# 6. Trouble Shooting Procedures

## 6.1 Checking the Process Controller Set-up

If a problem is experienced with the Pressure Controller, check the settings on the second menu. To access the second menu from the primary menu: Hold **UP ARROW & ENTER.** Press **Index** to scan the Lower Display. Press **UP ARROW** or **DOWN ARROW** to chan ge the value of the upper display.

**Table 6.1-1 Process Controller Set-up**

| DESCRIPTION | SETTING | DESCRIPTION | SETTING |
|---|---|---|---|
| AUTO | On | InPt | 0.1 (OFFI) * |
| ALHi | 20 (60) | SEnC | off |
| tunE | SELF | SCAL | 0.0 -50 |
| Strt | no | SCAH | 200 200 |
| LErn | Cont | SPL | 0.0 |
| dFAC | 3 | SPH | 160.0 |
| Pb2 | 1.2 | SP1o | OutA |
| Pid2 | off | S10t | Cy |
| ArUp | off | S1St | rE |
| ArtE | off | S10L | 0 |
| PEA | 123.5 (highest value since last i) | S10H | 100 |
| VAL | -3.9 | S1LP | 0 on |
| CY | 10 sec | S2t | dE |
| CY2 | 10 sec (16) | S20t | Cy |
| Pct0 | off | S2St | dir |
| Prog | off | S20L | 0 |
| StAt | off | S20H | 100 |
| 1rt | 0 | S2LP | 0 on |
| 1St | 0 | AL | HI |
| PEnd | hold | ALt | A65 |
| InPC | 0 | ALrE | OnOF |
| FiLt | 2 | ALPi | off |
| LPbr | off | ALiH | off |
| Lore | Loc (FE) * | ALSt | CLOS |
| CF5P | 18.5 | ALLP | 0 on |
| Addr | 32 | ALbr | off |

* changed

| | | | |
|---|---|---|---|
| SECr | 4 | Addr | 32 |
| InP | Curr | bAud | 9600 |
| OSUP | on | nAt | off |
| Unit | nonE | cFLt | 1 (2) * |
| dPt | 0.0 | | |

The P-Controller also displays various diagnostic error messages. These error messages are explained in Dwyer Process controller manual.

## *6.2 Changing Burst Discs*

The burst disc fitted to the Series C Cryo-cooler is there to protect the optic load from damage. Under normal operation it should never burst. Abnormal conditions may result in the burst disc blowing. The bursting pressure of the disc is 155 psi at 77K and 87 psi at 300K. The disc must be fully cold before raising the system pressure above 50 psi.

**CAUTION: If the system has been drained of liquid nitrogen, it should be left for at least 1 hour after re-filling before raising the system pressure. This is to ensure that the burst disc reaches its maximum burst rating.**

The burst disc should be handled very carefully. It is very delicate and can be easily crushed. Any imperfection on the surface of the disc can reduce its bursting pressure.

The burst disc blows into the vacuum space of the outlet bayonet which then relieves through the pressure relief valve on the vacuum chamber.

If the burst disc blows , it can be replaced following the instructions given below. The burst disc should be replaced as soon as soon as possible after blowing to prevent contamination of the nitrogen circuit which will still be cold. While gas is still venting from the system, contamination is less likely to occur. If the system is left open after all the gas has stopped venting, then it is almost certain that air will enter to contaminate the high pressure loop. If this occurs, the system should be warmed up completely and thoroughly purged with nitrogen gas before re-filling.

1. When the burst disc blows. most of the liquid nitrogen is blown out in a few minutes. There may however still be some liquid nitrogen collecting in the lower parts of the system e.g. the transfer lines to the optic.

Warning: Take care to avoid cold burns when replacing the burst disc as there may still be small volumes of liquid nitrogen remaining in the lines.

2. When the initial release of liquid nitrogen has stopped, the burst disc should be replaced as soon as possible. Leave the system for approximately 5-10 minutes to allow the system to vent fully. There should still however be a flow of gas out of the system to prevent air getting in.

