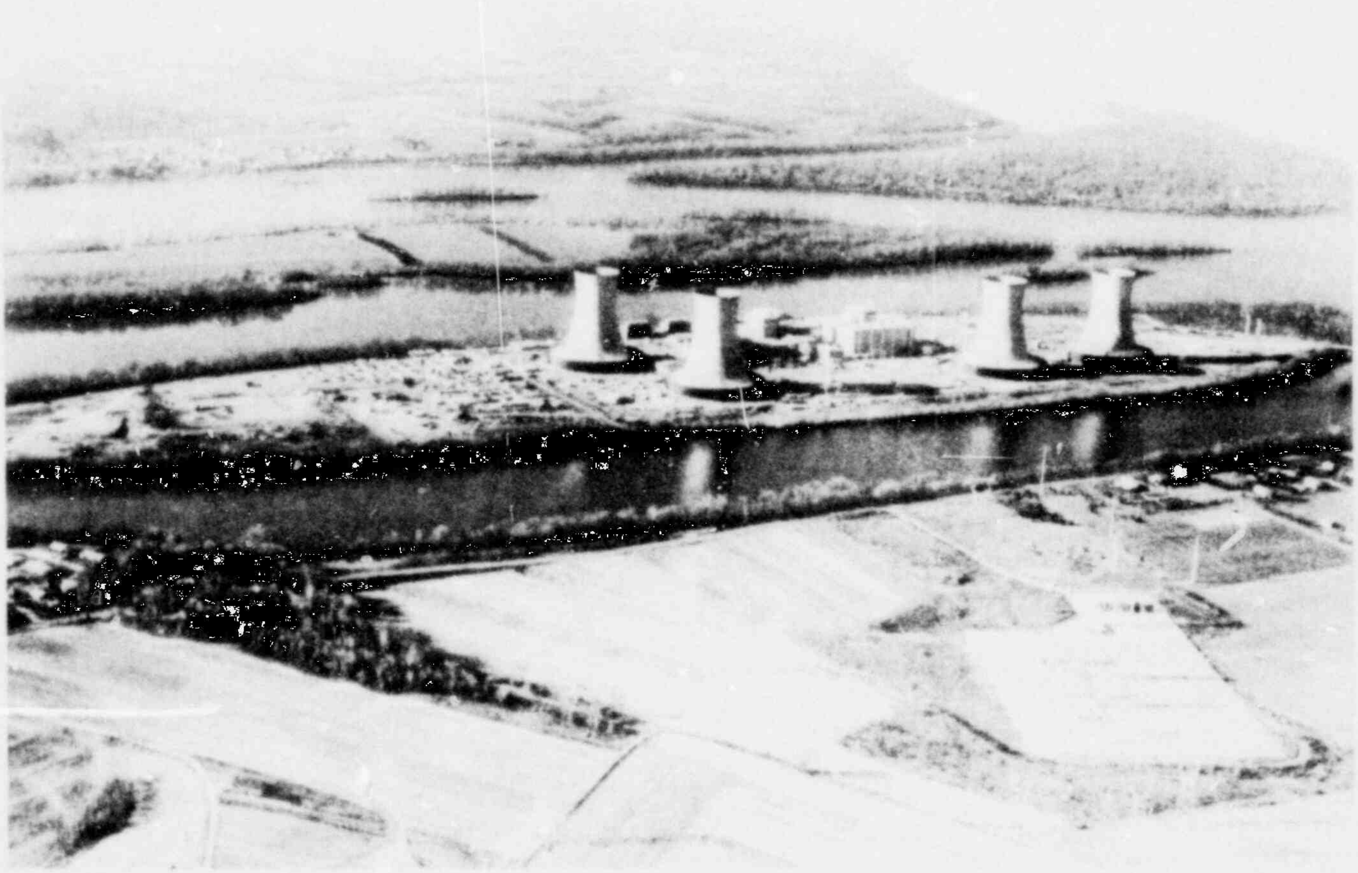
Human Factors Evaluation of Control Room Design and Operator Performance at Three Mile Island–2



The Essex Corporation
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HUMAN FACTORS EVALUATION OF CONTROL ROOM DESIGN AND OPERATOR PERFORMANCE AT THREE MILE ISLAND

Prepared For:

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Prepared By:

Thomas B. Malone, Ph.D.
Mark Kirkpatrick, Ph.D.
Kenneth M. Mallory
David R. Eike
Jimmie H. Johnson
Robin W. Walker

The Essex Corporation

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APPENDIX A

TASK DESCRIPTIONS

This section describes each of the four tasks which comprised this investigation. The tasks were:

- TASK A Control Room Design at TMI-2
- TASK B Analysis of Control Room Activity
- TASK C Evaluation of Operator Performance
- TASK D Application of Human Factors Principles to CR Design

A.1 TASK A — Control Room Design At TMI-2

Using a two-phased approach, Essex examined the degree to which human factors engineering considerations were taken into account in the TMI-2 design development process and in the resulting Control Room design. In the first phase, TMI-2 development and design were reviewed in light of human engineering criteria and practices existing at the time when TMI-2 was undergoing development. In the second phase, TMI-2 design and development processes were compared to two other nuclear power plants designed at about the same time.

Results (Section 3.0) show marked differences in Control Room development and design between the three Control Rooms selected. Furthermore, it is clearly indicated that human factors standards and criteria extant in the nuclear power community during the late '60's and early '70's were inadequate to properly guide Control Room design and development. With few exceptions, the Control Room at TMI-2 met the existing human engineering criteria.

A.1.1 Objectives and Scope

Through an examination of reports, design documentation, and criteria, and through a review of as-built Control Room designs, TASK A activities identified the general factors which influenced the human engineering design aspects of the TMI-2 Control Room. Factors included in the evaluations were: design bases; design philosophies; operating logic; industry standards; AEC (NRC) regulations and other Federal regulations; and human engineering involvement in Control Room planning design development, testing and operation.

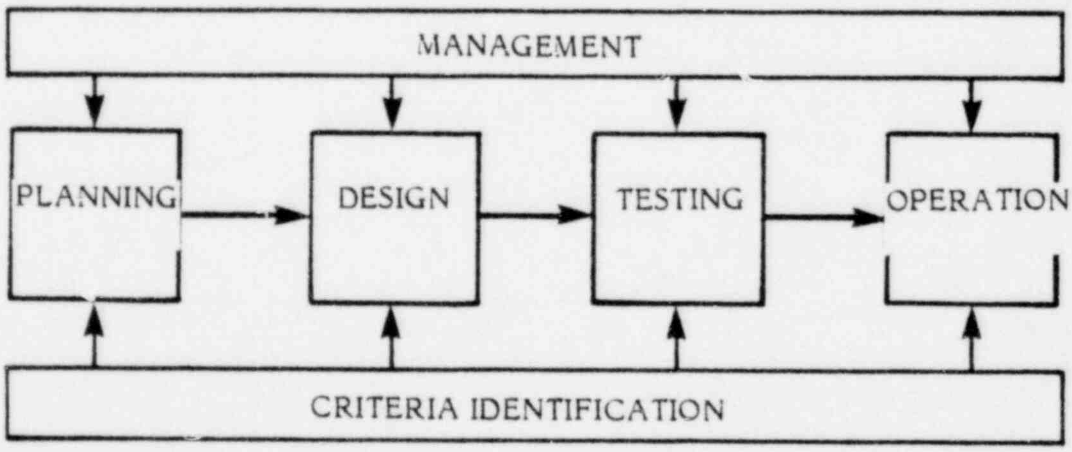
Taken broadly, the human engineering aspects of Control Room design included: anthropometry; control/display integration; controls; displays; labeling; Human Factors Engineering in systems; and procedural documentation (fidelity, accessability, legibility, readability, usability).

A.1.2 Approach

The goal of human engineering is to design Control Room equipment and procedures such that adequately trained operators can perform assigned tasks with the necessary speed, precision, and reliability. The likelihood that this goal will be met depends largely on the timely application of human engineering practices, principles and data throughout all phases of CR development and use.

In this task, the uses of human engineering in TMI-2 planning, design, testing, operations, criteria identification, and management were determined. Then these findings were compared to Baltimore Gas and Electric Company's Calvert Cliffs - Unit 1 and Duke Power Company's Oconee - Unit 3 Nuclear Power Plants to find if other plants of the same vintage made similar use of Human Engineering.

For purposes of this evaluation, planning, design, testing and operations functions are sequential, and management and criteria identification are parallel to all four as shown below:



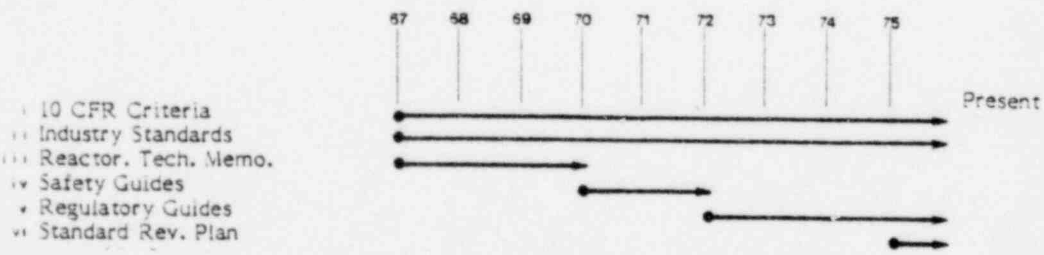
The human engineering aspects embraced by each function are described below, together with the means used to acquire data on each of the three plants.

Finally, some human engineering aspects of the TMI-2 as-built design were compared to Calvert Cliffs - Unit 1 and Oconee - Unit 3 to determine if same-vintage plants used similar design solutions for similar human engineering problems. Human engineering aspects included: reach and visibility; procedures design; panel complexity; coding and conventions; rules and philosophies; and an assessment of well-human engineered features of the Control Room.

A.1.2.1 Evaluation of TMI-2 Development Process — Interviews with engineers and managers cognizant of plant development, source documentation produced during the course of plant development, depositions and testimony where available, and a thorough review of standards and criteria available during the late '60's and early '70's were used to reconstruct the application of human engineering during the plant design development process.

Criteria Identification

In designing a nuclear power plant, engineers during the late 1960's were (and are) obliged to follow certain criteria, and advised to follow others. Federal Government criteria were imposed or recommended by the AEC (NRC) using Title 10 Code of Federal Regulations, Reactor Technology Memoranda, Safety Guides, Regulatory Guides, and industry standards. Voluntary criteria were industry standards or recommended practices issued primarily by the American Nuclear Society (ANS), the Institute of Electrical and Electronics Engineers (IEEE), and the American National Standards Institute (ANSI). In 1975, the NRC consolidated its review criteria in a Standard Review Plan aimed at providing a comprehensive approach to the examination and approval of Power Plant Safety Analysis Reports submitted by the utility constructing a nuclear power plant.



In order to obtain an accurate picture of the human engineering criteria imposed on CR design as well as the human engineering data widely publicized to the nuclear power engineering community, the criterion documentation available from 1967 to the present was identified and reviewed.

10CFR Criteria — As noted in the figure above, 10 CFR Criteria were available from 1967 to the present. The entire 10 CFR, Chapter 1 — Nuclear Regulatory Commission was reviewed for human engineering criteria. Then each of the criteria was traced to its genesis. Design criteria published during the period 1967-1973 were considered to be operative for TMI-2 (the TMI-2 FSAR was published in 1974).

Industry Standards — To identify currently-applicable standards, the 765 documents named by the Nuclear Standards Management Board (NSMB) of the American National Standards Institute were subjected to a title review by a Nuclear Engineer and a Human Engineer who sorted out documents that might contain criteria impacting the control room. Then 75 documents were reviewed and those containing criteria within the domain of human engi-neering were set aside for further analysis. Each criterion was classified and recorded according to its subject matter:

- Operator/System Integration
- Instrumentation and Control
- Control Room Environment
- Operator Procedures
- Operator Support Equipment
- Human Factors Test and Evaluation
- Policy, Planning and Management.

Documents containing human engineering criteria were then traced back to "trial use" standards, or to other predecessor documents which in turn were traced. This process was facilitated by ANSI-NTAB Project Status Reports dating back to 1972 and listing standards and standards development projects for the Nuclear Industry. Standards available during the 1967-1973 time frame were selected for closer analysis.

Each of the criteria within the domain of human engineering was examined to determine if its language imposed or suggested design features or principles that would improve Operator Performance.

It should be noted that the completion of this review would not have been possible without the continuing and patient cooperation of the American Nuclear Society, the Institute of Electrical and Electronic Engineers, and the American National Standards Institute.

Reactor Technology Memoranda (RTM) — RTM were the predecessors to Safety Guides and Regulatory Guides, and were rather informal in nature. As such, all of the RTMs could not be located for review. Those reviewed included:

- Recording Seismographs in Nuclear Facilities, RTM —
- Combustible Gas Control System, RTM 8
- Control Room Design Considerations, RTM 6
- Emergency Core Cooling System Evaluation Guidelines, RTM 4
- Seismic Design Criteria, RTM 3.

During the review, five criteria were noted within the human engineering domain. None of these impose or suggest features or principles that would improve operator performance.

Safety Guides and Regulatory Guides — Safety Guides are the predecessors of Regulatory Guides, and:

> Regulatory Guides are issued to describe and make available to the public methods acceptable to the NRC staff of implementing specific parts of the Commission's regulations, to delineate techniques used by the staff in evaluating specific problems or postulated accidents, or to provide guidance to applicants. Regulatory Guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those set out in the guides will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of a permit or license by the Commission.

The titles to 324 Regulatory and Safety Guides were reviewed by a Control Room Operator, a Nuclear Engineer and a Human Engineer with instructions to identify those guides that will or might impact any aspect of Control Room design. Sixty (60) guides were identified and reviewed to determine if any criteria were within the human engineering domain. Twenty (20) such guides were located and their criteria were identified using the same titles as in Industry Standards.

Guides were then traced to their origins. If their origin was 1973 or earlier (eight Guides), each criterion was examined to determine if its language imposed or suggested design features or principles that would improve operator performance.

Standard Review Plan (SRP) — The entire 1 300 page SRP was reviewed by a Nuclear Engineer and a Human Engineer to identify all criteria that impact Control Room design. One hundred forty-two (142) criteria were located and each criterion was classified according to the scheme outlined in Industry Standards.

Since the SRP was published in 1975, no additional analyses of SRP criteria were performed.

Engineers and managers participating in the development at TMI-2, Oconee-3 and Calvert Cliffs-1 were asked, during interviews discussed below, to identify standards and other criteria important to plant design.

Management

Much like the disciplines of system safety and reliability, human engineering is not effectively implemented when management is not sensitive to the operator and his capabilities and limitations under all operational circumstances.

In the Nuclear Industry, NSSS, A-E, and utility requirements for the control room must be integrated and an overall design philosophy acceptable to each must be developed and implemented with each participating in the design.

The role of each member of this team in CR development was addressed by questions asked of cognizant engineers and managers from the various firms:

TMI-2	Oconee-3	Calvert Cliffs-1
• Metropolitan Edison (Utility)	• Duke Power (A-E & Utility)	• Balt. Gas & Elec. (Utility)
• Burns & Row (A-E)	• Babcock & Wilcox (NSSS)*	• Combustion Eng. (NSSS)
• Babcock & Wilcox (NSSS)*		• Bechtel (A-E)

*Not interviewed — NSSS vendor specified equipment, but did not actively participate in layout.

Questions dealt with the following issues:

- Coordination in CR Design
- Procedure for Design Changes
- Selection Criteria for the A-E (HE considerations?)

- Meetings/Reviews on Control Panel
- Documentation Requirements
- Personnel Experience.

Notes, memoranda, and letters pertaining to TMI-2, in addition to interviews, were used to evaluate management factors.

Planning

Decisions such as Control Room sizing, basic control board arrangement, specification of design bases, and determination of baseline Control Room Crew complement are made during planning. Each of these has an important impact on Operator performance on the resulting control panel.

The degree to which human engineering was taken into account in CR planning was assessed by interviews with engineers from the several firms named above. Interview questions addressed:

- Utility-imposed criteria or other constraints
- Evaluation of alternate panel configurations
- Role of precedent in selecting CR arrangement
- Number of Operators in crew and role of each
- Design Basis for:
  - anthropometrics
  - color coding conventions
  - control room lighting
  - labeling conventions or rules
  - control/display grouping
  - annunciator grouping
  - switch orientation conventions or rules
  - acoustics
  - readout vs. computer printout assignment of variables
  - control selection
  - display selection
  - use of mimicking
  - video displays
  - separation of functions between primary and peripheral areas.

Design

Outside of mandatory criteria, the single most important factor during control panel design is the design philosophy(ies) adopted by the A-E, utility, NSSS vendor, and the AEC (NRC). The design philosophy usually stipulates the overall direction taken in the organization of the control panel, the trade-off priorities (cost, reliability, engineering, operator performance, etc.), and the basic approach taken to maximizing operator performance.

The design philosophies used during the development of the three plants were determined through:

- An examination of the control room As-Built Layouts (TMI-2; Calvert Cliffs-1; Oconee-3)
- A review of the FSAR (TMI-2; Calvert Cliffs-1; Oconee-3)
- A review of background documentation (TMI-2)
- A review of regulatory documentation (NRC)
- Interviews (TMI-2; Calvert Cliffs-1; Oconee-3; NRC).

The role of human factors engineering in design includes the following (28):

- To assure that the operator has sufficient information to perform his task, and that he is not burdened with excessive, extraneous data
- To design the control panels in such a way as to assure effective operation by a full range of trained operators under all operational conditions
- To establish and, as importantly, maintain coventions and rules incorporated in design (e.g., color coding)
- To participate in the development of procedures
- To develop training requirements based on procedures and control panel design.

The actual role of human engineering in the development of TMI-2, Calvert Cliffs-1, and Oconee-3 was determined by interviews with engineers and managers of the firms listed above. Topics covered in the interviews were:

- Review of panel operation with respect to design
- Use of operator opinion during design
- Determination of personnel training and selection requirements
- Attempts to minimize the likelihood of human error
- Selection of alarm & annuciator strategies
- Use of video displays
- Anthropometric ranges
- Color coding
- Display/background contrast (panel paint)
- Labeling
- Assessment of readability (displays & labels)

- Control/display grouping
- Auditory alarms
- Switch position orientation
- Design for operator wearing breathing apparatus and/or protective garments
- Operator recall/information processing requirements
- Maintainability
- Operator response times (considered in panel design?)
- Design for separation and redundancy
- Use of mockups, walk-throughs and simulators
- Noise level (taken into account?)
- Participation in developing procedures
- Task analyses (were they performed?)
- Design to protect expensive equipment.

Testing

Since the Operator is a critical "component" in the power plant system, evaluating the likelihood that he will be unable to perform properly under some conditions is a critical part of any comprehensive test program. Finding "error prone" procedures or control panels during testing can lead to corrective backfits before the plant is operational.

Personnel from the A-E, NSSS and utilities involved in testing TMI-2, Calvert Cliffs-1, and Oconee-3 were asked, during interviews, to describe any Human Engineering Test and Evaluation performed during the testing phase of their plants.

Operations

As in testing, the primary role of human engineering in Operations is to identify backfits which, if applied, would reduce the likelihood of human error. Two means to do this are apparent. First, backfit suggestions could be solicited (or accepted) from the operators who know many of the weaknesses in panel design and procedures. Second, a human performance surveillance program could be used to identify design, procedural and training problems.

To determine the role of human engineering in the Operations Phase, personnel from the three utilities were asked to describe programs aimed at improving panel designs or procedures.

A.1.2.2 Comparison of TMI-2 Control Room Design to Same Vintage Plants — In order to determine if other nuclear power plant designers arrived at the same solutions to human engineering problems as did the designers of TMI-2, two same-vintage plants were selected for comparison. Aside from date-of-design, other criteria used for selection included: Pressurized Water Reactor Plant; different Architect-Engineer and Utility; approximately the same plant output; and located on the east coast.

Two plants were chosen:

- Calvert Cliffs - Unit 1
- Oconee - Unit 3.

Human Engineering personnel visited each of these plants and collected the following information:

- Photographic Data for Later Analysis
- Procedures
- Number of Switches/Displays in Primary Areas
- Particular Control/Display Solutions to Specific Problems
- Photos of Specific Control/Display Components
- Description of Annuciator Procedures & Designs
- Role of Automation
- Description of Auditory Alarms
- Description of Communications Network
- Actual Color Coding Practice
- Photos of CR and Panel Arrangements
- Panel/Room Dimensions.

These data were synthesized into the following results:

- Control Room Descriptions
- Procedures Comparison
- Control Panel Human Engineering Comparisons (Notable Human Engineering Features of Panels)
- Reach and Visibility Survey.

A.2 TASK B — Analysis Of Control Room Activity

Location and arrangement of workstations within the control room represent design characteristics which can impact operator performance. Spatial arrangement within any control space should be designed based on expected operator activity sequences. Location of elements within the control room can facilitate operator performance to the extent that:

- Physical Access
- Visual Access
- Operator Travel

are reflected in the design. Failure to design relative to these factors can result in degraded performance primarily through:

- Excessive task time due to travel requirements between stations
- Lack of necessary information due to inappropriate location of displays relative to workstations.

The intent of Task B was to describe and analyze operator activities in the TMI-2 CR during the 150 minute period. Operator decisions, control actions, and motions were identified. These data were used to construct a timeline showing operator activities in relation to time and plant events. A full-scale mockup of the TMI-2 control room was constructed and used to reenact and video tape selected activity sequences.

A.2.1 Objectives and Scope

The objectives of Task B were as follows:

- Construct a full-scale mockup of the TMI-2 CR for use in studying operator activities.
- Develop a timeline showing activity sequences for the on-duty crew members during the first 150 minutes of the incident.
- Video tape selected activity sequences to analyze and demonstrate CR design factors which impacted crew performance.

A.2.2 Development of Crew Activity Timeline

The timeline was developed by identifying activities performed by the principal crew members during the 150 minute period. The primary sources of data used were:

- GPU Sequence of Events dated July 16, 1979 (43)
- NRC I&E Sequence of Events with revisions and updates by NRC staff (33, 42)
- Operator Interviews (44)
- Reactimeter data
- Plant stripcharts and computer printouts

- Reviews of timelines by NRC personnel and by the on-duty staff with inputs and comments
- Observation of walk-throughs using the mockup by NRC personnel and by the on-duty staff with inputs and comments.

Operator actions were initially identified using the available operator interviews. These actions were listed in the order they were performed where operators were able to recall sequence. Four main action types were noted:

- Action involving controls such as "starts makeup pumps MU-P-1A"
- Monitoring/observing plant parameters such as "observes pressurizer level on-scale"
- Decisions such as "decides to isolate OTSG"
- Travel within CR such as "moves from pressurizer station to makeup station."

A listing of operator actions was prepared describing the operator location, displays involved, and controls used. To locate these events in time, available plant event chronologies and plant data were used to determine times for operator actions.

An initial version of the timeline was reviewed by the on-duty shift supervisor, shift foreman, and control room operators. Their comments were included in the updated timeline.

Following construction of the CR mockup, the timelines were used to walk-though the sequence of activities to validate the sequence. At this point, the on-duty crew visited the mockup and observed the walk-through, making comments as appropriate. Data gathered by this process were then incorporated into the final timelines which were reviewed by NRC personnel. The final timelines are included as Appendix C.

A problem arose in limiting the number of personnel represented in the timeline. The purpose was to examine operator activities at the panels rather than to document the total personnel activity. Consequently, the personnel addressed in detail were limited to:

- The on-duty shift supervisor (shift supervisor E)
- The on-duty shift foreman (shift foreman C)
- The on-duty control room operators (CRO D and CRO C)
- Shift supervisor A who was called to the TMI-2 CR shortly after the reactor trip.

Other personnel actions are indicated in a single column of the timeline where these were directly involved in the sequence. These "other personnel" include two shift supervisors, two control room operators, and a plant engineer who arrived during the 150 minute period.

A.2.3 Fabrication of Control Room Mockup

A mockup was required for reenactment of operator activities and analysis of human factors related design characteristics of the CR. Panels directly involved in the incident were included in the mockup as follows:

- Inner Consoles

2	Computer console
3	Auxiliary systems console
4	Plant control console
5	Turbine control console
6ABC	Electric control console

- Vertical Panels

7	Fire detection panel
8	Coolant systems monitoring panel
9	Push-pull control panel
10	Plant equipment temperature recording panel
12	Radiation monitoring panel
13	Engineered safety features panel
14	Control rod drive panel
15	Containment isolation panel
16	Turbine supervisory panel
17	Turbine auxiliary monitoring panel
18	Station electric auxiliary monitoring panel
19	Vital power panel
19A	500 KV control panel
26	Diesel generator No. 1 panel
29	Diesel generator No. 2 panel

- Back Panels located outside main control

8A	Reactor coolant drain tank panel
20	Nuclear instrumentation cabinet No. 1
21	Nuclear instrumentation cabinet No. 2
25	HV&AC panel.

The control room layout is shown in Figure A-1.

The mockup was constructed of ¼ inch Foam-Core using photographs to represent controls and displays. The TMI-2 control room was photographed from August 13-16. A grid system was employed using horizontal steps of 2 feet for inner consoles and 3 feet elsewhere. The grid was superimposed on the panels by use of numbered dots which represent intersection points.

Several shots were taken of each grid square using a Minolta SRT-202 (35 mm.) with Kodak Plus-X film (ASA 125). Use of varying exposure yielded about 400 shots, 190 of which were used in construction. Rokkor 50 mm. (f1.4) and 28 mm. (f2.8) lenses were used. Due to the space limitations between the front faces of the vertical panels and the rear surfaces of the inner console (4 ft. 1 in.) it was necessary to use the wide lens for these shots. The 50 mm. lens was used elsewhere.

The negatives were developed in normal D-76 by Image, Inc., Alexandria, Virginia. The images were wall projected using a Beseler 23C-II enlarger with 100 mm. Schneider Componon—S lens. Magnification was adjusted to obtain the proper horizontal dimension for the grid square size originally used in shooting. Due to the lenses used and shooting angle, some trapezoidal distortion was introduced. It was necessary to adjust magnification on a frame-by-frame basis to achieve the best combination of dimensional accuracy and match between adjacent frames. Errors in locating controls and displays and total panel dimensions were kept to ± 1 inch. Images were printed on 20x24 Kodak Polycontrast Rapid II RC paper (N surface) and were developed in Dektol 2:1. An appropriate polycontrast filter and long exposure were used to heighten tonality and detail. This process was adequate for all legends and instrument scales to be readable.

The back and vertical panel mockups were constructed in eight foot high by four foot wide Foam-Core sections with wooden frames. Only the front faces of these panels were represented. Dimensionally accurate mockups of the inner consoles were constructed of Foam-Core using wooden supports and frames. The consoles were constructed in eight foot long sections to allow transport.

Grid lines corresponding to the original grid were constructed on the mockup sections and the photographic prints were placed in the grid. Print positions were adjusted to obtain the best dimensional accuracy and match between adjacent frames. The prints were trimmed and glued to the Foam-Core sections.

The mockup sections were positioned in a 60x50 foot area as shown in Figure A-1. Inaccuracies in the mockup include minor image distortion as noted above and changes in panel features made in the CR between the time of the incident and the time of photographing the panels. A major problem was encountered with regard to panel 14. Since the incident, a core thermocouple display has been placed over it. The corresponding panel in the TMI-1 CR was used, therefore, to produce photographs.

A general view of the CR mockup is shown in Figure A-2.

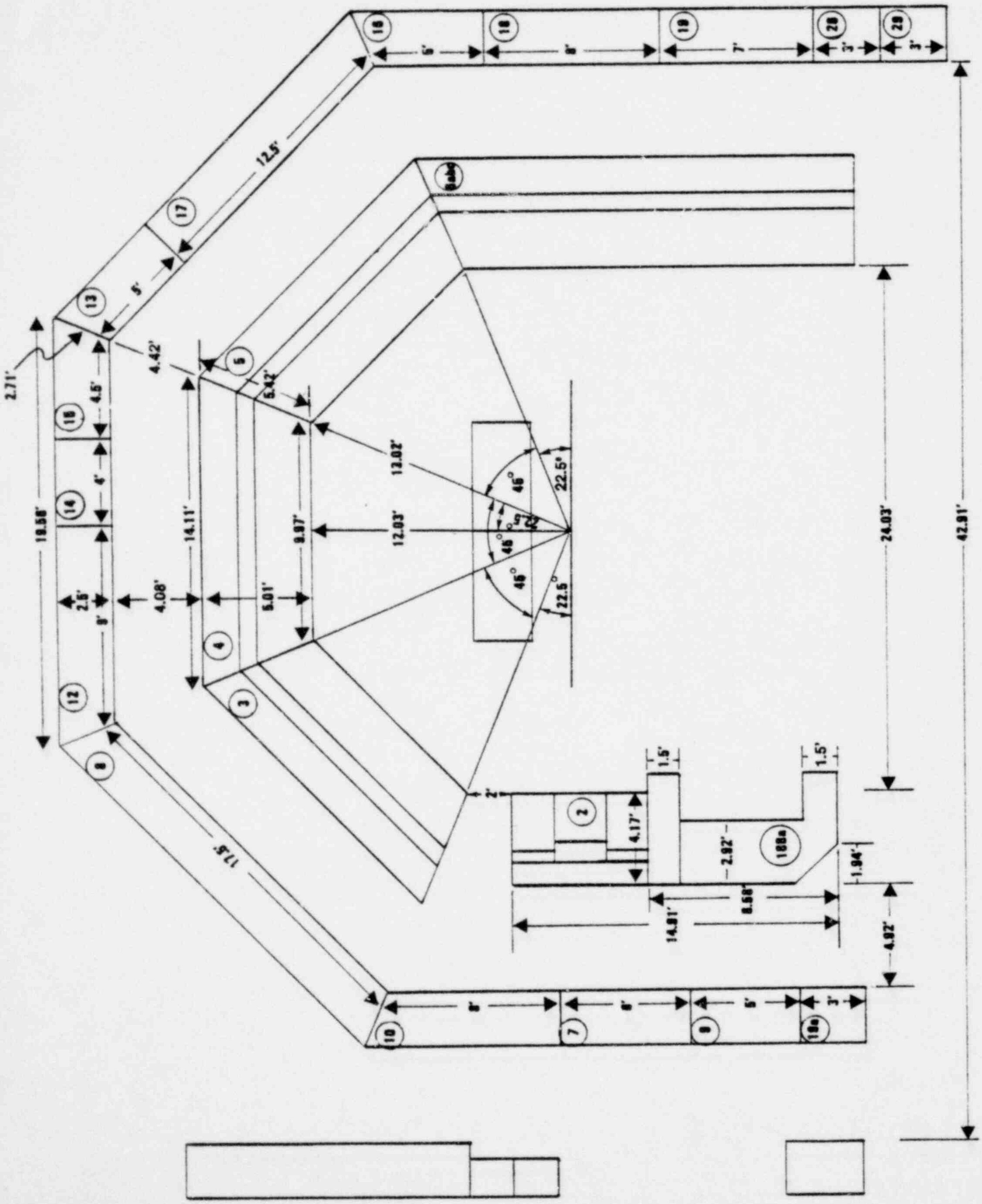


FIGURE A-1 PANEL ARRANGEMENTS

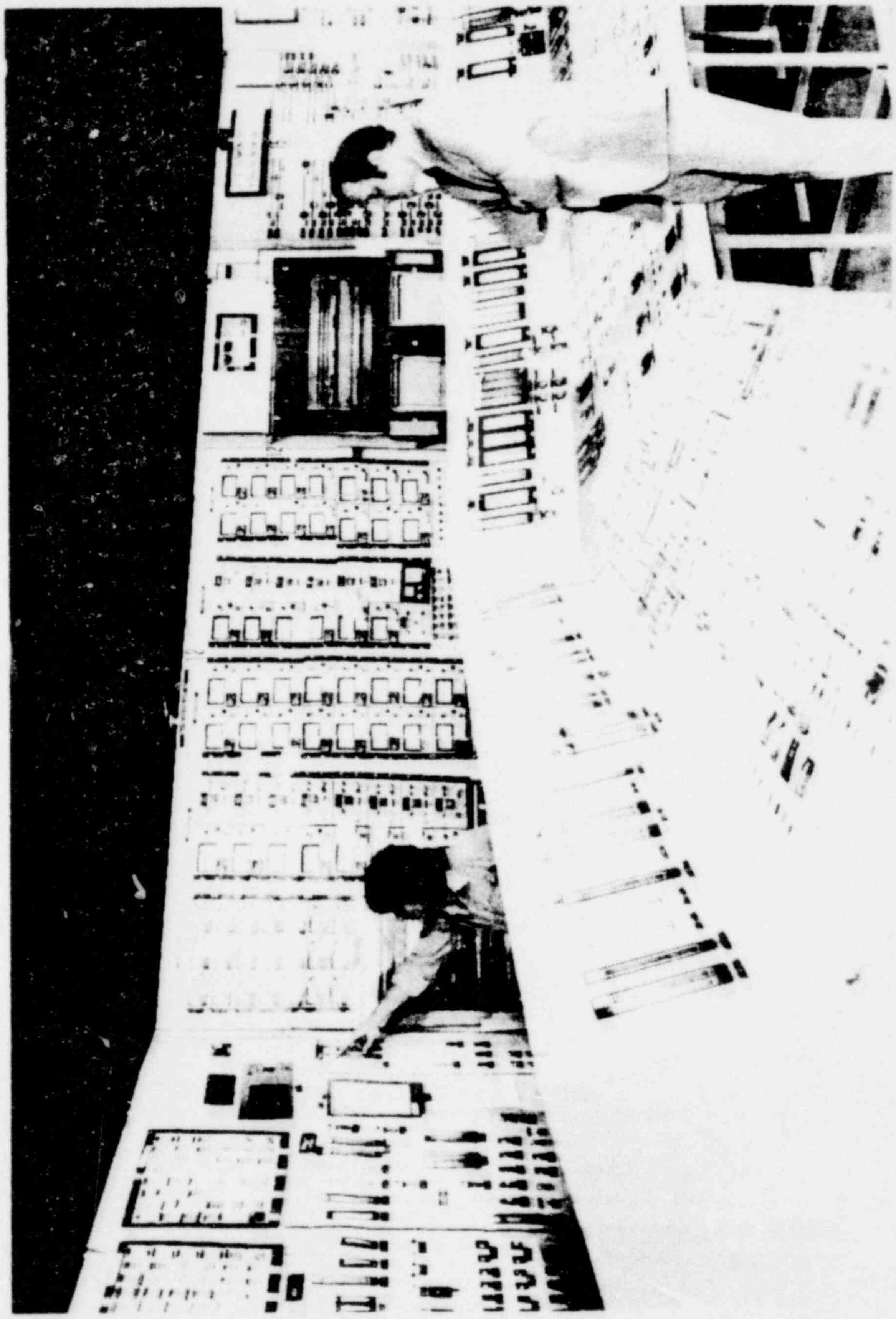


FIGURE 2
THE ESSEX TMI-2 MOCK-UP

A.2.4 Operator Activity Videotape

Selected operator actions were video taped using the mockup. A Panasonic VHS recorder, Panasonic Color Pilot monitor and Panasonic WV 3300 color camera were used. Essex personnel acted the parts of operators. The tape shows operator activity sequences which illustrate design problems in the control room including:

- Component placement requiring operator travel
- Display placement which interferes with acquisition of information by the operator
- Placement, labeling, and functional inconsistencies within panels.

The taped sequences do not represent a reenactment of the incident but do illustrate operator activities which took place during the incident. Narrative is included to describe the design problems depicted and the relationships of these to the accident.

A.3 TASK C — Operator Performance

The accident at TMI-2 evolved from a complex interaction of equipment failures and operator actions and inactions. Operator performance did significantly influence the course and outcome of the accident.

A.3.1 Objectives & Scope

This endeavor was undertaken to determine the role of training, information transfer and policy in the accident. The purpose of this task was to identify and analyze the relative contributions of each of these to operator performance. The objectives were:

- Determine the adequacy of the training program to ensure the operators' capability to diagnose problems and take appropriate actions during normal and emergency conditions, emphasizing the requirements which surfaced during the TMI-2 accident
- Identify the basis for each significant action/inaction resulting from operator performance that cannot be attributed to inadequate training.

A.3.2 Methods of Evaluating Selection Procedures

A thorough review was made of NRC requirements and regulations, as well as industry guidelines and standards, and Met Ed policies were compared to these. The above were also compared to FAA regulations regarding air traffic controller specialists.

A.3.3 Methods of Evaluating Control Room Manning

Met. Ed. policies regarding crew composition, task assignment procedures, skill levels, shift change procedures and workload criteria were reviewed. Depositions and interviews were read to determine the opinions of experts in nuclear engineering and the approach advocated by a group of scientists in the Swedish nuclear power station industry was reviewed.

A.3.4 Methods of Evaluating Training Policies and Regulations

Policies and regulations affecting the crew on duty at the time of the accident were reviewed to determine the impact of these upon operator performance. The organizations responsible for these policies and regulations were the NRC, B&W and Met Ed

A.3.5 Methods of Evaluating Training Programs

All available Met Ed and B&W training materials were reviewed and interviews were conducted in order to determine training requirements and objectives, to compare programs and objectives and to evaluate instructor skills, course content, training coverage, tests, media and training management. In order to determine the relationship between the training that these operators had and that others receive, the facilities and programs at TVA, Duke Power and the Singer-Link simulation facility were visited. Training objectives for emergency procedures judged to be relevant to the March 28 accident were developed. Based on the objectives, training requirements were developed. Problems for training involved situations where available training failed to meet requirements.

A.4 TASK D — Application Of Human Factors Principles To Control Room Design

A.4.1 Problem

Human factors engineering test and evaluation (HFE T&E) encompasses the techniques, methods, principles and data used to assess the adequacy of a system's design. In general, effective system performance is dependent on the extent to which the system's design incorporates the requirements of its constituent elements. For the human factors engineer, this tenet is expressed in terms of the capabilities and limitations of the human operator as they relate to the operator's functions within the system. By corollary, the crux of effective design, from an HFE perspective, is the translation of operator functions into specific tasks and, subsequently, into quantifiable information and performance requirements. These requirements are then used as standards against which the adequacy of the design of the man-system interface is measured. For the nuclear power plant, the keystone of this interface is the control room. As it relates to the incident at TMI-2, HFE T&E provided the tools for estimating the degree to which the control room's design and established operating procedures precipitated and/or compounded the sequence of events and associated operator actions which led to the accident.

A.4.2 Objectives:

1. Identify systems, components and procedures in the control room which played a critical role during the first 150 minutes of the accident
2. Identify relevant human factors considerations for each system, component and procedure which had a critical relationship to the accident
3. Evaluate degree of compliance of critical systems, components and procedures to applicable human factors principles and standards
4. Assess the impact on operator performance of specific system, component and procedural features which fail to comply with human factors principles and standards.

2.4.3 Method

This section describes the technical approach employed by Essex in the evaluation of the human engineering aspects of the design of the TMI-2 control room. Each of the major tasks will be described in terms of the methods and rationales used to collect, organize and interpret the data contained in this report.

