Y-12

OAK RIDGE Y-12 PLANT

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Programming Enhancements for Low Temperature
Thermal Decomposition Workstation

R. E. Igou
Fabrication Systems Department
Development Division

October 1998

Prepared by the
Oak Ridge Y-12 Plant
P. O. Box 2009,
Oak Ridge, TN 37831-8169
managed by
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-84OR21400

MANAGED BY
LOCKHEED MARTIN ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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ABSTRACT

This report describes a new control-and-measurement system design for the Oak Ridge Y-12 Plant's Low Temperature Thermal Decomposition (LTTD) process. The new design addresses problems with system reliability stemming from equipment obsolescence and addresses specific functional improvements that plant production personnel have identified, as required.

The new design will also support new measurement techniques, which the Y-12 Development Division has identified for future operations. The new techniques will function in concert with the original technique so that process data consistency is maintained.

INTRODUCTION

The Oak Ridge Y-12 Plant's Disassembly and Storage Organization (DSO) uses a process called Low Temperature Thermal Decomposition (LTTD). The existing LTTD process workstations, hereafter referred to as the legacy system, need to be redesigned. DSO's primary reason for the new design is a serious reliability problem due to the fact that the controllers are based on computer systems that have become obsolete over the past decade. A second reason is that the existing software for the LTTD legacy system exhibits a number of operational problems, which DSO wants to eliminate. An example of these problems is the unfriendly user interface typical of older computer systems. A third reason is that DSO has accumulated a list of functional improvements that are desired for the LTTD workstation software but cannot practically be implemented on the older computer platform.

The Y-12 Development Division also wants a redesigned controller for the LTTD process because the division has long proposed improvements to the LTTD measurements that the LTTD process performs. A newly designed LTTD that meets DSO's requirements is seen as a platform for developing an improved LTTD measurement process while maintaining consistency with the da

REQUIREMENTS

CUSTOMER REQUIREMENTS

- DSO has imposed a number of requirements and constraints on the design solution.
- A new LTTD workstation shall be constructed to be used as a test bed for the design solution. (The new workstation with the implementation of the design solution shall be referred to as the Enhanced LTTD (ELTTD) workstation).
- The ELTTD workstation shall be demonstrated to be functionally acceptable before deployment.
- The ELTTD workstation shall be demonstrated to be reliable before deployment.
- The design solution shall be implementable as an upgrade to the legacy LTTD workstations. The goal is to implement the upgrade with less than a week downtime.
- The functional behavior of the legacy LTTD workstations is to be considered the baseline for the functional behavior of the ELTTD workstation. DSO provides specific exceptions.
- The design solution shall use a widely accepted, commodity-priced computer system that has an expected product-family lifetime in excess of 7 years.
- The design solution shall use widely accepted, commodity-priced operating system software that has an expected product-family lifetime in excess of 7 years.
- The design solution shall use support software (compilers, interpreters, etc.) that is widely accepted for this type of application and that has an expected product-family lifetime in excess of 7 years.

DEVELOPMENT DIVISION REQUIREMENTS

Development Division has also imposed requirement constraints on the design solution.

- The design solution shall be flexible enough to support experiments on the LTTD measurement process.
- The design solution shall be flexible enough to support additional LTTD measurement techniques to be defined at some future date.
- The design solution shall support the existing LTTD measurement techniques to ensure continuity of data.

LOCKHEED MARTIN ENERGY SYSTEMS REQUIREMENTS

The U.S. Department of Energy (DOE) and the Y-12 Plant place requirements and constraints on the design in the form of software quality assurance requirements. Year 2000 compliance of all system components is a particular consideration this close to the millennium.

LEGACY SYSTEM DESCRIPTION

Figure 1 shows the legacy system vacuum manifold.

Fig. 1. Legacy system vacuum manifold

The legacy system has two vacuum ports for sample collection bottles and one port for the sample that will be placed in an oven. A mechanical pump is used to rough down the vacuum system and a cryopump is used to capture gas given off when the sample is heated. Two thermocouple gauges (TG1 & TG3) open and close relays when pressure is above or below a setpoint. An additional thermocouple gauge (TG2) has an analog pressure readout to monitor pressure on the manifold side of the sample port. A Baratron head provides precision measurements of pressure during sample gas collection. Thermocouple gauges are used to measure the temperatures of the manifold, oven, and cryopump.

Operation of the system is conceptually simple. The mechanical pump roughs down the vacuum and the system is then checked for leaks. The oven heats the sample, and the cryopump captures the resulting gas. When all of the gas has been captured, the cryopump is allowed to regenerate and the gas is transferred to the sample collection bottles.

A Hewlett-Packard industrial computer running the HPBasic Interpreter and a Basic program written specially for the system automates the operation of the system. The valves, contactors for the oven and cryopump, and sensors for pressure and temperature are wired to conditioning modules in a Hewlett-Packard data acquisition module. The data acquisition module is connected to the computer through a General Purpose Interface Bus (GPIB) cable.

LEGACY SYSTEM DOCUMENTATION

The documentation folder for the existing LTTDs was inventoried to capture the design of the legacy system. The items in the folder were divided into 14 categories, which are in Appendix A. The key items were found to be

- LTTD program source code,
- LTTD program flow chart,
- manifold volume calibration program source code.

These items (Appendices B, C, and D, respectively, in this report) correspond to entries 1, 7, and 9 in the inventory.

The Engineering drawings for the legacy system were also found to be important items. Copies of those drawings, Nos. I2E137698 and I2E143710, can be acquired from Y-12 Engineering records on request.

REQUESTED MODIFICATIONS TO THE LEGACY SYSTEM

DSO desired a number of modifications to the legacy system design. These changes had never been formally documented. A series of three interviews were conducted with DSO's designated representative to capture and document the desired changes. These interviews were carried out between May and June of 1997.

Two changes were desired in the vacuum manifold design:

- A turbomolecular pump was inserted to protect the manifold from oil contamination due to the roughing pump.
- All three thermocouple gauges were specified to be the same make and model to simplify system maintenance.

DSO also accepted proposed modifications to support future Development activities:

- Flanges were provided to support future connections for a mass spectrometer and standard leaks, and
- An ion gauge was incorporated.

Desired functional modifications to the legacy system software are as follows:

- The LTTD program sequence of operations to calibrate the Baratron zero reading was changed to improve the efficiency of the operation. Modifying the flowchart of the LTTD program (primarily page 3) captured this change. Appendix E presents the new flowchart.
- Operator inputs shall tolerate typing errors. (The legacy system has many operations for which extensive data entry is required. The program must be restarted at the beginning to correct typographical errors).

- Detection of problems (such as adjustments out of calibration) after thermal decomposition has started should cause the program to flag the problem but otherwise continue. (The legacy system will quit the program if it detects any kind of problem.)
- Detection of problems, which prevent continuation of the program, should allow restart if the operator can correct the problem. (The legacy system will quit if a sample bottle fails a leak check. The legacy system must be restarted at the beginning if this occurs. Several similar cases exist.)
- Cryopump saturation should be handled by allowing the operator to force the collection sequence to completion and then reenter thermal decomposition. (The legacy system requires the operator to stop the program and manually complete the sequence if cryopump saturation occurs.)
- The enhanced system shall automatically start when power is applied. (The legacy system requires substantial manual activities to start.)
- The enhanced system shall remember its position in the sequence of operations and attempt to automatically continue in the event of a power fail/restore condition. (The legacy system does not maintain state information of any kind and cannot automatically start on power restore.)
- The enhanced system shall graphically display process data. At a minimum, three process variables (oven temperature, cryopump temperature, and sample pressure) shall be simultaneously shown on a display like a "continuous strip chart." (The legacy system cannot support graphical data display.)
- The enhanced system shall protect system shutdown and any other maintenance operation by password-only access.

COMPUTER HARDWARE AND OPERATING SYSTEM CHOICES

Customer requirements for widely accepted, commodity-priced systems considerably constrain computer hardware and operating system choices. In practical terms, this implies some type of PC-compatible system running one of the Microsoft Windows operating systems. The Development Division takes the position that this is acceptable provided that

- An industrially hardened system is used,
- Failure of the system does not compromise safety,
- There are no real-time response requirements, and
- Windows NT is chosen.

An industrially hardened system was not an issue to DSO. The legacy LTTD system had no significant safety or real-time response issues, and none of the additional requirements change this. Windows NT was also not an issue for DSO. A rack mountable, industrially hardened PC system with Windows NT 4.0 Workstation was purchased for the first implementation of the ELTTD design. This system hardware is essentially the same as hardware chosen for the Intelligent Inspection System (IIS) design that the Y-12 Product Certification Organization employs.

A vast array of choices of data acquisition hardware and software exist for the PC/Windows platform. Development staff recommended National Instruments data acquisition hardware and support software (LabView or LabWindows), a choice that has been used successfully over the past several years and for which considerable expertise exists. LabView has gained considerable acceptance throughout the weapons complex, and Lawrence Livermore National Laboratory (LLNL) is one of the largest users of National Instruments products in the world. It is interesting to note that LLNL's laser cutting workstation, which DSO will ultimately own and operate, was designed primarily around National Instruments products.

HARDWARE DESIGN

A hardware design was created by use of a selection of National Instruments components to monitor and control the LTTD manifold valves, oven controls, cryopump, turbopump, and pressure and temperature readings. This design was placed in Y-12 Engineering records under the title "Enhanced LTTD Workstation" and may be retrieved by a request of Drawing Nos. E2E92042EA133 through E2E92042EA140. Appendix F presents the material from these drawings.

COMPUTER SOFTWARE DESIGN

This report will briefly describe the human interface and the top-level behavior of the ELTTD software design. Future technical reports will describe the internal features.

HUMAN INTERFACE DESIGN

Figure 2 shows a typical front panel for the ELTTD design.

Fig. 2. Enhanced LTTD workstation sample front panel

The front panel is divided into a lower and an upper half.

The upper half contains controls and displays, which are always available. There include the title, the system time display, mode control and status, automatic mode sequence control and status, alarm indicator and alarm reset, and display control for the lower half.

The lower half contents depend on the current mode and on the operators' selection. The operator always select at least two panels—the operator message history and the trend display. System mode enables the selection of two more panels—one that allows password-protected access to system functions (shutdown) and one that shows internal system statistics. Manual mode enables the selection of a process monitor panel, which graphically depicts vacuum manifold status and allows manual control of the system. Automatic mode enables the selection of three additional panels—a

process monitor panel (without the manual controls), an automatic sequence status display, and a process data display.

Figures 3–5 present additional examples of ELTTD front panels.

Fig. 3. System mode

Mode: Control

Operator Messages

☒ Automatic Mode Current Operating Mode
☐ Manual Mode SOFTWARE
☐ System Mode

Automatic Mode Sequence Controls

SystemTimes

<div> <div>WAITING</div> <div>Sequence Status</div> </div>		<div> <div>Sequence Start</div> <div>10/1/98 7:16:01 AM</div> </div>		<div>10/1/98 7:57:28 AM</div>	
<div> <div>STANDBY</div> <div>Sub Sequence Status</div> </div>				<div>Display Control</div>	
☐ Start/Continue Sequence	☐ AUTO	☐ Select Automatic Sequence	☐ Trending Display		
☐ Stop Sequence	☐ SUB START	☐ Select Sub Sequence	☐ Display Mode		
☐ Quit Sequence	☐ Accept New Sequence	☐ Cancel Alarm

Fig. 4. Manual mode with trend display.

Low Temperature Thermal Decomposition Workstation

Mode Control ☐ Automatic Mode ☐ Manual Mode ☐ System Mode		Operator Messages <div style="border: 1px solid black; height: 40px;"></div>	
Automatic Mode Sequence Control <div style="display: flex; justify-content: space-between;"> <div> Sequence Status Sub Sequence Status </div> <div> Sequence Start 10/1/98 7:16:01 AM </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div> ☒ Start/Continue Sequence ☐ Stop Sequence ☐ Quit Sequence </div> <div> <div style="border: 1px solid black; padding: 2px;">LITD</div> <div style="border: 1px solid black; padding: 2px;">STRT</div> <div style="border: 1px solid black; padding: 2px;">Accept New Sequence</div> </div> </div>		System Time 10/1/98 7:58:48 AM Display Control ☒ Process Data ☒ Display Mode ☐ Cancel Alarm	
SOFTWARE VERSION STATION NUMBER WORK REQUEST DATE TEST COMPLETED 12/31/03 8:00 PM CONTAINER NUMBER OPERATOR BADGE NUMBER SAMPLE BOTTLE A DATA M-NUMBER-A VOLUME-A 10.1X cc SAMPLE BOTTLE 2A DATA M-NUMBER-2A VOLUME-2A 10.1X cc SAMPLE BOTTLE PRESSURE 0.000 tor V(STP) 0.000 cc		INITIAL CAN PRESSURE 0.000 microns BARATRON ZERO VALUE 0.000 tor ATMOSPHERIC VALUE 0.000 tor WALLACE-TIERNAN VALUE 0.000 mm Hg CALIBRATED VOLUME CP 0.000 cc FINAL BARATRON PRESSURE 0.000 tor LABORATORY TEMPERATURE 0.000 deg C <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> Record "FINAL BARATRON PRESSURE" on both SAMPLE BOTTLE id tags along with the following DATA: SAMPLE BOTTLE NUMBER WORK REQUEST NUMBER PROCESS (BUILD) NUMBER CAN NUMBER CHARGE NUMBER DATE (When Sampled) Mark one tag "A-SAMPLE" and the other "2A-SAMPLE" </div>	

Fig. 5. Automatic mode process data/report generation

SUMMARY

This report has detailed a new design for the controller and manifold for the Y-12 Plants' LTTD process. Future technical reports will provide internal detail of the software implementation and will describe extension of the design to support new LTTD measurement capabilities.

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The author would also like to acknowledge contributions from a number of Development personnel, especially Tom Morris, who was responsible for the enhanced LTTD manifold; Jim Basford and Jennings Cline, who provided guidance with regard to vacuum technology and other experimental issues; and Roy Pollard, who provided invaluable computer support.

