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DEVELOPMENT AND IMPLEMENTATION OF AN AUTOMATED SYSTEM TO EXCHANGE ATTENUATORS OF THE OB85/1 GAMMA IRRADIATOR

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ABSTRACT

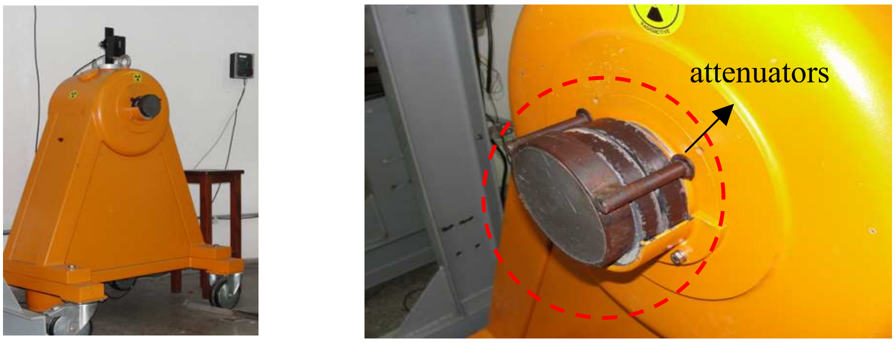
In order to improve the calibration process of portable detectors of the Instrument Calibration Laboratory of IPEN, an automated system to exchange the attenuators of the OB85/1 irradiator system was developed. This automation was developed following this sequence: (i) development of the device with the cooperation of the IPEN Sector of Projects, using the Solid Edge software to design the mechanical part of the exchanging device of the attenuators, in 3D; (ii) simulation with the Festo's FluidSim software to define the pneumatic components and their respective actuators; (iii) machining and assembly of mechanical parts; (iv) assembly of pneumatic components and their actuators, like magnetic pneumatic cylinders, which allow the use of magnetic sensors, used to confirm the attenuators opened or closed positions: actuators 5/2 each, with double solenoid; (v) assembly of the control panel for operating the device remotely from the operating room. With this automation, the technicians in charge of the detectors calibration and research testing will have no hand contact with lead attenuators, improving the calibration process due to the decrease in time spent with manual shift from the attenuators and avoiding accidents, like the fall of the lead attenuators. It has been a concern of the LCI-IPEN group the decrease in the time spent by the technicians in the calibration room controlled areas should follow the recommendations of the radiological protection rules, which recommend the shortest time possible of workers in these areas. Automated systems have, usually, a better rate of reproducibility, due to the small participation by the system operator, so the LCI-IPEN is following the trend of several laboratories and automating its processes.

1. INTRODUCTION

Process automation is generally used to enable greater efficiency in carrying out activities to facilitate control and minimize the variability of processes in general. The ABNT NBR IEC 17025:2005 norm [1] does not determine which processes should be automated, but it allows this automation to be implemented. Following a trend among calibration laboratories, which are increasingly looking for the automation to improve their calibration process, reducing uncertainties [2] and optimizing their activities, the Instrument Calibration Laboratory of the IPEN is seeking to improve their several calibration laboratories [3]. Among these, there is the calibration laboratory with gamma radiation, which uses an Irradiator System OB85/1 to perform the calibrations of portable detectors of different models and types. This irradiator system has a set of attenuators which were inserted manually and, in this work, an automated device was developed to enable the exchange of attenuators remotely from the control room, without the necessity for the technicians to go inside the irradiation room of calibration to perform this operation manually: this process contributes to radiation protection and complies with ALARA principles [4]. This article shows how this automation was developed and its advantages for the calibration process of portable detectors as to quality, reliability and reproducibility. This study is expected to contribute to the discussion for best practices of utilization and implementation of automated systems in calibration laboratories.

