

**Non-Proprietary**

Staffing and Qualifications Implementation Plan

APR1400-K-I-NR-14005-NP, Rev. 1

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# **Staffing and Qualifications Implementation Plan**

**Revision 1**

**Non-Proprietary**

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**REVISION HISTORY**

Revision	Date	Page	Description
0	December 2014	All	First Issue
1	February 2017	10,11	Additional explanation about operating experience review for staffing and qualification (RAI-8039 Q18-12)
		11	Additional explanation about task analysis for staffing and qualification (RAI-8039 Q18-12)
		12	Additional explanation about treatment of important human action for staffing and qualification (RAI-8039 Q18-12)
		15	Update references(RAI-8039 Q18-12)

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## **ABSTRACT**

This document provides the implementation plan (IP) for the human factors engineering (HFE) staffing and qualification (S&Q) program element (PE), which is one of twelve PEs in the Advanced Power Reactor 1400 (APR1400) HFE Program. This IP governs the technical activities conducted in the S&Q PE by defining the scope, methodology, output products, and the qualifications of the personnel who conduct the PE.

The primary purposes of the S&Q are to:

- Establish assumed number and qualifications of APR1400 operations staff based on the staffing constraint, U.S. regulations, and operating experience review (OER), all of which can be used as a starting point for the S&Q analysis as well as the other elements of the HFE Program.
- Conduct an S&Q analysis of plant evolutions comprising tasks to challenge the adequacy of the assumed number and qualifications of the APR1400 operations staff and determine the final operational staffing level and qualifications
- Resolve human engineering discrepancy (HEDs) from the task analysis (TA), S&Q analysis, and any other HFE PEs that identify issues related to the numbers or qualifications of staff

The IP for the APR1400 S&Q analysis describes the methodology used to determine the required number and qualifications of personnel to operate the plant safely and efficiently. The S&Q analysis addresses both licensed and non-licensed staff performing operational tasks as well other staff performing non-operational tasks (e.g., maintenance, surveillance, testing staff). The analysis considers the full range of plant conditions including normal operating modes and abnormal and emergency conditions.

The initial number and qualifications of APR1400 licensed operators are based on the number and qualifications of staff and policies of predecessor plants, conformance with U.S. regulations, and the evaluation of relevant operating experience. This information provides the initial S&Q assumption. Combined license applicant policies are included, if available. The initial S&Q assumption provides a starting point for the S&Q analysis and other elements of the HFE Program.

Using data from the TA, the S&Q analysis examines the acceptability of staffing number and qualifications for plant evolutions comprising multiple tasks. The evolutions are defined from plant procedures or portions of plant procedures. For each evolution, the contributing tasks are identified, and the task data are aggregated.

As the S&Q analysis proceeds, the adequacy of the number and qualifications of APR1400 staff are analyzed by subject matter experts (SMEs) for a broad range of plant evolutions under a full range of plant conditions and tasks, including operational tasks (under normal, abnormal, and emergency conditions). Additionally, the OER is reviewed to determine if any HEDs relative to the number and qualifications of plant staff need to be resolved. The functional requirements analysis and function allocation (FRA/FA) provide the success paths to aggregate the staffing number and qualifications from individual tasks established by the TA. The treatment of important human actions provides the important human actions to S&Q for confirmation that the staffing number and qualifications are sufficient to perform the action.

The number and qualifications of APR1400 non-operational staff, including maintenance, surveillance, and testing staff, are analyzed by the appropriate SMEs. This portion of the analysis starts with a baseline that reflects the staffing number and qualifications of personnel performing non-operational tasks at predecessor plants. The S&Q analysis then examines the changes in APR1400 technology and plant

system designs to determine any impact on the baseline. Staffing-related issues for non-operational positions previously identified in the OER PE are identified and considered.

