Title:

MTT 015

LMSC-D673325

Program User's manual - ^{NOTICE} cryogen system for the analysis for the

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Mirror Fusion Test Facility

UCRL--15059

DE84 013498

ABSTRACT

The Mirror Fusion Test Facility being designed and constructed at the Lawrence Livermore Laboratory requires a liquid helium liquefaction, storage, distribution, and recovery system and a liquid nitrogen storage and distribution system. To provide a powerful analytical tool to aid in the design evolution of this system through hardware, a thermodynamic fluid flow model was developed. This model allows the Lawrence Livermore Laboratory to verify that the design meets desired goals and to play "what if?" games during the design evolution. For example, what if the helium flow rate is changed in the magnet liquid helium flow loop; how does this affect the temperature, fluid quality, and pressure?

This manual provides all the information required to run all or portions of this program as desired. In addition, the program is constructed in a modular fashion so changes or modifications can be made easily to keep up with the evolving design.

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MASTER

FOREWORD

This Program Users Manual, LMSC-D673325, and the Final Report, LMSC-D673326 (under separate cover) were prepared for the Lawrence Livermore Laboratory (LLL), University of California, under Purchase Order No. 1025609. Mr. W. H. Sterbentz and R. L. Nelson of LLL were Technical Monitors for the program.

The Lockheed Palo Alto Research Laboratory conducted the program within the Thermophysics Group of the Materials Sciences Laboratory. R. T. Parmley was Program Manager. Key individuals who contributed to the success of this program and their contributions are as follows:

- o R. F. Hausman - Developed the program for the liquid helium distribution system and prepared the Program Users Manual.
- o L. G. Naes - Developed the program for the liquid nitrogen and helium gas recovery systems and analyzed in detail the recuperator used in the helium recovery system.

Information concerning detailed use of the program is provided in the Program Users Manual. A complete description of the cryogen systems that were modeled and the mathematical basis for the models are given in the Final Report.

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Section 1

INTRODUCTION

A Mirror Fusion Test Facility (MFTF) is being constructed at the Lawrence Livermore Laboratory of the University of California. This facility is one of a number of projects being funded by the Department of Energy to demonstrate fusion power as a potential commercial energy source by the end of this century. The large electromagnet system located within a high-vacuum chamber is required to confine the energetically charged plasma necessary to achieve the extremely high temperatures needed for fusion. To dramatically reduce power requirements for the electromagnet, the magnet temperature must be reduced to the superconducting range, ~ 4.35 K.

In addition, cryopanel at both liquid helium and liquid nitrogen temperatures are required as cryopumps to maintain the desired low vacuum pressure during fusion operation. Consequently, a cryogen liquefaction, storage and distribution system is required to support the test facility. This supply can be subdivided into three subsystems.

- (1) The liquid helium liquefaction, storage, and distribution system
- (2) The gaseous helium recovery systems (used during cooldown, warmup, and emergency magnet quench conditions)
- (3) The liquid nitrogen storage and distribution system

To ensure the cryogen system can maintain the temperatures required plus meet other engineering specifications such as heat rates, pressures, and fluid quality, a thermodynamic fluid flow computer model was developed. This program provides a powerful analytical tool for rapid analysis of the design and variations on the design as it evolves to the hardware stage.

This Program Users Manual provides all the necessary information required to use this program. A complete description of the cryogen systems being analyzed is found in the Final Report.

1.1 PROGRAM DESCRIPTION

The MFTF Cryogenic Systems Analysis Program is a flexible, broadly applicable systems parametric analysis tool. The program will effectively accommodate systems of considerable complexity involving large numbers of performance dependent variables such as are found in large-scale magnetic fusion test systems. Basically, the program logic structure pursues an orderly progression path through any given system in much the same fashion as is employed for manual systems analysis.

The system configuration schematic is converted to an alpha-numeric formatted configuration data table input starting with the cryogen supply source and identifying all components, such as lines, fittings, valves, etc., and ending with the fluid return connection. Then, for each of the constituent component assemblies, superconducting magnet assemblies, cryopanel, refrigerator-liquefiers, etc., the performance requirements are assembled in input data tabulations. Systems operating constraints and duty cycle definitions are further added as input data coded to the configuration operating sequence. Characteristic performance data over the range of temperatures, pressures, and flow rates of interest for each of the functional component assemblies, is input to the program or table lookup data arrays to be called as need in the analysis sequences. The use of table lookup data combined with closed-form solution analysis, where needed, permits the rapid computation of the desired parameters as the analysis proceeds through the system configuration.

The program permits system analysis to either single or multiple sets of operating demands and constraints, and, produces as output, the required component and system sizing information and computed performance values necessary for tradeoff studies. Data output in report-type format is easily accommodated into the program structure.

The intended purpose of the program is to provide an analytical tool which permits rapid parametric evaluation of cryogenics applications programs and

systems currently under study in the national energy program. The mathematical techniques built into the program provides the capability for in-depth analysis (combined with rapid problem solution) for the production of a larger quantity of soundly based trade-study data than normally would be obtained in hand calculations. Program flexibility in accommodating advanced systems resides in its modular type programming which permits program growth with simple addition of new subroutines and the addition of variables to existing common banks. Conversely, the program is easily dismantled if it is desired to limit analysis to only one or two systems and utilize a smaller computing machine.

In summary, the purpose of the program may be said to be that of providing an improved general analysis tool for cryogen technology applications.

1.2 PROGRAM STRUCTURE

The MFTF Cryogenic Systems Analysis Program consists essentially of three major sections as illustrated in Fig. 1. Within each of the major sections, the structure is further broken into block subsections, each of which is reserved for specific functions of data management, data utilization, or analytical data display.

1.2.1 Program Input Data Logic

Of necessity, the program accommodates large data banks capable of providing characteristic performance data for the wide variety of component assemblies found in typical cryogen systems.

Program data requirements are divided into two types. The first type consists of the "semi-permanent" data tables which the program employs to compute performance, strength properties, and other characteristics, as a function of up to four variables per data table.

PROGRAM INPUT

SYSTEM(S) CONFIGURATION
 INPUT PARAMETERS
 TABLE DATA BANK (FUNCTIONAL PROPERTIES DATA)
 PROGRAM OPTIONS (INPUT/OUTPUT CONTROL)
 PROGRAM INSTRUCTIONS (COMPUTATION OPTIONS)

PROGRAM COMPUTATION

MASS TRANSFER - ENERGY REQUIREMENTS - FLUID
 STATE DETERMINATION - THERMODYNAMIC PROCESSES -
 RESIDUALS - FLUID FLOW COMPUTATIONS - HEAT TRANSFER -
 SIZING CALCULATIONS - CUMULATIVE PARAMETER STORAGE
 - FOR -

CRYOGEN FLUIDS - LINES - FITTINGS - VALVES - MAGNETS -
 CRYOPANELS - REGULATORS - REFRIGERATOR-LIQUIFIERS -
 TANKS - COMPRESSOR-PURIFIERS - HEAT EXCHANGERS -
 RECUPERATORS - PRESSURIZATION PROCESSES - CONTROLS

PROGRAM OUTPUT

OUTPUT FORMAT - HARD COPY
 - PLOT COPY
 - TAPE GENERATION
 PARAMETRIC RECYCLE - DATA RETRIEVAL

Fig. 1 Major Program Structure

The table data bank contains the necessary component performance characterization data for the system configurations to be considered, as well as specialized cryogen properties data and required material properties data.

The "source data," as obtained, is verified as being authoritative, and is then processed into a formatted tabular array which specifies the table name, ID codes, the dependent variables, and the independent variables - in order of use. The tabulated array data are carefully ordered such that curve-fitting routines can extrapolate data points with good accuracy and speed. The prepared data array is punched into data card decks and verified for correctness. All data tables are logged as to reference, source, date of data acquisition, and pertinent data limitations such as range of application, etc.

Since a large volume of table data can be required by the program, a unique data management set of subroutines is employed to retrieve any particular table and extract the required information with remarkably high speed and accuracy.

The MFTF*CSA program currently contains six tables, and will accommodate up to fifty tables for a total of 7000 words.

The second type of input data is "variable" and contains the variable input parameters which may be perturbed for parametric system studies. These data include duty cycle characteristics, configuration description, and operational requirements of the system being studied. The variable input values are printed out just prior to the system computed data output as a means of input verification.

1.2.2 Program Computation Logic

For the MFTF*CSA program to accommodate the possible range of cryogenic systems likely to be considered and perform as a general systems analysis tool, the following three premises are established:

- (1) Any logical combination of supply tanks, lines, fittings, valves, regulators, heat exchangers, superconducting magnets, cryopanel, and "cryogen-consumer" components can be specified as a system configuration point.
- (2) The "cryogen-consumer" component may be any of the components being supplied with cryogenic fluids.
- (3) An integrated cryogenic system may contain a number of similar and/or different cryogen subsystems to be fed from a common cryogen supply source.

Although these premises appear to force the generation of a very large program, an examination of a number of individual cryogen system concepts reveals a marked similarity and commonality of components by kind.

There are less than 25 kinds of major component assemblies to be considered. Additionally, the temperatures, pressures, and flow rates are for the most part within reasonable range spans, thus further reducing the quantity of data to be manipulated.

1.3 PROGRAM DATA STORAGE

The program makes use of a number of defined ~~COMMON~~ storage blocks in order to provide for the relatively large amount of data input, storage and transfer which occurs in the various subprograms. These ~~COMMON~~ blocks are defined only once in FORTRAN PROCEDURE DEFINITION PROCESSORS (PDP's) and thereafter are transferred to any using subprogram by the use of the FORTRAN INCLUDE statement. The form of the FORTRAN procedure employed is described in the following paragraph.

The @PDP statement calls the Procedure Definition Processor, which is used to create or change procedure elements. Procedure elements (macros) are symbolic elements, which can augment the text of a source language program. The end of each procedure is delimited by "END," which must begin in column 2, and any

number of procedures can be defined in an element. FORTRAN V procedure elements are brought into the text by means of the INCLUDE statement (the general form of which is, INCLUDE n, LIST, where "n" is the name of a PROC created by a Procedure Definition Processor). The option clause (,LIST) will, if entered, cause the included statements to be listed whenever the source program is listed. A typical example of the FORTRAN PDPs employed in the program is presented in Table 1.

Table 1

TYPICAL FORTRAN PROCEDURE DEFINITION PROCESSOR

```
#PDP.FL      CCNTRL
PDP-9B LMSC42 12/11/78 18:16:15

PE0001      CCNTRL= PROC
0002        C
0003          PARAMETER NBRSY=4, NBRSR=4
0004        C
0005          INTEGER SCRIT,SYSNUM
0006        C
0007          COMMON /CCNTRL/                      NAMSYS(NBRSY),SCRIT,SYSNUM
0008            1,INTGSY,MDTRC(11),KSUBC(NBRSY,NBRSH),LREPT
0009        C
0010          SCRIT = 1 FOR SUB-CRITICAL
0011          SCRIT = 2 FOR SUPER-CRITICAL
0012          SYSNUM = 1, MAGNET LHE SUPPLY SYSTEM
0013          SYSNUM = 2, CRYOPANEL LHE SUPPLY SYSTEM
0014          SYSNUM = 3, GHE RECOVERY SYSTEM
0015          SYSNUM = 4, LN2 SUPPLY SYSTEM
0016        C
0017        C
0018        C
0019          END

END PDP  ERRORS : NONE
```

The FORTRAN PDPs employed in the program will contain, usually, PARAMETER statements, declaration statements for REAL or INTEGER variable names,

COMMON definitions and labels, LOGICAL statements, DIMENSION and EQUIVALENCE statements, and, usually a set of COMMENT cards which define the variable set listed in the labeled COMMON.

1.4 PROGRAM OPERATIONAL SEQUENCE

The program capability for accommodating a number of different kinds of systems analysis derives from the use of built-in sequencing indices. The indices are stored as data statements in subroutine STQDTA, and are readily available to a programmer or knowledgeable program-user for restructuring, if necessary. The indices are used by the various system analysis subprograms to direct the analysis from one set of procedural steps to the next in a preprogrammed manner. The details of the program operational sequence for the various systems to be analyzed are explained in the following subparagraphs.

1.4.1 Program Initiation and Control

Program initiation is accomplished through the driver subroutine CØNTRL. This subroutine initializes the data storage subroutines and reads the first card of the input data deck for the user's name and program title. Following this, a call to subroutine INTAB reads in table data deck (or file) to storage. As a check on the correctness of the data table input, subroutine INTAB causes an "echo" printout of the selected table numbers to be printed for visual reference. A typical "echo" print is illustrated in Table 2. Note that the "echo" also permits verification of the number of words in any given table, thus aiding the user in troubleshooting incomplete table entries. CØNTRL then reads in the name and type of system to be evaluated. This is followed by a call to subroutine CØMPIL which reads into core the cryogen system input data deck containing the system data input, configuration sequence, and pertinent system and component parametric information.

Subroutine CØNTRL next calls subroutine MAGNET to process the calculations required for the system being considered. Completion of the required calculations causes program control to return from MAGNET to CØNTRL.

Table 2

DATA TABLE "ECHO"

TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVI)

TABLE INPUT SUMMARY

TABLE NUMBER	TITLE OF TABLE	NUMBER OF DIMENSIONS	NUMBER OF SUBTABLES	NUMBER OF WORDS
1	FTU OF 321/347 ST. STEEL	2	1	34
2	FTU OF 2219-T87 ALUM.	2	1	34
3	FTU OF 6061-T6 ALUMINUM	2	1	34
4	FTU OF INCONEL-718	2	1	34
5	FTU OF T1-6AL-4V	2	1	34
6	FTU OF 304 ST. STEEL	2	1	36

TOTAL TABLE STORAGE = 206

Subroutine CONTRL then tests to see if additional system data decks are to be read in; if so, it does and repeats the cycle; if not, CONTRL calls EXIT and terminates the run.

Abbreviated flow-charts for CONTRL and COMPIL, are presented in Figs. 2 and 3. Detailed flow-charts for major subroutines are provided in Appendix C.

1.4.2 Program Sequencing Subroutine

The mechanism for controlling the analysis sequencing is set up in Subroutine CONTRL. This subroutine performs the major branching functions of calling in the various subprograms needed for each specific system type analysis. Key variables used by CONTRL to effect this control over the analysis sequencing are SYSNUM and SCRIT. For each cryogen system (and system kind), there exists a preprogrammed set of indices stored on a data statement KSUBC (SYSNUM, I) which defines the order in which the major analytical subroutines will be called. This set of indices are used in CONTRL for sequencing purposes.

The initiation of specific system calculations occurs in Subroutine CONTRL. For any of the cryogen systems, CONTRL will obtain from labeled common

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	GASRCV	C86
	N2MAIN	C95
	LNSYST	C103
	DPCAL	C123
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	MFTF LIQUID NITROGEN SUPPLY SYSTEM	D57
	MFTF GASEOUS HELIUM RECOVERY SYSTEM	D77

Fig. 2 Flow Chart for Subroutine CONTROL
(Simplified)

Fig. 3 Flow Chart for Subroutine COMPIL
(Simplified)

CCNTRL, the values for SYSNUM and SCRIT. This permits access to the indices stored in the preprogrammed set of data statements KSUBC (SYSNUM, 1). The branching index JKM then can assume the value of each stored sequencing index in a given KSUBC data statement as CCNTRL cycles through its "i" loop. The KSUBC data statements are physically located in Subroutine STODTA and are available through labeled common CCNTRL via an INCLUDE statement.

1.5 INPUT DATA

The input data deck structure provides wide flexibility in modeling the MFTF cryogen systems, permitting the evaluation of system modification tradeoff analysis. The segments of input data to be read are generally divided into two groups: (1) input data common to all system analyses, and (2) input data specific to a given system analysis. Necessarily, a variety of read statement formats must be used and these are defined in labeled card formats given later in this discussion.

In general, a data input deck, for any system to be analyzed, will be made up of a set of card groups from the following group list:

- (1) User Identification Card (First Header Card)
- (2) Case Title Card (Second Header Card)
- (3) Table Data Echo Control Card
- (4) Add-File Card - To cause loading of "Table Data" file - or - Actual "Table Data" cards may be placed here, replacing the Add-File card
- (5) System Definition Card
- (6) MAGNET Input Data Cards
- (7) Magnet Configuration Definition Data Cards
- (8) CRYPAN Input Data Cards
- (9) Cryopanel Configuration Definition Data Cards
- (10) REFLIQ Input Data Cards
- (11) Refrigerator-Liquefier Configuration Data Cards
- (12) LIQNIT Liquid Nitrogen System Input Data Cards
- (13) GHE Helium Recovery System Input Data Cards

Cards (1), (2), and (5) are read directly by subroutine CØNTRØL. Cards (3) and (4) are read by subroutine INTAB, called by CØNTRØL. Cards (6) through (13) are read by subroutine CØMPIL, called by CØNTRØL. Cards (12) are read by subroutine N2MAIN and Cards (13) are read by subroutine DATAIN, each called by subroutine CØNTRØL.

1.5.1 Input Data - Card Definition and Description

Data definition and input card descriptions for data contained in the nine data cards groups are presented in detail in the following subsections. Card data formats are presented in section 1.2.

1.5.1.1 User I.D. and Case Title Cards

Gp(a) Card-1

The User I.D. card identifies the analyst making the program run. This card is required in every run deck. The card contains the following information:

Name, Dept., Bldg., Extension

Gp(b) - Card-1

A case title card is to be provided for every system data deck as a means of providing run identification for the system being evaluated. Seventy-two spaces are provided for the title. Short titles are to be centered in the 72 spaces.

1.5.1.2 Table Data Input Cards

Gp(c) - Card-1

This card is the Table Data Echo control card. The variables contained on the card are:

IFT, ØFT, NPRT, NPRT2

IFT = Table Data Input Drum Unit
 OFT = Table Data Output Drum Unit
 NPRT = Table Data Echo Print Control
 = 0, Print All Tables, One Table per Page
 = 1, Print No Table Output
 = 2, Print All Tables With no Page Eject - Table Dump
 NPRT2 = Control for Table Summary
 NPRT = 1 Print Brief Table Summary
 NPRT2 = 1 Print Brief Table Summary

Gp(d) - Card-1 (Normal Setup)

If the Table Data has been entered and stored as a DATA File, then the Data File may be assigned and Card-1 here will be a simple:

@ ADD,P FILNAM

where

FILNAM is the Data File mnemonic.

If the Table Data are on cards to be read in at this time, then the Gp(d) cards will be the actual table data card sets as described in detail in section 1.5.6.

Alternate Table Deck Input: (N-sets)

Gp(d) - Card-1

The Table I.D. and Control Card will contain the following information:

Title - Table Title (Description)
 ND - Number of Dimensions in Table (MAX = 7, MIN = 2)
 NC - Number of Comments Cards in Table
 IP - Plot Option
 (0 = No Plot, 1 = Plot Table)
 NT - Table Number

Gp(d) - Card-2

Table Comment Card - Gives further description of table data and data reference sources. These may be NC comment cards.

Gp(d) - Card-3

Table Subset Variable Card - Specifies additional variable and its values for Table Data Subsets.

LABV - Variable Label
 NP - Number of Values to be used (is also number of data subsets)
 TAB - Value, Value₂, ... Value_{np}

There must be (ND-2) of these cards present in Table Set. (ND = Number of dimensions in Table.)

Gp(d) Card-4

Table Plot Control Card - Contains X-axis label, Y-axis label, X-MIN value, X-MAX value. One card is required for each Table Set. (Not currently used.)

Gp(d) - Card-5

Table Data Subset Characterization Card - card contains:

NV - Number of Data Point Sets (X,Y) or Number of coefficients
 TYPE - Type of Data in Table
 = 0, Coefficients of polynomial
 = 1, Discrete data points from curve
 = 2, Equation
 NIP - Number of points to be used for data interpolation
 = NV
 = 1
 = 2, Linear Interpolation
 = 3, Parabolic or Hyperbolic Interpolation

There must be one of these cards for each data subset in the Table Set.

Gp(d) - Card-6

Table Data Card:

For discrete data there are three data sets (X,Y) per card arranged in order of increasing values of X, for NV sets of points.

Coefficients are arranged in order of power and NV coefficients are read. (For example: $C_1X^2 + C_2X + C_3 = 0$; Input as C_1, C_2, C_3 and $NV = 3$)

There are $NV/3$ discrete data cards required, or $NV/6$ coefficient data cards required.

There will be N sets of the Gp(d) table card sets, where N equals the number of Table Data sets required for the program.

1.5.1.3 System Definition Card

Gp(e) - Card-1

The system definition card provides the system identification; specifies whether the system has a subcritical or supercritical fluid supply subsystem; and, specifies whether or not additional systems are to be read in for additional case consideration. The variables which are read are:

- NSYS - First three letters of system name
- NI - Additional six alpha spaces for rest of system name
- NCRIT - First three letters of subcritical or supercritical

There must be one system definition card in each system input deck.

1.5.1.4 Primary Component Characterization Data Cards

For each of the MFTF cryogen system and subsystem fluid circuits considered, there are primary components such as magnets, cryopanel, refrigerator-liquefiers, etc., which must be characterized in terms of energy transfer into

or out of the system. The input data cards for each of these primary components provide the boundary conditions and parameters necessary to compute the steady-state operating conditions resulting for a given set of input conditions.

1.5.1.4.1 Magnet Component Data Cards. The magnet characterization data are presently input on two data cards. The variables employed are defined as follows:

Gp(f) - Card-1

PMAGDW - Magnet Dewar Pressure (kPa)
 TMAGDW - Magnet Dewar Liquid Helium Temperature (K)
 HEMWT - Molecular Weight of Helium (4.0026 Gm/Mol)
 QMAGI - Magnet Heat Load Into Helium System (J/s)
 VHEMAG - Volume of Liquid Helium in Magnet (liters)
 VHENDW - Nominal Volume of Liquid Helium in Magnet Dewar (liters)
 VHESDW - Nominal Volume of Liquid Helium in Storage Dewar (liters)

Gp(f) - Card-2

HDMAGI - Liquid Helium Head Height at Magnet Inlet (m)
 HDMAGØ - Liquid Helium Head Height at Magnet Outlet (m)
 HDMAGC - Liquid Helium Head Height at Magnet Center (m)
 NUMMAG - Number of Magnets in Assembly
 WDTLHI - Mass Flow Rate of Liquid Helium Leaving Magnet Dewar (kg/hr)
 QLKSDW - Heat Load Into Magnet Storage Dewar (J/s)
 QLEAK1 - Heat Load Into Fluid Lines ($J/s \cdot m^2$)
 QLEAK2 - Heat Load Into a Valve Assembly ($J/s \cdot m^2$)

1.5.2.4.2 Cryopanel Component Data Cards. The Cryopanel characterization data are input on three data card types. Variables are defined as follows.

Gp(g) - Card-1

- NUMCRP - The Number of Cryopanel To Be Considered
- PCRYDW - Cryopanel Liquid Helium Dewar Pressure (kPa)
- TCRYDW - Cryopanel Liquid Helium Temperature in Dewar (K)
- VHECDW - Nominal Volume of Liquid Helium in Cryopanel Dewar (liters)
- WDTLCH - Mass Flow Rate of Liquid Helium Leaving Cryopanel Dewar (kg/hr)
- HEMW - Helium Molecular Weight (4.0026 Gm/Mol)

Gp(g) - Card-2

- QCR(I) - Heat Load Into ith Cryopanel (J/s)
- VHECR(I) - Fluid Volume of ith Cryopanel (liters)
- HDCRI(I) - Liquid Helium Head Height at Inlet of ith Cryopanel (m)
- HDCRØ(I) - Liquid Helium Head Height at Outlet of ith Cryopanel (m)
- WDTCR(I) - Liquid Helium Mass Flow Rate Into ith Cryopanel (kg/hr)

There will be NUMCRP sets of Card-2.

Gp(g) - Card-3

- QLEAK1 - Heat Load per Square Meter Into Cryopanel Lines (J/s-m²)
- QLEAK2 - Heat Load per Square Meter Into Cryopanel Valves (J/s-m²)

1.5.1.4.3 Refrigerator-Liquefier Data Cards. The Refrigerator-Liquefier characterization data are input on six data cards with the variables defined as follows:

Gp(h) - Card-1

Eleven Cold-Box temperatures are input for points of interest in the Refrigerator-Liquefier subsystem:

- TCB(1) - High Pressure Helium Gas Temperature Into Cold Box - From Compressor (K)

- TCB(2) - Low Pressure Helium Gas Temperature Out of Cold Box - To Compressor (K)
- TCB(3) - High Pressure Helium Gas Temperature Out of Liquid Nitrogen Precooler (K)
- TCB(4) - Saturated Liquid Nitrogen Temperature at 1 Atm. (K)
- TCB(5) - High Pressure Helium Gas Temperature Out of Second Intermediate Heat Exchanger, and Inlet Temperature Into Warm Gas Turbine Expander (K)
- TCB(6) - Warm Gas Turbine Expander Exhaust Temperature Into Third Intermediate Heat Exchanger (K)
- TCB(7) - High Pressure Helium Gas Temperature Out of Fourth Intermediate Heat Exchanger, and Inlet Temperature to Cold Gas Turbine Expander (K)
- TCB(8) - Average Low Pressure Helium Gas Temperature Into Cold Box (K)
- TCB(9) - High Pressure Helium Gas Temperature Into Joule-Thompson Valve (K)
- TCB(10) - Joule-Thompson Valve Exhaust Fluid Temperature (K)
- TCB(11) - Cold Gas Turbine Expander Exhaust Temperature Into Fifth Intermediate Heat Exchanger (K)

Gp(h) - Card-2

Eleven Cold-Box Helium Enthalpy values are input for the corresponding temperatures and pressures at positions of interest in the Refrigerator-Liquefier subsystem (Enthalpy values are in J/Mol):

- HENTH(1) - Enthalpy at TCB(1), PCB(1)
- HENTH(2) - Enthalpy at TCB(3), PCB(1)
- HENTH(3) - Enthalpy at TCB(5), PCB(1)
- HENTH(4) - Enthalpy at TCB(7), PCB(1)
- HENTH(5) - Enthalpy at TCB(9), PCB(1)
- HENTH(6) - Enthalpy at TCB(11), PCB(2)

HENTH(7) - Enthalpy at TCB(3), PCB(2)
 HENTH(8) - Enthalpy at TCB(6), PCB(2)
 HENTH(9) - Enthalpy at TCB(11), PCB(2)
 HFENTH(10) - Enthalpy at TCB(8), PCB(2)
 HENTH(11) - Enthalpy at TCB(10), PCB(2)

Gp(h) - Card-3

Three Cold-Box pressure values are input for the steady-state pressure conditions (pressures are given in kPa):

PCB(1) - High Pressure Helium Side of Cold Box
 PCB(2) - Low Pressure Helium Side of Cold Box
 PCB(3) - Nitrogen Precooler Pressure

Gp(h) - Card-4

Five Cold-Box mass flow-rate values which characterize Refrigerator-Liquefier steady-state conditions are input as follows:

WDTCB(1) - Mass Flow Rate Into High Pressure Helium Side of Refrigerator-Liquefier Assembly
 WDTCB(2) - Mass Flow Rate of Bleed Helium Into Warm Gas Expansion Turbine
 WDTCB(3) - Mass Flow Rate of High Pressure Helium Through Intermediate Heat Exchangers 3 and 4
 WDTCB(4) - Mass Flow Rate of High Pressure Helium Through Cold Gas Expansion Turbine
 WDTCB(5) - Mass Flow Rate of High Pressure Helium to Replenish Storage Dewars

Gp(h) - Card-5 and Card-6

Ten values characterizing conditions ascribable to the Nitrogen Precooler, and the molecular weight are input on Cards 5 and 6. The variables are as defined as follows:

TN2L	-	Liquid Nitrogen Saturation Temperature at Prescribed Pressure (K)
PN2L	-	LN ₂ Pressure (kPa)
DN2L	-	LN ₂ Density at Stated T&P (kg/m ³)
HN2L	-	LN ₂ Enthalpy (J/Mol)
DN2LL	-	Saturated N ₂ Vapor Density (kg/m ³)
HN2V	-	Saturated N ₂ Vapor Enthalpy (J/m)
TN2Ø	-	Temperature of N ₂ Gas Leaving Head-End Exchanger (K)
DN2Ø	-	Enthalpy of N ₂ Gas Leaving Head-End Exchanger (kg/m ³)
HN2Ø	-	Enthalpy of N ₂ Gas at PCB(3), (J/m)
GMWTN2	-	Molecular Weight of Nitrogen
HEMWT	-	Molecular Weight of Helium

Gp(h) - Card-7

Two values characterizing the heat load on the lines and valves in the Refrigerator-Liquefier are input as follows:

ØLEAK1	-	Heat Load Into Refrigerator-Liquefier Lines (J/s-m ²)
ØLEAK2	-	Heat Load Into Refrigerator-Liquefier Valves (J/s-m ²)

1.5.1.5 System Configuration Definition Data Cards

Gp(i) - Card-1

The system configuration definition data represents the program image of the system schematic diagram. Only one (1) card format is employed which

functions as a data input card, and as a configuration table END card. The flexibility of the data format card in providing different kinds of information resides in the technique of reading the array and changing the variable name to correspond to the value entered at any point in the array. Since each data card represents a specific item, such as, fluid, component, or line segment, and their associated parameters, the data array is conveniently manageable.

The variables which are allocated to the card are as follows:

- CFUNCT - Six alpha characters which specify either the fluid, consumer assembly, or system component item, currently being considered. The allowable names are defined in DATA (FNAME) located in subroutine STØDTA, and further described in PDP-CONFIG
- CFTYPE - A single, or, two digit number which characterizes the type or kind of fluid, consumer assembly, or system component item
- CNØPER - Single digit number - for number of consumer assemblies, or component items operating in parallel; or, in the case of a fluid, the digit specifies the fluid state (i.e., 1 = gas; 2 = liquid)
- CHEAD - Change in head-height (+ or -) for specified component relative to previously entered head-height change. (Real Number - meters)
- CMTYP - Single digit number which specifies the material type for the system component item. CMTYPE values are defined in PDP-CONFIG. For fluid parameter card, CMTYPE is used for-variable GLØØP to indicate a subbranch of a major fluid circuit loop
- FRCØEF - Variable containing the friction coefficient applicable to the system component item being considered
- LØD - Length over diameter ratio, or length applicable to the system component item under consideration (Real Number)

- DIAM - Diameter (I.D. or Port) applicable to system component item being considered
- CITYPE - Integer defining insulation type employed for system component item being considered
- ITHICK - Insulation thickness (Real Number) for system component item under consideration
- NBAR - Number (Real) of insulation layers per inch of thickness for component item being considered
- CØDE - Six alpha character code name for component item under consideration (i.e., PS02, etc.)

There must be one card for; (a) each fluid and fluid state change, (b) each fluid system component items, and (c) each fluid system line segment item. A typical configuration table is illustrated in the Input Data Deck Example given in section 1.5.5. The very last card in the configuration data set must have END entered in the CFUNCT field, since this is required in subroutine COMPIL to terminate the READ loop. (It is also advisable to use card columns 73-80 to number the configuration data cards.)

1.5.1.6 Liquid Nitrogen System Data Cards

Gp(j) - Card-1

Line geometry and description for each of the six lines to be analyzed is initialized by reading the variable LINE.

- LINE - An integer specifying the line number to which all succeeding data cards correspond. A preset flag terminates data for the given line number.

Gp(j) - Card-2

Description of each line section is contained on one card. Data input for each line section is completed when a negative value for XLEN is encountered. The variables contained on the card are:

- XLEN - Geometrical line length (m). A value of zero is used for any component other than a line.
- ZIN - The elevation of the component at the flow inlet (m).
- ZOUT - The elevation of the component at the flow exit (m).
- EFF - Effective length to diameter ratio to be used in pressure drop analysis (consistent units).
- Q0,Q1,Q2 - These variables are used to compute total heat flux into each line section (QNET). Q0 is an additive constant in the expression for QNET and represents the actual heat leak for line components determined from either tests or specification. Q0 is currently set to zero for all components, except Dewar shields, magnet section cryopanel, and magnet heat shields, where specific values have been provided by L.L.L. For shielded lines only, Q1 and Q2 represent the shield diameter and length. For all other line types, Q2 is a dummy variable which is not referenced. Q1 is a constant multiplier in the geometry dependent expression for QNET. When Q0 is zero, Q1 is unity, and when Q0 is set to a real value, Q1 is set to zero.
- TYPE - A real number between 1 and 6 which specifies component type:
 - = 1, Cryogen Line
 - = 2, Elbow
 - = 3, Valve
 - = 4, Bayonet Fitting

- * 5, "T" Branch
 - = 6, Shield Line
- TNUM - Real Number referenced only when a "T" branch in a line occurs. Beyond the "T," the initial line flow is divided equally into each of TNUM branches.

Gp(j) - Card-3

This card provides the initial constraining parameter for line 1 of the nitrogen system, defined as follows:

- PSTØR - Nitrogen storage tank pressure (kPa)
- QUAL - Initial fluid quality as input to Line 1

Gp(j) - Card-4

Card 4 provides the cryogen line insulation characterization and the upper temperature boundary conditions against which computations are to be made. The parameters are defined as follows:

- RNLAYR - The number of layers of multilayer insulation to be used on cryogen lines and shields (Integer)
- THØT - Hot boundary temperature existing on outside of insulation materials (K)

Gp(j) - Card-5

Card 5 inputs the flow requirements of the open loop nitrogen system. Each flow requirement is summed with the resultant being subtracted from the initial mass flow rate at the exit of line 1. The variables are defined as follows:

- WLN14 - Flow requirement to the external vacuum system (kg/s)
- WLN16 - Flow requirement to the magnet heat exchanger (kg/s)

- WLN17 - Flow requirement to the refrigerator cold box (kg/s)
- WLN18 - Flow requirement to the helium purifier (kg/s)

Gp(j) - Card-6

Seven parameters are input on Card-5 which provide the initial mass flow rate and the six line diameters necessary for the analysis. Parameter definitions are as follows:

- FLOW - Initial mass flow rate from liquid nitrogen storage tank (kg/s)
- DIA(1) - Line -1 diameter (m)
- DIA(2) - Line -2 diameter (m)
- DIA(3) - Line -3 diameter (m)
- DIA(4) - Line -4 diameter (m)
- DIA(5) - Line -5 diameter (m)
- DIA(6) - Line -6 diameter (m)

NOTE: A negative value in FLOW is used to terminate the run if only a few of the total number of cases available are to be run.

1.5.1.7 Gaseous Helium Recovery System Data Cards

Gp(k) - Card-1

The description of each line section in the low-pressure section of the helium recovery system is contained on one card. Configuration description is completed when a negative value for COMP is encountered. The variables contained on the card are:

- RL1 - Geometrical line length (m). A value of zero is used for any component other than a line.
- RN1 - The number of elbows included in the line of length RL1.

- RLD1 - The effective L/D ratio for line sections other than line (i.e., valves)
- COMP(1,I) - A Real Number which identifies major plumbing components of a line section. The identifiers used are:
- 1 - recovery blower (low pressure line)
 - 2 - dessicant dryer tower (high pressure line)
 - 3 - filter (high pressure line)
 - 4 - purification system (high pressure line)
- A negative value terminates the reading of data for the low pressure line definition

Gp(k) - Card-2

Description of each line section in the high pressure section of the helium recovery system is contained on one card. Configuration description is completed when a negative value for COMP is encountered. The variables contained on the card are:

- RL - Geometrical line length (m). A value of zero is used for any component other than a line.
- RN - The number of elbows included in the line of length RL.
- RLD - The effective L/D ratio for line sections other than lines (i.e., valves).
- COMP(2,I) - A Real Number which identifies major plumbing components of a line section. The identifiers used are:
- 1 - recovery blower (low pressure line)
 - 2 - dessicant dryer tower (high pressure line)
 - 3 - filter (high pressure line)
 - 4 - purification system (high pressure line)
- A negative value terminates the reading of data for the high pressure line definition.

Gp(k) - Card-3

The limits for the mass flow rate $D\emptyset$ loop are described on a single data card:

MINIT	-	100 times the minimum flow rate (kg/s)
MFINAL	-	100 times the maximum flow rate (kg/s)
MSTEP	-	100 times the mass flow rate increment (kg/s)

Values input are 100 times the required value in order to allow integer input for the $D\emptyset$ loop.

Gp(k) - Card-4

The limits for the diameter $D\emptyset$ loop are described on a single data card:

IDIAM1	-	100 times the minimum line diameter (m)
IDIAM2	-	100 times the maximum line diameter (m)
ISTEP	-	100 times the diameter increment (m)

Value input are 100 times the required value in order to allow integer input for the $D\emptyset$ loop.

Gp(k) - Card-5

Description of the temperature and pressure parameter is included on a single data card:

TG	-	Gas temperature (K)
PBAG	-	Recovery gas bay pressure (kPa)
PCOMP	-	Recovery compressor exit pressure (kPa)

Up to 10 cases may be investigated per run by adding additional data cards. Fewer cases may be considered by inputting a negative gas temperature.

1.5.2 Input Data Card and Card Format Description

The input data cards which make up the program input data deck are defined by the Read statements located in Subroutines CØNTRL, INTAB, and CØMPIL. This section presents a graphic description of each input card as an aid in visualizing and arranging the individual system input data decks needed for the analytical operation of the program. Included as aids are several tables which explain and define the construction and insulation material types employed by the various subprograms. Included also as aids in program data setup are several tables which define and explain important variables that occur repeatedly. Table 3 presents the variable names employed for control, branching and switching purposes. Table 4 presents the configuration variable names and definition. Following the tables are the data sheets which present the input data card formats.

Table 3

VARIABLE NAMES EMPLOYED FOR CONTROL, BRANCHING, AND SWITCHING PURPOSES

1. System Identification: (Subroutine CØNTRL)

Variable Read	Alpha Input	Variable Equivalent	Integer Value	System Defined
NSYS	MAG	NAMSYS	1	MAGNET Cooling Circuit
NSYS	CRY	NAMSYS	2	CRYOPANEL Cooling Circuit
NSYS	REF	NAMSYS	3	Refrigerator- Liquefier Circuit
NSYS	LN2	NAMSYS	4	LIQUID NITROGEN System
NSYS	GHE	NAMSYS	5	GHE RECOVERY SYSTEM

Table 3 (Cont.)

2. Control Variables: (Subroutine CØNTRL)

Control Variable	Integer Value	Description
SYSNUM	= 1	Controls Selection of Subprograms for MAGNET
	= 2	Controls Selection of Subprograms for CRYOPANELS
	= 3	Controls Selection of Subprograms for REF-LIQ
	= 4	Controls Selection of Subprograms for LN2 System
	= 5	Controls Selection of Subprograms for GHe Recovery System

3. Branching and Switching Variables:

KSUBC - Preprogrammed Branching Variable for specified system analysis program selection - Used in subroutine CØNTRL. Defined in STØDTA.

DATA STATEMENT DEFINITION:

```

DATA (KSUBC(1, I), I = 1, NBRSR)/1, 0, 0, 0/
DATA (KSUBC(2, I), I = 1, NBRSR)/2, 0, 0, 0/
DATA (KSUBC(3, I), I = 1, NBRSR)/3, 0, 0, 0/
DATA (KSUBC(4, I), I = 1, NBRSR)/4, 0, 0, 0/
DATA (KSUBC(5, I), I = 1, NBRSR)/5, 0, 0, 0/
  
```

Table 4

CONFIGURATION VARIABLE NAMES AND DEFINITIONS

(Used by Subroutine COMPIL, and CMPCAL)

1. Defined Configuration Names:

Defined Variable	Input Alpha	Variable Equivalent	Integer Value	Component Item
CFUNCT	GAS	FNAME	1	FLUID
CFUNCT	MAGNET	FNAME	2	MAGNET
CFUNCT	LINE	FNAME	3	LINE
CFUNCT	CONTRL	FNAME	4	CONTROL
CFUNCT	FITING	FNAME	5	FITTING
CFUNCT	TAP	FNAME	6	FLUID TAP
CFUNCT	TEE	FNAME	7	TEE
CFUNCT	ELBOW	FNAME	8	ELBOW
CFUNCT	VALVE	FNAME	9	VALVE
CFUNCT	REG	FNAME	10	REGULATOR
CFUNCT	CRYPAN	FNAME	11	CRYOPANEL
CFUNCT	REFLIQ	FNAME	12	REFRIGERATOR-LIQUEFIER
CFUNCT	TANK	FNAME	13	TANK
CFUNCT	COMPUR	FNAME	14	COMPRESSOR-PURIFIER
CFUNCT	HEX	FNAME	15	HEAT EXCHANGER
CFUNCT	END	FNAME	16	END OF TABLE

Table 4 (Cont.)

2. Configuration Variable Definitions:

CONFIGURATION FUNCTION CODE AND TYPE.

CFUNCT = 1, GAS	CFTYPE = 1, Helium = 2, Nitrogen
CFUNCT = 2, MAGNET	No options
CFUNCT = 3, LINE	CFTYPE = 10 a fixed number
CFUNCT = 4, CONTROL	Uses two digit index as follows, IDV = Tens digit (10, 20, etc.) CFTYPE = Units digit (1, 2, etc.) IDV = 10 for light weight control = 20 for medium weight control = 30 for heavy weight control = 40 for extra heavy control CFTYPE = 1 for orifice = 2 for flow meter
CFUNCT = 5, FITTING	Uses two digit index as follows, LDV = Tens digit (10, 20, etc.) CFTYPE = Units digit (1, 2, etc.) LDV = 10 for use in line only = 20 for 50% reducer = 30 for 20% reducer = 40 for bayonet fitting CFTYPE = 1 for miscellaneous fitting
CFUNCT = 6, TAP	Uses two digit index as follows, LDV = Tens digit (10, 20, etc.) CFTYPE = Units digit (1, 2, etc.) LDV = 10 for use in line only = 20 for 6 x 4 x 6 R-O-TEE = 30 for 6 x 2 x 6 R-O-TEE = 40 for 2 x 2 x 2 Y-TEE CFTYPE = 1 for TAP

Table 4 (Cont.)

CFUNCT = 7, TEE	Uses two digit index as follows,
LDV =	Tens digit (10, 20, etc.)
CFTYPE =	units digit (1, 2, etc.)
LDV =	10 for use in line only
	= 20 for 4-WAY TEE
	= 30 for 3-WAY TEE
CFTYPE =	1 for TEE
CFUNCT = 8, ELBOW	Uses two digit index as follows,
LDV =	Tens digit (10, 20, etc.)
CFTYPE =	Units digit (1, 2, etc.)
LDV =	10 for use in line only
	= 20 for 45 deg elbow
	= 30 for 90 deg elbow
	= 40 for 180 deg elbow
CFTYPE =	1 for elbow
CFUNCT = 9, VALVE	Uses two digit index as follows,
IDV =	Tens digit (10, 20, etc.)
CFTYPE =	Units digit (1, 2, etc.)
IDV =	10 for use in line only
	= 20 for ball valve
	= 30 for butterfly valve
	= 40 for globe valve
	= 50 for JT valve
CFTYPE =	1 for valve
CFUNCT = 10, REGULATOR	CFTYPE = Units digit (1, 2, etc.)
	IDV = 10 for line use only
	= 20 for single stage regulator
	CFTYPE = 1 for regulator
CFUNCT = 11, CRYOPANEL	- No options
CFUNCT = 12, REFRIGERATOR-LIQUEFIER	- No options
CFUNCT = 13, TANK	- No options

Table 4 (Cont.)

CFUNCT = 14, COMPRESSOR-PURIFIER - No options

CFUNCT = 15, HEX CFTYPE = 1 for high pressure
 = 2 for low pressure

CFUNCT = 16, END No options

CMTYPE - CONFIGURATION MATERIAL TYPE

 CMTYPE = 1, 321/347 Stainless steel
 = 2, 2219-T87 Aluminum alloy
 = 3, 6061-T6 Aluminum alloy
 = 4, Inconel-718 Alloy
 = 5, Titanium TI-6AL-4V Alloy
 = 6, Type 304 Stainless steel
 = 7, CRES Vacuum jacketed line
 = 8, 2219 Vacuum jacketed line

CITYPE - CONFIGURATION INSULATION TYPE

 CITYPE = 1, Dbl alum Mylar/silk net
 2, Dbl gold Mylar/silk net
 3, Dbl alum Mylar/Tissuglas
 4, Crink dbl alum Mylar
 5, NRC-2 crinkled aluminized Mylar
 6, Superfloc
 7, Microspheres (104-135 micron)
 8, Polyurethane foam
 9, Fiberglass batting (JM)
 10, Vacuum jacket insulation

CNOPER - NUMBER OF OPERATIONAL UNITS (CFUNCT)

CNSTBY - NUMBER OF STANDBY UNITS (CFUNCT)

CONFIG - CONFIGURATION TABLE

 COLUMN 1 Contains the above 6 variables packed one per byte
 in the order they are listed from left to right in
 the word.

 COLUMN 2 Contains the flow friction coefficient.

 COLUMN 3 Contains the length of a line or the effective L/D
 for other components.

Table 4 (Cont.)

COLUMN 4	Contains the diameter of a line.
COLUMN 5	Contains the insulation thickness for a line.
COLUMN 6	Contains the number of insulation layers
COLUMN 7	Contains the ID of the component
COLUMN 8	Contains the delta head at the component position in the system.

3. Computed Variables Definitions: (LHe System)

PRES	-	Pressure at each point in the configuration (kPa)
TEMP	-	Temperature at each point in the configuration (K)
WDOTN	-	Total mass flow-rate at each configuration point (kg/hr)
WDOTL	-	Liquid mass flow-rate at each configuration point (kg/hr)
WDOTG	-	Gaseous fluid mass flow-rate at each configuration point (kg/hr)
QUAL	-	Fluid quality at applicable configuration points
DELP	-	Pressure drop at each configuration point (kPa)
VELQ	-	Fluid velocity at each configuration point (m/hr)
RDENS	-	Fluid density at each configuration point (kg/m ³)
REYNQ	-	Reynolds Number at each configuration point
CMPVOL	-	Component volume at each configuration point (m ³)
MACH	-	Mach number at applicable configuration points

4. Computed Variables Definitions: (LN₂ Distribution System)

PKPA	-	Pressure at each line configuration point (kPa)
WDOT	-	Total mass flow rate within the line (kg/s)
WDOTL	-	Liquid mass flow rate (kg/s)
WDOTV	-	Liquid mass flow rate (kg/s)
FRICT	-	Friction factor for use in kinetic pressure loss
REYN	-	Reynolds Number
VAPVEL	-	Vapor phase linear velocity (m/s)

Table 4 (Cont.)

VAPMCH	-	Mach number of vapor
QUAL1	-	Mass quality at inlet of line section
QUAL2	-	Mass quality at exit of line section
PGRAD	-	Linear pressure gradient in line sections where applicable (kPa/m)
DENS	-	Liquid/vapor mixture density (kg/m^3)
T2	-	Temperature of mixture at exit of line section (K)
QNET	-	Heat rate to line section (W)
CONMLI	-	Thermal conductivity of double-aluminized mylar over insulated lines (conversion to SI units accomplished in expression for QNET) (W/cm-K)
WLN14	-	Flow rate required for external vacuum system (kg/s)
WLN16	-	Flow rate required for magnet heat exchanger (kg/s)
WLN17	-	Flow rate required for refrigerator cold box (kg/s)
WLN19	-	Flow rate required for helium purifier (kg/s)

5. Computed Variables Definition (Gaseous Helium Recovery System):

DIA	-	Line diameter (m)
MDQT	-	Max flow rate (kg/s)
REYN	-	Reynolds Number
F	-	Friction factor for use in kinetic pressure loss
DP	-	Pressure drop incurred across the line section (kPa)
PGRAD	-	Linear pressure gradient computed for plumbing lines only (kPa/m)
RMACH	-	Mach number of the gas at the section exit plane
DEN	-	Density of gas at exit of the line section (kg/m^3)
XLD	-	Effective L/D ratio for the line section which combines L/D ratios for components with geometrical L/D

TITLE	
-------	--

CARD TYPE - G (b) CARD-1^p

CARD FUNCTION - Case Title Card

READ BY - Subroutine CONTRL

CARD FORMAT - (12A6)

NAME	DEPT	BLDG	EXT
------	------	------	-----

CARD TYPE - G (a) CARD-1^p

CARD FUNCTION - User Identification Card

READ BY - Subroutine CONTRL

CARD FORMAT (2A6, 2XA4, 3XA3, 1XA5)

Prepared by:	Date	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page	Temp.	Form.
	Date				
Checked by:	Date	Title	Model	Report No.	
	Date				
Approved by:		CASE TITLE CARD			

Prepared by:	Date	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page	Temp.	Form.
Checked by:	Date	Title	Model		
Approved by:	Date	TABLE DATA CARDS (FOR STORED TABLE FILE)	Report No.		

CARD TYPE - G_p(c) CARD-1
CARD FUNCTION - TABLE DATA ECHO CONTROL CARD
READ BY - SUBROUTINE INTAB
CARD FORMAT - (515)

1ET	OPT	NPRT	NPRT2	(BLANK)
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>				

CARD TYPE - G_p(d) CARD-1
CARD FUNCTION - TABLE DATA FILE - ADD CARD
READ BY - SUBROUTINE INTAB
CARD FORMAT - @ADD - FILE ADD COMMAND
REF. - UNIVAC-1100 MANUAL

@ADD,P FILNAM

Prepared by:	Date	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page	Temp.	Form.
Checked by:	Date	Title SYSTEM DEFINITION INPUT CARD	Model		
Approved by:	Date		Report No.		

CARD TYPE - G_p(e) CARD -1

CARD FUNCTION - SYSTEM DEFINITION CARD

READ BY - SUBROUTINE CONTRL

CARD FORMAT - (A3, A6, 3X, A3, 14X, A3)

MSYS	NI	NCRT	INTGR

- THIS IS A BLANK SPACE -

GO TO NEXT PAGE

Prepared by:	Date	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page	Temp.	Form.
Checked by:	Date		Model		
Approved by:	Date				
		Title			
		REFRIGERATOR-LIQUIFIER INPUT DATA CARDS	Report No.		

CARD TYPE - G_P(h) CARD-1

CARD FUNCTION - REFRIGERATOR-LIQUIFIER DATA CARD

READ BY - SUBROUTINE COMPILE

CARD FORMAT - (11F7.3)

TCB(1)	TCB(2)	TCB(3)	TCB(4)	TCB(5)	TCB(6)	TCB(7)	TCB(8)	TCB(9)	TCB(10)	TCB(11)

CARD TYPE - G_P(h) CARD-2

CARD FORMAT - (11F7.3)

HENTH(1)	HENTH(2)	HENTH(3)	HENTH(4)	HENTH(5)	HENTH(6)	HENTH(7)	HENTH(8)	HENTH(9)	HENTH(10)	HENTH(11)

CARD TYPE - G_P(h) CARD-3

CARD FORMAT - (3F10.4)

PCB(1)	PCB(2)	PCB(3)

Prepared by:		Date	Title		LOCKHEED MISSILES & SPACE COMPANY, INC.		Page		Temp.		Form.	
Checked by:		Date	Title		REFRIGERATOR-LIQUIFIER		Model		Report No.			
Approved by:		Date	Title		INPUT DATA CARDS (Cont'd)		Report No.					
<p>CARD TYPE - G^p (h) CARD-4</p> <p>CARD FUNCTION - REFRIGERATOR-LIQUIFIER DATA CARD</p> <p>CARD FORMAT - (5F10.2)</p>												
<p>WDTCB (1)</p> <p>WDTCB (2)</p> <p>WDTCB (3)</p> <p>WDTCB (4)</p> <p>WDTCB (5)</p>												
<p>CARD TYPE - G^p (h) CARD-5</p> <p>CARD FORMAT - (2F10.4, F10.6, F10.4, F10.6, 2F10.4)</p>												
<p>TN2L</p> <p>FN2L</p> <p>DN2L</p> <p>HN2L</p> <p>DN2LV</p> <p>HN2V</p> <p>TN2O</p>												
<p>CARD TYPE - G^p (h) CARD-6</p> <p>CARD FORMAT - (F10.6, 3F10.4)</p>												
<p>DN2O</p> <p>HN2O</p> <p>GMATIN2</p> <p>HEMMT</p>												
<p>CARD TYPE - G^p (h) CARD-7</p> <p>CARD FORMAT - (2F10.4)</p>												
<p>QLEAK1</p> <p>QLEAK2</p>												

Prepared by:	Date	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page	Temp.	Perm.
Checked by:	Date	Title CONFIGURATION DEFINITION DATA CARDS	Model		
Approved by:	Date		Report No.		

CARD TYPE - G_P(i) CARD-1

CARD FUNCTION - CONFIGURATION DATA CARD

READ BY - SUBROUTINE COME

CARD FORMAT - (A6, 14, 15, F5.0, 15, 3F5.0, 15, 2F5.0, 5X, A6)

GFUNCT	CFTYPE	CNOPER	CHEAD	CMTYPE	FRCOEF	LOD	DIAM	CITYPE	ITHICK	NBAR	CODE	
000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000
111111	111111	111111	111111	111111	111111	111111	111111	111111	111111	111111	111111	111111

CARD TYPE - G_P(i) CARD-2

CARD FUNCTION - CONFIGURATION DATA END CARD

READ BY - SUBROUTINE COMPIL

FORMAT - (A6)

END

Prepared by:	Date	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page	Temp.	Part.
Checked by:	Date		Title LIQUID NITROGEN SYSTEM INPUT DATA CARDS		
Approved by:	Date				
			Report No.		

CARD TYPE Gp(j) CARD-3

READ BY N2MAIN

CARD FORMAT FORMAT (F10.2, F10.6)

PSTOR	QUAL	
<p>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80</p>		

CARD TYPE Gp(j) CARD-4

READ BY N2MAIN

CARD FORMAT FORMAT (2F10.3)

RNLAYR	THOT	
<p>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80</p>		

RT	RN	RLD	CØMP	
----	----	-----	------	--

CARD TYPE CARD-2
READ BY DATAIN
CARD FORMAT FORMAT (4F10.3)

RL1	RN1	RLD1	CØMP	
-----	-----	------	------	--

CARD TYPE CARD-1
READ BY DATAIN
CARD FORMAT FORMAT (4F10.3)

Prepared by:	Date	GASEOUS HELIUM RECOVERY SYSTEM INPUT DATA CARDS	Report No.
Checked by:	Date		
Approved by:	Date	Model	
LOCKHEED MISSILES & SPACE COMPANY, INC.		Page Temp. Form.	

Prepared by:	Date	LOCKHEED MISSILES & SPACE COMPANY, INC.	Page	Temp.	Power
Checked by:	Date		GASEOUS HELIUM RECOVERY SYSTEM INPUT DATA CARDS		
Approved by:	Date				
			Report No.		

CARD TYPE Gp(k) CARD-3

READ BY DATAIN

CARD F0RMAT F0RMAT (3I5)

MINIT	MEIHAL	MSTEP	
<div style="border: 1px solid black; height: 10px; width: 100%;"></div>			

CARD TYPE Gp(k) CARD 4

READ BY DATAIN

CARD F0RMAT F0RMAT (3I5)

IDIAN1	IDIAN2	ISTEP	
<div style="border: 1px solid black; height: 10px; width: 100%;"></div>			

1.5.3 Example - Use of Table Data Cards

The use of a semipermanent table data and the general means of acquiring such data has been previously discussed in section 2.2.2; and graphically outlined in Fig. 3. However, the use of an actual example will serve better to illustrate, and demonstrate, the procedure to be used in setting up tables for the user's own specific applications.

The example chosen is the Ultimate Tensile Strength of Type 304 Stainless Steel for low-temperature application, utilized in Data Table 6 of the current program table set. The data is presented in graphic form in Fig. 4 and represents a typical data source obtained from study reports and texts. The Ultimate Tensile Strength (F_{tu}) is given as a function of temperature in degrees Kelvin for a variety of Type-300 stainless steels. Type 304, however, is the subject of interest.

In translating curve data to table data, the limitations of computer data array manipulation must be kept in mind. Normally, if a computed independent variable is slightly off the end of a curve, the analyst simply takes a ships curve, or straight-edge, and fits the curve to extend the graphic function. But a computer table look-up program will only see the first or last value in the curve point data array and (if programmed) state that the value currently considered is out of range for the table. This problem is avoided by extending (extrapolation) each curve in the set (both ends) to ensure that the resulting table is adequate for the data range required in the planned analysis.

Translation of the data from Table 5 into the table data card format then consists of assigning the program variable names and values in the order illustrated in Fig. 5.

Fig. 4 Yield and Tensile Strength of Several AISI 300 Series Stainless Steels

Table 5
ULTIMATE TENSILE STRENGTH - TYPE 304 STAINLESS STEEL

Temperature (K)	(R)	Stress (PSI)
4.	7.2	276,000
10.	18.	274,000
15.	27.	270,000
20.	36.	266,000
25.	45.	263,000
50.	90.	250,000
75.	135.	235,000
100.	180.	220,000
125.	225.	206,000
150.	270.	188,000
175.	315.	172,000
200.	360.	155,000
225.	405.	139,000
250.	450.	124,000
275.	495.	109,000
300.	540.	96,000

Taking the variables as they appear for each of the table cards shown in Fig. 5, the following assignments are made:

Card-1, Title Card

Title = FTU OF 304 STAINLESS STEEL
 ND = 2 (Number of variables in table)
 NC = 3 (Number of command cards)
 IP = (Blank) (Table will not be plotted)
 NT = 6 (Table I.D. number)

Prepared by:	Date:	LOCKHEED MISSILES & SPACE COMPANY, INC.				Page	Temp.	Form.
Checked by:	Date:	Title TABLE DATA INPUT CARD FORMAT Fig 5				Model		
Approved by:	Date:					Report No.		
CARD TYPE		- G _p (d) CARD-1						
CARD FUNCTION		- TABLE IDENTIFICATION AND CONTROL CARD						
TITLE (4A6)		ID (16)	NC (16)	IP (16)	NT (16)			
CARD TYPE		- G _p (d) CARD-2						
CARD FUNCTION		- TABLE COMMENT CARD						
		COMMENT (13A6,A2)						
CARD TYPE		- G _p (d) CARD-3						
CARD FUNCTION		- TABLE SUBSET VARIABLE CARD						
LABV (3A6)	NP (17)	TAB ₁ (E10.0)	TAB ₂ (E10.0)	TAB ₃ (E10.0)	TAB ₄ (E10.0)	TAB _{NP} (E10.0)		
CARD TYPE		- G _p (d) CARD-4						
CARD FUNCTION		- TABLE DATA PLOT CONTROL CARD						
LAEX (3A6)	LABY (3A6)	XMIN (E12.0)	XMAX (E12.0)					
CARD TYPE		- G _p (d) CARD-5						
CARD FUNCTION		- TABLE SUBSET DATA CARD						
IV (16)	TYPE (16)	NIP (16)						
CARD TYPE		- G _p (d) CARD-6						
CARD FUNCTION		- TABLE DATA CARD (DISCRETE DATA)						
XTAB (E12.0)	YTAB (E12.0)	XTAB (E12.0)	YTAB (E12.0)	XTAB (E12.0)	YTAB (E12.0)			

Card-2, Command Card

Four Command Cards are used (NC=3). Two cards contain description of table and source data reference, while the third card is simply used as a spare card.

Card-3, Table Subset Variable Card

This card contains the name of the third variable (when used), the number of values the variable can take on, and the values themselves.

Card-4, Table Plot Control Card

This card is used to enter the X-AXIS and Y-AXIS labels and the X value minima and maxima for plot output of table data.

LABX = Temperature (R) (X variable)
 LABY = Ult. Strength (PSI)
 XMIN = Min. Value (if used)
 XMAX = Max. Value (if used)

Card-5, Table Subset Data Card

There will be a subtable of X and Y values for each value that LABV can assume. Each subtable will have a Card 5 giving the number of X, Y sets of points in the subtable, the "type" of data, and the number of points to be used for interpolation.

NV = 16 (sixteen sets of X, Y values per table subset)
 TYPE = 1 (discrete data points from curve)
 NIP = 3 (use 3 points for interpolation since curve is somewhat parabolic)

Card-6, Table Data Card

Use 6 data cards per table-subset, entering three sets of X, Y data per card with the last card having one set of X, Y data (NV = 16).

The completed Table is illustrated in Appendix B, lines 58 through 70.

1.5.4 Use of Program Files and Data Files

In the use of the MFTF*CSA Program as an operational analysis tool, it can be quite inconvenient to have to load the entire program, data tables, and problem deck each time a run is to be made. It is therefore recommended that the program and data tables be maintained as stored files in the facility, memory, or DISC storage.

1.5.4.1 Program File

The basic Program as currently structured contains approximately 4840 source cards including the thermodynamic properties subprograms. The program therefore is usually maintained on a master tape which can be read into core. It is considerably more convenient, however, to maintain the program file in memory storage or DISC storage and simply call in the file and copy it for use in a run.

For the UNIVAC-1100 OS, the procedure in setting up a mass-storage file and using it are generally as follows.

Creating a Program File. Assume that the mnemonic MFTF*CSA is used as the program file name, then the file creation cards are as follows: (A Master Tape and Program File will be created.)

@RUN	varies with facility operating procedures	
@LID		
@DELETE,C	MFTF*CSATAPE.	Purges tape name
@DELETE,C	MFTF*CSA.	Purges file record
@ASG,UP	MFTF*CSATAPE., 16N,T	Assigns tape requirement
@ASC,UP	MFTF*CSA., F40	Assigns file on DISC
@PDP,IFL	CCNFIG	Source Deck Cards For
@FOR,IS	COMPIL, COMPIL	Entire Program
@FOR,IS	CONTRL, CONTRL	
@COPY	TPFS.,MFTF*CSA.	Copies program to cata- loged file

@COPY, GM	MFTF*CSA.,MFTF* CSATAPE.	Copies program to file tape
@FREE	MFTF*CSATAPE.	Frees tape
@FREE	MFTF*CSA.	Frees file
@FIN		Ends run

A run is made and the Program File and Program Master Tape are created and logged in the Facility Program Library. The user is now protected in the event of a system which causes the loss of the stored program file since the Master Tape is a backup file. A program listing will be found in Appendix A.

Using the Program File. The stored Program File (MFTF*CSA.) may be called in for use in the following fashion:

@RUN		
@LID		
@ASC,A	MFTF*CSA.	Assigns file
@COPY,P	MFTF*CSA.,TPFS	Copies file to user portion of core
@FREE	MFTF*CSA.	Releases stored copy of file

1.5.4.2 Combined Run Stream and Table File

Since the DATA TABLES of use to the program consist on only 71 cards, it is advantageous to include them in the program RUN STREAM. A convenient method for building a large data file containing a number of smaller data files is provided in the FILE processor. The large data file can then be conveniently EDITED from a terminal when changes are necessary.

A copy of the master original data file should be stored on tape, as well as copies of any updated files that may be of future interest. The large data file will contain, in order; the Table Data, the Magnet Characterization Data, the Magnet Circuit Configuration Data, the Cryopanel Characterization Data,

and the Refrigerator-Liquefier Characterization Data

A complete RUN STREAM data file will be found in Appendix B. The following data file skeleton will serve to illustrate the file structure:

```

@FILE,UP      MFTF-A*RUNMFTF*A      Assign FILENAME
@ASC,T        CSATAB.               Assign Table Data File
@DATA,IL      CSATAB.               Declare as DATA File
      (Table Data Deck Followed by One Blank Card)
@END                                End of DATA File
@ASC,T        CVIDATAMAG.           Assign Magnet File
@DATA, IL     CVIDATAMAG.           Declare as DATA File
      (Magnet Characterization and Configuration Cards )
@END                                End of DATA File
ASC,T        CVIDATAMCR.           Assign Ref. Liq. File
@DATA,IL     CVIDATAMCR.           Declare as DATA File
      (Cryopanel Characterization and Configuration Cards)
@END                                End of DATA File
ASC,T        CVIDATAMCR.           Assign Ref. Liq. File
@DATA,IL     CVIDATAMCR.           Declare as DATA File
      (Refrigerator-Liquefier Characterization and Configuration Cards)

@END                                End of DATA FILE
@ENDF                                End of Large DATA File

```

Using the RUNSTREAM Data File. The stored RUNSTREAM data file (MFTF-A*RUNMFTF-A.) may be called in for use by placing the following ASC card and ADD file card in the job deck as follows:

```

@RUN
@LID
@ASC,A        MFTF*CSA.             Assign Program File
@COPY,P       MFTF*CSA.,TYPFS.      Copy Program File
@FREE         MFTF*CSA.             Free Program File

```

@ASG,A	MFTF-A*RUNMFTF-A.	Assign RUNSTREAM File
@XQT	TPF\$.ABS	Execute Absolute
		Element of Program
@ADD	MFTF-A*RUNMFTF-A.	Add the RUNSTREAM
@FIN		End of File for Run

Should the user desire to run the program on a computer other than the UNIVAC-100 OS, then very probably, all control cards will have to be changed to conform to the requirements of the different system.

1.5.4.3 Altering the RUNSTREAM Data File

For the case where a group of analyses are desired and the "run-to-run" changes in the data deck are relatively few, it is advantageous to make the input deck into a data file and use change cards to alter the file when it is called in. Or, if the facility has a DEMAND system with terminals, it is possible to use the system EDITOR processor and alter the data file prior to calling it in for a run.

The use of change cards to alter the data deck is a simple procedure, however, and the original Input Deck Data file can be preserved for repeated use by creating a temporary file containing the changes. For example, it is desired to change the value of NPRT2 to zero to suppress all table output on the TABLE ECHO CONTROL CARD. This requires a zero in column 20 of the card. The new file will be temporary for one run only and for this purpose use MFTFCHG-1. as the temporary file name.

The procedure and deck setup to be used follows:

(a) Before the run XQT card, insert these cards:

@ASG,A	MFTF-A*RUNMFTF-A.
@ASG,T	MFTFCHG-1.
@DATA,L	MFTF-A*RUNMFTF-A.,MFTFCHG-1.
-76,76	

10 1 0

(b) After the XQT card, and in place of a data input deck,
insert this card:

@ADD,P MFTFCHG-1.

The program will now run using the temporary MFTFCHG-1. file, and, will list MFTFCHG-1. as a record of the temporary input data used in the run. The temporary file vanishes and the original unchanged file is still available for use.

1.6 SYSTEM CONFIGURATION INPUT DATA DESCRIPTION

The system configuration input data is literally the computer coded equivalent of the cryogen system schematic diagram, wherein each component is identified and characterized according to its function in the system. (A complete description of the cryogen system is provided in the Final Report.) Figure 6 depicts the major components, the piping, flow-paths, and necessary instrumentation for system operation and control. Using the P&ID in conjunction with scaled component drawings, scaled plant layout sketches and the system specification, it is possible to closely characterize each individual component in the system. The system configuration for each major section of the overall system is best arrived at by the construction of a simplified line drawing which includes every component in each of the applicable fluid circuits, starting with the cryogen supply source and traversing the entire fluid path to its termination. Each component is identified uniquely with a six-character code. If there are several fluid paths, or branching paths, then each circuit is treated on a separate loop. The first, or primary loop, will originate at the cryogen supply source and terminate at the overall circuit end point. Secondary circuits, or loops, will originate at the point where they branch off from the primary loop and extend only to the point at which they rejoin the primary loop. The same logic is used for other subloops if they exist in the system. Branching will only occur at a TEF (equal flow splitting) or at a TAP (unequal flow splitting).

1) PUMP ALL VALVE, PUMP & INSTRUMENTS
 2) ADV-117, 118, 119
 3) ADV-117, 118, 119

Fig. 6 Liquid Helium System Schematic

As an example, the configuration line drawing employed in setting up the Magnet Helium Supply system is illustrated in Fig. 7. For clarity, only the primary loop is labeled. The secondary loop will begin at TEE (FS-101) with Line (MS-202) and will end at TEE (FR-115) with Line (MR-213). When all components have been identified, they must then be characterized as to function, redundancy, material type, flow friction coefficient, line length (or length over diameter ratio if component is a fitting), and line diameter. Additionally, if the component position vector is such that its extremes represent a relative fluid head change, the value and sign of the head change must be given. A tabulation of components which make up the Magnet Helium Supply System primary and secondary loops is presented in Tables 6 and 7. The characterizing data provided for each component is given in the appropriate column. The function type (CFUNCT) for each item is defined in Table 4. The same logic applies to the configuration buildup for the other major segments of the cryogen system.

1.7 MAJOR PROGRAM ELEMENTS DESCRIPTION

The major program routine and subroutines of primary interest are CCTRL, COMPIL, MAGNET, CRYPAN, HEMKUP, CMPCAL, LIQNT, and GHEREC. All other supporting subroutines either provide thermodynamic data, fluid flow characterization data, table data interpolation, variable array storage, or handle specific computational functions.

The major routine and subroutines will be briefly described as to function and presented in flow-chart form for the user's detailed examination.

Subroutines LIQNT and GHEREC are essentially dummy routines which simply call the subprograms described in sections 1.8 and 1.9.

Fig. 7 Configuration Component Identification Scheme
(Magnet Circuit Loop-1)

TABLE 6
MAGNET HELIUM SUPPLY SYSTEM
(MAGNET CIRCUIT LOOP-1)

COMP NAME	COMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRL. TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-D	LINE DIAMETER
GAS	HE-LIQ	1	2	-0.00	1	-0.00000000	-0.00	-0.00
TANK	HE-SV2	0	1	-0.00	6	-0.00000000	-0.00	-0.00
LINE	MS-100	10	1	1.48	6	.70000000-02	.23	.15
TEE	FS-101	31	1	-0.00	6	.70000000-02	60.00	-0.00
LINE	MS-102	10	1	-0.00	6	.70000000-02	1.07	.15
VALVE	CV-135	31	1	-0.00	6	.70000000-02	400.00	-0.00
LINE	MS-103	10	1	-0.00	6	.70000000-02	1.00	.15
ELBOW	FS-104	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-105	10	1	2.59	6	.70000000-02	2.59	.15
ELBOW	FS-106	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-107	10	1	-0.00	6	.70000000-02	12.40	.15
ELBOW	FS-108	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-109	10	1	17.25	6	.70000000-02	17.25	.15
ELBOW	FS-110	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-111	10	1	-0.00	6	.70000000-02	.80	.15
ELBOW	FS-112	21	1	-0.00	6	.70000000-02	8.60	-0.00
LINE	MS-113	10	1	-0.00	6	.70000000-02	5.00	.15
ELBOW	FS-114	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-115	10	1	-3.00	6	.70000000-02	3.00	.15
ELBOW	FS-116	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-117	10	1	-0.00	6	.70000000-02	4.00	.15
ELBOW	FS-118	21	1	-0.00	6	.70000000-02	8.60	-0.00
LINE	MS-119	10	1	-6.64	6	.70000000-02	.90	.15
MAGNET	MAG-01	0	1	-4.24	6	.70000000-02	10.96	.15
LINE	MR-101	10	1	-6.64	6	.70000000-02	.90	.15
ELBOW	FR-102	21	1	-0.00	6	.70000000-02	8.60	-0.00
LINE	MR-103	10	1	-0.00	6	.70000000-02	4.00	.15
ELBOW	FR-104	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MR-105	10	1	-4.00	6	.70000000-02	4.00	.15
ELBOW	FR-106	21	1	-0.00	6	.70000000-02	8.60	-0.00
LINE	MR-107	10	1	-4.75	6	.70000000-02	7.27	.15
ELBOW	FR-108	21	1	-0.00	6	.70000000-02	8.60	-0.00
LINE	MR-109	10	1	-0.00	6	.70000000-02	12.40	.15
ELBOW	FR-110	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MR-111	10	1	-2.59	6	.70000000-02	2.59	.15
ELBOW	FR-112	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MR-113	10	1	-0.00	6	.70000000-02	.61	.15
VALVE	CV-145	31	1	-0.00	6	.70000000-02	400.00	-0.00
LINE	MR-114	10	1	-0.00	6	.70000000-02	1.98	.15
TEE	FR-115	31	1	-0.00	6	.70000000-02	60.00	-0.00
LINE	MR-116	10	1	-1.48	6	.70000000-02	1.52	.15
TANK	HE-SV2	0	1	-0.00	6	-0.00000000	-0.00	-0.00

NOTE: RELATIVE HEAD CHANGE, LENGTH, AND DIAMETER ARE IN METERS.

TABLE 7
MAGNET HELIUM SUPPLY SYSTEM
(MAGNET CIRCUIT LOOP-2)

COMP NAME	CJMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRL. TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-D	LINE DIAMETER
GAS	HE-LIQ	1	2	-0.00	2	-0.00000000	-0.00	-0.00
LINE	MS-202	10	1	-0.00	6	.70000000-02	1.07	.15
VALVE	CV-136	31	1	-0.00	6	.70000000-02	400.00	-0.00
LINE	MS-203	10	1	-0.00	6	.70000000-02	1.00	.15
ELBOW	FS-204	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-205	10	1	2.59	6	.70000000-02	2.59	.15
ELBOW	FS-206	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-207	10	1	-0.00	6	.70000000-02	12.40	.15
ELBOW	FS-208	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-209	10	1	17.25	6	.70000000-02	17.25	.15
ELBOW	FS-210	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-211	10	1	-0.00	6	.70000000-02	.80	.15
ELBOW	FS-212	21	1	-0.00	6	.70000000-02	8.60	-0.00
LINE	MS-213	10	1	-0.00	6	.70000000-02	5.00	.15
ELBOW	FS-214	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-215	10	1	-3.00	6	.70000000-02	3.00	.15
ELBOW	FS-216	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MS-217	10	1	-0.00	6	.70000000-02	8.30	.15
ELBOW	FS-218	21	1	-0.00	6	.70000000-02	8.60	-0.00
LINE	MS-219	10	1	-0.64	6	.70000000-02	.90	.15
MAGNET	MAG-02	0	1	-4.24	6	.70000000-02	10.96	.15
LINE	MR-200	10	1	-0.64	6	.70000000-02	.90	.15
ELBOW	FR-201	21	1	-0.00	6	.70000000-02	8.60	-0.00
LINE	MR-202	10	1	-0.00	6	.70000000-02	8.30	.15
ELBOW	FR-203	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MR-204	10	1	-4.00	6	.70000000-02	4.00	.15
ELBOW	FR-205	21	1	-0.00	6	.70000000-02	8.60	-0.00
LINE	MR-206	10	1	-4.75	6	.70000000-02	7.27	.15
ELBOW	FR-207	21	1	-0.00	6	.70000000-02	8.60	-0.00
LINE	MR-208	10	1	-0.00	6	.70000000-02	12.40	.15
ELBOW	FR-209	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MR-210	10	1	-2.59	6	.70000000-02	2.59	.15
ELBOW	FR-211	31	1	-0.00	6	.70000000-02	13.00	-0.00
LINE	MR-212	10	1	-0.00	6	.70000000-02	.61	.15
VALVE	CV-146	31	1	-0.00	6	.70000000-02	400.00	-0.00
LINE	MR-213	10	1	-0.00	6	.70000000-02	1.98	.15
END		0	0	-0.00	0	-0.00000000	-0.00	-0.00

NOTE: RELATIVE HEAD CHANGE, LENGTH, AND DIAMETER ARE IN METERS.

1.7.1 Program CØNTRL

Program CØNTRL is the initialization and driver routine which sets up TCIMM for any of the five cryogen system analyses. The routine initializes the data storage subroutines, establishes the data, reads in the data tables via subroutine INTAB, and reads in the program data deck via subroutine CØMPIL. In so doing, CØNTRL sets up a number of index values relating to system type and kind and whether the input data deck is for a single case or multiple case run.

Input data for CØNTRL is read from the first several cards of the input data deck. These data are used and transferred to storage in labeled common areas defined by Procedure Definition Processor elements. The labeled common areas used by CØNTRL are:

```
COMMON/CØNTRL/
COMMON/CIDUNT/
COMMON/CKEYS/
COMMON/CPAGE/
```

Calling Sequence. CØNTRL is the driver routine and as a main program it is not called by any other subroutine.

SIGNIFICANT VARIABLES

<u>NAME</u>	<u>TYPE</u>	<u>I/O</u>	<u>DIMENSION</u>	<u>DESCRIPTION</u>
NAME	A	I	1	User Name
DEPT	I	I	1	User Department
BLD	I	I	1	Building Number
EXT	I	I	1	Phone Number
CTITLE	A	I	1	Case Title
NSYS	A	I	1	System Type Index
NI	A	I	1	Rest of System Name

<u>NAME</u>	<u>TYPE</u>	<u>I/O</u>	<u>DIMENSION</u>	<u>DESCRIPTION</u>
NCRIT	I	I	1	System Kind
INTGR	A	I	1	Case Index
NAMESYS	I	I	5	System Name Index
SCRIT	I	I	1	System Kind Index

A listing of subroutine CØNTRL will be found in Appendix A.

The flow chart for subroutine CØNTRL is presented in Appendix C.

1.7.2 Subroutine CØMPIL

The principle function of subroutine CØMPIL is to read the input data deck, storing all variables in their proper arrays. The input data is "echoed" to provide the user with a means of verifying input data value to assure accuracy in the analysis. This function is performed for each of the primary systems and their system configuration definitions. Tests are made in reading data to ensure the use of legal function code. The user is warned if errors are detected.

The labeled common areas used by CØMPIL are:

```

COMMON/CCNFIG/
COMMON/CCNTRL/
COMMON/CMAG/
COMMON/CIØUNT/
COMMON/CNAMES/
COMMON/CPAGE/

```

Calling Sequence

CØMPIL is called by driver routine CØNTRL.

Significant Variables

SYSNUM - Controls GO TO branching in COMPIL

A listing of COMPIL will be found in Appendix A.

The flow chart for subroutine COMPIL is presented in Appendix C.

1.7.3 Subroutine MAGNET

Subroutine MAGNET provides the program capability necessary to characterize the fluid and thermodynamic conditions existing in the superconducting magnet as a function of any given set of input operating conditions. For any specified inlet fluid temperature and pressure, fluid mass flow rate, and magnet heat load, the subroutine computes the outlet fluid state, quality, density, pressure drop, velocity and Reynolds Number, and outlet fluid temperature and pressure, for both no-flow conditions and flow at input mass-flow rate. The computer values are output in tabular format.

The subroutine additionally computes helium boil-off in the large helium storage tank based upon an input storage vessel heat load.

Finally, the subroutine calls CMPCAL to execute the computation of the fluid state changes and thermodynamic processes occurring in the entire magnet helium supply system configuration.

The labeled common areas used by subroutine MAGNET are:

```
COMMON/CMAG/
COMMON/CFLUID/
```

Calling Sequence. MAGNET is called by the driver routine CONTRL.

Significant Variables. Input variables are defined in section 1.5.1.4.1.

Computed variables are:

<u>NAME</u>	<u>TYPE</u>	<u>I/O</u>	<u>DESCRIPTION</u>
QUALØ	R	O	Fluid Mass Quality
SVLIN	R	O	Sp. Vol. Inlet Helium Fluid
SVLMIX	R	O	Sp. Vol. Outlet Helium Fluid
RHØMIX	R	O	Density Outlet Helium Fluid
WDØTI (I)	R	O	Mass Flow Inlet Fluid Per Magnet
WØTGHE	R	O	Mass Flow Outlet Gaseous Helium Per Magnet
WØTLHE	R	O	Mass Flow Outlet Liquid Helium Per Magnet
WDGSTØ	R	O	Mass Flow of Gaseous Helium From Helium Storage Vessel

A listing of subroutine MAGNET will be found in Appendix A.

A flow chart for subroutine MAGNET is presented in Appendix C.

1.7.4 Subroutine CRYPAN

Subroutine CRYPAN performs essentially the same calculations for the cryopanel as are performed in subroutine MAGNET. The major difference is the number of branching loops required for multiple cryopanel, and the necessity for keeping track of a larger number of different mass flow values in the two-phase fluid present in the separate loops.

It is expected that this subroutine will require some modification when the final cryopanel configuration is fixed by CVI. The subroutine characterizes the specified cryopanel and then calls subroutine CMPCAL for a complete characterization of the Cryopanel Supply System.

The labeled common area used by CRYPAN is: COMMON/CMAG/.

Calling Sequence. CRYPAN is called by the driver routine CCTRL.

Significant Variables. Input variables are described in section 1.5.2.4.2.

Computed variables are:

<u>NAME</u>	<u>TYPE</u>	<u>I/O</u>	<u>DESCRIPTION</u>
SLVIN(I)	R	O	Inlet Helium Fluid Specific Volume to each Cryopanel
QWAL(I)	R	O	Fluid Mass Quality of Helium out of each Cryopanel
SVLMX(I)	R	O	Specific Volume Outlet Helium Fluid - each Cryopanel
RHOMX(I)	R	O	Density of Fluid Mixture out of each Cryopanel
WGTG(I)	R	O	Mass Flow of Gaseous Helium out of each Cryopanel
WDTL(I)	R	O	Mass Flow of Liquid Helium out of each Cryopanel

A listing for subroutine CRYPAN will be found in Appendix A.

A Flow Chart for subroutine CRYPAN is presented in Appendix C.

1.7.5 Subroutine HEMKUP

Subroutine HEMKUP characterizes the Refrigerator-Liquefier operating conditions and additionally computes the LN_2 requirements for the Refrigerator-Liquefier Nitrogen Precooler.

The subroutine makes use of the nominal "cold-box" (refrigerator-liquefier) parameters provided by LLL/CVI to compute the amount of heat to be removed from the high-pressure hot helium entering the cold box, and the amount of heat that can be removed by the low-pressure cold helium gas entering the "cold box" from the Dewars. The subroutine then computes the amount of LN_2 fluid needed to make up the heat removal difference, and permits the production of the necessary makeup liquid helium to keep the overall system operating. After completing the characterization of the "cold-box," subroutine HEMKUP calls CMPCAL to characterize the fluid intake and thermodynamic processes throughout the entire helium makeup and resupply system. The labeled common areas used by subroutine HEMKUP are:

COMMON/CMAG/
COMMON/CFLUID/

Calling Sequence. HEMKUP is called by the driver routine CONTRL.

Significant Variables. Input variables used by subroutine HEMKUP are described in section 1.5.1.4.3. Computed variables generated within HEMKUP are utilized in a single output table characterizing the Refrigerator-Liquefier.

A listing of subroutine HEMKUP will be found in Appendix A.

A flow chart for subroutine HEMKUP is presented in Appendix C.

1.7.6 Subroutine CMPCAL

The subroutine CMPCAL is designed to perform fluid flow and thermodynamic analyses for all of the component units which make up the system configuration. The system configuration being defined is the computer image of the system main flow schematic diagram wherein all components and line segments are arranged in their normal logical sequence. The subroutine requires that each system or subsystem fluid segment begin with a data entry

which flags the fluid kind and state and further requires that when a fluid state changes (i.e., gas to liquid), a second data entry must be available.

The subroutine currently will process systems which employ helium and nitrogen as the cryogen fluids. The logic employed requires that the configuration data be entered starting with the cryogen supply source and proceeding to the fluid return to the storage tanks, thus permitting the accumulation of pressure drop data and thermal changes in an orderly fashion.

Subroutine CMPCAL is normally employed for the evaluation of a multibranch system and normally processes the primary branch of the system, followed by the other branches in order. It can, however, process any branch, or, just one branch, depending upon the setting of the input fluid flag variables. The program calls in required subprograms as needed for characterizing the individual components and line segments as they are encountered in the configuration sequence. The CMPCAL analysis procedure is based upon accomplishing a one-by-one analysis of the sequential component stream defined by the configuration table as read in by subroutine CMPIL. Based upon the input data, the subroutine accomplishes the computation of the individual component contribution to fluid state change, pressure drop, and energy change and presents the calculated values in tabular formatted output as a "Summary of Computed System Configuration Parameters."

The principal computations accomplished in subroutine CMPCAL are as follows:

- (a) Upon being called, the subroutine first initializes a set of flag and summation variables. It starts the configuration loop by calling for the decoding of the first branching variable as entered in the first configuration data card. The primary branching control variables employed are CFUNCT and CFTYPE as defined in subroutine CMPIL and PDP-CONFIG. The branching variable CFUNCT contains the coding for (in successive data entries), the fluid identification, primary component identification, and, in turn, each component unit sequentially considered in the system. The secondary branching control variable CFTYPE successively contains

the coding for, the fluid state, the consumer characteristic type, and, in turn, the controlling characteristics of each component unit sequentially considered in the system. Subroutine branching to the specified analysis region of the coding is accomplished via a computed $G\theta T\theta$ statement, controlled by the variable CFUNCT.

- (b) The subroutine identifies the fluid to be considered and identifies its state condition and then initializes the sequential indices.
- (c) Identifies the cryogen supply source and sets up the source fluid flow rate, fluid pressure, and fluid temperature with their respective sequential indices. At this point the actual configuration analysis has begun.
- (d) The subroutine then processes a line segment (whenever called for by CFUNCT) through the sequence of the line analysis to compute flow conditions, pressure drop and thermal changes. Fanno-flow, compressible-flow, velocity effects, as well as fluid head height are all taken into consideration in the analysis.
- (e) Processes a control unit (valve, J-T valve, or regulator) through the sequence of the control analysis to compute flow conditions, pressure drop, and thermal changes. Volume characteristics as a function of type for the control unit are specified in the "tens" digit of CFTYPE. Selection of the type of control unit is made via the "units" digit of CFTYPE, as defined in PDP-CONFIG.
- (f) The subroutine processes a fitting or tap in much the same fashion as for the line segment analysis, taking into account the flow geometry effects. It computes the flow conditions, pressure drop, and fitting or tap volume characteristics.
- (g) Processes a magnet; computes new fluid state conditions based upon inlet temperature, pressure and magnet heat load; computes pressure drop, fluid velocity, mixed phase density, quality, and Reynolds Number; defines mass flow for liquid and gaseous fluid states. Accounts for head height deltas.
- (h) Processes a heat exchanger, sets up the fluid conditions, inlet and outlet cold fluid temperatures and pressures, and heat source mixture ratios; then calls subroutine HEATEX to essentially design

- the heat exchanger and calculate pressure drop, hot fluid flow rates, and heat exchanger weight.
- (i) Processes a cryopanel taking into account the particular branching loop to which the cryopanel belongs, computes new fluid state conditions based upon inlet temperature, pressure, and cryopanel heat load, computes pressure drop, mixed phase density, quality, and Reynolds Number. Accounts for head height changes in the above computations.
 - (j) Processes a refrigerator-liquefier assembly based upon the CVI nominal refrigerator-liquefier design parameters. Computes new fluid state conditions based upon inlet temperature, pressure, and refrigerator-liquefier heat load values. Computes pressure drop, density, velocity, and Reynolds Number for fluid paths involved.
 - (k) Processes a compressor-purifier assembly. Computes new fluid state conditions based upon inlet temperature, pressure, and compressor-purifier operating specifications. Pressure drop, fluid density, velocity, and Reynolds Number are computed. Makeup helium added to the flow stream at this point is taken into account in the recomputed mass flow calculations.
 - (l) The subroutine then processes a fluid supply tank, first setting up the tank temperature and pressure. The program checks to see which cryogen supply source tank it is addressing and whether it is the first, or, second time it has encountered this particular tank, since this makes a difference in whether or not it will consider certain computations, and save certain specified values for use in other calculations.
 - (m) CMPCAL then outputs the computed configuration component data in a tabular formatted output with all components identified and in the same sequence as given in the original system schematic.

Input data for use in subroutine CMPCAL is read in at program initiation time via subroutine COMPIL from the configuration data cards. Data from each card are stored in a packed array by subroutine STDCON using equivalenced array variables defined in the Procedure Definition Processor CCONFIG.

Retrieval of the data is accomplished in CMPCAL via repeated calls to subroutine GETCON which unpacks the data as needed.

The input data and computed parameter values are stored in various regions of the labeled COMMON storage defined by PDP elements. The labeled common storage employed by subroutine CMPCAL are as follows:

COMMON/CONFIG/	COMMON/CONTRL/	COMMON/CFLUID/
COMMON/CIOUNT/	COMMON/CMAG	COMMON/CNAMES/
COMMON/CONST/	COMMON/CPAGE/	COMMON/TABLOCK/

Calling Sequence. Subroutine CMPCAL is initialized and brought into execution via a simple call statement from either subroutine MAGNET, subroutine CRYPAN, or, subroutine HEMKUP.

Data transfer to and from subroutine CMPCAL is effected through the use of INCLUDE statements which bring in the appropriate PDP element defining the required labeled COMMON storage areas. Upon completion of the CMPCAL computations, the program control returns to the calling subroutine.

Significant Variables. Significant variables employed in, and processed by, subroutine CMPCAL are defined in the following list:

<u>NAME</u>	<u>TYPE</u>	<u>I/O</u>	<u>DIMENSION</u>	<u>DESCRIPTION</u>
ICNF	I	I	1	Number of configuration data cards input
IDX	I	O	1	Configuration item index
ISIGN	I	O	1	Analysis directional index
CFUNCT	I	I	1	Integer corresponding to configuration item function
CFTYPE	I	I	1	Integer corresponding to function type

<u>NAME</u>	<u>TYPE</u>	<u>I/O</u>	<u>DIMENSION</u>	<u>DESCRIPTION</u>
CMTYPE	I	I	1	Integer corresponding to material type
CITYPE	I	I	1	Integer corresponding to insulation type
CNOPER	I	II	1	Number of units operating
CNSTBY	I	I	1	Number of units on standby
FRCDEF	R	I	100	Characteristic friction factor for flow region
LØD	R	I	100	Length over diameter, or, length
DIAM	R	I	100	Diameter
ITHIK	R	I	100	Insulation thickness
NØAR	R	I	100	Number of layers of insulation per inch
CØDE	R	I	100	Identification code for configuration unit
IGAS	I	I	1	Integer corresponding to fluid kind
GSTATE	I	I	1	Integer corresponding to fluid state
PRES	R	O	100	Fluid pressure at each point in system
TEMP	R	O	100	Fluid temperature at each point in system
WDØTN	R	O	100	Fluid flowrate at each point in system
WDØTI	R	I	6	Input fluid max flow rate at primary component
FLD	R	O	1	fl/D for configuration unit considered

IDV	I	I	1	Integer pointer for control volume characteristic
LDV	I	I	1	Integer pointer for fitting and tap configuration
RHO	R	0	1	Fluid density
DELP	R	0	1	Fluid pressure drop across component
A	R	0	1	Cross sectional area of flow region
GL00P	I	I	11	Integer defining branch-loop number

The subroutine CMPCAL listing will be found in Appendix A. A flow chart for subroutine CMPAL is presented in Appendix C.

1.7.7 Program Element Monitoring and Statusing

The MFTF*CSA. program currently contains 76 symbolic elements, 60 relocatable elements, and 1 absolute element. The status of any element in the file in terms of when it was last updated, the position of the element within the file and the element text size in sectors (a sector is 28 words), can be determined with a call to the Program Reference Table processor, using the "T" option to get a table of contents (viz: @PRT,T MFTF*CSA.). The current table of contents for MFTF*CSA. is presented in Fig. 7 given on the next several pages.

A second useful tool in the monitoring of a program file is the Cross Reference processor (viz: @XREF MFTF*CSA.). This processor produces a cross-referenced table which alphabetically lists the relocatable elements by name, and beside each element name lists the element entry point and entry point name. Next to the entry point name are listed all the relocatable element names which reference this entry point, thus giving a cross-reference for the whole file. The current XREF table for MFTF*CSA. is presented in Fig. 8. Note, for example, that the element CMPCAL has the entry point name CMPCAL, and is referenced (or called) by CRYPAN, HEMKUP, and MAGNET. Note also the

Fig. 7 Program Reference Table - File Element Listing

MFT*GSA(1) ELEMENT TABLE

D	NAME	VERSION	TYPE	DATE	TIME	SEQ #	SIZE-PRE,TEXT	(CYCLE WORD)	PSRMODE	LOCATION
	ABS		ABSOLUTE	05 APR 79	09:29:57	1	1022			1792
	ANALYSIS		FOR SYMB	29 MAR 79	21:17:09	2	33	5 0 1		2014
	ANALYSIS		RELOCATABLE	29 MAR 79	21:17:33	3	38			2047
	CCNFIG		FOR PROC	21 FEB 79	12:50:04	4	57	1 0 1		2087
	CCNTRL		FOR PROC	29 MAR 79	08:51:19	5	6	1 0 1		2044
	CFLUID		FOR PROC	21 FEB 79	17:35:29	6	3	1 0 1		2950
	CFTW		FOR SYMB	30 SEP 78	14:17:38	7	10	5 0 1		2953
	CFTW		RELOCATABLE	06 OCT 78	09:21:57	8	7			2963
	CIGNIT		FOR PROC	30 SEP 78	14:16:55	9	5	1 0 1		2971
	CKEYS		FOR PROC	30 SEP 78	14:16:55	10	1	1 0 1		2976
	CMAG		FOR PROC	24 FEB 79	15:15:22	11	12	1 0 1		2977
	CMATRL		FOR PROC	29 MAR 79	18:08:13	12	17	1 0 1		2989
	CMPCAL		FOR SYMB	29 MAR 79	21:08:47	13	410	5 0 1		3006
	CMPCAL		RELOCATABLE	29 MAR 79	21:10:14	14	178			3416
	CMANES		FOR PROC	27 FEB 79	14:06:58	15	2	1 0 1		3599
	COMILO		FOR SYMB	27 MAR 79	12:57:04	16	23	5 0 1		3601
	COMILO		RELOCATABLE	27 MAR 79	12:57:23	17	11			3624
	COMHDP		FOR SYMB	23 MAR 79	23:35:27	18	3	5 0 1		3637
	COMHDP		RELOCATABLE	28 MAR 79	15:14:25	19	1			3640
	COMHLL		FOR SYMB	27 MAR 79	16:17:36	20	125	5 0 1		3644
	COMHLL		RELOCATABLE	27 MAR 79	16:18:33	21	65			3769
	CONST		FOR PROC	17 FEB 79	15:46:28	22	4	1 0 1		3038
	CONTRL		FOR SYMB	29 MAR 79	08:53:20	23	24	5 0 1		3042
	CONTRL		RELOCATABLE	29 MAR 79	08:53:56	24	13			3066
	CP		FOR SYMB	28 SEP 78	07:56:56	25	4	5 0 1		3882
	CP		RELOCATABLE	06 OCT 78	09:24:09	26	3			3886
	CRAGE		FOR PROC	30 SEP 78	14:16:58	27	8	1 0 1		3891
	CRYPAN		FOR SYMB	06 DEC 78	11:51:11	28	45	5 0 1		3899
	CRYPAN		RELOCATABLE	24 FEB 79	15:20:16	29	34			3944
	CSUBP		FOR SYMB	30 SEP 78	14:17:36	30	7	5 0 1		3981
	CSUBP		RELOCATABLE	06 OCT 78	09:22:53	31	4			3988
	CSUBV		FOR SYMB	30 SEP 78	14:17:37	32	7	5 0 1		3994
	CSUBV		RELOCATABLE	06 OCT 78	09:22:56	33	4			4001
	CSYSWT		FOR PROC	30 SEP 78	14:16:59	34	6	1 0 1		4007
	LTAB		FOR PROC	30 SEP 78	14:16:59	35	10	1 0 1		4013
	LTABA		FOR PROC	30 SEP 78	14:17:00	36	2	1 0 1		4013
	CV		FOR SYMB	28 SEP 78	07:56:50	37	3	5 0 1		4025
	CV		RELOCATABLE	06 OCT 78	09:24:11	38	3			4028
	CVINT		FOR SYMB	28 SEP 78	07:57:02	39	12	5 0 1		4032
	CVINT		RELOCATABLE	06 OCT 78	09:24:13	40	19			4044
	CVOL		FOR SYMB	07 FEB 79	21:13:15	41	28	5 0 1		4065
	CVOL		RELOCATABLE	07 FEB 79	21:13:29	42	20			4093
	DATAIN		FOR SYMB	29 MAR 79	22:30:13	43	10	5 0 1		4114
	DATAIN		RELOCATABLE	29 MAR 79	22:30:37	44	11			4124
	DBDI		FOR SYMB	28 SEP 78	07:57:05	45	7	5 0 1		4137
	DBDI		RELOCATABLE	06 OCT 78	09:24:14	46	5			4144
	DDHET		FOR SYMB	28 SEP 78	07:57:08	47	9	5 0 1		4150
	DDHET		RELOCATABLE	06 OCT 78	09:24:17	48	14			4153
	DELT		FOR SYMB	28 SEP 78	07:57:11	49	2	5 0 1		4175
	DELT		RELOCATABLE	06 OCT 78	09:24:18	50	2			4177
	DENCAL		FOR SYMB	29 MAR 79	17:45:05	51	11	5 0 1		4180
	DENCAL		RELOCATABLE	29 MAR 79	18:00:44	52	12			4191
	DENSL		FOR SYMB	03 APR 79	22:00:52	53	7	5 0 1		4204

Fig. 7 (Cont.)

