

Example 4-4. Digital Modification that Satisfies Dependability, causing NO ADVERSE IMPACT on a UFSAR-described Design Function

An analog recorder is to be replaced with a new microprocessor-based recorder. The recorder is used for various purposes including Post Accident Monitoring, which is a UFSAR-described design function.

Dependability Assessment: An engineering evaluation performed as part of the technical assessment supporting the digital modification concluded that the new recorder will be highly dependable (based on a quality development process, testability, and successful operating history) and therefore, the risk of failure of the recorder due to software is considered very low.

The change will have NO ADVERSE IMPACT on any design function due to the dependability assessment.

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452 **4.2.1.2 Screening of Changes to Procedures as Described in the UFSAR**

453 **SCOPE**

454 If the digital modification does not include or affect a Human-System
455 Interface (e.g., the replacement of a stand-alone analog relay with a digital
456 relay that has no features involving personnel interaction and does not feed
457 signals into any other analog or digital device), then this section does not
458 apply and may be excluded from the Screen assessment.

459 In NEI 96-07, Section 3.11 defines procedures as follows:
460 "...Procedures include UFSAR descriptions of how actions related to
461 system operation are to be performed and controls over the performance
462 of design functions. This includes UFSAR descriptions of operator
463 action sequencing or response times, certain descriptions...of SSC
464 operation and operating modes, operational...controls, and similar
465 information."

466 Although UFSARs do not typically describe the details of a specific Human-
467 System Interface, UFSARs will describe any design functions associated with
468 the HSI.

469 Because the human-system interface (HSI) involves system/component
470 operation, this portion of a digital modification is assessed in this Screen
471 consideration. The focus of the Screen assessment is on potential adverse
472 effects due to modifications of the interface between the human user and the
473 technical device.

Comment [A42]: Comments on HSI Screening Guidance were previously provided in:
(1) ML17068A092 Comment Nos. 18-26
(2) ML17170A089 Comment Nos. A17-A27

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There are 3 "basic HSI elements" (Reference: NUREG-0700):

- Displays: the visual representation of the information operators need to monitor and control the plant.
- Controls: the devices through which personnel interact with the HSI and the plant.
- User-interface interaction and management: the means by which personnel provide inputs to an interface, receive information from it, and manage the tasks associated with access and control of information.

Operators must be able to accurately perceive, comprehend and respond to system information via the HSI to successfully complete their tasks. Specifically, nuclear power plant personnel perform "four generic primary tasks" (Reference: ~~XXX~~NUREG/CR 6947):

- (1) monitoring and detection (extracting information from the environment and recognizing when something changes).
- (2) situation assessment (evaluation of conditions).
- (3) response planning (deciding upon actions to resolve the situation) and
- (4) response implementation (performing an action).

To determine potential adverse impacts of HSI modifications on design functions, a two-step analysis must be performed. Step one is assessing if and in what way ~~how~~ the modification impacts (i.e., *positively, negatively or no impact*) the operators' abilities to perform each of the four primary types of tasks described above. ~~If there are negative impacts, step~~Step two of the analysis consists of determining if and how the impacts, identified in step one, affects the pertinent UFSAR-described design function(s) (i.e., *adversely or not adversely*). ~~Examples of~~Examples of ~~n~~egative impacts on operator performance of tasks that may result in adverse effects on a design function include but are not limited to:

- increased possibility of mis-operation.
- increased difficulty in evaluating conditions.
- increased difficulty in performing an action.
- increased time to respond.
- creation of new potential failure modes.

Table 1 contains examples of modifications to HSI elements that should be addressed in the response to this Screen consideration.

[INSERT TABLE 1 FROM HSI COMMENTS FILE HERE.]

In NEI 96-07, Section 3.11 defines *procedures* as follows:

Comment [DA43]: Clarification: Think of these elements as a way to define the entirety of what comprises and HSI. Some modifications may not fall neatly into one category, but if it falls within any or all of these categories, it is HSI related.

515 *"...Procedures include UFSAR descriptions of how actions related*
516 *to system operation are to be performed and controls over the*
517 *performance of design functions. This includes UFSAR*
518 *descriptions of operator action sequencing or response times,*
519 *certain descriptions...of SSC operation and operating modes,*
520 *operational...controls, and similar information."*

521 • Because the Human System Interface involves system/component operation, operator
522 actions, response times, etc., this portion of a digital modification is assessed in this Screen
523 consideration.

524 If the digital modification does not include or affect a Human System
525 Interface (e.g., the replacement of a stand-alone analog relay with a digital
526 relay that has no features involving personnel interaction and does not feed
527 signals into any other analog or digital device), then this section does not
528 apply and may be excluded from the Screen assessment.

