CHAPTER 5

ACCESS SYSTEMS

5.1 INTRODUCTION

The LHC access systems are two complementary systems dedicated to personnel protection inside the LHC interlocked areas, which are all located within the underground installations of LHC. These two systems are the LHC access safety system (LASS) [1] and the LHC access control system (LACS) [2].

During machine operation, the LHC access safety system ensures the protection of all personnel from the hazards arising from the operation of the accelerator and from the injection and circulation of the beams. It acts on specific equipment identified as important safety elements (ISE). By interlocking these elements, it is possible to establish the accelerator and equipment conditions in order to allow access to authorised personnel in the underground installations and vice versa, to allow the restart of the equipment and the accelerator when the access is finished.

When the accelerator is not operating with beam and the LHC is in the access mode of operation, the LHC access control system allows the operation of access equipment which must positively identify the person requesting access and check that the pre-requisites (safety training) and authorisations (access rights) of this person are valid. Access can then be granted through the release of some access equipment serving as a door. The LHC access control system is also designed to limit, for operational or safety reasons, the number of users simultaneously present in the interlocked areas. The LHC access systems do not directly protect against fire, explosive gas, oxygen deficiency hazards, beam losses or high radiation levels, however links to these systems are often used to establish if conditions are correct for safe access or operation. In addition, the system cannot protect against malicious intent to defeat or circumvent the access systems.

In designing the access systems, experience has been particularly sought in the fields of operations (LEP and SPS, both from users and operators), radiation safety, the rules and regulations in the host states, the current CERN practice, as well as the most current practice in laboratories with similar installations in France and in the USA.

The first section of this chapter reviews the access sectorisation of the LHC underground areas and defines the different types of access zones. The next section concentrates on the access safety system including the definition of the interlocked elements and the principle of the interlocking mechanism. Finally the access control system is detailed.

5.2 ACCESS SECTORISATION

The sectorisation of the LHC for access results from several considerations: the accessibility of the different zones from a radiological standpoint, the segmentation of the larger zones into smaller and more manageable sectors and the limitation of the occupancy of certain sectors.

5.2.1 Radiological Classification

On the basis of theoretical studies, simulations and calculations of radioactivity dose rates [3] associated with the injection, circulation and dumping of the beams, as well as beam losses in both normal and abnormal situations, the Radiation Protection group has determined an ensemble of zones classified as exclusion zones according to the CERN radiation protection code [4]. These zones need to be interlocked for access, and personnel are not allowed in these zones when the LHC is running.

Other zones where shielding is sufficient to lower the dose rates to an acceptable level have been classified as simple controlled zones. No access interlock needs to be provided, however people accessing these zones must carry a personal dosimeter.

This radiological classification, which is summarised in [5], is the basis for the definition of the interlocked and non-interlocked areas of the LHC as detailed below.

5.2.2 Non-interlocked Areas

Access to LHC surface buildings is not interlocked with the presence of beam or other hazards arising from the running of the accelerator. Wherever some hazards arise from the presence of specific equipment in the surface buildings, local protection is provided, including local interlocks and local emergency stop systems.

Some LHC underground installations are also accessible for authorised personnel irrespective of the machine conditions because adequate shielding from beam hazards has been provided and no other significant hazard is present; the installations concerned are:

- Point 1: PX15 and USA15,
- Point 2: Upper part of PX24, above the shielding plug,
- Point 3: PM32 and US32,
- Point 5: PM54 and USC55,
- Point 8: PZ85 and the shielded part of UX85.

If a zone is not interlocked with the presence of beams or other hazards, it does not mean that it is freely accessible. General safety or operational requirements might require access restrictions to non-interlocked zones. In particular all underground installations at CERN are under access control.

5.2.3 Interlocked Areas

The interlocked areas of the LHC are those areas of the LHC installations that must contain no personnel when the accelerator is operating with beam, is ready to start beam operation or is running equipment tests which present significant hazards.

The LHC access safety system provides the personnel protection and interlocking mechanism for the interlocked areas of the LHC installations. The interlocked areas are further divided into beam zones and service zones which are defined below.

