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TECHNICAL MANUAL FOR THE LARGE THERMO-VACUUM FACILITY

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TABLE OF CONTENTS

LARGE THERMO-VACUUM FACILITY

SECTION 1 PLANT DESCRIPTION

SECTION 2 SPECIFICATIONS

SECTION 3 - OPERATING INSTRUCTIONS

SECTION 6 DOCUMENTATION REFERENCE INDEX:

SCOPE OF MANUAL

This manual is intended to provide the user of the LARGE THERMO-VACUUM FACILITY, with the necessary information and procedures to operate and maintain the system.

This manual is to be used with the supporting engineering data pack and catalogue library as indexed in Section 6 of this manual.

SECTION 1

PLANT DESCRIPTION

1. INTRODUCTION

This manual is intended to provide the user with the necessary detail and procedures to operate and maintain the Large Thermo-Vacuum Facility.

The Large Thermo-Vacuum Facility is described under the following headings:

- Vacuum Vessel and Support System
- Thermal System
- Vacuum System
- Main Control and Data Acquisition

Where applicable, reference is made to design drawings, diagrams and component manuals. A complete documentation reference index of all component manuals is provided in Section 6 of the manual.

2. VACUUM VESSEL AND SUPPORT SYSTEM(S)

2.1 GENERAL DESCRIPTION OF VESSEL

The vacuum vessel is shown as detailed in Drawings VTFO-11000-122. The vessel is constructed of 304 stainless steel, with a wall thickness of 20mm. The internal diameter is 4.0m and the total length is 6.07m.

Penetrations in the rear dome (10 off), and front door (4 off) have been provided in the vessel for the nitrogen supply and return lines. In operation, only 8 of the rear penetrations and 2 of the front penetrations will be used, giving a total of 4 spare penetrations. The thermal system is described in paragraph 3.

Vacuum cryopumps are attached at four penetrations equally spaced around the diameter of the vessels shell to provide a homogeneous pressure distribution inside the vessel. The vacuum system is discussed in detail in paragraph 4.

The remaining penetrations in the vessel allow for pressure and temperature measurement inside the vessel, control and experiment cable lead-through and specialist equipment (such as a collimator on the rear dome).

2.2 DOOR CRANE

The door crane is shown in Drawing VTFO-60000-03.

The weight of the door is borne largely by a motorised wheel under the door. When the door is to be opened, the pneumatic door clamps are released and the motorised wheel then drives on a rail (embedded in the floor) about the crane radius, taking the door with it.

The door is supported in the vertical position by the upper arm of the crane.

Clearance is provided at the centre of the crane's axis to allow the flexible pipes (supplying the thermal shrouds mounted in the door, with nitrogen) to move without obstruction.

2.3 TROLLEY AND PALLET

The general layout of the trolley is shown in drawing VTFO-70000-122. Details of the pallet are shown in drawing VTFO-65000-03 and VTFO-65005-02.

The pallet is made of stainless steel and is supported by wheels with Teflon inserts (bushes). The wheels run on machined V-rails along the inside working length of the vessel.

Each rail is supported by 6 struts. These struts pass through the penetration in the thermal shrouds and are fixed to the vacuum vessels.

The trolley has mocked V-rails which match the pallet support rails inside the vessel. When the pallet is to be removed from the vessel, the trolley is moved into position in front of the vessel and the sets of matching rails are linked together. The trolley is then immobilized by support jacks (if fitted) and the pallet is rolled out onto the trolley, which can be released and moved away.

3. THERMAL SYSTEM

3.1 GENERAL DESCRIPTION

The thermal system comprises of the following main components as depicted in the P & I diagram, drawing no: VTFO-30000-05:

- Thermal Generator (refer assembly drawing no. VTFO-30000-03)
  - Nitrogen Injection Vessel (cooling unit)
  - Heater Unit
  - Gas Circulation Fan
  - Flashing Chamber
  - Top Manifold
  - Bottom Manifold
  - Gas Purge and Pressure Control System
  - Shrouds and Space Frame

Each of these main components are described in the paragraphs below and an overview of the operating modes are also given:

3.2 THERMAL GENERATOR

3.2.1 Nitrogen Injection Vessel (Cooler Unit)

The Nitrogen Injection Vessel is shown in drawing VTFO-31000-03. The unit is a pressure vessel manufactured from stainless steel, with a stainless steel outer jacket, the cavity being filled with polyurethane foam. Liquid nitrogen is injected by means of a lance through ten stainless steel nozzles. The nitrogen flow rate is controlled using a proportionally control cryogenic needle valve.

3.2.2 Heater

The heater unit is shown in drawing VTFO-31500-03. The unit is a pressure vessel manufactured from stainless steel, with a stainless steel outer jacket, the cavity being filled with polyurethane foam. The heating elements are able to generate 40kW of energy and are controlled by a thyristor drive.

3.2.3 Gas Circulation Fan

The circulation fan is shown in drawing VTFO-30500-03. This unit consists of a centrifugal fan, with a water cooling system for the motor. The motor and fan are inside the pressure system. The motor is a standard flanged mounted type, and the fan casing shaft and impeller are manufactured from stainless steel, with an outer jacket of stainless steel, the cavity being filled with polyurethane foam. The inlet to the water cooling system is fitted with a solenoid valve, and the outlet with a paddle switch and a thermocouple to monitor water flow and temperature. The fan speed is controlled using a variable speed drive.

3.2.4 Flashing Chamber

The flashing chamber is shown in the assembly drawing VTFO-00000-01. The liquid nitrogen level in the vessel is controlled by measuring the head pressure with a differential pressure transmitter, which operates the liquid nitrogen control injection valve. The valve is a cryogenic needle type, with proportional control.

3.2.5 Top Manifold

The top manifold is shown in the assembly drawing VTFO-00000-01. The unit is a 6 inch stainless steel pipe with a stainless steel outer jacket, the cavity being filled with polyurethane foam. This unit is connected to the following

- The gas circulation fan
- The flashing chamber (upper end)
- The gas purge and pressure control system
- Five cryogenic ball valves, proportionally controlled, each in turn connected to pipework leading from each of the five shrouds.

3.2.6 Bottom Manifold

The bottom manifold is shown in the assembly drawing VTFO-00000-01. This unit is a 6inch stainless steel pipe with a stainless steel outer jacket, the cavity being filled with polyurethane foam. This unit is connected to the following:

- The flashing chamber (Lower end)
- The injection unit (via actuated ball valve no V105)
- Five flanges which are connected to pipework feeding each of the five shrouds.
- An actuated ball valve which has a dual purpose. It is used as a vent during the nitrogen gas purge, and also as a drain valve to remove liquid nitrogen from the system after the flooding mode.

3.2.7 Gas Purge and Pressure Control System

This system consists of a number of valves on a stainless steel T-piece which is connected to the top manifold. These valves are as follows:

- Gas purge valve - the is a solenoid valve which is opened to allow nitrogen gas into the thermal system during the purging cycle.

- Pressure control valve - this is a proportionally controlled ball valve which is used to maintain the thermal system pressure at a predetermined level.

- Manual valve - this is a manual ball valve which can be used in case of emergencies.

- Safety relief valves - there are two safety relief valves, both preset at 6,5 bars (gauge). These will open and maintain the system pressure below safety limits in the unlikely event of a failure of the pressure control system

3.3 SHROUDS AND SPACE FRAME

There are five shrouds, these being housed in the vacuum vessel. These shrouds are shown in drawings VTFO-12500-122. Two of the shrouds are disc shaped and the remaining three are cylindrical. The shrouds may be described as two stainless steel sheets welded together, however with a gap between the sheets. This gap is used for circulating and/or containing liquid and gaseous nitrogen. The shrouds are connected to feeder pipes by means of a large number of small diameter feeder tubes to ensure even distribution of gas flow. The feeder pipes are in turn connected to the top and bottom manifolds via flexible hoses.

The shrouds are supported and held in position by a stainless steel space frame as shown in drawing VTFO-12700-122.

3.4 OPERATING MODES

3.4.1 General

The cryogenic fluid used is nitrogen, both in liquid and gaseous phases. There are two modes of operation, namely:

1) Gaseous mode

Gaseous nitrogen at seven bars (absolute) is recirculated through the shrouds by the gas circulation fan and the nitrogen gas is cooled or heated externally to the test vessel by the cooler and heater units respectively. The shroud temperatures in this mode are controllable from 393 K to 123 K with a transient rate of 1.5 K/minute.

2) Liquid (flooded) mode

In this mode, liquid nitrogen is forced into the shrouds and removes the heat from the shrouds by boiling at atmospheric pressure. This mode is "uncontrolled" with shroud temperatures in the region of 78→88 K.

The spreadsheets of the thermal systems designed performances can be found in the Performance Specification document no: VTFO-00000-62/2.

3.4.2 Gaseous Mode

The system must initially be flushed with gaseous nitrogen (valve V113) to remove air and water vapour.

In operation, the nitrogen gas is recirculated by the centrifugal fan (RF100) which has a variable speed motor (within a water cooled environment). To eliminate seal problems, the fan and motor are both encased in a pressure vessel. The fan speed is controlled by the mean temperature difference across the shrouds, such that this stays within the specified limits (approximately 3 K at steady state, approximately 7,5 K in transient).

The nitrogen stream is cooled by injecting liquid directly into the gas flow (Cu100), and heating by electrical elements in the gas stream (HU100). The injectors and heaters will be controlled by a comparison between the required mean shroud temperature and the actual mean shroud temperature. Flow through the different shrouds will be balanced by valves V100 to V104 which will in turn be controlled by the individual shroud temperatures.

3.4.3 Liquid Mode

The system is filled with liquid nitrogen from the bulk storage tank until the liquid nitrogen covers the shrouds almost completely (measured by pressure sensor PS101). The level is maintained at this position by topping up with liquid nitrogen (through valve V109). As the liquid boils, the gas is vented to atmosphere (valve V106).

With this method of flooding, the shroud wall temperature should stabilize at or lower than 88K.

3.5 THERMAL CONTROL AND INSTRUMENTATION SYSTEM

The control of the thermal system is achieved using a Telemecanique PLC in which a number of dedicated PID loops reside. The thermal control may be broken down into the following sub-sections:

3.5.1. FAN CONTROL.

The fan speed is a function derived directly from the temperature of the gas stream measured below the heater unit HU100. The colder the gas the slower the fan will turn. The warmer the gas, the faster the fan will turn.

3.5.2. HEATER AND COOLER CONTROL.

Both the heater and the cooler are controlled by dedicated PID loops. The required setpoint is input to the PID loop and the process variable is selected from the probes attached to the shrouds. When the system is heating, the system will select the highest temperature as the process variable, and when the system is cooling, the system will select the lowest temperature. During a transient, the setpoint for the system is automatically increased at a rate of 1,5 degrees per minute until the required system temperature is reached.

3.5.3 SHROUD CONTROL.

Fitted to each shroud is a balancing valve and four (4) PT100 probes. Two probes are attached to the inlet of each shroud, and two probes are attached to the outlet of each shroud. A separate PID loop is used to balance each shroud. The average of the inlet probes compared to the average of the outlet probes is kept to within 3 degrees Kelvin using this method. In the event that the difference is greater than 3 degrees Kelvin the balance valve will open more. When the shroud is within the 3 degree limit, the valve will close to a mimimum pre-determined position.

3.5.4 PRESSURE CONTROL.

A Pressure sensor PS100 is fitted to the system and the output of the transducer is input to a Shimanden Loop Controller and to the PLC. The output of the loop controller is connected to valve V106 the pressure control valve. When the system pressure approaches the setpoint level (Approximately 7 Bar absolute) the loopcontroller will open valve V106 proportionally and thus control the system pressure. If the system pressure rises above 7,5 bar absolute, the PLC will automatically close the nitrogen inlet valve and open the drain valve to prevent over-pressurisation.

3.5.5 FLASHING CHAMBER CONTROL.

A Pressure sensor PS101 is fitted to the flashing chamber and the output of the transducer is input to a Shimanden Loop Controller and to the PLC. The output of the loop controller is connected to valve V109 the flashing chamber inlet control valve. When the flashing chamber level approaches the setpoint level (Approximately 2,2 meters water) the loop controller will close valve V109 proportionally and thus control the flashing chamber level.

4. VACUUM SYSTEM

4.1 INTRODUCTION

Drawing VTFO-20000-05 depicts the schematic diagram (P & I) of the vacuum system. The numbering of the various components are as identified in this drawing.

This vacuum system consists of three separate pumping modules namely:

Module One • Fore-vacuum pumping system
Module Two • High-vacuum pumping system

Module Three • Door seal system which also serves as a backing pump for the turbo-molecular pumps when regeneration of the cryogenic pumps are being done.

The three modules are interconnected but are isolated from each other by valves. The reticulation is furthermore arranged in such a way that by-passing of modules is possible. The control of the system is done by means of a Programmable Logic Controller (PLC).

In the following paragraphs each of the above modules and its related control system are described in more detail.

4.2 FORE-VACUUM PUMPING SYSTEM

This is a three-stage rotary mechanical pumping system comprising of:

- One S630F single stage oil sealed rotary valve pump complete with integral oil mist exhaust filter unit (P8). A complete technical description of this pump and oil mist exhaust filter is given in document VTFO-20000-128-09/1 and 2.

- One WSAU/WAU 2001 single stage Roots pump with built-in by-pass valve (P7). A complete technical description of this pump is given in document VTFO-20000-128-08/1.

- One RA7001 single-stage Roots pump (P6). A complete technical description of this pump is given in document VTFO-20000-128-07/1 and 2.

The effective volume flow rate of this system is 7000m3/h. Typically, this system will operate from atmosphere down to pressures in the order of 5X10-4mbar.

The RA 7001 Roots pump has a by-pass valve in order to improve the system conductance, thereby reducing the initial pump down time i.e. during the first evacuation from atmospheric pressure down to about 1 mbar.

The interconnection of the pumps is shown in drawing VTFO-20000-05 and as shown the system is connected to the vacuum vessel through valve V1.

4.3 HIGH-VACUUM PUMPING SYSTEM

This high vacuum pumping system comprised of 4 identical parallel connected pumping systems each consisting of:

- A type RPK 10000 N cryopump with a pumping speed of 1000 l/s (P1 to P4). A complete technical description of this pump is given in document VTFO-20000-128-01/1, 2 and 3.

- A type RGD210 cold head forming an integral part of the cryopump. A complete technical description of this unit is given in document VTFO-20000-128-01/4.

- A helium compressor unit (He1 to He4), for the cryogenic refrigeration of the cold head. A complete technical description of this unit is given in documents VTFO-20000-02/1, 2, 3 and 4.

- A type TURBOVAC 50, (P10 to P13), turbomolecular pump. A complete technical description of this unit is given in document VTFO-20000-05/1, 2 and 3.

The interconnection of the pumps are shown in drawing VTFO-20000-05 and as shown, the cryogenic pumps is mounted directly onto the vacuum vessel.

4.4 DOOR SEAL- AND REGENERATIVE VACUUM PUMPING SYSTEM

Primarily this pump (P5), is used as an integral part of the vessel door sealing mechanism. It also fulfils a secondary role of providing backing pump speed for the four turbomolecular pumps during the regeneration of the cryogenic pumps. This is a type Trivac B; D16B single stage rotary valve pump and is described in document VTFO-20000-128-29/1 and 2.

This pump system connects to the vessel flange through V10 and to the manifold into which the turbomolecular pumps deliver, through valve V9.

4.5 THE VACUUM CONTROL AND INSTRUMENTATION SYSTEM

4.5.1 General

A PLC is used for remote control of the various individual control modules and to capture data measured at various points in the vacuum system.

4.5.2 Door seal and regenerative vacuum pump system

This system is connected via valve V10 to the door seal.

4.5.3 Fore-vacuum pumping system

The fore-vacuum pumping speed is increased at the commencement of pump down by the opening of valve V2 which allows for the by-passing of P6.

Pressure switch PS3 with a SV110 transmitter as well as signals from the Perani head PH4 supply a permit via the PLC to start P6 and to close valve V2 when the chamber pressure has fallen to 1mbar. This allows for maximum pumping speed of the fore-vacuum system.

The vacuum on the vessel side of this system is measured by a Pirani head PH2 while the vacuum at the inlet port of Roots pump P7 is measured by Pirani head PH1.

PH1 will be controlled by the Combitron 351 and PH4 by the Thermovac vacuum instruments. Complete technical descriptions of the Combitron 351 and thermovac are given in document VTFO-20000-128-14/1 and VTFO-20000-128-19/1 and 2.

4.5.4. High-vacuum pumping system

4.5.4.1 Vacuum Measurement

A Pirani, a Penning and a Viscovac Rotor Friction Gauge measuring sensors are mounted on an instrument port on the rear dome of the vessel. This port can be isolated from the vessel with valve V4 interposed between the instrument port and the vessel.

The Penning head reads into the Penningvac channel of the Combitron 351 while the Pirani-head reads into another channel of a Combitron 351 instrument. Pirani-head PH3 mounted on the manifold joining the exhausts of the turbomolecular pumps in the high vacuum system, reads into the second channel of the Thermovac instrument.

The Viscovac Rotor Friction Gauge is a new generation high vacuum measurement system. A complete technical description of this measuring system is given in document VTFO-20000-128-35/1. This is a autonomous system and will be used in parallel to the Penning head/Combitron system.

4.5.4.2 Vacuum pump-control

There are four parallel high-vacuum pump legs in the high-vacuum pumping system, consisting each of a turbo-molecular and a cryogenic pump. The control of the pumps in a typical leg is al follows:

(i) Turbo-molecular pumps.

The turbo-molecular pump is driven by a 3 phase induction motor. A Turbotronik solid state frequency converter is used to power the medium frequency motor in this pump. This unit is switched on remotely by the PLC. A complete technical description of this unit is given in document VTFO-20000-128-06/1.

(ii) Cryogenic pump operation permit.

The Perani PH2 mounted on the instrument port provides a permit for the operation of the Cryogenic pumps via the PLC.

(iii) Cryogenic pump temperature measurement.

The temperature of the cold heads of the cryogenic pumps are measure by Cryotherm LT10 low temperature instruments. Control to the helium refrigerators (He compressors) is done by the PLC. A complete technical description of He units are given in document VTFO-20000-128-04/1.

(iv) Cryogenic pump regeneration heating control.

HU1 heater control units are used for supplying and controlling the electric regeneration heaters of the cryogenic pumps. The heaters are installed directly on the refrigerating stages of the cold heads. Regeneration is controlled locally. A complete technical description of the units are given in document VTFO-20000-128-03/1.

The above mentioned for instrument per "leg" are all mounted inside the high vacuum control panel (HVCP). This panel is mounted on the test vessel; to be as near as possible to the items to be controlled. See complete control system overview.

4.5.5 Residual Gas Analyser

The Residual Gas Analyser (RGA) analyses the rarefied atmosphere in the vacuum vessel. The instrument consists of a sensor which functions only in the high vacuum environment and electronic circuits which operate the sensor and display its output. The sensor analyses the residual gases by ionising some of the gas molecules, separating the resulting ions according to their respective masses, and measuring the quantity of ions at each mass. The masses of the

various ions/species (produced by the sensor) are used to identify the gas molecules from which they were created; the magnitudes of these signals are used to determine the quantities of the respective species.

The information produced by the RGA is an important aid in the efficient use of the high vacuum system for example, indicating the presence of a leak or contaminant in the vacuum atmosphere.

The measuring sensor consists of three parts, namely:

- The ion source (ioniser)
- the analyser (ion filter); and
- the ion detector.

The sensor is mounted on a flange which in turn is bolted to an access port on top of the vessel. A complete technical description of the RGA is given in document VTFO-20000-128-36/1 and 2.

4.5.6 Film Thickness Controller

The Film Thickness Controller (FTC) is a micro balance which measures the mass deposited on the face of an oscillating quartz crystal sensor. This deposited material alters the oscillation frequency and the change in frequency is then related to the mass of material deposited.

The instrument's knowledge of the density of this added material allows the conversion of the mass information into thickness.

A complete technical description of the FTC is given in document VTFO-20000-128-37/1 and 2.

5. MAIN CONTROL AND DATA ACQUISITION SYSTEM

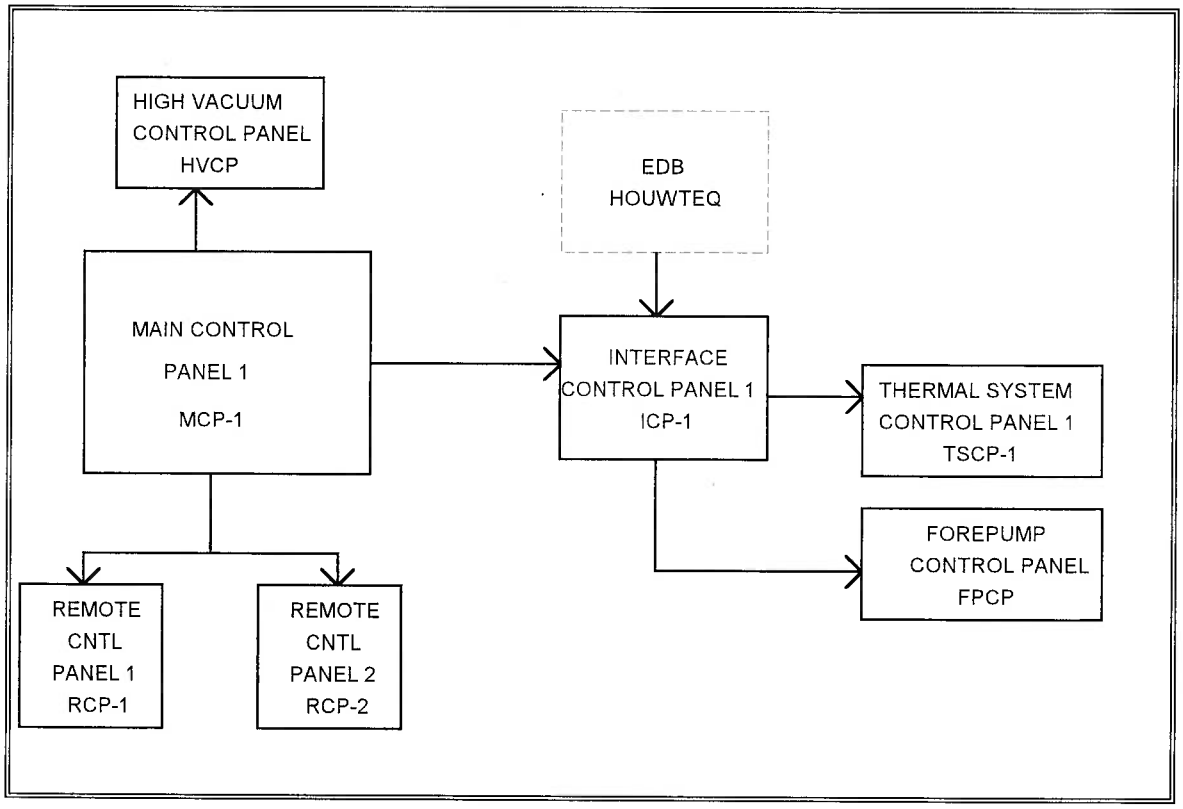
5.1 GENERAL

In the description of the thermal and vacuum systems brief mention was made of PLC control. This section provides more detailed component descriptions of the PLC network which provides control and captures data.

The PLC is connected to a 386 computer via a MAP networking system unique to Telemechanique. The following functions are supported by the PLC:

- Generation of discrete output signals
- Processing of discrete input signals
- Flow control of coolant
- Control of PID loops
- Measurement of temperature
- Measurement of pressure (vacuum)

The interface between the Main Control Panel and other subsystems are shown in the block diagram 1, below:



BLOCK DIAGRAM 1: CONTROL PANEL INTERFACE LAYOUT

5.2 SOFTWARE

5.2.1 Computer

The computer will be driven by a number of software packages namely:

OS/2: This operating system will reside on the computer. This software is described in document VTFO-40000-128-05/1 and 2.

Monitor 77: This program will monitor the process and allow data logging, trending and display a mimic of the system. This software is described in document VTFO-40000-129-21/1 and VTFO-40000-128-22/1 (6.22 PLC).

X-tel: This program will be used to program the PLC. It is important to note that the PLC chosen allows changes to the program to be made.while the PLC is executing the program. This facility must be distinguished from the feature where set points are altered. This software is described in document VTFO-40000-128-17/1.

5.3 HARDWARE

5.3.1 Computer

The computer used is a 386-At (Everex) with a clock speed of 33 MHz, 8 megabytes of RAM, one 102 megabyte hard disc, one 1,2 megabyte floppy drive and one 1,44 megabyte stiffy drive. Document VTFO-40000-128-01/1 and 2 contains the Owner Manual and Reference Guide.

The following hardware are located in, or are connected to the computer:

8120:	This is a high performance 16 bit ATA Floppy/Embedded Hard Disc Adapter. Document VTFO-40000-128-02/1 contains the Owner Manual and Reference Guide.
Viewpoint N1 VGA:	This is a VGA graphics adapter. Installation and User Instructions are contained in document VTFO-40000-128-03/1 (EV-633 Version 1.0)
Mapway Interface BOARD TSX MAP : PC 74	Installation of this board connects the PC to the PLC. Installation and User Instructions are contained in document VTFO-40000-128-12/1 (TSX DM MAP PC7 V4M)
Microsoft Serial Mouse:	It is connected to the serial port of the computer. The users guide contained in document VTFP-40000-128-04/1 describes the operation and installation of the serial mouse.

5.3.2 Programmable Logic Controller (PLC)

Power Supply:	The power supply supplies power to the cards located in the PLC card frame. The power Supply Specifications are listed in document VTFO-40000-128-10/1 (TSX SUP 70 manual)
Processor Module:	The PLC program is stored by the processor module type TSX 67-40. Installation and user instructions are contained in document VTFO-40000-128-06/1 (TSX DM-PR40 TSX model 40)
Discrete Input Card:	Discrete input lines are monitored and read by the 32 channel discrete input card type DET 32 12. Installation and user instructions are contained in document VTFO-40000-128-16/1 (TSX DET 32 12 32 point 24 VDC input module)
Discrete Output Card:	Discrete output lines are controlled by the 32 channel output card type VTFO-40000-128-15/1 (TSX DST 3292 Interface Output Module pamphlet)
Analog Input Signal Processor:	Analog input signals are processed by the AEM 811 8 channel analog input module. Installation and user instructions are contained in document VTFO-40000-128-09/1 and 2 (TSX D23 001E Analog Input Module User's Manual)
Temperature Signal : Processor:	PT100 signals are processed by the 4 channel AM 413 PT100 input card. Installation and user instructions are contained in document VTFO-40000- (TSX D43 727 Temperature Probe Manual)

Analog Output Signal Processor:	Analog output signals are processed by the 4 channel ASR 402 analog output card. Installation and user instructions are contained in document VTFO-40000-128-13/1 (TSX3 D23 007E Analog Output Manual)
Serial Communication Processing:	Serial communication signals are processed by the two channel Signal SCM2011 card. Installation and user instructions are contained in document VTFO-40000-128-07/7 (TSX D43 724 and TSX D23 004 E SCM User's Manual)
Networking Communication Signal Processing:	Networking communication signals are processed by the Mapway ation Network nodule SX MAP 107. Installation and user instructions are contained in document VTFO-40000-128-19/1 and VTFO-40000-128-20/1 (TSX DR MAP V4E and the TSX DM MAP 1074 E manuals)
Screen Terminal:	An XBT-VA compact screen terminal is connected to the Uni-Telway bus on the PLC Installation and user instructions are contained in document VTFO-40000-128-08/1 (TSX D24 004 and XBT VA)

5.3.3 Interface Control Panel (Refer to VTFO-43000-03)

The interface control panel (ICP) is used to connect the PLC discrete signals to the system. The unit functions primarily as a voltage interface and distribution unit. Signals received from the PLC are fuse protected and then either fed directly to the system (24V DC) or control relays and contactors from where the signals are fed to the system. Signals received from the system pass through the ICP where they are fuse protected before being input by the PLC.

The main supply voltages for all the vacuum and thermal system components are switched, isolated and protected via the ICP.

SECTION 2

SPECIFICATIONS

1. INTRODUCTION

This section provides the specification data for all major components of the Large Thermo Vacuum Facility.

The specifications of the vacuum system, vacuum vessel and pallet thermal system and main control/data acquisition system, are given in the tables.

The specifications are given in these tables are for quick reference purposes of the systems, sub-systems and components.

Please note that these tables are not complete in referring to each and every sub-component, etc., but rather concentrate on the overall picture.

