00
RESULTANT	4.79	476.93	500.10
FLOW PARA RATIO	.000	P PRI/P SEC	1.0852
JET PUMP RISE 1.0362	PRI FLOW PARA	.2145	JPSF 2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.792	476.9	476.5	500.1	562.9	1670.5	1893.8	.385
HOT SIDE 30.000	200.0	196.9	663.3	594.5	.0	.0	.422

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 4.792	476.4	475.9	562.9	736.3	1893.8	2501.1	.927
HOT SIDE 818.4	100.0	95.4	750.0	743.8	.0	.0	.033

HEAT REJECTED 2910.17

3

Case 139

145

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
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* CONDITION * 360 HP, 10, PAMB, 3000 HYDSYS

* UNITS * AREA*SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS COEFFICIENTS *10E+4							
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUP LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUBE O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	13.00	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS
HYD PUMP	GEAR BOX
400.00	20.63
ALTERNATOR	LUBE PUMP
12.00	.60

TURBINE OUTPUT POWER = 433.68 O/F = .560 SPC = 1.638

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.590	4.248
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE	YES	YES
IS IT IN CONTROL	YES	YES
PRESSURE IN	450.2	499.7
PRESSURE OUT	426.8	446.4
TEMPERATURE IN	1092.9	300.0

* GARRETT * AIRESEAFCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
8 JUNE 1971 17:05:22 PAGE 2 OF 2

* CONDITION * 360 HP, 10, PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.590	OXYGEN FLOW	4.248
PRESSURE IN	423.1	PRESSURE OUT	423.1
TEMPERATURE IN H2	1092.9	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.838	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	422.5	PRESSURE OUT	12.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1398.0
ENTHALPY IN	5024.9	ENTHALPY OUT	3468.2
PRESSURE RATIO	34.18	EFFICIENCY	.524

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.590	455.8	454.5	720.4	1092.9	2444.9	3742.1	.550
HOT SIDE	11.838	12.2	10.6	1398.0	1034.0	3468.2	2636.4	.537

* TURBINE EXHAUST OVERBOARD PRESSURE * 10.10

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.590	500.0	499.1	500.0	500.0	1670.5	1670.5	.000
HOT SIDE	.000	454.5	454.5	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	169.73	7.59	498.81
SECONDARY JET	.00	.00	428.34
RESULTANT		7.59	458.15
FLOW PARA RATIO		.000	P PRI/P SEC
JET PUMP RISE	1.0696	PRI FLOW PARA	.3403 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.590	458.0	457.1	500.2	552.2	1670.5	1856.2	.298
HOT SIDE	30.000	200.0	196.9	674.8	584.2	.0	.0	.519

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC CIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF	
COLD SIDE	7.590	456.9	455.8	552.2	720.4	1856.2	2444.9	.850
HOT SIDE	1450.0	100.2	91.5	750.0	744.6	.0	.0	.027

HEAT REJECTED 4466.45

146

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Case 140

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
8 JUNE 1971 17:05:35 PAGE 1 OF 2

• CONDITION • 0.0 HP, 14.7PAMB, 3000 PSI HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4			
.00	.00	.00	1110.00	7000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
.00	.00	14.70	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER	HP LOSS		
MYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
40.00	12.00	.60	2.63

TURBINE OUTPUT POWER = 55.57 O/F = .425 SPC = 2.529

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	1.644	.698
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE	YES	YES
IS IT IN CONTROL	YES	YES
PRESSURE IN	496.7	500.0
PRESSURE OUT	89.2	91.8
TEMPERATURE IN	1327.4	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
8 JUNE 1971 17:05:35 PAGE 2 OF 2

• CONDITION • 0.0 HP, 14.7PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	1.644	OXYGEN FLOW	.698
PRESSURE IN	88.2	PRESSURE OUT	88.2
TEMPERATURE IN H2	1327.4	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	2.342	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	88.1	PRESSURE OUT	14.8
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1668.5
ENTHALPY IN	5384.6	ENTHALPY OUT	4374.3
PRESSURE RATIO	5.97	EFFICIENCY	.498

