

# APR1400 HFE Documentation Improvement Status

- **Quality Improvement Plan**
- **Document Status**
  - FRA/FA
  - TA
  - TIHA
  - V&V & Scenario
- **Path Forward**

# APR1400 DCD Chapter 18

## Status of Activities in Response to the Acceptance Review

- **Presentation Outline**

- Background
  - As a result of the conclusions of the NRC's pre submittal review of the documentation supporting the APR1400 HFE program a Quality Improvement Plan (QIP) was proposed and implemented. This presentation addresses the status of this plan.
- Presentation Outline
  - Quality improvement plan
  - Document status
  - Path forward

# Document Quality Improvement Plan

## Goals

- **Resolution of Significant Issues Identified During the Acceptance Review (Implement Dec 12 Proposal). QIP activities are to:**
  - Provide a clear concise communication of respective subjects
  - Assure that all documents contain the required technical information, level of detail, acceptance criteria and measures
  - Clarify element & document interfaces, including referencing
  - Address internal and inter document consistency, including format
  - Resolve specific example issues identified by the NRC review
  - Reformat all Implementation Plans to expedite the NRC review
  - Clarify Result Summary Reports

# Document Quality Improvement Plan

## Goals (Cont'd)

- **Schedule (Full US Team Initiated May 15, 2014)**
  - Complete revision of all documents for submission to the NRC for Acceptance Review expected by December, 2014
    - All Implementation Plans
    - V&V Scenario Technical Report
    - Basic HSI Platform Technical Report
    - HFE Style Guide Technical Report
    - DCD Chapter 18, Tier 1 and 2, including ITAAC

# Document Quality Improvement Plan

## Staffing

- **US Based Team & Related Experience**
  - REH Technology Solutions
    - Robert Hall\* (HFE, PRA/HRA)
    - Tim Clouser\* (Plant Operations, HFE)
    - Ken Scarola\* (I&C, Design, CE plants)
    - Mike Boggi (HFE)
  - Westinghouse Electric Company
    - Robert Fuld (HFE, Design, CE plants)
    - Rick Turk\* (Plant Operations, Design, CE plants)

\* supported US-APWR HFE design and Ch 18 program

# Document Quality Improvement Plan

## Team Organization

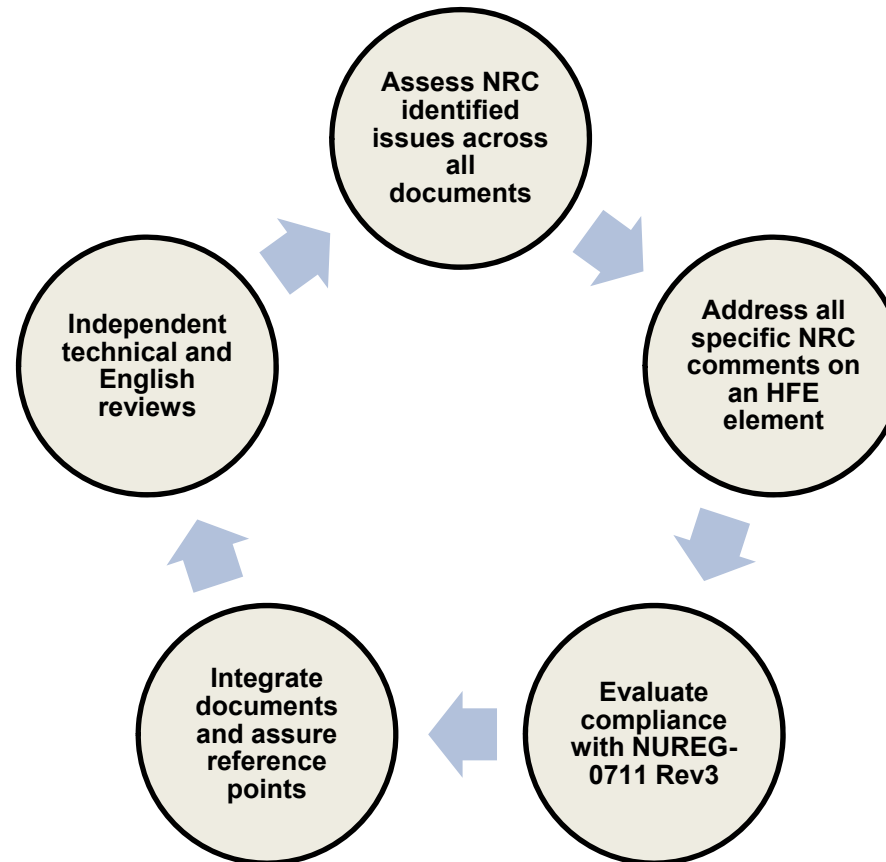
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# Document Quality Improvement Plan

