Nuclear
Utility
Task
Action
Committee

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Control Room Design Review Survey Development Guideline

November 1983

INPO 83-042 (NUTAC)

CONTROL ROOM DESIGN REVIEW
SURVEY DEVELOPMENT GUIDELINE

Developed by

Nuclear Utility Task Action Committee

for

Control Room Design Review

November 1983

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 its development:

Alabama Power Company
Arizona Public Service Company
Baltimore Gas and Electric Company
Boston Edison Company
Carolina Power & Light Company
Cincinnati Gas & Electric Company
Commonwealth Edison Company
Consumers Power Company
Duke Power Company
Duquesne Light Company
Florida Power & Light Company
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GPU Nuclear Corporation
Iowa Electric Light and Power Company
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Southern Company Services
Tennessee Valley Authority
Texas Utilities Generating Company
Virginia Electric and Power Company
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Yankee Atomic Electric Company

FOREWORD

This Control Room Design Review (CRDR) Survey Development Guideline was developed by the CRDR Nuclear Utility Task Action Committee (NUTAC) to assist individual utilities in developing materials to be used in performing the survey portion of the CRDR.

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 individual utilities could use assistance in the implementation of CRDRs. In addition to this document, the following documents have been published or are in advanced stages of development:

- Control Room Design Review Implementation Guideline, INPO 83-026 (NUTAC)
- Control Room Design Review Task Analysis Guideline (draft)
- Human Engineering Principles For Control Room Design Review, INPO 83-036 (NUTAC)

CHARTER
NUCLEAR UTILITY TASK ACTION COMMITTEE
ON
CONTROL ROOM DESIGN REVIEW

The Nuclear Utility Task Action Committee (NUTAC) on control room design review (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:

- o a CRDR methodology and implementation guideline
- o a guideline on the development of CRDR survey checklists
- o a CRDR task analysis guideline
- o 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 perspectives on CRDR integration issues.

SUMMARY

This Control Room Design Review (CRDR) Survey Development Guideline has been developed by the CRDR Nuclear Utility Task Action Committee (NUTAC) to assist individual utilities in developing their CRDR program plans in response to NUREG-0737, Supplement 1. The Survey Development Guideline was written in response to a utility industry request for assistance in the area of human factors, in general, and the CRDR, in particular. The Survey Development Guideline, as its name implies, is offered as guidance only. There is no obligation for any nuclear utility to follow the guidance or to use the surveys, checklists, or questionnaires in this guideline.

The Survey Development Guideline is divided into three complementary pieces. The introductory portion of the document describes the purpose and scope, defines the major terms used in the guideline, and describes briefly the methodology used, which is basically one of screening an existing set of items to find acceptable survey items.

The second portion contains an example set of the surveys, checklists, and questionnaires developed using this methodology. The purpose of this section is to illustrate the products produced by using the methodology and to assist member utilities by providing CRDR surveys, checklists, and questionnaires that can serve as examples around which each utility may develop instruments specifically tailored to their own control room survey. This is Appendix A to the document.

The third portion of the document is a set of appendixes containing items not included among the control room survey items. A rationale is provided for exclusion of each of the items from incorporation in the materials listed in Appendix A. This section illustrates the criteria for exclusion of items from

survey instruments. These exclusions are covered in Appendixes B through H. Cross-references among items for control room design review from NUREG-0700, Section 6, from Appendix A, Control Room Design Review Survey Development Guideline, and from the Human Engineering Principles for Control Room Design Review are contained in Appendixes I, J, and K.

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1. INTRODUCTION

1.1 PURPOSE AND SCOPE

This guideline outlines a method for generating checklists, surveys, and questionnaires to be used in the control room design review (CRDR) human factors survey. NUREG-0700, "Guidelines for Control Room Design Review," contains an entire section (Section 6) of items meant to be used during the survey portion of the CRDR. While presented in checklist format, many of these items are not applicable during a survey and can be addressed more appropriately using interviews, questionnaires, or during other CRDR activities. Recognizing this fact, the developers of NUREG-0700 advise users that ". . . guidelines (items) that cannot be applied or cannot be completely assessed from the component perspective should be flagged for attention during the next processes" [3.6.4]. Survey results should show ". . . which guidelines (items) have been applied. . ." and ". . . the disposition of each guideline (item)" [3.6.4].

Since some NUREG-0700, Section 6 items are not amenable to checklist evaluation, and sources of human factors criteria other than NUREG-0700 exist, each utility will probably develop its own checklist for the control room survey using items from NUREG-0700, Section 6, and other human factors references. The development of survey materials by an individual utility can be assisted by reviewing the methodology presented in this guideline. This methodology amounts to screening any existing set of human factors design items according to criteria related to their measurability and objectiveness. Items that can be assessed objectively are retained in checklist form. Those found to be highly subjective or not easily measured are addressed elsewhere in the CRDR.

1.2 DOCUMENT ORGANIZATION

This document, Control Room Design Review Survey Development Guideline, is presented in three sections and eleven appendixes.

1.2.1 Section 1 - Introduction

The introduction explains the purpose, scope, organization, and use of this document.

1.2.2 Section 2 - Definitions

This section provides definitions of the terms associated with the control room survey as those terms are used in this document.

1.2.3 Section 3 - Survey Development Method

This section describes the methodology to be used when screening items for inclusion in a control room survey checklist. Each element of the methodology is associated with at least one appendix that delineates those specific NUREG-0700, Section 6 items to which the screening criterion applies.

1.2.4 Appendixes

Appendix A contains examples of surveys, checklists, and questionnaires developed according to this guideline. Other appendixes contain CRDR items that have been reformulated so they are more objective or items that are addressed elsewhere in CRDR.

1.3 RECOMMENDED USE OF THIS DOCUMENT

This document describes a method that can be used to assess the appropriateness of any existing set of CRDR survey items. The appendixes constitute an example of the application of this method to the items in NUREG-0700, Section 6. As such, the example items can be used or they can be modified as appropriate.

2. DEFINITIONS

Control Room Design Review (CRDR) - A post-TMI task listed in NUREG-0660, "Task Action Plan Developed as a Result of the TMI-2 Accident," and NUREG-0737, "The Staff Supplement to NUREG-0660," as Task I.D.1.

Control Room Survey - One of the activities that constitutes a CRDR. The control room survey is a static verification of the control room performed by comparing the existing control room instrumentation and layout with selected human engineering design criteria, i.e., checking the control room match to the human operator.

Elements of a Utility CRDR Implementation Process - Necessary parts of a cohesive CRDR implementation process that a utility should consider in developing and reviewing their implementation plan and schedule.

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

Emergency Procedures Guidelines (EPGs) - Guidelines developed from system analysis of transients and accidents that provide sound technical bases for plant-specific EOPs.

Emergency Response Guidelines (ERGs) - Same as EPGs. The guidelines developed by Westinghouse Owners Group (WOG) are called ERGs.

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

Nuclear Utility Task Action Committee (NUTAC) for CRDR - Representatives from various nuclear utilities and INPO organized to define areas of CRDR implementation for which an overall industry effort can provide assistance to individual utilities in completing Task I.D.1, NUREG-0737.

Operational Experience Review - One of the activities that constitutes a CRDR. The operating experience review screens plant operating documents and operator experience to discover human engineering shortcomings that have caused actual operating problems in the past.

Review Team - A group of individuals responsible for directing the CRDR of a specific control room (see Survey Team).

Safety Parameter Display Systems (SPDS) - An aid to the control room operating crew for use in monitoring the status of critical safety functions (CSFs) that constitute the basis for plant-specific, symptom-oriented EOPs.

Survey Team - A group of individuals responsible for conducting the control room survey. The survey team may or may not include individuals from the review team (see Review Team).

Task Analysis - The systematic process of identifying and examining tasks in order to identify conditions, standards, 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 addition, in the CRDR context, verification implies a static check of instrumentation against human engineering criteria.

3. SURVEY DEVELOPMENT METHOD

The development method described in this document is basically one of screening an existing set of items to find appropriate survey items. From a set of candidate survey items, certain items are selected for inclusion in a control room survey checklist according to criteria described below. Some items are reformulated to be more objectively measurable. Still other items are augmented with more stringent criteria where this will result in a technically better control room survey.

3.1 ASSUMPTIONS

Certain assumptions have been made during the writing of this survey development guideline. In order for readers to assess this guideline in light of their specific utility's CRDR philosophy, the assumptions used in writing this document are described below.

3.1.1 Definition Of Control Room Survey

Although the control room survey is defined in Section 2 of this document, a more detailed description of the survey will be helpful when applying this document. The control room survey envisioned here is a static, objective check of physical control room characteristics against measurable criteria. Other activities conducted as part of the overall CRDR can be used to gather subjective information concerning control room design adequacy and operational characteristics.

The outcome of the control room survey is a list of human engineering discrepancies (HEDs) that will be assessed later in the CRDR process. Therefore, all retained survey items are either measurements to be recorded for later use (e.g, sound level survey) or Yes/No decisions, based on objectively measurable criteria (e.g., certain control board components are or are not above a given height).

Any item from the candidate pool of items that requires a judgment is not included in a checklist but is addressed elsewhere in the CRDR, such as during operator interviews.

3.1.2 Survey Team Composition

By limiting the control room survey to measurable phenomena, as in Section 3.1.1, an assumption regarding the makeup of the individuals conducting the survey is possible. It has been assumed that one or more individuals should be able to conduct the survey with items developed using the methodology presented in this document. If timely completion of the survey is important, a team of three to six individuals can be used. The individuals on the survey team are not required to have either plant operational experience or the level of qualifications required of the overall CRDR team. This is not to say that more experienced individuals cannot be used on the survey team, only that less experienced people can conduct an adequate survey, given proper items.

Another assumption made regarding the composition of the survey team is that the team will have an operator available to them on an as-needed basis. This is an important consideration since certain aspects of the survey require knowledge of the operation of specific control board components. This does not violate the "no subjective opinion" rule laid down in the survey definition since the operator will not be asked to give an opinion but simply to explain the operation of specific switches and controllers.

3.1.3 Pool Of Candidate Items

The list of candidate items used to demonstrate the survey development methodology for this document is Section 6 of NUREG-0700. Section 6 is treated as a list of potential survey items instead of a finished checklist. Several other sources of potential items could have been used such as MIL-STD-1472C; McCormick and Sanders, 1982; VanCott and Kinkade, 1972. However, most utility people involved with the CRDR are familiar with NUREG-0700 and, in particular, with Section 6. Also, the items

in NUREG-0700 have been gathered from many reference documents and represent a broad spectrum of typical design items.

3.2 SCREENING CRITERIA

The following criteria have been applied to the control room survey items found in NUREG-0700. Each criterion is explained in some detail, and the disposition of NUREG-0700 items not meeting the criterion is described.

3.2.1 Non-Measurable Items

Any items adopted for use in a CRDR survey must be quantifiable and measurable. It is easy to postulate items with which most people would agree but that are, in fact, not easily or objectively measurable. For example, few would argue with the statement that "the control room arrangement should minimize interference between the members of the operational crew." However, without further guidance, such an item is not measurable and, therefore, is not useful as a survey item. This principle can be addressed through operator interviews and walk-through/talk-throughs.

Certain checklist items within NUREG-0700, Section 6, are definitions rather than evaluation criteria. Others advocate principles that may be considered desirable but that are either unobservable or unquantifiable within the methodology of the survey. Still other items equivocate on their applicability. It is recommended that such items, presented in Appendix B, be excluded from the survey and, where possible, addressed during other CRDR activities.

3.2.2 Redesign Versus Review Items

The vast majority of control rooms that will be reviewed are already designed, fabricated, and installed. Under these conditions, the thrust of the CRDR is to assess whether or not the

existing control room characteristics are functionally adequate for emergency plant operation.

While the CRDR has been described as a review, a few items in NUREG-0700, Section 6, such as the concept of a "green board" color-coding scheme, constitute a major redesign. Such items in reality suggest a "preferred design" and do not refer to any given human factors principles. Instead of advocating particular designs, a control room review should analyze the existing design to determine its functional adequacy. Such analysis will be done in other portions of the CRDR. Therefore, it is recommended that these items listed in Appendix C not be included as survey items.

A similar group of items implying redesign rather than enhancement are component design specifications taken from MIL-STD-1472B and McCormick (1976). These items are listed in Appendix D. The intent of such specifications is to make components usable and, as such, are applicable in the design process. For a design review, however, the emphasis should be placed on usability of the existing controls. Simply measuring every control to determine whether or not it conforms to Mil-Spec design standards will not define functionality. NUREG-0700 requires measurements to be made ". . . when there is a reasonable doubt about conformance to a guideline (item) criterion." Therefore, it is recommended that the items listed in Appendix D be excluded from the survey and addressed only if other CRDR activities indicate the corresponding functional criteria are not being met.

3.2.3 Uncharacteristic Items

Items retained in a control room survey should discriminate between good human engineering characteristics and poor human engineering characteristics. Including items that either everyone complies with or that describe equipment that does not exist in most control rooms would be a poor use of resources.

A small number of items from NUREG-0700, Section 6 should be excluded from a working survey because violation is highly improbable or because they are not characteristic of the equipment and design of present-day control rooms. These items, listed in Appendix E, should be excluded to limit the survey to useful items.

3.2.4 Items That Might Degrade Performance

The basic assumption of the CRDR is that operator performance will be improved if the control room design complies with the CRDR survey items. While most of the NUREG-0700 items meet this assumption, several will tend to degrade performance in a nuclear power plant control room setting.

The NUREG-0700, Section 6 items listed in Appendix F should be excluded from incorporation in a working survey since they will tend to degrade rather than improve operator performance. The reason for excluding each item is listed with the item.

3.2.5 Redundant Items

To keep the working survey as short as possible, there should be as little repetition as practical. Some items in NUREG-0700, Section 6, are repeated elsewhere in that document. Appendix G contains a list of items and their redundant criteria from NUREG-0700, Section 6.

3.2.6 Guidelines Using Inappropriate Criteria

Translating useful ideas into appropriate items for a survey is a very difficult task. The items should reflect something measurable or observable but not so narrow as to disallow functionally equivalent characteristics. For certain items in NUREG-0700, Section 6, the intent was considered proper and desirable, while the criteria used in the items were not appropriate to accomplish the intent. Such items with more tractable criteria are listed in Appendix H.

3.3 COVERAGE OF PROPOSED SURVEY

Taken in its entirety, the surveys, checklists, and questionnaires in Appendix A will identify HEDs associated with the underlying principles of most NUREG-0700, Section 6 items. However, as indicated in Section 3.2, Appendix A does not address all Section 6 items. Some items are addressed in other CRDR activities, such as the systems review and the operating experience review.

A cross-reference list relating NUREG-0700, Section 6 items to NUTAC items is presented in Appendix I. This list shows where, in the CRDR NUTAC approach, each item in NUREG-0700, Section 6, is addressed. A second cross-reference list relating NUTAC items to NUREG-0700, Section 6 items is presented in Appendix J. A final cross-reference relates NUTAC items to specific NUTAC human engineering principles tying the CRDR survey and CRDR human engineering principles documents together.

APPENDIX A

COMPOSITE QUESTIONNAIRES, CHECKLISTS, AND SURVEYS

APPENDIX A

TABLE OF CONTENTS

INTRODUCTION

This appendix contains a set of questionnaires, checklists, and surveys that are organized to be convenient for use in a control room review. The individual surveys and checklists are designed to allow straightforward collection of data for a specific topic or control room system. The contents of this appendix represent a partial conversion of NUREG-0700, Section 6 items into a set of tasks that can be accomplished by relatively few individuals in a reasonably short time with little impact on plant operation.

Use of the checklists, questionnaires, and surveys presented here, in conjunction with other CRDR activities, will result in the control room being evaluated for the items in NUREG-0700, Section 6, except those items that have been explicitly rejected on technical grounds. Those rejected items are listed in Appendixes B-H.

USE OF APPENDIX

This appendix consists of two questionnaires, five checklists, and ten surveys. The distinction among questionnaire, checklist, and survey may not be obvious and should be understood before they are used.

Questionnaires

The questionnaires are designed to solicit specific knowledge about the design of the control room and, more important, opinions concerning the good and bad points about certain characteristics of the existing control room. The items in the operator questionnaires are formulated to identify design deficiencies that have resulted in actual operating problems. The engineering questionnaire is structured to help identify more subtle design problems that might not be revealed during most plant operating configurations. The CRDR NUTAC approach is heavily dependent on the quality of information provided by both the operator and engineering questionnaires. The identification of deficiencies that have caused operational problems is necessary for the CRDR to provide real benefits. Some of the Engineering Department Questionnaire items may require considerable research to answer completely. However, the issues addressed by these items are important to operations and justify the time required.

Checklists

The checklists contain short, declarative sentences that address specific control room design characteristics. If the checklist item is answered yes, then the existing feature of the control room is considered to conform to the criterion on which that checklist item is based. If a particular checklist item is not adhered to by the control room under review, then one or more HEDs should be generated to point out deviations from the underlying design criterion.

Completion of the checklists does not require specialized knowledge on the part of the survey team members. However, some operator time will be required to complete the Operator-Assisted Checklist and the Labeling, Mimics, and Demarcation Checklist. Some human factors input will also be required during the Labeling, Mimics, and Demarcation Checklist.

Surveys

There are ten separate surveys that should be completed during the CRDR survey activity. These surveys function as a framework within which various measurements can be recorded. Some of the surveys consist simply of recording (or determining) control room conventions, such as color usage and instrument arrangement. These surveys are used in other CRDR activities to determine where particular instruments or systems depart from the overall convention. Operator and human factors input are required for some of these surveys.

Other surveys direct individuals to measure certain physical quantities, such as illumination or sound level, and to compare these measurements to acceptable upper and lower limits for such quantities. For this type of survey, the only specialized skill required is the ability to operate and read the measuring instruments.

TIME REQUIREMENTS

The following table (Table 1) shows the estimated time and manpower loadings for the questionnaires, checklists, and surveys in this appendix. The time estimate for completion of the Operator Questionnaires is based on the assumption that this questionnaire is more specific than an interview and will require some time and thought to complete. It is suggested that most control room operators complete the questionnaire and that approximately six hours in the control room be set aside to do so. This will allow the operator to refer directly to the panels and locate specific components. The estimate in Table 1 is based on a total sample of 10 operators (x 6 hours each = 60 hours).

The time estimate for the Engineering Department Questionnaire is based on a single individual devoting three full working days to complete the questionnaire. Obviously, that one individual will have to seek other sources of information, but some slack time is built in for that purpose. The time requirements shown in Table 1 do not represent the total time requirements for a complete control room design review. Control room design review time requirements include time for items such as planning the review, documentation, and writing up of discovered HEDs; completing and writing up the task analysis; prioritizing and recommending disposition of the HEDs; and, finally, writing the entire report for the control room design review.

Table 1. Estimated Personnel Loading for CRDR Survey

Survey Instrument	Survey Team #	Survey Team Time/Person (Hours)	Survey Team Total (Man-Hours)	Operators #	Operators Time/Op (Hours)	Operators Total (Man-Hours)	Engineering #	Engineering Time (Man-Hours)
Questionnaire								
Operator				10	6	60		
Engineering Department							1	24
Checklist								
Overview	1	3	3	1	1	1		
Operator Assisted	1	6	6	1	6	6		
Labeling, Mimics and Demarcation	1	6	6	1	2	2		
General Panel	Open	Open	30					
Process Computer	1	5	5	1	2	2		
Survey								
Design Convention - General	1	30	30	1	2	2		
Design Convention - Groupings	1	6	6					
Lighting	1	4	4	1	1	1		
Noise	1	4	4					
Anthropometric	2	3	6					
Annunciator	1	8	8	1	3	3		
Communication	2	8	16	1	10	10		
Abbreviations & Acronyms	1	16	16	1	4	4		
Color Coding	1	3	3	1	3	3		
Process Computer	1	16	16	3	2	6		
		Total	159			100		24

SCHEDULING CONSTRAINTS

There are two constraints to scheduling tasks within the control room survey:

1. The Operator and Engineering Department Questionnaire should be completed before the arrival of the survey team.

2. The Abbreviation and Acronym Survey and the Color-Coding Survey should be completed prior to the General Panel Checklist.

All other surveys and checklists can be done in parallel, subject only to the constraints imposed by the number of people on the survey team and the potential overcrowding of the control room.

QUESTIONNAIRES

ENGINEERING DEPARTMENT QUESTIONNAIRE (EQ)

Some topics to be addressed in the upcoming control room review will not be evident to an outsider's examination of the control room. They require direct experience with design and operation of the control room equipment. The attached questions cover areas in which your experience is essential for an adequate review. IN ANSWERING THESE QUESTIONS, PLEASE BE AS SPECIFIC AS POSSIBLE BY LISTING PARTICULAR COMPONENTS, TYPES OF COMPONENTS, SYSTEMS, OR PANELS.

EQ-1 In the event of flasher failure to an alarmed annunciator tile, is this malfunction obvious to the operator? If yes, describe how the malfunction is identified.

EQ-2 Is the emergency lighting system independent of and automatically activated upon failure of normal control room lighting system? If yes, describe the method of activation.

EQ-3 Do you know of any events in which radio transmissions have interfered with plant instrumentation? If you know of any such events, please describe them.

EQ-4 Which indicators or groups of indicators show that a control signal has been sent rather than the resultant system condition? What are the backup displays for these indicators?

EQ-5 Which displays would fail in normal operating range on loss of power or input signal?

EQ-6 Describe how failed indicator lights and annunciator lights are found. List lights on control board not provided with dual lamps, dual filaments, or lamp test capability.

EQ-7 Are there status displays for shared equipment in each control room (for multiple unit plants only)?

EQ-8 In your opinion, which of the annunciator points might benefit from the following:

(a) larger deadband

(b) setpoint change

(c) removal

EQ-9 For multipoint annunciators, is the alarmed point printed out or otherwise indicated in the control room? List exceptions.

EQ-10 After acknowledgement of a multipoint annunciator, will the annunciator system respond if another of its points exceeds its setpoint? Briefly describe how the multipoint annunciators work.

EQ-11 Can significant degradation of computer or plant systems be caused by inadvertently making a single keystroke? If yes, describe.

OPERATOR QUESTIONNAIRE (OQ)

Some topics to be addressed in the upcoming control room review will not be evident to an outsider's examination of the control room. They require direct experience in operating the equipment. The attached questions cover areas in which your experience is essential for an adequate review. IN ANSWERING THESE QUESTIONS, PLEASE BE AS SPECIFIC AS POSSIBLE BY LISTING PARTICULAR COMPONENTS, TYPES OF COMPONENTS, SYSTEMS, OR PANELS.

Panels

OQ-1 Are there controls and displays that must be used in conjunction with each other that are too far apart?

OQ-2 Are any controls difficult to adjust as precisely as needed?

OQ-3 Are there switches that do not "snap" into position or that can be left halfway between positions or, where appropriate, do not have spring return? Are there switches that are difficult to turn?

OQ-4 Are any controls too large, too small, or too close together to operate easily?

OQ-5 Are knobs for spring-loaded switches and selector controls large enough to be held easily against the spring torque without fatigue for as long as necessary to accomplish the control action?

OQ-6 Are there spring-loaded switches that must be held for an extended period?

OQ-7 Are there broken, chipped, or crumbled control surfaces? Are there control knobs or handles that slip or move loosely on their shaft?

OQ-8 Are any meters scaled in different units than the procedures that reference them? In addition to listing the relevant meters, describe the discrepancies.

OQ-9 Do you have any trouble using posted nomographs?

OQ-10 Do any controls and displays work together in confusing ways? (See Design Convention Survey.) In addition to listing the relevant controls and displays, describe why they are confusing.

OQ-11 Are any instruments difficult to compare with backups because of differences in scale units, elevated zeros, etc.?

OQ-12 Are any instruments hard to use because they have to be read more precisely than the scale allows?

OQ-13 Is it particularly difficult to change paper or ink in any of the recorders?

OQ-14 Is there any difficulty with lamp replacement (for example: shock, accidental activation, or need to replace from behind panel)?

OQ-15 Do any important instruments on the back panels have neither an alarm you can hear in the control room nor their own annunciator on the front panel?

OQ-16 Are any labels unclear about what is being displayed, what a control does, or the control's position?

OO-17 Can the key for any key switch be removed when the switch is not in an "off" or a "safe" position?

OO-18 Have there been any difficulties with radios interfering with the instrumentation?

OO-19 Are there indicator lights where equipment status is indicated by a light being off (for example, pump is off when light is off)?

OO-20 Are there any controls with no direct, immediate display feedback? Where there is a time lag between control activation and ultimate system state, are there any instances in which there is not immediate feedback indicating what is occurring and the direction of parameter change?

OO-21 Are there chart recorders that lack Hi/Lo speed capability where fast tracking rates or trending is periodically required or desirable?

Annunciators

OO-22 Do you get recurring or "nuisance" alarms when a system is deactivated intentionally?

OO-23 Do you get any particular recurring invalid alarms?

OO-24 Do any alarms fail to give operators adequate time to respond to warning conditions before a serious problem develops?

OO-25 Are blank spare tiles ever "on" except when you are testing the system?

OO-26 Are there conditions requiring a rapid response that are signaled by light indicators instead of annunciators?

Control Room

OQ-27 Do you have a readily accessible place for adequate storage of operating procedures and reference documents?

OQ-28 Does the presence of excessive personnel in the control room ever cause a problem? If yes, describe how this has caused problems.

OQ-29 Is the lighting level inadequate for any areas in the control room? If yes, please indicate the relevant areas.

OQ-30 Is shadowing of instruments a problem?

OQ-31 Is glare on instruments a problem?

OQ-32 Are there problems with the heating/air conditioning system?

a. Is the control room comfortable?
b. Are there problems with static electricity?
c. Do control room panels or controls overheat?
d. Is the air in the control room stale?

OQ-33 Are any signals so loud or shrill that they startle or irritate you?

OQ-34 Do you have adequate working space, and is the working area comfortable?

Communication

OQ-35 Does background noise in the control room interfere with speech communication?

OQ-36 Can you be contacted from the control room with public address system or other means when you take a break? Relevant areas include the following:
rest rooms
locker room
kitchen
other areas where CR personnel normally might be located

OQ-37 Are there problems with handling communications from outside the plant during an emergency? Briefly describe any problems.

OQ-38 Have you been trained to use communications devices? List any communications equipment for which you think training has been inadequate. Do you know if any errors have occurred in the use of these communications devices? If yes, list the device and describe the error.

OQ-39 Do you anticipate any problems (or have any occurred) in the use of backup communications equipment during emergencies? In addition to listing such equipment, please describe the problem.

Computer

OQ-40 Do you have any trouble interacting with the computer to get the information you want? If yes, please describe the problem(s).

OQ-41 When the computer is used for reactivity or other computations, do you have to interpolate, do additional calculating, or mentally translate displayed data into other units? If yes, list the types of computation for which this is true.

OQ-42 When the printer is being reloaded, are data and information that normally would be printed lost?

OQ-43 Has significant degradation of computer or plant systems been caused by inadvertently making a single keystroke? If yes, describe.

OQ-44 Are there displays for which illustrations or pictures could be used to better describe text or alphanumeric material?

CHECKLISTS

OVERVIEW CHECKLIST (OC)

This checklist contains easily observed items related to control room design.

OC-1 If a control room is mirror-imaged, operational personnel are committed to a particular unit or the distinction between units should be heightened through demarcation, shading, etc.

OC-2 Sanitary facilities and drinking water are accessible easily.

OC-3 Public address speaker coverage is provided in the control room, restrooms, locker room, kitchen, and other areas where control room personnel might be located.

OC-4 The shift supervisor's (SS) office is near the control room, or a dedicated communications link is provided if SS location interferes with voice contact.

