NEI PROPOSED REVISIONS
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3 SCREEN GUIDANCE

CAUTION

The guidance contained in this appendix is intended to supplement the generic Screen guidance contained in the main body in NEI 96-07, Section 4.2. Namely, the generic Screen guidance provided in the main body of NEI 96-07 and the more-focused Screen guidance in this appendix BOTH apply to digital modifications.

NOTE: In the following sections and sub-sections that describe the Screen guidance unique to the application of 10 CFR 50.59 to digital modifications, each section and sub-section describes only a specific aspect, sometimes at the deliberate exclusion of other related aspects. This focused approach is intended to concentrate on the particular aspect of interest and does not imply that the other aspects do not apply or could not be related to the aspect being addressed.

3.1 INTRODUCTION

There is no regulatory or technical requirement for a proposed activity involving a digital modification to *default* (i.e., be mandatorily "forced") to having an adverse effect on how a UFSAR-described design function is performed or controlled. The introduction of software or digital hardware, in and of itself, does not cause the proposed activity to be adverse (i.e., "screen in"). Likewise, simply because software and/or digital hardware is replaced with other software and/or digital hardware does not cause the proposed activity to be adverse.

Similarly, a proposed activity involving a digital modification does not necessarily involve a fundamental change in how a design function is performed or controlled. The mere fact that a digital processor "calculates" a numerical value or "generates" a control signal using software is not fundamentally different from a numerical value or a control signal using analog components if the digital device (hardware and software) cannot produce erroneous numerical values or control signals due to failures any different from those produced by the analog devices. Similarly, the mere fact that a touchscreen may be used in place of hard controls (i.e., pushbuttons, knobs, switches, etc.) to operate or control plant equipment is not fundamentally different from the hard controls if the digital device (hardware and software) cannot produce erroneous operations or controls due to failures any different from those produced by the analog devices.

Examples 3-1 and 3-2 illustrate the relationship between a digital modification and the concept of a fundamental change in how a design function is performed.

Example 3-1. Digital Modification that does NOT contain a Fundamental Change to How a Design Function is Performed or Controlled

Flow in a system is measured using a venturi (which generates a differential pressure signal that is described in the UFSAR) and the instrumentation loop contains analog components (which are not described in detail in the UFSAR). If all of the analog components (except for the venturi itself) are replaced with digital components and/or a digital control system, but flow is still developed using the differential pressure signal, there is no change in how the design function (i.e., measuring flow) is performed.

The use of digital equipment (hardware and software) still needs to be addressed in the Screen to determine the impact on the pertinent design functions, but not as a "fundamental" change.

Example 3-2. Digital Modification that DOES contain a Fundamental Change to How a Design Function is Performed or Controlled

Main feedwater flow to the steam generators is manually controlled by the licensed Operators, who use steam generator level to determine if flow should be adjusted. There are two analog control systems, one for each MFWP, that are both physically and functionally the same. All of these features (i.e., manual operation, adjustments based on level and two separate control systems) are described in the UFSAR. Two new digital feedwater control systems will replace the analog control systems, maintaining the original separation provided by the analog systems. The new control systems will automatically control feedwater flow and will use steam generator *level* and steam generator *pressure* to determine the proper flow rate.

In this case, there are two activities that fundamentally alter how a design function is performed: (1) *manual-to-auto* and (2) *level-only to level-and-pressure*.

Note that the use of digital equipment (hardware and software) is not the source of the fundamental changes; it was the *manual-to-auto* and *level-only to level-and-pressure* activities that were the fundamental changes.

3.2 PROCESS

3.2.1 SCREENING OF CHANGES TO THE FACILITY AS DESCRIBED IN THE UFSAR

3.2.1.1 SCOPE

The screening of proposed activities involving the *facility as described in the UFSAR* considers the software and hardware portions of the digital modification.

In the determination of potential adverse impacts, the following aspects should be addressed in the response to this Screen consideration:

(a) Types of SSCs

(b) Combination of Components/Functions

(c) Dependability

3.2.1.2 Types of SSCs

During the original licensing process, the types of SSCs in the facility may have been a consideration. In general, different SSCs may be equivalent, similar or identical to one another physically or functionally.
The UFSAR may explicitly or implicitly describe the types of SSCs through diversity, separation, independence and/or redundancy discussions. With digital modifications, the new equipment has the potential to impact the diversity, separation, independence and/or redundancy of the SSCs described in the UFSAR.