**APPENDIX A: INVENTORY OF LEGACY LTTD WORKSTATION
DOCUMENTATION**

Inventory of LTTD Legacy System Documentation (97/02/05)

1. Source code for program "LTTD", 17-May-1989, AS-C-LTTD-1.3, runs under HP Basic Interpreter, ~600 lines, 16 pages
2. Source code for program "DECOMP", 17-May-1989, AS-C-DECO-1.3, runs under HP Basic, ~600 lines, 14 pages
3. Procedure for LTTD Manifold Volume Calculation, 7 pages
4. LTTD, Manual Interface Photometal Panel, 4/15/88, I2E137698, CADAM drawing showing photometal panel assembly
5. LTTD, System Diagram/Assembly, 4/15/88, I2E143710, CADAM drawing showing system level connections
6. Maintenance Work Request to modify LTTD 012 (6A-406), 2/8/88, YX178210, 4 pages, instructions for installation of LTTD vacuum system controls, also MWR for LTTD 011 (6A-407) 4/20/88 and LTTD 013 (6A-408) 5/7/87
7. Flowchart for LTTD program, 9-Feb-88, 5 pages
8. Variable usage list for LTTD program, 4-Feb-88, 5 pages
9. Source code for program "VOLCALC", 3-Feb-1988, runs under HP Basic Interpreter, ~600 lines, 16 pages
10. Process time sequence, undated, 1 page
11. Materials list, undated, 1 page
12. Manual procedure for measuring LTTD manifold volume, undated, 3 pages
13. Hand sketches, undated, 5 pages
14. Data sheet on GE CR305/CR306 contactor, 2 pages

**APPENDIX B: SOURCE CODE FOR LEGACY THERMAL
DECOMPOSITION SOFTWARE**

```

10 ' LTID'
15 SRS="AS-CAN-123"
20 PRINTER IS 10,80
25 SRS="AS-C-LTID-123"
30 Q1=-200
35 D=709
40 ON ERROR GOSUB 5130
45 CLEAR
50 GOSUB 5285 ; serial port setup (printer?)
55 GOSUB 5230 ; clear printer buffer
60 OUTPUT 10 ; "Please VERIFY that the PRINTER has sufficient PAPER"
65 OUTPUT 10 ; "PRESS the 'RTN' key to CONTINUE"
70 ENTER 10 USING "%, %K" ; K$
75 IF K$=CHR$(13) THEN 55
80 GOSUB 5230 ; clear printer buffer
85 GOSUB 5400 ; print the time
90 OUTPUT 10 ; "Is the printed TIME and DATE CORRECT (Y/N)?"
95 ENTER 10 USING "%, %K" ; A$
100 OUTPUT 10
105 IF NUM(A$)=89 THEN GOSUB 5435 ; set time
110 GOSUB 5230 ; clear printer buffer
115 OUTPUT 10 ; "Please ENTER the LTID STATION NO."
120 ENTER 10 USING "%, %K" ; L$
125 OUTPUT 10
130 OUTPUT 10 ; "The LTID NUMBER = "; L$
135 OUTPUT 10 ; "IS THIS CORRECT (Y/N)?"
140 ENTER 10 USING "%, %K" ; A$
145 OUTPUT 10
150 IF NUM(A$)=89 THEN 110
155 GOSUB 5230
160 OUTPUT 10 ; "Please ENTER the WORK REQUEST NO."
165 ENTER 10 USING "%, %K" ; R$
170 OUTPUT 10
175 OUTPUT 10 ; "The WORK REQUEST = "; R$
180 OUTPUT 10 ; "IS THIS CORRECT (Y/N)?"
185 ENTER 10 USING "%, %K" ; A$
190 OUTPUT 10
195 IF NUM(A$)=89 THEN 155
200 GOSUB 5230
205 OUTPUT 10 ; "Please ENTER the CAN NUMBER"
210 ENTER 10 USING "%, %K" ; C$
215 OUTPUT 10
220 OUTPUT 10 ; "The CAN NUMBER = "; C$
225 OUTPUT 10 ; "IS THIS CORRECT (Y/N)?"
230 ENTER 10 USING "%, %K" ; A$
235 OUTPUT 10
240 IF NUM(A$)=89 THEN 200
245 GOSUB 5230
250 OUTPUT 10 ; "Please ENTER your BADGE NUMBER"
255 ENTER 10 USING "%, %K" ; Q$
260 OUTPUT 10
265 OUTPUT 10 ; "Your BADGE NUMBER = "; Q$
270 OUTPUT 10 ; "IS THIS CORRECT (Y/N)?"
275 ENTER 10 USING "%, %K" ; A$
280 OUTPUT 10
285 IF NUM(A$)=89 THEN 245
290 OUTPUT D ; "BIT20"
295 ENTER D ; M
300 IF M=0 THEN 350

```

dot 16

```

305 GOSUB 5205 ; ALAem
310 GOSUB 5230 ; clear printer buffer
315 OUTPUT 10 ; "Please check the SWITCHES on the MANUAL INTERFACE PANEL,"
320 OUTPUT 10 ; "the MAN-IN-USE indicator is ON. Press the 'RTN' key when"
325 OUTPUT 10 ; "ALL SWITCHES are in the AUTO position."
330 OUTPUT 10 0 OUTPUT 10 0 OUTPUT 10
335 ENTER 10 USING "%,XK" ; K$
340 IF K$=CHR$(13) THEN 310
345 GOTO 330
350 OUTPUT 10 ; "SYSTEM IS BEING INITIALIZED"
355 OUTPUT 10 ; "WRT1,0"
360 OUTPUT 10 ; "WRT2,0"
365 WAIT 2000
370 OUTPUT 10 ; "WRT1,230" ! OPN 1,2,5,6,7
375 OUTPUT 10 ; "WRT2,3" ! OPN 8&9
385 GOSUB 5230 ; clear printer buffer
390 OUTPUT 10 ; "Please INSTALL the SAMPLE CAN in the OVEN"
395 OUTPUT 10 ; "PRESS the 'RTN' key to CONTINUE when the CAN is INSTALLED"
400 ENTER 10 USING "%,XK" ; K$
405 IF K$=CHR$(13) THEN 385
410 GOSUB 5230
415 OUTPUT 10 ; "Are 50cc Sample Bottles attached to V3 & V4 (Y/N)?"
420 ENTER 10 USING "%,XK" ; A$
425 OUTPUT 10
430 IF NUM(A$)=89 THEN 460
435 OUTPUT 10 ; "Please INSTALL two 50cc BOTTLES (connected to V3 & V4)."

```

```

550 OUTPUT 10 & OUTPUT 10
555 IF NUM(AS)*89 THEN 530
500 GOSUB 5230
605 OUTPUT 10 ; "Please ENTER the MANIFOLD'S CERTIFIED VOLUME"
610 ENTER 10 USING "%,%K" ; V0
615 OUTPUT 10
620 OUTPUT 10 ; "Value entered for the CERTIFIED MANIFOLD VOLUME = 'V0:' Is this
    correct (Y/N)?"
625 ENTER 10 USING "%,%K" ; AS
630 OUTPUT 10
635 IF NUM(AS)*89 THEN 600
640 V6=.1*INT(10*V0)
645 GOSUB 5230
650 OUTPUT 10 ; "Please OPEN the MANUAL VALVES on the two SAMPLE BOTTLES"
655 OUTPUT 10 ; "PRESS the 'RTN' key to CONTINUE"
660 ENTER 10 USING "%,%K" ; KS
665 IF KS#CHR$(13) THEN 645
675 OUTPUT 0 ; "DC1,192" ; CLS 6,7
680 WAIT 2000
685 OUTPUT 0 ; "DS1,24" ; OPN V3 & V4
690 WAIT 5000
695 OUTPUT 10 ; "Pumping to achieve TG1 setpoint - 5 minutes maximum"
700 T9=5 @ BS="21"
705 GOSUB 5145 ; set pt test
710 OUTPUT 10 ; "Pumping to achieve TG2 setpoint - 10 minutes maximum"
715 T9=10 @ BS="26"
720 GOSUB 5145 ; set pt test
725 P1=0
730 P2=2 @ P9=0 @ L=10
735 OUTPUT 10 @ OUTPUT 10
740 OUTPUT 10 ; "PERFORMING A SAMPLE BOTTLE PRESSURE RISE LEAK CHECK"
745 OUTPUT 0 ; "DC1,2" ; CLS V1
750 WAIT 5000
755 GOSUB 5050 ; 24 hr leak test
760 IF P9=0 THEN 820
765 IF P1>2 THEN 805
770 P1=P1+1
775 OUTPUT 0 ; "DS1,2" ; OPN V1
780 OUTPUT 10 ; "Pumping on the Sample Bottles for 1 hour at " ; TIMES
785 FOR I=1 TO 60
790 WAIT 60000
795 NEXT I
800 GOTO 730
805 OUTPUT 10 ; "Failed the Sample Bottle Pressure Rise Leak Test 3 times"
810 GOSUB 5205 ; alarm
815 GOTO 5355 ; THAT'S ALL shutdown
820 OUTPUT 0 ; "DS2,4" ; OPN V10
825 OUTPUT 0 ; "DS1,2" ; OPN V1
830 WAIT 5000
835 T9=5 @ BS="21"
840 OUTPUT 10
845 OUTPUT 10 ; "Pumping to achieve TG1 setpoint - 5 minutes maximum"
850 GOSUB 5145 ; set pt test
855 BS="26"
860 OUTPUT 10 ; "Started Pumping to achieve TG2 setpoint at " ; TIMES
865 OUTPUT 10 ; "Will pump for a maximum of 24 hours"
870 GOSUB 5965 ; 24 hr set pt test
875 P1=0
880 P2=3
885 P9=0

```

```

330 L=10
395 OUTPUT 0 : "DS2.2" : "PI V9
500 OUTPUT '0 : Started pumping on Hose 2 Manifold for 1 hour at 11 TIMES
905 FOR I=1 TO 60
910 WAIT 60000
915 NEXT I
920 OUTPUT 0 : "DC2.2" : "CLS V9
925 OUTPUT 10 0 OUTPUT 10
930 OUTPUT 10 : "PERFORMING SAMPLE CAN CONNECTION PRESSURE RISE LEAK CHECK"
935 WAIT 5000
940 GOSUB 5050 : 24 hr leak test
945 IF P9=0 THEN 975
950 P1=P1+1
955 IF P1<8 THEN 885
960 OUTPUT 10 : "FAILED THE PRESSURE RISE LEAK TEST 4 TIMES"
965 GOSUB 5205 : alarm
970 GOTO 5355 : shutdown
975 OUTPUT 0 : "DS1.192" : "OPN V7,V6
980 OUTPUT 0 : "DS2.2" : "OPN V9
985 WAIT 5000
990 T3=5 0 85="21"
995 OUTPUT 10
1000 OUTPUT 10 : "Pumping to achieve T61 setpoint - 5 minutes maximum"
1005 GOSUB 5145 : set pt test
1010 WAIT 60000
1015 B5="25"
1020 OUTPUT 10 : "Started Pumping to achieve T62 setpoint at 11 TIMES
1025 OUTPUT 10 : "Will pump for a maximum of 24 hours"
1030 GOSUB 5965 : 24 hour set pt test
1035 P1=0
1040 P2=2
1045 P3=0
1050 L=10
1055 OUTPUT 0 : "DS1.4" : "OPN V2
1060 OUTPUT 0 : "DS2.2" : "OPN V9
1065 OUTPUT 10 : "Started pumping on the Complete Manifold for 1 hour at 11 TIMES
1070 FOR I=1 TO 60
1075 WAIT 60000
1080 NEXT I
1085 OUTPUT 0 : "DC1.4" : "CLS V2
1090 OUTPUT 0 : "DC2.2" : "CLS V9
1095 OUTPUT 10 0 OUTPUT 10
1100 OUTPUT 10 : "PERFORMING MANIFOLD/CRYOPUMP PRESSURE FIVE MINUTE CHECK AT 11 TIME
$
1105 WAIT 5000
1110 GOSUB 5050 : 24 hr leak test
1115 IF P9=0 THEN 1145
1120 P1=P1+1
1125 IF P1<8 THEN 1045
1130 OUTPUT 10 : "FAILED PRESSURE RISE LEAK TEST TWICE"
1135 GOSUB 5205 : alarm
1140 GOTO 5355 : shutdown
1145 OUTPUT 0 : "DC1.192" : "CLS V6,V7
1150 OUTPUT 0 : "DS2.64" : "STRT CRYO
1155 OUTPUT 0 : "DC1.196" : "CLS V2,V6, & V7
1160 OUTPUT 0 : "DC2.2" : "CLS V9
1165 GOSUB 5330 : close print buffer
1170 OUTPUT 10 0 OUTPUT 10
1175 OUTPUT 10 : "OPEN the CAN'S MANUAL VALVE. PRESS the 'RTN' -> to CONTINUE"
1180 ENTER 10 USING "&.ZX" : KS

```


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```

1185 IF P=CHR$(13) THEN GSS
1190 OUTPUT 10
1195 OUTPUT 10 : "ONE MIN. : : = PRESSURE TO STABILIZE"
1200 WAIT 50000
1205 OUTPUT 0 : "DCV5"
1210 ENTER 0 : HI
1215 HI=.1*INT(10*1000)
1220 OUTPUT 10 : "The initial CAN PRESSURE = ":HI:" microns"
1225 OUTPUT 10
1230 IF HI<200 THEN 1250
1235 GOSUB 5205 alarm
1240 OUTPUT 10 : "THE CAN PRESSURE IS TOO HIGH. MEASURED VALUE = ":HI:" microns."

1245 OUTPUT 10 : "IT MUST BE LESS THAN 200 microns TO CONTINUE"
1250 OUTPUT 10 : "CALL THE LAB SUPERVISOR"
1255 GOTO 5350 : THAT'S ALL shutdown
1260 OUTPUT 0 : "DS2,2" : OPN V9
1265 WAIT 10000
1270 BS="25"
1275 OUTPUT 10 : "Started Pumping to achieve TG2 setpoint at ":TIMES
1280 OUTPUT 10 : "Will pump for a maximum of 24 hours"
1285 GOSUB 5955 : 24 hr setpoint test
1290 P1=0
1295 P2=2
1300 P9=0
1305 L=15
1310 OUTPUT 0 : "DS2,2" : OPN V9
1315 OUTPUT 10 : "Started pumping on the Sample Can for 1 hour at ":TIMES
1320 FOR I=1 TO 60
1325 WAIT 60000
1330 NEXT I
1335 OUTPUT 0 : "DC2,2" : CLS V9
1340 OUTPUT 10
1345 OUTPUT 10 : "PERFORMING A SAMPLE CAN & MANIFOLD PRESSURE RISE LEAK CHECK AT
":TIMES
1350 WAIT 10000
1355 GOSUB 5050 : 24 hr leak test
1360 IF P9=0 THEN 1395
1365 P1=P1+1
1370 IF P1<8 THEN 1300
1375 OUTPUT 10 : "FAILED THE PRESSURE RISE LEAK TEST - CLOSE THE CAN'S MANUAL VAL
VE"
1380 GOSUB 5205 alarm
1385 GOTO 5355 : shutdown
1390 : ***** THERMAL DECOMPOSITION *****
1395 GOSUB 5595
1400 OUTPUT 0 : "DS2,2" : OPN V9
1405 T9=10 @ BS="25"
1410 OUTPUT 10
1415 OUTPUT 10 : "Pumping to achieve TG2 setpoint - 10 minutes maximum"
1420 WAIT 10000
1425 GOSUB 5145 : setpoint test
1430 OUTPUT 0 : "DC1,64" : CLS V6
1435 OUTPUT 0 : "DC2,2" : CLS V9
1440 OUTPUT 0 : "DS2,1" : OPN V8
1445 WAIT 2000
1450 OUTPUT 0 : "DS1,128" : OPN V7
1455 OUTPUT 0 : "DS2,128" : STRT OVEN
1460 GOSUB 5230 : clear print buffer
1465 OUTPUT 10

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1470 OUTPUT "0 : Now, CLOSE the OVEN DOOR and SET the TEMPERATURE CONTROL."
1475 OUTPUT "0 : to 200 degrees C : SET :-- : LIMIT to 210 degrees C) Turn ON"

