LQXFA/B02 Documentation

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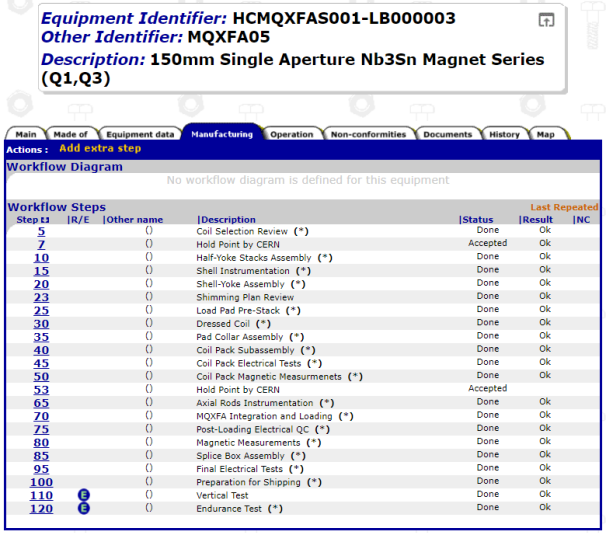
01.11.2024 – AUP-CERN Meeting

2nd Cryoassembly built by AUP (LQXFA/B02)

- HCQQXF_SC002-FL000002 - Cryostat standard section type QQXF_SC for Q1/Q3 cryostats
  - HCLMQXFA001-FL000002 - Cold Mass Assembly for Single Aperture (150mm) with MQXFA Quadrupole
    - HCMQXFAS001-LB000003 - 150mm Single Aperture Nb3Sn Magnet Series (Q1,Q3)
      - HCMQXFAC001-BL000006 - Coil
        - HCMQXFAC002-LB000022 - Cable
        - HCMQXFAC19-WS000006 - OUTER QUENCH HEATER MQXFA PRESERIES
      - HCMQXFAC001-BL000008 - Coil
        - HCMQXFAC002-LB000025 - Cable
        - HCMQXFAC19-WS000006 - OUTER QUENCH HEATER MQXFA PRESERIES
      - HCMQXFAC001-FL000015 - Coil
        - HCMQXFAC002-LB000015 - Cable
        - HCMQXFAC19-WS000006 - OUTER QUENCH HEATER MQXFA PRESERIES
      - HCMQXFAC001-FL000016 - Coil
      - HCMQXFAS002-LB000003 - Shell
      - HCMQXFAS003-LB000003 - Yoke
      - HCMQXFAS004-LB000003 - Collars
      - HCMQXFAS005-LB000003 - Loadpads
      - HCMQXFAS006-LB000003 - Master Keys
    - HCMQXFAS001-LB000004 - 150mm Single Aperture Nb3Sn Magnet Series (Q1,Q3)
      - HCMQXFAC001-BL000010 - Coil
      - HCMQXFAC001-FL000019 - Coil
      - HCMQXFAC001-FL000022 - Coil
      - HCMQXFAC001-FL000023 - Coil
        - HCMQXFAC002-LB000035 - Cable
        - HCMQXFAC008-LB000001 - Stainelss Steel for Cable
        - HCMQXFAC19-WS000001 - OUTER QUENCH HEATER MQXFA
      - HCMQXFAS002-LB000004 - Shell
      - HCMQXFAS003-LB000004 - Yoke
      - HCMQXFAS004-LB000004 - Collars
      - HCMQXFAS005-LB000004 - Loadpads
      - HCMQXFAS006-LB000004 - Master Keys
    - HCLMQXF_S002-1I002057 - MQXF - FLAT END COVER MONOBLOC
    - HCLMQXF_S002-1I002058 - MQXF - FLAT END COVER MONOBLOC
    - HCQITESCXT-CR111503 - Cryo Thermometer
    - HCQITESCXT-CR111504 - Cryo Thermometer
    - HCQITESCXT-CR111505 - Cryo Thermometer
    - HCQITESCXT-CR111506 - Cryo Thermometer

Cold Mass LMQXFA02 / CM02 (HCLMQXFA002-FL000002)
Magnet MQXFA05 (HCMQXFA001-LB000003)
Magnet MQXFA06 (HCMQXFA001-LB000004)