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.644	497.1	497.0	740.0	1327.4	2514.6	4564.4 .633
HOT SIDE	2.342	14.8	14.7	1668.5	1094.2	4374.3	2935.7 .619

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.69

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.644	500.0	499.9	500.0	500.0	1670.5	1670.5 .000
HOT SIDE	.000	497.0	497.0	.0	.0	.0	.0 .000

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE	
SECONDARY JET	36.76	1.64	499.93	500.00	
RESULTANT	.00	.00	495.19	.00	
FLOW PARA RATIO	.000	1.64	497.22	500.01	
JET PUMP RISE	1.0041	PRI FLOW PARA	.0735	JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.644	497.2	497.2	500.0	611.2	1670.5	2063.5 .578
HOT SIDE	30.000	200.0	196.9	692.4	652.9	.0	.0 .205

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	111.6	25.5	646.2

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	1.644	497.2	497.1	611.2	740.0	2063.5	2514.6 .928
HOT SIDE	29.0	100.0	99.8	750.0	704.5	.0	.0 .328

HEAT REJECTED 741.61

13

Case 141

147

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
8 JUNE 1971

17:05:42

PAGE 1 OF 2

* CONDITION * 100 HP, 14.7 PAMB, 3000 PSI HYDSYS

* UNITS * AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

* INPUT DATA *

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	110.00	.0000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR ON F	SF JP P	SF JP W	TUR OBCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

* POINT INPUT DATA *

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
100.00	.00	14.70	3000.0	35.0

* OUTPUT DATA *

DRIVE POWER		HP LOSS	
HYD PUMP	ALTERNATOR	LUBE PUMP	GEAR BOX
140.00	12.00	.60	7.63

TURBINE OUTPUT POWER = 159.95 O/F = .497 SPC = 1.868

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	3.327	1.652
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	486.3	500.0
PRESSURE OUT	184.0	191.4
TEMPERATURE IN	1204.6	300.0

* GARRETT * AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
8 JUNE 1971

17:05:42

PAGE 2 OF 2

* CONDITION * 100 HP, 14.7 PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	3.327	OXYGEN FLOW	1.652
PRESSURE IN	182.2	PRESSURE OUT	182.2
TEMPERATURE IN H2	1204.6	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	4.980	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	181.9	PRESSURE OUT	15.0
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1502.7
ENTHALPY IN	5183.5	ENTHALPY OUT	3819.6
PRESSURE RATIO	12.16	EFFICIENCY	.553

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.327	487.5	487.2	742.8	1204.5	2524.1	4130.9
HOT SIDE	4.980	14.9	14.8	1502.7	1092.2	3819.6	2746.0

* TURBINE EXHAUST OVERBOARD PRESSURE * 14.68

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.327	500.0	499.8	500.0	500.0	1670.5	1670.5
HOT SIDE	.000	487.2	487.2	.0	.0	.0	.0

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	74.40	3.33	499.76
SECONDARY JET	.00	.00	479.19
RESULTANT		3.33	488.07
FLOW PARA RATIO		.000	P PRI/P SEC
JET PUMP RISE	1.0185	PR: FLOW PARA	.1489 JPSF
			2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.327	488.0	487.8	500.0	572.7	1670.5	1928.4
HOT SIDE	30.000	200.0	196.9	659.8	604.8	.0	.0

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	323.7	25.5	858.3

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	3.327	487.8	487.5	572.7	742.8	1928.4	2524.1
HOT SIDE	423.7	100.0	97.8	753.0	741.8	.0	.0

HEAT REJECTED 1981.75

187

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Case 142

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II: TURB 16,500 R H2, T60 = 750.

