Glue-x Magnet Review
Indiana University Cyclotron Facility
November 30, 2004

Review Committee:

Bob Kephart, Fermilab (chair)
Claus Rode, Jefferson Lab
John Alcorn (LASS Solenoid Engineer and JLAB retired)

The review was held at IUCF November 30, 2004. The charge is attached below including our specific response to each item in the charge.

The committee heard a presentation from Elton Smith on the purpose of the review and on the charge to the committee. The committee heard about the work done at IUCF from Jeff Self. Alex Dzierba presented an overview of the Glue-X experiment. Paul Brindza provided a long and detailed talk on the solenoid status, coil refurbishment, test results, planned yoke modification, new DC system, new controls, new instrumentation, planned testing at JLAB, and various possible alternatives to deal with the N2 leaks and ground faults. The committee inspected coil 3 whose cryostat was open during the review. The LN2 shields were exposed and the repairs done at Los Alamos were viewable.

Charge

1) **Provide advice to guide the decision to continue coil refurbishment as planned, or opt for a more complete cryostat remanufacture.**

   The committee recommends a complete investigation of the nature of the observed ground faults before continuing the coil refurbishment. Inspection techniques including borescope, electrical measurements, attempts to clear the faults mechanically, pneumatically, or electrically should be completed and an evaluation of the situation should take place before further coil refurbishment continues.

   If the faults are found to be systemic in nature an aggressive systematic remanufacture of the coils may be warranted.

2) **Review plans for tests in the Test Lab (at JLab), including manpower required, and all preliminary activities in advance of installation of the magnet in Hall D.**

   The committee endorses the planned electrical retests after shipment of coils to JLAB. We consider the cryogenic tests to be of secondary priority in an era of tight budgets. To be successful these tests will need a small dedicated staff.

3) **Propose any near-term activities which could substantially reduce cost and/or risk to the project in the long-term.**

   In addition to the items mentioned under charge # 1 it is important to ensure that the coil plumbing is continuously protected from moisture and oxygen to limit further corrosion which can lead to leaks.

Other Comments and Recommendations:

1) Leaks and corrosion in the LN_2 shield circuits: Coil number 1 had a LN_2 leak that was repaired. Subsequent to passing a leak test the LN_2 system was pressurized to 30 psi and failed due to a new leak that developed. The problem was a “pitted” region in the LN_2 tubing near a solder joint. This may point to systematic corrosion problems. Further evidence is provided by the fact that at some point coil 3 had its LN_2 supply and return pipes replaced at Los Alamos.

   To date no leaks have been found in the copper shield panels themselves. Therefore a plan to replace the LN_2 shields with new stainless steel panels seems not to be justified.

   The committee feels that it would be prudent to protect all the coil plumbing from moisture and air.

   We also recommend that the return circuit be separated to produce two independent LN_2 circuits. This would allow isolation of one circuit at the junction box if a bad enough leak were to develop. The coil could still operate but with increased heat load.

2) Electrical Shorts to ground: Coil 1 has a short of approx 3 ohms to ground near the RH lead. Coil three has a short of .2 ohms close to the LH lead. The MEGA experiment ran with a low resistance short in coil 3. Operating the coil with one ground fault is risky but possible since the power supply can be floating. With two ground faults the result can be catastrophic. The observed new short in Coil 1 is a concern for two reasons. First, considerable current could now flow through the faults during a fast discharge of the coil. Second, one observed a change that may be due to contamination (e.g. metal chips) in the coil which has an open winding matrix. The shorts represent a significant risk for the long-term reliability of the magnet. It is worth considerable effort and possible risk to the coils to determine the nature of the ground faults.

3) It is worth considering if one can run the magnet without fast discharge. The magnet is designed to be cryostable. Thus it cannot quench so long as the conductor is immersed in liquid He. This is something that can be assured with carefully designed interlocks on the liquid level sensors and care to insure that the insulating vacuum never fails catastrophically. Provided one has current leads that can survive a loss of cooling incident, limiting the voltage during the discharge is probably a safer course of action than fast dumping the magnet if more than one ground fault is present. Consideration should be given to lowering the maximum operating current as an additional means of lowering the discharge voltage.

4) The fact that the resistance of the coil #1 fault has changed since its discovery is not reassuring. It is recommended that a careful inspection of the coil interior take place using a borescope. Particular attention should be paid to the lead area where it makes a right angle to enter the coil vessel. Our concern is that an insulating spacer may have broken or shifted in a way that results in the observed ground fault. In addition the coil pack should be inspected for metallic chips or debris.

5) The steel modifications that increase the forces on the axial support should not be considered. Opening the upstream end of the return yoke and filling the inter-coil gaps in the return yoke seems to have no negative effect on the coil forces. If modifications to the downstream end of the return steel are made, the option that adds steel to the outside is recommended.