A Conceptual Review of the Human Factors Engineering Process in the Design of APR1400 Man Machine Interface System

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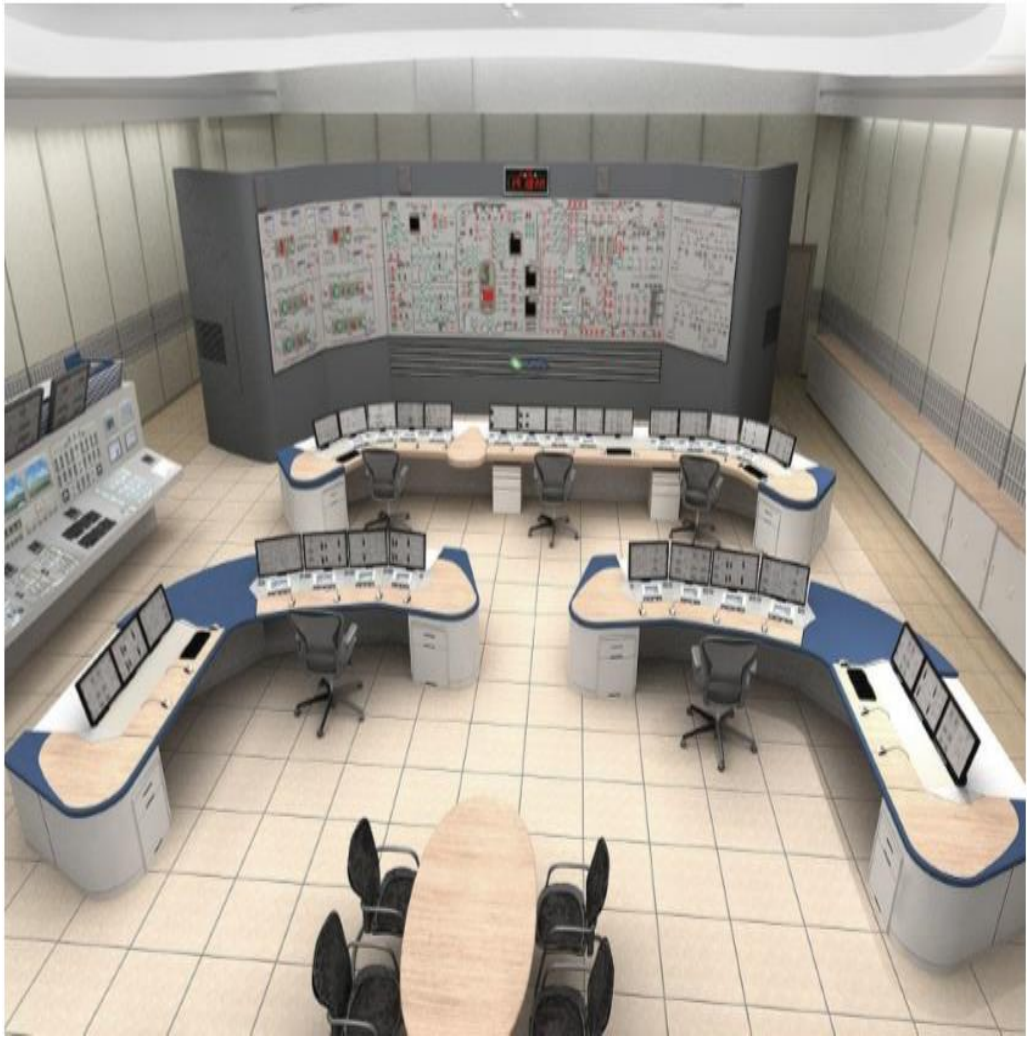
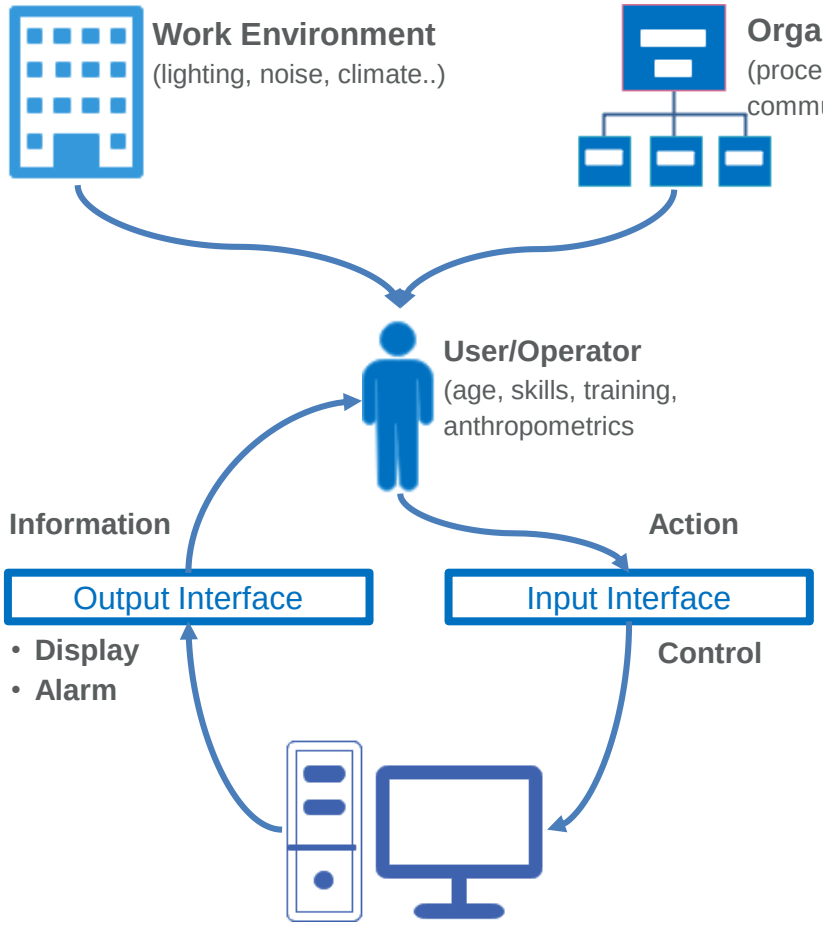
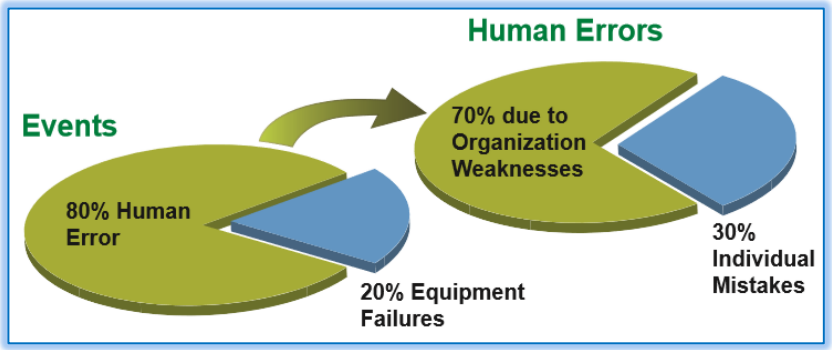


