Fermilab

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CCI Report 390-100

COOLDOWN/WARMUP CONTROL CIRCUITS FOR MAGNET TEST STANDS

MAGNET TEST FACILITY

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For

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This report has been prepared to explain the functional aspects of instrumentation associated with operation of the Magnet Test Facility. The report deals with instruments and control circuits associated with the liquid helium dewar, distribution box and magnet stand used for operation of the cryogenic circuit. The cooldown and warmup cycle and the steady state operation of the helium and nitrogen circuits are covered.

The design is based on input and suggestions from R.Walker and his operation crew. It reflects what they have determined to be desirable operating modes.

THEORY - Instrument Layout

The function of the various control circuits are delineated elsewhere. The theory behind the instrument layout is this:

1. All control circuits should be operated from the control room.
2. Intermediate control elements such as limiting relays, E/P converters and solenoid valves, should be located external to the control room but grouped together in a convenient location for ease of set-up, repair, etc.
3. All electrical instrumentation is to be used whenever possible.

CONTROL ROOM

The instruments in the control room consist of a 12 element Fisher cabinet mounted in a relay rack. Contained herein are PIC and HIC controllers associated with magnet cooldown and operation. Directly below and coordinated to (i.e., grouped directly below) is a panel containing on/off and selector switches which control the modes to various stands.

Also contained in that panel are on/off controls for the quench circuit and the cold gas return to the dewar.

The controls associated with the liquid helium dewar and distribution box feed will be encased in a six unit Fisher control rack. These controls are somewhat independent of the flow circuits of individual magnets and are grouped together for that reason.

INSTRUMENT CABINET

The instrument cabinet is a 4x5 foot electrical enclosure. It will contain, in one location, limit relays, solenoid valves and most E/P converters. This cabinet is at an intermediate point and allows trouble shooting and maintenance to be performed at a convenient location. When possible all such control elements were located in this cabinet. The one exception is an E/P associated with the magnet JT valve which was valve mounted.

CONTROL CIRCUITS

The control circuits covered in this write-up include:

PV31, PV62 - Magnet cooldown/warmup control
See instrument loop schematic

LIC113 - LN_2 subcooler level control controls PV112
See instrument loop schematic

HIC148 - Magnet JT valve control
See instrument loop schematic

PV136 - LN_2 Feed to magnet
See instrument loop schematic

PV101A - PV101A control (on/off)
See instrument loop schematic

PIC100 - PV100 control
See instrument loop schematic

LIC101 - PV101B control
See instrument loop schematic

PV149 - Currently dormant

PV31/62

This control circuit is described functionally on the instrument loop schematic. Simply, it is a pressure indicator control circuit which will be used during magnet cooldown or warmup.

The operator selects either warmup (PV62) or cooldown (PV31) mode. The pressure indicator controller controls the magnet pressure at set point and controls fluid flow through the magnet. As pressure drop through the magnet varies, the PIC varies flow accordingly.

PV31/62 exists for each magnet, the PIC is located in the 12 unit Fisher control cabinet. Selection of either PV31 or 62 is accomplished by a selector switch directly below the PIC for each magnet.

HIC148

This is a hand indicating control circuit. The magnet JT valve is controlled by this HIC. The controller is mounted adjacent to the PIC for respective magnet stands. The instrument loop schematic explains the circuit in detail.

PV136

PV136 controls LN_2 shield flow for each magnet. The circuit is described in detail on the instrument loop schematic. The shield circuit is controlled by LIC112 located in each magnet turnaround box but power is controlled from the console directly below the PV31/62 selector for each magnet respectively.

LIC113

A simple on/off switch for the power to LIC113 is located on the panel to the left of the six module Fisher control cabinet which houses dewar and distribution box source controllers.

PV101A

A simple on/off control for PV101A is located on the left of the control panel housing the magnet stand selections and controls. PV101A controls liquid flow into the dewar from the cold box. See instrument loop schematic for details.