The tables are given in the following order:

1. Vacuum system
2. Vacuum vessel and pallet
3. Thermal system
4. Main Control/Data Acquisition System

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM						
NO	**COMPONENT**	**ITEM**	**MODEL**	**DIMENSIONS/ MASS**	**SUPPLIER**	**CAPACITY**
1	FORE VACUUM PUMPS	1. P6 RUVAC Single Stage Roots Vacuum Pump	RA7001 380V 50Hz Motor with coupling & Lantern	870 kg Weight	Leybold	Nominal pumping speed 7470 m^3h^{-1} Max pumping speed with back-up pumps 6800 m^3h^{-1}
		2. P7 WAU 2001 Single Stage ~~Rotary Vane~~ Roots Vacuum Pump	WAU 2001 380V 50Hz	400 kg Weight	Leybold	Nominal pumping speed 2050 m^3h^{-1} Max pumping speed with back-up pumps 1850 m^3h^{-1}
		3. P8 VAROVAC S630F Single Stage Rotary Vane Vacuum Pump	S630F 15KW 380V	600 kg	Leybold	Nominal pumping speed 630 m^3h^{-1} Average pumping speed with back-up pumps 615 m^3h^{-1}
2.	HIGH VACUUM PUMPING SYSTEM	1. 4 x Cryopump	RPK 10000	Overall Height 702 mm, Weight 45kg	Leybold	Pumping speed 10000 ls^{-1} max each
		2. 4 x Thermo Mole-cular Pump	TURBOVAC 50 DN 65 ISOK	Weight 2 kg	Leybold	Pumping speed 30 ls^{-1} each Ultimate pressure 8 x 10^{-9} m bar

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM						
NO	**COMPONENT**	**ITEM**	**MODEL**	**DIMENSIONS/ MASS**	**SUPPLIER**	**CAPACITY**
		3. 4 x Helium Compressor	RW 6000	Weight 64 kg	Leybold	-
3.	DOOR SEAL & REGENERATIVE PUMPING SYSTEM	1. P5 Trivac B Rotary Vane Pump	D16B	Weight 36 kg		Nominal pumping speed 1819 m^3h^{-1} Max pumping speed with back-up pumps 1615 m^3h^{-1} Ultimate total pressure 5 x 10^{-3}m bar
4.	VACUUM MEASURING SYSTEM	1. PEH 1 Penning Measuring Head	Type PR 35	Weight 0,64 kg	Leybold GA 09.303/5	Gas Discharge range, 1 x 10 m^{-9} to10^{-2} mbar Permissable over pressure 10 bar absolute (26 bar testing pressure) Accuracy + 100% - 50% of indicated value. Amdient temp. 120°C. Measurement volume ± 18 cm^3
		2. PH1 - PH4 Perani sensing head	Type TR301	See Catalogue Fig 1 - 2 VTF0-20000-128-16/1	Leybold CAT no GA 09.204/3	Measuring range 10^{-3} - 1000 mbar Supply voltage 18 - 40V Signal 8 - 48 mA Operating temp 0 - 50°C
		3. PS2 + PS3 Pressure switch	Type SM42	See Catalogue VTFO 20000-128-10/2 Weight 1,4kg	Leybold CAT GA 09,600/3	Switching pressure 0,5-6 mbar Measuring volume 220 cm^3 Permissable ambient temp 50°C

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM VESSEL AND PALLET					
COMPONENT	**ITEM**	**MATERIAL**	**DIMENSIONS/MASS**	**TYPE**	**CAPACITY/CHA-RACTERISTICS**
1. VACUUM VESSEL		ASTM 240 304L S/S	a. Internal diameter = 4000 mm b. Overall length = 3810 (included end-domes) = 6070 (included end-domes) Vessel mass = 12,5 ton (include door)	Design and build in accordance with SACIF-ASME VIII DIV 1 addendums 90	a) Hinged door b) Doubble vacuum seal at door opening c) Vacuum leak-tightness better than 5 $x10^{-6}$ m bar d) Total penetrations = 61: 30 penetrations for process control 31 penetrations for experimental pur-poses e) Vessel allows ther-mal shrouds to be removable f) Polish internal sur-face g) Glass bead outer surface

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM VESSEL AND PALLET					
COMPONENT	**ITEM**	**MATERIAL**	**DIMENSIONS/MASS**	**TYPE**	**CAPACITY/CHA-RACTERISTICS**
2. PALLET		304L S/S	3700 length 1835 width		a) Universal bolt down position of experiment b) Slide on wheels c) Open structure for good heat transfer d) Low heat capacity e) 1,5 Ton load carrying capacity (spreaded load)

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
COMPONENT	**ITEM**	**MATERIAL**	**DIMENSIONS/MASS**	**TYPE**	**CAPACITY/CHA-RACTERISTICS**
1. COOLER UNIT	1.1 Pressure vessel	304 S/S	Length 1334 mm Diameter 269 mm	ASME 8 DIV 1	
	1.2 Insulation	Polyurethane	Thickness 112 mm		
	1.3 Outer Jacket	304 S/S	Length 1698 mm Diameter 497 mm		
	1.4 Spray system	304 S/S	Quantity 10	Hollow Cone	0,08 kg/sec; 40 kW
	1.5 Injection valve		1 inch	Proposional, needle pneumatic (Bau-mann)	
2. HEATER UNIT	2.1 Pressure vessel	304 S/S	Length 1549 mm Diameter 407 mm	ASME 8 DIV 1	
	2.2 Insulation	Polyurethane	Thickness 123 mm		
	2.3 Outer Jacket	304 S/S	Length 1588 mm Diameter 650mm		
	2.4 Heating Elements	-	Quantity 15		40 kW Total
3. GAS CIRCULATION FAN (CANNED TYPE)	3.1 Pressure vessel	304 S/S	Length 780 mm Diameter 611 mm	ASME 8 DIV 1	6 bar (abs) working pressure
	3.2 Insulation	Polyurethane	Thickness 125mm		

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM						
COMPONENT	**ITEM**		**MATERIAL**	**DIMENSIONS/MASS**	**TYPE**	**CAPACITY/CHA-RACTERISTICS**
	3.3	Outer jacket	304 S/S	Length 806 mm Diameter 861 mm		
	3.4	Cooling	304 S/S		Parallel flow - once through type. Water cooled safety inter-lock (flow & tempe-rature)	
	3.5	Electrical Motor			Leroy Somer	7,5kW, 2 Pole, 380V controlled by a variable speed drive controller
4. FLASHING CHAMBER	4.1	Pipe	304 S/S	Length 2230 mm Diameter 168 mm		
	4.2	Insulation	Polyurethane	Thickness 121 mm		
	4.3	Outer jacket	304 S/S	Length 2230 mm Diameter 396 mm		
5. TOP MANIFOLD	5.1	Pipe	304 S/S	Length 2570 mm Diameter 160 mm		
	5.2	Insulation	Polyurethane	Thickness 165 mm		

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM						
COMPONENT	**ITEM**		**MATERIAL**	**DIMENSIONS/MASS**	**TYPE**	**CAPACITY/CHA-RACTERISTICS**
	5.3	Outer jacket	304 S/S	Length 2570 mm Diameter 500 mm		
	5.4	Control valves		Quantity 5; 3 inch	Proportional Ball pneumatic (Worcester)	
6. BOTTOM MANI-FOLD	6.1	Pipe	304 S/S	Length 2798 mm Diameter 160 mm		
	6.2	Insulation	Polyurethane	Thickness 165 mm		
	6.3	Outer jacket	304 S/S	Length 2798 mm Diameter 500 mm		
7. GAS PURGE AND PRESSURE CONTROL SYSTEM	7.1	Gas purge valve		½ inch	Solenoid (supplied by Ascoreg)	
	7.2	Safety relief valve		Quantity 2; 1¼ inch	Preset (Bestobell)	6,5 bar (abs)
	7.3	Pressure control valve		3 inch	Proportional, ball, pneumatic (Worcester)	Cryogenic

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
COMPONENT	**ITEM**	**MATERIAL**	**DIMENSIONS/MASS**	**TYPE**	**CAPACITY/CHA-RACTERISTICS**
8. SHROUDS AND SPACE FRAME	8.1 Disc (shroud 1 - door)	304 S/S	Diameter 3650 mm	Hydraulic formed waver welded structure (HWW-Type)	6 bar (abs) working pressure + 120°C to - 195°C
	8.2 Cylindrical (shroud 2 and 4)	304 S/S	Diameter 3407 mm Length 1250 mm		
	8.3 Cylindrical (shroud 3)	304 S/S	Diameter 3590 mm Length 1535 mm		
	8.4 Disc (shroud 5 - rear)	304 S/S	Diameter 3387 mm		
	8.5 Space frame	304 S/S	Diameter 3630 mm Length 3680 mm Mass: without shourds: 1,2 ton with shrouds and pipework: 3,3 ton		
	8.6 Feeder tubes	304 S/S	3/4 inch		
	8.7 Main feeder pipes	304 S/S	4 inch		

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL AND DATA ACQUISITION SYSTEM						
NO	COMPONENT	ITEM	MODEL	DESCRIPTION	SUPPLIER	SPECIFICATION
		refer VTFO -42000-08				
1	PLC CPU UNIT	9	TSX 67420	PROCESSOR UNIT	TELEMECANIQUE	2048 I/0 V4 PLC
2	PLC PSU UNIT	9	TSX SUP702	POWER SUPPLY	TELEMECANIQUE	5VDC + 24VDC
3	PLC RACK UNIT	9	TSX RKN 82	8 SLOT RACK UNIT	TELEMECANIQUE	8 SLOT RACK
4	SERIAL CARD	10	TSX SCM 2011	2 CHANNEL RS232	TELEMECANIQUE	2 CHANNEL RS232 COMMUNICATION CARD
5	SERIAL CARD	10	TSX SCM 2011	2 CHANNEL RS232	TELEMECANIQUE	2 CHANNEL RS232 COMMUNICATION CARD
6	MAPWAY CARD	11	TSXMAP1074	MAPWAY COMS CARD	TELEMECANIQUE	5 M BIT DATA RATE
7	PT100 INPUT CARD	12	TSXAEM413	4 CHANNEL PT100 I/P	TELEMECANIQUE	RANGE -220 TO 880
8	PT100 INPUT CARD	12	TSXAEM413	4 CHANNEL PT100 I/P	TELEMECANIQUE	RANGE -220 TO 880
9	PT100 INPUT CARD	12	TSXAEM413	4 CHANNEL PT100 I/P	TELEMECANIQUE	RANGE -220 TO 880
10	PT100 INPUT CARD	12	TSXAEM413	4 CHANNEL PT100 I/P	TELEMECANIQUE	RANGE -220 TO 880
11	PT100 INPUT CARD	12	TSXAEM413	4 CHANNEL PT100 I/P	TELEMECANIQUE	RANGE -220 TO 880
12	INPUT CARD	14	TSX AEM 811	ANALOG 8 CHANNEL	TELEMECANIQUE	8 CHANNEL 4-20mA INPUT CARD
13	OUTPUT CARD	15	TSX ASR 402	4-20 mA 4 CHANNEL	TELEMECANIQUE	4 CHANNEL 4-20 mA OUTPUT CARD
14	OUTPUT CARD	15	TSX ASR 402	4-20 mA 4 CHANNEL	TELEMECANIQUE	4 CHANNEL 4-20 mA OUTPUT CARD
15	OUTPUT CARD	15	TSX ASR 402	4-20 mA 4 CHANNEL	TELEMECANIQUE	4 CHANNEL 4-20 mA OUTPUT CARD
16	INPUT CARD	16	TSX DET 3212	DISCRETE 24 VDC	TELEMECANIQUE	32 CHANNEL 24 VDC INPUT CARD
17	INPUT CARD	16	TSX DET 3212	DISCRETE 24 VDC	TELEMECANIQUE	32 CHANNEL 24 VDC INPUT CARD
18	OUTPUT CARD	17	TSX DST 3292	DISCRETE 24 VDC	TELEMECANIQUE	32 CHANNEL 100 mA 24 VDC OUTPUT CARD
19	OUTPUT CARD	17	TSX DST 3292	DISCRETE 24 VDC	TELEMECANIQUE	32 CHANNEL 100 mA 24 VDC OUTPUT CARD
20	PLC RACK UNIT	13	TSXRCE860	8 SLOT RACK UNIT	TELEMECANIQUE	8 SLOT RACK

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL AND DATA ACQUISITION SYSTEM						
NO	**COMPONENT**	**ITEM**	**MODEL**	**DESCRIPTION**	**SUPPLIER**	**SPECIFICATION**
21	PSU 24 VOLT	24	VTFM-42035	24 VOLT PSU	IST	24 VDC AT 2 AMP
22	RELAY	25	EMG 10-KSR	24V RELAY	PHOENIX	24V COIL, 6 AMP CONTACTS
23	COMBITRON	21	CM351	VACUUM INST.	LEYBOLD	2 PERANI HEADS, 1 PENNING HEAD AND SERIAL PORT
24	THERMOVAC	22	CM305	VACUUM INST.	LEYBOLD	2 PERANI HEADS AND SERIAL PORT
25	PC	3	EVEREX 386	COMPUTER	HP	386 33 MHZ, 8 MEG RAM, 102 MEG HD
26	MONITOR	1	HP	VGA SCREEN	HP	640*480 RESOLUTION
27	LRX PT100	28	LRX -200 TO 200	3 WIRE PT100 TX	EMMANUEL ELEC.	3 WIRE PT100 4-20 mA TRANSMITTER
		refer VTFO				
28	SDIO CARD	3	IAL4-00014	24 PIN I/O CARD	IST	24 CHANNEL OUTPUT AND INPUT CARD
29	HU100	7	HU1	HEATER UNIT	LEYBOLD	42VAC 1ST STAGE, 24VAC 2ND STAGE
30	HU100	7	HU1	HEATER UNIT	LEYBOLD	42VAC 1ST STAGE, 24VAC 2ND STAGE
31	HU100	7	HU1	HEATER UNIT	LEYBOLD	42VAC 1ST STAGE, 24VAC 2ND STAGE
32	HU100	7	HU1	HEATER UNIT	LEYBOLD	42VAC 1ST STAGE, 24VAC 2ND STAGE
33	CRYOTHERM	6	LTI10	TEMPERATURE INST	LEYBOLD	TYPE "D" SILICON DIODE
34	CRYOTHERM	6	LTI10	TEMPERATURE INST	LEYBOLD	TYPE "D" SILICON DIODE
35	CRYOTHERM	6	LTI10	TEMPERATURE INST	LEYBOLD	TYPE "D" SILICON DIODE
36	CRYOTHERM	6	LTI10	TEMPERATURE INST	LEYBOLD	TYPE "D" SILICON DIODE
37	TURBOTRONIC	4	NT50	POWER SUPPLY	LEYBOLD	POWER SUPPLY FOR TURBO PUMP

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL AND DATA ACQUISITION SYSTEM						
NO	COMPONENT	ITEM	MODEL	DESCRIPTION	SUPPLIER	SPECIFICATION
38	TURBOTRONIC	4	NT50	POWER SUPPLY	LEYBOLD	POWER SUPPLY FOR TURBO PUMP
39	TURBOTRONIC	4	NT50	POWER SUPPLY	LEYBOLD	POWER SUPPLY FOR TURBO PUMP
40	TURBOTRONIC	4	NT50	POWER SUPPLY	LEYBOLD	POWER SUPPLY FOR TURBO PUMP
		refer VTFO -47000-08				
41	TERMINAL	1	XBTVB	OPERATOR DIALOG	TELEMECANIQUE	TERMINAL WITH SINGLE LINE DISPLAY
42	MONITOR	2		RGB/VIDEO MONITOR	PHILIPS	RGB VIDEO MONITOR
		refer VTFO -46000-08				
43	TERMINAL	1	XBTVA	OPERATOR DIALOG	TELEMECANIQUE	TERMINAL WITH MONOCHROME DISPLAY
		Refer VTFO -44000-08				
44	FAN DRIVE	16	VARISPEED 7,5KW	7,5KW VARIABLE SPEED	VARISPEED	3KW 4-20mA 0 TO 6000 RPM

SPECIFICATIONS FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL AND DATA ACQUISITION SYSTEM						
NO	**COMPONENT**	**ITEM**	**MODEL**	**DESCRIPTION**	**SUPPLIER**	**SPECIFICATION**
45	HEATER UNIT	2	PHASECON 45KW	45KW THYRISTOR	PHASECON	8KW 4-20mA
46	ITP CONVERTER	1	4-20mA,20-100KPA	I TO P CONVERTER	EMMANUEL ELEC.	IPT/4-20mA/20-100KPA/20PSI/12-28VDC/FA3[DIN]
47	PID CONTROLLER	17	SHIMANDEN SR24	PID LOOP CONTROLLER	N.I.C.	SR24
48	PID CONTROLLER	18	SHIMANDEN SR24	PID LOOP CONTROLLER	N.I.C.	SR24

SECTION 3

OPERATING INSTRUCTIONS

1. PREPARATION PRIOR TO OPERATION

1.1 GENERAL

When the Thermal-Vacuum System (TV-system) was completely switched off and the door was in an open position for some time, this procedure has to be followed prior to operation of the system. One also assumes that the test equipment is already placed inside the test chamber, and that all signal/control wires to the experiment are coupled and that electrical feed-throughs are vacuum tested.

The pre-operational activities can be divided into "Test Chamber Preparation" and "Control System Start-up".

1.2 TEST CHAMBER PREPARATION

1.2.1 Make sure that the pallet is locked inside the vessel.

1.2.2 Clean the door and vessel flanges thoroughly with Proponol.

1.2.3 Clean the Viton O-Ring on the Vessel flange carefully with Proponol; make sure no solid particles are collected on the O-Ring.

1.2.4 Close the door, make sure the door and vessel flanges meet correctly.

1.2.5 Activate the door clamps. Make sure that the door and vessel flanges close to within acceptable tolerances. The door clamp activation switch can be switched to neutral position, while the clamps remain clamped.

Note:

1. **The system is now ready for evacuation.**
2. **The above switching (1.2.4 and 1.2.5) can only be done when the control system is already running as described in the next paragraph.**

WARNING: Once the vacuum inside the vessel is better than 200 m.bar. (Pressure < 200 m.bar), the clamps must be released to at least a distance of 20mm from the door flange.

1. 3 CONTROL SYSTEM START-UP

The "Start-up" of the control system is done at the Main Control Panel (MCP-1). The detailed procedure is described in paragraph 7 of this section, "Control and Supervisory System, Use of Monitor 77".

2 VACUUM SYSTEM

2.1 GENERAL DESCRIPTION

Once the Test Chamber is prepared and ready for evacuation, the pumping sequence may begin. Basically the sequence can be described as follows:

a) Evacuation:

1) All valves closed and pumps off.

2) Door pump starts to assist door sealing.

3) Fore pump system starts and evacuates chamber.

4) At 5×10^{-2} mbar the turbo pumps start to assist forepump system.

5) The He Compressors start to cool down the cryopumps.

6) At cryopump temperature of 70^{o} K, the forepumps and turbopumps stop.

7) The Test Chamber is now totally isolated from atmosphere.

8) Cryopump temperature drops to a minimum value ($\approx 9 \rightarrow 13^{o}$ K) for maximum pumping speed.

9) An ultimate pressure of 1×10^{-6} mbar and better should be reached.

Once the test is completed and devacuation is required, the basic sequence is as follows:

b) Devacuation: (clean cycle)

1) Switch off High vacuum pumps (He Compressors).

2) Start regeneration of Cryopumps, use Turbo pumps with backing pump function. The reason for this is to pump most of the "contaminants", as collected on the cryopumps, out of the vessel, meaning a cleaner devacuation process.

3) When the pressure in the chamber drops to $\approx 5 \times 10^{-1}$ mbar, the turbo pumps stop and purging of the test chamber with GN_2 starts with the forepumps still running for a pre-set time, continuing with "regeneration" of the cryopumps.

4) After the forepumps stop, GN_2 purging will continue until atmospheric pressure is reached inside the chamber.

5) The door opens slightly when atmospheric pressure inside the chamber is reached and purging of GN_2 will stop.

WARNING: A large quantity of GN_2 will expel from the test chamber with fatal effect to human life.

Note: Depending on the clients requirement, the vessel may be purged with GN_2 up to a pressure of ≈ 200 mbar, from where-on air can be let in by opening of a hand valve.

c) Devacuation (Fast)

Stop the vacuum system (assume system is operating in high vacuum automatic control mode) and switch to manual mode control. Open purging valves and purge till atmospheric pressure is reached inside the chamber.

d) Regeneration of Cryopumps (During high vacuum condition)

Regeneration of the cryopumps is required when one or more of the cold heads are saturated during high vacuum operation. This is done by running the turbo pumps on the cryopump(s) with the cold head heater(s) switched on. The turbo pump/s, need/s assistance of a forepump system.

The specific switching sequence as programmed for evacuation (pump down cycle) and devacuation (turn off) are given below:

(I) EVACUATION (PUMP DOWN CYCLE) PROGRAM SEQUENCE

A limit switch is fitted to the chamber door. The vacuum sequence will not start until the limit switch indicates that the door is closed. As soon as the vacuum sequence is started, the following will happen:

1) Cryopump 1 regeneration starts if compressor 1 is off.
2) Cryopump 2 regeneration starts if compressor 2 is off.
3) Cryopump 3 regeneration starts if compressor 3 is off.
4) Cryopump 4 regeneration starts if compressor 4 is off.
5) Pump 5 is started.
6) Pump 5 timer is started (5 minutes).
7) Pump 8 timer is started (10 seconds).
8) Alarm sounds for five seconds.
9) If pump 5 timer is done, open valve 9. (Connect door system roughing pump system)
10) If pump 5 is running, open valve 10. (Connect door to door pump)
11) If pressure measured by Perani 2>1,8 mB then open Valve 2 (Bypass valve for pump 6).
12) If Valve 4 is closed. then open valve 4 (Connect instrument port to vessel).
13) If Perani 2 pressure is not smaller than perani 4 then open valve 1, else go to step 15. This prevents the system from losing vacuum if the internal pressure is lower than the external pressure. When the forepump pressure is smaller than the chamber pressure, valve 1 will open.
14) If valve 4 is open then open valve 16. (Connects instrument port to the roughing pumps)
15) Open valve 17.(Connect roughing pumps to manifold).
16) If pump 8 timer is done, start pump 8, start pump 7 timer. (10 Seconds)
17) If pump 7 timer is done, start pump 7.
18) If perani 2 smaller 2 mBar, close valve 2, start pump 6 timer.(10 seconds)

* Remove bottom wire in connector block in TSX7 (PLC) before going over to manual mode.

FIGURE 16

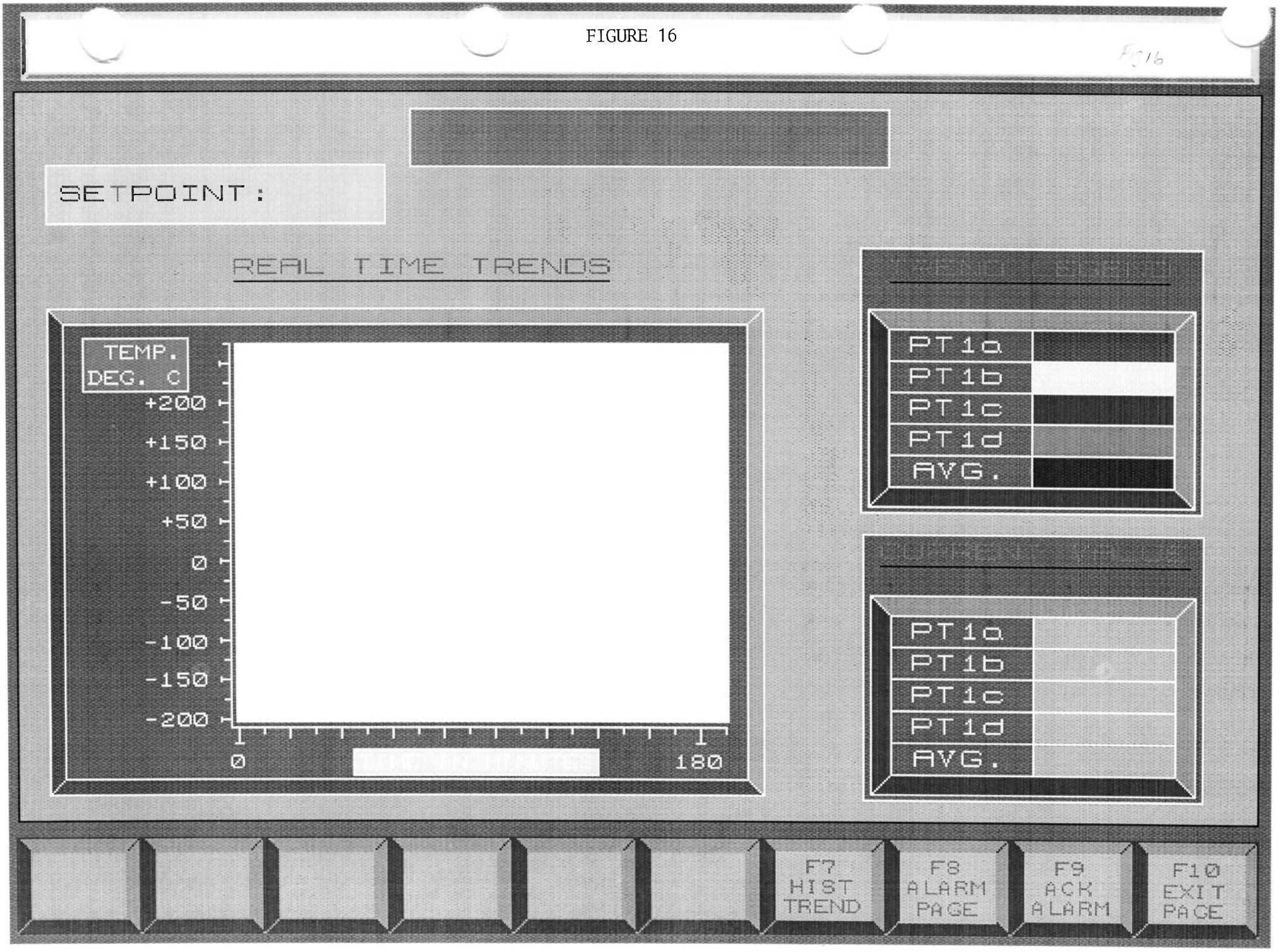
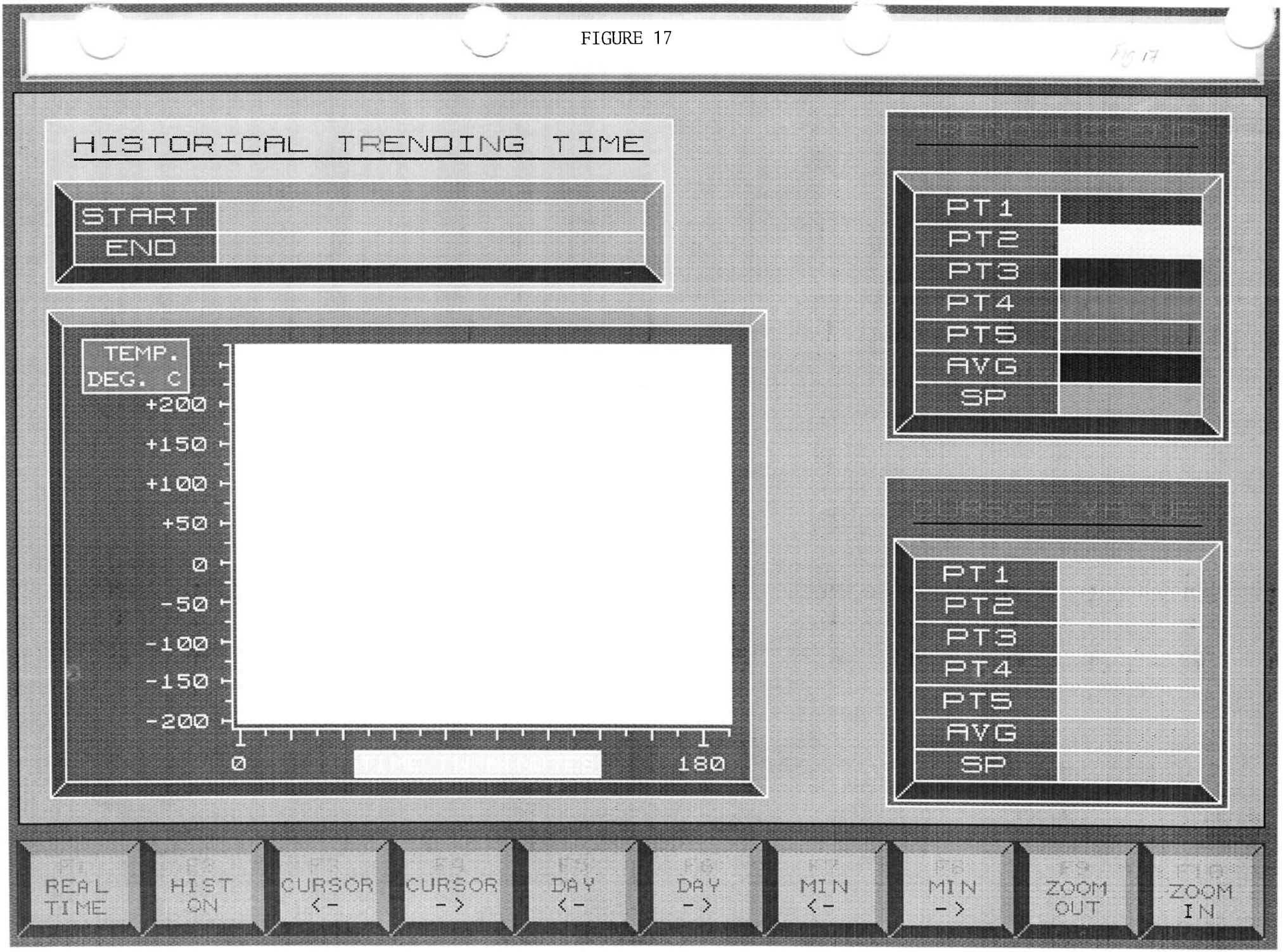

SETPOINT:
REAL TIME TRENDS
TEMP.
DEG. C
+200
+150
+100
+50
0
-50
-100
-150
-200
0
180
PT1a
PT1b
PT1c
PT1d
AVG.
PT1a
PT1b
PT1c
PT1d
AVG.
F7
HIST
TREND
F8
ALARM
PAGE
F9
ACK
ALARM
F10
EXIT
PAGE

FIGURE 17


HISTORICAL TRENDING TIME
START
END
TEMP.
DEG. C
+200
+150
+100
+50
0
-50
-100
-150
-200
0
180
PT1
PT2
PT3
PT4
PT5
AVG
SP
PT1
PT2
PT3
PT4
PT5
AVG
SP
F1
REAL TIME
F2
HIST ON
F3
CURSOR <-
F4
CURSOR ->
F5
DAY <-
F6
DAY ->
F7
MIN <-
F8
MIN ->
F9
ZOOM OUT
F10
ZOOM IN

19) If Perani 2 smaller 1.8 mBar and pump 6 timer is done, start pump 6.
20) If Perani 2 smaller 1*10-2 mBar start turbo pumps and open valves 5 through 8.
21) If Perani 2 smaller than 7*10-3 mBar stop cold head regeneration, and start compressors.
22) If one of the cold head temperatures is smaller than 70 Kelvin, then:
Turn turbo pumps off.
Close valve 5 through 8. (Turbo pump outlet valves).
Close valve 1.(Roughing pumps connection to chamber).
Close valve 16.(Roughing pumps connection to instrument port).
Close valve 17.(Roughing pumps connection to manifold).
Turn pump 6 off.
Turn pump 7 off.
Turn pump 8 off.
23) Chamber is now isolated, and the system will wait for the "STOPVAC" signal.

II) DEVACUATION (TURN OFF) PROGRAM SEQUENCE (CLEAN CYCLE)

On entry to the devacuation sequence, pump 5 is running, and is connected to the manifold as well as the door. When the PLC has received the "STOPVAC" signal, the following will happen:

1) Compressor 1 will stop, cryopump 1 regenerative heaters will turn on.
2) Compressor 2 will stop, cryopump 2 regenerative heaters will turn on.
3) Compressor 3 will stop, cryopump 3 regenerative heaters will turn on.
4) Compressor 4 will stop, cryopump 4 regenerative heaters will turn on.
5) 10 minute regenerative timer will start.
6) System will wait for timer or for pressure to rise above 5*10-3 mBar.
7) Turbo pumps 1 through 4 will start.
8) Valves 5 through 8 will open connecting turbo pumps to pump 5.
9) System will wait for pressure to rise above 5*10-2 mBar.
10) Turbo pumps 1 through 4 will stop.
11) Pump 8 will start.
12) Valve 17 will open. (Connect roughing pumps to manifold).
13) If pressure greater than 1 mBar valve 9 will close.(Disconnect door from roughing pump)
14) Valve 11 will open.
15) Valve 12 will open.
16) Valves 12 and 14 can be adjusted by the operator to control the devacuation time.
17) When the system pressure rises above 100 mBar, pump 7 will start.
18) ~~30 minute pump down timer will start, and sorption trap will~~ turn on. Perani 2 > 300 mbar then
19) ~~System will wait for time~~r.
20) ~~Valve 10 will close.(Disconnect door from pump 5)~~
21) Valve 17 will close.(Disconnect manifold from roughing pumps).
22) Pump 7 will turn off.
23) Pump 8 will turn off.
24) System will wait until door opens.
25) Valves 5 through 8 will close. at 900 mbar
26) Sorption trap will switch off.
27) Regenerative heaters will turn off.
28) Pump 5 will stop. — at 900 mbar & valve 10 will close
28) Valve 11 will close. } at 900 mbar
29) Valve 12 will close.
30) System is now devacuated.

Start vac will reset devacuation & not panic abort
panic abort works in Start vac only.

(III) REGENERATION (DURING HIGH VACUUM CONDITIONS)

Note: **Program sequence steps will be influenced by the clients specific requirements and is therefore not prescribed as a "normal" operating procedure.**

2.2 DETAIL INSTRUCTION

2.2.1 Evacuation

One of the following methods may be used to start the evacuation process:

1. From Monitor 77. On the vacuum menu screen select 'START VAC'
2. On the XBTVA select 'START VACUUM SYSTEM'
3. On the XBTVB select 'START VACUUM SYSTEM'

2.2.2 De-vacuation (Clean Cycle)

One of the following methods may be used to stop the evacuation process:

1. From Monitor 77. On the vacuum menu screen select 'STOP VAC'
2. On the XBTVA select 'STOP VACUUM SYSTEM'
3. On the XBTVB select 'STOP VACUUM SYSTEM'

2.2.3 Regeneration During High Vacuum

This process is done manually.

Fitted to each cryopump is a turbopump. The turbo pump is connected via a valve to the manifold, which in turn is connected to pump 5, the door seal pump during the high vacuum sequence. When the cold head temperature rises above 22 Kelvin, it is an indication that the cryopump must be regenerated. The following sequence is to be followed in order to regenerate a cryopump:

This example will assure that Cryopump 1 is saturated.

1. Open the High Vacuum Control panel, and turn the key switch for turbo pump 1 to the 'manual' position.
2. Open the front panel of the High Vacuum Control panel, and press 'START' on the NT6 control panel marked 'CRYO 1'. The 'START' LED will illuminate. After approximately 30 seconds, the 'RUN' LED will illuminate.
3. From the XBTVA terminal press 'CNTL' and 'INC' simultaneously, if the terminal is NOT in confidential mode.
4. Once the terminal is in confidential mode, select 'MANUAL MODE'.

5. Select 'MANUAL VALVE SELECTION' and open valve V5.

6. Return to the Main Menu, and select 'AUTOMATIC MODE' once this is done.

Note: It is important to return to AUTOMATIC MODE as soon as possible, extended periods in manual mode may upset the thermal control system, if the thermal system is running

.

