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Radiation Shielding Design Assessment of Nucleonic Gauges

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BACKGROUND

In recent years, several standards have been issued by different international committees in order to specify requirements for the design of nucleonic gauges taking into account issues related to radiological protection. For this purpose, the agreement with these standards should be included as part of the equipment specification to the licensing process, however, most nucleonic gauges in Brazil were installed in the period prior to the issuance of these international standards.

This study aims to evaluate the shielding performance of different models of nucleonic gauges, installed in Brazilian industrial facilities, during operational and maintenance procedures, taking into account the international standards (ISO/IEC) concerning to the constructional requirements and classification of nucleonic gauges.

METHODOLOGY

In Brazil there are several hundred of these equipments installed in at least 500 industrial facilities. Using the information available into Brazilian nuclear regulatory body database, it was selected reference industrial facilities that use a wide range of nucleonic gauges with different radioactive sources and manufacturers.

In order to assess the shielding performance of nucleonic gauges, the dose equivalent rate was determined in-loco during operational procedures. The protocol for the measurements took into account the requirements and procedures proposed by IEC 62598:2011. The maximum dose equivalent rate was determined at different distances from the nearest accessible surface using ionization chambers with different detection volumes.

In view of the specific operational conditions found at reference facilities (not covering all operational situations), the measurements obtained have been used for validation of a Monte Carlo code based on GEANT4 to allow extrapolations for other operational conditions.

RESULTS

Initially, it was evaluated different designs of nucleonic gauges developed in Brazil. The maximum dose equivalent rate was determined at the reference facility and the designs were modeled and simulated using GEANT4 Monte Carlo program, as shown in figure 1 for a specific model.

With the dose equivalent rate results to each model, the nucleonic gauges should be classified into the seven dose rates classes, as specified in the international standards. It should be noted that, according IEC standard, the equipments in class one are considered not in compliance with constructional requirements, and it should be removed from work.
The study is still in progress, in order to include other nucleonic gauge models in use in Brazil.

CONCLUSION

Nucleonic gauges can be subject to extreme environmental conditions such as high temperatures, salinity, humidity and explosive atmospheres. Aspects of the design and manufacture of these devices should be treated as an important feature for a proper approach to radiological protection.

The efficacy of a regulatory system to control radioactive sources is determined by its appropriated implementation considering the resources available, normally limited. Therefore an optimization of resources is needed. The results obtained in this study can enable the establishment of a safety indicator tool to industrial facilities, taking into account different designs of nucleonic gauges, so, this additional parameter can be used to determine and to optimize the frequency of regulatory inspections.

Country/Organization invited to participate

Brazil

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