OC-5 The visual and physical path from the operator's desk to the control board is unobstructed. Possible obstructions include the following:

- o tripping hazards
- o poorly positioned filing cabinets and storage racks
- o maintenance equipment

OC-6 Labels are positioned consistently either above (preferred to avoid visual obstruction when operating control) or below devices they describe and are readily associated with corresponding controls and displays.

OC-7 No uncovered openings are in panels.

OC-8 Coding by sound intensity is not employed.

OC-9 Control board tags to identify out-of-service equipment are affixed securely to the associated component and do not obscure labels or adjacent components.

OC-10 An automatic system warns operators of control room fires.

OC-11 Indirect or diffuse lighting is employed.

OC-12 Sufficient storage space exists for the crew's personal belongings.

OC-13 At locations with more than one telephone, (a) telephones that are ringing can be identified easily, and (b) dedicated telephones are identified distinctively and uniquely.

OC-14 Annunciator windows are prioritized.

OC-15 Annunciator window positions are labeled to facilitate access to procedures.

OC-16 Annunciator controls are set off from other controls through some form of coding (describe).

OC-17 Annunciator controls are arranged consistently (for example, functions should be in the same order).

OC-18 Annunicator controls are "nondefeatable" (for example, not encircled by a ring in which a coin might be inserted to defeat the control).

OC-19 Cords are positioned in a way that avoids entangling critical controls or endangering passing traffic.

OC-20 Speaker volume is adjusted to ensure that speaker communications will not prevent detection of annunciator, telephone, or other audible signals.

OC-21 Labels are sturdy and mounted securely.

OC-22 Labels have dark characters on a light background.

OC-23 Plant communications systems are redundant (not subject to common cause failures) e.g., public address and walkie-talkies or conventional and sound-powered telephones.

OPERATOR-ASSISTED CHECKLIST (OAC)

Information concerning some topics addressed in the control room review are most readily obtained with operator assistance. Such topics include inventorying available procedures, storage areas, spare parts, protective and emergency equipment, and some aspects of operator training. Operator assistance should be obtained for answering the following items.

I. ADMINISTRATIVE PROCEDURES AND PRACTICES

List procedure numbers for the following procedures controlling both temporary and permanent changes (such as labeling) to control board:

OAC-1 method of label application

OAC-2 language (acronyms and abbreviations)

OAC-3 typestyle or font

OAC-4 color

OAC-5 periodic review

OAC-6 incorporation in procedures if made permanent

List procedure numbers for the following:

OAC-7 Procedure for out-of-service annunciator tiles

OAC-8 Procedure for identifying annunciator tiles lit for an extended period during normal operations

OAC-9 Procedure controlling loudness adjustment for annunciator system (if adjustable)

OAC-10 Procedure(s) controlling annunciator window and legend light/switch removal to ensure replacement in correct location (N/A if hinged or keyed)

OAC-11 Procedures for control room emergencies involving fire or contamination

OAC-12 Instructions for use of personnel protective equipment

OAC-13 Procedure controlling the use of equipment shared between two or more units (N/A for single unit)

OAC-14 Procedure calling for the periodic cleaning of labels, panels, and instrument faces

OAC-15 Procedure that ensures infrequently activated auditory alarms are tested periodically

OAC-16 Operators have authority to limit access to the control room

II. RELEVANT DOCUMENTS

List procedure numbers and frequency of periodic inspection/ checks for each of the following:

OAC-17 Annunciator test

OAC-18 Control room fire-fighting equipment

OAC-19 Portable radiation monitoring equipment

OAC-20 Control room personnel protective equipment

OAC-21 Control room communication equipment

OAC-22 Periodic chart marking (once/shift and speed change)

III. STORAGE/SPARE PARTS

The following are true for storage of spare parts:

OAC-23 Expendables and spare parts are readily accessible and include items such as fuses, bulbs, ink, inking pens,

recorder charts, printer paper, batteries (i.e., if walkie-talkies used), special tools (as needed to install parts), and items for emergency equipment, such as filters.

OAC-24 Spare parts are identified clearly and distinctively, and an inventory system maintains an adequate supply of spare parts described in OAC-23.

OAC-25 Sufficient storage space exists for expendables and spare parts.

OAC-26 A well-marked, accessible place should be provided for headset storage.

A. Protective Equipment

The following should exist for protective equipment:

OAC-27 Accessible storage in or near the control room.

OAC-28 A supply adequate to outfit the shift crew, including breathing apparatus.

OAC-29 Face masks have speech diaphragm or microphone.

B. Emergency Equipment

Accessible storage in or near the control room is available for the following:

OAC-30 Fire-fighting equipment

OAC-31 Portable radiation monitoring equipment

IV. ORGANIZATION OF PROCEDURES

OAC-32 Operating procedures and reference documents are readily accessible, stored separately for each unit, and are separate from other documents.

OAC-33 Documents are protected from wear so they do not become dog-eared, dirty, loose, torn, or difficult to read.

OAC-34 Annunciator response procedures are indexed by panel identification and window position.

OAC-35 Documents are not fixed in racks and are bound so they can be opened fully and remain opened at the desired place without holding.

OAC-36 Clearly visible title labels identify specific documents.

V. TRAINING

OAC-37 Instructions for use of personnel protective equipment are available, and operators have received training and are practiced in their use.

OAC-38 Training is given on the use of each communication system, including familiarity with suggested alternatives if a system becomes inoperable.

OAC-39 Procedures are established for handling communications during an emergency, and these procedures must be known by all operators.

OAC-40 Operators are trained in the use of emergency equipment.

LABELING, MIMICS, AND DEMARCATION CHECKLIST (LMD)

These criteria address the organization and identification of components in the control room. Consistency is a prime consideration. Panels, systems, subsystems, and functional groupings should be properly spaced, demarcated, color shaded or mimicked, and hierarchically labeled in progressively smaller fonts. Full compliance with these criteria implies a pervasive, identifiable organizational scheme for which discrepancies may be identified and listed as HEDs.

I. LABELING

LMD-1 Labels are consistent in type style.

Letters appearing on control boards are all uppercase; simple; without prominent serifs or slants; have separations among letters, words, and lines approximating samples; and have type styles falling somewhere between these samples.

NOT THINNER THAN THIS	**NOT THICKER THAN THIS**
(Stroke width to character height = 1:8 letter width to height = 3:5	(Stroke width to character height = 1:6 letter width to height = 1:1

Style for numbers is similar to

1 2 3 4 5 6 7 8 9 0

LMD-2 Labels are coded hierarchically by size for panels, systems/subsystems, functional groupings, mimics, components, and position indication and do not repeat information contained at higher levels. (An exception is component identification numbers.)

Alphanumeric characters are of the following minimum heights:

	Maximum Viewing Distance	Minimum Height
Position indications	36"	5/32"
Component labels	50"	7/32"
Annunciator windows (locally acknowledged)	57"	1/4"
Labels for functional groupings small mimics, and subsystems (if present)	72"	5/16"
Labels for panels, systems, large mimics, annunciator windows (globally acknowledged)	115"	1/2"

II. MIMICS

LMD-3 Nomenclature printed on labels is the same as that used in procedures.

LMD-4 Mimic lines are marked clearly with arrows to show direction of "flow." "N/A" if no flow directions (e.g., electrical mimics).

LMD-5 Mimic lines are identified with starting and end points. "N/A" if no starting or end points (e.g., electrical mimics).

LMD-6 Component representations on mimic lines are identified.

LMD-7 No more than four mimic lines of the same color should run parallel in close proximity.

LMD-8 Mimics are consistent in the application of symbols for pumps, valves, and other process elements.

LMD-9 Mimic lines depicting flow of the same fluid should have the same easily discriminable color throughout the control room.

LMD-10 Mimic lines do not overlap.

III. DEMARCATION

LMD-11 Lines or color patches used for demarcation are visually distinctive, permanent, and well-maintained.

LMD-12 Strings of six or more components or matrices of more than 4 X 4 similar components are either demarcated into functional groups or are mimicked.

LMD-13 Repetitive groupings such as separate trains are identically demarcated.

LMD-14 If display(s) are not mounted above or to the left of their control(s), the grouping is demarcated.

IV. DOCUMENTS

LMD-15 Documents should be labeled clearly so they are easily distinguished from one another.

GENERAL PANEL CHECKLIST (G)

This checklist contains easily observed items related to control room panel design.

G-1 Controls and displays (indicating lights, meters, recorders, indicators, annunciators) generally are grouped by system and function, with identical layout for repetitive groups.

G-2 Components of similar function are consistently ordered, preferably from left to right or top to bottom.

Correct:	Incorrect:
A - B - C	B - C - A
1	2
2	3
3	1

G-3 Roman numerals are not used.

G-4 Labels in close proximity cannot be confused easily due to use of highly similar words, abbreviations, or acronyms (e.g., Effluent/Influent).

G-5 Panel access openings used by control room operators are labeled to identify by function the items accessible through them.

G-6 Labels, legend plates, and escutcheons are used to identify each component's function.

G-7 Labels are worded succinctly and accurately with respect to function or input signal.

G-8 Labels are oriented horizontally to read from left to right.

G-9 Adjacent labels are separated sufficiently so they are not read as one continuous label.

G-10 Displays, indicator lights, and labels are free from visual obstruction by hand or arm when switch is operated or from obstruction by other controls and displays.

G-11 Each control position is marked clearly, as is direction for increase.

G-12 When meaning is not obvious, light indicators and other displays are labeled clearly.

G-13 Control surfaces promote ease of use. Knurls or serrations are used for knobs, rocker, and slide switches and indentations for pushbuttons.

G-14 Rocker and toggle switches are oriented consistently either vertically or horizontally.

G-15 Toggle switch and rocker switch displacements are between those shown in Figure G-1.

G-16 Handles or knobs are shaped or marked clearly to indicate position, without obstruction of legends or confusion of direction.

G-17 Glare does not interfere with reading meters when they are viewed from operator's station at control panel.

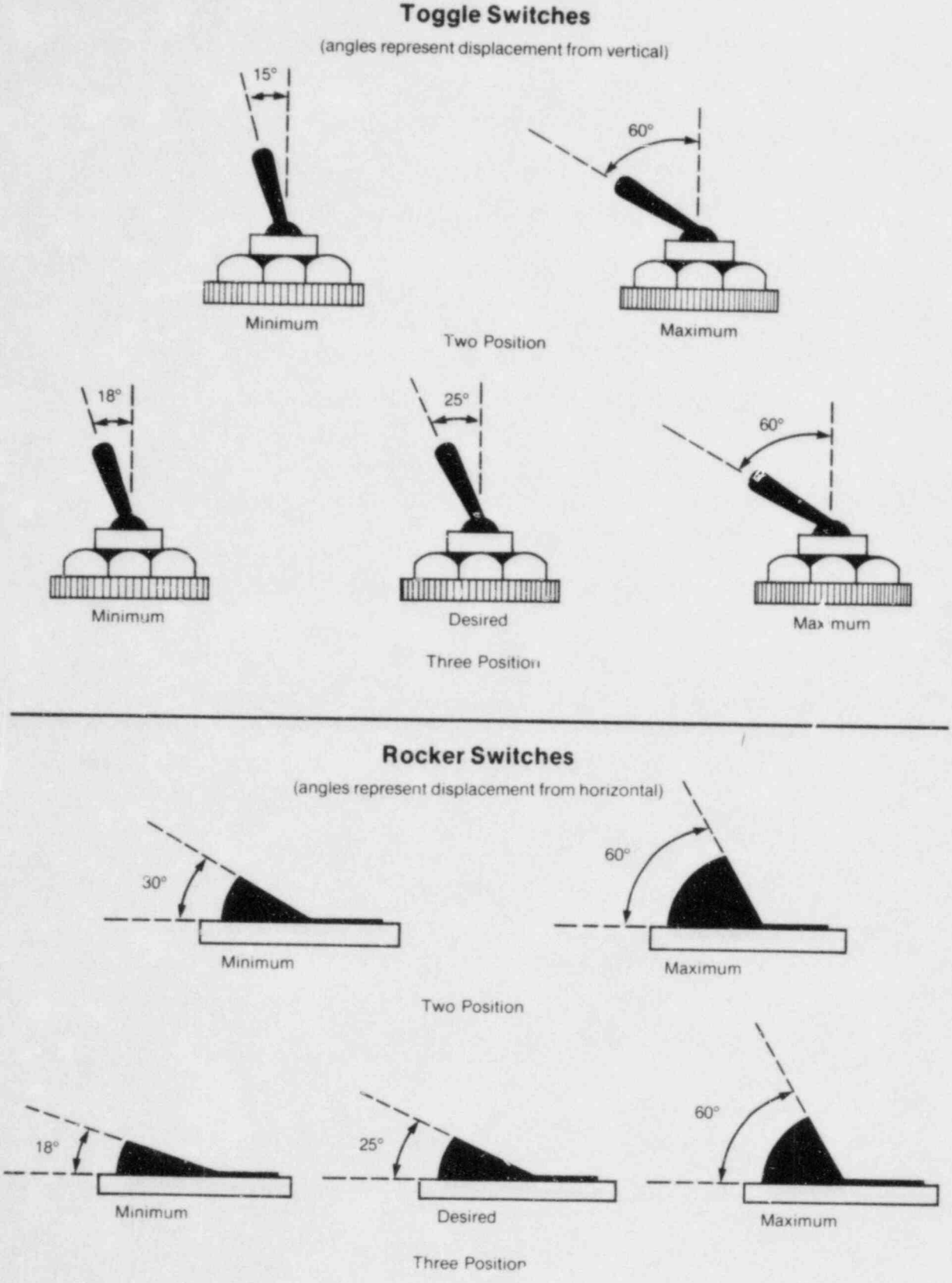


Figure G-1. (Illustrating Item G-15) Switch Displacements

Meters

General

G-18 Parallax does not interfere with reading meters when they are viewed from the operator's station at the control panel.

G-19 Moving scale indicators are not used.

G-20 In groups of similar displays, meters are aligned to promote visual comparison and provided with identical scales to facilitate comparative reading.

G-21 Meter scales are in commonly used engineering units and are in the same units as the associated controller if one exists.

G-22 Scales have black markings on a white background.

Conformation

G-23 Circular scales are symmetrical about their vertical axis, with the break centered at the 6 o'clock position, unless they are multi-revolution type.

G-24 If circular meters have multi-revolution or both positive and negative values, zero is located in the 12 o'clock position.

G-25 Meters are designed so the pointers do not obscure graduation marks, numerals, or process units.

G-26 No more than 1/16" separation exists between pointer tip and scale.

G-27 Sufficient visual contrast exists among scale graduations, process units, numerals, background, and pointer.

G-28 Meter scales contain a maximum of nine intermediate graduations between numbered markings. Intermediate and minor graduations are shown if there are five or more graduations between numerals.

G-29 Meters are scaled with subdivisions in decimal multiples of 1, 2, or 5.

G-30 Scales are marked with numerals oriented in an upright position.

Operation

G-31 Control/display operation conforms to control room design conventions (see Design Convention Survey).

G-32 Scales are marked to show normal and abnormal, safe and unsafe, or expected and unexpected ranges of operation, where applicable (pressures, flows, levels, etc.)

G-33 Meters have not been rescaled using temporary means (e.g., embossed tape).

G-34 Multirange meters are marked or color-coded to differentiate among range scales.

Indicator Lights Not Included In Design Convention Survey

G-35 Sets of lights are in alignment to facilitate comparison between related system elements.

G-36 Color of indicator lights is clearly identifiable.

Legend Lights/Switches

G-37 Legends for legend lights and legend pushbuttons have engraved dark lettering on a light backing, are readable under ambient lighting, and contain no more than three lines.

G-38 To prevent accidental activation, barriers are present when legend pushbuttons are contiguous.

G-39 Barriers have rounded edges to prevent injury.

G-40 Legend switches are easily discriminable from legend lights.

Chart Recorders

G-41 Printed chart recorder values are read easily.

G-42 Current data is readable through the window.

G-43 Printed value corresponds to scale value (i.e., proper chart paper is being used).

G-44 On multiple pen recorders, parameters are listed in the same order as their pens. Each pen prints with a different color ink.

G-45 If the chart recorder has switchable channels, a procedure or standard operating practice exists for marking channels, and use of different channels does not cause confusion because of different scale requirements.

G-46 Single-point select capability is available on multipoint recorders.

Counters

G-47 Mechanical counters use black numbers on a white background and have a matte or flat finish; electronic counters ("Nixie" tubes, light-emitting diodes, etc.) use alphanumerics that are easily read and have adequate character-to-background contrast.

G-48 To maximize viewing angle and minimize shadows, mechanical counters are mounted so the display is not recessed.

G-49 Mechanical counters and electronic counters should be oriented so they can be read horizontally from left to right.

Emergency Controls

G-50 Switches for emergency or abnormal use (such as turbine trip, scram, emergency trip, etc.) are clearly marked.

G-51 Emergency controls and other important controls are protected from inadvertent operation.

G-52 Emergency controls are readily accessible.

G-53 The purpose of key switches is not defeated by having keys in their locks.

G-54 Key switches are "off" or "safe" in the vertical position. They are nearly horizontal when operated (judge by position labels).

G-55 For display types listed in the engineering questionnaire as having indirect indication and any controls without associated indicator lights, readable backup displays are within view (example: a meter for pumps).

G-56 Color use conforms to the attachment from color-coding survey.

G-57 Abbreviation/acronym use conforms to the attachment from abbreviation/acronym survey.

CONTROL ROOM COMPUTER CHECKLIST (CRCC)

Computers used in the control room may vary widely in the functions they perform. Relatively simple systems use keyboards for input and printers and/or CRTs for output. These systems are used for recordkeeping, sequentially displaying annunciators and other alarms, and will display or trend parameter values upon request. More complex systems may use additional input devices, such as joysticks, and may integrate a range of parameter values to aid diagnosis of plant problems. Most of the items in this checklist are relevant to all computers used by the operator. Items relevant only to the more complex systems have an asterisk beside them.

Since answering most of the checklist items requires demonstration of the computer system(s), operator assistance should be obtained.

CRCC-1 The system has protection provisions to ensure that only authorized personnel can make changes in setpoints, constants, or system software.

CRCC-2 A record of changes to setpoints, constants, and software affecting the operator is provided.

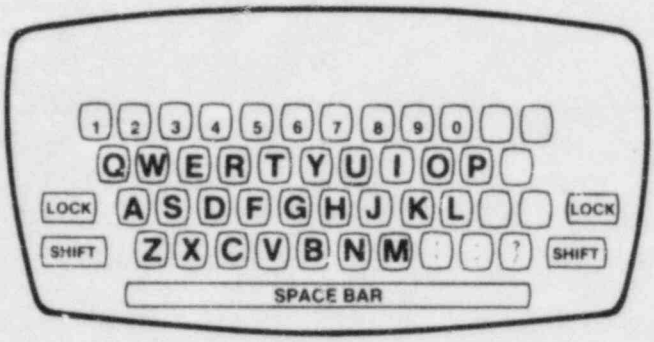
CRCC-3 Operating mode is displayed on CRT or printer if operation is not dedicated (e.g., alarm printer).

CRCC-4 Alphanumeric keyboards have QWERTY arrangement; number pads have telephone or calculator arrangement (see Figure CRCC-1).

CRCC-5 Keyboards contain only those keys used by operators.

CRCC-6 Abbreviations are used in place of long strings of alphanumerics to minimize operator input requirements.

QWERTY Keyboard Arrangement



Numeric Keyboard Arrangement

Figure CRCC-1. (Illustrating Item CRCC-4)
Numeric and Alphanumeric Keyboard Arrangements

CRCC-7 Alphanumeric codes used to call up displays do not exceed seven characters, unless acronyms are employed.

CRCC-8 If function keys are used, they have the following characteristics:

a. grouped together

b. labeled

c. laid out identically at all locations

CRCC-9 Key size, resistance, and displacement allow easy keying in of commands, while minimizing inadvertent activation of keys and providing positive key movement feedback.

CRCC-10 When a menu item or an option is selected, it should be highlighted or otherwise acknowledged by the system.

CRCC-11 Computer controls are operable from locations where the operator needs to interact with the computer.

CRCC-12 If CRTs can be operated by a centrally located master control, a positive indication is provided at both locations to identify when the local display is under master control.

*CRCC-13 Computer controls provide both rapid and accurate positioning of cursors or selection of choices.

*CRCC-14 Operators have a specific command to terminate functions or actions that are no longer needed.

CRCC-15 Response time for any query is not appreciably greater than three seconds (preferred), or a delay message is presented to maintain the operator's attention.

CRCC-16 Operators are able to correct individual errors easily without having to retype the entire query or entry.

CRCC-17 There is a procedure(s) in the control room with instructions suitable for the control room operator to operate the computer.

CRCC-18 A listing of computer points, cross-indexed by alphanumeric code, system/subsystem, and functional group, is provided in the control room.

CRCC-19 Lists and data presented in tabular form are left-hand justified and aligned vertically; numeric data are right-hand justified.

CRCC-20 Data are separated into groups for long columns.

*CRCC-21 Data subgroups are demarcated by spaces, lines, etc.

*CRCC-22 Lists of options (such as in a menu) have high probability items presented first.

*CRCC-23 Each page of multiple-paged data has both page number and total number of pages.

CRCC-24 Trend plot scales are consistent with intended functional use of data.

CRCC-25 Graphs and charts are concise and easily read.

CRCC-26 If the following information is presented, standardized fields are used:

a. telephone (area code) 000-0000
b. time HH:MM:AA, HH:MM, MM:SS:(.S)
c. date MM/DD/YY

CRCC-27 The operator has an unobstructed view of the CRT screen from the normal work station.

CRCC-28 The operator has some capability for controlling the amount, format, and complexity of information displayed (e.g., core dumps, program outputs, error messages).

CRCC-29 If CRT luminance (brightness), contrast, and color are adjustable, then a color standard for comparison should be provided.

CRCC-30 Alphanumeric characters are not less than 0.17" in height, where a maximum viewing distance of 48" is assumed.

CRCC-31 CRT alphanumerics are of a consistent style. Letters are all uppercase, simple, without prominent serifs or slants; have separations among letters, words, and lines approximating samples; and have styles falling somewhere among these samples.

NOT THINNER THAN THIS	**NOT THICKER THAN THIS**
(Stroke width to character height = 1:10 letter width to height = 3:5)	(Stroke width to character height = 1:5 letter width to height = 1:1)

CRCC-32 Data groups or messages have descriptive titles that reflect their content.

CRCC-33 CRT screen labels are oriented horizontally and are consistently located with respect to items they describe.

CRCC-34 Highlighting methods (brightness, flashing, etc.) are used in a consistent fashion to attract operator attention to important or action items.

CRCC-35 Data relevant to an operator entry are displayed on a single page, when possible.

CRCC-36 Flashing of a symbol or message is reserved for items requiring prompt operator action, such as emergency conditions.

CRCC-37 If pages are hierarchically organized allowing different paths through the series, an audit trail of choices is available upon operator request.

CRCC-38 When scrolling or panning a large frame or list, the location is shown; sectional coordinates are used when large schematics are panned or magnified.

CRCC-39 Invalid entries result in error messages that indicate required corrective action.

CRCC-40 System provides messages on change in status, including system malfunction, (e.g., "STATUS LOG UNAVAILABLE").

CRCC-41 Printer(s) with capabilities to record alarms and status data and printer or strip recorder(s) to record trend data are in the primary operating area.

CRCC-42 Alarm messages should be printed along with event times in the order of their occurrence.

CRCC-43 If an alarm corresponds to an annunciator tile, the message uses the wording of the annunciator tile and specifies the setpoint(s) violated.

CRCC-44 Alarm messages should be readily distinguishable from other messages.

CRCC-45 Printouts are legible.

CRCC-46 Printouts can be read and annotated as they are printed.

CRCC-47 Instructions for reloading paper, ribbon, etc., are posted on the printer.

CRCC-48 If it is possible to print hard copy of a CRT page, it is done without altering the screen content.

CRCC-49 Printers recording trend data, computer alarms, and critical status information have a high-speed printing capability.

CRCC-50 The collection device for the printer has a capacity adequate for the fastest printing speed.

SURVEYS

DESIGN CONVENTION SURVEY (DCS) - GENERAL

Design Convention - Controls

Due to the large number of valve, pump, and breaker controls and associated indicator lights in a control room, it is difficult to determine what conventions are present. It is suggested that a code accompanied by a sketch be assigned to each configuration encountered. A different code should be given to each configuration, based not only on appearance but also on special features, such as spring return to normal. Subsequently, controls of the same type can be recorded by listing control identification and the code.

Frequency counts using these codes can then determine design conventions for shape, color, and operation of these controls and indicator lights. Figures DCS-1, DCS-2, DCS-3, and DCS-4 illustrate worksheets that might be used during the Design Convention Survey to depict configurations for existing two- and three-position rotary selectors, and J-handle switches. Figure DCS-4, "Sample Design Convention Worksheet for Three-Position Rotary Selectors" illustrates a completed worksheet. A note concerning important features of the selector not evident in the drawing (in this case "spring return") is on the bottom left of the sketch. The number of occurrences for each configuration is on the bottom right of the sketch. A separate list containing the switch designation and the location also may be maintained. Note that the sketches in Figure DCS-4 make determination of actual configurations or conventions in use and inconsistencies readily apparent. For example, in sketches 1, 2, and 3, the varying positions for "Auto," "Close," and "Open" could be confusing. A single convention should be chosen and adhered to consistently.

Design Convention - Meters

Coding involving meters is less prevalent than for controls. It is suggested that 15-20 meters from a number of panels be examined. If appreciable correlation is found among meter type,

meter shape (circular/linear scale), or meter orientation (horizontal/vertical) and the parameters being displayed, it should be noted as a design convention. Such conventions should be included as added items on the panel checklist. While identification of these conventions at this stage may result in a greater number of HEDs, the documentation of coherent coding schemes will result in less effort during the implementation phase of the review.

