Readiness Review Comments and Recommendation Action Items (AI)

HL-LHC AUP Vertical Magnet Test Stand at BNL

August 9, 2018

**Comments**

1. The test insert top hat should be hipotted prior to connecting the magnet.

AI-0 : It will be included in the commissioning plan of the top hat.

1. Holding the test dewar liquid level below the current lead flags when not powering (e.g., during 1.9 K pumpdown) would reduce LHe usage.

AI-1 : Review test procedure and if it is relevant modify it.

1. There are other events that could result in freezing LN2 in the first heat exchanger that would not be addressed with the pressure pulse bypass.

AI-2 : Identify the other items

1. It is not clear if the expander maintenance requirement fits within the magnet change period without affecting the testing schedule.

AI-3 : Make the relevant response.

1. The integration of the Linde 1610 may be more involved than anticipated.

Al-4 : Make the relevant response.

1. Great job with obtaining a duplicate system as a full backup for the old Vax computer running the DEC VMS-CRISP supervisory controls (i.e., cryoplant controls system) that controls the main plant and Magcool distribution system.
2. The ground current monitors have low resistance (~0.5 ohm) to ground. A hard short to ground could generate excessive ground current during energy extraction.

AI-5 : Ground fault detector design is revisited, analyzed and proper modifications will be done before the next magnet test.

1. The schedule leaves little room for unexpected maintenance or equipment failures.

AI-6 : Make the relevant response.

1. Identification and succession planning for all critical resources would reduce the effects of unexpected personnel turnover.

AI-7 : Recourses will be identified prior to the DOE review.

1. Leakage rate of helium for the cryo system is high. It will be better quantified when they get a chance to baseline the leak rate vs. inventory loss from quench relief and purifier beds regeneration. Actual helium losses might alter the schedule and affect the vendor contract. For production run, it may be prudent to have 55,000 SCF tube trailer on hand.
2. Cross-training of existing BNL personnel would provide back-up of critical test support resources. Coordination of back-up resource requirements with the appropriate BNL organizations is needed.

AI-8 : Coordination for back-up resources will be provided.

1. The panel agrees with the plan to test the mechanical indium joint design prior to production testing, and consider using mechanical indium joints for the CLIQ connections.

AI-9 : Indium joint design for CLIQ leads will be considered.

1. Investigate options for test stand cold vapor returns to the cryoplant. (Currently the cold vapor returns to compressor suction and is not going to the cold end of plant, and thus the 4.5K load appears as a liquefaction load on the system. Around 2.7 g/s is required for current leads flow at full current.  Around 1.5-2 g/s goes to the 2K bath, the remaining 2-2.5 g/s can be converted back to extra net liquefaction  1.5 g/s [45 L/hr] if a cold vapor transfer line with control valve is installed to take this cold vapor back to plant. This is very useful when the test dewar is at 4.5K for a longer time before pumping down to 1.8K due to other reasons. The vapor return valve would close before the ramp-up, to prevent the quench flow from returning to the plant.)

AI-10 : Make the relevant response.

1. The panel supports the repair of inefficient transfer lines that will be started shortly.
2. Impulse testing requirements should be revisited.

AI-11 : The test stand capabilities allow this test.

1. Consider adding AC input power signals into the power supplies’ IGBT monitoring systems, which could prove useful.

AI-12 : The modification will be done prior to Prototype testing.

**Recommendations**

1. Hire the identified additional cryo operator as soon as possible. The alternative is to hire an operator who is not familiar with the test facility, requiring a longer training period.

AI-13 : Recommendation has been accepted and will be done prior to production testing.

1. To support two cryo operator shifts daily, hire a third cryo operator dedicated to the test facility or cross-train other SMD staff rather than relying on a RHIC operator as back-up.

AI-14 : Recommendation has been accepted and will be done prior to production testing.

1. Identify primary and backup engineers for critical cryo engineering resources during test support.

AI-15 : Recommendation has been accepted and will be done prior to production testing.

1. Ensure that quench detection software is under configuration review and control.

AI-16 : Recommendation has been accepted and will be done prior to production testing

1. For the magnetic measurements and electrical systems, evaluate spares inventory, procurement lead times of critical parts, and generate a tracking document for maintaining this inventory.

AI-17 : Recommendation has been accepted and will be done prior to production testing.

1. Investigate options for test stand cold vapor returns to the cryoplant.

See AI-10

1. Investigate the CTI4000 250L/hr capacity. It may be a matter of optimizing the operating point for the plant to get a higher liquefaction rate.

AI-18 : Recommendation has been accepted and will be done prior to production testing.

1. There needs to be a ground current interlock for the power supply system. In addition, design the ground current interlock system to limit ground current in the event of a ground short in the magnet.

AI-19 : Recommendation has been accepted and will be done prior to testing Prototype 2.

1. Implement a maintenance program for the electrical systems (power supplies, energy extraction, cooling).

AI-20 : Recommendation has been accepted and will be done prior to production testing.

1. The functional requirements and test plan must clearly state the hipot voltages and conditions.

AI-21 : The test plan will be updated prior to the Prototype 2 test.

1. The top hat voltage tap connectors need to be designed (potted) to meet the hipot requirements.

AI-22 : Recommendation has been accepted and will be done prior to testing Prototype 2.

1. The 15 kA power supply contactors need to replaced and adequate spares procured.

AI-23 : Recommendation has been accepted and will be done prior to testing Prototype 2.

1. Protective covers need to be installed to enclose the energy extraction resistors with proper high voltage signage.

AI-24 : Recommendation has been accepted and will be done prior to testing Prototype 2.

1. The quench detection system needs to be reviewed for the use of redundant voltage taps. If redundant taps are not used, a fail-safe method of detecting an open voltage tap needs to be implemented and verified.

AI-25 : Recommendation has been accepted and will be done prior to testing Prototype 2.

1. Investigate mechanical operation of the magnetic measurements probe/shafts to ensure reliable long-term operation.

AI-26 : Recommendation has been accepted and will be done prior to production testing.

1. Update travelers so the electrical testing section specifies enough details to meet the test requirements.

AI-27 : Recommendation has been accepted and will be done prior to production testing.

1. For production testing, a spare CLIQ system should be available at SMD.

AI-28 : Recommendation has been accepted and will be done prior to production testing.

Critical comments and recommendations that need to be addressed before Prototype testing:

AI-0, AI-5, AI-19, AI-21, AI-22, AI-23, AI-24, AI-25