Nuclear
Utility
Task
Action
Committee

nutac

Control Room Design Review Task Analysis Guideline

December 1983

INPO 83-046 (NUTAC)

CONTROL ROOM DESIGN REVIEW

TASK ANALYSIS GUIDELINE

Developed By

Nuclear Utility Task Action Committee

for

Control Room Design Review

December 1983

INPO 83-046

(NUTAC)

Publications produced by a nuclear utility task action committee (NUTAC) represent a consensus of the utilities represented in the NUTAC. These publications are not intended to be interpreted as industry standards. Instead, the publications are offered as suggested guidance with the understanding that individual utilities are not obligated to use the suggested guidance.

This publication has been produced by the NUTAC on control room design review (CRDR) with the support of the Institute of Nuclear Power Operations (INPO). The officers of this NUTAC were Chairman Hamilton Fish (New York Power Authority) and Vice Chairman Bill Gainey (Carolina Power & Light Company). The following utilities and service organizations have actively participated in the development of this document:

Alabama Power Company
Arizona Public Service Company
Carolina Power & Light Company
Cincinnati Gas & Electric Company
Commonwealth Edison Company
Consumers Power Company
Duke Power Company
Duquesne Light Company
Georgia Power Company
Iowa Electric Light and Power Company
Mississippi Power & Light Company
New York Power Authority
Niagara Mohawk Power Corporation
Northeast Utilities
Northern States Power Company
Pacific Gas and Electric Company
Pennsylvania Power & Light Company
Public Service Company of Colorado
Public Service Company of Indiana, Inc.
Public Service Electric and Gas Company
Rochester Gas and Electric Corporation
Sacramento Municipal Utility District
Tennessee Valley Authority
Texas Utilities Generating Company
Virginia Electric and Power Company
Yankee Atomic Electric Company

FOREWORD

Control Room Design Review Task Analysis Guideline was developed by the nuclear utility task action committee (NUTAC) on control room design review (CRDR) to assist individual utilities in conducting a task analysis as part of their control room reviews.

The INPO Analysis and Engineering Division Industry Review Group identified the need for a utility committee to deal with the CRDR item of the TMI Task Action Plan. The charter for such a group was approved by INPO management. The CRDR NUTAC, formed after this approval, identified several areas in which utilities could use assistance in the implementation of CRDRs. In addition to this document, the following documents have been published:

- Control Room Design Review Implementation Guideline
  INPO 83-026 (NUTAC)
- Human Engineering Principles For Control Room Design Review
  INPO 83-036 (NUTAC)
- Control Room Design Review Survey Development Guideline
  INPO 83-042 (NUTAC)

CHARTER
NUCLEAR UTILITY TASK ACTION COMMITTEE
ON
CONTROL ROOM DESIGN REVIEW

The Nuclear Utility Task Action Committee (NUTAC) on CRDR has been established by a group of representative utilities in recognition of the need for guidance on performing a CRDR. The principal objectives are (a) to determine the boundaries of the CRDR, (b) to develop a methodology, (c) to define terms, (d) to integrate other initiatives with the CRDR (e.g., SPDS development, EOP development, staffing, and training), and (e) to provide practical implementation guidelines that include but are not limited to the following:

- a CRDR methodology and implementation guideline
- a guideline on the development of CRDR survey checklists
- a CRDR task analysis guideline
- a set of human engineering review principles

The NUTAC will consider the need for other activities of generic benefit to the industry after the CRDR requirements are issued.

The NUTAC will establish liaison and solicit support from industry groups, such as NSSS owners groups, AIF, INPO, and EPRI. Communication on this industry initiative will be maintained with the NRC. Providing the NUTAC consensus to the NRC will help shape both the regulator and industry perspective on CRDR integration issues.

SUMMARY

This document was written in response to a utility industry request for assistance in the area of human factors, in general, and the CRDR, in particular. This document is offered as reference only. There is no obligation for any nuclear utility to follow any guidance contained in the document.

The process of task analysis has been difficult for nuclear utilities to understand in the context of the CRDR. Although task analysis is a relatively straightforward technique used traditionally during design, its use for identifying potential deficiencies in existing systems (i.e., control rooms) has caused confusion among utilities and practitioners.

This document is intended for use by personnel performing a CRDR. It is designed to assist utilities in understanding and implementing that portion of their CRDR that requires the use of task analysis. This document contains a discussion of the rudiments of tasks and task analysis. Following the introductory discussion are descriptions of each phase required to implement the task analysis process in order to obtain the kinds of information necessary for the CRDR.

Appendixes to this document provide a sample task analysis procedure as it might be written by a utility, an example of the output of that procedure, and a reference list of NUREG-0700, Section 6 items that are most appropriately addressed during the CRDR task analysis.

The task analysis methodology presented in this document provides guidance for the development of an effective CRDR task analysis plan of generic benefit to utilities. In addition to the CRDR task analysis, this document can be used as a review document in the development of any plant-specific task analysis program. For example, it can be used to analyze tasks not directly related to

reactor operation that operators may be required to perform, such as those tasks associated with the implementation of the emergency plan. In addition, guidance on job and task analysis for use in the development of training programs can be found in the following documents:

- o Job and Task Analysis Users Manual (INPO 83-033)
- o Task Analysis Procedure (INPO 83-009)
- o Training Systems Development Manual (draft)

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Purpose

The purpose of this document is to provide guidance that can be used by a utility in developing a procedure to perform task analysis required by the Control Room Design Review (CRDR). The objective of the CRDR task analysis is to identify the tasks required to support emergency operation and to determine whether the design of the existing control room, especially the controls and displays, allows and supports those tasks. This guidance can be used to identify the required input and output of such analysis. Although the focus of the document is on the CRDR, the guidance can be used to plan and execute task analysis for any major interface in a nuclear plant. A model is described that identifies and describes such interfaces. Task analysis is a reasonable vehicle with which to integrate the NUREG-0737, Supplement 1 requirements in the areas of CRDR, emergency procedures, emergency response facilities, and training.

1.2 Background

Since the TMI-2 accident, many requirements have been promulgated that are aimed at identifying and, where possible, eliminating human engineering problems in existing nuclear power plant control rooms. Although not widely used in the past, most human engineering principles and techniques are straightforward and intuitive. However, one particular technique--task analysis--has caused a great deal of confusion within the nuclear industry.

The reasons for much of the confusion are obvious, given the chronology of the post-TMI requirements and the methods used to clarify those requirements. The immediate

responses to proposed requirements contributed to the impression that no one really understood what task analysis is and how it should be applied to a review of control rooms.

This document utilizes and references compatible, existing industry documents. It attempts to dispel the mystery surrounding task analysis and to provide a clearer picture of the underlying principles and use of task analytic methods. It is written in a straightforward style as free of jargon as possible. Wherever possible, examples are used to illustrate important points and, in all cases, the descriptive text is aimed at typical electric utility activities.

The task analysis process described in this document includes task identification and analysis of those tasks, verification, and validation. Since these activities can be logically separated from each other, they are described in separate sections of the document, as shown below.

TASK ANALYSIS PROCESS

TASK ANALYSIS (Section 4)
- o Task Identification
- o Analysis of Tasks

TASK ANALYSIS VERIFICATION (Section 5)

TASK ANALYSIS VALIDATION (Section 6)

The section numbers beside the three major activities in the task analysis process refer to the sections within this document where that activity is discussed in detail.

1.3 Organization of Document

This document, Control Room Design Review Task Analysis Guideline, departs somewhat from previous CRDR NUTAC documents, in that the subject of task analysis is discussed both generally and as it relates specifically to the CRDR. Such a split is intentional and clarifies the relationship between task analysis, in general, and the specific application of task analysis to the CRDR. Task analysis is a tool that can be used to gather many kinds of information in a variety of applications. The task analysis conducted for the CRDR is more limited in scope than a more general task analysis.

The sections of this document that deal with the task analysis process, depicted in the previous section, begin with a general discussion of some aspect of task analysis, such as verification, and proceeds to the description of how that aspect is related directly to the CRDR task analysis. To avoid confusion, the term "CRDR task analysis" is used when referring specifically to the task analysis done to meet the requirements of NUREG-0737, Task I.D.1. The term "task analysis" is used to refer to the more general case.

This document is presented in seven sections and four appendixes. To enhance the usability of the document, a brief description of each major section and each appendix is provided below.

1.3.1 Section 1 - Introduction

The introduction explains the purpose, background, organization, definitions, and recommended use of the document.

1.3.2 Section 2 - The Concept of a Task

This section distinguishes between the concepts of a job and a task. It describes the various aspects of a task and briefly explains why those aspects should be identified by task analysis.

1.3.3 Section 3 - Task Analysis Overview

The overview section describes the principal uses of task analysis in a nuclear power plant setting. It also lists the various phases of task analysis, including setting objectives, performing the analysis, verification, and validation.

1.3.4 Section 4 - Task Analysis

This section goes into considerable detail on the generic considerations of actually performing task analysis. These include determining the purpose of the analysis, the resources available, the method to be used, and the planning that should occur.

1.3.5 Section 5 - Task Analysis Verification

This section describes the objectives of verification in general and establishes the specific steps required for CRDR task analysis verification.

1.3.6 Section 6 - Task Analysis Validation

The validation section describes the methods available to ensure the task analysis process accomplished the objectives set out beforehand.

1.3.7 Section 7 - Results of the Task Analysis Process

This section describes the process of evaluating the task analysis data as it pertains to various interfaces in the plant.

1.3.8 Appendix A

Appendix A is an example of the task analysis procedure used by the Horizon Generating Station, an imaginary plant. This procedure is accompanied, in Appendix C, by some example output of such an analysis performed on one emergency procedure guideline, found in Appendix B.

1.3.9 Appendix B

Appendix B is a copy of the emergency response guideline analyzed using the Appendix A procedure. Emergency Response Guideline El, LOCA, is used for purposes of illustration.

1.3.10 Appendix C

Appendix C is an example of the written output of the CRDR task analysis as it might be generated using the procedures in Appendix A.

1.3.11 Appendix D

Appendix D is a listing of those NUREG-0700, Section 6 items that are best addressed during the CRDR task analysis.

1.4 Definitions

To establish uniformity in the meaning of key words used in this guideline, the following definitions are provided.

Control Room Simulator - A device that dynamically models the plant functions as presented in the control room.

Emergency Operating Procedures (EOPs) - Plant procedures directing operator actions necessary to mitigate consequences of transients and accidents that cause plant parameters to exceed reactor protection setpoints, engineered safety feature setpoints, or other appropriate technical limits.

Emergency Operating Procedure Guidelines (EPGs) - Guidelines, developed from system analysis of transients and accidents, that provide technical bases for the development of EOPs.

Emergency Response Guideline (ERG) - See EPG. The emergency procedure guidelines developed by the Westinghouse Owner's Group are called ERGs.

EOP Network - The set of EOPs and all procedures that are called out in the EOPs or that support the use of the EOPs during emergency conditions.

Mock-Up - Static device (e.g., model, photos drawings) that portrays control room hardware and configuration.

Emergency Response System (System) - The emergency response system is composed of four integrated components:

- o The "operator" consists of the control room operating crew.
- o The "plant" consists of the plant as seen from its control room with its instruments and controls.
- o The "procedure" consists of the EOP set and supporting system operating procedures (EOP Network).

o The "training" consists of the operator training program.

Human Engineering Discrepancy (HED) - A characteristic of the existing control room that does not comply with the human engineering criteria used in the control room design review.

Paper and Pencil Task Analysis - Method of task analysis where one or more persons break down, on paper, a fairly high-level function into the tasks required to support that function. This is generally the first step in a CRDR task analysis.

Simulator Task Analysis - Method of task analysis whereby control room operators perform actual control functions on simulated equipment during a transient scenario while their actions are monitored by an observer or review team.

Source Documents - Documents or records upon which each of the four system components is based.

Symptoms - Plant characteristics that directly or indirectly indicate plant status.

System Operational Correctness - A characteristic of the overall emergency response system that indicates the degree to which its four components are compatible as they work together to mitigate the consequences of emergency conditions.

System Validation - The overall evaluation of the emergency response system performed to determine that the four system components, illustrated in Figure 1 on page 20, work together to accomplish the desired results.

Table-Top Task Analysis - Method of task analysis whereby personnel explain and/or discuss action steps in response to a proposed scenario.

Task - A well-defined unit of work having an identifiable beginning and end.

Task Analysis - The systematic process of identifying and examining operator tasks in order to identify conditions, instrumentation, skills, and knowledge associated with the performance of a task. In the CRDR context, task analysis is used to determine the individual tasks that must be completed to allow successful emergency system operation. In addition, this activity can verify and validate the match of information available in the control room to the information requirements of the emergency operating tasks.

Validation - The process of determining whether the control room operating crew can perform their tasks effectively given the control room instrumentation and controls, procedures, and training. In the CRDR context, validation implies a dynamic performance evaluation.

Verification - The process of determining whether instrumentation, controls, and other equipment exist to meet the specific requirements of the emergency tasks performed by operators. In the CRDR context, verification implies a static check of instrumentation against human engineering criteria.

Walk-Through Task Analysis - Method of task analysis whereby control room operators conduct a step-by-step

enactment of their actions during a transient scenario for an observer review team without carrying out the actual control functions.

1.5 Recommended Use of This Document

This document is organized to address a utility's individual task analysis program. Program objectives, evaluation criteria, and the program process are described. An example program with evaluating criteria is presented in the appendixes.

The task analysis methodology presented in this document provides recommendations for an effective plan of generic benefit to utilities. This document may be used in whole, in part, or simply as a review document in the development of a plant-specific task analysis program.

2. THE CONCEPT OF A TASK

2.1 Introduction

Before discussing a task analysis program, the concept of a task must be understood. Generally, discussions of task analysis in books or other references start with a detailed breakdown of a job into functions, tasks, steps, etc. Unfortunately, such detailed definitions allow the reader to lose sight of the main purpose of the discussion. This section presents a general, operation-oriented discussion of the concept of a task.

