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COMPARATIVE RESPONSE TIME AND FAULT LOGGING WITH A PLC AND SUPERVISORY SOFTWARE AND A STANDALONE UNIT DEVELOPED FOR RECORDING

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ABSTRACT

The Cobalt-60 irradiator of IPEN / CNEN, a category IV facility, has a security system for inter locking doors or exposure of radioactive sources made simultaneously by a programmable logic controller (PLC) model S7-200 from Siemens and a relay logic. From a set of information, both systems work together opening doors or exposing the sources. All incoming and outgoing information are sent serially via EIA232 communication to a personal computer with Windows® platform for a supervisory program which provides the monitoring of the entire process by a synoptic table on the computer screen and is also intended to keep records of all events on the computer's hard drive. A deficiency was found for the process of sending events via serial communication (EIA232) from PLC to the supervisory program. When failure occurred in a very short time, the PLC always took the right decision, but the registration process that had to go through the Windows® timeshare lost the information.
In the previous work [1] developed a standalone electronics unit connected to the inputs and outputs of the security system, fully optocoupled to avoid any interference to the security system that records each event on a memory card. In this work, for checking the unit developed record time ability, transients incoming signals for simulating failures, were injected at security system inputs and the response time of security system, supervisory program and the autonomous unity were measured and compared.

1. INTRODUCTION

The gamma radiation emitted by radioisotopes, electron beams and the X-rays are known as ionizing radiation. They are of high penetrating power, which to interact with the products, even within their packages, transfers its energy through collisions with electrons of the atoms that constitute the product.

As a result of this energy transfer process, the main process for industrial application of ionizing radiation, consists in inactivating microorganisms by radiation which is caused partly by the action of direct collision with the radiation-sensitive regions of the cell and by indirect way, through formation of highly active chemical radicals, produced in the liquid cell by radiation. In the case of direct action, radiation ionizes a part of the DNA molecule, an enzyme or any other vital component of the cell, leading her to a state of bankruptcy or in inhibiting its

reproduction [2]. For the indirect route, the radiation causes at the water molecules present in the microorganisms, the formation of free radicals such as OH^-, H^+ and H_2O_2 molecules.

While this ionization process is desirable because of their deleterious traits to microorganisms, indiscriminate exposure of the humans or animals to ionizing radiation present the same damage and high values can lead to death. Due to these circumstances, the equipment used for irradiation are built and operated under strict standards of construction and operation.

The Multipurpose IPEN irradiator was designed attending CNEN NN 6:02 [3] for Radioactive Facilities Licensing and the system of interlocks and safety by the standard 115. Basic Safety Standards [4] and the Specific Safety Guide No. SSG-8 [5]. The electronic management of the doors inter-locks or exposure of radioactive sources are made simultaneously by a programmable logic controller (PLC) model S7-200 from Siemens [6] and a relay logic. From a set of setup information, and many of them with redundancy function, the assembly allows opening of doors or exposure sources. All incoming and outgoing information is sent by EIA232 serial communication [7] to a personal computer with Windows® platform to a supervisory program. This software provides in addition to monitoring the entire process synoptic form on the computer screen also keeps records of all events on the computer's hard drive.

The electronic management has proved efficient and not presented any failure that had compromised safety. The PLC along with the relay logic has always taken the right decisions ensuring proper radiation protection of operators and the integrity of radioactive sources, but presented over the years of operation (beginning in 2004) less than a dozen flaws in system event log. The deficiency was found between the process of sending events via serial communication (EIA232) to the supervisory program. When the failure occurred in a very short time, as transients times, the PLC always took the right decision, but the registration process that had to go through the Windows® platform timeshare on the computer lost the information. In previous work from Baldaconi and Costa [1] developed an autonomous monitoring unit for overcome these deficiencies and the standalone unit built in these measurements is that finalized unit with a modification in the microcontroller to text generator.