Identification of Critical Systems, Components and Operator Actions/Inactions

The core of this task involved the development of a timeline/decision-action sequence describing plant status and operator activities during the first 150 minutes of the accident. This sequence was developed through a comprehensive review of the available documentation, including transcripts of operator interviews and various chronologies, and interviews with TMI-2 control room operators. The sequence was validated and revised during a walk-through of the accident, using a mockup of the control room, at which time inputs were made by four of the operators who participated in the incident.

In the course of developing the sequence, principal operator tasks were analyzed to identify critical systems, components and operator actions/inactions. Criticality was defined in terms of the subject item's relationship to the course and outcome of the accident.

Development of HFE Test and Evaluation Strategy

Each of the critical systems and components was analyzed to determine HFE considerations relevant to its design. This analysis focused on the following characteristics:

- Control/display integration
  - position relationships
  - movement relationships
  - control/display ratio
- Visual displays
  - information
  - location and arrangement
  - coding
- Audio displays/warnings
  - signal characteristics in relation to operational conditions and objectives
  - clarity of meaning
- Controls
  - selection (appropriateness)
  - direction of movement
  - arrangement of grouping
  - coding
  - prevention of accidental activation
- Labeling
  - orientation and location
  - content
  - design of characters
- Workspace
  - visual envelope
  - reach envelope.

Operator actions/inactions were analyzed to identify the information and control requirements of the operator.

Based on the above analyses, applicable HFE design checklists were selected from <u>TOP-1-2-610, Human Factors Engineering Test Procedures</u> (26). Checklists selected included:

- Labels, Markings
- Controls
- Displays
- Workspace.

(Copies of the above checklists are contained in Appendix D.)

<u>Data Acquisition</u>

During the course of the evaluation, four separate visits were made to TMI to collect data. The focus of these visits were as follows:

- Visit 1: initial familiarization with control room layout, systems and components

- Visit 2: application of HFE design checklists
- Visit 3: interviews with TMI-2 control room operators
- Visit 4: analysis of control room design in relation to critical operator tasks.

In addition, the full scale mockup developed under Task B was used to evaluate control-display design and workspace.

Data Analysis

Data collected during the evalution was analyzed to determine the following:

- General compliance of the control room design to established HFE principles and criteria
- Relationship of design deficiencies to overall operator performance during the first 150 minutes of the accident
- Relationship of specific design deficiencies to critical operator actions/inactions during the first 150 minutes of the accident.

APPENDIX B

OPERATOR ACTIONS, DECISIONS, AND RESPONSES DURING THE FIRST 150 MINUTES OF THE TMI-2 INCIDENT

APPENDIX B

OPERATOR ACTIONS, DECISIONS, AND RESPONSES DURING THE FIRST 150 MINUTES OF THE TMI-2 INCIDENT

This section describes the sequence of operator activities for the first 150 minutes of the incident at TMI. The time of the turbine trip (0400:37) is taken as time zero as in most chronologies. Time is expressed as minutes:seconds. More detailed information on plant status and events is available from References (33), (42) and (43) which were used extensively.

Throughout the section, drawings are provided to indicate operator locations and traffic patterns at selected points in time. Detailed time lines are included in Appendix C. These show activities performed by each operator with respect to time.

Initial Trip of Turbine and Reactor (-0:01-0:08)

The TMI-2 accident of 28 March 1979 apparently began with entry of water into the service air system. Water was introduced to the instrument air lines via a faulty check valve and resulted in closure of condensate polisher inlet and/or outlet valves isolating the polisher. The main feedpumps tripped on low suction pressure and one condensate pump (CO-P-1A) tripped. Both condensate booster pumps were subsequently found tripped but the trip time is not entirely certain.

The turbine tripped according to plant design on loss of both main feedpumps. The emergency feedwater pumps (EF-P-1, EF-P-2A, and EF-P-2B) started by design on loss of the main feedpumps. Flow to the Once Through Steam Generators (OTSG's) was blocked due to closed block valves EF-V12 A&B. Plant operation with these valves closed is not in accordance with operating procedure. The reason for closure is still unclear although it is obvious from later operator actions that the operators expected these valves to be open.

Following loss of the turbine, the Reactor Coolant System (RCS) pressure began to increase as would be expected due to loss of the secondary system heat sink. At 3-6 seconds, the Pilot Operated Relief Valve (PORV, RC-R2) lifted as RCS pressure increased to the setpoint of 2255 psig. At eight seconds, the reactor tripped on RCS pressure of 2355 psig. At 13 seconds, the PORV (RC-R2) closing setpoint of 2205 psig was reached. The PORV, however, failed to close resulting in a rapid depressurization of the primary system and subsequent core damage. The status light for this valve shows the solenoid command status rather than the physical status of the valve. Since the valve solenoid was de-energized on 2205 psig. the closed indication was displayed in the control room (CR) despite failure of the valve to close. Use of an extinguished light to indicate status violates standard human engineering practice (24).

Initial Operator Actions (0:00-2:00)

Figure B-1 shows the control room (CR) layout with the panels numbered. Table B-1 gives panel names. For purposes of analyzing operator activities, stations are defined as in Figure B-2. Operator initial positions and selected initial alarms are shown in Figure B-3. At the time of the trip, the shift foreman (SF C) was in the turbine building basement attempting to rectify a problem in the condensate system. Control Room Operator C (CRO C) noted annunciators on panel 18 associated with loss of the generator and announced that there was a problem in the plant. He then noted the turbine trip alarm on panel 17 and began moving to the make-up station to perform Emergency Procedure (EP) actions associated with the trip. Control Room Operator D (CRO D) noted the following alarms:

- Condensate pump trip—panel 17
- Turbine trip—panel 17
- Feedwater pump trip—panel 17
- Reactor limited by feedwater—panel 15

Prior to the trip, the pressurizer spray valve and pressurizer (PZR) heaters had been operated in manual control to permit equalization of RCS and PZR boron concentrations. CRO D immediately set these controls to automatic. Lack of a positive indication of PZR spray valve auto/manual indication and inconsistency of pressurizer heater auto/manual positions are noted in Section 3.1.7.

The shift supervisor (SS E) was in the office at the rear of the control room at the time of the turbine trip. Viewing the panels through the office windows, he noted the reactor limited by feedwater alarm and feedpump trip alarm. SS E entered the control room heading for the center desks.

At 8-9 seconds, SS E noted the rod bottom indicators on panel 14 and channel trip annunciators on panel 8 and announced the reactor trip. The CRO's also noted the rod bottom lights as they were moving to the make-up and RCS stations. CRO D remained at the RCS station monitoring PZR level which was expected to rise following the turbine trip and then drop after the reactor trip. During the period from 8 to 13 seconds, CRO C performed the following EP steps:

- Closed the letdown isolation valve (MU-V376)
- Opened one high pressure injection valve (MU-V16B)
- Attempted to start make-up pump MU-P-1A.

Failure to start the makeup pumps was due to the requirement to hold the pump control to the START position for 2-4 seconds before releasing it and/or a tendency of these pumps to trip following startups. Two unsuccessful attempts were made by CRO C to start MU-P-1A which delayed his arrival at the feedwater station.

SS E moved to the plant page phone and announced the turbine trip and reactor trip. SF C noted the announcement and proceeded to the CR. SS E moved to the RCS station to monitor the expected trends of RCS pressure and PZR level. During this time, the PORV opened and failed to close. The indicator showed the initial opening and then gave an erroneous closed indication as discussed in Section 3.1.7. Per training, the operators did not identify the PORV problem until 138 minutes due to the closed indication showing on the panel.

<u>Primary System Control Following Trip (0:41-3:13)</u>

At 41 seconds, make-up pump MU-P-1A was started by CRO D. CRO C moved to the secondary side to carry out EP steps associated with the turbine trip. CRO D and SS E were at the RCS station. CRO D opened HPI valve MU-V16B to the full-open indication and then moved to panel 8 to line up the Borated Water Supply Tank (BWST) to the make-up system. These actions are shown in Figure B-4. Opening the BWST supply valve (DH-V5A) is required to provide adequate make-up supply. The location of the DH-V5A control on the vertical panel (panel 8) violates standard human engineering practice as discussed in Section 3.1.7. The travel required results in the absence of the primary system operator from the primary system stations.

A PZR level minimum (158.5) in. was noted by SS E at 48 seconds. The PZR level showed a rapid increase from this time on. CRO D returned to the make-up station at about 56 seconds and joined SS E in monitoring PZR level and RCS pressure. The operating staff have asserted that the reactor trip button was pressed within the first minute but this is not supported by the alarm printer printout. The issue is not extremely important since SS E and both CRO's had verified rod bottom lights following the reactor trip.

At about 1:40, SS E moved to the direct phone to the TMI-1 control room and requested another shift supervisor (SS A) to assist in the TMI-2 post-trip activities. SS E then moved to the secondary system area.

At 2:02, RCS pressure dropped to the High Pressure Injection (HPI) setpoint of 1640 psig. and the Engineered Safeguards (ES) actuation took place as follows:

- MU-P-1B was tripped
- MU-P-1A &C were operating in the HPI mode
- MU-V1 A, B, C,D open
- Decay heat closed cooling pumps DH-P-1A&B start
- Emergency diesels start.

CRO D noted ES actuation and moved to the feedwater station area to confirm all ES features actuated as required by EP. The ES status lights are on vertical panel 13. Visual access to these lights is blocked by panel 5 unless the operator moves behind panel 5. The location of the ES features status lights and the arrangement of the indicators violates human engineering practice as noted in Section 3.1.7. CRO D returned to the RCS station and noted PZR level at 250 in. and increasing and RCS pressure at less than 1600 psig. and dropping rapidly.

At 2:28, SF C arrived in the control room and obtained the written EP's to review the immediate actions already performed. SS E directed him to take control of the primary system.

Based on the increasingly high PZR level, HPI was bypassed by CRO D at 3:13 following approval by SS E.

Primary System Control Following ES Bypass (3:13-6:00)

ES bypass permitted manual control of the HPI flow rate by means of MU-V16A, B, C, D. CRO D throttled these valves monitoring the HPI flow meters on panel 8 to achieve a flow of 250 gpm per loop. This relationship is shown in Figure B-5. The location of the HPI flow meters on panel 8 rather than in close association with the valve controls (MU-V16A, B, C, D) violates human engineering practice as discussed in Section 3.1.7.

Bypass of HPI/ES and subsequent throttling of HPI flow was warranted by PZR level but not warranted by RCS pressure which had not recovered to the 1640 psig. HPI setpoint. This has been termed "poor operator judgment". In fact, however, it is the result of operator training, CR design, and inadequacies in emergency procedures.

- PZR level is not a positive indication of core coverage in the situation which obtained but operators had been trained to consider it to be a positive indication.
- Operators were trained to avoid a solid pressurizer. They followed this training.
- The EP's do not address what action to take with a high PZR level and low RCS pressure.

These inadequacies are addressed in Section 3.

SS E had returned from the secondary area to the primary side following ES actuation and now approved going to maximum letdown since throttling HPI flow failed to halt the PZR level increase. In preparation for this CRO D started an intermediate closed cooling pump (IC-P-1A). This required moving to panel 8 as shown in Figure B-5. Placement of this control on the vertical panel requiring the operator to leave the primary stations during emergency operations violates human engineering practice as noted in Section 3. At the same time SF C opened MU-V376 and MU-V5 to initiate maximum letdown.

Other operator actions during this period were carried out at the make-up stations by CRO D and were intended to halt the rise in PZR level including:

- Closing MU-V16 ABCD
- Shutting off make-up pump MU-P-1C.

SS C and CRO D continued to monitor PZR level which went off scale (400 in.) at 5:51. The RCS hot leg temperature (Th) and RCS pressure reached saturation conditions at about 6:00. Despite the importance of maintaining these parameters subcooled, no integrated instrument showing this relationship is available in the CR. Operators were clearly not trained to refer Th and RCS pressure to steam tables to determine saturation. Failure to provide a positive indication of saturation in the core is a major instrument deficiency.

Secondary System Immediate Actions and Feedwater Recovery (0:41-20:00)

Following immediate EP steps at the make-up station, CRO C moved to the secondary side to carry out EP immediate steps associated with the turbine trip as shown in Figures B-6 and B-7. CRO C proceeded to the feedwater (FW) panel and performed the following checks:

- Verified main FW pumps tripped
- Noted OTSG levels decreasing on start-up range

- Verified emergency feedwater pumps on.

As noted previously, EFW pu ps were not delivering flow to the OTSG's because of closed block valves (EF-V12 A&B). The layout of the feedwater station violates standard human engineering practice in terms of panel layout. There is no evidence of control/display location based on sequence of use, frequency of use, criticality, or function. It should be noted that the make-up station uses a minic format while the feedwater station does not. The value of mimics in the design of CR's has not been conclusively shown. The TMI-2 design, however, is inconsistent. If a mimic is of value for the make-up station, then one would expect this principle to also be used at the feedwater station. Due to the layout of the feedwater station recognition of the EF-V12 A&B status among the numerous valve status lights precent would be difficult. Note that the closed EF-V12 A&B status indicators has apparently gone unnoticed during normal operation. CRO C was attempting to confirm EFW flow. No flow meter for EFW is provided although there are flowmeters for main F flow. At the time that CRO C checked for EFW flow, the OTSG's were below low ..vel limits (30 in.) so the Integrated Control System (ICS) should have opened the EF-V11 valves. Lack of flow under these circumstances could not be directly detected by the operator. Failure to provide a positive indication of EFW flow violates standard human engineering practice as noted in Section 3.1.7.

CRO C verified EFW pump operation by means of pump discharge pressure indication. Without a flow meter flow could only be verified by waiting for a change in OTSG level. Since the available indications showed proper EFW operation, CRO C continued with turbine trip EP steps.

CRO C proceeded to the turbine panel (panel 5) and performed the following EP immediate steps:

- Verified throttle valves closing—three showed closed, one showed erroneous open indication
- Verified governor valves closed
- Noted turbine bypass valves opening
- Manually tripped turbine
- Verified steam extraction valves closing
- Moved turbine breakers and field breakers into pull-to-lock
- Verified busses in normal line-up.

These steps are required by the EP for turbine trip. They require observing various indicators on panels 5, 6, and 17. Breaker controls are inconsistent in following standard human engineering practice of clock-wise motion for shutting off (open) as noted in Section 3.1.7. CRO C postponed the remaining steps which involve placing the turbine on jacking gear and returned to the feedwater station as shown in Figure B-6 to check on OSTG levels. He immediately noted that OTSG levels had not been held at 30 in. but had dropped to approximately 10 in. on the startup range meter. CRO C announced that the generators could be dry and sought the cause of the lack of feedwater beginning at about 2 minutes.

Following the call to the unit-1 CR at 1:40, SS E moved to the condensate system station, then to the feedwater station and noted the following:

- Condensate pump CO-P-1A tripped
- Condensate booster pumps (CO-P-2A&B) tripped
- Main feedwater pumps tripped.

He then attended to the HPI actuation and bypass situation until about 4-5 minutes at which time he returned to the condensate system station and carried out the following activities:

- Noted hotwell level indication off scale high
- Started condensate pump CO-P-1A
- Started condensate booster pump CO-P-2B twice—the pump tripped off both times.

During this time, CRO C was at the feedwater attempting to restore EFW feed to the OTSG's. He noted that the control valves EF-V-11 A&B were travelling whereas they should have been full open. Consequently, he took the controllers to manual and opened them. Without an EFW flow positive indication (as previously noted) it was necessary to wait to observe a change in OTSG level.

Between about 2:00 and 5:00, CRO C alternatively performed the following activities:

- Increased the demands on EF-V-11A&B and monitored the OTSG level start-up range meter for a level increase
- Monitored the Nuclear Instrumentation charts for a normal post-trip down trend
- Monitored Average Temperature (Tave) noting 570°-580° and increasing.

At about 5:00, CRO C decided that feedwater flow was blocked. During the next three minutes, CRO C reviewed the FW line-up to discover the reason for lack of flow. The closed block valves (EF-V12A&B) were discovered about 8:00. This time is clearly excessive. Among the violations of standard human engineering practice associated with this incident are the following:

- The layout of the feedwater station does not facilitate checking the valve lineup. As noted previously, the panel organization does not reflect plant configuration, sequence of operation, or component criticality.
- EF-V-12A&B controls and indicators are located in the extreme lower right-hand corner of the station despite the fact that they are normally open and are closed only for surveillance and maintenance. CRO C reported that he had to lean over the panel in order to check the valve line-up which caused the 12 valve indicators to be in a poor position for visual access.
- One 12 valve indicator was obscured by a caution tag which was attached to a control located above it.

CRO C was obliged to review the FW line-up twice before noting the EF-12 valves to be closed. Upon noting this, he announced that the valves had been shut and opened them.

EFW flow was then quickly confirmed by a drop in the EFW pump discharge pressure and noise heard from the loose parts monitor. Upon initiating EFW flow CRO C noted Th decreasing, NI counts decreasing, and (later) OTSG levels increasing. As OTSG pressure built up, it was noticed that the turbine bypass valves were not opening to modulate steam pressure. CRO C then moved to the turbine station, switched the turbine bypass valves to manual and opened them slightly. CRO C continued to manually control OTSG pressure by means of the turbine bypass valves. This task is made difficult by the fact that the OTSG pressure meters on panel 4 cannot accurately be read from the turbine station at panel 5. This distance from the control and display violates standard human engineering practice as noted in Section 3.1.7. CRO C continued to control OTSG level and pressure until OTSG minimum levels were re-established.

During this time period, SS E was attempting to assess the problems in the condensate system while also noting and approving operator actions. The condensate hotwell level indication was off-scale high. Normal rejection from the hotwell was precluded by the closed polisher bypass valve (CO-V12) and by a failed reject valve. Lack of rejection capability was attributed to the polisher bypass valve since the operators were unaware of the reject valve problem at this time.

SS E noted the EFW problem described earlier and the identification of the EF-V12 A&B valve closure at 8 minutes. At this time Shift Supervisor A (SS A) arrived from the TMI-1 CR and was requested by SS E to review the EP's, assist in primary system control, and operate the computer console.

At about 10 minutes, the CR situation was as shown in Figure B-8. CRO C was monitoring OTSG levels and assisting SS E who was trying to assess and rectify the condensate system problem. These activities certainly distracted the attention of SS E from the primary side where the major problem was located. In comparison with the stuck PORV problem, the condensate system problem was of lesser priority. The abnormal primary behavior (going solid with low pressure) should have alerted operators to the existence of a major difficulty. Concentration of SS E on the condensate system problem would appear to rest on several factors:

- The operators have stated that in the plant operating history, the primary system was extremely reliable while problems were common in the secondary system. Expecting the root cause of abnormal plant behavior to lie in the secondary system and expecting the primary system to recover would therefore be consistent with operator experience.
- Restoration of the hotwell rejection capability would be necessary prior to going back on line. Attention to restoring the system to operation was not warranted given the primary system conditions. It should be noted, however, that the full hotwell was restricting the ability to transfer heat out of the primary so that restoration of hotwell level and condensate booster pump operation would also be consistent with handling the emergency.

Between about 11 and 15 minutes, CRO C checked the high hotwell indication on panel 5. SS E attempted to open the polisher bypass valve (CO-V12) to restore the normal condensate flow path. The CO-V12 control is located on panel 17 as shown in Figure B-8. Access requires moving around panel 6. Location of a frequently operated control on the vertical panel rather than the front console violates standard human engineering practice as noted in Section 3.2. When the CR was being built, operators requested a walkway between consoles 4 and 5 (as between consoles 2 and 3). This request was turned down. Lack of input of operator task analysis data into the CR design is noted in Section 3.2.

The attempt by SS E to open CO-V12 was unsuccessful due to high differential pressure. CRO C directed an Auxiliary Operator (AO) to check locally on hotwell level and to restore the normal hotwell reject line-up. SS E again started condensate pump CO-P-1A. The AO reported high hotwell level and a condensate pump CO-P-2B leak between

16 and 19 minutes. Based on the condensate system situation, SS E left the CR at a' ut 20 minutes to go to the turbine building basement to rectify these problems.

At about 20 minutes, the OTSG levels were recovering toward low limits (30 in.). CRO C had throttled EF-V11 A&B to control the rate of increase of level. This violates procedures which call for maximum feedwater flow prior to reaching low limits. CRO C stated that he was concerned about potential tube damage which would result from introducing cold feedwater to the hot OTSG's.

Primary System Control Following Indication of Solid Pressurizer (6:00-73:00)

At about 6 minutes, the PZR level indication showed solid at 400 in. and saturation conditions had been reached in the core. Maximum letdown had been initiated in an attempt to slow down or reverse the PZR level increase. At 6:54 a letdown cooler high temperature alarm was received. In response to this, CRO D throttled letdown flow to 71 gpm using MU-V5 located at the make-up station. Actions during this time period are shown in Figure B-9.

During this time, SF C checked the PZR level indication using the three different instrument outputs. An instrument technician checked the level indication during the same period. The possibility of a faulty PZR level indication was considered and investigated several times.

At about 10 minutes, the PZR level came back on scale, dropped to about 380 in. and remained in the 375-390 in. range. RCS pressure continued to drop. Shortly after this, CRO D stopped and restarted make-up pump MU-P-1A twice and secured the decay heat removal pumps. CRO D and SF C continued to monitor PZR 'evel and RCS pressure. Operator actions at this point suggest uncertainty about what action to take in the presence of the conflicting PZR level and RCS pressure data.

At about 14 minutes, the rupture diaphragm on the Reactor Coolant Drain Tank (RCDT) burst at about 190 psig. The tank had filled due to flow from the stuck open EMOV. Operators did not become aware of this until later due to the location of the RCDT panel (panel 8A). RCDT parameters are critical to Loss of Coolant Accident (LOCA) diagnosis and the location of this panel violates standard human engineering practice as noted in Section 3.2. Overflow from the RCDT went into the Reactor Building (RB) sump which resulted in an increase of sump level and increase of RB pressure to about 1.2 psig.

Prior to the dump from the RCDT, the RB sump pumps had started. This information is displayed to the operators only via the alarm printer which was running considerably behind at the time. Operators have stated that the lag in the alarm printer due to the volume of alarms rendered it relatively useless during the incident. Use of the alarm printer to present information which must be received in real-time to be of value violates standard human engineering practice as noted in Section 3.2.

The flow path from the RB sump was thought by the operators to go to a radwaste holding tank. In fact the RB sump was lined up to the Auxiliary Building (AB) with the result that primary water was pumped to the AB until the RB sump pumps were turned off. Difficulty in determining flow paths is typically experienced by operators. Flow paths as determined by valve status are not displayed in a rapidly assimilable fashion. Instead, operators must establish line-up status by checking valve-by-valve. They are obliged to remember plant configuration or to consult drawings to do this. The error in RB sump line-up and the excessive time required to identify the closed feedwater block valve problem are results of lack of suitable line-up status displays.

At about 25 minutes, a high radiation alarm was received from the letdown cooler radiation monitors IC-R-1091 & 1092. These were discounted because of low setpoint. A number of other area radiation monitors showed increases during this period. However, there is no firm evidence that fuel damage took place this early.

At about 36 minutes, a discussion was held concerning securing the RB sump pumps. An AO had reported overflow of the RB sump. SS E briefly returned to the CR at this time and approved shutting down the RB sump pumps and CRO D directed an AO to do so. The pumps were secured at 38 minutes. At about this time, SS E checked the RCDT panel. Observing high level and low pressure he concluded that the diaphragm had burst.

By 25 to 40 minutes, the operators were in possession of several data points which were indicative of a LOCA generally and the stuck open PORV in particular:

- Low RCS pressure (1100-1300 psig) should have suggested loss of coolant. Operators, however, relied on PZR level as a positive indication of sufficient primary inventory per training.
- Hot leg temperature in relation to RCS pressure showed saturation conditions. Operators, however, had no positive display of saturation conditions and had apparently not been trained to refer these parameters to steam tables
- The loss of coolant EP lists low RCS pressure and low PZR level as LOCA symptoms. No guidance is given for high PZR level and low RCS pressure.
- High RCDT level and flow to the RB sump are LOCA symptoms. Operators, however, knew that the PORV had lifted and some water

would have been transferred to the RCDT. This LOCA clue is also complicated by the fact that water is received by the RCDT from other sources (such as RC pump seal water).

- The PORV tailpipe temperature was at 285°s while the code safety valve temperatures were at 264° and 275° at about 27 minutes. This condition is given in the EP as a symptom of a failed PORV. However, no quantitative guidance is given. The operators interpreted the elevated temperatures as due to the initial opening of the PORV-particularly in view of the erroneous closed PORV indication.

During the period from 40 to 70 minutes, a second attempt was made to verify PZR level instrument accuracy. By this time, the RC pumps were vibrating due to pumping two-phase mixture with increasing steam voids. It is not clear at what point the RC pump problem was noted by the operators. Pump vibration meters and annunciators are located at panel 10. These data are not readable from the center consoles which is a violation of standard human engineering practice as noted in Section 3.1.7. A high vibration alarm annunciator is provided at panel 8; but it is probable that the operators did not notice these alarms for some time due to the number of alarms in at the time. Alarm annunciators are grouped by sub-system but within annunciator panels, there is no organization by alarm priority. This clearly violates standard human engineering practice as noted in Section 3.1.7. In some cases, operators have resorted to color coding critical annunciators (turbine trip for example) using grease pencils and the like.

At about 70 minutes, SS A requested a computer print-out of current RC pump alarms. A discussion of the RC pump problem was in progress at this time. The operators realized that they were violating operating procedures in running the RC pumps at the noted vibration levels. They were reluctant to secure the pumps and lose forced circulation since RCS temperatures and the source range NI's were not dropping as expected. On the other hand, the operators were concerned about potential pump failure and realized that continued RC pump operation was an EP violation.

These conflicting factors resulted in a delay in securing the RC pumps. SS E reviewed the pump operating curves and decided to secure the B loop pumps. This action was carried out by CRO C at 73 minutes. Conditions then rapidly deteriorated in the primary system.

<u>Secondary System Control (20-150 minutes)</u>

At 20 minutes, feedwater flow had been established to both OTSGs. The OTSG A low level alarm cleared at 22:44. CRO C then throttled back on EF-V11A to maintain a 30 in. level. Emergency feedpump EF-P-1 was secured shortly thereafter. The operator was attempting to bring the secondary side to a normal shutdown condition although securing the emergency feedpump violates procedure.

At 26:46 the B OTSG low level alarm cleared and CRO C throttled the EF-V11B valve shortly thereafter. EF-P-2B was secured at 36:08 following a phone discussion with SS E who was in the turbine building. CRO C then secured the heater drain pumps and placed the ICS stations in a shutdown condition. CRO C continued to control OTSG pressure via the turbine bypass valves.

From 36 to about 60 minutes, CRO C noted that the OTSG B level continued to increase despite the closed control valves. CRO C closed block valve EF-V12B and then cross connect valves EF-V5A&B to hold the B OTSG level.

At about 59 minutes, SS E succeeded in opening the polisher bypass valve locally and returned to the CR. Hotwell reject capability was not restored, however, due to a failed reject valve. Upon SS E's return to the CR, it was decided to switch off the circulating water pumps to permit steam control via the atmospheric dump valves. This required CRO C to move to panel 17 as shown in Figure B-10. Steam control via atmospheric dump valves is an abnormal procedure which is necessary to transfer heat from the primary system when the normal condenser path is lost. The CW pump controls are used to enable atmospheric dump valve control. Location of these controls on panel 17 rather than on the front console violates standard human engineering practice as noted in Section 3.2.

At about 75 to 80 minutes, the possibility of a B OTSG tube leak was discussed. CRO C had noted the increase in OTSG B level despite FW isolation. The possibility was discussed that a tube leak could have developed with leakage to the RB sump. This would account (at least qualitatively) for the increase in B OTSG level, the low RCS pressure, the RB sump level, and the increased RB pressure. Following this discussion, SS E directed the CRO's to isolate the B OTSG. CRO D carried out this action by moving to panel 15 and closing isolation valves MS-V4B and MS-V7B as shown in Figure B-10. Since these isolation valve controls are not used frequently, the location is acceptable.

At approximately 90 minutes, CRO C noted that the source range NI's increased and that the intermediate range NI's came on scale. This combined with the decreasing RCS boron concentrations was a problem which concerned the operators since it clearly contradicted normal cooldown trends. CRO C had been alternatively steaming down and feeding OTSG A. The A OTSG level was rapidly decreasing at 90 minutes. At 92 minutes CRO C opened up on EF-V11B. At about 94 minutes, A OTSG boiled dry and CRO C immediately opened EF-V11A restoring EFW flow. Opening EF-V11B would have no effect on feed since the B OTSG was isolated. This series of events appears to represent a control confusion which further illustrates human engineering problems associated with the feedwater station as previously noted.

By 100 minutes, the A loop RC pumps had been secured and a discussion was held of going to natural circulation following loss of forced circulation. CRO C opened on EF-V11A to feed up OTSG A at 112 minutes. The A OTSG reached 50% level on the operating range at 125 minutes and CRO C continued to control OTSG A level and pressure via the turbine bypass controller (now controlling atmospheric dump valves) and EF-V11A through the rest of the 150 minute period.

Primary System Control (73 to 150 minutes)

Following securing of the B loop RC pumps at 73 minutes, an RCS sample showing 700 ppm boron was received. Since make-up water from the BWST was at a concentration of over 1000 ppm, operators became concerned about possible alternate MU paths, boron dilution, and NI indications. At 90 minutes a second sample showed 400-500 ppm boron and the intermediate range NI's came on scale. These data caused concern about shutdown margin and a possible restart. During this period, increased steam · void formation was taking place.

At about 80 minutes, SS A requested a computer print-out of RCS parameters and PORV outlet temperatures. The PORV outlet temperature was 283° compared with 211° for the code safeties. These data clearly point to an open PORV but this was not realized at the time. Either the operators were uncertain of the quantitative difference to expect or the 283° was misread as 233. The latter interpretation is supported by interviews with a plant engineer who stated that SS A interpreted the PORV temperature as having dropped from the previous reading (285°). RC pump alarms and flow fluctuations continued to be noted due to the operating A loop RC pumps. The A loop pumps were secured by CRO C at about 100 minutes as shown in Figure B-11. Emergency boration was conducted by CRO D at 100 minutes and again at 102 minutes.

Emergency boration requires setting up boric acid volume at one end of panel 3 and then moving to the other end to control pump operation. This layout is a violation of standard human engineering practice as noted in Section 3.2. If the intent is to prevent inadvertent addition of boron, this precaution should be incorporated in some manner which permits more effective operator action when boration is required.

Following shutdown of the A loop RC pumps, NI's showed increasing counts and hot and cold leg temperatures diverged rapidly. At 105-110 minutes SS D and SS F arrived in the CR and discussed the situation with the on-duty operators.

At about 137 minutes, PORV and code safety discharge temperatures were requested by SS F. Based on PORV temperature of 228° versus code safety temperatures of 190° and 194°, he suggested blocking the PORV. This action was carried out by SF C at 138 minutes.

Following blocking the PORV, RB pressure decreased and RCS pressure rose confirming PORV leakage as the major problem. Discussions were held concerning the location of the bubble in the RCS and entry into the containment to vent the hot legs. This option was lost at 144 minutes when the RB air sample gas monitor (HP-R-227) increased and went off scale high. By 150 minutes, Th had gone off scale high (750°). The site emergency was declared shortly thereafter.

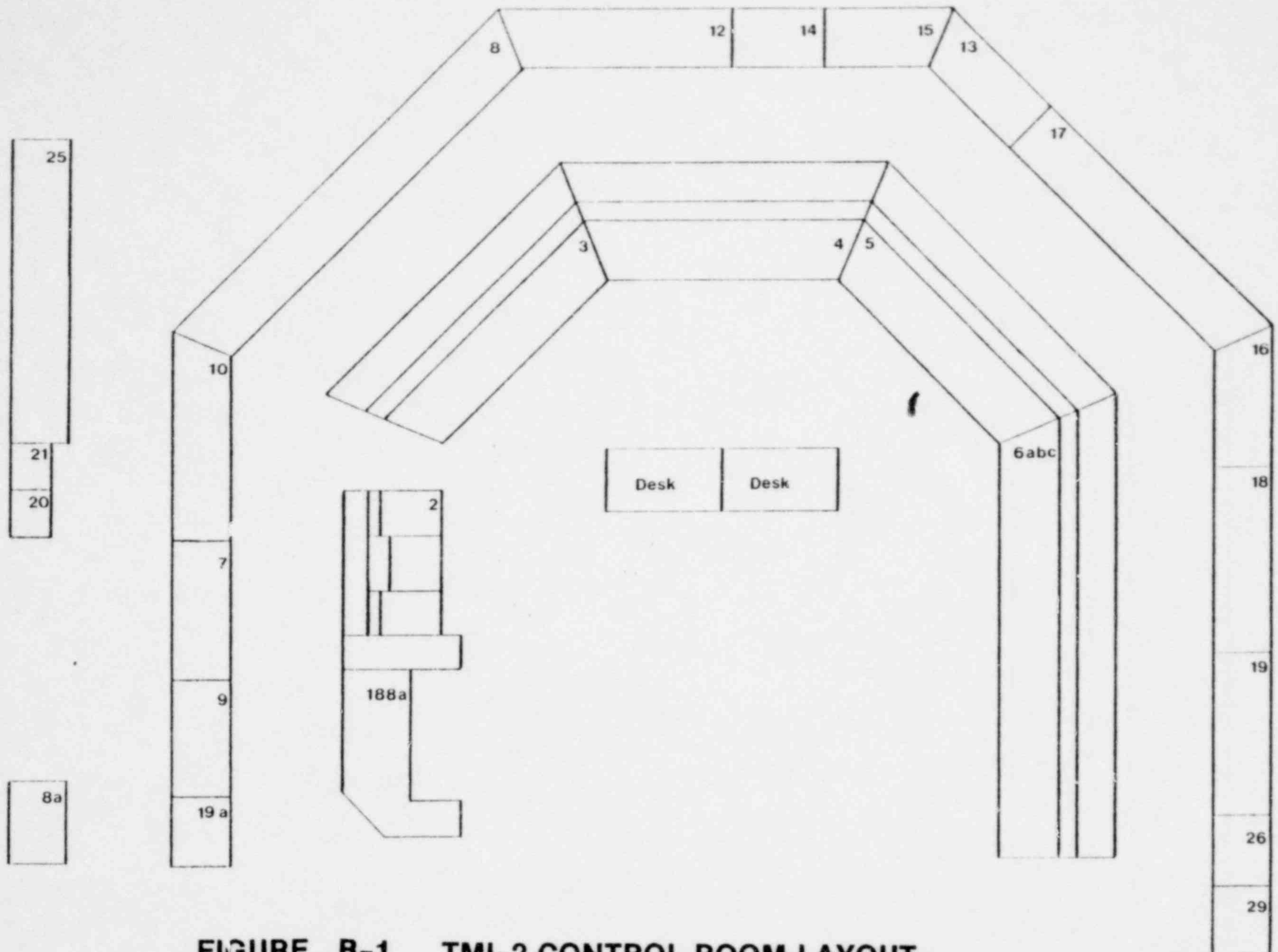


FIGURE B-1 TMI-2 CONTROL ROOM LAYOUT

TABLE B-1
TMI-2 PANEL DESIGNATIONS

- Inner Consoles

2	Computer console
3	Auxiliary systems console
4	Plant control console
5	Turbine control console
6ABC	Electric control console

- Vertical Panels

7	Fire detection panel
8	Coolant systems monitoring panel
9	Push-pull control panel
10	Plant equipment temperature recording panel
12	Radiation monitoring panel
13	Engineered safety features panel
14	Control rod drive panel
15	Containment isolation panel
16	Turbine supervisory panel
17	Turbine auxiliary monitoring panel
18	Station electric auxiliary monitoring panel
19	Vital power panel
19A	500 KV control panel
26	Diesel generator No. 1 panel
29	Diesel generator No. 2 panel

- Back Panels Located Outside Main Control Area

8A	Reactor coolant drain tank panel
20	Nuclear instrumentation cabinet No. 1
21	Nuclear instrumentation cabinet No. 2
25	HV&AC panel