3. Remove the pressure relief valve on the outer vacuum chamber of the outlet bayonet.

4. Remove the vacuum chamber covering the burst disc holder.

5. If the system is still cold it will be necessary to warm up the burst disc holder with a hot air blower.

6. With spanners on both the upper and lower parts of the burst disc holder, undo the upper nut holding the burst disc in place.

7. Remove the blown disc and support ring.

8. Examine the replacement disc and the support ring. They should be perfectly smooth with no imperfections anywhere on the surface of the disc. Ensure the disc is clean before fitting.

**CAUTION: Any nicks, dents, grit or scratches in the surface of the disc can reduce the bursting pressure of the disc.**

9. Ensure the mating surfaces of the burst disc holder are clean and smooth before fitting a new burst disc and support ring.

10. Place the new burst disc and support ring in the burst disc holder with the dome facing upwards, i.e. system pressure must be against the concave side of the disc.

11. With spanners on both the upper and lower parts of the burst disc holder, carefully tighten the upper nut to 70Nm torque (50lbs-ft).

12. Replace the vacuum chamber cover an vacuum chamber relief valve.

13. Remove the yellow cap on the vacuum pump-out port on the outlet bayonnet. Attach 3/8" pump-out tool to the pump-out port and connect a suitable vacuum pump to the line. Unscrew the vacuum plug and pump out the vacuum space to $<10^{-4}$ mbar.

14. Screw in the vacuum plug before switching off the vacuum pump and removing the pump out tool. Replace the yellow pump out port cap.

The system is now ready for re-filling.

## 6.3 Checking the Control System Operation

If you suspect a problem with the control system, carry out the following procedure to confirm the presence or absence of a fault, and to determine the source of the problem.

### 6.3.1 Tools and test equipment needed

- Vessel Pressure sensor
- Vessel level probe
- General purpose multimeter
- 3 Phase 208V supply ( no neutral needed)
- Vessel with at least 530mm of liquid nitrogen

WARNINGS: Mains voltage is present inside the control rack.

Observe liquid nitrogen safety precautions

**CAUTION: Never operate the heater unit when it is not in LN2, otherwise it will burn out.**

This test procedure describes the tests needed for a series C control rack before the vessel is cooled down to LN2 temperature. The first section describes the setup of the control rack units, and tests that should be done before the control rack is connected up to the cooler vessel. The second section describes the tests to be carried out when the cooler vessel is cold.

The test results should be recorded on the attached record sheet.

### 6.3.2. Test Procedure.

Before the control rack is connected to the cooler vessel:

1. Pull out the pressure display units from the front panel housing and check that the DIP switches are set for current input as shown in the diagram below :

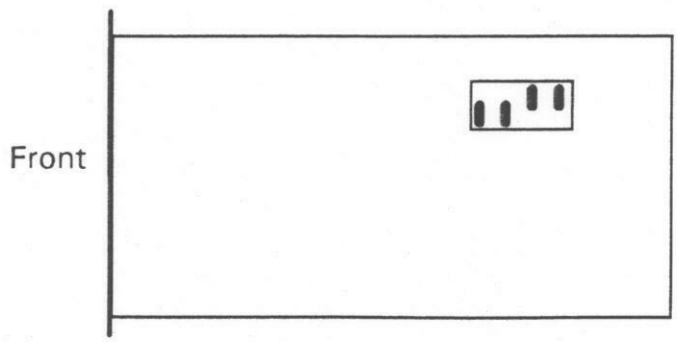


Figure 6.3-1 DIP Switch Settings on Pressure Display Units

2. Connect up the control rack to the 208V supply and turn on the "Main Rack Power" and the "Rack DC PSU" circuit breakers on the rear distribution panel. Turn off all the other circuit breakers.

   Check that the MAINS ON lamp is lit on the front panel of the control unit.

   Press the green button on the front panel which turns on the rack power. Check that the RACK ACTIVE lamp is lit, if not check that the EMO button is not pressed in or check that the EMO button is twisted and and reset. Press the EMO button on the front panel of the controller and check that the power is removed from the instruments so that only the MAINS ON lamp is lit.

   Twist the EMO button off and turn on the "Instmnt Power" and "Pump Power" breakers on the rear panel.

   Press the Green button on the front panel and check that all the instruments are powered up. Don't worry that the readouts may show overload, as there are no sensors connected at present.