7. In the High Vacuum Control Panel, switch the heating unit HU100 marked 'CRYO 1' to manual mode.

8. Select the regeneration period required by adjusting the timer on the HU100.

9. The temperature on the cold head will now rise, as indicated by the LT1 marked 'CRYO 1'.

10. When the cryopump has been regenerated, close valve V5 from the XBTVA terminal.

11. When valve 5 is closed, select 'STOP' on NT6 control panel, marked 'CRYO 1'.

12. Return the key switch position to 'AUTOMATIC' for turbopump 1.

13. Regeneration is complete, and CRYO 1 will cool down.

3 THERMAL SYSTEM

3.1 PURGE SYSTEM

3.1.1 General Description

This cycle is used to purge the thermal system of any impurities (e.g. moisture) with nitrogen gas prior to start up. The purging cycle must be initiated in the following circumstances:

- If the system has not been in use for an extended period
- After any maintenance has been carried out, especially if such maintenance involved opening of the thermal system.
- Any chance of getting air/moisture into the system.

Warning : Moisture in the system can cause ice blockages when the system is operating at sub zero temperatures.

The purge cycle consists of four separate sub cycles. Each of these sub cycles purge a different part of the thermal system. The purge cycle starts with an initial status set up for certain components and valves. This is as follows:

COMPONENT		
NO	DESCRIPTION	STATUS
RF 100	Fan	Off
HU 100	Heater	Off
V 107	Cooler Valve	Closed
V 109	Flooding Valve	Closed
V 106	Exhaust/Pressure Control Valve	Closed
V 113	Purge Valve	Closed
V 100 - V 104	Shroud Control Valves	Open
V 105	Main Inline Valve	Closed
V 111	Drain Valve	Open
V 123	Flashing Chamber Valve	Closed
V 128	Pressure Relieve Valve (hand)	Closed
V 130	Fan Purge Valve	Closed

First sub cycle:

The first sub cycle purges both manifolds, the shrouds and all pipework between the manifolds and shrouds. This involves opening valve V 113 for 3 minutes.

Second sub cycle:

The second sub cycle facilitates purging of the flashing chamber by closing valves V 100 - V 104 and opening Valve V 123 for one minute.

Third sub cycle:

The third sub cycle allows purging of the injection unit, heater unit and gas circulation fan. This is done by closing valve V 123 and opening valve V 105. The third sub cycle lasts three minutes after which valve V 111 closes. The system pressure is then allowed to build up to the required set point whereafter valve V 113 is closed. The system is now ready for operation.

All the above sub cycles are automatically initiated from the control desk as described in paragraph 3.1.2 below.

Fourth sub cycle:

The fourth sub cycle allows purging of the fan motor compartment, and is done manually by opening of valve V 130 for one minute. The system is now ready for operation.

3.1.2 Detailed Instructions

1. From the Main Menu in Monitor 77 select the "PROFILE MASK' menu. (F7)
2. From within the profile mask menu, select the purge function. (F2)
3. The system will now purge automatically as detailed in the purge mode flow diagram.

Note: The high alarm level on the system pressure controller must be set to setpoint 5,5 bar, and the system pressure must be set to 5,8 bar. Failure to do so will not allow the purge sequence to complete!

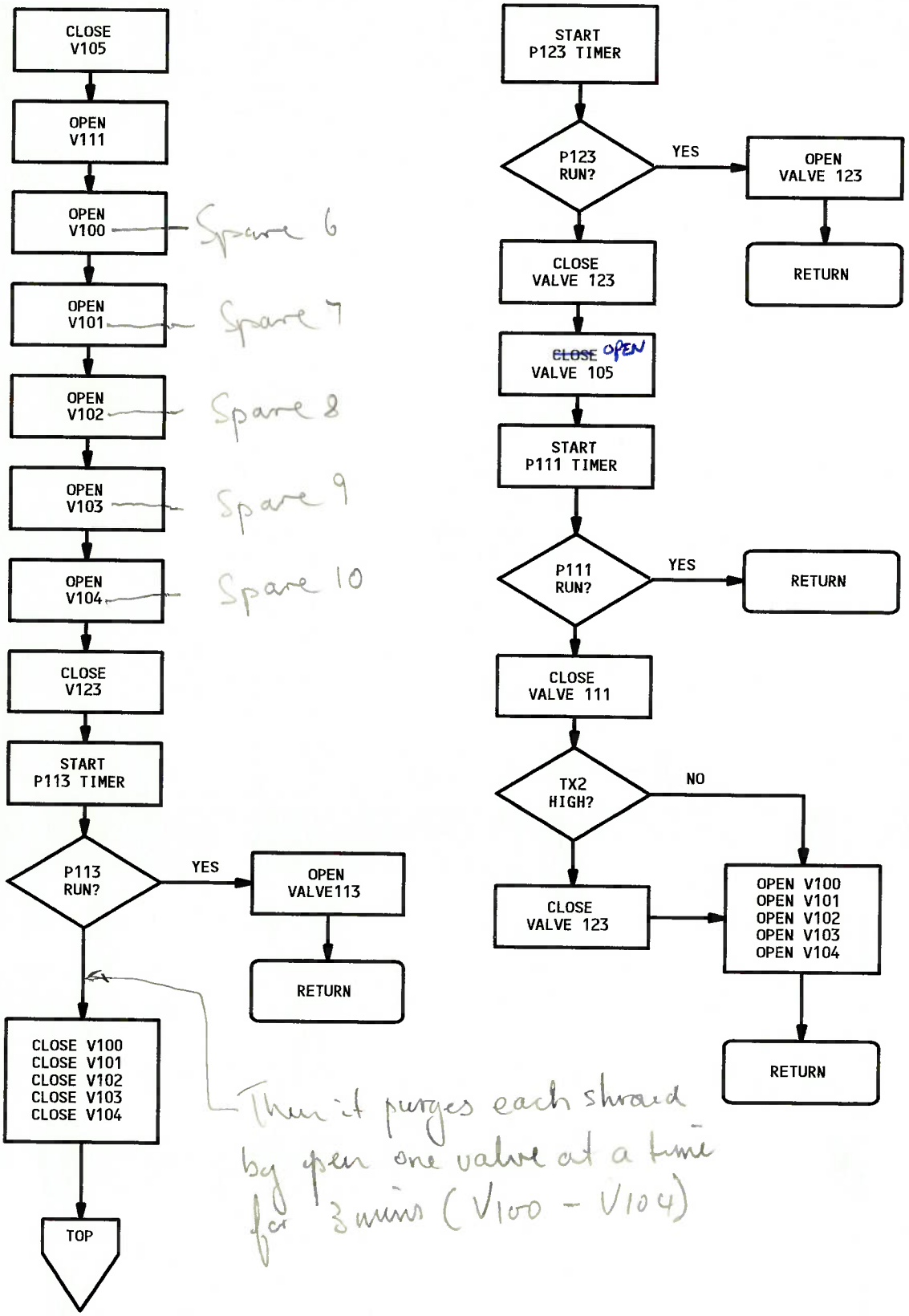
4. When the purge sequence has completed, valves V100-V105 will open and valve V123 will close.

5. Select the thermal mimic and verify the status of the valves.

6. From the thermal mimic use the mouse to click on the PS100 icon. The system pressure should be approximately 5,5 bar (6,5 bar absolute).

7. If the pressure is as stated in the above step, the purge cycle is complete.

Refer the purge mode diagram:


CLOSE V105
OPEN V111
OPEN V100
OPEN V101
OPEN V102
OPEN V103
OPEN V104
CLOSE V123
START P113 TIMER
P113 RUN?
YES
OPEN VALVE113
RETURN
CLOSE V100
CLOSE V101
CLOSE V102
CLOSE V103
CLOSE V104
TOP
Spare 6
Spare 7
Spare 8
Spare 9
Spare 10
START P123 TIMER
P123 RUN?
YES
OPEN VALVE 123
RETURN
CLOSE VALVE 123
CLOSE OPEN VALVE 105
START P111 TIMER
P111 RUN?
YES
RETURN
CLOSE VALVE 111
TX2 HIGH?
NO
CLOSE VALVE 123
OPEN V100
OPEN V101
OPEN V102
OPEN V103
OPEN V104
RETURN
Then it purges each shroud by open one valve at a time for 3 mins (V100 - V104)

3.2 THERMAL CYCLE(S)

WARNING: Complete Purge Cycle before proceeding with thermal cycle(s).

3.2.1 General Description

The thermal system has two basic modes of operation as follows:

Gaseous mode ("Controlled")

Gaseous nitrogen at 7 bar (absolute) is circulated through the shrouds by the gas circulation fan and can be heated or cooled in the heater and injection (cooler) units respectively. The cooler and heater units are controlled by comparing a set point temperature with the average temperature of all five shrouds. Balancing of the five shroud temperatures is done by comparing each individual shroud's average temperature with the average temperature and using this data to control valves V 100 - V 104. The shroud temperature in this mode is controlled from 393 °K to 123 °K with a transient rate of 1.5 °K/minute average. It is also possible to hold the shrouds at a constant temperature at any point within the range 393 K to 123 K for any length of time ("Soaking Period"). Thus it is possible to program the system to follow a predetermined profile which may include any number of transients and soaking periods. Paragraph 3.2.2 describes the basic program/sequence steps. Paragraph 3.2.3 gives the detail operators instructions for running the system in the automatic mode.

Liquid (flooded) mode ("Uncontrolled")

Liquid nitrogen is gravity fed into the shrouds from the flashing chamber. The flashing chamber is in turn fed with liquid nitrogen via valve V 109. The flashing chamber is allowed to fill and gravity feed liquid nitrogen to the shrouds until the shrouds are completely filled with liquid nitrogen. During this mode valve V 123 is opened to vent gaseous nitrogen from the flashing chamber and valve V 105 is closed in order to prevent liquid nitrogen reaching the heater unit's elements. In the shrouds the liquid nitrogen is allowed to boil off at atmospheric pressure. A differential pressure sensor facilitates the control of valve V 109 such that this level of liquid nitrogen is maintained in the system. This operating mode is uncontrolled in both the transient from the gaseous mode to a flooded situation, as well as in the steady state flooded mode. During the flooded mode the shroud temperatures are in the region of 78°K to 88°K. Paragraph 3.2.4 describes the basic program/sequence steps. Paragraph 3.2.5 gives the detail operators instructions for running the system in the automatic mode.

3.2.2 Gaseous Mode Program Steps

The basic steps of the automated program are as follows:

Note: This cycle is always preceded by a purge cycle. This means the thermal system is already on "set" pressure and valve status remains as per end of purge cycle. Pressure control valve V106 is active.

- Open V100 → V105 (shroud control valves) 100% open.
- Start recirculation fan (RF 100).
- Depend on pre-programmed thermal profile (mask) the heater or cooler units will become active to heat up or cool down the recirculation gas.

Note: • **To follow transient profiles (ΔT/min) within acceptable tolerances, both heater and cooler units are used in a "cooled down", and in a "heat-up" transient.**

• **The system is well interlocked to prevent undesirable scenarios. See paragraph 4 for "Interlock conditions".**

- V100 → V104 (shroud control valves) will be controlled by a independent software subroutine, and strive to be at maximum valve openings at all times.

Warning: **When the cooler unit is functioning, mass (LN_2) is injected into the system. That means mass in the form of gas (GN_2) has to be released to keep mass/pressure balance inside the pressure boundary of the thermal system. If for instance the exhaust/pressure control valve is stuck in a closed position, and LN_2 is still injected into the system, the pressure will build up and result in blowdown of the safety valves. For this scenario, the cooler injection valve V107 will be interlocked on high pressure signal. (Valve V107 will close).**

3.2.3 Gaseous Mode Detail Instruction

1. Before the thermal system will start, data must be entered into the profile mask. Refer section 7.2.7 as to how this may be done.

2. Once the data has been entered, select the thermal mimic, and press 'F1' to start the thermal system.

3. The thermal system will proceed from setpoint to setpoint automatically, until either the operator selects 'F2' to stop the thermal system from within the thermal mimic, or the system encounters both a time of 0 minutes and a setpoint of 0 degrees.

3.2.4 Liquid Mode - Basic Program/Sequence Steps & Philosophy

The basic steps of the automated program for the liquid mode are as follows:

Note: This cycle is always preceded by a automatic controlled gas mode cycle, ended at an average system temperature of 123^0 K (-150^0 C). All valve status as per gas mode operation:

1. **Switch heater unit (HU100) off.**

2. **Switch GN_2 recirculation fan (RF100) off.**

3. De-pressurize thermal system to atmospheric pressure. This is done manually" at thermal system's control panel (TSCP-1), this will automatically control V106.

   Note: System's temperature will drop immediately.

4. Open valve V100 → V104 to 100% open position (shroud control valves).

5. Open flashing chamber valve V123.

6. Close large in-line valve V105 to protect heater and cooler units against LN_2

7. Make sure drain valve V111 is closed.

8. Close purge valve V113

9. Close cooler unit's spray valve V107

   Note: The system is now ready to be flooded with LN_2.

10. Control LN_2 injection with flooding valve V109 with ΔP signal to obtain set point level of LN_2 inside shrouds. * 2200mm

    Note:- High set point level is reached when shroud 2 and/or shroud 4 most upper temperature probe(s) respond to LN_2 temperature of -190°C.

    - If possible, fill system quickly with LN_2 to upper temperature probe level of shroud 4 and 5. From here to reach set point level as described in Note above, LN_2 must be injected at low rate.

    - Care must be taken not to overfill the shrouds, in order to prevent LN_2 built-up in shroud outlet pipes, and hereby block the five boiling-off gas escape routes to the top manifold.

11. Once the set point level is reached, start timer count down for flooding mode duration required.

3.2.5 Liquid Mode: Detail Operators Instruction

Two methods may be used to engage liquid mode.

2 ~~1.~~ Enter a setpoint of -160°C or lower into the profile mask. - Skip setp and then select 'Super Cool'

1 ~~2.~~ Cool the system down to -150°C by entering a setpoint of -150°C. When the setpoint of -150°C is reached, select 'SUPER COOL' from the profile mask, by pressing 'F3'.

When the system enters liquid mode, it will automatically wait for the operator until the following conditions are met:

1. Valve V105 must close. If valve 105 is stuck, the system will not proceed until the valve is closed.

2. Once valve 105 is closed, the system will wait for the operator to adjust the system pressure to 0 bar from within the thermal control panel.

3. Once valve V106 is open, i.e.: the system is depressurising via valve V106, the system will ensure that the cooler valve V107 is closed. If the valve is stuck, the system will wait for the operator to close the valve.

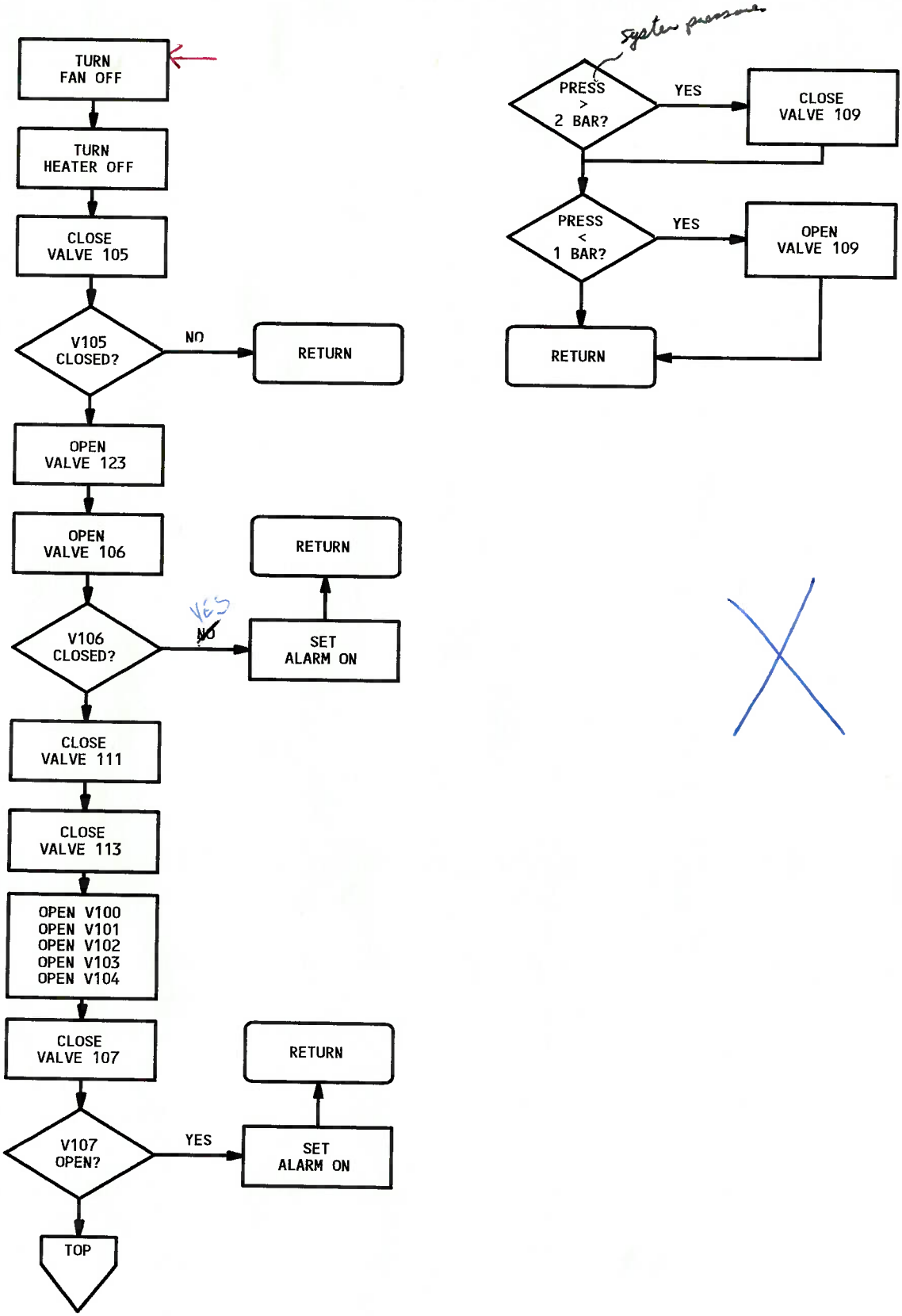
4. The shut off valve controlling valve V109 the flashing chamber inlet valve will only open once the system pressure is lower than 1 bar (2 bar absolute). If liquid nitrogen is poured into the system too quickly, the system pressure may rise. In the event that the system pressure rises above 2 bar (3 bar absolute) valve V109 shut off valve will automatically close until the system pressure drops below 1 bar (2 bar absolute).

The system will remain in the liquid mode until the operator selects the Drain Mode by pressing the F4 key from within the profile mask menu.

Refer the liquid mode flow diagram.

NB [illegible] V106

Flashing Chamber level 2200mm


TURN FAN OFF
TURN HEATER OFF
CLOSE VALVE 105
V105 CLOSED?
NO
RETURN
OPEN VALVE 123
OPEN VALVE 106
V106 CLOSED?
NO
YES
SET ALARM ON
RETURN
CLOSE VALVE 111
CLOSE VALVE 113
OPEN V100
OPEN V101
OPEN V102
OPEN V103
OPEN V104
CLOSE VALVE 107
V107 OPEN?
YES
SET ALARM ON
RETURN
TOP
system pressure
PRESS > 2 BAR?
YES
CLOSE VALVE 109
PRESS < 1 BAR?
YES
OPEN VALVE 109
RETURN

3.3 DRAIN CYCLE

3.3.1 General Description:

Pressure in the system can be created by gas forming (boiling off of GN_2 when the system is flooded with LN_2. If the set pressure cannot be sustained by boiling of gas (too little gas forming), the purge system (GN_2 supply) will become active to stabilized at "set" pressure. The liquid is drained through the drain valve and collected in the boil-off vat outside the building.

3.3.2 Drain Cycle - Basic Program/Sequence Steps and Philosophy

The basic steps of the automated program are as follows:

Note: This cycle is always preceded by a liquid mode cycle. This means that the system is filled with LN_2 and is close to atmospheric pressure at initiation of the drain cycle. The in line valve V105 is closed and the pressurised system is set to "rear" atmospheric pressure (V106 is open, or controlling slight pressure inside the thermal system).

SET LEVEL CONTROL AT 0 mm H_2O

1. **Close LN_2 injection valve V109 to flushing chamber.**

2. **Set pressure control system to 0,5 bar.**

Warning: Never close (override) exhaust valve V106 during the drain cycle. Even with the drain valve open, a "too high" pressure may build up.

3. **Open drain valve V111**

4. **Increase pressure setting to 2,5 bar on pressure control system inside the thermal system control panel. This higher pressure setting can be created by GN_2 boiling off, or purging through valve V113 that opens. If the system pressure doesn't rise to set point level, exhaust valve V106 will remain closed, and GN_2 injection valve (purging valve) V113 remain fully open. This situation is normal.**

5. **Continue until the average temperature is ≈ - 150°C.**

Note: If one of the shrouds reaches -150° C and the other shrouds not, this means that that specific shroud is dry (all LN_2 has boiled off), most of the GN_2 will now escape through that shroud, with little further heat-up effect on the other shrouds. The thermal system can now be "switched

Did not close

off" for natural "heat-up" making sure that valve V111 is closed and V105 is open and pressure setting is set at atmospheric pressure. If a quicker "heat-up" is required, steps 6 →9 are to be followed. This can be done manually or in a controlled fashion.

6. **Close the shroud balance valve (V100 to V104) of the shrouds that have reached -150° C. Continue till all five valves are closed.**

   Note: A shroud that has reached -150° C, may partly be filled up with LN_2 blown out of the other shrouds and which has collected in the lower manifold.

7. **The moment the last valve closes, all shroud balancing valves (V100 →V104) have to be opened.**

8. **Open in-line valve V105.**

9. **Set system pressure to atmospheric pressure. This means the GN_2 injection valve (purge valve) V113 is also closed.**

10. **Let system naturally heat up for approximately 8 hours to allow residual LN_2 in shrouds to boil off. A controlled gas mode can be initiated during heat up cycle if the next warning is complied with.**

    Warning: Before termination of the purge cycle to go into a controlled gas mode, all shrouds temperatures must be > -120° C. (>150°K)

3.3.3 Drain Cycle Detail Operators Instruction.

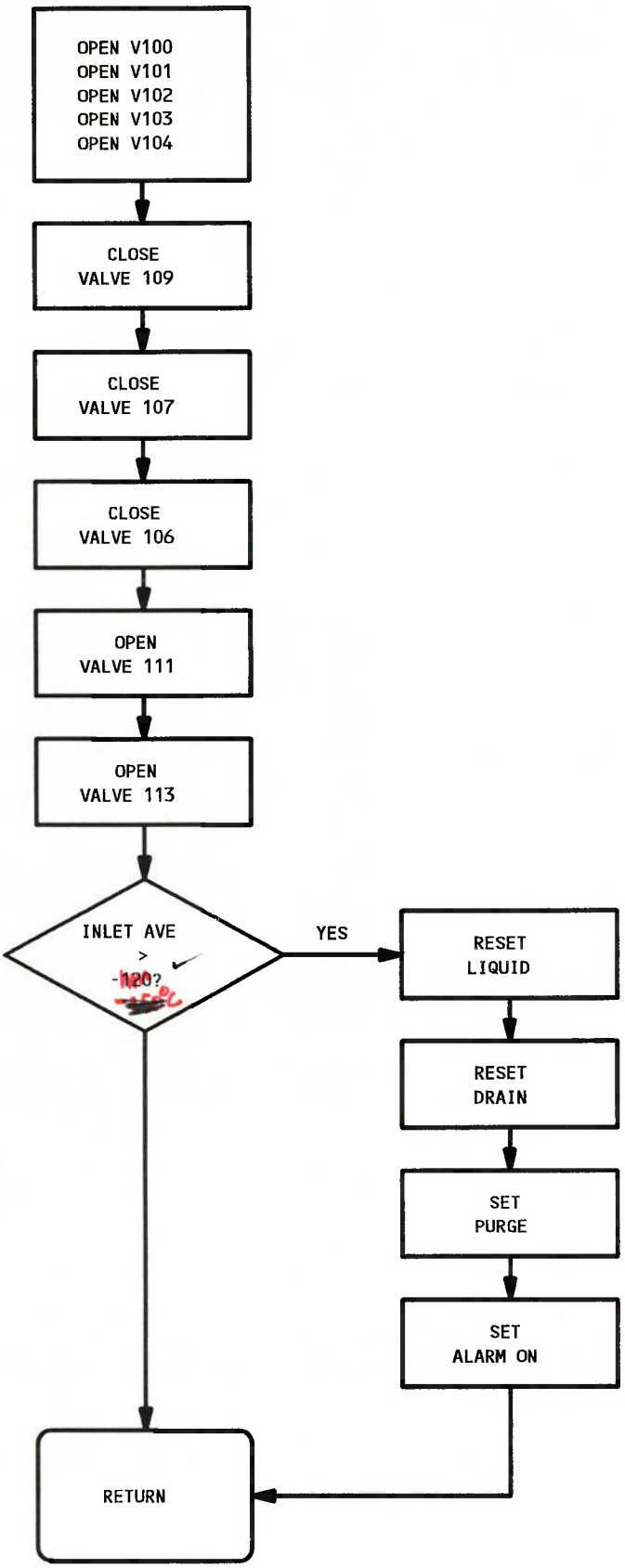
SET LEVEL CONTROL AT 0mm H_2O FIRST, THEN SYSTEM PRESSURE AT 0,8 BAR THEN..

Once the operator wishes to exit the liquid mode, 'DRAIN MODE' must be selected. In order to enter drain mode, the operator must first select the profile mask menu from the main menu by pressing the F7 key. From within the profile mask menu, the operator must then select F4, drain mode.

Once drain mode is initiated, the system will remain in this mode until the average inlet temperature is greater than -120°C. ~~-150°C~~ -120°C

When the drain mode is complete, the system will automatically purge, and the alarm will sound for 5 seconds. The system will continue purging until the operator adjusts the system pressure setpoint to 5,8 bar and the high alarm to 5,5 bar.

Refer the Drain Mode flow diagram:


OPEN V100
OPEN V101
OPEN V102
OPEN V103
OPEN V104
CLOSE VALVE 109
CLOSE VALVE 107
CLOSE VALVE 106
OPEN VALVE 111
OPEN VALVE 113
INLET AVE > -120?
YES
RESET LIQUID
RESET DRAIN
SET PURGE
SET ALARM ON
RETURN

4 INTERLOCK CONDITIONS FOR LARGE THERMOVACUUM FACILITY IN AUTOMATIC OPERATING MODE.

FAN:	Motor temperature > 70 Centigrade No water flowing at flow switch.
HEATER:	Gas temperature > 135 Centigrade System pressure < 5 Bar absolute Valve 105 closed Fan not running Gas temperature 60 degrees Centigrade higher than temperature at shrouds i.e.: Low flow rate.
SYSTEM PRESSURE > 7.5 BAR ABSOLUTE:	Drain valve will open Thermal system will reset Gaseous Nitrogen inlet will close Liquid Nitrogen inlet will close.
VALVE 106 CLOSED:	In ~~liquid~~ mode the system will wait until Valve 106 is open. This is to prevent the system from over pressurising.
VALVE 107 OPEN:	In ~~liquid~~ mode this valve must be closed, as liquid is injected into the system via Valve 109. The system will wait until Valve 107 is closed.
VALVE 105 STUCK:	In ~~liquid~~ mode, this valve must be closed to isolate the fan, heater and cooler. The system will wait until Valve 105 is closed.
CHILLED WATER:	The system will switch off if the chilled water supply is interrupted.
COMPRESSED AIR:	The system will switch off if the compressed air supply is interrupted.

x System's action ?

x System's action ?

x flooded

x flooded

flooded

5 ALARMS FOR GASEOUS AND LIQUID MODES

ALARMS FOR GASEOUS AND LIQUID MODES	ACTION	MODE
System pressure > 7,5 Bar absolute.	1. Drain valve will open. 2. Thermal system will reset. 3. Gaseous N2 inlet will close. 4. Liquid N2 inlet will close.	Manual and Automatic
Vacuum system starts.	Alarm will sound for 5 seconds.	Automatic
Fan temperature > 70 Celsius	Fan off.	Manual
Fan temperature > 70 Celsius	Fan speed to 30%	Automatic
No flow at flow switch	Fan off	
Gas temperature > 135 Celsius	Heater off	Automatic
System pressure < 4 Bar absolute	Heater off	Automatic
Valve 105 closed	Heater off	Manual and Automatic
Gas temperature 60 degrees Celsius higher than shroud temperature	Heater off	Automatic
Valve 105 stuck	Supervisory system Alarm Banner Line (ABL) indication	Manual and Automatic
System pressure > 7 Bar absolute and Valve 106 closed	Supervisory system ABL indication	Manual and Automatic
Chilled water off	1. Vacuum and thermal systems will turn off 2. Supervisory system ABL indication	Automatic
Chilled water off	Supervisory system ABL indication	Manual
Compressed air off	1. Vacuum and thermal systems will turn off 2. Supervisory system ABL indication	Automatic
Compressed air off	Supervisory system ABL indication	Manual
ALARMS FOR LIQUID MODE OPERATION	**ACTION**	**MODE**
Valve 106 closed	System will wait until Valve 106 is open	Automatic
Valve 107 open	System will wait until Valve 107 is closed	Automatic
Valve 105 stuck	System will wait until Valve 105 is closed,	Automatic

ALARMS FOR DRAIN MODE OPERATION	ACTION	MODE
Completion of a Liquid mode cycle, the system is in drain mode and the average inlet temperature exceeds -120 degrees centigrade.	Status indication to operator that Gaseous mode may resume	Automatic

6 MANUAL MODE OPERATION.

6.1 PURPOSE OF MANUAL MODE:

The purpose of the manual mode function, is to allow the operator to test various components of the thermovacuum facility before and after profile tests, but NOT during an active profile. In the event that a profile is active and manual mode is entered, the system may be damaged, as the safety interlocks between automatic and manual mode differ as listed below.

6.2 INTERLOCKS ACTIVE IN MANUAL MODE:

6.2.1 FAN:

The fan is interlocked to the motor temperature only, and not to the cooling water. This is to enable the operator to test the fan for a short period of time if the cooling water is disconnected. If the motor temperature exceeds 70 degrees centigrade, the fan will turn off, and the alarm will sound.

6.2.2 HEATER:

The heater is ONLY interlocked to valve 105. If valve 105 is closed, the heater will not energise. It is VERY important to note that it is the operator's responsibility to ensure that the fan is running, and that valves 100 to valves 104 are open BEFORE testing the heater. The reasons for the lack of interlocks are:

1. The system need not be pressurised.
2. To facilitate ease of testing.

6.2.3 OVER PRESSURE:

In the event that the system pressure is to rise above 7,5 bar absolute, the following will happen:

1. The thermal system will be shut down.
2. The drain valve will open.
3. The Nitrogen inlets will close, both gaseous and liquid.

6.2.4 VACUUM:

The Forepump system may be started with the chamber door open. In automatic mode, the chamber door must be closed.

6.2 OPERATION OF MANUAL MODE

1. Engage manual mode by selecting manual mode on either of the two terminals by selecting confidential mode on the XBTV terminals.

   To engage confidential mode on the XBTVA terminal, press CNTL + INC simultaneously. After a few seconds a message will appear at the top of the screen "CONFIDENTIAL MODE"

   To engage confidential mode on the XBTVB terminal, turn the key switch to the "CONFIDENTIAL" position.

2. Select one of the menus applicable i.e.:

   2.1 Pump Menu.
   2.2 Valve Menu (Open/close control).
   2.3 PID Menu (Proportional control).

3. The following pumps may be controlled:

   3.1 Pump 5.
   3.2 Pump 6.
   3.3 Pump 7.
   3.4 Pump 8.

4. The following valves may be controlled:

   4.1 Valve 1.
   4.2 Valve 2.
   4.3 Valve 4.
   4.4 Valve 5.
   4.5 Valve 6.
   4.6 Valve 7.
   4.7 Valve 8.
   4.8 Valve 9.
   4.9 Valve 10.
   4.10 Valve 11.
   4.11 Valve 12.
   4.12 Valve 16.
   4.13 Valve 17.
   4.14 Valve 18.
   4.15 Valve 105 shutoff.
   4.16 Valve 111 shutoff.
   4.17 Valve 112.
   4.18 Valve 113 shutoff.
   4.19 Valve 123 shutoff.
   4.20 Valve 100 shutoff.
   4.21 Valve 101 shutoff.
   4.22 Valve 102 shutoff.
   4.23 Valve 103 shutoff.
   4.24 Valve 104 shutoff.
   4.25 Valve 107 shutoff.
   4.26 Valve 109 shutoff.