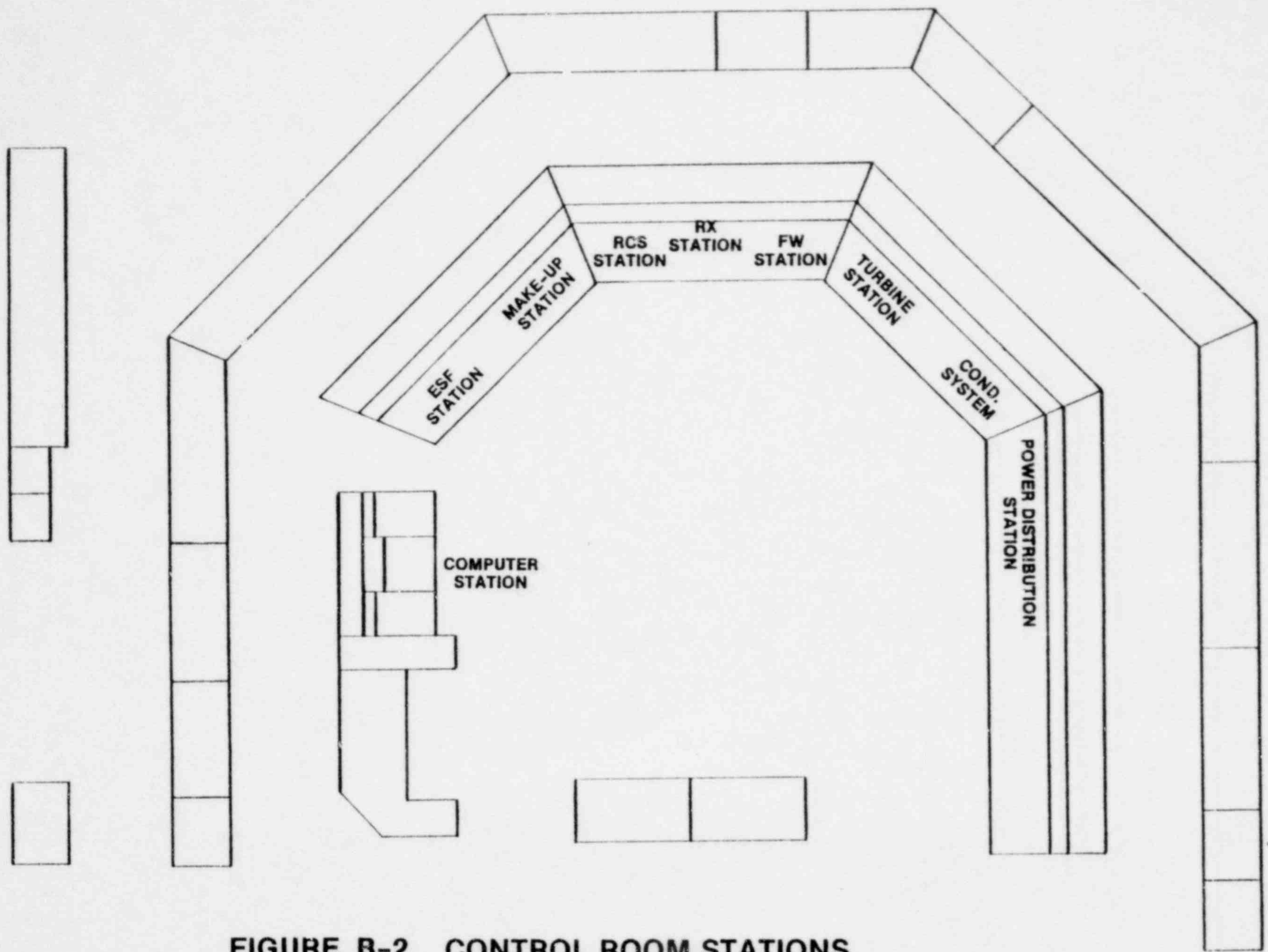


FIGURE B-2 CONTROL ROOM STATIONS

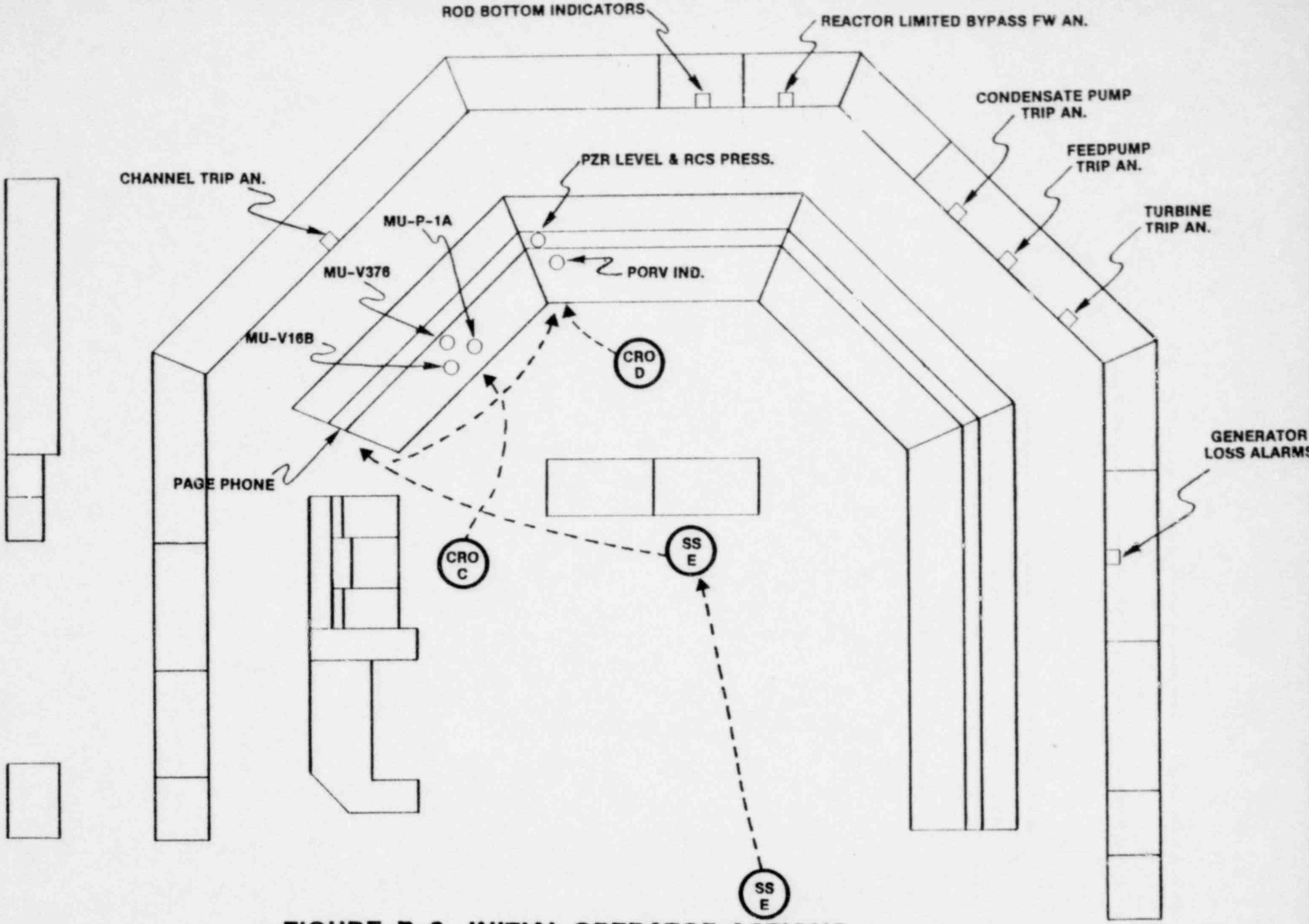


FIGURE B-3 INITIAL OPERATOR ACTIONS

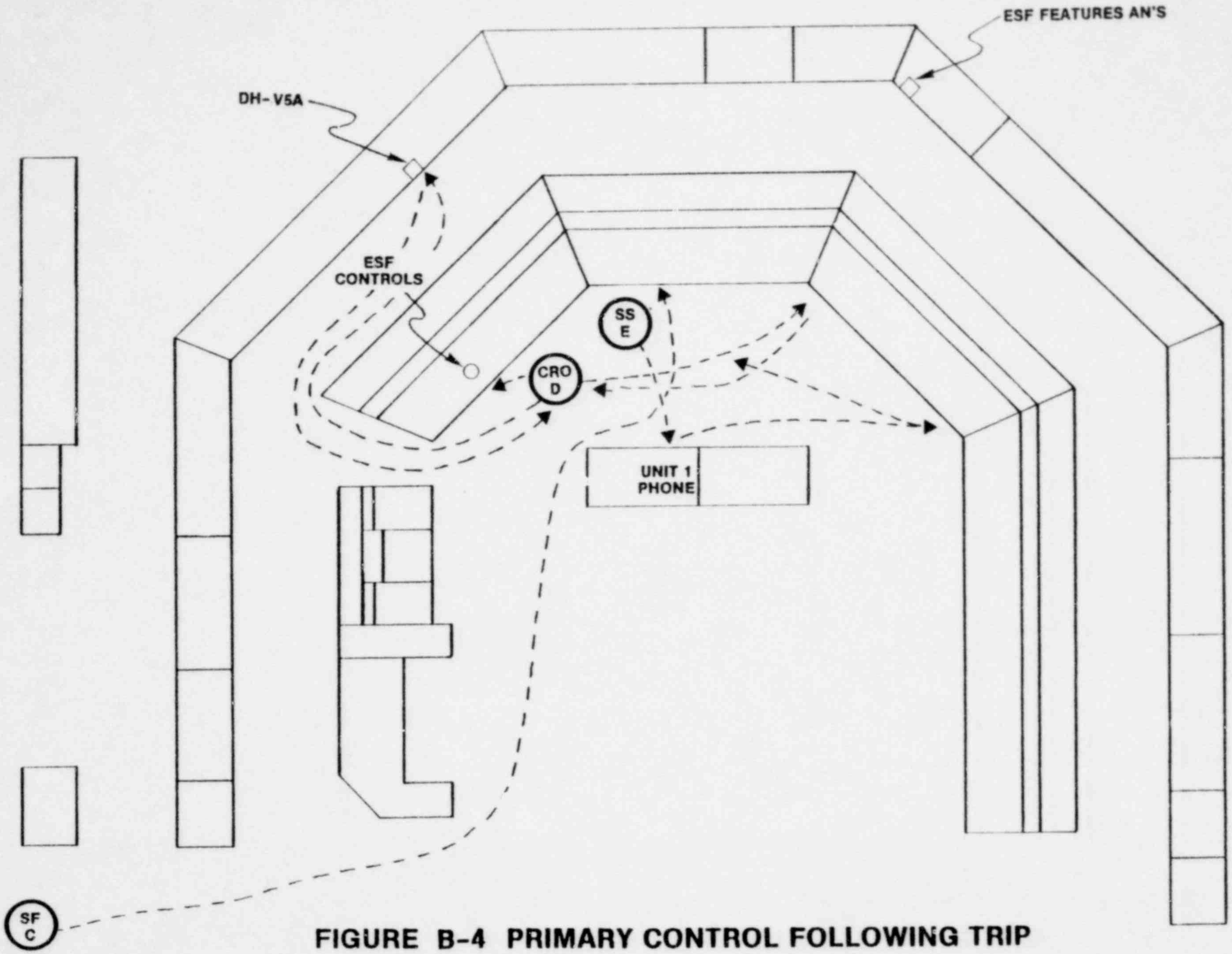


FIGURE B-4 PRIMARY CONTROL FOLLOWING TRIP

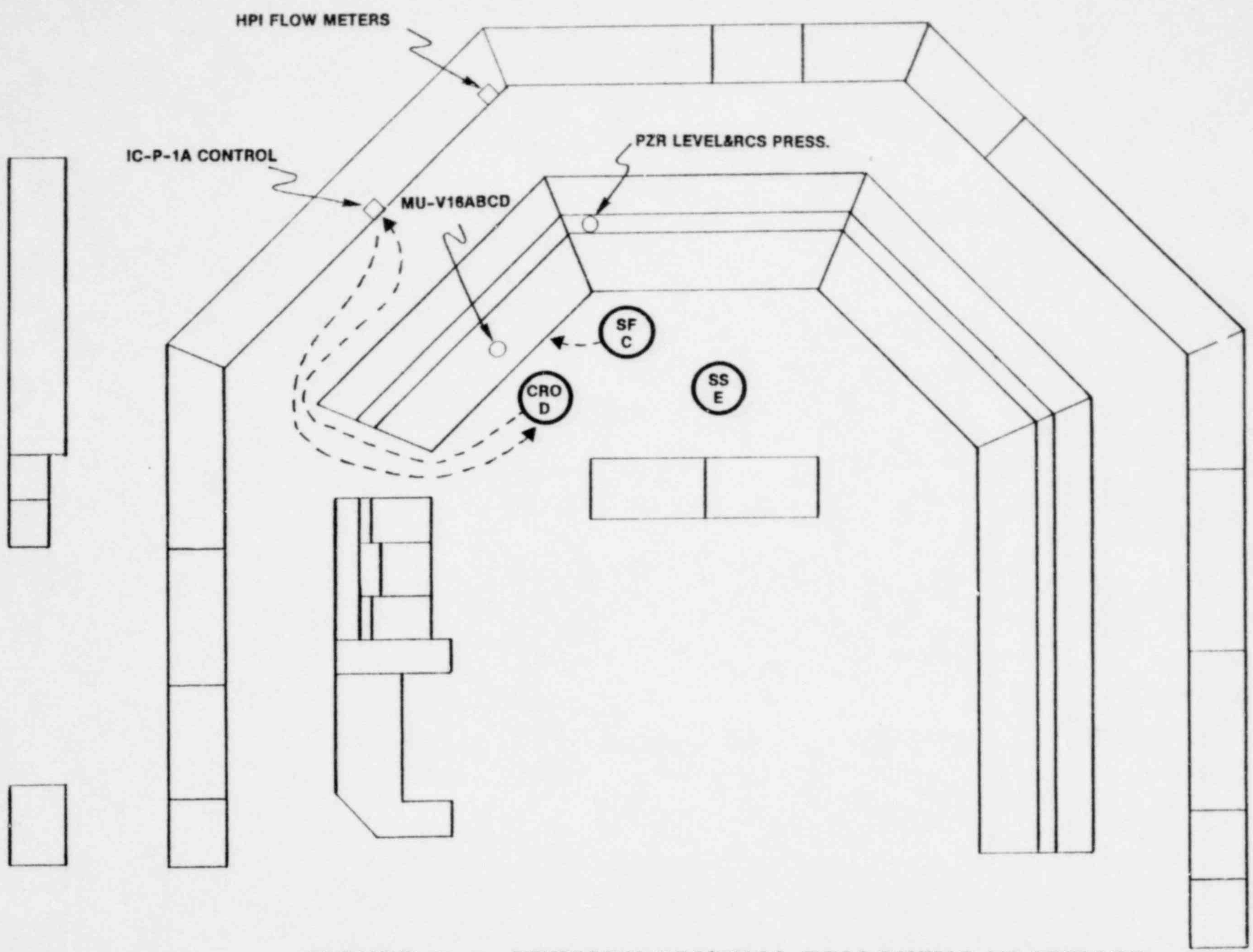


FIGURE B-5 PRIMARY CONTROL FOLLOWING ES BYPASS

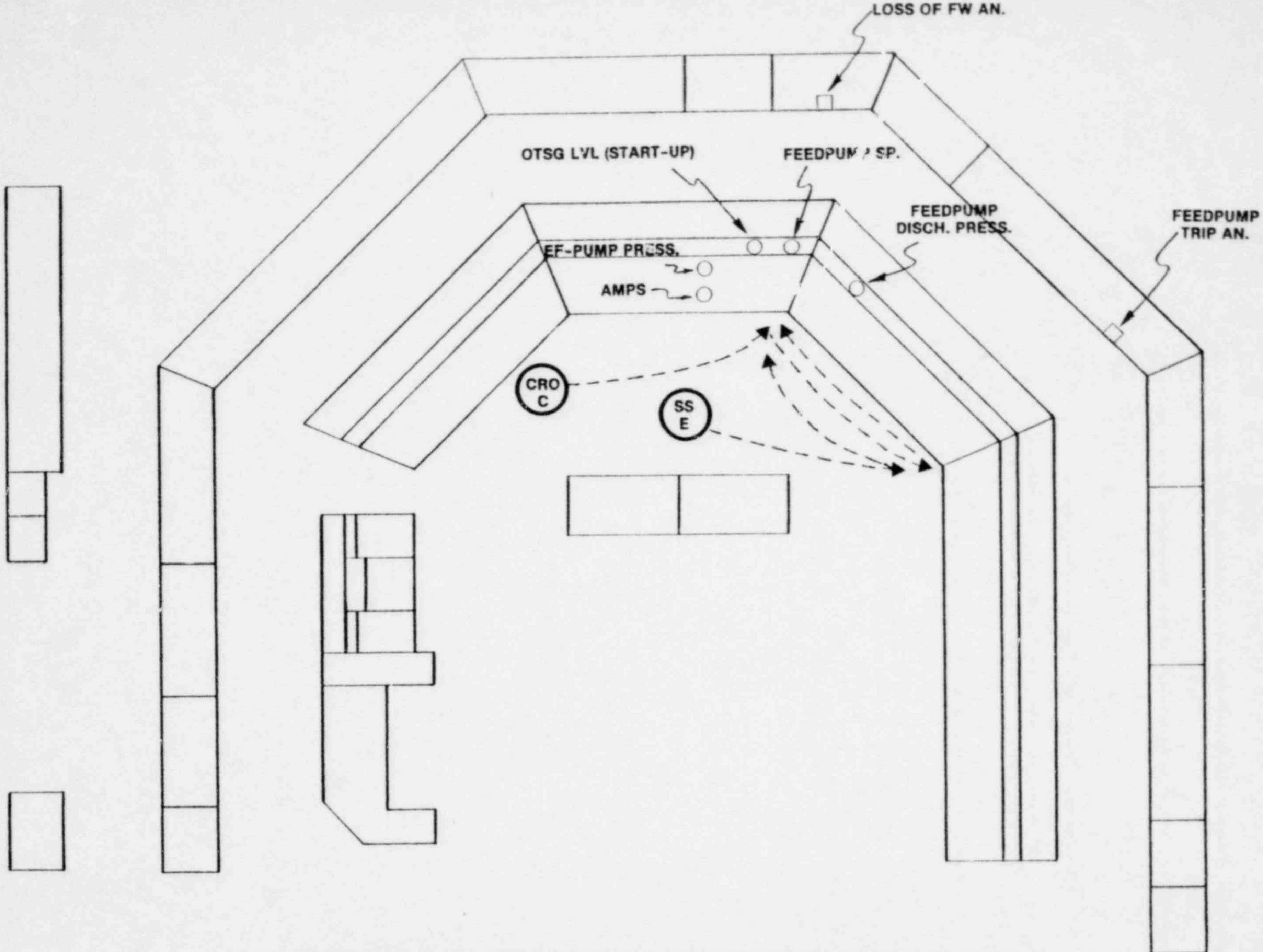


FIGURE B-6 SECONDARY SYSTEM IMMEDIATE ACTIONS

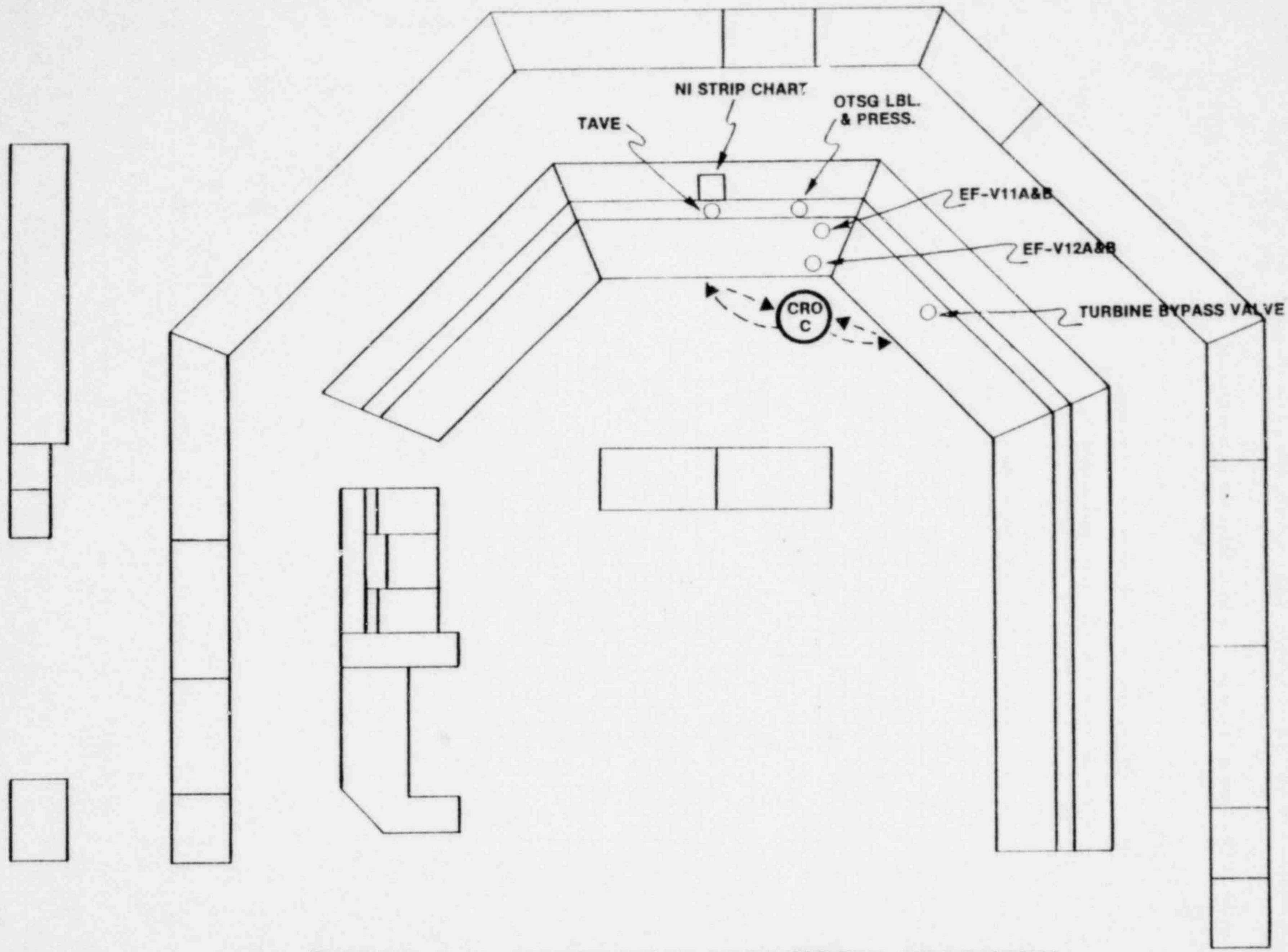


FIGURE B-7 EMERGENCY FEEDWATER RECOVERY

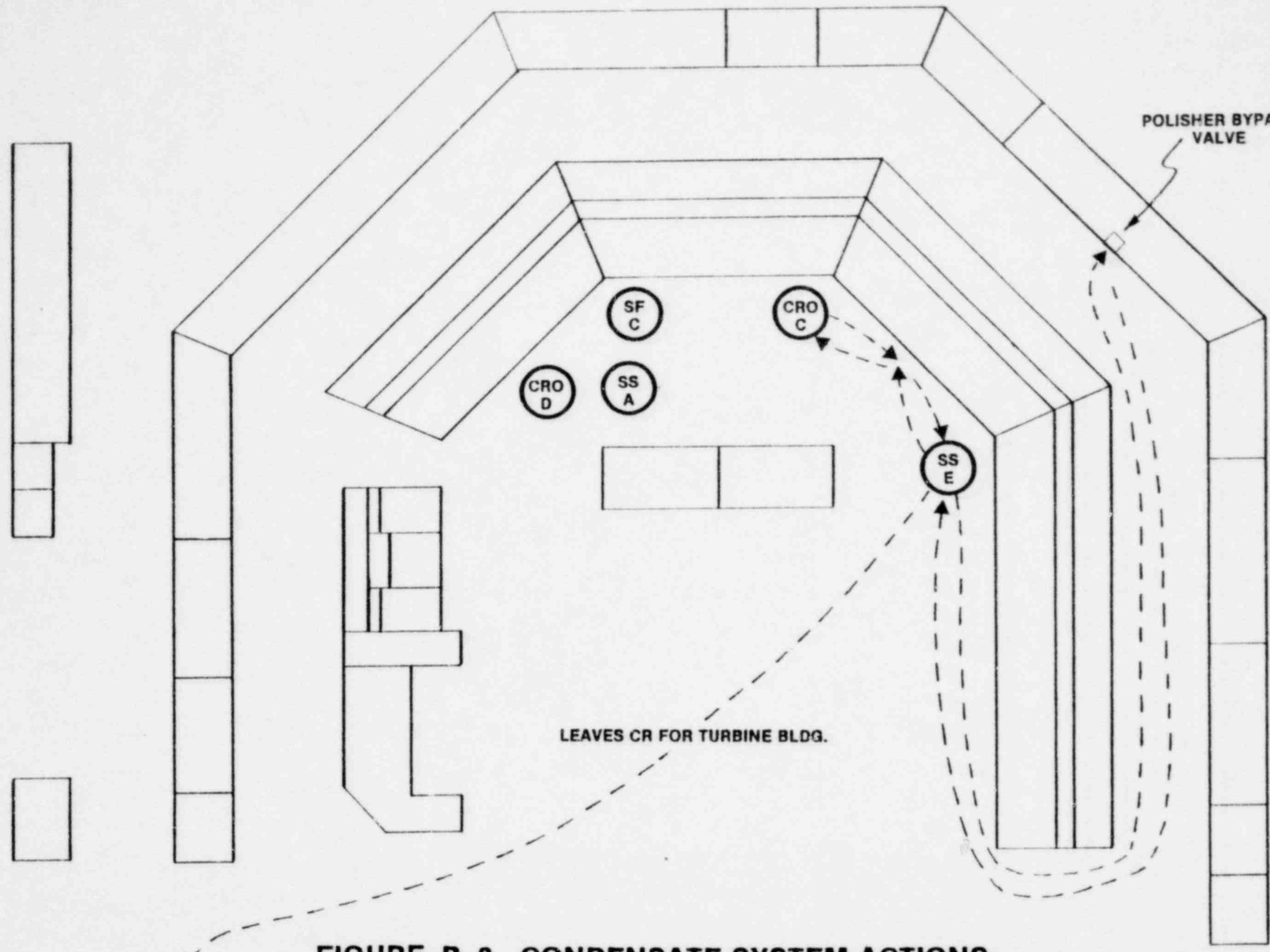


FIGURE B-8 CONDENSATE SYSTEM ACTIONS

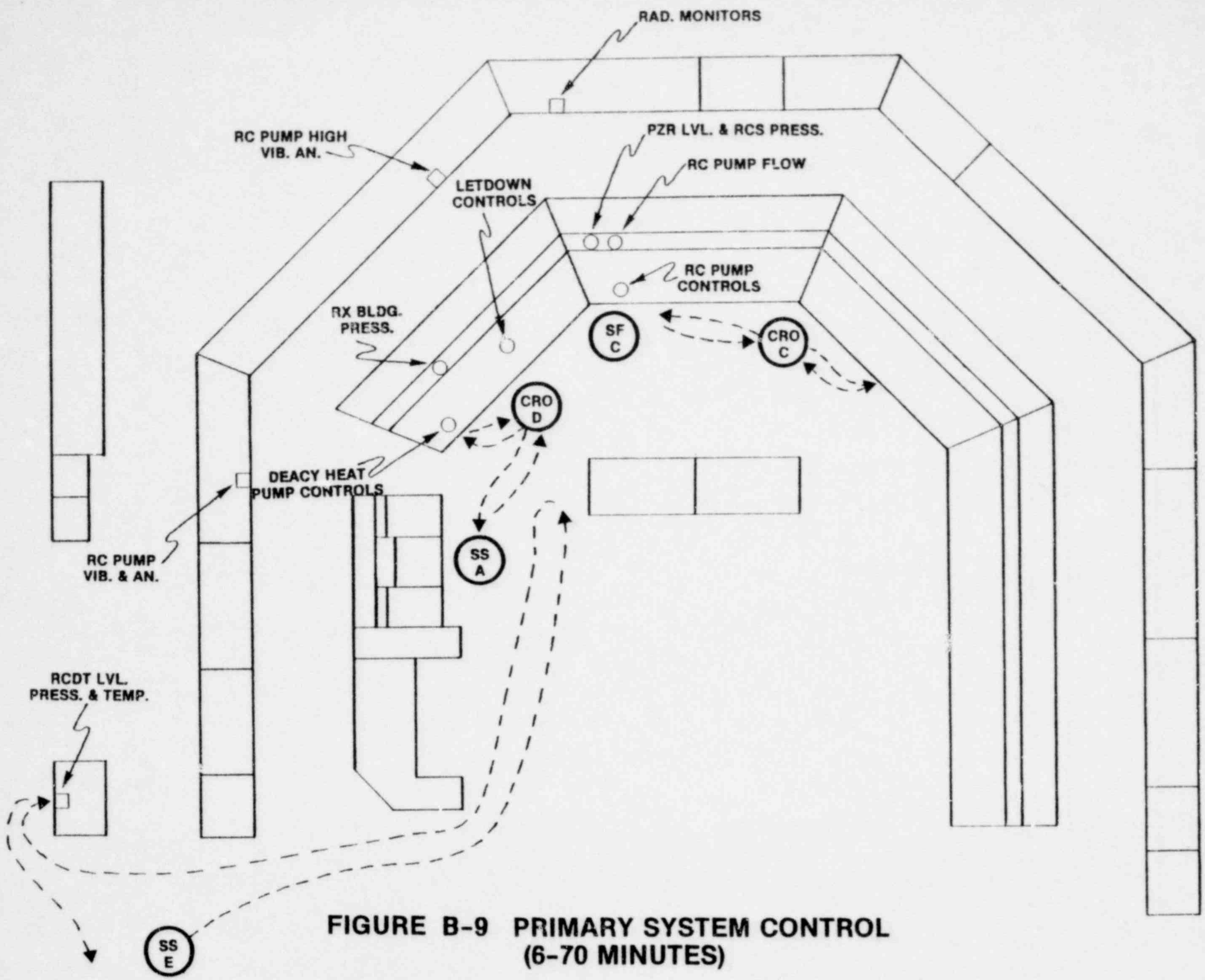


FIGURE B-9 PRIMARY SYSTEM CONTROL (6-70 MINUTES)

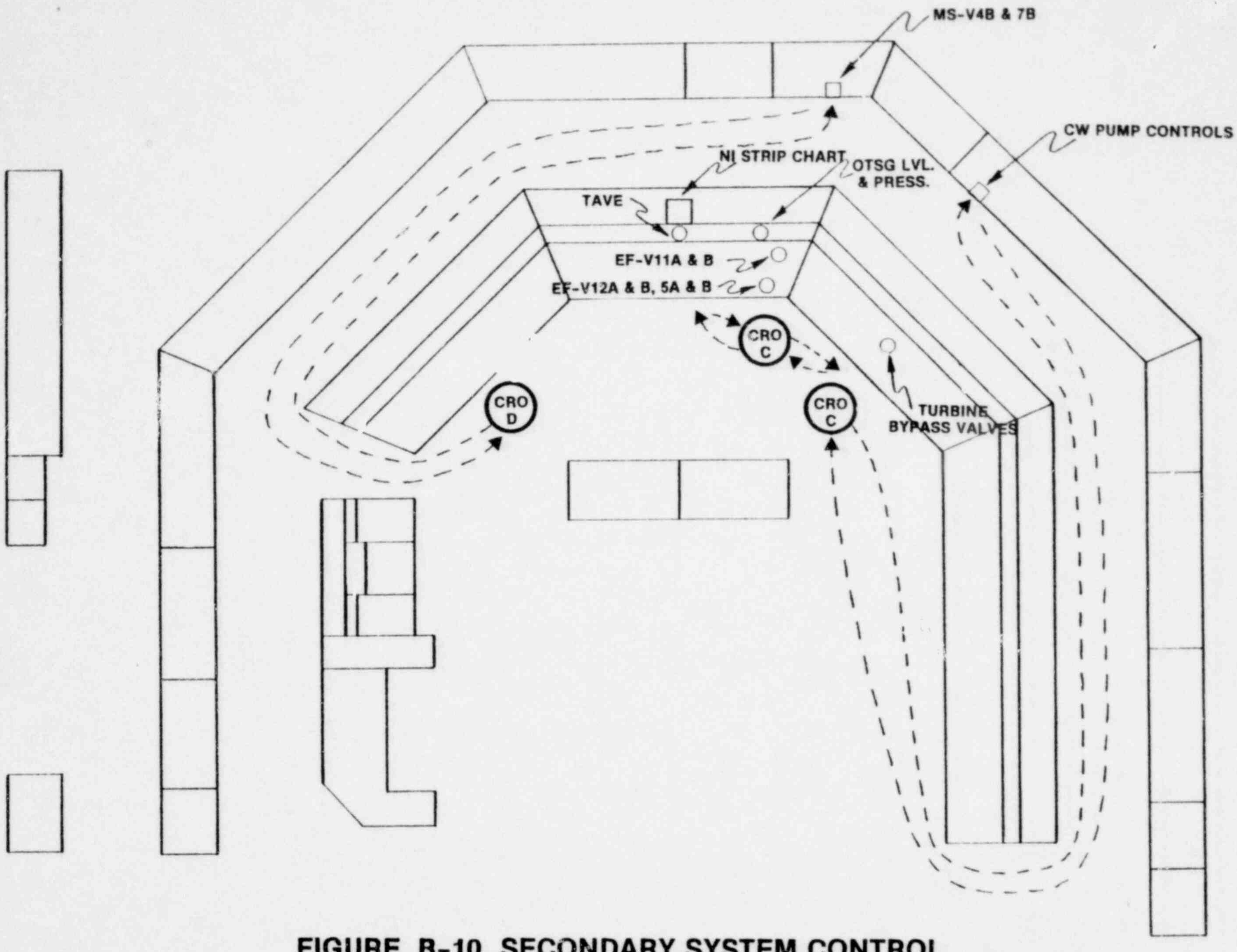


FIGURE B-10 SECONDARY SYSTEM CONTROL
(20-150 MINUTES)

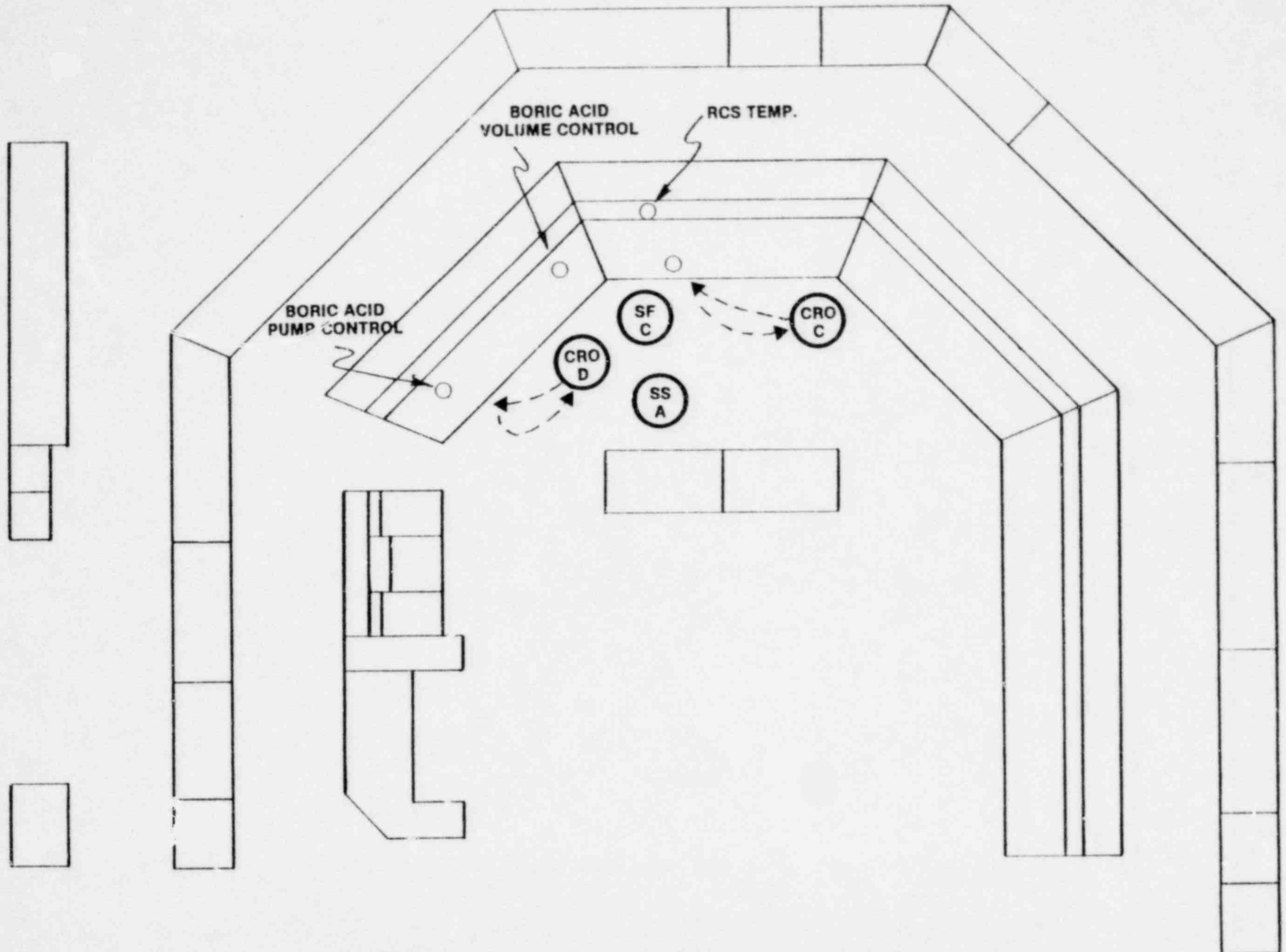


FIGURE B-11 PRIMARY SYSTEM CONTROL
(70-150 MINUTES)

APPENDIX C

SEQUENCE

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APPENDIX D

CHECKLISTS

DESIGN CHECKLIST

LABELS, MANUALS, MARKINGS

Test Title MAKEUP PANEL - 3

Test Project No. ______ Date ______

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Controls, displays and other items of equipment are clearly marked and labeled except in cases where use is obvious to the operator.	✓			
2. Labels are on or near the item to be identified.	✓			
3. Labels do not cover any other information and are not located behind controls. They can be seen easily by the operator and are not obscured by the operator's hand activating a control.		✓		Labels located behind controls
4. Labels are located in the same manner throughout the equipment and system.		✓		
5. Labels are not covered by other equipment and are located on the flattest, least cluttered and cleanest surface available.	✓			
6. Labels are mounted so that they cannot be accidentally damaged or removed.		✓		
7. Where instructions are lettered on hinged door, lettering is set so that it can be read when the door is open.			✓	
8. Labels are graduated in size. Group label characters are at least 25% larger than those of individual controls and displays.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
Control and display characters, in turn, are at least 25% larger than those identifying control positions.				
9. Spacing between characters is a minimum of one stroke; between words is a minimum of one character.	✓			
10. Abbreviations are capital letters, periods being omitted except when there is a possibility of misinterpretaion.	✓			
11. Extended copy (instructions) is in lower case letters.			✓	
12. Label characteristics are determined by illumination level and color.			✓	
13. Labels are easily read at operational reading distances with vibration/motion and lighting levels taken into consideration.	✓			
14. Labels are sharp with high contrast.		✓		
15. With illumination less than 1 ft-C, white, white florescent, or torch-lighted characters on a dark background are used.			✓	
16. With illumination above 1 ft-C, black letters against a light background are used.		✓		Some of each
17. For dark adaptation, letters are visible and do not interfere with night vision.			✓	
18. When letters, etc., are viewed by means of television, they are light against a dark background.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
19. Labels on production equipment are as durable as the equipment.		✓		Replaced by label maker labels
20. Labels for prototype equipment are easily affixed, altered and removed.			✓	
21. Markings and tags are as permanent as the equipment to which applied and able to withstand environmental and cleaning conditions.		✓		
22. Labels are accessible and visible during maintenance.			✓	
23. Load capacity is marked on lifting equipment.			✓	
24. Roman numerals are not used, if possible.	✓			
25. Vertical labels are used only when the labels are not critical for personal safety and performance, and space is limited.	✓			
26. Electrical receptacles are clearly marked with voltage, phase and frequency characteristics.			✓	
27. Pipe, hose, and tube lines are clearly labeled as to contents, pressure, temperature, and hazards.			✓	
28. Warning placards are well illuminated.	✓			
29. Warning notices are clear and direct. Characters are 25% larger than any following instructions.		✓		
30. Placards are placed adjacent to hazards.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
31. Circuit breakers are labeled and easily accessible.			✓	
32. Trade names and other irrelevant information do not appear on labeling.		✓		
33. Labels are concise with a minimum of repetitive information.	✓			
34. An abstract symbol is used only if meaningful.	✓			
35. Each assembly, component, and part is labeled with a visible and meaningful name, number, and symbol.		✓		Mimic leaves out a lot of controls
36. Printed information is directly useable with a minimum of decoding and interpolation.		✓		
37. Labels do not describe the engineering characteristics or nomenclature of the piece of equipment, if at all possible.		✓		
38. Labels are etched, embossed, or engraved into the component or chassis.		✓		