The S&Q is a one-time, nonrecurring HFE PE whose closure is marked by issuance of the S&Q results summary report (ReSR). However, staffing analyses are iterative in that HEDs generated by other HFE PEs are evaluated for any potential changes needed in these analyses. Similarly, APR1400 plant design changes are evaluated for their impact to the output of all HFE PEs, including the output of the S&Q PE, and HEDs are generated as needed. Therefore, any analysis changes that may be needed after completing the S&Q ReSR are managed through the HED resolution process. HEDs that affect S&Q outputs are resolved prior to completing the human-system interface design, which establishes the APR1400 HSI design for verification and validation (V&V).

After completion of V&V, site-specific changes, including any required FRA/FA output changes, are managed within the APR1400 HFE design implementation (DI) PE, which is a recurring PE for each plant. The DI PE also provides reasonable assurance that all HEDs are closed.

Section 1 of this IP defines the S&Q purpose, Section 2 establishes the Scope, Section 3 provides a methodology overview, Section 4 provide the details of the methodology , including the format and content of each S&Q output product, Section 5 establishes the qualification requirements for the S&Q implementation team, and Section 6 defines the required content of the S&Q ReSR, which demonstrates that the S&Q was conducted in accordance with this IP.

## **TABLE OF CONTENTS**

<b>1</b>	<b>PURPOSE .....</b>	<b>1</b>
<b>2</b>	<b>SCOPE .....</b>	<b>2</b>
<b>3</b>	<b>METHOD .....</b>	<b>3</b>
3.1	Development of the Initial S&Q Assumption .....	3
3.2	Staffing and Qualifications Analysis .....	3
3.3	Resolution of S&Q-Related HEDs .....	3
3.4	Interfaces .....	5
3.4.1	Operational Experience Review .....	5
3.4.2	Functional Requirements Analysis and Function Allocation .....	5
3.4.3	Task Analysis .....	5
3.4.4	Treatment of Important Human Actions .....	5
3.4.5	Staffing and Qualifications .....	5
3.4.6	Procedures Development .....	5
3.4.7	Training Program Development .....	5
3.4.8	Verification and Validation .....	6
<b>4</b>	<b>IMPLEMENTATION .....</b>	<b>7</b>
4.1	Applicable Staffing and Qualification Guidance .....	7
4.1.1	NUREG-0800, Section 13.1 .....	7
4.1.2	10 CFR 50.54 .....	7
4.2	Task Analysis Input to S&Q .....	7
4.3	Determination of Number and Qualifications of Operations Staff .....	7
4.3.1	Initial S&Q Assumption .....	7
4.3.2	S&Q Analysis .....	8
4.3.3	Resolution of S&Q-Related HEDs .....	9
4.4	Process Iterations .....	10
4.5	Considerations for Staffing and Qualification Levels .....	10
4.5.1	Operating Experience Review .....	10
4.5.2	Functional Requirements Analysis and Function Allocation .....	11
4.5.3	Task Analysis .....	11
4.5.4	Treatment of Important Human Actions .....	12
4.5.5	Procedure Development .....	12
4.5.6	Training Program Development .....	12
<b>5</b>	<b>IMPLEMENTATION TEAM .....</b>	<b>13</b>

<b>6</b>	<b>RESULTS SUMMARY REPORT .....</b>	<b>14</b>
<b>7</b>	<b>REFERENCES .....</b>	<b>15</b>
<b>8</b>	<b>DEFINITIONS .....</b>	<b>15</b>
<b>APPENDIX A</b>	<b>NUREG-0711, REV. 3, CONFORMANCE TABLE .....</b>	<b>A-1</b>
<b>APPENDIX B</b>	<b>PREDECESSOR PLANT STAFFING DATA FOR THE MAIN CONTROL ROOM .....</b>	<b>B-1</b>
<b>APPENDIX C</b>	<b>GUIDELINES FOR CONDUCTING S&amp;Q TALK-THROUGHS AND WALK-THROUGHS .....</b>	<b>C-1</b>
<b>APPENDIX D</b>	<b>EXAMPLE S&amp;Q EVOLUTION SUMMARY SHEET .....</b>	<b>D-1</b>

