Document Plan and Management of Change
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*International Review of HL-LHC Magnet Circuits*

2019-09-10
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The Mandate to the Magnet Circuit Forum

One of the recommendations of the March 2016 review on HL-LHC Magnet Circuits was:

“… to realize close and regular interaction (communication) between the involved experts and work-packages. This could be possibly done by setting-up of a dedicated working group or by using existing structures to discuss circuit integration and protection on a regular basis and to identify the optimum scheme for each magnet circuit system.”

**Mandate**

- The Magnet Circuit Forum (MCF) is the meeting where all aspects related to powering and protection of the HL-LHC circuits are discussed, in particular the ones pertaining to the optimization of circuit layouts and definition of protection means.
- Subjects in the agenda are defined in close collaboration with the relevant WPs.
- Interface aspects between systems are clarified through meetings at the forum. To this end, a documentation plan has to be developed and completed.
- The aim is to prepare a set of functional interface specifications that can be used as input for the design (technical specifications) of the different systems.
- Assessment on realistic failure scenarios and required mitigation strategies on a global basis is part of the activities of the MCF.
- The MCF is the meeting where aspects related to high voltage withstand levels are discussed and harmonized.
- The MCF reports regularly to TCC and takes up any relevant discussion within the domain of cold/warm powering and protection of the HL-LHC circuits in collaboration with the relevant WPs.
Introduction

- Proper documentation is fundamental for any part of the project
- The main questions to address
  - Do we have the necessary information in writing?
  - Is the information properly communicated to all Work Packages?
  - Are concerned parties aware of the information?
  - Is the information easily accessible?
  - Is the information properly referenced?
  - How to follow “living” documents?
  - How to trace change?
  - Is the information coherent with the HL-LHC project baseline documentation?
  - Is the information coherent with CERN official documentation?
Introduction

- Documentation related to circuits are co-ordinated in the MCF meetings
- 54 regular MCF meetings with 50 members from different WPs
- 27 topical meetings with reduced attendance
- Minutes of meetings include the discussions on circuit information
- In average, one in every two meetings, the documentation is addressed
MCF Related Documentation
MCF Related Documentation

- Magnet Circuit Forum Main Reference Documents
  - The HL-LHC Circuits Layout
  - The HL-LHC Circuits Table

https://espace.cern.ch/project-HL-LHC-Technical-coordination/MCF/Circuits%20Table
1. Acquiring change requests from different Work Packages

2. Presenting changes at Magnet Circuit Forum

3. Uploading to Magnet Circuit Forum sharepoint

4. Check by different Work Packages (3 weeks)

5. Presenting circuits changes to HL-LHC Technical Coordination Committee (+ECR)

Lifecycle for MCF Related Documents
HL-LHC Circuits Layout

[Diagram of HL-LHC Circuit Layout]


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### HL-LHC Circuits Parameters Table

- MCF leads the update of the circuits parameters table
  - In coordination with the different Work Packages
  - An excel sheet per involved Work Package
  - Main circuit parameters are shown (circuit current, inductance, resistance, operation conditions, etc.)

[Table Image]

https://espace.cern.ch/project-HL-LHC-Technical-coordination/MCF/Circuits%20Table
Magnet Circuit Forum team has worked with different WPs
- To define the functional specifications of the relative systems
- To coordinate the studies on the circuits (quench protection, powering, etc.)
- To write the circuit requirements for the systems
MCF has worked to define the electrical design criteria of the circuits

See Talk of Felix Rodriguez Mateos – Monday 09/09 p.m.
Engineering Change Requests (1/2)

- Request for change in the triplet circuit baseline has been launched
  - Suppression of the Q2a trim circuit
  - Addition of a circuit for k-modulation across half of Q1 (Q1a)
  - Update of the rating of the superconducting cables
  - Use of cold diodes as a supplementary quench protection element
  - Change of the pole order and polarities of the magnet
  - Change of the CLIQ connections

![Diagram of triplet circuit baseline changes](image-url)
Engineering Change Requests (2/2)

- Request for local powering of high order circuits approved
  - ECR launched in collaboration with WP6a (cold powering)
  - Leads to the simplification of the HL-LHC cold powering
  - Power converters placed in LHC galleries (UL14, UL16, UL557 and USC55)