2.2 Job Versus Task

Different slots in an organization are assigned job titles. In a nuclear power generating plant, for example, the job titles include plant manager, operations supervisor, maintenance foreman, control room operator, etc. Each job has associated with it some function that the person who bears that job title, the job incumbent, is supposed to fulfill. These functions normally are written into a job description. In its simplest form, the job description summarizes what is done by the job incumbent. In the case of a control room operator, a job function might include something like "Detects and diagnoses off-normal plant status and takes appropriate action to safeguard the plant equipment and the health and safety of the public."

Although it is straightforward to state generally what tasks the operator should do, determining how the operator can and should do those tasks is quite a different matter. Therein lies the distinction between a job and a task. A job is a finite set of tasks. The job description tells what tasks the operator is supposed to do. The next logical level of analysis must ask how the operator does the tasks that the job calls for him or

her to do. At the general level, a job can be considered a combination of activities an individual can do in series, in parallel, or, as in real life, both in series and parallel.

Some activities go on more or less continuously. For example, monitoring the net electrical output of the generator is something that goes on all the time. This is true even though an operator does not stare at the megawatt readout all the time, but glances at the reading to periodically update his memory. Other activities have a specific beginning and end. For example, manually tripping the turbine is an activity that begins and ends at a definite point in time. After it ends, the turbine is tripped. For purposes of this document, a task is an activity that has a definite beginning and a definite end.

By this definition, a task can be a pretty small unit of a job. It might seem more appropriate to define a task as an activity of relatively long duration (e.g., manually start the HPCI system) and define a step within that task as a shorter duration activity (e.g., open the HPCI turbine steam supply valve). The point to remember is that it makes no difference, from a practical standpoint, how one defines the duration of a task as long as the task has a specific beginning and end point. The appropriate length of any activity to be considered a task will usually be obvious from the context in which the activity is being analyzed.

2.3 Aspects Related to a Task

Some tasks are more technically difficult to perform than others, some are more physically demanding than others, and some tasks require tools and procedures, whereas others do not. Nearly everyone is familiar with

instances in which obviously unequally difficult tasks are treated as though they require the same level of effort. For example, the statement "verify safety injection" is found as one of the first tasks in some emergency procedures. Obviously, it is more easily written than done. As a precursor to discussing task analysis it is important to determine the aspects related to any task that might be important during the analysis.

2.3.1 Initiating Cues

An initiating cue for a task can be just about anything that lets a person know a particular task should be started. From the working definition given earlier, every task has a beginning point. A task may be the next step in a procedure. For example, one step in a valve lineup procedure might call for the high pressure injection (HPI) suction valve to be aligned to the condensate storage tank (CST). In such a case, the initiating cue for this task is the completion of the previous step. A task may be initiated as the result of a plant parameter reaching some predetermined value. For instance, reactor coolant pumps (RCPs) might have to be tripped manually when the reactor coolant system (RCS) primary pressure falls to some low value. In this case, the initiating cue for the task (tripping the RCPs) is the operator detecting a sufficiently low RCS pressure.

In addition to the procedure step and parameter value cited above, initiating cues can be verbal commands, annunciators, steps in system operating sequences, elapsed times, days of the week, etc.

In other words, an initiating cue is anything that cues the individual to begin a certain task.

2.3.2 Knowledge and Skills

Most tasks in a power plant require some degree of knowledge to complete. The level of knowledge can vary significantly from task to task. For example, the task, "Turn switch HPI-9-24 to 'ON'" does not require the same type or depth of knowledge as the task, "Borate RCS to ensure adequate shutdown margin." Likewise, some tasks require a special skill on the part of the person performing the tasks. For example, a task such as "Weld RTD well into piping using TIG welder" requires considerable skill to perform. Whereas, "Fill ink reservoir on chart recorder CR-2-13" does not require the same skill level.

The main thing to remember is that nearly every task requires some level of knowledge and/or skill on the part of the person performing the task. It is easy to lose sight of this fact, since many tasks require only rudimentary skills and superficial knowledge and it is sometimes assumed that people automatically possess these attributes.

2.3.3 Controls and Displays

The terms "controls" and "displays" should be interpreted in the most general way when associating them to tasks. In addition to CRTs, vertical edge meters, chart recorders, and similar displays, a display for a task should be interpreted to include direct indications, such as

steam escaping from a valve, the subjective speed of a visible shaft drive, and the position of a valve stem. Displays can even include sounds, vibration, smell, and heat. Likewise, controls should be interpreted as broadly as necessary to get an accurate picture of the controls necessary to perform a task. In many activities associated with the emergency operation of a power plant, the tasks performed by operators require the existence of certain controls and displays. For the control room operator, in particular, nearly all emergency tasks involve the use of the controls and displays located inside the control room. Equipment that is used for maintenance or sampling and other such activities is discussed in Section 2.3.4, Required Aids.

2.3.4 Required Aids

A task aid can be interpreted very broadly to mean anything that normally is not built into a person's environment, but is necessary to perform a task as intended. With this interpretation, an aid can be anything from a wrench, to welding goggles, to a C-clamp, to an SPDS display.

Besides knowledge, skills, and the existing controls and displays, other prerequisites may exist for certain tasks. Examples of such task "aids" are written or verbal procedures, hand tools, power tools, test equipment, access to a computerized data base, telephones, PA system--in short, anything a person has to have at hand to complete a task. These aids should not be considered as just nice things to have around or

conveniences. A task aid is any aid necessary to perform the task as the task is meant to be performed. Without the required aid, extra and perhaps more difficult steps must be taken to perform the task.

A good example of a task aid is the written procedure used to perform a surveillance test. With the procedure, the test is a simple step-by-step process easily carried out by a trained technician. Without the procedure, the technician must have an in-depth understanding of the system under test plus prior knowledge of the purpose of the test, the location of test points in the system, and the expected values to be obtained during the test.

2.3.5 Terminating Cues

As with initiating cues, terminating cues are anything that cues the individual that a certain task is complete. Just as each task has a starting point, it also must have an end point. To qualify as a task, an activity must have some observable event that signifies it is complete. As with initiating cues, terminating cues can and should be interpreted in the broadest sense. For most common control-room-oriented tasks, the terminating cue will be the observation that some plant state has been obtained, some parameter has reached a desired value, or some procedure has been completed.

Terminating cues can be simple or complex. For example, the terminating cue for the task "Open valve MS-3-24" is an indication that this valve has been opened. For the task "Verify turbine

tripped and in safe configuration," there are many terminating cues, such as stop valve positions, oil lift pump status, turning gear status, etc. Terminating cues do not have to be instrument indications. For instance, if the last step in a surveillance procedure is to replace an instrument cover, then that is the cue that the surveillance task is complete.

3. TASK ANALYSIS OVERVIEW

3.1 Introduction

The trained operator performing a given task in the control room as he is guided by procedures creates a dynamic system consisting of the following four integrated components:

- o operator - the individual performing a given task
- o plant - that part of the plant with which the individual is interfacing
- o procedures - both written and unwritten instructions governing the actions performed by the individual
- o training program - the program covering the actual training received by the individual resulting in his current level of skills and knowledge

This operator-plant-procedures-training system, referred to as the System, can be depicted as shown in Figure 1. The vertices represent the four components of the System. The interfaces are represented by the lines between the vertices. Task analysis is a tool that can be used to describe and analyze each interface.

3.2 Use of Task Analysis

Information on one or more interfaces between the operator and the other three components can be obtained through task analysis focused on the given interfaces. The use for the information produced by such an analysis is dependent on the status of the plant, i.e., operating or under construction, and on the system interface being studied.

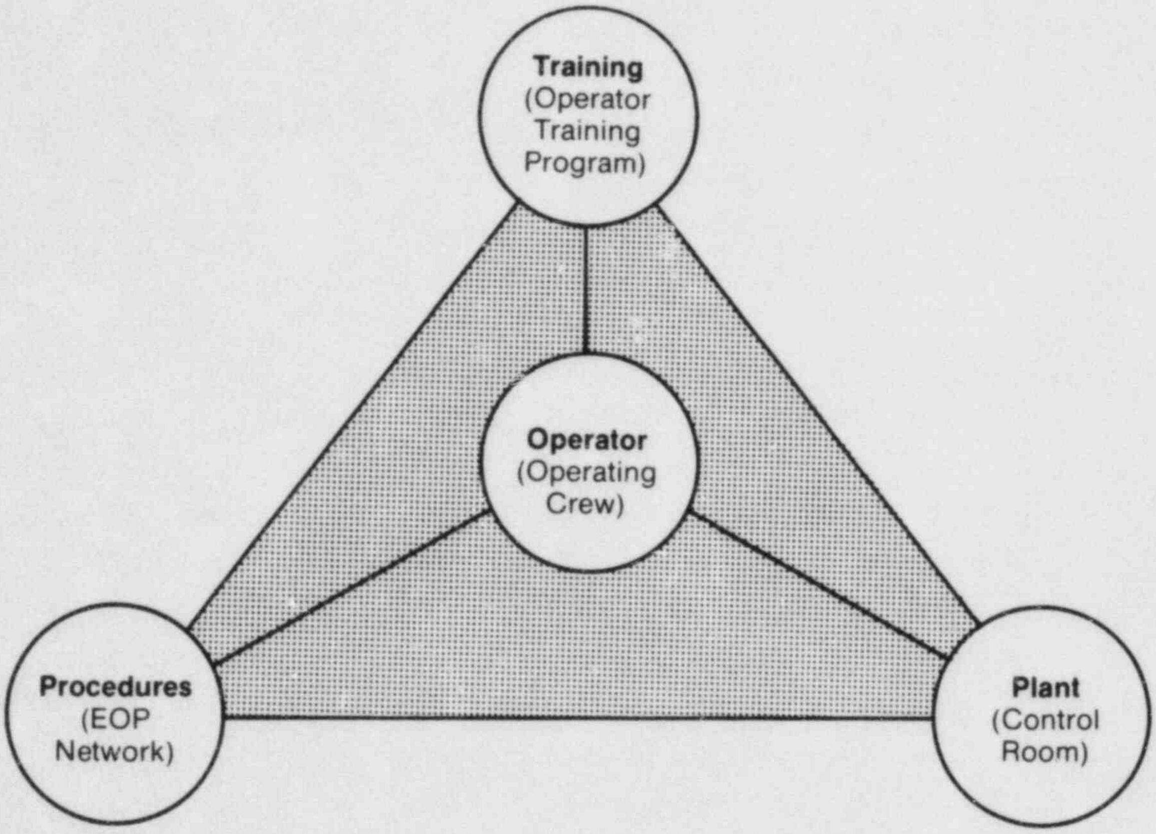

Figure 1. Operator/Plant/Procedures/Training System Schematic

For a near-term-operating-license (NTOL) plant, task analysis conducted for the three interfaces containing the operator can produce the following:

- o operator/plant - specification of required operator actions within the plant or hardware design requirements for preconstruction plants

- o operator/procedures - development of function-oriented procedures and identification of the required level of detail

- o operator/training - identification of conditions, standards, knowledge, and skills for developing performance objectives and lesson plans

For an operating plant, task analysis conducted for the three interfaces containing the "operator" component can produce the following:

- o operator/plant - an evaluation of the existing plant component status and its effect on required operator actions

- o operator/procedures - development or review of function-oriented procedures and their level of detail

- o operator/training - evaluation of conditions, standards, knowledge, and skills for reviewing performance objectives and lesson plans

Based in part on the results of any task analysis conducted, the system is either designed and implemented by NTOL plants or modified by operating plants. The general process of task analysis remains the same regardless of the interface being studied. The objectives of the analysis will, of course, vary with the purpose of

the analysis. Section 4 describes the task analysis process as it is applied to a nuclear power plant setting.

The implementation of task analysis, for any purpose, will involve the specification of four items. They are the following:

- o the objective of the program
- o the task analysis method to be used
- o the verification method to be used
- o the validation method to be used

The validation criteria are used to determine if the program's objective has been satisfied by the task analysis. Therefore, the objective and the validation criteria are developed first and are applied, as appropriate, each time the task analysis is used.

3.3 Task Analysis Program Objective

The objective of a task analysis program will depend on the system interface being studied. For the CRDR, the objectives are to identify the tasks required to support emergency operation and to determine whether the design of the control room allows and supports those tasks. Thus, the CRDR looks directly at the operator/plant interface and the procedures/plant interface.

The objective(s) must be decided before the task analysis process begins. Additional interfaces can be examined in a CRDR task analysis program. For example, the knowledge and skills required to perform emergency operation can be identified at the same time the information for the CRDR is being gathered. To do this requires some extra effort, but the incremental cost is small compared to the cost of conducting an entirely different task analysis program to get such training information. Thus, integrating the objectives of other ongoing

activities with those of the CRDR can be a very cost-effective and time-saving approach to gathering task information.

3.4 Task Analysis Process

The actual methods used during the task analysis process will vary for individual utilities and will depend on many factors, such as the availability of resources and the depth of analysis desired. An example of a specific CRDR task analysis procedure is presented in Appendix A to illustrate how one might take the general guidance in this document and use it to build a plant-specific program.

The task analysis process described in this document includes task identification and analysis of those tasks, verification, and validation. Since these activities can be logically separated from each other, they are described in separate sections of the document, as shown below.

TASK ANALYSIS PROCESS

TASK ANALYSIS (Section 4)
- o Task Identification
- o Analysis of Tasks

TASK ANALYSIS VERIFICATION (Section 5)

TASK ANALYSIS VALIDATION (Section 6)

The section numbers beside the three major activities in the task analysis process refer to the sections within this document where that activity is discussed in detail.

3.4.1 Task Analysis

Although the task analysis process, shown above, includes verification and validation, the task analysis step within that process consists of identifying the tasks required to carry out particular job functions and then analyzing those tasks to identify one or more of the components described in Section 2. There are several methods that can be used to conduct task analysis. Some of these methods are better suited than others to the requirements of the CRDR task analysis. Section 4 discusses the available task analysis methods and the suitability of each method for the CRDR task analysis. In addition, the planning and resource allocation for this step in the overall task analysis process is described.