To assist in determining the impact of a digital modification on the diversity, separation, independence and/or redundancy of the affected components, identify the types of SSCs described in the UFSAR. Compare the proposed types of SSCs with the existing types of SSCs. The impact of any differences in the types of SSCs on diversity, separation, independence and/or redundancy is then determined.

For redundant SSCs that must satisfy single failure criteria requirements, the following guidance applies:

1. The use of exactly the same software in two or more redundant SSCs is ADVERSE because the independence of the SSCs has been reduced.

2. The use of different software in two or more redundant SSCs is NOT ADVERSE because the independence of the SSCs has been maintained.

3. The use of exactly the same or different hardware in two or more redundant SSCs is subject to the same licensing considerations as described in the UFSAR as those for non-digital SSCs and a conclusion of ADVERSE or NOT ADVERSE is determined in the same manner as for non-digital proposed activities.

Examples 3-3 and 3-4 illustrate the application of the *types of SSCs* consideration.

Example 3-3. Replacing SSC Types with NO ADVERSE IMPACT on a UFSAR-Described Design Function

A licensee has two non-safety-related main feedwater pumps (MFWPs), each with 70% capacity. There are two analog control systems, one for each MFWP, that are physically and functionally the same.

The licensee proposes to replace the two analog control systems with two digital control systems. The hardware platform for each digital control system is from the same supplier and the software in each digital control system is exactly the same.

The UFSAR descriptions are as follows:

(1) Two analog control systems exist.

(2) Both analog control systems consist of the same physical and functional characteristics.

(3) The types of MFWP control system malfunctions include (a) failures causing the loss of all feedwater to the steam generators and (b) failures causing an increase in main feedwater flow to the maximum output from both MFWPs (140%).

The use of the same hardware platforms and identical software in both control systems is NOT ADVERSE for the following reasons:

(1) There are no UFSAR descriptions related to the ability of one MFWP and its analog control system to provide a redundant source of main feedwater flow in the event of the loss of one MFWP/control system. Therefore, the MFWPs and control systems are not required to satisfy single failure criteria. The two analog control systems existed for operational convenience only, not to satisfy any General Design Criteria requirements.

(2) There is no impact on diversity since none originally existed or was described in the UFSAR.

(3) There is no impact on the separation of the control systems described in the UFSAR since each of the analog control systems will be replaced with its own digital control system.

(4) Although both of the new digital control systems contains the exact same software (which is subject to a software CCF), no new types of malfunctions are introduced since the loss of BOTH MFWPs and failures causing an increase in main feedwater flow to the maximum output from both MFWPs (140%) are already considered in the licensing basis.

Example 3-4. Replacing SSC Types with an ADVERSE IMPACT on a UFSAR-Described Design Function

Using the same basic information from Example 3-3, this example illustrates how variations in the licensing basis as described in the UFSAR would result in ADVERSE conclusions.

Alternate Licensing Basis #1: If the UFSAR described the loss of only ONE MFWP, the proposed activity would be ADVERSE because a new type of malfunction would

be introduced due to a possible software CCF that could disable BOTH MFWPs.

Alternate Licensing Basis #2: If the UFSAR described the consideration of the maximum output from only ONE MFWP, the proposed activity would be ADVERSE because a new type of malfunction would be introduced due to a possible software CCF that could cause BOTH MFWPs to reach their maximum output.

3.2.1.3 COMBINATION OF COMPONENTS/FUNCTIONS

During the original licensing process, the number of components, how the components were arranged, and/or how functions were allocated to those components, may have been a consideration that provided a level of physical and/or functional variety and/or layers of design.

When replacing analog SSCs, it is potentially advantageous to combine multiple components and/or functions into a single device or control system. However, the failure of the single device or control system for any reason (e.g., software defect, hardware failure, environmental effects, etc.) can potentially affect multiple functions.

