Assessing Human and Organisational Factors in new reactors

EPR Flamanville 3 experience in France

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Some lessons for HOF in design, construction and commissioning

Assessment of HOF before Authorisation Decree for NI creation (April 2007)
- in Safety Options Assessment
- in Preliminary Safety Case Assessment

Assessment of HOF before ASN decision for commissioning
Fixing the safety objectives to generation III PWR

Approval of the safety options of EPR

Feb. 2007:
Positive position of ASN on:
- Flamanville 3 project
- the draft authorisation decree

Authorisation decree for NI creation by Prime Minister

May 2006
Authorisation application for Flamanville 3 NPP by EDF
- ASN/BMU position: Common Safety Approach for Future PWR (1993) which includes Human Factors requirements
  - To take into account human factors throughout the design stage to minimise the possibilities for human errors and making the plant less sensitive to these errors
  - Adequate grace periods have to be obtained for necessary operator actions
  - To ensure consistency and tracking of human factors issues and design choices in a well-structured and state-of-the-art human factors approach thanks to a comprehensive human factors engineering program
  - To develop adequate man-machine interfaces, taking into consideration teams organization
  - To apply appropriate ergonomic design principles
GPR (Advisory Committee)/RSK assessment in 1998
- HOF Design Approach and Methodology
- Man Machine Interface Design

Assessment based on:
- Experience from previous NPP design (N4 plants, …)
- HOF state of the art and standards
- Specific references regarding Human Factors Engineering Programs, from Aeronautics (FAA), Military systems (US DoD, French Army), Nuclear industry (US NRC NUREG-0711)

Main conclusions and requirements
- HOF Design Approach and Methodology
  - To elaborate a Human Factors Engineering Program
  - To take into account tasks everywhere in the plant for operating, maintenance, testing...
- MMI Design
  - Automation and function allocation
  - Alarm system design
  - Staffing
  - Information and controls
  - Main Control Room design, Remote Shutdown Station and local control stations design
  - Documentation and procedures
GPR / German experts meeting in October 2000

- **Due consideration** to HF throughout the design stage, during the entire design, in a systematic way
- **In all locations** where men interact with technical equipment (operation, testing, inspection, maintenance,…)
- **Make plant** less sensitive to human errors, to simplify operation, to minimize human actions necessary to ensure safety functions
- **A comprehensive HFE program** has to be implemented … to ensure consistency and tracking of human factors issues and design choices …
- **Human Factors issues**: task description and analysis, allocation of functions, design of interfaces, staffing (competences, training, organisation), operator guidance (documentation, procedures), verification and validation, alarm system

Basis for “Technical Guidelines for the design and construction of the next generation of nuclear power plants with pressurized water reactors” endorsed by ASN in 2004
Preliminary safety case assessment
Performed to deliver the authorization decree

- **GPR meetings**
  - **July 2003**: Human Factors Engineering (HFE) program developed by the designer
    - Goal, scope, methodology, organisation, position and integration in the EPR project, resources, staff, deliverables, schedule, …
    - Design of MMI in the main control room and outside the MCR
  - **November 2004 and July 2006**: principles of computerized operation
    - Experimentations on a mock-up (2003)
    - Assessment of:
      - initial requirements,
      - methodological aspects of tests,
      - and of results and conclusions of the tests
Preliminary safety case assessment
Performed to deliver the authorization decree

- **GPR/ German experts meeting in 2003**
  - Review of the Human Factors Engineering (HFE) program developed by the designer

- **Assessment based on:**
  - Designer documents (EPR Technical reports)
  - Meetings with designer
  - Observation of simulation on mock-up
    - Observation of a scenario with operating team
    - Debriefing with operating team
    - Post-test discussion with HF design team

- **Main conclusions and requirements**
  - HFE program
    - Compliant with NUREG 0711 but effort to be done one implementation of the HFE program
  - Importance of HOF in activities outside the Main Control Room
Preliminary safety case assessment

Performed to deliver the authorization decree

- GPR meetings in November 2004 and July 2006
  - Assessment of Principles of Computerised operation
    - Main orientations, consistency with current experience as well as with state of the art
    - Methodological aspects of tests on simulator
    - Tasks models, user needs and design requirements, MMI specification structuring,
    - Concept of assistance in operating: Automation of operating sequences, of initial orientation and reorientation in procedures, Operating imagery
    - Taking into account operating experience from existing plants

- Assessment based on:
  - Designer documents
  - Meetings with designer and with operators who participated in tests on simulator

- Main conclusions and requirements
  - Operational communication and team organisation
  - To improve integration of existing nuclear plants feedback in the design of MMI
**Article 28**
The « licensee » of a nuclear installation is **responsible for the safety of its installation.**

**Article 29**
The authorisation to create a nuclear installation can only be given if, on the basis of present knowledge and state-of-the-art technology, the « licensee » demonstrates that provisions, as regards [...] can limit and reduce risks in a sufficient way.

« Provisions » concern both technical and organisational aspects
Article 7
The application for an authorisation of creation of a nuclear installation is submitted to the Ministers in charge of nuclear safety by the organisation that will be tasked to operate the installation. This organisation is given the status of « operator » (= responsibility of a licensee) from the moment the application is submitted.