## Revision Process

- 3 iterations before submission



# Document Quality Improvement Plan

Preparer & Responsible Person

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# Document Quality Improvement Plan

## Process

- **Single Responsible Person-Champion**
  - Independent internal US team reviewer
  - External KHNP & KEPCO E&C reviewers
  - Final English reviewers
- **Three review cycles before submission for NRC Acceptance Review**
- **Application of NUREG-0711(Rev. 3) Compliance Matrix**
- **Communications and Integration**
  - Weekly US team teleconferences
  - Bi-weekly KHNP/KEPCO technical and management briefings

# Document Status

## Outline of Detailed Document Status Presentations

- **FRA/FA**
  - Bob Fuld
- **TA, TIHA**
  - Ken Scarola
- **V&V**
  - Bob Hall
- **Scenario**
  - Tim Clouser

# Document Status

## Special Considerations

- **TIHA Implementation Plan**
  - Discussion of IHA acquisition process, only high level application discussion and hand off to other elements. Each HFE element will describe the details of how IHAs are addressed
- **HPM**
  - To be handed off to the DC applicants program: no IP intended, instead will be discussed in the DCD

# FRA / FA Implementation Plan

## Introduction and Outline

- **Bob Fuld, CHFP, Westinghouse Electric Co.**
  - HFE for System 80+ and AP1000 designs
- **Outline**
  - Starting point
    - Predecessor designs & high level functions
  - Process
    - Revision of original function evaluation process to account for changes, including NUREG-0711 Rev 3
  - IP Revisions
    - Compliance, completeness, clarity & consistency