To assist in determining the impact of a digital modification on the number and/or arrangement of components, review the description of the existing system(s) and/or component(s) in the UFSAR and compare how the number and/or arrangement of components is reflected in the proposed number and/or arrangement of components. Typically, drawings included as part of the UFSAR or those considered to be *incorporated by reference* (see main body NEI 96-07, Section 3.7) will show the current configuration as having a specific number and/or a specific arrangement of components. Using the current configuration, consider how the proposed configuration affects the number and/or arrangement of components.

If the combination of components and/or functions does not involve SSCs described in the UFSAR (directly or indirectly), or does not involve UFSAR-described design functions, then there cannot be an adverse impact due to the combination aspect of the digital activity.

Alternately, if the affected SSCs are described in the UFSAR and/or the design functions of the affected SSCs are described in the UFSAR, then the determination of the impact of an activity involving a digital modification that combines components and/or functions considers if the activity reduces the existing number and/or arrangement of components.

The combination of previously separate components and/or functions, in and of itself, does not make the Screen conclusion adverse. Only if combining the previously separate components and/or functions causes a reduction in the reliability of performing a design function (e.g., by the creation of a new malfunction

or the creation of a new accident initiator) is the combination aspect of the digital activity adverse.

Examples 3-5 through 3-8 illustrate the application of the *combination of components/functions* consideration.

Example 3-5. Combining Components and Functions with NO ADVERSE IMPACT on a UFSAR-Described Design Function

A licensee has two non-safety-related main feedwater pumps (MFWPs) that were originally designed with two analog control systems that are physically and functionally the same. Each analog control system has many subcomponents performing dedicated functions.

The licensee proposes to replace all of the analog subcomponents with a digital device that consolidates all of the components, sub-components and the functions associated with each component and sub-component. Each analog control system will be replaced with a separate digital control system. The hardware platform for each digital control system is from the same supplier and the software in each digital control system is exactly the same. There are no interactions between the two new digital control systems or any other plant component(s) that did not previously exist.

Only the control system is described in the UFSAR, not the individual components or subcomponents. The loss of <u>all</u> feedwater to the steam generators due to the loss of both analog control systems has been previously considered in the licensing basis. Furthermore, the maximum output from both feedwater pumps has been previously considered in the licensing basis as a conservative assumption in the applicable accident analysis.

Since only the control system is described in the UFSAR, it is the only SSC to be examined for the identification of design functions. The control system contains a design function "to provide adequate cooling water to the steam generators during normal operation." This function rises to the level of a design function because, if not performed, the inability to provide cooling water to the steam generators would initiate a transient or accident that the plant is required to withstand (i.e., Loss of Feedwater).

The combination of components and functions has NO adverse impact on the identified design function for several reasons:

(1) No design functions for any of the sub-components are described in the UFSAR. Since no design functions are described for a particular SSC, then no adverse impacts can occur.
(2) Because the entire feedwater control system is non-safety-related, there is no regulatory requirement to provide redundancy. The two control systems existed for

operational convenience only, not to satisfy any General Design Criteria requirements.
(3) No new malfunctions are created. Since no new malfunctions are created, the ability to perform the design function "to provide adequate cooling water to the steam generators during normal operation" is maintained.

Example 3-6. Combining Components and Functions with NO ADVERSE IMPACT on a UFSAR-Described Design Function

Using the same initial facility configuration from Example 3-5, this example illustrates how a variation in the proposed activity would be addressed.

Instead of two separate, discreet, unconnected digital control systems being used for the feedwater control systems, only one central digital processor is proposed to be used that will combine the previously separate control systems and control both feedwater pumps.

Although the UFSAR explicitly describes the existence of two control systems, combining the two analog control systems into one digital control system is NOT adverse because no new malfunctions are created (i.e., recall that the loss of both control systems and maximum feedwater flows from both feedwater pumps have already been considered in the licensing basis). Since no new malfunctions are created, the reliability of the design function "to provide adequate cooling water to the steam generators during normal operation" is maintained.