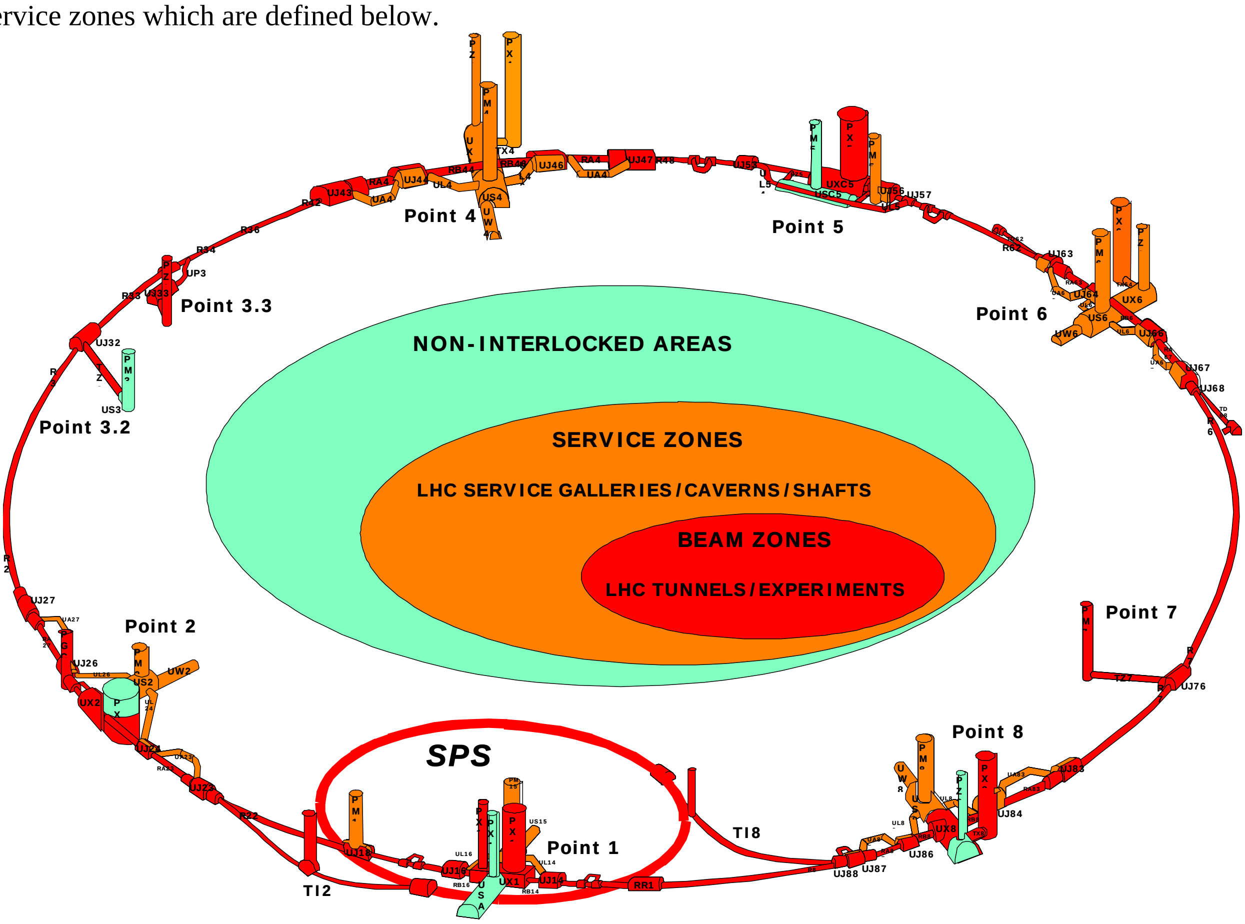

Figure 1: LHC underground areas classification.

Beam zones

Beam zones are those zones where beam could be present or which could be directly affected by the presence of circulating or injected beams during normal operation. Beam zones include the accelerator tunnel, all stub tunnels and enlargements, transfer line tunnels, the experimental caverns and the pits directly leading to the LHC ring tunnel and experimental caverns.

Service zones

Service zones are underground areas principally used to house service equipment of the LHC. They are normally not directly affected by the presence of beams. In these zones, the only hazard associated with beam operation could arise from an abnormal and significant beam loss in an adjacent beam zone that would induce a prompt radiation level higher than acceptable for human presence. Since in many cases the installation of additional shielding is not practical, or is too expensive and since one cannot exclude such cases of abnormal beam losses, the Service zones are not accessible during beam operation of the LHC.

