NRC Meeting:
Human Factors Engineering

HOLTEC
INTERNATIONAL

Date: 20 June 2023

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Meeting Agenda

- Introductions
- Purpose & Outcome
- Overview of HFE Program
- OER Summary
- FRA/FA Summary
- TA Summary
- S&Q Summary
- Simulator Configuration Control
- Open Forum

Introductions

- NRC Staff

- Holtec Staff

Purpose and Outcome

- Purpose

  To provide a high-level overview of the SMR-160 Human Factors Engineering (HFE) milestones and discuss the HFE Implementation Plans.

- Outcome

  To obtain feedback from the NRC staff on the HFE implementation plans and examples of OER, FRA/FA and TA elements.

Overview of HFE Program

- The Human Factors Engineering (HFE) program is being implemented according to NUREG-0711 and related regulatory requirements.

- The first element is the Program Plan which is HOLTEC procedure HPP-160-1014.

- The schedule is proprietary and will be discussed during the closed session.

Overview of HFE Program (cont'd)

- This procedure contains 11 Appendices – one for each of the other elements of the HFE program.

- Each Appendix represents the Implementation Plan for one of the HFE program elements.

- Question: How do we submit the Implementation Plans (procedure HPP-160-1014) for NRC review and feedback?

HFE Schedule

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HFE Issues Tracking

- HFE issues are identified and tracked in the HFE Issue Tracking System (HITS), which is a web-based database. HFE issues include:

  - known industry issues (typically identified in the OER)

  - issues identified in one of the HFE program elements

  - human engineering discrepancies (HED) identified during the HFE design (typically during the V&V process)

  - issues identified during HSI design

  - issues identified via simulator modeling

OER Scope

- The OER scope includes reviews of the following inputs:
  - predecessor and related plants and systems
  - recognized industry HFE issues
  - related HSI technology
  - issues identified by plant personnel
  - important human actions (IHAs)

OER Screening and Prioritization

- OE is reviewed by a team to screen according to the following:

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                    ┌──────────────────┐
                    │  Consider Each OE │
                    │  Issue Identified │
                    └──────────────────┘
                              │
                              ▼
        ◇ Relevant to the ◇   Yes    ◇ Linked to safety ◇   Yes   ┌─────────────────────┐
        ◇  SMR-160 Design ◇ ────────> ◇ or production ?  ◇ ──────> │  Priority 1 (High)  │
                                                                    │                     │
              │ No                          │ No                    │  Must be addressed  │
                                                                    └─────────────────────┘

                                                                    ┌─────────────────────┐
                                             └─────────────────────>│ Priority 2 (Medium) │
                                                                    │                     │
                                                                    │ Consider addressing │
                                                                    │    and document     │
                                                                    └─────────────────────┘

                                                                    ┌─────────────────────┐
              └────────────────────────────────────────────────────>│  Priority 3 (Low)   │
                                                                    │                     │
                                                                    │  Does not need to be │
                                                                    │  addressed other than│
                                                                    │documenting in report.│
                                                                    └─────────────────────┘
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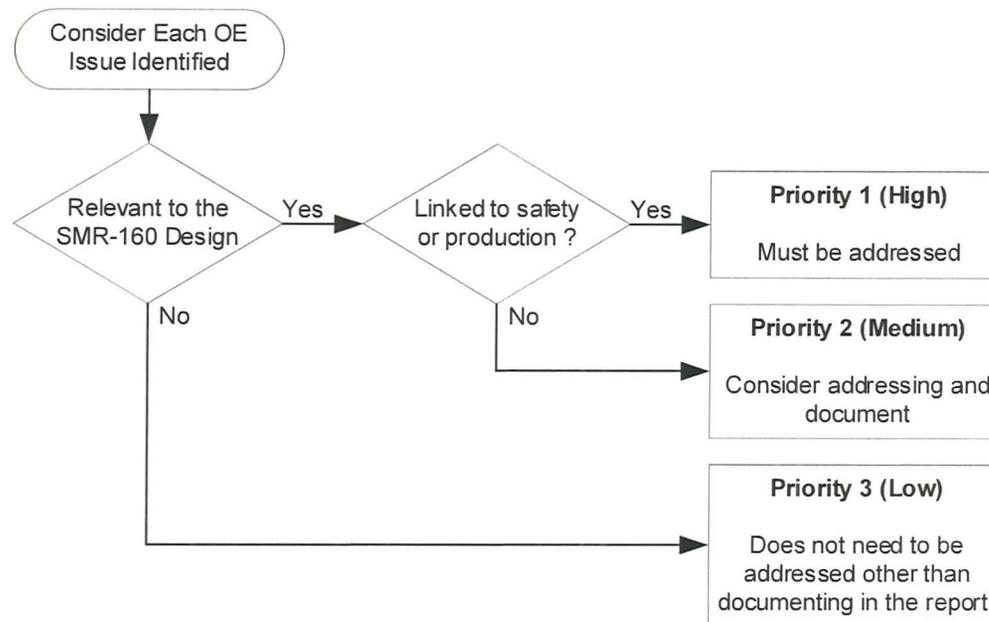
OER Priorities

■ The three priorities are defined as:

- Priority 1 issues are high priority and need to be addressed. These must have a documented way it is addressed. If it has not been addressed yet, it must be in the HITS database with a high priority.

