HPS SVT Interlocks v0.1

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Contents

1 Interlock hardware and requirements **2**
1.1 System description 2
1.1.1 Major components 2
1.1.2 Sensors and inputs 3
1.1.3 Control outputs 4
1.1.4 Potential accidents 4
1.2 Interlocks for operation with beam 5
1.2.1 Cooling loop failure (high or low temperature on either RTD, or flow switch trip) 5
1.2.2 Bad vacuum (vacuum gauge) 6
1.2.3 Beam trip (FSD signal) 6

Chapter 1

Interlock hardware and requirements

1.1 System description

1.1.1 Major components

List of equipment and experts.

- SVT DAQ (Pelle Hansson): controls LV regulation and distribution to hybrids. Provides IOC for hybrid LV control and temperature readout of FEBs and hybrids. All of these functions are provided by the FEBs and rely on the MPOD LV.
- PLC (Brian Eng): provides I/O for sensors and valves.
- MPOD (Pelle Hansson, Sho Uemura): LV supply to signal flange boards and FEBs, HV supply to sensors. Controlled through SNMP by EPICS IOC.
- SVT chiller (Sho Uemura, Marco Oriunno): Julabo Presto A80 chiller. Chills the SVT modules. HFE 7000 coolant, nominal flow 1-1.5 GPM, nominal temperature -20 C (normal range is -30 to 20 C). Will trip on low fluid level. Check valve at return to prevent backflow when chiller is off.
- FEB chiller (Wesley Moore): Anova A25. Chills the frontend boards. Distilled water coolant, nominal flow unknown, nominal temperature

20 C (normal range is 10 to 30 C). Will trip on low fluid level. Check valve at return to prevent backflow when chiller is off.

1.1.2 Sensors and inputs

FEB cooling loop

- To PLC: Flow switch (adjustable setpoint, set with reference to flow meter) at chiller return
- To PLC: 2x RTD on supply and return, near vacuum feedthroughs
- Through SVT DAQ: temperature sensors on FEBs
- From FEB chiller (via RS-232): temperature readout, what else?
- Local readout only: flow meter, next to flow switch

SVT cooling loop

- To PLC: Flow switch (fixed setpoint, 0.25 GPM) at chiller return
- To PLC: 2x RTD on supply and return, at manifold (before lines split to top and bottom halves of the SVT)
- Through SVT DAQ: temperature sensors on hybrids
- From SVT chiller (via RS-232): temperature readout, outlet pressure, status
- Local readout only: 2x pressure gauges, on supply and return at manifold

Beamline

- To PLC: FSD (beam trip) signal

1.1.3 Control outputs

FEB cooling loop

- From PLC: Solenoid valve at chiller outlet
- On FEB chiller (via RS-232): start/stop, temperature setpoint anything else?

SVT cooling loop

- From PLC: Actuated ball valve at chiller outlet
- From PLC: Chiller circuit breaker
- On SVT chiller (via RS-232): start/stop, temperature setpoint, pump power

Voltages

- From PLC: MPOD enable signal (shuts down all LV and HV channels)
- From MPOD IOC: Controls for individual MPOD channels

1.1.4 Potential accidents

Coolant leakage inside vacuum

A small leak inside the vacuum will be detected by the vacuum gauges. A large leak will trip the flow switch.

Coolant leakage outside vacuum

A small leak will drain the chiller until its level switch trips, then the flow switch will trip. A large leak will trip the flow switch.

Low level in SVT cooling system

The HFE 7000 fluid is very volatile and is known to evaporate from the chiller reservoir. Any bad seals in the system would increase the rate of loss. The observed rate of loss in testing is less than 1 L/week, and the reservoir capacity is more than 5 L, but the level should be monitored regularly. A low level warning (reported in RS-232 status) will precede a low level alarm (chiller trip).

Chiller failure or abnormal operation

A pump or power failure in a chiller will trip the flow switch.

A refrigerator or control failure may cause the chiller to run at an unexpected temperature. This would be detected by the RTDs.

Blockage in a cooling line

A blockage in the FEB cooling loop, or the SVT cooling lines before the manifold, would reduce total flow in the system. This would be detected by the flow switch or the RTD on the return side.

A blockage in one half of the SVT cooling manifold would reduce flow to half the SVT but might not be detectable by any of the cooling loop instrumentation. The only likely indication is a rise in the SVT hybrid temperatures. Since we don't expect this to happen suddenly or require rapid intervention, we will set an alarm on the SVT hybrid temperatures but no interlock.

Beam trip

The SVT HV must be shut off following a trip, to ensure that the HV is not accidentally left on while the beam is being brought back.

1.2 Interlocks for operation with beam

All interlocks are triggered by PLC inputs. Actions are divided into PLC (fast and reliable, since the inputs, logic and outputs are all internal to the PLC) and EPICS (slower, less reliable, less critical)

1.2.1 Cooling loop failure (high or low temperature on either RTD, or flow switch trip)

Trip points must be adjustable to allow for operation at different temperatures. There must be some sort of interlock bypass for system startup (i.e. it must be possible to start the chiller when temperatures are out of spec and the flow switch is tripped).

- PLC interlock: Close the valve at the chiller outlet. Disable the MPOD. After 30 seconds (or however much time we want to give the chiller to shut down), cut power to the chiller.
- EPICS interlock: Turn off the chiller.

1.2.2 Bad vacuum (vacuum gauge)

- PLC and EPICS interlocks: Same action as cooling loop failure, for both loops. (so chillers will be valved off and shut off, and the MPOD will be disabled)

1.2.3 Beam trip (FSD signal)

There should be an option to have a PLC interlock that disables the MPOD.

- EPICS interlock: Turn off all HV channels.