GUIDANCE FOR DEVELOPMENT OF A SIMULATION FACILITY TO MEET THE REQUIREMENTS OF 10CFR55.45

MARCH 1988

UTILITY SIMULATION FACILITY GROUP

REVISION 2

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There are definite, measurable benefits to be gained from the use of non-plant specific simulation devices, both in the areas of training and operator evaluation. The guidance of this document proposes a methodology for realizing those benefits.

This document was developed to provide consistent methodology for use by licensees in implementing plans to meet the requirements of 10CFR55.45(b)(1)(i). This document is also intended for use by the NRC in evaluating 10CFR55.45(b)(1)(i) simulation facilities. While this document provides generic guidance, the authors recognize that plant specific plans to meet 10CFR55.45 requirements may result in deviation from the guidance contained herein. This document also identifies the methods and generic limitations of operating tests on a simulation facility that is made up of the simulation devices discussed herein.

This document was prepared by representatives from the four author utilities that joined to form the Utility Simulation Facility Group (USFG). Specifically, the four USFG utilities and respective plants are:

Consumers Power Company (Big Rock Point),
Public Service Company of Colorado (Ft. St Vrain),
Southern California Edison Company (San Onofre 1), and
Yankee Atomic Electric Company (Yankee Nuclear Power Station).

The above licensees will utilize this document to outline their plans to develop a simulation facility to meet 10CFR55.45 using existing, upgraded or new operator training hardware, enhanced, as necessary, by some use of Controllers, pen and ink procedure changes, and walk-through methods discussed herein. The plans will describe the simulation device(s) to be used as a simulation facility to evaluate the operators' generic skills and knowledge necessary to satisfy the thirteen operating test criteria of 10CFR55.45. Evaluation of the generic skills and knowledge is fundamental to providing assurance that the operators are prepared to perform the duties and responsibilities required of reactor and senior reactor operators.

It is the conclusion of the author utilities that effective operator training and examination is realized if any one of the simulation devices used alone, or in combination with other devices, constitutes the licensee's simulation facility. Use of these simulation facilities provides for operators that are trained and evaluated to standards necessary to assure safe operation of nuclear power plants.

Utility Simulation Facility Group

NOTE: Revision 1 of this document reflects revisions to incorporate NRC comments and NRC/USFG agreements and understandings reached during an NRC/USFG meeting on September 15 and 16, 1987. Revision 2 reflects comments from a December 7, 1987 meeting.

1.0 INTRODUCTION

1.1 Purpose

This document provides sufficient generic guidance for the development and use of simulation facilities for those Nuclear Power Plant Licensees that plan to meet the requirements of 10CFR55.45(b)(1)(i). Plant specific plans will describe the licensee's simulation facility and chosen methods of conducting operating tests on the simulation facility.

1.2 Background

10CFR55, "Operator Licenses," Paragraph 55.45, "Operating Tests" requires that an applicant for a reactor operator or senior reactor operator license demonstrate both an understanding of and the ability to perform certain essential job tasks. It specifies that the demonstration will be done through the administration of operating tests in a plant walkthrough and in a simulation facility. The simulation facility may be one that consists solely of a plant-referenced simulator certified to the NRC by the facility licensee, or it may be one which has been approved by the NRC, after application for such approval has been made by the facility licensee.

This document addresses the preparation and implementation of a plan for the development of a simulation facility and guidance for use and approval of that simulation facility.

1.3 Definitions

Best Estimate - Reference plant response data based upon engineering evaluation or operational assessment.

Candidate - An individual being evaluated for a reactor operator or senior reactor operator license.

Controller - An individual responsible for clarifying deviations between a simulation device and the reference plant.

Critical Parameters - 1) Those parameters that require direct and continuous observation to operate a nuclear power plant under manual control.

2) Input parameters to nuclear power plant safety systems.

Cue - Information available for use in evaluating plant status.

Deviation - An identified difference between a simulation device and the reference plant.

Deficiency - A deviation that the fidelity evaluation identifies as a "need-to-fix" item.

Examiner - An NRC representative who conducts operating tests.

Fidelity - Reference plant replication in either system model, physical appearance or system function.

Instructor - A utility representative responsible for the operation of the simulation device.

Multidisciplinary Review - Review by disciplines of appropriate background and experience.

Operational Cue Analysis - An analysis to determine the cues available on a simulation device and the cues required by the referenced plant operating procedures.

Operator - An individual who possesses a reactor operator or senior reactor operator license.

Pen and Ink Procedure Changes - Changes made to controlled reference plant procedures for the purpose of mitigating simulation device deficiencies, before those procedures are used to conduct operating tests.

Potential to Confuse - Deviation potential to perplex the operator and disrupt his mental and physical actions.

Potential to Error - Deviation potential to lead the operator to not perform any action or to perform an incorrect action.

Potential to Impede - Deviation potential to delay or hinder significantly the operator's correct response.

Procedures - Reference plant normal operating procedures, abnormal operating procedures, emergency operating procedures, and emergency plan implementing procedures that an operator or candidate would be required to implement. When plant procedures are referenced to throughout this document, it is assumed that they are "controlled copies" of the procedures, unless otherwise specified.

Procedure Performance Time - The realistic or actual time for a candidate to perform a procedure or task in the reference plant control room.

Real Time - Computer simulation of dynamic performance in the same time base relationships, sequences, durations, rates and accelerations as the dynamic performance of the reference plant.

Reference Plant - The specific nuclear power plant from which a simulation facility's control room configuration, system control arrangement, and design data are derived.

Simulation Device - A component of a simulation facility that simulates a portion or all of the reference plant.

Simulation Facility - One or more of the following simulation devices, alone or in combination, used for the conduct of operating tests:

1) Non-Plant Referenced Simulator
2) Control Room Mock-Up
3) Reduced Scope Simulator
4) Part Task Simulator
5) CRT Simulator
6) Reference Plant

System Function/Task Analysis - A systematic analysis of the reference plant procedures that yield the cue and I&C requirements.

Task - A unit of control room operator work which may require plant information collection, systems operation, or both.

Task Element - A unit of human activity comprising a task.

Task Statement - An independent unit of control room operator work.

1.4 Acronyms

CFR - Code of Federal Regulations

CRDR - Control Room Design Review

CRT - Cathode Ray Tube

CRM - Control Room Mock-Up

HF - Human Factors

I&C - Instrumentation and Control

NPRS - Non-Plant Referenced Simulator

NRC - Nuclear Regulatory Commission

PRS - Plant Referenced Simulator

PTS - Part-Task Simulator

RO - Reactor Operator

RSS -- Reduced Scope Simulator

SFTA - System Function/Task Analysis

SME - Subject Matter Expert

SRO - Senior Reactor Operator

USFG - Utility Simulation Facility Group

2.0 CRITERIA

The following section provides generic criteria to be applied in the evaluation and use of a simulation device. All or part of each of these criteria is applied to specific simulation devices in the manner described in Sections 3 and 4.

2.1 Human Factors

Human factors addresses the comparability of the simulation device with the reference plant in the areas of control room and panel layout, I&C configuration and ambient operating environment. The primary human factor consideration in a plant referenced simulator (PRS) is for the simulator to have fidelity with the reference plant. PRS fidelity means duplication in physical appearance, physical layout, system function and system model. For a simulation device other than a PRS, 100% fidelity may not be achievable in system model and physical layout. Therefore, the only highly achievable fidelity component would be duplication in system function. A simulation device has to meet a high degree of duplication in system function criteria to be considered to be viable for the conduct of an operating test.

The degree to which a deviation does not meet physical/functional fidelity becomes a human factors concern. In a simulation device, the principle goal of human factors is to assure fidelity deviations have no negative impact on operator task performance. Deviations that hinder the operator should be documented and evaluated in a systematic fashion. Cognitive and behavioral operator actions should be considered. Operator perceptions (color, mimics, patterns, etc.) are to be considered if essential to task performance. Other human factors considerations deal with the specific components in Table 1. The simulation facility will

HUMAN FACTORS CONSIDERATIONS

Major Area	Components
Control Room Layout	- Physical Orientation Operator Station
Panel Layout	- Systems Orientation Control Panels Annunciator Panel Mimics
Instruments and Controls	- Displays Controls Instrument Range Instrument Accuracy Engineering Units
Ambient Operating Environment	- Normal and Emergency Lighting Humidity Temperature Noise Communications Auditory Signals

Table 1

contain controls, instruments, alarms and other man-machine interfaces for the operator to demonstrate his capability. The ambient environment in the simulation facility should be replicated to the extent possible. To the extent practicable, the following generic criteria should be applied to any simulation device. The specific application of this generic criteria to each simulation device is discussed in Section 4.