The separation of the interlocked areas of the LHC into service zones and beam zones is a topology constraint for the access systems, which must take into account a two layer model with beam zones embedded within service zones and often accessible only through the service zones. This constraint has many consequences on the number of access points, their locations and the access procedures to be followed. The complexity of the access systems stems in part from this topological constraint.

5.2.4 Constraints for Access Sectorisation

Access sectorisation is the subdivision of the access zones into smaller and more manageable areas. Access sectorisation is driven by different needs which are detailed below:

Experimental Areas

The experimental areas of the LHC contain the four large experimental detectors and the associated electronics and ancillary equipment. The experimental detectors are owned by experimental collaborations and are under their responsibility. It follows that the collaborations want to control and restrict the occupancy of the experimental areas to their collaborators and the CERN support personnel.

Because the equipment in the LHC accelerator tunnel and in the experimental areas will be very different, together with the people entering these different areas and the risks attached to the equipment in these areas being different, it has been decided to physically separate access to the LHC accelerator from access to the LHC experimental areas. Passages are nevertheless provided for emergency exit in both directions. In most cases (ALICE, ATLAS, LHCb), the access shafts used by experimental collaborations are different from the shafts used to access the accelerator.

Patrols

Access sectorisation is primarily needed to help with the Patrol procedure - which is a search and secure procedure to ensure that no personnel are left in the interlocked areas when the accelerator is about to restart for beam operation or equipment tests. The Patrol is also intended to check that the interlocked areas are in a safe state to restart beam operation or equipment tests, for example that no work area is still active and that all tools and other equipment have been safely removed.

Because the topology of the LHC underground installations is complex and in order to limit the number of persons and the time required to patrol the accelerator, the interlocked areas must be sectorised into topologically more simple patrol sectors.

Equipment Tests

It must be possible to perform equipment tests in the accelerator tunnel while the LHC is not running with beam and is generally in the access mode of operation. Some equipment tests generate significant hazards from which the personnel must be protected. This equipment is normally located in well defined areas such as the RF zone in the long straight section in Point 4. To help with the closure of zones for equipment tests while allowing access in adjacent zones, the equipment test areas are enclosed within an LHC access sector.

5.2.5 Access Sectorisation.

The access sectorisation [6] of the interlocked areas of the LHC has been derived from the different constraints above after several iterations with the equipment groups concerned, the accelerator operations group and representatives of the collaborations for the experiments. The result is necessarily a compromise which can be revised at a later stage. Wherever possible the sectorisation has been kept to a minimum, while still allowing evolution of the system.

The sectorisation as presently approved in the LHC baseline comprises a total of 74 access sectors, separated by 39 sector doors and gates and 63 end zone doors. Access into the LHC is possible through 6 access points leading into a service zone, 11 access points leading from a service zone into a beam zone, and 11 access points leading directly from a non-interlocked area into a beam zone.

5.3 LHC ACCESS SAFETY SYSTEM

5.3.1 Rules for Access Safety

The interlocked areas of the LHC must be completely empty of personnel and access forbidden when the accelerator is running with beams, or is ready to start beam operation.

When the accelerator is operating with beam or for equipment tests, any access violation of the interlocked areas of the LHC must automatically and systematically stop the circulation of beams and prevent the injection of new beams into the LHC as well as to stop or limit the powering of some specific equipment of the accelerator.

On the other hand when the accelerator is stopped and access has been granted to an interlocked area of the LHC, any starting up of dangerous equipment must be forbidden and any situation presenting a risk for the health or safety of persons must trigger the immediate evacuation of the concerned areas.

5.3.2 Important Safety Elements

Host state regulations define the concept of important safety elements (ISE) which applies to equipment or systems involved in the protection of personnel. The ISE can be either elements generating a specific risk, or elements designed to help prevent or limit the exposure to risks. In both cases these elements must be interlocked under certain conditions.