3. Check that there is +24v DC on pins 41(+24v) and 42(0v) on SKT4 at the rear of the instrument rack (CMG00800). Record the readings.

4. Setup the pressure controllers as follows:

   a) Press the E and up arrow button together. The display should read "On Auto". Press the I button until the lower display reads "tune". Press the up or down arrow until the upper display reads "self". Press the E button.

   b) Press the E and up arrow together again, but hold them down for about 5 secs until the "Secr" display is shown.

   c) Using the I button to increment through the settings, and the up, down and E buttons to change the data set the following settings an the controller:

      (Don't forget to press the E button after every change otherwise the setting will not be stored in the controller).

      inp = curr
      osup=on
      dPt = 0.0
      InPt = 0.1
      SCAH = 200.0
      SPL = 0.0

When complete you can scroll throught the menu with the "I" button until you come back to the main display or just leave it for a couple of minutes and it resets back to the main menu automatically.

5. Connect the 50w D-type connector from the control rack to the small distribution box. Plug in a temperature sensor and check that the temperature controller is reading room temperature. Record the readings on the results sheet.

6. Plug in the pressure sensor to the small distribution box. Check the pressure reading on the PID controller. (It may be necessary to remove the small cap to enable normal atmostpheric pressure to the sensor otherwise an underflow error reading may be given by the controller). The PID controller will require resetting , (check manual), press and Hold I+E for approximately 5 seconds. Record the readings on the result sheet. Repeat the step if there are two sensors on the controller.

7. Turn off the ILM meter and then turn it back on again. The two displays should read N2 when first powered up. (If not refer to A-2 of this test procedure - both channels should be configured to Op mode No. 5). Plug in the N2 level meter to the buffer input of the small distribution box. Check that the N2 level probe is reading 101.1%.

   Set the active length of the two probes as follows : Vessel = 520mm ; Buffer=330mm (see section A-3 of this test procedure)

   Set the default by pressing 0+100% . The meter shows the default. Calibrate the 0% level by pressing the 0% calibration button and using the adjust buttons to set the reading at 00.1%. (This may have to be adjusted when the probe is cold).

8. Refer to A-4 to set the trip levels on the vessel meter at : FULL= 60%; FILL=40%; LO= 20%. Set the buffer meter trip levels at: FULL= 44%; FILL= 40%; LO= 20%. (Immerse the active length of the level probes in a vessel of LN2 and calibrate the probe readings to give 100% at the top of the active length and 0% at the base). The fill level on the buffer is used as an interlock for the buffer heater.

   After setting all the parameters on the ILM store the data before removing power to the unit ( refer to Section A-5)

9. Connect the 10w Harting connector to rack rear panel SK1.

10. Measure the AC voltage across the autofill connections of the 10w Harting (pins 9&10). When the vessel level goes below 40% there should

be AC mains voltage on the connector. When the level rises above 60% the power should be turned off.

11. Measure the AC voltage across the heater control conections on the 10w Harting (pins 6&7). Next set the pressure of the buffer to 10 psi. The harting socket should show 208V. Now withdraw the buffer probe out of the vessel until the meter level falls below the buffer trip threshold set in step 7. The heater should now be disabled. Check that there is no voltage on the Harting pins.

### *6.3. 3 Setting Up the ILM Meter*

#### *6.3.3.1 Entering Test Mode*

With the instrument operating normally, enter the **TEST** mode by holding the **RAISE** and **LOWER** buttons depressed, whilst pressing and releasing the **SILENCE** button.

The message **tSt**

will appear followed shortly by: **t.00**

RAISE and LOWER may now be used to select a specific test in the range 1 to 11. For example to access test 7, press RAISE seven times to display:

**t.07**

With the required test number displayed, press and release **SILENCE**. The instrument will then enter that test, often displaying the first item in a further menu.

To leave test mode from the main test menu, select

**t.00**

When **SILENCE** is pressed, normal operation will resume. (Some tests automatically return to normal operation on completion, without returning to the test menu.)