3.4.2 Task Analysis Verification

Verification of task analysis is a relatively straightforward activity meant to ensure two things. First, it should ensure the technical accuracy and completeness of the information generated during task analysis. For the CRDR task analysis, this amounts to a double check on the revision level of emergency procedures or guidelines used, and the accuracy of transcription of information from one document to another. In addition to this traditional idea of verification, CRDR task analysis verification also ensures that the necessary displays and controls exist in the control room and are designed to fulfill the control and information requirements identified during the analysis.

3.4.3 Task Analysis Validation

The purpose of validation is to determine if the task analysis methods used in the task analysis process actually accomplished the program objective(s). Task analysis validation is discussed in Section 5. The CRDR task analysis validation method chosen by individual utilities will depend on many of the same factors that influenced their decision as to the task analysis method they used. Validation is an extremely important step in the CRDR program, since the CRDR task analysis deals almost exclusively with emergency plant operation.

4. TASK ANALYSIS

4.1 Introduction

In its simplest, most general form, task analysis consists of dividing a job (what has to be done) into its individual tasks (how it gets done). Ultimately, each task is then analyzed to determine its components, i.e., initiating cues, knowledge and skills, etc. Although a certain amount of customization is inevitable for any particular application, several aspects of task analysis can be generalized. That is, some things are required regardless of the situation. These general characteristics of task analysis are described below.

4.2 Determining the Purpose of the Analysis

The first step in any task analysis is to ask and answer the question "Why am I doing this?" It is essential to understand, before any analysis takes place, what one wants to wind up with when the analysis is over. This seems like such an obvious and trivial point that it hardly bears emphasizing. However, the failure to specify the desired results of task analysis is responsible for a great many useless products of such analysis.

The purpose and desired output of task analysis must be specified before conducting the analysis. One output of a CRDR task analysis will be a list of information required to complete all the steps in emergency procedures. This list is necessary to determine if all controls and displays required for emergency operations are present in the control room and are appropriately designed to transmit the necessary information. On the other hand, the desired output of a training-oriented task analysis might be a list of knowledge and skills required for control room operators to use a new SPDS display. Unless one knows what the results of task

analysis are to be used for, it is difficult to determine which questions to ask during the analysis.

4.3 Determining the Information Available From the Analysis

Assuming that the purpose of the task analysis is decided, the next logical question is "What kind of information can I expect to get from task analysis?" Ultimately, the answer to this question depends on the lengths one is willing to go to get information. However, fairly simple task analytic techniques exist to determine the major components of a task, as given in Section 2.3. For the CRDR task analysis, these components include the following:

- initiating cues
- controls and displays
- required aids
- terminating cues

These are not the only aspects of a task that might be of interest for applications other than the CRDR. For example, other frequently cited aspects of task performance are knowledge and skills, staffing requirements, crew interaction, conformance to operating philosophy, management interaction, and cost.

The emphasis placed on specifying the purpose of the analysis and the information required from the analysis is done so everything is "up front." If it is determined that certain information is not obtainable with the task analysis methods at one's disposal, the necessity for that information should be reevaluated before proceeding with the task analysis. Only when such a front-end analysis is done can task analysis proceed in an orderly and realistic manner.

4.4 Determining the Resources Available

In determining the resources available for task analysis, such resources can be grouped under the categories of personnel, equipment, and time. Time usually dictates the availability of other resources. Equipment resources for the CRDR task analysis include the control room, a control room simulator, a control room mock-up, or classroom. For the CRDR, in general, and particularly for CRDR task analysis, the availability of personnel is a major consideration. Manpower resources could include licensed personnel and non-licensed personnel with technical specialities.

It is important to remember that a mix of operational experience will best serve the purpose of the CRDR task analysis. Although "seasoned" operators may be quite familiar with the system, they may not recognize flaws, discrepancies, or have the same problems in interacting with the system as less experienced personnel. Likewise, novice operators will lack the exposure to many specific system modes and operating constraints that are familiar to more experienced operators.

4.5 Selecting the Task Analysis Method(s)

There are four methods commonly available for task analysis: paper and pencil method, table-top method, walk-through method, and simulator method.

In selecting the method or combination of methods to be used, the advantages and shortcomings of each method must be weighed relative to the objectives of the task analysis. This point can hardly be overstressed. The purpose of the task analysis and the information output required from the analysis must be explicitly specified before choosing the methods for the analysis. Other constraints will enter the decision, such as manpower,

cost, and availability of equipment and facilities. However, these constraints will not matter if the methods to be used cannot fulfill the purpose for conducting the analysis in the first place.

One further point should be made concerning the selection of task analysis methods. Of the four methods described, any one might produce the required output to support a given set of objectives. For the CRDR task analysis, however, some combination of the following methods is generally most appropriate for the information output required. These methods are best combined in a serial fashion to get the depth and type of information with which to assess control and display requirements, location, and design. For example, paper and pencil analysis, followed by table-top analysis and validated by walk-throughs in a mock-up or simulator is a commonly used combination of methods.

For the CRDR task analysis, the paper and pencil method is very narrowly defined in this guideline and should not be used by itself. It is included because it is a useful preliminary step in the CRDR task analysis and because, for other task analysis purposes (other than CRDR), it can produce entirely acceptable results. The following subsections describe each method and list the advantages and limitations of each.

4.5.1 Paper and Pencil Method

One of the most common forms of task analysis is paper and pencil analysis. As the name implies, paper and pencil analysis consists of separating, on paper, a fairly high level function into tasks or tasks into their components. This analysis is ideally done during the design process but is most often done as one step in

writing training manuals, system descriptions, or operating instructions. It is very narrowly defined for the purposes of this guideline and is distinguished by the absence of a subject matter expert (SME). That is, such an analysis is generally performed by one or two system designers, procedure writers, or training personnel who may have little or no actual operating experience.

Paper and pencil analysis is a worthwhile first step toward a more operation-oriented CRDR task analysis, in that it can encourage the analyst(s) to make explicit any baseline assumptions concerning the design of the system. If the paper and pencil method does nothing more than list the designers' assumptions concerning when, where, and under what conditions the system will be operated, then it is a valuable exercise. One thing that a paper and pencil analysis should do is delineate what the analyst perceives as the necessary and sufficient actions that must occur for the system to perform properly under the assumed operating conditions.

In a classic systems approach to design, the allocation of system functions to man and machine should occur after the preliminary paper and pencil analysis is completed. However, for most systems now under study, the allocation between automatic and manual operation has already been done. About the most that can be expected of function allocation for such systems is that the paper and pencil analysis will

indicate when automatic actions can be accomplished manually if the automatic systems fail.

For each method that might be used in the CRDR task analysis, there are certain advantages and limitations compared to other methods. The paper and pencil technique potentially has the following advantages:

- o Relatively Low Time Requirement--A paper and pencil analysis does not usually require as much time as more involved methods--on the order of one or two days per procedure if the analyst has some familiarity with the system(s) involved.

- o Low Manpower Requirement--A paper and pencil analysis usually involves only one or two people.

- o Low Support Requirement--A paper and pencil analysis generally will not require elaborate support facilities such as a simulator.

- o Few Constraints--Since a paper and pencil analysis is done in a fairly abstract environment, the results need not be constrained by the limitations of existing hardware, training, or staffing.

- o Design Input--A paper and pencil analysis provides a good vehicle for introducing engineering design considerations into the operational requirements.

The paper and pencil method has the following limitations:

- o Limited Applicability--The results of a paper and pencil analysis should not be applied without operational input and some type of validation.

- o Narrow Perspective--The analyst(s) may not be aware of the "Big Picture," that is, how the system or function being analyzed interacts with other systems and functions.

- o Potentially Inaccurate--Since the analyst is not necessarily an SME, his or her perception of the conditions of operation or other variables may be erroneous due to lack of exposure to such variables.

4.5.2 Table-Top Method

A technique that overcomes many of the limitations of the paper and pencil method as far as completeness and applicability is the table-top method. The table-top method consists of a group of individuals literally sitting around a table and verbally dissecting a function into tasks or analyzing the aspects of specific tasks. It is characterized by the ability of the individuals involved to look at the problem from different perspectives. The table-top method uses a group of people with varied backgrounds as opposed to one or two individuals with similar backgrounds working together.

The table-top method's strength is in the diversity of the individuals in the group. For a CRDR task analysis, such a group might include people with expertise in design, operations,

training, procedures, human engineering, instrumentation and control (I&C), and other specialties. Ultimately, any task analysis method must determine how certain tasks are performed and what prerequisites exist for task performance. The table-top method ensures that operational requirements are not determined in a vacuum and that engineering, psychophysical, and other aspects of tasks are considered also.

The value of the table-top method can be easily appreciated by considering the analysis that must take place to write emergency procedures. Given a fairly high-level task, such as "Manually Switch the Safety Injection System From Hot Leg to Cold Leg Discharge," it is then necessary to provide a procedure to accomplish this switch. From experienced operations people, it is certainly possible to determine how that task has been accomplished in the past, either at the plant under analysis or, for NTOLs, at similar facilities. Without engineering input, however, it is difficult to determine whether the accepted operational sequence is the preferred sequence, or even the correct sequence. When such questions arise, as they inevitably do, it is desirable to bring as many different perspectives to the problem as practical so the best overall solution can be obtained.

As with other CRDR task analysis methods, table-top analysis has its advantages and limitations. The advantages of the table-top method include the following:

- Broad Perspective--The big plus for the table-top method is the diversity of experience of the analysis group.

- Operational Input--Table-top analysis will usually result in task sequences and task characteristics that are operationally feasible and realistic.

- Interactive--The analysis achievable with the table-top method is generally more complete and usable than would be the sum of analyses performed separately by individual members of the analysis group.

- Low Support Requirement--A table-top analysis can usually be done without the use of high cost support facilities, such as a simulator.

- Relatively Fast--While not as fast as a paper and pencil analysis, table-top analysis can be performed in a fairly short time. Ultimately, the time required is a function of system or function complexity and the level of detail of the analysis.

Among the limitations of the table-top method for CRDR task analysis are the following:

- People Intensive--The one resource the table-top method uses rather intensively is people. For this method to be successful, the participants must be willing to devote a substantial proportion of their time to the analysis.

- o Too General--There is a tendency for table-top discussions to diverge from specific into more general topics.

- o Territorial--Sometimes, the table-top analysis group represents the first time individuals from design, operations, training, etc., have attempted to analyze something together. A period of adjustment is generally required while people learn to "talk the same language."

4.5.3 Walk-Through Method

Some individuals in a table-top analysis group will be familiar with the real operating environment. It is the goal of the table-top analysis group to come to a consensus on how certain tasks are performed (or should be performed). However, a general truth in task analysis is, "Just because a group of people agree that a certain task should be done in a particular way doesn't make it true." There may be reasons why a preferred task sequence is not or cannot be performed in a realistic operational setting.

For the CRDR task analysis, one essential element of the walk-through method is the participation of full-time control room operators. This requirement has a connotation that should be understood. A control room operator is not someone who used to be an operator or someone who knows what operators do, but a full-time, on-the-boards operator. That distinction is important because the failure to discriminate between those who <u>do</u> the job and those who only

know about the job can lead to erroneous results during the CRDR task analysis.

In its simplest form, walk-through analysis consists of observing an operator walking through some function (e.g., maintain steam generator level between low-level and high-level trip setpoints) or task (e.g., manually trip reactor) while recording his use of available controls, displays, and other resources. The object of a walk-through is to determine how the job incumbent performs a given task or, perhaps, what tasks the incumbent must perform to fulfill a particular function. This technique is sometimes called a walk-through, talk-through because the job incumbent may be asked to explain each action as it is being done.

Two characteristics distinguish the walk-through method from the methods discussed so far. First, the participation of a control room operator is required for the walk-through. Also, a walk-through must be conducted with some representation of the actual work environment. For the CRDR, the last requirement means doing the walk-through with a mock-up of the control boards, a simulator, or the actual control room.

The advantages of using walk-through analysis include the following:

- o Operator Input--In the case of the CRDR, real operators are asked to walk through a series of tasks and explain their activities.

- o Realistic Setting--As a minimum, a pictorial control board mock-up is used in a walk-through. The spatial relationships of controls and displays are realistically represented.

- o Start/Stop Nature--Observing and recording operator actions are facilitated by being able to stop certain task sequences, discuss any questions, and then continue.

- o Relatively Low Cost--It is not essential to use either a simulator or the real control room for a walk-through. A mock-up can be used with little loss of applicability.

- o Applicable Results--Since this method uses job incumbents and a representation of the real task environment, the results are likely to be applicable to the actual control room.

Some of the limitations of the walk-through method for CRDR task analysis are listed below:

- o Static--Due to the start-stop nature of the walk-through method, the dynamic nature of real plant behavior and operator response is lost.

- o Limited Cues--The numerous cues available to the operator in a dynamic control room setting are limited or unavailable using the walk-through method. This is especially true in the case of pictorial mock-ups used for walk-throughs.

- o Relatively High Level of Support--The walk-through method requires the time of actual job incumbents and the use of a mock-up, simulator, or actual control room.

- o Heavy Front-End Analysis--The walk-through method is most useful after a paper and pencil or table-top analysis has already been completed. It is less effective to attempt a walk-through without first doing some front-end analysis.

- o Cumbersome--The actions and explanations of the job incumbent(s) must be recorded for later, more detailed analysis. This can require a sizeable commitment of people and, possibly, equipment.

- o Biased--Each job incumbent approaches tasks differently. The perspective of any individual is influenced by past experience, personal preference, operating philosophy, mental "set," etc.