Example 3-7. Combining Components and Functions with an ADVERSE IMPACT on a UFSAR-Described Design Function

Using the same initial facility configuration and proposed activity from Example 3-5 (i.e., the use of two digital control systems), this example illustrates how a variation in the licensing basis as described in the UFSAR impacts the Screen conclusion, causing an adverse impact.

Instead of the loss of all feedwater to the steam generators due to the loss of both analog control systems being previously considered in the licensing basis, the loss of only one analog control system (and its worst-case affect on feedwater flow) has been considered.

In this case, the proposed activity would be adverse since a new malfunction is created (i.e., loss of both control systems) due to a CCF (e.g., a software defect in both digital control systems).

Similarly, if the combination of components and functions examined in Example 3-6 was proposed (i.e., the use of only one digital control system), the proposed activity would be adverse for the same reason as above (i.e., creation of a new malfunction).

In both cases, the adverse impact is due to the reduction in the reliability of the design function "to provide adequate cooling water to the steam generators during normal operation."

Example 3-8. Combining Components and Functions with an ADVERSE IMPACT on a UFSAR-Described Design Function

Using the same initial facility configuration from Example 3-5, this example illustrates how a significant variation in the proposed activity would cause an adverse impact.

In addition to the feedwater control systems, the licensee has several non-safety-related main turbine steam-inlet valves that are controlled with a single analog control system. The main turbine steam-inlet valves analog control system has many subcomponents performing dedicated functions. However, only the main turbine steam-inlet valves control system is described in the UFSAR, not the individual components or subcomponents.

The licensee proposes to combine the feedwater control systems and the turbine steam-inlet valves control system into one digital device.

The design function for the feedwater control system from Example 3-5 remains pertinent. Since only the turbine steam-inlet control valve control system is described in the UFSAR, it is the only other SSC to be examined for the identification of design functions. The turbine control system contains a design function "to control the amount of steam entering the main turbine during normal operation." This function rises to the level of a design function because, if not performed, the inability to control steam to the main turbine would initiate an accident (i.e., Excess Steam Demand or Loss of Load).

The loss of all feedwater to the steam generators due to the loss of both analog control systems has been previously considered in the licensing basis (i.e., the Loss of Feedwater accident).

The failure of all the steam-inlet valves (e.g., all valves going fully closed or all valves going fully open) due to the loss of the analog control system has been considered in the licensing basis, as follows: "all open" is considered in the Excess Steam Demand accident and "all closed" is considered in the Loss of Load accident. However, the licensing basis does not consider the combination of the Loss of Feedwater accident with either the Excess Steam Demand accident or the Loss of Load accident.

In this case, the proposed activity would be adverse because a new malfunction has been created (i.e., loss of both feedwater control systems and the loss of the turbine control system) that was not previously considered in the licensing basis.

Furthermore, the combination of the different control systems causes a reduction in the separation described in the UFSAR.

These impacts have an adverse impact on reliability of the feedwater control system design function "to provide adequate cooling water to the steam generators during normal operation" and the reliability of the turbine control system design function "to control the amount of steam entering the main turbine during normal operation."

3.2.1.4 DEPENDABILITY

In the main body of NEI 96-07, Section 4.2.1, subsection titled "Screening for Adverse Effects," reliability is mentioned in the following excerpt:

> "...a change that decreases the reliability of a [design] function whose failure could initiate an accident would be considered to adversely affect a design function..."

For digital modifications, the most commonly used term to describe this concept is "dependability." To address dependability of a design function for an activity involving a digital modification, the following tools may be used:

- Operating History of the Hardware and/or Software
- Development (including design attributes and the process), Testability, Verification & Validation (V&V), and Configuration Management of the Hardware and/or Software
- Design Measures (including data validation, cyclic software architecture, internal redundancy, etc.).

To address dependability, the Screen should contain a discussion of the information (including the identification of associated references) gathered from applying the tools identified above.

Typically, digital equipment is more reliable than the equipment it replaces and often incorporates design features that contribute to a lower likelihood of malfunction. Such features can improve the dependability of a train of a system; thus preserving the system-level design function. These features should be identified in the response to this Screen consideration, and may include discussions of the following attributes and/or characteristics:

- Internal redundancy and fault tolerance to preclude single faults from causing the device to malfunction.

