

## DISCUSSION: WHAT ELSE CAN GO WRONG

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### MAXIMUM CREDIBLE INCIDENTS – J. STRAIT

Q: Mike Lamont asked if the energy dependent numbers related to the maximum credible incidents could be scaled down from 7 TeV?

A: Reducing to 4TeV reduces the forces, which reduces probability, but reduction is by a factor 2 at most. Does not remove risk of MCI happening.

Q: Austin Ball pointed out that the rupture of the beam pipe can have significant affect on the experiments, and then asked what the baseline plan was for the DN200 pressure relief valve and rupture disk installation was.

A: At that point it was stated that the proposal was for DN200s to be installed in all the warmed up arcs, the short straight sections, the triplets and DFBs. At that stage of the meeting, the baseline for the rupture disk installation was not clear.

Ruediger Schmidt noted that a magnet failure by inter turn short could cause a significant damage due to rupture into vacuum system, and should be considered the most probable means of damage with significant repair time.

### RISKS DUE TO THE UPS MALFUNCTIONING – H. THEISEN

Herman Ten-Kate: Noted that the possibility that it was unacceptable to have the situation where, if the UPS is lost an uncontrolled quench could occurs.

Ruediger Schmidt noted that in such a case, we should not fire all the heaters. To avoid this you could distribute the heater power supplies over several UPS units. In response the speaker noted that this would not help, as you need the quench detector to trigger the quench heaters and without the UPS units, you cannot trigger. It was also noted that Rudiger's suggestion needs cabling but that the existing QPS system has spare slot for signal from a 2nd QPS (for quench detection)

Brennan Goddard noted that for the dump kickers, failure of both the mains and UPS was tested in 2008, but the issue of time between mains and UPS failure could need further consideration.

Q: Ralph Assmann asked if a controlled power failure test was foreseen?

A: Simple test of power cut has been done, but this was without circuits powered, so not really a proper.

Q: Andrei Siemko asked about the reliability of the UPS system, given that it is a system recovered from LEP.

A: There is no reason for the UPS system not being reliable as it has been fully maintained, and a UPS system can maintain power for 20 minutes without problem.

Q: Karl-Hubert Mess and Jean-Jacques Gras asked if the redundancy of quench protection was compromised by a lack of quench detection due to an individual circuit breaker tripping off or and if the circuit breaker layout was susceptible to a failure in protection.

A: Gunnar Fernqvist explained that there had not been any recorded problems of circuit breaker selectivity once the array of breakers was set up.

### IMPACT OF SEU – M. BRUGGER

Q: Jorg Wenniger asked Bruno Puccio if the BIS crates in Pt 5 (UJ56) could be moved (in case they were sensitive to radiation)

A: It would be possible if space could be found, and if the BIS team was given sufficient warning

Q: Brennan Goddard: asked, for safety critical equipment, what numbers are needed for the R2E simulations

A: Not an easy answer; the systems have to be evaluated on a case-by-case basis.

Q: Massi Ferro-Luzzi: What are the limitations if there is no 2009-2010 shutdown.

A: Would have to be evaluated, but conclusions would not really change. Would still expect to get failures from a high-energy hadron fluence of  $10^8 \text{ cm}^{-2} \text{ y}^{-1}$  onwards

Ralph Assmann noted that the predictions for failure are just scaled with intensity, but does not include the cleaning efficiency (especially at startup where the cleaning efficiency may be poor)

Q: Jim Virdee asked why (from Pg 9) failures are expected in some of the LHC areas, given that the radiation levels are not large.

A: The areas concerned may not have had the correct radiation zoning at the time of the installation of electronics, so that electronics susceptible to radiation could be installed in areas where radiation tolerant electronics is needed. Steve Myers pointed out that after the experience with radiation-induced failures of electronics at CNGS, the R2E working group was addressing exactly this issue

Q: Ralf Trant asked about the radiation tolerance of electronics used for safety of personnel

A: Some racks are of concern (due to location), and the racks associated with the Alarm level 3 equipment may not have been checked

### **BEAM INDUCED DAMAGE - WHAT IS A SAFE BEAM? - V.KAIN**

Q: Lucio Rossi agreed with the number for material damage in but asked if this was modified for beam-induced damage.

A: It was noted that we are dealing here with transient losses, and that the damage figure of  $87 \text{ J/cm}^3$  is based on the assumption of a change in temperature of 70 deg. Karl-Hubert Mess also noted that this damage level is also for Rutherford cable magnets, and that we should also consider the damage limit for potted coil magnets ie what is the effect of the shock wave in epoxy. In reference to the request for testing damage levels on magnets etc, Steve Myers pointed out that the HiRadMat was still at the proposal stage and that it should not be counted on as an input for resolving the damage level issues.

Jim Strait commented that (as is planned under MPS) any significant event has to be fully analysed before re-injection is permitted

### **WORST CASE BEAM INCIDENT CAUSES AND PROTECTION – B.GODDARD**

Q: Steve Myers asked how often should we have a dump kicker failure plus a failure of the retriggering system failure.

A: The system is SIL 4, so it should not happen over the lifetime of the LHC. However, Mike Lamont pointed out that we still estimate having 1 asynchronous beam dump per year.

Jim Strait commented on situation at Tevatron where the beam dump request was not correctly transmitted to the beam dump. This resulted in beam scrapping the dump line.

However, Jorg Wenninger noted that for perspective, when considering the worst case scenarios not covered by the protection system, Brennan had to resort to consider possible failure modes that required multiple failures in a given incident

Q: Steve Myers asked if there had been any studies done on beam instabilities at top energy, and if so what were the expected timescales of the instabilities. ie what if Sept 19th happened with beam.

A: It is expected that the BIS would respond to catch the instabilities and initiate a controlled dump, but Brennan noted that we should look carefully at the timing/sequences involved for scenarios with multiple failures. Further, Ralph Assmann noted that there is a lot of work done to carefully position the collimators (2-sided collimation, not 1-sided like the Tevatron) with sets of 10 position sensors installed and tested so giving additional confidence in protection. However Brennan Goddard pointed out that this depends on the collimator settings being correct when a Sept 19<sup>th</sup> like incident happens. Jose Jimenez noted that any sacrificial absorbers destroyed by the beam would create an area of high radiation where it would not be possible to work until after a sufficient cool down.

### **WEAKNESSES OF THE MPS - B.HOLZER**

Ralph Assman noted that the damaged collimator (shown on page 19 of presentation) was never replaced.

Rhodri Jones commented that on the discussion of the analysis of fast beam losses, for the worst case: normal conducting dipole magnets (RD1.LR1/LR5), the FMCM not really help, as small losses can't really be seen.