Overview

- Human Factors (HF) Program
- Management System and Human Factors Program
- HF in NPP life cycle
- Regulatory Oversight of HF Programmes
- Regulatory challenges
- Conclusions
Human Factors Program

• There are many factors influencing Human Performance in a complex system
• Human Factors – factors that influence human performance as it relates to the safety of a nuclear facility or activity throughout the lifecycle of the facility
Goal of the Human Factors Program

To ensure that licence applicants and licensees minimize the potential for human error by addressing factors that may influence human performance
Elements of Human Factors Program

• Human Factors (HF) Programs are one of the safety areas/elements considered by regulators
• Regulatory requirements/guidance and criteria should exist
• Establishment of HF program should be accompanied by adequate Human Performance programs
• IAEA Safety Standards do not prescribe the elements of HF program
• There is a general consensus regarding the elements of a HF program, but regulatory requirements are country specific
Elements of Human Factors Program- US NRC

• Human Factors Engineering Program Management
• Operating Experience Review
• Functional Requirements Analysis and Function Allocation
• Task Analysis
• Staffing and Qualifications
• Human Reliability Analysis
Elements of Human Factors Program - US NRC

- Procedure Development
- Training program Development
- Human-System Interface Design
- Human Factors Verification and Validation
- Design Implementation
- Human performance Monitoring
Elements of Human Factors Program - CNSC

• Organizational and management structures, policies and programs
• Allocation of functions between humans and automation
• User interface design
• Staffing and job design
• Shift work systems
Elements of Human Factors Program - CNSC

• Design of written procedures
• Physical work environment
• Human reliability
• Event investigation and root cause analysis (human performance focused)
• Training
• Safety Culture
Management System and Elements of Human Factors Program

- Quality Assurance and Management System requirements contain many Human Factors related elements:
  - Organizational aspects, roles and responsibilities
  - Training, qualification, competence
  - Safety Culture
  - Human Performance
  - Communication
  - Management of organizational changes
Management System and Elements of Human Factors Program

• Regulations and licence / licence conditions contain references to specific QA/management systems (e.g. ISO, GS-R-3, national / industry QA, etc)

• In general, HF programmes elements are contained in the regulations in more general terms (e.g. sufficient number of qualified personnel, fitness for duty, etc.)
Human Factors - IAEA

• Consideration of Human Factors Program elements are included in:
  • Legally binding instruments (e.g. Convention on Nuclear Safety)
  • IAEA Safety Standards
  • Other IAEA publications

• Requirements are specific to the stage of the lifetime of the facility
• Convention on Nuclear Safety (CNS):
  • “Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.”
• Safety Fundamentals:
  • “To prevent human and organizational failures, human factors have to be taken into account and good performance and good practices have to be supported”
• How can we do this?
  • Regulatory requirements/ guidance and criteria for Human Performance Programmes should exist
• **Safety Fundamentals:**
  
  • “where control measures or operator actions are called on to maintain safety, an initial safety assessment has to be carried out to demonstrate that the arrangements are robust and that they can be relied on”
Human Factors issues should be assessed as an integral component of all stages of the licensing process, including:
- application for reviews for an initial license
- license renewal, and
- periodic assessment of licensee performance

Human factors considerations are relevant to all phases of a nuclear activity, including design, construction, commissioning, operation, maintenance, and decommissioning.
HF in Design of NPPs

• CNS

• the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth)…

• the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface
HF in Design of NPPs

• GS-R-1
• Regulatory body shall review and assess:
  • Competence and capability of the applicant
  • Quality assurance organization and programmes of the applicant/ vendors
HF in Design of NPPs

• NS-R-1
• Human Factors – Design for optimal operator performance:
  • design limits effects of human error
  • plant layout and procedures should facilitate plant-operator interaction
  • application of ergonomic principles
  • human-machine interface
  • verification and validation of HF aspects
  • criteria for information display to consider operator’s dual role (manager and operator)
HF in Design of NPPs

- design at promoting success of human actions (response time, physical and psychological demands)
- escape routes and means of communications
- main and supplementary control room
- automatic control of safety actions and protection system
- availability for taking correct operator actions in design basis accidents
- human reliability analysis as part of PSA
Regulatory Review and Assessment

• Examples of documents to be submitted by the applicant, as part of the safety case:
  • Human Factors Engineering Programme Plans
  • Verification and Validation Plans
• QA programme applied to design activities
• Regulatory approval is necessary
• What if design was completed by the vendor country, based on country regulatory requirements, which may be different of those in the buyer country?
HF in Construction of NPPs

• GS-R-1
• Regulatory body shall review and assess:
  • Adequacy of operating instructions and procedures (e.g. administrative, operating, emergency, etc.)
  • Arrangements for ensuring training and qualifications of personnel, including staffing levels and fitness for duty
  • Quality assurance organization and programme for operation
HF in Construction of NPPs

• Human Performance Programmes in support of operational phase should be required and established during the construction phase
• How should regulators determine the requirements of such programmes and how could they be validated when the facility is not fully operational?
• How to create and support safety culture during construction and commissioning?
• Verification and validation of operational procedures are a critical activity at the end of construction phase
• How much should be the regulator involved in V&V?
HF in Operation of NPPs

- CNS:
- demonstration that the installation, as constructed, is consistent with design and safety requirements
- operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures
- procedures are established …
- programmes to collect and analyse operating experience are established …
HF in Operation of NPPs

• GS-R-1
• The regulatory body shall review and assess significant safety related modifications (including organizational changes)
• Regulatory assessment of safety factors and completed periodic safety review
• Periodic Safety Review contains several safety factors related to Human Factors program elements
• NS-R-2 – contains multiple requirements for HF in operation
Regulatory Oversight of HF Programmes

• Regulatory activities related to HF Programmes should include:
  • Development of specific Human Factors and Human Performance regulatory requirements (balance between flexibility and clarity)
  • Compliance activities
    • Promotion
    • Verification (review and assessment, inspection/audit, assessment of performance indicators, licensee’s events reports, etc.)
    • Enforcement
Regulatory Oversight of HF Programmes

• Different regulatory approaches (compliance-based, performance-based, process-based) can be used for conducting the regulatory oversight of licensee’s HF Program

• Regulatory body should identify HF elements for each licensing phase and incorporate them into the overall regulatory inspection programme

• Management System audit/inspections are related to and contribute to ensuring an adequate regulatory oversight of HF programmes
Regulatory Challenges

• Develop HF and HP requirements/guidance for each licensing phase
• Assessment of HF elements for new NPP design (lack of operational feedback, V&V, organizational issues, etc)
• Awareness and incorporation of R&D in regulatory framework
• Incorporate HF elements in assessment and inspection activities
• Develop performance measurements and indicators for HF and HP
• Interference between HF requirements and other laws in the country (e.g. for fitness for duty programmes)
Conclusions

• Various IAEA Safety Standards include Human Factors related requirements and guidance

• Human Factors should be considered early in the design stage and applied through the lifecycle of the facility

• Regulatory body should develop requirements and guidance for applicant’s/ licensee’s Human Factors Programmes
Conclusions

• Regulatory process and criteria for HF assessment should be developed
• Regulatory oversight should include specific verification activities aimed at ensuring that licensee’s HF programmes are effectively implemented
• Lessons learned from Human Performance Improvements in existing NPPs should be collected systematically and used for regulatory purposes