Treatment of Important Human Actions Implementation Plan

Revision 2

Non-Proprietary

January 2018

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REVISION HISTORY

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		4 (3.2)	Terminology changed. (safety analysis -> systems safety engineering) R_250-8282(27)
		7 (3.5.4)	Editorial correction. R_373-8481(97)
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		12 (Table 5-1)	Terminology changed. (HSI/I&C -> I&C engineering, safety analysis or plant operations -> plant operations

Revision	Date	Page	Description
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		C1-C3 (Appendix C)	List of RIHA added. R_510-8650(127)
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ABSTRACT

This document is the implementation plan (IP) for the human factors engineering (HFE) of important human actions (TIHA) program element (PE), which is one of 12 PEs in the Advanced Power Reactor 1400 (APR1400) HFE program. This IP governs the technical activities of the TIHA PE by defining the scope methodology output products and the qualifications of the personnel conduct the PE.

The primary purpose of the TIHA PE is to create a list of important human actions (IHAs) and the HFE characteristics assumed for the actions (e.g. stress levels, decision/action complexity, time required). IHAs are used in other APR1400 HFE PEs.

IHAs consist of:

- Risk-important human actions (RIHAs), which are extracted from Chapter 19, Probabilistic Risk Assessment, of the APR1400 Design Control Document (DCD).
- Deterministically important human actions, which are extracted from the defense-in-depth and diversity coping analysis in Chapter 7 of the APR1400 DCD, Instrumentation and Controls; and from Chapter 15, Transient and Accident Analyses, of the APR1400 DCD.

The TIHA IP describes the method of extracting and documenting IHAs. The TIHA IP also provides an overview of how IHAs are addressed in the following other HFE PEs:

- Functional Requirements Analysis and Function Allocation
- · Task Analysis
- Staffing and Qualifications
- Procedure Development
- Training Program Development
- Human System Interface Design
- Human Factors Verification and Validation (V&V)
- Design Implementation (DI)

The TIHA is conducted after the human actions (HAs) are identified in the APR1400 PRA, transient and accident analyses, and diversity and defense-in-depth coping analysis. The TIHA is a one-time, nonrecurring HFE PE whose closure is marked by the TIHA results summary report (ReSR). Plant design changes are conducted in accordance with engineering change procedures, which include an evaluation of the IHAs. During the APR1400 design process, the list of IHAs is revised as needed in accordance with the engineering change process; IHA revisions are available for regulatory inspection. After completion of the V&V, site-specific changes, including any required changes to the list of IHAs, are managed within the DI PE, which is a recurring PE for each plant.

Section 1 of this document defines the TIHA purpose; Section 2 establishes the scope, Section 3 provides a methodology overview, Section 4 provides the details of the methodology (implementation) are provided in Section 4, including the format and content of each TIHA output product, and Section 5 establishes the qualification requirements for the TIHA implementation team. Section 6 defines the required content of the TIHA ReSR, which demonstrates that the TIHA PE was conducted in accordance with this IP. Appendix A demonstrates conformance of this IP to the NUREG-0711 review criteria for TIHA.

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ACRONYMS AND ABBREVIATIONS

APR1400 Advanced Power Reactor 1400

BTA basic task analysis

CCF common cause failure

COL combined license

D3CA diversity and defense-in-depth coping analysis

DCD design control document

DI design implementation

DIHA deterministically identified important human action

DPS diverse protection system
ESF engineered safety feature

FA function allocation

FRA functional requirements analysis

FSAR Final Safety Analysis Report

HA human action

HD human-system interface design

HED human engineering discrepancy

HFE human factors engineering

HEP human error probability

HP human performance

HPM human performance monitoring

HSI human-system interface

I&C instrumentation and controls

IEEE Institute of Electrical and Electronics Engineers

IHA important human action

IP implementation plan

ISV integrated system validation

KEPCO Korea Electric Power Corporation

KHNP Korea Hydro & Nuclear Power Co., Ltd.