Introduction

HFE is concerned with the use of information about human characteristics, capabilities, and limitations to the design and construction of equipment, products, work systems, management systems and tasks in relation with machines, work methods, and the environment.





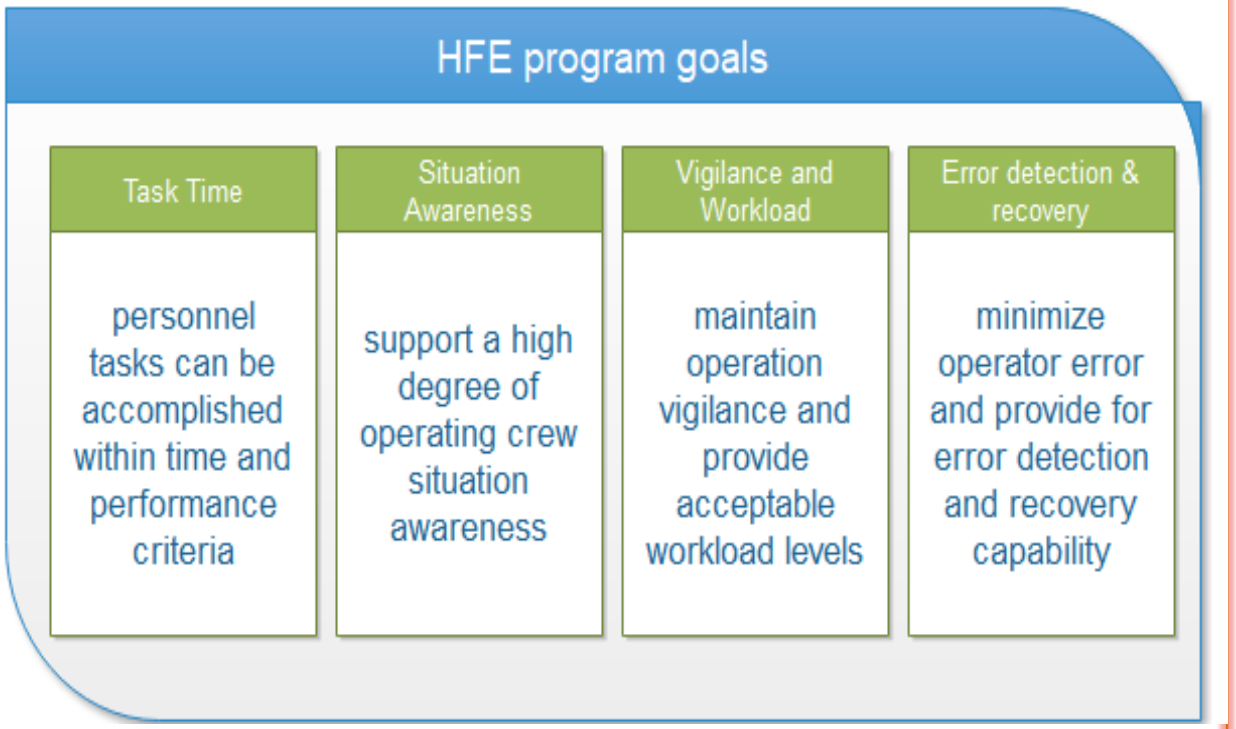
Objectives of HFE Program

Provides reasonable assurance that the HFE design effectively supports the operator and minimizes the potential for consequential operator errors.