529 The focus of the Screen assessment is on potential adverse effects due to
530 modifications of the *interface* between the human user and the technical
531 device [e.g., equipment manipulations, actions taken, options available,
532 decision-making, manipulation sequences or operator response times
533 (including the impact of errors of a cognitive nature in which the information
534 being provided is unclear or incorrect)], not the written procedure
535 modifications that may accompany a physical design modification (which are
536 addressed in the guidance provided in NEI 96-07, Section 4.2.1.2).

537 PHYSICAL INTERFACE WITH THE HUMAN SYSTEM INTERFACE

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

540 (a) — Physical Interaction with the Human System Interface (HSI)

541 (b) — Number/Type of Parameters

542 (c) — Information Presentation

543 (d) — Operator Response Time

544 **Physical Interaction with the Human System Interface**

545 A typical physical interaction modification might involve the use of a touch
546 screen in place of push buttons, switches or knobs, including sensory-based
547 aspects such as auditory or tactile feedback.

548 To determine if the HSI aspects of a digital modification have an adverse
549 impact on UFSAR described design functions, potential impacts due to the
550 physical interaction with the HSI should be addressed in the Screen.

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

561 Characteristics of HSI changes that could lead to potential adverse effects
562 may include, but are not limited to:

- 563 • Changes from manual to automatic initiation (or vice versa) of
564 functions,
- 565 • Changes in the data acquisition process (such as replacing an edgewise
566 analog meter with a numeric display or a multipurpose CRT in which
567 access to the data requires operator interaction to display),
- 568 • Changes that create new potential failure modes in the interaction of
569 operators with the system (e.g., new interrelationships or
570 interdependencies of operator actions and/or plant response, or new
571 ways the operator assimilates plant status information),
- 572 • Increased possibility of mis-operation related to performing a design
573 function,
- 574 • Increased difficulty for an operator to perform a design function, or
- 575 • Increased complexity or duration in diagnosing or responding to an
576 accident [e.g., Time Critical Operation Actions (TCOAs) identified in
577 the UFSAR].

578 If the HSI changes do not exhibit characteristics such as those listed above,
579 then it may be reasonable to conclude that the "method of performing or
580 controlling" a design function is not adversely affected.

581 Examples 4-5 through 4-7 illustrate the application of the *Physical*
582 *Interaction* aspect illustrates how to apply the assessment process to ONLY
583 the "controls" element of an HSI is process to an HISHSI modification

Example 4-5. Physical Interaction Assessment of Modification –with

NO ADVERSE IMPACT on a UFSAR-Described Design Function

Description of the Proposed Activity Involving the Control Element Modification:

Currently, a knob is rotated clock-wise to ~~increase a control function~~ open a flow control valve in 1% increments and counter clock-wise to ~~decrease the control function~~ close a flow control valve in 1% increments. This knob will be replaced with a touch screen that has two separate arrows, each in its own function block. Using the touch screen, touching the "up" arrow will ~~increase the control function~~ open the flow control valve in 1% increments and touching the "down" arrow will ~~decrease the control function~~ close the flow control valve in 1% increments.

Identification and Assessment of the Four Generic Primary Tasks Potentially Impacted/Involved:

- (1) monitoring and detection (extracting information from the environment and recognizing when something changes) - NOT INVOLVED
- (2) situation assessment (evaluation of conditions) - NOT INVOLVED
- (3) response planning (deciding upon actions to resolve the situation) - NOT INVOLVED
- (4) response implementation (performing an action) - NOT INVOLVED

Comment [DA44]: Response implementation is the only task that would be pertinent here as it changes the

Design Function Identification:

The UFSAR described design function states the operator can "increase and decrease the control functions using manual controls located in the Main Control Room." Thus, this UFSAR description implicitly identifies the SSC (i.e., the knob) and the design function of the SSC (i.e., its ability to allow the operator to manually adjust the control function).

Identification and Assessment of Modification Impacts on the Four Generic Primary Tasks INVOLVED:

As part of the technical evaluation supporting the proposed activity modification, a Human Factors Evaluation (HFE) was performed. Tasks 1, 2 and 3 are not involved therefore they do not have negative impacts. Task 4 is involved, but the HFE determined that the change from knob to touch screen was not going to have a negative impact on the operator because there was no change to the ability of the operator to perform the response implementation task. The HFE concluded that no new failures or malfunctions have been introduced as a result of the replacement from a knob to a touch screen.

