

## RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

### APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.: 374-8481

SRP Section: 18 – Human Factors Engineering

Application Section:

Date of RAI Issue: 01/22/2016

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### **Question No. 18-97**

NUREG-0711, Criterion 8.4.3(2), states, “The guidance in the applicant’s style guide(s) should be developed from generic HFE guidance and HSI design-related analyses. It should be tailored to reflect the applicant’s design decisions in addressing specific goals of the HSI design.” Additionally, NUREG-0711, Section 1.2.2, “Review Elements,” states that an acceptable implementation plan (IP) is complete, verifiable, and describes the methodology in a step-by-step format to ensure that design personnel can reliably use the IP and consistent results will be obtained from executing the methodology.

DCD Tier 2, Section 18.7.1, “Objectives and Scope,” state that “the detailed design for the APR1400 basic HSI is an extension of the conceptual design described in the APR1400 Basic HSI Technical Report (TeR).” APR1400-E-I-NR-14007-P, Rev. 0, Human-System Interface Design Implementation Plan,” (HD IP), Section 4.1.6, “Implementation Plan for Basic HSI Detailed Design,” identifies sections in the HD IP that describe how the conceptual design is “expanded;” however, the staff reviewed these sections (the HD IP, Sections 4.1.6.1-4.1.6.4) and also Section 2.2, “APR1400 HSIS,” which describes some outputs from this process in the fourth paragraph, and found that these sections provide a description of what will be provided instead of a method. The staff did not find that inputs, activities, and acceptance criteria had been identified. Therefore, it is not clear to the staff how the conceptual design is “expanded” to produce the products described in the HD IP, Section 2.2.

Also, Section 4.1.6.2, “Basic HSI Style Guide,” discusses development of a style guide; however, a style guide was submitted with the application (APR1400-E-I-NR-14012-P, Rev. 0, “Style Guide.” ), and the relationship between the style guide that was submitted and the style guide described in the HD IP, Section 4.1.6.2 is not clear to the staff.

**Question 1:**

Provide a method to develop the outputs identified in the HD IP, Sections 4.1.6.1 – 4.1.6.4 that is detailed, complete, and verifiable (i.e., identifies inputs, steps or actions that need to be taken, outputs, and any acceptance criteria).

**Question 2:**

Describe the difference between (if any), and the relationship between, the style guide described in the HD IP, Section 4.1.6.2, “Basic HSI Style Guide,” and APR1400-E-I-NR-14012-P, Rev. 0, “Style Guide.”

**Question 3:**

Clarify the extent to which the design described in the Basic HSI TeR conforms to the guidance described in the “Style Guide.”

**Question 4:**

Describe how the APR1400 HSI Design that results from the process described in the HD IP will conform to the Style Guide that was submitted with the application and to the other style guide described in the HD IP, Section 4.1.6.2, “Basic HSI Style Guide,” if it is different.

**Question 5:**

Revise the submittal as necessary.

**Response**

**Response to Question 1:**

The human system interface design program, as described in APR1400-E-I-NR-14007-P, Rev. 0, governs the technical activities, including scope, methodology, and output products, to move from the HSI design, as described in the APR1400 Basic Human-System Interface technical report (TeR), APR1400-E-I-NR-14011-P, Rev. 0, to the APR1400 HSIS. This process is shown in Figure 3-1 of the Human-System Interface Design Implementation Plan (HD IP), APR1400-E-I-NR-14007-P, Rev. 0. However, this is not a standalone process; it represents only one element of the integrated HFE program. Since the design shown in APR1400-E-I-NR-14011-P, Rev. 0 represents the design prior to completing the HDE design process, the APR1400 Basic HSI, which is based on the basic HSI of the reference design plant (Shin-Kori Nuclear Power Plant Units 3 and 4) will be modified by the results of the HFE program. This process is described in the HFE Program Plan, APR1400-E-I-NR-14001-P, Rev. 0. After completion of the V&V, as per APR1400-E-I-NR-14008-P, Rev. 0 site specific changes, including any required changes to the APR1400 HSI Design, will be managed within the Design Implementation program element, APR1400-E-I-NR-14009-P, Rev. 0, which is a recurring element for each plant.

The HFE Program Plan describes the design process interfaces, Figure 4-3, with inputs and outputs between the elements of the HFE program, as detailed in the HFE Implementation Plans. Section 4.7.3.6 of the HFE Program Plan describes the specific inputs and outputs for

the HD and each of the HFE program element Implementation Plans discuss the steps to move from the inputs to the outputs.

