



# **Report of the Production Readiness Review of the HL-LHC-AUP Pre- Series Magnets**

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## **US HL-LHC Accelerator Upgrade Project**

### **Report of the Production Readiness Review of the HL-LHC-AUP Pre-Series Magnets: Structure Fabrication and Magnet Assembly**

*Zoom meeting, 24<sup>th</sup> of June 2019*

- Peter Wanderer (BNL), chairperson
- Rodger Bossert (FNAL)
- Paolo Ferracin (CERN)
- Diego Perini (CERN)



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## 1. Goal and scope

The HL-LHC AUP project is starting the assembly of Pre-Series MQXFA Magnets (MQXFA03-07). Structure fabrication and magnet assembly are performed at LBNL, where all short model and prototype MQXF magnets were fabricated. Coils are fabricated at BNL and FNAL. Coil fabrication is outside of the scope of this review, which starts from coil reception at LBNL.

Production Readiness Review (PRR) is a major review step in the HL-LHC Accelerator Upgrade Project (AUP). It is held prior to the start of series production, and is intended to be a largely technical review, but include assessment of the planned cost, schedule, and personnel needs to complete the production.

Scope of this PRR are the following items for Pre-Series magnets:

Parts and materials for structure fabrication and magnet assembly

- Magnet drawings
- Manufacturing and test procedures
- Interfaces.

Goal of this PRR for Pre-Series magnets:

- Approval of plans and procedures for MQXF structure fabrication and magnet assembly task
- Validate plan to start manufacturing

## 2. Technical details

### Committee

- Peter Wanderer (BNL), chairperson
- Rodger Bossert (FNAL)
- Paolo Ferracin (CERN)
- Diego Perini (CERN)

### Date and Time

June 24, 2019. Start time is 9:00 am (Central time)

### Location/Connection

Video-link by Zoom, info

### Link to agenda with talks and other documents

<https://indico.fnal.gov/event/20961/>



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### 3. Review Charges and response

The committee was requested to answer the following questions:

- 1) Scope and interfaces: is the L3 task scope clearly defined, and are interfaces with other tasks sufficiently well-defined for executing the pre-series production?

Finding: Yes. Scope -- The pre-series scope is fully specified in WBS Control Account 302.2.07. Interface -- there are four interface documents in the WBS, two for receipt of coils and two for sending magnets. All have been reviewed and approved prior to this review. The interface documents have been used at least once.

Comment: none

Recommendation: none

- 2) Drawings: are all the magnet assembly and component drawings released? Have they been provided to CERN?

Finding: Yes (released); Underway (transferred). All the assembly and component drawings (called Assembly Baseline Structure or ABS) have been released, following a major update. A list of them was posted on the indico site for this review. The process of transferring them to CERN is underway.

Comment: Version control has been implemented -- a good idea.

Recommendation: none

- 3) Manufacturing: are the manufacturing work-flow documents and travelers -- including scheduling, personnel needs, floor space, and facilities requirement-- appropriate to execute the pre-series production?

Finding: Mostly. With one exception, Work Instruction (WI) and Verification Point (VP) documents are not finalized but are under version control. The exception is magnetic field measurement, which does not yet have either document in written form. In regard to scheduling, it was stated that "most durations for magnet assembly activities ... appear to be within reasonable learning curves baseline." (See also Charge #5.)

Comment: The WI and VP seem likely to be in final form by the end of the pre-series production.

Comment: Documentation of each assembly will be part of a Magnet Fabrication Report for each magnet.

Recommendation: Develop WI and VP documents for magnetic field measurements.



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- 4) QA/QC: is the QA/QC plan adequate? Is there appropriate documentation for quality control procedures, manufacturing and inspection plan, and data reporting? Is the magnet assembly MIP complete and approved?

Finding: Yes. The QA/QC effort includes measurement reports from vendors (initially checked against LBNL measurements), incoming inspection, VP data from magnet assembly, non-conformance reporting, data transfer to Fermilab's Vector system. The MIP was approved November 2018.

Comment: none

Recommendations: none

- 5) Cost and Schedule: are the cost and schedule estimates sufficiently well-defined and of adequate maturity to support the pre-series production?

Finding: No. Several unrelated problems have caused major delays in the pre-series schedule. There will be at least some standing-army costs due to these delays. However, in the absence of such delays, the cost and schedule seem to be in the appropriate place in the learning curve. There will be some benefit to the reliability of the pre-series cost and schedule from efforts (such as "Master" contracts and dual vendors for major components) focused on the full production run.

Comment: none

Recommendation: none

- 6) ES&H: Have all hazards been identified and addressed? Are ES&H policy and documentation sufficient for the pre-series production?

Finding: Yes. Documents were cited that attested to ES&H policy and documentation that follows project, laboratory, and state guidelines.

Comment:

Recommendation: none

- 7) Risk: are risks understood and appropriately managed for the pre-series production?

Finding: No. There are four risks and one opportunity. The lowest risk is "structure procurement delay," with "negligible" risk. However, completion of magnet 04 will be delayed approximately six months due to QC problems at ARMCO, the



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vendor for the yoke.

Comment:

Recommendation: reevaluate the risk matrix, taking into account the delays of the magnets already built and tested.

- 8) Reviews: are all recommendations for this L3 task from Final Design Review and from Review of the MQXFAP2 Al-Shell Issue and Lessons Learned addressed?

Finding: Yes.

Comment: BNL has recently installed instrumentation that permits good control of the cooldown time.

Recommendation: none

- 9) Is this L3 task ready for pre-series production?

Finding: Yes.

Comment: The specifications and procedures in place, plus the experience of the staff, are likely to yield well-documented magnets built using the best available information.

Recommendation: begin pre-series magnet production.