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USERS MANUAL

SPACE SHUTTLE ATMOSPHERIC REVITALIZATION SUBSYSTEM/ACTIVE THERMAL CONTROL SUBSYSTEM COMPUTER PROGRAM

National Aeronautics and Space Administration
Johnson Space Center
Houston, Texas.

CONTRACT NO. NAS 9—12411

Hamilton DIVISION OF UNITED AIRCRAFT CORPORATION **U**
Standard **A**®

1.0 INTRODUCTION

Under continuing NASA sponsorship (NAS9-12411), Hamilton Standard has developed a Shuttle ARS (atmosphere revitalization subsystem)/ ATCS (active thermal control subsystem) performance routine. This computer program is adapted from the Shuttle EC/LSS Design Computer Program developed under the basic contract. The new program has been upgraded in three noteworthy areas:

A. The functional ARS/ATCS schematic has been revised to accurately synthesize the Shuttle prime contractor's August 30, 1973 baseline system definition.

B. The program logic has been improved to provide a more accurate prediction of the integrated ARS/ATCS system performance. Additionally, the logic has been expanded to model all components and thermal loads in the ARS/ATCS system.

C. The program is designed to be used on the NASA JSC crew systems division's "programmable calculator" system. As written, the new computer routine has an average running time of five minutes.

The use of "desk top" type calculation equipment, and the rapid response of the program provides the NASA with an analytical tool for trade studies to refine the system definition, and for test support of the RSECS or integrated Shuttle ARS/ATCS test programs. The program can be used for:

A. Pre-test predictions,
B. Real-time test support, and
C. Post-test analysis.

To support the RSECS test program, the user needs only to update the input data and make minor program revisions to accurately synthesize the RSECS hardware and test configuration.

The objective of this document is to define this computer program and provide the user with sufficient information for running and modifying the program as may be desired.

An outline of this document is presented in Table 1.1.

TABLE 1.1   USER'S MANUAL OUTLINE

2.0   PROGRAM CHANGES

The ARS/ATCS performance routine is adapted from the Shuttle EC/LSS Design Computer Program developed under the auspices of the basic contract. The performance routine, however, is designed to be used in conjunction with the crew systems division's Wang 700-series "programmable calculator" system. By utilizing this "desk top" type equipment, the user is provided with an average running time of five minutes per case, in place of a minimum four hour turn-around associated with the NASA-JSC computer facilities.

This new computer routine performs a steady-state, thermodynamic anslysis of the combined ARS/ATCS system. Figures 2.1 through 2.4 are simplified schematics of the liquid and gas coolant loops incorporated in the program. These schematics are representative of Rockwell International's baseline configuration as defined on August 30, 1973. In addition to the changes required to model the baseline system, selected improvements were made in the calculation procedures. These changes provide a more accurate prediction of the actual ARS/ATCS performance. The modifications made to the basic program are summarized below:

2.1   ATCS Freon Coolant Loop, Figure 2.1

A. A flow rate convergence loop was added to the program. This loop calculates the mass flow rate of the coolant loop based on the Freon density at the pump inlet and the pump volumetric flow rate.

B. Temperature changes around the coolant loop are based on the Freon enthalpy change. This replaces the previous method of assuming a constant specific heat of Freon.

C. The oxygen restrictor/heater was added to the coolant loop. This model analyzes the Freon side only.

D. A payload heat exchanger model was incorporated downstream from the Freon to water interchanger. The analysis predicts Freon and payload coolant temperatures at the heat exchanger.

E. The fuel cell heat exchanger analysis was modified to reflect the baseline heat exchanger design. This configuration has one Freon circuit interfacing with all three fuel cell circuits.

F. A hydraulics heat exchanger model was added to the coolant loop. This heat exchanger transfers heat from the Freon circuit to the hydraulic circuits.

G. A heat node was added to simulate the coolant loop environment heat load. This node was placed upstream of the radiator.

ATCS FREON COOLANT LOOP

FIGURE 2.1
2-2

PUMP

FUEL CELL HEAT EXCHANGER

HYDRAULICS HEAT EXCHANGER

PAYLOAD HEAT EXCHANGER

ENVIRONMENT HEAT LOAD

F21 / H2O INTERCHANGER

RADIATOR

O2 RESTRICTOR / HEATER

GSE HEAT EXCHANGER
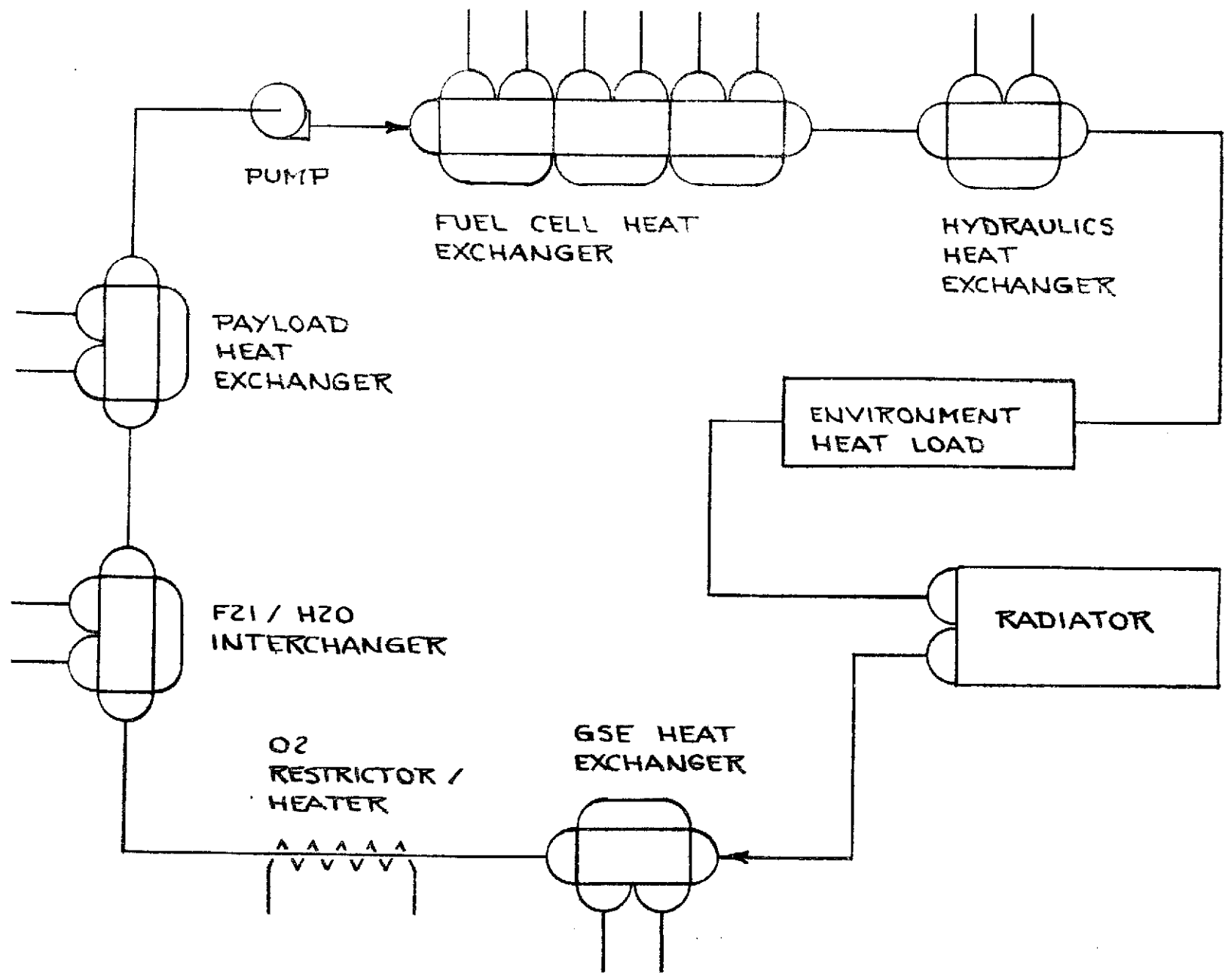
2.1   (Continued)

H. The radiator analysis was changed to predict the outlet temperature by interpolating a performance map. The performance map is input data and can reflect any radiator configuration or space environment.

I. The GSE heat exchanger model was altered. The GSE coolant inlet temperature and flow rate are now input data.

J. The sublimator, coldplates and avionics bay were deleted from the Freon coolant loop.

2.2   ARS Water Coolant Loop, Figure 2.2

A. A sublimator model was added to the coolant loop, downstream from the Freon to water interchanger.

B. The potable water chiller model was upgraded to predict both the ARS water coolant and the potable water temperatures at the heat exchanger.

C. A heat node was added to represent the coldwall. This heat node was placed downstream from the cabin IMU coldplates.

D. The avionics bay analysis was changed to model three parallel avionics bays. The water coolant flow is equally proportioned to the three bays.

E. A heat node was added downstream from the avionics bays to model the cabin windows cooling circuit.

2.3   ARS Cabin Gas Loop, Figure 2.3

A. A gas flow rate convergence loop has been incorporated in the program. The convergence loop calculates the air mass flow rate based on the fan inlet temperature and the fan volumetric flow rate.

B. A heat node was added upstream from the cabin fan to model the cabin avionics heat load.

C. The lithium hydroxide model was relocated to a series arrangement with the cabin heat exchanger, rather than the original, parallel location.

2.4   ARS Avionics Bay Package, Figure 2.4

A. A heat node was added to the ARS water coolant loop upstream from the water to air heat exchanger. This heat node models the avionics bay coldplates.

ARS WATER COOLANT LOOP

FIGURE 2.2
2-4

ARS CABIN GAS LOOP

FIGURE 2.3
2-5

CABIN
FAN

CABIN
AVIONICS

LITHIUM
HYDROXIDE
ASSEMBLY
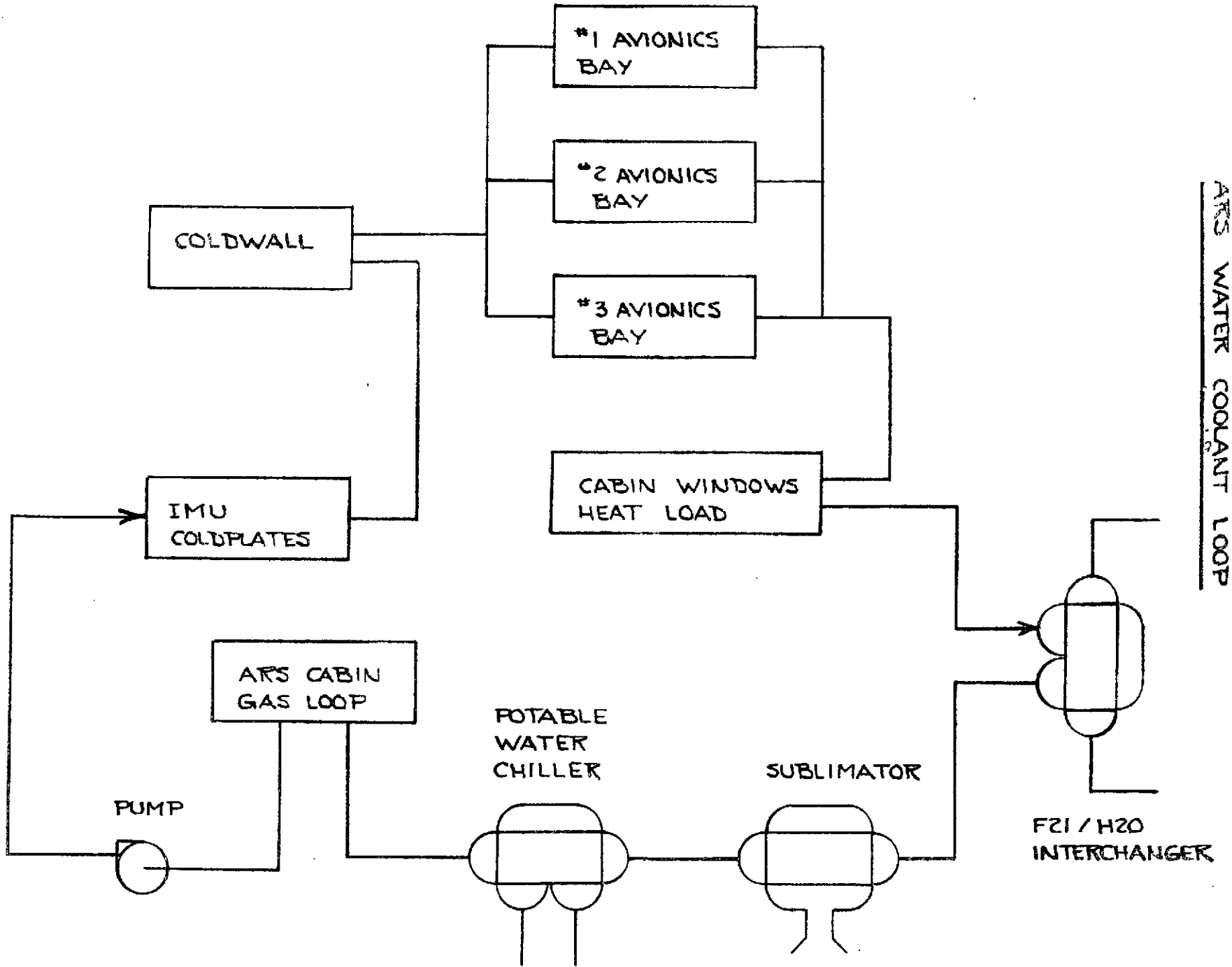
CABIN
HEAT
EXCHANGER
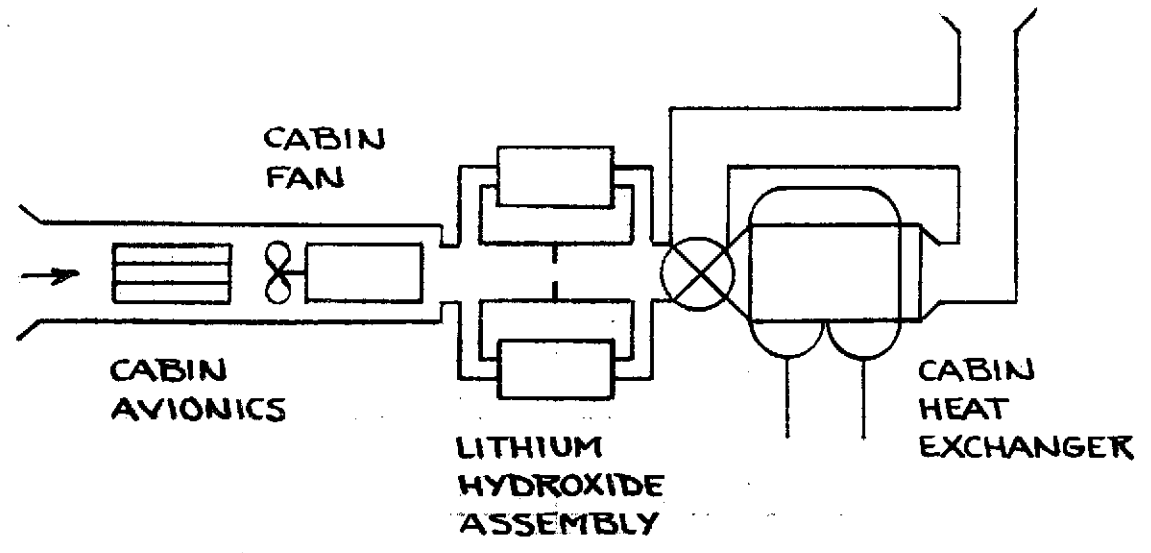
2.4   (Continued)

B. A convergence loop was incorporated to calculate the avionics
    bay air mass flow rate. The flow calculation is based on the
    fan inlet temperature and the fan volumetric flow rate.

COLDPLATE
NETWORK

HEAT
EXCHANGER

FAN
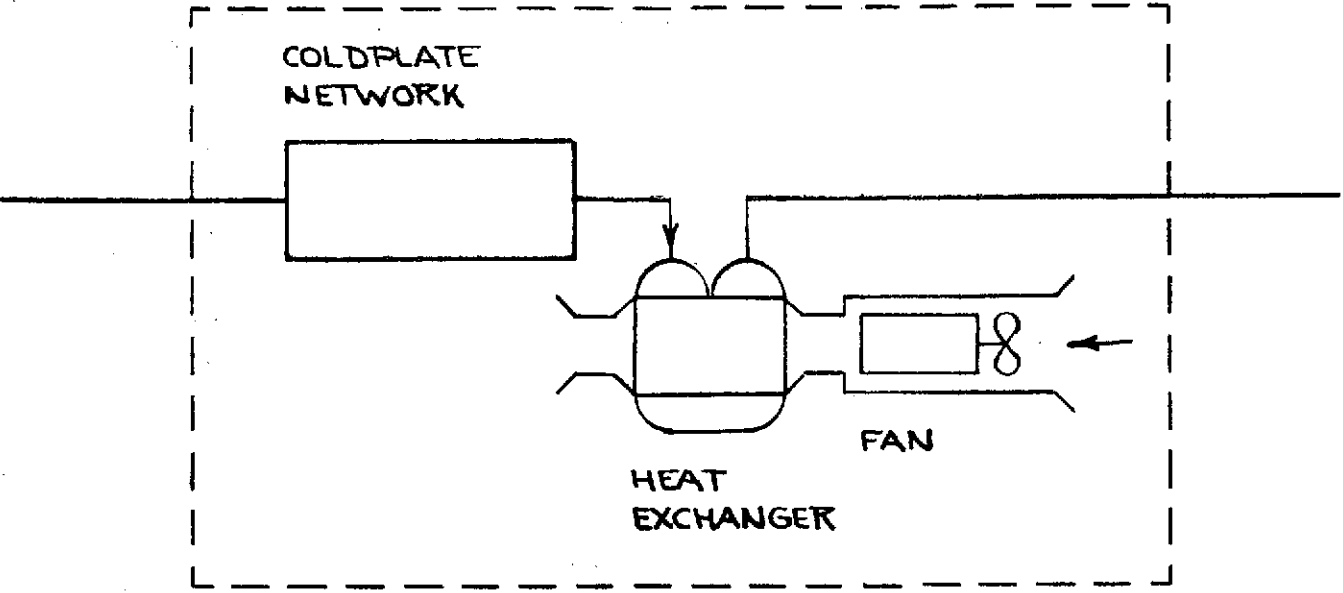
TYPICAL : 1 OF 3 AVIONICS BAYS

FIGURE 2.4

3.0   PROGRAM DESCRIPTION

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3.0   PROGRAM DESCRIPTION

The ARS/ATCS performance routine consists of: a system initiation
program, the main program tape cassette, and a data tape cassette.
The system initiation program rewinds and addresses the program
and data tapes at the start of a run. It also does the ARS/ATCS
component and/or heat node bookkeeping, calling-up the program
analysis groups in the desired sequence.

3.1   Main Program Tape

The main program tape is divided into 55 tape blocks; each block
consists of 256 program steps. The program logic required for the
performance analysis is functionally isolated on separate program
groups. Each group consists of an integer number of tape blocks.
The only interface between the program groups, therefore, is the
common outlet/inlet temperature of adjacent components. This
method of programming simplifies the effort required to revise the
ARS/ATCS thermal schematic in the program. The desired analysis
sequence is programmed so that the tape blocks are called-up
in ascending order. Table 3.1 is a listing of the 55 tape blocks
and a summary of their functions.

3.2   Data Tape

The ARS/ATCS performance routine data tape is designed to be both
a library and working tape. Storage blocks designated as "read"
are used for the continuous storage of basic ARS/ATCS system data
(radiator map, flow rates, heat exchanger UA's, etc.). Those
storage blocks designated "write" provide data storage for input
information that is unique to the particular case being run (heat
loads, heat sink selection, changes to flow rates or heat exchangers,
etc.).

Table 3.2 provides the user with an itemized list of all the data
tape storage blocks being used and their storage function. The
library data stored on the tape is representative of Rockwell
International's August 30, 1973 system definition.

TABLE 3.1   PROGRAM TAPE LISTING

Program Group Number	Tape Block Numbers Used	Program Function or Component Analyzed
1	0 - 4	Load/write input data
2	5	Sublimator
3	6, 7 - 9	GSE heat exchanger, ATCS Freon coolant loop mass flow rate calculation
4	6, 10 - 13	Radiator, ATCS coolant loop mass flow rate calculation
5	14 - 15	O_2 restrictor/heater, using the GSE heat exchanger or radiator heat sink
6	16 - 18	F21/H_2O interchanger, using the GSE heat exchanger or radiator heat sink
7	19 - 20	Potable H_2O chiller
8	21 - 27	ARS cabin gas loop
9	28 - 30	Print-out of the ARS cabin gas loop analysis
10	31	H_2O coolant loop pump
11	32	Cabin IMU coldplates
12	33	Coldwall
13	34 - 36	Avionics bay and cabin window cooling
14	37 - 40	F21/H_2O interchanger and ATCS Freon coolant loop mass flow rate calculation, using the sublimator heat sink
15	41 - 43	Payload heat exchanger

TABLE 3.1   (Continued)

Program Group Number	Tape Block Numbers Used	Program Function or Component Analyzed
16	44 - 45	F21 coolant loop pump
17	46 - 48	Fuel cell heat exchanger
18	49 - 51	Hydraulics heat exchanger
19	52 - 53	F21 coolant loop environment load
20	54 - 55	O_2 restrictor/heater, using the sublimator heat sink

TABLE 3.2   DATA TAPE LISTING

Program Symbol	Data Tape Block Number		Library Data Value	Refer to Note #
	Read	Write		
$C_1/2200$	1		$+.755145586603 \ (10^{-7})$	1, 2
$C_2/2200$	2		$-.358538490797 \ (10^{-4})$	1, 2
$C_3/2200$	3		$+.148430804566$	1, 2
$C_4/2200$	4		$+15.6603741282$	1, 2
$C_1/2400$	5		$+.158727535888 \ (10^{-6})$	1, 2
$C_2/2400$	6		$-.708924848657 \ (10^{-4})$	1, 2
$C_3/2400$	7		$+.174006815809$	1, 2
$C_4/2400$	8		$+17.0864342023$	1, 2
$C_1/2600$	9		$-.118499436421 \ (10^{-5})$	1, 2
$C_2/2600$	10		$+.477994683704 \ (10^{-3})$	1, 2
$C_3/2600$	11		$+.126070497831$	1, 2
$C_4/2600$	12		$+20.8707397789$	1, 2
$C_1/2800$	13		$-.19766620901 \ (10^{-5})$	1, 2
$C_2/2800$	14		$+.80626947099 \ (10^{-3})$	1, 2
$C_3/2800$	15		$+.103858233508$	1, 2
$C_4/2800$	16		$+23.5068463168$	1, 2
$C_1/3000$	17		$-.775095331913 \ (10^{-6})$	1, 2
$C_2/3000$	18		$+.321439903723 \ (10^{-3})$	1, 2
$C_3/3000$	19		$+.181889268439$	1, 2
$C_4/3000$	20		$+22.265232225$	1, 2
$C_1/3200$	21		0	1, 2
$C_2/3200$	22		0	1, 2
$C_3/3200$	23		$+.24$	1, 2
$C_4/3200$	24		$+21.5$	1, 2
$C_1/3400$	25		$-.208021726773 \ (10^{-6})$	1, 2
$C_2/3400$	26		$+.544525682339 \ (10^{-4})$	1, 2
$C_3/3400$	27		$+.25438554269$	1, 2
$C_4/3400$	28		$+21.9449515104$	1, 2
$C_1/3600$	29		$-.387691599036 \ (10^{-6})$	1, 2
$C_2/3600$	30		$+.69001872501 \ (10^{-4})$	1, 2
$C_3/3600$	31		$+.27706481558$	1, 2
$C_4/3600$	32		$+21.7352466989$	1, 2
$C_1/3800$	33		$-.139884144047 \ (10^{-5})$	1, 2
$C_2/3800$	34		$+.389367546703 \ (10^{-3})$	1, 2
$C_3/3800$	35		$+.265396744869$	1, 2
$C_4/3800$	36		$+22.4619961154$	1, 2
T CAB	37	38	$65°\,F$	3
T RAD	39	40	$40°\,F$	2
T GSE	41	42	$35°\,F$	2
T GSEHX	43	44	$20°\,F$	2
Q MET-S	45	46	3299 BTU/HR	4
Q MET-L	47	48	1518 BTU/HR	4
W CO_2	49	50	22.98 LBS/DAY	4
Q CAB-S	51	52	0	5

TABLE 3.2   (Continued)

Program Symbol	Data Tape Block Number Read	Write	Library Data Value	Refer to Note #
Q CAB-L	53	54	0	5
Q ELEC	55	56	0	5
Q FAN	57	58	1196 BTU/HR	2
Q H2O P	59	60	315 BTU/HR	2
Q CP-IMU	61	62	0	5
Q CWALL	63	64	0	5
Q CP-1	65	66	0	5
Q CP-2	67	68	0	5
Q CP-3	69	70	0	5
Q AB-1	71	72	0	5
Q AB-2	73	74	0	5
Q AB-3	75	76	0	5
Q ABFAN	77	78	150 BTU/HR	2
Q CHILL	79	80	0	5
Q PLDHX	81	82	0	5
Q F21P	83	84	1376 BTU/HR	2
Q FCELL	85	86	0	5
Q HYDHX	87	88	0	5
Q O2HTR	89	90	0	5
W H2O	91	92	700 LBS/HR	2
V F21P	93	94	32.7 FT^3/HR	2
V FAN	95	96	317 FT^3/MIN	2
V LIOH	97	98	66 FT^3/MIN	2
V ABFAN	99	100	125 FT^3/MIN	2
W CHILL	101	102	0	-
WCP PLD	103	104	700 BTU/HR-°F	2
WCP FCL	105	106	1990 BTU/HR-°F	2
WCP HYD	107	108	375 BTU/HR-°F	2
WCP GSE	109	110	2430 BTU/HR-°F	2
UA CABHX	111	112	975 BTU/HR-°F	2
UA ABHX	113	114	415 BTU/HR-°F	2
UA SUBLM	115	116	1674 BTU/HR-°F	2
UA CHILL	117	118	0	-
UA INTHX	119	120	5862 BTU/HR-°F	2
UA PLDHX	121	122	1850 BTU/HR-°F	2
UA FCLHX	123	124	1645 BTU/HR-°F	2
UA HYDHX	125	126	200 BTU/HR-°F	2
UA GSEHX	127	128	2107 BTU/HR-°F	2
TOL UA	129	130	.01	-
# FCELL	131	132	2	6
KY SINK	133	134	1	6
Q WINDOW	135	136	0	5
Q ENVIRN	137	138	0	5
Q H2O L		139	-	7
Q F21 L		140	-	7
Q TOT		141	-	7

TABLE 3.2 (Continued)

<u>NOTES</u>:

1. Radiator performance map data

2. Representative of Rockwell International's August 30, 1973 system definition

3. Minimum allowable cabin temperature under normal operating conditions

4. Value based on a 10 man crew; 4 men at maximum metabolic rate, 6 men at nom. metabolic rate, 65°F cabin

5. Subject to change with each mission phase

6. Most common mode of operation

7. Internally recalculated for each case

4.0 OPERATING PROCEDURES

4.0   OPERATING PROCEDURES

4.1   Program Operation

A. Turn-on the necessary Wang 700-Series calculation equipment:

    1. 720-C Programmable calculator
    2. 702 Output writer
    3. 708-1/-2 Extended memory controller/module
    4. 709 Dual tape cassette

B. Preliminary set-up of the 720-C programmable calculator:

    1. Set calculator in the run mode.
    2. Install system initiation program tape.
    3. Rewind tape, depress tape ready switch.

C. Preliminary set-up of the 702 output writer:

    1. Set left margin at 21.
    2. Switch output writer to auto.

D. Preliminary set-up of the 708-1/-2 extended memory and the 709 dual tape cassette:

    1. Install the program and data tapes into the dual tape cassette.
    2. Set slide-switch settings.

                                    8   4   2   1

    - Program Tape   ↓   ↓   ↓   ↑

    - Data Tape   ↓   ↓   ↑   ↓

    - Extended Memory   ↓   ↓   ↑   ↑

E. Load system initiation program:

    1. Key: Prime
              Load Prog

    2. Key: Verify Prog
              X-register will read 312.

F. Start system operation:

    1. Key: Prime
              Search
              00
              Program and data tapes will be rewound.

4.0   (Continued)

G. Key: <u>Go</u>

Load/write input program group will be transferred to the
calculator. Radiator data will be transferred to the extended
memory. Title will be printed.

H. Write headings:

1. Switch output writer to <u>MANL</u>.
2. Manually type any distinguishing notation for the case
    being run.
3. Switch output writer to <u>AUTO</u>.
4. Key: <u>GO</u>
5. Switch output writer to <u>MANL</u>.
6. Manually type crew size.
7. Switch output writer to <u>AUTO</u>.
8. Key: <u>GO</u>

I. Load input data:

X-register will display the library data stored on the tape for
the requested input. Table 4.1 provides the user with a listing
of the input data symbols and their functional definition.

- If the data value displayed in the X-register is acceptable
  for the case being run,
  Key: <u>GO</u>

- If this value is not acceptable for the case being run,
  Key: <u>NEW VALUE</u>
       <u>GO</u>

J. Repeat Step I until all data is loaded and the case runs.

K. Second case to be run:

1. Switch output writer to <u>MANL</u>.
2. Manually index a new sheet of paper.
3. Switch output writer to <u>AUTO</u>.
4. Revert to Step G above.

For user reference, three sample cases are enclosed. These
cases use the GSE heat exchanger, sublimator, and radiator heat
sinks, respectively. The program output is fully documented
in Table 4.2, <u>Output Definition</u>.

TABLE 4.1   INPUT DATA DEFINITION

Program Symbol	Units	Description
T CAB	°F	Cabin heat exchanger control setting; desired cabin temperature
T RAD	°F	Radiator outlet temperature control setting
T GSE	°F	GSE heat exchanger outlet temperature control setting
T GSEHX	°F	Temperature of the GSE coolant entering the heat exchanger
Q MET-S	BTU/HR	Cabin metabolic sensible heat load, corresponds to T CAB
Q MET-L	BTU/HR	Cabin metabolic latent heat load, corresponds to T CAB
Q W CO_2	LBS/DAY	Metabolic carbon dioxide generation rate
Q CAB-S	BTU/HR	Total sensible heat load in the cabin that remains constant as T CAB varies
Q CAB-L	BTU/HR	Total latent heat load in the cabin that remains constant as T CAB varies
Q ELEC	BTU/HR	Heat load of the cabin avionics; upstream of the cabin heat exchanger
Q FAN	BTU/HR	Power requirement of the cabin fan
Q H_2OP	BTU/HR	Power requirement of the ARS water coolant loop pump
Q CP-IMU	BTU/HR	Heat load from the cabin IMU coldplates
Q CWALL	BTU/HR	Coldwall heat load
Q CP-1 -2 -3	BTU/HR	Heat load from the coldplate network in avionics bays 1, 2 or 3
Q CAB-1 -2 -3	BTU/HR	Air-cooled avionics heat load in avionics bays 1, 2 or 3
Q ABFAN	BTU/HR	Power requirement of one avionics bay fan
Q CHILL	BTU/HR	Potable water chiller heat load
Q PLDHX	BTU/HR	Payload heat exchanger heat load
Q F21P	BTU/HR	Power requirement of the Freon coolant loop pump
Q FCELL	BTU/HR	Fuel cell heat exchanger heat load
Q HYDHX	BTU/HR	Heat load at the hydraulics heat exchanger; heat is transferred from the Freon circuit to the hydraulics circuit
Q O2HTR	BTU/HR	Heat load transferred to the O_2 lines by the Freon circuit
W $H_2$0	LBS/HR	ARS water coolant loop flow rate

TABLE 4.1 (Continued)

Program Symbol	Units	Description
V F21P	FT^3/HR	ATCS Freon coolant loop flow rate
V FAN	CFM	ARS cabin fan flow rate
V L1OH	CFM	ARS cabin fan air flow routed to the lithium hydroxide canisters
V ABFAN	CFM	Flow rate of one avionics bay fan
W CHILL	LBS/HR	Potable water flow rate to the chiller
WCP PLD	BTU/HR-°F	Payload coolant flow rate
WCP FCL	BTU/HR-°F	Flow rate of one fuel cell coolant loop
WCP HYD	BTU/HR-°F	Hydraulics fluid flow rate to the heat exchanger
WCP GSE	BTU/HR-°F	Ground support coolant flow rate to the heat exchanger
UA CABHX	BTU/HR-°F	Overall heat transfer coefficient of the cabin heat exchanger
UA ABHX	BTU/HR-°F	Overall heat transfer coefficient of one avionics bay heat exchanger
UA SUBLM	BTU/HR-°F	Overall heat transfer coefficient of the sublimator
UA CHILL	BTU/HR-°F	Overall heat transfer coefficient of the potable water chiller
UA INTHX	BTU/HR-°F	Overall heat transfer coefficient of the ATCS Freon to water interchanger
UA PLDHX	BTU/HR-°F	Overall heat transfer coefficient of the payload heat exchanger
UA FCLHX	BTU/HR-°F	Overall heat transfer coefficient of the fuel cell heat exchanger
UA HYDHX	BTU/HR-°F	Overall heat transfer coefficient of the hydraulics heat exchanger
UA GSEHX	BTU/HR-°F	Overall heat transfer coefficient of the ground support heat exchanger
TOL UA	-	Convergence tolerance for the ARS cabin gas loop analysis
# FCELL	-	Number of fuel cells operating: 1, 2 or 3
KY SINK	-	Heat sink selection: 1 - radiator 2 - GSE heat exchanger 3 - sublimator
Q WINDOW	BTU/HR	Heat transferred to the ARS coolant loop at the cabin windows
Q ENVIRN	BTU/HR	ATCS Freon coolant loop environment heat load

SAMPLE CASE # 1

SHUTTLE ARS / ATCS PERFORMANCE

MISSION PHASE: COUNTDOWN-LAUNCH
CREW SIZE   : 10

```
INPUT:
T CAB     =    65.00    T RAD    =    40.00    T GSE    =    35.00    T GSEHX  =    20.00
Q MET-S   =  3299.00    Q MET-L  =  1518.00    Q CO2    =    22.98    Q CAB-S  =  3430.00
Q CAB-L   =      .00    Q ELEC   =  4566.00    Q FAN    =  1196.00    Q H2OP   =   315.00
Q CP-IMU  =      .00    Q CWALL  =      .00    Q CP-1   =  3695.00    Q CP-2   =  3694.00
Q CP-3    =  3694.00    Q AB-1   =  3627.00    Q AB-2   =  3627.00    Q AB-3   =  3626.00
Q ABFAN   =   150.00    Q CHILL  =      .00    Q PLDHX  =  5200.00    Q F21P   =  1376.00
Q FCELL   = 49000.00    Q HYDHX  =      .00    Q O2HTR  =      .00    W H2O    =   700.00
W F21P    =    32.70    W FAN    =   317.00    W LIOH   =    66.00    V ABFAN  =   125.00
W CHILL   =      .00    WCp PLD  =   700.00    WCp FCL  =  1990.00    WCp HYD  =   375.00
WCp GSE   =  2430.00    UA CABHX =   975.00    UA ABHX  =   415.00    UA SUBLM = 1674.00
UA CHILL  =      .00    UA IMUHX =  5862.00    UA PLDHX =  1850.00    UA FCLHX = 1645.00
UA HYDHX  =   200.00    UA GSEHX =  2107.00    TOL-UA   =    .0100    # FCELL  =     2.00
KY SINK   =     2.00    Q WINDOW =      .00    TOL ENVIRN =    .00
```

```
GSE HEAT EXCHANGER
Q TOT   = 21669.45    T F21in  =   166.28    T F21out =    35.00    WCp F21  =   713.47
W F21   = -2725.37     T GSEout =    58.54
```

```
O2 RESTRICTOR / HEATER
T F21in  =    35.00    T F21out =    35.00    WCp F21  =      .00
```

```
F21 / H2O INTERCHANGER
Q H2OL   = 18093.45    T F21in  =    35.00    T F21out =    90.81    WCp F21  =   632.44
T H2Oin  =    26.64    T H2Oout =    42.22
```

```
POTABLE H2O CHILLER
T H2Oin  =    42.22    T H2Oout =    42.22    T POTin  =      .00    T POTout =      .00
```

```
ARS CABIN GAS LOOP
T CAB    =    71.20    T DEWPT  =    57.00    pp CO2   =     3.20    T AIRin  =    91.20
T AIRout =    52.14    T H2Oin  =    42.22    T H2Oout =    64.17    Q MET-S  =  2353.53
Q MET-L  =  1943.46    Q LIOH-S =   804.30    Q LIOH-L =   402.15    Q TOT-S  = 13014.83
Q TOT-L  =  2350.61    Q TOT    = 15365.44    WCp AIR  =   333.20    V CABHX  =   317.00
V BYPASS =      .00    UA REQD  =   967.35    LOOP CNT =    15.00
```

```
H2O COOLANT LOOP PUMP
T H2Oin  =    64.17    T H2Oout =    64.62
```

```
IMU COLDPLATES
T H2Oin  =    64.62    T H2Oout =    64.62
```

```
COLDWALL
T H2Oin  =    64.62    T H2Oout =    64.62
```

```
# 1 AVIONICS BAY
T H2Oin  =    64.62    T CPout  =    80.45    T H2Oout =    96.64    T ABAY   =   113.30
T AIRin  =   114.50    T AIRout =    84.27    WCp AIR  =   124.95    Q ABHX   =  3777.00
```

```
# 2 AVIONICS BAY
T H2Oin  =    64.62    T CPout  =    80.45    T H2Oout =    96.64    T ABAY   =   113.30
T AIRin  =   114.50    T AIRout =    84.27    WCp AIR  =   124.95    Q ABHX   =  3777.00
```

```
# 3 AVIONICS BAY
T H2Oin  =    64.62    T CPout  =    80.45    T H2Oout =    96.63    T ABAY   =   113.29
T AIRin  =   114.40    T AIRout =    84.27    WCp AIR  =   124.95    Q ABHX   =  3776.00
```

```
CABIN WINDOWS
T H2Oin  =    96.64    T H2Oout =    96.64
```

```
PAYLOAD HEAT EXCHANGER
T F21in  =    90.81    T F21out =    98.17    WCp F21  =   707.22    T PLDin  =   101.02
T PLDout =    93.59
```

```
F21 COOLANT LOOP PUMP
T F21in  =    98.17    T F21out =   100.10    WCp F21  =   712.70    W F21act =  2725.15
```

```
FUEL CELL HEAT EXCHANGER
T F21in  =   100.10    T F21out =   166.27    WCp F21  =   740.49    T FCLin  =   176.83
T FCLout =   164.52    WCp FCL  =  3980.00
```

```
HYDRAULICS HEAT EXCHANGER
T F21in  =   166.27    T F21out =   166.27    WCp F21  =      .00    T HYDin  =      .00
T HYDout =      .00
```

```
F21 COOLANT LOOP ENVIRONMENT LOAD
T F21in  =   166.27    T F21out =   166.27    WCp F21  =      .00
```

SHUTTLE ARS / ATCS PERFORMANCE

MISSION PHASE: ASCENT TO INSERTION
CREW SIZE   : 10

INPUT:
T CAB =	65.00	T RAD =	40.00	T CSE =	35.00	T CSEHX =	20.00
Q MET-S =	3299.00	Q MET-L =	1518.00	W CO2 =	22.98	Q CAB-S =	3480.00
Q CAB-L =	.00	Q ELEC =	4663.00	Q FAN =	1196.00	Q H2OP =	315.00
Q CP-IMU =	.00	Q CWALL =	.00	Q CP-1 =	3301.00	Q CP-2 =	3301.00
Q CP-3 =	3301.00	Q AB-1 =	3627.00	Q AB-2 =	3627.00	Q AB-3 =	3626.00
Q ABFAN =	150.00	Q CHILL =	.00	Q PLDHX =	5200.00	Q F21P =	1376.00
Q FCELL =	43000.00	Q HYDHX =	.00	Q O2HTR =	.00	W H2O =	700.00
V F21P =	32.70	V FAN =	317.00	V LIOH =	66.00	V ABFAN =	125.00
W CHILL =	.00	WCp PLD =	700.00	WCp FCL =	1990.00	WCp HYD =	375.00
WCp CSE =	2430.00	UA CABHX =	975.00	UA ABHX =	415.00	UA SUBLM =	1674.00
UA CHILL =	.00	UA INTHX =	5862.00	UA PLDHX =	1850.00	UA FCLHX =	1645.00
UA HYDHX =	200.00	UA CSEHX =	2107.00	TOL UA =	.0100	# FCELL =	2.00
XV SINK =	3.00	Q WINDOW =	.00	Q ENVIRN =	.00		

SUBLIMATOR
Q TOT = 36436.45   T H2Oin = 167.99   T H2Oout = 44.44

POTABLE H2O CHILLER
T H2Oin = 44.44   T H2Oout = 44.44   T POTin = .00   T POTout = .00

ARS CABIN GAS LOOP
T CAB =	73.00	T DEWPT =	59.23	pp CO2 =	3.30	T AIRin =	93.06
T AIRout =	54.36	T H2Oin =	44.44	T H2Oout =	66.38	Q MET-S =	2796.93
Q MET-L =	2110.06	Q LIOH-S =	304.30	Q LIOH-L =	402.15	Q TOT-S =	12850.23
Q TOT-L =	2512.21	Q TOT =	15362.44	WCp AIR =	332.00	V CABHY =	317.00
V BYPASS =	.00	UA REQD =	930.88	LOOP CNT =	6.00		

H2O COOLANT LOOP PUMP
T H2Oin = 66.38   T H2Oout = 66.83

IMU COLDPLATES
T H2Oin = 66.83   T H2Oout = 66.83

COLDWALL
T H2Oin = 66.83   T H2Oout = 66.83

1 AVIONICS BAY
T H2Oin = 66.83   T CPout = 80.92   T H2Oout = 97.17   T ABAY = 113.85
T AIRin = 115.05   T AIRout = 34.70   WCp AIR = 124.83   Q ABHX = 3777.00

2 AVIONICS BAY
T H2Oin = 66.83   T CPout = 80.92   T H2Oout = 97.17   T ABAY = 113.85
T AIRin = 115.05   T AIRout = 84.79   WCp AIR = 124.83   Q ABHX = 3777.00

3 AVIONICS BAY
T H2Oin = 66.83   T CPout = 80.92   T H2Oout = 97.16   T ABAY = 113.84
T AIRin = 115.04   T AIRout = 84.79   WCp AIR = 124.83   Q ABHX = 3776.00

CABIN WINDOWS
T H2Oin = 97.17   T H2Oout = 97.17

F21 / H2O INTERCHANGER
Q F21L = 49576.00   T H2Oin = 97.17   T H2Oout = 167.99   T F21in = 174.37
T F21out = 107.44   WCp F21 = 735.15   W F21 = 2679.33

PAYLOAD HEAT EXCHANGER
T F21in = 107.44   T F21out = 114.77   WCp F21 = 709.33   T PLDin = 117.63
T PLDout = 119.20

F21 COOLANT LOOP PUMP
T F21in = 114.77   T F21out = 116.69   WCp F21 = 715.92   W F21act = 2679.34

FUEL CELL HEAT EXCHANGER
T F21in = 116.69   T F21out = 174.36   WCp F21 = 739.26   T FCLin = 184.19
T FCLout = 173.30   WCp FCL = 3930.00

HYDRAULICS HEAT EXCHANGER
T F21in = 174.36   T F21out = 174.36   WCp F21 = .00   T HYDin = .00
T HYDout = .00

F21 COOLANT LOOP ENVIRONMENT LOAD
T F21in = 174.86   T F21out = 174.86   WCp F21 = .00

O2 RESTRICTOR / HEATER
T F21in = 174.86   T F21out = 174.86   WCp F21 = .00

SHUTTLE ARS / ATCS PERFORMANCE

MISSION PHASE: SORTIE OPS, DAY 5, MIN LOADS
CREW SIZE   : 4

```
INPUT:
T CAB    =     65.00    T RAD   =     40.00    T GSE   =     35.00    T GSEHX =     20.00
Q MET-S  =   1317.00    Q MET-L =    817.00    W CO2   =     10.32    Q CAB-S = -1646.00
Q CAB-L  =       .00    Q ELEC  =   1486.00    Q FAN   =   1196.00    Q H2OP  =    315.00
Q CP-IMU =       .00    Q CWALL =       .00    Q CP-1  =   1802.00    Q CP-2  =   1802.00
Q CP-3   =   1802.00    Q AB-1  =   1472.00    Q AB-2  =   1471.00    Q AB-3  =   1471.00
Q ABFAN  =    150.00    Q CHILL =       .00    Q PLDHX =       .00    Q F21P  =   1376.00
Q FCELL  =  21700.00    Q HYDHX = -15000.00    Q O2HTR =       .00    W H2O   =   -700.00
W F21P   =     32.70    W FAN   =    317.00    W LIOH  =     66.00    W ABFAN =    125.00
W CHILL  =       .00    WCp PLD =    700.00    WCp FCL =   1990.00    WCp HYD =    375.00
WCp GSE  =   2430.00    UA CABHX=    975.00    UA ABHX =    415.00    UA SUBLM= -1674.00
UA CHILL =       .00    UA INTHX=   3862.00    UA PLDHX=   1850.00    UA FCLHX=   1645.00
UA HYDHX =    200.00    UA GSEHX=   2107.00    TOL UA  =     .0100    # FCELL =      2.00
KY SINK  =      1.00    Q WINDOW=       .00    Q ENVIRN= -1000.00
```

```
RADIATOR
Q TOT    =  21372.80    T F21in =     70.45    T F21out=     40.00    WCp F21 =    701.76
Q-F21    =  -2827.47
```

```
O2 RESTRICTOR / HEATER
T F21in  =     40.00    T F21out=     40.00    WCp F21 =       .00
```

```
F21 / H2O INTERCHANGER
Q H2OL   =  14296.80    T F21in =     40.00    T F21out=     60.48    WCp F21 =    697.79
T H2Oin  =    -62.89    T H2Oout=     42.47
```

```
POTABLE H2O CHILLER
T H2Oin  =     42.47    T H2Oout=     42.47    T POTin =       .00    T POTout=       .00
```

```
ARS CABIN GAS LOOP
T CAB    =     65.00    T DEPT  =     50.57    pp CO2  =      1.46    T AIRin =     73.86
T AIRout =     44.47    T H2Oin =     42.47    T H2Oout=     47.77    Q MET-S =   1317.00
Q MET-L  =    817.00    Q LIOH-S=   -361.20    Q LIOH-L=   -180.60    Q TOT-S = -2714.20
Q TOT-L  =    997.60    Q TOT   =   3711.80    WCp AIR =    343.20    W CABHX =     85.28
W BYPASS =    231.71    UA REQD =    393.70    LOOP-CNT=      2.00
```

```
H2O COOLANT LOOP PUMP
T H2Oin  =     47.77    T H2Oout=     48.22
```

```
IMU COLDPLATES
T H2Oin  =     48.22    T H2Oout=     48.22
```

```
COLDWALL
T H2Oin  =     48.22    T H2Oout=     48.22
```

```
# 1 AVIONICS BAY
T H2Oin  =     48.22    T CPout =     55.94    T H2Oout=     62.89    T ABAY  =     55.73
T AIRin  =     69.83    T AIRout=     57.86    WCp AIR =    135.48    Q ABHX  =   1622.00
```

```
# 2 AVIONICS BAY
T H2Oin  =     48.22    T CPout =     55.94    T H2Oout=     62.89    T ABAY  =     68.72
T AIRin  =     69.83    T AIRout=     57.86    WCp AIR =    135.48    Q ABHX  =   1621.00
```

```
# 3 AVIONICS BAY
T H2Oin  =     48.22    T CPout =     55.94    T H2Oout=     62.89    T ABAY  =     68.72
T AIRin  =     69.83    T AIRout=     57.86    WCp AIR =    135.48    Q ABHX  =   1621.00
```

```
CABIN WINDOWS
T H2Oin  =     62.89    T H2Oout=     62.89
```

```
PAYLOAD HEAT EXCHANGER
T F21in  =     60.48    T F21out=     60.48    WCp F21 =       .00    T PLDin =       .00
T PLDout =       .00
```

```
F21 COOLANT LOOP PUMP
T F21in  =     60.48    T F21out=     62.44    WCp F21 =    702.95    W F21act=   2827.49
```

```
FUEL CELL HEAT EXCHANGER
T F21in  =     62.44    T F21out=     92.61    WCp F21 =    719.34    T FCLin =     97.09
T FCLout =     91.64    WCp FCL =   3930.00
```

```
HYDRAULICS HEAT EXCHANGER
T F21in  =     92.61    T F21out=     71.37    WCp F21 =    723.24    T HYDin =    -13.16
T HYDout =     26.83
```

```
F21 COOLANT LOOP ENVIRONMENT LOAD
T F21in  =     71.37    T F21out=     70.47    WCp F21 =    717.46
```

4-7

4.2   Program Modifications

The program is designed to minimize the user effort required to effect any desired modifications. Three basic steps comprise the modification procedure:

A.   Singularly transfer the program groups from the program tape to the 720-C calculator.

B.   Make any desired changes.

C.   Record the modified groups onto a new program tape.

An example is presented to demonstrate the ease of altering the program: The ATCS Freon coolant loop is modified with the addition of a second payload heat exchanger, parallel to the Freon to water interchanger. It is assumed that this heat exchanger is "valved-off" during periods of sublimator operation. To incorporate this change to the program, five program groups are affected: a) Load/write input data, b) GSE heat exchanger, c) Radiator, d) F21/H_2O interchanger, and e) Payload heat exchanger.

The load/write input data group is modified to accept additional input data for the new heat exchanger; a) heat load, b) payload coolant flow rate, c) heat exchanger capacity, and d) the percent of ATCS Freon coolant flow routed to it. With the increased data requirement, the storage locations of Q H_2O loop, Q F21 loop, and Q total are changed. Format changes to the data print-out are also required. The original payload heat exchanger shall be labelled #1 and the new payload heat exchanger shall be #2. Table 4.3 enumerates the program changes necessary to effect these modifications.

The GSE heat exchanger and radiator program groups require identical changes. The new storage location of Q total and the second payload heat exchanger heat load require minor changes in the data call-up and the Freon flow rate calculations. Tables 4.4 and 4.5 describe the required changes to the GSE heat exchanger and radiator program groups, respectively.

The F21/H_2O interchanger program group is completely rewritten to accommodate the second payload heat exchanger. The original program group has an adequate number of tape blocks to accomplish the revision if the calculations are generalized and made a subroutine to be addressed for the analysis of both heat exchangers. Table 4.6 is a program listing of the revised F21/H_2O interchanger program group.

4.2   (Continued)

The only revision necessary to the payload heat exchanger group
is output format. The required modifications are incorporated so
that the print-out will read "#1 payload heat exchanger." Table
4.7 describes this revision.

If a modified program group requires additional tape blocks, a
new program group is added, or a program group is deleted, the
succeeding groups will occupy different tape blocks than their
original locations. At the end of a program group's formating, there
is a six-step sequence directing the program control logic to call-
up the next desired tape block number. When the modified program
groups are recorded onto the new program tape, the user must insure
that the program groups are recorded at their new tape block
locations and that the block number call-up sequence is revised
accordingly.

When revising the program, the user should also note that storage
registers #01, 02, and 03 are reserved for the carry-over ARS
water and ATCS Freon coolant loop temperatures and the calculated
ATCS Freon coolant flow rate, respectively.

TABLE 4.3 EXAMPLE CHANGES TO THE LOAD/WRITE INPUT DATA PROGRAM GROUP

700 PROGRAM TITLE: NO.   Page   of

Step	Code	Key	Comment	Step	Code	Key	Comment
REPLACE PROGRAM STEPS #					0002		SPACE
674-675 WITH:					0413	END A	
	0102		SHIFT DN		0100		
	0000		—		0412	WRITE A	
	0209		1		0103		SHIFT UP
					0214		U
REPLACE PROGRAM STEPS #					0112		A
832-839 WITH:					0002		SPACE
	0002		SPACE		0005		P
	0005		P		0209		L
	0209		L		0213		D
	0213		D		0102		SHIFT DN
	0102		SHIFT DN		0000		—
	0000		—		0306		2
	0209		1		0413	END A	
					0100		
REPLACE PROGRAM STEPS #					0412	WRITE A	
955-956 WITH:					0103		SHIFT UP
	0102		SHIFT DN		0305		70
	0000		—		0002		SPACE
	0209		1		0014		F
					0209		L
INSERT THE FOLLOWING AFTER					0109		O
STEP # 1064:					0100		W
	0412	WRITE A			0002		SPACE
	0103		SHIFT UP		0002		SPACE
	0004		Q		0413	END A	
	0002		SPACE		0100		
	0005		P				
	0209		L	REPLACE PROGRAM STEPS #			
	0213		D	1088-1089 WITH:			
	0102		SHIFT DN		0704	4	
	0000		—		0707	7	
	0306		2				
	0002		SPACE				
	0413	END A					
	0100						
	0102						
	0103						
	0412	WRITE A					
	0108		CR/LF				
	0103		SHIFT UP				
	0100		W				
	0002		SPACE				
	0005		P				
	0209		L				
	0213		D				
	0102		SHIFT DN				
	0000		—				
	0306		2				

Remarks:

4-10

Step	Code	Key	Comment	Step	Code	Key	Comment
REPLACE PROGRAM STEPS #							
253-254 WITH:							
	0702	7					
	0700	0					
	0708	8					
INSERT THE FOLLOWING AFTER							
STEP # 419:							
	0702	7					
	0702	7					
	0704	4					
	0700	0					
	0404	ST DIR					
	0001	K.01	DATA BLK				
	0100						
	0405	RE DIR					
	0009	K.09	Q PLD-2				
	0400	+ DIR					
	0006	K.06	Q UP STRM				
	0701	1					
	0401	– DIR					
	0002	K.02	REG CNTR				

Remarks:

4-11

TABLE 4.5

700 PROGRAM TITLE: EXAMPLE CHANGES TO THE
RADIATOR PROGRAM GROUP

NO.