8 JUNE 1971

17:05:46

PAGE 1 OF 2

• CONDITION • 200 HP, 14.7PAMB, 3000 PSI HYDSYS

• UNITS • AREA*SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00
3.64	.00	1.18	1.44	.00	.66
19.00	13.85	54.00	.00	2.02	50.00
.12	.00				

SFT	TUR DN F	SF JP P	SF JP W	TUR OSCA	JP PRICA	TURB NOZ
1.000	.000	1.000	1.000	12,560	.2000	.1210
TUR LKCA	ETA COMB	LUBE P HP	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
200.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER	HP LOSS
MYD PUMP	GEAR BOX
240.00	12.63
ALTERNATOR	LUBE PUMP
12.00	.60

TURBINE OUTPUT POWER = 264.72 O/F = .530 SPC = 1.737

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	5.009	2.656
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

IS IT IN CONTROL	CONTROL VALVE
YES	YES
PRESSURE IN	471.8
PRESSURE OUT	280.1
TEMPERATURE IN	1147.3
	292.6
	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II: TURB 16,500 R H2, T60 = 750.

8 JUNE 1971

17:05:46

PAGE 2 OF 2

• CONDITION • 200 HP, 14.7PAMB, 3000 PSI HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	OXYGEN FLOW	2.656
PRESSURE IN	277.5	PRESSURE OUT
TEMPERATURE IN H2	1147.3	TEMPERATURE IN O2
		300.0

TURBINE INFORMATION

INLET FLOW	7.665	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	277.1	PRESSURE OUT	15.3
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1447.5
ENTHALPY IN	5096.8	ENTHALPY OUT	3630.3
PRESSURE RATIO	18.11	EFFICIENCY	.549

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.009	474.3	473.7	734.6	1147.4	2495.2	3931.8
HOT SIDE	7.665	15.3	14.8	1447.5	1044.7	3630.3	2691.5

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.67

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.009	500.0	499.6	500.0	500.0	1670.5	1670.5
HOT SIDE	.000	473.7	473.7	.0	.0	.0	.0

JET PUMP PERFORMANCE

PRIMARY JET	FLOW PARA	FLOW	PRESSURE	TEMPERATURE
112.01	5.01	499.47	500.00	
SECONDARY JET	.00	.00	457.65	.00
RESULTANT	5.01	475.44	500.10	
FLOW PARA RATIO	.000	P PRI/P SEC	1.0914	
JET PUMP RISE	1.0389	PRI FLOW PARA	.2243	JPSF
			2.30	

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.009	475.4	475.0	500.1	560.1	1670.5	1884.2
HOT SIDE	30.000	200.0	196.9	659.9	590.8	.0	.433

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	535.9	25.5	1070.4

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE	5.009	474.9	474.4	560.1	734.6	1884.2	2495.2
HOT SIDE	816.4	100.0	95.4	750.0	743.5	.0	.034

HEAT REJECTED 3060.77

149

Case 143

4

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
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• CONDITION • 360 HP, 14.7PAMB, 3000 HYDSYS

• UNITS • AREA=SQ IN, H=BTU/LB, P=PSIA, Q=BTU/MIN, T=DEG R, W=LB/MIN

• INPUT DATA •

DUCT		PRESSURE LOSS		COEFFICIENTS		*10E+4	
.00	.00	.00	1110.00	70000.00	.00	.00	10.00
3.64	.00	1.18	1.44	.00	.66	3.50	20.80
19.00	13.85	54.00	.00	2.02	50.00	2.74	.023
.12	.00						

SFT	TUR DN F	SF JP P	SF JP W	TUR O9CA	JP PRCA	TURB NOZ
1.000	.000	1.000	1.000	12.560	.2030	.1210
TUR LKCA	ETA COMB	LUBE P	ETA LOPP	T TUR IN	T HHX IN	T LHX O
.0002	.98	.30	.5	2060.00	400.00	1500.00
ETA CORF	O/F BASE					
.0925	.600					

