US HL-LHC Accelerator Upgrade Project

Report of the Review of coil 204 for MQXFA03 magnet

Zoom meeting 27 of June 2019

-Steve Gourlay–LBNL, chairperson
-Arup Ghosh–BNL, retired
-Paolo Ferracin–CERN

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1. Goal and scope

The HL-LHC AUP project started assembly of MQXFA03magnetin April2019. MQXFA03 is the first pre-series of the MQXFA low beta quadrupoles to be used in Q1 and Q3 for the High Luminosity LHC. If MQXFA03 meets MQXFA requirements [1] it will be used in the first Q1/Q3 cryo-assembly to be installed in the HL-LHC. AUP planned to use QXFA coils 109, 110, 111 and 202 for MQXFA03 assembly. These coils were reviewed on March 14, and all of them were accepted for use. Presentations and report are available at: https://indico.fnal.gov/event/20110/ During coil-pad sub-assembly preparation coil 109 developed an electrical weakness that degraded during investigation. Therefore, it was decided to remove coil 109 and select another coil (204) to replace it. The reviewers are requested to assess that coil 204 (including the conductor) meets specifications [2], and to evaluate the impact of non-conformities in strands, cables and coils. The reviewers should also evaluate the impact of the coil change on the coil shim plan.

2. Technical details

Committee

-Steve Gourlay–LBNL, chairperson
-Arup Ghosh–BNL, retired
-Paolo Ferracin–CERN

Date and Time

June27, 2019. Start time is7/9/10/15(LBNL/FNAL/BNL/CERN)

Location/Connection

Video-link by Zoom, info by email.

Link to agenda with talks and other documents

https://indico.fnal.gov/event/21083/

3. Review Charges response

The committee was requested to answer the following questions:

1. Does coil 204 meet MQXFA coil specifications [2]?

YES

2. Are conductor/coil fabrication and QC data of coil 204 adequate for a thorough evaluation and for allowing MQXFA03 to meet MQXFA requirements [1]?

Coil 204 was wound with cable 1099. This cable used strands from 11 different billets which is very unusual - normally strands are taken from 2-3 billets. However, all the spools for this cable are from billets that were part of a production run at B-OST. Tests done at the supplier and at the labs show that the *electrical properties were very uniform across all the 11 billets*.

The only significant DR was that strand pieces from one billet 0191 had diameters that were outside of specification - oversized. The out of spec deviations were less than .001 mm and deemed to be of *low risk* if used in a cable. This aspect of the risk was checked after cable fabrication by measuring the I_c and RRR of virgin and extracted strands from this billet, given a reaction of 665C/50h. The issue of oversized strand is that the over-compaction can lead to possible I_c and RRR degradation which is greater than nominal. However, data show that I_c of the extracted strands are not degraded by > than 3% (which is nominal) and also the major and minor edge RRR is well over 200 for all the extracted strands tested.

The *cable dimensions are well within specification* for the entire length of the cable, and the projected short sample limit is well above requirements for MQXFA magnets.

The overall assessment is that the cable P43OL1099 meets the specifications for the strand and cable and is *acceptable* for the coil 204 that is targeted for magnet MQXFA03.

3. Are there major non-conformities? If answer is yes, have they been adequately documented and processed?

NO, the coil has no major non-uniformities.

4. Is the impact of replacing coil 109 with 204 adequately taken into account in the proposed coil-shim?

YES, the coil size is comparable with respect to the previous coil so no change in the shimming is expected.

5. Do you have any other comment or recommendation regarding coil 204 or the coil-shim plan for allowing MQXFA03 to meet MQXFA requirements [1]?

The committee agrees that coil 204 is an acceptable choice for replacement of coil 109.

4. Comments

The committee suggests that management consider modifying the schedule for the coil pack assembly to take advantage of any possible improvements/changes coming from the mini-workshop on July 1 – 2 at LBNL since the goal of the workshop is indeed to review and analyze all the shimming and loading conditions of the previous magnets and identify possible changes to improve the mechanical conditions of the magnet.

5. Recommendations

NONE

6. References

1. Acceptance Criteria Part A: MQXFA Magnet, US-HiLumi-doc-1103.
2. MQXFA Final Design Report, US-HiLumi-doc-948 sections 3 and5.1.1; and QXFA Coil Fabrication Electrical QA, US-HiLumi-doc-521 step 16.