THE LHC ACCESS SYSTEM

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Abstract

The LHC complex is divided into a number of areas with different levels of access authorizations. The LHC interlocked areas are the ones where access is restricted, and not allowed during beam operation or equipment tests. Inside these interlocked areas, the personnel protection is ensured by the LHC Access System. This system is made of two parts: the LHC Access Control System and the LHC Access Safety System.

The LHC Access Control System regulates the access to the tunnels and experimental areas by identifying the users and checking their authorisations. It allows a remote or automatic operation of the access control equipment and restricts the number of users working simultaneously in the interlocked areas.

On the other hand, the LHC Access Safety System ensures the safety functions of the LHC Access System by interlocking the LHC key safety elements.

INTRODUCTION

The functional safety principle that consists of separating 'process functions' and 'safety functions' has been applied to the LHC Access system. Therefore, the project has been separated in two parts: the LHC Access Safety System and the LHC Access Control System Ref. [1][2][3].

The design strategy is based on three axes:

- Integration of the former LEP experience that demonstrated the importance of separating the Access operation functions from pure safety functions.
- Strict application of the Functional Safety principles. This requires a total quality approach and full documentation of every stage of the project, as well as the necessary safety studies. The safety studies determine during the specification stage the safety integrity level required by the system and will demonstrate at the end of the installation stage that the defined objectives are met.
- Specific hardware: the market offers now hardware specially designed for safety or high reliability applications that will be used to build the system.

The project entered in 2004 in its realisation stage. An architecture modelling the functions of the LHC Access Safety System (LASS) and of the LHC Access Control System (LACS) has been designed.

The LHC access concept is related to the LHC machine and experiments. Later, for rationalisation purpose, it will be applied to the other CERN accelerators and experimental areas.

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LHC ACCESS CONTROL SYSTEM

Specification

The LHC Access Control System shall allow a remote, local or automatic operation of the access control equipment. It must verify the users' authorization, identify them, lock and unlock access control equipment and restrict the number of users working simultaneously in the interlocked areas.

Technology

The system is based on an industrial access control system that provides all the standard access control functionalities: remote control, audio and video integration, proximity cards, authorisation management system, access sectors management.

Proximity reading devices will be used and will be integrated with the operational dosimeter that is compulsory to access the LHC underground areas. The authorisation management will be integrated with the CERN human resources database and safety training process. Biometric iris recognition will be used for further identification. Lock chambers will be used as personal and material access devices.

Realisation

The LHC Access Control System is provided by an external contractor. The contractor will supply, integrate, install, commission and maintain the many different subsystems of the LHC Access Control System.

The workflow of LHC Access Control System project is split into two parts Ref. [4].

Part 1 is further divided into work packages and validation stages related to the specification, design and installation of a pilot LHC Access Control system. The pilot will serve later as a validation and training platform. The next stage will be the installation of the control room computing infrastructure and of the access equipment of the sectors 8-1 and 7-8, required for the LHC injection tests. A synchronisation of the installation planning of the LHC Access Control and the planning of the hardware commissioning is under study. This synchronisation is possible but does not permit any manufacturing or validation delays for the access control equipment.

Part 2 of the project concerns the installation of each individual sector, its integration in the central access computing infrastructure and testing. An overall site acceptance demonstrating the correct functioning of the LHC Access Control and Safety systems will terminate the workflow.

LHC ACCESS SAFETY SYSTEM

Specification

The LHC Access Safety System shall ensure the collective protection of the personnel against the electrical and radiological hazards arising from the operation, maintenance and test of the LHC accelerator. The design of the system is verified by the French nuclear authority.

By interlocking the LHC key safety elements, the system permits access to authorized personnel in the underground premises during the accelerator shutdowns and denies access during accelerator operation; the system stops the accelerator in case of intrusion or emergency stops.

The LHC Access Safety System will provide the following operation modes:

'access to service areas', 'access to beam area', 'access during equipment tests', 'beam' 'and 'system security'.

In 'access' mode, the system will prevent the powering of dangerous equipment, the injection of beams and their circulation in the LHC. We distinguish between access to 'service areas' and access to 'beam area'. In the case of access to 'service areas' part of the machine equipment will remain powered.