![Diagram of SF Order 2 Corrector](image)

**SF HO**

- MCOXF/MCOSXF (2x120A)
- MCDXF/MCDSXF (2x120A)
- MCTXF/MCTSXF (2x120A)

**Local**

- ± 200 A
- ± 120 A

**ECR Summary**

- **ECR Request**: Engineering Change Request
- **ECR Number**: 0001
- **Affected Components**: SF HO, MQSXF (200A), MCSXF/MCSSXF (2x120A), MCOXF/MCOSXF (2x120A), MCDXF/MCDSXF (2x120A), MCTXF/MCTSXF (2x120A)

**Reason for Change**

- The request for the change is to simplify the HL-LHC power supply system and enable more efficient operation of the high order circuits.

**ECR Description**

- **Description**: Simplification of local powering of high order corrector magnets.
- **Details**: The simplification involves the use of power converters placed in specific galleries to provide local powering for high order corrector magnets, reducing the complexity of the HL-LHC cold powering system.

**ECR Execution**

- **Execution Status**: Approved
- **Implementation Plan**: The implementation plan includes the installation of power converters in specific LHC galleries and the reconfiguration of existing power supply systems.

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**Notes**

1. SF HO change is for the new SF HO power supply system.
2. MQSXF change is for the new MQSXF power supply system.
3. MCSXF/MCSSXF changes are for the new MCSXF/MCSSXF power supply systems, with additional changes in the related system.
4. MCOXF/MCOSXF changes are for the new MCOXF/MCOSXF power supply systems, with additional changes in the related system.
5. MCDXF/MCDSXF changes are for the new MCDXF/MCDSXF power supply systems, with additional changes in the related system.
6. MCTXF/MCTSXF changes are for the new MCTXF/MCTSXF power supply systems, with additional changes in the related system.
7. ± 200 A/± 120 A indicates the range of powering for different circuit orders.
8. ± 200 A local powering for SF HO, ± 120 A local powering for all others.
MCF has initiated work to define one document per magnet circuit
- Document contains all powering, protection and ElQA aspects of the circuits
- 7 documents in total (11T Dipole, Triplet, D1, D2, Triplet Correctors, High Order Correctors and D2 Correctors)
MCF has contributed to the circuit related chapter

- Chapter on circuit layout, powering and protection to reflect the baseline
- An overview of the circuits for HL-LHC and the electrical quality criteria

Chapter 6

Circuit Layout, Powering and Protection

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6.1 HL-LHC Cylindrical Upgrade

During LS2 and LS3, the HL-LHC upgrade will impose many changes to the magnet circuits of the LHC at points 1 and 2. Figure 6-1 shows the circuit types for the HL-LHC extraction regions. These magnets will be included in the machine during LS2. In addition to these changes, using LS2, two main dipole magnets (DMM) will be replaced by LMA cryo-assemblies in order to add two extra cavities. The two concerned magnets are MBB-A11 and MBB-A14. Figure 6-2 and 6-3 show the circuit upgrade for the LMA cryo-assemblies. The next paragraphs will detail each of the circuits concerned.

Figure 6-1: Magnet representation for the HL-LHC extraction region at right of point 1.

Figure 6-2: LMA cryo-replacement of the MBB magnet for circuit BLA67.

Figure 6-3: LMA cryo-replacement of an MBB magnet for circuit BLA70.

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CERN Official Documentation
Layout Database is the official database for circuits parameters at CERN
- MCF is coordinating the activity to introduce correct circuits parameters and layout

Circuits Layout

Circuits Description File

Target
Electrical Diagrams in CERN Drawing Directory

- LHCLSD drawings are official documents for electrical diagrams
  - MCF is coordinating the introduction of circuits diagram at IP1/5 and IP7
Summary

- Magnet Circuit Forum coordinates the documentation related to circuits
  - Living documents have been created to reference and follow ongoing work
  - Contribution to HL-LHC Project Documentation in coordination with the project office
  - Contribution to the CERN official documentation to include 11T Dipole and IR circuits
Thank you for your attention