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1480 OUTPUT "0 : the POWER SWITCH and RESET the HIGH LIMIT CONTROL."
1485 OUTPUT "0 : PRESS the 'RTN' key to CONTINUE"
1490 OUTPUT "0 @ OUTPUT "0 @ OUTPUT "0
1495 ENTER "0 USING "%,WK" : AS
1500 IF K$=CHR$(13) THEN 1460
1505 OUTPUT "0 @ OUTPUT "0 @ OUTPUT "0
1510 OUTPUT "0 : STARTING THERMAL DECOMPOSITION TEST AT"
1515 GOSUB 5400 ; print the time
1520 S0=TIME/3600 : START TIME - HOURS
1525 D0$=DATE$
1530 D0$=D0$(4,8)"/19"D0$(1,2) : START DATE
1535 OUTPUT "0 @ OUTPUT "0
1540 F1=0 : Z9=0
1545 GOSUB 5800 ; set ; print decomp values
1550 ON KEY# 1 GOSUB 1650
1555 FOR I=1 TO 4
1557 FOR K=1 TO 30
1559 WAIT 50000
1561 NEXT K
1563 IF I=4 THEN 1600
1565 IF F1>24 THEN 1600
1570 OUTPUT "0 : DCVS"
1575 ENTER "0 : G9
1577 G9=.1*INT(10*1000*G9)
1580 IF G9<Z9/2 THEN 1600
1590 OUTPUT "0 : Sample Can PRESSURE is "G9;" microns at "TIMES
1595 IF G9>Z9 THEN Z9=G9
1600 NEXT I
1605 GOSUB 5800 ; set ; print decomp values
1607 IF C0>1000 THEN 1610
1608 IF C0>-190 THEN GOSUB 6145 ; complain about cryopump temperature too high
1610 IF F1<4 THEN 1640 ; - temp is desired.
1615 IF O1<180 THEN GOSUB 6025 ; complain about oven temperature too low.
1620 T1$=TIMES
1625 T1$=T1$(1,2)
1630 IF VAL(T1$)<4 OR VAL(T1$)>14 THEN 1640
1635 IF G0<=5 THEN 1695 ; drop through to finish test
1640 F1=F1+1
1645 GOTO 1550
1650 GOSUB 5800 ; set ; print decomp values
1655 GOSUB 5230 ; clear print buffer
1660 OUTPUT "0 : Thermal Decomposition Test has been in progress for "F1*4;" ho
urs."
1665 OUTPUT "0 : do you want to TERMINATE the test (Y/N)?"
1670 ENTER "0 USING "%,WK" : AS
1675 OUTPUT "0
1680 IF NUM(AS)=89 THEN RETURN
1685 GOTO 1825
1695 OFF KEY# 1
1700 OUTPUT "0
1705 OUTPUT "0 : PERFORMING A 7 MICRON IN 15 MINUTE PRESSURE RISE CHECK"
1710 OUTPUT "0 : TO DETERMINE, IF TEST IS COMPLETE AT"
1715 GOSUB 5400 ; print the time
1720 OUTPUT "0
1725 OUTPUT "0 : "DC2,1" : CLS V8
1730 WAIT 5000
1735 OUTPUT "0 : "DCVS" : READ TG2

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1740 ENTER D : G1
1745 G1=.1*INT(10*1000*G1)
1750 OUTPUT 10 : "Initial pressure is : G1 : microns"
1755 FOR I=1 TO 15
1760 WAIT 50000
1765 OUTPUT D : "OCV5"
1770 ENTER D : G2
1775 G2=.1*INT(10*1000*G2)
1780 OUTPUT 10 : "1 minute pressure reading is : G2 : microns"
1785 IF G2-G1>=7 THEN 1800
1790 NEXT I
1795 GOTO 1825
1800 OUTPUT 10 : "The Pressure Rise Test was FAILED"
1805 OUTPUT 10 : "The Thermal Decomposition test will be CONTINUED"
1810 OUTPUT 10 @ OUTPUT 10
1815 OUTPUT D : "DS2,1" : OPN V8
1820 GOTO 1550
1825 OFF KEY: 1
1830 OUTPUT D : "DC1,64" : CLS V6
1835 OUTPUT D : "DC2,3" : CLS V8 & V9
1840 OUTPUT D : "DC2,196" : CLS V10 & STP CRYO & OVN
1845 OUTPUT D : "DC1,128" : CLS V7
1850 OUTPUT 10
1855 OUTPUT 10 : "THERMAL DECOMPOSITION TEST ENDED AT "
1860 GOSUB 5400
1865 OUTPUT 10
1870 OUTPUT 10 : "Please OPEN the OVEN DOOR."
1875 OUTPUT 10 @ OUTPUT 10 @ OUTPUT 10
1890 OUTPUT D : "DC1,196" : CLS V2, V6, & V7
1895 OUTPUT D : "DS1,32" : OPN V5
1900 OUTPUT D : "DC2,10" : CLS V9 & V11
1905 WAIT 2000
1910 OUTPUT D : "DS1,4" : OPN V2
1915 WAIT 2000
1920 T9=S @ BS="21"
1925 OUTPUT 10 : "PUMPING TO ACHIEVE TG1 SETPOINT - 5 minutes maximum"
1930 GOSUB 5145 ; set pt test
1935 WAIT 5000
1940 OUTPUT D "OCV4"
1945 ENTER D : B0
1950 B0=100*B0
1955 OUTPUT 10 : "The Baratron's ZERO READING = : B0 : torr."
1960 IF ABS(B0)<=.02 THEN 1985
1965 GOSUB 5205 ; alarm
1970 GOSUB 5230 ; clear alarm print buffer
1975 OUTPUT 10 : "The BARATRON'S zero is NOT correctly adjusted"
1980 GOSUB 5900 ; shutdown
1985 OUTPUT D : "DC1,38" : CLS V2, V3 & V4
1990 WAIT 2000
1995 OUTPUT D : "DS2,8" : OPN V11
2000 GOSUB 5000 ; read Baratron
2005 GOSUB 5230 ; clear print buffer
2010 OUTPUT 10 @ OUTPUT 10
2015 OUTPUT 10 : "Please ENTER the Barometric Pressure as read from the"
2020 OUTPUT 10 : "WALLACE-TIERNAN gauge in the Gas Sampling Room"
2025 ENTER 10 USING "%,XK" : W1
2030 OUTPUT 10
2035 OUTPUT 10 : "Value entered for the BAROMETRIC PRESSURE WAS : W1 : mmHg"
2040 OUTPUT 10 : "IS THIS CORRECT (Y/N)?"
2045 ENTER 10 USING "%,XK" : AS

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2050 OUTPUT 10
2055 IF NUM(AS)*89 THEN 2060
2060 GOSUB 5000
2065 B1=.1*INT(10*100*B2)
2070 OUTPUT 10 ; "The Baratron's ATMOSPHERIC PRESSURE READING = ";B1;" torr."
2075 IF ABS(W1-B1)*5 THEN 2105
2080 GOSUB 5205 ; alarm
2085 GOSUB 5230 ; clear print buffer
2090 OUTPUT 10 ; "The difference in readings between the BARATRON and the"
2095 OUTPUT 10 ; "WALLACE-TIERNAN gauge is greater than the allowable limit (5 to
    rr)"
2100 GOSUB 5900 ; shutdown
2105 OUTPUT D ; "OC2,9" ; CLS V11
2110 WAIT 2000
2115 OUTPUT D ; "DS1,4" ; OPN V2
2120 WAIT 2000
2125 T9=5 @ 89="21"
2130 OUTPUT 10 ; "PUMPING TO ACHIEVE T61 SETPOINT - 5 minutes maximum"
2135 GOSUB 5145 ; setpoint check
2140 OUTPUT 10 ; "30 SECOND WAIT AT ";TIMES
2145 WAIT 20000
2155 OUTPUT 10
2160 OUTPUT 10 ; "Waiting for the Cryopump to reach thermal equilibrium"
2165 OUTPUT D ; "DC1,188" ; CLS V2, V3, V4, V5 & V7
2170 OUTPUT D ; "DC2,11" ; CLS V8, V9 & V11
2175 WAIT 2000
2180 OUTPUT D ; "DS1,64" ; OPN V6
2185 OUTPUT D ; "DCV4"
2190 ENTER D ; 85
2195 B5=.01*INT(100*100*B5)
2200 OUTPUT 10
2205 OUTPUT D ; "TEMP"
2210 ENTER D ; C1
2215 OUTPUT 10 ; "      BARATRON PRESSURE = ";B5;" torr"
2220 IF C1>1000 THEN 2240
2225 C1=.1*INT(10*C1)
2230 OUTPUT 10 ; "      CRYOPUMP TEMP = ";C1;" degrees C"
2235 GOTO 2245
2240 OUTPUT 10 ; "      CRYOPUMP TEMP < -200 degrees C"
2245 OUTPUT 10 ; "      at ";TIMES
2250 OUTPUT 10 ; "There will be a 30 MINUTE WAIT before the next set of readings"

2255 FOR I=1 TO 3
2260 WAIT 600000
2265 NEXT I
2270 OUTPUT D ; "DCV4"
2275 ENTER D ; 85
2280 B5=.01*INT(100*100*B5)
2285 OUTPUT 10
2290 OUTPUT D ; "TEMP"
2295 ENTER D ; C2
2300 OUTPUT 10 ; "      BARATRON PRESSURE = ";B5;" torr"
2305 IF C2>1000 THEN 2325
2310 C2=.1*INT(10*C2)
2315 OUTPUT 10 ; "      CRYOPUMP TEMP = ";C2;" degrees C"
2320 GOTO 2330
2325 OUTPUT 10 ; "      CRYOPUMP TEMP < -200 degrees C"
2330 OUTPUT 10 ; "      at ";TIMES
2335 IF C2>1000 THEN 2250
2340 IF ABS(C2-C1)<=.2 THEN 2355

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2345 C1=C2
2350 GOTO 2350
2355 OUTPUT 0 ; "TEM7"
2360 ENTER 0 ; R0
2365 R0=.1*INT(100*R0)
2370 OUTPUT 10 ; "The EQUILIBRIATED BARATRON PRESSURE = ";R0;" and the LAB TEMP = ";R0
2375 GOSUB 5230 ; clear print buffer
2380 OUTPUT 10 ; "ENSURE that the MANUAL VALVES on BOTH 50cc SAMPLE BOTTLES"
2385 OUTPUT 10 ; "are OPEN. PRESS the 'RTN' key to CONTINUE"
2390 ENTER 10 USING "%,XK" ; K$
2395 IF K$=CHR$(13) THEN 2375
2400 OUTPUT 10
2405 OUTPUT 0 ; "DS1,32" ; OPN V5
2410 OUTPUT 10 ; "Valve V5 was OPENED"
2415 GOSUB 5000 ; wait Baratron to be stable ! read it
2420 B6=.01*INT(100*100*R2)
2425 OUTPUT 10 ; "The BARATRON PRESSURE after OPENING V5 = ";B6;" torr."
2430 OUTPUT 10
2435 OUTPUT 0 ; "DS1,8" ; OPN V3
2440 OUTPUT 10 ; "Valve V3 was OPENED"
2445 GOSUB 5000 ; wait Baratron to be stable ! read it
2450 B7=.01*INT(100*100*R2)
2455 OUTPUT 10 ; "The BARATRON PRESSURE after OPENING V3 = ";B7;" torr."
2460 IF ABS((B6-B7)/B6)>=.015 THEN 2485
2465 GOSUB 5205 ; alarm
2470 OUTPUT 10 ; "THE CHANGE IN PRESSURE AFTER OPENING V3 WAS LESS THAN 1.5 PERCENT"
2475 GOSUB 5230 ; clear print buffer
2480 GOSUB 5900 ; shutdown
2485 OUTPUT 10
2490 OUTPUT 0 ; "DS1,16" ; OPN V4
2495 OUTPUT 10 ; "Valve V4 was OPENED"
2500 GOSUB 5000 ; wait Baratron to be stable ! read it
2505 B8=.01*INT(100*100*R2)
2510 OUTPUT 10 ; "The BARATRON PRESSURE after OPENING V4 = ";B8;" torr."
2515 IF ABS((B7-B8)/B7)>=.015 THEN 2540
2520 GOSUB 5205 ; alarm
2525 OUTPUT 10 ; "THE CHANGE IN PRESSURE AFTER OPENING V4 WAS LESS THAN 1.5 PERCENT"
2530 GOSUB 5230 ; clear print buffer
2535 GOSUB 5900 ; shutdown
2540 OUTPUT 10 @ OUTPUT 10
2545 OUTPUT 10 ; "The FINAL BARATRON PRESSURE (after opening BOTH V3 & V4) = ";B8;" torr."
2550 OUTPUT 10 ; "RECORD this value on both SAMPLE BOTTLE identification tags"
2555 OUTPUT 10 ; "along with the following DATA:"
2560 OUTPUT 10 ; " SAMPLE BOTTLE NUMBER"
2565 OUTPUT 10 ; " WORK REQUEST NUMBER"
2570 OUTPUT 10 ; " PROCESS (BUILD) NUMBER"
2575 OUTPUT 10 ; " CAN NUMBER"
2580 OUTPUT 10 ; " CHARGE NUMBER"
2585 OUTPUT 10 ; " DATE (When Sampled)"
2590 OUTPUT 10 ; "Mark one tag 'A-SAMPLE' and the other 'B-A-SAMPLE'"
2595 OUTPUT 10 @ OUTPUT 10 @ OUTPUT 10
2600 OUTPUT 0 ; "DC1,216" ; CLS V3,V4,V6 & V7
2605 GOSUB 5230
2610 OUTPUT 10 ; "Please CLOSE the MANUAL VALVES on BOTH SAMPLE BOTTLES"
2615 OUTPUT 10 ; "PRESS the 'RTN' key to CONTINUE when the valves are CLOSED"
2620 ENTER 10 USING "%,XK" ; K$

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2625 IF #CHR$(13) THEN 2605
2630 OUTPUT 10
2635 OUTPUT 10 ; "The SAMPLE CAN may be REMOVED now, and"
2640 OUTPUT 10 ; "the SAMPLE CAN MANUAL VALVE may be CLOSED and the can removed n
ow."
2645 OUTPUT 10 ; "DC2,4" CLS
2650 FOR I=1 TO 10
2655 OUTPUT 10
2660 NEXT I
2665 : ***** CALCULATIONS *****
2670 : Para 6.7
2675 E1=85/760*(273/(R0+273))*V0
2680 UI=
2685 E1=.01*INT(100*E1)
2690 UI=.01*INT(100*E1)
2695 OUTPUT 10 ; " *****FOLD HERE ***** FOLD HERE ***** FOLD HERE
*****
2700 OUTPUT 10 ; " OUTPUT 10 ; " OUTPUT 10 ; "
2705 OUTPUT 10 ; " RESTRICTED DATA
2710 OUTPUT 10 ; " CONFIDENTIAL CONFIDENTIAL CONFIDENTIAL
2715 FOR I=1 TO 5 //
2720 OUTPUT 10
2725 NEXT I
2730 OUTPUT 10 ; " SOFTWARE VERSION ";S8$; " ";S9$
2735 OUTPUT 10 ; " STATION NUMBER ";L$
2740 OUTPUT 10 ; " WORK REQUEST ";R$
2745 OUTPUT 10 ; " DATE TEST COMPLETED ";D$
2750 OUTPUT 10 ; " CONTAINER NUMBER ";C$
2755 OUTPUT 10 ; " OPERATOR BADGE NUMBER ";O$
2760 OUTPUT 10
2765 OUTPUT 10 ; " SAMPLE BOTTLE A DATA:"
2770 OUTPUT 10 ; " M-NUMBER = ";M1$
2775 OUTPUT 10 ; " VOLUME = ";V1
2780 OUTPUT 10 ; " SAMPLE BOTTLE 2A DATA:"
2785 OUTPUT 10 ; " M-NUMBER = ";M2$
2790 OUTPUT 10 ; " VOLUME = ";V2
2795 OUTPUT 10 ; " SAMPLE BOTTLE PRESSURE = ";B8; " torr"
2800 OUTPUT 10
2805 OUTPUT 10 ; " THE INITIAL CAN PRESSURE WAS ";I1; " microns"
2810 OUTPUT 10 ; " THE BARATRON'S ZERO VALUE WAS ";B0; " torr"
2815 OUTPUT 10 ; " THE BARATRON'S ATMOSPHERIC VALUE WAS ";B1; " torr"
2820 OUTPUT 10 ; " THE WALLACE-TIERNAN BAROMETER VALUE WAS ";W1; " mmHg
"
2825 FOR I=1 TO 5
2830 OUTPUT 10
2835 NEXT I
2840 OUTPUT 10 ; " THE CALIBRATED VOLUME OF THE CRYOPUMP IS ";V6; " cc"
2845 OUTPUT 10 ; " THE FINAL BARATRON PRESSURE = ";B5; " torr"
2850 OUTPUT 10 ; " THE LABORATORY TEMPERATURE = ";C2; " DEG C"
2855 FOR I=1 TO 4
2860 OUTPUT 10
2865 NEXT I
2870 OUTPUT 10 ; " (STP) = ";E1; " cc"
2875 OUTPUT 10
2880 OUTPUT 10 ; " (EQ) = " PUT " "
2885 OUTPUT 10 ; " OUTPUT 10
2890 OUTPUT 10 ; " WORK REQUEST ";R$
2895 OUTPUT 10
2900 OUTPUT 10 ; " CONTAINER NUMBER ";C$