Control Room and Panel Layout

The simulation device should approximate the reference plant physical orientation and appearance. The simulation device should be the same physical size as the reference plant although reduced scale reproductions are acceptable provided the SFTA determines that the reduction does not significantly detract from the operating test.

The operator's station and other working space should be replicated. Deviations from the reference plant shall be evaluated as discussed in Section 3.

The control panels should be positioned on the simulation device in the same physical location as the reference plant. The systems orientation within the panel should replicate the reference plant. Deviations from the reference plant panel layout shall be evaluated as discussed in Section 3.

I&C Configuration

The simulation device controls, indications, etc., on the control panels should approximate the same physical location as in the reference plant. The instrument displays, controls, range, accuracy and units should replicate the reference plant. Deviations from the reference plant I&C configuration shall be evaluated as discussed in Section 3.

Ambient Operating Environment

The ambient operating environment shall permit the operator to perform his duties. The ambient operating environment factors to be considered are lighting, humidity, temperature, noise and communication. Significant deviations from the reference plant environment shall be evaluated as discussed in Section 3.

2.2 Procedures

The procedure considerations are: 1) the scope, 2) the manner of use and, 3) methods of modifying the procedures used in the administration of operating tests. Controlled copies of reference plant procedures are used in the conduct of an operating test. Procedures performed on a simulation device allow candidates to demonstrate their "ability to perform" the operations required by those procedures. The following generic criteria should be applied when reference plant procedures are used during the course of an

operating test on the simulation devices described herein. The specific application of these criteria to each simulation device is discussed in Section 4.

Procedure Scope

Types of procedures exercised on the simulation device include:

Normal Operating Procedures,
Abnormal Operating Procedures,
Emergency Operating Procedures, and
Emergency Plan Implementing Procedures.

The scope of procedures to be exercised on any simulation device shall be determined using the methods discussed in Section 3.

Procedure Use

Reference plant procedures will be used on the simulation device(s). The reference plant may be used to exercise the 'Normal Operating Procedures' that can be performed as part of normal operations. Those procedures or tasks requiring control room interaction should be performed on a single simulation device (or appropriately integrated simulation devices).

Procedure Modifications

The data obtained during the SFTA (described in Section 3) will be used to identify any deviations between the simulation device and the procedures that will be tested. The determination will then be made which, if any, of these deviations should be resolved by pen and ink procedure changes. The procedure steps may then be modified to accommodate simulation device deficiencies, provided the modifications do not significantly detract from the conduct of the operating test. This may include partial completion or deletion of procedure steps or assuming the successful or unsuccessful completion of operator tasks that cannot be performed on the simulation device.

Before procedures are used in the conduct of operating tests, any necessary pen and ink procedure changes identified by the SFTA will be made. Pen and ink procedure changes may possibly affect Procedure Performance Time. Procedure Performance Time will be taken into consideration in the development, upgrade or use of existing devices or in the implementation of the pen and ink procedure changes.

All recommended pen and ink procedure changes will be forwarded to the Multidisciplinary Review Team (see Section 3.1) for review.

Such changes will be made only after the following has been considered:

1. Determination has been made that the controlled procedure cannot be performed on existing simulation devices.

2. Upgrades to existing simulation devices, or the development of new simulation devices for the procedure(s) or part of the procedure(s) which cannot be conducted require an excessive effort or burden in relation to the benefit gained. The evaluation of this burden vs benefit shall be documented.

3. Determination has been made that pen and ink changes are preferable to other alternatives (i.e., use of controllers or other similar mechanisms have been considered, but would result in a degradation to the examination process).

Any procedure modifications will be controlled by the simulation facility Configuration Management Program described in Section 3.7.

2.3 Steady State and Transient Models

The steady state and transient modeling used as part of the simulation device(s) shall adequately model the operating behavior of the reference plant. The following generic criteria should be

applied, as applicable, to any simulation device. The specific application of this criteria to each simulation device is discussed in Section 4.

Scope

Simulation device output should approximate and display expected plant responses. The responses should be based upon plant operating data or best estimate analyses, as appropriate.

Fidelity

The models should be of a level of sophistication necessary to assure the adequacy of the output information being presented to the operator.

Time

All simulation devices should approximate real time.

2.4 Performance Testing

Performance testing is conducted to verify the simulation device performance as compared to actual or predicted reference plant performance. The initial performance testing shall serve to verify and validate the adequacy of the completed Simulation Facility, including any procedure modifications. The specific application of performance testing criteria to each simulation device is discussed in Section 4.

Performance testing should be conducted on a schedule consistent with 10CFR55.45.

2.5 Operating Test Methodology

This section provides a generic process for conducting examinations on simulation devices for the purpose of evaluation in accordance with 10CFR55.45(a). The following generic criteria should be implemented, as applicable, on any simulation device. The specific application of this criteria to each simulation device is discussed in Section 4.

Those portions of the operating test conducted on each simulation device shall be limited to the procedure scope determined by the Operational Cue Analysis (described in Section 3.2) for that simulation device.

Examinations should be conducted in accordance with NUREG-1021, "Operator Licensing Examiner Standards."

Procedure Performance Time on a simulation device should be followed as closely as possible during operating tests.

During the conduct of the operating test, Controllers may be required to mitigate identified simulation device deficiencies. The use of Controllers should follow the guidelines described below.

Guidelines for Controller Interaction

The role of the Controller is to provide an added dimension to the simulation device to enable the device to more closely approximate the reference plant during the conduct of operating tests. In this sense, Controller usage is similar in nature to those activities conducted by utility instructors who, during conduct of operating tests on Plant Reference Simulators, provide information as outside operators, I&C technicians, etc. In this case the Controller is used to augment the simulation devices. Therefore, the purpose of the Controller is to provide, under direction, those cues unavailable from the device that may be needed to carry out actions during the performance of the operating test.

Controllers used during implementation of operating tests on various simulation devices shall follow specific guidelines established herein and as mutually agreed upon by individual examiners and the simulation facility management.

Examination Integrity

- Examination integrity is paramount to the success of the operating test. The Controller should not compromise examination integrity.

- Controller actions shall be conducted under the direct supervision and control of the simulation facility operator.

- Controllers shall not prompt the operators in the performance of their duties. Prompting may result in the invalidation of the operating test.

Controller Qualifications

- Controllers shall be trained on their duties and responsibilities. Details of this training program shall be included as part of the simulation facility plan submitted by each utility.

- Qualifications of controllers shall be supplied as part of the simulation facility plans submitted by each individual utility and should meet the minimum criteria listed below.

  1) The controller should be employed by the utility or as a vendor under contract to the utility.

  2) The controller should posess the level of training and qualifications required by the utility for simulation facility instructors as outlined in their respective accredited training programs. Controllers should hold or have held an SRO license or certification on the

plant for which the operating test is being conducted. Controllers should also be knowledgeable on the simulation device on which the operating test is being conducted.

3) Controllers should receive additional training, as required by the utility, on the conduct of operating tests. As a minimum, this training shall cover the criteria listed above.

Controller Functions

- Controllers shall function to provide cues to the operators that are not available from the simulation device.

- Controllers shall provide cues only as answers to specific questions from the operators or as directed in the operating test scenario. These cues are only for the purpose of providing information not available from the simulation device or as necessary to clarify a deviation of the simulation device from the reference plant.

- Controllers shall perform any other actions as identified and directed by the examiner in the conduct of the operating test.