2. MATERIALS AND METHODS

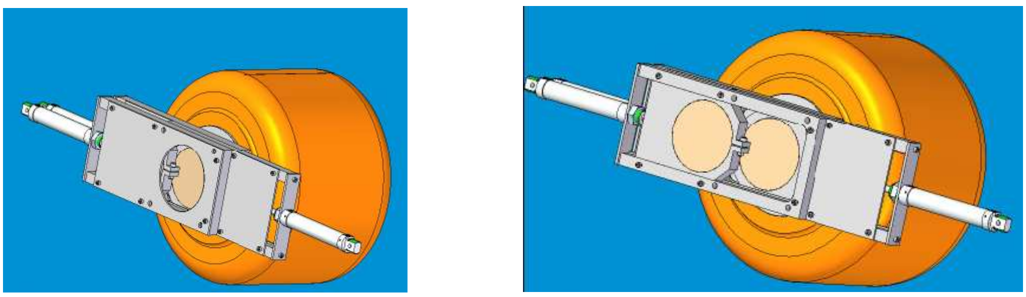
This automation was accomplished in the gamma calibration laboratory of the LCI-IPEN as part of the automation of the calibration process of portable detectors. The project was developed in order to automate the attenuators exchange of the OB85/1 Gamma Irradiator System. As part of this automation, a pneumatic system was developed [5]. Figure 1 shows the irradiator system and the detail of the attenuators before automation.



(a) (b)

Figure 1. (a) OB85/1 Irradiator System; (b) Detail of the OB85/1 Irradiator System Attenuators.

For the development of the mechanical part of this project the Solid Edge software was used by the sector of projects of IPEN, what enabled the development of projects in 3D, as shown in Figure 2 (a) and (b).



(a) (b)

Figure 2. (a) Drawing in Solid Edge of the attenuator complete device, (b) Drawing in Solid Edge of the attenuator device, without the front cover, allowing visualization of the inner part.

After this first step, a simulation of the pneumatic system with the software FluiSim 3.6 of the Festo was developed, allowing the virtual assembly of all components of the pneumatic part, pneumatic cylinders, directional actuators with solenoid, flow regulators and air system. Figure 3 shows one screen shot of the software with the developed simulation. With the simulation it was possible to observe the need of flow regulators for cylinders, which allow the control of opening and closing speed permitting a smooth movement of the mechanical components.

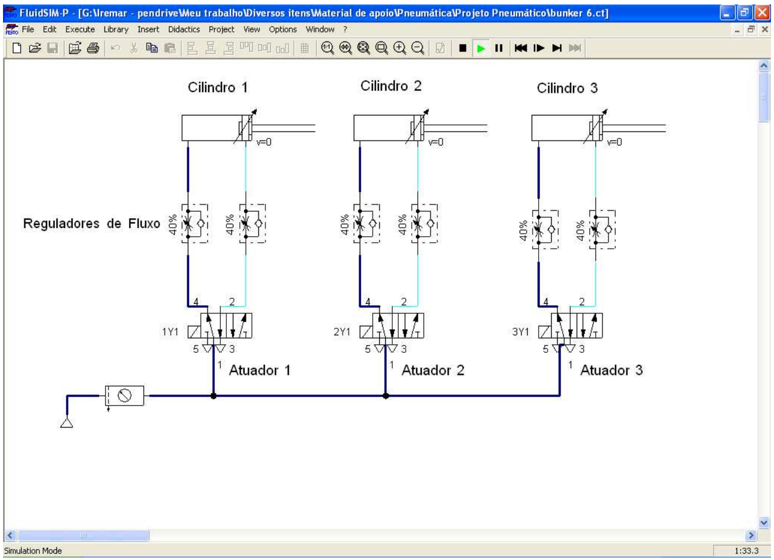


Figure 3. Screen the software FluidSim of FESTO, running the simulation of pneumatic parts.

Finally, an electromechanical control panel was made to remotely control the device developed and coupled on the OB85/1Irradiator System. In Figure 4, the wiring scheme of the control panel is shown.

