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NAA-SR-MEMO 9726

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ATOMICS INTERNATIONAL A Division of North American Aviation, Inc.		NAA-SR-MEMO TDR NO. 9726		APPROVALS	
TECHNICAL DATA RECORD		PAGE 1 OF 44		<i>[Signature]</i>	
AUTHOR <i>J. E. Bickel</i> J. E. Bickel		DEPT. & GROUP NO. 726-61		DATE 3-26-64	
TITLE Startup and Shutdown Transients for the SNAP-2 R/C and PCS Components		GO NO. 7562		<i>[Signature]</i>	
PROGRAM Mercury Rankine		SUBACCOUNT TITLE Startup and Control Analysis		S/A NO. 1230 TWR	
DISTRIBUTION Complete copies to each person on attached list.		SECURITY CLASSIFICATION (CHECK ONE BOX ONLY) UNCL. ☐ AEC ☐ DOD ☐ CONF. ☒ SECRET ☐		(CHECK ONE BOX ONLY) RESTRICTED DATA ☐ DEFENSE INFO. ☒	
M. P. Berhold HQ2 J. B. Goodblatt HQ2 V. Heiskala HQ2 L. James HQ2		STATEMENT OF PROBLEM 1. Determine the effective emissivity and steady state heat losses of the SNAP-2 Primary system necessary to prevent mercury freezing at the time of mercury injection. 2. Determine the temperature transients of the SNAP-2 system after an orbital shutdown. 3. Determine the temperature transients of the CRU and injection tank if both are preheated before launch.		AUTHORIZED CLASSIFIER SIGNATURE _____ DATE _____	
		ABSTRACT: <p>The orbital heating code (Reference 1) was used to determine the temperature transients discussed herein.</p> <p>An effective primary system emissivity of 0.15 internal to the R/C was found to be sufficient to insure that the PCS components and the R/C are above the freezing point of mercury at injection. This value of emissivity results in a steady-state heat loss of 2.5 KW.</p> <p>If the SNAP-2 system is shutdown while in orbit (constant sun-constant shade orbit), the mean R/C temperature after 120 minutes was 35°F while the coldest R/C node decays to 0°F in 100 minutes.</p> <p>An additional study was the effect of preheating the CRU and injection tank to 700 and 500°F, respectively, prior to launch. The resulting temperature of the CRU shaft was 225°F and the injection tank 140°F at mercury injection.</p>			
		<div><div><div>Confidential</div><div>Classification</div><div>RD/DI</div><div>Group 3</div><div><i>[Signature]</i></div><div>Date: 4/1/64</div><div>Authorized Classifier Signature</div></div></div>		<div>Classification Cancelled Or Changed To By Authority Of <i>DOC</i> By <i>[Signature]</i> Date 5 Nov 71 Exempt from CCRP Re-review Requirements (per 7/22/82 Duff/Caudle memorandum) <i>NA 9/28/04</i></div>	
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NO. NAA-SR-MEMO 9726

DATE March 26, 1964

PAGE 2 OF 44

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

DISCUSSIONStartup

From the results presented in reference 1, it was revealed that there was a strong possibility of mercury freezing in the R/C at the time of injection. For the reference case presented (gold-coating on the R/C subcooler and on all of the primary system), the temperatures of some portions of the R/C were as low as -120°F at injection.

Various cases were investigated in the referenced TDR to determine the feasibility of different methods of increasing the PCS components and the R/C nodes above the freezing point of mercury at injection. At the time these studies were conducted, no correlation between the effective primary system emissivity and the steady state losses had been made. This relationship has since been obtained by utilizing the interchange factor code. (Reference 3) By assigning the predicted steady-state temperatures to the absorbing and radiating surfaces, this code determined the net heat transfer from these surfaces and also the temperature of the no-flux surfaces contained in the system. Various values of emissivity were input for the cold NaK leg, resulting in a relationship between the effective primary system emissivity and the steady state heat losses to the R/C. (See Figure 1) Where the effective emissivity is defined as

$$E_{\text{eff}} = \frac{E_1 A_1 + E_2 A_2 + \dots + E_n A_n}{A_1 + A_2 + \dots + A_n}$$

The numbers 1, 2, ..., n are for the various NaK nodes which represent the primary system.

