SQ21 – Valve Box warm-up

**Sensors and actuators used:**

- Valve: CV580

- Temperature: list in the tables 2, 3 and 4

- Heater: list in the tables 2, 3 and 4

|  |  |
| --- | --- |
| **The user chooses:** | **Initial conditions:** |
| - Temperature setpoint: list in the tables 2, 3 and 4 | - Sequences from 1 to 3 stopped  - Sequences 5 and 9 stopped  - Sequence 8 in operation |

This sequence drives the electrical heaters implicated in the warm-up of the valve box. Each set of heaters has its own cycle. To limit the current draw when starting the heater, the sequences work this way: each set of heaters starts its cycle 10 seconds after the previous. The sequential starting of heaters may take several minutes. The cycles of heater control run in parallel until the user decides to stop the warm-up. The cycles then all stop at the same time.

The sequences used to warm-up the thermal shield and the helium circuits are very similar, but for the helium tank warm-up, the program checks the helium level. As long as the helium tank contains liquid helium, the heating is intermittent and allows evaporating the liquid stored in the tank. The heating operates in continuous mode when the helium tank is empty (LT600<5%).

The sequence 21 can start only when the valve box thermal shield cooling (sequence 5) and the valve box helium cooling sequences are stopped (sequence 9 to 20).

The sequences 21.1, 21.2 and 21.3 are started one after the other as described below:

**21.1:** Warm-up of the valve box thermal shield

All helium tank heaters are started

All thermal shield heaters are started

Warm-up VB

Stop

Stop

Warm-up of the valve box thermal shield

Start 21.1

Start 21.2

21.1 in operation

Warm-up of the helium tank

Start 21.3

21.1 in operation

21.2 in operation

Warm-up of the helium heat exchangers

“Do you want start the warm up of the Cryostat?”

Yes

“You must stop the sequences from 10 to 20”

Sequence 10 to 20 are stopped

Stop LN2

Sequence 5 stopped

Close CV700

The cycle 21-1 used for the control of the electrical heaters glue on the thermal shield heaters (EH701AB) is given below:

TT701 A or B >TT701setpoint

Warm-up VB

Stop

Stop

To other heaters

Stop warm-up

Stop EH701AB

Warm-up

Start EH701AB

TT701 A and B < (TT701setpoint - 5°C)

Delay

Subsequence

The table 2 gives the list of heaters implicated in the warm-up of the thermal shields.

|  |  |  |
| --- | --- | --- |
| Heater | Thermometer | Temperature setpoint |
| EH701AB  EH702AB  EH703AC | TT701AB  TT702AB  TT703AC | TT701setpoint  TT702setpoint  TT703setpoint |

**21.2:** Warm-up of the helium tank

The cycle 21-2 used for the helium heaters glue on a helium tank is given below:

TT600A OR B OR C OR D >TT600setpoint

LT600 ≤ 5

Start 21.2

Stop

Stop

Warm-up

Start EH600AD

CV580 opened

LT600 > 5

Stop

Warm-up

Stop EH600AD

CV580 opened

TT600A and B and C and D < (TT600setpoint – 5°C)

EH600AD running 5s, Delay 20s

Open CV580

Check liquid level

Subsequence

The table 3 gives the list of heaters implicated in the warm-up of the helium tanks.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Heater | Pt thermometer | Level | Temperature setpoint | CX thermometer | Temperature threshold |
| EH600AD | TT600AD | LT600 | TT600setpoint | TT603 | 30K |

**21-3:** Warm-up of the helium heat exchangers

The cycle 21-3 used for the helium heaters glue on the heat exchangers is given below:

Start 21.3

TT601 < (TT601setpoint – 5°C)

Stop

Stop

Warm-up

Start EH601

Stop

Warm-up

Stop EH601

Stop

Warm-up

Start EH354

Open FV381

Stop

Warm-up

Stop EH354

FV381 opened

TT354 >TT354setpoint

TT354 < (TT354setpoint – 5°C)

TT601 >TT601setpoint

Delay

He circuits closed

Close FV381

FV381 closed

Subsequence

The table 4 gives the list of heaters implicated in the warm-up of the heat exchangers.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Heater | Pt thermometer | Level | Temperature setpoint | CX thermometer | Temperature threshold |
| EH601  EH354 | TT601  TT354 |  | TT601setpoint  TT354setpoint | TT606  TT355 | 30K  50K |