Step	Code	Key	Comment	Step	Code	Key	Comment
REPLACE PROGRAM STEPS #							
253 - 254 WITH :							
	0702	2					
	0700	0					
	0708	8					
INSERT THE FOLLOWING AFTER							
STEP # 429 :							
	0702	2					
	0702	2					
	0704	4					
	0700	0					
	0404	ST DIR					
	0001	K.01	DATA BLK				
	0100						
	0405	RE DIR					
	0009	K.09	Q RD-2				
	0400	+ DIR					
	0006	K.06	Q UP STRM				
	0701	1					
	0401	- DIR					
	0002	K.02					

Remarks:

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0704	4	
				1	0707	7	
				2	0806		TRANSFER
				3	0708	B	
				4	0404	ST DIR	
				5	0006	K.06	RES CNTR
				6	0701	1	
				7	0704	4	
				8	0707	7	
				9	0702	2	
				60	0404	ST DIR	
				1	0007	K.07	DATA BLK
				2	0100		
				3	0704	4	
				4	0704	4	
				5	0708	B	
				6	0400	+ DIR	
				7	0007	K.07	DATA BLK
				8	0100		
				9	0704	4	
				70	0701	1	
				1	0706	6	
				2	0400	+ DIR	
				3	0007	K.07	DATA BLK
				4	0100		
				5	0701	1	
				6	0706	6	
				7	0400	+ DIR	
				8	0007	K.07	DATA BLK
				9	0100		
				80	0415	KE Y	
				1	0010	K.10	% FLOW
				2	0405	KE DIR	
				3	0003	K.03	W F21
				4	0602	X	
				5	0606	↓↑	
				6	0601	−	
				7	0414	ST Y	
5	0408	mARK		8	0010	K.10	W F21-INTHX
6	0003	03		9	0405	KE DIR	
7	0410	GROUP 2		90	0011	K.11	Q H_2O LOOP
8	0001	01	PROG TAPE	1	0404	ST DIR	
9	0415	KE Y		2	0107	K.17	Q H_2O LOOP
40	0000	K.00	BLK CNTR	3	0606	↓↑	
1	0701	1		4	0603	÷	
2	0600	+		5	0414	ST Y	
3	0702	2		6	0006	K.06	ΔH F21-INTHX
4	0709	9		7	0405	KE DIR	
5	0701	1		8	0007	K.07	T F21-IN
6	0806		TRANSFER	9	0404	ST DIR	
7	0701	1					
8	0600	+					
9	0705	S					

Remarks:

4-13

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0004	K.04	T F21	150	0113		R
1	0101			1	0108		CR/LF
2	0405	RE DIR		2	0004		Q
3	0006	K.06	ΔH F21-INTHX	3	0002		SPACE
4	0400	+ DIR		4	0201		H
5	0205	K.05	H F21	5	0102		SHIFT DN
6	0102			6	0306		Z
7	0415	KEY		7	0103		SHIFT UP
8	0204	K.04	T F21-OUT	8	0109		O
9	0405	RE DIR		9	0209		L
110	0002	K.02	T.F21-IN	160	0002		SPACE
1	0601	−		1	0202		SPACE
2	0405	RE DIR		2	0413	END A	
3	0011	K.11	Q H20 LOOP	3	0701	1	
4	0606	↓↑		4	0701	1	
5	0003	÷		5	0404	ST DIR	
6	0414	ST Y		6	0005	K.05	REG CNTR
7	0012	K.12	W(p F21-INTHX	7	0104		
8	0103			8	0412	WRITE A	
9	0405	RE DIR		9	0103		SHIFT UP
120	0013	K.13	T H20-OUT	170	0207		T
1	0404	ST DIR		1	0002		SPACE
2	0001	K.01	T H20-OUT	2	0014		F
3	0412	WRITE A		3	0102		SHIFT DN
4	0103		SHIFT UP	4	0306		Z
5	0014		F	5	0209		1
6	0102		SHIFT DN	6	0104		1
7	0306		Z	7	0206		N
8	0209		1	8	0002		SPACE
9	0002		SPACE	9	0413	END A	
130	0009		/	180	0709	9	
1	0002		SPACE	1	0401	− DIR	
2	0103		SHIFT UP	2	0005	K.05	REG CNTR
3	0201		H	3	0104		
4	0102		SHIFT DN	4	0412	WRITE A	
5	0306		Z	5	0103		SHIFT UP
6	0103		SHIFT UP	6	0207		T
7	0109		O	7	0002		SPACE
8	0002		SPACE	8	0014		F
9	0104		1	9	0102		SHIFT DN
140	0206		N	190	0306		Z
1	0207		T	1	0209		1
2	0205		E	2	0109		O
3	0113		K	3	0214		U
4	0212		C	4	0207		T
5	0201		H	5	0413	END A	
6	0117		A	6	0702	Z	
7	0206		N	7	0400	+ DIR	
8	0015		G	8	0005	K.05	REG CNTR
9	0205		E	9	0104		

Remarks:

4-14

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0412	WRITE A		250	0005	R.05	REG CNTR
1	0103		SHIFT UP	1	0104		
2	0100		W	2	0412	WRITE A	
3	0212		C	3	0103		SHIFT UP
4	0102		SHIFT DN	4	0207		T
5	0005		P	5	0002		SPACE
6	0002		SPACE	6	0201		H
7	0103		SHIFT UP	7	0102		SHIFT DN
8	0014		F	8	0306		Z
9	0102		SHIFT DN	9	0103		SHIFT UP
210	0306		Z	260	0109		O
1	0209		1	1	0102		SHIFT DN
2	0002		SPACE	2	0109		O
3	0413	END A		3	0214		U
4	070B	8		4	0207		T
5	0400	+ DIR		5	0413	END A	
6	0005	R.05	REG CNTR	6	0701	1	
7	0104			7	0401	- DIR	
8	0412	WRITE A		8	0005	R.05	REG CNTR
9	0108		CR/LF	9	0104		
220	0103		SHIFT UP	270	0701	1	
1	0100		W	1	0701	1	
2	0002		SPACE	2	0404	ST DIR	
3	0014		F	3	0006	R.06	REG CNTR
4	0102		SHIFT DN	4	0702	Z	
5	0306		Z	5	0702	Z	
6	0209		1	6	0704	4	
7	0413	END A		7	0700	O	
8	0411	WRITE		8	0404	ST DIR	
9	1503		3 SPACES	9	0007	R.07	DATA BLK
230	0702	Z		280	0100		
1	0401	- DIR		1	0703	3	
2	0005	R.05	REG CNTR	2	0702	Z	
3	0104			3	0400	+ DIR	
4	0412	WRITE A		4	0007	R.07	DATA BLK
5	0103		SHIFT UP	5	0708	8	
6	0207		T	6	0404	ST DIR	
7	0002		SPACE	7	0006	R.06	REG CNTR
8	0201		H	8	0100		
9	0102		SHIFT DN	9	0703	3	
240	0306		Z	290	0702	Z	
1	0103		SHIFT UP	1	0400	+ DIR	
2	0109		O	2	0007	R.07	DATA BLK
3	0102		SHIFT DN	3	0100		
4	0104		1	4	0703	3	
5	0206		N	5	0702	Z	
6	0002		SPACE	6	0400	+ DIR	
7	0413	END A		7	0007	R.07	DATA BLK
8	0704	4		8	0100		
9	0400	+ DIR		9	0415	KEY	

Remarks:

4-15

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0010	K.10	% Flow	350	0405	RE DIR	
1	0405	RE DIR		1	0011	R.11	Q PLDHX
2	0003	K.03	W FZI	2	0606	↓↑	
3	0607	X		3	0603	÷	
4	0414	ST Y		4	0414	ST Y	
5	0010	K.10	W FZI-PLDHX	5	0012	R.12	WCP FZI-PLDHX
6	0405	RE DIR		6	0103		
7	0011	R.11	Q PLDHX	7	0408	MARK	
8	0400	+ DIR		8	0007	07	
9	0107	R.17	Q TOT	9	0412	WRITE A	
310	0412	WRITE A	SKIP IF	360	0108		CR/LF
1	0611	Log e X	X = 0	1	0110		LF
2	0407	SEARCH		2	0103		SHIFT UP
3	0006	06		3	0314		#
4	0404	ST DIR		4	0002		SPACE
5	0012	K.12	WCP FZI	5	0102		SHIFT DN
6	0404	ST DIR		6	0306		Z
7	0013	R.13	T PLD-OUT	7	0002		SPACE
8	0404	ST DIR		8	0103		SHIFT UP
9	0014	R.14	T PLD-IN	9	0005		P
320	0405	RE DIR		370	0112		A
1	0002	R.02	T FZI-IN	1	0001		Y
2	0404	ST DIR		2	0209		L
3	0004	R.04	T FZI-OUT	3	0109		O
4	0407	SEARCH		4	0112		A
5	0007	07		5	0213		D
6	0408	MARK		6	0002		SPACE
7	0006	06		7	0201		H
8	0415	RE Y		8	0205		E
9	0211	R.11	Q PLDHX	9	0112		A
330	0405	RE DIR		380	0207		T
1	0010	K.10	W-FZI PLDHX	1	0002		SPACE
2	0603	÷		2	0205		E
3	0414	ST Y		3	0215		X
4	0006	K.06	ΔH FZI-PLDHX	4	0212		C
5	0405	RE DIR		5	0201		H
6	0002	R.02	T FZI-IN	6	0112		A
7	0404	ST DIR		7	0206		N
8	0004	R.04	T FZI	8	0015		G
9	0101			9	0205		E
340	0405	RE DIR		390	0113		R
1	0006	K.06	ΔH FZI-PLDHX	1	010B		CR/LF
2	0400	+ DIR		2	0207		T
3	0005	R.05	H FZI	3	0002		SPACE
4	0107			4	0014		F
5	0415	RE Y		5	0102		SHIFT DN
6	0004	R.04	T FZI-OUT	6	0306		Z
7	0405	RE DIR		7	0209		1
8	0002	R.02	T FZI-IN	8	0104		1
9	0601	-		9	0206		N

Remarks:

4-16

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0202		SPACE	450	1503		3 SPACES
1	0413	END A		1	0707	Z	
2	0702	Z		2	0401	− DIR	
3	0404	ST DIR		3	0005	R.05	REG CNTR
4	0005	R.05	REG CNTR	4	0104		
5	0104			5	0412	WRITE A	
6	0412	WRITE A		6	0108		CR/LF
7	0103		SHIFT UP	7	0103		SHIFT UP
8	0207		T	8	0207		T
9	0002		SPACE	9	0002		SPACE
410	0014		F	460	0005		P
1	0102		SHIFT DN	1	0209		L
2	0306		Z	2	0213		D
3	0209		1	3	0102		SHIFT DN
4	0109		O	4	0104		1
5	0214		U	5	0206		N
6	0207		T	6	0002		SPACE
7	0413	END A		7	0413	END A	
8	0702	Z		8	0704	4	
9	0400	+ DIR		9	0400	+ DIR	
420	0005	R.05	REG CNTR	470	0005	R.05	REG CNTR
1	0104			1	0104		
2	0412	WRITE A		2	0412	WRITE A	
3	0103		SHIFT UP	3	0103		SHIFT UP
4	0100		W	4	0207		T
5	0212		C	5	0002		SPACE
6	0102		SHIFT DN	6	0005		P
7	0005		P	7	0209		L
8	0002		SPACE	8	0213		D
9	0103		SHIFT UP	9	0102		SHIFT DN
430	0014		F	480	0109		O
1	0102		SHIFT DN	1	0214		U
2	0306		Z	2	0207		T
3	0209		1	3	0413	END A	
4	0002		SPACE	4	0701	1	
5	0413	END A		5	0401	− DIR	
6	0708	8		6	0005	R.05	REG CNTR
7	0400	+ DIR		7	0104		
8	0005	R.05	REG CNTR	8	0412	WRITE A	
9	0104			9	0108		CR/LF
440	0412	WRITE A		490	0110		LF
1	0103		SHIFT UP	1	0413	END A	
2	0100		W	2	0405	RE DIR	
3	0002		SPACE	3	0002	R.02	T F21−1N
4	0014		F	4	0404	ST DIR	
5	0102		SHIFT DN	5	0004	R.04	T F21
6	0306		Z	6	0101		
7	0209		1	7	0415	RE Y	
8	0413	END A		8	0107	R.17	Q TOT
9	0411	WRITE		9	0405	RE DIR	

Remarks:

4-17

Step	Code	Key	Comment	Step	Code	Key	Comment
500	0003	K.03	W F21	550	0704	4	
1	0603	÷		1	0705	5	
2	0605	↓		2	0702	2	
3	0400	+ DIR		3	0702	2	
4	0005	K.05	H F21	4	0708	8	
5	0102			5	0702	2	
6	0405	RE DIR		6	0710	SET EXP	
7	0004	K.04	T F21	7	0711	CHS SGN	
8	0404	ST DIR		8	0706	6	
9	0002	K.02	T F21-OUT	9	0607	X	
510	0701	1		560	0414	ST Y	
1	0709	9		1	0005	K.05	H F21
2	0404	ST DIR		2	0405	RE DIR	
3	0000	K.00	BLK CNTR	3	0004	K.04	T F21
4	0407	SEARCH		4	0713	X^2	
5	0001	01		5	0604	↑	
6	0408	MARK		6	0701	1	
7	0100			7	0700	0	
8	0410	STEP 2		8	0708	8	
9	0003	03	EXT CORE	9	0706	6	
520	0415	RE Y		570	0707	7	
1	0007	K.07	DATA BLK	1	0700	0	
2	0701	1		2	0704	4	
3	0709	9		3	0708	8	
4	0703	3		4	0703	3	
5	0706	6		5	0700	0	
6	0802		TRANSFER	6	0700	0	
7	0415	RE Y		7	0709	9	
8	0006	K.06	REG CNTR	8	0710	SET EXP	
9	0405	RE DIR		9	0711	CHS SGN	
530	0004	K.04	DATA	580	0703	3	
1	0504	ST INDIR		1	0602	X	
2	0701	1		2	0605	↓	
3	0400	+ DIR		3	0400	+ DIR	
4	0006	K.06	REG CNTR	4	0005	K.05	H F21
5	0511	RETURN		5	0415	RE Y	
6	0408	MARK		6	0004	K.04	T F21
7	0101			7	0712	.	
8	0415	RE Y		8	0702	2	
9	0004	K.04	T F21	9	0703	3	
540	0405	RE DIR		590	0704	4	
1	0004	K.04	T F21	1	0708	8	
2	0713	X^2		2	0708	8	
3	0602	X		3	0708	8	
4	0701	1		4	0705	5	
5	0704	4		5	0705	5	
6	0704	4		6	0705	5	
7	0708	8		7	0701	1	
8	0703	3		8	0700	0	
9	0707	7		9	0705	5	

Remarks:

4-18

Step	Code	Key	Comment	Step	Code	Key	Comment
600	0602	X		650	0704	4	
1	0605	↓		1	0704	4	
2	0400	+ DIR		2	0709	9	
3	0005	R.05	H F21	3	0700	0	
4	0709	9		4	0703	3	
5	0712	.		5	0702	2	
6	0704	4		6	0702	2	
7	0705	5		7	0704	4	
8	0706	6		8	0705	5	
9	0704	4		9	0707	7	
610	0701	1		660	0710	SET EXP	
1	0707	7		1	0711	CHS SGN	
2	0700	0		2	0702	2	
3	0709	9		3	0602	X	
4	0702	2		4	0605	↓	
5	0703	3		5	0401	– DIR	
6	0400	+ DIR		6	0004	R.04	T F21
7	0005	R.05	H F21	7	0415	KE Y	
8	0511	RETURN		8	0005	R.05	H F21
9	0408	MARK		9	0704	4	
620	0102			670	0712	.	
1	0415	KE Y		1	0704	4	
2	0005	R.05	H F21	2	0704	4	
3	0405	RE DIR		3	0703	3	
4	0005	R.05	H F21	4	0703	3	
5	0713	X²		5	0709	9	
6	0602	X		6	0703	3	
7	0709	9		7	0703	3	
8	0704	4		8	0705	5	
9	0705	5		9	0707	7	
630	0703	3		680	0707	7	
1	0706	6		1	0705	5	
2	0709	9		2	0602	X	
3	0703	3		3	0605	↓	
4	0700	0		4	0400	+ DIR	
5	0706	6		5	0004	R.04	T F21
6	0703	3		6	0704	4	
7	0704	4		7	0701	1	
8	0708	8		8	0712	.	
9	0710	SET EXP		9	0702	2	
640	0711	CHS SGN		690	0700	0	
1	0705	5		1	0707	7	
2	0602	X		2	0703	3	
3	0414	ST Y		3	0703	3	
4	0004	R.04	T F21	4	0704	4	
5	0405	RE DIR		5	0706	6	
6	0005	R.05	H F21	6	0700	0	
7	0713	X²		7	0703	3	
8	0604	↑		8	0401	– DIR	
9	0709	9		9	0004	R.04	T F21

Remarks:

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Step	Code	Key	Comment	Step	Code	Key	Comment
700	0511	RETURN		750	0601	−	
1	040B	MARK		1	0414	ST Y	
2	0103			2	0106	K.16	C_2
3	0415	KE Y		3	0405	KE DIR	
4	0012	K.12	WCP F21	4	0002	K.02	T F21-IN
5	0405	KE DIR		5	0607	X	
6	0008	K.08	WCP HOT	6	0405	KE DIR	
7	0603	÷		7	0015	K.15	C_1
8	0701	1		8	0601	−	
9	0601	−		9	0405	KE DIR	
710	0412	WRITE A	SKIP IF	760	0106	K.16	C_2
1	0411	WRITE	Y=0	1	0603	÷	
2	0407	SEARCH		2	0414	ST Y	
3	0004	04		3	0013	K.13	T HOT-OUT
4	0415	KE Y		4	040B	MARK	
5	0011	K.11	Q HX	5	0005	05	
6	0405	KE DIR		6	0415	KE Y	
7	0009	K.09	UA HX	7	0011	K.11	Q HX
8	0603	÷		8	0405	KE DIR	
9	0405	KE DIR		9	0008	K.08	WCP HOT
720	0002	K.02	T F21-IN	770	0603	÷	
1	0600	+		1	0405	KE DIR	
2	0414	ST Y		2	0013	K.13	T HOT-OUT
3	0013	K.13	T HOT-OUT	3	0600	+	
4	0407	SEARCH		4	0414	ST Y	
5	0005	05		5	0014	K.14	T HOT-IN
6	040B	MARK		6	0511	RETURN	
7	0004	04		7	040B	MARK	
8	0405	KE DIR		8	0104		
9	0008	K.08	WCP HOT	9	0412	WRITE A	
730	0615	√x		780	0102		SHIFT DN
1	0604	↑		1	0002		SPACE
2	0405	KE DIR		2	0006		=
3	0012	K.12	WCP F21	3	0413	END A	
4	0615	√x		4	0415	KE Y	
5	0601	−		5	0005	K.05	REG CNTR
6	0405	KE DIR		6	0505	KE INDIR	
7	0011	K.11	Q HX	7	0411	WRITE	
8	0606	↓↑		8	0502		DP-S.2
9	0602	X		9	0411	WRITE	
740	0414	ST Y		790	1503		3 SPACES
1	0015	K.15	C_1	1	0511	RETURN	
2	0415	KE Y					
3	0009	K.09	UA HX				
4	0602	X					
5	0605	↓					
6	0614	e^x					
7	0604	↑					
8	0701	1					
9	0606	↓↑					

Remarks:

Step	Code	Key	Comment	Step	Code	Key	Comment
INSERT THE FOLLOWING AFTER							
STEP #196:							
	0314		#				
	0002		SPACE				
	0102		SHIFT DN				
	0209		1				
	0103		SHIFT UP				
	0002		SPACE				

Remarks:

4-21

4.3   Procedure to Verify Library Data Stored on Tape

A. Load "read data" program into the 720-C calculator; Verification number <u>205</u>

B. Load data tape into the 709 dual tape cassette; Slide-Switch Setting -   8   4   2   1
    ↓   ↓   ↑   ↓

C. Key: <u>PRIME</u>
            <u>SEARCH</u>
            <u>00</u>
    Data tape will be rewound

D. Key: <u>DATA TAPE BLOCK NUMBER</u>
            <u>GO</u>
    X-register will display data stored in inputed data tape block number.

E. Repeat Step D as required, data tape block numbers should be in ascending order.

4.4   Procedure to Revise Library Data Stored on Tape

A. Load "write data" program into the 720-C calculator;
    Verification number <u>232</u>

B. Load data tape into the 709 dual tape cassette;
    Slide-Switch Setting -   8   4   2   1
                              ↓   ↓   ↑   ↓

C. Key: <u>PRIME</u>
          <u>SEARCH</u>
          <u>00</u>
    Data tape will be rewound.

D. Key: <u>DATA TAPE BLOCK NUMBER</u>
          <u>GO</u>
          <u>NEW DATA</u>
          <u>GO</u>

E. Repeat Step D as required, data tape block numbers should be
    in ascending order.

TABLE 4.2   OUTPUT DEFINITION

RADIATOR:

Program Symbol	Units	Description
Q TOT	BTU/HR	Heat load rejected by the radiator
T F21-IN	°F	ATCS Freon coolant inlet loop temperature
T F21-OUT	°F	ATCS Freon coolant loop outlet temperature
WCp F21	BTU/HR-°F	ATCS Freon coolant mass X specific heat flow rate through the radiator
W F21	LBS/HR	ATCS Freon collant flow rate

GSE HEAT EXCHANGER:

Q TOT	BTU/HR	Heat load rejected by the GSE heat exchanger
T F21-IN	°F	ATCS Freon coolant loop inlet temperature
T F21-OUT	°F	ATCS Freon coolant loop outlet temperature
WCP F21	BTU/HR-°F	ATCS Freon coolant mass X specific heat flow through the GSE heat exchanger
W F21	LBS/HR	ATCS Freon coolant flow rate
T GSE-OUT	°F	GSE coolant temperature exiting the heat exchanger

SUBLIMATOR:

Q TOT	BTU/HR	Heat load rejected by the sublimator
T H_2O-IN	°F	ARS water coolant loop inlet temperature
T H_2-OUT	°F	ARS water coolant loop outlet temperature

O_2 RESTRICTOR/HEATER:

T F21-IN	°F	ATCS Freon coolant loop inlet temperature
T F21-OUT	°F	ATCS Freon coolant loop outlet temperature
WCp F21	BTU/HR-°F	ATCS Freon coolant mass X specific heat flow rate through the O_2 restrictor

TABLE 4.2   (Continued)

F21/H$_2$O INTERCHANGER:

Program Symbol	Units	Description
Q H$_2$O L	BTU/HR	ARS heat load transferred to the ATCS coolant loop across the interchanger
Q F21 L	BTU/HR	ATCS heat load transferred to the ARS coolant loop across the interchanger
T F21-IN	°F	ATCS Freon coolant loop inlet temperature
T H$_2$O-IN	°F	A R S Freon coolant loop inlet temperature
T F21-OUT	°F	ATCS Freon coolant loop outlet temperature
T H$_2$O-OUT	°F	ARS water coolant loop outlet temperature
WC$_p$ F21	BTU/HR-°F	ATCS Freon coolant mass X specific heat flow rate through the interchanger
W F21	LBS/HR	ATCS Freon coolant flow rate

POTABLE H$_2$O CHILLER:

T H$_2$O-IN	°F	ARS water coolant loop inlet temperature
T H$_2$O-OUT	°F	ARS water coolant loop outlet temperature
T POT-IN	°F	Potable water temperature entering the chiller
T POT-OUT	°F	Potable water temperature exiting the chiller

ARS CABIN GAS LOOP:

T CAB	°F	Cabin dry bulb temperature
T DEWPT	°F	Cabin dewpoint temperature
pp CO$_2$	mmHg	Cabin carbon dioxide partial pressure
T AIR-IN	°F	Air temperature entering the cabin heat exchanger
T AIR-OUT	°F	Air temperature exiting the cabin heat exchanger
T H$_2$O-IN	°F	ARS water coolant loop inlet temperature
T H$_2$O-OUT	°F	ARS water coolant loop outlet temperature

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TABLE 4.2   (Continued)

ARS CABIN GAS LOOP:

Program Symbol	Units	Description
Q MET-S	BTU/HR	Cabin sensible metabolic heat load
Q MET-L	BTU/HR	Cabin latent metabolic heat load
Q LIOH-S	BTU/HR	Sensible heat generated by the CO_2/LIOH reaction
Q LIOH-L	BTU/HR	Latent heat generated by the CO_2/LIOH reaction
Q TOT-S	BTU/HR	Total cabin heat exchanger sensible heat load
Q TOT-L	BTU/HR	Total cabin heat exchanger latent heat load
Q TOT	BTU/HR	Total cabin heat exchanger heat load
WCp AIR	BTU/HR-°F	Cabin air mass X specific heat flow rate
V CABHX	FT^3/MIN	Cabin air volumetric flow rate through the heat exchanger
V BYPASS	FT^3/MIN	Cabin air volumetric flow rate through the heat exchanger bypass
UA REQD	BTU/HR-°F	Calculated overall heat transfer coefficient for the cabin heat exchanger
LOOP CNT	-	Number of times calculations went through the convergence loop. If value is 35, calculations have not converged

H_2O COOLANT LOOP PUMP:

T H_2O-IN	°F	ARS water coolant loop inlet temperature
T. H_2O-OUT	°F	ARS water coolant loop outlet temperature

IMU COLDPLATES:

T H_2O-IN	°F	ARS water coolant loop inlet temperature
T H_2O-OUT	°F	ARS water coolant loop outlet temperature

COLDWALL:

T H_2O-IN	°F	ARS water coolant loop inlet temperature
T H_2O-OUT	°F	ARS water coolant loop outlet temperature

TABLE 4.2   (Continued)

AVIONICS BAYS:

Program Symbol	Units	Description
T H$_2$O-IN	°F	ARS water coolant loop inlet temperature
T CP-OUT	°F	ARS water coolant loop temperature exiting the coldplate network
T H$_2$O-OUT	°F	ARS water coolant loop outlet temperature
T ABAY	°F	Avionics bay dry bulb air temperature
T AIR-IN	°F	Avionics bay air temperature entering the heat exchanger
T AIR-OUT	°F	Avionics bay air temperature exiting the heat exchanger
WC$_p$ AIR	BTU/HR-°F	Avionics bay air mass X specific heat flow rate through the heat exchanger
Q ABHX	BTU/HR	Total avionics bay heat load transferred through the heat exchanger to the ARS water coolant loop

CABIN WINDOWS:

Program Symbol	Units	Description
T H$_2$O-IN	°F	ARS water coolant loop inlet temperature
T H$_2$O-OUT	°F	ARS water coolant loop outlet temperature

PAYLOAD HEAT EXCHANGER:

Program Symbol	Units	Description
T F21-IN	°F	ATCS Freon coolant loop inlet temperature
T F21-OUT	°F	ATCS Freon coolant loop outlet temperature
WC$_p$ F21	BTU/HR-°F	ATCS Freon coolant mass X specific heat flow rate through the heat exchanger
T PLD-IN	°F	Payload coolant temperature entering the heat exchanger
T PLD-OUT	°F	Payload coolant temperature exiting the heat exchanger

TABLE 4.2   (Continued)

F21 COOLANT LOOP PUMP:

Program Symbol	Units	Description
T F21-IN	°F	ATCS Freon coolant loop inlet temperature
T F21-OUT	°F	ATCS Freon coolant loop outlet temperature
WC$_p$ F21	BTU/HR-°F	ATCS Freon coolant mass X specific heat flow rate through the pump
W F21-ACT	LBS/HR	Actual ATCS Freon coolant loop flow rate; not used for system thermodynamic balance

FUEL CELL HEAT EXCHANGER:

T F21-IN	°F	ATCS Freon coolant inlet temperature
T F21-OUT	°F	ATCS Freon coolant outlet temperature
WCp F21	BTU/HR-°F	ATCS Freon coolant mass X specific heat flow rate through the heat exchanger
T FCL-IN	°F	Fuel cell coolant temperature entering the heat exchanger
T FCL-OUT	°F	Fuel cell coolant temperature exiting the heat exchanger
WC$_p$ FCL	BTU/HR-°F	Total fuel cell coolant mass X specific heat flow rate through the heat exchanger

HYDRAULICS HEAT EXCHANGER:

T F21-IN	°F	ATCS Freon coolant inlet temperature
T F21-OUT	°F	ATCS Freon coolant outlet temperature
WC$_p$ F21	BTU/HR-°F	ATCS Freon coolant maxx X specific heat flow rate through the heat exchanger
T HYD-IN	°F	Hydraulics fluid temperature entering the heat exchanger
T HYD-OUT	°F	Hydraulics fluid temperature exiting the heat exchanger

TABLE 4.2   (Continued)

F21 COOLANT LOOP ENVIRONMENT LOAD:

Program Symbol	Units	
T F21-IN	°F	ATCS Freon coolant inlet temperature
T F21-OUT	°F	ATCS Freon coolant outlet temperature
WC_P F21	BTU/HR-°F	ATCS Freon coolant mass X specific heat flow rate through the heat node

APPENDIX I

I

I.1   INTERNAL PROGRAM DATA

The calculation procedures derived for the ARS/ATCS performance routine require the utilization of data tables that provide the following information:

A. Water vapor properties:
$$P\ H_2O = f(T\ H_2O)$$
$$T\ H_2O = f(P\ H_2O)$$

B. Freon 21 properties:
$$H\ F21 = f(T\ F21)$$
$$F21 = f(T\ F21)$$
$$T\ F21 = f(H\ F21)$$

C. Radiator performance map:
$$Tout = f(T\ in), \text{ for various flow rates}$$

D. Sensible/latent split of metabolic heat in the orbiter cabin:
$$A\ MET - Sensible = f\ (T\ CABIN)$$

To minimize the data storage requirement and the overall run time required per case, generalized, empirical equations were written for the above data. These equations took the form of:

$$Y = b_0 + b_1 + b_2x^2 + - - - - - + b_nx^n$$

These derivations were accomplished with the aid of the Nth ORDER REGRESSION ANALYSIS ROUTINE, program number 1063 A/ST3, supplied by Wang Laboratories, Inc. The following pages provide the user with example curves of these empirical equations.

P H2O
[PSIA]

WATER VAPOR PROPERTIES

P H2O = $-.137982438332(10-11) * T H2O**5$
$+ .727253519326(10- 8) * T H2O**4$
$- .421568057170(10- 6) * T H2O**3$
$+ .640627941428(10- 4) * T H2O**2$
$- .207624023110(10- 3) * T H2O$
$+ .359979371738(10- 1)$

.270

.250

.230

.210

.190

.170

.150

.130

.110

38.0   42.0   46.0   50.0   54.0   58.0   62.0

T H2O [°F]
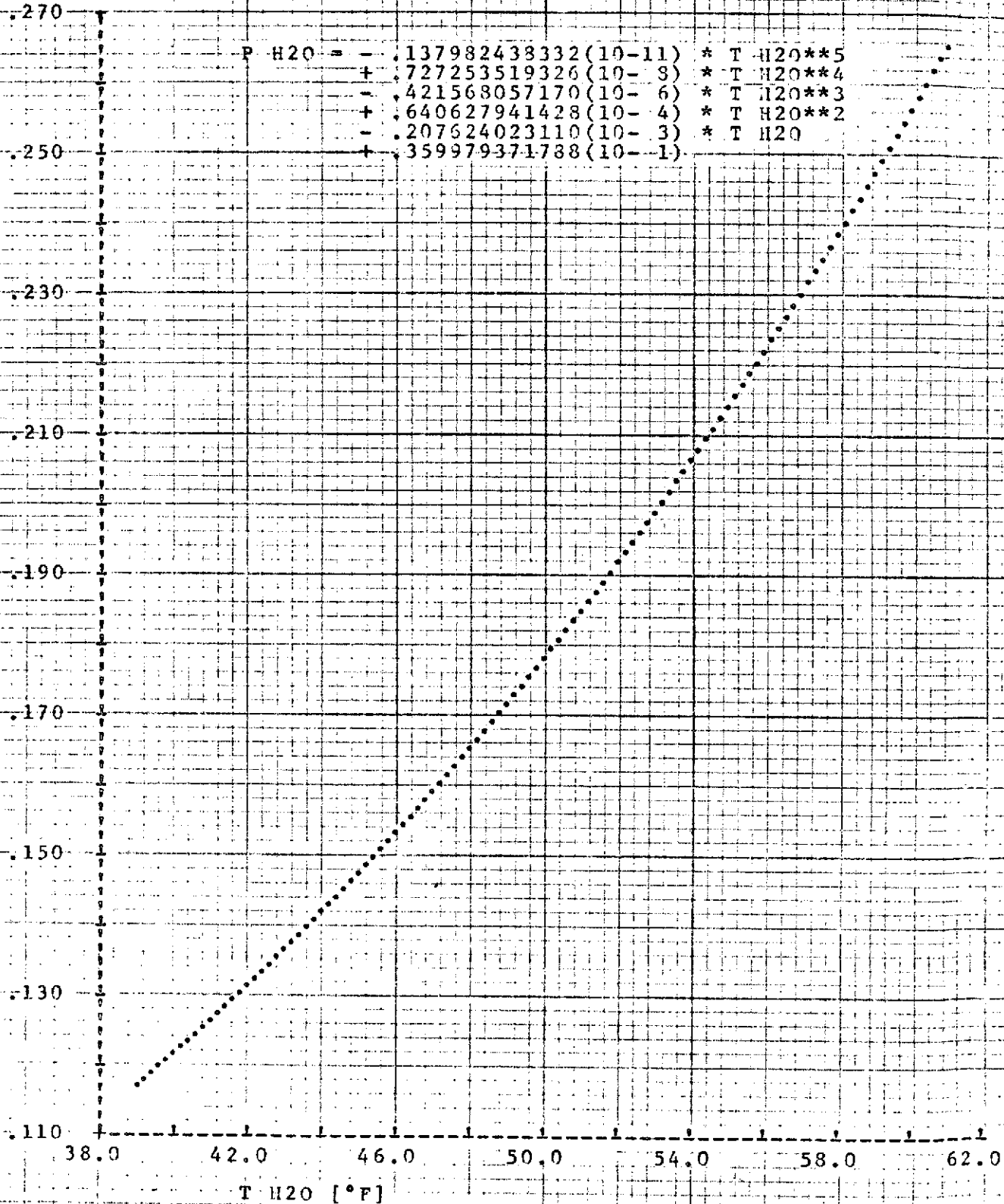
WATER VAPOR PROPERTIES

T H2O = + 3563.65514163 * P H2O**5
        - 6508.86440198 * P H2O**4
        + 4849.14313832 * P H2O**3
        - 1943.30027933 * P H2O**2
        + 511.128593630 * P H2O
        - .855385312000

Y-axis: T H2O [°F], ranging from 38.0 to 62.0

X-axis: P H2O [PSIA], ranging from .110 to .270
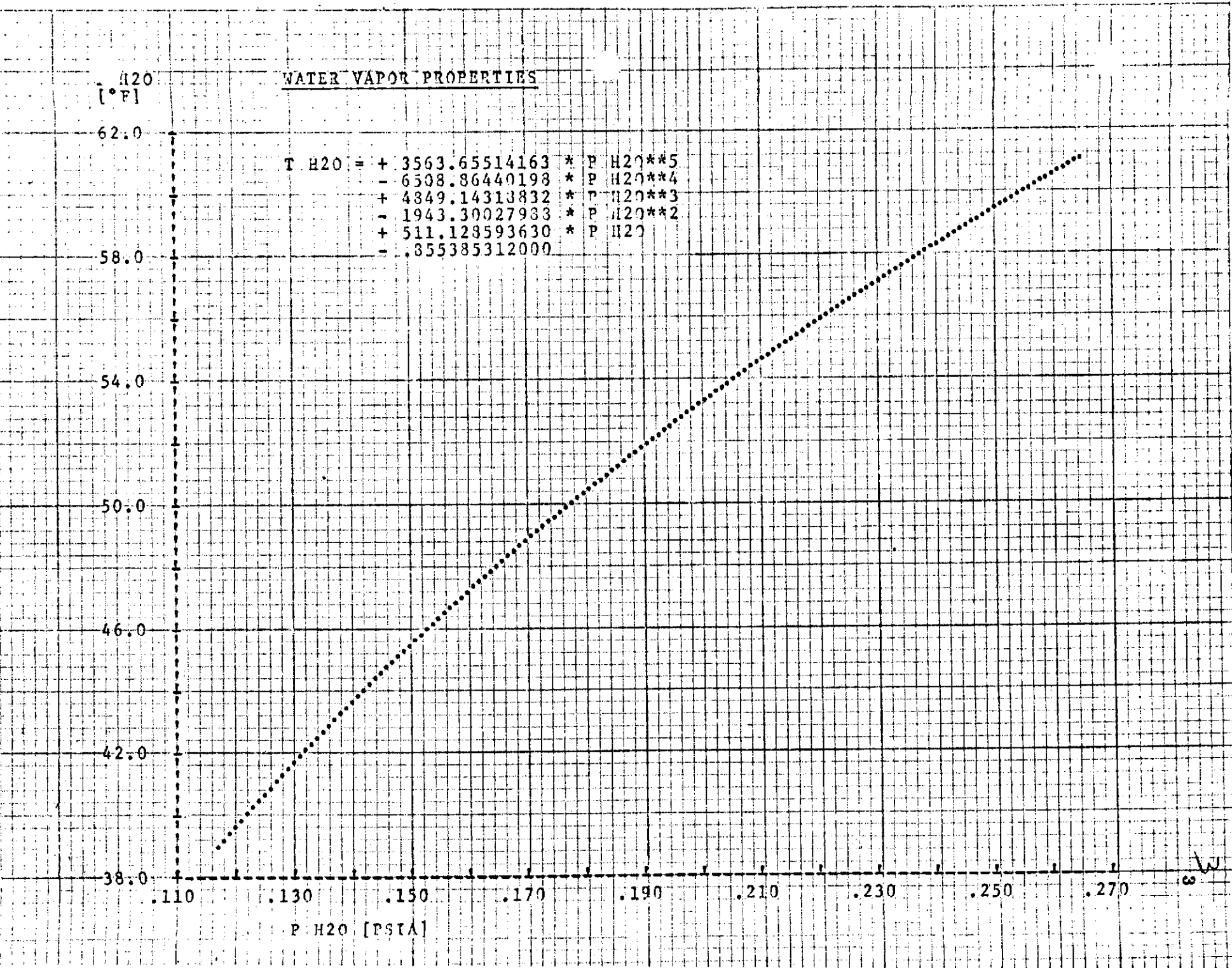
H F21
[3TU/LB]

F21 PROPERTIES

H F21 = + .144837452282(10-6)   * T F21**3
        + .108670483000(10-3)   * T F21**2
        + .234833555105   * T F21
        + 9.45641709230

T F21 [°F]

F21 DENSITY
[LBS/FT3]

F21 PROPERTIES

F21 DENSITY = $- .211247039686 (10-6) * T\ F21**3$
$+ .327797214027 (10-4) * T\ F21**2$
$- .841341492861 (10-1) * T\ F21$
$+ 91.4366666688$

90.0

87.5

85.0

82.5

80.0

77.5

75.0

72.5

70.0

0   50   100   150   200   250
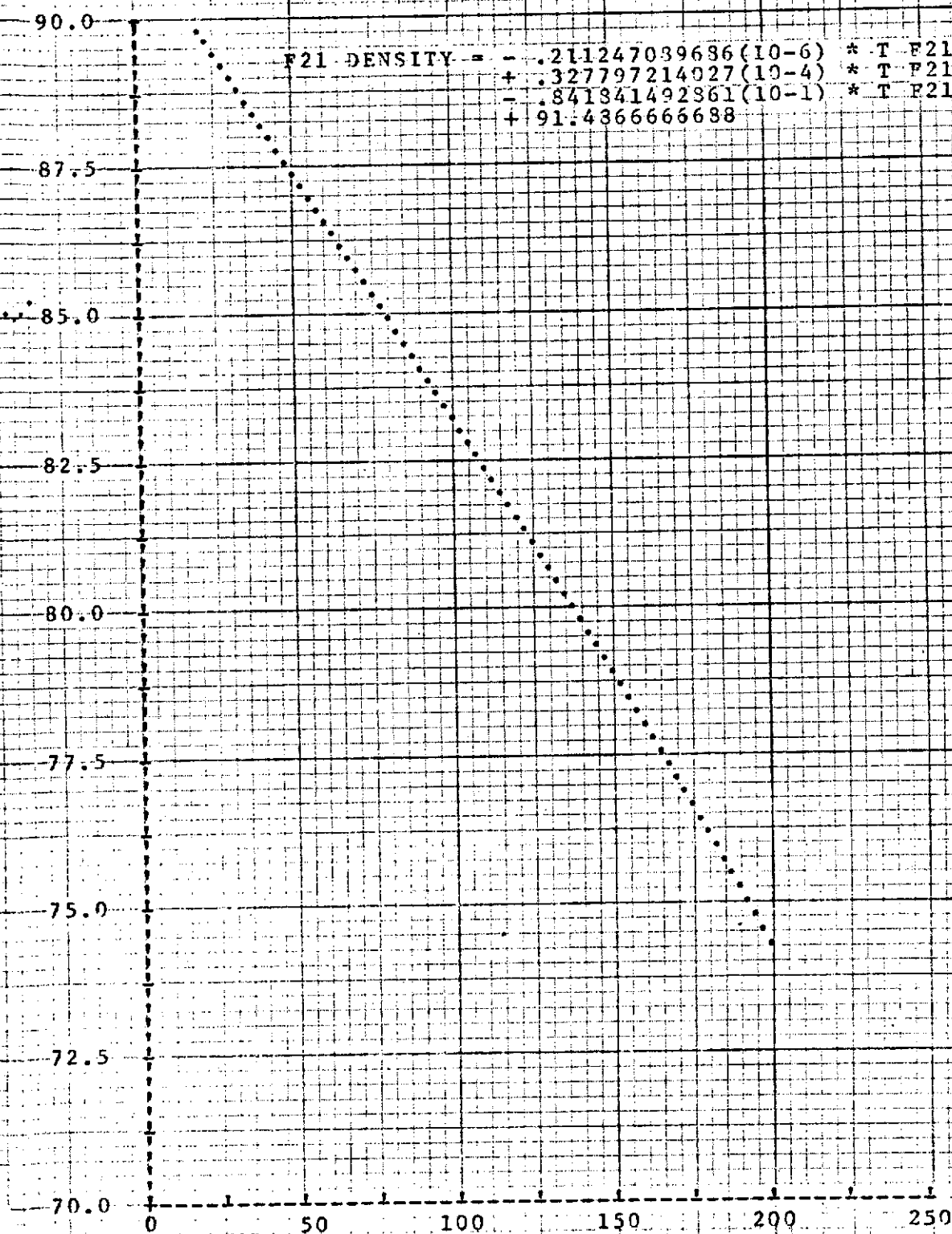
T F21 [°F]

F21 PROPERTIES

$$T\ F21 = +\ .945369306348(10-5)\ *\ H\ F21**3$$
$$-\ .944903224570(10-2)\ *\ H\ F21**2$$
$$+\ 4.44339335775\ *\ H\ F21$$
$$-\ 41.2073346030$$

T F21 [°F]

H F21 [BTU/LB]
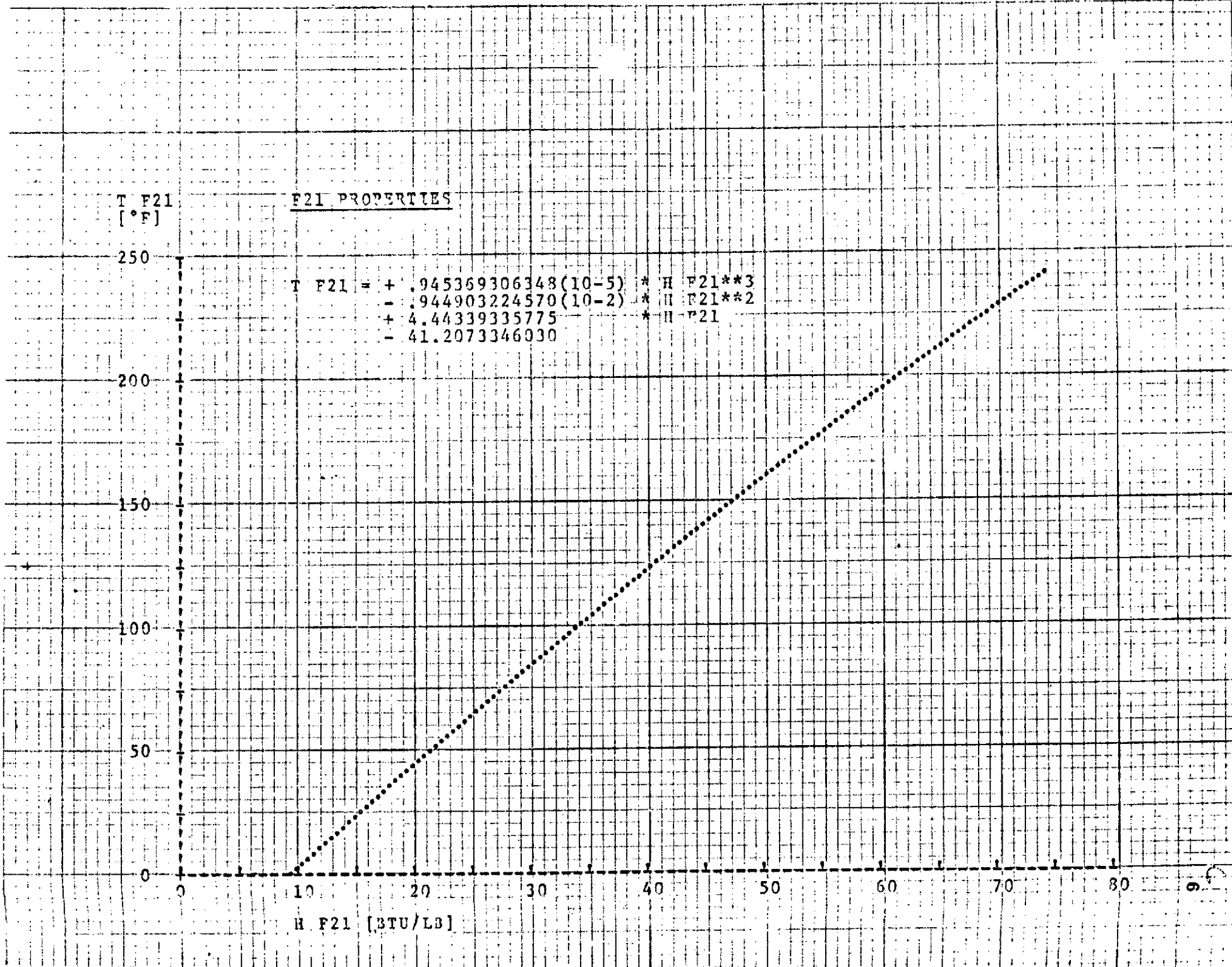
AVERAGE OUTLET TEMPERATURE [°F]

ORBIT:
- SOLAR ORIENTED, PAYLOAD BAY TOWARD SUN
- 73.4° BETA ANGLE

COATING PROPERTIES:
- ALPHA = .25
- EMISSIVITY = .92

$T_{out} = C1 \cdot T_{in}^{3} + C2 \cdot T_{in}^{2} + C3 \cdot T_{in} + C4$

W = 2200 LBS-F21/HR:
C1 = + .755145536603(10-7)
C2 = - .353538490797(10-4)
C3 = + .148430304566
C4 = + 15.6603741282

W = 2400 LBS-F21/HR:
C1 = + .158727535388(10-6)
C2 = - .708924843657(10-4)
C3 = + .174006315809
C4 = + 17.0864342023

W = 2600 LBS-F21/HR:
C1 = - .118499436421(10-5)
C2 = + .477994683704(10-3)
C3 = + .126070497331
C4 = + 20.8707397789

W = 2800 LBS-F21/HR:
C1 = - .197666209010(10-5)
C2 = + .806269470990(10-3)
C3 = + .103858233503
C4 = + 23.5068463168

W = 3000 LBS-F21/HR:
C1 = - .775095331913(10-6)
C2 = + .321439903723(10-3)
C3 = + .181389268439
C4 = + 22.2652322250

W = 3200 LBS-F21/HR:
C1 = + 0.0
C2 = + 0.0
C3 = + .24
C4 = + 21.5

W = 3400 LBS-F21/HR:
C1 = - .208021726773(10-6)
C2 = + .544525682339(10-4)
C3 = + .254385554269
C4 = + 21.9449515104

W = 3600 LBS-F21/HR:
C1 = - .387691599036(10-6)
C2 = + .690013725010(10-4)
C3 = + .277064815580
C4 = + 21.7352466989

W = 3800 LBS-F21/HR:
C1 = - .139884144047(10-5)
C2 = + .389367546703(10-3)
C3 = + .265396744869
C4 = + 22.4619961154

W = 3800, 3600, 3400, 3200, 3000, 2800, 2600, 2400, 2200
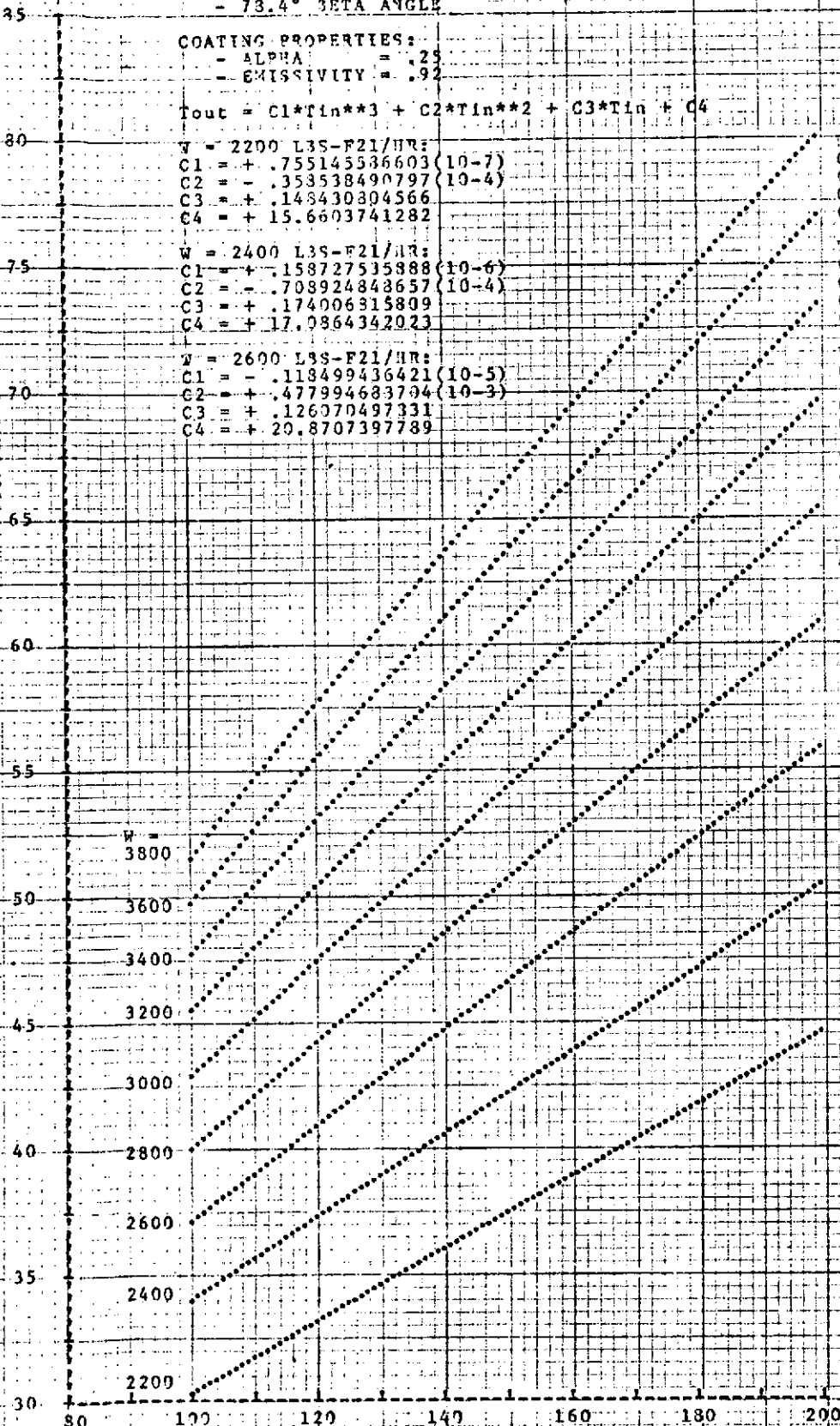
INLET TEMPERATURE [°F]

METABOLIC HEAT LOAD SPLIT

METABOLIC HEAT [BTU/MAN-HR]

Q MET-TOT = 12800 BTU/MAN-DAY

$$Q_{MET-S} = -.496454953521(10{-}3) * T_{CAB}^{**4}$$
$$+ .153423619595 * T_{CAB}^{**3}$$
$$- 17.8569340742 * T_{CAB}^{**2}$$
$$+ 917.607273430 * T_{CAB}$$
$$- 17141.1118240$$

LATENT HEAT

SENSIBLE HEAT

CABIN TEMPERATURE [°F]

METABOLIC HEAT LOAD SPLIT

METABOLIC HEAT [BTU/MAN-HR]

$$Q \text{ MET-TOT} = 19733 \text{ BTU/MAN-DAY}$$

$$Q \text{ MET-S} = - .496454953521(10-3) * T \text{ CAB}^{**4}$$
$$+ .153423619595 \qquad\qquad * T \text{ CAB}^{**3}$$
$$- 17.8569340742 \qquad\qquad * T \text{ CAB}^{**2}$$
$$+ 917.607273430 \qquad\qquad * T \text{ CAB}$$
$$- 17141.1118240$$