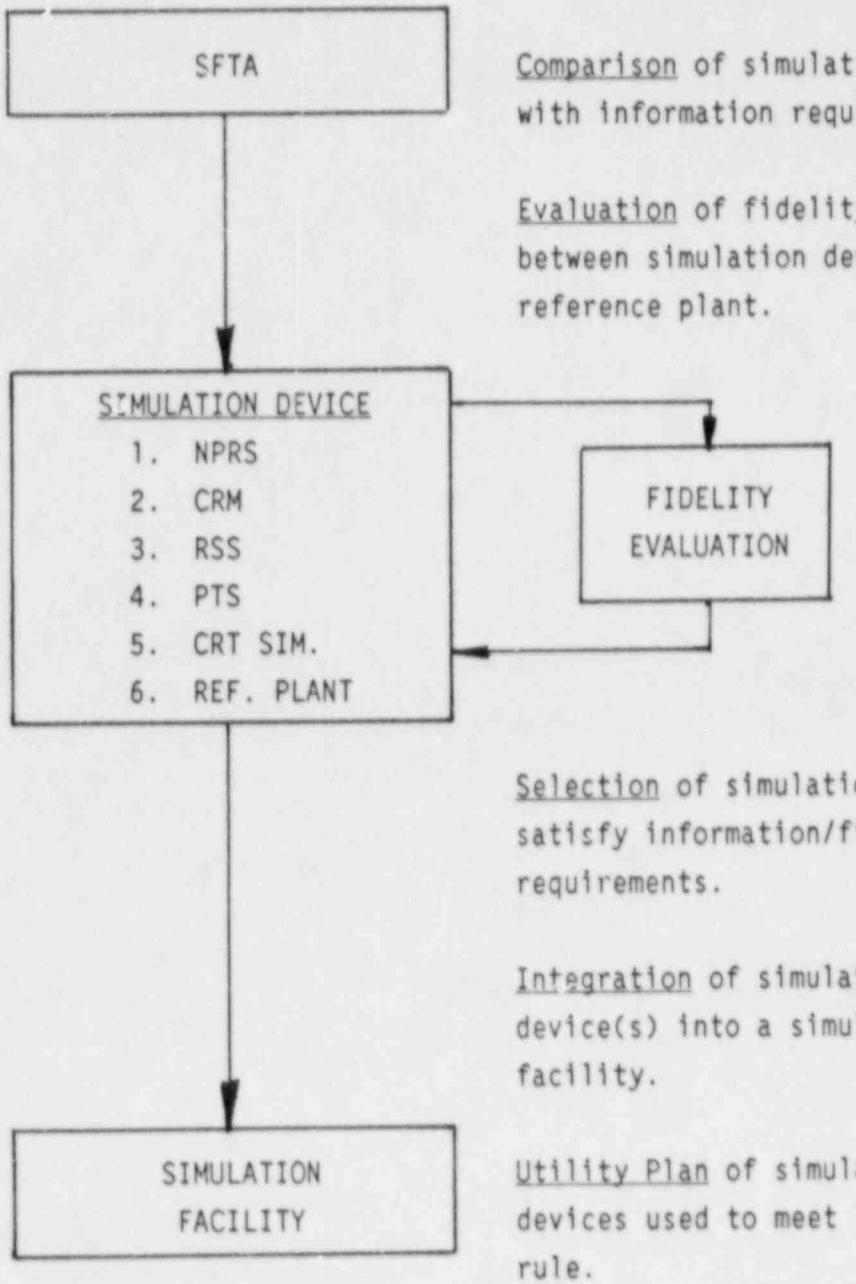
3.0 DEVELOPMENT OF A SIMULATION FACILITY

This section provides the methodology used to develop a simulation facility to meet 10CFR55.45(b)(1)(i) using one or more of the simulation devices that is described in Section 4. The purpose of the simulation facility is to enhance the conduct of operating tests.

It is recognized that operating tests are better performed on devices that promote an active man/machine interface, such as Non-Plant Reference Simulators, Reduced Scope Simulators, or Part Task Simulators. This interface facilitates evaluation of the individual(s) in an actual operating environment. However, in cases where there is limited implementation of an active man/machine interface, adequate qualifications can be demonstrated by alternate devices. As further discussed in Section 4, these methods use Control Room Mock-ups, CRT Simulation and the Reference Plant alone or in combination.

The following systematic evaluation methodology description below is based upon an SFTA. The process briefly identified in Figure 1 and Table 2 and further described in Section 3 is one method for developing a Simulation Facility based upon an SFTA. Each utility may have completed portions or all of the SFTA, but not in the exact format described below. Therefore, this section describes the USFG's understanding of the detail needed in such an analysis. It

SIMULATION FACILITY DEVELOPMENT PROCESS FLOW



Analysis of reference plant procedures to deduce cue and I&C information requirements.

Comparison of simulation device with information requirements.

Evaluation of fidelity deviations between simulation device and the reference plant.

Selection of simulation device to satisfy information/fidelity requirements.

Integration of simulation device(s) into a simulation facility.

Utility Plan of simulation devices used to meet 10CFR55.45 rule.

Figure 1

SIMULATION FACILITY DEVELOPMENT PROCESS STEPS

System Function/Task Analysis

1. Task Identification
2. Task Element Identification
3. Cue Information Requirements
4. I&C/Physical Characteristics

Simulation Device Comparison and Selection

1. Comparison of SFTA/Reference Plant with Simulation Device
2. Refer Deviation to Fidelity Evaluation

Fidelity Evaluation

1. Identification of Deviation
2. Assessment of Deviations
3. Disposition of Deviations

Simulation Facility Plan

1. Description of Simulation Devices
2. Match Procedures with Devices

Table 2

is expected that plant specific implementation of an SFTA will include parts of or all of any previously performed SFTA or related type work.

The rigorous implementation of this simulation development methodology will assure the appropriate use of a particular simulation device for the performance of operating tests. Conversely, the implementation may provide indication that a currently used simulation device is inappropriate to meet the needs of an operating test and a new device should be pursued. Therefore, it is the goal of this simulation facility development methodology to provide an appropriate simulation facility, considering both existing and new simulation devices.

3.1 System Function/Task Analysis (SFTA)

The SFTA is a systematic analysis of the reference plant procedures that yield the cue and I&C characteristics. From the reference plant control room instrumentation, the operator obtains the required cues to help him in performing his tasks. The systematic determination of these man/machine interface characteristics provides a basis for evaluating the adequacy of a simulation device to support the conduct of operating tests. Tables 3 and 4 (located at the end of Section 3) detail the SFTA steps and process and SFTA criteria, respectively.

The method is characterized as a top-down analysis which begins with the reference plant procedures. The procedures are partitioned into units of activities identified as tasks. A task is a unit of control room operator work which may require information collection, systems operation, or both. A task is characterized by being a relatively small unit of work which is comprised of approximately the same sequence of elementary human actions regardless of the operational sequence in which the task appears. The main criterion for the identification of a task is that the task should define the information and/or control functions needed by the operator to perform that unit of work.

Each task is further partitioned into the units of human activity, called task elements, which need to be sequentially accomplished in order to execute the task. The main criterion for identifying these task elements is that each should further refine and identify the information requirements needed by the operator to execute the task in the context of all the operational sequences in which the task appears.

A set of cues is developed from the task element requirements. The cue in this context is defined as the significant information acquired by the control room operator that prompts him to act. The cue is taken directly from the task element, taking into account the information required from the specific system.

A set of characteristics describing the functional requirements for each task element is identified. The task element may be associated with a specific instrument. In that case, the characteristics include range and units. The physical requirements will be specified if the particular characteristic is critical to performing the task. In cases where only one type of equipment will satisfy the physical and functional requirement, the specific manufacturer and component will be identified. Example 1 shows the breakdown of an operator task.

The SFTA will be conducted by a Multidisciplinary Review Team composed of subject matter experts (SMEs) of appropriate background and whose responsibilities are discussed below. The SMEs will utilize their expertise to process the task breakdown. The SFTA process steps will be documented and supported with appropriate sources.