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2905 FOR I=1 TO 3 :
2910 OUTPUT 10
2915 NEXT I
2920 OUTPUT 10 ; "CONFIDENTIAL"
2925 OUTPUT 10 ; "RESTRICTED DATA"
2930 OUTPUT 10 ; "*****CUT HERE ***** CUT HERE ***** CUT HERE *****"
2935 OUTPUT 10 ; "*****"
2940 FOR I=1 TO 10
2945 OUTPUT 10
2950 NEXT I
2965 GOSUB 5230
2970 OUTPUT 10 ; "Please INSTALL two 50cc SAMPLE BOTTLES on the manifold"
2975 OUTPUT 10 ; "PRESS the 'RTN' key to CONTINUE when the BOTTLES are INSTALLED"

2980 ENTER 10 USING "%,XK" ; K$
2985 IF K$=CHR$(13) THEN 2965
2990 GOSUB 5230
2995 OUTPUT 10 ; "Now, OPEN ALL THE MANUAL VALVES on both SAMPLE BOTTLES"
3000 OUTPUT 10 ; "PRESS the 'RTN' key when the valves are OPEN"
3005 ENTER 10 USING "%,XK" ; K$
3010 IF K$=CHR$(13) THEN 2990
3015 OUTPUT 10 ; "DS1,3" ; "OPN V1, V2, V3, V4"
3020 OUTPUT 10 ; "DS2,3" ; "OPN V8 & V9"
3025 OUTPUT 10 ; "ONE MINUTE WAIT AT " ; TIMES
3030 WAIT 60000
3035 T9=5 @ BS="21"
3040 OUTPUT 10 ; "PUMPING TO ACHIEVE T61 SETPOINT - 5 minutes maximum"
3045 GOSUB 5145
3050 OUTPUT 10 ; "PUMPING FOR 15 MINUTES AT " ; TIMES
3055 WAIT 900000
3060 T9=10 @ BS="26"
3065 OUTPUT 10 ; "PUMPING TO ACHIEVE T62 SETPOINT - 10 minutes maximum"
3070 GOSUB 5145
3075 P1=0
3080 P2=2 @ P9=0 @ L=10
3085 OUTPUT 10 ; "Performing a Sample Bottle Leak Test"
3090 OUTPUT 10 ; "DC1,2" ; "CLS V1"
3095 WAIT 10000
3100 GOSUB 5050
3105 IF P9=0 THEN 3190
3110 IF P1>2 THEN 3155
3115 P1=P1+1
3120 OUTPUT 10 ; "DS1,2" ; "OPN V1"
3125 OUTPUT 10
3130 OUTPUT 10 ; "Pumping on Sample Bottles for 1 hour at " ; TIMES
3135 FOR I=1 TO 60
3140 WAIT 60000
3145 NEXT I
3150 GOTO 3080
3155 OUTPUT 10 ; "Failed the Sample Bottle Pressure Rise Leak Test 3 times"
3160 GOSUB 5205
3165 GOSUB 5230
3170 OUTPUT 10 ; "REPLACE the SAMPLE BOTTLE GASKETS and PRESS the 'RTN' key to CO
NTINUE"
3175 ENTER 10 USING "%,XK" ; K$
3180 IF K$=CHR$(13) THEN 3165
3185 GOTO 3015
3190 OUTPUT 10 ; "DC1,24" ; "CLOSE V3 & V4"

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3195 WAIT 2000
3200 OUTPUT D ; "DS1,194" OPEN VS 2 : 7
3205 OUTPUT 10 ; "PUMPING on the CRYOPUMP for TWO HOURS at ":TIMES
3210 OUTPUT D ; "WRT2,3"
3215 FOR I=1 TO 8
3220 WAIT 500000
3225 NEXT I
3230 OUTPUT D ; "DCV5"
3235 ENTER D ; G4
3240 G4=.1*INT(10*1000*G4)
3245 OUTPUT 10 ; "The CRYOPUMP'S PRESSURE IS ":G4;" microns at ":TIMES
3250 IF G4>10 THEN 3205
3255 OUTPUT 10 ; "PUMPING on the CRYOPUMP for ONE HOUR at ":TIMES
3260 FOR I=1 TO 4
3265 WAIT 500000
3270 NEXT I
3275 OUTPUT D ; "WRT1,0"
3280 OUTPUT D ; "WRT2,0"
3285 OUTPUT D ; "WRT1,38"
3290 OUTPUT D ; "WRT2,3"
3295 OUTPUT 10 ; "SYSTEM HAS BEEN RETURNED TO THE STANDBY STATE"
3300 OUTPUT 10 ; "PROGRAM CONTROL HAS BEEN TERMINATED AT "
3305 GOSUB 5400
3310 OUTPUT 10 @ OUTPUT 10 @ OUTPUT 10 @ OUTPUT 10 @ OUTPUT 10
3315 STOP
5000 ! ***** READ BARATRON *****
5005 OUTPUT 10 ; "WAITING FOR BARATRON READING TO STABILIZE"
5010 OUTPUT D ; "DCV4"
5015 ENTER D ; R1
5020 WAIT 2000
5025 OUTPUT D ; "DCV4"
5030 ENTER D ; R2
5035 IF ABS(R2-R1)<.0001 THEN RETURN
5040 R1=R2
5045 GOTO 5020
5050 ! ***** 2u LEAK TEST *****
5055 OUTPUT D ; "DCV5"
5060 ENTER D ; G4
5065 G4=.1*INT(10*1000*G4)
5070 OUTPUT 10 ; "Performing a ":P2;" micron, ":L;" minute pressure rise leak tes
t"
5075 OUTPUT 10 ; "Initial pressure is ":G4;" microns"
5080 FOR I=1 TO L
5085 WAIT 50000
5090 OUTPUT D ; "DCV5"
5095 ENTER D ; G5
5100 G5=.1*INT(10*1000*G5)
5105 OUTPUT 10 ; I;" minute pressure reading is ":G5;" microns"
5110 IF ABS(G4-G5)>P2 THEN 5125
5115 NEXT I
5120 RETURN
5125 P9=1
5130 OUTPUT 10 ; "FAILED THE":L;" MINUTE PRESSURE RISE LEAK TEST"
5135 OUTPUT 10 @ OUTPUT 10
5140 RETURN
5145 ! ***** SETPOINT TEST *****
5150 N=1
5155 OS="BIT".B3
5160 OUTPUT D ; OS
5165 ENTER D ; S1

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5170 IF E1=1 THEN RETURN
5175 WAIT 10000
5180 N=N+1
5185 IF N<6*T9 THEN S155
5190 OUTPUT 10 ; "CANNOT PUMP BELOW SETPOINT IN ";T9;" MINUTES ALLOWED"
5195 GOSUB 5205 ;alarm,
5200 GOTO 5355 ; shutdown
5205 ' ..... ALARM .....
5210 OUTPUT 0 ; "CLS10"
5215 WAIT 100
5220 OUTPUT 0 ; "OPN10"
5225 RETURN
5230 ' ..... CLEAR TI'S BUFFER .....
5235 SET TIMEOUT 10;1000
5240 ON TIMEOUT 10 GOTO 5260
5245 ON ERROR GOSUB 5320
5250 ENTER 10 USING "%,B" ; Z
5255 GOTO 5250
5260 SET TIMEOUT 10;0
5265 ON ERROR GOSUB 5130
5270 RESET 10
5275 GOSUB 5285
5280 RETURN
5285 ' ..... SERIAL PORT SETUP .....
5290 CONTROL 10,4 ; 26
5295 CONTROL 10,9 ; 139
5300 CONTROL 10,11 ; 194
5305 CONTROL 10,12 ; 13
5310 CONTROL 10,14 ; 17
5315 RETURN
5320 ' ..... SERIAL PORT ERROR .....
5325 SET TIMEOUT 10;0
5330 OFF ERROR
5335 ' ERROR # 114 IS BUFFER OVERRUN
5340 IF ERRN=114 THEN RETURN
5345 OUTPUT 10 ; "SERIAL PORT ERROR NUMBER ";ERRN;" OCCURRED AT LINE ";ERRL
5350 STOP
5355 ' ..... SHUTDOWN .....
5360 OUTPUT 0 ; "WRT1,0"
5365 OUTPUT 0 ; "WRT2,0"
5370 OUTPUT 0 ; "WRT1,30"
5375 OUTPUT 0 ; "WRT2,3"
5380 OUTPUT 10 ; "PROGRAM CONTROL IS BEING TERMINATED"
5385 GOSUB 5400
5390 OUTPUT 10 @ OUTPUT 10 @ OUTPUT 10 @ OUTPUT 10
5395 STOP
5400 ' ..... PRINT THE TIME .....
5405 DIS=DATE$
5410 DS=DIS(4,5)&"-"&DIS(7,8)&"-"&DIS(1,2)
5415 HS=TIME$
5420 TS=HS(1,5)
5425 OUTPUT 10 ; " TIME ";TS;" DATE ";DS
5430 RETURN
5435 ' ..... SET TIME ROUTINE .....
5440 GOSUB 5230
5445 OUTPUT 10 ; "ENTER the DATE, format: MM,DD,YY ,e.g., 04,06,83 for April 6, 1
983"
5450 ENTER 10 USING "%,ZK" ; Z$
5455 OUTPUT 10
5460 MS=Z$(1,2)

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5465 WS=ZS(4,5)
5470 Y=VAL(ZS(7,3))
5475 OUTPUT 10 ; "DATE entered was MONTH = ";MS;" DAY = ";DS;" YEAR = ";Y
5480 OUTPUT 10 ; "IS THIS DATE CORRECT (Y/N)?"
5485 ENTER 10 USING "%,K" ; AS
5490 OUTPUT 10
5495 IF NUM(AS)=89 THEN 5440
5500 Y1=Y-1
5505 DS=MS/"&WS"/19*VALS(Y)
5510 DS="12/31/19"&VALS(Y1)
5515 Y=1000*Y
5520 Y2=Y+(MOY(DS)-MOY(D1S))
5525 GOSUB 5230
5530 OUTPUT 10 ; "ENTER the TIME, format: HH:MM"
5535 ENTER 10 USING "%,K" ; TS
5540 OUTPUT 10
5545 OUTPUT 10 ; "TIME entered was TIME = ";TS
5550 OUTPUT 10 ; "IS THIS TIME CORRECT (Y/N)?"
5555 ENTER 10 USING "%,K" ; AS
5560 OUTPUT 10
5565 IF NUM(AS)=89 THEN 5525
5570 TS=TS*100
5575 TS=TS(1,5)&TS(7,9)
5580 SETTIME HMS(TS),Y2
5585 GOSUB 5400
5590 RETURN
5595 ! ..... CRYOPUMP TEMP .....
5600 F2=0
5605 OUTPUT 0 ; "TEMP"
5610 ENTER 0 ; T0
5615 OUTPUT 10 0 OUTPUT 10
5620 IF T0>1000 THEN 5640
5625 T0=.1*INT(10*T0)
5630 OUTPUT 10 ; "The CRYOPUMP TEMPERATURE = ";T0;" degrees C at ";TIMES
5635 GOTO 5645
5640 OUTPUT 10 ; "The CRYOPUMP TEMPERATURE < -200 degrees C.AT ";TIMES
5645 IF T0<-01 OR T0>1000 THEN RETURN
5650 F2=F2+1
5655 IF F2>=4 THEN 5670
5660 GOSUB 5770
5665 GOTO 5605
5670 GOSUB 5205
5675 GOSUB 5230
5680 OUTPUT 10 ; "The CRYOPUMP has NOT reached the required TEMPERATURE"
5685 OUTPUT 10 ; "of ";Q1;" degrees within the past ";F2*30;" minutes"
5690 OUTPUT 10 ; "Do you want to WAIT another 30 MINUTES for it to reach the"
5695 OUTPUT 10 ; "required TEMPERATURE before assuming the CRYOPUMP is"
5700 OUTPUT 10 ; "DEFECTIVE and TERMINATING the TEST (Y/N)?"
5705 OUTPUT 10 0 OUTPUT 10 0 OUTPUT 10
5710 ENTER 10 USING "%,K" ; AS
5715 OUTPUT 10
5720 IF NUM(AS)=89 THEN 5735
5725 GOSUB 5770
5730 GOTO 5605
5735 GOSUB 5230
5740 OUTPUT 10 ; "ARE YOU SURE YOU WANT TO TERMINATE THE TEST (Y/N)?"
5745 ENTER 10 USING "%,K" ; AS
5750 OUTPUT 10
5755 IF NUM(AS)=89 THEN 5360
5760 GOSUB 5770

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5765 GOTO 5805
5770 OUTPUT 3 ; "Waiting . . . for the CRYOPUMP to reach correct"
5775 OUTPUT 10 ; "TEMPERATURE"
5780 FOR I=1 TO 3
5785 WAIT 500000
5790 NEXT I
5795 RETURN
5800 ! ***** DECOMP VALUES *****
5805 OUTPUT 3 ; "DCVS"
5810 ENTER 0 ; 60 ; TG2 PRESSURE
5815 C0=.1*INT(10*1000*60)
5820 OUTPUT 3 ; "TEMP"
5825 ENTER 0 ; C0 ; CRYO TMP
5830 OUTPUT 3 ; "TEMP"
5835 ENTER 0 ; 01 ; OVN TMP
5840 O1=.1*INT(10*01)
5845 OUTPUT 10 ; "TG2 PRESSURE = ";C0;" microns"
5850 OUTPUT 10 ; "OVN TEMPERATURE = ";O1;" degrees C."
5855 IF C0>1000 THEN 5875
5860 C0=.1*INT(10*C0)
5865 OUTPUT 10 ; "CRYOPUMP TEMP = ";C0;" degrees C"
5870 GOTO 5880
5875 OUTPUT 10 ; "CRYOPUMP TEMP < -200 degrees C"
5880 GOSUB 5400
5885 GOSUB 6050
5890 OUTPUT 10
5895 RETURN
5900 ! ***** ERROR TERMINATION *****
5905 OUTPUT 10 ; "DO YOU WISH TO CONTINUE THE TEST (Y/N)?"
5910 ENTER 10 USING "%,%K" ; A$
5915 OUTPUT 10
5920 IF NUM(A$)=89 THEN RETURN
5925 OUTPUT 10 ; "ARE YOU SURE YOU WANT TO TERMINATE PROGRAM CONTROL OF THE TEST (Y/N)?"
5930 ENTER 10 USING "%,%K" ; A$
5935 OUTPUT 10
5940 IF NUM(A$)=89 THEN RETURN
5945 OUTPUT 10 ; "PROGRAM CONTROL WAS TERMINATED AT"
5950 GOSUB 5400
5955 OUTPUT 10 @ OUTPUT 10 @ OUTPUT 10 @ OUTPUT 10 @ OUTPUT 10
5960 STOP
5965 ! ***** 24 HR SETPOINT TEST *****
5970 N=1
5975 OS="BIT*8$
5980 OUTPUT 0 10$
5985 ENTER 0 ; 51
5990 IF 51=1 THEN RETURN
5995 WAIT 60000
6000 N=N+1
6005 IF N<1440 THEN 5975
6010 OUTPUT 10 ; "CANNOT PUMP BELOW SETPOINT IN 24 HOURS ALLOWED"
6015 GOSUB 5205 alarm
6020 GOTO 5355 shutdown
6025 ! ... OVEN TEMP WARNING ...
6030 GOSUB 5205
6035 OUTPUT 10 ; "WARNING - THE OVEN TEMPERATURE IS TOO LOW - IT SHOULD BE 200 De
grees C"
6040 RETURN
6045 ! .... ELAPSED TIME CALC ....
6050 E=TIME/3600

