DOSE EVALUATION IN REMOVAL AND STORAGE OF WELL LOGGING SOURCES USING AN ANTHROPOMORPHIC PHANTOM SIMULATOR

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INTRODUCTION

During the licensing process of well logging radioactive facilities in Brazil, it is necessary to submit the assessment of the building where radioactive sources will be storage in the field station (base).

The Brazilian standard does not define a basic design for the storage location. So, there are in Brazil different design configurations in well logging facilities (Figure 1).

In the maximum storage capacity, defined in their licensing process, all of these locations have sufficient shielding to reduce dose rates, on the outside, to levels below the limit for the public. However these buildings have different degrees of shielding with respect to workers entering in the premises to carry out operations of removal and storage of radioactive sources.

OBJECTIVES

In this work are presented the estimative of doses equivalent in well logging workers during the removal and storage of radioactive source, in order to optimize procedures to minimize doses in workers during these activities, and define a basic design more suitable, for the radioactive source storage.

METHODS

In this work were modeled the main designs of storage locations of radioactive sources in well logging facilities in Brazil, using the GEANT4 tools for geometry and material modeling (Figure 2).

In these storage locations, with same area, were placed 6 Am-Be neutron sources with 740 GBq (20 Ci) and 6 sources of ^{137}Cs sources with 92 GBq (2.5 Ci).

GEANT4 was used for the simulation of the passage of particles and radiations through matter and was implemented a male MIRD mathematical phantom, where the size and shape of the body and its organs were described by analytical expressions, based in GEANT4 advanced example Human-Phantom.

The simulations were performed using the version 4.9.5 of Geant4 for the Linux operating system (Scientific Linux 6.1), on processors Intel Core i7.

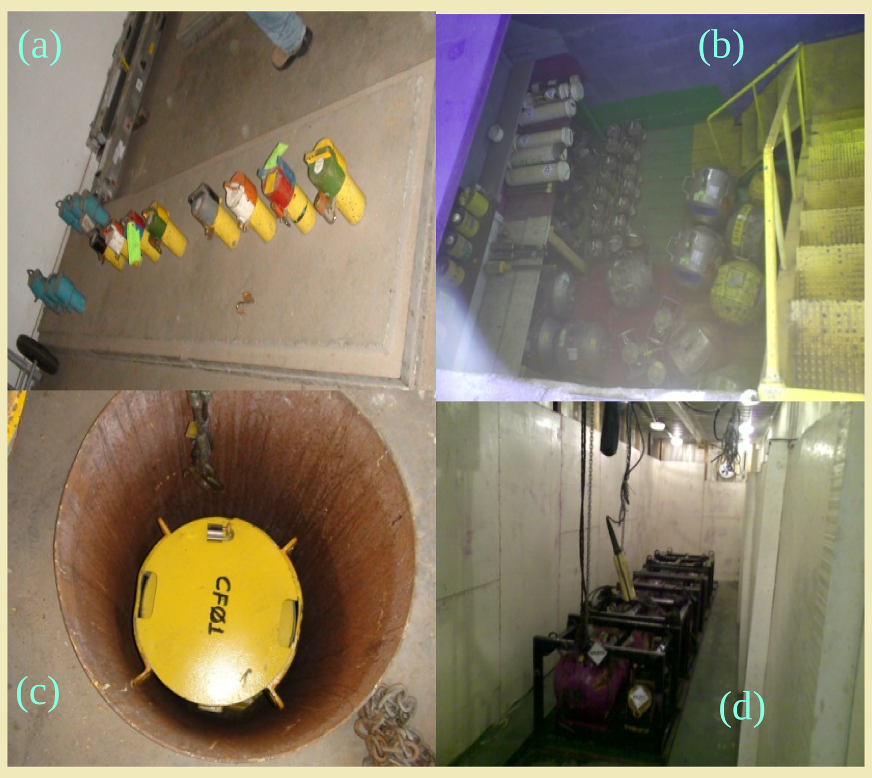

Figure 1 – Storage locations in well logging facilities.