LATENT HEAT

SENSIBLE HEAT

CABIN TEMPERATURE [°F]
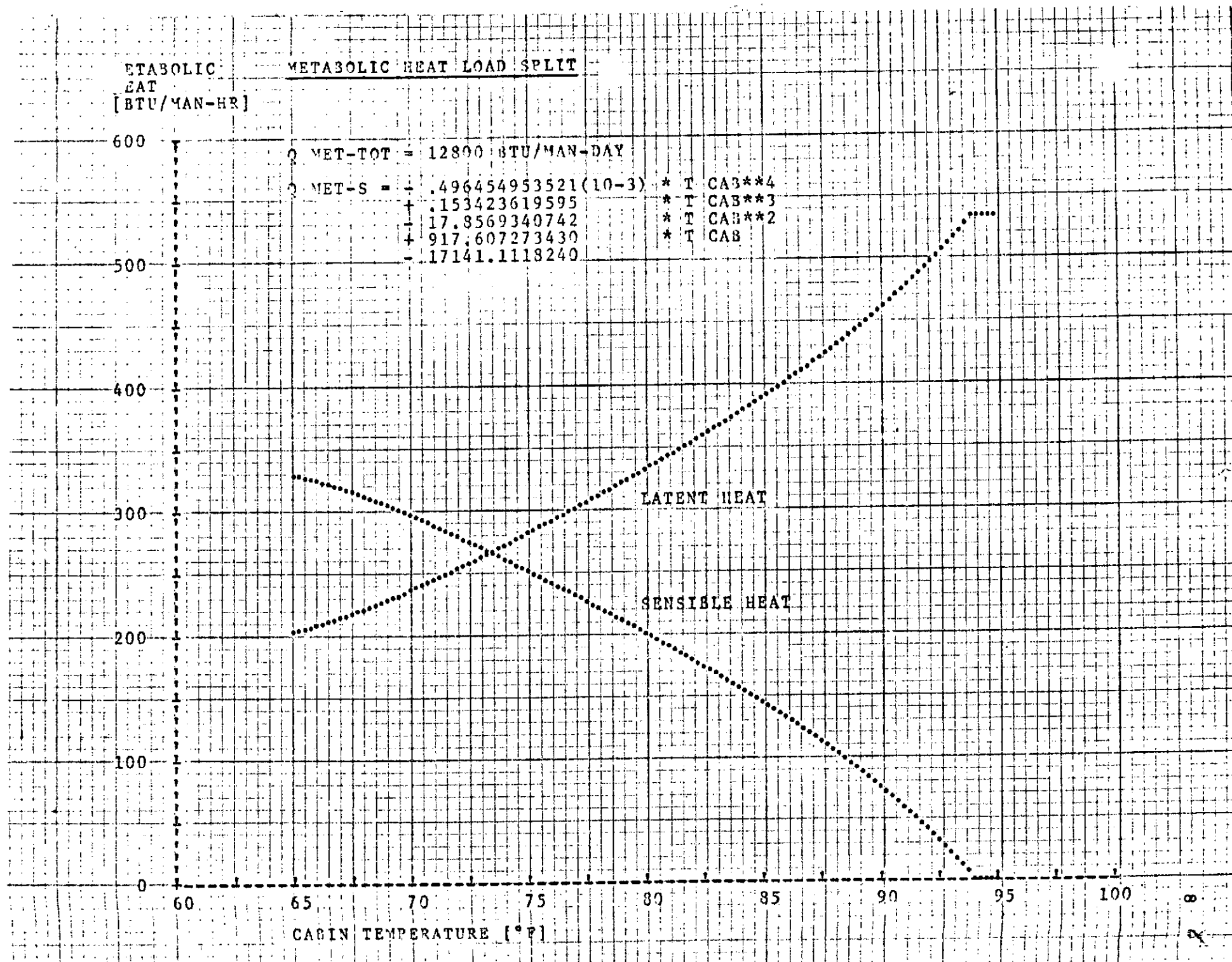
METABOLIC HEAT [BTU/MAN-HR]

METABOLIC HEAT LOAD SPLIT

$$Q \text{ MET-TOT} = 8640 \text{ BTU/MAN-DAY}$$

$$
\begin{aligned}
Q \text{ MET-S} = & - .496454953521(10^{-3}) * T_{CAB}^4 \\
& + .153423619595 * T_{CAB}^3 \\
& - 17.8569340742 * T_{CAB}^2 \\
& + 917.607273430 * T_{CAB} \\
& - 17141.1118240
\end{aligned}
$$

LATENT HEAT

SENSIBLE HEAT

CABIN TEMPERATURE [°F]
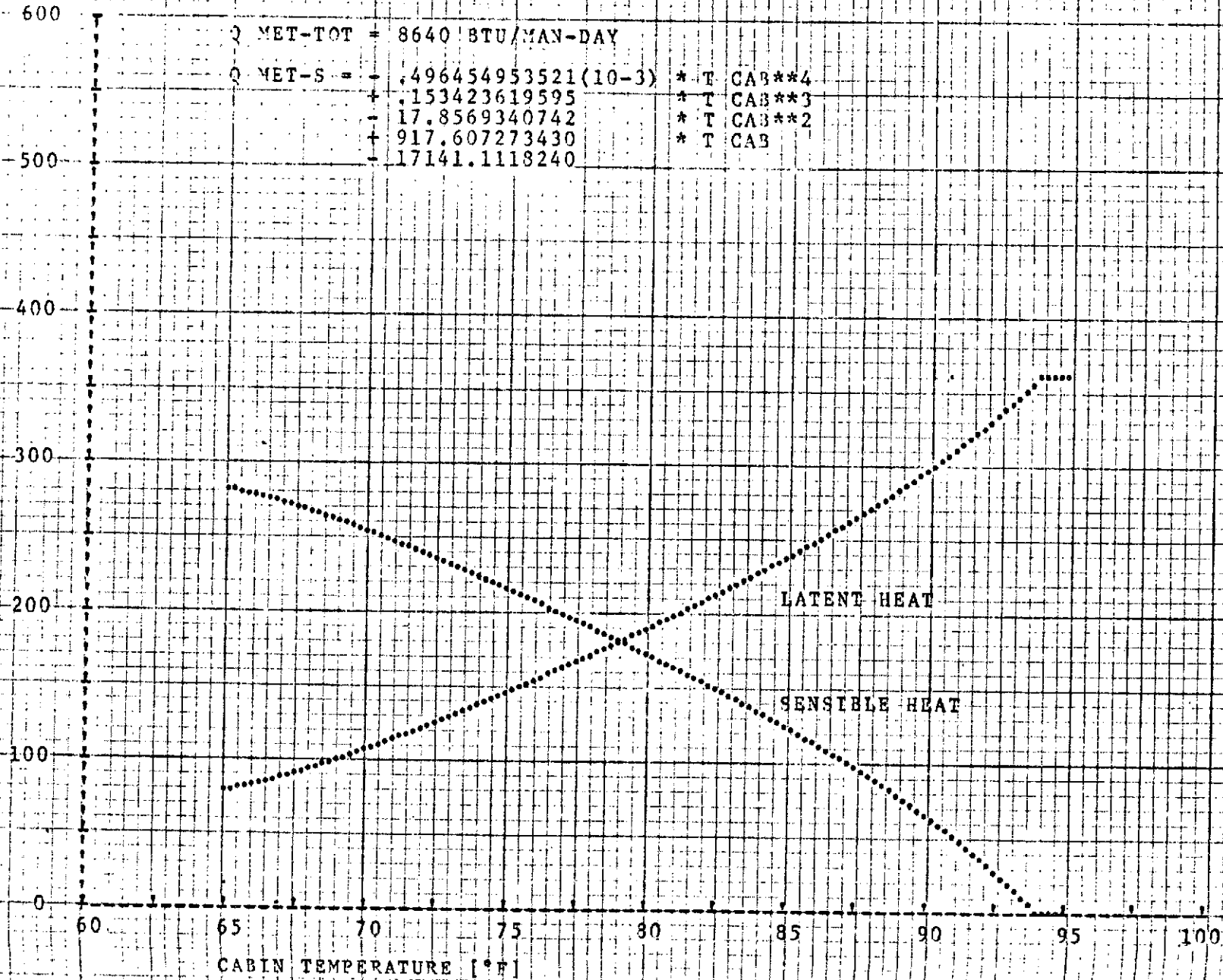
I.2   CALCULATION PROCEDURES

A. SUBLIMATOR

Calc.
Step

1	$EFF = 1 - 1/EXP\ (UA\text{-}SUBLM/W\ H_2O)$
2	$T_{IN} = 32 + Q\ TOT/(EFF)(W\ H_2O$
3	$T_{OUT} = T_{IN} - Q\ TOT/W\ H_2O$

B. GSE HEAT EXCHANGER

Calc.
Step

1	$Q\ UP\ STRM = Q\ H_2O\ LOOP + Q\ PLDHX - Q\ O_2HTR$
2	$T_{OUT} = T\ GSE$
3	ASSUME PUMP INLET $T = 75°\ F$
4	CALL SUBR 0103 (CAL. -F21 AT PUMP INLET)
5	$W\ F21 = (V\ F21P)\ (\rho\text{-}F21)$
6	$H\text{-}F21 = Q\ UP\ STRM/W\ F21$
7	CALL SUBR 0101 (CAL H-F21 FOR T_{OUT})
8	$H\text{-}F21\ AT\ PUMP\ INLET = H\text{-}F21\ @\ T_{OUT} + \Delta\ H\ F21$
9	CALL SUBR 0102 (CAL T-F21 AT PUMP INLET)
10	CALL SUBR 0103 (CAL ρ-F21 AT PUMP INLET)
11	$W\ F21_i = W\ F21$
12	$W\ F21 = (V\ F21P)\ (\rho\text{-}F21)$
13	$IF\ [.5(10^{-2}) - (ABS(W\ F21\text{-}W\ F21_i)/WF21]\ 6,\ 14,\ 14$
14	$H\text{-}F21 = Q\ TOT/W\ F21$
15	CALL SUBR 0101 (CAL H-F21 FOR T_{OUT})
16	$H\text{-}F21\ AT\ GSEHX\ INLET = H\text{-}F21\ @\ T_{OUT} + \Delta\ H\text{-}F21$
17	CALL SUBR 0102 (CAL T-F21 AT GSEHX INLET)
18	CALL SUBR 0104 (CAL T F21-OUT FROM GSEHX)
20	IF (T GSE - T F21-OUT) 21,30,30
21	$T_{OUT} = T\ F21\text{-}OUT$
22	$H\text{-}F21 = Q\ UP\ STRM/W\ F21$
23	CALL SUBR 0101 (CAL H-F21 FOR T_{OUT})
24	$H\text{-}F21\ AT\ PUMP\ INLET = H\text{-}F21\ @\ T_{OUT} + \Delta\ H\text{-}F21$
25	CALL SUBR 0102 (CAL T-F21 AT PUMP INLET)
26	CALL SUBR 0103 (CAL ρ-F21 AT PUMP INLET)
27	$W\ F21^1 = (V\ F21P)\ (\ \text{-}F21)$
28	$IF\ [.5(10^{-2}) - (ABS(WF21 - WF21^1)/WF21]\ 6,29,29$
29	$T\ GSE = T_{OUT}$
30	$\Delta\ H\text{-}F21 = Q\ TOT/W\ F21$
31	CALL SUBR 0101 (CAL H-F21 FOR T GSE)
32	$H\text{-}F21\ AT\ GSEHX\ INLET = H\text{-}F21\ @\ T\ GSE + \Delta\ H\text{-}F21$
33	CALL SUBR 0102 (CAL T-F21 AT GSEHX INLET)
34	$T\ F21\text{-}OUT = T\ GSE$
35	$WCP\ F21 = Q\ TOT/(T\ F21\text{-}IN - T\ F21\text{-}OUT)$
36	$T\ GSE\text{-}OUT = T\ GSEHX + Q\ TOT/WC_p\ GSE$

I.2   (Continued)

B. GSE Heat Exchanger

SUBR 0101

Calc.
Step

1       $H\text{-}F21 = + .144837452282(10^{-6})T\text{-}F21^3$
        $- .108670483009(10^{-3})T\text{-}F21^2$
        $+ .234888555105\ T\text{-}F21$

2   RETURN

SUBR 0102

1       $T\text{-}F21 = +.945369306348(10^{-5})H\text{-}F21^3$
        $- .94490322457(10^{-2})H\text{-}F21^2$
        $+ 4.44339335775\ H\text{-}F21$
        $- 41.207334603$

2   RETURN

SUBR 0103

1   IF $\left[(WC_P\ GSE/WC_P\ F21)-1 \right]\ 4,2,4$
2   T F21-OUT = T GSEHX + Q TOT/UA GSEHX
3   GO TO 7
4       $C_1 = Q\ TOT\ (1/WC_P\ F21 - 1/WC_P\ GSE)$
5       $C_2 = 1 - EXP\left[(UA\ GSEHX)(1/WC_P\ F21 - 1/WC_P\ GSE) \right]$
6   T F21-OUT $= \left[((2)(T\ GSEHX) - C_1 \right]/C_2$
7   RETURN

C. RADIATOR

1       $Q\ UP\ STRM = Q\ H_2O\ LOOP + Q\ PLDHX$
                    $- Q\ O_2HTR$
2       $T_{OUT} = T\ RAD$
3   ASSUME PUMP INLET $T = 75°F$
4   CALL SUBR 0103 (CAL C-F21 AT PUMP INLET)
5   W F21 = Q UP STRM/W F21
6   Δ H-F21 = Q UP STRM/W F21
7   CALL SUBR 0101 (CAL H-F21 FOR T_{OUT})
8   H-F21 AT PUMP INLET = H-F21 @ T_{OUT} + Δ H-F21
9   CALL SUBR 0102 (CAL T-F21 AT PUMP INLET)

I.2   (Continued)

C. Radiator (cont'd.)

Calc.
Step

10	CALL SUBR 0103 (CAL ρ-F21 AT PUMP INLET)
11	W F21$_i$ = W F21
12	W F21 = (V F21P) (ρ-F21)
13	IF $[.5(10^{-2}) - (ABS(W F21-W F21_i)/W F21]$ 6,14,14
14	Δ H - F21 = Q TOT/W F21
15	CALL SUBR 0101 (CAL H-F21 FOR T_{OUT})
16	H-F21 AT RAD INLET = H-F21 @ T_{OUT} + Δ H-F21
17	CALL SUBR 0102 (CALL T-F21 AT RAD INLET)
18	WCp F21 = Q TOT/(T_{IN}-T_{OUT})
19	CALL SUBR 0104 (CAL T F21-OUT FROM RADIATOR)
20	IF (T RAD - T F21-OUT) 21,30,30
21	T_{OUT} = T F21-OUT
22	Δ H-F21 = Q UP STRM/W F21
23	CALL SUBR 0101 (CAL H-F21 FOR T_{OUT})
24	H-F21 AT PUMP INLET = H-F21 @ T_{OUT} + Δ H-F21
25	CALL SUBR 0102 (CAL T-F21 AT PUMP INLET)
26	CALL SUBR 0103 (CAL ρ-F21 AT PUMP INLET)
27	W F21^1 = (V F21P)(ρ-F21)
28	IF $[.5(10^{-2}) - (ABS(W F21-W F21^1)/W F21]$6,29,29
29	T RAD = T_{OUT}
30	Δ H-F21 = Q TOT/W F21
31	CALL SUBR 0101 (CAL H-F21 FOR T RAD)
32	H-F21 AT RAD INLET = H-F21 @ T RAD + Δ H-F21
33	CALL SUBR 0102 (CAL T-F21 AT RAD INLET)
34	IF $[.5(10^{-2}) - ABS(T F21-IN-T_{IN}]$ 35,37,37
35	T_{IN} = T F21-IN
36	GO TO 19
37	WCp F21 = Q TOT/(T F21-IN-T RAD)
38	T F21-OUT = T RAD

SUBR 0101

1    $H\text{-}F21 = +.144837452282(10^{-6})T\text{-}F21^3$
$$+ .108670483009(10^{-3})T\text{-}F21^2$$
$$+ .234888555105\ T\text{-}F21$$
$$+ 9.4564170923$$

2   RETURN

I.2   (Continued)

C. Radiator (Cont'd.)

Calc.
Step

SUBR 0102

1       $T\text{-}F21 = +\ .945369306348(10^{-5})H\text{-}F21^3$
$-\ .94490322457(10^{-2})H\text{-}F21^2$
$+\ 4.44339335775\ H\text{-}F21$
$-\ 41.207334603$

2   RETURN

SUBR 0103

1       $\rho\ \text{-}F21 = -\ .211247089686(10^{-6})T\text{-}F21^3$
$+\ .3227797214027(10^{-4})T\text{-}F21^2$
$-\ .841841492861(10^{-1})T\text{-}F21$
$+\ 91.4866666688$

2   RETURN

SUBR 0104

1   CALL SUBR 0107 (CAL T_{OUT} FOR $\dot{\omega}$ = 2200)
2   CALL SUBR 0107 (CAL T_{OUT} FOR $\dot{\omega}$ = 2400)
3   CALL SUBR 0107 (CAL T_{OUT} FOR $\dot{\omega}$ = 2600)
4   CALL SUBR 0107 (CAL T_{OUT} FOR $\dot{\omega}$ = 2800)
5   CALL SUBR 0107 (CAL T_{OUT} FOR $\dot{\omega}$ = 3000)
6   CALL SUBR 0107 (CAL T_{OUT} FOR $\dot{\omega}$ = 3200)
7   CALL SUBR 0107 (CAL T_{OUT} FOR $\dot{\omega}$ = 3400)
8   CALL SUBR 0107 (CAL T_{OUT} FOR $\dot{\omega}$ = 3600)
9   CALL SUBR 0107 (CAL T_{OUT} FOR $\dot{\omega}$ = 3800)
10   IF (W F21 - 3000) 11,25,25
11   IF (W F21 - 2200) 12,12,14
12   T_{OUT} FOR$\dot{\omega}$ = T_{OUT} FOR 2200
13   GO TO 45
14   STEPS = INT $\left[(W\ F21 - 2000)/200 \right]$
15   m = $\left[\ W\ F21 - (\dot{\omega}STEPS)(200)+2200)\ \right]$/200
16      $\dot{\omega}_1$ = 2200 + (200) ($\dot{\omega}$ STEPS)
17   T_1 = T_{OUT} FOR $\dot{\omega}_1$.
18      $\dot{\omega}_1$ = $\dot{\omega}_1$ + 200
19   T_2 = T_{OUT} FOR $\dot{\omega}_1$
20      $\dot{\omega}_1$ = $\dot{\omega}_1$ + 200
21   T_3 = T_{OUT} FOR $\dot{\omega}_1$
22      $\dot{\omega}_1$ = $\dot{\omega}_1$ + 200
23   T_4 = T_{OUT} FOR $\dot{\omega}_1$

I.2   (Continued)

C. Radiator (Cont'd.)

Calc.
Step

24	GO TO 38
25	IF (3800 - W F21) 26,26,28
26	T_{OUT} FOR = T_{OUT} FOR 3800
27	GO TO 45
28	$\dot{\omega}$ STEPS = INT $[(3800 - W F21)/200]$
29	m = $[3800 - (200)(\dot{\omega} STEPS) - W F21]/200$
30	$\ddot{\omega}_1$ = 3800 - (200)($\dot{\omega}$ STEPS)
31	$T_1 = T_{OUT}$ FOR $\dot{W}_1$
32	$\ddot{\omega}_1 = \dot{\omega}_1 - 200$
33	$T_2 = T_{OUT}$ FOR ω_1
34	$\ddot{\omega}_1 = \ddot{\omega}_1 - 200$
35	$T_3 = T_{OUT}$ FOR $_1$
36	$\dddot{\omega}_1 = \ddot{\omega}_1 - 200$
37	$T_4 = T_{OUT}$ FOR $\dot{\omega}_1$
38	$D^1_3 = T_4 - T_3$
39	$D^1_2 = T_3 - T_2$
40	$D^1_1 = T_2 - T_1$
41	$D^2_2 = D^1_3 - D^1_2$
42	$D^2_1 = D^1_2 - D^1_1$
43	$D^3_1 = D^2_2 - D^2_1$
44	$T_{OUT} = T_1 + (m)(D^1_1) + (m)(m-1)(D^2_1)/2 + (m)(m-1)(m-2)(D^3_1)/6$
45	IF (T_{OUT} - T RAD) 46,46,47
46	T_{OUT} = T RAD
47	RETURN

<u>SUBR 0107</u>

1	$T_{OUT} = C_1 T_{IN}^3 + C_2 T_{IN}^2 + C_3 T_{IN} + C_4$
2	RETURN

D. <u>O_2 RESTRICTOR/HEATER</u>

Calc.
Step

1	Δ H - F21 = Q O_2HTR/W F21
2	CALL SUBR 0101 (CAL H-F21 AT T F21-IN)
3	H-F21 AT HTR OUTLET = H-F21 T F21-IN - Δ H - F21
4	CALL SUBR 0102 (CALL T-F21 AT HTR OUTLET)
5	WC_P F21 = Q O_2HTR/(T F21-IN - T F21-OUT)

I.2   (Continued)

D.   (Cont'd.)

SUBR 0101

1       $H - F21 = + .144837452282(10^{-6})T\text{-}F21^3$
$+ .108670483009(10\text{-}3)T\text{-}F21^2$
$+ .234888555105\ T\text{-}F21$
$+ 9.4564170923$

2   RETURN

SUBR 0102

1       $T - F21 = + .945369306348(10^{-5})\ H\text{-}F21^3$
$- .94490322347(10^{-2})\ H\text{-}F21^2$
$+ 4.44339335775\ H\text{-}F21$
$- 41.207334603$

2   RETURN

E.   F21/H_2O INTERCHANGER

Radiator or GSE Heat Exchanger Heat Sink

Calc.
Step

1       $\Delta\ H - F21 = Q\ H_2O\ LOOP/W\ F21$
2   CALL SUBR 0101 (CAL H-F21 AT T F21-IN)
3   H-F21 AT INTHX OUTLET = H-F21 @ T F21-IN $+ \Delta\ H - F21$
4   CALL SUBR 0102 (CAL T-F21 AT INTHX OUTLET)
5       $WC_P\ F21 = Q\ H_2O\ LOOP/(T\ F21\text{-}OUT\text{-}T\ F21\text{-}IN)$
6   IF ($WC_P\ F21/W\ H_2O - 1$) 9,7,9
7       $T\ H_2O\text{-}OUT = T\ F21\text{-}IN + Q\ H_2O\ LOOP/UA\text{-}INTHX$
8   GO TO 12
9       $C_1 = Q\ H_2O\ LOOP\ (1/W\ H_2O - 1/WC_P\ F21)$
10      $C_2 = 1 - EXP\ [(UA\ INTHX)\ (1/W\ H_2O - 1/WC_P\ F21)]$
11      $T\ H_2O\text{-}OUT = C_2\ T\ F21\text{-}IN - C_1)/C_2$
12      $T\ H_2O\text{-}IN = T\ H_2O\text{-}OUT + Q\ H_2O\ LOOP/W\ H_2O$

SUBR 0101

1       $H\text{-}F21 = + .144837452282(10^{-6})T\text{-}F21^3$
$+ .108670483009(10\text{-}3)T\text{-}F21^2$
$+ .234888555105\ T\text{-}F21$
$+ 9.4564170923$

2   RETURN

I.2   (Continued)

E.   (Continued)

Calc.
Step

SUBR 0102

1        $T\text{-}F21 = + .945369306348(10^{-5})\ H\text{-}F21^3$
         $- .94490322457(10^{-2})\ H\text{-}F21^2$
         $+ 4.44339335775\ H\text{-}F21$
         $- 41.207334603$

2   RETURN

F.   POTABLE H_2O CHILLER

1   IF (W H_2O/W CHILL - 1) 4,2,4
2   T POT-OUT = T H_2O-IN + Q CHILL/UA CHILL
3   GO TO 7
4   C_1 = Q CHILL (1/W CHILL - 1/W H_2O)
5   C_2 = 1 - EXP (UA CHILL) (1/W CHILL - 1/W H_2O)
6   T POT-OUT = C_2 T H_2O-IN - C_1 /C_2
7   T H_2O-OUT = T H_2O-IN + Q CHILL/W H_2O
8   T POT-IN = T POT-OUT + Q CHILL/W CHILL

G.   ARS CABIN GAS LOOP

1   LOOP CNTR = 0
2   T CAB = T CAB_i
3   Q MET-S = Q $MET\text{-}S_i$
4   Q MET-L = Q $MET\text{-}L_i$
5   Q HX INLET = Q ELEC + Q FAN + (35)(W CO_2)
6   Q TOT-S = Q MET-S + Q CAB-S + Q HX INLET
7   Q TOT-L = Q MET-L + Q CAB-L + (17.5)(W CO_2)
8   H_2O COND = Q TOT-L/106S
9   CALL SUBR 0101 (CAL WC_P FAN FOR T CAB)
10   WC_P HX = WC_P FAN
11   T HX-IN = T CAB + Q HX INLET/WC_P FAN
12   T HX-OUT = T HX-IN - Q TOT-S/WC_P HX
13   IF [(THX-OUT - 2) - T H_2O -IN] 14,22,22
14   t HX-OUT = T HX-OUT + 1
15   T HX-IN = T HX-OUT + Q TOT-S/WC_P HX
16   T CAB = T HX-IN + Q HX INLET/WC_P FAN
17   CALL SUBR 0101 (CAL WC_P FAN FOR T CAB)
18   CALL SUBR 0102 (CAL Q MET-S, Q MET-L, Q TOT-S AND Q TOT-L FOR T CAB)

G. ARS Cabin Gas Loop (Continued)

Calc.
Step

Step	
19	$T\ HX\text{-}IN = T\ CAB + Q\ HX\ INLET/WC_p\ FAN$
20	$T\ HX\text{-}OUT = T\ HX\text{-}IN - Q\ TOT\text{-}S/WC_p\ HX$
21	IF $[(T\ HX\text{-}OUT - 2) - T\ H_2O\text{-}IN]\ 14,22,22$
22	CALL SUBR 0103 (CAL CABIN T DEWPT)
23	$T\ COND = T\ DEWPT - 1$
24	$Q\ TOT = Q\ TOT\text{-}S + Q\ TOT\text{-}L$
25	$T\ H_2O\text{-}OUT = T\ H_2O\text{-}IN + Q\ TOT/W\ H_2O$
26	IF $(T\ HX\text{-}IN - T\ H_2O\text{-}OUT)\ 14,14,27$
27	$Q\ WET = W\ H_2O\ (T\ COND - T\ H_2O\text{-}IN)$
28	IF $(Q\ TOT - Q\ WET)\ 29,29,34$
29	$UA\text{-}DRY = 0$
30	$T\ COND = T\ H_2O\text{-}OUT$
31	$T\ OUT\text{-}DRY = T\ HX\text{-}IN$
32	$Q\ WET = Q\ TOT$
33	GO TO 39
34	$Q\ DRY = Q\ TOT - Q\ WET$
35	$T\ OUT\text{-}DRY = T\ HX\text{-}IN - Q\ DRY/WC_p\ HX$
36	IF $(T\ COND - T\ OUT\text{-}DRY)\ 37,61,61$
37	$\Delta\ TLM\text{-}DRY = \dfrac{(T_{HX\text{-}IN} - T_{H_2O\text{-}OUT} - T\ OUT\text{-}DRY + T\ COND)}{In\ [(T\ HX\text{-}IN - T_{H_2O\text{-}OUT})/(T_{OUT\text{-}DRY} - T\ COND)]}$
38	$UA\text{-}DRY = Q\ DRY/\ TLM\text{-}DRY$
39	$\Delta\ TLM\text{-}WET = \dfrac{(T\ OUT\text{-}DRY - T\ COND - T\ HX\text{-}OUT + T\ H_2O\text{-}IN)}{In\ [(T\ OUT\text{-}DRY - T\ COND)/(T\ HX\text{-}OUT - T\ H_2O\text{-}IN)]}$
40	$UA\text{-}WET = Q\ WET/\ TLM\text{-}WET$
41	$UA\ REQ'D = UA\text{-}DRY + UA\text{-}WET$
42	$\Delta\ UA = UA\ REQ'D - UA\ CABHX$
43	$TOL\ UA = (TOL\ UA)\ (UA\ CABHX)$
44	IF $TOL\ UA - ABS\ (\Delta\ UA)\ 45,76,76$
45	IF $(\Delta\ UA)\ 46,61,61$
46	IF $(T\ HX\text{-}OUT - 2) - T\ H_2O\text{-}IN\ 76,76,47$
47	$T\ HX\text{-}OUT = T\ H_2O\text{-}IN + \dfrac{(T\ HX\text{-}OUT - T\ H_2O\text{-}IN)\ (UA\ REQ'D)}{UA\ CABHX}$
48	$WC_p\ HX = Q\ TOT\text{-}S/(T\ HX\text{-}IN - T\ HX\text{-}OUT)$
49	IF $(T\ CAB_i - T\ CAB)\ 50,54,54$
50	$WC_p\ HX = WC_p\ FAN$
51	$T\ CAB = T\ CAB - 0.1$
52	CALL SUBR 0101 (CAL WC_p FAN FOR T CAB)
53	CALL SUBR 0102 (CAL Q MET-S, Q MET-L, Q TOT-S AND Q TOT-L FOR T CAB)
54	$T\ HX\text{-}IN = T\ CAB + Q\ HX\ INLET/WC_p\ FAN$
55	$T\ HX\text{-}OUT = T\ HX\text{-}IN - Q\ TOT\text{-}S/WC_p\ HX$
56	IF $[(T\ HX\text{-}OUT\ 6\ 2) - T\ H_2O\text{-}IN]\ 57,74,74$
57	$WC_p\ HX = Q\ TOT\text{-}S/\ (Q\ HX\ INLET/WC_p\ FAN) - (T\ H_2O\text{-}IN + 2) + T\ CAB$
58	$T\ HX\text{-}OUT = T\ H_2O\text{-}IN + 2$
59	$T\ HX\text{-}IN = T\ HX\text{-}OUT + Q\ TOT\text{-}S/WC_p\ HX$
60	GO TO 74
61	IF $(WC_p\ HX - WC_p\ FAN)\ 62,68,68$
62	$WC_p\ HX = Q\ TOT\text{-}S/[T\ HX\text{-}IN - T\ HX\text{-}OUT - 0.2]$
63	IF $(WC_p\ HX - WC_p\ FAN)\ 65,64,64$
64	$WC_p\ HX = WC_p\ FAN$
65	$T\ HX\text{-}IN = T\ CAB + Q\ HX\ INLET/WC_p\ FAN$
66	$T\ HX\text{-}OUT = T\ HX\text{-}IN - Q\ TOT\text{-}S/WC_p\ HX$

G. ARS Cabin Gas Loop (Continued)

Calc.
Step

67	GO TO 74
68	T CAB = T CAB + 1
69	CALL SUBR 0101 (CAL WC_p FAN FOR T CAB)
70	CALL SUBR 0102 (CAL Q MET-S, Q MET-L, Q TOT-S AND Q TOT-L FOR T CAB)
71	WC_p HX = WC_p FAN
72	T HX-IN = T CAB - Q HX INLET/WC_p FAN
73	T HX-OUT = T HX-IN - Q TOT-S WC_p HX
74	LOOP CNTR = LOOP CNTR + 1
75	IF (LOOP CNTR - 35) 22,76,76
76	CALL SUBR 0103 (CAL CABIN T DEWPT)
77	Q L1OH-S = (35) (W CO_2)
78	Q L1OH-L = (17.5) (W CO_2)
79	$ppCO_2 = \dfrac{(T\ CAB + 459.6)\ (W\ CO_2)}{(56.1)\ (V\ L1OH)}$
80	V HX = $[(WC_p$ HX) (V FAN)$]$/WC_p FAN
81	V BYPASS = V FAN - V HX

SUBR 0101

1	WC_p FAN = 1.0711842838 (V FAN)
2	WC_p FAN_1 = WC_p FAN
3	WC_p FAN = $\dfrac{(572.65511811)\ (V\ FAN)}{[(Q\ ELEC/WC_p\ FAN_1) + T\ CAB + 459.6]}$
4	IF $[.5(10^{-2}) - (ABS(WC_p$ FAN - WC_p $FAN_1)/WC_p$ FAN$]$ 2,5,5
5	WC_p HX = WC_p FAN
6	RETURN

SUBR 0102

1	Q TOT-S = Q TOT-S - Q MET-S
2	Q TOT-L = Q TOT-L - Q MET-L
3	IF (94 - T CAB) 4,4,7
4	Q MET-S = 0
5	Q MET-L = Q MET-S_i + Q MET-L_i
6	GO TO 11
7	CALL SUBR 0104 (CAL Q_S FOR T CAB_i)
8	CALL SUBR 0104 (CAL Q_S FOR T CAB)
9	Q MET-S = $[$Q MET-S_i 1 - (Q_{S_i} - Q_S)/$Q_{S_i}]$
10	Q MET-L = Q MET-S_i + Q MET-L_i - Q MET-S
11	Q TOT-S = Q TOT-S + Q MET-S
12	Q TOT-L = Q TOT-L + Q MET-L
13	H_2O COND = Q TOT-L/1065
14	RETURN

G. ARS Cabin Gas Loop (Continued)

Calc.
Step

SUBR 0104

1      $Q_S = -.4964549535211(10^{-3})$ T CAB^4
         $+.153423619595$ T CAB^3
         -17.8569340742 T CAB^2
         $+917.60727343$ T CAB
         -1714.111824

2   RETURN

SUBR 0103

1   COUNTER = 0
2   CALL SUBR 0105 (CAL P H_2O FOR T HX-OUT)
3   H_2O OUT $= \dfrac{(P\ H_2O\text{-OUT})(V\ FAN)(60)(WC_P\ HX)}{(.595)(T\ HX\text{-OUT} + 459.6)(WC_P\ FAN)}$
4   TOT H_2O = H_2O OUT + H_2O COND
5   T $H2O$ = T HX-OUT
6   P H_2O $= \dfrac{(T\ H_2O + 459.6)(.595)(TOT\ H_2O)(WC_P\ FAN)}{(V\ FAN)\ (60)\ (WC_P\ HX)}$
7   CALL SUBR 0106 (CAL T H_2O FOR P H_2O)
8   COUNTER = COUNTER + 1
9   I (COUNTER - 3) 6,10,10
10   T DEWPT = T H_2O
11   RETURN

SUBR 0105

1   P $H2O$ $= -.137982438332(10^{-11})$ T H_2O^5

         $+.727253519326(10^{-8})$ T H_2O^4
         $-.42156805717(10^{-6})$ T H_2O^3
         $+.640627941428(10^{-4})$ T H_2O^2
         $-.20762402311(10^{-3})$ T H_2O
         $+.359979371788(10^{-1})$

2   RETURN

SUBR 0106

1   T H_2O = $+3563.65514163$ P H_2O^5
         -6508.86440198 P H_2O^4
         $+4849.14318832$ P H_2O^3
         -1943.30027988 P H_2O^2
         $+511.12859363$ P H_2O
         $-.855385312$

2   RETURN

H. H_2O COOLANT LOOP PUMP, IMU COLDPLATES, COLDWALL, OR CABIN WINDOWS

Calc.
Step

1    $T_{H_2O - OUT} = T_{H_2O - IN} + Q/W\ H_2O$

I. AVIONICS BAYS - TYPICAL FOR ONE BAY

Calc.
Step

1    $W\ H_2O = W\ H_2O/3$
2   T CP-OUT = $T\ H_2O$-IN $+$ Q CP/W H_2O
3   Q ABHX = Q AB $+$ Q ABFAN
4   WCp AIR = $\dfrac{(572.65511811)(V\ ABFAN)}{[(Q\ ABHX/W\ H_2O) + T\ Q\text{-}OUT + 459.6]}$
5   CALL SUBR 0101 (CAL $T_{AIR\text{-}OUT}$)
6   WCp AIR' = WCp AIR
7   WCp AIR = $\dfrac{(572.65511B11)(V\ ABFAN)}{[(Q\ AB/WCp\ AIR') + T_{AIR\text{-}OUT} + 459.6]}$
8   IF $.5(10^{-2})$ - (ABS(WCp AIR - WCp AIR')/WCp AIR)   5, 9, 9
9   CALL SUBR 0101 (CAL $T_{AIR\text{-}OUT}$)
10   T ABAY = $T_{AIR\text{-}OUT} +$ Q AB/WCp AIR
11   $T_{AIR\text{-}IN} = T_{AIR\text{-}OUT} +$ Q ABHX/WCp AIR
12   T H_2O-OUT = T CP-OUT $+$ Q ABHX/W H_2O

SUBR 0101

1   IF (W H_2O/WCp AIR-1) 4, 2, 4
2   T AIR-OUT = T CP-OUT $+$ Q ABHX/UA ABHX
3   GO TO 7
4   C_1 = Q ABHX (1/WCp AIR - 1/W H_2O)
5   C_2 = 1 - EXP (UA ABHX) (1/WCp AIR - 1/W H_2O)
6   T AIR-OUT = $[C_2$ T CP-OUT - $C_1]$ /C_2
7   RETURN

J. F21/H_2O INTERCHANGER; SUBLIMATOR HEAT SINK

Calc.
Step

1   ASSUME PUMP INLET T = 100°F
2   CALL SUBR 0103 (CAL ρ -F21 AT PUMP INLET)
3   W F21 = (V F21P) (ρ -F21)
4   T F21-OUT = T H_2O-IN $+5$
5   CALL SUBR 0101 (CAL H-F21 AT T F21-OUT)
6   Δ H-F21 = Q F21 LOOP/W F21
7   H-F21 AT INTHX INLET = H-F21 T F21-OUT $+\Delta$ H-F21
8   CALL SUBR 0102 (CAL T-F21 AT INTHX INLET)

J. F21/H₂0 Interchanger (Cont'd.)

Calc.
Step

9   W Cp F21 = Q F21 LOOP/T F21-IN-T F21-OUT
10   CALL SUBR 0104 (CAL T F21-OUT)
11   CALL SUBR 0101 (CAL H-F21 AT T F21-OUT)
12   H-F21 = Q PLDHX/W F21
13   H-F21 AT PUMP INLET = H-F21 @ T F21-OUT $+\Delta$ H-F21
14   CALL SUBR 0102 (CAL T-F21 AT PUMP INLET)
15   CALL SUBR 0103 (CAL -F21 AT PUMP INLET)
16   W F21' = W F21
17   W F21 = (V F21P)(-F21)
18   IF $\lceil$.5(10⁻²)-(ABS(W F21-W F21')/W F21)$\rceil$ 19, 25, 25
19   CALL SUBR 0101 (CAL H-F21 AT T F21-OUT)
20   H-F21 = Q F21 LOOP/W F21
21   H-F21 AT INTHX INLET = H-F21 @ T F21-OUT
                                   $+\Delta$ H-F21
22   CALL SUBR 0102 (CAL T-F21 AT INTHX INLET)
23   WCp F21 = Q F21 LOOP/T F21-IN-T F21-OUT
24   GO TO 10
25   CALL SUBR 0104 (CAL T F21-OUT)
26   CALL SUBR 0101 (CAL H-F21 AT T F21-OUT)
27   Δ H-F21 = Q F21 LOOP/W F21
28   H-F21 AT INTHX INLET = H-F21 AT T F21-OUT $+\Delta$ H-F21
29   CALL SUBR 0102 (CAL T-F21 AT INTHX INLET)
30   WCp F21 = Q F21 LOOP/T F21-IN-T F21-OUT
31   T H₂0-OUT = T H₂0-IN $+$ Q F21 LOOP/W H₂0

SUBR 0101

1   H-F21 = $+$ .144837452282(10⁻⁶)T-F21³
         $+$ .108670483009(10⁻³)T-F21²
         $+$ .234888555105 T-F21
         $+$ 9.4564170923

2   RETURN

SUBR 0102

1   T-F21 = $+$ .945369306348(10⁻⁵)H-F21³
        $-$ .94490322457(10⁻²)H-F21²
        $+$ 4.44339335775 H-F21
        $-$ 41.207334603

2   RETURN

SUBR 0103

1   -F21 = $-$ .211247089686(10⁻⁶)T-F21³
         $+$ ..327797214027(10⁻⁴)T-F21²
         $-$ .841841492861(10⁻¹)T-F21
         $+$ 91.4866666688

2   RETURN

J. F21/H$_2$O Interchanger (Cont'd.)

SUBR 0104

1	IF (W H$_2$O/WCp F21-1) 4, 2, 4
2	T F21-OUT = T H$_2$O-IN $+$ Q F21 LOOP/UA INTHX
3	GO TO 7
4	C_1 = Q F21 LOOP (1/WCp F21-1/W H$_2$O)
5	C_2 = 1-EXP [(UA INTHX)(1/WCp F21-1/W H$_2$O)]
6	T F21-OUT = [C_2 T H$_2$O-IN-C_1] /C_2
7	RETURN

K. PAYLOAD HEAT EXCHANGER

Calc.
Step

1	CALL SUBR 0101 (CAL H-F21 AT T F21-IN)
2	Δ H-F21 = Q PLDHX/W F21
3	H-F21 AT PLDHX OUTLET = H-F21 @ T F21-IN $+ \Delta$ H-F21
4	CALL SUBR 0102 (CAL T-F21 AT PLDHX OUTLET)
5	WCp F21 = Q PLDHX/(T F21-OUT-T F21-IN)
6	IF (WCp F21/WCp PLD-1) 9,7,9
7	T PLD-OUT = T F21-IN $+$ Q PLDHX/UA PLDHX
8	GO TO 12
9	C_1 = Q PLDHX (1/WCp PLD - 1/WCp F21)
10	C_2 = 1-EXP [(UA PLDHX)(1/WCp PLD-1/WCp F21)]
11	T PLD-OUT = [C_2 T F21-IN-C_1] /C_2
12	T PLD-IN = T PLD-OUT $+$ Q PLDHX/WCp PLD

SUBR 0101

1	H-F21 = $+$ .144837452282(10^{-6})T-F21^3
	$+$ .108670483009(10^{-3})T-F21^2
	$+$ .234888555105 T-F21
	$+$ 9.4564170923
2	RETURN

SUBR 0102

1	T-F21 = $+$ .945369306348(10^{-3})H-F21^3
	$-$ .94490322457(10^{-2})H-F21^2
	$+$ 4.44339335775 H-F21
	$-$ 41.207334603
2	RETURN

L. F21 COOLANT LOOP PUMP

Calc.
Step

1	CALL SUBR 0101 (CAL H-F21 AT T F21-IN)
2	Δ H-F21 = Q F21 PUMP/W F21
3	H-F21 AT PUMP OUTLET = H-F21 @ T F21-IN $+ \Delta$ H-F21
4	CALL SUBR 0102 (CAL T-F21 AT PUMP OUTLET)

L. <u>F21 Coolant Loop Pump (Cont'd.)</u>

$\quad$ 5 $\quad$ WCp F21 = Q F21 PUMP/(T F21-OUT-T F21-IN)

$\quad$ 6 $\quad$ CALL SUBR 0103 (CAL ρ-F21 AT PUMP INLET)

$\quad$ 7 $\quad$ W F21-ACT = (V F21P)(ρ-F21)

<u>SUBR 0101</u>

$\quad$ 1 $\quad$ H-F21 = + .144837452282(10^{-6})T-F21^3
$\qquad$ + .108670483009(10^{-3})T-F21^2
$\qquad$ + .23488555105 T-F21
$\qquad$ + 9.4564170923

$\quad$ 2 $\quad$ RETURN

<u>SUBR 0102</u>

$\quad$ 1 $\quad$ T-F21 = + .945369306348(10^{-5})H-F21^3
$\qquad$ − .94490322457(10^{-2})H-F21^2
$\qquad$ + 4.44339335775 H-F21
$\qquad$ − 41.207334603

$\quad$ 2 $\quad$ RETURN

<u>SUBR 0103</u>

$\quad$ 1 $\quad$ ρ-F21 = − .211247089686(10^{-6})T-F21^3
$\qquad$ + .327797214027(10^{-4})T-F21^2
$\qquad$ − .841841492861(10^{-1})T-F21
$\qquad$ + .91.4866666688

$\quad$ 2 $\quad$ RETURN

M. <u>FUEL CELL HEAT EXCHANGER</u>

Calc.
<u>Step</u>

$\quad$ 1 $\quad$ IF (# FCELL-1) 2,2,4

$\quad$ 2 $\quad$ UA FCLHX = (2/3)(UA FCLHX)

$\quad$ 3 $\quad$ W F21 = (2/3)(W F21)

$\quad$ 4 $\quad$ WCp FCL = (# FCELL)(WCp FCL)

$\quad$ 5 $\quad$ CALL SUBR 0101 (CAL H-F21 AT T F21-IN)

$\quad$ 6 $\quad$ ΔH-F21 = Q FCELL/W F21

$\quad$ 7 $\quad$ H-F21 AT FCLHX OUTLET = H-F21 @ T F21-IN + ΔH-F21

$\quad$ 8 $\quad$ CALL SUBR 0102 (CAL T-F21 AT FCLHX OUTLET)

$\quad$ 9 $\quad$ WCp F21 = Q FCELL/(T F21-OUT-T F21-IN)

$\quad$ 10 $\quad$ IF (WCp F21/WCp FCL-1) 13,11,13

$\quad$ 11 $\quad$ T FCL-OUT = T F21-IN + Q FCELL/UA FCLHX

$\quad$ 12 $\quad$ GO TO 16

$\quad$ 13 $\quad$ C_1 = Q FCELL (1/WCp FCL − 1/WCp F21)

$\quad$ 14 $\quad$ C_2 = 1-EXP [(UA FCLHX)(1/WCp FCL-1/WCp F21)]

$\quad$ 15 $\quad$ T FCL-OUT = [C_2 T F21-IN-C_1]/C_2

$\quad$ 16 $\quad$ T FCL-IN = T FCL-OUT + Q FCELL/WCp FCL

<u>SUBR 0101</u>

$\quad$ 1 $\quad$ H-F21 = + .144837452282(10^{-6})T-F21^3
$\qquad$ + .108670483009(10^{-3})T-F21^2
$\qquad$ + .234888555105 T-F21
$\qquad$ + 9.4564170923

M.   <u>Fuel Cell Heat Exchanger</u> (Cont'd.)

Calc.
<u>Step</u>

2   RETURN

<u>SUBR 0102</u>

1       $\text{T-F21} = + .945369306348(10^{-5})\text{H-F21}^3$
$- .94490322457(10^{-2})\text{H-F21}^2$
$+ 4.44339335775 \text{ H-F21}$
$- 41.207334603$

2   RETURN

N.   <u>HYDRAULICS HEAT EXCHANGER</u>

Calc.
<u>Step</u>

1   CALL SUBR 0101 (CAL H-F21 AT T F21-IN)
2       $\Delta\text{H-F21} = \text{Q HYDHX/W F21}$
3   H-F21 AT HYDHX OUTLET = H-F21 @ T F21-IN $- \Delta$H-F21
4   CALL SUBR 0102 (CAL T-F21 AT HYDHX OUTLET)
5   WCp F21 = Q HYDHX/(T F21-IN-T F21-OUT)
6   IF (WCp F21/WCp HYD-1) 9,7,9
7   T HYD-IN = T F21-OUT-Q HYDHX/UA HYDHX
8   GO TO 13
9       $C_1 = \text{EXP}\big[(\text{T F21-IN-T F21-OUT-Q HYDHX/Wp HYD})(\text{UA HYDHX})/(\text{Q HYDHX})\big]$
10      $C_2 = C_1\text{-}1$
11      $C_1 = (C_1) (\text{T F21-OUT})$
12   T HYD-IN = $(\text{Q HYDHX/WCp HYD-T F21-IN}^+C_1)/C_2$
13   T HYD-OUT = T HYD-IN $^+$ Q HYDHX/WCp HYD

<u>SUBR 0101</u>

1       $\text{H-F21} = + .144837452282(10^{-6})\text{T-F21}^3$
$+ .108670483009(10^{-3})\text{T-F21}^2$
$+ .234888555105 \text{ T-F21}$
$+ 9.4564170923$

2   RETURN

<u>SUBR 0102</u>

1       $\text{T-F21} = + .945369306348(10^{-5})\text{H-F21}$
$- .94490322457(10^{-2})\text{H-F21}$
$+ 4.44339335775 \text{ H-F21}$
$- 41.207334603$

2   RETURN

O.   <u>F21 COOLANT LOOP ENVIRONMENT LOAD</u>

Calc.
<u>Step</u>

1   CALL SUBR 0101 (CAL H-F21 AT T F21-IN)

O. <u>F21 Coolant Loop Environment Load</u> (Cont'd.)

Calc.
<u>Step</u>

2   Δ H-F21 = Q ENVIRN/WF21
3   H-F21 AT OUTLET = H-F21 @ T F21-IN $+\Delta$ H-F21
4   CALL SUBR 0102 (CAL T-F21 AT OUTLET)
5   WCp F21 = Q ENVIRN/ABS (T F21-OUT-T F21-IN)

<u>SUBR 0101</u>

1   H-F21 = $+$ $.144837452282(10^{-6})$T-F21^3
$+$ $.108670483009(10$-$3)$T-F21^2
$+$ $.234888555105$ T-F21
$+$ 9.4564170923
2   RETURN

<u>SUBR 0102</u>

1   T-F21 = $+$ $.945369306348(10^{-5})$H-F21^3
$-$ $.94490322457(10^{-2})$H-F21^2
$+$ 4.44339335775 H-F21
$-$ 41.207334603
2   RETURN

APPENDIX II

I

Step	Code	Key	Comment	Step	Code	Key	Comment
0	040B	mark					
1	0000	00					
2	0410	GROUP 2					
3	0001	01	PROG TAPE				
4	0410	GROUP 2					
5	0100		REWIND				
6	0410	GROUP 2					
7	0002	02	DATA TAPE				
8	0410	GROUP 2					
9	0100		REWIND				
10	0700	0					
1	0404	ST DIR					
2	0000	K.00	BLK CNTR				
3	040B	mark					
4	0001	01					
5	0405	RE DIR					
6	0000	K 00	BLK CNTR				
7	0514	GO					
8	0514	GO					
9	0412	WRITE A	SKIP IF				
20	0611	LOG cX	X=0				
1	0407	SEARCH					
2	0002	02					
3	0515	STOP					
4	040B	mark					
5	0002	02					
6	0410	GROUP 2					
7	0001	01	PROG TAPE				
8	0415	RE Y					
9	0000	K.00	BLK CNTR				
30	0703	3					
1	0705	5					
2	0806		TRANSFER				
3	0407	SEARCH					
4	0003	03					
5	0512	END PROG					

Remarks:

Step	Code	Key	Comment
5	0408	MARK	
6	0003	03	
7	0701	1	
8	0400	+ DIR	
9	0000	R.00	BLK CNTR
4	0410	GROUP 2	
1	0001	01	PROG. TAPE
2	0415	KEY	
3	0000	R.00	BLK CNTR
4	0702	2	
5	0709	9	
6	0701	1	
7	0806		TRANSFER
8	0701	1	
9	0400	+ DIR	

Step	Code	Key	Comment
50	0000	R.00	BLK CNTR
1	0415	KEY	
2	0000	R.00	BLK CNTR
3	0705	S	
4	0704	4	
5	0707	7	
6	0806		TRANSFER
7	0701	1	
8	0400	+ DIR	
9	0000	R.00	BLK CNTR
60	0415	KEY	
1	0000	R.00	BLK CNTR
2	0708	8	
3	0700	0	
4	0703	3	
5	0806		TRANSFER
6	0701	1	
7	0400	+ DIR	
8	0000	R.00	BLK CNTR
9	0415	KEY	
70	0000	R.00	BLK CNTR
1	0701	1	
2	0700	0	
3	0705	S	
4	0709	9	
5	0806		TRANSFER
6	0701	1	
7	0400	+ DIR	
8	0000	R.00	BLK CNTR
9	0701	1	
80	0404	ST DIR	
1	0010	R.10	DATA BLK
2	0701	1	
3	0706	6	
4	0404	ST DIR	
5	0015	R.15	DATA BLK
6	0408	MARK	
7	0009	09	
8	0410	GROUP 2	
9	0007	07	DATA TAPE
90	0415	KEY	
1	0010	R.10	DATA BLK
2	0701	1	
3	0709	9	
4	0703	3	
5	0706	6	
6	0802		TRANSFER
7	0410	GROUP 2	
8	0003	03	EXT. CORE
9	0415	KEY	