All ISE are identified on the schematics of the interlocked areas of the LHC per site, in a separate document [6]. Each ISE in the LHC is identified on an ISE identification sheet, which contains all the information relevant to this ISE and in particular its name, function, exact location and the detailed definition of all safety signals to and from this element, including the clear definition of the SAFE and UNSAFE status of the element. As an example, the SAFE status of a sector door is returned when the redundant detectors on the door indicate that it is "closed" and "not open". Alternatively a door for which the detectors indicate that it is at the same time "closed" and "open" – indicating a detector or communication fault – would be UNSAFE. All such combinations must figure on the ISE identification sheet.

Three classes of important safety elements are defined: ISE-access, ISE-beam and ISE-machine.

ISE–access

The equipment dedicated to the access into the LHC and which can trigger the stop of the accelerator are classified as important safety elements for access (ISE-access). This equipment forms the boundary of the interlocked areas of the LHC. The following have been classified as ISE-access:

- Personnel access device and material access device: these are key elements of the access points belonging to the LHC access control system, but will be monitored by the LHC access safety system as physical barriers that can prevent entry into the interlocked areas.
- Sector doors and grids: these separate two access sectors in the interlocked areas and are equipped with electro-mechanical locks including an emergency passage mechanism from both sides. Sector doors usually act as ventilation barriers as well, while sectors grids are used where the ventilation flow must be maintained.

- End zone doors and grids: these separate two sectors or zones where passage is not allowed except in emergency conditions. They are equipped with locks providing only an emergency passage mechanism from both sides. The only way to open an end zone door or grid is to force open the lock mechanism for an emergency passage. In a limited number of special cases all related to the geometrical survey of the accelerator around the experiments, some end zone doors will be equipped with an additional lock to allow limited passage without triggering the emergency passage.
- Patrol box: these are located close to the access points and serve to validate the patrol procedure of the relevant access sectors.
- Safety key: these elements are linked to a key rack located at each access point. The safety key is liberated from the rack by the LHC access control system. The number of safety keys is limited in order to limit the number of persons present at the same time in a given access zone. The presence of all safety keys on a rack or the absence of at least one safety key from the rack is monitored by the access safety system.
- Fixed grids, mobile shielding walls etc.: any physical obstacle that can be used to block a passage to guarantee that no one can go through this passage and therefore ensure the “tightness” of the interlocked areas.

ISE-beam

The equipment of the LHC accelerator which are concerned with the protection of personnel from the risks associated with the circulation or injection of beams into the LHC are known as important safety elements for beam operation (ISE-beam). Further a distinction is made between the ISE-beam for circulating beam and the ISE-beam for injected beam.

The list of ISE-beam element is in the process of being finalised. In drawing up this list care has been taken to choose elements for which the SAFE and UNSAFE status can be readily and clearly defined. The chosen elements must also be able to fulfil their safety function in isolation and not require being in conjunction with other elements. In particular, each of the ISE-beam for circulating beam must be able to eliminate the circulating beam from the accelerator independently of the other elements.

ISE-machine

The equipment of the LHC accelerator which are concerned with the protection of personnel against risks other than the presence of beam are called important safety elements for machine operation (ISE-machine). The ISE-machine must be stopped and interlocked before access can be granted to certain zones of the LHC interlocked areas. At the time of writing, the list of ISE-machine is in the process of being finalised.

5.3.3 INTERLOCK CHAINS

An interlock chain is composed of an ensemble of ISE which, together and through the actions of the LHC access safety system, ensure the protection of the personnel in a given zone. The smallest zone to be covered is an access sector; the largest is the ensemble of the interlocked areas of the LHC.

As a minimum, an interlock chain contains all the ISE-access forming the envelope of the zone to be protected. The other ISE-access elements belonging to this zone are, in most cases, also part of the interlock chain. The ISE-beam or ISE-machine associated with the danger from which protection is required will also form part of the chain.

The following rules have been used to establish the interlock chains:

- A given ISE-access can belong to several interlock chains.
- A given ISE-machine can in principle belong to several interlock chains but as much as possible, a given ISE-machine should belong to only one interlock chain.
- An ISE-beam and an ISE-machine cannot belong to the same interlock chain.
- All ISE-beam belong to one and only one interlock chain. This chain is known as the principal interlock chain.
- The interlock chains containing an ISE-machine are called Local Interlock Chains.