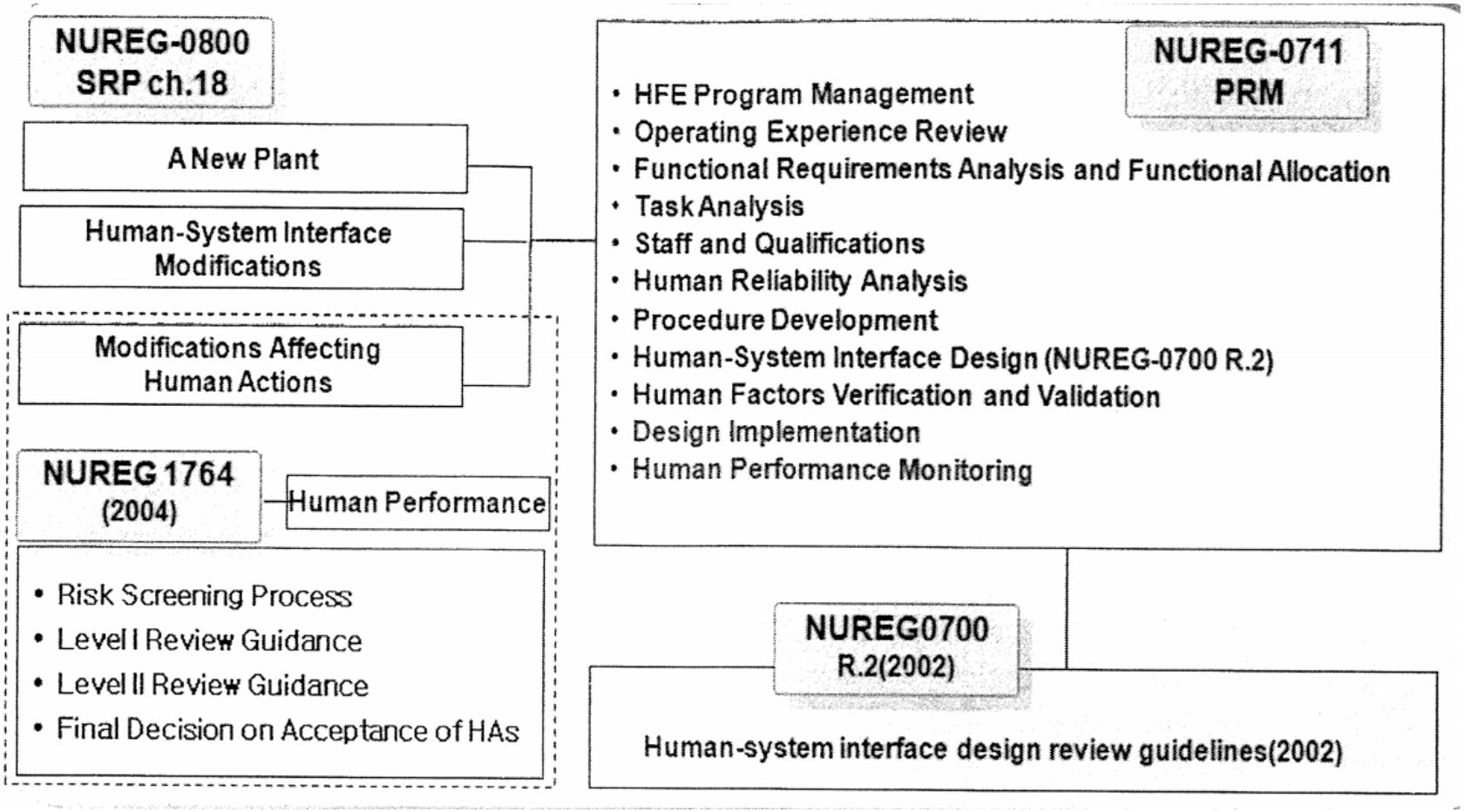
This implies that:

- ❑ HFE program must have human-centered goals
- ❑ incorporates HFE principles and methods,
- ❑ developed according to a systematic approach

Four generic human-centered design goals are:



Applicable Documents



HFE Elements

Planning & Analysis

HFE Program Management

Operating Experience Review (OER)

Functional Requirements Analysis and Function Allocation (FRA/FA)

Task Analysis (TA)

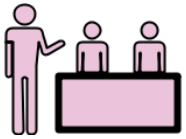
Staffing and Qualifications (S&Q)

Treatment of Important Human Action (TIHA)

Design

Human System Interface (HSI) Design

Procedure Development (PD)



Training Program Development (TPD)

V&V

Human Factors Verification and Validation

Implementation & Operation

Design Implementation (DI)

Human Performance Monitoring (HPM)

Implementation plan (IP) Result Summary Report (ReSR)

