

Introduction of Human Factors Engineering Program Plan of a Research Reactor

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1. Introduction

KAERI (Korea Atomic Energy Research Institute) has a contract with Jordan to export a research and training reactor. KAERI is performing the project as an SD (System Design) and the design work has been performing by 8 design teams which include an Instrumentation and Control (I&C). A design of the MCR (Main Control Room) and the SCR (Supplementary Control Room) is being developed by the HFE design team which is a part of the I&C team. For the control room design considering the human factors principles, the HFE design team developed an HFEP (Human Factors Engineering Program) which should be established to meet regulatory requirements.

In this study, the HFEP for the JRTR (Jordan Research and Training Reactor) is introduced and the details are described.

2. Purpose of HFEP

According to NUREG-0711 Rev.2 of USNRC, the purpose of HFE program is to satisfy the following ;

- integration of HFE into plant development, design, and evaluation.
- providing HFE products(e.g., HSIs, procedures, and training) that allow safe, efficient, and reliable performance of operation, test, inspection, and surveillance tasks[4].

In the JRTR, to meet above requirements, 10 of 12 items on HFE activities of NUREG-0711 were selected, as shown in Fig. 1.

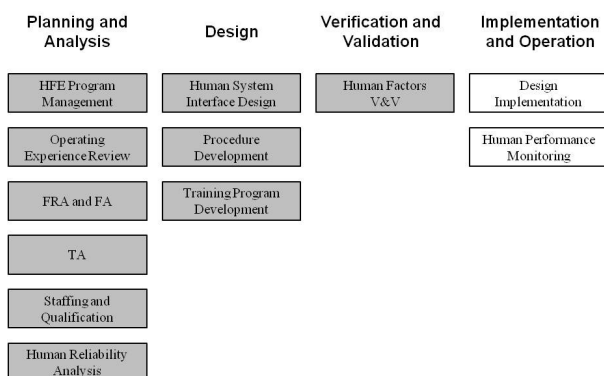


Fig.1. Selected 10 HFE activities(shaded) from 12 activities of NUREG-0711 Rev.2.

3. HFE Activities of JRTR

In this section, the scope and the plan for the above 10 elements are described.

2.1 HFE Program Management

Regarding the HFE Program Management, an organization and the role of the HFE design team of JRTR and an issue tracking system are described.

The HFE design team is included in the Instrumentation & Control (I&C) part one of the design organization. The HFE design team is responsible for all human factors concerning design activities. Other design parts, however, should cooperate with HFE design team and provide sufficient support and aid [4].

An Issue Tracking System (ITS) to manage issues which are identified during the life cycle of HSI such as design, development, and evaluation is in progress and being used. Through the ITS, it is possible to document and track human factors issues needed to manage.

2.2 Operating Experience Review

In the OER for the JRTR, the following activities are performed.

- Operation experience of HANARO which is the reference reactor of JRTR
- Operation experience of some commercial plants
- Interview with HANARO operators

The incidents analysis reports of HANARO are reviewed and analyzed. The results of the OER for Kori unit 1 which is preparing an overall improvement were analyzed and are utilized for OER of JRTR. For Items which are produced through interviews or questionnaires for operators, managers, and other personnel, problems and requests for improvements are reviewed.

2.3 Functional Requirement Analysis and Function Allocation

FRA and FA include the systems and components which are important to safety, required for safe shut down, and provided for mitigating severe accidents[4].

In an FRA the identification of safety objectives and safety functions of JRTR is performed. For this purpose, the interviews with the safety analysis correspondences and the reviews on the design documents of the JRTR are performed. In an FA stage, requirement analysis for control such as automation, a manual, and a combination of both are performed. Whether the control functions of operators, system elements, and

combinations of both are properly allocated or not is checked.

2.4 Task Analysis

In the TA, it is ensured that the requirements of actions by operators to perform MCR tasks are successfully identified and analyzed [4].

The operator input and output requirements for representative tasks of the MCR such as normal, abnormal, and emergency operations are identified. Requirements for alarms, displays and indicators, information processing, equipment operating and so on which are necessary to accomplish the MCR tasks are decided[1,2]. Hierarchical Task Analysis (HTA) and Task Decomposition methods can be used as major TA methodology.

2.5 Staffing and Qualification

The assumed number of staffing personnel of the MCR is two operators. Thus all related designs are assuming that the MCR is manned by two persons (a supervisor and a reactor operator)[1].

The staffing analysis is performed at the level of verifying the suitability of the personnel number through the results of FA and TA. Furthermore, the result of human factors validation is considered.

2.6 Human Reliability Analysis

In the safety assessment of JRTR, a qualitative safety evaluation may be mainly performed. Accordingly HRA is not performed and therefore Critical Operator Actions (COAs) are not defined. Instead of HRA, a human error possibility analysis (HEA) on the control room design may be performed. The HEA is performed to provide the input for HSI design. Also, the results of HEA are inputted into ITS.

2.7 Human System Interface Design

In the HSI design, the most emphasized step considering human factors engineering, it is verified that functions and task requirements of HSI are appropriately translated into the design by a structured methodology.

In the HSI design step, all results which are produced in the planning and analyzing steps related to the HFE activities are applied. Also the safety and convenience for operators' are considered. A design guideline for HSI design of JRTR is developed and independent style guidelines of each HSI are described [3].

2.8 Procedure and Training Program Development

In the JRTR, because of the special condition of research reactor, guidelines to meet human factors principles in developing procedures and training

programs and requirements produced from the HFE activities are provided.

Required writing guidelines of procedure to meet human factors principles are produced by international standards and guidelines. Also, for the developed procedures, a human factors review is performed to validate that procedures are adequately described with consideration on human factors.

2.9 HFE Verification and Validation

The HFE V&V applies to all HSI and workspace environment in the Main Control Room, and the Supplementary Control Room.

To identify whether the HSI is sufficiently provided to perform the assigned tasks to the operators, an HSI task support verification is performed. In addition, an HFE design verification that the HSI has designed applying human factors principles, standards, and guidelines.

It is identified by the performance based evaluation if an integrated system design satisfies the performance requirements and supports the safe operation of JRTR. During a test operation with the Jordan operators, it is checked that the design products are consistent with the results of verification and validation.

Additionally, HF issues which are derived in the design process are checked if they are acceptably addressed and resolved.

3. Conclusions

As mentioned above, the HFEPP is essentially required to provide reliable HFE products for the safe, efficient, and reliable performance of operation, test, inspection, and surveillance tasks of reactors. The JRTR project has an HF design team and the team has developed the HFEPP to sufficiently consider human factors principles to the MCR/SCR design. Accordingly, it is expected that the design of the MCR/SCR can meet the regulatory requirements and the control room can support the safe operation of the JRTR.

REFERENCES

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