LBLOCA large break loss-of-coolant accident

LCS local control station
MCR main control room

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NRC U.S. Nuclear Regulatory Commission

OER operating experience review

PD procedure development

PE program element

PPS plant protection system

PRA probabilistic risk assessment

ReSR results summary report

RG Regulatory Guide

RIHA risk-important human action

RT reactor trip

S&Q staffing and qualifications

SDCV spatially dedicated continuously visible

SGTR steam generator tube rupture

SME subject matter expert

TA task analysis

TAA transient and accident analysis

TIHA treatment of important human actions

TPD training program development

TS trade secret

TTA task timing analysis

V&V verification and validation

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1. PURPOSE

This document is the implementation plan (IP) for the human factors engineering (HFE) treatment of important human actions (TIHA) program element (PE), one of 12 PEs in the APR1400 HFE program. This IP governs the technical activities in the TIHA PE by defining the scope, methodology, products, and qualifications of the personnel conduct the PE.

The TIHA is performed to create a list of important human actions (IHAs) IHAs, and the HFE characteristics assumed for the actions (e.g., stress levels, decision/action complexity, time required). The IHAs are used in other APR1400 HFE PEs.

- Risk-important human actions (RIHAs), which are extracted from Chapter 19, Probabilistic Risk Assessment, of the APR1400 Design Control Document (DCD) (Reference 4)
- Deterministically identified important human action (DIHAs), which are extracted from the from the APR1400 defense-in-depth and diversity coping analysis (D3CA) in Chapter 7 of the APR1400 DCD, Instrumentation and Controls; and Chapter 15, Transient and Accident Analyses, of the APR1400 DCD

This TIHA IP describes the process for extracting the IHAs from the DCD sources, and the information that is included in that extraction process.

This TIHA IP also provides an overview of how the IHAs identified in the TIHA are addressed in subsequent APR1400 HFE PEs. The details of how IHAs are addressed in the other HFE PEs are described in the IPs of these HFE PEs.

As demonstrated in Appendix A, this IP conforms to the review criteria in Section 7 of NUREG-0711, "Human Factors Engineering Program Review Model." Rev. 3 (Reference 3). This TIHA IP defines the qualifications of the SMEs required to conduct the TIHA and its independent review. This TIHA IP also defines the required content of the TIHA results summary report (ReSR), which demonstrates that the TIHA was conducted in accordance with this IP.

2. SCOPE

The TIHA encompasses the RIHAs defined by the APR1400 PRA, and the DIHAs defined by the APR1400 TAA and D3CA. Some of the RIHAs identified in the PRA may also be DIHAs identified in the TAA and D3CA.

These APR1400 analyses encompass actions taken by operators from the main control room (MCR) and other plant areas. Abnormal and accident conditions include both normal and degraded human-system interface (HSI) conditions, as defined in the analyses.