Remarks: PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0015	R.15	DATA BLK	150	0415	RE Y	
1	0701	1		1	0010	R.10	DATA BLK
2	0709	9		2	0701	1	
3	0703	3		3	0703	3	
4	0706	6		4	0700	O	
5	0810		TRANSFER	5	0509	SKIP IF Y=X	
6	0701	1		6	0407	SEARCH	
7	0400	+ DIR		7	0005	05	
8	0010	R.10	DATA BLK	8	0405	RE DIR	
9	0701	1		9	0004	R.04	DATA
110	0706	6		160	0411	WRITE	
1	0400	+ DIR		1	0304		DP-3.4
2	0015	R.15	DATA BLK	2	0407	SEARCH	
3	0415	RE Y		3	0006	06	
4	0010	R.10	DATA BLK	4	0408	MARK	
5	0703	3		5	0005	05	
6	0707	7		6	0405	RE DIR	
7	0509	SKIP IF Y=X		7	0004	R.04	DATA
8	0407	SEARCH		8	0411	WRITE	
9	0009	09		9	0502		DP-5.2
120	0703	3		170	0408	MARK	
1	0707	7		1	0006	06	
2	0404	ST DIR		2	0411	WRITE	
3	0010	R.10	DATA BLK	3	1503		3 SPACES
	0407	SEARCH		4	0415	RE Y	
	0004	04		5	0010	R.10	DATA BLK
6	0408	MARK		6	0701	1	
7	0100			7	0709	9	
8	0410	GROUP 2		8	0703	3	
9	0002	02	DATA TAPE	9	0706	6	
130	0415	RE Y		180	0810		TRANSFER
1	0010	R.10	DATA BLK	1	0405	RE DIR	
2	0701	1		2	0010	R.10	DATA BLK
3	0709	9		3	0404	ST DIR	
4	0703	3		4	0015	R.15	DATA BLK
5	0706	6		5	0701	1	
6	0802		TRANSFER	6	0706	6	
7	0405	RE DIR		7	0402	X DIR	
8	0004	R.04	DATA	8	0015	R.15	DATA BLK
9	0515	STOP		9	0410	GROUP 2	
140	0404	ST DIR		190	0003	03	EXT. CORE
1	0004	R.04	DATA	1	0415	RE Y	
2	0412	WRITE A		2	0015	R.15	DATA BLK
3	0102		SHIFT DN	3	0701	1	
4	0002		SPACE	4	0709	9	
5	0006		=	5	0703	3	
6	0413	END A		6	0706	6	
7	0701	1		7	0810		TRANSFER
8	0400	+ DIR		8	0701	1	
9	0010	R.10	DATA BLK	9	0400	+ DIR	

Remarks: PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0010	R.10	DATA BLK	250	0113		R
1	0511	RETURN		1	0014		F
2	0408	MARK		2	0109		O
3	0101			3	0113		R
4	0405	RE DIR		4	0115		M
5	0004	R.04	DATA	5	0112		A
6	0400	+ DIR		6	0206		N
7	0001	R.01	Q H2O LOOP	7	0212		C
8	0511	RETURN		8	0205		E
9	0408	MARK		9	0108		CR/LF
210	0102			260	0110		LF
1	0405	RE DIR		1	0115		M
2	0004	R.04	DATA	2	0104		I
3	0400	+ DIR		3	0101		S
4	0002	R.02	Q F21 LOOP	4	0101		S
5	0511	RETURN		5	0104		I
6	0408	MARK		6	0109		O
7	0103			7	0206		N
8	0405	RE DIR		8	0002		SPACE
9	0004	R.04	DATA	9	0005		P
220	0400	+ DIR		270	0201		H
1	0003	R.03	Q TOT	1	0112		A
2	0511	RETURN		2	0101		S
3	0408	MARK		3	0205		E
	0004	04		4	0013		.
5	0412	WRITE A		5	0002		SPACE
6	0103		SHIFT UP	6	0002		SPACE
7	0101		S	7	0413	END A	
8	0201		H	8	0515	STOP	
9	0214		U	9	0412	WRITE A	
230	0207		T	280	0108		CR/LF
1	0207		T	1	0103		SHIFT UP
2	0209		L	2	0212		C
3	0205		E	3	0113		R
4	0002		SPACE	4	0205		E
5	0112		A	5	0100		W
6	0113		R	6	0002		SPACE
7	0101		S	7	0101		S
8	0102		SHIFT DN	8	0104		I
9	0002		SPACE	9	0307		Z
240	0009		/	290	0205		E
1	0002		SPACE	1	0413	END A	
2	0103		SHIFT UP	2	0411	WRITE	
3	0112		A	3	1504		4 SPACES
4	0207		T	4	0412	WRITE A	
5	0212		C	5	0103		SHIFT UP
6	0101		S	6	0013		.
7	0002		SPACE	7	0002		SPACE
8	0005		P	8	0002		SPACE
9	0205		E	9	0413	END A	

Remarks: PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment
30	0515	STOP	
1	0412	WRITE A	
2	010B		CR/LF
3	0110		LF
4	0103		SHIFT UP
5	0104		I
6	0206		N
7	0005		P
8	0214		U
9	0207		T
310	0013		.
1	010B		CR/LF
2	0207		T
3	0002		SPACE
4	0212		C
5	0112		A
6	0200		B
7	0413	END A	
8	0411	WRITE	
9	1503		3 SPACES
320	0100		
1	0412	WRITE A	
2	0103		SHIFT UP
3	0207		T
4	0002		SPACE
5	0113		R
6	0112		A
7	0213		D
8	0413	END A	
9	0411	WRITE	
330	1503		3 SPACES
1	0100		
2	0412	WRITE A	
3	0103		SHIFT UP
4	0207		T
5	0002		SPACE
6	0015		G
7	0101		S
8	0205		E
9	0413	END A	
340	0411	WRITE	
1	1503		3 SPACES
2	0100		
3	0412	WRITE A	
4	0103		SHIFT UP
5	0207		T
6	0002		SPACE
7	0015		G
8	0101		S
9	0205		E

Step	Code	Key	Comment
350	0201		H
1	0215		X
2	0002		SPACE
3	0413	END A	
4	0100		
5	0412	WRITE A	
6	010B		CR/LF
7	0103		SHIFT UP
8	0004		Q
9	0002		SPACE
360	0115		m
1	0205		E
2	0207		T
3	0102		SHIFT DN
4	0000		-
5	0103		SHIFT UP
6	0101		S
7	0002		SPACE
8	0413	END A	
9	0100		
370	0405	RE DIR	
1	0204	R.04	DATA
2	0404	ST DIR	
3	0001	R.01	Q H2O LOOP
4	0404	ST DIR	
5	0003	R.03	Q TOT
6	0412	WRITE A	
7	0103		SHIFT UP
8	0004		Q
9	0002		SPACE
380	0115		m
1	0205		E
2	0207		T
3	0102		SHIFT DN
4	0000		-
5	0103		SHIFT UP
6	0209		L
7	0002		SPACE
8	0413	END A	
9	0100		
390	0101		
1	0103		
2	0412	WRITE A	
3	0103		SHIFT UP
4	0100		W
5	0002		SPACE
6	0212		C
7	0109		O
8	0102		SHIFT DN
9	0306		Z

Remarks:
PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0413	END A		450	0209		L
1	0411	WRITE		1	0205		E
2	1503		3 SPACES	2	0212		C
3	0100			3	0002		SPACE
4	0705	S		4	0002		SPACE
5	0707	Z		5	0413	END A	
6	0712	.		6	0100		
7	0705	S		7	0101		
8	0402	X DIR		8	0103		
9	0004	R.04	DATA	9	0412	WRITE A	
410	0101			460	0103		SHIFT UP
1	0103			1	0004		Q
2	0412	WRITE A		2	0002		SPACE
3	0103		SHIFT UP	3	0014		F
4	0004		Q	4	0112		A
5	0002		SPACE	5	0206		N
6	0212		C	6	0413	END A	
7	0112		A	7	0411	WRITE	
8	0200		B	8	1503		3 SPACES
9	0102		SHIFT DN	9	0100		
420	0000		—	470	0101		
1	0103		SHIFT UP	1	0103		
2	0101		S	2	0412	WRITE A	
3	0002		SPACE	3	0103		SHIFT UP
4	0413	END A		4	0004		Q
	0100			5	0002		SPACE
6	0101			6	0201		H
7	0103			7	0102		SHIFT DN
8	0412	WRITE A		8	0306		Z
9	0108		CR/LF	9	0103		SHIFT UP
430	0103		SHIFT UP	480	0109		O
1	0004		Q	1	0005		P
2	0002		SPACE	2	0202		SPACE
3	0212		C	3	0002		SPACE
4	0112		A	4	0413	END A	
5	0200		B	5	0100		
6	0102		SHIFT DN	6	0101		
7	0000		—	7	0103		
8	0103		SHIFT UP	8	0412	WRITE A	
9	0209		L	9	0108		CR/LF
440	0002		SPACE	490	0103		SHIFT UP
1	0413	END A		1	0004		Q
2	0100			2	0002		SPACE
3	0101			3	0212		C
4	0103			4	0005		P
5	0412	WRITE A		5	0102		SHIFT DN
6	0103		SHIFT UP	6	0000		—
7	0004		Q	7	0103		SHIFT UP
8	0002		SPACE	8	0104		I
9	0205		E	9	0115		m

Remarks: PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment	Step	Code	Key	Comment
S00	0214		U	S50	0108		CR/LF
1	0413	END A		1	0103		SHIFT UP
2	0100			2	0004		Q
3	0101			3	0002		SPACE
4	0103			4	0212		C
5	0412	WRITE A		5	0005		P
6	0103		SHIFT UP	6	0102		SHIFT DN
7	0004		Q	7	0000		—
8	0002		SPACE	8	0314		3
9	0212		C	9	0002		SPACE
S10	0100		W	S60	0002		SPACE
1	0112		A	1	0413	END A	
2	0209		L	2	0100		
3	0209		L	3	0101		
4	0002		SPACE	4	0103		
5	0413	END A		5	0412	WRITE A	
6	0100			6	0103		SHIFT UP
7	0101			7	0004		Q
8	0103			8	0002		SPACE
9	0412	WRITE A		9	0112		A
S20	0103		SHIFT UP	S70	0200		B
1	0004		Q	1	0102		SHIFT DN
2	0002		SPACE	2	0000		—
3	0212		C	3	0209			
''	0005		P	4	0002		SPACE
	0102		SHIFT DN	5	0002		SPACE
6	0000		—	6	0413	END A	
7	0209				7	0100		
8	0002		SPACE	8	0101		
9	0002		SPACE	9	0103		
S30	0413	END A		S80	0405	RE DIR	
1	0100			1	0004	R.04	DATA
2	0101			2	0404	ST DIR	
3	0103			3	0006	R.06	Q AB-1
4	0412	WRITE A		4	0412	WRITE A	
5	0103		SHIFT UP	5	0103		SHIFT UP
6	0004		Q	6	0004		Q
7	0002		SPACE	7	0002		SPACE
8	0212		C	8	0112		A
9	0005		P	9	0200		B
S40	0102		SHIFT DN	S90	0102		SHIFT DN
1	0000		—	1	0000		—
2	0306		Z	2	0306		Z
3	0002		SPACE	3	0002		SPACE
4	0002		SPACE	4	0002		SPACE
5	0413	END A		5	0413	END A	
6	0100			6	0100		
7	0101			7	0101		
8	0103			8	0103		
9	0412	WRITE A		9	0405	RE DIR	

Remarks: PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment	Step	Code	Key	Comment
600	0004	K.04	DATA	650	0611	Loge X	X=0
1	0404	ST DIR		1	0101		
2	0007	K.07	Q AB-2	2	0103		
3	0412	WRITE A		3	0412	WRITE A	
4	0103		SHIFT UP	4	0103		SHIFT UP
5	0004		Q	5	0004		Q
6	0002		SPACE	6	0002		SPACE
7	0112		A	7	0212		C
8	0200		B	8	0201		H
9	0102		SHIFT DN	9	0104		I
610	0000		—	660	0209		L
1	0314		3	1	0209		L
2	0002		SPACE	2	0002		SPACE
3	0002		SPACE	3	0413	END A	
4	0413	END A		4	0100		
5	0100			5	0101		
6	0101			6	0103		
7	0103			7	0412	WRITE A	
8	0405	RE DIR		8	0103		SHIFT UP
9	0004	K.04	DATA	9	0004		Q
620	0404	ST DIR		670	0002		SPACE
1	000B	K.0B	Q AB-3	1	0005		P
2	0412	WRITE A		2	0209		L
3	010B		CR/LF	3	0213		D
4	0103		SHIFT UP	4	0201		H
5	0004		Q	5	0215		X
6	0002		SPACE	6	0002		SPACE
7	0112		A	7	0413	END A	
8	0200		B	8	0100		
9	0014		F	9	0405	RE DIR	
630	0112		A	680	0004	K.04	DATA
1	0206		N	1	0404	ST DIR	
2	0002		SPACE	2	0002	K.02	Q FZI LOOP
3	0413	END A		3	0103		
4	0100			4	0412	WRITE A	
5	0405	RE DIR		5	0103		SHIFT UP
6	0006	K.06	Q AB-1	6	0004		Q
7	0412	WRITE A	SKIP IF	7	0002		SPACE
8	0611	Loge X	X=0	8	0014		F
9	0101			9	0102		SHIFT DN
640	0103			690	0306		Z
1	0405	RE DIR		1	0209		1
2	0007	K.07	Q AB-2	2	0103		SHIFT UP
3	0412	WRITE A	SKIP IF	3	0005		P
4	0611	Loge X	X=0	4	0002		SPACE
5	0101			5	0002		SPACE
6	0103			6	0413	END A	
7	0405	RE DIR		7	0100		
8	000B	K.0B	Q AB-3	8	0102		
9	0412	WRITE A	SKIP IF	9	0103		

Remarks: PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment	Step	Code	Key	Comment
700	0412	WRITE A		750	0004	R.04	DATA
1	010B		CR/LF	1	0102		
2	0103		SHIFT UP	2	0103		
3	0004		Q	3	0412	WRITE A	
4	0002		SPACE	4	0103		SHIFT UP
5	0014		F	5	0100		W
6	0212		C	6	0002		SPACE
7	0205		E	7	0201		H
8	0209		L	8	0102		SHIFT DN
9	0209		L	9	0306		Z
710	0002		SPACE	760	0103		SHIFT UP
1	0413	END A		1	0109		O
2	0100			2	0413	END A	
3	0102			3	0411	WRITE	
4	0103			4	1503		3 SPACES
5	0412	WRITE A		5	0100		
6	0103		SHIFT UP	6	0412	WRITE A	
7	0004		Q	7	010B		CR/LF
8	0002		SPACE	8	0103		SHIFT UP
9	0201		H	9	0114		V
720	0001		Y	770	0002		SPACE
1	0213		D	1	0014		F
2	0201		H	2	0102		SHIFT DN
3	0215		X	3	0306		Z
4	0002		SPACE	4	0209		1
5	0413	END A		5	0103		SHIFT UP
6	0100			6	0005		P
7	0711	CHS SEN		7	0002		SPACE
8	0701	1		8	0002		SPACE
9	0402	X DIR		9	0413	END A	
730	0004	R.04	DATA	780	0100		
1	0102			1	0412	WRITE A	
2	0103			2	0103		SHIFT UP
3	0412	WRITE A		3	0114		V
4	0103		SHIFT UP	4	0002		SPACE
5	0004		Q	5	0014		F
6	0002		SPACE	6	0112		A
7	0109		O	7	0206		N
8	0102		SHIFT DN	8	0413	END A	
9	0306		Z	9	0411	WRITE	
740	0103		SHIFT UP	790	1503		3 SPACES
1	0201		H	1	0100		
2	0207		T	2	0412	WRITE A	
3	0113		R	3	0103		SHIFT UP
4	0002		SPACE	4	0114		V
5	0413	END A		5	0002		SPACE
6	0100			6	0209		L
7	0711	CHS SEN		7	0104		1
8	0701	1		8	0109		O
9	0402	X DIR		9	0201		H

Remarks:

PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment	Step	Code	Key	Comment
800	0002		SPACE	850	0103		SHIFT UP
1	0002		SPACE	1	0014		F
2	0413	END A		2	0212		C
3	0100			3	0209		L
4	0412	WRITE A		4	0002		SPACE
5	0103		SHIFT UP	5	0413	END A	
6	0114		V	6	0100		
7	0002		SPACE	7	0412	WRITE A	
8	0112		A	8	0103		SHIFT UP
9	0200		B	9	0100		W
810	0014		F	860	0212		C
1	0112		A	1	0102		SHIFT DN
2	0206		N	2	0005		P
3	0002		SPACE	3	0002		SPACE
4	0413	END A		4	0103		SHIFT UP
5	0100			5	0201		H
6	0412	WRITE A		6	0001		Y
7	0108		CR/LF	7	0213		D
8	0103		SHIFT UP	8	0002		SPACE
9	0100		W	9	0413	END A	
820	0002		SPACE	870	0100		
1	0212		C	1	0412	WRITE A	
2	0201		H	2	0108		CR/LF
3	0104		I	3	0103		SHIFT UP
4	0209		L	4	0100		W
	0209		L	5	0212		C
6	0002		SPACE	6	0102		SHIFT DN
7	0413	END A		7	0005		P
8	0100			8	0002		SPACE
9	0412	WRITE A		9	0103		SHIFT UP
830	0103		SHIFT UP	880	0015		G
1	0100		W	1	0101		S
2	0212		C	2	0205		E
3	0102		SHIFT DN	3	0002		SPACE
4	0005		P	4	0413	END A	
5	0002		SPACE	5	0100		
6	0103		SHIFT UP	6	0412	WRITE A	
7	0005		P	7	0103		SHIFT UP
8	0209		L	8	0214		U
9	0213		D	9	0112		A
840	0002		SPACE	890	0002		SPACE
1	0413	END A		1	0212		C
2	0100			2	0112		A
3	0412	WRITE A		3	0200		B
4	0103		SHIFT UP	4	0201		H
5	0100		W	5	0215		X
6	0212		C	6	0413	END A	
7	0102		SHIFT DN	7	0100		
8	0005		P	8	0412	WRITE A	
9	0002		SPACE	9	0103		SHIFT UP

Remarks: PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment	Step	Code	Key	Comment
900	0214		U	950	0112		A
1	0112		A	1	0002		SPACE
2	0002		SPACE	2	0005		P
3	0112		A	3	0209		L
4	0200		B	4	0213		D
5	0201		H	5	0201		H
6	0215		X	6	0215		X
7	0002		SPACE	7	0413	END A	
8	0413	END A		8	0100		
9	0100			9	0412	WRITE A	
910	0412	WRITE A		960	0103		SHIFT UP
1	0103		SHIFT UP	1	0214		U
2	0214		U	2	0112		A
3	0112		A	3	0002		SPACE
4	0002		SPACE	4	0014		F
5	0101		S	5	0212		C
6	0214		U	6	0209		L
7	0200		B	7	0201		H
8	0209		L	8	0215		X
9	0115		m	9	0413	END A	
920	0413	END A		970	0100		
1	0100			1	0412	WRITE A	
2	0412	WRITE A		2	0108		CR/LF
3	0108		CR/LF	3	0103		SHIFT UP
"	0103		SHIFT UP	4	0214		U
	0214		U	5	0112		A
6	0112		A	6	0002		SPACE
7	0002		SPACE	7	0201		H
8	0212		C	8	0001		Y
9	0201		H	9	0213		D
930	0104		I	980	0201		H
1	0209		L	1	0215		X
2	0209		L	2	0413	END A	
3	0413	END A		3	0100		
4	0100			4	0412	WRITE A	
5	0412	WRITE A		5	0103		SHIFT UP
6	0103		SHIFT UP	6	0214		U
7	0214		U	7	0112		A
8	0112		A	8	0002		SPACE
9	0002		SPACE	9	0015		G
940	0104		I	990	0101		S
1	0206		N	1	0205		E
2	0207		T	2	0201		H
3	0201		H	3	0215		X
4	0215		X	4	0413	END A	
5	0413	END A		5	0100		
6	0100			6	0412	WRITE A	
7	0412	WRITE A		7	0103		SHIFT UP
8	0103		SHIFT UP	8	0207		T
9	0214		U	9	0109		O

Remarks:

PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment	Step	Code	Key	Comment
1000	0209		L	1050	0103		
1	0002		SPACE	1	0412	WRITE A	
2	0214		U	2	0103		SHIFT UP
3	0112		A	3	0004		Q
4	0002		SPACE	4	0002		SPACE
5	0002		SPACE	5	0205		E
6	0413	END A		6	0206		N
7	0100			7	0114		Y
8	0412	WRITE A		8	0104		I
9	0103		SHIFT UP	9	0113		R
1010	0314		#	1060	0206		N
1	0002		SPACE	1	0413	END A	
2	0014		F	2	0100		
3	0212		C	3	0102		
4	0205		E	4	0103		
5	0209		L	5	0412	WRITE A	
6	0209		L	6	0108		CR/LF
7	0002		SPACE	7	0110		LF
8	0413	END A		8	0413	END A	
9	0100			9	0415	RE Y	
1020	0412	WRITE A		1070	0000	R.00	KY SINK
1	0108		CR/LF	1	0703	3	
2	0103		SHIFT UP	2	0509	SKIP IF Y=X	
3	0204		K	3	0407	SEARCH	
4	0001		Y	4	0007	07	
5	0002		SPACE	5	0705	S	
6	0101		S	6	0404	ST DIR	
7	0104		I	7	0000	R.00	BLK CNTR
8	0206		N	8	0407	SEARCH	
9	0204		K	9	0008	08	
1030	0002		SPACE	1080	0408	MARK	
1	0413	END A		1	0007	07	
2	0100			2	0706	6	
3	0405	RE DIR		3	0404	ST DIR	
4	0004	R.04	DATA	4	0000	R.00	BLK CNTR
5	0404	ST DIR		5	0408	MARK	
6	0000	R.00	KY SINK	6	0008	08	
7	0412	WRITE A		7	0701	1	
8	0103		SHIFT UP	8	0703	3	
9	0004		Q	9	0709	9	
1040	0002		SPACE	1090	0404	ST DIR	
1	0100		W	1	0010	R.10	DATA BLK
2	0104		I	2	0405	RE DIR	
3	0206		N	3	0001	R.01	Q H2O LOOP
4	0213		D	4	0404	ST DIR	
5	0109		O	5	0004	R.04	DATA
6	0100		W	6	0104		
7	0413	END A		7	0405	RE DIR	
8	0100			8	0002	R.02	Q FZI LOOP
9	0101			9	0404	ST DIR	

Remarks: PROGRAM TAPE BLOCK #0 -4

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Step	Code	Key	Comment	Step	Code	Key	Comment
1100	0004	R.04	DATA				
1	0104						
2	0405	RE DIR					
3	0003	R.03	Q TOT				
4	0404	ST DIR					
5	0004	R.04	DATA				
6	0104						
7	0407	SEARCH					
8	0001	01					
9	0408	MARK					
1110	0104						
1	0410	GROUP 2					
2	0002	02	DATA TAPE				
3	0415	RE Y					
4	0010	R.10	DATA BLK				
5	0701	1					
6	0709	9					
7	0703	3					
8	0706	6					
9	0810		TRANSFER				
1120	0405	RE DIR					
1	0010	R.10	DATA BLK				
2	0404	ST DIR					
3	0015	R.15	DATA BLK				
4	0701	1					
	0706	6					
6	0402	X DIR					
7	0015	R.15	DATA BLK				
8	0410	GROUP 2					
9	0003	03	EXT CORE				
1130	0415	RE Y					
1	0015	R.15	DATA BLK				
2	0701	1					
3	0709	9					
4	0703	3					
5	0706	6					
6	0810		TRANSFER				
7	0701	1					
8	0400	+ DIR					
9	0010	R.10	DATA BLK				
1140	0511	RETURN					

Remarks: PROGRAM TAPE BLOCK #0 - 4

Step	Code	Key	Comment
5	040B	MARK	
6	0003	03	
7	0701	1	
8	0400	+ DIR	
9	0000	K.00	BLK CNTR
40	0407	SEARCH	
1	0004	04	
2	040B	MARK	
3	0100		
4	0410	GROUP 2	
5	0003	03	EXT CORE
6	0415	RE Y	
7	0001	K.01	DATA BLK
8	0701	1	
9	0709	9	

Step	Code	Key	Comment
50	0703	3	
1	0706	6	
2	0B02		TRANSFER
3	0415	RE Y	
4	0007	K.02	REG CNTR
5	0405	RE DIR	
6	0004	K.04	DATA
7	0504	ST INDIR	
8	0701	1	
9	0400	+ DIR	
60	0002	K.02	REG CNTR
1	0511	RETURN	
2	040B	MARK	
3	0004	04	
4	0706	6	
5	0404	ST DIR	
6	0002	K.02	REG CNTR
7	0701	1	
8	0704	4	
9	0707	7	
70	0702	2	
1	0404	ST DIR	
2	0001	K.01	DATA BLK
3	0100		
4	0701	1	
5	070B	8	
6	070S	S	
7	0706	6	
8	0404	ST DIR	
9	0001	K.01	DATA BLK
80	0100		
1	0702	2	
2	0702	2	
3	0705	S	
4	0706	6	
5	0404	ST DIR	
6	0001	K.01	DATA BLK
7	0100		
8	0415	RE Y	
9	0007	K.07	UA-SUBLM
90	0405	RE DIR	
1	0006	K.06	W H2O
2	0603	÷	
3	0605	↓	
4	0614	$\subseteq^x$	
5	061S	'/x	
6	0604	↑	
7	0701	1	
8	0606	↓↑	
9	0601	-	

Remarks:

PROGRAM TAPE BLOCK #5

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0405	RE DIR		150	0411	WRITE	
1	0008	R.08	Q TOT	1	0502		DP-5.2
2	0606	↓↑		2	0411	WRITE	
3	0603	÷		3	1503		3 SPACES
4	0405	RE DIR		4	0412	WRITE A	
5	0006	R.06	W H2O	5	0103		SHIFT UP
6	0603	÷		6	0207		T
7	0703	3		7	0002		SPACE
8	0702	2		8	0201		H
9	0600	+		9	0102		SHIFT DN
110	0414	ST Y		160	0306		2
1	0010	R.10	T IN	1	0103		SHIFT UP
2	0415	RE Y		2	0109		O
3	0008	R.08	Q TOT	3	0102		SHIFT DN
4	0405	RE DIR		4	0104		1
5	0006	R.06	W H2O	5	0206		N
6	0603	÷		6	0002		SPACE
7	0405	RE DIR		7	0002		SPACE
8	0010	R.10	T IN	8	0006		=
9	0606	↓↑		9	0413	END A	
120	0601	−		170	0405	RE DIR	
1	0414	ST Y		1	0010	R.10	T IN
2	0011	R.11	T OUT	2	0411	WRITE	
3	0412	WRITE A		3	0502		DP-5.2
4	0103		SHIFT UP	4	0411	WRITE	
5	0101		S	5	1503		3 SPACES
6	0214		U	6	0412	WRITE A	
7	0200		B	7	0103		SHIFT UP
8	0209		L	8	0207		T
9	0104		I	9	0002		SPACE
130	0115		m	180	0201		H
1	0112		A	1	0102		SHIFT DN
2	0207		T	2	0306		2
3	0109		O	3	0103		SHIFT UP
4	0113		R	4	0109		O
5	0108		CR/LF	5	0102		SHIFT DN
6	0004		Q	6	0109		O
7	0002		SPACE	7	0214		U
8	0207		T	8	0207		T
9	0109		O	9	0002		SPACE
140	0207		T	190	0006		=
1	0413	END A		1	0413	END A	
2	0411	WRITE		2	0405	RE DIR	
3	1504		4 SPACES	3	0011	R.11	T OUT
4	0412	WRITE A		4	0411	WRITE	
5	0102		SHIFT DN	5	0502		DP-5.2
6	0006		=	6	0412	WRITE A	
7	0413	END A		7	0108		CR/LF
8	0405	RE DIR		8	0110		LF
9	0008	R.08	Q TOT	9	0413	END A	

Remarks: PROGRAM TAPE BLOCK #5

Step	Code	Key	Comment	Step	Code	Key	Comment
20	0405	RE DIR					
1	0011	R. 11	T out				
2	0404	ST DIR					
3	0001	R. 01	T H2O-out				
4	0701	1					
5	0709	9					
6	0404	ST DIR					
7	0000	R. 00	BLK CNTR				
8	0407	SEARCH					
9	0001	01					

Remarks:

PROGRAM TAPE BLOCK #5

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Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0703	3	
				1	0706	6	
				2	0802		TRANSFER
				3	0415	RE Y	
				4	0202	R.02	REG CNTR
				5	0405	RE DIR	
				6	0004	R.04	DATA
				7	0504	ST INDIR	
				8	0701	1	
				9	0400	+ DIR	
				60	0002	R.02	REG CNTR
				1	0511	RETURN	
				2	0408	mARK	
				3	0101		
				4	0415	RE Y	
				5	0001	R.01	T F21
				6	0405	RE DIR	
				7	0001	R.01	T F21
				8	0713	x^2	
				9	0602	X	
				70	0701	1	
				1	0704	4	
				2	0704	4	
				3	0708	8	
				4	0703	3	
				5	0707	7	
				6	0704	4	
				7	0705	5	
				8	0702	2	
				9	0702	2	
				80	0708	8	
				1	0702	2	
				2	0710	SET EXP	
				3	0711	CHS SGN	
				4	0706	6	
5	0408	mARK		5	0602	X	
6	0003	03		6	0414	ST Y	
7	0706	6		7	0002	R.02	H F21
8	0404	ST DIR		8	0405	RE DIR	
9	0002	R.02	REG CNTR	9	0001	R.01	T F21
40	0407	SEARCH		90	0713	x^2	
1	0004	04		1	0604	↑	
2	0408	mARK		2	0701	1	
3	0100			3	0700	0	
4	0410	GROUP 2		4	0708	8	
5	0003	03	EXT CORE	5	0706	6	
6	0415	RE Y		6	0707	7	
7	0001	R.01	DATA BLK	7	0700	0	
8	0701	1		8	0704	4	
9	0709	9		9	0708	8	

Remarks: PROGRAM TAPE BLOCK #6, 7 - 9

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0703	3		150	0002	R.02	H F21
1	0700	0		1	0713	x^2	
2	0700	0		2	0602	X	
3	0709	9		3	0709	9	
4	0710	SET EXP		4	0704	4	
5	0711	CHS SGN		5	0705	5	
6	0703	3		6	0703	3	
7	0602	X		7	0706	6	
8	0605	↓		8	0709	9	
9	0400	+ DIR		9	0703	3	
110	0002	R.02	H F21	160	0700	0	
1	0415	RE Y		1	0706	6	
2	0001	R.01	T F21	2	0703	3	
3	0712	.		3	0704	4	
4	0702	2		4	0708	8	
5	0703	3		5	0710	SET EXP	
6	0704	4		6	0711	CHS SGN	
7	0708	8		7	0705	5	
8	0706	6		8	0602	X	
9	0708	8		9	0414	ST Y	
120	0705	5		170	0001	R.01	T F21
1	0705	5		1	0405	RE DIR	
2	0705	5		2	0002	R.02	H F21
3	0701	1		3	0713	x^2	
4	0700	0		4	0604	↑	
5	0705	5		5	0709	9	
6	0602	X		6	0704	4	
7	0605	↓		7	0704	4	
8	0400	+ DIR		8	0709	9	
9	0002	R 02	H F21	9	0700	0	
130	0709	9		180	0703	3	
1	0712	.		1	0702	2	
2	0704	4		2	0702	2	
3	0705	5		3	0704	4	
4	0706	6		4	0705	5	
5	0704	4		5	0707	7	
6	0701	1		6	0710	SET EXP	
7	0707	7		7	0711	CHS SGN	
8	0700	0		8	0702	2	
9	0709	9		9	0602	X	
140	0702	2		190	0605	↓	
1	0703	3		1	0401	- DIR	
2	0400	+ DIR		2	0001	R 01	T F21
3	0002	R 02	H F21	3	0415	RE Y	
4	0511	RETURN		4	0002	R 02	H F21
5	0408	MARK		5	0704	4	
6	0102			6	0712	.	
7	0415	RE Y		7	0704	4	
8	0002	R 02	H F21	8	0704	4	
9	0405	RE DIR		9	0703	3	

Remarks: PROGRAM TAPE BLOCK #6, 7 - 9

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0703	3		250	0400	+ DIR	
1	0709	9		1	0001	R.01	DATA BLK
2	0703	3		2	0100		
3	0703	3		3	070B	8	
4	0705	5		4	0700	0	
5	0707	7		5	0400	+ DIR	
6	0707	7		6	0001	R.01	DATA BLK
7	0705	5		7	0100		
8	0602	X		8	0703	3	
9	0605	↓		9	0702	2	
210	0400	+ DIR		260	0400	+ DIR	
1	0001	R.01	T F21	1	0001	R.01	DATA BLK
2	0704	4		2	0100		
3	0701	1		3	0415	RE Y	
4	0712	.		4	0009	R.09	KY SINK
5	0702	2		5	0702	2	
6	0700	0		6	0509	SKIP IF Y=X	
7	0707	7		7	0407	SEARCH	
8	0703	3		8	0005	05	
9	0703	3		9	0707	7	
220	0704	4		270	0404	ST DIR	
1	0706	6		1	0000	R.00	BLK CNTR
2	0700	0		2	0407	SEARCH	
3	0703	3		3	0006	06	
4	0401	- DIR		4	040B	MARK	
5	0001	R.01	T F21	5	0005	05	
6	0511	RETURN		6	0701	1	
7	040B	MARK		7	0700	0	
8	0004	04		8	0404	ST DIR	
9	0701	1		9	0000	R.00	BLK CNTR
230	0703	3		280	040B	MARK	
1	0701	1		1	0006	06	
2	0702	2		2	0410	GROUP 2	
3	0404	ST DIR		3	0001	01	PROG TAPE
4	0001	R.01	DATA BLK	4	0415	RE Y	
5	0100			5	0000	R.00	BLK CNTR
6	0701	1		6	0702	2	
7	0702	2		7	0709	9	
8	070B	8		8	0701	1	
9	0400	+ DIR		9	0B06		TRANSFER
240	0001	R.01	DATA BLK	290	0514	GO	
1	0100			1	0701	1	
2	0706	6		2	0400	+ DIR	
3	0704	4		3	0000	R.00	BLK CNTR
4	0400	+ DIR		4	0410	GROUP 2	
5	0001	R.01	DATA BLK	5	0001	01	PROG TAPE
6	0100			6	0415	RE Y	
7	0706	6		7	0000	R.00	BLK CNTR
8	0704	4		8	0705	5	
9	0700	0		9	0704	4	

Remarks: PROGRAM TAPE BLOCK #6, 7 - 9

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0707	7		350	0708	8	
1	0806		TRANSFER	1	0706	6	
2	0701	1		2	0710	SET EXP	
3	0400	+ DIR		3	0711	CHS SGN	
4	0000	R.00	BLK CNTR	4	0706	6	
5	0415	RE Y		5	0602	X	
6	0000	R.00	BLK CNTR	6	0414	ST Y	
7	0708	8		7	0003	R.03	P F21
8	0700	0		8	0405	RE DIR	
9	0703	3		9	0001	R.01	T F21
310	0806		TRANSFER	360	0713	x^2	
1	0701	1		1	0604	↑	
2	0400	+ DIR		2	0703	3	
3	0000	R.00	BLK CNTR	3	0702	2	
4	0405	RE DIR		4	0707	7	
5	0007	R.07	Q O2HTR	5	0707	7	
6	0401	– DIR		6	0709	9	
7	0006	R.06	Q UP STRM	7	0707	7	
8	0405	RE DIR		8	0702	2	
9	0010	R.10	Q H2O-LOOP	9	0701	1	
320	0400	+ DIR		370	0704	4	
1	0006	R.06	Q UP STRM	1	0700	0	
2	0405	RE DIR		2	0702	2	
3	0011	R.11	Q TOT	3	0707	7	
4	0404	ST DIR		4	0710	SET EXP	
5	0007	R.07	Q TOT	5	0711	CHS SGN	
6	0709	9		6	0704	4	
7	0404	ST DIR		7	0602	X	
8	0002	R.02	REG CNTR	8	0605	↓	
9	0407	SEARCH		9	0400	+ DIR	
330	0007	07		380	0003	R.03	P F21
1	0408	MARK		1	0415	RE Y	
2	0103			2	0001	R.01	T F21
3	0415	RE Y		3	0708	8	
4	0001	R.01	T F21	4	0704	4	
5	0405	RE DIR		5	0701	1	
6	0001	R.01	T F21	6	0708	8	
7	0713	x^2		7	0704	4	
8	0602	X		8	0701	1	
9	0711	CHS SGN		9	0704	4	
340	0702	2		390	0709	9	
1	0701	1		1	0702	2	
2	0701	1		2	0708	8	
3	0702	2		3	0706	6	
4	0704	4		4	0701	1	
5	0707	7		5	0710	SET EXP	
6	0700	0		6	0711	CHS SGN	
7	0708	8		7	0701	1	
8	0709	9		8	0602	X	
9	0706	6		9	0605	↓	

Remarks: PROGRAM TAPE BLOCK #6, 7 – 9

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0401	– DIR		450	0404	ST DIR	
1	0003	R.03	ρ F21	1	0001	R.01	T F21
2	0709	9		2	0103		
3	0701	1		3	0405	RE DIR	
4	0712	.		4	0003	R.03	ρ F21
5	0704	4		5	0402	X DIR	
6	0708	8		6	0013	R.13	ω F21
7	0706	6		7	0408	mARK	
8	0706	6		8	0008	08	
9	0706	6		9	0415	RE Y	
410	0706	6		460	0006	R.06	Q UP STEm
1	0706	6		1	0405	RE DIR	
2	0706	6		2	0013	R.13	ω F21
3	0708	8		3	0603	÷	
4	0708	8		4	0414	ST Y	
5	0400	+ DIR		5	0014	R.14	ΔH F21
6	0003	R.03	ρ F21	6	0405	RE DIR	
7	0511	RETURN		7	0009	R.09	T OUT
8	0408	mARK		8	0404	ST DIR	
9	0007	07		9	0001	R.01	T F21
420	0706	6		470	0101		
1	0707	7		1	0405	RE DIR	
2	0702	2		2	0014	R.14	ΔH F21
3	0404	ST DIR		3	0400	+ DIR	
"	0001	R.01	DATA BLK	4	0002	R.02	H F21
	0100			5	0102		
6	0703	3		6	0103		
7	0702	2		7	0415	RE Y	
8	0400	+ DIR		8	0003	R.03	ρ F21
9	0001	R.01	DATA BLK	9	0405	RE DIR	
430	0100			480	0008	R.08	V F21 P
1	0701	1		1	0602	X	
2	0700	0		2	0405	RE DIR	
3	0705	5		3	0013	R.13	ω F21
4	0706	6		4	0606	↓↑	
5	0400	+ DIR		5	0404	ST DIR	
6	0001	R.01	DATA BLK	6	0013	R.13	ω F21
7	0100			7	0601	–	
8	0702	2		8	0606	↓↑	
9	0708	8		9	0607	|x|	
440	0708	8		490	0606	↓↑	
1	0400	+ DIR		1	0603	÷	
2	0001	R.01	DATA BLK	2	0705	5	
3	0100			3	0710	SET EXP	
4	0405	RE DIR		4	0711	CHS SGN	
5	0008	R.08	V F21 P	5	0702	2	
6	0404	ST DIR		6	0606	↓↑	
7	0013	R.13	ω F21	7	0507	SKIP IF Y≥X	
8	0707	7		8	0407	SEARCH	
9	0705	5		9	0008	08	

Remarks: PROGRAM TAPE BLOCK #6, 7 – 9

Step	Code	Key	Comment	Step	Code	Key	Comment
500	0415	KEY		550	0603	÷	
1	0007	K.07	Q TOT	1	0701	1	
2	0405	RE DIR		2	0601	−	
3	0013	K.13	W FZI	3	0412	WRITE A	SKIP IF
4	0603	÷		4	0411	WRITE	Y=0
5	0414	ST Y		5	0407	SEARCH	
6	0014	K.14	ΔH FZI	6	0010	10	
7	0405	RE DIR		7	0415	KEY	
8	0009	K.09	T out	8	0007	K.07	Q TOT
9	0404	ST DIR		9	0405	RE DIR	
510	0001	K.01	T FZI	560	0012	K.12	UA GSEHX
1	0101			1	0603	÷	
2	0405	RE DIR		2	0405	RE DIR	
3	0014	K.14	ΔH FZI	3	0010	K.10	T GSEHX
4	0400	+ DIR		4	0600	+	
5	0002	K.02	H FZI	5	0414	ST Y	
6	0102			6	0106	K.16	T FZI-OUT
7	0415	KEY		7	0407	SEARCH	
8	0001	K.01	T IN	8	0011	11	
9	0405	RE DIR		9	0408	MARK	
520	0009	K.09	T out	570	0010	10	
1	0601	−		1	0405	RE DIR	
2	0405	RE DIR		2	0015	K.15	WCp FZI
3	0007	K.07	Q TOT	3	0615	1/x	
"	0606	↓↑		4	0604	↑	
	0603	÷		5	0405	RE DIR	
6	0414	ST Y		6	0011	K.11	WCp GSE
7	0015	K.15	WCp FZI	7	0615	1/x	
8	0415	KEY		8	0601	−	
9	0000	K.00	BLK CNTR	9	0405	RE DIR	
530	0701	1		580	0007	K.07	Q TOT
1	0700	0		1	0606	↓↑	
2	0509	SKIP IF Y=X		2	0602	×	
3	0407	SEARCH		3	0414	ST Y	
4	0009	09		4	0106	K.16	C_1
5	0405	RE DIR		5	0415	KEY	
6	0009	K.09	T out	6	0012	K.12	UA GSEHX
7	0404	ST DIR		7	0602	×	
8	0108	K.18	T GSE	8	0605	↓	
9	0701	1		9	0614	e^x	
540	0400	+ DIR		590	0604	↑	
1	0000	K.00	BLK CNTR	1	0701	1	
2	0407	SEARCH		2	0606	↓↑	
3	0009	09		3	0601	−	
4	0408	MARK		4	0414	ST Y	
5	0104			5	0107	K.17	C_2
6	0415	KEY		6	0405	RE DIR	
7	0011	K.11	WCp GSE	7	0010	K.10	T GSEHX
8	0405	RE DIR		8	0602	×	
9	0015	K.15	WCp FZI	9	0405	RE DIR	

Remarks: PROGRAM TAPE BLOCK #6, 7 − 9

Step	Code	Key	Comment	Step	Code	Key	Comment
600	0106	R.16	C_1	650	0606	↓↑	
1	0601	–		1	0603	÷	
2	0405	RE DIR		2	0705	S	
3	0107	R.17	C_2	3	0710	SET EXP	
4	0603	÷		4	0711	CHS SEN	
5	0414	ST Y		5	0702	Z	
6	0106	R.16	T FZ1-OUT	6	0606	↓↑	
7	0408	MARK		7	0507	SKIP IF Y^2X	
8	0011	11		8	0407	SEARCH	
9	0511	RETURN		9	0008	08	
610	0408	MARK		660	0405	RE DIR	
1	0009	09		1	0009	R.09	T OUT
2	0104			2	0404	ST DIR	
3	0415	RE Y		3	0108	R.18	T FZ1-OUT
4	0108	R.18	T GSE	4	0408	MARK	
5	0405	RE DIR		5	0012	12	
6	0106	R.16	T FZ1-OUT	6	0415	RE Y	
7	0404	ST DIR		7	0007	R.07	Q TOT
8	0009	R.09	T OUT	8	0405	RE DIR	
9	0508	SKIP IF Y<X		9	0013	R.13	W FZ1
620	0407	SEARCH		670	0603	÷	
1	0012	12		1	0414	ST Y	
2	0415	RE Y		2	0014	R.14	ΔH FZ1
3	0006	R.06	Q UP STRM	3	0405	RE DIR	
"	0405	RE DIR		4	0108	R.18	T FZ1-OUT
	0013	R.13	W FZ1	5	0404	ST DIR	
6	0603	÷		6	0001	R.01	
7	0414	ST Y		7	0101		
8	0014	R.14	ΔH FZ1	8	0405	RE DIR	
9	0405	RE DIR		9	0014	R.14	ΔH FZ1
630	0009	R.09	T OUT	680	0400	+ DIR	
1	0404	ST DIR		1	0002	R.02	H FZ1
2	0001	R.01	T FZ1	2	0102		
3	0101			3	0415	RE Y	
4	0405	RE DIR		4	0001	R.01	T FZ1-IN
5	0014	R.14	ΔH FZ1	5	0414	ST Y	
6	0400	+ DIR	H FZ1	6	0106	R.16	T FZ1-IN
7	0002	R.02	H FZ1	7	0405	RE DIR	
8	0102			8	0108	R.18	T FZ1-OUT
9	0103			9	0001	–	
640	0415	RE Y		690	0405	RE DIR	
1	0003	R.03	P FZ1	1	0007	R.07	Q TOT
2	0405	RE DIR		2	0606	↓↑	
3	0008	R.08	V FZ1 P	3	0603	÷	
4	0002	X		4	0414	ST Y	
5	0405	RE DIR		5	0015	R.15	WCP FZ1
6	0013	R.13	W FZ1	6	0415	RE Y	
7	0601	–		7	0007	R.07	Q TOT
8	0606	↓↑		8	0405	RE DIR	
9	0607	|X|		9	0011	R.11	WCP GSE

Remarks: PROGRAM TAPE BLOCK #6, 7 - 9

Step	Code	Key	Comment	Step	Code	Key	Comment
700	0603	÷		750	0102		SHIFT DN
1	0405	RE DIR		1	0306		Z
2	0010	R.10	T GSE HX	2	0209		1
3	0600	+		3	0104		1
4	0414	ST Y		4	0206		N
5	0107	R.17	T GSE-OUT	5	0002		SPACE
6	0412	WRITE A		6	0002		SPACE
7	0103		SHIFT UP	7	0006		=
8	0015		G	8	0413	END A	
9	0101		S	9	0405	RE DIR	
710	0205		E	760	0106	R.16	T FZ1-IN
1	0002		SPACE	1	0411	WRITE	
2	0201		H	2	0502		DP-S.2
3	0205		E	3	0411	WRITE	
4	0112		A	4	1503		3 SPACES
5	0207		T	5	0412	WRITE A	
6	0002		SPACE	6	0103		SHIFT UP
7	0205		E	7	0207		T
8	0215		X	8	0002		SPACE
9	0212		C	9	0014		F
720	0201		H	770	0102		SHIFT DN
1	0112		A	1	0306		Z
2	0206		N	2	0209		1
3	0015		G	3	0109		O
4	0205		E	4	0214		U
5	0113		R	5	0207		T
6	0108		CR/LF	6	0002		SPACE
7	0004		Q	7	0006		=
8	0002		SPACE	8	0413	END A	
9	0207		T	9	0405	RE DIR	
730	0109		O	780	0108	R.18	T FZ1-OUT
1	0207		T	1	0411	WRITE	
2	0413	END A		2	0502		DP-S.2
3	0411	WRITE		3	0411	WRITE	
4	1504		4 SPACES	4	1503		3 SPACES
5	0412	WRITE A		5	0412	WRITE A	
6	0102		SHIFT DN	6	0103		SHIFT UP
7	0006		=	7	0100		W
8	0413	END A		8	0217		C
9	0405	RE DIR		9	0102		SHIFT DN
740	0007	R.07	Q TOT	790	0005		P
1	0411	WRITE		1	0002		SPACE
2	0502		DP-S.2	2	0103		SHIFT UP
3	0411	WRITE		3	0014		F
4	1503		3 SPACES	4	0102		SHIFT DN
5	0412	WRITE A		5	0306		Z
6	0103		SHIFT UP	6	0209		1
7	0207		T	7	0002		SPACE
8	0002		SPACE	8	0002		SPACE
9	0014		F	9	0006		=

Remarks:

PROGRAM TAPE BLOCK #6, 7 - 9

Step	Code	Key	Comment	Step	Code	Key	Comment
80	0413	END A		850	0013	R.13	W F21
1	0405	RE DIR		1	0404	ST DIR	
2	0015	R.15	WCP F21	2	0003	R.03	W F21
3	0411	WRITE		3	0405	RE DIR	
4	0502		DP-S.2	4	0108	R.18	T F21-OUT
5	0412	WRITE A		5	0404	ST DIR	
6	0108		CR/LF	6	0002	R.02	T F21-OUT
7	0103		SHIFT UP	7	0701	1	
8	0100		W	8	0704	4	
9	0002		SPACE	9	0404	ST DIR	
B10	0014		F	860	0000	R.00	BLK CNTR
1	0102		SHIFT DN	1	0407	SEARCH	
2	0306		Z	2	0001	01	
3	0209		\				
4	0413	END A					
5	0411	WRITE					
6	1504		4 SPACES				
7	0412	WRITE A					
8	0102		SHIFT DN				
9	0006		=				
B20	0413	END A					
1	0405	RE DIR					
2	0013	R.13	W F21				
3	0411	WRITE					
4	0502		DP-S.2				
5	0411	WRITE					
6	1503		3 SPACES				
7	0412	WRITE A					
8	0103		SHIFT UP				
9	0207		T				
B30	0002		SPACE				
1	0015		G				
2	0101		S				
3	0205		E				
4	0102		SHIFT DN				
5	0109		O				
6	0214		U				
7	0207		T				
8	0002		SPACE				
9	0006		=				
B40	0413	END A					
1	0405	RE DIR					
2	0107	R.17	T GSE-OUT				
3	0411	WRITE					
4	0502		DP-S.2				
5	0412	WRITE A					
6	0108		CR/LF				
7	0110		LF				
8	0413	END A					
9	0405	RE DIR					

Remarks: PROGRAM TAPE BLOCK #6, 7 - 9

Step	Code	Key	Comment
5	0408	mARK	
6	0003	03	
7	0706	6	
8	0404	ST DIR	
9	0002	R.02	REG CNTR
40	0407	SEARCH	
1	0004	04	
2	040B	mARK	
3	0100		
4	0410	SROUP Z	
5	0003	03	EXT CODE
6	0415	RE Y	
7	0001	R.01	DATA BLK
8	0701	1	
9	0709	9	

Step	Code	Key	Comment
50	0703	3	
1	0706	6	
2	0B02		TRANSFER
3	0415	RE Y	
4	0007	R.02	REG CNTR
5	0405	RE DIR	
6	0004	R.04	DATA
7	0504	ST INDIR	
8	0701	1	
9	0400	+ DIR	
60	0002	R.02	REG CNTR
1	0511	RETURN	
2	040B	mARK	
3	0101		
4	0415	RE Y	
5	0001	R.01	T FZI
6	0405	RE DIR	
7	0001	R.01	T FZI
8	0713	x^2	
9	0602	X	
70	0701	1	
1	0704	4	
2	0704	4	
3	070B	8	
4	0703	3	
5	0707	7	
6	0704	4	
7	0705	5	
8	0702	2	
9	0702	2	
80	070B	8	
1	0702	2	
2	0710	SET EXP	
3	0711	CHS SGN	
4	0706	6	
5	0602	X	
6	0414	ST Y	
7	0002	R.02	H FZI
8	0405	RE DIR	
9	0001	R.01	T FZI
90	0713	x^2	
1	0604	↑	
2	0701	1	
3	0700	0	
4	070B	8	
5	0706	6	
6	0707	7	
7	0700	0	
8	0704	4	
9	070B	8	

Remarks:

PROGRAM TAPE BLOCK #6, 10 - 13

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0703	3		150	0002	R.02	H FZI
1	0700	0		1	0713	X²	
2	0700	0		2	0602	X	
3	0709	9		3	0709	9	
4	0710	SET EXP		4	0704	4	
5	0711	CHS SGN		5	0705	5	
6	0703	3		6	0703	3	
7	0602	X		7	0706	6	
8	0605	↓		8	0709	9	
9	0400	+ DIR		9	0703	3	
110	0002	R.02	H FZI	160	0700	0	
1	0415	RE Y		1	0706	6	
2	0001	R.01	T FZI	2	0703	3	
3	0712	.		3	0704	4	
4	0702	2		4	0708	8	
5	0703	3		5	0710	SET EXP	
6	0704	4		6	0711	CHS SGN	
7	0708	8		7	0705	5	
8	0708	8		8	0602	X	
9	0708	8		9	0414	ST Y	
120	0705	5		170	0001	R.01	T FZI
1	0705	5		1	0405	RE DIR	
2	0705	5		2	0002	R.02	H FZI
3	0701	1		3	0713	X²	
1'	0700	0		4	0604	↑	
	0705	5		5	0709	9	
6	0602	X		6	0704	4	
7	0605	↓		7	0704	4	
8	0400	+ DIR		8	0709	9	
9	0002	R.02	H FZI	9	0700	0	
130	0709	9		180	0703	3	
1	0712	.		1	0702	2	
2	0704	4		2	0702	2	
3	0705	5		3	0704	4	
4	0706	6		4	0705	5	
5	0704	4		5	0707	7	
6	0701	1		6	0710	SET EXP	
7	0707	7		7	0711	CHS SGN	
8	0700	0		8	0702	2	
9	0709	9		9	0602	X	
140	0702	2		190	0605	↓	
1	0703	3		1	0401	- DIR	
2	0400	+ DIR		2	0001	R.01	T FZI
3	0002	R.02	H FZI	3	0415	RE Y	
4	0511	RETURN		4	0002	R.02	H FZI
5	0408	MARK		5	0704	4	
6	0102			6	0712	.	
7	0415	RE Y		7	0704	4	
8	0002	R.02	H FZI	8	0704	4	
9	0405	RE DIR		9	0703	3	

Remarks: PROGRAM TAPE BLOCK #6, 10 - 13

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0703	3		250	0400	+ DIR	
1	0709	9		1	0001	R.01	DATA BLK
2	0703	3		2	0100		
3	0703	3		3	0708	8	
4	0705	S		4	0700	0	
5	0707	7		5	0400	+ DIR	
6	0707	7		6	0001	R.01	DATA BLK
7	0705	S		7	0100		
8	0602	X		8	0703	3	
9	0605	↓		9	0702	2	
210	0400	+ DIR		260	0400	+ DIR	
1	0001	R.01	T FZ1	1	0001	R.01	DATA BLK
2	0704	4		2	0100		
3	0701	1		3	0415	KE Y	
4	0712	·		4	0009	R.09	KY SINK
5	0702	2		5	0702	2	
6	0700	0		6	0509	SKIP IF Y=X	
7	0707	7		7	0407	SEARCH	
8	0703	3		8	0005	OS	
9	0703	3		9	0707	7	
220	0704	4		270	0404	ST DIR	
1	0706	6		1	0000	R.00	BLK CNTR
2	0700	0		2	0407	SEARCH	
3	0703	3		3	0006	06	
"	0401	- DIR		4	0408	MARK	
	0001	R.01	T FZ1	5	0005	OS	
6	0511	RETURN		6	0701	1	
7	0408	MARK		7	0700	0	
8	0004	04		8	0404	ST DIR	
9	0701	1		9	0000	R.00	BLK CNTR
230	0703	3		280	0408	MARK	
1	0701	1		1	0006	06	
2	0702	2		2	0410	GROUP 2	
3	0404	ST DIR		3	0001	01	PROG. TAPE
4	0001	R.01	DATA BLK	4	0415	KE Y	
5	0100			5	0000	R.00	BLK CNTR
6	0701	1		6	0702	2	
7	0702	2		7	0709	9	
8	0708	8		8	0701	1	
9	0400	+ DIR		9	0806		TRANSFER
240	0001	R.01	DATA BLK	290	0514	GO	
1	0100			1	0701	1	
2	0706	6		2	0400	+ DIR	
3	0704	4		3	0000	R.00	BLK CNTR
4	0400	+ DIR		4	0410	GROUP 2	
5	0001	R.01	DATA BLK	5	0001	01	PROG TAPE
6	0100			6	0415	KE Y	
7	0706	6		7	0000	R.00	BLK CNTR
8	0704	4		8	0705	S	
9	0700	0		9	0704	4	