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6055 D95=DATE$
6060 D95=D95(4,818"/19"3035(11.2:
6065 E4=MDY(D95)-MDY(D05)
6070 IF E4>0 THEN 6085
6075 E3=.01*INT(100*(E-S0))
6080 GOTO 6115
6085 IF E>=S0 THEN 6105
6090 E4=(E4-1)*24
6095 E3=.01*INT(100*(E4+E+24-S0))
6100 GOTO 6115
6105 E4=E4+24
6110 E3=.01*INT(100*(E4+E-S0))
6115 OUTPUT 10 ; "The Test ELAPSED TIME is ";E3; " Hours"
6120 RETURN
6125 ! *** ERROR SUBROUTINE ***
6130 OUTPUT 10 ; "ERROR NUMBER ";ERRN; " OCCURED AT LINE ";ERRL
6135 RETURN
6140 END
6145 GOSUB 5205; alarm
6150 GOSUB 5235; clear print buffer
6155 OUTPUT 10 ; "The CRYOPUMP TEMPERATURE is too HIGH - It should be < -200 degr
ees C"
6160 OUTPUT 10 ; "DO YOU WISH TO TERMINATE THE TEST (Y/N)?"
6165 ENTER 10 USING "%,%K" ; AS
6170 OUTPUT 10
6175 IF NUM(AS)*89 THEN RETURN
6180 OUTPUT 10 ; "PROGRAM CONTROL HAS BEEN TERMINATED"
6185 STOP

```

APPENDIX C: FLOWCHART FOR LEGACY THERMAL DECOMPOSITION SOFTWARE

Original L.T.D Flow Chart
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page 1 of 5

Original L.T.D Flow Chart
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**APPENDIX D: SOURCE CODE FOR LEGACY MANIFOLD
VOLUME CALIBRATION SOFTWARE**

```

10 1
30 1 THIS PROGRAM IS UTILIZED TO COMPUTE THE LTID'S MANIFOLD VOLUME
40 1
50 1 03-FEE-86
60 PRINTER IS 10,80
70 D=709
80 CLEAR
90 GOSUB 4950 1 INITIALIZE THE SERIAL PORT
100 OUTPUT D ;"BIT20" 1 TEST MAN IN USE
110 ENTER D ; M
120 IF M=0 THEN 220
130 GOSUB 4790 1 START ALARM
140 GOSUB 4840 1 CLR TI'S BUF
150 OUTPUT 10 ;"Please check the SWITCHES on the MANUAL INTERFACE PANEL."
160 OUTPUT 10 ;"the MAN-IN-USE indicator is ON. Press the 'RTN' key when"
170 OUTPUT 10 ;"ALL SWITCHES are in the AUTO position."
180 OUTPUT 10 0 OUTPUT 10 0 OUTPUT 10
190 ENTER 10 USING "%,K" ; Ks
200 IF Ks#CHRS(13) THEN 140
210 GOTO 100
220 OUTPUT 10 ;"SYSTEM IS BEING INITIALIZED"
230 OUTPUT D ;"WRT1,0"
240 OUTPUT D ;"WRT2,0"
250 OUTPUT D ;"WRT1,39"
260 OUTPUT D ;"WRT2,3"
270 OUTPUT 10 ;"PUMPING TO ACHIEVE T51 SETPOINT"
280 BS="21"
290 GOSUB 4670 1 BELOW TG1 SP?
300 OUTPUT 10 ;"PUMPING TO ACHIEVE T52 SETPOINT"
310 BS="26"
320 GOSUB 4670 1 BELOW TG2 SP?
330 GOSUB 4840 1 CLR TI'S BUFF
340 OUTPUT 10 ;"Please INSTALL two 500cc bottles in place of the 50cc"
350 OUTPUT 10 ;"sample bottles. PRESS the 'RTN' key to CONTINUE"
360 ENTER 10 USING "%,K" ; Ks
370 IF Ks#CHRS(13) THEN 330
380 OUTPUT 10 ;"ARE THE 500cc BOTTLES INSTALLED (Y/N)"
390 ENTER 10 USING "%,K" ; As
400 OUTPUT 10
410 IF NUM(As)#89 THEN 330
420 GOSUB 4840 1 CLR TI'S BUFF
430 OUTPUT 10 ;"OPEN the MANUAL VALVE(S) on the 500cc bottles"
440 OUTPUT 10 ;"PRESS the 'RTN' key to CONTINUE"
450 ENTER 10 USING "%,K" ; Ks
460 IF Ks#CHRS(13) THEN 420
470 OUTPUT D ;"DS1,24" 1 OPN V3,V4
480 GOSUB 4840 1 CLR TI'S BUFF
490 OUTPUT 10 ;"Give me the DATA for 500cc BOTTLE A, which is connected to VALVE
V3"
500 OUTPUT 10
510 OUTPUT 10 ;"What is the CERTIFIED VOLUME?"
520 ENTER 10 USING "%,K" ; V1
530 OUTPUT 10
540 OUTPUT 10 ;"What is the M-NUMBER?"
550 ENTER 10 USING "%,K" ; M1
560 OUTPUT 10
570 OUTPUT 10 ;"Values entered for BOTTLE A are: VOLUME = "V1;" M NUMBER = "M1
580 OUTPUT 10

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530 OUTPUT 10 : ARE THESE CORRECT (Y/N)?
540 ENTER 10 USING "%,KK" : A$
550 OUTPUT 10
560 IF NUM(A$)=89 THEN 480
570 OUTPUT 10 : Now I need the DATA for 500cc BOTTLE B, which is connected to VA
LVE V4"
580 OUTPUT 10
590 OUTPUT 10 : What is the CERTIFIED VOLUME?"
600 ENTER 10 USING "%,KK" : V2
610 OUTPUT 10
620 OUTPUT 10 : What is the M-NUMBER?"
630 ENTER 10 USING "%,KK" : M2$
640 OUTPUT 10
650 OUTPUT 10 : Values entered for BOTTLE B are: VOLUME = ":V2;" M NUMBER = ":M2
$
660 OUTPUT 10
670 OUTPUT 10 : ARE THESE CORRECT (Y/N)?"
680 ENTER 10 USING "%,KK" : A$
690 OUTPUT 10 : OUTPUT 10
700 IF NUM(A$)=89 THEN 630
710 B$="25"
720 OUTPUT 10 : PUMPING TO ACHIEVE T62 SETPOINT"
730 OUTPUT 10
740 GOSUB 4670 : BELOW T62 SP?
750 OUTPUT 0 : "DC1,192" : OPN V6,V7
760 OUTPUT 10 : WAITING 30 SECONDS BEFORE NEXT OPERATION"
770 WAIT 30000
780 B$="25"
790 GOSUB 4670 : BELOW T62 SP?
800 OUTPUT 0 : "DC1,4" : CLS V2
810 OUTPUT 0 : "DC2,2" : CLS V9
820 OUTPUT 10 : WAITING 30 SECONDS BEFORE NEXT OPERATION"
830 WAIT 30000 : 30 SEC WAIT
840 GOSUB 4490 : PRESSURE RISE LEAK TEST
850 : ..... BARATRON TEST .....
860 OUTPUT 0 : "DCV4"
870 ENTER 0 : B0
880 B0=100*B0
890 IF ABS(B0)>.25 THEN 1000 : 2.5 millivolts?
900 OUTPUT 10 : THE BARATRON'S ZERO IS NOT PROPERLY ADJUSTED."
910 OUTPUT 10 : IT IS READING ":B0:" TORR BUT SHOULD READ LESS THAN .25 TORR"
920 GOSUB 4790 : START ALARM
930 GOTO 5090
1000 OUTPUT 0 : "DC1,128" : CLS V7
1010 GOSUB 4840 : CLR TI703'S BUF
1020 OUTPUT 10 : "Please CLOSE the MANUAL valves NEAREST the bottle on BOTH"
1030 OUTPUT 10 : "500cc bottles. Press the 'RTN' key when VALVES are CLOSED"
1040 ENTER 10 USING "%,KK" : K$
1050 IF K$=CHR$(13) THEN 1010
1060 OUTPUT 0 : "DS2,9" : OPN V11
1070 OUTPUT 0 : "DCV4"
1080 ENTER 0 : P1 : READ BARA
1090 R1=100*P1
1100 OUTPUT 10 : WAITING FOR BARATRON READING TO STABILIZE. CURRENT READING = ":
R1:" TORR"
1110 WAIT 10000
1120 OUTPUT 0 : "DCV4"
1130 ENTER 0 : P1 : READ BARA
1140 P1=100*P1
1150 IF ABS(P1-R1)>.1 THEN 1180

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1170 GOTO 1100
1180 OUTPUT 10 ; "THE FINAL BARATRON READING = "; P1
1190 GOSUB 4840 ; CLEAR TI'S BUF
1200 OUTPUT 10 ; "Please ENTER the Barometric pressure as read from the"
1210 OUTPUT 10 ; "WALLACE-TIERMAN gage in the Gas Sampling Room"
1220 ENTER 10 USING "%,XX" : B1
1230 OUTPUT 10
1240 OUTPUT 10 ; "Value entered for the BAROMETRIC PRESSURE was "; B1 ; " TORR"
1250 OUTPUT 10 ; "IS THIS CORRECT (Y/N)?"
1260 ENTER 10 USING "%,X" : A5
1270 OUTPUT 10
1280 IF NUM(A5)*85 THEN 1190
1290 OUTPUT 0 ; "DCV4"
1300 ENTER 0 ; P1 ; READ SARA
1310 P1=100*P1
1320 IF ABS(P1-B1)*5 THEN 1370
1330 OUTPUT 10 ; "THE BARATRON IS NOT PROPERLY ADJUSTED"
1340 OUTPUT 10 ; "IT CURRENTLY READS "; P1 ; " TORR, BUT SHOULD READ "; B1 ; " TORR"
1350 GOSUB 4790 ; START ALARM
1360 GOTO 5090
1370 OUTPUT 0 ; "DC1,32" ; CLS V5
1380 OUTPUT 0 ; "DC2,9" ; CLS V11
1390 WAIT 2000
1400 OUTPUT 0 ; "DS1,4" ; OPN V2
1410 BS="C1"
1420 GOSUB 4670 ; BELOW T31 SP?
1430 OUTPUT 0 ; "DC1,4" ; CLS V2
1440 WAIT 2000
1450 OUTPUT 0 ; "DCV4"
1460 ENTER 0 ; P1
1470 P1=100*P1
1480 OUTPUT 10 ; "PRESSURE P1 = "; P1 ; " TORR"
1490 OUTPUT 0 ; "DS1,32" ; OPN V5
1500 GOSUB 4390 ; READ THE SARA
1510 P2=100*R2
1520 OUTPUT 10 ; "PRESSURE P2 = "; P2 ; " TORR"
1530 GOSUB 4840 ; CLR TI'S BUFF
1540 OUTPUT 10 ; "OPEN the MANUAL VALVE nearest the bottle on 500cc BOTTLE A"
1550 OUTPUT 10 ; "Press the 'RTN' key when that VALVE is OPENED"
1560 ENTER 10 USING "%,XK" : K5
1570 IF K5*CHR$(13) THEN 1530
1580 GOSUB 4390 ; READ THE SARA
1590 P3=100*R2
1600 OUTPUT 10 ; "PRESSURE P3 = "; P3 ; " TORR"
1610 GOSUB 4840 ; CLR TI'S BUFF
1620 OUTPUT 10 ; "CLOSE the MANUAL VALVE nearest the bottle on 500cc BOTTLE A"
1630 OUTPUT 10 ; "Press the 'RTN' key when the VALVE is CLOSED"
1640 ENTER 10 USING "%,XK" : K5
1650 IF K5*CHR$(13) THEN 1610
1660 GOSUB 4840
1670 OUTPUT 10 ; "Now, OPEN the VALVE nearest the bottle ON 500cc BOTTLE B"
1680 OUTPUT 10 ; "Press the 'RTN' key when that VALVE is OPENED"
1690 ENTER 10 USING "%,XK" : K5
1700 IF K5*CHR$(13) THEN 1660
1710 GOSUB 4390 ; READ THE SARA
1720 P4=100*R2
1730 OUTPUT 10 ; "PRESSURE P4 = "; P4 ; " TORR"
1740 OUTPUT 0 ; "DC1,32" ; CLS V5
1750 WAIT 2000

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770 GOSUB 4640
1760 OUTPUT 10 : "Please OPEN ALL MANUAL VALVES on BOTH 500cc bottles"
1780 OUTPUT 10 : "Press the 'RTN' key when the VALVES are OPEN"
1800 ENTER 10 USING "%,KK" : K$
1810 IF K$=CHR$(13) THEN 1770
1820 BS="21"
1830 OUTPUT 10 : "PUMPING TO ACHIEVE T61 SETPOINT"
1840 GOSUB 4670 : BELOW T61?
1850 OUTPUT D : "DC1,4" : CLS V2
1860 GOSUB 4840
1870 OUTPUT 10 : "Please CLOSE the MANUAL VALVES nearest the bottle on BOTH"
1880 OUTPUT 10 : "500cc bottles. Press the 'RTN' key when the VALVES are CLOSED"
1890 ENTER 10 USING "%,KK" : K$
1900 IF K$=CHR$(13) THEN 1850
1910 WAIT 3000
1920 OUTPUT D : "DS1,22" : OPN V5
1930 GOSUB 4390 : READ THE BARA
1940 P5=100*R2
1950 OUTPUT 10 : "PRESSURE P5 = :P5: TORR"
1960 GOSUB 4840
1970 OUTPUT 10 : "Please OPEN the VALVE nearest the bottle on 500cc BOTTLE A"
1980 OUTPUT 10 : "Press the 'RTN' key when that VALVE is OPEN"
1990 ENTER 10 USING "%,KK" : K$
2000 IF K$=CHR$(13) THEN 1950
2010 GOSUB 4390 : READ THE BARA
2020 P6=100*R2
2030 OUTPUT 10 : "PRESSURE P6 = :P6: TORR"
2040 GOSUB 4840
2050 OUTPUT 10 : "Now, CLOSE the VALVE nearest the bottle on BOTTLE A,"
2060 OUTPUT 10 : "and OPEN the VALVE nearest the bottle on BOTTLE B."
2070 OUTPUT 10 : "Press the 'RTN' key when finished"
2080 OUTPUT 10 @ OUTPUT 13 @ OUTPUT 10
2090 ENTER 10 USING "%,KK" : K$
2100 IF K$=CHR$(13) THEN 2040
2110 GOSUB 4390
2120 P7=100*R2
2130 OUTPUT 10 : "PRESSURE P7 = :P7: TORR"
2140 GOSUB 4840
2150 OUTPUT 10 : "Now, please OPEN ALL the MANUAL VALVES on BOTH"
2160 OUTPUT 10 : "the 500cc bottles. Press the 'RTN' key when VALVES are OPEN"
2170 ENTER 10 USING "%,KK" : K$
2180 IF K$=CHR$(13) THEN 2140
2190 OUTPUT D : "DC1,32" : CLS V5
2200 WAIT 1000
2210 OUTPUT D : "DS1,4" : OPN V2
2220 BS="21"
2230 OUTPUT 10 : "PUMPING TO ACHIEVE T61 SETPOINT"
2240 GOSUB 4670
2250 GOSUB 4840
2260 OUTPUT 10 : "Please CLOSE the MANUAL VALVES nearest the bottle on BOTH"
2270 OUTPUT 10 : "500cc bottles. Press the 'RTN' key when the VALVES are CLOSED"
2280 ENTER 10 USING "%,KK" : K$
2290 IF K$=CHR$(13) THEN 2250
2300 OUTPUT D : "DC1,4" : CLS V2
2310 WAIT 1000
2320 OUTPUT D : "DS1,32" : OPN V5
2330 WAIT 1000
2340 OUTPUT D : "DS2,9" : OPN V11
2350 OUTPUT D : "DCV4"

