ACCESS AND ALARM SAFETY SYSTEMS – ACTIVITIES FOR THE 2012/2013 LONG SHUTDOWN*

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Abstract

This paper presents the 2012/2013 long shutdown activities for the access, emergency evacuation, gas and fire detection systems. First, an overview of the required minimal annual maintenance and tests is presented; including the first feedback from the 9 weeks of the Technical Stop. Second, planned upgrades, new installations and consolidation activities, such as the R2E relocations and systems improvements, are discussed. For all these activities, the required resources are estimated, the constraints on other groups are listed, the associated risks analyzed and time estimation provided. The evaluation of the required resources takes into consideration the activities in the injector chain during the long shutdown.

ALARMS SYSTEMS

This chapter describes the long shutdown activities for the fire and gas detection systems, the emergency evacuation and beam imminent warning systems and for the SNIFFER systems (the combined fire and gas detection systems for the LHC Experiments). Maintenance activities are presented first, followed by the consolidation activities.

Activities discussed concern alarm system's preventive and recurrent maintenance operations. Preventive maintenance shall be performed at least on an annual basis [1]. Quarterly maintenances are not compulsory but they are important to minimise spurious alarms and identify latent faults. A non execution of preventive maintenance would lead to an accumulation of latent faults and therefore to a reduction of safety and, most probably to an increase of physics downtime.

Annual preventive maintenance covers three main operations. First, a visual inspection of the system components to verify their physical external status is correct. Second, a functional test to verify that equipment is working as expected. This point includes an alarm test with the triggering of all sensors thresholds, the generation of all alarms and defaults and their transmission through the CERN Safety Alarm Monitoring system (CSAM) to the CERN Safety Control Room (SCR).Third, the replacement and repair of components when necessary.

Automatic Fire Detection Systems

Two activities are foreseen in the long shutdown for the automatic fire detection systems, the preventive maintenance and the relocation of smoke detectors in critical radiation areas (R2E activities).

Annual and quarterly preventive maintenance are foreseen for the long shutdown. Quarterly maintenance is especially important for air sampling smoke detectors to clean the accumulated dust in the air sampling networks and minimise spurious alarms during the operation.

If the long shutdown is delayed to 2013, the annual maintenance for underground installations would be performed during the 9 weeks of Xmas Break, and quarterly maintenance during the Technical Stops.

This planning is realistic only if the inter-site doors are open. The sectorisation of the alarm systems does not correspond to the sectorisation of the inter-site access doors. Therefore, when executing the maintenance on a site it is required to pass beyond the adjacent sector's inter-site doors to complete the maintenance. This constraint affects not only the fire but also the gas and the emergency evacuation systems. A conclusion from the 2010 Xmas Break is that 9 weeks with the inter-site doors opened would be more adequate to complete the alarm system's annual maintenances, before the hardware commissioning phases start.

For surface installations, the preventive annual and quarterly maintenance is to be performed during the Run and the Technical Stops.

In the context of R2E activities, the relocation of air sampling smoke detectors in critical radiation areas is foreseen.

Table 1: R2E smoke detectors relocation

Current location	Future location	Number of fire detectors
RR13/17	UL14/16	4 non-standard air sampling smoke detectors
UJ14/16	UL14/16	8 standard air sampling smoke detectors
RR53/57	UJ561	4 non-standard air sampling smoke detectors
UJ56	UJ561	4 standard air sampling smoke detectors
RR73/77	TZ76	4 non-standard air sampling smoke detectors
UJ76	TZ76	8 standard air sampling smoke detectors

This relocation is required to minimise the impact of radiation, particularly due to Single Event Effects (SEE), to the alarm systems' electronics that would perturb the LHC operation, possibly leading to the decision to stop

the machine. Fire detector units were tested in the 2010 CNRAD test campaign and showed destructive failures, as well as a moderate soft failure cross-section [2].

The relocation of smoke detectors is summarised in Table 1, with the current and future locations, the number of sensors to be relocated and the type of detectors to be installed per location (Figure 1).

If the long shutdown is delayed to 2013, the relocation would be partially implemented during the 2011 Xmas Break (up to 4 weeks of preparation work per location). This consolidation depends on the cabling activity performed by EN/EL. In addition, up to 3 days of sensor's detection interruption per location are foreseen.

Figure 1: Air sampling smoke detectors with aspiration boxes (in this note referred as non-standard air sampling smoke detectors).

Automatic Gas Detection Systems

Two activities are foreseen in the long shutdown for the automatic gas detection systems, the preventive maintenance and the consolidation of two underground gas centrals located in Point 1 (SGGAZ-00153) and 5 (SGGAZ-00148). By gas detection it is meant oxygen deficiency and flammable gas detection.

