tecnatom, s.a.

Experience of Tecnatom in

2008 LAS/ANS Annual Symposium

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Rio de Janeiro, Brazil

EXPERIENCE OF TECNATOM IN THE DESIGN OF NEW NUCLEAR POWER PLANTS

OBJECTIVE

- PARTICIPATION AND EXPERIENCES OF TECNATOM IN THE DESIGN AND DEVELOPMENT OF ADVANCED MAIN CONTROL ROOMS, PROCEDURES AND TRAINING, IMPLEMENTING HFE CRITERIA AND GUIDELINES.
- HUMAN FACTORS PLAY A SIGNIFICANT ROLE IN SUPPORTING PLANT SAFETY AND DEFENCE IN DEPTH.

DEVELOPMENT (I)

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Integration of HFE principles into NPP design, development and evaluation:

- ☒ Activities to be performed
  - ✞ Development of methodologies
  - ✞ Implementation of the methodologies
- ☒ Definition of an HFE team
  - ✞ The HFE team is independent of the Engineering Organizations

DEVELOPMENT (II)

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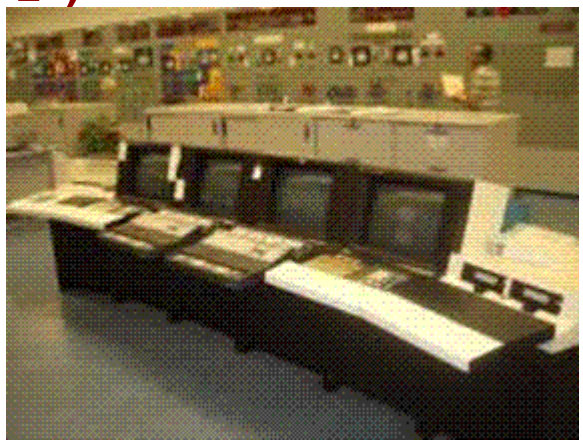
- Methodologies
  - Human Factors Engineering Implementation for the design of the Man-Machine Interfaces (MMI)
  - Plant System Functional Requirements Analysis (SFRA)
  - Allocation Of Functions (AOF)
  - Task Analysis (TA)



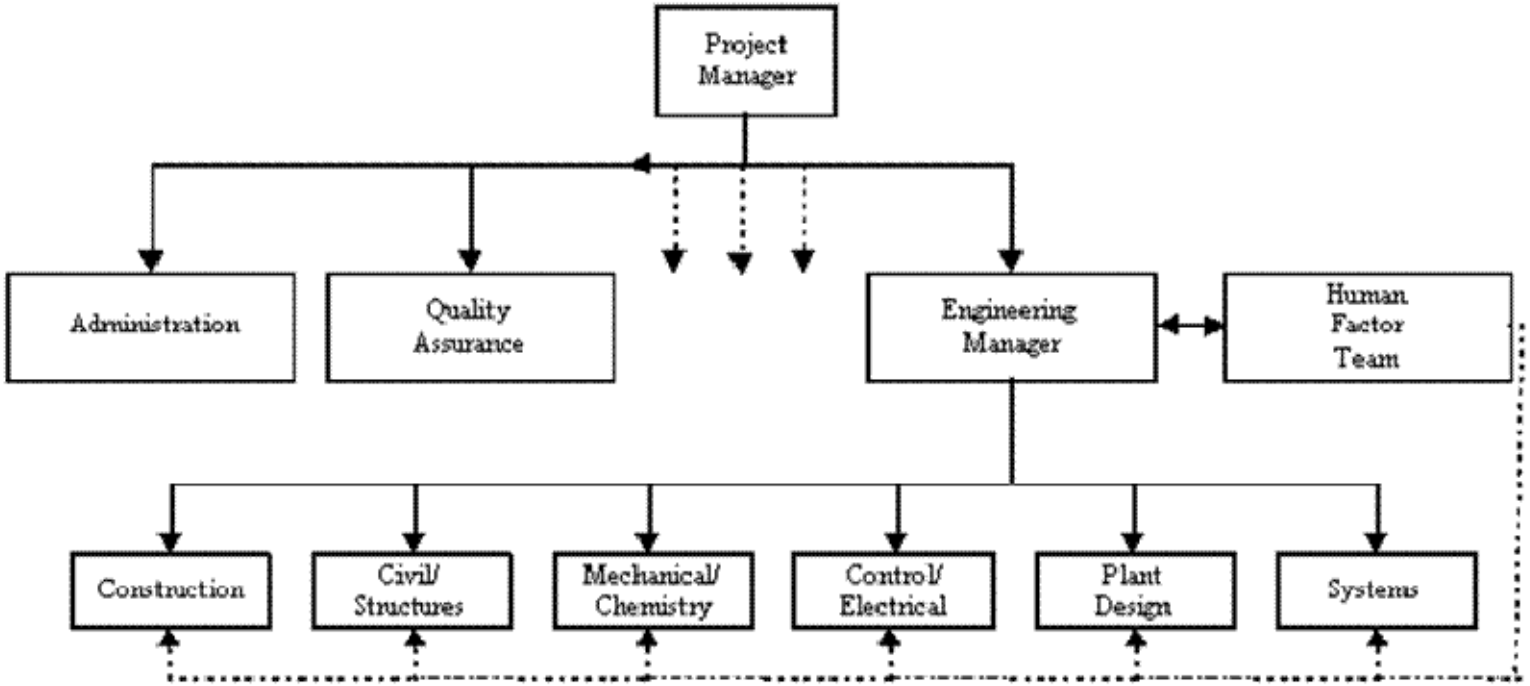
DEVELOPMENT (III)