Remarks: PROGRAM TAPE BLOCK #6, 10 - 13

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0707	7		350	0702	2	
1	0806		TRANSFER	1	0701	1	
2	0701	1		2	0701	1	
3	0400	+ DIR		3	0702	2	
4	0000	R.00	BLK CNTR	4	0704	4	
5	0415	KEY		5	0707	7	
6	0000	R.00	BLK CNTR	6	0700	0	
7	0708	8		7	0708	8	
8	0700	0		8	0709	9	
9	0703	3		9	0706	6	
310	0806		TRANSFER	360	0708	8	
1	0701	1		1	0706	6	
2	0400	+ DIR		2	0710	SET EXP	
3	0000	R.00	BLK CNTR	3	0711	CHS SGN	
4	0415	KEY		4	0706	6	
5	0000	R.00	BLK CNTR	5	0602	X	
6	0701	1		6	0414	ST Y	
7	0700	0		7	0003	R.03	P F21
8	0705	5		8	0405	RE DIR	
9	0709	9		9	0001	R.01	T F21
320	0806		TRANSFER	370	0713	x^2	
1	0701	1		1	0604	↑	
2	0400	+ DIR		2	0703	3	
3	0000	R.00	BLK CNTR	3	0702	2	
4	0405	RE DIR		4	0707	7	
5	0007	R.07	Q O2HTR	5	0707	7	
6	0401	- DIR		6	0709	9	
7	0006	R.06	Q UP STRM	7	0707	7	
8	0405	RE DIR		8	0702	2	
9	0010	R.10	Q H2O LOOP	9	0701	1	
330	0400	+ DIR		380	0704	4	
1	0006	R.06	Q UP STRM	1	0700	0	
2	0405	RE DIR		2	0702	2	
3	0011	R.11	Q TOT	3	0707	7	
4	0404	ST DIR		4	0710	SET EXP	
5	0007	R.07	Q TOT	5	0711	CHS SGN	
6	0709	9		6	0704	4	
7	0404	ST DIR		7	0602	X	
8	0002	R.02	REG CNTR	8	0605	↓	
9	0407	SEARCH		9	0400	+ DIR	
340	0007	07		390	0003	R.03	P F21
1	0408	MARK		1	0415	KEY	
2	0103			2	0001	R.01	T F21
3	0415	KEY		3	0708	8	
4	0001	R.01	T F21	4	0704	4	
5	0405	RE DIR		5	0701	1	
6	0001	R.01	T F21	6	0708	8	
7	0713	x^2		7	0704	4	
8	0602	X		8	0701	1	
9	0711	CHS SGN		9	0704	4	

Remarks: PROGRAM TAPES BLOCK #6, 10 - 13

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0709	9		450	0003	R.03	ρ FZI
1	0702	2		1	0402	X DIR	
2	0708	8		2	0010	R.10	W FZI
3	0706	6		3	0408	mARK	
4	0701	1		4	0008	OB	
5	0710	SET EXP		5	0415	RE Y	
6	0711	CHS SGN		6	0006	R.06	Q UP STRm
7	0701	1		7	0405	RE DIR	
8	0602	X		8	0010	R.10	W FZI
9	0605	↓		9	0603	÷	
410	0401	- DIR		460	0414	ST Y	
1	0003	R.03	ρ FZI	1	0011	R.11	ΔH FZI
2	0709	9		2	0405	RE DIR	
3	0701	1		3	0009	R.09	T OUT
4	0712	.		4	0404	ST DIR	
5	0704	4		5	0001	R.01	T FZI
6	0708	8		6	0101		
7	0706	6		7	0405	RE DIR	
8	0706	6		8	0011	R.11	ΔH FZI
9	0706	6		9	0400	+ DIR	
420	0706	6		470	0007	R.02	H FZI
1	0706	6		1	0102		
2	0706	6		2	0103		
3	0708	8		3	0415	RE Y	
4	0708	8		4	0003	R.03	ρ FZI
5	0400	+ DIR		5	0405	RE DIR	
6	0003	R.03	ρ FZI	6	0008	R.08	√ FZIP
7	0511	RETURN		7	0602	X	
8	0408	mARK		8	0405	RE DIR	
9	0007	07		9	0010	R.10	W FZI
430	0706	6		480	0606	↓↑	
1	0704	4		1	0404	ST DIR	
2	0700	0		2	0010	R.10	W FZI
3	0404	ST DIR		3	0601	-	
4	0001	R.01	DATA BLK	4	0606	↓↑	
5	0100			5	0607	|x|	
6	0405	RE DIR		6	0606	↓↑	
7	0009	R.09	T RAD	7	0603	÷	
8	0404	ST DIR		8	0705	S	
9	0209	R.29	T RAD	9	0710	SET EXP	
440	0405	RE DIR		490	0711	CHS SGN	
1	0008	R.08	√ FZIP	1	0702	2	
2	0404	ST DIR		2	0606	↓↑	
3	0010	R.10	W FZI	3	0507	SKIP IF Y≥X	
4	0707	7		4	0407	SEARCH	
5	0705	S		5	0008	OB	
6	0404	ST DIR		6	0415	RE Y	
7	0001	R.01	T FZI	7	0007	R.07	Q TOT
8	0103			8	0405	RE DIR	
9	0405	RE DIR		9	0010	R.10	W FZI

Remarks:
PROGRAM TAPE BLOCK #6, 10 - 13

Step	Code	Key	Comment
S00	0603	÷	
1	0414	ST Y	
2	0011	K.11	ΔH FZI
3	0405	RE DIR	
4	0009	K.09	T OUT
5	0404	ST DIR	
6	0001	K.01	T FZI
7	0101		
8	0405	RE DIR	
9	0011	K.11	ΔH FZI
S10	0400	+ DIR	
1	0002	K.02	H FZI
2	0102		
3	0415	RE Y	
4	0001	K.01	T FZI
5	0414	ST Y	
6	0014	K.14	T FZI-IN
7	0405	RE DIR	
8	0009	K.09	T OUT
9	0601	–	
S20	0405	RE DIR	
1	0007	K.07	Q TOT
2	0606	↓↑	
3	0603	÷	
4	0414	ST Y	
5	0012	K.12	W(p FZI
6	0415	RE Y	
7	0000	K.00	BLK CNTR
8	0701	1	
9	0704	4	
S30	0509	SKIP IF Y=X	
1	0407	SEARCH	
2	0009	09	
3	0405	RE DIR	
4	0009	K.09	T OUT
5	0404	ST DIR	
6	0013	K.13	T RAD
7	0701	1	
8	0400	+ DIR	
9	0000	K.00	BLK CNTR
S40	0408	MARK	
1	0009	09	
2	0104		
3	0415	RE Y	
4	0013	K.13	T RAD
5	0405	RE DIR	
6	0208	K.28	T FZI-OUT
7	0404	ST DIR	
8	0009	K.09	T OUT
9	0508	SKIP IF Y<X	
S50	0407	SEARCH	
1	0010	10	
2	0415	RE Y	
3	0006	K.06	Q UP STRM
4	0405	RE DIR	
5	0010	K.10	W FZI
6	0603	÷	
7	0414	ST Y	
8	0011	K.11	ΔH FZI
9	0405	RE DIR	
S60	0009	K.09	T OUT
1	0404	ST DIR	
2	0001	K.01	T FZI
3	0101		
4	0405	RE DIR	
5	0011	K.11	ΔH FZI
6	0400	+ DIR	
7	0002	K.02	H FZI
8	0102		
9	0103		
S70	0415	RE Y	
1	0003	K.03	P FZI
2	0405	RE DIR	
3	0008	K.08	V FZI P
4	0602	X	
5	0405	RE DIR	
6	0010	K.10	W FZI
7	0601	–	
8	0606	↓↑	
9	0607	|x|	
S80	0606	↓↑	
1	0603	÷	
2	0705	5	
3	0710	SET EXP	
4	0711	CHS SGN	
5	0702	2	
6	0606	↓↑	
7	0507	SKIP IF Y≥X	
8	0407	SEARCH	
9	0008	08	
S90	0405	RE DIR	
1	0009	K.09	T OUT
2	0404	ST DIR	
3	0013	K.13	T RAD
4	0408	MARK	
5	0010	10	
6	0415	RE Y	
7	0007	K.07	Q TOT
8	0405	RE DIR	
9	0010	K.10	W FZI

Remarks: PROGRAM TAPE BLOCK #6, 10 – 13

Step	Code	Key	Comment	Step	Code	Key	Comment
600	0603	÷		650	0405	RE DIR	
1	0414	ST Y		1	0013	R.13	T OUT
2	0011	R.11	ΔH FZI	2	0601	−	
3	0405	RE DIR		3	0405	RE DIR	
4	0013	R.13	T OUT	4	0007	R.07	Q TOT
5	0404	ST DIR		5	0606	↓↑	
6	0001	R.01	T FZI	6	0603	÷	
7	0101			7	0414	ST Y	
8	0405	RE DIR		8	0012	R.12	WGP FZI
9	0011	R.11	ΔH FZI	9	0412	WRITE A	
610	0400	+ DIR		660	0103		SHIFT UP
1	0002	R.02	H FZI	1	0113		R
2	0102			2	0112		A
3	0415	RE Y		3	0213		D
4	0001	R.01	T FZI	4	0104		I
5	0414	ST Y		5	0112		A
6	0106	R.16	T IN	6	0207		T
7	0405	RE DIR		7	0109		O
8	0014	R.14	T FZI-IN	8	0113		R
9	0404	ST DIR		9	010B		CR/LF
620	0107	R.17	T FZI-IN	670	0004		Q
1	0601	−		1	0002		SPACE
2	0606	↓↑		2	0207		T
3	2607	|x|		3	0109		O
4	0606	↓↑		4	0207		T
5	0603	÷		5	0413	END A	
6	0705	S		6	0411	WRITE	
7	0710	SET EXP		7	1504		4 SPACES
8	0711	CHS SGN		8	0412	WRITE A	
9	0702	2		9	0102		SHIFT DN
630	0606	↓↑		680	0006		=
1	0507	SKIP IF YZX		1	0413	END A	
2	0407	SEARCH		2	0405	RE DIR	
3	0702	2		3	0007	R.07	Q TOT
4	0407	SEARCH		4	0411	WRITE	
5	0703	3		5	0502		DP-S.2
6	040B	MARK		6	0411	WRITE	
7	0702	2		7	1503		3 SPACES
8	0405	RE DIR		8	0412	WRITE A	
9	0106	R.16	T IN	9	0103		SHIFT UP
640	0404	ST DIR		690	0207		T
1	0014	R.14	T FZI-IN	1	0002		SPACE
2	0407	SEARCH		2	0014		F
3	0009	09		3	0102		SHIFT DN
4	0408	MARK		4	0306		2
5	0703	3		5	0209		1
6	0415	RE Y		6	0104		1
7	0106	R.16	T IN	7	0206		N
8	0414	ST Y		8	0002		SPACE
9	0014	R.14	T FZI-IN	9	0002		SPACE

Remarks:
PROGRAM TAPE BLOCK #6; 10 - 13

Step	Code	Key	Comment	Step	Code	Key	Comment
700	0006		=	750	0103		SHIFT UP
1	0413	END A		1	0100		W
2	0405	RE DIR		2	0002		SPACE
3	0014	R.14	T F21-IN	3	0014		F
4	0411	WRITE		4	0102		SHIFT DN
5	0502		DP-S.2	5	0306		Z
6	0411	WRITE		6	0209		1
7	1503		3 SPACES	7	0413	END A	
8	0412	WRITE A		8	0411	WRITE	
9	0103		SHIFT UP	9	1504		4 SPACES
710	0207		T	760	0412	WRITE A	
1	0002		SPACE	1	0102		SHIFT DN
2	0014		F	2	0006		=
3	0102		SHIFT DN	3	0413	END A	
4	0306		Z	4	0405	RE DIR	
5	0209		1	5	0010	R.10	W F21
6	0109		O	6	0411	WRITE	
7	0214		U	7	0502		DP-S.2
8	0207		T	8	0412	WRITE A	
9	0002		SPACE	9	0108		CR/LF
720	0006		=	770	0110		LF
1	0413	END A		1	0413	END A	
2	0405	RE DIR		2	0405	RE DIR	
3	0013	R.13	T F21-OUT	3	0010	R.10	W F21
4	0411	WRITE		4	0404	ST DIR	
5	0502		DP-S.2	5	0003	R.03	W F21
6	0411	WRITE		6	0405	RE DIR	
7	1503		3 SPACES	7	0013	R.13	T F21-OUT
8	0412	WRITE A		8	0404	ST DIR	
9	0103		SHIFT UP	9	0002	R.02	T F21-OUT
730	0100		W	780	0701	1	
1	0212		C	1	0704	4	
2	0102		SHIFT DN	2	0404	ST DIR	
3	0005		P	3	0000	R.00	BLK CNTR
4	0002		SPACE	4	0407	SEARCH	
5	0103		SHIFT UP	5	0001	01	
6	0014		F	6	0408	MARK	
7	0102		SHIFT DN	7	0104		
8	0306		Z	8	0407	SEARCH	
9	0209		1	9	0011	11	
740	0002		SPACE	790	0408	MARK	
1	0002		SPACE	1	0106		
2	0006		=	2	0701	1	
3	0413	END A		3	0705	5	
4	0405	RE DIR		4	0404	ST DIR	
5	0012	R.12	W(6 F21	5	0002	R.02	REG CNTR
6	0411	WRITE		6	0100		
7	0502		DP-S.2	7	0408	MARK	
8	0412	WRITE A		8	0012	12	
9	0108		CR/LF	9	0701	1	

Remarks: PROGRAM TAPE BLOCK #6, 10 - 13

Step	Code	Key	Comment
800	0706	6	
1	0400	+ DIR	
2	0001	R.01	DATA BLK
3	0100		
4	0415	RE Y	
5	0001	R.01	DATA BLK
6	0405	RE DIR	
7	0208	R.28	LAST BLK
8	0509	SKIP IF Y=X	
9	0407	SEARCH	
810	0012	12	
1	0511	RETURN	
2	0408	MARK	
3	0107		
4	0415	RE Y	
5	0014	R.14	T IN
6	0405	RE DIR	
7	0014	R.14	T IN
8	0713	X^2	
9	0602	X	
820	0405	RE DIR	
1	0015	R.15	C_1
2	0602	X	
3	0414	ST Y	
4	0207	R.27	T OUT
5	0405	RE DIR	
6	0014	R.14	T IN
7	0713	X^2	
8	0415	RE Y	
9	0106	R.16	C_2
830	0602	X	
1	0605	↓	
2	0400	+ DIR	
3	0207	R.27	T OUT
4	0415	RE Y	
5	0014	R.14	T IN
6	0405	RE DIR	
7	0107	R.17	C_3
8	0602	X	
9	0605	↓	
840	0400	+ DIR	
1	0207	R.27	T OUT
2	0405	RE DIR	
3	0108	R.18	C_4
4	0400	+ DIR	
5	0207	R.27	T OUT
6	0511	RETURN	
7	0408	MARK	
8	0011	11	
9	0410	GROUP 2	

Step	Code	Key	Comment
850	0003	03	EXT. CORE
1	0701	1	
2	0706	6	
3	0404	ST DIR	
4	0001	R.01	DATA BLK
5	0706	6	
6	0704	4	
7	0404	ST DIR	
8	0208	R.28	LAST BLK
9	0106		
860	0107		
1	0405	RE DIR	
2	0207	R.27	T OUT
3	0404	ST DIR	
4	0109	R.19	T out (2200)
5	0708	8	
6	0700	0	
7	0404	ST DIR	
8	0001	R.01	DATA BLK
9	0701	1	
870	0702	2	
1	0708	8	
2	0404	ST DIR	
3	0208	R.28	LAST BLK
4	0106		
5	0107		
6	0405	RE DIR	
7	0207	R.27	T out
8	0404	ST DIR	
9	0200	R.20	T out (2400)
880	0701	1	
1	0704	4	
2	0704	4	
3	0404	ST DIR	
4	0001	R.01	DATA BLK
5	0701	1	
6	0709	9	
7	0702	2	
8	0404	ST DIR	
9	0208	R.28	LAST BLK
890	0106		
1	0107		
2	0405	RE DIR	
3	0207	R.27	T out
4	0404	ST DIR	
5	0201	R.21	T out (2600)
6	0702	2	
7	0700	0	
8	0708	8	
9	0404	ST DIR	

Remarks: PROGRAM TAPE BLOCK #6, 10 - 13

Step	Code	Key	Comment	Step	Code	Key	Comment
900	0001	R.01	DATA BLK	950	0704	4	
1	0702	2		1	0708	8	
2	0705	5		2	0404	ST DIR	
3	0706	6		3	0208	R.28	LAST BLK
4	0404	ST DIR		4	0106		
5	0208	R.28	LAST BLK	5	0107		
6	0106			6	0405	RE DIR	
7	0107			7	0207	R.27	Tout
8	0405	RE DIR		8	0404	ST DIR	
9	0207	R.27	T out	9	0205	R.25	Tout (3400)
910	0404	ST DIR		960	0704	4	
1	0202	R.22	Tout (2800)	1	0706	6	
2	0702	2		2	0704	4	
3	0707	7		3	0404	ST DIR	
4	0702	2		4	0001	R.01	DATA BLK
5	0404	ST DIR		5	0705	5	
6	0001	R.01	DATA BLK	6	0701	1	
7	0703	3		7	0702	2	
8	0702	2		8	0404	ST DIR	
9	0700	0		9	0208	R.28	LAST BLK
920	0404	ST DIR		970	0106		
1	0208	R.28	LAST BLK	1	0107		
2	0106			2	0405	RE DIR	
3	0107			3	0207	R.27	T out
4	0405	RE DIR		4	0404	ST DIR	
5	0207	R.27	T out	5	0206	R.26	Tout (3600)
6	0404	ST DIR		6	0705	5	
7	0203	R.23	Tout (3000)	7	0702	2	
8	0703	3		8	0708	8	
9	0703	3		9	0404	ST DIR	
930	0706	6		980	0001	R.01	DATA BLK
1	0404	ST DIR		1	0705	5	
2	0001	R.01	DATA BLK	2	0707	7	
3	0703	3		3	0706	6	
4	0708	8		4	0404	ST DIR	
5	0704	4		5	0208	R.28	LAST BLK
6	0404	ST DIR		6	0106		
7	0208	R.28	LAST BLK	7	0107		
8	0106			8	0415	RE Y	
9	0107			9	0010	R.10	W F21
940	0405	RE DIR		990	0703	3	
1	0207	R.27	Tout	1	0700	0	
2	0404	ST DIR		2	0700	0	
3	0204	R.24	Tout (3200)	3	0700	0	
4	0704	4		4	0508	SKIP IFY<X	
5	0700	0		5	0407	SEARCH	
6	0700	0		6	0013	13	
7	0404	ST DIR		7	0702	2	
8	0001	R.01	DATA BLK	8	0702	2	
9	0704	4		9	0700	0	

Remarks: PROGRAM TAPE BLOCK #6, 10 - 13

Step	Code	Key	Comment	Step	Code	Key	Comment
1000	0700	0		1050	0015	R.15	T_1
1	0606	↓↑		1	0701	1	
2	0507	SKIP IF Y≥X		2	0600	+	
3	0407	SEARCH		3	0505	RE INDIR	
4	0014	14		4	0404	ST DIR	
5	0405	RE DIR		5	0106	R.16	T_2
6	0109	R.19	Tout (2200)	6	0701	1	
7	0404	ST DIR		7	0600	+	
8	0208	R.28	T RAD-OUT	8	0505	RE INDIR	
9	0407	SEARCH		9	0404	ST DIR	
1010	0015	15		1060	0107	R.17	T_3
1	040B	MARK		1	0701	1	
2	0014	14		2	0600	+	
3	0606	↓↑		3	0505	RE INDIR	
4	0601	-		4	0404	ST DIR	
5	0702	2		5	0108	R.18	T_4
6	0700	0		6	0407	SEARCH	
7	0700	0		7	0700	0	
8	0603	÷		8	040B	MARK	
9	0605	↓		9	0013	13	
1020	060B	INT X		1070	0703	3	
1	0404	ST DIR		1	070B	B	
2	0001	R.01	ω STEPS	2	0700	0	
3	0604	↑		3	0700	0	
4	0707	7		4	0507	SKIP IF Y≥X	
5	0700	0		5	0407	SEARCH	
6	0700	0		6	0701	1	
7	0602	X		7	0405	RE DIR	
8	0702	2		8	0207	R.27	Tout (3800)
9	0702	2		9	0404	ST DIR	
1030	0700	0		1080	0208	R.28	T RAD-OUT
1	0700	0		1	0407	SEARCH	
2	0600	+		2	0015	15	
3	0405	RE DIR		3	040B	MARK	
4	0010	R.10	ω F21	4	0701	1	
5	0606	↓↑		5	0606	↓↑	
6	0601	-		6	0601	-	
7	0702	2		7	0702	2	
8	0700	0		8	0700	0	
9	0700	0		9	0700	0	
1040	0603	÷		1090	0603	÷	
1	0414	ST Y		1	0605	↓	
2	0002	R.02	m	2	060B	INT X	
3	0415	RE Y		3	0404	ST DIR	
4	0001	R.01	ω STEPS	4	0001	R.01	ω STEPS
5	0701	1		5	0604	↑	
6	0709	9		6	0702	2	
7	0600	+		7	0700	0	
8	0505	RE INDIR		8	0700	0	
9	0404	ST DIR		9	0602	X	

Remarks:

PROGRAM TAPE BLOCK #6, 10 - 13

Step	Code	Key	Comment	Step	Code	Key	Comment
1100	0703	3		1150	0200	R.20	D1-2
1	0708	8		1	0405	RE DIR	
2	0700	0		2	0106	R.16	T₂
3	0700	0		3	0401	- DIR	
4	0606	↓↑		4	0200	R.20	D1-2
5	0601	-		5	0404	ST DIR	
6	0405	RE DIR		6	0201	R.21	D1-1
7	0010	R.10	W F21	7	0405	RE DIR	
8	0601	-		8	0015	R.15	T₁
9	0702	2		9	0401	- DIR	
1110	0700	0		1160	0201	R.21	D1-1
1	0700	0		1	0405	RE DIR	
2	0603	÷		2	0109	R.19	D1-3
3	0414	ST Y		3	0404	ST DIR	
4	0002	R.02	m	4	0202	R.22	D2-2
5	0702	2		5	0405	RE DIR	
6	0707	7		6	0200	R.20	D1-2
7	0604	↑		7	0401	- DIR	
8	0405	RE DIR		8	0202	R.22	D2-2
9	0001	R.01	W STEPS	9	0404	ST DIR	
1120	0601	-		1170	0203	R.23	D2-1
1	0505	RE INDIR		1	0405	RE DIR	
2	0404	ST DIR		2	0201	R.21	D1-1
3	0015	R.15	T₁	3	0401	- DIR	
4	0701	1		4	0203	R.23	D2-1
5	0601	-		5	0405	RE DIR	
6	0505	RE INDIR		6	0202	R.22	D2-2
7	0404	ST DIR		7	0404	ST DIR	
8	0106	R.16	T₂	8	0204	R.24	D3-1
9	0701	1		9	0405	RE DIR	
1130	0601	-		1180	0203	R.23	D2-1
1	0505	RE INDIR		1	0401	- DIR	
2	0404	ST DIR		2	0204	R.24	D3-1
3	0107	R.17	T₃	3	0405	RE DIR	
4	0701	1		4	0015	R.15	T₁
5	0601	-		5	0404	ST DIR	
6	0505	RE INDIR		6	0208	R.28	T RAD-OUT
7	0404	ST DIR		7	0415	RE Y	
8	0108	R.18	T₄	8	0002	R.02	m
9	0408	MARK		9	0405	RE DIR	
1140	0700	0		1190	0201	R.21	D1-1
1	0405	RE·DIR		1	0602	×	
2	0108	R.18	T₄	2	0605	↓	
3	0404	ST DIR		3	0400	+ DIR	
4	0109	R.19	D1-3	4	0208	R.28	T RAD-OUT
5	0405	RE DIR		5	0415	RE Y	
6	0107	R.17	T₃	6	0002	R.02	m
7	0401	- DIR		7	0701	1	
8	0109	R.19	D1-3	8	0601	-	
9	0404	ST DIR		9	0414	ST Y	

Remarks: PROGRAM TAPE BLOCK #6, 10 - 13

Step	Code	Key	Comment	Step	Code	Key	Comment
1200	0207	R.27	m-1				
1	0405	RE DIR					
2	0002	R.02	m				
3	0602	X					
4	0702	Z					
5	0603	÷					
6	0405	RE DIR					
7	0203	R.23	D2-1				
8	0602	X					
9	0605	↓					
1210	0400	+ DIR					
1	0208	R.28	T RAD-OUT				
2	0415	RE Y					
3	0002	R.02	m				
4	0702	Z					
5	0601	—					
6	0405	RE DIR					
7	0207	R.27	m-1				
8	0602	X					
9	0405	RE DIR					
1220	0002	R.02	m				
1	0602	X					
2	0706	6					
3	0603	÷					
4	0405	RE DIR					
5	0204	R.24	D3-1				
6	0602	X					
7	0605	↓					
8	0400	+ DIR					
9	0208	R.28	T RAD-OUT				
1230	0408	mARK					
1	0015	15					
2	0415	RE Y					
3	0209	R.29	T RAD				
4	0405	RE DIR					
5	0208	R.28	T RAD-OUT				
6	0507	SKIP IF Y≥X					
7	0407	SEARCH					
8	0704	4					
9	0414	ST Y					
1240	0208	R.28	T RAD-OUT				
1	0408	mARK					
2	0704	4					
3	0511	RETURN					

Remarks:

PROGRAM TAPE BLOCK #6, 10 - 13

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0000	R.00	BLK CNTR
				1	0708	8	
				2	0404	ST DIR	
				3	0006	R.06	REG CNTR
				4	0701	1	
				5	0704	4	
				6	0704	4	
				7	0700	0	
				8	0404	ST DIR	
				9	0007	R.07	DATA BLK
				60	0100		
				1	0415	KE Y	
				2	0008	R.08	Q O2HTR
				3	0412	WRITE A	SKIP IF
				4	0411	WRITE	Y=0
				5	0407	SEARCH	
				6	0004	04	
				7	0405	RE DIR	
				8	0002	R.02	T FZI-IN
				9	0404	ST DIR	
				70	0007	R.07	T FZI-OUT
				1	0700	0	
				2	0404	ST DIR	
				3	0009	R.09	WCP FZI
				4	0407	SEARCH	
				5	0005	05	
				6	0408	MARK	
				7	0004	04	
				8	0405	RE DIR	
				9	0003	R.03	W FZI
				80	0603	÷	
				1	0414	ST Y	
				2	0006	R.06	ΔH FZI
				3	0405	RE DIR	
				4	0002	R.02	T FZI-IN
5	0408	MARK		5	0404	ST DIR	
6	0003	03		6	0004	R.04	T FZI
7	0701	1		7	0101		
8	0400	+ DIR		8	0405	RE DIR	
9	0000	R.00	BLK CNTR	9	0006	R.06	ΔH FZI
40	0410	GROUP 2		90	0401	- DIR	
1	0001	01	PROG TAPE	1	0005	R.05	H FZI
2	0415	KE Y		2	0102		
3	0000	R.00	BLK CNTR	3	0405	RE DIR	
4	0702	2		4	0004	R.04	T FZI
5	0709	9		5	0404	ST DIR	
6	0701	1		6	0007	R.07	T FZI-OUT
7	0806		TRANSFER	7	0415	KE Y	
8	0701	1		8	0002	R.02	T FZI-IN
9	0400	+ DIR		9	0601	-	

Remarks: PROGRAM TAPE BLOCK #14 - 15

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0405	RE DIR		150	0002	R.02	T FZ1-IN
1	0008	R.08	Q O2HTR	1	0411	WRITE	
2	0606	↑↑		2	0502		DP-5.2
3	0603	÷		3	0411	WRITE	
4	0414	ST Y		4	1503		3 SPACES
5	0009	R.09	WGP FZ1	5	0412	WRITE A	
6	0408	MARK		6	0103		SHIFT UP
7	0005	OS		7	0207		T
8	0412	WRITE A		8	0002		SPACE
9	0103		SHIFT UP	9	0014		F
110	0109		O	160	0102		SHIFT DN
1	0102		SHIFT DN	1	0306		Z
2	0306		Z	2	0209		1
3	0002		SPACE	3	0109		O
4	0103		SHIFT UP	4	0214		U
5	0113		R	5	0207		T
6	0205		E	6	0002		SPACE
7	0101		S	7	0006		=
8	0207		T	8	0413		END A
9	0113		R	9	0405		RE DIR
120	0104		1	170	0007	R.07	T FZ1-OUT
1	0212		C	1	0411	WRITE	
2	0207		T	2	0502		DP-5.2
3	0109		O	3	0411	WRITE	
4	0113		R	4	1503		3 SPACES
5	0002		SPACE	5	0412	WRITE A	
6	0102		SHIFT DN	6	0103		SHIFT UP
7	0009		/	7	0100		W
8	0002		SPACE	8	0212		C
9	0103		SHIFT UP	9	0102		SHIFT DN
130	0201		H	180	0005		P
1	0205		E	1	0002		SPACE
2	0112		A	2	0103		SHIFT UP
3	0207		T	3	0014		F
4	0205		E	4	0102		SHIFT DN
5	0113		R	5	0306		Z
6	0108		CR/LF	6	0209		1
7	0207		T	7	0002		SPACE
8	0002		SPACE	8	0002		SPACE
9	0014		F	9	0006		=
140	0102		SHIFT DN	190	0413	END A	
1	0306		Z	1	0405	RE DIR	
2	0209		1	2	0009	R.09	WGP FZ1
3	0104		1	3	0411	WRITE	
4	0206		N	4	0502		DP-5.2
5	0002		SPACE	5	0412	WRITE A	
6	0002		SPACE	6	0108		CR/LF
7	0006		=	7	0110		LF
8	0413	END A		8	0413	END A	
9	0405	RE DIR		9	0405	RE DIR	

Remarks:

PROGRAM TAPE BLOCK #14 - 15

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0007	R.07	T FZI-OUT	250	0711	CHS SGN	
1	0404	ST DIR		1	0706	6	
2	0007	R.07	T FZI-OUT	2	0602	X	
3	0701	1		3	0414	ST Y	
4	0706	6		4	0005	R.05	H FZI
5	0404	ST DIR		5	0405	RE DIR	
6	0000	R.00	BLK CNTR	6	0004	R.04	T FZI
7	0407	SEARCH		7	0713	X²	
8	0001	01		8	0604	÷	
9	0408	MARK		9	0701	1	
210	0100			260	0700	0	
1	0410	GROUP 2		1	0708	8	
2	0003	03	EXT CORE	2	0706	6	
3	0415	RE Y		3	0707	7	
4	0007	R.07	DATA BLK	4	0700	0	
5	0701	1		5	0704	4	
6	0709	9		6	0708	8	
7	0703	3		7	0703	3	
8	0706	6		8	0700	0	
9	0802		TRANSFER	9	0700	0	
220	0415	RE Y		270	0709	9	
1	0006	R.06	REG CNTR	1	0710	SET EXP	
2	0405	RE DIR		2	0711	CHS SGN	
3	0004	R.04	DATA	3	0703	3	
4	0504	ST INDIR		4	0602	X	
5	0701	1		5	0605	↓	
6	0400	+ DIR		6	0400	+ DIR	
7	0006	R.06	REG CNTR	7	0005	R.05	H FZI
8	0511	RETURN		8	0415	RE Y	
9	0408	MARK		9	0004	R.04	T FZI
230	0101			280	0712	.	
1	0415	RE Y		1	0702	2	
2	0004	R.04	T FZI	2	0703	3	
3	0405	RE DIR		3	0704	4	
4	0004	R.04	T FZI	4	0708	8	
5	0713	X²		5	0708	8	
6	0602	X		6	0708	8	
7	0701	1		7	0705	5	
8	0704	4		8	0705	5	
9	0704	4		9	0705	5	
240	0708	8		290	0701	1	
1	0703	3		1	0700	0	
2	0707	7		2	0705	5	
3	0704	4		3	0602	X	
4	0705	5		4	0605	↓	
5	0702	2		5	0400	+ DIR	
6	0702	2		6	0005	R.05	H FZI
7	0708	8		7	0709	9	
8	0702	2		8	0712	.	
9	0710	SET EXP		9	0704	4	

Remarks: PROGRAM TAPE BLOCK #14 - 15

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0705	S		350	0704	4	
1	0706	6		1	0705	5	
2	0704	4		2	0707	7	
3	0701	1		3	0710	SET EXP	
4	0707	7		4	0711	CHS SGN	
5	0700	0		5	0702	2	
6	0709	9		6	0602	X	
7	0702	2		7	0605	↓	
8	0703	3		8	0401	- DIR	
9	0400	+ DIR		9	0004	R.04	T FZI
310	0005	R.05	H FZI	360	0415	RE Y	
1	0511	RETURN		1	0005	R.05	H FZI
2	0408	MARK		2	0704	4	
3	0102			3	0712	.	
4	0415	RE Y		4	0704	4	
5	0005	R.05	H FZI	5	0704	4	
6	0405	RE DIR		6	0703	3	
7	0005	R.05	H FZI	7	0703	3	
8	0713	X²		8	0709	9	
9	0602	X		9	0703	3	
320	0709	9		370	0703	3	
1	0704	4		1	0705	5	
2	0705	5		2	0707	7	
3	0703	3		3	0707	7	
4	0706	6		4	0705	5	
5	0709	9		5	0602	X	
6	0703	3		6	0605	↓	
7	0700	0		7	0400	+ DIR	
8	0706	6		8	0004	R.04	T FZI
9	0703	3		9	0704	4	
330	0704	4		380	0701	1	
1	0708	8		1	0712	.	
2	0710	SET EXP		2	0702	2	
3	0711	CHS SGN		3	0700	0	
4	0705	S		4	0707	7	
5	0602	X		5	0703	3	
6	0414	ST Y		6	0703	3	
7	0004	R.04	T FZI	7	0704	4	
8	0405	RE DIR		8	0706	6	
9	0005	R.05	H FZI	9	0700	0	
340	0713	X²		390	0703	3	
1	0604	↑		1	0401	- DIR	
2	0709	9		2	0004	R.04	T FZI
3	0704	4		3	0511	RETURN	
4	0704	4					
5	0709	9					
6	0700	0					
7	0703	3					
8	0702	2					
9	0702	2					

Remarks:
PROGRAM TAPE BLOCK #14 - 15

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0000	K.00	BLK CNTR
				1	0415	KEY	
				2	0000	K.00	BLK CNTR
				3	0705	5	
				4	0704	4	
				5	0707	7	
				6	0806		TRANSFER
				7	0701	1	
				8	0400	+ DIR	
				9	0000	K.00	BLK CNTR
				60	0708	8	
				1	0404	ST DIR	
				2	0006	K.06	BEG CNTR
				3	0701	1	
				4	0704	4	
				5	0707	7	
				6	0702	2	
				7	0404	ST DIR	
				8	0007	K.07	DATA BLK
				9	0100		
				70	0701	1	
				1	0709	9	
				2	0702	2	
				3	0700	0	
				4	0404	ST DIR	
				5	0007	K.07	DATA BLK
				6	0100		
				7	0702	2	
				8	0702	2	
				9	0702	2	
				80	0704	4	
				1	0404	ST DIR	
				2	0007	K.07	DATA BLK
				3	0100		
				4	0415	KEY	
5	0408	MARK		5	0010	K.10	R H2O LOOP
6	0003	03		6	0405	RE DIR	
7	0701	1		7	0003	K.03	W F21
8	0400	+ DIR		8	0603	÷	
9	0000	K.00	BLK CNTR	9	0414	ST Y	
40	0410	GROUP 2		90	0006	K.06	ΔH F21
1	0001	01	PROS TAPE	1	0405	RE DIR	
2	0415	KEY		2	0002	K.02	T F21-IN
3	0000	K.00	BLK CNTR	3	0404	ST DIR	
4	0702	2		4	0004	K.04	T F21
5	0709	9		5	0101		
6	0701	1		6	0405	RE DIR	
7	0806		TRANSFER	7	0006	K.06	ΔH F21
8	0701	1		8	0400	+ DIR	
9	0400	+ DIR		9	0005	K.05	H F21

Remarks: PROGRAM TAPE BLOCK #16 - 18

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0102			150	0013	K.13	C_1
1	0415	RE Y		1	0415	RE Y	
2	0004	K.04	T FZI	2	0009	K.09	UA INTHX
3	0414	ST Y		3	0602	X	
4	0007	K.07	T FZI-OUT	4	0605	↓	
5	0405	RE DIR		5	0614	e^x	
6	0002	K.02	T FZI-IN	6	0604	↑	
7	0601	−		7	0701	1	
8	0405	RE DIR		8	0606	↓↑	
9	0010	K.10	Q H2O LOOP	9	0601	−	
110	0606	↓↑		160	0414	ST Y	
1	0603	÷		1	0014	K.14	C_2
2	0414	ST Y		2	0405	RE DIR	
3	0011	K.11	WXP FZI	3	0002	K.02	T FZI-IN
4	0405	RE DIR		4	0602	X	
5	0008	K.08	W H2O	5	0405	RE DIR	
6	0603	÷		6	0013	K.13	C_1
7	0701	1		7	0601	−	
8	0601	−		8	0405	RE DIR	
9	0412	WRITE A	SKIP IF	9	0014	K.14	C_2
120	0411	WRITE	Y=0	170	0603	÷	
1	0407	SEARCH		1	0414	ST Y	
2	0004	04		2	0001	K.01	T H2O-OUT
3	0415	RE Y		3	0408	MARK	
4	0010	K.10	Q H2O LOOP	4	0005	05	
5	0405	RE DIR		5	0415	RE Y	
6	0009	K.09	UA INTHX	6	0010	K.10	Q H2O LOOP
7	0603	÷		7	0405	RE DIR	
8	0405	RE DIR		8	0008	K.08	W H2O
9	0002	K.02	T FZI-IN	9	0603	÷	
130	0600	+		180	0405	RE DIR	
1	0414	ST Y		1	0001	K.01	T H2O-OUT
2	0001	K.01	T H2O-OUT	2	0600	+	
3	0407	SEARCH		3	0414	ST Y	
4	0005	05		4	0012	K.12	T H2O-IN
5	0408	MARK		5	0412	WRITE A	
6	0004	04		6	0103		SHIFT UP
7	0405	RE DIR		7	0014		F
8	0008	K.08	W H2O	8	0102		SHIFT DN
9	0615	1/X		9	0306		2
140	0604			190	0209		1
1	0405	RE DIR		1	0002		SPACE
2	0011	K.11	WXP FZI	2	0009		/
3	0615	1/X		3	0002		SPACE
4	0601	−		4	0103		SHIFT UP
5	0405	RE DIR		5	0201		H
6	0010	K.10	Q H2O LOOP	6	0102		SHIFT DN
7	0606	↓↑		7	0306		2
8	0602	X		8	0103		SHIFT UP
9	0414	ST Y		9	0109		0

Remarks:

PROGRAM TAPE BLOCK #16 - 18

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0002		SPACE	250	0002	R.02	T F21-IN
1	0104		I	1	0411	WRITE	
2	0206		N	2	0502		DP-S.2
3	0207		T	3	0411	WRITE	
4	0205		E	4	1503		3 SPACES
5	0113		R	5	0412	WRITE A	
6	0212		C	6	0103		SHIFT UP
7	0201		H	7	0207		T
8	0112		A	8	0002		SPACE
9	0206		N	9	0014		F
210	0015		G	260	0102		SHIFT DN
1	0205		E	1	0306		Z
2	0113		R	2	0209		1
3	0108		CR/LF	3	0109		O
4	0004		Q	4	0214		U
5	0002		SPACE	5	0207		T
6	0201		H	6	0002		SPACE
7	0102		SHIFT DN	7	0006		=
8	0306		Z	8	0413	END A	
9	0103		SHIFT UP	9	0405	RE DIR	
220	0109		U	270	0007	R.07	T F21-OUT
1	0209		L	1	0411	WRITE	
2	0413	END A		2	0502		DP-S.2
3	0411	WRITE		3	0411	WRITE	
4	1503		3 SPACES	4	1503		3 SPACES
5	0412	WRITE A		5	0412	WRITE A	
6	0102		SHIFT DN	6	0103		SHIFT UP
7	0006		=	7	0100		W
8	0413	END A		8	0212		C
9	0405	RE DIR		9	0102		SHIFT DN
230	0010	R.10	Q H2O LOOP	280	0005		P
1	0411	WRITE		1	0002		SPACE
2	0502		DP-S.2	2	0103		SHIFT UP
3	0411	WRITE		3	0014		F
4	1503		3 SPACES	4	0102		SHIFT DN
5	0412	WRITE A		5	0306		Z
6	0103		SHIFT UP	6	0209		1
7	0207		T	7	0002		SPACE
8	0002		SPACE	8	0002		SPACE
9	0014		F	9	0006		=
240	0102		SHIFT DN	290	0413	END A	
1	0306		Z	1	0405	RE DIR	
2	0209		1	2	0011	R.11	WX2 F21
3	0104		1	3	0411	WRITE	
4	0206		N	4	0502		DP-S.2
5	0002		SPACE	5	0412	WRITE A	
6	0002		SPACE	6	0108		CR/LF
7	0006		=	7	0103		SHIFT UP
8	0413	END A		8	0207		T
9	0405	RE DIR		9	0002		SPACE

Remarks: PROGRAM TAPE BLOCK #16 - 18

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0201		H	350	0407	SEARCH	
1	0102		SHIFT DN	1	0201	01	
2	0306		Z	2	0408	MARK	
3	0103		SHIFT UP	3	0100		
4	0109		O	4	0410	GROUP 2	
5	0102		SHIFT DN	5	0003	03	EXT CORE
6	0104		1	6	0415	RE Y	
7	0206		N	7	0007	R.07	DATA BLK
8	0002		SPACE	8	0701	1	
9	0002		SPACE	9	0709	9	
310	0006		=	360	0703	3	
1	0413	END A		1	0706	6	
2	0405	RE DIR		2	0802		TRANSFER
3	0012	R.12	T H2O-IN	3	0415	RE Y	
4	0411	WRITE		4	0006	R.06	REG CNTR
5	0502		DP-S.2	5	0405	RE DIR	
6	0411	WRITE		6	0004	R.04	DATA
7	1503		3 SPACES	7	0504	ST INDIR	
8	0412	WRITE A		8	0701	1	
9	0103		SHIFT UP	9	0400	+ DIR	
320	0207		T	370	0006	R.06	REG CNTR
1	0002		SPACE	1	0511	RETURN	
2	0201		H	2	0408	MARK	
3	0102		SHIFT DN	3	0101		
4	0306		Z	4	0415	RE Y	
5	0103		SHIFT UP	5	0004	R.04	T F21
6	0109		O	6	0405	RE DIR	
7	0102		SHIFT DN	7	0004	R.04	T F21
8	0109		O	8	0713	X^2	
9	0214		U	9	0602	X	
330	0207		T	380	0701	1	
1	0002		SPACE	1	0704	4	
2	0006		=	2	0704	4	
3	0413	END A		3	0708	8	
4	0405	RE DIR		4	0703	3	
5	0001	R.01	T H2O -OUT	5	0707	7	
6	0411	WRITE		6	0704	4	
7	0502		DP-S.2	7	0705	5	
8	0412	WRITE A		8	0702	2	
9	0108		CR/LF	9	0702	2	
340	0110		LF	390	0708	8	
1	0413	END A		1	0702	2	
2	0405	RE DIR		2	0710	SET EXP	
3	0007	R.07	T F21-OUT	3	0711	CHS SGN	
4	0404	ST DIR		4	0706	6	
5	0002	R.02	T F21-OUT	5	0602	X	
6	0701	1		6	0414	ST Y	
7	0709	9		7	0005	R.05	H F21
8	0404	ST DIR		8	0405	RE DIR	
9	0000	R.00	BLK CNTR	9	0004	R.04	T F21

Remarks:
PROGRAM TAPE BLOCK #16 - 18

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0713	x^2		450	0702	2	
1	0604	↑		1	0703	3	
2	0701	1		2	0400	+ DIR	
3	0700	0		3	0005	R.05	H F21
4	0708	8		4	0511	RETURN	
5	0706	6		5	0408	MARK	
6	0707	7		6	0102		
7	0700	0		7	0415	RE Y	
8	0704	4		8	0005	R.05	H F21
9	0708	8		9	0405	RE DIR	
410	0703	3		460	0005	R.05	H F21
1	0700	0		1	0713	x^2	
2	0700	0		2	0602	X	
3	0709	9		3	0709	9	
4	0710	SET EXP		4	0704	4	
5	0711	CHS SGN		5	0705	5	
6	0703	3		6	0703	3	
7	0602	X		7	0706	6	
8	0605	↓		8	0709	9	
9	0400	+ DIR		9	0703	3	
420	0005	R.05	H F21	470	0700	0	
1	0415	RE Y		1	0706	6	
2	0004	R.04	T F21	2	0703	3	
3	0712	.		3	0704	4	
4	0702	2		4	0708	8	
5	0703	3		5	0710	SET EXP	
6	0704	4		6	0711	CHS SGN	
7	0708	8		7	0705	5	
8	0708	8		8	0602	X	
9	0708	8		9	0414	ST Y	
430	0705	5		480	0004	R.04	T F21
1	0705	5		1	0405	RE DIR	
2	0705	5		2	0005	R.05	H F21
3	0701	1		3	0713	x^2	
4	0700	0		4	0604	↑	
5	0705	5		5	0709	9	
6	0602	X		6	0704	4	
7	0605	↓		7	0704	4	
8	0400	+ DIR		8	0709	9	
9	0005	R.05	H F21	9	0700	0	
440	0709	9		490	0703	3	
1	0712	.		1	0702	2	
2	0704	4		2	0702	2	
3	0705	5		3	0704	4	
4	0706	6		4	0705	5	
5	0704	4		5	0707	7	
6	0701	1		6	0710	SET EXP	
7	0707	7		7	0711	CHS SGN	
8	0700	0		8	0702	2	
9	0709	9		9	0602	X	

Remarks:

PROGRAM TAPE BLOCK #16 - 18

Step	Code	Key	Comment	Step	Code	Key	Comment
500	0605	↓					
1	0401	– DIR					
2	0004	R.04	T F21				
3	0415	KEY					
4	0005	R.05	H F21				
5	0704	4					
6	0712	.					
7	0704	4					
8	0704	4			←		
9	0703	3					
510	0703	3					
1	0709	9					
2	0703	3					
3	0703	3					
4	0705	5					
5	0707	7					
6	0707	7					
7	0705	5					
8	0602	X					
9	0605	↓					
520	0400	+ DIR					
1	0004	R.04	T F21				
2	0704	4					
3	0701	1					
4	0712	.					
5	0702	2					
6	0700	0					
7	0707	7					
8	0703	3					
9	0703	3					
530	0704	4					
1	0706	6					
2	0700	0					
3	0703	3					
4	0401	– DIR					
5	0004	R.04	T F21				
6	0511	RETURN					

Remarks:

Step	Code	Key	Comment
5	0408	mARK	
6	0003	03	
7	0701	1	
8	0400	+ DIR	
9	0000	R.00	BLK CNTR
40	0410	GROUP 2	
1	0001	01	PROG TAPE
2	0415	RE Y	
3	0000	R.00	BLK CNTR
4	0702	2	
5	0709	9	
6	0701	1	
7	0806		TRANSFER
8	0701	1	
9	0400	+ DIR	

Step	Code	Key	Comment
50	0000	R.00	BLK CNTR
1	0708	8	
2	0404	ST DIR	
3	0006	R.06	REG CNTR
4	0701	1	
5	0702	2	
6	0708	8	
7	0700	0	
8	0404	ST DIR	
9	0007	R.07	DATA BLK
60	0100		
1	0701	1	
2	0704	4	
3	0707	7	
4	0702	2	
5	0404	ST DIR	
6	0007	R.07	DATA BLK
7	0100		
8	0701	1	
9	0706	6	
70	0703	3	
1	0702	2	
2	0404	ST DIR	
3	0007	R.07	DATA BLK
4	0100		
5	0701	1	
6	0708	8	
7	0708	8	
8	0708	8	
9	0404	ST DIR	
80	0007	R.07	DATA BLK
1	0100		
2	0405	RE DIR	
3	0008	R.08	Q CHILL
4	0412	WRITE A	SKIP IF
5	0611	LOG e X	X=0
6	0407	SEARCH	
7	0004	04	
8	0404	ST DIR	
9	0005	R.05	T PoT-OUT
90	0404	ST DIR	
1	0006	R.06	T PoT-IN
2	0405	RE DIR	
3	0001	R.01	T H2O-IN
4	0404	ST DIR	
5	0004	R.04	T H2O-OUT
6	0407	SEARCH	
7	0005	05	
8	0408	mARK	
9	0004	04	

Remarks: PROGRAM TAPE BLOCK #19 - 20

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0415	RE Y		150	0405	RE DIR	
1	0009	R.09	W H$_2$O	1	0001	R.01	T H2O-IN
2	0405	RE DIR		2	0602	X	
3	0010	R.10	W CHILL	3	0405	RE DIR	
4	0603	÷		4	0007	R.07	C$_1$
5	0701	1		5	0601	−	
6	0601	−		6	0405	RE DIR	
7	0412	WRITE A	SKIP IF	7	0012	R.12	C$_2$
8	0411	WRITE	Y=0	8	0603	÷	
9	0407	SEARCH		9	0414	ST Y	
110	0006	06		160	0005	R.05	T POT-OUT
1	0415	RE Y		1	0408	MARK	
2	0008	R.08	Q CHILL	2	0007	07	
3	0405	RE DIR		3	0415	RE Y	
4	0011	R.11	VA CHILL	4	0008	R.08	Q CHILL
5	0603	÷		5	0405	RE DIR	
6	0405	RE DIR		6	0009	R.09	W H2O
7	0001	R.01	T H2O-IN	7	0603	÷	
8	0600	+		8	0405	RE DIR	
9	0414	ST Y		9	0001	R.01	T H2O-IN
120	0005	R.05	T POT.-OUT	170	0600	+	
1	0407	SEARCH		1	0414	ST Y	
2	0007	07		2	0004	R.04	T H2O-OUT
3	0408	MARK		3	0415	RE Y	
4	0006	06		4	0008	R.08	Q CHILL
5	0405	RE DIR		5	0405	RE DIR	
6	0010	R.10	W CHILL	6	0010	R.10	W CHILL
7	0615	Yx		7	0603	÷	
8	0604	↑		8	0405	RE DIR	
9	0405	RE DIR		9	0005	R.05	T POT-OUT
130	0009	R.09	W H2O	180	0600	+	
1	0615	Yx		1	0414	ST Y	
2	0601	−		2	0006	R.06	T POT-IN
3	0405	RE DIR		3	0408	MARK	
4	0008	R.08	Q CHILL	4	0005	05	
5	0606	↓↑		5	0412	WRITE A	
6	0602	X		6	0103		SHIFT UP
7	0414	ST Y		7	0005		P
8	0007	R.07	C$_1$	8	0109		O
9	0415	RE Y		9	0207		T
140	0011	R.11	VA CHILL	190	0112		A
1	0602	X		1	0200		B
2	0605	↓		2	0209		L
3	0614	e^x		3	0205		E
4	0604	↑		4	0002		SPACE
5	0701	1		5	0201		H
6	0606	↓↑		6	0102		SHIFT DN
7	0601	−		7	0306		Z
8	0414	ST Y		8	0103		SHIFT UP
9	0012	R.12	C$_2$	9	0109		O

Remarks:

PROGRAM TAPE BLOCK #19 – 20

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0002		SPACE	250	1503		3 SPACES
1	0212		C	1	0412	WRITE A	
2	0201		H	2	0103		SHIFT UP
3	0104		I	3	0207		T
4	0205		L	4	0002		SPACE
5	0209		L	5	0205		P
6	0205		E	6	0109		O
7	0113		R	7	0207		T
8	0108		CR/LF	8	0102		SHIFT DN
9	0207		T	9	0104		I
210	0002		SPACE	260	0206		N
1	0201		H	1	0002		SPACE
2	0102		SHIFT DN	2	0002		SPACE
3	0306		Z	3	0006		=
4	0103		SHIFT UP	4	0413	END A	
5	0109		O	5	0405	RE DIR	
6	0102		SHIFT DN	6	0006	R.06	T POT-IN
7	0104		I	7	0411	WRITE	
8	0206		N	8	0502		DP-S.2
9	0002		SPACE	9	0411	WRITE	
220	0002		SPACE	270	1503		3 SPACES
1	0006		=	1	0412	WRITE A	
2	0413	END A		2	0103		SHIFT UP
3	0405	RE DIR		3	0207		T
4	0001	R.01	T H2O-IN	4	0002		SPACE
5	0411	WRITE		5	0005		P
6	0502		DP-S.2	6	0109		O
7	0411	WRITE		7	0207		T
8	1503		3 SPACES	8	0102		SHIFT DN
9	0412	WRITE A		9	0109		O
230	0103		SHIFT UP	280	0214		U
1	0207		T	1	0207		T
2	0002		SPACE	2	0002		SPACE
3	0201		H	3	0006		=
4	0102		SHIFT DN	4	0413	END A	
5	0306		Z	5	0405	RE DIR	
6	0103		SHIFT UP	6	0005	R.05	T POT-OUT
7	0109		O	7	0411	WRITE	
8	0102		SHIFT DN	8	0502		DP-S.2
9	0109		O	9	0412	WRITE A	
240	0214		U	290	0108		CR/LF
1	0207		T	1	0110		LF
2	0002		SPACE	2	0413	END A	
3	0006		=	3	0405	RE DIR	
4	0413	END A		4	0004	R.04	T H2O-OUT
5	0405	RE DIR		5	0404	ST DIR	
6	0004	R.04	T H2O-OUT	6	0001	R.01	T H2O-OUT
7	0411	WRITE		7	0702	Z	
8	0502		DP-S.2	8	0701	1	
9	0411	WRITE		9	0404	ST DIR	

Remarks: PROGRAM TAPE BLOCK #19 - 20

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0000	R.00	BLK CNTR				
1	0407	SEARCH					
2	0001	01					
3	0408	MARK					
4	0100						
5	0410	GROUP 2					
6	0003	03	EXT CORE				
7	0415	RE Y					
8	0007	R.07	DATA BLK				
9	0701	1					
310	0709	9					
1	0703	3					
2	0706	6					
3	0802		TRANSFER				
4	0415	RE Y					
5	0006	R.06	REG CNTR				
6	0405	RE DIR					
7	0004	R.04	DATA				
8	0504	ST INDIR					
9	0701	1					
320	0400	+ DIR					
1	0006	R.06	REG CNTR				
2	0511	RETURN					

Remarks:

PROGRAM TAPE BLOCK #19 - 20

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0704	4	
				1	0707	7	
				2	0806		TRANSFER
				3	0701	1	
				4	0600	+	
				5	0708	8	
				6	0700	0	
				7	0703	3	
				8	0806		TRANSFER
				9	0701	1	
				60	0600	+	
				1	0701	1	
				2	0700	0	
				3	0705	5	
				4	0709	9	
				5	0806		TRANSFER
				6	0701	1	
				7	0600	+	
				8	0701	1	
				9	0703	3	
				70	0701	1	
				1	0705	5	
				2	0806		TRANSFER
				3	0701	1	
				4	0600	+	
				5	0701	1	
				6	0705	5	
				7	0707	7	
				8	0701	1	
				9	0806		TRANSFER
5	0408	mARK		80	0708	8	
6	0003	03		1	0404	ST DIR	
7	0410	GROUP 2		2	0006	$\bar{x}$.06	REG CNTR
8	0001	01	PROG TAPE	3	0706	6	
9	0415	RE Y		4	0700	0	
40	0000	$\bar{x}$.00	BLK CNTR	5	0708	8	
1	0701	1		6	0404	ST DIR	
2	0600	+		7	0007	$\bar{x}$.07	DATA BLK
3	0702	2		8	0100		
4	0709	9		9	0701	1	
5	0701	1		90	0702	2	
6	0806		TRANSFER	1	0708	8	
7	0701	1		2	0400	+ DIR	
8	0600	+		3	0007	$\bar{x}$.07	DATA BLK
9	0705	5		4	0100		
				5	0703	3	
				6	0702	2	
				7	0400	+ DIR	
				8	0007	$\bar{x}$.07	DATA BLK
				9	0100		

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0703	3		150	0400	+ DIR	
1	0702	2		1	0007	K.07	DATA BLK
2	0400	+ DIR		2	0100		
3	0007	K.07	DATA BLK	3	0405	RE DIR	
4	0100			4	0008	K.08	T CAB
5	0703	3		5	0404	ST DIR	
6	0702	2		6	0000	K.00	T CAB
7	0400	+ DIR		7	0405	RE DIR	
8	0007	K.07	DATA BLK	8	0009	K.09	Q mET-S
9	0100			9	0404	ST DIR	
110	0703	3		160	0004	K.04	Q mET-S
1	0702	2		1	0400	+ DIR	
2	0400	+ DIR		2	0012	K.12	Q TOT-S
3	0007	K.07	DATA BLK	3	0405	RE DIR	
4	0100			4	0010	K.10	Q mET-L
5	0703	3		5	0404	ST DIR	
6	0702	2		6	0005	K.05	Q mET-L
7	0400	+ DIR		7	0400	+ DIR	
8	0007	K.07	DATA BLK	8	0013	K.13	Q TOT-L
9	0100			9	0415	RE Y	
120	0703	3		170	0011	K.11	W CO$_2$
1	0702	2		1	0703	3	
2	0400	+ DIR		2	0705	S	
3	0007	K.07	DATA BLK	3	0602	X	
4	0100			4	0605	↓	
5	0705	S		5	0400	+ DIR	
6	0704	4		6	0015	K.15	Q HX INLET
7	0704	4		7	0702	2	
8	0400	+ DIR		8	0603	÷	
9	0007	K.07	DATA BLK	9	0605	↓	
130	0100			180	0400	+ DIR	
1	0706	6		1	0013	K.13	Q TOT-L
2	0704	4		2	0405	RE DIR	
3	0400	+ DIR		3	0014	K.14	Q ELEC
4	0007	K.07	DATA BLK	4	0400	+ DIR	
5	0100			5	0015	K.15	Q HX INLET
6	0703	3		6	0405	RE DIR	
7	0702	2		7	0015	K.15	Q HX INLET
8	0400	+ DIR		8	0400	+ DIR	
9	0007	K.07	DATA BLK	9	0012	K.12	Q TOT-S
140	0100			190	0700	0	
1	0702	2		1	0404	ST DIR	
2	0702	2		2	0006	K.06	LOOP CNTR
3	0704	4		3	0101		
4	0400	+ DIR		4	0415	RE Y	
5	0007	K.07	DATA BLK	5	0013	K.13	Q TOT-L
6	0100			6	0701	1	
7	0702	2		7	0700	0	
8	0708	8		8	0706	6	
9	0708	8		9	0705	S	

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0603	÷		250	0203	R.23	T HX-IN
1	0414	ST Y		1	0415	RE Y	
2	0201	R.21	H2O COND	2	0015	R.15	Q HX INLET
3	0405	RE DIR		3	0405	RE DIR	
4	0007	R.07	WCP FAN	4	0007	R.07	WCP FAN
5	0404	ST DIR		5	0603	÷	
6	0202	R.22	WCP HX	6	0405	RE DIR	
7	0415	RE Y		7	0203	R.23	T HX-IN
8	0015	R.15	Q HX INLET	8	0606	↓↑	
9	0405	RE DIR		9	0601	—	
210	0007	R.07	WCP FAN	260	0414	ST Y	
1	0603	÷		1	0000	R.00	T CAB
2	0405	RE DIR		2	0101		
3	0000	R.00	T CAB	3	0102		
4	0600	+		4	0415	RE Y	
5	0414	ST Y		5	0015	R.15	Q HX INLET
6	0203	R.23	T HX-IN	6	0405	RE DIR	
7	0415	RE Y		7	0007	R.07	WCP FAN
8	0012	R.12	Q TOT-S	8	0603	÷	
9	0405	RE DIR		9	0405	RE DIR	
220	0202	R.22	WCP HX	270	0000	R.00	T CAB
1	0603	÷		1	0600	+	
2	0405	RE DIR		2	0414	ST Y	
3	0203	R.23	T HX-IN	3	0203	R.23	T HX-IN
4	0606	↓↑		4	0415	RE Y	
5	0601	—		5	0012	R.12	Q TOT-S
6	0414	ST Y		6	0405	RE DIR	
7	0204	R.24	T HX-OUT	7	0202	R.22	WCP HX
8	0702	2		8	0603	÷	
9	0601	—		9	0405	RE DIR	
230	0405	RE DIR		280	0203	R.23	T HX-IN
1	0001	R.01	T H2O-IN	1	0606	↓↑	
2	0508	SKIP IF Y<X		2	0601	—	
3	0407	SEARCH		3	0414	ST Y	
4	0703	3		4	0204	R.24	T HX-OUT
5	0408	MARK		5	0702	2	
6	0702	2		6	0601	—	
7	0703	3		7	0405	RE DIR	
8	0600	+		8	0001	R.01	T H2O-IN
9	0414	ST Y		9	0507	SKIP IF Y²X	
240	0204	R.24	T HX-OUT	290	0407	SEARCH	
1	0415	RE Y		1	0702	2	
2	0012	R.12	Q TOT-S	2	0408	MARK	
3	0405	RE DIR		3	0703	3	
4	0202	R.22	WCP HX	4	0103		
5	0603	÷		5	0415	RE Y	
6	0405	RE DIR		6	0205	R.25	T DP
7	0204	R.24	T HX-OUT	7	0701	1	
8	0600	+		8	0601	—	
9	0414	ST Y		9	0414	ST Y	

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0206	R.26	T COND	350	0206	R.26	T COND
1	0415	RE Y		1	0405	RE DIR	
2	0012	R.12	Q TOT-S	2	0203	R.23	T HX-IN
3	0405	RE DIR		3	0404	ST DIR	
4	0013	R.13	Q TOT	4	0301	R.31	T OUT-DRY
5	0600	+		5	0405	RE DIR	
6	0414	ST Y		6	0207	R.27	Q TOT
7	0207	R.27	Q TOT	7	0404	ST DIR	
8	0405	RE DIR		8	0209	R.29	Q WET
9	0106	R.16	W H2O	9	0407	SEARCH	
310	0603	÷		360	0706	6	
1	0405	RE DIR		1	040B	MARK	
2	0001	R.01	T H2O-IN	2	0705	S	
3	0600	+		3	0606	↓↑	
4	0414	ST Y		4	0601	-	
5	0208	R.28	T H2O-OUT	5	0414	ST Y	
6	0405	RE DIR		6	0302	R.32	Q DRY
7	0203	R.23	T HX-IN	7	0405	RE DIR	
8	0507	SKIP IF Y≤X		8	0202	R.22	WCp HX
9	0407	SEARCH		9	0603	÷	
320	0704	4		370	0405	RE DIR	
1	0415	RE Y		1	0203	R.23	T HX-IN
2	0204	R.24	T HX-OUT	2	0606	↓↑	
3	0702	2		3	0601	-	
4	0601	-		4	0414	ST Y	
5	0407	SEARCH		5	0301	R.31	T OUT-DRY
6	0702	2		6	0405	RE DIR	
7	040B	MARK		7	0206	R.26	T COND
8	0704	4		8	0606	↓↑	
9	0415	RE Y		9	0508	SKIP IF Y<X	
330	0206	R.26	T COND	380	0407	SEARCH	
1	0405	RE DIR		1	070B	B	
2	0001	R.01	T H2O-IN	2	0606	↓↑	
3	0601	-		3	0601	-	
4	0405	RE DIR		4	0414	ST Y	
5	0106	R.16	W H2O	5	0300	R.30	UA-DRY
6	0607	X		6	0415	RE Y	
7	0414	ST Y		7	0203	R.23	T HX-IN
8	0209	R.29	Q WET	8	0405	RE DIR	
9	0405	RE DIR		9	0208	R.28	T H2O-OUT
340	0207	R.27	Q TOT	390	0601	-	
1	0507	SKIP IF Y≤X		1	0405	RE DIR	
2	0407	SEARCH		2	0300	R.30	UA-DRY
3	0705	S		3	0603	÷	
4	0700	O		4	0605	↓	
5	0404	ST DIR		5	0611	LOG e X	
6	0300	R.30	UA-DRY	6	0404	ST DIR	
7	0405	RE DIR		7	0300	R.30	UA-DRY
8	0208	R.28	T H2O-OUT	8	0415	RE Y	
9	0404	ST DIR		9	0203	R.23	T HX-IN

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0405	RE DIR		450	0405	RE DIR	
1	0208	R.28	T H2O-OUT	1	0303	R.33	UA-WET
2	0601	−		2	0603	÷	
3	0405	RE DIR		3	0405	RE DIR	
4	0301	R.31	T OUT-DRY	4	0209	R.29	Q WET
5	0601	−		5	0606	↓↑	
6	0405	RE DIR		6	0603	÷	
7	0206	R.26	T COND	7	0414	ST Y	
8	0600	+		8	0303	R.33	UA-WET
9	0405	RE DIR		9	0405	RE DIR	
410	0300	R.30	UA-DRY	460	0300	R.30	UA-DRY
1	0603	÷		1	0400	+ DIR	
2	0405	RE DIR		2	0303	R.33	UA-REQ'D
3	0302	R.32	Q DRY	3	0600	+	
4	0606	↓↑		4	0405	RE DIR	
5	0603	÷		5	0109	R.19	UA CABHX
6	0414	ST Y		6	0601	−	
7	0300	R.30	UA-DRY	7	0414	ST Y	
8	0408	MARK		8	0300	R.30	Δ UA
9	0706	6		9	0415	RE Y	
420	0415	RE Y		470	0200	R.20	TOL UA
1	0204	R.24	T HX-OUT	1	0602	X	
2	0405	RE DIR		2	0405	RE DIR	
3	0001	R.01	T H2O-IN	3	0300	R.30	Δ UA
4	0601	−		4	0607	1x1	
5	0414	ST Y		5	0508	SKIP IF Y<X	
6	0303	R.33	UA-WET	6	0407	SEARCH	
7	0415	RE Y		7	0710	SET EXP	
8	0301	R.31	T OUT-DRY	8	0405	RE DIR	
9	0405	RE DIR		9	0300	R.30	Δ UA
430	0206	R.26	T COND	480	0412	WRITE A	SKIP IF
1	0601	−		1	0710	SET EXP	X IS NEG
2	0405	RE DIR		2	0407	SEARCH	
3	0303	R.33	UA-WET	3	0708	8	
4	0603	÷		4	0415	RE Y	
5	0605	↓		5	0204	R.24	T HX-OUT
6	0611	Log e X		6	0702	2	
7	0404	ST DIR		7	0601	−	
8	0303	R.33	UA-WET	8	0405	RE DIR	
9	0415	RE Y		9	0001	R.01	T H2O-IN
440	0301	R.31	T OUT-DRY	490	0606	↓↑	
1	0405	RE DIR		1	0508	SKIP IF Y<X	
2	0206	R.26	T COND	2	0407	SEARCH	
3	0601	−		3	0710	SET EXP	
4	0405	RE DIR		4	0405	RE DIR	
5	0204	R.24	T HX-OUT	5	0204	R.24	T HX-OUT
6	0601	−		6	0606	↓↑	
7	0405	RE DIR		7	0601	−	
8	0001	R.01	T H2O-IN	8	0405	RE DIR	
9	0600	+		9	0303	R.33	UA-REQ'D

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
S00	0602	X		S50	0000	R.00	T CAB
1	0405	RE DIR		1	0600	+	
2	0109	R.19	UA-CABHX	2	0414	ST Y	
3	0603	÷		3	0203	R.23	T HX-IN
4	0405	RE DIR		4	0415	RE Y	
5	0001	R.01	T H2O-IN	5	0012	R.12	Q TOT-S
6	0600	+		6	0405	RE DIR	
7	0414	ST Y		7	0202	R.22	WCP HX
8	0204	R.24	T HX-OUT	8	0603	÷	
9	0405	RE DIR		9	0405	RE DIR	
S10	0203	R.23	T HX-IN	S60	0203	R.23	T HX-IN
1	0606	↓↑		1	0606	↓↑	
2	0601	−		2	0601	−	
3	0405	RE DIR		3	0414	ST Y	
4	0012	R.12	Q TOT-S	4	0204	R.24	T HX-OUT
5	0606	↓↑		5	0702	2	
6	0603	÷		6	0601	−	
7	0414	ST Y		7	0405	RE DIR	
8	0202	R.22	WCP HX	8	0001	R.01	T H2O-IN
9	0415	RE Y		9	0508	SKIP IF Y<X	
S20	0000	R.00	T CAB	S70	0407	SEARCH	
1	0405	RE DIR		1	0713	X^2	
2	0008	R.08	T CAB-INITIAL	2	0415	RE Y	
3	0601	−		3	0015	R.15	Q HX INLET
4	0412	WRITE A	SKIP IF	4	0405	RE DIR	
5	0410	GROUP 2	Y IS POS	5	0007	R.07	WCP FAN
6	0407	SEARCH		6	0603	÷	
7	0008	08		7	0405	RE DIR	
8	0412	WRITE A	SKIP IF	8	0001	R.01	T H2O-IN
9	0511	RETURN	Y≠0	9	0601	−	
S30	0407	SEARCH		S80	0702	2	
1	0008	08		1	0601	−	
2	0405	RE DIR		2	0405	RE DIR	
3	0007	R.07	WCP FAN	3	0000	R.00	T CAB
4	0404	ST DIR		4	0600	+	
5	0202	R.22	WCP HX	5	0405	RE DIR	
6	0712	.		6	0012	R.12	Q TOT-S
7	0701	1		7	0606	↓↑	
8	0401	− DIR		8	0603	÷	
9	0000	R.00	T CAB	9	0414	ST Y	
S40	0101			S90	0202	R.22	WCP HX
1	0102	.		1	0415	RE Y	
2	0408	MARK		2	0001	R.01	T H2O-IN
3	0008	08		3	0702	2	
4	0415	RE Y		4	0600	+	
5	0015	R.15	Q HX INLET	5	0414	ST Y	
6	0405	RE DIR		6	0204	R.24	T HX-OUT
7	0007	R.07	WCP FAN	7	0415	RE Y	
8	0603	÷		8	0012	R.12	Q TOT-S
9	0405	RE DIR		9	0405	RE DIR	

Remarks: PROGRAM TAPE BLOCK #21 − 27

Step	Code	Key	Comment	Step	Code	Key	Comment
600	0202	R.22	WCP HX	650	0415	RE Y	
1	0603	÷		1	0012	R.12	Q TOT-S
2	0405	RE DIR		2	0405	RE DIR	
3	0204	R.24	T HX-OUT	3	0202	R.22	WCP HX
4	0600	+		4	0603	÷	
5	0414	ST Y		5	0405	RE DIR	
6	0203	R.23	T HX-IN	6	0203	R.23	T HX-IN
7	0407	SEARCH		7	0606	↓↑	
8	0713	x²		8	0601	−	
9	040B	mARK		9	0414	ST Y	
610	0708	8		660	0204	R.24	T HX-OUT
1	0415	RE Y		1	0407	SEARCH	
2	0202	R.22	WCP HX	2	0713	x²	
3	0405	RE DIR		3	040B	mARK	
4	0007	R.07	WCP FAN	4	0714	RE RES	
5	0601	−		5	0701	1	
6	0412	WRITE A	SKIP IF	6	0400	+ DIR	
7	0510	SKIP IF ERROR	Y IS NEG	7	0000	R.00	T CAB
8	0407	SEARCH		8	0101		
9	0714	RE RES		9	0102		
620	0415	RE Y		670	0415	RE Y	
1	0203	R.23	T HX-IN	1	0015	R.15	Q HX INLET
2	0405	RE DIR		2	0405	RE DIR	
3	0204	R.24	T HX-OUT	3	0007	R.07	WCP FAN
4	0601	−		4	0404	ST DIR	
5	0712	.		5	0202	R.22	WCP HX
6	0702	2		6	0603	÷	
7	0601	−		7	0405	RE DIR	
8	0405	RE DIR		8	0000	R.00	T CAB
9	0012	R.12	Q TOT-S	9	0600	+	
630	0606	↓↑		6B0	0414	ST Y	
1	0603	÷		1	0203	R.23	T HX-IN
2	0414	ST Y		2	0415	RE Y	
3	0202	R.22	WCP HX	3	0012	R.12	Q TOT-S
4	0405	RE DIR		4	0405	RE DIR	
5	0007	R.07	WCP FAN	5	0202	R.22	WCP HX
6	0606	↓↑		6	0603	÷	
7	0507	SKIP IF Y≥X		7	0405	RE DIR	
8	0414	ST Y		8	0203	R.23	T HX-IN
9	0202	R.22	WCP HX	9	0606	↓↑	
640	0415	RE Y		690	0601	−	
1	0015	R.15	Q HX INLET	1	0414	ST Y	
2	0405	RE DIR		2	0204	R.24	T HX-OUT
3	0007	R.07	WCP FAN	3	040B	mARK	
4	0603	÷		4	0713	x²	
5	0405	RE DIR		5	0701	1	
6	0000	R.00	T CAB	6	0400	+ DIR	
7	0600	+		7	0006	R.06	LOOP CNTR
8	0414	ST Y		8	0703	3	
9	0203	R.23	T HX-IN	9	0705	5	

Remarks:

PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
700	0415	RE Y		750	0606	↓↑	
1	0006	R.06	LOOP CNTR	1	0601	–	
2	0507	SKIP IFYZX		2	0414	ST Y	
3	0407	SEARCH		3	0107	R.17	V BYPASS
4	0703	3		4	0405	RE DIR	
5	0408	MARK		5	0000	R.00	T CAB
6	0710	SET EXP		6	0404	ST DIR	
7	0103			7	0304	R.34	T CAB
8	0415	RE Y		8	0702	2	
9	0011	R.11	W CO₂	9	0708	8	
710	0703	3		760	0404	ST DIR	
1	0705	5		1	0000	R.00	BLK CNTR
2	0602	X		2	0407	SEARCH	
3	0414	ST Y		3	0101	01	
4	0014	R.14	Q LIOH-S	4	0408	MARK	
5	0702	2		5	0100		
6	0603	÷		6	0410	GROUP Z	
7	0414	ST Y		7	0003	03	EXT CORE
8	0015	R.15	Q LIOH-L	8	0415	RE Y	
9	0415	RE Y		9	0007	R.07	DATA BLK
720	0000	R.00	T CAB	770	0701	1	
1	0704	4		1	0709	9	
2	0705	5		2	0703	3	
3	0709	9		3	0706	6	
4	0712	.		4	0802		TRANSFER
5	0706	6		5	0415	RE Y	
6	0600	+		6	0006	R.06	REG CNTR
7	0405	RE DIR		7	0405	RE DIR	
8	0011	R.11	W CO₂	8	0004	R.04	DATA
9	0602	X		9	0504	ST INDIR	
730	0405	RE DIR		780	0701	1	
1	0108	R.18	V LIOH	1	0400	+ DIR	
2	0603	÷		2	0006	R.06	REG CNTR
3	0705	5		3	0511	RETURN	
4	0706	6		4	0408	MARK	
5	0712	.		5	0101		
6	0701	1		6	0405	RE DIR	
7	0603	÷		7	0107	R.17	V FAN
8	0414	ST Y		8	0404	ST DIR	
9	0108	R.18	PP CO₂	9	0007	R.07	WCP FAN
740	0415	RE Y		790	0701	1	
1	0202	R.22	WCP HX	1	0712	.	
2	0405	RE DIR		2	0700	0	
3	0007	R.07	WCP FAN	3	0707	7	
4	0603	÷		4	0701	1	
5	0405	RE DIR		5	0701	1	
6	0107	R.17	V FAN	6	0708	8	
7	0602	X		7	0704	4	
8	0414	ST Y		8	0702	2	
9	0011	R.11	V HX	9	0708	8	

Remarks:

PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
800	0703	3		850	0702	2	
1	070B	8		1	0606	↓↑	
2	0402	X DIR		2	0507	SKIP IF Y≥X	
3	0007	R.07	WCP FAN	3	0407	SEARCH	
4	040B	MARK		4	0004	04	
5	0204	04		5	0405	RE DIR	
6	0415	RE Y		6	0007	R.07	WCP FAN
7	0014	R.14	Q ELEC	7	0404	ST DIR	
8	0405	RE DIR		8	0202	R.22	WCP HX
9	0007	R.07	WCP FAN	9	0511	RETURN	
810	0603	÷		860	040B	MARK	
1	0405	RE DIR		1	0102		
2	0000	R.00	T CAB	2	0405	RE DIR	
3	0600	+		3	0004	R.04	Q MET-S
4	0704	4		4	0401	- DIR	
5	0705	5		5	0012	R.12	Q TOT-S
6	0709	9		6	0405	RE DIR	
7	0712	.		7	0005	R.05	Q MET-L
8	0706	6		8	0401	- DIR	
9	0600	+		9	0013	R.13	Q TOT-L
820	0705	5		870	0415	RE Y	
1	0707	7		1	0000	R.00	T CAB
2	0702	2		2	0709	9	
3	0712	.		3	0704	4	
4	0706	6		4	0507	SKIP IF Y≥X	
5	0705	5		5	0407	SEARCH	
6	0705	5		6	0005	05	
7	0701	1		7	0700	0	
8	0701	1		8	0404	ST DIR	
9	070B	8		9	0004	R.04	Q MET-S
830	0701	1		880	0415	RE Y	
1	0701	1		1	0009	R.09	Q MET-S i
2	0606	↓↑		2	0405	RE DIR	
3	0603	÷		3	0010	R.10	Q MET-L i
4	0405	RE DIR		4	0600	+	
5	0107	R.17	V FAN	5	0414	ST Y	
6	0602	X		6	0005	R.05	Q MET-L
7	0405	RE DIR		7	0407	SEARCH	
8	0007	R.07	WCP FAN	8	0006	06	
9	0606	↓↑		9	040B	MARK	
840	0404	ST DIR		890	0005	05	
1	0007	R.07	WCP FAN	1	0405	RE DIR	
2	0601	-		2	0008	R.08	T CAB-INITIAL
3	0606	↓↑		3	0404	ST DIR	
4	0607	|X|		4	0304	R.34	T
5	0606	↓↑		5	0104		
6	0603	÷		6	0405	RE DIR	
7	0705	5		7	0305	R.35	Q S
8	0710	SET EXP		8	0404	ST DIR	
9	0711	CHS SGN		9	0306	R.36	Q S-1

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
700	0405	RE DIR		950	0408	MARK	
1	0000	K.00	T CAB	1	0104		
2	0404	ST DIR		2	0405	RE DIR	
3	0304	K.34	T	3	0304	K.34	T
4	0104			4	0713	X^2	
5	0415	RE Y		5	0713	X^2	
6	0306	K.36	Q_{S-1}	6	0604	↑	
7	0405	RE DIR		7	0711	CHS SGN	
8	0305	K.35	Q_{S-2}	8	0704	4	
9	0601	−		9	0709	9	
910	0405	RE DIR		960	0706	6	
1	0306	K.36	Q_{S-1}	1	0704	4	
2	0603	÷		2	0705	5	
3	0701	1		3	0704	4	
4	0606	↓↑		4	0709	9	
5	0601	−		5	0705	5	
6	0405	RE DIR		6	0703	3	
7	0009	K.09	$Q_{MET-S\ i}$	7	0705	5	
8	0602	X		8	0702	2	
9	0414	ST Y		9	0701	1	
920	0004	K.04	Q_{MET-S}	970	0710	SET EXP	
1	0415	RE Y		1	0711	CHS SGN	
2	0010	K.10	$Q_{MET-L\ i}$	2	0703	3	
3	0600	+		3	0602	X	
4	0405	RE DIR		4	0414	ST Y	
5	0004	K.04	Q_{MET-S}	5	0305	K.35	Q_S
6	0601	−		6	0415	RE Y	
7	0414	ST Y		7	0304	K.34	T
8	0005	K.05	Q_{MET-L}	8	0405	RE DIR	
9	0408	MARK		9	0304	K.34	T
930	0006	06		980	0713	X^2	
1	0405	RE DIR		1	0602	X	
2	0004	K.04	Q_{MET-S}	2	0712	.	
3	0400	+ DIR		3	0701	1	
4	0012	K.12	Q_{TOT-S}	4	0705	5	
5	0415	RE Y		5	0703	3	
6	0013	K.13	Q_{TOT-L}	6	0704	4	
7	0405	RE DIR		7	0702	2	
8	0005	K.05	Q_{MET-L}	8	0703	3	
9	0600	+		9	0706	6	
940	0414	ST Y		990	0701	1	
1	0013	K.13	Q_{TOT-L}	1	0709	9	
2	0701	1		2	0705	5	
3	0700	0		3	0709	9	
4	0706	6		4	0705	5	
5	0705	5		5	0602	X	
6	0603	÷		6	0605	↓	
7	0414	ST Y		7	0400	+ DIR	
8	0201	K.21	H2O COND	8	0305	K.35	Q_S
9	0511	RETURN		9	0405	RE DIR	

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
1000	0304	R.34	T	1050	0401	– DIR	
1	0713	x^2		1	0305	R.35	Qs
2	0604	↑		2	0511	RETURN	
3	0701	1		3	040B	MARK	
4	0707	7		4	0103		
5	0712	.		5	0700	0	
6	070B	8		6	0404	ST DIR	
7	0705	5		7	0304	R.34	COUNTER
8	0706	6		8	0405	RE DIR	
9	0709	9		9	0204	R.24	T HX-OUT
1010	0703	3		1060	0404	ST DIR	
1	0704	4		1	0306	R.36	T H2O
2	0700	0		2	0105		
3	0707	7		3	0405	RE DIR	
4	0704	4		4	0305	R.35	P H2O
5	0702	2		5	0404	ST DIR	
6	0602	X		6	0307	R.37	P H2O-OUT
7	0605	↓		7	0415	RE Y	
8	0401	– DIR		8	0204	R.24	T HX-OUT
9	0305	R.35	Qs	9	0704	4	
1020	0415	RE Y		1070	0705	5	
1	0304	R.34	T	1	0709	9	
2	0709	9		2	0712	.	
3	0701	1		3	0706	6	
4	0707	7		4	0600	+	
5	0712	.		5	0712	.	
6	0706	6		6	0705	5	
7	0700	0		7	0709	9	
8	0707	7		8	0705	5	
9	0702	2		9	0602	X	
1030	0707	7		1080	0405	RE DIR	
1	0703	3		1	0307	R.37	P H2O-OUT
2	0704	4		2	0606	↓↑	
3	0703	3		3	0603	÷	
4	0602	X		4	0405	RE DIR	
5	0605	↓		5	0107	R.17	V FAN
6	0400	+ DIR		6	0602	X	
7	0305	R.35	Qs	7	0706	6	
8	0701	1		8	0700	0	
9	0707	7		9	0602	X	
1040	0701	1		1090	0405	RE DIR	
1	0704	4		1	0202	R.22	WCP HX
2	0701	1		2	0602	X	
3	0712	.		3	0405	RE DIR	
4	0701	1		4	0007	R.07	WCP FAN
5	0701	1		5	0603	÷	
6	0701	1		6	0414	ST Y	
7	070B	8		7	0308	R.38	H2O OUT
8	0702	2		8	0405	RE DIR	
9	0704	4		9	0201	R.21	H2O COND

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
1100	0400	+ DIR		1150	0105		
1	0308	R.38	TOT H₂O	1	0415	RE Y	
2	040B	MARK		2	0306	R.36	T H2O
3	0007	07		3	0405	RE DIR	
4	0415	RE Y		4	0306	R.36	T H2O
5	0306	R.36	T H2O	5	0713	x^2	
6	0704	4		6	0602	X	
7	0705	5		7	0602	X	
8	0709	9		8	0711	CHS SGN	
9	0712	.		9	0701	1	
1110	0706	6		1160	0703	3	
1	0600	+		1	0707	7	
2	0712	.		2	0709	9	
3	0705	5		3	070B	B	
4	0709	9		4	0702	2	
5	0705	5		5	0704	4	
6	0602	X		6	0703	3	
7	0405	RE DIR		7	070B	B	
8	0308	R.38	TOT H2O	8	0703	3	
9	0602	X		9	0703	3	
1120	0405	RE DIR		1170	0702	2	
1	0107	R.17	V FAN	1	0710	SET EXP	
2	0603	÷		2	0711	CHS SGN	
3	0706	6		3	0701	1	
4	0700	0		4	0701	1	
5	0603	÷		5	0602	X	
6	0405	RE DIR		6	0414	ST Y	
7	0202	R.22	WCP HX	7	0305	R.35	P H2O
8	0603	÷		8	0405	RE DIR	
9	0405	RE DIR		9	0306	R.36	T H2O
1130	0007	R.07	WCP FAN	1180	0713	x^2	
1	0602	X		1	0604		
2	0414	ST Y		2	0602	X	
3	0305	R.35	P H2O	3	0707	7	
4	0106			4	0702	2	
5	0701	1		5	0707	7	
6	0400	+ DIR		6	0702	2	
7	0304	R.34	COUNTER	7	0705	5	
8	0415	RE Y		8	0703	3	
9	0304	R.34	COUNTER	9	0705	5	
1140	0703	3		1190	0701	1	
1	0509	SKIP IF Y=X		1	0709	9	
2	0407	SEARCH		2	0703	3	
3	0007	07		3	0702	2	
4	0405	RE DIR		4	0706	6	
5	0306	R.36	T H2O	5	0710	SET EXP	
6	0404	ST DIR		6	0711	CHS SGN	
7	0205	R.25	T DEWPT	7	070B	B	
8	0511	RETURN		8	0602	X	
9	040B	MARK		9	0605		

Remarks:

PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment		Step	Code	Key	Comment
1200	0400	+ DIR			1250	0306	R.36	T H2O
1	0305	R.35	P H2O		1	0702	2	
2	0415	KEY			2	0700	0	
3	0306	R.36	T H2O		3	0707	7	
4	0405	RE DIR			4	0706	6	
5	0306	R.36	T H2O		5	0702	2	
6	0713	x^2			6	0704	4	
7	0607	X			7	0700	0	
8	0704	4			8	0702	2	
9	0702	2			9	0703	3	
1210	0701	1			1260	0701	1	
1	0705	5			1	0701	1	
2	0706	6			2	0710	SET EXP	
3	0708	8			3	0711	CHS SGN	
4	0700	0			4	0703	3	
5	0705	5			5	0602	X	
6	0707	7			6	0605	↓	
7	0701	1			7	0401	— DIR	
8	0707	7			8	0305	R.35	P H2O
9	0710	SET EXP			9	0703	3	
1220	0711	CHS SGN			1270	0705	5	
1	0706	6			1	0709	9	
2	0602	X			2	0709	9	
3	0605	↓			3	0707	7	
4	0401	— DIR			4	0709	9	
5	0305	R.35	P H2O		5	0703	3	
6	0405	RE DIR			6	0707	7	
7	0306	R.36	T H2O		7	0701	1	
8	0713	x^2			8	0707	7	
9	0604	↑			9	0708	8	
1230	0706	6			1280	0708	8	
1	0704	4			1	0710	SET EXP	
2	0700	0			2	0711	CHS SGN	
3	0706	6			3	0701	1	
4	0702	2			4	0400	+ DIR	
5	0707	7			5	0305	R.35	P H2O
6	0709	9			6	0511	RETURN	
7	0704	4			7	0408	MARK	
8	0701	1			8	0106		
9	0704	4			9	0415	RE Y	
1240	0702	2			1290	0305	R.35	P H2O
1	0708	8			1	0405	RE DIR	
2	0710	SET EXP			2	0305	R.35	P H2O
3	0711	CHS SGN			3	0713	x^2	
4	0704	4			4	0602	X	
5	0602	X			5	0602	X	
6	0605	↓			6	0703	3	
7	0400	+ DIR			7	0705	5	
8	0305	R.35	P H2O		8	0706	6	
9	0415	RE Y			9	0703	3	

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
1300	0712	.		1350	0708	8	
1	0706	6		1	0703	3	
2	0705	5		2	0702	2	
3	0705	5		3	0602	X	
4	0701	1		4	0605	↓	
5	0704	4		5	0400	+ DIR	
6	0701	1		6	0306	R.36	T H2O
7	0706	6		7	0405	RE DIR	
8	0703	3		8	0305	R.35	P H2O
9	0602	X		9	0713	X^2	
1310	0414	ST Y		1360	0604	↑	
1	0306	R.36	T H2O	1	0701	1	
2	0405	RE DIR		2	0709	9	
3	0305	R.35	P H2O	3	0704	4	
4	0713	X^2		4	0703	3	
5	0604	↑		5	0712	.	
6	0602	X		6	0703	3	
7	0706	6		7	0700	0	
8	0705	5		8	0700	0	
9	0700	0		9	0702	2	
1320	0708	8		1370	0707	7	
1	0712	.		1	0709	9	
2	0708	8		2	0708	8	
3	0706	6		3	0708	8	
4	0704	4		4	0602	X	
5	0704	4		5	0605	↓	
6	0700	0		6	0401	- DIR	
7	0701	1		7	0306	R.36	T H2O
8	0709	9		8	0415	RE Y	
9	0708	8		9	0305	R.35	P H2O
1330	0602	X		1380	0705	5	
1	0605	↓		1	0701	1	
2	0401	- DIR		2	0701	1	
3	0306	R.36	T H2O	3	0712	.	
4	0415	RE Y		4	0701	1	
5	0305	R.35	P H2O	5	0702	2	
6	0405	RE DIR		6	0708	8	
7	0305	R.35	P H2O	7	0705	5	
8	0713	X^2		8	0709	9	
9	0602	X		9	0703	3	
1340	0704	4		1390	0706	6	
1	0708	8		1	0703	3	
2	0704	4		2	0602	X	
3	0709	9		3	0605	↓	
4	0712	.		4	0400	+ DIR	
5	0701	1		5	0306	R.36	T H2O
6	0704	4		6	0712	.	
7	0703	3		7	0708	8	
8	0701	1		8	0705	5	
9	0708	8		9	0705	5	

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment	Step	Code	Key	Comment
00	0703	3					
1	0708	8					
2	0705	5					
3	0703	3					
4	0701	1					
5	0702	2					
6	0401	− DIR					
7	0306	P.36	$T\ H_2O$				
8	0511	RETURN					

Remarks: PROGRAM TAPE BLOCK #21 - 27

Step	Code	Key	Comment
5	0408	MARK	
6	0003	03	
7	0410	GROUP 2	
8	0001	01	PROG. TAPE
9	0415	REY	
40	0000	R.00	BLK CNTR
1	0701	1	
2	0600	+	
3	0702	2	
4	0709	9	
5	0701	1	
6	0806		TRANSFER
7	0701	1	
8	0600	+	
9	0705	S	

Step	Code	Key	Comment
50	0704	4	
1	0707	7	
2	0806		TRANSFER
3	0412	WRITE A	
4	0103		SHIFT UP
5	0112		A
6	0113		R
7	0101		S
8	0002		SPACE
9	0212		C
60	0112		A
1	0200		B
2	0104		I
3	0206		N
4	0002		SPACE
5	0015		G
6	0112		A
7	0101		S
8	0002		SPACE
9	0209		L
70	0109		O
1	0109		O
2	0005		P
3	0108		CR/LF
4	0207		T
5	0002		SPACE
6	0212		C
7	0112		A
8	0200		B
9	0413	END A	
80	0411	WRITE	
1	1503		3 SPACES
2	0703	3	
3	0704	4	
4	0404	ST DIR	
5	0000	R.00	REG CNTR
6	0100		
7	0412	WRITE A	
8	0103		SHIFT UP
9	0207		T
90	0002		SPACE
1	0213		D
2	0205		E
3	0100		W
4	0005		P
5	0207		T
6	0002		SPACE
7	0413	END A	
8	0707	2	
9	0705	S	

Remarks:

PROGRAM TAPE BLOCK #28 - 30

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0404	ST DIR		150	0413	END A	
1	0000	R.00	REG CNTR	1	0702	2	
2	0100			2	0704	4	
3	0412	WRITE A		3	0404	ST DIR	
4	0102		SHIFT DN	4	0000	R.00	REG CNTR
5	0005		P	5	0100		
6	0005		P	6	0412	WRITE A	
7	0002		SPACE	7	0103		SHIFT UP
8	0103		SHIFT UP	8	0207		T
9	0212		C	9	0002		SPACE
110	0109		O	160	0201		H
1	0102		SHIFT DN	1	0102		SHIFT DN
2	0306		Z	2	0306		Z
3	0002		SPACE	3	0103		SHIFT UP
4	0002		SPACE	4	0109		O
5	0413	END A		5	0102		SHIFT DN
6	0701	1		6	0104		I
7	0708	8		7	0206		N
8	0404	ST DIR		8	0002		SPACE
9	0000	R.00	REG CNTR	9	0413	END A	
120	0100			170	0701	1	
1	0412	WRITE A		1	0404	ST DIR	
2	0103		SHIFT UP	2	0000	R.00	REG CNTR
3	0207		T	3	0100		
4	0002		SPACE	4	0412	WRITE A	
5	0112		A	5	0103		SHIFT UP
6	0104		I	6	0207		T
7	0113		R	7	0002		SPACE
8	0102		SHIFT DN	8	0201		H
9	0104		I	9	0102		SHIFT DN
130	0206		N	180	0306		Z
1	0002		SPACE	1	0103		SHIFT UP
2	0413	END A		2	0109		O
3	0702	2		3	0102		SHIFT DN
4	0703	3		4	0109		O
5	0404	ST DIR		5	0214		U
6	0000	R.00	REG CNTR	6	0207		T
7	0100			7	0413	END A	
8	0412	WRITE A		8	0702	2	
9	0108		CR/LF	9	0708	8	
140	0103		SHIFT UP	190	0404	ST DIR	
1	0207		T	1	0000	R.00	REG CNTR
2	0002		SPACE	2	0100		
3	0112		A	3	0412	WRITE A	
4	0104		I	4	0103		SHIFT UP
5	0113		R	5	0004		Q
6	0102		SHIFT DN	6	0002		SPACE
7	0109		O	7	0115		m
8	0214		U	8	0205		E
9	0207		T	9	0207		T

Remarks: PROGRAM TAPE BLOCK #28 - 30

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0102		SHIFT DN	250	0209		L
1	0000		—	1	0104		I
2	0103		SHIFT UP	2	0109		O
3	0101	S	S	3	0201		H
4	0002		SPACE	4	0102		SHIFT DN
5	0413	END A		5	0000		—
6	0704	4		6	0103		SHIFT UP
7	0404	ST DIR		7	0209		L
8	0000	R.00	REG CNTR	8	0413	END A	
9	0100			9	0701	1	
210	0412	WRITE A		260	0705	S	
1	0108		CR/LF	1	0404	ST DIR	
2	0103		SHIFT UP	2	0000	R.00	REG CNTR
3	0004		Q	3	0100		
4	0002		SPACE	4	0412	WRITE A	
5	0115		M	5	0103		SHIFT UP
6	0205		E	6	0004		Q
7	0207		T	7	0002		SPACE
8	0102		SHIFT DN	8	0207		T
9	0000		—	9	0109		O
220	0103		SHIFT UP	270	0207		T
1	0209		L	1	0102		SHIFT DN
2	0002		SPACE	2	0000		—
3	0413	END A		3	0103		SHIFT UP
4	0705	S		4	0101		S
5	0404	ST DIR		5	0002		SPACE
6	0000	R.00	REG CNTR	6	0413	END A	
7	0100			7	0701	1	
8	0412	WRITE A		8	0702	2	
9	0103		SHIFT UP	9	0404	ST DIR	
230	0004		Q	280	0000	R.00	REG CNTR
1	0002		SPACE	1	0100		
2	0209		L	2	0412	WRITE A	
3	0104		I	3	0108		CR/LF
4	0109		O	4	0103		SHIFT UP
5	0201		H	5	0004		Q
6	0102		SHIFT DN	6	0002		SPACE
7	0000		—	7	0207		T
8	0103		SHIFT UP	8	0109		O
9	0101		S	9	0207		T
240	0413	END A		290	0102		SHIFT DN
1	0701	1		1	0000		—
2	0704	4		2	0103		SHIFT UP
3	0404	ST DIR		3	0209		L
4	0000	R.00	REG CNTR	4	0002		SPACE
5	0100			5	0413	END A	
6	0412	WRITE A		6	0701	1	
7	0103		SHIFT UP	7	0703	3	
8	0004		Q	8	0404	ST DIR	
9	0002		SPACE	9	0000	R.00	REG CNTR

Remarks:
PROGRAM TAPE BLOCK #28 - 30

Step	Code	Key	Comment	Step	Code	Key	Comment
350	0100			350	0108		CR/LF
1	0412	WRITE A		1	0103		SHIFT UP
2	0103		SHIFT UP	2	0114		V
3	0004		Q	3	0002		SPACE
4	0002		SPACE	4	0200		B
5	0207		T	5	0001		Y
6	0109		O	6	0005		P
7	0207		T	7	0112		A
8	0413	END A		8	0101		S
9	0411	WRITE		9	0101		S
310	1503		3 SPACES	360	0413	END A	
1	0707	2		1	0701	1	
2	0707	7		2	0707	7	
3	0404	ST DIR		3	0404	ST DIR	
4	0000	R.00	REG CNTR	4	0000	R.00	REG CNTR
5	0100			5	0100		
6	0412	WRITE A		6	0412	WRITE A	
7	0103		SHIFT UP	7	0103		SHIFT UP
8	0100		W	8	0214		U
9	0212		C	9	0112		A
320	0102		SHIFT DN	370	0002		SPACE
1	0005		P	1	0113		R
2	0002		SPACE	2	0205		E
3	0103		SHIFT UP	3	0004		Q
4	0112		A	4	0213		D
5	0104		I	5	0002		SPACE
6	0113		K	6	0413	END A	
7	0002		SPACE	7	0703	3	
8	0413	END A		8	0703	3	
9	0707	7		9	0404	ST DIR	
330	0404	ST DIR		380	0000	R.00	REG CNTR
1	0000	R.00	REG CNTR	1	0100		
2	0100			2	0412	WRITE A	
3	0412	WRITE A		3	0103		SHIFT UP
4	0103		SHIFT UP	4	0209		L
5	0114		V	5	0109		O
6	0002		SPACE	6	0109		O
7	0212		C	7	0005		P
8	0112		A	8	0002		SPACE
9	0200		B	9	0212		C
340	0201		H	390	0206		N
1	0215		X	1	0207		T
2	0002		SPACE	2	0413	END A	
3	0413	END A		3	0706	6	
4	0701	1		4	0404	ST DIR	
5	0701	1		5	0000	R.00	REG CNTR
6	0404	ST DIR		6	0100		
7	0000	R.00	REG CNTR	7	0412	WRITE A	
8	0100			8	0108		CR/LF
9	0412	WRITE A		9	0110		LF

Remarks: PROGRAM TAPE BLOCK #28 - 30

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0413	END A					
1	0405	RE DIR					
2	0208	R. 28	T H2O-OUT				
3	0404	ST DIR					
4	0001	K. 01	T H2O-OUT				
5	0703	3					
6	0701	1					
7	0404	ST DIR					
8	0000	K. 00	BLK CNTR				
9	0407	SEARCH					
410	0001	01					
1	0408	MARK					
2	0100						
3	0412	WRITE A					
4	0102		SHIFT DN				
5	0002		SPACE				
6	0006		=				
7	0413	END A					
8	0415	RE Y					
9	0000	K. 00	REG CNTR				
420	0505	RE INDIR					
1	0411	WRITE					
2	0502		DP - S. 2				
3	0411	WRITE					
4	1503		3 SPACES				
5	0511	RETURN					

Remarks: PROGRAM TAPE BLOCK #28 - 30

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0404	ST DIR	
				1	0007	R.07	DATA BLK
				2	0100		
				3	0415	RE Y	
				4	0008	R.08	Q H2O P
				5	0405	RE DIR	
				6	0009	R.09	W H2O
				7	0603	÷	
				8	0405	RE DIR	
				9	0001	R.01	T H2O-IN
				60	0600	+	
				1	0414	ST Y	
				2	0010	R.10	T H2O-OUT
				3	0412	WRITE A	
				4	0103		SHIFT UP H
				5	0201		SHIFT DN Z
				6	0102		
				7	0306		
				8	0103		SHIFT UP O
				9	0109		
				70	0002		SPACE C
				1	0212		
				2	0109		O
				3	0109		O
				4	0209		L
				5	0112		A
				6	0206		N
				7	0207		T
				8	0002		SPACE L
				9	0209		
				80	0109		O
				1	0109		O
				2	0005		P
				3	0002		SPACE P
				4	0005		
				5	0214		U
				6	0115		m
				7	0005		P
				8	0108		CR/LF T
				9	0207		
5	0408	MARK		90	0002		SPACE H
6	0003	03		1	0201		
7	0708	8		2	0102		SHIFT DN Z
8	0404	ST DIR		3	0306		
9	0006	R.06	REG CNTR	4	0103		SHIFT UP O
40	0709	9		5	0109		
1	0706	6		6	0102		SHIFT DN 1
2	0700	0		7	0104		
3	0404	ST DIR		8	0206		N
4	0007	R.07	DATA BLK	9	0002		SPACE
5	0100						
6	0701	1					
7	0704	4					
8	0707	7					
9	0702	2					

Remarks: PROGRAM TAPE BLOCK #31

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0002		SPACE	150	0709	9	
1	0006		=	1	0703	3	
2	0413	END A		2	0706	6	
3	0405	RE DIR		3	0802		TRANSFER
4	0001	R.01	T H2O-IN	4	0415	RE Y	
5	0411	WRITE		5	0006	R.06	REG CNTR
6	0502		DP-S.2	6	0405	RE DIR	
7	0411	WRITE		7	0004	R.04	DATA
8	1503		3 SPACES	8	0504	ST INDIR	
9	0412	WRITE A		9	0701	1	
110	0103		SHIFT UP	160	0400	+ DIR	
1	0207		T	1	0006	R.06	REG CNTR
2	0002		SPACE	2	0511	RETURN	
3	0201		H				
4	0102		SHIFT DN				
5	0306		2				
6	0103		SHIFT UP				
7	0109		O				
8	0102		SHIFT DN				
9	0109		O				
120	0214		U				
1	0207		T				
2	0002		SPACE				
3	0006		=				
4	0413	END A					
5	0405	RE DIR					
6	0010	R.10	T H2O-OUT				
7	0411	WRITE					
8	0502		DP-S.2				
9	0412	WRITE A					
130	0108		CR/LF				
1	0110		LF				
2	0413	END A					
3	0405	RE DIR					
4	0010	R.10	T H2O-OUT				
5	0404	ST DIR					
6	0001	R.01	T H2O-OUT				
7	0703	3					
8	0702	2					
9	0404	ST DIR					
140	0000	R.00	BLK CNTR				
1	0407	SEARCH					
2	0001	01					
3	0408	MARK					
4	0100						
5	0410	GROUP 2					
6	0003	03	EXT CORE				
7	0415	RE Y					
8	0007	R.07	DATA BLK				
9	0701	1					

Remarks:

PROGRAM TAPE BLOCK #31

Step	Code	Key	Comment
5	0408	mARK	
6	0003	03	
7	0708	B	
8	0404	ST DIR	
9	0006	K.06	REG CNTR
40	0709	9	
1	0709	9	
2	0702	2	
3	0404	ST DIR	
4	0007	K.07	DATA BLK
5	0100		
6	0701	1	
7	0704	4	
8	0707	7	
9	0702	2	

Step	Code	Key	Comment
50	0404	ST DIR	
1	0007	K.07	DATA BLK
2	0100		
3	0415	KEY	
4	0008	K.08	Q IMU-CP
5	0405	RE DIR	
6	0009	R.09	W H2O
7	0603	÷	
8	0405	RE DIR	
9	0001	K.01	T H2O-IN
60	0600	+	
1	0414	ST Y	
2	0010	K.10	T H2O-OUT
3	0412	WRITE A	
4	0103		SHIFT UP
5	0104		I
6	0115		m
7	0214		U
8	0002		SPACE
9	0212		C
70	0109		O
1	0209		L
2	0213		D
3	0005		P
4	0209		L
5	0112		A
6	0207		T
7	0205		E
8	0101		S
9	0108		CR/LF
80	0207		T
1	0002		SPACE
2	0201		H
3	0102		SHIFT DN
4	0306		2
5	0103		SHIFT UP
6	0109		O
7	0102		SHIFT DN
8	0104		1
9	0206		N
90	0002		SPACE
1	0002		SPACE
2	0006		=
3	0413	END A	
4	0405	RE DIR	
5	0001	K.01	T H2O-IN
6	0411	WRITE	
7	0502		DP-5.2
8	0411	WRITE	
9	1503		3 SPACES

Remarks: PROGRAM TAPE BLOCK #32

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0412	WRITE A		150	0701	1	
1	0103		SHIFT UP	1	0400	+ DIR	
2	0207		T	2	0006	R.06	REG CNTR
3	0002		SPACE	3	0511	RETURN	
4	0201		H				
5	0102		SHIFT DN				
6	0306		Z				
7	0103		SHIFT UP				
8	0109		O				
9	0102		SHIFT DN				
110	0109		O				
1	0214		U				
2	0207		T				
3	0002		SPACE				
4	0006		=				
5	0413	END A					
6	0405	RE DIR					
7	0010	R.10	T H2O-OUT				
8	0411	WRITE					
9	0502		DP-5.2				
120	0412	WRITE A					
1	0106		CR/LF				
2	0110		LF				
3	0413	END A					
4	0405	RE DIR					
5	0010	R.10	T H2O-OUT				
6	0404	ST DIR					
7	0001	R.01	T H2O-OUT				
8	0703	3					
9	0703	3					
130	0404	ST DIR					
1	0000	R.00	BLK CNTR				
2	0407	SEARCH					
3	0001	01					
4	0408	MARK					
5	0100						
6	0410	GROUP 2					
7	0003	03	EXT CORE				
8	0415	RE Y					
9	0007	R.07	DATA BLK				
140	0701	1					
1	0709	9					
2	0703	3					
3	0706	6					
4	0802		TRANSFER				
5	0415	RE Y					
6	0006	R.06	REG CNTR				
7	0405	RE DIR					
8	0004	R.04	DATA				
9	0504	ST INDIR					

Remarks:

PROGRAM TAPE BLOCK #32

Step	Code	Key	Comment
5	0408	mARK	
6	0003	03	
7	070B	B	
8	0404	ST DIR	
9	0006	R.06	RES CNTR
40	0701	1	
1	0700	0	
2	0702	Z	
3	0704	4	
4	0404	ST DIR	
5	0007	R.07	DATA BLK
6	0100		
7	0701	1	
8	0704	4	
9	0707	7	

Step	Code	Key	Comment
50	0702	Z	
1	0404	ST DIR	
2	0007	R.07	DATA BLK
3	0100		
4	0415	RE Y	
5	0008	R.08	Q CWALL
6	0405	RE DIR	
7	0009	R.09	W H2O
8	0603	÷	
9	0405	RE DIR	
60	0001	R.01	T H2O-IN
1	0600	+	
2	0414	ST Y	
3	0010	R.10	T H2O-OUT
4	0412	WRITE A	
5	0103		SHIFT UP
6	0212		C
7	0109		O
8	0209		L
9	0213		D
70	0100		W
1	0112		A
2	0209		L
3	0209		L
4	0108		CR/LF
5	0207		T
6	0002		SPACE
7	0201		H
8	0102		SHIFT DN
9	0306		Z
80	0103		SHIFT UP
1	0109		O
2	0102		SHIFT DN
3	0104		I
4	0206		N
5	0002		SPACE
6	0002		SPACE
7	0006		=
8	0413	END A	
9	0405	RE DIR	
90	0001	R.01	T H2O-IN
1	0411	WRITE	
2	0502		DP-5.2
3	0411	WRITE	
4	1503		3 SPACES
5	0412	WRITE A	
6	0103		SHIFT UP
7	0207		T
8	0002		SPACE
9	0201		H

Remarks: PROGRAM TAPE BLOCK #33

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0102		SHIFT DN				
1	0306		Z				
2	0103		SHIFT UP				
3	0109		O				
4	0102		SHIFT DN				
5	0109		O				
6	0214		U				
7	0207		T				
8	0002		SPACE				
9	0006		=				
110	0413	END A					
1	0405	RE DIR					
2	0010	K.10	T H2O-OUT				
3	0411	WRITE					
4	0502		DP·S.2				
5	0412	WRITE A					
6	0108		CR/LF				
7	0110		LF				
8	0413	END A					
9	0405	RE DIR					
120	0010	K.10	T H2O-OUT				
1	0404	ST DIR					
2	0001	K.01	T H2O-OUT				
3	0703	3					
4	0704	4					
5	0404	ST DIR					
6	0200	K.00	BLK CNTR				
7	0407	SEARCH					
8	0001	01					
9	0408	MARK					
130	0100						
1	0410	GROUP 2					
2	0003	03	EXT CORE				
3	0415	KEY					
4	0007	K.07	DATA BLK				
5	0701	1					
6	0709	9					
7	0703	3					
8	0706	6					
9	0802		TRANSFER				
140	0415	KEY					
1	0006	K.06	REG CNTR				
2	0405	RE DIR					
3	0004	K.04	DATA				
4	0504	ST INDIR					
5	0701	1					
6	0400	+ DIR					
7	0006	K.06	REG CNTR				
8	0511	RETURN					

Remarks:

PROGRAM TAPE BLOCK #33

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0704	4	
				1	0707	7	
				2	0806		TRANSFER
				3	0708	8	
				4	0404	ST DIR	
				5	0006	R.06	REG CNTR
				6	0701	1	
				7	0700	0	
				8	0705	S	
				9	0706	6	
				60	0404	ST DIR	
				1	0007	R.07	DATA BLK
				2	0100		
				3	0703	3	
				4	0702	2	
				5	0400	+ DIR	
				6	0007	R.07	DATA BLK
				7	0100		
				8	0703	3	
				9	0702	2	
				70	0400	+ DIR	
				1	0007	R.07	DATA BLK
				2	0100		
				3	0703	3	
				4	0702	2	
				5	0400	+ DIR	
				6	0007	R.07	DATA BLK
				7	0100		
				8	0703	3	
				9	0702	2	
				80	0400	+ DIR	
				1	0007	R.07	DATA BLK
				2	0100		
				3	0703	3	
				4	0702	2	
5	0408	mARK		5	0400	+ DIR	
6	0003	03		6	0007	R.07	DATA BLK
7	0410	GROUP 2		7	0100		
8	0001	01	PROG TAPE	8	0703	3	
9	0415	KEY		9	0702	2	
40	0000	R.00	BLK CNTR	90	0400	+ DIR	
1	0701	1		1	0007	R.07	DATA BLK
2	0600	+		2	0100		
3	0702	2		3	0702	2	
4	0709	9		4	0702	2	
5	0701	1		5	0704	4	
6	0806		TRANSFER	6	0400	+ DIR	
7	0701	1		7	0007	R.07	DATA BLK
8	0600	+		8	0100		
9	0705	S		9	0701	1	

Remarks: PROGRAM TAPE BLOCK #34 - 36

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0702	Z		150	0414	ST Y	
1	070B	B		1	0201	R.21	Q ABHX
2	0400	+ DIR		2	0414	ST Y	
3	0007	R.07	DATA BLK	3	0202	R.22	LXP AIR
4	0100			4	0414	ST Y	
5	0702	Z		5	0203	R.23	T ABAY
6	0702	Z		6	0414	ST Y	
7	0704	4		7	0204	R.24	T AIR-IN
8	0400	+ DIR		8	0414	ST Y	
9	0007	R.07	DATA BLK	9	0205	R.25	T AIR-OUT
110	0100			160	0415	RE Y	
1	0703	3		1	0109	R.19	COUNTER
2	0702	Z		2	0703	3	
3	0700	0		3	0600	+	
4	0400	+ DIR		4	0405	RE DIR	
5	0007	R.07	DATA BLK	5	0200	R.20	T CP-OUT
6	0100			6	0504	ST INDIR	
7	0702	Z		7	0407	SEARCH	
8	0706	6		8	0006	06	
9	0404	ST DIR		9	040B	mARK	
120	0006	R.06	REG CNTR	170	0005	05	
1	0703	3		1	0405	RE DIR	
2	0702	Z		2	0014	R.14	Q ABFAN
3	0400	+ DIR		3	0600	+	
	0007	R.07	DATA BLK	4	0414	ST Y	
	0100			5	0201	R.21	Q ABHX
6	0701	1		6	0405	RE DIR	
7	0404	ST DIR		7	0015	R.15	W H2O
8	0109	R.19	COUNTER	8	0603	÷	
9	0703	3		9	0405	RE DIR	
130	0403	÷ DIR		180	0200	R.20	T CP-OUT
1	0015	R.15	W H2O	1	0600	+	
2	040B	mARK		2	0704	4	
3	0004	04		3	0705	5	
4	0415	RE Y		4	0709	9	
5	000B	R.0B	Q CP	5	0712	.	
6	0405	RE DIR		6	0706	6	
7	0015	R.15	W H2O	7	0600	+	
8	0603	÷		8	0705	5	
9	0405	RE DIR		9	0707	7	
140	0001	R.01	T H2O-IN	190	0702	Z	
1	0600	+		1	0712	.	
2	0414	ST Y		2	0706	6	
3	0200	R.20	T CP-OUT	3	0705	5	
4	0415	RE Y		4	0705	5	
5	0011	R.11	Q AB	5	0701	1	
6	0412	WRITE A	SKIP IF	6	0701	1	
7	0411	WRITE	Y=0	7	070B	B	
8	0407	SEARCH		8	0701	1	
9	0005	05		9	0701	1	

Remarks: PROGRAM TAPE BLOCK #34 – 36

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0606	↓↑		250	0603	÷	
1	0603	÷		1	0705	S	
2	0405	RE DIR		2	0710	SET EXP	
3	0106	R.16	V ATBEAN	3	0711	CHS SEN	
4	0602	X		4	0702	2	
5	0414	ST Y		5	0606	↓↑	
6	0202	R.22	WCP AIR	6	0507	SKIP IF Y≥X	
7	0408	MARK		7	0407	SEARCH	
8	0007	07		8	0007	07	
9	0101			9	0101		
210	0415	RE Y		260	0415	RE Y	
1	0011	R.11	Q AB	1	0011	R.11	Q AB
2	0405	RE DIR		2	0405	RE DIR	
3	0202	R.22	WCP AIR	3	0202	R.22	WCP AIR
4	0603	÷		4	0603	÷	
5	0405	RE DIR		5	0405	RE DIR	
6	0205	R.25	T AIR-OUT	6	0205	R.25	T AIR-OUT
7	0600	+		7	0600	+	
8	0704	4		8	0414	ST Y	
9	0705	S		9	0203	R.23	T ATBAY
220	0709	9		270	0415	RE Y	
1	0712	.		1	0201	R.21	Q ABHX
2	0706	6		2	0405	RE DIR	
3	0600	+		3	0202	R.22	WCP AIR
	0705	S		4	0603	÷	
5	0707	7		5	0405	RE DIR	
6	0702	2		6	0205	R.25	T AIR-OUT
7	0712	.		7	0600	+	
8	0706	6		8	0414	ST Y	
9	0705	S		9	0204	R.24	T AIR-IN
230	0705	S		280	0415	RE Y	
1	0701	1		1	0201	R.21	Q ABHX
2	0701	1		2	0405	RE DIR	
3	0708	8		3	0015	R.15	W H2O
4	0701	1		4	0603	÷	
5	0701	1		5	0405	RE DIR	
6	0606	↓↑		6	0200	R.20	T CP-OUT
7	0603	÷		7	0600	+	
8	0405	RE DIR		8	0414	ST Y	
9	0106	R.16	V ATBEAN	9	0006	R.06	T H2O-OUT
240	0602	X		290	0415	RE Y	
1	0405	RE DIR		1	0109	R.19	COUNTER
2	0202	R.22	WCP AIR	2	0703	3	
3	0606	↓↑		3	0600	+	
4	0404	ST DIR		4	0405	RE DIR	
5	0202	R.22	WCP AIR	5	0006	R.06	T H2O-OUT
6	0601	−		6	0504	ST INDIR	
7	0606	↓↑		7	0408	MARK	
8	0007	|X|		8	0006	06	
	0606	↓↑		9	0412	WRITE A	

Remarks:

PROGRAM TAPE BLOCK #34 - 36

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0103		SHIFT UP	350	0002		SPACE
1	0314		#	1	0413	END A	
2	0102		SHIFT DN	2	0702	Z	
3	0413	END A		3	0700	O	
4	0405	RE DIR		4	0404	ST DIR	
5	0109	R.19	COUNTER	5	0000	R.00	REG CNTR
6	0411	WRITE		6	0102		
7	0100		DP-1.0	7	0412	WRITE A	
8	0412	WRITE A		8	0103		SHIFT UP
9	0103		SHIFT UP	9	0207		T
310	0002		SPACE	360	0002		SPACE
1	0112		A	1	0201		H
2	0114		V	2	0102		SHIFT DN
3	0104		I	3	0306		Z
4	0109		O	4	0103		SHIFT UP
5	0206		N	5	0109		O
6	0104		I	6	0102		SHIFT DN
7	0212		C	7	0109		O
8	0101		S	8	0214		U
9	0002		SPACE	9	0207		T
320	0200		B	370	0413	END A	
1	0112		A	1	0415	RE Y	
2	0001		Y	2	0109	R.19	COUNTER
3	0108		CR/LF	3	0703	3	
4	0207		T	4	0600	+	
5	0002		SPACE	5	0414	ST Y	
6	0201		H	6	0000	R.00	REG CNTR
7	0102		SHIFT DN	7	0102		
8	0306		Z	8	0412	WRITE A	
9	0103		SHIFT UP	9	0103		SHIFT UP
330	0109		O	380	0207		T
1	0102		SHIFT DN	1	0002		SPACE
2	0104		I	2	0112		A
3	0206		N	3	0200		B
4	0002		SPACE	4	0112		A
5	0413	END A		5	0001		Y
6	0701	1		6	0002		SPACE
7	0404	ST DIR		7	0002		SPACE
8	0000	R.00	REG CNTR	8	0413	END A	
9	0102			9	0702	Z	
340	0412	WRITE A		390	0703	3	
1	0103		SHIFT UP	1	0404	ST DIR	
2	0207		T	2	0000	R.00	REG CNTR
3	0002		SPACE	3	0102		
4	0212		C	4	0412	WRITE A	
5	0005		P	5	0108		CR/LF
6	0102		SHIFT DN	6	0103		SHIFT UP
7	0109		O	7	0207		T
8	0214		U	8	0002		SPACE
9	0207		T	9	0112		A

Remarks: PROGRAM TAPE BLOCK #34 - 36

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0104		1	450	0002		SPACE
1	0113		R	1	0112		A
2	0102		SHIFT DN	2	0200		B
3	0104		1	3	0201		H
4	0206		N	4	0215		X
5	0002		SPACE	5	0002		SPACE
6	0413	END A		6	0002		SPACE
7	0702	Z		7	0413	END A	
8	0704	4		8	0702	Z	
9	0404	ST DIR		9	0701	1	
410	0000	R.00	REG CNTR	460	0404	ST DIR	
1	0102			1	0000	R.00	REG CNTR
2	0412	WRITE A		2	0102		
3	0103		SHIFT UP	3	0412	WRITE A	
4	0207		T	4	0108		CR/LF
5	0002		SPACE	5	0110		LF
6	0112		A	6	0413	END A	
7	0104		1	7	0415	RE Y	
8	0113		R	8	0109	R.19	COUNTER
9	0102		SHIFT DN	9	0703	3	
420	0109		O	470	0509	SKIP IF Y=X	
1	0214		U	1	0407	SEARCH	
2	0207		T	2	0008	08	
3	0413	END A		3	0415	RE Y	
4	0702	Z		4	0004	R.04	T H2O-OUT-1
5	0705	S		5	0405	RE DIR	
6	0404	ST DIR		6	0005	R.05	T H2O-OUT-2
7	0000	R.00	REG CNTR	7	0600	+	
8	0102			8	0405	RE DIR	
9	0412	WRITE A		9	0006	R.06	T H2O-OUT-3
430	0103		SHIFT UP	480	0600	+	
1	0100		W	1	0703	3	
2	0212		C	2	0603	÷	
3	0102		SHIFT DN	3	0414	ST Y	
4	0005		P	4	0001	R.01	T H2O-OUT
5	0002		SPACE	5	0415	RE Y	
6	0103		SHIFT UP	6	0108	R.18	KY SINK
7	0112		A	7	0703	3	
8	0104		1	8	0509	SKIP IF Y=X	
9	0113		R	9	0407	SEARCH	
440	0002		SPACE	490	0009	09	
1	0413	END A		1	0703	3	
2	0702	Z		2	0707	7	
3	0702	Z		3	0404	ST DIR	
4	0404	ST DIR		4	0000	R.00	BLK CNTR
5	0000	R.00	REG CNTR	5	0407	SEARCH	
6	0102			6	0010	10	
7	0412	WRITE A		7	0408	MARK	
8	0103		SHIFT UP	8	0009	09	
9	0004		Q	9	0704	4	

Remarks: PROGRAM TAPE BLOCK #34 - 36

Step	Code	Key	Comment	Step	Code	Key	Comment
500	0701	1		550	0502		DP-5.2
1	0404	ST DIR		1	0411	WRITE	
2	0000	K.00	BLK CNTR	2	1503		3 SPACES
3	040B	MARK		3	0412	WRITE A	
4	0010	10		4	0103		SHIFT UP
5	0415	KEY		5	0207		T
6	0206	K.26	Q WINDOW	6	0002		SPACE
7	0405	RE DIR		7	0201		H
8	0015	K.15	W H2O	8	0102		SHIFT DN
9	0603	÷		9	0306		Z
510	0703	3		560	0103		SHIFT UP
1	0603	÷		1	0109		O
2	0405	RE DIR		2	0102		SHIFT DN
3	0001	K.01	T H2O-IN	3	0109		O
4	0600	+		4	0214		U
5	0414	ST Y		5	0207		T
6	0207	K.27	T H2O-OUT	6	0002		SPACE
7	0412	WRITE A		7	0006		=
8	0103		SHIFT UP	8	0413	END A	
9	0212		C	9	0405	RE DIR	
520	0112		A	570	0207	K.27	T H2O-OUT
1	0200		B	1	0411	WRITE	
2	0104		1	2	0502		DP-5.2
3	0206		N	3	0412	WRITE A	
4	0002		SPACE	4	010B		CR/LF
5	0100		W	5	0110		LF
6	0104		1	6	0413	END A	
7	0206		N	7	0405	RE DIR	
8	0213		D	8	0207	K.27	T H2O-OUT
9	0109		O	9	0404	ST DIR	
530	0100		W	580	0001	K.01	T H2O-OUT
1	0101		S	1	0407	SEARCH	
2	010B		CR/LF	2	0001	01	
3	0207		T	3	040B	MARK	
4	0002		SPACE	4	000B	0B	
5	0201		H	5	0415	KEY	
6	0102		SHIFT DN	6	0109	K.19	COUNTER
7	0306		Z	7	0708	8	
8	0103		SHIFT UP	8	0600	+	
9	0109		O	9	0505	RE INDR	
540	0102		SHIFT DN	590	0404	ST DIR	
1	0104		1	1	000B	K.0B	Q CP
2	0206		N	2	0703	3	
3	0002		SPACE	3	0600	+	
4	0002		SPACE	4	0505	RE INDR	
5	0006		=	5	0404	ST DIR	
6	0413	END A		6	0011	K.11	Q AB
7	0405	RE DIR		7	0701	1	
8	0001	K.01	T H2O-IN	8	0400	+ DIR	
9	0411	WRITE		9	0109	K.19	COUNTER

Remarks: PROGRAM TAPE BLOCK #34 - 36

Step	Code	Key	Comment	Step	Code	Key	Comment
600	0407	SEARCH		650	0202	R.22	WGP AIR
1	0004	04		1	0615	1/x	
2	0408	MARK		2	0604	↑	
3	0100			3	0405	RE DIR	
4	0410	GROUP 2		4	0015	R.15	W H2O
5	0003	03	EXT CORE	5	0615	1/x	
6	0415	RE Y		6	0601	−	
7	0007	R.07	DATA BLK	7	0405	RE DIR	
8	0701	1		8	0201	R.21	Q ABHX
9	0709	9		9	0606	↕	
610	0703	3		660	0602	X	
1	0706	6		1	0414	ST Y	
2	0802		TRANSFER	2	0007	R.07	C_1
3	0415	RE Y		3	0415	RE Y	
4	0006	R.06	REG CNTR	4	0107	R.17	UA ABHX
5	0405	RE DIR		5	0602	X	
6	0004	R.04	DATA	6	0605	↓	
7	0504	ST INDIR		7	0614	e^x	
8	0701	1		8	0604	↑	
9	0400	+ DIR		9	0701	1	
620	0006	R.06	REG CNTR	670	0606	↕	
1	0511	RETURN		1	0601	−	
2	0408	MARK		2	0414	ST Y	
3	0101			3	0205	R.25	C_2
4	0415	RE Y		4	0405	RE DIR	
5	0015	R.15	W H2O	5	0200	R.20	TCP-OUT
6	0405	RE DIR		6	0602	X	
7	0202	R.22	WGP AIR	7	0405	RE DIR	
8	0603	÷		8	0007	R.07	C_1
9	0701	1		9	0601	−	
630	0601	−		680	0405	RE DIR	
1	0412	WRITE A	SKIP IF	1	0205	R.25	C_2
2	0411	WRITE	Y=0	2	0603	÷	
3	0407	SEARCH		3	0414	ST Y	
4	0011	11		4	0205	R.25	T AIR-OUT
5	0415	RE Y		5	0408	MARK	
6	0201	R.21	Q ABHX	6	0012	12	
7	0405	RE DIR		7	0511	RETURN	
8	0107	R.17	UA ABHX	8	0408	MARK	
9	0603	÷		9	0102		
640	0405	RE DIR		690	0412	WRITE A	
1	0200	R.20	T CP-OUT	1	0102		SHIFT DN
2	0600	+		2	0002		SPACE
3	0414	ST Y		3	0006		=
4	0205	R.25	T AIR-OUT	4	0413	END A	
5	0407	SEARCH		5	0415	RE Y	
6	0012	12		6	0000	R.00	REG CNTR
7	0408	MARK		7	0505	RE INDIR	
8	0011	11		8	0411	WRITE	
9	0405	RE DIR		9	0502		DP-S.2

Remarks: PROGRAM TAPE BLOCK #34 - 36

Step	Code	Key	Comment	Step	Code	Key	Comment
700	0411	WRITE					
1	1503		3 SPACES				
2	0511	RETURN					

Remarks:
PROGRAM TAPE BLOCK #34 - 36

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0704	4	
				1	0707	7	
				2	0806		TRANSFER
				3	0701	1	
				4	0600	+	
				5	070B	8	
				6	0700	0	
				7	0703	3	
				8	0806		TRANSFER
				9	070B	8	
				60	0404	ST DIR	
				1	0006	K.06	REG CNTR
				2	0701	1	
				3	0703	3	
				4	0701	1	
				5	0702	2	
				6	0404	ST DIR	
				7	0007	K.07	DATA BLK
				8	0100		
				9	0701	1	
				70	0706	6	
				1	0700	0	
				2	0400	+ DIR	
				3	0007	K.07	DATA BLK
				4	0100		
				5	0703	3	
				6	0702	2	
				7	0400	+ DIR	
				8	0007	K.07	DATA BLK
				9	0100		
				80	0704	4	
				1	0701	1	
				2	0706	6	
				3	0400	+ DIR	
5	0408	MARK		4	0007	K.07	DATA BLK
6	0003	03		5	0100		
7	0410	GROUP 2		6	0703	3	
8	0001	01	PROG TAPE	7	0702	2	
9	0415	RE Y		8	0700	0	
40	0000	K.00	BLK CNTR	9	0400	+ DIR	
1	0701	1		90	0007	K.07	DATA BLK
2	0600	+		1	0100		
3	0702	2		2	0405	RE DIR	
4	0709	9		3	0010	K.10	V F21 P
5	0701	1		4	0404	ST DIR	
6	0806		TRANSFER	5	0013	K.13	W F21
7	0701	1		6	0701	1	
8	0600	+		7	0700	0	
9	0705	5		8	0700	0	
				9	0404	ST DIR	

Remarks: PROGRAM TAPE BLOCK #37 - 40
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0004	K.04	T F21	150	0400	+ DIR	
1	0103			1	0005	K.05	H F21
2	0405	RE DIR		2	0102		
3	0006	K.06	P F21	3	0103		
4	0402	X DIR		4	0415	RE Y	
5	0013	K.13	W F21	5	0006	K.06	P F21
6	0415	RE Y		6	0405	RE DIR	
7	0001	K.01	T H2O-IN	7	0010	K.10	V F21P
8	0705	S		8	0602	X	
9	0600	+		9	0405	RE DIR	
110	0414	ST Y		160	0013	K.13	W F21
1	0004	K.04	T F21	1	0606	↓↑	
2	0101			2	0404	ST DIR	
3	0415	RE Y		3	0013	K.13	W F21
4	0012	K.12	Q F21 LOOP	4	0601	-	
5	0405	RE DIR		5	0606	↓↑	
6	0013	K.13	W F21	6	0607	|X|	
7	0603	÷		7	0606	↓↑	
8	0605	↓		8	0603	÷	
9	0400	+ DIR		9	0705	S	
120	0005	K.05	H F21	170	0710	SET EXP	
1	0102			1	0711	CHS SEN	
2	0415	RE Y		2	0702	Z	
3	0001	K.01	T H2O-IN	3	0606	↓↑	
4	0705	S		4	0508	SKIP IF Y< X	
5	0600	+		5	0407	SEARCH	
6	0405	RE DIR		6	0005	05	
7	0004	K.04	T F21	7	0405	RE DIR	
8	0606	↓↑		8	0015	K.15	T F21-OUT
9	0601	-		9	0404	ST DIR	
130	0405	RE DIR		180	0004	K.04	T F21
1	0012	K.12	Q F21 LOOP	1	0101		
2	0606	↓↑		2	0415	RE Y	
3	0603	÷		3	0012	K.12	Q F21 LOOP
4	0414	ST Y		4	0405	RE DIR	
5	0014	K.14	W(P F21	5	0013	K.13	W F21
6	040B	MARK		6	0603	÷	
7	0004	04		7	0605	↓	
8	0104			8	0400	+ DIR	
9	0405	RE DIR		9	0005	K.05	H F21
140	0015	K.15	T F21-OUT	190	0102		
1	0404	ST DIR		1	0415	RE Y	
2	0004	K.04	T F21	2	0004	K.04	T F21
3	0101			3	0405	RE DIR	
4	0415	RE Y		4	0015	K.15	T F21-OUT
5	0008	K.08	Q PLDHX	5	0601	-	
6	0405	RE DIR		6	0405	RE DIR	
7	0013	K.13	W F21	7	0012	K.12	Q F21 LOOP
8	0603	÷		8	0606	↓↑	
9	0605	↓		9	0603	÷	

Remarks: PROGRAM TAPE BLOCK #37 - 40
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment	Step	Code	Key	Comment
700	0414	ST Y		250	0002		SPACE
1	0014	R.14	WCp F21	1	0009		/
2	0407	SEARCH		2	0002		SPACE
3	0004	04		3	0103		SHIFT UP
4	0408	MARK		4	0201		H
5	0005	05		5	0102		SHIFT DN
6	0104			6	0306		Z
7	0405	RE DIR		7	0103		SHIFT UP
8	0015	R.15	T F21-OUT	8	0109		O
9	0404	ST DIR		9	0002		SPACE
210	0004	R.04	T F21	260	0104		1
1	0101			1	0206		N
2	0415	RE Y		2	0207		T
3	0012	R.12	Q F21 LOOP	3	0205		E
4	0405	RE DIR		4	0113		R
5	0013	R.13	W F21	5	0212		C
6	0603	÷		6	0201		H
7	0605	↓		7	0112		A
8	0400	+ DIR		8	0206		N
9	0005	R.05	H F21	9	0015		G
220	0107			270	0205		E
1	0415	RE Y		1	0113		R
2	0004	R.04	T F21	2	0108		CR/LF
3	0414	ST Y		3	0004		Q
4	0106	R.16	T F21-IN	4	0002		SPACE
5	0405	RE DIR		5	0014		F
6	0015	R.15	T F21-OUT	6	0102		SHIFT DN
7	0601	–		7	0306		Z
8	0405	RE DIR		8	0209		1
9	0012	R.12	Q F21 LOOP	9	0103		SHIFT UP
230	0606	↓↑		280	0209		L
1	0603	÷		1	0002		SPACE
2	0414	ST Y		2	0002		SPACE
3	0014	R.14	WCp F21	3	0413	END A	
4	0415	RE Y		4	0701	1	
5	0012	R.12	Q F21 LOOP	5	0702	2	
6	0405	RE DIR		6	0404	ST DIR	
7	0009	R.09	W H2O	7	0000	R.00	RE CNTR
8	0603	÷		8	0105		
9	0405	RE DIR		9	0412	WRITE A	
240	0001	R.01	T H2O-IN	290	0103		SHIFT UP
1	0600	+		1	0207		T
2	0414	ST Y		2	0002		SPACE
3	0107	R.17	T H2O-OUT	3	0201		H
4	0412	WRITE A		4	0102		SHIFT DN
5	0103		SHIFT UP	5	0306		Z
6	0014		F	6	0103		SHIFT UP
7	0102		SHIFT DN	7	0109		O
8	0306		Z	8	0102		SHIFT DN
9	0209		1	9	0104		1

Remarks: PROGRAM TAPE BLOCK #37 - 40
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0206		N	350	0306		Z
1	0002		SPACE	1	0209		1
2	0413	END A		2	0109		O
3	0701	1		3	0214		U
4	0404	ST DIR		4	0207		T
5	0000	R.00	REG CNTR	5	0413	END A	
6	0105			6	0701	1	
7	0412	WRITE A		7	0705	5	
8	0103		SHIFT UP	8	0404	ST DIR	
9	0207		T	9	0000	R.00	REG CNTR
310	0002		SPACE	360	0105		
1	0201		H	1	0412	WRITE A	
2	0102		SHIFT DN	2	0103		SHIFT UP
3	0306		Z	3	0100		W
4	0103		SHIFT UP	4	0212		C
5	0109		O	5	0102		SHIFT DN
6	0102		SHIFT DN	6	0205		P
7	0109		O	7	0002		SPACE
8	0214		U	8	0103		SHIFT UP
9	0207		T	9	0014		F
320	0413	END A		370	0102		SHIFT DN
1	0701	1		1	0306		Z
2	0707	7		2	0209		1
3	0404	ST DIR		3	0002		SPACE
4	0000	R.00	REG CNTR	4	0413	END A	
5	0105			5	0701	1	
6	0412	WRITE A		6	0704	4	
7	0103		SHIFT UP	7	0404	ST DIR	
8	0207		T	8	0000	R.00	REG CNTR
9	0002		SPACE	9	0105		
330	0014		F	380	0412	WRITE A	
1	0102		SHIFT DN	1	0103		SHIFT UP
2	0306		Z	2	0100		W
3	0209		1	3	0002		SPACE
4	0104		1	4	0014		F
5	0206		N	5	0102		SHIFT DN
6	0002		SPACE	6	0306		Z
7	0413	END A		7	0209		1
8	0701	1		8	0413	END A	
9	0706	6		9	0411	WRITE	
340	0404	ST DIR		390	1503		3 SPACES
1	0000	R.00	REG CNTR	1	0701	1	
2	0105			2	0703	3	
3	0412	WRITE A		3	0404	ST DIR	
4	0108		CR/LF	4	0000	R.00	REG CNTR
5	0103		SHIFT UP	5	0105		
6	0207		T	6	0412	WRITE A	
7	0002		SPACE	7	0108		CR/LF
8	0014		F	8	0110		LF
9	0102		SHIFT DN	9	0413	END A	

Remarks: PROGRAM TAPE BLOCK #37 - 40
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0405	RE DIR		450	0703	3	
1	0107	R.17	T H2O-OUT	1	0707	7	
2	0404	ST DIR		2	0704	4	
3	0001	R.01	T H2O-OUT	3	0705	5	
4	0405	RE DIR		4	0702	2	
5	0015	R.15	T F21-OUT	5	0702	2	
6	0404	ST DIR		6	070B	8	
7	0002	R.02	T F21-OUT	7	0702	2	
8	0405	RE DIR		8	0710	SET EXP	
9	0013	R.13	W F21	9	0711	CHS SEN	
410	0404	ST DIR		460	0706	6	
1	0003	R.03	W F21	1	0602	X	
2	0704	4		2	0414	ST Y	
3	0701	1		3	0005	R.05	H F21
4	0404	ST DIR		4	0405	RE DIR	
5	0000	R.00	BLK CNTR	5	0004	R.04	
6	0407	SEARCH		6	0713	x^2	
7	0001	01		7	0604	↑	
8	040B	MARK		8	0701	1	
9	0100			9	0700	0	
420	0410	GROUP 2		470	070B	8	
1	0003	03	EXT CORE	1	0706	6	
2	0415	RE Y		2	0707	7	
3	0007	R.07	DATA BLK	3	0700	0	
4	0701	1		4	0704	4	
5	0709	9		5	070B	8	
6	0703	3		6	0703	3	
7	0706	6		7	0700	0	
8	0802		TRANSFER	8	0700	0	
9	0415	RE Y		9	0709	9	
430	0006	R.06	REG CNTR	480	0710	SET EXP	
1	0405	RE DIR		1	0711	CHS SEN	
2	0004	R.04	DATA	2	0703	3	
3	0504	ST INDIR		3	0602	X	
4	0701	1		4	0605	↓	
5	0400	+ DIR		5	0400	+ DIR	
6	0006	R.06	REG CNTR	6	0005	R.05	H F21
7	0511	RETURN		7	0415	RE Y	
8	040B	MARK		8	0004	R.04	T F21
9	0101			9	0712	.	
440	0415	RE Y		490	0702	2	
1	0004	R.04	T F21	1	0703	3	
2	0405	RE DIR		2	0704	4	
3	0004	R.04	T F21	3	070B	8	
4	0713	x^2		4	070B	8	
5	0602	X		5	070B	8	
6	0701	1		6	0705	5	
7	0704	4		7	0705	5	
8	0704	4		8	0705	5	
9	070B	8		9	0701	1	

Remarks:
PROGRAM TAPE BLOCK #37 - 40
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment	Step	Code	Key	Comment
500	07000	0		550	0604	↑	
1	0705	S		1	0709	9	
2	0602	X		2	0704	4	
3	060S	↓		3	0704	4	
4	0400	+ DIR		4	0709	9	
5	0005	K.05	H F21	5	0700	0	
6	0709	9		6	0703	3	
7	0712	.		7	0702	2	
8	0704	4		8	0702	2	
9	0705	S		9	0704	4	
510	0706	6		560	0705	S	
1	0704	4		1	0707	7	
2	0701	1		2	0710	SET EXP	
3	0707	7		3	0711	CHS SGN	
4	0700	0		4	0702	2	
5	0709	9		5	0602	X	
6	0702	2		6	0605	↓	
7	0703	3		7	0401	- DIR	
8	0400	+ DIR		8	0004	K.04	T F21
9	0005	K.05	H F21	9	0415	KEY	
520	0511	RETURN		570	0005	K.05	H F21
1	0408	MARK		1	0704	4	
2	0102			2	0712	.	
3	0415	KEY		3	0704	4	
4	0005	K.05	H F21	4	0704	4	
5	0405	RE DIR		5	0703	3	
6	0005	K.05	H F21	6	0703	3	
7	0713	X²		7	0709	9	
8	0602	X		8	0703	3	
9	0709	9		9	0703	3	
530	0704	4		580	0705	S	
1	0705	S		1	0707	7	
2	0703	3		2	0707	7	
3	0706	6		3	0705	S	
4	0709	9		4	0602	X	
5	0703	3		5	0605	↓	
6	0700	0		6	0400	+ DIR	
7	0706	6		7	0004	K.04	T F21
8	0703	3		8	0704	4	
9	0704	4		9	0701	1	
540	0708	8		590	0712	.	
1	0710	SET EXP		1	0702	2	
2	0711	CHS SGN		2	0700	0	
3	0705	S		3	0707	7	
4	0602	X		4	0703	3	
5	0414	ST Y		5	0703	3	
6	0004	K.04	T F21	6	0704	4	
7	0405	RE DIR		7	0706	6	
8	0005	K.05	H F21	8	0700	0	
9	0713	X²		9	0703	3	

Remarks: PROGRAM TAPE BLOCK #37 - 40
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment	Step	Code	Key	Comment
600	0401	- DIR		650	0605	↓	
1	0004	R.04	T F21	1	0400	+ DIR	
2	0511	RETURN		2	0006	R.06	P F21
3	0408	MARK		3	0415	RE Y	
4	0103			4	0004	R.04	T F21
5	0415	RE Y		5	0708	8	
6	0004	R.04	T F21	6	0704	4	
7	0405	RE DIR		7	0701	1	
8	0004	R.04	T F21	8	0708	8	
9	0713	x²		9	0704	4	
610	0602	X		660	0701	1	
1	0711	CHS SGN		1	0704	4	
2	0702	2		2	0709	9	
3	0701	1		3	0702	2	
4	0701	1		4	0708	8	
5	0702	2		5	0706	6	
6	0704	4		6	0701	1	
7	0707	7		7	0710	SET EXP	
8	0700	0		8	0711	CHS SGN	
9	0708	8		9	0701	1	
620	0709	9		670	0602	X	
1	0706	6		1	0605	↓	
2	0708	8		2	0401	- DIR	
3	0706	6		3	0006	R.06	P F21
4	0710	SET EXP		4	0709	9	
5	0711	CHS SGN		5	0701	1	
6	0706	6		6	0712	.	
7	0602	X		7	0704	4	
8	0414	ST Y		8	0708	8	
9	0006	R.06	P F21	9	0706	6	
630	0405	RE DIR		680	0706	6	
1	0004	R.04	T F21	1	0706	6	
2	0713	x²		2	0706	6	
3	0604	↑		3	0706	6	
4	0703	3		4	0706	6	
5	0702	2		5	0708	8	
6	0707	7		6	0708	8	
7	0707	7		7	0400	+ DIR	
8	0709	9		8	0006	R.06	P F21
9	0707	7		9	0511	RETURN	
640	0702	2		690	0408	MARK	
1	0701	1		1	0104		
2	0704	4		2	0415	RE Y	
3	0700	0		3	0009	R.09	W H2O
4	0702	2		4	0405	RE DIR	
5	0707	7		5	0014	R.14	WCP F21
6	0710	SET EXP		6	0603	÷	
7	0711	CHS SGN		7	0701	1	
8	0704	4		8	0601	-	
9	0602	X		9	0412	WRITE A	SKIP IF

Remarks: PROGRAM TAPE BLOCK #37 - 40
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment	Step	Code	Key	Comment
700	0411	WRITE	Y=0	750	0603	÷	
1	0407	SEARCH		1	0414	ST Y	
2	0006	06		2	0015	R.15	T FZI-OUT
3	0415	RE Y		3	0408	MARK	
4	0012	R.12	Q FZI LOOP	4	0007	07	
5	0405	RE DIR		5	0511	RETURN	
6	0011	R.11	UA INTHX	6	0408	MARK	
7	0603	÷		7	0105		
8	0405	RE DIR		8	0412	WRITE A	
9	0001	R.01	T H2O-IN	9	0102		SHIFT DN
710	0600	+		760	0002		SPACE
1	0414	ST Y		1	0006		=
2	0015	R.15	T FZI-OUT	2	0413	END A	
3	0407	SEARCH		3	0415	RE Y	
4	0007	07		4	0000	R.00	REG CNTR
5	0408	MARK		5	0505	RE INDIR	
6	0006	06		6	0411	WRITE	
7	0405	RE DIR		7	0502		DP-S.2
8	0014	R.14	WCP FZI	8	0411	WRITE	
9	0615	1/X		9	1503		3 SPACES
720	0604	↑		770	0511	RETURN	
1	0405	RE DIR					
2	0009	R.09	W H2O				
3	0615	1/X					
4	0601	−					
5	0405	RE DIR					
6	0012	R.12	Q FZI LOOP				
7	0606	↓↑					
8	0602	X					
9	0414	ST Y					
730	0007	R.07	C$_1$				
1	0415	RE Y					
2	0011	R.11	UA INTHX				
3	0602	X					
4	0605	↓					
5	0614	e^x					
6	0604	↑					
7	0701	1.					
8	0606	↓↑					
9	0601	−					
740	0414	ST Y					
1	0015	R.15	C$_2$				
2	0405	RE DIR					
3	0001	R.01	T H2O-IN				
4	0602	X					
5	0405	RE DIR					
6	0007	R.07	C$_1$				
7	0601	−					
8	0405	RE DIR					
9	0015	R.15	C$_2$				

Remarks: PROGRAM TAPE BLOCK #37 - 40
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0704	4	
				1	0707	7	
				2	0806		TRANSFER
				3	0708	8	
				4	0404	ST DIR	
				5	0006	K.06	REG CNTR
				6	0701	1	
				7	0703	3	
				8	0701	1	
				9	0702	2	
				60	0404	ST DIR	
				1	0007	K.07	DATA BLK
				2	0100		
				3	0703	3	
				4	0705	S	
				5	0702	2	
				6	0400	+ DIR	
				7	0007	K.07	DATA BLK
				8	0100		
				9	0702	2	
				70	0708	8	
				1	0708	8	
				2	0400	+ DIR	
				3	0007	K.07	DATA BLK
				4	0100		
				5	0405	RE DIR	
				6	0008	K.08	Q PLDHX
				7	0412	WRITE A	SKIP IF
				8	0611	LoGe X	X=0
				9	0407	SEARCH	
				80	0006	06	
				1	0404	ST DIR	
				2	0012	K.12	WXp F21
				3	0404	ST DIR	
				4	0013	K.13	T PLD-OUT
5	0408	mARK		5	0404	ST DIR	
6	0003	03		6	0014	K.14	T PLD-IN
7	0410	GROUP 2		7	0405	RE DIR	
8	0001	01	PROG TAPE	8	0002	K.02	T F21-IN
9	0415	KEY		9	0404	ST DIR	
40	0000	K.00	BLK CNTR	90	0011	K.11	T F21-OUT
1	0701	1		1	0407	SEARCH	
2	0600	+		2	0007	07	
3	0702	2		3	0408	mARK	
4	0709	9		4	0006	06	
5	0701	1		5	0405	RE DIR	
6	0806		TRANSFER	6	0002	K.02	T F21-IN
7	0701	1		7	0404	ST DIR	
8	0600	+		8	0004	K.04	T F21
9	0705	S		9	0101		

Remarks: PROGRAM TAPE BLOCK #41 – 43

Step	Code	Key	Comment	Step	Code	Key	Comment
700	0415	RE Y		150	0012	R.12	WCp FZ1
1	0008	R.08	Q PLDHX	1	0615	1/x	
2	0405	RE DIR		2	0601	−	
3	0003	R.03	W FZ1	3	0405	RE DIR	
4	0603	÷		4	0008	R.08	Q PLDHX
5	0605	↓		5	0606	↓↑	
6	0400	+ DIR		6	0602	X	
7	0005	R.05	H FZ1	7	0414	ST Y	
8	0102			8	0007	R.07	C_1
9	0415	RE Y		9	0415	RE Y	
110	0004	R.04	T FZ1	160	0010	R.10	UA PLDHX
1	0414	ST Y		1	0602	X	
2	0011	R.11	T FZ1-OUT	2	0605	↓	
3	0405	RE DIR		3	0614	e^x	
4	0002	R.02	T FZ1-IN	4	0604	↑	
5	0601	−		5	0701	\	
6	0405	RE DIR		6	0606	↓↑	
7	0008	R.08	Q PLDHX	7	0601	−	
8	0606	↓↑		8	0414	ST Y	
9	0603	÷		9	0013	R.13	C_2
120	0414	ST Y		170	0405	RE DIR	
1	0012	R.12	WCp FZ1	1	0002	R.02	T FZ1-IN
2	0405	RE DIR		2	0602	X	
3	0009	R.09	WCp PLD	3	0405	RE DIR	
4	0603	÷		4	0007	R.07	C_1
5	0701	↑		5	0601	−	
6	0601	−		6	0405	RE DIR	
7	0412	WRITE A	SKIP IF	7	0013	R.13	C_2
8	0411	WRITE	Y=0	8	0603	÷	
9	0407	SEARCH		9	0414	ST Y	
130	0004	04		180	0013	R.13	T PLD-OUT
1	0415	RE Y		1	0408	MARK	
2	0008	R.08	Q PLDHX	2	0005	05	
3	0405	RE DIR		3	0415	RE Y	
4	0010	R.10	UA PLDHX	4	0008	R.08	Q PLDHX
5	0603	÷		5	0405	RE DIR	
6	0405	RE DIR		6	0009	R.09	WCp PLD
7	0002	R.02	T FZ1-IN	7	0603	÷	
8	0600	+		8	0405	RE DIR	
9	0414	ST Y		9	0013	R.13	T PLD-OUT
140	0013	R.13	T PLD-OUT	190	0600	+	
1	0407	SEARCH		1	0414	ST Y	
2	0005	05		2	0014	R.14	T PLD-IN
3	0408	MARK		3	0408	MARK	
4	0004	04		4	0007	07	
5	0405	RE DIR		5	0412	WRITE A	
6	0009	R.09	WCp PLD	6	0103		SHIFT UP
7	0615	1/x		7	0205		P
8	0604	↑		8	0112		A
9	0405	RE DIR		9	0001		Y

Remarks: PROGRAM TAPE BLOCK #41 − 43

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0209		L	250	0103		
1	0109		O	1	0412	WRITE A	
2	0112		A	2	0103		SHIFT UP
3	0213		D	3	0100		W
4	0002		SPACE	4	0212		C
5	0201		H	5	0102		SHIFT DN
6	0205		E	6	0005		P
7	0112		A	7	0002		SPACE
8	0207		T	8	0103		SHIFT UP
9	0002		SPACE	9	0014		F
210	0205		E	260	0102		SHIFT DN
1	0215		X	1	0306		Z
2	0212		C	2	0209		1
3	0201		H	3	0002		SPACE
4	0112		A	4	0413	END A	
5	0206		N	5	0701	1	
6	0015		G	6	0702	2	
7	0205		E	7	0404	ST DIR	
8	0113		R	8	0000	K.00	REG CNTR
9	0108		CR/LF	9	0103		
220	0207		T	270	0412	WRITE A	
1	0002		SPACE	1	0103		SHIFT UP
2	0014		F	2	0207		T
3	0102		SHIFT DN	3	0002		SPACE
4	0306		Z	4	0005		P
5	0209		1	5	0209		L
6	0104		1	6	0213		D
7	0206		N	7	0102		SHIFT DN
8	0002		SPACE	8	0104		1
9	0413	END A		9	0206		N
230	0702	2		280	0002		SPACE
1	0404	ST DIR		1	0413	END A	
2	0000	K.00	REG CNTR	2	0701	1	
3	0103			3	0704	4	
4	0412	WRITE A		4	0404	ST DIR	
5	0103		SHIFT UP	5	0000	K.00	REG CNTR
6	0207		T	6	0103		
7	0002		SPACE	7	0412	WRITE A	
8	0014		F	8	0108		CR/LF
9	0102		SHIFT DN	9	0103		SHIFT UP
240	0306		Z	290	0207		T
1	0209		1	1	0002		SPACE
2	0109		O	2	0005		P
3	0214		U	3	0209		L
4	0207		T	4	0213		D
5	0413	END A		5	0102		SHIFT DN
6	0701	1		6	0109		O
7	0701	1		7	0214		U
8	0404	ST DIR		8	0207		T
9	0000	K.00	REG CNTR	9	0413	END A	

Remarks: PROGRAM TAPE BLOCK #41 - 43

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0701	\		350	0708	8	
1	0703	3		1	0703	3	
2	0404	ST DIR		2	0707	7	
3	0000	R.00	REG CNTR	3	0704	4	
4	0103			4	0705	5	
5	0412	WRITE A		5	0702	2	
6	0108		CR/LF	6	0702	2	
7	0110		LF	7	0708	8	
8	0413	END A		8	0707	2	
9	0405	RE DIR		9	0710	SET EXP	
310	0011	R.11	T F21-OUT	360	0711	CHS SGN	
1	0404	ST DIR		1	0706	6	
2	0002	R.02	T F21-OUT	2	0602	X	
3	0704	4		3	0414	ST Y	
4	0704	4		4	0005	R.05	H F21
5	0404	ST DIR		5	0405	RE DIR	
6	0000	R.00	BLK CNTR	6	0004	R.04	T F21
7	0407	SEARCH		7	0713	X²	
8	0001	01		8	0604	↑	
9	0408	MARK		9	0701	\	
320	0100			370	0700	0	
1	0410	GROUP 2		1	0708	8	
2	0003	03	EXT CORE	2	0706	6	
3	0415	RE Y		3	0707	7	
4	0007	R.07	DATA BLK	4	0700	0	
5	0701	\		5	0704	4	
6	0709	9		6	0708	8	
7	0703	3		7	0703	3	
8	0706	6		8	0700	0	
9	0802		TRANSFER	9	0700	0	
330	0415	RE Y		380	0709	9	
1	0006	R.06	REG CNTR	1	0710	SET EXP	
2	0405	RE DIR		2	0711	CHS SGN	
3	0004	R.04	DATA	3	0703	3	
4	0504	ST INDIR		4	0602	X	
5	0701	\		5	0605	↓	
6	0400	+ DIR		6	0400	+ DIR	
7	0006	R.06	REG CNTR	7	0005	R.05	H F21
8	0511	RETURN		8	0415	RE Y	
9	0408	MARK		9	0004	R.04	T F21
340	0101			390	0712	.	
1	0415	RE Y		1	0702	2	
2	0004	R.04	T F21	2	0703	3	
3	0405	RE DIR		3	0704	4	
4	0004	R.04	T F21	4	0708	8	
5	0713	X²		5	0708	8	
6	0602	X		6	0708	8	
7	0701	\		7	0705	5	
8	0704	4		8	0705	5	
9	0704	4		9	0705	5	

Remarks:

PROGRAM TAPE BLOCK #41 - 43

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0701	1		450	0713	x^2	
1	0700	0		1	0604	↑	
2	0705	5		2	0709	9	
3	0602	X		3	0704	4	
4	0605	↓		4	0704	4	
5	0400	+ DIR		5	0709	9	
6	0005	K.05	H F21	6	0700	0	
7	0709	9		7	0703	3	
8	0712	.		8	0702	2	
9	0704	4		9	0702	2	
410	0705	5		460	0704	4	
1	0706	6		1	0705	5	
2	0704	4		2	0707	7	
3	0701	1		3	0710	SET EXP	
4	0707	7		4	0711	CHS SGN	
5	0700	0		5	0702	2	
6	0709	9		6	0602	X	
7	0702	2		7	0605	↓	
8	0703	3		8	0401	- DIR	
9	0400	+ DIR		9	0004	K.04	T F21
420	0005	K.05	H F21	470	0415	KEY	
1	0511	RETURN		1	0005	K.05	H F21
2	0408	MARK		2	0704	4	
3	0102			3	0712	.	
4	0415	KEY		4	0704	4	
5	0005	K.05	H F21	5	0704	4	
6	0405	RE DIR		6	0703	3	
7	0005	K.05	H F21	7	0703	3	
8	0713	x^2		8	0709	9	
9	0602	X		9	0703	3	
430	0709	9		480	0703	3	
1	0704	4		1	0705	5	
2	0705	5		2	0707	7	
3	0703	3		3	0707	7	
4	0706	6		4	0705	5	
5	0709	9		5	0602	X	
6	0703	3		6	0605	↓	
7	0700	0		7	0400	+ DIR	
8	0706	6		8	0004	K.04	T F21
9	0703	3		9	0704	4	
440	0704	4		490	0701	1	
1	0708	8		1	0712	.	
2	0710	SET EXP		2	0702	2	
3	0711	CHS SGN		3	0700	0	
4	0705	5		4	0707	7	
5	0602	X		5	0703	3	
6	0414	ST Y		6	0703	3	
7	0004	K.04	T F21	7	0704	4	
8	0405	RE DIR		8	0706	6	
9	0005	K.05	H F21	9	0700	0	

Remarks: PROGRAM TAPE BLOCK #41 - 43

Step	Code	Key	Comment	Step	Code	Key	Comment
500	0703	3					
1	0401	– DIR					
2	0004	R.04	T F21				
3	0511	RETURN					
4	0408	MARK					
5	0103						
6	0412	WRITE A					
7	0102		SHIFT DN				
8	0007		SPACE				
9	0006		=				
510	0413	END A					
1	0415	RE Y					
2	0000	R.00	REG CNTR				
3	0505	RE INDIR					
4	0411	WRITE					
5	0502		DP-S.2				
6	0411	WRITE					
7	1503		3 SPACES				
8	0511	RETURN					

Remarks: PROGRAM TAPE BLOCK #41 – 43

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0701	1	
				1	0703	3	
				2	0704	4	
				3	0704	4	
				4	0404	ST DIR	
				5	0007	R.07	DATA BLK
				6	0100		
				7	0701	1	
				8	0706	6	
				9	0700	0	
				60	0400	+ DIR	
				1	0007	R.07	DATA BLK
				2	0100		
				3	0405	RE DIR	
				4	0008	R.08	Q F21 PUMP
				5	0412	WRITE A	SKIP IF
				6	0611	LOG e X	X=0
				7	0407	SEARCH	
				8	0004	04	
				9	0404	ST DIR	
				70	0011	R.11	WCP F21
				1	0405	RE DIR	
				2	0002	R.02	T F21-IN
				3	0404	ST DIR	
				4	0010	R.10	T F21-OUT
				5	0407	SEARCH	
				6	0005	05	
				7	0408	mARK	
				8	0004	04	
				9	0405	RE DIR	
5	0408	mARK		80	0002	R.02	T F21-IN
6	0003	03		1	0404	ST DIR	
7	0410	GROUP 2		2	0004	R.04	T F21
8	0001	01	PROG TAPE	3	0101		
9	0415	RE Y		4	0415	RE Y	
40	0000	R.00	BLK CNTR	5	0008	R.08	Q F21 PUMP
1	0701	1		6	0405	RE DIR	
2	0600	+		7	0003	R.03	W F21
3	0702	2		8	0603	÷	
4	0709	9		9	0605	↓	
5	0701	1		90	0400	+ DIR	
6	0B06		TRANSFER	1	0005	R.05	H F21
7	070B	8		2	0102		
8	0404	ST DIR		3	0415	RE Y	
9	0006	R.06	REG CNTR	4	0004	R.04	T F21
				5	0414	ST Y	
				6	0010	R.10	T F21-OUT
				7	0405	RE DIR	
				8	0002	R.02	T F21-IN
				9	0601	-	

Remarks: PROGRAM TAPE BLOCK #44 - 45

Step	Code	Key	Comment
100	0405	RE DIR	
1	0008	R.08	Q F21 PUMP
2	0606	↓↑	
3	0603	÷	
4	0414	ST Y	
5	0011	R.11	W(P F21
6	0408	MARK	
7	0005	OS	
8	0405	RE DIR	
9	0002	R.02	T F21-IN
110	0404	ST DIR	
1	0004	R.04	T F21
2	0103		
3	0405	RE DIR	
4	0006	R.06	P F21
5	0415	RE Y	
6	0009	R.09	V F21 PUMP
7	0602	X	
8	0414	ST Y	
9	0012	R.12	W F21 ACT
120	0412	WRITE A	
1	0103		SHIFT UP
2	0014		F
3	0102		SHIFT DN
4	0306		Z
5	0209		1
6	0002		SPACE
7	0103		SHIFT UP
8	0212		C
9	0109		O
130	0109		O
1	0209		L
2	0112		A
3	0206		N
4	0207		T
5	0002		SPACE
6	0209		L
7	0109		O
8	0109		O
9	0005		P
140	0002		SPACE
1	0005		P
2	0214		U
3	0115		M
4	0005		P
5	0108		CR/LF
6	0207		T
7	0002		SPACE
8	0014		F
9	0102		SHIFT DN

Step	Code	Key	Comment
150	0306		Z
1	0209		1
2	0104		1
3	0206		N
4	0002		SPACE
5	0413	END A	
6	0202		Z
7	0404	ST DIR	
8	0200	R.00	REG CNTR
9	0104		
160	0412	WRITE A	
1	0103		SHIFT UP
2	0207		T
3	0002		SPACE
4	0014		F
5	0102		SHIFT DN
6	0306		Z
7	0209		1
8	0109		O
9	0214		U
170	0207		T
1	0413	END A	
2	0701		1
3	0700		O
4	0404	ST DIR	
5	0000	R.00	REG CNTR
6	0104		
7	0412	WRITE A	
8	0103		SHIFT UP
9	0100		W
180	0212		C
1	0107		SHIFT DN
2	0005		P
3	0002		SPACE
4	0103		SHIFT UP
5	0014		F
6	0102		SHIFT DN
7	0306		Z
8	0209		1
9	0002		SPACE
190	0413	END A	
1	0701		1
2	0701		1
3	0404	ST DIR	
4	0000	R.00	REG CNTR
5	0104		
6	0412	WRITE A	
7	0103		SHIFT UP
8	0100		W
9	0002		SPACE

Remarks:
PROGRAM TAPE BLOCK #44 - 45

Step	Code	Key	Comment
700	0014		F
1	0102		SHIFT DN
2	0306		Z
3	0209		1
4	0112		A
5	0212		C
6	0207		T
7	0413	END A	
8	0701	1	
9	0702	2	
210	0404	ST DIR	
1	0000	R.00	REG CNTR
2	0104		
3	0412	WRITE A	
4	0108		CR/LF
5	0110		LF
6	0413	END A	
7	0405	RE DIR	
8	0010	R.10	T F21-OUT
9	0404	ST DIR	
220	0002	R.02	T F21-OUT
1	0704	4	
2	0706	6	
3	0404	ST DIR	
4	0000	R.00	BLK CNTR
5	0407	SEARCH	
6	0001	01	
7	0408	MARK	
8	0100		
9	0410	GROUP 2	
230	0003	03	EXT CORE
1	0415	RE Y	
2	0007	R.07	DATA BLK
3	0701	1	
4	0709	9	
5	0703	3	
6	0706	6	
7	0802		TRANSFER
8	0415	RE Y	
9	0006	R.06	REG CNTR
240	0405	RE DIR	
1	0004	R.04	DATA
2	0504	ST INDIR	
3	0701	1	
4	0400	+ DIR	
5	0006	R.06	REG CNTR
6	0511	RETURN	
7	0408	MARK	
8	0101		
9	0415	RE Y	

Step	Code	Key	Comment
250	0004	R.04	T F21
1	0405	RE DIR	
2	0004	R.04	T F21
3	0713	x^2	
4	0602	X	
5	0701	1	
6	0704	4	
7	0704	4	
8	0708	8	
9	0703	3	
260	0707	7	
1	0704	4	
2	0705	5	
3	0702	2	
4	0702	2	
5	0708	8	
6	0702	2	
7	0710	SET EXP	
8	0711	CHS SGN	
9	0706	6	
270	0602	X	
1	0414	ST Y	
2	0005	R.05	H F21
3	0405	RE DIR	
4	0004	R.04	T F21
5	0713	x^2	
6	0604	↑	
7	0701	1	
8	0700	0	
9	0708	8	
280	0706	6	
1	0707	7	
2	0700	0	
3	0704	4	
4	0708	8	
5	0703	3	
6	0700	0	
7	0700	0	
8	0709	9	
9	0710	SET EXP	
290	0711	CHS SGN	
1	0703	3	
2	0602	X	
3	0605	↓	
4	0400	+ DIR	
5	0005	R.05	H F21
6	0415	RE Y	
7	0004	R.04	T F21
8	0712	.	
9	0702	2	

Remarks: PROGRAM TAPE BLOCK #44 - 45

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0703	3		350	0710	SET EXP	
1	0704	4		1	0711	CHS SGN	
2	0708	8		2	0705	S	
3	0708	8		3	0602	X	
4	0708	8		4	0414	ST Y	
5	0705	S		5	0004	R.04	T F21
6	0705	S		6	0405	RE DIR	
7	0705	S		7	0005	R.05	H F21
8	0701	1		8	0713	x²	
9	0700	0		9	0604	↑	
310	0705	S		360	0709	9	
1	0602	X		1	0704	4	
2	0605	↓		2	0704	4	
3	0400	+ DIR		3	0709	9	
4	0005	R.05	H F21	4	0700	0	
5	0709	9		5	0703	3	
6	0712	.		6	0702	2	
7	0704	4		7	0702	2	
8	0705	5		8	0704	4	
9	0706	6		9	0705	S	
320	0704	4		370	0707	7	
1	0701	1		1	0710	SET EXP	
2	0707	7		2	0711	CHS SGN	
3	0700	0		3	0702	2	
4	0709	9		4	0602	X	
5	0702	2		5	0605	↓	
6	0703	3		6	0401	- DIR	
7	0400	+ DIR		7	0004	R.04	T F21
8	0005	R.05	H F21	8	0415	RE Y	
9	0511	RETURN		9	0005	R.05	H F21
330	0408	MARK		380	0704	4	
1	0102			1	0712	.	
2	0415	RE Y		2	0704	4	
3	0005	R.05	H F21	3	0704	4	
4	0405	RE DIR		4	0703	3	
5	0005	R.05	H F21	5	0703	3	
6	0713	x²		6	0709	9	
7	0602	X		7	0703	3	
8	0709	9		8	0703	3	
9	0704	4		9	0705	S	
340	0705	S		390	0707	7	
1	0703	3		1	0707	7	
2	0706	6		2	0705	S	
3	0709	9		3	0602	X	
4	0703	3		4	0605	↓	
5	0700	0		5	0400	+ DIR	
6	0706	6		6	0004	R.04	T F21
7	0703	3		7	0704	4	
8	0704	4		8	0701	1	
9	0708	8		9	0712	.	