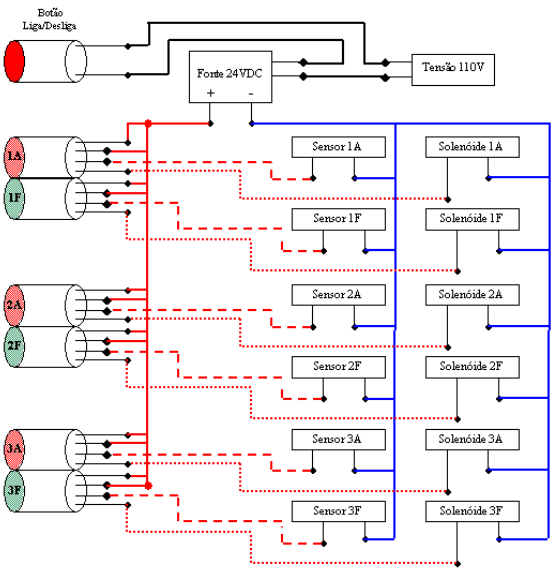


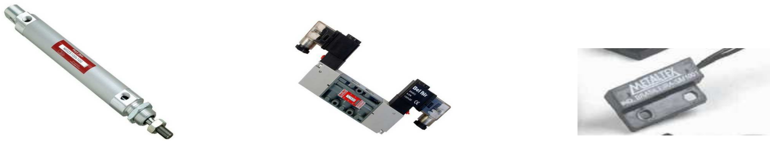
Figure 4. Scheme of the of the Control panel electrical components.

The main components used in the control panel assembly are presented in Figure 5.

(a) (b) (c)

Figure 5. (a) Button on/off switch, (b) Button of pulse type, (c) Power supply 24VDC 2A.

In Figure 6, the main components used in the pneumatic part of the automation of the Irradiator System OB85/1 are shown.



(a) (b) (c)

Figure 6. (a) Magnetic pneumatic cylinder; (b) Directional valve 5/2; (c) magnetic sensor.

The pneumatic part is composed of three magnetic pneumatic cylinders from Bel Air (Mini cylinder ISO 6432), three directional valves 5/2 with two solenoids each (Series 7000 FL - Freelub 1/4 "), six valves of flow control, six magnetic sensors from Metaltex (SM1000 - magnetic), a flexible polyurethane tube (10 meters) and various connectors. To feed the pneumatic system, compressed air prepared by the OB85/1 Irradiator System was used. The use of the Metaltex magnetic sensor to replace the sensors, normally, used in magnetic pneumatic cylinders provided a significant saving in costs.

3. RESULTS

During the development of the mechanical parts, aluminum was chosen as the material to make the exchange device of attenuators, since it is a lightweight material, suitable for the weight of the lead attenuators to be mounted on it. The part that is fixed to the OB85/1 Irradiator System is steel 1045, to provide a good fixation. Figure 7 shows the mechanical device in the stage of machining.

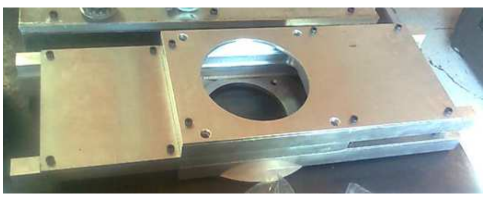
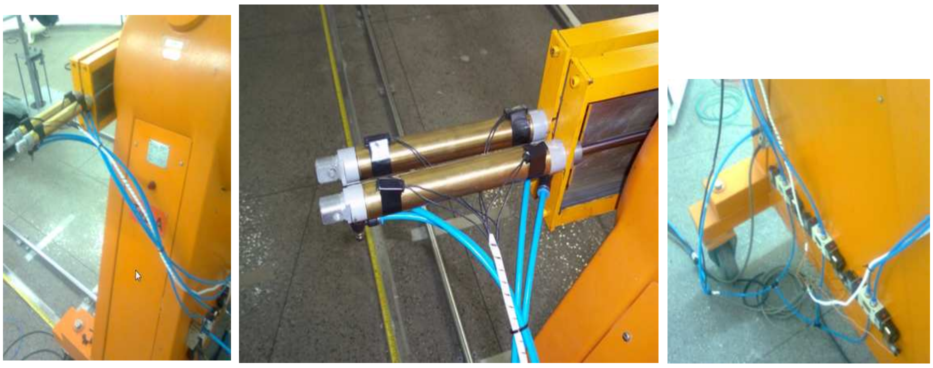


Figure 7. Attenuator device machined and partially assembled.

