THE DESIGN OF THE FERMI PERSONNEL ACCESS CONTROL AND INTERLOCK SYSTEM

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ABSTRACT

FERMI is the proposed IR/FIR FEL user facility in Trieste, Italy. The electron beam is supplied by the first 100 MeV part of the ELETTRA injector linac and transferred via a transfer line into the FEL room which is attached to the linac tunnel. The interlock and personnel access control systems protect personnel against radiation hazards induced by linac or FEL operation and regulates the access to the FEL room.

1 INTRODUCTION

The FERMI (Free-Electron Radiation and Matching Instrumentation) project is divided into different phases which successively extend its size and operational wavelength range [1, 2]. The development of the interlock and personnel access control systems take place from the beginning and the design has to take into account the future growth of the plant avoiding project extra costs. In addition to a proven reliability, the main system feature must be the ease of upgrade during the project evolution. In this article we will describe the design guidelines, the possible choices and the adopted solutions for both the interlock and the access control systems, their relationship and the operator supervisor.

2 GENERAL ASPECTS

The interlock system and the personnel access control system usually have different evolutions. An interlock system is subject to adjustments especially during the commissioning period. New interlock signals have to be added during the successive construction phases and new logical relationships among them arise. On the other hand, a personnel access control system needs no major modifications, the devices involved remain mostly the same and the number of signals to control is poor.

An other major aspect to consider in the choice of the final system architecture is that the interlock and the access control system are strictly linked each other and have to exchange information about fault conditions and status of the controlled devices. Moreover, this information has to be sent to an operator console located in the control room.

The personnel access control system for FERMI, like the one for ELETTRA, has to obey to a strict regulation and a national inspectorate approval. Any modification must be registered and submitted to an official revision.

3 ARCHITECTURE

The requirements of system reliability, easy maintenance and upgrade flexibility together with the experience gained during the last two and half years of ELETTRA operation lead us to the decision of using Programmable Logic Controllers (PLC) for the system implementation. Two solutions have been considered:

- two different PLCs respectively for the interlock and for the personnel access control system and
- a single PLC for both systems.

The first solution, which keeps the two systems separate was already adopted for ELETTRA. It has the advantage that part of the already developed software could be used and the reconfiguration of one system can be performed while the other is running. The main disadvantage is the necessity to implement a communication path between the two separate PLCs.

The integration of the two systems in a single controller leaves a more complex hardware and software configuration for the designer, but has the advantage of being cheaper and of solving all the information exchange within the same PLC.

We have decided to adopt the single PLC solution for the FERMI project (figure 1).

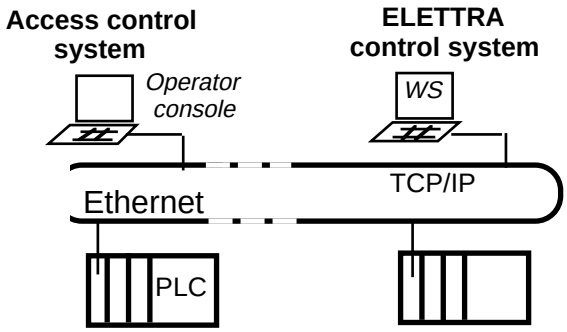

Figure: 1 System Architecture.

The new generation of PLCs provides an open automation architecture and supports different types of networks (e.g. Ethernet) and standard communication protocols (e.g. TCP/IP). It implements multiple industry-standard programming languages, in a structured text form, that allow an easier software development and maintenance. Well tested industrial software is also available. In order to achieve a complete integration of the FERMI interlock and personnel access with the

general ELETTRA control system [3], we are considering to choose a new, faster, easier to program and fully integrable PLC brand.

4 TECHNICAL DETAILS

Systems like accelerators as FERMI which can constitute a hazard for personnel, environment or equipment are demanded by law to meet special security requirements. Fail-safe systems are requested and designed to prevent dangerous situations by entering a safe state in the event of a fault, e.g. switching off a faulty component.

In order to operate under these conditions, special care has been taken for the configuration of the input/output channels which are often subject to faults. Three types of interface circuits are implemented:

1. A single input/output circuit is used for not safety related channels (e.g. incandescent lamp indicator).
2. A couple of redundant identical circuits is foreseen for safety related channels. The inputs are connected to a couple of sensors or, more often, short-circuited to the same sensor (figure 2).

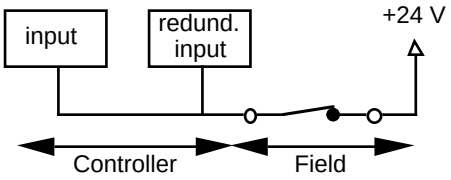

Figure: 2 Input channel configuration (second type).

The outputs are linked to the opposite poles of the actuator, deliver 0 and 24 V, and are connected to read-back inputs (figure 3).