# FRA / FA Implementation Plan

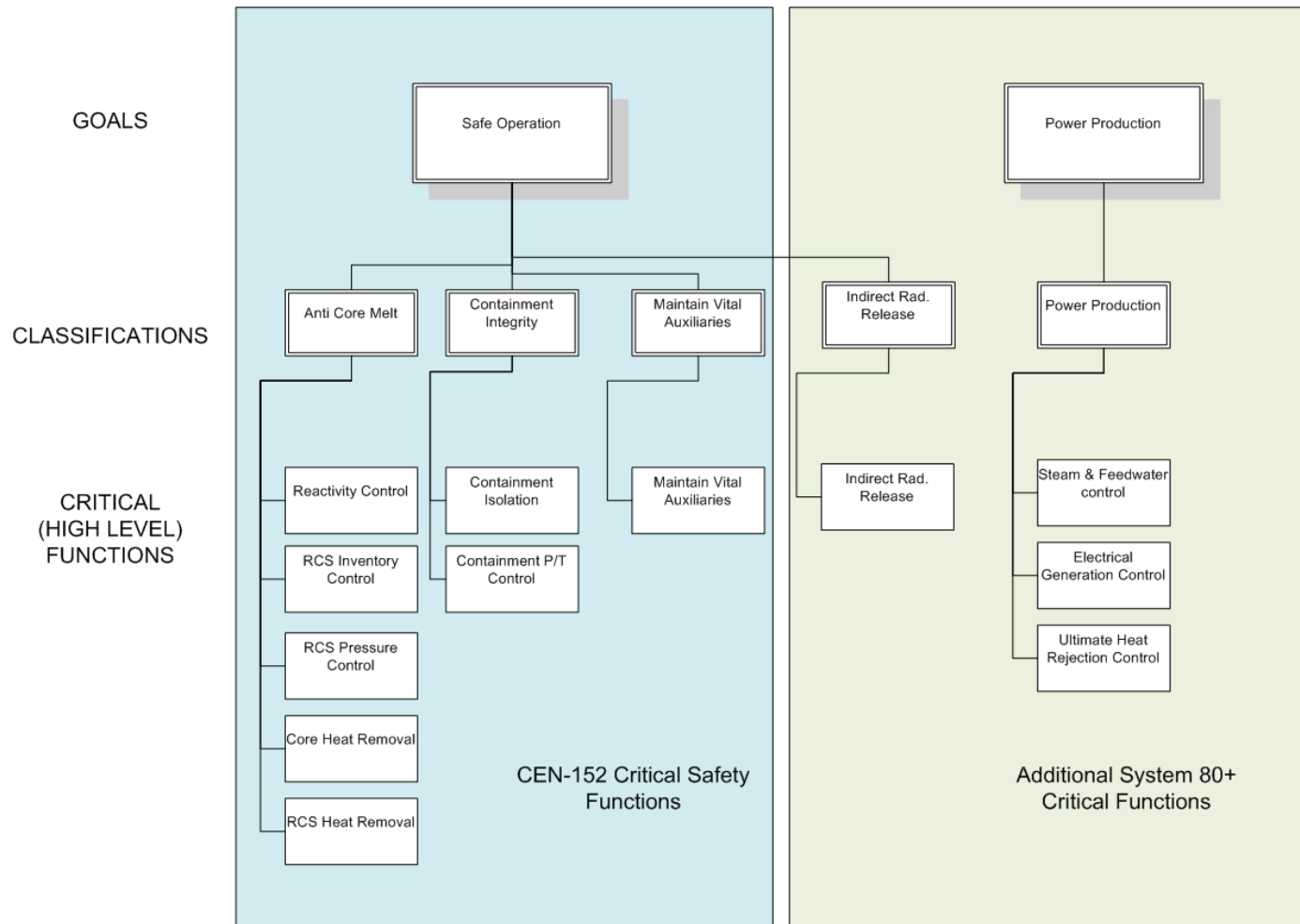
## Starting point & High Level Functions

- **Predecessor Design – System 80+**
  - Evaluation and allocation of functions report submitted and reviewed: NUREG-1462 (FSER)
- **High Level Functions Expected to be Unchanged**
  - No significant change in functional design of plant
  - Some additions and changes to success paths (processes systems and components)
    - No success paths were deleted
  - High level (critical) safety functions for large 2-loop US PWRs\* are standardized by PWROG Functional Recovery Guidelines (CEN-152)

\* ANO 2, Calvert Cliffs 1&2, Millstone 2, St. Lucie 1&2, Waterford 3, PVNGS 1,2&3, System 80 +

# FRA / FA Implementation Plan

## Starting point & High Level Functions



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# FRA / FA Implementation Plan

## Starting point & High Level Functions

System 80+ Safety Functions	APR1400 Safety Functions	Purpose
Reactivity Control	Reactivity Control	Shut reactor down to reduce heat production *
Maintenance of Vital Auxiliaries	Maintenance of Vital Auxiliaries*	Maintain operability of systems needed to support safety systems*
RCS Inventory Control	RCS Inventory Control	Keep the core covered with an effective coolant medium*
RCS Pressure Control	RCS Pressure Control	Keep the core covered with an effective coolant medium*
Core Heat Removal	Core Heat Removal	Transfer heat out of core to the RCS cooling medium*
RCS Heat Removal	RCS Heat Removal	Transfer heat out of coolant medium to another heat sink*
Containment Isolation	Containment Isolation	Close containment penetrations to prevent radiation release*
Containment Environment**	Containment Temperature and Pressure Control	Prevent overstressing the containment and damage to equipment*
	Containment Combustible Gas Control	Maintain containment integrity
Radiation Emission	Radiation Emission	Prevent radiological release from sources outside containment