#### *6.3.3.2 Test t.05 Configuring the Channels*

The first stage in configuring an ILM for a specific application is to set a configuration number for each channel in turn. When t.05 is selected, the channel 1 display will show **"CFG".** If SILENCE is now pressed and held in, the configuration number for channel 1 will be displayed. This is a decimal number in the range 0 to 255, the meaning of which is described below. Whilst SILENCE is held, RAISE or LOWER may be used to change this number. When SILENCE is released, the channel 2 display will show **"C".** The same

procedure of using RAISE and LOWER whilst holding SILENCE pressed may be used to adjust this. Finally the same process is repeated for channel 3. When SILENCE is released for the third time, the main test menu will return on the channel 1 display.

Where an instrument only has displays fitted for one or two channels, it is still necessary to step through the configuration for all three channels. Normally this just means pressing and releasing SILENCE until the **"tst"** message returns. The configuration number for the unused channels will have been set to zero during manufacture. If you suspect that it may have been set to some other value, for each unused channel, hold SILENCE pressed, then press and hold LOWER for 10 seconds. This will ensure that the value is changed to zero.

The configuration is specified by a number in the range 0 to 255. The number is made up of 4 parts, as follows. Just one option should be selected from each part. The final number is obtained by adding the numbers for the 4 parts.

OPERATING MODE
0 - Channel not in use
1 - Channel used for Nitrogen Level
4 - Activates Channel Relay (for Autofill)
8 - Activates Alarm & Relay 4 (SILENCE clears Relay 4)

It is important to set the configuration number first when setting up an ILM, since the choices offered for the later options will depend on the use for which the channel has been configured. (Do not forget to STORE the new configuration before switching off.)

### *6.3.3.3 Test t.07 Setting Probe Active Length*

An essential part of the calibration of ILM is to tell the meter the active length of the probe. This is the length of the section of the probe between the 0% cryogen level and the 100% cryogen level. ILM uses this to establish an approximate default calibration in the absence of cryogen and to ensure that the accurate calibration is within the range of the 0% and 100% adjustments. For a nitrogen probe there will be an indeterminate length of probe between the 100% point and the physical top of the probe. This makes predicting an accurate default calibration harder.

In some cases it may be necessary to set an "incorrect" figure for the active length in order to ensure that the 0% and 100% points can both be calibrated correctly. If the displayed reading is too low, try setting a longer active length. If it is too high, try setting a shorter active length.

When test t.07 is selected the display will show **"LEn"**. Pressing and holding SILENCE will then show the nominal length in millimetres, which may be adjusted by RAISE and LOWER.

#### *6.3.3.4 Test t.11 Setting Full, Fill and Low Thresholds*

A similar procedure is again used to set the thresholds for each channel in use. The prompts for the thresholds are **"FUL"**, **"FIL"** and **"LO"** respectively. Default settings are 90%, 20% and 10%.

### *6.3.4 Final Reminder*

After setting up the instrument, please remember to STORE the results before switching off or they will be lost. To STORE, press and hold any 0% or 100% key (it does not matter which) and press and release SILENCE. The channel 1 display should show **"Sto"**. If it shows **"Pro"** instead, the internal switch S2/1 is in the OFF position and must be set to ON before data can be stored.

# Control System Test Record

| Tested by: | Date: |
|---|---|
| Serial number: | Passed: |

## Results

| Step | Test | Acceptable range | Result | Pass? |
|---|---|---|---|---|
| 1. | Pressure controller DIP switch set | | | |
| 2 | Rack power up test | | | |
| 3 | 24v DC measured on 50w D-type | 23-25v | | |
| 4. | Press. Cont. parameters set | | | |
| 5 | Pump inlet Room temperature | 280K-305K | | |
| 6 | Pump inlet pressure reading | 0.0-1.4 psi | | |
| 6 | Pump outlet pressure reading | 0.0-1.4 psi | | |
| 7 | Vessel N2 0% level set | | | |
| 7 | Buffer N2 0% level set | | | |
| 8 | Vessel trip level hysteresis set | 40-55% | | |
| 8 | Buffer trip level interlock set | 40% | | |
| 10 | Autofill control voltage | 200-215VAC | | |
| 11 | Heater control voltage | 200-215VAC | | |

## 6.4 Checking the Performance of the Complete System

The performance of the complete system can be checked by following the procedures given below.