Article 8
The application file:
- specifies who is the « operator » (= licensee applicant), name of the company, head office address, status of the person who signed the application;
- [...]  
The « licensee » has to transmit in complement to the application file a note that includes:
1°) a presentation of its technical capabilities, in particular:
   - its in-house technical resources;
   - its organisation in the nuclear field;
   - its experience in operating nuclear installations.
- Is the applicant a licensable organisation?
  - Is licensee organisation is well structured and does it have sufficient resources and competencies to manage safety?
  - Flamanville 3 situation: not a requirement (at the time of authorisation decree application, but due to new regulation, it is now a regulatory requirement)

- EPR Flamanville 3 project
  - French applicant is EDF
at the corporate level, is the only « licensee » for all present French operating plants

1. Adequate in house technical resources (numerous nuclear engineering departments)
2. EDF’s organisation in the nuclear field well known
3. Years of experience in operating nuclear facilities

No difficulty to consider EDF as an adequate « Licensee » for the application of « Flamanville 3 »

- What about new applicants in the future?
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Assessment of HOF before ASN decision for commissioning

Lessons for HOF in design, construction and commissioning
Construction regulation
ASN-IRSN activities

Authorization decree for NI creation (Apr. 07)

ASN decision for commissioning

Sept. 10

EDF operating licence application

Anticipated assessment of regulatory documents + environmental prescriptions

Final assessment of regulatory docs.

Construction

- Detailed design activities
- Inspections: on-site, manufacturers, contractors, engineering offices…
- Assessment and regulation of the hazards to adjacent operating reactors due to EPR construction activities
- Assessment of main non-compliances
- Management of events relevant to safety or radiological protection
ASN requirements

French order concerning quality management of the operator

- **“Quality” order of 10 August 1984**
  - Identification of activities important for safety and definition of requirements
  - System, Organisation and Resources
  - Competencies, training, qualification
  - Supervision of contractors
  - Control and supervision
  - Operating Experience feedback…

- **Concern all steps of installation**
  - Design, Construction, Operating, Decommissioning
Organisation and management

- In a written document, EDF shall describe its safety policy concerning the design and construction of the basic nuclear installation, called Flamanville-3.
- Such policy shall include the priority level to be given to the protection of the interests referred to in Article 28 of Law of 13 June 2006;
  
  => art. 28: “Basic nuclear installations and the transport of radioactive substances are subject to the provisions of this Title on account of the risks or drawbacks they can present for security, public health and salubrity or protection of nature and the environment”

EDF shall ensure that any person involved in the design and construction of the installation is aware of and implement the aforementioned safety policy.
Assessment performed to deliver ASN decision for the commissioning

- Assessments performed in 2008 and 2009
  - Methodology for validating computerized operation on simulator
  - Principles for a new organization of operation team
  - Human Factors integration in the design outside of the main control room

- Topics in progress (2010)
  - Validation of computerized operation
    - First tests campaign on simulator by end of 2009
    - To validate MMI for operating in MCR
    - To test also a new team organization
  - GPR meeting expected by 2012
Assessment

to be performed to deliver ASN decision for the commissioning

- Inspections of design and construction
  - Corporate level – Engineering departments
    - Safety policy and integration of safety in the design
    - OEF process, non-compliances, anomalies, events
  - On-site : Flamanville 3
    - Policy and management of safety
    - Supervision of contractors
    - Human Factors in construction activities
  - Contractors, vendors
    - Organisation, competencies, …
Assessment to be performed to deliver ASN decision for the commissioning

• **Commissioning**
  
  • Preparation of the organization and management for operating the installation after commissioning (including human factors consideration)
  
  • Meetings with EDF

  • Inspections to be performed in 2010
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Lessons for HOF in design, construction and commissioning
Main first lessons to learn from assessing HOF

- Four main phases in which to consider HOF
  - Assessment of the applicant
  - Design
  - Construction / manufacturing on-site
  - Licensee organisation before commissioning

- Main topics to consider during these phases:
  - Human Factors, Ergonomics, MMI, Organization of Team
  - Health and occupational safety
  - Managing Safety in the Design and Construction
  - Staffing - Management of Competencies
  - Supervision of contractors

- Need for appropriate regulation and control means at each phases

- Assessment of Applicant before submission of application file
  - Suitability of licensee organisational structure, resources and competencies
  - A lot of issues:
    - New comer / well known licensee
    - International licensee: what “in-house technical resources” to require?
    - Licensee owned by a financial structure: who is responsible for safety?
    - How to assess an organisation for a project that can last 100 years? Iterative process?
Main first lessons to learn from assessing HOF

Assessment of HOF aspects during design

- Main Control Room
  - Adequate simulation means at different steps before commissioning
  - Presence of safety authority or TSO during tests on simulator
- Everywhere in the plant outside the Main Control Room
- Design choices must take into account users needs and activities performed (observation and analysis of working situations in existing plants)
- To consider health and occupational safety issues in the design

HOF supervision of construction

- Safety culture issues: designers, contractors, vendors
- Planning and time pressure
- Integration on HOF in analysis of non-compliances and events
- Preventive approach based on HOF
- Importance of health and occupational safety issues

HOF and organisation: different aspects for assessment

- Global licensee organisation including contractors / vendors
- Organisation in place for integrating HOF in design and construction
- Global organisation of the future plant for operating, maintenance, etc.
- Specific organisation for operating in control room