Multidisciplinary Review Team

The Multidisciplinary Review Team shall consist of utility or consultant personnel that are SMEs of appropriate disciplines. The areas of expertise and experience of the personnel on the Multidisciplinary Review Team will be detailed in each utility's plant specific plans. The role of the Multidisciplinary Review Team is to:

BREAKDOWN OF AN OPERATOR TASK

Operation Procedure - EOP XXX

Task Statement - Determine if RCPs are operating

Task Element - Read RCP ON/OFF Status, System - RCP
Read RCP current, System - RCP
Read RCP flow, System - RCP
Read RCP Delta P, System - RCS
Read Voltage to RCP, System - RCP
Read RCP Speed, System - RCP
Read RCP Electric Power, System - EDS

Cue Information - RCP Speed > 500 rpm
Annunciator Window Off
No Annunciator Audio Alarm

I&C/Physical Requirement - Display Value
Range, 0-1200
Units, RPM
Accuracy, N/A
Display on Control Room Panel 56

Abbreviations

RCP - Reactor Coolant Pump
EDS - Electrical Distribution System

Example 1

- Review the SFTA process and documentation generated by the SFTA.

- Evaluate the Operational Cue Analysis data and disposition the deviations identified in this process.

- Determine the applicability of each procedure to each simulation device.

- Recommend the makeup of the Simulation Facility.

SFTA Philosophy

The System Function/Task Analysis (SFTA) is a logical link to the other analyses that have been conducted to support training programs. The starting point for SFTA is the procedures which were also the basis for the job analysis previously done for the training programs. The job analysis provides the skills and knowledge requirements needed for the operator to perform his job. The task analysis provides the task information requirements for the operator to perform his tasks. The system function analysis provides the functional operator controls requirements needed to perform procedural steps.

The job analysis, task analysis, and system function analysis connect to the three points of a man/machine interface model that exists at the utilities and discussed in INPO Document 83-047. The operator is the center of the triangular model shown in Figure 2. The model addresses the interfaces and interrelationships that exist among the operator, the plant (system function analysis), the procedure (task analysis), and the training (job analysis). The SFTA process ensures that the component interfaces have been considered adequately and that the operators can operate the plant safely and efficiently during all operating situations.

3.2 Operational Cue Analysis

The Operational Cue Analysis consists of the SFTA and the simulation device comparison and selection process. An I&C inventory will be conducted on each simulation device. The I&C inventory will include a listing of the presence of both static and dynamic cues, each type of cue being important to the operational cue analysis. As shown in Figure 1, the I&C inventory is then compared to the SFTA results to identify the I&C set and cues available to execute the reference plant procedure set. Each procedure task listing is evaluated to determine the ability to adequately perform the procedure on the simulation device. This process yields a procedure set applicable for examination on that particular simulation device. Procedures

MAN-MACHINE INTERFACE
MODEL

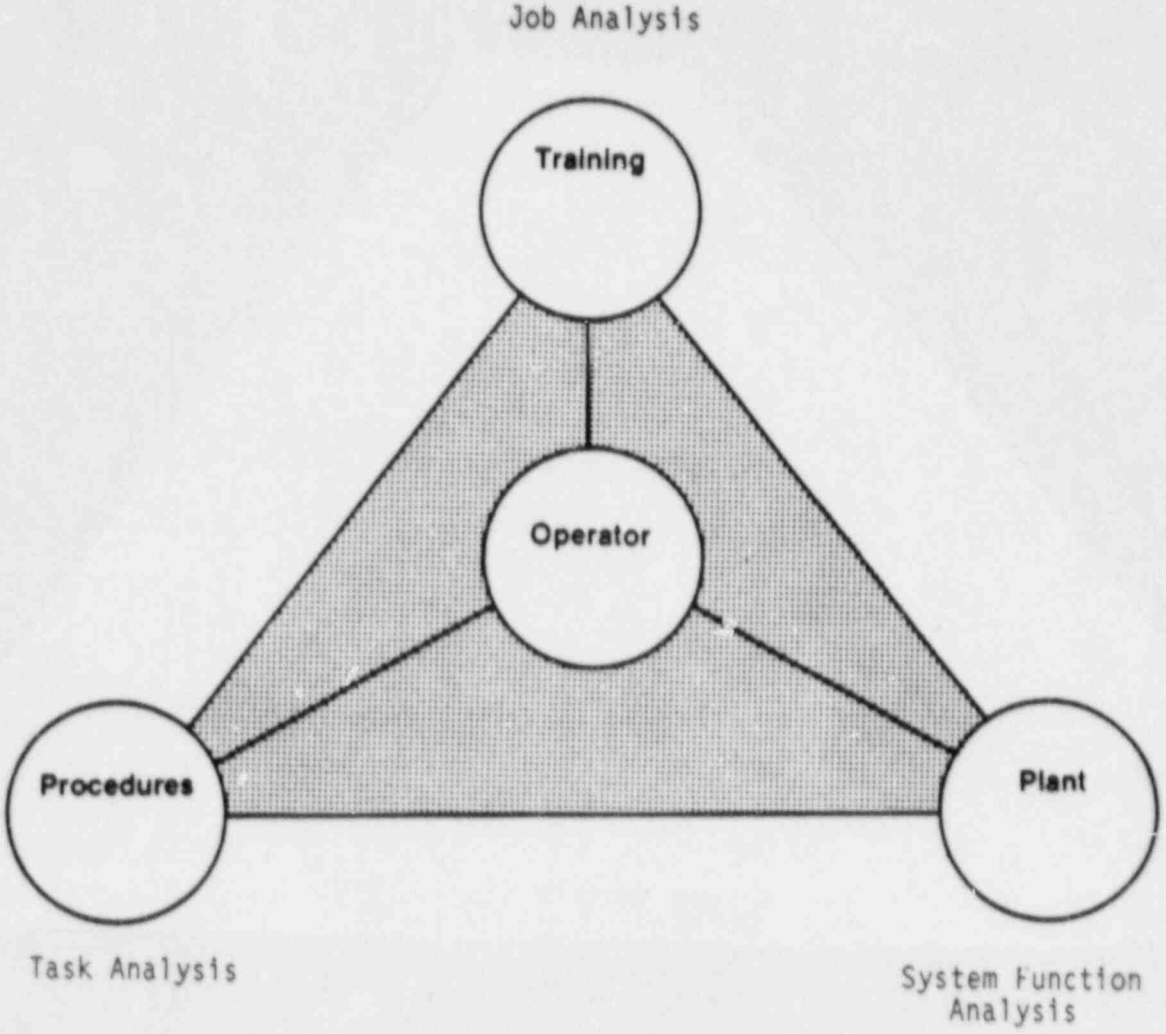


Figure 2

that cannot be implemented on any other simulation device can be examined on the reference plant. Accordingly, it is expected that all procedures can be examined on the Simulation Facility.

The process of collecting data for the Operational Cu[illegible]alysis shall be similar to that identified in NUREG-[illegible], Appendix B. The data fields to be evaluated shall be [illegible]mined by the SFTA. The discrepancies between the ref[illegible] plant and the simulation device shall be dispositi[illegible] the Multidisciplinary Review Team using [illegible]s identified in Section 3.3.

3.3 Fidelity Evaluation

After a simulation device goes through the SFTA comparison process, a fidelity evaluation should be performed. The purpose of the fidelity evaluation is to identify and assess the deviations of a simulation device from the reference plant. A type of fidelity evaluation process and criteria that could be used is detailed in Figure 3 and Table 5 (located at the end of Section 3). The fidelity evaluation identifies the potential areas where comparability deviations could cause an operator difficulties in performing procedure tasks. Deviations are identified from three