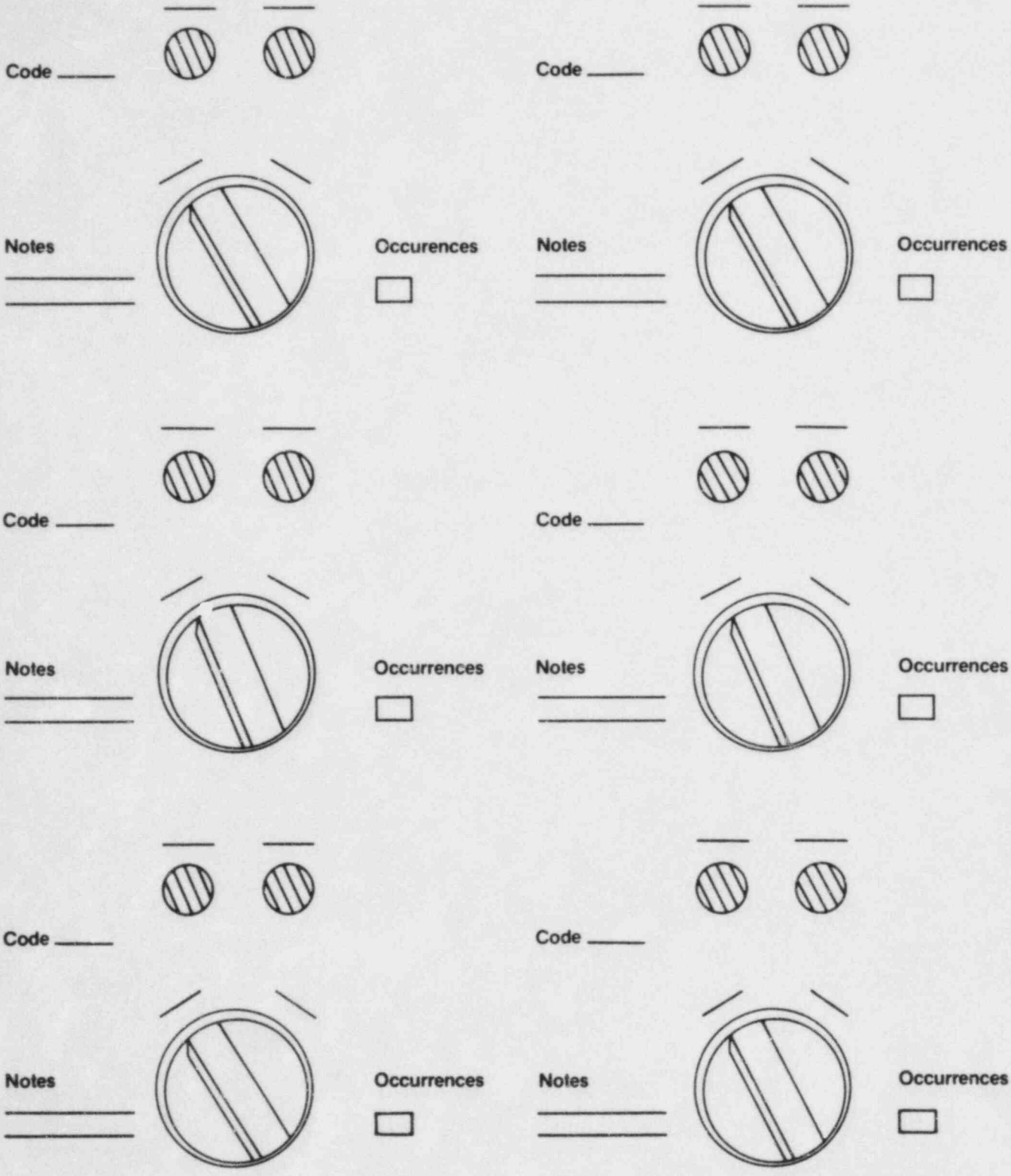


Figure DCS-1. Design Convention Worksheet For Two-Position Rotary Selectors

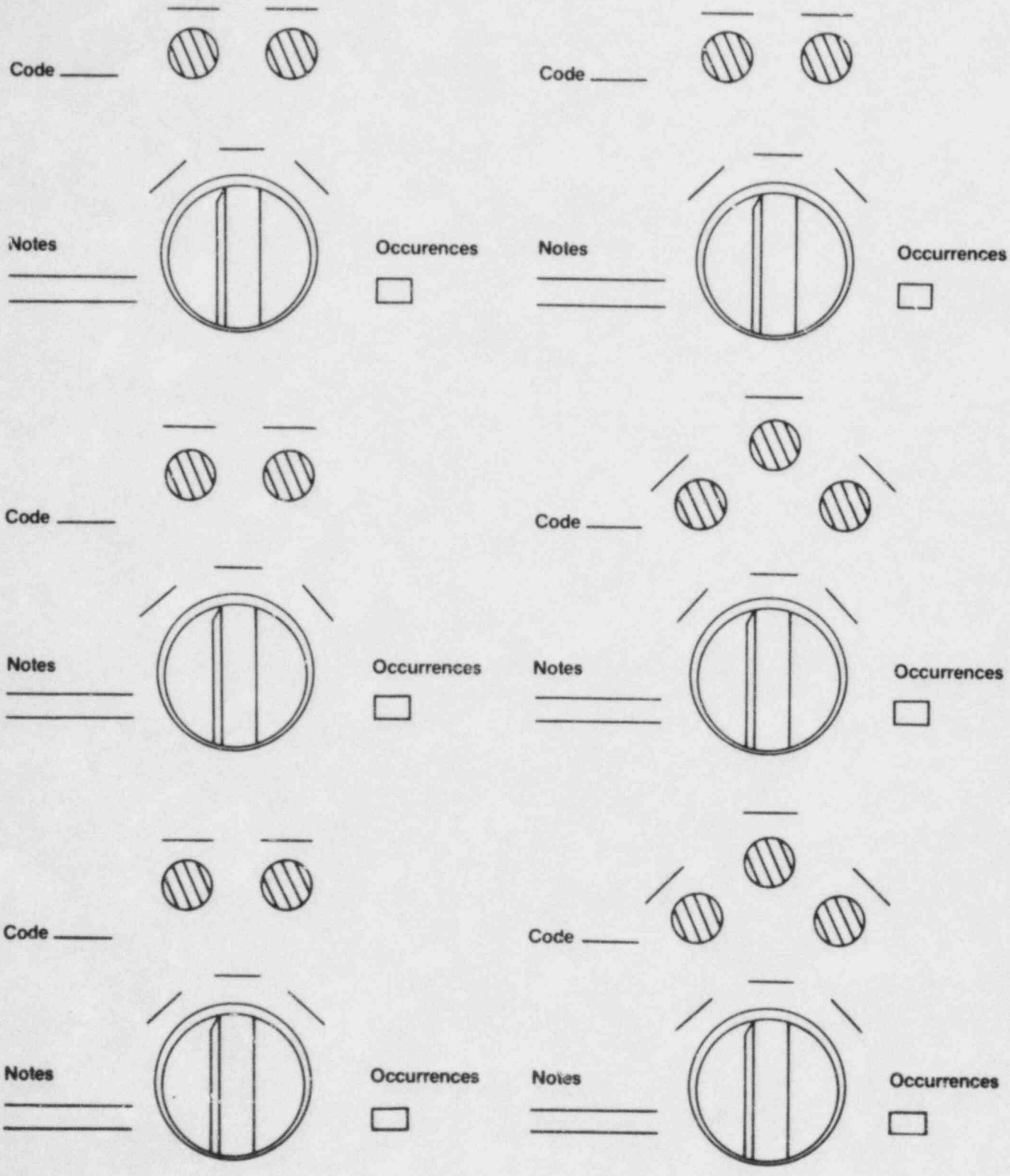


Figure DCS-2. Design Convention Worksheet For Three-Position Rotary Selectors

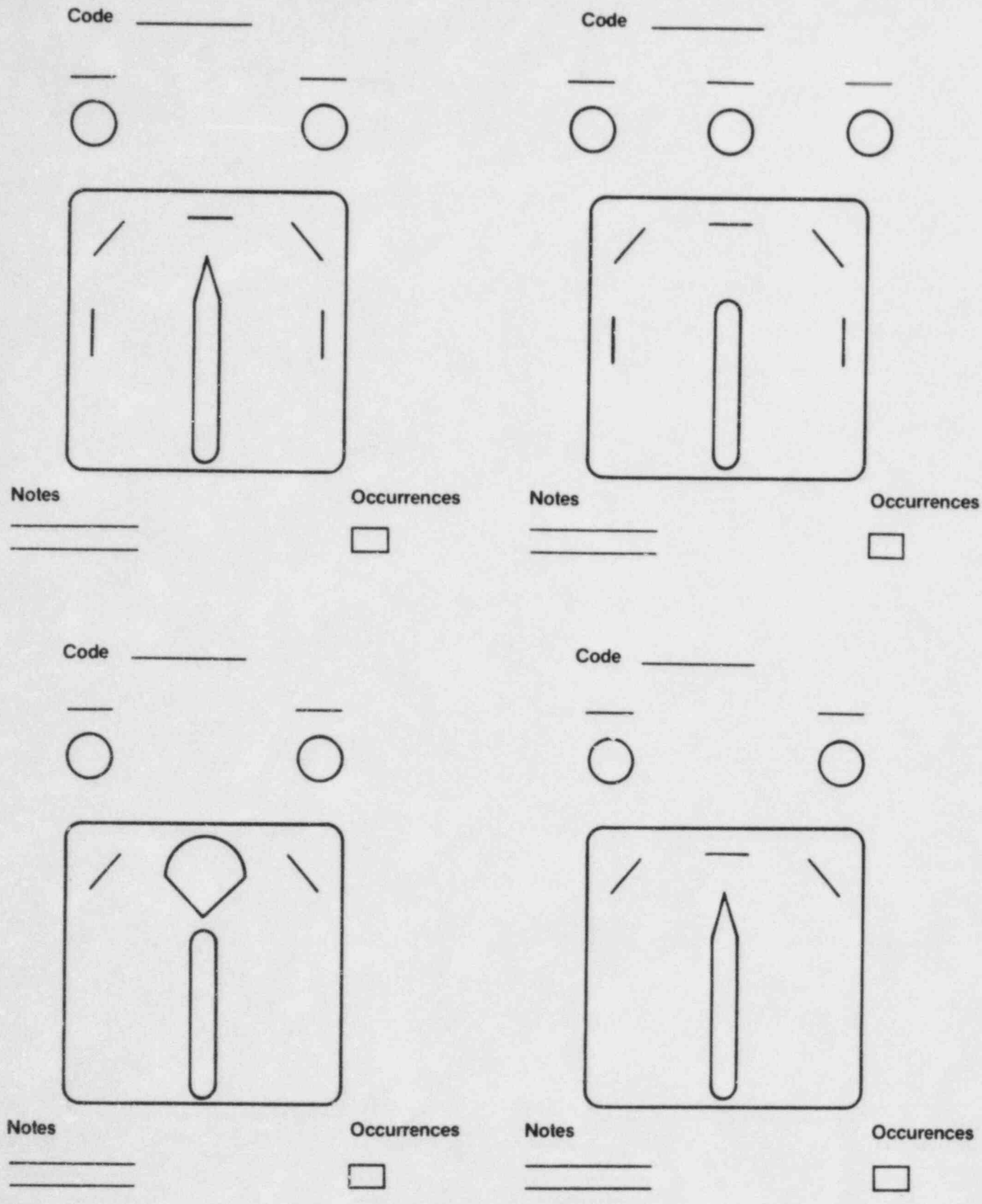


Figure DCS-3. Design Convention Worksheet For J-Handle Switches

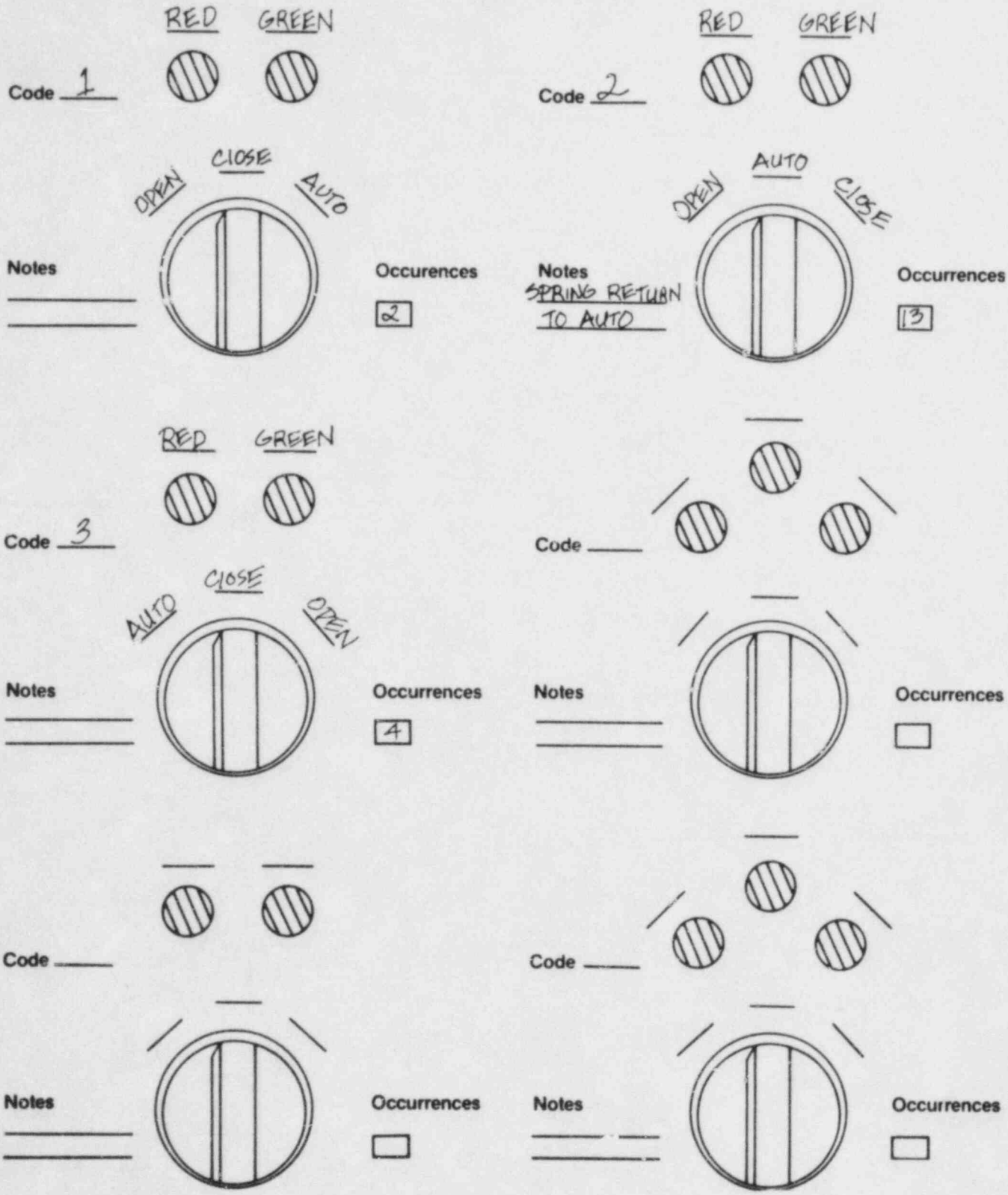


Figure DCS-4. Sample/Design Convention Worksheet For Three-Position Rotary Selections

DESIGN CONVENTION SURVEY - REPETITIVE GROUPINGS (DCS)

Similar sets of controls and displays will appear in different panels and systems where similar equipment is being operated. Arrangement, shape, and color codings within such grouping should be examined for consistency. (For example, for groups of pump and suction valve controls, the suction valve controls are in a consistent position, such as on the bottom and to the left side of the pump control.)

These conventions are more general than others being considered and should be stated at whatever level of detail they best apply. This data will not be used to generate HEDs. In the implementation phase, the presence of such conventions may limit the need for enhancements for consistent groupings.

Subset of General Panel Checklist To Be Used For Coded Controls

The items listed below are General Panel Checklist items that could be answered most easily in conjunction with the Design Convention Survey.

G-10 Display, indicator lights, and labels are free from visual obstruction by hand or arm when the switch is operated or from obstruction by other controls and displays.

G-11 Each control position is marked clearly, as is direction for increase.

G-12 When meaning is not obvious, light indicators and other displays are labeled clearly.

G-13 Control surfaces promote ease of use. Knurls or serrations are used for knobs, rocker, and slide switches, and indentations are used for pushbuttons.

G-16 Handles or knobs are shaped or marked clearly to indicate position, without obstruction of legends or confusion of direction.

LIGHTING SURVEY (LS)

This survey consists of a series of luminance and illuminance readings taken with a light meter/spot photometer. The control room layout should be sketched labeling all panel sections, operators' desks, alarm printer, and other work stations. Two vertical and two horizontal illuminance readings should be taken for each labeled section of benchboard. Two luminance readings, taken in the plane normally viewed, should be recorded for other operating stations. This process should be repeated under emergency lighting conditions, taking single measurements. There should be no apparent change in the discriminability of colors under emergency lighting conditions. (See also "Control Room Computer Survey," CRCS-7, for additional measurement requirements.)

Evaluation

There is some latitude in assessing the adequacy of illumination. NUREG-0700, 6.1.5.3a, specifies Illuminating Engineering Society (IES) criteria for recommended illumination levels. The IES criteria for a power plant control room specified below are more appropriate. The recommended illumination level for a power plant control room, 50 footcandles, allows reading printed material, meter reading, and ordinary seeing tasks (IES, MIL-STD-1472C). Whichever criteria are chosen, they should be used consistently in assessing survey results.

Illuminating Engineering Society (IES) Criteria For Power Plant Control Room (Footcandles)

	Emergency	Minimum	Recommended
Panels	20	20	50
Desks	20	50	75
Printer	20	50	75

Note: It is assumed that only typed or printed material will need to be read under emergency lighting and that annotation may be used on alarm copy. If little writing is done at desks, lowering these minimum levels may be justified.

Assessment

LS-1 Note on sketch any illumination readings falling outside specified range (normal and emergency lighting).

LS-2 Note on sketch all instances in which any of the following are true:

(a) paired readings exceed a ratio of 3:1

(b) horizontal and vertical readings from a benchboard section exceed a ratio of 3:1

(c) adjacent panel sections exceed a ratio of 3:1 (NORMAL LIGHTING)

LS-3 Compare highest and lowest illuminations recorded. Note if a ratio of 10:1 has been exceeded (NORMAL LIGHTING).

LS-4 Compute luminance ratios for indicator, legend, and annunciator lights measured.

Note any contrast of less than 10 percent. If contrasts are found to be inadequate, take additional readings of the dimmest of the remaining luminaires. Repeat until all luminaires with inadequate contrast have been identified.

LS-5 Are colors used in coding recognizable under both normal and emergency lighting conditions?

NOISE SURVEY (NS)

The noise survey covers items that could interfere with verbal communication or reception of auditory alarms.

NS-1 Take sound pressure level (SPL) readings at desks, each panel, and other control room operating stations. Note readings higher than 65 db(A).

NS-2 Take readings of annunciator alarms at locations used in NS-1. Note if alarm is not 10 db(A) above ambient at any location.

NS-3 Take readings adjacent to ventilation duct(s), printer(s), and door(s). Note if readings are 6 db(A) above average ambient level.

ANTHROPOMETRIC SURVEY (AS)

Anthropometric criteria, as presented in Section 6 of NUREG-0700 correspond in intent to Principle 3.2.2.5 of the Human Engineering Principles for Control Room Design Review, "Controls should be located so they are reachable and accessible," and to Principle 3.3.2.1, "Dislays should be readable to the required precision from the operating locations."

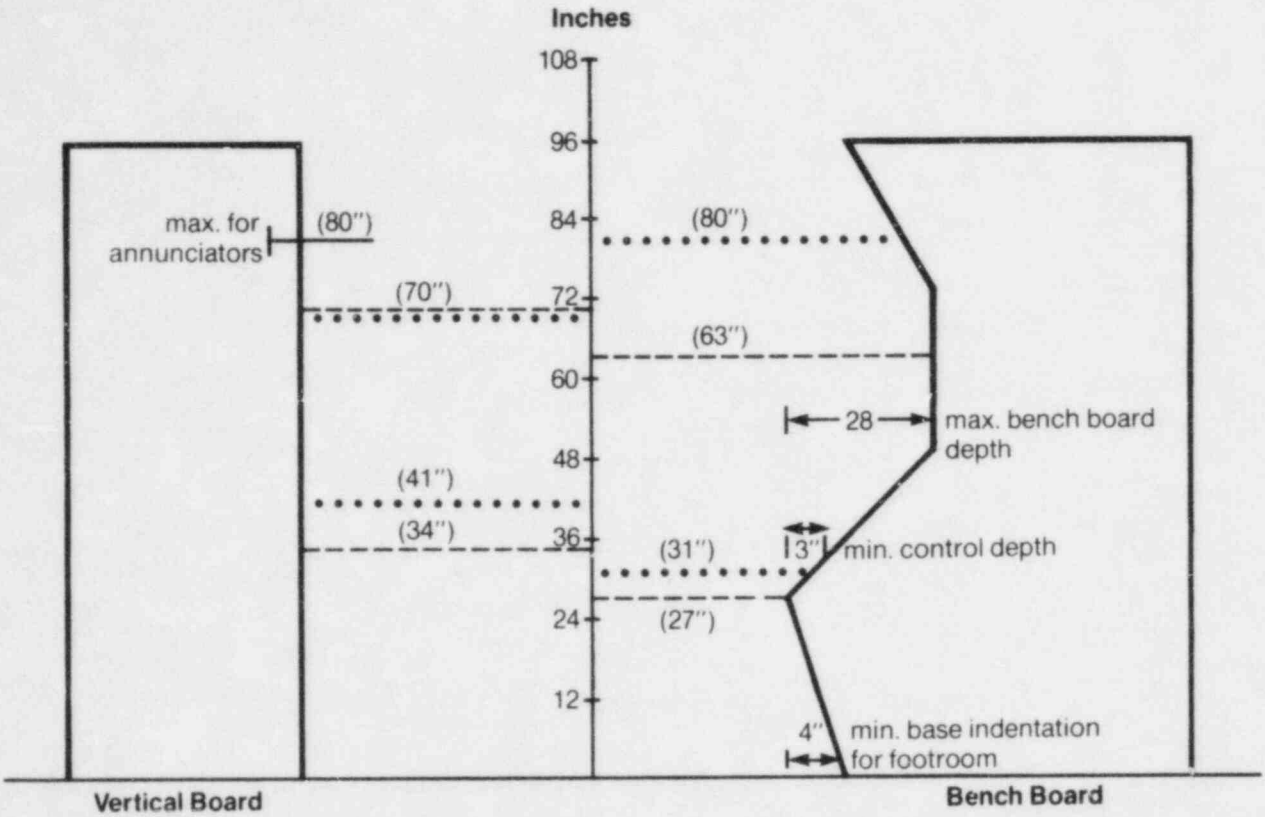
The proliferation of criteria measurements in NUREG-0700, Section 6, conflicts with NUREG-0700's injunction that "compliance with most of the workspace guidelines (items) can be determined by inspection" (p. 3-26).

For this reason, the Section 6 criteria have been condensed into a smaller number of screening measurements similar to placement limits in MIL-STD-1472C.

This condensation is intended to facilitate inspection. Viewing angle, reach envelope, etc., are reformulated in terms of simple placement limits for a prototypical control room. These dimensions have been derived from NUREG-0700, Section 6 criteria based on a benchboard depth of 25" and the anthropometric dimensions for fifth percentile females and ninety-fifth percentile males used by NUREG-0700.

Allowable benchboard depth has been relaxed from 25" to 28" to accommodate arm reach, including shoulder flexion (functional extended reach), as listed in MIL-STD-1472C for fifth percentile females. Measurements based on displacement of the face plane from the benchboard when operating annunciator controls, as recommended in 6.1.2.2.d, are felt reasonable and are applied to dimensions derived from 6.1.2.2.b, as well. Annunciator heights for vertical boards are based on acknowledgement with the face plane of the operator displaced from the panel by 24".

The recommended anthropometric criteria for benchboards, vertical boards, and sitdown consoles are illustrated in Figure AS-1, "Anthropometric Criteria For Benchboards, Vertical Boards, and Sitdown Consoles." Panels and consoles in the control room should be checked for compliance with these screening criteria.



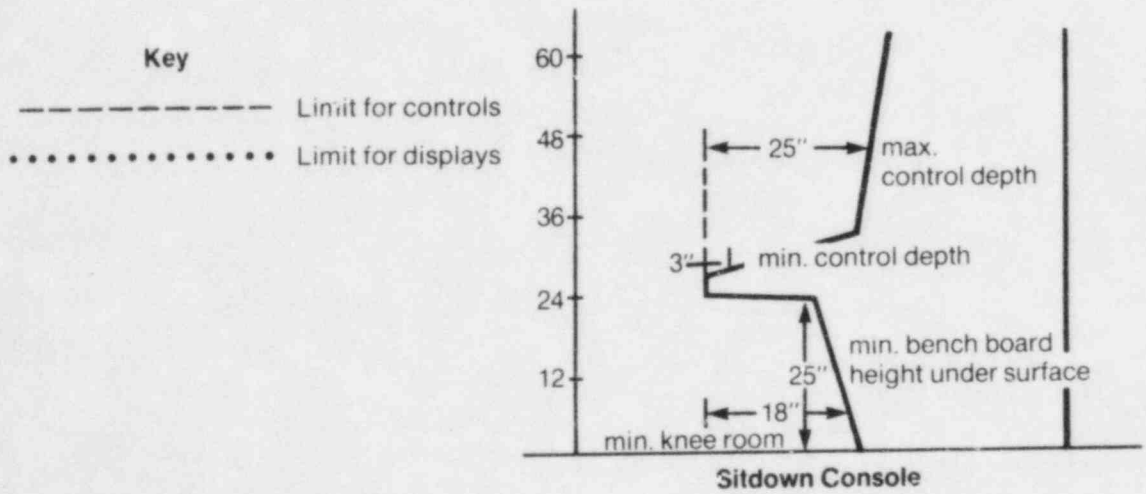


Figure AS-1. Anthropometric Criteria For Benchboards, Vertical Boards, and Sitdown Consoles

Benchboards

AS-1	Depth (max.)	28"
AS-2	Control depth (min.)	3"
AS-3	Base indentation (min.) (foot room)	4"
AS-4	Controls (min.)	27"
AS-5	Controls (max.)	63"
AS-6	Displays (min.)	31"
AS-7	Displays (max.)	range of 56"-70" for mechanical counters, 80" for annunciators

Vertical Boards

AS-8	Controls (min.)	34"
AS-9	Controls (max.)	70"
AS-10	Displays (min.)	41"
AS-11	Displays (max.)	70"
AS-12	Annunciators (max.)	vertical 80" 15° forward tilt 90" 30° forward tilt 95"

Sitdown Console

AS-13	Knee room (min.)	18"
AS-14	Benchboard height under surface (min.)	25"
AS-15	Control depth (min.)	3"
AS-16	Control depth (max.)	25"

AS-17 Measure smallest rotary control separations. Record separations of less than 4" (center to center) for "J-handles" and less than 2" for other controls.

AS-18 At a minimum, distance from back of desks to opposing surface(s) is 36".

AS-19 Displays including annunciator tiles are located and oriented so they can be read by operators.

AS-20 From a seated position, instruments and controls on other panels can be seen over the console.

ANNUNCIATOR SURVEY (ANS)

This survey covers items that are important determinants of the operation of annunciator systems.

Examine each annunciator panel.

ANS-1 Are tiles grouped functionally?

ANS-2 If alarms are prioritized, is the method of prioritization followed consistently?

ANS-3 List tiles with the following traits:

(a) They employ multiple-choice indication.

(b) They have legends that do not unambiguously specify alarmed point or disagree with abbreviation/acronym list.

(c) They are not associated with controls and displays on same panel segment.

ANS-4 List tiles that normally or frequently are on during normal operation.

COMMUNICATION SURVEY (CS)

The intent of many of the criteria contained in Section 6.2.1 of NUREG-0700 is to ensure the intelligibility of speech over the plant communications systems. The Articulation Index (US ANSI, S3.5) commonly is used to estimate speech intelligibility from such measurements. Direct intelligibility measurement, however, is preferable.

TESTING: The attached phonetically balanced (PB) word lists may be used for this purpose. All devices used for communication between the control room and plant should be tested. Select a "speaker" with a reasonably good speaking voice (if you have trouble understanding the person during normal conversation, then the test of communication devices will not be valid). The test list should be read slowly, without repetition. The "listener," who should have normal hearing, will write the words. The words then can be read back to the "reader" for checking (and for an additional rough check of the communications device). Use one list per communication device tested. Do not repeat lists with the same listener. You will want to test some devices, alternating the roles of "speaker" and "listener," so communication is tested in both directions. A number of plant areas covered by each device should be sampled. Locations with the highest noise levels, as well as less noisy locations, if less well equipped (such as absence of "hear-here" booths), should be tested. SPL readings should be taken at each location, and PB word lists communicated in each direction. If paging or alerting signals are employed, SPL readings should be taken for these signals to determine signal-to-noise ratio. Separate assessments using the PB word list should be run both with operators wearing face masks and for unimpeded voice communication among operators in the control room.

ASSESSMENT: Eighteen to 20 words correctly received correspond to an evaluation of the communication link as very good to excellent (Baranek, 1947). Three or more errors indicate potential problems. Note if alarm is not 10 db(A) above ambient noise at any location.