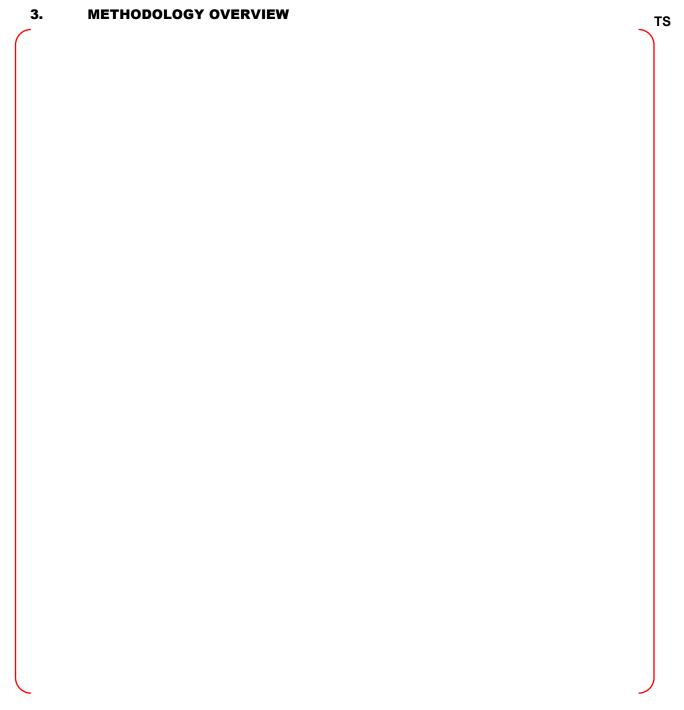
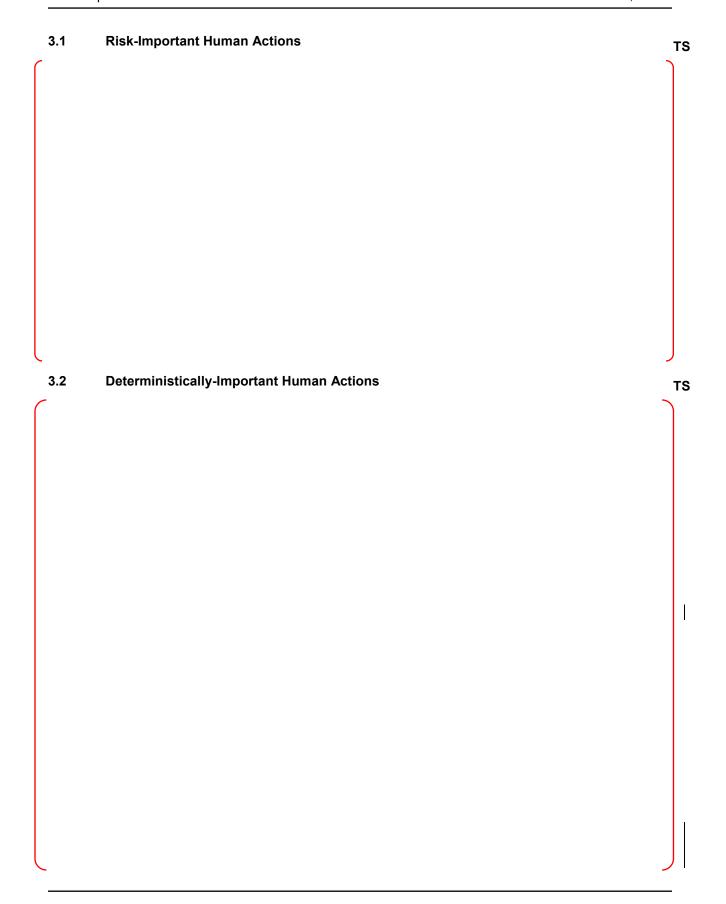