In 'test' mode some of the interlocking conditions of the system will be disabled to allow equipment tests. The test mode concerns principally the RF and the power converters.

In 'beam' mode, the system will put the access into lock mode and will stop the beams in case of access violation or an emergency stop.

The 'system security' is a fall-back mode that will cope with major breakdown of the system and will ensure that the personnel protection is always ensured.

Functional Safety

The functional safety standards IEC 61508 and IEC 880 are used as references to specify and design the system. In order to assess the risks, the hazards and the undesired events that the system have to deal with, a 'preliminary risk analysis has been made. The next stage concerns the specification of the safety functions of the system. For each one a Safety Integrity Level (SIL) has been defined.

During the design stage an AMDEC (critical effect of failure analysis) was conducted at the functional bloc level, as well as a fault tree analysis. The AMDEC procedure highlights primarily the single mode of failures of the system.

The same type of analysis will be made during the implementation stage in order to verify that the SIL level of each safety functions is met and to prepare the future system maintenance plan.

The system has two distinct objectives: safety and reliability. The safety objective ensures that whatever incident may arise, the system is always able to reach a fail-safe position. The reliability objective ensures that the LHC is not stopped spuriously by a fault of the LHC Access Safety system.

Technology

The LHC Access Safety system is built using hardware specially designed for safety and high reliability applications. Signals are acquired from equipment using redundant wiring by remote acquisition devices. These devices communicate with local redundant safety PLCs located in each LHC point, using a safety-oriented protocol on a field bus. The local PLCs communicate on a self-healing loop. Redundant safety PLCs concentrate the data, and send commands as a function of the accelerator operation mode set on the access control desk that is located in the CERN common control centre.

Realisation

The LHC Access Safety System id being designed by a CERN project team, however industrial support will be necessary to deal with it implementation, installation and commissioning. The evolution of this project is regularly controlled by the French Authority IRSN and INB.

The project follows a total quality approach philosophy with particular emphasis on the detailed documentation of all the life-cycle stages of the project. The roles, documents, life-cycle stages, safety studies, verification, validation are described in a set of managerial document ref. [5][6][7]. Two independent teams will be set up to build the system: one will cope with design and implementation realisation and the other team will take care of the verification and validation activities. The on-site installation will be performed by a third team.

The workflow of LHC Access Safety System project is also organised in two parts, both are synchronised with the LHC Access Control System.

The first part of the project is divided into the specification, design, realisation and installation of a pilot LHC Access Safety system. This pilot system will be integrated in the validation and training platform. The next stage will be the installation of the common control room Man-Machine-Interfaces and of the software and hardware that are necessary for the control of the sectors 8-1 and 7-8.

The 2nd part is the installation of each individual LHC sector, its integration in the central access computing infrastructure and testing. An overall site acceptance demonstrating the correct functioning of the LHC Access Control and Safety systems terminates the project.

ARCHITECTURE

The LHC Access Control and the LHC Access Safety systems are separate but complementary systems that are integrated in a common concept.

As shown in Figure 1, the LHC Access System is conceptually divided in four layers:

The Control Room layer is made of the Man Machine Interface that will permit the operation, and supervision of the LHC access systems, the external interfaces to the alarm system, Man Machine Interfaces for the experiments and guardian control rooms, as well as the enrolment desks.