DENSL	RELOCATABLE	04 APR 79	11:17:50	54	1	7			4211
DENSV	FOR SYMB	03 APR 79	22:00:53	55		7	5	0	4219
DENSV	RELOCATABLE	03 APR 79	11:59:07	56	1	8			4226
CHLOP	FOR SYMB	03 APR 79	22:00:56	57		8	5	0	4235
CHLOP	RELOCATABLE	12 MAR 79	15:30:22	58	1	9			4243
OCAL	FOR SYMB	03 APR 79	22:00:49	59		41	5	0	4253
OCAL	RELOCATABLE	04 APR 79	11:17:03	60	2	49			4294
OCLOD	FOR SYMB	20 SEP 78	07:57:13	61		2	5	0	4345
OCLOD	RELOCATABLE	06 OCT 78	09:24:19	62	1	3			4347
OCLOT	FOR SYMB	28 SEP 78	07:57:16	63		2	5	0	4351
OCLOT	RELOCATABLE	06 OCT 78	09:24:21	64	1	3			4353
OPOTVP	FOR SYMB	28 SEP 78	07:57:18	65		7	5	0	4357
OPOTVP	RELOCATABLE	06 OCT 78	09:24:24	66	1	9			4364
OPLINE	FOR SYMB	29 MAR 79	17:46:28	67		6	5	0	4374
OPLINE	RELOCATABLE	29 MAR 79	18:02:14	68	1	7			4380
OPVALV	FOR SYMB	29 MAR 79	17:47:37	69		3	5	0	4388
OPVALV	RELOCATABLE	29 MAR 79	18:03:46	70	1	3			4391
OSAIL	FOR SYMB	28 SEP 78	07:57:20	71		4	5	0	4395
OSAIL	RELOCATABLE	06 OCT 78	09:24:26	72	1	4			4399
OSATV	FOR SYMB	28 SEP 78	07:57:21	73		4	5	0	4404
OSATV	RELOCATABLE	06 OCT 78	09:24:28	74	1	4			4408
OTHIF	FOR SYMB	28 SEP 78	07:57:24	75		10	5	0	4413
OTHIF	RELOCATABLE	06 OCT 78	09:24:31	76	2	15			4423
DUMJY	FOR PROC	13 MAR 73	01:52:04	77		3	1	0	4440
C2DBT2	FOR SYMB	28 SEP 78	07:57:25	78		7	5	0	4443
C2DBT2	RELOCATABLE	06 OCT 78	09:24:33	79	1	5			4450
ENTHAL	FOR SYMB	28 SEP 78	07:57:27	80		4	5	0	4456
ENTHAL	RELOCATABLE	06 OCT 78	09:24:35	81	1	4			4460
ENTROP	FOR SYMB	28 SEP 78	07:57:29	82		4	5	0	4465
ENTROP	RELOCATABLE	06 OCT 78	09:24:36	83	1	5			4469
FINDU	FOR SYMB	28 SEP 78	07:57:32	84		5	5	0	4475
FINDU	RELOCATABLE	06 OCT 78	09:24:38	85	1	5			4480
FINDR	FOR SYMB	17 FEB 79	15:15:13	86		3	5	0	4486
FINDR	RELOCATABLE	17 FEB 79	15:15:27	87	1	2			4489
FINTAB	FOR SYMB	27 MAR 79	12:59:35	88		11	5	0	4492
FINTAB	RELOCATABLE	27 MAR 79	12:59:52	89	2	6			4503
FLODQ	FOR SYMB	17 FEB 79	15:27:36	90		8	5	0	4511
FLODQ	RELOCATABLE	17 FEB 79	15:27:48	91	1	3			4519
GETCON	FOR SYMB	27 MAR 79	13:01:24	92		7	5	0	4523
GETCON	RELOCATABLE	27 MAR 79	13:01:50	93	2	3			4530
GHENCV	SYMBOLIC	27 MAR 79	16:09:12	94		1	5	0	4535
GHENCV	RELOCATABLE	27 MAR 79	16:13:03	95	1	1			4536
GH2DEN	FOR SYMB	03 APR 79	22:00:54	96		10	5	0	4538
GH2DEN	RELOCATABLE	29 MAR 79	07:20:29	97	1	12			4548
HEF11	FOR SYMB	28 SEP 78	07:57:35	98		9	5	0	4561
HEF11	RELOCATABLE	06 OCT 78	09:24:44	99	2	12			4570
HEMED	FOR SYMB	04 OCT 78	16:25:46	100		2	5	0	4584
HEMED	RELOCATABLE	06 OCT 78	09:25:19	101	1	2			4586
HEMKUP	ELT SYMB	15 FEB 79	14:43:05	102		38	5	0	4589
HEMKUP	RELOCATABLE	24 FEB 79	15:20:36	103	3	23			4627
HEPROD	FOR SYMB	09 OCT 78	12:38:29	104		41	5	0	4653
HEPROD	RELOCATABLE	09 OCT 78	12:38:28	105	3	25			4694
HINT	FOR SYMB	28 SEP 78	07:57:38	106		9	5	0	4722
HINT	RELOCATABLE	06 OCT 78	09:24:48	107	2	16			4731
HVAP	FOR SYMB	03 APR 79	22:00:59	108		17	5	0	4749
HVAP	RELOCATABLE	12 MAR 79	15:29:39	109	2	19			4766
INTAB	FOR SYMB	13 MAR 73	01:59:16	110		66	5	0	4787
INTAB	RELOCATABLE	09 OCT 78	12:38:20	111	2	57			4853

Fig. 7 (Cont.)

LIGHT	SYMBOLIC	27 MAR 79	16:07:21	112		1	5	0	1	4912
LIGHT	RELOCATABLE	27 MAR 79	16:12:13	113	1	1				4913
LNSYST	FOR SYMB	05 APR 79	08:05:48	114		89	5	0	1	4915
LNSYST	RELOCATABLE	05 APR 79	08:06:20	115	3	78				5004
LOCATE	FOR SYMB	27 MAR 79	13:03:39	116		11	5	0	1	5085
LOCATE	RELOCATABLE	27 MAR 79	13:03:52	117	2	6				5096
MAGNET	FOR SYMB	21 FEB 79	17:35:50	118		82	5	0	1	5104
MAGNET	RELOCATABLE	24 FEB 79	15:27:46	119	4	20				5186
MFTT	MAP SYMB	30 SEP 78	14:17:50	120		1	5	0	1	5210
MIPE	FOR SYMB	27 MAR 79	13:06:04	121		26	5	0	1	5211
MIPE	RELOCATABLE	27 MAR 79	13:06:19	122	2	16				5237
N2MAIN	FOR SYMB	05 APR 79	09:26:19	123		44	5	0	1	5255
N2MAIN	RELOCATABLE	05 APR 79	09:26:53	124	2	35				5299
N2PROP	FOR SYMB	13 MAR 79	18:03:04	125		4	5	0	1	5336
N2PROP	RELOCATABLE	13 MAR 79	18:03:04	126	2	4				5340
OUTPUT	FOR SYMB	13 MAR 79	02:01:29	127		13	5	0	1	5346
OUTPUT	RELOCATABLE	06 OCT 78	09:23:35	128	2	19				5359
PAGE	FOR SYMB	13 MAR 79	02:01:43	129		31	5	0	1	5380
PAGE	RELOCATABLE	06 OCT 78	09:23:37	130	2	7				5411
PCAL	FOR SYMB	20 SEP 78	07:57:40	131		2	5	0	1	5420
PCAL	RELOCATABLE	06 OCT 78	09:24:50	132	1	3				5422
RHOJAS	FOR SYMB	04 OCT 78	16:25:42	133		14	5	0	1	5426
RHOJAS	RELOCATABLE	06 OCT 78	09:23:40	134	2	8				5440
RHOLIQ	FOR SYMB	04 OCT 78	16:25:45	135		14	5	0	1	5450
RHOLIQ	RELOCATABLE	06 OCT 78	09:23:42	136	2	8				5464
SINT	FOR SYMB	20 SEP 78	07:57:43	137		10	5	0	1	5474
SLETHH	RELOCATABLE	06 OCT 78	09:24:53	138	2	17				5484
SLETHH	FOR SYMB	03 APR 79	22:00:56	139		5	5	0	1	5503
SOUT	RELOCATABLE	12 MAR 79	15:30:19	140	1	5				5508
SOUT	FOR SYMB	28 SEP 78	07:57:45	141		3	5	0	1	5514
SPEFHT	RELOCATABLE	06 OCT 78	09:24:55	142	2	3				5517
SPEFHT	FOR SYMB	03 APR 79	22:00:54	143		6	5	0	1	5522
STOCUN	RELOCATABLE	28 MAR 79	18:53:34	144	1	6				5528
STOCUN	FOR SYMB	30 SEP 78	14:17:18	145		7	5	0	1	5535
STODTA	RELOCATABLE	06 OCT 78	09:23:48	146	1	3				5542
STODTA	FOR SYMB	29 MAR 79	08:54:43	147		64	5	0	1	5546
SVENTH	RELOCATABLE	29 MAR 79	08:55:13	148	3	24				5610
SVENTH	FOR SYMB	03 APR 79	22:00:50	149		39	5	0	1	5637
TABLOM	RELOCATABLE	12 MAR 79	15:30:17	150	2	42				5676
TCOND	FOR PROC	14 FEB 79	19:46:06	151		2	1	0	1	5720
TCOND	FOR SYMB	30 SEP 78	14:17:54	152		22	5	0	1	5722
TEL	RELOCATABLE	06 OCT 78	09:23:51	153	1	17				5744
TEL	FOR SYMB	30 SEP 78	14:17:52	154		15	5	0	1	5762
1VP	RELOCATABLE	06 OCT 78	09:23:54	155	2	9				5777
1VP	FOR SYMB	03 APR 79	22:00:55	156		13	5	0	1	5788
VELI	RELOCATABLE	21 MAR 79	22:46:04	157	2	16				5801
VELI	FOR SYMB	30 SEP 78	14:17:23	158		2	5	0	1	5819
VGVS	RELOCATABLE	06 OCT 78	09:23:56	159	1	2				5821
VGVS	FOR SYMB	30 SEP 78	14:17:56	160		12	5	0	1	5824
VIRB	RELOCATABLE	06 OCT 78	09:23:59	161	2	5				5836
VIRB	FOR SYMB	28 SEP 78	07:57:49	162		7	5	0	1	5843
VISC	RELOCATABLE	28 SEP 78	07:57:48	163	1	4				5850
VISC	FOR SYMB	12 MAR 79	15:29:33	164		3	5	0	1	5855
VISCOT	RELOCATABLE	12 MAR 79	15:29:32	165	1	3				5858
VISCOT	FOR SYMB	09 OCT 78	12:38:37	166		6	5	0	1	5862
VISCHE	RELOCATABLE	09 OCT 78	12:38:37	167	1	7				5868
VISCHE	FOR SYMB	09 OCT 78	12:38:32	168		7	5	0	1	5876
VISCHE	RELOCATABLE	09 OCT 78	12:38:32	169	1	7				5883

Fig. 7 (Cont.)

VISCK	FOR SYMB	09 OCT 78	12:38:34	170		2	5	0	1	5891
VISCK	RELOCATABLE	09 OCT 78	12:38:34	171	1	3				5893
VPN	FOR SYMB	28 SEP 78	07:57:51	172		7	5	0	1	5897
VPN	RELOCATABLE	06 OCT 78	09:25:00	173	1	8				5904
VPTEMP	FOR SYMB	28 SEP 78	07:57:53	174		5	5	0	1	5913
VPTEMP	RELOCATABLE	06 OCT 78	09:25:01	175	1	6				5918
YLGINT	FOR SYMB	30 SEP 78	14:17:58	176		42	5	0	1	5925
YLGINT	RELOCATABLE	06 OCT 78	09:24:05	177	1	15				5967
ZCALC	FOR SYMB	28 SEP 78	07:57:55	178		2	5	0	1	5983
ZCALC	RELOCATABLE	06 OCT 78	09:25:03	179	1	2				5985

NEXT AVAILABLE LOCATION- 5988

ASSEMBLER PROCEDURE TABLE EMPTY

COMOL PROCEDURE TABLE EMPTY

FORTRAN PROCEDURE TABLE

D NAME	LOCATION	LINK	D NAME	LOCATION	LINK	D NAME	LOCATION	LINK
CCNFIG	80839	4	CCNTRL	82434	5	CFLUID	82602	6
CIDUNT	83190	9	CKEYS	83330	10	CMAQ	83359	11
CMATRL	83694	12	CNAMES	100774	15	CONST	107466	22
CPAGE	108950	27	CSYSNT	112198	34	CTAB	112366	35
CTABA	112646	36	DUMMY	124322	77	TABLOK	160162	151

ENTRY POINT TABLE

D NAME	LINK	D NAME	LINK	D NAME	LINK	D NAME	LINK	D NAME	LINK
CFIW	8	CMPCAL	14	COMFLO	17	COMPPDP	19	COMPII	21
CP	26	CRYPAN	29	CSUBP	31	CSUBV	33	CV	38
CVINT	40	CVOL	42	DATAIN	44	DDDT	46	DDHEF	48
DELT	50	DENCAL	52	DENSL	54	DENSV	56	DPCAL	60
DPCLDD	62	DPCLDT	64	DPDTVP	66	DPLINE	68	DPVALV	70
DSATL	72	DSATV	74	OTHEF	76	D2DBT2	79	ENTHAL	81
ENTHSL	140	ENTHSV	150	ENTROP	83	FINDO	85	FINDR	87
FINTAB	89	FLODEQ	91	GASRCV	3	GETCON	93	GHERCV	95
GN2DEN	97	HEFIT	99	HEHED	101	HEMKUP	103	HEPROP	105
HINT	107	HPRAT	58	HTVAP	109	INTAB	111	LIONIT	113
LN5YST	115	LOCAT	117	MAGNET	119	MIPE	122	N2MAIN	124
N2INDP	126	OTUNIT	128	OUTPA	128	OUTPF	128	OUTPF1	128
OUTPI	128	OUTPW	128	PAGE	130	PCAL	132	RHOGAS	134
RHOLIO	136	RVMIPE	122	SINT	138	SCUN	142	SPACE	128
SPCFHT	144	STOCOM	146	STODTA	148	TCOND	153	TEL	155
TVP	157	VELF	159	VGVS	161	VIRB	163	VISC	165
VISCOT	167	VISCHE	169	VISCK	171	VPN	173	VPTEMP	175
YLGINT	177	ZCALC	179						

XREF MFIF+CSA-XP.
 XREF 01A LMSC43 04,05/79 00:20:49

Fig. 8 Program Cross Reference Table

XREF OF FILE MFIF+CSA-XP

CFTW	001 (000103)	(CFTW)	
CMPCAL	001 (005404)	(CMPCAL)	.CRYPAN,HEMKUP,MAGNET
COMFLO	001 (000204)	(COMFLO)	.CMPCAL
COMPD	001 (000030)	(COMPD)	.ANALYSIS
COMPIL	001 (001143)	(COMPIL)	.CONTRL
CP	001 (000043)	(CP)	.SDUN
CRYPAN	001 (000507)	(CRYPAN)	.CONTRL
CSUBP	001 (000046)	(CSUBP)	.COMFLO
CSUBV	001 (000047)	(CSUBV)	.COMFLO
CV	001 (000031)	(CV)	.CP,HEPROP,SDUN
CVINT	001 (000443)	(CVINT)	.CV
CVOL	001 (000351)	(CVOL)	.CMPCAL
DATIN	001 (000204)	(DATIN)	.GHERCV
DBDI	001 (000046)	(DBDI)	.CVINT,DPCLDT,HINT,SINT
DDHEF	001 (000331)	(DDHEF)	.CP,FINDD,HEPROP,SDUN
DEL	001 (000011)	(DEL)	.DPDTVP,VPN
DENCAL	001 (000237)	(DENCAL)	.ANALYSIS
DENSL	001 (000115)	(DENSL)	.N2PROP
DENSV	001 (000121)	(DENSV)	.N2PROP
DPCAL	001 (001432)	(DPCAL)	.LNSYST
DPCLDD	001 (000023)	(DPCLDD)	.DDHEF
DPCLDT	001 (000033)	(DPCLDT)	.DTHEF
DPDTVP	001 (000144)	(DPDTVP)	.VPTMP
DPLINE	001 (000130)	(DPLINE)	.ANALYSIS
DPVALV	001 (000031)	(DPVALV)	.ANALYSIS
DSATL	001 (000046)	(DSATL)	.HEPROP
DSATV	001 (000046)	(DSATV)	.HEPROP
DTHEF	001 (000347)	(DTHEF)	.CP,HEPROP
D2DBT2	001 (000052)	(D2DBT2)	.CVINT
ENTHAL	001 (000053)	(ENTHAL)	.HEPROP
ENTHSL	001 (000056)	(ENTHSL)	.DHLDP
ENTHSV	001 (001152)	(ENTHSV)	.SLENTH
ENTROP	001 (000061)	(ENTROP)	.HEPROP
FINDD	001 (000074)	(FINDD)	.HEPROP,RHOGAS,RHOLIQ
FINDR	001 (000012)	(FINDR)	.COMFLO,VGV5
FINTAB	001 (000113)	(FINTAB)	
FLODEQ	001 (000042)	(FLODEQ)	.COMFLO
GASRCV	001 (000721)	(GASRCV)	.DATIN
GETCON	001 (000031)	(GETCON)	.CMPCAL
GHERCV	001 (000006)	(GHERCV)	.CONTRL
GN2DEN	001 (000233)	(GN2DEN)	.DPCAL,LNSYST
HEFIT	001 (000304)	(HEFIT)	.FINDD
HEHED	001 (000011)	(HEHED)	.CMPCAL,CRYPAN,MAGNET
HEMKUP	001 (000330)	(HEMKUP)	.CONTRL
HEPROP	001 (000545)	(HEPROP)	.CMPCAL,CRYPAN,CSUBP,CSUBV,HEMKUP,MAGNET,VGV5
HINT	001 (000361)	(HINT)	.ENTHAL
HPRAT	001 (000132)	(HPRAT)	.N2PROP
HTVAP	001 (000357)	(HTVAP)	.N2PROP,SLENTH
INTAB	001 (001467)	(INTAB)	.CONTRL
LIQNT	001 (000006)	(LIQNT)	.CONTRL
LNSYST	001 (002257)	(LNSYST)	.N2MAIN
LOCAT	001 (000126)	(LOCATE)	.MPE
MAGNET	001 (000260)	(MAGNET)	.CONTRL

Fig. 8 (Cont.)

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MIPE      001 (000377) (MIPE)
N2MAIN    001 (000577) (N2MAIN)
N2PROP    001 (000064) (N2PROP) ,LIGNIT
OTUNIT    001 (000442) (OUTPUT) ,DPCAL,LNSYST,N2MAIN
OUTPA     001 (000375) (OUTPUT) ,CONTRL
OUTPF     001 (000332) (OUTPUT)
OUTPF1    001 (000347) (OUTPUT)
OUTPI     001 (000360) (OUTPUT)
OUTPW     001 (000412) (OUTPUT)
PAGE      001 (000116) (PAGE) ,ANALYSIS,CMPCAL,COMPIL,CONTRL,CRYPAN,HEMKUP,INTAB,LNSYST,MAGNET,N2MAIN
PCAL      001 (000025) (PCAL) ,HEFIT
RHOGAS    001 (000062) (RHOGAS) ,CMPCAL
RHOLIQ    001 (000062) (RHOLIQ) ,CMPCAL
RVMIP     001 (000406) (MIPE)
SINT      001 (000377) (SINT) ,ENTROP
SOUN      001 (000041) (SOUN)
SPACE     001 (000437) (OUTPUT)
SPCFHT    001 (000113) (SPCFHT) ,DPCAL,LNSYST
STOCDN    001 (000036) (STOCDN) ,COMPIL
STODTA    001 (000005) (STODTA) ,CONTRL
TCOND     001 (000365) (TCOND)
TEL       001 (000153) (TEL) ,MIPE
TVP       001 (000303) (TVP) ,DHLOP,N2PROP
VELF      001 (000021) (VELF) ,CMPCAL
VGVS      001 (000075) (VGVS)
VIRB      001 (000040) (VIRB) ,DPCLDD,OPCLDT,PCAL,SINT
VISC      001 (000027) (VISC) ,N2PROP
VISCDT    001 (000121) (VISCDT) ,VISCHE
VISCHE    001 (000142) (VISCHE) ,HEPROP
VISCK     001 (000030) (VISCK) ,VISCHE
VPN       001 (000116) (VPN) ,DPDTVP,VPTMP
VPTMP     001 (000113) (VPTMP) ,HEPROP,RHOGAS,RHOLIQ
VLGINT    001 (000370) (VLGINT) ,TEL
ZCALC     001 (000015) (ZCALC) ,HEPROP
*** DONE ***

```

*FREE MFTF+CSA-XP.

*XOT TPFS.ABS

2

LINE IN PIPE VALVE AND INSTRUMENT NUMBERS WITH L-100
 EXAMPLE: L-100-LN2-10 (VALVE)
 L-100-LN2-12 (PIPE)
 GENERAL NOTES

Fig. 9 Liquid Nitrogen System Schematic

Not included in the current analysis is the utilization of four lines which also branch from the inlet liquid nitrogen valve box. These lines shown in Fig. 10 as LN₂-14, LN₂-16, LN₂-17, and LN₂-19 support an external vacuum system, the magnet heat exchanger, the refrigerator cold box, and helium purifier. They are all open-loop systems which will effect a reduction in fluid availability to the closed-loop system described above.

1.8.2 Program Description

The program to analyze the liquid nitrogen distribution system LIQNIT is composed of four separate subroutine programs - N2MAIN, LNSYST, DPCAL, and N2PROP. Calling LIQNIT from the main system program subroutine CONTRL will transfer program control to the subroutine N2MAIN. Subroutine N2MAIN in turn calls the remaining three subroutines as required to perform the analysis.

1.8.2.1 N2MAIN

This subroutine reads in all data pertinent to the liquid nitrogen systems analysis from a data deck (or data file). N2MAIN will first set up the line geometry for each of the six flow lines analyzed. The line number is first read in, followed by a sequence of cards which contain the line length, inlet/exit height, effective L/D ratio for components, three heat rate terms, the line-type identifier, and number of branches should the line section be a "T" branch. Up to 100 data cards are input for each line number, with termination being made after a negative line length is encountered.

External parameters are next read into the system. The first card initializes the thermodynamic state of the nitrogen by specifying the storage tank pressure and inlet quality. The next card inputs the number of layers of multilayer insulation to be wrapped about the insulated lines and shields as well as the ambient boundary temperature. Flow rate to the four open-loop systems is input followed by the flow rate and line diameters of all six lines to complete the data necessary for a run. This last input is read in as part of a DO loop which allows for up to 10 different cases to be analyzed for

any given run. Fewer cases may be run by inserting a negative flow rate on a data card following the last case of interest.

The program proceeds to first evaluate the multilayer insulation thermal conductivity and, second, the net heat rate to each of the line sections. A printout is then provided to the user summarizing the input line geometry, heat rates, and line type. Control is then transferred to subroutine LNSYST where the thermal analysis is performed.

1.8.2.2 LNSYST

Subroutine LNSYST controls the step-by-step evaluation of the pressure drop and change in thermodynamic state of the nitrogen in consecutive line sections. Given the vapor pressure, the following properties are evaluated - temperature, liquid density, liquid viscosity, vapor density, vapor viscosity, heat of vaporization, and the enthalpy versus pressure slope of the saturated liquid. The Reynolds Number and friction factor are then computed. The line configuration variables are changed to reflect the next line section under analysis to complete the set of data required for the pressure drop calculation. Subroutine DPCAL is then called to determine both the change in pressure along the line section as well as the change in thermodynamic state of the nitrogen.

Included in subroutine LNSYST is a routine to adjust the mass flow rates in each of the four parallel lines (LN_0-11 , LN_1-12 , LN_2-13 , and LN_3-15 in Fig. 1) until an equal pressure is realized at the LN_1 return valve box where the lines recombine.

1.8.2.3 DPCAL

Given the input thermodynamic state of the nitrogen and the line section description, subroutine DPCAL computes the pressure drop across the component and change in thermodynamic state of the nitrogen. The vapor velocity, vapor

Mach number, as well as the combined liquid/vapor mixture density, are also determined.

Called at several locations in the subroutine (as well as in subroutine LYSYST) is a subroutine which evaluates the nitrogen thermodynamic properties from the equation of state, N2PROP.

1.8.2.4 N2PROP

Subroutine N2PROP determines thermodynamic properties of nitrogen required in the pressure drop calculation. Input is the line pressure and the nitrogen temperature from the previous calculation. N2PROP solves the vapor pressure equation for the new nitrogen temperature and then uses that temperature to compute the liquid and vapor viscosity, density, and enthalpy, heat of vaporization, and the slope of the liquid enthalpy curve with respect to pressure. These variables float through LNSYST, DPCAL, and N2PROP using COMMON statements.

1.9 GASEOUS HELIUM RECOVERY SYSTEM ANALYSIS SUBPROGRAM

The GHe Recovery System Analysis Subprogram is an integrated analysis package which may be called in by the MFTF*CSA program to perform single or multiple case analyses for the purpose of evaluating GHe recovery performance against specified operating constraints.

1.9.1 Problem Definition

The configuration analyzed is as described in the CVI Helium Recovery System P&I schematic, Fig. 10. More detailed definition of the subsystem is provided in the Final Report. Both the low-pressure (ambient) and high-pressure line sections are analyzed independently with mass flow rate, line size, and ambient temperature as the input parameters.

CONTRL, being a "main" or "driver" routine, is only mentioned where it calls another element (subroutine or function). Other elements listed beside them are currently not in use by the program; however, they are present in the file for planned future use when the program is expanded and upgraded to the final MFTF configuration.

1.8 LIQUID NITROGEN DISTRIBUTION SYSTEM ANALYSIS SUBPROGRAM

The LN₂ Distribution System Analysis Subprogram is an integrated analysis package which may be called in by the MFTF*CSA program to perform single or multiple case analyses for the purpose of evaluating LN₂ distribution system performance against specified operating constraints.

1.8.1 Problem Definition

Definition of the liquid nitrogen distribution system geometry used in this analysis is based primarily upon the CVI plumbing schematic shown in Fig. 9. A more detailed description of the system is provided in the Final Report.

A single service line will provide 5000 liters/hr of saturated liquid nitrogen at 308 kPa (44 psia) from an external storage tank. The liquid is pumped to the liquid nitrogen inlet valve box located on the third floor of the MFTF building. The current analysis allows for flow to four parallel flow loops which are designated as lines LN₂-11, LN₂-12, LN₂-13, and LN₂-15 on Fig. 9 (external upper cryopanel, external lower cryopanel, internal cryopanel, and Dewar shield, respectively). Each loop returns to the liquid nitrogen exit valve box where the cryogen lines recombine to a single vent line. The vent line is then routed to a location near the liquid nitrogen storage tank where the excess vapor is vented to the atmosphere.

Given the line size used in each of the flow loops, including supply and vent line, the pressure gradient and thermodynamic state of the nitrogen is determined at each successive line location along the distribution line.

2

Fig. 10 Gaseous Helium Recovery System Schematic

100% SUPPLY

REF. 100%

GENERAL NOTES

In the low-pressure section, helium is displaced from the recovery gas bag to the compressor with the driving force being provided by one of the two parallel recovery system blowers - the redundant blower being valved "OFF." The pressure in the helium gas bag is assumed constant during the recovery process at the local ambient pressure.

The recovery compressor causes a step-function change in the gas exit pressure to 16543.0 kPa which initiates flow in the high-pressure line section. The helium continues through a single dryer dessicant tower, filter and purifier system leading ultimately to the clean gas storage farm. Access to the parallel dryer, filter, and purifier components is not allowed by analytically valving "OFF" that section of the line.

1.9.2 Program Description

The program to analyze the helium gas recovery system GHe is composed of six separate subroutine programs - DATAIN, GASRCV, DPLINE, DPVALV, DENCAL, and COMPDP. Calling GHe from the main system program subroutine CCTRL will transfer program control to the subroutine DATAIN. Subroutine DATAIN will read in the system configuration input data and call GASRCV to perform the analysis. The remaining subroutines perform calculations which are required at several locations within GASRCV.

1.9.2.1 DATAIN

Subroutine DATAIN reads in the line geometry information that is required to perform the analysis. Each data card contains data for one line section and includes line length, elbows, effective L/D for components other than lines or elbows (i.e., valves, etc.) and the component type identifier. The component type identifier is a positive real number that refers to those components where further flow information is needed, i.e., the recovery blower, dessicant dryer, gas filter, and gas purifier system.

The low-pressure system configuration is first input with a maximum capability for 100 line sections to be defined. Input may be terminated earlier if desired by inputting a negative component identifier. The total number of line sections in the low-pressure system is given by the variable NUMBL0 which is computed as each card is being read. In a similar manner, the high-pressure system configuration is next input with, again, a maximum capacity for 100 line sections to be defined. Input may be terminated earlier by inputting a negative component identifier. The total number of line sections in the high-pressure system is given by the variable NUMBH1 which is computed as each card is being read.

For each system configuration as specified above, a parametric analysis is performed where mass flow rate and line diameter is varied for any given ambient temperature. The mass flow rate and diameter are varied within the program of a nested D0 loop (diameter being varied with the mass flow loop). The limits and increments on these parameters are specified in the data cards as MINIT, MFINAL, MSTEP, and IDIAM1, IDIAM2, ISTEP, respectively. Integer values are converted to real property parameters by multiplying by 0.01 within the program.

The gas temperature, gas bag pressure, and recovery compressor exit pressure are next input from a single data card after which control is transferred to subroutine GASRCV where the analysis is performed. Up to 10 different cases can be performed for each run by listing the required temperature and pressure on successive data cards. Should lower cases be required, exiting to the program RETURN may be accomplished by placing a negative gas temperature after the last case of interest.

1.9.2.2 GASRCV

Subroutine GASRCV performs the analysis of the helium recovery system in the form of a parametric analysis. Pressure, pressure gradient, Mach number, and density, as well as the Reynolds Number and friction factor, are all evaluated as a function of mass flow rate and diameter.

For all mass flow rates and line diameters, the analysis of the low pressure line is performed first. The thermodynamic state of the helium at each successive line location is evaluated until either the gas reaches the recovery compressor or the flow becomes choked. At that point, the program begins analysis of the high-pressure system using the same mass flow rates and diameter as used in the low-pressure analysis. In the high-pressure section, analysis of each line section continues until either the storage farm is reached or again the flow becomes choked.

At each line section, the program makes a check of the line type (line, valve, or component) and transfers control to either subroutine DPLINE, DPVALV, or CØMPDP to evaluate the pressure drop. Upon return from the subroutine, the density is reevaluated at the new line section pressure by subroutine DENCAL.

1.9.2.3 DPLINE, DPVALV, CØMPDP, DENCAL

Subroutines DPLINE and DPVALV, respectively, compute the line section pressure drop across a line (including elbows) or valve. Standard frictional pressure drop consistent with an equivalent L/D ratio is used to determine the valve pressure drop, while the line pressure drop is found assuming isothermal frictional flow in a constant area duct.

Subroutine CØMPDP is used to evaluate the pressure drop across the recovery blower, dryer dessicant, filter, and purifier system. At present, constant worst case values of -13.8 kPa across the recovery blower and 172.0 kPa across all three remaining components is assumed. The program can easily be updated to incorporate actual data when available.

After each pressure drop calculation, the gas density is reevaluated in subroutine DENCAL. Subroutine DENCAL uses the equation of state as described in NBS Technical Note 15PA, January 1962, to perform this calculation.

Section 2

SAMPLE PROGRAM RUN - MFTF*CSA

A sample run of the MFTF*CSA. program is presented in Appendix D of this manual. The run was executed using the runstream MFTF-A*RUNMFTF-A listed in Appendix B and discussed in sections 1.5.4 and 1.5.4.2.

The sample run was initiated with an assignment of the runstream file followed with an adding of the assigned file:

```
@ASC,A      MFTF-A*RUNMFTF-A.  
@ADD        MFTF-A*RUNMFTF-A.
```

These commands caused the computer system software to read-in, setup, and list the several input data files required for the program run. Following the setting up and listing of the data files, the system software copied in the MFTF*CSA. program file into core memory and proceeded with program execution.

The program, in this instance, was called upon to evaluate all major subsystems of the MFTF configuration and therefore executed all major program elements. No tradeoff or parametric comparisons were included in this run.

As an aid in finding information in the printed run output, a paging header has been made a part of the output format. This heading currently gives the users name, department, phone extension, building location, page number, date of run, time of run, and case number. The system assigned RUN number was not included, since it was not known if the LLL computer system assigned such numbers.

For the sample run, the following page numbers help locate the specifics of the information presented in the printed output:

<u>PAGE</u>	<u>INFORMATION</u>
D20	Table Input Summary
D21	First System (MAGNET) Called
D22	MAGNET Input Data
D23 - D24	MAGNET System Configuration
D25	Estimated MAGNET Parameters
D26	Computed Configuration Parameters Loop-1
D27	Computed Configuration Parameters Loop-2
D28	MAGNET Supply Tank Data
D29	Second System (CRYOPANELS) Called
D30	CRYOPANEL Input Data
D31 - D33	CRYOPANEL System Configuration
D34	Estimated CRYOPANEL Parameters
D35	Configuration Parameters - Zone-2
D36	Configuration Parameters - Zone-1
D37	Configuration Parameters - Zone-3
D38	Configuration Parameters - Zone-4
D39	Configuration Parameters - Return Line
D40	CRYOPANEL Supply Tank Data
D41	Third System (REFLIQ) Called
D42	Refrigerator-Liquefier Input Data
D43 - D46	REFLIQ System Configuration
D47	Computed REFLIQ Parameters
D48	Configuration Parameter - MAGNET Dewar Off-gas Line
D49	Configuration Parameter - CRYOPANEL Dewar Off-gas Line
D50	Configuration Parameter - Storage Dewar Off-gas Line
D51	Configuration Parameter - HP Cold Gas Helium Outlet
D52	Configuration Parameter - Sto. Dewar HP-Cold He Supply
D53	Configuration Parameter - MAGNET Dewar HP-Cold He Supply

<u>PAGE</u>	<u>INFORMATION</u>
D54	Configuration Parameter - CRYPAN Dewar HP-Cold He Supply
D55	Configuration Parameter - Comp. Purif. Circuit (LP-HP)
D57	LN ₂ Supply System
D77	GHe Recovery System

```
1      SUBROUTINE GASRCV(TG,PBAG,PCOMP)
2      C
3      LOGICAL PAGE, JP
4      C
5      INCLUDE CPAGE
6      C
7      COMMON/HEGAS/RL(100),RN(100),RLD(100),COMP(2,100)
8      COMMON/HEGAS/RL1(100),RN1(100),RLD1(100)
9      COMMON/HEGAS/NUMBLD,NUMBHI
10     COMMON/HEGAS/MINIT,MFINAL,MSTEP
11     COMMON/HEGAS/IDIAM1,IDIAM2,ISTEP
12     C
13     C
14     C SPECIFY MDOT(KG/SEC) AND DIA(M) --- EVALUATE REYN AND F-FACTOR
15     C
16     REAL MDOT
17     DO 390 II=MINIT,MFINAL,MSTEP
18     RI=II
19     MDOT=0.01*RI
20     DO 390 JJ=IDIAM1,IDIAM2,ISTEP
21     RJ=JJ
22     DIA=0.01*RJ
23     REYN=2.645E6*MDOT/(DIA*(TG**0.656))
24     F=0.005
25     BOUND=0.01
26     100 FUNC1=4.0*(ALOG10(REYN*(F**0.5)))-0.4-(1.0/(F**0.5))
27     DFUNCT=(1.73718/(F*REYN))+0.5/(F**1.5)
28     IF (FUNCT.EQ.0.0) GO TO 120
29     IF (DFUNCT.EQ.0.0) DFUNCT=0.001
30     FF=F-(FUNCT/DFUNCT)
31     IF (FF.GT.0.0) GO TO 110
32     F=BOUND/10.0
33     GO TO 100
34     110 IF ((F-FF)**2.LT.1.0E-13) GO TO 120
35     F=FF
36     GO TO 100
37     120 CONTINUE
38     C
39     JP = PAGE(0)
40     C
41     WRITE (6,130) DIA,MDOT,REYN,F
42     130 FORMAT(1H0,T3,'DIA(METER)',F6.3,T25,'MDOT(KG/SEC)',F6.3,T50,'REYN0
43     1LDS NUMBER',F10.1,T82,'F-FACTOR',F9.6)
44     WRITE (6,140) TG,PBAG,PCOMP
45     140 FORMAT(1H0,TG=' ',F7.2,T35,'PBAG=' ,F8.3,T65,'PCOMP=' ,F9.2)
46     WRITE (6,150)
47     150 FORMAT(/,T5,'LINE',T12,'END NODES',T26,'DP',T40,'DP/L(GEOM)',T60,'
48     IMACH NO.',T76,'PRESSURE',T92,'DENS(Y')
49     WRITE (6,160)
50     160 FORMAT(125,'(KPA)',T41,'(KPA/M)',T77,'(KPA)',T91,'(KG/M**3)',/,/)
51     C
52     C
53     C LOW PRESSURE HELIUM RECOVERY SYSTEM LINE ANALYSIS
54     C
55     PP=PBAG
56     CALL DENCAL(DEN,PP,TG)
57     RMACH=2.163E-2*MDOT/((DEN*DIA*DIA*SQRT(TG))
```

```

58 WRITE (6,170)RMACH,PP,DEN
59 170 FORMAT(15,'LOW PRESSURE LINE ANALYSIS'//,T35,'AT RECOVERY BAG EXIT
60 1','T60,F7.5,T75,F12.4,T92,F7.3)
61 DO 240 KA=1,NUMBLO
62 K1=KA+B
63 K2=KA+9
64 XLD=(RL1(KA)/DIA)+(31.0*RN1(KA))+RLD1(KA)
65 IF (XLD.LE.0.0) GO TO 230
66 IF (RLD1(KA).GT.0.0) GO TO 180
67 CALL DPLINE(OP,F,XLD,PP,RMACH,PGRAD,DIA)
68 GO TO 190
69 180 CALL DPVALV(DP,F,XLD,PP,MDOOT,DEN,DIA,PGRAD)
70 190 IF (DP.LT.0.0) GO TO 250
71 PP=PP-DP
72 CALL DENCAL(DEN,PP,TG)
73 RMACH=2.163E-2*MDOOT/(DEN*DIA*DIA*SQRT(TG))
74 IF (RMACH.GT.0.7745) GO TO 250
75 IF (PGRAD.LT.0.0) GO TO 210
76 WRITE (6,200)KA,K1,K2,DP,PGRAD,RMACH,PP,DEN
77 200 FORMAT(15,'L',I3,T11,I3,'-',I3,T22,F9.4,T38,F12.4,T60,F7.5,T75,F1
78 12.4,T92,F7.3)
79 GO TO 240
80 210 WRITE (6,220)KA,K1,K2,DP,RMACH,PP,DEN
81 220 FORMAT(15,'L',I3,T11,I3,'-',I3,T22,F9.4,T60,F7.5,T75,F12.4,T92,F7
82 1.3)
83 GO TO 240
84 230 TYPE=COMP(1,KA)
85 CALL COMPOP(TYPE,DP)
86 PP=PP-DP
87 CALL DENCAL(DEN,PP,TG)
88 RMACH=2.163E-2*MDOOT/(DEN*DIA*DIA*SQRT(TG))
89 IF (RMACH.GT.0.7745) GO TO 250
90 GO TO 210
91 240 CONTINUE
92 C
93 GO TO 270
94 250 WRITE (6,260)KA,K1,K2
95 260 FORMAT(15,'L',I3,T11,I3,'-',I3,T22,'FLOW IS CHOKED IN THIS LINE S
96 1ECTION FOR THIS FLOW RATE AND DIAMETER')
97 C
98 C
99 C
100 C
101 HIGH PRESSURE HELIUM RECOVERY SYSTEM LINE ANALYSIS
102 270 PP=PCOMP
103 CALL DENCAL(DEN,PP,TG)
104 RMACH=2.163E-2*MDOOT/(DEN*DIA*DIA*SQRT(TG))
105 WRITE (6,280)RMACH,PP,DEN
106 280 FORMAT(//,T4,'HIGH PRESSURE LINE ANALYSIS'//,T37,'AT COMPRESSOR E
107 1XIT',T60,F7.5,T75,F12.4,T92,F7.3)
108 DO 360 KB=1,NUMBH1
109 K1=KB+20
110 K2=KB+21
111 XLD=(RL(KB)/DIA)+(31.0*RN(KB))+RLD(KB)
112 IF (XLD.GT.0.0) GO TO 290
113 TYPE=COMP(2,KB)
114 CALL COMPOP(TYPE,DP)
115 GO TO 320
116 290 IF (RLD(KB).GT.0.0) GO TO 300

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** ANALYSIS **

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116 CALL DPLINE(DP,F,XLD,PP,RMACH,PGRAD,DIA)
117 GO TO 310
118 CALL DPVALV(DP,F,XLD,PP,MDDT,DEN,DIA,PGRAD)
119 310 IF (DP.LT.0.0) GO TO 360
120 PP=PP-OP
121 CALL DENCAL(DEN,PP,TG)
122 RMACH=2.163E-2*MDDT/(DEN*DIA*DIA*SQR(TG))
123 IF (RMACH.GT.0.7745) GO TO 360
124 IF (PGRAD.LT.0.0) GO TO 340
125 WRITE (6,330)KB,K1,K2,DP,PGRAD,RMACH,PP,DEN
126 330 FORMAT(15,'H',I3,T11,I3,'-',I3,T22,F9.4,T38,F12.4,T60,F7.5,T75,F1
127 12.4,T92,F7.3)
128 GO TO 380
129 340 WRITE (6,350)KB,K1,K2,DP,RMACH,PP,DEN
130 350 FORMAT(15,'H',I3,T11,I3,'-',I3,T22,F9.4,T60,F7.5,T75,F12.4,T92,F7
131 1.3)
132 GO TO 380
133 360 WRITE (6,370)KB,K1,K2
134 370 FORMAT(15,'H',I3,T11,I3,'-',I3,T22,'FLOW IS CHOKED IN THIS LINE S
135 1ECTION FOR THIS FLOW RATE AND DIAMETER')
136 GO TO 390
137 380 CONTINUE
138 390 CONTINUE
139 C
140 RETURN
141 C
142 END

```

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1  CCONFIG* PROC
2  C
3  C
4  C    PARAMETER ICNF=180
5  C
6  C    INTEGER CFUNCT,CFTYPE,CMTYPE,CITYPE,CNOPER,CNSTBY
7  C
8  C    REAL LOD, ITHICK, MACH, NBAR
9  C
10 C
11 C    COMMON /CCNFIG/ (ICNF(6), CONFIG(ICNF,8), PRES(ICNF), TEMP(ICNF),
12 C      WDDTN(ICNF), WDOT1(ICNF), WDOT6(ICNF), QUAL(ICNF),
13 C      DELP(ICNF), VELO(ICNF), RDENS(ICNF), REYND(ICNF),
14 C      MACH(ICNF), MFLG(ICNF), CMPVOL(ICNF),
15 C      ISTRT(2), KENDC(2), LCNF1(4,6), WTOFSY(5)
16 C
17 C    DIMENSION FRCDEF(ICNF), LOD(ICNF), DIAM(ICNF), ITHICK(ICNF),
18 C      NBAR (ICNF), CODE(ICNF), CHEAD(ICNF)
19 C
20 C    EQUIVALENCE (FRCDEF(1),CCNFIG(1,2)),(LOD (1),CCNFIG(1,3)),
21 C      (DIAM (1),CCNFIG(1,4)),(ITHICK(1),CCNFIG(1,5)),
22 C      (NBAR (1),CCNFIG(1,6)),(CODE (1),CCNFIG(1,7)),
23 C      (CHEAD (1),CCNFIG(1,8))
24 C
25 C    EQUIVALENCE (CFUNCT,ICNF(1)),(CFTYPE,ICNF(2)),
26 C      (CMTYPE,ICNF(3)),(CITYPE,ICNF(4)),(CNOPER,ICNF(5)),
27 C      (CNSTBY,ICNF(6))
28 C
29 C    EQUIVALENCE (ISTRT,IOSTT),(ISTRT(2),IHSTT),(KENDC,KOEND),
30 C      (KENDC(2),KHEND)
31 C
32 C    EQUIVALENCE (WTOFSY ,O2SWT),(WTOFSY(2),D2IWT),
33 C      (WTOFSY(3),H2SWT),(WTOFSY(4),H2IWT),(WTOFSY(5),TTLSWT)
34 C
35 C    CNSTBY = 0
36 C
37 C    ***** CCONFIG VARIABLE DEFINITIONS.
38 C
39 C      * CONFIGURATION FUNCTION CODE AND TYPE.
40 C      * CFUNCT = 1, GAS          CFTYPE = 1, HELIUM
41 C      *              = 2, NITROGEN
42 C
43 C      *
44 C      * = 2, MAGNET      NO OPTIONS
45 C
46 C      * = 3, LINE      CFTYPE = 10 A FIXED NUMBER
47 C
48 C      * = 4, CONTROL    USES TWO DIGIT INDEX AS FOLLOWS.
49 C      *                  IDV = TENS DIGIT (10,20,ETC.)
50 C      *                  CFTYPE = UNITS DIGIT (1,2,ETC.)
51 C      *                  IDV = 10 FOR LIGHT WGT.CONTROL
52 C      *                  = 20 FOR MED. WGT.CONTROL
53 C      *                  = 30 FOR HEAVY WGT.CONTROL
54 C      *                  = 40 FOR EXT.HEAVY CONTROL
55 C      *                  CFTYPE = 1 FOR ORIFICE
56 C      *                  = 2 FOR FLOW METER
57 C
58 C      *
59 C      * = 5, FITTING    USES TWO DIGIT INDEX AS FOLLOWS.
60 C      *                  LDV = TENS DIGIT (10,20,ETC.)

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58 C * CFTYPE = UNITS DIGIT (1,2,ETC.)
59 C * LDV = 10 FOR USE IN LINE ONLY
60 C * = 20 FOR 50% REDUCER
61 C * = 30 FOR 20% REDUCER
62 C * = 40 FOR DAYONET FITTING
63 C * CFTYPE = 1 FOR MISC. FITTINGS
64 C *
65 C * = 6. TAP USES TWO DIGIT INDEX AS FOLLOWS,
66 C * LDV = TENS DIGIT (10,20,ETC.)
67 C * CFTYPE = UNITS DIGIT (1,2,ETC.)
68 C * LDV = 10 FOR USE IN LINE ONLY
69 C * = 20 FOR 6X4X5 R-O-TEE
70 C * = 30 FOR 6X2X5 R-O-TEE
71 C * = 40 FOR 2X2X2 Y-TEE
72 C * CFTYPE = 1 FOR TAP
73 C *
74 C * = 7. TEE USES TWO DIGIT INDEX AS FOLLOWS,
75 C * LDV = TENS DIGIT (10,20,ETC.)
76 C * CFTYPE = UNITS DIGIT (1,2,ETC.)
77 C * LDV = 10 FOR USE IN LINE ONLY
78 C * = 20 FOR 4-WAY TEE
79 C * = 30 FOR 3-WAY TEE
80 C * CFTYPE = 1 FOR TEE
81 C *
82 C * = 8. ELBOW USES TWO DIGIT INDEX AS FOLLOWS,
83 C * LDV = TENS DIGIT (10,20,ETC.)
84 C * CFTYPE = UNITS DIGIT (1,2,ETC.)
85 C * LDV = 10 FOR USE IN LINE ONLY
86 C * = 20 FOR 45 DEG. ELBOW
87 C * = 30 FOR 90 DEG. ELBOW
88 C * = 40 FOR 180 DEG. ELBOW
89 C * CFTYPE = 1 FOR ELBOW
90 C *
91 C * = 9. VALVE USES TWO DIGIT INDEX AS FOLLOWS,
92 C * LDV = TENS DIGIT (10,20,ETC.)
93 C * CFTYPE = UNITS DIGIT (1,2,ETC.)
94 C * LDV = 10 FOR USE IN LINE ONLY
95 C * = 20 FOR BALL VALVE
96 C * = 30 FOR BUTTERFLY VALVE
97 C * = 40 FOR GLOBE VALVE
98 C * = 50 FOR JT VALVE
99 C * CFTYPE = 1 FOR VALVE
100 C *
101 C * 10. REGULATOR CFTYPE = UNITS DIGIT (1,2,ETC.)
102 C * LDV = 10 FOR LINE USE ONLY
103 C * = 20 FOR SINGLE STAGE REG.
104 C * CFTYPE = 1 FOR REGULATOR
105 C *
106 C * 11. CRYOPANEL - NO OPTIONS
107 C *
108 C * 12. REFRIGERATOR-LIQUIFIER - NO OPTIONS
109 C *
110 C * 13. TANK NO OPTIONS
111 C *
112 C * 14. COMPRESSOR-PURIFIER - NO OPTIONS
113 C *
114 C * 15. HEX CFTYPE = 1 FOR HIGH PRESSURE
115 C * = 2 FOR LOW PRESSURE

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116      *
117      *
118      *      16, END      NO OPTIONS
119      *
120      * CMTYPE - CONFIGURATION MATERIAL TYPE.
121      *      CMTYPE = 1, 321/347 STAINLESS STEEL
122      *                = 2, 2219-T87 ALUMINUM ALLOY
123      *                = 3, 6061-T6 ALUMINUM ALLOY
124      *                = 4, INCONEL-718 ALLOY
125      *                = 5, TITANIUM TI-6AL-4V ALLOY
126      *                = 6, TYPE 304 STAINLESS STEEL
127      *                = 7, CRES VACUUM JACKETED LINE
128      *                = 8, 2219 VACUUM JACKETED LINE
129      *
130      * CITYPE - CONFIGURATION INSULATION TYPE.
131      *      CITYPE = 1, DBL.ALUM.MYLAR/SILK NET
132      *                = 2, DBL.GOLD.MYLAR/SILK NET
133      *                = 3, DBL.ALUM.MYLAR/TISSUE GLASS
134      *                = 4, CRINK.DBL.ALUM. MYLAR
135      *                = 5, NRC-2 CRINKLED ALUMINIZED MYLAR
136      *                = 6, SUPERFLOC
137      *                = 7, MICROSPHERES (104-135 MICRON)
138      *                = 8, POLYURETHANE FOAM
139      *                = 9, FIBERGLASS BATTING (JM)
140      *                = 10, VACUUM JACKET INSULATION
141      *
142      * CNOPER - NUMBER OF OPERATIONAL UNITS (CFUNCT)
143      *
144      * CNSTBY - NUMBER OF STANDBY UNITS (CFUNCT)
145      *
146      * CONFIG - CONFIGURATION TABLE
147      *      COLUMN 1 CONTAINS THE ABOVE 6 VARIABLES PACKED
148      *                ONE PER BYTE IN THE ORDER THEY ARE
149      *                LISTED FROM LEFT TO RIGHT IN THE WORD.
150      *      COLUMN 2 CONTAINS THE FLOW FRICTION COEFFICIENT.
151      *      COLUMN 3 CONTAINS THE LENGTH OF A LINE OR THE
152      *                EFFECTIVE L/D FOR OTHER COMPONENTS.
153      *      COLUMN 4 CONTAINS THE DIAMETER OF A LINE.
154      *      COLUMN 5 CONTAINS THE INSULATION THICKNESS FOR
155      *                A LINE.
156      *      COLUMN 6 CONTAINS THE NO. OF INSULATION LAYERS
157      *      COLUMN 7 CONTAINS THE ID OF THE COMPONENT
158      *      COLUMN 8 CONTAINS THE DELTA HEAD AT THE
159      *                COMPONENT POSITION IN THE SYSTEM
160      *
161      * PRES - PRESSURE AT EACH POINT IN THE CONFIGURATION.
162      *      *****
163      *
164      *      END
```



```

1  CCNTRL* PROC
2  C
3      PARAMETER NBR SY=5, NBR SR=4
4  C
5      INTEGER  SCRIT, SYSNUM
6  C
7      COMMON /CCNTRL/              NAMSYS(NBR SY), SCRIT, SYSNUM
8      1, INTG SY, MOTRC(11), KSDGC(NBR SY, NBR SR), LREPT, NDX GAS
9  C
10     SCRIT = 1  FOR SUB-CRITICAL
11     = 2  FOR SUPER-CRITICAL
12     SYSNUM = 1, MAGNET LHE SUPPLY SYSTEM
13     = 2, CRYOPANEL LHE SUPPLY SYSTEM
14     = 3, REFRIGERATOR-LIQUIFIER SYSTEM
15     = 4, LN2 SUPPLY SYSTEM
16     = 5, GHE RECOVERY SYSTEM
17
18     NDX GAS IS THE GAS CARD INDEX (COUNTER)
19
20 C
21 END

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```

1 CFLUID* PROC
2 C
3   COMMON /CFLUID/ TSYSVO, VOLMAG, VOLCRY, WDGTDI, WDLTOT,
4   WOGMAG, WOLMAG, WOGCRY, WOLCRY, WOGSTO,
5   WOGMAG, WOLMAG, WOGCRY, WOLCRY, WOGSTO,
6   WOGMAG, WOLMAG, WOGCRY, WOLCRY, WOGSTO,
7   WOGMAG, WOLMAG, WOGCRY, WOLCRY, WOGSTO,
8   WOGMAG, WOLMAG, WOGCRY, WOLCRY, WOGSTO,
9   WOGMAG, WOLMAG, WOGCRY, WOLCRY, WOGSTO,
10  WOGMAG, WOLMAG, WOGCRY, WOLCRY, WOGSTO,
11  WOGMAG, WOLMAG, WOGCRY, WOLCRY, WOGSTO,
    END

```

1 FUNCTION CFTW (D,P,IDV)

2 C

3 C

4 C

5 C

6 C

7 C

8 C

9 C

10 REAL K1,K2,K3,K4

11 C

12 DIMENSION K1(4),K2(4),K3(4),K4(4),C1(4),C2(4),C3(4),C4(4)

13 C

14 DATA K1/0.040,0.057,0.073,0.090/

15 DATA K2/0.057,0.073,0.090,0.107/

16 DATA K3/1.000,2.500,3.300,5.500/

17 DATA K4/2.500,3.300,5.500,7.700/

18 DATA C1/1.750,3.950,5.730,8.910/

19 DATA C2/3.950,5.730,8.910,12.35/

20 DATA C3/0.800,1.500,2.500,3.500/

21 DATA C4/1.500,2.500,3.500,4.500/

22 C

23 C

SET IDV TO EXTRA HEAVY IF NOT INPUT

24 IF (IDV .EQ. 0) IDV = 4

25 IF(D.LE.1.) GO TO 10

26 IF(P.GT.300.0.AND.D.GT.3.5) GO TO 5

27 IF(P.GT.1000.0.AND.D.LE.3.5) GO TO 5

28 CFTW = K1(IDV)*D*D*D + C1(IDV)

29 RETURN

5 CFTW = K2(IDV)*D*D*D + C2(IDV)

30 RETURN

10 IF(P.GE.1000.) GO TO 15

31 CFTW = K3(IDV)*D + C3(IDV)

32 RETURN

15 CFTW = K4(IDV)*D + C4(IDV)

33 RETURN

34 END

```

1  CIOUNT* PROC
2  C
3      COMMON /CIOUNT/ IOUNIT(14),IIN,IOI
4  C
5      EQUIVALENCE      (MURD1 ,IOUNIT( 1)),(MURD2 ,IOUNIT( 2)),
6      1(MURD3 ,IOUNIT( 3)),(MURD4 ,IOUNIT( 4)),(MURD5 ,IOUNIT( 5)),
7      2(MURD6 ,IOUNIT( 6)),(NTAPE1,IOUNIT( 7)),(NTAPE2,IOUNIT( 8)),
8      3(NTAPE3,IOUNIT( 9)),(NTAPE4,IOUNIT(10)),(NTAPE5,IOUNIT(11)),
9      4(NTAPE6,IOUNIT(12)),(NTAPE7,IOUNIT(13)),(NTAPE8,IOUNIT(14))
10 C
11 C
12 C      IOUNIT - AND ARRAY OF VALUES WITH ARE THE LOGICAL UNIT NUMBERS
13 C      AS DETAILED IN SEC. 4.4.1 OF THE LMSC DIGITAL
14 C      COMPUTER SYSTEMS MANUAL (LMSC-685147).
15 C
16 END

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.. CKEYS ..

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1 CKEYS= PROC
2 C
3 COMMON /CKEYS/ KEY1,KEY2
4 C
5 END
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ALL

AL2

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1
2 CMAG* PROC
3 C
4   COMMON/HEDATA/HELD,HELH,HELS,HELCV,HELZ,HELE,HELCP,HELW,HELVS
5     1 , HEVSC
6 C
7   COMMON/HESATD/HEDG,HEDL,HESG,HESL,HEHG,HEHL,HEEG,HEEL,HECVG,HECVL,
8     1 , HECRG,HECPL,HEWG,HEWL,HEZG,HEZL,HESVG,HESVL,HET
9     2 , HELVSC,HEGVSC
10 C
11   COMMON /CMAG/ PMAGDW, TMAGDW, HEMWT, QMAGI, VHEMAG, VHEMDW,
12     1 , VHESDW, HDMAGI, HDMAGO, HDMAGC, NUMMAG, WDTLH1
13     2 , QLKSDW
14 C
15   COMMON /CMAGO/ WDOT1(6), SVLINT, SVLMIX, RHOMIX, QVALD,
16     1 , WDTGHE, WDTGH2, PMAGO, TMAGO
17 C
18   COMMON /CRYIN/ NUMCRP, PCRYDW, TCRYDW, VHECDW, WDTLCH,
19     1 , QCR(5), VHECR(5), HOCRI(5), HOCRO(5), WDTCR(5)
20 C
21   COMMON /CRYP/ PCRYI(5), PCRYO(5), SLVIN(5), TCRI(5), TCRO(5),
22     1 , DENS(5), QGENHR(5), TIM1(5), TIM2(5), WDTMXG(5), WDTG(5),
23     2 , WDTL(5), QVAL(5), SVLMX(5), RHOMX(5), RHOL(5), RHUG(5),
24     3 , WDOTBR(6), TEMTAP(6), PRSTAP(6)
25 C
26   COMMON/PSET/ NPSYS
27 C
28   COMMON/MCTANK/ PTANK, TTANK
29 C
30   COLD BOX TEMPERATURES, PRESSURES, AND FLOWRATES
31 C
32   COMMON /RLDATA/ TCB(11), PCB(3), WDTCB(5), HENTH(11)
33 C
34   COMMON /RLINP1/ TN2L,DN2O,TN2O,PN2I,HN2L,HN2V,HN2O,GMWTN2,
35     1 , DN2L,DN2LV,QLEAK1,QLEAK2
36 C
37   ****
38   * HEDATA CONTAINS THE CURRENT PROPERTY VALUES FOR THE LAST
39   * CALL TO HEPROP FOR LIQUID OR GAS STATES.
40   *
41   * HESATD CONTAINS THE CURRENT SATURATED PROPERTY VALUES FOR
42   * THE LAST CALL TO HEPROP FOR THE SATURATED LIQUID-VAPOR
43   * STATE
44   ****
45   END

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1  CMATRL+ PROC
2  C
3  REAL MINTHK
4  C
5  COMMON/CMATRL/RHOM(10),RHOI(10),RHOIS(10),MINTHK(15)
6  C
7  **** RHOM(I) IS THE DENSITY OF THE SELECTED LINE MATL. (LB/CU.FT)
8  C
9  C
10 C
11 C      * I = 1, FOR 321/347 STAINLESS STEEL
12 C      * I = 2, FOR 2219-T87 ALUM. ALLOY
13 C      * I = 3, FOR 6061-TL ALUM. ALLOY
14 C      * I = 4, FOR INCONEL-718
15 C      * I = 5, FOR TITANIUM TI-6AL-4V ALLOY
16 C
17 C
18 C
19 C
20 C      **** RHOI(1)-THE DENSITY OF THE CHOSEN INSULATION MATRL.(LB/CU.FT)
21 C      * OPTIMIZED LAYER DENSITY VALUES.
22 C
23 C      * I = 1, FOR DOUBLE ALUMINIZED MYLAR/SILK NET (50 LAYER/INCH)
24 C      * I = 2, FOR DOUBLE GOLDIZED MYLAR/SILK NET ( 50 LAYER/INCH)
25 C      * I = 3, FOR DOUBLE ALUMINIZED MYLAR/TISSUE GLASS (100-LAY/IN)
26 C      * I = 4, FOR CRINKLED DBLE.ALUM.MYLAR/TISS.GLASS ( 30-LAY/IN)
27 C      * I = 5, FOR NRC-2 CRINKLED ALUM. MYLAR ( 40 LAYER/INCH)
28 C      * I = 6, FOR SUPERFLOC ( 30 LAYER/INCH)
29 C      * I = 7, FOR MICROSPHERES (104 MICRON DIA.) (PER CUBIC FOOT)
30 C      * I = 8, FOR POLYURETHANE FOAM (PER CUBIC FOOT)
31 C      * I = 9, FOR FIBERGLASS (J.M)(800-1200 DEG.R) (PER CUBIC FOOT)
32 C
33 C      * REF.'HDBK FOR THERMAL DESIGN'-LMSC-AB47082,VOL.2,25 JUNE 1967
34 C      * 'MICROSPHERES'-DATA OF PARMLEY AND CUNNINGHAM, LMSC.
35 C
36 C
37 C
38 C
39 C      **** RHOIS(I)--DENSITY OF THE CHOSEN INSULATION MATRL.(LB/CU.FT)
40 C      * ON PER LAYER BASIS FOR SPECIFYING LAYER FENSITY.
41 C
42 C      * I = 1, FOR DOUBLE ALUMINIZED MYLAR/SILK NET (PER LAYER/INCH)
43 C      * I = 2, FOR DOUBLE GOLDIZED MYLAR/SILK NET (PER LAYER/INCH)
44 C      * I = 3, FOR DOUBLE ALUMINIZED MYLAR/TISSUE GLASS (PER-LAY/IN)
45 C      * I = 4, FOR CRINKLED DBLE.ALUM.MYLAR/TISS.GLASS (PER-LAY/IN)
46 C      * I = 5, FOR NRC-2 CRINKLED ALUM. MYLAR (PER LAYER/INCH)
47 C      * I = 6, FOR SUPERFLOC (PER LAYER/INCH)
48 C      * I = 7, FOR MICROSPHERES (104 MICRON DIA.) (PER CUBIC FOOT)
49 C      * I = 8, FOR POLYURETHANE FOAM (PER CUBIC FOOT)
50 C      * I = 9, FOR FIBERGLASS (J.M)(800-1200 DEG.R) (PER CUBIC FOOT)
51 C      * REF.'HDBK FOR THERMAL DESIGN'-LMSC-AB47882,VOL.2,25 JUNE 1967
52 C      * 'MICROSPHERES'-DATA OF PARMLEY AND CUNNINGHAM, LMSC.
53 C
54 C
55 C
56 C
57 C

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MINIMUM THICKNESS DATA (INCHES)

.. CMATRL ..

58 C
59 END

FILE: MFTF+CSA

TIME: 10:20:38

DATE 040579

PAGE 15

ALS

```

1      C
2      C
3      C      * * * * *
4      C      * ROUTINE NAME - PRESSURE DROP COMPUTATION *
5      C      * FOR ENTIRE CONFIGURATION *
6      C      * ROUTINE LANG - FORTRAN V UNIVAC 1110 EXEC 8 *
7      C      * PROGRAMMER - R.F.HAUSMAN 104-6213-30235 *
8      C      * DATE CODED - AUGUST 23, 1978 *
9      C      * * * * *
10     C      * INPUT DATA 15: PRESSURE IN KPA, AND TEMP IN DEG. K *
11     C
12     C
13     C      SUBROUTINE CMPCAL
14     C      INTEGER GSTATE, GLOOP
15     C      REAL MUHE
16     C
17     C      LOGICAL PAGE, JP
18     C
19     C
20     C      INCLUDE CCNFIG
21     C      INCLUDE CCNTRL
22     C      INCLUDE CFLUID
23     C      INCLUDE CIOUNT
24     C      INCLUDE CMAG
25     C      INCLUDE CNAMES
26     C      INCLUDE CONST
27     C      INCLUDE CPAGE
28     C      INCLUDE TABLOK
29     C
30     C
31     C      ****
32     C      * IF CFUNCT = 1, A GAS GO TO (100)
33     C      * 2, A MAGNET GO TO (200)
34     C      * 3, A LINE GO TO (300)
35     C      * 4, A CONTROL GO TO (400)
36     C      * 5, A FITTING GO TO (450)
37     C      * 6, A TAP GO TO (500)
38     C      * 7, A TEE GO TO (460)
39     C      * 8, A ELBOW GO TO (450)
40     C      * 9, A VALVE GO TO (400)
41     C      * 10, A REGULATOR GO TO (405)
42     C      * 11, A CRYOPANEL GO TO (600)
43     C      * 12, A REF-LIQ. GO TO (250)
44     C      * 13, A TANK GO TO (700)
45     C      * 14, A COMPUR GO TO (800)
46     C      * 15, A HT.XCHNGR GO TO (900)
47     C      * 16, A END GO TO (1100)
48     C      ****
49     C      ***** INITIALIZE THE ROUTINE
50     C
51     C      IOX = 0
52     C      ISIGN = 1
53     C      ITEE = 0
54     C      ITAP = 0
55     C      IRLQ = 0
56     C      MAGIX = 0
57     C      ITANK = 0

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CMP00100
CMP00200
CMP00300
CMP00400
CMP00500
CMP00600
CMP00700
CMP00800
CMP00900
CMP01000
CMP01100
CMP01200
CMP01300
CMP01400
CMP01500
CMP01600
CMP01700
CMP01800
CMP01900
CMP02000
CMP02100
CMP02200
CMP02300
CMP02400
CMP02500
CMP02600
CMP02700
CMP02800
CMP02900
CMP03000
CMP03100
CMP03200
CMP03300
CMP03400
CMP03500
CMP03600
CMP03700
CMP03800
CMP03900
CMP04000
CMP04100
CMP04200
CMP04300
CMP04500
CMP04600
CMP04700
CMP04800
CMP04900
CMP05000
CMP05100
CMP05200
CMP05300
CMP05400
CMP05500
CMP05600

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AL6

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58      JKM = 0
59      DLPTOT = 0.0
60      SYSVOL = 0.0
61      C1 = 1.5134E-09/(GRAVITY * PI * PI)
62
63      C      NDXGAS = NDXGAS + 1
64      IF(PAGE(0)) WRITE (10T,6050) (L5(1,NDXGAS),I=1,5)
65      WRITE (10T,6020)
66
67      C      JP = PAGE (3)
68
69      C      ***** START OF CONFIGURATION PROCESSING LOOP
70
71      C      GO 1000 11=1,1CNF
72      IDX = IDX + 1SIGN
73      MACH(IDX) = 0.0
74      MFLG(IDX) = 6H
75      CALL GETCON(IDX)
76
77      C      ***** BRANCH TO THE REQUIRED CONFIGURATION TYPE. SEE CCNFIG
78      C      ***** FOR BRANCH DEFINITIONS.
79
80      C      GO TO (100,200,300,400,450,500,460,450,400,405,600,250,700,
81      1800,900,1100), CFUNCT
82
83      C      ***** SETUP THE GAS TYPE *****
84
85      C      100 IGAS = CFTYPE
86      GSTATE = ICNFIG(5)
87      GLOOP = ICNFIG(3)
88      MAGIX = 1
89      IF(NPSYS.EQ.1) QUALX = QUALD
90      IF(NPSYS.EQ.2) QUALX = QWAL(GLDOP)
91      DIAM(IDX) = 0.0
92      WDOTN(IDX) = 0.0
93      WDOTL(IDX) = 0.0
94      WDOTG(IDX) = 0.0
95      QUAL(IDX) = 0.0
96      TEMP(IDX) = 0.0
97      PRES(IDX) = 0.0
98      DELP(IDX) = 0.0
99      VELO(IDX) = 0.0
100     RDENS(IDX) = 0.0
101     REYND(IDX) = 0.0
102     IF (IGAS .EQ. JKM) GO TO 110
103     JKM = IGAS
104     1SIGN = 1
105     1STRT(IGAS) = IDX + 1
106     JX = 0
107     110 CONTINUE
108
109     C      IF((NPSYS.EQ.1).AND.(GLOOP.GE.2)) GO TO 111
110     IF((NPSYS.EQ.2).AND.(GLOOP.GE.2)) GO TO 111
111     IF((NPSYS.EQ.3).AND.(GLOOP.GE.2).AND.(GLOOP.LE.7)) GO TO 111
112     IF((NPSYS.EQ.3).AND.(GLOOP.EQ.8)) GO TO 1111
113     GO TO 112
114     111 NDXGAS = NDXGAS + 1
115     IF(PAGE(0)) WRITE (10T,6050) (L5(1,NDXGAS),I=1,5)

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CMP05700
 CMP05800
 CMP05900
 CMP06000
 CMP06100
 CMP06200
 CMP06300
 CMP06400
 CMP06500
 CMP06600
 CMP06700
 CMP06800
 CMP06900
 CMP07000
 CMP07100
 CMP07200
 CMP07300
 CMP07400
 CMP07500
 CMP07600
 CMP07700
 CMP07800
 CMP07900
 CMP08000
 CMP08100
 CMP08200
 CMP08300
 CMP08400
 CMP08500
 CMP08600
 CMP08700
 CMP08900
 CMP08800
 CMP09000
 CMP09100
 CMP09200
 CMP09300
 CMP09400
 CMP09500
 CMP09600
 CMP09800

AL7

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116      WRITE (IOT,6020)                                CMP10000
117      JP = PAGE(3)                                     CMP10100
118      GO TO 112
119      1111 NDXGAS = NDXGAS + 1
120      IF(PAGE(0)) WRITE (IOT,6050) (LS(I,NDXGAS),I=1,5)
121      WRITE (IOT,6021)
122      JP = PAGE(3)
123
124      C 112 CONTINUE                                     CMP10200
125      C 112 CONTINUE                                     CMP10300
126      IF(I1.EQ.1) GO TO 999                             CMP10400
127
128      C 112 CONTINUE                                     CMP10500
129      IF((NPSYS.EQ.2).AND.(GLOOP.EQ.4)) GO TO 117
130      IF((NPSYS.EQ.2).AND.(GLOOP.EQ.5)) MAGIX = 2 ; GO TO 113
131      IF(NPSYS.EQ.3) GO TO 999
132
133      C 113 CONTINUE
134      TEMP(IDX) = TEMPBR                                CMP10800
135      PRES(IDX) = PRESBR                                CMP10900
136      WDOTN(IDX) = WDOTBR(GLOOP)                        CMP11000
137      IF((NPSYS.EQ.1).AND.(GLOOP.EQ.2)) WDOTN(IDX)=WDOT1(GLOOP)
138      WDOTL(IDX) = WDOTN(IDX)                           CMP11100
139      WDOTG(IDX) = 0.0
140      GO TO 114
141      113 CONTINUE                                     CMP11200
142      C 113 CONTINUE                                     CMP11300
143      DO 116 I = 1,NUMCRP                                CMP11400
144      SUMTMP = SUMTMP + TEMTAP(I)                        CMP11500
145      SUMPRS = SUMPRS + PRSTAP(I)                        CMP11600
146      116 CONTINUE                                     CMP11700
147      C 116 CONTINUE                                     CMP11800
148      XP = NUMCRP                                        CMP11900
149      TEMAVG = SUMTMP/XP                                CMP12000
150      PRSAVG = SUMPRS/XP                                CMP12100
151      C 116 CONTINUE                                     CMP12200
152      TEMP(IDX) = TEMAVG                                CMP12300
153      PRES(IDX) = PRSAVG                                CMP12400
154      WDOTN(IDX) = WDOTNQ                                CMP12500
155      WDOTL(IDX) = WDOTLO                                CMP12600
156      WDOTG(IDX) = WDOTGO                                CMP12700
157      QUAL(IDX) = WDOTG(IDX)/WDOTN(IDX)                 CMP12800
158      GO TO 114                                         CMP12900
159      C 117 CONTINUE                                     CMP13000
160      PRES(IDX) = TAPPRS
161      TEMP(IDX) = TAPTEM
162      WDOTN(IDX) = WDOTBR(GLOOP)
163      WDOTL(IDX) = WDOTN(IDX)
164      WDOTG(IDX) = 0.0
165      QUAL(IDX) = 0.0
166      C 114 CONTINUE                                     CMP13100
167      IF((IGAS.EQ.1).AND.(GLOOP.GE.2)) GO TO 999       CMP13200
168      GO TO 999                                         CMP13300
169      C 114 CONTINUE                                     CMP13400
170      C 114 CONTINUE                                     CMP13500
171      C 114 CONTINUE                                     CMP13600
172      200 CONTINUE                                       CMP13700
173      NPSYS = 1                                         CMP13800

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174      MAGIX = MAGIX + 1
175      C
176      FLD = FRCOEF(IDX) * LOD(IDX) / DIAM(IDX)
177      CMPVOL(IDX) = P104 * DIAM(IDX)**2 * LOD(IDX)
178      WDOTN(IDX) = WDOTN(IDX-1SIGN)
179      IX = IDX - 1SIGN
180      CALL HEPROP(PMAGDW,IMAGDW,1)
181      RHO = HELD + HEMWT
182      PMAGI = PMAGDW + HEHED(RHO, NOMAGI)
183      PMAGO = PMAGDW + HEHED(RHO, NOMAGO)
184      IMAGI = TEMP(IX)
185      CALL HEPROP(PMAGI,IMAGI,1)
186      CALL HEPROP(PMAGO,IMAGI,3)
187      DELH1 = HEHL - HELH
188      DELH2 = HEHG - HELH
189      QHR = OMAGI * 3600.0/2.0
190      QSAT = ((WDOTL(IX)+1000.0)/HEMWT)*DELH1
191      QVAP = QHR - QSAT
192      WDOTG(IDX) = (QVAP/DELH2)*HEMWT/1000.0
193      QUAL(IDX) = WDOTG(IDX)/WDOTL(IX)
194      WDOTL(IDX) = WDOTL(IX) - WDOTG(IDX)
195      SVLMIX = (1.-QUAL(IDX))*HESVL + QUAL(IDX)*HESVG
196      RDENS(IDX) = (1.0/SVLMIX) * HEMWT @ KG/CU-M
197      RHO = RDENS(IDX)
198      DELP(IDX) = C1*FLD*(WDOTN(IX)/CNOPER)**2/(RHO*DIAM(IDX)**4)
199      PRES(IDX) = PRES(IX) - DELP(IDX)
200      VELO(IDX) = VELF(WDOTN(IDX),SVLMIX,HEMWT,DIAM(IDX))
201      C
202      CALL HEPROP(PRES(IDX),TEMP(IX),3)
203      TEMP(IDX) = HET
204      QUALX = QUAL(IDX)
205      RHOLGM = (1.0/SVLMIX) * HEMWT @ KG/CU-M
206      MUHE = (((1.0-QUALX) * HELVSC) + QUALX * HEGVSC) * 0.00001
207      REYNO(IDX) = (DIAM(IDX)*(VELO(IDX)/3600.)*RHOLGM)/MUHE
208      HDLP = HEHED(RHOLGM,CHEAD(IDX))
209      PRES(IDX) = PRES(IDX) + HDLP
210      C
211      GO TO 999
212      C
213      C
214      C
215      C
216      C
217      C
218      C
219      C
220      C
221      C
222      C
223      C
224      C
225      C
226      C
227      C
228      C
229      C
230      C
231      C

```

***** PROCESS A REFRIGERATOR - LIQUIFIER UNIT *****

250 CONTINUE

IRLQ = IRLQ + 1

QUAL(IDX) = 0.0 @ SET QUALITY = ZERO

IF((IRLQ.EQ.2).AND.(GLOOP.EQ.5)) GO TO 252

IF((GLOOP.EQ.8).AND.(IRLQ.EQ.4)) GO TO 254

IF(GLOOP.EQ.8) GO TO 253

FLD = FRCOEF(IDX) * LOD(IDX)/DIAM(IDX)

CMPVOL(IDX) = P104 * DIAM(IDX)**2 * LOD(IDX)

WDOTN(IDX) = WDOTN(5)+3.8

WDOTL(IDX) = WDOTL(IDX-1SIGN)

WDOTG(IDX) = WDOTN(IDX)

PRES(IDX) = PCB(1)

TEMP(IDX) = TCB(9)

AL8

CMP13900
CMP14000
CMP14100
CMP14200
CMP14300

CMP14H00
CMP14900
CMP15100

CMP15300
CMP15400
CMP15500

CMP15600
CMP15800
CMP15900
CMP16000

CMP16100
CMP16200
CMP16300
CMP16400
CMP16500
CMP16600
CMP16700

A19

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232      RDENS(IDX) = RHOGAS(PRES(IDX),TEMP(IDX))
233      DELP(IDX) = C1*FLD*WDOTN(IDX)**2/(RDENS(IDX)*DIAM(IDX)**4)
234      PRES(IDX) = PRES(IDX) - DELP(IDX)
235      VELO(IDX) = 4.0*WDOTN(IDX)/(P1*DIAM(IDX)**2 * RDENS(IDX))
236      CALL HEPROP(PRES(IDX),TEMP(IDX),2)
237      MUHE = HEVSC * 0.00001
238      REYNO(IDX) = (DIAM(IDX)*(VELO(IDX)/3600.)*RDENS(IDX))/MUHE
239      GO TO 999
240
C
241      252 WDOTN(IDX) = WDTCB(5)+3.6-(WDGMAG + WDGCYR)
242      WDOTG(IDX) = WDOTN(IDX)
243      WDOTL(IDX) = 0.0
244      PRES(IDX) = PCB(1)
245      TEMP(IDX) = TCB(9)
246      RDENS(IDX) = RDENS(IDX-1SIGN)
247      DELP(IDX) = 0.0
248      VELO(IDX) = 0.0
249      REYNO(IDX) = 0.0
250      GO TO 999
251
C
252      253 WDOTN(IDX) = WDTCB(4)+3.6 + WDGMAG + WDGCYR + WDGSTO
253      WDOTG(IDX) = WDOTN(IDX)
254      WDOTL(IDX) = 0.0
255      PRES(IDX) = PCB(3)
256      TEMP(IDX) = TCB(2)
257      RDENS(IDX) = RHOGAS(PRES(IDX),TEMP(IDX))
258      DELP(IDX) = 0.0
259      VELO(IDX) = 0.0
260      REYNO(IDX) = 0.0
261      GO TO 999
262
C
263      254 WDOTN(IDX) = WDOTN(IDX-1SIGN)
264      WDOTG(IDX) = WDOTG(IDX-1SIGN)
265      WDOTL(IDX) = WDOTL(IDX-1SIGN)
266      PRES(IDX) = PRES(IDX-1SIGN)
267      TEMP(IDX) = TEMP(IDX-1SIGN)
268      RDENS(IDX) = RDENS(IDX-1SIGN)
269      DELP(IDX) = 0.0
270      VELO(IDX) = VELO(IDX-1SIGN)
271      REYNO(IDX) = REYNO(IDX-1SIGN)
272      GO TO 999
273
C
274      ***** PROCESS A CRYOPANEL
275
C
276      600 CONTINUE
277
C
278      NPSYS = 2
279      MAGIX = MAGIX + 1
280
C
281      FLD = FRCOEF(IDX) * LOD(IDX) / DIAM(IDX)
282      CMPVOL(IDX) = P104 * DIAM(IDX)**2 * LOD(IDX)
283      IX = IX - 1SIGN
284      WDOTN(IDX) = WDOTN(IDX-1SIGN)
285      PCRYI = PCRYI(GLODP)
286      PCRYI = PCRYI(GLODP)
287      TCRYI = TEMP(IX)
288      CALL HEPROP(PCRYI,TCRYI,1)
289      CALL HEPROP(PCRYI,TCRYI,3)

```

CMP16800

CMP16900

CMP17000

CMP17100

CMP17200

CMP17300

CMP17400

CMP17500

CMP17600

CMP17700

CMP17800

CMP17900

A20

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290 DH1 = HEHL - HELH
291 DH2 = HEHG - HEHL
292 QHR = QCR(GLOOP) * 3600.0
293 QSAT = ((WDOTN(IDX)*1000.0)/HEMWT) * DH1
294 QVAP = QHR - QSAT
295 WDOTG(IDX) = ((QVAP/DH2) * HEMWT)/1000.0
296 WDOTL(IDX) = WDOTL(IX) - WDOTG(IDX)
297 QUALX = WDOTG(IDX)/WDOTN(IDX)
298 SVLGMX = (1.0-QUALX) * HESVL + QUALX * HESVG
299 RDENS(IDX) = (1.0/SVLGMX) * HEMWT @ KG/CU-M
300 RHO = RDENS(IDX)
301 DELP(IDX) = C1*FLD*(WDOTN(IX)/CNOPER)**2/(RHO*DIAM(IDX)**4) CMP18700
302 PRES(IDX) = PRES(IX) - ISIGN * DELP(IDX) CMP18800
303 VELO(IDX) = VELF(WDOTN(IDX),SVLGMX,HEMWT,DIAM(IDX)) CMP18900
304 C CMP19000
305 CALL HEPROP(PRES(IDX),TEMP(IX),3) CMP19100
306 TEMP(IDX) = HET
307 QUAL(IDX) = QUALX CMP19300
308 RHOLGM = (1.0/SVLGMX) * HEMWT @ KG/CU-M
309 MUHE = (((1.0-QUALX) * HELVSC) + QUALX * HEGVSC) * 0.00001 CMP19500
310 REYN(IDX) = (DIAM(IDX)*(VELO(IDX)/3600.)*RHOLGM)/MUHE CMP19600
311 HDLP = HEHED(RHOLGM,CHEAD(IDX))
312 PRES(IDX) = PRES(IDX) + HDLP
313 C CMP19700
314 GD TO 999 CMP19800
315 C CMP19900
316 C **** PROCESS A LINE **** CMP20000
317 C CMP20100
318 300 FLD = FRUDEF(IDX)*LOD(IDX)/DIAM(IDX) CMP20200
319 LDV = CFTYPE/10 CMP20300
320 CFTYPE = CFTYPE - LDV * 10 CMP20400
321 SFAREA = P1 * DIAM(IDX) * LOD(IDX)
322 QUSE = QLEAK1
323 CMPVOL(IDX) = P104 * DIAM(IDX)**2 * LOD(IDX) CMP20500
324 IF((NPSYS.NE.3) GD TO 310
325 IF((NPSYS.EQ.3).AND.(GSTATE.EQ.2)) GO TO 310
326 IF((NPSYS.EQ.3).AND.(GLOOP.LE.5)) GO TO 311
327 IF((NPSYS.EQ.3).AND.(GLOOP.EQ.8)) GO TO 311
328 C
329 IF((NPSYS.EQ.3).AND.(GLOOP.EQ.6)) GO TO 315
330 IF((NPSYS.EQ.3).AND.(GLOOP.EQ.7)) GO TO 320
331 C
332 311 WDOTN(IDX) = WDOTN(IDX-ISIGN)
333 WDOTL(IDX) = WDOTL(IDX-ISIGN)
334 WDOTG(IDX) = WDOTG(IDX-ISIGN)
335 TEMP(IDX) = TEMP(IDX-ISIGN)
336 QUAL(IDX) = 0.0
337 GD TO 510
338 C
339 315 WDTXS = WDTXB(5)*3.6-(WDGSTO + WDGMAg + WDGCRY)
340 WDOTN(IDX) = WDTXB(5)*3.6-(WDGSTO + WDTXS)
341 IF((GLOOP.EQ.6).AND.(ITEE.EQ.4)) WDOTN(IDX) = WDOTN(IDX) - WDGCRY
342 WDOTG(IDX) = WDOTN(IDX)
343 WDOTL(IDX) = 0.0
344 TEMP(IDX) = TCB(9)
345 PRES(IDX) = PCB(1)
346 GD TO 510
347 C

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```

348      320      WDTXS = WDTCB(5)*3.6-(WDGSTO + WDCRY + WDGWAG)
349      WDOTN(IDX) = WDTCB(5)*3.6-(WDGSTO + WDTXS + WDGWAG)
350      WDOTG(IDX) = WDOTN(IDX)
351      WDOTL(IDX) = 0.0
352      TEMP(IDX) = TCB(9)
353      PRES(IDX) = PCB(1)
354      GO TO 510
355  C
356      310 WDOTN(IDX) = WDOTN(IDX-1SIGN)
357      TEMP(IDX) = TEMP(IDX-1SIGN)
358      GO TO 510
359  C
360      ***** PROCESS A CONTROL *****
361  C
362      400 FLD = FRCOEF(IDX)*LOD(IDX)
363      IDV = CFTYPE /10
364      CFTYPE = CFTYPE - IDV * 10
365      DIAM(IDX) = AMINI(DIAM(IDX+1),DIAM(IDX-1))
366      SFAREA = PI * DIAM(IDX)**2 * 2.0
367      QUSE = QLEAK2
368      CMPVOL(IDX) = CVOL(CFUNCT,CFTYPE,IDV,DIAM(IDX))
369      IF((NPSYS.EQ.3).AND.(IDV.EQ.5)) GO TO 430
370      IF(NPSYS.EQ.3) GO TO 311
371  C
372      GO TO 310
373  C
374      430 CONTINUE
375  C
376      ***** PROCESS A JGULE-THOMPSON VALVE *****
377  C
378      GSTATE = 2
379  C
380      WDOTN(IDX) = WDOTN(IDX-1SIGN)
381      WDOTG(IDX) = 0.0
382      WDOTL(IDX) = WDOTN(IDX)
383      PRES(IDX) = PCB(2)
384      TEMP(IDX) = TCB(10)
385      CALL HEPROP (PRES(IDX),TEMP(IDX),1)
386      RDENS(IDX) = HELD * HEMWT
387      MUHE = HELVSC * 0.00001
388      VELO(IDX) = 4.0*WDOTN(IDX)/(PI * DIAM(IDX)**2 * RDENS(IDX))
389      REYNO(IDX) = (DIAM(IDX)*(VELO(IDX)/3600.0)*RDENS(IDX))/MUHE
390      DELP(IDX) = 0.0
391      QUAL(IDX) = 0.0
392  C
393      GO TO 999
394  C
395      ***** PROCESS A REGULATOR *****
396  C
397      405 FLD = FRCOEF(IDX)*LOD(IDX)
398      IDV = CFTYPE /10
399      CFTYPE = CFTYPE - IDV * 10
400      DIAM(IDX) = AMINI(DIAM(IDX+1),DIAM(IDX-1))
401      CMPVOL(IDX) = CVOL(CFUNCT,CFTYPE,IDV,DIAM(IDX))
402      WDOTN(IDX) = WDOTN(IDX-1SIGN)
403      WDOTL(IDX) = WDOTL(IDX-1SIGN)
404      WDOTG(IDX) = WDOTG(IDX-1SIGN)
405      RDENS(IDX) = RDENS(IDX-1SIGN)

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CMP20690

CMP20700

CMP20800

CMP20900

CMP21000

CMP21100

CMP21200

CMP21300

CMP21400

CMP21500

CMP21600

CMP21700

CMP21800

CMP21900

CMP22000

CMP22100

CMP22200

CMP22300

CMP22400

CMP22500

CMP22600

CMP22700

CMP22800

CMP22900

A22

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406 TEMP(IDX) = TEMP(IDX-ISIGN)
407 IF((MAGIX.EQ.1).OR.(MAGIX.EQ.3))GO TO 866
408 VELO(IDX) = VELD(WDOTN(IDX),SVLNEW,HEMWT,DIAM(IDX))
409 REYNQ(IDX) = REYNQ(IDX-ISIGN)
410 QUAL(IDX) = QUAL(IDX-ISIGN)
411 GO TO 867
412 866 CONTINUE
413 VELO(IDX) = VELD(WDOTN(IDX),SLVIN(GLOOP),HEMWT,DIAM(IDX))
414 REYNQ(IDX) = REYNQ(IDX-ISIGN)
415 QUAL(IDX) = QUAL(IDX-ISIGN)
416 867 CONTINUE
417 C
418 IX = IDX - ISIGN
419 DLPREG = 0.0 @ DEFINE THIS TERM WHEN NEEDED
420 PRES(IDX) = PRES(IX) - ISIGN * DLPREG
421 GO TO 561
422 C
423 C ***** PROCESS A FITTING OR ELBOW *****
424 C
425 450 FLD = FRCOEF(IDX) * LOD(IDX)
426 LDV = CFTYPE/10
427 CFCTYPE = CFCTYPE - LDV * 10
428 DIAM(IDX) = AMINI(DIAM(IDX+1),DIAM(IDX-1))
429 IF(DIAM(IDX+ISIGN).EQ.0.0) DIAM(IDX) = DIAM(IDX-ISIGN)
430 IF(DIAM(IDX-ISIGN).EQ.0.0) DIAM(IDX) = DIAM(IDX+ISIGN)
431 SFAREA = PI * DIAM(IDX) * 0.25
432 QUSE = QLEAK1
433 CMPVOL(IDX) = CVOL(CFUNCT,CFCTYPE,LDV,DIAM(IDX))
434 IF(NPSYS.EQ.3) GO TO 311
435 GO TO 310
436 C
437 C ***** PROCESS A TEE OR FLOW SPLITTER *****
438 C
439 460 FLD = FRCOEF(IDX) * LOD(IDX)
440 LDV = CFCTYPE/10
441 CFCTYPE = CFCTYPE - LDV * 10
442 IF(DIAM(IDX).EQ.0.0) DIAM(IDX) = DIAM(IDX-1)
443 SFAREA = PI * DIAM(IDX) * 0.5225
444 QUSE = QLEAK1
445 CMPVOL(IDX) = CVOL(CFUNCT,CFCTYPE,LDV,DIAM(IDX))
446 TEMP(IDX) = TEMP(IDX-ISIGN)
447 C
448 IF(NPSYS.EQ.3) GO TO 470
449 C
450 WDOTN(IDX) = WDOTI(GLOOP)
451 WDOTL(IDX) = WDOTL(IDX-ISIGN)
452 WDOTG(IDX) = WDOTG(IDX-ISIGN)
453 RDENS(IDX) = RDENS(IDX-ISIGN)
454 IF((MAGIX.EQ.1).OR.(MAGIX.EQ.3))GO TO 862
455 VELO(IDX) = VELD(WDOTN(IDX),SVLNEW,HEMWT,DIAM(IDX))
456 GO TO 863
457 862 CONTINUE
458 VELO(IDX) = VELD(WDOTN(IDX),SLVIN(GLOOP),HEMWT,DIAM(IDX))
459 863 CONTINUE
460 C
461 ITEE = ITEE + 1
462 IF(ITEE.EQ.1) GO TO 461
463 IF((ITEE.EQ.2).AND.(NPSYS.EQ.1)) WDOTN(IDX) = WDTLHI

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CMP23000
CMP23100
CMP23200
CMP23300
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CMP26400
CMP26500
CMP26600
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CMP26900
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CMP27200
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CMP27400
CMP27500
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CMP27700
CMP27800
CMP27900

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464      IF((ITEE.EQ.2).AND.(NPSYS.EQ.2)) WDOTN(IDX) = WOTLCH      CMP28000
465      WDOTL(IDX) = WDOTL(IDX-ISIGN) * 2.0      CMP28100
466      WDOTG(IDX) = WDOTG(IDX-ISIGN) * 2.0      CMP28200
467      RDENS(IDX) = RDENS(IDX-ISIGN)      CMP28300
468      GO TO 462      CMP28400
469      461 CONTINUE      CMP28500
470      TEMPBR = TEMP(IDX)      CMP28600
471      IF(NPSYS.EQ.1) GO TO 510
472
473      C      DO 464 IZ = 2,NUMCRP      CMP28700
474      WDOTBR(IZ) = WDOTI(IZ)      CMP28800
475      IF(IZ.EQ.3) WDOTBR(IZ) = WDOTI(IZ) + WDOTI(IZ+1)      CMP28900
476      464 CONTINUE      CMP29000
477      C      462 CONTINUE      CMP29100
478      C      GO TO 510      CMP29200
479      C      470 CONTINUE      CMP29300
480      C      ITEE = ITEE + 1      CMP29400
481      C      485      IF(ITEE.EQ.1) WDOTN(IDX) = WDGWAG + WDGCRY      * KG/HR
482      IF(ITEE.EQ.2) WDOTN(IDX) = WDGWAG + WDGCRY + WDGSTO      * KG/HR
483      IF(ITEE.EQ.3) WDOTN(IDX) = WDTCB(5) * 3.6      * KG/HR
484      IF(ITEE.EQ.4) WDOTN(IDX) = WDTCB(5) * 3.6 -      * KG/HR
485      1      (WDGSTO + WDGCRY + WDTXS)      * KG/HR
491      C      WDOTL(IDX) = WDOTL(IDX-ISIGN)
492      WDOTG(IDX) = WDOTN(IDX)
493      RDENS(IDX) = RDENS(IDX-ISIGN)
494      VELO(IDX) = 4.0*WDOTN(IDX)/(PI*DIAM(IDX)**2 * RDENS(IDX))
495
496      C      GO TO 510
497
498      C
499      C      ***** PROCESS A TAP OR FLOW DIRECTION SHIFTER *****      CMP29600
500      C      500 CONTINUE      CMP29700
501      C      ITAP = ITAP + 1      CMP29800
502      C      WDOTN(IDX) = WDOTN(IDX-ISIGN)      CMP29900
503      IF(ITAP.EQ.3) WDOTN(IDX) = WDOTBR(3) - WDOTI(4)      CMP30000
504      WDOTL(IDX) = WDOTL(IDX-ISIGN)      CMP30100
505      WDOTG(IDX) = WDOTG(IDX-ISIGN)      CMP30200
506      IF(ITAP.EQ.3) GO TO 502      CMP30300
507      WDOTNQ = WDOTNQ + WDOTN(IDX)      CMP30400
508      WDOTLQ = WDOTLQ + WDOTL(IDX)      CMP30500
509      WDOTGQ = WDOTGQ + WDOTG(IDX)      CMP30600
510      502 CONTINUE      CMP30700
511      RDENS(IDX) = RDENS(IDX-ISIGN)      CMP30800
512      LDV = CFTYPE/10      CMP30900
513      CFTYPE = CFTYPE - LDV * 10      CMP31000
514      FLD = FRCOEF(IDX)*LOD(IDX)      CMP31100
515      TEMP(IDX) = TEMP(IDX-ISIGN)      CMP31200
516      DIAM(IDX) = AMINI(DIAM(IDX+1),DIAM(IDX-1))      CMP31300
517      IF(DIAM(IDX).EQ.0.0) DIAM(IDX) = DIAM(IDX+1)      CMP31400
518
519
520
521

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522 SFAREA = PI * DIAM(IDX) * 0.5225
523 QUSE = QLEAK1
524 CMPVOL(IDX) = CVOL(CFUNCT,CFTYPE,LDV,DIAM(IDX))
525 IF((MAGIX.EQ.1).OR.(MAGIX.EQ.3))GO TO 864
526 VELO(IDX) = VELF(WDOTN(IDX),SVLNEW,HEMWT,DIAM(IDX))
527 GO TO 865
528
529 864 CONTINUE
530 VELO(IDX) = VELF(WDOTN(IDX),SLVIN(GLOOP),HEMWT,DIAM(IDX))
531 865 CONTINUE
532
533 C
534 C
535 C
536 C
537 C
538 C
539 C
540 C
541 C
542 510 CONTINUE
543 IF(PRES(IX).EQ.0.0) PRES(IX) = PRES(IDX)-0.1
544 IF(TEMP(IX).EQ.0.0) TEMP(IX) = TEMP(IDX)-0.02
545 RHO = RHOGAS(PRES(IX),TEMP(IDX))
546 RDENS(IDX) = RHO
547 DELP(IDX) = C1*FLD(WDOTN(IX)/CNOPER)**2/(RHO*DIAM(IDX)**4)
548 VELO(IX) = 4.0*WDOTN(IDX)/(PI*DIAM(IDX)**2 * RDENS(IDX))
549 QUAL(IDX) = 0.0
550
551 C
552 C
553 C
554 C
555 C
556 C
557 C
558 C
559 C
560 C
561 C
562 C
563 C
564 C
565 C
566 C
567 C
568 C
569 C
570 C
571 C
572 C
573 C
574 C
575 C
576 C
577 C
578 C
579 C

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***** COMPUTE LINE, CONTROL, FITTING OR TAP DELTA PRESSURE.