This work measured the response time and fault logging from a security system with CLP and supervisory software and an autonomous electronic system specially developed to register all information to and from security system cobalt-60 facility.

2. MATERIAL AND METHODS

The standalone unit for recording was built to avoid any interference from and to cobalt-60 facility security system. The block diagram of standalone unit is showed in Figure 1. The diagram shows the connections to the Cobalt 60 facility control panel that includes the security system.
For simulated transients times, a circuit auxiliary was build, and its block diagram is showed in Figure 2. The width of the pulses generated in this circuit can be programed by a personal computer for widths from 1 µs to any time. In this way, the circuit simulates interruptions in short times in the input of the security system and the PLC must take de correct action and the software supervisory and the standalone unit must register the fault.

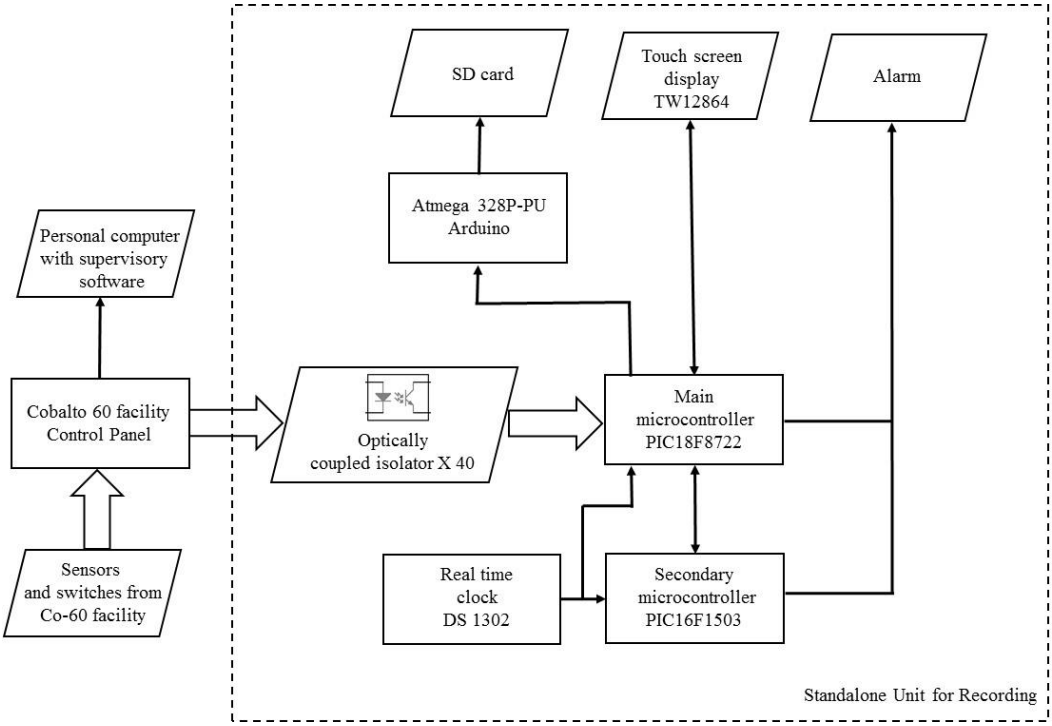

Figure 1: Standalone unit for recording block diagram and connections to the cobalt 60 facility control panel that includes the security system.