Therefore, the HD IP, APR1400-E-I-NR-14007-P, Rev. 0 identifies the inputs, steps or actions, and outputs. The ReSR constitutes the verification that the HD IP was followed and the V&V program ensures that the resulting design meets the acceptance criteria.

Technical report APR1400-E-I-NR-14007-P, HD IP, Rev. 0 will be revised as indicated in Attachment 1 associated with this response.

**Response to Question 2:**

There is only one style guide, APR1400-E-I-NR-14012-P, Rev. 0, "Style Guide" and it has been submitted to the NRC Staff for review. All references to the "Basic HSI Style Guide" will be corrected to read "Style Guide," as correctly titled in reference 4 of Section 7 of the TeR.

Technical report APR1400-E-I-NR-14006-P, Rev. 0, TIHA Implementation Plan, technical report APR1400-E-I-NR-14007-P, Rev. 0, HD IP, and technical report APR1400-E-I-NR-14011-P, Rev. 0, Basic Human-System Interface will be revised to change the title from "Basic HSI Style Guide" to "Style Guide" as indicated in Attachment 2 associated with this response.

**Response to Question 3:**

The design of the APR1400, as described in the Basic HSI TeR, APR1400-E-I-NR-14011-P, Rev. 0, completely conforms to Style Guide, APR 1400-I-NR-14012-P, Rev. 0.

**Response to Question 4:**

As noted in the response to question 2, there is only one style guide and it is APR1400-E-I-NR-14012-P, Rev. 0, Style Guide.

As part of the APR1400's HFE program, the Style Guide is provided, and as describe in the Human Factors Engineering Program Plan, APR1400-E-I-NR-14001-P, Rev. 0, it is applied throughout the design process as a general process procedure. Any deviations, which are expected to be few, from the Style Guide must have a technical justification and approval by the HFE Design Team Leader and the Project Manager. Deviations will be assessed for their impacts across the design, and will be documented for future revisions to the Style Guide. Section 4.4, "HFE Design Verification," of the V&V Implementation Plan (IP), APR1400-E-I-NR-14008-P, Rev. 0 independently ensures that the results of the HD IP conform to the Style Guide, and if a divergence is found, an HED is generated. The HED then follows the standard resolution and closure process, in accordance with Section 4.5.9 of the V&V IP.

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**Impact on DCD**

There is no impact on the DCD.

**Impact on PRA**

There is no impact on the PRA.

**Impact on Technical Specifications**

There is no impact on the Technical Specifications.

**Impact on Technical/Topical/Environmental Reports**

Technical report APR1400-E-I-NR-14006-P, Rev. 0, "TIHA Implementation Plan," Section 3.5.4, technical report APR1400-E-I-NR-14007-P, Rev. 0, "HSI Design Implementation Plan," Sections 1, 2, 3, 4.1 and Appendix A, and technical report APR1400-E-I-NR-14011-P, Rev. 0, "Basic Human-System Interface," Table of Contents, Sections 1, 2, 3.6, 4.7.5 and Appendix A will be revised, as indicated in the Attachments associated with this response.

## 2 SCOPE

The scope of the HD includes the facility design of the MCR, RSR, and TSC. The scope also includes the HSIS design of the MCR and a subset of the HSIS, which is applied to the RSR and TSC. For the emergency operation facility (EOF), the scope of the HD is limited to the HSI inventory for the SPDS. For the LCSs, the scope of the HD is limited to the HSI used for IHAs.

The HD scope is divided into the following areas:

- APR1400 Basic HSI
- APR1400 HSI System
- APR1400 HSI Facilities

The scope of each area is defined in Subsections 2.1, 2.2, and 2.3.

### 2.1 APR1400 Basic HSI

Based on the results from the HFE program plan (Reference 1, Figure 4-3 and Section 4.7.3.6), the

The APR1400 Basic HSI encompasses the physical design of the MCR, which includes operator consoles, the safety console, the large display panel (LDP), and furnishings such as book cases and work tables. The APR1400 Basic HSI defines the generic methods for controls, alarms, information displays, and procedure displays. These generic HSI methods are applied to Basic HSI functions, such as CBPs, critical function monitoring (CFM), success path monitoring (SPM), accident monitoring instrumentation (AMI), and bypassed and inoperable status indication (BISI). All Basic HSI functions are seamlessly integrated through Basic HSI features such as the information display hierarchy, single point alarm acknowledgment, intuitive diagnostic drill down and inter-function navigational hyperlinks. These physical and functional resources constitute the APR1400 Basic HSI, within which the HSI inventory for the APR1400 plant system designs is implemented.

