Hall A Cryogenic Target Operation Guide

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8th June 2004

1 Overview

The purpose of this document is to describe the general operation of the standard cryogenic target in Hall A. This document includes general instructions for the safe and courteous operation of both the hydrogen and helium targets. Sections are included to describe responsible operation when connected the 4K and 15K supplies of the ESR. In addition to standard operations, it also includes instructions for the operation of the target when connected to the 4K helium supply from the CHL. For a comprehensive guide to understanding the graphical user interface (GUI) to the control system, the reader is referred to the "User's Guide to the Hall A Cryotarget" by Chris Keith. Each operator must be fully trained by a knowledgeable Hall A staff member or designee. This document is not intended to provide this training.

2 General Operations

General operations of the cryogenic target user/operator are as follows:

- Monitoring of the target control GUI (this includes the target charts) and servicing of alarms.
- Target motion
- JT valve adjustment
- Reboot of the target control IOC
- Operation of heater and pump (fan) controls

Under normal conditions, the cryogenic targets are cooled by the End Station Refrigerator (ESR). The ESR is capable of supplying 4 or 15K refrigerant. It is essential that the cryo target operator know which coolant is being supplied. Further, it is essential that the target operator monitor the GUI/alarm handler for unacceptable values of any operation parameter. It is noted that all of the critical parameters and their operational limits are monitored by the alarm handler. The operator must also be aware of the refrigerant needs of the other halls. Abrupt changes in coolant flow can be detrimental to other halls and the ESR as well. Adjustment of the JT valves which control the coolant flow to the target is described in Section 6. Be kind to your fellow coolant users and communicate your intentions.

3 Target Alarms

Under normal conditions the target alarms should not be tripped. In the event of an alarm, the following procedure should be followed:

1. Inspect the alarm handler to determine what tripped and severity of the trip.

2. A white alarm indicates a communication error. If a significant portion of the alarm tree is white then communication has been lost and the IOC must be rebooted. Follow the procedure for IOC reboot as described in the User's Guide.

3. A yellow alarm is least severe. This reveals that the tripped indicator has exceeded the hi or low limit. Check the value of the tripped indicator. In many cases, the trip is not persistent and can be simply acknowledged. If the trip is persistent and attempts to adjust heat loads and other parameters are not successful, inform the target expert on call.

4. A red alarm is the most severe. This reveals that the tripped indicator has exceeded the hi hi or low low limit. Check the value of the tripped indicator. In some cases, the trip is not persistent and may be acknowledged. If the trip is persistent and attempts to adjust heat loads and other parameters are not successful, inform the target expert on call.

Other alarms outside of the target GUI also exist.

1. If a hydrogen gas alarm is tripped the Hall should be evacuated and the target expert on call must be informed. This alarm will cause a machine FSD.

2. If a loop low pressure alarm is tripped, as indicated by the low pressure alarm box in the counting house, then inform the target expert on call.

3. If the target vent line pressure alarm has tripped (on the GUI), then inform the target expert on call.

4. If the scattering chamber vacuum pressure alarm trips, then inform the target expert on call. Most likely this condition will result in a target warm up. Follow the instructions of the target expert. This alarm will cause a machine FSD.

4 IOC Reboot

This section has been taken almost entirely from Chris Keith's User's Guide.

Under normal circumstances, the IOC %CPU Free number should be 50-70%. During an experiment, it has been observed that intense radiation can cause the IOC to reboot itself or "freeze" (require rebooting externally). You can tell that the IOC is frozen when the MEDM screens go "white". The reboot procedure requires about 5 minutes, so please be patient. If the IOC never comes back to life, contact target expert on call and follow the procedures outlined in "What to do while the IOC Reboots" in the User's Guide.

If the IOC requires a reboot, follow these steps:

- walk into the middle room and press the green button labeled "Reset IOC". This button is located under the auxiliary heaters.
- After about 5 minutes the MEDM screens should return to life.
- If the MEDM screens remain "white" after 5 minutes, try restarting the screens – first find the primary MEDM window and press the X button in it upper right corner. Then follow the steps in Starting the GUI.
- If the controls do not come back or it is known that the IOC is not rebooting (ping iocha13 to check response) this is a serious problem. Inform the target expert on call immediately.

During the reboot procedure the operator's primary concern is the temperature of the 3 Loops. While the IOC reboots, the High Power Heaters will continue to provide exactly the same amount of power as just before the reboot. There is a period of a few seconds when this power will drop to zero. During this time the operator may need to use the Auxiliary heaters to maintain the loop temperatures. Following a reboot, the High Power Heaters should return to exactly the same state they were before the reboot (PID, MAN or OFF). Since it is initialized with zero watts following a reboot, the PID loop will require a few seconds before it can successfully regulate the temperature at the set point.