- ~~— possibility of mis operation — NO IMPACT~~
- ~~— difficulty in evaluating conditions — N/A~~
- ~~— difficulty in performing an action — NO IMPACT~~
- ~~— time to respond — N/A~~
- ~~— new potential failure modes — NO IMPACT~~

Comment [DA45]: These are only some of the possible negative impacts, thus, listing them here makes it appear that these are the ONLY outcomes that should be considered. Again, we do not want to get in a situation where we are trying to list all the possibilities.

Identification of the Relevant Design Function(s):

The UFSAR design function states the operator can "increase and decrease the control functions open and close the flow control valve using manual controls located in the Main Control Room." Thus, this UFSAR description implicitly identifies the SSC (i.e., the knob) and the design function of the SSC (i.e., its ability to allow the operator to manually adjust the control function position of the flow control valve).

Assessment of Impact(s) on Design Function Impact(s)

Using the results from the HFE and examining only the physical interaction aspect "controls" element of an HSI (e.g., ignoring the impact on operator response time or the number and/or sequence of steps necessary to access the new digital control (the other three HSI elements), the replacement of the "knob" with a "touch screen" is not adverse since it does not impact the ability of the operator to "increase and decrease the control functions open and close the flow control valve using manual controls located in the Main Control Room," maintaining satisfaction of the UFSAR-described design function.

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Using the same proposed activity provided in Example 4-5, Example 4-6 illustrates how a variation in the UFSAR description would cause an adverse impact.

Example 4-6. Physical Interaction with an ADVERSE IMPACT on a UFSAR-Described Design Function

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 because it adversely impacts the ability of the operator to obtain tactile feedback from the device.

587 Using the same proposed activity provided in Example 4-5 and the same
588 UFSAR descriptions from Example 4-6, Example 4-7 illustrates how a
589 variation in the proposed activity would also cause an adverse impact.

Example 4-7. Physical Interaction with an ADVERSE IMPACT on a UFSAR-Described Design Function

In addition to the touch screen control "arrows" themselves, a sound feature and associated components will be added to the digital design that will 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 auditory "feedback" during the operation of the digital device, the means by which this feedback is provided has been altered. Since the 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 the ability of the design function to be performed.

590 ***Number and/or Type of Parameters Displayed By and/or Available***
591 ***From the Human System Interface***
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593 One advantage of a digital system is the amount of information that can be
594 monitored, stored and presented to the user. However, the possibility exists
595 that the amount of such information may lead to an *over abundance* that is
596 not necessarily beneficial in all cases.

597 To determine if the HSI aspects of a digital modification have an adverse
598 effect on UFSAR-described design functions, potential impacts due to the
599 number and/or type of parameters displayed by and/or available from the
600 HSI should be addressed in the Screen.

601 Consideration of a digital modification's impact due to the number and/or
602 type of parameters displayed by and/or available from the HSI involves an
603 examination of the actual number and/or type of parameters displayed by
604 and/or available from the HSI and how they could impact the performance
605 and/or satisfaction of UFSAR-described design functions. Potential causes for
606 an adverse impact on a UFSAR-described design function could include a
607 reduction in the number of parameters monitored (which could make the
608 diagnosis of a problem or determination of the proper action more challenging
609 or time consuming for the operator), the absence of a previously available
610 parameter (i.e., a type of parameter), a difference in how the loss or failure of

611 | parameters occurs (e.g., as the result of combining parameters), or an
612 | increase in the amount of information that is provided such that the amount
613 | of available information has a detrimental impact on the operator's ability to
614 | discern a particular plant condition or to perform a specific task.

615 | Example 4-8 illustrates the application of the *Number and/or Type of*
616 | *Parameters* aspect.

Example 4-8. Number and Type of Parameters with NO ADVERSE IMPACT on a UFSAR-Described Design Function

Currently, all controls and indications for a single safety-related pump are analog. There are two redundant channels of indications, either of which can be used to monitor pump performance, but only one control device. For direct monitoring of pump performance, redundant *motor electrical current* indicators exist. For indirect monitoring of pump performance, redundant *discharge pressure* and *flow rate* indicators exist. Furthermore, at the destination of the pump's flow, redundant *temperature* indicators exist to allow indirect monitoring of pump performance to validate proper pump operation by determination of an increasing temperature trend (i.e., indicating insufficient flow) or a stable/decreasing temperature trend (i.e., indicating sufficient flow). All of these features are described in the UFSAR.