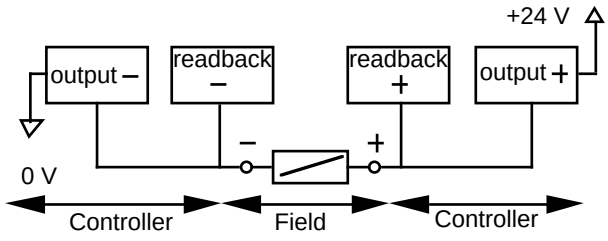

Figure: 3 Output channel configuration (second and third type).

3. The inputs are connected to a couple of sensors or to the same sensor which is powered by a dedicated test output (figure 4). The test output is sometimes deenergized in order to test the inputs.

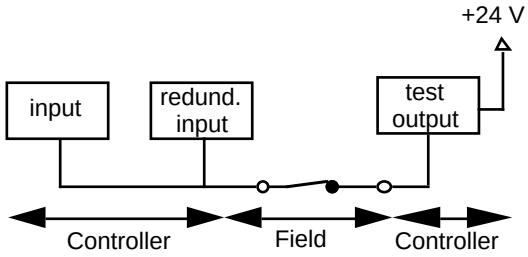

Figure: 4 Input channel configuration (third type).

The outputs have the same configuration as the second type (figure 3) but they are periodically disabled and verified through the read-back inputs. The period for this test procedure has to be less than the double Mean Time Before Fault (MTBF) foreseen for each channel.

As the correct operation of the second type redundant channels is effectively checked at each state transition of the actuator/sensor, the third configuration is only used for safety related channels which rarely change state (like emergency push buttons).

5 PERSONNEL ACCESS CONTROL SYSTEM

The FERMI area (figure 5) is divided in two parts:

- the control room and
- the FEL room.

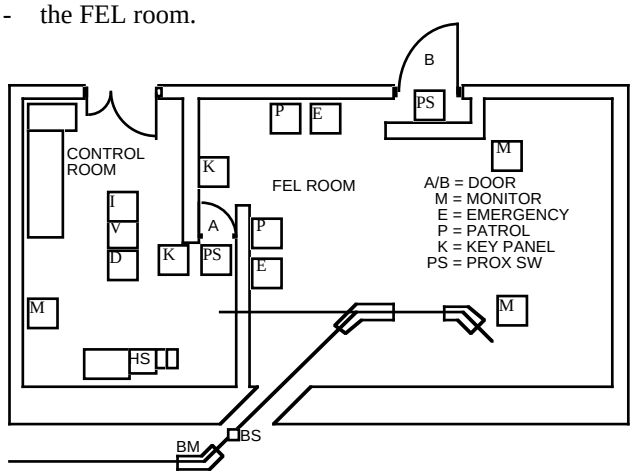

Figure: 5 The FERMI facility area.

The control room has no access restriction while the FEL room is subject to a strict procedure.

The injection of the beam into the FEL is interlocked by two devices: the beamstopper BS and the power supply of the bending magnet BM. Two status are defined for the FEL injection:

- DISABLED, when BS is closed and the BM power supply is off;
- ENABLED, in all the other cases.

We identify three cases for the FEL operational status and the FEL room access conditions: ON, OFF and SHUTDOWN (see table 1).

FEL status	Notes	FEL room Access
ON	- Linac on and FEL injection ENABLED.	BLOCKED
OFF	- Linac on and FEL injection DISABLED; - Linac off and FEL injection ENABLED or DISABLED; - If no more user is inside the FEL room, the FEL status automatically switches to ON when the linac is on and the injection is ENABLED.	CONTROLLED
SHUT DOWN	- Linac on and FEL injection DISABLED; - Linac off and FEL injection ENABLED or DISABLED.	FREE

Table 1.

Switching between the OFF and SHUTDOWN status can only be done manually by the operator.

The access to the FEL room occurs through the A door while the B one is only used in case of emergency exit. In order to enter when in OFF status, four subsequent steps are foreseen:

- the user presents his personal card to a card reader; if he is authorized to enter, the personnel access control system gives its first assent to open the door;
- one key is automatically unlocked from an external panel K and taken by the user;
- the control room operator, after recognizing the entering user, gives the third assent by unlocking the door;
- the user enters, closes the door and deposits the key inside the internal panel K.

The doors are provided with some proximity switches PS to avoid positioning problems and to turn off the whole plant whenever an attempt to force them occurs.

In the FEL room there are also some other safety related devices such as gamma/neutron monitors M and emergency push buttons E. Another push button set P is installed to allow the operator patrol after a shutdown period or an emergency situation.

6 OPERATOR CONSOLE

An operator console provides an unified and consistent user interface to the interlock and access control systems. All the alarms, malfunctioning and emergency conditions are reported and archived.

A UNIX workstation of the type already used at ELETTRA will be chosen. The Man-Machine Interface software will be based on the same graphic standards, as adopted for the ELETTRA control system [4].

7 CONCLUSIONS

The FERMI interlock and personnel access control systems have been designed taking advantage of the experience gained during the last two and a half years of ELETTRA operations. The described solutions take also into account the trend of the PLC industrial market which allows a better integration into the well proven ELETTRA control system.

REFERENCES

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