Safety in the Experiments - Still Something To Do

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Abstract

With the re-start of LHC after the incident of 19-Sept-2008, safe operation of the experiments with LHC beam was possible after significant consolidation works and improvement during 2009. This is an excellent achievement from both the machine and experiment's sides. This paper "Safety in the Experiments - still something to do" on behalf of the LHC experiments reflects this consolidation and outlines the remainders. It is complementary to the talk given by O. Beltramello, GLIMOS of ATLAS, same proceedings.

INTRODUCTION

The incident of 19-Sept-2008 on the LHC machine, only ten days after start-up came as a big shock to the community. In the aftermath of this incident, enormous consolidation efforts on the machine and experiment's sides were carried out. The presentation "Safety in the Experiments - still something to do" on behalf of the LHC experiments reflects this consolidation and outlines the remainders. All four large LHC experiments already operated for several years before LHC start-up and without the LHC beam, e.g. by taking cosmic ray data or during calibrations and tests of the experimental magnets. With the re-start of LHC, safe operation of the experiments with LHC beam was possible due to significant consolidation works and improvement during 2009. This is an excellent achievement. Nevertheless, further safety consolidation is required and to a part already underway to allow sustainable operation of all experiments and the experimental areas for the next 15 years, at least. The topics considered most urgent by the experiments for safe operation currently and in the future can be summarized as follows:

- The underground ventilation system;
- The underground evacuation system;
- The completeness and soundness of the emergency procedures underground and on surface;
- The implementation and modification of the existing automatic alarm action matrix explicitly the commissioning of actions following alarms of level 3;
- Verification of the procedures and instrumentation used for radiation protection;
- Definition and procedural approach to general safety systems.

Figure 1: Example for a blast resistant, air tight and fire proof sealing done in 2009 in the CMS experiment.

THE UNDERGROUND VENTILATION SYSTEM

The underground ventilation system is of utmost importance with respect of safety of personnel working in underground facilities. Above all, breathable air is what we need at least. In this context, a comprehensive safety assessment for the existing ventilation system and the underground requirements are needed to ensure that ventilation can be guaranteed during all possible situations. Although this requirement appears to be obvious, all LHC experiments agreed on the need to underline the safety function of the underground ventilation system by submitting a request as follows:

- An overpressure regime between the service caverns and the experimental caverns as well as between the latter and the LHC machine tunnel needs to be kept. In locations where this is not yet the case, this pressure hierarchy[1] described above has to be established and its stability ensured. It has to be emphasized that

[1]The pressure hierarchy or overpressure regime denote a differential overpressure of the service caverns with respect to the experimental caverns of at least 20 Pa, and equally a differential overpressure of the experimental caverns with respect to the LHC machine tunnel of at least 20 Pa

the purpose of the overpressure regime in the LHC underground areas is for safety of personnel, consequently, it may not be violated in any situation with people underground. This includes maintaining the overpressure regime during the LHC shut-down periods as much as possible.

- A sufficient air flow has to be provided for all underground safe areas, i.e. the areas in front of the access lifts. This air flow rate has to be such that the ingress of smoke in case of fire is excluded. In addition, the required overpressure in all safe areas has to be 20 Pa at least. Further, it has to be guaranteed that said overpressure within the safe area can be maintained in the case of an incident while evacuating personnel accesses the safe area by opening the large fire doors. This requirement is currently not met.

- The underground ventilation system is part of the existing automatic alarm action matrix. The functionality of the underground ventilation system has to be ensured in application of the existing automatic alarm action matrix, and in possible emergency scenarios "mode degradée", e.g. for the case of a general power cut, or similar scenarios. Further, it has to be ensured that the safety action creates no conflict with other emergency procedures, e.g. in the case of an ODH alarm when the air extraction works under full power such that the pressure difference is increased, it has to be ensured that the escape doors can still be opened by one person only.

- All critical safety functions of the underground ventilation system have to be operated via a reliable and redundant control system in agreement with the safety standards. This includes an adequate instrumentation.

EVACUATION

The safe areas in front of the access lifts are the backbone of all LHC evacuation scenarios. These areas are intended to work as temporary waiting areas for the personnel in underground in the case of an incident. Hence, their resistance to fire was agreed to be of duration of 120 minutes at least. In order to meet these requirements, a revision of the safe areas is mandatory, comprising the above-mentioned aspects of underground ventilation as well as their structural integrity. The structural integrity includes, amongst others, the appropriate seals of cable passages and correct joints between fire doors and surrounding walls, as well as the installation of fire dampers complying with international standards. Further, two independent and individually secured evacuation paths have to be made permanently available for the personnel in the case of emergency. To this effect, all areas have to be re-visited in which measures following the recommendations of the Safety Task Force were recently installed. In the case of an emergency, it is possible that one of the two evacuation paths is inhabited by the nature of the emergency, e.g. due to fire or helium release such that it is mandatory to make a correct choice of the safe exit path. To that end, an automatic signalization of the evacuation paths is needed, including a clear indication of the paths prohibited for exit. A public address system in the underground caverns as safety supporting system is required, mainly due to the size and complexity of the experimental underground areas. This public address system will be used to provide the personnel with specific information in the case of emergency or abnormal events such that e.g. panics can be avoided in the case of evacuation alarms or instructions can be given that could otherwise provided only to personnel equipped with portable phones.