DESIGN CHECKLIST

6

CONTROLS

Test Title MAKEUP PANEL - 3

Test Project No. ______ Date ______

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Control relationship to its display is apparent.		✓		Displays of flow, press., etc. not related to mimic
2. Functionally related controls and displays are grouped together.		✓		
3. Control groups, sequential operations have left-to-right order of use or top-to-bottom order of use.		✓		
4. Controls in functional groups are located in accordance with operational sequence and/or function.		✓		
5. Lifting equipment controls are within easy reach with the load visible.			✓	
6. Controls are located so that they cannot be accidentally moved.		✓		
7. Groups with similar functions are similar throughout the system.			✓	
8. Controls are marked to indicate in which direction to operate the control.	✓			
9. Control/display groups used only for maintenance are not located in prime operating space.			✓	
10. Controls used most often are located in the best position for ease of reaching and grasping.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
11. Controls operated without visual reference are located in front rather than to the side or behind the operator.			✓	
12. Internally mounted controls are located away from dangerous voltage.			✓	
13. Sensitive adjustments are located or guarded to prevent accidental activation.		✓		
14. Controls used for same function on different types of equipment are of the same size and shape.	✓			
15. Rotary Control DIMENSIONS:				
Length min 1.0 inches (25mm) max 4.0 inches (100mm)	✓			
Width max 1.0 inches (25mm)	✓			
Depth min 0.625 inches (16mm) max 3.0 inches (75mm)	✓			
RESISTANCE min 1.0 inch-lb (113 mN-m) max 6.0 inch-lb (678mN-m)			✓	
DISPLACEMENT For facilitating performance min 30 degrees max 90 degrees	✓			
SEPARATION One Hand Random min 1.0 inches (25 mm) preferred 2.0 in. (50 mm)	✓			
Two-Hand Operation min 3.0 inches (75 mm) preferred 5.0 in. (125 mm)			✓	
16. Key Operated Switch DISPLACEMENT min 80 degrees			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
max 90 degrees HEIGHT min 0.5 inches (13mm) max 3.0 inches (75mm) RESISTANCE min 1 in/lb (113 mNm) max 6 in/lb (678 mNm)				
17. Discrete Thumbwheel Control DIMENSIONS: Diameter min 1.5 in. (38mm) max 2.5 in. (65 mm) Trough min 0.45 inches (11 mm) Distance max 0.75 inches (19 mm) Width min 0.1 inches (3 mm) Depth min 0.125 inches (3 mm) max 0.5 inches (13 mm) Separation min 0.4 inches (10 mm) RESISTANCE: min 6 oz. (165 mN) max 20 oz. (560 mN)			✓	
18. Continuous Adjustment Rotary Knobs DIMENSIONS: Fingertip Grasp Height min 0.5 inches (13 mm) max 1.0 inches (25 mm) Diameter min 0.375 inches (10 mm) max 4.0 inches (100 mm) Thumb and Finger Encircled Diameter min 1.0 inches (25 mm) max 3.0 inches (75mm) Palm Grasp Diameter min 1.5 inches (38 mm) max 3.0 inches (75 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
Length min 3.0 inches (75 mm) TORQUE: Height max 4.5 in-oz (32 mN-m) Diameter max 6.0 in-oz (42 mN-m) SEPARATION: One Hand Individually min 1.0 inches (25 mm) max 2.0 inches (50 mm) Two Hands Simultaneously min 2.0 inches (50 mm) max 5.0 inches (125 mm)				
19. Cranks DIMENSIONS: Handle Diameter (rpm-dia) none - 1.0 inches (25 mm) 175 - 1.0 inches (25 mm) 275 - 0.5 inches (13 mm) Length (rpm-length) none - 3.75 inches (95 mm) 175 - 3.75 inches (95 mm) 275 - 1.5 inches (38 mm) Radius (rpm-radius) none - min 9.0 in. (230 mm) max 16.0 in. (410 mm) 175 - min 5.0 in. (125 mm) max 8.0 in. (200 mm) 275 - min 0.5 in. (13 mm) max 4.5 in. (115 mm) RESISTANCE: (rpm-resistance) none - min 2.0 lb (9N) max 50 lb. (220N) 175 - min 6.0 lb. (27N) max 15 lb (67N) 275 - min 2.0 lb (9N) max 5 lb (22N) SEPARATION: (rpm-separation) none - min 3.0 inches (75mm) 175 - min 3.0 inches (75mm) 275 - min 3.0 inches (75mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
20. Handwheels DIMENSIONS: Wheel Diameter One Hand min 2.0 inches (50 mm) max 4.25 inches (110 mm) Two Hands min 7.0 inches (180 mm) max 21.0 inches (530 mm) Rim Diameter: min 0.75 inches (19mm) max 2.0 inches (50 mm) RESISTANCE: One Hand min 5 lb. (22N) max 30 lb. (133N) Two Hands min 5 lb (22 N) max 50 lb. (220 N) DISPLACEMENT: Two Hands max 120 deg. SEPARATION: Two Hands - Simultaneously min 3.0 inches (75 mm) max 5.0 inches (125 mm)			✓	
21. Pushbuttons (Finger or Hand Operated) DIMENSIONS: Diameter Fingertip Operation min 0.385 inches (10 mm) max 0.75 inches (19 mm) Thumb or Heel of Hand Operation min 0.75 inches (19 mm) RESISTANCE: Finger Operation min 10 oz. (2.8N) max 40 oz. (11.0N) Little Finger Operation min 5 oz. (1.4N) max 20 oz. (5.6N) DISPLACEMENT: Thumb or Finger Operation min 0.125 inches (3 mm) max 1.5 inches (38 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
SEPARATION: Single Finger Operation min 0.5 inches (13 mm) preferred 2.0 in. (50 mm) Single Finger Sequential Operation min 0.25 inches (6 mm) preferred 1.00 in. (25 mm) Operation by Several Fingers min 0.5 inches (13 mm) max 0.5 inches (13 mm)				
22. Pushbuttons (Foot Operated) DIMENSIONS: Diameter min 0.50 inches (13 mm) RESISTANCE: Foot will not rest on control min 4.0 lb. (18 N) max 20.0 lb. (90 N) Foot will rest on control min 10.0 lb. (45N) max 20 lb. (90N) DISPLACEMENT: Normal Boot Operation min 0.50 inches (13 mm) max 2.5 inches (65 mm) Heavy Boot Operation min 1.0 inches (25 mm) max 2.5 inches (65 mm) Ankle Flexion Only min 1.0 inches (25 mm) max 2.5 inches (65 mm) Total Leg Movement min 1.0 inches (25 mm) max 4.0 inches (100 mm)			✓	
23. Keyboards DIMENSIONS: Diameter Bare-handed min 0.385 inches (10 mm) max 0.75 inches (19 mm) preferred 0.5 in. (13 mm) Cold Regions mittens min 0.75 inches (19 mm) preferred 0.75 in. (19 mm) RESISTANCE:			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
Numeric min 3.5 oz. (1N) max 14.0 oz. (4N) Alphanumeric min 0.9 oz. (250 mN) max 5.3 oz. (1.5 N) Dual Function min 0.9 oz. (250 mN) max 5.3 oz. (1.5N) DISPLACEMENT: Numeric min 0.03 inches (0.8 mm) max 0.19 inches 4.8 mm) Alphanumeric min 0.05 inches (1.3 mm) max 0.25 inches (6.3 mm) Dual Function min 0.03 inches (0.8 mm) max 0.19 inches (4.8 mm) SEPARATION: Between adjacent key tops min 0.25 inches (6.4 mm) preferred 0.25 in. (6.4 mm)				
24. Toggle Switches DIMENSIONS: Arm Length (Bare finger) min 0.5 inches (13 mm) max 2.0 inches (50 mm) Arm Length (Gloved finger) min 1.5 inches (38 mm) max 2.0 inches (50 mm) Control Tip min 0.125 inches (3 mm) max 1.0 inches (25 mm) RESISTANCE: Small Switch min 10 oz. (2.8N) max 16 oz. (4.5N) Large Switch min 10 oz. (2.8N) max 40 oz. (11N) DISPLACEMENT: 2 Position min 30 deg max 120 deg.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
<u>3 Position</u> min 18 deg. max 60 deg. desired 25 deg. SEPARATION: <u>Single Finger Operation</u> min 0.75 inches (19 mm) optimum 2.0 in. (50 mm) <u>Single Finger Operation-lever lock toggle switch</u> min 1.0 inches (25 mm) optimum 1.0 in. (50 mm) <u>Simultaneous Operation by Different Finger</u> min 0.625 inches (16 mm) optimum 0.75 in. (19 mm)				
25. Legend Switch DIMENSIONS: min 0.75 inches (19 mm) max 1.5 inches (38 mm) DISPLACEMENT: min 0.125 inches (3 mm) max 0.250 inches (6 mm) positive position switch 3/16 in. (5 mm) BARRIERS: <u>Barrier Width</u> min 0.125 inches (3 mm) max 0.250 inches (6 mm) <u>Barrier Depth</u> min 0.88 inches (5 mm) max 0.250 inches (6 mm) RESISTANCE min 10 oz (280 mN) max 40 oz. (11N)			✓	
26. Lever DIMENSIONS: <u>Diameter</u> <u>Finger Grasp</u> min 0.5 inches (13 mm) max 3.0 inches (75 mm) <u>Hand Grasp</u> min 1.5 inches (38 mm) max 3.0 inches (75 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
RESISTANCE:				
One Hand (d-1)				
min 2 lb. (9N)				
max 30 lb. (135N)				
Two Hands				
min 2 lb. (9N)				
max 50 lb. (220N)				
One Hand (d-2)				
min 2 lb. (9N)				
max 20 lb. (90N)				
Two Hands				
min 2 lb. (9N)				
max 30 lb. (135N)				
DISPLACEMENT:				
Forward (d-1)				
max 14.0 inches (360 mm)				
Lateral (d-2)				
max 38.0 inches (970 mm)				
SEPARATION:				
One Hand Random				
min 3.0 inches (75 mm)				
preferred 5.0 in. (125 mm)				
27. Pedals			✓	
DIMENSIONS:				
Height				
min 10 inches (25 mm)				
Width				
min 3.0 inches (75 mm)				
DISPLACEMENT:				
Normal Operation				
min 0.5 inches (13 mm)				
max 2.5 inches (65 mm)				
Ankle Flexion				
min 1.0 inches (25 mm)				
max 2.5 inches (65 mm)				
Total Leg Movement				
min 1.0 inches (25 mm)				
max 7.0 inches (180 mm)				
RESISTANCE:				
Foot Not Resting on Pedal				
min 4 lb. (18 N)				
max 20 lb. (90 N)				
Foot Resting on Pedal				
min 10 lb. (45 N)				
max 20 lb. (90N)				

Detailed Design Considerations	YES	NO	N/A	Comments
<u>Ankle Flexion Only</u> max 10 lb. (45 N) <u>Total Leg Movement</u> min 10 lb. (45 N) max 180 lb. (800 N) SEPARATION: <u>One Foot Random</u> min 4.0 inches (100 mm) preferred 6.0 in. (150 mm) <u>One Foot Sequential</u> min 2.0 inches (50 mm) preferred 4.0 in. (100 mm)				
28. Adequate control response feedback is provided.		✓		
29. Rotary valves open counterclockwise.		✓		
30. Control movement conforms with corresponding related display.		✓		
31. Rotary controls turn to the right (clockwise) to increase, and left (counterclockwise) to decrease.	✓			
32. Stops are provided at the beginning and end of the control movement travel.	✓			
33. In right-hand operations, knobs are placed below or to the right of displays.		✓		
34. For left-hand operations knobs are placed below or to the left of displays.		✓		
35. Controls meant to have a limited degree of motion have adequate mechanical stops.	✓			
36. Controls are labeled as to function and method of operation by means of arrows and appropriate legends.	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
37. Selector switches have sufficient spring loading to keep from stopping between detents.	✓			
38. Range of control action does not interfere with other controls.	✓			
39. Shape coded controls are visually and tactually identifiable.			✓	
40. Control color has high contrast with background.	✓			
41. Ambient light color determines useable control colors.			✓	
42. Switch legend is legible with or without internal illumination.	✓			
43. Legend switch lamps are replaceable from the front of the panel by hand and the legends or covers are keyed to prevent the possibility of interchanging the legend covers.			✓	
44. Controls are selected and distributed so that none of the operator's limbs are overburdened.	✓			
45. Coding is uniform throughout the system.		✓		
46. Controls are useable in the time required despite inadvertent operation protection (guards).			✓	
47. Controls are not adversely affected by distortion, shock and vibration.			✓	
48. Control motion is minimized, not cycled through ON/OFF unnecessarily.	✓			
49. Latches on levers do not cause delay in operation.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
50. Minimum use made of horizontal or 3 position toggle switches.	✓			
51. Shape coded controls are free of sharp edges.			✓	
52. Critical controls are designed and located so that they are not susceptible to being moved accidentally.		✓		
53. If there is a possiblity of inadvertent activation causing a hazardous condition, controls are recessed or shielded by a physical barrier.		✓		
54. "Dead man" controls are used when operator incapacity can produce a critical condition.			✓	
55. The main power ON/OFF switch cuts all power to the complete equipment.			✓	
56. Main Power switch is labeled.			✓	
57. Failure of power steering does not incapacitate steering.			✓	
58. Resistance is built in so that definite or sustained effort is required for activation.			✓	
59. Controls are black or gray.	✓			
60. Controls are labeled with basic information for proper identification, utilization, actuation, or manipulation of the element.		✓		
61. Operating instructions are provided except where use is obvious.		✓		
62. Diagrams are used wherever possible.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
63. Calibration instructions are placed as close to the calibrating control as possible.			✓	
64. Adjustment controls are easy to set and lock.		✓		
65. All controls have appropriate scales or indexing.		✓		
66. If red lighting is used, red is not used for coding. Use black and yellow striping.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST
8
DISPLAYS

Test Title Makeup Panel - 3

Test Project No. ______________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Relationship between the display and its associated controls is unmistakable in terms of:				
a) The proper control to use.		✓		
b) Direction of movement of the control.	✓			
c) Rate and limits of movement of the control.	✓			
2. Controls are located adjacent to (either under or to right of) associated displays.		✓		
3. Functionally related units are grouped together and are similar from panel to panel.		✓		
4. Displays in groups are located from left-to-right and/or top-to-bottom order of use.		✓		
5. Displays used in system checkout are located so they can be observed from one position.		✓		
6. All displays are arranged in the sequence in which they are used.		✓		
7. Meters, dials, and instruments are so sized/arranged that they can be read from the normal operating position.		✓		Makeup flow on panel 8

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
8. In standing positions, the most frequently used displays are located approximately at the eye level of the operator.		✓		
9. Frequently used displays are grouped together.		✓		
10. Displays are located where they can be read to the required degree of accuracy.		✓		
11. If on separate panels, positions of related controls and displays correspond and the panels do not face each other.		✓		
12. Control display groups for maintenance use only are not located in prime operating space.			✓	
13. Display arrangement is consistent from one situation to another.		✓		
14. Unusual aids such as ladders, extra lighting, etc., are not needed to read or gain access to a display.			✓	
15. Display scales are limited to only information needed to make a decision or take action. All needed information is presented.		✓		
16. Information is presented in such form that no interpretation or decoding is necessary.		✓		
17. Information for different types of activities is not combined unless the activities require the same information.		✓		
18. Failure in the unit is clearly shown or the operator is otherwise warned.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
19. Trademarks, company names, and other unnecessary information are not on the panel face.		✓		
20. Job aids (graphic overlays) are provided when a plotter operator is required to interpret graphic data.		✓		
21. On units having operator displays, maintenance displays are located behind access doors on the operator's panel.			✓	
22. On units without operator panel, maintenance displays are located on one face accessible in normal installation.			✓	
23. Viewing distance from the eye to the displays located close to controls is 28 inches (710mm) maximum and 13 inches (510mm) minimum.		✓		
24. The display pointer extends to but does not obscure the index mark width.		✓		
25. Display pointer is mounted as close as possible to dial face to eliminate parallax and shadows.		✓		
26. Counters and flags are mounted close to the panel surface.		✓		
27. CRT target visual angle exceeds 2.0 minutes and 10 lines of resolution; viewing distance is 16 inches (10 in. minimum).			✓	
28. Illumination is uniform.		✓		
29. Multiple displays grouped together will have brightness uniformity across the range of full "ON" to full "OFF."			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
30. The display face is not less than 45° from the operator's normal line of sight.		✓		
31. There is a high degree of contrast between the scale face and markings.		✓		
32. Frequently used displays are grouped together and are placed in the optimal visual zone. Limits are as follows: <u>Eye Rotation Alone</u> Horizontal Plane 35° maximum 15° optimum Vertical Plane Horizontal Line of Sight 40° maximum 15° optimum Normal Line of Sight 20° maximum 15° optimum <u>Head Rotation Alone</u> Horizontal Plane 60° maximum 0° optimum Vertical Plane Horizontal Line of Sight 65° maximum Normal Line of Sight 35° maximum <u>Head and Eye Rotation</u> Horizontal Plane 95° maximum 15° optimum Vertical Plane 90° maximum 15° optimum Normal Line of Sight 15° optimum		✓		
33. Glare does not interfere with readability of the display at a location.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
34. Indicator lights show equipment response, not merely control position; are used sparingly and only show information needed for effective system operation.		✓		
35. Luminance contrast exceeds 50%.		✓		
36. Flashing lights have a flash rate of 3 to 5 flashes per second; in case of flasher failure, the light illuminates and burns steadily.	✓			
37. Color coding is used where possible; unused scales are covered.		✓		
38. Indicators used at night are dimmable (0.02-1.0 ft-L).			✓	
39. If faint signal detection is required and ambient illumination is above 0.25 ft-C (2-7 lux) the CRT is hooded, shielded, or recessed.			✓	
40. Printed matter is visible. If ambient illumination inadequate, matter is illuminated by the printer. Plotted matter is also readily visible.		✓		
41. Projection display rates for group viewing are as follows: FACTOR: Ratio of $\frac{\text{viewing distance}}{\text{screen diagonal}}$ OPTIMUM: 4 PREFERRED LIMITS: 3-6 ACCEPTABLE LIMTS: 2-8 FACTOR: Angle off centerline OPTIMUM: 0^{o}			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
PREFERRED LIMITS: 20° ACCEPTABLE LIMITS: 30° FACTOR: Image luminance (no film in operating projector) (for still projections higher values may be used) OPTIMUM: 10 ft-L (34 cd/m^2) PREFERRED LIMITS: 8-14 ft-L (27-48 cd/m^2) ACCEPTABLE LIMITS: 5-20 ft-L (17-69 cd/m^2) FACTOR: Luminance variation across screen (ratio of maximum to minimum luminance) OPTIMUM: 1 PREFERRED LIMITS: 1.5 ACCEPTABLE LIMITS: 3.0 FACTOR: Luminance variations as a function of viewing location (ratio of maximum to minimum luminance) OPTIMUM: 1 PREFERRED LIMITS: 2.0 ACCEPTABLE LIMITS: 4.0 FACTOR: Ratio of $\frac{\text{ambient light}}{\text{bright part of image}}$ OPTIMUM: 0 PREFERRED LIMITS: 0.002-0.01 ACCEPTABLE LIMITS: 0.1 max				22

Detailed Design Considerations	YES	NO	N/A	Comments
For presentation not involving gray scale or color (e.g., line drawings, tables) 0.2 may be used.				
42. Supplemental viewing system is provided for remote handling situations.			✓	
43. LED are red only and not near red warning lights. Dimming is compatible.			✓	
44. Critical warning lights are isolated from other less important lights for best effectiveness.		✓		
45. Internal instrument lighting is provided where effective.		✓		
46. Indicator lights are immediately and unavoidably associated with the proper control.		✓		
47. Legend lights are used in preference to simple instructor lights.		✓		
48. Indicator lights are capable of providing flashing red for emergency or malfunction conditions.		✓		
49. The information displayed is clear, specific, and useable. It is not redundant or degraded by vibration. It is at a level of accuracy required for the operator's action or decision.		✓		
50. The provision of the display presentation is consistent with system precision.		✓		
51. The display indicator ceases to move after the control movement stops.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
52. Displays which cannot or may not be watched continuously, but need continuous monitoring, have a suitable auditory or visual warning backup.	✓			
53. Counter numbers change by snap action, follow each other not faster than 2 per second if read consecutively, increase with clockwise rotation of the reset knob, and automatically reset sequencing as well as having a manual reset.			✓	
54. Material in printer is easily changed and indicates remaining supply of printing materials.		✓		
55. Failure of a display circuit is immediately apparent.		✓		
56. Failure of the display circuit does not affect display equipment.		✓		
57. Most important displays are placed in the optimum visual zone.		✓		
58. A signal absence does not denote "go ahead," "ready," etc., only a power off condition.		✓		
59. Transilluminated, LED and incandescent displays conform to the following color code, except that training equipment colors can be approximate:			✓	
a. Flashing red denotes only emergency conditions which require operator action without undue delay to avert personnel injury and/or equipment damage.				

Detailed Design Considerations	YES	NO	N/A	Comments
b. Red alerts an operator that a system or any of its parts is inoperative or that a successful mission is not possible unless corrective action is taken.				
c. Yellow advises an operator of a marginal condition or alerts him to situations of caution, recheck or unexpected delay.				
d. Green indicates that monitored equipment is in tolerance or that a state of readiness exists.				
e. White shows system conditions that do not have "right" or "wrong" implicatons such as alternating functions except that white is not used in aircraft flight stations.				
f. Blue is used for advisory lights only, except that blue is not used in aircraft flight stations.				
60. Flashing lights are used only to call the operator's attention to a condition requiring action.	✓			
61. Legend lights signifying danger are larger than other legend lights.		✓		
62. If operator is wearing earphones during normal operations, audio warning signals are directed to both earphones and work area.			✓	
63. Audio signal action specifies the nature of the problem (maintenance, emergency, health hazard).			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
64. Audio signals denoting emergencies are notably different from routine signals.		✓		
65. The following types of signals may not be used as warning devices:		✓		
a. Modulated or interrupted tones that resemble navigation signals or coded radio transmissions.				
b. Steady signals that resemble hisses, static, or sporadic radio signals.				
c. Trains of impulses that resemble electrical interference whether regularly or irregularly spaced in time.				
d. Simple warbles which may be confused with the type made by two carriers when one is being shifted in frequency (beat-frequency-oscillator effect).				
e. Scrambled speech effects that may be confused with cross modulation signals from adjacent channels.				
f. Signals that resemble random noise, periodic pulses, steady or frequency modulated simple tones, or any other signals generated by standard countermeasure devices (e.g., "bagpipes").				
g. Signals similar to random noise generated by air conditioning or any other equipment.				

Detailed Design Considerations	YES	NO	N/A	Comments
h. Signals that resemble sounds likely to occur accidentally under operational conditions.				
66. The first 0.5 seconds of an audio signal is discriminable from the first 0.5 second of any other signal. The length of the warning is a minimum of 1/2 second until corrective action is taken.		✓		
67. The audio device and circuit design preclude false alarms.		✓		
68. The height to width ratio of all labeling is acceptable for fast and accurate reading.		✓		
69. Counters are horizontally positioned.	✓			
70. The same numerical progression is used on all scales of combined displays.		✓		
71. In sequential displays, the sequence progresses from left to right.		✓		
72. Scale values and their indexes are consistent in directions of increase or decrease.		✓		
73. The display can be read quickly in the manner desired (quantitative, qualitative, or check reading).		✓		

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST
10
WORKSPACE

Test Title MAKeup PAnel 3

Test Project No. ________________ Date ________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Design and sizing insures accommodation, compatibility, operability and maintainability by at least 90 percent of the user population (a range from the 5th percentile to the 95th percentile for single dimensions).		✓		
2. Cabinets, consoles, and work surfaces that require an operator to stand or sit close to their front surfaces contain a kick space at the base at least 4 inches (100 mm) deep and 4 inches (100 mm) high to allow for protective or specialized apparel.		✓		
3. Panel Dimensions - seated - with vision over top.		✓		
a) Seat height 18" (460 mm) from floor				
writing surface-25.5" (650 mm) above the floor				
vertical dimension of panel-22" (56 mm) above writing surface				
maximum console width - 44" (1.120 m)				
b) Seat height 23" (580 mm)				
writing surface - 32" (810 mm)				
vertical dimension of panel - 22" (560 mm)				

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
maximum console width - 44" (1.120 m)				
c) Seat height 28.5" (725 mm)				
writing surface - 36" (910 mm)				
vertical dimension of panel 22" (560 mm)				
Maximum console width - 44" (1.120 m)				
4. Panel Dimensions - seated - without vision over top.			✓	
a) Seat height - 18" (460 mm)				
writing surface 25.5" (650 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
b) Seat height - 23" (580 mm)				
writing surface - 32" (810 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
c) Seat height - 28.5" (720 mm)				
writing surface - 36" (910 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width - 36" (910 mm)				
5. Panel Dimensions - seated or standing with standing vision over top.		✓		
seat height - 28.5" (720 mm)				

Detailed Design Considerations	YES	NO	N/A	Comments
writing surface - 36" (910 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
6. Panel Dimensions - standing with vision over top.		✓		
writing surface - 36" (910 mm)				
vertical dimension of panels 26" (660 mm)				
maximum console width - 44" (1.120 m)				
7. Panel Dimensions - standing (without vision over top).			✓	
writing surface - 36" (910 mm)				
vertical dimension of panel - 36" (910 mm)				
maximum console width - 36" (910 mm)				
8. Consoles have at least 4 feet (1.220 m) of free floor space in front whenever feasible.		✓		
9. The seated operator has free pedal access and use of foot pedals.			✓	
10. Compartment design allows equipment sharing and good communication.		✓		
11. Workspace allows ease of weapon handling, aiming, loading, firing, and field stripping.			✓	
12. User is oriented to work site.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
13. Crane controls are easily reached and afford load visibility.			✓	
14. Display reading location is identified.		✓		
15. Equipment is designed and installed with workspace requirements in mind.		✓		
16. Armrests are at least 2 inches (50 mm) wide and 8 inches (200 mm) long.			✓	
17. Knee and foot room should exceed the following dimensions beneath work surfaces: a) Height: 25 inches (640 mm) b) Width: 20 inches (510 mm) c) Depth: 18 inches (460 mm)			✓	
18. Back and seat of chair have 1" minimum padding.			✓	
19. Lateral work space is 30" wide x 16" deep; writing space is 24" wide x 16" deep.			✓	
20. Armrests do not interfere with work, egress or emergency procedures.			✓	
21. Vertical seat adjustments are 15-21" (16-21" for male use exclusively) in 1 inch maximum increments.			✓	
22. The seat backrest reclines 103-11[illegible]° and supports the torso so th[illegible]e operator's eyes are within 3" of the "eye-line."			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
23. Rotating seats have 8 locking positions minimum and support 250 lbs. The seat adjusts fore and aft at least 4" minimum.			✓	
24. The operator does not have to lift self to adjust the seat.			✓	
25. Easy access is provided to and from a station.		✓		
26. Equipment racks requiring maintenance have space available, when feasible, as follows:		✓		
a) Minimum distance from the front of the rack to the opposite surface or obstacle is 42 inches (1.070 m).				
b) Minimum lateral workspace for racks having drawers:				
1) With drawers weighing less than 45 pounds (20.4 kg); 18 inches (460 mm) on one side and 4 inches (100 mm) on the other.				
2) With drawers weighing over 45 pounds (20.4 kg) 18 inches on each side.				
27. Allowances are made for heavy clothing and protective equipment.		✓		
28. A loader can comfortably sit in the closed hatch mode or stand in the open hatch mode.			✓	
29. Workspace provides head, arm and body clearance at any weapon position.			✓	
30. User space is not encroached upon by others.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
31. Reflection of instruments or console in windows or windshields is avoided.		✓		
32. Right-left viewing angle for a wrap-around console is 190° maximum.		✓		
33. The forward field of view is 180° minimum.		✓		
34. Minimum illumination levels for different work areas and types of work are as follows in Footcandles (LUX): Console surface 30 (325) Dials 30 (325) Emergency lighting 3 (30) Gauges 30 (325) Meters 30 (325) Missiles: Repair/Service 60 (640) Storage areas 10 (110) General inspection 30 (325) Panels: Front 30 (325) Rear 10 (110) Passageways 10 (110) Reading Large print 10 (110) News print 30 (325) Pencil reports 50 (540) Small type 50 (540) Prolonged reading 50 (540) Recording 50 (540) Repair work: General 30 (325) Instrument 100 (1075)	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
35. Visors, etc., reduce external glare.			✓	
36. Transparent areas are free from color, distortion, etc.			✓	
37. Multireflections from multilayered windows are minimized.			✓	
38. Windscreen angle of incidence is 60° maximum to undistorted vision.			✓	
39. Windows or canopies have optimum unobstructed vision.			✓	
40. Instrument reflection is avoided.		✓		
41. If possible there is a direct view of work.	✓			
42. Distortion is avoided in windows.			✓	
43. Door posts or wiper motors do not obscure vision.			✓	
44. Loader can see outside while operating in close hatch mode.			✓	
45. Provisions for auxiliary power and lighting are provided.	✓			
46. Seating is compatible with console.		✓		
47. Heating and air conditioning specifications for mobile detail work areas - 50°F to 85°F. For permanent details work areas - 65°F to 85°F.			✓	
48. Air conditioning systems do not discharge cold air directly on personnel.			✓	
49. Adequate ventilation is provided by a minimum of 30 cubic ft.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
per minute per man minimum. Air is moved past the operator at a velocity of not more than 100 feet (30 m) per minute - 65 feet (20 m) per minute if possible.				
50. The effective temperature within enclosures for extended periods is at or below 85°F (29°C).	✓			
51. The acoustical environment does not degrade system effectiveness.		✓		
52. The average room sound absorption coefficient is at least 0.20.		✓		
53. Facilities and equipment are designed to control the transmission of whole body vibration to levels permitting safe operation and maintenance.			✓	
54. Test stands are part of the equipment.			✓	
55. Handles are provided on units which are removed or carried.			✓	
56. Vehicles have a minimum temperature of 68°F (20°C)(unless wearing cold regions clothing and exposure less than 3 hours).			✓	
57. Fresh air is provided at a minimum of 20 cu. ft. (0.43 cu m)/minute/person; in a hot climate, air flow rates should be between 150 and 200 cu. ft. (4.25 and 5.66 cu m) / min./person.			✓	
58. Protective padding is used.			✓	
59. Mirrors are braced against vibration.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
60. Ventilation or other protective measures are provided within limits.			✓	
61. Intakes for ventilation systems are located so as to minimize the introduction of contaminated air from exhaust pipes, etc.			✓	
62. Cars have seat belts.			✓	
63. Windshields and windows are shatterproof and do not distort vision.			✓	
64. Hazard alerting devices are provided.	✓			
65. Illumination is adequate, glare is reduced and capability for dimming is provided.		✓		
66. Maintenance workspace is free of obstructions which could cause injury.		✓		
67. Equipment is guarded if temperature exceeds 140°F (120°F if handled).			✓	
68. Exposed edges are rounded and have a .04" minimum radius. Exposed corners are also rounded and have a 0.5" minimum radius.		✓		
69. Guards are provided on moving parts.			✓	
70. Radiation hazards are minimized.	✓			
71. Padding is non-abrasive and non-toxic.			✓	
72. Exhausts are directed away from compartments.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
73. Adequate and suitable storage is provided for manuals, worksheets, etc.		✓		
74. Standees have work surfaces provided to support manuals, etc.		✓		
75. Conspicuous placards are adjacent to equipment which is hazardous to the user.		✓		
76. Areas requiring special equipment and/or clothing are specifically identified.	✓			
77. Any structure which can be chopped through in an emergency is clearly marked, axes provided.			✓	
78. Emergency procedures are detailed.		✓		
79. Instructions are kept simple.		✓		
80. Push-out escape windows are marked.			✓	
81. Equipment is located so that awkward working positions are unnecessary.		✓		
82. Sufficient space is provided to use test equipment and other tools required during checkout.		✓		
83. Controls (switches, knobs, etc.) are easily reached from the working position.		✓		
84. Components are located so that physical interference among operators working on the same areas is lessened.		✓		
85. The lines of sight to a display are not obscured by poor arrangement of people or equipment.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
86. Traffic flow between areas is efficient.		✓		
87. Auditory alerting and warning signals are loud enough to be heard above environmental noise.	✓			
88. Equipment is secured in order to prevent shifting or overturning accidentally.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST
20
MEASURES

Test Title Makeup Panel 3

Test Project No. ______ Date ______

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Displays are located so they can be read to the required accuracy.		✓		
2. Display arrangement is consistent from one application to another.		✓		
3. Measuring marks on opaque containers are placed inside.			✓	
4. Display viewing distance: 13-28".		✓		
5. Minimum number of measuring devices is used.		✓		
6. Canteen cup is useable as standard or emergency measuring device for field use.			✓	
7. Item container used for measuring where possible.			✓	
8. Measurement marks raised.			✓	
9. Containers allow for full hand, finger, clearance when using opening tool.			✓	
10. Reflections minimized.		✓		
11. Display precision, response is consistent with that of system.		✓		
12. Scales: linear, start at 0, use whole numbers, 2 pointers max, numerals oriented upright.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
13. Field items are non-corrosive, easily cleaned or disposed.			✓	
14. Information limited to that necessary to take action.		✓		
15. Information is directly useable.		✓		
16. Specified measuring amounts are consistent with measuring device.			✓	
17. Measures clearly detailed.		✓		
18. For group use: multiple of food components or general formula for computation given.			✓	

DESIGN CHECKLIST

LABELS, MANUALS, MARKINGS

Test Title Turbine Control System - Panel 5

Test Project No. ______________________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Controls, displays and other items of equipment are clearly marked and labeled except in cases where use is obvious to the operator.		✓		1.1 Operators add clarifying info on turb. bypass valve controllers A&B 1.2 Clarifying info added to Elec/Hqd Gov. oil cooler cont. 1.3 Turbine EHC System status, lines and ref. displays have extensive operator supplied notation 1.4 Turbine EHC system load rate display - operator notation
2. Labels are on or near the item to be identified.	✓			
3. Labels do not cover any other information and are not located behind controls. They can be seen easily by the operator and are not obscured by the operator's hand activating a control.		✓		
4. Labels are located in the same manner throughout the equipment and system.		✓		4.1 Turning gear oil and seal backup pump control label above control 4.2 Turning gear control label above control
5. Labels are not covered by other equipment and are located on the flattest, least cluttered and cleanest surface available.		✓		5.1 Low E.H. fluid level lockout control obscures its own status indicators
6. Labels are mounted so that they cannot be accidentally damaged or removed.	✓			
7. Where instructions are lettered on hinged door, lettering is set so that it can be read when the door is open.			✓	
8. Labels are graduated in size. Group label characters are at least 25% larger than those of individual controls and displays.		✓		8.1 Turbine EHC system ID same label as ind. components 8.2 Turbine supervisory indication system label

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
Control and display characters, in turn, are at least 25% larger than those identifying control positions.				8.3 Turbine lube oil temp cont.; E/H Gov. oil cooler temp cont.; Gen. Hydrogen temp. cont.; and Exciter Cold Air temp cont. - display characteristics smaller than position identifiers
9. Spacing between characters is a minimum of one stroke; between words is a minimum of one character.		✓		9.1 Between word spacing nearly always below min.
10. Abbreviations are capital letters, periods being omitted except when there is a possibility of misinterpretaion.	✓			
11. Extended copy (instructions) is in lower case letters.		✓		11.1 Turbine speed hold recommendations in all caps
12. Label characteristics are determined by illumination level and color.		✓		
13. Labels are easily read at operational reading distances with vibration/motion and lighting levels taken into consideration.		✓		13.1 Turbine EHC system panel linear scales are too small
14. Labels are sharp with high contrast.		✓		
15. With illumination less than 1 ft-C, white, white florescent, or torch-lighted characters on a dark background are used.			✓	
16. With illumination above 1 ft-C, black letters against a light background are used.		✓		16.1 Except for backlight displays, this is never the case
17. For dark adaptation, letters are visible and do not interfere with night vision.			✓	
18. When letters, etc., are viewed by means of television, they are light against a dark background.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
19. Labels on production equipment are as durable as the equipment.		✓		
20. Labels for prototype equipment are easily affixed, altered and removed.			✓	
21. Markings and tags are as permanent as the equipment to which applied and able to withstand environmental and cleaning conditions.		✓		21.1 Operator notations indicated in 1.1-1.4 above
22. Labels are accessible and visible during maintenance.			✓	
23. Load capacity is marked on lifting equipment.			✓	
24. Roman numerals are not used, if possible.	✓			
25. Vertical labels are used only when the labels are not critical for personal safety and performance, and space is limited.			✓	
26. Electrical receptacles are clearly marked with voltage, phase and frequency characteristics.			✓	
27. Pipe, hose, and tube lines are clearly labeled as to contents, pressure, temperature, and hazards.			✓	
28. Warning placards are well illuminated.			✓	
29. Warning notices are clear and direct. Characters are 25[illegible] larger than any following instructions.			✓	
30. Placards are placed adjacent to hazards.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
31. Circuit breakers are labeled and easily accessible.			✓	
32. Trade names and other irrelevant information do not appear on labeling.		✓		32.1 Bailey and G.E. controls are so labeled
33. Labels are concise with a minimum of repetitive information.		✓		33.1 Turb. lube oil temp.; E/H gov. oil cooler temp.; Gen. Hydrogen temp and Exciter cold air temp controls have redundant labeling
34. An abstract symbol is used only if meaningful.			✓	
35. Each assembly, component, and part is labeled with a visible and meaningful name, number, and symbol.		✓		
36. Printed information is directly useable with a minimum of decoding and interpolation.		✓		
37. Labels do not describe the engineering characteristics or nomenclature of the piece of equipment, if at all possible.		✓		
38. Labels are etched, embossed, or engraved into the component or chassis.		✓		38.1 Except for operator notations already cited

DESIGN CHECKLIST

6

CONTROLS

Test Title Turbine Control System - 5

Test Project No. ______________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Control relationship to its display is apparent.		✓		1.1 Throttle valve controls and position indicators might be better arranged
2. Functionally related controls and displays are grouped together.		✓		
3. Control groups, sequential operations have left-to-right order of use or top-to-bottom order of use.		✓		
4. Controls in functional groups are located in accordance with operational sequence and/or function.		✓		
5. Lifting equipment controls are within easy reach with the load visible.			✓	
6. Controls are located so that they cannot be accidentally moved.		✓		6.1 Most controls can be engaged by accidental bumping
7. Groups with similar functions are similar throughout the system.		✓		
8. Controls are marked to indicate in which direction to operate the control.	✓			
9. Control/display groups used only for maintenance are not located in prime operating space.			✓	
10. Controls used most often are located in the best position for ease of reaching and grasping.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
11. Controls operated without visual reference are located in front rather than to the side or behind the operator.			✓	
12. Internally mounted controls are located away from dangerous voltage.			✓	
13. Sensitive adjustments are located or guarded to prevent accidental activation.			✓	
14. Controls used for same function on different types of equipment are of the same size and shape.		✓		
15. Rotary Control DIMENSIONS: Length min 1.0 inches (25mm) max 4.0 inches (100mm) Width max 1.0 inches (25mm) Depth min 0.625 inches (16mm) max 3.0 inches (75mm) RESISTANCE min 1.0 inch-lb (113 mN-m) max 6.0 inch-lb (678mN-m) DISPLACEMENT For facilitating performance min 30 degrees max 90 degrees SEPARATION One Hand Random min 1.0 inches (25 mm) preferred 2.0 in. (50 mm) Two-Hand Operation min 3.0 inches (75 mm) preferred 5.0 in. (125 mm)		✓		15.1 Controls ref. in 8.3 use rotary knobs 1/2 in diam. 1" high
16. Key Operated Switch DISPLACEMENT min 80 degrees		✓		16.1 Overspeed protection controller uses __ 45° displacements

