ISBN: 978-3-95450-193-9 doi:10.18429/JACoW-ICALEPCS2017-THPHA099

NEW CONCEPTS FOR ACCESS DEVICES IN THE SPS PERSONNEL PROTECTION SYSTEM

T. Ladzinski, F. Valentini, F. Havart, P Ninin, E. Sanchez-Corral, D. Vaxelaire
CERN, Geneva, Switzerland

Abstract

The accelerator facilities at CERN span large areas and the personnel protection systems consist of hundreds of interlocked doors delimiting the accelerator zones. Entrance into the interlocked zones from the outside is allowed only via a small number of access points. These are no longer made of doors, which have left their place to turnstiles and then to mantraps or Personnel Access Devices (PAD). Originally meant for high security zones, the commercially available PADs have a number of CERN specific additions. This paper presents in detail the purpose and characteristics of each piece of equipment constituting the access devices and its integration within the personnel protection system. Key concepts related to personnel safety (e.g. interlocked safety tokens, patrols) and to access control (e.g. access authorisation, biometric identity verification, equipment checks) are introduced and solutions discussed. Three generations of access devices are presented, starting from the LHC model put in service in 2008, continuing with the PS devices operational since 2014 and finally introducing the latest model under development for the refurbishment of the SPS Personnel Protection System.

INTRODUCTION

In 2008, a modern LHC Access System [1] was put in operation; this was followed by a complete refurbishment of the PS Personnel Protection System [2]. Today, preparations are under way for the renovation of the SPS Personnel Protection System and a 3rd generation Personnel Access Device (PAD) has just been ordered. A new design was done, providing ease of installation, use and maintenance. At the same time, new functionalities were added to the already long list of access control and safety requirements that the access devices at CERN have to meet.

ACCESS CONTROL KEY CONCEPTS AND EQUIPMENT

Access control to the installations at CERN is based on a principle of layers of protection, each one allowing only a more restricted number of people to enter. On-site access is permitted to identified affiliated personnel, entering a surface building housing an accelerator or an experimental hall requires special authorisations, and finally entering a beam facility is subject to the strictest control.

Identification

Entry into or exit from a beam facility is subject to prior identification of the person requesting access or egress. A user-ID number is obtained from a special RFID chip added to the personal dosimeter and not from the standard badge read at the site entrance. Thus, anyone accessing a beam facility is sure to be in possession of a valid personal dosimeter. The badge reader itself is a commercial-off-the-shelf device complying with the international standard for contactless Smart Cards ISO 14443.

Access Control

Once a user's identifier is read, it is checked against a database table for a given access point. This is a simple verification, but there is a lot going on behind the scenes. In a big organisation, a number of services are involved in validating a user's access permit to a given location. At CERN, these involve:

- Authorisation granted by the facility responsible to people recognized by the Organization and with a professional need to access the facility;
- Valid Safety Training - only people having successfully completed appropriate safety courses are allowed to enter the beam facilities;
- Activity Approval - the activities requiring access to the facilities are either planned or based on imminent maintenance needs. The organisational unit in charge of works coordination keeps a detailed list of planned and approved activities together with the assigned personnel as well as a nominative list of on-call personnel prone to intervene at short notice. Entry into an interlocked area is subject to a prior authorization by the works coordination unit.

Identity Confirmation

Entry into a beam facility is subject to positive identity confirmation by means of biometrics verification. The biometrics data of the user, acquired by the access control system at the access point, is compared to the data kept in an encoded format in a database. At CERN, iris recognition has been the biometric technology in use for the last 10 years, with very good user feedback.

Equipment Checks

Personal Protective Equipment is to be worn by users at all times and in every facility, hence it is a well-developed habit. However, some facilities may require additional equipment, e.g. an operational dosimeter. This is enforced by procedures, but an automatic check that the user requesting access is in possession of an operational dosimeter and that it is correctly set, is a new stage in access control [3]. It will be added in the SPS access devices and, at a later stage, in the rest of CERN's accelerator complex.