FIDELITY EVALUATION

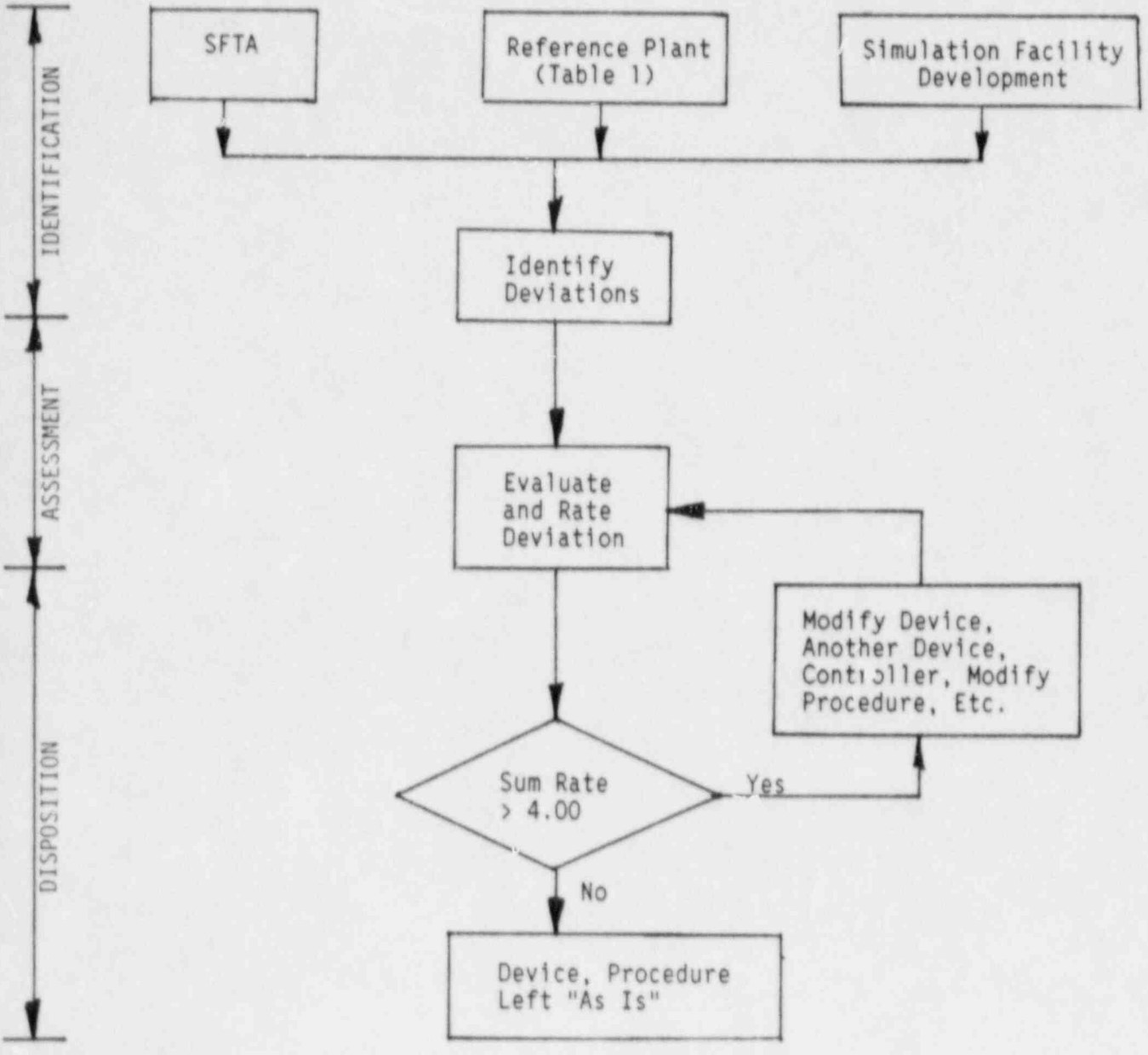


Figure 3

different sources: 1) the SFTA results, 2) the control room as noted in Table 1 and 3) the Simulation Facility Development process. The evaluation process will consist of identifying the deviation, assessing the deviation, and dispositioning the deviation. The evaluation process will be done by the Multidisciplinary Review Team.

Deviations vary to degrees of impact on the operator. Three factors will be used to assess the deviation impact; (1) Potential to Impede, (2) Potential to Error, and (3) Potential to Confuse. The Potential to Impede is the potential that the deviation has to delay or hinder significantly the operators correct response. The Potential to Error is the potential that the deviation has to lead the operator to not perform any action or to perform an incorrect action. The Potential to Confuse is the potential that the deviation has to perplex the operator and disrupt his mental and physical actions. The Potential to Confuse includes the potential for the simulation to enhance the operator's performance by the presentation of information not available in the reference plant. The Potential to Impede is the most important factor since this factor can prevent the operator from performing the tasks. The Potentials to Error and to Confuse are of equal value. The three factors are weighted with the Potential to Impede having a factor of 0.50 and the Potential to Error and to Confuse having a factor of 0.25 each.

Each deviation will be rated on each potential from 1-10. A low probability is a measure of 1-3. A medium probability is a measure of 4-7. A high probability is a measure of 8-10. The formula to derive the sum rate is:

$$\text{Sum Rate} = P_1 (.50) + P_2 (.25) + P_3 (.25)$$

where: P_1 is the Probability to Impede

P_2 is the Probability to Error

P_3 is the Probability to Confuse

The sum rate will determine the degree of deviation impact on the operator and direct the solution to the fix. For example, any sum rate less than or equal to 4.00 may denote the deviation can be left "as is." Consequently, any sum rate greater than 4.00 may denote a deviation that must be addressed by modification.

The weighing factor is derived from the D. Meister method of assigning weights to criteria factors. The method of assigning 1-10 measurements is derived from the CRDR experience of rating Human Engineering Descrepancies (HEDs) for priority.

It is recognized that the process described above is a subjective one, since the results depend upon the judgment of the personnel evaluating the deviation in their application of the low, medium and high probability values discussed above. The assignation of

probability ratings and determination of modifications disposition is the responsibility of the Multidisciplinary Review Team performing the evaluation(s). Therefore, the guidance of this document suggests the use of a rating criteria such as the 4.00 criteria suggested above. It is the purpose of this rating guidance to specify that this type of rating of deviations be performed to determine the need for modifications and/or justification of existing design. The use of 4.00 allows for the judgment that deviations of low probability most likely would not require modification and that some medium probability deviations should not require upgrade. It is expected that these types of medium probability deviations could consist of, but would not be limited to, deviations that are not frequently encountered by the operator in his duties and, therefore, would not be expected to significantly degrade the examination process. This rating acknowledges that the majority of the medium probability deviations and all of the high probability deviations should be addressed by a simulation facility modification, unless significant justification is provided to the contrary. Plant specific plans should describe the rating criteria and basis for that criteria, if the proposed criteria takes exception to this guidance.

3.4 Simulation Device Integration

The integration of the SFTA and the simulation device capabilities is necessary to ascertain the optimum simulation facility for the performance of operating tests. The goal of the selection process

is to provide a simulated control room environment that presents the highest level of active man/machine interface, in which the reference plant procedures can be exercised. The Simulation Facility shall provide the opportunity to test all of the operator responses to the cues identified by the operational cue analysis of the reference plant procedures. The ability of the operator to use controlled copies of the reference plant procedures and produce the desired responses on the simulation device, so as to place the plant in the desired operating configuration, shall be a determining factor in selecting the simulation device for the operating test. The simulation device shall be capable of producing the desired response to the operator actions identified in the reference plant procedures to the extent necessary to assure that the operator can determine from the available cues that the plant is responding in the direction predicted in the reference plant transient analysis.

The process of selecting the simulation device(s) that will make up the simulation facility begins by identifying the device(s) that provides the most active man/machine interface. An I&C inventory would be conducted on the selected simulation device(s). As shown in Figure 1, the I&C inventory is then compared to the SFTA results to identify the I&C set and cues available to execute the reference plant procedures. Each procedure task listing will be evaluated to determine the ability to adequately perform the procedure(s) on the simulation device(s) without consideration of modifications to the device(s).

Following consideration of simulation device modifications, the process would then be repeated. The end result of this process will yield a procedure set applicable for examination on that simulation device and a list of simulation device modifications that are appropriate.

A similar process would be conducted on other simulation devices in descending order of their capabilities for active man/machine interface.

The emphasis during this process is to identify the simulation device that is most useful for examiners and at the same time provides a cost effective simulation device that will provide for effective training. Before any passive simulation device is selected consideration will be given to the use of controllers and pen and ink changes to the procedures with the intent to always try to use the device that promotes the most active man/machine interface.

The final selection of devices and the integration into a simulation facility is an iterative process. The benefits of a device that promotes active man/machine interface must be continuously evaluated against the negative aspects of the device. Consideration must be given to the number of pen and ink changes, intrusion of the controller on the operators activities, human factors issues, etc.

3.5 Simulation Facility

The last step of the flow process illustrated in Figure 1, is to describe all the devices that makeup the Simulation Facility. The plant specific application for approval should describe the procedures to be run on each simulation device. The supporting documentation for each plant's application should include all the dispositioned deviations along with the evaluations and backup information.