Checklist To Be Used With Communications Survey

CS-1 Handsets/cords should be examined to ensure the following:

(a) Handsets are easily held, with ear contact being maintained while speaking.

(b) Cords are of sufficient length to permit operator mobility.

(c) Cords are nonkinking or self-retracting.

CS-2 Sound-powered telephone system headsets are comfortable and held firmly in place.

CS-3 If used, walkie-talkies or portable communication devices are light, easy to carry, and allow manipulation of plant controls, when required.

CS-4 If gain adjustment can be made with an accessible control, it cannot be set so low that the device cannot be heard.

CS-5 To preclude wrong instrument system connections, jacks for the system being examined should differ from those used for other communication systems in the control room; otherwise, another means should be employed to make plugging into the wrong circuit obvious.

CS-6 Patch panels are conspicuously marked, accessible, and provided with a complete set of cords (N/A if not sound-powered phone).

CS-7 Switching for conventional-powered phones is maintained during emergency conditions.

COMMUNICATION SURVEY WORD LISTS

1	2	3	4
gill	such	smile	strife
perk	fate	pest	end
five	need	heap	toe
pick	log	hid	creed
gloss	hire	there	then
bought	dab	fern	box
wish	bean	deed	feast
nut	ways	hunt	grove
cloud	else	rub	slip
blush	fuss	use	is
snuff	shoe	not	pile
mute	moose	are	cleanse
corpse	trash	hive	bash
job	bait	plush	rag
knock	hit	ford	rise
tan	niece	dish	fraud
bounce	start	folk	bar
frog	bud	dike	such
rap	quart	wheat	nook
sludge	change	pen	death

ABBREVIATION AND ACRONYM SURVEY (AAS)

The purpose of this survey is to compile a list of abbreviations and acronyms commonly used in the control room. Violations of these conventions need not be determined at this time. Abbreviations used on annunciator windows and labels for words such as pump, steam, isolation, etc., should be recorded. Acronyms for system names found on annunciator windows, labels, and component identifications (such as LPI-311) should be recorded separately.

Using a sketch, also record symbols to make sure they are being used consistently.

Copies of these lists should be attached to the panel checklists so deviations may be noted. These lists also will be employed in the Systems Review to verify consistency between CR and EOF use of acronyms and abbreviations. Note that terms may either be spelled out or abbreviated, but when abbreviated, they should be abbreviated consistently.

ABBREVIATION AND ACRONYM SURVEY

WORD	ABBREVIATION OR ACRONYM
-A-	
Abnormal	
Accumulator	
Acid	
Activity	
Air	
Airborne	
Amperes	
Area	
Atmosphere	
Atomospheric	
Auxiliary	
Average	
-B-	
Bearing	
Bleed	
Blowdown	
Blower	
Booster	
Borate	
Boric	
Boron	
Bottom	
Breaker	
Building	
Bus	
Bypass	

WORD	ABBREVIATION OR ACRONYM
-C-	
Canal	
Charging	
Check	
Chemical	
Circuit	
Code	
Compressed	
Compressor	
Condensate	
Condenser	
Containment	
Control	
Coolant	
-D-	
Decade per minute	
Demineralized	
Demineralizer	
Detector	
Diesel	
Differential	
Disc	
Discharge	
Display	
Down	
Downcomer	
Drain	
Drive	
Drywell	
Dump	

WORD	ABBREVIATION OR ACRONYM
-E-	
Effluent	
Ejector	
Electrical	
Element	
Emergency	
Exchanger	
Exciter	
Exhaust	
Exhauster	
Exit	
External	
Extraction	
-F-	
Failure	
Fan	
Fast	
Feed	
Feedwater	
Flow	
Flux	
-G-	
Gallons	
Gallons per minute	
Gallons per hour	
Gas	
Gasket	
Gear	
Generator	
Gland	
Grid	

WORD	ABBREVIATION OR ACRONYM
-H-	
Hand/Auto	
Head	
Header	
Heat	
Heater	
High	
Holding	
Hotwell	
Hydraulic	
Hydrogen	
-I-	
Incore	
Indicator	
Injection	
Inlet	
Intermediate	
Iodine	
Isolation	
-J-	
-K-	
Kilovolt	
-L-	
Large	
Leak	
Leakoff	
Left	
Letdown	
Level	
Lift	

WORD	ABBREVIATION OR ACRONYM
-L- (continued)	
Light	
Lighting	
Limit	
Liquid	
Load	
Logarithm	
Low	
Lubrication	
-M-	
Main	
Manual	
Margin	
Mechanical	
Megawatt	
Monitor	
Motor	
-N-	
Neutron	
Nitrogen	
Normal	
Number	
-O-	
Oil	
Open	
Operating	
Operator	
Orifice	
Out	
Output	

WORD	ABBREVIATION OR ACRONYM
-O- (continued)	
Over	
Overspeed	
-P-	
Permissive	
Plot	
Pipe	
Poison	
Polisher	
Pool	
Power	
Pressure	
Pump	
-O-	
-R-	
Radiation	
Rate	
Reactor	
Refueling	
Relief	
Remote	
Revolutions per minute	
Right	
Rod	
Rotation	
Rotor	
Rupture	
-S-	
Safety	
Samarium	

WORD	ABBREVIATION OR ACRONYM
-S- (continued)	
Saturated	
Saturation	
Service	
Shut	
Shutdown	
Single	
Slow	
Solenoid	
Sound	
Sparger	
Speed	
Spray	
Stack	
Start	
Start-up	
Station	
Stator	
Steam	
Storage	
Strainer	
Stuck	
Subcooling	
Suction	
Sump	
Superheat	
Suppression	
Switch	

WORD	ABBREVIATION OR ACRONYM
-T-	
Tachometer	
Tailpipe	
Tank	
Temperature	
Thermal	
Total	
Transfer	
Transformer	
Trip	
Tripped	
Turbine	
-U-	
Unit	
-V-	
Vacuum	
Valve	
Ventilation	
Vibration	
Volts	
Volume	
-W-	
Waste	
Water	
-X-	
Xenon	
-Y-	
-Z-	

PLANT SYSTEMS AND EQUIPMENT

SYSTEM	ABBREVIATION OR ACRONYM
Area Radiation Monitoring System	
Auxiliary Feedwater System	
Balance of Plant	
Chemical and Volume Control System	
Containment Spray System	
Control Rod Drive System	
Decay Heat Removal System	
Emergency Service Water System	
High Pressure Injection System	
Incore Monitoring System	
Loose Parts Monitoring System	
Low Pressure Injection System	
Main Feedwater System	
Pressurizer Pressure Control System	
Pressurizer Level Control System	
Reactor Coolant System	
Reactor Protection System	
Reactor Vessel Level Instrumentation System	
Rod Position Indication System	
Safety Injection System	
Shutdown Cooling System	

EQUIPMENT	ABBREVIATION OR ACRONYM
Atmospheric Dump Valve	
Borated Water Storage Tank	
Boron Injection Tank	
Check Valve	
Code Safety Valve	
Condensate Booster Pump	
Condensate Storage Tank	
Condenser Dump Valve	
Incore Thermocouples	
Power-Operated Relief Valve	
Pressurizer	
Pressurizer Relief Tank	
Reactor Coolant Pump	
Reactor Vessel	
Refueling Water Storage Tank	
Resistance Temperature Detector	
Safety Valve	
Steam Generator	
Thermocouple	
Turbine Bypass Valve	
Turbine Generator	
Turbine Steam Supply Valve	
Turning Gear	

COLOR-CODING SURVEY (CCS)

The purpose of this survey is to compile a list of dominant color-coding conventions used in the control room. Violations of these conventions need not be determined at this time. It is suggested that this survey be conducted with the assistance of an operator. If no single convention is clearly dominant for a particular color meaning, this should be noted as well. The survey should include the following as a minimum: indicator lights, legend lights and switches, control handles, labels, any markings on meter faces, chart recorders, board coloring, demarcation lines, mimic lines, annunciator windows, and computer-generated displays. The operator should be asked to supply additional uses of color. Any meanings found for color not included in the attached list should be added. Text should be used freely to explain or qualify any of the recorded meanings. Copies of this list should be attached to the panel checklists so deviations may be noted.

COLOR-CODING SURVEY

COLOR	MEANING	COMMENTS
_____	Valve Open	_____
_____	Valve Closed	_____
_____	Breaker Open	_____
_____	Breaker Closed	_____
_____	Mid- or Transitional Position	_____
_____	On or Operating	_____
_____	Off or Not Operating	_____
_____	Start	_____
_____	Stop	_____
_____	Danger or Warning	_____
_____	Caution, Trouble, or Pre-trip	_____
_____	Trip or Failure	_____
_____	Automatic Operation or Control	_____
_____	Manual Operation or Control	_____
_____	Limit Condition	_____
_____	General Status	_____
_____	Hot	_____
_____	Cold	_____
_____	Channel	_____
_____	Train	_____
_____	Bus	_____
_____	Other (specify)	_____

CONTROL ROOM COMPUTER SURVEY (CRCS)

Process computers in the control room may vary widely in the functions they perform. These survey items are applicable to all process computers.

CRCS-1 Have three or more randomly selected operators initiate and complete all computer functions. Also have these operators use all computer controls (i.e., keyboards, joysticks, etc.). List any problems observed.

CRCS-2 Use the "Abbreviation and Acronym Survey" to check for consistent use in computer input/output.

Note excessive use of abbreviations in output (printers, CRTs) where not required by space limitations.

CRCS-3 Sketch each graphic or shape code and write its meaning to check for consistent use. List all displays that use more than 20 different codes.

CRCS-4 Obtain a list of messages and prompts and examine them to determine if they are complete and easily understood.

CRCS-5 Look for displays and data groups that re-occur in different contexts. Check to see that identical data in different presentations are displayed in a consistent, standardized manner.

CRCS-6 Under both emergency and normal lighting conditions, check to see that the following are true:

a. CRT screen flicker is not perceptible.
b. Alphanumeric and graphic characters are easily readable by the operator from the normal work station.
c. Glare does not interfere with reading CRT screens at normal operator viewing angles.

CRCS-7 CRT screens are located and oriented so they can be read easily by operators from their normal work station, representative criteria being the following:

a. The minimum viewing angle between the operator's line of sight and the plane of the CRT screen should be 45° or greater, as measured from the operator's normal work station.

b. For screens that require continuous or frequent monitoring or display important information (e.g., alarms), the screens comply with the following:

- o not more than 35° to the left or right of the operator's normal line of sight

- o not more than 20° above or 40° below the operator's horizontal line of sight (seated operator) or more than 35° above and 25° below the operator's horizontal line of sight (standing operator)

APPENDIX B

NONMEASURABLE ITEMS

INTRODUCTION

Certain items in NUREG-0700, Section 6, are statements of human engineering principles that, while desirable, are vague or unquantifiable. In general, these principles are represented within other parts of Section 6 by more specific objective items. Others are stated without specification of how compliance might be determined within the CRDR methodologies outlined in NUREG-0700.

To conduct a CRDR, it is necessary to express these items in objective form. This appendix contains a listing of such items, each listed item being a direct quote from NUREG-0700, Section 6.

6.1.1.2 CONSISTENCY OF MANNING WITH EQUIPMENT LAYOUT

b. UTILIZATION OF ADDITIONAL PERSONNEL--Additional on-site or off-site personnel may augment the normal crew complement under certain conditions (e.g., refueling). If so, activities and task assignments should be planned to ensure proper coordination. (Note: Special training for this situation may be required.)

Reason: This guideline can be addressed more definitively during the systems review. It should be noted, however, that the current scope of the CRDR systems review is limited to the analysis of generic emergency procedure guidelines and associated plant-specific systems. It does not include analysis of the tasks necessary to implement the utility site emergency plan.

6.1.1.3 FURNITURE AND EQUIPMENT LAYOUT

b. COMMUNICATIONS--Desk and console placement should facilitate voice communications from operators seated at those work stations to any point in the primary operating area.

Reason: This guideline will be addressed during the systems review portion of the CRDR.

c. OPERATOR ACCESS

(2) Operators should be able to position themselves conveniently for performing task actions at any work station.

Reason: This guideline will be addressed during the systems review portion of the CRDR.

d. CIRCULATION PATTERNS

(2) The control room arrangement should minimize interference between the members of the operational crew.

Reason: This guideline will be addressed during the systems review portion of the CRDR.

6.1.2.3 SIT-DOWN CONSOLE DIMENSIONS

a. CONSOLE HEIGHT TO SEE OVER

(2) See-over console heights above 45 inches may be acceptable, for example, where the seated operator need only monitor (not read) status lights and annunciators beyond the console, if they are at a suitable distance and height.

Reason: This guideline is not really a criterion but a principle to be used in assessing the potential consequences of an HED. The objective criteria concerning see-over consoles are contained elsewhere. No assessment will be attempted during the control room survey.

f. LATERAL SPREAD OF CONTROLS AND DISPLAYS

(2) For the situation described in item 1, above, and sustained or precise control action, the operator should be able to reach the controls without having to bend/stretch significantly (item not included).

Reason: This guideline will be addressed during operator interviews and the systems review.

6.1.2.4 SIT-STAND WORK STATIONS

c. KNEE ROOM--Knee room and comfortable foot support should be provided.

Reason: This guideline is addressed by objective criteria in the Anthropometric Survey.

6.1.2.5 VERTICAL PANELS

a. CONTROL HEIGHT

(2) Controls requiring precise or frequent operation and emergency controls should be placed in an area between 34 inches and 53 inches above the floor.

Reason: The determination of which controls must be manipulated precisely and/or frequently cannot be made during the survey. The height limits are addressed during the Anthropometric Survey. The functional requirement is dealt with during the systems review and by operator questionnaires.

b. DISPLAY HEIGHT

(2) Displays that must be read frequently or precisely should be placed in an area between 50 inches and 65 inches above the floor.

Reason: The determination of which displays must be read precisely and/or frequently cannot be made during the survey. The height limits are addressed during the Anthropometric Survey. The functional requirement is dealt with during the systems review and by operator questionnaires.

6.1.2.7 DESK DIMENSIONS

a. WORKING SPACE--Desks should provide enough clear working space for all materials required for task performance.

b. CHAIR POSITIONS--The desk should allow for different chair positions, as required, with adequate knee space.

c. OPERATOR COMFORT--The relationships of working surface height and area, knee room, and chair height should allow operators to work comfortably.

Reason: These guidelines are not quantifiable to a degree consistent with the objectives of the control room survey. Work space requirements for emergency operation will be addressed during the systems review, but operator seating and comfort should be ensured by using standard office model furniture.

6.1.3.1 UNIT INTEGRATION AND INTERFERENCE

a. EQUIPMENT ARRANGEMENT--Equipment should be arranged with movement and communication patterns in mind, so that unit operations do not interfere with each other.

Reason: This guideline is not suitable for assessment during a survey. The operator questionnaire addresses the functional criterion.

e. SHARED EQUIPMENT

(4) A single, centrally located control panel/console may be used for dual-unit control rooms within the same isolation boundary when this design does not conflict with the panel layout and control-display integration guidelines of Sections 6.8 and 6.9.

Reason: This guideline is not really a criterion but a justification for violating another guideline. There should be no assessment during the survey.

6.1.5.2 VENTILATION

b. AIR VELOCITY--Air velocities in the primary operating area should not exceed 45 feet per minute (fpm) measured at operator head level and should not produce a no iceable draught.

Reason: This guideline is addressed by Item OQ-32 in the Operator Questionnaire.

6.1.5.3 ILLUMINATION

g. REFLECTANCE--The amount of reflected light is affected by illuminated surface colors. Reflectance should conform to the recommendations shown in Exhibit 6.1-24. (See also Exhibit 6.1-25.) (Exhibit is not included.)

Reason: This guideline is not related directly to operator performance. The subject of glare and visual discomfort is addressed in the operator questionnaire and by other objective criteria.

6.1.5.5 AUDITORY ENVIRONMENT

a. BACKGROUND NOISE--Background noise should not impair verbal communication between any two points in the primary operating area. Verbal communications between these points should be intelligible using normal or slightly raised voice levels. See Exhibit 6.1-26 (conflicts with 6.1.5.5.b).

c. FURTHER REDUCTIONS--Further reductions in background noise may be required where communications between the primary operating area and other control room locations are necessary and voice transmission systems are not provided.

Reason: Both of these guidelines are covered in the noise survey, the operator questionnaire, and, for emergency operation, during the systems review.

6.1.5.7 AMBIENCE AND COMFORT

a. DECOR--Features to be considered include the following:

(1) color coordination

(2) use of color and lighting to create a cheerful atmosphere (without introducing glare and brightness to a degree that causes eye fatigue or an overly intense atmosphere)

(3) visual relief from arrays of instrumentation

(4) comfortable seating

(5) carpeting to lessen the fatigue of standing and walking

Reason: These guidelines are extremely subjective. The topic of operator comfort is addressed in a general way in the operator questionnaire.

c. REST AREA/LOUNGE--Consideration should be given to providing a rest area (possibly in conjunction with the eating area) conducive to relaxation and revitalization, especially where shifts are long.

Reason: This guideline is really a suggestion. The provision of a lounge facility is not directly related to operator performance.

6.2.1.2 CONVENTIONALLY POWERED TELEPHONE SYSTEMS

c. SWITCHING MECHANISM--Usually the switching function is accomplished by dial switching and the switching mechanism is located in the plant.

Reason: This guideline is really a definition. All definitions should be placed in a separate section of documentation, not interleaved with guidelines.

(1) Switching should be designed and/or programmed to minimize delay in making desired connections under both normal and emergency conditions.

Reason: The functional aspect of this guideline is addressed in the Communications Survey.

6.2.1.3 SOUND-POWERED TELEPHONE SYSTEMS

c. RINGING--Sound-powered phones require supplemental power, which is often hand-generated, to energize a ringing function. Often sound-powered phone circuits have no provision for ringing.

Reason: This guideline is really a definition. All definitions should be placed in a separate section of documentation, not interleaved with guidelines.

(1) Need for ringing must be determined for the individual plant depending on the sound-powered phone procedures.

Reason: This guideline is addressed in the Communications Survey.

e. SWITCHING

(1) The requirements for switching must be assessed for the individual plant depending on procedures for use of sound-powered phones.

Reason: This guideline is addressed in the Communications Survey.

6.2.1.4 WALKIE-TALKIE RADIO TRANSCEIVERS

b. AREA COVERAGE

(1) Modulation and a radio frequency should be chosen, as FCC regulations permit, to provide broad-area, walkie-talkie communication to the control room. One consideration for frequency selection should be radio-wave penetration of metal or reinforced concrete barriers, which at certain frequencies would tend to attenuate or bounce the signal.

Reason: The functional aspect of this guideline is addressed in the Communications Survey.

e. BATTERY REPLENISHMENT

(2) The stock should be kept large enough to support long periods of continuous operation in case of emergency.

Reason: Spare parts storage and inventory are addressed in the Administrative Procedures Survey.

6.2.1.8 EMERGENCY COMMUNICATIONS

c. VOICE COMMUNICATIONS WITH MASKS

(2) The diaphragms should be able to separate voice from exhaust valve action.

Reason: This guideline is covered by Item OAC-29 in the Operator-Assisted Checklist.

6.2.2.1 USE OF AUDITORY SIGNALS

c. SELECTION

(1) Auditory signals should be selected to avoid confusion with ambient control room noises.

(2) Auditory signals should be selected to avoid interference with other auditory sources, including verbal communication.

Reason: These guidelines are addressed in the operator questionnaire and, for emergency operation, during the systems review.

6.2.2.7 RELIABILITY

b. FALSE ALARMS--Auditory alarm systems should be designed so that false alarms are avoided.

Reason: This guideline is addressed in the Operator Questionnaire.

6.3.1.2 ALARM PARAMETER SELECTION

a. SET POINTS

(2) However, set points should be established to give operators adequate time to respond to the warning condition before a serious problem develops.

Reason: The functional aspect of this guideline is addressed during the systems review.

6.3.1.3 FIRST-OUT ANNUNCIATORS

d. APPLICATION--First-out annunciators should conform to the general auditory, visual, and operator response guidelines of this section.

Reason: The necessity for, and adequacy of, first-out annunciators will be determined during the systems review.

6.3.1.5 CLEARED ALARMS

b. VISUAL SIGNAL

(1) A special flash rate

(2) Reduced brightness

(3) A special color, consistent with the overall control room color coding scheme, produced by a differently colored bulb behind the tile.

Reason: These guidelines are, in fact, suggestions. There are many more ways to signal a cleared alarm than those presented by these guidelines.

6.4.1.1 GENERAL PRINCIPLES

b. ECONOMY--Each control should be necessary, and the simplest effective control for the task concerned.

(1) There should be a good reason to require a control for the function concerned.

(2) Duplication of controls should not occur, except for a specific reason.

(3) The precision and range of a control should not greatly exceed the need.

(4) Selected controls should be economic of space.

Reason: As the subsection title states, these guidelines are really general principles and, as such, should not be included in a survey. The principles related to a control room design review are addressed elsewhere.

6.4.1.2 PREVENTION OF ACCIDENTAL ACTIVATION

a. PROPER LOCATION--Controls should be located and oriented so that the operator is not likely to strike or move them accidentally in any sequence of control movements.

Reason: This guideline is really a general principle. However, the functional equivalent of this principle is addressed in the operator questionnaire and, for emergency operation, during the systems review.

b. FIXED PROTECTIVE STRUCTURES

(1) Controls may be recessed, shielded, or otherwise surrounded by physical barriers. (See Exhibit 6.4-1.) (Exhibit is not included.)

Reason: This guideline is really an example of a particular method for preventing accidental activation. It should be classified as such and not be included as a guideline.

c. MOVABLE COVERS OR GUARDS

(1) Controls may be covered or guarded with movable (e.g., hinged) barriers. (See Exhibit 6.4-2.) (Exhibit is not included.)

Reason: This guideline is really an example of a particular method for preventing accidental activation. It should be classified as such and not be included as a guideline.

d. INTERLOCKING CONTROLS--Controls may be provided with interlocks so that:

(1) Extra movement is required (e.g., a side movement out of a detent position or a pull-to-engage clutch).

(2) Prior operation of a related or locking control is required.

Reason: This guideline is really an example of a particular method for preventing accidental activation. It should be classified as such and not be included as a guideline.

g. CHOICE OF ACTION--Rotary action controls should be used in situations where linear or push-button controls would be subject to inadvertent activation and fixed protective structures are impractical or inappropriate.

Reason: This guideline is really a suggestion. There are other acceptable methods to prevent accidental activation when a fixed, protective structure is not used. Any such method will be validated for emergency operation during the systems review.

6.4.4.2 J-HANDLES

b. LOW-TORQUE DESIGNS--For certain purposes, smaller scale J-handles may be used. In such cases the handle proportion usually has a flattened or flared tip for finger placement, and the clearance between handle and panel surface can be less.

Reason: This guideline is really just a general statement, without any associated criteria to determine compliance. The adequacy of any control or switch will be determined through operator questionnaires and, for emergency operation, during the systems review.

6.4.4.5 ROTARY SELECTOR CONTROLS

d. POSITION INDICATION

(1) Position indication should be provided. Desirable alternatives are:

(a) illuminated indicator lights

(b) a line engraved both on the top of the knob and down the side

Reason: These guidelines are suggested methods for meeting a very general principle. The methods used for indicating the position of a rotary selector will be reviewed for adequacy using objective criteria given elsewhere.

6.5.1.1 INFORMATION TO BE DISPLAYED

a. TASK ANALYSIS--Analysis of operator tasks in relation to system engineering and system functional objectives is recommended as the surest means of establishing operator information requirements.

Reason: This guideline is really a recommendation. As such, it should not be included in a survey. Task analysis will be performed for emergency operation during the systems review.

c. UNNECESSARY INFORMATION--Efficient performance requires not only display of all needed information but also avoiding the display of extraneous information in the prime operating area.

d. REDUNDANCY--Redundancy in the presentation of information items should be limited to cases where needed for backup or to avoid excessive operator movement.

Reason: These guidelines are really principles that require extensive analysis to determine compliance. Control room information requirements are addressed in other phases of the CRDR.

6.5.1.2 USABILITY OF DISPLAYED VALUES

c. PERCENTAGE INDICATION--Percentage indication may be used when the parameter is meaningfully reflected by percentage.

f. SENSITIVITY--Display dynamic sensitivity should be selected to minimize the display of normal, random variations in equipment performance.

Reason: The usability of displayed information in the control room cannot be addressed adequately during the control room survey since usability depends on task-specific requirements. Information usability will be addressed in other phases of the CRDR.

6.5.1.6 COLOR CODING

b. NUMBER OF COLORS

(1) The number of colors used for coding should be kept to the minimum needed for providing sufficient information.

Reason: This guideline is a general statement of principle, without any objective criteria to determine compliance. The use of color-coding is addressed in the checklists provided in Appendix A.

e. PRINCIPLES OF COLOR SELECTION

(1) The primary principle that should be applied in selecting colors for coding purposes that do not have the immediate safety implications of red, green, and amber is to ensure

that each color is recognized as different from any other. Exhibit 6.5-7 lists 22 colors of maximum contrast. Each successive color has been selected so that it will contrast maximally with the color just preceding it and satisfactorily with earlier colors in the list. The first 9 colors have been selected so as to yield satisfactory contrast for red-green-deficient as well as color-normal observers. The remaining 13 colors are useful only for color-normal observers. (Exhibit is not included.)

Reason: This guideline is really a general principle, along with suggestions as to possible colors to be adopted for use in a control room. Ths discriminability of control room colors will be addressed in other phases of the CRDR.

(2) Colors selected for coding should contrast well with the background on which they appear.

Reason: This guideline is really a general principle with no supporting criteria. The quantification of color contrast is a difficult task. Achromatic contrast will be determined quantitatively during the lighting survey and subjectively through the operator questionnaire.

6.5.4.1 GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS

g. USE--As a general rule, recorders should be used to record trend information and material that may be needed for later reference.

Reason: As its title indicates, this guideline is really a general principle with no supporting criteria. Recorders are treated as display devices of what they are used to record. Their suitability is addressed during other CRDR activities.

6.5.5.2 ELECTRONIC COUNTERS

c. CONTRAST--Character-to-background contrast ratio should be between 15:1 minimum and 20:1 preferred.

Reason: It is not necessary to supply a separate contrast guideline for electronic counters. These devices will be treated as any other display and will be surveyed accordingly.

6.6.2.3 SPATIAL ORIENTATION

Improperly oriented labels can lead to confusion and cause delays in location and identification of important controls and/or displays.

a. HORIZONTAL ORIENTATION

(2) Although not normally recommended, vertical orientation may be used only where space is limited.

Reason: The placement of labels with respect to labeled control board components is addressed in the Label, Mimic, and Demarcation Survey.

6.6.3.1 KINDS OF INFORMATION

b. SECONDARY FUNCTION--If needed for clarity, engineering characteristics or nomenclature may also be described.

Reason: Clarity of labels is addressed in the operator questionnaire. The control room survey is not an appropriate vehicle for determining the information necessary for labels.

6.6.3.9 ACCESS OPENING, DANGER, WARNING, AND SAFETY INSTRUCTION LABELING

b. DANGER, WARNING, AND SAFETY INSTRUCTION LABELS--All danger, warning, and safety instruction labels should be in accordance with appropriate safety standards.

Reason: This guideline is a general suggestion without specific supporting criteria. The adequacy of labels or instructions associated with protective equipment or emergency procedures is addressed during other survey activities or the systems review.

6.6.6.4 USE OF MIMICS

b. MIMIC LINES

(1) Differential line widths may be used to code flow paths (e.g., significance, volume, level).

Reason: This guideline is really a suggestion for coding by line width. The Label, Mimic, and Demarcation Survey contains objective criteria for mimics.