✓ The HD initially expands the APR1400 Basic HSI concept, which is described in the APR1400 Basic HSI Description technical report (TeR) in conjunction with the APR1400 ~~Basic HSI~~ Style Guide. The scope of the APR1400 Basic HSI includes:

1. The design basis (i.e., the HSI inventory selection criteria) for SDCV indications and alarms to be displayed on the non-safety LDP and safety related displays. SDCV alarms and indications promote plant level situation awareness.
2. The design basis for SDCV controls and their location within the HSI facilities.
3. The methods (e.g., dynamic video symbols, conventional HSI components) for all displays, alarms and controls, including distinctions required to accommodate Class 1E HSI, diverse HSI, and LCS HSI, and for providing operator feedback to control actions.
4. Criteria for alarm applicability and prioritization and the display and control methods for alarm states and priorities.
5. Design criteria for graphic displays including density, graphic symbol and character size, line thickness, and information orientation.
6. The video display hierarchy, including the function, task, and system design content of each hierarchical level.
7. The navigation methods between and within hierarchical display levels and between alarms, displays, controls, and CBPs and methods for providing operator feedback to screen selection actions.
8. CBP methods, including navigation within and among procedures, place keeping, annotations and bookmarks, multiple procedure usage, independent step verification, archiving, automated data checking, and provisions for continuous action steps.
9. Configuration of operator consoles and the safety console and their arrangement within the HSI facilities.
10. Methods for control transfer between HSI facilities.

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#### 4.1.5.2 Changes from SKN 3&4

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, as described in this implementation plan, and shown in Figure 3-1. The

and, revised based on the outputs from the HFE program and the final detailed plant design,

#### 4.1.6 Implementation Plan for Basic HSI Detailed Design

The design concept described in the APR1400 Basic HSI TeR (Reference 2) is expanded to create a detailed design through the generation of the output products described in Subsections 4.1.6.1 through 4.1.6.4.

documents

**4.1.6.1 Functional Specifications**

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**4.1.6.2 Basic HSI Style Guide**

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**4.1.6.3 Nomenclature and Labeling Guide**

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**4.1.6.4 Component Control and Instrumentation Design Guide**

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**4.1.7 Basic HSI Tests and Evaluations**

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| 3.5.8 <b>Design Implementation</b>  | TS |
| 3.5.9 <b>Human Performance Monitoring</b>   | TS |
| <b>3.6       Treatment of Important Human Actions Interface with the APR1400 Plant Design</b> | TS |

## 1 PURPOSE

This document provides the implementation plan (IP) for the human factors engineering (HFE) human-system interface design (HD) program element (PE), which is one of 12 PEs in the APR1400 HFE Program. This IP governs the technical activities conducted in the HD PE by defining the scope, methodology, output products, and the qualifications of the personnel who conduct the PE.

The HD PE creates the functional designs of the APR1400 Human-System Interface (HSI Design), which includes:

1. The detailed design of the APR1400 Basic HSI, which establishes the generic indication, alarm, control, and procedural methods applied to all systems and functions controlled from the main control room (MCR) and the remote shutdown room (RSR). The same HSI methods apply to the safety parameter display system (SPDS) indications provided in the technical support center (TSC). The APR1400 Basic HSI also defines indication, alarm, and control methods for local control station (LCSs) used for important human action (IHAs). The HD uses the APR1400 Basic HSI to provide reasonable assurance that the HSI design is consistently applied throughout the APR1400 plant systems and at the HSI locations credited for controlling the critical safety functions (CSFs) and critical power production functions (CPPFs) defined by the functional requirements analysis / function allocation (FRA/FA), during normal and degraded HSI conditions.

The conceptual design of the APR1400 Basic HSI is described in "APR1400 Basic Human-System Interface" (Reference 2) and APR1400 ~~Basic HSI~~ Style Guide (Reference 4). The Basic HSI concept includes the HSI accommodations for the plant's operations staff, such as the ergonomic designs of operator consoles, the safety console, and their architectural configurations to provide reasonable assurance of visibility and audibility for crew coordination.

The Basic HSI concept also defines the criteria and methods for spatially dedicated and continuously visible (SDCV) HSI, the methods for Class 1E and diverse HSI, and the strategies for managing degraded HSI. This IP governs the evolution of the APR1400 Basic HSI concept into APR1400 Basic HSI detailed design through the documentation of detailed functional designs, prototype development, and design tests using U.S. licensed reactor operators.

2. The APR1400 HSIS, which refers to the soft and conventional indications, alarms, controls and operating procedures that encompass the HSI inventory defined by the TA and plant system designs, within the HSI methods defined in the APR1400 Basic HSI. The APR1400 HSIS encompasses all plant operating modes, including shutdown and refueling, for both normal and abnormal conditions.

