Machine Protection Working Group

Minutes of the 2nd meeting held on March 30th 2001

Present: L. Arnaudon, P. Bonnal, F. Bordry, J.C. Billy, E. Carlier, E. Cennini, P. Dahlen, B. Dehning, R. Denz, E. Gschwendtner, J.B. Jeanneret, D. Lacarrere, V. Montabonnet, G. Mugnai, B. Puccio, R. Schmidt, A. Siemko, F. Szoncso, J. Wenninger

Excused: E. Ciappala

Main topics of this meeting:

- Interface between Power Converters and Power Interlock System (V. Montabonnet)
- Schedules for critical systems :
  1. TCC (P. Bonnal)
  2. Access system (E. Cennini)
  3. Beam dump system (E. Carlier)
  4. Quench protection system (R. Denz)

V. Montabonnet presented the interface between PC and the Power Interlock system for String 2. Each PC receives 3 inputs: a Power Permit, a Slow Power Abort and a Fast Power Abort signal. While the first 2 signals interface to the digital controller of the PC, the Fast Power Abort goes directly to the power source and activates the circuit breakers. The PC sends one PC Fault output signal to the Power Interlock system. An Open Switch Request output signal, present for the main dipoles only, is used to request an opening of the energy extraction switches. For the LHC, the Power Permit signal will be combined with the Slow Power Abort signal (name to be defined, either Power Permit of Slow Power Abort). The Open Switch Request signal will become Discharge Request and the PC Fault signal will be renamed to Circuit Fault signal. A new output signal that is required by the access system will be added. It will be present on the MB, MQ and inner triplet PCs to prevent access to the tunnel if the PC current is above 1000 A (it needs to be defined which power converters should inhibit access if operated above a current of 1000 A). An exact definition of how this signal will be generated (from one or two DCCTs) does not yet exist. For orbit correctors (± 60 A) there is no HW interlock foreseen. For the ± 120 A PCs it has to be decided if they will have a hardware interlock (as the ± 600 A converters) or no hardware interlock (as the ± 60 A converters). For some of the ± 600 A circuits energy extraction by a dump resistor is required. For these circuits, the dump resistor switches are opened through the Fast Power Abort signal via the power converter. A question that was addressed concerns the dump resistors for the main dipoles in case of a PC Discharge Request. The PCs are located in the even points.

The dump resistors are in even and odd points (one at the end of each sector). In order to open both switches, a 3 km long cable would be required to trigger the dump resistors at the remote end of the arc. If only one switch opens, the time constant for discharge is 200 s. This has been taken into account in the design of the PC that can accept such time constant. It was pointed out that the heaters, which would be fired if the dump resistor switch does not open, give an additional redundancy. **B. Dehning** suggested summarizing the signals between PC and interlock system.

P. Bonnal presented the LHC installation plans, which were reviewed after the LEP stop. The installation of the QRL for sector 7-8 will start in the beginning of 2003. The infrastructure for magnet transportation should be ready by March 2003 and in August 2003 the first magnets will arrive in the tunnel. It will take about 1 day to install a magnet, while 7 to 8 weeks are needed to complete one interconnect. To respect the schedule, work will progress at the same time in the two halves of each sector. It will take ≈ 30 weeks to complete one sector. The first sector (7-8) should be installed in April 2004. This sector will then be tested until October 2004. To meet the installation deadlines, two teams of 40 people will work in parallel in the tunnel. Later, when other sectors are installed, four such teams are required. An important short-term deadline concerns the cables to be installed in the tunnel: a rough idea of what cables are needed (type, length and destination) must be known by June 2001. **B. Puccio** pointed out that the commissioning of the power interlock system would also require some time.

E. Cennini discussed the plans for the access system. He pointed out that a number of systems that are important for machine protection would also have to be interfaced to the access system. He stressed that a definition of the exact access conditions is required. He needs input from all equipment groups and from TIS. Details should be settled inside the Access and Interlock WG. Interfaces to the access system must be defined ASAP, at the latest by the end of 2001 (call for tender). Among the many activities of his team, one must not forget that the SPS access system must be adapted for LHC beams (and beam lines). An important work is done in relation with the INB regulations. Obviously the access system must be ready and commissioned before the injection test in 2004.

E. Carlier presented requirements from the beam dump system. The most critical elements of the beam dump system are the dump kicker (MKD) and the septum magnet. For machine protection the status, the (kick) strength and the synchronization of the kick with the particle free gap in the beam are very critical. For tracking of the kicker strength, the source of the energy information must be defined (where does it come from, who provides it…). A similar problem exists for the synchronization with the abort gap. A highly reliable detection system of the free gap must be developed ASAP (who?). **E. Carlier** suggested considering the use of the revolution frequency between the beam permit controllers, instead of a 10 MHz signal. External inputs from the machine protection and access system (the clients of the beam dump system) must be defined. Deadlines for the technical specification of the triggering system is by the end of 2002 (which involves the free gap detection and synchronization) and by the end of 2003 for the kicker tests where everything must be specified. Some open questions related to machine protection concern the access system and the “internal” fault detection: should

those “clients” trigger the dump via the MPS or should they have dedicated inputs to the dump system. It was decided to discuss the source of beam energy information for the dump system at the next meeting.

R. Denz presented the quench protection system. 2016 quench detectors will be installed in the tunnel, in total there are 3336 detectors. Their technical specifications must be ready at the end of 2001 and the interface to the power interlock system must be known ASAP. The components of the system in the tunnel (relays,…) must be radiation tolerant. The link between quench protection system of an arc cryostat and extraction system, power converter and power interlock system will be based on a hardwired, 3 km long current loop. Tests of such a long loop must be done beforehand (such current loops are used for String 2). In the discussion it was pointed out that the experience from LEP (**G. Beetham**) might be a useful input for the design. **G. Mugnai** mentioned that some of the relays installed in LEP survived huge radiation doses without problems. **E. Carlier** reported about problems with such relays close to target zones.

In the discussion it was decided to organize informal “subgroup” discussions on the reliability of electronic components (including radiation hardness), since this is a common problem and that experience has been gained inside various groups. The results of the discussions should be reported at the MPWG meeting in 6 weeks from now.