6.7.1.5 COMPUTER FUNCTION CONTROLS

a. CONTROL DESIGN--When dedicated controls are used for selection of computer or display functions or modes, the design of the controls should conform to the appropriate guidelines specified in Section 6.4, Controls.

Reason: This is redundant with other items.

6.7.2.1 CRT DISPLAY CHARACTERISTICS

h. CRT DISPLAY CONTROLS

(2) Adjustment controls should conform to the appropriate guidelines in Section 6.4, Controls, and Section 6.9, Control Display Integration.

Reason: This is redundant with other items.

6.7.2.7 GRAPHIC CODING AND HIGHLIGHTING

f. INVERSE VIDEO--Image reversal (e.g., dark character is on a light background) should be used primarily for highlighting in dense data fields, such as a word or phrase in a paragraph of text, or a set of characters in a table of data.

Reason: This is a suggestion rather than a prescriptive statement.

g. USE OF GRAPHIC CODING--Graphic coding methods (e.g., symbols, boxes, underlines, colors) should be used to present standard qualitative information to the operator or to draw the operator's attention to a particular portion of the display.

Reason: This is a suggestion rather than a prescriptive statement.

6.8.1.1 ASSIGNING PANEL CONTENTS

c. GROUPING BY IMPORTANCE AND FREQUENCY OF USE--Within the constraints of grouping by task sequence and by system function, controls and displays should be assigned to panels depending on their importance and frequency of use. Controls or displays that are neither important to plant safety nor frequently used should be installed in secondary panel locations.

Reason: The control room survey is not an appropriate activity in which to determine which controls and displays are "important to plant safety . . . or . . . frequently used . . . ." The suggestion for assignment of controls or displays to specific panels is inappropriate, since this survey is part of an overall review of existing panel layout. The systems review will address the adequacy of existing board layout for emergency operation.

6.8.1.3 ENHANCING RECOGNITION AND IDENTIFICATION

Several enhancement techniques are available for setting apart groups of controls and displays. Three preferred techniques for enhancement are spacing, demarcation, and color shading. Other

acceptable techniques for setting apart groups of controls include the use of insert panels and added panel relief.

a. SPACING--Spacing consists of physically separating groups of components on a panel with enough space between groups so that the boundaries of each group are obvious. Spacing between groups should be at least the width of a typical control or display in the group (see Exhibit 6.8-1). (Exhibit is not included.)

b. DEMARCATION--Demarcation consists of circumscribing functional or selected groups of controls and displays with a contrasting line. The application of demarcation techniques should conform to Guideline 6.6.8.2. (See also Exhibit 6.8-1.) (Exhibit is not included.)

c. COLOR SHADING--Color shading may be used to enhance recognition of controls, displays, or functional groups. When color shading is used, colors should provide adequate contrast, and should be consistent with other color coding in the control room.

Reason: These guidelines are really suggestions for control board enhancement methods. The control room survey should not address potential enhancement methods, since the specific method chosen, if any, will depend on the output from other CRDR activities.

6.8.2.1 SEQUENCE, FREQUENCY OF USE, AND FUNCTIONAL CONSIDERATIONS

b. FREQUENCY OF USE--Frequently used controls and displays should be arranged to reduce search time and minimize the potential for error during use.

(1) They should be near the center of the preferred visual and manual areas.

(2) They should be positioned so as to be easily identified.

Reason: These guidelines are really descriptions of specific design considerations. The Control Room Survey is part of an overall review of existing panel layout. The systems review will address the adequacy of existing control and display layout for emergency operation.

c. FUNCTIONAL CONSIDERATIONS--Functionally related controls and displays should be grouped together when they are:

(1) used together to perform tasks related to a specific function (e.g., operation of the residual heat removal system)

(2) identical in purpose (e.g., reactor coolant pumps)

Reason: These guidelines are really descriptions of specific design considerations. The Control Room Survey is part of an overall review of existing panel layout. The systems review will address the adequacy of existing control and display layout for emergency operation.

6.8.2.2 LOGICAL ARRANGEMENT AND LAYOUT

b. OTHER EXPECTATIONS--Where other operator expectations can be identified, components should be arranged to match these expectations.

Reason: The Control Room Survey is not the appropriate place to identify operator expectations. The Operator Questionnaire and, for emergency operation, the systems review will address the adequacy of existing control board layout.

6.8.3.1 SEPARATION OF CONTROLS

b. INADVERTENT ACTUATION--Control actuation should not result in inadvertent actuation of an adjacent control.

Reason: The functional aspect of this guideline is addressed during the Operator Questionnaire and, for emergency operation, during the systems review.

6.9.1.1 SINGLE CONTROL AND DISPLAY PAIRS

c. ASSOCIATION--Related controls and displays should be easily identified as being associated. This association can be established (or enhanced) by (1) location, (2) labeling, (3) coding, (4) demarcation, and (5) consistency with operator expectations. The following relationships should be immediately apparent to the operator:

(3) the rate and limits of movement of the control and display

Reason: The control room survey is not the appropriate place to determine either the adequacy of rates and limits for controls and displays or the necessity that these characteristics be obvious to operators. The Operator Questionnaire and the systems review will address this issue.

6.9.2.2 SINGLE PANEL ARRANGEMENTS

e. CONTROL/DISPLAY PACKAGES--When controls and related displays are assembled using modular, packaged units, the design of the packages will limit the location and arrangement that can be achieved. In this case, modules should be selected and arranged to achieve maximum conformity with the principles described above.

Reason: This guideline invokes certain design principles related to modular control and display placement. The control room survey is part of an overall review or existing panel layout. The systems review will address the adequacy of existing control and display layout for emergency operation.

6.9.3.2 CONTROL-DISPLAY RATIO

c. EXCESS PRECISION--Both displays and controls should have a precision which does not greatly exceed that required.

Reason: The determination of how much precision is "required" is beyond the scope of the Control Room Survey. The Operator Questionnaire and the systems review will address the adequacy of control and display precision.

APPENDIX C

REDESIGN ITEMS - SYSTEMS

INTRODUCTION

An effort has been made by the NRC to assure utilities that the CRDR required by Task I.D.1 of NUREG-0737 ". . . [is] not a redesign effort for operating control rooms."

Certain items within NUREG-0700, however, reference "preferred designs" rather than human engineering design principles. These items are considered by this approach to be redesign guidance to be used in the "Selection of Design Improvements" phase of CRDR.

This appendix provides a listing of items requiring redesign. When the "preferred design" has not been followed in a control room under review, additional survey items are considered to determine whether the associated human engineering principle(s) has been violated.

6.1.1.3 FURNITURE AND EQUIPMENT LAYOUT

f. EQUIPMENT-TO-OPPOSING-SURFACE DISTANCE--Enough space should be allowed so that personnel can perform all required tasks. The space should accommodate kneeling and bending, simultaneous work by more than one operator, and simultaneous performance of operational and maintenance tasks as may be required. Recommended minimum separations are illustrated in Exhibit 6.1-4. (Exhibit is not included.)

(1) A minimum separation of 50 inches is recommended between a single row of equipment/panel and a wall or other opposing surface.

(2) A minimum separation of 50 inches is also recommended between two rows of facing equipment if both rows are worked by a single operator.

(3) A minimum separation of 8 feet is recommended between opposing rows of equipment where more than one person must work simultaneously on operational or maintenance tasks and kneeling, bending, or use of test equipment may be necessary.

6.3.1.3 FIRST-OUT ANNUNCIATORS

As an aid to diagnostic procedures, provision should be made for identifying the initiating event (first out) associated with automatic plant shutdowns.

a. REACTOR SYSTEM

(1) A separate first-out panel should be provided for the reactor system.

(2) The first-out panel should consist of separate annunciator tiles for each of the automatic reactor trip functions.

(3) In the event of a reactor trip, the tile associated with the event should illuminate, and no other.

b. TURBINE-GENERATOR SYSTEM--A separate first-out panel, similar in function to the reactor system panel, is recommended.

c. POSITION--First-out panels should be located directly above the main control work station for the system.

6.3.1.4 PRIORITIZATION

b. PRIORITY CODING

(2) Auditory signal coding for priority level is also appropriate. See Guideline 6.2.2.3 for recommended coding techniques.

6.3.1.5 CLEARED ALARMS

a. AUDITORY SIGNAL--Cleared alarms should have a dedicated, distinctive audible signal which should be of finite duration.

6.3.4.1 CONTROLS

b. ACKNOWLEDGE

(2) Acknowledgement should be possible only at the work station where the alarm originated.

c. RESET

(3) The reset control should be effective only at the work station for the annunciator panel where the alarm initiated.

6.5.1.6 COLOR CODING

c. MEANING OF COLORS

(2) Red, green, and amber (yellow) should be reserved for the following uses:

Red: unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolerance.

Green: safe, no operator action required, or an indication that a parameter is within tolerance.

Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value or parameter exists.

6.8.2.4 STANDARDIZATION

b. SIMULATOR-TO-CONTROL ROOM STANDARDIZATION--Standardization should be maintained where simulators or procedure trainers are used that simulate the actual operational equipment.

APPENDIX D

REDESIGN ITEMS - COMPONENTS

INTRODUCTION

The "Survey Orientation" for the "Controls Survey" section in NUREG-0700 states, "Measurements should be made when there is a reasonable doubt about conformance to a guideline (item) criterion." The items in this appendix are made up predominantly of procurement specifications from MIL-STD-1472. The measurement of all controls to determine their conformance to these procurement specifications is time-consuming and not necessarily performance-related.

The control room survey methodology presented in this survey development guideline does not require individual controls to be compared to the items in this appendix unless a reasonable doubt about conformance is established.

Reference to a control characteristic covered by these criteria in response to operator questionnaire items dealing with the involved human engineering principle(s) is the method used by this CRDR methodology to establish "reasonable doubt."

6.1.1.3 FURNITURE AND EQUIPMENT LAYOUT

(2) Lateral space for a seated operator should be no less than 30 inches (see Exhibit 6.1-3). (Exhibit is not included.) Greater latitude is preferable.

6.2.1.2 CONVENTIONALLY POWERED TELEPHONE SYSTEMS

d. TELEPHONE RINGING--Loudness of ringing should be adjustable at the individual telephone instrument.

6.2.2.3 AUDITORY CODING TECHNIQUES

b. PULSE CODING--Auditory signals may be pulse-coded by repetition rate, but the number of codes should be limited (2 or 3). Repetition rates should be sufficiently separated to ensure operator discrimination.

c. FREQUENCY CHANGE CODING--If modulation of the frequency (Hz) of a signal denotes information, center frequencies should be between 500 and 1000 Hz.

d. DISCRETE FREQUENCY CODING--Discrete frequency codes may be used for audible signal coding. Frequencies should be broad band ($\pm$100Hz) and widely spaced within the 200 to 5000-Hz range. No more than 5 separate frequencies should be used.

6.2.2.4 PROPAGATION OF SIGNALS

a. DIRECTION OF SOUND--Sound sources (speakers, buzzers, etc.) should direct sound toward the center of the primary operating area.

6.2.2.5 FREQUENCY

a. RANGE--Auditory signal frequencies should be between 200 and 5000 Hz. The optimum frequency range is between 500 and 3000 Hz.

b. BAND WIDTH--Wide-band auditory signals of approximately 200 Hz should be used.

6.3.3.2 VISUAL ALARM RECOGNITION AND IDENTIFICATION

b. FLASH RATE--Flash rates should be from 3 to 5 flashes per second with approximately equal on- and off-times.

6 4.1.2 PREVENTION OF ACCIDENTAL ACTIVATION

f. SEQUENTIAL ACTIVATION--When a strict sequential activation is necessary, controls should be provided with locks to prevent the controls from passing through a position. Further movement should require a new control action.

6.4.2.2 CODING OF CONTROLS

c. SIZE CODING

(1) No more than three different sizes of controls should be used for discrimination by absolute size.

(3) When knob diameter is used as a coding parameter, differences between diameters should be at least 0.5 inch.

(4) When knob thickness is a coding parameter, differences between thicknesses should be at least 0.4 inch.

6.4.3.2 ROUND PUSHBUTTONS

For best operation, pushbutton parameters should be as follows. (See Exhibit 6.4-7.) (Exhibit is not included.)

a. Diameter (D) for fingertip operation (inches)

(1) Unguarded and nonrecessed pushbuttons: Minimum 0.385

(2) Guarded or recessed pushbuttons: Minimum 0.75

b. Diameter (D) for thumb or heel of hand operation (inches): Minimum 0.75

c. Displacement (A) for thumb or finger operation (inches): Minimum 0.125

6.4.3.3 LEGEND PUSHBUTTONS

e. LEGEND PUSHBUTTON DIMENSIONS--For maximum effectiveness of legend pushbutton controls, the following dimensions should be used (see Exhibit 6.4.8). (Exhibit is not included.)

(1) Size (S) (inches): Minimum 0.75; Maximum 1.5

(2) Displacement (A) (inches): Minimum 0 (touch plate); Minimum 0.125 (all others); Maximum 0.250

(3) Barrier width (B_w) (inches): Minimum 0.125

(4) Barrier depth (B_d) (inches): Minimum 0.183; Maximum 0.250

6.4.4.2 J-HANDLES

a. HIGH-TORQUE DESIGNS--J-handles should conform to dimensions as follows (see Exhibit 6.4-9). (Exhibit is not included.)

(1) Length (L) (inches): Minimum 3.75; Optimum 4.0

(2) Clearance (C) (inches): Minimum 1.0; Optimum 2.0

6.4.4.3 KEY-OPERATED CONTROLS

b. TEETH: SINGLE ROW--Keys with a single row of teeth should be inserted into the lock with the teeth pointing up or forward.

c. TEETH: DOUBLE ROW--If keys have teeth on both edges, they should fit the lock with either side up or forward.

g. KEY-OPERATED CONTROL DIMENSIONS--The following dimensions should be used for key-operated controls (see Exhibit 6.4-10). (Exhibit not included.)

(1) Displacement (A) (degrees): Minimum 80°; Maximum 90°

(2) Height (H) (inches): Minimum 0.5; Maximum 3.0

6.4.4.4 CONTINUOUS ADJUSTMENT ROTARY CONTROLS

c. DIMENSIONS

(1) Fingertip grasp knobs should conform to the following dimensions:

(a) Height (inches): Minimum 0.5; Maximum 1.0

(b) Diameter (inches): Minimum 0.375; Maximum 4.0

(2) Thumb and forefinger encircled knobs should conform to the following dimensions:
Diameter (inches): Minimum 1.0; Maximum 3.0

6.4.4.4 CONTINUOUS ADJUSTMENT ROTARY CONTROLS

e. CONTINUOUS ADJUSTMENT ROTARY CONTROLS WITH KNOB SKIRTS--If knob skirts are used, such controls should conform to approximately the following dimensions. See Exhibit 6.4-12. (Exhibit is not included.)

(1) Skirt diameter (D_S): 2.0 inches.

(2) Skirt height (H_S): 0.25 inch.

(3) Finger stop diameter (D_F): 1.25 inches.

(4) Finger stop height (H_F) plus rotary knob height (H_K): total 0.75 inch.

(5) Knob diameter (D_K): 0.75 inch.

6.4.4.5 ROTARY SELECTOR CONTROLS

a. SELECTION--Rotary selector controls should be used when three or more detented positions are required, and may be used for two-detented position operation.

b. POSITIONING

(3) A maximum of 24 positions should be used on a rotary selector control.

6.4.4.5 ROTARY SELECTOR CONTROLS

e. DIMENSIONS--Recommended dimensions for rotary selector switches are as follows (see Exhibit 6.4-13) (Exhibit not included.):

(1) Length (L) (inches): Minimum 1.0

(2) Width (W) (inches): Maximum 1.0

(3) Diameter (D) (inches): Minimum 1.0

(4) Depth (H) (inches): Minimum 0.625

6.4.5.1 THUMBWHEELS

b. CODING--If the thumbwheel is used as an input device, the OFF, zero, or normal position should be coded to facilitate visual recognition of status.

c. CONTINUOUS ADJUSTMENT THUMBWHEELS--The dimensions of thumbwheel controls that permit continuous adjustment (not stepped or detented) should be as follows:

(1) At least 1 inch of the wheel should be exposed to permit easy manipulation.

d. DISCRETE SETTING (STEPPED) THUMBWHEELS

(2) Discrete thumbwheel controls should conform to the following specifications. (See Exhibit 6.4-14.) (Exhibit is not included.)

(a) Diameter (D) (inches): Minimum 1.5; Maximum 2.5

(b) Trough distance (L) (inches): Minimum 0.45; Maximum 0.75

(c) Width (W) (inches): Minimum 0.1

(d) Depth (H) (inches): Minimum 0.125; Maximum 0.5

6.4.5.2 SLIDE SWITCHES

b. DIMENSIONS--Slide switches should conform to approximately the following dimensions. See Exhibit 6.4-15. (Exhibit is not included.)

(1) Thickness (T): 0.25 inch.

(2) Length (L): 1.0 inch.

6.4.5.3 TOGGLE SWITCHES

c. DIMENSIONS--To ensure the most effective use, toggle switches should conform to the following dimensions. See Exhibit 6.4-16. (Exhibit is not included.)

(1) Arm length (L), for use by one finger (inches): Minimum 0.5; Maximum 2.0

(2) Tip diameter (D) (inches): Minimum 0.125; Maximum 1.0

(5) Displacement (A), two position (degrees): Minimum 30°; Maximum 120°

(6) Displacement (A), three position (degrees between settings): Minimum 18°; Maximum 60°; Optimum 25°

6.4.5.4 ROCKER SWITCHES

b. INDICATION OF ACTIVATION

(2) In the ON position, the top of the switch should be flush with the panel surface.

e. ROCKER SWITCH DIMENSIONS--For maximum effectiveness, rocker switches should conform to the following dimensions (see Exhibit 6.4-17). (Exhibit is not included.)

(1) Width (W) (inches): Minimum 0.75; Maximum 1.5

(3) Displacement, two-position switches (A) (degrees): Minimum 30°; Maximum 120°

(4) Displacement, three-position switches (A) (degrees): Minimum 18°; Maximum 60°; Optimum 25°

6.5.1.4 PRINTING ON THE DISPLAY FACE

b. AVOIDANCE OF EXTRANEOUS ITEMS--Categories of information not needed in using the display should be avoided (e.g., patent notices, manufacturer's trademark or address).

6.5.1.5 SCALE MARKING

b. GRADUATION HEIGHT--Graduation heights as a function of viewing distance should be as indicated in Exhibit 6.5-4.

VIEWING DISTANCE (feet)	INDEX HEIGHT (inches) Major	Intermediate	Minor
1-1/2 or less	0.22	0.16	0.09
3 or less	0.40	0.28	0.17
6 or less	0.78	0.56	0.34
12 or less	1.57	1.12	0.65
20 or less	2.63	1.87	1.13

Exhibit 6.5-4. Index Heights For Various Viewing Distances.

6.5.5.1 DRUM-TYPE COUNTERS

a. NUMERICAL PRESENTATION FACTORS

(3) GROUPING OF NUMERALS--If more than 4 digits are required, they should be grouped and the groupings separated as appropriate by a comma, by a decimal point, or by additional space (see Exhibit 6.5-15). (Exhibit is not included.)

b. MOUNTING

(3) The window should be sized to allow no more than 1 digit per drum to appear in the window at any one time.

c. DRUM MOVEMENT

(1) Numbers should change by snap action rather than through continuous movement.

APPENDIX E

UNCHARACTERISTIC ITEMS

INTRODUCTION

The items listed in this appendix are considered inappropriate as written for a CRDR survey either because they are not characteristic of the equipment in present-day control rooms or because violation of the item is highly improbable.

6.1.2.4 SIT-STAND WORK STATIONS

b. CHAIR HEIGHT--The operator should be provided with a high chair so that the seated eye height is approximately the same as standing eye height.

6.2.1.6 ANNOUNCING SYSTEMS

b. MICROPHONE CHARACTERISTICS

(5) Microphone input should be provided within the control room.

6.2.2.7 RELIABILITY

a. FAILURE OF ALARM CIRCUITRY--Failure of auditory signal circuitry should not adversely affect plant equipment.

6.3.1.4 PRIORITIZATION

a. LEVELS OF PRIORITY

(1) Prioritization should be accomplished using a relatively small (2-4) number of priority levels.

6.5.1.6 COLOR CODING

b. NUMBER OF COLORS

(2) The number of colors used for coding should not exceed 11.

6.5.2.2 POINTERS

a. POINTER TIP FORM

(1) Pointer tips should be simple. Examples of preferred- and non-preferred types are given in Exhibit 6.5-11. (Exhibit is not included.)

6.5.4.1 GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS

d. PAPER TAKEUP AND CUTOFF--A takeup spool should be provided to receive completed recordings. On most instruments this is provided as an inherent part of the design. Also, means should be provided for tearing off completed records for storage.

6.6.2.2 MOUNTING

b. SURFACE--Labels should be mounted on a flat surface.

6.7.1.1 SOFTWARE SECURITY

c. EDITING--When characters, words, or phrases are to be inserted, such items should first be collected and displayed on a buffer area of the screen, and then collectively inserted by one operator command.

Reason: Storage of input characters in a suffered display is in our experience a universal practice.

6.7.1.4 DATA ENTRY - KEYBOARDS

h. VISUAL FEEDBACK--Data being entered via keyboards should be displayed as it is keyed.

Reason: This is a universal practice.

APPENDIX F

ITEMS THAT MIGHT DEGRADE PERFORMANCE

INTRODUCTION

The items listed in this appendix are considered inappropriate as criteria for a control room survey either because they will tend to degrade operator performance or they conflict with other items that are more appropriate.

The reason for discarding each item is listed directly below the item in question.

6.2.2.1 USE OF AUDITORY SIGNALS

a. DEDICATED USE--Systems used to transmit non-verbal auditory signals should be used only for that purpose.

Reason: This prohibits alerting signals for public address system or walkie-talkie use.

6.5.4.1 GENERAL CHARACTERISTICS OF GRAPHIC RECORDERS

h. PLACEMENT OF RECORDERS--As devices that must be verified and attended by the operator, graphic recorders should, in principle, be located within the primary operating area rather than on back panels.

Reason: The proliferation of displays within the primary operating area is a root problem behind CRDR requirements. Recorders are both bulky and rarely used directly in controlling the plant. A new item is suggested: "Graphic recorders should, in principle, be located on back panels unless there are evolutions in which the recorder is directly referenced to control the plant."

6.9.3.1 GENERAL MOVEMENT RELATIONSHIPS

c. DISPLAY RESPONSE TIME LAG

(2) When there is a time lag between control actuation and ultimate system state, there should be an intermediate feedback indication of the process and direction of parameter change.

Reason: This calls for a predictor or quickened display that conflicts with the direct indication requirement.

6.8.3.2 STRINGS OR CLUSTERS OF SIMILAR COMPONENTS

d. LARGE MATRICES

(1) Large matrices of similar components should have coordinate axes labeled for identification of any single component within the grid. The left and top sides of the matrix should be used for labeling.

Reason: Groups of five or more similar components are already "broken up by techniques such as physical spacing or demarcation" (6.8.3.2.c.2) and functional groups are demarcated (6.8.1.3.b) or color shaded (6.8.1.3.c). Item 6.8.3.2.d.1 now requires a parallel identification scheme for these same items based on coordinates. It is felt that such an organizational scheme is inherently inferior to functional grouping, would clutter the boards, and would cause confusions due to dual identification schemes for items.

APPENDIX G

REDUNDANT ITEMS

INTRODUCTION

The items from NUREG-0700, Section 6, listed in this appendix are redundant with other items in NUREG-0700, Section 6. Items to the right of the equal sign are repetitions of the item on the left of the sign. Inclusion of redundant guidelines lengthens the survey unnecessarily.

Redundant Items

Item		
6.1.2.4.a	=	6.1.2.2
6.1.3.1.b	=	6.1.1.3.a, 6.1.1.3.b
6.1.3.1.c	=	6.1.1.2.a
6.1.3.1.d	=	6.1.1.4.e
6.1.5.3.h	=	6.5.1.6
6.2.1.6.e.1	=	6.2.2.6.a
6.3.1.2.d.1	=	6.1.3.1.e.2, 6.1.3.1.e.3
6.3.1.2.d.2	=	6.1.3.1.e.2, 6.1.3.1.e.3
6.4.2.2.f.1	=	6.5.1.6
6.4.2.2.f.2	=	6.5.1.6
6.4.2.2.f.3	=	6.5.1.6
6.4.3.3.b.3	=	6.5.3.3
6.4.4.1.c.1	=	6.4.2.2.d.1
6.4.4.1.c.2	=	6.4.2.2.d.2
6.5.1.3.e	=	6.7.2.2.g
6.5.2.3.c	=	6.5.1.6.c
6.5.3.2.a.2	=	6.5.1.6
6.5.3.3.a.1	=	6.5.3.2.b
6.5.3.3.b.2	=	6.5.1.3
6.5.3.3.d	=	6.5.1.6
6.5.4.1.c	=	6.5.1.5, 6.5.1.3, 6.5.1.4
6.6.3.7.b	=	6.6.2.1.a
6.6.4.1.b.2	=	6.5.1.6
6.6.6.3	=	6.5.1.6
6.9.2.2.b.1	=	6.8.2.1.a.3
6.9.3.2.d	=	6.9.3.1.c.2

APPENDIX H

ITEMS USING INAPPROPRIATE CRITERIA

INTRODUCTION

The items from NUREG-0700, Section 6, listed in this appendix are considered to be based on inappropriate criteria. The reason is listed directly below the items in question.

6.5.1.1 INFORMATION TO BE DISPLAYED

f. DISPLAY FAILURE--When panel instruments, such as meters, fail or become inoperative, the failure should be apparent to the operator (e.g., through off-scale indication).

6.7.1.1 SOFTWARE SECURITY

b. SECURE STORAGE--At least one copy of the current operating software should be stored in a secure remote location.

Reason: Operator does not normally load the operating software.

6.9.1.2 MULTIPLE CONTROLS OR DISPLAYS

c. DISPLAY SELECTORS

(4) Displays should read off-scale, not zero, when not selected, especially if zero is a possible parameter displayed (see Exhibit 6.9-2). (Exhibit is not included.)

PREFERRED GUIDELINE

Panel instruments do not fail or unselected instruments read in their normal operating ranges.

Reason: Requirement of off-scale indication is a design specification. Detection of failure or "nonselection" is a functional issue that should be addressed. Relaxation of these criteria (reads off scale, top of scale, or bottom of scale) making failure or nonselection mode evident accomplishes this objective.

6.6.2.1 PLACEMENT

a. NORMAL PLACEMENT--Labels should be placed above the panel element(s) they describe.

PREFERRED GUIDELINE

Labels are placed consistently above or below the labeled item.

Reason: The intent of this item is to prevent confusion in labeling of adjacent items. Consistency accomplishes this. While certain benefits, such as a lessened chance of obscuring the label when operating control, accrue to placement above labeled item, this benefit is outweighed by transfer of training difficulties inherent in reversing label placements throughout an operating control room.

6.6.6.4 USE OF MIMICS

Mimics integrate system components into functionally oriented diagrams that reflect component relationships. Properly designed mimics should decrease the operator's decision-making load.

a. COLOR

(1) Flow paths should be color coded. Colors should be selected in conformance with Guideline 6.5.1.6.

Reason: Simple mimics for which contents do not change appreciably in the depicted flow paths do not require color coding. A "neutral" color such as black should suffice and would enhance the "information" provided by color where it is used. When color coding of flow paths is employed, this item becomes redundant with use of Section 6.5.1.6.

6.6.5.1 USE

g. ACTIVATION--Tag-outs should be designed to physically prevent actuation of a control.