3.6 Implementation

The development of a Simulation Facility should be undertaken in a systematic manner, giving consideration to the benefit of any upgrades to a simulation device. When considering or upgrading any simulation devices, the Operational Cue Analysis (Section 3.2) should be used to assess the significance and importance of the modification. The implementation of the Simulation Facility should give consideration to any device that promotes active man/machine interface, not necessarily just those included in this document. It is understood that there are other simulation devices available now or will be available with advancing technology that may be cost effective for particular applications. The intent of this document is to describe a systematic approach to the development of a facility; not to restrict the facility to using any particular simulation device(s). It is important that the simulation facility provide the opportunity to examine all of the operator responses to the cues listed in the Operational Cue Anaysis.

3.7 Configuration Management Program

A program to provide accountability of Simulation Facility physical and functional capabilities will be developed and implemented. This program will consist of procedures and/or guidelines and will be controlled by established administrative procedure controls for each utility. The program will perform the following functions:

1. Identify, document, track and test discrepancies.

2. Identify, document and track deviations between the Simulation Facility and the reference plant.

3. Identify, document and track reference plant changes denoting effects on operating tests.

The details of the program will be described in the individual utilities plan and will include the following:

1. An outline of the administrative procedures and responsibilities for maintaining the Simulation Facility current in accordance with the guidelines of this document.

2. A description of the organization(s) responsible for maintaining the Simulation Facility.

3. The administrative procedures, including time requirements, for updating the Simulation Facility upon a reference plant modification.

4. The administrative procedure(s), including time requirements, for completing, if necessary, a review of the SFTA upon a modification to the Simulation Facility.

5. The administrative procedure(s) for review/evaluation of the performance test baseline data upon, modifications to the reference plant, modifications to the Simulation Facility or on a periodic bases (i.e., once every four years).

SYSTEM FUNCTION/TASK ANALYSIS
STEPS AND PROCESS

STEPS	PROCESS
I. Task Identification	
A. Select Station Procedure	- Select one station procedure at a time to process.
B. Breakdown Station Procedure	- Breakdown the procedure according to operators actions (task).
II. Task Element Identification	
A. Breakdown Operator Task	- Breakdown the operator tasks into small units of work. (task element)
B. Identify Cognitive/ Behavioral Action	- Associate task element with operator's cognitive and behavioral actions.
III. Cue Information Requirements	
A. Specify Task Element Information	- Determine information operator needs to do task elements.
B. Specify Perceptual Information Required	- Determine information operator is cognizant about before, after and during task element performance.
C. Identify Time Dependency Requirements	- Determine information that will assist operator in performing the task element.
	- Determine information that is very critical relative to operator actions.

Table 3

SYSTEM FUNCTION/TASK ANALYSIS
STEPS AND PROCESS

STEPS	PROCESS
IV. I&C/Physical Characteristics	
A. Identify I&C Characteristics	- Deduce the functional I&C characteristics required to carry out the task.
B. Identify Physical Characteristics	- Identify physical characteristics if required to perform task element and function.
	- Specify type and model of component, if one-of-a-kind.

Table 3 (Continued)

SYSTEM FUNCTION/TASK ANALYSIS CRITERIA

Task Identification

1. A task is a unit of control room work that can be easily analyzed.

2. A task completion is independent of the preceding or following task.

3. A task is comprised of a limited number of human action units (elements).

Task Element Identification

1. Task elements are elementary human actions needed to accomplish a particular task.

2. Task elements can be divided into cognitive and behavioral divisions.

3. Each task element refers to information or control requirements.

4. Task elements are written only for operator actions which require control room information or control function.

Cue Information Requirements

1. The cues required enable operator task performance.

2. The cues assist the operator in assessing the control room status relative to the immediate tasks.

3. The cues are a perceptual process that include audio, visual and sensory inputs.

4. Cues that are time dependent must denote the time window required.

Table 4

SYSTEM FUNCTION/TASK ANALYSIS CRITERIA

I&C Physical Characteristics

1. The I&C characteristics must specify the:

   - Display required.
   - Range required.
   - Units of the quantity.

2. State physical requirements, if critical to performing the immediate task and function.

Table 4 (Continued)

FIDELITY EVALUATION CRITERIA

Identification of Deviation

1. A deviation is a physical difference that exists between the simulation device and the reference plant for the areas in Table 1.

2. A deviation is a difference in function between the SFTA and the simulation device.

3. A deviation is any other significant differences found between reference plant and simulation device during the development of the simulation facility.

Assessment of Deviation

1. The deviation must not prevent the operator from performing tasks.

2. The deviation must not confuse the operator to the point of affecting task performance.

3. The deviation must not lead the operator to an error in task performance.

Disposition of Deviation

1. Any modification to the simulation device in question will require approval by the Multidisciplinary Review Team.

2. Any deviation referred to another simulation device for resolution will require feedback through the Fidelity Evaluation process.

3. The selected disposition will require verification.

4. Any deviation left "as is" must have all supporting documentation and analysis and an adequate description.

5. Pen and ink procedure changes to the procedure will be the last option to resolve deviations.

Table 5

4.0 SIMULATION DEVICES

The following sections discuss the various simulation devices used in the conduct of operating tests. These simulation devices are currently available simulation technology that can be used in the development of a simulation facility. Each section discusses the application of the previously described criteria to each simulation device, the recognized limitations of each simulation device and the advantages of each simulation device.

4.1 NON-PLANT REFERENCED SIMULATOR

A Non-Plant Referenced Simulator (NPRS) is a simulation device that models plant systems. The following criteria apply to the use of an NPRS as a simulation device.

4.1.1 Human Factors

Control Room and Panel Layout

An NPRS may not replicate the reference plant control room and panel layout. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

I&C Configuration

Hardware and location differences are allowed. Plant specific labels, overlays, scaling modifications or other surface enhancements should be used to make NPRS controls and panels more closely approximate the reference plant. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

Ambient Operating Environment

An NPRS may not replicate the reference plant control room ambient operating environment. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

4.1.2 Procedures

As previously noted, the types of procedures exercised on the NPRS may include:

Normal Operating Procedures
Abnormal Operating Procedures
Emergency Operating Procedures, and
Emergency Plan Implementing Procedures.

The scope of procedures to be used on the NPRS will be determined by the SFTA process described in Section 3. For each procedure performed on the NPRS, the Procedure Performance Time will be matched as closely as possible. The remainder of the generic Procedures (Section 2.2) criteria applies to the NPRS.

4.1.3 Steady State and Transient Models

Scope

The output of the NPRS should approximate reference plant response. However, the similarity will be limited by considerations such as core size and numbers of redundant or auxiliary systems. As a minimum, the NPRS should be capable of producing the operator cues required to enable implementation of those procedures identified by

the process described in 4.1.2. Software modifications should be implemented, as practicable, to achieve full exercise of the procedures on the NPRS.

Fidelity

The steady state values for critical parameters shall be stable and not vary significantly from the initial values over a 60-minute period. Changes in critical parameters should correspond in direction to those expected from operating data or a best estimate analysis and should not violate any physical laws of nature. If parameters deviate significantly and software modeling changes cannot be reasonably pursued, these parameters may exceed the criteria, provided:

- They are specifically corrected using a Controller

OR

- Cue cards are substituted for these parameters

OR

- Appropriate pen and ink procedure changes are implemented.

Time

NPRS plant operating and transient time responses should approximate real time simulation. Any deviations will be handled by the SFTA process described in Section 3.

4.1.4 Performance Testing

Scope

The NPRS performance testing should be limited to those procedures identified by the process described in 4.1.2.

Methodology

Those procedures identified in 4.1.2 should be performed on the NPRS after all identified software modifications have been incorporated. An initial set of data shall be collected and evaluated. After review and approval by the Multidisciplinary Review Team, these transient results become the baseline data set for subsequent performance testing evaluation.

Acceptance Criteria

Determination of acceptability of performance test results shall be performed by the Multidisciplinary Review Team.

4.1.5 Operating Test Methodology

The NPRS permits evaluation in a control room team environment. The operating test conducted on the NPRS shall be limited to the procedures identified by the process described in 4.1.2. The generic guidelines for Controller interaction (Section 2.5) shall apply. Those procedures not accomplished on the NPRS should be evaluated separately on another simulation device.