Magnets – MQXFA05 and MQXFA06



Equipment Identifier: **HCMQXFAS001-LB000003**
Other Identifier: **MQXFA05**
Description: **150mm Single Aperture Nb3Sn Magnet Series (Q1,Q3)**

Main | Made of | Equipment data | Manufacturing | Operation | Non-conformities | Documents | History | Map

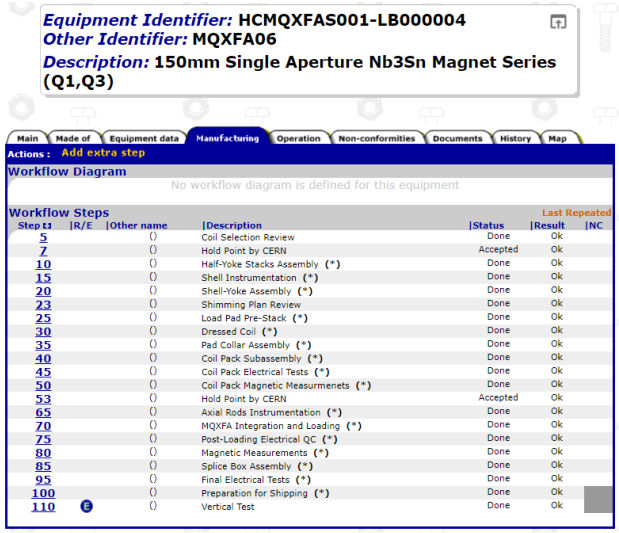
Actions : Add extra step

Workflow Diagram

No workflow diagram is defined for this equipment

Workflow Steps

Step	R/E	Other name	Description	Status	Result	Last Repeated NC
5		()	Coil Selection Review (*)	Done	Ok	
7		()	Hold Point by CERN	Accepted	Ok	
10		()	Half-Yoke Stacks Assembly (*)	Done	Ok	
15		()	Shell Instrumentation (*)	Done	Ok	
20		()	Shell-Yoke Assembly (*)	Done	Ok	
23		()	Shimming Plan Review	Done	Ok	
25		()	Load Pad Pre-Stack (*)	Done	Ok	
30		()	Dressed Coil (*)	Done	Ok	
35		()	Pad Collar Assembly (*)	Done	Ok	
40		()	Coil Pack Subassembly (*)	Done	Ok	
45		()	Coil Pack Electrical Tests (*)	Done	Ok	
50		()	Coil Pack Magnetic Measurmenets (*)	Done	Ok	
53		()	Hold Point by CERN	Accepted		
65		()	Axial Rods Instrumentation (*)	Done	Ok	
70		()	MQXFA Integration and Loading (*)	Done	Ok	
75		()	Post-Loading Electrical QC (*)	Done	Ok	
80		()	Magnetic Measurements (*)	Done	Ok	
85		()	Splice Box Assembly (*)	Done	Ok	
95		()	Final Electrical Tests (*)	Done	Ok	
100		()	Preparation for Shipping (*)	Done	Ok	
110	E	()	Vertical Test	Done	Ok	
120	E	()	Endurance Test (*)	Done	Ok	



Equipment Identifier: **HCMQXFAS001-LB000004**
Other Identifier: **MQXFA06**
Description: **150mm Single Aperture Nb3Sn Magnet Series (Q1,Q3)**

Main | Made of | Equipment data | Manufacturing | Operation | Non-conformities | Documents | History | Map