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2370 R1=100*R1
2380 OUTPUT 10 ; "WAITING FOR SEAPATRON READING TO STABILIZE. CURRENT READING = ";
R1; " TORR"
2390 WAIT 10000
2400 OUTPUT 0 ; "DCV4"
2410 ENTER 0 ; 21
2420 Z1=100*Z1
2430 IF ABS(Z1-R1) .: THEN 2460
2440 R1=Z1
2450 GOTO 2380
2460 OUTPUT 10 ; "THE FINAL SEAPATRON READING = ";P1
2470 OUTPUT 0 ; "DC1,32" ; CLS V5
2480 OUTPUT 0 ; "DC2,8" ; CLS V11
2490 WAIT 2000
2500 OUTPUT 0 ; "DS1,4" ; OPN V2
2510 BS="21"
2520 OUTPUT 10 ; "PUMPING TO ACHIEVE T51 SETPOINT"
2530 OUTPUT 10
2540 GOSUB 4670
2550 OUTPUT 0 ; "DC1,4" ; CLS V2
2560 WAIT 2000
2570 OUTPUT 0 ; "DCV4"
2580 ENTER 0 ; 21
2590 Z1=100*Z1
2600 OUTPUT 10 ; "PRESSURE P11 = ";Z1; " TORR"
2610 OUTPUT 10
2620 OUTPUT 0 ; "DS1,32" ; OPN V5
2630 GOSUB 4390
2640 Z2=100*R2
2650 OUTPUT 10 ; "PRESSURE P12 = ";Z2; " TORR"
2660 GOSUB 4840
2670 OUTPUT 10 ; "OPEN the MANUAL VALVE nearest the bottle on 500cc BOTTLE A"
2680 OUTPUT 10 ; "Press the 'RTN' key when that VALVE is OPENED"
2690 ENTER 10 USING "%,%K" ; K5
2700 IF K5*CHR$(13) THEN 2660
2710 GOSUB 4390 ; READ THE BARA
2720 Z3=100*R2
2730 OUTPUT 10 ; "PRESSURE P13 = ";Z3; " TORR"
2740 GOSUB 4840 ; CLR T1'S BUFF
2750 OUTPUT 10 ; "CLOSE the MANUAL VALVE nearest the bottle on 500cc BOTTLE A"
2760 OUTPUT 10 ; "Press the 'RTN' key when the VALVE is CLOSED"
2770 ENTER 10 USING "%,%K" ; K5
2780 IF K5*CHR$(13) THEN 2740
2790 GOSUB 4840
2800 OUTPUT 10 ; "Now, OPEN the VALVE nearest the bottle on 500cc BOTTLE B"
2810 OUTPUT 10 ; "Press the 'RTN' key when that VALVE is OPENED"
2820 ENTER 10 USING "%,%K" ; K5
2830 IF K5*CHR$(13) THEN 2790
2840 GOSUB 4390 ; READ THE BARA
2850 Z4=100*R2
2860 OUTPUT 10 ; "PRESSURE P14 = ";Z4; " TORR"
2870 OUTPUT 0 ; "DC1,32" ; CLS V5
2880 WAIT 2000
2890 OUTPUT 0 ; "DS1,4" ; OPN V2
2900 GOSUB 4840
2910 OUTPUT 10 ; "Please OPEN ALL MANUAL VALVES on BOTH 500cc bottles"
2920 OUTPUT 10 ; "Press the 'RTN' key when the VALVES are OPEN"
2930 ENTER 10 USING "%,%K" ; K5
2940 IF K5*CHR$(13) THEN 2900

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2950 OUTPUT 10 : "PUMPING TO ACHIEVE TSI SETPOINT"
2970 GOSUB 4670 : BELOW TSI?
2980 OUTPUT 0 : "OC1,4" : CLS V2
2990 GOSUB 4840
3000 OUTPUT 10 : "Please CLOSE the MANUAL VALVES nearest the bottle on BOTH"
3010 OUTPUT 10 : "500cc bottles. Press the 'RTN' key when the VALVES are CLOSED"
3020 ENTER 10 USING "%,XK" : P$
3030 IF K$=CHR$(13) THEN 3090
3040 WAIT 3000
3050 OUTPUT 0 : "DS1,32" : CPN V5
3060 GOSUB 4390 : READ THE BARA
3070 Z5=100*R2
3080 OUTPUT 10 : "PRESSURE P15 = :Z5: TORR"
3090 GOSUB 4840
3100 OUTPUT 10 : "Please OPEN the VALVE nearest the bottle on 500cc BOTTLE A"
3110 OUTPUT 10 : "Press the 'RTN' key when that VALVE is OPEN"
3120 ENTER 10 USING "%,XK" : K$
3130 IF K$=CHR$(13) THEN 3090
3140 GOSUB 4390 : READ THE BARA
3150 Z6=100*R2
3160 OUTPUT 10 : "PRESSURE P16 = :Z6: TORR"
3170 GOSUB 4840
3180 OUTPUT 10 : "Now, CLOSE the VALVE nearest the bottle on BOTTLE A,"
3190 OUTPUT 10 : "and OPEN the VALVE nearest the bottle on BOTTLE B."
3200 OUTPUT 10 : "Press the 'RTN' key when finished"
3210 OUTPUT 10 : 0 OUTPUT 10 : 0 OUTPUT 10
3220 ENTER 10 USING "%,XK" : P$
3230 IF K$=CHR$(13) THEN 3170
3240 GOSUB 4390
3250 Z7=100*R2
3260 OUTPUT 10 : "PRESSURE P17 = :Z7: TORR"
3270 OUTPUT 0 : "OC1,24" : CLS V3, AND V4
3280 OUTPUT 0 : "WRT1,230" : CPN : 1,2,3,6,7
3290 OUTPUT 0 : "WRT2,2" : CPN 8,9
3300 OUTPUT 10 : "Please REMOVE the two 500cc bottles and INSTALL two"
3310 OUTPUT 10 : "500cc bottles in their place"
3320 : ***** CALCULATIONS *****
3330 X1=V1*P2*P3/(P1*(P2-P3))
3340 X2=V2*P2*P4/(P1*(P3-P4))
3350 X3=V1*P5*P6/(P4*(P5-P6))
3360 X4=V2*P5*P7/(P4*(P6-P7))
3370 X5=V1*Z2*Z3/(Z1*(Z2-Z3))
3380 X6=V2*Z2*Z4/(Z1*(Z3-Z4))
3390 X7=V1*Z5*Z6/(Z4*(Z5-Z6))
3400 X8=V2*Z5*Z7/(Z4*(Z6-Z7))
3410 X9=X1+X2+X3+X4+X5+X6+X7+X8
3420 A1=X9/8
3430 Q1=X1^2+X2^2+X3^2+X4^2+X5^2+X6^2+X7^2+X8^2
3440 S1=((Q1-X9^2/8)/7)^.5 : THIS IS THE STD DEV
3450 L1=S1*(1.96*(8-1.69)/(8-2.08)) : THIS IS LE X
3460 L2=L1/8^1.5 : THIS IS LE X BAR
3470 L3=100*(L1/A1) : % LE
3480 L4=100*(L2/A1) : % LE X BAR
3490 P1=.01*INT(100*P1)
3500 P2=.01*INT(100*P2)
3510 P3=.01*INT(100*P3)
3520 P4=.01*INT(100*P4)
3530 P5=.01*INT(100*P5)
3540 P6=.01*INT(100*P6)

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3550 Z1=.01*INT(100*Z1)
3570 Z2=.01*INT(100*Z2)
3590 Z3=.01*INT(100*Z3)
3590 Z4=.01*INT(100*Z4)
3600 Z5=.01*INT(100*Z5)
3610 Z6=.01*INT(100*Z6)
3620 Z7=.01*INT(100*Z7)
3630 X1=.01*INT(100*X1)
3640 X2=.01*INT(100*X2)
3650 X3=.01*INT(100*X3)
3660 X4=.01*INT(100*X4)
3670 X5=.01*INT(100*X5)
3680 X6=.01*INT(100*X6)
3690 X7=.01*INT(100*X7)
3700 X8=.01*INT(100*X8)
3710 A1=.01*INT(100*A1)
3720 S1=.01*INT(100*S1)
3730 L3=.01*INT(100*L3)
3740 L4=.01*INT(100*L4)
3750 ! ***** PRINT REPORT *****
3760 FOR I=1 TO 5
3770 OUTPUT 10
3780 NEXT I
3790 OUTPUT 10 ; "THE 50cc BOTTLE DATA IS:"
3800 OUTPUT 10 ; "BOTTLE # VOLUME = ";V1;" cc
3810 OUTPUT 10 ; "BOTTLE # VOLUME = ";V2;" cc
3820 OUTPUT 10
3830 OUTPUT 10 ; "MEASURED PRESSURES:"
3840 OUTPUT 10 ; "PRESSURE P1 = ";P1;" TORR
3850 OUTPUT 10 ; "PRESSURE P3 = ";P3;" TORR
3860 OUTPUT 10 ; "PRESSURE P5 = ";P5;" TORR
3870 OUTPUT 10 ; "PRESSURE P7 = ";P7;" TORR"
3880 OUTPUT 10
3890 OUTPUT 10 ; "PRESSURE P11 = ";Z1;" TORR
3900 OUTPUT 10 ; "PRESSURE P13 = ";Z3;" TORR
3910 OUTPUT 10 ; "PRESSURE P15 = ";Z5;" TORR
3920 OUTPUT 10 ; "PRESSURE P17 = ";Z7;" TORR"
3930 OUTPUT 10
3940 OUTPUT 10 ; "CALCULATED VOLUMES:"
3950 OUTPUT 10 ; "MEASUREMENT 1 = ";X1;" cc
3960 OUTPUT 10 ; "MEASUREMENT 3 = ";X3;" cc
3970 OUTPUT 10 ; "MEASUREMENT 5 = ";X5;" cc
3980 OUTPUT 10 ; "MEASUREMENT 7 = ";X7;" cc
3990 OUTPUT 10
4000 OUTPUT 10 ; "LIMIT OF ERROR ON THE VOLUME (LE X) = ";L3;" PERCENT"
4010 OUTPUT 10
4020 OUTPUT 10 ; "CALCULATED AVERAGE VOLUME = ";A1;" cc WITH A STANDARD DEVI
ATION OF ";S1
4030 OUTPUT 10 ; "LIMIT OF ERROR ON THE AVERAGE VOLUME (LE Xbar) = ";L4;" PERCENT"
4040 !
4050 !
4060 !
4070 FOR I=1 TO 5
4080 OUTPUT 10
4090 NEXT I
4100 GOSUB 4840
4110 OUTPUT 10 ; "When the 50cc bottles have been INSTALLED, Press the 'RTN' key"

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4120 OUTPUT !0
4130 ENTER !0 USING "%,KK"; K$
4140 IF K$=CHR$(13) THEN 4100
4150 OUTPUT 0 ; "WRT1,30" ; OPN 1,2,3,4 AND CLS 5,6,7
4160 BS="26"
4170 OUTPUT !0 ; "PUMPING TO ACHIEVE T92 SETPOINT"
4180 OUTPUT !0
4190 GOSUB 4670
4200 OUTPUT !0 ; "WAITING 10 MINUTES BEFORE NEXT OPERATION"
4210 WAIT 600000
4220 OUTPUT 0 ; "WRT1,0"
4230 OUTPUT 0 ; "WRT2,0"
4240 OUTPUT 0 ; "WRT1,30" ; OPN 2,3,4 AND CLS 1,5,6,7
4250 OUTPUT 0 ; "WRT2,3" ; OPN 8,9
4260 OUTPUT !0 ; "WAITING 30 SECONDS BEFORE NEXT OPERATION"
4270 WAIT 30000
4280 GOSUB 4490 ; 15 MIN LEAK TEST
4290 OUTPUT 0 ; "WRT1,62" ; OPN 1,2,3,4,5
4300 GOSUB 4840
4310 OUTPUT !0 ; "Please OPEN BOTH the MANUAL VALVES on BOTH the 50cc bottles"
4320 OUTPUT !0 ; "Press the 'STN' key when the VALVES have been OPENED"
4330 ENTER !0 USING "%,KK"; K$
4340 IF K$=CHR$(13) THEN 4300
4350 OUTPUT !0
4360 OUTPUT !0 ; "TEST IS COMPLETE PROGRAM CONTROL HAS ENDED"
4370 OUTPUT !0 @ OUTPUT !0 @ OUTPUT !0 @ OUTPUT !0
4380 STOP
4390 ; ***** READ BARATRON *****
4400 OUTPUT !0 ; "WAITING FOR BARATRON READING TO STABILIZE"
4410 OUTPUT 0 ; "OCV4"
4420 ENTER 0 ; R1
4430 WAIT 3000
4440 OUTPUT 0 ; "OCV4"
4450 ENTER 0 ; R2
4460 IF ABS(R2-R1)>.0001 THEN RETURN
4470 R1=R2
4480 GOTO 4430
4490 ; ***** 2d LEAK TEST *****
4500 OUTPUT 0 ; "OCV5"
4510 ENTER 0 ; T9
4520 T9=1000*T9
4530 OUTPUT !0 ; "PERFORMING A 15 MINUTE PRESSURE RISE LEAK TEST"
4540 OUTPUT !0 ; "INITIAL PRESSURE IS ";T9;" MICRONS"
4550 FOR I=1 TO 15
4560 WAIT 60000
4570 OUTPUT 0 ; "OCV5"
4580 ENTER 0 ; T1
4590 T1=1000*T1
4600 OUTPUT !0 ; I;" MINUTE PRESSURE READING IS ";T1;" MICRONS"
4610 IF ABS(T9-T1)>5 THEN 4640
4620 NEXT I
4630 RETURN
4640 OUTPUT !0 ; "FAILED THE 15 MINUTE PRESSURE RISE LEAK TEST"
4650 GOSUB 4790 ; START ALARM
4660 GOTO 5070
4670 ; SETPOINT TEST
4680 C=1
4690 OS="0117.28s
4700 OUTPUT !1 ; OS
4710 ENTER !1 ; '

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4730 WAIT 10000
4740 C=C+1
4750 IF C<30 THEN 4690
4760 OUTPUT 10 ; "CANNOT PUMP BELOW SETPOINT IN FIVE MINUTES ALLOWED"
4770 GOSUB 4790 ; START ALARM
4780 GOTO 5090
4790 ; START THE ALARM
4800 OUTPUT 0 ; "CLS10"
4810 WAIT 100
4820 OUTPUT 0 ; "OPN10"
4830 RETURN
4840 ; THIS CLEARS THE TI703'S BUFFER
4850 SET TIMEOUT 10;1000
4860 ON TIMEOUT 10 GOTO 4900
4870 ON ERROR GOSUB 5020
4880 ENTER 10 USING "#,B" ; 4
4890 GOTO 4880
4900 SET TIMEOUT 10;0
4910 OFF ERROR
4920 RESET 10
4930 GOSUB 4950 ; SERIAL PORT SETUP
4940 RETURN
4950 ; SERIAL PORT SETUP
4960 CONTROL 10,4 ; 25
4970 CONTROL 10,9 ; 139
4980 CONTROL 10,11 ; 194
4990 CONTROL 10,12 ; 13
5000 CONTROL 10,14 ; 17
5010 RETURN
5020 ; SERIAL PORT ERROR S/R
5030 SET TIMEOUT 10;0
5040 OFF ERROR
5050 ; ERROR # 114 IS BUFFER OVERRUN
5060 IF ERRN=114 THEN RETURN
5070 OUTPUT 10 ; "SERIAL PORT ERROR NUMBER ";ERRN;" OCCURRED AT LINE ";EPRL
5080 STOP
5090 ; ***** SHUTDOWN *****
5100 OUTPUT 0 ; "WRT1,0"
5110 OUTPUT 0 ; "WRT2,0"
5120 OUTPUT 0 ; "WRT1,62"
5130 OUTPUT 0 ; "WRT2,3"
5140 OUTPUT 10 ; "PROGRAM CONTROL IS BEING TERMINATED"
5150 OUTPUT 10 0 OUTPUT 10 0 OUTPUT 10 0 OUTPUT 10
5160 STOP

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APPENDIX E: FLOWCHART FOR MODIFIED THERMAL DECOMPOSITION SOFTWARE

APPENDIX F: HARDWARE DESIGN FOR ENHANCED LTTD WORKSTATION

Note: The material in this appendix corresponds to the detail sections of the Engineering drawing package titled **Enhanced LTTD Workstation**. The Y-12 Engineering drawing numbers associated with this package are E2E92042EA133 through E2E92042EA140 inclusive.

