Machine Protection Working Group

Minutes of the 4th meeting held on June 1rst 2001

Present: F. Bordry, E. Carlier, E. Ciapala, C. Dehavay, B. Dehning, R. Denz, E. Gschwendtner, B. Puccio, F. Rodriguez-Mateos, M. Sanmarti, R. Schmidt, J. Wenninger

Excused: B. Jeanneret, G. Mugnai, L. Serio

Main topics of this meeting:

- Proposal for LHC powering zones (B. Puccio)
- Interface between quench protection system and power interlock system (R. Denz)

Proposal for LHC powering zones (B. Puccio)

The concept of powering zone was introduced by **B. Puccio**. Each electrical circuit of a powering zone will be monitored by a Power Permit Controller (PPC). In the LHC there are 44 cryostats and 52 feed-boxes (DFBs). The number of circuits for each DFB varies between 2 for the smallest and 30 for the largest (arc cryostat DFB). A priori a powering zone does not necessarily correspond to a single cryostat. He insisted that the powering zones should be properly defined to de-couple the machine elements for commissioning and testing. For most of the powering zones, the zone corresponds to a single cryostat. Each arc cryostat has one PPC at each end. For cryostats that are close to each other and where the number of circuits is small, it could be meaningful to merge them into a single powering zone. **B. Puccio** identified 5 cases where it would be meaningful to merge elements (for LHC optics V6.3, drawing ref. LHCLSXG_0001):

- Case 1 (IR2 & IR8): the cryostats for Q4D2 and Q5 are close to each other and could be merged into a single zone. This situation occurs 4 times around the ring.
- Case 2 (IR4): although quadrupole Q6 has its own DFB, it is installed inside the arc cryostat and could be merged in the same zone as the arc. This case occurs twice.
- Case 3 (IR3): the cryostats of quadrupoles Q3, Q4 and Q5 could be merged, even though the total distance covers ~ 120 m. This case occurs twice.
- Case 4 (IR6): the cryostats of quadrupoles Q4 and Q5 are 33 m apart and could be merged. This case also occurs twice.
- Case 5 (IR7): the cryostat of quadrupole Q6 is ~ 28 m away from the arc cryostat and could be included in the arc powering zone. This case occurs twice.

With this proposal a total of only 36 PPCs would be required for 44 cryostats and 52 DFBs.

B. Puccio concluded after the presentation and the discussions that the main open questions are:

- Is this proposal in line with the access zones?
- How should the warm magnets in IR1,3,5, and 7 be handled ? For those magnets the power converters are installed in the SR (surface) buildings.
- What are the implications for the cryogenic system?
- What is the cabling and the exact location of the main components (power converters, quench protection and PPCs)?

Discussion: **F. Bordry** insisted on the importance of "matching" the powering and access zones (e.g. for testing). He also needs to know which power converters have to provide the "Access OK" signal to the PPC (see also the presentation of V. Montabonnet on March 30th 2001). For the moment this is only foreseen for the main dipoles and quadrupoles. Feedback is required from the Access and Interlock WG. **R. Schmidt** suggested as a pragmatic approach to provide this "Access Ok" signal for all PCs with maximum current above 1kA. Concerning Case 2 mentioned above, **F. Rodriguez-Mateos** asked whether from the cryogenics point of view it was possible to power independently Q6 and the arc. For Case 3, **F. Bordry** commented that the somewhat larger distances were not a problem provided the power converters were located close to each other. This statement can in fact be applied to all cases listed above. **M. Sanmarti** indicated that so far the cryogenics system would provide a single status flag/OK signal for each sector. This will clearly be a problem for independent testing of the various cryostats or powering zones. It would be useful to split the signal up for testing. **ACTION:** The ACR Group should discuss the consequences, and possibly report back to the MPWG in a future meeting. Concerning the number of powering zones, it seems clear that the minimum number is 24 (2×8 for the arc cryostats $\oplus$ 8 for the inner-triplets). **F. Rodriguez-Mateos** insisted that it was not obvious to determine the "optimum" (cost…) number of PPCs precisely without detailed information of the cable routing and location of the various elements. In addition he said that one must also consider the flexibility required for commissioning, testing and cold-checkouts.

On a more general level, **F. Bordry** and **F. Rodriguez-Mateos** argued that the name "Power Permit Controller" was not well adapted. They would prefer to name it "Power Interlock Controller". **ACTION:** The naming of the "Power Permit Controller" and "Beam Permit Controller" should be reviewed (R. Schmidt).

Interface between quench protection system and power interlock system (R. Denz)

R. Denz presented the interface between quench protection and power interlock system. The quench detectors for the main magnets in each sector are connected to 5 km long current loops, one loop for the dipole circuit, and one loop for the two quadrupole circuits. If a quench is detected, the corresponding detector opens the loop via a relay. As soon as the current loop is interrupted, the energy extraction switches that read the status of the loop open automatically to discharge all magnets in the circuit. The loop will operate at a voltage of 300 V and a current of 1 A. At one end a signal derived from the state of the loop is send to the associated PPC. The delay between the start of a quench and the time the signal reaches that PPC is given by the quench detection time (at least

10 ms) and the delay for opening the relay (about 20 ms). After the PPC receives the signal, the beam will be dumped. About 40 ms after the quench starts (assuming operating at high current) the diode that is installed parallel to the magnet opens and the current of the quenched magnet begins to decrease. In case the switch does not open, the quench heaters of a selected number of magnets are fired directly by the switch and the PPC is informed. A discharge request from the power converters is also send to the PPC that informs the switch to open. One point to clarify concerns the role of the PPC for the main circuits installed in the odd points, since the quench protection system talks basically to the power converters in the even points. How will the odd-point PPC be informed about quenches of the main magnets?

Discussion: **R. Schmidt** pointed out that in the case where the main dipoles are discharged directly over a signal from the quench detectors (following a quench in one of the dipoles), the main quadrupoles would then be discharged via the PPC. The situation is reversed in the case of main quadrupole quench. **F. Rodriguez-Mateos** indicated that in the case of a discharge request coming from the power converter for the main dipole magnets, only one of the two extraction switches of the arc cryostat would be opened. **F. Bordy** said that the decay time of the current for the dipole magnet would be about 200 s which is still acceptable for the power converter.

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Due to a clash with PAC 2001, it was decided to cancel the meeting foreseen on June 22nd 2001. The next meeting has been fixed to July 13th 2001.

On June 8th a special subgroup meeting will be devoted to the problem of energy tracking and surveillance of the beam dump kickers and septa magnets.