Note:

1. **Valve 106 cannot be controlled, as the PLC will automatically keep the shutoff valve open, and the PID controller in the Thermal control panel will control the proportional position of the valve.**

2. **The shutoff valves are located in the Thermal control panel and are the electro-pneumatic type.**

5. The following proportional devices may be controlled:

5.1 Valve 100.
5.2 Valve 101.
5.3 Valve 102.
5.4 Valve 103.
5.5 Valve 104.
5.6 Valve 107 (Cooler or LN2 injection system).
5.7 Fan (Speed).
5.8 Heater (Output).

Pressing increment will increase the output to the selected device by 2,5% each time. Pressing decrement will increase the output to the selected device by 2,5% each time.

Valves 106 and 109 cannot be controlled from this menu as their control signals are wired directly from the PID controllers in the Thermal control panel. Their menus are included in the event that their control signals should be routed via the PLC.

7. MONITOR 77 - OPERATOR INSTRUCTIONS

7.1. START UP PROCEDURE.

7.1.1. Ensure that the printer is on line.

7.1.2. At the DOS command line prompt type "RUN". After a minute or two Figure 1 will be displayed on the computer screen.

7.1.3. Ensure that the Combitron and the Thermovac are turned on.

7.1.4. Press "PANIC ABORT" to reset the PLC.

7.1.5. Press the "REM" button on the Combitron. The LCD bar above the "REM" switch should return after one or two seconds

7.1.6. Press the "REM" button on the Thermovac. The LCD bar above the "REM" switch should return after one or two seconds.

7.1.7. Ensure that the LED's in the High Vacuum Control panel flash sequentially on each card.

7.1.8. If the LCD bar in steps 3 and 4 above do not re-appear or the LED's do not flash as described in step 5 repeat steps 2 to 5.

7.2. MAIN MENU DESCRIPTION.

There are eleven (11) selections which may be made from the main menu.

7.2.1 F1 Panic Abort

This function will reset the PLC and all the setpoint data previously entered will be lost. The system will automatically return to a safe state.

7.2.2 Shift F1 Help Page

Selecting this option will display a brief help page as displayed in Figure 2.

7.2.3 F3 Automatic Manual Mode Selection

This function allows the operator to toggle between Automatic and Manual mode without having to access one of the XBTV terminals. The system mode will appear in the block. i.e.: In automatic mode, "**AUTO**" will be displayed and in manual mode "**MAN**" will be displayed. Manual mode should **ONLY** be selected when components of the system wish to be tested.

7.2.4 F4 Tune Pid Loop

Pressing this function will display an image similar to Figure 3. The following data is displayed:

DATA DISPLAYED	UNITS	FUNCTION
SETPOINT	Degrees Centigrade.	Displays the moving setpoint during a transient and the final setpoint when the system is in a steady state.
PROCESS VARIABLE	Degrees Centigrade.	Displays the temperature measured by the PLC.
%HEATER OUTPUT	Percentage.	Displays the value output to the heater.
HIGH ALARM	Degrees Centigrade.	Maximum temperature limit setting.
LOW ALARM	Degrees Centigrade.	Minimum temperature limit setting.
YELLOW DEVIATION	Degrees Centigrade.	Deviation around the setpoint. (Deadband control)
ORANGE DEVIATION	Degrees Centigrade.	Deviation around the setpoint.
% COOLER OUTPUT	Percentage	Displays the value output to the cooler.
P TERM	Engineering units.	Alters the gain of the PID loop.
I TERM	Engineering units.	Alters the integral term.
D TERM	Engineering units.	Alters the derivative term.

7.2.4.1 Pid Reset.

Pressing F1 will reset the PID loop with the default values stored in the PLC constant words.

7.2.4.2 Next Screen.

Pressing F7 will display the Cooling loop PID screen, refer Figure 4.

7.2.4.3 Acknowledge Alarm.

F8 will acknowledge the alarm displayed in the Alarm Banner Line above.

7.2.4.4 Alarm Page.

F9 will display the Alarm page with all listed alarms

7.2.4.5 Exit Page.

F10 will return the operator to the Main Menu

7.2.5 F5 VACUUM MIMIC

Selecting F5 from the Main Menu will display the vacuum menu similar to Figure 5. The following options are available from this menu:

7.2.5.1 F1 Start Vacuum.

Selecting this function will start the Vacuum system.

7.2.5.2 F2 Stop Vacuum.

Selecting this function will stop the Vacuum system.

7.2.5.3 F3 Vacuum Trends.

Selecting this function will display an image similar to Figure 6. The trending chart will display the last three hour vacuum trending data. The scale on the left hand side applies to the Perani heads, and the scale on the RHS applies to the Penning head. Select F10 to return to the Vacuum Mimic menu.

7.2.5.4 F7 Cryopump Temperature Trends.

Selecting this function will display an image similar to Figure 7. The trending chart displays the last three hour cryo pump temperature data. Each pump may be identified by the Trend Legend box. The current temperature The current temperatures are displayed in the Current Value box.

7.2.5.4.1 F7-Historical trending.

Refer section 3 for a detailed description on the use of this function.

7.2.5.5 F8 Acknowledge Alarm.

If an alarm appears in the Alarm Banner Line, pressing F8 from any menu displayed, will accept the alarm.

7.2.5.6 F9 Alarm Page.

If the operator wishes to view the list of alarms, pressing F9 from any menu, will display the alarm page to the operator.

7.2.5.7 F10 Exit.

Pressing F10 will return the operator to the Main Menu.

7.2.6 F6 PLC Diagnostics

Selecting F6 from the Main Menu will display the PLC diagnostic menu similar to Figure 8. If any of the components in the PLC fail, i.e.: Hardware failure on one of the interface cards on the PLC, the status box opposite the failed component will turn red. If the component is serviceable, the status box will be green.

7.2.7 F7 Profile Mask

Selecting F7 from the Main Menu will display the profile mask menu similar to Figure 9.
The following functions are available from this menu:

7.2.7.1 F1 Data Input.

Selecting this option will display the Data Entry menu, similar to Figure 10. The following procedure describes how data is entered or inserted:

7.2.7.1.1 Writing New Data

UPDATE PROFILE VALUES BOX:

1. Enter the required setpoint steady state time in minutes.
2. Enter the required setpoint value in degrees Celcius.
3. Enter the required stage number.
4. Press F1 to transfer the data to the PLC.

DEFAULT PROFILE VALUES BOX:

After a few seconds, the data entered above will be displayed in the default profile values box.

7.2.7.1.2 INSERTING A STEP:

UPDATE PROFILE VALUES BOX:

1. Enter the required setpoint steady state time in minutes.
2. Enter the required setpoint value in degrees Celcius.
3. Enter the required stage number.
4. Press F2 to transfer the data to the PLC.

CURRENT PROFILE STATUS BOX:

This box will display the current thermal stage number, the final setpoint and the remaining time for that stage number if the steady state conditions have been met. The data displayed in only valid if the thermal system is running.

DEFAULT PROFILE VALUES BOX:

After a few seconds, the data entered above will be displayed in the default profile values box, and all the data below the inserted stage will be moved down. i.e.: A stage was inserted at stage 4. Stage 4 will now become stage 5, stage 5 will now become stage 6 etc.

7.2.7.2 F2 Purge Mode.

Selecting F2 will purge the thermal system.

7.2.7.3 F3 Super Cool.

There are two methods to engage liquid mode:

7.2.7.3.1. Enter a temperature lower than or equal to -160 degrees C in the Data Update Menu.

7.2.7.3.2. Press F3 to engage liquid mode, regardless of the temperature in the thermal system.

7.2.7.4 F4 Drain Mode.

Press F4 in order to stop the liquid mode. The system will automatically enter the drain mode, and remain in this mode until the average inlet temperature is greater than -120 degrees centigrade. The drain mode function will only engage if the system is in liquid mode.

7.2.7.5 F5 Skip Step.

Pressing F5 will force the system to start the next stage number, regardless whether the system is in a steady state or not.

7.2.7.6 F8 Alarm Page.

Pressing F8 will display the alarm page, with a list of all the alarms.

7.2.7.7 F9 Acknowledge Alarm.

Pressing F9 will acknowledge the alarms detected by the system.

7.2.7.8 F10 Exit Page.

Pressing F10 will return the operator to the Main Menu display screen.

7.2.8 F8 Alarm Page

Selecting F8 from the Main Menu will display the alarm page to the operator. A list of all alarms will be displayed.

7.2.9 F9 ACKNOWLEDGE ALARM

Selecting F9 from the Main Menu will acknowledge the alarms displayed in the Alarm Banner Line.

7.2.10 F10 Thermal Mimic

Selecting F10 from the Main Menu will display an image similar to Figure 11. The following functions are available from this menu:

7.2.10.1 F1 Start.

Pressing F1 will start the thermal system, if data has been input into the Update Profile Menu.

7.2.10.2 SHIFT F1 Help Screen

Pressing Shift F1 will display a brief help screen similar to Figure 12

7.2.10.3 F2 Stop.

Pressing F2 will stop the thermal system. The thermal system will stop automatically if the next stage number data it loads from the internal PLC table contains a zero in the time and temperature data fields.

The following "HOT AREAS" are available for selection using the mouse:

7.2.10.4 PS100 icon.

Selecting this icon, will display the PS100 Trending menu, similar to Figure 13
The following options are available:

7.2.10.4.1 Acknowledge Alarm.

Pressing F8 will acknowledge the alarm displayed in the Alarm Banner Line above.

7.2.10.4.2 Alarm Page.

Pressing F9 will display the Alarm page with all listed alarms.

7.2.10.4.3 Exit Page

Pressing F10 will return the operator to the Thermal Menu.

The system pressure trends will be displayed on the trending chart.

7.2.10.5 PS101 icon.

Selecting one of these icons, will display the Average Trending menu, similar to Figure 14
The following options are available:

7.2.10.5.1 Acknowledge Alarm.

Pressing F8 will acknowledge the alarm displayed in the Alarm Banner Line above.

7.2.10.5.2 Alarm Page.

Pressing F9 will display the Alarm page with all listed alarms.

7.2.10.5.3 Exit Page.

Pressing F10 will return the operator to the Thermal Menu.

The flashing chamber trends will be displayed on the trending chart.

7.2.10.6 The areas marked "AVG"

Selecting one of these icons, will display the Average Trending menu, similar to Figure 15
The following options are available:

7.2.10.6.1 Historical Trending

Refer Section 3 for a detailed description of this function.

7.2.10.6.2 Acknowledge Alarm.

Pressing F9 will acknowledge the alarm displayed in the Alarm Banner Line above.

7.2.10.6.3 Alarm Page.

Pressing F8 will display the Alarm page with all listed alarms.

7.2.10.6.4 Exit Page.

Pressing F10 will return the operator to the Thermal Menu.

The trending chart displays the last three hour average shroud temperature data. Each shroud may be identified by the Trend Legend box. The current shroud temperatures are displayed in the Current Value box.

7.2.10.7 The areas marked "PT1d", "PT2d", "PT3d", "PT4d" and "PT5d".

Selecting one of these icons, will display one of the Temperature Trending menus, similar to Figure 16.
The following options are available:

7.2.10.7.1 Historical Trending

Refer Section 3 for a detailed description of this function.

7.2.10.7.2 Acknowledge Alarm.

Pressing F8 will acknowledge the alarm displayed in the Alarm Banner Line above.

7.2.10.7.3 Alarm Page.

Pressing F9 will display the Alarm page with all listed alarms.

7.2.10.7.4 Exit Page.

Pressing F10 will return the operator to the Thermal Menu.

The trending chart displays the last three hour individual PT100 temperature data. Each probe may be identified by the Trend Legend box. The current temperatures are displayed in the Current Value box.

7.2.11 Shift -F10 System Shut Down

Selecting SHIFT-F10 from the Main Menu will transfer the operator to the RUN-TIME menu. From this menu the operator must select F2 and then press ENTER, (or the password and then ENTER if enabled) to shut the system down. This is the only method that must be used in order to shut the system down in an orderly sequence. **Failure to do so may result in a loss of data!**

7.3. HISTORICAL TRENDING FUNCTION.

When the operator has selected F7 the Historical Trending menu similar to Figure 17 will appear. The method of operation is as follows:

(1) The data displayed in the trending screen is data recorded over a three hour data period. Any data older than this is automatically saved on the hard disk.

(2) Three functions are available to retrieve and view the data that has been recorded:

- (2.1) Minute.
- (2.2) Day.
- (2.3) Zoom.

(3) Retrieving data using the "MINUTE" method.

- (3.1) Select F2 to turn History On.
- (3..2) The Historical Trending Time Box displays the START and END times.
- (3.3) Pressing F7 will increment the START time.
- (3.4) Pressing F8 will decrement the START time.
- (3.5) When the period has been selected pressing F2 will retrieve the data, and update the trending area.
- (3.6) Pressing F3 or F4 will move the cursor over the trend, displaying the c current cursor value in the cursor value box.
- (3.7) When the trend has been viewed, restore the START time to the most recent time available by pressing F7 until the START time no longer changes.
- (3.8) Press F1 to return to Real Time mode.
- (3.9) Press ESC to return to the previous menu.

(4) Retrieving data using the "DAY" method.

- (4.1) Select F2 to turn History On.
- (4.2) The Historical Trending Time Box displays the START and END times.
- (4.3) Pressing F5 will increment the START time.
- (4.4) Pressing F6 will decrement the START time.
- (4.5) When the period has been selected pressing F2 will retrieve the data, and update the trending area.
- (4.6) Pressing F3 or F4 will move the cursor over the trend, displaying the current cursor value in the cursor value box.

(4.7) When the trend has been viewed, restore the START time to the most recent time available by pressing F5 until the START time no longer changes.
(4.8) Press F1 to return to Real Time mode.
(4.9) Press ESC to return to the previous menu.

The Zoom function is used to display the data logged over a long period of time, in order to display a complete historical trend of the system performance.

(5) Retrieving data using the "ZOOM" method.

(5.1) Select F2 to turn History On.
(5.2) The Historical Trending Time Box displays the START and END times.
(5.3) Pressing F10 will increment the START time.
(5.4) Pressing F9 will decrement the START time.
(5.5) When the period has been selected pressing F2 will retrieve the data, and update the trending area.
(5.6) Pressing F3 or F4 will move the cursor over the trend, displaying the current cursor value in the cursor value box.
(5.7) When the trend has been viewed, restore the START time to the most recent time available by pressing F9 until the START time no longer changes.
(5.8) Press F1 to return to Real Time mode.
(5.9) Press ESC to return to the previous menu.

Note: The time scale is not applicable when the ZOOM function is in use.

7.4 CONVERTING LOG FILES TO LOTUS FORMAT.

7.4.1 Path Setup.

Before using this function, the following must be in the path of the computer:
Path=C:\FLINK\EXE;C:\LOTUS;C:\
The data logged by the system, is logged to the following directories: C:\FLINK\PRINTER and C:\FLINK\SPOOL. Each of the files logged can have a suffix of .000 to .999, eg:PRINTER.000.

7.4.2. Converting the file.

Select the logfile which you wish to convert, e.g.: PRINTER.000, and enter the following: "DIF PRINTER.000." The DIF formatter program will automatically convert the file to a DIF format which may be imported into LOTUS.

7.4.3 Importing the file.

At the DOS command line type "123" The LOTUS menu will appear. Select Import, and select DIF format. Enter the name of the file, in this example, PRINTER.DIF. LOTUS will import the document, and it may be viewed in the LOTUS spreadsheet.

For further information regarding the use of the DIF formatter, refer the Monitor 77 handbook section 13.5.

FIGURE 1

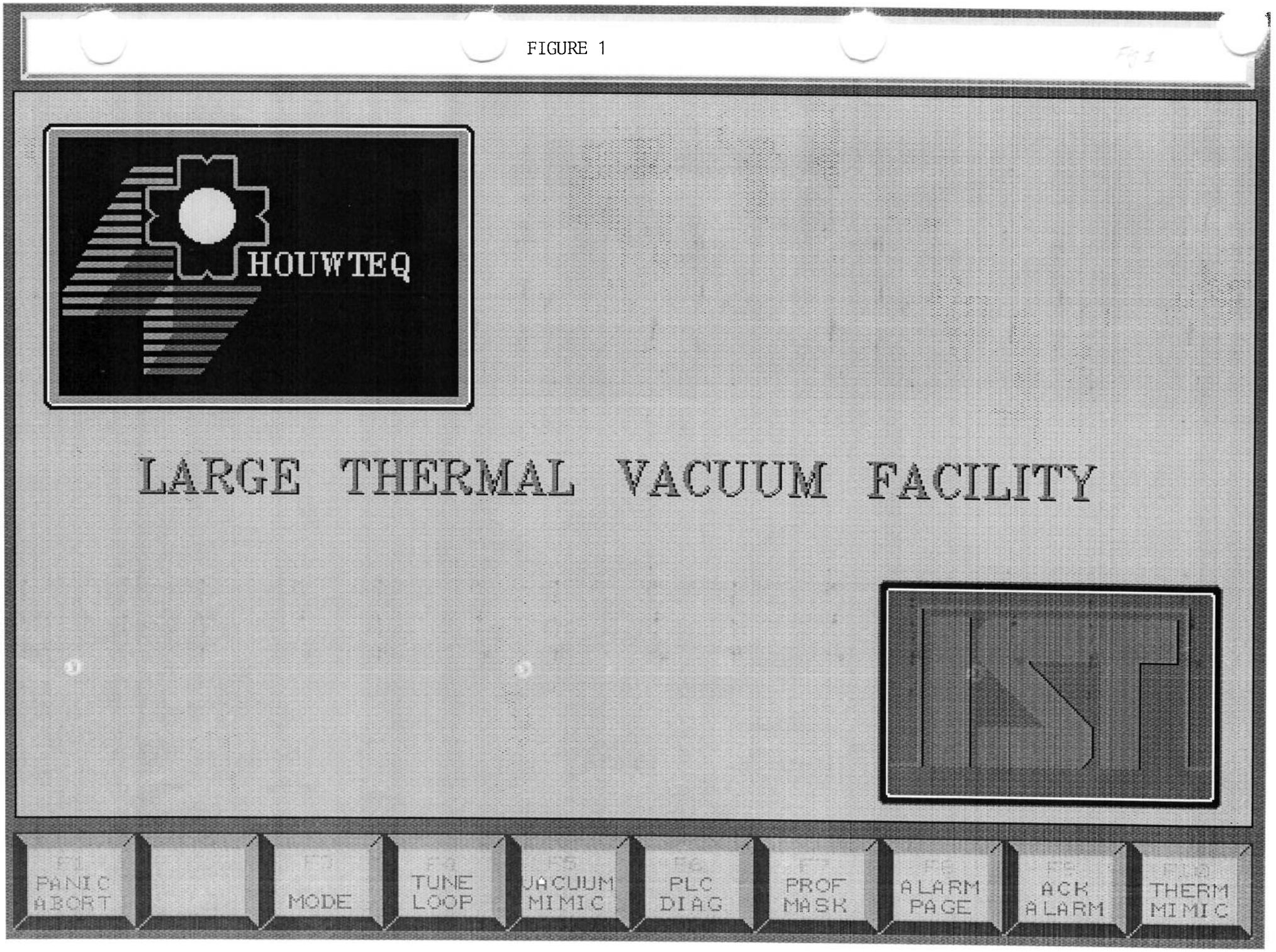

HOUWTEQ
LARGE THERMAL VACUUM FACILITY
F1 PANIC ABORT
F3 MODE
F4 TUNE LOOP
F5 VACUUM MIMIC
F6 PLC DIAG
F7 PROF MASK
F8 ALARM PAGE
F9 ACK ALARM
F10 THERM MIMIC

FIGURE 2

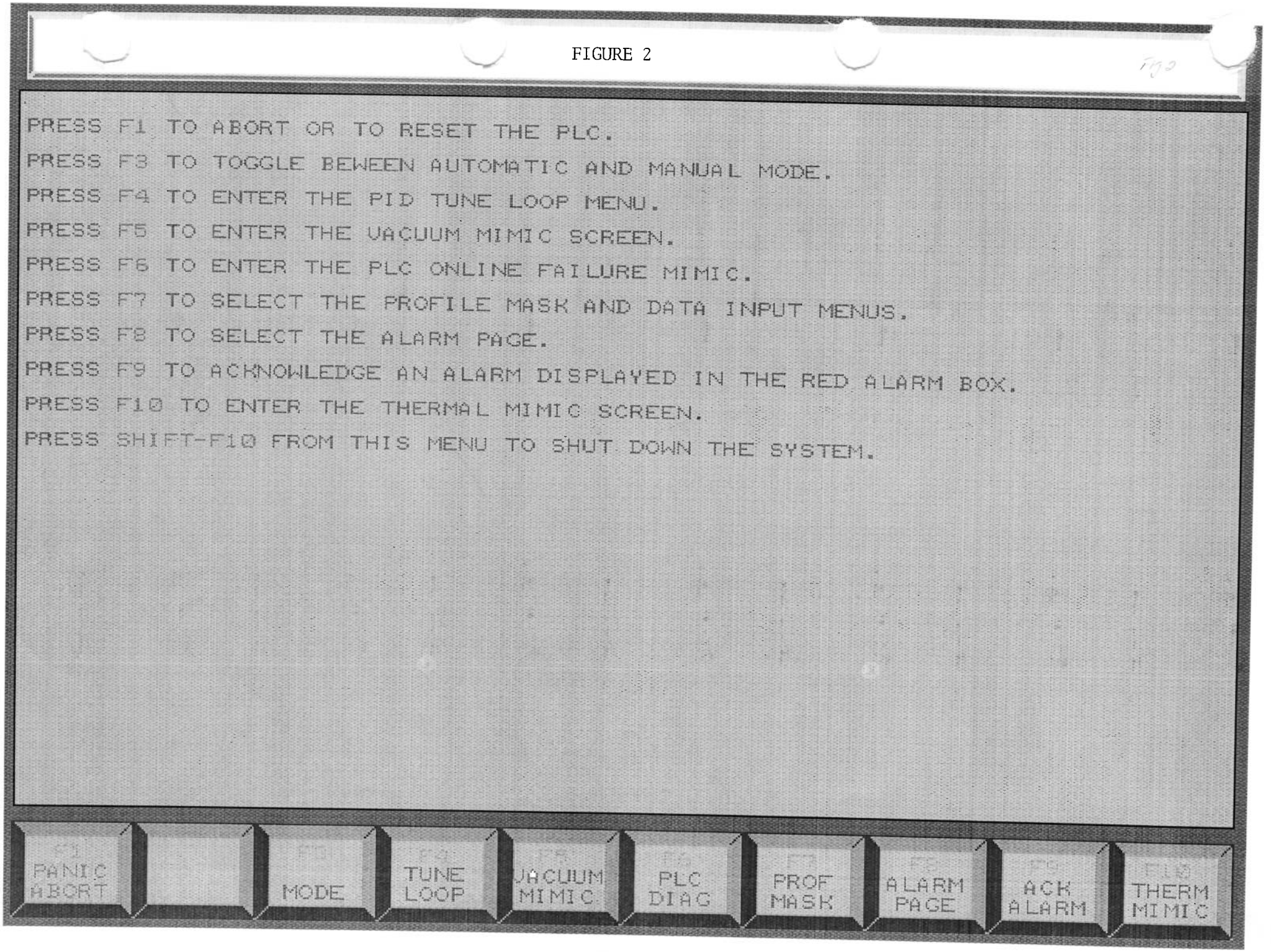

PRESS F1 TO ABORT OR TO RESET THE PLC.
PRESS F3 TO TOGGLE BEWEEN AUTOMATIC AND MANUAL MODE.
PRESS F4 TO ENTER THE PID TUNE LOOP MENU.
PRESS F5 TO ENTER THE VACUUM MIMIC SCREEN.
PRESS F6 TO ENTER THE PLC ONLINE FAILURE MIMIC.
PRESS F7 TO SELECT THE PROFILE MASK AND DATA INPUT MENUS.
PRESS F8 TO SELECT THE ALARM PAGE.
PRESS F9 TO ACKNOWLEDGE AN ALARM DISPLAYED IN THE RED ALARM BOX.
PRESS F10 TO ENTER THE THERMAL MIMIC SCREEN.
PRESS SHIFT-F10 FROM THIS MENU TO SHUT DOWN THE SYSTEM.
F1 PANIC ABORT
F3 MODE
F4 TUNE LOOP
F5 VACUUM MIMIC
F6 PLC DIAG
F7 PROF MASK
F8 ALARM PAGE
F9 ACK ALARM
F10 THERM MIMIC

FIGURE 3

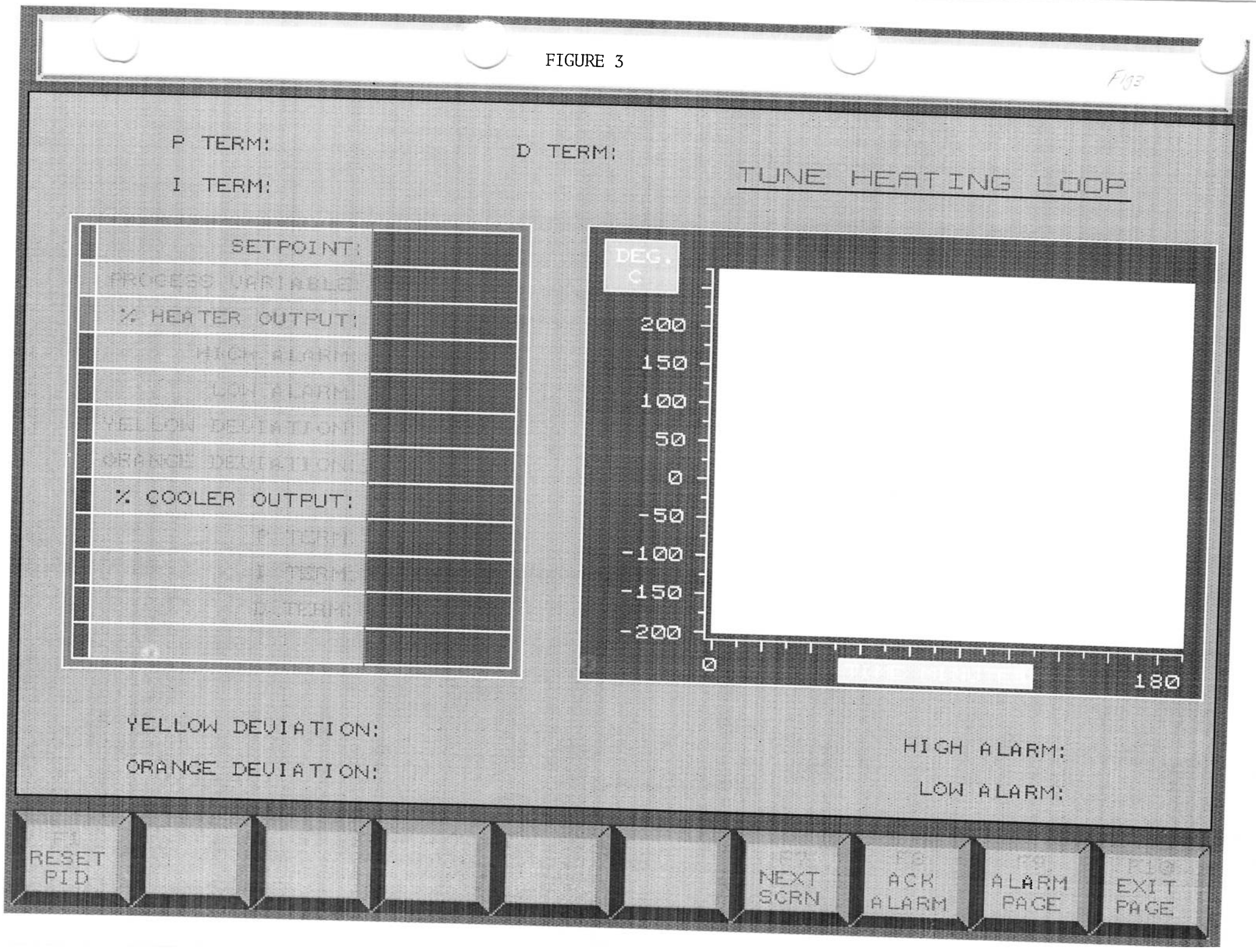

P TERM:
D TERM:
I TERM:
TUNE HEATING LOOP
SETPOINT:
% HEATER OUTPUT:
% COOLER OUTPUT:
DEG. C
200
150
100
50
0
-50
-100
-150
-200
0
180
YELLOW DEVIATION:
ORANGE DEVIATION:
HIGH ALARM:
LOW ALARM:
RESET PID
NEXT SCRN
ACK ALARM
ALARM PAGE
EXIT PAGE

FIGURE 4

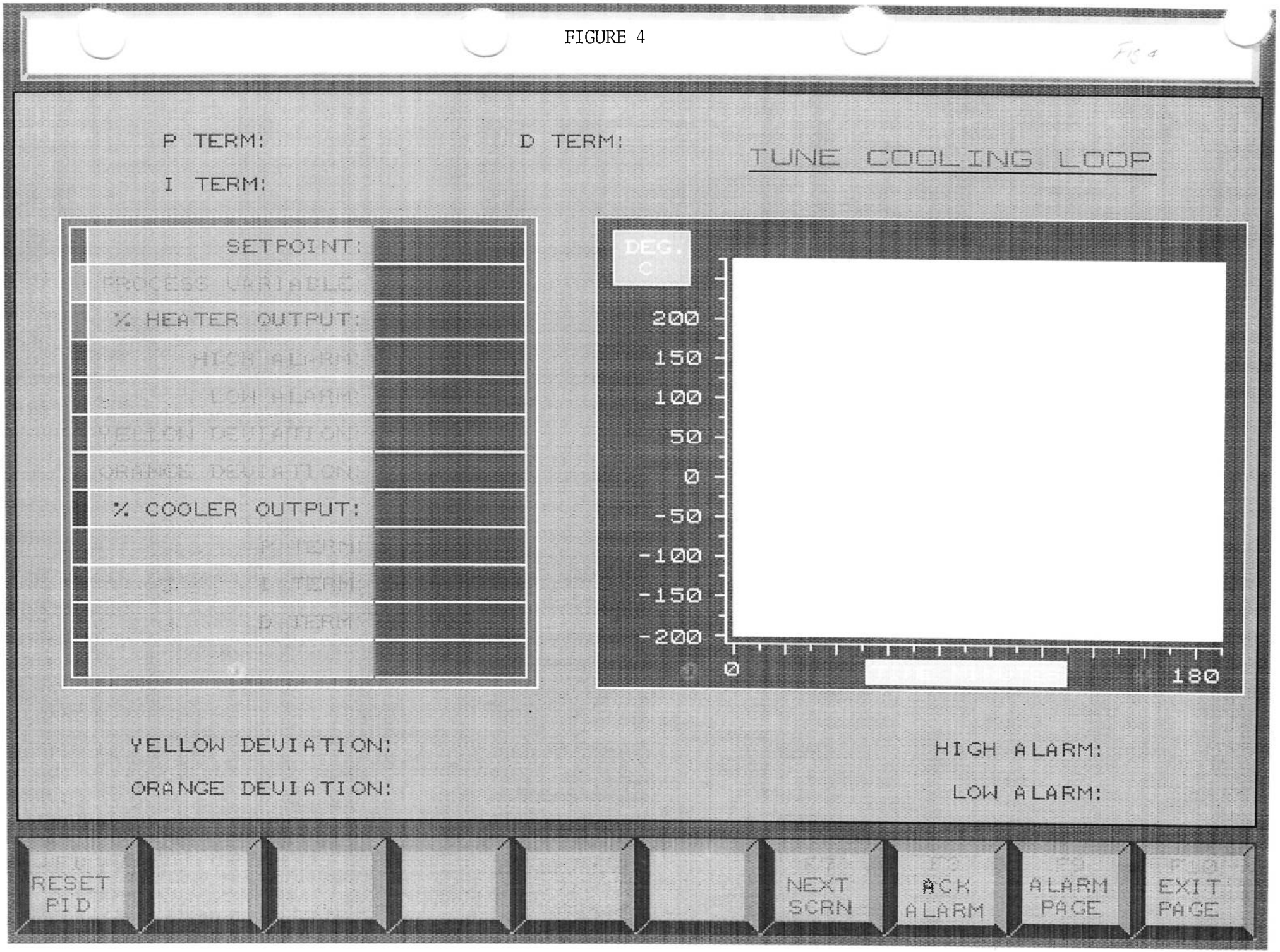

P TERM:
D TERM:
I TERM:
TUNE COOLING LOOP
SETPOINT:
% HEATER OUTPUT:
% COOLER OUTPUT:
DEG. C
200
150
100
50
0
-50
-100
-150
-200
0
180
YELLOW DEVIATION:
ORANGE DEVIATION:
HIGH ALARM:
LOW ALARM:
RESET PID
NEXT SCRN
ACK ALARM
ALARM PAGE
EXIT PAGE