The current R/C design is such that 3.17 KW of primary loop heat loss can be accommodated at steady-state. This is the current design point of the radiator as per specification NR 7550-42, "Specification for SNAP-2 Design Point". The largest steady-state heat loss investigated in reference 1 was that with no gold-coating on the cold NaK leg and resulted in a steady-state heat loss of 1.90 KW.

The orbital heating code was used to determine the effective emissivity of the primary system necessary to assure that none of the PCS components or R/C nodes were below 0°F at the time of mercury injection. This conservative value (mercury freezes at approximately -40°F) was chosen to compensate for inherent analytical uncertainties. From these studies it was found that this condition can be attained with a steady-state heat loss of 2.5 KW. From Figure 1, this heat loss represents an effective primary system emissivity of 0.15. It should be noted that this value of 2.5 KW is less than the maximum allowed by the design point specification. The PCS components and R/C temperature transients are presented for this case in figures 2 through 17. These figures should be compared to and should supercede those presented in NR 7550-43, "Specification for SNAP-2 Orbital Startup."

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ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. NAA-SR-MEMO 9726
DATE March 26, 1964
PAGE 3 OF 44

Orbital Shutdown

Recent investigations of the orbital re-start capabilities of the SNAP-2 system have warranted a closer analysis of the temperature transients after an orbital shutdown. The orbital heating code was used for this analysis by assigning the normal steady-state temperatures as the initial component temperatures and by programming in the shutdown NaK system temperature transients. These NaK transients were calculated with the primary loop digital program. The system was assumed to be in a constant sun-constant shade orbit during this initial study.

The temperature transients for the mean R/C temperature, coldest R/C node, and primary loop are shown in Figure 18 through 20. All of the PCS components were well above the freezing point of mercury during this two hours.

CRU and Injection Tank Heat Prior to Launch

An additional study which was conducted with the orbital heating code was an estimation of the temperature transients of the CRU and injection tank assuming they were launched at 700°F and 500°F, respectively, with no heat supplied after launch. The temperature transients from launch to startup for both components are shown by Figure 21 for a transient orbit. This graph indicates that ground preheating is only a partial alternative to orbital preheat of the CRU. However, this method would reduce the heating requirements for orbital preheat.

Orbital Heating Code

Presented below is the method of data preparation which supercedes that presented in TDR 9004. Replacement of this section was necessary because of refinements which were made in the orbital heating code.

Data Preparation

It is essential to the correct running of the program that the node data be entered in proper sequence. It is, therefore, suggested that the user write out his sequence according to the format below before attempting to prepare the data sheets. A sample node sequence follows the format.

<u>NODE</u>	<u>COMPONENT</u>
1-10	R/C Nodes
11-20	sub-cooler nodes
21	top
22	bottom

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ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. NAA-SR-MEMO 9726

DATE March 26, 1964

PAGE 4 OF 44

NODE

COMPONENT

:	internal components
:	:
XX	NaK nodes
:	:
XX	injection tank storage
	CRU housing
	CRU shaft
	bracket 1 - first component bracketed
	bracket 2 - first component bracketed
	bracket 3 - first component bracketed
	bracket 4 - first component bracketed
	bracket 1 - second component bracketed
	.
	.
	.

Nodes 1-22 are always in the same order. The number of radiating internal nodes may be added to rearrange, etc., but must always follow the bottom node (22). All internal components classified as NaK nodes must be together and be the last of the internal components listed. This order also applies when preparing data sheets for the interchange factor code by M. P. Berhold. Punched output from the program is used as input to this code. The number of nodes at this point is the total which require the interchange factor data.

Immediately below the NaK nodes are the injection storage tank, CRU housing, and CRU shaft followed by the bracket nodes (4) for each component attached to the wall.

~~CONFIDENTIAL~~

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ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. NAA-SR-MEMO 9726

DATE March 26, 1964

PAGE 5 OF 44

Sample Case*

1-10	R/C nodes
11-20	subcooler nodes
21	radiation/shield (Top)
22	bottom node (top of thermal barrier)
23	N ₂ tank
24	Hg injection storage tank
25	Hg regulator tank
26	injection line
27	Hg regulator line
28	CRU exposed bearing line (directly exposed to NaK loop nodes)
29	CRU unexposed line
30	upper vapor riser
31	lower vapor riser
32	Hg turbine feed line
33	CRU outer shell
34	boiler
35	NaK expansion compensator
36	hot NaK line
37	cold NaK line
38	Hg injection storage tank
39	CRU housing
40	CRU shaft
41	Hg regulator bracket

* Node sequence defined here applies to sample data sheets attached.