\* CEN-152 FRGs are maintained by PWROG for the these high Level functions

\*\* Combined Temperature and Pressure Control with Combustible Gas Control

# FRA / FA Implementation Plan

## Process

- **Revision of System 80+ Evaluation and Allocation, with updated content and methodology to address:**
  - Any changes in high level functions (none anticipated)
  - Evolutionary design changes resulting in modifications to the functional hierarchy (i.e., changes to processes, systems and components resulting in changes to the original success paths)
  - HSI differences that result in changes to the original allocation of high-level functions
  - Operating experience incurred subsequent to the original evaluation
  - Additional information needed to address the review criteria of NUREG-0711 Rev 3



# FRA / FA Implementation Plan

Process (Cont'd)

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# FRA / FA Implementation Plan

Process (Cont'd)

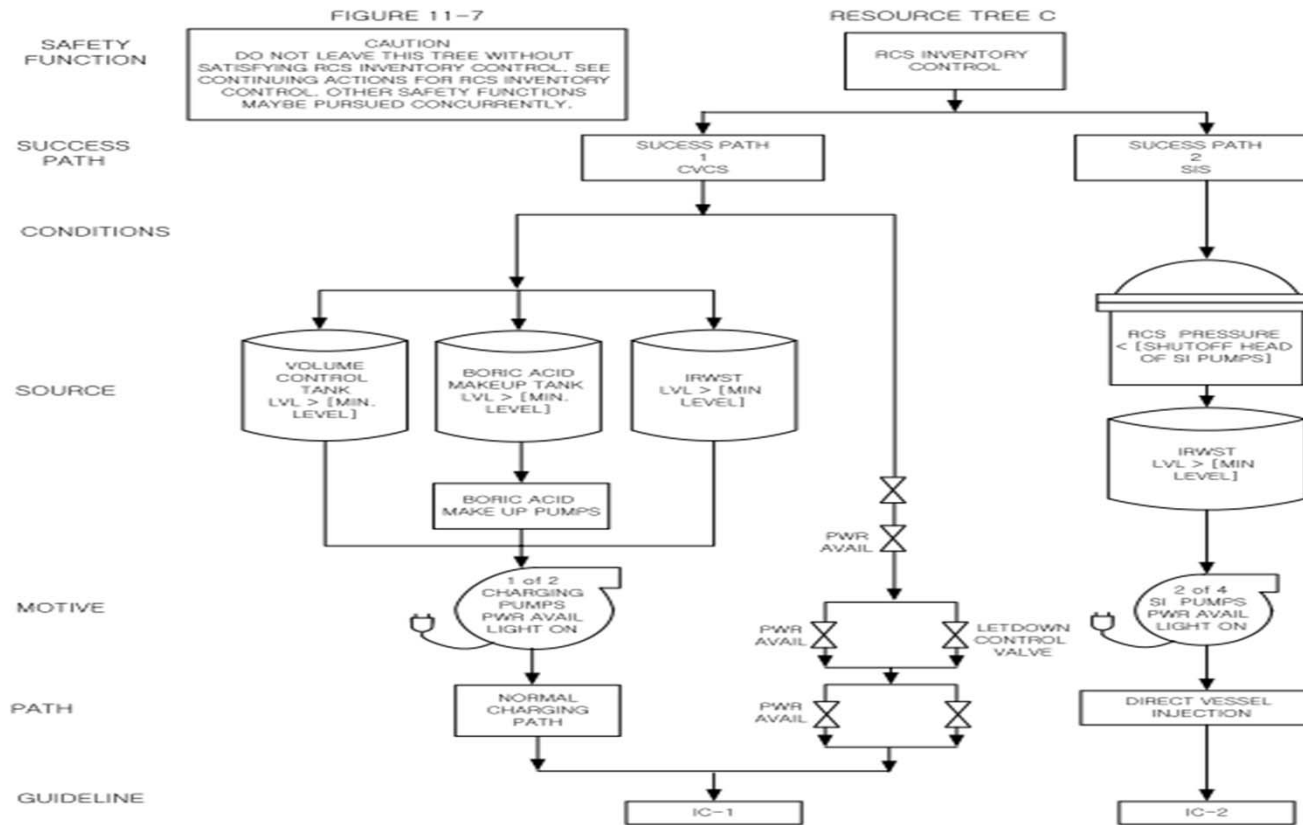
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# FRA / FA Implementation Plan