ISBN: 978-3-95450-193-9 doi:10.18429/JACoW-ICALEPCS2017-THPHA099

Control Room Supervision

The access control system is able to function automatically and grant or deny access according to pre-set rules and procedures. In some cases however, human supervision of the operation of the system may be required and in particular, the decision to grant or deny access can be entrusted to the operators in a control room. Moreover, error situations may result in the user being blocked at access point and requiring assistance. To this end, each access device is always equipped with intercoms, varying in number from two for a turnstile to three for a PAD (outside on both sides and inside the device). In addition, two cameras are placed allowing the control room to observe an access point from outside and from inside the access zone.

SAFETY OF THE PERSONNEL

Even the most sophisticated access control system delimiting a beam facility cannot eliminate situations potentially hazardous to the personnel; the lead cause being human error. In the accelerator context, the main hazard is prompt radiation. Two families of hazardous events can be identified:

- intrusion into the facility when it is potentially operating with beams;
- human presence inside the facility when the accelerator is about to be operated with beam.

In order to cope with these safety aspects, the access control system is complemented with its safety counterpart, which implements one or more safety instrumented functions. The external envelope and most importantly, the doors or other devices serving as access points into the beam facility need to be correctly instrumented for the safety system to ensure its mission.

Intrusion Detection

The consequences of an intrusion with circulating beams can be fatal and this is why all the doors are systematically interlocked with beam safety elements. At least two complementary sensors with a one-out-of-two vote detect intrusion. They are installed on each door. In a PAD device, both the inner and the outer doors are equipped with a set of sensors, allowing more redundancy. Finally, since a PAD door can be forced open manually, with an emergency handle, the latter is also equipped with complementary contacts triggering the same action as a door opening.

Human Presence Verification

Ideally, prior to any operation with beam, the entire facility should be patrolled for presence of anyone that might have stayed behind. This is indeed the case, at the end of long period of access (e.g. a winter technical stop for maintenance lasting a few months). However, a short intervention of a few hours by one or two technicians in a precise location is usually not followed by a long patrol procedure. This would usually not be considered necessary, especially if the operators know that the intervening personnel has left the premises. In small machines, with very limited number of personnel involved, the operators do know, and the intervening personnel will in fact often pass by the control room once the intervention finished. In geographically spread installations, with a big number of technical teams intervening, this is far more problematic and the operation team usually relies on the access control system for information of the presence of personnel within the facility. Obviously, complementary protection is expected from the safety system. It is obtained with the introduction of interlocked safety tokens and a patrol-search mechanism.

Interlocked safety tokens offer individual protection to personnel entering the beam facility. Absence of any safety token interlocks the beam important safety elements; hence, the beam cannot restart until all tokens are back in the distributors. In this respect, each token placeholder of a distributor is equipped like an interlocked door with a minimum of two complementary position sensors. The interlocked safety tokens represent a very good protection, but sometimes are not sufficient, e.g. when an emergency exit door is forced open, anyone can enter without having a token.

Patrol-search mechanism is used to complement the interlocked safety tokens with collective protection measures in case an intrusion or an entry without a safety token takes place. Every interlocked zone of a beam facility is divided into smaller entities, called access sectors, separated by doors. Should an intrusion (i.e. a detected violation of a facility envelope) occur or an access without a safety token take place, the *search memory* of the corresponding access sector is disarmed. A disarmed search memory interlocks the beam safety elements and a new patrol is required prior to beam operation.

FROM ACCESS DOORS TO ACCESS DEVICES

Initially, the beam facilities at CERN were equipped with doors. Through the years the doors used as access points have been replaced by more sophisticated devices, first turnstiles and today mostly mantraps or access booths, known in the CERN jargon as Personnel Access Devices. The fundamental reason for the introduction of more complex devices is their capacity of allowing only one person to enter at a time. In fact, both the access control and access safety mechanisms introduced in the previous sections are based on a fundamental hypothesis that only one person can use the access point at a time. In the absence of devices meeting this criterion, the mechanisms only work if an operator supervises every entry and exit cycle and assures that there is never more than one person using a door. This is not impossible, in fact for small machines it is probably very easy to achieve, but becomes extremely complex in case of a big facility. E.g. in the LHC, on peak technical stop days, one can observe more than a 1000 people entering during the morning rush hours [4].