While the TA and plant system designs define the HSI inventory using text descriptions and characterizations, the HD reflects the inventory in graphical displays, soft controls, and conventional controls that integrate multiple, related inventory components. The HD integration is based on the inventory component relationships within plant systems, operator tasks, and plant functions using the generic techniques defined in the APR1400 ~~Basic HSI~~ Style Guide. The HD also expands the alarm inventory from the TA and plant system designs, to establish prioritization of and applicability to plant and system operating modes. The HD results in a hierarchical structure of alarms, displays, controls, and procedures that promote a mental model of the plant and plant-wide situation awareness, from the highest level functions to the success path actions needed to maintain these functions.

The HD process for the APR1400 HSIS starts with the APR1400 Basic HSI and the HSI inventory defined in Chapter 7 of the APR1400 Design Control Document (DCD) (Reference 11) to fulfill regulatory guidance, such as indications, alarms, and controls for credited manual actions, controls for manual initiation of automated protective functions, indications on the SPDS, and

indications and controls for common cause failure (CCF) conditions. HD creates graphic displays, soft controls and conventional controls to fulfill that DCD inventory and to fulfill the expanded HSI inventory defined by the TA and plant system designs.

3. The APR1400 HSI , which are the MCR, RSR and TSC, which accommodate the APR1400 HSIS as well as storage, communication, meeting, and other habitability features important to facilitating required operations crew performance during all facets of plant operation. The HD establishes the architectural configuration of operations crew offices, kitchen, and restroom facilities; meeting areas; and facility lighting requirements. It provides reasonable assurance that the HSI facilities accommodate face-to-face interaction between the operations crew and other plant staff without interfering plant operations. The HD also establishes the functional design of voice communications and paging throughout the plant and in designated offsite facilities for emergency plan coordination during abnormal events. The HD generates the three-dimensional plant model for the MCR and the functional aspects of the MCR simulator specification for the integrated system validation (ISV), which is conducted during V&V.

The integration of the APR1400 HSIS and APR1400 HSI Facilities is referred to as the APR1400 HSI Design. This HD IP defines the activities that are necessary to develop the APR1400 HSI Design. The activities include the incorporation of HFE design standards and guidance applicable to the APR1400 HSIS, as defined in the APR1400 ~~Basic HSI~~ Style Guide and NUREG-0700 (Reference 5), into the APR1400 HSI Facilities. This IP provides a systematic approach to integrating the HFE design standards, guidance, and results of other HFE PEs into a comprehensive HSI design process. The integration provides reasonable assurance that the resulting HSI resources and facilities effectively support performance of operational functions and tasks.

The end product of the HD PE is the functional design of the APR1400 HSI (i.e., the APR1400 HSI Design), which is implemented into the detailed designs of HSI hardware, software, and physical facilities by APR1400 engineers in multiple disciplines. The APR1400 HSI Design is formally verified and validated during the V&V through high-fidelity simulation.

A key purpose of the HD is to provide reasonable assurance that the end product (i.e., APR1400 HSI Design) reflects the resolutions of all human engineering discrepancies (HEDs) generated in previous HFE PEs and the resolutions of any HEDs that may have been generated during the HD. While the APR1400 HSI Design must reflect all HED resolutions, closure of all HEDs is not required for completion of the HD because some HEDs may require resolution to be successfully demonstrated during the ISV of the V&V.

As demonstrated in Appendix A, this IP conforms to the review criteria in Section 8 of NUREG-0711, "Human Factors Engineering Program Review Model," Rev. 3 (Reference 10).

This document defines the qualifications of the subject matter experts (SMEs) required to conduct HD and the independent review of its output products. This document also defines the required content of the HD ReSR, which demonstrates that the HD was conducted in accordance with this IP.

11. Nomenclature and labeling standards for all elements of both soft and conventional HSI, including abbreviations and syntax for labels and alarm messages.

The APR1400 Basic HSI also establishes standard functional specifications for the indications and controls associated with plant instrumentation and components, referred to as the basic component control and instrumentation design guide. The guide provides reasonable assurance of HSI consistency across all APR1400 plant systems.

## 2.2 APR1400 HSIS

The HD implements the HSI inventory defined by the TA and plant system designs in the Basic HSI methods described above, which encompass both video and conventional devices. For plant systems that are site specific, such as the switchyard and ultimate heat sink, the HD is based on generic assumptions that are made to establish a complete plant design that is reflected in the complete APR1400 HSIS. These generic assumptions are modified as necessary for each plant-specific application of the APR1400 during the design implementation (DI) HFE PE.