4.5.4 Simulator Method

The walk-through technique is a relatively attractive method for performing the CRDR task analysis due to its ability to use mock-ups to represent the control room environment. Walk-throughs can be quite thorough when preceded by adequate front-end analysis. The one aspect of operator-plant interaction that cannot be represented using a mock-up is the dynamic nature of actual plant operation. Also, very few mock-ups contain real controls and displays, nor are they

capable of activating status lights, annunciators, motor trip relays, etc. The presence or absence of such attributes is generally classified as the "fidelity" of the representation. High fidelity representations are very "true to life," that is, they look and feel like the real control room. Full-scale simulators are high-fidelity representations of a particular control room.

For task analysis, high fidelity is desirable. The reason is simple. Task analysis aims to describe the tasks required to do a job and the characteristics of those tasks in the actual environment in which the tasks are performed. Unless there is some prior reason for eliminating characteristics of the task environment from consideration, then any element in that environment might function as an initiating cue, data source, or terminating cue for a particular task. High fidelity is necessary to identify important task characteristics.

If a dynamic simulator is used for the CRDR task analysis, it should conform as closely as possible to the configuration of the actual control room where, ultimately, the tasks to be analyzed will be performed. As with the walk-through, control room operators should be used for the analysis. The basic analysis consists of operating the simulator in the appropriate mode (e.g., full power, start up, etc.) and recording the operators' performance for later review. Simulator analysis requires the same front-end work as the walk-through method. In fact, most simulator analysis is done in phases that include

some type of slow-time walk-through talk-through during which the operator(s) describe their activities during the real time scenario.

There are many advantages to using dynamic, full-scale simulators for the CRDR task analysis. These include the following:

- o Realistic--A full-scale simulator is as realistic a setting as possible without the actual use of the control room. Even if the simulator being used is for a slightly different control room configuration, the realism induced by the dynamic nature of the displays may make up for any slight dissimilarities.

- o Dynamic--A simulator is designed to portray an actual plant, with realistic time constants for the physical processes in the plant.

- o Directly Applicable--Real operators manipulate actual controls and are confronted with entirely appropriate sensory input. The results from a simulator analysis are directly applicable to the simulated control room.

- o Flexible--Many transients that would be unlikely to appear in an operating plant can be run on a simulator. This is especially relevant to task analyses performed to support emergency procedure development and abnormal operation.

- o Efficient--Dynamic transients can be run on the simulator in much less time than it would take to talk through those transients on a mock-up.

Although the advantages are many, simulator task analysis also has several limitations. Among the limitations are the following:

- o Expensive--Simulator time is very costly.
- o Unavailable--Simulators are used extensively for training operators. The heavy demand coupled with the relatively low number of simulators cause such high fidelity machines, where they even exist, to be in use most of the time.
- o Heavy Front-End Analysis--Even more than with the static walk-through method, the use of simulators for task analysis requires thorough analysis <u>before</u> going into the simulator.
- o Cumbersome Data Gathering--The dynamic nature of simulators (one of their greatest advantages) makes recording task data in real time very challenging.

4.6 Planning for the Task Analysis Methods

4.6.1 Introduction

Once the methods have been selected, planning for the CRDR task analysis must begin. Personnel, equipment, and documentation resources

required for the chosen methods must be allocated. Following is a list for consideration when checking the availability of resources:

- o generic EPGs, plant-specific EOPs if available, plant technical specifications, related technical documentation, results of operating experience review

- o room equipped with adequate table surface to layout EOPs and related documentation

- o support equipment (for walk-through and simulator methods)
  - -- real equipment
  - -- simulator
  - -- mock-up
  - -- operator auxiliary equipment (e.g., respirators, protective clothing, radiation detectors) if required
  - -- A/V equipment if videotape is to be used

- o required personnel
  - -- control room operators
  - -- nonoperating specialists
  - -- observer/review team
  - -- support equipment operators

- o task analysis and debriefing forms to be used

4.6.2 Personnel Requirements

Several options for combining operators and observer/review team personnel can be used for the walk-through and simulator methods:

- o one-on-one - one member of the observer/review team for each operator

- one-on-crew - one member of the observer/review team for an operating crew

- team-on-crew - the observer/review team for the operating crew

- team-on-one - the observer/review team for one operator

Each combination has advantages and limitations. While conducting a walk-through or simulator analysis, one-on-one may be necessary due to the amount of information that must be recorded. More operator and observer/review team participants may result in greater insight into the operational correctness of the system. In general, the number and type of participants in a table-top or walk-through task analysis will depend on the following:

- the number of operating/nonoperating people available to participate in the task analysis

- the number of qualified observer/reviewers and their availability

- the background and skill level of people available

4.6.3 Equipment Requirements

Planning for the simulator method is more complex than the other task analysis methods due to the need to integrate hardware, software, and personnel during relatively short periods of simulator availability. Therefore, appropriate personnel should be organized, documents should be researched, and appropriate checklists and

debriefing forms should be prepared for this method in accordance with a well thought out timetable.

The simulator to be used should conform as closely as possible to the configuration of the actual plant control room and to the physical plant dynamics. Where differences in the characteristics of human factors design, operational design, work-space design, communications system design, and dynamics do exist between the simulator and the control room, it is important to understand that the CRDR task analysis is being done for the actual plant and not for the simulator. The simulator is simply being used as the setting for the CRDR task analysis process.

A comparison of the two settings with respect to the actual control room's design, operational design, work-space design and communication system design will aid the observer/review team members later in determining whether or not operator performance in the simulator setting would occur in the same way in the actual plant. In addition, the observer/review team members might be able to identify potential problem areas that would arise at the simulator but not at the actual plant.

Changes to the simulator should be made if necessary to increase compatibility between the simulator and the existing control room. For example, if a system is demarcated in the plant, the corresponding simulator system should be demarcated to obtain an equivalent human factors design. Operational differences between the

plant and simulator can be minimized by adapting the initial symptoms designated in the scenario on the plant to equivalent simulator systems through programming.

Differences that remain between actual plant equipment and simulator equipment may be resolved by rewording the references to the plant-specific equipment in the procedures. However, the strict intention of amending the procedures is only to reword references to plant-specific equipment such that the procedures' characteristics are not altered and the operators will not be faced with equipment substitution decisions as they use the procedures on the simulator.

Planning the techniques for detecting and recording operator performance data on the simulator during the analysis is also necessary. These data collection techniques will fall into two major categories--automatic and/or manual. Automatic data collection techniques require the use of recorders, computers, and software whereas manual techniques would involve experienced personnel who observe operator actions using observation forms and/or videotape. A combination of these measures can be employed by the utility to record operator performance and provide a reliable task analytic data base.

4.6.4 Documentation Requirements

The details of documenting the CRDR task analysis will depend on the task analysis method chosen. There are general documentation

requirements, however, that apply regardless of the method used. The basis for task analysis documentation should be that an individual who was not involved in the task analysis process can read and understand what was done, by whom, for what purpose, and the findings. Some of this information will be in the summary report presented to the NRC. By its very nature a summary report cannot contain the level of detail that should exist somewhere in the CRDR task analysis documentation.

The documentation for the CRDR task analysis should include but should not be limited to the following:

- o a summary of the background of individuals conducting the CRDR task analysis

- o a list of EPGs and plant-specific EOPs that were analyzed

- o standard forms containing task breakdowns for each procedure or guideline analyzed

- o worksheets listing the verified, but prevalidation, CRDR task analysis output (e.g., instruments, controls, etc.) for each procedure or guideline analyzed

- o worksheets listing the verified, but prevalidation, CRDR task analysis for each plant system analyzed (e.g., HPCI)

- o descriptions of the analysis and validation techniques used

- validated task worksheets for each procedure or guideline analyzed

- a list of human engineering discrepancies (HEDs) identified during the CRDR task analysis and task analysis validation

Such documentation will ensure that questions concerning the adequacy of the current control room for emergency operation can be answered.

Perhaps as important as determining the adequacy of the present control room, documentation of the quality described above can be used in the design and engineering change process. In that context, future control room modifications can be reviewed to ensure that the current operational basis of the control room, as depicted in the CRDR documentation, is not compromised.

5. TASK ANALYSIS VERIFICATION

5.1 Introduction

Verification of the task analysis output is a relatively straightforward activity, but one that should not be overlooked. In the context of the CRDR task analysis, verification consists of three steps. These are (1) verification of documentation, (2) verification of the existence of required controls and displays, and (3) verification of the suitability of existing controls and displays. The first step is intended to ensure that the documents used in the CRDR task analysis are the correct documents and that they are updated to their most current revision level. The final two steps are meant to determine the existence and suitability of control room instrumentation required for emergency operation.

For the CRDR task analysis, verification can help the review team make sure they have analyzed the correct revision level of the EPGs, that all applicable EPGs have been studied, and that the support documentation is technically accurate and up to date. Further, verification will determine whether displays and controls called for by the EPGs are present in the control room and are designed to support the decisions and control actions called out in the EPGs.

5.2 Verification Activities

The following sections briefly describe each step applicable to the verification of the CRDR task analysis.

5.2.1 Document Verification

The CRDR task analysis is very much document-oriented. Not only are several kinds of documents used as source and reference material, but the output of the CRDR task analysis consists

mainly of written instrument lists, worksheets, comment forms, etc. In such an undertaking, there is ample opportunity to retrieve and use incorrect source documents and to err while transcribing information from one document to another.

Document verification, although listed here as a discrete step, should be practiced in an ongoing manner during the entire CRDR, including the task analysis phase. It is not feasible to specify a single mechanism to ensure that documentation is verified - the most sensible mechanism will vary from utility to utility. As a minimum, however, a single person or group should be assigned the responsibility of checking all source documents to ensure correctness. Further, some amount of independent review should be considered for output documentation.

5.2.2 Verification of Required Controls and Displays

One output of the CRDR task analysis will be a list of information and controls required to proceed with each step in the EPG or plant-specific procedure. During the CRDR task analysis, there should have been no attempt to associate existing control room displays and controls with the information and control requirements gleaned from the emergency procedures (or guidelines). For example, one step in a procedure or guideline might have called for a specific action, such as stopping all reactor coolant pumps (RCPs), to be taken when a particular parameter, such as RC pressure, reached a predetermined setpoint. The information requirements for this step are that RC pressure has

reached the setpoint and that the RC pumps have been stopped. The controls required are those necessary to stop the RC pumps.

The purpose of verification is to associate existing controls and displays with the control and information requirements identified during the CRDR task analysis. To follow the specific example given above, the existence of an RC pressure indicator, RC pump status indicators, and RC pump motor controls should be ascertained. If such displays and controls exist, then the next verification step (5.2.3) should be completed. If any of these displays and controls do not exist in the control room, then that fact should be documented as an HED and any alternate instrumentation that exists to accomplish the required steps should be noted for possible use during the assessment of the HEDs.

5.2.3 Verification of Suitability

In addition to noting the existence of required displays and controls, the verification must check the design of those displays and controls against the requirements listed during the CRDR task analysis. Thus, using the RC pressure example once again, the existing RC pressure display must be scaled so the RC pump trip setpoint is readable from the normal operating location. Also, the location of the RC pump motor controls must be evaluated relative to the location of the RC pressure indication. Finally, the RC pump motor status displays need to be evaluated as to their ability to transmit status information to the operator.

Although described here as two separate steps, verification of the existence and suitability of required displays and controls can usually be done simultaneously. As the review team goes through the process of comparing the list of required displays and controls to the existing control room instrumentation, plant-specific identifiers for those controls and displays that match the requirements should be recorded for later reference.

6. TASK ANALYSIS VALIDATION

6.1 Introduction

To ensure that the CRDR task analysis process has correctly portrayed the emergency operational environment, a validation of the process should be conducted. In theory, the CRDR task analysis process is capable of identifying tasks, task conditions, controls and displays, etc. In practice, however, the process is constrained to use specific equipment and personnel that may not produce a completely accurate picture of the operational environment.

One must choose certain operators to participate in the CRDR task analysis process. Usually such a sample of operators will be small and may not be representative of the general population of operators at a particular plant or utility. The remainder of this section will identify and describe some of the more common validation techniques that might be used to validate the CRDR task analysis process

6.2 Validation Framework

Regardless of the validation technique to be used, there is a general validation philosophy that should be understood and adopted. The concept of validity has several aspects, but the kernel of the concept is quite simply stated. A process is valid if it does what it is intended to do. Establishing the objective for the task analysis (Subsection 3.3) defines what the task analysis process is intended to do. The validation technique must determine whether the objective has been met.

To determine whether the CRDR task analysis is valid, the results obtained with the operators who participated in the analysis must be related to the general operator

population at the plant. The techniques for accomplishing this validation are described later. A representative sample of operators, other than those who participated in the CRDR task analysis, should be selected for the process of validation. The intent of validation is to ensure that the results obtained with the original sample, or group, of operators is representative of the entire operator population. Therefore, the individual operators who were used to produce the CRDR task analysis results cannot be used to validate those results.

An example will illustrate the framework within which validation should take place. The objective for a CRDR task analysis is to identify plant-specific displays and controls required for emergency operation as specified in the EOPs (or EPGs) and to determine whether those displays and controls exist in the control room and are appropriately designed and located for emergency operation. Suppose a utility chooses to use the simulator method of task analysis and selects two crews, currently undergoing requalification training at the utility's simulator, to participate in the CRDR task analysis. After the CRDR task analysis has been conducted, a list of required controls and displays is produced along with a list of possible problems with control and display location and arrangement. The question now becomes, How valid is this CRDR task analysis? Put another way, Are the results of this analysis representative of the operators at this plant or are the results somehow peculiar to the two crews that participated in the task analysis?

6.3 Validation Methods

The list of task analysis validation methods is identical to the list of task analysis techniques. The difference comes in the execution of the technique. During

the task analysis process, the level of detail of the information that is recorded and the level of effort on the part of the review/observer team will vary considerably from the levels necessary during validation.

