Machine Protection Working Group

Minutes of the 44th meeting, held 29th April 2005

Present: A. Butterworth, J. Uythoven, R. Filippini, B. Goddard, C. Zamantzas, G. Guaglio, V. Kain, D. Macina, M. Lamont, R. Giachino M. Zerlauth, P. Bonnal, R. Denz, F. Schmidt, B. Todd, R. Steinhagen, J. Wenninger, R. Schmidt.

Meeting Agenda:

- Machine Protection Review Analysis [RS]
- AOB

Machine Protection Review Analysis [RS]

R. Schmidt began by presenting slides by **J. Wenninger** that had been previously shown in the LHC Technical Committee, breaking down the comments from the reviewers into points to be analysed.

1. **Configuration Control**

Machine Protection **Reviewers** described Configuration Control as one of the key risks in LHC exploitation, citing the need for secure settings management. **M. Lamont** described this as being a 2-fold issue: *secure settings* and *general settings*. **R. Schmidt** commented that a fellow started in AB/CO to assist in the development of software related to safety, possibly including configuration control. **B. Goddard** questioned the scope of the fellow's work, asking whether the role played is clearly defined, suggesting further action be taken to describe the work that needs to be done in this area. **R. Schmidt** commented that there are three areas in the software development related to machine protection: post mortem, software interlocks and configuration control

Action: Configuration Control, post mortem and software interlock roles and responsibilities to be clearly laid out (Action: R. Schmidt and J. Wenninger)

2. **Dump Kickers**

Reviewers said that dump kickers were involved in almost all critical failures of the machine. **B. Goddard** clarified that single points of failure may be related in some way to the Beam Dump Kickers, for example a missing trigger. This is an accepted part of LHC design as these kickers are inherently a dangerous part of the machine. However, there are failures in several systems that could also have similar consequences, such as the injection kickers and the aperture kicker (if installed).

3. **Beam Loss Mechanisms Not Considered by LHC MPS**

R. Schmidt described how TEVATRON experienced ultra-fast quenches, involving the deposition of high beam energy into only a few magnets, **R. Schmidt** questioned whether the scenario of a single bunch at 7TeV hitting a single magnet had been modelled, and whether this posed any danger for the magnet. **R. Denz** stated that a fast beam loss is better for the magnet, many areas become simultaneously normally conducting, giving a larger ΔV across the effected magnet. **R. Schmidt** asked whether it's possible for the QPS to have different response times for different voltages.

R. Denz explained that in general a validation time of 10 ms is required to avoid false beam dump triggers. However, special solutions should still be found for magnets in the Insertion Regions.

Action: In a future meeting R. Denz will present the options for reducing the validation time.

4. **Interfacing Hardware and Software Systems**

The Machine Protection **Reviewers** agreed that the interface on the hardware level was well described; however the software interface to control and monitor the hardware was less clear. **M. Lamont** said work had already started on the LHC Post Mortem, for the reconstruction of events leading up to a mission abort, and on State Control which is not in the scope of the Machine Protection System. LHC OP was formed to discuss these issues, but it remains a select forum, **R. Schmidt** suggested it would be advantageous to more involve members from BT, BDI and the Collimation teams into these discussions to discuss State Control of LHC.

Action: Clarify with LHC-OP how to start discussions regarding the LHC state control and software systems including other people (R.Schmidt)

5. **Critical System Malfunction**

A single failure of a critical system would result in LHC being completely unprotected. **Reviewers** suggested that the critical LHC systems be vetted by an external company, and backup systems proposed if required. **J. Uythoven** questioned the scope of such an external review, **R. Schmidt** and **J. Wenninger** emphasised that it's mainly the LBDS and the BIS that would fall into this category. **R. Schmidt** continued to explain that propositions are emerging for a review of the BIS by an external third party. **B. Goddard** questioned whether this really needed to be carried out by people external to CERN.