**LIST OF TABLES**

Table 5-1. S&Q Implementation Summary..... 13

**LIST OF FIGURES**

Figure 3-1. S&Q Process ..... 4

**ACRONYMS AND ABBREVIATIONS**

ANS	American Nuclear Society
ANSI	American National Standards Institute
APR1400	Advanced Power Reactor 1400
BA	bachelor of art
BS	bachelor of science
CESSAR-DC	Combustion Engineering Standard Safety Analysis Report – Design Certification
COL	combined license
DI	design implementation
EOF	emergency operation facility
FA	function allocation
FRA	functional requirements analysis
FRA/FA	functional requirements analysis and function allocation
FSAR	Final Safety Analysis Report
HD	HSI design
HED	human engineering discrepancy
HFE	human factors engineering
HSI	human-system interface
IHA	important human actions
IP	implementation plan
ITS	issue tracking system
KEPCO	Korea Electric Power Corporation
KHNP	Korea Hydro & Nuclear Power Co., Ltd.
LCS	local control station
MCR	main control room
NLO	non-licensed operator
OER	operating experience review
PE	program element
PP	program plan
PWR	pressurized water reactor
ReSR	results summary report
RO	reactor operator
RSR	remote shutdown room
S&Q	staffing and qualifications



SME	subject matter expert
SRO	senior reactor operator
TA	task analysis
TIHA	treatment of important human actions
TS	trade secret
TSC	technical support center
TT/WT	talk-through/walk-through
V&V	verification and validation

## **1. PURPOSE**

This document provides the staffing and qualifications (S&Q) implementation plan (IP) as an element of the APR1400 Human Factors Engineering (HFE) Program. This IP governs the technical activities conducted in the S&Q program element (PE) by defining the scope, methodology, output products, and qualifications of the personnel who conduct the PE.

The primary purposes of the S&Q analysis are to:

- Establish assumed number and qualifications of the APR1400 operations staff based on the staffing constraint, U.S. regulations, and operating experience review (OER), all of which can be used as a starting point for the S&Q analysis as well as the other elements of the HFE Program
- Conduct an S&Q analysis of plant evolutions comprising tasks to challenge the adequacy of the assumed number and qualifications of the APR1400 operations staff and determine the final operational staffing level and qualifications
- Resolve human engineering discrepancies (HEDs) from the task analysis (TA), S&Q, and any other HFE PE that identify issues related to the number or qualifications of operations staff

The starting point is an initial S&Q assumption based on predecessor pressurized water reactor (PWR) plants and APR1400 design goals and constraints and a consideration of applicable regulations and operational experience. The final staffing number and qualifications are determined by analyzing plant evolutions comprising tasks that were analyzed in the TA PE of the HFE Program. Additional inputs are provided through iterative interaction with the other elements of the HFE Program using HEDs. The result is to confirm or modify the number and qualifications of the APR1400 operations staff consistent with the TA, treatment of important human actions (TIHA), and design implementation (DI). HEDs identified in any PE, including those identified during the S&Q, are tracked and resolved in accordance with the process defined in the HFE Program Plan (PP).

## **2. SCOPE**

The scope of the APR1400 S&Q analysis is defined in the following three aspects:

- Staffing positions (roles) being considered
- Locations at which staff conduct operations
- Plant operating conditions when staff are performing operations

The S&Q scope includes operations performed by senior reactor operators (SRO), reactor operators (RO), and non-licensed operators (NLO) in the main control room (MCR), remote shutdown room (RSR), technical support center (TSC), and emergency operations facility (EOF), and also in local control stations (LCSs) where important human actions (IHAs) are performed.

The S&Q for the EOFs is limited to the consideration of communication with operators in the MCR or RSR.

The range of operating conditions considered for the S&Q analysis cover normal, abnormal, and emergency operating conditions for all modes of operation. In addition, the staffing number and qualifications are analyzed for any other plant personnel who perform tasks that are determined to be IHAs.

As stated in Section 13.1 of the APR1400 Design Control Document (DCD), Tier 2, the combined license (COL) applicant is responsible for providing the number and qualifications of the technical support staff including maintenance, surveillance, and testing staff.