While any validation method is feasible, the choices will be limited in practice. From a pragmatic standpoint, it is not likely that a utility would choose a validation method that requires a significantly greater commitment of resources than the method they choose for the CRDR task analysis itself. The validation methods discussed below are presented in greater detail in the Component Verification and System Validation Guideline, INPO 83-047 (NUTAC) written by the ERC NUTAC. Whether or not a formal validation method is used, the operator's performance during real emergencies will demonstrate the validity (or lack of validity) of the CRDR task analysis.

6.3.1 Paper and Pencil

The usefulness of the paper and pencil method for task analysis validation is limited, in that it does not require operational input. It can provide some degree of validation in two specific areas, however. First, the output of the task analysis is a list of tasks and associated controls and displays. The paper and pencil method can be used to get engineering judgement as to the correctness or optimality of the task sequences identified during the analysis. For example, suppose the operators who participated in the CRDR task analysis agree that they perform a given sequence of tasks to start a turbine-driven coolant injection pump. It is possible that the sequence of tasks agreed upon is not correct from an engineering perspective.

That information can be obtained using the paper and pencil method of validation.

A second potential use of this validation method is to get other operators to examine the output of the CRDR task analysis and comment on how closely those task sequences conform to <u>their</u> method of operation. Although this is not a very reliable way to gather such information, it should provide an indication of how representative the results from the operators who participated are to the entire population of plant operators.

6.3.2 Table-Top

Table-top validation consists of the task analysis team meeting with operators, other than those who participated in the analysis, and discussing the results of the analysis. For the CRDR task analysis, this method allows engineering input like that described in the paper and pencil method and input from a representative sample of plant operators. The advantage of table-top validation, over paper and pencil validation, is that the table-top method is highly interactive. Perhaps there are operational reasons why certain task sequences cannot be executed in the optimum engineering configuration. The interactive nature of table-top validation is more likely to identify these conflicts than is the paper and pencil method.

As validation methods, both table-top and paper and pencil suffer from a common shortcoming. That is, both techniques can be applied outside the operational environment. What is done,

essentially, is to ask a group of operators whether the task sequences delineated during the CRDR task analysis are correct from their perspective as operators. The problem is that the recollection of operators concerning how they do certain tasks is not necessarily complete or even accurate. The methods described below can overcome this shortcoming by putting operators into a semblance of the operating environment during validation.

6.3.3 Walk-Through

The walk-through method of validation is very similar to the walk-through method of task analysis. For the CRDR, both the process and validation technique require the use of a control room mock-up or simulator. It is not necessary for the representation of the control room to be capable of dynamically depicting indicators and controls. A walk-through validation consists of having operators, other than those who participated in the CRDR task analysis, go through the actions they would normally do to complete certain activities. They essentially walk through these actions using the control room mock-up, simulator, or the actual control room.

In the case of the CRDR, the activities to be walked through come from the symptom-oriented EPGs or the plant-specific EOPs. The big difference in the walk-through done for validation and that done for the analysis is that during validation the observer(s) is looking only for differences between the task sequences developed from the analysis and those observed during the validation. Major differences may indicate that

the operators who participated in the CRDR task analysis may not be representative of the entire operator population.

6.3.4 Simulator

The simulator method of validation is very similar to the walk-through method. For the simulator method, operators complete certain activities in real time on a dynamic, full-scope simulator. The operators perform in real time. For the CRDR, the activities to be done on the simulator are taken from the symptom-oriented EPGs or plant-specific EOPs.

As in the walk-through method, the observers are looking for differences between the task sequences delineated during CRDR task analysis and the tasks observed during validation. Simulator validation comes as close as possible to real plant validation without actually using the real plant equipment.

7. RESULTS OF THE TASK ANALYSIS PROCESS

7.1 Introduction

The product of the CRDR task analysis will be a significant quantity of information concerning the operators' relationship with the control room, the emergency procedures, and the training program. The use one makes of this information depends on the purpose for which the task analysis is conducted. If the operator, plant, procedures, and training are considered in the context of the System model (see Figure 1, page 20), then the information from task analysis can be used to evaluate the interfaces between each pair of system components.

For the CRDR, the major interfaces examined are the operator/plant interface, the procedures/plant interface, and the procedures/operator interface. Of these interfaces, one not likely to be improved by direct control room modification is the procedures/operator interface. This is not to say that other areas of interest should not be pursued during the CRDR task analysis process. In fact, the simple addition of some relevant questions during the CRDR task analysis can yield information concerning the system interfaces involving training.

The following subsections describe the type of information potentially available concerning each system interface and how that information can be combined with information from other sources to yield valuable insights into particular system interfaces.

7.2 Areas of Interest for CRDR

The specific information required from task analysis will vary, depending on the particular interface being studied. The results of task analysis can be evaluated

by posing a series of questions concerning each system interface. The questions listed below can be thought of as criteria with which to evaluate the information obtained during the CRDR task analysis.

7.2.1 Operator/Plant Interface

The operator/plant interface is the main focus of the CRDR. The objective of performing the CRDR task analysis is to ensure that controls and displays exist and are appropriately located and designed to support emergency operation in the control room. The following questions, at least, should be resolvable using the information obtained during the CRDR task analysis. This list is not exhaustive, but concentrates on major categories of information.

- o Are indications available for all parameters required by the operators during emergency operation?

- o Are there situations in which the operators cannot perform control manipulations because of time constraints?

- o Does the placement of controls and related displays require one person to read a display while another manipulates the control?

- o Is any control or display that is required for emergency operation located on a back panel?

- o Do certain alarms and annunciators mislead or distract the operators?

- o Does the arrangement of the control room tend to cause the members of the operating crew to get in each other's way?

- o Are there instances where initiating cues for specific emergency tasks do not exist in the control room?

- o Is the information from computer systems used as an aid for emergency operation and, if so, is it in a readily usable form?

In addition to the information generated by the CRDR task analysis, data are available from the operating experience review and the control room survey. Taken together, a relatively comprehensive picture of the appropriateness of the control room design (operator/plant interface) should emerge.

7.2.2 Procedures/Plant Interface

The CRDR task analysis deals exclusively with emergency operation. For this reason much can be learned about the adequacy of the interface between the emergency operating procedures (EOPs), or emergency operating procedure guidelines (EPGs), and the control room. The CRDR task analysis can be used to help write and/or evaluate the plant-specific EOPs from the generic EPGs. The following questions can be used to organize the task analysis information concerning the emergency procedure/plant interface. The extension of this technique to normal operation is direct but will not be explored here.

- o Are indications available for all parameters used for decision and branching points in the emergency operating procedures or guidelines?

- If time constraints are contained in the procedures or guidelines, are the constraints reasonable for the control room as designed?
- Are the entry and exit conditions for each procedure or guideline observable with the existing displays and controls?
- Does the control room layout allow the tasks listed in the procedures or guidelines to be accomplished by the number of people on shift?
- Do all equipment controls, and displays used by the control room operators to perform the steps in procedures or guidelines actually exist in the control room?
- Is the name or label of equipment, controls, and displays called out in a procedure or guideline the same as the name or label in the control room?
- Are the range, precision, and units of parameters referenced in procedures or guidelines compatible with those available in the control room?
- Are there instances where the operator is forced to do mental arithmetic or remember seldom-used numbers or setpoints due to lack of proper controls or displays in the control room?

As with the operator/plant interface, the information concerning the procedures/plant interface

should be supplemented with data from the operating experience review.

7.3 Other Areas of Interest

In addition to the two system interfaces directly addressed in the CRDR task analysis, other interfaces can be analyzed. The questions listed below can be used to help evaluate those interfaces not directly examined by the CRDR task analysis. These questions are provided to assist utilities that may want to go beyond the basic CRDR requirements and integrate the CRDR task analysis with other task analysis programs.

7.3.1 Procedures/Operator Interface

The CRDR task analysis may not indicate the adequacy of the existing EOPs, since plant-specific EOPs might not be written prior to the CRDR. However, even if generic EPGs are used for the CRDR task analysis, the results of the analysis can be used to generate useful plant-specific procedures.

The following questions can be used to relate task analysis information to emergency operating procedures.

- o Is there any ambiguity in the procedures concerning the action(s) the operator is to take?

- o If more than one procedure is active at any time, is there a clear priority of execution among the different procedures?

- o Can the operating crew members read and understand the procedures?

- Can procedures, or points within procedures, be easily located when referenced?

- Are notes and cautions in the procedures clearly written, properly located, and easily distinguishable from the normal procedure steps?

Some data from the operating experience review may be useful in evaluating the procedures/ operator interface.

7.3.2 Training/Plant Interface

The three system interfaces involving training are not studied explicitly during the CRDR. The CRDR is, however, an ideal time to collect information concerning the training interfaces. It is ideal because the operator training program must incorporate the very aspects of control room design and procedures that are examined during the CRDR. The following questions pertain to each individual task and give an idea of the type of information necessary to describe the training/plant interface.

- What skills and knowledge are required to operate specific plant systems safely and correctly?

- Have the operators been trained to function in the control room as it actually exists in the plant?

- What skills and knowledge are required to facilitate response to annunciators?

- What skills and knowledge are needed to prevent information from controls and displays being misinterpreted?

- Have operators been informed of all modifications to systems or equipment and trained to use such equipment as modified?

- Do operators understand what effect the manipulation of one system may have on interconnected systems?

The aim of examining the training/plant interface is to ensure that the operator trainees have a complete and accurate picture of the physical plant as it really exists.

7.3.3 Training/Procedures Interface

In most training programs, the plant procedures are used as the foundation for instructional material when training on procedures. Certain information can be gathered during task analysis of emergency procedures that will help ensure the adequacy of the training program for those procedures. The following questions indicate the type and level of information required to help develop the training program as it relates to procedures.

- What skills and knowledge are required to perform each step in a procedure?

- How are plant systems referenced in the procedures?

- Is there an explicit priority of execution for emergency operating procedures?

- o What conditions will cause an operator to recognize the necessity of going to an emergency operating procedure?

- o What skills and knowledge are required for the operator to use titles and numbers for locating referenced or branched procedures?

- o What is the overall priority of emergency operating procedure execution? Is that clear to the operator?

The object of analyzing the training/procedures interface is to ensure the operator knows what the procedure assumes he knows. For example, a procedure might not list every step in a sequence of steps to start a turbine-driven pump. It is incumbent on the training program to make certain the operator knows what those steps are and has the skill to perform them.

7.3.4 Training/Operator Interface

Of all the interfaces between training and the remainder of the System, the most basic is the interface between the training program and the operator. As important as the characteristics of the operating crew are during normal operation, they can be critical during emergency operation. The following questions illustrate the kind of task analysis information needed to evaluate the requirements of the training program as it relates to the operating crew.

- o Is there confusion as to who is in charge during emergency operation?

- Are verbal instructions passed among operators? If so, are they understood correctly?
- Are procedures used and followed?
- Is any one operator overburdened?
- Does the operating crew appear to be following any particular strategy to determine the cause(s) of transients?
- Does the appropriate person take charge during transients?
- Is there sufficient coordination between the control room and support personnel outside the control room?

These questions are all aimed at determining whether the training program teaches operators to function in the plant environment with the existing crew structure. It also can help identify modes or periods of operation during which the operating philosophy of the utility may not be appropriate.

APPENDIX A

EXAMPLE PROCEDURE FOR CONDUCTING TASK ANALYSIS FOR THE CRDR

CONTROL ROOM DESIGN REVIEW
TASK ANALYSIS PROCEDURE

ACWORTH POWER AND LIGHT COMPANY
HORIZON GENERATING STATION

1. INTRODUCTION

As part of the Control Room Design Review (CRDR) for the Horizon Generating Station (HGS), Acworth Power and Light Company (APLC) intends to conduct task analyses for certain emergency procedures (or associated guidelines). The purpose of this task analysis and its relationship to the overall CRDR is described in the document Program Plan for Implementation of Control Room Design Review recently submitted to the Nuclear Regulatory Commission (NRC) by APLC. A fairly detailed outline of the task analysis procedure is also contained in the APLC program plan.

This procedure has been written to develop the goals of the CRDR task analysis more fully and to provide more specific guidance to those individuals who will actually conduct the analysis. The CRDR task analysis described herein is a straightforward process that will identify control room design characteristics that might degrade emergency operation.

2. CRDR TASK ANALYSIS PROCESS

The HGS CRDR task analysis will consist of three distinct phases:

- o task identification and analysis of tasks
- o verification of controls and displays
- o validation of control room functions

Each phase will be described briefly and the procedure to be used for each phase will be delineated in the next chapter.

2.1 Task Identification and Analysis of Tasks

The task identification phase consists of two steps. The CRDR task analysis is based on the Emergency Response Guidelines (ERGs) developed by the Westinghouse Owners Group (WOG). The first step involves extracting from the ERGs to be analyzed the tasks required to com-

plete those ERGs. As stated in the APLC program plan, HGS has not yet generated plant-specific procedures from the WOG ERGs so this task extraction process ultimately will aid in writing such procedures. The second step in the task identification and analysis phase is to identify the plant parameters and, ultimately, the displays and controls necessary to actually accomplish the tasks delineated in the first step.

When the task identification and analysis phase is complete, the HGS review team will have a list of tasks, and the displays and controls required by those tasks, to complete the WOG ERGs that have been selected for analysis.

2.2 Verification of Controls and Displays

The verification phase consists of two steps involving the controls and displays identified during the task identification and analysis phase. First, a determination will be made as to whether the controls and displays necessary to make the decisions and implement the tasks identified previously are, in fact, present in the control room. If not, any such instance will be defined as an HED and documented accordingly.

For those controls and displays found in step one, the second step will be a comparison of those instruments with appropriate human engineering design criteria, based on their use in the ERGs. Although the control room survey examined all control room instrumentation for conformance with human engineering design criteria, this verification step is required to determine if a meter, for example, has the appropriate range and scale gradations to support a particular ERG or system-specific task.