The UFSAR also states that the operator will "examine pump performance and utilize the information from at least one of the redundant plant channels to verify performance" and "the information necessary to perform this task is one parameter directly associated with the pump (motor electrical current) and three parameters indirectly associated with pump performance (discharge pressure, flow rate, and response of redundant temperature indications)."

A digital system will replace all of the analog controls and indicators. Two monitoring stations will be provided, either of which can be used to monitor the pump. Each monitoring station will display the information from one of the two redundant channels. The new digital system does not contain features to automatically control the pump, but does contain the ability to monitor each of the performance indications and inform/alert the operator of the need to take action. Therefore, all pump manipulations will still be manually controlled.

Since the new digital system presents the same number (one) and type (motor electrical current) of pump parameters to directly ascertain pump performance and the same number (three) and type (discharge pressure, flow rate and redundant temperature) of system parameters to indirectly ascertain pump performance, there is no adverse impact on the UFSAR-

described design function to perform *direct* monitoring of pump performance and no adverse impact on the UFSAR-described design function to perform *indirect* monitoring of pump performance.

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Information Presentation on the Human System Interface

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A typical change in data presentation might result from the replacement of an edgewise analog meter with a numeric display or a multipurpose CRT.

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

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Consideration of a digital modification's impact due to how the information is presented involves an examination of how the actual information presentation method could impact the performance and/or satisfaction of UFSAR-described design functions. To determine possible impacts, the UFSAR should 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.

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

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- Addition or removal of a dead band, or
- Replacement of instantaneous readings with time-averaged readings (or vice-versa).

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If the HSI changes do not exhibit characteristics such as those listed above, then it may be reasonable to conclude that the "method of performing or controlling" a design function is not adversely affected.

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Example 4-9 illustrates the application of the *Information Presentation* aspect.

Example 4-9. Information Presentation with an ADVERSE IMPACT on a UFSAR-Described Design Function

A digital modification consolidates system information onto two flat panel displays (one for each redundant channel/train). Also, due to the increased precision of the digital equipment, the increment of presentation on the HSI will be improved from 10 gpm to 1 gpm. Furthermore, the HSI will now

present the information layout "by channel/train."

The UFSAR identifies the existing presentation method as consisting of "indicators with a 10 gpm increment" to satisfy safety analysis assumptions and the physical layout as being "by flow path" to allow the operator to determine system performance.

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 UFSAR-described design function.

The new display method (i.e., "by channel/train") adversely affects the ability of the operator to satisfy the design function to ascertain system performance "by flow path."

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Operator Response Time

647 Typically, an increase in the operator response time might result from the
648 need for the operator to perform additional actions (e.g., due to the additional
649 steps necessary to call up or retrieve the appropriate display and operate the
650 "soft" control rather than merely reading an indicator on the Main Control
651 Board).

652 To determine if the HSI aspects of a digital modification have an adverse
653 effect on UFSAR-described design functions, potential impacts on the
654 operator response time should be addressed in the Screen.

655 Consideration of a digital modification's impact on the operator response time
656 due to the modification of the number and/or type of decisions made, and/or
657 the modification of the number and/or type of actions taken, involves an
658 examination of the actual decisions made/actions taken and how they could
659 impact the performance and/or satisfaction of UFSAR-described design
660 functions. To determine possible impacts, the UFSAR must be reviewed to
661 identify descriptions relating to operator response time requirements and if
662 those timing requirements are related to the performance and/or satisfaction
663 of a UFSAR-described design function.

664 Example 4-10 is the same as Example 4-9, but illustrates the application of
665 the *Operator Response Time* aspect.

Example 4-10. Operator Response Time with NO ADVERSE IMPACT on a UFSAR-Described Design Function

A digital modification consolidates system information onto two flat panel

displays (one for each redundant channel/train). Also, due to the increased precision of the digital equipment, the increment of presentation on the HSI will be improved from 10 gpm to 1 gpm. Furthermore, the HSI will now present the information layout "by channel/train."

The UFSAR identifies the existing presentation method as consisting of the physical layout as being "by flow path" to allow the operator to determine system performance.

Although the UFSAR identifies the existing presentation method as consisting of a physical layout "by flow path" to allow the operator to determine system performance and the new display method (i.e., "by channel/train") will require additional steps by the operator to determine system performance, requiring more time, there is no adverse impact on satisfaction of the design function to ascertain system performance because no response time requirements are applicable to the design function of the operator being able "to determine system performance."

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COMPREHENSIVE HUMAN-SYSTEM INTERFACE EXAMPLE

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Although no additional guidance is provided in this section, Example 4-11 illustrates how each of the aspects identified above would be addressed.