**3. METHOD**

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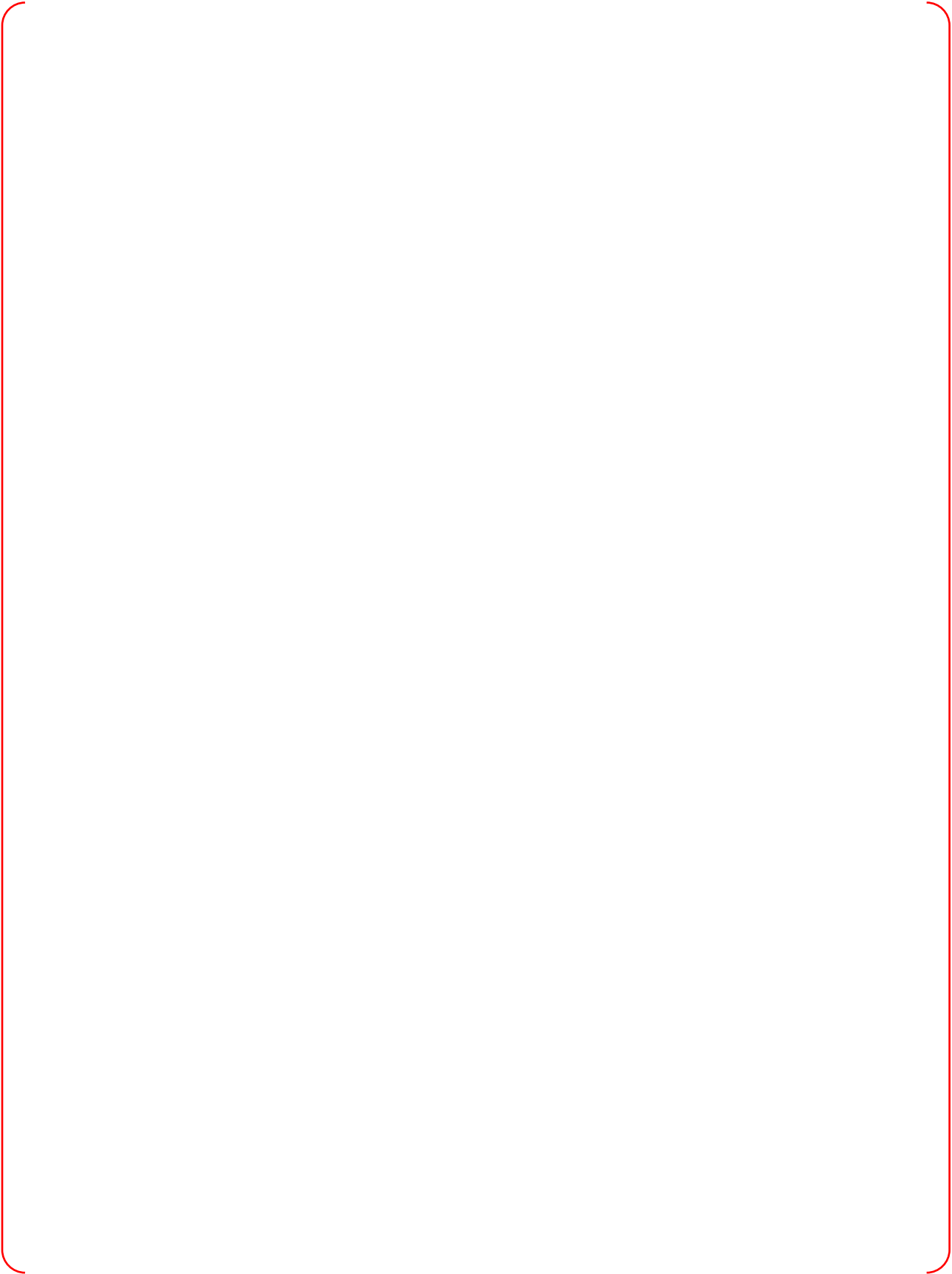




**4. IMPLEMENTATION**















## 5. IMPLEMENTATION TEAM

The S&Q implementation team is composed of a team leader and SMEs. The S&Q is a qualitative analysis using the quantitative data from the TA that requires subjective judgments on the part of the analysts. Consequently, the S&Q PE is implemented by an interdisciplinary team of SMEs. Collaborative evaluations leading to consensus by the SMEs are used throughout the S&Q analysis. The disciplines on the S&Q implementation team shown in

Table 5-1 are:

- Operating group – plant operations expert
- Operating group – plant procedures developers
- Human factors engineer

Qualifications are in accordance with the HFEPP.