PIC100

Dewar pressure control. This PIC senses pressure in the liquid helium dewar and controls gas flow return to the cold box through PV100 as dictated by Fisher controller PIC100 located in the six unit Fisher control cabinet.

LIC101

This valve acts to maintain level in the distribution box liquid helium subcooler. It responds to LIC101 controlling PV101B to divert liquid from the feed line directly to the shell of the subcooler should liquid level (as measured by the superconducting level probe) drop.

PV149

PV149 is currently dormant. The purpose of this device is to provide an artificial heat load to the dewar. The valve controls warm gas flow into the dewar liquid volume to provide the heat load. The unit is a viable heat load only in the refrigerator mode of operation

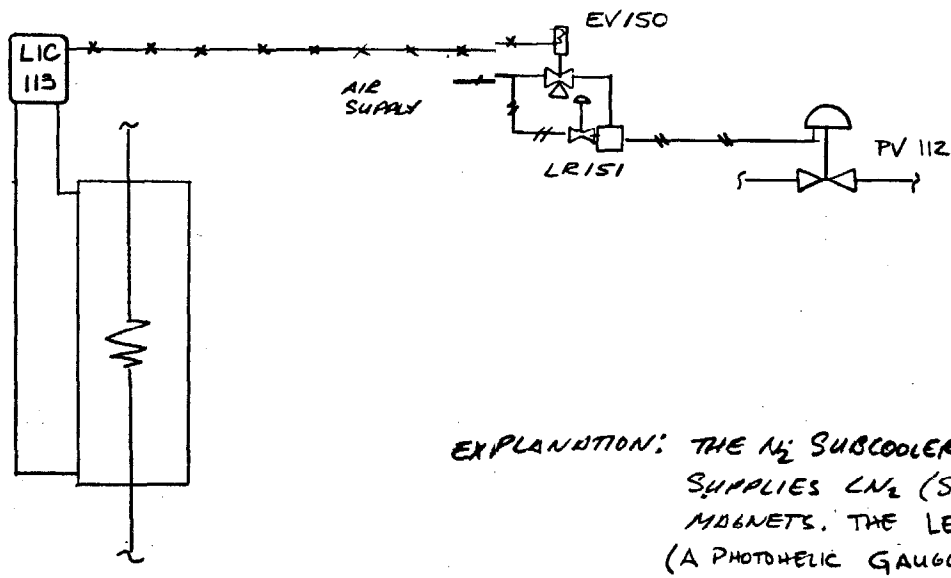
when no liquid accumulation takes place. When used in the liquefier mode excess gas generated by the load unbalances the process and causes turbine speed problems.

The instrument loop schematics includes with this report describe, in detail, the operation of each control loop.

Drawings of the instrument cabinet includes terminal strips and terminal identification tables. This drawing will provide the necessary information for fabrication of the cabinet.

Electrical schematics have also been provided for the small panel which will be located immediately below the 12 unit Fisher cabinet.

ON DIST Box Panel



LIC 113 PHOTOHELIC 0-40"