## Functional Recovery Resource Tree

- Functional hierarchy displayed graphically



# FRA / FA Implementation Plan

Function Definition Tables (FDT)

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# FRA / FA Implementation Plan

## Process

- **Analyze Function Characteristics**
  - Start with characterizations determined for System 80+
  - Review and update original characteristics to account for APR1400 design differences
  - Use decision tree approach based on NUREG/CR-3331 criteria, as for predecessor design and analysis

# FRA / FA Implementation Plan

Allocation Decision Tree

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# FRA / FA Implementation Plan

## Process

- **Specify Allocation Configuration:**
  - Automatic (Auto)
    - completely automatic, without a means for manual control.
  - Automatic-AND-Manual (AAM) (parallel configuration)
    - both manual and automatic with manual actuation at any time but no ability to defeat the automatic (e.g., reactor trip)
  - Automatic-OR-Manual (AOM) (alternate configuration)
    - both manual and automatic control with ability to select the mode of control (e.g., pressurizer spray control)

# FRA / FA Implementation Plan

## Process

- **Specify Allocation Configuration (Cont'd):**
  - Automatic-XOR-Manual (AXM) complementary configuration (i.e., shared)
    - both manual and automatic with a division of operator and system responsibilities
    - some functional overlap, but not complete redundancy. (e.g., SI automatic for inventory control and manual heat removal)
  - Manual
    - Completely manual without a means for automatic control
- **Confirmation**
  - In V&V element of HFEP: Functions, requirements & allocations



# FRA / FA Implementation Plan

## IP Revisions

- **Compliance**
  - NUREG-0711 Rev 3 Compliance matrix added
  - Define iteration triggers (e.g., submittal of COL application) to maintain analysis current
- **Completeness**
  - ITAAC to cover complete scope
  - More robust illustrative tables and figures
  - Address processes and IHAs in functional hierarchy

# TA Implementation Plan

## Introduction and Outline

- **Ken Scarola, Nuclear Automation Engineering**
  - I&C and HFE for US-APWR, Westinghouse and CE Design
- **Outline**
  - Purpose of the TA
  - Scope
  - Methodology
  - Output Interfaces
  - IP Revisions
    - Compliance, Completeness, Clarity & Consistency

# TA Implementation Plan

## Purpose of TA

- **To establish HSI inventory**
  - For display screens, alarms, controls, data processing, operating procedures, and training programs that support the accomplishment of the tasks
  - Inventory characteristics
- **To define staff number and qualifications for each task**
  - Based on Workload and Time Margin
- **To confirm human performance assumptions for IHAs in the PRA, TAA and D3CA**

# TA Implementation Plan

## Scope

- **Tasks performed by SROs, ROs, NLOs associated with the following generic procedures (no task selection)**
  - Normal operation, abnormal operation, emergency response, alarm response
    - Tasks performed with normal HSI
    - Tasks performed with degraded HSI: Loss of non-safety HSI, CCF of safety HSI
- **Includes tasks in all modes**
  - Operating, Shutdown, Refueling
- **Includes tasks at all locations**
  - MCR, RSR
  - TSC (tasks that directly support event mitigation)
  - LCS (tasks that are conducted by ROs and NLOs)
  - EOF (tasks involving voice communication w/ MCR)

# TA Implementation Plan

## Scope (Cont'd)

- **Tasks identified in other HFE program elements**
  - OER – OE issues resolved by Manual Action
  - TIHA - All tasks including
    - RIHAs from PRA
    - Credited manual actions in TAA
    - Credited manual actions in D3CA
  - FRA/FA
    - Tasks allocated to human – manual control tasks
    - Tasks allocated to machine – supervising and backup control
- **Tasks selected by Plant Operations SMEs which have challenged other operating crews**
  - Surveillance, test, inspection, and maintenance activities
  - Human actions that are not identified as IHAs, but if performed incorrectly have negative consequences