HFE Program Management

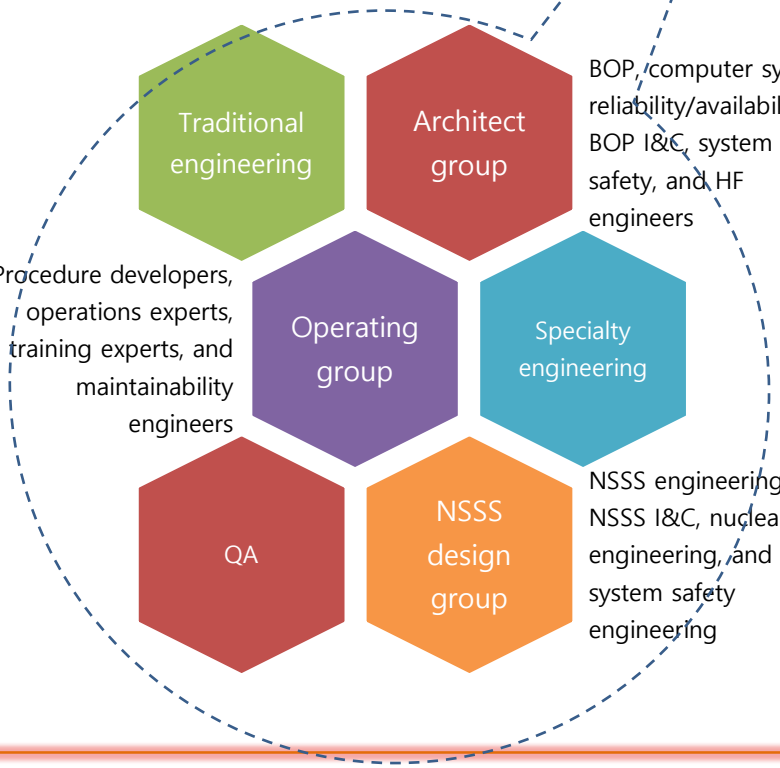
Design Team

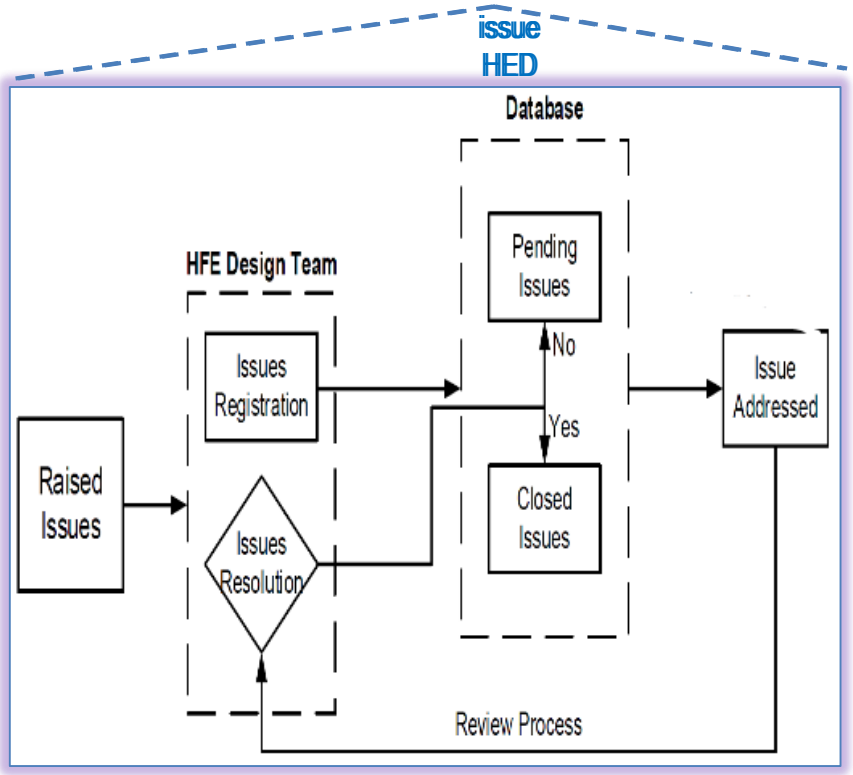
Program Plan (HFEPP)

Scope, structure (RRAQ), HFE elements integration

Management Tools

- Review & Comment System (ReCS)
- Issue Tracking System (ITS)

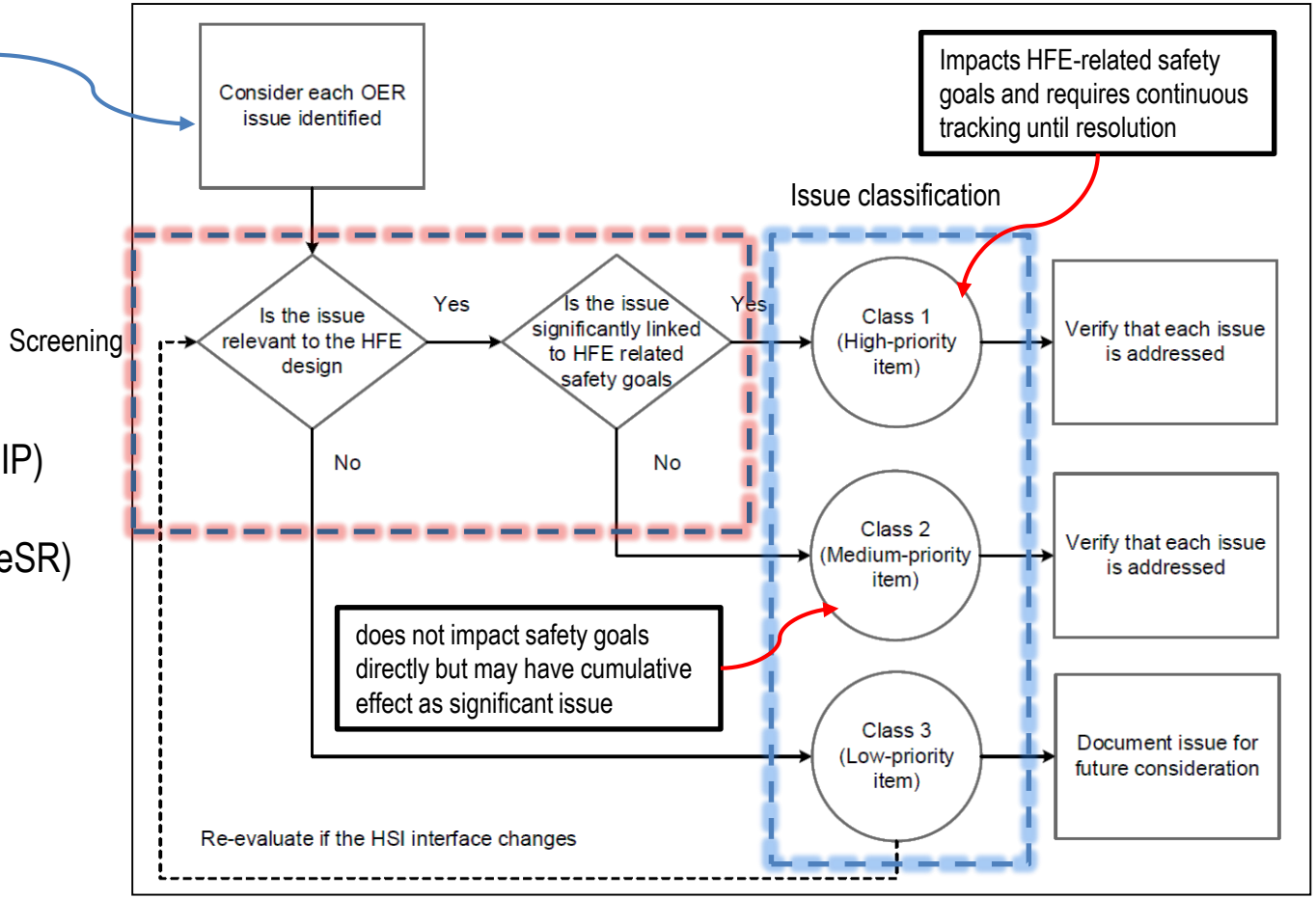




Operating Experience Review

- Objective is to identify safety issues to keep out of design and positive features to retain based on OE.