- Priority 2 issues are moderate priority and should be assessed to determine if they should be addressed. If the issue has not been addressed yet, it should be in the HITS Database.

- Priority 3 issues are low priority and normally not considered. These issues are documented in the OER report but not entered into the HITS Database.

OER Documentation

- The OER report includes:

  - The sources of information and methodology used to perform the OER

  - Description of how the OER was conducted

  - A list of the OER-identified issues that have been or will be incorporated including any open issues from the HITS
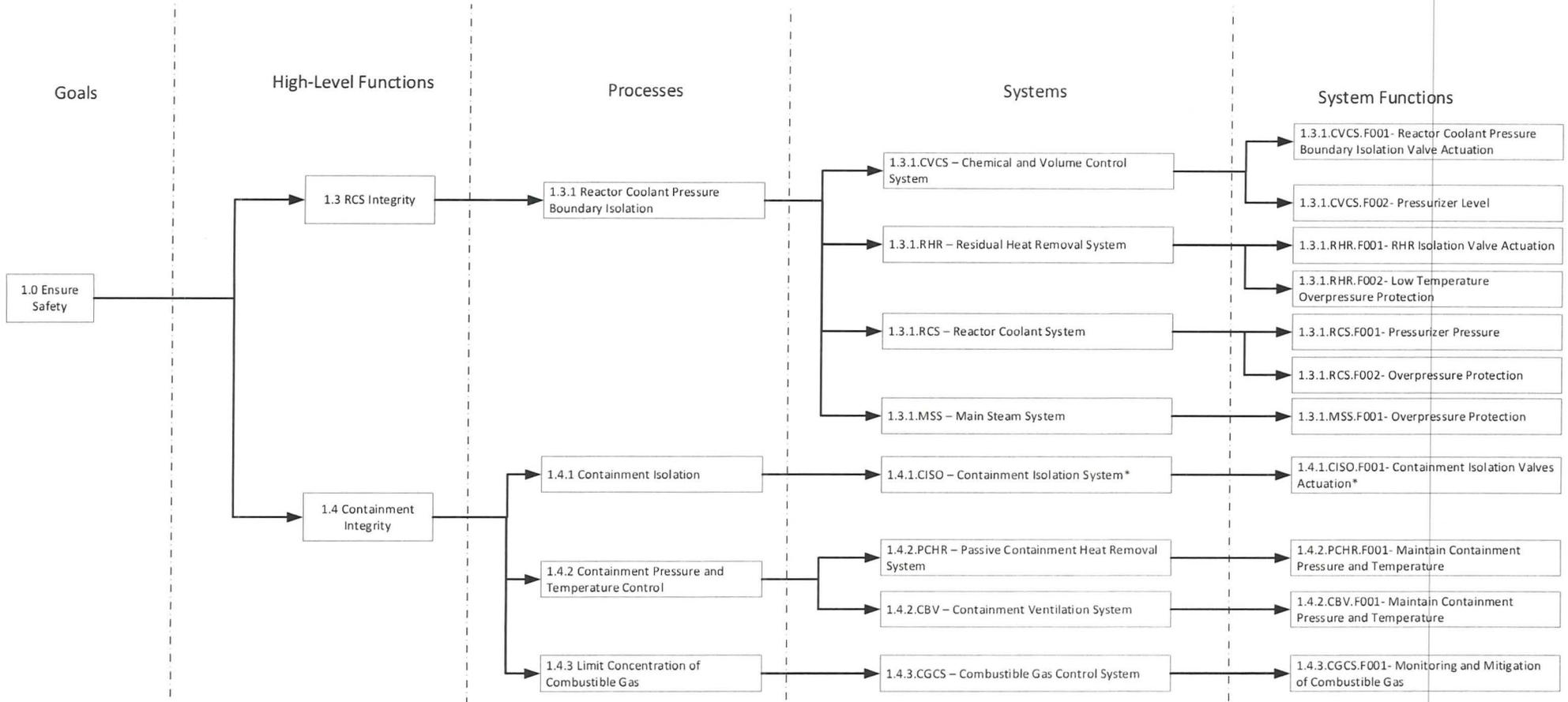
FRA/FA

- The Functional Requirements Analysis and Function Allocation (FRA/FA) defines the plant's high-level functions of safety and power production and allocates the actions to human and system resources:
    - Establish a description of the plant functions that are required to operate the plant
    - Establish the inter-relationships between plant functions
    - Describe the allocation assignment of functions
    - Assess the adequacy of functions against operational and human needs

FRA/FA Process

- Step 1: Plant Function Identification and Decomposition is performed for overall plant design to identify all the plant functions required to accomplish plant goals.