Examiners will be able to select various NPRS initial conditions and plant malfunctions to evaluate operators' or candidates' responses. The NPRS should have the capability to stop and restart the simulation, as necessary, at any point.

The remainder of the generic Operating Test Methodology (Section 2.5) applies to the NPRS.

4.2 CONTROL ROOM MOCK-UP

A Control Room Mock-up (CRM) is a simulation device that consists of a display of the reference plant control room panels, including the switches, indications, and alarms, arranged in a configuration similar to the reference plant. The CRM may consist of photographs, three-dimensional mock-ups or a combination of both. The following criteria apply to the use of a CRM as a simulation device.

4.2.1 Human Factors

Control Room and Panel Layout

The CRM should replicate the reference plant physical orientation and appearance. The CRM should be the same physical size as the reference plant although reduced scale reproductions are acceptable provided the SFTA determines that the reduction does not significantly detract from the operating test. Any reduction effort should be limited such that labels, controls, indications, alarms, etc., remain clearly legible. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

I&C Configuration

The CRM controls, indications, etc., should be in the same physical location as in the reference plant. They should be replicated in sufficient detail to enable the desired operator capabilities to be

successfully demonstrated. Functional fidelity of a CRM cannot be achieved due to its passive nature. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

Ambient Operating Environment

The CRM may not replicate the ambient operating environment of the reference plant. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

4.2.2 Procedures

As previously noted, the types of procedures exercised on a CRM may include:

Normal Operating Procedures,
Abnormal Operating Procedures,
Emergency Operating Procedures, and
Emergency Plan Implementing Procedures

The scope of procedures to be used on the CRM will be determined by the SFTA process described in Section 3. For each procedure performed on the CRM, the Procedure Performance Time will be matched as closely as possible. The remainder of the generic Procedures (Section 2.2) criteria applies to the CRM.

4.2.3 Steady State and Transient Models

Scope

Operator cues required for those procedures identified by the process described in 4.2.2 will be given on the CRM using cue cards or by use of a Controller. These cues should be based on reference plant operating data or steady state and transient best estimate analysis data.

Fidelity

The CRM should be a representation of the reference plant. Controllers or cue cards may be used to enhance procedure usage.

Time

CRM usage is not expected to be in real time.

4.2.4 Performance Testing

Performance testing to verify a simulation facility's performance as compared to actual or predicted reference plant performance is not applicable for a CRM.

4.2.5 Operating Test Methodology

Operating tests conducted on a CRM are to consist of walkthroughs for each procedure to be tested. Task performance can only be

discussed and may require extensive use of Controllers and/or cue cards to provide operational cues. The remainder of the generic Operating Test Methodology (Section 2.5) applies to the CRM.

4.3 REDUCED SCOPE SIMULATOR

A Reduced Scope Simulator (RSS) is a simulation device that physically and functionally models significant portions of the major systems of the reference plant. A RSS demonstrates expected plant response to operator input and to normal and transient conditions to which the simulator has been designed to respond. However, the number of initial conditions, normal functions, and malfunctions available will be less than the standard defined by ANS-3.5-1985. The following criteria apply to the use of a RSS as a simulation device.

4.3.1 Human Factors

Control Room and Panel Layout

The RSS should be positioned to approximate the reference plant physical orientation and appearance. The RSS should be the same physical size as the reference plant although reduced scale reproductions are acceptable provided the SFTA determines that the reduction does not significantly detract from the operating test. Any reduction effort should be limited such that labels, controls, indications, alarms, etc., remain clearly legible. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

I&C Configuration

The RSS controls, indications, alarms, etc., should be in the same physical location as in the reference plant. They should be replicated in sufficient detail to enable the desired operator function(s) to be successfully demonstrated.

Photographic images of non-functional control board components are acceptable. Operator control input/output devices, such as handswitches and recorders, should be similar in operation but need not be identical in manufacturer or model number to those installed in the reference plant. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

Ambient Operating Environment

The RSS may not replicate the reference plant control room ambient operating environment. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

4.3.2 Procedures

As previously noted, the types of procedures exercised on a RSS may include:

Normal Operating Procedures

Abnormal Operating Procedures

Emergency Operating Procedures, and

Emergency Plan Implementing Procedures.

The scope of procedures to be used on the RSS will be determined by the SFTA process described in Section 3. For each procedure performed on the RSS, the Procedure Performance Time will be matched as closely as possible. The remainder of the generic Procedures (Section 2.2) criteria applies to the RSS.

4.3.3 Steady State and Transient Models

Scope

The output of the RSS should approximate expected reference plant responses. For the system(s) modeled, the majority of the operator cues required for the use of the procedures identified by the process described in 4.3.2 shall be modeled and displayed.

Fidelity

The RSS computed values for steady state operation with the reference plant control system configuration (for those systems modeled) shall be stable and not vary more than ±2% of the initial values over a 60-minute period for critical parameters or more than ±10% of the initial values for non-critical parameters. Transient changes in displayed parameters shall not violate any physical laws

of nature and shall be in the same direction as operating data or a best estimate analysis of the reference plant. Expected relationships between parameters should occur in a manner consistent with expected reference plant response. For those alarms modeled and displayed, the RSS shall not fail to cause an alarm or automatic action that would have been actuated in the reference plant, or cause an alarm or automatic action that would not actuate in the reference plant. The RSS accuracies shall be related to full power values and interim power levels for which valid reference plant information is available.

Time

The RSS should approximate real time.

4.3.4 Performance Testing

Scope

The RSS performance testing should be limited to those procedures identified by the process described in 4.3.2. The performance testing should include validation of the pen and ink changes made to any modified procedures.

Methodology

Those procedures identified by the process described in 4.3.2 should be performed on the RSS after all identified software modifications have been incorporated. An initial set of data shall be collected

and evaluated. After review and approval by the Multidisciplinary Review Team, these transient results become the baseline data set for subsequent performance testing evaluation.

Acceptance Criteria

Determination of acceptability of performance test results shall be performed by the Multidisciplinary Review Team.

4.3.5 Operating Test Methodology

The RSS permits evaluation in a control room team environment with a major portion of the control boards replicated. Therefore, most procedures can be evaluated even if some components are not software modeled. The operating test on the RSS shall be limited to the procedures identified by the process described in 4.3.2.

Examiners will be able to select various RSS initial conditions and plant malfunctions to evaluate operators' or candidates' responses. The RSS should have the capability to stop and restart the simulation, as necessary, at any point.

The systems that are not modeled in the RSS may require evaluation of operating license candidates on other simulation devices (e.g. reference plant).

The remainder of the generic Operating Test Methodology (Section 2.5) applies to the RSS.

4.4 PART TASK SIMULATOR

Part Task Simulator (PTS) is a simulation device incorporating detailed modeling of a limited number of specific reference plant components or subsystems. Such a device demonstrates expected response of those components or subsystems. The following criteria applies to the use of a PTS as a simulation device.

4.4.1 Human Factors

Control Room and Panel Layout

As necessary, layout of the PTS should be similar to the portion of the panel or system being simulated. The PTS should be the same physical size as the reference plant although reduced scale reproductions are acceptable provided the SFTA determines that the reduction does not significantly detract from the operating test. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

The PTS should replicate the various reference plant surface enhancements, such as the use of color and mimics. The degree of correspondence with the reference plant should be consistent with the capability to replicate the existing surface enhancement with a given simulation device construction technique.

I&C Configuration

The PTS controls, indications, alarms, etc., should be in the same physical location as in the reference plant. They should be replicated in sufficient detail to enable the desired operator function(s) to be successfully demonstrated. If the switch, control, indicator, alarm, or recorder is not required for the scope of the PTS, it does not need to be included on the simulator. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

Ambient Operating Environment

A PTS may not replicate the ambient operating environment of the reference plant control room. Deviations will be evaluated for impact on performance of operator tasks in accordance with the Section 3 methodology.

4.4.2 Procedures

As previously noted, the types of procedures exercised on a PTS may include:

Normal Operating Procedures
Abnormal Operating Procedures
Emergency Operating Procedures, and
Emergency Plan Implementing Procedures.

The scope of procedures to be used on the PTS will be determined by the SFTA process described in Section 3. For each procedure performed on the PTS, the Procedure Performance Time will be matched as closely as possible. The remainder of the generic Procedures (Section 2.2) criteria applies to the PTS.