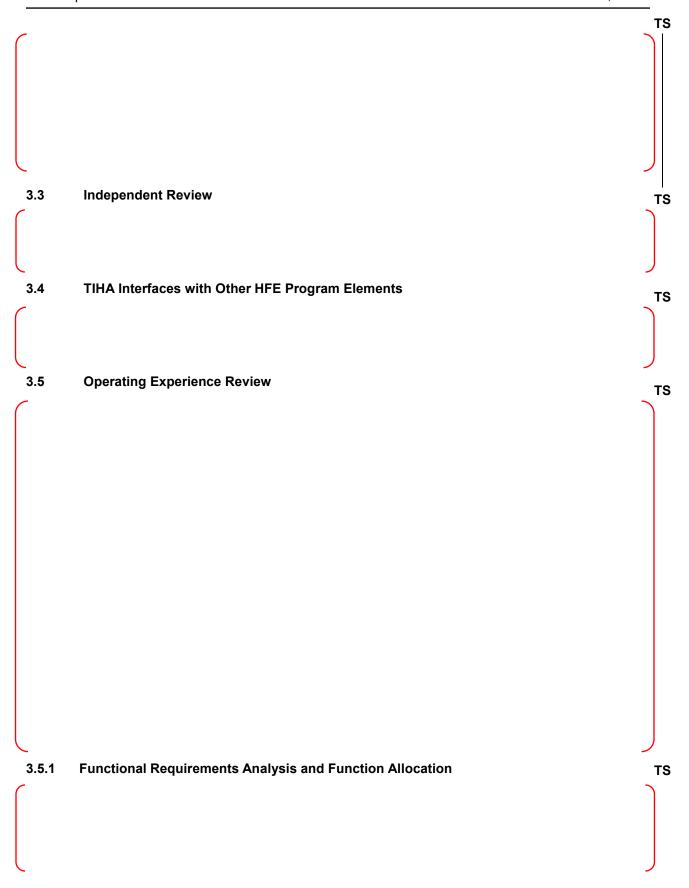
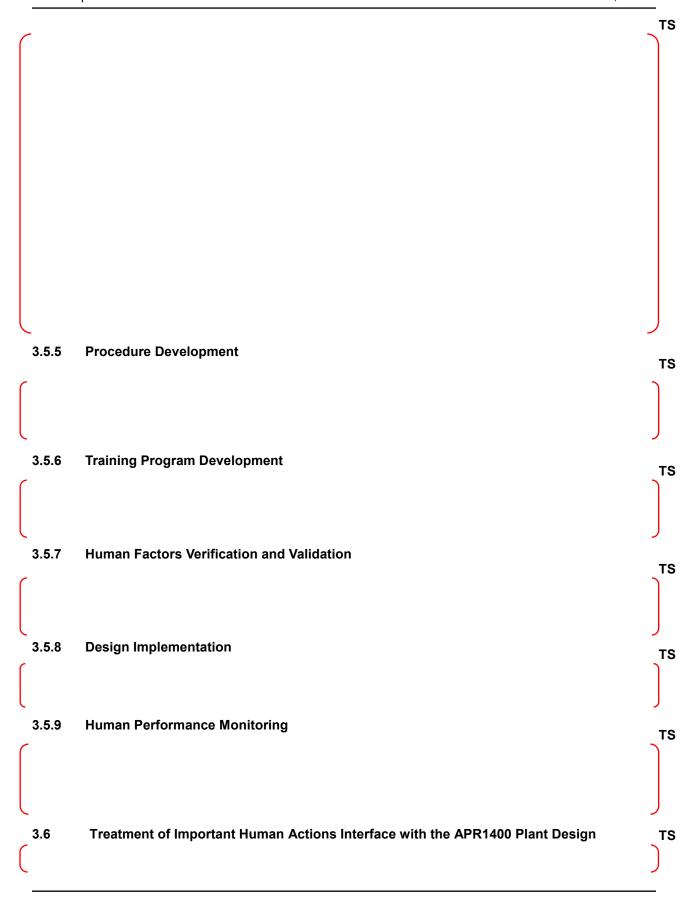