Reason: Due to the diversity of control types in a control room, it is impractical to devise tags that would "physically prevent actuation." Typically, tagging procedures call

for isolation of secured equipment outside of the control room. When this is done, tags on the control board provide information rather than physical isolation.

APPENDIX I

CROSS-REFERENCE OF NUREG-0700, SECTION 6, AND APPENDIX A ITEMS

The tabulation in this appendix relates specific items in NUREG-0700, Section 6, to the phase or item in the CRDR plan developed by the CRDR NUTAC. NUTAC items consisting of alphabetic characters, a dash, and numerals denote an item in one of the questionnaires, checklists, or surveys in Appendix A. For example, OC-5 refers to Item 5 in the overview checklist. The abbreviations used in this appendix are listed below.

EQ	Engineering Department Questionnaire
OQ	Operator Questionnaire
OC	Overview Checklist
OAC	Operator-Assisted Checklist
LMD	Labeling, Mimics, and Demarcation Checklist
G	General Panel Checklist
CRCC	Control Room Computer Checklist
DCS	Design Convention Survey
LS	Lighting Survey
NS	Noise Survey
AS	Anthropometric Survey
ANS	Annunciator Survey
CS	Communication Survey
CSI	Communication Survey-Intelligibility Section
AAS	Abbreviation and Acronym Survey
CCS	Color-Coding Survey
SR	Systems Review
CRCS	Control Room Computer Survey
ER	Operating Experience Review
PER	Permissive/Impossible to Violate
TBWP	To Be Written in Terms of Principles

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.1.1.1.A	SR
6.1.1.1.B	SR
6.1.1.2.A	SR,ER
6.1.1.2.B	SR
6.1.1.3.A	OC-5, AS-20
6.1.1.3.B	OC-4, OC-5, CSI, OQ-35
6.1.1.3.C.1	OC-5, SR
6.1.1.3.C.2	SR
6.1.1.3.D.1	OC-5, CSI
6.1.1.3.D.2	SR
6.1.1.3.E.1	AS-18
6.1.1.3.E.2	OQ-34
6.1.1.3.F	Appendix C
6.1.1.3.G	OC-7
6.1.1.4.A.1	OAC-33, OQ-27
6.1.1.4.A.2	OAC-33, OQ-27
6.1.1.4.B.1	OAC-36, LMD-15
6.1.1.4.B.2	OAC-36, LMD-15
6.1.1.4.B.3	OAC-32
6.1.1.4.C.1	OAC-35
6.1.1.4.C.2	OAC-35
6.1.1.4.D	OAC-33
6.1.1.4.E	OAC-32
6.1.1.5.A	OAC-24
6.1.1.5.B	OAC-23
6.1.1.5.C	OAC-23
6.1.1.5.D	OAC-25
6.1.1.5.E	OAC-24
6.1.1.5.F	OAC-24
6.1.1.6.A	OC-4
6.1.1.6.B	OC-4
6.1.1.7	OAC-16, OQ-28
6.1.2.1	Not Applicable

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.1.2.2.A	OC-5
6.1.2.2.B.1	AS-5, AS-9
6.1.2.2.B.2	AS-4, AS-8
6.1.2.2.C	AS-1, AS-5, AS-9
6.1.2.2.D.1	AS-2, AS-15
6.1.2.2.D.2	AS-1, AS-16
6.1.2.2.E.1.A	AS-7, AS-11, AS-12, AS-19
6.1.2.2.E.1.B	AS-19
6.1.2.2.E.2	OQ-1, SR
6.1.2.2.F	G-1, SR, OQ-1
6.1.2.2.G	AS-3
6.1.2.3.A.1	AS-20
6.1.2.3.A.2	AS-20
6.1.2.3.B	AS-16
6.1.2.3.C	AS-16, AS-20
6.1.2.3.D.1	AS-15
6.1.2.3.D.2	AS-16
6.1.2.3.E.1	AS-19
6.1.2.3.E.2	AS-19
6.1.2.3.F.1	SR
6.1.2.3.F.2	SR
6.1.2.3.G	AS-13, AS-14
6.1.2.3.H	OQ-34
6.1.2.4.A	AS-4, AS-5, AS-6, AS-7, AS-8, AS-9, AS-10, AS-11
6.1.2.4.B	Appendix E
6.1.2.4.C	AS-13
6.1.2.5.A.1	AS-8, AS-9
6.1.2.5.A.2	SR, OQ-2
6.1.2.5.B.1	AS-10, AS-11
6.1.2.5.B.2	SR, OQ-12
6.1.2.6	OQ-27, OQ-35, OAC-32, OAC-35
6.1.2.7 (All)	OQ-34

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.1.2.8 (All)	OQ-34
6.1.3.1.A	OC-5, SR
6.1.3.1.B	OC-4, SR
6.1.3.1.C	SR
6.1.3.1.D	OAC-32
6.1.3.1.E.1	EQ-7, OAC-13
6.1.3.1.E.2	EQ-7
6.1.3.1.E.3	EQ-7
6.1.3.1.E.4	EQ-7
6.1.3.1.E.5	OAC-13
6.1.3.2.A	OC-1
6.1.3.2.B	OC-1
6.1.4.1.A	OAC-28
6.1.4.1.B	OAC-28
6.1.4.1.C	OAC-20
6.1.4.1.D	OAC-28
6.1.4.1.E	OAC-28
6.1.4.1.F	OAC-23, OAC-28
6.1.4.1.G	OAC-27
6.1.4.1.H	OAC-37
6.1.4.1.I	OAC-12, OAC-37
6.1.4.2.A	OAC-18, OAC-19
6.1.4.2.B	OAC-30, OAC-31
6.1.4.2.C	OAC-40
6.1.4.2.D	OAC-11
6.1.4.2.E	OC-10
6.1.4.3.A	OAC-30, OAC-31
6.1.4.3.B	OAC-30, OAC-31
6.1.5.1.A	OQ-32
6.1.5.1.B	OQ-32
6.1.5.2.A	OQ-32
6.1.5.2.B	OQ-32
6.1.5.3.A	LS-1, OQ-29

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.1.5.3.B	LS-2, OQ-29, OQ-30
6.1.5.3.C	LS-1, OQ-29
6.1.5.3.D	LS-2, LS-3, OQ-29
6.1.5.3.E	OQ-29, OQ-30, OC-11
6.1.5.3.F	G-17, OQ-31
6.1.5.3.G	G-17, OQ-31
6.1.5.3.H	LS-5
6.1.5.4.A	EQ-2, OQ-29
6.1.5.4.B	EQ-2, OQ-29
6.1.5.4.C	LS-1, OQ-29
6.1.5.5.A	NS-1, NS-3, CSI, OQ-35
6.1.5.5.B	NS-1, OQ-35
6.1.5.5.C	SR, CSI, OQ-35, OQ-36
6.1.5.5.D	CSI, OQ-35
6.1.5.5.E	CSI, OQ-35
6.1.5.6.A	OC-12
6.1.5.6.B	OC-12
6.1.5.7.A	OQ-34
6.1.5.7.B.1	OC-2
6.1.5.7.B.2	OC-2
6.1.5.7.B.3	OC-3, OQ-36
6.1.5.7.C	Appendix B
6.2.1.1.A	OQ-38, OAC-38
6.2.1.1.B	OAC-21
6.2.1.1.C.1	OAC-38, OAC-39
6.2.1.1.C.2	OAC-38, OAC-39
6.2.1.2.A	CSI
6.2.1.2.B.1	CS-1
6.2.1.2.B.2	CS-1
6.2.1.2.B.3	CS-1
6.2.1.2.B.4	CS-1
6.2.1.2.B.5	OC-19
6.2.1.2.B.6	OC-6

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.2.1.2.B.7	OC-13
6.2.1.2.B.8	OQ-38
6.2.1.2.C.1	CS-7, OAC-39
6.2.1.2.C.2	CS-7, OAC-39
6.2.1.2.D	Appendix C
6.2.1.2.E	CSI
6.2.1.3.A.1	CSI
6.2.1.3.A.2	CSI
6.2.1.3.B.1	CS-2
6.2.1.3.B.2	CS-2
6.2.1.3.B.3	CS-2
6.2.1.3.B.4	CS-2
6.2.1.3.B.5	CSI
6.2.1.3.B.6	OAC-26
6.2.1.3.C.1	OAC-38
6.2.1.3.C.2	OAC-38
6.2.1.3.D.1	CS-6
6.2.1.3.D.2	CS-6
6.2.1.3.D.3	CS-5
6.2.1.3.E.1	CS-7, OAC-38
6.2.1.3.E.2	CS-6
6.2.1.3.E.3	CS-6
6.2.1.4.A.1	CSI
6.2.1.4.A.2	CSI
6.2.1.4.B.1	CSI, ER
6.2.1.4.B.2	EQ-3, OQ-18
6.2.1.4.C.1	CS-3
6.2.1.4.C.2	CS-3
6.2.1.4.C.3	OQ-39
6.2.1.4.D	OAC-38, OAC-39
6.2.1.4.E.1	OAC-23
6.2.1.4.E.2	OAC-23
6.2.1.5.A	CSI

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.2.1.5.B	CS-4
6.2.1.5.C	OAC-38, OAC-39
6.2.1.6.A.1	CSI
6.2.1.6.A.2	CSI
6.2.1.6.B.1	CSI
6.2.1.6.B.2	CSI
6.2.1.6.B.3	CSI
6.2.1.6.B.4	CSI
6.2.1.6.B.5	Appendix E
6.2.1.6.C.1	OC-3
6.2.1.6.C.2	CSI
6.2.1.6.D	OAC-39
6.2.1.6.E.1	OC-20
6.2.1.6.E.2	CS-4
6.2.1.6.F	OAC-39
6.2.1.7.A	CSI
6.2.1.7.B	CS-4
6.2.1.8.A	OC-23, OQ-37, OQ-39
6.2.1.8.B	CSI, OAC-30
6.2.1.8.C.1	OAC-30, OQ-39
6.2.1.8.C.2	CSI, OQ-39
6.2.1.8.C.3	OAC-30, OQ-39
6.2.2.1.A	Appendix F
6.2.2.1.B	OQ-15, OQ-24
6.2.2.1.C.1	OC-20, OC-8, OQ-35
6.2.2.1.C.2	OC-20, OC-8, OQ-35
6.2.2.2.A	OC-8, OC-20
6.2.2.2.B	OC-8, OC-20
6.2.2.2.C	OC-20
6.2.2.3.A	OC-20, OQ-35
6.2.2.3.B	Appendix D
6.2.2.3.C	Appendix D
6.2.2.3.D	Appendix D

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.2.2.3.E	OC-8
6.2.2.4.A	CSI, NS-2
6.2.2.4.B	CSI, NS-2
6.2.2.5 (All)	Appendix D
6.2.2.6.A	NS-2
6.2.2.6.B	OQ-33
6.2.2.6.C	OQ-33
6.2.2.7.A	Appendix E
6.2.2.7.B	EQ-8, OQ-22, OQ-23
6.2.2.7.C	OAC-17
6.3.1.1	OQ-26
6.3.1.2.A.1	EQ-8, OQ-22, OQ-23, ANS-4
6.3.1.2.A.2	SR, ER, OQ-24
6.3.1.2.B.1	OQ-15
6.3.1.2.B.2	OQ-24
6.3.1.2.C.1	ANS-3
6.3.1.2.C.2	EQ-9, CRCC-41
6.3.1.2.C.3	EQ-10
6.3.1.2.D.1	EQ-7
6.3.1.2.D.2	EQ-7
6.3.1.3.A.1	OC-14, Appendix C
6.3.1.3.A.2	OC-14, Appendix C
6.3.1.3.A.3	OC-14, Appendix C
6.3.1.3.B	OC-14, Appendix C
6.3.1.3.C	OC-14, ANS-3, Appendix C
6.3.1.3.D	OC-14, ANS-1, ANS-2, ANS-3, ANS-4, CCS, SR
6.3.1.4.A.1	Appendix E
6.3.1.4.A.2	OQ-24, OC-14
6.3.1.4.B.1	OC-14, ANS-2
6.3.1.4.B.2	PER, Appendix C
6.3.1.5.A	TBWP, Appendix C
6.3.1.5.B.1	TBWP, Appendix B

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.3.1.5.B.2	TBWP, Appendix B
6.3.1.5.B.3	TBWP, Appendix B
6.3.2.1.A	NS-2
6.3.2.1.B	OAC-9
6.3.2.1.C	NS-2, OQ-33
6.3.2.1.D	OAC-9
6.3.2.1.E	TBWP, EQ-10
6.3.2.1.F	TBWP, ANS-3
6.3.2.2.A.1	OQ-15
6.3.2.2.A.2	OC-8
6.3.2.2.B	PER, OC-14
6.3.3.1.A	ANS-3
6.3.3.1.B.1	LMD-2
6.3.3.1.B.2	LMD-2
6.3.3.1.C.1	OAC-10
6.3.3.1.C.2	OQ-14
6.3.3.1.C.3	OAC-23
6.3.3.2.A	TBWP
6.3.3.2.B	Appendix D
6.3.3.2.C	EQ-1
6.3.3.2.D	LS-4
6.3.3.2.E	OQ-23, OQ-25, ANS-4
6.3.3.2.F.1	OAC-8
6.3.3.2.F.2	OAC-8
6.3.3.3.A	OC-15
6.3.3.3.B	ANS-1, ANS-3, OC-15
6.3.3.3.C.1	OC-15
6.3.3.3.C.2	OC-15
6.3.3.3.C.3	OC-15, LMD-2
6.3.3.3.D.1	EQ-8
6.3.3.3.D.2	LMD-2, ANS-1
6.3.3.3.E	OAC-7, OAC-17, EQ-1
6.3.3.3.F	OQ-23, OQ-25, ANS-4

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.3.3.4.A	ANS-3
6.3.3.4.B	ANS-3
6.3.3.4.C	ANS-3
6.3.3.4.D	ANS-3
6.3.3.5.A.1	LMD-2
6.3.3.5.A.2	LMD-2
6.3.3.5.B.1	LMD-1
6.3.3.5.B.2	LMD-1
6.3.3.5.B.3	LMD-1
6.3.3.5.C.1	G-37
6.3.3.5.C.2	G-37
6.3.3.5.D.1	LMD-1
6.3.3.5.D.2	LMD-1
6.3.3.5.D.3	LMD-1
6.3.3.5.D.4	LMD-1
6.3.3.5.D.5	LMD-1
6.3.3.5.D.6	LMD-1
6.3.4.1.A.1	TBWP
6.3.4.1.A.2	TBWP
6.3.4.1.B.1	TBWP
6.3.4.1.B.2	TBWP, Appendix C
6.3.4.1.C.1	TBWP
6.3.4.1.C.2	TBWP
6.3.4.1.C.3	TBWP, Appendix C
6.3.4.1.D.1	EQ-1, OAC-17
6.3.4.1.D.2	EQ-1, OAC-17
6.3.4.2.A	G-1, OC-17
6.3.4.2.B.1	OC-16
6.3.4.2.B.2	OC-16
6.3.4.2.B.3	OC-16
6.3.4.2.B.4	OC-16
6.3.4.2.C	OC-18
6.3.4.3.A	OAC-32

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.3.4.3.B	OAC-34
6.4.1.1.A.1	OQ-2, SR
6.4.1.1.A.2	OQ-2
6.4.1.1.B (All)	Appendix B
6.4.1.1.C.1	DCS
6.4.1.1.C.2	DCS
6.4.1.1.D (All)	OAC-37
6.4.1.1.E.1	OQ-7
6.4.1.1.E.2	OQ-3
6.4.1.1.E.3	OQ-3
6.4.1.2.A	OQ-4, G-51, AS-2, AS-15
6.4.1.2.B.1	G-51
6.4.1.2.B.2	G-51
6.4.1.2.C.1	G-51
6.4.1.2.C.2	G-51
6.4.1.2.C.3	G-51
6.4.1.2.D.1	PER
6.4.1.2.D.2	PER
6.4.1.2.E	OQ-5
6.4.1.2.F	SR, Appendix D
6.4.1.2.G	PER
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6.7.2.3.E	CRCC-27, CRCS-7
6.7.2.3.F	CRCC-27
6.7.2.4.A (All)	OQ-41, CRCC-24
6.7.2.4.B	OQ-44
6.7.2.4.C (All)	CRCC-21, CRCC-28
6.7.2.4.D	CRCC-21, CRCC-28, CRCS-5
6.7.2.4.E	CRCC-25, CRCS-5
6.7.2.4.F (All)	OQ-40, CRCC-10
6.7.2.4.G	CRCC-19
6.7.2.4.H	OC-44, CRCC-24, CRCC-25
6.7.2.4.I	CRCC-6
6.7.2.4.J	CRCC-19
6.7.2.4.K	CRCC-10
6.7.2.4.L.1	CRCC-26
6.7.2.4.L.2	CRCC-26
6.7.2.4.L.3	CRCC-26
6.7.2.4.M.1	CRCC-32
6.7.2.4.M.2	CRCC-32
6.7.2.4.N	CRCC-33
6.7.2.4.O	CRCC-33
6.7.2.4.P.1	CRCC-34
6.7.2.4.P.2	CRCC-34

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.7.2.4.Q	CRCC-32
6.7.2.5.A	CRCC-28, CRCC-35
6.7.2.5.B	CRCS-5
6.7.2.5.C	CRCC-21, CRCS-5
6.7.2.5.D	CRCC-22
6.7.2.5.E	CRCC-22,
6.7.2.5.F	CRCS-4
6.7.2.5.G	CRCC-10
6.7.2.5.H	CRCC-23
6.7.2.5.I	CRCC-23
6.7.2.5.J	CRCS-4, CRCS-5
6.7.2.5.K.1	CRCC-34
6.7.2.5.K.2	CRCC-34
6.7.2.5.L	CRCC-13, CRCC-29
6.7.2.5.M	CRCC-25
6.5.2.5.N	CRCC-24
6.7.2.6.A	CRCS-4
6.7.2.6.B	CRCS-4
6.7.2.6.C	CRCS-1, CRCS-4
6.7.2.6.D	CRCS-1, CRCS-4
6.7.2.6.E	CRCS-1
6.7.2.6.F	CRCC-39, CRCS-4
6.7.2.6.G	CRCC-39, CRCS-4
6.7.2.6.H	CRCC-16
6.7.2.6.I	CRCC-40
6.7.2.6.J	CRCC-10
6.7.2.6.K	CRCC-15
6.7.2.6.L	CRCC-10, CRCC-14
6.7.2.7.A	CRCC-34
6.7.2.7.B.1	CRCC-34
6.7.2.7.B.2	CRCC-34, CRCC-36
6.7.2.7.C	CRCC-34
6.7.2.7.D	CRCC-36

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.7.2.7.E.1	CRCC-36
6.7.2.7.E.2	CRCC-36
6.7.2.7.E.3	CRCC-36
6.7.2.7.E.4	CRCC-36
6.7.2.7.E.5	CRCC-36
6.7.2.7.F	Appendix B
6.7.2.7.G	Appendix B
6.7.2.7.H	CRCS-3
6.7.2.7.I	CRCS-3
6.7.2.7.J.1	CRCS-3
6.7.2.7.J.2	CRCS-3
6.7.2.7.J.3	CRCS-3
6.7.2.7.J.4	PER
6.7.2.7.K.1	CCS, CRCC-29
6.7.2.7.K.2	CCS, CRCC-29
6.7.2.7.L.1	CCS
6.7.2.7.L.2	CCS
6.7.2.7.L.3	CCS
6.7.2.7.M.1	CCS
6.7.2.7.M.2	CCS, CRCS-6
6.7.2.8.A (All)	CRCC-35
6.7.2.8.B	CRCC-37
6.7.2.8.C.1	CRCC-38
6.7.2.8.C.2	CRCC-38
6.7.2.8.D	CRCC-28
6.7.2.8.E	CRCS-5
6.7.3.1.A (All)	CRCC-41
6.7.3.1.B (All)	CRCC-48
6.7.3.1.C	CRCS-2, CRCS-5, CRCC-24, CRCC-32, OQ-41
6.7.3.1.D	CRCC-49
6.7.3.1.E.1	CRCC-45
6.7.3.1.E.2	CRCC-47

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.7.3.1.E.3	CRCC-47
6.7.3.1.E.4	OQ-42
6.7.3.1.E.5	CRCC-50
6.7.3.1.F.1	CRCC-46
6.7.3.1.F.2	CRCC-45
6.7.3.1.F.3	CRCC-46
6.7.3.1.F.4	CRCC-46
6.7.3.2.A.1	CRCC-41, CRCC-42
6.7.3.2.A.2	CRCC-41, CRCC-42
6.7.3.2.B	CRCC-42
6.7.3.2.C	CRCC-48
6.7.3.2.D	CRCC-44
6.7.3.2.E	CRCC-43
6.7.3.2.F.1	CRCC-43
6.7.3.2.F.2	CRCC-43
6.7.3.2.F.3	CRCC-43
6.7.3.3.A	CRCC-25
6.7.3.3.B	CRCC-25
6.7.3.3.C (All)	CRCC-25
6.7.3.3.D.1	CRCC-25
6.7.3.3.D.2	CRCC-20, CRCC-21
6.7.3.3.D.3	CRCC-21, CRCC-25
6.8.1.1.A	SR
6.8.1.1.B	G-1, G-2, SR
6.8.1.1.C	SR, Appendix B
6.8.1.2	G-1, SR
6.8.1.3.A	PER, Appendix B
6.8.1.3.B	PER, Appendix B
6.8.1.3.C	PER, Appendix B
6.8.1.3.D	G-50
6.8.2.1.A.1	G-2, SR
6.8.2.1.A.2	G-2, SR
6.8.2.1.A.3	G-1, LMD-14

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.8.2.1.B (All)	G-52, Appendix B
6.8.2.1.C.1	SR, G-1, Appendix B
6.8.2.1.C.2	G-1, G-2, Appendix B
6.8.2.2.A	G-2
6.8.2.2.B	DCS, Appendix B
6.8.2.3.A	G-1, DCS
6.8.2.3.B	G-1, DCS
6.8.2.4.A	G-1, G-2, DCS
6.8.2.4.B	Appendix C
6.8.3.1.A	OQ-4, G-52, AS-17
6.8.3.1.B	OQ-4, G-38, G-51, AS-2, AS-15, AS-17, Appendix B
6.8.3.1.C	OQ-1
6.8.3.2.A	OQ-11, G-20
6.8.3.2.B	G-20, LMD-12
6.8.3.2.C.1	LMD-12
6.8.3.2.C.2	LMD-12
6.8.3.2.D.1	Appendix F
6.8.3.2.D.2	LMD-12
6.8.3.3	OC-1, G-1
6.9.1.1.A	OQ-1, SR, G-18
6.9.1.1.B	G-10
6.9.1.1.C.1	LMD-14
6.9.1.1.C.2	OQ-10, G-11, G-31, DCS
6.9.1.1.C.3	OQ-10, Appendix B
6.9.1.2.A.1	G-10, LMD-14
6.9.1.2.A.2	G-10, LMD-14
6.9.1.2.A.3	LMD-14
6.9.1.2.A.4	LMD-14
6.9.1.2.A.5	G-2, SR
6.9.1.2.A.6	LMD-12, LMD-14
6.9.1.2.B.1	LMD-14
6.9.1.2.B.2	LMD-14

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.9.1.2.B.3	G-20, LMD-14
6.9.1.2.B.4	LMD-14
6.9.1.2.B.5	SR, G-2
6.9.1.2.B.6	LMD-14
6.9.1.2.B.7	G-10
6.9.1.2.C.1	OQ-10, G-31, DCS
6.9.1.2.C.2	OQ-10, G-31, DCS
6.9.1.2.C.3	G-11, OQ-10, OQ-16
6.9.1.2.C.4	Appendix H
6.9.2.1.A	G-1
6.9.2.1.B.1	SR, G-2
6.9.2.1.B.2	SR, G-2
6.9.2.1.B.3	SR, G-2
6.9.2.2.A.1	LMD-14
6.9.2.2.A.2	G-20, G-35
6.9.2.2.B.1	G-1, DCS
6.9.2.2.B.2	G-6, G-12
6.9.2.2.C.1	G-2
6.9.2.2.C.2	G-6, G-12, OQ-16
6.9.2.2.D	G-2, DCS
6.9.2.2.E	G-2, G-10, LMD-14, DCS, Appendix B
6.9.2.3.A	OQ-1
6.9.2.3.B	OQ-1, G-1
6.9.3.1.A.1	OQ-10, G-31, DCS
6.9.3.1.A.2	OQ-10, G-31, DCS
6.9.3.1.A.3	OQ-10, G-31, DCS
6.9.3.1.A.4	OQ-10, G-31, DCS
6.9.3.1.B.1	OQ-10, G-31, DCS
6.9.3.1.B.2	OQ-10, G-31, DCS
6.9.3.1.B.3	OQ-10, G-31, DCS
6.9.3.1.C.1	G-55, OQ-20
6.9.3.1.C.2	G-55, OQ-20, Appendix F

NUREG-0700 SECTION 6 GUIDELINE NUMBER	NUTAC ITEM NUMBER
6.9.3.2.A	OQ-2, OQ-20, SR
6.9.3.2.B	OQ-12, G-32, SR
6.9.3.2.C	Appendix B
6.9.3.2.D	G-55, OQ-20

APPENDIX J

CROSS-REFERENCE OF APPENDIX A AND NUREG-0700, SECTION 6 ITEMS

INTRODUCTION

The tabulation in this appendix relates specific items in the CRDR plan developed by the CRDR NUTAC to specific items in NUREG-0700, Section 6. NUTAC items consisting of alpahabetic characters, a dash, and numerals denote an item in one of the questionnaires, checklists, or surveys in Appendix A. For example, OC-5 refers to Item 5 in the overview checklist. The abbreviations used in this appendix are listed below.