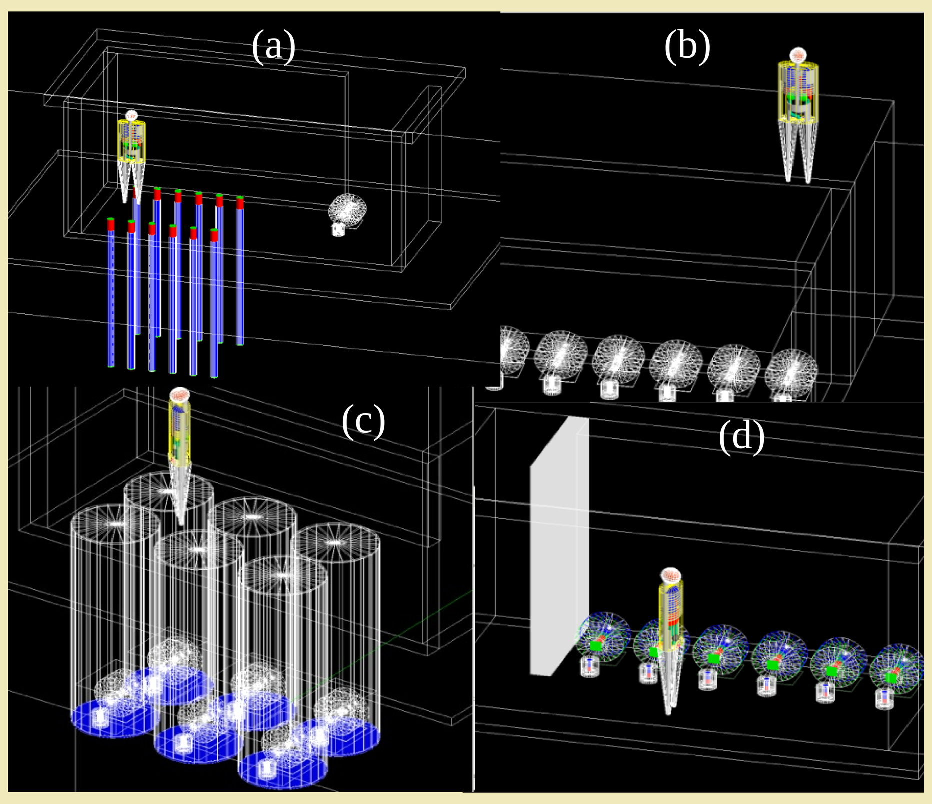

Figure 2 – Storage location simulated. (a) Radioactive sources stored outside the shipping cask in small individual steel tubes in the soil. (b) Storage location under the soil level. (c) Storage location under the soil level in multi-well configuration. (d) Storage location in maritime container concrete coated at ground surface.

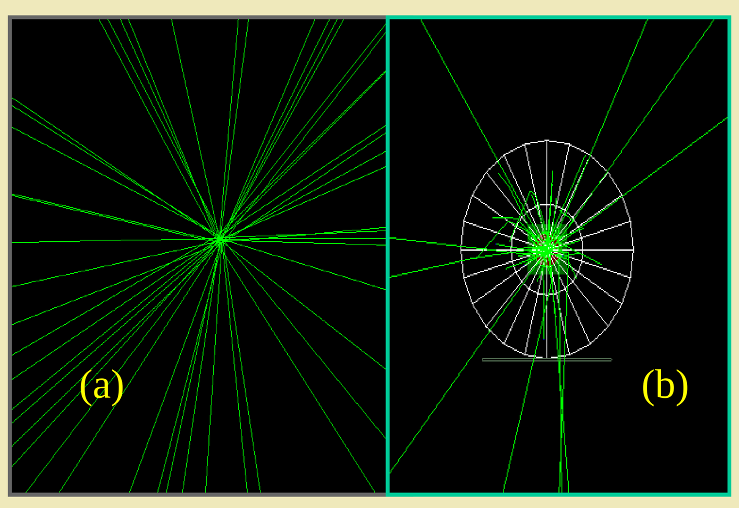

Figure 3 – Am-Be Sources: (a) without shielding and (b) in shielding source storage.