### 6.4.1 Tools and test equipment needed

| | |
|---|---|
| 1 | Dummy heat load (immersion heater element in liquid nitrogen enclosure leak tight at >10bar). |
| 2 | Variac |
| 3 | Clip on ammeter and DVM |
| 4 | Chart recorder |
| 5 | 500l liquid nitrogen dewar or liquid nitrogen supply |

**Cautions:**

1. **Do not run pump for extended periods unless it is pumping liquid nitrogen.**
2. **Do not isolate the high pressure lines from the rest of the system without allowing nitrogen boiloff from the lines to vent.**

Warning: Cryogenic liquids. Observe standard precautions (goggles, gloves, no solo working, no working in enclosed spaces). Read the health and safety section of the this manual.

### 6.4.2 Objective of tests

The objective of these tests is to ensure that the cooler is capable of its basic function of cooling continuously loads of not less than 1kW, with a flow rate controllable up to 5gpm, and pressure controllable up to 75psi.

The procedure assumes that

the system has been fully leak checked (including cold leaks)

the control rack has been tested, and the results recorded.

the vessel is connected to a pressurised refill dewar of sufficient capacity for the duration of the test (typically 500 litres)

the high pressure circuit including the test load has been fully vented of gas bubbles and filled to not less than 55%.

the burst disc in the high pressure circuit has been conditioned to low temperature operation, either by running at 30Hz / 30psi for not less than one hour, or at 30Hz without pressuriation for not less than two hours.

### *6.4.3 Procedure*

1. Connect the control rack up to the cooler via the 50w D-type connector and the 10w harting connector. Check that the temperature , flow, and pressure sensors is reading normally.

2. Pulse the cooler motor briefly by pressing the "Jog" button on the motor controller panel. Check that the motor is rotating in a clockwise direction, when viewed from above, by unscrewing the viewing port on the pump and monitoring the pump shaft operation.

3. Connect the data aquisition system to the control unit and check that all the units respond to a request for data from the system

4. Make a record of the configuration of the system in the relevant boxes, including flow sensors, pressure transducers, temperature probes and the type of liquid nitrogen lines.

5. Set up to pump LN2 through the dummy load. Run the pump at 30 Hz (approx 2 gpm. with the pressurisation heater lead disconnected) and note the high pressure circuit pressure, temperature. Record the time taken for the values to stabilise. Record the final values. Repeat at 60 Hz (approx 4 gpm) and 90Hz (approx 6 gpm). If the flow sensor option is fitted, then the flow readings should also be recorded.

6. Set the pump speed back to 60Hz (approx 4gpm). Alter the pressure set point to 75psi and reconnect the heater lead. Check that the pressure stabilises at this value and record the value.

7. Turn on the dummy load at 1kW, using a DVM and clip on ammeter to measure the voltage and current readings (typically around 7A at 145VAC for a 20ohm immersion heater element). Leave the system to run for four hours, recording the pressure, temperature and level of the high pressure circuit every hour. The pressure should not change by more than +/- 1psi. If the system has the flow sensor option fitted, then the flow readings should also be recorded. Check that the automatic refill is functioning and record the times and vessel levels at which the valve opens and closes.

8. Turn off the dummy load heater and check that the system holds 75psi. Reduce the set pressure to 40psi and confirm that the system stabilises at the lower value.

# System Performance Test Results

| **Tested by** | | **Date** | |
|---|---|---|---|

| Flow sensor? | | Pressure sensor at pump outlet? | |
|---|---|---|---|
| High pressure line length? | | | |
| Other configuration notes | | | |