- Self-diagnostics to detect and alarm faults, or abnormal or unanticipated conditions so that operators can take timely corrective action before the system is called upon to perform its design function.
- Self-test routines that perform surveillance testing functions on a more frequent basis than the original, manually executed surveillance tests.
- Preventive measures
- System performance under high duty cycle loading (e.g., computational burden during accident conditions).
- Availability of a means to alert the operators to the failure condition.

3.2.2 SCREENING OF CHANGES TO PROCEDURES AS DESCRIBED IN THE UFSAR

3.2.2.1 SCOPE

The screening of proposed activities involving *procedures as described in the UFSAR* considers the Human-System Interface (HSI) portion of the digital modification.

The focus of the Screen is on potential adverse effects due to modifications of the *interface* between the human user and the technical device [e.g., equipment manipulations, actions taken, options available, manipulation sequences or operator response times (including the impact of errors of a cognitive nature in which the information being provided is unclear or incorrect)], not the written procedure modifications that may accompany a physical design modification.

3.2.2.2 PHYSICAL INTERFACE

Physical Interaction

Consideration of the digital modification on the impact on physical interaction involves an examination of the actual physical interface and how it could impact the performance and/or satisfaction of UFSAR-described design functions. For example, if a new malfunction is created as a result of the physical interaction, then the HSI portion of the digital modification would be adverse. Such a new malfunction may be created by the interface requiring the human user to choose which of multiple components is to be controlled, creating the possibility of selecting the wrong component (which could not occur with an analog system that did not need the human user to make a "selection").

To determine if the HSI aspects of a digital modification have an adverse effect on UFSAR-described design functions, potential impacts to the physical interaction should be addressed in the Screen.

To determine possible impacts, the UFSAR must be reviewed to identify descriptions regarding how the interaction with the current component or system is described and how that interaction contributes to UFSAR-described design functions being performed and/or satisfied.

A typical physical interaction modification might involve use of a touch screen in place of push-buttons, switches or knobs.

Examples 3-9 through 3-11 illustrate the application of the *physical interaction* consideration.

Example 3-9. Physical Interaction with NO ADVERSE IMPACT on a UFSAR-Described Design Function

Currently, a knob is rotated clock-wise to increase a control function and counter clock-wise to decrease the control function. This knob will be replaced with a touch screen. Using the touch screen, touching the "up" arrow will increase the control function and touching the "down" arrow will decrease the control function.

The UFSAR states that the operator can "increase and decrease the control functions using manual controls located in the Main Control Room."

Examining only the digital modification aspect (i.e., ignoring the impact on operator response time or the number and/or sequence of steps necessary to access the new digital controls), the replacement of the "knob" with a "touch screen" is not adverse since it does not adversely impact the ability of the operator to "increase and decrease the control functions using manual controls located in the Main Control Room."

Example 3-10. Physical Interaction with an ADVERSE IMPACT on a UFSAR-Described Design Function

Using the same proposed activity described in Example 3-9, this example illustrates how a variation in the UFSAR description would cause an adverse impact.

In this case, the UFSAR states not only that the operator can "increase and decrease the control functions using manual controls located in the Main Control Room," but also that "the control mechanism provides tactile feedback to the operator as the mechanism is rotated through each setting increment."

Since a touch screen cannot provide (or duplicate) the "tactile feedback" of a mechanical device, replacing the "knob" with a "touch screen" is adverse since it adversely impacts the ability of the operator to obtain tactile feedback from the device.

Example 3-11. Physical Interaction with an ADVERSE IMPACT on a UFSAR-Described Design Function

Using the same proposed activity described in Example 3-9 and the same UFSAR descriptions from Example 3-10, this example illustrates how a variation in the proposed activity would also cause an adverse impact.

In addition to the touch screen control "arrows" themselves, a sound feature and components are added to the digital design that emit a clearly audible and distinct "tone" each time the control setting passes through the same setting increment that the tactile feature provided with the mechanical device.