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ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. NAA-SR-MEMO 9726

DATE March 30, 1964

PAGE 6 OF 44

Sample Case (Continued)

42	Hg regulator bracket
43	Hg regulator bracket
44	Hg regulator bracket
45	CRU bracket
46	CRU bracket
47	CRU bracket
48	CRU bracket
49	Hg injection tank bracket
50	Hg injection tank bracket
51	Hg injection tank bracket
52	Hg injection tank bracket

Secondly, and prior to filling out the data sheets, if plotting is desired the user should decide which nodes (by number) are to be put on each graph. A maximum of 14 nodes may be plotted in any manner, i.e., all one graph, one per graph, two, three, etc. A sample plot set up is shown below and applies to the case used which is attached.

Plot 1	node	24 38
Plot 2	node	33 39 40
Plot 3	node	25 27
Plot 4	node	28 29 23 26 32
Plot 5	node	30 31

In preparing the data in the IP array, enter a zero for nodes not to be plotted and enter the plot number for those to be plotted. A single node may be placed on one graph only.

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ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. NAA-SR-MEMO 9726

DATE March 30, 1964

PAGE 7 OF 44

For each case the input data consists of two parts:

1. A title card containing up to 72 alpha-numeric characters describing the case.
2. The decimal case data. The program uses the FORTRAN DECRD routing. Each piece of data has an index assigned to it from an array (defined on following pages). The index of the first piece of data on a card is entered to the far right of the first field (using FORTRAN FIXED 10 DIGIT DECIMAL DATA sheets). Data are then entered in numerical order by index filling the card. The last card of data in each case must contain a minus in column one.

If the user wishes to run more than one case at a time, it is necessary to have the title card and at least one data card. The user needs only to enter the data that is changing from the previous case.

Sample data sheets are attached.

NUMERICAL DATA INDEX	EQUATION SYMBOL	PROGRAM SYMBOL	DESCRIPTION
1		IDØRT	=0, data entered, printed, and plotted as a function of time; =1, data as a function of revolution
2		ISØRCS	=0, sun-shade orbit; =1, constant sun-constant shade orbit
3		NPASS	if IDØRT=0, enter time in even number of revolutions at end of case
4		NIN	number of internal components which have radiation term requiring intercahnge factor code data plus top and bottom
5		NAKN	number of NaK components (≤ 10)
6		IPLØT	=0, no CRT plotting will be done (all data below applicable to plotting need not be entered); =1, CRT plotting is desired
7		NAVGT	node number assigned to component being used as reference node in computing R/C average temperature

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NO. NAA-SR-MEMO 9726

DATE March 30, 1964

PAGE 8 OF 44

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NUMERICAL DATA INDEX	EQUATION SYMBOL	PROGRAM SYMBOL	DESCRIPTION
8		INIT	=0, initial temperatures of components are all equal except top; =1, initial temperatures vary for some or all components; =2, program will pick up last values of previous case (this option allows the user to split the CRT plots of the nodes if desired, that is the only purpose of the option and it is suggested it not be used otherwise as it requires extra computer time). Note: must be =1 if shutdown case.
9		NPLØT	enter even number of hour or revolution (depending on IDØRT) to begin the continuous plots of node temperatures.
10		NCON2	=0, CRU outer shell and injection tank storage varies; =2, CRU varies, injection tank storage constant; =3, both vary.
11		INJ	node number assigned to injection tank
12		ICRU	node number assigned to CRU
13		ICØN	number of brackets or nodes attached to the R/C (≤ 10)
14		ISHUT	=0, startup case; =1, shutdown
15-20			
21		IBRAC (1,1)	node number assigned to first component bracketed to the R/C
22		IBRAC (2,1)	node number assigned to upper section of R/C to which component conducts heat.
23		IBRAC (3,1)	node number assigned to section of subcooler to which component conducts heat