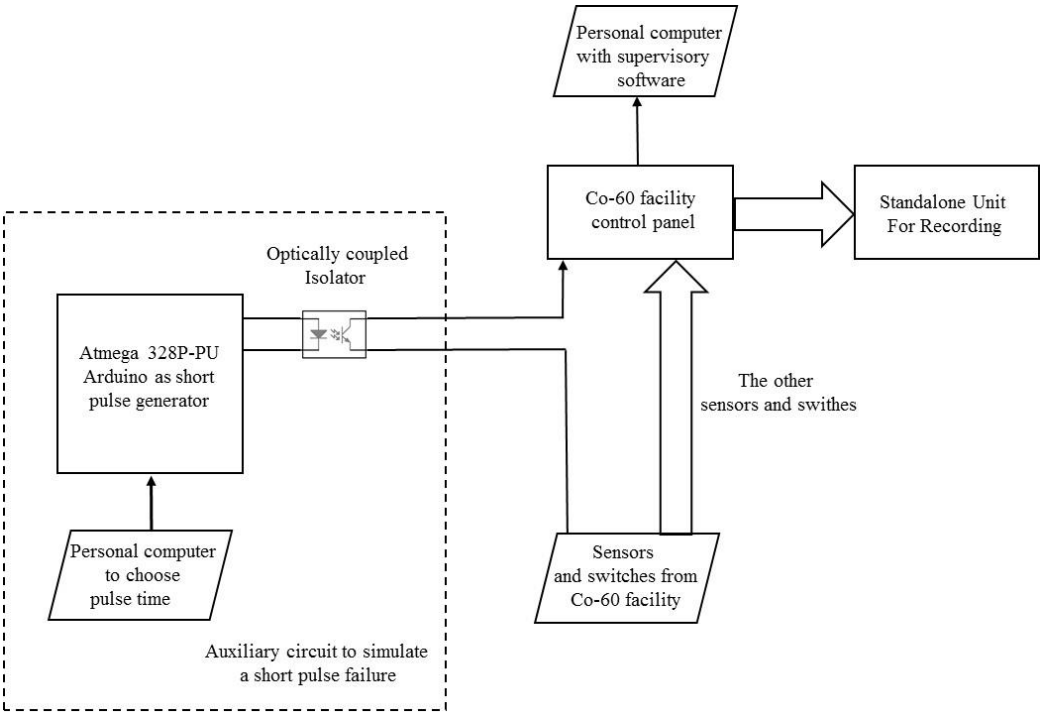

Figure 2: Auxiliary circuit to simulate short pulses failures at Cobalt 60 facility control panel.

3. RESULTS

With the arrangement of Figure 2, short pulses were injected, simulating faults. By changing the pulse width, 3 tables were elaborated with the percentages of failures observed by the safety system composed by the PLC and relays, for the registration in the supervisory at the personal computer and in the autonomous unit.

Table 1 shows the percentages of failures detected by the safety system composed of PLC and relays as function of failure time produced. In this situation, it was only observed when the control panel made the right decision. As can be observed, the security system identifies 100% of failures for events with times equal or greater than 60 μs.

Table 1: Percentages of failures detected by the safety system composed of PLC and relays as function of failure time produced.

Failure time (μs)	10	20	30	40	50	60	70	80	90	100
Failure detected (%)	14	67	93	87	87	100	100	100	100	100

Table 2 shows the percentages of failures registered by the supervisory software as function of failure time produced. The failure time must be more then 2 s to assure the register of failure at supervisory software.

Table 2: Percentages of failures registered by the supervisory software as function of failure time produced.

Failure time (s)	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	>2.0
Failure detected (%)	6	0	13	20	26	54	87	84	84	87	87	87	90	94	98	98	100

Table 3 shows the percentages of failures registered by the standalone unit as function of failure time. As can be observed, failure times more than 10 μs to assure the register of failure at standalone unit.

Table 3: Percentages of failures registered by the standalone unit as function of failure time produced.

Failure time (μs)	1	5	10	50	100	1 s	2 s
Failure (%)	90	90	99	100	100	100	100

3. CONCLUSIONS

The facility security system identifies failures in 100% of cases for times greater or equal than 60 µs. In turn, the supervisory program already requires times greater than 2s to be fully efficient. The developed standalone unit has already recorded reliability close to 100% with only 10 µs for failure time. The developed unit aiding in the observation of failures even without detection by the safety system and should aid in the premature verification of sensors and switches wear. This work suggests that the PLC resident program must include some routine that increases the efficiency of event logging by supervisory software.

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