Annual and quarterly preventive maintenance are foreseen for the long shutdown. During the annual maintenance the replacement of 1/3 of the LHC machine and Experiment oxygen deficiency cells is performed. During annual and quarterly maintenance, gas sensors are recalibrated when required. Because oxygen deficiency cells need to be calibrated at certain temperature, pressure and humidity values, the changing of this conditions with time creates a derive in the detector that needs to be corrected. These operations are essential to minimise spurious alarms.

If the long shutdown is delayed to 2013, the annual maintenance for underground installations would be performed during the 9 weeks of Xmas Break, if the inter-site doors are open. Quarterly maintenance would be performed during the Technical Stops.

For surface installations the maintenance would be performed during the Run and Technical Stops.

Figure 2: Oxygen deficiency gas sensor in the SD and SDx surface buildings.

Consolidation of the underground gas centrals in Point 1 and 5 is required because the current racks where the centrals are installed are saturated. There is no space available to add any new sensor or any contact to trigger safety actions. Rack centrals need to be split in two separated racks. In Point 5, one will be dedicated for the machine and another for the experiment. The identification of additional rack space is not yet completed.

During the migration there will be a gas detection interruption in UX15, USA15, USC55 or UXC55. Therefore, procedures and compensatory measures will need to be discussed with the concerned GLIMOSes, EN and BE DSOs and the LHC Coordination.

If the long shutdown is delayed to 2013, this consolidation will be delayed.

Emergency Evacuation and Beam Imminent Warning Systems

Annual and quarterly preventive maintenance are foreseen for the Emergency Evacuation and Beam Imminent Warning systems for the long shutdown.

Annual preventive maintenance implies the triggering of all underground sirens in the LHC machine and Experiments. It is organised together with the triggering of all oxygen deficiency flashes in the same area. Nobody shall be present in the area where the sirens and flashes are triggered, because the personnel would not be able to distinguish between a real alarm and a test. Cryogenics shall be in *Cold Gas He standby phase*, which means that no He liquid under pressure is present in the area where the flashes are triggered, because the maintenance team

would not be able to distinguish between a real He release and a test.

To minimise the impact on underground activities, this maintenance is performed during the Xmas Closure of CERN. Therefore, if the long shutdown is delayed to 2013, the maintenance would still be performed during the CERN 2011 Xmas Closure for underground installations.

SNIFFER – combined fire and gas detection inside the LHC Experiments

The SNIFFER system is a combined fire and gas detection system that uses air sampling technology to reach inside the confined areas inside the LHC Experiments. There is a SNIFFER system per LHC Experiment. SNIFFER systems are composed of detection modules, each of them associated to an air sampling line. Each module contains a pump and up to 3 detectors (smoke, oxygen deficiency and flammable gas or carbon dioxide detector) depending on the risks associated to the air sampling area. Certain components of the modules need to be replaced on an annual basis to ensure a correct pumping. This includes pump's valves and membranes, and the filter. The replacement of these components is performed during the preventive annual maintenance

To maintain a total of 235 detection modules, a minimum of 12 weeks are required. Two constraints are considered when organising this maintenance. First, for ATLAS and ALICE, the detection modules are located in a non accessible area during the run (in the US15 for ATLAS and in the UX25 for ALICE). Second, the maintenance cannot be performed during the run because an interlock to cut off the Experiment could be triggered (through the Detector Safety System). Because the 9 weeks of a Xmas Break are not enough, maintenance is organised so that it can also be performed during the Technical Stops.

Figure 3: SNIFFER systems.

When performing the maintenance of a module a detection interruption of the module in the concerned sampling area is required.

If the long shutdown is delayed to 2013, the maintenance would be performed during the Xmas Break and Technical Stops.

ACCESS SYSTEMS

This chapter describes the long shutdown activities for the LHC Access Safety System (LASS) and the LHC Access Control system (LACS). Preventive maintenance is presented first, followed by the consolidation and upgrades activities: the relocation of access electronics in critical radiation areas, the video and IT network improvement, the interlock of "overpressure doors", the external envelope modification for maintenance purposes, and the new access points in TZ32 and PZ65.

Preventive maintenance

Preventive maintenance for the LHC Access Safety System (LASS) and LHC Access Control System (LACS) consists of performing a mechanical verification of all doors and access points, followed by a test of all acquisition chains, from the interlocked equipment (doors, power converters, etc) to the PLC.

This maintenance needs to be performed once per year, as stated in the "Regles Générales d'Exploitation du LHC". The correct signal acquisition is verified before the start of the LHC, more precisely before the DSO tests. The DSO test is to be organised with the different equipment groups to verify that all equipment conditions are correctly seen and that all the safety interlocks are correctly applied by the LASS.