EQ	Engineering Department Questionnaire
OQ	Operator Questionnaire
OC	Overview Checklist
OAC	Operator-Assisted Checklist
LMD	Labeling, Mimics, and Demarcation Checklist
G	General Panel Checklist
CRCC	Control Room Computer Checklist
DCS	Design Convention Survey
LS	Lighting Survey
NS	Noise Survey
AS	Anthropometric Survey
ANS	Annunciator Survey
CS	Communication Survey
CSI	Communication Survey-Intelligibility Section
AAS	Abbreviation and Acronym Survey
CCS	Color-Coding Survey
CRCS	Control Room Computer Survey
SR	Systems Review
ER	Operating Experience Review
PR	Permissive/Impossible to Violate
TBWP	To Be Written in Terms of Principles

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
EQ-1	6.3.3.2.C, 6.3.3.3.E, 6.3.4.1.D.1, 6.3.4.1.D.2
EQ-2	6.1.5.4.A, 6.1.5.4.B
EQ-3	6.2 1.B.2
EQ-4	6.5.1.1.E.1, 6.5.1.1.E.2
EQ-5	6.5.1.1.F
EQ-6	6.4.3.3.C.1, 6.5.1.1.F, 6.5.3.1.A.1, 6.5.3.1.A.2, 6.5.3.2.B, 6.3.3.3.A.1
EQ-7	6.1.3.1.E.1, 6.1.3.1.E.2, 6.1.3.1.E.3, 6.1.3.1.E.4, 6.3.1.2.D.1, 6.3.1.2.D.2
EQ-8	6.2.2.7.B, 6.3.1.2.A.1, 6.3.3.3.D.1
EQ-9	6.3.1.2.C.2
EQ-10	6.3.1.2.C.3, 6.3.2.1.E
EQ-11	6.7.1.2.D
OQ-1	6.1.2.2.E.2, 6.1.2.2.F, 6.8.3.1.C, 6.9.1.1.A, 6.9.2.3.A, 6.9.2.3.B
OQ-2	6.1.2.5.A.2, 6.4.1.1.A.1, 6.4.1.1.A.2, 6.9.3.2.A
OQ-3	6.4.1.1.E.2, 6.4.1.1.E.3, 6.4.3.1.B, 6.4.3.2.C, 6.4.3.2.D, 6.4.3.3.E.2, 6.4.3.3.E.5, 6.4.4.3.G.1, 6.4.4.3.G.3, 6.4.4.4.D, 6.4.4.5.B.1, 6.4.4.5.B.2, 6.4.4.5.B.4, 6.4.4.5.E.5, 6.4.5.1.C.1, 6.4.5.1.C.2, 6.4.5.1.C.3, 6.4.5.1.D.1, 6.4.5.1.D.2.E, 6.4.5.3.A, 6.4.5.3.B., 6.4.5.3.C.3, 6.4.5.3.C.4, 6.4.5.4.B.1, 6.4.5.4.C.1, 6.4.5.4.C.2, 6.4.5.4.E.2,
OQ-4	6.4.1.2.A, 6.4.3.1.C, 6.4.3.2.A.1, 6.4.3.2.A.2, 6.4.3.2.B, 6.4.3.3.E.1, 6.4.4.2.A.1, 6.4.4.2.A.2, 6.4.4.2.B, 6.4.4.3.G.2, 6.4.4.4.C.1.A, 6.4.4.4.C.1.B, 6.4.4.4.C.2, 6.4.4.4.E.1, 6.4.4.4.E.2, 6.4.4.4.E.3, 6.4.4.4.E.4, 6.4.4.4.E.5, 6.4.4.5.E.1, 6.4.4.5.E.2, 6.4.4.5.E.3, 6.4.4.5.E.4, 6.4.4.5.E.5., 6.4.5.1.C.1, 6.4.5.1.D.2.A, 6.4.5.1.D.2.B, 6.4.5.1.D.2.C, 6.4.5.1.D.2.D,

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
OQ-4	6.4.5.2.B.1, 6.4.5.2.B.2, 6.4.5.3.C.1, 6.4.5.3.C.2, 6.4.5.4.E.1, 6.8.3.1.A, 6.8.3.1.B
OQ-5	6.4.1.2.E, 6.4.4.2.B, 6.4.4.4.D, 6.4.4.5.E.5, 6.4.4.5.F, 6.4.5.1.C.3, 6.4.5.1.D.2.E, 6.4.5.3.C.3, 6.4.5.3.C.4
OQ-6	6.4.5.3.A
OQ-7	6.4.1.1.E.1
OQ-8	6.5.1.2.B, 6.5.1.2.C, 6.5.1.2.D.1, 6.5.1.2.D.2, 6.5.1.2.D.3, 6.5.1.2.E, 6.5.1.4.E, 6.5.1.4.F, 6.5.1.5.E, 6.6.3.3.C
OQ-9	6.5.1.2.B, 6.5.1.4.F
OQ-10	6.5.5.1.C.2, 6.9.1.1.C.2, 6.9.1.1.C.3, 6.9.1.2.C.1, 6.9.1.2.C.2, 6.9.1.2.C.3, 6.9.3.1.A.1, 6.9.3.1.A.2, 6.9.3.1.A.3, 6.9.3.1.A.4, 6.9.3.1.B.1, 6.9.3.1.B.2, 6.9.3.1.B.3
OQ-11	6.5.1.2.B., 6.5.1.5.D., 6.8.3.2.A
OQ-12	6.1.2.5.B.2, 6.5.1.2.A, 6.5.1.2.D.1, 6.5.1.2.D.2, 6.5.1.2.D.3, 6.5.4.1.C, 6.5.5.2.B, 6.9.3.2.B
OQ-13	6.5.4.1.F
OQ-14	6.3.3.1.C.2, 6.4.3.3.C.2, 6.4.3.3.C.3, 6.5.3.1.A.3
OQ-15	6.2.2.1.B, 6.3.1.2.B.1, 6.3.2.2.A.1, 6.5.3.1.D
OQ-16	6.5.1.4.A.1, 6.5.1.4.A.2, 6.6.3.1.A, 6.6.3.1.B, 6.6.3.2.A, 6.6.3.2.B, 6.6.3.2.C, 6.6.3.2.D, 6.6.3.2.E, 6.6.3.2.F, 6.6.3.3.A, 6.6.3.3.B, 6.6.3.4.A, 6.6.3.4.B, 6.6.3.4.C, 6.6.3.4.D, 6.6.3.4.E, 6.9.1.2.C.3, 6.9.2.2.C.2
OQ-17	6.4.4.3.E
OQ-18	6.2.1.4.B.2
OQ-19	6.5.3.1.C.1
OQ-20	6.9.3.1.C.1, 6.9.3.1.C.2, 6.9.3.2.A, 6.9.3.2.D
OQ-21	6.5.4.1.I

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
OQ-22	6.2.2.7.B, 6.3.1.2.A.1
OQ-23	6.2.2.7.B, 6.3.1.2.A.1, 6.3.3.2.E, 6.3.3.3.F
OQ-24	6.2.2.1.B, 6.3.1.2.A.2, 6.3.1.2.B.2, 6.3.1.4.A.2
OQ-25	6.3.3.2.E, 6.3.3.3.F
OQ-26	6.3.1.1, 6.5.3.1.D
OQ-27	6.1.1.4.A.1, 6.1.1.4.A.2, 6.1.2.6
OQ-28	6.1.1.7
OQ-29	6.1.5.3.A, 6.1.5.3.B, 6.1.5.3.C, 6.1.5.3.D, 6.1.5.3.E.1, 6.1.5.4.A, 6.1.5.4.B, 6.1.5.4.C
OQ-30	6.1.5.3.B., 6.1.5.3.E.1
OQ-31	6.1.5.3.F, 6.1.5.3.G
OQ-32	6.1.5.1.A, 6.1.5.1.B, 6.1.5.2.A, 6.1.5.2.B
OQ-33	6.2.2.6.B, 6.2.2.6.C, 6.3.2.1.C
OQ-34	6.1.1.3.E.2, 6.1.2.3.H, 6.1.2.6, 6.1.2.7, 6.1.2.8, 6.1.5.7.A
OQ-35	6.1.1.3.B, 6.1.5.5.A, 6.1.5.5.B, 6.1.5.5.C, 6.1.5.5.D, 6.1.1.5.E, 6.2.2.1.C.1, 6.2.2.1.C.2, 6.2.2.3.A
OQ-36	6.1.5.5.C, 6.1.5.7.B.3
OQ-37	6.2.1.4.D, 6.2.1.8.A
OQ-38	6.2.1.1.A
OQ-39	6.2.1.4.C.3, 6.2.1.8.A, 6.2.1.8.C.1, 6.2.1.8.C.2, 6.2.1.8.C.3
OQ-40	6.7.1.1.A, 6.7.1.2.A.1, 6.7.1.2.A.2, 6.7.1.2.A.3, 6.7.1.2.A.4, 6.7.1.2.A.5, 6.7.1.4.H, 6.7.1.5.A, 6.7.2.4.F
OQ-41	6.7.2.4.A, 6.7.3.1.C
OQ-42	6.7.3.1.E.4
OQ-43	6.7.1.1.D, 6.7.1.2.D
OQ-44	6.7.2.4.B, 6.7.2.4.H, 6.7.2.7.G
OC-1	6.1.3.2.A, 6.1.3.2.B, 6.8.3.3
OC-2	6.1.5.7.B.1, 6.1.5.7.B.2

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
OC-3	6.1.5.7.B.3, 6.2.1.6.C.1
OC-4	6.1.1.3.B, 6.1.1.6.A, 6.1.1.6.B, 6.1.2.7, 6.1.3.1.B
OC-5	6.1.1.3.A, 6.1.1.3.B, 6.1.1.3.C.1, 6.1.1.3.D.1, 6.1.2.2.A, 6.1.3.1.A
OC-6	6.2.[illegible].2.B.6, 6.6.2.1.A, 6.6.2.1.B, 6.6.2.1.D, 6.6.3.7.B
OC-7	6.1.1.3.G
OC-8	6.2.2.1.C.1, 6.2.2.1.C.2, 6.2.2.2.A, 6.2.2.2.B, 6.2.2.3.E, 6.3.2.2.A.2
OC-9	6.6.5.1.D, 6.6.5.1.E, 6.6.5.1.F, 6.6.5.1.H
OC-10	6.1.4.2.E
OC-11	6.1.5.3.E
OC-12	6.1.5.6.A, 6.1.5.6.B
OC-13	6.2.1.2.B.7
OC-14	6.3.1.3.A.1, 6.3.1.3.A.2, 6.3.1.3.A.3, 6.3.1.3.B., 6.3.1.3.C, 6.3.1.3.D, 6.3.1.4.A.2 6.3.1.4.B.1, 6.3.2.2.B
OC-15	6.3.3.3.A, 6.3.3.3.B, 6.3.3.3.C.1, 6.3.3.3.C.2, 6.3.3.3.C.3
OC-16	6.3.4.2.B.1, 6.3.4.2.B.2, 6.3.4.2.B.3, 6.3.4.2.B.4
OC-17	6.3.4.2.A
OC-18	6.3.4.2.C
OC-19	6.2.1.2.B.5
OC-20	6.2.1.6.E.1, 6.2.2.1.C.1, 6.2.2.1.C.2, 6.2.2.2.A, 6.2.2.2.B, 6.2.2.2.C, 6.2.2.3.A, 6.2.2.1.C.1, 6.2.2.1.C.2
OC-21	6.6.2.2.A, 6.6.2.2.B
OC-22	6.6.4.1.B.1
OC-23	6.2.1.8.A
OAC-1	6.6.2.2.A, 6.6.2.2.B, 6.6.5.1.A, 6.6.5.1.B, 6.6.5.1.C, 6.6.5.2.A, 6.6.5.2.B.1, 6.6.5.2.B.2, 6.6.5.2.B.4

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
OAC-2	6.6.3.3.A, 6.6.5.1.A, 6.6.5.1.B, 6.6.5.2.A, 6.6.5.2.B.1, 6.6.5.2.B.3
OAC-3	6.6.5.1.A, 6.6.5.1.B, 6.6.5.2.A, 6.6.5.2.B.1
OAC-4	6.6.4.1.B.2, 6.6.5.1.A, 6.6.5.1.B, 6.6.5.2.A, 6.6.5.2.B.1
OAC-5	6.6.5.1.A, 6.6.5.1.B, 6.6.5.2.A, 6.6.5.2.B.1, 6.6.5.2.B.2, 6.6.5.2.B.3, 6.6.5.2.B.5, 6.6.5.2.B.6, 6.6.5.2.B.7, 6.6.5.2.B.8, 6.6.5.2.B.9
OAC-6	6.6.5.2.B.6, 6.6.5.2.B.7, 6.6.5.2.B.9
OAC-7	6.3.3.3.E
OAC-8	6.3.3.2.F.1, 6.3.3.2.F.2
OAC-9	6.3.2.1.B, 6.3.2.1.D
OAC-10	6.3.3.1.C.1, 6.4.3.3.C.4, 6.5.3.1.C.2
OAC-11	6.1.4.2.D
OAC-12	6.1.4.1.I
OAC-13	6.1.3.1.E.1, 6.1.3.1.E.5
OAC-14	6.6.2.4.D
OAC-15	
OAC-16	
OAC-17	6.2.2.7.C, 6.3.3.3.E, 6.3.4.1.D.1, 6.3.4.1.D.2
OAC-18	6.1.4.2.A
OAC-19	6.1.4.2.A
OAC-20	6.1.4.1.C
OAC-21	6.2.1.1.B
OAC-22	6.5.4.1.J
OAC-23	6.1.1.5.B, 6.1.1.5.C, 6.1.4.1.F, 6.2.1.4.E.1, 6.2.1.4.E.2, 6.3.3.1.C.3, 6.5.3.1.A.3, 6.5.4.1.E
OAC-24	6.1.1.5.A, 6.1.1.5.E, 6.1.1.5.F
OAC-25	6.1.1.5.D
OAC-26	6.2.1.3.B.6
OAC-27	6.1.4.1.G
OAC-28	6.1.4.1.A, 6.1.4.1.B, 6.1.4.1.D, 6.1.4.1.E, 6.1.4.1.F

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
OAC-29	6.2.1.8.B, 6.2.1.8.C.1, 6.2.1.8.C.3
OAC-30	6.1.4.2.B, 6.1.4.3.A, 6.1.4.3.B
OAC-31	6.1.4.2.B, 6.1.4.3.A, 6.1.4.3.B
OAC-32	6.1.1.4.A.1, 6.1.1.4.A.2, 6.1.1.4.B.3, 6.1.1.4.E, 6.1.2.6, 6.1.3.1.D, 6.3.4.3.A
OAC-33	6.1.1.4.D
OAC-34	6.3.4.3.B
OAC-35	6.1.1.4.C.1, 6.1.1.4.C.2, 6.1.2.6
OAC-36	6.1.1.4.B.1, 6.1.1.4.B.2
OAC-37	6.1.4.1.H, 6.1.4.1.I, 6.4.1.1.D
OAC-38	6.2.1.1.A, 6.2.1.1.C.1, 6.2.1.1.C.2, 6.2.1.3.C.1, 6.2.1.3.C.2, 6.2.1.3.E.1, 6.2.1.4.D, 6.2.1.5.C
OAC-39	6.2.1.1.C.1, 6.2.1.1.C.2, 6.2.1.2.C.1, 6.2.1.2.C.2, 6.2.1.5.C, 6.2.1.4.D, 6.2.1.6.D., 6.2.1.6.F
OAC-40	6.1.4.2.C
LMD-1	6.3.3.5.B.1, 6.3.3.5.B.2, 6.3.3.5.B.3, 6.3.3.5.D.1, 6.3.3.5.D.2, 6.3.3.5.D.3, 6.3.3.5.D.4, 6.3.3.5.D.5, 6.3.3.5.D.6, 6.5.1.3.B.1, 6.5.1.3.B.2, 6.5.1.3.B.3, 6.5.1.3.D.1, 6.5.1.3.D.2, 6.5.1.3.D.3, 6.5.1.3.D.4, 6.5.1.3.D.5, 6.5.1.3.D.6, 6.5.3.3.B.1, 6.5.3.3.B.2, 6.6.4.1.A.2, 6.6.4.2.A.1, 6.6.4.2.A.2, 6.6.4.2.B.1, 6.6.4.2.B.2, 6.6.4.2.C, 6.6.4.2.D.1, 6.6.4.2.D.2, 6.6.4.2.D.3
LMD-2	6.3.3.1.B.1, 6.3.3.1.B.2, 6.3.3.3.C.3, 6.3.3.3.D.2, 6.3.3.5.A.1, 6.3.3.5.A.2, 6.5.1.3.A, 6.6.1.1, 6.6.1.2.A.1, 6.6.1.2.A.2, 6.6.1.2.A.3, 6.6.1.2.A.4, 6.6.1.2.B.1, 6.6.1.2.B.2, 6.6.1.2.B.3, 6.6.1.2.B.4, 6.6.2.1.B, 6.6.2.1.C, 6.6.3.7.A, 6.6.4.1.A.1, 6.6.4.1.A.2
LMD-3	6.5.1.4.D, 6.6.3.3.C
LMD-4	6.6.6.4.B.3

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
LMD-5	6.6.6.4.B.4, 6.6.6.4.B.5
LMD-6	6.6.6.4.B.6
LMD-7	6.6.6.4.A.5
LMD-8	6.6.6.4.C.1, 6.6.6.4.C.2
LMD-9	6.6.6.4.A.1, 6.6.6.4.A.2, 6.6.6.4.A.3, 6.6.6.4.A.4
LMD-10	6.6.6.4.B.2
LMD-11	6.6.6.2.B, 6.6.6.2.C
LMD-12	6.6.6.2.A, 6.8.3.2.B, 6.8.3.2.C.1, 6.8.3.2.C.2, 6.8.3.2.D.2, 6.9.1.2.A.6
LMD-13	6.6.6.2.A
LMD-14	6.6.6.2.A, 6.8.2.1.A.3, 6.9.1.1.C.1, 6.9.1.2.A.1, 6.9.1.2.A.2, 6.9.1.2.A.3, 6.9.1.2.A.4, 6.9.1.2.A.6, 6.9.1.2.B.1, 6.9.1.2.B.2, 6.9.1.2.B.3, 6.9.1.2.B.4, 6.9.1.2.B.6, 6.9.2.2.A.1, 6.9.2.2.E
LMD-15	6.1.1.4.B.1, 6.1.1.4.B.2
G-1	6.1.2.2.F, 6.4.2.2.B, 6.3.4.2.A, 6.4.3.1.A, 6.8.1.1.B, 6.8.1.2, 6.8.2.1.A.3, 6.8.2.1.C.1, 6.8.2.1.C.2, 6.8.2.3.A, 6.8.2.3.B, 6.8.2.4.A, 6.8.3.3, 6.9.2.1.A, 6.9.2.2.B.1, 6.9.2.3.B
G-2	6.4.2.2.B, 6.4.3.1.A, 6.8.1.1.B, 6.8.2.1.A.1, 6.8.2.1.A.2, 6.8.2.1.C.2, 6.8.2.2.A, 6.8.2.4.A, 6.9.1.2.A.5, 6.9.1.2.B.5, 6.9.2.1.B.1, 6.9.2.1.B.2, 6.9.2.1.B.3, 6.9.2.2.C.1, 6.9.2.2.D, 6.9.2.2.E
G-3	6.6.3.4.E
G-4	6.6.3.6
G-5	6.6.3.9.A
G-6	6.6.1.2.A.3, 6.6.1.2.A.4, 6.6.2.1.D, 6.6.3.1.A, 6.9.2.2.B.3, 6.9.2.2.C.2
G-7	6.4.3.3.B.4, 6.4.3.3.B.5, 6.5.1.4.C, 6.5.3.3.B.4, 6.5.3.3.B.7, 6.6.2.1.A.4, 6.6.3.1.A, 6.6.3.1.B, 6.6.3.2.A, 6.6.3.2.B, 6.6.3.2.C, 6.6.3.2.D., 6.6.3.2.E, 6.6.3.2.F, 6.6.3.5

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
G-8	6.6.2.3.A.1, 6.6.2.3.B
G-9	6.6.2.1.F, 6.6.2.4.A
G-10	6.4.5.1.A, 6.6.2.1.E, 6.6.2.4.A, 6.6.2.4.B, 6.6.2.4.C, 6.6.3.8.C, 6.9.1.1.B, 6.9.1.2.A.1, 6.9.1.2.A.2, 6.9.1.2.B.7, 6.9.2.2.E
G-11	6.4.4.3.F, 6.4.4.5.D.1.A, 6.4.4.5.D.1.B, 6.4.4.5.D.1.C, 6.4.4.5.D.2, 6.4.5.1.B, 6.6.1.2.B.4, 6.6.2.1.D, 6.6.3.8.A, 6.6.3.8.B, 6.9.1.1.C.2, 6.9.1.2.C.3, 6.9.2.2.E
G-12	6.5.3.2.A.1, 6.5.3.3.B.3, 6.6.1.2.A.3, 6.9.2.2.B.2, 6.9.2.2.C.2
G-13	6.4.3.1.C, 6.4.3.2.A.1, 6.4.4.4.A, 6.4.5.2.A
G-14	6.4.5.4.A.1, 6.4.5.4.A.2
G-15	6.4.5.3.C.5, 6.4.5.3.C.6, 6.4.5.4.B.2, 6.4.5.4.E.3, 6.4.5.4.E.4
G-16	6.4.4.4.B, 6.4.4.5.C, 6.4.4.5.D.1.A, 6.4.4.5.D.1.B, 6.4.4.5.D.1.C, 6.4.4.5.D.2
G-17	6.1.5.3.F, 6.1.5.3.G
G-18	6.5.2.2.B.2, 6.9.1.1.A
G-19	6.5.2.5
G-20	6.5.1.5.D, 6.8.3.2.A, 6.8.3.2.B, 6.9.1.2.B.3 6.9.2.2.A.2
G-21	6.5.1.2.B, 6.3.1.5.D,
G-22	6.5.1.3.C.1
G-23	6.5.2.4.C.1, 6.5.2.4.C.2, 6.5.2.4.C.3
G-24	6.5.2.4.B.1, 6.5.2.4.B.2
G-25	6.5.2.2.A.2
G-26	6.5.2.2.B.1
G-27	6.5.1.6.E.2, 6.5.2.2.C, 6.5.2.3.A
G-28	6.5.1.5.A.1, 6.5.1.5.A.2, 6.5.1.5.A.3
G-29	6.5.1.2.B, 6.5.1.2.E, 6.5.1.5.C, 6.5.1.5.E
G-30	6.5.2.4.A

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
G-31	6.4.2.1, 6.4.4.1.A, 6.5.2.1.A, 6.5.2.1.B, 6.5.2.1.C, 6.9.1.1.C.2, 6.9.1.2.C.1, 6.9.3.1.A.1, 6.9.3.1.A.2, 6.9.3.1.A.3, 6.9.3.1.A.4, 6.9.3.1.B.1, 6.9.3.1.B.2, 6.9.3.1.B.3
G-32	6.5.2.3.A, 6.5.2.3.B, 6.9.3.2.B
G-33	6.5.1.4.A.1, 6.3.1.4.A.2, 6.5.1.4.F, 6.5.1.5.C
G-34	6.5.1.5.F
G-35	6.9.2.2.A.2
G-36	6.5.1.6.E.2, 6.5.3.2.A.3
G-37	6.3.3.5.C.1, 6.3.3.5.C.2, 6.4.3.3.B.1, 6.4.3.3.B.3, 6.4.3.3.B.4, 6.5.3.3.A.2, 6.5.3.3.A.3, 6.5.3.3.B.2, 6.5.3.3.B.4, 6.5.3.3.B.5
G-38	6.4.3.3.D.1, 6.4.3.3.E.3, 6.4.3.3.E.4, 6.8.3.1.B
G-39	6.4.3.3.D.2
G-40	6.4.3.3.A, 6.5.3.3.C
G-41	6.5.4.1.A, 6.5.4.2.B.3
G-42	6.5.4.1.K., 6.5.4.2.B.2
G-43	6.5.4.1.B
G-44	6.5.4.2.A.1, 6.5.4.2.A.2
G-45	6.5.4.2.A.1, 6.5.4.2.A.2., 6.5.4.2.B.1
G-46	6.5.4.2.B.2, 6.5.4.2.B.4
G-47	6.5.5.1.A.2, 6.5.5.1.A.4, 6.5.5.1.A.5, 6.5.5.2.A.2, 6.5.5.2.A.3, 6.5.5.2.A.4, 6.5.5.2.A.5, 6.5.5.2.C
G-48	6.5.5.1.B.1, 6.5.5.1.B.2
G-49	6.5.5.1.A.1, 6.5.5.2.A.1
G-50	6.8.1.3.D
G-51	6.4.1.2.A, 6.4.1.2.B.1, 6.4.1.2.B.2, 6.4.1.2.C.1, 6.4.1.2.C.2, 6.4.1.2.C.3, 6.4.5.4.D, 6.8.3.1.B
G-52	6.8.2.1.B, 6.8.3.1.A
G-53	6.4.4.3.A
G-54	6.4.4.3.D
G-55	6.5.1.1.E.1, 6.5.1.1.E.2, 6.9.3.1.C.1, 6.9.3.1.C.2, 6.9.3.2.D

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
G-56	6.4.2.2.F.1, 6.4.2.2.F.2, 6.4.2.2.F.3, 6.5.1.3.C.2, 6.5.1.6.A, 6.5.1.6.C.1, 6.5.1.6.D.1, 6.5.1.6.D.2, 6.5.1.6.D.3, 6.5.2.3.C, 6.5.3.2.A.2, 6.5.3.3.D, 6.6.4.1.B.2, 6.6.6.3, 6.6.6.4.A.2
G-57	6.5.1.4.D, 6.5.3.3.B.6, 6.6.3.2.D, 6.6.3.2.E, 6.6.3.2.F, 6.6.3.3.A, 6.6.3.3.B, 6.6.3.4.A, 6.6.3.4.B, 6.6.3.4.C, 6.6.3.4.D
CRCC-1	6.7.1.1.A
CRCC-2	6.7.1.3.E
CRCC-3	6.7.1.3.C
CRCC-4	6.7.1.4.A, 6.7.1.4.B, 6.7.1.4.C
CRCC-5	6.7.1.4.I
CRCC-6	6.7.1.2.C.1, 6.7.1.2.C.2, 6.7.2.4.I
CRCC-7	6.7.1.2.B
CRCC-8	6.7.1.5.B, 6.7.1.5.D.1, 6.7.1.5.D.2, 6.7.1.5.D.3, 6.7.1.5.D.4, 6.7.1.5.D.5
CRCC-9	6.7.1.4.D, 6.7.1.4.E, 6.7.1.4.F, 6.7.1.4.G
CRCC-10	6.7.2.4.F, 6.7.2.4.K, 6.7.2.5.G, 6.7.2.6.J, 6.7.2.6.L
CRCC-11	6.7.1.6.A, 6.7.1.6.D
CRCC-12	6.7.1.5.C.1, 6.7.1.5.C.2
CRCC-13	6.7.1.6.B, 6.7.1.6.C, 6.7.2.5.L
CRCC-14	6.7.1.2.A.6, 6.7.2.6.L
CRCC-15	6.7.1.7.A, 6.7.1.7.B, 6.7.2.6.K
CRCC-16	6.7.1.1.C, 6.7.1.3.D, 6.7.2.6.H
CRCC-17	6.7.1.8.A.1, 6.7.1.8.A.2, 6.7.1.8.A.3, 6.7.1.8.A.4, 6.7.1.8.A.5
CRCC-18	6.7.1.8.B.1, 6.7.1.8.B.2
CRCC-19	6.7.2.4.G, 6.7.2.4.J
CRCC-20	6.7.2.5.M, 6.7.3.3.D.2
CRCC-21	6.7.2.4.C, 6.7.2.4.D, 6.7.2.5.C, 6.7.3.3.D.2, 6.7.3.3.D.3

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
CRCC-22	6.7.2.5.D, 6.7.2.5.E
CRCC-23	6.7.2.5.H, 6.7.2.5.I
CRCC-24	6.7.2.4.A, 6.7.2.4.H, 6.7.2.5.N, 6.7.3.1.C
CRCC-25	6.7.2.4.E, 6.7.2.4.H, 6.7.2.5.M, 6.7.3.3.A, 6.7.3.3.B, 6.7.3.3.C, 6.7.3.3.D.1, 6.7.3.3.D.3
CRCC-26	6.7.2.4.L.1, 6.7.2.4.L.2, 6.7.2.4.L.3
CRCC-27	6.7.2.3.E, 6.7.2.3.F
CRCC-28	6.7.2.4.C, 6.7.2.4.D, 6.7.2.5.A, 6.7.2.8.D
CRCC-29	6.7.2.1.C, 6.7.2.1.H.1, 6.7.2.7.K.1, 6.7.2.7.K.2
CRCC-30	6.5.5.2.A.3, 6.7.2.1.A, 6.7.2.2.A, 6.7.2.2.B.1, 6.7.2.2.F.2, 6.7.2.3.A
CRCC-31	6.5.1.3.E, 6.7.2.1.A, 6.7.2.2.B.2, 6.7.2.2.C, 6.7.2.2.D, 6.7.2.2.F.1, 6.7.2.2.F.2, 6.7.2.2.G.1, 6.7.2.2.G.3
CRCC-32	6.7.2.4.M.1, 6.7.2.4.M.2, 6.7.2.4.Q, 6.7.3.1.C
CRCC-33	6.7.2.4.N, 6.7.2.4.O,
CRCC-34	6.7.2.4.P.1, 6.7.2.4.P.2, 6.7.2.5.K.1, 3.7.2.5.K.2, 6.7.2.7.A, 6.7.2.7.B.1, 6.7.2.7.B.2, 6.7.2.7.C
CRCC-35	6.7.2.5.A, 6.7.2.8.A
CRCC-36	6.7.2.7.B.2, 6.7.2.7.D, 6.7.2.7.E.1, 6.7.2.7.E.2, 6.7.2.7.E.3, 6.7.2.7.E.4, 6.7.2.7.E.5
CRCC-37	6.7.2.8.B
CRCC-38	6.7.2.8.C.1, 6.7.2.8.C.2
CRCC-39	6.7.2.6.F, 6.7.2.6.G
CRCC-40	6.7.2.6.I
CRCC-41	6.3.1.2.C.2,6.7.3.1.A, 6.7.3.2.A.1, 6.7.3.2.A.2
CRCC-42	6.7.3.2.A.1, 6.7.3.2.A.2, 6.7.3.2.B
CRCC-43	6.7.3.2.E, 6.7.3.2.F.1, 6.7.3.2.F.2, 6.7.3.2.F.3
CRCC-44	6.7.3.2.D
CRCC-45	6.7.3.1.E.1, 6.7.3.1.F.2
CRCC-46	6.7.3.1.F.1, 6.7.3.1.F.3, 6.7.3.1.F.4
CRCC-47	6.7.3.1.E.2, 6.7.3.1.E.3
CRCC-48	6.7.3.1.B, 6.7.3.2.C

