Conductor and Cable
Summary and Comparison of MQXFB08 Witness Sample Results

S. C. Hopkins, J. Fleiter, T. Boutboul (TE-MSC-LSC)

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Cable and Coil Overview

Coil	Cable [1]	Cabling Report	HT	Witness Report	Cable NCRs	Strand Contract [2]	Billets
CR148	H16OC0455A	3091621	822	3185366	-	F663/Am4 (9) F663/Am5 (31)	AO08S00399 (9) AO08S00615 (9) AO08S00619 (9) AO08S00629 (4) AO08S00639 (9)
CR149	H16OC0409A	2772479	830	3185367	-	F663/Am3 (2) F663/Am4 (31) F663/Am5 (7)	AO08S00283 (8) AO08S00308 (7) AO08S00444 (8) AO08S00476 (8) AO08S00625 (7) AO08S99116 (2)
CR150	H16OC0412A	2774489	837	3185368	-	F663/Am4 (21) F663/Am5 (19)	AO08S00561 (11) AO08S00569 (10) AO08S00598 (10) AO08S00613 (9)
CR151	H16OC0414A	2791624	844	3185369	-	F663/Am5 (40)	AO08S00593 (11) AO08S00597 (11) AO08S00599 (9) AO08S00601 (9

[1] MQXF cable specification, EDMS 1863790 [2] MQXF wire specification, LHC-MQXF-CI-0001, EDMS 1419924

Nonconformities

- NCRs affecting the cable are summarised below
  - Insulated cables
    - NCRs concerning strand pop-ups for CR148, CR149 and CR150, not treated further in this presentation
  - Witness samples (coil heat treatments)
    - No indication of a significant performance impact from minor coil HT NCRs for CR148 and CR149

Coil	HT	Cable NCRs	NCRs Implicating Cable	Coil HT NCRs
CR148	822		3093358	3129199
CR149	830		2811007	3138474
CR150	837		3017026, 3132312	
CR151	844			

Testing Anomalies

- For CR148 and CR150, the **maximum** cabling degradation evaluated from witness samples is reported as exceeded the 5 % specification:
  - For CR148:
    - Anomalous value for strand 13 at 14.5–15 T only: mean for strand 13 is 4.1 %, in specification
    - Also in specification for other witness samples and original cable qualification
  - For CR150:
    - Higher degradation value is for strand 11 only: excluding this strand, average degradation is ~2 %
    - This might suggest slight degradation of the test piece; but I_c is nevertheless within the I_c band
- For CR149, I_c data for strand 6 were included in the evaluation only at 4.3 K due to a testing issue in the first cooldown
  - Retests at 1.9 K were successful, but not considered in the report due to the possibility of an I_c increase on the second cooldown
  - I_c is comparable to strand 7; calculation of margin is not significantly affected
- For CR150, extracted sample WE06 was degraded, probably due to sample damage
  - Excluded from analysis
  - No correlation with furnace position, so not caused by heat treatment anomalies
- For CR151, measurement could not be performed at 1.9 K, so coil short sample limits are reported only at 4.5 K
  - The values have been estimated by scaling (next slide) and are in the normal range
  - Samples will be remeasured at 1.9 K for confirmation (expected by the end of November); note that as this is a second cooldown, the I_c may be slightly increased

CR151 Performance at 1.9 K

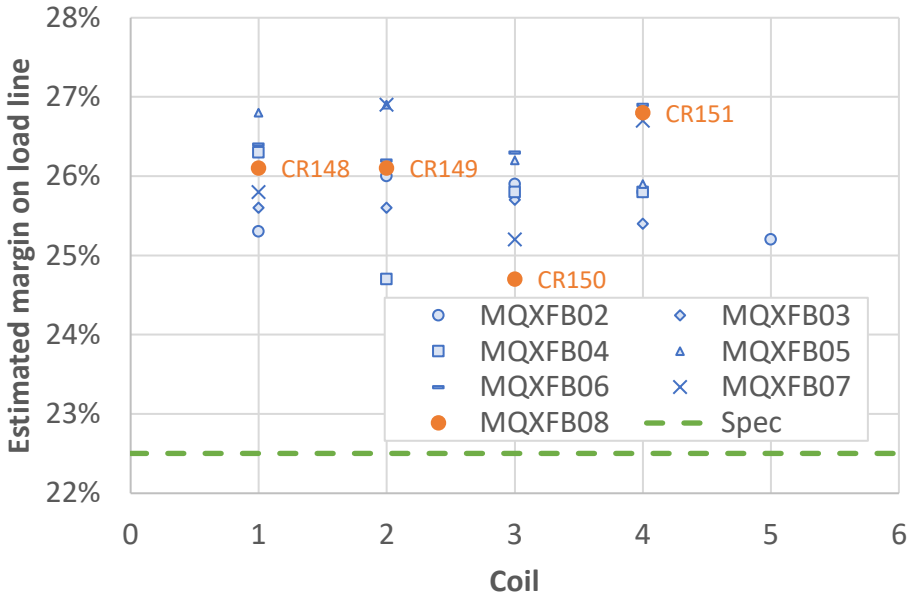
- I_c parameters for the witness samples at 1.9 K have been estimated assuming the typical temperature scaling for MQXF wire