Predecessor plant OE
International OE
Domestic OE
Non-nuclear OE
U.S Fleet OE

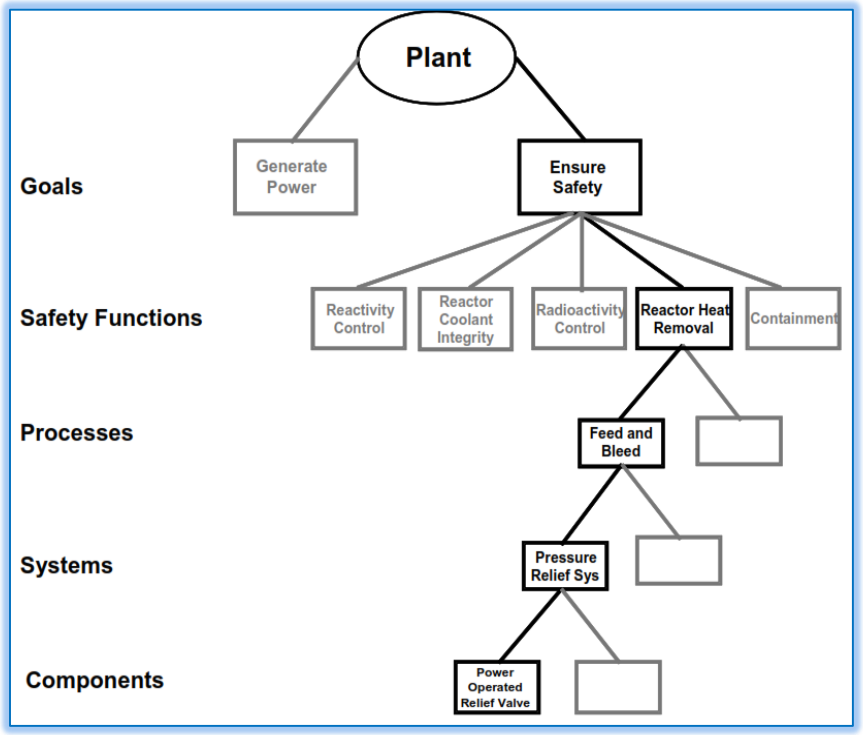


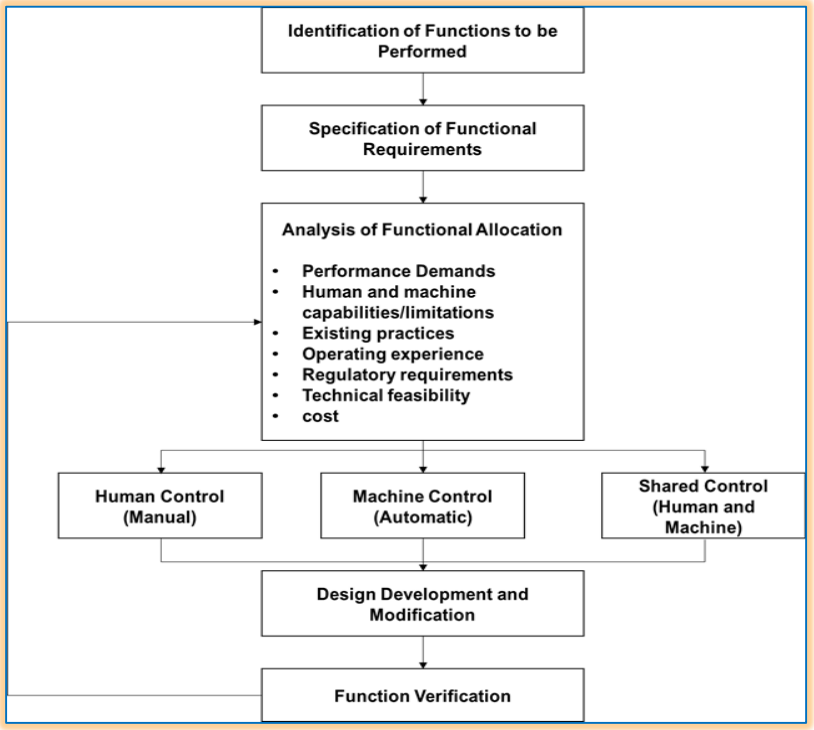
- OER Implementation Plan (IP)
- Result Summary Report (ReSR)

FRA/FA

- critical safety functions (CSF)
- critical power production function (CPPF)
- Success paths for functions

- Allocates functions to human and/or system resource





Task Analysis

- TA identifies the tasks that are needed to accomplish the functions allocated to plant operations personnel, including the tasks required to monitor and back up automated systems.

Basic task analysis (BTA)

identifies the inventory requirement for HSI elemen ts that are required for all tasks

Task timing analysis (TTA)

evaluates the operator's workload and the margin between the available time and the required time to perform the task