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
CRCC-49	6.7.3.1.D
CRCC-50	6.7.3.1.E.5
DCS	6.4.1.1.C.1, 6.4.1.1.C.2, 6.4.2.1, 6.4.2.2.A, 6.4.2.2.B, 6.4.2.2.C.1, 6.4.2.2.C.2, 6.4.2.2.C.3, 6.4.2.2.D.1, 6.4.2.2.D.2, 6.4.2.2.E, 6.4.4.1.A, 6.4.4.1.B, 6.4.4.1.C.1, 6.4.4.1.C.2, 6.5.2.1.A, 6.5.2.1.B, 6.5.2.1.C, 6.5.5.1.C.2, 6.8.2.2.B, 6.8.2.3.A, 6.8.2.3.B, 6.8.2.4.A, 6.9.1.1.C.2, 6.9.1.2.C.1, 6.9.1.2.C.2, 6.9.2.2.B.1, 6.9.2.2.D, 6.9.2.2.E, 6.9.3.1.A.1, 6.9.3.1.A.2, 6.9.3.1.A.3, 6.9.3.1.A.4, 6.9.3.1.B.1, 6.9.3.1.B.2, 6.9.3.1.B.3
LS-1	6.1.5.3.A, 6.1.5.3.C, 6.1.5.4.C
LS-2	6.1.5.3.B, 6.1.5.3.D
LS-3	6.1.5.3.D
LS-4	6.3.3.2.D, 6.4.3.3.B.2, 6.5.3.1.B, 6.5.3.2.B, 6.5.3.3.A.1
LS-5	6.1.5.3.H, 6.5.1.6.E.3
NS-1	6.1.5.5.A, 6.1.5.5.B
NS-2	6.2.2.4.A, 6.2.2.4.B, 6.2.2.6.A, 6.3.2.1.A, 6.3.2.1.C
NS-3	6.1.5.5.A
AS-1	6.1.2.2.C, 6.1.2.2.D.2
AS-2	6.1.2.2.D.1, 6.4.1.2.A, 6.8.3.1.B
AS-3	6.1.2.2.G
AS-4	6.1.2.2.B.2, 6.1.2.4.A
AS-5	6.1.2.2.B.1, 6.1.2.2.C, 6.1.2.4.A
AS-6	6.1.2.4.A
AS-7	6.1.2.2.E.1.A, 6.1.2.4.A
AS-8	6.1.2.2.B.2, 6.1.2.4.A, 6.1.2.5.A.1

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
AS-9	6.1.2.2.B.1, 6.1.2.2.C, 6.1.2.4.A, 6.1.2.5.A.1
AS-10	6.1.2.4.A, 6.1.2.5.B.1
AS-11	6.1.2.2.E.1.A, 6.1.2.4.A, 6.1.2.5.B.1
AS-12	6.1.2.2.E.1.A
AS-13	6.1.2.3.G
AS-14	6.1.2.3.G
AS-15	6.1.2.2.D.1, 6.1.2.3.D.1, 6.4.1.2.A, 6.8.3.1.B
AS-16	6.1.2.2.D.2, 6.1.2.3.B, 6.1.2.3.C, 6.1.2.3.D.2
AS-17	6.8.3.1.A, 6.8.3.1.B, 6.8.3.1.D
AS-18	6.1.1.3.E.1
AS-19	6.1.2.2.E.1.A, 6.1.2.2.E.1.B, 6.1.2.3.E.1, 6.1.2.3.E.2
AS-20	6.1.1.3.A, 6.1.2.3.A.1, 6.1.2.3.A.2, 6.1.2.3.C
ANS-1	6.3.1.3.D, 6.3.3.3.B, 6.3.3.3.D.2
ANS-2	6.3.1.3.D, 6.3.1.4.B.1
ANS-3	6.3.1.2.C.1, 6.3.3.1.A, 6.3.1.3.C, 6.3.1.3.D, 6.3.2.1.F, 6.3.3.3.B, 6.3.3.4.A, 6.3.3.4.B, 6.3.3.4.C, 6.3.3.4.D
ANS-4	6.3.1.2.A.1, 6.3.1.3.D, 6.3.3.2.E, 6.3.3.3.F
CS-1	6.2.1.2.B.1, 6.2.1.2.B.2, 6.2.1.2.B.3, 6.2.1.2.B.4
CS-2	6.2.1.3.B.1, 6.2.1.3.B.2, 6.2.1.3.B.3, 6.2.1.3.B.4
CS-3	6.2.1.4.C.1, 6.2.1.4.C.2
CS-4	6.2.1.5.B, 6.2.1.6.E.2, 6.2.1.7.B
CS-5	6.2.1.3.D.3
CS-6	6.2.1.3.D.1, 6.2.1.3.D.2, 6.2.1.3.E.2, 6.2.1.3.E.3
CS-7	6.2.1.2.C.1, 6.2.1.2.C.2, 6.2.1.3.E.1

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
CSI	6.1.1.3.B, 6.1.1.3.D.1, 6.1.5.5.A, 6.1.5.5.C, 6.1.5.5.D, 6.1.5.5.E, 6.2.1.2.A, 6.2.1.2.E, 6.2.1.3.A.1, 6.2.1.3.A.2, 6.2.1.3.B.5, 6.2.1.4.A.1, 6.2.1.4.A.2, 6.2.1.4.B.1, 6.2.1.5.A, 6.2.1.6.A.1, 6.2.1.6.A.2, 6.2.1.6.B.1, 6.2.1.6.B.2, 6.2.1.6.B.3, 6.2.1.6.B.4, 6.2.1.6.C.2, 6.2.1.7.A, 6.2.1.8.B, 6.2.1.8.C.2, 6.2.2.4.A, 6.2.2.4.B
AAS	6.5.1.4.D, 6.6.3.2.D, 6.5.3.3.B.3, 6.5.3.3.B.6, 6.5.3.2.D, 6.6.3.2.F, 6.6.3.3.A, 6.6.3.3.B, 6.6.3.3.C, 6.6.3.4.A, 6.6.3.4.B, 6.6.3.4.C., 6.6.3.4.D
CCS	6.3.1.3.D, 6.5.1.6.C.1, 6.5.1.6.D.1, 6.5.1.6.D.2, 6.5.1.6.D.3, 6.5.2.3.C, 6.5.3.2.A.2, 6.5.3.3.D, 6.6.6.3, 6.7.2.7.K.1, 6.7.2.7.K.2, 6.7.2.7.L.1, 6.7.2.7.L.2, 6.7.2.7.L.3, 6.7.2.7.M.1, 6.7.2.7.M.2
CRCS-1	6.7.1.2.A.1, 6.7.1.2.A.2, 6.7.1.2.A.3, 6.7.1.2.A.4, 6.7.1.2.A.5, 6.7.1.3.A, 6.7.1.3.B, 6.7.1.4.H, 6.7.1.5.A, 6.7.1.6.B, 6.7.1.6.C, 6.7.2.1.H.2, 6.7.2.6.C, 6.7.2.6.D, 6.7.2.6.E
CRCS-2	6.7.1.2.A.3, 6.7.1.2.A.5, 6.7.1.2.C.2, 6.7.1.2.C.3, 6.7.1.5.B, 6.7.3.1.C
CRCS-3	6.7.2.7.H, 6.7.2.7.I, 6.7.2.7.J.1, 6.7.2.7.J.2, 6.7.2.7.J.3
CRCS-4	6.7.1.3.A, 6.7.2.5.F, 6.7.2.5.J, 6.7.2.6.A, 6.7.2.6.B, 6.7.2.6.C, 6.7.2.6.D, 6.7.2.6.F, 6.7.2.6.G
CRCS-5	6.7.2.4.D, 6.7.2.4.E, 6.7.2.5.B, 6.7.2.5.C, 6.7.2.5.J, 6.7.2.8.E, 6.7.3.1.C

NUTAC ITEM NUMBER	NUREG-0700 SECTION 6 GUIDELINE NUMBER
CRCS-6	6.7.2.1.A, 6.7.2.1.B, 6.7.2.1.C., 6.7.2.1.D, 6.7.2.1.E, 6.7.2.1.F, 6.7.2.1.G, 6.7.2.2.A, 6.7.2.2.B.1, 6.7.2.2.B.2, 6.7.2.2.C, 6.7.2.2.D, 6.7.2.2.E, 6.7.2.2.F.1, 6.7.2.2.F.2, 6.7.2.2.G.2, 6.7.2.7.F, 6.7.2.7.M.2
CRCS-7	6.7.2.3.A, 6.7.2.3.B, 6.7.2.3.C, 6.7.2.3.D, 6.7.2.3.E
SR	6.1.1.1.A, 6.1.1.1.B, 6.1.1.2.A, 6.1.1.2.B, 6.1.1.3.C.1, 6.1.1.3.C.2, 6.1.1.3.D.2, 6.1.2.2.E.2, 6.1.2.2.F, 6.1.2.3.F.1, 6.1.2.3.F.2, 6.1.2.5.A.2, 6.1.2.5.B.2, 6.1.3.1.A, 6.1.3.1.B, 6.1.3.1.C, 6.1.5.5.C, 6.3.1.2.A.2, 6.3.1.3.D, 6.4.1.1.A.1, 6.4.1.2.F, 6.4.2.2.D.1, 6.4.2.2.D.2, 6.5.1.1.A, 6.5.1.1.B, 6.5.1.2.D.1, 6.5.1.2.D.2, 6.5.1.2.D.3, 6.6.3.3.C, 6.8.1.1.A, 6.8.1.1.B, 6.8.1.1.C, 6.8.1.2, 6.8.2.1.A.1, 6.8.2.1.A.2, 6.8.2.1.C.1, 6.9.1.1.A, 6.9.1.2.A.5, 6.9.1.2.B.5, 6.9.2.1.B.1, 6.9.2.1.B.2, 6.9.2.1.B.3, 6.9.3.2.A, 6.9.3.2.B
ER	6.1.1.2.A, 6.2.1.4.B.1, 6.3.1.2.A.2
PER	6.3.1.4.B.2, 6.3.2.2.B, 6.4.1.2.D.1, 6.4.1.2.D.2, 6.4.1.2.G, 6.4.4.5.A, 6.5.4.1.G, 6.6.2.3.A.2, 6.6.6.1, 6.6.6.4.B.1, 6.7.2.7.J.4, 6.8.1.3.A, 6.8.1.3.B, 6.8.1.3.C
TBWP	6.3.1.5.A, 6.3.1.5.B.1, 6.3.1.5.B.2, 6.3.1.5.B.3, 6.3.2.1.E, 6.3.2.1.F, 6.3.3.2.A, 6.3.4.1.A.1, 6.3.4.1.A.2, 6.3.4.1.B.1, 6.3.4.1.B.2, 6.3.4.1.C.1, 6.3.4.1.C.2, 6.3.4.1.C.3

APPENDIX K

CROSS-REFERENCE OF APPENDIX A AND HUMAN ENGINEERING PRINCIPLES FOR CONTROL ROOM DESIGN REVIEW

INTRODUCTION

The tabulation in this appendix relates specific items in the CRDR Survey Development Guideline to specific items in Human Engineering Principles for Control Room Design Review. Alphabetic characters, a dash, and numerals are used to denote an item in one of the questionnaires, checklists, or surveys in the survey development guideline. For example, OC-5 refers to Item 5 in the overview checklist. The abbreviations used in this appendix are listed below.

EQ	Engineering Department Questionnaire
OQ	Operator Questionnaire
OC	Overview Checklist
OAC	Procedures and Practices/Operator-Assisted Checklist
LMD	Labeling, Mimics, and Demarcation Checklist
G	General Panel Checklist
CRCC	Process Computer Checklist
DCS	Design Convention Survey
LS	Lighting Survey
NS	Noise Survey
AS	Anthropometric Survey
ANS	Annunciator Survey
CS	Communication Survey
CSI	Communication Survey-Intelligibility Section
AAS	Abbreviation and Acronym Survey
CCS	Color-Coding Survey
CRCS	Process Computer Survey

NUTAC ITEM NUMBER	CRDR HUMAN ENGINEERING PRINCIPLES
EQ-1	3.4.2.3
EQ-2	3.1.4.3
EQ-3	3.8.1.1
EQ-4	3.1.2.1
EQ-5	3.1.2.2
EQ-6	3.2.2.2
EQ-7	3.1.3.5
EQ-8	3.4.1.1, 3.4.1.2, 3.4.1.3
EQ-9	3.4.3.3, 3.4.5.2
EQ-10	3.4.5.2
EQ-11	3.7.1.1, 3.7.2.8
OQ-1	3.1.1.1, 3.2.2.2, 3.2.2.6, 3.2.2.8
OQ-2	3.2.1.2, 3.2.1.4, 3.2.3.1, 3.2.3.2
OQ-3	3.2.1.3, 3.2.1.4
OQ-4	3.2.2.4, 3.2.2.9
OQ-5	3.2.1.4
OQ-6	3.2.1.4
OQ-7	3.2.1.3, 3.2.1.4
OQ-8	3.3.3.1
OQ-9	3.3.3.3
OQ-10	3.1.1.6, 3.2.1.1, 3.3.1.1
OQ-11	3.3.3.6
OQ-12	3.3.3.5
OQ-13	3.3.4.6
OQ-14	3.1.2.2, 3.1.5.1
OQ-15	3.1.1.8, 3.4.1.1
OQ-16	3.6.1.1, 3.6.1,2, 3.6.1.6
OQ-17	3.2.2.5
OQ-18	3.8.1.1
OQ-19	3.1.2.1
OQ-20	3.1.2.1, 3.2.2.1
OQ-21	3.3.4.1

NUTAC ITEM NUMBER	CRDR HUMAN ENGINEERING PRINCIPLES
OQ-22	3.4.1.2, 3.4.1.3, 3.4.2.1
OQ-23	3.4.1.3
OQ-24	3.4.1.1
OQ-25	3.4.1.2, 3.4.2.1
OQ-26	3.4.1.1
OQ-27	3.1.3.4
OQ-28	3.1.6.1
OQ-29	3.1.4.3
OQ-30	3.1.4.3
OQ-31	3.1.4.4
OQ-32	3.1.4.1, 3.1.4.2
OQ-33	3.4.2.6
OQ-34	3.1.3.6
OQ-35	3.1.4.5
OQ-36	3.8.1.1
OQ-37	3.8.1.1
OQ-38	3.8.1.1
OQ-39	3.8.1.1
OQ-40	3.7.1.1, 3.7.2.8
OQ-41	3.7.1.1
OQ-42	3.7.1.1, 3.7.2.9
OQ-43	3.7.1.1, 3.7.2.8
OQ-44	3.7.1.1, 3.7.2.6
OC-1	3.1.3.5
OC-2	3.1.4.6
OC-3	3.8.1.1
OC-4	3.1.3.1
OC-5	3.1.3.1, 3.1.3.2, 3.1.5.1
OC-6	3.6.1.1
OC-7	3.1.5.1
OC-8	3.4.2.5, 3.4.2.8
OC-9	3.4.3.5, 3.6.1.8

NUTAC ITEM NUMBER	CRDR HUMAN ENGINEERING PRINCIPLES
OC-10	3.1.5.1
OC-11	3.1.4.3, 3.1.4.4
OC-12	3.1.3.3
OC-13	3.8.1.1
OC-14	3.4.2.8, 3.4.4.2
OC-15	3.4.3.2, 3.4.3.4
OC-16	3.2.2.7
OC-17	3.1.1.6, 3.1.1.7
OC-18	3.2.2.5
OC-19	3.1.5.1
OC-20	3.1.4.5
OC-21	3.6.1.1
OC-22	3.6.1.3
OC-23	3.8.1.1
OAC-1	3.6.1.1, 3.6.1.11
OAC-2	3.6.1.2, 3.6.1.11
OAC-3	3.6.1.3, 3.6.1.11
OAC-4	3.6.1.4, 3.6.1.11
OAC-5	3.6.1.1, 3.6.1.11
OAC-6	3.6.1.1, 3.6.1.11
OAC-7	3.4.3.5
OAC-8	3.4.2.1
OAC-9	3.4.2.6
OAC-10	3.4.3.2, 3.4.5.1
OAC-11	3.1.5.1
OAC-12	3.5.1.2
OAC-13	3.1.3.5
OAC-14	3.6.1.3
OAC-15	3.4.1.1, 3.4.2.5, 3.4.2.6
OAC-16	3.1.3.2, 3.1.6.1
OAC-17	3.4.2.2, 3.4.2.3, 3.4.2.5, 3.4.2.6, 3.4.3.1
OAC-18	3.5.1.2

NUTAC ITEM NUMBER	CRDR HUMAN ENGINEERING PRINCIPLES
OAC-19	3.5.1.2
OAC-20	3.5.1.2
OAC-21	3.8.1.1
OAC-22	3.3.4.1, 3.3.4.2
OAC-23	3.1.3.7
OAC-24	3.1.3.7
OAC-25	3.1.3.7
OAC-26	3.8.1.1
OAC-27	3.1.7.1, 3.5.1.2
OAC-28	3.1.7.1, 3.5.1.2
OAC-29	3.8.1.1
OAC-30	3.1.7.1
OAC-31	3.1.7.1
OAC-32	3.1.3.4
OAC-33	3.1.3.4
OAC-34	3.4.3.2
OAC-35	3.1.3.4
OAC-36	3.1.3.4
OAC-37	3.1.7.1
OAC-38	3.8.1.1
OAC-40	3.8.1.1
OAC-41	3.1.7.1, 3.5.1.2
LMD-1	3.6.1.3
LMD-2	3.1.1.4, 3.1.1.5, 3.6.1.3, 3.6.1.6
LMD-3	3.6.1.2, 3.6.1.6
LMD-4	3.6.1.6
LMD-5	3.6.1.6
LMD-6	3.6.1.6
LMD-7	3.6.1.6
LMD-8	3.6.1.6
LMD-9	3.6.1.4, 3.6.1.6
LMD-10	3.6.1.3, 3.6.1.6

NUTAC ITEM NUMBER	CRDR HUMAN ENGINEERING PRINCIPLES
LMD-11	3.6.1.4
LMD-12	3.1.1.1
LMD-13	3.1.1.7
LMD-14	3.1.1.2, 3.1.1.4
LMD-15	3.6.1.10
G-1	3.1.1.1, 3.1.1.6, 3.1.1.7
G-2	3.1.1.4, 3.1.1.6
G-3	3.6.1.2
G-4	3.6.1.1, 3.6.1.10
G-5	3.6.1.9
G-6	3.6.1.6, 3.6.1.7
G-7	3.6.1.6, 3.6.1.10
G-8	3.6.1.5
G-9	3.6.1.10
G-10	3.2.2.4, 3.3.2.4, 3.6.1.1
G-11	3.2.1.3, 3.2.2.1
G-12	3.6.1.6, 3.6.1.7
G-13	3.2.1.4
G-14	3.1.1.2
G-15	3.2.1.3, 3.2.2.1
G-16	3.2.1.3, 3.2.2.1
G-17	3.1.4.4
G-18	3.3.2.1
G-19	3.3.1.5, 3.3.3.5, 3.3.3.7
G-20	3.3.1.4, 3.3.3.6
G-21	3.3.2.1
G-22	3.3.2.1
G-23	3.3.1.4, 3.3.1.5
G-24	3.3.1.4, 3.3.1.5
G-25	3.3.3.5, 3.3.3.7
G-26	3.3.2.1
G-27	3.3.2.1, 3.3.3.2, 3.3.3.3

NUTAC ITEM NUMBER	CRDR HUMAN ENGINEERING PRINCIPLES
G-28	3.3.3.5
G-29	3.3.3.3
G-30	3.3.2.1
G-31	3.1.1.6, 3.2.1.1, 3.3.1.1
G-32	3.1.2.3, 3.3.1.4
G-33	3.3.3.1, 3.3.3.2
G-34	3.3.1.2, 3.3.3.2
G-35	3.3.1.4
G-36	3.3.1.6
G-37	3.3.2.1
G-38	3.2.2.9
G-39	3.1.5.1
G-40	3.2.2.7, 3.2.2.9
G-41	3.3.4.1
G-42	3.3.4.1
G-43	3.3.4.1, 3.3.4.6
G-44	3.3.4.2, 3.3.4.3
G-45	3.3.4.3
G-46	3.3.4.2
G-47	3.3.2.1
G-48	3.3.2.1
G-49	3.3.1.1
G-50	3.1.1.3, 3.2.2.7
G-51	3.2.2.9
G-52	3.2.2.5, 3.2.2.6
G-53	3.1.1.3, 3.2.1.1, 3.2.1.4, 3.2.2.5
G-54	3.2.1.1, 3.2.2.1
G-55	3.1.2.1, 3.2.2.2
G-56	3.1.1.3, 3.1.2.3, 3.6.1.4, 3.7.2.3
G-57	3.6.1.2, 3.7.2.2
CRCC-1	3.7.1.1, 3.7.1.2
CRCC-2	3.7.1.1, 3.7.1.2

NUTAC ITEM NUMBER	CRDR HUMAN ENGINEERING PRINCIPLES
CRCC-3	3.7.1.1
CRCC-4	3.7.1.1
CRCC-5	3.7.1.1
CRCC-6	3.7.1.1, 3.7.2.2
CRCC-7	3.7.1.1, 3.7.2.2, 3.7.2.4
CRCC-8	3.7.1.1
CRCC-9	3.7.1.1
CRCC-10	3.7.1.1, 3.7.2.8
CRCC-11	3.7.1.1, 3.7.2.5
CRCC-12	3.7.1.1, 3.7.2.4
CRCC-13	3.7.1.1, 3.7.2.8
CRCC-14	3.7.1.1, 3.7.2.8
CRCC-15	3.7.1.1, 3.7.2.8
CRCC-16	3.7.1.1
CRCC-17	3.7.1.2
CRCC-18	3.7.1.2
CRCC-19	3.7.1.1, 3.7.2.1, 3.7.2.6
CRCC-20	3.7.1.1, 3.7.2.1, 3.7.2.6
CRCC-21	3.7.1.1, 3.7.2.1, 3.7.2.6
CRCC-22	3.7.1.1, 3.7.2.1
CRCC-23	3.7.2.1, 3.7.2.4
CRCC-24	3.7.1.1, 3.7.2.1, 3.7.2.5, 3.7.2.6
CRCC-25	3.7.1.1, 3.7.2.1, 3.7.2.2, 3.7.2.6
CRCC-26	3.3.2.1, 3.7.2.1, 3.7.2.5
CRCC-27	3.7.1.1, 3.7.2.5
CRCC-28	3.7.1.1, 3.7.2.5, 3.7.2.6
CRCC-29	3.7.2.3
CRCC-30	3.7.2.5
CRCC-31	3.7.2.5
CRCC-32	3.7.2.4
CRCC-33	3.7.2.4, 3.7.2.5
CRCC-34	3.7.1.1, 3.7.2.1
CRCC-35	3.7.1.1, 3.7.2.1, 3.7.2.8

NUTAC ITEM NUMBER	CRDR HUMAN ENGINEERING PRINCIPLES
CRCC-36	3.7.1.1., 3.7.2.8
CRCC-37	3.7.1.1, 3.7.2.4
CRCC-38	3.7.1.1
CRCC-39	3.7.1.1
CRCC-40	3.7.1.1
CRCC-41	3.7.2.9
CRCC-42	3.7.1.1, 3.7.2.9
CRCC-43	3.7.1.1, 3.7.2.2, 3.7.2.9
CRCC-44	3.7.1.1, 3.7.2.2, 3.7.2.9
CRCC-45	3.7.1.1, 3.7.2.9
CRCC-46	3.7.1.1, 3.7.2.9
CRCC-47	3.7.1.2, 3.7.2.9
CRCC-48	3.7.1.1
CRCC-49	3.7.1.1, 3.7.2.9
CRCC-50	3.7.2.9
DCS	3.1.1.3, 3.1.1.6, 3.1.1.7, 3.1.2.1, 3.1.2.2, 3.1.2.3, 3.2.1.1, 3.3.1.1
LS-1	3.1.4.3, 3.1.4.4
LS-2	3.1.4.3, 3.1.4.4
LS-3	3.1.4.3, 3.1.4.4
LS-4	3.3.1.6
LS-5	3.3.1.6, 3.6.1.4, 3.7.2.3
NS-1	3.1.4.5
NS-2	3.4.2.5, 3.4.2.6
NS-3	3.1.4.5
AS-1	3.2.2.5, 3.3.2.1
AS-2	3.2.2.5, 3.2.2.9
AS-3	3.2.2.5
AS-4	3.2.2.5

NUTAC ITEM NUMBER	CRDR HUMAN ENGINEERING PRINCIPLES
AS-5	3.2.2.5
AS-6	3.3.2.1
AS-7	3.3.2.1
AS-8	3.2.2.5
AS-9	3.2.2.5
AS-10	3.3.2.1
AS-11	3.3.2.1
AS-12	3.4.3.1
AS-13	3.1.3.2, 3.1.3.6
AS-14	3.1.3.2, 3.1.3.6
AS-15	3.2.2.5, 3.2.2.9
AS-16	3.2.2.5
AS-17	3.2.2.4, 3.2.2.9
AS-18	3.1.3.6
AS-19	3.3.2.1, 3.4.3.1
AS-20	3.1.3.1
ANS-1	3.4.4.1, 3.4.4.2
ANS-2	3.4.2.8
ANS-3	3.4.3.2, 3.4.3.3, 3.4.3.4, 3.4.4.1
ANS-4	3.4.1.1, 3.4.1.2, 3.4.1.3, 3.4.2.1
CS-1	3.1.3.2, 3.1.5.1, 3.8.1.1
CS-2	3.8.1.1
CS-3	3.8.1.1
CS-4	3.8.1.1
CS-5	3.8.1.1
CS-6	3.6.1.2, 3.6.1.9, 3.8.1.1
CS-7	3.8.1.1
CSI	3.8.1.1
AAS	3.4.3.4, 3.6.1.2, 3.7.2.2

NUTAC ITEM NUMBER	CRDR HUMAN ENGINEERING PRINCIPLES
CCS	3.1.2.3, 3.3.1.6, 3.7.2.3
CRCS-1	3.7.1.1
CRCS-2	3.7.2.2
CRCS-3	3.7.2.6
CRCS-4	3.7.1.1, 3.7.2.2
CRCS-5	3.7.2.1
CRCS-6	3.1.4.4, 3.7.2.5, 3.7.2.7
CRCS-7	3.7.2.5

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