T (K)	B_{c2} (T)	C_{min} (A·T)	C_{avg} (A·T)	C_{max} (A·T)
1.9	28.6	54210	55759	58443
4.3	25.8	46082	47399	46981

- With those values, margin at 1.9 K would be **26.8 %**

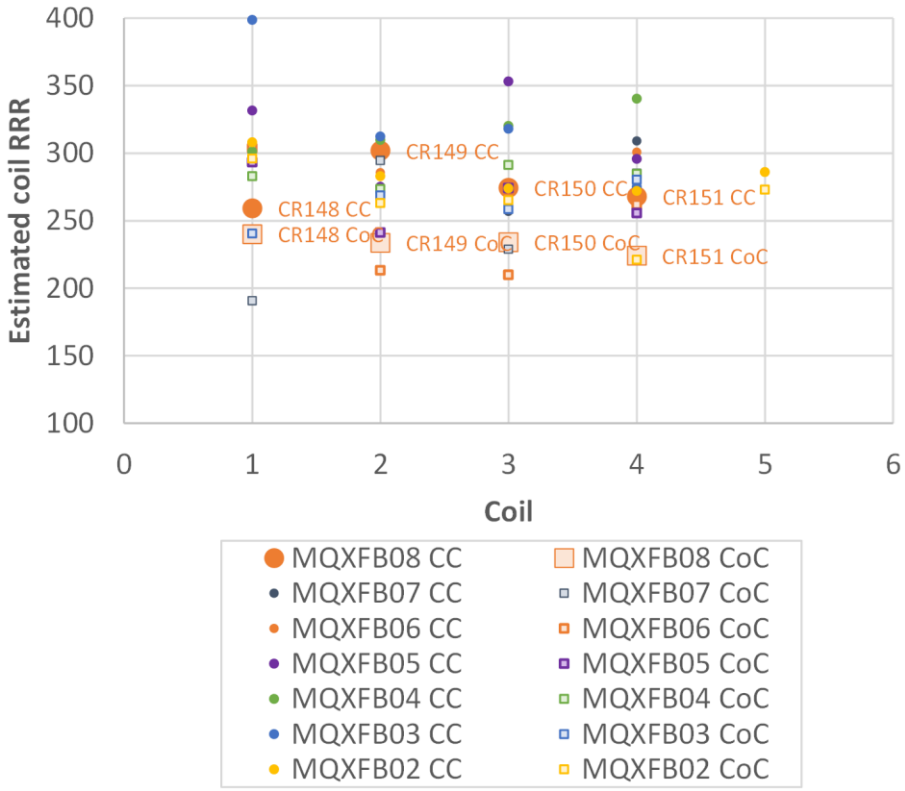
At 1.9 K	$I_{c,SS}$ (A)	$I_{op}/I_{c,SS}$ (%)
Min	22488	73.2%
Avg	22664	72.7%
Max	22957	71.7%

Load Line Margin



- Large margin on load line of ~26 %
  - Consistent in mean and spread with recent coils