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~~CONFIDENTIAL~~

NO. ~~NAA-BR-MEMO~~ 9726

DATE March 30, 1964

PAGE 9 OF 44

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NUMERICAL DATA INDEX	EQUATION SYMBOL	PROGRAM SYMBOL	DESCRIPTION
24		IBRAC (1,2)	same as IBRAC (1,1) for second bracket node
.		.	
.		.	
.		.	
50		IBRAC (3,10)	
51-90			
91		DTIME	time increment for calculations in minutes
92	⁽¹⁵⁾ (mc) _i	AMCRC (1)	product of mass and specific heat for R/C nodes
93	⁽¹⁶⁾ (mc) _{i+10}	AMCRC (2)	product of mass and specific heat for subcooler nodes
94	⁽¹⁵⁾ (KA) ₁	AK (1)	product of heat transfer coeffic- ient and cross-sectional area for: R/C nodes
95	⁽¹⁶⁾ (KA) ₃	AK (2)	sub cooler nodes
96	⁽¹⁵⁺¹⁶⁾ (KA) ₂	AK (3)	R/C and subcooler nodes vertically
97	⁽¹⁵⁺¹⁶⁾ α_s	ALPHAS (1)	absorbtivity to solar radiation
98	⁽¹⁵⁺¹⁶⁾ α_s	ALPHAS (2)	for subcooler nodes
99	⁽¹⁵⁺¹⁶⁾ α_T (E_T)	EPSI	absorbtivity to thermal radiation (emissivity of outside area)
100		ANGI	angle of launch in relation to sun if the sun-shade orbit is being considered (0° is directly into sun 0° + to 180° is moving away from the sun, and 180° + to 360° is approaching sun)

*the ΔX shown in equation is constant and therefore built into the code.

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NO. NAA-SR-MEMO 9726
DATE March 30, 1964
PAGE 10 OF 44

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NUMERICAL DATA INDEX	EQUATION SYMBOL	PROGRAM SYMBOL	DESCRIPTION
101		TØR	frequency of R/C and subcooler profile plots (enter in minutes or fractions of revolutions depending on IDØRT) note: plot will be done every TOR minutes or revolutions - value has been set on test case such that one set of profiles before temperature ramp is given and in second case following the ramp (second case is continuation of first, see data sheets)
102		TRAM1	time in minutes at which the NaK nodes temperatures are raised by constant specified in array below*
103		TRAM2	time at which temperature ramp of NaK nodes begins - enter in minutes*
104		TRAM3	time in minutes when temperature ramp of NaK nodes ends and temperatures become constant again*
105		TRAM4	startup time of temperature ramp for the top of the R/C given in minutes*
106		TRAM5	termination time for ramp of top in minutes*
107		TSLØPE	rate of increase of top during ramp period - enter in BTU/hour
108		CUT	time in minutes to stop plotting (- time at end of case)
109		TAU	time constant in shutdown case - enter in minutes
110			

* in figuring time use 107 minutes/revolution

~~CONFIDENTIAL~~

NO. NAA-SR-MEMO 9726

DATE March 30, 1964

PAGE 11 OF 44

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NUMERICAL DATA INDEX	EQUATION SYMBOL	PROGRAM SYMBOL	DESCRIPTION
111	⁽¹⁸⁾ (mc) _i	AMC (1)	product of mass and specific heat for bottom node (node 22)
112		AMC (2)	product of mass and specific heat for first internal node specified (node 23)
			Enter order of nodes user has specified, the mc of each internal node except NaK nodes. Then immediately following the mc of the last internal node, in the same array, enter data as follows:
	⁽²⁴⁾ (mc) _i	AMC (XX)	product of mass and specific heat for injection storage tank
	⁽²¹⁾ (mc) _i	AMC (XX+1)	product of mass and specific heat for CRU housing
	⁽²²⁾ (mc) _i	AMC (XX+2)	for CRU shaft
140		AMC (30)	(see sample data case)
141	⁽¹⁸⁾ A _i	AREA (1)	area of bottom in ft ² (node 22)
142	⁽¹⁸⁾ A _i	AREA (2)	area of first internal component specified (node 23)
			Enter same order as the mc's the area of each internal component. Then again in the same order for the remainder of the AREA array enter values equal to the product of the emissivity and area for that particular component.
	⁽²³⁺²⁴⁾ (EA) ₁₂	AREA (XX)	product of emissivity and area for injection tank storage
	⁽²⁰⁺²¹⁾ (EA) ₁₂		product of emissivity and area for CRU housing
	⁽²¹⁺²²⁾ (EA) ₂₃		product of emissivity and area for CRU shaft