## Results

| **Step** | **Test** | **Acceptable range** | **Result** | **Pass?** |
|---|---|---|---|---|
| 1 | Check all sensors operate correctly | | | |
| 2 | Check operation of pump motor | | | |
| 3 | Check operation of data aquisition | | | |
| 5 | Time to stabilise at 30Hz (no power to load) | | | |
| 5 | Loop pressure at 30Hz | < 35 psi | | |
| 5 | Loop flow at 30Hz (Flow sensor option) | (2 USgpm typ.) | | |
| 5 | Loop temperature at 30Hz | 78 - 82 K | | |
| 5 | Time to stabilise at 60Hz (no power to load) | | | |
| 5 | Loop pressure at 60Hz | < 35 psi | | |
| 5 | Loop flow at 60Hz (Flow sensor option) | (3.5 - 4 USgpm typ.) | | |
| 5 | Loop temperature at 60Hz | 78 - 82 K | | |
| 5 | Time to stabilise at 90Hz (no power to load) | | | |
| 5 | Loop pressure at 90Hz | < 35 psi | | |

| | | | | |
|---|---|---|---|---|
| 5 | Loop flow at 90Hz (Flow sensor option) | (6 USgpm typ.) | | |
| 5 | Loop temperature at 90Hz | 78 - 82 K | | |
| 6 | Pressure stable at 75psi setpoint at 60Hz (no power to load) | 74 to 76 psi | | |
| 7 | Voltage on dummy load | | | |
| 7 | Current through dummy load | | | |
| 7 | Loop pressure reading 1 (1kW load) | 74 to 76 psi | | |
| 7 | (Loop flow reading 1) (1 kW load) | (3.5 - 4 USgpm typ.) | | |
| 7 | Loop temp reading 1 (1kW load) | 78 to 85K | | |
| 7 | Loop level reading 1 (1kW load) | 50 to 90% | | |
| 7 | Loop pressure reading 2 (1kW load) | 74 to 76 psi | | |
| 7 | (Loop flow reading 2) (1 kW load) | (3.5 - 4 USgpm typ.) | | |
| 7 | Loop temp reading 2 (1kW load) | 78 to 85K | | |
| 7 | Loop level reading 2 (1kW load) | 50 to 90% | | |
| 7 | Loop pressure reading 3 (1kW load) | 74 to 76 psi | | |
| 7 | (Loop flow reading 3) (1 kW load) | (3.5 - 4 USgpm typ.) | | |
| 7 | Loop temp reading 3 (1kW load) | 78 to 85K | | |
| 7 | Loop level reading 3 (1kW load) | 50 to 90% | | |
| 7 | Loop pressure reading 4 (1kW load) | 74 to 76 psi | | |
| 7 | (Loop flow reading 4) (1 kW load) | (3.5 - 4 USgpm typ.) | | |
| 7 | Loop temp reading 4 (1kW load) | 78 to 85K | | |
| 7 | Loop level reading 4 (1kW load) | 50 to 90% | | |
| 7 | Loop pressure reading 5 (1kW load) | 74 to 76 psi | | |
| 7 | (Loop flow reading 5) (1 kW load) | (3.5 - 4 USgpm typ.) | | |
| 7 | Loop temp reading 5 (1kW load) | 78 to 85K | | |
| 7 | Loop level reading 5 (1kW load) | 50 to 90% | | |

| | | | | |
|---|---|---|---|---|
| 7 | Note refill times and levels during run | | | |
| 8 | Loop pressure stabilises to setpoint with dummy load off? | 74 to 76 psi | | |
| 8 | Loop pressure stabilises to 40 psi setpoint with dummy load off? | 39 to 41 psi | | |

## 6.5 Procedure for Pumping Out the Bayonet

The bayonet can be pumped out during operation, but it is more effective to do it at room temperature, or when baked to 120 °C.

1. Remove yellow relief cap assembly from the pump out relief valve.
2. Retract the adjustment drive on the Valve Operator. (The Valve Operator is a separate item not shipped with all systems.)
3. Locate Valve Operator over pump out valve and screw into position.
4. Locate the adjustment drive of the Valve Operator over the pump out valve and screw into position.
5. Connect up pumping line to NW16 flange .
6. Pump out connecting line.
7. Open the relief valve of the valve using the Valve Operator

## 6.6 Procedure for Pumping Out the Flexible Lines

The procedure for pumping out the flexible lines is the same as that given in section 6.5 (Procedure for pumping out the bayonet). The flexible lines should pump out to a pressure of $10^{-5}$ mbar with a leak rate of better than $3 \times 10^{-9}$ mbar litre /sec..