4.1 Auxiliary Heaters

The auxiliary power supplies for the high power heaters are mounted in a rack in the middle room of the counting house. During an "extended" IOC reboot, these supplies for (at least) the deuterium loop should be turned on by pressing the on/off switch on the left hand side of the box. The power output to the heater is then controlled by individually setting the voltage and current outputs with two knobs located on the front of the supply (voltage=left knob, current=right knob).

When the auxiliary power set by the operator exceeds that of the primary supply in the hall, the heater inside the loop will begin to draw current from the auxiliary supply. This will be evident when the voltage and current read backs both begin to display non-zero numbers. If the auxiliary supply isn't putting out enough power to maintain the desired temperature, it may have reached either a voltage or current limit. These limits are indicated by the illumination of two lights on the front of the power supply, close to the knobs. Simply increase the voltage or current output by turning the knobs until you have passed the limit.

5 Target Motion

All user allowed motion of the cryogenic target is contained in the GUI. The target operator is responsible for making sure that current limits for the individual targets in the stack are not exceeded. A list of these limits should be posted in the counting house. It is to be noted that any target motion will cause a machine fast shutdown (FSD). Therefore, motion of the target is to be performed following a strict procedure. Failure to follow the procedure may cause all halls to loose beam. The procedure for target motion is as follows:

1. Inform the MCC that the Hall A target needs to be moved. Do not move the target until the MCC has given permission. The MCC will remove the beam from the target and mask the FSD for target motion. This FSD should be visible in the counting house.

2. Once the MCC has given permission for the target to be moved, follow the target motion procedure as described in the User's Guide by Chris Keith.

3. Adjust the JT valves for the given target (if necessary) following the procedure outlined in Section 6.

4. Once the target motion is complete inform the MCC which target is now in the beam and what current is desired. Observe the current limits as described above.

6 JT Valve Changes

Operation of the coolant supply JT valves must be performed properly. This activity can effect other halls as well as trip the ESR. While changing JT valve settings the operator must monitor the GUI for indications of a problem.

JT valve changes are necessary under the following conditions:

1. Change heat load available for a given target after target motion.

2. Adjust heat load in anticipation of long term current changes.

3. Allow more cooling power for neighboring halls.

4. Relieve stress on the ESR (at the request of the cryo group)

6.1 15K coolant supply

It is necessary for the target operator to use care when adjusting JT valves. These valves control the flow of the He refrigerant to the target and abrupt changes can cause problems at the ESR. Valves should be changed slowly; no more than 3-8% per minute for 15K supply. During these periods and for 10 minutes following them, it is important to monitor the following indicators ensure that limits are not exceeded.

1. The total flow to Hall A and to Hall C. The sum of the Hall A and Hall C flows is not to exceed 25 g/s for the 15k target.
2. The coolant return temperature. This temperature should not exceed 30K at any time and should be below 25K at all times.
3. The coolant supply temperature. This temperature should not exceed 14K.
4. If the return or supply temperature shows a trend indicating an ultimate temperature above acceptable limits slowly return the JT valves to their original positions.

Instructions for using the GUI to adjust the JT valves can be found in the User's Guide.

6.2 4K coolant supply

It is necessary for the target operator to use care when adjusting JT valves. These valves control the flow of the He refrigerant to the target and abrupt changes can cause problems at the ESR. Valves should be changed slowly; no more than 3-4% per minute for 4K supply. During these periods and for 10 minutes following them, it is important to monitor the following indicators

1. The total flow to Hall A and the total flow to Hall C. The 4K target is significantly harder to adjust than the 15K target and depends on current running conditions for the ESR (i.e. spectrometer configurations in all the halls).
2. The coolant return temperature. This temperature should not exceed 6.5K at any time. If the return temperature trend, as seen on the GUI charts, indicates that the temperature will exceed 6.5K the JT valve must be closed to a point where this temperature remains acceptable. Do this slowly as outlined above.
3. The coolant supply temperature. The trend in this temperature should not be positive over the long term. Fluctuations of about 0.15K are normal. The temperature should not exceed 4.5K
4. If the return or supply temperature shows a trend indicating an ultimate temperature above acceptable limits, slowly return the JT valves to their original positions.

Instructions for using the GUI to adjust the JT valves can be found in the User's Guide.