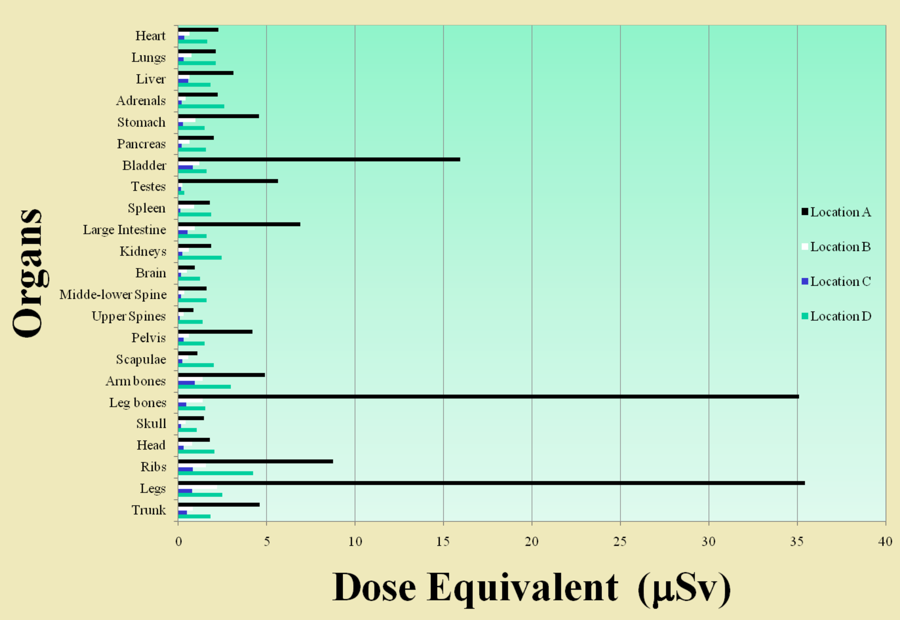

Figure 4 – Estimated dose equivalent for the removal and storage of radioactive source.

Was used a PhysicsList where the interactions of low energy neutrons (< 20 MeV) were governed by the modeling package High Precision (HP), based on data available in the Geant4 Neutron Data Library (G4NDL4.0), which provides information based on the ENDF/B-VII neutron cross section evaluation.

In this study was used the neutron weighting factor (w_R), recommended by International Comission on Radiological Protection :

$$= \begin{cases} 2.5 + 18.2\, e^{-\frac{ln(E)^2}{6}} , & E < 1\ MeV \\ 5.0 + 17.0\, e^{-\frac{ln(2E)^2}{6}} , & 1\ MeV \le E \le 50\ MeV \\ 2.5 + 3.25\, e^{-\frac{ln(0.04\,E)^2}{6}} , & E > 50\ MeV \end{cases}$$

RESULTS

For each storage location modeled, were simulated about 600 million events with the emission of gamma radiation characteristic of ^{137}Cs, and 80 million neutrons emitted with energy related to the emission spectrum of Am-Be neutron sources. Thus, it was possible to obtain the dose equivalent for each organ of interesting in the phantom body. These results was shown in Figure 4.

Analyzing this figure, it is possible to verify that the configuration of storage location where the radioactive sources are stored outside the transport container has the worst shielding efficiency when of entrance of well logging workers to accomplish the removal or storage of radioactive sources.

CONCLUSIONS

In this study, the following conclusions were observed:

The storage of radioactive sources in configurations outside of its transport container, makes that workers receive a radiation dose, often up to 10 times higher when compared with others design layouts of storage locations, when of the removal and storage of radioactive sources .

In the definition of a basic design of storage locations in the future specific Brazilian standard to licensing of well logging facilities, should be discouraged the option to build storage facilities in configuration where radioactive sources are stored outside of the shipping container.

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