Actions : Add extra step

Workflow Diagram

No workflow diagram is defined for this equipment

Workflow Steps

Step	R/E	Other name	Description	Status	Result	Last Repeated NC
5		()	Coil Selection Review	Done	Ok	
7		()	Hold Point by CERN	Accepted	Ok	
10		()	Half-Yoke Stacks Assembly (*)	Done	Ok	
15		()	Shell Instrumentation (*)	Done	Ok	
20		()	Shell-Yoke Assembly (*)	Done	Ok	
23		()	Shimming Plan Review	Done	Ok	
25		()	Load Pad Pre-Stack (*)	Done	Ok	
30		()	Dressed Coil (*)	Done	Ok	
35		()	Pad Collar Assembly (*)	Done	Ok	
40		()	Coil Pack Subassembly (*)	Done	Ok	
45		()	Coil Pack Electrical Tests (*)	Done	Ok	
50		()	Coil Pack Magnetic Measurmenets (*)	Done	Ok	
53		()	Hold Point by CERN	Accepted	Ok	
65		()	Axial Rods Instrumentation (*)	Done	Ok	
70		()	MQXFA Integration and Loading (*)	Done	Ok	
75		()	Post-Loading Electrical QC (*)	Done	Ok	
80		()	Magnetic Measurements (*)	Done	Ok	
85		()	Splice Box Assembly (*)	Done	Ok	
95		()	Final Electrical Tests (*)	Done	Ok	
100		()	Preparation for Shipping (*)	Done	Ok	
110	E	()	Vertical Test	Done	Ok	

- Documentation related to **MQXFA05 and MQXF06** (**including cables and coils**) is **complete and released**
- **During the Coil Selection Review (1st step of the workflow), the data of the coils is assessed and validated prior to starting the magnet manufacturing (Hold Point by CERN): EDMS 2444265 (Coil Selection Review MQXFA06) and EDMS 2350172 (Coil Selection Review MQXFA05)**

Cold mass – LMQXFA02

Equipment Identifier: **HCLMQXFA001-FL000002**
Other Identifier: **LMQXFA02**
Description: **Cold Mass Assembly for Single Aperture (150mm) with MQXFA Quadrupole**

Main | Made of | Equipment data | Manufacturing | Operation | Non-conformities | Documents | History | Map