510 IX = IX - ISIGN
GO TO(520,550),GSTATE

***** DELTA PRESSURE WHEN GASEOUS

CALC. RHO OF GAS

520 CONTINUE
IF(PRES(IX).EQ.0.0) PRES(IX) = PRES(IDX)-0.1
IF(TEMP(IX).EQ.0.0) TEMP(IX) = TEMP(IDX)-0.02
RHO = RHOGAS(PRES(IX),TEMP(IDX))
RDENS(IDX) = RHO
DELP(IDX) = C1*FLD(WDOTN(IX)/CNOPER)**2/(RHO*DIAM(IDX)**4)
VELO(IX) = 4.0*WDOTN(IDX)/(PI*DIAM(IDX)**2 * RDENS(IDX))
QUAL(IDX) = 0.0

***** IF PCT. OF PRESSURE CHANGE EXCEEDS ONE PCT. - RECOMPUTE
***** DELTA-P, IF NOT, COMPUTE THE NEW PRESSURE

IF(DELP(IDX)/(PRES(IX) + DELP(IDX)) - 0.01) 560,560.530

CALC. RHO OF GAS

530 RHO = RHOGAS(PRES(IX) + DELP(IDX)/2.0,TEMP(IDX))
RDENS(IDX) = RHO
DELP(IDX) = C1*FLD(WDOTN(IX)/CNOPER)**2/(RHO*DIAM(IDX)**4)
VELO(IX) = 4.0*WDOTN(IDX)/(PI*DIAM(IDX)**2 * RDENS(IDX))

***** AGAIN CHECK PCT. OF PRESSURE CHANGE. IF PCT. EXCEEDS
2.8 PCT. COMPUTE THE DELTA-P BY USE OF THE COMPRESSIBLE
***** FLOW EQUATIONS. (REF.-RPL-TDR-64-25,VOL.1,REV.D)

IF(DELP(IDX)/(PRES(IX) + DELP(IDX)) - 0.028) 580,560.540

540 A = PI*DIAM(IDX)**2/4.0
CALL COMFLO(IX,PRES(IX),TEMP(IX),FLD,A,WDOTN(IX)/CNOPER,IGAS,
1 DELP(IDX))

IF(CHEAD(IDX).EQ.0.0) GO TO 543

HDLP = HEHED(RHO,CHEAD(IDX))
PRES(IDX) = PRES(IX) + HDLP - ISIGN * DELP(IDX)
GO TO 544

543 CONTINUE
PRES(IDX) = PRES(IX) - ISIGN * DELP(IDX)

544 CONTINUE
GO TO 561

CMP31900
CMP32000
CMP32100
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CMP37400

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580      C      ***** DELTA PRESSURE WHEN LIQUID
581      C
582      C
583      550 CONTINUE
584      IF((NPSYS.EQ.3).AND.(GSTATE.EQ.2)) GO TO 554
585      IF(MAGIX.EQ.2) GO TO 551
586      RHO = RHOLIQ(PRES(IX),TEMP(IX))
587      RDENS(IX) = RHO
588      DELP(IX) = C1*FLD*(WDOTN(IX)/CNOPER)**2/(RHO*DIAM(IX)**4)
589      GO TO 552
590      551 RHO = RHOLGM
591      RDENS(IX) = RHO
592      DELP(IX) = C1*FLD*(WDOTN(IX)/CNOPER)**2/(RHO*DIAM(IX)**4)
593      552 CONTINUE
594      C
595      IF(CHEAD(IX).EQ.0.0) GO TO 563
596      C
597      HDLP = HEHED(RHO,CHEAD(IX))
598      PRES(IX) = PRES(IX) + HDLP - ISIGN * DELP(IX)
599      IF((CFUNCT.EQ.7).AND.(MAGIX.EQ.1)) PRESBR = PRES(IX)
600      IF((CFUNCT.EQ.6).AND.(MAGIX.EQ.2)) PRSTAP(GLOOP) = PRES(IX)
601      IF((CFUNCT.EQ.6).AND.(MAGIX.EQ.2)) TEMTAP(GLOOP) = TEMP(IX)
602      GO TO 564
603      563 CONTINUE
604      PRES(IX) = PRES(IX) - ISIGN * DELP(IX)
605      IF((CFUNCT.EQ.7).AND.(MAGIX.EQ.1)) PRESBR = PRES(IX)
606      IF((CFUNCT.EQ.6).AND.(MAGIX.EQ.2)) PRSTAP(GLOOP) = PRES(IX)
607      IF((CFUNCT.EQ.6).AND.(MAGIX.EQ.2)) TEMTAP(GLOOP) = TEMP(IX)
608      564 CONTINUE
609      C
610      IF((MAGIX.EQ.1).OR.(MAGIX.EQ.3)) GO TO 860
611      C
612      IF(DIAM(IX).EQ.0.0) DIAM(IX) = DIAM(IX-1)
613      C
614      IF(CHEAD(IX).EQ.0.0) GO TO 872
615      C
616      NGSTAT = 2
617      IF(GSTATE.EQ.2) NGSTAT = 1
618      C
619      CALL HEPROP(PRES(IX),TEMP(IX),NGSTAT)
620      CPFLU = HELCP @ J/MOL-K
621      QIN = QUSE * 3600.0 @ J/HR-SQMETER
622      QXFER = QIN + SFAREA @ J/HR
623      CPNU = (CPFLU/HEMWT) * 1000.0 @ J/KG-K
624      TEMPNU = TEMP(IX) + (QXFER/(CPNU * WDOTN(IX)))
625      C
626      CALL HEPROP(PRES(IX),TEMPNU,1)
627      H1 = HEHL
628      CALL HEPROP(PRES(IX),TEMP(IX),3)
629      H2 = HEHL
630      DLH1 = H1 - H2
631      DLH2 = HEHG - HEHL
632      TEMP(IX) = HET
633      DELQ = ((WDOTL(IX) * DLH1)/HEMWT) * 1000.0
634      WDTG1 = (DELQ * HEMWT)/(DLH2 * 1000.0)
635      WDOTG(IX) = WDOTG(IX) + WDTG1
636      WDOTL(IX) = WDOTL(IX) - WDTG1
637      QUALX = WDOTG(IX)/WDOTN(IX)

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CMP37500
CMP37600
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CMP40900
CMP41000
CMP41100
CMP41200
CMP41300
CMP41400
CMP41500
CMP41600
CMP41700
CMP41800
CMP41900
CMP42000
CMP42100
CMP42200
CMP42300
CMP42400
CMP42500

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A26

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638      QUAL(IDX) = QUALX
639      SVLNEW = ((1.0-QUALX)*HESVL + QUALX*HESVG) * L/MOL
640      VELO(IDX) = VELF(WDDTN(IDX),SVLNEW,HEMWT,DIAM(IDX))
641
642      C
643      RHOLGM = ((1.0/SVLNEW) * HEMWT
644      RDENS(IDX) = RHOLGM
645      MUHE = (((1.0-QUALX) * HELVSC) + QUALX * HEGVSC) * 0.00001
646      REYNO(IDX) = (DIAM(IDX)*(VELO(IDX)/3600.)*RHOLGM)/MUHE
647
648      C
649      GO TO 561
650
651      C
652      872 CONTINUE
653      VELO(IDX) = VELF(WDDTN(IDX),SVLNEW,HEMWT,DIAM(IDX))
654
655      C
656      IF((CFUNCT.EQ.7).AND.(ITEE.EQ.2)) GO TO 874
657      WDDTL(IDX) = WDDTL(IX)
658      WDDTG(IDX) = WDDTG(IX)
659      REYNO(IDX) = REYNO(IDX-ISIGN)
660      QUAL(IDX) = QUAL(IDX-ISIGN)
661      GO TO 861
662
663      C
664      874 CONTINUE
665      WDDTL(IDX) = WDDTL(IDX)
666      WDDTG(IDX) = WDDTG(IDX)
667      REYNO(IDX) = REYNO(IDX-ISIGN)
668      QUAL(IDX) = QUAL(IDX-ISIGN)
669      GO TO 861
670
671      C
672      860 CONTINUE
673      IF(DIAM(IDX).EQ.0.0) DIAM(IDX) = DIAM(IDX-1)
674      VELO(IDX) = VELF(WDDTN(IDX),SVLNEW,HEMWT,DIAM(IDX))
675      WDDTL(IDX) = WDDTN(IDX)
676      WDDTG(IDX) = WDDTG(IDX-ISIGN)
677
678      C
679      NGSTAT = 2
680      IF(GSTATE.EQ.2) NGSTAT = 1
681
682      C
683      CALL HEPROP(PRES(IDX),TEMP(IDX),NGSTAT)
684      CPFLU = HELCP
685      QIN = QUSE + 3600.0
686      QXFER = QIN + SFAREA
687      CPNU = (CPFLU/HEMWT) * 1000.0
688      TEMP(IDX) = TEMP(IDX) + (QXFER/(CPNU * WDDTN(IDX)))
689
690      C
691      CALL HEPROP(PRES(IDX),TEMP(IDX),1)
692      MUHE = HELVSC * 0.00001
693      REYNO(IDX) = (DIAM(IDX)*(VELO(IDX)/3600.)*RDENS(IDX))/MUHE
694      QUAL(IDX) = QUAL(IDX-ISIGN)
695      IF((INPSYS.EQ.2).AND.(CFUNCT.EQ.6).AND.(ITAP.EQ.3))
696      1 TAPTEM = TEMP(IDX) ; TAPPRS = PRES(IDX)
697      GO TO 561
698
699      C
700      554 CONTINUE
701      IF(DIAM(IDX).EQ.0.0) DIAM(IDX) = DIAM(IDX-1)
702      RHO = RHOIQ(PRES(IX),TEMP(IDX))
703      RDENS(IDX) = RHO
704      DELP(IDX) = C1*FLD*(WDDTN(IX)/CNOPER)**2/(RHO*DIAM(IDX)**4)
705      VELO(IDX) = 4.0 * WDDTN(IDX)/(PI * DIAM(IDX)**2 * RDENS(IDX))

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CMP42600
 CMP42700
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 CMP46400
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 CMP38000
 CMP38100
 CMP38200

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696      WDDTL(IDX) = WDDTN(IDX)
697      WDDTG(IDX) = WDDTG(IDX-ISIGN)
698
699      C      CALL HEPROP(PRES(IDX),TEMP(IDX),1)
700      MUHE = HEVSC * 0.00001 @ KG/M-SEC
701      REYNO(IDX) = (DIAM(IDX)*(VELO(IDX)/3600.)*RDENS(IDX))/MUHE
702      QUAL(IDX) = QUAL(IDX-ISIGN)
703
704      C      ***** COMPUTE A NEW PRESSURE
705      C
706      C      560 PRES(IDX) = PRES(IX) - ISIGN * DELP(IDX)
707      C
708      C      861 CONTINUE
709      C
710      C      NGSTAT = 2
711      C      IF(GSTATE.EQ.2) NGSTAT = 1
712      C
713      C      CALL HEPROP(PRES(IDX),TEMP(IDX),NGSTAT)
714      CPFLU = HELCP @ J/MOL-K
715      QIN = QUSE * 3600.0 @ J/HR-SQMETER
716      QXFER = QIN * SFAREA @ J/HR
717      CPNU = (CPFLU/HEMWT) * 1000.0 @ J/KG-K
718      TEMP(IDX) = TEMP(IDX) + (QXFER/(CPNU * WDDTN(IDX)))
719
720      C
721      C
722      C      IF(GSTATE.EQ.2) GO TO 561
723      C
724      C      CALC. RHO OF GAS
725      C      RHO = RHOGAS(PRES(IDX),TEMP(IDX))
726      RDENS(IDX) = RHO
727      VELO(IDX) = 4.0 * WDDTN(IDX)/(PI * DIAM(IDX)**2 * RHO)
728      CALL HEPROP(PRES(IDX),TEMP(IDX),2)
729      MUHE = HEVSC * 0.00001
730      REYND(IDX) = (DIAM(IDX)*(VELO(IDX)/3600.)*RDENS(IDX))/MUHE
731
732      C      561 CONTINUE
733      C
734      C      GO TO 999
735      C
736      C      ***** PROCESS A TANK OR SUPPLY *****
737      C
738      C      700 CONTINUE
739      C
740      C      ITANK = ITANK + 1
741      C
742      C      IF(NPSYS.EQ.3) GO TO 720
743      C
744      C      IF(NPSYS.EQ.1) WDDTN(IDX) = WDTLH1
745      IF((NPSYS.EQ.1).AND.(ITANK.EQ.1)) CMPVOL(IDX) = VHENDW/1000.0
746      IF(NPSYS.EQ.2) WDDTN(IDX) = WDTLCH
747      IF((NPSYS.EQ.2).AND.(ITANK.EQ.1)) CMPVOL(IDX) = VHECDW/1000.0
748      WDDTL(IDX) = WDDTL(IDX-ISIGN)
749      IF(ITANK.EQ.1) WDDTL(IDX) = WDDTN(IDX)
750      WDDTG(IDX) = WDDTG(IDX-ISIGN)
751      PRES(IDX) = PTANK
752      TEMP(IDX) = TTANK
753      RDENS(IDX) = RHOLIQ(PTANK,TTANK)

```

CMP45700
 CMP45800
 CMP45900
 CMP46000
 CMP46100
 CMP46200
 CMP46300
 CMP46500

CMP46700
 CMP46800
 CMP46900
 CMP47000
 CMP47100
 CMP47200
 CMP47300
 CMP47400

CMP47500
 CMP47800
 CMP47900
 CMP48000
 CMP48100
 CMP48200
 CMP48300
 CMP48400
 CMP48500
 CMP48600
 CMP48700

CMP48800
 CMP48900
 CMP49000
 CMP49100
 CMP49200
 CMP49300
 CMP49400
 CMP49500
 CMP49600
 CMP49700

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754      VELO(IDX) = 0.0      CMP49800
755      DELP(IDX) = 0.0      CMP49900
756      REYN0(IDX) = 0.0      CMP50000
757      QUAL(IDX) = 0.0      CMP50100
758      IF(1TANK.EQ.2) GO TO 711  CMP50200
759      GO TO 999              CMP50300
760
761  C
762  720 CONTINUE
763  C
764      IF(1TANK.EQ.1) WDOTN(IDX) = WDG MAG ; TEMP(IDX) = TMPMRT
765      IF(1TANK.EQ.2) WDOTN(IDX) = WDGCRT ; TEMP(IDX) = TMPCRT
766      IF(1TANK.EQ.3) WDOTN(IDX) = WDGSTO ; TEMP(IDX) = TMPSTRT
767      IF(1TANK.GT.3) GO TO 721
768  C
769      WDOTG(IDX) = WDOTN(IDX)
770      WDOTL(IDX) = 0.0
771      PRES(IDX) = PTANK
772      RDENS(IDX) = RHOGAS(PRES(IDX),TEMP(IDX))
773      GO TO 722
774  C
775  721 WDOTN(IDX) = WDOTN(IDX-1SIGN)
776      WDOTG(IDX) = WDOTG(IDX-1SIGN)
777      WDOTL(IDX) = WDOTL(IDX-1SIGN)
778      TEMP(IDX) = TEMP(IDX-1SIGN)
779      PRES(IDX) = PRES(IDX-1SIGN)
780      RDENS(IDX) = RDENS(IDX-1SIGN)
781  C
782  722 VELO(IDX) = 0.0
783      DELP(IDX) = 0.0
784      REYN0(IDX) = 0.0
785      QUAL(IDX) = 0.0
786      GO TO 999
787  C
788  711 CONTINUE
789      WDOTRTN = WDOTL(IDX)      CMP50400
790      WDTMKU = WDOTG(IDX)      CMP50500
791      QUALTY = QUALX           CMP50600
792      TEMP(IDX) = TEMP(IDX-1SIGN)  CMP50700
793      TEMFIN = TEMP(IDX)
794  C
795      GO TO 999              CMP50800
796  C
797      ***** PROCESS A COMPRESSOR-PURIFIER UNIT *****
798  C
799  800 CONTINUE
800  C
801      WDOTN(IDX) = WDOTCB(1) + 3.6      @ KG/HR
802      WDOTG(IDX) = WDOTN(IDX)
803      WDOTL(IDX) = 0.0
804      PRES(IDX) = PCB(1)
805      TEMP(IDX) = TCB(1)
806      CALL HEPRDP (PRES(IDX),TEMP(IDX),2)
807      RDENS(IDX) = HELO + HEMWT      @ KG/CU.M.
808      MUHE = HEVSC + 0.00001
809      DIAM(IDX) = AMINI(DIAM(IDX+1),DIAM(IDX-1))
810      CMPVOL(IDX) = 3.0      @ ASSUMED VALUE
811      VELO(IDX) = 4.0*WDOTN(IDX)/(PI * DIAM(IDX)**2 * RDENS(IDX))
812      REYN0(IDX) = (DIAM(IDX)*(VELO(IDX)/3600.0)*RDENS(IDX))/MUHE

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812      DELP(IDX) = 0.0
813      C
814      GO TO 999
815      C
816      C      ***** PROCESS A HEAT EXCHANGER *****
817      C
818      900 CONTINUE
819      C
820      GO TO 999
821      C
822      C      ***** END OF CONFIGURATION PROCESSING LOOP *****
823      C
824      999 CONTINUE
825      IF (.NOT. PAGE(1)) GO TO 1998
826      C
827      C      *** PAGE HEADER HAS BEEN MOVED TO STATEMENT GROUP 100
828      C
829      1998 CONTINUE
830      KFUNCT = FNAME(CFUNCT)
831      VELSEC = VELO(IDX)
832      IF((NPSYS.EQ.3).AND.(GLODP.EQ.8)) VELSEC = VELO(IDX)/3600.0
833      WRITE(6,6030) KFUNCT, CODE(IDX), IDX, IGAS,GSTATE, DIAM(IDX),
834      1      WDOTN(IDX), WDOTL(IDX), WDOTG(IDX), QUAL(IDX),
835      2      TEMP(IDX), PRES(IDX), DELP(IDX), VELSEC
836      3      RDENS(IDX), REYNO(IDX)
837      C
838      IF (PRES(IDX) .GE. 0. .AND. TEMP(IDX) .GE. 0.) GO TO 998
839      WRITE (10T,6040)
840      CALL EXIT
841      998 CONTINUE
842      DLPTOT = DLPTOT + DELP(IDX)
843      SYSVOL = SYSVOL + CMPVOL(IDX)
844      IF((NPSYS.EQ.3).AND.(GLODP.EQ.7)) DLPRLO = DLPTOT
845      IF((NPSYS.EQ.3).AND.(GLODP.EQ.7)) RLQSVL = SYSVOL
846      IF((NPSYS.EQ.3).AND.(GLODP.EQ.8)) DLPCPU = DLPTOT - DLPRLO
847      IF((NPSYS.EQ.3).AND.(GLODP.EQ.8)) CPUSVL = SYSVOL - RLQSVL
848      C
849      1000 CONTINUE
850      1100 CONTINUE
851      C
852      VOLLIT = SYSVOL * 1000.0      @ LITER EQUIV OF SYSVOL
853      RLQLIT = RLQSVL * 1000.0      @ LITER EQUIVALENT
854      CPULIT = CPUSVL * 1000.0      @ LITER EQUIVALENT
855      TSYSVO = TSYSVO + SYSVOL
856      WDOTOT = WDOTOT + WDOTMKU
857      WDLTOT = WDLTOT + WDLRTN
858      IF(NPSYS.EQ.1) VDL MAG = SYSVOL ; WDMAG = WDMKU ; WDL MAG = WDLRTN
859      IF(NPSYS.EQ.1) TMPMRT = TEMFIN
860      IF(NPSYS.EQ.2) VOLCRY = SYSVOL ; WDCRY = WDMKU ; WOLCRY = WDLRTN
861      IF(NPSYS.EQ.2) TMPCRT = TEMFIN
862      C
863      IF(NPSYS.EQ.1) WRITE (6,6052) DLPTOT
864      IF(NPSYS.EQ.1) WRITE (6,6056) SYSVOL, VOLLIT
865      IF(NPSYS.EQ.2) WRITE (6,6053) DLPTOT
866      IF(NPSYS.EQ.2) WRITE (6,6057) SYSVOL, VOLLIT
867      C
868      IF(NPSYS.EQ.3) JP = PAGE(0)
869      C

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870      IF(NPSYS.EQ.3) WRITE (6,6065) DLPRLO
871      IF(NPSYS.EQ.3) WRITE (6,6066) RLQSVL, RLQLIT
872      IF(NPSYS.EQ.3) WRITE (6,6067) DLPCPU
873      IF(NPSYS.EQ.3) WRITE (6,6068) CPUSVL, CPULIT
874
875      C
876      6052 FORMAT(// T20,'TOTAL PRESSURE DROP IN THE MAGNET LOOP =',
877      1 T70,E13.8,T85,'KPA' /T20,' (MAGNET INCLUDED)')
878      6053 FORMAT(// T20,'TOTAL PRESSURE DROP IN THE CRYOPANEL LOOP =',
879      1 T75,E13.8,T90,'KPA' /T20,' (CRYOPANELS INCLUDED)')
880      6056 FORMAT( T20,'TOTAL FLUID VOLUME IN THE MAGNET LOOP =',
881      1 T70,E13.8,T85,'CUBIC METERS',T105,'('F10.2,' LITERS)',
882      2 /T20,' (MAGNET INCLUDED)')
883      6057 FORMAT( T20,'TOTAL FLUID VOLUME IN THE CRYOPANEL LOOP =',
884      1 T70,E13.8,T85,'CUBIC METERS',T105,'('F10.2,' LITERS)',
885      2 /T20,' (CRYOPANELS INCLUDED)')
886      C
887      IF(NPSYS.EQ.3) RETURN @ ALTERNATE RETURN
888      C
889      JP = PAGE(0)
890      C
891      IF(NPSYS.EQ.1) WRITE (6,6055) (LO(I,6),I=1,9)
892      IF(NPSYS.EQ.2) WRITE (6,6055) (LO(I,7),I=1,9)
893      6055 FORMAT('0',3BX9A6//)
894      C
895      IF(NPSYS.EQ.1) WRITE (6,6060) VHEMDW,WDTLHI,WDTRTN,WDTMKU,QUALTY
896      IF(NPSYS.EQ.2) WRITE (6,6060) VHECDW,WDTLCH,WDTRTN,WDTMKU,QUALTY
897      6060 FORMAT(T20,'NOMINAL VOLUME OF HELIUM IN TANK - (LITERS) =',
898      1 T75,F10.4//T20,'TANK OUTFLOW OF HELIUM',T55,'(KG/HR) =',T75,
899      2 F10.4//T20,'LIQUID HELIUM IN RETURN FLOW',T55,'(KG/HR) =',T75,
900      3 F10.4//T20,'LIQUID HELIUM MAKE-UP REQUIRED',T55,'(KG/HR) =',
901      4 T75,F10.4//T20,'RETURN FLUID QUALITY',T45,'(DECIMAL FRACTION) =',
902      5 T75,F10.4)
903      6065 FORMAT(// T10,'TOTAL PRESSURE DROP IN THE REFRIGERATOR-LIQUIFIER L
904      100P =',T75,E13.8,T90,'KPA' /T20,' (REF-LIQ. INCLUDED) (J-T VALVES
905      2 EXCLUDED)')
906      6066 FORMAT( T10,'TOTAL FLUID VOLUME IN THE REFRIGERATOR-LIQUIFIER LO
907      10P =',T70,E13.8,T85,'CUBIC METERS',T105,'('F10.2,' LITERS)',
908      2 /T20,' (REF-LIQ INCLUDED)')
909      6067 FORMAT(// T10,'TOTAL PRESSURE DROP IN THE COMPRESSOR-PURIFIER LOOP
910      1 =', T75,E13.8,T90,'KPA' /T20,' (CMP-PUR. EXCLUDED)')
911      6068 FORMAT( T10,'TOTAL FLUID VOLUME IN THE COMPRESSOR - PURIFIER LOO
912      1P =', T70,E13.8,T85,'CUBIC METERS',T105,'('F10.2,' LITERS)',
913      2 /T20,' (CMP-PUR INCLUDED)')
914      C
915      RETURN
916      C
917      C
918      C
919      C
920      C
921      C
922      C
923      C
924      C
925      C
926      C
927      C

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CMP55800

CMP55900

CMP56000

CMP56100

CMP56200

CMP56300

CMP56400

CMP56500

CMP56600

CMP56700

CMP56800

CMP56900

CMP57000

CMP57100

CMP57200

CMP57300

CMP57400

CMP57500

CMP57600

CMP57700

CMP57800

CMP57900

CMP58000

CMP58100

CMP58200

CMP58300

CMP58400

CMP58500

CMP58600

CMP58700

CMP58800

CMP58900

CMP59000

CMP59100

CMP59200

CMP59300

CMP59400

CMP59500

CMP59600

CMP59700

CMP59800


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928      1 QUAL- TEMP. PRESS. DELTA-P VELOCITY DENSITY REYNCP59900
929      2OLD5'/T27,'(M) (KG/HR) (KG/HR) (KG/HR) IFY',T71,'(K)',T79, CMP60000
930      3 '(KPA) (KPA) (M/HR) (KG/CU-M) NUMBER'/) CMP60100
931      C CMP60200
932      6021 FORMAT('D F CODE IDX G GS DIAM. WDDT-T WDDT-L WDDT-G CMP59900
933      1 QUAL- TEMP. PRESS. DELTA-P VELOCITY DENSITY REYNCP59900
934      2OLD5'/T27,'(M) (KG/HR) (KG/HR) (KG/HR) IFY',T71,'(K)',T79, CMP60000
935      3 '(KPA) (KPA) (M/SEC) (KG/CU-M) NUMBER'/) CMP60100
936      C CMP60200
937      6030 FORMAT(2XA3,2XA6,I4,2I3,F7.3,3F9.3,F9.5,F9.3,F10.4,F10.6,F11.4,
938      1 F11.5,F12.3) CMP60300
939      C CMP60400
940      6040 FORMAT (I44, '*** TERMINATE - NEGATIVE TEMP. OR PRES. ***')
941      C CMP60500
942      6050 FORMAT(/T18,'*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETE
943      1RS - FOR 'SAG,' ***') CMP60600
944      C CMP60700
945      6051 FORMAT(/T32,'*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETE
946      1RS - CONTD, ***') CMP60800
947      C CMP61000
948      END CMP61100
          CMP61200
          CMP61300
          CMP61400

```

```
1 CNAME* PROC
2 C
3   INTEGER FNAME
4 C
5   COMMON /CNAME/FNAME(16), L0(9,9), L1(21,2), L2(4,12), L3(4,10),
6   1 L4(4,11), L5(5,15), JFLUID(2,2), KFLUID(2,2)
7 C
8   NAMES ARE GIVEN IN S.R. STODTA
9 C
10  END
```


58 C
59 C
60 C
61
62 M2MIN = 1.E-10
63 M2MAX = 1.0
64 C
65 DO 40 I1 = 1,20
66 M2 = (M2MAX + M2MIN)/2.0
67 FAC = FLODEQ(M2,GMA) - DF
68 IF(ABS(FAC) - 0.00005) 50,50.10
69 10 IF(FAC) 20,50.30
70 20 M2MAX = M2
71 GO TO 40
72 30 M2MIN = M2
73 40 CONTINUE
74 C
75 WRITE (6,6000) M2
76 C
77 C
78 C
79 C
80 50 A1 = M1**2
81 A2 = M2**2
82 P2OP1 = (M1/M2) * (2.0 + (GMA - 1.0) * A1)/(2.0 + (GMA - 1.0) * A2)
83 DLP = P * (1.0/P2OP1 - 1.0) @ DELTA-PRESSURE
84 C
85 C
86 C
87 C
88 C
89 C
90 C
91 C
92 C
93 C
94 C
95 C
96 C
97 C
98 C
99 C
100 C
101 C
102 C
103 C
104 C

***** ITERATE TO FIND MACH NUMBER AT CURENT CONDITIONS

***** COMPUTE THE PRESSURE DROP

***** SET FINAL MACH NUMBER FROM ITERATION

MACH(1DX) = M2

***** CHECK MACH NUMBER, FLAG MACH NUMBER GREATER THAN 0.3
* WITH ONE ASTERISK, FLAG MACH NUMBER GREATER THAN
* 1.0 WITH SIX ASTERISKS.

IF(MACH(1DX) - 0.3) 80,80.81
81 IF(MACH(1DX) - 1.0) 82,83.83
82 MFLG(1DX) = JAST1
GO TO 80
83 MFLG(1DX) = JAST6
80 CONTINUE
RETURN

***** DIAGNOSTIC MESSAGE

6000 FORMAT('O *DIAGNOSTIC* MACH NUMBER COMPUTATION FAILED TO CONVERGE
1WHILE COMPUTING COMPRESSABLE FLOW EQUATIONS. MACH SET = ',E12.7)

END

** COMDPD **

FILE: MFTF*CSA

TIME: 10:21:01

DATE 040579

PAGE 36

```
1      SUBROUTINE COMDPD(TYPE,DP)
2      IF (TYPE.EQ.1.0) GO TO 120
3      IF (TYPE.EQ.2.0) GO TO 110
4      IF (TYPE.EQ.3.0) GO TO 100
5      DP=172.0
6      GO TO 130
7      100 DP=172.0
8      GO TO 130
9      110 DP=172.0
10     GO TO 130
11     120 DP=-13.786
12     130 RETURN
13     END
```

A36

```

1      C      * * * * *
2      C      * ROUTINE NAME - DATA INPUT, VERIFY AND ECHO *
3      C      * ROUTINE LANG - FORTRAN V UNIVAC 1110 EXEC 8 *
4      C      * PROGRAMMER - R.F.HAUSMAN 104-6213-30235 *
5      C      * DATE CODED - NOVEMBER 30, 1978 *
6      C      * * * * *
7      C
8      C      SUBROUTINE COMPIL
9      C
10     C      LOGICAL JP,PAGE
11     C
12     C      INCLUDE CCNFIG
13     C      INCLUDE CCNTRL
14     C      INCLUDE CMAG
15     C      INCLUDE CIOUNT
16     C      INCLUDE CNAMES
17     C      INCLUDE CPAGE
18     C
19     C      *****
20     C      ***** CHECK 'NBLK' BEFORE DATA SETUP - INCLUDE ALL DATA BLOCKS *****
21     C      ***** REQUIRED FOR THE SYSTEM BEING STUDIED. *****
22     C
23     C      *****
24     C      *****
25     C      GO TO (110,120,130,140,150), SYSNUM
26     C
27     C      *****
28     C
29     C      110 CONTINUE
30     C
31     C      ***** READ IN THE MAGNET DATA
32     C
33     C      IF(PAGE(0)) WRITE(6,6030) (LO(1,2),I=1,9)
34     C      6030 FORMAT('0',3BX9A6/' ')
35     C
36     C      READ (11N,5020) PMAGDW, TMAGDW,HEMWT, QMAGI,VHEMAG,VHEMDW,
37     C      1 VHESDW, HDMAGI, HDMAGO,HDMAGC, NUMMAG, WDTLHI
38     C      2 , QLKSDW, QLEAK1, QLEAK2
39     C      5020 FORMAT(7F10.2,3F10.2,15.2F10.4)
40     C
41     C      WRITE (6,6040) (L2(1, 1),I=1,4), NUMMAG,
42     C      1 (L2(1, 2),I=1,4), PMAGDW,
43     C      2 (L2(1, 3),I=1,4), TMAGDW,
44     C      3 (L2(1, 4),I=1,4), HEMWT,
45     C      4 (L2(1, 5),I=1,4), QMAGI,
46     C      5 (L2(1, 6),I=1,4), VHEMAG,
47     C      6 (L2(1, 7),I=1,4), VHEMDW,
48     C      7 (L2(1, 8),I=1,4), VHESDW,
49     C      8 (L2(1, 9),I=1,4), HDMAGI,
50     C      9 (L2(1,10),I=1,4), HDMAGO,
51     C      A (L2(1,11),I=1,4), HDMAGC,
52     C      B (L2(1,12),I=1,4), WDTLHI
53     C
54     C      6040 FORMAT(145,4A6,T80,13/T45,4A6,T77,F9.2/T45,4A6,T77,F9.2/,
55     C      1 145,4A6,T77,F9.2/T45,4A6,T77,F9.2/T45,4A6,T77,F9.2/,
56     C      2 145,4A6,T77,F9.2/T45,4A6,T77,F9.2/T45,4A6,T77,F9.2/,

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CPL00100
CPL00200
CPL00300
CPL00400
CPL00500
CPL00600
CPL00700
CPL00800
CPL00900
CPL01000
CPL01100
CPL01200
CPL01300
CPL01400
CPL01500
CPL01600
CPL01700
CPL01800
CPL01900
CPL02000
CPL02100
CPL02200
CPL02300
CPL02400
CPL02500
CPL02700
CPL02800
CPL02900
CPL03000
CPL03100
CPL03200
CPL03300
CPL03400
CPL03500
CPL03600
CPL03700
CPL03800
CPL04000
CPL04100
CPL04200
CPL04300
CPL04400
CPL04500
CPL04600
CPL04700
CPL04800
CPL04900
CPL05000
CPL05100
CPL05200
CPL05300
CPL05400
CPL05500
CPL05600

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A37

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58      3      T45.4A6,T77,F9.2/T45.4A6,T77.F9.2/T45.4A6,T77.F9.2/)      CPL05700
59      C                                          CPL05800
60      GO TO 113                                CPL05900
61      C                                          CPL06000
62      C      .....                                CPL06100
63      C                                          CPL06200
64      120 CONTINUE                             CPL06300
65      C                                          CPL06400
66      C      ***** READ IN THE CRYOPANEL DATA      CPL06500
67      C                                          CPL06600
68      IF(PAGE(0)) WRITE (6,6050) (LO(1,3),I=1,9)      CPL06700
69      6050 FORMAT('0',3BX9A6/' ')                  CPL06800
70      C                                          CPL06900
71      READ (11N,5021) NUMCRP, PCRYDW, TCRYDW, VHECDW, WDTLCH, HEMWT      CPL07000
72      5021 FORMAT(15,5X,5F10.2)                    CPL07100
73      DD 70 I = 1,NUMCRP                            CPL07200
74      70 READ (11N,5022) QCR(1),VHECR(1),HDCRI(1),HDCRO(1),WDTCR(1)      CPL07300
75      5022 FORMAT(5F10.2)                            CPL07400
76      READ (11N,5023) QLEAK1, QLEAK2
77      5023 FORMAT(2F10.4)
78      C                                          CPL07500
79      WRITE (6,6055) (L3(1,1),I=1,4), NUMCRP,          CPL07600
80      1      (L3(1,2),I=1,4), PCRYDW,                  CPL07700
81      2      (L3(1,3),I=1,4), TCRYDW,                  CPL07800
82      3      (L3(1,4),I=1,4), VHECDW,                  CPL07900
83      4      (L3(1,5),I=1,4), WDTLCH,                  CPL08000
84      5      (L2(1,4),I=1,4), HEMWT                    CPL08100
85      6055 FORMAT(145,4A6,T8D,13/T45,4A6,T77,F9.2/T45,4A6,T77,F9.2/,      CPL08200
86      1      T45,4A6,T77,F9.2/T45,4A6,T77.F9.2/T45,4A6,T77.F9.2/)      CPL08300
87      C                                          CPL08400
88      WRITE (6,6056)                                CPL08500
89      6056 FORMAT(/T50,'CRYOPANEL-2',T6B,'CRYOPANEL-1',T6B,'CRYOPANEL-3',      CPL08600
90      1 T104,'CRYOPANEL-4'/)                        CPL08700
91      WRITE (6,6057) (L3(1,6),I=1,4), (QCR(1),I=1,4),      CPL08800
92      1      (L3(1,7),I=1,4), (VHECR(1),I=1,4),        CPL08900
93      2      (L3(1,8),I=1,4), (HDCRI(1),I=1,4),        CPL09000
94      3      (L3(1,9),I=1,4), (HDCRO(1),I=1,4),        CPL09100
95      4      (L3(1,10),I=1,4), (WDTCR(1),I=1,4),        CPL09200
96      6057 FORMAT(119,4A6,9X,4(F9.2,10X)/T19,4A6,9X,4(F9.2,10X)/T19,4A6,9X,      CPL09300
97      1 4(F9.2,10X)/T19,4A6,9X,4(F9.2,10X)/T19,4A6,9X,4(F9.2,10X))      CPL09400
98      C                                          CPL09500
99      GO TO 113                                CPL09600
100     C                                          CPL09700
101     C      .....                                CPL09800
102     C                                          CPL09900
103     130 CONTINUE                             CPL10000
104     C                                          CPL10100
105     C      ***** READ IN THE REFRIGERATOR-LIQUIFIER DATA      CPL10200
106     C                                          CPL10300
107     IF(PAGE(0)) WRITE (6,6060) (LO(1,8),I=1,9)      CPL10400
108     6060 FORMAT('0',3BX,9A6/' ')                  CPL10500
109     C                                          CPL10600
110     READ (11N,5042) (TCB(1),I=1,11)
111     5042 FORMAT(11F7.3)
112     READ (11N,5043) (HENTH(1),I=1,11)
113     5043 FORMAT(11F7.2)
114     READ (11N,5044) (PCB(1),I=1,13)
115     5044 FORMAT(3F10.4)

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116 READ(IIN,5045) (WDTCB(I),I=1,5)
117 5045 FORMAT(5F10.2)
118 READ (IIN,5040) IN2L, PN2L, DN2L, HN2L, DN2LV, HN2V, TN20, DN20,
119 1 HN20, GMWNTN2, HEMWT CPL10700
120 5040 FORMAT(2F10.4,F10.6,F10.4,F10.6,2F10.4/F10.6,3F10.4) CPL10800
121 C CPL10900
122 READ (IIN,5041) QLEAK1, QLEAK2 CPL11000
123 5041 FORMAT(2F10.4) CPL11100
124 C CPL11200
125 WRITE (6,6061) TCB(1), PCB(1), WDTCB(1), HENTH(1), CPL11300
126 1 TCB(3), PCB(1), WDTCB(1), HENTH(2), CPL11400
127 2 TCB(3), PCB(2), HENTH(7), CPL11500
128 3 TCB(2), PCB(2), HENTH(6), CPL11600
129 4 TCB(4), PCB(3), HN2L CPL11700
130 5 TCB(2), PCB(3), HN20 CPL11800
131 C CPL11900
132 6061 FORMAT( T4,'REFRIGERATOR-LIQUIFIER HEAD-END CONDITIONS:',T87,'COMP' CPL12000
133 1RESSOR',T104,'N2-VENT',T123,'MAKE-UP',T102,'N',T37,'TEMP. PRESCPL12100
134 25, FLOW ENTHALPY',T94,'CC',T102,'N',T6'/T30,'DEG.K) (KPACPL12200
135 3) (GM/SEC) (J/MOL),T93,'C',T102,'N',P3',T23,'V',E'/T4,'UCPL12300
136 4PPER HEX-LN2 BOILER ASSY',T92,'C',T102,'N',T23,'A',V+''/T87, CPL12400
137 5'HHHHHC CXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXH L HHHH/T7,'WARM HELIUM INLETCPL12500
138 6' (T1,P1,W1) ',F6.2,2F10.1,F11.1,T87,H',C',T102,'N',T117,'HCPL12600
139 7 'A',V+''/T83,'T1,H',C',T102,'N',T113,'T1,H',V',E'/T7CPL12700
140 8,'WARM HELIUM OUTLET (T2,P1,W1) ',F6.2,2F10.1,F11.1,T83,'P1,H',CPL12800
141 9 CC',T102,'N',T113,'P2,H'/T83,'W',HHHHH',T102,'NNNNN',T113,'W2 CPL12900
142 A HHHHH'/T7,'COLD HELIUM INLET (T3,P2,W2) ',F6.2,F10.1,'T80 CPL13000
143 B' F11.1,T91,'H',T106,'N',T121,'H'/T83,'HHHHHHHHH',T98,'NNNNNNNNN',CPL13100
144 C,T113,'HHHHHHHHH',T7,'COLD HELIUM OUTLET (T4,P2,W2) ',F6.2,F10.1,'CPL13200
145 D TBD ',F11.1,T83,'H',T98,'N',T113,'H'/T83,9('H'),T98,9('N'), CPL13300
146 ET113,9('H')/T7,'LN2-BOILER INLET (T5,P3,W3) ',F6.2,F10.1,'TCL13400
147 FBD ',F11.1,T91,'H',T106,'N',T121,'H'/T83,9('H'),T98,9('N'),T113, CPL13500
148 G9('H')/T7,'GN2 TOP-HEX OUTLET (T6,P3,W3) ',F6.2,F10.1,'TBD 'CPL13600
149 H,F11.1,T83,'H',T98,'N',T113,'H'/T83.5('H'),T98,5('N'),T113.5('H'),CPL13700
150 C CPL13800
151 WRITE (6,6062) TCB(5), PCB(1), WDTCB(2), HENTH(3), CPL13900
152 1 TCB(6), PCB(2), WDTCB(2), HENTH(9), CPL14000
153 2 TCB(7), PCB(1), WDTCB(4), HENTH(4), CPL14100
154 3 TCB(11),PCB(2), WDTCB(4), HENTH(9), CPL14200
155 4 TCB(9), PCB(1), WDTCB(5), HENTH(5), CPL14300
156 5 TCB(10),PCB(2), WDTCB(5), HENTH(11), CPL14400
157 6 TCB(8), PCB(2), HENTH(10) CPL14500
158 C CPL14600
159 6062 FORMAT(T4,'TURBINE EXPANDERS:',T87,'H',T102,'N',T117,'H',T3'/T87,CPL14700
160 1 'H',T102,'N',T117,'H',P2'/T7,'WARM TURBINE INLET',T37,F6.2,2F10.1,CPL14800
161 21,F11.1,T79,B('H'),H',T4('H'),N',4('H'),T117,'H',W2'/T79,'', CPL14900
162 3T87,'H',T102,'N',T117,'H'/T7,'WARM TURBINE OUTLET',T37,F6.2, CPL15000
163 42F10.1,F11.1,T79,'H',T87,5('H'),T106,'H',T117,'H'/T79,'',T91,'H',CPL15100
164 5T106,'H',T117,'H'/T7,'COLD TURBINE INLET',T37,F6.2,2F10.1,F11.1, CPL15200
165 6T79,'H',T83,9('H'),T98,'LN2',T106,'H',T117,'H'/T79,'H',T96,'BOCPL15300
166 7ILER ',T117,'H'/T7,'COLD TURBINE OUTLET',T37,F6.2,2F10.1,F11.1,CPL15400
167 8,T79,'H',T83,9('H'),T106,'H',T117,'H'/T79,'H',T91,'H',T103,'T5', CPL15500
168 9T106,'H',T117,'H'/T4,'REF-LIQ BOTTOM-END CONDITIONS:',T79,'H',T87,CPL15600
169 A 5('H'),T103,'P3',T106,'H',T117,'H'/T79,'H',T87,'H',T103,'W3',T106CPL15700
170 B,'H',T117,'H'/T7,'J-T VALVE - INLET',T37,F6.2,2F10.1,F11.1,T79, CPL15800
171 C 8('H'),T117,'H'/T87,'H',T117,'H'/T7,'J-T VALVE - OUTLCPL15900
172 DET',T37,F6.2,2F10.1,F11.1,T83,'T2',H',T117,'H',T83,'P1',H',T117, CPL16000
173 E'H'/T7,'COLD HE-VAPOR INLET',T37,F6.2,F10.1,T58,'TBD ',F11.1,T83,CPL16100

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174      F'M) H',T117,'H'/T87,'H',T117,'H')          CPL16300
175      C                                              CPL16400
176      WRITE (6,6063) TCB(2), PCB(2), WDTCB(1), HENTH(6),
177      1      TCB(1), PCB(1), WDTCB(1), HENTH(1)      CPL16500
178      C                                              CPL16600
179      6063 FORMAT(I4,'COMPRESSOR-PURIFIER ASSY: '//T7,'LOW-PRES. HELIUM INLET'
180      1,T37,F6.2,2F10.1,F11.1//T7,'HIGH-PRES. HELIUM OUTLET',T37,F6.2,
181      2 2F10.1,F11.1//T10,'** TBD VALUES ARE COMPUTED IN PROGRAM **')
182      C                                              CPL16700
183      GO TO 113                                       CPL16800
184      C                                              CPL16900
185      C*****
186      C                                              CPL17000
187      140 CONTINUE                                   CPL17100
188      C                                              CPL17200
189      C***** READ IN THE LIQUID NITROGEN SYSTEM DATA
190      C
191      IF(PAGE(0)) WRITE(6,6070) (LO(I,5),I=1,9)
192      6070 FORMAT('0',3BX,9A6/' ')
193      C
194      GO TO 35
195      C                                              CPL17300
196      C*****
197      C*****
198      C*****
199      150 CONTINUE                                   CPL17400
200      C                                              CPL17500
201      C***** READ IN THE GASEOUS HELIUM RECOVERY SYSTEM DATA
202      C
203      IF(PAGE(0)) WRITE(6,6080) (LO(I,4),I=1,9)
204      6080 FORMAT('0',3BX,9A6/' ')
205      C
206      GO TO 35
207      C*****
208      C*****
209      113 CONTINUE                                   CPL17800
210      C                                              CPL17900
211      C***** INPUT THE CONFIGURATION TABLE
212      C
213      IF(PAGE(0)) WRITE(6,6000) (LO(I,1),I=1,9),((L1(I,J),I=1,2),J=1,2)
214      6000 FORMAT('0',3BX9A6//21A6/21A6/' ')
215      JP = PAGE(6)
216      C
217      IERR = 0
218      DO 30 I1=1,ICNF
219      READ (11N,5010) CFUNCT, CFTYPE, CNOPER, CHEAD(11), CMTYPE,
220      1      FRCOE(11), LOD(11), DIAM(11), CITYPE, ITHICK(11),
221      1      NBAR(11), CODE(11)
222      5010 FORMAT(A6,14,15,F5.2,15,3F5.0,15,2F5.0,5X,A6)
223      IF(PAGE(1)) WRITE(6,6000) (LO(I,1),I=1,9),((L1(I,J),I=1,2),J=1,2)
224      1      : JP = PAGE(6)
225      WRITE(10T,6010) CFUNCT, CODE(11), CFTYPE, CNOPER, CHEAD(11), CMTYPE,
226      1      FRCOE(11), LOD(11), DIAM(11), CITYPE,
227      2      ITHICK(11), NBAR(11)
228      6010 FORMAT(3XA6,2XA6,1X14,2X15,4XF5.2, 15,2X,E15.8,6XF7.2,6XF6.2,
229      15X15,9XF6.2,7XF5.1)
230      C
231      C***** SEARCH FOR THE CONFIGURATION NAME.
232      C
233      C*****

```



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1  CONST*  PROC
2  C
3      COMMON /CONST/  GRAVITY, PI, PI2D3, PI04, CKPKGM
4  C
5  C      ***** CONST VARIABLE DEFINITION
6  C      *
7  C      * GRAVITY - UNIVERSAL GRAVITATIONAL CONSTANT
8  C      * PI      = 3.1415927
9  C      * PI2D3   = 2.0 * PI/3.0
10 C      * PI04    = PI/4.0
11 C      * CKPKGM  = 101.97162      CONVERTS KPA TO KG/CU.M.
12 C      *****
13 C
14 C  END
15

```

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```
1 C
2 C
3 C
4 C
5 C
6 C
7 C
8 C
9 LOGICAL PAGE
10 C
11 INCLUDE CONTRL
12 INCLUDE CIOUNT
13 INCLUDE CKEYS
14 INCLUDE CPAGE
15 C
16 DATA NSPC / 'SUP' / 1LST / 'LAS' /
17 C
18 5000 FORMAT(2A6,2X,A4,3X,A3,1X,A5/12A6)
19 5001 FORMAT(A3,A6,3X,A3,14X,A3)
20 6000 FORMAT ('0'19X '*** SYSTEM NAME STARTING ',A3,' IS IN ERROR ***')
21 6001 FORMAT ('0'/// 44X'*** YOU HAVE CALLED FOR THE ',A3,A6,' SYSTEM
22 1 '***')
23 C
24 C
25 C
26 CALL STODTA
27 CALL OTUNIT (IDT)
28 C
29 NDXGAS = 0 @ INITIALIZE NDXGAS
30 C
31 CALL DATE (9,DOR)
32 C
33 C
34 C
35 READ(5,5000) NAME,DEPT,BLD,EXT,CTITLE
36 NCASE = 1
37 INTGSY = 1
38 C
39 C
40 C
41 CALL INTAB
42 C
43 1 CONTINUE
44 KEY1 = 1
45 KEY2 = 0
46 C
47 IF (INTGSY.EQ.1) GO TO 5
48 READ (5,5000) NAME,DEPT,BLD,EXT,CTITLE
49 C
50 5 CONTINUE
51 READ (11N,5001) NSYS,N1,NCRIT,INTGR
52 DO 10 I=1,NBRSY
53 IF (NSYS .EQ. NAMSYS(I)) GO TO 20
54 10 CONTINUE
55 WRITE (IDT,6000) NSYS
56 CALL EXIT
57 20 SYSNUM = 1
```

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```
58      IF (PAGE(0)) WRITE (10T,6001) NSYS,N1
59      SCRIT = 1
60      IF (NCRIT .EQ. NSPC) SCRIT = 2
61      INTGSY = 2
62      IF (INTGR .EQ. ILST) INTGSY = 1
63      C
64      C          READ COMPONENT INPUT DATA
65      C
66      CALL COMPII
67      C
68      C          DO SYSTEM CALCULATIONS FOR THE GIVEN SYSTEM
69      C
70      KEY1 = 1613
71      C
72      K = 0
73      C
74      40 I = 1
75      K = 0
76      LREPT = 0
77      C
78      30 JKM = KSUBC(SYSNUM,I)
79      C
80      C          IF ZERO HAVE REACHED END OF CALLING SEQUENCE
81      IF (JKM .EQ. 0) GO TO 2200
82      C          CALL ROUTINES DEPENDING ON SYSTEM SPECIFIED (SYSNUM)
83      GO TO (100,200,300,400,500,600,700,800,900,1000),JKM
84      C
85      100 CALL MAGNET
86      GO TO 2000
87      C
88      200 CALL CRYPAN
89      GO TO 2000
90      C
91      300 CALL HENKUP
92      GO TO 2000
93      C
94      400 CALL LIGNIT
95      GO TO 2000
96      C
97      500 CALL GHERCV
98      GO TO 2000
99      C
100     600 CONTINUE
101     GO TO 2000
102     C
103     700 CONTINUE
104     GO TO 2000
105     C
106     800 CONTINUE
107     GO TO 2000
108     C
109     900 CONTINUE
110     GO TO 2000
111     C
112     1000 CONTINUE
113     GO TO 2000
114     C
115     2000 CONTINUE
```

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116      IF(LREPT) 40,2100,40
117      C
118      2100 I = I + 1
119      IF(1-9) 30,30,2200
120      C      END OF PROCESS THIS SYSTEM
121      2200 CONTINUE
122      C
123      C      IF THIS IS AN INTEGRATED SYSTEM - GO READ NEXT
124      C      SYSTEM NAME
125      C      IF IT IS A LAST CARD EXIT
126      C
127      IF (INTGSY .EQ. 2) GO TO 1
128      CALL EXIT
129      END

```

** CP **

FILE: MFTF.CSA

TIME: 10:21:03

DATE 040579

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```
1  DOUBLE PRECISION FUNCTION CP(D,T)
2  DOUBLE PRECISION A,B,D,T,CVH,CV,DD,TT,DPDD,DPDT,PP
3  DOUBLE PRECISION GAMMA,WT
4  DIMENSION A(30),B(30)
5  COMMON/DATA/PP,DD,TT,WT,A,B,N,GAMMA,L
6  CVH=CV(D,T)/4.0026D+0
7  DD=D
8  TT=T
9  CALL DDHEF
10 DPDD=PP
11 CALL DTHEF
12 DPDT=PP
13 CP=CVH+(T*(DPDT**2)/((D**2)*DPDD))-101.3278D+0/4.0026D+0
14 CP=CP*4.0026D+0
15 RETURN
16 END
```

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```

1 CPAGE= PROG
2 C
3
4 INTEGER DEPT ,BLD ,EXT ,PTITLE,CTITLE,OPTLUN,DOR ,TIME
5 C
6 COMMON /CPAGE/NAME(2),DEPT,BLD,EXT,MAXLIN,JNUM,PTITLE(6),
7 1 CTITLE(12),OPTLUN,NCASE,DOR(2),TIME(2)
8 C
9
10
11
12
13
14
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16
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18
19
20
21
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24
25
26
27
28
29
30
31
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33
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35

```

END

*** CPAGE VARIABLE DEFINITION

```

NAME - USER'S NAME (INPUT).
DEPT - USER'S DEPARTMENT (INPUT).
BLD - USER'S BUILDING (INPUT).
EXT - USER'S EXTENSION (INPUT).
MAXLIN - MAXIMUM LINES PER OUTPUT PAGE.
JNUM - PROGRAM IDENTIFICATION NUMBER.
PTITLE - PROGRAM TITLE.
CTITLE - CASE TITLE (INPUT).
OPTLUN - OUTPUT LOGICAL UNIT NUMBER.
NCASE - CASE NUMBER (INTERNALLY CREATED).
DOR - DATE OF THIS RUN (INTERNALLY CREATED).
TIME - TIME OF THIS RUN (INTERNALLY CREATED).

```


SUBROUTINE CRYPAN

```

* * * * *
* ROUTINE NAME - CRYOPANEL CHARACTERIZATION
* ROUTINE LANG - FORTRAN V UNIVAC 1100-DS
* EXEC-B
* PROGRAMMER - R.F. HAUSMAN 104-6213-30235
* DATE CODED - NOVEMBER 29, 1978
* * * * *

```

**** THIS SUBROUTINE CHARACTERIZES THE CRYOPANEL CONDITIONS

LOGICAL JP,PAGE

INCLUDE CMAG

BEGIN COMPUTATIONS FOR THE CRYOPANEL SYSTEM

NPSYS = 2

PTANK = PCRYDW

TTANK = TCRYDW

NP = NUMCRP

DO 5 I = 1, NP

CALL HEPROP(PCRYDW, TCRYDW, I)

2 GET LIQ PROPS

RHO = HELD * HEMWT

2 KG/CU-METER

PCRYI(I) = PCRYDW + HEHED(RHO, HDCRI(I))

2 KPA

PCRYDI(I) = PCRYDW + HEHED(RHO, HDCRO(I))

2 KPA

SLVIN(I) = HELSV

2 L/MOL

TCRI (I) = TCRYDW

2 DEG K

DENS (I) = HELD

CALL HEPROP(PCRYI(I), TCRI(I), 1)

2 CP INLET PROP

CAL HEPROP(PCRYDI(I), TCRI(I), 3)

2 CP OUTLET PROP

DELTA-H SUBCOOLED LIQUID TO SAT. LIQUID

DELH1 = HEHL - HELH

2 J/MOL

DELTA-H, SUBCOOLED LIQUID TO SAT. VAPOR

DELH2 = HEHG - HEHL

2 J/MOL

ENERGY - SUBCOOLED LIQUID TO SAT. LIQUID

QUANT = VHECR(I) * HEDL

2 MOLS

QSAT1 = QUANT * DELH1

2 JOULES

848

ENERGY - SATURATED LIQUID TO SAT. VAPOR

QEVAP = QUANT * DELH2 J/DOULES

ENERGY INPUT TO CRYOPANELS - PER HOUR

QGENHR(I) = QCR(I) * 3600 J/HR

TIME TO OBTAIN NO FLOW COOLANT LOSS

TIM1(I) = QSAT1/QGENHR(I) HRS
 TIM2(I) = QEVAP/QGENHR(I) HRS
 TCRO(I) = HET DEG K - TSAT
 RHOL(I) = HEDL MOL/L
 RHOG(I) = HEDG MOL/L

MAX. GAS GENERATION AT NO FLOW CONDITION

WDTMXG(I) = ((QGENHR(I)/DELH2) + HEMWT)/1000.0 KG/HR

ENERGY REQD. FOR SAT. LIQUID AT SPECIFIED FLOWRATE (WDTCR(I))

QSAT2 = ((WDTCR(I) * 1000.0)/HEMWT) * DELH1 J/HR

ENERGY AVAILABLE FOR VAPORIZATION OF HELIUM

QEVAP1 = QGENHR(I) - QSAT2 J/HR

VAPOR GENERATED AT SPECIFIED FLOW RATE

WDTG(I) = ((QEVAP1/DELH2) + HEMWT)/1000.0 KG/HR
 WDTL(I) = WDTCR(I) - WDTG(I)

QUALITY OF THE LIQUID

QWAL(I) = WDTG(I)/WDTCR(I) DEC-FRACTION

SP.VOL. AND RHO OF THE LIQUID OUT OF CRYOPANELS

SVLMX(I) = HESVL + QWAL(I) * HESVG L/MOL
 RHOMX(I) = 1.0/SVLMX(I) MOL/L

WDDFI(I) = WDTCR(I) KG/HR

5 CONTINUE

JP = PAGE(0)

WRITE (6,10)

10 FORMAT(//T33,'*** CHARACTERIZE CRYOPANEL INPUT AND OUTPUT CONDITIO
 1NS ***//T48,'** ESTIMATED CRYOPANEL PARAMETERS **//T5,'FLUID FLO
 2WING CONDITIONS:',T50,'CRYOPANEL-2',T68,'CRYOPANEL-1',T86,'CRYOPAN
 3EL-3',T104,'CRYOPANEL-4//')

WRITE (6,15) (WDTCR(I),I=1,NP)

15 FORMAT(T10,'INLET FLOW RATE',T35,'(KG/HR) = ',.4(E12.6,6X))

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116 WRITE (6,16) (TCRI(I),I=1,NP)
117 FORMAT(110,'INLET TEMPERATURE',T35,'(DEG.K)   =   ',4(E12.6,6X))
118 WRITE (6,17) (PCRYI(I),I=1,NP)
119 FORMAT(110,'INLET PRESSURE',T35,'( KPA )   =   ',4(E12.6,6X))
120 WRITE (6,18) (IDENS(I),I=1,NP)
121 FORMAT(110,'INLET FLUID DENSITY',T35,'(MOL/L)   =   ',4(E12.6,6X))
122 WRITE (6,19) (SLVIN(I),I=1,NP)
123 FORMAT(110,'INLET SPECIFIC VOLUME',T35,'(L/MOL)   =   ',4(E12.6,6X)
124 1)/)
125 WRITE (6,20) (WDCRI(I),I=1,NP)
126 FORMAT(110,'OUTLET FLOW RATE',T35,'(KG/HR)   =   ',4(E12.6,6X))
127 WRITE (6,21) (TCRO(I),I=1,NP)
128 FORMAT(110,'OUTLET TEMPERATURE',T35,'(DEG.K)   =   ',4(E12.6,6X))
129 WRITE (6,22) (PCRYO(I),I=1,NP)
130 FORMAT(110,'OUTLET PRESSURE',T35,'( KPA )   =   ',4(E12.6,6X))
131 WRITE (6,23) (RHOL(I),I=1,NP)
132 FORMAT(110,'OUTLET LIQUID DENSITY',T35,'(MOL/L)   =   ',4(E12.6,6X)
133 1))
134 WRITE (6,24) (RHOG(I),I=1,NP)
135 FORMAT(110,'OUTLET GAS DENSITY',T35,'(MOL/L)   =   ',4(E12.6,6X))
136 WRITE (6,25) (RHOMX(I),I=1,NP)
137 FORMAT(110,'OUTLET MIXTURE DENSITY',T35,'(MOL/L)   =   ',4(E12.6,
138 1 6X))
139 WRITE (6,26) (SVLMX(I),I=1,NP)
140 FORMAT(110,'OUTLET MIXTURE SP.VOL.',T35,'(L/MOL)   =   ',4(E12.6,
141 1 6X))
142 WRITE (6,27) (QWAL(I),I=1,NP)
143 FORMAT(110,'OUTLET FLUID QUALITY',T35,'(FRACT)   =   ',4(E12.6,
144 1 6X))
145 WRITE (6,28) (WDTL(I),I=1,NP)
146 FORMAT(110,'OUTLET FLUID COMPOSITION:',T23,'LIQUID',T35,'(KG/HR)
147 1 =   ',4(E12.6,6X))
148 WRITE (6,29) (WDTG(I),I=1,NP)
149 FORMAT(123,'VAPOR',T35,'(KG/HR)   =   ',4(E12.6,6X))
150 WRITE (6,30) (QGENHR(I),I=1,NP)
151 FORMAT(115,'NO-FLOW CONDITIONS:',T10,'INPUT CRYOPANEL ENERGY',T35,
152 1 '(J/HR.)   =   ',4(E12.6,6X))
153 WRITE (6,31) (TIM1(I),I=1,NP)
154 FORMAT(110,'TIME TO SAT. LIQUID',T35,'(HOURS)   =   ',4(E12.6,6X))
155 WRITE (6,32) (TIM2(I),I=1,NP)
156 FORMAT(110,'TIME TO SAT. VAPOR',T35,'(HOURS)   =   ',4(E12.6,6X))
157 WRITE (6,33) (WDTMXG(I),I=1,NP)
158 FORMAT(110,'RATE OF VAPOR BOILDOFF',T35,'(KG/HR)   =   ',4(E12.6,
159 1 6X))
160 C
161 C *****
162 C
163 C DO THE CRYOPANEL SUPPLY SYSTEM COMPONENT CONFIGURATION ANALYSIS
164 C
165 C CALL CMPCAL                               @ DO THE COMPONENT ANALYSIS
166 C
167 C RETURN
168 C
169 C ENO

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1      SUBROUTINE CSUBP(TEMP,PRES,NGAS,C)
2      C
3      C
4      C *****
5      C NGAS = 1   FOR HELIUM
6      C       = 2   FOR NITROGEN
7      C
8      C *****
9      C
10     INCLUDE CMAG
11     C
12     T = TEMP
13     P = PRES
14     C
15     IF(NGAS.GT.2) GO TO 5
16     GO TO (1,2),NGAS
17     C
18     COMPUTE CSUBP FOR HELIUM
19     C
20     1  CONTINUE
21     C
22     CALL HEPROP(P,T,2)
23     C = HELCP
24     RETURN
25     C
26     COMPUTE CSUBP FOR NITROGEN
27     C
28     2  CONTINUE
29     C NOT DEFINED YET
30     C = 0.1
31     RETURN
32     C
33     FOR ERRONEOUS NGAS INDEX
34     C
35     5  C = 0.0
36     WRITE (6,100)
37     100 FORMAT('0',20(' '), ' ERRONEOUS NGAS INDEX WAS USED IN S.R. CSUBP
38     1',20(' ')/)
39     RETURN
40     C
41     END

```

51

```

1      FUNCTION CSUBV(TEMP,PRES,NGAS)
2      C
3      C .....
4      C
5      C      NGAS = 1      FOR HELIUM
6      C      = 2      FOR NITROGEN
7      C
8      C .....
9      C
10     C      INCLUDE CMAG
11     C
12     C      T = TEMP
13     C      P = PRES
14     C
15     C      IF(NGAS.GT.2) GO TO 5
16     C      GO TO (1,2),NGAS
17     C
18     C      COMPUTE CSUBV FOR HELIUM
19     C
20     C      1 CONTINUE
21     C
22     C      CALL HEPROP(P,T,2)
23     C      C = HELCV
24     C
25     C      RETURN
26     C
27     C      COMPUTE CSUBV FOR NITROGEN
28     C
29     C      2 CONTINUE
30     C
31     C      NOT DEFINED YET
32     C      C = 0.1
33     C
34     C      RETURN
35     C
36     C      FOR ERRONEOUS NGAS INDEX
37     C
38     C      5 CSUBV = 0.0
39     C      WRITE (6,100)
40     C      100 FORMAT('0',20(' '), ' ERRNEOUS NGAS INDEX WAS USED IN S.R. CSUBV
41     C      1 ' ,20(' ')/)
42     C      RETURN
43     C
44     C      END

```

```
1 CSYSWT* PROC
2 C
3     PARAMETER JWA=120, JWB=3
4 C
5     INTEGER CNUM
6 C
7 C
8     COMMON /CSYSWT/ CNUM, WTCOMP(JWA,JWB), WTCUMT(JWA,JWB),
9     1 CMPCOD(JWA,JWB), WTSUBT, WTSUMT
10 C
11     ***** CNUM - COMPONENT INDEX IN SERIAL LIST
12     *
13     * WTCOMP - COMPONENT WEIGHT
14     *
15     * WTCUMT - SYSTEM CUMULATIVE WEIGHT IN SERIAL LIST
16     *
17     * CMPCOD - COMPONENT ID CODE FROM CONFIGURATION
18     *
19     * WTSUBT - SUBSYSTEM WEIGHT SUBTOTAL
20     *
21     * WTSUMT - SYSTEM TOTAL WEIGHT
22     *****
23 C
24     END
```

AS2

```
1 CTAB* PROC
2 C
3   PARAMETER NTBN = 10 , NSBZ = 40
4 C
5   INTEGER TLA,TYPE
6 C
7   COMMON /CTAB/ TLA(NTBN),NV,TYPE,NIP,ND,XTAB(NSBZ),YTAB(NSBZ),
8 1 TAB(6,5),JTABID,NTBL
9 C
10  DIMENSION ITAB(6,5)
11 C
12  EQUIVALENCE (ITAB,TAB)
13 C
14  ***** CTAB VARIABLE DEFINITION
15 C
16  TLA - TABLE LOCATION ARRAY
17      THIS ARRAY CONTAINS THE BEGINNING ORUM ADDRESS
18      - 1, FOR UP TO 10 TABLES
19 C
20  NV - NUMBER OF VALUES IN THE INPUT TABLE (NV<101).
21 C
22  TYPE - TYPE OF THE INPUT TABLE (0 = COEFFICIENT,
23        . 1 = DISCRETE ).
24 C
25  NIP - NUMBER OF TABLE VALUES TO BE USED IN
26        INTERPOLATION (NIP<NV).
27 C
28  ND - NUMBER OF DIMENSIONS FOR THE INPUT TABLE
29        (ND<7).
30 C
31  XTAB - ARRAY OF COEFFICIENTS FOR POLYNOMIAL EVALUATION
32        OR ARRAY OF VALUES OF THE INDEPENDENT VARIABLE
33        FOR INTERPOLATION.
34 C
35  YTAB - ARRAY OF VALUES OF THE DEPENDENT VARIABLE
36        FOR INTERPOLATION.
37 C
38  TAB - ARRAY OF VALUES OF THE REMAINING ND-2
39  ITAB INDEPENDENT VARIABLES FOR INTERPOLATION.
40 C
41  END
```

```

1  CTABA*  PROC
2  C
3      PARAMETER MXWRD = 2000
4  C
5      COMMON /CTABA/ 1DX1, TABLE(MXWRD)
6  C
7      DIMENSION 1TABLE(MXWRD)
8  C
9      EQUIVALENCE (TABLE, 1TABLE)
10 C
11  END
    
```


•• CV ••

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```
1  DOUBLE PRECISION FUNCTION CV(D,T)
2  DOUBLE PRECISION A,B,CVD,T,D,CVINT,ZERO,DD,PP,TT
3  DOUBLE PRECISION GAMMA,WT
4  DIMENSION A(30),B(30)
5  COMMON/DATA/PP,DD,TT,WT,A,B,N,GAMMA,L
6  CVD = 5.193043D+0*(3.D+0/5.D+0)
7  ZERO = 0.0D+0
8  1 CV=CVD-(CVINT(D,T)-CVINT(ZERO,T))*101.3278D+0/4.0026D+0
9  CV=CV*4.0026D+0
10 RETURN
11 END
```

ASS

```

1  DOUBLE PRECISION FUNCTION CVINT(D,T)
2  DOUBLE PRECISION A,B,D,D2,D3,D4,WT,D,R,DAMMA,EX,SINT,DBDT,DGAMA
3  DOUBLE PRECISION D2DBT2,T,PP,DD,TT
4  DOUBLE PRECISION YA,YB,YC,YD,YE,YG,YH,YP,YQ,YR,YS
5  DOUBLE PRECISION GAMMA,WT
6  DIMENSION A(30),B(30)
7  COMMON/DATA/PP,DD,TT,WT,A,B,N,GAMMA,L
8  D2=D*D
9  D3=D2*D
10 D4=D3*D
11 WTD = WT
12 N=1
13 N=.0820558D+0
14 DAMMA = GAMMA
15 DGAMA = D2*(-.5D-3)
16 EX = OEXP(DGAMA)
17 SINT=T*R*D*(2.D+0*DBDT(T)+D2DBT2(T)*T)
18 A(N)=0.0
19 N=N+1
20 YA=-2.
21 A(N)=(D4*D/5.D+0)*T**YA*YA*(-1.0D+0)
22 N=N+1
23 DO 2 1=1,6
24 F1=1
25 YB=.75-F1/4.-1
26 YC=.73-F1/4.
27 A(N)=(D4/4.D+0)*T**YB*YC*YB
28 N=N+1
29 DO 3 1=1,4
30 F1=1
31 YD=1.5-F1-1
32 YE=1.5-F1
33 A(N)=(D3/3.D+0)*T**YD*YE*YD
34 N=N+1
35 DO 1 1=1,8
36 F1=1
37 YG=1.5-F1/2.-1
38 YH=1.5-F1/2.
39 A(N)=(D2/2.D+0)*T**YG*YH*YG
40 N=N+1
41 DO 4 1=1,3
42 F1=1
43 YP=1.-F1-1.
44 YQ=1.-F1
45 A(N)=(EX/(2.D+0*DAMMA))*T**YP*YQ*YP
46 N=N+1
47 DO 5 1=1,3
48 F1=1
49 YR=1.-F1-1.
50 YS=1.-F1
51 A(N)=(D2*EX/(2.D+0*DAMMA)-EX/(2.0D+0*DAMMA*DAMMA))*T**YR*YS*YR
52 N=N+1
53 IF( L.GT.0)GO TO 10
54 A(N)=PP*SINT
55 DO 7 1=1,N
56 7 A(N)=A(N)*WTD
57 N=N-1

```

.. CVINT ..

```
58 RETURN
59 10 N=N-I
60 DO 6 I=1,N
61 6 SINT=SINT+B(I)*A(I)
62 CVINT=CVINT+SINT
63 RETURN
64 END
```

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```

1  C
2
3  C
4  C
5  C
6  C
7  C
8  C
9  C
10 C
11
12 C
13
14 C
15
16 C
17
18 C
19
20 C
21
22 C
23
24 C
25
26 C
27
28 C
29
30 C
31
32 C
33
34 C
35 C
36 C
37 C
38 C
39 C
40 C
41 C
42 C
43 C
44 C
45 C
46 C
47 C
48 C
49 C
50 C
51 C
52 C
53 C
54 C
55 C
56 C
57 C

```

FUNCTION CVOL(NFUNCT,NFTYPE,KDV,DIA)

FINDS METRIC VOLUME OF VALVES, ELBOWS, TEES, TAPS, ETC. FOR
COMPONENT DIAMETERS OF 1 TO 12 INCHES.
DATA TAKEN FROM TUBETURN PIPING HANDBOOK. (DATA ARE IN CU.INCHES)

DIMENSION E180(12), E90(12), E45(12), T3W(12), T1W(12), TRD(3),
VAL(12), R50(12), R20(12), BF(12), VLV(12)

DATA (E180(1),1=1,12)/ 4.1, 31.6, 104.4, 239.7, 471.0, 816.1,
/ 1000.0, 1884.7, 2500.0, 3713.0, 4500.0, 6391.8/
DATA (E90(1),1=1,12)/ 2.0, 15.8, 52.2, 119.8, 235.5, 408.1,
/ 500.0, 942.4, 1250.0, 1856.9, 2250.0, 3185.9/
DATA (E45(1),1=1,12)/ 1.0, 7.9, 26.1, 59.9, 117.8, 204.0,
/ 250.0, 471.2, 625.0, 928.5, 1125.0, 1597.9/
DATA (T3W(1),1=1,12)/ 3.5, 22.2, 65.2, 135.8, 249.7, 413.2,
/ 648.0, 881.1, 1278.0, 1675.4, 2246.2, 2816.9/
DATA (T1W(1),1=1,12)/ 4.3, 27.7, 80.5, 166.5, 304.4, 501.3,
/ 781.5, 1061.9, 1536.0, 2010.4, 2691.0, 3371.9/
DATA (TRD(1),1=1,3)/ 100.0, 329.4, 354.1/
DATA (VAL(1),1=1,12)/ 3.2, 20.0, 58.7, 122.2, 224.8, 371.9,
/ 583.2, 793.0, 1150.2, 1507.9, 2021.4, 2535.3/
DATA (VLV(1),1=1,12)/ 2.8, 16.9, 52.9, 110.4, 204.1, 340.0,
/ 535.3, 730.6, 1063.1, 1396.1, 1872.1, 2348.1/
DATA (R50(1),1=1,12)/ 1.76, 8.51, 21.9, 41.8, 77.2, 123.7, 179.6,
/ 235.6, 331.9, 428.3, 563.0, 697.7/
DATA (R20(1),1=1,12)/ 2.14, 11.4, 25.5, 54.4, 107.0, 147.1, 228.1,
/ 309.2, 447.6, 586.0, 789.9, 993.8/
DATA (BF(1),1=1,12)/ 3.14, 12.56, 28.27, 50.26, 78.5, 113.09,
/ 153.93, 201.06, 254.46, 314.16, 380.13, 452.38/

TRD(1) = A DUMMY NUMBER TO FILL ARRAY
TRD(2) = 6X2XG REDUCING OUTLET TAP
TRD(3) = 6X4XG REDUCING OUTLET TAP

C1 = 1.639E-05 * CU.IN. TO CU.METERS
C2 = 39.37007 * INCHES PER METER

IF(NFUNCT.EQ.6) GO TO 10
IF(NFUNCT.EQ.7) GO TO 20
IF(NFUNCT.EQ.8) GO TO 30
IF(NFUNCT.EQ.9) GO TO 40
IF(NFUNCT.EQ.10) GO TO 40
IF(NFUNCT.EQ.4) GO TO 50
IF(NFUNCT.EQ.5) GO TO 60

10 CONTINUE

IB = DIA * C2 + .01
IF((KDV.EQ.2).OR.(KDV.EQ.3)) GO TO 11
IF(KDV.EQ.4) GO TO 12

11 CVOL = TRD(KDV) * C1
RETURN
CVOL = T3W(1B) * C1
RETURN

AS9

```

58 C
59 20 CONTINUE
60 C
61 IB = DIA * C2 + .01
62 IF(KDV.EQ.2) GO TO 21
63 IF(KDV.EQ.3) GO TO 22
64 C
65 21 CVOL = T4W(IB) * C1
66 RETURN
67 22 CVOL = T3W(IB) * C1
68 RETURN
69 C
70 30 CONTINUE
71 C
72 IB = DIA * C2 + .01
73 IF(KDV.EQ.2) GO TO 31
74 IF(KDV.EQ.3) GO TO 32
75 IF(KDV.EQ.4) GO TO 33
76 C
77 31 CVOL = E45(IB) * C1
78 RETURN
79 32 CVOL = E90(IB) * C1
80 RETURN
81 33 CVOL = E180(IB) * C1
82 RETURN
83 C
84 40 CONTINUE
85 C
86 IB = DIA * C2 + .01
87 IF(KDV.EQ.2) GO TO 41
88 IF(KDV.EQ.3) GO TO 42
89 IF(KDV.EQ.4) GO TO 43
90 IF(KDV.EQ.5) GO TO 44
91 C
92 41 CVOL = VAL(IB) * C1
93 RETURN
94 42 CVOL = (VAL(IB) - (0.1 * VAL(IB))) * C1
95 RETURN
96 43 CVOL = VAL(IB) * C1
97 RETURN
98 44 CVOL = VLV(IB) * C1
99 RETURN
100 C
101 50 CONTINUE
102 C
103 IB = DIA * C2 + .01
104 IF(NFTYPE.EQ.1) GO TO 51
105 IF(NFTYPE.EQ.2) GO TO 52
106 C
107 51 CVOL = 1.0 * C1
108 RETURN
109 52 CVOL = VAL(IB) * C1
110 RETURN
111 C
112 60 CONTINUE
113 C
114 IB = DIA * C2 + .01
115 IF(KDV.EQ.2) GO TO 61

```

.. CVOL ..

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```
116 IF(KDV.EQ.3) GO TO 62
117 IF(KDV.EQ.4) GO TO 63
118
119 C 61 CVOL = R50(IB) * C1
120 RETURN
121 C 62 CVOL = R20(IB) * C1
122 RETURN
123 C 63 CVOL = BF(IB) * C1
124 RETURN
125 C
126 END
```

61

```

1 C
2
3 C
4 COMMON/HEGAS/RL(100),RN(100),RLD(100),COMP(2,100)
5 COMMON/HEGAS/RL1(100),RN1(100),RLD1(100)
6 COMMON/HEGAS/NUMBLO,NUMBHI
7 COMMON/HEGAS/MINIT,MFINAL,MSTEP
8 COMMON/HEGAS/IDIAM1,IDIAM2,ISTEP
9 C
10 DO 100 J=1,100
11 READ (5,140)RL(J),RN(J),RLD(J),COMP(1,J)
12 IF (COMP(1,J).LT.0.0) GO TO 110
13 NUMBLO=J-1
14 C
15 WRITE (6,300)
16 300 FORMAT(1H0,T7,'LOW PRESSURE SECTION':',T37,'LINE LENGTH'.
17 1 T55,'NUM.-ELBOWS',T74,'L/D OF CDMF.',T91,'MAJOR CDMF.'/)
18 DO 305 I = 1,NUMBLO
19 WRITE (6,310) RL(I),RN(I),RLD(I),COMP(1,I)
20 310 FORMAT(T39,F8.3,T56,F6.1,T76,F6.1,T94,F5.1)
21 305 CONTINUE
22 C
23 DO 120 J=1,100
24 READ (5,140)RL(J),RN(J),RLD(J),COMP(2,J)
25 IF (COMP(2,J).LT.0.0) GO TO 130
26 NUMBHI=J-1
27 C
28 WRITE (6,320)
29 320 FORMAT(1G,'HIGH PRESSURE SECTION:')
30 DO 325 I = 1,NUMBHI
31 WRITE (6,310) RL(I),RN(I),RLD(I),COMP(2,I)
32 325 CONTINUE
33 C
34 140 FORMAT(4F10.3)
35 150 FORMAT(3F10.3)
36 READ (5,160)MINIT,MFINAL,MSTEP
37 READ (5,160)IDIAM1,IDIAM2,ISTEP
38 160 FORMAT(3I5)
39 DO 170 ITEMP=1,10
40 READ (5,150)TG,PBAG,PCOMP
41 IF (TG.LT.0.0) GO TO 180
42 170 CALL GASRCV(TG,PBAG,PCOMP)
43 180 CONTINUE
44 C
45 RETURN
46 C
47 END

```

```

1      DOUBLE PRECISION FUNCTION DBDT(T)
2      DOUBLE PRECISION A,B,T,YZ,YY
3      DIMENSION A(9)
4      DATA A/-5.0815710041D-7,-1.1168680862D-4,1.1652480354D-2,
5      17.4474587998D-2,-5.3143174768D-1,-9.5759219306D-1,
6      23.9374411843D+0,-5.1370239224D+0,2.0804456338D+0/
7      C COEFFICIENTS FROM PROGRAM 5/28/70-1630
8      C THIS SUB PROGRAM CALCULATES THE SECOND VIRIAL COEFFICIENT FOR
9      C HELIUM. THE RANGE IS FROM 2 TO 1500 DEG K. INPUT IS TEMPERATURE
10     C IN DEGREES KELVIN AND IUSE, IF IUSE IS 0 OR NEGATIVE THE ROUTINE
11     C CALCULATES B FOR THE EQUATION PV=RT(1+B/D+...), FOR OTHER VALUES OF
12     C IUSE, THE ROUTINE CALCULATES THE VARIANCE OF B AT THE INPUT TEMP
13     C UNITS ARE ATM, DEG KELVIN, AND MOLES/LITER, 4/3/69-1253, R.D. MCCARTY
14     1 B=0
15     DO 5 I=1,9
16     FI=1
17     YZ=.5-FI/2.
18     YY=1.5-FI/2.
19     5 B=B+T**YZ*A(I)*YY
20     DBDT=B
21     RETURN
22     END

```


63

```

1  SUBROUTINE DDHEF
2  DOUBLE PRECISION A,B,D,DD,D2,D3,D4,D5,T,TT,DAMMA,EX,DEX,P,PP
3  DOUBLE PRECISION DPCLDD,ZA,ZB,ZC,ZD,DGAMA
4  DOUBLE PRECISION GAMMA,WT
5  DIMENSION A(30),B(30)
6  COMMON/DATA/PP,DD,TT,WT,A,B,N,GAMMA,L
7  D=DD
8  T=TT
9  D2=D*D
10 D3=D2*D
11 D4=D3*D
12 D5=D4*D
13 DAMMA = GAMMA
14 DGAMA = D2*(-.50-3)
15 EX = DEXP(DGAMA)
16 DEX = DAMMA*2.D+0*D*EX
17 N=1
18 A(N)=6.D+0*D5
19 N=N+1
20 A(N)=A(N-1)/T
21 N=N+1
22 DO 2 I=1,6
23 F1=1
24 ZA=.75-F1/4.
25 A(N)=5.D+0*D4*T**ZA
26 N=N+1
27 DO 3 I=1,4
28 F1=1
29 ZB=.15-F1
30 A(N)=D3*4.D+0*T**ZB
31 N=N+1
32 DO 1 I=1,8
33 F1=1
34 ZC=.15-F1/2.
35 A(N)=D2*3.D+0*T**ZC
36 N=N+1
37 DO 4 I=1,3
38 F1=1
39 ZD=.1.-F1
40 A(N)=(DEX*D3+3.D+0*D2*EX)*T**ZD
41 N=N+1
42 DO 5 I=1,3
43 F1=1
44 ZD=.1.-F1
45 A(N)=(DEX*D5+5.D+0*D4*EX)*T**ZD
46 N=N+1
47 N=N-1
48 P=0
49 DO 15 J=1,N
50 P=P+A(J)*B(J)
51 P = P + DPCLDD(D,T)
52 PP=P
53 RETURN
54 END

```

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1
2
3
4
5
6

DOUBLE PRECISION FUNCTION DELT(TT)
DOUBLE PRECISION T,TT
T=TT
DELT = .001D+0+.002D+0*T
RETURN
END

AGA

```

1 SUBROUTINE DENCAL(DEN,F0,TG)
2
3 C
4 C
5 C
6 C
7 C
8 C
9 C
10 C
11 C
12 C
13 C
14 C
15 C
16 C
17 C
18 C
19 C
20 C
21 C
22 C
23 C
24 C
25 C
26 C
27 C
28 C
29 C
30 C
31 C
32 C
33 C
34 C
35 C
36 C
37 C
38 C
39 C
40 C
41 C

    CALCULATION OF DENSITY, GIBBS PRESSURE AND TEMPERATURE

    DIMENSION ATM(8),DATM(8),A(17)
    RHO=1.0
    DATA(A(1),1=3.4)/1.277E-2,-3.7009E-2,7.5673E-3,-1.8876E-2/
    DATA(A(1),1=5.8)/4.7023E-2,1.5603E-4,9.2743E-4,-2.834E-5/
    DATA(A(1),1=9.12)/-5.0039E-3,3.4513E-2,1.0089E-1,6.55F-3/
    DATA(A(1),1=13.16)/-1.8516E-5,4.2044E-5,-1.7124E-4,7.7394E-7/
    DATA(A(1),1=17.1)/-2.8709E-9,8.2058E-2/
    PATM=PI/101.325
    100 ATM(1)=R-RHO*1G
    ATM(2)=(RHO*2)*(R*A(1)*TG+A(2)+A(3)/TG+A(4))/(TG*2)+A(5)/(TG**4))
    ATM(3)=(RHO*3)*(R*A(6)*TG+A(7))
    ATM(4)=(RHO*4)*A(8)
    ATM(5)=(RHO*3)*(A(9)/(TG*2)+A(10)/(1G*3)+A(11)/(TG**4))
    ATM(6)=ATM(5)*EXP(-A(12)*RHO/RHO/TG)
    ATM(7)=(RHO*5)*(A(13)/(TG*2)+A(14)/(TG*3)+A(15)/(TG**4))
    ATM(8)=ATM(6)*EXP(-A(12)*RHO/RHO/TG)
    ATM(7)=(RHO*5)*A(16)
    ATM(8)=(RHO*6)*A(17)
    DATM(1)=ATM(1)/RHO
    DATM(2)=2.0*ATM(2)/RHO
    DATM(3)=3.0*ATM(3)/RHO
    DATM(4)=4.0*ATM(4)/RHO
    DATM(5)=ATM(5)*{(3.0/RHO)-[2.0*A(12)*RHO/TG]}
    DATM(6)=ATM(6)*{(5.0/RHO)-[2.0*A(12)*RHO/TG]}
    DATM(7)=5.0*ATM(7)/RHO
    DATM(8)=6.0*ATM(8)/RHO
    DPATM=0.0
    DPPATM=0.0
    DO 110 I=1,8
    DPATM=DPATM+ATM(I)
    110 DPPATM=DPPATM+DATM(I)
    IF (DPPATM-2.0*LT-1.0E-8) GO TO 120
    RHO=RHO*(DPPATM-PATM)/DPPATM
    GO TO 100
    120 DEN=4.0*RHO
    RETURN
    END

```

Agg

```

1      SUBROUTINE DENS1(T,DSATL)
2
3      C
4      C      T=T(X) -- SUM=SUM((GM-MOLE)/LITER) -- DSATL=DSATL(KG/METER-3)
5      C
6      DIMENSION B(7)
7      TCRIT=126.2
8      TTRIPL=63.15
9      IF (T-TCRIT) GO TO 110
10     IF (T-TRIPL) GO TO 130
11     X=(TCRIT-T)/TCRIT
12     B(1)=-0.19424403E2
13     B(2)=X*(0.57083748E2)
14     B(3)=(X**2)*(-0.24326985E3)
15     B(4)=(X**3)*(0.88516838E3)
16     B(5)=(X**4)*(-0.16393680E4)
17     B(6)=(X**5)*(0.11574320E4)
18     B(7)=(ALOG(X))*(-0.10182210E1)
19     SUM=0.0
20     DO 100 I=1,7
21     SUM=SUM+B(I)
22     DSATL=28.0134*SUM
23     GO TO 150
24     110 WRITE (6,120)
25     120 FORMAT(T10,'TEMPERATURE GREATER THAN CRITICAL TEMPERATURE')
26     DSATL=-1.0
27     GO TO 150
28     130 WRITE (6,140)
29     140 FORMAT(T10,'TEMPERATURE LESS THAN TRIPLE POINT TEMPERATURE')
30     DSATL=-1.0
31     150 RETURN
32     END

```

1 SUBROUTINE DENSU(T,DSATV)
2 C
3 C T=T(K) -- SUM=SUM((GM-MOLE)/LITER) -- DSATV=DSATV(KG/METER-3)
4 C
5 DIMENSION B(7)
6 TCRIT=126.2
7 TTRIPL=63.15
8 IF (T.GT.TCRIT) GO TO 110
9 IF (T.LT.TTRIPL) GO TO 130
10 X=(TCRIT-T)/TCRIT
11 B(1)=0.16333345E1
12 B(2)=X*(-0.94043771E1)
13 B(3)=(X+.2)*(-0.21852746E2)
14 B(4)=(X+.3)*(-0.10268744E3)
15 B(5)=(X+.4)*(-0.18794974E3)
16 B(6)=(X+.5)*(-0.16402437E3)
17 B(7)=(ALOG(X))*(-0.95731639E-1)
18 TSUM=0.0
19 DO 100 I=1,7
20 100 TSUM=TSUM+B(I)
21 SUM=EXP(TSUM)
22 DSATV=28.0134*SUM
23 GO TO 150
24 110 WRITE (6,120)
25 120 FORMAT(110,'TEMPERATURE GREATER THAN CRITICAL TEMPERATURE')
26 DSATV=-1.0
27 GO TO 150
28 130 WRITE (6,140)
29 140 FORMAT(110,'TEMPERATURE LESS THAN TRIPLE POINT TEMPERATURE')
30 DSATV=-1.0
31 150 RETURN
32 END

C
C
C
C

SUBROUTINE HPRAT(T,P,DHLDP,TOLD,SLENTH,SVENTH,HVAP)

T=T(K) -- DHLDP=SLOPE OF SATURATED LIQUID ENTHALPY WITH PRESSURE
IN (JOULE/KG)/(NT/METER-2)

TCRIT=126.2

TRIPPL=63.15

IF (T.GT.TCRIT) GO TO 100

IF (T.LT.TRIPPL) GO TO 120

EPS=0.01*P

PUPPER=P+EPS

PLOWER=P-EPS

PMEAN=P

TMEAN=T

P=PUPPER

TOLD=T

CALL TVP(P,T,TOLD)

CALL ENTHSL(T,P,SLENTH,SVENTH,HVAP)

HUPPER=SLENTH

P=PLOWER

TOLD=T

CALL TVP(P,T,TOLD)

CALL ENTHSL(T,P,SLENTH,SVENTH,HVAP)

HLOWER=SLENTH

P=PMEAN

T=TMEAN

DHLDP=(HUPPER-HLOWER)/(2.0*EPS)

GO TO 140

100 WRITE (6,110)

110 FORMAT(110,'TEMPERATURE GREATER THAN CRITICAL TEMPERATURE')

DHLDP=-1.0

GO TO 140

120 WRITE (6,130)

130 FORMAT(110,'TEMPERATURE LESS THAN TRIPLE POINT TEMPERATURE')

DHLDP=-1.0

140 RETURN

END

ASB

```

1  SUBROUTINE DPCAL(DP,T2,A1,A2,A3,A4,A5,A6,A7)
2  COMMON/PROP/B1,B2,B3,B4,B5,B6
3  COMMON/CALC/WDOT,QUAL1,QUAL2,DIAM,P,T
4  COMMON/CALC/REYN,FRIC,VAPVEL,VAPMCH,DENS
5  COMMON/CALC/TQUAL
6  PFRAC=0.0
7  P1=P
8  IF (QUAL1.GE.1.0) GO TO 230
9
10 C
11 C      PRESSURE DROP AND QUALITY CHANGE ANALYSIS FOR TWO-PH
12 C      FLOW (QUALITY < 1.0)
13
14  IF (P.LT.101325.0) GO TO 240
15  CALL N2PROP(P,T)
16  T1=T
17  VV1=B1
18  VL1=B2
19  RHOV1=B3
20  RHOL1=B4
21  HV1=B5
22  DH1=B6
23  REYN=4.0*WDOT/(3.14159*DIAM*VL1)
24  FRIC=0.0056+0.5*(REYN**(-0.32))
25  RLD=(A1/DIAM)+A4
26  EFFL=RLD*DIAM
27  IF (EFFL.EQ.0.0) GO TO 120
28  DPINIT=FRIC*RLD+(((4.0*WDOT)/(3.14159*(DIAM**2))**2)/(2.0*RHOL1)
29  DPULOD=DPINIT/EFFL
30  IF (QUAL1.NE.0.0) GO TO 100
31  XT1=0.0
32  XLOCK=1.0
33  GO TO 110
34  100 XT1=((1.0-QUAL1)/QUAL1)**1.8*(((VL1/VV1)**0.2)*(RHOV1/RHOL1)
35  XLOCK=1.50*(XT1)**(1.0/1.8)
36  PHIFR=1.0+((1.703454/XLOCK)+(1.269076/(XLOCK**2)))
37  DPDL=DPULOD*(PHIFR**2)*(((1.0-QUAL1)**1.8)
38  DPFRIC=DPDL*EFFL
39  GO TO 130
40  120 DPFRIC=0.0
41  DPULOD=0.0
42  130 DPHEAD=9.8066*(A3-A2)/DH1
43  DP=DPFRIC+DPHEAD
44  P=P1-DP
45  IF (P.LT.101325.0) GO TO 240
46  CALL N2PROP(P,T)
47  T2=T
48  VV2=B1
49  VL2=B2
50  RHOV2=B3
51  RHOL2=B4
52  HV2=B5
53  DH2=B6
54  Y1=(DP*DH1)/HV2
55  Y2=(QUAL1+HV1)/HV2
56  Y3=(9.8066*(A3-A2))/HV2
57  Y4=(A5/WDOT)/HV2
58  QUAL2A=Y1+Y2-Y3+Y4