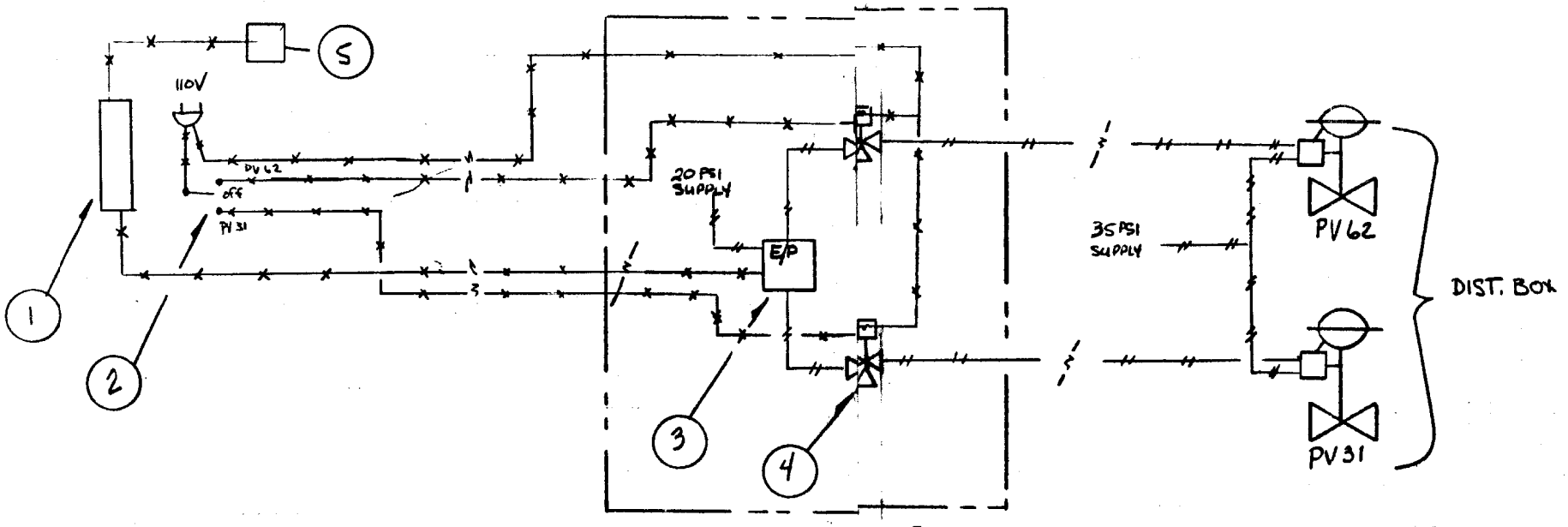
EV 150 SOLENOID VALVE 3WAY SKINNER

LR151 LOW LIMIT RELAY
FAIRCHILD

PV112 FISHER CONTROLS - DIST. BOX.

EXPLANATION: THE N_2 SUBCOOLER CKT FOR THE DIST BOX SUPPLIES LN_2 (SUBCOOLED) TO INDIVIDUAL MAGNETS. THE LEVEL IS SET ON LIC113 (A PHOTOHELIC GAUGE) FLOW IS ESTABLISHED USING PV 112 + LR 151. LR 151 IS A LOW LIMIT RELAY WHICH WOULD BE SET MANUALLY FOR STEADY STATE BY TRIAL/ERROR SHOULD DEMAND INCREASE, LIC 113 WOULD ACTIVATE PV112 TO SATISFY