- Methodologies
  - Human System Inter-face design (HSI)
  - Procedure development
  - Training program development
  - HFE Verification and Validation

HFE TEAM (I)

- The Human Factor Engineering Team is an independent team responsible for:
  - Reviewing all activities related to design, development and tests
  - Recommending and providing solutions from a HFE point of view
  - Assuring that the activities carried out conform to the established plans and generated procedures

HFE TEAM (II)



Typical organization

IMPLEMENTATION PROCESS (I)

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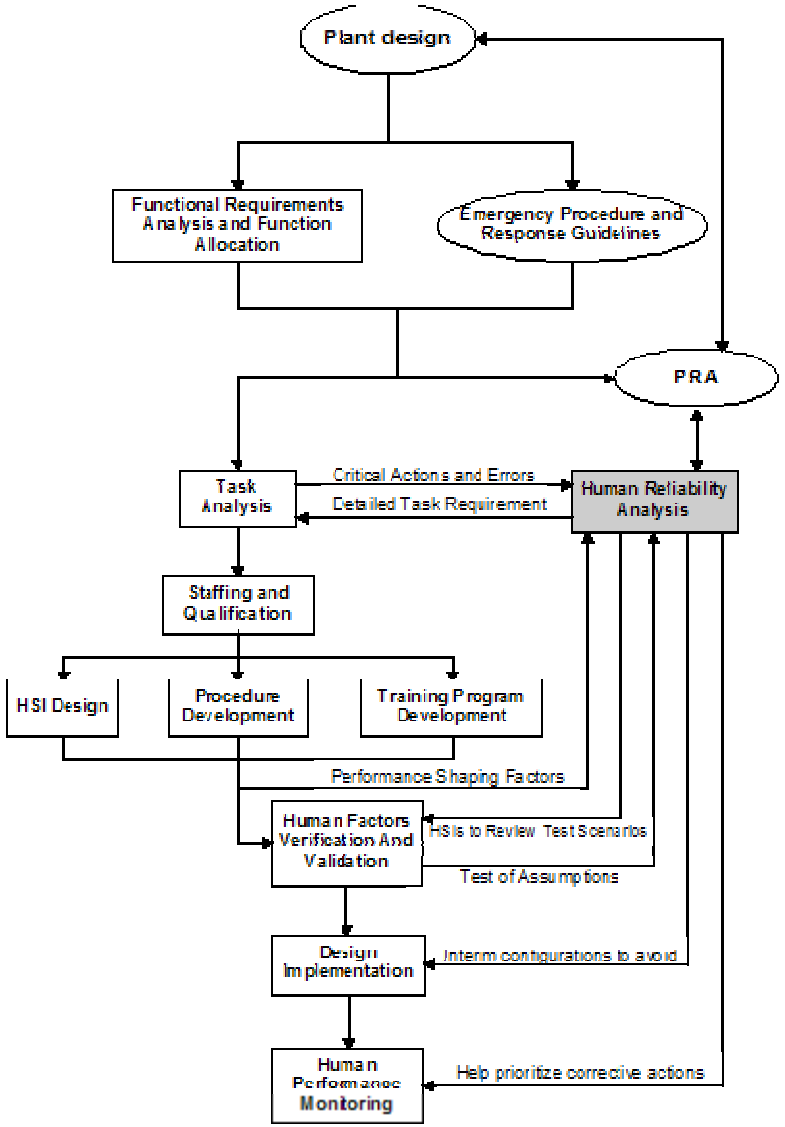

Human Factors Engineering Implementation Process (NUREG 711 Rev 2)

OPERATIONAL ANALYSIS
(First step) (I)

- System Functional Analysis (SFRA)

Identification of WHAT does the system do?