Principal Interlock Chain

This chain contains all ISE-beam including those for injected beam as well as those for circulating beam. The principal interlock chain also contains all the ISE-access elements of the LHC and not just the ISE-access elements which form the envelope of the installation. This chain is always active independent of the status of the LASS or the access modes applied to the access points.

Local Interlock Chains

These chains contain all of the ISE-access elements and all of the ISE-machine for a given sector or ensemble of sectors delimiting an access zone. This chain is active unless a local interlock chain for test purposes has been enabled for the zone in the LASS and, in addition, the access mode for this zone is the test mode.

Local Interlock Chains for Tests

These chains contain a subset of the ISE-access elements. Each one should contain at least all of the ISE-access elements which make the envelope of the sector to which it belongs, with the possible exception of the personnel access device of the sector access point. In addition, each chain will contain a subset of the ISE-machine elements belonging to a sector, or ensemble of sectors, which delimit a test zone. Excluding an ISE-machine from the interlock chain will allow the operation of this equipment for test while access is given under special conditions (test mode). Conversely, excluding an ISE-access (for example the personnel access device of the access point) from the interlock chain will allow, under special conditions (i.e. test mode), the access to the zone while the equipment is under operation in that zone. A chain of this type is only active when it has been enabled for a zone in the LASS and the access mode for this zone is the test mode.

Interlock chain documentation

Each interlock chain is identified in a configuration data sheet which contains all the information about the interlock chain, including its type, function and an exhaustive list of the associated ISE with reference to the corresponding ISE identification sheets. A list covering all interlock chains together with their corresponding configuration data sheets is grouped in a single document. At the time of writing the list of all interlock chains for the LHC is in progress.

5.3.4 Principle of Interlocking Mechanism

Access safety is ensured by applying a mutual locking or interlocking mechanism between an ISE-access element and the ISE-machine, or ISE-beam element of an interlock chain. This mechanism follows the following rules:

1) All ISE-access elements in an interlock chain must be in a safe position in order for an operator to manually remove the inhibition commands on the ISE-machine or ISE-beam element.
   In order to manually (by action of an operator) remove the inhibit commands which maintain the ISE-machine or ISE-beam element of an interlock chain in a safe position, all ISE-access elements of the same interlock chain must be in a safe position.
   In other words, the access sector where the ISE-machine or ISE-beam elements are located must be closed and empty of all personnel. Once the inhibit commands have been manually removed the ISE-machine or ISE-beam element can be activated.
2) The unsafe position of at least one ISE-machine or ISE-beam of an interlock chain automatically and systematically generates an inhibit command on the access control equipment (e.g. identifier readers) associated with the ISE-access elements of the same interlock chain.
3) The unsafe position of at least one ISE-access element in an interlock chain automatically and systematically generates an inhibit command on all ISE-machine or ISE-beam elements of the same interlock chain.
4) All ISE-machine or ISE-beam elements of an interlock chain must be in a safe position in order for an operator to manually remove the inhibition commands on the ISE-access, thereby allowing the operation of access control equipment.

5.3.5 Main functions of the LHC Access Safety System

The complete list of all safety functions of the LHC access safety system is in the process of being defined. However, the main functions are outlined below:

Monitoring the interlocked areas when operating with beam.

When the accelerator is operating with beam, i.e. when the machine equipment is powered and the beams are either circulating or about to circulate, the LHC access safety system monitors the integrity of both the envelope and the internal sectorisation of the zones where access is prohibited. Any loss of integrity, such as an intrusion, triggering of an emergency stop (AUG), uncertain or incoherent state of a door, gate or other access element is detected by the LHC access safety system which automatically and systematically triggers an inhibit on the equipment presenting a danger for the personnel and hence stops the accelerator. Moreover, the information about the loss of integrity is transmitted to the beam interlock system (part of the LHC machine protection system), which protects the sensitive components of the accelerator against hardware failures. This link between the LHC access safety system and the beam interlock system is a redundant path for stopping the circulating beams in case of loss of integrity of the access envelope of the LHC.

Establishing conditions for access operation.

In order to establish conditions for access operation, the operators first stop the accelerator equipment from the operation consoles using the LHC control system. Through the LHC access safety system the operators then stop and inhibit the restart of the equipment involved in personnel safety (ISE-beam and ISE-machine). Once these conditions are met the operators can lift the inhibit on the operation of the access control equipment (ISE-access) and can then operate these elements via the LHC access control system.

