SPS ACCESS SYSTEM UPGRADE

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Abstract

The present SPS access system is not entirely compatible with the formal requirements of the French Radioprotection Authorities, and a project has been launched to remedy this situation. The upgrade project is split into three phases that will be implemented, in the present planning, in the shutdowns 2006, 2007 and after the first physics run of the LHC, respectively. This paper presents the results of the safety study, the upgrade strategy and the architecture of the upgraded system.

INTRODUCTION

The SPS access system in its present implementation [1] does not entirely satisfy the requirements imposed on an access control and safety system used at an installation classified as a basic nuclear installation (INB in French). In particular, the present system which uses Programmable Logic Controllers (PLC) of the first generation does not respect the safety criteria recommended by the nuclear installation supervisory authority. The system does not have another, secondary and redundant, path available to ensure the execution of the safety functions if a PLC fails. The upgrade project has been aligned, in terms of planning, with the operations schedule of the accelerators and will be split into three parts:

- Phase I – SPS run 2006. A number of compensatory measures have been taken in order to prevent any problems due to possibly dangerous (unsafe) failures of the present system, see [2].
- Phase II – SPS run 2007. The present safety system will be complemented with an independent cabled safety system. The result will be a diversely redundant system that has no common mode failure risk.
- Phase III – After the first LHC physics run and succeeding runs. The present SPS Access system will be successively replaced by a new access safety and control system, based on the LHC Access system software and hardware architecture.

SPS ACCESS SYSTEM IN ITS PRESENT CONFIGURATION

The localization of the different SPS access points and the architecture of the present SPS access system are shown in Figure 1 and Figure 2 respectively. The SPS has at present 11 safety chains which are controlled by the Access system. The weakness of the system in terms of INB recommendations is clearly visible in Figure 2. The PLCs used as local and central signal concentrators are single points of failures in this architecture. There is no secondary, redundant, path for information from a signal chassis to a higher level of the system.

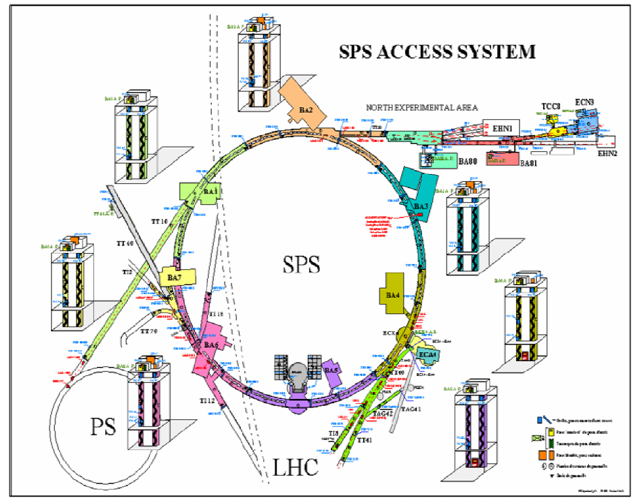

Figure 1: SPS access points

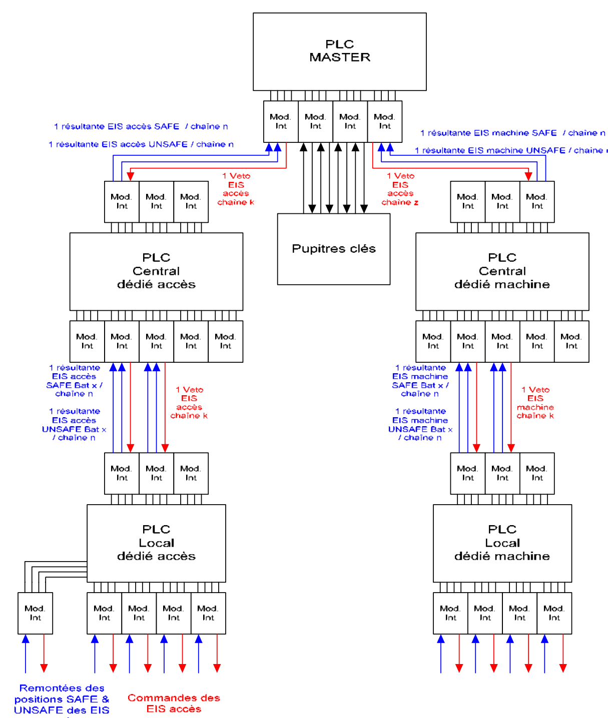

Figure 2: The SPS access system architecture

SYSTEM UPGRADE PHASE I: COMPENSATORY MEASURES

Despite the excellent safety record track of the present system, a number of measures had to be taken to mitigate any potential risk during the operation in the 2006 run.

The choice of compensatory measures has been directed on preventing personnel to enter the machine when there is a beam circulating or being injected from PS:

- Personnel turnstiles at the SPS access points (Figure 3) have been padlocked.
- The locks of the adjacent material doors have been covered by supplementary devices, preventing access through them. This supplementary lock device has the added advantage that it does not prevent the use of the controlled zones' emergency exits as the use of padlocks would do.

Figure 3: SPS access point

Dedicated compensatory measures have also been applied to the underground emergency doors of the safety chain 1, located in the transfer lines TT10, TT20, TT40 and TT60. For general safety reasons, these doors cannot be locked in the entry direction. The danger of irradiation due to a possible failure of the access system in the case of intrusion had to be eliminated by introducing an additional, redundant way to stop any circulating beam or any injection of beam. The required redundancy has been achieved by integrating those doors in the neighbouring power emergency stop chain (AUG). An opening of any of these doors provokes an immediate emergency stop of the accelerator. New position contacts have been added to the doors in order to provide complete redundancy with respect to the access system. An emergency stop of the machine can have serious consequences in the terms of material damage but this risk has to be taken. Unjustified use of these doors is strictly forbidden and the corresponding signalisation has been put in place.