Table 5-1. S&Q Implementation Summary

Implementation Activity	IP Section	Subject Matter Expertise
Initial S&Q assumption	4.3.1	Plant operations
S&Q analysis	4.3.2	Plant operations, plant procedures, HFE
HED resolution	4.3.3	Plant operations, plant procedures, HFE

## **6. RESULTS SUMMARY REPORT**

The results of the S&Q analysis are documented in the ReSR, either directly or through reference to the S&Q data documentation. The ReSR demonstrates that the functional analysis and allocation were conducted in accordance with this IP.

The S&Q evolution TT/WT data are created and stored in a documentation system or database to allow information to be manipulated and updated. Existing portions of the analysis are updated to reflect any changes to the plant design to provide reasonable assurance of internal consistency between the S&Q data and the APR1400 design. The S&Q data are linked with the TA database.

In addition to referencing the S&Q evolution data, the S&Q ReSR includes the following:

- S&Q results overview, which describes the principal findings of the S&Q PE with a tabular listing of the number and qualifications of operations personnel and an overview of any HEDs
- Explanation of the methodology used to conduct the S&Q analysis
- Name of each S&Q team member, SME position filled, and the types of outputs generated by the team member
- Evolution summary sheet from each evolution TT/WT
- Detailed description of any resulting HEDs
- Conclusion that the S&Q PE:
  - Has been conducted in accordance with the S&Q IP
  - Has determined the number and qualifications of operations personnel for the full range of plant conditions and tasks, including operational tasks (under normal, abnormal, and emergency conditions), plant maintenance, plant surveillance, and testing

## 7. REFERENCES

1. APR1400-E-I-NR-14001-P, "Human Factors Engineering Program Plan," Rev.0, KHNP, December 2014.
2. 10 CFR 50.54, "Conditions of Licenses," U.S. Nuclear Regulatory Commission.
3. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)," U.S. Nuclear Regulatory Commission, various dates and revisions.
4. APR1400-E-I-NR-14004-P, "Task Analysis Implementation Plan," Rev.0, KHNP, December 2014.
5. NUREG/CR-6400, "Human Factors Engineering (HFE) Insights for Advanced Reactors Based upon Operating Experience," U.S. Nuclear Regulatory Commission, January 1997.
6. Information Notice 95-48, "Results of Shift Staffing Study," U.S. Nuclear Regulatory Commission, October 1995.
7. Information Notice 97-78, "Crediting of Operator Actions in Place of Automatic Actions and Modifications of Operator Actions, Including Response Times," U.S. Nuclear Regulatory Commission, October 1997.
8. 10 CFR 50.47, "Emergency Plans," U.S. Nuclear Regulatory Commission.
9. NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," U.S. Nuclear Regulatory Commission, November 2011.
10. NUREG-0711, "Human Factors Engineering Program Review Model," Rev. 3, U.S. Nuclear Regulatory Commission, November 2012.
11. "Combustion Engineering Standard Safety Analysis Report – Design Certification (CESSAR-DC)," Combustion Engineering, Inc., June 1994.
12. 10 CFR 26, "Fitness for Duty Programs," U.S. Nuclear Regulatory Commission.
13. RIS 2009-10, "Communications between the NRC and Reactor Licensees during Emergencies and Significant Events," U.S. Nuclear Regulatory Commission, June 2009.
14. ANSI/ANS 58.8-1994, "Time Response Design Criteria for Safety-Related Operator Actions," American Nuclear Society, 1994.
15. NUREG/CR-6753, "Review of Findings for Human Performance Contribution to Risk in Operating Events", U.S. Nuclear Regulatory Commission, March 2002.



## **8. DEFINITIONS**

**Evolution** – Process of completing multiple operator tasks in accordance with one or more procedures or portions of procedures.