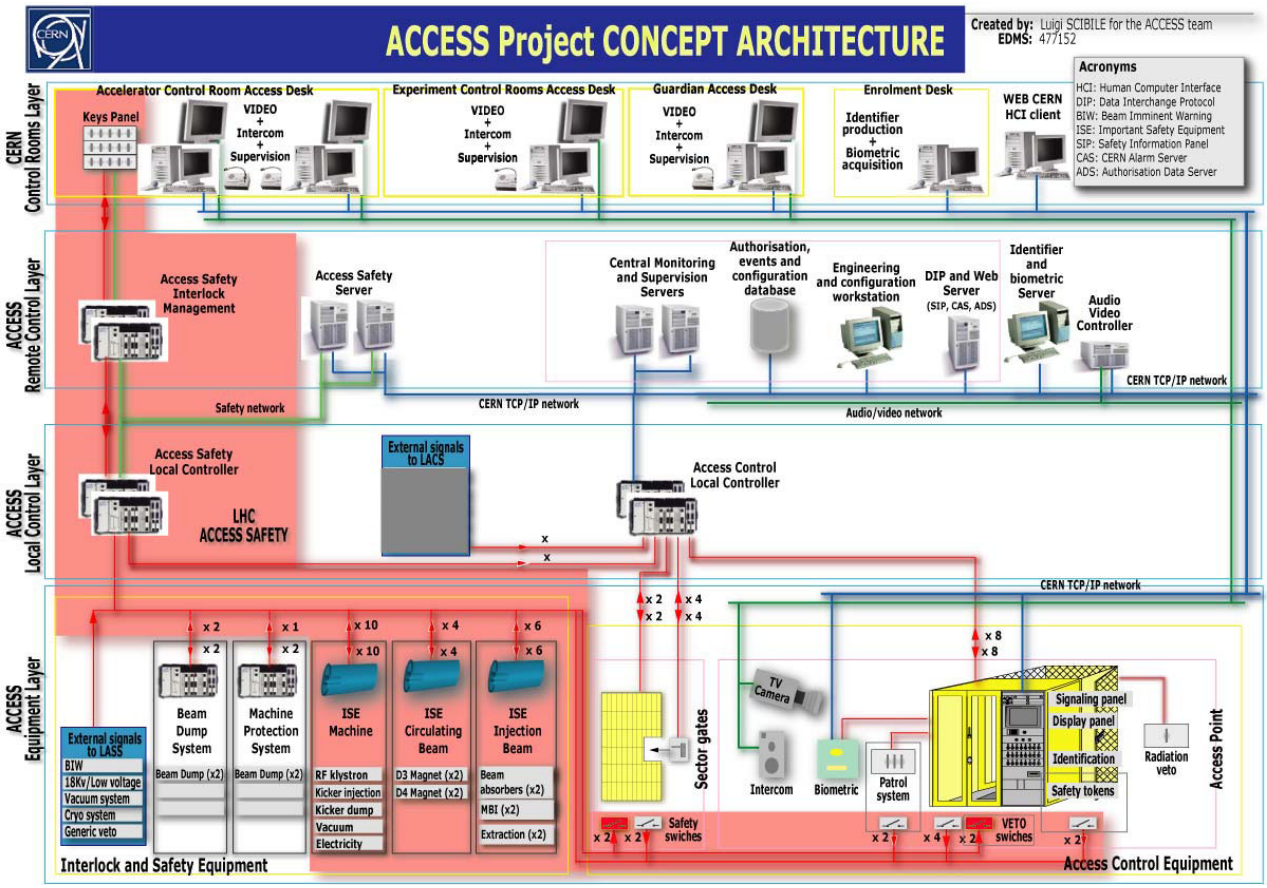

Figure 1: Overview of the LHC Access System Architecture

- The Access Remote Control layer gathers the central servers, the database for authorisation and archiving, audio and video controllers, maintenance and configuration workstations, and the access safety interlock management system.
- The Access Local Control layer ensures the control of the access equipment of each LHC point and the management of the local safety chains.
- The ACCESS Equipment layer gathers all the access equipment and the interface to the access, beam and machine Important Safety Elements (ISE).

CONCLUSION

A performing access system is a key element for accelerator operation; it shall protect the personnel 24h/365d and be highly robust. Concerning the LHC Access Control system, the challenge will reside in the smooth processing of a very large number of users as well as a successful integration in the CERN environment.

On the other hand, for the LHC Access Safety system the project will have to find the correct balance between safety, reliability and cost of the system.

ACKNOWLEDGEMENTS

This paper summarizes the work of the LHC access project team: J-F Juget, S. Di Luca, E. Sanchez-Corral, F. Havart, A. Day, L. Scibile, M. Boffard, T. Riesco, N. Rama, S. Grau, M. Munoz, T. Ladzinski, L. Mancer, M. Trichet under the specification of the product owner G. Roy.

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