Machine Protection Working Group

Minutes of the 60th meeting, held 10th November 2006

Present: J. Wenninger, B. Todd, B. Puccio, V. Kain, B. Goddard, S.Lüders, A. Gomez Alonso, B. Dehning, C. Zamantzas, D. Macina.

Meeting Agenda:

- Corrections to Powering Failure Talk from Meeting 59 [AGA]
- Introduction to the Beam Interlock System Audit [RS]
- Results of the Beam Interlock System Audit [SL]
- Tackling the Issues Raised in the Audit [BP]

Corrections to Powering Failure Talk from Meeting 59 [AGA]

A. Gomez Alonso made a brief presentation summarising corrections to the presentation made in Meeting 59. These corrections came as a result of comments made by **R. Steinhagen** regarding the time constants of Closed Orbit Dipole failures. After the corrections the time response of quenches at injection becomes around 10ms, originally this was reported as 10-20ms. **R. Schmidt** remarked that this 10ms value brings the new simulations in line with old ones, and that the philosophy of the Machine Protection System remains unchanged by these results.

Introduction to the Beam Interlock System Audit [RS]

R. Schmidt briefly introduced the scope and requirements of the audit of the Beam Interlock System (see presentation) that was carried out in September 2006. This was the last opportunity to make limited design changes to the system before LHC production. The motivations of the audit were to ensure that the Beam Interlock System was well defined and well implemented, without major safety issues or oversights.

Results of the Beam Interlock System Audit [SL] & Tackling the Issues Raised in the Audit [BP]

S. Lüders presented the results of the Beam Interlock System audit, with emphasis on the key points noted by the auditors. A report (found here) has been written with a detailed breakdown of each item discussed in the presentation.

S. Lüders continued to say that in general, the Beam Interlock System gave a good impression to the auditors. The design decisions have been correct, the design is consistent and the interfaces between systems are well defined. The audit was looking for evidence of a system giving safe and efficient operation, having a high reliability and availability without single point of failure in the link from User to Beam Dump. Certain aspects of the system were not considered by the audit, such as the Power PC and Ethernet.

The key points from the audit are listed below, the numbering corresponds to the report written by the auditors. After the presentation **various members** discussed certain points raised by the audit.
B. Puccio responded to these questions and summarised the actions taken by the Machine Interlocks section to tackle the issues raised by the audit, these comments have been added in blue into this list.

Documentation
1. Consistent set of up-to-date and finalized documents should be provided.
This is in the process of being done, although it is not considered critical.
2. Ensure that all information relevant for the project is properly retrieved following PhD student leaving.
Arrangements have been made to employ the PhD student on a longer term contract.

Beam Permit Loop
3. Find a solution to avoid spurious signals on the fibre optic link
Three new optical transceivers are in production, this combined with a change of philosophy by removing the inversion of the signal at each point will solve this problem.
4. Confirm the availability of the 'old-fashioned' ELED
PD-LD has confirmed that it will produce this component for at least five more years; this has been given in writing to AB/CO/MI.
4. Choose more separated frequencies for the Beam Permit Loops, like 8.750 and 9.375 MHz.
Oscillators have been specially made, at 29.5M, 31.5M, 33.5M, 35.5M and 37.5M. This means permit loop frequencies of 7.375M, 7.875M, 8.375M, 8.875M and 9.375M are possible.
5. The signals from the CERN Control Centre have a long way to travel to reach the Beam Interlock System in the LHC, a solution should be found for this.
A seventeenth LHC Beam Interlock Controller will be added in the CCC.

Testing and Environment
16. Electrical tests should be carried out for all PCBs
Special test equipment for the passive boards has been designed and is in fabrication.
17. The duration of the Power Soaking should be justified and adjusted.
Initially the power soak time has been increased from one to six hours; failure rate analysis will allow the correct power soak timing to be determined.
17. The accelerated thermal aging test of one system should be carried out.
This is foreseen in the near future, when spares are delivered.
18. A Walkie-Talkie type RF susceptibility test should be carried out.
This will be done in the near future.
19. The conductivity of the unit's enclosure to ground should be ensured.
This will be discussed with ST and if necessary tests will be arranged, it is not easy to determine if this is correctly done.
27. The radiation tolerance of the User Interface should be defined.
One User Interface will be radiation tested in early 2007.
27. Users of the Beam Interlock System should be made aware of the degree of radiation tolerance of the Beam Interlock System.
This will follow in due course.