- Verify that all operating experiences and lessons learned previously identified from former designs have been incorporated in the new design
- Identification of the system functions
- Identification of the processes for each function
- Identification of the Operating Modes and Operating Mode Changes for each function

OPERATIONAL ANALYSIS
(First step) (II)

- System Functional Analysis (SFRA) (cont.)
  - Identification of the instrumentation required for performing the functions
  - List of components, with their corresponding status for fulfilling the system functions in each Operating Mode and Operating Change Mode

OPERATIONAL ANALYSIS

(Second step)

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☒ Allocation Of Functions (AOF)

Identification of WHO must do it?

- Definition of one hypothetical allocation

  (Prepared by Engineering Department)

  - Man meets core performance requirements?
  - Man meets human performance requirements?
  - Cost trade off acceptable?
  - Is HF structure adequate?
  - Is cognitive support adequate?
  - Is job satisfaction optimal?

- Evaluation of the hypothetical allocation

  - Recomendations in order to modify the level of automation

OPERATIONAL ANALYSIS
(Third step) (I)

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- Task Analysis (TA)
  - Identification of HOW to do it?
    - Initial Task Analysis
      - Operating Sequence Scenarios (OSS)
      - Task Identification
        - Coincident tasks
        - Individual activities
        - Critical tasks
        - Operating Sequence Diagrams (OSD)

OPERATIONAL ANALYSIS
(Third step) (II)

- Detailed Task Analysis

  Table Data Form containing:
  - Task Identification code
  - Activity number
  - Behavior
  - Object of action
  - Information requirements
  - Frequency of action
  - Connections with other tasks
  - Feedback requirements
  - Job performance aids
  - Communications
- HFE Analysis and results

OPERATIONAL ANALYSIS (Results)

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Output from SFRA, AOF, and TA:

- ☒ Operating Sequence Diagrams (OSD)
- ☒ Identification of Critical Tasks
- ☒ List of Instruments and Controls
- ☒ Location of Instruments and Controls in Main Control Room
- ☒ Discrepancies from the current design
- ☒ Procedure Recommendations
- ☒ Communications Requirements
- ☒ Job Performance Aids
- ☒ Operator workload

HSI DESIGN

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- Human System Interfaces Design
  - Design of the operating displays, containing:
    - P&IDs
    - Controls
    - Instrumentation
    - Trends
    - Links to other displays

V&V (I)

- Verification and Validation activities:
  - HSI Task Support Verification
  - HFE Design Verification
  - Integrated System Validation
  - Human Factor Issue Resolution Verification
  - Final Plant HFE/HSI Design Verification
- Verification:
  - Evaluation of the availability of the correct information and controls
  - Conformance of HSI to the HFE guidelines established for the HSI

V&V (II)

- Validation:
  - The control room configuration design is validated against the functional requirements
  - This process is achieved by simulating operations with a control room mockup
  - Time dependent characteristics are evaluated using a full-scope simulator

COMMENTS (I)

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- ☒ STANDARDISATION
- ☒ DOCUMENTARY CONTROL
- ☒ OTHERS

COMMENTS (II)

☒STANDARDISATION

IF THE DESIGN OF THE SYSTEMS OF THE PLANT IS NOT STANDARD THE ACTIVITIES TO BE PERFORMED BY THE OPERATOR WILL DIFFER DEPENDING ON THE SYSTEM WHICH WILL IMPLY DIFFERENT I&C FOR EACH COMPONENT, INCREASE OF TRAINING AND INCREASE OF HUMAN ERROR PROBABILITY.

COMMENTS (III)

☒DOCUMENTARY CONTROL

Inadequate management of the documentation implies the possibility of different participants in the project working with different revisions of the documentation, as a result of which there might be a number of incoherencies and the swapping of documents to correct errors that are, in fact, nothing more than different versions of the design documents.

COMMENTS (IV)

☒ OTHERS

- INCOMPLETE DESIGN INPUTS CREATES DELAYS.

- CLOSE WORK BETWEEN THE SYSTEM ENGINEERS, DISPLAY DESIGNERS AND DISPLAY BUILDERS.

- ETC.

CONCLUSION

Experience of Tecnatom in the design of new nuclear power plamts

- TECNATOM S.A.has been part of several Design and Human Factors Engineering Teams, collaborating in the design of several advanced Nuclear Power Plants.