EMERGENCY PROCEDURES

Emergency procedures are one of the main ingredients for a successful handling of dangerous situations. In order that these emergency procedures are correctly launched it is obvious that the CERN Fire Brigade has to be always and immediately and duly informed about the safety situation of the CERN premises. At several occasions it could be observed that the chain of actions starting with the automatic recognition of a potentially dangerous situation until the correct reaction of the CERN fire brigade was not optimal. Therefore, the LHC experiments request that this chain of actions is assessed and properly implemeted. An important point for this chain of actions is the validation of emergency procedures. The LHC experiments are currently either finalizing and validating their individual emergency procedures or have already approved. As for all procedures, a regular application or training is mandatory to achieve success, especially for emergency procedures, since stress can be an important obstacle in this case. Hence, the LHC experiments request that regular training and emergency exercises are done. These exercises must be done with the participation of all departments involved as well as the CERN fire brigade and very important the local fire brigade of the host states.

ALARM ACTION MATRIX

The majority of the automatic alarm action matrices was defined and implemented already before the incident of 19th September 2008. Consequently, they cannot reflect the new risk analyses and the evaluation of the new situation in the underground areas that were carried out after the incident. In some rare cases, the implemented measures create a conflict with the exiting safety concept in place. Examples are that the recently implemented very tight sealing of the CMS experimental cavern leads to the situation that in case of an ODH alarm with air extraction the door to the safe area can no longer be easily opened due to the increased under pressure provided by the air extraction system. Consequently, the exit of a person in the cavern could be blocked by this door such that one may not be able to enter the safe area. Another example is the evacuation signal

by activating the sirens. It is currently not clarified whether the experimental caverns also have to be evacuated in the case of an emergency in the LHC machine. Equally, it has to be excluded that people enter the LHC machine during LHC emergency. To answer these questions, it is necessary to perform a systematic review of all automatic alarm action matrices in view of the new safety situation.

Currently the experiments are equipped with two major systems performing automatic safety actions: CERN Safety Alarm Monitoring (CSAM) and the Detector Safety System (DSS); the first being in charge of personnel safety and the latter used for equipment protection. These safety systems must be as simple as possible in order to achieve a maximum reliability. The complexity of some experiments makes it necessary though that relatively complex alarm action matrices have to be created to guarantee personal protection. In the case of the ATLAS experiment, this complexity is not covered with the existing systems and there could be a need to develop a third system.

RADIATION PROTECTION

With increased luminosity delivered to the LHC experiments by the LHC machine, it is very important to take all aspects of radiation protection into account. One of these aspects is the so-called lifting of the RP veto, i.e. the measuring of the radiation level in the experimental caverns before access can be granted. For safe operation of the detectors, access to these caverns is needed on a regular basis and for short accesses the experimental magnets might not be switched off. It has been observed that some areas of the cavern have a magnetic stray field that is influencing the proper functioning of the hand held RP instruments. Therefore it cannot be proven that for all work places in the cavern the radiation field is compatible with a supervised area in terms of radiation protection. Nevertheless, simulation data shows that with the current luminosity, these areas should not give rise to safety concerns. With increased luminosity though some of the LHC experiments need adequate hand held RP instruments to guarantee the safety of the workplace. As an immediate action, the experiments are currently revising the need for additional fixed RAMSES monitors in order to cope with the shortcomings of the hand held instruments.

In order to avoid that activated material leaves unauthorized the experimental sites, the already existing RAMSES gate monitors on the surface, detecting an increased level of ionizing radiation, shall be connected to the CERN access control system. In case that RAMSES triggers, the gate barriers shall not open automatically. An individual intervention of a group member of DGS-RP or a radiation protection expert of the experiment must be required.

Another very important aspect of radiation protection is the work planning, allowing including the "ALARA[2]" principle right from the beginning as well as the required traceability of radioactive material when it leaves the experimental caverns. The LHC experiments are currently working on an integrated approach in order to cover all the different aspects in a common application and database.

Important for radiation protection is that it must be guaranteed that only those people enter a radiation area that have not yet taken a too high dose. Since the time gap of two mandatory read outs of the personal dosimeter could be almost 2 month, the experiments request that a more adapted surveillance of the personal doses should be done when needed. In addition it is necessary to determine the individual and collective dose for every work package within the global application, to that end the LHC experiments must have access to the RP database. A review is needed of how to connect the reading of the individual dosimeter can be connected to the access control system, ensuring that only people access the caverns that have readout their dosimeters right before access and right after leaving.

SAFETY SYSTEMS

Today, CERN has a comprehensive set of rules for alarm level 3 systems, i.e. systems that detect emergency situations and transmit this information to the CERN fire brigade. These rules define the scope of alarm level 3 systems as well as their commissioning and their maintenance. Unfortunately there is currently no set of CERN rules about safety systems, i.e. systems that are important for the safety of personnel. The LHC experiments request that the Safety Commission defines, as already done for level 3 alarm systems, what a safety system is. An example about the implication of missing rules is the foam system in some of the experimental caverns. This system is clearly not a alarm level 3 system, since it will not generate an alarm to the fire brigade, in contrary it is the fire brigade that will operate this system in an emergency. On the other hand, this is obviously a safety system. Nevertheless the water reservoir of the surface that serves the foam system for proper operation does not underlie any safety rule especially not for the periodic maintenance. It must be guaranteed that all safety systems operate correctly and if not available, compensatory measures are in place. There is also a strong need to improve the operation and maintenance procedures and especially their application for both level 3 alarm systems and also for safety systems, as soon as they are defined as such.

CONCLUSION

For the LHC experiments and their experimental areas, a comprehensive set of safety equipment is installed. In order to maintain their very good safety records it is important to focus now on areas that have not gotten the necessary attention so far. The first priorities identified by the LHC experiments are the safety aspects of the underground ventilation system, especially the pressure regimes and equally

[2] As Low As Reasonable Achievable

the evacuation means and procedures in the underground. Since safety is an iterative process, all aspects of safety must be revisited regularly.