# TA Implementation Plan

## Methodology

- **Conducted by plant operations SMEs**
- **May be conducted**
  - After detailed system design is available
    - TA confirms HSI inventory, generates HEDs as necessary
  - Before detailed system design is available
    - TA establishes HSI inventory requirements

# TA Implementation Plan

## Methodology (Cont'd)

- **All tasks in scope get a Basic TA**
  - Task Narrative
    - HSI inventory overview
    - Situational performance shaping factors
    - Task support requirements
    - Time constraints
    - Number and qualifications of personnel
  - Detailed HSI Inventory Database
    - Instrument ranges
    - Alarms, controls, relative setpoints (e.g., High, High-High)
    - Trends
  - Detailed TA Assessment
    - Conducted by SMEs to identify which tasks require further analysis

# TA Implementation Plan

## Methodology (Cont'd)

- **Detailed TA Assessment selects**
  - Tasks related to human performance issues from OER
  - Tasks that directly support critical safety and power production functions from FRA
  - Unique tasks
  - Tasks with time constraints
  - Tasks requiring interaction with personnel outside MCR/RSR
  - Tasks that may challenge staffing constraints
- **Selected tasks get a Detailed TA which determines**
  - Workload
  - Time Margin
  - HEDs are generated for excessive Workload or inadequate Time Margin



# TA Implementation Plan

TA Output Interfaces

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# TA Implementation Plan

## TA Output Interfaces (Cont'd)

- **Procedure development (responsibility of COL applicant)**
  - HSI inventory for each operative instruction or action
- **Training development (responsibility of COL applicant)**
  - Based on tasks identified in TA as posing
    - Unusual demands
    - Unique tasks
    - High workload
    - Special skills

# TA Implementation Plan

## Defines Content of Results Summary Report

- SMEs names and qualifications
- Principal findings of TA
- Specific tasks selected by SME judgment
- Basic TA Results
  - Task Narratives, Inventory, Detailed TA Assessment
- Detailed TA Results
  - Workload, Time Margin
- Confirmation of IHAs
- Description of each HED
- Documented independent review

# TIHA Implementation Plan

## Purpose of TIHA

- To describe how IHAs are extracted from
  - PRA
  - TAA
  - D3CA
- Describes (at a high level) how IHAs are addressed in subsequent HFE program elements:
  - Functional Requirements Analysis and Function Allocation (FRA/FA)
  - Task Analysis (TA)
  - Staffing and Qualifications (S&Q)
  - HSI Design (HD)
  - Human Factors Verification and Validation (V&V)
  - Design Implementation (DI)

# TIHA Implementation Plan

## Defines Content of Results Summary Report

- SMEs names and qualifications
- RIHAs with HFE characteristics assumed in PRA
- DIHAs, the source of those DIHAs in the TAA or D3CA, the assumed HFE characteristics, the time available, and the basis for concluding any HAs identified in those analyses are not DIHAs
- Documented independent review

# Human Factors Verification & Validation

## Introduction and Outline

- **Bob Hall, REH Technology Solutions**
  - HFE & PRA Manager at BNL, HFE for US-APWR & mPOWER plant
- **Outline**
  - General changes
  - Specific changes
  - Content of the RSR

# V&V Implementation Plan

## General Changes

- **Clarify Wording and Add Detail**
  - Align definition of V&V between Purpose, ISV and NUREG-0711 Rev. 3
  - Identify explicit performance measures & link to Table 11-1(0711)
  - Identify explicit acceptance criteria & link to Table 11-2 (0711)
  - Build a stronger tie between the IP and 0711 Section 11.4.1, “Sampling Of Operational Conditions,” and the scenarios
  - Consistence of wording between IP & scenarios(i.e., primary tasks)
- **Current IP Tracks Well With NUREG-0711 Rev 3 Review Criteria**
- **Move from Tutorial Discussions to Evaluative Methods & Acceptance Criteria**
- **Add Stronger Description of Interface With Other HFE Elements & V&V Scenarios TeR**