The scope of the APR1400 HSIS encompasses soft displays and controls, and conventional displays and controls for all aspects of the APR1400 Basic HSI, as follows:

1. Large display panel (LDP); SDCV sections
2. Information flat panel displays (IFPDs); selectable displays with soft controls, including SPDS (displays are also applicable to the selectable sections of the LDP)
3. Engineered safety features control modules (ESCMs); selectable soft controls
4. Qualified indication and alarm system — non-safety (QIAS-N); SDCV and selectable displays
5. Qualified indication and alarm system – post accident monitoring (QIAS-P); SDCV and selectable displays
6. Plant protection system (PPS) and core protection calculator (CPC) operator modules; selectable displays with soft controls
7. Reactor trip (RT) and engineered safety features (ESF) system-level initiation (SLI) controls; conventional SDCV controls
8. Minimum inventory controls (MICs); conventional SDCV controls
9. Diverse manual actuation (DMA) controls; conventional SDCV controls
10. Diverse indication system (DIS); selectable displays
11. Safety console configuration (encompassing all items above, except LDP and IFPD)
12. Alarms that are displayed on the LDP, IFPDs, and QIAS-N displays
13. LCS; conventional indications and controls

For all items in the above list, the HD generates pictorial design drawings with a database that correlates each pictorial element to a unique instrumentation or control item in the plant system designs. The pictorial designs integrate the HSI inventory defined by the TA and plant system designs in the information hierarchy of the APR1400 Basic HSI, using the conventions established by the APR1400 **Basic HSI** Style Guide.

As for all computer driven displays, the HD graphical design output for the SPDS is implemented in software for the MCR, RSR and TSC. However, for the EOF the HD output for the SPDS is provided only to define the HSI inventory requirements and to provide guidance for graphical implementation of the SPDS within the EOF. The EOF HSI system is provided by the combined license (COL) applicant. Therefore, the COL applicant provides the actual graphical design and software for the SPDS in the EOF, in accordance with the EOF HSI system style guide to provide reasonable assurance of conformance with the HFE criteria for the EOF.

The HD PE also includes the CBPs that are used for the scenarios conducted during the ISV. Other procedures that are unrelated to the V&V scenarios are not within the scope of the HD PE because they have their own development and verification program through the procedure development (PD) PE.