FIGURE 5

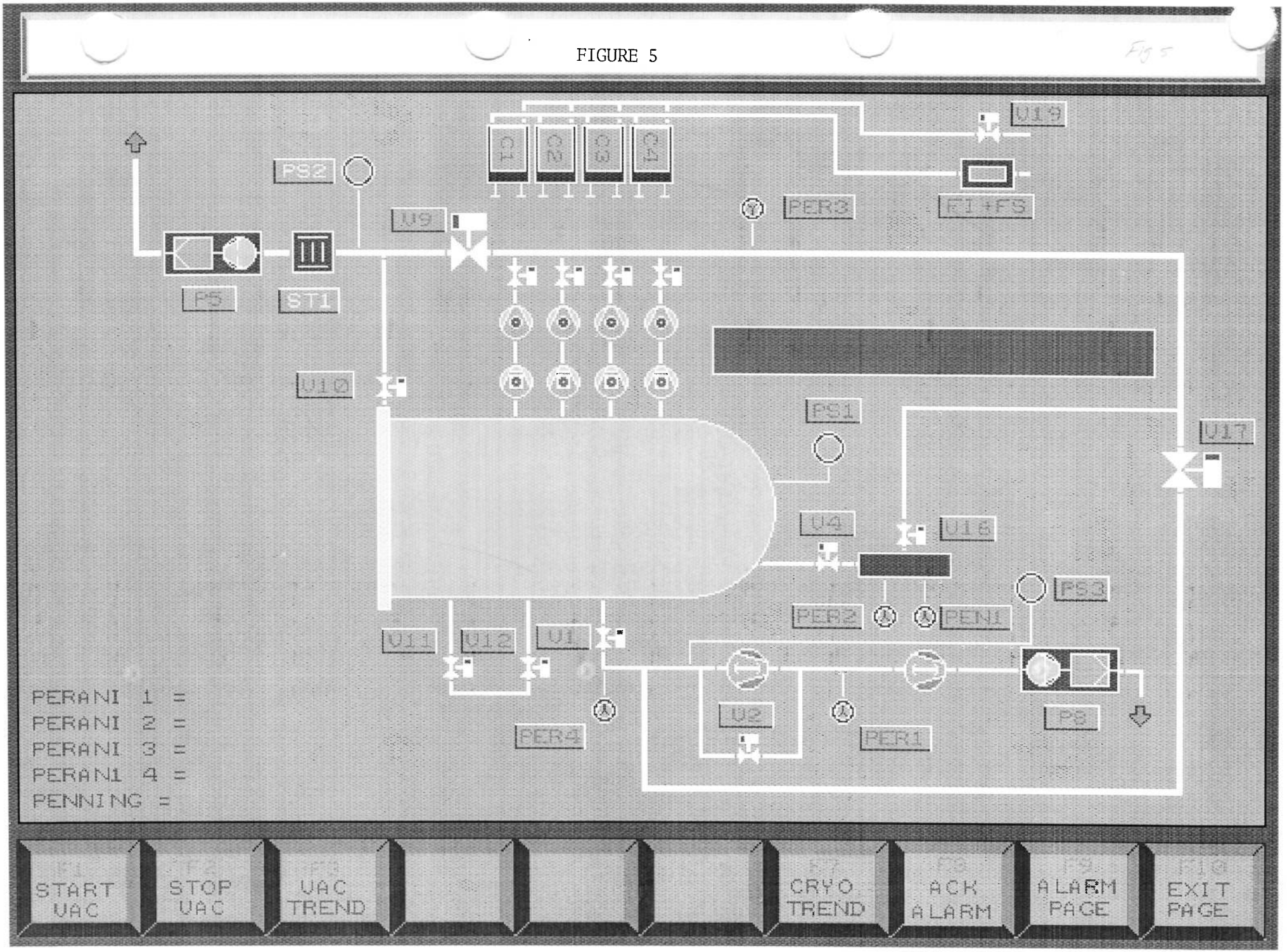

U19
PS2
U9
PER3
F1 +F5
P5
ST1
U10
PS1
U17
U4
U16
PS3
PER2
PEN1
U11
U12
U1
U2
PER1
PER4
P8
PERANI 1 =
PERANI 2 =
PERANI 3 =
PERANI 4 =
PENNING =
F1 START VAC
F2 STOP VAC
F3 VAC TREND
F7 CRYO TREND
F8 ACK ALARM
F9 ALARM PAGE
F10 EXIT PAGE

FIGURE 6

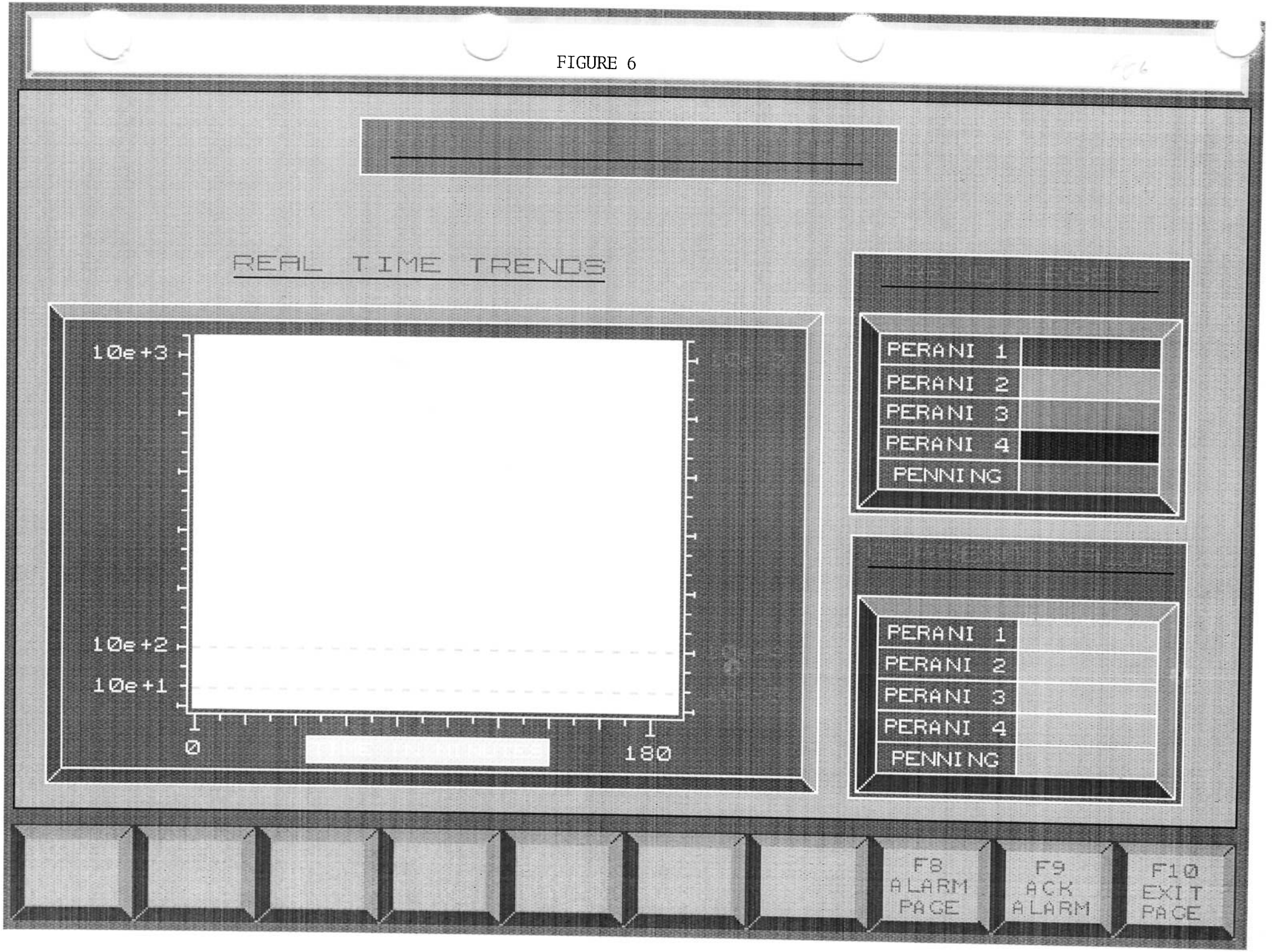

REAL TIME TRENDS
10e+3
10e+2
10e+1
0
180
PERANI 1
PERANI 2
PERANI 3
PERANI 4
PENNING
PERANI 1
PERANI 2
PERANI 3
PERANI 4
PENNING
F8 ALARM PAGE
F9 ACK ALARM
F10 EXIT PAGE

FIGURE 7

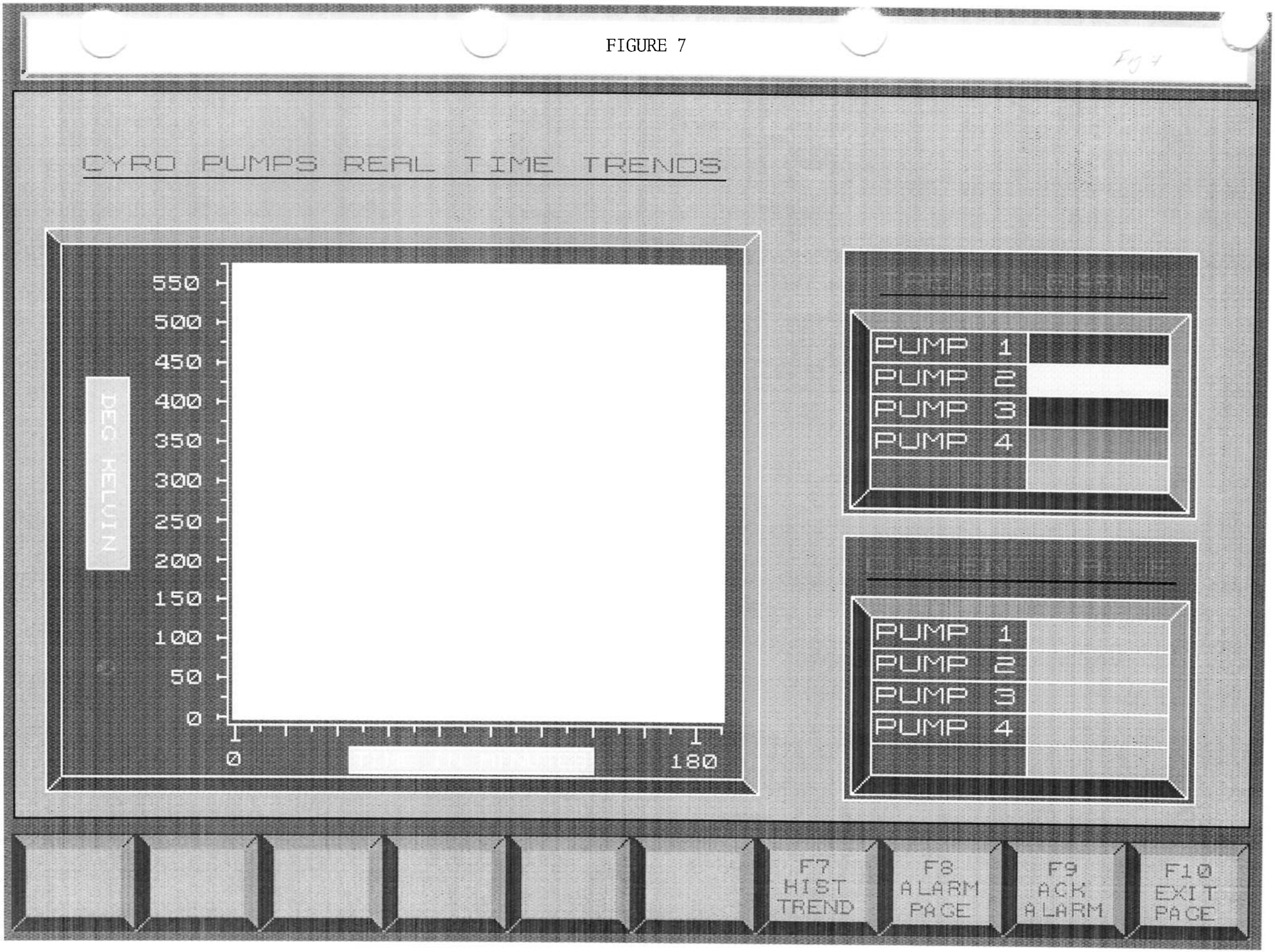
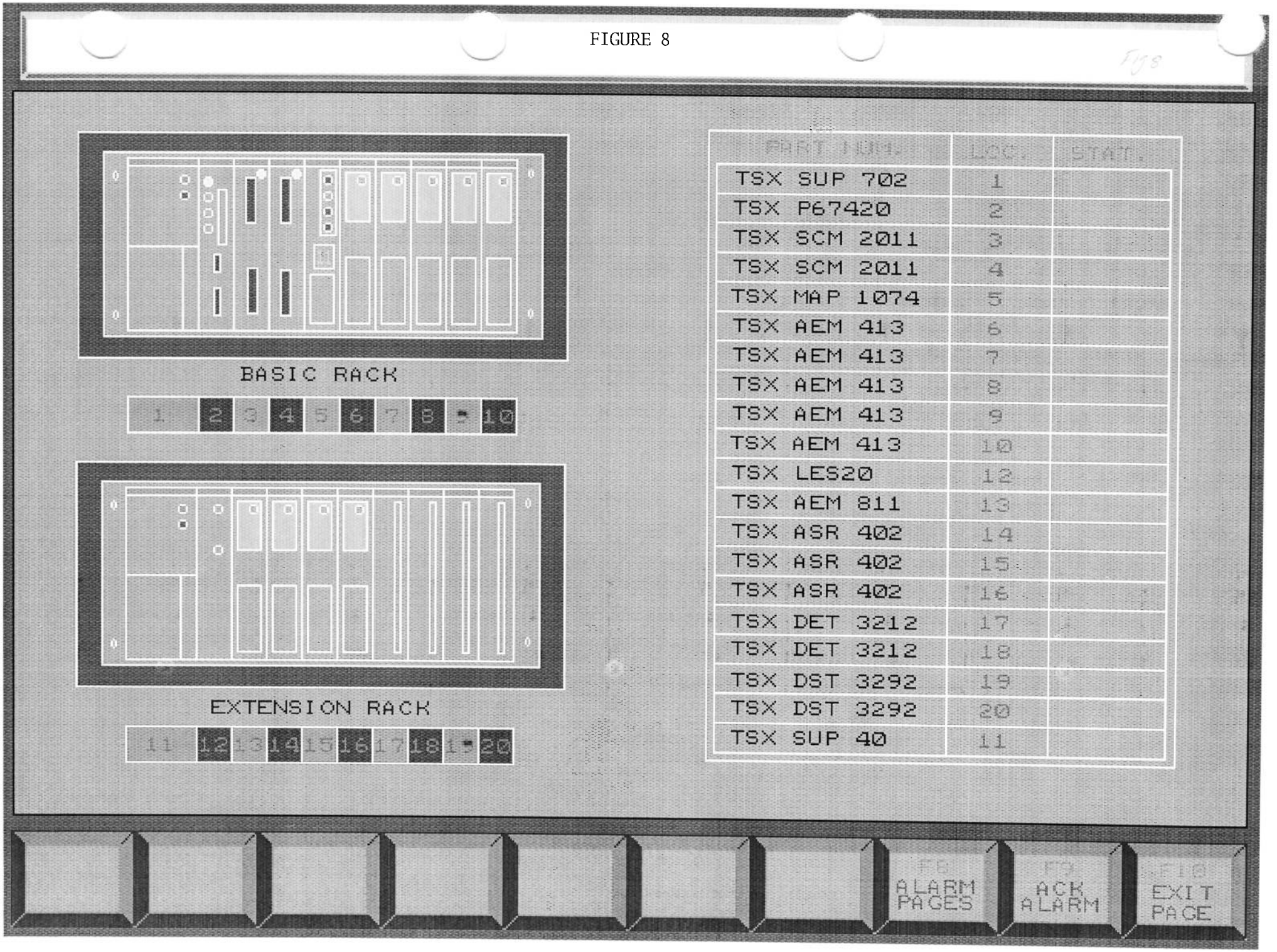

CYRO PUMPS REAL TIME TRENDS
550
500
450
400
350
300
250
200
150
100
50
0
DEG KELVIN
0
180
PUMP 1
PUMP 2
PUMP 3
PUMP 4
PUMP 1
PUMP 2
PUMP 3
PUMP 4
F7 HIST TREND
F8 ALARM PAGE
F9 ACK ALARM
F10 EXIT PAGE

FIGURE 8



PART NUM.	LOC.	STAT.
TSX SUP 702	1	
TSX P67420	2	
TSX SCM 2011	3	
TSX SCM 2011	4	
TSX MAP 1074	5	
TSX AEM 413	6	
TSX AEM 413	7	
TSX AEM 413	8	
TSX AEM 413	9	
TSX AEM 413	10	
TSX LES20	12	
TSX AEM 811	13	
TSX ASR 402	14	
TSX ASR 402	15	
TSX ASR 402	16	
TSX DET 3212	17	
TSX DET 3212	18	
TSX DST 3292	19	
TSX DST 3292	20	
TSX SUP 40	11	

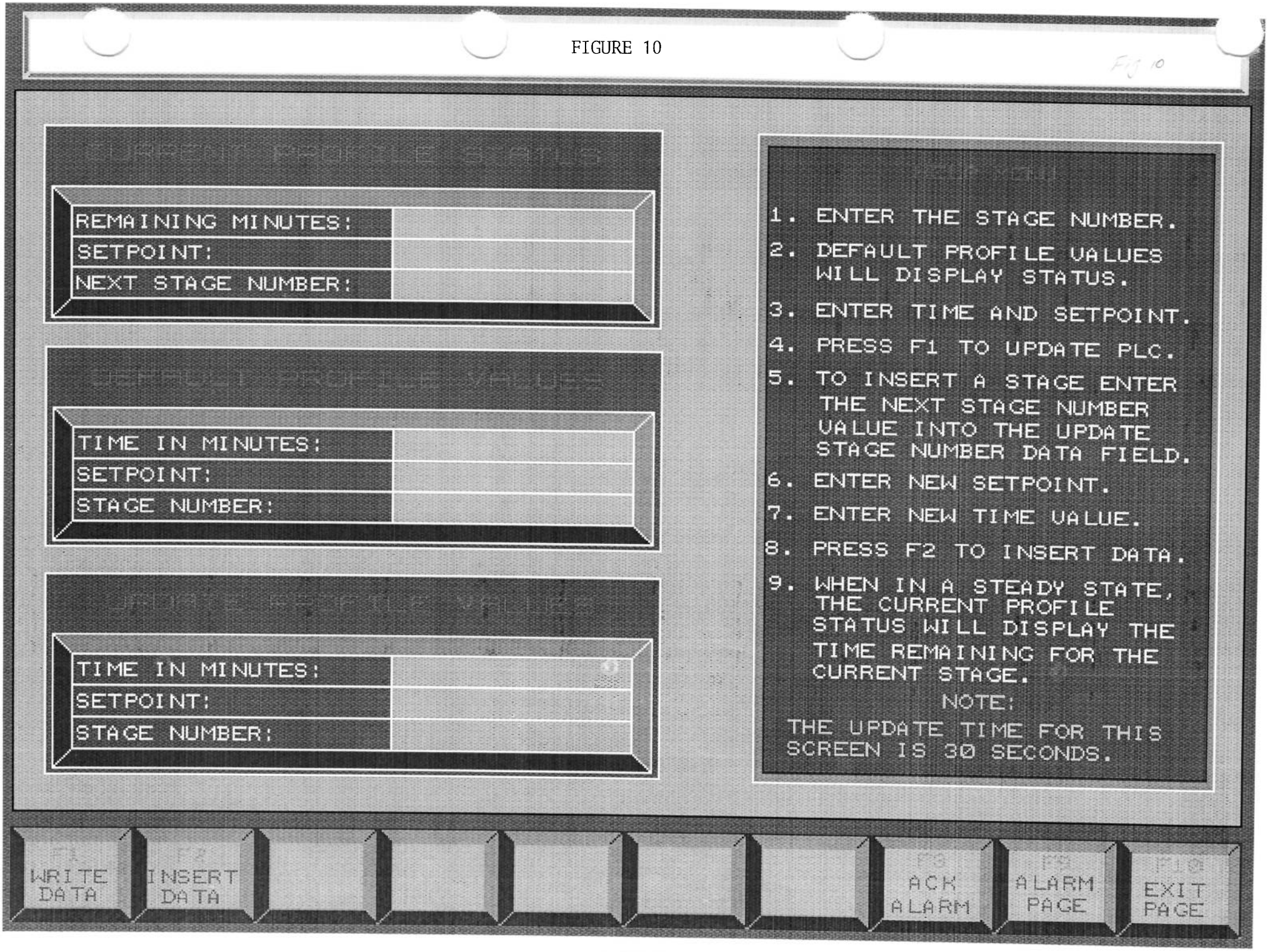
FIGURE 9

Fig 9

SETPOINT DEG. C	STAGE TIME MINUTES	STAGE NUMBER		STAGE TIME MINUTES	SETPOINT DEG. C
		0	25		
		1	26		
		2	27		
		3	28		
		4	29		
		5	30		
		6	31		
		7	32		
		8	33		
		9	34		
		10	35		
		11	36		
		12	37		
		13	38		
		14	39		
		15	40		
		16	41		
		17	42		
		18	43		
		19	44		
		20	45		
		21	46		
		22	47		
		23	48		
		24	49		

F1 DATA INPUT | F2 PURGE MODE | F3 SUPER COOL | F4 DRAIN MODE | F5 SKIP STEP | F6 | F7 | F8 ALARM PAGE | F9 ACK ALARM | F10 EXIT PAGE

FIGURE 10


CURRENT PROFILE STATUS
REMAINING MINUTES:
SETPOINT:
NEXT STAGE NUMBER:
DEFAULT PROFILE VALUES
TIME IN MINUTES:
SETPOINT:
STAGE NUMBER:
UPDATE PROFILE VALUES
TIME IN MINUTES:
SETPOINT:
STAGE NUMBER:
1. ENTER THE STAGE NUMBER.
2. DEFAULT PROFILE VALUES WILL DISPLAY STATUS.
3. ENTER TIME AND SETPOINT.
4. PRESS F1 TO UPDATE PLC.
5. TO INSERT A STAGE ENTER THE NEXT STAGE NUMBER VALUE INTO THE UPDATE STAGE NUMBER DATA FIELD.
6. ENTER NEW SETPOINT.
7. ENTER NEW TIME VALUE.
8. PRESS F2 TO INSERT DATA.
9. WHEN IN A STEADY STATE, THE CURRENT PROFILE STATUS WILL DISPLAY THE TIME REMAINING FOR THE CURRENT STAGE.
NOTE:
THE UPDATE TIME FOR THIS SCREEN IS 30 SECONDS.
F1 WRITE DATA
F2 INSERT DATA
F8 ACK ALARM
F9 ALARM PAGE
F10 EXIT PAGE

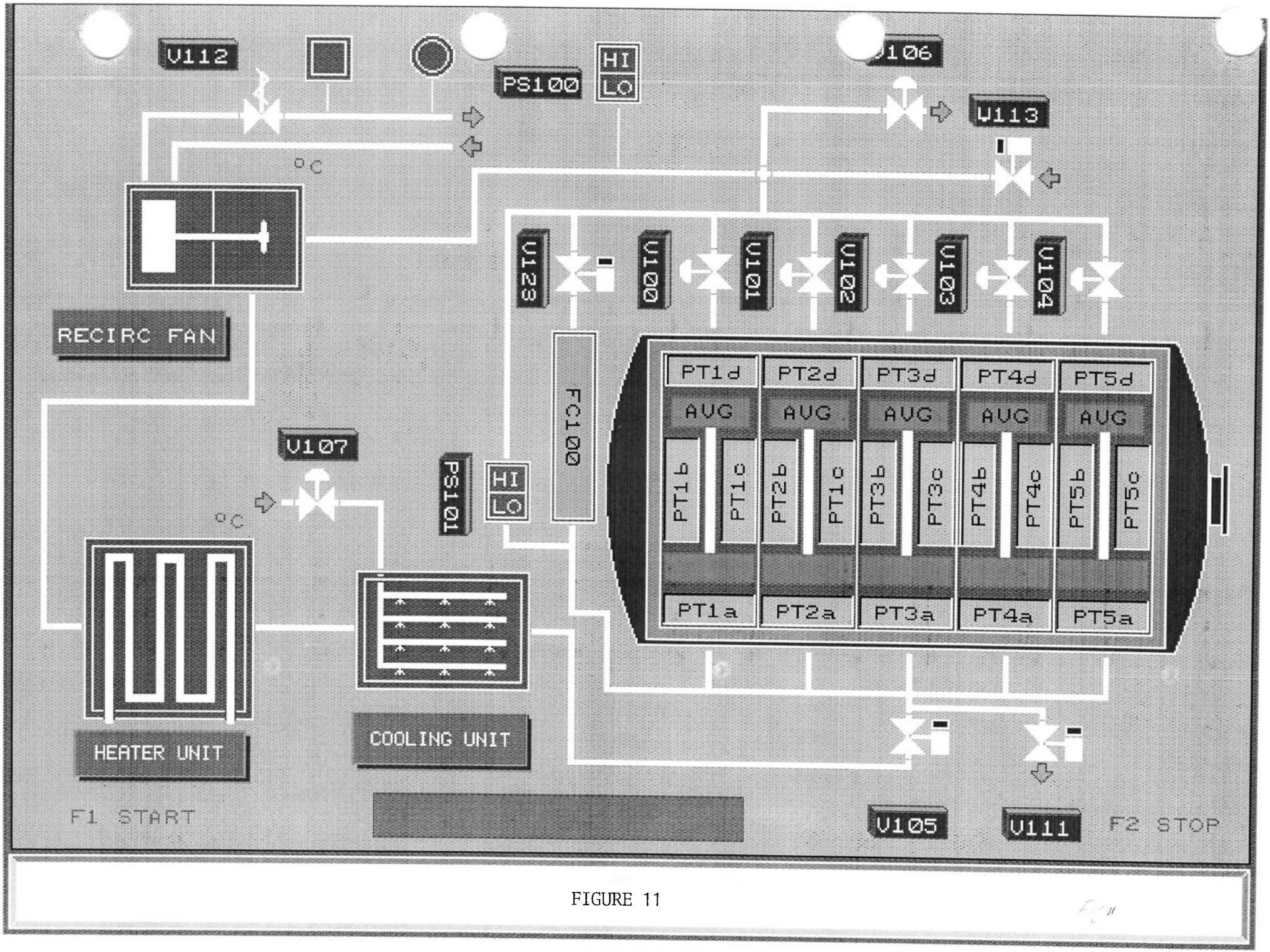

V112
PS100
HI
LO
V106
V113
°C
RECIRC FAN
V123
V100
V101
V102
V103
V104
FC100
PT1d
PT2d
PT3d
PT4d
PT5d
AVG
PT1b
PT1c
PT2b
PT2c
PT3b
PT3c
PT4b
PT4c
PT5b
PT5c
PT1a
PT2a
PT3a
PT4a
PT5a
V107
PS101
HEATER UNIT
COOLING UNIT
F1 START
V105
V111
F2 STOP

FIGURE 11

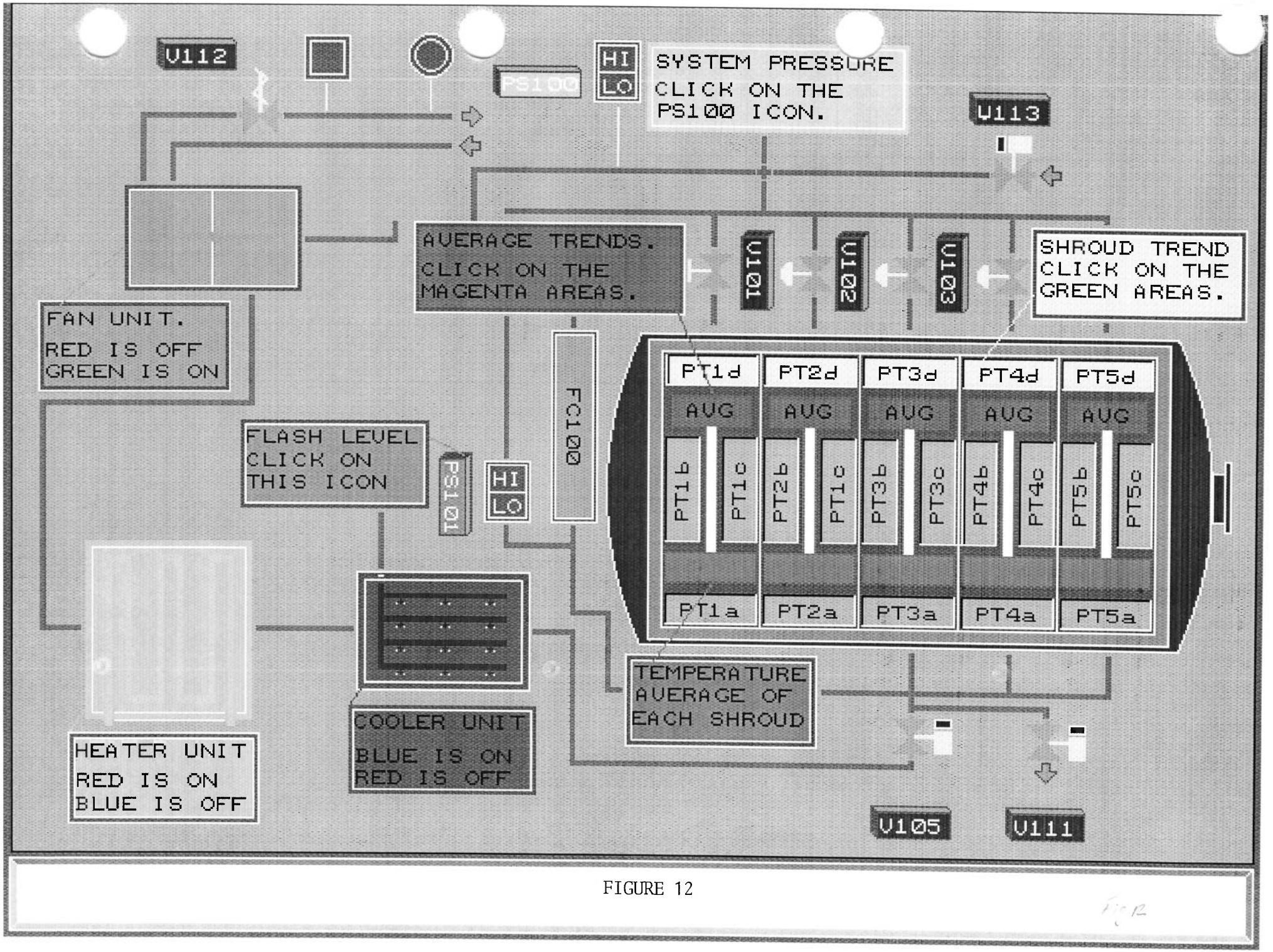

V112
PS100
HI
LO
SYSTEM PRESSURE
CLICK ON THE
PS100 ICON.
V113
AVERAGE TRENDS.
CLICK ON THE
MAGENTA AREAS.
U101
U202
U303
SHROUD TREND
CLICK ON THE
GREEN AREAS.
FAN UNIT.
RED IS OFF
GREEN IS ON
FC100
FLASH LEVEL
CLICK ON
THIS ICON
PS101
HI
LO
PT1d
PT2d
PT3d
PT4d
PT5d
AUG
PT1b
PT1c
PT2b
PT1c
PT3b
PT3c
PT4b
PT4c
PT5b
PT5c
PT1a
PT2a
PT3a
PT4a
PT5a
TEMPERATURE
AVERAGE OF
EACH SHROUD
COOLER UNIT
BLUE IS ON
RED IS OFF
HEATER UNIT
RED IS ON
BLUE IS OFF
V105
V111

