MINUTES –ACCEPTANCE MEETING FOR LHC MAGNETS BUILT AT BNL
Magnets: D1L101, D1L102, D1L104
Date of meeting: March 7, 2003
Date of these minutes: April 6, 2003. Amended April 17 to include discussion of UAI for beam tube horizontal positions of D1L102, D1L104 in appendix [5].
Present: Anerella, Cozzolino, Escallier, Hocker, Jain, Killian, Muratore, Pilat, Plate, Porretto, Wanderer, Willen

[Information added after the acceptance meeting is in square brackets or has been added to the appendix.]

Summary.
None of the three magnets reviewed (D1L101, D1L102, D1L104) was completely ready for approval at the time of the meeting. The work necessary for the acceptance of D1L102 and D1L104 was completed after the meeting, as noted by H. Hocker [2]. These two magnets have been accepted by the BNL LHC Acceptance Committee.

A short was found in D1L101. The disposition of this magnet will be decided at a later time.

Quench Data. J. Muratore showed a summary of the quench data for all five D1 magnets. During the initial cooldown of D1L101, quench currents were affected by a heat leak from the warm finger used for the magnetic field measurement probe. For the first five quenches, the warm finger was evacuated. For the next four, the warm finger was open to the atmosphere, further reducing the quench currents. The warm finger was removed during the thermal cycle, and the last two quenches were far above the current required for 7.56 T.

D1L102 and D1L104 were tested without warm fingers. Their initial quenches were above 7 TeV. They exceeded 7.56 TeV after one or two training quenches. The quench training was stopped when the magnets reached 7 kA.

Field Quality. A. Jain showed warm measurements from the straight sections of all five magnets. These slides have been posted on the Web. (Warm-cold correlations were presented at a previous acceptance meeting.) The rms skew quadrupole was slightly larger than expected, probably due to the limited number of coils available for size matching. Attention focused on D1L102, which was straightened after it was dropped. The twist in this magnet was not greater than that in the other four magnets. No discontinuities were found in the harmonics. F. Pilat reported that the skew quad and decapole would have to be corrected but were well within the range of the correction system.

Engineering, Survey, QA.
J. Escallier reported that D1L101 has a 6.5kΩ short between the coil and one of the quench protection heaters. Further investigations of this are underway.

As mentioned above, D1L102 required extensive repairs after it was dropped. A summary of the problem and the repair is appended to these minutes [1].

J. Cozzolino reported that each of the magnets had a small number of unresolved mechanical items, primarily related to the position of pipes in the interconnect region and the final survey of these pipes. A. Jain noted that the beam tube in D1L101 was 2 mm off center and that the limit was 1 mm. This will be investigated also. [During March, the positions and length of the interconnect pipes for all three magnets were brought within specifications or designated “use as is.” The “use as is” designation for the beam tubes is explained in appendix [5]. The “use as is” items were reviewed and approved by P. Pfund.[3]]

[Also, the BNL Cryogenic Safety Committee reviewed the engineering staff's analysis of a weld made during the repair of D1L102[4]. The weld did not pass visual inspection. The Safety Committee agreed with the analysis and also recommended that the weld be pressure tested and leak checked after cold shock. The weld passed these tests. In a memo dated March 28, 2003, the committee agreed that the "use as is" recommendation is reasonable and consistent with standard safely practices and procedures of BNL.]

APPENDIX

[1] Damage to and repair of D1L102. After assembly of the cold mass into the cryostat, the magnet fell 1.5 m due to the failure of a sling during a lifting operation. The fall damaged numerous components but did not affect the electrical integrity of the cold mass. For the repair, the cold mass was removed from the vacuum vessel. The cold mass was straightened by applying stripes of weld material to the outside of the helium vessel. (This procedure was developed during the manufacture of RHIC magnets.) The same method was used to straighten the vacuum vessel. The support posts were replaced. The smaller pipes were replaced or repaired by cutting off damaged portions and welding new pieces to the undamaged sections. The repair procedure is documented in discrepancy report R-1066.

[2] **Email from Hocker to Wanderer, April 3, 2003.**
Attached are the updated open issues lists for the above. The open waivers listed involve pipe end locations and the failed weld inspection. Since these items have already been brought to Phil Pfund's attention, closing them out should be a matter of following up with him. The remainder of the items is of a housekeeping nature and will be closed out as a matter of course.

With these comments noted, I would consider the documentation packages for these two magnets as acceptable. Thanks.

[3] **email from P. Pfund to P. Wanderer, 4 April 2003**

Peter,

I have reviewed DWR M0296 and Richard Thomas' memo of 28 March 2003 reporting the conclusion of the Cryogenic Safety Committee after the additional tests requested by the Committee were successfully completed. These steps satisfy our MoU agreement with the CERN TIS Division regarding safety.

As documented in my email of 3 April 2003, I have also reviewed the final X, Y, Z positions of the cryogenic pipes for magnets D1L101, D1L102 and D1L104, and agree with the BNL recommendations to "accept-as-is" those that are out of tolerance.