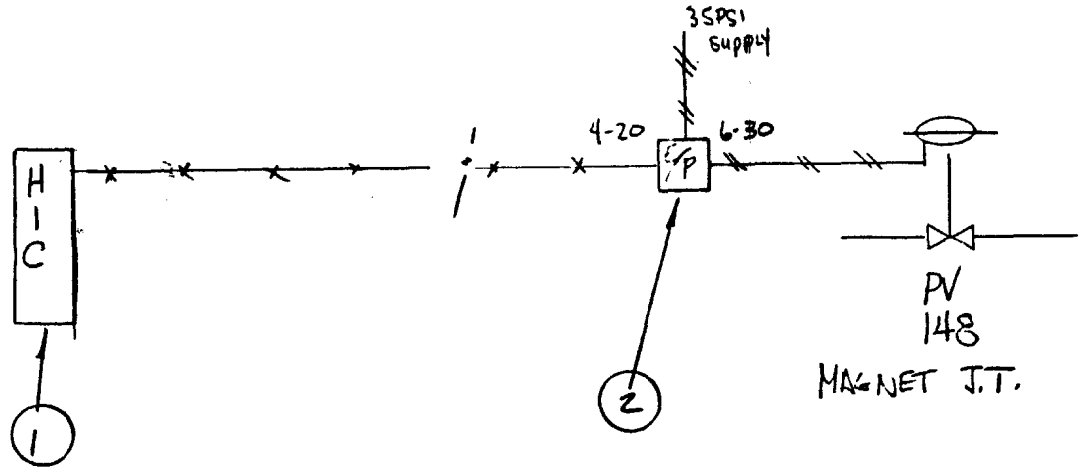
INST. LOOP SCHEMATIC
CONTROL CKT
LN_2 LEVEL CONTROL
DIST. BOX



CONTROL RM PANEL. INSTRUMENT JUNCTION BOX DISTRIBUTION BOX

	QTY
1.) FISHER TL101 PRES. IND. CONTR.	
2.) SWITCH, 3 POS, CENTER OFF SPDT	
3.) ELECTRO/PNEUMATIC CONVERTER FAIRCHILD.	
4.) VALVE, SOLENOID, SKINNER C3	
5) PRESSURE TRANSDUCER DYNISCO 0-100 PSIA	

THIS CONTROL CIRCUIT IS PRESSURE RESPONSIVE. THE CONTROLLER RESPONDS TO A PRESSURE SIGNAL FROM ITEM 5. IT ACTUATES VALVE PV 62 OR PV31 DEPENDING ON THE POSITION OF SWITCH ITEM 2 AN THE PRESSURE SETTING ON THE PIC ITEM 1, ITEM 3 CONVERTS THE PIC'S 4-20 ma OUTPUT TO A 3-15 PSI AIR SIGNAL WHICH IS ROUTED THROUGH THE APPROPRIATE SOLENOID VALVE (ITEM 4) TO EITHER PV 31 OR PV 62. THE SWITCH (ITEM 2) OPENS THE



1) HAND INDICATING CONTROLLER
HIC 148 - FISHER TL 121
MANUAL LOADING STATION

2) ELECTRO/PNEUMATIC CONVERTER
4-20ma INPUT 6-30 PSI
OUTPUT FISHER MODEL
I-46-??

PV 148 IS THE MAGNET JT VALVE LOCATED IN THE MAGNET T.R. BOX. IT RESPONDS TO A 6-30 PSI SIGNAL. ON STANDS 3 THRU 6.
HIC 148 WILL BE LOCATED IN THE