**APPENDIX A. NUREG-0711, REV. 3, CONFORMANCE TABLE**

NUREG-0711, Rev. 3, Review Criteria	IP Section
(1) The applicant should address the applicable staffing and qualifications guidance in NUREG-0800 Section 13.1.	2.0, 4.1.1
Additional Information: The NRC's reviewers for Chapter 18 of NUREG-0800 should verify that the reviews of Section 13.1 were completed.	2.0, 4.1.1
(2) The applicant should address the applicable staffing and qualifications guidance in 10 CFR 50.54.	3.1, 4.1.2, 4.3.1
Additional Information: As part of their verification, the Chapter 18 reviewers should assure that staffing meets the requirements of 10 CFR 50.54. For plant staffing levels that require an exemption from 10 CFR 50.54, the NRC's reviewers should use the guidance in NUREG-1791 (Persensky et al., 2005) and NUREG/CR-6838 (Plott et al., 2004).	3.1, 4.1.2, 4.3.1
(3) The applicant should use the results of the task analysis as an input to the staffing and qualification analyses. Personnel tasks, addressed in task analysis, should be assigned to staffing positions to ensure that jobs are defined considering: <ul style="list-style-type: none"> <li>• the task characteristics, such as the knowledge and abilities required, relationships among tasks, time required to perform the task, and estimated workload</li> </ul>	3.2, 4.2, App. C
<ul style="list-style-type: none"> <li>• the person's ability to maintain situation awareness within the area of assigned responsibility</li> </ul>	4.2
<ul style="list-style-type: none"> <li>• teamwork and team processes, such as peer checking</li> </ul>	4.2
(4) The applicant's staffing analysis should determine the number and qualifications of operations personnel for the full range of plant conditions and tasks, including operational tasks (under normal, abnormal, and emergency conditions), plant maintenance, plant surveillance, and testing.	2.0, 4.3.2, 6.0
Additional Information: The staffing analysis should address how the activities performed by personnel listed in Section 2.4.1, General HFE Program Goals and Scope, Criterion (5) impact and/or interface with the MCR. A reasonable approach is using predecessor plant data as a starting point for the analysis and adjusting the staffing numbers in accord with information from the new plant's design.	3.1, 4.3.1
(5) The applicant's staffing analysis should be iterative; that is, the initial staffing goals should be modified as information from the HFE analyses from other elements becomes available.	4.4
(6) The applicant should address the basis for staffing and qualification levels considering the specific staffing-related issues noted below. These considerations may be identified in other HFE elements or in related source documents as follows:	4.5

NUREG-0711, Rev. 3, Review Criteria	IP Section
<p>Operating Experience Review</p> <ul style="list-style-type: none"> <li>• operational problems and strengths resulting from staffing levels in predecessor designs</li> <li>• initial staffing goals and their bases, including staffing levels of predecessor designs and a description of significant similarities and differences between predecessor and current designs</li> <li>• staffing considerations described in NRC Information Notice 95-48, "Results of Shift Staffing Study"</li> <li>• possible impact on staffing of requirements of limits to work hours, required break times, and required days off, as specified in 10 CFR 26.205, Work Hours, as part of the Fitness for Duty Rule</li> <li>• Regulatory Issue Summary (RIS) 2009-10, Communications Between the NRC and Reactor Licensees During Emergencies and Significant Events</li> </ul>	4.5.1
<p>Functional Requirements Analysis and Function Allocation</p> <ul style="list-style-type: none"> <li>• potential mismatches between functions allocated to personnel and their qualifications</li> <li>• changes to the roles of personnel due to modifying the plant's systems and HFE aspects</li> </ul>	4.5.2
<p>Task Analysis</p> <ul style="list-style-type: none"> <li>• time needed to perform a task, and the workload involved</li> <li>• personnel communication and coordination, including interactions between individuals for diagnosing, planning, and controlling the plant, and interactions between personnel for administrative, communications, and reporting activities</li> <li>• the job requirements resulting from the sum of all tasks allocated to each individual inside and outside the control room</li> <li>• potential decreases in the ability of personnel to coordinate their work due to changes to the plant</li> <li>• availability of personnel considering other work that may be ongoing, and for which operators may be responsible outside the control room (e.g., fire brigade)</li> <li>• actions identified in 10 CFR 50.47, NUREG-0654, and procedures to implement an initial accident response in key functional areas, as denoted in the emergency plan</li> <li>• staffing considerations described by the application of ANSI/ANS 58.8-1994, "Time Response Design Criteria for Safety-Related Operator Actions" (ANS, 1994), if used by the applicant</li> </ul>	4.2, 4.5.3, App. C
<p>Treatment of Important Human Actions</p> <ul style="list-style-type: none"> <li>• the effect of staffing levels on the performance of the identified important HAs</li> <li>• the effect of staffing levels on personnel coordination for important HAs</li> <li>• NUREG/CR-6753, Review of Findings for Human Performance Contribution to Risk in Operating Events</li> </ul>	4.5.4

