

# Training and Certification of Human Organizational Factors Designers in Nuclear Plant Engineering

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## ABSTRACT

Performing an increasing number of small and large-scope nuclear Human Factors Programs, AREVA NP is facing the challenging situation that (1) well-trained experts in Human Factors or Usability Engineering are currently hard to find and (2) newly hired ones need at least two years “on the job” to become familiar with the nuclear field and the complexity of engineering Human Factors in this field.

To innovatively meet this challenge we focus instead on company-internal engineers. Demonstrated nuclear engineering knowledge and skills and pronounced interest to extend both renders them optimal applicants to the AREVA NP two years Human Organizational Factors Training & Certification program.

The AREVA NP training shall convey Human Factors knowledge and skills within the limited time of two years. We also stress the need to change participants’ mindset from a technically-biased to a human-centered approach, committed to involve end-users throughout design. Next to psychology principles, user testing, user-centered design, plant operation principles, and the acquisition and documentation of users’ requirements, design constraints, and inherent tradeoffs, participants will be trained to apply learned methods in a real environment and meet the challenges of real projects.

The following sections provide insights in the training conception and preparation phase, the identification of appropriate candidates, the development of course syllabuses, and the schedule of lectures and tests. The promising experiences made thus far are reported as well.

*Key Words:* AREVA, Human Factors Engineering (HFE), Human Machine Interface (HMI), Verification and Validation (V&V), Qualified Personnel, Training, Certification, Nuclear Power Plant (NPP)

## 1 INTRODUCTION

The practice-intensive pair of training courses described in this paper was designed by the AREVA NP group “HFE, HMI and Control Room Design” in collaboration with members of the Psychology faculty at the Karlsruhe Institute of Technology (KIT) and members of the AREVA NP Human Resources department.

The HFE/HMI group, established 2008, acquired its competencies and improved its skills in numerous new-build and plant modernization projects. Deliverables included these projects’ procedures, style guides for HMI design, implementation plans for HFE analysis, guidance and evaluation activities, and numerous design documents and evaluation reports.

The HFE/HMI group repeatedly faced the challenge of concurrent engagement in an increasing number of projects, providing HFE analyses and supporting HMI design.

As there is only a small number of experts in nuclear HFE all over the world, the number of internationally offered Human Factors training classes is limited, and none focuses on nuclear-oriented methods, processes, and applications, nor on the management of complexity, the decision was made to train and subsequently certify AREVA NP internal nuclear engineers in the area of Human Factors Engineering.

The AREVA NP training shall convey Human Factors knowledge and skills within the limited time of two years. We also stress the need to change participants' mindset from a technically-biased to a human-centered approach, committed to involve end-users throughout design. Next to psychology principles, user testing, user-centered design, plant operation principles, and the acquisition and documentation of users' requirements, design constraints, and inherent tradeoffs, participants will be trained to apply learned methods in a real environment and meet the challenges of real projects.

AREVA NP, supported by the Karlsruhe Institute of Technology (KIT), developed a one-year basic course for Human Machine Interface (HMI) designers, followed by a one-year course for Human Organizational Factors (HOF) designers. The courses combine theoretical and practical training and include classroom lectures, co-work on assignments in current projects, and personal mentoring by experienced engineers and trainers. Each training closes with a written exam, the scope and nature of which are compliant with the TÜV requirements for their personal certification process.

## **2 OBJECTIVES**

The pair of training courses "Certified HMI Designer" and "Certified HOF Designer" with a TÜV Rheinland certified qualification shall provide participants with the comprehensive knowledge of the human factors that must be taken into account in the engineering, operation, administration, and maintenance of nuclear power plants. Course participants shall acquire understanding of plant personnel roles, tasks, needs, behavior, and obligatory past experience, all of which serve as input for the design of the plant HMIs and underlie our group's efforts to enhance these HMIs' usability.