INST LOOP SCHEMATIC

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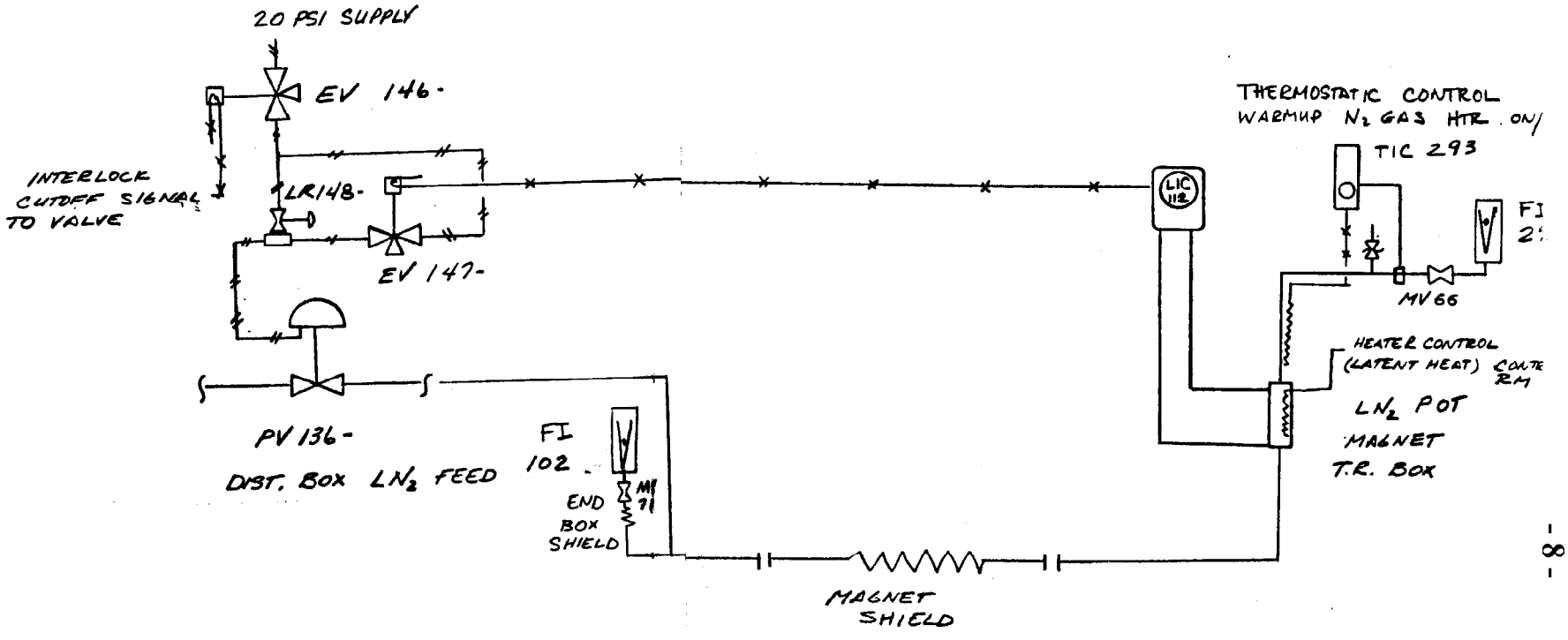
MAGNET J.T. VALVE CONTROL



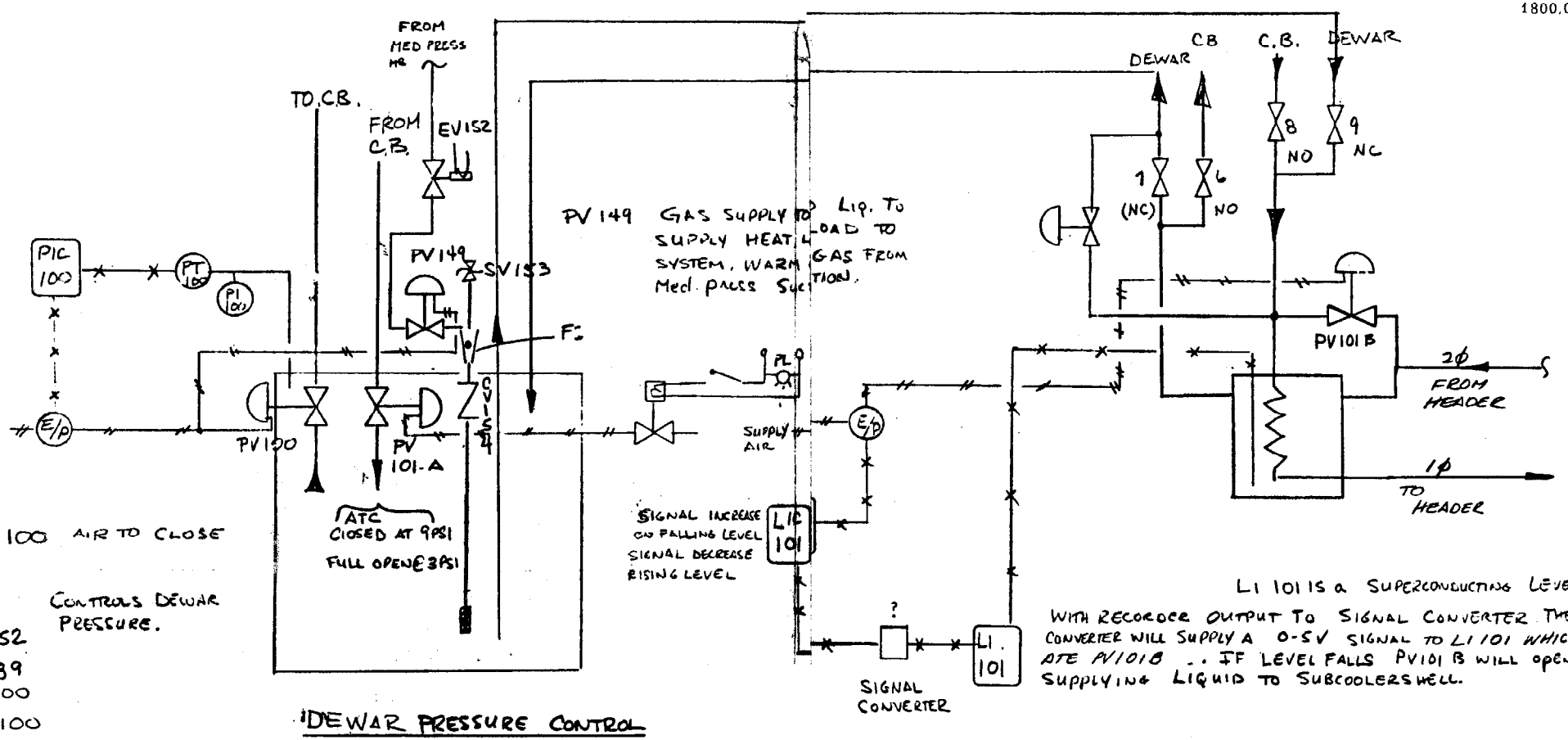
PV 136	LN_2 CONTROL VALVE
EV 146	SOLENOID, INTERLOCK INST. AIR
EV 147	SOLENOID, ACTUATOR PRESSURE, TO PV 136
LIC 112	0-10" H_2O PHOTOHELIC
TIC 293	THERMOSTATIC HEATER CONTROL