Components, Xilinx and VHDL

5. Extra power filters should be added to the mains.

Power filters exist in all sections of the Beam Interlock System, except on the VME power supply. After discussion it has been decided that no extra power filters will be added to this section, as the Wiener design is used throughout CERN. The recommendation is motivated by experience at DESY, and we will discuss with our colleagues if their experience is applicable to CERN, and possibly install such filters as an upgrade.

9. The choice of ceramic capacitors should be adjusted to select less dense capacitors, as it has been shown in the past that large capacitances in small packages are weak.

38 capacitors have been found that have 1uF or greater in a package of 1206 or smaller. These are used (in every case) to make a time constant. The corresponding resistance value has been increased to allow capacitor values to be reduced to 470nF or less.

10. The fabricant of the Transient Voltage Suppressor should be carefully selected as it is known that Fairchild have a reliability problem with their fabrication.

The Dutch manufacturers of the Beam Interlock System have agreed that no Fairchild TVS will be used in the Beam Interlock System. They added that no Fairchild diodes have been used to date.

21. The matrix will stop once the external clock has stopped, possible mitigations for this type of failure should be investigated.

A ring-oscillator is being investigated, although care has to be made to ensure that it does not lead to false information. Industrial oscillators have also been specified for use in these cases. Common mode failures that could stop both oscillators will be addressed.

22. When the final CIBM design is made a VHDL code review should be conducted.

This will be done.

23. The final code should be stored on a repository such as CVS

This also will be done.

Interfaces

35. Clear procedures should be made for testing the full BEAM_PERMIT chain.

The procedures will be written, and the commissioning working group will address these issues.

29. Similar audit should be conducted for LBDS kicker magnets and their trigger mechanism.

This is to be decided by the respective projects.

31. A dependency analysis of the LHC Machine Protection System should be carried out and an audit of the major dependencies should be conducted.

This is to be decided by the MPWG.

32. Procedures should be applied to ensure that the user systems obey standard safety rules.

A document exists that explains the basics of the interconnection to the User Systems.

32. Users should be made aware of the risks by discussions & training.

User Systems will be addressed in due course. Following the guidelines in the document is sufficient to maintain a secure link between User System and Beam Interlock System.

33. A Walkie-Talkie or RF susceptibility test should be made on critical users.

This will be done in coordination with User Systems.

34. The SOFTWARE_PERMIT needs to sustain the high level of reliability and availability.

SOFTWARE_PERMIT has been removed from the Beam Interlock Controllers, if it is to be used then a system based on a classic USER_PERMIT through a User Interface must be sought.

Safe Beam Mode

36. There is no protection mechanism to prevent the exchange of cables from maskable to unmaskable.
In principle there need not be a physical mechanism, as remote read-back can ensure that the cabling is coherent with predetermined configurations.
37. Safe solutions for the implementation of the Safe Machine Parameters should be investigated.
This is in planning.
37. There is no documentation for the implementation of the Safe Machine Parameters.
This exists and is to be distributed in the near future.
38. The distribution of the SAFE_BEAM_FLAG should be consistent with reliability / availability / safety of Beam Interlock System.
This is also the opinion of the Machine Interlocks Section.

Following the presentations, **R. Schmidt** added that the audit had been a very useful tool for the Machine Interlocks section. It had required only a moderate effort. Already at the end of the first day some interesting points were raised. However, the real value of the audit was due to the intense work of the experts during the whole week, and their discussions with the interlock team.
R. Schmidt concluded that the experts did a great job, and expressed his gratitude!

AOB

The presentation regarding the interlocking of injection and extraction beam screens has been postponed until meeting 61.

Next Meeting

Meeting 61, Friday 1st December 2006, 864-1C01, 10:00 (TBC)

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