If the long shutdown is delayed to 2013, the maintenance would be performed during the 9 weeks of the Xmas Break. The disadvantage of performing this maintenance during the Xmas Break is that it limits other activities during this period, and the access point under maintenance is unavailable. This is the reason why the possibility of performing maintenance during the Run is analysed in section "Access envelope modification".

Figure 4: LHC Access System's access point. Two Personnel Access Devices (PAD) and a Material Access Device (MAD)

Video system and IT network

A first consolidation activity is the improvement of the video system and the IT network.

The objective behind the development of the video system is to avoid problems of image freezing and to improve the fluidity of images. This implementation concerns the installation of encoders as well as reviewing the archiving architecture of the PAD. To deploy this upgrade, all video cameras of all access points need to be migrated at the same time. A progressive migration is not possible.

The objective behind the improvement of the IT network is to increase the Access Point availability by reducing the dependency on network components. Indeed, associated to each Access Point there are many network connections with several routers and switches. As a consequence, the access point unavailability increases with the unavailability of the network components.

The design phase of IT network consolidation is to be done in close collaboration with the IT department. The modifications will mainly concern IT.

If the long shutdown is delayed to 2013, the consolidation activities would be delayed. There is no potential risk associated to the non implementation of this task.

R2E effects

In order to minimise the impact of radiation onto the access system's electronics, the relocation of LACS racks in UJ56 and UJ76 is required, as well as the displacement of the UJ561=YCPY01 door. The risk associated if not performed would be a reduction of the availability of the affected access points.

This consolidation depends on the cabling activity performed by EN/EL and on the network connections carried out by IT. Several weeks of work preparation are required per location, and a minimum of 3 days test with access interruption to the concerned octants is foreseen.

If the long shutdown is delayed to 2013, this consolidation activity would be only partially implemented.

Interlock of "overpressure doors"

This activity concerns enlarging the LASS scope to include additional ventilation doors (mainly the newly installed "overpressure doors") in the access beam interlock and creating a reliable framework for an access powering interlock. The ventilation doors participate to the protection against two risks. First, the containment of a major He release during a magnet powering phase. Second, ensure a correct ventilation path for activated air in the tunnel.

The interlock of "overpressure doors" within the LASS system would imply the deployment of a reliable acquisition of safety signals from these doors and the implementation of the associated safety actions. The risk analysis and the specification of the associated safety actions are currently under discussion. A deployment during a long shutdown in 2012 would be unrealistic unless the specification is finalised by spring 2011. A delay of the long shutdown to 2013 would be favourable in this case.

Figure 5: An example of "overpressure door" in the LHC machine

An important work with TE/MPE is foreseen to define a reliable interface with the Power Interlock Controller. This link is necessary as during a magnet test the opening of an overpressure door should interlock the powering of the magnets.

Access envelope modification

In order to allow the maintenance of the external envelope (access points in the PM shafts) during run periods the possibility of an additional temporary physical barrier is analysed in this paragraph. This temporary barrier would be used to move the interlock during the maintenance of the surface access points.

The advantage of this modification is the possibility of perform the surface access point maintenance during the LHC run, when there are no accesses. This would allow maximum availability of the access points during the access periods, when they are used. The risk of not implementing such a modification is a reduction of the system availability.

The technical solution for the temporary barrier needs to be defined, but a possible impact on civil engineering should not be excluded.

If the long shutdown is delayed to 2013, this would be favourable for this project.

New access points in TZ32 and PZ65

Possible installation of two new access points is foreseen for the long shutdown. First, a new access zone in TZ32 to enable CLIC alignment studies. Second, a new access point in PZ65 to access Point 6 in case of PM65 elevator unavailability. An alternative solution to the new access point in PZ65 would be the improvement of the lift reliability in PM65.

In both cases, a possible impact on civil engineering cannot be excluded. This installation depends on the cabling activity performed by EN/EL and MME for the integration exists.

If the long shutdown is delayed to 2013, implementation would be delayed.

ACTIVITIES IN THE INJECTOR CHAIN

The renewal of the PS Primary Areas Access System is foreseen for the next long Shutdown. The renewal implies the deployment of new access points and access doors, as well as the deployment of the new access safety system for the execution of safety interlocks. It also includes the deployment of a Beam Imminent Warning and Evacuation system.

If the long shutdown is delayed to 2013 it would be favourable in the sense of providing more time for the validation of the new system and more time for preparing the migration.

CONCLUSION

- 9 weeks with the inter-site doors opened would be more adequate to complete the alarm system's annual maintenances, before the hardware commissioning phases start.
- A delay of the long shutdown to 2013 would be favourable for the alarms and access systems consolidation and new installations activities.

REFERENCES

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