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NO. NAA-SR-MEMO 9726

DATE March 30, 1964

PAGE 12 OF 44

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NUMERICAL DATA INDEX	EQUATION SYMBOL	PROGRAM SYMBOL	DESCRIPTION
170		AREA (30)	
171	⁽¹⁸⁾ Q	QCØN (1)	
172		QCØN (2)	heat being added to first internal component in BTU/hr. if necessary to prevent freezing
173		QCØN (3)	heat being added to last internal component exclusive of NaK nodes
200		QCØN (30)	
201-2700	^(15,11,18) F _{0j}	FSCRIP	these values are punched directly from interchange factor of code in proper format (see deck set up)
2701		TI (1)	if INIT=0, TI(1) equals initial temperature of all components except the top; if INIT=1, TI(1) equals initial temperature of first node; if INIT=2, the TI array need not be entered at all - values must be entered in shutdown case.
		TI (2)	if INIT=0, TI(2) equals initial temperature of the top; if INIT=1, TI (2) equals initial temperature of node 2 remainder of array needs to be entered only if INIT = 1
		TI (3)	initial temperature of node 3 must have initial temperature specified for all components, brackets, etc.
2790		TI (90)	

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~~CONFIDENTIAL~~

NO. NAA-SR-MEMO 9726

DATE March 30, 1964

PAGE 13 OF 44

ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NUMERICAL DATA INDEX	EQUATION SYMBOL	PROGRAM SYMBOL	DESCRIPTION
2791		CØNT (1)	instantaneous change in temperature of first NaK node at time TRAM1 - enter in degrees fahrenheit (rankine)
2792		CØNT (2)	instantaneous change in second
2800		CØNT (10)	
2801		SLØPE (1)	rate of heat change of first NaK node during ramp period in startup case enter in BTU/hr - temperature difference between initial NaK system temperature and sink temperature in shutdown case - enter in °F
2810		SLØPE (10)	
2811		IP (1)	= 0, do not plot node 1;=X, plot on graph X
		IP(2)	= 0, do not plot node 2;=X; plot on graph X
			note: a limit of 14 nodes plus the mean temperature will be plotted for each case thus there should be entered ≤ 14 values in IP array > one
2900		IP(90)	
2901	(mc) _i ⁽²⁶⁾	AMCB (1,1)	product of mass and specific heat for first node of bracket of first component which is attached to R/C (see figure 6)
2902	(mc) _i ⁽²⁷⁾	AMCB (2,1)	for second node of bracket of first component which is attached
2903	(mc) _i ⁽²⁸⁾	AMCB (3,1)	for third
2904	(mc) _i ⁽²⁹⁾	AMCB (4,1)	for fourth
2905		AMCB (1,2)	for first node of bracket of second component which is attached to R/C
.			
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ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. NAA-SR-MEMO 9726

DATE March 30, 1964

PAGE 14 OF 44

NUMERICAL DATA INDEX	EQUATION SYMBOL	PROGRAM SYMBOL	DESCRIPTION
2940		AMCB (4,10)	
2941		EAREA (1,)	product of emissivity and area for first node of bracket of first component which is attached to R/C
2942		EAREA (2,1)	for second
2943		EAREA (3,1)	for third
2944		EAREA (4,1)	for fourth
2945		EAREA (1,2)	for first node of second compon- ent attached to R/C
2980		EAREA (4,10)	
2981	⁽²⁵⁺²⁶⁾ (KA/ΔX) ₁₋₂	AKX (1,1)	thermal conductance in BTU/hr-°R for first component attached to R/C between the internal component and first 1/3 of equivalent bracket
2982	^(26,27,28) (KA/ΔX) ₂₋₃	AKX (2,1)	thermal conductance for first component between first 1/3 and second; also, equal to thermal conductance between second 1/3 and third.
2983	⁽²⁸⁺²⁹⁾ (KA/ΔX) ₄₋₅	AKX (3,1)	thermal conductance term of third 1/3 of equivalent bracket through total surface area of bracket attached to supporting wall
2984	⁽²⁹⁺³⁰⁾ (KA/ΔX) ₅₋₆	AKX (4,1)	thermal conductance through total surface area of bracket attached to supporting wall to the upper R/C node.
2985	⁽²⁹⁺³¹⁾ (KA/ΔX) ₅₋₇	AKX (5,1)	the lower R/C or subcooler node