Actions : Add extra step

Workflow Diagram

No workflow diagram is defined for this equipment

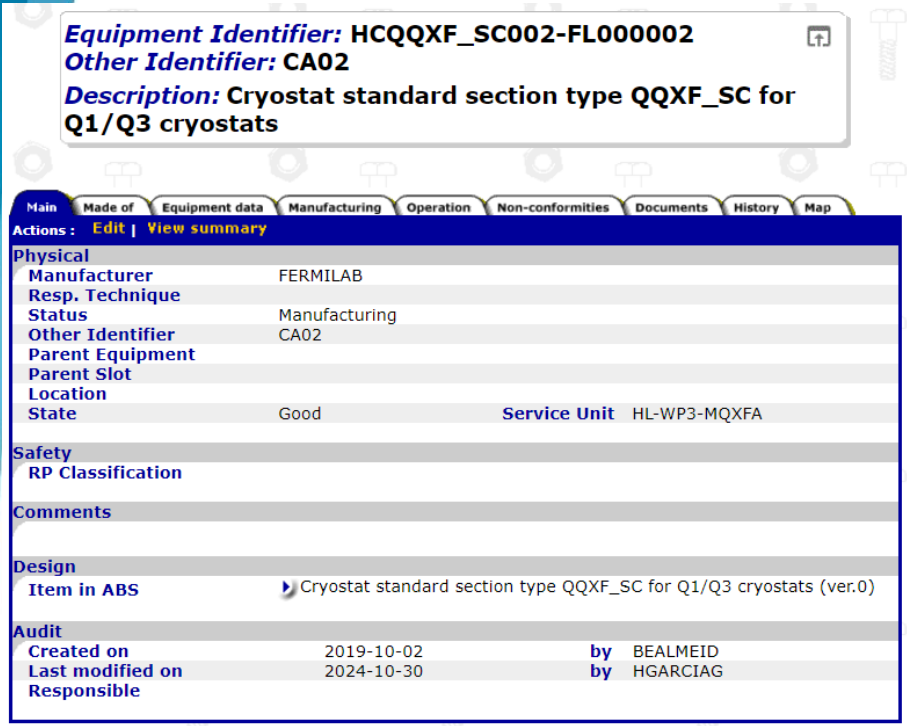
Workflow Steps

Step	R/E	Other name	Description	Last Repeated Status	Result	NC
10			Hold Point by CERN	Done	Ok	
11			Magnets approved for coldmass assembly (pending incoming inspection at FNAL)	Done	Ok	
20			Kit components for CM assembly	Done	Ok	
30			Assemble Local and Through Buses	Done	Ok	
40			Magnet Selection & Receiving Inspection	Done	Ok	
50			Install tack blocks and welding backing strips	Done	Ok	
60			Position magnets onto CM alignment tooling,complete survey and warm magnetic mea	Done	Ok	
70			Bus & Instrumentation Assembly	Done	Ok	
80			Perform electrical inspection of magnets, CLIQ leads, and trim leads	Done	Ok	
90			Insert the heat exchangers	Done	Ok	
100			Beam Tube Insertion	Done	Ok	
110			Shell Installation	Done	Ok	
120			End Cover Installation	Done	Ok	
130			Final Assembly	Done	Ok	
140			Install Lower Plates (Saddles)	Done	Ok	
150			Complete full electrical inspection	Done	Ok	
160			Perform Ultrasonic Testing of pressure boundary welds	Done	Ok	
170			Perform pressure test and leak check	Done	Ok	
180			Weigh the Cold Mass	Done	Ok	
190			Review of all data	Done	Ok	

- Documentation related to **CM02** is **complete** and mostly released with a few exceptions:
  - Position magnets onto CM alignment tooling,complete survey and warm magnetic mea - HCLMQXFA001-FL000002 – EDMS 3126405
  - Alignment report after End Cover Installation – EDMS 3126445
  - Final Assembly Alignment – EDMS 3126433

  Alignment data & reports have been discussed by both teams. They are under final check by CERN colleagues.
- As requested and agreed in **CA01 review**, held in Oct'23, most of the cold mass manufacturing data has been provided **prior to starting** the horizontal test (**Thanks**)

Cryo-assembly Standard Section – LQXFA02



Equipment Identifier: **HCQQXF_SC002-FL000002**
Other Identifier: **CA02**
Description: **Cryostat standard section type QQXF_SC for Q1/Q3 cryostats**

Main | Made of | Equipment data | Manufacturing | Operation | Non-conformities | Documents | History | Map

Actions : Edit | View summary

Physical

Manufacturer	FERMILAB		
Resp. Technique			
Status	Manufacturing		
Other Identifier	CA02		
Parent Equipment			
Parent Slot			
Location			
State	Good	Service Unit	HL-WP3-MQXFA

Safety

RP Classification

Comments

Design

Item in ABS: Cryostat standard section type QQXF_SC for Q1/Q3 cryostats (ver.0)

Audit

Created on	2019-10-02	by	BEALMEID
Last modified on	2024-10-30	by	HGARCIAG
Responsible			

- **Documentation** related to CA02 is still being uploaded (alignment report is there, RT report,

What's missing:

- Assembly documentation for AUP Q1/Q3 cryoassembly 02 - HCQQXF_SC002-FL000002, including the traveller, parts used, assembly procedure filled in, dimensional inspection report, etc.)
- Weld map/Welding book
- Combined Pressure & Leak Test report
- Horizontal Cold Test Report
- DRs

This is to be provided asap – We still have **time** to **look through** and **provide feedback prior** to **shipment**.

Main Nonconformities

- Total of ~150 AUP-internal Discrepancy/Nonconformance reports issued (associated to cables, coils, magnets, cold mass and cryostat for CA02); most were minor and handled within AUP (level 1 or 2)
- Only 1 critical Nonconformity related to this Cryo-assembly.
  - EDMS 3024619 : **CM02 Instrumentation Wire Damage and Repair** ; Repair performed by AUP and NCR was **closed**

However, recently, another NC became critical due to schedule constraints for shipment EDMS 3153512 - LQXFA/B-02 IFS Warm Head Misalignment – Pressure weld for which CERN HSE clearance is required. Following the distribution of the NCR, CERN provided feedback (HSE and WP3), and 2 dedicated meetings were organized. A FEA was performed by AUP, which shows a safety margin of almost a factor of 2 wrt Pressure at Operation (20 bar).