Remarks:

PROGRAM TAPE BLOCK #44 - 45

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0702	2		450	0701	1	
1	0700	0		1	0704	4	
2	0707	7		2	0700	0	
3	0703	3		3	0702	2	
4	0703	3		4	0707	7	
5	0704	4		5	0710	SET EXP	
6	0706	6		6	0711	CHS SGN	
7	0700	0		7	0704	4	
8	0703	3		8	0602	X	
9	0401	− DIR		9	0605	↓	
410	0004	R. 04	T F21	460	0400	+ DIR	
1	0511	RETURN		1	0006	R. 06	P F21
2	0408	MARK		2	0415	RE Y	
3	0103			3	0004	R. 04	T F21
4	0415	RE Y		4	0708	8	
5	0004	R. 04	T F21	5	0704	4	
6	0405	RE DIR		6	0701	1	
7	0004	R. 04	T F21	7	0708	8	
8	0713	x^2		8	0704	4	
9	0602	X		9	0701	1	
420	0711	CHS SGN		470	0704	4	
1	0702	2		1	0709	9	
2	0701	1		2	0702	2	
3	0701	1		3	0708	8	
4	0702	2		4	0706	6	
5	0704	4		5	0701	1	
6	0707	7		6	0710	SET EXP	
7	0700	0		7	0711	CHS SGN	
8	0708	8		8	0701	1	
9	0709	9		9	0602	X	
430	0706	6		480	0605	↓	
1	0708	8		1	0401	− DIR	
2	0706	6		2	0006	R. 06	P F21
3	0710	SET EXP		3	0709	9	
4	0711	CHS SGN		4	0701	1	
5	0706	6		5	0712	.	
6	0602	X		6	0704	4	
7	0414	ST Y		7	0708	8	
8	0006	R. 06	P F21	8	0706	6	
9	0405	RE DIR		9	0706	6	
440	0004	R. 04	T F21	490	0706	6	
1	0713	x^2		1	0706	6	
2	0604	↑		2	0706	6	
3	0703	3		3	0706	6	
4	0702	2		4	0708	8	
5	0707	7		5	0708	8	
6	0707	7		6	0400	+ DIR	
7	0709	9		7	0006	R. 06	P F21
8	0707	7		8	0511	RETURN	
9	0702	2		9	0408	MARK	

Remarks:
PROGRAM TAPE BLOCK #44 − 45

Step	Code	Key	Comment	Step	Code	Key	Comment
500	0104						
1	0412	WRITE A					
2	0102		SHIFT DN				
3	0002		SPACE				
4	0006		=				
5	0413	END A					
6	0415	RE Y					
7	0000	K. 00	REG CNTR				
8	0505	RE INDIR					
9	0411	WRITE					
510	0502		DP-S.2				
1	0411	WRITE					
2	1503		3 SPACES				
3	0511	RETURN					

Remarks:

PROGRAM TAPE BLOCK #44 - 45

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0704	4	
				1	0707	7	
				2	0806		TRANSFER
				3	0708	8	
				4	0404	ST DIR	
				5	0006	K.06	REG CNTR
				6	0701	1	
				7	0703	3	
				8	0707	7	
				9	0706	6	
				60	0404	ST DIR	
				1	0007	K.07	DATA BLK
				2	0100		
				3	0703	3	
				4	0702	2	
				5	0700	0	
				6	0400	+ DIR	
				7	0007	K.07	DATA BLK
				8	0100		
				9	0702	2	
				70	0708	8	
				1	0708	8	
				2	0400	+ DIR	
				3	0007	K.07	DATA BLK
				4	0100		
				5	0701	1	
				6	0702	2	
				7	0708	8	
				8	0400	+ DIR	
				9	0007	K.07	DATA BLK
				80	0100		
				1	0405	RE DIR	
				2	0008	K.08	Q FCELL
				3	0412	WRITE A	SKIP IF
				4	0611	LOG e X	X=0
5	0408	mARK		5	0407	SEARCH	
6	0003	03		6	0004	04	
7	0410	GROUP 2		7	0404	ST DIR	
8	0001	01	PROG TAPE	8	0013	K.13	WXp FZ1
9	0415	RE Y		9	0404	ST DIR	
40	0000	K.00	BLK CNTR	90	0014	K.14	WXp FCL
1	0701	1		1	0404	ST DIR	
2	0600	+		2	0015	K.15	T FCL-OUT
3	0702	2		3	0404	ST DIR	
4	0709	9		4	0106	K.16	T FCL-IN
5	0701	1		5	0405	RE DIR	
6	0806		TRANSFER	6	0002	K.02	T FZ1-IN
7	0701	1		7	0404	ST DIR	
8	0600	+		8	0012	K.12	T FZ1-OUT
9	0705	5		9	0407	SEARCH	

Remarks: PROGRAM TAPE BLOCK #46 - 48

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0005	05		150	0603	÷	
1	0408	MARK		1	0414	ST Y	
2	0004	04		2	0013	R.13	WX₀ FZ1
3	0405	RE DIR		3	0405	RE DIR	
4	0003	R.03	W FZ1	4	0009	R.09	WX₀ FCL
5	0404	ST DIR		5	0603	÷	
6	0107	R.17	W FZ1-EFF	6	0701	1	
7	0415	RE Y		7	0601	−	
8	0011	R.11	# FCELL	8	0412	WRITE A	SKIP IF
9	0701	1		9	0411	WRITE	Y=0
110	0509	SKIP IF Y=X		160	0407	SEARCH	
1	0407	SEARCH		1	0007	07	
2	0006	06		2	0415	RE Y	
3	0702	2		3	0008	R.08	Q FCELL
4	0604	↑		4	0405	RE DIR	
5	0703	3		5	0010	R.10	UA FCLHX
6	0603	÷		6	0603	÷	
7	0605	↓		7	0405	RE DIR	
8	0402	X DIR		8	0002	R.02	T FZ1-IN
9	0010	R.10	UA FCLHX	9	0600	+	
120	0402	X DIR		170	0414	ST Y	
1	0107	R.17	W FZ1-EFF	1	0015	R.15	T FCL-o
2	0408	MARK		2	0407	SEARCH	
3	0006	06		3	0008	08	
4	0405	RE DIR		4	0408	MARK	
5	0011	R.11	# FCELL	5	0007	07	
6	0402	X DIR		6	0405	RE DIR	
7	0009	R.09	WX₀ FCL	7	0009	R.09	WX₀ FCL
8	0405	RE DIR		8	0615	1/X	
9	0002	R.02	T FZ1-IN	9	0604	↑	
130	0404	ST DIR		180	0405	RE DIR	
1	0004	R.04	T FZ1	1	0013	R.13	WX₀ FZ1
2	0101			2	0615	1/X	
3	0415	RE Y		3	0601	−	
4	0008	R.08	Q FCELL	4	0405	RE DIR	
5	0405	RE DIR		5	0008	R.08	Q FCELL
6	0107	R.17	W FZ1-EFF	6	0606	↓↑	
7	0603	÷		7	0602	X	
8	0605	↓		8	0414	ST Y	
9	0400	+ DIR		9	0007	R.07	C₁
140	0005	R.05	H FZ1	190	0415	RE Y	
1	0102			1	0010	R.10	UA FCLH
2	0415	RE Y		2	0602	X	
3	0004	R.04	T FZ1-OUT	3	0605	↓	
4	0405	RE DIR		4	0614	c^X	
5	0002	R.02	T FZ1-IN	5	0604	↑	
6	0601	−		6	0701	1	
7	0405	RE DIR		7	0606	↓↑	
8	0008	R.08	Q FCELL	8	0601	−	
9	0606	↓↑		9	0414	ST Y	

Remarks: PROGRAM TAPE BLOCK #46 − 48

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0015	K.15	C_2	250	0002		SPACE
1	0405	RE DIR		1	0212		C
2	0002	K.02	T F21-IN	2	0205		E
3	0602	X		3	0209		L
4	0405	RE DIR		4	0209		L
5	0007	K.07	C_1	5	0002		SPACE
6	0601	-		6	0201		H
7	0405	RE DIR		7	0205		E
8	0015	K.15	C_2	8	0112		A
9	0603	÷		9	0207		T
210	0414	ST Y		260	0002		SPACE
1	0015	K.15	T FCL-OUT	1	0205		E
2	0408	MARK		2	0215		X
3	0008	08		3	0212		C
4	0405	RE DIR		4	0201		H
5	0002	K.02	T F21-IN	5	0112		A
6	0404	ST DIR		6	0206		N
7	0004	K.04	T F21	7	0015		G
8	0101			8	0205		E
9	0415	RE Y		9	0113		R
220	0008	K.08	Q FCELL	270	0108		CR/LF
1	0405	RE DIR		1	0207		T
2	0003	K.03	W F21	2	0002		SPACE
3	0603	÷		3	0014		F
4	0605	↓		4	0102		SHIFT DN
5	0400	+ DIR		5	0306		2
6	0005	K.05	H F21	6	0209		1
7	0102			7	0104		1
8	0405	RE DIR		8	0206		N
9	0004	K.04	T F21	9	0002		SPACE
230	0404	ST DIR		280	0413	END A	
1	0012	K.12	T F21-OUT	1	0707	2	
2	0415	RE Y		2	0404	ST DIR	
3	0008	K.08	Q FCELL	3	0000	K.00	REG CNTR
4	0405	RE DIR		4	0103		
5	0009	K.09	WCP FCL	5	0412	WRITE A	
6	0603	÷		6	0103		SHIFT UP
7	0405	RE DIR		7	0207		T
8	0015	K.15	T FCL-OUT	8	0002		SPACE
9	0600	+		9	0014		F
240	0414	ST Y		290	0102		SHIFT DN
1	0106	K.16	T FCL-IN	1	0306		2
2	0408	MARK		2	0209		1
3	0005	05		3	0109		0
4	0412	WRITE A		4	0214		U
5	0103		SHIFT UP	5	0207		T
6	0014		F	6	0413	END A	
7	0214		U	7	0701	1	
8	0205		E	8	0707	2	
9	0209		L	9	0404	ST DIR	

Remarks: PROGRAM TAPE BLOCK #46 - 48

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0000	K.00	REG CNTR	350	0413	END A	
1	0103			1	0701	1	
2	0412	WRITE A		2	0705	5	
3	0103		SHIFT UP	3	0404	ST DIR	
4	0100		W	4	0000	K.00	REG CNTR
5	0212		C	5	0103		
6	0102		SHIFT DN	6	0412	WRITE A	
7	0005		P	7	0103		SHIFT UP
8	0002		SPACE	8	0100		W
9	0103		SHIFT UP	9	0212		C
310	0014		F	360	0102		SHIFT DN
1	0102		SHIFT DN	1	0005		P
2	0306		Z	2	0002		SPACE
3	0209		L	3	0103		SHIFT UP
4	0002		SPACE	4	0014		F
5	0413	END A		5	0212		C
6	0701	1		6	0209		L
7	0703	3		7	0002		SPACE
8	0404	ST DIR		8	0413	END A	
9	0000	K.00	REG CNTR	9	0709	9	
320	0103			370	0404	ST DIR	
1	0412	WRITE A		1	0000	K.00	REG CNTR
2	0103		SHIFT UP	2	0103		
3	0207		T	3	0412	WRITE A	
4	0002		SPACE	4	0108		CR/LF
5	0014		F	5	0110		LF
6	0212		C	6	0413	END A	
7	0209		L	7	0405	RE DIR	
8	0102		SHIFT DN	8	0012	K.12	T FZ1-ON
9	0104		I	9	0404	ST DIR	
330	0206		N	380	0002	K.02	T FZ1-ON
1	0002		SPACE	1	0704	4	
2	0413	END A		2	0709	9	
3	0701	1		3	0404	ST DIR	
4	0706	6		4	0000	K.00	BLK CNT
5	0404	ST DIR		5	0407	SEARCH	
6	0000	K.00	REG CNTR	6	0001	01	
7	0103			7	0408	MARK	
8	0412	WRITE A		8	0100		
9	0108		CR/LF	9	0410	GROUP 2	
340	0103		SHIFT UP	390	0003	03	EXT CORE
1	0207		T	1	0415	KEY Y	
2	0002		SPACE	2	0007	K.07	DATA BL
3	0014		F	3	0701	1	
4	0212		C	4	0709	9	
5	0209		L	5	0703	3	
6	0102		SHIFT DN	6	0706	6	
7	0109		O	7	0802		TRANSFER
8	0214		U	8	0415	KEY Y	
9	0207		T	9	0006	K.06	REG CNTR

Remarks: PROGRAM TAPE BLOCK #46 - 48

Step	Code	Key	Comment	Step	Code	Key	Comment
00	0405	RE DIR		450	0711	CHS SGN	
1	0004	R.04	DATA	1	0703	3	
2	0504	ST INDIR		2	0602	X	
3	0701	1		3	0605	↓	
4	0400	+ DIR		4	0400	+ DIR	
5	0006	R.06	REG CNTR	5	0005	R.05	H FZ1
6	0511	RETURN		6	0415	RE Y	
7	0408	MARK		7	0004	R.04	T FZ1
8	0101			8	0712	.	
9	0415	RE Y		9	0702	2	
10	0004	R.04	T FZ1	460	0703	3	
1	0405	RE DIR		1	0704	4	
2	0004	R.04	T FZ1	2	0708	8	
3	0713	x^2		3	0708	8	
4	0602	X		4	0708	8	
5	0701	1		5	0705	5	
6	0704	4		6	0705	5	
7	0704	4		7	0705	5	
8	0708	8		8	0701	1	
9	0703	3		9	0700	0	
20	0707	7		470	0705	5	
1	0704	4		1	0602	X	
2	0705	5		2	0605	↓	
3	0702	2		3	0400	+ DIR	
4	0702	2		4	0005	R.05	H FZ1
5	0708	8		5	0709	9	
6	0702	2		6	0712	.	
7	0710	SET EXP		7	0704	4	
8	0711	CHS SGN		8	0705	5	
9	0706	6		9	0706	6	
30	0602	X		480	0704	4	
1	0414	ST Y		1	0701	1	
2	0005	R.05	H FZ1	2	0707	7	
3	0405	RE DIR		3	0700	0	
4	0004	R.04	T FZ1	4	0709	9	
5	0713	x^2		5	0702	2	
6	0604	↑		6	0703	3	
7	0701	1		7	0400	+ DIR	
8	0700	0		8	0005	R.05	H FZ1
9	0708	8		9	0511	RETURN	
40	0706	6		490	0408	MARK	
1	0707	7		1	0102		
2	0700	0		2	0415	RE Y	
3	0704	4		3	0005	R.05	H FZ1
4	0708	8		4	0405	RE DIR	
5	0703	3		5	0005	R.05	H FZ1
6	0700	0		6	0713	x^2	
7	0700	0		7	0602	X	
8	0709	9		8	0709	9	
9	0710	SET EXP		9	0704	4	

Remarks: PROGRAM TAPE BLOCK #46 - 48

Step	Code	Key	Comment	Step	Code	Key	Comment
500	0705	S		550	0707	7	
1	0703	3		1	0707	7	
2	0706	6		2	0705	S	
3	0709	9		3	0602	X	
4	0703	3		4	0605	↓	
5	0700	0		5	0400	+ DIR	
6	0706	6		6	0004	R.04	T FZI
7	0703	3		7	0704	4	
8	0704	4		8	0701	1	
9	0708	8		9	0712	.	
510	0710	SET EXP		560	0702	2	
1	0711	CHS SGN		1	0700	0	
2	0705	S		2	0707	7	
3	0602	X		3	0703	3	
4	0414	ST Y		4	0703	3	
5	0004	R.04	T FZI	5	0704	4	
6	0405	RE DIR		6	0706	6	
7	0005	R.05	H FZI	7	0700	0	
8	0713	X²		8	0703	3	
9	0604	↑		9	0401	- DIR	
520	0709	9		570	0004	R.04	T FZI
1	0704	4		1	0511	RETURN	
2	0704	4		2	0408	MARK	
3	0709	9		3	0103		
4	0700	0		4	0412	WRITE A	
5	0703	3		5	0102		SHIFT DN
6	0702	2		6	0002		SPACE
7	0702	2		7	0006		=
8	0704	4		8	0413	END A	
9	0705	S		9	0415	RE Y	
530	0707	7		580	0000	R.00	REG CNTR
1	0710	SET EXP		1	0505	RE LINE	
2	0711	CHS SGN		2	0411	WRITE	
3	0702	2		3	0502		DP-5.2
4	0602	X		4	0411	WRITE	
5	0605	↓		5	1503		3 SPACES
6	0401	- DIR		6	0511	RETURN	
7	0004	R.04	T FZI				
8	0415	RE Y					
9	0005	R.05	H FZI				
540	0704	4					
1	0712	.					
2	0704	4					
3	0704	4					
4	0703	3					
5	0703	3					
6	0709	9					
7	0703	3					
8	0703	3					
9	0705	S					

Remarks:

PROGRAM TAPE BLOCK #46 - 48

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0704	4	
				1	0707	7	
				2	0806		TRANSFER
				3	070B	B	
				4	0404	ST DIR	
				5	0006	K.06	REG CNTR
				6	0701	1	
				7	0704	4	
				8	0700	0	
				9	070B	B	
				60	0404	ST DIR	
				1	0007	K.07	DATA BLK
				2	0100		
				3	0703	3	
				4	0702	2	
				5	0700	0	
				6	0400	+ DIR	
				7	0007	K.07	DATA BLK
				8	0100		
				9	0702	2	
				70	070B	B	
				1	070B	B	
				2	0400	+ DIR	
				3	0007	K.07	DATA BLK
				4	0100		
				5	0405	RE DIR	
				6	0008	K.08	Q HYDHX
				7	0412	WRITE A	SKIP IF
				8	0611	LOG eX	X=0
				9	0407	SEARCH	
				80	0004	04	
				1	0404	ST DIR	
				2	0013	K.13	WGP FZI
				3	0404	ST DIR	
				4	0014	K.14	T HYD-IN
				5	0404	ST DIR	
				6	0015	K.15	T HYD-OUT
				7	0405	RE DIR	
				8	0002	K.02	T FZI-IN
				9	0404	ST DIR	
5	040B	mARK		90	0012	K.12	T FZI-OUT
6	0003	03		1	0407	SEARCH	
7	0410	GROUP 2		2	0005	OS	
8	0001	01	PROG TAPE	3	040B	mARK	
9	0415	RE Y		4	0004	04	
40	0000	K.00	BLK CNTR	5	0405	RE DIR	
1	0701	1		6	0002	K.02	T FZI-IN
2	0600	+		7	0404	ST DIR	
3	0702	2		8	0004	K.04	T FZI
4	0709	9		9	0101		
5	0701	1					
6	0806		TRANSFER				
7	0701	1					
8	0600	+					
9	0705	5					

Remarks: PROGRAM TAPE BLOCK #49 - 51

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0415	RE Y		150	0603	÷	
1	0008	R.08	Q HYDHX	1	0405	RE DIR	
2	0405	RE DIR		2	0002	R.02	T FZ1-IN
3	0003	R.03	W FZ1	3	0606	↓↑	
4	0603	÷		4	0601	-	
5	0605	↓		5	0405	RE DIR	
6	0401	- DIR		6	0012	R.12	T FZ1-OUT
7	0005	R.05	H FZ1	7	0601	-	
8	0102			8	0405	RE DIR	
9	0415	RE Y		9	0010	R.10	UA HYDHX
110	0002	R.02	T FZ1-IN	160	0602	X	
1	0405	RE DIR		1	0405	RE DIR	
2	0004	R.04	T FZ1	2	0008	R.08	Q HYDHX
3	0404	ST DIR		3	0603	÷	
4	0012	R.12	T FZ1-OUT	4	0605	↓	
5	0601	-		5	0614	e^x	
6	0405	RE DIR		6	0404	ST DIR	
7	0008	R.08	Q HYDHX	7	0007	R.07	C_1
8	0606	↓↑		8	0604	↓	
9	0603	÷		9	0701	1	
120	0414	ST Y		170	0601	-	
1	0013	R.13	WCp FZ1	1	0414	ST Y	
2	0405	RE DIR		2	0014	R.14	C_2
3	0009	R.09	WCp HYD	3	0405	RE DIR	
4	0603	÷		4	0012	R.12	T FZ1-OUT
5	0701	1		5	0402	X DIR	
6	0601	-		6	0007	R.07	C_1
7	0412	WRITE A	SKIP IF	7	0415	RE Y	
8	0411	WRITE	Y=0	8	0008	R.08	Q HYDHX
9	0407	SEARCH		9	0405	RE DIR	
130	0006	06		180	0009	R.09	WXp HYD
1	0415	RE Y		1	0603	÷	
2	0008	R.08	Q HYDHX	2	0405	RE DIR	
3	0405	RE DIR		3	0002	R.02	T FZ1-IN
4	0010	R.10	UA HYDHX	4	0601	-	
5	0603	÷		5	0405	RE DIR	
6	0405	RE DIR		6	0007	R.07	C_1
7	0012	R.12	T FZ1-OUT	7	0600	+	
8	0606	↓↑		8	0405	RE DIR	
9	0601	-		9	0014	R.14	C_2
140	0414	ST Y		190	0603	÷	
1	0014	R.14	T HYD-IN	1	0414	ST Y	
2	0407	SEARCH		2	0014	R.14	T HYD-IN
3	0007	07		3	0408	MARK	
4	0408	MARK		4	0007	07	
5	0006	06		5	0415	RE Y	
6	0415	RE Y		6	0008	R.08	Q HYDHX
7	0008	R.08	Q HYDHX	7	0405	RE DIR	
8	0405	RE DIR		8	0009	R.09	WCp HYD
9	0009	R.09	WCp HYD	9	0603	÷	

Remarks: PROGRAM TAPE BLOCK #49 - 51

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0405	RE DIR		250	0103		SHIFT UP
1	0014	R.14	T HYD-IN	1	0207		T
2	0600	+		2	0002		SPACE
3	0414	ST Y		3	0014		F
4	0015	R.15	T HYD-OUT	4	0102		SHIFT DN
5	0408	MARK		5	0306		Z
6	6005	OS		6	0209		\
7	0412	WRITE A		7	0109		O
8	0103		SHIFT UP	8	0214		U
9	0201		H	9	0207		T
210	0001		Y	260	0413	END A	
1	0213		D	1	0701	1	
2	0113		R	2	0702	2	
3	0112		A	3	0404	ST DIR	
4	0214		U	4	0000	R.00	REG CNTR
5	0209		L	5	0103		
6	0104		I	6	0412	WRITE A	
7	0212		C	7	0103		SHIFT UP
8	0101		S	8	0100		W
9	0002		SPACE	9	0212		C
220	0201		H	270	0102		SHIFT DN
1	0205		E	1	0005		P
2	0112		A	2	0002		SPACE
3	0207		T	3	0103		SHIFT UP
4	0002		SPACE	4	0014		F
5	0205		E	5	0102		SHIFT DN
6	0215		X	6	0306		Z
7	0212		C	7	0209		\
8	0201		H	8	0002		SPACE
9	0112		A	9	0413	END A	
230	0206		N	280	0701	1	
1	0015		G	1	0703	3	
2	0205		E	2	0404	ST DIR	
3	0113		R	3	0000	R.00	REG CNTR
4	0108		CR/LF	4	0103		
5	0207		T	5	0412	WRITE A	
6	0002		SPACE	6	0103		SHIFT UP
7	0014		F	7	0207		T
8	0102		SHIFT DN	8	0002		SPACE
9	0306		Z	9	0201		H
240	0209		\	290	0001		Y
1	0104		\	1	0213		D
2	0206		N	2	0102		SHIFT DN
3	0002		SPACE	3	0104		\
4	0413	END A		4	0206		N
5	0702	2		5	0002		SPACE
6	0404	ST DIR		6	0413	END A	
7	0000	R.00	REG CNTR	7	0701	1	
8	0103			8	0704	4	
9	0412	WRITE A		9	0404	ST DIR	

Remarks: PROGRAM TAPE BLOCK #49 - 51

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0000	R.00	REG CNTR	350	0701	1	
1	0103			1	0400	+ DIR	
2	0412	WRITE A		2	0006	R.06	REG CNTR
3	010B		CR/LF	3	0511	RETURN	
4	0103		SHIFT UP	4	0408	MARK	
5	0207		T	5	0101		
6	0002		SPACE	6	0415	RE Y	
7	0201		H	7	0004	R.04	T F21
8	0001		Y	8	0405	RE DIR	
9	0213		D	9	0004	R.04	T F21
310	0102		SHIFT DN	360	0713	x^2	
1	0109		O	1	0602	X	
2	0214		U	2	0701	1	
3	0207		T	3	0704	4	
4	0413	END A		4	0704	4	
5	0701	1		5	0708	8	
6	0705	5		6	0703	3	
7	0404	ST DIR		7	0707	7	
8	0000	R.00	REG CNTR	8	0704	4	
9	0103			9	0705	5	
320	0412	WRITE A		370	0702	2	
1	010B		CR/LF	1	0702	2	
2	0110		LF	2	0708	8	
3	0413	END A		3	0702	2	
4	0405	RE DIR		4	0710	SET EXP	
5	0012	R.12	T F21-OUT	5	0711	CHS SGN	
6	0404	ST DIR		6	0706	6	
7	0002	R.02	T F21-OUT	7	0602	X	
8	0705	5		8	0414	ST Y	
9	0702	2		9	0005	R.05	H F21
330	0404	ST DIR		380	0405	RE DIR	
1	0000	R.00	BLK CNTR	1	0004	R.04	T F21
2	0407	SEARCH		2	0713	x^2	
3	0001	01		3	0604	↑	
4	0408	MARK		4	0701	1	
5	0100			5	0700	0	
6	0410	GROUP 2		6	0708	8	
7	0003	03	EXT CORE	7	0706	6	
8	0415	RE Y		8	0707	7	
9	0007	R.07	DATA BLK	9	0700	0	
340	0701	1		390	0704	4	
1	0709	9		1	0708	8	
2	0703	3		2	0703	3	
3	0706	6		3	0700	0	
4	0B02		TRANSFER	4	0700	0	
5	0415	RE Y		5	0709	9	
6	0006	R.06	REG CNTR	6	0710	SET EXP	
7	0405	RE DIR		7	0711	CHS SGN	
8	0004	R.04	DATA	8	0703	3	
9	0504	ST INDIR		9	0602	X	

Remarks:

PROGRAM TAPE BLOCK #49 - 51

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0605	↓		450	0709	9	
1	0400	+ DIR		1	0703	3	
2	0005	R 0S	H F21	2	0700	0	
3	0415	KE Y		3	0706	6	
4	0004	R.04	T F21	4	0703	3	
5	0712	.		5	0704	4	
6	0702	2		6	0708	B	
7	0703	3		7	0710	SET EXP	
8	0704	4		8	0711	CHS SGN	
9	0708	8		9	0705	5	
410	0708	8		460	0602	X	
1	0708	8		1	0414	ST Y	
2	0705	5		2	0004	R.04	T F21
3	0705	5		3	0405	RE DIR	
4	0705	5		4	0005	R 0S	H F21
5	0701	1		5	0713	X^2	
6	0700	0		6	0604	↑	
7	0705	5		7	0709	9	
8	0602	X		8	0704	4	
9	0605	↓		9	0704	4	
420	0400	+ DIR		470	0709	9	
1	0005	R 0S	H F21	1	0700	0	
2	0709	9		2	0703	3	
3	0712	.		3	0702	2	
4	0704	4		4	0702	2	
5	0705	5		5	0704	4	
6	0706	6		6	0705	5	
7	0704	4		7	0707	7	
8	0701	1		8	0710	SET EXP	
9	0707	7		9	0711	CHS SGN	
430	0700	0		480	0702	2	
1	0709	9		1	0602	X	
2	0702	2		2	0605	↓	
3	0703	3		3	0401	- DIR	
4	0400	+ DIR		4	0004	R.04	T F21
5	0005	R 0S	H F21	5	0415	KE Y	
6	0511	RETURN		6	0005	R.0S	H F21
7	040B	MARK		7	0704	4	
8	0102			8	0712	.	
9	0415	KE Y		9	0704	4	
440	0005	R 0S	H F21	490	0704	4	
1	0405	R DIR		1	0703	3	
2	0005	R.0S	H F21	2	0703	3	
3	0713	X^2		3	0709	9	
4	0602	X		4	0703	3	
5	0709	9		5	0703	3	
6	0704	4		6	0705	5	
7	0705	5		7	0707	7	
8	0703	3		8	0707	7	
9	0706	6		9	0705	5	

Remarks: PROGRAM TAPE BLOCK #49 - 51

Step	Code	Key	Comment	Step	Code	Key	Comment
500	0602	X					
1	0605	↓					
2	0400	+ DIR					
3	0004	R 04	T F21				
4	0704	4					
5	0701	1					
6	0712	-					
7	0702	2					
8	0700	0					
9	0707	7					
510	0703	3					
1	0703	3					
2	0704	4					
3	0706	6					
4	0700	0					
5	0703	3					
6	0401	- DIR					
7	0004	R 04	T F21				
8	0511	RETURN					
9	0408	MARK					
520	0103						
1	0412	WRITE A					
2	0102		SHIFT DN				
3	0002		SPACE				
4	0006		=				
5	0413	END A					
6	0415	RE Y					
7	0000	R 00	REG CNTR				
8	0505	RE INDIR					
9	0411	WRITE					
530	0502		DP - S.2				
1	0411	WRITE					
2	1503		3 SPACES				
3	0511	RETURN					

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0006	K.06	REG CNTR
				1	0702	2	
				2	0701	1	
				3	0704	4	
				4	0704	4	
				5	0404	ST DIR	
				6	0007	K.07	DATA BLK
				7	0100		
				8	0708	8	
				9	0404	ST DIR	
				60	0006	K.06	REG CNTR
				1	0702	2	
				2	0702	2	
				3	0700	0	
				4	0708	8	
				5	0404	ST DIR	
				6	0007	K.07	DATA BLK
				7	0100		
				8	0405	RE DIR	
				9	0008	K.08	Q ENVIRN
				70	0412	WRITE A	SKIP IF
				1	0611	LOG eX	X=0
				2	0407	SEARCH	
				3	0004	04	
				4	0404	ST DIR	
				5	0010	K.10	WCp F21
				6	0405	RE DIR	
				7	0002	K.02	T F21-IN
				8	0404	ST DIR	
				9	0009	K.09	T F21-OUT
				80	0407	SEARCH	
				1	0005	05	
				2	0408	mARK	
				3	0004	04	
				4	0405	RE DIR	
5	0408	mARK		5	0002	K.02	T F21-IN
6	0003	03		6	0404	ST DIR	
7	0410	GROUP 2		7	0004	K.04	T F21
8	0001	01	PROG TAPE	8	0101		
9	0415	KEY		9	0415	KEY	
40	0000	K.00	BLK CNTR	90	0008	K.08	Q ENVIRN
1	0701	1		1	0405	RE DIR	
2	0600	+		2	0003	K.03	W F21
3	0702	2		3	0603	÷	
4	0709	9		4	0005		
5	0701	1		5	0400	+ DIR	
6	0806		TRANSFER	6	0005	K.05	H F21
7	0701	1		7	0102		
8	0705	5		8	0405	RE DIR	
9	0404	ST DIR		9	0004	K.04	T F21

Remarks: PROGRAM TAPE BLOCK #52 - 53

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0404	ST DIR		150	0109		O
1	0009	R.09	T F21-OUT	1	0112		A
2	0415	RE Y		2	0213		D
3	0002	R 02	T F21-IN	3	010B		CR/LF
4	0606	↓↑		4	0207		T
5	0601	-		5	0002		SPACE
6	0405	RE DIR		6	0014		F
7	000B	R 0B	R ENVIRN	7	0102		SHIFT DN
8	0606	↓↑		8	0306		Z
9	0603	÷		9	0209		1
110	0605	↓		160	0104		1
1	0607	1x1		1	0206		N
2	0404	ST DIR		2	0002		SPACE
3	0010	R.10	W@ F21	3	0413	END A	
4	040B	mARK		4	0702	Z	
5	0005	0S		5	0404	ST DIR	
6	0412	WRITE A		6	0000	R.00	REG CNTR
7	0103		SHIFT UP	7	0103		
8	0014		F	8	0412	WRITE A	
9	0102		SHIFT DN	9	0103		SHIFT UP
120	0306		Z	170	0207		T
1	0209		1	1	0002		SPACE
2	0002		SPACE	2	0014		F
3	0103		SHIFT UP	3	0102		SHIFT DN
4	0212		C	4	0306		Z
5	0109		O	5	0209		1
6	0109		O	6	0109		O
7	0209		L	7	0214		V
8	0112		A	8	0207		T
9	0206		N	9	0413	END A	
130	0207		T	180	0709	9	
1	0002		SPACE	1	0404	ST DIR	
2	0209		L	2	0000	R.00	REG CNTR
3	0109		O	3	0103		
4	0109		O	4	0412	WRITE A	
5	0005		P	5	0103		SHIFT UP
6	0002		SPACE	6	0100		W
7	0205		E	7	0212		C
8	0206		N	8	0102		SHIFT DN
9	0114		V	9	0005		P
140	0104		I	190	0002		SPACE
1	0113		R	1	0103		SHIFT UP
2	0109		O	2	0014		F
3	0206		N	3	0102		SHIFT DN
4	0115		m	4	0306		Z
5	0205		E	5	0209		1
6	0206		N	6	0002		SPACE
7	0207		T	7	0413	END A	
8	0002		SPACE	8	0701	1	
9	0209		L	9	0700	O	

Remarks: PROGRAM TAPE BLOCK #52 - 53

Step	Code	Key	Comment	Step	Code	Key	Comment
200	0404	ST DIR		250	0602	X	
1	0000	R.00	REG CNTR	1	0701	1	
2	0103			2	0704	4	
3	0412	WRITE A		3	0704	4	
4	0108		CR/LF	4	0708	8	
5	0110		LF	5	0703	3	
6	0413	END A		6	0707	7	
7	0405	RE DIR		7	0704	4	
8	0009	R.09	T F21-OUT	8	0705	5	
9	0404	ST DIR		9	0702	2	
210	0002	R.02	T F21-OUT	260	0702	2	
1	0415	RE Y		1	0708	8	
2	0015	R.15	KY SINK	2	0702	2	
3	0703	3		3	0710	SET EXP	
4	0509	SKIP IF Y=X		4	0711	CHS SGN	
5	0407	SEARCH		5	0706	6	
6	0000	00		6	0602	X	
7	0705	S		7	0414	ST Y	
8	0704	4		8	0005	R.05	H F21
9	0404	ST DIR		9	0405	RE DIR	
220	0000	R.00	BLK CNTR	270	0004	R.04	T F21
1	0407	SEARCH		1	0713	X^2	
2	0001	01		2	0604	↑	
3	0408	MARK		3	0701	1	
4	0100			4	0700	0	
5	0410	GROUP 2		5	0708	8	
6	0003	03	EXT CORE	6	0706	6	
7	0415	RE Y		7	0707	7	
8	0007	R.07	DATA BLK	8	0700	0	
9	0701	1		9	0704	4	
230	0709	9		280	0708	8	
1	0703	3		1	0703	3	
2	0706	6		2	0700	0	
3	0802		TRANSFER	3	0700	0	
4	0415	RE Y		4	0709	9	
5	0006	R.06	REG CNTR	5	0710	SET EXP	
6	0405	RE DIR		6	0711	CHS SGN	
7	0004	R.04	DATA	7	0703	3	
8	0504	ST INDIR		8	0602	X	
9	0701	1		9	0605	↓	
240	0400	+ DIR		290	0400	+ DIR	
1	0006	R.06	REG CNTR	1	0005	R.05	H F21
2	0511	RETURN		2	0415	RE Y	
3	0408	MARK		3	0004	R.04	T F21
4	0101			4	0712	.	
5	0415	RE Y		5	0702	2	
6	0004	R.04	T F21	6	0703	3	
7	0405	RE DIR		7	0704	4	
8	0004	R.04	TF21	8	0708	8	
9	0713	X^2		9	0708	8	

Remarks: PROGRAM TAPE BLOCK #52 - 53

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0708	8		350	0414	ST Y	
1	0705	S		1	0004	R.04	T F21
2	0705	S		2	0405	RE DIR	
3	0705	S		3	0005	R.05	H F21
4	0701	1		4	0713	x^2	
5	0700	0		5	0604	↑	
6	0705	S		6	0709	9	
7	0602	X		7	0704	4	
8	0605	↓		8	0704	4	
9	0400	+ DIR		9	0709	9	
310	0005	R.05	H F21	360	0700	0	
1	0709	9		1	0703	3	
2	0712	.		2	0702	2	
3	0704	4		3	0702	2	
4	0705	S		4	0704	4	
5	0706	6		5	0705	S	
6	0704	4		6	0707	7	
7	0701	1		7	0710	SET EXP	
8	0707	7		8	0711	CHS SGN	
9	0700	0		9	0702	2	
320	0709	9		370	0602	X	
1	0702	2		1	0605	↓	
2	0703	3		2	0401	- DIR	
3	0400	+ DIR		3	0004	R.04	T F21
4	0005	R.05	H F21	4	0415	RE Y	
5	0511	RETURN		5	0005	R.05	H F21
6	0408	MARK		6	0704	4	
7	0102			7	0712	.	
8	0415	RE Y		8	0704	4	
9	0005	R.05	H F21	9	0704	4	
330	0405	RE DIR		380	0703	3	
1	0005	R.05	H F21	1	0703	3	
2	0713	x^2		2	0709	9	
3	0602	X		3	0703	3	
4	0709	9		4	0703	3	
5	0704	4		5	0705	S	
6	0705	S		6	0707	7	
7	0703	3		7	0707	7	
8	0706	6		8	0705	S	
9	0709	9		9	0602	X	
340	0703	3		390	0605	↓	
1	0700	0		1	0400	+ DIR	
2	0706	6		2	0004	R.04	T F21
3	0703	3		3	0704	4	
4	0704	4		4	0701	1	
5	0708	8		5	0712	.	
6	0710	SET EXP		6	0702	2	
7	0711	CHS SGN		7	0700	0	
8	0705	S		8	0707	7	
9	0602	X		9	0703	3	

Remarks:

PROGRAM TAPE BLOCK #52 - 53

Step	Code	Key	Comment	Step	Code	Key	Comment
400	0703	3					
1	0704	4					
2	0706	6					
3	0700	0					
4	0703	3					
5	0401	– DIR					
6	0004	K. 04	T F21				
7	0511	RETURN					
8	0408	MARK					
9	0103						
410	0412	WRITE A					
1	0102		SHIFT ON				
2	0002		SPACE				
3	0006		=				
4	0413	END A					
5	0415	RE Y					
6	0000	K. 00	REG CNTR				
7	0505	RE INDIR					
8	0411	WRITE					
9	0502		DP-5.2				
420	0411	WRITE					
1	1503		3 SPACES				
2	0511	RETURN					

Remarks: PROGRAM TAPE BLOCK #52 – 53

Step	Code	Key	Comment	Step	Code	Key	Comment
				50	0701	1	
				1	0704	4	
				2	0704	4	
				3	0700	0	
				4	0404	ST DIR	
				5	0007	R.07	DATA BLK
				6	0100		
				7	0405	RE DIR	
				8	0008	R.08	Q O2HTR
				9	0412	WRITE A	SKIP IF
				60	0611	LOG eX	X=0
				1	0407	SEARCH	
				2	0004	04	
				3	0404	ST DIR	
				4	0010	R.10	WXP FZ1
				5	0405	RE DIR	
				6	0002	R.02	T FZ1-IN
				7	0404	ST DIR	
				8	0009	R.09	T FZ1-OUT
				9	0407	SEARCH	
				70	0005	05	
				1	0408	mARK	
				2	0004	04	
				3	0405	RE DIR	
				4	0002	R.02	T FZ1-IN
				5	0404	ST DIR	
				6	0004	R.04	T FZ1
				7	0101		
				8	0415	RE Y	
				9	0008	R.08	Q O2HTR
				80	0405	RE DIR	
				1	0003	R.03	W FZ1
				2	0603	÷	
				3	0605	↓	
				4	0401	– DIR	
5	0408	mARK		5	0005	R.05	H FZ1
6	0003	03		6	0102		
7	0410	GROUP 2		7	0405	RE DIR	
8	0001	01	PROG TAPE	8	0004	R.04	T FZ1
9	0415	RE Y		9	0404	ST DIR	
40	0000	R.00	BLK CNTR	90	0009	R.09	T FZ1-OUT
1	0701	1		1	0415	RE Y	
2	0600	+		2	0002	R.02	T FZ1-IN
3	0702	2		3	0601	–	
4	0709	9		4	0405	RE DIR	
5	0701	1		5	0008	R.08	Q O2HTR
6	0806		TRANSFER	6	0606	↓↑	
7	0708	8		7	0603	÷	
8	0404	ST DIR		8	0414	ST Y	
9	0006	R.06	REG CNTR	9	0010	R.10	WXP FZ1

Remarks: PROGRAM TAPE BLOCK #54 - 55
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment	Step	Code	Key	Comment
100	0408	MARK		150	0102		SHIFT DN
1	0005	05		1	0306		Z
2	0412	WRITE A		2	0209		1
3	0103		SHIFT UP	3	0109		O
4	0109		O	4	0214		U
5	0102		SHIFT DN	5	0207		T
6	0306		Z	6	0413	END A	
7	0002		SPACE	7	0709	9	
8	0103		SHIFT UP	8	0404	ST DIR	
9	0113		R	9	0000	R.00	REG CNTR
110	0205		E	160	0103		
1	0101		S	1	0412	WRITE A	
2	0207		T	2	0103		SHIFT UP
3	0113		R	3	0100		W
4	0104		I	4	0212		C
5	0212		C	5	0102		SHIFT DN
6	0207		T	6	0005		P
7	0109		O	7	0002		SPACE
8	0113		R	8	0103		SHIFT UP
9	0002		SPACE	9	0014		F
120	0102		SHIFT DN	170	0102		SHIFT DN
1	0009		/	1	0306		Z
2	0002		SPACE	2	0209		1
3	0103		SHIFT UP	3	0002		SPACE
4	0201		H	4	0413	END A	
5	0205		E	5	0701	1	
6	0112		A	6	0700	O	
7	0207		T	7	0404	ST DIR	
8	0205		E	8	0000	R.00	REG CNTR
9	0113		R	9	0103		
130	0108		CR/LF	180	0412	WRITE A	
1	0207		T	1	0108		CR/LF
2	0002		SPACE	2	0110		LF
3	0014		F	3	0413	END A	
4	0102		SHIFT DN	4	0405	RE DIR	
5	0306		Z	5	0009	R.09	T F21-OUT
6	0209		1	6	0404	ST DIR	
7	0104		1	7	0002	R.02	T F21-OUT
8	0206		N	8	0407	SEARCH	
9	0002		SPACE	9	0000	00	
140	0413	END A		190	0408	MARK	
1	0702	Z		1	0100		
2	0404	ST DIR		2	0410	GROUP 2	
3	0000	R.00	REG CNTR	3	0003	03	EXT CORE
4	0103			4	0415	KE Y	
5	0412	WRITE A		5	0007	R.07	DATA BLK
6	0103		SHIFT UP	6	0701	1	
7	0207		T	7	0709	9	
8	0002		SPACE	8	0703	3	
9	0014		F	9	0706	6	

Remarks: PROGRAM TAPE BLOCK #54 - 55
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment
200	0802		TRANSFER
1	0415	RE Y	
2	0006	R.06	REG CNTR
3	0405	RE DIR	
4	0004	R.04	DATA
5	0504	ST INDIR	
6	0701	1	
7	0400	+ DIR	
8	0006	R.06	REG CNTR
9	0511	RETURN	
210	0408	MARK	
1	0101		
2	0415	RE Y	
3	0004	R.04	T F21
4	0405	RE DIR	
5	0004	R.04	T F21
6	0713	X^2	
7	0602	X	
8	0701	1	
9	0704	4	
220	0704	4	
1	0708	8	
2	0703	3	
3	0707	7	
4	0704	4	
5	0705	S	
6	0702	2	
7	0702	2	
8	0708	8	
9	0702	2	
230	0710	SET EXP	
1	0711	CHS SGN	
2	0706	6	
3	0602	X	
4	0414	ST Y	
5	0005	R.05	H F21
6	0405	RE DIR	
7	0004	R.04	T F21
8	0713	X^2	
9	0604	↑	
240	0701	1	
1	0700	0	
2	0708	8	
3	0706	6	
4	0707	7	
5	0700	0	
6	0704	4	
7	0708	8	
8	0703	3	
9	0700	0	

Step	Code	Key	Comment
250	0700	0	
1	0709	9	
2	0710	SET EXP	
3	0711	CHS SGN	
4	0703	3	
5	0602	X	
6	0605	↓	
7	0400	+ DIR	
8	0005	R.05	H F21
9	0415	RE Y	
260	0004	R.04	T F21
1	0712	.	
2	0702	2	
3	0703	3	
4	0704	4	
5	0708	8	
6	0708	8	
7	0708	8	
8	0705	S	
9	0705	S	
270	0705	S	
1	0701	1	
2	0700	0	
3	0705	S	
4	0602	X	
5	0605	↓	
6	0400	+ DIR	
7	0005	R.05	H F21
8	0709	9	
9	0712	.	
280	0704	4	
1	0705	S	
2	0706	6	
3	0704	4	
4	0701	1	
5	0707	7	
6	0700	0	
7	0709	9	
8	0702	2	
9	0703	3	
290	0400	+ DIR	
1	0005	R.05	H F21
2	0511	RETURN	
3	0408	MARK	
4	0102		
5	0415	RE Y	
6	0005	R.05	H F21
7	0405	RE DIR	
8	0005	R.05	H F21
9	0713	X^2	

Remarks: PROGRAM TAPE BLOCK #54 - 55
USED WITH SUBLIMATOR HEAT SINK

Step	Code	Key	Comment	Step	Code	Key	Comment
300	0602	X		350	0703	3	
1	0709	9		1	0703	3	
2	0704	4		2	0705	S	
3	0705	S		3	0707	7	
4	0703	3		4	0707	7	
5	0706	6		5	0705	S	
6	0709	9		6	0602	X	
7	0703	3		7	0605	↓	
8	0700	0		8	0400	+ DIR	
9	0706	6		9	0004	R.04	T FZI
310	0703	3		360	0704	4	
1	0704	4		1	0701	1	
2	0708	8		2	0712	.	
3	0710	SET EXP		3	0702	2	
4	0711	CHS SGN		4	0700	0	
5	0705	S		5	0707	7	
6	0602	X		6	0703	3	
7	0414	ST Y		7	0703	3	
8	0004	R.04	T FZI	8	0704	4	
9	0405	RE DIR		9	0706	6	
320	0005	R.05	H FZI	370	0700	0	
1	0713	X^2		1	0703	3	
2	0604	↑		2	0401	- DIR	
3	0709	9		3	0004	R.04	T FZI
4	0704	4		4	0511	RETURN	
5	0704	4		5	0408	MARK	
6	0709	9		6	0103		
7	0700	0		7	0412	WRITE A	
8	0703	3		8	0102		SHIFT DN
9	0702	2		9	0002		SPACE
330	0702	2		380	0006		=
1	0704	4		1	0413	END A	
2	0705	S		2	0415	RE Y	
3	0707	7		3	0200	R.00	REG CNTR
4	0710	SET EXP		4	0505	RE INDIR	
5	0711	CHS SGN		5	0411	WRITE	
6	0702	2		6	0502		DP-S.2
7	0602	X		7	0411	WRITE	
8	0605	↓		8	1503		3 SPACES
9	0401	- DIR		9	0511	RETURN	
340	0004	R.04	T FZI				
1	0415	RE Y					
2	0005	R.05	H FZI				
3	0704	4					
4	0712	.					
5	0704	4					
6	0704	4					
7	0703	3					
8	0703	3					
9	0709	9					

Remarks:
PROGRAM TAPE BLOCK #54 - 55
USED WITH SUBLIMATOR HEAT SINK