4.4.3 Steady State and Transient Models

Scope

The output of the PTS should approximate expected reference plant responses. For the system(s) modeled, the operator cues (responses) required for the use of the procedures identified in 4.4.2 should be displayed.

Fidelity

The PTS computed values for steady state operation with the reference plant control system configuration (for those systems modeled) shall be stable and not vary more than ±2% of the initial values over a 60-minute period for critical values or more than ±10% of the initial values for non-critical values. Transient changes in displayed parameters shall not violate any physical laws of nature and shall be in the same direction as operating data or a best estimate analysis of the reference plant. Expected relationships between parameters should occur in a manner consistent with expected plant response. For those alarms modeled and displayed, the PTS shall not fail to cause an alarm or automatic action that would have

been actuated in the reference plant, or cause an alarm or automatic action that would not actuate in the reference plant. The PTS accuracies shall be related to full power values and interim power levels for which valid reference plant information is available.

Time

The PTS should approximate real time.

4.4.4 Performance Testing

Scope

The PTS performance testing should be limited to those procedures identified by the process described in 4.4.2.

Methodology

Those procedures identified by the process described in 3.4.2 should be performed on the PTS after all identified software modifications have been incorporated. An initial set of data shall be collected and evaluated. After review and approval by the Multidisciplinary Review Team, these transient results become the baseline data set for subsequent performance testing evaluation.

Acceptance Criteria

Determination of acceptability of performance test results shall be performed by the Multidisciplinary Review Team.

4.4.5 Operating Test Methodology

Operating Tests shall be limited to those normal operator tasks and responses to cues that can be accomplished on the PTS. The instructor or examiner should have the ability to stop and restart the simulation, as necessary, at any point.

The remainder of the generic Operating Test Methodology (Section 2.5) applies to the PTS.

4.5 CRT SIMULATORS

A CRT Simulator is a simulation device that is computer based and CRT displayed. The information presented is a model of the reference plant operating behavior. The Input/Output may be limited to a computer keyboard and CRT, and the parameter set limited to a specific scope. The following criteria apply to the use of a CRT Simulator as a simulation device.

4.5.1 Human Factors

The human factors that can be properly addressed in using a CRT Simulator is essentially limited to the scope of information cues that are presented. Due to the keyboard and CRT I/O methodology the control panel layout, I & C configuration or ambient operating environment cannot be accommodated in a CRT Simulator. Deviations will be evaluated for impact on the performance of operator tasks in accordance with the Section 3 methodology.

4.5.2 Procedures

As previously noted, the types of procedures exercised on a CRT Simulator may include:

Normal Operating Procedures
Abnormal Operating Procedures
Emergency Operating Procedures, and
Emergency Plan Implementing Procedures.

The scope of procedures to be used on the CRT Simulator will be determined by the SFTA process described in Section 3. For each procedure performed on the CRT Simulator, the Procedure Performance Time will be matched as closely as possible. The remainder of the generic Procedures (Section 2.2) criteria applies to the CRT Simulator.

4.5.3 Steady State and Transient Models

Scope

The output of the CRT Simulator should approximate expected reference plant responses for those systems modeled. The system modeled and the displayed responses should be based on those cues required to use those procedures identified by the process described in 4.5.2.

Fidelity

The level of sophistication for CRT Simulator models should assure adequacy of output information. The CRT Simulator computed values for steady state full power operation with the reference plant control system configuration (for those systems modeled) shall be stable and not vary more than ±2% of the initial values over a 60-minute period for critical values or more than ±10% of the initial values for non-critical values. Transient changes in displayed parameters shall not violate any physical laws of nature

and shall be in the same direction as operating data or a best estimate analysis of the reference plant. Expected relationships between parameters should occur in a manner consistent with expected plant response.

Time

CRT simulator responses should approximate real time. Any inadequacies in the models can be compensated by the support of pen and ink procedure changes, Controller use, or other methods, provided that the use of these methods does not detract from the examination.

4.5.4 Performance Testing

Scope

The CRT Simulator performance testing should be limited to those procedures identified by the process described in 4.5.2.

Methodology

Those procedures identified by the process described in 4.5.2 should be performed on the CRT Simulator after all identified software modifications have been incorporated. An initial set of data shall be collected and evaluated. After review and approval by the Multidisciplinary Review Team, these transient results become the baseline data set for subsequent performance testing evaluation.

Acceptance Criteria

Determination of acceptability of performance test results shall be performed by the Multidisciplinary Review Team.

4.5.5 Operating Test Methodology

Examiners will be able to select various initial conditions and plant malfunctions to evaluate operators or candidates. The CRT Simulator should have the capability to stop and restart the simulation, as necessary, at any point.

The CRT Simulator can be used in conjunction with a Control Room Mock-up, a Part Task Simulator, or the Reference Plant. The use of the CRT Simulator is both enhanced by and enhances the use of these other simulation devices in the simulation facility. The use of these other devices in conjunction with the CRT Simulator should reduce the amount of pen and ink procedure changes and controller use.

The remainder of the generic Operating Test Methodology (Section 2.5) applies to the CRT Simulator.

4.6 REFERENCE PLANT

The Reference Plant, as a simulation device, is the Control Room of the specific nuclear power plant which serves as all or part of a simulation facility. The following criteria apply to the use of the Reference Plant as a simulation device.

4.6.1 Human Factors

When using the Reference Plant, equipment layout, instrument and control configuration, cue scope and environment is exact. Human factors need only be addressed as applied to the plant operating conditions for the evolution to be examined.

4.6.2 Procedures

Use of the Reference Plant as a simulation device allows usage of all of the procedures. No modifications to these procedures are required. To the extent consistent with existing plant conditions, the operating test may address any or all of these procedures to demonstrate familiarity with the plant. Operator tasks which cannot be actually performed should be accomplished through verbal discussion and a walkthrough of the evolution being examined. The controls and indication needed to perform the evolution should be physically shown to the examiner and accompanied by a description of what occurs when that control is manipulated. Deviations, such as

the above discussed static operating environment versus a desired dynamic operating environment, will be evaluated for impact on the performance of operator tasks in accordance with the Section 3 methodology.

4.6.3 Steady State and Transient Analysis Models

When using the Reference Plant as a simulation device, steady state and transient models are only applicable to the extent necessary to assure that the examiners and controllers possess appropriate information regarding expected plant behavior. This information should be based upon plant operating data or best estimate data.

4.6.4 Performance Testing

Performance testing is not applicable when the Reference Plant is utilized as the simulation device.

4.6.5 Operating Test Methodology

Operating tests conducted on a Reference Plant may consist of walkthroughs and/or operation of selected plant evolutions, for each procedure to be tested. Task performance that cannot actually be performed should be discussed and may require extensive use of controllers and/or cue cards to provide operational cues. The remainder of the generic Operating Test Methodology (Section 2.5) applies to the Reference Plant.

5.0 CONCLUSIONS, OBSERVATIONS, AND RECOMMENDATIONS

- Operating tests can be performed on simulation devices other than plant referenced simulators.

- Use of the simulation devices described herein enable the evaluation of the generic skills and knowledge necessary to fulfill the responsibilities of a reactor or senior reactor operator.

- Those specific skills and knowledge that cannot be evaluated on other simulation devices can be evaluated in reference plant walkthroughs.

- The development of a simulation facility should consist of a systematic evaluation, such as the method described herein, of the operating test requirements and be responsive to those needs.

- It is preferred that simulation devices present the information in an active man/machine interface.

- It is recommended that the NRC approve the USFG methodology and use it to evaluate the adequacy of the resultant Simulation Facilities.

6.0 REFERENCES

NUREG-1258, "Evaluation Procedure for Simulation Facilities Certified Under 10 CFR 55." Draft Report, March 1987

NUREG-1021, "Operator Licensing Examiner Standards," Revision September 1986

ANS-3.5-1985, "American National Standard for Nuclear Power Plant Simulators for Use in Operator Training."

Regulatory Guide 1.149, "Nuclear Power Plant Simulation Facilities for Use in Operator License Examinations," Revision 1, April 1987

"Behavioral Analysis and Measurement Methods," D. Meister, Wiley and Sons, 1985

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