7 Operation of the Target with Coolant from the CHL

During the Hapex running scheduled for June and July of 2004, the ESR will not be able to provide enough refrigeration to operate the Hall A cryogenic target at the power requested by the experiment. To provide the necessary cooling power, the CHL will be connected directly to the Hall A target. During this period, extra caution must be taken when operating the target. Failure to operate the target properly could cause the CHL to shutdown further causing the Accelerator, FEL and all three experimental halls to cease operations. This section describes the necessary operational restrictions which must be adhered to during this period.

Under these operational conditions, the coolant return temperature does not need to be monitored and can be up to 300K. JT valve changes must be performed as described in Section 7.1. The measured flow

at flow meter CFI 6061 is not to exceed 25 g/s under any condition. Care must be taken when operating the JT valves to ensure that this does not happen. Further, ESR and Hall B problems can effect the flow measured by this meter. Communication between Hall B and The Hall A target operator is essential. An alarm on this meter will be installed in the GUI. There is also an extra set of emergency conditions and responses to them described in Section 7.2.

During this time period, the hydrogen target will also have to be cooled using the CHL 4K supply. With this low temperature coolant, it is possible to freeze the hydrogen target. Care must be taken while rebooting the IOC. Also it is critical that the circulation pump (fan) is operating properly.

7.1 JT valve changes

All JT valve changes (even under emergency conditions) must conform to the following parameters.

1. Movement of the valve must not exceed 5% per minute in either direction when the JT valve position is less than 50% open.
2. Movement of the valve must not exceed 1% per minute in either direction when the JT valve position is greater than 50% open.
3. The JT valve crash button, located in the counting house will be disabled.
4. During any JT valve change the flow meter CFI 6061 must be monitored. The total flow on this meter is not to exceed 25 g/s. Any trend indicating that this flow will exceed this value dictates that the supply JT valve must be closed according to the parameters outlined in 1 and 2.
5. The cryo-group may at any time call and request that the valve position be changed as per their instructions. Any request must be conceded immediately.

7.2 Emergency conditions

The following list describes extra emergency conditions and proper responses for the Hapex running period.

1. Hall B toroidal magnet trip
   Remove beam from the target and slowly close the supply JT valve according the parameters outlined in Section 7.1. Leave enough coolant to keep the loop cold. Monitor the flow meter CFI 6061 and adjust the JT valve as needed.
2. ESR crash
   Remove beam from the target and slowly close the supply JT valve according the parameters outlined in Section 7.1. Leave enough coolant to keep the loop cold. Monitor the flow meter CFI 6061 and adjust the JT valve as needed. Inform target expert on call.
3. CHL trip
   Remove beam from the target and slowly close the supply JT valve according the parameters outlined in Section 7.1. Monitor the flow meter CFI 6061 and adjust the JT valve as needed. Inform target expert on call.
4. Scattering chamber vacuum loss
   An FSD should have already ocurred if not, remove beam from the target and infom the target expert on call. Slowly close the supply JT valve according the parameters outlined in Section 7.1 and follow target experts instructions. Request access to the hall.
5. Control Loss
   If attempts to reboot the IOC are unsuccessful then inform target expert on call and request access to hall. Inform MCC of control loss. Request that MCC inform the cryo coordinator of the situation.

6. Signal loss for CFI 6061
   If the CFI 6061 signal is lost to the Hall A target control screen, the target operator must reduce the supply JT valve by 5% over 1 minute. Further, inform the MCC and request that the cryo coordinator be informed of the situation. Contact the target expert on call and inform them of the situation. Make no other changes unless instructed to do so by the target expert or the cryo coordinator.

7. Flow exceeds 25 g/s on CFI 6061
   Remove beam from target. Slowly close supply JT following parameters given in Section 7.1 until the flow reaches acceptable limits.

8. Recirculation pump/fan failure
   An alarm will sound if the fan speed drops below an acceptable limit. This could cause the target to freeze at the heat exchanger. If attempts to restart the fan are not successful slowly close the JT valves according to the parameters outlined in Subsection 7.1. Contact the target expert on call and request an access to the hall.

7.3 IOC reboot

Because of the low temperature of the coolant the target is susceptible to freezing. Care must be taken to properly energize the auxiliary high power heater supply (located above the reboot button). Instructions for performing this task are given in the User's Guide and in Section 4. If there are any problems with the IOC reboot contact the target expert on call immediately. If the operator is unable to regain control of the target, then the hall must be put in controlled access. The supply JT valve can then be throttled back slowly conforming to Subsection 7.1 parameters 1 and 2. The GUI should still indicate the proper reading for flow meter CFI 6061.