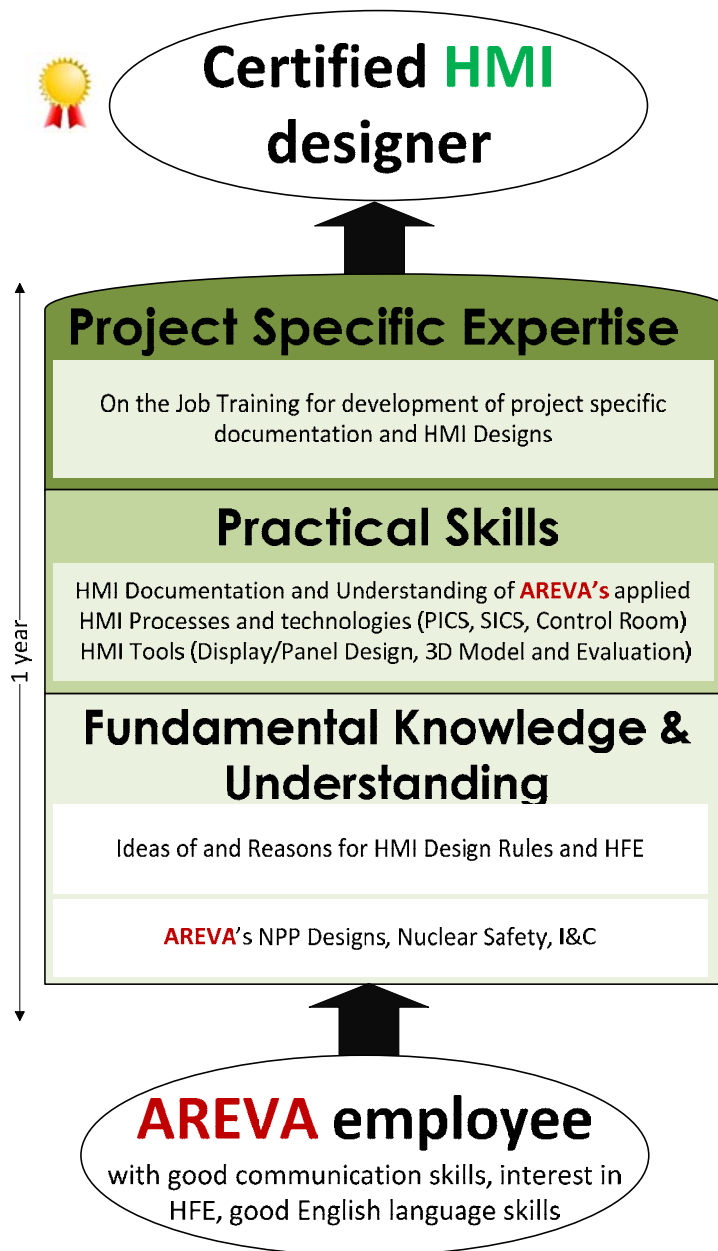
The pair of training courses shall be practice-intensive. Participants shall not be merely aware of principles, concepts, and methods but be able to apply them to perform project-specific design and review assignments professionally and effectively. Assignments range from design over the verification of design adequacy to the conductance of human-subject tests for the validation of the resulting HMIs' adequacy.

## **3 PARTICIPANTS**

Participants are AREVA NP employees, comprising process engineers, civil engineers, project managers, IT specialists, and quality managers. They completed their study at universities and gained theoretical and practical expertise in nuclear plant engineering at AREVA NP for 3 years or more. An internal assessment process was conducted by the AREVA Human Resources department. The HFE/HMI group verified applicants' technical knowledge, basic understanding of human/machine interaction and its design, and excellent communication skills.

## **4 QUALIFICATION PROGRAM "HMI DESIGN"**

The one year Qualification Program "HMI Design" took place 2016/17. The structure of the AREVA NP HMI qualification program is illustrated in Figure 1. The figure stresses the program's focus on practical skills and project-specific expertise, complementing the provision of fundamental and advanced knowledge.



**Figure 1. The AREVA NP HMI Qualification Program**

On successful completion of the HMI qualification program, participants earn the Certified HMI Designer designation, awarded by TÜV Rheinland.