Identifies the HSI inventory to be implemented in the design

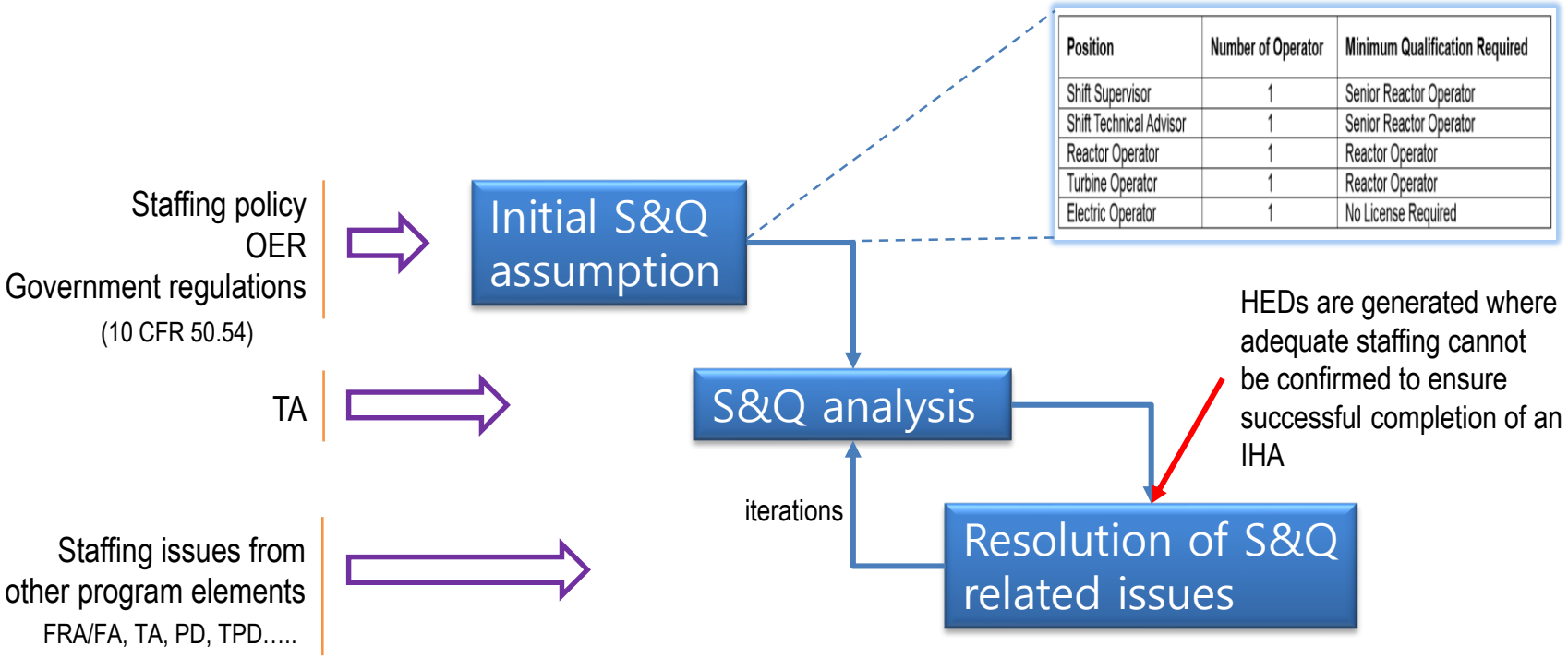
Provides input to the staffing and qualification (S&Q) program element

Confirms the FA results and resolves any HEDs generated during the FRA/FA process

Confirms the human performance assumptions for important human actions (IHAs)

Staffing and Qualification

- The goal is to determine the number and qualifications of personnel to safely operate the plant under the full range of plant conditions

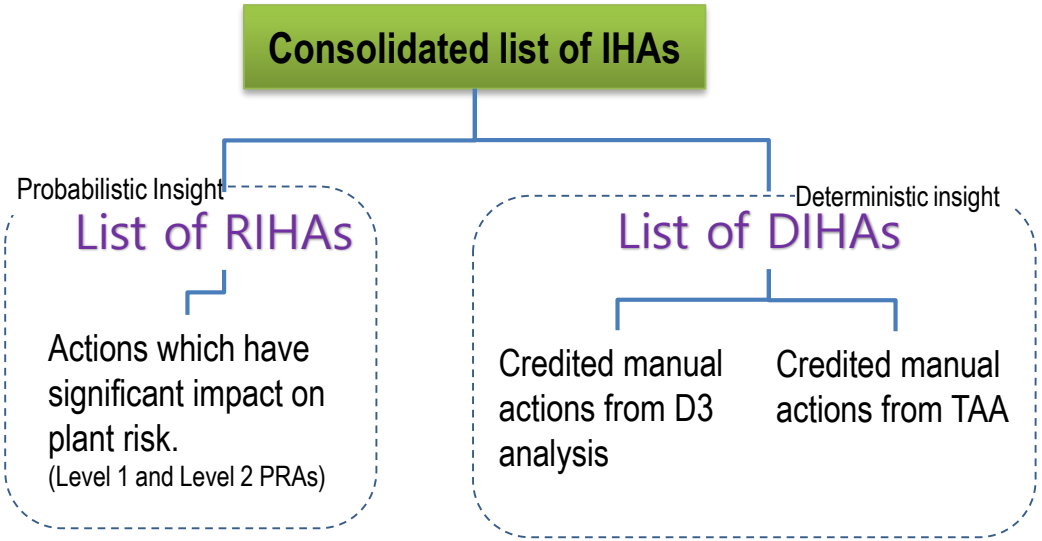


Position	Number of Operator	Minimum Qualification Required
Shift Supervisor	1	Senior Reactor Operator
Shift Technical Advisor	1	Senior Reactor Operator
Reactor Operator	1	Reactor Operator
Turbine Operator	1	Reactor Operator
Electric Operator	1	No License Required

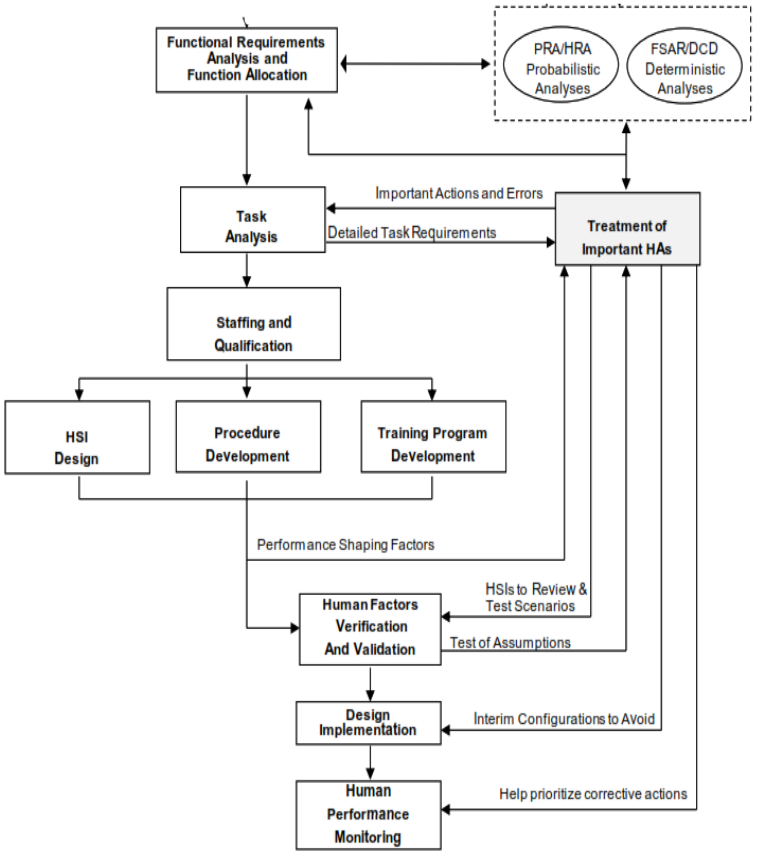
E.g
- Potential mismatch between functions allocated to personnel and their qualifications
- Too high workload to the number and qualification of crew

TIHA

- The objective is to create a consolidated list of IHAs, based on a combination of probabilistic and deterministic insights.
- Integrate into the HFE program & HSI design process in order to minimize personnel errors and enhance detection and recovery capabilities.