2.3 Validation of Control Room Functions

The final analytical phase in the CRDR task analysis is to validate that the tasks delineated earlier are indeed the tasks that must be performed to carry out emergency functions and that those tasks can be completed in the existing HGS control room by the normal operating crew. In order to integrate the CRDR and the emergency operating procedures, the validation will be completed after HGS-specific EOPs are written from the WOG generic ERGs. This will allow the task analytic information developed for the CRDR to be used in writing the HGS emergency operating procedures. Likewise, the EOP validation will automatically check the CRDR task analysis and the new procedures.

The CRDR task analysis validation will be conducted in two steps. The first will be done immediately after the task identification and analysis and verification phases are complete, but before the HGS-specific EOPs are written. This will validate the list of required controls and displays. For this first step, the HGS control room mock-up will be used to determine if the controls and displays called for in the ERGs are located so they can be used easily by the number of individuals normally on shift. This activity will not duplicate the CRDR survey, since the survey was not really concerned with such operational constraints as the use of specific controls and displays during emergencies. For the final validation step, specific transients will be selected that will require operators to use the HGS-specific EOPs. These transients will be run on the Sunrise Plant Simulator and an HGS operating crew will walk through the tasks that are required by the EOPs.

3. CRDR TASK ANALYSIS PROCEDURES

The following procedures will be followed by the HGS review team when conducting the HGS CRDR task analysis. References are made, where appropriate, to standardized forms developed by APLC for this task analysis. Blank forms are included in this document.

3.1 Task Identification and Analysis of Tasks

3.1.1 Personnel Assignments

The review team leader will supplement the core review team with at least one individual from the areas of training and procedures. These individuals plus the individuals in the core team will conduct the task identification and analysis portion of the CRDR task analysis. If this team requires individuals from other disciplines during this phase of the task analysis, the review team leader will arrange to have such expertise made available to the review team.

3.1.2 Resources Required

The identification and analysis of emergency tasks will require that the review team have easy access to the WOG ERGs, HGS system operating instructions, and other documentation. The review team leader will arrange for the following documentation to be available on a continuous basis to the review team:

- o the latest version of WOG ERGs E0, E1, E2, E3, and all function restoration guidelines
- o the generic task analysis documentation generated by the WOG as part of a project by the WOG to supply whatever generic information possible to its members

- a complete set of HGS system operating procedures (SOPs)
- a complete set of HGS system drawings, including elevation, block diagram, and P&I drawings
- any existing system descriptions including those used for training and FSAR system documentation
- a complete set of the current HGS Emergency Operating Procedures (EOPs) - even though those EOPs are not based on the WOG ERGs
- a copy of the HGS instrument tabulation
- a complete set of annunciator procedures

This documentation will be assembled in a location to be provided on an extended basis for the use of the review team. Should other documentation be required during the CRDR task analysis, the review team leader will obtain such documentation, if available, through the HGS Document Center.

3.1.3 Initial Task Identification

For each guideline to be analyzed, an initial list of tasks will be identified using the appropriate ERG, the WOG generic task analysis, and HGS system descriptions. This list will be compiled by a subset of the review team composed of the reactor operator (or operations technical advisor), the human factors specialist, and the procedures individual. These tasks will be

entered on the "Control and Display Requirements" form (See Page A-17) in the "ERG Task/Step" column.

3.1.4 Control and Display Identification

After the initial list of tasks is compiled, the types of controls and displays required to complete those tasks will be identified and entered on the "Control and Display Requirements" form. The same individuals who compiled the initial task list will be responsible for identifying required controls and displays. During this process, emphasis will be given to identifying the controls and displays that should be available to complete the given tasks, not just the controls and displays that are used normally because they happen to be in the control room.

In addition to the types of controls and displays required, the capabilities of these and any required supporting instruments will be identified. The list of control and display requirements will be reviewed by the I&C specialist and the design engineer for their concurrence that appropriate control and display types have been listed.

3.2 Verification of Controls and Displays

3.2.1 Existence of Required Controls and Displays

With the initial task list and the list of required controls and displays complete, the review team members who generated these lists will go through the control room and determine whether each listed control and display exists. For example, if a step in an ERG calls for action

to be taken based on pressurizer level, then the instrument displaying pressurizer level should be located in the control room. If so, the instrument number, location, and range, if applicable, will be entered on the "Task Analysis Worksheet" (See Page A-19) for the appropriate ERG. Any control or display on the required list that is not located in the control room will be counted automatically as an HED and documented as such.

If any instances should occur when a required control or display is not in the control room, the review team members will ascertain whether the function of that instrument is fulfilled by other controls or displays in the control room and list those instruments on the "Task Analysis Worksheet." During the assessment phase of the CRDR, this information will be considered when formulating the resolution for HEDs associated with missing controls and displays.

3.2.2 Suitability of Controls and Displays

After identifying the required controls and displays that exist in the HGS control room, the suitability of those controls and displays will be verified by the operations and I&C specialists. The human factors specialist will act in an advisory capacity for this activity. The suitability will be checked by comparing the characteristics of each listed control and display with the requirements of the task that control or display supports. For example, if performing a task requires that steam generator pressures be compared and a difference of 100 psig be detected, the SG pressure displays would be examined to determine whether their location

allows simultaneous readings and their scales permit a 100 psig pressure increment to be detected.

To facilitate this suitability verification, the task analysis worksheet contains space to note the task requirements of each control and display. As the verification is being done, any control or display on the requirements list that is judged not to be suitable for its purpose in an emergency task will be considered an HED and documented as such.

3.3 Validation of Control Room Functions

The task identification and analysis and verification phases of the CRDR task analysis will result in a list of tasks, a control and display requirements list, a listing of HGS-specific controls and displays that are matched to the requirements list, and findings as to the suitability of the HGS-specific controls and displays for their emergency task requirements. The final step is to validate that (a) the CRDR task analysis has yielded an accurate listing of emergency tasks and (b) those emergency tasks can be performed in the HGS control room by the normal shift personnel complement in the required time frame. This second validation step will occur after the HGS emergency procedures are written. The first validation step will be completed immediately following the verification phase of the CRDR task analysis.

3.3.1 Mock-up Walk-through

The first validation step will be completed by conducting a series of walk-throughs in the HGS mock-up. These walk-throughs will be done using actual HGS operations crews, whose actions will

be observed and recorded by a team of individuals under the direction of the review team. The purpose of the walk-throughs is to answer the following questions concerning emergency operation at HGS using the new procedures. Some of these questions are oriented toward development of the new procedures, while some are aimed specifically at the CRDR task analysis.

- Does the placement of controls and related displays require one person to read a display while another manipulates a control?
- Is any control or display that is required for emergency operation located on a back panel?
- Do operators have any difficulty reading required displays or reaching required controls?
- Does the arrangement of the control room tend to cause the members of the operating crew to get in each other's way?
- Are there instances in which initiating cues for specific tasks do not exist in the control room?
- Are there emergency tasks that potentially cannot be done in the manner specified by the number of persons normally on shift?
- Are there instances when the operator is forced to do mental arithmetic or remember seldom-used numbers or setpoints?

- Are there instances during the walk-throughs when tasks or task sequences are performed that are significantly different than the tasks and sequences developed during the task identification and analysis phase?

A positive answer to most of these questions connotes potentially poor emergency design and should be documented as HEDs and assessed during the CRDR assessment. A positive answer to the last question listed above carries more subtle implications than does a potential design problem. The walk-throughs will be done using the task worksheets developed from the ERGS used in the task identification and analysis phase, but will use two operational crews that will not have been involved in the CRDR, except for filling out operational experience questionnaires. Therefore, if one or both of the walk-through crews perform in a manner that is inconsistent with the predefined task sequences, the reason for such inconsistency should be ascertained.

Since the walk-throughs will consist of having HGS crews walk through the HGS mock-up, the general flow of tasks will be, by definition, the same as that defined during the task identification and analysis phase. However, the ERGs contain some fairly high-level tasks that may be performed differently by different crews. Members of the review team have supposedly identified the optimal HGS-specific sequence that should be followed to accomplish the high-level tasks. Significant deviations from this sequence may indicate that the review team is not aware of certain operational constraints, the operating

crews have not been trained in the "correct" task sequence for specific operations, or the task sequence may not be critical to correct system operation.

The mock-up walk-throughs will be recorded using task analysis worksheets on which the tasks defined during the task identification and analysis have already been entered. The controls and displays associated with each task also will have been entered on these worksheets. During the walk-throughs, the observers will record any deviation from the task sequences and control and display usage listed on the data sheets. Any discrepancies will be discussed with the operating crew members. The resolution of discrepancies will be recorded on the data sheets under "Comments."

The walk-through for each task worksheet will be conducted in the same manner. Each operating crew member will be assigned to the same role he or she fulfills when actually on duty (e.g., RO, SRO, SS). The entry conditions will be discussed by the crew and observation team. This discussion will result in a specification by the crew of (a) what each entry condition means, (b) the displays used to detect entry conditions, and (c) the location of these displays. These will be recorded by the observation team.

Each step in the guideline will be taken in turn, and the crew will specify (a) what actions are required to complete the step, (b) which controls and displays are used, and (c) which member(s) of the crew has primary responsibility for those

actions. Each step in the Westinghouse ERGs contain an action with expected response and an instruction in case the expected response is not obtained. For the HGS CRDR walk-through, the crew will specify the above three items of information for both eventualities.

Where steps in the ERGs are high level, e.g., manually trip turbine, the observation team will make certain that the operating crew has specified all the HGS-specific steps necessary to complete that high-level procedure step.

3.3.2 Simulator Transients

While the mock-up walk-throughs will provide much information on the accessibility of controls and displays and during emergency operation, they cannot realistically simulate the dynamic nature of actual plant operation. For that purpose, a second validation step will consist of having HGS operational crews respond to several transients on the Sunrise plant simulator using the HGS-specific EOPs, when written. The Sunrise plant control room is very similar, although not identical, to the HGS control room. The two plants' dynamics are very similar. Currently, all HGS operators complete their requalification training on the Sunrise simulator.

The simulator validation will follow the procedures outlined in the Emergency Operating Procedures Validation Guidelines developed by the EOPIA Review Group (INPO 83-006). The checklists and simulator scenario forms contained in the

appendix of that document will require few, if any, modifications to be useful for the HGS EOP validation.

The purpose of running transients on the Sunrise simulator is to answer the following questions concerning emergency operation at HGS using the new emergency procedures:

- o Are there situations in which the operators cannot perform emergency control manipulations because of time constraints?

- o Do certain alarms and annunciators mislead or distract the operators?

- o Does the arrangement of the control room tend to cause members of the operating crew to get in each other's way?

- o Is information from computer systems used as an aid for emergency operation and, if so, is it in a readily usable form?

- o If time constraints are contained in the procedures, are the constraints reasonable for the control room as designed?

- o Can procedures, or points within procedures, be located easily when referenced?

CONTROL AND DISPLAY REQUIREMENTS

ERG NAME: REVISION NUMBER:

ERG TASK/STEP	REQUIREMENTS	CAPABILITY	USED WITH	OK

Task Analysis Worksheet

ERG Title:

Plant: HNP

REVISION NUMBER:

NO.	STEP NAME/ACTION	CONTROL(S) LOCATION	INDICATOR(S) LOCATION	FEEDBACK	BRANCH POINT	COMMENTS

APPENDIX B

EMERGENCY RESPONSE GUIDELINE ANALYZED

USING PROCEDURES

IN APPENDIX A

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
	NOTE *Foldout page should be open.*	
1	**Check RWST Level:**	
	a. RWST level – SLOWLY DECREASING	a. IF RAPIDLY decreasing, THEN go to step 9.
2	**Check Containment Sump Level:**	
	a. Containment sump level – INCREASING	a. IF NOT increasing, THEN rediagnose event, go to E-0, REACTOR TRIP OR SAFETY INJECTION, STEP 29.
	Caution *Alternate water sources for AFW pumps will be necessary if CST level is low.*	
3	**Check Steam Generator Levels:**	
	a. Narrow range level – GREATER THAN ___(1)___ %	a. IF less than ___(1)___ %, THEN maintain full AFW flow until narrow range level is greater than ___(1)___ %.
	b. Throttle AFW flow to maintain narrow range level at ___(2)___ %	b. IF narrow range level in one steam generator continues to increase, THEN go to E-3, STEAM GENERATOR TUBE RUPTURE.
4	**Check Pressurizer PORV Block Valves:**	
	a. Power available to block valves	a. Restore power to block valves.
	b. Block valves – OPEN	b. Open block valve unless it was closed to isolate a faulty PORV.

(1) Enter plant specific value showing level just in the narrow range including allowances for normal channel accuracy, post-accident transmitter errors and reference leg process errors.

(2) Enter plant specific value corresponding to no-load steam generator level including allowances for post-accident transmitter errors and reference leg process errors.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
5	**Check Pressurizer PORVs:**	
	a. PORVs – CLOSED	a. Manually close PORVs. <u>IF</u> any valve cannot be closed, <u>THEN</u> manually close its block valve.

Caution *If any pressurizer PORV opens because of high RCS pressure, repeat step 5 after pressure drops below PORV setpoint.*

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
6	**Check If SI Can Be Terminated:**	
	a. RCS pressure – GREATER THAN 2000 PSIG AND INCREASING	a. DO NOT TERMINATE SI. Go to step 8.
	b. Pressurizer level – GREATER THAN 50%	b. DO NOT TERMINATE SI. Go to step 8.
	c. RCS subcooling – GREATER THAN _(1)_ °F	c. DO NOT TERMINATE SI. Go to step 8.
	d. Secondary heat sink: 1) Total AFW flow to non-faulted steam generators – GREATER THAN _(2)_ GPM -OR- 2) Narrow range level in at least one non-faulted steam generator – GREATER THAN _(3)_ %	d. <u>IF</u> neither condition is satisfied, <u>THEN</u> DO NOT TERMINATE SI. Go to step 8.

(1) Enter sum of temperature and pressure measurement system errors translated into temperature using saturation tables.

(2) Enter plant specific value derived from background document.