Monitoring the interlocked areas when operating with access.

When the accelerator is operating for access, i.e. when the access equipment is actually operated or can be operated, the LHC access safety system monitors the equipment involved in personnel protection (ISE-beam and ISE-machine) and prevents any abnormal situation that could present a danger for the persons present inside the interlocked areas. In the case of abnormal situations, the LHC access safety system must inhibit the operation of the LHC access control system, thereby preventing access into the areas concerned. In addition, if necessary the evacuation of the areas will be triggered via the emergency evacuation system.

Establishing conditions for beam operation.

Prior to establishing conditions for beam operation, the zones that have been accessed may have to be patrolled by a team according to a search and secure procedure that ensures that no personnel are present in the interlocked areas, that the equipment and the areas are in a safe state for beam operation and that all ISE-access equipment are in a safe state. Once all ISE-access elements of the LHC are in a safe position the operators can lock the doors and access points and inhibit the operation of the LHC access control system via the LHC access safety system.

Prior to removing the inhibit signals on the ISE-machine and ISE-beam elements which would authorise the operation of the LHC with beam, an audible signal emitted by the sirens used for the emergency evacuation system is activated for a preset time duration. This signal acts to warn anyone still be within the interlocked areas of the accelerator of the imminent arrival of beam. When the LHC access safety system receives confirmation that the sirens have been sounded for the preset time, the inhibit signals on the ISE-machine and ISE-beam are removed and the operation of the LHC with beam becomes possible.

5.4 LHC ACCESS CONTROL SYSTEM

5.4.1 Introduction

The LHC access control system allows the operation of access equipment to manage the access and egress of personnel and material in the interlocked areas of the LHC. The LHC access control system is designed as a complementary system to the LHC access safety system and must be simple, reliable and highly available.

The LHC access control system will be the most visible part of the access systems for the users and it should not limit the operational time for beam in the LHC nor should it unduly prevent authorised users from accessing in the interlocked areas when safety conditions are met. The LHC access control system must be active and ready, when required, 24 h per day and all year-round. Preventive maintenance and upgrades must not impact on this availability. In order to be immune to potential network unavailability, or saturation, the LHC access control system does not permanently rely on networks or remote databases.

For the purpose of access control, each sector of the interlocked areas controlled by one or more access points is generally independent from the others, while for safety aspects the interdependencies are handled by the access safety systems through cabled links.

Because access control to the LHC must also be maintained during the annual long shutdowns, when the control room is not staffed on a 24 hour basis, the LHC access control system is designed to function automatically and autonomously and to not generally require personnel for its operation except when human supervision of the process is specifically foreseen (see access modes below). When necessary, human supervision of access will be performed remotely from a control room with data, video and audio communication between the access point and the control room.

Access to all interlocked areas of the LHC is always controlled by the LHC access control system. No passage can be left open and unattended. The LHC access control system remains available in the event of a power cut in order to allow the evacuation of all personnel under safe conditions. The LHC access control system must timestamp and log all events. Timestamping must be made according to standards set by the LHC logging system.

The LHC access control system hardware that will be located close to the beam path is likely to be subject to electronic upsets and other effects coming from prompt radiation when beam is present. To minimize the impact of beam operation on the LHC access control system it must also be possible (without degrading the safety level) to switch off sensitive equipment when the LHC is not in access mode and might be operating with beams.

The LHC access control system is designed and will be built in an extendable and scalable way to allow possible add-ons or a reconfiguration of access equipment or zones at a later stage and to allow future implementation of the same system on other CERN accelerators such as the SPS and the PS, or other CERN installations.

The LHC access control system is described in detail in a Functional Specification [2].

5.4.2 Access Modes

The access mode determines the conditions under which access can be granted in an access zone. Different access modes can be assigned to an access zone. There are three main access modes (Closed, Restricted and General) and two additional specialised modes (Test and Patrol). Each mode is described below.

Closed mode

No access is allowed. Beam or other hazards could be present in this mode and the safety conditions are handled by the LHC access safety system. Alternatively, when safety conditions for access are met, this mode can be set for operational reasons in order to prevent anyone from entering into the zone. This mode, set for all access points of the LHC, is a prerequisite to LHC beam operation.