HEAT EXCHANGER SCALE FACTORS

HEAT EXCHANGER	ETAHA COLD	ETAHA HOT	RHODP COLD	RHODP HOT
H2 PREHEATER	2.00	2.00	.50	1.00
HYD O COOLER	1.00	1.00	1.00	1.00
LUB O COOLER	1.00	1.00	1.00	1.00
RECUPERATOR	1.00	1.00	1.00	1.00

• POINT INPUT DATA •

HYDRA HP	ELECT HP	P AMB	P HYDRA OIL	ALT SIZE(KW)
360.00	.00	14.70	3000.0	35.0

• OUTPUT DATA •

DRIVE POWER		HP LOSS
HYD PUMP	ALTERNATOR	GEAR BOX
400.00	12.00	20.63

TURBINE OUTPUT POWER = 429.10 O/F = .556 SPC = 1.675

PROPELLANT	HYDROGEN	OXYGEN
FLOW RATE	7.698	4.284
PRESSURE	500.00	500.00
TEMPERATURE	500.00	300.00
ENTHALPY	1670.5	52.8

CONTROL VALVE

IS IT IN CONTROL	YES	YES
PRESSURE IN	449.2	499.7
PRESSURE OUT	432.0	451.6
TEMPERATURE IN	1100.7	300.0

• GARRETT • AIRESEARCH MANUFACTURING DIVISION LOS ANGELES, CALIF.

SSAPU PHASE II, TURB 16,500 R H2, T60 = 750.
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• CONDITION • 360 HP, 14.7PAMB, 3000 HYDSYS

COMBUSTOR INFORMATION

HYDROGEN FLOW	7.698	OXYGEN FLOW	4.284
PRESSURE IN	428.3	PRESSURE OUT	428.3
TEMPERATURE IN H2	1100.7	TEMPERATURE IN O2	300.0

TURBINE INFORMATION

INLET FLOW	11.982	SPECIFIC HEAT RATIO	1.368
PRESSURE IN	427.6	PRESSURE OUT	16.4
TEMPERATURE IN	2060.0	TEMPERATURE OUT	1414.3
ENTHALPY IN	5032.8	ENTHALPY OUT	3510.8
PRESSURE RATIO	26.01	EFFICIENCY	.537

RECUPERATOR INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.698	455.0	453.7	719.5	1100.8	2441.9	3769.3	.549
HOT SIDE 11.982	16.3	15.1	1414.3	1042.1	3510.8	2658.0	.536

• TURBINE EXHAUST OVERBOARD PRESSURE • 14.73

HOT BYPASS VALVE INFORMATION

FLOW	PRESSURE DROP
.000	.000

H2 PREHEATER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.698	500.0	499.1	500.0	500.0	1670.5	1670.5	.000
HOT SIDE .000	453.7	453.7	.0	.0	.0	.0	.000

JET PUMP PERFORMANCE

FLOW PARA	FLOW	PRESSURE	TEMPERATURE
PRIMARY JET	172.14	7.70	498.78
SECONDARY JET	.00	.00	427.19
RESULTANT	7.70	457.47	500.18
FLOW PARA RATIO	.000	P PRI/P SEC	1.1676
JET PUMP RISE	1.0709	PRI FLOW PARA	.3451
		JPSF	2.30

LUBE OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.698	457.3	456.4	500.2	551.5	1670.5	1853.6	.295
HOT SIDE 30.000	200.0	196.9	673.9	583.2	.0	.0	.522

HEAT REJECTED	ALTERNATOR	GEAR BOX	LUBE PUMP	TOTAL
	509.1	875.3	25.5	1409.8

HYDRAULIC OIL COOLER INFORMATION

FLOW	PRE IN	P OUT	T IN	T OUT	H IN	H OUT	EFF
COLD SIDE 7.698	456.2	455.1	551.5	719.5	1853.6	2441.9	.846
HOT SIDE 1450.0	100.0	91.5	750.0	744.6	.0	.0	.027

HEAT REJECTED 4524.08

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