ISBN: 978-3-95450-193-9 doi:10.18429/JACoW-ICALEPCS2017-THPHA099

The turnstiles, installed today in the SPS have been in wide use for decades, providing an easy way of counting the number of people entering or leaving a site. They are robust, integrating them with access control is easy and they provide a reasonably satisfactory mechanism of ensuring that only one person passes at a time. Introducing biometric identity confirmation of a user poses a problem, as it is very difficult to isolate an individual in a turnstile. Furthermore, increasing the reliability of the one-person-at-a-time passage can only be achieved by reducing the size of a turnstile to a very uncomfortable minimum.

Mantraps or security booths have recently seen an explosion in the numbers of units sold. The devices meant for high security zones (banks, government offices, data centres, airports) have smaller footprint than a turnstile. Biometric identity confirmation is very easy to implement, as a person is actually trapped within the device during the passage. Complex algorithms based on floor pressure or weight distribution to detect piggybacking coupled with infrared sensors make them the number one device in terms of ensuring that only one person passes at a time.

THE NEW SPS PERSONNEL ACCESS DEVICE

The first PADs at CERN were installed in the LHC accelerator. They included all access safety and most of access control features described in the previous sections. When introducing the device for the PS accelerator the activity approval was added at the access control level and the base model of the device changed from Compact Save by Gunnebo-Hammer to Ele 2000 manufactured by Saima Sicurezza.

One of the inconveniences of using an access device is the total time it takes to get a token and to pass the identification – access control verification – biometric confirmation process. Unexperienced users may make mistakes, in which case the PAD passage procedure, known as cycle, is usually aborted. In the LHC, the delivery of the safety token is integrated with the PAD entry cycle and thus a new token cannot be delivered until the previous person has successfully entered. In the PS, the two actions were decoupled, with the user first taking a token and then badging again to enter the PAD. This was considered a major improvement for experienced users, on the other hand, in case of supervised access mode the operator was usually busy delivering tokens and a user inside the PAD could not be helped immediately, hence an unexperienced user could still provoke congestion. In addition, the PS safety token distributors were custom made electromechanical devices requiring considerable maintenance, while the LHC ones are based on RFID token distributors from Deister Electronics seamlessly integrating with major access control systems.

In the SPS, the currently installed turnstiles will be replaced with new Personnel Access Devices during the 2019-2020 Long Shutdown period. This major project will complete the renovation process of the Personnel Protection Systems, providing the same level of safety across the CERN accelerator complex. Several PAD models available on the market have been compared and the decision was taken to base the PAD on the same model as for the PS system. Having a common pool of spare parts and same maintenance procedures played an important role in the decision.

Although it shares a common base with the PS, the SPS Personnel Access Device has been completely redesigned in terms of user ergonomics, ease of maintenance and installation.

Single Cycle Controller

The PAD is a complex device equipped by the vendor with its own controller and sensors to ensure that one person passes at a time. In our context, a number of additional checks is added and, most importantly, the device is part of the SPS Personnel Protection System, which blocks access when beam operation is ongoing, or when the radiation protection group measures that the level of remnant radiation is too high to enter. Integration of the PAD in the accelerator context is therefore twofold: on the one hand, it implies the installation of several additional pieces of equipment (like safety token distributors, intercoms, cameras etc.) and on the other hand the integration of the PAD controller with the rest of the system.

Installing additional equipment is within standard practice in the industry. Integrating the PAD controller with a complex safety instrumented system is more specific to our use of the devices. A physical separation between the access control and access safety functionalities used in the LHC meant that the PAD cycle was entirely managed by the PAD controller which interfaced with other systems, and the access safety PLC was in an independent manner blocking/unblocking the use of the device by acting directly on the power supplies of its motors. The inconvenience of this approach is a possible race and hazard condition that may arise between signals sent by the two controllers, which results in the safety system reacting to a spurious intrusion causing unnecessary accelerator downtime.