The take away message is that these type of NCs are to be communicated timely as HSE (Notified Body for WP3 pressure equipment) needs to be in the loop – Lesson learned for the future

Deviation Request

- No **Deviation Requests** have been issued in the **framework of CA02**

Miscellaneous

- **In-track documentation file** prepared by **Gorana Prica**, which is timely shared with **WP3** and **AUP,** is proven to be very helpful to keep track of **MTF status** (documentation and steps) and easily spot **what's missing**
- **Regular QA meetings between both teams and dedicated technical meetings with tehcnial experts (i.e. alignment) are very much helpful to discuss an agree on actions.**

Asset name	**Cold Mass Assembly for Single Aperture**		
Asset no.	HCLMQXFA001-FL000002		
Steps	Status	Documentation	NCRs
Hold Point by CERN	Done	Hold Point CM2: Review documentation	
Magnets approved for coldmass assembly (pendin	Done		
Kit components for CM assembly	Done	Kit components for CM assembly	
Assemble Local and Through Buses	Done		
Magnet Selection & Receiving Inspection	Done		
Install tack blocks and welding backing strips	Done		
Position magnets onto CM alignment tooling,comp	Done	Position magnets onto CM alignment tooling,complete survey and warm magnetic mea; Magnets 05 and 06 SSW results - LMQXFA02	
Bus & Instrumentation Assembly	Done		LHC-LMQXFA-QN-0026 - DR - 13115 Bus Assembly inspection
Perform electrical inspection of magnets, CLIQ lea	Done	Perform electrical inspection of magnets, CLIQ leads, and trim leads	
Insert the heat exchangers	Done	Electrical inspection after Insert the heat exchangers	
Beam Tube Insertion	Done	Electrical check before/after Beam Tube Insertion; Alignment data LMQXFA02 prior to NDE	LHC-LMQXFA-QN-0025 - DR - 13097 cut pre series voltage tap wires on return end of B side magnet 06
Shell Installation	Done	Shell Installation	
End Cover Installation	Done	Alignment report after End Cover Installation; Electrical Test after End Cover Installation; Electrical Test prior to End Cover Installation	
Final Assembly	Done	Final Assembly Alignment; Final Assembly	
Install Lower Plates (Saddles)	Done		
Complete full electrical inspection	Done	Complete full electrical inspection	
Perform Ultrasonic Testing of pressure boundary w	Done	Perform Ultrasonic Testing of pressure boundary welds	
Perform pressure test and leak check	Done		LHC-LMQXFA-QN-0027 - DR 13659 for calibration of pressure gauge
Weigh the Cold Mass	Done		
Review of all data	Done	LMQXFA02 Cold Mass Assembly Traveler;	