Action: Consider if a detailed examination of electronics for critical LHC sub-system design, BIS, LBDS, etc., possibly by an outside company, is useful (ALL, in particular E.Carlier and B.Puccio)

6. **Other Channels to the Beam Interlock System not considered by MPS**

Reviewers were also asked to comment on other possible sources of Dump Request that hadn't been considered by the MPS so far. **R. Schmidt** emphasised that the number of sub-systems connected should remain as small as reasonably possible, False Beam Dumps should be avoided. The Timing system should be maintained independent of machine safety. **B. Goddard** asked whether the timing should not be considered critical for TCDQ, **R. Schmidt** said that a double failure, both in timing and TCDQ monitoring would need to occur for this to be serious. The Control Network was also considered as a possible input to the BIS by the Machine Protection **Reviewers**. **R. Schmidt** commented that a single network failure should not lead to a beam dump. **R. Steinhagen** commented that packet switched networks are inherently redundant, with only the last stretch to the control room being common to all circuits. **J. Wenninger** suggested that studies be made into the dependability of the control system network.

Action: Determine whether control system network failures are critical for safety, in particular the timing system (Action: All))

7. **Aperture Kicker**

Reviewers were concerned with the implementation of an aperture kicker in the LHC. **R. Schmidt** said that this (and potentially all dangerous kicking devices) needs to be safely interlocked.
F. Schmidt indicated that ABP insist these kickers are needed in the design. LHC-OP has been mandated to investigate if an aperture kicker is really required.

Action: LHC-OP to determine if aperture kickers are mandatory

Vacuum Valves
Fast acting vacuum valves are employed for protection around LHCb, their movement is potentially very damaging for machine safety, as a full sweep open-closed is in the order of only 15ms.
J. Wenninger stated that similar valves exist in SPS and none have failed critically in 10-20 years operation. **J. Uythoven** stressed that from such experience if could not be concluded that fast valves have the required safety level.

Action: Determine the safety and need for fast vacuum valves (Action: AT-VAC)

8. Commissioning of LHC MPS

Reviewers stressed that LHC MPS Commissioning be carried out in a complete manner to ensure machine start-up is as safe as possible, it was emphasised that there's a higher chance of failure in the commissioning stage, as systems are new, and not fully understood. **Various Members** agreed with the need for a complete description of the phases of commissioning, saying it should be addressed with soon. This effort should be driven by someone to be defined.

Action: Determine a course of action for the commissioning of the full LHC MPS, and a person (or a small team) to drive this effort (R.Schmidt, J.Wenninger)

9. Post Mortem

Reviewers stressed that LHC should not start without an adequate Post Mortem system, to allow for full reconstruction of events leading up to a failure. **M. Lamont** said that even in commissioning a Post Mortem would be essential. Work is underway on a Post-Mortem analysis tool.

Action: see point 1

10. Beam Dump Septum Spares

LBDS requires a series of Septa magnets, of which there are very few spares. It was suggested that more be purchased to avoid a long downtime if the worst should happen. **B. Goddard** strongly agreed with this point, emphasising that spares should be sought for other magnets such as the Injection Kickers, and possibly other equipment such as tertiary collimators.

Action: Renew the spares policy for LHC magnets and other equipment (B.Goddard, others)

11. SPPS – Personnel Protection Device

This integrity of this part of the machine was questioned by the LHC Machine Protection Review. The supervision of the condition of this section of the machine was unclear. **R. Schmidt** said a radiation monitor could be installed at the location of the SPPS to give an indication of its condition. However, the responsibility for personnel protection devices is elsewhere.

12. DC Beam Current Measurement

The 100ms sampling period of the proposed Beam Current measurement system is unacceptably long, reviewers suggested efforts be made to improve this. **J. Wenninger** said conflicting information exists on the status of this project, it is to be clarified.

Action: Determine what action should be taken concerning the Beam Current measurement (R.Schmidt, J.Wenninger with BDI)

13. Other Topics

J. Uythoven questioned the anticipated safety of the LHC Safe Beam Parameters, as it's clear the system proposed will not be SIL3.

B. Goddard questioned whether the reliability of the SPS Safe Beam Flag could become an issue for the protection of the SPS. **R. Schmidt** agreed this should be understood.

Action: More clearly establish the safety requirements of the Safe LHC Parameters Project (B.Puccio, R.Schmidt)

M. Lamont asked whether the beam abort gap was to be interlocked, dumping the beam as soon as the abort gap begins to fill. **Various Members** said this would not be the case.

Action: A presentation on the beam abort gap monitoring is suggested (R.Schmidt to ask BDI)

When the written report by the Reviews will become available, a second iteration will be made.

AOB

None.

Next Meeting

3 June 2005