Detailed Design Considerations	YES	NO	N/A	Comments
max 90 degrees HEIGHT min 0.5 inches (13mm) max 3.0 inches (75mm) RESISTANCE min 1 in/lb (113 mNm) max 6 in/lb (678 mNm)				
17. Discrete Thumbwheel Control DIMENSIONS: <u>Diameter</u> min 1.5 in. (38mm) max 2.5 in. (65 mm) <u>Trough</u> min 0.45 inches (11 mm) <u>Distance</u> max 0.75 inches (19 mm) <u>Width</u> min 0.1 inches (3 mm) <u>Depth</u> min 0.125 inches (3 mm) max 0.5 inches (13 mm) <u>Separation</u> min 0.4 inches (10 mm) RESISTANCE: min 6 oz. (165 mN) max 20 oz. (560 mN)		✓		17.1 Turbine EHC system low load limit MW; acceleration rate RPM per min.; high load limit min.; load rate MW per min. controls use 1" diam. thumb wheels 17.2 Above thumbwheels use ≈ .25" ___ throughs
18. Continuous Adjustment Rotary Knobs DIMENSIONS: <u>Fingertip Grasp Height</u> min 0.5 inches (13 mm) max 1.0 inches (25 mm) <u>Diameter</u> min 0.375 inches (10 mm) max 4.0 inches (100 mm) <u>Thumb and Finger Encircled Diameter</u> min 1.0 inches (25 mm) max 3.0 inches (75mm) <u>Palm Grasp Diameter</u> min 1.5 inches (38 mm) max 3.0 inches (75 mm)	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
Length min 3.0 inches (75 mm) TORQUE: Height max 4.5 in-oz (32 mN-m) Diameter max 6.0 in-oz (42 mN-m) SEPARATION: One Hand Individually min 1.0 inches (25 mm) max 2.0 inches (50 mm) Two Hands Simultaneously min 2.0 inches (50 mm) max 5.0 inches (125 mm)				
19. Cranks DIMENSIONS: Handle Diameter (rpm-dia) none - 1.0 inches (25 mm) 175 - 1.0 inches (25 mm) 275 - 0.5 inches (13 mm) Length (rpm-length) none - 3.75 inches (95 mm) 175 - 3.75 inches (95 mm) 275 - 1.5 inches (38 mm) Radius (rpm-radius) none - min 9.0 in. (230 mm) max 16.0 in. (410 mm) 175 - min 5.0 in. (125 mm) max 8.0 in. (200 mm) 275 - min 0.5 in. (13 mm) max 4.5 in. (115 mm) RESISTANCE: (rpm-resistance) none - min 2.0 lb (9N) max 50 lb. (220N) 175 - min 6.0 lb. (27N) max 15 lb (67N) 275 - min 2.0 lb (9N) max 5 lb (22N) SEPARATION: (rpm-separation) none - min 3.0 inches (75mm) 175 - min 3.0 inches (75mm) 275 - min 3.0 inches (75mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
20. Handwheels DIMENSIONS: Wheel Diameter One Hand min 2.0 inches (50 mm) max 4.25 inches (110 mm) Two Hands min 7.0 inches (180 mm) max 21.0 inches (530 mm) Rim Diameter: min 0.75 inches (19mm) max 2.0 inches (50 mm) RESISTANCE: One Hand min 5 lb. (22N) max 30 lb. (133N) Two Hands min 5 lb (22 N) max 50 lb. (220 N) DISPLACEMENT: Two Hands max 120 deg. SEPARATION: Two Hands - Simultaneously min 3.0 inches (75 mm) max 5.0 inches (125 mm)			✓	
21. Pushbuttons (Finger or Hand Operated) DIMENSIONS: Diameter Fingertip Operation min 0.385 inches (10 mm) max 0.75 inches (19 mm) Thumb or Heel of Hand Operation min 0.75 inches (19 mm) RESISTANCE: Finger Operation min 10 oz. (2.8N) max 40 oz. (11.0N) Little Finger Operation min 5 oz. (1.4N) max 20 oz. (5.6N) DISPLACEMENT: Thumb or Finger Operation min 0.125 inches (3 mm) max 1.5 inches (38 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
SEPARATION: Single Finger Operation min 0.5 inches (13 mm) preferred 2.0 in. (50 mm) Single Finger Sequential Operation min 0.25 inches (6 mm) preferred 1.00 in. (25 mm) Operation by Several Fingers min 0.5 inches (13 mm) max 0.5 inches (13 mm)		✓		21.1 Never this great when two or more are used together - usually ≈ .1".
22. Pushbuttons (Foot Operated) DIMENSIONS: Diameter min 0.50 inches (13 mm) RESISTANCE: Foot will not rest on control min 4.0 lb. (18 N) max 20.0 lb. (90 N) Foot will rest on control min 10.0 lb. (45N) max 20 lb. (90N) DISPLACEMENT: Normal Boot Operation min 0.50 inches (13 mm) max 2.5 inches (65 mm) Heavy Boot Operation min 1.0 inches (25 mm) max 2.5 inches (65 mm) Ankle Flexion Only min 1.0 inches (25 mm) max 2.5 inches (65 mm) Total Leg Movement min 1.0 inches (25 mm) max 4.0 inches (100 mm)			✓	
23. Keyboards DIMENSIONS: Diameter Bare-handed min 0.385 inches (10 mm) max 0.75 inches (19 mm) preferred 0.5 in. (13 mm) Cold Regions mittens min 0.75 inches (19 mm) preferred 0.75 in. (19 mm) RESISTANCE:			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
<u>Numeric</u> min 3.5 oz. (1N) max 14.0 oz. (4N) <u>Alphanumeric</u> min 0.9 oz. (250 mN) max 5.3 oz. (1.5 N) <u>Dual Function</u> min 0.9 oz. (250 mN) max 5.3 oz. (1.5N) DISPLACEMENT: <u>Numeric</u> min 0.03 inches (0.8 mm) max 0.19 inches 4.8 mm) <u>Alphanumeric</u> min 0.05 inches (1.3 mm) max 0.25 inches (6.3 mm) <u>Dual Function</u> min 0.03 inches (0.8 mm) max 0.19 inches (4.8 mm) SEPARATION: <u>Between adjacent key tops</u> min 0.25 inches (6.4 mm) preferred 0.25 in. (6.4 mm)				
24. Toggle Switches DIMENSIONS: <u>Arm Length (Bare finger)</u> min 0.5 inches (13 mm) max 2.0 inches (50 mm) <u>Arm Length (Gloved finger)</u> min 1.5 inches (38 mm) max 2.0 inches (50 mm) <u>Control Tip</u> min 0.125 inches (3 mm) max 1.0 inches (25 mm) RESISTANCE: <u>Small Switch</u> min 10 oz. (2.8N) max 16 oz. (4.5N) <u>Large Switch</u> min 10 oz. (2.8N) max 40 oz. (11N) DISPLACEMENT: <u>2 Position</u> min 30 deg max 120 deg.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
3 Position min 18 deg. max 60 deg. desired 25 deg. SEPARATION: Single Finger Operation min 0.75 inches (19 mm) optimum 2.0 in. (50 mm) Single Finger Operation-lever lock toggle switch min 1.0 inches (25 mm) optimum 1.0 in. (50 mm) Simultaneous Operation by Different Finger min 0.625 inches (16 mm) optimum 0.75 in. (19 mm)				
25. Legend Switch DIMENSIONS: min 0.75 inches (19 mm) max 1.5 inches (38 mm) DISPLACEMENT: min 0.125 inches (3 mm) max 0.250 inches (6 mm) positive position switch 3/16 in. (5 mm) BARRIERS: Barrier Width min 0.125 inches (3 mm) max 0.250 inches (6 mm) Barrier Depth min 0.88 inches (5 mm) max 0.250 inches (6 mm) RESISTANCE min 10 oz (280 mN) max 40 oz. (11N)			✓	
26. Lever DIMENSIONS: Diameter Finger Grasp min 0.5 inches (13 mm) max 3.0 inches (75 mm) Hand Grasp min 1.5 inches (38 mm) max 3.0 inches (75 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
RESISTANCE:				
One Hand (d-1)				
min 2 lb. (9N)				
max 30 lb. (135N)				
Two Hands				
min 2 lb. (9N)				
max 50 lb. (220N)				
One Hand (d-2)				
min 2 lb. (9N)				
max 20 lb. (90N)				
Two Hands				
min 2 lb. (9N)				
max 30 lb. (135N)				
DISPLACEMENT:				
Forward (d-1)				
max 14.0 inches (360 mm)				
Lateral (d-2)				
max 38.0 inches (970 mm)				
SEPARATION:				
One Hand Random				
min 3.0 inches (75 mm)				
preferred 5.0 in. (125 mm)				
27. Pedals			✓	
DIMENSIONS:				
Height				
min 10 inches (25 mm)				
Width				
min 3.0 inches (75 mm)				
DISPLACEMENT:				
Normal Operation				
min 0.5 inches (13 mm)				
max 2.5 inches (65 mm)				
Ankle Flexion				
min 1.0 inches (25 mm)				
max 2.5 inches (65 mm)				
Total Leg Movement				
min 1.0 inches (25 mm)				
max 7.0 inches (180 mm)				
RESISTANCE:				
Foot Not Resting on Pedal				
min 4 lb. (18 N)				
max 20 lb. (90 N)				
Foot Resting on Pedal				
min 10 lb. (45 N)				
max 20 lb. (90N)				

Detailed Design Considerations	YES	NO	N/A	Comments
Ankle Flexion Only max 10 lb. (45 N) Total Leg Movement min 10 lb. (45 N) max 180 lb. (800 N) SEPARATION: One Foot Random min 4.0 inches (100 mm) preferred 6.0 in. (150 mm) One Foot Sequential min 2.0 inches (50 mm) preferred 4.0 in. (100 mm)				
28. Adequate control response feed-back is provided.		✓		
29. Rotary valves open counterclock-wise.		✓		
30. Control movement conforms with corresponding related dis-play.		✓		
31. Rotary controls turn to the right (clockwise) to increase, and left (counterclockwise) to decrease.	✓			
32. Stops are provided at the begin-ning and end of the control movement travel.	✓			
33. In right-hand operations, knobs are placed below or to the right of displays.		✓		
34. For left-hand operations knobs are placed below or to the left of displays.		✓		
35. Controls meant to have a limited degree of motion have adequate mechanical stops.	✓			
36. Controls are labeled as to func-tion and method of operation by means of arrows and appro-priate legends.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
37. Selector switches have sufficient spring loading to keep from stopping between detents.		✓		
38. Range of control action does not interfere with other controls.		✓		
39. Shape coded controls are visually and tactually identifiable.			✓	
40. Control color has high contrast with background.		✓		
41. Ambient light color determines useable control colors.			✓	
42. Switch legend is legible with or without internal illumination.	✓			
43. Legend switch lamps are replaceable from the front of the panel by hand and the legends or covers are keyed to prevent the possibility of interchanging the legend covers.		✓		43.1 All pushbuttons on turbine EHC system panel (≈ 54) are interchangeable
44. Controls are selected and distributed so that none of the operator's limbs are overburdened.		✓		
45. Coding is uniform throughout the system.		✓		
46. Controls are useable in the time required despite inadvertent operation protection (guards).		✓		
47. Controls are not adversely affected by distortion, shock and vibration.			✓	
48. Control motion is minimized, not cycled through ON/OFF unnecessarily.	✓			
49. Latches on levers do not cause delay in operation.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
50. Minimum use made of horizontal or 3 position toggle switches.	✓			
51. Shape coded controls are free of sharp edges.	✓			
52. Critical controls are designed and located so that they are not susceptible to being moved accidentally.		✓		
53. If there is a possiblity of inadvertent activation causing a hazardous condition, controls are recessed or shielded by a physical barrier.		✓		
54. "Dead man" controls are used when operator incapacity can produce a critical condition.			✓	
55. The main power ON/OFF switch cuts all power to the complete equipment.			✓	
56. Main Power switch is labeled.			✓	
57. Failure of power steering does not incapacitate steering.			✓	
58. Resistance is built in so that definite or sustained effort is required for activation.	✓			
59. Controls are black or gray.		✓		
60. Controls are labeled with basic information for proper identification, utilization, actuation, or manipulation of the element.		✓		
61. Operating instructions are provided except where use is obvious.		✓		
62. Diagrams are used wherever possible.		✓		62.1 None used

Detailed Design Considerations	YES	NO	N/A	Comments
63. Calibration instructions are placed as close to the calibrating control as possible.		✓		
64. Adjustment controls are easy to set and lock.		✓		
65. All controls have appropriate scales or indexing.		✓		
66. If red lighting is used, red is not used for coding. Use black and yellow striping.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST

8

DISPLAYS

Test Title Turbine Control System - 5

Test Project No. ______ Date ______

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Relationship between the display and its associated controls is unmistakable in terms of:				1.1 Tracking meter; throttle valve position; governor valve position; gov. cont.; and valve position limit displays on turbine EHC system panel indicator 0 to 100% - they do not indicate open or closed
a) The proper control to use.		✓		
b) Direction of movement of the control.		✓		
c) Rate and limits of movement of the control.		✓		
2. Controls are located adjacent to (either under or to right of) associated displays.		✓		
3. Functionally related units are grouped together and are similar from panel to panel.		✓		
4. Displays in groups are located from left-to-right and/or top-to-bottom order of use.		✓		
5. Displays used in system checkout are located so they can be observed from one position.		✓		
6. All displays are arranged in the sequence in which they are used.		✓		
7. Meters, dials, and instruments are so sized/arranged that they can be read from the normal operating position.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
8. In standing positions, the most frequently used displays are located approximately at the eye level of the operator.		✓		
9. Frequently used displays are grouped together.		✓		
10. Displays are located where they can be read to the required degree of accuracy.		✓		
11. If on separate panels, positions of related controls and displays correspond and the panels do not face each other.			✓	
12. Control display groups for maintenance use only are not located in prime operating space.			✓	
13. Display arrangement is consistent from one situation to another.		✓		
14. Unusual aids such as ladders, extra lighting, etc., are not needed to read or gain access to a display.			✓	
15. Display scales are limited to only information needed to make a decision or take action. All needed information is presented.		✓		
16. Information is presented in such form that no interpretation or decoding is necessary.		✓		
17. Information for different types of activities is not combined unless the activities require the same information.	✓			
18. Failure in the unit is clearly shown or the operator is otherwise warned.		✓		No indication of failed unit shown

Detailed Design Considerations	YES	NO	N/A	Comments
19. Trademarks, company names, and other unnecessary information are not on the panel face.		✓		Company names and trademarks all over unit
20. Job aids (graphic overlays) are provided when a plotter operator is required to interpret graphic data.			✓	
21. On units having operator displays, maintenance displays are located behind access doors on the operator's panel.		✓		Valve test is right out in open
22. On units without operator panel, maintenance displays are located on one face accessible in normal installation.			✓	
23. Viewing distance from the eye to the displays located close to controls is 28 inches (710mm) maximum and 13 inches (510mm) minimum.		✓		Viewing distance to display ≈ 40 inches
24. The display pointer extends to but does not obscure the index mark width.		✓		
25. Display pointer is mounted as close as possible to dial face to eliminate parallax and shadows.		✓		
26. Counters and flags are mounted close to the panel surface.			✓	
27. CRT target visual angle exceeds 2.0 minutes and 10 lines of resolution; viewing distance is 16 inches (10 in. minimum).			✓	
28. Illumination is uniform.		✓		
29. Multiple displays grouped together will have brightness uniformity across the range of full "ON" to full "OFF."		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
30. The display face is not less than 45° from the operator's normal line of sight.		✓		
31. There is a high degree of contrast between the scale face and markings.		✓		
32. Frequently used displays are grouped together and are placed in the optimal visual zone. Limits are as follows: <u>Eye Rotation Alone</u> Horizontal Plane 35° maximum 15° optimum Vertical Plane Horizontal Line of Sight 40° maximum 15° optimum Normal Line of Sight 20° maximum 15° optimum <u>Head Rotation Alone</u> Horizontal Plane 60° maximum 0° optimum Vertical Plane Horizontal Line of Sight 65° maximum Normal Line of Sight 35° maximum <u>Head and Eye Rotation</u> Horizontal Plane 95° maximum 15° optimum Vertical Plane 90° maximum 15° optimum Normal Line of Sight 15° optimum		✓		
33. Glare does not interfere with readability of the display at a location.		✓		Glare is evident on Governor and Throttle Valve Position indicators

Detailed Design Considerations	YES	NO	N/A	Comments
34. Indicator lights show equipment response, not merely control position; are used sparingly and only show information needed for effective system operation.		✓		34.1 Are used appropriately
35. Luminance contrast exceeds 50%.		✓		
36. Flashing lights have a flash rate of 3 to 5 flashes per second; in case of flasher failure, the light illuminates and burns steadily.	✓			
37. Color coding is used where possible; unused scales are covered.		✓		37.1 Operating limits could be indicated to advantage - are not
38. Indicators used at night are dimmable (0.02-1.0 ft-L).			✓	
39. If faint signal detection is required and ambient illumination is above 0.25 ft-C (2-7 lux) the CRT is hooded, shielded, or recessed.			✓	
40. Printed matter is visible. If ambient illumination inadequate, matter is illuminated by the printer. Plotted matter is also readily visible.			✓	
41. Projection display rates for group viewing are as follows: FACTOR: Ratio of $\frac{\text{viewing distance}}{\text{screen diagonal}}$ OPTIMUM: 4 PREFERRED LIMITS: 3-6 ACCEPTABLE LIMTS: 2-8 FACTOR: Angle off centerline OPTIMUM: 0°			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
PREFERRED LIMITS: 20^{o} ACCEPTABLE LIMITS: 30^{o} FACTOR: Image luminance (no film in operating projector) (for still projections higher values may be used) OPTIMUM: 10 ft-L (34 cd/m^2) PREFERRED LIMITS: 8-14 ft-L (27-48 cd/m^2) ACCEPTABLE LIMITS: 5-20 ft-L (17-69 cd/m^2) FACTOR: Luminance variation across screen (ratio of maximum to minimum luminance) OPTIMUM: 1 PREFERRED LIMITS: 1.5 ACCEPTABLE LIMITS: 3.0 FACTOR: Luminance variations as a function of viewing location (ratio of maximum to minimum luminance) OPTIMUM: 1 PREFERRED LIMITS: 2.0 ACCEPTABLE LIMITS: 4.0 FACTOR: Ratio of $\frac{\text{ambient light}}{\text{bright part of image}}$ OPTIMUM: 0 PREFERRED LIMITS: 0.002-0.01 ACCEPTABLE LIMITS: 0.1 max				

Detailed Design Considerations	YES	NO	N/A	Comments
For presentation not involving gray scale or color (e.g., line drawings, tables) 0.2 may be used.				
42. Supplemental viewing system is provided for remote handling situations.			✓	
43. LED are red only and not near red warning lights. Dimming is compatible.			✓	
44. Critical warning lights are isolated from other less important lights for best effectiveness.		✓		
45. Internal instrument lighting is provided where effective.			✓	
46. Indicator lights are immediately and unavoidably associated with the proper control.		✓		
47. Legend lights are used in preference to simple instructor lights.		✓		47.1 Both are used
48. Indicator lights are capable of providing flashing red for emergency or malfunction conditions.		✓		
49. The information displayed is clear, specific, and useable. It is not redundant or degraded by vibration. It is at a level of accuracy required for the operator's action or decision.		✓		
50. The provision of the display presentation is consistent with system precision.		✓		
51. The display indicator ceases to move after the control movement stops.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
52. Displays which cannot or may not be watched continuously, but need continuous monitoring, have a suitable auditory or visual warning backup.		✓		52.1 Auditory and sup. visual alarm system could be better
53. Counter numbers change by snap action, follow each other not faster than 2 per second if read consecutively, increase with clockwise rotation of the reset knob, and automatically reset sequencing as well as having a manual reset.			✓	
54. Material in printer is easily changed and indicates remaining supply of printing materials.		✓		
55. Failure of a display circuit is immediately apparent.		✓		
56. Failure of the display circuit does not affect display equipment.		✓		56.1 Normal condition may be with all indicator lights out
57. Most important displays are placed in the optimum visual zone.		✓		
58. A signal absence does not denote "go ahead," "ready," etc., only a power off condition.		✓		58.1 See 56.1
59. Transilluminated, LED and incandescent displays conform to the following color code, except that training equipment colors can be approximate:		✓		
a. Flashing red denotes only emergency conditions which require operator action without undue delay to avert personnel injury and/or equipment damage.				

Detailed Design Considerations	YES	NO	N/A	Comments
b. Red alerts an operator that a system or any of its parts is inoperative or that a successful mission is not possible unless corrective action is taken.		✓		59.1 b. red indicates operating or engaged
c. Yellow advises an operator of a marginal condition or alerts him to situations of caution, recheck or unexpected delay.		✓		
d. Green indicates that monitored equipment is in tolerance or that a state of readiness exists.		✓		59.2 d. Green indicator absence of power or not active
e. White shows system conditions that do not have "right" or "wrong" implicatons such as alternating functions except that white is not used in aircraft flight stations.		✓		59.3 e. White indicates on
f. Blue is used for advisory lights only, except that blue is not used in aircraft flight stations.			✓	
60. Flashing lights are used only to call the operator's attention to a condition requiring action.		✓		
61. Legend lights signifying danger are larger than other legend lights.		✓		
62. If operator is wearing earphones during normal operations, audio warning signals are directed to both earphones and work area.			✓	
63. Audio signal action specifies the nature of the problem (maintenance, emergency, health hazard).		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
64. Audio signals denoting emergencies are notably different from routine signals.		✓		
65. The following types of signals may not be used as warning devices:			✓	
a. Modulated or interrupted tones that resemble navigation signals or coded radio transmissions.				
b. Steady signals that resemble hisses, static, or sporadic radio signals.				
c. Trains of impulses that resemble electrical interference whether regularly or irregularly spaced in time.				
d. Simple warbles which may be confused with the type made by two carriers when one is being shifted in frequency (beat-frequency-oscillator effect).				
e. Scrambled speech effects that may be confused with cross modulation signals from adjacent channels.				
f. Signals that resemble random noise, periodic pulses, steady or frequency modulated simple tones, or any other signals generated by standard countermeasure devices (e.g., "bagpipes").				
g. Signals similar to random noise generated by air conditioning or any other equipment.				

Detailed Design Considerations	YES	NO	N/A	Comments
h. Signals that resemble sounds likely to occur accidentally under operational conditions.				
66. The first 0.5 seconds of an audio signal is discriminable from the first 0.5 second of any other signal. The length of the warning is a minimum of 1/2 second until corrective action is taken.		✓		66.1 All are same
67. The audio device and circuit design preclude false alarms.		✓		
68. The height to width ratio of all labeling is acceptable for fast and accurate reading.		✓		
69. Counters are horizontally positioned.	✓			
70. The same numerical progression is used on all scales of combined displays.			✓	
71. In sequential displays, the sequence progresses from left to right.		✓		
72. Scale values and their indexes are consistent in directions of increase or decrease.		✓		
73. The display can be read quickly in the manner desired (quantitative, qualitative, or check reading).		✓		

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST

10

WORKSPACE

Test Title Turbine Control System-5

Test Project No. ______ Date ______

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Design and sizing insures accommodation, compatibility, operability and maintainability by at least 90 percent of the user population (a range from the 5th percentile to the 95th percentile for single dimensions).		✓		
2. Cabinets, consoles, and work surfaces that require an operator to stand or sit close to their front surfaces contain a kick space at the base at least 4 inches (100 mm) deep and 4 inches (100 mm) high to allow for protective or specialized apparel.		✓		
3. Panel Dimensions - seated - with vision over top.			✓	
a) Seat height 18" (460 mm) from floor				
writing surface-25.5" (650 mm) above the floor				
vertical dimension of panel-22" (56 mm) above writing surface				
maximum console width - 44" (1.120 m)				
b) Seat height 23" (580 mm)				
writing surface - 32" (810 mm)				
vertical dimension of panel - 22" (560 mm)				

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
maximum console width - 44" (1.120 m)				
c) Seat height 28.5" (725 mm)				
writing surface - 36" (910 mm)				
vertical dimension of panel 22" (560 mm)				
Maximum console width - 44" (1.120 m)				
4. Panel Dimensions - seated - without vision over top.			✓	
a) Seat height - 18" (460 mm)				
writing surface 25.5" (65C mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
b) Seat height - 23" (580 mm)				
writing surface - 32" (810 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
c) Seat height - 28.5" (720 mm)				
writing surface - 36" (910 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width - 36" (910 mm)				
5. Panel Dimensions - seated or standing with standing vision over top.				
seat height - 28.5" (720 mm)				

Detailed Design Considerations	YES	NO	N/A	Comments
writing surface - 36" (910 mm)		✓		
vertical dimension of panel 26" (660 mm)	✓			
maximum console width 36" (910 mm)		✓		5.1 46" wide
6. Panel Dimensions - standing with vision over top.				6.1 46" wide
writing surface - 36" (910 mm)		✓		
vertical dimension of panels 26" (660 mm)	✓			
maximum console width - 44" (1.120 m)		✓		
7. Panel Dimensions - standing (without vision over top).			✓	
writing surface - 36" (910 mm)				
vertical dimension of panel - 36" (910 mm)				
maximum console width - 36" (910 mm)				
8. Consoles have at least 4 feet (1.220 m) of free floor space in front whenever feasible.		✓		
9. The seated operator has free pedal access and use of foot pedals.			✓	
10. Compartment design allows equipment sharing and good communication.		✓		
11. Workspace allows ease of weapon handling, aiming, loading, firing, and field stripping.			✓	
12. User is oriented to work site.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
13. Crane controls are easily reached and afford load visibility.			✓	
14. Display reading location is identified.		✓		
15. Equipment is designed and installed with workspace requirements in mind.		✓		
16. Armrests are at least 2 inches (50 mm) wide and 8 inches (200 mm) long.			✓	
17. Knee and foot room should exceed the following dimensions beneath work surfaces: a) Height: 25 inches (640 mm) b) Width: 20 inches (510 mm) c) Depth: 18 inches (460 mm)			✓	
18. Back and seat of chair have 1" minimum padding.			✓	
19. Lateral work space is 30" wide x 16" deep; writing space is 24" wide x 16" deep.			✓	
20. Armrests do not interfere with work, egress or emergency procedures.			✓	
21. Vertical seat adjustments are 15-21" (16-21" for male use exclusively) in 1 inch maximum increments.			✓	
22. The seat backrest reclines 103-115° and supports the torso so that the operator's eyes are within 3" of the "eye-line."			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
23. Rotating seats have 8 locking positions minimum and support 250 lbs. The seat adjusts fore and aft at least 4" minimum.			✓	
24. The operator does not have to lift self to adjust the seat.			✓	
25. Easy access is provided to and from a station.	✓			
26. Equipment racks requiring maintenance have space available, when feasible, as follows:			✓	
a) Minimum distance from the front of the rack to the opposite surface or obstacle is 42 inches (1.070 m).				
b) Minimum lateral workspace for racks having drawers:				
1) With drawers weighing less than 45 pounds (20.4 kg); 18 inches (460 mm) on one side and 4 inches (100 mm) on the other.				
2) With drawers weighing over 45 pounds (20.4 kg) 18 inches on each side.				
27. Allowances are made for heavy clothing and protective equipment.		✓		
28. A loader can comfortably sit in the closed hatch mode or stand in the open hatch mode.			✓	
29. Workspace provides head, arm and body clearance at any weapon position.			✓	
30. User space is not encroached upon by others.	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
31. Reflection of instruments or console in windows or windshields is avoided.			✓	
32. Right-left viewing angle for a wrap-around console is 190° maximum.			✓	
33. The forward field of view is 180° minimum.	✓			
34. Minimum illumination levels for different work areas and types of work are as follows in Footcandles (LUX): Console surface 30 (325) Dials 30 (325) Emergency lighting 3 (30) Gauges 30 (325) Meters 30 (325) Missiles: Repair/Service 60 (640) Storage areas 10 (110) General inspection 30 (325) Panels: Front 30 (325) Rear 10 (110) Passageways 10 (110) Reading Large print 10 (110) News print 30 (325) Pencil reports 50 (540) Small type 50 (540) Prolonged reading 50 (540) Recording 50 (540) Repair work: General 30 (325) Instrument 100 (1075)	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
35. Visors, etc., reduce external glare.			✓	
36. Transparent areas are free from color, distortion, etc.			✓	
37. Multireflections from multilayered windows are minimized.			✓	
38. Windscreen angle of incidence is 60° maximum to undistorted vision.			✓	
39. Windows or canopies have optimum unobstructed vision.			✓	
40. Instrument reflection is avoided.		✓		40.1 Linear scale gages produce detrimental glare
41. If possible there is a direct view of work.			✓	
42. Distortion is avoided in windows.			✓	
43. Door posts or wiper motors do not obscure vision.			✓	
44. Loader can see outside while operating in close hatch mode.			✓	
45. Provisions for auxiliary power and lighting are provided.	✓			
46. Seating is compatible with console.			✓	
47. Heating and air conditioning specifications for mobile detail work areas - $50^{\circ}F$ to $85^{\circ}F$. For permanent details work areas - $65^{\circ}F$ to $85^{\circ}F$.	✓			
48. Air conditioning systems do not discharge cold air directly on personnel.	✓			
49. Adequate ventilation is provided by a minimum of 30 cubic ft.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
per minute per man minimum. Air is moved past the operator at a velocity of not more than 100 feet (30 m) per minute - 65 feet (20 m) per minute if possible.				
50. The effective temperature within enclosures for extended periods is at or below 85°F (29°C).	✓			
51. The acoustical environment does not degrade system effectiveness.		✓		51.1 Auditory clutter is present from competing sources
52. The average room sound absorption coefficient is at least 0.20.			✓	
53. Facilities and equipment are designed to control the transmission of whole body vibration to levels permitting safe operation and maintenance.			✓	
54. Test stands are part of the equipment.			✓	
55. Handles are provided on units which are removed or carried.			✓	
56. Vehicles have a minimum temperature of 68°F (20°C)(unless wearing cold regions clothing and exposure less than 3 hours).			✓	
57. Fresh air is provided at a minimum of 20 cu. ft. (0.43 cu m)/minute/person; in a hot climate, air flow rates should be between 150 and 200 cu. ft. (4.25 and 5.66 cu m) / m /person.			✓	
58. Protective padding is used.			✓	
59. Mirrors are braced against vibration.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
60. Ventilation or other protective measures are provided within limits.			✓	
61. Intakes for ventilation systems are located so as to minimize the introduction of contaminated air from exhaust pipes, etc.			✓	
62. Cars have seat belts.			✓	
63. Windshields and windows are shatterproof and do not distort vision.			✓	
64. Hazard alerting devices are provided.			✓	
65. Illumination is adequate, glare is reduced and capability for dimming is provided.		✓		65.1 With exceptions already noted
66. Maintenance workspace is free of obstructions which could cause injury.			✓	
67. Equipment is guarded if temperature exceeds 140°F (120°F if handled).			✓	
68. Exposed edges are rounded and have a .04" minimum radius. Exposed corners are also rounded and have a 0.5" minimum radius.			✓	
69. Guards are provided on moving parts.			✓	
70. Radiation hazards are minimized.			✓	
71. Padding is non-abrasive and non-toxic.			✓	
72. Exhausts are directed away from compartments.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
73. Adequate and suitable storage is provided for manuals, worksheets, etc.		✓		
74. Standees have work surfaces provided to support manuals, etc.		✓		
75. Conspicuous placards are adjacent to equipment which is hazardous to the user.		✓		
76. Areas requiring special equipment and/or clothing are specifically identified.			✓	
77. Any structure which can be chopped through in an emergency is clearly marked, axes provided.			✓	
78. Emergency procedures are detailed.		✓		
79. Instructions are kept simple.		✓		
80. Push-out escape windows are marked.			✓	
81. Equipment is located so that awkward working positions are unnecessary.	✓			
82. Sufficient space is provided to use test equipment and other tools required during checkout.			✓	
83. Controls (switches, knobs, etc.) are easily reached from the working position.		✓		
84. Components are located so that physical interference among operators working on the same areas is lessened.		✓		
85. The lines of sight to a display are not obscured by poor arrangement of people or equipment.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
86. Traffic flow between areas is efficient.		✓		
87. Auditory alerting and warning signals are loud enough to be heard above environmental noise.	✓			
88. Equipment is secured in order to prevent shifting or overturning accidentally.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST
20
MEASURES

Test Title Turbine contol system -5

Test Project No. ______________________ Date __________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Displays are located so they can be read to the required accuracy.		✓		
2. Display arrangement is consistent from one application to another.		✓		
3. Measuring marks on opaque containers are placed inside.			✓	
4. Display viewing distance: 13-28".		✓		4.1 As great as 40"
5. Minimum number of measuring devices is used.			✓	
6. Canteen cup is useable as standard or emergency measuring device for field use.			✓	
7. Item container used for measuring where possible.			✓	
8. Measurement marks raised.			✓	
9. Containers allow for full hand, finger, clearance when using opening tool.			✓	
10. Reflections minimized.		✓		10.1 Already noted
11. Display precision, response is consistent with that of system.			✓	
12. Scales: linear, start at 0, use whole numbers, 2 pointers max, numerals oriented upright.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
13. Field items are non-corrosive, easily cleaned or disposed.			✓	
14. Information limited to that necessary to take action.		✓		
15. Information is directly useable.		✓		
16. Specified measuring amounts are consistent with measuring device.			✓	
17. Measures clearly detailed.			✓	17.1 See earlier ref. to % open closed linear scales
18. For group use: multiple of food components or general formula for computation given.			✓	

DESIGN CHECKLIST

LABELS, MANUALS, MARKINGS

Test Title Secondary System - Panel 4

Test Project No. ______________________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Controls, displays and other items of equipment are clearly marked and labeled except in cases where use is obvious to the operator.		✓		• Upper RT __ - 2 knobs and lites -probably latching sys. - no labels at all! • Labeling generally poor - scribed letters not readily readable - too much info. • 2 transmation; ~~f~~low totalizers - no label • Latching sys. - labels hidden by control. Labels above and below - not always consistent - different designations • Numerous labels added. Bailey controls -labels above. Meters - above. Pumpspeed - below
2. Labels are on or near the item to be identified.		✓		
3. Labels do not cover any other information and are not located behind controls. They can be seen easily by the operator and are not obscured by the operator's hand activating a control.		✓		
4. Labels are located in the same manner throughout the equipment and system.		✓		
5. Labels are not covered by other equipment and are located on the flattest, least cluttered and cleanest surface available.		✓		tags
6. Labels are mounted so that they cannot be accidentally damaged or removed.		✓		worn
7. Where instructions are lettered on hinged door, lettering is set so that it can be read when the door is open.			✓	
8. Labels are graduated in size. Group label characters are at least 25% larger than those of individual controls and displays.		✓		No groups

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
Control and display characters, in turn, are at least 25% larger than those identifying control positions.				
9. Spacing between characters is a minimum of one stroke; between words is a minimum of one character.		✓		
10. Abbreviations are capital letters, periods being omitted except when there is a possibility of misinterpretaion.	✓			
11. Extended copy (instructions) is in lower case letters.		✓		Caution placard - white on red - for discharge to condenser
12. Label characteristics are determined by illumination level and color.		✓		
13. Labels are easily read at operational reading distances with vibration/motion and lighting levels taken into consideration.		✓		Letters worn - poor; contrast - glare
14. Labels are sharp with high contrast.		✓		Poor contrast - some with none at all, letters on labels too thin
15. With illumination less than 1 ft-C, white, white florescent, or torch-lighted characters on a dark background are used.			✓	
16. With illumination above 1 ft-C, black letters against a light background are used.		✓		White (or silver) on black
17. For dark adaptation, letters are visible and do not interfere with night vision.			✓	
18. When letters, etc., are viewed by means of television, they are light against a dark background.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
19. Labels on production equipment are as durable as the equipment.		✓		
20. Labels for prototype equipment are easily affixed, altered and removed.			✓	
21. Markings and tags are as permanent as the equipment to which applied and able to withstand environmental and cleaning conditions.		✓		No consistent method of modifying
22. Labels are accessible and visible during maintenance.		✓		
23. Load capacity is marked on lifting equipment.			✓	
24. Roman numerals are not used, if possible.			✓	
25. Vertical labels are used only when the labels are not critical for personal safety and performance, and space is limited.		✓		2B and 2A EMERG, Feed Pump AMPs
26. Electrical receptacles are clearly marked with voltage, phase and frequency characteristics.			✓	
27. Pipe, hose, and tube lines are clearly labeled as to contents, pressure, temperature, and hazards.			✓	
28. Warning placards are well illuminated.		✓		Glare probs on caution placard
29. Warning notices are clear and direct. Characters are 25% larger than any following instructions.		✓		Same size
30. Placards are placed adjacent to hazards.	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
31. Circuit breakers are labeled and easily accessible.			✓	
32. Trade names and other irrelevant information do not appear on labeling.		✓		Transmation, Bailey
33. Labels are concise with a minimum of repetitive information.		✓		
34. An abstract symbol is used only if meaningful.			✓	
35. Each assembly, component, and part is labeled with a visible and meaningful name, number, and symbol.		✓		
36. Printed information is directly useable with a minimum of decoding and interpolation.		✓		
37. Labels do not describe the engineering characteristics or nomenclature of the piece of equipment, if at all possible.		✓		
38. Labels are etched, embossed, or engraved into the component or chassis.		✓		

DESIGN CHECKLIST

6

CONTROLS

Test Title Secondary System - Panel 4

Test Project No. ______ Date ______

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Control relationship to its display is apparent.		✓		ΔTC Bailey control - 66" from meter RC inlet ΔTC
2. Functionally related controls and displays are grouped together.		✓		Emerg. Feed Pump discharge to condenser -V8A&B V7A&B - next to rod control, V8C-V7C on right edge
3. Control groups, sequential operations have left-to-right order of use or top-to-bottom order of use.		✓		
4. Controls in functional groups are located in accordance with operational sequence and/or function.		✓		No sequence of operation
5. Lifting equipment controls are within easy reach with the load visible.			✓	
6. Controls are located so that they cannot be accidentally moved.		✓		Rod control panel - Pb Reactor Trip Pushbutton
7. Groups with similar functions are similar throughout the system.		✓		
8. Controls are marked to indicate in which direction to operate the control.	✓			Generally
9. Control/display groups used only for maintenance are not located in prime operating space.		✓		Instrumentation markings - prime lable space
10. Controls used most often are located in the best position for ease of reaching and grasping.		✓		No logic