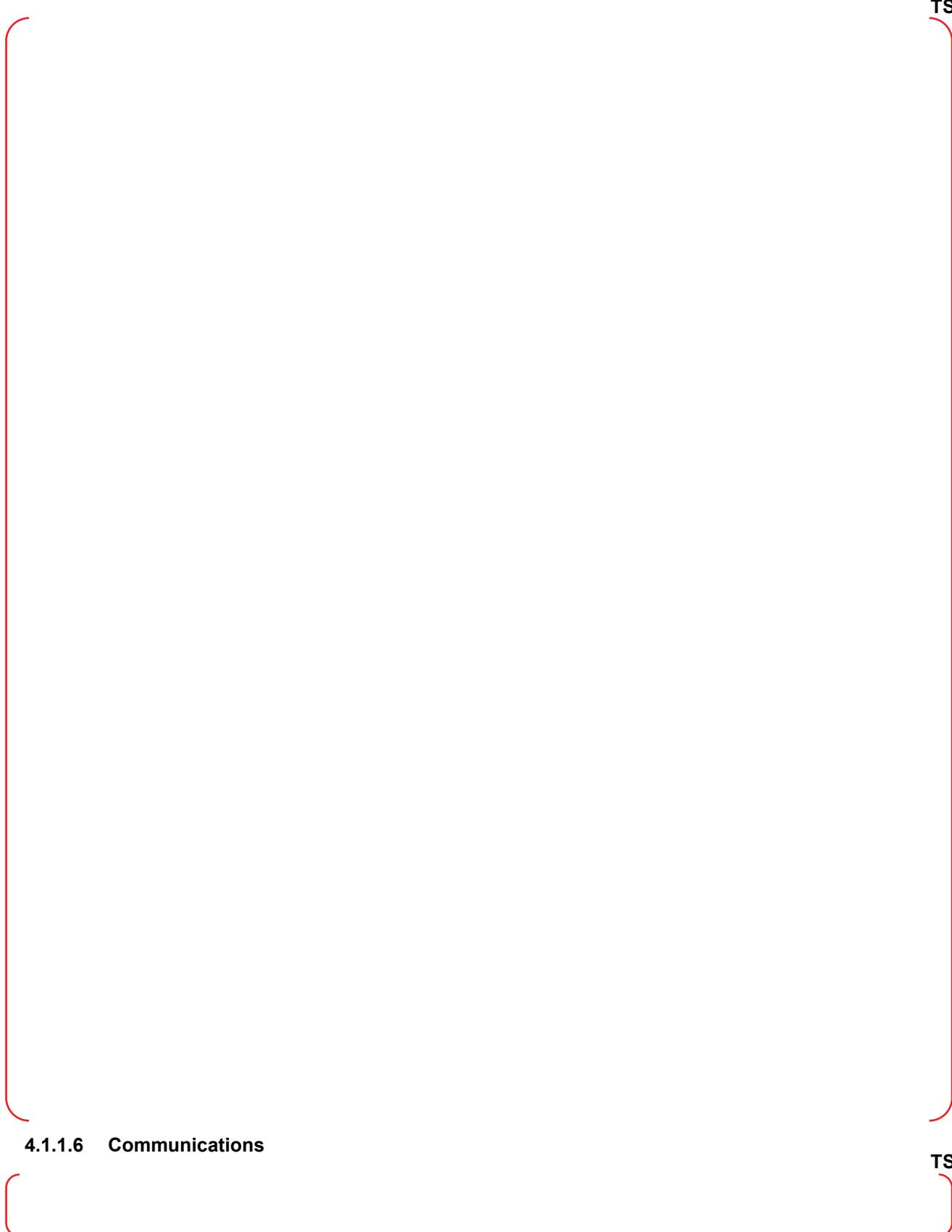
**3.2 APR1400 HSIS**

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#### 4.1.1.1 LDP





| NUREG-0711, Rev. 3, Review Criteria  | IP Section and Paragraph                              |
|--|---|
| <p><b>8.4.3 HFE Design Guidance for HSIs</b></p> <p>Applicants should employ design-specific HFE design guidance in designing the features of the HSIs, their layout, and environments. Although design guidance documents are called by different names, NUREG-0711 refers to them as “style guides.” Applicants may use one or more individual documents to serve this purpose. The HFE guidelines in NUREG-0700 may serve to support the NRC staff’s review of the guidance in an applicant’s style guide.</p>                                | 3.3.2, 4.1.6.2  |
| <p>(1) The topics in the applicant’s style guide(s) should address the scope of HSIs included in the design, and address their form, function, and operation, as well as the environmental conditions in which they will be used that are relevant to human performance.</p> <p><i>Additional Information:</i> NUREG-0700 lists HSI topics around which a style guide(s) may be organized.</p>   | Refer to APR1400 <del>Basic HSI</del> Style Guide TeR |
| <p>(2) The guidance in the applicant’s style guide(s) should be developed from generic HFE guidance and HSI design-related analyses. It should be tailored to reflect the applicant’s design decisions in addressing specific goals of the HSI design.</p> <p><i>Additional Information:</i> Analyses related to the HSI design might include an evaluation of recent literature, analysis of current industry practices and operational experience, tradeoff studies, and the findings from design-engineering experiments and evaluations.</p> | 4.1.6.2 paragraph 1                                   |
| <p>(3) The individual guidelines in the applicant’s style guide(s) should be expressed precisely and describe easily observable HSI characteristics, such as “Priority 1 alarms are shown in red.” The guidelines in the style guide(s) should be sufficiently detailed so that design personnel can deliver a consistent, verifiable design meeting the applicant’s guidelines.</p>   | Refer to APR1400 <del>Basic HSI</del> Style Guide TeR |
| <p>(4) The applicant’s style guide(s) should contain procedures for determining where and how HFE guidance will be used in the overall design process. They should be written so designers can readily understand them; the text should be supplemented with graphical examples, figures, and tables to facilitate comprehension.</p>  | Refer to APR1400 <del>Basic HSI</del> Style Guide TeR |
| <p>(5) The applicant should maintain the style guide(s) in a form that is readily accessible and usable by designers, and is easily modified and updated as the design matures. The guidance should include a reference(s) to the source upon which it is based.</p>   | Refer to APR1400 <del>Basic HSI</del> Style Guide TeR |

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## 1. PURPOSE

This document describes the APR1400 Basic HSI, which establishes the generic indication, alarm, control and procedure methods applied to all systems and functions controlled from the main control room (MCR) and the remote shutdown room (RSR). These same human-system interface (HSI) methods apply to the safety parameter display system (SPDS) indications provided in the technical support center (TSC). The APR1400 Basic HSI also defines indication, alarm, and control methods for local control stations (LCS) used for important human actions (IHA). The APR1400 Basic HSI ensures the same HSI design is consistently applied throughout the plant systems of APR1400 and at the HSI locations credited for controlling the critical safety functions (CSF) and critical power production functions (CPPF) defined by the human factors engineering (HFE) functional requirements analysis (FRA), during normal and degraded HSI conditions.