Any discrepancy between the drawing package and the material in this appendix shall be resolved in favor of the drawings.

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Documentation Key, Rev O, REI 980210*

System Cabling

ConnectionDiagram,
CableIdentification

Major Modules

InstrumentCabinetConfiguration1,
InstrumentCabinetConfiguration2,
WirewayAssembly,
ManifoldTerminalBoxPanelAssembly1,
ManifoldTerminalBoxPanelAssembly2,
VacuumManifoldschematic

Other System Documentation

PowerRequirements,
LTTDPartList,
InstrCabAssemblyInstructions,
LTTDFinalAssemblyInstructions

Instrument Cabinet Detail

DigitalOutputTerminalBlockDetail,
DigitalOutputTerminalBlockDetail,
AnalogInputTerminalBlockDetail,
DigitalInputTerminalBlockDetail,
Aux5VDCPowerDistributionDetail,
Aux14VDCPowerDistributionDetail,
RS232InterfaceDetail,
TurbopumpFreqConverterDetail,
CryopumpTemperatureDisplayDetail,
BaratronDisplayDetail,
ConvectorDisplayDetail,
IonGaugeDisplayDetail

Vacuum Manifold Detail

ManifoldSolenoidValveDetail1,
ManifoldSolenoidValveDetail2,
OvenDisableDetail1,
OvenDisableDetail2,
CryopumpCompressorDetail,
CanTemperatureSensorDetail,
ManifoldTemperatureSensorDetail

Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation Connection Diagram, Rev A, REI 980115

Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation Cable Identification, Rev A, REI 980210

Cable 1: Adapter for facility supplied TP Ethernet. Mfg 3COM. VPN 3C-PC-COMBO-CBL. See vendor supplied documentation.

Cable 2: Control cable between Data Acquisition Interface and Data Acquisition Sub Rack. Mfg National Instruments. VPN's SCXI-1349 plus adapter PSIR68-68M. See vendor supplied documentation.

Cable 3: Auxiliary +5 VDC power distribution. See *Auxiliary VDC Power Distribution Detail*.

Cable 4: Digital output signals. See *Digital Output Terminal Block 1 Detail* and *Digital Output Terminal Block 2 Detail*.

Cable 5: Analog input signals. See *Analog Input Terminal Block Detail*.

Cable 6: Digital input signals. See *Digital Input Terminal Block Detail*.

Cable 7: RS232 channels. See *RS232 Interface Detail*.

Cable 8: Digital control signals for manifold valve solenoids. See *Manifold Solenoid Valve Detail*.

Cable 9: Digital disable signal for Grieve oven. See *Oven Disable Detail*.

Cable 10: Digital control signal for cryopump compressor. See *Cryopump Compressor Detail*.

Cable 11: Digital control signal for turbopump frequency converter. See *Turbopump Freq Converter Detail*.

Cable 12: Digital output signals (setpoints) for Cryopump Temperature Monitor. See *Cryopump Temperature Display Detail*.

Cable 13: Analog output signal for cryopump temperature display. See *Cryopump Temperature Display Detail*.

Cable 14: Analog signal for can temperature sensor. See *Can Temperature Sensor Detail*.

Cable 15: Analog signal for manifold temperature sensor. See *Manifold Temperature Sensor Detail*.

Cable 16: Analog output signal for Convectron gauge power supply and display. See *Convectron Display Detail*.

Cable 17: Analog output signal for Convectron gauge power supply and display. See *Convectron Display Detail*.

Cable 18: Analog output signal for thermocouple gauge signal processor. See *Convectron Display Detail*.

Cable 19: Analog output signal for Baratron signal processor. See *Baratron Display Detail*.

Cable 20: Digital output signal (setpoint) from Convectron gauge power supply and display. See *Convectron Display Detail*.

Cable 21: Digital output signal (setpoint) from Convectron gauge power supply and display. See *Convectron Display Detail*.

Cable 22: Digital output signal (setpoint) from Convectron gauge power supply and display. See *Convectron Display Detail*.

Cable 23: RS232 channel for turbo pump frequency converter. See *Turbopump Freq Converter Detail*.

Cable 24: RS232 channel for ion gauge. See *Ion Gauge Display Detail*.

Cable 25: Power and control cable for connecting turbo pump and frequency converter. Mfg Pfeiffer Vacuum Technology. VPN TCP015-TPD 022/TMBVU 064/065.

Cable 26: Cryopump base set. Mfg Ebara Technologies. VPN 563-121.

Cable 27: Cryopump temperature sensor cable. Mfg Ebara Technologies. cable for VPN 917-0085.

Cable 28: Sensor cable for Convectron gauge #1. Mfg Granville-Phillips. VPN 275075.

Cable 29: Sensor cable for Convectron gauge #2. Mfg Granville-Phillips. VPN 275075.

Cable 30: Sensor cable for Convectron gauge #3. Mfg Granville-Phillips. VPN 275075.

Cable 31: Sensor cable for Baratron. Mfg MKS Instruments. VPN CB-270-2-20.

Cable 32: Sensor cable for Ion gauge. Mfg Vacuum Technology Distribution. VPN L6440325-DGCIII.

Cable 33: Control cable for Oven Disable Relay. See *Oven Disable Detail*.

Cable 34: Control cable for Cryopump Enable Relay. See *Cryopump Compressor Detail*.

Cable 35: Control cable for Manifold Solenoid Relay. See *Manifold Solenoid Valve Detail*.

Cable 36: +24VDC power and power sense cable. See *Manifold Terminal Box Panel Assembly*.

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Instrument Cabinet Configuration, Sheet 1 of 2, Rev A, REI 970815*

Front View

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Instrument Cabinet Configuration, Sheet 2 of 2, Rev A, REI 980815*

Rear View

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Wireway Assembly, Rev O, REI 970711*

Parts List for 2.5x2.5 "Lay in" Wireway

90 degree elbow, Hoffman F-22LE9A, 2 ea
 6" straight section, Hoffman F-22L06, 1 ea
 12" straight section, Hoffman F-22L12, 2 ea
 36" straight section, Hoffman F-22L60, 1 ea
 telescope sect. (1-7"), Hoffman F-22LA, 2 ea
 flat sealing plate, Hoffman F-22LSGQR, 2 ea pkg(5)
 90 deg. sealing plate, Hoffman F-22LSAG, 1 ea pkg(5)
 box connector, Hoffman F-22LB, 3 ea

Wireway Cross-section Detail

B - Baratron Sensor Cable - OD 1/2"
 GP - Granville-Phillips Sensor Cable (3 ea) - OD 1/4"
 IC - Perkin Elmer Ion Gauge Sensor Cable - OD 1/4"
 TP - Pfeiffer TurboPump Control Cable - OD 1/2"
 TC - Type "J" Thermocouple Wire - OD 1/8"
 RTD - RTD Cable - OD 1/8"
 CT - Cryopump Temperature Sensor Cable - OD 1/4"
 DC - Digital Control Cable - OD 3/4"
 24V - 24VDC Power Cable - OD 1/4"
 SP - Spare shielded pair wires - OD 1/4"

**Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Manifold Terminal Box Panel Assembly, Sheet 1 of 2 , Rev A, REI 980204**

See notes 1 - 13 on sheet 2
for assembly instructions.

**Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Manifold Terminal Box Panel Assembly, Sheet 2 of 2 , Rev A, REI 980115**

- Note 1: Mounting plate is 0.08 aluminum, 14.75x12.58
 Note 2: Standoff spacing is 14.25x12.27
 Note 3: Label all terminal blocks and relays as shown.
 Note 4: All terminal connections labeled +24VDC are bussed and connected to +24VDC via the +24 volt power supply cable (cable #36).
 Note 5: All terminal connections labeled GND are bussed and connected to +24VDC return via the +24 volt power supply cable (cable #36).
 Note 6: Terminal blocks are Allen-Bradley modular NEMA/IEEMAC series.
 Blocks: 1492-F1
 Ends: 1492-N18
 Rails: 1492-N1
 Marking Strips: 1492-N4
 Note 7: Cryopump relay/ relay socket are Allen-Bradley 700HC14Z24 and 700HN128 respectively. (24V coil)
 Note 8: Mechanical pump power sense relay/ relay socket are Allen-Bradley 700HC14A1 and 700HN128 respectively. (110VAC coil)
 Note 9: Make manifold solenoid connections per detail drawings.
 See *DigitalOutputTerminalBlock1Detail*
 See *DigitalOutputTerminalBlock3Detail*
 See *ManifoldSolenoidValveDetail* Sheets 1 & 2
 Note 10: Make oven disable connections per detail drawings.
 See *DigitalOutputTerminalBlock2Detail*
 See *OvenDetail*
 Note 11: Make cryopump enable connections per detail drawings.
 See *DigitalOutputTerminalBlock2Detail*
 See *CryopumpCompressorDetail*

- Note 12: The following cables are routed through the manifold terminal box
 • Turbopump power and control cable (#25)
 • Cryopump temperature sensor cable (#27)
 • Can temperature sensor cable (#14)
 • Manifold temperature sensor cable (#15)
 • 3 Convectron gauge sensor cables (#28, #29, #30)
 • Baratron gauge sensor cable (#31)
 • Ion gauge sensor cable (#32)
 Note 13: 110 VAC power cable from the source feeding the mechanical pump enters the manifold terminal box and drives the input of the mechanical pump power sense relay.
 See *ManifoldSolenoidValveDetail* Sheet 2.

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
LTTD Vacuum Manifold Schematic, Rev O, JAB/REC 970922*

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Power Requirements, Rev A, REI 980110*

Instrument Rack

Computer
1P 110VAC 7.0A 100 W
Monitor
1P 110VAC 7.5A 110W
Data Acq. Sub Rack
1P 110VAC 1.35A 100W
CG #1 PS & DISPLAY
1P 110VAC 2.5A 10W
CG #1 PS & DISPLAY
1P 110VAC 2.5A 10W
CG #1 PS & DISPLAY
1P 110VAC 2.5A 10W
Baratron PS & DISPLAY
1P 110VAC .6A 40W
Cryopump Temp Display
1P 110VAC .5A 50W
Turbopump Pres. Converter
1P 110VAC 1A 100W
Ion Gauge PS & DISPLAY
1P 110VAC 7A 750W

5 Volt Power Supply
1P 110VAC .3A max
~10W typ

24 Volt Power Supply
1P 110VAC 3.5A max
~180W typ

Instrument cabinet Heat Dissipation Summary:
1800 Watts
~ 1000/70 sq-in = 14 Watts/sq-in
Instrument cabinet Power Summary:
12 outlets 1P 110VAC, 1.30 Amp circuit

Vacuum Manifold & Grieve Oven

Manifold Valves (13)
No external power
Grieve Oven
3P 460VAC 55A
Roughing Pump
1P 110VAC 6.8A
Turbopump Fan
1P 110VAC 1A
Turbopump
No external power
Cryopump
No external power
Cryopump Compressor
3P 208VAC 20A
Convection Gauge #1
No external power
Convection Gauge #2
No external power
Convection Gauge #3
No external power
Can Temperature Sensor
No external power
Manifold Temperature Sensor
No external power
Baratron Gauge
No external power
Ion Gauge
No external power

Vacuum Manifold/Oven Power Summary:
2 outlets 1P 110VAC, 1.15A circuits
1 outlet 3P 460VAC, 1.55A circuit
1 outlet 3P 208VAC, 1.20A circuit

Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation Instrument Cabinet Assembly Instructions, Rev O, REI 970628

<p>Step 1: Modify 3 ea. Convection sensor cables (vendor supplied) per notes on <i>ConvectionDisplayDetail</i>.</p> <p>Step 2: Prepare and apply 12 labels for cables modified in step 1. The labels are:
TCG1-power, TCG1-sensor-#28, TCG1-Recorder-#16, TCG1-PC1R-#20
TCG2-power, TCG2-sensor-#29, TCG2-Recorder-#17, TCG2-PC1R-#21
TCG3-power, TCG3-sensor-#30, TCG3-Recorder-#18, TCG3-PC1R-#22</p> <p>Step 3: Fabricate Cryopump Temperature cable per notes on <i>CryopumpTemperatureDisplayDetail</i>.</p> <p>Step 4: Fabricate Cryopump Setpoints cable per notes on <i>CryopumpTemperatureDisplayDetail</i>.</p> <p>Step 5: Fabricate Baratron pressure cable per notes on <i>BaratronDisplayDetail</i>.</p> <p>Step 6: Fabricate Turbopump remote control cable per notes on <i>TurbopumpFreqConverterDetail</i>.</p> <p>Step 7: Fabricate Turbopump RS232 cable per notes on <i>TurbopumpFreqConverterDetail</i>.</p> <p>Step 8: Fabricate Ion gauge Rh232 cable per notes on <i>IonGaugeDisplayDetail</i>.</p> <p>Step 9: Fabricate Can temperature sensor cable per notes on <i>CanTemperatureSensorDetail</i>.</p> <p>Step 10: Fabricate Manifold temperature sensor cable per notes on <i>ManifoldTemperatureSensorDetail</i>.</p> <p>Step 11: Fabricate Manifold solenoids, Oven disable and Cryopump enable cables per notes on <i>ManifoldSolenoidValveDetail</i>, <i>OvenDisableDetail</i> and <i>CryopumpCompressorDetail</i>.</p> <p>Step 12: Fabricate mounting bracket for the three Convection gauges per notes on <i>ConvectionRackMountBracketDetail</i>.</p> <p>Step 13: Fabricate mounting bracket for the Baratron display and the Cryopump temperature monitor per notes on <i>BaratronRackMountBracketDetail</i> and <i>CryopumpTemperatureMonitorRackMountBracketDetail</i>.</p> <p>Step 14: Install UL listed AC power strips in instrument rack.</p>	Step 15: Install +5 VDC power supply on rear rail of instrument rack. Step 16: Fabricate +5 VDC power cable per notes on <i>DCPowerDistributionDetail</i>. Step 17: Penetrate top of instrument rack in two places for overhead cable egress. Step 18: Install rack mount computer, keyboard and monitor in instrument rack per <i>InstrumentRackAssemblyDiagram</i>. Step 19: Install Convection gauges, Baratron gauge, Cryopump Temperature Monitor, Ion gauge, and the Turbopump frequency converter in instrument rack per <i>InstrumentRackAssemblyDiagram</i>. Step 20: Install terminal block connections per <i>AnalogInputTerminalBlockDetail</i>, <i>DigitalInputTerminalBlockDetail</i>, <i>DigitalOutputTerminalBlock1Detail</i>, <i>DigitalOutputTerminalBlock2Detail</i> and <i>DCPowerDistributionDetail</i>. Step 21: Install instrument cabinet connections for cables 2, 11,12,13,16,17,18,19,20,21,22,23,24,25,27,28,29,30,31,32.

Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation LTTD Final Assembly Instructions, Rev O, REI 970711

- Step 1: Locate final positions for manifold, instrument cabinet, mechanical pump and cryopump compressor. Bolt manifold to the floor. Set breaks on casters for instrument cabinet and compressor.
- Step 2: Install utilities
- * 1 110VAC 30A circuit for instrument cabinet.
 - * 1 110VAC 15A circuit for mechanical pump, mechanical pump power sense relay and turbopump cooling fan.
 - * 1 3P 203VAC 20A circuit for cryopump compressor.
 - * Cooling water for cryopump compressor (minimum 2 GPM)
 - * 1 3P 440VAC 55A circuit for oven.
 - * 100 psi instrument air for air actuated valves.
- Step 3: Install wireway between instrument cabinet and manifold terminal box.
- * Penetrate top panels in the instrument cabinet and the manifold terminal box at locations determined in the field.
 - * Install wireway.
- See *WirewayAssemblyDetail*
- Step 4: Penetrate bottom of the manifold terminal box for instrumentation cables.
- Step 5: Run cables from instrument cabinet to the manifold terminal box.
- * Bundle, bind and secure cables within the instrument cabinet.
 - * Run cables through wireway.
 - * Bundle, bind and secure instrumentation cables which pass through the manifold terminal box. (Baratron (#31), J Granville-Phillips (#28-29-30), Ion Gauge (#32), Turbo pump (#25), thermocouple (#14), RTD (#15) and cryopump temperature sensor (#27))
 - * Connect instrumentation cables to sensors.
- See *ConnectionDiagram*
See *CableIdentification*
See *WirewayAssemblyDetail*
- Step 6: Make electrical connections for manifold valve solenoids.
- See *ManifoldSolenoidValveDetail1* and *ManifoldSolenoidValveDetail2*
- Step 7: Make electrical connections for cryopump control.
- See *CryopumpCompressorDetail*
- Step 8: Make electrical connections for oven control.
- See *OvenDisableDetail*.

Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Digital Output Terminal Block 1 Detail , Rev O, REI 970711

Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Digital Output Terminal Block 2 Detail , Rev O, REI 970711

Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Analog Input Terminal Block Detail, Rev O, REI 970711

Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Digital Input Terminal Block Detail, Rev O, REI 970711

Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Auxiliary +5 VDC Power Distribution Detail, Rev O, REI 970711

Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Auxiliary +24 VDC Power Distribution Detail, Rev O, REI 980115

Note 1: The Auxiliary +24 VDC power supply is mounted on a rail in the rear of the instrument cabinet.

Note 2: The Auxiliary +24 VDC cable (#36) shall be shielded twisted pair 14 AWG stranded cable twenty five feet long. Label one wire +24 VDC on both ends. Label the other wire +24VDC Return on both ends. Label the outer insulation +24 VDC Power Cable on both ends. Terminate the cable with screw terminations on each end.

**Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
RS232 Interface Detail, Rev O, REI 970711**

Note 1: Turbopump RS232 cable shall be shielded 3 conductor 22 AWG stranded cable eight feet long. Label the cable "Turbopump RS232 #23. Attach one end of the cable to a nine pin female type "D" subminiature connector. Label it COM1. Attach the other end to the vendor supplied connector per the vendor's requirements.

The connections are as follows - "D" connector X5
 jumper D pins 1-4-6 pin 2 <<-----<< X5-D2
 jumper D pins 7-8 pin 3 >>----->> X5-B2
 pin 5 ----- X5-Z2

Note 2: Ion gauge RS232 cable shall be shielded 3 conductor 22 AWG stranded cable eight feet long. Label the cable "Ion gauge RS232 #24. Attach one end of the cable to a nine pin female type "D" subminiature connector. Label it COM2. Attach the other end to a 25 pin male type "D" subminiature connector. Label it COMP. INT.

The connections are as follows - 9pin "D" connector 25 pin "D" connector
 jumper D pins 1-4-6 pin 2 <<-----<< 2
 jumper D pins 7-8 pin 3 >>----->> 3
 pin 5 ----- 7

**Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Turbopump Frequency Converter Detail, Rev O, REI 970711**

Note 1: Vendor supplied drive cable shall be modified to provide reset and start control inputs per vendor instructions - reference Pfeiffer Vacuum GmbH, Operating Instructions TCP 015/TCP 035, Section 1.3.1, "Electrical Connections"

Note 2: Turbopump remote control cable shall be 2 shielded twisted pair 24 AWG stranded cable eight feet long. Label one wire "+" on each pair. Label the other wires "-" on both ends. Label one pair "Shutdown". Label the other pair "Reset". Attach one end of the cable to the vendor supplied connector per the vendor's requirements. Label outer insulation "Turbopump Remote Control #11"

The connections are as follows - Shutdown "+" - X5-Z6
 Reset "+" - X5-B6
 Shutdown "-", Reset "-" and both shields - X5-Z2

Prepare opposite end of cable for terminal block connections.

Note 3: Turbopump RS232 cable shall be shielded 3 conductor 22 AWG stranded cable eight feet long. Label the cable "Turbopump RS232 #23. Attach one end of the cable to a nine pin female type "D" subminiature connector. Label it COM1. Attach the other end to the vendor supplied connector per the vendor's requirements.

The connections are as follows - "D" connector X5
 jumper D pins 1-4-6 pin 2 <<-----<< X5-D2
 jumper D pins 7-8 pin 3 >>----->> X5-B2
 pin 5 ----- X5-Z2

**Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Cryopump Temperature Display Detail, Rev O, REI 970711**

Note 1: User supplied cables for analog and digital outputs shall be constructed per vendor instructions - reference Ebara Technologies Inc. Cryopump Remote Temperature Monitor Operator's Manual, Section 4, "Installation and Operation".

Note 2: Cryopump Temperature cable shall be shielded twisted pair 20 AWG stranded cable eight feet long. Label "Cryopump Temp. #13" on both ends outer insulation. Label one wire of the pair "+" on both ends. Label other wire of the pair "-" on both ends. On one end of the cable terminate the + and - pairs with red and black banana plugs respectively. Terminate the cable shield with the black (-) plug. Prepare opposite end of cable for terminal block connections.

Note 3: Cryopump Setpoints cable shall be three shielded twisted pair 20 or 22 AWG stranded cable eight feet long. Label "Cryopump Setpoints #12" on both ends outer insulation. Label one wire of each pair "COMMON" on both ends. Label other wire of each pair "N.O." on both ends. Label each pair on both ends with "ROOM TEMP", "HIGH TEMP" and "LOW TEMP" respectively. On one end terminate each pair with the vendor supplied connectors. For each pair, the "common" wire goes to pin 2 and the N.O. wire goes to pin 1. Prepare opposite end of cable for terminal block connections.

**Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Baratron Display Detail, Rev O, REI 970711**

Note 1: User supplied cable for analog outputs shall be constructed per vendor instructions - reference MKS Instruments Inc., Instruction Manual MKS Type 270D High Accuracy Signal Conditioner, Chapter 3, "Rear Panel Controls".

Note 2: Baratron pressure cable shall be shielded twisted pair 20 AWG stranded cable eight feet long. Label "Baratron Pressure" on both ends outer insulation. Label one wire of the pair "+" on both ends. Label other wire of the pair "-" on both ends. On one end of the cable terminate the + and - pairs with a 9 pin female type "D" subminiature connector. The connections are as follows - "+" - pin 1
"-" - pin 8
shield - pin 6

Prepare opposite end of cable for terminal block connections.

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Convectron Display Detail, Rev O, REI 970711*

Note 1: Vendor supplied cable shall be modified to provide Recorder and Process Control Outputs per vendor instructions - reference Granville Phillips Series 275 Instruction Manual, Section 3, "Controller Installation Instructions and Precautions", subsections 2-4

Note 2: Recorder Output cable shall be shielded twisted pair 20 AWG stranded cable eight feet long. Label one wire "Recorder Output" on both ends. Label the other wire "Recorder Return" on both ends. Attach one end of the cable to the vendor supplied connector per the vendor's requirements. The connections are as follows - Recorder Output - pin M
Recorder Return - pin N
shield - pin L

Prepare opposite end of cable for terminal block connections.

Note 3: Process Control No. 1 Relay cable shall be shielded twisted pair 20 AWG stranded cable eight feet long. Label one wire "Process Control No. 1 relay common" on both ends. Label the other wire "Process Control No. 1 relay N.O." on both ends. Attach one end of the cable to the vendor supplied connector per the vendor's requirements.

The connections are as follows - PC1R common - pin D
PC1R N.O. - pin E
shield - pin 10

Prepare opposite end of cable for terminal block connections.

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Ion Gauge Display Detail, Rev O, REI 970711*

Note 1: Ion gauge RS232 cable shall be shielded 3 conductor 22 AWG stranded cable eight feet long. Label the cable "Ion gauge RS232 #24. Attach one end of the cable to a nine pin female type "D" subminiature connector. Label it COM2. Attach the other end to a 25 pin male type "D" subminiature connector. Label it COMP. INT.

The connections are as follows - 9pin "D" connector 25 pin "D" connector
jumper D pins 1-4-6 pin 2 <<-----<< 2
jumper D pins 7-8 pin 3 >>----->> 3
pin 5 ----- 7

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Manifold Solenoid Valve Detail, Sheet 1 of 2, Rev O, REI 980210*

Note 1: Manifold Solenoid Relay cable shall be 15 pair, shielded twisted 24 AWG cable eight feet long. For each pair, Label one wire "Vxx" on both ends (where xx is 01 - 15). Label the other wire "+24VDC" on both ends. Label the outer insulation "Vxx" on both ends. Label the entire bundle Manifold Solenoid Relay.

Prepare both ends of each pair for terminal block connections. Wire as shown typically in above drawing for V01 - V11. See sheet 2 for remainder of connections. Bind and tape ends of spares (V14, V15).

Note 2: Manifold Solenoid cable shall be 15 pair, shielded twisted 24 AWG twenty five feet long. For each pair, Label one wire "Vxx" on both ends (where xx is 01 - 15). Label the other wire "GND" on both ends. Label the outer insulation "Vxx" on both ends. Label the entire bundle Manifold Solenoid.

Prepare both ends of each pair for terminal block connections. Wire as shown typically in above drawing for V01 - V11. See sheet 2 for remainder of connections. Bind and tape ends of spares (V13,V14,V15).

Note 3: Install 1N4004 suppression diodes in the body of the Solenoid connectors. The cathode goes to pin 1 and the anode goes to pin 2.

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Manifold Solenoid Valve Detail, Sheet 2 of 2, Rev O, REI 980210*

Note 1: *ManifoldTerminalBoxPanelAssembly* shows the location of the Mechanical Pump Power Sense (MPPS) Relay Socket. This socket is an Allen-Bradley 700HN128 and is used with an Allen-Bradley 700HC14A1 relay (110VAC coil). Connect the relay and the Siemens S14K130 MOV (or equivalent) as shown in the above drawing.

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Oven Disable Detail, Sheet 1 of 2, Rev O, REI 970711*

Note 1: Oven Disable Relay cable shall be shielded twisted pair 20 AWG stranded cable eight feet long. Label one wire "Oven Disable Relay" on both ends. Label the other wire "+24VDC" on both ends. Label the outer insulation "Oven Disable Relay #33" on both ends. Attach one end of the cable to a MS 3106A-14S-9S plug. The connections are as follows:

+24VDC	- pin A
Oven Disable Relay	- pin B

Prepare opposite end of cable for terminal block connections.

Note 2: Modifications to oven control wiring (Ref: The Grieve Corporation, drawing 069058E). Mount a MS 3102A-14S-9P receptacle on the oven terminal box. Mount a Potter-Brumfield 27E122 relay socket on the inside of the oven terminal box and install a Potter-Brumfield KRPA-11DG-24 relay. Per manufacturers instructions, use #16 AWG stranded wire with red insulation for all control wiring connections. Connector pins A & B are connected to relay socket pins 2 and 7 respectively. Label the new wires MOD1 and MOD2 respectively. Disconnect wire 7 (near line 14 on the Grieve ladder diagram) from the "ON" contact of IHS. Reconnect wire 7 to pin 1 of the relay socket. Add the label "MOD3" to wire 7. Connect the "ON" contact of IHS to pin 4 of the relay socket. Label the new wire "MOD4".

Install a 1N4004 power diode on the relay socket with the anode connected to pin 7 and the cathode connected to pin 2.

See sheet 2 of this drawing for additional detail.

Note 3: Oven Disable cable shall be shielded twisted pair 24 AWG stranded cable twenty five feet long. Label one wire "Oven Disable" on both ends. Label the other wire "GND" on both ends. Label the outer insulation "Oven Disable #9" on both ends.

Prepare both ends of the cable for terminal block connections.

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Oven Disable Detail, Sheet 2 of 2, Rev O, REI 970711*

**Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Cryopump Compressor Detail, Rev O, REI 970711**

Note 1: Cryopump Enable Relay cable shall be shielded twisted pair 20 AWG stranded cable one foot long. Label one wire "Cryo Enable Relay" on both ends. Label the other wire "+24VDC" on both ends. Label the outer insulation "Cryo Enable Relay #34". Prepare both ends of cable for terminal block connections. Wire as shown in above diagram.

Note 2: *Manifold/Terminal/Box/Panel Assembly* shows the location of the Cryopump Enable Relay Socket. This socket is an Allen-Bradley 700HN128 and is used with an Allen-Bradley 700HC14Z24 relay. Connect the relay and the 1N4004 power diode as shown in the above drawing.

Note 3: Cryo Remote cable shall be shielded twisted pair 18 AWG stranded cable fifteen feet long. Label one wire "24VAC" on both ends. Label the other wire "24VAC Neutral" on both ends. Label the outer insulation "Cryopump Remote #35" on both ends. Install the vendor supplied connector on one end of the cable. The connections are as follows:

24VAC	- pin 3
GND	- pin 2
24VAC Neutral	- pin 1

Prepare other end of the cable for terminal block connections and connect as shown in the above drawing.

Note 4: Cryo Enable cable shall be shielded twisted pair 24 AWG stranded cable twenty five feet long. Label one wire "Cryo Enable" on both ends. Label the other wire "GND" on both ends. Label the outer insulation "Cryopump Enable #10" on both ends.

Prepare both ends of the cable for terminal block connections and connect as shown in the above drawing.

**Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Can Temperature Sensor Detail, Rev O, REI 970711**

Note 1: Can Temperature Sensor shall be a type J thermocouple (the same sensor used by the oven manufacturer).

The analog input channel shall be connected through type J 20AWG extension grade thermocouple wire (iron:white sheath:+, Constantan:red sheath:-, overall black teflon sheath, -450-500 F (temperature range). There shall be twenty five feet of extension wire terminated by a type J receptacle.

The sensing element shall be a six foot length of Type J 20AWG thermocouple grade wire (iron:white sheath:+, Constantan:red sheath:-, overall brown glass braid, -100to 900 F (temperature range) welded on the sensing end and terminated in a type J plug on the opposite end.

Omega part number for a five pack of pre-made six foot type J thermocouples is STC-GG-J-20-72.

Omega part number for a twenty five foot length of type J 20AWG thermocouple extension wire is EXTT-J-20-SB-T-25

Omega part number for type J thermocouple connectors (plug-receptacle pairs) is OGP-J-MF.

*Enhanced Low Temperature Thermal Decomposition (LTTD) Workstation
Manifold Temperature Sensor Detail, Rev O, REI 970711*

Note 1: Manifold Temperature Sensor shall be a "button" style RTD.

Omega part number RTD-809 is a "button" style RTD with a connector for user cabling.

User cabling shall be a twenty five foot length of 24 AWG three conductor shielded cable. Label the outer insulator "Manifold Temp #19" on each end. Prepare both ends of all three conductors for screw terminations and connect as shown the above drawing. Connect the shield to the terminal block ground lug.