Asset name	**150mm Single Aperture Nb3Sn Magnet Series (Q1,Q3)**	
Asset no.	HCMQXFAS001-LB000003	HCMQXFAS001-LB000004
Steps	Status	Status
Coil Selection Review (*)	Done	Done
Hold Point by CERN	Accepted	Accepted
Half-Yoke Stacks Assembly (*)	Done	Done
Shell Instrumentation (*)	Done	Done
Shell-Yoke Assembly (*)	Done	Done
Shimming Plan Review	Done	Done
Load Pad Pre-Stack (*)	Done	Done
Dressed Coil (*)	Done	Done
Pad Collar Assembly (*)	Done	Done
Coil Pack Subassembly (*)	Done	Done
Coil Pack Electrical Tests (*)	Done	Done
Coil Pack Magnetic Measurmenets (*)	Done	Done
Hold Point by CERN	Accepted	Accepted
Axial Rods Instrumentation (*)	Done	Done
MQXFA Integration and Loading (*)	Done	Done
Post-Loading Electrical QC (*)	Done	Done
Magnetic Measurements (*)	Done	Done
Splice Box Assembly (*)	Done	Done
Final Electrical Tests (*)	Done	Done
Preparation for Shipping (*)	Done	Done
Vertical Test	Done	Done
Endurance Test (*)	Done	-
Documentation	Status	Status
Deviation requests	yes	yes
Engineering change notes	yes	yes
Coil Acceptance Review Report	yes	yes
Shell Instrumentation Verification sheet	yes	yes
Shell-Yoke Assembly Verification sheet	yes	yes
Dressed Coil Verification sheet	yes	yes
Pad Collar Assembly Verification sheet	yes	yes
Coil Pack Electrical Tests	yes	yes
Axial Rods Instrumentation Verification sheet	yes	yes
MQXFA Integration and Loading	yes	yes
Magnetic Measurements	yes	yes
Splice Box Assembly	yes	yes
Final Electrical Tests	yes	yes
Quality Manufacturing and Inspection Plan - MQX	yes	yes
Preparation for Shipping	yes	yes
Structure & Shims Review	yes	yes
Quadrupole Fabrication Report	yes	yes
MQXFA Vertical Testing Interface Traveler	yes	yes, but in work
Vertical Test	yes	yes
MQXFA Incoming Inspection and QA Traveler	yes	yes
Coil Pack Magnetic Measurements	yes	yes
Half-Yoke Stacks Assembly	yes	yes
Load Pad Pre-Stack	yes	yes
Endurance Test	yes	-
Coil Pack Subassembly	yes	yes
Post-Loading Electrical QC		yes
NCRs	Status	Status
	closed	closed
Responsible	LAWRENCE BERKELEY	LAWRENCE BERKELEY
Asset name	**Coil**	
Asset no.	HCMQXFAC001-BL000006	HCMQXFAC001-BL000008
Steps	Status	Status
Cable:Review data from LBNL (*)	Done	Done
Parts Supplied by FNAL to BNL	Done	Done
Preparation Winding & Curing (*)	Done	Done
Winding & Curing (*)	Done	Done
Preparation Reaction (*)	Done	Done
Reaction (*)	Done	Done
Preparation Impregnation (*)	Done	Done
Splice/Epoxy Impregnation (*)	Done	Done
Coil CMM measurements	Done	Done
Electrical Testing (*)	Done	Done
Electrical ID	Done	Done
Shipping to LBNL (*)	Done	Done

Conclusions (and lessons learned)

- **Intermediate steps** for **revision** of documentation is proven to be **effective** (**coils, magnets, cold mass**) and **avoid unnecessary overload** to everyone **at the end** of the **production**
- Improvement for Cold Mass documentation – Shared prior to cold test (We already look forward to CM03)
- **Timely issuing** of **critical NCRs** to trigger the **discussions** and the **formal approval process**. We sometimes need **external colleagues** to **WP3** (or even **the Project**) to **give feedback and grant concessions**
- **Documentation is in good shape for CA02 and main subassemblies but still not completed**
- **All critical NCRs are closed or about to be (misalignment of the IFS head)**

Looking forward to receiving CA02 at CERN

Main Nonconformities

- Total of ~150 AUP-internal Discrepancy/Nonconformance reports issued (integrated for cables, coils, magnets, cold mass and cryo-assembly CA02); most were minor and handled within AUP (level 1 or 2)
- Only 1 critical Nonconformity related to this Cryo-assembly.
  - **EDMS 2515070**: "nodal" distance between two magnets out of spec; NCR accepted and **closed with warnings** – **Decision to wait for the results of CM02 before changing the acceptance criteria**
  - **EDMS 2905753**: leak check of CM in the CA was not able to achieve necessary background to verify spec; NCR has been accepted by WP3 and CERN TE-VSC – Waiting for final approval from TE DH and HL PL (already given offline), will be **closed with warnings** – **Results of the Leak Test to be done at CERN after phase II cryostating shall be added to this NCR. Leak Test procedure to be shared with CERN/TE-VSC before the next test and results to be immediately share with CERN/TE-VSC for validation. OK for installation in the IT String**
  - **EDMS 2937955**: VT EE152 is open; NCR under review. **Suggestion from TE-MPE to disconnect VT EE152 completely at the IFS, and use VT EE151 instead (bridge at IFS).** To be **closed with warning** adding **this remark** and also **adding preventive actions**
  - **EDMS 2769128** and **2883868**: two QH failures; NCR under review – **OK for installation in the IT String. The NC shall be repaired via a disassembly of the cold mass and (if needed) a magnet replacement prior to installing the machine (or to be considered as spare)**