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ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. NAA-SR-MEMO 9726
DATE March 30, 1964
PAGE 15 OF 44

NUMERICAL DATA INDEX	EQUATION SYMBOL	PROGRAM SYMBOL	DESCRIPTION
2986		AKX (1,2)	same as AKX (1,1) for second node bracketed to wall
3030		AKX (5,10)	

Desk Set Up

* The script *f* data has a minus in column one of the last card. The user does not need one for the first case and must allow for the script *f* data deck to follow has decimal data.

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ATOMICS INTERNATIONAL

A Division of North American Aviation, Inc.

NO. NAA-SR-MEMO 9726

DATE March 30, 1964

PAGE 16 OF 44

REFERENCES

1. J. Bickel- TDR 9004, "SNAP-2 R/C and PCS Component Temperatures prior to launch."
2. P. Gresho and M. P. Berhold (not published), "Interchange Factor Code."

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FORTRAN FIXED 10 DIGIT DECIMAL DATA

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 1 of _____ JOB NO. _____

NUMBER	IDENTIFICATION	DESCRIPTION DO NOT KEY PUNCH
1		<p>IDPRT = 0, data and plots are a function of time IDPRT = 1, " " " " " " " " resolution ISPRCS = 0, sun-shade orbit ISPRCS = 1, constant sun-constant shade orbit NPASS = if IDPRT=0, NPASS = number of hours if IDPRT=1, " " " " " " " " resolution NIN - number of internal components requiring script f=0 ≤ 30 (INCLUDING STOP & Debug)</p>
6		<p>NHKN - number of Nak nodes ≤ 10</p>
11		<p>IPLDT = 0, no CRT; = 1, CRT plotting will be done NAVGT - node number assigned to component used as reference node in computing average temperatures INIT = 0, initial temperatures are all equal except top = 1, initial temperatures vary = 20 NPLDT = if IDPRT=0, NPLDT = hour number to begin plotting " = 1, " = resolution " " " NCN2 = 0, CPU housing + inject or tank shaft constant = 1, " " is constant; = 2 inject shaft " ; = 3 both vary</p>
21		<p>INT - node number assigned to injection tank ICRU - " " " " CPU TCN - number of components attached to R/C by brackets (≤ 10) ISHOT = 0, start-up case; = 1, shutdown</p>
		<p>IBRAC(1,1) - node number of first component bracketed (2,1) - " " " R/C mode affected (3,1) - " " " sub-cooler " " (1,2) - " " " second component bracketed</p>

CONFIDENTIAL

NAA-SK-MEMO 9/26
March 30, 1964
Page 17 of 44
...

FORTRAN FIXED 10 DIGIT DECIMAL DATA

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 2 of _____ JOB NO. _____

NUMBER	IDENTIFICATION	DESCRIPTION DO NOT KEY PUNCH
26		:
		:
		:
		:
	73 80	etc to IBRAC(3, ICN)
91		DTIME - time increment desired in minutes AMCRC(1) - mc of R/C nodes AMCRC(2) - mc of sub-cooler nodes AK(1) - K _a of R/C nodes AK(2) - K _a of sub-cooler nodes
96		AK(3) - K _a of R/C to sub-cooler nodes vertically ALPHAS(1) - absorptivity to solar radiation - R/C nodes ALPHAS(2) " " " " sub-cooler nodes EPSI - absorptivity to thermal radiation (emissivity of outside areas) ANGI - if IDORT=0, angle of relation to sun (0.0 = directly into sun; 50 going away from sun to shade)
101		TOR - if IDORT=0, interval in minutes to take R/C profile on CET TRM11 - time in minutes to increase Nak temperatures by constant TRM12 - time in minutes to begin Nak nodes ramp TRM13 - " " " end " " TRM14 - " " " begin ramp for top

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NAH-SK-MEMO 9/20
March 30, 1964
Page 18, of 44