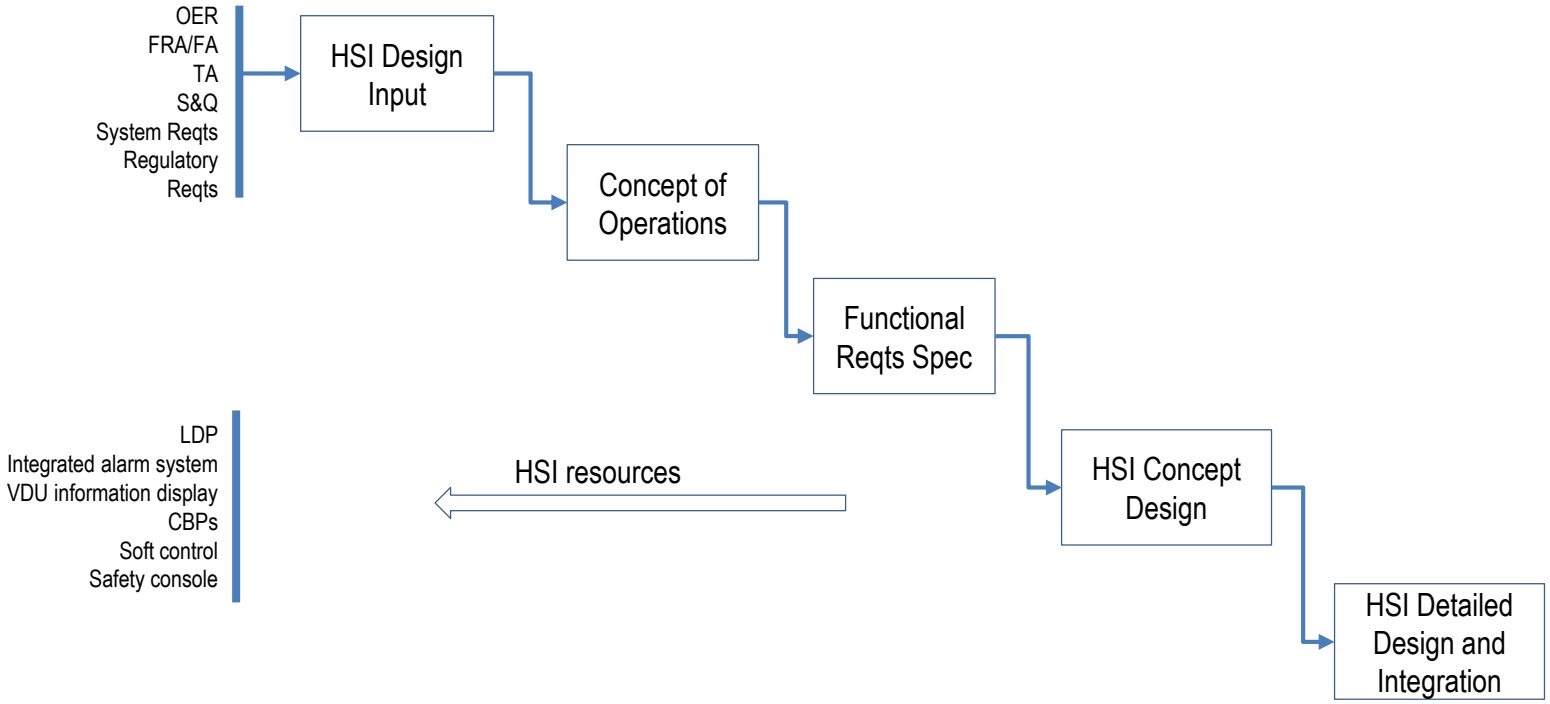


TAA: Transient and Accident Analysis
D3: Diversity and defense-in-depth analysis
Credited manual actions: mitigate an accident and achieve plant stabilization when automatic actions are not triggered