This document describes the conceptual design of the APR1400 Basic HSI which includes, by reference, the APR1400 ~~Basic HSI~~ Style Guide (Reference 1) (also referred to as Style Guide). The Basic HSI concept includes the HSI accommodations for the plant's operating staff, such as the ergonomic designs of operator consoles (OC) and the safety console (SC), and their architectural configuration to ensure visibility and hearing for crew coordination. The Basic HSI concept also defines the criteria and methods for spatially dedicated and continuously visible (SDCV) HSI, the methods for safety and diverse HSI, and the strategies for managing degraded HSI.

The implementation plan (IP) for the HD PE (Reference 2) governs the evolution of the APR1400 Basic HSI concept into the complete APR1400 Basic HSI detailed design through documentation of detailed functional designs, prototype development, and design tests using United States (US) licensed reactor operators.

All figures in this document that show video displays or control panel layouts depict the design standards of the Style Guide and the design basis inventory content of the Basic HSI. But the actual HSI inventory for the video displays and control panels for the APR1400 Human System Interface System (HSIS) will reflect the APR1400 plant design. For example, the typical large display panel (LDP) shown in Figure 3-3 employs the graphical standards of the Style Guide and the design basis content of CSFs and CPPFs (and their preferred normal and emergency success paths). However, the actual APR1400 LDP will reflect the CSFs and CPPFs for APR1400 (and their preferred normal and emergency success paths). Therefore, the APR1400 LDP graphic may have a different inventory and mimic configuration than the graphic shown in Figure 3-3. The design of all APR1400 displays and control panels is based on the Style Guide criteria and the analyses of personnel roles (job analysis), and systematic strategies for organization, such as arrangement by importance, and frequency and sequence of use.

## 2. SCOPE

The APR1400 Basic HSI encompasses the physical design of the MCR, which includes OCs, the SC, the LDP, and furnishings such as bookcases and worktables. The APR1400 Basic HSI defines the generic methods for controls, alarms, information displays, and procedure displays. These generic HSI methods are applied to Basic HSI functions, such as computer-based procedures (CBP), critical function monitoring (CFM), success path monitoring, accident monitoring instrumentation (AMI), and bypassed and inoperable status indication (BISI). All Basic HSI functions are seamlessly integrated through Basic HSI features such as the information display hierarchy, single point alarm acknowledgment, intuitive diagnostic drill down and inter-function navigational hyperlinks. These physical and functional resources constitute the APR1400 Basic HSI, within which the HSI inventory for the APR1400 design is implemented.

The scope of the APR1400 Basic HSI includes:

- The design basis (i.e., the HSI inventory selection criteria) for SDCV indications and alarms to be displayed on the non-safety LDP and safety related displays.
- The design basis for SDCV controls and their location within the HSI facilities.
- The methods (e.g., dynamic video symbols, conventional HSI components) for all displays, alarms and controls, including distinctions required to accommodate safety HSI, diverse HSI, and LCS HSI.
- Criteria for alarm applicability and prioritization, and the display and control methods for alarm states and priorities.
- Design criteria for graphic displays including density, graphic symbol and character size, line thickness, and information orientation (as defined in the Style Guide).
- The video display hierarchy, including the function, task and system design content of each hierarchical level.
- The navigation methods between and within hierarchical display levels, and between alarms, displays, controls and CBPs.
- CBP methods, including navigation within and among procedures, place keeping, annotations and bookmarks, multiple procedure usage, independent step verification, archiving, automated data checking, and provisions for continuous action steps.
- Configuration of OCs and the SC, and their arrangement within the HSI facilities.
- Methods for control transfer between HSI facilities.
- Nomenclature and labeling standards for all elements of both soft and conventional HSI, including abbreviations and syntax for labels and alarm messages.

The APR1400 Basic HSI includes the APR1400 ~~Basic HSI~~ Style Guide. This document defines the design standards for visual display unit (VDU) and conventional HSI devices, including screen and panel layout standards, visual coding standards (e.g., shapes and colors) and all alphanumeric styles.