OPERATION:

LIC 112 IS A DISCRETE POINT LEVEL SWITCH (ADJUSTABLE) PHOTOHELIC WHICH WILL OPEN PV136 WHEN LEVEL FALLS. NORMALLY A STEADY STATE CONDITION WITH THE LATENT HEAT HEATER AND LOW LIMIT SELECTOR RELAY WILL ESTABLISH A LEVEL & CONTROLLED FEED CONDITION THRU PV136. IF UPSET OR HEAT LOAD SHOULD VARY, THE LEVEL SWITCH WILL ADD LIQUID THRU PV136 AS REQ'D.

TIC 293 IS A HOTWATT THERMOSTATIC CONTROL USING A BULB FILLED SENSOR

INST LOOP SCHEMATIC
CONTROL CIRCUIT
LN_2 CIRCUIT



PV100 AIR TO CLOSE

CONTROLS DEWAR PRESSURE.

EV152
F1289
PI 100
PT 100
PIC 100 TL101 FISHER
PV 100
PV 101A
PV 149
PV 102

LI 101 IS a SUPERCONDUCTING LEVEL PROBE WITH RECORDER OUTPUT TO SIGNAL CONVERTER THE SIGNAL CONVERTER WILL SUPPLY A 0-5V SIGNAL TO LI 101 WHICH OPERATE PV101B .. IF LEVEL FALLS PV101B WILL open SUPPLYING LIQUID TO SUBCOOLERS HELL.

DEWAR PRESSURE CONTROL

PV100 . CONTROLS PRESSURE IN THE DEWAR. IN RESPONSE TO PIC100 PIC100 READS AND MAINTAINS DEWAR PRESSURE AT OPERATOR SELECTED CONTROL POINT.

COLD BOX / DIST BOX
FLUID CONTROL CKT

MORGAN 2-28-78