Example 4-11. Digital Modification Involving Extensive HSI Considerations with NO ADVERSE IMPACTS on a UFSAR-Described Design Function

Component controls for a redundant safety-related system are to be replaced with PLCs. The existing HSI for these components is made up of redundant hard-wired switches, indicator lights, and analog meters. The new system consolidates the information and controls onto two flat panel displays (one per redundant train), each with a touch screen providing "soft" control capability.

The existing number and type of parameters remains the same, which can be displayed in a manner similar to the existing presentations (e.g., by train). However, the information can be also presented in different configurations that did not previously exist (e.g., by path or by parameter type to allow for easier comparison of like parameters), using several selectable displays.

The flat panel display can also present any of several selectable pages depending on the activity being performed by the operator (e.g., starting/initiating the system, monitoring the system during operation, or

changing the system line-up).

To operate a control, the operator must (via the touch screen) select the appropriate activity (e.g., starting/initiating the system, monitoring the system during operation, or changing the system line-up), select the desired page (e.g., train presentation, path presentation, or parameter comparison), select the component to be controlled (e.g., pump or valve), select the control action (e.g., start/stop or open/close), and execute it.

The display remains on the last page selected, but each page contains a "menu" of each possible option to allow direct access to any page without having to return to the "main menu."

The two new HSIs (one per redundant train) will provide better support of operator tasks and reduced risk of errors due to:

- Consolidation of needed information onto a single display (within the family of available displays) that provides a much more effective view of system operation when it is called into action.
- Elimination of the need for the operator to seek out meter readings or indications, saving time and minimizing errors.
- Integration of cautions and warnings within the displays to help detect and prevent potential errors in operation (e.g., warnings about incorrect system lineups during a test or maintenance activity).

The design was developed using a human factors engineering design, with a verification and validation process consistent with current industry and regulatory standards and guidelines. As part of the technical evaluation supporting the proposed activity, a Human Factors Evaluation (HFE) was performed. Based on the conclusions from the HFE, the design provides a more effective HSI that is less prone to human error than the existing design.

The UFSAR-described design functions applicable to this proposed activity include ~~descriptions of how~~ the existing controls, including the physical switches, indicator lights and meters, ~~and how each of these SSCs is used during normal and abnormal (including accident) operating conditions.~~ The UFSAR identifies the current physical arrangement (i.e., two physically separate locations) ~~as providing a~~ provides assurance that the design function is satisfied by preventing the operator ~~that prevents the operator~~ from operating the "wrong" component. There are no UFSAR-described design functions related to the operator response times associated with using the existing controls.

The impacts on design functions are identified below:

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- *Physical Interaction* - NOT ADVERSE because the new HSI consists of two physically separate displays.
 - *Number and Type of Parameters* - NOT ADVERSE because the same number and type of parameters exist with the new HSI.
 - *Information Presentation* - NOT ADVERSE because all of the existing features (e.g., individual controls, indicator lights and parameters displays that mimic the analog meters) continue to exist with the new HSI.
 - *Operator Response Time* - NOT ADVERSE because no response time requirements were applicable to any of the design functions and there were no indirect adverse affects on any other design function.
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671 **4.2.1.3 Screening Changes to UFSAR Methods of Evaluation**

672 By definition, a proposed activity involving a digital modification involves
673 SSCs and how SSCs are operated and controlled, not a *method of evaluation*
674 described in the UFSAR (see NEI 96-07, Section 3.10).

675 Methods of evaluation are analytical or numerical computer models used to
676 determine and/or justify conclusions in the UFSAR (e.g., accident analyses
677 that demonstrate the ability to safely shut down the reactor or prevent/limit
678 radiological releases). These models also use "software." However, the
679 software used in these models is separate and distinct from the software
680 installed in the facility. The response to this Screen consideration should
681 reflect this distinction.

682 A necessary revision or replacement of a *method of evaluation* (see NEI 96-
683 07, Section 3.10) resulting from a digital modification is separate from the
684 digital modification itself and the guidance in NEI 96-07, Section 4.2.1.3
685 applies.

686 **4.2.2 Is the Activity a Test or Experiment Not Described in the UFSAR?**

687 By definition, a proposed activity involving a digital modification involves
688 SSCs and how SSCs are operated and controlled, not a test or experiment
689 (see NEI 96-07, Section 4.2.2). The response to this Screen consideration
690 should reflect this characterization.

691 A necessary *test or experiment* (see NEI 96-07, Section 3.14) involving a
692 digital modification is separate from the digital modification itself and the
693 guidance in NEI 96-07, Section 4.2.2 applies.