While the Style Guide establishes the format and fonts for labels used on all HSI elements, the APR1400 Nomenclature and Labeling Guide establishes the naming, abbreviations, acronyms, numbering and syntax rules for components of the plant used by plant operators. This includes:

**3.6 ~~Basic HSI Style Guide~~**

TS



**4.7.4 Historical Data Storage and Retrieval**

TS

**4.7.5 Conformance to HFE Requirements**

TS

**4.7.5.1 Consistency**

TS

**4.7.5.2 Task Usability**

TS



| NUREG-0711 Rev. 3 Review Criteria   | Section and Paragraph  |
|---|--|
| HSI design.   |  |
| <p>8.4.2 Concept of Use and HSI Design Overview</p> <p>(1) The applicant should develop a concept of use stating the roles and responsibilities of operations personnel based upon anticipated staffing levels. The concept of use should:</p> <ul style="list-style-type: none"> <li>• provide a high-level description of how personnel will work with HSI resources</li> <li>• address the coordination of personnel activities, such as interactions with auxiliary operators and the coordination of maintenance and operations</li> </ul> <p><i>Additional Information:</i> Examples of the types of information the applicant may identify include the allocation of tasks between the main control room or to local control stations, whether personnel will work at a single large workstation or at individual ones, to what types of information each crew member will have access, and what types of information will be displayed to the entire crew.</p>  | 3.4, 3.5 including all subsections   |
| <p>(2) The applicant should provide an overview of the HSI, covering the technical bases demonstrating that they constitute a state-of-the-art HSI design supporting personnel performance. These bases may include analyses of operating experience and the literature, tradeoff studies simultaneously considering multiple alternatives, and engineering tests and evaluations. The overview should include a description of:</p> <ul style="list-style-type: none"> <li>• facility layouts, including workstations, large screen displays, and the nominal staff working positions</li> <li>• key HSI resources and their functionality, such as alarms, displays, controls, computer-based procedures, and other support and job aids</li> <li>• technologies to support teamwork and communication within the main control room and between the main control room, the remote shutdown facility, the TSC, EOF, and local control stations</li> <li>• the responsibilities of the crew for monitoring, interacting, and overriding automatic systems and for interacting with computerized procedures systems and other computerized operator support systems</li> </ul> | 3.0 including all subsections, 4.8, 4.11.4, 4.11.5 including all subsections |
| <p>8.4.3 HFE Design Guidance for HSIs</p> <p>Applicants should employ design-specific HFE design guidance in designing the features of the HSIs, their layout, and environments. Although design guidance documents are called by different names, NUREG-0711 refers to them as "style guides." Applicants may use one or more individual documents to serve this purpose. The HFE guidelines in NUREG-0700 may serve to support the NRC staff's review of the guidance in an applicant's style guide.</p>  | 3.6 (see separate <del>Basic HSI</del> Style Guide)                          |

| NUREG-0711 Rev. 3 Review Criteria   | Section and Paragraph  |
|---|--|
| (1) The topics in the applicant's style guide(s) should address the scope of HSIs included in the design, and address their form, function, and operation, as well as the environmental conditions in which they will be used that are relevant to human performance.<br><br><i>Additional Information:</i> NUREG-0700 lists HSI topics around which a style guide(s) may be organized.   | 4.0 including all subsections                                |
| (2) The guidance in the applicant's style guide(s) should be developed from generic HFE guidance and HSI design-related analyses. It should be tailored to reflect the applicant's design decisions in addressing specific goals of the HSI design.<br><br><i>Additional Information:</i> Analyses related to the HSI design might include an evaluation of recent literature, analysis of current industry practices and operational experience, tradeoff studies, and the findings from design-engineering experiments and evaluations.                                       | 5.0  |
| (3) The individual guidelines in the applicant's style guide(s) should be expressed precisely and describe easily observable HSI characteristics, such as "Priority 1 alarms are shown in red." The guidelines in the style guide(s) should be sufficiently detailed so that design personnel can deliver a consistent, verifiable design meeting the applicant's guidelines.   | 3.6 (see separate <del>Basic HSI Style Guide</del> , 4.15.1) |
| (4) The applicant's style guide(s) should contain procedures for determining where and how HFE guidance will be used in the overall design process. They should be written so designers can readily understand them; the text should be supplemented with graphical examples, figures, and tables to facilitate comprehension.  | See HD IP and Style Guide                                    |
| (5) The applicant should maintain the style guide(s) in a form that is readily accessible and usable by designers, and is easily modified and updated as the design matures. The guidance should include a reference(s) to the source upon which it is based.   | See Style Guide  |
| 8.4.4 HSI Detailed Design and Integration<br><br>The criteria in this section are divided into the following subsections:<br><br>8.4.4.1, General<br>8.4.4.2, Main Control Room<br>8.4.4.3, Technical Support Center<br>8.4.4.4, Emergency Operations Facility<br>8.4.4.5, Remote Shutdown Facility<br>8.4.4.6, Local Control Stations<br><br>Many criteria in this section are based on HFE guidance from other documents. We listed these documents and give the full references for them, including the specific revision or year of publication, in Section 14, References. | No criteria  |