```

```

58 IF (QUAL2A-1.0) 140,220,220
59
60 C
61 140 RELVL1=((1.0-QUAL1)/((((1.0-QUAL1)/RHOL1)+(QUAL1/RHOV1))*RHOL1)
62 RELVL2=((1.0-QUAL2A)/((((1.0-QUAL2A)/RHOL2)+(QUAL2A/RHOV2))*RHOL2)
63 RELVV1=1.0-RELVL1
64 RELVV2=1.0-RELVL2
65 PHIMOM=((((1.0-QUAL2A)**2)/RELVL2)-((((1.0-QUAL1)**2)/RELVV1))+((QU
66 AL2A**2, RELVV2)-(QUAL1**2/RELVV1))*((RHOL1+RHOL2)/(RHOV1+RHOV2))
67 DPMOM=PHIMOM*(WDOT**2)/((((3.14159/4.0)*DIAM**2)**2)*(RHOL1+RHOL2
68 1*0.5)
69 DPHEAD=9.8066*(A3-A2)/DHI
70 IF (DPDLOD.EQ.0.0) GO TO 190
71 TRM1=((1.0-QUAL1)**2.8)-((1.0-QUAL2A)**2.8)
72 TRM2=((1.0-QUAL1)**1.8)-((1.0-QUAL2A)**1.8)
73 TRM3=((1.0-QUAL1)**0.8)-((1.0-QUAL2A)**0.8)
74 RINT1=TRM1/2.8
75 RINT2=(-TRM1/2.80)+(TRM2/1.80)
76 RINT3=(TRM1/2.80)-(2.0/1.8)*TRM2+((1.0/0.8)*TRM3)
77 IFLAG=0
78 RN=1.30
79 RM=0.50
80 SUM1=0.0
81 SUM2=0.0
82 AK=1.0/(RM+1.0)
83 DD 160 K=1,10
84 RK=K
85 SUM1=SUM1+AK*(QUAL2A***(RM+RK))
86 SUM2=SUM2+AK*(QUAL1***(RM+RK))
87 RK=RK+1.0
88 160 AK=-AK*(RM+RK-1.0)+(RN-RK+2.0)/((RM+RK)*(RK-1.0))
89 IF (IFLAG.EQ.0) GO TO 170
90 RINT5=SUM1-SUM2
91 GO TO 180
92 170 RINT4=SUM1-SUM2
93 IFLAG=1
94 RN=0.300
95 RM=1.500
96 GO TO 150
97 180 THETA=((VLT/VVT)**0.1)*((RHOV1/RHOL1)**0.5)**(1.0/1.8)
98 RINT=RINT1+3.406908*RINT4/THETA+5.439908*RINT2/(THETA**2)+4.323625
99 1+RINT5/(THETA**3)+1.610554*RINT3/(THETA**4)
100 DPFRIC=EFL*DPDLOD*RINT/(QUAL2A-QUAL1)
101 GO TO 200
102 190 DPFRIC=0.0
103 200 DP=DPFRIC+DPHEAD+DPMOM
104 P=P1-DP
105 IF (P.LT.101325.0) GO TO 240
106 CALL N2PROP(P,T)
107 T2=T
108 VV2=B1
109 VL2=B2
110 RHOV2=B3
111 RHOL2=B4
112 HV2=B5
113 DV2=B6
114 VEL1=(4.0*WDOT)/(3.14159*(DIAM**2))*(((1.0/RHOL1)+QUAL1*((1.0/RHOV1
115 1)-(1.0/RHOL1)))
116 VEL2=(4.0*WDOT)/(3.14159*(DIAM**2))*(((1.0/RHOL2)+QUAL2A*((1.0/RHOV2

```

A70


```

116 12)-(1.0/RHDL2)))
117 QUAL2=(1.0*(DP+DH1)*(QUAL1+HV1)-(9.8066*(A3-A2)))+(A5/WDOT)-0.5*((VEL2+
118 1.2)-(VEL1+.2))/HV2
119 RELCHG=((QUAL2A-QUAL2)/QUAL2A)*100.0
120 IF (RELCHG*.2.LT.1.0E-2) GO TO 210
121 QUAL2A=QUAL2
122 ICOUNT=ICOUNT+1
123 IF (ICOUNT.GT.10) GO TO 210
124 GO TO 140
125 210 VAPVEL=WDOT/(0.5*(RH0V1+RH0V2))
126 VAPMCH=VAPVEL/(20.414*SQRT((T1+T2)*0.5))
127 SPECVL=0.5*((1.0-QUAL1)/RH0L1)+((1.0-QUAL2)/RH0L2)+(QUAL1/RH0V1)+
128 1*(QUAL2/RH0V2))
129 DENS=1.0/SPECVL
130 B1=VV2
131 B2=VL2
132 B3=RH0V2
133 B4=RH0L2
134 B5=HV2
135 B6=DH2
136 GO TO 240
137 C
138 C PRESSURE DROP ANALYSIS IN FOR QUALITY =1.0 CASES
139 C
140 220 XFRAC=(HV2-QUAL1+HV1)/(DP+DH1-9.8066*(A3-A2)+(A5/WDOT))
141 PFRAC=XFRAC*DP
142 P=P1-PFRAC
143 IF (P.LT.101325.0) GO TO 240
144 CALL N2PROP(P,T)
145 TQUAL=T
146 A1=A1*(1.0-XFRAC)
147 A2=A2*(1.0-XFRAC)
148 A3=A3*(1.0-XFRAC)
149 A4=A4*(1.0-XFRAC)
150 A5=A5*(1.0-XFRAC)
151 230 VISCAS=1.185E-7*(T+.0.8815)
152 REYN=4.0*WDOT/(3.14159*DIAM*VISCAS)
153 FRIC=0.0056+0.5*(REYN**(-0.32))
154 RLD=(A1/DIAM)+A4
155 PP=P
156 QUAL2=1.0
157 CALL GN2DEN(T,PP,DENS)
158 DENIN=DENS
159 CALL SPECFT(T,SPECFT)
160 GMACH=VAPMCH
161 G1=1.0+0.2065*(GMACH**2)
162 G2=1.0-(GMACH**2)
163 G3=0.413*(GMACH**2)
164 G4=1.0+G3
165 TSTAG=T*(1.0+0.2065*(GMACH**2))
166 IMASS=WDOT+DENS*A1*(DIAM**2)*(0.785398)
167 DTSTAG=A5/(SPECFT*IMASS)
168 DMM=(G3*G1/(2.0*G2))*(DTSTAG/TSTAG)+((G3*G1/(2.0*G2))*4.0*FRIC*RL
169 1D)
170 GMACH=GMACH+(GMACH*DMM)
171 TSTAG=TSTAG+DTSTAG
172 T=TSTAG/(1.0+0.2065*(GMACH**2))
173 T2=T

```

** DPCAL **

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```
174      TEXT=T
175      CALL GN2DEN(T,PP,DENS)
176      DENOUT=DENS
177      DPINIT=(4.0*FRICT*RLD/(2.0*((DENOUT+DENIN)/2.0)))*((WDDT/(0.78540*
178      1(DIAM*2)))*2)
179      PP=PP-DPINIT
180      CALL GN2DEN(T,PP,DENS)
181      DENOUT=DENS
182      DP=PFRACT*9.8066*(A3-A2)*((DENOUT+DENIN)/2.0)
183      DP=DP+(4.0*FRICT*RLD/(2.0*((DENOUT+DENIN)/2.0)))*((WDDT/(0.78540*(
184      1(DIAM*2)))*2)
185      P=P1-DP-PFRACT
186      VAPMCH=GMACH
187      VAPVEL=VAPMCH*20.414*SQRT(T)
240      DP=P1-P
189      F=P1
190      RETURN
191      END
```

A72

** DPCLDD **

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```
1 DOUBLE PRECISION FUNCTION DPCLDD(D,T)
2 DOUBLE PRECISION D,T,R,VIRB
3 R=.0820558D+0
4 DPCLDD=R-T+2.D+0*R+T*D*VIRB(T)
5 RETURN
6 END
```

A73

** DPCLDT **

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1
2
3
4
5
6

DOUBLE PRECISION FUNCTION DPCLDT(D,T)
DOUBLE PRECISION D,T,R,VIRB,DBDT
R=.0820558D+0
DPCLDT=R*D+R*D*VIRB(T)+D+R*T*D*DBDT(T)+D
RETURN
END

A74

```
1  DOUBLE PRECISION FUNCTION DPDTVP(TT)
2  DOUBLE PRECISION DELT,VPN
3  DOUBLE PRECISION TT,T,P,C,D,Z,Y
4  DIMENSION C(10),D(14)
5  DATA C/-3.9394635287D+0.141.27497598D+0,-1640.7711565D+0.11974.557
6  1102D+0,-55283.309818D+0.166219.56504D+0,-325212.02840D+0.398843.22
7  2750D+0,-277718.06992D+0.83395.204183D+0/
8  DATA D/-49.510540356D+0.651.9236417D+0,-3707.5430856D+0.12880.6734
9  191D+0,-30048.54554D+0.49532.267436D+0,-59337.568548D+0.52311.2960
10 225D+0,-33950.233134D+0.16028.674003D+0,-5354.1038967D+0.1199.03019
11 306D+0,-161.40362959D+0.9.8811553386D+0/
12 P=0
13 T=TT-DELT(TT)
14 IF(T-2.172D)10,0,1
15 DO 5 I=1,10
16   Z=1-I
17   Y = 2-I
18   5 P=P+C(I)*T**2*Y
19   DPDTVP=P+VPN(T)
20   RETURN
21 10 DO 15 I=1,14
22   Z=1-I
23   Y = 2-I
24   15 P=P+D(I)*T**2*Y
25   DPDTVP=P+VPN(T)
26   RETURN
27 END
```

```

1      SUBROUTINE DPLINE(DP,F,XLD,PP,RMACH,PGRAD,DIA)
2
3      C
4      C      ISOTHERMAL LINE PRESSURE DROP SUBROUTINE
5      C
6          Y=1.667*(RMACH**2)
7          XLDMAX=0.25*((1.0-Y)/Y)+ALOG(Y))/F
8          IF (XLD.GT.XLDMAX) GO TO 140
9          BND=10.0
10         X=BND/10.0
11         110 G=(1.0-X**2)/Y+2.0*ALOG(X)-4.0*F*XLD
12         DG=-2.0*X/Y+2.0/X
13         IF (G**2.LT.1.0E-5) GO TO 130
14         XNEW=X-G/DG
15         IF (XNEW.LT.0.0) GO TO 100
16
17         C
18         IF (XNEW.GT.1.0) GO TO 120
19         IF ((X-XNEW)**2.LT.1.0E-8) GO TO 130
20
21         120 CONTINUE
22
23         C
24         X=XNEW
25         GO TO 110
26         130 DP=PP-(X*PP)
27         PGRAD=DP/(XLD*DIA)
28         GO TO 150
29
30         140 DP=-1.0
31         PGRAD=-1.0
32
33         150 RETURN
34
35         END

```

A76

** DPVALV **

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```
1      SUBROUTINE DPVALV(DP,F,XLD,PP,MDDT,DEN,DIA,PGRAD)
2
3      VALVE PRESSURE DROP SUBROUTINE
4
5      REAL MDDT
6      DP=3.242E-3-F*XLD*(MDDT**2)/(DEN*(DIA**4))
7      IF (DP.LT.PP) GO TO 100
8      DP=-1.0
9      PGRAD=-1.0
10     RETURN
11     END
```

A77

```

1      DOUBBLE PRECISION FUNCTION DSATL(TT)
2      DOUBBLE PRECISION GL,T,DCAL,R,TCR,XZ,TT, ..TC
3      DIMENSION GL(6),DC(1),TC(1)
4      DATA GL/1.2874326484D-1,-4.3128217346D-1,17.851911824D-1,-33.50962
5      14402D-1,30.343215824D-1,-10.981289602D-1/
6      DATA DC/.06964D+0/
7      DATA TC/5.2014D+0/
8      T=TT
9      DCAL=DC
10     TCR=TC
11     R=(1.0+0-T/TCR)
12     DO 2 I=1,6
13     F1=1
14     XZ= F1/3.
15     2 DCAL=DCAL+GL(I)*R**XZ
16     DSATL=DCAL
17     RETURN
18     END

```



```

1  DOUBLE PRECISION FUNCTION DSATV(TT)
2  DOUBLE PRECISION GV,T,DCAL,R,TCR,XZ,TT,DC,TC
3  DIMENSION GV(6),DC(1),TC(1)
4  DATA GV,-0.69267495322D-1,-1.292532553D-1,2.9347470712D-1,-4.08066
5  158212D-1,3.5809505624D-1,-1.1315580397D-1/
6  DATA DC,.06964D+0/
7  DATA TC/5.2D14D+0/
8  T=TT
9  DCAL=DC
10 TCR=TC
11 R=(1.D+0-T/TCR)
12 DO I 1=1,6
13 FI=1
14 XZ= FI/3.
15 1 DCAL=DCAL+GV(I)*R**XZ
16 DSATV=DCAL
17 RETURN
18 END

```

080

```

1  SUBROUTINE DTHLF
2  DOUBLE PRECISION A,B,D,DD,D2,D3,D4,D5,D6,T,TT,Z2,Z3,Z4,DGAMA,EX
3  DOUBLE PRECISION R,P,PP,VA,YB,YC,YO,YE,YF,YG,YH
4  DOUBLE PRECISION GAMMA,WT
5  DOUBLE PRECISION DPCLDT
6  DIMENSION A(30),B(30)
7  COMMON/DATA/PP,DD,TT,WT,A,B,N,GAMMA,L
8  D=DD
9  T=TT
10 D2=D*D
11 D3=D2*D
12 D4=D3*D
13 D5=D4*D
14 D6=D5*D
15 Z2=T*T
16 Z3=Z2*T
17 Z4=Z3*T
18 DGAMA = D2*(-.5D-3)
19 EX = DEXP(DGAMA)
20 N=1
21 R=.C820558D+0
22 A(N)=0.0
23 N=N+1
24 A(N)=(-1.D+0)*D6/Z2
25 N=N+1
26 DO 2 I=1,6
27   FI=I
28   YA=.75-FI/4.-1.
29   YB=.75-FI/4.
30   A(N)=D5*T**YA*YB
31   2 N=N+1
32   DO 3 I=1,4
33     FI=I
34     YC=1.5-FI/1.-1.
35     YD=1.5-FI
36     A(N)=D4*T**YC*YD
37     3 N=N+1
38     DO 1 I=1,8
39       FI=I
40       YE=1.5-FI/2.-1.
41       YF=1.5-FI/2.
42       A(N)=D3*T**YE*YF
43       1 N=N+1
44       DO 4 I=1,3
45         FI=I
46         YG=1.-FI-1.
47         YH=1.-FI
48         A(N)=EX*D3*T**YG*YH
49         4 N=N+1
50         DO 5 I=1,3
51           FI=I
52           YG=1.-FI-1.
53           YH=1.-FI
54           A(N) = EX*D5*T**YG*YH
55           5 N=N+1
56           N=N+1
57   10 P=0

```

.. DINLF ..

58
59
60
61
62
63

15 DD 15 J-1 N
P=P*(U)*B(U)
PP=P + DPCLD(I,D,T)
PP=P
RETURN
END

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```

1  DUMMY*  PRDC
2  C
3  DIMENSION  SCRCH(100)
4  C
5  COMMON /CDUMMY/  IGRBAG(100)
6  C
7  EQUIVALENCE  (IGRBAG,SCRCH)
8  C
9  C      ***** CDUMMY VARIABLE DESCRIPTION
10 C
11 C      IGRBAG - A SCRATCH AREA FOR VARIABLE STORAGE WHICH IS
12 C      NOT TO BE SAVE FROM ON ROUTINE TO ANOTHER.
13 C      END

```

```

1  DOUBLE PRECISION FUNCTION D2DBT2(T)
2  DOUBLE PRECISION A,B,T,YA,YB,YC
3  DIMENSION A(9)
4  DATA A/-6.0815710031D-7,-1.1168680862D-4,1.1652410354D-2,
5  17.4474587998D-2,-5.3143174768D-1,-9.5759219306D-1,
6  23.9374314843D+0,-5.1370239224D+0,2.0804456338D+0/
7  COEFFICIENTS FROM PROGR 5/28/70-1630
8  C THIS SUB PROGRAM CALCULATES THE SECOND VIRIAL COEFFICIENT FOR
9  C HELIUM. THE RANGE IS FROM 2 TO 1500 DEG K. INPUT IS TEMPERATURE
10 C IN DEGREES KELVIN AND TUSE. IF TUSE IS 0 OR NEGATIVE THE ROUTINE
11 C CALCULATES B FOR THE EQUATION  $PV=RT(1+BD+...)$  FOR OTHER VALUES OF
12 C TUSE, THE ROUTINE CALCULATES THE VARIATION OF B AT THE INPUT TEMP
13 C UNITS ARE ATM, DEG KELVIN, AND MOLES/LITER, 4/3/69-1252, R.D. MCCARTY
14 C REVISED 2/12/70-925
15 C
16 1 B=0
17 DO 5 I=1,9
18 F1=1
19 YA=.5-F1/2.-1
20 YB=.5-F1/2.
21 YC=.5-F1/2.
22 5 B=B+T**YA*YB+YC*A(I)
23 D2DBT2=B
24 RETURN
25 END

```

```
1  DOUBLE PRECISION FUNCTION ENTHAL(P,D,T)
2  DOUBLE PRECISION T,CPDH,R,D,P,H0,HD,HINT,HTD,CXT,ZERO
3  C  CALCULATES ENTHALPY FOR HELIUM FROM PROGRAM 1-1M-8/,13-40-27,MCCART
4  CPDH = 5.193043D+0*(T-4.2144D+0)
5  HTD=36.5582D+0
6  R=.0820558D+0
7  CXT = 25.31469D+0
8  ZERO = 0.0D+0
9  1 H0 = HINT(ZERO,T)
10  HD=HINT( D,T)
11  ENTHAL = HTD+CPDH+CXT*(HD-H0+P/D-R*T)
12  ENTHAL=ENTHAL+4.0D26D+0
13  RETURN
14  END
```

** ENTROP **

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```
1  DOUBLE PRECISION FUNCTION ENTROP(D,T)
2  DOUBLE PRECISION STD,D,T,CPOS,ENTO,SINT,ENTD,R,ZERO
3  DOUBLE PRECISION XLT,RLRTO
4  C  CALCULATES ENTROPY FOR HELIUM FROM PROGRAM 1-1M-W/,13-40-27,MCCART
5  ZERO = 0.0D+0
6  STD=9.2609D+0
7  XLT = DLOG(1/4.2144D+0)
8  CPOS = 5.1930D+0+XLT
9  R=.0820558D+0
10  ENTO = SINT(ZERO,T)
11  ENTD = SINT(D,T)
12  RLRTO = R*DLOG(R+T+0)
13  ENTRDP = STD+CPOS+25.31469D+0*(ENTO-ENTD-RLRTO)
14  ENTROP=ENTROP+4.0026D+0
15  RETURN
16  END
```

A85

```
1 DOUBLE PRECISION FUNCTION FINDD(PI,DI,TI)
2 DOUBLE PRECISION A,B,T,D,P,P2,DP,CORR,TT,DD,PP,PI,DI,TI
3 DOUBLE PRECISION GAMMA,WT
4 DIMENSION A(30),B(30)
5 COMMON/DATA/PP,DD,TT,WT,A,B,NC,GAMMA,L
6 P=PI
7 D=DI
8 DD=DI
9 T=TI
10 TT=TI
11 DD 10 1=1.50
12 DD=D
13 CALL HEFIT
14 P2=PP
15 IF(ABS(P-P2)-1.D-7*P)20,20,1
16 1 CALL DDHEF
17 DP=PP
18 CORR=(P2-P)/DP
19 IF(ABS(CORR)-1.0-7*D)20,20,10
20 10 D=D-CORR
21 FIND D=0
22 RETURN
23 20 FIND D=D
24 RETURN
25 END
```


** FINDR **

FILE: MFTF+CSA

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```
1      FUNCTION FINDR(N)
2
3      C      FINDR RETRIEVES THE GAS CONSTANT
4      C      IF N = 1, HELIUM GAS CONSTANT
5      C      IF N = 2, NITROGEN GAS CONSTANT
6      C
7      DIMENSION G(2)
8      DATA G / 0.21183406, 0.03026719/
9
10     C
11     FINDR=G(N)
12     RETURN
13     END
```

A87

888

```

1  C      * * * * *
2  C      * ROUTINE NAME - FIND AND INPUT THE MASTER *
3  C      * TABLE OF A SET OF TABLES *
4  C      * ROUTINE LANG - FORTRAN V UNIVAC 110B EXEC 2 *
5  C      * PROGRAMMER - R. BOLLINGER 1943 102 26933 *
6  C      * DATE CODED - 3/9/70 *
7  C      * * * * *
8  C
9  C      SUBROUTINE FINTAB(MTN)
10 C
11 C      ***** EXPLANATION OF THE CALLING SEQUENCE
12 C      *
13 C      * MTN - MASTER TABLE NUMBER. THE INDEX OF THE ARRAY TLA
14 C      * (SEE PDP CTAB) WHICH POINTS TO THE PROPER DRUM
15 C      * LOCATION FOR THE TABLE.
16 C      *****
17 C
18 C      INCLUDE CIOUNT
19 C      INCLUDE CTAB
20 C      INCLUDE CTABA
21 C
22 C      JTABID = MTN
23 C      IF (TLA(MTN) .GT. 0) GO TO 5
24 C      WRITE (IOT,6020) MTN
25 C      CALL EXIT
26 C      5 CONTINUE
27 C      IDX1 = TLA(MTN)
28 C      ND = ITABLE(IDX1)
29 C      IF(ND.LE.2) GO TO 20
30 C
31 C      NDM2 = ND - 2
32 C      DO 10 I1=1,NDM2
33 C      IDX1 = IDX1 + 1
34 C      NP = ITABLE(IDX1)
35 C      ITAB(I,1) = NP
36 C      DO 10 I2=1,NP
37 C      IDX1 = IDX1 + 1
38 C      TAB(I2+1,1) = TABLE(IDX1)
39 C      10 CONTINUE
40 C
41 C      20 IDX1 = IDX1 + 1
42 C      RETURN
43 C
44 C
45 C      6020 FORMAT ('0'// 20X '*** LOAD TABLE ND.' 14, ' BEFORE YOU TRY TO USE
46 C      1 IT.. ***')
47 C      END

```

```

1      C      * * * * *
2      C      * ROUTINE NAME - FANO LINE - ONE DIMENSIONAL *
3      C      * COMPRESSIBLE FLOW FUNCTION *
4      C      * FOR ADIABATIC FLOW AT *
5      C      * CONSTANT AREA WITH FRICTION *
6      C      * ROUTINE LANG - FORTRAN V UNIVAC 1110 EXEC 8 *
7      C      * DATE CODED - AUGUST 23, 1978 *
8      C      * PROGRAMMER - R.F.HAUSMAN 104-6213-30235 *
9      C      * * * * *
10     C
11     C      FUNCTION FLODEQ(M,G)
12     C
13     C      * * * * * EXPLANATION OF THE CALLING SEQUENCE
14     C      *
15     C      * M - MACH NUMBER
16     C      *
17     C      * G - SPECIFIC HEAT AT CONSTANT PRESSURE/
18     C      * * * * * SPECIFIC HEAT AT CONSTANT VOLUME
19     C
20     C      REAL M,MSQ
21     C
22     C      MSQ = M**2
23     C      FLODEQ = (1.0 - MSQ)/(C*MSQ) + (G + 1.0)/(2.0*G)*ALOG((G+1.0)*MSQ/
24     C      1      (2.0 + (1.0+((G-1.0)/2.0)*MSQ)))
25     C      RETURN
26     C      END

```

```

1      C      * * * * *
2      C      * ROUTINE NAME - ROUTINE TO UNPACK THE FIRST *
3      C      * WORD OF THE CONFIGURATION *
4      C      * TABLE. SEE S.R. STOCON FOR *
5      C      * WORD FORMAT *
6      C      * ROUTINE LANG - FORTRAN V UNIVAC 110B EXEC 2 *
7      C      * PROGRAMMER - R. BOLLINGER 1943 102 26933 *
8      C      * DATE CODED - 3/11/70 *
9      C      * * * * *
10     C
11     C      SUBROUTINE GETCON(IDX)
12     C
13     C      ***** EXPLANATION OF THE CALLING SEQUENCE
14     C      *
15     C      ***** IDX - INDEX OF THE CONFIGURATION TABLE
16     C
17     C
18     C      INCLUDE CCONFIG
19     C      INCLUDE CIOUNT
20     C
21     C      DD 10 11 = 1.6
22     C      1CNFIG(11) = 1PBYTE(CONFIG(IDX,1),11,0.6)
23     C      10 CONTINUE
24     C
25     C      RETURN
26     C      END

```

.. GHERCV ..

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1 C
2 C
3 C
4 C
5 C
6 C
7 C
8

SUBROUTINE GHERCV

CALL DATAIN

RETURN

END

```
1      SUBROUTINE GN2DEN(T,PP,DENS)
2      TG=T
3      DIMENSION ATM(7),DATM(7),A(16)
4      RHO=1.0
5      DATA(A(1),1=1,4)/.3371608E-1,-0.5771943,-0.1142108E3,0.8522635E3/
6      DATA(A(1),1=5,8)/.3440176E7,.1650366E-2,-.1578906E-1,.41683569E-5/
7      DATA(A(1),1=9,12)/.3211549E3,.108012E6,-.106658E8,-.3304488E1/
8      DATA(A(1),1=13,16)/.1223694E4,-.5693539E5,.1675167E-5,0.56E-2/
9      DATA R/O.820574E-1/
10     PATM=PP/101325.0
11     100 ATM(1)=R*RHO*TG
12     ATM(2)=(RHO*.2)*(R*A(1)+TG+A(2)+A(3)/TG+A(4)/(TG**.2)+A(5)/(TG**.4))
13     ATM(3)=(RHO*.3)*(R*A(6)+TG+A(7))
14     ATM(4)=(RHO*.4)*(A(8)+TG)
15     ATM(5)=(RHO*.3)*(A(9)/(TG**.2)+A(10)/(TG**.3)+A(11)/(TG**.4))
16     ATM(5)=ATM(5)*EXP(-A(16)*RHO*RHO)
17     ATM(6)=(RHO*.5)*(A(12)/(TG**.2)+A(13)/(TG**.3)+A(14)/(TG**.4))
18     ATM(6)=ATM(6)*EXP(-A(16)*RHO*RHO)
19     ATM(7)=(RHO*.6)*A(15)
20     DATM(1)=ATM(1)/RHO
21     DATM(2)=2.0*ATM(2)/RHO
22     DATM(3)=3.0*ATM(3)/RHO
23     DATM(4)=4.0*ATM(4)/RHO
24     DATM(5)=ATM(5)+((3.0/RHO)-(2.0*A(16)*RHO))
25     DATM(6)=ATM(6)+((5.0/RHO)-(2.0*A(16)*RHO))
26     DATM(7)=6.0*ATM(7)/RHO
27     FPATM=0.0
28     OFPATM=0.0
29     DO 110 I=1,7
30     FPATM=FPATM+ATM(I)
31     110 OFPATM=OFPATM+DATM(I)
32     IF ((FPATM-PATM)**2.LT.1.0E-8) GO TO 120
33     RHO=RHO-((FPATM-PATM)/OFPATM)
34     GO TO 100
35     120 DENS=RHO*28.016
36     RETURN
37     END
```

```

1      SUBROUTINE HE FIT
2      DOUBLE PRECISION A,B,D,D2,D3,D4,D5,DD,T,TT,DGAMA,EX,EXD3,EXD5
3      DOUBLE PRECISION P,PP,PCAL,XA,XB,XC,XD
4      DOUBLE PRECISION GAMMA,WT
5      DIMENSION A(30),B(30)
6      COMMON/DATA/PP,DD,TT,WT,A,B,N,GAMMA,LL
7      D=DD
8      T=TT
9      D2=D*D
10     D3 =D2*D
11     D4=D3*D
12     D5=D4*D
13     DGAMA = D2*(-.5D-3)
14     EX = DEXP(DGAMA)
15     N=1
16     EXD3=EX*D3
17     EXD5=EX*D5
18     A(N)=D5*D
19     N=N+1
20     A(N)=A(N-1)/T
21     N=N+1
22     DD 2 I=1,6
23     FI=I
24     XA=.75-FI/4.
25     A(N)=D5*T**XA
26 2     N=N+1
27     DD 3 I=1,4
28     FI=I
29     XB=1.5-FI
30     A(N)=D4*T**XB
31 3     N=N+1
32     DD 1 I=1,8
33     FI=I
34     XC=1.5-FI/2.
35     A(N)=D3*T**XC
36     N=N+1
37 1 CONTINUE
38     DD 4 I=1,3
39     FI=I
40     XD=1.-FI
41     A(N)=EXD3*T**XD
42 4     N=N+1
43     DD 5 I=1,3
44     FI=I
45     XD=1.-FI
46     A(N)=EXD5*T**XD
47 5     N=N+1
48     N=N-1
49 10 P=0
50     DO 15 J=1,N
51 15 P=P+A(J)*B(J)
52     P = P + PCAL(DD,TT)
53     PP=P
54     RETURN
55     END

```

```

1      C
2      C
3      C
4      C
5      C
6      C
7      C
8      C
9      C
10     C
11     C

```

CALCULATES HEAD PRESSURE FOR LIQUID HELIUM FLUID
 FUNCTION HEHED(RHOA,HED)
 RHD = RHOA * HED * 0.00980665 @ KPA
 HEHED = RHD
 RETURN
 END


```

1  C
2  C
3  C
4  C
5  C
6  C
7  C
8  C
9  C
10 C
11 C
12 C
13 C
14 C
15 C
16 C
17 C
18 C
19 C
20 C
21 C
22 C
23 C
24 C
25 C
26 C
27 C
28 C
29 C
30 C
31 C
32 C
33 C
34 C
35 C
36 C
37 C
38 C
39 C
40 C
41 C
42 C
43 C
44 C
45 C
46 C
47 C
48 C
49 C
50 C
51 C
52 C
53 C
54 C
55 C
56 C
57 C

```

* * * * *
 * ROUTINE NAME - HELIUM MAKE-UP COMPUTATION *
 * ROUTINE LANG - FORTRAN V UNIVAC 1110 EXEC 8 *
 * PROGRAMMER - R.F.HAUSMAN 104-6213-30235 *
 * DATE CODED - FEBRUARY 12, 1979 *
 * * * * *

SUBROUTINE HEMKUP

**** THIS SUBROUTINE CHARACTERIZES THE REFRIGERATOR-LIQUIFIER
CONDITIONS AND COMPUTES LN2 REQUIREMENTS FOR REF.-LIQFR.

LOGICAL JP, PAGE

INCLUDE CMAG
INCLUDE CFLUID

BEGIN COMPUTATIONS FOR REFRIGERATOR-LIQUIFIER SUBSYSTEM

* * * * *

NPSYS = 3
IF(WDGTOT.EQ.0.0) WDGTOT = 302.0 * KG/HR
WDGTOT = WDGTOT/3.6

SET LN2 BOILER HEX PARAMETERS

DHN2LV = (HN2V - HN2L)/GMWTN2 @ J/GM
DHN2VP = (HN2D - HN2V)/GMWTN2 @ J/GM
SDHN2 = DHN2LV + DHN2VP @ J/GM

DLN2 = DN2L * GMWTN2 * 1000. @ KG/CU.M.
DVN2 = DN2LV * GMWTN2 * 1000. @ KG/CU.M.
DN2HV = DN2D * GMWTN2 * 1000. @ KG/CU.M.

HEAT TO BE REMOVED FROM HOT HELIUM

CALL HEPROP(PCB(1),TCB(1),2)
HHE1 = HELH/HEMWT @ J/GM
DHE1 = HELD * HEMWT * 1000. @ KG/CU.M.

CALL HEPROP(PCB(1),TCB(3),2)
HHE2 = HELH/HEMWT @ J/GM
DHE2 = HELD * HEMWT * 1000. @ KG/CU.M.
QDTHHE = (HHE1-HHE2) * WDTCB(1) @ J/SEC
Q1 = QDTHHE/1000. @ KW
FWDTH = WDTCB(1) * 3.6 @ KG/CU.M.

HEAT TO BE TAKEN OUT BY COLD HELIUM

CALL HEPROP(PCB(1),TCB(2),2)
HHE3 = HELH/HEMWT @ J/GM
DHE3 = HELD * HEMWT * 1000. @ KG/CU.M.

QDTHO = (HHE3-HHE2) * (WDTCB(2) + WDTCB(4)) @ J/SEC
Q2 = QDTHO/1000. @ KW

```

58 FWD12 = (WDTCB(2)+WDTCB(4)) * 3.6           @ KG/CU.M.
59
60 QDTCHE = (HHE3-HHE2) * (WDTCB(2) + WDTCB(4) + DWGTOT) @ J/SEC
61 Q4      = QDTCHE/1000.           @ KW
62 FWD14 = (WDTCB(2) + WDTCB(4) + DWGTOT) * 3.6 @ KG/CU.M.
63
64 HEAT TO BE TAKEN OUT IN LN2 BOILER HEAT EXCHANGER
65
66 QDTLNO = QDTHHE - QDTCHE           @ J/SEC
67 Q3      = QDTLNO/1000.           @ KW
68
69 QDTLN2 = QDTHHE - QDTCHE           @ J/SEC
70 Q5      = QDTLN2/1000.           @ KW
71
72 QUANTITY OF LN2 REQUIRED AS FUNCTION OF TIME
73
74 WOTNO = QDTLNO/SDHN2           @ GM/SEC
75 FWD13 = WOTNO * 3.6           @ KG/CU.M.
76 WDTN2 = QDTLN2/SDHN2           @ GM/SEC
77 FWD15 = WOTN2 * 3.6           @ KG/CU.M.
78
79 HEAT LOAD ON LN2 BOILER
80
81 QSUBS = WOTNO * DHN2LV/1000.     @ KW
82 QSUBS1 = WOTN2 * DHN2LV/1000.    @ KW
83
84 * * * * *
85
86 JP = PAGE(0)
87
88 WRITE (6,10)
89
90 10 FORMAT(/T26,'*** CHARACTERIZE REFRIGERATOR-LIQUIFIER INPUT AND OU
91 TPUT CONDITIONS ***//T46,'** REFRIGERATOR-LIQUIFIER PARAMETERS **
92 2//T13,'ZERO MAKE-UP FLOW CONDITIONS: '/T54,'WARM HE - UPPER',T75,
93 3'COLD HELIUM THRU',T99,'LN2 BOILER AND'/T54,'HEX & LN2 BOILER',T79
94 4,'UPPER HEX',T102,'UPPER HEX'/)
95
96 WRITE (6,20) TCB(1),TCB(3),TCB(4),PCB(1),PCB(2),PCB(3),DHE1,DHE2,
97 1 DLN2,FWD11,FWD12,FWD13,TCB(3),TCB(2),TCB(2),PCB(1),PCB(2),PCB(3),
98 3 DHE2,DHE3,DN2IV,FWD11,FWD12,FWD13,Q1,Q2,Q3,QSUBS
99
100 20 FORMAT(12,'INLET TEMPERATURE ( DEG.K )',E12.6,12X,E12.6,9X,
101 1E12.6/121,'INLET PRESSURE ( KPA )',E12.6,12X,E12.6,9X,
102 2E12.6/121,'INLET FLUID DENSITY (KG/CU.M)',E12.6,12X,E12.6,9X,E
103 312.6/121,'INLET FLOW RATE ( KG/HR )',E12.6,12X,E12.6,9X,E1
104 42.6//121,'OUTLET TEMPERATURE ( DEG.K )',E12.6,12X,E12.6,9X,E1
105 52.6/121,'OUTLET PRESSURE ( KPA )',E12.6,12X,E12.6,9X,E12
106 6.6/121,'OUTLET GAS DENSITY (KG/CU.M)',E12.6,12X,E12.6,9X,E12.
107 76/121,'OUTLET FLOW RATE ( KG/HR )',E12.6,12X,E12.6,9X,E12.6
108 8//121,'ENERGY TRANSFER ( J/HR )',E12.6,11X,'+',E12.6,8X,
109 9+',E12.6/121,'HEAT LOAD: '/T26,'LN2 BOILER ( KW )',T99,
110 A E12.6/)
111
112 WRITE (6,30)
113
114 30 FORMAT(113,'CURRENT MAKE-UP FLOW CONDITIONS: '/T54,'WARM HE - UPPER
115 1',T75,'COLD HELIUM THRU',T99,'LN2 BOILER AND'/T54,'HEX & LN2 BOILE

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-- HEMKUP --

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```
116 2R',179,'UPPER-HEX',T102,'UPPER HEX'/)
117
118 C WRITE (6,20) TCB(1),TCB(3),TCB(4),PCB(1),PCB(2),PCB(3),DHE1,DHE2,
119 1 DLN2,FWD1,FWD4,FWD5,TCB(3),TCB(2),TCB(2),PCB(1),PCB(2),PCB(3),
120 2 DHE2,DHE3,DN2HV,FWD1,FWD4,FWD5,Q1,Q4,Q5,QSUBS1
121
122 C
123 C *****
124 C DO THE REFRIGERATOR-LIQUIFIER SYSTEM COMPONENT CONFIGURATION
125 C ANALYSIS
126 C
127 C CALL CMPCAL
128 C
129 C RETURN
130 C
131 END
```

A97

SUBROUTINE HEPROP(SP,ST,NSTAT)

* * * * *

* NBS PROGRAM "HE PROPS", RECD.6/3/71. REFERENCE NBS-9762. *

* * * * *

* REFERENCES: NBS REPORT 9762 (1970), NBS-TN-622 (1972), *

* NBS-TN-631 (1972) R.D.MCCARTY, NBS *

* THERMOPHYSICAL PROPERTIES OF HELIUM-4 FROM 2 TO 1500 K. WITH *

* PRESSURES TO 1000 ATMOSPHERES *

* * * * *

* THIS VERSION OF HEPROP PRODUCES HELIUM PROPERTIES IN MKS UNITS *

* * * * *

* EQUATIONS ARE VALID FROM 2 TO 1500 K. TO 1000 ATMOSPHERES EXCLUDING *

* ANY SUPERFLUID OR SOLID PHASE WHICH MIGHT OCCUR WITHIN THE ABOVE *

* TEMPERATURE AND PRESSURE RANGE. THE CRITICAL REGION IS ALSO *

* QUESTIONABLE, I.E. T=5.2014 PLUS OR MINUS 1 K AND P=2.24 +/- .2ATM *

* NOTE WHEN ITERATING FOR DENSITIES AT TEMPERATURES BELOW CRITICAL *

* IT IS IMPORTANT TO START WITH A PROPER GUESS. IF THE SOLUTION *

* IS IN THE GAS PHASE, START WITH .01 MOLES/LITER. IF THE SOLUTION *

* IS IN THE LIQUID PHASE, START THE ITERATION WITH DENSITY EQUAL TO *

* 45. MOLES /LITER *

* * * * *

* PROGRAM MODIFIED BY R.F.HAUSMAN, 62-13, 104, 25 JULY, 1978 *

* * * * *

DOUBLE PRECISION VTEMP,FINDD,ENTHAL,ENTROP,CV,DSATV,DSATL

DOUBLE PRECISION A,B,D,DD,PP,T,TT,TVP,PDT,POD,P

DOUBLE PRECISION H,S,CSUBV,E,CSUBP,SOUND,DG,DL,HG,HL,SG,SL,CVG,

CVL,CPG,CPL,EG,EL,SOUNG,SOUNL

DOUBLE PRECISION GAMMA,WT

DIMENSION A(30),B(30)

COMMON/DATA/PP,DD,TT,WT,A,B,NN,GAMMA,LL

COMMON/HEDATA/HELD,HELH,HELS,HELCV,HELZ,HELE,HELCP,HELW,HELVS

,HEVSC

COMMON/HESATD/HEDG,HEDL,HESG,HESL,HEHG,HEHL,HEEG,HEEL,HECVG,HECVL,

HECPG,HECPL,HEWG,HEWL,HEZG,HEZL,HESVG,HESVL,HET

,HELVSC,HEGVSC

NSTAT - PERMITS GENERATION OF EITHER LIQUID, GAS, OR SATURATED

LIQUID AND VAPOR PROPERTIES

IF NSTAT = 1, GENERATE LIQUID PROPERTIES

= 2, GENERATE GAS PROPERTIES

= 3, GENERATE SATURATED LIQUID AND VAPOR PROPERTIES

DATA LL/1/

DATA GAMMA/-.5D-3/

DATA WT/1.0D+0/

DATA B/5.988310109D-9,-4.9653052187D-7,-3.8116033499D-6,3.68111671

13D-5,-1.4830691828D-4,3.0595174335D-4,-3.3908190224D-4,1.962408024

22D-4,1.5527899712D-5,-3.6110403503D-5,-1.0839788073D-5,4.972810121

37D-5,1.938145109D-5,-4.149640896D-4,-5.7465772899D-4,-4.3470945634

4D-3,-6.8383888924D-2,-2.1382474225D-2,2.7106954908D-2,-1.262796778

58D-2,2.587575338D-3,7.9041608815D-2,-1.4024724310D-4,-2.8278987249

```

58      6D-7.1.7336410358D-6,-2.5454187855D-6,0.0D+0,0.0D+0,0.0D+0,0.0D+0/
59
60      C      I1=6
61      P = SP/101.325          @ KILOPASCALS TO ATMOSPHERES
62      T = ST
63
64      C      IF(NSTAT.EQ.1) SD = 45.0
65      IF(NSTAT.EQ.2) SD = 0.01
66      D=SD
67      IF(NSTAT.EQ.3) TVP = VPTEMP(P*.76D+6) ; GO TO 8
68      IF(ST.GT.5.2014)GO TO 2
69      IF(P.GT.2.2449)GO TO 2
70      IF(P.LT..0308234)GO TO 2
71      TVP=VPTEMP(P*.76D+6)
72      GO TO 3
73      2 TVP=101.D+0
74      3 CONTINUE
75      D = FIND D(P,D,T)
76      HELD = D
77      H=ENTHAL(P,D,T)
78      HELH = H
79      S=ENTROP(D,T)
80      HELS = S
81      CSUBV=CV(D,T)
82      MELCV = CSUBV
83      ZB = ZCALC(D,P,T)
84      HELZ = ZB
85      DD=D
86      E=H-(P/D)*101.3278D+0
87      HELE = E
88      TT=T
89      CALL DTREF
90      PDT = PP
91      CALL DDHEF
92      PDD = PP
93      CSUBP=CSUBV+(T*(PDT+PDT)/((D+D)*PDD))*101.3278D+0
94      HELCP = CSUBP
95      SOUND=DSORT((CSUBP/CSUBV)*(PDD+25311.D+0))
96      KELW = SOUND
97      HELSV = 1.0/HELD
98      D2 = D
99      T2 = T
100     VISC1 = VISCHE(D2,T2)
101     HEVSC = VISC1
102
103     C
104     RETURN
105
106     * * * * *
107
108     GENERATE THE SATURATED PROPERTY DATA
109
110     B DG=FIND D(P,DSATV(TVP)*1000,D+0/4.0026D+0,TVP)
111     HEDG = DG
112     DL=FIND D(P,DSATL(TVP)*1000,D+0/4.0026D+0,TVP)
113     HEDL = DL
114     SG=ENTROP(DG,TVP)
115     HESG = SG
116     SL=ENTROP(DL,TVP)

```

AL00

```

116 HESL = SL
117 HG=ENTHAL(P,DG,TVP)
118 HENG = HG
119 HL=ENTHAL(P,DL,TVP)
120 HEHL = HL
121 EG=HG-(P/DG)*101.3278D+0
122 HEEG = EG
123 EL=HL-(P/DL)*101.3278D+0
124 HEEL = EL
125 CVG=CV(DG,TVP)
126 HECVG = CVG
127 CVL=CV(DL,TVP)
128 HECVL = CVL
129 DD=DG
130 TT=TVP
131 CALL DTHEF
132 PDT = PP
133 CALL DDHEF
134 PDD = PP
135 CPG=CVG*(TVP*(PDT*PDT)/((DG+DG)*PDD))*101.3278D+0
136 HECPG = CPG
137 SOUNG=DSORT((CPG/CVG)*(PDD*25311.D+0))
138 HEWG = SOUNG
139 DD=DL
140 CALL DTHEF
141 PDT = PP
142 CALL DDHEF
143 PDD = PP
144 CPL=CVL*(TVP*(PDT*PDT)/((DL+DL)*PDD))*101.3278D+0
145 HECPL = CPL
146 SOUNL=DSORT((CPL/CVL)*(PDD*25311.D+0))
147 HEWL = SOUNL
148 T=TVP
149 HET = T
150 ZG = ZCALC(DG,P,TVP)
151 HEZG = ZG
152 ZL = ZCALC(DL,P,TVP)
153 HEZL = ZL
154 HESVG = 1.0/HEDG
155 HESVL = 1.0/HEDL
156 DDL = DL
157 DDG = DG
158 TTS = TVP
159 VISCL = VISCHE(DDL,TTS)
160 HELVSC = VISCL
161 C
162 VISCQ = VISCHE(DDG,TTS)
163 HEGVSC = VISCQ
164 C
165 C * * * * *
166 C
167 C RETURN
168 C
169 END

```

A101

```

1  DOUBLE PRECISION FUNCTION HINT(D,T)
2  DOUBLE PRECISION A,B,D,D2,D3,D4,R,DAMMA,EX,T,DBDT,DGAMA,DD,PP,TT
3  DOUBLE PRECISION XA,XB,XC,XD,XE
4  DOUBLE PRECISION GAMMA,WT
5  DIMENSION A(30),B(30)
6  COMMON/DATA/PP,DD,TT,WT,A,B,N,GAMMA,L
7  D2=D*D
8  D3=D*D2
9  D4=D3*D
10 N=1
11 R=.0820558D+0
12 DAMMA = GAMMA
13 DGAMA = D2*(-.5D-3)
14 EX = DEXP(DGAMA)
15 A(N)=(D4*D)/5D+0
16 N=N+1
17 A(N)=(D4*D/5.D+0)*(2.0D+0/T)
18 N=N+1
19 DD 2 I=1,6
20 FI=I
21 XA=.75-FI/4.
22 A(N)=(D4/4.D+0)*(T**XA-(T**XA*XA))
23 N=N+1
24 DD 3 I=1,4
25 FI=I
26 XB=1.5-FI
27 A(N)=(D3/3.D+0)*(T**XB-(T**XB*XB))
28 N=N+1
29 DD 1 I=1,8
30 FI=I
31 XC=1.5-FI/2.
32 A(N)=(D2/2.D+0)*(T**XC-(T**XC*XC))
33 N=N+1
34 DD 4 I=1,3
35 FI=I
36 XD=1.-FI
37 A(N)=(EX/(2.D+0*DAMMA))*(T**XD-(T**XD*XD))
38 N=N+1
39 DD 5 I=1,3
40 FI=I
41 XE=1.-FI
42 A(N)=(D2*EX/(2.D+0*DAMMA)-EX/(2.0D+0*DAMMA*DAMMA))*(T**XE-(T**XE
43 1*XE))
44 N=N+1
45 N=N-1
46 HINT=R*T*D*DBDT(T)*(-1.0D+0)
47 DD 6 I=1,N
48 HINT=HINT+B(I)*A(I)
49 RETURN
50 END

```

AL02

```

1      SUBROUTINE HTVAP(T,HVAP)
2
3      C
4      C      T=T(K) -- HVAP=HVAP(JOULES/KG)
5      C
6      DIMENSION B(2,7),C(7),DEN(2),X(10),DXDT(10),G(11)
7      TCRIT=126.2
8      TTRIPL=63.15
9      IF (T.GT.TCRIT) GO TO 120
10     IF (T.LT.TTRIPL) GO TO 140
11     Z=(TCRIT-T)/TCRIT
12     B(1,1)=0.19424403E2
13     B(1,2)=0.57083748E2
14     B(1,3)=-0.24326905E3
15     B(1,4)=0.8..516038E3
16     B(1,5)=-0.16393680E4
17     B(1,6)=0.11574320E4
18     B(1,7)=0.10182210E1
19     B(2,1)=0.16333345E1
20     B(2,2)=-0.94043771E1
21     B(2,3)=0.21852746E2
22     B(2,4)=-0.10268744E3
23     B(2,5)=0.18794974E3
24     B(2,6)=-0.16402437E3
25     B(2,7)=-0.95731639E-1
26     C(1)=1.0
27     C(2)=Z
28     C(3)=Z**2
29     C(4)=Z**3
30     C(5)=Z**4
31     C(6)=Z**5
32     C(7)=ALOG(Z)
33     DEN(1)=0.0
34     DEN(2)=0.0
35     DO 100 J=1,2
36     DO 100 I=1,7
37     DEN(J)=DEN(J)+C(I)*B(J,I)
38     SPVOL=1.0/(28.0134*DEN(1))
39     DEN(2)=EXP(DEN(2))
40     SPVOLG=1.0/(28.0134*DEN(2))
41
42     C
43     G(1)=0.83944094E4
44     G(2)=-0.18900453E4
45     G(3)=-0.72822292E1
46     G(4)=0.0
47     G(5)=0.55560638E-3
48     G(6)=-0.59445447E-5
49     G(7)=0.27154339E-7
50     G(8)=-0.40795359E-10
51     G(9)=0.50953608E3
52     G(10)=0.10228510E-1
53     G(11)=0.19500E1
54     X(1)=1.0/T
55     X(2)=1.0
56     X(3)=T
57     X(4)=T**2
58     X(5)=T**3
59     X(6)=T**4

```


59 X(7)=T**5
60 X(8)=T**6
61 X(9)=ALOG(T)
62 X(10)=(TCRIT-T)**G(11)
63 DXDT(1)=-1.0/(T**2)
64 DXDT(2)=0.0
65 DXDT(3)=1.0
66 DXDT(4)=2.0*T
67 DXDT(5)=3.0*(T**2)
68 DXDT(6)=4.0*(T**3)
69 DXDT(7)=5.0*(T**4)
70 DXDT(8)=6.0*(T**5)
71 DXDT(9)=1.0/T
72 DXDT(10)=-G(11)*((TCRIT-T)**(G(11)-1.0))
73 SSUM=0.0
74 TSUM=0.0
75 DO ITO I=1,10
76 SSUM=SSUM+G(I)*X(I)
77 TSUM=TSUM+G(I)*DXDT(I)
78 DPDF=1.01325E5*(EXP(SSUM))*TSUM
79 HVAP=OPDT*T*(SPVOLG-SPVOLL)
80 GO TO 160
81 120 WRITE (6,130)
82 130 FORMAT(T10,'TEMPERATURE GREATER THAN CRITICAL TEMPERATURE')
83 HVAP=-1.0
84 GO TO 160
85 140 WRITE (6,150)
86 150 FORMAT(T10,'TEMPERATURE LESS THAN TRIPLE POINT TEMPERATURE')
87 HVAP=-1.0
88 160 RETURN
END

```

1 C      * * * * *
2 C      * ROUTINE NAME - TABLE INPUT ROUTINE *
3 C      * ROUTINE LANG - FORTRAN V UNIVAC 1100 EXEC 2 *
4 C      * PROGRAMMER - R. BOLLINGER 1943 102 26933 *
5 C      * DATE CODED - 3/4/70 *
6 C      * REVISED - JUNE 1971 .. DEC. 1971 *
7 C      * PROGRAMMER - J. MCKAY 19-43 201 45178 *
8 C      * * * * *
9 C
10 C      SUBROUTINE INTAB
11 C
12 C      INTEGER TITLE,OFT
13 C
14 C      LOGICAL WP,PAGE
15 C
16 C      INCLUDE CIOUNT
17 C      INCLUDE CTAB
18 C      INCLUDE CTABA
19 C
20 C      DIMENSION TITLE(4),ICMT(14),LABV(3,5),LABX(3),LABY(3),II(5)
21 C
22 C      **** INPUT FORMATS
23 C
24 C      5000 FORMAT (4A6,2I6,6X,I6)
25 C      5010 FORMAT(13A6,A2)
26 C      5020 FORMAT(3A6,I7,5E10.0)
27 C      5030 FORMAT(6A6,2E12.0)
28 C      5040 FORMAT(3I6)
29 C      5050 FORMAT(6E12.0)
30 C      5060 FORMAT(5I5)
31 C
32 C      **** OUTPUT FORMATS
33 C
34 C      6000 FORMAT('0',I43,'***** E C H O   O F   T A B L E   D A T A *****',
35 C      1 // I54,4A6,I100,'TABLE NO. 'I4//)
36 C      6010 FORMAT('0 **ERROR** THE NUMBER OF DIMENSION IS WRONG. ND = ',I5)
37 C      6020 FORMAT(I26,13A6,A2)
38 C      6030 FORMAT('0 **ERROR** THE NUMBER OF POINT IS WRONG. NP = ',I5)
39 C      6040 FORMAT(I36,3A6,2X,5F13.4)
40 C      6050 FORMAT('0 **ERROR** THE NUMBER OF DATA POINTS IS WRONG. NV = ',I5)
41 C      6060 FORMAT('0 **ERROR** THE TABLE TYPE IS WRONG. TYPE = ',I5)
42 C      6070 FORMAT('0 **DIAGNOSTIC** THE NUMBER OF INTERPOLATION POINTS IS WRONG. NIP = ',I5,'. NIP IS SET EQUAL TO ',I5)
43 C      6080 FORMAT(I52,3A6,2X,F12.4)
44 C      6090 FORMAT(I52,F12.4,5XF12.4)
45 C      6100 FORMAT(I52,F12.4)
46 C      6110 FORMAT(I38,F12.4,2XF12.4,5XF12.4,2XF12.4)
47 C      6120 FORMAT(I38,F12.4,2XF12.4)
48 C      6130 FORMAT('0',I53,'COEFFICIENTS',6X,'COEFFICIENTS/' ' )
49 C      6140 FORMAT('0',I44,'X',I3X,'Y',I6X,'X',I3X,'Y')
50 C      6150 FORMAT('0 **ERROR** THE ABOVE TABLE NUMBER IS LESS THAN 0 OR GREAT
51 C      1ER THAN 50'//)
52 C      6160 FORMAT('0 **DIAGNOSTIC** THE ABOVE TABLE HAS ALREADY BEEN INPUT. T
53 C      HIS TABLE SHALL REPLACE THE PREVIOUS TABLE.')
54 C      6170 FORMAT('0 **ERRDR** THE TOTAL SIZE OF THE TABLES HAS EXCEEDED 7000.
55 C      1 THE REQUIRED SIZE IS ',I6,'. RUN TERMINATED.')
56 C      6180 FORMAT('0',75X,'TOTAL TABLE STORAGE =',I6)
57 C

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58      6200 FORMAT ('0'5GX'TABLE INPUT SUMMARY'// 28X'TABLE'6X'TITLE OF TABLE'
59      1 12X'NUMBER OF' 6X'NUMBER OF'6X'NUMBER OF' / 27X'NUMBER'T66,
60      2 12X'DIMENSIONS'5X'SUBTABLES'9X'WORDS'/)
61      6210 FORMAT (28X14,2X,4A6,3I15)
62      6220 FORMAT ('0' 190,'NO. WORDS THIS TABLE' 14)
63
64      C
65      ***** INITIALIZE THE ROUTINE
66
67      C          NPRT = 0 PRINT ALL TABLES (1 TABLE/PAGE)
68      C          NPRT = 1 PRINT NO TABLE OUTPUT
69      C          NPRT > 1 PRINT ALL TABLES (NO PAGE EJECT)
70      C          NPRT2 > 0 AND NPRT = 1 PRINT SUMMARY
71
72      INTAP = NTAPE1
73      IOTAP = NTAPE1
74      READ (IIN,5060) IFT,DFT,NPRT,NPRT2
75      IF (IFT.EQ. 0) GO TO 5
76      IF (IFT.GT. 2) INTAP = IFT
77      READ (INTAP) TLA,NV
78      READ (INTAP) (TABLE(JKM),JKM=1,NV)
79      REWIND INTAP
80      KMURD1 = NV
81      GO TO 350
82
83      C
84      5 KMURD1 = 0
85      IF (NPRT.NE. 1) GO TO 2
86      IF (NPRT2.EQ. 0) GO TO 2
87      IF (PAGE(0)) WRITE (IOT,6200)
88
89      2 CONTINUE
90      ***** START OF TABLE INPUT LOOP
91
92      C
93      DO 290 II=1,NTBN
94      KMUD = KMURD1
95
96      C
97      ***** INPUT TITLE - THE TABLE TITLE.
98      C          *      ND - THE NUMBER OF DIMENSIONS OF THIS TABLE.
99      C          *      NC - THE NUMBER OF COMMENT CARDS FOR THIS TABLE
100     C          *      IP - PLOT OPTION, NOT IN MATH MODEL
101     C          ***** (SEE AUXILIARY TABLE PROGRAM)
102
103     READ (IIN,5000) TITLE,ND,NC,NT
104     IF (ND.LE. 0) GO TO 300
105     IF (NPRT.EQ. 1) GO TO 1001
106     IF (PAGE(0)) WRITE (IOT,6000) TITLE,NT
107     JP = PAGE (5)
108
109     1001 CONTINUE
110     KMURD1 = KMURD1 + 1
111     IF (NT.GT. 0 .AND. NT.LE. NTBN) GO TO 4
112     WRITE(6,6150)
113     CALL EXIT
114
115     4 IF (TLA(NT).LE. 0) GO TO 6
116     WRITE(6,6160)
117
118     6 TLA(NT) = KMURD1
119     ITABLE(KMURD1) = ND
120
121     C
122     ***** TEST INPUT VALUE.
123
124     IF (ND.GT. 1 .AND. ND.LT. 7) GO TO 20

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116      WRITE(6,6010) ND
117      CALL EXIT
118
119      C      ***** IF THERE ARE ANY COMMENT CARDS FOR THIS PLOT PRINT
120      C      ***** THEN OUT.
121      C
122      20 IF (NC .LE. 0) GO TO 40
123      C
124      DO 30 I2 = 1,NC
125      READ(5,5010) ICM1
126      IF (NPRT .EQ. 1) GO TO 30
127      IF (PAGE(1)) WRITE (10T,6000) TITLE,NT
128      WRITE(6,6020) ICM1
129      30 CONTINUE
130
131      C      ***** INITIALIZE THE INPUT OF THN ND - 2 INDEPENDENT
132      C      ***** VARIABLES.
133      C
134      40 NDM2 = ND - 2
135      NXYT = 1
136      IF (NDM2.EQ.0) GO TO 90
137      IF (NPRT .EQ. 1) GO TO 50
138      IF (PAGE(NDM2+1)) WRITE (10T,6000) TITLE,NT
139      C
140      C      ***** INPUT ND - 2 INDEPENDENT VARIABLES.
141      C
142      50 DO 80 I2 = 1,NDM2
143      READ(5,5020) (LABV(I,I2),I=1,3),NP,(TAB(I+1,I2),I=1,NP)
144      IF (NP.GT.1.AND.NP.LT.6) GO TO 60
145      WRITE(6,6030) NP
146      CALL EXIT
147      C
148      60 NXYT = NXYT+NP
149      IF (NPRT .EQ. 1) GO TO 70
150      WRITE(6,6040) (LABV(I,I2),I=1,3),(TAB(I+1,I2),I=1,NP)
151      70 CONTINUE
152      KMURD1 = KMURD1 + 1
153      ITABLE(KMURD1) = NP
154      DO 75 I3=1,NP
155      KMURD1 = KMURD1 + 1
156      C
157      C      *** STORE THE (ND-2) INDEPENDENT VARIABLES IN TABLE ARRAY
158      C
159      75 TABLE(KMURD1) = TAB(I3+1,I2)
160      80 CONTINUE
161      C
162      C      ***** IF PLOTTING IS DESIRED, INPUT THE PLOT LABELS AND
163      C      ***** THE MIN/MAX VALUES OF THE INDEPENDENT VARIABLE.
164      C
165      90 READ(5,5030) LABX,LABY,XMIN,XMAX
166      C
167      C      ***** START OF THE LOOP TO INPUT THE VALUES FOR EACH
168      C      ***** OF THE TWO DIMENSIONAL TABLES WHICH MAKE UP THE MAIN
169      C      ***** ND DIMENSIONAL TABLES.
170      C
171      I1(1) = -1
172      DO 100 I2 = 2,5
173      100 I1(I2) = -1

```

A07

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174 C
175 DD 280 12 = 1,NXYT
176 C
177 C ***** INPUT THE 2D TABLE HEADER CARD AND VERIFY THE DATA.
178 C = NV - NUMBER OF DATA POINTS IN THE TABLE
179 C = TYPE - TABLE TYPE (SEE CTAB)
180 C ***** NIP - NUMBER OF POINTS TO BE USED FOR INTERPOLATION.
181 C
182 READ(5,5040) NV,TYPE,NIP
183 IF (NPRT .NE. 0) GO TO 1004
184 IF (PAGE(0)) WRITE (107,6000) TITLE,NT
185 1004 CONTINUE
186 C
187 IF (NV .GT. 0 .AND. NV .LE. NSBZ) GO TO 110
188 WRITE(6,6050) NV
189 CALL EXIT
190 C
191 110 IF (TYPE.EQ.0.OR.TYPE.EQ.1) GO TO 120
192 WRITE(6,6060) TYPE
193 CALL EXIT
194 C
195 120 IF (TYPE.EQ.0) GO TO 130
196 IF (NIP.GT.1.AND.NIP.LE.NV) GO TO 130
197 WRITE(6,6070) NIP,NV
198 NIP = NV
199 C
200 C ***** OUTPUT THE HEADER DATA TO DRUM
201 C
202 130 ITABLE(KMURD1+1) = NV
203 ITABLE(KMURD1 + 2) = TYPE
204 ITABLE(KMURD1+3) = NIP
205 KMURD1 = KMURD1 + 3
206 C
207 C ***** INPUT, ECHO AND OUTPUT TO DRUM THE 2D TABLES.
208 C
209 IF (NPRT .EQ. 1) GO TO 170
210 I1(NDM2) = MOD(I1(NDM2) + 1,ITAB(1,NDM2))
211 IF (NDM2.EQ.0) GO TO 170
212 IF (NDM2.EQ.1) GO TO 150
213 NDM3 = NDM2 - 1
214 C
215 DD 140 13 = NDM3,1,-1
216 IF (I1(13+1).GT.0) GO TO 150
217 I1(13) = MOD(I1(13) + 1,ITAB(1,13))
218 140 CONTINUE
219 C
220 DD 160 13 = 1,NDM2
221 IDX = I1(13) + 2
222 WRITE(6,6080) (LABV(I,13),I=1,3),TAB(IDX,13)
223 160 CONTINUE
224 C
225 170 IF (TYPE.EQ.1) GO TO 210
226 C
227 C ***** COEFFICIENT TABLE INPUT
228 C
229 READ(5,5050) (XTAB(I),I=1,NV)
230 DD 175 13 = 1,NV
231 KMURD1 = KMURD1 + 1

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232 TABLE(KMURD1) = XTAB(I3)
233 175 CONTINUE
234 IF (NPRT .EQ. 1) GO TO 280
235 WRITE(6,6130)
236 C
237 IF (NV.GT.50) GO TO 180
238 N1 = 1
239 N2 = NV
240 GO TO 190
241 C
242 180 N2 = NV - 50
243 WRITE(6,6090) (XTAB(I),XTAB(I+50),I=1,N2)
244 N1 = N2 + 1
245 IF (N1.GT. 50) GO TO 280
246 N2 = 50
247 190 WRITE(6,6100) (XTAB(I),I=N1,N2)
248 C
249 ***** DISCRETE TABLE INPUT
250 C
251 C
252 210 READ(5,5050) (XTAB(I),YTAB(I),I=1,NV)
253 DO 215 I3 = 1,NV
254 KMURD1 = KMURD1 + 1
255 TABLE(KMURD1) = XTAB(I3)
256 TABLE(KMURD1+NV) = YTAB(I3)
257 215 CONTINUE
258 KMURD1 = KMURD1 + NV
259 IF (NPRT .EQ. 1) GO TO 1005
260 WRIT : (6,6140)
261 1005 CONTINUE
262 IF (NV.GT.50) GO TO 220
263 N1 = 1
264 N2 = NV
265 GO TO 230
266 C
267 220 N2 = NV - 50
268 WRITE(6,6110) (XTAB(I),YTAB(I),XTAB(I+50),YTAB(I+50),I=1,N2)
269 N1 = N2 + 1
270 IF (N1.GT. 50) GO TO 280
271 N2 = 50
272 230 CONTINUE
273 IF (NPRT .EQ. 1) GO TO 280
274 WRITE (6,6120) (XTAB(I),YTAB(I),I=N1,N2)
275 C
276 280 CONTINUE
277 KWRD = KMURD1 - KMUD
278 IF (NPRT .EQ. 1 .AND. NPRT2 .NE. 0) WRITE (10T,6210) NT,TITLE,
279 ND,NXYT,KWRD
280 IF (NPRT .NE. 1) WRITE (10T,6220) KWRD
281 C
282 290 CONTINUE
283 C
284 300 IF (KMURD1 .LE. MXWRD) GO TO 310
285 WRITE(6,6170) KMURD1
286 CALL EXIT
287 310 IF (OFT .EQ. 0) GO TO 350
288 IF (OFT .GT. 2) IOTAP = OFT
289 WRITE (10TAP) TLA,NV
290 WRITE (10TAP) (TABLE(JKM),JKM=1,KMURD1)

```

** INTAB **

FILE: MFTF-CSA

TIME: 10:21:29

DATE 040579

PAGE 110

290 END FILE IOTAP
291 REWIND IOTAP
292 350 WRITE (101.6180) KMURD1
293 RETURN
294 C
295 END

109

** LIQNT **

FILE: MFTF-CSA

TIME: 10:21:30

DATE 040579

PAGE 111

1	C	
2		SUBROUTINE LIQNT
3	C	
4		CALL N2MAIN
5	C	
6		RETURN
7	C	
8		END

ALLO


```

1      SUBROUTINE LNSYST(DIA, FLOW, PSTOR, QUAL)
2      C
3      LOGICAL PAGE, JP
4      C
5      INCLUDE CPAGE
6      C
7      COMMON/GEOM/XLEN(6,100),ZIN(6,100),ZOUT(6,100),QNET(6,100)
8      COMMON/GEOM/EFF(6,100),TYPE(6,100),TNUM(6,100),JMAX(6)
9      COMMON/GEOM/Q0(6,100),Q1(6,100),Q2(6,100)
10     COMMON/GEOM/WLOST,THOT
11     COMMON/PROP/B1,B2,B3,B4,B5,B6
12     COMMON/CALC/WDOT,QUAL1,QUAL2,DIAM,P,T
13     COMMON/CALC/REYN,FRICT,VAPVEL,VAPMCH,DENS
14     COMMON/CALC/TQUAL
15     DIMENSION DIA(6)
16     DIMENSION WFLOW(10),DPEXIT(10),QEXIT(5)
17     DIMENSION X0(2,5),X1(2,5),X2(2,5),X3(2,5),X4(2,5)
18     DIMENSION Y(2,5),XY(2,5),XXY(2,5)
19     DIMENSION C(2,3,5),CC(3,5)
20     DIMENSION TGAS(5),TOUT(5)
21     DIMENSION VMAX(5)
22     DIMENSION FLAG(2,5)
23     C
24     C      ANALYSIS ROUTINE FOR LINES 1 AND 6
25     C
26     JP = PAGE(0)
27     C
28     QUAL=QUAL
29     I=1
30     WRITE (6,100)I
31     100 FORMAT(1H0,T50,'ANALYSIS OF LINE NUMBER',I3,'/',/, ' INDEX DIAM   WDO
32     1T-L  WDOT-V QUALITY   TEMP   PRESSURE   PR GRAD   FRICTION   REY
33     2N   VAPOR VEL VAPOR MACH   DENSITY',/,T8,'(M)',T14,'(KG/S) (KG/S
34     3)',T39,'(K)',T48,'(KPA)',T59,'(KPA/M)',T69,'FACTOR',T79,'NUMBER',T
35     490,'(M/S)',T100,'NUMBER',T111,'(KG/M-3)',/)
36     T=08.190
37     P=PSTOR
38     CALL N2PROP(P,T)
39     VV1=B1
40     VL1=B2
41     RHOV1=B3
42     RHOL1=B4
43     HV1=B5
44     DH1=B6
45     DENS=RHO11
46     C
47     C      VV -- VAPOR VISCOSITY   KG/M-SEC
48     C      VL -- LIQUID VISCOSITY  KG/M-SEC
49     C      RHOV -- VAPOR DENSITY    KG/M**3
50     C      RHOL -- LIQUID DENSITY   KG/M**3
51     C      HV -- HT OF VAPORIZATION J/KG
52     C      DH -- CHANGE IN SAT LIQUID ENTHALPY WITH PRESSURE
53     C      (J/KG)/(NT/M**2)
54     C
55     WDOT=FLOW*RHO11
56     110 WDOTL=(1.0-QUAL1)*WDOT
57     WDOTV=QUAL1*WDOT

```

```

58 DIAM=DIA(1)
59 REYN=4.0*WDOT/(3.14159*DIAM*VL(1))
60 FRICT=0.00560+0.500*(REYN**(-0.32))
61 VAPVEL=WDOTV/RHOV1
62 VAPMCH=VAPVEL/(20.414*SORT(T))
63 PKPA=P/1000.0
64 WRITE (6,120)DIAM,WDOTL,WDOTV,QUAL1,T,PKPA,FRICT,REYN,VAPVEL,VAPMCH
65 1H,DENS
66 120 FORMAT(15,F7.4,T13,F7.4,T21,F7.4,T30,F6.4,T37,F8.3,T46,F10.5,T68,F
67 18.5,T77,F10.1,T88,F9.4,T99,F7.4,T109,F11.6)
68 DO 160 J=1,JMAX(1)
69 A1=XLEN(1,J)
70 A2=ZIN(1,J)
71 A3=ZOUT(1,J)
72 A4=EFF(1,J)
73 A5=QNE(1,J)
74 A6=TYPE(1,J)
75 A7=TNUV(1,J)
76 CALL DPCAL(DP,T2,A1,A2,A3,A4,A5,A6,A7)
77 IF (XLEN(1,J).EQ.0.0) GO TO 130
78 PGRAD=DP/(1000.0*XLEN(1,J))
79 GO TO 140
80 130 PGRAD=0.0
81 140 P=P-DP
82 IF (P.LT.101325.0) GO TO 570
83 WDOTL=(1.0-QUAL2)*WDOT
84 WDOTV=QUAL2*WDOT
85 PKPA=P/1000.0
86 WRITE (6,150)J,DIAM,WDOTL,WDOTV,QUAL2,T2,PKPA,PGRAD,FRICT,REYN,VAP
87 1VEL,VAPMCH,DENS
88 150 FORMAT(14,15,F7.4,T13,F7.4,T21,F7.4,T30,F6.4,T37,F8.3,T46,F10.5,T5
89 17,F10.5,T68,F8.5,T77,F10.1,T88,F9.4,T99,F7.4,T109,F11.6)
90 QUAL1=QUAL2
91 VV1=B1
92 VL1=B2
93 RHOV1=B3
94 RHOL1=B4
95 HV1=B5
96 DH1=B6
97 160 T=T2
98 C
99 C
100 C
101 C
102 WFLOW(1)=WDOT
103 QEX17(1)=QUAL1
104 IF (1.EQ.6) GO TO 610
105 DO 170 K1=1,2
106 DO 170 K2=2,5
107 FLAG(K1,K2)=0.0
108 X0(K1,K2)=0.0
109 X1(K1,K2)=0.0
110 X2(K1,K2)=0.0
111 X3(K1,K2)=0.0
112 X4(K1,K2)=0.0
113 Y(K1,K2)=0.0
114 XY(K1,K2)=0.0
115 170 XXY(K1,K2)=0.0

```

ANALYSIS ROUTINE TO DETERMINE FLOW RATES IN EACH OF
THE PARALLEL LINES 2,3,4 AND 5

A13

```
116 PVALIN=P
117 TBRNCH=T
118 QUALIN=QUAL1
119 WDOTIN=WDOT-WLOST
120 WLOT=WDOTIN
121 WFLOW(2)=WDOTIN
122 WFLOW(3)=WDOTIN
123 WFLOW(4)=WDOTIN
124 WFLOW(5)=WDOTIN
125 WMAX(2)=WDOTIN
126 WMAX(3)=WDOTIN
127 WMAX(4)=WDOTIN
128 WMAX(5)=WDOTIN
129 JCOUNT=0
130 180 DO 330 I=2,5
131     DIAM=DIA(I)
132     WDOT=WFLOW(I)
133     QUAL1=QUALIN
134     P=PVALIN
135     T=TBRNCH
136 190 DO 240 J=1,JMAX(I)
137     A1=XLEN(I,J)
138     A2=ZIN(I,J)
139     A3=ZOUT(I,J)
140     A4=EFF(I,J)
141     A5=QNET(I,J)
142     A6=TYPE(I,J)
143     A7=TNUM(I,J)
144     IF (A6.NE.5.0) GO TO 200
145     WDOT=WDOT/TNUM(I,J)
146 200 CALL DPCAL(DP,T2,A1,A2,A3,A4,A5,A6,A7)
147     IF (XLEN(I,J).EQ.0.0) GO TO 210
148     PGRAD=DP/(1000.0*XLEN(I,J))
149     GO TO 220
150 210 PGRAD=0.0
151 220 P=P-DP
152     IF (P.GT.101325.0) GO TO 230
153     WMAX(1)=WDOT
154     WDOT=0.50*WMAX(1)
155     WFLOW(1)=WDOT
156     QUAL1=QUALIN
157     P=PVALIN
158     T=TBRNCH
159     GO TO 190
160 230 WDOTL=(1.0-QUAL2)*WDOT
161     WDOTV=QUAL2*WDOT
162     PKPA=P/1000.0
163     QUAL1=QUAL2
164     VV1=31
165     VL1=82
166     RHQV1=83
167     RHQV1=84
168     HV1=85
169     DH1=86
170 240 T=T2
171     DPEXIT(I)=PVALIN-P
172     QEXIT(I)=QUAL2
173     TGAS(I)=TQUAL
```

A114

```

174 TOUT(I)=T
175 WFLOW(I+5)=WFLOW(I)
176 IF (DPEXIT(I)-1.0,0) GO TO 310
177 IF (QEXIT(I)-EQ.1.0) GO TO 280
178 X0(2,1)=X0(2,1)+1.0
179 X1(2,1)=X1(2,1)+WFLOW(I)
180 X2(2,1)=X2(2,1)+(WFLOW(I)**2)
181 X3(2,1)=X3(2,1)+(WFLOW(I)**3)
182 X4(2,1)=X4(2,1)+(WFLOW(I)**4)
183 Y(2,1)=Y(2,1)+DPEXIT(I)
184 XY(2,1)=XY(2,1)+DPEXIT(I)*WFLOW(I)
185 XXV(2,1)=XXV(2,1)+DPEXIT(I)*(WFLOW(I)**2)
186 IF (FLAG(2,1)-1.0) 250,260,270
187 C(2,1,1)=0.0
188 C(2,2,1)=DPEXIT(I)/WFLOW(I)
189 C(2,3,1)=0.0
190 FLAG(2,1)=FLAG(2,1)+1.0
191 GO TO 330
192 260 C(2,1,1)=0.0
193 DENOM=X1(2,1)*X3(2,1)-X2(2,1)*X2(2,1)
194 C(2,2,1)=(Y(2,1)*X3(2,1)-X2(2,1)*XY(2,1))/DENOM
195 C(2,3,1)=(X1(2,1)*XY(2,1)-X2(2,1)*Y(2,1))/DENOM
196 FLAG(2,1)=FLAG(2,1)+1.0
197 GO TO 330
198 270 DET1=(X2(2,1)*X4(2,1)-X3(2,1)*X3(2,1))
199 DET2=(X1(2,1)*X4(2,1)-X2(2,1)*X3(2,1))
200 DET3=(X1(2,1)*X3(2,1)-X2(2,1)*X2(2,1))
201 DENOM=X0(2,1)*DET1-X1(2,1)*DET2+X2(2,1)*DET3
202 C(2,1,1)=(Y(2,1)*DET1-XY(2,1)*DET2+XXV(2,1)*DET3)/DENOM
203 DET1=(X1(2,1)*X4(2,1)-X2(2,1)*X3(2,1))
204 DET2=(X0(2,1)*X4(2,1)-X2(2,1)*X2(2,1))
205 DET3=(X0(2,1)*X3(2,1)-X1(2,1)*X2(2,1))
206 C(2,2,1)=(-Y(2,1)*DET1+XY(2,1)*DET2-XXV(2,1)*DET3)/DENOM
207 DET1=(X1(2,1)*X3(2,1)-X2(2,1)*X2(2,1))
208 DET2=(X0(2,1)*X3(2,1)-X2(2,1)*X1(2,1))
209 DET3=(X0(2,1)*X2(2,1)-X1(2,1)*X1(2,1))
210 C(2,3,1)=(Y(2,1)*DET1-XY(2,1)*DET2+XXV(2,1)*DET3)/DENOM
211 FLAG(2,1)=FLAG(2,1)+1.0
212 GO TO 330
213 280 X1(1,1)=X1(1,1)+WFLOW(I)
214 X2(1,1)=X2(1,1)+(WFLOW(I)**2)
215 X3(1,1)=X3(1,1)+(WFLOW(I)**3)
216 Y(1,1)=Y(1,1)+DPEXIT(I)
217 XY(1,1)=XY(1,1)+(DPEXIT(I)*WFLOW(I))
218 IF (FLAG(1,1)-1.0) 290,300,300
219 C(1,1,1)=0.0
220 C(1,2,1)=DPEXIT(I)/WFLOW(I)
221 C(1,3,1)=0.0
222 FLAG(1,1)=FLAG(1,1)+1.0
223 GO TO 330
224 300 C(1,1,1)=0.0
225 DENOM=X1(1,1)*X3(1,1)-X2(1,1)*X2(1,1)
226 C(1,2,1)=(Y(1,1)*X3(1,1)-X2(1,1)*XY(1,1))/DENOM
227 C(1,3,1)=(X1(1,1)*XY(1,1)-X2(1,1)*Y(1,1))/DENOM
228 FLAG(1,1)=FLAG(1,1)+1.0
229 GO TO 330
230 310 CONTINUE
231 DIA(I)=1.25*DIA(I)

```

```

-232 IF (C1A(I).GT.1.0) GO TO 590
-233 DO 340 K1=1,2
-234 FLAG(K1,1)=0.0
-235 X0(K1,1)=0.0
-236 X1(K1,1)=0.0
-237 X2(K1,1)=0.0
-238 X3(K1,1)=0.0
-239 X4(K1,1)=0.0
-240 Y(K1,1)=0.0
-241 X1(K1,1)=0.0
-242 320 XXY(K1,1)=0.0
-243 WMAX(1)=WDOTIN
-244 330 CONTINUE
-245 JTAG=0
-246 DPAVG=0.25*(DPEXIT(2)+DPEXIT(3)+DPEXIT(4)+DPEXIT(5))
-247 WTOT1=WFLOW(2)+WFLOW(3)+WFLOW(4)+WFLOW(5)
-248 IF (WTOT1.NE.WTOT) JTAG=1
-249 DO 360 I5=2,5
-250 IF (ABS(DPAVG-DPEXIT(I5)).GE.100.0) JTAG=1
-251 IF (DPEXIT(I5).LT.1.0) GO TO 340
-252 CC(1,I5)=C(1,1,I5)
-253 CC(2,I5)=C(1,2,I5)
-254 CC(3,I5)=C(1,3,I5)
-255 GO TO 350
-256 340 CC(1,I5)=C(2,1,I5)
-257 CC(2,I5)=C(2,2,I5)
-258 CC(3,I5)=C(2,3,I5)
-259 350 CONTINUE
-260 360 CONTINUE
-261 IF (JTAG.EQ.0) GO TO 460
-262 DELP=3000.0
-263 PTRIAL=0.0
-264 370 WTOT=0.0
-265 DO 400 I5=2,5
-266 IF (DPEXIT(I5).LT.0.0) GO TO 390
-267 IF (CC(3,I5).EQ.0.0) GO TO 380
-268 XROOT=CC(2,I5)**2-4.0*CC(3,I5)*(CC(1,I5)-PTRIAL)
-269 IF (XROOT.LE.0.0) XROOT=0.0
-270 WFLOW(I5)=(-CC(2,I5)+SQRT(XROOT))/(2.0*CC(3,I5))
-271 GO TO 400
-272 380 IF (CC(2,I5).LE.0.0) GO TO 390
-273 WFLOW(I5)=PTRIAL/CC(2,I5)
-274 GO TO 400
-275 390 WFLOW(I5)=0.0
-276 400 WTOT=WTOT+WFLOW(I5)
-277 IF ((WDOTIN-WTOT)/WDOTIN)**2.LT.1.0E-6) GO TO 430
-278 IF (WTOT.LT.WDOTIN) GO TO 420
-279 PTRIAL=PTRIAL-DELP
-280 DELP=DELP/10.0
-281 PTRIAL=PTRIAL+DELP
-282 IF (DELP.GT.0.00001) GO TO 370
-283 WRITE (6,410)
-284 410 FORMAT(/,F30,'DELP LESS THAN 1.0E-5')
-285 GO TO 430
-286 420 PTRIAL=PTRIAL+DELP
-287 GO TO 370
-288 430 DO 450 I5=2,5
-289 IF (WFLOW(I5).NE.0.0) GO TO 440

```

All6

```

290      WFLOW(15)=1.25*WFLOW(15+5)
291      GO TO 450
292 440    Z9=WFLOW(15)-WFLOW(15+5)
293      Z8=0.5*WMAX(15)
294      IF (ABS(Z9).GT.Z8) WFLOW(15)=Z8*(ABS(Z9)/Z8)+WFLOW(15+5)
295      IF (WFLOW(15).GE.WMAX(15)) WFLOW(15)=WMAX(15)*(1.0-WMAX(15)/WFLOW(15))
296
297      IF (WFLOW(15).LE.0.0) WFLOW(15)=0.5*WFLOW(15+5)
298 450    CONTINUE
299      WTOT=WFLOW(2)+WFLOW(3)+WFLOW(4)+WFLOW(5)
300      JCOUNT=JCOUNT+1
301      IF (JCOUNT.LE.20) GO TO 180
302
303 C
304 C      ANALYSIS ROUTINE FOR LINES 2 TO 5
305 C
306 460    DD 530 I=2,5
307      WFLOW(I)=WFLOW(1+5)
308      WDOT=WFLOW(I)
309      QUALI=QUALIN
310      P=PVALIN
311      T=TBRNCH
312
313 C      JP = PAGE(0)
314 C
315      WRITE (6,100) I
316      CALL N2PROP(P,T)
317      VV1=B1
318      VL1=B2
319      RHOV1=B3
320      RHDL1=B4
321      HV1=B5
322      DH1=B6
323      WDOTL=((1.0-QUALI)*WDOT
324      WDOTV=QUALI*WDOT
325      DIAM=DIAM(I)
326      REYN=4.0*WDOT/(3.14159*DIAM*VL1)
327      FRICT=0.00560+0.500*(REYN**(-0.32))
328      VAPVEL=WDOTV/RHOV1
329      VAPMCH=VAPVEL/(20.414*SQRT(T))
330      PKPA=P/1000.0
331      WRITE (6,120) DIAM,WDOTL,WDOTV,QUALI,T,PKPA,FRICT,REYN,VAPVEL,VAPMC
332      H,DENS
333      IFLAG=0
334      DO 510 J=1,JMAX(1)
335      IFLAG=IFLAG+1
336      A1=XLEN(1,J)
337      A2=ZINI(1,J)
338      A3=ZOUT(1,J)
339      A4=EFFI(1,J)
340      A5=QNET(1,J)
341      A6=TYPE(1,J)
342      A7=TNUM(1,J)
343      IF (A6.NE.5.0) GO TO 470
344      WDOT=WDOT/TNUM(1,J)
345 470    CALL DPCAL(DP,T2,A1,A2,A3,A4,A5,A6,A7)
346      IF (XLEN(1,J).EQ.0.0) GO TO 480
347      PCRAD=DP/(1000.0*XLEN(1,J))
348      GO TO 490

```

A17

```

348 480 PGRAD=0.0
349 490 P=P-DP
350 WDOTL=(1.0-QUAL2)*WDOT
351 WDOTV=QUAL2*WDOT
352 PKPA=P/1000.0
353 IF (IFLAG.LE.38) GO TO 500
354 C
355 JP = PAGE(0)
356 C
357 WRITE (6,100)I
358 IFLAG=0
359 500 CONTINUE
360 WRITE (6,150)J,DIAM,WDOTL,WDOTV,QUAL2,T2,PKPA,PGRAD,FRICT,REYN,VAP
361 IVEL,VAPMCH,DENS
362 QUAL1=QUAL2
363 VV1=B1
364 VL1=B2
365 RHOV1=B3
366 RHOL1=B4
367 HV1=B5
368 DH1=B6
369
370 510 T=T2
371 DPEXIT(1)=PVALIN-P
372 WRITE (6,520)WFLOW(1),DPEXIT(1)
373 520 FORMAT(7,T10,'WFLOW =',F10.6,10X,'DPEXIT =',F12.4)
374 530 QEXIT(1)=QUAL2
375 DPAVG=0.25*(DPEXIT(2)+DPEXIT(3)+DPEXIT(4)+DPEXIT(5))
376 P=PVALIN-DPAVG
377 I=6
378 WDOT=WDOTIN
379 C
380 JP = PAGE(0)
381 C
382 WRITE (6,100)I
383 CALL N2PROP(P,T)
384 TBRNCH=T
385 VV1=B1
386 VL1=B2
387 RHOV1=B3
388 RHOL1=B4
389 HV1=B5
390 DH1=B6
391 HEAT=0.0
392 EXITQL=0.0
393 WTOT=0.0
394 DO 550 KK=2,5
395 IF (QEXIT(KK).EQ.1.0) GO TO 540
396 EXITQL=EXITQL+QEXIT(KK)*WFLOW(KK)
397 WTOT=WTOT+WFLOW(KK)
398 GO TO 550
399 540 IAVG=(TOUT(KK)+TGAS(KK))/2.0
400 T=IAVG
401 CALL SPCFHT(T,SPECHT)
402 HEAT=HEAT+SPECHT*WFLOW(KK)*(TOUT(KK)-TGAS(KK))
403 550 CONTINUE
404 EXITQL=EXITQL/WTOT
405 HVAPOR=B5-WTOT*(1.0-EXITQL)
406 IF (HVAPOR.LT.HEAT) GO TO 560

```

```
406      DELO=(HEAT/HVAPOR)*(1.0-EXITQL)
407      QUALI=EXITQL+DELO
408      T=TBRNCH
409      GO TO 110
560      EXITQL=1.0
411      DELTG=(HEAT-HVAPOR)/(WDOTIN*SPECHT)
412      T=T+DELTG
413      PP=P
414      CALL GN2DEN(T,PP,DENS)
415      QUALI=1.0
416      GO TO 110
417      570 WRITE (6,580)
418      580 FORMAT(/,/,T30,'FLOWRATE IS TOO LARGE FOR THIS CONFIGURATION')
419      GO TO 660
420      590 WRITE (6,600)
421      600 FORMAT(/,/,T30,'DIAMETER INCREASED TO GREATER THAN 1 METER - TERM1
422      2NATE RUN')
423      GO TO 660
424      610 CONTINUE
425      WRITE (6,620)
426      620 FORMAT(/,/,T50,'DISPLAY OF FINAL FLOW PARAMETERS',/,/,/)
427      DO 630 KK=1,6
428      630 WRITE (6,640)KK,WFLOW(KK),KK,DIA(KK),KK,QEXIT(KK)
429      640 FORMAT(T15,'WFLOW(','.I2,' )='',F10.7,' KG/SEC',8X,'DIA(','.I2,' )='',F8
430      1.5,' M',8X,'QEXIT(','.I2,' )='',F8.5,/)
431      WRITE (6,650)THOT,T
432      650 FORMAT(/,/,T30,'AMBIENT TEMP ='',F8.3,10X,'EXIT TEMP ='',F8.3)
433      RETURN
434      END
```



```

1      C      * * * * *
2      C      * ROUTINE NAME - LOCATE AND INPUT THE TABLE *
3      C      *          TO BE LOOKED-UP *
4      C      * ROUTINE LANG - FORTRAN V UNIVAC 1110 EXEC 8 *
5      C      * DATE CODED - AUGUST 23, 1978 *
6      C      * PROGRAMMER - R.F.HAUSMAN 104-6213-30235 *
7      C      * * * * *
8      C
9      SUBROUTINE LOCAT (MNT)
10     C
11     C      ***** EXPLANATION OF THE CALLING SEQUENCE
12     C      *
13     C      * NT - THE TABLE NUMBER WITHIN A MASTER TABLE. THAT IS.
14     C      *          THE NUMBER OF WORDS TO BE SKIPE TO FIND THE
15     C      *          DESIRED TABLE IS 200*(NT-1).
16     C      *****
17     C
18     INCLUDE CIGUNT
19     INCLUDE CTAB
20     INCLUDE CTABA
21     C
22     NT = IABS (MNT)
23     IDX = IDX1
24     NIM1 = NT - 1
25     IF (NTM1.LE.0) GO TO 20
26     C
27     DO 10 I1 = 1,NTM1
28     MM = 1
29     IF (ITABLE (IDX+1).EQ.1) MM = 2
30     10  IDX = IDX + MM*ITABLE (IDX) + 3
31     C
32     20  NV = ITABLE (IDX)
33     TYPE = ITABLE (IDX+1)
34     NIP = ITABLE (IDX+2)
35     IDX = IDX + 2
36     C
37     DO 30 I1 = 1,NV
38     IDX = IDX + 1
39     IF (MNT.LT. 0) GO TO 26
40     XTAB(I1) = TABLE (IDX)
41     IF (TYPE.EQ.1) YTAB(I1) = TABLE (IDX+NV)
42     GO TO 30
43     C
44     26  XTAB(I1) = TABLE (IDX+NV)
45     YTAB(I1) = TABLE (IDX)
46     30  CONTINUE
47     RETURN
48     END

```

SUBROUTINE MAGNET

```

* * * * *
* ROUTINE NAME ~ MAGNET CHARACTERIZATION
* ROUTINE LANG ~ FORTRAN V UNIVAC 1110 EXEC 8
* PROGRAMMER ~ R.F.HAUSMAN 104-6213-30235
* DATE CODED ~ AUGUST 23, 1978
* * * * *

```

**** THIS SUBROUTINE CHARACTERIZES THE MAGNET CONDITIONS

LOGICAL JP,PAGE

```
INCLUDE CFLUID
INCLUDE CMAG
```

BEGIN COMPUTATIONS FOR MAGNET SYSTEM

NPSYS = 1

PTANK = PMAGDW
TTANK = TMAGDW

CALL HEPROP(PMAGDW,TMAGDW,1)

RHO = HELD + HEMWT @ KG/CU-METER

```
PMAGI = PMAGDW + HEHEO(RHO ,HOMAGI)      @ KPA
PMAGO = PMAGDW + HEHEO(RHO ,HOMAGO)      @ KPA
```

```
SVLINT = HELSV                                @ L/MOL
SLVIN(1) = SVLINT
SLVIN(2) = SVLINT
TMAG1 = TMAGDW                                @ DEG K
```

```
CALL HEPROP(PMAGI, TMAGI, 1)      ③ MAG INLET PROP
CALL HEPROP(PMAGO, TMAGI, 3)      ③ MAG OUTLET PROP
```

DELTA-H, SUBCOOLED LIQUID TO SAT. LIQUID

$$\text{DELH1} = \text{HEHL} - \text{HELH} \quad @ \text{ J/MOL}$$

DELTA-H, SUBCOOLED LIQUID TO SAT. VAPOR

DELH2 = HEHG - HELH J/MOL

ENERGY TO RAISE CONDITION TO SAT. LIQUID (NO FLOW)

QUANT = VHEMAG * HEDL @ MOLS
QSAT1 = QUANT * DELHI @ JOULES

ENERGY TO RAISE CONDITION TO SAT. VAPOR (NO FLOW)

MAG00100
MAG00200
MAG00300
MAG00400
MAG00500
MAG00600
MAG00700
MAG00800
MAG00900
MAG01000
MAG01100
MAG01200
MAG01300
MAG01400
MAG01500

MAG01600
MAG01700
MAG01800
*MAG02000
MAG02100
MAG02200
MAG02300
MAG02400
MAG02500
MAG02600
MAG02700
MAG02800
MAG02900
MAG03000
MAG03100
MAG03200
MAG03300
MAG03400
MAG03500
MAG03600
MAG03700
MAG03800
MAG03900
MAG04000
MAG04100
MAG04200
MAG04300
MAG04400
MAG04500
MAG04600
MAG04700
MAG04800
MAG04900
MAG05100
MAG05000
MAG05200
MAG05300
MAG05500
MAG05600

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58		QEVP = QUANT * DELH2	2 JOULES	MAG05700
59	C			MAG05800
60		ENERGY GENERATED IN MAGNETS PER HOUR		MAG05900
61	C			MAG06000
62		QGEQHR = QMAG1 * 3600.0	2 J/HR	MAG06100
63	C			MAG06200
64		TIME TO OBTAIN NO FLOW COOLANT LOSS		MAG06300
65	C			MAG06400
66		TIME4 = QSAT1/QGEQHR	2 HRS	MAG06500
67		TIME5 = QEVP/QGEQHR	2 HRS	MAG06600
68		TEMP1 = HET	2 DEG-K	MAG06700
69		TMAG0 = HET	2 SATURATION TEMPERATURE	MAG06800
70		ROHL = HEDL	2 MOL/L	MAG06900
71		ROHG = HEDG	2 MOL/L	MAG07000
72	C			MAG07100
73		MAX. GAS GENERATION AT NO FLOW CONDITION		MAG07200
74	C			MAG07300
75		WDMAG = ((QGEQHR/DELH2) + HEMWT)/1000.0	2 KG/HR	MAG07400
76	C			MAG07500
77		ENERGY REQD. FOR SAT. LIQUID AT SPECIFIED FLOW RATE (WDTLHI)		MAG07600
78	C			MAG07700
79		QSAT2 = ((WDTLHI * 1000.0)/HEMWT) + DELH1	2 JOULES/HR	MAG07800
80	C			MAG07900
81		ENERGY AVAILABLE FOR VAPORIZATION OF HELIUM		MAG08000
82	C			MAG08100
83		QEVAP1 = QGEQHR - QSAT2	2 JOULES/HR	MAG08200
84	C			MAG08300
85		VAPOR GENERATED AT SPECIFIED FLOW RATE		MAG08400
86	C			MAG08500
87		WDTGHE = ((QEVAP1/DELH2) + HEMWT)/1000.0	2 KG/HR	MAG08600
88	C			MAG08700
89		DETERMINE THE QUALITY OF THE LIQUID		MAG08800
90	C			MAG08900
91		QUAL0 = WDTGHE/WDTLHI	2 DEC-FRACTION	MAG09000
92	C			MAG09100
93		SP. VOL. AND RHO OF THE LIQUID OUT OF MAGNETS		MAG09200
94	C			MAG09300
95		SVLMIX = (1.0-QUAL0)*HESVL + QUAL0*HESVG	2 L/MOL	MAG09400
96		RHOMIX = 1.0/SVLMIX		MAG09500
97	C			MAG09600
98		WDOT1(1) = WDTLHI/2.0 : WDOT1(2) = WDOT1(1)	2 KG/HR	MAG09700
99	C			MAG09800
100		WDTGH2 = WDTGHE/2.0	2 KG/HR	MAG09900
101	C			MAG10000
102		WDTLHG = WDTLHI - WDTGHE		MAG10100
103	C			MAG10200
104				
105	C	COMPUTE BOILOFF IN STORAGE DEWAR DUE TO HEAT-LFAK		
106				
107	C	PSTODW = PMAGDW		
108		TSTODW = TMAGDW		
109		CALL HEPROP (PSTODW, TSTODW, 3)		
110		DLTH5 = HENG - HEHL	2 J/MOL L. TO G.	
111		QHTSHR = QLKSDW * 3600.0	2 J/HR	
112		WDTMOL = QHTSHR/DLTH5	2 MOL/HR	
113		WDGSTD = (WDTMOL * HEMWT)/1000.0	2 KG/HR	
114		TMPSTR = HET	2 DEG. K	
115	C			