The mechanical device for the exchange of the attenuators was installed in the OB85/1 Irradiator System; the total set was also assembled, as shown in Figures 8 and 9.



(a) (b) (c)

Figure 8. (a) Detail of the wires and hoses. cylinders; (b) Detail of the magnetic sensors installed; (c) Directional valves installed.

Figure 9. Device installed in the OB85/1 Irradiator System.

The pneumatic cylinders were chosen because of the possibility of using magnetic sensors, which have a long life and low cost. The use of flow regulators in the cylinders was necessary to provide a smooth movement of the device parts, where the attenuators had been installed. The choice of directional valves, with two solenoids each, was due to the durability and low maintenance of this set, not requiring the solenoids to remain energized. An aluminum cabinet for mounting the components, on/off button, pulse button and a switch power supply were used, following the scheme shown in Figure 4. This control panel is shown in the assembly phase in Figure 9 and installed, in Figure 10.

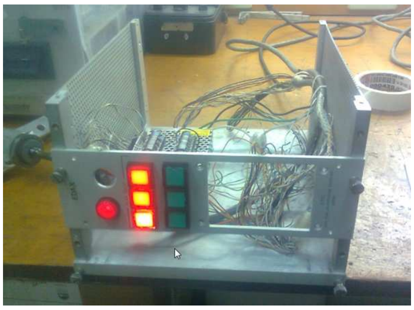


Figure 10. Control panel of the automated system to exchange the attenuators of the OB85/1 Irradiator System, in the assembly phase.

The electromechanical control panel was installed in the control room of the Irradiator System OB85/1. Figure 10 shows the control panel installed next to the control modules of both irradiators of the LCI-IPEN gamma calibration room.

Figure 11. (a) Overview of the control modules of the radiators and the control panel of the attenuators exchange device; (b) Control panel of the attenuators exchange device of the OB85/1 Irradiator System.

4. CONCLUSIONS

The benefits from the process of automation can be exemplified with the reduction of the calibration time and exposure by the technicians. Workers spend less time inside the calibration room, where the background radiation is higher than in the control room. Furthermore, there is a gain in precision with the reduction of the attenuators positioning, not requiring the memorization of the number of attenuators to be placed before entering the room calibration, thus providing a higher quality in the calibration process. This article aims to contribute to the automation process in calibration laboratories, with the purpose of being an initial step towards safety and accuracy.

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REFERENCES

1. ABNT. NBR ISO/IEC 17025 – Requisitos Gerais para Competência de Laboratórios de Ensaio e Calibração. [s.n.], 2001.
2. INMETRO, ABNT, SBM. "Versão Brasileira do Documento de Referência EA-4/02 – Expressão da Incerteza de Medição na Calibração". 1ª ed. Rio de Janeiro: [s.n.], 1999. 35p.
3. SILVA JÚNIOR, I. A., Ramos, M. A. G., et al. "Adequação e ajuste dos elementos eletromecânicos de um gerador de radiação X para automação do sistema de filtração adicional", RADIO 2011. Anais. Recife, 2011.
4. ICRP, 1991. 1990 Recommendations of the International Commission on Radiological Protection. ICRP Publication 60. Ann. ICRP 21 (1-3).
5. PARKER TRAINING – Tecnologia Pneumática Industrial. São Paulo: [s.n.], 2000. (Apostila M1001 BR).