Although the operator will now receive "feedback" during the operation of the digital device, the fundamental means by which this feedback is provided has been altered. Since the fundamental means of controlling the design function has changed, new malfunctions can be postulated (e.g., high ambient sound levels that prevent the operator from hearing the feedback). Therefore, the modification of the feedback feature (i.e., from tactile to auditory) has an adverse impact on how the design function is performed.

Number and/or Type of Parameters

Potential impacts due to the modification of the number and/or type of parameters monitored should be addressed. The purpose of addressing this factor is to determine if the number of parameters and/or type of information available due to a digital modification causes an adverse impact on the performance and/or satisfaction of a UFSAR-described design function.

Potential causes for an adverse impact on a UFSAR-described design function could include a reduction in the number of system parameters monitored (which could make the diagnosis of a problem or determination of the proper action more challenging or time-consuming to the operator), the absence of a previously available parameter (i.e., a type of parameter), a difference in how the loss or failure of parameters occurs (e.g., as the result of combining parameters), or an increase in the amount of information that is provided such that the amount of available information has a detrimental impact on the operator's ability to discern a particular plant condition or to perform a specific task.

To determine possible impacts, the UFSAR must be reviewed to identify descriptions regarding which information is necessary for a UFSAR-described design function to be performed and/or satisfied.

Example 3-12 illustrates the application of the *number and/or type of parameters* consideration.

Example 3-12. Number and Type of Parameters with NO ADVERSE IMPACT on a UFSAR-Described Design Function

A UFSAR states that the operator will "examine pump response and utilize redundant plant channels to verify performance." This statement means that parameters *directly* associated with the pump (e.g., motor electrical current, discharge pressure and flow rate) and parameters *indirectly* associated with pump performance (e.g., response of redundant temperature indications or response of redundant level indications, as appropriate) are necessary to validate correct pump operation.

A new digital system presents the same number ("three") and type ("motor electrical current, discharge pressure and flow rate") of parameters. Furthermore, the new digital system presents the same indirect redundant information to the operator

Therefore, there is no adverse impact on the UFSAR-described ability to perform *direct* monitoring of pump performance and no adverse impact on the UFSAR-described ability to perform *indirect* monitoring of pump performance.

Information Presentation

Potential impacts due to the modification of how information is presented should be addressed.

The purpose of addressing this factor is to determine if the method by which information is presented due to a digital modification causes an adverse impact on the performance and/or satisfaction of a UFSAR-described design function.

To determine possible impacts, the UFSAR must be reviewed to identify descriptions regarding how information is presented, organized (e.g., how the information is physically presented) or accessed, and if that presentation, organization or access relates to the performance and/or satisfaction of a UFSAR-described design function.

One advantage of a digital system is the amount of information that can be monitored, stored and presented to the user. However, the possibility exists that the amount of such information may lead to an *over-abundance* that is not necessarily beneficial in all cases.

Examples of activities that have the potential to cause an adverse effect include the following activities:

- An increase in the number and/or type of parameters available for observation.
- Addition or removal of a dead-band

- Replacement of instantaneous readings with time-averaged readings (or vice-versa).

Example 3-13 illustrates the application of the *information presentation* consideration.

Example 3-13. Information and Data Presentation with an ADVERSE IMPACT on a UFSAR-Described Design Function

Using the pump example introduced in Example 3-12, the UFSAR describes a presentation method as consisting of "indicators with a 10 gpm increment" and the physical layout as being "by flow path" (i.e., not by channel/train).

A digital modification consolidates the information and controls on two flat panel displays (one for each redundant channel/train), each with a touch screen providing "soft" control capability. Also, due to the increased precision of the digital equipment, the increment of presentation will be improved to 1 gpm.

Two specific considerations due to the modification in data presentation include:

- A fundamental change in how the information is presented to the operator (by *channel/train* instead of by *flow path*).
- An increase in the precision of the information being provided (e.g., from the original "10 gpm increments" to "1 gpm increments").

Since the UFSAR describes a design function related to the *flow-path* approach, this portion of the proposed activity is adverse (i.e., the difference in presentation approach is fundamentally different than that described in the UFSAR). However, the increase in the display increment is not adverse since the operator will continue to be able to distinguish the minimum increment of 10 gpm as described in the UFSAR.