



**Report of
MQXFA17 and MQXFA13b
Coils Acceptance Review**

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US HL-LHC Accelerator Upgrade Project

**Report of
MQXFA17 and MQXFA13b
Coils Acceptance Review**

October 6 2023

- Arup Ghosh (Chairperson), BNL retired
- Susana Izquierdo Bermudez, CERN
- Helene Felice, CEA



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1. Goal and scope

The HL-LHC AUP project is planning to start assembly of MQXFA17. This is the 10th series low-beta quadrupole magnet (MQXFA) for the Inner Triplet of the High Luminosity LHC. If MQXFA17 meets MQXFA requirements [1] it will be used in a Q1/Q3 cryo-assembly to be installed in the HL-LHC.

For MQXFA17 assembly AUP is planning to use these QXFA coils (including two spare coils): 150, 151, 152, 237, 239 and 242.

A spare coil may be used in MQXFA13b after MQXFA17 assembly.

Conductor and series coil specifications are presented in [2-6]. Discrepancy or Non-conformity Reports are generated whenever a component does not meet specifications. Magnet MQXFA17 is planned for use in Cold Mass 05 without previous vertical test. Therefore, the coils presented at this review were selected because they do not have critical Discrepancies/Non-conformities.

The reviewers are requested to review discrepancies and non-conformities in strands, cables, and coils for the following coils: 150 (P43OL1186), 151 (1190), 152 (1193), 237 (1182), 239 (1184), 242 (1189).

Technical details

Committee

- Arup Ghosh (Chairperson), BNL retired
- Susana Izquierdo Bermudez, CERN
- Helene Felice, CEA

Date and Time

October 6, 2023. Start time is 7/9/10/16 (LBNL/FNAL/BNL-FSU/CEA-CERN)

Location/Connection

Video-link by Zoom, info by email.

Link to agenda with talks and other documents

<https://indico.fnal.gov/event/61535/>



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2. Review Charges responses

The committee is requested to answer the following questions:

1. Have all recommendations from previous reviews [7] been adequately addressed?

Yes, as recommended coils 144, 145, 235 and 236 were used in the assembly of magnet MQXFA16. Also, as requested, additional measurements were made at the LE Coil end for Coils 157, 158, and 159. Coil end dimensional specification limits have yet to be settled.

2. Have Discrepancies and Non-conformities been adequately documented and processed?

Strand and Cable: There were no critical DRs recorded for the cables in the six coils. As noted for previous MQXFA cable qualifications, during the sample heat-treatment of the RRR samples for the cables used in coils for MQXFA17, the TC's recorded at the 210C stage was higher than specification by a few degrees. This, did not impact the RRR or the I_c of the strands as measured. All RRR recorded for the minor and major edges were > 200 .

The other DRs related to out-of-specification mid-thickness were all at startup of the cable runs (which is typical) and were properly recorded. It is noted in the acceptance that these out-of-specification sections of the cable are part of the drop-off during coil fabrication.

Coil 150, 151 and 152: Several DRs were recorded, none of which were critical. All Dr's were properly addressed and suitable corrective actions were taken.

Coil 237, 239 and 242: most of the DR's were non-critical and recorded and addressed.

Coil Dimensions: There are no significant deviations in the dimensions measured at LBNL. None of the coils have any excess arc lengths. In fact, some of them are smaller than specs. As has been done for previous magnets, the coils will be shimmed on the mid-plane to compensate.

Additional information was also provided regarding the arc length of the coils at the lead and return ends. Lately, there has been an interest in these dimensions to hypothesize an explanation for Coil 227 limiting the performance of magnet MQXFA13. It is noted that coil 227 of all the coils measured to date had the lowest arc length at the ends.



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Coil Ordering: Based on RRR measurements of rolled strands and minor edge RRR of extracted strands, there are many possible assembly options even without the use of coils 150 and 242 (see comments below).

Overall, all DRs were properly recorded and adequately addressed.

3. Is there any critical Discrepancy/Non-conformity?

No

4. Is there any coil that you recommend not to use in MQXFA17?

Based on the cable and coil manufacture information, we do not reject any coil for use in the magnet. However, see below for our recommendation of the choice of the 4 coils for this magnet.

5. Do you have any other comment or recommendation regarding these coils and their conductor for allowing MQXFA17 to meet MQXFA requirements [1]?

See sections below for comments and recommendations

3. Comments

As was noted for some of the coils considered for MQXFA16, we find that the coils 150 and 242 have the smallest arc lengths excess of all coils manufactured to date and like that measured for coil 227 which was the limiting coil for magnet MQXFA13.

4. Recommendations

1. Pending further analysis and assessment of the corrective actions for coil compensation at the ends, use coils 151, 152, 237 and 239 for the assembly of magnet MQXFA17.
2. Coils 150 and 242 are, for now, to be held as spares. However, their use in a magnet (such as MQXF13b) will require having a well-established strategy regarding highly undersized coils (in particular, setting up a minimum threshold below which a critical discrepancy/non conformity would be triggered).
3. In addition to measurements done at the lead-end, as was presented here, perform additional measurements also in the coil return end such that the same criteria/correction action to both ends can be applied.



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5. References

- 1) *MQXFA Functional Requirements Specification*, US-HiLumi-doc-36
- 2) *Specification for Quadrupole Magnet Conductor*, US-HiLumi-doc-40
- 3) *Cable Specification*, US-HiLumi-doc-74
- 4) *Quadrupole Magnet Cable Insulation*, US-HiLumi-doc-75
- 5) *QXFA Series Coil Production Specification*, US-HiLumi-doc-2986
- 6) *QXFA Series Coil Fabrication Electrical QC plan*, US-HiLumi-doc-521
- 7) *MQXFA16 Coils Acceptance Review*, US-HiLumi-doc-4900