# V&V Implementation Plan

## Sampling Dimensions & Verification

- **Stronger Correlation Between Sampling & Scenarios**
  - Discussion of application of section 3 of V&V Scenarios TeR
- **HSI Task Support Verification**
  - Firmer link between Figure 1 “HSI Inventory and Characterization of Task Support Verification Process” and the TA output
  - Clearer distinction in use of simulation
  - Add a discussion of the Implementation Procedure
- **HFE Design Verification**
  - Style Guide
  - Revision of process and Figure 2, “HFE Design Verification Process”



# V&V Implementation Plan

## Integrated System Validation

- **Assumed MCR staffing**
  - Electric Operator will be licensed
- **Test Procedure**
  - Extensive details are embedded in the scenarios
- **Training**
  - Test Personnel: add content and duration
  - Test Participants: add measure of evidence of performance

# V&V Implementation Plan

## Specific Measures

- **Pass/ Fail Criteria**
  - Clearly identified in IP and scenarios
  - Eliminate varied uses of terms (e.g., Pass/Fail)
  - Criteria will be identified as firm, can not be overridden
- **Situation Awareness**
  - Identify the application of SAGAT, observations & post scenario debriefing and questionnaires
- **Work Load**
  - Identify the Application of NASA-TLX, questionnaires & observations

# V&V Implementation Plan

## Data Analysis

- Describe the relationship between quantitative and qualitative data analysis including the use of statistical techniques
- Describe the methodology to assess across data sets and HSI features
- Describe use of convergent results

# V&V Implementation Plan

## HED Resolution Process

- Describe analysis of personnel tasks/ functions & plant systems
- Describe methods to assess cumulative effects
- Describe methods to assess broader issues represented by an HED
- Describe methods to select which HEDs to correct and the process
- Identify the interface between V&V and Design Implementation
- Add a link and reference to the HFE Program Plan

# V&V Implementation Plan

## Content of the Results Summary Report

- Specific SMEs, and their credentials, that performed the V&V
- Detailed Scenarios, identify any changes from the reviewed TR
- Summary of collected data and its analysis
- List of HEDs, their analysis and resulting impact on the design
- Documented independent review

# V&V Scenarios Technical Report

## Introduction and Outline

- **Tim Clouser, Seabreeze Technology**
  - Formally RO, SRO, Shift Manager, Operations Manager, and New Plant Manager for Luminant Power Comanche Peak 3&4, HFE for US-APWR
  
- **Outline**
  - Revisions to Scenarios

# V&V Scenarios Technical Report

Revise Scenarios to correct the following discrepancies:

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# V&V Scenarios Technical Report

Revise to correct the following discrepancies (Cont'd)

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# V&V Scenarios Technical Report

Revise to correct the following discrepancies (Cont'd)

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# V&V Scenarios Technical Report

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# V&V Scenarios Technical Report

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# V&V Scenarios Technical Report

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# V&V Scenarios Technical Report

Performance Measures Example

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# V&V Scenarios Technical Report

## Operational Condition Sampling

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# Document Status

**In summation: revisions underway on**

- **Already In Progress**
  - FRA/FA IP
  - TA IP
  - V&V IP
  - Scenario TeR
  - OER IP
- **Starting**
  - Remaining IPs and TeRs
  - DCD Tier 1 and Tier 2 Ch. 18



# Path Forward

## Schedule Details (2014)

	May	June	July	Aug	Sep	Oct	Nov	Dec
2014 1 <sup>st</sup> HFE PARM	◆							
1 <sup>st</sup> Draft of DOCs		◆						
2014 2 <sup>nd</sup> HFE PARM				◆				
2 <sup>nd</sup> Draft of DOCs					◆			
2014 Pre-Audit						◆		
Final HFE DOCs							◆	
DC Submission								◆

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# Wrap Up

## Discussion

- Questions & comments not already addressed
- Action Items