```

116 C * * * * * MAG10300
117 C * * * * * MAG10400
118 JP = PAGE(0) MAG10500
119 C * * * * * MAG10600
120 WRITE (6,6000) MAG10700
121 6000 FORMAT(/T27,'*** INITIATE PROGRAM AND CHARACTERIZE MAGNET INPUT AMAG10800
122 1ND OUTPUT CONDITIONS ***'/) MAG10900
123 C * * * * * MAG11000
124 WRITE (6,6100) WDTLHI, TMAGOW, PMAGI, HELD, HELSV, WDTLHI, HET, MAG11100
125 2 PMAGD, ROHL, ROHG, RHOMIX, SVLMIX, QVALD, MAG11200
126 3 WDTLNG, WDTGHE MAG11300
127 6100 FORMAT(I55,'** ESTIMATED MAGNET PARAMETERS **//T20,'FLUID FLOWINGMAG11400
128 1CONDITIONS: '/T45,'INLET FLOW RATE (KG/HR)',T80,E15.8, MAG11500
129 2 /T45,'INLET TEMPERATURE (DEG.K)',T80,E15.8, MAG11600
130 3 /T45,'INLET PRESSURE ( KPA )',T80,E15.8, MAG11700
131 4 /T45,'INLET FLUID DENSITY (MOL/L)',T80,E15.8, MAG11800
132 5 /T45,'INLET SPECIFIC VOLUME (L/MOL)',T80,E15.8, MAG11900
133 6 //T45,'OUTLET FLOW RATE (KG/HR)',T80,E15.8, MAG12000
134 7 /T45,'OUTLET TEMPERATURE (DEG.K)',T80,E15.8, MAG12100
135 8 /T45,'OUTLET PRESSURE ( KPA )',T80,E15.8, MAG12200
136 9 /T45,'OUTLET LIQUID DENSITY (MOL/L)',T80,E15.8, MAG12300
137 A /T45,'OUTLET GAS DENSITY (MOL/L)',T80,E15.8, MAG12400
138 B /T45,'OUTLET MIXTURE DENSITY(MOL/L)',T80,E15.8, MAG12500
139 C /T45,'OUTLET MIXTURE SP.VOL.(L/MOL)',T80,E15.8, MAG12600
140 D /T45,'OUTLET FLUID QUALITY (FRACT)',T80,E15.8, MAG12700
141 E//T45,'OUTLET FLUID COMPOSITION: '/T57,'LIQUID (KG/HR)',T80,E15.8MAG12800
142 F/T57,'VAPOR (KG/HR)',T80,E15.8/) MAG12900
143 C * * * * * MAG13000
144 WRITE(6,6200) QGEQHR, TIM4, TIM5, WDTMXG MAG13100
145 6200 FORMAT(T20,'NO-FLOW CONDITIONS: ', MAG13200
146 D /T45,'MAGNET ENERGY (J/HR.)',T80,E15.8, MAG13300
147 E /T45,'TIME TO SAT. LIQUID (HOURS)',T80,F7.3, MAG13400
148 F /T45,'TIME TO SAT. VAPOR (HOURS)',T80,F7.3, MAG13500
149 G /T45,'RATE OF VAPOR BOILOFF (KG/HR)',T80,E15.8) MAG13600
150 C * * * * * MAG13700
151 C * * * * * MAG13800
152 C * * * * * MAG13900
153 C DO THE MAGNET SUPPLY SYSTEM COMPONENT CONFIGURATION ANALYSIS MAG14000
154 C * * * * * MAG14100
155 CALL CMPCAL MAG14200
156 C * * * * * MAG14300
157 RETURN MAG14400
158 C * * * * * MAG14500
159 END MAG14600

```

.. MFTF ..

1 IN CONTRL
2 END

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```

      * * * * *
      * ROUTINE NAME - MULTI-TABLE INTERPOLATION
      *                   AND POLYNOMIAL EVALUATION
      * ROUTINE LANG - FORTRAN V UNIVAC 1108 EXEC 2
      * PROGRAMMER   - R. BOLLINGER 1943 102 26933
      * DATE CODED   - 3/3/70
      * REVISED     - SEPTEMBER 3, 1971
      * PROGRAMMER   - J. MCKAY 19-43 201 X45178
      * * * * *

      FUNCTION MIPE(NL,XVAL)

      ***** EXPLANATION OF THE CALLING SEQUENCE

      NL - THE NUMBER OF LEVELS OF INTERPOLATION OR ONE
           LESS THAN THE NUMBER OF DIMENSIONS OR THE NUMBER
           OF VALUES IN THE ARRAY XVAR.

      XVAR - AN ARRAY OF INDEPENDENT VARIABLES ON WHICH
            TO INTERPOLATE OR EVALUATE POLYNOMIALS.

      REAL MIPE

      INCLUDE CIOUNT
      INCLUDE CKEYS
      INCLUDE CTAB

      DIMENSION XVAL(6),YVAL(32),KNT(5),L(5),NTD(6),TAB1(6,5),
1  ITAB1(6,5)

      EQUIVALENCE (TAB1,ITAB1,TAB,ITAB)

      ***** LOCATE THE POSITION IN EACH OF THE FIRST NL-1 TABLES OF
      ***** THE INDEPENDENT VARIABLE AND STORE THE INDEXES IN KNT.

      MPX = 1
1  CONTINUE
      IF(NL.GT.1) GO TO 5
      CALL LOCAT (MPX)
      NL1BL = 1
      CALL TEL(XVAL(1),YVAL(1))
      GO TO 220
5  NL1 = NL - 1
      DO 70 I1 = 1,NL1
      NTAB1 = ITAB1(1,I1)
      IF(XVAL(I1) - TAB1(2,I1)) 50,50,10
10  IF(XVAL(I1) - TAB1(NTAB1+1,I1)) 20,60,60

      DO 30 I2 = 1,NTAB1
      I3 = I2
      IF(XVAL(I1) - TAB1(I2+1,I1)) 40,40,30
30  CONTINUE

      40 KNT(I1) = I3 - 1
      GO TO 70

```

A125

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58      50 KNT(I1) = 1
59      GO TO 70
60      C
61      60 KNT(I1) = NTAB1 - 1
62      70 CONTINUE
63      C
64      C      ***** COMPUTE THE TABLE NUMBER OF THE XY TABLES FOR
65      C      ***** INTERPOLATION.
66      C
67      NT = 2**NLM1
68      NLTL = NT
69      DO 110 I1=1,NL
70      110 NTD(I1) = NT / 2**(I1-1)
71      C      CALC. INTERPOLATION LEVEL COEF.
72      L(NLM1) = 1
73      IF (NLM1 .EQ. 0) GO TO 125
74      DO 120 I1=NLM1,2,-1
75      120 L(I1-1) = L(I1) * ITAB1(I1,I1)
76      C      COMPUTE THE ID NO. OF THE X-Y SUB-TABLES
77      C      USED FOR INTERPOLATION
78      125 DO 140 I1=1,NT
79      KTB = 1
80      DO 130 I2=1,NLM1
81      130 KTB = KTB + L(I2)* (KNT(I2)-1+MOD(I1-1,NTD(I2)))/NTD(I2+1))
82      C      LOOK UP SUBTABLE LOCATION
83      CALL LOCAT (MPX*KTB)
84      C
85      C      COMPUTE THE YVAL FOR XY-CURVES OR
86      C      POLYNOMIALS
87      CALL TEL (XVAL(NL),YVAL(I1))
88      IF (KEY2 .EQ. KEY1) RETURN
89      140 CONTINUE
90      C
91      C      ***** COMPUTE THE FINAL VALUE OF YVAL
92      C
93      DO 210 I1 = NLM1,1,-1
94      KYVAL = 1
95      IDX1 = KNT(I1) + 1
96      FAC = (XVAL(I1) - TAB1(IDX1 ,I1))/(TAB1(IDX1+1,I1)-TAB1(IDX1,I1))
97      C
98      DO 200 I2 = 1,NT,2
99      YVAL(KYVAL) = (YVAL(I2+1) - YVAL(I2))*FAC + YVAL(I2 )
100      KYVAL = KYVAL + 1
101      200 CONTINUE
102      C
103      NT = 2**(I1-1)
104      210 CONTINUE
105      C
106      C      ***** SET THE ANSWER AND RETURN TO THE CALLING PROGRAM
107      C
108      220 MIPE = YVAL(I1)
109      RETURN
110      C
111      C      RVMPE CAUSES INDEP AND DEP VAR TO SWITCH
112      C
113      ENTRY RVMPE (NL,XVAL)
114      MPX = -1
115      GO TO 1

```

** MIPE **

116

END

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```

1      SUBROUTINE N2MAIN
2      C
3      LOGICAL PAGE, JP
4      C
5      INCLUDE CPAGE
6      C
7      COMMON/GEOM/XLEN(6,100),ZIN(6,100),ZOUT(6,100),QNET(6,100)
8      COMMON/GEOM/EFF(6,100),TYPE(6,100),TNUM(6,100),JMAX(6)
9      COMMON/GEOM/Q0(6,100),Q1(6,100),Q2(6,100)
10     COMMON/GEOM/WLOST,THOT
11     DIMENSION DIA(6)
12     C
13     C----- INPUT LIQUID NITROGEN CONFIGURATION GEOMETRY
14     C
15     C
16     C      'I' REFERS TO LINE NUMBER
17     C      'J' REFERS TO LINE SECTION NUMBER
18     C
19     C      XLEN(I,J) -- GEOMETRICAL LINE SECTION LENGTH (METER)
20     C      ZIN(I,J) -- INLET HEIGHT (METER)
21     C      ZOUT(I,J) -- EXIT HEIGHT (METER)
22     C      EFF(I,J) -- EFFECTIVE L/D RATIO FOR BENDS, VALVES, TEES, ETC
23     C      Q0(I,J) -- HEAT RATE TERM
24     C      Q1(I,J) -- HEAT RATE TERM
25     C      Q2(I,J) -- HEAT RATE TERM
26     C
27     C      LINE 1 -- LN2 STORAGE TANK TO VALVE BOX INLET
28     C      LINE 2 -- VALVE BOX TO DEWAR SHIELDS AND RETURN
29     C      LINE 3 -- VALVE BOX TO INTERNAL CRYOPANELS AND RETURN
30     C      LINE 4 -- VALVE BOX TO UPPER EXTERNAL CRYOPANELS AND RETURN
31     C      LINE 5 -- VALVE BOX TO LOWER EXTERNAL CRYOPANELS PLUS BEAM LINE
32     C      MODULE SHIELDS AND RETURN
33     C      LINE 6 -- VALVE BOX EXIT TO ATMOSPHERE VENT NEAR STORAGE TANK
34     C
35     C
36     C      IRUN = 0
37     C
38     C      DO 110 I=1,6
39     C      READ (5,130) LINE
40     C      DO 100 J=1,100
41     C      READ (5,120) A1,A2,A3,A4,A5,A6,A7,A8,A9
42     C      IF (A1,L,T,O) GO TO 110
43     C      XLEN(I,J)=A1
44     C      ZIN(I,J)=A2
45     C      ZOUT(I,J)=A3
46     C      EFF(I,J)=A4
47     C      Q0(I,J)=A5
48     C      Q1(I,J)=A6
49     C      Q2(I,J)=A7
50     C      TYPE(I,J)=A8
51     C      TNUM(I,J)=A9
52     C      100 JMAX(I)=J-1
53     C      110 CONTINUE
54     C      120 FORMAT(7F10.3,2F5.1)
55     C      130 FORMAT(15)
56     C
57     C ----- DEFINE INPUT PARAMETERS

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116 IFLAG=3B
117 DO 350 J=1,UMAX(1)
118 IF (IFLAG.EQ.3B) GO TO 330
119 220 IFLAG=IFLAG+1
120 IF (TYPE(I,J).EQ.1.0) GO TO 270
121 IF (TYPE(I,J).EQ.2.0) GO TO 260
122 IF (TYPE(I,J).EQ.3.0) GO TO 250
123 IF (TYPE(I,J).EQ.4.0) GO TO 240
124 IF (TYPE(I,J).EQ.5.0) GO TO 230
125 C
126 C LINE TYPE 1 -- CRYOGEN LINE
127 C LINE TYPE 2 -- ELBOW
128 C LINE TYPE 3 -- VALVE
129 C LINE TYPE 4 -- BAYONET FITTING
130 C LINE TYPE 5 -- 'T' BRANCH
131 C LINE TYPE 6 -- SHIELD LINE
132 C
133 QNET(I,J)=Q0(I,J)+1.361E6*CONMLI*Q1(I,J)*Q2(I,J)*(THOT-TCOLD)/RNLA
134 1YR
135 WRITE (6,320)J,XLEN(I,J),ZIN(I,J),ZOUT(I,J),EFF(I,J),QNET(I,J)
136 GO TO 350
137 230 QNET(I,J)=Q0(I,J)
138 WRITE (6,280)J,XLEN(I,J),ZIN(I,J),ZOUT(I,J),EFF(I,J),QNET(I,J)
139 GO TO 350
140 240 QNET(I,J)=Q0(I,J)+((1.010E-7*(DIA(I)**2)*(THOT**4-TCOLD**4)))+(0.43
141 10B*DIA(I)*(THOT-TCOLD)))*Q1(I,J)
142 WRITE (6,290)J,XLEN(I,J),ZIN(I,J),ZOUT(I,J),EFF(I,J),QNET(I,J)
143 GO TO 350
144 250 QNET(I,J)=Q0(I,J)+(2.337*DIA(I)*(THOT-TCOLD))*Q1(I,J)
145 WRITE (6,300)J,XLEN(I,J),ZIN(I,J),ZOUT(I,J),EFF(I,J),QNET(I,J)
146 GO TO 350
147 260 QNET(I,J)=Q0(I,J)
148 WRITE (6,310)J,XLEN(I,J),ZIN(I,J),ZOUT(I,J),EFF(I,J),QNET(I,J)
149 GO TO 350
150 270 QNET(I,J)=Q0(I,J)+(1.361E6*CONMLI*DIA(I)*XLEN(I,J)*(THOT-TCOLD)/RN
151 1LAYR)*J(I,J)
152 WRITE (6,320)J,XLEN(I,J),ZIN(I,J),ZOUT(I,J),EFF(I,J),QNET(I,J)
153 GO TO 350
154 280 FORMAT(13,I7,F7.2,T16,F6.2,T24,F6.2,T32,F6.1,T41,F8.2,T90,'X')
155 290 FORMAT(13,I7,F7.2,T16,F6.2,T24,F6.2,T32,F6.1,T41,F8.2,T83,'X')
156 300 FORMAT(13,I7,F7.2,T16,F6.2,T24,F6.2,T32,F6.1,T41,F8.2,T75,'X')
157 310 FORMAT(13,I7,F7.2,T16,F6.2,T24,F6.2,T32,F6.1,T41,F8.2,T68,'X')
158 320 FORMAT(13,I7,F7.2,T16,F6.2,T24,F6.2,T32,F6.1,T41,F8.2,T62,'X')
159 330 CONTINUE
160 C
161 C UP = PAGE(0)
162 C
163 WRITE (6,340)I
164 340 FORMAT(1H0,T30,'LINE DESCRIPTION FOR LINE NUMBER',I3,/,/,I3,'LIN
165 1E',T18,'INLET',T26,'EXIT',T32,'EFFECTIVE HEAT',T69,'-LINE TYPE-',
166 2/, 'SECTION LENGTH HEIGHT',T35,'L/D',T43,'RATE',T60,'LINE
167 3 ELBOW VALVE BAYONET -T-',/, 'NUMBER (METER) (METER) (METER)',T
168 441,'(WATTS)',/,/)
169 IFLAG=0
170 GO TO 220
171 350 CONTINUE
172 CALL LNSYST(DIA,FLOW,PSTOR,QUAL)
173 RETURN

```

** NZMAIN **
174

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END

•• N2PROP ••

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```
1  SUBROUTINE N2PROP(P,T)
2  COMMON/PROP/B1,B2,B3,B4,B5,B6
3  TOLD=T
4  CALL TVP(P,T,TOLD)
5  CALL VISC(T,VISCL,VISCV)
6  CALL DENS(V,T,DSATV)
7  CALL DENS(L,T,DSATL)
8  CALL HTVAP(T,HVAP)
9  CALL HPRAT(T,P,DHLDP,TOLD,SLENTH,SVENTH,HVAP)
10 B1=VISCV
11 B2=VISCL
12 B3=DSATV
13 B4=DSATL
14 B5=HVAP
15 B6=DHLDP
16 RETURN
17 END
```

AL31

```
1 C
2 SUBROUTINE OUTPF (NTL,ITITL,NVL,VAR1,VAR2)
3 C
4 DIMENSION ITITL(6),IVA1(2),IVA2(2)
5 C
6 6001 FORMAT (29X,6A6)
7 6002 FORMAT ('+'64X,E15.6)
8 6003 FORMAT ('+'84X,E15.6)
9 6004 FORMAT ('+'64X,I11)
10 6005 FORMAT ('+'84X,I11)
11 6006 FORMAT ('+'68X,2A6)
12 6007 FORMAT ('+'88X,2A6)
13 6008 FORMAT ('+' )
14 6009 FORMAT (T13,A6,T27,A6,2F14.3,T66,'.')
15 6010 FORMAT (T66,'.'T73,A6,T87,A6,2F14.3)
16 6011 FORMAT (T13,A6,T27,A6,2F14.3,T66,'.'T73,A6,T87,A6,2F14.3)
17 C
18 WRITE (IOU,6001) (ITITL(I),I=1,NTL)
19 GO TO (110,120,110),NVL
20 110 WRITE (IOU,6002) VAR1
21 IF (NVL.EQ. 1) RETURN
22 120 WRITE (IOU,6003) VAR2
23 RETURN
24 C
25 ENTRY OUTPF1 (NTL,ITITL,VAR1)
26 C
27 WRITE (IOU,6001) (ITITL(I),I=1,NTL)
28 WRITE (IOU,6002) VAR1
29 RETURN
30 C
31 ENTRY OUTPI (NTL,ITITL,NVL,IVR1,IVR2)
32 C
33 WRITE (IOU,6001) (ITITL(I),I=1,NTL)
34 GO TO (210,220,210),NVL
35 210 WRITE (IOU,6004) IVR1
36 IF (NVL.EQ. 1) RETURN
37 220 WRITE (IOU,6005) IVR2
38 RETURN
39 C
40 ENTRY OUTPA (NTL,ITITL,NVL,IVA1,IVA2)
41 C
42 WRITE (IOU,6001) (ITITL(I),I=1,NTL)
43 GO TO (310,320,310),NVL
44 310 WRITE (IOU,6006) IVA1
45 IF (NVL.EQ. 1) RETURN
46 320 WRITE (IOU,6007) IVA2
47 RETURN
48 C
49 ENTRY OUTPW (NVL,JVA1,JVA2,VAR1,VAR3,JVA3,JVA4,VAR2,VAR4)
50 C
51 GO TO (410,420,430),NVL
52 410 WRITE (IOU,6009) JVA1,JVA2,VAR1,VAR3
53 GO TO 450
54 420 WRITE (IOU,6010) JVA3,JVA4,VAR2,VAR4
55 GO TO 450
56 430 WRITE (IOU,6011) JVA1,JVA2,VAR1,VAR3,JVA3,JVA4,VAR2,VAR4
57 450 RETURN
```

•• OUTPUT ••

58 C
59 C
60 C
61
62 WRITE (IOU,6008)
63 RETURN
64 C
65 ENTRY DTUNIT (IONO)
66 ION = ION0
67 RETURN
68 END

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AL34

```

C      * * * * *
C      * ROUTINE NAME - PAGE HEADING SUBFUNCTION. *
C      * ROUTINE LANG - FORTRAN IV UNIVAC 1107/1108 *
C      * PROGRAMMER - R. BOLLINGER 5432 101 22898 *
C      * DATE CODED - 03/10/66 *
C      * * * * *
C
C      FUNCTION PAGE(NLINES)
C
C      ***** EXPLANATION OF CALLING SEQUENCE *****
C
C      INPUT TO PAGE
C
C      NLINES - NUMBER OF LINES
C      IF NLINES = -1,
C          THE ROUTINE WILL INITIALIZE
C          THE ROUTINE FOR A NEW CASE,
C          PAGE EJECT, AND OUTPUT THE
C          PAGE HEADING.
C      0, THE ROUTINE WILL PAGE EJECT,
C          AND OUTPUT THE PAGE HEADING.
C      +, THE ROUTINE WILL ADD NLINES
C          TO LINECT AND TEST TO SEE IF
C          LINECT IS GREATER THAN MAXLIN.
C          IF IT IS, THE ROUTINE WILL
C          PAGE EJECT AND OUTPUT THE PAGE
C          HEADING.
C
C      OUTPUT FROM PAGE
C
C      PAGE - PAGE EJECT OR NO PAGE EJECT
C      IF PAGE = TRUE, THE ROUTINE HAS PAGE EJECTED.
C      FALSE, THE ROUTINE HAS NOT PAGE
C      EJECTED.
C
C      LOGICAL PAGE
C
C      INCLUDE 'CPAGE'
C
C      PAGE = .FALSE.
C      IF(NLINES)10,30,20
C
C      10 NCASE = NCASE + 1
C      CALL DATE(9,ODH)
C      GO TO 40
C
C      20 LINECT = LINECT + NLINES
C      IF(LINECT.LE.MAXLIN) RETURN
C      30 LINECT = NLINES
C      40 NPAGE = NPAGE + 1
C      CALL TOD(8,TIME)
C      PAGE = .TRUE.
C      WRITE(DPTLUN,6000)NAME,NPAGE, DEPT,PTITLE,DOR,EXT,TIME,BLD.
C      1
C      RETURN
C      JNUM,NCASE,CTITLE
C
C      6000 FORMAT ('1' T28,'NAME ' 2A6, 21(' *),' PAGE ' I5 /
C      1 T28,'DEPT ' A4,9X' ' 6A6,' = DATE 'A6,A3 /
C      2 T28,'EXT. ' A5,9X'+'39X' * TIME ' A8,A2 /

```

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.. PAGE ..

58
59
60
61

C

3
4

END

FILE: MFIF+CSA

T28. 'BLD. ' A3.10X'.17XA6.16X ' + CASE 'IS /
T28. 39(' . ') / 130. 12A6)

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++ PCAL ++

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```
1  DOUBLE PRECISION FUNCTION PCAL(DD,TT)
2  DOUBLE PRECISION T,TT,D,DD,VIRB,R
3  I=TT
4  D=DD
5  R = .0820558D+0
6  PCAL = R*D*T*(1.D+D+VIRB(T)+D)
7  RETURN
8  END
```

AL36

AL37

```

1      C      * * * * *
2      C      * NBS PROGRAM *HE PROPS* , RECD.6/3/71. REFERENCE NBS-9762. *
3      C      * * * * *
4      C      * THIS SUBROUTINE PRODUCES DENSITY IN METRIC UNITS *
5      C      * * * * *
6      C      * PROGRAM MODIFIED BY R.F.HAUSMAN, 62-13, LMSC, 28 SEPT 1978 *
7      C      * * * * *
8      C
9      C
10     C      FUNCTION RHOGAS(SP,ST)
11     C
12     C      * INPUT DATA IS: PRESSURE IN KPA. AND TEMP IN DEG. K *
13     C
14     C      INCLUDE CMAG
15     C
16     C      DOUBLE PRECISION A,B,D,T,P,VPTMP,TVP,FINDD,GAMMA,WT,PP,DD,TT
17     C
18     C      DIMENSION A(30),B(30)
19     C
20     C      COMMON/DATA/PP,DD,TT,WT,A,B,NN,GAMMA,LL
21     C
22     C      DATA LL/1/
23     C      DATA GAMMA/-.5D-3/
24     C      DATA WT/1.0D+0/
25     C      DATA B/5.988310109D-9,-4.9653052187D-7,-3.8116033499D-6,3.68111671
26     C      13D-5,-1.4830691828D-4,3.0596174335D-4,-3.3908190224D-4,1.962408024
27     C      22D-4,1.5527899712D-5,-3.6110403503D-5,-1.0839788073D-5,4.972810121
28     C      37D-5,1.938145109D-5,-4.149640896D-4,-5.7465772899D-4,-4.3470945634
29     C      4D-3,-6.838388H924D-2,-2.1382474225D-2,2.7106954908D-2,-1.262796778
30     C      58D-2,2.587575338D-3,7.9041608815D-2,-1.4024724318D-4,-2.8278987249
31     C      6D-7,1.7336410358D-6,-2.5454187855D-6,0.0D+0,0.0D+0,0.0D+0,0.0D+0/
32     C
33     C      IF(ST.GT.5.2014)GO TO 2
34     C      IF(P.GT.2.2449)GO TO 2
35     C      IF(P.LT..0308234)GO TO 2
36     C      TVP=VPTMP(P*.76D+6)
37     C      GO TO 3
38     C      2 TVP=101.D+0
39     C      3 CONTINUE
40     C
41     C      SPK = SP/101.325
42     C      P = SPK
43     C      T = ST
44     C      SD = 0.01
45     C      D = SD
46     C
47     C      R1 = FINDD(P,D,T)
48     C      RHOGAS = R1 * HEMWT
49     C
50     C      RETURN
51     C
52     C      END

```

@ KILOPASCALS TO ATMOSPHERES

@ STARTING GAS DENSITY

```

* * * * *
* NBS PROGRAM *HE PROPS* , RECD.6/3/71. REFERENCE NBS-9762.
* * * * *
* THIS SUBROUTINE PRODUCES DENSITY IN METRIC UNITS
* * * * *
* PROGRAM MODIFIED BY R.F.HAUSMAN. 62-13, LMSC, 2B SEPT 1978
* * * * *

```

```
FUNCTION RHOLIQ(SP,ST)
```

```
* INPUT DATA IS: PRESSURE IN KPA. AND TEMP IN DEG. K
```

```
INCLUDE CMAG
```

```
DOUBLE PRECISION A,B,D,T,P,VPTEMP,TVP,FINDD,GAMMA,WT,PP,DD,TT
```

```
DIMENSION A(30),B(30)
```

```
COMMON/DATA/PP,DD,TT,WT,A,B,NN,GAMMA,LL
```

```
DATA LL/1/
```

```
DATA GAMMA/-.5D-3/
```

```
DATA WT/1.0D+0/
```

```

DATA B/5.988310109D-9,-4.9653052187D-7,-3.8116033499D-6,3.68111671
13D-5,-1.4830691828D-4,3.0596174335D-4,-3.3908190224D-4,1.962408024
22D-4,1.5527899712D-5,-3.6110403503D-5,-1.0839788073D-5,4.972810121
37D-5,1.938145109D-5,-4.149640896D-4,-5.7465772899D-4,-4.3470945634
40D-3,-6.838388924D-2,-2.1382474225D-2,2.7106954908D-2,-1.262796778
58D-2,2.587575338D-3,-7.9041608815D-2,-1.4024724318D-4,-2.8278987249
6D-7,1.7336410358D-6,-2.5454187855D-6,0.0D+0,0.0D+0,0.0D+0,0.0D+0/

```

```
SPK = SP/101.325
```

```
@ KILOPASCALS TO ATMOSPHERES
```

```
P = SPK
```

```
T = ST
```

```
SD = 45.0
```

```
@ STARTING LIQUID DENSITY
```

```
D = SD
```

```
IF(ST.GT.5.2014)GO TO 2
```

```
IF(P.GT.2.2449)GO TO 2
```

```
IF(P.LT. 0.308234)GO TO 2
```

```
TVP=VPTEMP(P+.76D+6)
```

```
GO TO 3
```

```
2 TVP=101.D+0
```

```
3 CONTINUE
```

```
R2 = FINDD(P,D,T)
```

```
RHOLIQ = R2 * HEMWT
```

```
RETURN
```

```
END
```

AL38

```

1  DOUBLE PRECISION FUNCTION SINT(D,T)
2  DOUBLE PRECISION A,B,D,D2,D3,D4,R,DAMMA,EX,T,VIRB,DBDT,DGAMA
3  DOUBLE PRECISION YA,YB,YC,YD,YE,YF,YG,YP,YQ,YR,YS,OD,PP,TT
4  DOUBLE PRECISION GAMMA,WT
5  DIMENSION A(30),B(30)
6  COMMON/DATA/PP,DD,TT,WT,A,B,N,GAMMA,L
7  D2=D*D
8  D3=D2*D
9  D4=D3*D
10 N=1
11 R=.0020558D+0
12 DAMMA = GAMMA
13 DGAMA = D2*(-.5D-3)
14 EX = DEXP(DGAMA)
15 A(N)=0.0
16 N=N+1
17 YA = (-2.0D+0)
18 A(N) = (D4/D/5.D+0)*T**YA*(-1.D+0)
19 N=N+1
20 DO 2 I=1,6
21 FI=I
22 YB=-.75-FI/4.-1.
23 YC=-.75-FI/4.
24 A(N) = (D4/4.D+0)*T**YB+YC
25 N=N+1
26 DO 3 I=1,4
27 FI=I
28 YD=1.5-FI-1.
29 YE=1.5-FI
30 A(N) = (D3/3.D+0)*T**YD+YE
31 N=N+1
32 DO 1 I=1,8
33 FI=I
34 YF=1.5-FI/2.-1.
35 YG=1.5-FI/2.
36 A(N) = (D2/2.D+0)*T**YF+YG
37 N=N+1
38 DO 4 I=1,3
39 FI=I
40 YP=1.-FI-1.
41 YQ=1.-FI
42 A(N) = (EX/(2.D+0*DAMMA))*T**YP+YQ
43 N=N+1
44 DO 5 I=1,3
45 FI=I
46 YR=1.-FI-1.
47 YS=1.-FI
48 A(N) = (D2*EX/(2.D+0*DAMMA)-EX/(2.D+0*DAMMA*DAMMA))*T**YR+YS
49 N=N+1
50 N=N-1
51 SINT=D*R*(VIRB(T)+T*DBDT(T))
52 DO 6 I=1,N
53 SINT=SINT+B(I)*A(I)
54 RETURN
55 END

```

```
1      SUBROUTINE ENTHSL(T,P,SLENTH,SVENTH,HVAP)
2
3      C
4      C
5      C
6      TCRIT=126.2
7      TTRIP=63.15
8      IF (T.GT.TCRIT) GO TO 100
9      IF (T.LT.TTRIP) GO TO 120
10     CALL ENTHSV(T,P,SVENTH)
11     CALL HTVAP(T,HVAP)
12     SLENTH=SVENTH-HVAP
13     GO TO 140
14     100 WRITE (6,(10)
15     110 FORMAT(T10,'TEMPERATURE GREATER THAN CRITICAL TEMPERATURE')
16     SLENTH=-1.0
17     GO TO 140
18     120 WRITE (6,(130)
19     130 FORMAT(T10,'TEMPERATURE LESS THAN TRIPLE POINT TEMPERATURE')
20     SLENTH=-1.0
21     140 RETURN
22     END
```

AL40

•• SOUN ••

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```
1  DOUBLE PRECISION FUNCTION SOUN(D,T)
2  DOUBLE PRECISION A,B,T,TT,D,DD,D1,PP,FACT2,CP,CV
3  DOUBLE PRECISION GAMMA,WT
4  DIMENSION A(30),B(30)
5  COMMON/DATA/PP,DD,TT,WT,A,B,NC,GAMMA,L
6  TT=T
7  DD=D
8  CALL DDHEF
9  D1=PP
10 FACT2=25311.D+0
11 SOUN=DSQRT(((CP(D,T)/CV(D,T))*(D1-FACT2))
12 RETURN
13 END
```

AL41

```
1  SUBROUTINE SPCFHT(T,SPECHT)
2  DOUBLE PRECISION G9,U,U2,DU
3  DIMENSION X(8)
4  R=0.820539E-1
5  AK=0.101327BE3
6  T2=T*T
7  T3=T*T2
8  X9=0.33534061E4
9  G9=DBLE(X9)
10 U=G9/DBLE(T)
11 U2=U*U
12 X(1)=(1.0/T3)*(-0.73521040E3)
13 X(2)=(1.0/T2)*(-0.34223998E2)
14 X(3)=(1.0/T)*(-0.55764828E0)
15 X(4)=0.35040423E1
16 X(5)=T*(-0.17339019E-4)
17 X(6)=T2*(-0.17465085E-7)
18 X(7)=T3*(-0.35689203E-11)
19 DU=DEXP(U)
20 X(8)=SINGL(U2*DU/(DU-1.000))**2)
21 X(8)=X(8)+0.10053872E1
22 CPIG=0.0
23 DO 100 I=1,8
24 100 CPIG=CPIG+X(I)
25 CPIG=CPIG*R*AK
26 SPECHT=35.6939+CPIG
27 RETURN
28 END
```



```

1      C      * * * * *
2      C      * ROUTINE NAME - ROUTINE TO PACK THE FIRST *
3      C      * WORD OF THE CONFIGURATION *
4      C      * TABLE. *
5      C      * ROUTINE LANG - FORTRAN V UNIVAC 1108 EXEC 2- *
6      C      * PROGRAMMER - R. BOLLINGER 1943 102 26933 *
7      C      * DATE CODED - 3/11/70 *
8      C      * * * * *
9      C
10     SUBROUTINE STOCON(IDX)
11
12     C      ***** EXPLANATION OF THE CALLING SEQUENCE
13     C      =
14     C      ***** IDX - INDEX OF THE CONFIGURATION TABLE.
15     C
16     C      INCLUDE CCNFIG
17     C
18     C      DO 10 I1 = 1,6
19     C      IF(ICNFIG(I1).EQ.0) ICNFIG(I1) = 0
20     C      CONFIG(IDX,I) = GPBYTE(ICNFIG(I1),6,CONFIG(IDX,1),I1)
21     C      10 CONTINUE
22     C
23     C      RETURN
24     C      END

```

ROUTINE NAME
ROUTINE LANG - FORTRAN V UNIVAC 1110 EXEC 8
PROGRAMMER - R.F. HAUSMAN 104-6213-30235
DATE CODED - AUGUST 23, 1978

SUBROUTINE STODTA

INCLUDE CCNFIG
INCLUDE CCNTRL
INCLUDE CIOUR
INCLUDE CMAIR
INCLUDE CNAMES
INCLUDE CONST
INCLUDE CPAGE
INCLUDE TABLOK

***** PDP CCNTRL *****

DATA (KSUBC(1,1),1=1,NBRSR) / 1, 0, 0, 0, 0/
DATA (KSUBC(2,1),1=1,NBRSR) / 2, 0, 0, 0, 0/
DATA (KSUBC(3,1),1=1,NBRSR) / 3, 0, 0, 0, 0/
DATA (KSUBC(4,1),1=1,NBRSR) / 4, 0, 0, 0, 0/
DATA (KSUBC(5,1),1=1,NBRSR) / 5, 0, 0, 0, 0/

DATA NAMSYS / 'MAG', 'CRY', 'REF', 'LN2', 'GHE' /

***** PDP CNAMES *****

DATA (FNAME(1),1=1,16) / 'GAS', 'MAGNET', 'LINE', 'CONTROL',
'FILING', 'TAP', 'TEE', 'ELBOW',
'VALVE', 'REG', 'CRYSPAN', 'REFLIO',
'TANK', 'COMPUR', 'HEX', 'END' /

DATA ((10(1,1),1=1,9),1=1,9) /
***** SYSTEM CONFIGURATION *****
1 ***** MAGNET DATA *****
2 ***** CRYOPANEL DATA *****
3 ***** LIQUID NITROGEN SYSTEM *****
4 ***** MAGNET SUPPLY TANK DATA *****
5 ***** CRYOPANEL SUPPLY TANK DATA *****
6 ***** REFRIGERATOR-LIQUIDIFIER SUMMARY DATA *****
7
8
9

DATA ((1(1,1),1=1,21),1=1,21) /
1 LEAD MATRL. FLOW FRICTION LINE LENGTH COMP FUNC. NUMB. NHTSD04500
2 INSULATION COEFFICIENT NO. LAYERS NAME CODE LINE TYPE INSULATION OPER. (M) NHTSD04100
3 TYPE INSULATION / OR L-OVER-D DIAMETER TYPE TYPE TS1004700
4 THICKNESS TS1004900

DATA ((12(1,1),1=1,4),1=1,4) / 'NUMBER OF MAGNETS',
1 'MAGNET DEWAR PRES. - KPA', 'MAGNET DEWAR TEMP-DEG.K',
2 'HELIUM MOLEC. WGT.', 'MAGNET HEAT LEAK- WATTS',
3 'VOL. LIQ. HE-MAGNET LITERS', 'VOL. MAG-DEWAR(LINE) LITERS',
NHTSD04300
NHTSD04200
NHTSD04100
NHTSD04000
NHTSD03900
NHTSD03800
NHTSD03700
NHTSD03600
NHTSD03500
NHTSD03400
NHTSD03300
NHTSD03200
NHTSD03100
NHTSD03000
NHTSD02900
NHTSD02800
NHTSD02700
NHTSD02600
NHTSD02500

A145

```

58      4 'VOL.RESERVE(LHC)-LITERS ','HEAD-MAG.INLET - METERS', ST005500
59      5 'HEAD-MAG.OUTLET - METERS','HEAD-MAG.CENTER - METERS', ST005600
60      6 'INITIAL FLOW RATE-KG/HR.'/ ST005700
61      C ST005800
62      DATA ((L3(I,J),I=1,4,J=1,10) / 'NUMBER OF CRYDPANELS ', ST005900
63      1 'CP DEWAR PRESSURE - KPA','CP DEWAR TEMP. - DEG.K', ST006000
64      2 'CP DEWAR LIQ.VOL.-LITERS','TOTAL FLOW RATE - KG/HR', ST006100
65      3 'CP HEAT INPUT - WATTS','CRYDPANEL VOLUME- LITERS', ST006200
66      4 'HEAD AT CP INLET- METERS','HEAD AT CP OUTLET-METERS', ST006300
67      5 'CP INLET FLOW RATE-KG/HR.'/ ST006400
68      C ST006500
69      DATA ((L4(I,J),I=1,4,J=1,11) / 'HEX HOT INLET TEMP. ', ST006600
70      1 'HEX HOT OUTLET TEMP. ','HEX COLD INLET TEMP. ', ST006700
71      2 'HEX COLD OUTLET TEMP. ','HEX HOT INLET PRES. ', ST006800
72      3 'HEX HOT OUTLET PRES. ','HEX COLD INLET PRES. ', ST006900
73      4 'HEX COLD OUTLET PRES. ','HEX HOT SIDE DELTA-P ', ST007000
74      5 'HEX COLD SIDE DELTA-P ','HEX GAS GEN. D/F RATIO ', ST007100
75      C ST007200
76      DATA ((L5(I,J),I=1,5,J=1,15) /
77      1 'MAGNET PRIMARY CIRCUIT NO. -1 ', 'MAGNET PRIMARY CIRCUIT NO. -2 ',
78      2 'CRYDPANEL CIRCUIT - ZONE 2 ', 'CRYDPANEL CIRCUIT - ZONE 1 ',
79      3 'CRYDPANEL CIRCUIT - ZONE 3 ', 'CRYDPANEL CIRCUIT - ZONE 4 ',
80      4 'CRYDPANEL CIRCUIT RETURN LINE ', 'MAGNET DEWAR OFF-GAS LINE ',
81      5 'CRYDPANEL DEWAR OFF-GAS LINE ', 'STORAGE DEWAR OFF-GAS LINE ',
82      6 'REF-L10 HP-COLD HELIUM OUTLET ', 'STD-DEWAR HP-COLD HE SUPPLY ',
83      7 'MAGNET DEWAR HP-COLD HE-SUPPLY', 'CRYPAN DEWAR HP-COLD HE-SUPPLY',
84      8 'COMP-PURIFIER CIRCUIT (LP-HP) ' /
85      C
86      DATA ((JFLUID(I,J),I=1,2,J=1,2) / 'HELIUM ', 'NITROGEN ' / ST007300
87      C ST007400
88      DATA ((KFLUID(I,J),I=1,2,J=1,2) / 'HE-CRYOGEN ', 'N2-CRYOGEN ' / ST007500
89      C ST007600
90      C ST007700
91      C ST007800
92      DATA GRAVITY,P1,PI203 / 4.4482152 .3.14159265 .2.0943951 / ST007900
93      DATA P104 /0.78539816/
94      DATA CKPKGM /101.97162/
95      C
96      C ST008000
97      C ST008100
98      C ST008200
99      DATA PTITLE/' CRYOGEN SYSTEMS ANALYSIS ' / ST008300
100     C ST008400
101     C ST008500
102     C ST008600
103     C ST008700
104     DATA NTBID / 1. 2. 3. 4. 5. 6. 0. 0. 0. 0 / ST008800
105     C ST008900
106     C ST009000
107     C ST009100
108     DATA IOUNIT/14,21,22,23,19,29,15,16,17,18,25,26,27,28 / ST009200
109     DATA IIN.IDT / 5.6 / ST009300
110     C ST009400
111     C ST009500
112     C ST009600
113     C ST009700
114     DATA (RHOL(I),I=1,6) /501.120,176.256,169.344,511.488,276.480, ST009800
115     DATA (RHOL(I),I=1,9) /2.14,2.45,2.80,0.836,0.59,0.65,5.0,2.2,1.0 / ST009900
116     ST010000

```

** STODTA **

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```
116 DATA (RHDIS(1),1=1,9)/0.0428,0.0430,0.0280,0.027867,0.01475, STO10100
117 1 0.021667,5.0,2.20,1.0/ STO10200
118 DATA(MINTHK(1),1=1,15)/0.020,0.025,0.028,0.020,0.016,0.035,0.058, STO10300
119 1 0.065,0.042,0.020,0.049,0.083,0.095,0.049,0.035/ STO10400
120 C STO10500
121 RETURN STO10900
122 C STO11000
123 END STO11100
```

AL46

```

1      SUBROUTINE ENTHSV(T,P,SVENTH)
2
3      C      T=T(K) -- SVENTH=SAT VAPOR ENTHALPY IN JOULES/KG
4      C      SVENTH(JOULE/KG)=35.6972*SVENTH(JOULES/(GM-MOLE))
5
6      C      H=HO+(T*(FING1(T,D)-FING1(T,0.0))+(FING2(T,D)-FING2(T,0.0))
7      C      +P/D-R*T)*101.3278 JOULES/GM-MOLE
8      C
9      DIMENSION G(33),GG(9),X(2,32),XX(2,8),GDEN(7),FING1(2),FING2(2)
10     TCRIT=126.2
11     TTRIPL=63.15
12     IF (T.G1.TCRIT) GO TO 150
13     IF (T.LT.TTRIPL) GO TO 170
14     TREF=298.15
15     GG(1)=-0.73521040E3
16     GG(2)=0.34223998E2
17     GG(3)=-0.55764820
18     GG(4)=0.35040423E1
19     GG(5)=-0.17339019E-4
20     GG(6)=0.17465085E-7
21     GG(7)=-0.35689203E-11
22     GG(8)=0.10053872E1
23     GG(9)=0.33534061E4
24     XX(1,1)=-1.0/(2.0*T*T)
25     XX(1,2)=-1.0/T
26     XX(1,3)=ALOG(T)
27     XX(1,4)=T
28     XX(1,5)=(T**2)/2.0
29     XX(1,6)=(T**3)/3.0
30     XX(1,7)=(T**4)/4.0
31     XX(1,8)=GG(9)/(EXP(GG(9)/T)-1.0)
32     XX(2,1)=-1.0/(2.0*TREF*TREF)
33     XX(2,2)=-1.0/TREF
34     XX(2,3)=ALOG(TREF)
35     XX(2,4)=TREF
36     XX(2,5)=(TREF**2)/2.0
37     XX(2,6)=(TREF**3)/3.0
38     XX(2,7)=(TREF**4)/4.0
39     XX(2,8)=GG(9)/(EXP(GG(9)/TREF)-1.0)
40     XX1SUM=0.0
41     XX2SUM=0.0
42     DO 100 I=1,8
43     XX1SUM=XX1SUM+GG(I)*XX(1,I)
44     XX2SUM=XX2SUM+GG(I)*XX(2,I)
45     100 HO=8669.0+(101.3278*0.0820539*(XX1SUM-XX2SUM))
46     C      HO=HO(JOULES/GM-MOLE)
47     C
48     Y=(TCRIT-T)/TCRIT
49     GDEN(1)=0.16333345E1
50     GDEN(2)=-9.4043771*Y
51     GDEN(3)=21.852746*Y*Y
52     GDEN(4)=-102.68744*(Y**3)
53     GDEN(5)=187.94974*(Y**4)
54     GDEN(6)=-164.02437*(Y**5)
55     GDEN(7)=-0.095731639*ALOG(Y)
56     GDSUM=0.0
57     DO 110 I=1,7

```

AL48

```

58      110 GDSUM=GDSUM+GDEN(1)
59      DSATV=EXP(GDSUM)
60      D=DSATV
61      G(1)=0.13622377E-2
62      G(2)=0.10703247
63      G(3)=-0.24390072E1
64      G(4)=0.34100745E2
65      G(5)=-0.42237431E4
66      G(6)=0.10509080E-3
67      G(7)=-0.11253443E-1
68      G(8)=0.14260079E-3
69      G(9)=0.10469850E5
70      G(10)=0.01114008E-7
71      G(11)=0.73301165E-2
72      G(12)=-0.50775250
73      G(13)=0.48502788E-4
74      G(14)=-0.11365676E-2
75      G(15)=-0.70743027
76      G(16)=0.75170665E-4
77      G(17)=-0.11161412E-5
78      G(18)=0.36879656E-3
79      G(19)=-0.20131769E-5
80      G(20)=-0.16971744E5
81      G(21)=-0.11971924E6
82      G(22)=-0.97521127E2
83      G(23)=0.55463971E5
84      G(24)=-0.17992045
85      G(25)=-0.25658293E1
86      G(26)=-0.41370772E-3
87      G(27)=-0.25624542
88      G(28)=-0.12422237E-6
89      G(29)=0.10355654E-4
90      G(30)=-0.53869917E-9
91      G(31)=-0.75741541E-8
92      G(32)=0.58536717E-7
93      G(33)=-0.5600E-2
94      DD 140 1=-1.2
95      RI=1
96      IF (RI.LT.2.0) GO TO 120
97      D=0.0
98      120 F=EXP(G(33)*D*D)
99      G1=F/(2.00*G(33))
100     G2=(F*(D**2)-2.00*G1)/(2.00*G(33))
101     G3=(F*(D**4)-4.00*G2)/(2.00*G(33))
102     G4=(F*(D**6)-6.00*G3)/(2.00*G(33))
103     G5=(F*(D**8)-8.00*G4)/(2.00*G(33))
104     G6=(F*(D**10)-10.00*G5)/(2.00*G(33))
105     X(1,1)=-D
106     X(1,2)=-D/(2.0*SQRT(T))
107     X(1,3)=0.0
108     X(1,4)=0/(T*T)
109     X(1,5)=2.0*D/(T**3)
110     X(1,6)=-D*D/2.0
111     X(1,7)=0.0
112     X(1,8)=D*D/(2.0*(T**2))
113     X(1,9)=D**2/(T**3)
114     X(1,10)=-D**3/3.0
115     X(1,11)=0.0

```

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```

116 X(1,12)=D**3/(3.0*(T**2))
117 X(1,13)=0.0
118 X(1,14)=D**5/(5.0*(T**2))
119 X(1,15)=2.0*(D**5)/(5.0*(T**3))
120 X(1,16)=D**6/(6.0*(T**2))
121 X(1,17)=D**7/(7.0*(T**2))
122 X(1,18)=2.0*(D**7)/(7.0*(T**3))
123 X(1,19)=D**8/(4.0*(T**3))
124 X(1,20)=2.0*G1/(T**3)
125 X(1,21)=3.0*G1/(T**4)
126 X(1,22)=2.0*G2/(T**3)
127 X(1,23)=4.0*G2/(T**5)
128 X(1,24)=2.0*G3/(T**3)
129 X(1,25)=3.0*G3/(T**4)
130 X(1,26)=2.0*G4/(T**3)
131 X(1,27)=4.0*G4/(T**5)
132 X(1,28)=2.0*G5/(T**3)
133 X(1,29)=3.0*G5/(T**4)
134 X(1,30)=2.0*G6/(T**3)
135 X(1,31)=3.0*G6/(T**4)
136 X(1,32)=1.0*G6/(T**5)
137 X(2,1)=D*T
138 X(2,2)=D*SORT(T)
139 X(2,3)=D
140 X(2,4)=D/T
141 X(2,5)=D/(T**2)
142 X(2,6)=D*D*T/2.0
143 X(2,7)=D*D/2.0
144 X(2,8)=D**2/(2.0*T)
145 X(2,9)=D**2/(2.0*(T**2))
146 X(2,10)=D**3*T/3.0
147 X(2,11)=D**3/3.0
148 X(2,12)=D**3/(3.0*T)
149 X(2,13)=D**4/4.0
150 X(2,14)=D**5/(5.0*T)
151 X(2,15)=D**5/(5.0*(T**2))
152 X(2,16)=D**6/(6.0*T)
153 X(2,17)=D**7/(7.0*T)
154 X(2,18)=D**7/(7.0*(T**2))
155 X(2,19)=D**8/(8.0*(T**2))
156 X(2,20)=G1/(T**2)
157 X(2,21)=G1/(T**3)
158 X(2,22)=G2/(T**2)
159 X(2,23)=G2/(T**4)
160 X(2,24)=G3/(T**2)
161 X(2,25)=G3/(T**3)
162 X(2,26)=G4/(T**2)
163 X(2,27)=G4/(T**4)
164 X(2,28)=G5/(T**2)
165 X(2,29)=G5/(T**3)
166 X(2,30)=G6/(T**2)
167 X(2,31)=G6/(T**3)
168 X(2,32)=G6/(T**4)
169 FING1(I)=0.0
170 FING2(I)=0.0
171 DO 130 J=1,32
172 FING1(I)=FING1(I)+X(1,J)*G(J)
173 FING2(I)=FING2(I)+X(2,J)*G(J)

```

```

174      140 CONTINUE
175      PATM=P/1.01325E5
176      H=HO+101.3270*(T*(FING1(1)-FING1(2))+(FING2(1)-FING2(2))+PATM/DSAT
177      IV-T*8.20539E-2)
178      SVENTH=35.6972*M
179      GO TO 190
180      150 WRITE (6,160)
181      160 FORMAT(T10,'TEMPERATURE GREATER THAN CRITICAL TEMPERATURE')
182      SVENTH=-1.0
183      GO TO 190
184      170 WRITE (6,180)
185      180 FORMAT(T10,'TEMPERATURE LESS THAN TRIPLE POINT TEMPERATURE')
186      190 RETURN
187      END

```


** TABLOK **

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```
1  TABLOK- PROC
2  C
3      REAL MIPE
4
5  C      COMMON /TABLOK/ XTAB(7), NTBID(10)
6
7  C      MIPE = 0.0
8
9  C      END
```

ASTI

A152

```

1      SUBROUTINE TCOND(TH,TC,NBAR,THKIN,INTYPE,QCOND)
2      *
3      C THIS SUBROUTINE COMPUTES THE THERMAL CONDUCTIVITY FOR NINE
4      C INSULATION MATERIALS. REF., LMSC-A964947-VOL.11, LMSC A981608,
5      C WITH MICROSPHERE EQNS. PER R.PARMLEY. EMITTANCE VALUES ARE FROM
6      C LMSC A903316 (NASA CR-72605).
7      *
8      REAL NSHLD,NBAR
9      C *
10     DELT = TH-TC
11     TMEAN = (TH+TC)/2.0
12     SUMT = TH+TC
13     SUMSQ = (TH**2)+(TC**2)
14     TMPR1 = TC/TH
15     TMPR2 = IMPR1*TMPR1
16     TH3 = TH*TH*TH
17     NSHLD = THKIN*NBAR
18     THKFT = THKIN/12.0
19     THETA1 = (1.0+TMPR1)
20     THETA2 = (1.0+TMPR2)
21     SIGMA = 0.1713E-08
22     *
23     GO TO (10,20,30,40,50,60,70,80,90),INTYPE
24     *
25     C * FOR DOUBLE ALUMINIZED MYLAR-SILK NET
26     *
27     10 SCNST = 2.22E-09
28     EMIT1 = 4.40E-04 * (TMEAN**0.667)
29     DEMIT = ((2.0/EMIT1)-1.0)
30     GO TO 22
31     *
32     C * FOR DOUBLE GOLDIZED MYLAR-SILK NET
33     *
34     20 SCNST = 2.22E-09
35     EMIT2 = 8.76E-04 * (TMEAN**0.509)
36     DEMIT = ((2.0/EMIT2)-1.0)
37     22 SCOND = SCNST*NBAR*TMEAN
38     RNUM = SIGMA*SUMSQ*SUMT*THKFT
39     RDEN = (NSHLD-1.0) * DEMIT
40     RCOND = RNUM/RDEN
41     QCOND = (SCOND+RCOND) * (DELT/THKFT)
42     RETURN
43     *
44     C * FOR DOUBLE ALUMINIZED MYLAR-TISSUE GLASS
45     *
46     30 SCNST = 7.00E-12
47     EMIT1 = 4.40E-04 * (TMEAN**0.667)
48     DEMIT = ((2.0/EMIT1)-1.0)
49     GO TO 42
50     *
51     C * FOR CRINKLED DOUBLE ALUMINIZED MYLAR-TISSUE GLASS
52     *
53     40 SCNST = 8.80E-12
54     EMIT1 = 4.90E-04 * (TMEAN**0.67)
55     DEMIT = ((2.0/EMIT1)-1.0)
56     42 SCOND = SCNST*(NBAR**2)*TMEAN
57     RNUM = 1.7*SIGMA*SUMSQ*SUMT*THKFT

```

A153

```
58      RDEN = (NSHLD-1.0) * DEMIT
59      RCOND = RNUM/RDEN
60      QCOND = (SCOND+RCOND) * (DELT/THKFT)
61      RETURN
62      C
63      C * FOR NRC-2 CRINKLED SINGLE ALUMINIZED MYLAR
64      C *
65      50 SCNST = 2.00E-10
66      EMITA = 4.90E-04 * (TMEAN**0.67)
67      EMITB = 5.98E-03 * (TMEAN**0.667)
68      GO TO 62
69      C
70      C * FOR SUPERFLOC
71      C *
72      60 SCNST = 15.40E-11
73      EMITA = 4.40E-04 * (TMEAN**0.667)
74      EMITB = 4.10E-01
75      62 DEMIT = ((1.0/EMITA)+(1.0/EMITB))-1.0)
76      SCOND = SCNST*(HBAR**2)*TMEAN
77      RNUM = SIGMA*SUMSQ(T*SUNT*THKFT
78      RDEN = (NSHLD-1.0)*DEMIT
79      RCOND = RNUM/RDEN
80      QCOND = (SCOND+RCOND)*(DELT/THKFT)
81      RETURN
82      C
83      C * FOR MICROSPHERES (104 TO 135 MICRONS)
84      C *
85      70 RCNST = 1.56E-13
86      RCOND = RCNST*TH3*THETA1*THETA2
87      QCOND = RCOND * (DELT/THKFT)
88      RETURN
89      C
90      C * FOR POLYURETHANE FOAM
91      C *
92      80 PKSUBE = 1.1295E-03 + (3.481E-05 * TMEAN)
93      QCOND = PKSUBE * (DELT/THKFT)
94      RETURN
95      C
96      C * FOR FIBERGLASS BATTING - HELIUM PURGED
97      C *
98      90 FKSUBE = 1.3836E-03 * (TMEAN**0.662)
99      QCOND = FKSUBE * (DELT/THKFT)
100      RETURN
101      C
102      END
```

```

1      * * * * *
2      C      * ROUTINE NAME - TABLE EVALUATION OR LOOKUP *
3      C      * ROUTINE LANG - FORTRAN V UNIVAC 1108 EXEC 2 *
4      C      * PROGRAMMER - R. BOLLINGER 1943 102 26933 *
5      C      * DATE CODED - 2/25/70 *
6      C      * * * * *
7
8      SUBROUTINE TEL(X,Y)
9
10     C      ***** EXPLANATION OF THE CALLING SEQUENCE
11
12     C      X - VALUE OF THE INDEPENDENT VARIABLE TO BE
13     C      INTERPOLATED ON.
14
15     C      Y - VALUE OF THE DEPENDENT VARIABLE WHICH IS THE
16     C      INTERPOLATION RESULTS.
17
18     C      INCLUDE CIOUNT
19     C      INCLUDE CKEYS
20     C      INCLUDE CTAB
21
22     C      6000 FORMAT ('D'10X'*** INTERPOLATION ERROR -- OVERFLOW OR NV WRONG NV='
23     C      1 13,'***')
24     C      6100 FORMAT ('H0 10X'*** INDEP. VAR. =' F10.4, ' OUT OF TABLE RANGE ('
25     C      1 1 F10.4, ' TO' F10.4, ' ) TABLE NO.'14,' NO. SUBTABLES'13,' ***')
26
27     C      IF(TYPE.EQ.1) GO TO 30
28
29     C      ***** EVALUATE THE COEFFICIENT POLYNOMIAL FOR Y.
30
31     C      Y = XTAB(1)
32     C      DO 20 I1 = 2,NV
33     C      Y = XTAB(I1) + X*Y
34     C      20 CONTINUE
35     C      RETURN
36
37     C      ***** EVALUATE THE TABLE LOOKUP FOR Y.
38
39     C      30 IF (XTAB(1) .LE. XTAB(NV)) GO TO 33
40     C      MAKE INDEPENDENT VAR. NON-DECREASING
41
42     C      NV1 = NV + 1
43     C      NVD2 = NV / 2
44     C      DO 32 I=1,NVD2
45     C      PIVOT = XTAB(NV1-I)
46     C      XTAB(NV1-I) = XTAB(I)
47     C      XTAB(I) = PIVOT
48     C      PIVOT = XTAB(NV1-I)
49     C      YTAB(NV1-I) = YTAB(I)
50     C      32 YTAB(I) = PIVOT
51     C      33 IF (KEY1 .LT. 1612) GO TO 34
52     C      TEST FOR INDEP. VAR. OUT OF RANGE
53     C      IF (X .GE. XTAB(1) .AND. X .LE. XTAB(NV)) GO TO 34
54     C      WRITE (10T,6100) X,XTAB(1),XTAB(NV),JTAB10,NLT8L
55     C      IF (KEY1 .NE. 1612) GO TO 34
56     C      KEY2 = KEY1
57     C      RETURN

```

AL54

•• TEL ••

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```
58      34 Y = YLGINT(XTAB,YTAB,NV,X,NIP,$40)
59      RETURN
60      40 WRITE (107,6000) NV
61      CALL EXIT
62      C
63      END
```

ALSS

AL56

```

1      SUBROUTINE TVP(P,T,TOLD)
2
3      C
4      C
5      C
6      T=T(K) -- PATM=PATM(ATMOSPHERES) -- P=P(NT/METER-2) = P(PASCALS)
7
8      DOUBLE PRECISION PATM,PREF,DPDT
9      DOUBLE PRECISION SSUM,X(10),DXDT(10),G(11)
10     DOUBLE PRECISION TSUM
11     PCRT=3.3997E6
12     PTRIPL=1.2530E4
13     IF (P.GT.PCRT) GO TO 130
14     IF (P.LT.PTRIPL) GO TO 150
15     PREF=P/1.01325E5
16     G(1)=0.83944094E4
17     G(2)=-0.18900453E4
18     G(3)=-0.72822292E1
19     G(4)=0.0
20     G(5)=0.55560638E-3
21     G(6)=-0.59445447E-5
22     G(7)=0.27154339E-7
23     G(8)=-0.48795359E-10
24     G(9)=0.50953608E3
25     G(10)=0.10228510E-1
26     G(11)=0.19500E1
27     TCRIT=126.2
28     T=TOLD
29
30     100 X(1)=1.0/T
31     X(2)=1.0
32     X(3)=T
33     X(4)=T**2
34     X(5)=T**3
35     X(6)=T**4
36     X(7)=T**5
37     X(8)=T**6
38     X(9)=ALOG(T)
39     X(10)=(TCRIT-T)**G(11)
40     TSUM=0.0
41
42     DO 110 J=1,10
43     110 TSUM=TSUM+(X(J)*G(J))
44     PATM=EXP(TSUM)
45     DXDT(1)=-1.0/(T**2)
46     DXDT(2)=0.0
47     DXDT(3)=1.0
48     DXDT(4)=2.0*T
49     DXDT(5)=3.0*(T**2)
50     DXDT(6)=4.0*(T**3)
51     DXDT(7)=5.0*(T**4)
52     DXDT(8)=6.0*(T**5)
53     DXDT(9)=1.0/T
54     DXDT(10)=-G(11)*((TCRIT-T)**G(11)-1.0)
55     SSUM=0.0
56     DO 120 I=1,10
57     120 SSUM=SSUM+(DXDT(I)*G(I))
58     DPDT=SSUM*PATM
59     TNEW=T-(PATM-PREF)/DPDT
60     TCHANG=(TNEW-T)/T
61     IF (TCHANG**2.LT.3.0E-11) GO TO 170
62     T=TNEW

```

.. TVP ..

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```
58      GO TO 100
59      130 WRITE (6,140)
60      140 FORMAT(T10,'PRESSURE GREATER THAN CRITICAL PRESSURE')
61      T=-1.0
62      GO TO 170
63      150 WRITE (6,160)
64      160 FORMAT(T10,'PRESSURE LESS THAN TRIPLE POINT PRESSURE')
65      T=-1.0
66      170 RETURN
67      END
```

AL7

```
1      C
2      C      CALCULATES VELOCITY OF LIQUID CRYOGEN IN CIRCULAR DUCT
3      C
4      C      FUNCTION VELF(AWD,ASV,AMWT,ADIA)
5      C
6      C      VF = AWD * ASV * (1.0/AMWT) * (1.0/(0.7854 * (ADIA**2)))
7      C
8      C      VELF = VF
9      C
10     RETURN
11     END
```

AL58


```

1      C      * * * * *
2      C      * ROUTINE NAME - MACH NUMBER COMPUTATION *
3      C      * ROUTINE LANG - FORTRAN V UNIVAC 1110 EXEC B *
4      C      * DATE CODED - AUGUST 23, 1979 *
5      C      * PROGRAMMER - R.F.HAUSMAN 104-6213-30235 *
6      C      * * * * *
7      C
8      C      SUBROUTINE VGVS(IDX,RHO,IGAS)
9      C
10     C      ***** EXPLANATION OF THE CALLING SEQUENCE
11     C      *
12     C      *   IDX - INDEX OF THE CONFIGURATION TABLE
13     C      *
14     C      *   RHO - DENSITY OF THE GAS
15     C      *
16     C      ***** IGAS - GAS NUMBER (SEE S.R. FINDR)
17     C
18     C      INCLUDE CCONFIG
19     C      INCLUDE CONST
20     C      INCLUDE CMAG
21     C
22     C      DATA IBLNK,IAS11,IAS16/'      ','      ','*****'/
23     C
24     C      ***** COMPUTE THE VELOCITY OF THE GAS
25     C
26     C      MFLG(IDX) = IBLNK
27     C      VG = 4.0 * WDDTN(IDX)/(PI * DIAM(IDX)**2 * RHO)
28     C
29     C      ***** COMPUTE THE VELOCITY OF SOUND IN GAS.
30     C
31     C      CALL HEPROP(PRES(IDX),TEMP(IDX),2)
32     C      CPGAS = HELCP
33     C      CVGAS = HELCV
34     C
35     C      VS = SQRT(GRAVITY*(CPGAS*FINDR(IGAS)-TEMP(IDX)/CVGAS))
36     C
37     C      ***** COMPUTE MACH NUMBER
38     C
39     C      MACH(IDX) = VG/VS
40     C
41     C      ***** CHECK MACH NUMBER. FLAG MACH GREATER THAN .3 WITH ONE
42     C      ***** ASTRIK. FLAG MACH NUMBER GREATER THAN 1.0 WITH 6 ASTRIK
43     C
44     C      IF(MACH(IDX) - 0.3) 40,40,10
45     C      10 IF(MACH(IDX) - 1.0) 20,30,30
46     C      20 MFLG(IDX) = IAS11
47     C      GO TO 40
48     C      30 MFLG(IDX) = IAS16
49     C      40 RETURN
50     C      END

```

```
1      DOUBLE PRECISION FUNCTION VIRB(T)
2      DOUBLE PRECISION A,B,I,YZ
3      DIMENSION A(9)
4      DATA A/-5.0815710041D-7,-1.1168680862D-4,1.1652430354D-2,
5      17.4474587990D-2,-5.3143174768D-1,-9.5759219306D-1,
6      23.9374414843D+0,-5.1370239224D+0,2.0804456338D+0/
7      C
8      C THIS SUB PROGRAM CALCULATES THE SECOND VIRIAL COEFFICIENT FOR
9      C HELIUM. THE RANGE IS FROM 2 TO 1500 DEG K. INPUT IS TEMPERATURE
10     C IN DEGREES KELVIN AND IUSE. IF IUSE IS 0 OR NEGATIVE THE ROUTINE
11     C CALCULATES B FOR THE EQUATION PV=RT(1+BD+...), FOR OTHER VALUES OF
12     C IUSE, THE ROUTINE CALCULATES THE VARIANCE OF B AT THE INPUT TEMP
13     C UNITS ARE ATM, DEG KELVIN, AND MOLES/LITER.4/3/69-1253,R.D.MCCARTY
14     C REVISED 2/12/70-925
15     1 B=0
16     DO 5 I=1,9
17     FI=I
18     YZ=1.5-FI/2.
19     5 B=B+I**YZ*A(I)
20     VIRB=B
21     RETURN
22     END
```

ALGO

•• VISC ••

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```
1      SUBROUTINE VISC(T,VISCL,VISCV)
2      C
3      C      VISCL=LIQUID VISCOSITY    VISCV=VAPOR VISCOSITY
4      C
5      C      T=T(K)  -- VISCL=VISCL(KG/M-SEC)  -- VISCV=VISCV(KG/M-SEC)
6      C
7      VISCL=2.70635E-3-7.22121E-5*T+6.78384E-7*T*T-2.10367E-9*T*T*T
8      VISCV=1.185E-7*(T+46.8815)
9      RETURN
10     END
```

1974

```
1 C
2 C
3 C
4 C
5 C
6 C
7 C
8 C
9 C
10 C
11 TL = ALOG(T)
12 R = DGC * 4.0026/1000.
13 ANUM = -0.135311743/TL + 1.00347841 + 1.20651649 * TL
14 1 -0.149564551 * TL**2 + 0.0125208416 * TL**3
15 BNUM = R * (-47.5295259/TL + 87.6799309 - 42.0741589 * TL
16 1 + 8.33128289 * TL**2 - 0.589252385 * TL**3)
17 CNUM = R*R * (547.309267/TL - 904.870586 + 431.404928 * TL
18 1 - 81.4504854 * TL**2 + 5.37008433 * TL**3)
19 DNUM = R*R*R * (-1684.39324/TL + 3331.08630 - 1632.19172 * TL
20 1 + 308.004413 * TL**2 - 20.2936367 * TL**3)
21 C
22 VISCDT = EXP(ANUM + BNUM + CNUM + DNUM)
23 C
24 RETURN
25 C
END
```

AL62

AL63

```

1      C
2      C      COMPUTES THE VISCOSITY OF HELIUM FROM 2 TO 2000 K
3      C      FROM ROUTINES SUPPLIED BY R. MCCARTY - AUG.78
4      C
5      C      FUNCTION VISCHE(DD,TT)
6      C
7      C      OUTPUT UNITS ARE MICRO-POISE=(GM/CM-SEC)*1.E-06
8      C
9      D      = DD
10     T      = TT
11     IF(T.LT.100.0) GO TO 10
12     IF(T.LT.300.0) GO TO 8
13     ETA0 = VISCX(T)
14     ET030 = VISCX(300.0)
15     ET0300 = VISCOT(0.0,300.0)
16     ETE300 = VISCOT( D,300.0) - ET0300
17     VISCHE = ETA0 + ETE300
18     RETURN
19     8 IF(T.LT.110.0) GO TO 9
20     ETA0 = VISCX(T)
21     ETEB = VISCOT(D,T) - VISCOT(0.0,T)
22     VISCHE = ETA0 + ETEB
23     RETURN
24     9 ETA1 = VISCOT(0.0,100.0)
25     ETA2 = VISCX(110.0)
26     ETA0 = ETA1 + (ETA2-ETA1) * (T-100.0)/10.
27     VISCHE = ETA0 + VISCOT(D,T) - VISCOT(0.0,T)
28     RETURN
29     10 VISCHE = VISCOT(D,T)
30     RETURN
31     C
32     END

```

** VISCK **

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```
1 C
2 C
3 C
4 C
5 C
6 C
7 C
8 C
9 C
10 C
11 C
12 C
13 C
14 C
15 C
16 C
17 C
18 C
19 C
20 C
21 C
22 C
23 C
24 C
25 C
26 C
27 C
28 C
29 C
30 C
31 C
32 C
33 C
34 C
35 C
36 C
37 C
38 C
39 C
40 C
41 C
42 C
43 C
44 C
45 C
46 C
47 C
48 C
49 C
50 C
51 C
52 C
53 C
54 C
55 C
56 C
57 C
58 C
59 C
60 C
61 C
62 C
63 C
64 C
65 C
66 C
67 C
68 C
69 C
70 C
71 C
72 C
73 C
74 C
75 C
76 C
77 C
78 C
79 C
80 C
81 C
82 C
83 C
84 C
85 C
86 C
87 C
88 C
89 C
90 C
91 C
92 C
93 C
94 C
95 C
96 C
97 C
98 C
99 C
100 C
```

FUNCTION VISCK(T)

VISCK = 196.0 * (T**0.71938) * EXP(12.451/T-295.67/T/T-4.1249)

RETURN

END

ATV

```

1      DOUBLE PRECISION FUNCTION VPN(TT)
2      DOUBLE PRECISION DELT
3      DOUBLE PRECISION TT,T,P,C,D,XA
4      DIMENSION C(10),D(14)
5      DATA C/ -3.9394635287D+0,141.27497508D+0,-1640.7711565D+0,11974.557
6      1102D+0,-55283.369818D+0,166219.58504D+0,-325212.82840D+0,398843.22
7      2750D+0,-277718.06992D+0,83395.204183D+0/
8      DATA D/ -49.510540356D+0,651.9236417D+0,-3707.5430856D+0,12880.6734
9      191D+0,-30048.545554D+0,49532.267436D+0,-59337.558548D+0,52311.2960
10     225D+0,-33950.233134D+0,16028.674003D+0,-5354.1038967D+0,1199.03019
11     306D+0,-161.46362959D+0,9.8811553386D+0/
12     P=0
13     T=TT
14     T=T-DELT(T)
15     IF(T-2.172D)10,10,1
16     1 DD 5 I=1,10
17     XA=2-I
18     5 P=P+C(I)+T**XA
19     VPN = DEXP(P)
20     RETURN
21     10 DD 15 I=1,14
22     XA=2-I
23     15 P=P+D(I)+T**XA
24     VPN = DEXP(P)
25     RETURN
26     END

```

5915

```
1      DOUBLE PRECISION FUNCTION VPTEMP(PP)
2      DOUBLE PRECISION VPN,DPDTPV
3      DOUBLE PRECISION T,P,PCAL,DP,DEL,PP
4      P=PP
5      IF(P.LT.6.4D+5) GOTO 12
6      T=5.0D+0
7      PCAL=VPN(T)
8      GO TO 13
9      12 PCAL=37800.D+0
10     IF(ABS(P-PCAL)-.0001D-3* P)11,11,1
11     1 T=2.1720D+0
12     13 DO 10 I=1,50
13     DP=DPDTPV(T)
14     DEL=(PCAL-P)/DP
15     T=T-DEL
16     PCAL=VPN(T)
17     IF(ABS(P-PCAL)-.0001D-3*P)11,11,2
18     2 IF(ABS(DEL)-.0001D-3*T)11,11,10
19     10 CONTINUE
20     PRINT 100,T
21     VPTEMP=T
22     RETURN
23 100 FORMAT(' TEMPERATURE ITERATION FAILED AT T=',E14.7)
24     END
```


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```

1      FUNCTION YLGINT(X,Y,N,XBAR,NPTS,$)                                YLGINT
2      C-----
3      C      LAGRANGE INTERPOLATION                                    YLGINT
4      C-----
5      C      ARGUMENT DEFINITION                                      YLGINT
6      C      X      -- ARRAY OF N INDEPENDENT VARIABLE VALUES(INPUT)  YLGINT
7      C      Y      -- ARRAY OF N DEPENDENT VARIABLE VALUES (INPUT)  YLGINT
8      C      N      -- NUMBER OF DATA POINTS (INPUT)                 YLGINT
9      C      XBAR   -- INDEPENDENT VARIABLE VALUE FOR WHICH YLGINT IS THE YLGINT
10     C      INTERPOLANT (INPUT)                                       YLGINT
11     C      NPTS   -- NUMBER OF DATA POINTS TO BE USED IN INTERPOLATION(INPUT) YLGINT
12     C      $      -- ERROR EXIT IF N IS LESS THAN 2, OR IF OVERFLOW IS YLGINT
13     C      DETECTED.                                                YLGINT
14     C-----
15     C      REFERENCE                                                YLGINT
16     C      K. S. KUNZ, NUMERICAL ANALYSIS, MCGRAW-HILL BOOK COMPANY, 1957. YLGINT
17     C-----
18     C      DIMENSION X(N),Y(N)                                       YLGINT
19     C-----
20     C      CHECK ARGUMENTS N AND NPTS                                YLGINT
21     C      IF NPTS IS OUT OF RANGE, USE ALL POINTS                  YLGINT
22     C-----
23     C      IF(N.LT.2) RETURN 6                                       YLGINT
24     C      IF(NPTS.GT.1.AND.NPTS.LT.N) GO TO 2                      YLGINT
25     C      NPTS=N                                                    YLGINT
26     C      JL=1                                                       YLGINT
27     C      JH=NPTS                                                    YLGINT
28     C      GO TO 9                                                    YLGINT
29     C-----
30     C      DETERMINE POSITION OF XBAR WITHIN X ARRAY                  YLGINT
31     C      UPON EXIT FROM LOOP 3, X(JH-1) LT XBAR LE X(JH)          YLGINT
32     C-----
33     C      2 DO 3 JH=1,N                                              YLGINT
34     C      IF(XBAR-X(JH)) 5,12,3                                       YLGINT
35     C      3 CONTINUE                                                YLGINT
36     C      4 JH=N                                                      YLGINT
37     C      JL=N-NPTS+1                                                YLGINT
38     C      GO TO 9                                                    YLGINT
39     C-----
40     C      DET:  IN RE WHICH POINTS USED IN INTERPOLATION          YLGINT
41     C      THE POINTS CHOSEN ARE THE ONES WHOSE ABSCISSAS ARE CLOSEST TO XBAR. YLGINT
42     C      JL IS LOWEST SUBSCRIPT OF POINTS USED, JH IS HIGHEST SUBSCRIPT YLGINT
43     C-----
44     C      5 JL=JH                                                    YLGINT
45     C      D2=X(JH)-XBAR                                              YLGINT
46     C      6 JL=JL-1                                                  YLGINT
47     C      IF(JL.LE.1) GO TO 1                                         YLGINT
48     C      IF(NPTS.EQ.2) GO TO 99                                     YLGINT
49     C      D1=XBAR-X(JL)                                              YLGINT
50     C      7 IF(JH-JL+1.EQ.NPTS) GO TO 8                              YLGINT
51     C      IF(XBAR-X(JL-1).LT.D2) GO TO 8                            YLGINT
52     C      JH=JH+1                                                    YLGINT
53     C      IF(JH.GE.N) GO TO 4                                         YLGINT
54     C      D2=X(JH)-XBAR                                              YLGINT
55     C      GO TO 7                                                    YLGINT
56     C      8 INDCT=0                                                  YLGINT
57     C      IF(JL.GT.1.AND.XBAR-X(JL-1).LT.D2) INDCT=-1

```

89TV

```

58      IF(JH.LT.N.AND.X(JH+1)-XBAR.LT.D1) INDCT=1
59      JL=JL+INDCT                                YLGINT
60      JH=JH+INDCT                                YLGINT
61      C-----
62      C DETERMINE INTERPOLATING POLYNOMIAL VALUE      YLGINT
63      C INNER LOOP COMPUTES PRODUCT                  YLGINT
64      C OUTER LOOP COMPUTES SUM                      YLGINT
65      C ERROR RETURN FOR DETECTED OVERFLOW           YLGINT
66      C-----
67      9 IF(NP15 .EQ. 2) GO TO 99
68      YLGINT = 0.
69      DO 11 K=JL,JH                                YLGINT
70      PROD=1.                                        YLGINT
71      DO 10 J=JL,JH                                YLGINT
72      IF(K.EQ.J) GO TO 13
73      PROD=PROD*(XBAR-X(J))/(X(K)-X(J))            YLGINT
74      C TEST FOR OVERFLOW
75      IF (PROD .GT. 1.E+20) RETURN 6
76      10 CONTINUE                                  YLGINT
77      YLGINT=YLGINT+Y(K)*PROD                        YLGINT
78      C TEST FOR OVERFLOW
79      IF (YLGINT .GT. 1.E+20) RETURN 6
80      11 CONTINUE                                  YLGINT
81      RETURN                                         YLGINT
82      C-----
83      C XBAR EQUAL TO AN ELEMENT OF THE X ARRAY      YLGINT
84      C-----
85      12 YLGINT=Y(JH)                                YLGINT
86      RETURN                                         YLGINT
87      C
88      C FOR LINEAR INTERPOLATION USE THIS SIMPLIFIED FORM, MODIFIED BY
89      C J.MCKAY 3-21-1972
90      C
91      99 YLGINT = (Y(JH)-Y(JL))*(XBAR-X(JL))/(X(JH)-X(JL))+Y(JL)
92      RETURN
93      END

```

YLGINT

.. ZCALC ..

FILE: MFTF*CSA

TIME: 10:21:58

DATE 040579

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```
1      FUNCTION ZCALC(D,P,T)
2      C
3      C*** COMPUTES Z FACTOR FROM  $Z=P/(D*R*T)$ 
4      C
5      DOUBLE PRECISION D,T,R,P
6      h = .0820558D+0
7      ZC = P/(D*R*T)
8      ZCALC = ZC
9      RETURN
10     END
```

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APPENDIX B

LISTING OF PROGRAM INPUT DATA RUNSTREAM

1 PASG.T CSATAB..740
 2 PDATA.II CSATAB.
 3 FTU OF 321/347 ST. STEEL 2 3 1
 4 EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF 321/347 STAINLESS STEEL
 5 REF. MIL HANDBOOK -5.
 6

7 TEMPERATURE (F) ULT. STRENGTH (PSI)

TEMPERATURE (F)	1	2	3	4	5
15	279500.	18.0	273500.	27.0	269500.
7.2	266500.	59.7	251000.	159.7	207000.
36.7	173000.	359.7	143000.	459.7	121000.
259.7	108000.	659.7	91000.	859.7	75000.
559.7	70000.	1259.7	66000.	1459.7	63000.

14 FTU OF 2219-T87 ALUM. 2 3
 15 EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF 2219-T87 ALUMINUM
 16 REF. SEC. 9-LMSC A981608, PAGE 8.1.1-8
 17

18 TEMPERATURE (F) ULT. STRENGTH (PSI)

TEMPERATURE (F)	1	2	3	4	5
15	100300.	18.0	98000.	27.0	96000.
7.2	94000.	100.0	82400.	150.0	76000.
36.7	72000.	250.0	68500.	300.0	67800.
200.0	67000.	400.0	66300.	450.0	65000.
350.0	63800.	550.0	62000.	600.0	60000.

25 FTU OF 6061-T6 ALUMINUM 2 3
 26 EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF 6061-T6 ALUMINUM ALLOY
 27 REF. MIL HANDBOOK -5
 28

29 TEMPERATURE (F) ULT. STRENGTH (PSI)

TEMPERATURE (F)	1	3	4	5
15	67500.	18.0	66100.	27.0
7.2	63840.	100.0	57330.	150.0
36.7	50610.	250.0	48384.	300.0
200.0	45696.	400.0	44940.	450.0
350.0	42840.	550.0	41496.	600.0

36 FTU OF INCONEL-718 2 3
 37 EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF INCONEL-718
 38 REF. MIL HANDBOOK -5.
 39

40 TEMPERATURE (F) ULT. STRENGTH (PSI)

TEMPERATURE (F)	1	3	4	5
15	221900.	18.0	220800.	27.0
7.2	219600.	100.0	213660.	150.0
36.7	206100.	250.0	201240.	300.0
200.0	193140.	400.0	189000.	450.0
350.0	182160.	550.0	179460.	600.0

47 FTU OF TI-6AL-4V 2 3
 48 EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF TITANIUM TI-6AL-4V
 49 REF. MIL HANDBOOK -5.
 50

51 TEMPERATURE (F) ULT. STRENGTH (PSI)

TEMPERATURE (F)	1	3	4	5
15	296000.	18.0	293000.	27.0
7.2	288320.	100.	261600.	150.
36.7	226880.	250.	212800.	300.
200.0	190720.	400.	181280.	450.
350.0	165260.	550.	158720.	600.

FTU OF 304 ST. STEEL 2 3 6
EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF 304 STAINLESS STEEL
REF.APPL.CRYOGENIC ENG.PAGE 48

TEMPERATURE (R) ULT. STRENGTH (PSI)

16	1	2			
7.2	276000.	18.0	274000.	27.0	270000.
36.0	266000.	45.0	263000.	90.0	250000.
135.0	235000.	180.0	220000.	225.0	206000.
270.0	188000.	315.0	172000.	360.0	155000.
405.0	139000.	450.0	124000.	495.0	109000.
540.0	96000.				

END TABS

```

END
MSG.T      CVIDATAMAG.,F40
DATA.IL    CVIDATAMAG.
USER NAME  6213  104 30235
           TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVID)

```

[illegible]

116	ELBOW	31	1	6.007013.00	FR-112
117	LINE	10	1	6.00700.609.1523	MR-113
118	VALVE	31	1	6.0070400.0	CV-145
119	LINE	10	1	6.00701.980.1523	MR-114
120	TEE	31	1	6.007050.00	FR-115
121	LINE	10	1-1.48	6.00701.520.1523	MR-116
122	TANK	0	1	6	HE-SV2
123	GAS	1	2	2	HE-LIQ
124	LINE	10	1	6.00701.056.1523	MS-202
125	VALVE	31	1	6.0070400.0	CV-136
126	LINE	10	1	6.00701.00.1523	MS-203
127	ELBOW	31	1	6.007013.00	FS-204
128	LINE	10	1+2.59	6.00702.587.1523	MS-205
129	ELBOW	31	1	6.007013.00	FS-206
130	LINE	10	1	6.007012.40.1523	MS-207
131	ELBOW	31	1	6.007013.00	FS-208
132	LINE	10	117.25	6.007017.25.1523	MS-209
133	ELBOW	31	1	6.007013.00	FS-210
134	LINE	10	1	6.0070 0.80.1523	MS-211
135	ELBOW	21	1	6.0070 8.60	FS-212
136	LINE	10	1	6.0070 5.00.1523	MS-213
137	ELBOW	31	1	6.007013.00	FS-214
138	LINE	10	1-3.00	6.0070 3.00.1523	MS-215
139	ELBOW	31	1	6.007013.00	FS-216
140	LINE	10	1	6.0070 8.30.1523	MS-217
141	ELBOW	21	1	6.0070 8.60	FS-218
142	LINE	10	1-0.64	6.0070 0.90.1523	MS-219
143	MAGNET	0	1-4.24	6.007010.96.1523	MAG-02
144	LINE	10	1-0.64	6.0070 0.90.1523	MR-200
145	ELBOW	21	1	6.0070 8.60	FR-201
146	LINE	10	1	6.0070 8.30.1523	MR-202
147	ELBOW	31	1	6.007013.00	FR-203
148	LINE	10	1-4.00	6.0070 4.00.1523	MR-204
149	ELBOW	21	1	6.0070 8.60	FR-205
150	LINE	10	1-4.75	6.00707.267.1523	MR-206
151	ELBOW	21	1	6.0070 8.60	FR-207
152	LINE	10	1	6.007012.40.1523	MR-208
153	ELBOW	31	1	6.007013.00	FR-209
154	LINE	10	1-2.59	6.00702.587.1523	MR-210
155	ELBOW	31	1	6.007013.00	FR-211
156	LINE	10	1	6.00700.609.1523	MR-212
157	VALVE	31	1	6.0070400.0	CV-146
158	LINE	10	1	6.00701.980.1523	MR-213

Q-1

M-2

END

160 SEND
 161 MSG.T CVIDATACRP.,F40
 162 DATA.IL CVIDATACRP.
 163 USER NAME
 164
 165 TEST CASE FOR THE MFTF CRYOPANEL SUPPLY SYSTEM (CV1)
 166 SUBCRIT SECN DECK
 167 113.7879 4.35 4000.00 2406.949 4.0026
 168 550.00 7000.00 19.57 19.07 1022.953
 169 450.00 7000.00 10.57 10.07 902.605
 170 200.00 4000.00 19.37 11.02 300.868
 171 100.00 3000.00 19.37 11.02 180.521
 172 0.9728 5.00
 173 GAS 1 2 1 HE-LIQ
 TANK 0 1 6 HE-SV1

CRP-1

CRP-2

CRP-3

CRP-4

CRP-5

CRP-6

G-1

175	LINE	10	1+1.48	6.00700.228.1015	CS-100
176	TEE	21	1	6.007060.0	FS-101
177	LINE	10	1	6.00701.117.1015	CS-102
178	VALVE	31	1	6.0070400.	CV-141
179	LINE	10	1	6.00700.863.1015	CS-103
180	ELBOW	31	1	6.007013.00	FS-104
181	LINE	10	1+2.59	6.00702.587.1015	CS-105
182	ELBOW	31	1	6.007013.00	FS-106
183	LINE	10	1	6.007012.35.1015	CS-107
184	ELBOW	31	1	6.007013.00	FS-108
185	LINE	10	117.25	6.007017.25.1015	CS-109
186	ELBOW	31	1	6.007013.00	FS-110
187	LINE	10	1	6.00700.800.1015	CS-111
188	ELBOW	21	1	6.00708.60	FS-112
189	LINE	10	1	6.00705.000.1015	CS-113
190	ELBOW	31	1	6.007013.00	FS-114
191	LINE	10	1-1.50	6.00701.500.1015	CS-115
192	ELBOW	31	1	6.007013.00	FS-116
193	LINE	10	1	6.007010.00.1015	CS-117
194	ELBOW	41	1	6.007018.0	FS-118
195	LINE	10	1-0.25	6.00700.200.1015	CS-119
196	CRYPAN	2	1-3.046	6.007012.50.1015	CYP-22
197	LINE	10	1	6.00700.2 .1015	CR-100
198	ELBOW	31	1	6.007013.00	FR-101
199	LINE	10	1-9.00	6.00709.0 .1015	CR-102
200	TAP	31	1	6.007060.00	TR-103
201	GAS	1	2	2	HE-LIQ
202	LINE	10	1+1.48	6.00701.117.1015	CS-202
203	VALVE	31	1	6.0070400.	CV-142
204	LINE	10	1	6.00700.863.1015	CS-203
205	ELBOW	31	1	6.007013.00	FS-204
206	LINE	10	1+2.59	6.00702.587.1015	CS-205
207	ELBOW	31	1	6.007013.00	FS-206
208	LINE	10	1	6.007012.30.1015	CS-207
209	ELBOW	31	1	6.007013.00	FS-208
210	LINE	10	117.25	6.007017.25.1015	CS-209
211	ELBOW	31	1	6.007013.00	FS-210
212	LINE	10	1	6.00700.8 .1015	CS-211
213	ELBOW	21	1	6.00708.60	FS-212
214	LINE	10	1	6.00705.0 .1015	CS-213
215	ELBOW	31	1	6.007013.00	FS-214
216	LINE	10	1-1.50	6.00701.5 .1015	CS-215
217	ELBOW	31	1	6.007013.00	FS-216
218	LINE	10	1	6.007010.0 .1015	CS-217
219	ELBOW	31	1	6.007013.00	FS-218
220	LINE	10	1-9.25	6.0070 9.0 .1015	CS-219
221	ELBOW	31	1	6.007013.00	FS-220
222	LINE	10	1	6.0070 0.2 .1015	CS-221
223	CRYPAN	1	1-3.046	6.007012.50.1015	CYP-21
224	LINE	10	1	6.0070 0.2 .1015	CR-200
225	TAP	31	1	6.007015.5	TR-103
226	GAS	1	2	2	HE-LIQ
227	LINE	10	1+1.48	6.00701.117.0508	CS-302
228	VALVE	31	1	6.0070400.	CV-143
229	LINE	10	1	6.00700.863.0508	CS-303
230	ELBOW	31	1	6.007013.00	FS-304
231	LINE	10	1+2.59	6.00702.587.0508	CS-305
232	ELBOW	31	1	6.007013.00	FS-306

C-2

G-2

C-1

G-3

FILE: MFTF-A*RUNMFTF-A

TIME: 10:42:06

DATE 040579

PAGE 8

232 LINE 10 1 6.007012.30.0508 CS-307
 232 ELBOW 31 1 6.007013.00 FS-308
 234 LINE 10 117.75 6.007017.75.0508 CS-309
 235 ELBOW 31 1 6.007013.00 FS-310
 235 LINE 10 1 6.0070 0.8 .0508 CS-311
 237 ELBOW 21 1 6.0070 8.6 FS-312
 237 LINE 10 1 6.0070 5.0 .0508 CS-313
 239 ELBOW 31 1 6.007013.00 FS-314
 240 LINE 10 1-1.50 6.0070 1.5 .0508 CS-315
 241 ELBOW 31 1 6.007013.00 FS-316
 242 LINE 10 1 6.007011.0 .0508 CS-317
 243 ELBOW 41 1 6.007018.00 FS-318
 244 LINE 10 1-0.25 6.00700.25 .0508 CS-319
 245 TAP 31 1 6.007015.00 TP-320
 245 LINE 10 1-0.20 6.00700.20 .0508 CS-321
 247 CRYPAN 3 1-1.523 6.0070 6.00.0508 CYP-23 C-3
 248 LINE 10 1-0.20 6.00700.20 .0508 CR-300
 249 ELBOW 31 1 6.007013.00 FR-301
 250 LINE 10 1 6.007010.0 .0508 CR-302
 251 TAP 31 1 6.007060.00 TP-103
 252 GAS 1 2 4 HE-L1Q G-4
 253 LINE 10 1 6.007010.0 .0508 CS-401
 254 ELBOW 31 1 6.007013.00 FS-402
 255 LINE 10 1-0.2 6.0070 0.2 .0508 CS-403
 256 CRYPAN 4 1-1.523 6.0070 6.00.0508 CYP-24 C-4
 257 LINE 10 1-0.2 6.0070 0.2 .0508 CR-401
 258 ELBOW 31 1 6.007013.00 FR-402
 259 LINE 10 1-0.5 6.0070 0.5 .0508 CR-403
 260 TAP 31 1 6.007060.00 TP-103
 261 GAS 1 2 5 HE-L1Q G-4
 262 TAP 31 1 6.007015.50 TP-103
 263 LINE 10 1-1.50 6.00701.5 .1523 CR 104
 264 ELBOW 21 1 6.00708.60 FR 105
 265 LINE 10 1-4.75 6.00707.267.1523 CR 106
 266 ELBOW 21 1 6.00708.60 FR 107
 267 LINE 10 1 6.007012.30.1523 CR 108
 268 ELBOW 31 1 6.007013.00 FR 109
 269 LINE 10 1-2.59 6.00702.587.1523 CR 110
 270 ELBOW 31 1 6.007013.00 FR 111
 271 LINE 10 1 6.00700.533.1523 CR 112
 272 VALVE 31 1 6.0070400. CV-144
 273 LINE 10 1 6.00702.208.1523 CR 113
 274 ELBOW 31 1 6.007013.00 FR 114
 275 LINE 10 1-1.48 6.00701.480.1523 CR 115
 276 TANK 0 1 6 HE-SV1
 277 END
 278
 279 PEND
 280 PASG.T CVIDATAMCR..F40
 280 PDATA.IL CVIDATAMCR.
 281 USER NAME
 282 TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)
 283 REFLO SUBCRIT THIRD DECK
 284 300.0 290.0 80.0 77.348 38.0 23.0 13.0 5.0 4.8 4.35 7.0 1
 285 6310.4 1731.6 845.8 277.3 66.4 6088.1 1727.6 534.0 191.9 142.0 41.1 2
 286 1215.90 113.7879 101.325 401.5 155.1 246.4 4
 287 474.1 72.6 28.7042 -3504.3 0.164621 2160.3 290.0 RLO-1
 288 77.348 101.325 28.7042 -3504.3 0.164621 2160.3 290.0 RLO-2
 289 0.0420370 8426.2 28.0134 4.0026

348	LINE	10	1	.00	6.009	1.218.1015	10	0	0	SHP601	HP-CLDHE
349	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FHP602	HP-CLDHE
350	LINE	10	1	.00	6.009	5.787.1015	10	0	0	SHP603	HP-CLDHE
351	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FAP604	HP-CLDHE
352	LINE	10	1	.00	6.009	.6092.1015	10	0	0	SHP605	HP-CLDHE
353	FITING	41	1	.00	6.009	8.0 .0	10	0	0	FHP606	HP-CLDHE
354	LINE	10	1	.00	6.009	.6092.1015	10	0	0	SHP607	HP-CLDHE
355	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FHP608	HP-CLDHE
356	LINE	10	1	.00	6.009	.3046.1015	10	0	0	SHP609	HP-CLDHE
357	VALVE	51	1	.00	6.008	422. .0	10	0	0	CV-104	JT-VALVE
358	LINE	10	1	.00	6.007	.1523.1015	10	0	0	SHP610	LP-LIQHE
359	ELBOW	31	1	.00	6.007	13. .0	10	0	0	FHP611	LP-LIQHE
360	LINE	10	1	.00	6.007	2.437.1015	10	0	0	SHP612	LP-LIQHE
361	TANK	0	1	.00	6.0	.0 .0	0	0	0	HE-SV3	STQ-DEWR
362	GAS	1	1	.00	6					HE-GAS	CYP R-6
363	LINE	10	1	.00	6.009	4.264.1015	10	0	0	CHP701	HP-CLDHE
364	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FHP702	HP-CLDHE
365	LINE	10	1	.00	6.009	1.218.1015	10	0	0	CHP703	HP-CLDHE
366	TEE	31	1	.00	6.009	60.0 .0	10	0	0	FHP704	HP-CLDHE
367	LINE	10	1	.00	6.009	.6092.1015	10	0	0	CHP705	HP-CLDHE
368	FITING	41	1	.00	6.009	8.0 .0	10	0	0	FHP706	HP-CLDHE
369	LINE	10	1	.00	6.009	.6092.1015	10	0	0	CHP707	HP-CLDHE
370	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FHP708	HP-CLDHE
371	LINE	10	1	.00	6.009	.0507.1015	10	0	0	CHP709	HP-CLDHE
372	VALVE	41	1	.00	6.009	400. .0	10	0	0	CV-105	SO-VALVE
373	LINE	10	1	.00	6.009	.0507.1015	10	0	0	CHP710	HP-CLDHE
374	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FHP711	HP-CLDHE
375	LINE	10	1	.00	6.009	.6029.1015	10	0	0	CHP712	HP-CLDHE
376	VALVE	51	1	.00	6.009	422. .0	10	0	0	AV-129	JT-VALVE
377	LINE	10	1	.00	6.007	.9138.1015	10	0	0	CHE713	LP-LIQHE
378	TANK	0	1	.00	6.0	.0 .0	0	0	0	HE-SV1	CYP-DEWR
379	GAS	1	1	.00	7					HE-GAS	MAG R-7
380	LINE	10	1	.00	6.009	6.244.1015	10	0	0	MHP801	HP-CLDHE
381	ELBOW	31	1	.00	6.009	13. .0	10	0	0	FHP802	HP-CLDHE
382	LINE	10	1	.00	6.009	.6092.1015	10	0	0	MHP803	HP-CLDHE
383	FITING	41	1	.00	6.009	8.0 .0	10	0	0	FHP804	HP-CLDHE
384	LINE	10	1	.00	6.009	.6092.1015	10	0	0	MHP805	HP-CLDHE
385	ELBOW	31	1	.00	6.009	13. .0	10	0	0	FHP806	HP-CLDHE
386	LINE	10	1	.00	6.009	.0507.1015	10	0	0	MHP807	HP-CLDHE
387	VALVE	41	1	.00	6.009	400. .0	10	0	0	CV-106	SO-VALVE
388	LINE	10	1	.00	6.009	.0507.1015	10	0	0	MHP808	HP-CLDHE
389	ELBOW	31	1	.00	6.009	13. .0	10	0	0	FHP809	HP-CLDHE
390	LINE	10	1	.00	6.009	.6029.1015	10	0	0	MHP810	HP-CLDHE
391	VALVE	51	1	.00	6.009	422. .0	10	0	0	AV-128	JT-VALVE
392	LINE	10	1	.00	6.009	.9138.1015	10	0	0	MHE811	LP-CLDHE
393	TANK	0	1	.00	6.0	.0 .0	0	0	0	HE-SV2	MAG-DEWR
394	GAS	1	1	.00	8					HE-GAS	CPU R-8
395	REFLIO	0	1	.00	6.007	.0 .0	10	0	0	RF-LQ3	LP-HOTHE
396	LINE	10	1	.00	6.006	.3046.1523	10	0	0	CLP101	LP-HOTHE
397	ELBOW	31	1	.00	6.006	13. .0	10	0	0	FLP102	LP-HOTHE
398	LINE	10	1	.00	6.006	7.920.1523	10	0	0	CLP103	LP-HOTHE
399	ELBOW	31	1	.00	6.006	13. .0	10	0	0	FLP104	LP-HOTHE
400	LINE	10	1	.00	6.006	3.960.1523	10	0	0	CLP105	LP-HOTHE
401	ELBOW	31	1	.00	6.006	13. .0	10	0	0	FLP108	LP-HOTHE
402	LINE	10	1	.00	6.006	9.74 .1523	10	0	0	CLP107	LP-HOTHE
403	ELBOW	31	1	.00	6.006	13. .0	10	0	0	FLP108	LP-HOTHE
404	LINE	10	1	.00	6.006	8.22 .1523	10	0	0	CLP109	LP-HOTHE
405	ELBOW	31	1	.00	6.006	13. .0	10	0	0	FLP110	LP-HOTHE

406	LINE	10	1	.00	6.006	8.0	.1523	10	0	0	CLP111	LP-HOTHE
407	ELBOW	31	1	.00	6.006	13.0	.0	10	0	0	FLP112	LP-HOTHE
408	LINE	10	1	.00	6.006	7.0	.1523	10	0	0	CLP113	LP-HOTHE
409	ELBOW	31	1	.00	6.006	13.0	.0	10	0	0	FLP114	LP-HOTHE
410	LINE	10	1	.00	6.006	6.0	.1523	10	0	0	CLP115	LP-HOTHE
411	ELBOW	31	1	.00	6.006	13.0	.0	10	0	0	FLP116	LP-HOTHE
412	LINE	10	1	.00	6.006	0.5	.1523	10	0	0	CLP117	LP-HOTHE
413	COMPUR	0	1	.00	6.006			10	0	0	CPU-01	COMPUPFR
414	LINE	10	1	.00	6.008	0.5	.0761	10	0	0	CHP101	HP-HOTHE
415	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP102	HP-HOTHE
416	LINE	10	1	.00	6.008	6.0	.0761	10	0	0	CHP103	HP-HOTHE
417	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP104	HP-HOTHE
418	LINE	10	1	.00	6.008	8.0	.0761	10	0	0	CHP105	HP-HOTHE
419	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP106	HP-HOTHE
420	LINE	10	1	.00	6.008	9.74	.0761	10	0	0	CHP107	HP-HOTHE
421	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP108	HP-HOTHE
422	LINE	10	1	.00	6.008	9.74	.0761	10	0	0	CHP109	HP-HOTHE
423	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP110	HP-HOTHE
424	LINE	10	1	.00	6.008	3.95	.0761	10	0	0	CHP111	HP-HOTHE
425	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP112	HP-HOTHE
426	LINE	10	1	.00	6.008	7.92	.0761	10	0	0	CHP113	HP-HOTHE
427	VALVE	41	1	.00	6.008	422.0	.0	10	0	0	AV-041	CV-VALVE
428	LINE	10	1	.00	6.008	.0507	.0761	10	0	0	CHP114	HP-HOTHE
429	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP115	HP-HOTHE
430	LINE	10	1	.00	6.008	.3046	.0761	10	0	0	CHP116	HP-HOTHE
431	REFLIO	0	1	.00	6.007	.0	.0	10	0	0	RF-LQ4	HPHHE IN

END

PEND

PMSG.T

DATA12..F40

DATA.IL

DATA12..