As we discussed by phone today, I agree that once you complete the collection of end item documentation for each magnet, submit the "ID cards" to the CERN MEB and receive CERN approvals, each of the magnets will be ready to ship to CERN.

Phil

[4]

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BROOKHAVEN NATIONAL LABORATORY

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Date: March 28, 2003

Memo

To: Distribution

From: Richard Thomas, Chairman, Cryogenic Safety Committee

Subject: CSC Recommendation Regarding the Document *Weld Inspection Waiver - D1L102* as submitted by the BNL Superconducting Magnet Division

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The Superconducting Magnet Division asked the committee to review the attached document, *Weld Inspection Waiver - D1L102*, and it was requested that the review be expedited. The cognizant engineer requesting the review was Steve Plate.

Due to the nature of the material, the chair of the BNL Cryogenic Safety Committee appointed two members of the CSC, who have expertise in the application of the relevant ASME Boiler Code and who are familiar with standard BNL practice, to serve as a subcommittee. They were asked to review the document and make recommendations to the whole committee. Steve Kane and Mike Gaffney agreed to be the members of the subcommittee. They were instructed to contact Steve Plate directly and to take whatever actions they felt necessary to resolve issues or questions that might arise before making their recommendations to the committee. Steve Kane and Mike Gaffney completed their review, and made the recommendations appearing below.

Background

Magnet D1L102 is a magnet that was built for CERN's LHC. It suffered damage when it fell while being suspended from a crane. It was subsequently repaired and pressure tested, but the step of visually inspecting the welds was unintentionally skipped until after the cold mass had been re-cryostated. The visual inspection was performed after the cold mass had been re-cryostated using a video probe. One weld did not pass visual inspection. (See pages 3 and 5 of the attached PDF document, "M0296.pdf.")

The "Memorandum of Understanding" between the collaborating US Labs and CERN requires "verification by the relevant US Lab that all fabrication checks/tests are successfully completed with acceptable results."

Philip Pfund of Fermilab has interpreted this to mean that BNL's Cryogenic Safety Committee must review the "inspection, analysis, and conclusions" contained in the Waiver and state whether they are consistent with the "standard safety procedures" and practices of Brookhaven National Laboratory. (If they are not, then recommendations should be made, that, if carried out successfully, would allow Magnet D1L102 to satisfy our standard procedures and practices.)

Results of the Review

An analysis by Steve Plate was presented in the attached document. The calculation was performed according to the ASME code and assuming the entire wall thickness to be only

half the actual wall thickness. The calculation indicated that the assumed reduced wall thickness would safely contain a pressure that is six times the operating pressure.

The reduced wall thickness is not, however, over the entire cross section, but is instead localized to one small region. The stress concentration was calculated to be 2 to 2.5 in the document submitted (p. 5). According to the document, should the stress approach the ASME limit, (that is, if the stress concentration were to be much larger than the rough calculation which predicted a concentration of 2 or 2.5), then the expected result would be "imperceptible local yielding."

The repair was pressure-tested to 75 psig and leak checked successfully in accordance with the written repair procedure prior to being reinstalled into the cryostat. It was then cold tested. The subcommittee was concerned that the area in question might fail once cold shocked.

The area of concern is part of the heat exchanger/phase separator circuit. This circuit is not used during the cryogenic tests of the magnet here at BNL. It was under vacuum during these tests. The area of concern is located outside of the pressure vessel, in the insulating vacuum, so it was not subjected to any pressure differential. Therefore, it was not pressurized after being subjected to cryogenic temperatures.

The subcommittee requested that the weld be pressure-tested again to verify that it would not fail after having been subjected to cryogenic temperatures.

The heat exchanger/phase separator circuit was successfully pressurized to 75 psig for 10 minutes and vacuum leak-checked on 19 March 2003.

Therefore, it is the recommendation of the subcommittee that the Cryogenic Safety Committee agree that the approval of the waiver for the weld inspection is reasonable and consistent with standard safety procedures and practices of Brookhaven National Laboratory.

Action of the Whole Committee

After reviewing the attached document and the material provided by the subcommittee, the committee voted to adopt the recommendation of the subcommittee.

Recommendations:

The Cryogenic Safety Committee agrees that the approval of the waiver for the weld inspection is reasonable and consistent with standard safety procedures and practices of Brookhaven National Laboratory.

Approved: _____

Richard Thomas, Chairman, CSC

Attachments

Distribution:

T. Sheridan
Members of the Cryogenic Safety Committee
M. Harrison
S. Plate

[5] The horizontal deviations of the cold bore tubes from the geometric axis are slightly outside the specification dx < 1.0 mm (dx = -1.22 mm for the lead end of D1L104, dx = -1.10 mm for the return end of D1L102). Because the distance from the end of the beam tube to the place where it is welded into the end domes is so short (175 mm), it is not possible to adjust the tubes once they are in place. The tubes are marked “use as is” since it should be possible to take small variances into account when setting the installation position of the magnet and because there is some flexibility in the interconnect tubes.