NAA-SR-MEMO 9726
March 20 1964

FORTRAN FIXED 10 DIGIT DECIMAL DATA

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 2 of _____ JOB NO. _____

NUMBER	IDENTIFICATION	DESCRIPTION DO NOT KEY PUNCH
106		TRAMS - time in minutes to end ramp for top TSLOPE - increase of toe in ltu./hr (slope) CUT - time in minutes to stop plotting TAU - time constant for shut down case in minutes
111		AMC(1) - me of node 22 " (2) - " " " 23
116		AMC(6)
XXX		AMC(n) - me of last internal node AMC(n+1) - me of interval mode of injection tank " " CPU timing " " " shaft

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NAA-SR-MEMO 9726
Mar 30, 1964
Page 19 of 44

FORTRAN FIXED 10 DIGIT DECIMAL DATA

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 4 of _____ JOB NO. _____

NUMBER

IDENTIFICATION

DESCRIPTION DO NOT KEY PUNCH

141

AREA (1) - area of node 22
" (2) - " " " 23

146

AREA (6)

151

AREA (N) - area of last internal node
" (N+1) - E * area of internal node of ing tank
" " " " CRU housing
" " " " CRU shaft

171

QCφN (1) - blank
" (2) heater on node 23 in btau / hr
" (3) " " " 24 " " "

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NAA-SR-MEMO 9726
March 30, 1964
Page: 20 of 44

FORTRAN FIXED 10 DIGIT DECIMAL DATA

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 5 of _____ JOB NO. _____

NUMBER	IDENTIFICATION	DESCRIPTION DO NOT KEY PUNCH
1.76		
		QCpN(6)
	73 80	
1.81		
		QCpN(4) - location of internal node
	73 80	
2701		<p>if INIT = 2 - <i>red time card</i></p> <p>(note - all values must be entered in shut down)</p> <p>TI(1) - if INIT = 0, TI(1) = temperature of 1st node by top</p> <p>TI(2) - if INIT = 0, TI(2) = temperature of top</p> <p>TI(3) - if INIT = 0, TI(3) = temperature of 1st node</p>
	73 80	
2706		
		TI(4)
	73 80	TI (total number of nodes)

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NAA-SR-MEMO 9726
 March 30, 1964
 Page 21 of 44

FORTRAN FIXED 10 DIGIT DECIMAL DATA

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 6 of _____ JOB NO. _____

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and give temperature
in minutes - of

NAA-SR-MEMO 9726
March 30, 1964
Page 22 of 44

NUMBER	IDENTIFICATION	DESCRIPTION DO NOT KEY PUNCH
1	2791	
13		CONT(1) - °F added to first Nak node at TRM. 1
25		(2) - " " "second" " " "
37		
49	73 80	
61		CONT (NAKN)
1	2801	
13		SLOPE(1) - slope of first Nak node during ramp period in start up ramp or temperature difference between initial Nak system temperature
25		(2) - " " "second" " " "
37		
49	73 80	
61		SLOPE (NAKN)
1	2811	if IPLPT=0, do not plot DATA (2811-2900)
13		IP(1) = 0 do not plot node 1
25		= X plot node 1 on graph X
37		(2) = 0 do not plot node 2
49	73 80	= X plot node 2 on graph X
61		IP (total number of nodes)
1	2901	
13		NMCB(1,1) - no. of first node in first burst
25		(2,1) " " "second" " " "
37		(3,1) " " "third" " " "
49	73 80	(4,1) " " "fourth" " " "
61		(1,2) " " "first" " " "second"

DECK NO. _____ PROGRAMMER _____ DATE _____ PAGE 7 of _____ JOB NO. _____

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NAA-DR-2000-2/60
March 30, 1966
Page 24 of 44

FIGURE 1

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NAA-SR-MEMO 9726

March 30, 1964

Page 25 of 44

AVERAGE R/C TEMPERATURE
TRANSIENT ORBIT

PRE-START UP MEAN TEMPERATURE VERSUS REVOLUTION

7526-aa L
ccc ccc

[1.8 HOUR/REVOLUTION]

FIGURE 2

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NAA-SR-MEMO 9726
March 30, 1964
Page 26 of 44

R/C TEMPERATURE DISTRIBUTION
TRANSIENT ORBIT
TEMPERATURE DISTRIBUTION OF R/C NODES

7526-aa L
cc1 cc2

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March 30, 1964

Page 27 of 44

TRANSIENT ORBIT
TEMPERATURE DISTRIBUTION OF SUB-COOLER NODES

7526-00 L
002 000

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FIGURE 4

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March 30, 1964
Page 28 of 44