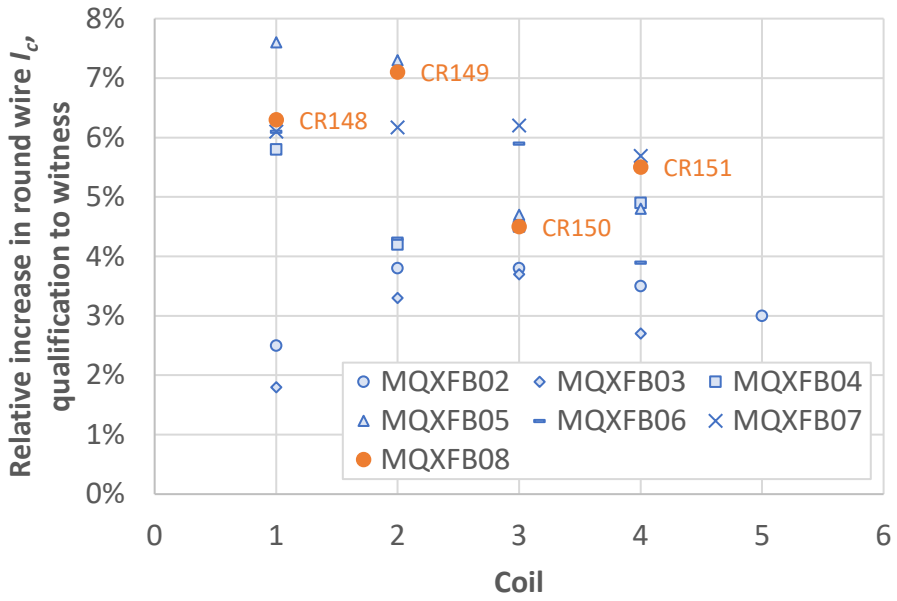
Estimated Coil RRR



- Large RRR margin
- Connection side (CC) has higher RRR
- All values within the range of other recent coils

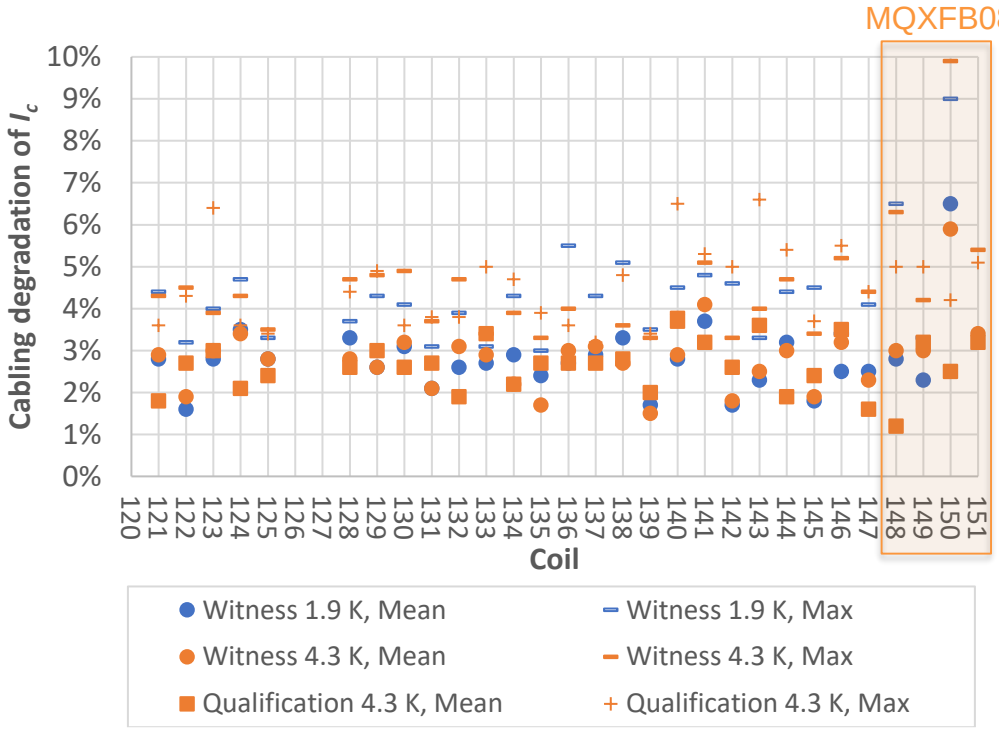
Effect of HT/Furnace on Round Wire I_c

- I_c of virgin **witness** samples (building 180) – I_c of virgin **qualification** samples (building 163)



- I_c consistently slightly higher for witness samples (HT in building 180) than qualification samples (HT in building 163)
- In a consistent range for recent coils

Cabling Degradation of I_c



- Cabling degradation of I_c is within the 5 % specification for **qualification** samples of all coils
- Mean cabling degradation is also <5 % for **witness** samples
  - Except the CR150, for which degradation values are available for only two strands, one of which shows anomalously high degradation
  - Excluding this outlier, mean
- Otherwise, consistent and conforming degradation as assessed from witness samples across all recent production, both at 1.9 K and 4.3 K
- Excluding outliers above: mean cabling degradation ~3 %

Summary

- Cable data in specification for all coils
  - Excluding anomalous cabling degradation for two potentially damaged extracted strand samples
  - Lack of I_c data at 1.9 K for one coil, but scaling suggests performance in the normal range
- Good consistency between recent coils, and data in a comparable range to MQXFB02-07
- Systematic differences remain between small (building 163) and large (building 180) HT furnaces, and in RRR between CC and CoC

Thank you for your attention!