The SPS PAD will be equipped with an additional Access Point Controller, a Siemens Open Controller 1500F model, on top of the vendor supplied PAD controller. The Access Point Controller will run two distinct processes. One standard process to interface between the user inputs and the access control units on the one hand, and the PAD controller on the other hand. In addition, it will run a safety process permitting, or not, the PAD use. The Access Point Controller will be the unique conductor of the PAD cycles. The interface with the PAD motors will remain the same; the Access Point Controller safety process will cut the power supply to the motor in case of need, but will not do it when a door is moving.

ISBN: 978-3-95450-193-9 doi:10.18429/JACoW-ICALEPCS2017-THPHA099

Symmetrical Cycle

It was decided to keep the safety token distribution coupled with the entry cycle. Moreover, the design strategy was to keep the user experience of the entry and exit cycles as close as possible and to install the token distributors inside the PAD, as opposed to the previous designs, where the distributors were placed in electronics racks next to the PAD. The new location naturally solves all problems with users leaving the facility and forgetting to return the token to the distributor. In the new SPS PAD this will no longer be possible. When entering, the inner door will only open once a safety token is taken. When exiting, the outer door will only open once a safety token is returned. Similarly, the proposed solution fixes a weak point of the LHC devices, where a token could be taken, but lost before actually entering the facility, thus creating a potentially hazardous situation.

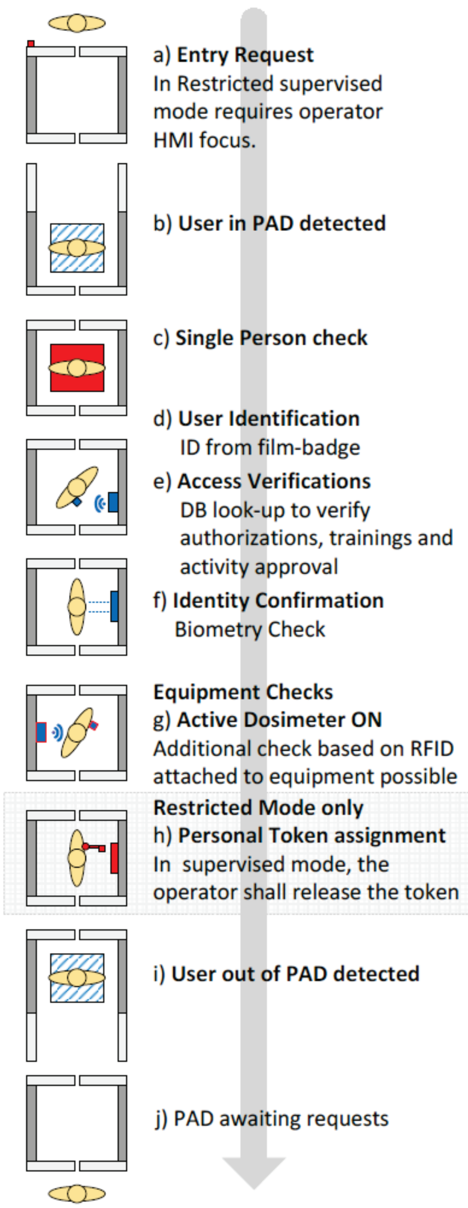

Figure 1: SPS PAD Entry Cycle.

Figure 1 shows the entry cycle, where all steps of the access control and token distribution are shown. Blue colour depicts actions related to access control, whereas the red one denotes safety critical actions. The exit cycle is shown in Fig. 2. Although the user responses and actions are very similar in both the entry and exit cycles, there is a smaller number of verifications and checks in the exit one.

