



Report of the MQXFA19

Coils Acceptance Review

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US HL-LHC Accelerator Upgrade Project

Report of the MQXFA19 Coils Acceptance Review

September 25, 2024

- Arup Ghosh (Chairperson), BNL retired
- Susana Izquierdo Bermudez, CERN
- GianLuca Sabbi, LBNL



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1. Goal and scope

The HL-LHC AUP project is planning to start assembly of MQXFA19. This is the 16th low-beta quadrupole magnet (MQXFA) for the Inner Triplet of the High Luminosity LHC. If MQXFA19 meets MQXFA requirements [1] it will be used in a Q1/Q3 cryo-assembly to be installed in the HL-LHC. AUP is planning to skip MQXFA19 vertical test. Therefore, the coils presented at this review were selected because they do not have critical Discrepancies/Non-conformities. Nonetheless, an alternative plan is being evaluated and a decision is expected shortly.

For MQXFA19 assembly AUP is planning to use these QXFA coils: 156, 161, 248, and 251 with 244 and 163 as spare coils.

Conductor and series coil specifications are presented in [2-6]. Discrepancy or Non-conformity Reports are generated whenever a component does not meet specifications.

Coils 161 and 244 were review during the MQXFA18 Coils Acceptance Review [7]. Therefore, reviewers are requested to review discrepancies and non-conformities in strands, cables, and coils for the following coils: 156 (cable P43OL1197), 163 (1210), 248 (1147), and 251 (1205).

2. Technical information

Committee

Arup Ghosh (chairperson), BNL retired
Susana Izquierdo Bermudez, CERN
GianLuca Sabbi, LBNL

Date and Time

September 25, 2024. 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

[MQXFA19 Coils Acceptance Review \(September 25, 2024\) · INDICO-FNAL \(Indico\)](#)



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3. Review Charges responses

The committee is requested to answer the following questions:

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

The committee members are of the opinion that the recommendation made at the last review needs to be addressed further. This recommendation reads:

“As coil production is nearing completion, there is a good pool of coils at FNAL and BNL waiting to be shipped to LBNL. If logistically feasible, (space and resource permitting for storage at LBNL), we suggest that these coils be shipped to LBNL and measured. This will allow for flexibility when selecting coils for the upcoming magnets.”

It appears that at LBNL- where there is only a capacity of storing 16 coils – the facility currently has 14 coils in storage. The question remains whether some coils will be utilized soon and whether some coils can be shipped back to FNAL, to make space for coils awaiting shipment from FNAL and BNL which can be measured at LBNL. We understand the issue must be considered taking cost and risk in shipping coils into account.

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

Strand and Cable: Cable for Coils 244 and 161 were reviewed previously. The cables for the other 4 Coils had no Critical DR's. As seen for other cables, the cable mid-thickness is typically set at the UCL at the beginning of the cable run as the mid-thickness usually decreases toward nominal thickness within a short length of 25-50 m. However, for cable 1147 (Coil 248) Cable mid-thickness did not decrease as expected and a correction was made 36m into the cable run. Hence, there is a section of the cable with mid-thickness slightly above UCL. As noted in previous instances, these out-of-specification section of the cable is part of the cable drop-off during coil winding.

Electrically all cables meet critical current and RRR specifications.

FNAL Coils: Coil 156 has a couple of non-critical DR reflecting an insulation repair and a minor excursion of temperature during the reaction cycle. Coil 163 had no DR's recorded.

BNL Coils: Coil 248 had a minor DR requiring replacing one of the mid-plane shims with a new one. Coil 251 had one DR recorded for a scuffed area on the fiberglass insulation which was remedied by adding additional 3 mil S2 glass placed over the scuffed region.



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It is noted that coils 156, 161 163 and 244 do not meet the Delta arc-length minimum specification of - 210 um.

COILS	Δ _Arc length Excess (SS-Ends), um
156	-264
161	-242
163	-357
234	-312
244	-269
248	-18
251	-147

The disposition plan being used is:

- If Delta arc-length is slightly above 210 um, disposition may be to set minimum magnet preload > 80+ MPa.
- If Delta arc-length is significantly above 210 um, disposition may be to use tapered shims for loading keys in the ends. It is our understanding that this has been implemented for Magnet MQXFA18 which is currently under test.

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

No Critical DR's recorded for any of the coils.

4. Is there any coil that you recommend not to use in MQXFA19?

With the present set of coils that were selected, we would endorse the use of coils 156, 161,248 and 251. We also endorse that coil 244 be held as a spare. Coil 163, which has a much larger Delta Arc-Length Excess (see Table above) compared to the other coils is not presently recommended for Magnet MQXFA19.

5. Do you have any other comment or recommendation regarding these coils and their conductor for allowing MQXFA19 to meet MQXFA requirements [1]?

See below.

4. Comments

1. All recent coils that have been made are free of any critical DR's and meet the required specification except that for the parameter "Delta arc-length excess (straight section – ends)" This specification is set to a minimum of -210 um. This parameter is being used to choose the appropriate 4 coils to assemble in the magnet structure. Using this criterion the choice of



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coils 156, 161, 248 and 251 is considered appropriate. It is noted, that since two of the 4 chosen coils have Delta arc-length excess that are considerably less than – 210 um, tapered load shims will be used in the lead ends of those coils.

2. We wish to emphasize that the complete set of documentation for cables and coils should be uploaded to EDMS. We note that there has been a marked improvement in the coils in the recent years. However, there is still a lot of documentation missing for coils and cables. The *attached file "Status_AUP_hgg_gp_September.xlsx"* contains a detailed extraction of the documentation status and what is missing. This has been shared with AUP QA office on several occasions. We request that AUP address this in a timely manner. The hold-point for cold masses starting from CM03 are not signed by CERN because of missing documentation, which will soon become critical.

5. Recommendations

1. We recommend management to review the overall work plan to further explore options to have a larger pool of coils measured at LBNL, and based on that, make a preliminary plan to optimize the use of these coils over the next several magnets, matching coils with similar dimensions.
2. We would also like to bring up the issue of the coils that are on hold at FNAL and BNL. There are currently 16, and it is not clear what the final disposition will be. This should be clarified to determine if/how many additional coils the project needs to make. From the schedule standpoint it would also be beneficial to use these coils in earlier magnets; this way there would be more time for a second assembly of a magnet replacing any faulty coils.

6. 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) *MQXFA18 Coils Acceptance Review*, US-HiLumi-doc-5084



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7. Attachment



Status_AUP_hgg_g
p_September.xlsx