(3) Enter plant specific value showing level just in the narrow range including allowances for normal accuracy, post-accident transmitter errors and reference leg process errors.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
7	**Terminate SI:**	
	a. Go to ES-1.1, SI TERMINATION FOLLOWING LOSS OF REACTOR COOLANT	
8	**Check If Low-Head SI Pumps Should Be Stopped:**	
	a. RCS pressure – GREATER THAN ___(1)___ PSIG AND STABLE OR INCREASING	a. IF RCS pressure low or decreasing, THEN go to step 9.
	b. Reset SI	
	c. Stop low-head SI pumps and place in standby	

Caution

- *If RCS pressure drops below ___(1)___ psig, the low-head SI pumps must be manually restarted to supply water to the RCS.*
- *Seal injection flow should be maintained to all RCPs.*

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
9	**Check If RCPs Should Be Stopped:**	
	a. SI running – CHECK FOR FLOW OR PUMP BREAKER INDICATOR LIGHTS LIT • Charging/SI –OR– • High-head SI	a. DO NOT STOP RCPs. Go to step 10.
	b. RCS pressure – EQUAL TO OR LESS THAN ___(2)___ PSIG	b. DO NOT STOP RCPs. Go to step 10.
	c. Stop all RCPs	
10	**Compare RCS And Steam Generator Pressures:**	
	a. RCS pressure – GREATER THAN OR EQUAL TO STEAM GENERATOR PRESSURES	a. IF RCS pressure less than steam generator pressures, THEN go to step 12.

(1) Enter plant specific shutoff head pressure of low-head SI pumps.
(2) Enter plant specific value derived from background document to E-O.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
11	**Decrease Steam Generator Pressure To** (1) **PSIG:**	
	a. Dump steam to condenser: 1) [Enter plant specific steps]	a. Dump steam with steam generator PORVs.
12	**Implement ES-1.2, POST LOCA COOLDOWN AND DEPRESSURIZATION**	
13	**Check For Switchover To Cold Leg Recirculation:**	
	a. RWST level – AT _(2)_	a. Until RWST reaches _(2)_, perform a preliminary evaluation of plant status in steps 14 to 17.
	b. Align SI system for cold leg recirculation per ES-1.3, TRANSFER TO COLD LEG RECIRCULATION FOLLOWING LOSS OF REACTOR COOLANT	
14	**Check Containment Spray System:**	
	a. Spray pumps – RUNNING	a. <u>IF</u> pumps not running, <u>THEN</u> go to step 15.
	b. Containment pressure – LESS THAN _(3)_ PSIA	b. <u>IF</u> pressure high, <u>THEN</u> maintain containment spray until containment pressure is reduced to normal range.
	c. Reset containment spray signal	
	d. Stop containment spray pumps and place in standby 1) [Enter plant specific steps]	

(1) Enter plant specific value corresponding to 200 psi below the lowest steam generator safety valve setpoint.
(2) Enter plant specific value corresponding to RWST switchover alarm in plant specific units.
(3) Enter plant specific value.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
	Caution *SI recirculation flow to RCS must be maintained at all times.*	
15	**Check Auxiliary Building Radiation:**	
	a. [Enter plant specific list] - NORMAL	a. Try to identify and isolate leakage.
16	**Evaluate Plant Equipment:**	
	a. [Enter plant specific list]	
17	**Obtain Samples:**	
	a. [Enter plant specific list]	
18	**Prepare For Switchover To Hot Leg Recirculation:**	
	a. Verify control room valve switches in the following position: 1) [Enter plant specific list of normally deenergized valves used for transfer to hot leg recirculation with their correct position during cold leg recirculation]	a. Set valve switches to proper position.
	b. Verify circuit breakers for the following valves are energized. 1) [Enter plant specific list of valves used for transfer to hot leg recirculation]	b. Energize circuit breakers, as required.

STEP	ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
19	At (1) Hours After Event Initiation, Align SI System For Hot Leg Recirculation Per ES-1.4, TRANSFER TO HOT LEG RECIRCULATION.	
20	Plant Staff Should Determine If Reactor Vessel Head Should Be Vented.	
21	Evaluate Long Term Plant Status.	

— END —

(1) Enter plant specific time.

APPENDIX C

TASK ANALYSIS OUTPUT

USING PROCEDURES

IN APPENDIX A

CONTROL AND DISPLAY REQUIREMENTS

ERG NAME: E1 LOCA REVISION NUMBER: 0

ERG TASK/STEP	REQUIREMENTS	CAPABILITY	USED WITH	OK
1. Check RWST Level Slowly Decreasing	RWST Level	Slowly Decreasing Trend	N/A	
2. Check CTMT Sump Level Increasing	Containment Sump Level	Increasing Trend	N/A	
3. Check SG NR Levels	STM Generator NR Level	>60%	N/A	
Throttle AFW Flow to Maintain SG NR Level	AFW Flow Control	Throttle	SG NR Level Indicators	
4. Check PRZR PORV Block Valve Power	Voltage	120 Volts AC	N/A	
PORV Block Valves Open	PRZR PORV Block Valve Position	Open/Closed	PRZR PORV Block Valve Controls	
5. Check PRZR PORVs closed	PRZR PORV Position	Open/Closed	PRZR PORV Control	
6. Check RCS Pressure >2000 psig & Increasing	RCS Pressure	>2000 psig Increasing Trend	N/A	
Check PRZR Level >50%	PRZR Level	>50%	N/A	
Check RCS Subcooling Margin >50° F	RCS Subcooling	>50° F	RCS Pressure RCS Temp.	
Total AFW Flow to Non-Faulted SGs > 300 gpm	Total AFW Flow	>300 gpm	AFW Flow Control	
NR Level in One Non-Faulted SG > 60%	STM Generator NR Level	>60%	N/A	

CONTROL AND DISPLAY REQUIREMENTS

ERG NAME: E1 LOCA   REVISION NUMBER: 0

ERG TASK/STEP	REQUIREMENTS	CAPABILITY	USED WITH	OK
7. Terminate SI	Procedure	ES-1.1 SI Termination Following LOCA	N/A	
8. Check RCS Pressure > 2000 psig & Stable or Incr.	RCS Pressure	> 2000 psig Stable or Increasing Trend	N/A	
Reset SI Signal	SI Reset Control	Reset	SI Initiation Display	
Reset ED/G Sequencers	D/G Load Sequencer	Reset	Load Sequence Actuation Indication	
Stop Low Head SI Pumps & Place in Standby	Low Head SI Pump Controls	On/Off/Standby	SI Pump Status Indicator SI Pump Motor Current	
9. Check SI Running	Charging Pump or Hi-Head SI Pump Status/Current SI Flow	On/Off On/Off Any Amps Any Flow	RC Pump Controls	
Check RCS Pressure ≤ 1500 psig	RCS Pressure	< 1500 psig	RC Pump Controls	
Stop All RC Pumps	RC Pump Controls	On/Off	RC Pump Status RC Pump Motor Current RC Flow	
10. Check RCS Pressure ≥ SG Pressures	RCS Pressure SG Pressures	RCS ≥SGs	N/A	
11. Use STM Dumps to Reduce SG Pressure to 975 psig	Condenser STM Dump Valve Controls or SG PORV Controls	Throttle Setpoint Adjustment	SG Pressure Dump Valve Position PORV Position PORV Setpoint Condenser Vacuum	

CONTROL AND DISPLAY REQUIREMENTS

ERG NAME: E1 LOCA REVISION NUMBER: 0

ERG TASK/STEP	REQUIREMENTS	CAPABILITY	USED WITH	OK
12. Implement Post-LOCA Cooldown	Procedure	ES 1.2 Post LOCA Cooldown Depressurization		
13. Check RWST Level $\geq$ 12,000 Gal	RWST Level	$\geq$ 12,000 Gal	N/A	
Align SI for Cold Leg Recirculation	Procedure	ES 1.3 Xfer to cold Leg Recirc. Following LOCA		
14. Check CTMT Spray Pumps Running	CTMT Spray Pump Status Motor Current Flow	On/Off/Standby Any Amps Any GPM	CTMT Spray Pump Controls Aux Bldg RAD Monitors	
Check CTMT Pressure < 9.5 psia	CTMT Pressures	9.5 psia	CTMT Spray Controls	
Reset CTMT Spray Signal	CTMT Spray Initiation Control	Reset	CTMT Spray Initiation Sta us	
Stop CTMT Spray Pumps & Place in Standby	CTMT Spray Pump Controls	On/Off/Standby	CTMT Spray Pump Status Motor Current Flow	
15. Check Aux Bldg Radiation $<10^{-5}$ $\mu C/cm^3$	Aux Bldg Radiation	10^{-5} $\mu C/cm^3$	N/A	
16. Evaluate Plant Equipment	Eqpt List	Eqpt Dependent	Eqpt Dependent	
17. Obtain Samples	Sample List	Communication w/Chem.Dept.	N/A	
18. Verify Hot Leg Recirc Valves are in Correct Position for Cold Leg. Recirc.	Valve Lineup List with Valve Status Indication	Depends on Valve	Valve Controls	

CONTROL AND DISPLAY REQUIREMENTS

ERG NAME: E1 LOCA REVISION NUMBER: 0

ERG TASK/STEP	REQUIREMENTS	CAPABILITY	USED WITH	OK
Energize Circuit Breakers for Hot Leg Recirc Valves	Circuit Breaker Controls	Close/Open	Voltage Indication	
19. Align SI for Hot Leg Recirculation	Procedure	ES 1.4 Xfer to Hot Leg Recirculation	N/A	
20. Determine if Vessel Head Must be Vented	Procedure	Function Restoration Procedure for Low Inventory	N/A	

Task Analysis Worksheet

ERG Title: LOCA

Plant: HNP

REVISION NUMBER: 0

NO.	STEP NAME/ACTION	CONTROL(S)/ LOCATION	INDICATOR(S)/ LOCATION	FEEDBACK	BRANCH POINT	COMMENTS
1	Check RWST level is slowly decreasing	N/A	LR 13-9 LR 13-10 LI 13-6 (PANEL 9-2)	Trace on recorders shows level slowly decreasing	If rapidly decreasing, go to Step 9.	How slowly is slowly?
2	Check containment sump level is increasing	N/A	LR 5-4 LI 5-2 Lights above HS-512 (PANEL 9-1)	Meter and recorder show level increasing or sump pump "on" continuously	If not inc., then go back to E0.	What if sump pump is cycling on & off?
3a	Check STM Gen levels ≥ 60% narrow range	N/A	LI 7-1 LI 7-2 LI 7-3 LI 7-4 (PANEL 9-4)	All levels ≥ 60%		
3b	If 3a is satisfied, throttle AFW flow to maintain NR level at 60%	HAS 7-8 HAS 7-9 HAS 7-10 HAS 7-11 (PANEL 9-4)	LI 7-1 LI 7-2 LI 7-3 LI 7-4 (PANEL 9-4)	Levels being maintained at 60% NR	If one or more levels continue to increase--go to E-3	Can AFW be throttled while reading NR level indicators?

Task Analysis Worksheet

ERG Title: LOCA

REVISION NUMBER: 0

Plant: HNP

NO.	STEP NAME/ACTION	CONTROL(S)/ LOCATION	INDICATOR(S)/ LOCATION	FEEDBACK	BRANCH POINT	COMMENTS
4a	Check power available to PRZR PORV block valves	HS-33A HS-33B HS-33C (PANEL 9-4)	Lights above HS-33A HS-33B (9-4) HS-33C VI-33A VI-33B (9-9) VI-33C	Lights show red-breakers closed Voltage available on PORV block valve BUS		
4b	Verify PRZR PORV block valves open	HS 33-1 HS-33-2 HS-33-3 (PANEL 9-4)	Lights above valve controls (PANEL 9-4)	Lights show red, indicating block valves open		Do not open block valve if it is closed to isolate a faulty PORV
5	Verify PRZR PORVs closed	HS-33-8 HS-33-9 HS 33-10 (PANEL 9-4)	Lights above PORV controls (PANEL 9-4)	Lights show green, indicating PORVs closed		If any PORV cannot be closed, manually close its block valve
6a	Check if RCS pressure > 2000 psig and increasing	N/A	PR 10-2 (PANEL 9-3)	Present value is > 2000 & trace shows positive slope	If not, do not terminate SI. Go to Step 8.	

Task Analysis Worksheet

ERG Title: LOCA

Plant: HNP

REVISION NUMBER: 0

NO.	STEP NAME/ACTION	CONTROL(S)/ LOCATION	INDICATOR(S)/ LOCATION	FEEDBACK	BRANCH POINT	COMMENTS
6b	Check if PRZR level > 50%	N/A	LI 10-3 LI 10-4 (PANEL 9-3)	Present level shows > 50%	If not, do not terminate SI. Go to Step 8.	If instruments disagree, use LI 10-3.
6c	Check RCS subcooling > 50° F	N/A	XI 10-7 (PANEL 9-3)	Digital value of subcooling > 50°	If not, do not terminate SI. Go to Step 8.	If subcooling indicator unavailable, use RCS pressure & hot leg temp
6d (1)	Verify total AFW flow to non-faulted SGs > 300 gpm OR	N/A	FI 7-8 FI 7-9 FI 7-10 FI 7-11 (PANEL 9-4)	Sum of flows is > 300 gpm	See 6d (2)	Requires mental arithmetic by operator
6d (2)	NR level in at least one non-faulted SG > 60%	N/A	LI 7-1 LI 7-2 LI 7-3 LI 7-4 (PANEL 9-4)		If neither 6d(1) nor 6d(2) is satisfied, do not terminate SI. Go to Step 8.	