Test mode

This mode is used when equipment which is undergoing tests in the access zone generates equipment specific and significant hazards. These hazards might mean either no entry at all while the tests are ongoing, or only entry by specially trained personnel. Access is therefore allowed but is restricted to a list of registered specialists with a special authorization. There is no remote supervision from the control rooms. The safety is ensured by the access safety system. In this mode all personnel accessing must take their own safety token (see below) at the access point.

Restricted mode

This mode is used when there are operational constraints on access duration, the type of work to be performed, or when the occupancy of the zone must be limited. Access is allowed after approval by a control room operator. This supervision by a control room operator is only needed for operational aspects (duration and time limits, type of work to be performed, optimisation of accelerator beam time) and is not required for safety reasons. In this mode all personnel accessing must take their own safety token at the access point.

Patrol mode

This mode is used during the period when a patrol is being conducted in the zone. This walk-through procedure by a patrolling team is intended to check that no personnel is present in the zone that the installation is safe before powering or activating equipment and before injecting beam into the accelerator. Access is allowed after approval by a control room operator. The patrol itself is under the responsibility of the patrolling team. In this mode all personnel accessing the zone must take their own safety token at the access point.

General mode

This mode is used when there are no operational constraints on access such as duration or type of work to be performed. Access is allowed without prior approval by the control rooms. In this mode a safety token is not delivered at the access point. Any access in this mode implies a patrol before equipment test, test mode, or beam operation can resume.

Access modes can only be applied or changed when the LHC access safety system is in a state that authorizes access operation. Access modes can only be applied or changed manually from the accelerator control room, via the LHC access control system. Access modes are not changed automatically, in particular a fault in the system, an intrusion or the starting up of dangerous equipment does not change the access mode. All mode transitions are allowed through the LHC access control system and the consequences for safety are handled by the LHC access safety system.

5.4.3. Main Functions

When the accelerator is stopped and the safety conditions for access are met (absence of an access veto from LASS) the LHC access control system positively identifies the person who wants to access, checks the relevant authorizations and related safety training and finally controls the access equipment according to pre-established procedures triggered by the user at the access point. The LHC access control system also limits the occupancy of the interlocked areas and helps with the evacuation of the zones before the restart of the accelerator.

When the safety conditions are not met (presence of an access veto from LASS), the LHC access control system acts as a physical barrier preventing access to the interlocked areas of the LHC.

5.4.4 Personnel Access

The LHC Access Control System ensures that only one, positively identified and fully authorised, person enters into a zone for each access granted:

Identification

Access into an interlocked area of the LHC is subject to prior identification of the person. The identification is encoded on an identification chip. In order to reasonably ensure that everyone accessing into a controlled area of the LHC wears their personal dosemeter, while only requiring a single object to be checked at the access point, the personal dosemeter casing supplied by CERN is used as the support of the identifier chip and both are tightly bound together. The identifier is read remotely, without contact or manipulation by the user.

Authorization

Access into an interlocked area of the LHC is subject to a prior authorisation which is checked by the LHC access control system at the access point. Access authorisations can be valid for a specific access zone or an ensemble of access zones, for specific access modes where necessary (see Test mode above), for a defined work schedule (daily, weekly, annual), and until an expiration date is reached (e.g. end of contract or end of shutdown work). Authorisations are stored in a central database and mirrored at each access point.

Safety Training

Access into an interlocked area of the LHC is subject to having successfully completed the appropriate safety courses which are checked, together with associated expiration dates, at the access point. Information on safety courses and expiration dates are stored in a central database and mirrored at each access point.

Positive Identification

Access into an interlocked area of the LHC is subject to positive identification by means of a biometric verification of the identity of the person. The biometric method chosen is the iris pattern recognition. The biometric data of the user, acquired by the LHC access control system at the access point, is compared to fiducial biometric data. The biometric reader to acquire the live data of the user is installed within the personnel access device and the data acquisition will be made without contact and will be non-invasive. The fiducial biometric data is kept in an encoded format in a central database and mirrored at each access point.