The program's modules are shortly described below:

**Fundamentals:** The participants coming from different nuclear fields enroll in AREVA professional continuing education programs to complement their knowledge and skills in the fields of process engineering, I&C engineering, nuclear and plant safety, and plant systems design. In addition they will be trained in technical English writing if needed.

**HFE/HMI Understanding:** In the first training session participants are introduced to HFE and HMI Design, attend a three days introductory course in Psychology, three days on Interaction Design and lectures on the Concept(s) of Operating Nuclear Power Plants.

**Practical Skills:** Skills are acquired and trained via on-the-job training in current AREVA projects, where participants, guided by their mentors, can apply gained HFE/HMI knowledge to the field or engineering discipline they originally mastered. Parallel training sessions are conducted on Interaction Design, Ergonomics and Anthropometrics, the Design of Conventional HMIs, the Design of Computerized screen-based HMIs, the HMI Engineering Process, and Control Room Design. In addition, the applicable AREVA NP processes and tools are trained.

Throughout the year, participants shall successfully present one of the nuclear HMI/HFE standards and complete - guided by their mentor - their personalized obligatory reading list. Throughout the training, two written exams and two practical tests have to be successfully passed.

## 5 QUALIFICATION PROGRAM “HOF DESIGN”

The one year Qualification Program “HOF Design” is scheduled for 2017/18. The focus is on increasing the knowledge and understanding of Human Factors by intensive training of methods and practical experiences to allow single-handed and unaided performance of project assignments.

The program’s modules are shortly described below:

**Advanced Knowledge and Understanding:** Training sessions of the processes and standards regulatory prescribed or recommended in the nuclear field.

**Practical Skills:** Training sessions of psychological measurements methods, usability testing, interview techniques, and questionnaires design and use.

This is followed by training of the AREVA methods and processes to be applied during the

- Review of plant personnel’s Operating Experiences, the Assessment of Functions Allocation (and the Level of Automation), and the Analysis of Tasks, all of which serve as input for HMI Design
- Design Evaluation, incl. the static and dynamic Verification of Human Factors in the designed HMI and its Integrated System Validation
- Development of concepts for the functionality and form of Operating Procedures
- Design and Evaluation of Operator Training
- HFE Management.

In parallel, participants are trained on-the-job in current HFE projects and R&D (Research and Development) activities, guided by an experienced mentor and a personalized reading list. Participants are further expected to complete their R&D assignment with a final written report and an oral presentation.

Throughout the training participants must pass two written exams and two practical tests. On successful completion of the HOF qualification program, participants earn the Certified HOF Designer designation awarded by TÜV Rheinland.