MERCURY INJECTION TANK-TRANSIENT
ORBIT

PLOT 1

7526-00 1-
004 000

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FIGURE 5

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NAA-SR-MEMO 9726

March 30, 1964

Page 29 of 44

CRU - TRANSIENT ORBIT

PLOT 2

7526-aa L
007 000

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FIGURE 6

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NAA-SR-MEMO 9726

March 30, 1964

Page 30 of 44

Hg REGULATOR & REGULATOR LINE
TRANSIENT ORBIT

PLOT 3

7526-aa L
005 000

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FIGURE 7

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March 30, 1964

Page 31 of 44

PCS COMPONENTS - TRANSIENT ORBIT

PLOT 4

7526-AA L
OC3 OC4

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FIGURE 8

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NAA-SR-MEMO 9726

March 30, 1964

Page 32 of 44

MERCURY VAPOR RISER-TRANSIENT ORBIT

PLOT 5

7526-AA L
006 000

CONFIDENTIAL 05 OF 100 FIGURE 9

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NAA-SR-MEMO 9726

March 30, 1964

Page 33 of 44

AVERAGE R/C TEMPERATURE
CONSTANT SUN-CONSTANT SHADE ORBIT

PRE-START UP MEAN TEMPERATURE VERSUS REVOLUTION

7526 RS
CSC 1000

FIGURE 10

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March 30, 1964

Page 34 of 44

CONSTANT SUN- CONSTANT SHADE ORBIT
TEMPERATURE DISTRIBUTION OF R/C NODES

7526 no 1-
rev 1000

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NAA-SR-MEMO 9726
March 30, 1964
Page 35 of 44

CONSTANT SUN-CONSTANT SHADE ORBIT
TEMPERATURE DISTRIBUTION OF SUB-COOLER NODES

~~CONFIDENTIAL~~ FIGURE 12

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NAA-SR-MEMO 9726

March 30, 1964

Page 36 of 44

MERCURY INJECTION TANK - CONSTANT SUN - CONSTANT SHADE
PLOT 1

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FIGURE 13

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NAA-SR-MEMO 9726
March 30, 1964
Page 37 of 44

CRU; CONSTANT SUN-CONSTANT SHADE ORBIT

PLOT 2

PAGE NO.
37

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FIGURE 14

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March 30, 1964

Page 38 of 44

Hg REGULATOR & REGULATOR LINE CONSTANT SUN-CONSTANT SHADE
PLOT 3

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FIGURE 15

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NAA-SR-MEMO 9726

March 30, 1964

Page 39 of 44

PCS COMPONENTS CONSTANT SUN-CONSTANT SHADE ORBIT
PLOT 4

FIGURE 16

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NAA-SR-MEMO 9726

March 30, 1964

Page 40 of 44

MERCURY VAPOR RISER CONSTANT SUN-CONSTANT SHADE
PLOT 5

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FIGURE 17

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WPA-NA-REF ID: A7120

March 30, 1964

Page 41 of 44

MEAN R-C TEMPERATURE
VERSUS
TIME FROM SHUTDOWN
(CONSTANT SUN-CONSTANT SHADE ORBIT)

TEMPERATURE OF

500
450
400
350
300
250
200
150
100
50
25

TIME MIN

FIGURE 18

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NAVJAG MEMO 7120

March 30, 1964

Page 42 of 44

GOLDEST R-C NODE TEMPERATURE
VERSUS
TIME FROM SHUT DOWN
CONSTANT SUN - CONSTANT SHADE ORBIT

TEMPERATURE, °F

380
300
200
100
0
-20

TIME, MIN

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March 30, 1964
Page 43 of 44

AVERAGE NAK TEMPERATURE
VERSUS
TIME FROM SHUTDOWN
(CONSTANT SUN - CONSTANT SWAGE ORBIT)

TEMPERATURE, °F

1200

1000

800

600

400

200

0

↑
SHUTDOWN

30

60

TIME, MIN

120

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20

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March 30, 1964
Page 44 of 44

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CRU AND INJECTION TANK HEATED
PRIOR TO LAUNCH VERSUS REVOLUTIONS