Airlock

Personnel access will be physically done through an airlock to ensure that only one person at a time can enter into the interlocked areas of the LHC. This personnel access device is based on industrial equipment for which CERN already has considerable experience. It allows the passage of one person at a time but does not trap the person inside the mechanism through the simultaneous movement of the sliding doors on both sides. In case of emergency the system can be forced open to allow unrestricted passage e.g. for interventions of the fire-brigade or the passage of a stretcher.

Counters

The LHC access control system keeps a record of the number of persons present in a zone, their identities, the date and time of entry and the duration of the access. This data is displayed at the access point and available in the accelerator control room and the experimental control rooms for their respective zones. A maximum number of persons that can simultaneously be present in each access zone will be defined for safety reasons. When the maximum number of persons in an access zone is reached, the LHC access control system inhibits the entry procedure until the number of persons in the zone is again below the maximum. At this stage, the access procedure for entry is re-enabled.

Time Constants

In General access mode, the complete procedure to access into an interlocked area of the LHC will take less than ten seconds. In Test mode the access time is slightly increased because of the additional token delivery process, but should take less than 12 seconds. In Patrol or Restricted mode, the access time is further increased because of the interaction with a control room and this time (queuing of access requests and dialogue with the operator) can hardly be quantified.

The complete procedure to exit from an interlocked area of the LHC will take less than ten seconds.

5.4.5 Material Access

The LHC access control system allows the passage of material in both directions through a dedicated airlock device which is distinct from the personnel access device. The material is introduced on one side of the lock-chamber through the first door and is later extracted from the lock-chamber through the second door which can only be opened when the first door is closed. Not all access points will be fitted with a material access device, which will only be placed in certain key locations [6].

In rare cases where the dimensions of the material or equipment is larger than the internal dimensions of the material access device, the closest end-zone door or sliding shielding wall (“bouchon”) will be opened. This can only be done on request and under strict supervision by a person who will be responsible for limiting the duration of this opening and making sure that no personnel uses this opening to access into the interlocked areas instead of using the personnel airlock.

5.4.6 Additional Access Point Equipment

At each access point, one display attached to the access point controller presents the information relevant to the operation of the access point (in graphical and/or textual form). A set of visible indicator lights indicates the access mode of the access point and if necessary the presence of an access veto from the LHC access safety system. Different audible and visible signals are used to help the users at the access point and indicate failures in the procedures or alarms requiring attention. The visible signals will be labelled with the relevant information.

The LHC access control system is fitted with a full-duplex intercom system between each access point and the access consoles in the control room. Video supervision of the access point with displays in the relevant control rooms is also provided.

In Restricted, Patrol or Test access modes, anyone accessing must take a personal safety token at the access point and carry it with them during the whole access. The token must be returned to the same access point from which it was taken as soon as the access is finished. The number of safety tokens at each access point will be between 8 and 48 depending on the access point.

Hardware test or beam operation cannot resume unless all safety tokens are returned to the access point from which they were taken; this is ensured by the LHC Access Safety System.

5.4.7 Delegation of the Supervision

The interlocked areas of the LHC include the four large experimental caverns (UX15, UX25, UXC55 and UX85 in part) housing the four experimental detectors.

Because the hazards, personnel concerned and operational constraints in experimental areas are very different from those found on the accelerator side, it might be difficult for an operator in the accelerator control room to make an educated decision to allow or deny access to experimental areas during Restricted or Patrol modes.

The experimental control rooms will be able to manage the supervision of access control to their respective experimental areas in Restricted or Patrol Modes. Each of the four experiments control rooms will be equipped with an access console with functionality limited to this supervision process.

REFERENCES

[1] Système de Sûreté d’Accès du LHC, LHC-Y-ES-0005-10-00 – EDMS 362437

[2] The LHC Access Control System, LHC-Y-ES-006-10-00 – EDMS 386759

[3] Calculation of radioactivity dose rates…

[4] Radiation Safety Manual (Safety Code F)

[5] Accessibilité des Zones Verrouillées du LHC en Fonction de la Classification Radiologique – LHC-Y-ES-0001-10-00 – EDMS 352114

[6] Sectorisation Accès des zones verrouillées du LHC, – LHC-Y-ES-0002-10-00 – EDMS 344410

[7] Systèmes généraux de sécurité du LHC, – LHC-P-ES-0002-10-10 – EDMS 346512