FIGURE 12

FIGURE 14

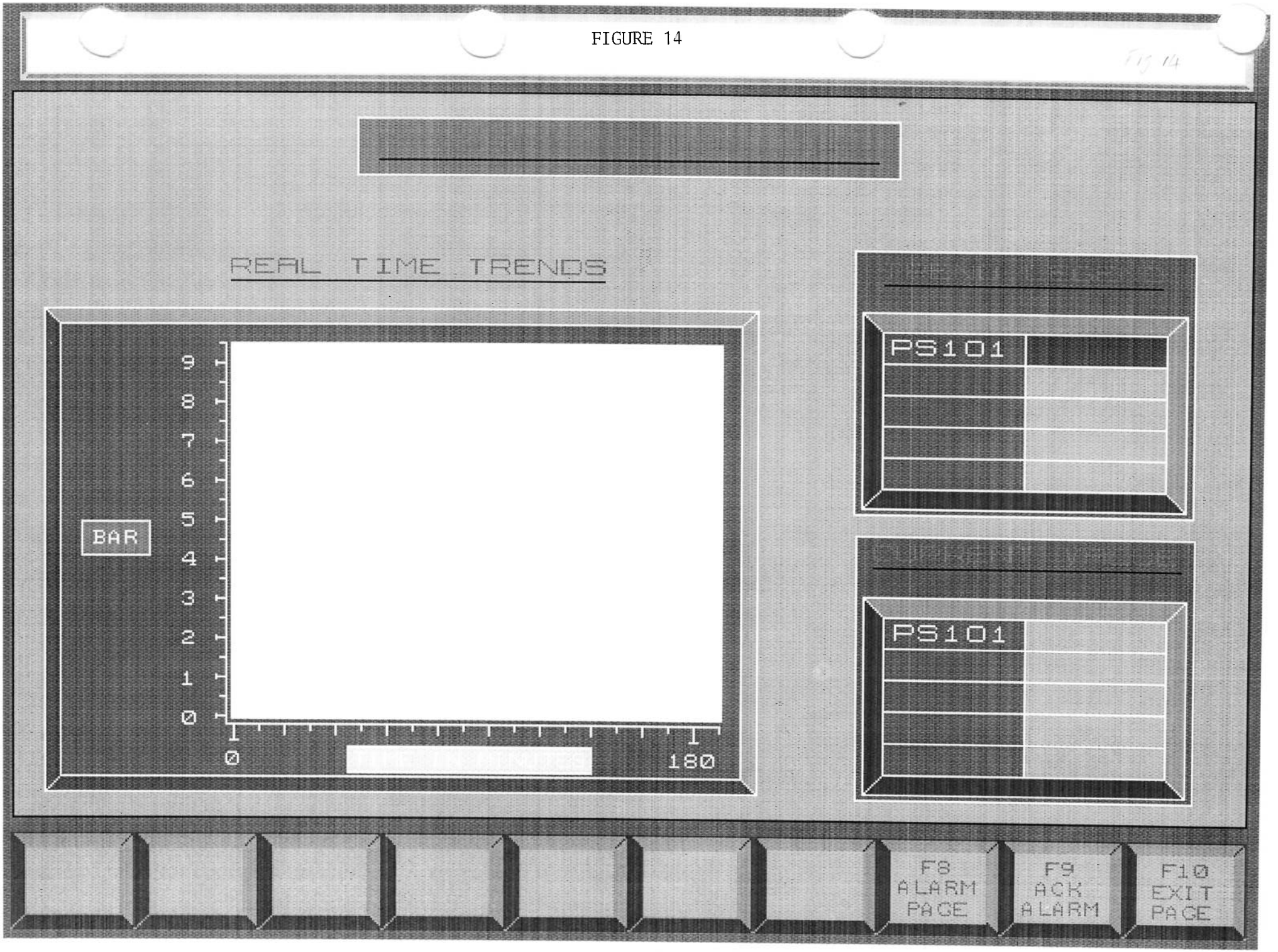
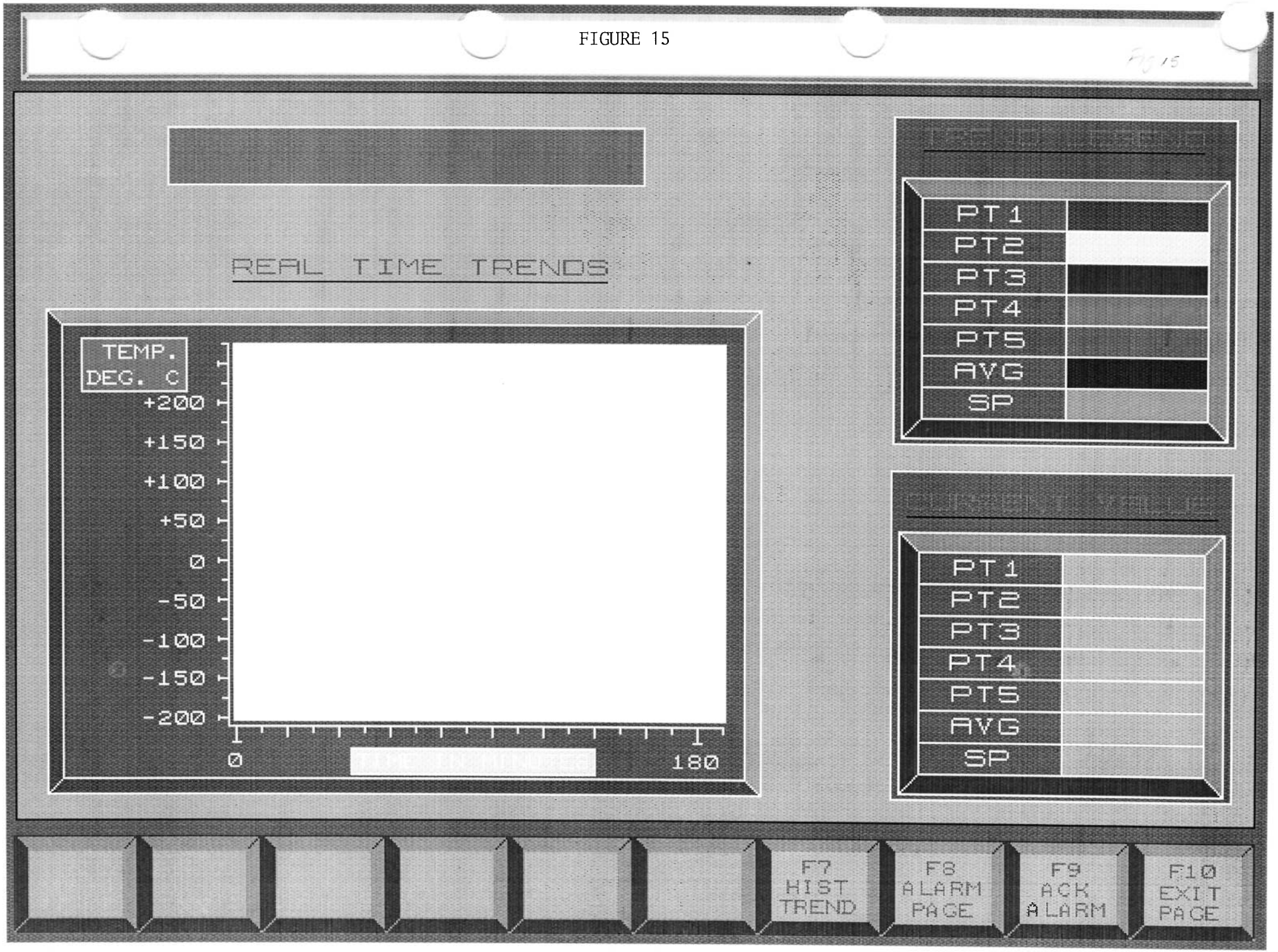

REAL TIME TRENDS
BAR
9
8
7
6
5
4
3
2
1
0
0
180
PS101
PS101
F8
ALARM
PAGE
F9
ACK
ALARM
F10
EXIT
PAGE

FIGURE 15


REAL TIME TRENDS
TEMP.
DEG. C
+200
+150
+100
+50
0
-50
-100
-150
-200
0
180
PT1
PT2
PT3
PT4
PT5
AVG
SP
PT1
PT2
PT3
PT4
PT5
AVG
SP
F7
HIST
TREND
F8
ALARM
PAGE
F9
ACK
ALARM
F10
EXIT
PAGE

SECTION 4

MAINTENANCE INSTRUCTIONS FOR THE LARGE THERMAL VACUUM FACILITY

1. INTRODUCTION

The maintenance requirements for the Vacuum System, Thermal System and Control System are given in the tables included in this paragraph.

The tables prescribe the required routine/preventative measures to be taken to maintain the system operatable. Guidelines are also given for breakdown repair. Detail instructions to follow are available in the refered documents/catalogues. Simple and logic maintenance actions like checking a valve operation etc, are not supported by detail instructions

Note: The descriptions given in the tables ask for "what" to do and not "how" to do. The "How" to do are given in the refered documents/catalogues. This maintenance instructions cover only the maintenance prescriptions of the Major Functional Components and sub-components of the system.

Maintenance intervals (time in hours, months, years, etc) refer to actual operating time. When the system is not in operation for long periods, certain maintenance is also required.

Where maintenance time intervals (hours, months, years, etc.) are not given direct or indirect, symtoms will indicate when necessary maintenance/repair is required. The catalogues often refers to such symptoms.

Warning: The client is responsible to keep his own appropriate logbook(s) of individual components, systems, sub-systems, etc.

The Maintenance Instructions are given in the following tables:

1. Table A : VTFO - Maintenance Descriptions for the Vacuum System
2. Table B : VTFO - Maintenance Descriptions for the Thermal System
3. Table C : VTFO - Maintenance Descriptions for the Control System

TABLE A	MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM			
GROUP	**ITEM DESCRIPTION**	**PREVENTATIVE MAINTENANCE**	**BREAKDOWN REPAIR**	**REFERENCE**
1. Forepump system	1.1 Pump Ruvac RA7001 Single Stage Roots Vacuum Pump	1.1.1 - Check the oil level frequently - Change oil after first 500 hours of operation and then after every 3000 hours of operation 1.1.2 Cleaning the Dirt Trap 1.1.3 Cleaning or replacing the internal demister 1.1.4 Test cooling water supply frequently (Pressure: 2-5 bar) (Consumption: 200l/h)	A falling oil level in the oiler is a sign of malfunctioning radial shaft seal, that must be replaced. In case of further serious breakdown repair or refer to the supplier, Leybold/ Krisch	VTFO-20000-128-07/1 VTFO-20000-128-07/2
	1.2 Pump 7 Ruvac WAU 2001 Single stage Roots Vacuum Pump	1.2.1 - Check the oil level frequently - Change oil after first 500 hours of operation, and then after every 3000 hours of operation 1.2.2 Cleaning the dirt trap 1.2.3 Cleaning the pump chamber 1.2.4 Test cooling water supply frequently (Pressure: 2-5 bar) (Consumption: 200 l/h)	A falling oil level in the oiler is a sign of mal-functioning radial shaft seals, that must be replaced In case of further serious breakdown repair or refer to the supplier, Leybold/ Krisch	VTFO-20000-128-08/1

TABLE A	MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM			
GROUP	**ITEM DESCRIPTION**	**PREVENTATIVE MAINTENANCE**	**BREAKDOWN REPAIR**	**REFERENCE**
	1.3 Pump 8 Varovac S630F Single Stage Rotary Vane Vacuum Pump	1.3.1 - Check the oil level frequently - Change oil after first 500 hours of operation, and hten after every 2000 hours of operation 1.3.2 Cleaning the Dirt Trap and maintenance flap 1.3.3 Cleaning the water cooler 1.3.4 Cleaning the gas ballast filter 1.3.5 Checking the float valve **<u>Note</u>: The sealing elements can be damaged if the pump runs in the wrong direction** 1.3.6 Lubrication of the bearings after 10 000 hours of operation 1.3.7 Test cooling water supply frequently: (Pressure: min of 2 bar) (Consumption: 300 l/h)	1. Exchanging the coupling **<u>Important</u>: Disconnect the motor from the mains** 2. Exchanging the Exhaust filter. In case of breakdown repair or replace, or refer to the supplier, Leybold/ Krisch	VTFO-20000-128-09/1 VTFO-20000-128-09/2

TABLE A MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM

GROUP	ITEM DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN REAPIR	REFERENCE
2. Door Seal Regenerative Pumping System	2.1 Pump 5 Trivac B Rotary Vane Pump D16B	2.1.1 - Check the oil level frequently - Change oil after first 100 hours of operation and then after every 2000-3000 hours of operation 2.1.2 Cleaning the Dirt Trap 2.1.3 Cleaning or replacing the internal demister	A falling oil level in the oiler is a sign of malfunctioning outer shaft seal, that must be replaced. In case of further breakdown, repair or refer to the supplier, Leybold	VTFO-20000-128-29/1 VTFO-20000-128-29/2
	2.2 FXC Filter AF 16-25	2.2.1 Check the oil level and clean frequently	In case of breakdwon repair or replace	VTFO-20000-128-31/1
	2.3 ST1 - Adsorption Trap FA8-16, and Heater		When the trap begins to deteriorate considerably in its effectiveness, it is time to **change the zeolite**	
3. High Vacuum Pumping system	3.1 Pump 1 - Pump 4 RPK 10 000 Cryopump	3.1.1 Replacing the charcoal adsorber and the displacers	In case of breakdown refer to the supplier, Leybold to repair or replace	VTFO-20000-128-01/1 VTFO-20000-128-01/2 VTFO-20000-128-01/3
	3.2 He1 - He4 RW 6000 Helium Compressors	3.2.1 Rinsing and filling the refrigerator with helium	In case of breakdown, repair or refer to supplier, Leybold to repair or replace	VTFO-2000-128-02/1 VTFO-20000-128-02/2 VTFO-20000-128-02/3 VTFO-20000-128-02/4

TABLE A	MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM			
GROUP	**ITEM DESCRIPTION**	**PREVENTATIVE MAINTENANCE**	**BREAKDOWN REAPIR**	**REFERENCE**
	3.3 Pump 10 - Pump 13 Thermomolecular pump Turbovac 50 DN 65		In case of breakdown refer to the supplier, Leybold to repair or replace	VTFO-20000-128-05/1 VTFO-20000-128-05/2 VTFO-20000-128-05/3
4. Vacuum Valves	4.1 - Main Test Chamber insolation valves: - Valve 1 DN250 ISO-F electro pneumatic bellow sealed gate valve - Valve 4 DN/60 ISO-F electro pneumatic valve - Valve 11 DN25 KF electro pneumatic valve - Valve 12 DN40 KF electro pneumatic valve	4.1.1 To get or maintain vacuum it is necessary to check the valves on regular basis and before major tests 4.1.2 Use the residual gas analyser and Helium Leak Detector to check the leaktightness of the valves	In case of breakdown clean or repalce the seal, or refer to the supplier, Leybold to repair or replace	VTFO-20000-128-20/1 VTFO-20000-128-20/2 VTFO-20000-128-24/1 VTFO-20000-128-24/2
	4.2 All the other valves	4.2.1 Check the operation of the valves frequently	In case of breakdown clean or replace the seal, or refer to the supplier, Leybold to repair or replace	VTFO-20000-128-20/1 VTFO-20000-128-20/2 VTFO-20000-128-21/1 VTFO-20000-128-21/2 VTFO-20000-128-22/2 VTFO-20000-128-23/2 VTFO-20000-128-24/1 VTFO-20000-128-24/2 VTFO-20000-128-25/1

TABLE A	MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM			
GROUP	ITEM DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN REAPIR	REFERENCE
5. Hydraulic System for door clamping	5.1 Hydraulic Pump and door-clamps (Hydraulic Cilinders)	5.1.1 Check for hydraulic leaks in the system 5.1.2 Check the oil level of the pump 5.1.3 Check and adjust if necessary the pressure regulator for the system pressure	In case of breakdown, repair or refer to the supplier, Hy-design (Krugersdorp) to re-pair or replace	
6. Pressure Measure and Controlling Instrumentation	6.1 Pressure swith Type SM42		In case of breakdown replace or refer to supplier, Leybold to repair	VTFO-20000-128-10/1 VTFO-20000-128-10/2
	6.2 SV110 Switching Ampli-fiers for SM42 Type SV110		In case of breakdown replace or refer to supplier, Leybold to repair	VTFO-20000-128-11/1 VTFO-20000-128-11/2
	6.3 PS1 Safety Vacuum Switch Type SM40			VTFO-20000-128-12/1
	6.4 DG1 - DG5 Capsule vacuum guage		In case of breakdown replace or refer to supplier, Leybold to repair	VTFO-20000-128-13/1 VTFO-20000-128-13/2
	6.5 Combitron CM350 com-bination Pirani/Penning Measuring System		In case of breakdown replace or refer to supplier, Leybold to repair	VTFO-20000-128-14/1

TABLE A	MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM				
GROUP	ITEM DESCRIPTION		PREVENTATIVE MAINTENANCE	BREAKDOWN REAPIR	REFERENCE
	6.6	PEH1 Penning Measuring Head type PR35	6.6.1 Cleaning of the guage head in general 6.6.2 Mechanical Maintenance: - Removing the anode ring and the cathode plate, to clean or replace **Note: The ceramics disc must be exchanged each time the anode ringor cathode plate is exchanged or cleaned** - Detaching the permanent magnet to clean or replace	In case of breakdown repair or replace as required	VTFO-20000-128-15/1 VTFO-20000-128-15/2
	6.7	PH1 - PH4 Pirani Sensing Head Type TR301	6.7.1 Cleaning the Thermovac Guage Head in general **Important: Do not clean the sensing tube mechanicallky (brush or similar) because this damages the sensing filament**	In case of breakdown repair or replace as required	VTFO-20000-128-16/1 VTFO-20000-128-16/2
	6.8	Pirani Measuring System Thermovac Type TM321		In case of breakdown replace or refer to the supplier, Leybold, to repair	VTFO-20000-128-19/1 VTFO-20000-128-19/2
7. Special Equipment and Instruments	7.1	Ultratest UL500 Helium Leak Detector	7.1.1 Checking the oil level and Gas Ballast Switch of the Auxiliary Pump or forepump	In case of breakdown refer to the supplier, Leybold for repair	VTFO-20000-128-34/1 VTFO-20000-128-34/2

TABLE A		MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM		
GROUP	ITEM DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN REAPIR	REFERENCE
		7.1.2 Exchanging the Fluorescent Tube behind the display (after 1000 - 2000 operating hours) **Note: Exchaning of the Fuorescent Tube should be done by Leybold the supplier, as the display can easily be damaged**		
		7.1.3 Changing the fuses on the Power Distribution (LV) Front panel **Caution: Before exchanging the fuses, switch off the unit and diconnect it from the mains**		
		7.1.4 Exchanging the filter mat when applicable		
		7.1.5 If condensed water has collected in the compressor buffer vessel of the compressor assembly, the buffder vessel has to be drained when applicable		
	7.2 Viscovac VM212 Insatrument and pinter module		7.2.1 Exchanging the EPROMS (D003) 7.2.2 Exchanging the RAM (D001) 7.2.3 Exchanging the PALS (D006, D011, D014, D016) In case of further breakdown refer to the supplier for repair	VTFO-20000-128-35/1

TABLE A	MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM			
GROUP	**ITEM DESCRIPTION**	**PREVENTATIVE MAINTENANCE**	**BREAKDOWN REAPIR**	**REFERENCE**
	7.3 Residual Gas Analyser RGA Type QX2000-01211000 including 9m cable		**Warning: High voltage exists in the cables, control display unit and the interface unit. Extreme care should be exercised when operating the unit with covers removed** 7.3.1 Interchaning sensors 7.3.2 Servicing and cleaning the sensors **Caution: Do not attempt to clean the head (with solvents) without disassembling** **Warning: Precautions must be taken when performing any service operations on the sensors. They are:**	VTFO-20000-128-36/1 VTFO-20000-128-36/2

TABLE A	MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM			
GROUP	ITEM DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN REAPIR	REFERENCE
			1. Performing any servicing in a clean area 2. Wear clean nylon, lint-free lab gloves or finger cots 3. Avoid touching any part of the sensor with unprotected fingers 4. Use clean tools for sensor disassembly (and assembly) 7.3.3 Filament Replacement **<u>Caution</u>: The filament can't be cleaned. The filament, which is thoria-coated iridium, will be damaged if cleaned with cleaning solutions such as acetone** 7.3.4 Ion source removal and disassembly	

TABLE A	MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM			
GROUP	ITEM DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN REAPIR	REFERENCE
			Note: Note the orientation of all lenses before disassembly. Each lens must be re-assembled in the same orientation 7.3.5 Sensor cleaning **Caution: The quadrupole filter rods should not be dis-assembled for cleaning. Minor cleaning can be done with the ion source removed** 7.3.6 Replacing the elec-tron multiplier	

TABLE A	MAINTENANCE INSTRUCTIONS FOR VACUUM SYSTEM			
GROUP	ITEM DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN REAPIR	REFERENCE
			Caution: The elec tron multiplier cant be cleaned. If ex-cessive degration is noted, it should be replaced. Unless you are familiar with electron multipliers, send the sensor to the supplier, Leybold for replacement In case of further breakdown refer to the supplier Leybold for repair or replacement.	

TABLE B	MAINTENANCE INSTRUCTIONS FOR THERMAL SYSTEM			
GROUP	ITEM DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN REPAIR	REFERENCE
1 Gas re-circulation Fan		1.1 Annual visual inspection of the outer jacket 1.2 After the first 2000 operating hours, a full inspection of the electric motor, rotating impeller, cooling coil, etc, is required 1.3 After every year of operation a major inspection of the fan and all its internals in detail is required	In case of breakdown repair or replace as required **Warning: Ensure that the fan is electrically isolated and that the cooling water supply is switched off**	VTFO-30000-128-01/1
2 Heater Unit		2.1 Annual visual inspection of the heating elements 2.2 Check the heater elements electricaly on the outside for "burn outs", every 3 months of operation 2.3 After every year of operation the heater and its internals must be inspected in detail	In case of breakdown repair or replace heater unit elements **Warning: Ensure that the isolation valve at the liquid nitrogen storage tank is closed and that there is no pressure in the liquid nitrogen pipeline**	
3. Cooler unit			In case of breakdown or deteriorating perfor-mance clean or re-place the injection unit nozzles	VTFO-30000-128-01/1

TABLE B	MAINTENANCE INSTRUCTIONS FOR THERMAL SYSTEM			
GROUP	**ITEM DESCRIPTION**	**PREVENTATIVE MAINTENANCE**	**BREAKDOWN REPAIR**	**REFERENCE**
4. Piping system			**<u>Warning</u>: Ensure that the isolation valve at the liquid nitrogen storage tank is closed and that there is no pressure in the liquid nitrogen pipeline** In case of gas leak tighten the bolts or replace the seal	
5 Valves	Safety valves V117, V120 and V121	Annual testing and pressure setting to 6,5 bar gauge. To be tested by supplier (Bestobell)		
6 Pressure vessels general	Thermal system pressure boundary include: - Fan housing - Heater housing - Cooler housing - Pipework and manifolds - Shrouds	Regular pressure tests to comply to Reg of MOS. ACT. 6; 1983		

MAINTENANCE INSTRUCTIONS FOR LARGE THERMO-VACUUM FACILITY

TABLE C	MAINTENANCE INSTRUCTIONS FOR CONTROL SYSTEM				
NO	ITEM	MODEL	DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN/REPAIR
	refer VTFO -42000-08				
1	9	TSX 67420	PROCESSOR UNIT	NONE	TELEMECANIQUE
2	9	TSX SUP702	POWER SUPPLY	NONE	TELEMECANIQUE
3	9	TSX RKN 82	8 SLOT RACK UNIT	NONE	TELEMECANIQUE
4	10	TSX SCM 2011	2 CHANNEL RS232	NONE	TELEMECANIQUE
5	10	TSX SCM 2011	2 CHANNEL RS232	NONE	TELEMECANIQUE
6	11	TSXMAP1074	MAPWAY COMS CARD	NONE	TELEMECANIQUE
7	12	TSXAEM413	4 CHANNEL PT100 I/P	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
8	12	TSXAEM413	4 CHANNEL PT100 I/P	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
9	12	TSXAEM413	4 CHANNEL PT100 I/P	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
10	12	TSXAEM413	4 CHANNEL PT100 I/P	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
11	12	TSXAEM413	4 CHANNEL PT100 I/P	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
12	14	TSX AEM 811	ANALOG 8 CHANNEL	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
13	15	TSX ASR 402	4-20 mA 4 CHANNEL	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
14	15	TSX ASR 402	4-20 mA 4 CHANNEL	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
15	15	TSX ASR 402	4-20 mA 4 CHANNEL	RECOMMEND ANNUAL CALIBRATION	TELEMECANIQUE
16	16	TSX DET 3212	DISCRETE 24 VDC	NONE	TELEMECANIQUE
17	16	TSX DET 3212	DISCRETE 24 VDC	NONE	TELEMECANIQUE
18	17	TSX DST 3292	DISCRETE 24 VDC	NONE	TELEMECANIQUE

MAINTENANCE INSTRUCTIONS FOR LARGE THERMO-VACUUM FACILITY

TABLE C		MAINTENANCE INSTRUCTIONS FOR CONTROL SYSTEM			
NO	**ITEM**	**MODEL**	**DESCRIPTION**	**PREVENTATIVE MAINTENANCE**	**BREAKDOWN/REPAIR**
19	17	TSX DST 3292	DISCRETE 24 VDC	NONE	TELEMECANIQUE
20	13	TSXRCE860	8 SLOT RACK UNIT	NONE	TELEMECANIQUE
21	24	VTFM-42035	24 VOLT PSU	NONE	IST
22	25	EMG 10-KSR	24V RELAY	NONE	PHOENIX
23	21	CM351	VACUUM INST.	RECOMMEND ANNUAL CALIBRATION	LEYBOLD
24	22	CM305	VACUUM INST.	RECOMMEND ANNUAL CALIBRATION	LEYBOLD
25	3	EVEREX 386	COMPUTER	NONE	HP
26	1	HP	VGA SCREEN	CLEAN DISPLAY WITH SOAP ONLY	HP
27	28	LRX -200 TO 200	3 WIRE PT100 TX	RECOMMEND ANNUAL CALIBRATION	EMMANUEL ELECTRONICS
	refer VTFO -45000-08				
28	3	IAL4-00014	24 PIN I/O CARD	NONE	IST
29	7	HU1	HEATER UNIT	NONE	LEYBOLD/KRISCH
30	7	HU1	HEATER UNIT	NONE	LEYBOLD/KRISCH
31	7	HU1	HEATER UNIT	NONE	LEYBOLD/KRISCH
32	7	HU1	HEATER UNIT	NONE	LEYBOLD/KRISCH
33	6	LTI10	TEMPERATURE INST	NONE	LEYBOLD/KRISCH
34	6	LTI10	TEMPERATURE INST	NONE	LEYBOLD/KRISCH
35	6	LTI10	TEMPERATURE INST	NONE	LEYBOLD/KRISCH

MAINTENANCE INSTRUCTIONS FOR LARGE THERMO-VACUUM FACILITY

TABLE C		MAINTENANCE INSTRUCTIONS FOR CONTROL SYSTEM			
NO	**ITEM**	**MODEL**	**DESCRIPTION**	**PREVENTATIVE MAINTENANCE**	**BREAKDOWN/REPAIR**
36	6	LTI10	TEMPERATURE INST	NONE	LEYBOLD/KRISCH
37	4	NT50	POWER SUPPLY	NONE	LEYBOLD/KRISCH
38	4	NT50	POWER SUPPLY	NONE	LEYBOLD/KRISCH
39	4	NT50	POWER SUPPLY	NONE	LEYBOLD/KRISCH
40	4	NT50	POWER SUPPLY	NONE	LEYBOLD/KRISCH
	refer VTFO -47000-08				
41	1	XBTVB	OPERATOR DIALOG	CLEAN KEYBOARD WITH SOAP ONLY	TELEMECANIQUE
42	2		RGB/VIDEO MONITOR	CLEAN DISPLAY WITH SOAP ONLY	PHILIPS
	refer VTFO -46000-08				
43		XBTVA	OPERATOR DIALOG	CLEAN DISPLAY WITH SOAP ONLY	TELEMECANIQUE
	Refer VTFO -44000-08				
44	16	VARISPEED 7,5KW	7,5KW VARIABLE SPEED	RECOMMEND ANNUAL CALIBRATION	VARI-SPEED

MAINTENANCE INSTRUCTIONS FOR LARGE THERMO-VACUUM FACILITY

TABLE C		MAINTENANCE INSTRUCTIONS FOR CONTROL SYSTEM			
NO	ITEM	MODEL	DESCRIPTION	PREVENTATIVE MAINTENANCE	BREAKDOWN/REPAIR
45	2	PHASECON 45KW	45KW THYRISTOR	RECOMMEND ANNUAL CALIBRATION	PHASECON
46	1	4-20mA,20-100KPA	I TO P CONVERTER	RECOMMEND ANNUAL CALIBRATION	EMMANUEL ELECTRONICS
47	17	SHIMANDEN SR24	PID LOOP CONTROLLER	NONE	N.S.C.
48	18	SHIMANDEN SR24	PID LOOP CONTROLLER	NONE	N.S.C.

SECTION 5

TROUBLE SHOOTING

1. INTRODUCTION

This section provides information for the identification and solution of all major failures experienced on the large thermo-vacuum facility.

The failure symptom or problem, actual failure or fault, detection method, probable cause and solution to the failure or fault is given in the tables hereto.