UPGRADE PHASE II: ADDITIONAL CABLED SYSTEM

The access system has to be designed such that in case of an non-authorized intrusion a circulating beam is immediately dumped and that any beam extraction from the PS is inhibited. This condition has to be ensured in a redundant fashion, i.e. several EIS-f[*] in the SPS, the injection line and the extraction channel of the PS have to be put into safe position in parallel. An EIS-f can be a bending magnet power supply which by virtue of being cut disables the passing of the beam down the beamline or a beam dump which is inserted into the particle beam path to stop it completely. The access system itself must also guarantee that even in case of a failure of the PLC path it can handle such intrusions. The chosen approach is similar to the one used for the LHC, i.e. the addition of a cabled safety system in parallel to the PLC system.

The design of the cabled system is based on the LHC model. The system consists of several cabled loops:

- One cabled loop per access point (BA) and per safety chain, integrating all EIS-a that define the external envelope of the accelerator. This loop is designed to control the EIS-a of the envelope and detect any intrusion or access in the controlled zones. The list of EIS-a's integrated in the cabled loop includes all access doors, ventilation doors and goods lifts giving access to the accelerator.
- One resulting EIS-a loop per safety chain.
- One EIS-f loop per chain designed to send a VETO to the totality of the EIS-f of the chain.

The functional schema of the cabled system is given in Figure 4 and Figure 5. The generation of a VETO is illustrated with the example of the safety chain 1. The implementation of a redundant cabled access safety system required the installation of additional, independent position contacts allowing the detection of the UNSAFE state of the EIS-a. Furthermore, new additional interfaces between the EIS-f elements and the access system are being implemented in order to allow their integration in the cabled loop. These interfaces are in addition to the existing ones, thus providing a completely redundant hardwired access system.

A detailed safety study based on a Failure Mode and Effects Analysis method has demonstrated that the introduction of the additional cabled system provides the required redundancy and meets the safety requirements with respect to the risk of intrusion in the accelerator in the presence of the beam.

[*] EIS-f in French= Element Important pour la Securite – faisceau

[*] EIS-a in French = Element Important pour la Securite – acces

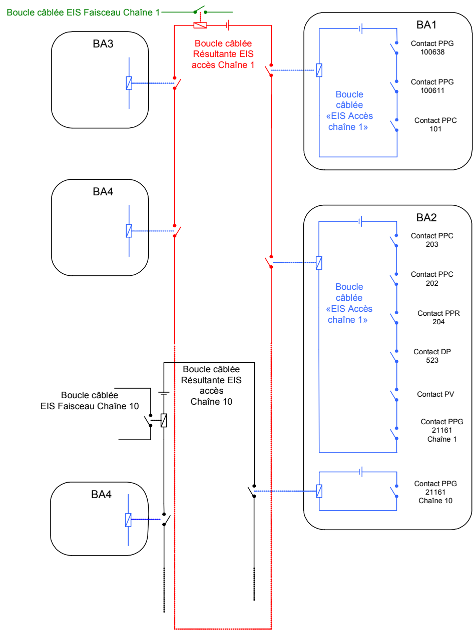

Figure 4: Functional schema of the cabled loop EIS-a. For the simplicity of illustration, only the EIS-a of the access point in BA1 and BA2 have been represented on this picture.

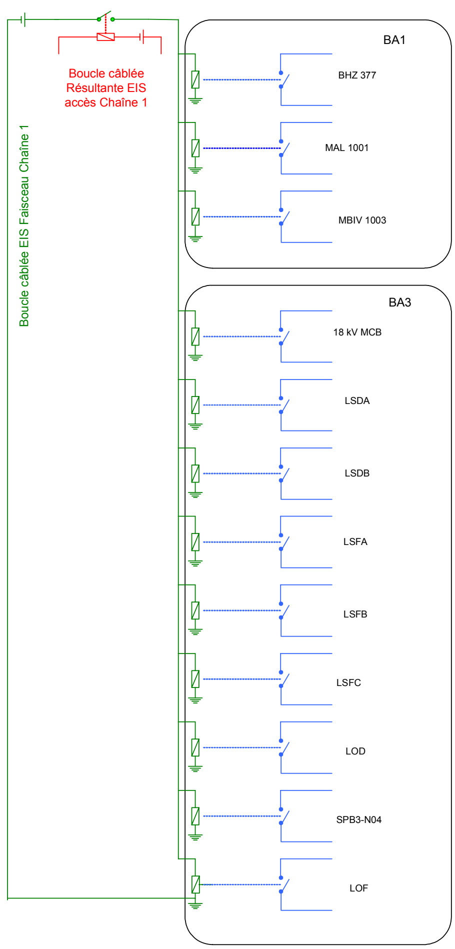

Figure 5: Functional schema of the cabled loop EIS-f of the safety chain 1.

UPGRADE PHASE III: COMPLETE UPGRADE OF THE ACCESS SYSTEM

After the first physics run of LHC, the present SPS access system will be over 15 years old forcing a major upgrade of the PLC's and of the general access control devices. To standardize and to reduce the maintenance cost, the new access safety and access control systems for SPS willl adopt as much as possible the architecture and infrastructure model of the LHC access system, see [3].

CONCLUSIONS

The upgrade of the SPS access system will span over a period of several years. The upgrade project has put in place the necessary compensatory measure for the physics run 2006 to ensure adequate personnel safety. A supplementary access control system, based on wired logic only is being designed in parallel, and will be installed during the shutdown 2006-2007. A major overhaul of the present SPS access system is planned to be launched after the first physics run with LHC and then continued during successive shutdowns until the entire system is replaced.

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