

Using participatory design to improve control center design of research nuclear reactor

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A working system involves people interacting with and/or software, internal and external environment, processes and an organizational structure. Ergonomics tries to optimize a working system through considerations of technology, personnel, environmental variables and their interaction. Participatory ergonomics is an approach that involves experts and workers actively engaged in system development and in the analysis of ergonomics problems [1]. The system development must be done with a deep understanding of the activities performed by users, of their current work practices, of their needs and skills. Human Factors Engineering (HFE) program for nuclear industry aims to include human factors issues in the various phases of the installation design [1]. HFE seeks to obtain data on human characteristics through laboratory experiments and simulation techniques. The aim is to use this data into the design of control rooms, interfaces, equipment, for effective use by humans in comfortable and safe conditions [2]. The control center design should ensure availability of plant systems when they are needed, providing an effective assignment of functions to personnel and automation, testing based on plant performance, permitting system/equipment maintenance safely, quickly, and cost-effectively, in order to minimize the cost of operating and maintaining the plant. According to ISO 11064, the Control Centre is a combination of control rooms and local control stations, functionally connected and located on the same plant [3]. The Main Control Room (MCR) of a nuclear reactor centralizes the information about the systems and presents the necessary instructions for the control of the operational conditions of a reactor, so as to ensure its reliable and safe operation and shutdown, on both normal and accident situations. In this report we describe the development of a 3D virtual environment Control Centre of a nuclear research reactor through information obtained from experts, similar control

rooms analysis, and approaches based on human factors standards and guidelines. The main guideline used was NUREG 700 [4]. The human factors standards used were 711[2] and ISO 11064 [3]. Figure 1 shows the 3D model of the Control Centre, containing the MCR and others auxiliary rooms defined by the experts during the design method. The Control Centre modeling shows that the rooms, equipment, furniture, and operators should be disposed, considering the proper positioning of the MCR consoles and the proper view of the reactor pool in order to ensure good handling during routine operations or emergency situations.



Figure 1. Top View of the Control Centre Model

References

- [1] SANTOS, I. J. A. L. et al. Using participatory ergonomics to improve nuclear equipment design. **Journal of Loss Prevention in Process Industries**, Amsterdam, v. 24, p. 594-600, 2011.
- [2] NUREG 711, Revision 1. **Human Factors Engineering Program Review Model**, US Nuclear Regulatory Commission, 2002.
- [3] ISO 11064, International Organization for Standardization ISO. **Design of Control Centers – Part 1: Principles for the Design of Control Centers**, 2000.
- [4] NUREG 700, Revision 2. **Human System Interface Design Review Guideline**. US Nuclear Regulatory Commission, 2002.
- [5] FARIAS, L. P. et al. Human factors engineering applied to control centre design of a research nuclear reactor. In: INTERNATIONAL NUCLEAR ATLANTIC CONFERENCE, - ENFIR - Meeting on Nuclear Reactor Physics and Thermal Hydraulics, 10., 2017, Belo Horizonte. **Anais...** Rio de Janeiro: ABEN, 2017. Não paginado.