USER NAME 6213 104 30235

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

LN2SUPPLY SUBCRIT FRTH DECK

439	1											
440	3.06	2.06	-1.00	0.0	0.0	1.0	0.0	1.	1.			
441	0.0	-1.00	-1.00	31.0	0.0	0.0	0.0	2.	1.			
442	18.00	-1.00	-1.00	0.0	0.0	1.0	0.0	1.	1.			
443	0.0	-1.00	-1.00	31.0	0.0	0.0	0.0	2.	1.			
444	54.50	-1.00	-1.00	0.0	0.0	1.0	0.0	1.	1.			
445	0.0	-1.00	-1.00	31.0	0.0	0.0	0.0	2.	1.			
446	7.90	-1.00	6.90	0.0	0.0	1.0	0.0	1.	1.			
447	0.0	6.90	6.90	31.0	0.0	0.0	0.0	2.	1.			
448	18.50	6.90	6.90	0.0	0.0	1.0	0.0	1.	1.			
449	0.0	6.90	6.90	31.0	0.0	0.0	0.0	2.	1.			
450	8.50	6.90	15.40	0.0	0.0	1.0	0.0	1.	1.			
451	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.			
452	26.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.			
453	0.0	15.40	15.40	90.0	0.0	7.0	0.0	3.	1.			
454	-1.0											
455	2											
456	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.			
457	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.			
458	0.00	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.			
459	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.			
460	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.			
461	0.68	15.40	16.08	0.0	0.0	1.0	0.0	1.	1.			
462	0.0	16.08	16.08	31.0	0.0	1.0	0.0	2.	1.			
463	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.			

464	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
465	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
466	6.36	16.08	16.08	0.0	0.0	0.90	1.00	6.	1.
467	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
468	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
469	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
470	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
471	8.72	16.08	17.45	0.0	288.0	0.0	0.0	6.	1.
472	0.0	17.45	17.45	31.0	0.0	0.0	0.0	2.	1.
473	1.37	17.45	16.08	0.0	0.0	1.0	0.0	1.	1.
474	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
475	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
476	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
477	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
478	12.72	16.08	16.08	0.0	0.0	0.90	2.00	6.	1.
479	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
480	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
481	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
482	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
483	17.37	16.08	18.81	0.0	576.0	0.0	0.0	6.	1.
484	0.0	18.81	18.81	31.0	0.0	0.0	0.0	2.	1.
485	2.73	18.81	16.08	0.0	6.0	1.0	0.0	1.	1.
486	0.0	16.08	16.08	31.0	0.0	1.0	0.0	2.	1.
487	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
488	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
489	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
490	12.72	16.08	16.08	0.0	0.0	0.90	2.00	6.	1.
491	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
492	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
493	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
494	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
495	17.37	16.08	18.81	0.0	576.0	0.0	0.0	6.	1.
496	0.0	18.81	18.81	31.0	0.0	0.0	0.0	2.	1.
497	2.73	18.81	16.08	0.0	6.0	1.0	0.0	1.	1.
498	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
499	0.0	16.08	16.08	0.0	6.0	1.0	0.0	4.	1.
500	0.50	16.08	16.08	0.0	6.0	1.0	0.0	1.	1.
501	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
502	12.72	16.08	14.08	0.0	0.0	0.90	2.00	6.	1.
503	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
504	89.07	14.08	14.08	0.0	0.0	0.90	14.00	6.	1.
505	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
506	119.61	14.08	-4.72	0.0	0.0	0.90	18.80	6.	1.
507	0.0	-4.72	-4.72	31.0	0.0	0.0	0.0	2.	1.
508	46.44	-4.72	-4.72	0.0	0.0	0.90	7.30	6.	1.
509	0.0	-4.72	-4.72	31.0	0.0	0.0	0.0	2.	1.
510	13.36	-4.72	-2.62	0.0	0.0	0.90	2.10	6.	1.
511	11.94	-2.62	9.32	0.0	0.0	1.0	0.0	1.	1.
512	30.28	9.32	14.08	0.0	0.0	0.90	4.76	6.	1.
513	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
514	46.44	14.08	14.08	0.0	0.0	0.90	7.30	6.	1.
515	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
516	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
517	2.00	14.08	16.08	0.0	0.0	1.0	0.0	1.	1.
518	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
519	5.00	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
520	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
521	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.

FILE: MFTF-A-RUNMFTF-A

TIME: 10:42:06

DATE 040579

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522	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
523	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
524	0.68	16.08	15.40	0.0	0.0	1.0	0.0	1.	1.
525	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
526	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
527	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
528	2.06	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
529	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
530	-2.								
531	3								
532	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
533	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
534	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
535	1.0	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
536	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
537	1.32	15.40	14.08	0.0	0.0	1.0	0.0	1.	1.
538	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
539	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
540	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
541	5.08	14.08	9.00	0.0	0.0	1.0	0.0	1.	1.
542	0.0	9.0	9.0	31.0	0.0	0.0	0.0	2.	1.
543	3.08	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
544	0.0	9.0	9.0	31.0	0.0	0.0	0.0	2.	1.
545	1.00	9.00	8.00	0.0	0.0	1.0	0.0	1.	1.
546	0.0	8.00	8.00	0.0	0.0	1.0	0.0	4.	1.
547	0.50	8.00	7.50	0.0	0.0	1.0	0.0	1.	1.
548	0.50	7.50	7.00	0.0	0.0	1.0	0.0	1.	1.
549	0.0	7.00	7.00	90.0	0.0	0.0	0.0	5.	4.
550	0.50	7.00	6.50	0.0	0.0	1.0	0.0	1.	1.
551	6.30	6.50	0.20	0.0	7500.0	0.0	0.0	6.	1.
552	1.50	0.20	-1.30	0.0	0.0	1.0	0.0	1.	1.
553	1.00	-1.30	-2.30	0.0	0.0	1.0	0.0	1.	1.
554	0.0	-2.30	-2.30	31.0	0.0	0.0	0.0	2.	1.
555	3.08	-2.30	-2.30	0.0	0.0	1.0	0.0	1.	1.
556	0.0	-2.30	-2.30	31.0	0.0	0.0	0.0	2.	1.
557	11.30	-2.30	9.00	0.0	0.0	1.0	0.0	1.	1.
558	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
559	5.08	9.00	14.08	0.0	0.0	1.0	0.0	1.	1.
560	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
561	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
562	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
563	1.32	14.08	15.40	0.0	0.0	1.0	0.0	1.	1.
564	0.0	15.40	15.40	31.0	0.0	0.0	0.0	1.	1.
565	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
566	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
567	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
568	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
569	-3.								
570	4								
571	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
572	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
573	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
574	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
575	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
576	1.32	15.40	14.08	0.0	0.0	1.0	0.0	1.	1.
577	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
578	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
579	0.0	14.08	14.08	31.0	0.0	1	0.0	2.	1.

580	5.08	14.08	9.00	0.0	0.0	1.0	0.0	1.	1.
581	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
582	3.08	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
583	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
584	9.70	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
585	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
586	1.00	9.00	8.00	0.0	0.0	1.0	0.0	1.	1.
587	0.0	8.00	8.00	0.0	0.0	1.0	0.0	4.	1.
588	0.0	8.00	8.00	90.0	0.0	0.0	0.0	5.	2.
589	1.00	8.00	7.00	0.0	0.0	1.0	0.0	1.	1.
590	0.0	7.00	7.00	31.0	0.0	0.0	0.0	2.	1.
591	0.0	7.00	7.00	0.0	320.0	0.0	0.0	6.	1.
592	0.0	7.00	7.00	31.0	0.0	0.0	0.0	2.	1.
593	1.00	7.00	8.00	0.0	0.0	1.0	0.0	1.	1.
594	0.0	8.00	8.00	0.0	0.0	1.0	0.0	4.	1.
595	1.00	8.00	8.00	0.0	0.0	1.0	0.0	1.	1.
596	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
597	9.70	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
598	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
599	3.08	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
600	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
601	5.08	9.00	14.08	0.0	0.0	1.0	0.0	1.	1.
602	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
603	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
604	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
605	1.32	14.08	15.40	0.0	0.0	1.0	0.0	1.	1.
606	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
607	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
608	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
609	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
610	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
611	4.								
612	5.								
613	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
614	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
615	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
616	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
617	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
618	1.32	15.40	14.08	0.0	0.0	1.0	0.0	1.	1.
619	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
620	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
621	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
622	5.08	14.08	9.00	0.0	0.0	1.0	0.0	1.	1.
623	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
624	2.00	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
625	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
626	9.70	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
627	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
628	5.50	9.00	3.50	0.0	0.0	1.0	0.0	1.	1.
629	0.0	3.50	3.50	0.0	0.0	1.0	0.0	4.	1.
630	0.50	3.50	3.00	0.0	0.0	1.0	0.0	1.	1.
631	0.0	3.00	3.00	90.0	0.0	0.0	0.0	5.	3.
632	0.50	3.00	2.50	0.0	0.0	1.0	0.0	1.	1.
633	0.0	2.50	2.50	31.0	0.0	0.0	0.0	2.	1.
634	0.0	2.50	2.50	0.0	0.0	1.0	0.0	1.	1.
635	0.0	2.50	2.50	31.0	0.0	0.0	0.0	2.	1.
636	1.00	2.50	3.50	0.0	0.0	1.0	0.0	1.	1.
637	0.0	3.50	3.50	0.0	0.0	1.0	0.0	4.	1.

B11

FILE: MFTF-A-RUNMFTF-A

TIME: 10:42:06

DATE 040579

PAGE 13

638 5.50 3.50 9.00 0.0 0.0 1.0 0.0 1. 1.
 639 0.0 9.00 9.00 31.0 0.0 0.0 0.0 2. 1.
 640 9.70 9.00 9.00 0.0 0.0 1.0 0.0 1. 1.
 641 0.0 9.00 9.00 31.0 0.0 0.0 0.0 2. 1.
 642 2.00 9.00 9.00 0.0 0.0 1.0 0.0 1. 1.
 643 0.0 9.00 9.00 31.0 0.0 0.0 0.0 2. 1.
 644 5.08 9.00 14.08 0.0 0.0 1.0 0.0 1. 1.
 645 0.0 14.08 14.08 31.0 0.0 0.0 0.0 2. 1.
 646 14.00 14.08 14.08 0.0 0.0 1.0 0.0 1. 1.
 647 0.0 14.08 14.08 31.0 0.0 0.0 0.0 2. 1.
 648 1.32 14.08 15.40 0.0 0.0 1.0 0.0 1. 1.
 649 0.0 15.40 15.40 31.0 0.0 10.0 0.0 2. 1.
 650 1.00 15.40 15.40 0.0 0.0 1.0 0.0 1. 1.
 651 0.0 15.40 15.40 0.0 0.0 1.0 0.0 4. 1.
 652 2.00 15.40 15.40 0.0 0.0 1.0 0.0 1. 1.
 653 0.0 15.40 15.40 340.0 0.0 0.0 0.0 3. 1.
 654 -5.
 655 6
 656 0.0 15.40 15.40 90.0 0.0 7.0 0.0 3. 1.
 657 26.00 15.40 15.40 0.0 0.0 1.0 0.0 1. 1.
 658 0.0 15.40 15.40 31.0 0.0 0.0 0.0 2. 1.
 659 8.50 15.40 6.90 0.0 0.0 1.0 0.0 1. 1.
 660 0.0 6.90 6.90 31.0 0.0 0.0 0.0 2. 1.
 661 18.50 6.90 6.90 0.0 0.0 1.0 0.0 1. 1.
 662 0.0 6.90 6.90 31.0 0.0 0.0 0.0 2. 1.
 663 7.90 6.90 -1.00 0.0 0.0 1.0 0.0 1. 1.
 664 0.0 -1.00 -1.00 31.0 0.0 0.0 0.0 2. 1.
 665 54.50 -1.00 -1.00 0.0 0.0 1.0 0.0 1. 1.
 666 0.0 -1.0 -1.0 31.0 0.0 0.0 0.0 2. 1.
 667 18.00 -1.00 -1.00 0.0 0.0 1.0 0.0 1. 1.
 668 0.0 -1.0 -1.0 31.0 0.0 0.0 0.0 2. 1.
 669 3.06 -1.00 2.06 0.0 0.0 1.0 0.0 1. 1.
 670 -6.
 671 308110.71 0.00
 672 10. 293.15
 673 0.0 0.0 0.100 0.0
 674 0.001389 0.1016 0.0254 0.0508 0.0508 0.0508 0.1016
 675 0.001042 0.1016 0.0254 0.0508 0.0508 0.0508 0.1016
 676 -1.
 677 #END
 678 #ASG.T DATAGHERC.
 679 #DATA.IL DATAGHERC.
 680 USER NAME
 681 TEST CASE FOR THE MFTF GASEOUS HELIUM SUPPLY SYSTEM (CVI)
 682 GHE RECOVERYSUBCRIT LAST DECK
 683 48.0 1.0 0.0
 684 0.0 0.0 340.0
 685 5.0 2.0 0.0
 686 0.0 0.0 340.0
 687 1.0 0.0 0.0
 688 0.0 0.0 0.0 1.0
 689 1.0 0.0 0.0
 690 0.0 0.0 340.0
 691 12.0 2.0 0.0
 692 0.0 0.0 340.0
 693 1.0 0.0 0.0
 694 -1.0
 695 1.0 0.0 0.0

696	0.0	0.0	340.0	
697	1.0	0.0	0.0	
698	0.0	0.0	77.0	
699	3.0	4.0	0.0	
700	7.0	3.0	0.0	
701	0.0	0.0	170.0	
702	2.0	1.0	0.0	
703	0.0	0.0	0.0	2.0
704	2.0	1.0	0.0	
705	0.0	0.0	0.0	3.0
706	2.0	0.0	0.0	
707	0.0	0.0	170.0	
708	5.0	3.0	0.0	
709	0.0	0.0	340.0	
710	1.0	1.0	0.0	
711	0.0	0.0	0.0	4.0
712	1.0	1.0	0.0	
713	0.0	0.0	340.0	
714	1.0	1.0	0.0	
715	0.0	0.0	340.0	
716	2.0	2.0	0.0	
717	0.0	0.0	240.0	
718	99.0	5.0	0.0	
719	0.0	0.0	340.0	

-2.0

720				
721	5	5	1	
722	1	16	1	
723	273.15		101.325	16542.86
724	293.15		101.325	16542.86
725	-1.0			

726	END	
727	MSG.N	TEST RUN OF THE CRYOGENIC SYSTEMS ANALYSIS PROGRAM
728	PASG.A	MFTF*CSA.
729	PCOPY.P	MFTF*CSA..TPF\$.
730	PXREF	MFTF*CSA.
731	PFREE	MFTF*CSA.
732	PXQT	TPF\$.ABS
733	PADD	CVIDATAMAG.
734	PADD	CVIDATACRP.
735	PADD	CVIDATAMCR.
736	PADD	DATALN2.
737	PADD	DATAGHERC.
738	PPMD.ELP	

. DUMP IF IN ERROR ONLY

APPENDIX C
PROGRAM ELEMENT FLOWCHARTS

Routine CØNTRL	C1
Subroutine CØMPIL	C8
Subroutine MAGNET	C18
Subroutine CRYPAN	C25
Subroutine HEMKUP	C33
Subroutine CMPCAL	C40
Subroutine GASRCV	C86
Subroutine N2MAIN	C95
Subroutine LNSYST	C103
Subroutine DPCAL	C123

CONTROL

FLOWCHARTED BY FORFLO /X888/ ON 31 MAR 79 AT 09:57:08

CONTROL

62

CONTRAL

[illegible]


~~~~~  
 ~~~~~  
 ~~~~~  
 ~~~~~

CONTRL

38

C&A 11

FLOWCHARTED BY FOHFLG /X800/ DN 31 MAR 79 AT 08:57:15

COMPL
CALO

50 10 112

[120]

.....
CONTINUE

***** READ IN THE CRYDPANEL
DATA

```
IF (PAGE(0))
```

FALSE

TRUE

```
WRITE (6,8050) (LO(I,3),I=1,9)
```

```
-[ 6050 FORMAT('0',30X9AB/' ')
```

READ (11N,5021) HUNCRP, PCRYDW, TCRYDW/
VHECDW, WDILCH, HEMNT /

```
-[ 5021 FORMAT(15,5X,5F10.2)
```

DD FORM 1 SEP 64, UNCLAS

701

```
READ (11H,5022) QCR(1),VHECR(1),HDCR(1),  
1),HDCR0(1),WDICR(1)
```

```

-| 5022 FORMAT(5F10.2)

```

```
READ (11N,5023) QLEAK1, QLEAK2
```

工

com 14

[illegible]

21

COMPL

[illegible]

XX

COMPL
CH

[illegible]

Z

```

1---[ 6003 FORMAT(I4,'COMPRESSOR-
2[PURIFIER ASSY: //T7, 'LOW-PRES.
3[HELIUM INLET', I37,F8.2,2F10.1,
4[F11,1//T7, 'HIGH-PRES. HELIUM
5[OUTLET', I37,F8.2, 2 F10.1,F11,
6[1//T10, '** TWO VALUES ARE
7[COMPUTED IN PROGRAM **')

```

[illegible]

.....
CONTINUE

```

1 ..... \ FALSE
PAGE(D)) ..... \
2 ..... /
3 ..... TRUE

```

```

1
1---( 6070 FORMAT('0',38X,9AB/' '))
1

```

I

I

I

COMPTL

COMPL

MAGNET

FLOWCHARTED BY FORFLO /X808/ ON 31 MAR 79 AT 08:57:27

CLB

UAGNET

```

1 1 CALL HEPROD(PMAGDW, TMAGDW, 1) 1 1
1 .....
1 |---| KG/CU-METER |
1 .....
1 RHO = HELD * HEMHI
1 .....
1 |---| KG, |
1 .....
1 PMAGI = PMAGDW * NEHEH(RHO, HDMAGI)
1 .....
1 |---| KPA |
1 .....
1 .....
1 |---| L/MOL |
1 .....
1 SVLINT = HELSV
1 SLVIN(1) = SVLINT
1 SLVIN(2) = SVLINT
1 .....
1 |---| DEG K |
1 .....
1 TMAGI = TMAGDW
1 .....
1 1 CALL HEPROD(PMAGI, TMAGI, 1) * MAG 1 1
1 1 INLET PROP 1 1
1 .....
1 1 CALL HEPROD(PMAGI, TMAGI, 3) * MAG 1 1
1 1 OUTLET PROP 1 1
1 .....
1 |---| DELTA-H, SUBCOOLED LIQUID TO |
1 | SAT. LIQUID |
1 |---| J/MOL |
1 .....
1 DELHI = HEHL - HELHI
1 .....
1 |---| DELTA-H, SUBCOOLED LIQUID TO |
1 | SAT. VAPOR |
1 |---| J/MOL |

```

```

      |
      |
      |-----|
      | DELH2 = HEND - HELH |
      |-----|
      |
      |---[ ENERGY TO RAISE CONDITION TO ]
      | [ SAT. LIQUID (NO FLOW) ]
      |---[ MOLS ]
      |
      |-----|
      |
      |---[ JOULES ]
      |
      |-----|
      | QSAT1 = QHANT * DELH1 |
      |-----|
      |
      |---[ ENERGY TO RAISE CONDITION TO ]
      | [ SAT. VAPOR (NO FLOW) ]
      |---[ JOULES ]
      |
      |-----|
      | QEVAP * QHANT = DELH2 |
      |-----|
      |
      |---[ ENERGY GENERATED IN MAGNETS PER ]
      | [ HOUR ]
      |---[ J/HR ]
      |
      |-----|
      | QGEQHR = QHANT * 3600.0 |
      |-----|
      |
      |---[ TIME TO OBTAIN NO FLOW COOLANT ]
      | [ LOSS ]
      |---[ HRS ]
      |
      |-----|
      | TIM4 = QSAT1/QGEQHR |
      |-----|
      |
      |---[ HRS ]
      |
      |-----|
      | TIM5 = QEVAP/QGEQHR |
      |-----|
      |
      |---[ DEG-K ]
      |
      |-----|
      | TEMP1 = HET |
      |-----|
  
```

```

      |---[ SATURATION TEMPERATURE      ]
      |
      |-----[ ]-----
      |-----[ ]-----
      |---[ MOL/L                        ]
      |
      |-----[ ]-----
      |-----[ ]-----
      |---[ MOL/L                        ]
      |
      |-----[ ]-----
      |-----[ ]-----
      |---[ MAX. GAS GENERATION AT NO FLOW ]
      |---[ CONDITION                    ]
      |---[ KG/HR                        ]
      |
      |-----[ ]-----
      |-----[ ]-----
      |---[ ENERGY REQD. FOR SAT. LIQUID AT ]
      |---[ SPECIFIED FLOW RATE (WDTLH1) ]
      |---[ JOULES/HR                    ]
      |
      |-----[ ]-----
      |-----[ ]-----
      |---[ QSAT2 = ((WDTLH1 * 1000.0)/HENMT) * ]
      |---[ DELH1                          ]
      |
      |-----[ ]-----
      |-----[ ]-----
      |---[ ENERGY AVAILABLE FOR VAPORIZATI ]
      |---[ N OF HELIUM                    ]
      |---[ JOULES/HR                      ]
      |
      |-----[ ]-----
      |-----[ ]-----
      |---[ QEVAP1 = QGEQHR - QSAT2          ]
      |
      |-----[ ]-----
      |-----[ ]-----
      |---[ VAPOR GENERATED AT SPECIFIED ]
      |---[ FLOW RATE                      ]
      |---[ KG/HR                          ]
      |
      |-----[ ]-----
      |-----[ ]-----
      |---[ WDTGHE = ((QEVAP1/DELH2) * HENWT)/1000.0 ]
      |
      |-----[ ]-----
      |-----[ ]-----
      |---[ DETERMINE THE QUALITY OF THE ]
      |---[ LIQUID                        ]
  
```

```

      |---| DEC-FRACTION                               1
      |
      |-----|
      | QUALQ = WDTQHE/WDTLH1 |
      |-----|
      |
      |---| SP. VOL. AND RHO OF THE LIQUID             |
      |   | OUT OF MAGNETS                               |
      |---| L/MPL                                         1
      |
      |-----|
      | SYLMIX = (1.0-QUALQ)*HESVL + QUALQ*HESVD        |
      | WDMIX = 1.0/SYLMIX |
      |-----|
      |---| KG/HR                                         1
      |
      |-----|
      | WDTL1(1) = WDTLH1/2.0 ; WDTL1(2) = WDTL1(1) |
      | 11 |
      |-----|
      |---| KG/HR                                         1
      |
      |-----|
      | WDTQH2 = WDTQHE/2.0 |
      |-----|
      |
      |-----|
      | WDTLMO = WDTLH1 - WDTQHE |
      |-----|
      |
      |---| COMPUTE BOILOFF IN STORAGE                 |
      |   | DEWAR DUE TO HEAT-LEAK                     |
      |---|
      |-----|
      | PSTODW = PMAGDW |
      | 1STODW = 1MAGDW |
      |-----|
      |
      |-----|
      | CALL HEPROP (PSTODW,1STODW,3) |
      |-----|
      |
      |---| J/MPL L TO G.                               1
      |
      |-----|
      | DLTHS = HENH - HENL |
      |-----|
      |
      |---| J/HR                                         1
      |
      |-----|
      |
      |-----|
  
```



```

      )---[ MOL/HR
      |
      |-----[ WDTMOL = QHTSHR/DLTHS
      |
      |---[ KG/HR
      |
      |-----[ WDGSTD = (WDTMOL * HEHWT)/1000.0
      |
      |---[ DEG. K
      |
      |-----[ TMSRT = HET
      |
      |-----[ .....
      |
      |-----[ JP = PAGE(0)
      |
      |-----[ WRITE (6,6000)
      |
      |-----[ 6000 FORMAT(/T27, '*** INITIALI
      |          PROGRAM AND CHARACTERIZE MAGNET
      |          INPT A TWO OUTPUT CONDITIONS --
      |          '///)
      |
      |-----[ .....
      |
      |-----[ WRITE (6,6100) WDTLHI, TMAGDW, PMAGI,
      |          HELD, HELSV, WDTLHI, HET, PMAGD, RQHL,
      |          RQHG, RQHIX, SVLIX, QVALG, WDTLNG,
      |          MOTGHE
      |
      |-----[ .....
      |
      |-----[ 6100 FORMAT(T55, '*** ESTIMATO
      |          MAGNET PARAMETERS --//T20, '
      |          FLUID FLOWING ICONDITONS: //T45,
      |          INLET FLOW RATE (KG/HR)', T80, E15,
      |          B, 2 //T45, 'INLET TEMPERATURE (
      |          DEG.K)', T80, E15, B, 2 //T45, '
      |          INLET PRESSURE ( KPA )', T80, E15,
      |          B, 4 //T45, 'INLET FLUID DENSITY
      |          (MOL/L)', T80, E15, B, 5 //T45, '
      |          INLET SPECIFIC VOLUME (L/MOL)',
      |          T80, E15, B, 8 //T45, 'OUTLET FLOW
      |          RATE (KG/HR)', T80, E15, B, 7 //T45,
      |          'OUTLET TEMPERATURE (DEG.K)', T80,
      |          E15, B, 8 //T45, 'OUTLET PRESSURE
      |          (KPA )', T80, E15, B, 8 //T45, '
      |          OUTLET LIQUID DENSITY (MOL/L)',
      |          T80, E15, B, 8 //T45, 'OUTLET GAS
      |          DENSITY (MOL/L)', T80, E15, B, 8 /
  
```

```

1  T45, 'OUTLET MIXTURE DENSITY(MOL/
1  L)', T88, E15, B, C / T45, 'OUTLET
1  MIXTURE SP. VOL. (L/MOL)', T88, E15,
1  B, D / T45, 'OUTLET FLUID QUALITY
1  (FRACT)', T88, E15, B, E // T45, '
1  OUTLET FLUID COMPOSITION' / T87, '
1  LIQUID (KG/HR)', T88, E15, B, F / T87,
1  VAPOR (KG/HR)', T88, E15, B, G)

```

```

.....
WRITE(8, 200) QGEQHR, TIM4, TIM5,
NTDMX2
.....

```

```

1  S2DB FORMAT(120, 'NO-FLOW
1  CONDITIONS:', D / T45, 'MAGNET
1  ENERGY (J/HR)', T88, E15, B, E /
1  T45, 'TIME TO SAT. LIQUID (HOURS)',
1  T88, F7, 3, F / T45, 'TIME TO SAT.
1  VAPOR (HOURS)', T88, F7, 3, G / T45,
1  'RATE OF VAPOR BOILOFF (KG/HR)',
1  T88, E15, B)

```

```

1  .....
1  DO THE MAGNET SUPPLY SYSTEM
1  COMPONENT CONFIGURATION ANALYSIS

```

```

.....
CALL CMPCAL
.....

```

```

.....
RETURN
.....

```

```

.....
END
.....

```

224

MAGNET

CRYPAN

FLOWCHARTED BY FORFLO /X806/ ON 31 MAR 79 AT 08:57:35

25

CRYPAN

CATPA

```

      DO 5 I = 1, NP
      CALL HEPROP(PCRYDM, TCRYDM, 1) @ GET
      LIQ PROPS
      ---[ KO/CU-METER
      RHO = HELD * HENMT
      ---[ KPA
      PCRYI(I) = PCRYDM * HEHEI(RHO, HOCRI(I))
      ---[ KPA
      PCRYD(I) = PCRYDM * HEHEI(RHO, HOCRO(I))
      ---[ L/MOL
      SLVIN(I) = HELSV
      ---[ DEG K
      TCRI(I) = TCRYDM
      DENS(I) = HELD
      CALL HEPROP(PCRYI(I), TCRI(I), 1) @ CP
      INLET PROP
      CALL HEPROP(PCRYO(I), TCRIO(I), 3) @ CP
      OUTLET PROP
      ---[ DELTA-H SUBCOOLED LIQUID TO SAT
      LIQUID
      ---[ J/MOL
  
```


[illegible]

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```

      15 FORMAT(110,'INLET FLOW RATE'
      135,'(KG/HR) = ',4(E12.6,GX))

      WRITE (8,16) (ICR1(I),I=1,NP)

      16 FORMAT(110,'INLET TEMPERATURE'
      135,'(DEG.K) = ',4(E12.6,GX))

      WRITE (8,17) (ICRV1(I),I=1,NP)

      17 FORMAT(110,'INLET PRESSURE',
      135,'( KPA ) = ',4(E12.6,GX))

      WRITE (8,18) (IDENS1(I),I=1,NP)

      18 FORMAT(110,'INLET FLUID
      DENSITY',135,'(MOL/L) = ',4(E12.
      6,GX))

      WRITE (8,19) (ISLV1(I),I=1,NP)

      19 FORMAT(110,'INLET SPECIFIC
      VOLUME',135,'(L/MOL) = ',4(E12.6
      GX 11/1)

      WRITE (8,20) (INDICR1(I),I=1,NP)

      20 FORMAT(110,'OUTLET FLOW RATE'
      135,'(KG/HR) = ',4(E12.6,GX))

      WRITE (8,21) (ICR2(I),I=1,NP)

      21 FORMAT(110,'OUTLET TEMPERATURE'
      135,'(DEG.K) = ',4(E12.6,GX))

      WRITE (8,22) (ICRV2(I),I=1,NP)

      22 FORMAT(110,'OUTLET PRESSURE'
      135,'( KPA ) = ',4(E12.6,GX))

      WRITE (8,23) (RHOL(I),I=1,NP)
  
```



```

      23 FORMAT(T10,'OUTLET LIQUID
      (DENSITY',T35,'(MOL/L) = ',4(E12,
      (6,6X))
      1
      WRITE (6,24) (RHOG(I),I=1,NP)
      24 FORMAT(T10,'OUTLET GAS
      (DENSITY',T35,'(MOL/L) = ',4(E12,
      (6,6X))
      1
      WRITE (6,25) (RHOG(I),I=1,NP)
      25 FORMAT(T10,'OUTLET MIXTURE
      (DENSITY',T35,'(MOL/L) = ',4(E12,
      (6,1 6X))
      1
      WRITE (6,26) (SVLMX(I),I=1,NP)
      26 FORMAT(T10,'OUTLET MIXTURE
      SP.VOL.',T35,'(L/MOL) = ',4(E12,
      (6,1 6X))
      1
      WRITE (6,27) (QUAL(I),I=1,NP)
      27 FORMAT(T10,'OUTLET FLUID
      (QUALITY',T35,'(FRACT) = ',4(E12,
      (6,1 6X))
      1
      WRITE (6,28) (WDTL(I),I=1,NP)
      28 FORMAT(T10,'OUTLET FLUID
      (COMPOSITION',T23,'LIQUID',T35,'
      (KG/HR) = ',4(E12,6,6X))
      1
      WRITE (6,29) (WDTG(I),I=1,NP)
      29 FORMAT(T23,'VAPOR',T35,'(KG/
      (HR) = ',4(E12,6,6X))
      1
      WRITE (6,30) (QGENHR(I),I=1,NP)
      30 FORMAT(T5,'HQ-FLOW
      CONDITIONS',T10,'INPUT
      CRYOPANEL ENERGY',T35,' (J/HR.
      = ',4(E12,6,6X))

```

HEMUP

FLOWCHARTED BY FORFLD /KROB/ ON 31 MAR 70 AT 08:57:43

03

HEMUP

C36

HEPMUP

```

      | TRUE |
      |-----|
      | WOGTOT = 302.0 |
      |-----|
      |
      | DWOOTOT = WOGTOT/3.6 |
      |-----|
      | ---[ SET LN2 BOILER HEX PARAMETERS ] |
      | ---[ J/GM ] |
      |-----|
      |
      | ---[ J/GM ] |
      |-----|
      |
      | DHW2VP = (HW20 - HW2V1)/GMWTN2 |
      |-----|
      | ---[ J/GM ] |
      |-----|
      |
      | SDHW2 = DHW2LV + DHW2VP |
      |-----|
      | ---[ KG/CU.M. ] |
      |-----|
      |
      | D1H2 = DN2L + GMWTN2 + 1000. |
      |-----|
      | ---[ KG/CU.M. ] |
      |-----|
      |
      | D1H2 = DN2L + GMWTN2 + 1000. |
      |-----|
      | ---[ KG/CU.M. ] |
      |-----|
      |
      | DN2HV = DN20 + GMWTN2 + 1000. |
      |-----|
      | ---[ HEAT TO BE REMOVED FROM HOT ] |
      | ---[ HELIUM ] |
      |-----|
      |
      | CALL HEPROP(PCB(1),TCB(1),2) |
      |-----|
      | ---[ J/GM ] |
      |-----|

```

НЕМКУ

1

1

1

1

1

1

1

1

```

      |---[ KG/CU.M.
      |
      |-----[
      | DHE3 = HELD + HEMMT * 1000.
      |-----[
      |---[ J/SEC
      |
      |-----[
      | QDTCH0 = (HHE3-HHE2) * (WDTCB(2) + WDTCB(
      | 4))
      |-----[
      |---[ KW
      |
      |-----[
      | Q2 = QDTCH0/1000.
      |-----[
      |---[ KG/CU.M.
      |
      |-----[
      | FMDT3 = (WDTCB(2)+WDTCB(4)) * 3.6
      |-----[
      |---[ J/SEC
      |
      |-----[
      | QDTCH1 = (HHE3-HHE2) * (WDTCB(2) + WDTCB(
      | 4) + DMGTOT)
      |-----[
      |---[ KW
      |
      |-----[
      | Q4 = QDTCH1/1000.
      |-----[
      |---[ KG/CU.M.
      |
      |-----[
      | FMDT4 = (WDTCB(2) + WDTCB(4) + DMGTOT) *
      | 3.6
      |-----[
      |---[ HEAT TO BE TAKEN OUT IN LN2
      | BOILER HEAT EXCHANGER
      |---[ J/SEC
      |
      |-----[
      | QDTLND = QDTCH1 - QDTCH0
      |-----[
      |---[ KW.
  
```

```

.....
Q3 = QDTLN0/1000.
.....
    ---[ J/SEC
    ]
.....
QDTLN2 = QDTNIE - QDICHE
.....
    ---[ KW
    ]
.....
Q5 = QDTLN2/1000.
.....
    ---[ QUANTITY OF LN2 REQUIRED AS
    ]
    ---[ FUNCTION OF TIME
    ]
    ---[ GM/SEC
    ]
.....
WDIN0 = QDTLN0/SDHN2
.....
    ---[ KG/CU.M.
    ]
.....
FWDI3 = WDIN0 * 3.6
.....
    ---[ GM/SEC
    ]
.....
WDIN2 = QDTLN2/SDHN2
.....
    ---[ KG/CU.M.
    ]
.....
FWDI5 = WDIN2 * 3.6
.....
    ---[ HEAT LOAD ON LN2 BOILER
    ]
    ---[ KW
    ]
.....
QSUBS = WDIN0 * DHN2LV/1000.
.....
    ---[ KW
    ]
.....
QSUB2 = WDIN2 * DHN2LV/1000.
.....
    ---[ .....
    ]

```

```

      ( ..... )
      |
      |-----|
      |      JP = PAGE(0)      |
      |-----|
      |
      |-----|
      |      WRITE (6,10)      |
      |-----|
      |
      |-----|
      |      10 FORMAT(/T28,'*** CHARACTER|
      |      |E REFRIGERATOR-LIQUIFIER INPUT|
      |      |AND NO INPUT CONDITIONS ***//|
      |      |T45,'** REFRIGERATOR-LIQUIFIER|
      |      |PARAMETERS ** 2'//T13,'ZERO MAKE|
      |      |UP FLOW CONDITIONS'//T54,'WARM|
      |      |HE - UPPER',T75,'COLD HELIUM|
      |      |THRU',T99,'LN2 BOILER AND'//T54,'|
      |      |HEX & LN2 BOILER',T79 4,'UPPER|
      |      |HEX',T102,'UPPER HEX'//)|
      |-----|
      |
      |-----|
      |      WRITE (8,20) TCB(1),TCB(2),TCB(3),PCB(1)|
      |      |11,PCB(2),PCB(3),DME1,DME2,OLN2,FMDT1,|
      |      |FMDT2,FMDT3,TCB(3),TCB(3),TCB(2),PCB(1)|
      |      |PCB(2),PCB(3),DME3,DME3,DN2HV,FMDT1,|
      |      |FMDT2,FMDT3,Q1,Q2,Q3,Q5485|
      |-----|
      |
      |-----|
      |      20 FORMAT(T21,'INLET TEMPERATURE|
      |      |( DEG.K )',E12.6,12X,E12.6,9X,|
      |      |E12.6/T21,'INLET PRESSURE ( KPA|
      |      |)',E12.6,12X,E12.6,9X, 2E12.6/|
      |      |T21,'INLET FLUID DENSITY (MG/CU.|
      |      |M)',E12.6,12X,E12.6,9X,E 312.6/|
      |      |T21,'INLET FLOW RATE ( KG/HR )',|
      |      |E12.6,12X,E12.6,9X,E1 42.6//T21,|
      |      |OUTLET TEMPERATURE ( DEG.K )',|
      |      |E12.6,12X,E12.6,9X,E1 52.6/T21,|
      |      |OUTLET PRESSURE ( KPA )',E12.6,|
      |      |12X,E12.6,9X,E12 6.6/T21,'OUTLET|
      |      |GAS DENSITY (KG/CU.M)',E12.6,|
      |      |12X,E12.6,9X,E12. 76/T21,'OUTLET|
      |      |FLOW RATE ( KG/HR )',E12.6,12X,|
      |      |E12.6,9X,E12.6 8//T21,'ENERGY|
      |      |TRANSFER ( J/HR )',E12.6,11X,|
      |      |',E12.6,9X, 3'4',E12.6//T21,|
      |      |HEAT LOAD:'/T28,'LN2 BOILER ( Mw|
      |      |',T99, 4 E12.6/)|
      |-----|
      |
      |-----|
      |      WRITE (6,30)      |
      |-----|
      |
      |-----|
      |      30 FORMAT(T13,'CURRENT MAKE-UP|
      |      |FLOW CONDITIONS'//T54,'WARM HE -|
      |      |UPPER 1',T75,'COLD HELIUM THRU'|
      |      |T99,'LN2 BOILER AND'//T54,'HEX &|
      |      |LN2 BOILE 2R',T79,'UPPER HEX',|
      |      |T102,'UPPER HEX'//)|
      |-----|

```

CMPCAL

FLOWCHARTED BY FORFLD /AB08/ ON 31 MAR 79 AT 08157:57

```

      .....
      BEGIN
  
```

```

      .....
      * * * * *
      * ROUTINE NAME - PRESSURE DROP
      * COMPUTATION *
      * FOR ENTIRE CONFIGURATION *
      * ROUTINE LANG - FORTRAN V
      * UNIVAC 1110 EXEC B *
      * PROGRAMMER - W.F. HAUSMAN 104-
      * 6213-30235 *
      * DATE CODED - AUGUST 23, 1978
      * * * * *
      * * * * *
      * INPUT DATA IS: PRESSURE IN
      * KPA, AND TEMP IN DEG. K *
      * * * * *
  
```

```

      .....
      SUBROUTINE CMPCAL
      .....
      .....
      INTEGER GSTATE, GLOOP
      REAL MUHE
      .....
      .....
      LOGICAL PAGE, JP
      .....
      .....
      INCLUDE CCONFIG
      .....
      .....
      INCLUDE CCNTRL
      .....
      .....
      INCLUDE CFLUID
      .....
      .....
      INCLUDE CIGOUNT
      .....
      .....
      INCLUDE CMAG
      .....
  
```

END

CMPCAL

CAL
CIRCUIT

```

1.....1
1
1.....1
1      INCLUDE CHAMES      1
1.....1
1
1.....1
1      INCLUDE CONST      1
1.....1
1
1.....1
1      INCLUDE CPAGE      1
1.....1
1
1.....1
1      INCLUDE TABLOK      1
1.....1
1
1.....1
1      IF CFUNCT = 1, A GAS GO TO (
1      100)
1      * 2, A MAGNET GO TO (200)
1      * 3, A LINE GO TO (300)
1      * 4, A CONTROL GO TO (400)
1      * 5, A FITTING GO TO (450)
1      * 6, A TAP GO TO (500)
1      * 7, A TEE GO TO (550)
1      * 8, A ELBOW GO TO (450)
1      * 9, A VALVE GO TO (400)
1      * 10, A REGULATOR GO TO (405)
1      * 11, A CRYOPANEL GO TO (600)
1      * 12, A REF-LIQ. GO TO (250)
1      * 13, A TANK GO TO (700)
1      * 14, A COMPUR GO TO (800)
1      * 15, A HF-CHMGR GO TO (800)
1      * 16, A END GO TO (1100)
1      *****
1
1      [ ***** INITIALIZE THE ROUTINE ]
1
1.....1
1      IDA = 0
1      ISIGN = 1
1      ITCE = 0
1      ITAP = 0
1      ITLO = 0
1      MAGIX = 0
1      ITANK = 0
1      JHM = 0
1      DEPTOT = 0.0
1      STSVOL = 0.0
1      C1 = 1.5134E-09/(GRAVITY * PI * PI)
1.....1
1
1.....1
1      NDXGAS = NDXGAS + 1
1.....1
1
1.....1
1      /.....1 \ FALSE

```


CHICAL

644

clinical

CHPCAL

CHICAL

648

CHPCAL

1- - - (KG/CU-M

1

```
1:1 CALL HEPROP(PRES(IDX),TEMP(IX1,3))
```

```

1      TEMP(IDX) = HET
2      QUALX = QUAL(IDX)

```

1-1-1 КО/СУ-М

```

1      RHOLGM = ((.0/SVLMIX) * MENWT
2      MUHE = (((1.0-QUALX) * HELVSC) + QUALX *
3      HEGVSC) * 0.00001
4      REYNO(IDX) = (DTAM(IDX)*(VELO(IDX)/3600.)
5      *RHOLGM)/MUHE
6      HOLF = HIEHD(RHOLGM,CHEAD(IDX))
7      PRES(IDX) = PRES(IDX) + HOLF

```

1

GO 10 889

-[***** PROCESS A REFRIGERATOR -
[LIQUIFIER UNIT *****

[250]

CONTINUE

Z

CHICAL

 S U X
 S U X
 S U X

```

      0<-----0
[ 352]
      WDOTN(1DX) = WDTCB(3)*3.6+WDGMAQ +
      WDGCRY
      WDOTG(1DX) = WDOTN(1DX)
      WDOTL(1DX) = 0.0
      PRES(1DX) = PCB(1)
      TEMP(1DX) = TCB(3)
      RDENS(1DX) = RDENS(1DX-1SIGN)
      DELP(1DX) = 0.0
      VELO(1DX) = 0.0
      REYNO(1DX) = 0.0

      GO TO 999

      0<-----0
[ 253]
      WDOTN(1DX) = WDTCB(4)*3.6 + WDGMAQ +
      WDGCRY + WDGSTO
      WDOTG(1DX) = WDOTN(1DX)
      WDOTL(1DX) = 0.0
      PRES(1DX) = PCB(3)
      TEMP(1DX) = TCB(2)
      RDENS(1DX) = RHOGAS(PRES(1DX),TEMP(1DX))
      DELP(1DX) = 0.0
      VELO(1DX) = 0.0
      REYNO(1DX) = 0.0

      GO TO 999

      0<-----0
[ 254]
      WDOTN(1DX) = WDOTN(1DX-1SIGN)
      WDOTG(1DX) = WDOTG(1DX-1SIGN)
      WDOTL(1DX) = WDOTL(1DX-1SIGN)
      PRES(1DX) = PRES(1DX-1SIGN)
      TEMP(1DX) = TEMP(1DX-1SIGN)
      RDENS(1DX) = RDENS(1DX-1SIGN)
      DELP(1DX) = 0.0
      VELO(1DX) = VELO(1DX-1SIGN)
      REYNO(1DX) = REYNO(1DX-1SIGN)

      GO TO 999

      ] --[ ***** PROCESS A CRYOPANEL *****
[ 800]

```


COPY

3

CHURCHILL

[310]

GO TO 519

```

[---] ***** PROCESS A CONTROL *****

```

[400]

```
< IF (HPSYS.EQ.3).AND.(IDV.EQ.5)) GO TO  
< 430
```

..... 1 FALSE

```

.....
IF(NPSYS.EQ.3) GO TO 311
.....

```

GO TO 310

[430]

CONTINUE

CS3

CHICAL

```

      |-----| PROCESS A JOULE-THOMPSON |
      | VALVE -----|
      |-----| RESET TO THE LIQUID STATE |
      |
      |-----|
      | GSTATE = 3 |
      |
      |-----|
      | WOOTN(IX) = WOOTN(IX-15IGN) |
      | WOOTL(IX) = 0.0 |
      | WOOTL(IX) = WOOTN(IX) |
      | PRES(IX) = PCBL(2) |
      | TEMP(IX) = TCB(10) |
      |
      |-----|
      | CALL NEPROP (PRES(IX),TEMP(IX)) |
      |
      |-----|
      |-----| KG/CU.M. |
      |
      |-----|
      | RDENS(IX) = HELO + HEMH |
      | MMHE = HELVSC + 0.00001 |
      | VELO(IX) = 0.0*WOOTN(IX)/(PI * DIAM( |
      | IX)**2 + RDENS(IX)) |
      | REYNO(IX) = (DIAM(IX)*(VELO(IX)/3800. |
      | 0)*RDENS(IX))/MMHE |
      | DELP(IX) = 0.0 |
      | QUAL(IX) = 0.0 |
      |
      |-----|
      |-----| GO TO 999 |-----|
      |
      |-----|
      |-----| ***** PROCESS A REGULATOR ***** |
      |
      |-----|
      | FLD = FRCCOF(IX)*OD(IX) |
      | IDV = CFTYPE / 10 |
      | CTYPE = CFTYPE - IDV + 10 |
      | DIAM(K) = AMEN(GIAM(IX+1),DIAM(IX-1) |
      | ) |
      | CMPVOL(IX) = VOLC(FUNCT,CTYPE,IDV, |
      | GIAM(IX) |
      | WOOTN(IX) = WOOTN(IX-15IGN) |
      | WOOTL(IX) = WOOTL(IX-15IGN) |
      | WOOTG(IX) = WOOTG(IX-15IGN) |
      | RDENS(IX) = RDENS(IX-15IGN) |
      | TEMP(IX) = TEMP(IX-15IGN) |
      |
      |-----|
      |
      |-----|
      | IF ((MAG(X.EQ.1).OR.(MAG(X.CO.3)))GO TO TRUE

```

[illegible]

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CNICAL

```

1 CWPVOL(1DX) = CVOL(CFUNCT,CFTYPE,LDV,
2 DIAM(1DX))
3 TEMP(1DX) = TEMP(1DX-1SIGN)
4
5 IF(NPSYS.EQ.3) GO TO 470
6
7 WDOTN(1DX) = WDOT(1GLOPP)
8 WDOTL(1DX) = WDOTL(1DX-1SIGN)
9 WDOTG(1DX) = WDOTG(1DX-1SIGN)
10 WDOTS(1DX) = WDOTS(1DX-1SIGN)
11
12 IF((MAG1X.EQ.1).OR.(MAG1X.EQ.3))GO TO
13 862
14
15 VELOC(1DX) = VELF(WDOTN(1DX),SULVEN,HEMWT,
16 DIAM(1DX))
17
18 GO TO 863
19
20 [ 862 ]
21 CONTINUE
22 VELD(1DX) = VELF(WDOTN(1DX),SLVIN(1GLOPP),
23 HEMWT,DIAM(1DX))
24
25 [ 863 ]
26 CONTINUE
27
28 ITEE = ITEE + 1
29
30 IF(ITEE.EQ.1) GO TO 461
31
32 IF(ITEE.EQ.2).AND.(NPSYS.EQ.1))

```

◎ 2000年12月10日 星期四

```

      TRUE
      |
      |-----|
      | WOOTN(IDX) = WOTLH |
      |-----|
      | Q |
      |-----|
      | IF((IEEE.EQ.2).AND.(NPSYS.EQ.2)) | FALSE
      |-----|
      | TRUE |
      |-----|
      | WOOTN(IDX) = WOTLCH |
      |-----|
      | Q |
      |-----|
      | WOOTG(IDX) = WOOTG(IDX-1SIGN) + 2.0 |
      | RDENS(IDX) = RDENS(IDX-1SIGN) |
      |-----|
      | GO TO 462 |
      |-----|
      | Q |
      |-----|
      | 461 |
      |-----|
      | CONFINE |
      | TEMPB = TEMP(IDX) |
      |-----|
      | IF(NPSYS.EQ.1) GO TO 510 | TRUE
      |-----|
      | FALSE |
      |-----|
      | DD 464 IZ = 2,NUMCRP |
      |-----|
      | WOOTB(IZ) = WOOTI(IZ) |
      |-----|
      | IF(IZ.EQ.3) | FALSE
      |-----|
      | TRUE |
      |-----|
      | WOOTB(IZ) = WOOTI(IZ) + WOOTI(IZ,1) |
      |-----|
      | Q |
      |-----|
  
```

[illegible]

[illegible][illegible]

```

1                                     I FALSE
1                                     I
2 WOOTNQ = WOOTNQ + WOOTME(IX)
2 WOOTLO = WOOTLO + WOOTLL(IX)
2 WOOTGO = WOOTGO + WOOTGI(IX)
1
1                                     I
1 [ 502 ]
1                                     I OK
1
-----
1 CONTINUE
1 RDENS(IX) = RDENS(IX-1SIGN)
1 LOV = TYPE/10
1 CFTYPE = CFTYPE - LOV = 10
1 FLD = FCODEF(IX) + LOO(IX)
1 TEMP(IX) = TEMP(IX-1SIGN)
1 DIAM(IX) = AMINI(DIAM(IX+1),DIAM(IX-1))
1
1                                     I
1                                     I
1 < IF(DIAM(IX).EQ.0.0)
1                                     I
1                                     I TRUE
1
1 DIAM(IX) = DIAM(IX+1)
1
1                                     I
1                                     I
1 < IF(SFAREA = PSE + DIAM(IX) * 0.5225
1 GUSE = OLAM1
1 CMPVOL(IX) = CVDL(CFUNCI,CFTYPE,LOV,
1 DIAM(IX))
1
1                                     I
1
1 < IF(MADIX.EQ.1).OR.(MADIX.EQ.3)GO TO
1 < 884
1                                     I FALSE
1
1                                     I
1
1 VELD(IX) = VELF(WOOTN(IX),SYLNEN,HEAM,
1 DIAM(IX))
1
1                                     I
1
1 ( GO TO 805 )
1
1
1 [ 804 ]
1                                     I OK
1
1 CONTINUE

```

[illegible][illegible]

[illegible]

● 本報為便利讀者起見，特在報內附設「讀者信箱」，歡迎讀者來信。來信請註明真實姓名及地址，以便本報轉寄。來信請寄：本報編輯部，地址：台北市中正區中正路一號。來信請註明真實姓名及地址，以便本報轉寄。來信請寄：本報編輯部，地址：台北市中正區中正路一號。

PLATE

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CNPGAL

CNICAL

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      |
      | TRUE
      |
      |-----|
      | CIMPVOLI(IX) = WIECOM/1000.0 |
      |-----|
      |
      | O<
      |
      |-----|
      | WOOTL(IX) = WOOTL(IX-1SIGN) |
      |-----|
      |
      | |
      | | IF(1TANK.EQ.1) |
      | |-----| FALSE |
      | |
      | | TRUE |
      | |-----|
      | |
      | | WOOTL(IX) = WOOTN(IX) |
      | |-----|
      | |
      | | O<
      | |-----|
      | | WOOTG(IX) = WOOTG(IX-1SIGN) |
      | |-----|
      | | PRES(IX) = PTANK |
      | | TEMP(IX) = ITANK |
      | | RDENS(IX) = RWOLQ(PTANK, TTANK) |
      | |-----|
      | | VELOI(IX) = 0.0 |
      | | DELPI(IX) = 0.0 |
      | | REVHGI(IX) = 0.0 |
      | | QVAL(IX) = 0.0 |
      | |-----|
      | |
      | | | | |
      | | | IF(1TANK.EQ.2) GO TO 751 |
      | | |-----| TRUE |
      | | |
      | | | FALSE |
      | | |-----|
      | | |
      | | | GO TO 999 |
      | | |-----|
      | | |
      | | | O<
      | | |-----| | |
      | | | [ 720] |
      | | |-----|
      | | | CONTINUE |
      | | |-----|
      | | |
      | | | |
      | | | | IF(1TANK.EQ.1) |
      | | | |-----| FALSE |
      | | | |
      | | | | TRUE |
      | | | |-----|
      | | | | WOOTN(IX) = WOGMAQ * TEMP(IX) * |
      | | | | IMPWR |
      | | | |-----|
      | | | | O<
      | | | |-----|

```

[illegible]

CPICAL

```

1 VOLCRV = SVSVOL ; WDCRV = WOTMMU ;
1 WOLCRV = WDIRTN
1 .....
1 O<-----
1 .....
1 IF(NPSVS.EQ.2) ..... FALSE
1 .....
1 TRUE
1 .....
1 IMPCRT = IEMFIN
1 .....
1 O<-----
1 .....
1 IF(NPSVS.EQ.1) ..... FALSE
1 .....
1 TRUE
1 .....
1 WRITE (6,6052) DLP101
1 .....
1 O<-----
1 .....
1 IF(NPSVS.EQ.1) ..... FALSE
1 .....
1 TRUE
1 .....
1 WRITE (6,6056) SVSVOL, VOLLL17
1 .....
1 O<-----
1 .....
1 IF(NPSVS.EQ.2) ..... FALSE
1 .....
1 TRUE
1 .....
1 WRITE (6,6053) DLP101
1 .....
1 O<-----
1 .....
1 IF(NPSVS.EQ.2) ..... FALSE
1 .....
1 TRUE
1 .....
1 WRITE (6,6057) SVSVOL, VOLLL17
1 .....
1 O<-----
1 .....
1 IF(NPSVS.EQ.3) ..... FALSE
1 .....
1 TRUE
1 .....

```

CANCEL

END

083
CIRCAL

CNICAL
CMA

```

1 6060 FORMAT(120,'NOMINAL VOLUME
1 OF HELIUM IN TANK - (LITERS) *',
1 175.F10.4//120,'TANK OUTFLOW
1 OF HELIUM',175,'(KG/HR) *',175.)
1 2 F10.4//120,'LIQUID HELIUM IN
1 RETURN FLOW',175,'(KG/HR) *',
1 175., 3 F10.4//120,'LIQUID
1 HELIUM MAKE-UP REQUIRED',175,'
1 (KG/HR) *', 4 175.F10.4//120,'
1 RETURN FLUID QUALITY',145,'
1 (DECIMAL FRACTION) *', 5 175.F10.
1 4)
1 6065 FORMAT// 110,'TOTAL
1 PRESSURE DROP IN THE REFRIGERATO
1 LIQUIFIER LOOP *',175.E13.0,
1 170.'MPA' /120,'(REF-LIQ.
1 INCLUDED) (J-T VALVES 2 EXCLUDED
1 /)
1 6066 FORMAT 110,'TOTAL FLUID
1 VOLUME IN THE REFRIGERATION-
1 LIQUIFIER LOOP *',170.E13.0,
1 175.'CUBIC METERS',170,'(F10.
1 2.' LITERS)', 3 /120,'(REF-LIQ.
1 INCLUDED) /)
1 6067 FORMAT// 110,'TOTAL
1 PRESSURE DROP IN THE COMPRESSOR-
1 PURIFIER LOOP *', 175.E13.0,
1 170.'MPA' /120,'(CMP-PUR.
1 EXCLUDED) /)
1 6068 FORMAT 110,'TOTAL FLUID
1 VOLUME IN THE COMPRESSOR -
1 PURIFIER LOOP *', 170.E13.0,
1 175.'CUBIC METERS',170,'(F10.
1 2.' LITERS)', 3 /120,'(CMP-PUR.
1 INCLUDED) /)

```

RETURN

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1 6070 FORMAT(10,'***** OUTPUT FORMATS
1
1 6080 FORMAT(10,'DIAGNOSTIC*
1 TANK INPUT PRESSURE IS LESS THAN
1 THE REQUIRED PRESSURE. TANK
1 PRESSURE SET = REQUIRED PRESSURE
1 /15A,'TANK INPUT PRESSURE = ',F7
1 2.2., REQUIRED PRESSURE = ',F7
1 2)
1 6085 FORMAT(10,'**ERROR** ISIGH
1 ',13,'THERE IS A CONFIGURATION
1 ERROR' /)
1 6090 FORMAT(10,'**ERROR** A PUMP
1 WAS ENCOUNTERED BUT NO TANK CAN
1 BE FOUND. 1 PUMP CONFIGURATION
1 (INDIA NUMBER = ',13)
1 6095 FORMAT(10,' CODE FOR G GS
1 (UNIT NOT-T WOOD-L WOOD-G 1

```

```

[ QUAL- TEMP. PRESS. DELTA-P
[ VELOCITY DENSITY MEVN 20LDS'/127
[ 'IM) (KG/HR) (KG/HR) (KG/HR) ITY
[ 'T71 (K1)' 179. 3 '(KPA) (KPA)
[ M/HR) (KG/CU-M) NUMBER'?)
[
[ 6021 FORMAT('D F CODE IDN G GS
[ DIAM. WOOD-T WOOD-L WOOD-G 1
[ QUAL- TEMP. PRESS. DELTA-P
[ VELOCITY DENSITY R.VN 20LDS'/127
[ 'IM) (KG/HR) (KG/HR) (KG/HR) ITY
[ 'T71 (K1)' 179. 3 '(KPA) (KPA)
[ M/SEC) (KG/CU-M) NUMBER'?)
[
[ 6030 FORMAT(2X40,2X40,14,213,F7
[ 2,3F9.3,F9.5,F8.3,F10.4,F10.8,
[ F11.4, 1 F11.6,212.3)
[
[ 6040 FORMAT (144, '***
[ TERMINATE - NEGATIVE TEMP. OR
[ PRES. ***.)
[
[ 6050 FORMAT(116, '*** SUMMARY
[ OF COMPUTED SYSTEM CONFIGURATION
[ PARAMETE IRS - FOR 'SAB, ' ***.)
[
[ 6051 FORMAT(1132, '*** SUMMARY OF
[ COMPUTED SYSTEM CONFIGURATION
[ PARAMETE
[ IRS - CONTO. ***.)

```

END

CAS

CIPAL

ANALYSIS

FLOWCHARTED BY FORFLD /X808/ ON 31 MAR 78 AT 09:59:49

CBS
GASFCV

SUBROUTINE GASFCV1G,PBAD,PCOMP)

LOGICAL PAGE, JP

INCLUDE CPAGE

COMMON/HEGAS/RL(100),RN(100),RLO(100),
COMP(2,100)
COMMON/HEGAS/RL1(100),RN1(100),RLO1(100)
COMMON/HEGAS/HUMBLO,HUMBN1
COMMON/HEGAS/MINIT,MFINAL,MSTEP
COMMON/HEGAS/IDIAM1,IDIAM2,ISTEP

--- SPECIFY MDOT(KG/SEC) AND DIA(M)
--- EVALUATE REYN AND F-FACTOR

REAL MDOT

DO 390 JJ=MINIT,MFINAL,MSTEP

R1=1
MDOT=0.01+R1

DO 390 JJ=IDIAM1,IDIAM2,ISTEP

RJ=RJ+1
DIA=0.0+RJ
REYN=2.645E8*MDOT/(DIA**3)
F=0.005
BOUND=0.01

[100]

2

C68

CLIST

```

1      CONTINUE
2
3      JP = PAGE(0)
4
5      /-----/
6      WRITE (6,130) DIA, MDOT, REYN, F
7
8      /-----/
9      [ 130 FORMAT(1H0,T3,'DIA(METER)',
10     [ F8.3,T29,'MDOT(KG/SEC)',F8.3,T50
11     [ 'REYNOLD'S NUMBER',F10.4,T62,'F
12     [ 'FACI/F',F9.6)
13
14     /-----/
15     WRITE (6,140) TQ, PMAQ, PCOMP
16
17     /-----/
18     [ 140 FORMAT(1H0,'TQ-',F7.2,T35,'
19     [ 'PMAQ-',F8.3,T65,'PCOMP-',F9.2)
20
21     /-----/
22     WRITE (6,150)
23
24     /-----/
25     [ 150 FORMAT(1H0,'LINE',T12,'END
26     [ 'NODES',T26,'DP',T40,'DP/LIGDOM',
27     [ 'TGO', 'IMACH NO.',T76,'PRESSURE',
28     [ 'T92,'DENSITY')
29
30     /-----/
31     WRITE (6,160)
32
33     /-----/
34     [ 160 FORMAT(1H0,'(KPA)',T41,'(
35     [ 'KPA/M',T77,'(KPA)',T91,'(KG/M**
36     [ '3)',T99)
37
38     /-----/
39     [ LOW PRESSURE HELIUM RECOVERY
40     [ SYSTEM LINE ANALYSIS
41
42     /-----/
43     PP=PBAG
44
45     /-----/
46     CALL DENCAL(LEN,PP,TG)
47
48     /-----/
49     RMACH=2.163E-2*MDOT/(LEN*DIA*DIA*SQRTE(TQ)
50
51     /-----/

```

[illegible]

```

WRITE (8,170)RMACH,PP,DEN
-----|
| | 170 FORMAT(15,'  
| LINE ANALYSIS',/,  
| RECOVERY MAG EXIT  
| T75,F12.4,I92,F7.2,  
|  
DO 240 NAL=1,NMULO
-----|
| N1=NAB  
| N2=NABD  
XLD=(N1*(NA)/DIA)*(21.0*RN1(NA))+RND1(NA)
-----|
| IF (XLD.LE.0.0) GO TO 239
| FALSE
|  
IF (RND1(NA).GT.0.0) GO TO 186
| FALSE
|  
CALL DPLINE(DP,P,XLD,PP,RMACH,PGRAD,  
DIA)  
|  
GO TO 190
|  
[ 140 ]  
|  
CALL DPVAL(VDP,P,XLD,PP,MODT,DEN,DIA,  
PGRAD)  
|  
D=PP-OP  
|  
IF (DP.LT.0.0) GO TO 250
| FALSE
|  
PP=OP  
|  
CALL DENCAL(DEN,PP,T0)

```

TRUE

[illegible]

[illegible]

```

      RMACH=3.163E-3*DDOT7(DEN-DIA-DIA-SQRT170)
      IF (RMACH.GT.0.7745) GO TO 200
      FALSE
      IF (PGRAD.LT.0.0) GO TO 210
      FALSE
      WRITE (6,200)KA,K1,K2,DP,PGRAD,RMACH,
      PP_DEN
      200 FORMAT('E',L
      13,I22,F9.4,I30,
      179,F1 1E.4,I22,F
      GO TO 240
      210
      WRITE (6,220)KA,K1,K2,DP,RMACH,PP_DEN
      220 FORMAT('E',L
      13,I22,F9.4,I30,
      179,F7 1.3)
      GO TO 240
      230
      TYPE=COMP(S,NA)
      CALL IDMPDP(TYPE,DP)
      DP=DP

```

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1970	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100

092

DATA

094

02450

N2MAIN

FLOWCHARTED BY FORFLO /X808/ ON 04 APR 78 AT 22:00:26

035

IN/IN

 

[illegible]

 

42441

NNNNNNNN

N2MAIN

C102

LN5751
C104

{ 110 }

WRITE (6,120)DIAM,WDOT1,WDOTV,QUAL1,1.
PKPA,FRIC1,REYN,VAPVEL,VAPMCH,DENS

```

1      00 160 J=1,JMAX(1)
1      A1=XLEN(1,J)
1      A2=ZIN(1,J)
1      A3=ZOUT(1,J)
1      A4=E(F(1,J)
1      A6=QNET(1,J)
1      A6=TYPE(1,J)
1      A7=ATNUM(1,J)

```

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LN5Y5T

6207

LM5Y87

DO 330 I=2,5

```

1      *****
2      DIAM=DIAC(I)
3      WDOT=WFLOW(I)
4      QUALI=QUALIN
5      P=PVALIN
6      T=TBENCH

```

[190]

```

1      DD 240 J.1,UMAX(1)
2      A1=XLEM(1,J)
3      A2=ZIN(1,J)
4      A3=ZOUT(1,J)
5      A4=EFF(1,J)
6      A5=QNET(1,J)
7      A6=TYPE(1,J)
8      A7=THUM(1,J)

```

```

IF (AB.HE.5.0) GO TO 200
      FALSE

```

```

      I
      I
.....
      WDOT=WDOT/TNUM(I,J)
.....

```

30

[200]

```
1 1 CALL DPCALC(DP,12,A1,A2,A3,A4,A5,A6. 1
1 1 A7) 1
```

.....

```

1
.....
< IF (ALEN(I,J).EQ.0.0) GO TO 210
.....
1 FALSE

```

```

1
1
.....
1      PGRAD=DP/(1000.0*KLEN(I,J))
1
.....

```

[illegible]

LAST

```

1 DET3
1 C(2,1,1)=(Y(2,1)*DET1-XY(2,1)*DET2+XV(2,
1 1)-DET3)/DENOM
1 DET1=(X1(2,1)*X4(2,1)-X2(2,1)*X3(2,1))
1 DET2=(X0(2,1)*X4(2,1)-X2(2,1)*X2(2,1))
1 DET3=(X0(2,1)*X3(2,1)-X1(2,1)*X2(2,1))
1 C(2,2,1)=(Y(2,1)*DET1+XY(2,1)*DET2-MAY(
1 2,1)-DET3)/DENOM
1 DET1=(X1(2,1)*X3(2,1)-X2(2,1)*X2(2,1))
1 DET2=(X0(2,1)*X3(2,1)-X2(2,1)*X1(2,1))
1 DET3=(X0(2,1)*X2(2,1)-X1(2,1)*X1(2,1))
1 C(2,3,1)=(Y(2,1)*DET1-XY(2,1)*DET2+XV(2,
1 1)-DET3)/DENOM
1 FLAG(2,1)=FLAG(2,1)+1.0
1 .....

```

GO TO 330

[200]

```

1 X(1,1)=X(1,1)+MFLOW(1)
1 X2(1,1)=X2(1,1)+MFLOW(1)*2
1 X3(1,1)=X3(1,1)+MFLOW(1)*3
1 Y(1,1)=Y(1,1)+DPEXIT(2)
1 XV(1,1)=XV(1,1)+DPEXIT(1)+MFLOW(1)
1 .....

```

```

1 IF (FLAG(1,1)-1.0) 250,300,320
1 .....

```

[250]

```

1 C(1,1,1)=0.0
1 C(1,2,1)=DPEXIT(1)/MFLOW(1)
1 C(1,3,1)=0.0
1 FLAG(1,1)=FLAG(1,1)+1.0
1 .....

```

GO TO 330

[300]

```

1 C(1,1,1)=0.0
1 DENOM=X1(1,1)*X3(1,1)-X2(1,1)*X2(1,1)
1 C(1,2,1)=(Y(1,1)*X3(1,1)-X2(1,1)*XV(1,1)
1 /DENOM
1 C(1,3,1)=(X3(1,1)*XV(1,1)-X2(1,1)*Y(1,1)
1 /DENOM
1 FLAG(1,1)=FLAG(1,1)+1.0
1 .....

```

.....

```

graph TD
    Start(( )) --> JTAG1[JTAG=1]
    JTAG1 --> DO360[DO 360 IS=2.5]
    DO360 --> IFABS[IF ABS(ORAVG-OREXT(15)) GE 100.0]
    IFABS -- TRUE --> JTAG8[JTAG=8]
    IFABS -- FALSE --> IFEQ340[IF OREXT(15) EQ 340]
    IFEQ340 -- TRUE --> GO350[GO TO 350]
    IFEQ340 -- FALSE --> CC[CC(1,15)-CC(1,15)  
CC(2,15)-CC(2,15)  
CC(3,15)-CC(3,15)]
    CC --> GO350
    GO350 --> J340[340]
    J340 --> CC1[CC(1,15)-CC(2,15)  
CC(2,15)-CC(2,15)  
CC(3,15)-CC(3,15)]
    CC1 --> J350[350]
    J350 --> CONT1[CONTINUE]
    CONT1 --> J360[360]
    J360 --> CONT2[CONTINUE]
    CONT2 --> IFJTAG[IF JTAG.EQ.0 GO TO 460]
    IFJTAG -- TRUE --> End(( ))
    IFJTAG -- FALSE --> End

```

LNSYSF

CTID

LS15M1

A

CLL

ISMSH

[illegible]

 

```

1      WRITE (7,120)DIAM,WOODTL,WOODTV,QUALTY,
2      PKPA,FRICE,REYN,VAPVEL,VAPMCH,DENS
3      .....
4      IFLAG=0
5      DO 510 J=1,224(1)
6      IFLAG=IFLAG+1
7      A1=XLEN(1,J)
8      A2=ZINI(1,J)
9      A3=ZOUT(1,J)
10     A4=EFF(1,J)
11     A5=QNE(1,J)
12     A6=TYPE(1,J)
13     A7=TNUM(1,J)
14     .....
15     IF (AS.NE.5.0) GO TO 470
16     FALSE
17     .....
18     WOODT=WOODT/TNUM(1,J)
19     .....
20     GO TO 470
21     .....
22     CALL DPCAL(DP,T2,A1,A2,A3,A4,A5,A6,
23     A7)
24     .....
25     IF (XLEN(1,J).EQ.0.0) GO TO 490
26     FALSE
27     .....
28     PGRAD=DP/(1000.0-XLEN(1,J))
29     .....
30     GO TO 490
31     .....
32     GO TO 460
33     .....
34     PGRAD=.0
35     .....
36     GO TO 490
37     .....

```

[illegible]

The diagram illustrates a sequence of operations. At the top, there are 16 squares, each followed by a circle containing a number from 0 to 15. Below this, a long horizontal sequence of circles is shown, representing a stream of data or operations.

6179

15A5N7

C120

UNSYT

LM575T

[illegible][illegible]

20

0<

[660]

RETURN

LNSYST

G122

DPCAL

FLOWCHARTED BY FORFLG /K808/ ON 04 APR 79 AT 22:00:03

C123

DPCAL

```

IF (P.LI.101325.0) GO TO 240
I FALSE

```

TRUE

[illegible]

CL26

10340

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```

[illegible]

```

1      QUAL2A=QUAL2      1
2      1COUNT=1COUNT+1 2
3      -----
4      IF (1COUNT.GT.10) GO TO 210  TRUE
5      FALSE
6      GO TO 140
7      -----

```

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GO TO 240