The tables are given in the following order:

1. Vacuum System
2. Thermal System
3. Main Control and Data Acquisition System

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM

PROBLEM/ SYMPTOM	FAILURE/FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/REMEDY	REMARKS/ REFERENCES
1. LOSS OF HIGH VACUUM	1.a Failure of helium compressor - slow pumping speed - stop working	1.a - Temperature rise of cryo-pump head. - Low He pressure on pressure gauge - "No-moving" He pressure gauge needle - Audio sensing	1.a - Helium leak - Broken/damaged helium compressor - Overheat (self protection) - Electrical Power failure - Faulty control signal	1.a - Detect leak repair and refil compressor - Connect affected cryo-pump with any other helium compressor - Automatic reset after 3 hours - Check water supply, restore if necessary - Check electrical power supply, restore if necessary - Check control signal, repair if necessary	Refer to catalogues
	1.b Cryogenic cold head failure (stop working)	1.b - Audio sensing by ear - Rise in temperature	1.b - Broken/damaged helium compressor - Broken/damaged cold heat	1.b - Refer to failure of helium compressor (1a). - Return to supplier for repair, or repair insitu by qualified Technician	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM

PROBLEM/ SYMPTOM	FAILURE/FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/REMEDY	REMARKS/ REFERENCES
	1.c Isolation valve(s) failure (Unexpected valve switching)	1.c - Check valve status on control panel - Visual/physical check of valves status	1.c - Broken/damaged vavle - No control signal - No compressed air	1.c - Repair broken valve - Restore control signal - Restore compressed air	Refer to catalogues
	1.d Vacuum leak (developed)	1.d - Detect gas composition/leak using RGA - Assumption of vacuum leak if failure is not due too one of other failures	1.d - Leaking seals - Latent leaks open - Structural fatigue - Electrical feadthrough leak	1.d - Replace defective seals: **Note: Defective seals can be temporally seal-ed with putty** - Repair leak or structural damage - Replace defective electrical feadthrough	

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/REMEDY**	**REMARKS/ REFERENCES**
	1.e Gryo-pump saturated	1.e - Test accordance with saturation test procedure - Second stage cold heat tempe- rature rise	1.e - Capacity limi-tation - Switched on at a too high pres-sure initially - Operate at too high pressure for too long	1.e - Clean by regene-ration	Refer to paragraph in this manual for proce-dure "Rege-neration" of Cryo-Cryopumps
	1.f Vacuum measurement system failure	1.f - Compare Penning vacuum reading with Viscovac reading	1.f - Dirty Penning sensing head - Faulty Penning sensing head - Damaged cables - Faulty vacuum instrument (Combitron) - Software error on PLC system	1.f - Service Penning head - Repair/replace Penning sensing head - Repair cables - Repair/replace vacuum instru-ment - Rectify error on PLC system	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM

PROBLEM/ SYMPTOM	FAILURE/FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/REMEDY	REMARKS/ REFERENCES
2. UNABLE TO ACHIEVE HIGH VACUUM	2.a Under performance of high vacuum pump system (unable to achieve low temperatures on cryo-pump cold heads)	2.a - Check temperature of all cold heads (to be lower than 13°K)	2.a - Failure of helium compressor(s) (refer to 1(a) above) - Cryogenic cold head failure (refer to 1(b) above) - Contaminated helium if non of other causes - Contaminated cold heads	2.a - Refer to failure of helium compressor 1(a) above - Refer to 1(b) Cryogenic cold head failure - Replace with clean helium - Clean cold heads by regeneration - Clean cold heads in accordance with cleaning procedure (special activity)	
	2.b Contaminated vessel	2.b - Contamination level determined in accordance with procedure Houwteq doc no. - RGA determine volatile materials	2.b - Contamination due to open vessel	2.b - Clean vessel in-accordance with cleaning procedure doc no.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM

PROBLEM/ SYMPTOM	FAILURE/FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/REMEDY	REMARKS/ REFERENCES
		- FTC measuring condensable materials			
	2.c Excessive high out-/ degassing of experiment	2.c - Contamination level determined in accordance with procedure Houwteq doc. no. - RGA determine volatile materials - FTC measuring condensable materials	2.c - Material charac-teristics	2.c - To be decided by user, eg. use other material(s)	
	2.d External leak	2.d - Detect gas com-position by RGA (high O_2 and M_2 or tracer gas levels)	2.d - Leaking seals - Latent leaks open - Structural fa-tigue - Electrical pene-tration leak	2.d - Replace defec-tive seals. **Note: Defective seals can be temporally sealed with putty** - Repair leak or structural damage - Replace defec-tive penetration	Follow procedure Houwteq doc no. "Procedure to find and repair a va-cuum leak in the thermal facility

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM				
PROBLEM/ SYMPTOM	**FAILURE/FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/REMEDY**	**REMARKS/ REFERENCES**
	2.e Internal leak	2.e - Detect gas composition by RGA (for shrouds) - Detect gas composition by RGA (experiment)	2.e - Leaking shroud - Experimental leak	2.e - Locate and repair leak on shroud - To be decided by user	"Follow procedure to find and repair a va-cuum leak in the thermal va-cuum facility Houwteq doc no.
3. SUDDEN CHANGE OF GAS COMPOSITION INSIDE VESSEL	3.a Unexpected experimental degassing/outgassing or internal leak	3.a - Detect by RGA	3.a - Experimantal characteristics	3.a - To be decided by user (engineering and cientific analysis and synthesis)	
	3.b Unexpected leak development	3.b - Detect by RGA	3.b - As per internal and external leaks 2(d) and 2(e)		
	3.c Faulty RGA sensing head	3.c Indicated by RGA instrument (this statement to be verify)	3.c - Inherent cause	3.c - Replace, repair or couple additional/spare RGA sensing head to instrument port	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/REMEDY**	**REMARKS/ REFERENCES**
4. UNABLE TO START VACUUM SYSTEM	4.a Software error	4.a - Non flickering lights on PLC - Mapway error on screen (monitor 77 error) - Interlock active - Check communication signal from PLC to Combitron and Thermovac (Ref Remote indication)	4.a - Mapway cable error - Mapway card failure - Refer interlocking flow diagram - PLC off line - PLC not initialised	4.a - Check cable/card (repair/replace) - Restart PLC - Correct error - Panic abord	
	4.b Electrical supply failure	4.b - Check voltage at Interface and sub panels	4.b - Main supply off - Isolation switch off - Trip switch(es), solonoid(es) or fuse(s) activated (short circuiting)	4.b - Restore electrical supply - Switch isolation on - Find short circuit starting testing at relevant components	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/REMEDY**	**REMARKS/ REFERENCES**
	4.c Control Signal Failure	4.c - Measure at point of control	4.c - Faulty cable - Loose connections - Relay faulty	4.c - Repair or replace cable - Fix cables at connector blocks - Test for short circuiting and replace fuce	
5. STRANGE NOISES	5.a Gas ballast open of rotary vane pump	5.a - See ballast valve status on rotary van pump	5.a - Valve was opened for cleaning oil of pump	5.a - Close valve by hand	
	5.b Bypass valve closed while rootspump P6 not running	5.b - Whistle noise through roots pump P6 - Check valve status on PLC/PC or check visually status on valve	5.b - Wrong or no control signal - Stucking valve	5.b - Check and restore/correct signal - Repair valve	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM

PROBLEM/ SYMPTOM	FAILURE/FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/REMEDY	REMARKS/ REFERENCES
	5.c Faulty forepumps	5.c - By ear, friction like noise	5.c - Pump turn wrong direction - Contaminted with dirt - Worn pump	5.c - Correct electric supply for correct phase coupling - Clean pump(s) out. Replace components which are damaged. Remove/ repair source of contamination - Service pumps, replace parts which are out of specification	Refer to Catalogues
6. FAST SATURATION OF CRYO-PUMPS	6.a Dirty vessels	6.a - RGA composite evaluation	6.a - Vessel was not thoroughly cleaned out before strarting evacuation	6.a - If it's impossilbe to de-evacuate, start regenerative process/cycle. - If de-evacuation is possible, clean out vessel according to procedure	See Houwteq doc no.

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/REMEDY**	**REMARKS/ REFERENCES**
	6.b Leaking vessel	6.b - RGA composite evaluation; high percentage of O_2 or N_2	6.b - Leaking valve - Leaking seal(s) - Leaking shroud - Leaking of base material, eg weld etc.	6.b Replace and/or repair as per 2(d) or 2(e)	Follow procedure "Procedure to find and repair a leak in thermal vacuum facility" Houwteq doc no
	6.c High degassing/out-gassing rate of equip-ment under test	6.c - RGA composite evalaution - FTC output eva-luation	6.c - Wrong material used - Dirty equipment	6.c - Use correct (low outgassing) material - Clean equipment before thermal vacuum test, follow procedure doc no.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM

PROBLEM/ SYMPTOM	FAILURE/FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/REMEDY	REMARKS/ REFERENCES
7. CRYO PUMP STOP WORKING (CRYO HEAD TEMPERA-TURE GOES UP)	7.a He-compressor faulty	7.a - He-compressor overheat warning light on	7.a - Unsufficient cooling water supply	7.a - Restore correct cooling water supply	
			- System He pressure too high	- Blow down He to specified pres-sure	
		- He-compressor not running	- Faulty electrical power supply	- Restore electrical power supply	
			- Faulty "remote" control signal	- Restore remote control signal	
			- Faulty "local" control	- Repair local control unit	
		- He-pressure to high	- Too much He in compressor	- Blown down He to specified pressure	
	7.b Cold head faulty	7.b - No hearing pump-ing action while He compressor works normally	7.b - Stuck piston be- cause of conta- minated He or loose particals	7.b - Clean and/or re-place piston. This should be done by a trained tech-nician	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM				
PROBLEM/ SYMPTOM	**FAILURE/FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/REMEDY**	**REMARKS/ REFERENCES**
	7.c Electrical power cut off	7.c - Measure electrical power supply to He-compressor and high vacuum control pannel	7.c - Trip active or fuse blown be cause of too high electrical current con-sumption - Trip or fuse failure	7.c - Repair source of too high electrical current consump-tion - Repair trip or fuse	
	7.d Control signal failure	7.d - Check for control signals at He-compressor and at cryopump head and check for short circuiting	7.d - Faulty cable - Loose connec-tion - Blown fuse - Faulty relay - Software error	7.d - Repair or replace - Fix cable/s at connector blocks - Replace fuse - Replace relay - Correct software	
8. CRYO PUMP UNABLE TO ACHIEVE CRYO TEM-PERATURE	8.a "Pressure" inside vessel too high	8.a Read Penning vacuum gauge	8.a - "Dirty Vessel" - Leaking Vessel - High degassing/ outgassing rate of equipment under test	8.a - Refer to para-graph 6(a), 6(b) and 6(c) above	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/REMEDY**	**REMARKS/ REFERENCES**
	8.b Too low He-pressure	8.b - Check pressure gauge on He-com-pressor (to be min 16 bar)	8.b - Helium leak on closed circuit	8.b - Refill if small leak - Repair leak and refil closed circuit	
	8.c Faulty cold head	8.c - No hearing pump-ing action while He-compressor works normally	8.c - Stucked piston beacuse of con-taminated He or loose particals	8.c - Clean out or replace piston (This should be done by a trained technician)	
	8.d Temperature sensor or temperature measuring instrument fauluty	8.d - LTI indicates faulty sensor - Indication M77 (error) - Cross couple instrument(s) and sensor(s) to iden-tify faulty compo-nents	8.d - Cable failure - LTI failure - SDIO card failure	8.d - Check / test / replace	Ref LTI handbook

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM

PROBLEM/ SYMPTOM	FAILURE/FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/REMEDY	REMARKS/ REFERENCES
9. UNRELIABLE VACUUM READINGS (VARIATION IN READING FROM VACUUM PROBE "MAD READ-INGS"):	9.a Sensor isolated	9.a - Check vacuum valve status	9.a - Valve closed on prupose - Valve closed by mistake	9.a - Reset valve status	
	9.b Sensor faulty	9.b - Replace sensor for comparison measurements - Couple "faulty" sensor to non faulty measuring instrument and evaluate readings	9.b - Dirty sensor - Loose connec-tor or wires - Broken sensore	9.b - Clean sensor - Fix connector or wires - Replace sensor	
	9.c Measuring instrument faulty Combitron and/or Thermovac	9.c - Change probe(s) coupled to measuring instru-ment and valuate readings(s)	9.c - Broken instrument - Loose wires/ connections - Short circuiting	9.c - Repair or replace - Fix wires/ connectors - Repair circuiting	
	9.d Faulty communication route	9.d - Measure commu-nication route integrity	9.d - Damage cable(s) (physi-cally) - Blown fuses	9.d - Repair or replace (cable(s)) - Replace fuses	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM											
PROBLEM/ SYMPTOM		**FAILURE/FAULT**		**DETECTION METHOD(S)**			**PROBABLE CAUSES**			**SOLUTION/REMEDY**			**REMARKS/ REFERENCES**
	9.e	Faulty software (wrong readings at PLC or XBT)	9.e	-	If measuring in-strumens and PLC output read ings differ, a soft ware error is indi cated	9.e	-	Accidential change of software	9.e	-	Reprogram or relaod correct program	
							-	Loss of memory				
10 SLOW PUM-PING OF FO-RE VACUUM	10.a	Some of fore-vacuum pumps not running	10.a	-	Check electric motor operation	10.a	-	Electric motor power failure	10.a	-	Repair electric power supply	
							-	Electric motor failure		-	Repair or replace electric motor	
							-	Stuck pump because of loose particals or lack of oil		-	Clean out pump. Repair or replace damage com-ponents	
				-	Pressure too high for roots pump P6 to start. Pump is interlocked		-	Leaking pipe-work or vessel		-	Fix leak or start pump by manual control	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/REMEDY**	**REMARKS/ REFERENCES**
	10.b Bypass valve open	10.b - Check status at control panels or check visually at valve	10. b - Signal failure - Compressed air failure - Stuck valve - Damaged valve	10.b - Restore correct signal - Restore compressed air supply - Clean out valve - Repair or replace valve	
	10.c Main vessel isolation valve V1 not fully open	10.c - Check status on valve position indicator (small pin will be out in valve full open position)	10.c - Signal failure - Compressed air failure - Stuck valve - Damaged valve - Too high ΔP over valve	10.c - Restore correct signal - Restore compressed air - Clean out valve - Repair or replace valve - Equilize pressure across valve and switch valve to desired position	
	10.d Oil on Roughing pump P8 contaminated	10.d - Check oil colour	10.d - Contamination inside vessel	10.d - Replace oil - Clean vessel interior	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/REMEDY**	**REMARKS/ REFERENCES**
	10.e Exhaust blocked	10.e - Feel by hand low/ no gas stream at exhasut outlet at relative high pressure inside vessel	10.e - Exhaust pipe blocked by obstruction	10.e - Remove obstruction	
	10.f Faulty pump	10.f - Uncouple pumps for indivual spinning tests	10.f - Damaged or weared motors or blades - Leaking or stucked internally non return valve in rotary vane pump P8	10.f - Repair or replace damage components	
11 OVERHEATING OF COMPONENTS	11.a Cooling water supply failure	11.a - Wrong valve(s) status - No flow "Overall cooling flow indicator" feed back	11.a - Wrong switching or setting or valve failure - Recirculation pump or pipe system failure	11.a - Correct switching status - Repair or replace valve - Repair cooling system	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

VACUUM SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/REMEDY**	**REMARKS/ REFERENCES**
		- No flow "Sub-system/compo-nent fow indica-tor" signal/feed back	- Solenoid valve failure	- Repair or replace salonoid	
	11.b Component cooling system failure	11.b - Water leak - Restricted water through-put	11.b - Fatique or rust - Dirt in pipe line	11.b - Replace compo-nents - Clean out pipe	
	11.c Overload of component	11.c - Too high electri-cal current used - Typical "overload" noise	11.c - Wrong ope-rational input or too high firction	11.c - Correct opera-tional/perfor-mance require-ment. Change PLC program - Service/replace component	
	11.d Main cooling water too hot	11.d - Temperature measurement, high reading	11.d - Wrong or faulty temperature setting in water recirculation system	11.d - Set system for cooler recircula-tion water, or re-pair/replace faulty instru-ments	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
1. LOSS OF PRESSURE.	1.a. - No supply of LN_2.	1.a. - Check LN_2 tank level gauge.	1.a. - Empty tank .	1.a. - Refill tank.	
	1.b. - Nitrogen tank pressure too low.	1.b. - Check pressure gauge on tank. (Pressure below 8 bar gauge). - Check line regulator correctly set.	1.b. - Tank pressure setting incorrect.	1.b. - Contact supplier.	
	1.c. - Pressure control system not functioning or functioning incorrectly.	1.c. - Check system pressure on Monitor 77. - Check system pressure on pressure control unit on thermal system control panel. (TSCP) - Check pressure on pressure gauge PG 100.	1.c. - Incorrect pressure setting on pressure control unit in thermal system Control Panel (TSCP) - Faulty pressure control unit in thermal system control panel.	1.c. - Restore incorrect pressure setting on thermal system control panel (TSCP). - Contact supplier. - Replace faulty pressure control unit on thermal system control panel.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	1.d. - Leak.	1.d. - Check for leaks on all flanges. - Check for pipe leaks audio or visual. - Check vacuum of vessel.	1.d. - Damaged or broken seals. - Loose bolts. - Fatigue. - Shroud leak.	1.d. - Fasten bolts. - Replace damaged seals. - Repair leak. - Repair leak	
	1.e. - Incorrect valve setting.	1.e. - Check valves to be closed V128 and V111, V130. - Check if valve V116 is open. - Check supply valves to be closed V120, V121, V117	1.e. - Incorrect signal from main control panel. - Manual valve in-correct position. - Damaged/broken valve.	1.e. - Restore incorrect signal on main control panel (software or hardware). - Adjust valve to correct position. - Replace damaged/broken valve.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
2. THERMAL DEVIATION ON SINGLE SHROUD.	2.a. - Excessive or insufficient gas flow to the shroud.	2.a. - Single shroud temperature differs by more than 20° C from average temperature of remaining 4 shrouds as indicated on the mimic display.	2.a. - Possible deficiency in software program. - Incorrect signal from MCP. - Incorrect signal from IPT transmitter. - Faulty valve.	2.a. - Reprogram if required. - Restore incorrect signal on MCP. - Replace defective IPT transmitter. - Repair/ Re-place valve.	
	2.b. - Ice blockage in shroud feeder pipes.	2.b. - Undetectable.	2.b. - Moisture in the system before going into cooling cycle.	2.b. - Allow system to return to ambient temp. - Initiate heating cycle and maintain at 100° C for 2 hours.	

MCP = Main Control Panel
IPT = Current Pressure Transmitter

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	2.c. - LN_2 in the shroud.	2.c. - Excessive low temperature (-170° C) on single shroud as indicated on mimic display.	2.c. - Poor atomization of LN_2 in the cooler unit. - Sudden pressure drop in thermal system resulting in liquidizing of GN_2.	2.c. - Reduce maximum setting of valve V107. - Refer to loss of pressure - ref. 1. above.	
	2.d. - Unrealistically low shroud temperature.	2.d. - LED on PLC will be illuminated. - PT 100 readout on mimic screen will indicate -220°C.	2.d. - PT 100 failure.	2.d. - Replace faulty PT 100 unit.	
3. SLOW OR NON - RESPON- SIVE TRANSIENT.	3.a. - No supply of LN_2.	3.a. - Check LN_2 tank level gauge.	3.a. - Empty tank.	3.a. - Refill tank.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	FAILURE/ FAULT	**DETECTION/ METHOD**	CAUSES	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.b - No electrical power to heater unit.	3.b. - Check for signal on mimic display. - Check LED on thyristor. - Check current on power cable from thyristor to heater with clamp meter.	3.b - No signal from MCP. - No signal from thyristor. - Burntout heater element.	3.b - Restore signal on MCP. - Repair/replace faulty thyristor. - Replace heater element.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	FAILURE/ FAULT	**DETECTION/ METHOD**	CAUSES	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.c. - Insufficient fan performance.	3.c. - No signal on variable speed controller on TSCP. - Audio detection. - Alarm indicator on mimic display.	3.c. - No electrical power to fan. - Damaged/ broken fan. - No signal to valve V105. (V105 closed). - No cooling water supply. (Inter-locked, fan will not start) - Excessive motor temperature (>70° C). (Interlock on temperature)	3.c. - Restore electrical power to fan. - Repair/re-place faulty fan. - Restore signal to valve V105. - Restore cooling water supply. - Inspection on fan motor as per manual.	

TSCP = Thermal System Control Panel

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.d. - Incorrect closed-loop in-line valve setting.	3.d. - Valve V123 is open as indicated on mimic display - Valve V105 closed or partly closed.	3.d. - Incorrect signal from MCP. - Faulty solenoid valves. - Faulty valve.	3.d. - Restore incorrect signal on MCP. - Replace faulty solinoid valve. - Repair/re-place valve.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.e. - Nitrogen tank pressure too low.	3.e. - Check pressure gauge on tank. Pressure not to be below 8 bar gauge. - Check line regulator correctly set.	3.e. - Tank pressure setting incorrect.	3.e. - Contact supplier.	
	3.f. - Pressure control system not functioning or functioning incorrectly.	3.f. - Check system pressure on Monitor 77. - Check system pressure setting on pressure control unit on thermal system control panel.(TSCP) Check pressure on - pressure gauge PG 100.	3.f. - Incorrect pressure setting on pressure control unit in thermal system control panel. (TSCP) - Faulty pressure control unit in thermal system control panel.	3.f. - Restore incorrect pressure setting on thermal system control panel. (TSCP) - Replace faulty pressure control unit on thermal system control panel. (TSCP) - Contact supplier	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.g. - Leak -	3.g. - Check for leak on all flanges. - Check for pipe leaks audio or visual. - Check vacuum of vessel	3.g. - Damaged or broken seals. - Loose bolts. - Fatigue. - Shroud leak.	3.g. - Replace damaged seals. - Fasten bolts. - Repair leak. - Repair leak.	
	3.h. - Incorrect pressure control valve setting	3.h. - Check valves V128, V111and V130 if closed.. - Check valve V116 if open. - Check valve V113 for activeness..	3.h. - Incorrect signal from main control panel. - Manual valve in-correct position. - Damaged/ broken valve.	3.h. - Restore incorrect signal on main control panel (software or hardware). - Adjust valve to correct position. - Replace damaged/ broken valve. - Contact supplier	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	3.i. - Incorrect test profile.	3.i. - Incorrect un-expected re-sponse of transient profile on mimic display.	3.i. - Operator error.	3.i. - Correct error on test profile.	
4. STEADY STATE TEMPERA-TURE DRIFT	4.a. - Interrupted LN_2 supply to cooler unit..	4.a. - Check LN_2 tank level gauge. - Check tank pressure to be minimum 8 bar gauge. - Check cooler unit feed valve V107 for correct operation	4.a. - Empty tank. - Unsufficient pressure build-up in tank, because of too much GN_2 used elsewhere. - Stuck cooler unit feed valve V107.	4.a. - Refill tank. - Regain pressure in tank. - Repair/replace valve V107.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	4.b. - Interrupted electrical power to heater unit.	4.b. - Check for signal on mimic display. - Check LED on thyristor. - Check current on powder cable from thyristor to heater with clamp meter.	4.b. - No signal from MCP. - No signal from thyristor. - Burnt out heater element.	4.b. - Restore signal on MCP. - Repair/replace faulty thyristor. - Replace heater element.	
	4.c. - Interrupted mass flow of recirculating N_2.	4.c. - ΔT on shrouds changed even with heater and cooler switched off. - Check for correct valve settings V105 and V100-> V104	4.c. - Control hardware error, wrong valve setting(s), undesired valve switching or drift	4.c. - Change/repair control hardware - Re-programme - Change control parameters - Change control philosophy.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
5. UNSTABLE STEADY STATE TEMPERA-TURE CONTROL.	5.a. - Excessive capacity on heater or cooler.	5.a. - Excessive fluctuation of shroud temperature from steady state temperatures as displayed on mimic screen.	5.a. - Maximum heater and cooler limit setting on PL 7 to high. - Incorrect PID settings on the heater or cooler.	5.a. - Reset maximum limit setting in PL 7 software. - Reset PID settings in Monitor 77.	
6. UNACCEP-TABLE ΔT ACROSS SHROUDS.	6.a. - Too low N_2 mass flow through shrouds	6.a. - Wrong valve setting V105 and/or V100 to V104 - Alarm on mimic - Too low fan speed - Overload indi-cation of fan motor and for variable speed drive - Low-up from inlet to outlet manifolds Read OP meter	6.a. - Error on electrical power to fan. - Damaged/broken fan. (electric motor, rotor or stator). - Wrong speed setting of fan - Restriction in flow path. (valve{s} closed or physical blocking by loose particle) - Valve 123 open or partly open. (GN_2 bypass shrouds).	6.a. - Restore electrical power to fan. - Inspection on fan motor as per manual. - Correct fan speed setting. - Correct valve settings or clean blockage. - Close V123.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	6.b. - GN_2 pressure in thermal system too low.	6.b. - Check LN^2 tank level gauge.	6.b. - Empty tank.	6.b. - Refill tank.	
		- Check pressure gauge on tank. (Pressure not below 8 bar gauge).	- Tank pressure setting incorrect.	- Contact supplier.	
		- Check line regulator correctly set.	- Leaking N_2 close loop.	- Leaktight system.	
	-	- Check for low system pressure on monitor 77.	- Incorrect pressure setting on pressure control unit inside TSCP.	- Restore incorrect pressure setting.	
		- Check system pressure on pressure control unit on thermal system control panel. (TSCP) - Check pressure on pressure gauge GP100.	- Faulty pressure control unit in TSCP.	- Contact supplier. - Replace faulty pressure control unit in TSCP.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
		- Check and listen for leaks on components and pipework	- Stuck or incorrect functioning of pressure control valves V106 and/or V113 and/or LN_2 injection valve V107.	- Repair/clean out or replace valves	
	6.c. - Incorrect valve setting	- Check valves to be properly closed V128 and V111, V130. - Check valves to be open V116, V108.	- Incorrect signal from main control panel. - Manual valve in correct position. - Damaged/broken valve	- Restore incorrect signal on main control panel (software or hardware). - Adjust valve to correct position. - Replace damaged/broken valve.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	6.d. - LN_2 in the shroud .	6.d. - Excessive low temperature (-170° C) on single shroud as indicated on mimic display.	6.d. - Poor atomization of LN_2 in the cooler unit. - Sudden pressure drop in thermal system resulting in GN_2 to LN_2.	6.d. - Reduce maximum setting of valve V107 at low operating tempe-ratures. - Refer loss of pressure. Ref 1 above.	
7. ABNORMAL NOISES.	7.a. - Gas leak.	7.a - Audio. - Pressure loss on mimic display.	7.a. - Burst/ damaged pipe. - Loose connection.	7.a. - Repair leak. - Rectify connection.	
	7.b. - Chattering of solenoid valve.	7.b. - Audio.	7.b. - Faulty solenoid valve.	7.b. - Replace solenoid valve.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	7.c. - Excessive noise on fan.	7.c. - Audio.	7.c. - Excessive thermal contraction/ex-pansion on components. - Unbalanced fan.	7.c. - Inspect fan assy and repair. - Reduce operating limits. - Balance fan.	
8. ICE FORMATION ON INSULATED COMPO-NENTS OR PIPES.	8.a. - Gas leak.	8.a. - Visual; excessive ice near leak under cold operating conditions..	8.a. - Damaged pipe. - Loose connection.	8.a. - Repair leak. - Rectify connection.	
	8.b. - Insufficient thermal protection.	8.b. - Visual, excessive ice near damaged insulation.	8.b. - Damaged insulation.	8.b. - Repair insulation.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
9. BAD SMELLS	9.a. - Burning insulation.	9.a. - Smelling/Smoke	9.a. - Unbalanced heater output vs. recirculated gas flow in closed loop.	9.a. - Reset PID on Monitor 77. - Reduce maximum, setting for heater on PL 7 software.	
	9.b. - Electrical and electronic cable or component burn-out.	9.b. - Smell - Flame - Colour	9.b. - Electrical short circuitring - Overloading.	9.b. - Replace wire and/or affected component and repair cause.	
10. WATER VAPOUR CLOUDS.	10.a. - Gas leak during cold operating cycle.	10.a. - Visual.	10.a. - Burst/ damaged pipe. - Loose connection.	10.a. - Repair leak. - Rectify connection .	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM						
	PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
11.	EXCESSIVE PRESSURE	11.a. - Pressure control system failure OR undesired/spurious opening of LN_2 injection valves V107 and V109	11.a - Check system pressure on Monitor 77 - Check system pressure on pressure control unit in TSCP. Check pressure on pressure gauge - PG 100. Opening of safety valves V120, - V121 and V117	11.a. - Incorrect signal from main control panel (Monitor 77). - Faulty pressure control unit in TSCP. - Stuck pressure control valve V106 Stuck LN_2 - injection valves V107 & V109	11.a. - Restore incorrect signal on main control panel (software or hardware). - Contact supplier. - Replace faulty pressure control unit in TSCP. - Repair or replace faulty valves.	
12.	NO START AFTER ACTIVATION OF THERMAL SYSTEM.	12.a. - No power supply to thermal system.	12.a. - No indication on DB volt meter. - Tripped isolator. - Phase indicator on volt meter.	12.a. - Power failure. - Incorrect or no phase supply. - Overload/ short circuiting. - Blown fuses.	12.a. - Restore power supply. - Repair electrical faults. - Replace fuse.	

DB = Distribution board

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	12.b. - Interlocks active (cooling water supply, valve settings, motor temperature and system pressure).	12.b. - Warning signal displayed on mimic screen.	12.b. - No cooling water supply. - Excessive fan motor temperature (>70° C). - Incorrect valve setting: * Incorrect signal from MCP. * Faulty IPT transmitter. * Faulty valve. - Insufficient system pressure.	12.b. - Restore cooling water supply. - Inspection fan electrical motor as per manual. - Restore valve setting * Restore incorrect signal on MCP. * Replace defector IPT transmitter. * Repair/ replace valve. - Activate purge cycle. If pressure setpoint not achievable, refer to 1. above - "Loss of Pressure".	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
13. LED INDICATOR ON VSC FLASING.	13.a. - Overload on fan.	13.a. - Visual; LED indicator on VSC.	13.a. - Incorrect maximum limit settings of fan speed. - Faulty fan.	13.a. - Reduce maximum limit setting on PL 7 software to eliminate overload situation. - Inspection of fan assy.	
	13.b. - VSC faulty.	13.b. - Visual; LED indicator on VSC.	13.b. - Damaged/ broken VSC.	13.b. - Replace/repair VSC. (to be done by qualified Technician).	
14. ICE FORMATION ON VACUUM INSULATED PIPES.	14.a - Loss of vacuum.	14.a. - Visual, ice forming on pipe.	14.a - Leak on inner or outer pipe.	14.a - Repair leak. - Re-evacuate.	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

THERMAL SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION/ METHOD**	**CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
15. EXCESSIVE HEAT (>50° c) ON VACUUM INSULATED PIPES.	15.a. - Loss of vacuum.	15.a. - Feel by hand or measure with temp probe.	15.a. - Leak on inner or outer pipe.	15.a. - Repair leak. - Re-evacuate.	
16. PERSONNEL EXPERIEN-CE DIZZI-NESS AND NAUSEA.	16.a. - Lack of O_2 in test area.	16.a. - Verify N_2 conta-mination on N_2 indicator in test area. OR Low level O_2 alarm activated.	16.a. - Excessive N_2 leak in test area. - Opening of N_2 filled test vessel.	16.a. - Locate and repair leak. - Operators to wear protection equipment.	

