

Virtual Reality Applied to Physical Protection of Nuclear Facilities

E. R. Marins¹, A. C. A. Mól², A. C. E. SANTO³
E-mail: eugenio@ien.gov.br, mol@ien.gov.br,
cotelli.andre@gmail.com

¹ SEESC/IEN; ² DIENS/IEN; ³ Centro
Universitário Carioca

Keywords: physical protection, virtual reality,
nuclear facility.

Due to the sensitive nature of its materials and processes, nuclear facilities must have a Physical Protection Plan (PPP) in order to prevent theft or sabotage. In Brazil, the National Nuclear Energy Commission applies, through a set of Standards [1], the recommendations of the International Atomic Energy Agency [2].

These standards and recommendations prescribe a methodology to develop and test PPPs. The objective is to create strategies on how to protect the facility from adversaries using hypothetical attack scenarios and assessing the effectiveness of the PPP [3].

The final two steps in evaluating the effectiveness of PPPs are the analysis of sequences of events of an attack (tabletop analysis) and the conduction of war games on the premises (Force on Force).

The limitations of these two steps of evaluation (lack of realism in tabletop analysis and the high cost and complexity of carrying out Force on Force exercises) led to the object of this study: the use of a Virtual Reality (VR) model of a facility to perform simulations, with low cost, low risk and in a highly realistic environment [4].

To assess the suitability of this new method, the model of a nuclear facility was built, in this case, of the Nuclear Engineering Institute (IEN). The virtual model was inserted in a game engine (Unity version 5) to allow the interaction between multiple characters and that of each character with the environment. These *avatars* represent the defense force members and the adversaries.

Figure 1(a) shows a building in the facility, whereas figure 1(b), its VR counterpart. Figure 2 shows the defense force's VR Central Alarm Station (CAS) and its VR CCTV screens. Figure 3 shows the interaction of a defense force member and an adversary.

To evaluate the utility of the virtual model, simulations were performed, with adversary attacks and the execution of the PPP's strategies by the defense forces. These simulations were presented to three groups: members of the

facility's real security force, members of IEN's Physical Protection Group and researchers on Human-System Interfaces. The evaluation was made with a questionnaire, whose answers were submitted to content analysis and to a classification with the Likert method. The results indicated that the virtual model is a useful tool in the evaluation of PPPs.



Figure 1: A building on the premises.



Figure 2: The defense force's CAS.



Figure 3: Characters in the simulation.

References

- [1] Norma CNEN-NN-3.01, Comissão Nacional de Energia Nuclear, 2011.
- [2] IAEA Nuclear Security Series No. 13, *Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities* (INFCIRC/225/Revision 5), 2011.
- [3] Sandia National Laboratories, *Vulnerability Analysis Methodology for Determining Physical Protection System Effectiveness*, Department of Energy, 2011.
- [4] MARINS, E. R.; *Realidade Virtual Aplicada à Proteção Física de Instalações Nucleares*; doctorate thesis, UFRJ; advisers: Landau, L.; Mól, A. C. A.; 2018.