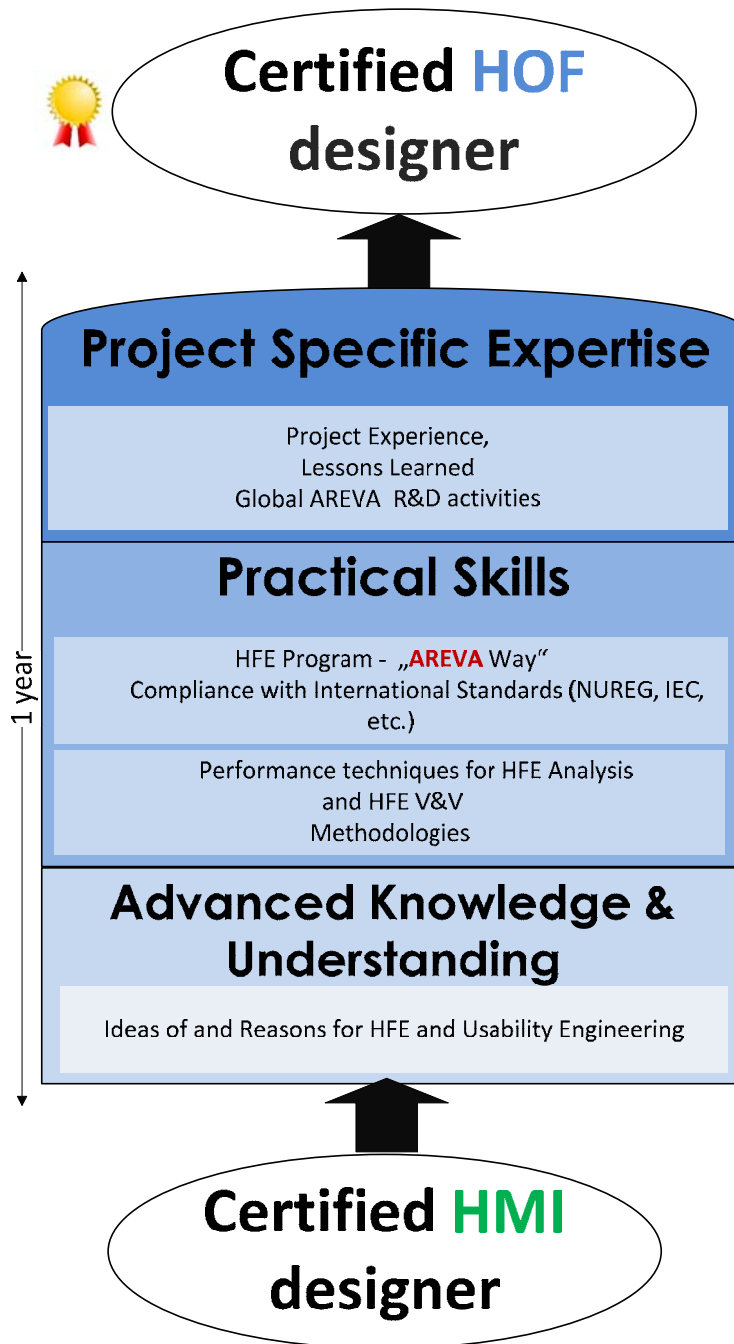


Figure 2. The AREVA NP HOF Qualification Program

## 6 VISIT TO THE SIMULATOR CENTER

Two one week visits to the Simulator Center of the German KSG/GfS in Essen are scheduled for 2017. For over 40 years, the Simulator Center – equipped with 8 plant-specific simulators and the world’s

largest facility of its type – provides training for staff of a Dutch and all operating German nuclear power plants.

As the simulators exactly reproduce the referenced plants' control rooms functionality and appearance, participants will – during the first visit – explore control room ergonomics and the various contexts of HMI use for plant monitoring and control.

In a second visit, participants will attend short lectures on the principles of engineering the systems of a (pressurized water) plant, followed by the exploration of plant operating scenarios in all conceivable operation conditions, i.e. normal operation, operational disturbances, accidents, and conditions beyond the design basis.

Operating practices, decision-making, and coordinated team collaboration (incl. shift briefing, debriefing, peer checking, and communication) will be also explored.

Short lectures prior to each scenario will explain what participants will practice. A subsequent lecture will reflect on the acquired knowledge during scenario practice.

## **7 CONCLUSIONS**

As of today, six AREVA employees, adequately skilled, participate in the first HMI Design qualification program. The campaign to recruit the right persons, open to start a career in a new field and committed to apply human factors in plant design while inspiring fellow engineers to interdisciplinary collaboration, was challenging.

The HMI Design qualification program is in its final stage and will end in May 2017. The training sessions were well accepted and covered the needed topics. A session on requirements and configuration management was added to train their application in HMI design.

The HOF Design qualification program is in the final stage of preparation together with KIT and TÜV. A smaller group of participants will attend the upcoming hands-on sessions to explore the application of taught methods and train the techniques of application.

The workload situation at AREVA NP indicates that the training described in this paper will be extended to other regions of AREVA NP. Moreover, three customers announced their intention to enroll their HFE-newcomer personnel in next year's qualification program.

## **8 ACKNOWLEDGMENTS**

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- The AREVA Human Resources department for support, funding, and the "Train the Trainer" course.