VSC = Variable Speed Controller
LED = Light Emitting Diode

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
1. ELECTRICAL MALFUNCTION OR FAILURE	1 V112 will not open	1 - M77 + 24 VDC at valve 112 - M77 + no voltage at valve 112 - M77 + no voltage at valve 112 - M77 + no voltage at valve 112	1 - V112 faulty - Fuse 10 - Relay 16 MCP - PLC DST 32992 cRD	1 - Replace V112 - Replace fuse - Replace relay - Replace card	
	2 V105 will not open	2 - M77 + 24 VDC at cut off valve 105 - M77 + O VDC at cut off valve 105 - M77 + O VDC at cut off valve 105 - M77 + O VDC at cut off valve 105	2 - Cut off V105 faulty - Fuse 8 - Relay 14 MCP - PLC DST 3292 card	2 - Replace cut off valve - Replace fuse Replace relay - Replace card	
	3 V106 will not open	3 - M77 + 24 VDC at cut off valve 106 - M77 + 0 VDC at cut off valve 106 - M77 + O VDC at cut off valve 106 - M77 + O VDC at cut off valve 106 - M77 +>3.5mA at V106 ITP - M77 + <3.5mA at V1096 ITP - M77 + > 4mA at V106 ITP	3 - Cut off V106 faulty - Fuse 24 - Relay 30 MCP - PLC DST 3292 card - V106 ITP - PID pressure control - Valve 106	3 - Replace cut off valve - Replace fuse - Replace relay - Replace card - Replace card - Replace controller - Replace valve	
	4 V107 will not open	4 - M77 + 24 VDC at cut off valve 107	4 - Cut off V107 faulty	4 - Replace cut off valve	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
		- M77 + O VDC at cut off valve 107	- Fuse 25	- Replace fuse	
		- M77 + O VDC at cut off valve 107	- Relay 31 MCP	- Replace relay	
		4 - M77 + O VDC at cut off valve 107	4 - PLC DST 3292 card	4 - Replace card	
		- M77 + > 4mA at V107 ITP	- V107 ITP	- Replace ITP	
		- M77 + <3.5mA at V107 ITP	- PLC ASR 402 card	- Replace card	
		- M77 + > 4mA at V107 ITP	- Valve 107	- Replace valve	
	5 V109 will not open	- M77 + 24 VDC at cut off valve 109	- Cut off V109 faulty	- Replace cut off valve	
		- M77 + O VDC at cut off valve 109	- Fuse26	- Replace fuse	
		- M77 + O VDC at cut off valve 109	- Relay 32 MCP	- Replace relay	
		- M77 + O VDC at cut off valve 109	- PLC DST 3292 card	- Replace card	
		- M77 + > 4mA at V109 ITP	- V109 ITP	- Replace ITP	
		- M77 + <3.5mA at V109 ITP	- Flash level controll	- Replace controller	
		- M77 + > 4mA at V109 ITP	- Valve 109	- Replace valve	
	6 V100 will not open	6 - M77 + 24 VDC at cut off valve 100	6 - Cut off V100 faulty	6 - Replac e cut off valve	
		- M77 + O VDC at cut off valve 100	- Fuse 19	- Replace fuse	
		- M77 + O VDC at cut off valve 100	- Relay 25 MCP	- Replace relay	
		- M77 + O VDC at cut off valve 100	- PLC DST 3292 card	- Replace card	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
		- M77 + > 4mA at V100 ITP - M77 + <3.5mA at V100 ITP - M77 + >4mA at V100 ITP	- V100 ITP - PLC ASR 402 card - Valve 100	- Replace ITP - Replace card - Replace valve	
	7 V101 will not open	7 - M77 + 24 VDC at cut off valve 101 - M77 + O VDC at cut off valve 101 - M77 + O VDC at cut off valve 101 - M77 + O VDC at cut off valve 101 - M77 + > 4mA at V101 ITP - M77 + >3.5Ma AT v101 ITP - M77 + > 4mA at V101 ITP	7 - Cut off V101 faulty - Fuse 20 - Relay 26 MCP - PLC DST 3292 card - V101 ITP - PLC ASR 402 card - Valve 101	7 - Replace cut off valve - Replace fuse - Replace relay - Replace card - Replace ITP - Replace card - Replace valve	
	8 V102 will not open	8 - M77 + 24 VDC at cut off valve 102 - M77 + O VDC at cut off valve 102 - M77 + O VDC at cut off valve 102 - M77 + O VDC at cut off valve 102 - M77 + > 4mA at V102 ITP - M77 + <3.5mA at V102 ITP - M77 + >4mA at V102 ITP	8 - Cut off V102 faulty - Fuse 21 - Relay 27 MCP - PLC DST 3292 card - V102 ITP - PLC ASR 402 card - Valve 102	8 - Replace cut off valve - Replace fuse - Replace relay - Replace card - Replace ITP - Replace card - Replace valve	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	9 V103 will not open	9 - M77 + 24 VDC at cut off valve 103 - M77 + O VDC at cut off valve 103 - M77 + O VDC at cut off valve 103 - M77 + O VDC at cut off valve 103 - M77 + > 4mA at V103 ITP - M77 + <3.5mA at V103 ITP - M77 + > 4mA at V103 ITP	9 - Cut off V103 - Fuse 22 - Relay 28 MCP - PLC DST 3292 card - V103 ITP - PLC ASR 402 card - Valve 103	9 - Replace cut off valve - Replace fuse - Replace relay - Replace card - Replace ITP - Replace card - Replace valve	
	10 V104 will not open	10 - M77 + 24 VDC at cut off valve 104 - M77 + O VDC at cut off valve 104 - M77 + O VDC at cut off valve 104 - M77 + O VDC at cut off valve 104 - M77 + > 4mA at V104 ITP - M77 + <3.5mA at V104 ITP - M77 + >5mA at V104 ITP	10 - Cut off V104 faulty - Fuse 23 - Relay 29 MCP - PLC DST 3292 card - V104 ITP - PLC ASR 402 card - Valve 104	- Replace cut off valve - Replace fuse - Replace relay Replace card - Replace ITP - Replace card - Replace valve	
	11 V113 will not open	11 - M77 + 24 VDC at cut off valve 113 - M77 + O VDC at cut off valve 113	11 - Cut off V113 faulty - Fuse 11	11 - Replace cut off valve - Replace fuse	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
		- M77 + O VDC at cut off valve 113 - M77 + O VDC at cut off valve 113	- Relay 17 MCP - PLC DST 3292 card	- Replace relay - Replace card	
	12 V111 will not open	12 - M77 + 24 VDC at cut off valve 111 - M77 + O VDC at cut off valve 111 - M77 + O VDC at cut off valve 111 - M77 + O VDC at cut off valve 111	12 - Cut off V111 faulty - Fuse 9 - Relay 15 MCP - PLC DST 3292 card	12 - Replace cut off valve - Replace fuse - Replace relay - Replace card	
	13 V1 will not open	13 - M77 + 220 VAC at valve 1 - M77 + No voltage at valve 1 - M77 + No voltage at valve 1 - M77 + No voltage at valve 1	13 - V1 faulty - Fuse 4 - Relay 10 MCP - PLC DST 3292 card	13 - Replace V1 - Replace fuse - Replace relay - Replace card	
	14 V2 will not open	14 - M77 + 220 VAC at valve 2 - M77 + No voltage at valve 2 - M77 + No voltage at valve 2 - M77 + No voltage at valve 2	14 - V2 faulty - Fuse 7 - Relay 13 MCP - PLC DST 3292 card	14 - Replace V2 - Replace fuse - Replace relay - Replace card	
	15 V4 will not open	15 - M77 + 220 VAC at valve 4 - M77 + No voltage at valve 4 - M77 + No voltage at valve 4 - M77 + No voltage at valve 4	15 - V4 faulty - Fuse 50, fuse 37 - Relay 8 ICP - PLC DST 3292 card	15 - Replace V4 - Replace fuse - Replace relay - Replace card	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	16 V9 will not open	16 - M77 + 220 VAC at valve 9 - M77 + No voiltage at valve 9 - M77 + No voltage at valve 9 - M77 + No voltage at valve 9	16 - V9 faulty - Fuse 55, Fuse 42 - Relay 13 ICP - PLC DST 3292 card	16 - Replace V9 - Replace fuse - Replace relay - Replace card	
	17 V11 will not open	17 - M77 + 220 VAC at valve 11 - M77 + No voltage at valve 11 - M77 + No voltage at valve 11 - M77 + No voltage at valve 11	17 - V11 faulty - Fuse 57, Fuse 44 - Relay 15 ICP - PLC DST 3292 card	17 - Replace V11 - Replace fuse - Replace relay - Replace card	
	18 V12 will not open	18 - M77 + 220 VAC at valve 12 - M77 + No voltage at valve 12 - M77 + No voltage at valve 12 - M77 + No voltage at valve 12	18 - V12 faulty - Fusde 58, Fuse 45 - Relay 16 ICP - PLC DST 3292 card	18 - Replace V12 - Replace fuse - Replace relay - Replacde card	
	19 V18 will not open	19 - M77 + 220 VAC at valve 18 - M77 + No voltage at valve 18 - M77 + No voltage at valve 18 - M77 + No voltage at valve 18	19 - V18 faulty - Fuse 59, Fuse 46 - "Relay 17 ICP - PLC DST 3292 card	19 - Replace V18 - Replace fuse - Replace relay - Replace card	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	20 V17 will not open	20 - M77 + 220 VAC at valve 17 - M77 + No voltage at valve 17 - M77 + No voltage at valve 17 - M77 + No voltage at valve 17	20 - V17 faulty - Fuse 6 - Relay 12 MCP - PLC DST 3292 card	20 - Replace V17 - Replace fuse - Replace relay - Replace card	
	21 V16 will not open	21 - M77 + 220 VAC at valve 16 - M77 + No voltage at valve 16 - M77 + No voltage at valve 16 - M77 + No voltage at valve 16	21 - V16 faulty - Fuse 5 - Relay 11 MCP - PLC DST 3292 card	21 - Rep0lace V16 - Replace fuse - Replace relay - Replace card	
	22 V123 will not open	22 - M77 + 24 VDC at cut off valve 123 - M77 + O VDC at cut off valve 123 - M77 + O VDC at cut off valve 123 - M77 + O VDC at cut off valve 123	22 - Cut off V123 faulty - Fuse 12 - Relay 18 MCP - PLC DST 3292 card	22 - Replace cut off valve - Replace fuse - Replace relay - Replace card	
	23 V5 will not open	23 - M77 + 220 VAC at valve 5 - M77 + No voltage at valve 5 - M77 + No voltage at valve 5 - M77 + No voltage at valve 5	23 - V5 faulty - Fuse 51, Fuse 38 - Relay 9 ICP - PLC DST 3292 card	23 - Replace V5 - Replace fuse - Replace relay - Replace card	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	24 V6 will not open	24 - M77 + 220 VAC at valve 6 - M77 + No voltage at valve 6 - M77 + No voltage at valve 6	24 - V6 faulty - Fuse 52, Fuse 39 - Relay 10 ICP	24 - Replace V6 - Replace fuse - Replace relay	
		- M77 + No voltage at valve 6	- PLC DST 3292 card	- Replace card	
	25 V7 will not open	25 - M77 + 220 VAC at valve 7 - M77 + No voltage at valve 7 - M77 + No voltage at valve 7 - M77 + No voltage at valve 7	25 - V7 faulty - Fuse 53, Fused 40 - Relay 11 ICP - PLC DST 3292 card	25 - Replace V7 - Replace fuse - Replace relay - Replace card	
	26 V8 will not open	26 - M77 + 220 VAC at valve 8 - M77 + No voltage at valve 8 - M77 + No voltage at valve 8 - M77 + No voltage at valve 8	26 - V8 faulty - Fuse 41, Fuse 54 - Relay 12 ICP - PLC DST 3292 card	26 - Replace V8 - Replace fuse - Replace relay - Replace card	
	27 V10 will not open	27 - M77 + 220 VAC at valve 10 - M77 + No voltage at valve 10 - M77 + No voltage at valve 10 - M77 + No voltage at valve 10	27 - V10 faulty - Fuse 56, Fuse 43 - Relay 14 ICP - PLC DST 3292 card	27 - Replace V10 - Replace fuse - Replace relay - Replace card	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
	28 Pump 5 will not turn on	28 - M77 - No vacuum at door seal	28 - Relay 6 MCP - Pump 5 contractor	28 - Replace relay - Reset overload	
	29 Pump 6 will not turn on	29 - M77 - M77 - Pump 6 does not start	29 - Relay 7 MCP - Fuse 1 - Pump 6 Integral	29 - Replace relay - Replace fuse - Reset overload	
	30 Pump 7 will not turn on	30 - M77 - M77 - Pump 7 does not start	30 - Relay 8 MCP - Fuse 2 - Pump 7 Integral	30 - Replace relay - Replace fuse - Reset overload	
	31 Pump 8 will not turn on	31 - M77 - M77 - Pump 8 does not start	31 - Relay 9 MCP - Fuse 3 - Pump 8 Integral	31 - Replace relay - Replace fuse - Reset overload	
	32 Compressor 1 will not turn on	32 - M77 - Compressor does not start - Compressor 1 will not turn on	32 - Relay 1 MCP - Comp 1 contactor - Comp 1 cct breaker	32 - Replace relay - Reset overload - Reset cct breaker	
	33 Compressor 2 will not turn on	33 - M77 - Compressor does not start` - Compressor does not start	33 - Relay 2 MCP - Comp 2 contactor - Comp 2 cct breaker	33 - Replace relay - Reset overload - Reset cct breaker	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	34 Compressor 3 will not turn on	34 - M77 - Compressor does not start - Compressor does not start	34 - Relay 3 MCP - Comp 3 Contactor - Comp 3 cct breaker	34 - Replace relay - Reset overload - Reset cct breaker	
	35 Compressor 4 will not turn on	35 - M77 - Compressor does not start - Compressor does not start	35 - Relay 4 MCP - Comp 4 contactor - Comp 4 cct breaker	35 - Replace relay - Reset overload - Reset cct breaker	
	36 Door motor will not turn on	36 - M77 - Door motor does not start - Door motor does not start	36 - Relay 5 MCP - Door contactor - Door cct breaker	36 - Replace relay - Repklace contactor - Reset cct breaker	
	37 Heater will not turn on	37 - M77 +OV at relay 19 wire 19 - M77 + OV at relay 1 wire 130 - M77 + OV at fuse 13 wire 62 - M77 + OV at relay 21 wire 21 - M77 + OV at relay 3 wire 132 - M77 + OV at fuse 15 wire 61 - M77 + OVAC to thyristor drive	37 - Relay 19 MCP - Relay 1 ICP - Fuse 13 - Relay 21 MCP - Relay 3 ICP - Fuse 15 - 380 V input fuses	37 - Replace relay - Replace relay - Replace fuse - Replace relay - Replace relay - Replace fuse - Replace fuse	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
		- M77 + 380 VAC to thyristor drive	- Thyristor drive	- Replace drive	
		- M77 + < 3,5 mA at heater cntl	- PLC ASR 402 card	- Replace card	
	38 Fan will not turn on	38 - M77 + OV at relay 20 wires 20	38 - Relay 20 MCP	38 - Replace relay	
		- M77 + OV at relay 2 wire 131	- Relay 2 ICP	- Replace relay	
		- M77 + OV at fuse 14 wire 7	- Fuse 14	- Replace fuse	
		- M77 + OV at relay 22 wire 22	- Relay 22 MCP	- Replace relay	
		- M77 + OV at relay 4 wire 133	- Relay 4 ICP	- Replace relay	
		- M77 + OV at fuse 16 wire 6	- Fuse 16	- Replace fuse	
		- M77 + OVAC to thyristor drive	- 380 V Input fuses	- Replace fuse	
		- M77 + 380 VAC to thyristor drive	- Thyristor drive	- Replace drive	
		- M77 + < 3,5 mA at fan cntl	- PLC ASR 402 card	- Replace card	
	39 Sorbtion trap	39 - Heater does not heat up	39 - Relay 24 ICP	39 - Replace relay	
		- Heater does not heat up	- Fuse 66	- Replace fuse	
		- Heater does not heat up	- Fuse 32	- Replace fuse	
	40 All thermal valves dead	40 - M77 + PSU current limit LED's on	40 - 24 VDC short circuit	40 - Locate and correct	
	41 All vacuum valves dead	41 - M77	41 - CCT breaker trip	41 - Reset cct breaker	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM

PROBLEM/ SYMPTOM	FAILURE/ FAULT	DETECTION METHOD(S)	PROBABLE CAUSES	SOLUTION/ REMEDY	REMARKS/ REFERENCES
	42 Heater and fan dead	42 - M77 - M77	42 - Isolater trip - Cabinet switch off	42 - Reset isolator - Switch cabinet on	
	43 Forepump system dead	43 - M77 - M77	43- - Isolator trip - Cabinet switch off	43 - Reset isolator - Switch cabinet on	
	44 Compressors, doors, pumps dead	44 - M77	44 - V3E active	44 - Chech 380V phase voltage	
	45 No update to M77	45 - M77 Mapway error - M77 Mapway error - M77 Mapway error - M77 Mapway error	45 - Mapway cable fault - PLC Mapway card fail - PC Mapway card fail - Hardware error	45 - Check "Inring LED" - Check COMs LED's - Check COMs LED'a - Contact supplier	
	46 No update to XBTV terminals	46 - Error message on terminals - Error message on terminals - Error message on terminals	46 - Cable fault - Hardware error - PLC telway LED on	46 - Check cable - Contact supplier - Contact supplier	
	47 PLC dead	47 - No response from system - No response from system - No response from system - No response from system	47 - PLC "MEM" LED on - No PLC LED's on - No PLC LED's on - No PLC LED's on	47 - Reset PLC on fron panel - Check PLC power supply - Check 220 VAC to PLC - Contact supplier	

TROUBLE SHOOTING LIST FOR THE LARGE THERMO-VACUUM FACILITY

MAIN CONTROL & DATA ACQUISITION SYSTEM					
PROBLEM/ SYMPTOM	**FAILURE/ FAULT**	**DETECTION METHOD(S)**	**PROBABLE CAUSES**	**SOLUTION/ REMEDY**	**REMARKS/ REFERENCES**
	48 PC does not boot	48 - Display screen on	48 - PC PSU	48 - Contact supplier	
		- Display screen on	- PC CMOS set-up	- Contact supplier	
		- Display screen on	- PC controller card	- C ontact supplier	
		- Display screen on	- Command com missing	- C ontact supplier	
		- Display screen off	- 220 VAC missing	- Check 220 VAC to PC	

SECTION 6

DOCUMENTATION REFERENCE INDEX

1. INTRODUCTION

This section provides a quick reference documentation index, of all the catalogues as refered to in this manual. These catalogues are associated with the detail description, operation and maintenance of the individual components in subsystems of the Large Thermo-Vacuum Facility.

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
VACUUM SYSTEM VTFO 20000	A High vacuum pumping system	1 P1-P4 RPK 10000 cryopumps	- Spares list - Ley Boldag CAT - Operating Instructions	- VTFO 20000-128-01/1 - VTFO 20000-128/02 - VTFO-20000-128-01/3	ET 12,102/2 182, 01, 02 GA12,102/2
		2 He_1-He_4 RW 6000 Helium compressors	- Technical manuals - Functional Description - Spare Parts List - Spare Parts List	- VTFO-20000-128-02/1 - VTFO-20000-128-02/2 - VTFO-20000-128-02/3 - VTFO-20000-128-02/4	GA12,100 GA12,104/3 ET 12,104/5 ET 12,103/3
		3 HS_1-HS_4 Flexible pressure tubing type FL4.5	- Technical Data	- VTFO 20000-128-02/1	GA12.100
		4 HU_1-HU_4 Regeneration heat control unit type HU_1	- Operating Instructions	- VTFO-20000-128-03/1	GA12,303
		5 LT_1-LT_4 Low temperature measuring instrument Cryotherm LT_1 10	- Operating Instructions	- VTFO-20000-128-04/1	GA12,306
		6 P10-P13 Thermomolecular pump Turbovac 50 DN65 I.S.O.K.	- Operating Instructions - Spare Parts List - Leyboldag Catalogue	- VTFO-20000-128-05/1 - VTFO-20000-128-05/2 - VTFO-20000-128-05/3	GA05,100/4 ET05,100/7 165.01.02
		7 F.C. Frequency Converter N.T. 50 Turbotronik	- Operating Instructions	- VTFO-20000-128-06/1	GA05,200/4
	B Fore Vacuum pumps	1 P6 Ruvac RA7001 single stage roots vacuum pump	- Operating instructions - Spare Parts List	- VTFO-20000-128-07/1 - VTFO-20000-128-07/2	GA03,201/2 ET03 201/4
		2 Thermovac T301			
		3 P7 Ruvac WAU 2001 single stage roots vacuum pump	- Technical data - Operating Instructions	- VTFO-20000-128-08/1 - VTFO-20000-128-08/2	173.1.02 SA.09/204/3
		4 P8 Varovac S630F single stage rotary vane vacuum pump	- Operating Instructions - Spare Parts List - Brochure	- VTFO-20000-128-09/1 VTFO-20000-128/09/2 VTFO-20000-128-09/3	GA02,101/3 ET02,101/ 1.10.87

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
	C Pressure Measure and controlling instrumentation	1 PS_2 & PS_3 Pressure switch type SM42	- Technical data - Operating Instructions	- VTFO-20000-128-10/1 - VTFO-20000-128-10/2	16405 GA09 600/3
		2 SV110 Switching amplifiers for SM42 type SV110	- Technical data - Leyboldag CAT	- VTFO-20000-128-11/1 - VTFO-20000-128-11/2	16078 179,59-02
		3 PSI Safety Vacuum Switch Type SM40	- NO Technical data	- VTFO-20000-128-12/1	16411
		4 DG_1-DG_5 Capsule vacuum gauge	- Technical data - Operating instructions	- VTFO-20000-128-13/1 - VTFO-20000-128-13/2	16064 GA09,101/2
		5 Combitron CM350 Combination Pirani/Penning measuring system	- Technical data - Operating instructions	- VTFO-20000-128-14/1 VTFO-20000-128-14/2	15755 GA09,010
		6 P.E.H.I. Penning measuring head Type PR35	- Leybold Technical data - Operating Instructions	- VTFO-20000-128-15/1 - VTFO-20000-128-15/2	15751 GA09,303/5
		7 PH_1-PH_4 Perani sensing head type TR301	- Operating Instructions - Technical data	- VTFO-20000-128-16/1 - VTFO-20000-128-16/2	GA09,204/3 15740
		8 Gauge head cable for PR35-10 metres	- Technical data - Operating instructions	- VTFO-20000-128-17/1 - VTFO-20000-128-15/2	16289 GA09,303/5
		9 Gauge head cable for TR301	- Catalogue data	- VTFO-20000-128-18/1	15758
		10 Perani measuring system thermovacuum TM321	- Technical data - Leybold HV250 section 9	- VTFO-20000-128-19/1 - VTFO-20000-128-19/2	15750 179.63.02
	D Vacuum valves (stainless steel	1 V_2 DN160 ISOK bellow-sealed right angle valve. Elektro-pneumatically operated.	- Leybold Technical data Catalogue HV250 Section 6	- VTFO-20000-128-20/1	29727 176.1.02
		2 V_9 & V_{17} DN40KF bellow-sealed right angle electrical-pneumatically operated.	- Operating Instructions - Spare Parts List - Catalogue HV250	- VTFO-20000-128-21/1 - VTFO-20000-128-21/2 - VTFO-20000-128-20/1	GA 06,200/2 ET06,200/3 28723

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
		3 V1 DN250 electro-magnetic bellows sealed valve	- Technical data	- VTFO-20000-128-20/1	28679
		4 V13 & V14 variable leak valve with shut-off valve	- Technical data - Operating instructions	- VTFO-20000-128-20/1 - VTFO-20000-128-22/2	28341 GA06,108/3
		5 V10 & V11 DNK25KF bellows sealed right angle electro pneumatic controlled valve.	- Technical data - Operating instructions	- VTFO-20000-128-20/1 - VTFO-20000-128-23/2	28822 GA06,200/4
		6 V12 & V16 DN40KF bellows sealed right angle electro pneumatic controlled valve	- Operating instructions - Spare Parts List	- VTFO-20000-128-24/1 - VTFO-20000-128/24/2	GA06,200/2 ET06-200/7
		7 V3 & V18 DN40KF bellows sealed right angle valve manual	- Operating instructions	- VTFO-20000-128-25/1 - VTFO-20000-128-20/1	GA06,100/6 28803
		8 VSV, special DN40 over pressure safety valve			
		9 V4 DN160 ISOF electro-pneumatic valve	- Technical data - Spare Parts List	- VTFO-20000-128-20/1 - VTFO-20000-128-20/2	28647 ET06,302/5
		10 V5-V8 DN 16 KF bellows sealed right angle valve electro-pneumatic	- Technical data - Operating instructions	- VTFO-20000-128-20/1 - VTFO-20000-128-23/2	28821 GA06,200/4
	E VACUUM FITTINGS AND LEADTHROUGHS	A BELLOWS:			
		1 B1 DN250 ISO -K S.S. bellows	- Leybold data catalogue HV250 Section 7	- VTFO-20000-128-26/1	88768
		2 B2 DN150 ISOK S.S. bellows			88767
		3 B3 DN100 ISOK S.S. bellows			CAT 88766
		4 B4 & B9 DN40KF 1000 mm bellows S.S.			CAT 86805
		5 B5 & B8 DN16KF 500 mm bellows S.S.			CAT 86791

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
		B SEALS:			
		1 UHV sealing rings DN10/16KF			CAT 88373
		2 Supporting rings DN10/16K			CAT 88374
		3 UHV sealing rings DN20/25KF			CAT 88375
		4 Supporting rings DN20/25KF			CAT 88376
		5 UHV sealing rings DN32/40KF			CAT 88377
		6 Supporting rings DN32/40KF			CAT 88378
		7 UHV sealing discs DN63 ISOF.			CAT 88267
		8 UHV sealing discs DN100 ISOF			CAT 88270
		9 UHV sealing discs DN160 ISOF			CAT 88271
		10 Clamps for UHV sealing discs DN10/16KF			CAT 88275
		11 Clamps for UHV sealing discs DN20/25KF			CAT 88277
		12 Clamps for UHV sealing disc DN32/40KF			CAT 88278

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
		B SEALS: 13 CEFILAC Helico Flex seals HNV 200/Torus 4.9/4.8 mm Aluminium lining & incone/600 inner lining & Nimonic 90 spring {y_2 = 140 dN/cm at e_z = 0.9} dim I.D. 220,5 x O.D. 230,3 groove surface finish 0,8 µ (RA) hardness 65 HV min.	- Technical data	- VTFO-20000-128-27/1 - VTFO-20000-128-27/2 - VTFO-20000-128-27/3 - VTFO-20000-128-27/4	Suppliers Labotec (Pty) Ltd, Industria " " "
		C ELECTRICAL LEAD-THROUGHS: 1 EFT52 (for clients signal use) instrumentation feed-through	- Technical data	- VTFO-20000-128-28/1	EFT series
		2 GM34/7/Ss current feed-through	- Leybold technical data catalogue HV250 section 7	- VTFO-20000-128-26/1	CAT 18007
		3 GM40/9/5 IST feed-throughs for process control	- Leybold technical data catalogue HV250 section 7	- VTFO-20000-128-26/1	CAT 18144
		4 345 SMA-50-0-3 Suhner type High Frequency lead-throughs	- Technical data	- VTFO-20000-128-28/2	345 SMA-50-0-3
	F Door seal & regenerative pumping system	1 P5 Trivac B Rotary Vane Pump D16B	- Operating Instructions Spare parts list Brochure	- VTFO-20000-128-29/1 - VTFO-20000-128-29/2 - VTFO-20000-128-29/3	GA01,202/5 ET01,202/8 1.10.87
		2 FX filter AF16/25	- Spare parts list	- VTFO-20000-128-30/1	ET01,299/6
		3 STI Absorption trap FA8-16	- Technical data	- VTFO-20000-128-31/1	-
		4 STI Absorption trap heater	Operating Instructions	- VTFO-20000-128-31/2	GA01,198/3

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
		5 Door seal	- Check drawings for detail specs.	VTFO-20000-128-32/1	
		6 HP100 hydraulic pump for door clamps (hydraulic pack)	- Technical data	VTFO-20000-128-33/1	
	G Special Equipment & Instruments	1.a Helium Leak Detector UL500	- Complete file for: Technical data, Operating & service manual etc.	- VTFO-20000-128-34/1 - VTFO-20000-128-34/2	Leybold 180,36,02
		1.b Leak detection by the helium sample probe	Technical data	VTFO-20000-128-34/3	180.28.2
		2 Viscovac VM212 Instrument & Printer module	- Leybold catalogues: Technical data, operating instructions & interfaces	- VTFO-20000-128-35/1	Leybold 15883
		(V.M.T.) Viscovac measuring tube V.M.H.			15879 15871
		Viscovac measuring head including cable			15882
		3 Residual gas analyser RGA type QX2000-01211000 incl. 9m cable	- Leybold catalogue	- VTFO-20000-128-36/1 - VTFO-20000-128-36/2	074-137 187,01,01

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
		4 Film thickness controller QCM: & Quartz crystal controller type XTC & Oscillator package for XTC & STD. 1" feed-through for sensors without shutter & Std. crystal sensor complete & Sensor crystals for thermal depositions Quadruvac PGA100	- Leybold: STD compact dual sensors manual - Technical data	VTFO-20000-128-37/1 VTFO-20000-128-37/2 VTFO-20000-128-34/3	074-183 83.8221 83.747 83.7207 074-15.6 1.10.87

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
N2 Thermal System VTFO-30000-00	A Main components	1 Gas circulation fan	Maintenance manual	VTFO-30000-128-01/1	-
		2 Heater unit	Maintenance manual	VTFO-30000-128-01/1	-
		3 Cooler unit	Maintenance manual	VTFO-30000-128-01/1	-
	B Valves	1 Proportional control pneumatic needle valve (V109 and V107)	Technical data	VTFO-30000-128-02/1	Baumann Bulletin No 55-9
		2 Actuated ball valve (V105; V111; V113 and V123)			Worcester
		3 Isolation valve (manual) (V130; V110; V108; V125; V126; V127; V128 and V116)	Technical data for ball valves	VTFO-30000-128-03/1	Worcester 08164-G
		4 Proportional control pneumatic ball valve (V106; V100; V101; V102; V103 and V104)	Technical data Technical data for pneumatic actuators	VTFO-30000-128-04/1 VTFO-30000-128-04/2	Worcester SB-442-13 Norbro series 40RSB
		5 Solenoid valve (V112)			Supplied by Ascoreg

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
		6 Thermal relief valve (V129; V119 and V118)			Supplied by APC Engineering
		7 Safety valve (V117; V120 and V121)			Bestobell
		8 Non-return valve (V114)			Bestobell
	C. LN_2 Level Control	1. Model 1151 DP Differential + High Differential Pressure Transmitters	Instruction Manual	VTFO 30000-128-05/1	Rosemount 4256/4257 Nov. 1990
		2. Model 1151 AP absolute and Model 1151 GP Gage pressure Transmitters	Product Manual.	VTFO 30000-128-05/2	Rosemount 4260/4261 May 1987

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
CONTROL SYSTEM VTFO-40000	A CP-1 (Contol Panel)	1a PC (computer) manuals: hardware	- Owners Manual Volume 1 Volume 2	- VTFO-40000-128-01/1	386-25/33
			- 16 Bit ATA floppy/hard disk adapter Owners Manual	- VTFO-40000-128-02/1	8120A
			- View point NI VGA graphics adapter Owners Manual	- VTFO-40000-128-03/1	EV633
			- Microsoft Mouse Users Guide	- VTFO-40000-128-04/1	-
		1b PC Manuals software	- MS 0S2 Volume 1 Users Guide	- VTFO-40000-128-05/1	05/2
			Volume 2 Getting Started	- VTFO-40000-128-05/2	05/2
		2 PLC (programmable Logic controller)	- TSX7 model 40 programmable controller Installation manual	- VTFO-40000-128-06/1	TSX DM PR40E
			- TSX SCM 20/21/22 half/full duplex character mode	- VTFO-40000-128-07/1	TSX D 23 004E
			- Uni Telway Bus reference manual	- VTFO-40000-128/08/1	TSX D24 004E
			- TSX AEM 811 Analkog Input Module User's manual	- VTFO-40000-128-09/1	TSX D23 001E
				- VTFO-40000-128-09/2	W91262-952
			- TSX SUP 70 110/220 VAC 60W Power Supply	- VTFO-40000-128-10/1	-
			- TSX SUP 70 Alimentation 110/220 VCA - 50/60 Hz	- VTFO-40000-128-11/1	W91329-086
			- TSX MAP PC74 Mapway module	- VTFO-40000-128-12/1	TSX DM MAP

DOCUMENTATION REFERENCE INDEX - LARGE THERMO-VACUUM FACILITY

SUB-SYSTEM	GROUP	ITEM DESCRIPTION REF TO P & ID	DOCUMENT DESCRIPTION	IST DOCUMENT NO	SUPPLIER CAT NO
			- TSX AST/ASR Analog Output module	- VTFO-40000-128-13/1	TSXD23007 E
			- TSX SCM 21,6 voie 1 Bus UNI-Telway	- VTFO-40000-128-14/1	TSX D24005F
			- TSX DST 3292 Interface Output Module	- VTFO-40000-128-15/1	W91262-975
			- TSX DET 321232-Point 24 VDC input module service instruction	- VTFO-40000-128-16/1	W91262951
			- PL7 operating modes V4 under X-tel software workshop	- VTFO-40000-128-17/1	Telemecanique
			- X-tel software workshop base - standards tools	- VTFO-40000-128-18/1	Telemecanique
			- TSX MAP 1074 mapway module users manual	- VTFO-40000-128-19/1	Telemecanique
			- Mapway Network Reference Manual	- VTfO-40000-128-20/1	Telemecanique
			- XBT-VB8 Terminal	- VTFO-40000-128-21/1	Telemecanique
			- XBT-VB Terminal	- VTFO-40000-128-22/1	Telemecanique
		3 Monitor 77	- Monitor 77 Users manual	- VTFO-40000-128-23/1	-
			- Monitor 77 Software manual	- VTFO-40000-128-24/1	-