Task Analysis Worksheet

ERG Title: LOCA

Plant: HNP

REVISION NUMBER: 0

NO.	STEP NAME/ACTION	CONTROL(S)/ LOCATION	INDICATOR(S)/ LOCATION	FEEDBACK	BRANCH POINT	COMMENTS
7	Terminate SI	N/A	N/A		Go to ES 1.1 SI TERMINATION FOLLOWING LOCA	
8a	Check RCS Pressure > 2000 psig and stable or increasing	N/A	PR 10-2 (PANEL 9-3)	Present value is > 2000 & trace is level or shows positive slope	If not, then skip to Step 9.	If recorder is unavailable, then use WR PI 16-6 and PI 10-7.
8b	Reset SI	HS 22-1 HS 22-2 (PANEL 9-2)	Annunciator 4B on panel 9-2 and ECCS status panel	"Auto SI Blocked" annunciator lit and "SI initiate" off on status panel		
8b cont		HS 41-3 (PANEL 9-6)	ECCS Status Panel	"D/G Load Step Reset" and "D/G Load Seq Actuate" Lights go off		

Task Analysis Worksheet

ERG Title: LOCA

Plant: HNP

REVISION NUMBER: 0

NO.	STEP NAME/ACTION	CONTROL(S)/ LOCATION	INDICATOR(S)/ LOCATION	FEEDBACK	BRANCH POINT	COMMENTS
8c	Stop low-head SI pumps and place in standby	HS 22-6 HS 22-7 (PANEL 9-2)	Lights above HS 22-6 & 22-7 XI 22-6 XI 22-7 (PANEL 9-2)	Lights go from red to green. Amp Meters Read Ø Amps.		
9a	Check if SI running	N/A	Lights above HS 22-8 22-9 22-10 XI 22-8 XI 22-9 XI 22-10 (PANEL 9-2)	Any lights red or amp meters show > Ø amps	Do not stop RCP's if SI is running. Go to Step 10.	
9b	Check if RCS pressure < 1500 psig	N/A	PR 10-2 PR 10-4 PR 10-5 (PANEL 9-3)	Pressure is < 1500 psig	If pressure > 1500, do not stop RCPs. Go to Step 10.	2/3 instruments must show < 1500 psig to stop RCPs.

Task Analysis Worksheet

ERG Title: LOCA

REVISION NUMBER: 0

Plant: HNP

NO.	STEP NAME/ACTION	CONTROL(S)/ LOCATION	INDICATOR(S)/ LOCATION	FEEDBACK	BRANCH POINT	COMMENTS
9c	Stop All RCPs	HS 6-2 HS 6-3 HS 6-4 HS 6-5 (PANEL 9-3)	Lights above HS 6-2 6-3 6-4 6-5 XI 6-2 6-3 6-4 6-5 (PANEL 9-3)	Lights go from red to green Amp meters read Ø amps		
10	Check RCS Pressure > Steam Gen. Pressures	N/A	PR 10-2 PI 10-4, 10-5 (PANEL 9-3) PI 7-1, 7-2, 7-3, 7-4 (PANEL 9-4)	RCS pressure ≥ all SG pressures	If RCS pressure < SG. pressures Go to Step 12.	How many SGs does RCS press have to be less than before skip to step 12?
11	Decrease SG pressures to 975 psig using cond. dumps	HAC 7-2 HAC 7-3 HAC 7-4 HAC 7-5 HAC 7-1 (PANEL 9-4)	PI 7-1, 7-2, 7-3, 7-4 Valve position indicators on HAC 7-2, 7-3, 7-4, 7-5 (PANEL 9-4)	Main steam isolation bypass valves open, Stm dump opens, steam flows to cond. SG pres. goes to 975 psig		If condenser is unavailable, then use SG Porus.

Task Analysis Worksheet

ERG Title: LOCA

Plant: HNP

REVISION NUMBER: 0

NO.	STEP NAME/ACTION	CONTROL(S)/ LOCATION	INDICATOR(S)/ LOCATION	FEEDBACK	BRANCH POINT	COMMENTS
11	Decrease SG pressures to 975 psig using SG PORVS	HC 7-12 HC 7-13 HC 7-14 HC 7-15 (PANEL 9-4)	Valve Position Indicators on HC 7-12, 7-13, 7-14, 7-15 PI 7-1, 7-2, 7-3, 7-4 (PANEL 9-4)	PORVS open SG pressures decrease to 975 psig		
12	Cooldown & Depressurize	N/A	N/A		Go to ES 1.2 Post-LOCA Cooldown & Depressuri-zation	Should ES 1.2 be completed before going to the next step?
13a	Check RWST Level = 12,000 Gallons.	N/A	LR 13-9 LR 13-10 LR 13-6 (PANEL 9-2)	Current level shows RWST at or slightly below 12,000 gallons.	Until RWST reaches 12,000 gal., do steps 14 thru 17.	How is operator cued back to 13b after Step 17.
13b	Align SI for cold leg recirculation	N/A	N/A		Go to ES 1.3 TRANSFER TO COLD LEG RECIRCULATION FOLLOWING LOCA	

Task Analysis Worksheet

ERG Title: LOCA

Plant: HNP

REVISION NUMBER: 0

NO.	STEP NAME/ACTION	CONTROL(S)/ LOCATION	INDICATOR(S)/ LOCATION	FEEDBACK	BRANCH POINT	COMMENTS
14a	Check containment spray pumps running	N/A	Lights above HS 16-1, 16-2 XI 16-1, 16-2 (PANEL 9-1)	Lights above HS 16-1 & 16-2 are red Current meters XI 16-1 & 16-2 show Amps	If pumps not running, go to step 15.	Do both pumps have to be off before skip to step 15.
14b	Check containment pressure < 9.5 psia	N/A	PI 16-22 PI 16-23 PR 16-15 (PANEL 9-1)	Current value < 9.5 psia	If CTMT pressure ≥ 9.5 psia, then go to step 15.	
14c	Reset containment spray system	XS 16-12 (PANEL 9-1)	Annunciator 1D on PANEL 9-1	"Containment Spray Activated" Annunicator is off.		
14d	Stop Containment spray pumps and place in standby	HS 16-1 HS 16-2 (PANEL 9-1)	Lights above HS 16-1, 16-2 XI 16-1, 16-2 (PANEL 9-1)	Lights above HS 16-1, 16-2 go from red to green Current meters show Ø Amps.		

Task Analysis Worksheet

ERG Title: LOCA

Plant: HNP

REVISION NUMBER: 0

NO.	STEP NAME/ACTION	CONTROL(S)/ LOCATION	INDICATOR(S)/ LOCATION	FEEDBACK	BRANCH POINT	COMMENTS
15	Check auxiliary building radiation $< 10^{-5}\ \mu C/cm^3$	N/A	ARM 41-2 ARM BACK PANEL	Current airborne activity $< 10^{-5}\ \mu C/cm^3$		No control room action other than notification if radiation is above normal.
16	Evaluate plant equipment	Depends on Eqpt	Depends on Eqpt		Use plant Eqpt Checklist	
17	Obtain samples	N/A	N/A	Radiation levels in samples	Use plant-specific sample list	Requires communication with Chemistry Dept.
18a	Verify hot leg recirc valves are in correct cold leg recirc position.	HS 22-17 HS 22-18 HS 22-19 HS 22-31 HS 22-33 (PANEL 9-2)	Lights above controls listed. (PANEL 9-2)	Control / Light 22-17 Red 22-18 Red 22-19 Green 22-31 Green 22-33 Green		

Task Analysis Worksheet

ERG Title: LOCA

Plant: HNP

REVISION NUMBER: 0

NO.	STEP NAME/ACTION	CONTROL(S)/ LOCATION	INDICATOR(S)/ LOCATION	FEEDBACK	BRANCH POINT	COMMENTS
18b	Verify circuit breakers for above valves energized	HS 44-P1 HS 44-P2 HS 44-P3 (PANEL 9-9)	Lights above HS 44-P1, P2, P3. VI 44-1, 44-2 (PANEL 9-9)	Lights go from green to red Voltage shows 480V		
19	Align SI system for hot leg recirculation	N/A	N/A		Go to ES 1.4 TRANSFER TO HOT LEG RECIRCULATION	
20	Determine if vessel head should be vented	N/A	N/A		Go to FR procedures for low inventory	

APPENDIX D

NUREG-0700, SECTION 6

ITEMS TO BE ADDRESSED

DURING THE CRDR TASK ANALYSIS

NUREG-0700 ITEM NUMBER	DESCRIPTION
6.1.1.1.A	Presence of Required Instrumentation
6.1.1.1.B	Arrangement of Instrumentation
6.1.1.2.A	Adequacy of Control Room Manning
6.1.1.2.B	Utilization of Additional Personnel
6.1.1.3.C.1	Operator Access to Workstations
6.1.1.3.C.2	Operator Positioning at Workstations
6.1.1.3.D.2	Interference Between Operators
6.1.2.2.E.2	Horizontal Displacement of Displays
6.1.2.2.F	Lateral Spread of Controls and Displays
6.1.2.3.F.1 6.1.2.3.F.2	Lateral Spread of Controls and Displays on Sit-down Consoles
6.1.2.5.A.2	Control Height for Precise/Frequent Adjustment
6.1.2.5.B.2	Display Height for Precise/Frequent Reading
6.1.3.1.A	Equipment Arrangement
6.1.3.1.B	Location of Senior Operator Station
6.1.3.1.C	Sharing Personnel Between Units
6.1.5.5.C	Reductions in Background Noise
6.3.1.2.A.2	Annunciator Set Point Selection
6.3.1.3.D	Criteria for First-Out Annunciators
6.4.1.1.A.1	Adequacy of Controls
6.4.1.2.F	Sequential Control Positions
6.4.2.2.D.1	Visually Identifiable Shape Coding
6.4.2.2.D.2	Tactually Identifiable Shape Coding
6.5.1.1.A	Task Analysis
6.5.1.1.B	Completeness of Available Information
6.5.1.2.A	Display Scale Selection
6.5.1.2.B	Elimination of Operator Conversion
6.5.1.2.D.1	Span of Display Scale Range
6.5.1.2.D.2	Appropriateness of Scale Ranges
6.5.1.2.D.3	Auxiliary Wide-Range Instruments
6.6.3.3.C	Consistency of Labels With Procedures
6.8.1.1.A	Control/Display Grouping by Sequence of Use

6.8.1.1.B	Control/Display Grouping by System Function
6.8.1.1.C	Control/Display Grouping by Importance and Frequency of Use
6.8.1.2	Effective Panel Layout
6.8.2.1.A.1	Display Grouping by Sequence of Use
6.8.2.1.A.2	Control Arrangement by Sequence of Use
6.8.2.1.C.1	Control/Display Grouping by Functional Outcome
6.8.3.1.C	Simultaneous Actuation of Controls
6.9.1.1.A	Proximity of Related Controls and Displays
6.9.1.2.A.5	Normal Order of Control Arrangement
6.9.1.2.B.5	Normal Order of Display Arrangement
6.9.2.1.B.1	Left-to-Right Sequence of Use
6.9.2.1.B.2	Top-to-Bottom Sequence of Use
6.9.2.1.B.3	Combined Ordering for Sequence of Use
6.9.3.2.A	Precision of Control Movement
6.9.3.2.B	Display Resolution

QUESTIONNAIRE

GENERAL

This questionnaire will assist in collecting additional and practical information on the applicability and use of the CRDR task analysis guideline. Its value can only be judged by you, the user. Please take a few minutes and comment on the four questions.

QUESTIONS

1. Was this guideline useful? If not, why not?

____

2. How did you use this guideline (e.g., in total, as background, selected portions)?

____

3. What would you recommend to improve this guideline?

____

4. What other sources (if any) did you use to develop your approach? (Please include name and telephone number of a contact person.)

____

____

____

____

____

COMPLETED QUESTIONNAIRE

This guideline was developed by industry representatives and should not be considered an INPO document, although INPO supplied the publication and other staff support. Please forward your comments and questionnaire to the address below:

CRDR NUTAC
Communications Division
Institute of Nuclear Power Operations
Suite 1500
Circle 75 Parkway
Atlanta, GA 30339

QUESTIONNAIRE

GENERAL

This questionnaire will assist in collecting additional and practical information on the applicability and use of the CRDR task analysis guideline. Its value can only be judged by you, the user. Please take a few minutes and comment on the four questions.

QUESTIONS

1. Was this guideline useful? If not, why not?

____

____

____

____

____

2. How did you use this guideline (e.g., in total, as background, selected portions)?

____

____

____

____

____

3. What would you recommend to improve this guideline?

____

____

____

____

____

4. What other sources (if any) did you use to develop your approach? (Please include name and telephone number of a contact person.)

____

____

____

____

____

COMPLETED QUESTIONNAIRE

This guideline was developed by industry representatives and should not be considered an INPO document, although INPO supplied the publication and other staff support. Please forward your comments and questionnaire to the address below:

CRDR NUTAC
Communications Division
Institute of Nuclear Power Operations
Suite 1500
Circle 75 Parkway
Atlanta, GA 30339

QUESTIONNAIRE

GENERAL

This questionnaire will assist in collecting additional and practical information on the applicability and use of the CRDR task analysis guideline. Its value can only be judged by you, the user. Please take a few minutes and comment on the four questions.

QUESTIONS

1. Was this guideline useful? If not, why not?

   ____
   ____
   ____
   ____
   ____

2. How did you use this guideline (e.g., in total, as background, selected portions)?

   ____
   ____
   ____
   ____
   ____

3. What would you recommend to improve this guideline?

   ____
   ____
   ____
   ____
   ____

4. What other sources (if any) did you use to develop your approach? (Please include name and telephone number of a contact person.)

____

____

____

____

____

COMPLETED QUESTIONNAIRE

This guideline was developed by industry representatives and should not be considered an INPO document, although INPO supplied the publication and other staff support. Please forward your comments and questionnaire to the address below:

CRDR NUTAC
Communications Division
Institute of Nuclear Power Operations
Suite 1500
Circle 75 Parkway
Atlanta, GA 30339

Printed in U.S.A.

INPO
Institute of
Nuclear Power
Operations

1100 Circle 75 Parkway
Suite 1500
Atlanta, Georgia 30339
Telephone 404 953-3600