```

1
1---[ PRESSURE DROP ANALYSIS IN FOR ]
1   [ QUALITY =1.0 CASES

```

```

1 220]
1 XFRAC1=(MV2-QUAL1*HV1)/(DP-DH1-Q.4258*(
1 A3-A2)/(A5/WQ1))
1 PFRAC1=XFRAC1*DP
1 P=P1-PFRAC1

```

```

      1
      <-----> TRUE
      IF (P.LF.101325.0) GO TO 240
      1 FALSE

```

```

.....
1)      CALL NZPROP(P,I)
.....

```

```

1          TQUAL=1
1          A1=A1*(1.0-XFRAC1)
1          A2=A2*(1.0-XFRAC1)
1          A3=A3*(1.0-XFRAC1)

```

[illegible]

0129

08CA4

[illegible]

XXXXXXXXXXXX

OPCAL
GL30

APPENDIX D

SAMPLE PROGRAM LISTING

MFTF*CSA

Magnet Supply System	D21
Cryopanel Supply System	D30
Refrigerator-Liquefier Subsystem	D41
Liquid Nitrogen Supply System	D57
Gaseous Helium Recovery System	D77

APPENDIX A

MEF*CSA PROGRAM LISTING

DATA,IL
DATA BR1

CSATAB.

LMSC49 04/05/79 12:13:53 (0)

1. FTU OF 321/347 ST. STEEL 2 3 1
2. EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF 321/347 STAINLESS STEEL
3. REF. MIL HANDBOOK -5.
4.

5. TEMPERATURE (R) ULT. STRENGTH (PSI)

15	1	2			
7.2	279500.	18.0	273500.	27.0	269500.
36.7	266500.	59.7	251000.	159.7	207000.
259.7	173000.	359.7	143000.	459.7	121000.
559.7	108000.	659.7	91000.	859.7	75000.
1059.7	70000.	1259.7	66000.	1459.7	63000.

12. FTU OF 2219-T87 ALUM. 2 3 2
13. EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF 2219-T87 ALUMINUM
14. REF. SEC. 8-LMSC A981608, PAGE 8.1.1-8
15.

16. TEMPERATURE (R) ULT. STRENGTH (PSI)

15	1	2			
7.2	100300.	18.0	98000.	27.0	96000.
36.7	94000.	100.0	82400.	150.0	76000.
200.0	72000.	250.0	68500.	300.0	67800.
350.0	67000.	400.0	66300.	450.0	65000.
500.0	63800.	550.0	62000.	600.0	60000.

23. FTU OF 6061-T6 ALUMINUM 2 3 3
24. EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF 6061-T6 ALUMINUM ALLOY
25. REF. MIL HANDBOOK -5
26.

27. TEMPERATURE (R) ULT. STRENGTH (PSI)

15	1	3			
7.2	67500.	18.0	66100.	27.0	64800.
36.7	63840.	100.0	57330.	150.0	53340.
200.0	50610.	250.0	48384.	300.0	46830.
350.0	45696.	400.0	44940.	450.0	43848.
500.0	42840.	550.0	41496.	600.0	40152.

34. FTU OF INCONEL-718 2 3 4
35. EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF INCONEL-718
36. REF. MIL HANDBOOK -5.
37.

38. TEMPERATURE (R) ULT. STRENGTH (PSI)

15	1	3			
7.2	221900.	18.0	220800.	27.0	220000.
36.7	219600.	100.0	213660.	150.0	210240.
200.0	206100.	250.0	201240.	300.0	196200.
350.0	193140.	400.0	189000.	450.0	185400.
500.0	182160.	550.0	179460.	600.0	177300.

45. FTU OF TI-6AL-4V 2 3 5
46. EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF TITANIUM TI-6AL-4V
47. REF. MIL HANDBOOK -5.
48.

49. TEMPERATURE (R) ULT. STRENGTH (PSI)

15	1	3			
7.2	296000.	18.0	293000.	27.0	289000.
36.7	288320.	100.	281600.	150.	244480.
200.0	226880.	250.	212800.	300.	200960.
350.0	190720.	400.	181280.	450.	173120.
500.0	165280.	550.	158720.	600.	154240.

56. FTU OF 304 ST. STEEL 2 3 6

57. EFFECT OF TEMPERATURE ON THE TENSILE STRENGTH OF 304 STAINLESS STEEL
 58. REF. APPL. CRYOGENIC ENG. PAGE 48
 59.

60. TEMPERATURE (R)   ULT. STRENGTH (PSI)
 61.   16   1   2
 62.   7.2   276000.   18.0   274000.   27.0   270000.
 63.   36.0   266000.   45.0   263000.   90.0   250000.
 64.   135.0   235000.   180.0   220000.   225.0   206000.
 65.   270.0   188000.   315.0   172000.   360.0   155000.
 66.   405.0   139000.   450.0   124000.   495.0   109000.
 67.   540.0   96000.
 68.

END DATA.

END TABS

QASG.T   CV1DATAMAQ., F40

DATA.IL CVIDATAMAG.
 DATA BR1 LMSC49 04/05/79 12:13:54 (0)
 USER NAME 6213 104 30235
 TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVI)

	PADD	CSATAG.	SUBCRIT	FRST DECK								
4.	MAGNET											
5.	113.7879	4.35	4.0026	565.	3000.	4000.	28000.					
6.	18.69	14.45	16.47	2	962.545	16.00	0.5728	5.00				
7.												
8.	GAS	1	2	1								
9.	TANK	0	1	6								
10.	LINE	10	1+1.48	6.00700.228.1523								
11.	TEE	31	1	6.007060.00								
12.	LINE	10	1	6.00701.066.1523								
13.	VALVE	31	1	6.0070400.0								
14.	LINE	10	1	6.00701.00.1523								
15.	ELBOW	31	1	6.007013.00								
16.	LINE	10	1+2.59	6.00702.587.1523								
17.	ELBOW	31	1	6.007013.00								
18.	LINE	10	1	6.007012.40.1523								
19.	ELBOW	31	1	6.007013.00								
20.	LINE	10	117.25	6.007017.25.1523								
21.	ELBOW	31	1	6.007013.00								
22.	LINE	10	1	6.0070 0.80.1523								
23.	ELBOW	21	1	6.0070 8.60								
24.	LINE	10	1	6.0070 5.00.1523								
25.	ELBOW	31	1	6.007013.00								
26.	LINE	10	1-3.00	6.0070 3.00.1523								
27.	ELBOW	31	1	6.007013.00								
28.	LINE	10	1	6.0070 4.00.1523								
29.	ELBOW	21	1	6.0070 8.60								
30.	LINE	10	1-0.64	6.0070 0.90.1523								
31.	MAGNET	0	1-4.24	6.007010.96.1523								
32.	LINE	10	1-0.64	6.0070 .90.1523								
33.	ELBOW	21	1	6.0070 8.60								
34.	LINE	10	1	6.0070 4.00.1523								
35.	ELBOW	31	1	6.007013.00								
36.	LINE	10	1-4.00	6.0070 4.00.1523								
37.	ELBOW	21	1	6.0070 8.60								
38.	LINE	10	1-4.75	6.00707.267.1523								
39.	ELBOW	21	1	6.0070 8.60								
40.	LINE	10	1	6.007012.40.1523								
41.	ELBOW	31	1	6.007013.00								
42.	LINE	10	1-2.59	6.00702.587.1523								
43.	ELBOW	31	1	6.007013.00								
44.	LINE	10	1	6.00700.609.1523								
45.	VALVE	31	1	6.0070400.0								
46.	LINE	10	1	6.00701.980.1523								
47.	TEE	31	1	6.007060.00								
48.	LINE	10	1-1.48	6.00701.520.1523								
49.	TANK	0	1	6								
50.	GAS	1	2	2								
51.	LINE	10	1	6.00701.066.1523								
52.	VALVE	31	1	6.0070400.0								
53.	LINE	10	1	6.00701.00.1523								
54.	ELBOW	31	1	6.007013.00								
55.	LINE	10	1+2.59	6.00702.587.1523								
56.	ELBOW	31	1	6.007013.00								

MAG1
MAG2
C-1

M-1

D-1

57.	LINE	10	1	6.007012.40.1523
58.	ELBOW	31	1	6.007013.00
59.	LINE	10	117.25	6.007017.25.1523
60.	ELBOW	31	1	6.007013.00
61.	LINE	10	1	6.0070 0.80.1523
62.	ELBOW	21	1	6.0070 8.60
63.	LINE	10	1	6.0070 5.00.1523
64.	ELBOW	31	1	6.007013.00
65.	LINE	10	1-3.00	6.0070 3.00.1523
66.	ELBOW	31	1	6.007013.00
67.	LINE	10	1	6.0070 8.30.1523
68.	ELBOW	21	1	6.0070 8.60
69.	LINE	10	1-0.64	6.0070 0.90.1523
70.	MAGNET	0	1-4.24	6.007010.98.1523
71.	LINE	10	1-0.64	6.0070 0.90.1523
72.	ELBOW	21	1	6.0070 8.60
73.	LINE	10	1	6.0070 8.30.1523
74.	ELBOW	31	1	6.007013.00
75.	LINE	10	1-4.00	6.0070 4.00.1523
76.	ELBOW	21	1	6.0070 8.60
77.	LINE	10	1-4.75	6.00707.267.1523
78.	ELBOW	21	1	6.0070 8.60
79.	LINE	10	1	6.007012.40.1523
80.	ELBOW	31	1	6.007013.00
81.	LINE	10	1-2.59	6.00702.587.1523
82.	ELBOW	31	1	6.007013.00
83.	LINE	10	1	6.00700.609.1523
84.	VALVE	31	1	6.0070400.0
85.	LINE	10	1	6.00701.980.1523
86.	END			

END DATA.

ΦASG.T

CVIDATA CRP., F40

MS-207
FS-208
MS-209
FS-210
MS-211
FS-212
MS-213
FS-214
MS-215
FS-216
MS-217
FS-218
MS-219
MAG-02
MR-200
FR-201
MR-202
FR-203
MR-204
FR-205
MR-206
FR-207
MR-208
FR-209
MR-210
FR-211
MR-212
CV-146
MR-213

M-2

END

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CRP-1
CRP-2
CRP-3
CRP-4
CRP-5
CRP-6
G-1

C-2

G-2

57.	LINE	10	1-9.25	6.0070 9.0 .1015
58.	ELBOW	31	1	6.007013.00
59.	LINE	10	1	6.0070 0.2 .1015
60.	CRYPAN	1	1-3.046	6.007012.50.1015
61.	LINE	10	1	6.0070 0.2 .1015
62.	TAP	31	1	6.007015.5
63.	GAS	1	2	3
64.	LINE	10	1+1.48	6.00701.117.0508
65.	VALVE	31	1	6.0070400.
66.	LINE	10	1	6.00700.863.0508
67.	ELBOW	31	1	6.007013.00
68.	LINE	10	1+2.59	6.00702.587.0508
69.	ELBOW	31	1	6.007013.00
70.	LINE	10	1	6.007012.30.0508
71.	ELBOW	31	1	6.007013.00
72.	LINE	10	117.75	6.007017.75.0508
73.	ELBOW	31	1	6.007013.00
74.	LINE	10	1	6.0070 0.8 .0508
75.	ELBOW	21	1	6.0070 8.6
76.	LINE	10	1	6.0070 5.0 .0508
77.	ELBOW	31	1	6.007013.00
78.	LINE	10	1-1.50	6.0070 1.5 .0508
79.	ELBOW	31	1	6.007013.00
80.	LINE	10	1	6.007011.0 .0508
81.	ELBOW	41	1	6.007018.00
82.	LINE	10	1-0.25	6.00700.25 .0508
83.	TAP	31	1	6.007015.00
84.	LINE	10	1-0.20	6.00700.20 .0508
85.	CRYPAN	3	1-1.523	6.0070 6.00.0508
86.	LINE	10	1-0.20	6.00700.20 .0508
87.	ELBOW	31	1	6.007013.00
88.	LINE	10	1	6.007010.0 .0508
89.	TAP	31	1	6.007060.00
90.	GAS	1	2	4
91.	LINE	10	1	6.007010.0 .0508
92.	ELBOW	31	1	6.007013.00
93.	LINE	10	1-0.2	6.0070 0.2 .0508
94.	CRYPAN	4	1-1.523	6.0070 6.00.0508
95.	LINE	10	1-0.2	6.0070 0.2 .0508
96.	ELBOW	31	1	6.007013.00
97.	LINE	10	1-0.5	6.0070 0.5 .0508
98.	TAP	31	1	6.007060.00
99.	GAS	1	2	5
100.	TAP	31	1	6.007015.50
101.	LINE	10	1-1.50	6.00701.5 .1523
102.	ELBOW	21	1	6.00708.60
103.	LINE	10	1-4.75	6.00707.267.1523
104.	ELBOW	21	1	6.00708.60
105.	LINE	10	1	6.007012.30.1523
106.	ELBOW	31	1	6.007013.00
107.	LINE	10	1-2.59	6.00702.587.1523
108.	ELBOW	31	1	6.007013.00
109.	LINE	10	1	6.00700.533.1523
110.	VALVE	31	1	6.0070400.
111.	LINE	10	1	6.00702.208.1523
112.	ELBOW	31	1	6.007013.00
113.	LINE	10	1-1.48	6.00701.480.1523
114.	TANK	0	1	6

CS-219
FS-220
CS-221
CYP-21
CR-200
TR-103
HE-LIQ
CS-302
CV-143
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CS-313
FS-314
CS-315
FS-316
CS-317
FS-318
CS-319
TP-320
CS-321
CYP-23
CR-300
FR-301
CR-302
TP-103
HE-LIQ
CS-401
FS-402
CS-403
CYP-24
CR-401
FR-402
CR-403
TP-103
HE-LIQ
TP-103
CR-104
FR-105
CR-106
FR-107
CR-108
FR-109
CR-110
FR-111
CR-112
CV-144
CR-113
FR-114
CR-115
HE-SV1

C-1

G-3

C-3

G-4

C-4

G-4

115. END
END DATA.

0ASGT CUIDATA'3.F40

END

18

1.	TEST CASE FOR THE MFI REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)										1		
2.	REFLQ SUBCRIT THIRD DECK										2		
3.	300.0	290.0	80.0	77.348	38.0	23.0	13.0	5.0	4.8	4.35	7.0	3	
4.	6310.4	1731.6	845.8	277.3	66.4	6088.1	1727.6	534.8	191.9	142.0	41.5	4	
5.	1215.90	113.7879	101.325									5	
6.	474.1	72.6	401.5	155.1	246.4							6	
7.	77.348	101.325	28.7042	-3504.3	0.164621	2169.3	290.0					7	
8.	0.0420370	8426.2	28.0134	4.0026								8	
9.	0.5728	5.0										9	
10.	GAS	1	1	1								HE-GAS	R-1
11.	TANK	0	1	.00	6.0	.0	.0	0	0	0		HE-SV1	MAGNET
12.	LINE	10	1	.00	6.006	.9138	.0761	10	0	0		CGV301	LP-CLDHE
13.	ELBOW	31	1	.00	6.007	13.0	.0	10	0	0		FGV302	LP-CLDHE
14.	LINE	10	1	.00	6.006	.4569	.0761	10	0	0		CGV303	LP-CLDHE
15.	ELBOW	31	1	.00	6.007	13.0	.0	10	0	0		FGV304	LP-CLDHE
16.	LINE	10	1	.00	6.006	.0507	.0761	10	0	0		CGV305	LP-CLDHE
17.	VALVE	41	1	.00	6.010	400.0	.0	10	0	0		AV-121	LP-CLDHE
18.	LINE	10	1	.00	6.006	.0762	.0761	10	0	0		CGV306	LP-CLDHE
19.	ELBOW	31	1	.00	6.007	13.0	.0	10	0	0		FGV307	LP-CLDHE
20.	LINE	10	1	.00	6.006	.6092	.0761	10	0	0		CGV308	LP-CLDHE
21.	FITTING	41	1	.00	6.006	8.00	.0	10	0	0		FGV309	LP-CLDHE
22.	LINE	10	1	.00	6.006	.6092	.0761	10	0	0		CGV310	LP-CLDHE
23.	ELBOW	31	1	.00	6.007	13.00	.0	10	0	0		FGV311	LP-CLDHE
24.	LINE	10	1	.00	6.006	5.939	.0761	10	0	0		CGV312	LP-CLDHE
25.	GAS	1	1		2							HE-GAS	R-2
26.	TANK	0	1	.00	6	.0	.0	0	0	0		HE-SV2	CRYSTAL
27.	LINE	10	1	.00	6.006	.9138	.0761	10	0	0		MGV401	LP-CLDHE
28.	ELBOW	31	1	.00	6.007	13.0	.0	10	0	0		FGV402	LP-CLDHE
29.	LINE	10	1	.00	6.006	.4569	.0761	10	0	0		MGV403	LP-CLDHE
30.	ELBOW	31	1	.00	6.007	13.0	.0	10	0	0		FGV404	LP-CLDHE
31.	LINE	10	1	.00	6.006	.0507	.0761	10	0	0		MGV405	LP-CLDHE
32.	VALVE	41	1	.00	6.010	400.0	.0	10	0	0		AV-122	LP-CLDHE
33.	LINE	10	1	.00	6.006	.0762	.0761	10	0	0		MGV406	LP-CLDHE
34.	ELBOW	31	1	.00	6.007	13.0	.0	10	0	0		FGV407	LP-CLDHE
35.	LINE	10	1	.00	6.006	.6092	.0761	10	0	0		MGV408	LP-CLDHE
36.	FITTING	41	1	.00	6.007	8.0	.0	10	0	0		FGV409	LP-CLDHE
37.	LINE	10	1	.00	6.006	.6092	.0761	10	0	0		MGV410	LP-CLDHE
38.	TEE	31	1	.00	6.007	60.0	.0	10	0	0		FGV313	LP-CLDHE
39.	LINE	10	1	.00	6.006	1.827	.0761	10	0	0		MGV411	LP-CLDHE
40.	ELBOW	31	1	.00	6.007	13.0	.0	10	0	0		FGV41	

57.	LINE	10	1	.00	6.006	1.218.0761	10	0	0	SGV512	LP-CLDHE
58.	TEE	31	1	.00	6.007	15.5 .0	10	0	0	FGV513	CLDBOXIN
59.	LINE	10	1	.00	6.006	1.218.0761	10	0	0	CB1101	LP-CLOHE
60.	GAS	1	1	.00	4					HE-GAS	RLO R-4
61.	REFLIQ	0	1	.00	6.007	.0 .0	10	0	0	RF-LQ1	LPCHE IN
62.	LINE	10	1	.00	6.009	.6092.1015	10	0	0	CB0101	HP-CLDHE
63.	FITING	41	1	.00	6.009	8.0 .0	10	0	0	FB0102	HP-CLDHE
64.	LINE	10	1	.00	6.009	.6092.1015	10	0	0	CB0103	HP-CLDHE
65.	TEE	31	1	.00	6.010	60. .0	10	0	0	FB0104	CLDBXGUT
66.	GAS	1	1	.00	5					HE-GAS	STO R-5
67.	REFLIQ	0	1	.00	6.007	100. .0253	10	0	0	RF-LQ2	HPCHEOUT
68.	LINE	10	1	.00	6.009	1.218.1015	10	0	0	SHP601	HP-CLDHE
69.	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FHP602	HP-CLDHE
70.	LINE	10	1	.00	6.009	5.787.1015	10	0	0	SHP603	HP-CLDHE
71.	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FAP604	HP-CLDHE
72.	LINE	10	1	.00	6.009	.6092.10.5	10	0	0	SHP605	HP-CLDHE
73.	FITING	41	1	.00	6.009	8.0 .0	10	0	0	FHP606	HP-CLDHE
74.	LINE	10	1	.00	6.009	.6092.1015	10	0	0	SHP607	HP-CLDHE
75.	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FHP608	HP-CLDHE
76.	LINE	10	1	.00	6.009	.3046.1015	10	0	0	SHP609	HP-CLDHE
77.	VALVE	51	1	.00	6.008	422. .0	10	0	0	CV-104	JT-VALVE
78.	LINE	10	1	.00	6.007	.1523.1015	10	0	0	SHP610	LP-LIQHE
79.	ELBOW	31	1	.00	6.007	13. .0	10	0	0	FHP611	LP-LIQHE
80.	LINE	10	1	.00	6.007	2.437.1015	10	0	0	SHP612	LP-LIQHE
81.	TANK	0	1	.00	6.0	.0 .0	0	0	0	HE-SV3	STD-DEWR
82.	GAS	1	1	.00	6					HE-GAS	CYP R-6
83.	LINE	10	1	.00	6.009	4.264.1015	10	0	0	CHP701	HP-CLDHE
84.	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FHP702	HP-CLDHE
85.	LINE	10	1	.00	6.009	1.218.1015	10	0	0	CHP703	HP-CLDHE
86.	TEE	31	1	.00	6.009	60.0 .0	10	0	0	FHP704	HP-CLDHE
87.	LINE	10	1	.00	6.009	.6092.1015	10	0	0	CHP705	HP-CLDHE
88.	FITING	41	1	.00	6.009	8.0 .0	10	0	0	FHP706	HP-CLDHE
89.	LINE	10	1	.00	6.009	.6092.1015	10	0	0	CHP707	HP-CLDHE
90.	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FHP708	HP-CLDHE
91.	LINE	10	1	.00	6.009	.0507.1015	10	0	0	CHP709	HP-CLDHE
92.	VALVE	41	1	.00	6.009	400. .0	10	0	0	CV-105	SO-VALVE
93.	LINE	10	1	.00	6.009	.0507.1015	10	0	0	CHP710	HP-CLDHE
94.	ELBOW	31	1	.00	6.009	13.0 .0	10	0	0	FHP711	HP-CLDHE
95.	LINE	10	1	.00	6.009	.6029.1015	10	0	0	CHP712	HP-CLDHE
96.	VALVE	51	1	.00	6.009	422. .0	10	0	0	AV-129	JT-VALVE
97.	LINE	10	1	.00	6.007	.9138.1015	10	0	0	CNE713	LP-LIQHE
98.	TANK	0	1	.00	6.0	.0 .0	0	0	0	HE-SV1	CYP-DEWR
99.	GAS	1	1	.00	7					HE-GAS	MAG R-7
100.	LINE	10	1	.00	6.009	6.244.1015	10	0	0	MHP801	HP-CLDHE
101.	ELBOW	31	1	.00	6.009	13. .0	10	0	0	FHP802	HP-CLDHE
102.	LINE	10	1	.00	6.009	.6092.1015	10	0	0	MHP803	HP-CLDHE
103.	FITING	41	1	.00	6.009	8.0 .0	10	0	0	FHP804	HP-CLDHE
104.	LINE	10	1	.00	6.009	.6092.1015	10	0	0	MHP805	HP-CLDHE
105.	ELBOW	31	1	.00	6.009	12. .0	10	0	0	FHP806	HP-CLDHE
106.	LINE	10	1	.00	6.009	.0507.1015	10	0	0	MHP807	HP-CLDHE
107.	VALVE	41	1	.00	6.009	400. .0	10	0	0	CV-106	SO-VALVE
108.	LINE	10	1	.00	6.009	.0507.1015	10	0	0	MHP808	HP-CLDHE
109.	ELBOW	31	1	.00	6.009	13. .0	10	0	0	FHP809	HP-CLDHE
110.	LINE	10	1	.00	6.009	.6029.1015	10	0	0	MHP810	HP-CLDHE
111.	VALVE	51	1	.00	6.009	422. .0	10	0	0	AV-128	JT-VALVE
112.	LINE	10	1	.00	6.009	.9138.1015	10	0	0	MHE811	LP-CLDHE
113.	TANK	0	1	.00	6.0	.0 .0	0	0	0	HE-SV2	MAG-DEWR
114.	GAS	1	1	.00	8					HE-GAS	CPU R-8

115.	REFLIO	0	1	.00	6.007	.0	.0	10	0	0	RF-LQ3	LPHHSEUT
116.	LINE	10	1	.00	6.006	.3046	.1523	10	0	0	CLP101	LP-HOTHE
117.	ELBOW	31	1	.00	6.006	13.	.0	10	0	0	FLP102	LP-HOTHE
118.	LINE	10	1	.00	6.006	7.920	.1523	10	0	0	CLP103	LP-HOTHE
119.	ELBOW	31	1	.00	6.006	13.	.0	10	0	0	FLP104	LP-HOTHE
120.	LINE	10	1	.00	6.006	3.960	.1523	10	0	0	CLP105	LP-HOTHE
121.	ELBOW	31	1	.00	6.006	13.	.0	10	0	0	FLP106	LP-HOTHE
122.	LINE	10	1	.00	6.006	9.74	.1523	10	0	0	CLP107	LP-HOTHE
123.	ELBOW	31	1	.00	6.006	13.	.0	10	0	0	FLP108	LP-HOTHE
124.	LINE	10	1	.00	6.006	8.22	.1523	10	0	0	CLP109	LP-HOTHE
125.	ELBOW	31	1	.00	6.006	13.	.0	10	0	0	FLP110	LP-HOTHE
126.	LINE	10	1	.00	6.006	8.0	.1523	10	0	0	CLP111	LP-HOTHE
127.	ELBOW	31	1	.00	6.006	13.0	.0	10	0	0	FLP112	LP-HOTHE
128.	LINE	10	1	.00	6.006	7.0	.1523	10	0	0	CLP113	LP-HOTHE
129.	ELBOW	31	1	.00	6.006	13.0	.0	10	0	0	FLP114	LP-HOTHE
130.	LINE	10	1	.00	6.006	6.0	.1523	10	0	0	CLP115	LP-HOTHE
131.	ELBOW	31	1	.00	6.006	13.0	.0	10	0	0	FLP116	LP-HOTHE
132.	LINE	10	1	.00	6.006	0.5	.1523	10	0	0	CLP117	LP-HOTHE
133.	COMPUT	0	1	.00	6.006			10	0	0	CPU-01	COMPUFR
134.	LINE	10	1	.00	6.008	0.5	.0761	10	0	0	CHP101	HP-HOTHE
135.	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP102	HP-HOTHE
136.	LINE	10	1	.00	6.008	6.0	.0761	10	0	0	CHP103	HP-HOTHE
137.	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP104	HP-HOTHE
138.	LINE	10	1	.00	6.008	8.0	.0761	10	0	0	CHP105	HP-HOTHE
139.	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP106	HP-HOTHE
140.	LINE	10	1	.00	6.008	8.22	.0761	10	0	0	CHP107	HP-HOTHE
141.	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP108	HP-HOTHE
142.	LINE	10	1	.00	6.008	9.74	.0761	10	0	0	CHP109	HP-HOTHE
143.	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP110	HP-HOTHE
144.	LINE	10	1	.00	6.008	3.96	.0761	10	0	0	CHP111	HP-HOTHE
145.	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP112	HP-HOTHE
146.	LINE	10	1	.00	6.008	7.92	.0761	10	0	0	CHP113	HP-HOTHE
147.	VALVE	41	1	.00	6.008	422.0	.0	10	0	0	AV-041	CV-VALVE
148.	LINE	10	1	.00	6.008	.0507	.0761	10	0	0	CNP114	HP-HOTHE
149.	ELBOW	31	1	.00	6.008	13.0	.0	10	0	0	FHP115	HP-HOTHE
150.	LINE	10	1	.00	6.008	.3046	.0761	10	0	0	CNP116	HP-HOTHE
151.	REFLIO	0	1	.00	6.007	.0	.0	10	0	0	RF-LQ4	HPHHE IN
152.	END											

END DATA.

*ASG,T

DATLN2..F40

DATA.IL DATALN2.
DATA 8R1 LMSC49 04/05/79 12:14:00 (0)

USER NAME 6213 104 30235

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)
LN2SUPPLY SUBGRIT FRTH DECK

1.									
2.									
3.									
4.									
5.	3.06	2.06	-1.00	0.0	0.0	1.0	0.0	1.	1.
6.	0.0	-1.00	-1.00	31.0	0.0	0.0	0.0	2.	1.
7.	18.00	-1.00	-1.00	0.0	0.0	1.0	0.0	1.	1.
8.	0.0	-1.00	-1.00	31.0	0.0	0.0	0.0	2.	1.
9.	54.50	-1.00	-1.00	0.0	0.0	1.0	0.0	1.	1.
10.	0.0	-1.00	-1.00	31.0	0.0	0.0	0.0	2.	1.
11.	7.90	-1.00	6.90	0.0	0.0	1.0	0.0	1.	1.
12.	0.0	6.90	6.90	31.0	0.0	0.0	0.0	2.	1.
13.	18.50	6.90	6.90	0.0	0.0	1.0	0.0	1.	1.
14.	0.0	6.90	6.90	31.0	0.0	0.0	0.0	2.	1.
15.	8.50	6.90	15.40	0.0	0.0	1.0	0.0	1.	1.
16.	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
17.	26.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
18.	0.0	15.40	15.40	90.0	0.0	7.0	0.0	3.	1.
19.	-1.0								
20.	2								
21.	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
22.	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
23.	0.00	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
24.	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
25.	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
26.	0.68	15.40	16.08	0.0	0.0	1.0	0.0	1.	1.
27.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
28.	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
29.	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
30.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
31.	6.36	16.08	16.08	0.0	0.0	0.90	1.00	6.	1.
32.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
33.	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
34.	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
35.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
36.	8.72	16.08	17.45	0.0	288.0	0.0	0.0	6.	1.
37.	0.0	17.45	17.45	31.0	0.0	0.0	0.0	2.	1.
38.	1.37	17.45	16.08	0.0	0.0	1.0	0.0	1.	1.
39.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
40.	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
41.	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
42.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
43.	12.72	16.08	16.08	0.0	0.0	0.90	2.00	6.	1.
44.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
45.	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
46.	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
47.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
48.	17.37	16.08	18.81	0.0	576.0	0.0	0.0	6.	1.
49.	0.0	18.81	18.81	31.0	0.0	0.0	0.0	2.	1.
50.	2.73	18.81	16.08	0.0	0.0	1.0	0.0	1.	1.
51.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
52.	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
53.	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
54.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
55.	12.72	16.08	16.08	0.0	0.0	0.90	2.00	6.	1.
56.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.

57.	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
58.	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
59.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
60.	17.37	16.08	18.81	0.0	576.0	0.0	0.0	6.	1.
61.	0.0	18.81	18.81	31.0	0.0	0.0	0.0	2.	1.
62.	2.73	18.81	16.08	0.0	6.0	1.0	0.0	1.	1.
63.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
64.	0.0	16.08	16.08	0.0	6.0	1.0	0.0	4.	1.
65.	0.50	16.08	16.08	0.0	6.0	1.0	0.0	1.	1.
66.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
67.	12.72	16.08	14.08	0.0	0.0	0.90	2.00	6.	1.
68.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
69.	89.07	14.08	14.08	0.0	0.0	0.90	14.00	6.	1.
70.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
71.	119.61	14.08	-4.72	0.0	0.0	0.90	18.80	6.	1.
72.	0.0	-4.72	-4.72	31.0	0.0	0.0	0.0	2.	1.
73.	46.44	-4.72	-4.72	0.0	0.0	0.90	7.30	6.	1.
74.	0.0	-4.72	-4.72	31.0	0.0	0.0	0.0	2.	1.
75.	13.36	-4.72	-2.62	0.0	0.0	0.90	2.10	6.	1.
76.	11.94	-2.62	9.32	0.0	0.0	1.0	0.0	1.	1.
77.	30.28	9.32	14.08	0.0	0.0	0.90	4.76	6.	1.
78.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
79.	46.44	14.08	14.08	0.0	0.0	0.90	7.30	6.	1.
80.	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
81.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
82.	2.00	14.08	16.08	0.0	0.0	1.0	0.0	1.	1.
83.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
84.	5.00	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
85.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
86.	0.0	16.08	16.08	0.0	0.0	1.0	0.0	4.	1.
87.	0.50	16.08	16.08	0.0	0.0	1.0	0.0	1.	1.
88.	0.0	16.08	16.08	31.0	0.0	0.0	0.0	2.	1.
89.	0.68	16.08	15.40	0.0	0.0	1.0	0.0	1.	1.
90.	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
91.	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
92.	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
93.	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
94.	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
95.	-2.								
96.	3								
97.	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
98.	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
99.	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
100.	1.0	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
101.	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
102.	1.32	15.40	14.08	0.0	0.0	1.0	0.0	1.	1.
103.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
104.	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
105.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
106.	5.08	14.08	9.00	0.0	0.0	1.0	0.0	1.	1.
107.	0.0	9.0	9.0	31.0	0.0	0.0	0.0	2.	1.
108.	3.08	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
109.	0.0	9.0	9.0	31.0	0.0	0.0	0.0	2.	1.
110.	1.00	9.00	8.00	0.0	0.0	1.0	0.0	1.	1.
111.	0.0	8.00	8.00	0.0	0.0	1.0	0.0	4.	1.
112.	0.50	8.00	7.50	0.0	0.0	1.0	0.0	1.	1.
113.	0.50	7.50	7.00	0.0	0.0	1.0	0.0	1.	1.
114.	0.0	7.00	7.00	90.0	0.0	1.0	0.0	5.	4.

115.	0.50	7.00	6.50	0.0	0.0	1.0	0.0	1.	1.
116.	6.30	6.50	0.20	0.0	7500.0	0.0	0.0	6.	1.
117.	1.50	0.20	-1.30	0.0	0.0	1.0	0.0	1.	1.
118.	1.00	-1.30	-2.30	0.0	0.0	1.0	0.0	1.	1.
119.	0.0	-2.30	-2.30	31.0	0.0	0.0	0.0	2.	1.
120.	3.08	-2.30	-2.30	0.0	0.0	1.0	0.0	1.	1.
121.	0.0	-2.30	-2.30	31.0	0.0	0.0	0.0	2.	1.
122.	11.30	-2.30	9.00	0.0	0.0	1.0	0.0	1.	1.
123.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
124.	5.08	9.00	14.08	0.0	0.0	1.0	0.0	1.	1.
125.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
126.	14.50	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
127.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
128.	1.32	14.08	15.40	0.0	0.0	1.0	0.0	1.	1.
129.	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
130.	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
131.	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
132.	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
133.	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
134.	-3.								
135.	4								
136.	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
137.	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
138.	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
139.	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
140.	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
141.	1.32	15.40	14.08	0.0	0.0	1.0	0.0	1.	1.
142.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
143.	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
144.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
145.	5.08	14.08	9.00	0.0	0.0	1.0	0.0	1.	1.
146.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
147.	3.08	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
148.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
149.	9.70	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
150.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
151.	1.00	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
152.	0.0	8.00	8.00	0.0	0.0	1.0	0.0	4.	1.
153.	0.0	8.00	8.00	90.0	0.0	0.0	0.0	5.	2.
154.	1.00	8.00	7.00	0.0	0.0	1.0	0.0	1.	1.
155.	0.0	7.00	7.00	31.0	0.0	0.0	0.0	2.	1.
156.	0.0	7.00	7.00	0.0	320.0	0.0	0.0	6.	1.
157.	0.0	7.00	7.00	31.0	0.0	0.0	0.0	2.	1.
158.	1.00	7.00	8.00	0.0	0.0	1.0	0.0	1.	1.
159.	0.0	8.00	8.00	0.0	0.0	1.0	0.0	4.	1.
160.	1.00	8.00	9.00	0.0	0.0	1.0	0.0	1.	1.
161.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
162.	9.70	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
163.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
164.	3.08	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
165.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
166.	5.08	9.00	14.08	0.0	0.0	1.0	0.0	1.	1.
167.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
168.	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
169.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
170.	1.32	14.08	15.40	0.0	0.0	1.0	0.0	1.	1.
171.	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
172.	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.

173.	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
174.	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
175.	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
176.	-4.								
177.	5								
178.	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
179.	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
180.	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
181.	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
182.	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
183.	1.32	15.40	14.08	0.0	0.0	1.0	0.0	1.	1.
184.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
185.	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
186.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
187.	5.08	14.08	9.00	0.0	0.0	1.0	0.0	1.	1.
188.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
189.	2.00	9.00	9.00	3.0	0.0	1.0	0.0	1.	1.
190.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
191.	9.70	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
192.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
193.	5.50	9.00	3.50	0.0	0.0	1.0	0.0	1.	1.
194.	0.0	3.50	3.50	0.0	0.0	1.0	0.0	4.	1.
195.	0.50	3.50	3.00	0.0	0.0	1.0	0.0	1.	1.
196.	0.0	3.00	3.00	90.0	0.0	0.0	0.0	5.	3.
197.	0.50	3.00	2.50	0.0	0.0	1.0	0.0	1.	1.
198.	0.0	2.50	2.50	31.0	0.0	0.0	0.0	2.	1.
199.	0.0	2.50	2.50	0.0	0.0	1.0	0.0	1.	1.
200.	0.0	2.50	2.50	31.0	0.0	0.0	0.0	2.	1.
201.	1.00	2.50	3.50	0.0	0.0	1.0	0.0	1.	1.
202.	0.0	3.50	3.50	0.0	0.0	1.0	0.0	4.	1.
203.	5.50	3.50	9.00	0.0	0.0	1.0	0.0	1.	1.
204.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
205.	9.70	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
206.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
207.	2.00	9.00	9.00	0.0	0.0	1.0	0.0	1.	1.
208.	0.0	9.00	9.00	31.0	0.0	0.0	0.0	2.	1.
209.	5.08	9.00	14.08	0.0	0.0	1.0	0.0	1.	1.
210.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
211.	14.00	14.08	14.08	0.0	0.0	1.0	0.0	1.	1.
212.	0.0	14.08	14.08	31.0	0.0	0.0	0.0	2.	1.
213.	1.32	14.08	15.40	0.0	0.0	1.0	0.0	1.	1.
214.	0.0	15.40	15.40	31.0	0.0	10.0	0.0	2.	1.
215.	1.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
216.	0.0	15.40	15.40	0.0	0.0	1.0	0.0	4.	1.
217.	2.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
218.	0.0	15.40	15.40	340.0	0.0	0.0	0.0	3.	1.
219.	-5.								
220.	6								
221.	0.0	15.40	15.40	90.0	0.0	7.0	0.0	3.	1.
222.	26.00	15.40	15.40	0.0	0.0	1.0	0.0	1.	1.
223.	0.0	15.40	15.40	31.0	0.0	0.0	0.0	2.	1.
224.	8.50	15.40	6.90	0.0	0.0	1.0	0.0	1.	1.
225.	0.0	6.90	6.90	31.0	0.0	0.0	0.0	2.	1.
226.	18.50	6.90	6.90	0.0	0.0	1.0	0.0	1.	1.
227.	0.0	6.90	6.90	31.0	0.0	0.0	0.0	2.	1.
228.	7.90	6.90	-1.00	0.0	0.0	1.0	0.0	1.	1.
229.	0.0	-1.00	-1.00	31.0	0.0	0.0	0.0	2.	1.
230.	54.50	-1.00	-1.00	0.0	0.0	1.0	0.0	1.	1.

231.	0.0	-1.0	-1.0	31.0	0.0	0.0	0.0	2.	1.
232.	18.00	-1.00	-1.00	0.0	0.0	1.0	0.0	1.	1.
233.	0.0	-1.0	-1.0	31.0	0.0	0.0	0.0	2.	1.
234.	3.06	-1.00	2.06	0.0	0.0	1.0	0.0	1.	1.
235.	-6.								
236.	308110.71	0.00							
237.	10.	293.15							
238.	0.0	0.0	0.100	0.0					
239.	0.001389	0.1016	0.0254	0.0508	0.0508	0.0508	0.1016		
240.	0.001042	0.1016	0.0254	0.0508	0.0508	0.0508	0.1016		
241.	-1.								

END DATA.

0ASG.T DATAGHERC.

DATA.1L DATAGHERC.

DATA BRI LMSC49 04/05/79 12:14:03 (0)

1.	USER NAME			TEST CASE FOR THE MFTF GASEOUS HELIUM SUPPLY SYSTEM (CVI)
2.	GHE RECOVERY	SUBCRIT	LAST DECK	
3.	48.0	1.0	0.0	
4.	0.0	0.0	340.0	
5.	5.0	2.0	0.0	
6.	0.0	0.0	340.0	
7.	1.0	0.0	0.0	
8.	0.0	0.0	0.0	1.0
9.	1.0	0.0	0.0	
10.	0.0	0.0	340.0	
11.	12.0	2.0	0.0	
12.	0.0	0.0	340.0	
13.	1.0	0.0	0.0	
14.				-1.0
15.	1.0	0.0	0.0	
16.	0.0	0.0	340.0	
17.	1.0	0.0	0.0	
18.	0.0	0.0	77.0	
19.	3.0	4.0	0.0	
20.	7.0	3.0	0.0	
21.	0.0	0.0	170.0	
22.	2.0	1.0	0.0	
23.	0.0	0.0	0.0	2.0
24.	2.0	1.0	0.0	
25.	0.0	0.0	0.0	3.0
26.	2.0	0.0	0.0	
27.	0.0	0.0	170.0	
28.	5.0	3.0	0.0	
29.	0.0	0.0	340.0	
30.	1.0	1.0	0.0	
31.	0.0	0.0	0.0	4.0
32.	1.0	1.0	0.0	
33.	0.0	0.0	340.0	
34.	1.0	1.0	0.0	
35.	0.0	0.0	340.0	
36.	2.0	2.0	0.0	
37.	0.0	0.0	340.0	
38.	99.0	5.0	0.0	
39.	0.0	0.0	340.0	
40.				-2.0
41.	5	5	1	
42.	1	16	1	
43.	273.15	101.325	16542.86	
44.	293.15	101.325	16542.86	
45.	-1.0			

END DATA.

MSG.N TEST RUN OF THE CRYOGENIC SYSTEMS ANALYSIS PROGRAM

MSG.A MFTF+CSA.

COPY.P MFTF+CSA..TPFS.

FURPUR 27R3B E33 SL73R1 04/05/79 12:14:04
97 SYM 81 REL 1 ABS

DL7

9XREF MFTF+CSA.
XREF 01A LMSC43 04/05/79 12:14:22

XREF OF FILE MFTF+CSA

CFTW	001	(000103)	(CFTW)	
CMPCAL	001	(005404)	(CMPCAL)	,CRYPAN,HEMKUP,MAGNET
COMFLO	001	(000204)	(COMFLO)	,CMPCAL
COMPOP	001	(000030)	(COMPOP)	,ANALYSIS
COMPIL	001	(001143)	(COMPIL)	,CONTRL
CP	001	(000043)	(CP)	,SOUN
CRYPAN	001	(000507)	(CRYPAN)	,CONTRL
CSUBP	001	(000046)	(CSUBP)	,COMFLO
CSUBV	001	(000047)	(CSUBV)	,COMFLO
CV	001	(000031)	(CV)	,CP,HEPROP,SOUN
CVINT	001	(000443)	(CVINT)	,CV
CVOL	001	(000351)	(CVOL)	,CMPCAL
DATAIN	001	(000204)	(DATAIN)	,GHERCV
DBDT	001	(000046)	(DBDT)	,CVINT,DPCLOT,HINT,SINT
DDHEF	001	(000331)	(DDHEF)	,CP,FINDO,HEPROP,SOUN
DELT	001	(000011)	(DELT)	,DPDTPV,VPN
DENCAL	001	(000237)	(DENCAL)	,ANALYSIS
DENSL	001	(000115)	(DENSL)	,N2PROP
DENSV	001	(000121)	(DENSV)	,N2PROP
DPCAL	001	(001432)	(DPCAL)	,LNSYST
DPCLDD	001	(000023)	(DPCLDD)	,DDHEF
DPCLDT	001	(000033)	(DPCLDT)	,DTHEF
DPDTPV	001	(000134)	(DPDTPV)	,VPTMP
DPLINE	001	(000130)	(DPLINE)	,ANALYSIS
DPVALV	001	(000031)	(DPVALV)	,ANALYSIS
DSATL	001	(000046)	(DSATL)	,HEPROP
DSATV	001	(000046)	(DSATV)	,HEPROP
DTHEF	001	(000347)	(DTHEF)	,CP,HEPROP
D2DBT2	001	(000052)	(D2DBT2)	,CVINT
ENTHAL	001	(000053)	(ENTHAL)	,HEPROP
ENTHSL	001	(000056)	(ENTHSL)	,DHLOP
ENTHSV	001	(001152)	(ENTHSV)	,SLENTH
ENTROP	001	(000061)	(ENTROP)	,HEPROP
FINDO	001	(000074)	(FINDO)	,HEPROP,RHOGAS,RHOLIQ
FINDR	001	(000012)	(FINDR)	,COMFLO,VGVS
FINTAB	001	(000113)	(FINTAB)	
FLODEQ	001	(000042)	(FLODEQ)	,COMFLO
GASRCV	001	(000721)	(ANALYSIS)	,DATAIN
GETCON	001	(000031)	(GETCON)	,CMPCAL
GHERCV	001	(000006)	(GHERCV)	,CONTRL
GN2DEN	001	(000233)	(GN2DEN)	,DPCAL,LNSYST
HEFIT	001	(000301)	(HEFIT)	,FINDO
HEHED	001	(000011)	(HEHED)	,CMPCAL,CRYPAN,MAGNET
HEMKUP	001	(000330)	(HEMKUP)	,CONTRL
HEPROP	001	(000545)	(HEPROP)	,CMPCAL,CRYPAN,CSUBP,CSUBV,HEMKUP,MAGNET,VGVS
HINT	001	(000361)	(HINT)	,ENTHAL
HPRAT	001	(000132)	(DHLOP)	,N2PROP
HTVAP	001	(000357)	(HVAP)	,N2PROP,SLENTH
INTAB	001	(001467)	(INTAB)	,CONTRL
LIONIT	001	(000006)	(LIONIT)	,CONTRL
LNSYST	001	(002257)	(LNSYST)	,N2MAIN
LOCAT	001	(000126)	(LOCATE)	,MIPE
MAGNET	001	(000260)	(MAGNET)	,CONTRL


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MIPE      001 (000377) (MIPE)
N2MAIN    001 (000611) (N2MAIN) ,LIGNIT
N2PROP    001 (000654) (N2PROP) ,DPCAL,LNSYST,N2MAIN
DTUNIT    001 (000442) (OUTPUT) ,CONTRL
OUTPA     001 (000375) (OUTPUT)
OUTPF     001 (000332) (OUTPUT)
OUTPF1    001 (000347) (OUTPUT)
OUTP1     001 (000360) (OUTPUT)
OUTPW     001 (000412) (OUTPUT)
PAGE      001 (000116) (PAGE) ,ANALYSIS,CMPCAL,COMPIL,CONTEL,CRYPAN,HEMKUP,INTAB,LNSYST,MAGNET,N2MAIN
PCAL      001 (000025) (PCAL) ,HEFIT
RHOGAS    001 (000062) (RHOGAS) ,CMPCAL
RHOLIQ    001 (000062) (RHOLIQ) ,CMPCAL
RVMIFE    001 (000406) (MIPE)
SINT      001 (000377) (SINT) ,ENTROP
SDUN      001 (000041) (SDUN)
SPACE     001 (000437) (OUTPUT)
SPCFHT    001 (000113) (SPCFHT) ,DPCAL,LNSYST
STOCON    001 (000036) (STOCON) ,COMPIL
STODTA    001 (000005) (STODTA) ,CONTRL
TCOND     001 (000365) (TCOND)
TEL       001 (000153) (TEL) ,MIPE
TVP       001 (000303) (TVP) ,DHLDP,N2PROP
VELF      001 (000021) (VELF) ,CMPCAL
VGVS      001 (000075) (VGVS)
VIRB      001 (000040) (VIRB) ,DPCLDD,DPCLDT,PCAL,SINT
VISC      001 (000027) (VISC) ,N2PROP
VISCDT    001 (000124) (VISC DT) ,VISCH
VISCH     001 (000142) (VISCH) ,HEPROP
VISCHX    001 (000030) (VISCHX) ,VISCH
VPRN      001 (000116) (VPRN) ,DPDTVP,VPTMP
VPTMP     001 (000113) (VPTMP) ,HEPROP,RHOGAS,RHOLIQ
YLGINT    001 (000370) (YLGINT) ,TEL
ZCALC     001 (000015) (ZCALC) ,HEPROP
*** DONE ***

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0FREE MFTF.CSA.

0XQT TPF\$.ABS

NAME USER NAME * * * * * PAGE 1
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * TIME 12:14:45
 BLD. 104 * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVI)

TABLE INPUT SUMMARY

TABLE NUMBER	TITLE OF TABLE	NUMBER OF DIMENSIONS	NUMBER OF SUBTABLES	NUMBER OF WORDS
1	FTU OF 321/347 ST. STEEL	2	1	34
2	FTU OF 2219-T87 ALUM.	2	1	34
3	FTU OF 6061-T6 ALUMINUM	2	1	34
4	FTU OF INCONEL-718	2	1	34
5	FTU OF T1-6AL-4V	2	1	34
6	FTU OF 304 ST. STEEL	2	1	36

TOTAL TABLE STORAGE = 206

NAME	USER NAME	*****	PAGE	2
DEPT	6213	CRYOGEN SYSTEMS ANALYSIS	DATE	05 APR 79
EXT.	30235		TIME	12:14:47
BLD.	104	MFTF	CASE	1
*****				
TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVI)				

*** YOU HAVE CALLED FOR THE MAGNET SYSTEM ***

NAME USER NAME * * * * * PAGE 3
DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
EXT. 30235 * * TIME 12:14:47
BLD. 104 * MFTF * CASE 1
* * * * *
TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVI)

***** M A G N E T D A T A *****

NUMBER OF MAGNETS	2
MAGNET DEWAR PRES. - KPA	113.79
MAGNET DEWAR TEMP-DEG.K	4.35
HELIUM MOLEC. WGT.	4.00
MAGNET HEAT LEAK- WATTS	565.00
VOL.LIQ.HE-MAGNET,LITERS	3000.00
VOL.MAG-DEWAR(LHE)LITERS	4000.00
VOL.RESERVE(LHE)-LITERS	26000.00
HEAD-MAG.INLET - METERS	18.69
HEAD-MAG.OUTLET - METERS	14.45
HEAD-MAG.CENTER - METERS	16.47
INITIAL FLOW RATE-KG/HR.	962.54

NAME USER NAME * * * * * PAGE 4
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * TIME 12:14:47
 BLD. 104 * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVI)

***** SYSTEM CONFIGURATION *****

COMP NAME	COMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRL. TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-D	LINE DIAMETER	INSULATION TYPE	INSULATION THICKNESS	NO. LAYERS INSULATION
GAS	HE-LIQ	1	2	-0.00	1	-0.00000000	-0.00	-0.00	0	-0.00	-0.0
TANK	HE-SV2	0	1	-0.00	6	-0.00000000	-0.00	-0.00	0	-0.00	-0.0
LINE	MS-100	10	1	1.48	6	.70000000-02	.23	.15	0	-0.00	-0.0
TEE	FS-101	31	1	-0.00	6	.70000000-02	60.00	-0.00	0	-0.00	-0.0
LINE	MS-102	10	1	-0.00	6	.70000000-02	1.07	.15	0	-0.00	-0.0
VALVE	CV-135	31	1	-0.00	6	.70000000-02	400.00	-0.00	0	-0.00	-0.0
LINE	MS-103	10	1	-0.00	6	.70000000-02	1.00	.15	0	-0.00	-0.0
ELBOW	FS-104	31	1	-0.00	6	.70000000-02	13.00	-0.00	0	-0.00	-0.0
LINE	MS-105	10	1	2.59	6	.70000000-02	2.59	.15	0	-0.00	-0.0
ELBOW	FS-106	31	1	-0.00	6	.70000000-02	13.00	-0.00	0	-0.00	-0.0
LINE	MS-107	10	1	-0.00	6	.70000000-02	12.40	.15	0	-0.00	-0.0
ELBOW	FS-108	31	1	-0.00	6	.70000000-02	13.00	-0.00	0	-0.00	-0.0
LINE	MS-109	10	1	17.25	6	.70000000-02	17.25	.15	0	-0.00	-0.0
ELBOW	FS-110	31	1	-0.00	6	.70000000-02	13.00	-0.00	0	-0.00	-0.0
LINE	MS-111	10	1	-0.00	6	.70000000-02	.80	.15	0	-0.00	-0.0
ELBOW	FS-112	21	1	-0.00	6	.70000000-02	8.60	-0.00	0	-0.00	-0.0
LINE	MS-113	10	1	-0.00	6	.70000000-02	5.00	.15	0	-0.00	-0.0
ELBOW	FS-114	31	1	-0.00	6	.70000000-02	13.00	-0.00	0	-0.00	-0.0
LINE	MS-115	10	1	-3.00	6	.70000000-02	3.00	.15	0	-0.00	-0.0
ELBOW	FS-116	31	1	-0.00	6	.70000000-02	13.00	-0.00	0	-0.00	-0.0
LINE	MS-117	10	1	-0.00	6	.70000000-02	4.00	.15	0	-0.00	-0.0
ELBOW	FS-118	21	1	-0.00	6	.70000000-02	8.60	-0.00	0	-0.00	-0.0
LINE	MS-119	10	1	-0.64	6	.70000000-02	.90	.15	0	-0.00	-0.0
MAGNET	MAG-01	0	1	-4.24	6	.70000000-02	10.96	.15	0	-0.00	-0.0
LINE	MR-101	10	1	-0.64	6	.70000000-02	.90	.15	0	-0.00	-0.0
ELBOW	FR-102	21	1	-0.00	6	.70000000-02	8.60	-0.00	0	-0.00	-0.0
LINE	MR-103	10	1	-0.00	6	.70000000-02	4.00	.15	0	-0.00	-0.0
ELBOW	FR-104	31	1	-0.00	6	.70000000-02	13.00	-0.00	0	-0.00	-0.0
LINE	MR-105	10	1	-4.00	6	.70000000-02	4.00	.15	0	-0.00	-0.0
ELBOW	FR-106	21	1	-0.00	6	.70000000-02	8.60	-0.00	0	-0.00	-0.0
LINE	MR-107	10	1	-4.73	6	.70000000-02	7.27	.15	0	-0.00	-0.0
ELBOW	FR-108	21	1	-0.00	6	.70000000-02	8.60	-0.00	0	-0.00	-0.0
LINE	MR-109	10	1	-0.00	6	.70000000-02	12.40	.15	0	-0.00	-0.0
ELBOW	FR-110	31	1	-0.00	6	.70000000-02	13.00	-0.00	0	-0.00	-0.0
LINE	MR-111	10	1	-2.59	6	.70000000-02	2.59	.15	0	-0.00	-0.0
ELBOW	FR-112	31	1	-0.00	6	.70000000-02	13.00	-0.00	0	-0.00	-0.0
LINE	MR-113	10	1	-0.00	6	.70000000-02	.61	.15	0	-0.00	-0.0
VALVE	CV-145	31	1	-0.00	6	.70000000-02	400.00	-0.00	0	-0.00	-0.0
LINE	MR-114	10	1	-0.00	6	.70000000-02	1.98	.15	0	-0.00	-0.0
TEE	FR-115	31	1	-0.00	6	.70000000-02	60.00	-0.00	0	-0.00	-0.0
LINE	MR-116	10	1	-1.48	6	.70000000-02	1.52	.15	0	-0.00	-0.0
TANK	HE-SV2	0	1	-0.00	6	-0.00000000	-0.00	-0.00	0	-0.00	-0.0
GAS	HE-LIQ	1	2	-0.00	2	-0.00000000	-0.00	-0.00	0	-0.00	-0.0
LINE	MS-202	10	1	-0.00	6	.70000000-02	1.07	.15	0	-0.00	-0.0

NAME USER NAME * * * * * PAGE 5
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * TIME 12:14:48
 BLD. 104 * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CV1)

***** SYSTEM CONFIGURATION *****

COMP NAME	COMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRL. TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-O	LINE DIAMETER	INSULATION TYPE	INSULATION THICKNESS	NO. LAYERS INSULATION
VALVE	CV-136	31	1	-1.00	6	.70000000-02	400.00	-1.00	0	-1.00	-1.0
LINE	MS-203	10	1	-1.00	6	.70000000-02	1.00	.15	0	-1.00	-1.0
ELBOW	FS-204	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	MS-205	10	1	2.59	6	.70000000-02	2.59	.15	0	-1.00	-1.0
ELBOW	FS-206	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	MS-207	10	1	-1.00	6	.70000000-02	12.40	.15	0	-1.00	-1.0
ELBOW	FS-208	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	MS-209	10	1	17.25	6	.70000000-02	17.25	.15	0	-1.00	-1.0
ELBOW	FS-210	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	MS-211	10	1	-1.00	6	.70000000-02	.80	.15	0	-1.00	-1.0
ELBOW	FS-212	21	1	-1.00	6	.70000000-02	8.60	-1.00	0	-1.00	-1.0
LINE	MS-213	10	1	-1.00	6	.70000000-02	5.00	.15	0	-1.00	-1.0
ELBOW	FS-214	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	MS-215	10	1	-3.00	6	.70000000-02	3.00	.15	0	-1.00	-1.0
ELBOW	FS-216	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	MS-217	10	1	-1.00	6	.70000000-02	8.30	.15	0	-1.00	-1.0
ELBOW	FS-218	21	1	-1.00	6	.70000000-02	8.60	-1.00	0	-1.00	-1.0
LINE	MS-219	10	1	-1.64	6	.70000000-02	.90	.15	0	-1.00	-1.0
MAGNET	MAG-02	0	1	-4.24	6	.70000000-02	10.96	.15	0	-1.00	-1.0
LINE	MR-200	10	1	-1.64	6	.70000000-02	.90	.15	0	-1.00	-1.0
ELBOW	FR-201	21	1	-1.00	6	.70000000-02	8.60	-1.00	0	-1.00	-1.0
LINE	MR-202	10	1	-1.00	6	.70000000-02	8.30	.15	0	-1.00	-1.0
ELBOW	FR-203	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	MR-204	10	1	-1.00	6	.70000000-02	4.00	.15	0	-1.00	-1.0
ELBOW	FR-205	21	1	-1.00	6	.70000000-02	8.60	-1.00	0	-1.00	-1.0
LINE	MR-206	10	1	-4.75	6	.70000000-02	7.27	.15	0	-1.00	-1.0
ELBOW	FR-207	21	1	-1.00	6	.70000000-02	8.60	-1.00	0	-1.00	-1.0
LINE	MR-208	10	1	-1.00	6	.70000000-02	12.40	.15	0	-1.00	-1.0
ELBOW	FR-209	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	MR-210	10	1	-2.59	6	.70000000-02	2.59	.15	0	-1.00	-1.0
ELBOW	FR-211	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	MR-212	10	1	-1.00	6	.70000000-02	.61	.15	0	-1.00	-1.0
VALVE	CV-146	31	1	-1.00	6	.70000000-02	400.00	-1.00	0	-1.00	-1.0
LINE	MR-213	10	1	-1.00	6	.70000000-02	1.98	.15	0	-1.00	-1.0
END		0	0	-1.00	0	.00000000	-1.00	-1.00	0	-1.00	-1.0

NAME USER NAME * * * * * PAGE 6
 DEPT S213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * TIME 12:14:50
 BLD. 104 * MFTF * CASE 1
 * * * * *
 TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVI)

*** INITIATE PROGRAM AND CHARACTERIZE MAGNET INPUT AND OUTPUT CONDITIONS ***

** ESTIMATED MAGNET PARAMETERS **

FLUID FLOWING CONDITIONS:

INLET FLOW RATE	(KG/HR)	.96254500+03
INLET TEMPERATURE	(DEG.K)	.43500000+01
INLET PRESSURE	(KPA)	.13641071+03
INLET FLUID DENSITY	(MOL/L)	.31277659+02
INLET SPECIFIC VOLUME	(L/MOL)	.31971702-01

OUTLET FLOW RATE	(KG/HR)	.96254500+03
OUTLET TEMPERATURE	(DEG.K)	.43503336+01
OUTLET PRESSURE	(KPA)	.13127851+03
OUTLET LIQUID DENSITY	(MOL/L)	.29932681+02
OUTLET GAS DENSITY	(MOL/L)	.56402012+01
OUTLET MIXTURE DENSITY	(MOL/L)	.23655197+02
OUTLET MIXTURE SP.VOL.	(L/MOL)	.42274008-01
OUTLET FLUID QUALITY	(FRACT)	.61614337-01

OUTLET FLUID COMPOSITION:		
LIQUID	(KG/HR)	.90323843+03
VAPOR	(KG/HR)	.59306572+02

NO-FLOW CONDITIONS:

MAGNET ENERGY	(J/HR.)	.20340000+07
TIME TO SAT. LIQUID	(HOURS)	.161
TIME TO SAT. VAPOR	(HOURS)	3.452
RATE OF VAPOR BOILOFF	(KG/HR)	.10413321+03

NAME USER NAME * * * * * PAGE 7
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * TIME 12:14:51
 BLD. 104 * * CASE 1
 * * * * * MFTF * * * * *

TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVI)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR MAGNET PRIMARY CIRCUIT NO. -1 ***

F	CODE	IDX	G	GS	DIAM. (M)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-L13	1	1	2	.000	.000	.000	.00000	.000	.0000	.0000000	.00000	.0000	.00000	.000
TAN	HE-SV2	2	1	2	.000	962.545	962.545	.000	.00000	4.350	113.7879	.000000	.0000	123.42882	.000
LIN	MS-100	3	1	2	.152	962.545	962.545	.000	.00000	4.350	115.5793	.000005	428.0690	123.42882	7097.898
TEE	FS-101	4	1	2	.152	481.272	481.272	.000	.00000	4.350	115.5791	.000202	214.0345	123.57646	3553.398
LIN	MS-102	5	1	2	.152	481.272	481.272	.000	.00000	4.351	115.5791	.000006	214.0345	123.57062	3553.644
VAL	CV-135	6	1	2	.152	481.272	481.272	.000	.00000	4.352	115.5788	.000336	214.0345	123.55873	3554.337
LIN	MS-103	7	1	2	.152	481.272	481.272	.000	.00000	4.352	115.5788	.000006	214.0345	123.52903	3553.872
ELB	FS-104	8	1	2	.152	481.272	481.272	.000	.00000	4.352	115.5788	.000011	214.0345	123.51788	3553.648
LIN	MS-105	9	1	2	.152	481.272	481.272	.000	.00000	4.353	118.7159	.000014	214.0345	123.51509	3542.429
ELB	FS-106	10	1	2	.152	481.272	481.272	.000	.00000	4.353	118.7159	.000011	214.0345	123.74410	3549.093
LIN	MS-107	11	1	2	.152	481.272	481.272	.000	.00000	4.358	118.7159	.000058	214.0345	123.74132	3553.818
ELB	FS-108	12	1	2	.152	481.272	481.272	.000	.00000	4.358	118.7159	.000011	214.0345	123.60325	3549.945
LIN	MS-109	13	1	2	.152	481.272	481.272	.000	.00000	4.365	139.6246	.000095	214.0345	123.60047	3480.250
ELB	FS-110	14	1	2	.152	481.272	481.272	.000	.00000	4.365	139.6246	.000011	214.0345	125.02970	3520.586
LIN	MS-111	15	1	2	.152	481.272	481.272	.000	.00000	4.366	139.6246	.000004	214.0345	125.02704	3520.806
ELB	FS-112	16	1	2	.152	481.272	481.272	.000	.00000	4.366	139.6246	.000007	214.0345	125.01850	3520.657
LIN	MS-113	17	1	2	.152	481.272	481.272	.000	.00000	4.368	139.6245	.000027	214.0345	125.01583	3522.426
ELB	FS-114	18	1	2	.152	481.272	481.272	.000	.00000	4.368	139.6245	.000011	214.0345	124.96236	3521.012
LIN	MS-115	19	1	2	.152	481.272	481.272	.000	.00000	4.369	135.9482	.000016	214.0345	124.95969	3535.058
ELB	FS-116	20	1	2	.152	481.272	481.272	.000	.00000	4.369	135.9482	.000011	214.0345	124.95320	3526.480
LIN	MS-117	21	1	2	.152	481.272	481.272	.000	.00000	4.371	135.9482	.000022	214.0345	124.65051	3527.893
ELB	FS-118	22	1	2	.152	481.272	481.272	.000	.00000	4.371	135.9482	.000007	214.0345	124.60737	3526.765
LIN	MS-119	23	1	2	.152	481.272	481.272	.000	.00000	4.371	135.1661	.000005	214.0345	124.60467	3529.832
MAG	MAG-01	24	1	2	.152	481.272	448.793	32.480	.06749	4.546	131.3063	.000081	284.5955	92.82658	3827.349
LIN	MR-101	25	1	2	.152	481.272	443.092	38.180	.07933	4.507	130.7237	.000007	296.1127	89.21613	3826.299
ELB	FR-102	26	1	2	.152	481.272	443.092	38.180	.07933	4.507	130.7237	.000010	296.1127	89.21613	3826.299
LIN	MR-103	27	1	2	.152	481.272	443.092	38.180	.07933	4.508	130.7236	.000031	296.1127	89.21613	3826.299
ELB	FR-104	28	1	2	.152	481.272	443.092	38.180	.07933	4.508	130.7236	.000015	296.1127	89.21613	3826.299
LIN	MR-105	29	1	2	.152	481.272	438.757	42.516	.08834	4.476	127.2240	.000031	306.8673	86.08942	3825.807
ELB	FR-106	30	1	2	.152	481.272	438.757	42.516	.08834	4.476	127.2240	.000010	306.8673	86.08942	3825.807
LIN	MR-107	31	1	2	.152	481.272	433.945	47.328	.09834	4.439	123.2137	.000058	319.9798	82.56154	3825.578
ELB	FR-108	32	1	2	.152	481.272	433.945	47.328	.09834	4.439	123.2137	.000011	319.9798	82.56154	3825.578
LIN	MR-109	33	1	2	.152	481.272	433.945	47.328	.09834	4.444	123.2136	.000102	319.9798	82.56154	3825.578
ELB	FR-110	34	1	2	.152	481.272	433.945	47.328	.09834	4.444	123.2136	.000016	319.9798	82.56154	3825.578
LIN	MR-111	35	1	2	.152	481.272	431.487	49.786	.10345	4.420	121.1166	.000021	327.2013	80.73936	3825.605
ELB	FR-112	36	1	2	.152	481.272	431.487	49.786	.10345	4.420	121.1165	.000017	327.2013	80.73936	3825.605
LIN	MR-113	37	1	2	.152	481.272	431.487	49.786	.10345	4.420	121.1165	.000005	327.2013	80.73936	3825.605
VAL	CV-145	38	1	2	.152	481.272	431.487	49.786	.10345	4.421	121.1160	.000515	327.2013	80.73936	3825.605
LIN	MR-114	39	1	2	.152	481.272	431.487	49.786	.10345	4.422	121.1160	.000017	327.2013	80.73936	3825.605
TEE	FR-115	40	1	2	.152	962.545	862.973	99.572	.10345	4.422	121.1159	.000077	654.4026	80.73936	3825.605
LIN	MR-116	41	1	2	.152	962.545	860.258	102.287	.10627	4.409	119.9440	.000051	662.7070	79.72761	7651.330
TAN	HE-SV2	42	1	2	.000	962.545	860.258	102.287	.00000	4.409	113.7879	.000000	.0000	123.42882	.000

NAME USER NAME * * * * * PAGE 8
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * * * * TIME 12:16:06
 BLD. 104 * * * * * CASE 1
 * * * * * MFTF * * * * *
 TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVI)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR MAGNET PRIMARY CIRCUIT NO. -2 ***

F	CODE	IDX	G_GS	DIAM. (IN)	WDDT-T (KG/HR)	WDDT-L (KG/HR)	WDDT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-L13	43	1	2	.000	481.272	481.272	.0000	4.350	115.5791	.000000	.0000	.00000	.000
LIN	MS-202	44	1	2	.152	481.272	481.272	.0000	4.350	115.5791	.000006	214.0345	123.57645	3553.608
VAL	CV-136	45	1	2	.152	481.272	481.272	.0000	4.351	115.5788	.000336	214.0345	123.56456	3554.302
LIN	MS-203	46	1	2	.152	481.272	481.272	.0000	4.352	115.5788	.000006	214.0345	123.53486	3553.837
ELB	FS-204	47	1	2	.152	481.272	481.272	.0000	4.352	115.5788	.000011	214.0345	123.52371	3553.612
LIN	MS-205	48	1	2	.152	481.272	481.272	.0000	4.353	118.7161	.000014	214.0345	123.52092	3542.396
ELB	FS-206	49	1	2	.152	481.272	481.272	.0000	4.353	118.7161	.000011	214.0345	123.74984	3549.058
LIN	MS-207	50	1	2	.152	481.272	481.272	.0000	4.358	118.7160	.000068	214.0345	123.74707	3553.782
ELB	FS-208	51	1	2	.152	481.272	481.272	.0000	4.358	118.7160	.000011	214.0345	123.60900	3549.914
LIN	MS-209	52	1	2	.152	481.272	481.272	.0000	4.365	139.6257	.000095	214.0345	123.60623	3480.233
ELB	FS-210	53	1	2	.152	481.272	481.272	.0000	4.365	139.6257	.000011	214.0345	125.03495	3520.552
LIN	MS-211	54	1	2	.152	481.272	481.272	.0000	4.366	139.6257	.000004	214.0345	125.03228	3520.771
ELB	FS-212	55	1	2	.152	481.272	481.272	.0000	4.366	139.6257	.000007	214.0345	125.02374	3520.623
LIN	MS-213	56	1	2	.152	481.272	481.272	.0000	4.368	139.6257	.000027	214.0345	125.02107	3522.391
ELB	FS-214	57	1	2	.152	481.272	481.272	.0000	4.368	139.6257	.000011	214.0345	124.96762	3520.977
LIN	MS-215	58	1	2	.152	481.272	481.272	.0000	4.369	135.9492	.000016	214.0345	124.96494	3535.021
ELB	FS-216	59	1	2	.152	481.272	481.272	.0000	4.369	135.9492	.000011	214.0345	124.65854	3526.446
LIN	MS-217	60	1	2	.152	481.272	481.272	.0000	4.372	135.9491	.000045	214.0345	124.65585	3529.464
ELB	FS-218	61	1	2	.152	481.272	481.272	.0000	4.373	135.9491	.000007	214.0345	124.56621	3527.019
LIN	MS-219	62	1	2	.152	481.272	481.272	.0000	4.373	131.1673	.000005	214.0345	124.56351	3530.091
MAC	MAG-02	63	1	2	.152	481.272	448.585	32.687	.06792	4.506	131.1330	.000081	285.0041	92.69348
LIN	MR-200	64	1	2	.152	481.272	442.896	38.377	.07974	4.507	130.7313	.000007	296.4992	89.09981
ELB	FR-201	65	1	2	.152	481.272	442.896	38.377	.07974	4.507	130.7313	.000010	296.4992	89.09981
LIN	MR-202	66	1	2	.152	481.272	442.896	38.377	.07974	4.510	130.7312	.000064	296.4992	89.09981
ELB	FR-203	67	1	2	.152	481.272	442.896	38.377	.07974	4.510	130.7312	.000015	296.4992	89.09981
LIN	MR-204	68	1	2	.152	481.272	438.568	42.705	.08873	4.476	127.2361	.000031	307.2509	85.98191
ELB	FR-205	69	1	2	.152	481.272	438.568	42.705	.08873	4.476	127.2361	.000010	307.2509	85.98191
LIN	MR-206	70	1	2	.152	481.272	433.763	47.509	.09872	4.440	123.2308	.000058	320.3591	82.46377
ELB	FR-207	71	1	2	.152	481.272	433.763	47.509	.09872	4.440	123.2308	.000011	320.3591	82.46377
LIN	MR-208	72	1	2	.152	481.272	433.763	47.509	.09872	4.444	123.2307	.000103	320.3591	82.46377
ELB	FR-209	73	1	2	.152	481.272	433.763	47.509	.09872	4.444	123.2307	.000016	320.3591	82.46377
LIN	MR-210	74	1	2	.152	481.272	431.309	49.964	.10382	4.420	121.1362	.000021	327.5781	80.64648
ELB	FR-211	75	1	2	.152	481.272	431.309	49.964	.10382	4.420	121.1361	.000017	327.5781	80.64648
LIN	MR-212	76	1	2	.152	481.272	431.309	49.964	.10382	4.420	121.1361	.000005	327.5781	80.64648
VAL	CV-146	77	1	2	.152	481.272	431.309	49.964	.10382	4.421	121.1356	.000515	327.5781	80.64648
LIN	MR-213	78	1	2	.152	481.272	431.309	49.964	.10382	4.422	121.1356	.000017	327.5781	80.64648

TOTAL PRESSURE DROP IN THE MAGNET LOOP = .36441060-02 KPA
 (MAGNET INCLUDED)

TOTAL FLUID VOLUME IN THE MAGNET LOOP = .77555842+01 CUBIC METERS (7755.58 LITERS)
 (MAGNET INCLUDED)

NAME USER NAME * * * * * PAGE 9
DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
EXT. 30235 * TIME 12:16:56
BLD. 104 * MFTF * CASE 1
* * * * *

TEST CASE FOR THE MFTF MAGNET SUPPLY SYSTEM (CVI)

***** MAGNET SUPPLY TANK DATA *****

NOMINAL VOLUME OF HELIUM IN TANK - (LITERS) =	4000.0000
TANK OUTFLOW OF HELIUM (KG/HR) =	962.5450
LIQUID HELIUM IN RETURN FLOW (KG/HR) =	860.2579
LIQUID HELIUM MAKE-UP REQUIRED (KG/HR) =	102.2871
RETURN FLUID QUALITY (DECIMAL FRACTION) =	.1063

NAME	USER NAME	* * * * *	* PAGE	10
DEPT		* * * * *	* DATE	05 APR 79
EXT.		* * * * *	* TIME	12:16:58
BLD.		* * * * *	* CASE	1
		* * * * *		
TEST CASE FOR THE MFTF CRYOPANEL SUPPLY SYSTEM (CVI)				

*** YOU HAVE CALLED FOR THE CRYOPANEL SYSTEM ***

NAME USER NAME * * * * * PAGE 11
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:16:58
 BLD. * * * * * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF CRYOPANEL SUPPLY SYSTEM (CV1)

***** C R Y O P A N E L D A T A *****

NUMBER OF CRYOPANELS 4
 CP DEWAR PRESSURE - KPA 113.79
 CP DEWAR TEMP. - DEG.K 4.35
 CP DEWAR LIQ.VOL.-LITERS 4000.00
 TOTAL FLOW RATE - KG/HR 2406.95
 HELIUM MOLEC. WGT. 4.00

	CRYOPANEL-2	CRYOPANEL-1	CRYOPANEL-3	CRYOPANEL-4
CP HEAT INPUT - WATTS	550.00	450.00	200.00	100.00
CRYOPANEL VOLUME- LITERS	7000.00	7000.00	4000.00	3000.00
HEAD AT CP INLET- METERS	19.57	10.57	19.37	19.37
HEAD AT CP OUTLET-METERS	19.07	10.07	11.02	11.02
CP INLET FLOW RATE-KG/HR	1022.95	902.61	300.87	180.52

NAME USER NAME * * * * * PAGE 12
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:16:56
 BLD. * * * * * CASE 1
 * * * * * MFTF * * * * *

TEST CASE FOR THE MFTF CRYOPANEL SUPPLY SYSTEM (CVI)

***** SYSTEM CONFIGURATION *****

COMP NAME	COMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRL. TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-D	LINE DIAMETER	INSULATION TYPE	INSULATION THICKNESS	NO. LAYERS INSULATION
GAS	HE-110	1	2	-1.00	1	-1.00000000	-1.00	-1.00	0	-1.00	-1.0
TANK	HE-SV1	0	1	-1.00	6	-1.00000000	-1.00	-1.00	0	-1.00	-1.0
LINE	CS-100	10	1	1.48	6	.70000000-02	.23	.10	0	-1.00	-1.0
TEE	FS-101	21	1	-1.00	6	.70000000-02	60.00	-1.00	0	-1.00	-1.0
LINE	CS-102	10	1	-1.00	6	.70000000-02	1.12	.10	0	-1.00	-1.0
VALVE	CV-141	31	1	-1.00	6	.70000000-02	400.00	-1.00	0	-1.00	-1.0
LINE	CS-103	10	1	-1.00	6	.70000000-02	.86	.10	0	-1.00	-1.0
ELBOW	FS-104	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-105	10	1	2.59	6	.70000000-02	2.59	.10	0	-1.00	-1.0
ELBOW	FS-106	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-107	10	1	-1.00	6	.70000000-02	12.35	.10	0	-1.00	-1.0
ELBOW	FS-108	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-109	10	1	17.25	6	.70000000-02	17.25	.10	0	-1.00	-1.0
ELBOW	FS-110	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-111	10	1	-1.00	6	.70000000-02	.80	.10	0	-1.00	-1.0
ELBOW	FS-112	21	1	-1.00	6	.70000000-02	8.60	-1.00	0	-1.00	-1.0
LINE	CS-113	10	1	-1.00	6	.70000000-02	5.00	.10	0	-1.00	-1.0
ELBOW	FS-114	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-115	10	1	-1.50	6	.70000000-02	1.50	.10	0	-1.00	-1.0
ELBOW	FS-116	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-117	10	1	-1.00	6	.70000000-02	10.00	.10	0	-1.00	-1.0
ELBOW	FS-118	41	1	-1.00	6	.70000000-02	18.00	-1.00	0	-1.00	-1.0
LINE	CS-119	10	1	-1.25	6	.70000000-02	.20	.10	0	-1.00	-1.0
CRYSPAN	CYP-22	2	1	-3.0460006	6	.70000000-02	12.50	.10	0	-1.00	-1.0
LINE	CR-100	10	1	-1.00	6	.70000000-02	.20	.10	0	-1.00	-1.0
ELBOW	FR-101	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CR-102	10	1	-9.00	6	.70000000-02	9.00	.10	0	-1.00	-1.0
TAP	TR-103	31	1	-1.00	6	.70000000-02	60.00	-1.00	0	-1.00	-1.0
GAS	HE-LIQ	1	2	-1.00	2	-1.00000000	-1.00	-1.00	0	-1.00	-1.0
LINE	CS-202	10	1	1.48	6	.70000000-02	1.12	.10	0	-1.00	-1.0
VALVE	CV-142	31	1	-1.00	6	.70000000-02	400.00	-1.00	0	-1.00	-1.0
LINE	CS-203	10	1	-1.00	6	.70000000-02	.86	.10	0	-1.00	-1.0
ELBOW	FS-204	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-205	10	1	2.59	6	.70000000-02	2.59	.10	0	-1.00	-1.0
ELBOW	FS-206	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-207	10	1	-1.00	6	.70000000-02	12.30	.10	0	-1.00	-1.0
ELBOW	FS-208	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-209	10	1	17.25	6	.70000000-02	17.25	.10	0	-1.00	-1.0
ELBOW	FS-210	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-211	10	1	-1.00	6	.70000000-02	.80	.10	0	-1.00	-1.0
ELBOW	FS-212	21	1	-1.00	6	.70000000-02	8.60	-1.00	0	-1.00	-1.0
LINE	CS-213	10	1	-1.00	6	.70000000-02	5.00	.10	0	-1.00	-1.0
ELBOW	FS-214	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-215	10	1	-1.50	6	.70000000-02	1.50	.10	0	-1.00	-1.0

NAME USER NAME * * * * * PAGE 13
 DEPT * * * * * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * * TIME 12:16:58
 BLD. * * * * * MFTF * CASE 1
 * * * * * * * * * * * * * * * *

TEST CASE FOR THE MFTF CRYOPANEL SUPPLY SYSTEM (CVI)

***** SYSTEM CONFIGURATION *****

COMP NAME	COMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRL. TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-D	LINE DIAMETER	INSULATION TYPE	INSULATION THICKNESS	NO. LAYERS INSULATION
ELBOW	FS-216	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-217	10	1	-1.00	6	.70000000-02	10.00	-1.00	0	-1.00	-1.0
ELBOW	FS-218	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-219	10	1	-9.25	6	.70000000-02	9.00	-1.00	0	-1.00	-1.0
ELBOW	FS-220	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-221	10	1	-1.00	6	.70000000-02	.20	-1.00	0	-1.00	-1.0
CRYPAN	CR-21	1	1	-3.0460006	6	.70000000-02	12.50	-1.00	0	-1.00	-1.0
LINE	CR-200	10	1	-1.00	6	.70000000-02	.20	-1.00	0	-1.00	-1.0
TAP	TH-103	31	1	-1.00	6	.70000000-02	15.50	-1.00	0	-1.00	-1.0
GAS	HE-L10	1	2	-1.00	3	.00000000	-1.00	-1.00	0	-1.00	-1.0
LINE	CS-302	10	1	1.48	6	.70000000-02	1.12	.05	0	-1.00	-1.0
VALVE	CV-143	31	1	-1.00	6	.70000000-02	400.00	-1.00	0	-1.00	-1.0
LINE	CS-303	10	1	-1.00	6	.70000000-02	.86	.05	0	-1.00	-1.0
ELBOW	FS-304	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-305	10	1	2.59	6	.70000000-02	2.59	.05	0	-1.00	-1.0
ELBOW	FS-306	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-307	10	1	-1.00	6	.70000000-02	12.30	.05	0	-1.00	-1.0
ELBOW	FS-308	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-309	10	1	17.75	6	.70000000-02	17.75	.05	0	-1.00	-1.0
ELBOW	FS-310	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-311	10	1	-1.00	6	.70000000-02	.80	.05	0	-1.00	-1.0
ELBOW	FS-312	21	1	-1.00	6	.70000000-02	8.60	-1.00	0	-1.00	-1.0
LINE	CS-313	10	1	-1.00	6	.70000000-02	5.00	.05	0	-1.00	-1.0
ELBOW	FS-314	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-315	10	1	-1.50	6	.70000000-02	1.50	.05	0	-1.00	-1.0
ELBOW	FS-316	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-317	10	1	-1.00	6	.70000000-02	11.00	.05	0	-1.00	-1.0
ELBOW	FS-318	41	1	-1.00	6	.70000000-02	18.00	-1.00	0	-1.00	-1.0
LINE	CS-319	10	1	-1.25	6	.70000000-02	.25	.05	0	-1.00	-1.0
TAP	TP-320	31	1	-1.00	6	.70000000-02	15.00	-1.00	0	-1.00	-1.0
LINE	CS-321	10	1	-1.20	6	.70000000-02	.20	.05	0	-1.00	-1.0
CRYPAN	CYP-23	3	1	-1.5230006	6	.70000000-02	6.00	.05	0	-1.00	-1.0
LINE	CR-300	10	1	-1.20	6	.70000000-02	.20	.05	0	-1.00	-1.0
ELBOW	FR-301	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CR-302	10	1	-1.00	6	.70000000-02	10.00	.05	0	-1.00	-1.0
TAP	TP-103	31	1	-1.00	6	.70000000-02	60.00	-1.00	0	-1.00	-1.0
GAS	HE-L10	1	2	-1.00	4	.00000000	-1.00	-1.00	0	-1.00	-1.0
LINE	CS-401	10	1	-1.00	6	.70000000-02	10.00	.05	0	-1.00	-1.0
ELBOW	FS-402	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CS-403	10	1	-1.20	6	.70000000-02	.20	.05	0	-1.00	-1.0
CRYPAN	CYP-24	4	1	-1.5230006	6	.70000000-02	6.00	.05	0	-1.00	-1.0
LINE	CR-401	10	1	-1.20	6	.70000000-02	.20	.05	0	-1.00	-1.0
ELBOW	FR-402	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CR-403	10	1	-1.50	6	.70000000-02	.50	.05	0	-1.00	-1.0

NAME USER NAME * * * * * PAGE 14
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:17:00
 BLD. * * * * * CASE 1
 * * * * *
 TEST CASE FOR THE MPTF CRYOPANEL SUPPLY SYSTEM (CVI)

***** S Y S T E M C O N F I G U R A T I O N *****

COMP NAME	COMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRL. TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-D	LINE DIAMETER	INSULATION TYPE	INSULATION THICKNESS	NO. LAYERS INSULATION
TAP	TP-103	31	1	-1.00	6	.70000000-02	60.00	-1.00	0	-1.00	-1.0
GAS	HE-L10	1	2	-1.00	5	-.00000000	-1.00	-1.00	0	-1.00	-1.0
TAP	TP-103	31	1	-1.00	6	.70000000-02	15.50	-1.00	0	-1.00	-1.0
LINE	CR 104	10	1	-1.50	6	.70000000-02	1.50	-1.15	0	-1.00	-1.0
ELBOW	FR 105	21	1	-1.00	6	.70000000-02	8.60	-1.00	0	-1.00	-1.0
LINE	CR 106	10	1	-4.75	6	.70000000-02	7.27	-1.15	0	-1.00	-1.0
ELBOW	FR 107	21	1	-1.00	6	.70000000-02	8.60	-1.00	0	-1.00	-1.0
LINE	CR 108	10	1	-1.00	6	.70000000-02	12.30	-1.15	0	-1.00	-1.0
ELBOW	FR 109	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CR 110	10	1	-2.59	6	.70000000-02	2.59	-1.15	0	-1.00	-1.0
ELBOW	FR 111	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CR 112	10	1	-1.00	6	.70000000-02	.53	-1.15	0	-1.00	-1.0
VALVE	CV-144	31	1	-1.00	6	.70000000-02	400.00	-1.00	0	-1.00	-1.0
LINE	CR 113	10	1	-1.00	6	.70000000-02	2.21	-1.15	0	-1.00	-1.0
ELBOW	FR 114	31	1	-1.00	6	.70000000-02	13.00	-1.00	0	-1.00	-1.0
LINE	CR 115	10	1	-1.48	6	.70000000-02	1.48	-1.15	0	-1.00	-1.0
TANK	HE-SV1	0	1	-1.00	6	-.00000000	-1.00	-1.00	0	-1.00	-1.0
END		0	0	-1.00	0	-.00000000	-1.00	-1.00	0	-1.00	-1.0

D34

INPUT CRYOPANEL ENERGY	(J/HR.)	=	.198000+07	.162000+07	.720000+06	.360000+08
TIME TO SAT. LIQUID	(HOURS)	=	.506506+00	.332004+00	.462178+00	.693267+00
TIME TO SAT. VAPOR	(HOURS)	=	.763125+01	.993038+01	.126878+02	.190316+02
RATE OF VAPOR BOILOFF	(KG/HR)	=	.108785+03	.852443+02	.380489+02	.190244+02

50:
51 2

••• ZONE 2

F	CODE	IDX	G	SS	DIAM.	(M)	NDOT-1	WDOT-1	WDOT-L	(KG/HR)	WDOT-G	QUAL	TEMP.	(K)	PRESS.	DELTA-P	VELOCITY	DENSITY	REYNOLDS
																			NUMBER
GAS	HE-L12	1	1	2			.000		.000		.000		.000		.000		.000		.000
TAN	HE-S10	2	1	2			-0.00	2406.949	2406.949		.000		.000		.000		.000		.000
LIN	CS-100	3	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
TEE	FS-101	4	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
VAL	CV-141	7	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
VAL	CV-103	6	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	CS-105	9	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	FS-106	10	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	CS-107	11	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	FS-108	12	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	CS-109	13	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	FS-110	14	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	CS-113	17	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	FS-114	18	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	FS-115	19	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	FS-116	20	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	CS-117	21	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	FS-118	22	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
CIN	CS-119	23	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
CRY	CVP-22	24	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	CR-100	25	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
ELB	FR-101	26	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
LIN	CR-102	27	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
TAP	TR-103	28	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
HE-L12		1	1	2			.000		.000		.000		.000		.000		.000		.000
HE-S10		2	1	2			-0.00	2406.949	2406.949		.000		.000		.000		.000		.000
CS-100		3	1	2			.101	1022.953	1022.953		.000		.000		.000		.000		.000
FS-101		4	1	2															

NAME USER NAME : * * * * * PAGE 17
 DEPT : CRYOGEN SYSTEMS ANALYSIS : DATE 05 APR 79
 EXT. : : TIME 12:17:51
 BLD. : MFTF : CASE 1
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TEST CASE FOR THE MFTF CRYOPANEL SUPPLY SYSTEM (CVI)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR CRYOPANEL CIRCUIT - ZONE 1 ***

F	CODE	IDX	G	GS	DIAM. (M)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-L12	29	1	2	.000	902.605	902.605	.000	.000000	4.350	115.5727	.000000	.00000	.00000	.000
LIN	CS-202	30	1	2	.101	902.605	902.605	.000	.000000	4.350	117.3661	.000165	903.7705	123.57605	9979.966
VAL	CV-142	31	1	2	.101	902.605	902.605	.000	.000000	4.350	117.3601	.005989	903.7705	123.71977	9992.259
LIN	CS-203	32	1	2	.101	902.605	902.605	.000	.000000	4.351	117.3600	.000127	903.7705	123.71229	9991.989
ELB	FS-204	33	1	2	.101	902.605	902.605	.000	.000000	4.351	117.3598	.000195	903.7705	123.70888	9991.812
LIN	CS-205	34	1	2	.101	902.605	902.605	.000	.000000	4.351	120.5015	.000362	903.7705	123.70788	9958.958
ELB	FS-206	35	1	2	.101	902.605	902.605	.000	.000000	4.351	120.5013	.000194	903.7705	123.95203	9978.711
LIN	CS-207	36	1	2	.101	902.605	902.605	.000	.000000	4.353	120.4995	.001811	903.7705	123.95103	9983.377
ELB	FS-208	37	1	2	.101	902.605	902.605	.000	.000000	4.353	120.4993	.000194	903.7705	123.90260	9979.574
LIN	CS-209	38	1	2	.101	902.605	902.605	.000	.000000	4.355	141.4565	.002541	903.7705	123.90160	9775.218
ELB	FS-210	39	1	2	.101	902.605	902.605	.000	.000000	4.355	141.4563	.000192	903.7705	125.42096	9895.182
LIN	CS-211	40	1	2	.101	902.605	902.605	.000	.000000	4.355	141.4562	.000116	903.7705	125.42001	9895.400
ELB	FS-212	41	1	2	.101	902.605	902.605	.000	.000000	4.355	141.4561	.000127	903.7705	125.41699	9895.255
LIN	CS-213	42	1	2	.101	902.605	902.605	.000	.000000	4.356	141.4554	.000728	903.7705	125.41604	9897.013
ELB	FS-214	43	1	2	.101	902.605	902.605	.000	.000000	4.356	141.4552	.000192	903.7705	125.39717	9895.919
LIN	CS-215	44	1	2	.101	902.605	902.605	.000	.000000	4.356	139.6104	.000218	903.7705	125.39621	9913.925
ELB	FS-216	45	1	2	.101	902.605	902.605	.000	.000000	4.356	139.6102	.000192	903.7705	125.25779	9903.076
LIN	CS-217	46	1	2	.101	902.605	902.605	.000	.000000	4.358	139.6087	.001457	903.7705	125.25683	9906.690
ELB	FS-218	47	1	2	.101	902.605	902.605	.000	.000000	4.358	139.6086	.000192	903.7705	125.21891	9903.784
LIN	CS-219	48	1	2	.101	902.605	902.605	.000	.000000	4.359	128.2485	.001312	903.7705	125.21795	10021.289
ELB	FS-220	49	1	2	.101	902.605	902.605	.000	.000000	4.359	128.2483	.000194	903.7705	124.33178	9950.463
LIN	CS-221	50	1	2	.101	902.605	902.605	.000	.000000	4.359	128.2483	.000029	903.7705	124.33080	9950.460
CRY	CYP-21	51	1	2	.101	902.605	845.260	57.345	.06353	4.485	125.4592	.002440	1193.3851	93.47471	10629.452
LIN	CR-200	52	1	2	.101	902.605	845.260	57.345	.06353	4.485	125.4592	.000039	1239.2070	93.47471	10629.452
TAP	TR-103	53	1	2	.101	902.605	845.260	57.345	.06353	4.485	125.4592	.000000	1239.2070	93.47471	10629.452

037

TEST CASE FOR THE MEF1F CRYOPANEL SUPPLY SYSTEM (CVI)

***

F	CODE	IDX	G	GS	DIAM. (M)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-L113	54	1	2	.000	481.389	481.389	.000	.00000	4.350	115.5727	.000000	.0000	.00000	.000
LIN	CS-302	55	1	2	.051	481.389	481.389	.000	.00000	4.350	117.3648	.001494	1924.2490	123.57685	10634.799
VAL	CV-143	56	1	2	.051	481.389	481.389	.000	.00000	4.350	117.3376	.0027147	1924.2490	123.71994	10647.76
LIN	CS-303	57	1	2	.051	481.389	481.389	.000	.00000	4.350	117.3365	.001153	1924.2490	123.71444	10647.644
ELB	FS-304	58	1	2	.051	481.389	481.389	.000	.00000	4.350	117.3355	.000882	1924.2490	123.71115	10647.468
LIN	CS-305	59	1	2	.051	481.389	481.389	.000	.00000	4.351	120.4743	.003456	1924.2490	123.71015	10612.429
ELB	FS-306	60	1	2	.051	481.389	481.389	.000	.00000	4.351	120.4734	.000081	1924.2490	123.95465	10633.511
LIN	CS-307	61	1	2	.051	481.389	481.389	.000	.00000	4.352	120.4570	.016402	1924.2490	123.95366	10638.338
ELB	FS-308	62	1	2	.051	481.389	481.389	.000	.00000	4.352	120.4561	.000081	1924.2490	123.90703	10634.442
LIN	CS-309	63	1	2	.051	481.389	481.389	.000	.00000	4.355	142.0005	.023678	1924.2490	123.90604	10410.566
ELB	FS-310	64	1	2	.051	481.389	481.389	.000	.00000	4.355	141.9996	.000870	1924.2490	125.46903	10541.889
LIN	CS-311	65	1	2	.051	481.389	481.389	.000	.00000	4.355	141.9986	.001054	1924.2490	125.46809	10542.210
ELB	FS-312	66	1	2	.051	481.389	481.389	.000	.00000	4.355	141.9980	.000576	1924.2490	125.46519	10542.064
LIN	CS-313	67	1	2	.051	481.389	481.389	.000	.00000	4.356	141.9914	.006587	1924.2490	125.46427	10543.882
ELD	FS-314	68	1	2	.051	481.389	481.389	.000	.00000	4.356	141.9906	.000870	1924.2490	125.44616	10542.459
LIN	CS-315	69	1	2	.051	481.389	481.389	.000	.00000	4.356	140.1433	.001976	1924.2490	125.44522	10561.898
ELB	FS-316	70	1	2	.051	481.389	481.389	.000	.00000	4.356	140.1424	.000871	1924.2490	125.30745	10550.399
LIN	CS-317	71	1	2	.051	481.389	481.389	.000	.00000	4.358	140.1279	.014510	1924.2490	125.30651	10554.508
ELB	FS-318	72	1	2	.051	481.389	481.389	.000	.00000	4.358	140.1267	.001207	1924.2490	125.26647	10551.239
LIN	CS-319	73	1	2	.051	481.389	481.389	.000	.00000	4.358	139.8193	.000330	1924.2490	125.26549	10554.427
TAP	TP-320	74	1	2	.051	300.868	300.868	.000	.00000	4.358	139.8103	.001006	1202.6551	125.24236	6595.495
LIN	CS-321	75	1	2	.051	300.868	300.868	.000	.00000	4.358	139.5725	.000103	1202.6551	125.23933	6596.999
CRY	CYP-23	76	1	2	.051	300.868	273.161	27.707	.09209	4.583	138.3004	.004556	1745.6239	85.03681	7322.677
LIN	CR-300	77	1	2	.051	300.868	271.988	28.880	.09599	4.571	138.1335	.000152	1727.6055	85.92373	7322.335
ELB	FR-301	78	1	2	.051	300.868	271.988	28.880	.09599	4.571	138.1335	.000496	1727.6055	85.92373	7322.335
LIN	CR-302	79	1	2	.051	300.868	271.988	28.880	.09599	4.573	138.1255	.000754	1727.6055	85.92373	7322.335
TAP	TP-103	80	1	2	.051	300.868	271.988	28.880	.09599	4.573	138.1255	.000000	1727.6055	85.92373	7322.335

NAME USER NAME * * * * * PAGE 19
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:19:04
 BLD. * * * * * CASE 1
 * * * * * MFTF * * * * *

TEST CASE FOR THE MFTF CRYOPANEL SUPPLY SYSTEM (CVI)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR CRYOPANEL CIRCUIT - ZONE 4 ***

F	CODE	IDX	G	GS	DIAM. (M)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-LIQ	81	1	2	.000	180.521	180.521	.000	.00000	4.358	139.8183	.000000	.0000	.00000	.000
LIN	CS-401	82	1	2	.051	180.521	180.521	.000	.00000	4.361	139.8164	.001856	721.5939	125.23933	3960.895
ELB	FS-402	83	1	2	.051	180.521	180.521	.000	.00000	4.362	139.8163	.000123	721.5939	125.14437	3957.984
LIN	CS-403	84	1	2	.051	180.521	180.521	.000	.00000	4.362	139.5708	.000037	721.5939	125.14200	3958.940
CRY	CYP-24	85	1	2	.051	180.521	167.521	13.000	.07202	4.583	138.2145	.001534	979.9352	90.88915	4345.292
LIN	CR-401	86	1	2	.051	180.521	166.752	13.769	.07628	4.570	138.0362	.000051	978.3976	91.03199	4344.840
ELB	FR-402	87	1	2	.051	180.521	166.752	13.769	.07628	4.570	138.0360	.000169	978.3976	91.03199	4344.840
LIN	CR-403	88	1	2	.051	180.521	166.530	13.991	.07750	4.567	137.5895	.000128	982.6068	90.64204	4344.723
TAP	TP-103	89	1	2	.051	180.521	166.530	13.991	.07750	4.567	137.5895	.000000	982.6068	90.64204	4344.723

TEST CASE FOR THE METE CRYOPANEL SUPPLY SYSTEM (CV1)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR CRYOPANEL CIRCUIT RETURN LINE ***

F	CODE	IDX	G	GS	DIAM. (M)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-L10	90	1	2	.000	2406.947	2230.996	175.951	.07310	4.521	131.6632	.000000	.0000	.00000	.000
TAP	TP-103	91	1	2	.152	2406.947	2230.996	175.951	.07310	4.521	131.6628	.000444	1457.6262	90.64204	.000
LIN	CR 104	92	1	2	.152	2406.947	2184.631	222.316	.09236	4.504	130.3292	.000282	1544.4739	85.54512	19268.530
ELB	FR 105	93	1	2	.152	2406.947	2194.631	222.316	.09236	4.504	130.3289	.000261	1544.7739	85.54512	19268.530
LIN	CR 106	94	1	2	.152	2406.947	2160.395	246.552	.10243	4.468	126.3426	.001449	1608.4369	82.14323	19247.560
ELB	FR 107	95	1	2	.152	2406.947	2160.395	246.552	.10243	4.468	126.3424	.000272	1608.4369	82.14323	19267.560
LIN	CR 108	96	1	2	.152	2406.947	2160.395	246.552	.10243	4.469	126.3390	.002555	1608.4369	82.14323	19267.560
ELB	FR 109	97	1	2	.152	2406.947	2160.395	246.552	.10243	4.469	126.3364	.000411	1608.4369	82.14323	19267.560
LIN	CR 110	98	1	2	.152	2406.947	2147.998	258.949	.10758	4.449	124.2521	.000537	1643.7034	80.38080	19267.813
ELB	FR 111	99	1	2	.152	2406.947	2147.998	258.949	.10758	4.449	124.2521	.000420	1643.7034	80.38080	19267.813
LIN	CR 112	100	1	2	.152	2406.947	2147.998	258.949	.10758	4.449	124.2520	.000113	1643.7034	80.38080	19267.813
VAL	CV-144	101	1	2	.152	2406.947	2147.998	258.949	.10758	4.449	124.2390	.012930	1643.7034	80.38080	19267.813
LIN	CR 113	102	1	2	.152	2406.947	2147.998	258.949	.10758	4.449	124.2386	.000469	1643.7034	80.38080	19267.813
ELB	FR 114	103	1	2	.152	2406.947	2147.998	258.949	.10758	4.449	124.2381	.000420	1643.7034	80.38080	19267.813
LIN	CR 115	104	1	2	.152	2406.947	2141.081	265.866	.11046	4.438	123.0712	.000314	1664.1676	79.39141	19268.163
TAN	HE-SV1	105	1	2	-.000	2406.949	2141.081	265.866	.00000	4.438	113.7879	.000000	.0000	123.42882	.000

.19384493+00 KPA

.60712414+01 CUBIC METERS (6071.24 LITERS)

NAME USER NAME * * * * * PAGE 21
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * TIME 12:20:04
 BLD. * * CASE 1
 * * * * * MFTF * * * * *

TEST CASE FOR THE MFTF CRYOPANEL SUPPLY SYSTEM (CVI)

***** CRYOPANEL SUPPLY TANK DATA *****

NOMINAL VOLUME OF HELIUM IN TANK - (LITERS) =	4000.0000
TANK OUTFLOW OF HELIUM (KG/HR) =	2406.9490
LIQUID HELIUM IN RETURN FLOW (KG/HR) =	2141.0807
LIQUID HELIUM MAKE-UP REQUIRED (KG/HR) =	265.8664
RETURN FLUID QUALITY (DECIMAL FRACTION) =	.1105

*** YOU HAVE CALLED FOR THE REFLIQ SYSTEM ***

TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CV1)

REFRIGERATOR-LIQUIFIER HEAD-END CONDITIONS:

TURBINE EXPANDERS:

REF-LIQ BOTTOM-END CONDITIONS:

COMPRESSOR-PURIFIER ASSY:

LOW-PRES. HELIUM INLET	290.00	113.8	474.1	6088.1
HIGH-PRES. HELIUM OUTLET	300.00	1215.9	474.1	6310.4

COMPRESSOR

N2-VENT

MAKE-UP

[illegible]

TBD VALUES ARE COMPUTED IN PROGRAM

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NAME USER NAME * * * * * PAGE 24
 DEPT. * * * * * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * * TIME 12:20:05
 BLD. * * * * * MFTF * CASE 1
 * * * * *
 TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

***** SYSTEM CONFIGURATION *****

COMP NAME	COMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRL. TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-D	LINE DIAMETER	INSULATION TYPE	INSULATION THICKNESS	NO. LAYERS INSULATION
GAS	HE-GAS	1	1	-.00	1	-.00000000	-.00	-.00	0	-.00	-.0
TANK	HE-SV1	0	1	.00	6	.00000000	.00	.00	0	.00	.0
LINE	CGV301	10	1	.00	6	.60000000-02	.91	.08	10	.00	.0
ELBDW	FGV302	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	CGV303	10	1	.00	6	.60000000-02	.46	.08	10	.00	.0
ELBDW	FGV304	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	CGV305	10	1	.00	6	.60000000-02	.05	.08	10	.00	.0
VALVE	AV-121	41	1	.00	6	.10000000-01	400.00	.00	10	.00	.0
LINE	CGV306	10	1	.00	6	.60000000-02	.08	.08	10	.00	.0
ELBDW	FGV307	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	CGV308	10	1	.00	6	.60000000-02	.61	.08	10	.00	.0
FITING	FGV309	41	1	.00	6	.60000000-02	8.00	.00	10	.00	.0
LINE	CGV310	10	1	.00	6	.60000000-02	.61	.08	10	.00	.0
ELBDW	FGV311	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	CGV312	10	1	.00	6	.60000000-02	5.94	.08	10	.00	.0
GAS	HE-GAS	1	1	-.00	2	-.00000000	-.00	-.00	0	-.00	-.0
TANK	HE-SV2	0	1	-.00	6	-.00000000	.00	.00	0	.00	.0
LINE	MSV401	10	1	.00	6	.60000000-02	.91	.08	10	.00	.0
ELBDW	FGV402	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	MSV403	10	1	.00	6	.60000000-02	.46	.08	10	.00	.0
ELBDW	FGV404	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	MSV405	10	1	.00	6	.60000000-02	.05	.08	10	.00	.0
VALVE	AV-122	41	1	.00	6	.10000000-01	400.00	.00	10	.00	.0