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
11. Controls operated without visual reference are located in front rather than to the side or behind the operator.			✓	
12. Internally mounted controls are located away from dangerous voltage.			✓	
13. Sensitive adjustments are located or guarded to prevent accidental activation.			✓	
14. Controls used for same function on different types of equipment are of the same size and shape.			✓	
15. Rotary Control DIMENSIONS: Length min 1.0 inches (25mm) max 4.0 inches (100mm) Width max 1.0 inches (25mm) Depth min 0.625 inches (16mm) max 3.0 inches (75mm) RESISTANCE min 1.0 inch-lb (113 mN-m) max 6.0 inch-lb (678mN-m) DISPLACEMENT For facilitating performance min 30 degrees max 90 degrees SEPARATION One Hand Random min 1.0 inches (25 mm) preferred 2.0 in. (50 mm) Two-Hand Operation min 3.0 inches (75 mm) preferred 5.0 in. (125 mm)			✓	
16. Key Operated Switch DISPLACEMENT min 80 degrees			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
max 90 degrees				
HEIGHT				
min 0.5 inches (13mm)				
max 3.0 inches (75mm)				
RESISTANCE				
min 1 in/lb (113 mNm)				
max 6 in/lb (678 mNm)				
17. Discrete Thumbwheel Control			✓	
DIMENSIONS:				
<u>Diameter</u>				
min 1.5 in. (38mm)				
max 2.5 in. (65 mm)				
<u>Trough</u>				
min 0.45 inches (11 mm)				
<u>Distance</u>				
max 0.75 inches (19 mm)				
<u>Width</u>				
min 0.1 inches (3 mm)				
<u>Depth</u>				
min 0.125 inches (3 mm)				
max 0.5 inches (13 mm)				
<u>Separation</u>				
min 0.4 inches (10 mm)				
RESISTANCE:				
min 6 oz. (165 mN)				
max 20 oz. (560 mN)				
18. Continuous Adjustment Rotary Knobs				
DIMENSIONS:				
<u>Fingertip Grasp Height</u>		✓		Set Point Controls in Bailey Controls
min 0.5 inches (13 mm)				
max 1.0 inches (25 mm)				
<u>Diameter</u>				
min 0.375 inches (10 mm)				
max 4.0 inches (100 mm)				
<u>Thumb and Finger Encircled Diameter</u>				
min 1.0 inches (25 mm)				
max 3.0 inches (75mm)		✓		≈ .5"
<u>Palm Grasp Diameter</u>				
min 1.5 inches (38 mm)				
max 3.0 inches (75 mm)				

Detailed Design Considerations	YES	NO	N/A	Comments
Length				
min 3.0 inches (75 mm)				
TORQUE:				
Height				
max 4.5 in-oz (32 mN-m)				
Diameter				
max 6.0 in-oz (42 mN-m)				
SEPARATION:				
One Hand Individually				
min 1.0 inches (25 mm)				
max 2.0 inches (50 mm)				
Two Hands Simultaneously				
min 2.0 inches (50 mm)				
max 5.0 inches (125 mm)				
19. Cranks			✓	
DIMENSIONS:				
Handle				
Diameter (rpm-dia)				
none - 1.0 inches (25 mm)				
175 - 1.0 inches (25 mm)				
275 - 0.5 inches (13 mm)				
Length (rpm-length)				
none - 3.75 inches (95 mm)				
175 - 3.75 inches (95 mm)				
275 - 1.5 inches (38 mm)				
Radius (rpm-radius)				
none - min 9.0 in. (230 mm)				
max 16.0 in. (410 mm)				
175 - min 5.0 in. (125 mm)				
max 8.0 in. (200 mm)				
275 - min 0.5 in. (13 mm)				
max 4.5 in. (115 mm)				
RESISTANCE: (rpm-resistance)				
none - min 2.0 lb (9N)				
max 50 lb. (220N)				
175 - min 6.0 lb. (27N)				
max 15 lb (67N)				
275 - min 2.0 lb (9N)				
max 5 lb (22N)				
SEPARATION: (rpm-separation)				
none - min 3.0 inches (75mm)				
175 - min 3.0 inches (75mm)				
275 - min 3.0 inches (75mm)				

Detailed Design Considerations	YES	NO	N/A	Comments
20. Handwheels DIMENSIONS: Wheel Diameter One Hand min 2.0 inches (50 mm) max 4.25 inches (110 mm) Two Hands min 7.0 inches (180 mm) max 21.0 inches (530 mm) Rim Diameter: min 0.75 inches (19mm) max 2.0 inches (50 mm) RESISTANCE: One Hand min 5 lb. (22N) max 30 lb. (133N) Two Hands min 5 lb (22 N) max 50 lb. (220 N) DISPLACEMENT: Two Hands max 120 deg. SEPARATION: Two Hands - Simultaneously min 3.0 inches (75 mm) max 5.0 inches (125 mm)			✓	
21. Pushbuttons (Finger or Hand Operated) DIMENSIONS: Diameter Fingertip Operation min 0.385 inches (10 mm) max 0.75 inches (19 mm) Thumb or Heel of Hand Operation min 0.75 inches (19 mm) RESISTANCE: Finger Operation min 10 oz. (2.8N) max 40 oz. (11.0N) Little Finger Operation min 5 oz. (1.4N) max 20 oz. (5.6N) DISPLACEMENT: Thumb or Finger Operation min 0.125 inches (3 mm) max 1.5 inches (38 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
SEPARATION:				
Single Finger Operation				
min 0.5 inches (13 mm)				
preferred 2.0 in. (50 mm)				
Single Finger Sequential Operation				
min 0.25 inches (6 mm)				
preferred 1.00 in. (25 mm)				
Operation by Several Fingers				
min 0.5 inches (13 mm)				
max 0.5 inches (13 mm)				
22. Pushbuttons (Foot Operated)			✓	
DIMENSIONS:				
Diameter				
min 0.50 inches (13 mm)				
RESISTANCE:				
Foot will not rest on control				
min 4.0 lb. (18 N)				
max 20.0 lb. (90 N)				
Foot will rest on control				
min 10.0 lb. (45N)				
max 20 lb. (90N)				
DISPLACEMENT:				
Normal Boot Operation				
min 0.50 inches (13 mm)				
max 2.5 inches (65 mm)				
Heavy Boot Operation				
min 1.0 inches (25 mm)				
max 2.5 inches (65 mm)				
Ankle Flexion Only				
min 1.0 inches (25 mm)				
max 2.5 inches (65 mm)				
Total Leg Movement				
min 1.0 inches (25 mm)				
max 4.0 inches (100 mm)				
23. Keyboards			✓	
DIMENSIONS:				
Diameter Bare-handed				
min 0.385 inches (10 mm)				
max 0.75 inches (19 mm)				
preferred 0.5 in. (13 mm)				
Cold Regions mittens				
min 0.75 inches (19 mm)				
preferred 0.75 in. (19 mm)				
RESISTANCE:				130

Detailed Design Considerations	YES	NO	N/A	Comments
Numeric				
min 3.5 oz. (1N)				
max 14.0 oz. (4N)				
Alphanumeric				
min 0.9 oz. (250 mN)				
max 5.3 oz. (1.5 N)				
Dual Function				
min 0.9 oz. (250 mN)				
max 5.3 oz (1.5N)				
DISPLACEMENT:				
Numeric				
min 0.03 inches (0.8 mm)				
max 0.19 inches 4.8 mm)				
Alphanumeric				
min 0.05 inches (1.3 mm)				
max 0.25 inches (6.3 mm)				
Dual Function				
min 0.03 inches (0.8 mm)				
max 0.19 inches (4.8 mm)				
SEPARATION:				
Between adjacent key tops				
min 0.25 inches (6.4 mm)				
preferred 0.25 in. (6.4 mm)				
24. Toggle Switches			✓	
DIMENSIONS:				
Arm Length (Bare finger)				
min 0.5 inches (13 mm)				
max 2.0 inches (50 mm)				
Arm Length (Gloved finger)				
min 1.5 inches (38 mm)				
max 2.0 inches (50 mm)				
Control Tip				
min 0.125 inches (3 mm)				
max 1.0 inches (25 mm)				
RESISTANCE:				
Small Switch				
min 10 oz. (2.8N)				
max 16 oz. (4.5N)				
Large Switch				
min 10 oz. (2.8N)				
max 40 oz. (11N)				
DISPLACEMENT:				
2 Position				
min 30 deg				
max 120 deg.				

Detailed Design Considerations	YES	NO	N/A	Comments
3 Position min 18 deg. max 60 deg. desired 25 deg. SEPARATION: Single Finger Operation min 0.75 inches (19 mm) optimum 2.0 in. (50 mm) Single Finger Operation-lever lock toggle switch min 1.0 inches (25 mm) optimum 1.0 in. (50 mm) Simultaneous Operation by Different Finger min 0.625 inches (16 mm) optimum 0.75 in. (19 mm)				
25. Legend Switch DIMENSIONS: min 0.75 inches (19 mm) max 1.5 inches (38 mm) DISPLACEMENT: min 0.125 inches (3 mm) max 0.250 inches (6 mm) positive position switch 3/16 in. (5 mm) BARRIERS: Barrier Width min 0.125 inches (3 mm) max 0.250 inches (6 mm) Barrier Depth min 0.88 inches (5 mm) max 0.250 inches (6 mm) RESISTANCE min 10 oz (280 mN) max 40 oz. (11N)			✓	
26. Lever DIMENSIONS: Diameter Finger Grasp min 0.5 inches (13 mm) max 3.0 inches (75 mm) Hand Grasp min 1.5 inches (38 mm) max 3.0 inches (75 mm)		✓		J type switches

Detailed Design Considerations	YES	NO	N/A	Comments
RESISTANCE: <u>One Hand (d-1)</u> min 2 lb. (9N) max 30 lb. (135N) <u>Two Hands</u> min 2 lb. (9N) max 50 lb. (220N) <u>One Hand (d-2)</u> min 2 lb. (9N) max 20 lb. (90N) <u>Two Hands</u> min 2 lb. (9N) max 30 lb. (135N) DISPLACEMENT: <u>Forward (d-1)</u> max 14.0 inches (360 mm) <u>Lateral (d-2)</u> max 38.0 inches (970 mm) SEPARATION: <u>One Hand Random</u> min 3.0 inches (75 mm) preferred 5.0 in. (125 mm)				
27. Pedals DIMENSIONS: <u>Height</u> min 10 inches (25 mm) <u>Width</u> min 3.0 inches (75 mm) DISPLACEMENT: <u>Normal Operation</u> min 0.5 inches (13 mm) max 2.5 inches (65 mm) <u>Ankle Flexion</u> min 1.0 inches (25 mm) max 2.5 inches (65 mm) <u>Total Leg Movement</u> min 1.0 inches (25 mm) max 7.0 inches (180 mm) RESISTANCE: <u>Foot Not Resting on Pedal</u> min 4 lb. (18 N) max 20 lb. (90 N) <u>Foot Resting on Pedal</u> min 10 lb. (45 N) max 20 lb. (90N)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
<u>Ankle Flexion Only</u> max 10 lb. (45 N) <u>Total Leg Movement</u> min 10 lb. (45 N) max 180 lb. (800 N) SEPARATION: <u>One Foot Random</u> min 4.0 inches (100 mm) preferred 6.0 in. (150 mm) <u>One Foot Sequential</u> min 2.0 inches (50 mm) preferred 4.0 in. (100 mm)				
28. Adequate control response feedback is provided.		✓		Latch controls - lights indicate system status - rather than setting
29. Rotary valves open counterclockwise.			✓	
30. Control movement conforms with corresponding related display.	✓			
31. Rotary controls turn to the right (clockwise) to increase, and left (counterclockwise) to decrease.		✓		Bias - to left increases pump B speed
32. Stops are provided at the beginning and end of the control movement travel.	✓			
33. In right-hand operations, knobs are placed below or to the right of displays.		✓		Bailey controls
34. For left-hand operations knobs are placed below or to the left of displays.		✓		
35. Controls meant to have a limited degree of motion have adequate mechanical stops.			✓	
36. Controls are labeled as to function and method of operation by means of arrows and appropriate legends.		✓		Some - no labels

Detailed Design Considerations	YES	NO	N/A	Comments
37. Selector switches have sufficient spring loading to keep from stopping between detents.		✓		J switches pull to lock - depress -pop into next setting - usually close
38. Range of control action does not interfere with other controls.		✓		
39. Shape coded controls are visually and tactually identifiable.		✓		
40. Control color has high contrast with background.	✓			
41. Ambient light color determines useable control colors.			✓	
42. Switch legend is legible with or without internal illumination.	✓			
43. Legend switch lamps are replaceable from the front of the panel by hand and the legends or covers are keyed to prevent the possibility of interchanging the legend covers.		✓		
44. Controls are selected and distributed so that none of the operator's limbs are overburdened.		✓		
45. Coding is uniform throughout the system.		✓		Red light on latching control means bypass - otherwise open - red light on Bailey control means auto Red light for 2A FWP gov., high speed -green lo speed
46. Controls are useable in the time required despite inadvertent operation protection (guards).	✓			
47. Controls are not adversely affected by distortion, shock and vibration.			✓	
48. Control motion is minimized, not cycled through ON/OFF unnecessarily.	✓			
49. Latches on levers do not cause delay in operation.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
50. Minimum use made of horizontal or 3 position toggle switches.	✓			
51. Shape coded controls are free of sharp edges.			✓	
52. Critical controls are designed and located so that they are not susceptible to being moved accidentally.	✓	✓		Pull to lock feature on J switches Trip
53. If there is a possiblity of inadvertent activation causing a hazardous condition, controls are recessed or shielded by a physical barrier.		✓		
54. "Dead man" controls are used when operator incapacity can produce a critical condition.			✓	
55. The main power ON/OFF switch cuts all power to the complete equipment.			✓	
56. Main Power switch is labeled.			✓	
57. Failure of power steering does not incapacitate steering.			✓	
58. Resistance is built in so that definite or sustained effort is required for activation.			✓	
59. Controls are black or gray.		✓		Knobs are silver-Pb on Bailey controls are red and white
60. Controls are labeled with basic information for proper identification, utilization, actuation, or manipulation of the element.		✓		Generally too much info Part # and full title
61. Operating instructions are provided except where use is obvious.		✓		
62. Diagrams are used wherever possible.		✓		Operator developed only

Detailed Design Considerations	YES	NO	N/A	Comments
63. Calibration instructions are placed as close to the calibrating control as possible.		✓		
64. Adjustment controls are easy to set and lock.		✓		
65. All controls have appropriate scales or indexing.		✓		
66. If red lighting is used, red is not used for coding. Use black and yellow striping.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments

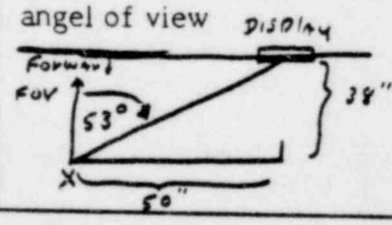
DESIGN CHECKLIST

8

DISPLAYS

Test Title Secondary System - Panel 4

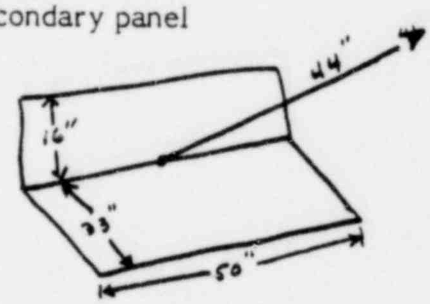
Test Project No. ______________________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Relationship between the display and its associated controls is unmistakable in terms of: a) The proper control to use. b) Direction of movement of the control. c) Rate and limits of movement of the control.		✓		2 knobs for sensor selection - A&B mounted vertically below meters where A&B scales are side by side
2. Controls are located adjacent to (either under or to right of) associated displays.		✓		Emerg. F.P. current display next to activation control
3. Functionally related units are grouped together and are similar from panel to panel.		✓		Meters, strip charts, dual open/closed readouts, and lights
4. Displays in groups are located from left-to-right and/or top-to-bottom order of use.		✓		No logic for meters
5. Displays used in system checkout are located so they can be observed from one position.		✓		
6. All displays are arranged in the sequence in which they are used.		✓		
7. Meters, dials, and instruments are so sized/arranged that they can be read from the normal operating position.		✓		Main FW Flow A (left side) cannot be seen 50 in. to left - 53° angel of view 

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
8. In standing positions, the most frequently used displays are located approximately at the eye level of the operator.		✓		Discharge press 35° down Angle
9. Frequently used displays are grouped together.		✓		
10. Displays are located where they can be read to the required degree of accuracy.		✓		Not with stripcharts
11. If on separate panels, positions of related controls and displays correspond and the panels do not face each other.			✓	
12. Control display groups for maintenance use only are not located in prime operating space.			✓	
13. Display arrangement is consistent from one situation to another.		✓		
14. Unusual aids such as ladders, extra lighting, etc., are not needed to read or gain access to a display.			✓	
15. Display scales are limited to only information needed to make a decision or take action. All needed information is presented.		✓		Diagnostic information
16. Information is presented in such form that no interpretation or decoding is necessary.		✓		Bailey controls do not indicate %
17. Information for different types of activities is not combined unless the activities require the same information.		✓		Turb. HDR press (Bailey control) -6 to 12 x 10, Set point - 40, 50, 60
18. Failure in the unit is clearly shown or the operator is otherwise warned.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
19. Trademarks, company names, and other unnecessary information are not on the panel face.		✓		
20. Job aids (graphic overlays) are provided when a plotter operator is required to interpret graphic data.		✓		
21. On units having operator displays, maintenance displays are located behind access doors on the operator's panel.		✓		
22. On units without operator panel, maintenance displays are located on one face accessible in normal installation.			✓	
23. Viewing distance from the eye to the displays located close to controls is 28 inches (710mm) maximum and 13 inches (510mm) minimum.		✓		≈ 40" to back panel
24. The display pointer extends to but does not obscure the index mark width.	✓			
25. Display pointer is mounted as close as possible to dial face to eliminate parallax and shadows.		✓		
26. Counters and flags are mounted close to the panel surface.	✓			
27. CRT target visual angle exceeds 2.0 minutes and 10 lines of resolution; viewing distance is 16 inches (10 in. minimum).			✓	
28. Illumination is uniform.		✓		# of lights on
29. Multiple displays grouped together will have brightness uniformity across the range of full "ON" to full "OFF."	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
30. The display face is not less than 45° from the operator's normal line of sight.		✓		Feed pump current
31. There is a high degree of contrast between the scale face and markings.		✓		Poor on stripcharts
32. Frequently used displays are grouped together and are placed in the optimal visual zone. Limits are as follows: <u>Eye Rotation Alone</u> Horizontal Plane 35° maximum 15° optimum Vertical Plane Horizontal Line of Sight 40° maximum 15° optimum Normal Line of Sight 20° maximum 15° optimum <u>Head Rotation Alone</u> Horizontal Plane 60° maximum 0° optimum Vertical Plane Horizontal Line of Sight 65° maximum Normal Line of Sight 35° maximum <u>Head and Eye Rotation</u> Horizontal Plane 95° maximum 15° optimum Vertical Plane 90° maximum 15° optimum Normal Line of Sight 15° optimum		✓		Secondary panel  lateral for 60°
33. Glare does not interfere with readability of the display at a location.		✓		Labels! Bailey control meters

Detailed Design Considerations	YES	NO	N/A	Comments
34. Indicator lights show equipment response, not merely control position; are used sparingly and only show information needed for effective system operation.		✓		≈ 100 lights x 48 red 35 green 13 white 4 amber 100
35. Luminance contrast exceeds 50%.		✓		
36. Flashing lights have a flash rate of 3 to 5 flashes per second; in case of flasher failure, the light illuminates and burns steadily.			✓	
37. Color coding is used where possible; unused scales are covered.		✓		
38. Indicators used at night are dimmable (0.02-1.0 ft-L).			✓	
39. If faint signal detection is required and ambient illumination is above 0.25 ft-C (2-7 lux) the CRT is hooded, shielded, or recessed.			✓	
40. Printed matter is visible. If ambient illumination inadequate, matter is illuminated by the printer. Plotted matter is also readily visible.		✓		
41. Projection display rates for group viewing are as follows: FACTOR: Ratio of $\frac{\text{viewing distance}}{\text{screen diagonal}}$ OPTIMUM: 4 PREFERRED LIMITS: 3-6 ACCEPTABLE LIMTS: 2-8 FACTOR: Angle off centerline OPTIMUM: 0°			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
PREFERRED LIMITS: 20^o ACCEPTABLE LIMITS: 30^o FACTOR: Image luminance (no film in operating projector) (for still projections higher values may be used) OPTIMUM: 10 ft-L (34 cd/m^2) PREFERRED LIMITS: 8-14 ft-L (27-48 cd/m^2) ACCEPTABLE LIMITS: 5-20 ft-L (17-69 cd/m^2) FACTOR: Luminance variation across screen (ratio of maximum to minimum luminance) OPTIMUM: 1 PREFERRED LIMITS: 1.5 ACCEPTABLE LIMITS: 3.0 FACTOR: Luminance variations as a function of viewing location (ratio of maximum to minimum luminance) OPTIMUM: 1 PREFERRED LIMITS: 2.0 ACCEPTABLE LIMITS: 4.0 FACTOR: Ratio of $\frac{\text{ambient light}}{\text{bright part of image}}$ OPTIMUM: 0 PREFERRED LIMITS: 0.002-0.01 ACCEPTABLE LIMITS: 0.1 max				

Detailed Design Considerations	YES	NO	N/A	Comments
For presentation not involving gray scale or color (e.g., line drawings, tables) 0.2 may be used.				
42. Supplemental viewing system is provided for remote handling situations.			✓	
43. LED are red only and not near red warning lights. Dimming is compatible.			✓	
44. Critical warning lights are isolated from other less important lights for best effectiveness.		✓		
45. Internal instrument lighting is provided where effective.		✓		
46. Indicator lights are immediately and unavoidably associated with the proper control.		✓		
47. Legend lights are used in preference to simple instructor lights.		✓		
48. Indicator lights are capable of providing flashing red for emergency or malfunction conditions.		✓		
49. The information displayed is clear, specific, and useable. It is not redundant or degraded by vibration. It is at a level accuracy required for the operator's action or decision.		✓		Immediate and trend; diagnostic and status
50. The provision of the display presentation is consistent with system precision.		✓		
51. The display indicator ceases to move after the control movement stops.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
52. Displays which cannot or may not be watched continuously, but need continuous monitoring, have a suitable auditory or visual warning backup.			✓	
53. Counter numbers change by snap action, follow each other not faster than 2 per second if read consecutively, increase with clockwise rotation of the reset knob, and automatically reset sequencing as well as having a manual reset.			✓	
54. Material in printer is easily changed and indicates remaining supply of printing materials.		✓		Probably not
55. Failure of a display circuit is immediately apparent.		✓		Light failure not apparent - no test
56. Failure of the display circuit does not affect display equipment.		✓		
57. Most important displays are placed in the optimum visual zone.		✓		No priority - totalizers in prime space, operators do not even know what they are for
58. A signal absence does not denote "go ahead," "ready," etc., only a power off condition.		✓		
59. Transilluminated, LED and incandescent displays conform to the following color code, except that training equipment colors can be approximate:		✓		
a. Flashing red denotes only emergency conditions which require operator action without undue delay to avert personnel injury and/or equipment damage.				

Detailed Design Considerations	YES	NO	N/A	Comments
b. Red alerts an operator that a system or any of its parts is inoperative or that a successful mission is not possible unless corrective action is taken.		✓		Red means open, start, pump gov hi speed stop, bypass, and auto (Bailey)
c. Yellow advises an operator of a marginal condition or alerts him to situations of caution, recheck or unexpected delay.		✓		Yellow means bus fault and pump speed range available
d. Green indicates that monitored equipment is in tolerance or that a state of readiness exists.		✓		Green means closed, stop, gov. low speed stop, and latch.
e. White shows system conditions that do not have "right" or "wrong" implicatons such as alternating functions except that white is not used in aircraft flight stations.		✓		White means hand mode on Bailey controls
f. Blue is used for advisory lights only, except that blue is not used in aircraft flight stations.				
60. Flashing lights are used only to call the operator's attention to a condition requiring action.			✓	
61. Legend lights signifying danger are larger than other legend lights.		✓		
62. If operator is wearing earphones during normal operations, audio warning signals are directed to both earphones and work area.			✓	
63. Audio signal action specifies the nature of the problem (maintenance, emergency, health hazard).		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
64. Audio signals denoting emergencies are notably different from routine signals.		✓		
65. The following types of signals may not be used as warning devices:			✓	
a. Modulated or interrupted tones that resemble navigation signals or coded radio transmissions.				
b. Steady signals that resemble hisses, static, or sporadic radio signals.				
c. Trains of impulses that resemble electrical interference whether regularly or irregularly spaced in time.				
d. Simple warbles which may be confused with the type made by two carriers when one is being shifted in frequency (beat-frequency-oscillator effect).				
e. Scrambled speech effects that may be confused with cross modulation signals from adjacent channels.				
f. Signals that resemble random noise, periodic pulses, steady or frequency modulated simple tones, or any other signals generated by standard countermeasure devices (e.g., "bagpipes").				
g. Signals similar to random noise generated by air conditioning or any other equipment.				

Detailed Design Considerations	YES	NO	N/A	Comments
h. Signals that resemble sounds likely to occur accidentally under operational conditions.				
66. The first 0.5 seconds of an audio signal is discriminable from the first 0.5 second of any other signal. The length of the warning is a minimum of 1/2 second until corrective action is taken.		✓		
67. The audio device and circuit design preclude false alarms.		✓		
68. The height to width ratio of all labeling is acceptable for fast and accurate reading.		✓		Labels too thin
69. Counters are horizontally positioned.			✓	
70. The same numerical progression is used on all scales of combined displays.		✓		
71. In sequential displays, the sequence progresses from left to right.		✓		
72. Scale values and their indexes are consistent in directions of increase or decrease.		✓		
73. The display can be read quickly in the manner desired (quantitative, qualitative, or check reading).		✓		

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST

10
WORKSPACE

Test Title Secondary System - Panel 4

Test Project No. ______________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Design and sizing insures accommodation, compatibility, operability and maintainability by at least 90 percent of the user population (a range from the 5th percentile to the 95th percentile for single dimensions).		✓		
2. Cabinets, consoles, and work surfaces that require an operator to stand or sit close to their front surfaces contain a kick space at the base at least 4 inches (100 mm) deep and 4 inches (100 mm) high to allow for protective or specialized apparel.		✓		
3. Panel Dimensions - seated - with vision over top.			✓	
a) Seat height 18" (460 mm) from floor				
writing surface-25.5" (650 mm) above the floor				
vertical dimension of panel-22" (56 mm) above writing surface				
maximum console width - 44" (1.120 m)				
b) Seat height 23" (580 mm)				
writing surface - 32" (810 mm)				
vertical dimension of panel - 22" (560 mm)				

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
maximum console width - 44" (1.120 m)				
c) Seat height 28.5" (725 mm)				
writing surface - 36" (910 mm)				
vertical dimension of panel 22" (560 mm)				
Maximum console width - 44" (1.120 m)				
4. Panel Dimensions - seated - without vision over top.			✓	
a) Seat height - 18" (460 mm)				
writing surface 25.5" (650 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
b) Seat height - 23" (580 mm)				
writing surface - 32" (810 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
c) Seat height - 28.5" (720 mm)				
writing surface - 36" (910 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width - 36" (910 mm)				
5. Panel Dimensions - seated or standing with standing vision over top.			✓	
seat height - 28.5" (720 mm)				

Detailed Design Considerations	YES	NO	N/A	Comments
writing surface - 36" (910 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
6. Panel Dimensions - standing with vision over top.		✓		
writing surface - 36" (910 mm)				
vertical dimension of panels 26" (660 mm)				
maximum console width - 44" (1.120 m)				
7. Panel Dimensions - standing (without vision over top).			✓	
writing surface - 36" (910 mm)				
vertical dimension of panel - 36" (910 mm)				
maximum console width - 36" (910 mm)				
8. Consoles have at least 4 feet (1.220 m) of free floor space in front whenever feasible.		✓		
9. The seated operator has free pedal access and use of foot pedals.			✓	
10. Compartment design allows equipment sharing and good communication.		✓		
11. Workspace allows ease of weapon handling, aiming, loading, firing, and field stripping.			✓	
12. User is oriented to work site.	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
13. Crane controls are easily reached and afford load visibility.			✓	
14. Display reading location is identified.		✓		
15. Equipment is designed and installed with workspace requirements in mind.		✓		
16. Armrests are at least 2 inches (50 mm) wide and 8 inches (200 mm) long.			✓	
17. Knee and foot room should exceed the following dimensions beneath work surfaces:			✓	
a) Height: 25 inches (640 mm)				
b) Width: 20 inches (510 mm)				
c) Depth: 18 inches (460 mm)				
18. Back and seat of chair have 1" minimum padding.			✓	
19. Lateral work space is 30" wide x 16" deep; writing space is 24" wide x 16" deep.			✓	
20. Armrests do not interfere with work, egress or emergency procedures.			✓	
21. Vertical seat adjustments are 15-21" (16-21" for male use exclusively) in 1 inch maximum increments.			✓	
22. The seat backrest reclines 103-115° and supports the torso so that the operator's eyes are within 3" of the "eye-line."			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
23. Rotating seats have 8 locking positions minimum and support 250 lbs. The seat adjusts fore and aft at least 4" minimum.			✓	
24. The operator does not have to lift self to adjust the seat.			✓	
25. Easy access is provided to and from a station.	✓			
26. Equipment racks requiring maintenance have space available, when feasible, as follows:			✓	
a) Minimum distance from the front of the rack to the opposite surface or obstacle is 42 inches (1.070 m).				
b) Minimum lateral workspace for racks having drawers:				
1) With drawers weighing less than 45 pounds (20.4 kg); 18 inches (460 mm) on one side and 4 inches (100 mm) on the other.				
2) With drawers weighing over 45 pounds (20.4 kg) 18 inches on each side.				
27. Allowances are made for heavy clothing and protective equipment.		✓		
28. A loader can comfortably sit in the closed hatch mode or stand in the open hatch mode.			✓	
29. Workspace provides head, arm and body clearance at any weapon position.			✓	
30. User space is not encroached upon by others.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
31. Reflection of instruments or console in windows or windshields is avoided.		✓		
32. Right-left viewing angle for a wrap-around console is 190° maximum.			✓	
33. The forward field of view is 180° minimum.	✓			
34. Minimum illumination levels for different work areas and types of work are as follows in Footcandles (LUX): Console surface 30 (325) Dials 30 (325) Emergency lighting 3 (30) Gauges 30 (325) Meters 30 (325) Missiles: Repair/Service 60 (640) Storage areas 10 (110) General inspection 30 (325) Panels: Front 30 (325) Rear 10 (110) Passageways 10 (110) Reading Large print 10 (110) News print 30 (325) Pencil reports 50 (540) Small type 50 (540) Prolonged reading 50 (540) Recording 50 (540) Repair work: General 30 (325) Instrument 100 (1075)	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
35. Visors, etc., reduce external glare.			✓	
36. Transparent areas are free from color, distortion, etc.			✓	
37. Multireflections from multilayered windows are minimized.			✓	
38. Windscreen angle of incidence is 60° maximum to undistorted vision.			✓	
39. Windows or canopies have optimum unobstructed vision.			✓	
40. Instrument reflection is avoided.		✓		
41. If possible there is a direct view of work.	✓			
42. Distortion is avoided in windows.			✓	
43. Door posts or wiper motors do not obscure vision.			✓	
44. Loader can see outside while operating in close hatch mode.			✓	
45. Provisions for auxiliary power and lighting are provided.	✓			
46. Seating is compatible with console.			✓	
47. Heating and air conditioning specifications for mobile detail work areas - 50°F to 85°F. For permanent details work areas - 65°F to 85°F.			✓	
48. Air conditioning systems do not discharge cold air directly on personnel.			✓	
49. Adequate ventilation is provided by a minimum of 30 cubic ft.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
per minute per man minimum. Air is moved past the operator at a velocity of not more than 100 feet (30 m) per minute - 65 feet (20 m) per minute if possible.				
50. The effective temperature within enclosures for extended periods is at or below 85°F (29°C).	✓			
51. The acoustical environment does not degrade system effectiveness.		✓		
52. The average room sound absorption coefficient is at least 0.20.			✓	
53. Facilities and equipment are designed to control the transmission of whole body vibration to levels permitting safe operation and maintenance.			✓	
54. Test stands are part of the equipment.			✓	
55. Handles are provided on units which are removed or carried.			✓	
56. Vehicles have a minimum temperature of 68°F (20°C)(unless wearing cold regions clothing and exposure less than 3 hours).			✓	
57. Fresh air is provided at a minimum of 20 cu. ft. (0.43 cu m)/minute/person; in a hot climate, air flow rates should be between 150 and 200 cu. ft. (4.25 and 5.66 cu m) / min./person.			✓	
58. Protective padding is used.			✓	
59. Mirrors are braced against vibration.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
60. Ventilation or other protective measures are provided within limits.			✓	
61. Intakes for ventilation systems are located so as to minimize the introduction of contaminated air from exhaust pipes, etc.			✓	
62. Cars have seat belts.			✓	
63. Windshields and windows are shatterproof and do not distort vision.			✓	
64. Hazard alerting devices are provided.			✓	
65. Illumination is adequate, glare is reduced and capability for dimming is provided.		✓		
66. Maintenance workspace is free of obstructions which could cause injury.			✓	
67. Equipment is guarded if temperature exceeds 140°F (120°F if handled).			✓	
68. Exposed edges are rounded and have a .04" minimum radius. Exposed corners are also rounded and have a 0.5" minimum radius.			✓	
69. Guards are provided on moving parts.			✓	
70. Radiation hazards are minimized.	✓			
71. Padding is non-abrasive and non-toxic.			✓	
72. Exhausts are directed away from compartments.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
73. Adequate and suitable storage is provided for manuals, work-sheets, etc.		✓		
74. Standees have work surfaces provided to support manuals, etc.		✓		
75. Conspicuous placards are adjacent to equipment which is hazardous to the user.		✓		
76. Areas requiring special equipment and/or clothing are specifically identified.		✓		
77. Any structure which can be chopped through in an emergency is clearly marked, axes provided.			✓	
78. Emergency procedures are detailed.		✓		
79. Instructions are kept simple.		✓		
80. Push-out escape windows are marked.			✓	
81. Equipment is located so that awkward working positions are unnecessary.			✓	
82. Sufficient space is provided to use test equipment and other tools required during checkout.			✓	
83. Controls (switches, knobs, etc.) are easily reached from the working position.		✓		
84. Components are located so that physical interference among operators working on the same areas is lessened.		✓		
85. The lines of sight to a display are not obscured by poor arrangement of people or equipment.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
86. Traffic flow between areas is efficient.		✓		
87. Auditory alerting and warning signals are loud enough to be heard above environmental noise.	✓			
88. Equipment is secured in order to prevent shifting or overturning accidentally.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST
20
MEASURES

Test Title Secondary System - Panel 4

Test Project No. ______________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Displays are located so they can be read to the required accuracy.		✓		
2. Display arrangement is consistent from one application to another.		✓		
3. Measuring marks on opaque containers are placed inside.			✓	
4. Display viewing distance: 13-28".		✓		
5. Minimum number of measuring devices is used.			✓	
6. Canteen cup is useable as standard or emergency measuring device for field use.			✓	
7. Item container used for measuring where possible.			✓	
8. Measurement marks raised.			✓	
9. Containers allow for full hand, finger, clearance when using opening tool.			✓	
10. Reflections minimized.		✓		
11. Display precision, response is consistent with that of system.		✓		
12. Scales: linear, start at 0, use whole numbers, 2 pointers max. numerals oriented upright.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
13. Field items are non-corrosive, easily cleaned or disposed.			✓	
14. Information limited to that necessary to take action.		✓		
15. Information is directly useable.		✓		
16. Specified measuring amounts are consistent with measuring device.			✓	
17. Measures clearly detailed.		✓		
18. For group use: multiple of food components or general formula for computation given.			✓	

DESIGN CHECKLIST

LABELS, MANUALS, MARKINGS

Test Title Pressurizer Control - Panel 4

Test Project No. ________________ Date ________________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Controls, displays and other items of equipment are clearly marked and labeled except in cases where use is obvious to the operator.		✓		Press relief valve - 2 Key switches 1 man, off, auto 1 off and auto 2nd one - low press setti Auto-Auto - 500 lbs Auto-off - 2300 lbs 2 lights - man setting, auto setting and open signal to valve
2. Labels are on or near the item to be identified.		✓		
3. Labels do not cover any other information and are not located behind controls. They can be seen easily by the operator and are not obscured by the operator's hand activating a control.		✓		
4. Labels are located in the same manner throughout the equipment and system.		✓		Labels - bottom of J switches top of rotarys
5. Labels are not covered by other equipment and are located on the flattest, least cluttered and cleanest surface available.	✓			
6. Labels are mounted so that they cannot be accidentally damaged or removed.		✓		
7. Where instructions are lettered on hinged door, lettering is set so that it can be read when the door is open.			✓	
8. Labels are graduated in size. Group label characters are at least 25% larger than those of individual controls and displays.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
Control and display characters, in turn, are at least 25% larger than those identifying control positions.				
9. Spacing between characters is a minimum of one stroke; between words is a minimum of one character.		✓		
10. Abbreviations are capital letters, periods being omitted except when there is a possibility of misinterpretaion.		✓		
11. Extended copy (instructions) is in lower case letters.		✓		
12. Label characteristics are determined by illumination level and color.		✓		
13. Labels are easily read at operational reading distances with vibration/motion and lighting levels taken into consideration.		✓		Glare
14. Labels are sharp with high contrast.		✓		Poor contrast
15. With illumination less than 1 ft-C, white, white florescent, or torch-lighted characters on a dark background are used.			✓	
16. With illumination above 1 ft-C, black letters against a light background are used.	✓			
17. For dark adaptation, letters are visible and do not interfere with night vision.			✓	
18. When letters, etc., are viewed by means of television, they are light against a dark background.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
19. Labels on production equipment are as durable as the equipment.		✓		
20. Labels for prototype equipment are easily affixed, altered and removed.			✓	
21. Markings and tags are as permanent as the equipment to which applied and able to withstand environmental and cleaning conditions.		✓		
22. Labels are accessible and visible during maintenance.		✓		
23. Load capacity is marked on lifting equipment.			✓	
24. Roman numerals are not used, if possible.			✓	
25. Vertical labels are used only when the labels are not critical for personal safety and performance, and space is limited.		✓		RC pump-amps - displays
26. Electrical receptacles are clearly marked with voltage, phase and frequency characteristics.			✓	
27. Pipe, hose, and tube lines are clearly labeled as to contents, pressure, temperature, and hazards.			✓	
28. Warning placards are well illuminated.		✓		
29. Warning notices are clear and direct. Characters are 25% larger than any following instructions.		✓		
30. Placards are placed adjacent to hazards.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
31. Circuit breakers are labeled and easily accessible.			✓	
32. Trade names and other irrelevant information do not appear on labeling.		✓		
33. Labels are concise with a minimum of repetitive information.		✓		
34. An abstract symbol is used only if meaningful.	✓			
35. Each assembly, component, and part is labeled with a visible and meaningful name, number, and symbol.		✓		NDTT mode
36. Printed information is directly useable with a minimum of decoding and interpolation.		✓		
37. Labels do not describe the engineering characteristics or nomenclature of the piece of equipment, if at all possible.		✓		
38. Labels are etched, embossed, or engraved into the component or chassis.	✓			Etched