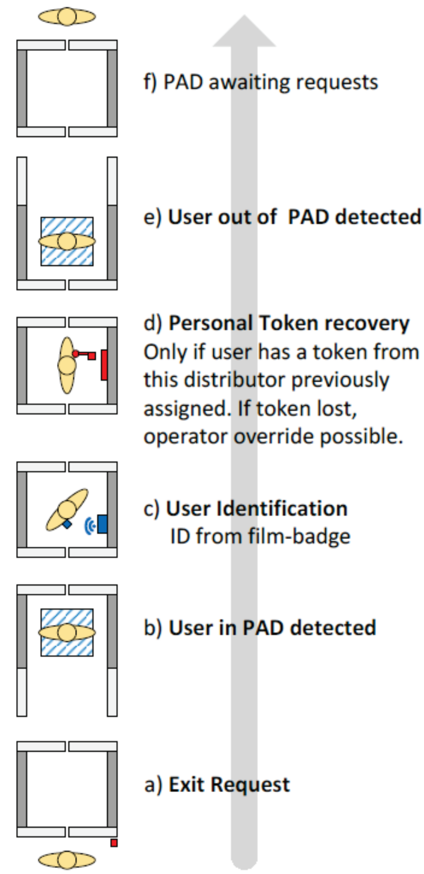

Figure 2: SPS PAD Exit Cycle.

Standalone Device

The functional design involving placing the bulky token distributors inside the PAD as well as a need to house the Access Point Controller have led to a physical design where the electronics rack with additional equipment is physically integrated with the PAD forming one object; it is depicted in Fig. 3.

On the outer side, the device has a push button to start an entry cycle, a 19” screen to display information to the user plus a hardwired LED panel to show the state of the accelerator operation modes, as well as an intercom module. All these devices are placed on a front panel of a sliding cabinet, which houses the Access Point Controller and its I/O modules, the terminal blocks, relays, as well as a local treatment unit of the NEDAP access control suite. The fact that the cabinet can slide out improves maintainability. Below the cabinet, a special sliding drawer allows the user to pass medium size equipment (a tool case or a

ISBN: 978-3-95450-193-9 doi:10.18429/JACoW-ICALEPCS2017-THPHA099

laptop), which could otherwise hinder his passage through the device.

Figure 3: SPS PAD Design.

Inside the PAD there are two token distributor modules from Deister Electronics, IrisID biometric reader, a film-badge reader, special operational dosimeter detector and a mechanical emergency handle to allow exit in case of need. Moreover, to help the users a small screen was placed inside; its principle role is to show which verification check a user failed in case of access refusal.

Finally, on the inner side of the PAD, one can find a push button to start the exit cycle, an intercom and the material drawer.

Having the entire PAD equipment housed in the same unit and not spreading it between the PAD and an adjacent rack reduces the test and installation phases. Once the PAD is completely mounted, it can be fully tested at the factory site. After shipment to CERN and on-site installation there are far fewer signal cables and connections to test. A modest footprint of the ensemble (1050 x 1600 mm) allows the installation not only in the SPS accelerator, but also in a number of North Hall experiments, should a need arise to replace the existing doors.

CONCLUSION

Building on the experience from the LHC and PS access systems, a third generation Personnel Access Device for the SPS has been fully developed. Its design is more ergonomic for both the end-user and the maintenance team. The mechanical design, combining all elements into one unit, should allow rapid installation of 16 access points in a very dense Long Shutdown 2 period.

ACKNOWLEDGEMENTS

The design of the new SPS Personnel Access Devices would not be possible without the help of industrial partners, especially Saima Sicurezza from Arezzo, Italy and Procon Systems from Badalona, Spain. The authors would like to thank them for the fruitful collaboration.

The authors would also like to express their thanks to the colleagues from the LHC and PS Personnel Protection Systems project and maintenance teams for sharing their ideas and knowledge.

REFERENCES

[1] T. Ladzinski *et al.,* "The LHC access system", in *Proc. ICALEPCS'09*, Kobe, Japan, Oct 2009, pp. 600-602
[2] P. Ninin *et al.,* "Refurbishing of the CERN PS complex personnel protection system", in *Proc. ICALEPCS'13*, San Francisco, USA, Oct 2013, pp. 234-237
[3] P. Pok, F. Havart, T. Ladzinski "Integration of personal protective equipment checks in access control", presented at ICALEPCS'17, Barcelona, Spain, Oct 2017, paper THPHA100, this conference
[4] T. Ladzinski *et al.,* "Access safety systems – new concepts from the LHC experience" in *Proc. ICALEPCS'11*, Grenoble, France, Oct 2011, pp. 1066-1069