Figure 3-1 Treatment of Important Human Actions Overview



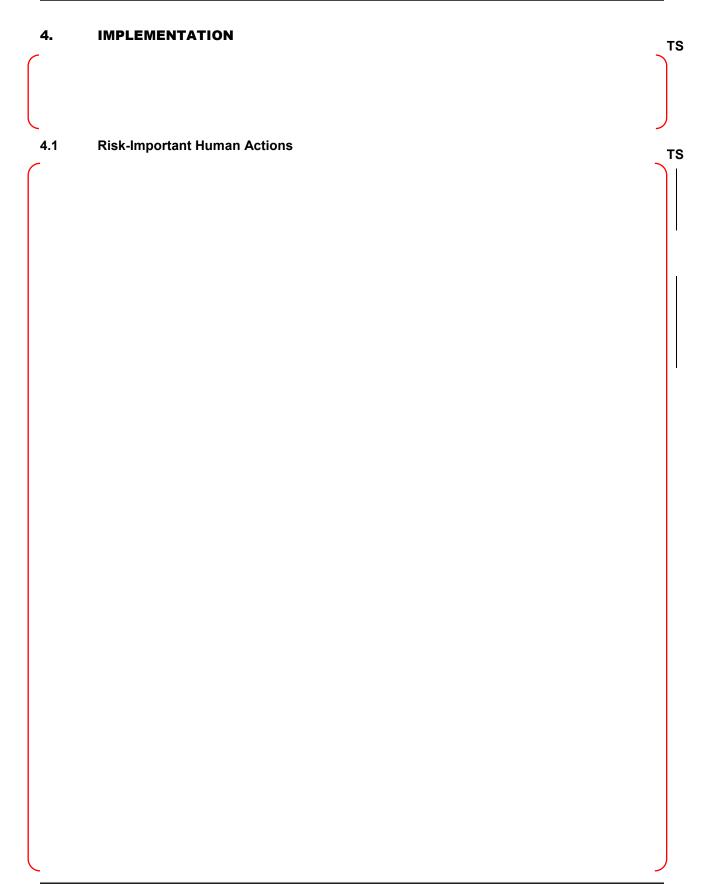


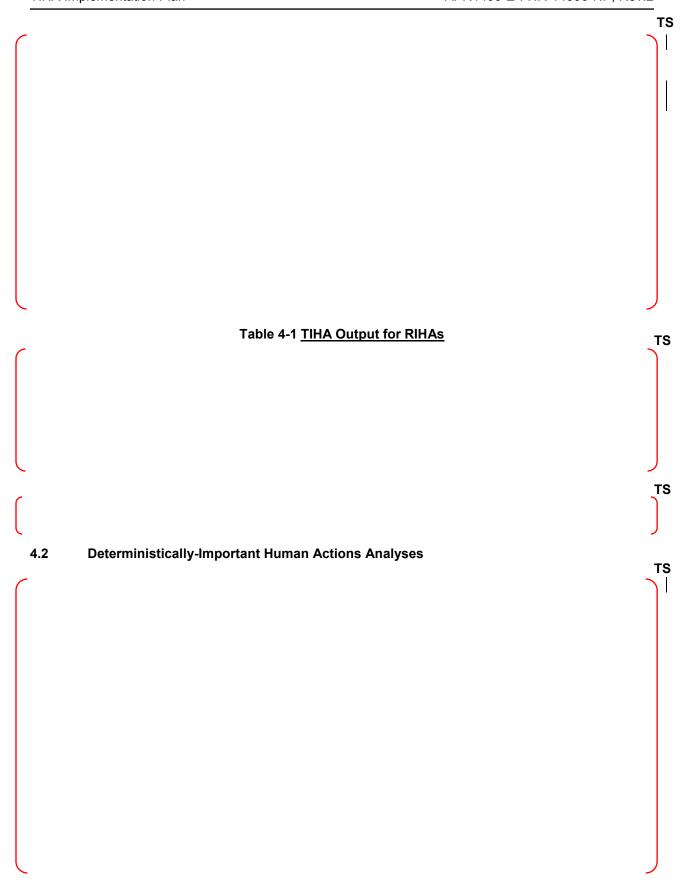
TS Task Analysis 3.5.2 TS **Staffing and Qualifications** 3.5.3 TS **Human-System Interface Design** 3.5.4 TS



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	Table 5-1 <u>TIHA Implementation Summary</u>	тѕ
		

6. RESULTS SUMMARY REPORT

The results of the TIHA are documented in the ReSR, which demonstrates that the TIHA PE was conducted in accordance with this IP.

The TIHA ReSR includes the following:

- The TIHA results overview, which describes the principal findings of the HFE program element
- Name of each TIHA team member, SME position fulfilled, and the TIHA outputs generated by each team member
- The TIHA execution results, including the following details, which demonstrate conformance with Sections 3 and 4 of this IP:
 - Identified RIHAs, the source of the RIHAs in the PRA, and the HFE characteristics assumed in the PRA
 - Identified DIHAs, the source of the DIHAs in the TAA or D3CA, the HFE characteristics assumed in those analyses, and the basis for concluding any HAs identified in those analyses are not DIHAs
- A conclusion that the TIHA:
 - Has been conducted in accordance with the TIHA IP
 - Demonstrates that the IHAs identified in the TIHA output reflect all of the RIHAs from the PRA and all DIHAs from the TAA and D3CA
 - o Has consolidated the IHAs with an adequate level of detail for use in other HFE PEs

The TIHA is a one-time, nonrecurring HFE PE whose closure is marked by the TIHA ReSR. The HSI to support IHAs is ultimately reflected in the APR1400 HSI design, which is tested during V&V. After completion of V&V, site-specific changes, including any required changes to the TIHA output, are managed within the DI PE, which is a recurring PE for each plant.

7. REFERENCES

TIHA Implementation Plan

- 1. IEEE Std. 497-2002, "IEEE Standard Criteria for Accident Monitoring Instrumentation for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers, 2002.
- 2. Regulatory Guide 1.97, "Criteria For Accident Monitoring Instrumentation for Nuclear Power Plants," Rev. 4, U.S. Nuclear Regulatory Commission, June 2006.
- 3. NUREG-0711, "Human Factors Engineering Program Review Model," Rev. 3, U.S. Nuclear Regulatory Commission, November 2012.
- 4. APR1400-K-X-FS-14002, "APR1400 Design Control Document Tier 2," Rev.2, KHNP, January 2018.
- 5. APR1400-E-I-NR-14011-P, "Basic Human-System Interface," Rev. 2, KHNP, January 2018.
- 6. APR1400-E-I-NR-14001-P, "Human Factors Engineering Program Plan," Rev. 1, KHNP, January 2018.
- 7. Full Power Level 1 PRA Human Reliability Analysis (1-035-N463-105), Rev. 1, KEPCO E&C, April 2015.
- 8. Low Power and Shutdown PRA Human Reliability Analysis Notebook (1-035-N463-705), Rev. 0, KEPCO E&C, April 2015.