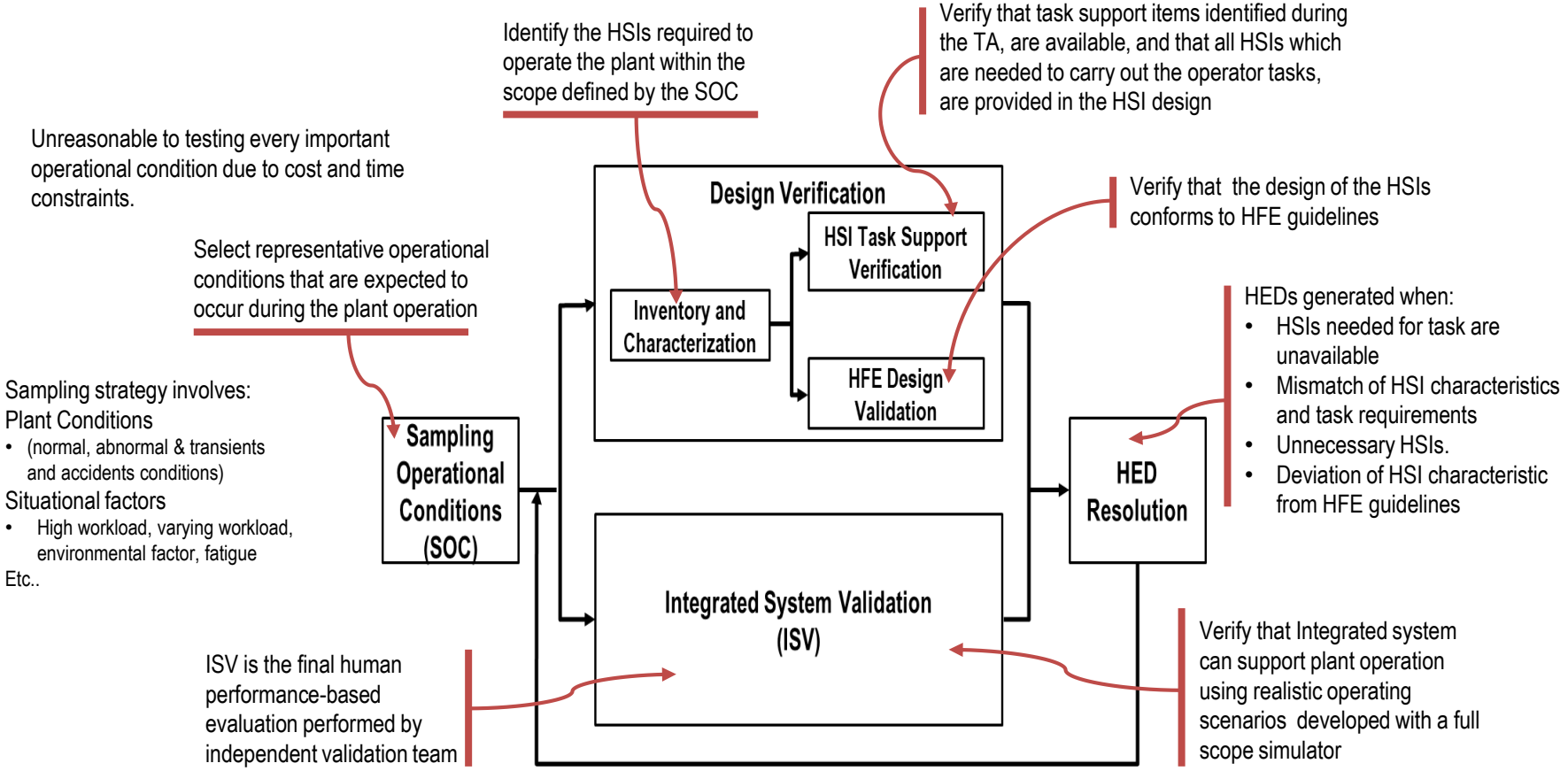
HSI Design

❑ translate plant instrumentation and control (I&C), function, and task requirements into the functional designs of the APR1400 human-system in terface (HSI) and APR1400 HSI facilities, through the systematic application of HFE principles and criteria.



HF V&V

- The purpose is to confirm that the HSI design conforms to the acceptable HFE requirements and principles and that it enables plant personnel to successfully perform tasks to achieve plant safety and other operational goals



Conclusion

- Interests and Opportunities in using AI techniques to support plant operations
- NUREG0700 provides a general framework for computerized operator support system (COSS).

COSS features include

- Surveillance and process monitoring
- Diagnosis of plant faults
- Prediction of future plant states
- Recommendation of mitigation alternatives
- Decision support in selecting mitigation actions

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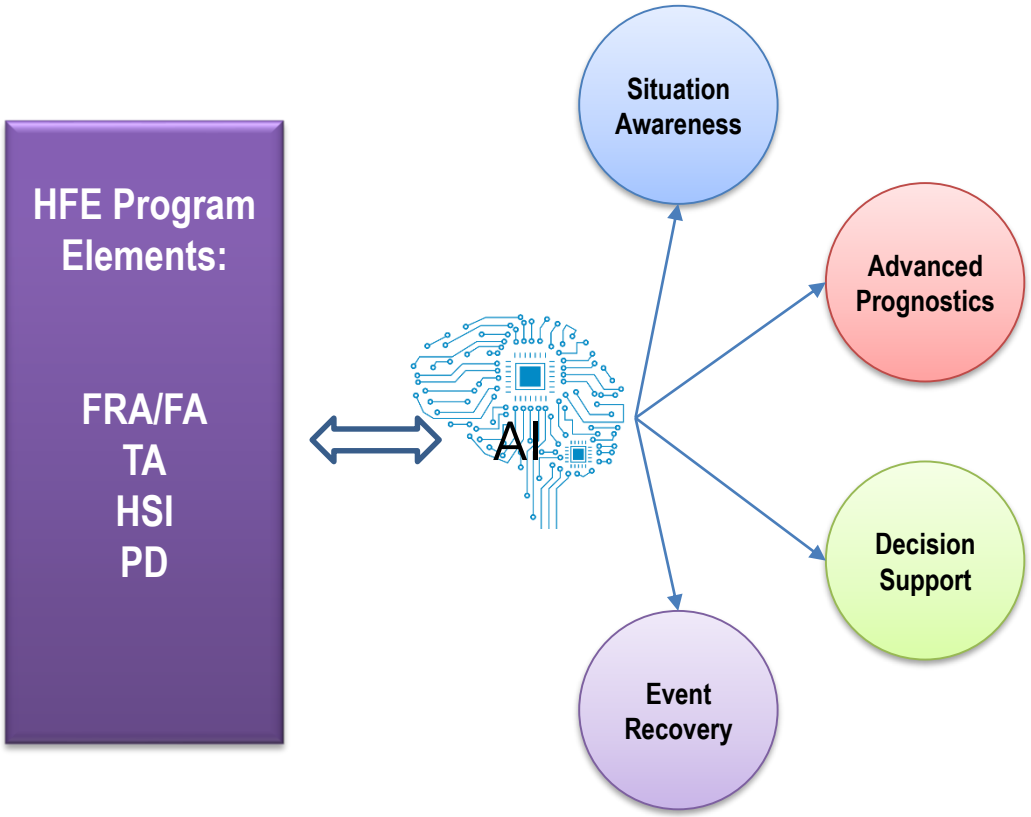

Q&A

Thank You

KINGS IAEA KHNP KEPCO