<b>NUREG-0711, Rev. 3, Review Criteria</b>	<b>IP Section</b>
Procedure Development <ul style="list-style-type: none"><li>• staffing demands resulting from requirements to concurrently use multiple procedures</li><li>• personnel knowledge, abilities, and authorities identified in the procedures</li></ul>	4.5.5
Training Program Development <ul style="list-style-type: none"><li>• concerns about coordinating personnel that are identified during the development</li></ul>	4.5.6

**APPENDIX B. PREDECESSOR PLANT STAFFING DATA FOR THE MAIN CONTROL ROOM**

**System 80+ Staffing (from CESSAR-DC (Reference 11))**

Number	Position	Qualification
1	Shift Supervisor	SRO
1	Control Room Supervisor	SRO
3	Assistant Reactor Operators	RO
1	Shift Technical Advisor	BA or BS degree
2	Nuclear Equipment Operator	NLO

**Palo Verde Nuclear Generating Station Staffing (from Updated FSAR)**

Number	Position	Qualification
1	Shift Manager	SRO
1	Control Room Supervisor	SRO
2	Reactor Operators	RO
1*	Shift Technical Advisor	BA or BS degree
4**	Auxiliary Operators	NLO

\*Minimum 2 for site (3 units)

\*\* Minimum 2

**Shin Kori 3&4**

Number	Position	Qualification
1	Shift Supervisor	SRO
1	Shift Technical Advisor	SRO
1	Reactor Operators	RO
1	Turbine Operator	RO
1	Electrical Operator	NLO

**APPENDIX C. GUIDELINES FOR CONDUCTING S&Q TALK-THROUGHS AND WALK-THROUGHS**

The S&Q analysis of each selected evolution is conducted by three SMEs meeting face-to-face in an environment that promotes interaction and consensus. The purpose of the analysis is to determine if the number and qualifications of staff identified as needed in the TA for individual tasks can be supported by the staffing constraint for multi-task evolutions. The SMEs have reviewed and are familiar with the procedure(s) that govern the evolution, the task narratives for all tasks within the evolution, and any unresolved HEDs associated with tasks within the evolution. The tabletop TT/WT review proceeds systematically through the applicable portion of the evolution's procedures stopping at each task to:

- Assign each task in the evolution to a designated staff member (e.g., RO 1, RO 2)
- Identify any concurrent tasks (e.g., previous tasks still in progress)
- Review the secondary task multiplier assigned to the individual task in the TA and determine if it is appropriate considering communication interactions between people for diagnostic, planning, control, administrative, and reporting activities
- Assess the need for concurrent use of controls and displays by multiple personnel
- Assess the impact of design differences in the plant and the HSI, compared to predecessor plants

Following the completion of the TT/WT, the SMEs review the aggregate workload for each task assigned to a designated staff member to identify any potential adverse workload issues or times at which adverse effects created by the combination of the primary tasks and loading from secondary tasks may exist. Any mismatches between personnel assigned to tasks and their qualifications is noted and an HED is submitted.

**APPENDIX D. EXAMPLE S&Q EVOLUTION SUMMARY SHEET**

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