LINE	MSV406	10	1	.00	6	.60000000-02	.08	.08	10	.00	.0
ELBDW	FGV407	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	MSV408	10	1	.00	6	.60000000-02	.61	.08	10	.00	.0
FITING	FGV409	41	1	.00	6	.70000000-02	8.00	.00	10	.00	.0
LINE	MSV410	10	1	.00	6	.60000000-02	.61	.08	10	.00	.0
TEE	FGV313	31	1	.00	6	.70000000-02	30.00	.00	10	.00	.0
LINE	MSV411	10	1	.00	6	.60000000-02	1.83	.08	10	.00	.0
ELBDW	FGV412	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	MSV413	10	1	.00	6	.60000000-02	3.96	.08	10	.00	.0
GAS	HE-GAS	1	1	-.00	3	-.00000000	-.00	-.00	0	-.00	-.0
TANK	HE-SV3	0	1	-.00	6	-.00000000	.00	.00	0	.00	.0
LINE	SGV501	10	1	.00	6	.60000000-02	.91	.08	10	.00	.0
ELBDW	FGV502	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	SGV503	10	1	.00	6	.60000000-02	.05	.08	10	.00	.0
VALVE	CV-123	41	1	.00	6	.10000000-01	400.00	.00	10	.00	.0
LINE	SGV504	10	1	.00	6	.60000000-02	.08	.08	10	.00	.0
ELBDW	FGV505	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	SGV506	10	1	.00	6	.60000000-02	.61	.08	10	.00	.0
FITING	FGV507	41	1	.00	6	.70000000-02	8.00	.00	10	.00	.0
LINE	SGV508	10	1	.00	6	.60000000-02	.61	.08	10	.00	.0
ELBDW	FGV509	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0

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NAME USER NAME * * * * * PAGE 25
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:20:08
 BLD. * * * * * CASE 1
 * * * * * MFTF * * * * *

TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CV1)

***** SYSTEM CONFIGURATION *****

COMP NAME	COMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRI TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-D	LINE DIAMETER	INSULATION TYPE	INSULATION THICKNESS	NO. LAYERS INSULATION
LINE	SGVS10	10	1	.00	6	.60000000-02	6.09	.08	10	.00	.0
ELBOW	FGVS11	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	SGVS12	10	1	.00	6	.60000000-02	1.22	.08	10	.00	.0
TEE	FGVS13	31	1	.00	6	.70000000-02	15.50	.00	10	.00	.0
LINE	CB1101	10	1	.00	6	.60000000-02	1.22	.08	10	.00	.0
GAS	HE-GAS	1	1	.00	4	-.00000000	-.00	-.00	0	-.00	-.0
REFLIO	RF-LQ1	0	1	.00	6	.70000000-02	100.00	.03	10	.00	.0
LINE	CB0101	10	1	.00	6	.90000000-02	.61	.10	10	.00	.0
FITING	FBD102	41	1	.00	6	.90000000-02	8.00	.00	10	.00	.0
LINE	CB0103	10	1	.00	6	.90000000-02	.61	.10	10	.00	.0
TEE	FBD104	31	1	.00	6	.10000000-01	60.00	.00	10	.00	.0
GAS	HE-GAS	1	1	.00	5	-.00000000	-.00	-.00	0	-.00	-.0
REFLIO	RF-LQ2	0	1	.00	6	.70000000-02	100.00	.03	10	.00	.0
LINE	SHPG01	10	1	.00	6	.90000000-02	1.22	.10	10	.00	.0
ELBOW	FHPG02	31	1	.00	6	.90000000-02	13.00	.00	10	.00	.0
LINE	SHPG03	10	1	.00	6	.90000000-02	5.79	.10	10	.00	.0
ELBOW	FAPG04	31	1	.00	6	.90000000-02	13.00	.00	10	.00	.0
LINE	SHPG05	10	1	.00	6	.90000000-02	.61	.10	10	.00	.0
FITING	FHPG06	41	1	.00	6	.90000000-02	8.00	.00	10	.00	.0
LINE	SHPG07	10	1	.00	6	.90000000-02	.61	.10	10	.00	.0
ELBOW	FHPG08	31	1	.00	6	.90000000-02	13.00	.00	10	.00	.0
LINE	SHPG09	10	1	.00	6	.90000000-02	.30	.10	10	.00	.0
VALVE	CV-104	51	1	.00	6	.80000000-02	422.00	.00	10	.00	.0
LINE	SHPG10	10	1	.00	6	.70000000-02	.15	.10	10	.00	.0
ELBOW	FHPG11	31	1	.00	6	.70000000-02	13.00	.00	10	.00	.0
LINE	SHPG12	10	1	.00	6	.70000000-02	2.44	.10	10	.00	.0
TANK	HE-SV3	0	1	.00	6	-.00000000	-.00	-.00	0	-.00	-.0
GAS	HE-GAS	1	1	.00	6	-.00000000	-.00	-.00	0	-.00	-.0
LINE	CHP701	10	1	.00	6	.90000000-02	4.26	.10	10	.00	.0
ELBOW	FHP702	31	1	.00	6	.90000000-02	13.00	.00	10	.00	.0
LINE	CHP703	10	1	.00	6	.90000000-02	1.22	.10	10	.00	.0
TEE	FHP704	31	1	.00	6	.90000000-02	60.00	.00	10	.00	.0
LINE	CHP705	10	1	.00	6	.90000000-02	.61	.10	10	.00	.0
FITING	FHP706	41	1	.00	6	.90000000-02	8.00	.00	10	.00	.0
LINE	CHP707	10	1	.00	6	.90000000-02	.61	.10	10	.00	.0
ELBOW	FHP708	31	1	.00	6	.90000000-02	13.00	.00	10	.00	.0
LINE	CHP709	10	1	.00	6	.90000000-02	.05	.10	10	.00	.0
VALVE	CV-105	41	1	.00	6	.90000000-02	400.00	.00	10	.00	.0
LINE	CHP710	10	1	.00	6	.90000000-02	.05	.10	10	.00	.0
ELBOW	FHP711	31	1	.00	6	.90000000-02	13.00	.00	10	.00	.0
LINE	CHP712	10	1	.00	6	.90000000-02	.60	.10	10	.00	.0
VALVE	AV-129	51	1	.00	6	.90000000-02	422.00	.00	10	.00	.0
LINE	CHP713	10	1	.00	6	.70000000-02	.91	.10	10	.00	.0
TANK	HE-SV1	0	1	.00	6	.00000000	.00	.00	0	.00	.0

044

NAME USER NAME * * * * * PAGE 26
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * * TIME 12:20:08
 BLD. * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

***** SYSTEM CONFIGURATION *****

DAS

COMP NAME	COMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRL. TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-D	LINE DIAMETER	INSULATION TYPE	INSULATION THICKNESS	NO. LAYERS INSULATION
GAS	HE-CAS	1	1	.00	7	.00000000	.00	.00	0	.00	.0
LINE	MHP001	10	1	.00	6	.90000000-02	6.24	.10	10	.00	.0
ELBOW	FHP002	31	1	.00	6	.90000000-02	13.00	.00	10	.00	.0
LINE	MHP003	10	1	.00	6	.90000000-02	.61	.10	10	.00	.0
FITING	FHP004	41	1	.00	6	.90000000-02	8.00	.00	10	.00	.0
LINE	MHP005	10	1	.00	6	.90000000-02	.61	.10	10	.00	.0
ELBOW	FHP006	31	1	.00	6	.90000000-02	13.00	.00	10	.00	.0
LINE	MHP007	10	1	.00	6	.90000000-02	.05	.10	10	.00	.0
VALVE	CV-106	41	1	.00	6	.90000000-02	400.00	.00	10	.00	.0
LINE	MHP008	10	1	.00	6	.90000000-02	.05	.10	10	.00	.0
ELBOW	FHP009	31	1	.00	6	.90000000-02	13.00	.00	10	.00	.0
LINE	MHP010	10	1	.00	6	.90000000-02	.60	.10	10	.00	.0
VALVE	AV-12B	51	1	.00	6	.90000000-02	422.00	.00	10	.00	.0
LINE	MHE011	10	1	.00	6	.90000000-02	.91	.10	10	.00	.0
TANK	HE-SV2	0	1	.00	6	.00000000	.00	.00	0	.00	.0
GAS	HE-GAS	1	1	.00	8	.00000000	.00	.00	0	.00	.0
REFLIQ	RF-LQ3	0	1	.00	6	.70000000-02	.00	.00	10	.00	.0
LINE	CLP101	10	1	.00	6	.60000000-02	.30	.15	10	.00	.0
ELBOW	FLP102	31	1	.00	6	.60000000-02	13.00	.00	10	.00	.0
LINE	CLP103	10	1	.00	6	.60000000-02	7.92	.15	10	.00	.0
ELBOW	FLP104	31	1	.00	6	.60000000-02	13.00	.00	10	.00	.0
LINE	CLP105	10	1	.00	6	.60000000-02	3.96	.15	10	.00	.0
ELBOW	FLP106	31	1	.00	6	.60000000-02	13.00	.00	10	.00	.0
LINE	CLP107	10	1	.00	6	.60000000-02	9.74	.15	10	.00	.0
ELBOW	FLP108	31	1	.00	6	.60000000-02	13.00	.00	10	.00	.0
LINE	CLP109	10	1	.00	6	.60000000-02	8.22	.15	10	.00	.0
ELBOW	FLP110	31	1	.00	6	.60000000-02	13.00	.00	10	.00	.0
LINE	CLP111	10	1	.00	6	.60000000-02	8.00	.15	10	.00	.0
ELBOW	FLP112	31	1	.00	6	.60000000-02	13.00	.00	10	.00	.0
LINE	CLP113	10	1	.00	6	.60000000-02	7.00	.15	10	.00	.0
ELBOW	FLP114	31	1	.00	6	.60000000-02	13.00	.00	10	.00	.0
LINE	CLP115	10	1	.00	6	.60000000-02	6.00	.15	10	.00	.0
ELBOW	FLP116	31	1	.00	6	.60000000-02	13.00	.00	10	.00	.0
LINE	CLP117	10	1	.00	6	.60000000-02	.50	.15	10	.00	.0
COMPUR	CPU-01	0	1	.00	6	.60000000-02	.00	.00	10	.00	.0
LINE	CHP101	10	1	.00	6	.80000000-02	.50	.08	10	.00	.0
ELBOW	FHP102	31	1	.00	6	.80000000-02	13.00	.00	10	.00	.0
LINE	CHP103	10	1	.00	6	.80000000-02	6.00	.08	10	.00	.0
ELBOW	FHP104	31	1	.00	6	.80000000-02	13.00	.00	10	.00	.0
LINE	CHP105	10	1	.00	6	.80000000-02	6.00	.08	10	.00	.0
ELBOW	FHP106	31	1	.00	6	.80000000-02	13.00	.00	10	.00	.0
LINE	CHP107	10	1	.00	6	.80000000-02	8.22	.08	10	.00	.0
ELBOW	FHP108	31	1	.00	6	.80000000-02	13.00	.00	10	.00	.0
LINE	CHP109	10	1	.00	6	.80000000-02	9.74	.08	10	.00	.0

NAME USER NAME * * * * * PAGE 27
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:20:10
 BLD. * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CV1)

***** SYSTEM CONFIGURATION *****

COMP NAME	COMP CODE	FUNC. TYPE	NUMB. OPER.	NHEAD (M)	MATRL. TYPE	FLOW FRICTION COEFFICIENT	LINE LENGTH OR L-OVER-D	LINE DIAMETER	INSULATION TYPE	INSULATION THICKNESS	NO. LAYERS INSULATION
ELBOW	FHP110	31	1	.00	6	.80000000-02	13.00	.00	10	.00	.0
LINE	CHP111	10	1	.00	6	.80000000-02	3.96	.08	10	.00	.0
ELBOW	FHP112	31	1	.00	6	.80000000-02	13.00	.00	10	.00	.0
LINE	CHP113	10	1	.00	6	.80000000-02	7.92	.08	10	.00	.0
VALVE	AV-041	41	1	.00	6	.80000000-02	422.00	.00	10	.00	.0
LINE	CHP114	10	1	.00	6	.80000000-02	.05	.08	10	.00	.0
ELBOW	FHP115	31	1	.00	6	.80000000-02	13.00	.00	10	.00	.0
LINE	CHP116	10	1	.00	6	.80000000-02	.30	.08	10	.00	.0
REFLIQ	RF-LQ4	0	1	.00	6	.70000000-02	.00	.00	10	.00	.0
END		0	0	-.00	0	-.00000000	-.00	-.00	0	-.00	-.0

NAME USER NAME * * * * * PAGE 28
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * TIME 12:20:14
 BLD. * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

*** CHARACTERIZE REFRIGERATOR-LIQUIFIER INPUT AND OUTPUT CONDITIONS ***

** REFRIGERATOR-LIQUIFIER PARAMETERS **

ZERO MAKE-UP FLOW CONDITIONS:

	WARM HE - UPPER HEX & LN2 BOILER	COLD HELIUM THRU UPPER HEX	LN2 BOILER AND UPPER HEX
INLET TEMPERATURE (DEG.K)	.300000+03	.800000+02	.773480+02
INLET PRESSURE (KPA)	.121590+04	.113788+03	.101325+03
INLET FLUID DENSITY (KG/CU.M)	.193991+04	.717032+04	.804102+06
INLET FLOW RATE (KG/HR)	.170676+04	.819720+03	.248261+04
OUTLET TEMPERATURE (DEG.K)	.800000+02	.290000+03	.290000+03
OUTLET PRESSURE (KPA)	.121590+04	.113788+03	.101325+03
OUTLET GAS DENSITY (KG/CU.M)	.717032+04	.200637+04	.117760+04
OUTLET FLOW RATE (KG/HR)	.170676+04	.819720+03	.248261+04
ENERGY TRANSFER (J/HR)	- .542350+03	+ .248653+03	+ .293697+03
HEAT LOAD: LN2 BOILER (KW)			.139669+03

CURRENT MAKE-UP FLOW CONDITIONS:

	WARM HE - UPPER HEX & LN2 BOILER	COLD HELIUM THRU UPPER HEX	LN2 BOILER AND UPPER HEX
INLET TEMPERATURE (DEG.K)	.300000+03	.800000+02	.773480+02
INLET PRESSURE (KPA)	.121590+04	.113788+03	.101325+03
INLET FLUID DENSITY (KG/CU.M)	.193991+04	.717032+04	.804102+06
INLET FLOW RATE (KG/HR)	.170676+04	.118787+04	.153862+04
OUTLET TEMPERATURE (DEG.K)	.800000+02	.290000+03	.290000+03
OUTLET PRESSURE (KPA)	.121590+04	.113788+03	.101325+03
OUTLET GAS DENSITY (KG/CU.M)	.717032+04	.200637+04	.117760+04
OUTLET FLOW RATE (KG/HR)	.170676+04	.118787+04	.153862+04
ENERGY TRANSFER (J/HR)	- .542350+03	+ .360329+03	+ .182021+03
HEAT LOAD: LN2 BOILER (KW)			.865610+02

NAME USER NAME * * * * * PAGE 29
 DEPT * CRYODGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * TIME 12:20:14
 BLD. * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR MAGNET DEWAR OFF-GAS LINE ***

#	CODE	IDX	G	GS	DIAM. (M)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
IAS	HE-GAS	1	1	1	.000	.000	.000	.000	.00000	.000	.0000	.000000	.0000	.00000	.000
IAN	HE-SV1	2	1	1	.000	102.287	.000	102.287	.00000	4.409	113.7879	.000000	.0000	18.41883	.000
LIN	CGV301	3	1	1	.076	102.287	.000	102.287	.00000	4.410	113.7879	.000042	1221.3203	18.41333	3622.298
ELB	FGV302	4	1	1	.076	102.287	.000	102.287	.00000	4.410	113.7878	.000053	1221.4210	18.41181	3622.247
LIN	CGV303	5	1	1	.076	102.287	.000	102.287	.00000	4.410	113.7871	.000021	1221.6036	18.40906	3622.153
ELB	FGV304	6	1	1	.076	102.287	.000	102.287	.00000	4.410	113.7877	.000053	1221.7042	18.40754	3622.102
LIN	CGV305	7	1	1	.076	102.287	.000	102.287	.00000	4.410	113.7877	.000002	1221.7245	18.40723	3622.091
VAL	AV-121	8	1	1	.076	102.287	.000	102.287	.00000	4.411	113.7854	.002337	1222.2989	18.39858	3621.837
LIN	CGV306	9	1	1	.076	102.287	.000	102.287	.00000	4.411	113.7854	.000004	1222.3293	18.39813	3621.821
ELB	FGV307	10	1	1	.076	102.287	.000	102.287	.00000	4.411	113.7853	.000053	1222.4300	18.39661	3621.770
LIN	CGV308	11	1	1	.076	102.287	.000	102.287	.00000	4.411	113.7853	.000028	1222.6735	18.39295	3621.645
FEI	FGV309	12	1	1	.076	102.287	.000	102.287	.00000	4.411	113.7853	.000028	1222.7737	18.39144	3621.593
LIN	CGV310	13	1	1	.076	102.287	.000	102.287	.00000	4.412	113.7853	.000028	1223.0172	18.38778	3621.468
ELB	FGV311	14	1	1	.076	102.287	.000	102.287	.00000	4.412	113.7852	.000053	1223.1178	18.38627	3621.416
LIN	CGV312	15	1	1	.076	102.287	.000	102.287	.00000	4.415	113.7849	.000274	1225.4887	18.35069	3620.189

NAME USER NAME * * * * * PAGE 30
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:21:09
 BLD. * MFTF * CASE 1
 * * * * *
 TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR CRYOPANEL DEWAR OFF-GAS LINE ***

F	CODE	IDX	G	GS	DIAM. (M)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-GAS	16	1	1	.000	.000	.000	.000	.00000	.000	.0000	.000000	.0000	.00000	.000
TAN	HE-SV2	17	1	1	.000	265.866	.000	265.866	.00000	4.438	113.7879	.000000	.0000	18.08592	.000
LIN	MGV401	18	1	1	.076	265.866	.000	265.866	.00000	4.438	113.7876	.000289	3232.3208	18.08381	9384.482
ELB	FGV402	19	1	1	.076	265.866	.000	265.866	.00000	4.438	113.7872	.000366	3232.4384	18.08315	9384.435
LIN	MGV403	20	1	1	.076	265.866	.000	265.866	.00000	4.438	113.7871	.000145	3232.6277	18.08209	9384.339
ELB	FGV404	21	1	1	.076	265.866	.000	265.866	.00000	4.438	113.7867	.000366	3232.7454	18.08143	9384.292
LIN	MGV405	22	1	1	.076	265.866	.000	265.866	.00000	4.438	113.7867	.000016	3232.7662	18.08131	9384.281
VAL	AV-122	23	1	1	.076	265.866	.000	265.866	.00000	4.439	113.7706	.016073	3234.0886	18.07392	9384.322
LIN	MGV406	24	1	1	.076	265.866	.000	265.866	.00000	4.439	113.7706	.000024	3234.1200	18.07375	9384.307
ELB	FGV407	25	1	1	.076	265.866	.000	265.866	.00000	4.439	113.7703	.000366	3234.2377	18.07309	9384.260
LIN	MGV408	26	1	1	.076	265.866	.000	265.866	.00000	4.439	113.7701	.000193	3234.4901	18.07168	9384.132
FIT	FGV409	27	1	1	.076	265.866	.000	265.866	.00000	4.439	113.7698	.000225	3234.6009	18.07106	9384.081
LIN	MGV410	28	1	1	.076	265.866	.000	265.866	.00000	4.439	113.7695	.000193	3234.8534	18.06965	9383.953
TEE	FGV313	29	1	1	.076	368.154	.000	368.154	.00000	4.439	113.7680	.001689	4479.7263	18.06834	12994.189
LIN	MGV411	30	1	1	.076	368.154	.000	368.154	.00000	4.439	113.7669	.001111	4480.5306	18.06510	12993.823
ELB	FGV412	31	1	1	.076	368.154	.000	368.154	.00000	4.439	113.7662	.000702	4480.6782	18.06450	12993.788
LIN	MGV413	32	1	1	.076	368.154	.000	368.154	.00000	4.440	113.7637	.002408	4482.4216	18.05748	12992.994

TEST CASE FOR THE MTTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

[illegible]


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NAME      USER NAME      * * * * * PAGE      32
DEPT      *              * * * * * DATE      05 APR 79
EXT.      *              * * * * * TIME     12:21:34
BLD.      *              * * * * * CASE      1
* * * * *
TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

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*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR REF-LIQ HP-COLD HELIUM OUTLET ***

F	CODE	IDX	G	GS	D.IAM. (M)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-GAS	50	1	1	.000	.000	.000	.000	.00000	.000	.0000	.000000	.0000	.00000	.000
REF	FR-L01	51	1	1	.000	887.040	.000	887.040	.00000	4.800	1215.9000	.000000	.0000	151.10625	.000
LIN	CB0103	52	1	1	.101	887.040	.000	887.040	.00000	4.800	1215.8999	.000000	725.5151	151.10625	6244.292
TEE	FB0102	54	1	1	.101	887.040	.000	887.040	.00000	4.800	1215.8999	.000000	725.5098	151.10625	6244.312
LIN	CB0103	54	1	1	.101	887.040	.000	887.040	.00000	4.800	1215.8997	.000001	725.5151	151.10360	6244.427
TEE	FB0104	55	1	1	.101	887.040	.000	887.040	.00000	4.801	1215.8987	.000105	725.5197	151.10264	6244.510

NAME USER NAME * * * * * PAGE 33
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT * * * * * TIME 12:21:38
 RLD * * * * * CASE 1
 * * * * * MFTF * * * * *

TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR STO-DEWAR HP-COLD HE SUPPLY ***

F	CODE	IDK	G	GS	DIAM. (IN)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-GAS	56	1	1	.000	.000	.000	.000	.00000	.000	.0000	.000000	.0000	.00000	.000
REF	RF-LQ2	57	1	1	.025	518.886	.000	518.886	.00000	4.800	1215.9000	.000000	.0000	.00000	.000
LIN	SHP601	58	1	1	.101	518.886	.000	518.886	.00000	4.801	1215.8999	.000063	424.4033	151.10249	3652.820
ELB	FHP602	59	1	1	.101	518.886	.000	518.886	.00000	4.801	1215.8999	.000068	424.4055	151.10172	3652.860
LIN	SHP603	60	1	1	.101	518.886	.000	518.886	.00000	4.803	1215.8996	.000297	424.4557	151.08384	3653.758
ELB	FHP604	61	1	1	.101	518.886	.000	518.886	.00000	4.803	1215.8995	.000068	424.4579	151.08307	3653.797
LIN	SHP605	62	1	1	.101	518.886	.000	518.886	.00000	4.803	1215.8995	.000031	424.4631	151.08118	3653.891
FIT	FHP606	63	1	1	.101	518.886	.000	518.886	.00000	4.804	1215.8995	.000042	424.4653	151.08041	3653.931
LIN	SHP607	64	1	1	.101	518.886	.000	518.886	.00000	4.804	1215.8994	.000031	424.4706	151.07853	3654.024
ELB	FHP608	65	1	1	.101	518.886	.000	518.886	.00000	4.804	1215.8994	.000068	424.4728	151.07776	3654.063
LIN	SHP609	66	1	1	.101	518.886	.000	518.886	.00000	4.804	1215.8994	.000016	424.4754	151.07681	3654.111
VAL	CV-104	67	1	2	.101	518.886	518.886	.000	.00000	4.350	113.7879	.000000	519.5577	123.42882	5843.895
LIN	SHP610	68	1	2	.101	518.886	518.886	.000	.00000	4.350	113.7879	.000007	519.5577	123.42882	5587.902
ELB	FHP611	69	1	2	.101	518.886	518.886	.000	.00000	4.350	113.7878	.000064	519.5622	123.42776	5597.936
LIN	SHP612	70	1	2	.101	518.886	518.886	.000	.00000	4.351	113.7877	.000119	519.5695	123.42603	5598.024
TAN	HE-SV3	71	1	2	.000	518.886	518.886	.000	.00000	4.351	113.7877	.000000	.0000	123.42603	.000

NAME USER NAME * * * * * PAGE 34
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:21:51
 BLD. * MFTF * CASE 1
 * * * * *
 TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR MAGNET DEWAR HP-COLD HE-SUPPLY ***

F	CODE	IDX	G	GS	DIAM. (M)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-GAS	72	1	1	.000	.000	.000	.000	.00000	.000	.0000	.000000	.0000	.00000	.000
LIN	CHP701	73	1	1	.101	368.154	.000	368.154	.00000	4.803	1215.8000	.000000	301.1498	151.08610	2592.302
ELB	FHP702	74	1	1	.101	368.154	.000	368.154	.00000	4.803	1215.8000	.000034	301.1519	151.08501	2592.341
LIN	CHP703	75	1	1	.101	368.154	.000	368.154	.00000	4.801	1215.7999	.000031	301.1233	151.09936	2591.830
TEE	FHP704	76	1	1	.101	102.287	.000	102.287	.00000	4.802	1215.7998	.000157	83.6681	151.09117	720.191
LIN	CHP705	77	1	1	.101	102.287	.000	102.287	.00000	4.801	1215.7998	.000001	83.6659	151.09512	720.151
FIT	FHP706	78	1	1	.101	102.287	.000	102.287	.00000	4.802	1215.7998	.000002	83.6681	151.09120	720.190
LIN	CHP707	79	1	1	.101	102.287	.000	102.287	.00000	4.801	1215.7998	.000001	83.6659	151.09512	720.151
ELB	FHP708	80	1	1	.101	102.287	.000	102.287	.00000	4.802	1215.7998	.000003	83.6681	151.09120	720.190
LIN	CHP709	81	1	1	.101	102.287	.000	102.287	.00000	4.800	1215.7998	.000000	83.6611	151.10386	720.065
VAL	CV-105	82	1	1	.101	102.287	.000	102.287	.00000	4.804	1215.7997	.000081	83.6765	151.07609	720.340
LIN	CHP710	83	1	1	.101	102.287	.000	102.287	.00000	4.800	1215.7997	.000000	83.6611	151.10386	720.065
ELB	FHP711	84	1	1	.101	102.287	.000	102.287	.00000	4.801	1215.7997	.000003	83.6633	151.09995	720.103
LIN	CHP712	85	1	1	.101	102.287	.000	102.287	.00000	4.801	1215.7997	.000001	83.6659	151.09521	720.151
VAL	AV-129	86	1	2	.101	102.287	102.287	.000	.00000	4.350	113.7879	.000000	102.4195	123.42882	1151.996
LIN	CHP713	87	1	2	.101	102.287	102.287	.000	.00000	4.351	113.7879	.000002	102.4195	123.42882	1105.771
TAN	HE-SV1	88	1	2	.000	102.227	102.287	.000	.00000	4.351	113.7879	.000000	.0000	123.42882	.000

NAME USER NAME * * * * * PAGE 35
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * TIME 12:22:06
 BLD. * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVII)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR CRYPAN DEW/R HP-COLD HE-SUPPLY ***

F	CODE	IDX	G	GS	DIAM. (M)	WDOT-T (KG/HR)	WDOT-L (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/HR)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-GAS	89	1	1	.000	.000	.000	.000	.000000	.000	.0000	.000000	.0000	.00000	.000
LIN	MHP001	90	1	1	.101	265.866	.000	265.866	.000000	4.805	1215.8000	.000000	217.5063	151.06701	1872.553
ELB	FHP002	91	1	1	.101	265.866	.000	265.866	.000000	4.805	1215.8000	.000018	217.5085	151.06550	1872.592
LIN	MHP003	92	1	1	.101	265.866	.000	265.866	.000000	4.801	1215.8000	.000008	217.4574	151.10099	1871.678
FIT	FHP004	93	1	1	.101	265.866	.000	265.866	.000000	4.801	1215.8000	.000011	217.4596	151.09948	1871.717
LIN	MHP005	94	1	1	.101	265.866	.000	265.866	.000000	4.801	1215.8000	.000008	217.4574	151.10099	1871.678
ELB	FHP006	95	1	1	.101	265.866	.000	265.866	.000000	4.801	1215.8000	.000018	217.4596	151.09948	1871.717
LIN	MHP007	96	1	1	.101	265.866	.000	265.866	.000000	4.800	1215.8000	.000001	217.4526	151.10435	1871.592
VAL	CV-100	97	1	1	.101	265.866	.000	265.866	.000000	4.802	1215.7994	.000547	217.4679	151.09367	1871.867
LIN	MHP008	98	1	1	.101	265.866	.000	265.866	.000000	4.800	1215.7994	.000001	217.4526	151.10435	1871.592
ELB	FHP009	99	1	1	.101	265.866	.000	265.866	.000000	4.800	1215.7994	.000018	217.4547	151.10284	1871.631
LIN	MHP010	100	1	1	.101	265.866	.000	265.866	.000000	4.801	1215.7994	.000008	217.4574	151.10102	1871.677
VAL	AV-128	101	1	2	.101	265.866	265.866	.000	.000000	4.350	113.7879	.000000	266.2104	123.42882	2994.288
LIN	MHE011	102	1	2	.101	265.866	265.866	.000	.000000	4.350	113.7879	.000015	266.2104	123.42882	2914.563
TAN	HE-SV2	103	1	2	.000	265.866	265.866	.000	.000000	4.350	113.7879	.000000	.0000	123.42882	.000

NAME USER NAME * * * * * PAGE 36
 DEPT : CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. : * TIME 12:22:42
 BLD. : * CASE 1
 * * * * *

TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

*** SUMMARY OF COMPUTED SYSTEM CONFIGURATION PARAMETERS - FOR COMP-PURIFIER CIRCUIT (LP-HP) ***

F	CODE	IDX	G	GS	DIAM. (M)	WDOT-T (KG/HR)	WDOT-I (KG/HR)	WDOT-G (KG/HR)	QUAL- ITY	TEMP. (K)	PRESS. (KPA)	DELTA-P (KPA)	VELOCITY (M/SEC)	DENSITY (KG/CU-M)	REYNOLDS NUMBER
GAS	HE-GAS	104	1	1	.000	.000	.000	.000	.00000	.000	.0000	.000000	.0000	.00000	.000
REF	RF-LQ3	105	1	1	.000	929.420	.000	929.420	.00000	290.000	101.3250	.000000	.0000	.16812	.000
LIN	CLP101	106	1	1	.152	929.420	.000	929.420	.00000	290.000	101.3210	.003951	84.2987	.16811	1108.354
ELB	FLP102	107	1	1	.152	929.420	.000	929.420	.00000	290.000	101.2954	.025660	84.3201	.16807	1108.354
LIN	CLP103	108	1	1	.152	929.420	.000	929.420	.00000	290.002	101.1926	.102750	84.4061	.16790	1108.350
ELB	FLP104	109	1	1	.152	929.420	.000	929.420	.00000	290.002	101.1669	.025712	84.4276	.16786	1108.350
LIN	CLP105	110	1	1	.152	929.420	.000	929.420	.00000	290.003	101.1155	.051440	84.4707	.16777	1108.348
ELB	FLP106	111	1	1	.152	929.420	.000	929.420	.00000	290.003	101.0897	.025732	84.4922	.16773	1108.348
LIN	CLP107	112	1	1	.152	929.420	.000	929.420	.00000	290.005	100.9631	.126619	84.5987	.16752	1108.343
ELB	FLP108	113	1	1	.152	929.420	.000	929.420	.00000	290.005	100.9373	.025771	84.6203	.16747	1108.343
LIN	CLP109	114	1	1	.152	929.420	.000	929.420	.00000	290.006	100.8303	.107021	84.7106	.16729	1108.339
ELB	FLP110	115	1	1	.152	929.420	.000	929.420	.00000	290.006	100.8045	.025805	84.7323	.16725	1108.339
LIN	CLP111	116	1	1	.152	929.420	.000	929.420	.00000	290.008	100.7002	.104295	84.8204	.16708	1108.335
ELB	FLP112	117	1	1	.152	929.420	.000	929.420	.00000	290.008	100.6744	.025839	84.8422	.16704	1108.335
LIN	CLP113	118	1	1	.152	929.420	.000	929.420	.00000	290.010	100.5830	.091376	84.9197	.16688	1108.331
ELB	FLP114	119	1	1	.152	929.420	.000	929.420	.00000	290.010	100.5571	.025869	84.9415	.16684	1108.331
LIN	CLP115	120	1	1	.152	929.420	.000	929.420	.00000	290.011	100.4797	.074414	85.0081	.16671	1108.328
ELB	FLP116	121	1	1	.152	929.420	.000	929.420	.00000	290.011	100.4528	.025886	85.0301	.16667	1108.328
LIN	CLP117	122	1	1	.152	929.420	.000	929.420	.00000	290.011	100.4463	.006541	85.0356	.16666	1108.328
COM	CPU-01	123	1	1	.076	1706.760	.000	1706.760	.00000	300.000	1215.9000	.000000	53.7314	1.93991	3972.413
LIN	CHP101	124	1	1	.076	1706.760	.000	1706.760	.00000	300.000	1215.8189	.081127	53.7350	1.93979	3972.413
ELB	FHP102	125	1	1	.076	1706.760	.000	1706.760	.00000	300.000	1215.6584	.160529	53.7420	1.93953	3972.414
LIN	CHP103	126	1	1	.076	1706.760	.000	1706.760	.00000	300.000	1214.6846	.973721	53.7849	1.93798	3972.418
ELB	FHP104	127	1	1	.076	1706.760	.000	1706.760	.00000	300.000	1214.5240	.160678	53.7920	1.93773	3972.419
LIN	CHP105	128	1	1	.076	1706.760	.000	1706.760	.00000	300.001	1213.2245	1.299501	53.8444	1.93566	3972.424
ELB	FHP106	129	1	1	.076	1706.760	.000	1706.760	.00000	300.001	1213.0636	.160871	53.8565	1.93541	3972.425
LIN	CHP107	130	1	1	.076	1706.760	.000	1706.760	.00000	300.001	1211.7268	1.336838	53.9156	1.93329	3972.430
ELB	FHP108	131	1	1	.076	1706.760	.000	1706.760	.00000	300.001	1211.5657	.161069	53.9228	1.93303	3972.431
LIN	CHP109	132	1	1	.076	1706.760	.000	1706.760	.00000	300.002	1209.9797	1.585989	53.9931	1.93051	3972.437
ELB	FHP110	133	1	1	.076	1706.760	.000	1706.760	.00000	300.002	1209.8185	.161300	54.0003	1.93025	3972.438
LIN	CHP111	134	1	1	.076	1706.760	.000	1706.760	.00000	300.002	1209.1727	.645744	54.0290	1.92923	3972.440
ELB	FHP112	135	1	1	.076	1706.760	.000	1706.760	.00000	300.002	1209.0113	.161408	54.0362	1.92897	3972.441
LIN	CHP113	136	1	1	.076	1706.760	.000	1706.760	.00000	300.003	1207.7150	1.292346	54.0937	1.92692	3972.446
VAL	AV-041	137	1	1	.076	1706.760	.000	1706.760	.00000	300.003	1202.4732	5.245818	54.3284	1.91860	3972.481
LIN	CHP114	138	1	1	.076	1706.760	.000	1706.760	.00000	300.003	1202.4648	.008318	54.3288	1.91858	3972.482
ELB	FHP115	139	1	1	.076	1706.760	.000	1706.760	.00000	300.003	1202.3026	.162303	54.3361	1.91833	3972.482
LIN	CHP116	140	1	1	.076	1706.760	.000	1706.760	.00000	300.003	1202.2526	.049979	54.3383	1.91825	3972.483
REF	RF-LQ4	141	1	1	.000	1706.760	.000	1706.760	.00000	300.003	1202.2526	.000000	54.3383	1.91825	3972.483

D55

NAME USER NAME * * * * * PAGE 37
DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
EXT. * * * * * TIME 12:22:54
BLD. * * * * * CASE 1
* * * * *
* * * * * MFTF * * * * *
* * * * *
TEST CASE FOR THE MFTF REFRIGERATOR-LIQUIFIER SUBSYSTEM (CVI)

TOTAL PRESSURE DROP IN THE REFRIGERATOR-LIQUIFIER LOOP = (REF-LIQ. INCLUDED) (J-T VALVES EXCLUDED)	.31114243-01 KPA	
TOTAL FLUID VOLUME IN THE REFRIGERATOR-LIQUIFIER LOOP = (REF-LIQ INCLUDED)	.45255086+01 CUBIC METERS	(4525.51 LITERS)
TOTAL PRESSURE DROP IN THE COMPRESSOR-PURIFIER LOOP = (CMP-PUR. EXCLUDED)	.14526250+02 KPA	
TOTAL FLUID VOLUME IN THE COMPRESSOR - PURIFIER LOOP = (CMP-PUR INCLUDED)	.42315506+01 CUBIC METERS	(4231.55 LITERS)

NAME	USER NAME	.....	PAGE	38
DEPT	6213	CRYOGEN SYSTEMS ANALYSIS	DATE	05 APR 79
EXT.	30235		TIME	12:22:54
BLD.	104	MFTF	CASE	1
.....				
TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CV1)				

*** YOU HAVE CALLED FOR THE LN2SUPPLY SYSTEM ***

NAME USER NAME * * * * * PAGE 39
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * TIME 12:22:54
 BLD. 104 * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

**** LIQUID NITROGEN SYSTEM ****

DISPLAY OF INPUT PARAMETERS

VOLUME FLOW RATE = .0013890 METER**3/SEC
 INLET PRESSURE = 308110.71 NT/METER**2
 QUAL = .000000

THOT = 293.150 K
 TCOLD = 88.196 K

INITIAL DIAMETER INPUT

DIA(1) = .10160 M
 DIA(2) = .02540 M
 DIA(3) = .05080 M
 DIA(4) = .05080 M
 DIA(5) = .05080 M
 DIA(6) = .10160 M

RNLAYR = 10.000
 CONNLI = .40028435-06

FLOW LOST AT END OF LINE 1
 TO OPEN LOOP NITROGEN USERS = .1000000 KG/SEC

NAME USER NAME * * * * * PAGE 40
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * TIME 12:22:57
 BLD. 104 * MFTF * CASE 1
 * * * * *
 TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

LINE DESCRIPTION FOR LINE NUMBER 1

LINE SECTION NUMBER	LENGTH (METER)	INLET HEIGHT (METER)	EXIT HEIGHT (METER)	EFFECTIVE L/D	HEAT RATE (WATTS)	LINE	-LINE TYPE-	-T-
						ELBOW	VALVE	BAYONET
1	3.05	2.05	-1.00	.0	3.47	X		
2	.00	-1.00	-1.00	31.0	.00		X	
3	10.00	-1.00	-1.00	.0	20.42	X		
4	.00	-1.00	-1.00	31.0	.00		X	
5	54.50	-1.00	-1.00	.0	61.83	X		
6	.00	-1.00	-1.00	31.0	.00		X	
7	7.90	-1.00	6.90	.0	8.96	X		
8	.00	6.90	6.90	31.0	.00		X	
9	18.50	6.90	6.90	.0	20.99	X		
10	.00	6.90	6.90	31.0	.00		X	
11	8.50	8.90	15.40	.0	9.64	X		
12	.00	15.40	15.40	31.0	.00		X	
13	26.00	15.40	15.40	.0	29.50	X		

D60

LINE SECTION NUMBER	LENGTH (METER)	INLET HEIGHT (METER)	EXIT HEIGHT (METER)	EFFECTIVE L/D	HEAT RATE (WATTS)	LINE	-LINE TYPE- ELBOW VALVE BAYONET	-T-
1	.00	15.40	15.40	340.0	.00		X	
2	2.00	15.40	15.40	.0	.57	X		
3	.00	15.40	15.40	.0	2.72			X
4	1.00	15.40	15.40	.0	.28	X		
5	.00	15.40	15.40	31.0	.00		X	
6	.68	15.40	16.08	.0	.19	X		
7	.00	16.08	16.08	31.0	.00		X	
8	.50	16.08	16.08	.0	.14	X		
9	.00	16.08	16.08	.0	2.72			X
10	.00	16.08	16.08	31.0	.00		X	
11	.36	16.08	16.08	.0	10.05	X		
12	.00	16.08	16.08	31.0	.00		X	
13	.50	16.08	16.08	.0	.14	X		
14	.00	16.08	16.08	.0	2.72			X
15	.00	16.08	16.08	31.0	.00		X	
16	8.72	16.08	17.45	.0	288.00	X		
17	.00	17.45	17.45	31.0	.00		X	
18	1.37	17.45	16.08	.0	.39	X		
19	.00	16.08	16.08	31.0	.00		X	
20	.00	16.08	16.08	.0	2.72			X
21	.50	16.08	16.08	.0	.14	X		
22	.00	16.08	16.08	31.0	.00		X	
23	12.72	16.08	16.08	.0	20.10	X		
24	.00	16.08	16.08	31.0	.00		X	
25	.50	16.08	16.08	.0	.14	X		
26	.00	16.08	16.08	.0	2.72			X
27	.00	16.08	16.08	31.0	.00		X	
28	17.37	16.08	18.81	.0	576.00	X		
29	.00	18.81	18.81	31.0	.00		X	
30	2.73	18.81	16.08	.0	.77	X		
31	.00	16.08	16.08	31.0	.00		X	
32	.00	16.08	16.08	.0	2.72			X
33	.50	16.08	16.08	.0	.14	X		
34	.00	16.08	16.08	31.0	.00		X	
35	12.72	16.08	16.08	.0	20.10	X		
36	.00	16.08	16.08	31.0	.00		X	
37	.50	16.08	16.08	.0	.14	X		
38	.00	16.08	16.08	.0	2.72			X

NAME USER NAME * * * * * PAGE 42
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * TIME 12:22:57
 BLD. 104 * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

LINE DESCRIPTION FOR LINE NUMBER 2

LINE SECTION NUMBER	LENGTH (METER)	INLET HEIGHT (METER)	EXIT HEIGHT (METER)	EFFECTIVE L/D	HEAT RATE (WATTS)	LINE	ELBOW	VALVE	BAYONET	-T-
39	.00	16.08	16.08	31.0	.00		X			
40	17.37	16.08	18.81	.0	576.00	X				
41	.00	18.81	18.81	31.0	.00		X			
42	2.73	18.81	16.08	.0	6.77	X				
43	.00	16.08	16.08	31.0	.00		X			
44	.00	16.08	16.08	.0	8.72					
45	.50	16.08	16.08	.0	6.14	X				X
46	.00	16.08	16.08	31.0	.00		X			
47	12.72	16.08	14.08	.0	20.10	X				
48	.00	14.08	14.08	31.0	.00		X			
49	89.07	14.08	14.08	.0	140.69	X				
50	.00	14.08	14.08	31.0	.00		X			
51	119.61	14.08	-4.72	.0	108.92	X				
52	.00	-4.72	-4.72	31.0	.00		X			
53	46.44	-4.72	-4.72	.0	73.36	X				
54	.00	-4.72	-4.72	31.0	.00		X			
55	13.36	-4.72	-2.62	.0	21.10	X				
56	11.94	-2.62	9.32	.0	3.39	X				
57	30.28	9.32	14.08	.0	47.83	X				
58	.00	14.08	14.08	31.0	.00		X			
59	46.44	14.08	14.08	.0	73.36	X				
60	14.00	14.08	14.08	.0	3.97	X				
61	.00	14.08	14.08	31.0	.00		X			
62	2.00	14.08	16.08	.0	.57	X				
63	.00	16.08	16.08	31.0	.00		X			
64	5.00	16.08	16.08	.0	1.42	X				
65	.00	16.08	16.08	31.0	.00		X			
66	.00	16.08	16.08	.0	2.72					X
67	.50	16.08	16.08	.0	.14	X				
68	.00	16.08	16.08	31.0	.00		X			
69	.68	16.08	15.40	.0	.19	X				
70	.00	15.40	15.40	31.0	.00		X			
71	1.00	15.40	15.40	.0	.28	X				
72	.00	15.40	15.40	.0	2.72					X
73	2.00	15.40	15.40	.0	.57	X				

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NAME USER NAME * * * * * PAGE 43
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
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 BLD. 104 * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CV11)

LINE DESCRIPTION FOR LINE NUMBER 3

LINE SECTION NUMBER	LENGTH (METER)	INLET HEIGHT (METER)	EXIT HEIGHT (METER)	EFFECTIVE L/D	HEAT RATE (WATTS)	-LINE TYPE-				
						LINE	ELBOW	VALVE	BAYONET	-T-
1	.00	15.40	15.40	340.0	.00			X		
2	2.00	15.40	15.40	.0	1.13	X				
3	.00	15.40	15.40	.0	6.39				X	
4	1.00	15.40	15.40	.0	.57	X				
5	.00	15.40	15.40	31.0	.00		X			
6	1.32	15.40	14.08	.0	.75	X				
7	.00	14.08	14.08	31.0	.00		X			
8	14.00	14.08	14.08	.0	7.94	X				
9	.00	14.08	14.08	31.0	.00		X			
10	5.08	14.08	9.00	.0	2.88	X				
11	.00	9.00	9.00	31.0	.00		X			
12	3.08	9.00	9.00	.0	1.75	X				
13	.00	9.00	9.00	31.0	.00		X			
14	1.00	9.00	8.00	.0	.57	X				
15	.00	8.00	8.00	.0	6.39				X	
16	.50	8.00	7.50	.0	.28	X				
17	.50	7.50	7.00	.0	.28	X				
18	.00	7.00	7.00	90.0	.00					X
19	.50	7.00	6.50	.0	.28	X				
20	6.30	6.50	.20	.0	7500.00	X				
21	1.50	.20	-1.30	.0	.85	X				
22	1.00	-1.30	-2.30	.0	.57	X				
23	.00	-2.30	-2.30	31.0	.00		X			
24	3.08	-2.30	-2.30	.0	1.75	X				
25	.00	-2.30	-2.30	31.0	.00		X			
26	11.30	-2.30	9.00	.0	6.41	X				
27	.00	9.00	9.00	31.0	.00		X			
28	5.08	9.00	14.08	.0	2.88	X				
29	.00	14.08	14.08	31.0	.00		X			
30	14.00	14.08	14.08	.0	7.94	X				
31	.00	14.08	14.08	31.0	.00		X			
32	1.32	14.08	15.40	.0	.75	X				
33	.00	15.40	15.40	31.0	.00		X			
34	1.00	15.40	15.40	.0	.57	X				
35	.00	15.40	15.40	.0	6.39				X	
36	2.00	15.40	15.40	.0	1.13	X				

NAME USER NAME * * * * * PAGE 44
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * TIME 12:22:59
 BLD. 104 * MFTF * CASE 1
 * * * * *
 TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

LINE DESCRIPTION FOR LINE NUMBER 4

LINE SECTION NUMBER	LENGTH (METER)	INLET HEIGHT (METER)	EXIT HEIGHT (METER)	EFFECTIVE L/D	HEAT RATE (WATTS)	LINE	ELBOW	VALVE	BAYONET	-T-
1	.00	15.40	15.40	340.0	.00				X	
2	2.00	15.40	15.40	.0	1.13					
3	.00	15.40	15.40	.0	6.39	X				
4	1.00	15.40	15.40	.0	.57				X	
5	.00	15.40	15.40	31.0	.00	X				
6	1.32	15.40	14.08	.0	.75		X			
7	.00	14.08	14.08	31.0	.00	X				
8	14.00	14.08	14.08	.0	7.94		X			
9	.00	14.08	14.08	31.0	.00	X				
10	5.08	14.08	9.00	.0	2.88		X			
11	.00	9.00	9.00	31.0	.00			X		
12	3.08	9.00	9.00	.0	1.75	X				
13	.00	9.00	9.00	31.0	.00			X		
14	9.70	9.00	9.00	.0	5.50	X				
15	.00	9.00	9.00	31.0	.00			X		
16	1.00	9.00	8.00	.0	.57	X				
17	.00	8.00	8.00	.0	6.39				X	
18	.00	8.00	8.00	90.0	.00					X
19	1.00	8.00	7.00	.0	.57	X				
20	.00	7.00	7.00	31.0	.00		X			
21	.00	7.00	7.00	.0	320.00	X				
22	.00	7.00	7.00	31.0	.00			X		
23	1.00	7.00	8.00	.0	.57	X				
24	.00	8.00	8.00	.0	6.39				X	
25	1.00	8.00	9.00	.0	.57	X				
26	.00	9.00	9.00	31.0	.00		X			
27	9.70	9.00	9.00	.0	5.50	X				
28	.00	9.00	9.00	31.0	.00			X		
29	3.08	9.00	9.00	.0	1.75	X				
30	.00	9.00	9.00	31.0	.00			X		
31	5.08	9.00	14.08	.0	2.88	X				
32	.00	14.08	14.08	31.0	.00		X			
33	14.00	14.08	14.08	.0	7.94	X				
34	.00	14.08	14.08	31.0	.00			X		
35	1.32	14.08	15.40	.0	.75	X				
36	.00	15.40	15.40	31.0	.00		X			
37	1.00	15.40	15.40	.0	.57	X				
38	.00	15.40	15.40	.0	6.39				X	

NAME USER NAME * * * * * PAGE 45
DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
EXT. 30235 * * TIME 12:22:59
BLD. 104 * MFTF * CASE 1
* * * * *
TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

LINE DESCRIPTION FOR LINE NUMBER 4

LINE SECTION NUMBER	LENGTH (METER)	INLET HEIGHT (METER)	EXIT HEIGHT (METER)	EFFECTIVE L/D	HEAT RATE (WATTS)	-LINE TYPE-			
						LINE	ELBOW	VALVE	BAYONET -T-
39	2.00	15.40	15.40	.0	1.13	X			

NAME USER NAME * * * * * PAGE 46
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * TIME 12:22:59
 BLD. 104 * MFTF * CASE 1
 * * * * *
 TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

LINE DESCRIPTION FOR LINE NUMBER 5

LINE SECTION NUMBER	LENGTH (METER)	INLET HEIGHT (METER)	EXIT HEIGHT (METER)	EFFECTIVE L/D	HEAT RATE (WATTS)	LINE	ELBOW	VALVE	BAYONET	-T-
1	.00	15.40	15.40	340.0	.00					
2	2.00	15.40	15.40	.0	1.13					
3	.00	15.40	15.40	.0	6.39	X				
4	1.00	15.40	15.40	.0	.57				X	
5	.00	15.40	15.40	31.0	.00	X				
6	1.32	15.40	14.08	.0	.75		X			
7	.00	14.08	14.08	31.0	.00	X				
8	14.00	14.08	14.08	.0	7.94		X			
9	.00	14.08	14.08	31.0	.00	X				
10	5.08	14.08	9.00	.0	2.88		X			
11	.00	9.00	9.00	31.0	.00	X				
12	2.00	9.00	9.00	.0	1.13		X			
13	.00	9.00	9.00	31.0	.00	X				
14	9.70	9.00	9.00	.0	5.50		X			
15	.00	9.00	9.00	31.0	.00	X				
16	5.50	9.00	3.50	.0	3.12		X			
17	.00	3.50	3.50	.0	6.39				X	
18	.50	3.50	3.00	.0	.28	X				
19	.00	3.00	3.00	90.0	.00					X
20	.50	3.00	2.50	.0	.28	X				
21	.00	2.50	2.50	31.0	.00		X			
22	.00	2.50	2.50	.0	.00	X				
23	.00	2.50	2.50	31.0	.00		X			
24	1.00	2.50	3.50	.0	.57	X				
25	.00	3.50	3.50	.0	6.39				X	
26	5.50	3.50	9.00	.0	3.12	X				
27	.00	9.00	9.00	31.0	.00		X			
28	9.70	9.00	9.00	.0	5.50	X				
29	.00	9.00	9.00	31.0	.00		X			
30	2.00	9.00	9.00	.0	1.13	X				
31	.00	9.00	9.00	31.0	.00		X			
32	5.08	9.00	14.08	.0	2.88	X				
33	.00	14.08	14.08	31.0	.00		X			
34	14.00	14.08	14.08	.0	7.94	X				
35	.00	14.08	14.08	31.0	.00		X			
36	1.32	14.08	15.40	.0	.75	X				
37	.00	15.40	15.40	31.0	.00		X			
38	1.00	15.40	15.40	.0	.57	X				

NAME USER NAME * * * * * PAGE 47
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * TIME 12:23:00
 BLD. 104 * MFIF * CASE 1
 * * * * *
 TEST CASE FOR THE MFIF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

LINE DESCRIPTION FOR LINE NUMBER 5

LINE SECTION NUMBER	LENGTH (METER)	INLET HEIGHT (METER)	EXIT HEIGHT (METER)	EFFECTIVE L/O	HEAT RATE (WATTS)	-LINE TYPE-			
						LINE	ELBOW	VALVE	BAYONET -T-
39	.00	15.40	15.40	.0	6.39				X
40	2.00	15.40	15.40	.0	1.13	X			

NAME USER NAME * * * * * PAGE 48
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * * * * TIME 12:23:00
 BLD. 104 * MFTF * CASE 1
 * * * * *
 TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

LINE DESCRIPTION FOR LINE NUMBER 6

LINE SECTION NUMBER	LENGTH (METER)	INLET HEIGHT (METER)	EXIT HEIGHT (METER)	EFFECTIVE L/D	HEAT RATE (WATTS)	-LINE TYPE-			
						LINE	ELBOW	VALVE	BAYONET -T-
1	.00	15.40	15.40	90.0	340.65				X
2	26.00	15.40	15.40	.0	29.50	X			
3	.00	15.40	15.40	31.0	.00		X		
4	9.50	15.40	6.90	.0	9.64	X			
5	.00	6.90	6.90	31.0	.00		X		
6	18.50	6.90	6.90	.0	20.99	X			
7	.00	6.90	6.90	31.0	.00		X		
8	7.90	6.90	-1.00	.0	8.96	X			
9	.00	-1.00	-1.00	31.0	.00		X		
10	54.50	-1.00	-1.00	.0	61.83	X			
11	.00	-1.00	-1.00	31.0	.00		X		
12	18.00	-1.00	-1.00	.0	20.42	X			
13	.00	-1.00	-1.00	31.0	.00				X

NAME USER NAME * * * * * PAGE 49
DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
EXT. 30235 * * TIME 12:23:00
BLD. 104 * MFTF * CASE 1
* * * * *
TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

ANALYSIS OF LINE NUMBER 1

INDEX	DIAM (M)	WDOT-L (KG/S)	WDOT-V (KG/S)	QUALITY	TEMP (K)	PRESSURE (KPA)	PR GRAD (KPA/M)	FRICTION FACTOR	REYN NUMBER	VAPOR VEL (M/S)	VAPOR MACH NUMBER	DENSITY (KG/M-3)
1	.1016	1.0463	.0000	.0000	88.196	308.11071		.01769	112751.2	.0000	.0000	753.256584
2	.1016	1.0463	.0000	.0000	88.209	308.47939	-.12048	.01769	112751.2	.0804	.0004	752.778290
3	.1016	1.0462	.0000	.0000	88.209	308.47307	.00000	.01769	112796.2	.0803	.0004	752.240799
4	.1016	1.0461	.0002	.0001	88.208	308.43544	.00209	.01769	112796.2	.0803	.0004	749.572090
5	.1016	1.0451	.0002	.0001	88.208	308.42884	.00000	.01769	112790.9	.0803	.0004	746.921005
6	.1016	1.0457	.0005	.0005	88.203	308.30538	.00227	.01769	112790.9	.0804	.0004	739.048058
7	.1016	1.0457	.0006	.0005	88.203	308.29821	.00000	.01769	112775.6	.0804	.0004	731.333733
8	.1016	1.0457	.0006	.0006	88.167	307.30139	.12618	.01769	112775.6	.0805	.0004	730.222572
9	.1016	1.0457	.0006	.0006	88.167	307.29421	.00000	.01769	112651.4	.0806	.0004	729.114349
10	.1016	1.0455	.0007	.0007	88.165	307.24928	.00243	.01769	112651.4	.0806	.0004	726.465660
11	.1016	1.0455	.0008	.0007	88.165	307.24195	.00000	.01769	112644.5	.0806	.0004	723.836319
12	.1016	1.0455	.0008	.0008	88.126	306.19458	.12322	.01769	112644.5	.0808	.0004	722.641563
13	.1016	1.0455	.0008	.0008	88.126	306.18731	.00000	.01769	112514.1	.0809	.0004	721.448605
13	.1016	1.0453	.0010	.0010	88.124	306.12217	.00261	.01769	112514.1	.0809	.0004	717.802872

NAME USER NAME * * * * * PAGE 50
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * * * * TIME 12:26:00
 BLD. 104 * MFTF * CASE 1
 * * * * *
 TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CV1)

ANALYSIS OF LINE NUMBER 2

INDEX	D:AM (M)	WDOT-L (KG/S)	WDOT-V (KG/S)	QUALITY	TEMP (K)	PRESSURE (KPA)	PR GRAD (KPA/M)	FRICTION FACTOR	REYN NUMBER	VAPOR VEL (M/S)	VAPOR MACH NUMBER	DENSITY (KG/M-3)
	.0254	.0005	.0000	.0010	86.124	306.12217		.09471	219.2	.0000	.0000	554.264549
1	.0254	.0005	.0000	.0010	88.124	306.12178	.00000	.09471	219.2	.0000	.0000	714.253448
2	.0254	.0005	.0000	.0070	88.124	306.12177	.00000	.09471	219.2	.0000	.0000	613.325798
3	.0254	.0005	.0000	.0361	88.124	306.12177	.00000	.09471	219.2	.0000	.0000	337.199639
4	.0254	.0005	.0000	.0391	88.124	306.12176	.00001	.09471	219.2	.0000	.0000	238.916925
5	.0254	.0005	.0000	.0391	88.124	306.12175	.00000	.09471	219.2	.0000	.0000	232.520153
6	.0254	.0005	.0000	.0412	88.124	306.03877	.12203	.09471	219.2	.0000	.0000	228.350868
7	.0254	.0005	.0000	.0412	88.121	306.03876	.00000	.09471	219.2	.0000	.0000	224.320328
8	.0254	.0005	.0000	.0427	88.121	306.03876	.00001	.09471	219.2	.0000	.0000	221.452778
9	.0254	.0005	.0000	.0718	88.121	306.03876	.00000	.09471	219.2	.0000	.0000	176.111158
10	.0254	.0005	.0000	.0718	88.121	306.03874	.00000	.09471	219.2	.0000	.0000	147.422716
11	.0254	.0004	.0001	.1792	88.121	306.03854	.00003	.09471	219.2	.0000	.0000	52.034881
12	.0254	.0004	.0001	.1792	88.121	306.03850	.00000	.09471	219.2	.0000	.0000	66.898682
13	.0254	.0004	.0001	.1807	88.121	306.03848	.00004	.09471	219.2	.0000	.0000	66.641541
14	.0254	.0004	.0001	.2097	88.121	306.03848	.00000	.09471	219.2	.0000	.0000	61.850571
15	.0254	.0004	.0001	.2097	88.121	306.03844	.00000	.09471	219.2	.0000	.0000	57.894579
16	.0254	.0000	.0005	1.0000	92.928	305.82555	.02430	.04034	4159.3	.0000	.0000	12.040748
17	.0254	.0000	.0005	1.0000	92.928	305.82635	.00000	.04087	3969.0	.0000	.0000	12.033546
18	.0254	.0000	.0005	1.0000	92.970	305.88760	.11770	.04087	3969.0	.0000	.0000	12.026637
19	.0254	.0000	.0005	1.0000	92.970	305.88739	.00000	.04087	3967.4	.0000	.0000	12.033569
20	.0254	.0000	.0005	1.0000	98.150	305.98724	.00000	.04087	3967.4	.0000	.0000	11.257551
21	.0254	.0000	.0005	1.0000	98.150	305.98739	.00029	.04141	3783.6	.0000	.0000	11.251873
22	.0254	.0000	.0005	1.0000	98.150	305.98701	.00000	.04142	3782.2	.0000	.0000	11.251864
23	.0254	.0000	.0005	1.0000	98.415	305.98328	.00000	.04142	3773.3	.0000	.0000	11.214871
24	.0254	.0000	.0005	1.0000	98.415	305.98305	.00000	.04144	3773.3	.0000	.0000	11.214862
25	.0254	.0000	.0005	1.0000	98.456	305.98231	.00029	.04144	3773.3	.0000	.0000	11.209215
26	.0254	.0000	.0005	1.0000	103.595	305.98201	.00000	.04145	3771.9	.0000	.0000	10.546261
27	.0254	.0000	.0005	1.0000	103.595	305.98766	.00000	.04197	3606.5	.0000	.0000	10.546252
28	.0254	.0000	.0005	1.0000	109.537	305.70353	.01607	.04197	3606.5	.0000	.0000	9.881538
29	.0254	.0000	.0005	1.0000	109.537	305.70325	.00003	.04254	3433.4	.0000	.0000	9.872240
30	.0254	.0000	.0005	1.0000	109.589	305.96655	.09644	.04254	3433.4	.0000	.0000	9.866748
31	.0254	.0000	.0005	1.0000	109.589	305.96628	.00000	.04255	3432.0	.0000	.0000	9.875706
32	.0254	.0000	.0005	1.0000	114.729	305.96628	.00000	.04255	3432.0	.0001	.0000	9.372205
33	.0254	.0000	.0005	1.0000	114.776	305.96610	.00036	.04303	3296.1	.0001	.0000	9.367823
34	.0254	.0000	.0005	1.0000	114.776	305.96581	.00000	.04303	3294.9	.0001	.0000	9.367814
35	.0254	.0000	.0005	1.0000	115.094	305.96115	.00037	.04303	3294.9	.0001	.0000	9.338406
36	.0254	.0000	.0005	1.0000	115.094	305.96086	.00000	.04306	3286.9	.0001	.0000	9.338397
37	.0254	.0000	.0005	1.0000	115.141	305.96058	.00037	.04306	3286.9	.0001	.0000	9.334037
38	.0254	.0000	.0005	1.0000	120.280	305.96058	.00000	.04307	3285.7	.0001	.0000	8.887698

NAME USER NAME * * * * * PAGE 51
 DEPT 6213 * * * * * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * * * * * * * * * * TIME 12:26:02
 BLD. 104 * * * * * MFTF * * * * * CASE 1
 *

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CV1)

ANALYSIS OF LINE NUMBER 2

INDEX	DIAM (IN)	WDOT-L (KG/S)	WDOT-V (KG/S)	QUALITY	TEMP (K)	PRESSURE (KPA)	PR GRAD (KPA/M)	FRICTION FACTOR	REYN NUMBER	VAPOR VEL (M/S)	VAPOR MACH NUMBER	DENSITY (KG/M-3)
39	.0254	-.0000	.0005	1.0000	120.280	305.96037	.00000	.04353	3161.6	.0001	.0000	8.887687
40	.0254	-.0000	.0005	1.0000	127.324	305.72270	.01368	.04353	3161.6	.0001	.0000	8.345835
41	.0254	-.0000	.0005	1.0000	127.324	305.72237	.00000	.04415	3006.9	.0001	.0000	8.339335
42	.0254	-.0000	.0005	1.0000	127.866	305.94395	-.08117	.04415	3006.9	.0001	.0000	8.300625
43	.0254	-.0000	.0005	1.0000	127.866	305.94362	.00000	.04419	2995.7	.0001	.0000	8.306851
44	.0254	-.0000	.0005	1.0000	144.342	305.94352	.00000	.04419	2995.7	.0001	.0000	7.288052
45	.0254	-.0000	.0005	1.0000	146.852	305.94337	.00050	.04553	2692.1	.0001	.0000	7.155524
46	.0254	-.0000	.0005	1.0000	146.852	305.94297	.00000	.04573	2651.5	.0001	.0000	7.155514
47	.0254	-.0000	.0005	1.0000	147.267	306.07662	-.01051	.04573	2651.5	.0001	.0000	7.133936
48	.0254	-.0000	.0005	1.0000	147.267	306.07622	.00003	.04576	2644.9	.0001	.0000	7.137257
49	.0254	-.0000	.0005	1.0000	147.687	306.03067	.00051	.04576	2644.9	.0001	.0000	7.114629
50	.0254	-.0000	.0005	1.0000	147.687	306.03027	.00000	.04579	2638.3	.0001	.0000	7.114619
51	.0254	-.0000	.0005	1.0000	148.108	307.27841	-.01044	.04579	2638.3	.0001	.0000	7.091684
52	.0254	-.0000	.0005	1.0000	148.108	307.27801	.00000	.04582	2631.7	.0001	.0000	7.122606
53	.0254	-.0000	.0005	1.0000	148.528	307.25418	.00051	.04582	2631.7	.0001	.0000	7.100664
54	.0254	-.0000	.0005	1.0000	148.528	307.25378	.00000	.04586	2625.1	.0001	.0000	7.100654
55	.0254	-.0000	.0005	1.0000	148.947	307.10089	.01144	.04586	2625.1	.0001	.0000	7.079342
56	.0254	-.0000	.0005	1.0000	149.022	306.26543	.06989	.04589	2618.6	.0001	.0000	7.071981
57	.0254	-.0000	.0005	1.0000	149.446	305.92200	.01137	.04589	2617.5	.0001	.0000	7.030994
58	.0254	-.0000	.0005	1.0000	149.446	305.92160	.00000	.04593	2610.9	.0001	.0000	7.023300
59	.0254	-.0000	.0005	1.0000	149.872	305.89737	.00052	.04593	2610.9	.0001	.0000	7.001584
60	.0254	-.0000	.0005	1.0000	149.848	305.89005	.00052	.04596	2604.4	.0001	.0000	6.997646
61	.0254	-.0000	.0005	1.0000	149.848	305.88964	.00000	.04597	2603.2	.0001	.0000	6.997636
62	.0254	-.0000	.0005	1.0000	150.020	305.75139	.06913	.04597	2603.2	.0001	.0000	6.994063
63	.0254	-.0000	.0005	1.0000	150.020	305.75098	.00000	.04597	2602.1	.0001	.0000	6.990859
64	.0254	-.0000	.0005	1.0000	150.095	305.74836	.00052	.04597	2602.1	.0001	.0000	6.987103
65	.0254	-.0000	.0005	1.0000	150.095	305.74795	.00000	.04598	2601.0	.0001	.0000	6.987093
66	.0254	-.0000	.0005	1.0000	155.234	305.74795	.00000	.04598	2601.0	.0001	.0000	6.743051
67	.0254	-.0000	.0005	1.0000	155.295	305.74768	.00055	.04836	2524.9	.0001	.0000	6.740230
68	.0254	-.0000	.0005	1.0000	155.295	305.74725	.00003	.04837	2524.0	.0001	.0000	6.740220
69	.0254	-.0000	.0005	1.0000	155.361	305.79181	-.06553	.04837	2524.0	.0001	.0000	6.737216
70	.0254	-.0000	.0005	1.0000	155.361	305.79138	.00000	.04837	2523.1	.0001	.0000	6.738213
71	.0254	-.0000	.0005	1.0000	155.431	305.79084	.00055	.04837	2523.1	.0001	.0000	6.735023
72	.0254	-.0000	.0005	1.0000	160.570	305.79084	.00000	.04838	2522.1	.0001	.0000	6.508737
73	.0254	-.0000	.0005	1.0000	160.647	305.78970	.00057	.04675	2450.8	.0001	.0000	6.505449

WFLOW = .000510

DPEXIT = 332.4727

NAME USER NAME * * * * * PAGE 52
 DEPT 6213 * * * * * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * * * * * TIME 12:26:05
 BLD. 104 * * * * * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

ANALYSIS OF LINE NUMBER 3

INDEX	DIAM (M)	WDOT-L (KG/S)	WDOT-V (KG/S)	QUALITY	TEMP (K)	PRESSURE (KPA)	PR GRAD (KPA/M)	FRICTION FACTOR	REYN NUMBER	VAPOR VEL (M/S)	VAPOR MACH NUMBER	DENSITY (KG/M-3)
1	.0992	.6179	.0006	.0010	88.124	306.12217		.01980	68106.8	.0000	.0000	6.505449
2	.0992	.6179	.0006	.0010	88.122	306.08376	.00000	.01980	68106.8	.0478	.0002	713.933502
3	.0992	.6179	.0006	.0010	88.122	306.08156	.00110	.01980	68104.1	.0478	.0002	713.400208
4	.0992	.6179	.0006	.0010	88.122	306.08153	.00000	.01980	68104.1	.0478	.0002	712.102409
5	.0992	.6179	.0007	.0011	88.122	306.08032	.00121	.01980	68104.1	.0478	.0002	710.911507
6	.0992	.6179	.0007	.0011	88.122	306.07639	.00000	.01980	68104.1	.0478	.0002	710.770996
7	.0992	.6179	.0007	.0011	88.128	306.23886	-.12309	.01980	68102.9	.0478	.0002	710.596458
8	.0992	.6179	.0007	.0011	88.128	306.23573	.00000	.01980	68115.4	.0478	.0002	710.428505
9	.0992	.6178	.0007	.0011	88.127	306.21974	.00114	.01980	68115.4	.0478	.0002	708.930054
10	.0992	.6178	.0007	.0011	88.127	306.21652	.00000	.01980	68113.7	.0478	.0002	707.439316
11	.0992	.6178	.0007	.0012	88.149	306.82096	-.11899	.01980	68113.7	.0478	.0002	708.869911
12	.0992	.6178	.0007	.0012	88.149	306.81688	.00000	.01980	68159.2	.0477	.0002	708.292351
13	.0992	.6178	.0007	.0012	88.149	306.81330	.00116	.01980	68159.2	.0477	.0002	705.936905
14	.0992	.6178	.0007	.0012	88.149	306.80927	.00000	.01980	68159.2	.0477	.0002	705.583023
15	.0992	.6178	.0007	.0012	88.153	306.93112	-.12185	.01980	68158.2	.0477	.0002	705.444008
16	.0992	.6178	.0008	.0013	88.153	306.93109	.00000	.01980	68167.2	.0477	.0002	704.276726
17	.0992	.6178	.0008	.0013	88.155	306.99241	-.12263	.01980	68167.2	.0477	.0002	703.165802
18	.0992	.6178	.0008	.0013	88.158	307.05470	-.12457	.01980	68172.1	.0477	.0002	703.062218
19	.0992	.1544	.0002	.0013	88.158	307.05381	.00000	.02772	17044.2	.0119	.0001	703.004143
20	.0992	.1544	.0002	.0013	88.160	307.11523	-.12282	.02772	17044.2	.0119	.0001	702.808479
21	.0992	.1136	.0411	.2656	88.188	307.87375	-.12040	.02772	17045.3	.0119	.0001	87.622155
22	.0992	.1136	.0411	.2656	88.194	308.05149	-.12049	.02772	17059.7	.0119	.0001	46.731894
23	.0992	.1136	.0411	.2656	88.198	308.17507	-.12059	.02772	17062.9	.0119	.0001	46.746180
24	.0992	.1136	.0411	.2657	88.198	308.16824	.00000	.02772	17065.1	.0119	.0001	46.751908
25	.0992	.1135	.0411	.2657	88.199	308.16260	.00199	.02772	17065.1	.0119	.0001	46.744975
26	.0992	.1135	.0411	.2657	88.198	308.15665	.00000	.02772	17065.1	.0119	.0001	46.737358
27	.0992	.1135	.0411	.2658	88.146	306.73061	.12620	.02772	17064.9	.0119	.0001	46.630512
28	.0992	.1135	.0411	.2658	88.146	306.72446	.00000	.02773	17038.1	.0119	.0001	46.525410
29	.0992	.1135	.0411	.2659	88.123	306.09758	.12340	.02773	17038.1	.0119	.0001	46.476139
30	.0992	.1135	.0411	.2659	88.123	306.09140	.00000	.02773	17026.3	.0120	.0001	46.428023
31	.0992	.1135	.0412	.2662	88.121	306.06332	.00201	.02773	17026.3	.0120	.0001	46.402472
32	.0992	.1135	.0412	.2662	88.121	306.05714	.00000	.02773	17025.6	.0120	.0001	46.375764
33	.0992	.1135	.0412	.2662	88.115	305.89165	.12537	.02773	17025.6	.0120	.0001	46.363101
34	.0992	.1135	.0412	.2662	88.115	305.88549	.00000	.02773	17022.4	.0120	.0001	46.350384
35	.0992	.1134	.0412	.2662	88.115	305.88348	.00201	.02773	17022.4	.0120	.0001	46.346511
36	.0992	.1134	.0412	.2665	88.115	305.88348	.00000	.02773	17022.1	.0120	.0001	46.325051
				.2665	88.115	305.87946	.00201	.02773	17022.1	.0120	.0001	46.303708

WFLOW = .518535

DPEXIT = 242.7070

071

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

INDEX	DIAM (M)	WDDT-L (KG/S)	WDDT-V (KG/S)	QUALITY	TEMP (K)	PRESSURE (KPA)	PR GRAD (KPA/M)	FRICTION FACTOR	REYN NUMBER	VAPOR VEL (M/S)	VAPOR MACH NUMBER	DENSITY (KG/M-3)
	.0508	.1761	.0002	.0010	88.124	306.12217		.02273	37914.2	.0000	.0000	46.303708
1	.0508	.1761	.0002	.0010	88.122	306.07058	.00000	.02273	37914.2	.0136	.0001	713.823845
2	.0508	.1761	.0002	.0010	88.122	306.06462	.00298	.02273	37912.1	.0136	.0001	712.663322
3	.0508	.1761	.0002	.0012	88.122	306.06450	.00000	.02273	37912.1	.0136	.0001	708.149231
4	.0508	.1761	.0002	.0012	88.122	306.06143	.00307	.02273	37912.1	.0136	.0001	704.046394
5	.0508	.1761	.0002	.0012	88.121	306.05707	.00000	.02273	37912.1	.0136	.0001	703.656268
6	.0508	.1761	.0002	.0013	88.127	306.21357	.11855	.02273	37911.5	.0136	.0001	702.151611
7	.0508	.1761	.0002	.0013	88.127	306.20835	.00000	.02273	37917.8	.0136	.0001	702.639297
8	.0508	.1760	.0003	.0015	88.125	306.16451	.00313	.02273	37917.8	.0136	.0001	697.665024
9	.0508	.1760	.0003	.0015	88.125	306.15914	.00000	.02273	37915.8	.0136	.0001	692.760178
10	.0508	.1760	.0003	.0016	88.147	306.75954	.11819	.02273	37915.8	.0136	.0001	690.972198
11	.0508	.1760	.0003	.0016	88.147	306.75546	.00000	.02273	37940.9	.0136	.0001	689.201881
12	.0508	.1760	.0003	.0017	88.146	306.74554	.00322	.02273	37940.9	.0136	.0001	688.119713
13	.0508	.1760	.0003	.0017	88.146	306.74033	.00000	.02273	37940.3	.0136	.0001	687.033859
14	.0508	.1760	.0003	.0019	88.145	306.70867	.00326	.02273	37940.3	.0136	.0001	683.713326
15	.0508	.1760	.0003	.0019	88.145	306.70446	.00000	.02273	37939.7	.0136	.0001	680.432632
16	.0508	.1760	.0003	.0019	88.149	306.82232	.11786	.02273	37938.7	.0136	.0001	680.070175
17	.0508	.1759	.0004	.0021	88.149	306.82220	.00003	.02273	37943.4	.0136	.0001	676.294960
18	.0508	.0880	.0002	.0021	88.149	306.81743	.00000	.02698	18971.7	.0068	.0000	672.848007
19	.0508	.0880	.0002	.0021	88.153	306.83938	.12196	.02698	18971.7	.0068	.0000	672.205544
20	.0508	.0880	.0002	.0021	88.153	306.93806	.00000	.02698	18974.1	.0068	.0000	671.591141
21	.0508	.0862	.0019	.0219	88.153	306.93522	.00000	.02698	18974.1	.0068	.0000	446.680927
22	.0508	.0862	.0019	.0219	88.153	306.93170	.00000	.02698	18974.1	.0068	.0000	334.614456
23	.0508	.0862	.0019	.0219	88.148	306.80682	.12488	.02698	18974.1	.0068	.0000	334.421268
24	.0508	.0862	.0020	.0223	88.148	306.80677	.00000	.02698	18971.3	.0068	.0000	332.569565
25	.0508	.0862	.0020	.0224	88.144	306.68174	.12502	.02698	18971.3	.0068	.0000	330.741779
26	.0508	.0862	.0020	.0224	88.144	306.67797	.00000	.02698	18968.8	.0068	.0000	330.558605
27	.0508	.0861	.0020	.0227	88.143	306.65597	.00227	.02698	18968.8	.0068	.0000	329.101006
28	.0508	.0861	.0020	.0227	88.143	306.65221	.00000	.				

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NAME USER NAME * * * * * PAGE 54
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * TIME 12:26:10
 BLD. 104 * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

ANALYSIS OF LINE NUMBER 4

INDEX	DIAM (M)	WDOT-L (KG/S)	WDOT-V (KG/S)	QUALITY	TEMP (K)	PRESSURE (KPA)	PR GRAD (KPA/M)	FRICTION FACTOR	REYN NUMBER	VAPOR VEL (M/S)	VAPOR MACH NUMBER	DENSITY (KG/M-3)
39	.0508	.0860	.0021	.0241	88.112	305.79293	.00235	.02699	18950.3	.0068	.0000	316.817551

WFLOW = .176297

DPEXIT = 329.2344

NAME USER NAME * * * * * PAGE 55
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * * TIME 12:26:10
 BLD. 104 * * * CASE 1
 * * * * * MFTF * * * * *

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVII)

ANALYSIS OF LINE NUMBER 5

INDEX	DIAM (M)	WDOT-L (KG/S)	WDOT-V (KG/S)	QUALITY	TEMP (K)	PRESSURE (KPA)	PR GRAD (KPA/M)	FRICTION FACTOR	REYN NUMBER	VAPOR VEL (M/S)	VAPOR MACH NUMBER	DENSITY (KG/M-3)
1	.0508	.1501	.0001	.0010	88.124	306.12217		.02363	32320.2	.0000	.0000	316.817551
2	.0508	.1501	.0001	.0010	88.122	306.08303	.00000	.02363	32320.2	.0116	.0001	713.927582
3	.0508	.1501	.0002	.0010	88.122	306.07854	.00224	.02363	32318.8	.0116	.0001	712.766823
4	.0508	.1501	.0002	.0013	88.122	306.07845	.00000	.02363	32318.8	.0116	.0001	707.499565
5	.0508	.1501	.0002	.0013	88.122	306.07608	.00237	.02363	32318.8	.0116	.0001	702.712013
6	.0508	.1501	.0002	.0013	88.122	306.07188	.00000	.02363	32318.8	.0116	.0001	702.271263
7	.0508	.1501	.0002	.0013	88.127	306.22822	-.11844	.02363	32318.3	.0116	.0001	701.699829
8	.0508	.1501	.0002	.0013	88.127	306.22500	.00000	.02363	32324.0	.0116	.0001	701.138412
9	.0508	.1500	.0002	.0016	88.126	306.19170	.00238	.02363	32324.0	.0116	.0001	695.519005
10	.0508	.1500	.0002	.0016	88.126	306.18750	.00000	.02363	32322.4	.0116	.0001	689.980255
11	.0508	.1500	.0003	.0017	88.148	306.79777	-.12013	.02363	32322.4	.0116	.0001	687.970917
12	.0508	.1500	.0003	.0017	88.148	306.79464	.00000	.02362	32344.1	.0116	.0001	685.983345
13	.0508	.1500	.0003	.0018	88.148	306.78975	.00245	.02362	32344.1	.0116	.0001	685.185394
14	.0508	.1500	.0003	.0018	88.148	306.78527	.00000	.02362	32344.1	.0116	.0001	684.380836
15	.0508	.1500	.0003	.0020	88.147	306.76119	.00248	.02362	32344.1	.0116	.0001	680.635651
16	.0508	.1500	.0003	.0020	88.147	306.75790	.00000	.02362	32342.9	.0116	.0001	676.938202
17	.0508	.1500	.0003	.0021	88.171	307.40973	-.11851	.02362	32342.9	.0116	.0001	674.866020
18	.0508	.1499	.0004	.0023	88.171	307.40964	.00000	.02362	32366.1	.0116	.0001	668.879944
19	.0508	.1499	.0004	.0023	88.173	307.47163	-.12398	.02362	32366.1	.0116	.0001	664.798279
20	.0508	.0500	.0001	.0023	88.173	307.47097	.00000	.03121	10789.4	.0039	.0000	664.614708
21	.0508	.0500	.0001	.0024	88.175	307.53228	-.12261	.03121	10789.4	.0039	.0000	664.094788
22	.0508	.0500	.0001	.0024	88.175	307.53183	.00000	.03121	10790.1	.0039	.0000	663.579552
23	.0508	.0500	.0001	.0024	88.175	307.53183	.00000	.03121	10790.1	.0039	.0000	663.576797
24	.0508	.0500	.0001	.0024	88.175	307.53139	.00000	.03121	10790.1	.0039	.0000	663.572784
25	.0508	.0500	.0001	.0024	88.170	307.40745	.12394	.03121	10790.1	.0039	.0000	662.533363
26	.0508	.0498	.0002	.0031	88.170	307.40742	.00000	.03121	10788.6	.0039	.0000	650.179932
27	.0508	.0498	.0002	.0035	88.146	306.73240	.12273	.03121	10788.6	.0039	.0000	633.963478
28	.0508	.0498	.0002	.0035	88.146	306.73197	.00000	.03122	10780.6	.0039	.0000	628.771416
29	.0508	.0498	.0002	.0041	88.146	306.72764	.00043	.03122	10780.6	.0039	.0000	619.896210
30	.0508	.0498	.0002	.0041	88.146	306.72767	.00000	.03122	10780.6	.0039	.0000	611.268837
31	.0508	.0498	.0002	.0042	88.146	306.72680	.00044	.03122	10780.6	.0039	.0000	609.519348
32	.0508	.0498	.0002	.0042	88.146	306.72565	.00000	.03122	10780.6	.0039	.0000	607.775063
33	.0508	.0498	.0002	.0045	88.123	306.10944	.12130	.03122	10780.6	.0039	.0000	603.320473
34	.0508	.0498	.0003	.0054	88.123	306.10810	.00000	.03122	10773.2	.0039	.0000	598.933495
35	.0508	.0498	.0003	.0054	88.123	306.10168	.00046	.03122	10773.2	.0039	.0000	587.349236
36	.0508	.0498	.0003	.0055	88.117	306.10118	.00000	.03122	10773.2	.0039	.0000	576.206215
37	.0508	.0498	.0003	.0055	88.117	305.94141	.12104	.03122	10773.2	.0039	.0000	575.148476
38	.0508	.0498	.0003	.0055	88.117	305.94011	.00000	.03122	10771.2	.0039	.0000	574.088593
						305.93964	.00047	.03122	10771.2	.0039	.0000	573.309715

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NAME USER NAME * * * * * PAGE 56
DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
EXT. 30235 * * TIME 12:26:12
BLD. 104 * MFTF * CASE 1
* * * * *

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CVI)

ANALYSIS OF LINE NUMBER 5

INDEX	DIAM (M)	WDOT-L (KG/S)	WDOT-V (KG/S)	QUALITY	TEMP (K)	PRESSURE (KPA)	NO GRAD (KPA/M)	FRICTION FACTOR	REYN NUMBER	VAPOR VEL (M/S)	VAPOR MACH NUMBER	DENSITY (KG/M-3)
39	.0508	.0498	.0003	.0062	88.117	305.93961	.00000	.03122	10771.2	.0039	.0000	564.001686
40	.0508	.0498	.0003	.0063	88.117	305.93863	.00049	.03122	10771.2	.0039	.0000	554.264549
WFLOW =		.150285		DPEXIT =		183.5430						

NAME USER NAME * * * * * PAGE 57
 DEPT 6213 * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. 30235 * * * * * TIME 12:26:12
 BLD. 104 * * * * * CASE 1
 * * * * * MFTF * * * * *

TEST CASE FOR THE MFTF LIQUID NITROGEN SUPPLY SYSTEM (CV1)

ANALYSIS OF LINE NUMBER 6

INDEX	DIAM (M)	WOOT-L (KG/S)	WOOT-V (KG/S)	QUALITY	TEMP (K)	PRESSURE (KPA)	PR GRAD (KPA/M)	FRICTION FACTOR	REYN NUMBER	VAPOR VEL (M/S)	VAPOR MACH NUMBER	DENSITY (KG/M-3)
1	.1016	.7758	.1704	.1801	88.113	305.85018		.01809	101721.0	.0132	.0001	554.264549
2	.1016	.7739	.1724	.1822	88.104	305.58675	.00000	.01809	101721.0	.0733	.0004	66.166949
3	.1016	.7734	.1728	.1826	88.077	304.83749	.02882	.01809	101692.5	.0734	.0004	65.656142
4	.1016	.7734	.1729	.1827	88.073	304.74648	.00000	.01810	101608.0	.0735	.0004	65.494113
5	.1016	.7732	.1731	.1829	88.102	305.53384	-.09263	.01810	101597.5	.0734	.0004	65.520137
6	.1016	.7732	.1731	.1829	88.099	305.44293	.00000	.01809	101686.2	.0733	.0004	65.545472
7	.1016	.7729	.1734	.1832	88.079	304.90750	.02894	.01809	101675.3	.0734	.0004	65.428081
8	.1016	.7728	.1734	.1833	88.076	304.81611	.00000	.01810	101614.9	.0735	.0004	65.310872
9	.1016	.7727	.1736	.1835	88.103	305.55808	-.09392	.01810	101604.6	.0734	.0004	65.334365
10	.1016	.7726	.1736	.1835	88.099	305.46675	.00000	.01809	101688.7	.0733	.0004	65.358314
11	.1016	.7717	.1746	.1845	88.042	303.88149	.02909	.01809	101677.7	.0735	.0004	65.039374
12	.1016	.7717	.1746	.1845	88.038	303.78931	.00000	.01810	101500.6	.0737	.0004	64.722990
13	.1016	.7714	.1749	.1848	88.019	303.26194	.02930	.01810	101488.9	.0738	.0004	64.609149
13	.1016	.7714	.1749	.1848	88.015	303.16949	.00000	.01810	101429.3	.0738	.0004	64.496052

DISPLAY OF FINAL FLOW PARAMETERS

WFLOW(1) = 1.0462734 KG/SEC	DIA(1) = .10160 M	OEXIT(1) = .00096
WFLOW(2) = .0005096 KG/SEC	DIA(2) = .02540 M	OEXIT(2) = 1.00000
WFLOW(3) = .6185346 KG/SEC	DIA(3) = .09922 M	OEXIT(3) = .26649
WFLOW(4) = .1762970 KG/SEC	DIA(4) = .05080 M	OEXIT(4) = .02408
WFLOW(5) = .1502854 KG/SEC	DIA(5) = .05080 M	OEXIT(5) = .00634
WFLOW(6) = .9462734 KG/SEC	DIA(6) = .10160 M	OEXIT(6) = .18485

AMBIENT TEMP = 293.150

EXIT TEMP = 88.015

NAME	USER NAME	* * * * *	PAGE	77
DEPT		* CRYOGEN SYSTEMS ANALYSIS	DATE	05 APR 79
EXT.		* MFTF	TIME	12:27:25
BLD.		* * * * *	CASE	1
* * * * * TEST CASE FOR THE MFTF GASEOUS HELIUM SUPPLY SYSTEM (CVI) * * * * *				

*** YOU HAVE CALLED FOR THE GHE RECDV SYSTEM ***

NAME USER NAME * * * * * PAGE 78
 DEPT * * * * * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * MFTF * TIME 12:27:25
 BLD. * * * * * * * * * * CASE 1
 * * * * *

TEST CASE FOR THE MFTF GASEOUS HELIUM SUPPLY SYSTEM (CVI)

***** G H E R E C O V E R Y D A T A *****

LOW PRESSURE SECTION:	LINE LENGTH	NUM.-ELBOWS	L/D OF COMP.	MAJOR COMP.
	48.000	1.0	.0	-.0
	.000	.0	340.0	-.0
	5.000	2.0	.0	-.0
	.000	.0	340.0	-.0
	1.000	.0	.0	-.0
	.000	.0	.0	1.0
	1.000	.0	.0	-.0
	.000	.0	340.0	-.0
	12.000	2.0	.0	-.0
	.000	.0	340.0	-.0
	1.000	.0	.0	-.0
HIGH PRESSURE SECTION:	1.000	.0	.0	-.0
	.000	.0	340.0	-.0
	1.000	.0	.0	-.0
	.000	.0	77.0	-.0
	3.000	4.0	.0	-.0
	7.000	3.0	.0	-.0
	.000	.0	170.0	-.0
	2.000	1.0	.0	-.0
	.000	.0	.0	2.0
	2.000	1.0	.0	-.0
	.000	.0	.0	3.0
	2.000	.0	.0	-.0
	.000	.0	170.0	-.0
	5.000	3.0	.0	-.0
	.000	.0	340.0	-.0
	1.000	1.0	.0	-.0
	.000	.0	.0	4.0
	1.000	1.0	.0	-.0
	.000	.0	340.0	-.0
	1.000	1.0	.0	-.0
	.000	.0	340.0	-.0
	2.000	2.0	.0	-.0
	.000	.0	340.0	-.0
	99.000	5.0	.0	-.0
	.000	.0	340.0	-.0

NAME USER NAME * * * * * PAGE 82
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:27:27
 BLD. * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF GASEOUS HELIUM SUPPLY SYSTEM (CV1)

DIA(METER) .040 MDOT(KG/SEC) .050 REYNOLDS NUMBER 83379.0 F-FACTOR .004676
 TG= 273.15 PBAG= 101.325 PCOMP= 16542.86

LINE	END NODES	DP (KPA)	DP/L(GEOM) (KPA/M)	MACH NO.	PRESSURE (KPA)	DENSITY (KG/M**3)

LOW PRESSURE LINE ANALYSIS

AT RECOVERY BAG EXIT .22931 101.3250 .178
 L 1 9 - 10 FLOW IS CHOKED IN THIS LINE SECTION FOR THIS FLOW RATE AND DIAMETER

HIGH PRESSURE LINE ANALYSIS

LINE	END NODES	DP (KPA)	DP/L(GEOM) (KPA/M)	MACH NO.	PRESSURE (KPA)	DENSITY (KG/M**3)
AT COMPRESSOR EXIT						
H 1	21 - 22	- .0000	- .0000	.00155	16542.8601	26.374
H 2	22 - 23	- .1909	- .0000	.00155	16542.8601	26.374
H 3	23 - 24	- .0000	- .0000	.00155	16542.6694	26.374
H 4	24 - 25	- .0432	- .0000	.00155	16542.6694	26.374
H 5	25 - 26	- .0000	- .0000	.00155	16542.6262	26.374
H 6	26 - 27	- .0000	- .0000	.00155	16542.6262	26.374
H 7	27 - 28	- .0954	- .0000	.00155	16542.6262	26.374
H 8	28 - 29	- .0000	- .0000	.00155	16542.5310	26.374
H 9	29 - 30	172.0000	- .0000	.00155	16542.5310	26.374
H 10	30 - 31	- .0000	- .0000	.00157	16370.5310	26.125
H 11	31 - 32	172.0000	- .0000	.00157	16370.5310	26.125
H 12	32 - 33	- .0000	- .0000	.00158	16198.5310	25.875
H 13	33 - 34	- .0973	- .0000	.00158	16198.5310	25.875
H 14	34 - 35	- .0000	- .0000	.00158	16198.4338	25.875
H 15	35 - 36	- .1945	- .0000	.00158	16198.4338	25.875
H 16	36 - 37	- .0000	- .0000	.00158	16198.2394	25.875
H 17	37 - 38	172.0000	- .0000	.00160	16026.2394	25.625
H 18	38 - 39	- .0000	- .0000	.00160	16026.2394	25.625
H 19	39 - 40	- .1964	- .0000	.00160	16026.0430	25.624
H 20	40 - 41	- .0000	- .0000	.00160	16026.0430	25.624
H 21	41 - 42	- .1964	- .0000	.00163	16025.8461	25.624
H 22	42 - 43	- .0000	- .0000	.00160	16025.8461	25.624
H 23	43 - 44	- .1964	- .0000	.00160	16025.6501	25.624
H 24	44 - 45	1.6738	.0159	.00160	16023.9763	25.621
H 25	45 - 46	- .1965	- .0000	.00160	16023.7799	25.621

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NAME USER NAME * * * * * PAGE 83
 DEPT * * * * * CRYOGEN SYSTEMS ANALYSIS * * * * * DATE 05 APR 79
 EXT * * * * * * * * * * TIME 12:27:27
 BLD * * * * * MFTF * * * * * CASE 1
 * * * * *

TEST CASE FOR THE MFTF GASEOUS HELIUM SUPPLY SYSTEM (CVI)

DIA(METER) .050 MDOT(KG/SEC) .050 REYNOLDS NUMBER 66703.2 F-FACTOR .004905
 TG= 273.15 PBAG= 101.325 PCOMP= 16542.86

LINE	END NODES	OP (KPA)	DP/L(GEOM) (KPA/M)	MACH NO.	PRESSURE (KPA)	DENSITY (KG/M**3)

LOW PRESSURE LINE ANALYSIS

L 1	9 - 10	50.4149	1.0175	.14676	101.3250	.178
L 2	10 - 11	24.1250		.29198	50.9101	.090
L 3	11 - 12			.55480	26.7851	.047

AT RECOVERY BAG EXIT
 FLOW IS CHOKED IN THIS LINE SECTION FOR THIS FLOW RATE AND DIAMETER

HIGH PRESSURE LINE ANALYSIS

H	LINE	END NODES	OP (KPA)	DP/L(GEOM) (KPA/M)	MACH NO.	PRESSURE (KPA)	DENSITY (KG/M**3)
					.00099	16542.8601	26.374
H 1	21 - 22	-.0000	-.0000	.00099	16542.8601	26.374	
H 2	22 - 23	-.0820	-.0000	.00099	16542.7793	26.374	
H 3	23 - 24	-.0000	-.0000	.00099	16542.7793	26.374	
H 4	24 - 25	-.0186	-.0000	.00099	16542.7598	26.374	
H 5	25 - 26	-.0000	-.0000	.00099	16542.7598	26.374	
H 6	26 - 27	-.0000	-.0000	.00099	16542.7598	26.374	
H 7	27 - 28	-.0410	-.0000	.00099	16542.7190	26.374	
H 8	28 - 29	-.0000	-.0000	.00099	16542.7190	26.374	
H 9	29 - 30	172.0000	-.0000	.00100	16370.7190	26.125	
H 10	30 - 31	-.0000	-.0000	.00100	16370.7190	26.125	
H 11	31 - 32	172.0000	-.0000	.00101	16198.7190	25.875	
H 12	32 - 33	-.0000	-.0000	.00101	16198.7190	25.875	
H 13	33 - 34	-.0418	-.0000	.00101	16198.6772	25.875	
H 14	34 - 35	-.0000	-.0000	.00101	16198.6772	25.875	
H 15	35 - 36	-.0836	-.0000	.00101	16198.5937	25.875	
H 16	36 - 37	-.0000	-.0000	.00101	16198.5937	25.875	
H 17	37 - 38	172.0000	-.0000	.00102	16026.5937	25.625	
H 18	38 - 39	-.0000	-.0000	.00102	16026.5937	25.625	
H 19	39 - 40	-.0844	-.0000	.00102	16026.5094	25.625	
H 20	40 - 41	-.0000	-.0000	.00102	16026.5094	25.625	
H 21	41 - 42	-.0844	-.0000	.00102	16026.4250	25.625	
H 22	42 - 43	-.0000	-.0000	.00102	16026.4250	25.625	
H 23	43 - 44	-.0844	-.0000	.00102	16026.3407	25.625	
H 24	44 - 45	-.0000	-.0000	.00102	16026.3407	25.625	
H 25	45 - 46	-.0844	-.0000	.00102	16026.2563	25.625	

AT COMPRESSOR EXIT

NAME USER NAME * * * * * PAGE 84
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:27:28
 BLD. * MFTF * CASE 1
 * * * * *

TEST CASE FOR THE MFTF GASEOUS HELIUM SUPPLY SYSTEM (CV1)

DIA(METER) .060 MDOOT(KG/SEC) .050 REYNOLDS NUMBER 55586.0 F-FACTOR .005105
 TG= 273.15 PBAG= 101.325 PCOMP= 16542.86

LINE	END NODES	DP (KPA)	DP/L(GEUM) (KPA/M)	MACH NO.	PRESSURE (KPA)	DENSITY (KG/M**3)

LOW PRESSURE LINE ANALYSIS

			AT RECOVERY BAG EXIT	.10192	101.3250	.178
L 1	9 - 10	16.5509	.3319	.12180	84.7741	.149
L 2	10 - 11	7.2738		.13322	77.5002	.136
L 3	11 - 12	3.5948	.4123	.13970	73.9054	.130
L 4	12 - 13	8.3429		.15747	65.5625	.115
L 5	13 - 14	.4811	.4811	.15863	65.0815	.115
L 6	14 - 15	-13.7860		.13092	78.8675	.139
L 7	15 - 16	.3947	.3947	.13157	78.4728	.138
L 8	16 - 17	7.8576		.14621	74.8152	.124
L 9	17 - 18	7.3958	.4705	.16330	63.2194	.111
L 10	18 - 19	9.7522		.19307	53.4671	.094
L 11	19 - 20	.6028	.6028	.19527	52.8643	.093

081 HIGH PRESSURE LINE ANALYSIS

			AT COMPRESSOR EXIT	.00069	16542.8601	26.374
H 1	21 - 22	-.0000	-.0000	.00069	16542.8601	26.374
H 2	22 - 23	-.0412		.00069	16542.8191	26.374
H 3	23 - 24	-.0000	-.0000	.00069	16542.8191	26.374
H 4	24 - 25	-.0093		.00069	16542.8098	26.374
H 5	25 - 26	-.0000	-.0000	.00069	16542.8098	26.374
H 6	26 - 27	-.0000	-.0000	.00069	16542.8098	26.374
H 7	27 - 28	-.0206		.00069	16542.7893	26.374
H 8	28 - 29	-.0000	-.0000	.00069	16542.7893	26.374
H 9	29 - 30	172.0000	-.0000	.00070	16370.7893	26.125
H 10	30 - 31	-.0000	-.0000	.00070	16370.7893	26.125
H 11	31 - 32	172.0000	-.0000	.00070	16198.7893	25.875
H 12	32 - 33	-.0000	-.0000	.00070	16198.7893	25.875
H 13	33 - 34	-.0210		.00070	16198.7684	25.875
H 14	34 - 35	-.0000	-.0000	.00070	16198.7684	25.875
H 15	35 - 36	-.0420		.00070	16198.7266	25.875
H 16	36 - 37	-.0000	-.0000	.00070	16198.7266	25.875
H 17	37 - 38	172.0000	-.0000	.00071	16026.7266	25.625
H 18	38 - 39	-.0000	-.0000	.00071	16026.7266	25.625
H 19	39 - 40	-.0424		.00071	16026.6842	25.625
H 20	40 - 41	-.0000	-.0000	.00071	16026.6842	25.625
H 21	41 - 42	-.0424		.00071	16026.6418	25.625
H 22	42 - 43	-.0000	-.0000	.00071	16026.6418	25.625
H 23	43 - 44	-.0424		.00071	16026.5995	25.625
H 24	44 - 45	-.0000	-.0000	.00071	16026.5995	25.625
H 25	45 - 46	-.0424		.00071	16026.5571	25.625

NAME	USER NAME	* * * * *	PAGE	98
DEPT		* CRYOGEN SYSTEMS ANALYSIS	DATE	05 APR 79
EXT.		*	TIME	12:27:35
BLD.		* MFTF	CASE	1

TEST CASE FOR THE MFTF GASEOUS HELIUM SUPPLY SYSTEM (CVI)

DIA(METER) .040 MDOT(KG/SEC) .050 REYNOLDS NUMBER 79602.1 F-FACTOR .004722
TG= 293.15 PBAG= 101.325 PCOMP= 16542.86

LINE	END, NODES	DP (KPA)	DP/L(GEOM) (KPA/M)	MACH NO.	PRESSURE (KPA)	DENSITY (KG/M**3)

LOW PRESSURE LINE ANALYSIS

AT RECOVERY BAG EXIT

23755

101.3250

156

L 1 9 - 10 FLOW IS CHOKED IN THIS LINE SECTION FOR THIS FLOW RATE AND DIAMETER

HIGH PRESSURE LINE ANALYSIS

AT COMPRESSOR EXIT

၁၆၆

'16542, 8601

24,719

H 1	21	22	- .0000	- .0000	.00160	16542.8601	24.719
H 2	22	23	- .2056	- .0000	.00160	16542.6545	24.719
H 3	23	24	- .0000	- .0000	.00160	16542.6545	24.719
H 4	24	25	- .0466	- .0000	.00160	16542.6082	24.719
H 5	25	26	- .0000	- .0000	.00160	16542.6082	24.719
H 6	26	27	- .0000	- .0000	.00160	16542.6082	24.719
H 7	27	28	- .1028	- .0000	.00160	16542.5054	24.718
H 8	28	29	- .0000	- .0000	.00160	16542.5054	24.718
H 9	29	30	172.0000	- .0000	.00161	16370.5054	24.484
H 10	30	31	- .0000	- .0000	.00161	16370.5054	24.484
H 11	31	32	172.0000	- .0000	.00163	16198.5054	24.248
H 12	32	33	- .0000	- .0000	.00163	16198.5054	24.248
H 13	33	34	- .1048	- .0000	.00163	16198.4006	24.248
H 14	34	35	- .0000	- .0000	.00163	16198.4006	24.248
H 15	35	36	- .2095	- .0000	.00163	16198.1910	24.248
H 16	36	37	- .0000	- .0000	.00163	16198.1910	24.248
H 17	37	38	172.0000	- .0000	.00164	16026.1910	24.012
H 18	38	39	- .0000	- .0000	.00164	16026.1910	24.012
H 19	39	40	- .2117	- .0000	.00164	16025.9794	24.012
H 20	40	41	- .0000	- .0000	.00164	16025.9794	24.012
H 21	41	42	- .2117	- .0000	.00164	16025.7677	24.012
H 22	42	43	- .0000	- .0000	.00164	16025.7677	24.012
H 23	43	44	- .2117	- .0000	.00164	16025.5560	24.012
H 24	44	45	1.7937	.0171	.00164	16023.7623	24.009
H 25	45	46	- .2117	- .0000	.00164	16023.5507	24.009

NAME USER NAME * * * * * PAGE 99
 DEPT * CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT. * * * * * TIME 12:27:35
 BLD. * * * * * CASE 1
 * * * * *

TEST CASE FOR THE MFTF GASEOUS HELIUM SUPPLY SYSTEM (CVI)

DIA(METER) .050 MDOOT(KG/SEC) .050 REYNOLDS NUMBER 63681.7 F-FACTOR .004955
 TG- 293.15 PBAG= 101.325 PCOMP= 16542.86

LINE	END NODES	DP (KPA)	DP/L(GEOM) (KPA/M)	MACH NO.	PRESSURE (KPA)	DENSITY (KG/M**3)

LOW PRESSURE LINE ANALYSIS

		AT RECOVERY BAG EXIT		.15203	101.3250	.166
L 1	9 - 10	58.7721	1.1861	.36184	42.5529	.070
L 2	10 - 11	FLOW IS CHOKED IN THIS LINE SECTION FOR THIS FLOW RATE AND DIAMETER				

HIGH PRESSURE LINE ANALYSIS

		AT COMPRESSOR EXIT		.00102	16542.8601	24.719
H 1	21 - 22	-.0000	-.0000	.00102	16942.8601	24.719
H 2	22 - 23	-.0884	-.0000	.00102	16542.7717	24.719
H 3	23 - 24	-.0000	-.0000	.00102	16542.7717	24.719
H 4	24 - 25	-.0200	-.0000	.00102	16542.7520	24.719
H 5	25 - 26	-.0000	-.0000	.00102	16542.7520	24.719
H 6	26 - 27	-.0000	-.0000	.00102	16542.7520	24.719
H 7	27 - 28	-.0442	-.0000	.00102	16542.7078	24.719
H 8	28 - 29	-.0000	-.0000	.00102	16542.7078	24.719
H 9	29 - 30	172.0000	-.0000	.00102	16370.7078	24.484
H 10	30 - 31	-.0000	-.0000	.00103	16370.7078	24.484
H 11	31 - 32	172.0000	-.0000	.00104	16198.7078	24.249
H 12	32 - 33	-.0000	-.0000	.00104	16198.7078	24.249
H 13	33 - 34	-.0450	-.0000	.00104	16198.6627	24.249
H 14	34 - 35	-.0000	-.0000	.00104	16198.6627	24.249
H 15	35 - 36	-.0901	-.0000	.00104	16198.5726	24.249
H 16	36 - 37	-.0000	-.0000	.00104	16198.5726	24.249
H 17	37 - 38	172.0000	-.0000	.00105	16026.5726	24.013
H 18	38 - 39	-.0000	-.0000	.00105	16026.5726	24.013
H 19	39 - 40	-.0910	-.0000	.00105	16026.4817	24.013
H 20	40 - 41	-.0000	-.0000	.00105	16026.4817	24.013
H 21	41 - 42	-.0910	-.0000	.00105	16026.3907	24.013
H 22	42 - 43	-.0000	-.0000	.00105	16026.3907	24.013
H 23	43 - 44	-.0910	-.0000	.00105	16026.2998	24.013
H 24	44 - 45	-.0000	-.0000	.00105	16026.2998	24.013
H 25	45 - 46	-.0910	-.0000	.00105	16026.2089	24.013

NAME USER NAME * * * * * PAGE 100
 DEPT CRYOGEN SYSTEMS ANALYSIS * DATE 05 APR 79
 EXT * * * * * TIME 12:27:38
 BLD * * * * * MFTF * CASE 1

TEST CASE FOR THE MFTF GASEOUS HELIUM SUPPLY SYSTEM (CV1)

DIA(METER) .060 MOOT(KG/SEC) .050 REYNOLDS NUMBER 53068.1 F-FACTOR .005158
 TG= 293.15 PBAG= 101.325 PCOMP= 16542.86

LINE	END NODES	DP (KPA)	DP/L(GEOM) (KPA/M)	MACH NO.	PRESSURE (KPA)	DENSITY (KG/M**3)
LOW PRESSURE LINE ANALYSIS						
AT RECOVERY BAG EXIT				.10558	101.3250	.166
L 1	9 - 10	18.1336	.3637	.12857	83.1914	.138
L 2	10 - 11	8.0367		.14231	75.1547	.123
L 3	11 - 12	4.0541	.4649	.15042	71.1006	.117
L 4	12 - 13	9.4025		.17334	61.6981	.101
L 5	13 - 14	.5593	.5593	.17492	61.1388	.100
L 6	14 - 15	-13.7860		.14275	74.9248	.123
L 7	15 - 16	-4530	.4530	.14362	74.4716	.122
L 8	16 - 17	8.9771		.16329	65.4947	.107
L 9	17 - 18	8.8935	.5657	.18894	56.6012	.093
L 10	18 - 19	11.8097		.23873	44.7915	.073
L 11	19 - 20	.8175	.8175	.24316	43.9740	.072

286 HIGH PRESSURE LINE ANALYSIS

LINE	END NODES	DP (KPA)	DP/L(GEOM) (KPA/M)	MACH NO.	PRESSURE (KPA)	DENSITY (KG/M**3)
AT COMPRESSOR EXIT				.00071	16542.8601	24.719
H 1	21 - 22	-.0000	-.0000	.00071	16542.8601	24.719
H 2	22 - 23	-.0444		.00071	16542.8159	24.719
H 3	23 - 24	-.0000	-.0000	.00071	16542.8159	24.719
H 4	24 - 25	-.0100		.00071	16542.8059	24.719
H 5	25 - 26	-.0000	-.0000	.00071	16542.8059	24.719
H 6	26 - 27	-.0000	-.0000	.00071	16542.8059	24.719
H 7	27 - 28	-.0222		.00071	16542.7839	24.719
H 8	28 - 29	-.0000	-.0000	.00071	16542.7839	24.719
H 9	29 - 30	172.0000	-.0000	.00072	16370.7839	24.484
H 10	30 - 31	-.0000	-.0000	.00072	16370.7839	24.434
H 11	31 - 32	172.0000	-.0000	.00072	16198.7839	24.249
H 12	32 - 33	-.0000	-.0000	.00072	16198.7839	24.249
H 13	33 - 34	-.0226		.00072	16198.7614	24.249
H 14	34 - 35	-.0000	-.0000	.00072	16198.7614	24.249
H 15	35 - 36	-.0452		.00072	16198.7162	24.249
H 16	36 - 37	-.0000	-.0000	.00072	16198.7162	24.249
H 17	37 - 38	172.0000	-.0000	.00073	16026.7162	24.013
H 18	38 - 39	-.0000	-.0000	.00073	16026.7162	24.013
H 19	39 - 40	-.0457		.00073	16026.6705	24.013
H 20	40 - 41	-.0000	-.0000	.00073	16026.6705	24.013
H 21	41 - 42	-.0457		.00073	16026.6249	24.013
H 22	42 - 43	-.0000	-.0000	.00073	16026.6249	24.013
H 23	43 - 44	-.0457		.00073	16026.5792	24.013
H 24	44 - 45	-.0000	-.0000	.00073	16026.5792	24.013
H 25	45 - 46	-.0457		.00073	16026.5336	24.013