ASSESSMENT OF SAFETY SYSTEMS DESIGN OF INDUSTRIAL IRRADIATION FACILITIES IN BRAZIL

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BACKGROUND

Several accidents were recorded in irradiation facilities, including fatal ones, have demonstrated that these facilities have safety-critical systems, which should be designed to meet high safety and reliability requirements.

The first industrial irradiation facility in operation in Brazil was designed in the 70s. Nowadays, twelve (12) facilities are in operation, with maximum activity up to 5 MCi (185 pBq), and two (2) decommissioned. Minor modifications and upgrades, as sensors replacement, have been introduced in these facilities, in order to reduce the technological gap in the control and safety systems.

Table 1 – Number of industrial irradiation facilities in Brazil with regard to IAEA SSG-8 categorization.

CATEGORIZATION	I	II	III	IV
Gamma	They are not dealt with in this study	3	0	5
Electron Beam		4		

UPGRADING SAFETY SYSTEMS

The safety systems are designed in agreement with the codes and standards at the time. Since then, new standards, codes and recommendations, as well as lessons from accidents, have been issued by various international committees or regulatory bodies. The rapid advance of the industry makes the safety equipment used in the original construction become obsolete. The decreasing demand for these older products means that they are no longer produced, which can make it impossible or costly to obtain spare parts and the expansion of legacy systems to include new features.

METHODOLOGY

Irrespective of the fact that during its operational period no event with victims have been recorded in Brazilian facilities, and that the regulatory inspections does not present any serious deviations regarding to the safety procedures, it is necessary an assessment of safety system with the purpose of bringing their systems to "*the state of the art*", avoiding their rapid obsolescence, thus, this work aims to evaluate the safety systems at Brazilian irradiators, mainly the oldest facilities, taking into account the requirements of IAEA SSG-8. This study also taken into account the knowledgement, concepts and solutions developed to upgrading safety system in irradiation facilities throughout the world.

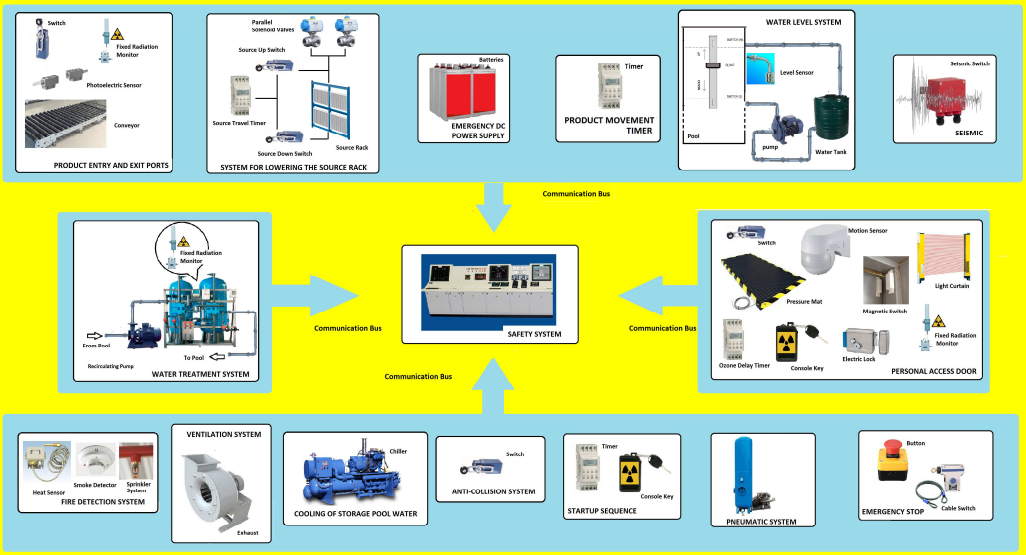

Fig 1. Main equipment and sensors of the safety system.

RESULTS

With regard to the main safety subsystems, we can mention as a priority:

Safety System Control Unit

Old control units based on relay logic should be replaced with a new ones based on redundant programmable logic controllers (PLC). Standard PLC controllers used in safety applications should be configured in pairs. The redundant controller is used to support a safe and orderly shutdown when the primary controller fails.

Safety and Process Control System Sharing

The sharing of equipment and components between safety and process control systems is not prohibited, but in this case, an analysis should be carried out in order to assess if the occurrence of a common cause failure in a shared device can cause an uncontroll in the industrial process and simultaneously a demand on the safety system preventing it to act properly to the shutdown. It was observed that, even when the systems are separated, sensors and valves are the main devices that are often shared in Brazil, however no safety analysis was performed regarding this sharing.

Personnel Access Door

All irradiators in Brazil have an electric lock that does not allow the opening of the door when the source is exposed. If the door is opened with the source exposed, a switch will command the return of the source to its safe position. The door key is the same as that enables the startup of the facility. The difference between the facilities is at the level of redundancy and diversity. The older ones do not have additional sensors to the access door. All other irradiators have photoelectric sensors in the main access door, which can be single-beam emitter and receiver units or light curtains. It should be noted that none of the gamma irradiators use motion sensors or pressure mats.

Automatic Actuation Device

In the oldest facilities some sensors are interlocked with the safety system, but they act automatically only to return the source to a safe condition, not performing additional actions, mainly:

- The radiation monitor of water treatment system not stopping the circulation of water;
- The product exit radiation monitor not stopping the system carrying product.
- The sprinkler valve in the fire protection system is manually open.

Loss of External Power

Two facilities does not have uninterruptible power supply (UPS) in order to allow safe shutdown in case of external power failure. Critical components in the safety system should be connected to an UPS capable of providing the necessary electrical power for a controlled shutdown.

Irradiator Pool

The older ones facilities does not have a water-tight stainless steel liner, being tile coated pools. A cost-benefit analysis should be performed in order to define the need for change in the pool structure.

The main equipment and sensors of the safety system of irradiation facilities assessed in this study are shown in figure 1.

CONCLUSION

It was carried out a diagnosis of safety systems of Brazilian irradiators, taking into account the national regulations and requirements of IAEA. The safety systems control unit in the oldest Brazilian irradiators should be improved in the next years, however, it should be emphasized that the operating organization should obtain the approval of the regulatory authority before implementing any modifications on the irradiator that may have significant implications for radiation protection.