DESIGN CHECKLIST

6

CONTROLS

Test Title Pressurizer control - Panel 4

Test Project No. ______________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Control relationship to its display is apparent.		✓		Aux pumps - 3 pairs of lights over 2 Pb
2. Functionally related controls and displays are grouped together.		✓		
3. Control groups, sequential operations have left-to-right order of use or top-to-bottom order of use.		✓		
4. Controls in functional groups are located in accordance with operational sequence and/or function.		✓		
5. Lifting equipment controls are within easy reach with the load visible.			✓	
6. Controls are located so that they cannot be accidentally moved.		✓		Pump controls - RC pump HP DC oil lift pump - can be activated
7. Groups with similar functions are similar throughout the system.		✓		
8. Controls are marked to indicate in which direction to operate the control.		✓		Label worn off of press. spray valve
9. Control/display groups used only for maintenance are not located in prime operating space.		✓		
10. Controls used most often are located in the best position for ease of reaching and grasping.		✓		Backup pump controls in front

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
11. Controls operated without visual reference are located in front rather than to the side or behind the operator.			✓	
12. Internally mounted controls are located away from dangerous voltage.			✓	
13. Sensitive adjustments are located or guarded to prevent accidental activation.		✓		
14. Controls used for same function on different types of equipment are of the same size and shape.		✓		
15. Rotary Control DIMENSIONS: <u>Length</u> min 1.0 inches (25mm) max 4.0 inches (100mm) <u>Width</u> max 1.0 inches (25mm) <u>Depth</u> min 0.625 inches (16mm) max 3.0 inches (75mm) RESISTANCE min 1.0 inch-lb (113 mN-m) max 6.0 inch-lb (678mN-m) DISPLACEMENT <u>For facilitating performance</u> min 30 degrees max 90 degrees SEPARATION <u>One Hand Random</u> min 1.0 inches (25 mm) preferred 2.0 in. (50 mm) <u>Two-Hand Operation</u> min 3.0 inches (75 mm) preferred 5.0 in. (125 mm)		✓		.75"
16. Key Operated Switch DISPLACEMENT min 80 degrees		✓		Press Relief Valve 45° displacement

Detailed Design Considerations	YES	NO	N/A	Comments
max 90 degrees HEIGHT min 0.5 inches (13mm) max 3.0 inches (75mm) RESISTANCE min 1 in/lb (113 mNm) max 6 in/lb (678 mNm)				
17. Discrete Thumbwheel Control DIMENSIONS: <u>Diameter</u> min 1.5 in. (38mm) max 2.5 in. (65 mm) <u>Trough</u> min 0.45 inches (11 mm) <u>Distance</u> max 0.75 inches (19 mm) <u>Width</u> min 0.1 inches (3 mm) <u>Depth</u> min 0.125 inches (3 mm) max 0.5 inches (13 mm) <u>Separation</u> min 0.4 inches (10 mm) RESISTANCE: min 6 oz. (165 mN) max 20 oz. (560 mN)			✓	
18. Continuous Adjustment Rotary Knobs DIMENSIONS: <u>Fingertip Grasp Height</u> min 0.5 inches (13 mm) max 1.0 inches (25 mm) <u>Diameter</u> min 0.375 inches (10 mm) max 4.0 inches (100 mm) <u>Thumb and Finger Encircled Diameter</u> min 1.0 inches (25 mm) max 3.0 inches (75mm) <u>Palm Grasp Diameter</u> min 1.5 inches (38 mm) max 3.0 inches (75 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
Length min 3.0 inches (75 mm) TORQUE: Height max 4.5 in-oz (32 mN-m) Diameter max 6.0 in-oz (42 mN-m) SEPARATION: One Hand Individually min 1.0 inches (25 mm) max 2.0 inches (50 mm) Two Hands Simultaneously min 2.0 inches (50 mm) max 5.0 inches (125 mm)				
19. Cranks DIMENSIONS: Handle Diameter (rpm-dia) none - 1.0 inches (25 mm) 175 - 1.0 inches (25 mm) 275 - 0.5 inches (13 mm) Length (rpm-length) none - 3.75 inches (95 mm) 175 - 3.75 inches (95 mm) 275 - 1.5 inches (38 mm) Radius (rpm-radius) none - min 9.0 in. (230 mm) max 16.0 in. (410 mm) 175 - min 5.0 in. (125 mm) max 8.0 in. (200 mm) 275 - min 0.5 in. (13 mm) max 4.5 in. (115 mm) RESISTANCE: (rpm-resistance) none - min 2.0 lb (9N) max 50 lb. (220N) 175 - min 6.0 lb. (27N) max 15 lb (67N) 275 - min 2.0 lb (9N) max 5 lb (22N) SEPARATION: (rpm-separation) none - min 3.0 inches (75mm) 175 - min 3.0 inches (75mm) 275 - min 3.0 inches (75mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
20. Handwheels DIMENSIONS: Wheel Diameter One Hand min 2.0 inches (50 mm) max 4.25 inches (110 mm) Two Hands min 7.0 inches (180 mm) max 21.0 inches (530 mm) Rim Diameter: min 0.75 inches (19mm) max 2.0 inches (50 mm) RESISTANCE: One Hand min 5 lb. (22N) max 30 lb. (133N) Two Hands min 5 lb (22 N) max 50 lb. (220 N) DISPLACEMENT: Two Hands max 120 deg. SEPARATION: Two Hands - Simultaneously min 3.0 inches (75 mm) max 5.0 inches (125 mm)			✓	
21. Pushbuttons (Finger or Hand Operated) DIMENSIONS: Diameter Fingertip Operation min 0.385 inches (10 mm) max 0.75 inches (19 mm) Thumb or Heel of Hand Operation min 0.75 inches (19 mm) RESISTANCE: Finger Operation min 10 oz. (2.8N) max 40 oz. (11.0N) Little Finger Operation min 5 oz. (1.4N) max 20 oz. (5.6N) DISPLACEMENT: Thumb or Finger Operation min 0.125 inches (3 mm) max 1.5 inches (38 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
SEPARATION:				
Single Finger Operation				
min 0.5 inches (13 mm)				
preferred 2.0 in. (50 mm)				
Single Finger Sequential Operation				
min 0.25 inches (6 mm)				
preferred 1.00 in. (25 mm)				
Operation by Several Fingers				
min 0.5 inches (13 mm)				
max 0.5 inches (13 mm)				
22. Pushbuttons (Foot Operated)			✓	
DIMENSIONS:				
Diameter				
min 0.50 inches (13 mm)				
RESISTANCE:				
Foot will not rest on control				
min 4.0 lb. (18 N)				
max 20.0 lb. (90 N)				
Foot will rest on control				
min 10.0 lb. (45N)				
max 20 lb. (90N)				
DISPLACEMENT:				
Normal Boot Operation				
min 0.50 inches (13 mm)				
max 2.5 inches (65 mm)				
Heavy Boot Operation				
min 1.0 inches (25 mm)				
max 2.5 inches (65 mm)				
Ankle Flexion Only				
min 1.0 inches (25 mm)				
max 2.5 inches (65 mm)				
Total Leg Movement				
min 1.0 inches (25 mm)				
max 4.0 inches (100 mm)				
23. Keyboards			✓	
DIMENSIONS:				
Diameter Bare-handed				
min 0.385 inches (10 mm)				
max 0.75 inches (19 mm)				
preferred 0.5 in. (13 mm)				
Cold Regions mittens				
min 0.75 inches (19 mm)				
preferred 0.75 in. (19 mm)				
RESISTANCE:				

Detailed Design Considerations	YES	NO	N/A	Comments
Numeric				
min 3.5 oz. (1N)				
max 14.0 oz. (4N)				
Alphanumeric				
min 0.9 oz. (250 mN)				
max 5.3 oz. (1.5 N)				
Dual Function				
min 0.9 oz. (250 mN)				
max 5.3 oz. (1.5N)				
DISPLACEMENT:				
Numeric				
min 0.03 inches (0.8 mm)				
max 0.19 inches 4.8 mm)				
Alphanumeric				
min 0.05 inches (1.3 mm)				
max 0.25 inches (6.3 mm)				
Dual Function				
min 0.03 inches (0.8 mm)				
max 0.19 inches (4.8 mm)				
SEPARATION:				
Between adjacent key tops				
min 0.25 inches (6.4 mm)				
preferred 0.25 in. (6.4 mm)				
24. Toggle Switches			✓	
DIMENSIONS:				
Arm Length (Bare finger)				
min 0.5 inches (13 mm)				
max 2.0 inches (50 mm)				
Arm Length (Gloved finger)				
min 1.5 inches (38 mm)				
max 2.0 inches (50 mm)				
Control Tip				
min 0.125 inches (3 mm)				
max 1.0 inches (25 mm)				
RESISTANCE:				
Small Switch				
min 10 oz. (2.8N)				
max 16 oz. (4.5N)				
Large Switch				
min 10 oz. (2.8N)				
max 40 oz. (11N)				
DISPLACEMENT:				
2 Position				
min 30 deg				
max 120 deg.				

Detailed Design Considerations	YES	NO	N/A	Comments
3 Position				
min 18 deg.				
max 60 deg.				
desired 25 deg.				
SEPARATION:				
Single Finger Operation				
min 0.75 inches (19 mm)				
optimum 2.0 in. (50 mm)				
Single Finger Operation-lever lock toggle switch				
min 1.0 inches (25 mm)				
optimum 1.0 in. (50 mm)				
Simultaneous Operation by Different Finger				
min 0.625 inches (16 mm)				
optimum 0.75 in. (19 mm)				
25. Legend Switch			✓	
DIMENSIONS:				
min 0.75 inches (19 mm)				
max 1.5 inches (38 mm)				
DISPLACEMENT:				
min 0.125 inches (3 mm)				
max 0.250 inches (6 mm)				
positive position switch 3/16 in. (5 mm)				
BARRIERS:				
Barrier Width				
min 0.125 inches (3 mm)				
max 0.250 inches (6 mm)				
Barrier Depth				
min 0.88 inches (5 mm)				
max 0.250 inches (6 mm)				
RESISTANCE				
min 10 oz (280 mN)				
max 40 oz. (11N)				
26. Lever			✓	
DIMENSIONS:				
Diameter				
Finger Grasp				
min 0.5 inches (13 mm)				
max 3.0 inches (75 mm)				
Hand Grasp				
min 1.5 inches (38 mm)				
max 3.0 inches (75 mm)				

Detailed Design Considerations	YES	NO	N/A	Comments
RESISTANCE: One Hand (d-1) min 2 lb. (9N) max 30 lb. (135N) Two Hands min 2 lb. (9N) max 50 lb. (220N) One Hand (d-2) min 2 lb. (9N) max 20 lb. (90N) Two Hands min 2 lb. (9N) max 30 lb. (135N) DISPLACEMENT: Forward (d-1) max 14.0 inches (360 mm) Lateral (d-2) max 38.0 inches (970 mm) SEPARATION: One Hand Random min 3.0 inches (75 mm) preferred 5.0 in. (125 mm)				
27. Pedals DIMENSIONS: Height min 10 inches (25 mm) Width min 3.0 inches (75 mm) DISPLACEMENT: Normal Operation min 0.5 inches (13 mm) max 2.5 inches (65 mm) Ankle Flexion min 1.0 inches (25 mm) max 2.5 inches (65 mm) Total Leg Movement min 1.0 inches (25 mm) max 7.0 inches (180 mm) RESISTANCE: Foot Not Resting on Pedal min 4 lb. (18 N) max 20 lb. (90 N) Foot Resting on Pedal min 10 lb. (45 N) max 20 lb. (90N)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
Ankle Flexion Only max 10 lb. (45 N) Total Leg Movement min 10 lb. (45 N) max 180 lb. (800 N) SEPARATION: One Foot Random min 4.0 inches (100 mm) preferred 6.0 in. (150 mm) One Foot Sequential min 2.0 inches (50 mm) preferred 4.0 in. (100 mm)				
28. Adequate control response feedback is provided.		✓		
29. Rotary valves open counterclockwise.	✓			
30. Control movement conforms with corresponding related display.		✓		
31. Rotary controls turn to the right (clockwise) to increase, and left (counterclockwise) to decrease.	✓			
32. Stops are provided at the beginning and end of the control movement travel.	✓			
33. In right-hand operations, knobs are placed below or to the right of displays.		✓		
34. For left-hand operations knobs are placed below or to the left of displays.		✓		
35. Controls meant to have a limited degree of motion have adequate mechanical stops.	✓			
36. Controls are labeled as to function and method of operation by means of arrows and appropriate legends.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
37. Selector switches have sufficient spring loading to keep from stopping between detents.	✓			
38. Range of control action does not interfere with other controls.	✓			
39. Shape coded controls are visually and tactually identifiable.		✓		
40. Control color has high contrast with background.	✓			
41. Ambient light color determines useable control colors.		✓		
42. Switch legend is legible with or without internal illumination.		✓		
43. Legend switch lamps are replaceable from the front of the panel by hand and the legends or covers are keyed to prevent the possibility of interchanging the legend covers.			✓	
44. Controls are selected and distributed so that none of the operator's limbs are overburdened.		✓		
45. Coding is uniform throughout the system.		✓		J switches - Positions: ·Auto-off-man ·Auto-off-hand -Pull to lock-stop-start -Main heat, zero heat, auto heat ·close, auto, open
46. Controls are useable in the time required despite inadvertent operation protection (guards).		✓		Key in press relief - not in NDTT mode
47. Controls are not adversely affected by distortion, shock and vibration.			✓	
48. Control motion is minimized, not cycled through ON/OFF unnecessarily.		✓		Auto-off-man
49. Latches on levers do not cause delay in operation.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
50. Minimum use made of horizontal or 3 position toggle switches.	✓			
51. Shape coded controls are free of sharp edges.			✓	
52. Critical controls are designed and located so that they are not susceptible to being moved accidentally.		✓		RC pump J switches
53. If there is a possiblity of inadvertent activation causing a hazardous condition, controls are recessed or shielded by a physical barrier.		✓		
54. "Dead man" controls are used when operator incapacity can produce a critical condition.			✓	
55. The main power ON/OFF switch cuts all power to the complete equipment.			✓	
56. Main Power switch is labeled.			✓	
57. Failure of power steering does not incapacitate steering.			✓	
58. Resistance is built in so that definite or sustained effort is required for activation.			✓	
59. Controls are black or gray.		✓		Knobs - silver
60. Controls are labeled with basic information for proper identification, utilization, actuation, or manipulation of the element.		✓		NDTT mode Press spray valve - labels worn off
61. Operating instructions are provided except where use is obvious.		✓		
62. Diagrams are used wherever possible.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
63. Calibration instructions are placed as close to the calibrating control as possible.		✓		
64. Adjustment controls are easy to set and lock.		✓		
65. All controls have appropriate scales or indexing.		✓		Poor labeling
66. If red lighting is used, red is not used for coding. Use black and yellow striping.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST

8

DISPLAYS

Test Title Pressurizer Control - Panel 4

Test Project No. ____________ Date ____________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Relationship between the display and its associated controls is unmistakable in terms of: a) The proper control to use. b) Direction of movement of the control. c) Rate and limits of movement of the control.		✓		Each of 4 RC pumps - backup pumps lights - 3 pairs - 2 Aux pump controls
2. Controls are located adjacent to (either under or to right of) associated displays.		✓		See above
3. Functionally related units are grouped together and are similar from panel to panel.		✓		
4. Displays in groups are located from left-to-right and/or top-to-bottom order of use.		✓		
5. Displays used in system checkout are located so they can be observed from one position.		✓		
6. All displays are arranged in the sequence in which they are used.		✓		
7. Meters, dials, and instruments are so sized/arranged that they can be read from the normal operating position.		✓		7 strip chart displays - press level - RC press - wide, narrow B - narrow A - RC outlet temp - RC unit ave temp - RC total flow

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
8. In standing positions, the most frequently used displays are located approximately at the eye level of the operator.		✓		
9. Frequently used displays are grouped together.		✓		
10. Displays are located where they can be read to the required degree of accuracy.		✓		Not when strip charts are pulled out
11. If on separate panels, positions of related controls and displays correspond and the panels do not face each other.			✓	
12. Control display groups for maintenance use only are not located in prime operating space.			✓	
13. Display arrangement is consistent from one situation to another.			✓	
14. Unusual aids such as ladders, extra lighting, etc., are not needed to read or gain access to a display.			✓	
15. Display scales are limited to only information needed to make a decision or take action. All needed information is presented.		✓		
16. Information is presented in such form that no interpretation or decoding is necessary.		✓		
17. Information for different types of activities is not combined unless the activities require the same information.			✓	
18. Failure in the unit is clearly shown or the operator is otherwise warned.		✓		Lights

Detailed Design Considerations	YES	NO	N/A	Comments
19. Trademarks, company names, and other unnecessary information are not on the panel face.		✓		
20. Job aids (graphic overlays) are provided when a plotter operator is required to interpret graphic data.		✓		
21. On units having operat‹ - displays, maintenance displays are located behind access doors on the operator's panel.			✓	
22. On units without operator panel, maintenance displays are located on one face accessible in normal installation.			✓	
23. Viewing distance from the eye to the displays located close to controls is 28 inches (710mm) maximum and 13 inches (510mm) minimum.		✓		40 in. min. - to back panel
24. The display pointer extends to but does not obscure the index mark width.	✓			
25. Display pointer is mounted as close as possible to dial face to eliminate parallax and shadows.		✓		
26. Counters and flags are mounted close to the panel surface.		✓		
27. CRT target visual angle exceeds 2.0 minutes and 10 lines of resolution; viewing distance is 16 inches (10 in. minimum).			✓	
28. Illumination is uniform.		✓		
29. Multiple displays grouped together will have brightness uniformity across the range of full "ON" to full "OFF."			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
30. The display face is not less than 45° from the operator's normal line of sight.		✓		
31. There is a high degree of contrast between the scale face and markings.		✓		Stripcharts
32. Frequently used displays are grouped together and are placed in the optimal visual zone. Limits are as follows: Eye Rotation Alone Horizontal Plane 35° maximum 15° optimum Vertical Plane Horizontal Line of Sight 40° maximum 15° optimum Normal Line of Sight 20° maximum 15° optimum Head Rotation Alone Horizontal Plane 60° maximum 0° optimum Vertical Plane Horizontal Line of Sight 65° maximum Normal Line of Sight 35° maximum Head and Eye Rotation Horizontal Plane 95° maximum 15° optimum Vertical Plane 90° maximum 15° optimum Normal Line of Sight 15° optimum		✓		
33. Glare does not interfere with readability of the display at a location.				

Detailed Design Considerations	YES	NO	N/A	Comments
34. Indicator lights show equipment response, not merely control position; are used sparingly and only show information needed for effective system operation.		✓		36 red lights 34 green lights 2 white lights 7 amber lights
35. Luminance contrast exceeds 50%.		✓		Labels
36. Flashing lights have a flash rate of 3 to 5 flashes per second; in case of flasher failure, the light illuminates and burns steadily.			✓	
37. Color coding is used where possible; unused scales are covered.		✓		
38. Indicators used at night are dimmable (0.02-1.0 ft-L).			✓	
39. If faint signal detection is required and ambient illumination is above 0.25 ft-C (2-7 lux) the CRT is hooded, shielded, or recessed.			✓	
40. Printed matter is visible. If ambient illumination inadequate, matter is illuminated by the printer. Plotted matter is also readily visible.		✓		
41. Projection display rates for group viewing are as follows: FACTOR: Ratio of $\frac{\text{viewing distance}}{\text{screen diagonal}}$ OPTIMUM: 4 PREFERRED LIMITS: 3-6 ACCEPTABLE LIMTS: 2-8 FACTOR: Angle off centerline OPTIMUM: 0°			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
PREFERRED LIMITS: 20^{o} ACCEPTABLE LIMITS: 30^{o} FACTOR: Image luminance (no film in operating projector) (for still projections higher values may be used) OPTIMUM: 10 ft-L (34 cd/m^2) PREFERRED LIMITS: 8-14 ft-L (27-48 cd/m^2) ACCEPTABLE LIMITS: 5-20 ft-L (17-69 cd/m^2) FACTOR: Luminance variation across screen (ratio of maximum to minimum luminance) OPTIMUM: 1 PREFERRED LIMITS: 1.5 ACCEPTABLE LIMITS: 3.0 FACTOR: Luminance variations as a function of viewing location (ratio of maximum to minimum luminance) OPTIMUM: 1 PREFERRED LIMITS: 2.0 ACCEPTABLE LIMITS: 4.0 FACTOR: Ratio of $\frac{\text{ambient light}}{\text{bright part of image}}$ OPTIMUM: 0 PREFERRED LIMITS: 0.002-0.01 ACCEPTABLE LIMITS: 0.1 max				

Detailed Design Considerations	YES	NO	N/A	Comments
For presentation not involving gray scale or color 3., line drawings, tables) 0.2 may be used.				
42. Supplemental viewing system is provided for remote handling situations.			✓	
43. LED are red only and not near red warning lights. Dimming is compatible.			✓	
44. Critical warning lights are isolated from other less important lights for best effectiveness.		✓		
45. Internal instrument lighting is provided where effective.		✓		
46. Indicator lights are immediately and unavoidably associated with the proper control.		✓		
47. Legend lights are used in preference to simple instructor lights.		✓		
48. Indicator lights are capable of providing flashing red for emergency or malfunction conditions.		✓		
49. The information displayed is clear, specific, and useable. It is not redundant or degraded by vibration. It is at a level of accuracy required for the operator's action or decision.		✓		
50. The provision of the display presentation is consistent with system precision.		✓		
51. The display indicator ceases to move after the control movement stops.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
52. Displays which cannot or may not be watched continuously, but need continuous monitoring, have a suitable auditory or visual warning backup.			✓	
53. Counter numbers change by snap action, follow each other not faster than 2 per second if read consecutively, increase with clockwise rotation of the reset knob, and automatically reset sequencing as well as having a manual reset.			✓	
54. Material in printer is easily changed and indicates remaining supply of printing materials.		✓		
55. Failure of a display circuit is immediately apparent.		✓		Light
56. Failure of the display circuit does not affect display equipment.			✓	
57. Most important displays are placed in the optimum visual zone.		✓		
58. A signal absence does not denote "go ahead," "ready," etc., only a power off condition.		✓		
59. Transilluminated, LED and incandescent displays conform to the following color code, except that training equipment colors can be approximate:				
a. <u>Flashing red</u> denotes only emergency conditions which require operator action without undue delay to avert personnel injury and/or equipment damage.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
b. Red alerts an operator that a system or any of its parts is inoperative or that a successful mission is not possible unless corrective action is taken.		✓		Red - open, auto, start, manual (Press Relief)
c. Yellow advises an operator of a marginal condition or alerts him to situations of caution, recheck or unexpected delay.		✓		Yellow - Auto test
d. Green indicates that monitored equipment is in tolerance or that a state of readiness exists.		✓		Green - closed, stop
e. White shows system conditions that do not have "right" or "wrong" implicatons such as alternating functions except that white is not used in aircraft flight stations.		✓		White - hand (Bailey)
f. Blue is used for advisory lights only, except that blue is not used in aircraft flight stations.			✓	
60. Flashing lights are used only to call the operator's attention to a condition requiring action.			✓	
61. Legend lights signifying danger are larger than other legend lights.			✓	
62. If operator is wearing earphones during normal operations, audio warning signals are directed to both earphones and work area.			✓	
63. Audio signal action specifies the nature of the problem (maintenance, emergency, health hazard).			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
64. Audio signals denoting emergencies are notably different from routine signals.	✓			
65. The following types of signals may not be used as warning devices:			✓	
a. Modulated or interrupted tones that resemble navigation signals or coded radio transmissions.				
b. Steady signals that resemble hisses, static, or sporadic radio signals.				
c. Trains of impulses that resemble electrical interference whether regularly or irregularly spaced in time.				
d. Simple warbles which may be confused with the type made by two carriers when one is being shifted in frequency (beat-frequency-oscillator effect).				
e. Scrambled speech effects that may be confused with cross modulation signals from adjacent channels.				
f. Signals that resemble random noise, periodic pulses, steady or frequency modulated simple tones, or any other signals generated by standard countermeasure devices (e.g., "bagpipes").				
g. Signals similar to random noise generated by air conditioning or any other equipment.				

Detailed Design Considerations	YES	NO	N/A	Comments
h. Signals that resemble sounds likely to occur accidentally under operational conditions.				
66. The first 0.5 seconds of an audio signal is discriminable from the first 0.5 second of any other signal. The length of the warning is a minimum of 1/2 second until corrective action is taken.		✓		
67. The audio device and circuit design preclude false alarms.			✓	
68. The height to width ratio of all labeling is acceptable for fast and accurate reading.		✓		
69. Counters are horizontally positioned.			✓	
70. The same numerical progression is used on all scales of combined displays.		✓		
71. In sequential displays, the sequence progresses from left to right.		✓		
72. Scale values and their indexes are consistent in directions of increase or decrease.		✓		
73. The display can be read quickly in the manner desired (quantitative, qualitative, or check reading).		✓		

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST

10

WORKSPACE

Test Title Pressurizer Control - Panel 4

Test Project No. ________________ Date ________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Design and sizing insures accommodation, compatibility, operability and maintainability by at least 90 percent of the user population (a range from the 5th percentile to the 95th percentile for single dimensions).		✓		
2. Cabinets, consoles, and work surfaces that require an operator to stand or sit close to their front surfaces contain a kick space at the base at least 4 inches (100 mm) deep and 4 inches (100 mm) high to allow for protective or specialized apparel.		✓		
3. Panel Dimensions - seated - with vision over top.			✓	
a) Seat height 18" (460 mm) from floor writing surface-25.5" (650 mm) above the floor vertical dimension of panel-22" (56 mm) above writing surface maximum console width - 44" (1.120 m)				
b) Seat height 23" (580 mm) writing surface - 32" (810 mm) vertical dimension of panel - 22" (560 mm)				

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
maximum console width - 44" (1.120 m)				
c) Seat height 28.5" (725 mm)				
writing surface - 36" (910 mm)				
vertical dimension of panel 22" (560 mm)				
Maximum console width - 44" (1.120 m)				
4. Panel Dimensions - seated - without vision over top.			✓	
a) Seat height - 18" (460 mm)				
writing surface 25.5" (650 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
b) Seat height - 23" (580 mm)				
writing surface - 32" (810 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
c) Seat height - 28.5" (720 mm)				
writing surface - 36" (910 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width - 36" (910 mm)				
5. Panel Dimensions - seated or standing with standing vision over top.			✓	
seat height - 28.5" (720 mm)				

Detailed Design Considerations	YES	NO	N/A	Comments
writing surface - 36" (910 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
6. Panel Dimensions - standing with vision over top.		✓		
writing surface - 36" (910 mm)				
vertical dimension of panels 26" (660 mm)				
maximum console width - 44" (1.120 m)				
7. Panel Dimensions - standing (without vision over top).			✓	
writing surface - 36" (910 mm)				
vertical dimension of panel - 36" (910 mm)				
maximum console width - 36" (910 mm)				
8. Consoles have at least 4 feet (1.220 m) of free floor space in front whenever feasible.		✓		
9. The seated operator has free pedal access and use of foot pedals.			✓	
10. Compartment design allows equipment sharing and good communication.		✓		
11. Workspace allows ease of weapon handling, aiming, loading, firing, and field stripping.			✓	
12. User is oriented to work site.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
13. Crane controls are easily reached and afford load visibility.			✓	
14. Display reading location is identified.		✓		
15. Equipment is designed and installed with workspace requirements in mind.		✓		
16. Armrests are at least 2 inches (50 mm) wide and 8 inches (200 mm) long.			✓	
17. Knee and foot room should exceed the following dimensions beneath work surfaces: a) Height: 25 inches (640 mm) b) Width: 20 inches (510 mm) c) Depth: 18 inches (460 mm)			✓	
18. Back and seat of chair have 1" minimum padding.			✓	
19. Lateral work space is 30" wide x 16" deep; writing space is 24" wide x 16" deep.			✓	
20. Armrests do not interfere with work, egress or emergency procedures.			✓	
21. Vertical seat adjustments are 15-21" (16-21" for male use exclusively) in 1 inch maximum increments.			✓	
22. The seat backrest reclines 103-115° and supports the torso so that the operator's eyes are within 3" of the "eye-line."			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
23. Rotating seats have 8 locking positions minimum and support 250 lbs. The seat adjusts fore and aft at least 4" minimum.			✓	
24. The operator does not have to lift self to adjust the seat.			✓	
25. Easy access is provided to and from a station.	✓			
26. Equipment racks requiring maintenance have space available, when feasible, as follows:			✓	
a) Minimum distance from the front of the rack to the opposite surface or obstacle is 42 inches (1.070 m).				
b) Minimum lateral workspace for racks having drawers:				
1) With drawers weighing less than 45 pounds (20.4 kg); 18 inches (460 mm) on one side and 4 inches (100 mm) on the other.				
2) With drawers weighing over 45 pounds (20.4 kg) 18 inches on each side.				
27. Allowances are made for heavy clothing and protective equipment.		✓		
28. A loader can comfortably sit in the closed hatch mode or stand in the open hatch mode.			✓	
29. Workspace provides head, arm and body clearance at any weapon position.			✓	
30. User space is not encroached upon by others.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
31. Reflection of instruments or console in windows or windshields is avoided.		✓		
32. Right-left viewing angle for a wrap-around console is 190° maximum.			✓	
33. The forward field of view is 180° minimum.	✓			
34. Minimum illumination levels for different work areas and types of work are as follows in Footcandles (LUX): Console surface 30 (325) Dials 30 (325) Emergency lighting 3 (30) Gauges 30 (325) Meters 30 (325) Missiles: Repair/Service 60 (640) Storage areas 10 (110) General inspection 30 (325) Panels: Front 30 (325) Rear 10 (110) Passageways 10 (110) Reading Large print 10 (110) News print 30 (325) Pencil reports 50 (540) Small type 50 (540) Prolonged reading 50 (540) Recording 50 (540) Repair work: General 30 (325) Instrument 100 (1075)	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
35. Visors, etc., reduce external glare.			✓	
36. Transparent areas are free from color, distortion, etc.			✓	
37. Multireflections from multilayered windows are minimized.			✓	
38. Windscreen angle of incidence is 60° maximum to undistorted vision.			✓	
39. Windows or canopies have optimum unobstructed vision.			✓	
40. Instrument reflection is avoided.		✓		
41. If possible there is a direct view of work.	✓			
42. Distortion is avoided in windows.			✓	
43. Door posts or wiper motors do not obscure vision.			✓	
44. Loader can see outside while operating in close hatch mode.			✓	
45. Provisions for auxiliary power and lighting are provided.	✓			
46. Seating is compatible with console.			✓	
47. Heating and air conditioning specifications for mobile detail work areas - $50^{\circ}F$ to $85^{\circ}F$. For permanent details work areas - $65^{\circ}F$ to $85^{\circ}F$.			✓	
48. Air conditioning systems do not discharge cold air directly on personnel.			✓	
49. Adequate ventilation is provided by a minimum of 30 cubic ft.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
per minute per man minimum. Air is moved past the operator at a velocity of not more than 100 feet (30 m) per minute - 65 feet (20 m) per minute if possible.				
50. The effective temperature within enclosures for extended periods is at or below 85°F (29°C).	✓			
51. The acoustical environment does not degrade system effectiveness.		✓		
52. The average room sound absorption coefficient is at least 0.20.			✓	
53. Facilities and equipment are designed to control the transmission of whole body vibration to levels permitting safe operation and maintenance.			✓	
54. Test stands are part of the equipment.			✓	
55. Handles are provided on units which are removed or carried.			✓	
56. Vehicles have a minimum temperature of 68°F (20°C)(unless wearing cold regions clothing and exposure less than 3 hours).			✓	
57. Fresh air is provided at a minimum of 20 cu. ft. (0.43 cu m)/minute/ person; in a hot climate, air flow rates should be between 150 and 200 cu. ft. (4.25 and 5.66 cu m) / min./person.			✓	
58. Protective padding is used.			✓	
59. Mirrors are braced against vibration.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
60. Ventilation or other protective measures are provided within limits.			✓	
61. Intakes for ventilation systems are located so as to minimize the introduction of contaminated air from exhaust pipes, etc.			✓	
62. Cars have seat belts.			✓	
63. Windshields and windows are shatterproof and do not distort vision.			✓	
64. Hazard alerting devices are provided.			✓	
65. Illumination is adequate, glare is reduced and capability for dimming is provided.		✓		
66. Maintenance workspace is free of obstructions which could cause injury.			✓	
67. Equipment is guarded if temperature exceeds 140°F (120°F if handled).			✓	
68. Exposed edges are rounded and have a .04" minimum radius. Exposed corners are also rounded and have a 0.5" minimum radius.			✓	
69. Guards are provided on moving parts.			✓	
70. Radiation hazards are minimized.	✓			
71. Padding is non-abrasive and non-toxic.			✓	
72. Exhausts are directed away from compartments.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
73. Adequate and suitable storage is provided for manuals, worksheets, etc.		✓		
74. Standees have work surfaces provided to support manuals, etc.		✓		
75. Conspicuous placards are adjacent to equipment which is hazardous to the user.		✓		
76. Areas requiring special equipment and/or clothing are specifically identified.		✓		
77. Any structure which can be chopped through in an emergency is clearly marked, axes provided.			✓	
78. Emergency procedures are detailed.		✓		
79. Instructions are kept simple.		✓		
80. Push-out escape windows are marked.			✓	
81. Equipment is located so that awkward working positions are unnecessary.			✓	
82. Sufficient space is provided to use test equipment and other tools required during checkout.			✓	
83. Controls (switches, knobs, etc.) are easily reached from the working position.		✓		
84. Components are located so that physical interference among operators working on the same areas is lessened.		✓		
85. The lines of sight to a display are not obscured by poor arrangement of people or equipment.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
86. Traffic flow between areas is efficient.		✓		
87. Auditory alerting and warning signals are loud enough to be heard above environmental noise.	✓			
88. Equipment is secured in order to prevent shifting or overturning accidentally.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST

20
MEASURES

Test Title Pressurizer Control - panel 4

Test Project No. ______________________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Displays are located so they can be read to the required accuracy.		✓		
2. Display arrangement is consistent from one application to another.		✓		
3. Measuring marks on opaque containers are placed inside.		~~✓~~	✓	
4. Display viewing distance: 13-28".		✓		
5. Minimum number of measuring devices is used.			✓	
6. Canteen cup is useable as standard or emergency measuring device for field use.			✓	
7. Item container used for measuring where possible.			✓	
8. Measurement marks raised.			✓	
9. Containers allow for full hand, finger, clearance when using opening tool.			✓	
10. Reflections minimized.		✓		
11. Display precision, response is consistent with that of system.		✓		
12. Scales: linear, start at 0, use whole numbers, 2 pointers max, numerals oriented upright.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
13. Field items are non-corrosive, easily cleaned or disposed.			✓	
14. Information limited to that necessary to take action.		✓		
15. Information is directly useable.		✓		
16. Specified measuring amounts are consistent with measuring device.			✓	
17. Measures clearly detailed.		✓		
18. For group use: multiple of food components or general formula for computation given.			✓	

DESIGN CHECKLIST

LABELS, MANUALS, MARKINGS

Test Title Rod Control - Panel 4

Test Project No. ______ Date ______

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Controls, displays and other items of equipment are clearly marked and labeled except in cases where use is obvious to the operator.		✓		CRDM Group ind. - 2 meters - no labels
2. Labels are on or near the item to be identified.	✓			
3. Labels do not cover any other information and are not located behind controls. They can be seen easily by the operator and are not obscured by the operator's hand activating a control.	✓			
4. Labels are located in the same manner throughout the equipment and system.	✓			
5. Labels are not covered by other equipment and are located on the flattest, least cluttered and cleanest surface available.	✓			
6. Labels are mounted so that they cannot be accidentally damaged or removed.	✓			
7. Where instructions are lettered on hinged door, lettering is set so that it can be read when the door is open.			✓	
8. Labels are graduated in size. Group label characters are at least 25% larger than those of individual controls and displays.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
Control and display characters, in turn, are at least 25% larger than those identifying control positions.				
9. Spacing between characters is a minimum of one stroke; between words is a minimum of one character.	✓			
10. Abbreviations are capital letters, periods being omitted except when there is a possibility of misinterpretaion.		✓		
11. Extended copy (instructions) is in lower case letters.		✓		
12. Label characteristics are determined by illumination level and color.		✓		Engraved labels on diamond panel
13. Labels are easily read at operational reading distances with vibration/motion and lighting levels taken into consideration.		✓		Worn - poor contrast
14. Labels are sharp with high contrast.		✓		No !
15. With illumination less than 1 ft-C, white, white florescent, or torch-lighted characters on a dark background are used.			✓	
16. With illumination above 1 ft-C, black letters against a light background are used.		✓		Dark silver or light
17. For dark adaptation, letters are visible and do not interfere with night vision.			✓	
18. When letters, etc., are viewed by means of television, they are light against a dark background.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
19. Labels on production equipment are as durable as the equipment.		✓		
20. Labels for prototype equipment are easily affixed, altered and removed.			✓	
21. Markings and tags are as permanent as the equipment to which applied and able to withstand environmental and cleaning conditions.		✓		
22. Labels are accessible and visible during maintenance.		✓		
23. Load capacity is marked on lifting equipment.			✓	
24. Roman numerals are not used, if possible.			✓	
25. Vertical labels are used only when the labels are not critical for personal safety and performance, and space is limited.			✓	
26. Electrical receptacles are clearly marked with voltage, phase and frequency characteristics.			✓	
27. Pipe, hose, and tube lines are clearly labeled as to contents, pressure, temperature, and hazards.			✓	
28. Warning placards are well illuminated.			✓	
29. Warning notices are clear and direct. Characters are 25% larger than any following instructions.			✓	
30. Placards are placed adjacent to hazards.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
31. Circuit breakers are labeled and easily accessible.			✓	
32. Trade names and other irrelevant information do not appear on labeling.		✓		
33. Labels are concise with a minimum of repetitive information.		✓		Group position indication select
34. An abstract symbol is used only if meaningful.			✓	
35. Each assembly, component, and part is labeled with a visible and meaningful name, number, and symbol.		✓		Scale labeled in $\pm$ 10% - no other label
36. Printed information is directly useable with a minimum of decoding and interpolation.			✓	
37. Labels do not describe the engineering characteristics or nomenclature of the piece of equipment, if at all possible.			✓	
38. Labels are etched, embossed, or engraved into the component or chassis.	✓			Engroned