- Step 2: Functional Requirements Analysis is done for each high-level function associated with the system, the requirements are identified, and the results are captured in the Function Description Form.

- Step 3: Function Allocation divides the system functions identified in the previous steps into actions, evaluated, and allocated as automatic, manual, or shared control.

FRA/FA Plant Function Identification example

Goals	High-Level Functions	Processes	Systems	System Functions

1.0 Ensure Safety

1.3 RCS Integrity

1.4 Containment Integrity

1.3.1 Reactor Coolant Pressure Boundary Isolation

1.4.1 Containment Isolation

1.4.2 Containment Pressure and Temperature Control

1.4.3 Limit Concentration of Combustible Gas

1.3.1.CVCS – Chemical and Volume Control System

1.3.1.RHR – Residual Heat Removal System

1.3.1.RCS – Reactor Coolant System

1.3.1.MSS – Main Steam System

1.4.1.CISO – Containment Isolation System*

1.4.2.PCHR – Passive Containment Heat Removal System

1.4.2.CBV – Containment Ventilation System

1.4.3.CGCS – Combustible Gas Control System

1.3.1.CVCS.F001- Reactor Coolant Pressure Boundary Isolation Valve Actuation

1.3.1.CVCS.F002- Pressurizer Level

1.3.1.RHR.F001- RHR Isolation Valve Actuation

1.3.1.RHR.F002- Low Temperature Overpressure Protection

1.3.1.RCS.F001- Pressurizer Pressure

1.3.1.RCS.F002- Overpressure Protection

1.3.1.MSS.F001- Overpressure Protection

1.4.1.CISO.F001- Containment Isolation Valves Actuation*

1.4.2.PCHR.F001- Maintain Containment Pressure and Temperature

1.4.2.CBV.F001- Maintain Containment Pressure and Temperature

1.4.3.CGCS.F001- Monitoring and Mitigation of Combustible Gas

TA Process

- The Task Analysis (TA) takes Human Actions (HA) identified in the FRA/FA and other HFE program elements and further analyzes them to identify the tasks that personnel must perform to accomplish the HA.

- Task analysis encompasses a range of plant operating conditions, including startup, normal operations, abnormal operations, transient conditions, low power, shutdown, and refueling conditions.

TA Process (cont'd)

- The task analysis includes four major steps:

   1) Identify and Define Tasks - gathers the HAs to be analyzed and defines tasks that encompass all the HAs.

   2) Develop Task Descriptions – develops task descriptions, which include attributes about the task

   3) Analyze Tasks – refines the Task Descriptions to include enough detail to allow requirements to be developed

   4) Identify Requirements - identifies task requirements such as: information, controls, alarms or other support needed to perform the task; K&A required; workload estimates; and constraints

TA Process (cont'd)

- Each task contains 3 elements:
    1) Task Description Form documenting the HAs and task attributes
    2) Task Analysis identifying specific tasks, subtasks and actions to perform the function containing HAs
    3) Operational Sequence Diagram (OSD) to graphically shows the relationship between personnel and automated actions

S&Q

- The Staffing & Qualification (S&Q) is applicable licensed operators as defined in 10CFR55 or optimized for SMR-160.

- The SMR-160 intends to seek an exemption to the staffing guidance in 10 CFR 50.54(m) based on results of the HFE V&V and validation testing of the staffing plan. Currently no operator actions are credited for DBAs with a digital control system containing defense-in-depth monitoring, tiered alarm system and computerized procedures.

- Question: How is the workload scenario(s) for the unaffected unit determined?

OER, FRA/FA, TA examples

- Some OERs have been prioritized with examples for each priority (1, 2, and 3).
- The initial FRA/FA for major systems are complete.
- Some TAs for completed FRA/FAs have been prepared.

- Question: How do we submit examples of completed OERs, FRA/FAs and TAs for NRC review and feedback?

TA V&V

- Once the desktop simulator is ready, the HFE Verification & Validation (V&V) will begin.

- The HFE V&V will be used as part of the plant referenced simulator (PRS) testing and qualification.

- HOLTEC will use qualified Subject Matter Experts (SMEs) for simulator testing, including HFE V&V.

Simulator Testing per ANSI/ANS-3.5

- ANSI/ANS-3.5-2018 will be used to perform simulator testing.
- Section 5.1 provides details for initial construction.

- Question: Reg Guide 1.149 endorses the 2009 version, can we use the 2018 version?
- Question: Section 5.1 implies that an SME can verify the simulator configuration. What training documentation is required for an SME?

Simulator Configuration Control

- HOLTEC will have a configuration control program in place to track plant (design) and simulator changes following declaration of a PRS.

- Question: Will the NRC want to see a configuration control program during simulator development? How about after HFE V&V but prior to declaring a PRS?

Open Forum