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8. **DEFINITIONS**

The following terms are used in this document.

Control Lowest decomposition of a success path within the FRA. Control actions are

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allocated to humans or machine in the FA.

Diagnosis Examination and evaluation of data from the HSI to determine the condition of

the plant or the cause of the condition.

Human action Manual response by a member of the plant's operating crew.

Human error Mismatch between a performance demand and the diagnosis or execution of

tasks to satisfy the demand.

Human-system interface Alarms, indications, controls, and procedures used by the plant operating

crew to monitor the plant, supervise automation, and execute HAs.

Local control station HSI control device that is not located in the main control room or the remote

shutdown room; includes single function panels (e.g., controls for a single breaker or valve) and multifunction panels (e.g., controls for a group of plant

components).

Performance-based testing Testing using dynamic simulation and plant operators that includes

scenarios targeted to confirm the design of specific HSI features.

Performance-shaping factor Factor that influences HEP, such as availability of procedural

guidance and time available to perform an action.

Recovery Restoration actions to transition from an abnormal state to a normal state.

Task Collection of activities with a common purpose, often occurring in temporal

proximity, with identifiable start and end points. Control actions are defined and allocated to humans or machine in the FRA/FA PE. HAs are decomposed

into tasks, which are analyzed in the TA PE.

Time available Amount of time from the presentation of a cue for HA or equipment response

to when adverse consequences will occur if no action is taken.

Time requiredTime it takes an operator to complete the action that prevents adverse

consequences.

APPENDIX-A NUREG-0711, REV. 3, REVIEW CRITERIA CONFORMANCE TABLE

NUREG-0711 Rev. 3 Review Criteria	IP Section
7.4 Review Criteria (1) The applicant should identify risk-important HAs from the PRA/HRA. Additional Information: The NRC's technical branch responsible for PRA reviews the acceptability of the applicant's methodology for identifying risk-important human actions. The human factors engineering staff is responsible for ensuring that risk-important HAs included in the HFE design process are the same as those identified in Chapter 19. NRC reviewers should be aware that risk- important HAs may be distributed throughout multiple Chapter 19 tables, a practice that has caused delays in completing reviews.	Subsections 3.1, 4.1
 (2) Applicants should identify deterministically important HAs from the following licensing analyses: operator actions credited in the DCD/FSAR Chapter 15 accident and transient analyses operator actions identified in the D3 coping analyses performed for DCD/FSAR Chapter 7, as specified in Section 1 and 2 of Interim Staff Guidance DI&C-ISG-02, <i>Diversity and Defense in Depth (D3) Issues</i> (NRC, 2009) Additional Information: The HFE reviewer should coordinate with the appropriate NRC technical staff to ensure that the operator actions credited in the Chapter 15 accident and transient analysis and D3 coping analyses are correctly identified. 	Subsections 3.2, 4.2
(3) The applicant should specify how important HAs are addressed by the HFE program, in Function Allocation, Task Analysis, HSI design, Procedural Development, and Training Program Development, in order to minimize the likelihood of human error and facilitate error-detection and recovery capability. Additional Information: The applicant's treatment of important HAs will help ensure that the design supports these actions, and that they are within acceptable human performance capabilities (e.g., within time and workload requirements).	Subsections 3.4.1 3.4.10
(4) Additional Considerations for Reviewing the HFE Aspects of Plant Modifications	Not applicable

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APPENDIX-B PRELIMINARY TIHA OUTPUT FOR DIHAS

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The Values of Time Available for All Important Human Actions (IHAs) from Chapter 15

Abbreviations

1. ADV atmospheric dump valve
 2. AFW auxiliary feedwater
 3. SG steam generator
 4. SI safety injection

The Values of Time Available for All Important Human Actions (IHAs) from CCF Coping Analysis

TS

Abbreviations

CIAS containment isolation actuation signal
 CSAS containment spray actuation signal
 EDG emergency diesel generator
 RCP reactor coolant pump
 SG steam generator

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APPENDIX-C PRELIMINARY TIHA OUTPUT FOR RIHAs			
	Table 1. Risk-Important Human Actions (RIHAs) at Power from Chapter 19	7	

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Table 2. Risk-Important Human Actions (RIHAs) at LPSD from Chapter 19