DESIGN CHECKLIST

6
CONTROLS

Test Title Rod Control - Panel 4

Test Project No. ______________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Control relationship to its display is apparent.	✓			
2. Functionally related controls and displays are grouped together.	✓			
3. Control groups, sequential operations have left-to-right order of use or top-to-bottom order of use.	✓			
4. Controls in functional groups are located in accordance with operational sequence and/or function.		✓		
5. Lifting equipment controls are within easy reach with the load visible.			✓	
6. Controls are located so that they cannot be accidentally moved.	✓			
7. Groups with similar functions are similar throughout the system.			✓	
8. Controls are marked to indicate in which direction to operate the control.	✓			
9. Control/display groups used only for maintenance are not located in prime operating space.			✓	
10. Controls used most often are located in the best position for ease of reaching and grasping.	✓			

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
11. Controls operated without visual reference are located in front rather than to the side or behind the operator.			✓	
12. Internally mounted controls are located away from dangerous voltage.			✓	
13. Sensitive adjustments are located or guarded to prevent accidental activation.			✓	
14. Controls used for same function on different types of equipment are of the same size and shape.			✓	
15. Rotary Control DIMENSIONS: Length min 1.0 inches (25mm) max 4.0 inches (100mm) Width max 1.0 inches (25mm) Depth min 0.625 inches (16mm) max 3.0 inches (75mm) RESISTANCE min 1.0 inch-lb (113 mN-m) max 6.0 inch-lb (678mN-m) DISPLACEMENT For facilitating performance min 30 degrees max 90 degrees SEPARATION One Hand Random min 1.0 inches (25 mm) preferred 2.0 in. (50 mm) Two-Hand Operation min 3.0 inches (75 mm) preferred 5.0 in. (125 mm)			✓	
16. Key Operated Switch DISPLACEMENT min 80 degrees			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
max 90 degrees HEIGHT min 0.5 inches (13mm) max 3.0 inches (75mm) RESISTANCE min 1 in/lb (113 mNm) max 6 in/lb (678 mNm)				
17. Discrete Thumbwheel Control DIMENSIONS: Diameter min 1.5 in. (38mm) max 2.5 in. (65 mm) Trough min 0.45 inches (11 mm) Distance max 0.75 inches (19 mm) Width min 0.1 inches (3 mm) Depth min 0.125 inches (3 mm) max 0.5 inches (13 mm) Separation min 0.4 inches (10 mm) RESISTANCE: min 6 oz. (165 mN) max 20 oz. (560 mN)			✓	
18. Continuous Adjustment Rotary Knobs DIMENSIONS: Fingertip Grasp Height min 0.5 inches (13 mm) max 1.0 inches (25 mm) Diameter min 0.375 inches (10 mm) max 4.0 inches (100 mm) Thumb and Finger Encircled Diameter min 1.0 inches (25 mm) max 3.0 inches (75mm) Palm Grasp Diameter min 1.5 inches (38 mm) max 3.0 inches (75 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
<u>Length</u> min 3.0 inches (75 mm) TORQUE: <u>Height</u> max 4.5 in-oz (32 mN-m) <u>Diameter</u> max 6.0 in-oz (42 mN-m) SEPARATION: <u>One Hand Individually</u> min 1.0 inches (25 mm) max 2.0 inches (50 mm) <u>Two Hands Simultaneously</u> min 2.0 inches (50 mm) max 5.0 inches (125 mm)				
19. Cranks DIMENSIONS: <u>Handle</u> <u>Diameter (rpm-dia)</u> none - 1.0 inches (25 mm) 175 - 1.0 inches (25 mm) 275 - 0.5 inches (13 mm) <u>Length (rpm-length)</u> none - 3.75 inches (95 mm) 175 - 3.75 inches (95 mm) 275 - 1.5 inches (38 mm) <u>Radius (rpm-radius)</u> none - min 9.0 in. (230 mm) max 16.0 in. (410 mm) 175 - min 5.0 in. (125 mm) max 8.0 in. (200 mm) 275 - min 0.5 in. (13 mm) max 4.5 in. (115 mm) RESISTANCE: (rpm-resistance) none - min 2.0 lb (9N) max 50 lb. (220N) 175 - min 6.0 lb. (27N) max 15 lb (67N) 275 - min 2.0 lb (9N) max 5 lb (22N) SEPARATION: (rpm-separation) none - min 3.0 inches (75mm) 175 - min 3.0 inches (75mm) 275 - min 3.0 inches (75mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
20. Handwheels DIMENSIONS: <u>Wheel Diameter</u> <u>One Hand</u> min 2.0 inches (50 mm) max 4.25 inches (110 mm) <u>Two Hands</u> min 7.0 inches (180 mm) max 21.0 inches (530 mm) <u>Rim Diameter:</u> min 0.75 inches (19mm) max 2.0 inches (50 mm) RESISTANCE: <u>One Hand</u> min 5 lb. (22N) max 30 lb. (133N) <u>Two Hands</u> min 5 lb (22 N) max 50 lb. (220 N) DISPLACEMENT: <u>Two Hands</u> max 120 deg. SEPARATION: <u>Two Hands</u> - Simultaneously min 3.0 inches (75 mm) max 5.0 inches (125 mm)			✓	
21. Pushbuttons (Finger or Hand Operated) DIMENSIONS: <u>Diameter</u> <u>Fingertip Operation</u> min 0.385 inches (10 mm) max 0.75 inches (19 mm) <u>Thumb or Heel of Hand Operation</u> min 0.75 inches (19 mm) RESISTANCE: <u>Finger Operation</u> min 10 oz. (2.8N) max 40 oz. (11.0N) <u>Little Finger Operation</u> min 5 oz. (1.4N) max 20 oz. (5.6N) DISPLACEMENT: <u>Thumb or Finger Operation</u> min 0.125 inches (3 mm) max 1.5 inches (38 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
SEPARATION: Single Finger Operation min 0.5 inches (13 mm) preferred 2.0 in. (50 mm) Single Finger Sequential Operation min 0.25 inches (6 mm) preferred 1.00 in. (25 mm) Operation by Several Fingers min 0.5 inches (13 mm) max 0.5 inches (13 mm)				
22. Pushbuttons (Foot Operated) DIMENSIONS: Diameter min 0.50 inches (13 mm) RESISTANCE: Foot will not rest on control min 4.0 lb. (18 N) max 20.0 lb. (90 N) Foot will rest on control min 10.0 lb. (45N) max 20 lb. (90N) DISPLACEMENT: Normal Boot Operation min 0.50 inches (13 mm) max 2.5 inches (65 mm) Heavy Boot Operation min 1.0 inches (25 mm) max 2.5 inches (65 mm) Ankle Flexion Only min 1.0 inches (25 mm) max 2.5 inches (65 mm) Total Leg Movement min 1.0 inches (25 mm) max 4.0 inches (100 mm)			✓	
23. Keyboards DIMENSIONS: Diameter Bare-handed min 0.385 inches (10 mm) max 0.75 inches (19 mm) preferred 0.5 in. (13 mm) Cold Regions mittens min 0.75 inches (19 mm) preferred 0.75 in. (19 mm) RESISTANCE:			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
Numeric min 3.5 oz. (1N) max 14.0 oz. (4N) Alphanumeric min 0.9 oz. (250 mN) max 5.3 oz. (1.5 N) Dual Function min 0.9 oz. (250 mN) max 5.3 oz. (1.5N) DISPLACEMENT: Numeric min 0.03 inches (0.8 mm) max 0.19 inches 4.8 mm) Alphanumeric min 0.05 inches (1.3 mm) max 0.25 inches (6.3 mm) Dual Function min 0.03 inches (0.8 mm) max 0.19 inches (4.8 mm) SEPARATION: Between adjacent key tops min 0.25 inches (6.4 mm) preferred 0.25 in. (6.4 mm)				
24. Toggle Switches DIMENSIONS: Arm Length (Bare finger) min 0.5 inches (13 mm) max 2.0 inches (50 mm) Arm Length (Gloved finger) min 1.5 inches (38 mm) max 2.0 inches (50 mm) Control Tip min 0.125 inches (3 mm) max 1.0 inches (25 mm) RESISTANCE: Small Switch min 10 oz. (2.8N) max 16 oz. (4.5N) Large Switch min 10 oz. (2.8N) max 40 oz. (11N) DISPLACEMENT: 2 Position min 30 deg max 120 deg.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
<u>3 Position</u> min 18 deg. max 60 deg. desired 25 deg. SEPARATION: <u>Single Finger Operation</u> min 0.75 inches (19 mm) optimum 2.0 in. (50 mm) <u>Single Finger Operation-lever lock toggle switch</u> min 1.0 inches (25 mm) optimum 1.0 in. (50 mm) <u>Simultaneous Operation by Different Finger</u> min 0.625 inches (16 mm) optimum 0.75 in. (19 mm)				
25. Legend Switch DIMENSIONS: min 0.75 inches (19 mm) max 1.5 inches (38 mm) DISPLACEMENT: min 0.125 inches (3 mm) max 0.250 inches (6 mm) positive position switch 3/16 in. (5 mm) BARRIERS: <u>Barrier Width</u> min 0.125 inches (3 mm) max 0.250 inches (6 mm) <u>Barrier Depth</u> min 0.88 inches (5 mm) max 0.250 inches (6 mm) RESISTANCE min 10 oz (280 mN) max 40 oz. (11N)			✓	
26. Lever DIMENSIONS: <u>Diameter</u> <u>Finger Grasp</u> min 0.5 inches (13 mm) max 3.0 inches (75 mm) <u>Hand Grasp</u> min 1.5 inches (38 mm) max 3.0 inches (75 mm)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
RESISTANCE: One Hand (d-1) min 2 lb. (9N) max 30 lb. (135N) Two Hands min 2 lb. (9N) max 50 lb. (220N) One Hand (d-2) min 2 lb. (9N) max 20 lb. (90N) Two Hands min 2 lb. (9N) max 30 lb. (135N) DISPLACEMENT: Forward (d-1) max 14.0 inches (360 mm) Lateral (d-2) max 38.0 inches (970 mm) SEPARATION: One Hand Random min 3.0 inches (75 mm) preferred 5.0 in. (125 mm)				
27. Pedals DIMENSIONS: Height min 10 inches (25 mm) Width min 3.0 inches (75 mm) DISPLACEMENT: Normal Operation min 0.5 inches (13 mm) max 2.5 inches (65 mm) Ankle Flexion min 1.0 inches (25 mm) max 2.5 inches (65 mm) Total Leg Movement min 1.0 inches (25 mm) max 7.0 inches (180 mm) RESISTANCE: Foot Not Resting on Pedal min 4 lb. (18 N) max 20 lb. (90 N) Foot Resting on Pedal min 10 lb. (45 N) max 20 lb. (90N)			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
Ankle Flexion Only max 10 lb. (45 N) Total Leg Movement min 10 lb. (45 N) max 180 lb. (800 N) SEPARATION: One Foot Random min 4.0 inches (100 mm) preferred 6.0 in. (150 mm) One Foot Sequential min 2.0 inches (50 mm) preferred 4.0 in. (100 mm)				
28. Adequate control response feedback is provided.		✓		Out limit, control on, in limit by group - safety and regulating
29. Rotary valves open counterclockwise.			✓	
30. Control movement conforms with corresponding related display.	✓			
31. Rotary controls turn to the right (clockwise) to increase, and left (counterclockwise) to decrease.	✓			
32. Stops are provided at the beginning and end of the control movement travel.			✓	
33. In right-hand operations, knobs are placed below or to the right of displays.		✓		
34. For left-hand operations knobs are placed below or to the left of displays.		✓		
35. Controls meant to have a limited degree of motion have adequate mechanical stops.			✓	
36. Controls are labeled as to function and method of operation by means of arrows and appropriate legends.	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
37. Selector switches have sufficient spring loading to keep from stopping between detents.			✓	
38. Range of control action does not interfere with other controls.	✓			
39. Shape coded controls are visually and tactually identifiable.		✓		
40. Control color has high contrast with background.		✓		Push button - poor contrast
41. Ambient light color determines useable control colors.			✓	
42. Switch legend is legible with or without internal illumination.			✓	
43. Legend switch lamps are replaceable from the front of the panel by hand and the legends or covers are keyed to prevent the possibility of interchanging the legend covers.			✓	
44. Controls are selected and distributed so that none of the operator's limbs are overburdened.			✓	
45. Coding is uniform throughout the system.		✓		
46. Controls are useable in the time required despite inadvertent operation protection (guards).	✓			
47. Controls are not adversely affected by distortion, shock and vibration.			✓	
48. Control motion is minimized, not cycled through ON/OFF unnecessarily.	✓			
49. Latches on levers do not cause delay in operation.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
50. Minimum use made of horizontal or 3 position toggle switches.	✓			
51. Shape coded controls are free of sharp edges.			✓	
52. Critical controls are designed and located so that they are not susceptible to being moved accidentally.		✓		Gear shift on diamond panel
53. If there is a possiblity of inadvertent activation causing a hazardous condition, controls are recessed or shielded by a physical barrier.	✓			
54. "Dead man" controls are used when operator incapacity can produce a critical condition.			✓	
55. The main power ON/OFF switch cuts all power to the complete equipment.			✓	
56. Main Power switch is labeled.			✓	
57. Failure of power steering does not incapacitate steering.			✓	
58. Resistance is built in so that definite or sustained effort is required for activation.			✓	
59. Controls are black or gray.		✓		Reactor trip is red - guarded
60. Controls are labeled with basic information for proper identification, utilization, actuation, or manipulation of the element.		✓		
61. Operating instructions are provided except where use is obvious.		✓		
62. Diagrams are used wherever possible.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
63. Calibration instructions are placed as close to the calibrating control as possible.		✓		
64. Adjustment controls are easy to set and lock.		✓		
65. All controls have appropriate scales or indexing.	✓			
66. If red lighting is used, red is not used for coding. Use black and yellow striping.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST

8

DISPLAYS

Test Title Rod Control - Panel 4

Test Project No. __________ Date __________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Relationship between the display and its associated controls is unmistakable in terms of: a) The proper control to use. b) Direction of movement of the control. c) Rate and limits of movement of the control.		✓		8 green lights 14 white 10 amber 8 red
2. Controls are located adjacent to (either under or to right of) associated displays.	✓			
3. Functionally related units are grouped together and are similar from panel to panel.	✓			
4. Displays in groups are located from left-to-right and/or top-to-bottom order of use.		✓		
5. Displays used in system checkout are located so they can be observed from one position.		✓		Cannot red labels behind protruding lights on diamond panel
6. All displays are arranged in the sequence in which they are used.		✓		
7. Meters, dials, and instruments are so sized/arranged that they can be read from the normal operating position.		✓		4 scales are log scales

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
8. In standing positions, the most frequently used displays are located approximately at the eye level of the operator.		✓		Tave - low
9. Frequently used displays are grouped together.	✓			
10. Displays are located where they can be read to the required degree of accuracy.	✓			
11. If on separate panels, positions of related controls and displays correspond and the panels do not face each other.			✓	
12. Control display groups for maintenance use only are not located in prime operating space.			✓	
13. Display arrangement is consistent from one situation to another.	✓			
14. Unusual aids such as ladders, extra lighting, etc., are not needed to read or gain access to a display.			✓	
15. Display scales are limited to only information needed to make a decision or take action. All needed information is presented.		✓		
16. Information is presented in such form that no interpretation or decoding is necessary.		✓		Meaning of lights - in limit - out limit, etc.
17. Information for different types of activities is not combined unless the activities require the same information.	✓			
18. Failure in the unit is clearly shown or the operator is otherwise warned.		✓		Light bulbs

Detailed Design Considerations	YES	NO	N/A	Comments
19. Trademarks, company names, and other unnecessary information are not on the panel face.		✓		
20. Job aids (graphic overlays) are provided when a plotter operator is required to interpret graphic data.		✓		
21. On units having operator displays, maintenance displays are located behind access doors on the operator's panel.			✓	
22. On units without operator panel, maintenance displays are located on one face accessible in normal installation.			✓	
23. Viewing distance from the eye to the displays located close to controls is 28 inches (710mm) maximum and 13 inches (510mm) minimum.		✓		≈ 40"
24. The display pointer extends to but does not obscure the index mark width.	✓			
25. Display pointer is mounted as close as possible to dial face to eliminate parallax and shadows.		✓		
26. Counters and flags are mounted close to the panel surface.			✓	
27. CRT target visual angle exceeds 2.0 minutes and 10 lines of resolution; viewing distance is 16 inches (10 in. minimum).			✓	
28. Illumination is uniform.		✓		
29. Multiple displays grouped together will have brightness uniformity across the range of full "ON" to full "OFF."			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
30. The display face is not less than 45° from the operator's normal line of sight.		✓		Diamond displays - less than 45°
31. There is a high degree of contrast between the scale face and markings.		✓		Diamond
32. Frequently used displays are grouped together and are placed in the optimal visual zone. Limits are as follows: <u>Eye Rotation Alone</u> Horizontal Plane 35° maximum 15° optimum Vertical Plane Horizontal Line of Sight 40° maximum 15° optimum Normal Line of Sight 20° maximum 15° optimum <u>Head Rotation Alone</u> Horizontal Plane 60° maximum 0° optimum Vertical Plane Horizontal Line of Sight 65° maximum Normal Line of Sight 35° maximum <u>Head and Eye Rotation</u> Horizontal Plane 95° maximum 15° optimum Vertical Plane 90° maximum 15° optimum Normal Line of Sight 15° optimum				
33. Glare does not interfere with readability of the display at a location.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
34. Indicator lights show equipment response, not merely control position; are used sparingly and only show information needed for effective system operation.		✓		
35. Luminance contrast exceeds 50%.			✓	
36. Flashing lights have a flash rate of 3 to 5 flashes per second; in case of flasher failure, the light illuminates and burns steadily.			✓	
37. Color coding is used where possible; unused scales are covered.		✓		
38. Indicators used at night are dimmable (0.02-1.0 ft-L).			✓	
39. If faint signal detection is required and ambient illumination is above 0.25 f[illegible]ux) the CRT is hood[illegible]ded, or recessed.			✓	
40. Printed matter is visible. If ambient illumination inadequate, matter is illuminated by the printer. Plotted matter is also readily visible.			✓	
41. Projection display rates for group viewing are as follows: FACTOR: Ratio of $\frac{\text{viewing distance}}{\text{screen diagonal}}$ OPTIMUM: 4 PREFERRED LIMITS: 3-6 ACCEPTABLE LIMTS: 2-8 FACTOR: Angle off centerline OPTIMUM: 0°			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
PREFERRED LIMITS: 20° ACCEPTABLE LIMITS: 30° FACTOR: Image luminance (no film in operating projector) (for still projections higher values may be used) OPTIMUM: 10 ft-L (34 cd/m^2) PREFERRED LIMITS: 8-14 ft-L (27-48 cd/m^2) ACCEPTABLE LIMITS: 5-20 ft-L (17-69 cd/m^2) FACTOR: Luminance variation across screen (ratio of maximum to minimum luminance) OPTIMUM: 1 PREFERRED LIMITS: 1.5 ACCEPTABLE LIMITS: 3.0 FACTOR: Luminance variations as a function of viewing location (ratio of maximum to minimum luminance) OPTIMUM: 1 PREFERRED LIMITS: 2.0 ACCEPTABLE LIMITS: 4.0 FACTOR: Ratio of $\frac{\text{ambient light}}{\text{bright part of image}}$ OPTIMUM: 0 PREFERRED LIMITS: 0.002-0.01 ACCEPTABLE LIMITS: 0.1 max				

Detailed Design Considerations	YES	NO	N/A	Comments
For presentation not involving gray scale or color (e.g., line drawings, tables) 0.2 may be used.				
42. Supplemental viewing system is provided for remote handling situations.			✓	
43. LED are red only and not near red warning lights. Dimming is compatible.			✓	
44. Critical warning lights are isolated from other less important lights for best effectiveness.		✓		
45. Internal instrument lighting is provided where effective.		✓		
46. Indicator lights are immediately and unavoidably associated with the proper control.		✓		
47. Legend lights are used in preference to simple instructor lights.		✓		40 single lights on diamond
48. Indicator lights are capable of providing flashing red for emergency or malfunction conditions.			✓	
49. The information displayed is clear, specific, and useable. It is not redundant or degraded by vibration. It is at a level of accuracy required for the operator's action or decision.		✓		lights on diamond
50. The provision of the display presentation is consistent with system precision.			✓	
51. The display indicator ceases to move after the control movement stops.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
52. Displays which cannot or may not be watched continuously, but need continuous monitoring, have a suitable auditory or visual warning backup.			✓	
53. Counter numbers change by snap action, follow each other not faster than 2 per second if read consecutively, increase with clockwise rotation of the reset knob, and automatically reset sequencing as well as having a manual reset.			✓	
54. Material in printer is easily changed and indicates remaining supply of printing materials.			✓	
55. Failure of a display circuit is immediately apparent.		✓		Light
56. Failure of the display circuit does not affect display equipment.			✓	
57. Most important displays are placed in the optimum visual zone.		✓		Diamond lights too low also 10 legend lights
58. A signal absence does not denote "go ahead," "ready," etc., only a power off condition.	✓			
59. Transilluminated, LED and incandescent displays conform to the following color code, except that training equipment colors can be approximate:				
a. <u>Flashing red</u> denotes only emergency conditions which require operator action without undue delay to avert personnel injury and/or equipment damage.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
b. Red alerts an operator that a system or any of its parts is inoperative or that a successful mission is not possible unless corrective action is taken.		✓		Red means: out limit - 8 auto - 1
c. Yellow advises an operator of a marginal condition or alerts him to situations of caution, recheck or unexpected delay.		✓		Yellow means: 10 failure modes - diamond White means: 1 hand 6 pwr supply status 8 control on
d. Green indicates that monitored equipment is in tolerance or that a state of readiness exists.		✓		Green means: 8 in limit
e. White shows system conditions that do not have "right" or "wrong" implicatons such as alternating functions except that white is not used in aircraft flight stations.			✓	
f. Blue is used for advisory lights only, except that blue is not used in aircraft flight stations.			✓	
60. Flashing lights are used only to call the operator's attention to a condition requiring action.			✓	
61. Legend lights signifying danger are larger than other legend lights.			✓	
62. If operator is wearing earphones during normal operations, audio warning signals are directed to both earphones and work area.			✓	
63. Audio signal action specifies the nature of the problem (maintenance, emergency, health hazard).		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
64. Audio signals denoting emergencies are notably different from routine signals.			✓	
65. The following types of signals may not be used as warning devices:			✓	
a. Modulated or interrupted tones that resemble navigation signals or coded radio transmissions.				
b. Steady signals that resemble hisses, static, or sporadic radio signals.				
c. Trains of impulses that resemble electrical interference whether regularly or irregularly spaced in time.				
d. Simple warbles which may be confused with the type made by two carriers when one is being shifted in frequency (beat-frequency-oscillator effect).				
e. Scrambled speech effects that may be confused with cross modulation signals from adjacent channels.				
f. Signals that resemble random noise, periodic pulses, steady or frequency modulated simple tones, or any other signals generated by standard countermeasure devices (e.g., "bagpipes").				
g. Signals similar to random noise generated by air conditioning or any other equipment.				

Detailed Design Considerations	YES	NO	N/A	Comments
h. Signals that resemble sounds likely to occur accidentally under operational conditions.				
66. The first 0.5 seconds of an audio signal is discriminable from the first 0.5 second of any other signal. The length of the warning is a minimum of 1/2 second until corrective action is taken.		✓		
67. The audio device and circuit design preclude false alarms.			✓	
68. The height to width ratio of all labeling is acceptable for fast and accurate reading.		✓		
69. Counters are horizontally positioned.			✓	
70. The same numerical progression is used on all scales of combined displays.			✓	
71. In sequential displays, the sequence progresses from left to right.			✓	
72. Scale values and their indexes are consistent in directions of increase or decrease.			✓	
73. The display can be read quickly in the manner desired (quantitative, qualitative, or check reading).		✓		

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST

10

WORKSPACE

Test Title Rod control - Panel 4

Test Project No. ______ Date ______

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Design and sizing insures accommodation, compatibility, operability and maintainability by at least 90 percent of the user population (a range from the 5th percentile to the 95th percentile for single dimensions).		✓		
2. Cabinets, consoles, and work surfaces that require an operator to stand or sit close to their front surfaces contain a kick space at the base at least 4 inches (100 mm) deep and 4 inches (100 mm) high to allow for protective or specialized apparel.		✓		
3. Panel Dimensions - seated - with vision over top.			✓	
a) Seat height 18" (460 mm) from floor				
writing surface-25.5" (650 mm) above the floor				
vertical dimension of panel-22" (56 mm) above writing surface				
maximum console width - 44" (1.120 m)				
b) Seat height 23" (580 mm)				
writing surface - 32" (810 mm)				
vertical dimension of panel - 22" (560 mm)				

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
maximum console width - 44" (1.120 m)				
c) Seat height 28.5" (725 mm)				
writing surface - 36" (910 mm)				
vertical dimension of panel 22" (560 mm)				
Maximum console width - 44" (1.120 m)				
4. Panel Dimensions - seated - without vision over top.			✓	
a) Seat height - 18" (460 mm)				
writing surface 25.5" (650 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
b) Seat height - 23" (580 mm)				
writing surface - 32" (810 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
c) Seat height - 28.5" (720 mm)				
writing surface - 36" (910 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width - 36" (910 mm)				
5. Panel Dimensions - seated or standing with standing vision over top.			✓	
seat height - 28.5" (720 mm)				

Detailed Design Considerations	YES	NO	N/A	Comments
writing surface - 36" (910 mm)				
vertical dimension of panel 26" (660 mm)				
maximum console width 36" (910 mm)				
6. Panel Dimensions - standing with vision over top.		✓		
writing surface - 36" (910 mm)				
vertical dimension of panels 26" (660 mm)				
maximum console width - 44" (1.120 m)				
7. Panel Dimensions - standing (without vision over top).			✓	
writing surface - 36" (910 mm)				
vertical dimension of panel - 36" (910 mm)				
maximum console width - 36" (910 mm)				
8. Consoles have at least 4 feet (1.220 m) of free floor space in front whenever feasible.		✓		
9. The seated operator has free pedal access and use of foot pedals.			✓	
10. Compartment design allows equipment sharing and good communication.		✓		
11. Workspace allows ease of weapon handling, aiming, loading, firing, and field stripping.			✓	
12. User is oriented to work site.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
13. Crane controls are easily reached and afford load visibility.			✓	
14. Display reading location is identified.		✓		
15. Equipment is designed and installed with workspace requirements in mind.		✓		
16. Armrests are at least 2 inches (50 mm) wide and 8 inches (200 mm) long.			✓	
17. Knee and foot room should exceed the following dimensions beneath work surfaces: a) Height: 25 inches (640 mm) b) Width: 20 inches (510 mm) c) Depth: 18 inches (460 mm)			✓	
18. Back and seat of chair have 1" minimum padding.			✓	
19. Lateral work space is 30" wide x 16" deep; writing space is 24" wide x 16" deep.			✓	
20. Armrests do not interfere with work, egress or emergency procedures.			✓	
21. Vertical seat adjustments are 15-21" (16-21" for male use exclusively) in 1 inch maximum increments.			✓	
22. The seat backrest reclines 103-115° and supports the torso so that the operator's eyes are within 3" of the "eye-line."			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
23. Rotating seats have 8 locking positions minimum and support 250 lbs. The seat adjusts fore and aft at least 4" minimum.			✓	
24. The operator does not have to lift self to adjust the seat.			✓	
25. Easy access is provided to and from a station.	✓			
26. Equipment racks requiring maintenance have space available, when feasible, as follows:			✓	
a) Minimum distance from the front of the rack to the opposite surface or obstacle is 42 inches (1.070 m).				
b) Minimum lateral workspace for racks having drawers:				
1) With drawers weighing less than 45 pounds (20.4 kg); 18 inches (460 mm) on one side and 4 inches (100 mm) on the other.				
2) With drawers weighing over 45 pounds (20.4 kg) 18 inches on each side.				
27. Allowances are made for heavy clothing and protective equipment.		✓		
28. A loader can comfortably sit in the closed hatch mode or stand in the open hatch mode.			✓	
29. Workspace provides head, arm and body clearance at any weapon position.			✓	
30. User space is not encroached upon by others.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
31. Reflection of instruments or console in windows or windshields is avoided.		✓		
32. Right-left viewing angle for a wrap-around console is 190° maximum.			✓	
33. The forward field of view is 180° minimum.	✓			
34. Minimum illumination levels for different work areas and types of work are as follows in Footcandles (LUX): Console surface 30 (325) Dials 30 (325) Emergency lighting 3 (30) Gauges 30 (325) Meters 30 (325) Missiles: Repair/Service 60 (640) Storage areas 10 (110) General inspection 30 (325) Panels: Front 30 (325) Rear 10 (110) Passageways 10 (110) Reading Large print 10 (110) News print 30 (325) Pencil reports 50 (540) Small type 50 (540) Prolonged reading 50 (540) Recording 50 (540) Repair work: General 30 (325) Instrument 100 (1075)	✓			

Detailed Design Considerations	YES	NO	N/A	Comments
35. Visors, etc., reduce external glare.			✓	
36. Transparent areas are free from color, distortion, etc.			✓	
37. Multireflections from multilayered windows are minimized.			✓	
38. Windscreen angle of incidence is 60° maximum to undistorted vision.			✓	
39. Windows or canopies have optimum unobstructed vision.			✓	
40. Instrument reflection is avoided.		✓		
41. If possible there is a direct view of work.	✓			
42. Distortion is avoided in windows.			✓	
43. Door posts or wiper motors do not obscure vision.			✓	
44. Loader can see outside while operating in close hatch mode.			✓	
45. Provisions for auxiliary power and lighting are provided.	✓			
46. Seating is compatible with console.			✓	
47. Heating and air conditioning specifications for mobile detail work areas - 50°F to 85°F. For permanent details work areas - 65°F to 85°F.			✓	
48. Air conditioning systems do not discharge cold air directly on personnel.			✓	
49. Adequate ventilation is provided by a minimum of 30 cubic ft.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
per minute per man minimum. Air is moved past the operator at a velocity of not more than 100 feet (30 m) per minute - 65 feet (20 m) per minute if possible.				
50. The effective temperature within enclosures for extended periods is at or below 85°F (29°C).	✓			
51. The acoustical environment does not degrade system effectiveness.		✓		
52. The average room sound absorption coefficient is at least 0.20.			✓	
53. Facilities and equipment are designed to control the transmission of whole body vibration to levels permitting safe operation and maintenance.			✓	
54. Test stands are part of the equipment.			✓	
55. Handles are provided on units which are removed or carried.			✓	
56. Vehicles have a minimum temperature of 68°F (20°C)(unless wearing cold regions clothing and exposure less than 3 hours).			✓	
57. Fresh air is provided at a minimum of 20 cu. ft. (0.43 cu m)/minute/person; in a hot climate, air flow rates should be between 150 and 200 cu. ft. (4.25 and 5.66 cu m) / min./person.			✓	
58. Protective padding is used.			✓	
59. Mirrors are braced against vibration.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
60. Ventilation or other protective measures are provided within limits.			✓	
61. Intakes for ventilation systems are located so as to minimize the introduction of contaminated air from exhaust pipes, etc.			✓	
62. Cars have seat belts.			✓	
63. Windshields and windows are shatterproof and do not distort vision.			✓	
64. Hazard alerting devices are provided.			✓	
65. Illumination is adequate, glare is reduced and capability for dimming is provided.		✓		
66. Maintenance workspace is free of obstructions which could cause injury.			✓	
67. Equipment is guarded if temperature exceeds 140°F (120°F if handled).			✓	
68. Exposed edges are rounded and have a .04" minimum radius. Exposed corners are also rounded and have a 0.5" minimum radius.			✓	
69. Guards are provided on moving parts.			✓	
70. Radiation hazards are minimized.	✓			
71. Padding is non-abrasive and non-toxic.			✓	
72. Exhausts are directed away from compartments.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments
73. Adequate and suitable storage is provided for manuals, worksheets, etc.		✓		
74. Standees have work surfaces provided to support manuals, etc.		✓		
75. Conspicuous placards are adjacent to equipment which is hazardous to the user.		✓		
76. Areas requiring special equipment and/or clothing are specifically identified.		✓		
77. Any structure which can be chopped through in an emergency is clearly marked, axes provided.			✓	
78. Emergency procedures are detailed.		✓		
79. Instructions are kept simple.		✓		
80. Push-out escape windows are marked.			✓	
81. Equipment is located so that awkward working positions are unnecessary.			✓	
82. Sufficient space is provided to use test equipment and other tools required during checkout.			✓	
83. Controls (switches, knobs, etc.) are easily reached from the working position.		✓		
84. Components are located so that physical interference among operators working on the same areas is lessened.		✓		
85. The lines of sight to a display are not obscured by poor arrangement of people or equipment.		✓		

Detailed Design Considerations	YES	NO	N/A	Comments
86. Traffic flow between areas is efficient.		✓		
87. Auditory alerting and warning signals are loud enough to be heard above environmental noise.	✓			
88. Equipment is secured in order to prevent shifting or overturning accidentally.			✓	

Detailed Design Considerations	YES	NO	N/A	Comments

DESIGN CHECKLIST

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MEASURES

Test Title Rod control – Panel 4

Test Project No. ______________ Date ______________

Detailed Design Considerations	YES	NO	N/A	COMMENTS
1. Displays are located so they can be read to the required accuracy.		✓		
2. Display arrangement is consistent from one application to another.		✓		
3. Measuring marks on opaque containers are placed inside.		~~✓~~	✓	
4. Display viewing distance: 13-28".		✓		
5. Minimum number of measuring devices is used.			✓	
6. Canteen cup is useable as standard or emergency measuring device for field use.			✓	
7. Item container used for measuring where possible.			✓	
8. Measurement marks raised.			✓	
9. Containers allow for full hand, finger, clearance when using opening tool.			✓	
10. Reflections minimized.		✓		
11. Display precision, response is consistent with that of system.		✓		
12. Scales: linear, start at 0, use whole numbers, 2 pointers max. numerals oriented upright.		✓		

YES = Adequate NO = Inadequate N/A = Not Applicable

Detailed Design Considerations	YES	NO	N/A	Comments
13. Field items are non-corrosive, easily cleaned or disposed.			✓	
14. Information limited to that necessary to take action.		✓		
15. Information is directly useable.		✓		
16. Specified measuring amounts are consistent with measuring device.			✓	
17. Measures clearly detailed.		✓		
18. For group use: multiple of food components or general formula for computation given.			✓	

APPENDIX E

COLOR CODES

SURVEY OF COLOR MEANINGS (LIGHTS)

Red Color Coding	CC	OC	TMI
Raise			X
Danger			X
Trouble			X
Normal Operation			X
Fault			X
Rods Out	X	X	X
On	X	X	X
Stop			X
Start			X
Open	X	X	X
Auto			X
Manual		X	X
Trip			X
High	X		X
Running	X		
Alarm in and acknowledged	X		

SURVEY OF COLOR MEANINGS (LIGHTS)

Green Color Coding	CC	OC	TMI
Lower			X
O.K.			X
Fail			X
Normal			X
Rods In	X	X	X
Off	X	X	X
Start			X
Stop			X
Close	X	X	X
Manual			X
Auto			X
Alarm Clear	X		

SURVEY OF COLOR MEANINGS (LIGHTS)

Amber Color Coding	CC	OC	TMI
Off			X
Auto		X	X
Alert			X
Fault - (dropped rod)	X	X	X
Test			X
Reset			X
Manual	X(soft)	X	
Operate Here		X	
Lockout	X		
Slow Speed	X		
Energized (Busses) Operating	X		
Power On			X
Load Problem/Breaker Problem			X
Load OK			X
Valve Position			X
Motor Fault			X

SURVEY OF COLOR MEANINGS (LIGHTS)

Blue Color Coding	CC	OC	TMI
Auto	X	X	X
Manual			X
Trip			X
Shutdown Rods Below Exercise Limit	X		
Normal (Lockout Relays)	X		
Power On	X		

SURVEY OF COLOR MEANINGS (LIGHTS)

Black Color Coding	CC	OC	TMI
Test			X
Start			X
Reset			X
Close			X

SURVEY OF COLOR MEANINGS (LIGHTS)

White Color Coding	CC	OC	TMI
Power (On)		X	X
Control On			X
Reset			X
ES Position			X
Annuciators (Alarm)	X	X	X
Most Other Legend Switches (BWST Level Not Low)			X
Close		X	
Auto		X	
Manual	X		
Mimic Normal Operating Range	X		

APPENDIX F

SELECTION CRITERIA

OPERATOR SELECTION CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
CFR-S.1	Criterion	10 CFR - Energy	Part 55 — Operators' Licenses, Section 55.11 Requirements for the Approval of Applications, page 410. (a) The physical condition and the general health of the applicant are not such as might cause operational errors endangering public health and safety. (1) Epilepsy, insanity, diabetes, hypertension, cardiac disease, fainting spells, defective hearing or vision or any other physical or mental condition which might cause impaired judgment or motor coordination may constitute sufficient cause for denial of an application. (2) If an applicant's vision, hearing and general physical condition do not meet the minimum standards normally considered necessary, the Commission may approve the application and include conditions in the license to accommodate the physical defect. The Commission will consider the recommendations of the facility licensee or holder of an authorization and of the examining physician on Form NRC-396 in arriving at its decision.	Yes	Memorandum of M.J. Ross - Met. Ed. Description of bases for selecting and/or recruiting	CFR-S.1
STD-S.1	Requirement	ANS 3.4/ANSI N546 Medical Certification and Monitoring of Personnel Requiring Operator Licenses for Nuclear Power Plants	Section 5. Health Requirements and Disqualifying Conditions 5.2 General Requirements, page 2. 5.2.1 Capacity. The examinee shall demonstrate stability and capacity for all of the following: (1) Mental alertness and emotional stability (2) Acuity of senses and ability of expression to allow rapid, accurate communication by spoken, written, and other audible, visible, or tactile signals (3) Physique, motor power, range of motion, and dexterity to allow ready access to and safe execution of assigned duties.	Yes	Memorandum of M.J. Ross - Met. Ed. Description of bases for selecting and/or recruiting	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR SELECTION CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
STD-S.2	Requirement	ANS 3.4/ANSI N546 Medical Certification and Monitoring of Personnel Requiring Operator License for Nuclear Power Plants	Section 5. Health Requirements and Disqualifying Conditions 5.2 General Requirements, page 2. 5.2.2 Freedom from Incapacity. The examinee shall be free of any of the following conditions which are considered by the designated medical examiner as significantly predisposing to incapacity for duty: (1) Mental or physical impairments (2) Any medical, surgical, or other professional treatment (3) Any other source or use of treatment, drugs, chemicals, diets, or other agents (4) Any condition, habit, or practice which might result in sudden or unexpected incapacitation	Yes	Memorandum of M.J. Ross - Met. Ed. Description of bases for selecting and/or recruiting	STD-S.2
STD-S.3	Requirement	ANS 3.4/ANSI N546 Medical Certification and Monitoring of Personnel Requiring Operator Licenses for Nuclear Power Plants	Section 5. Health Requirements and Disqualifying Conditions 5.3 Disqualifying Conditions, page 2. A history or other indication of any disqualifying condition shall be considered disqualifying unless adequate supplemental findings demonstrate that no disqualifying condition exists. Such demonstration shall include at least the specific narrative entries by the designated medical examiner and relevant aspects of medical history and physical examination. . . The presence of any of the following conditions shall disqualify. 5.3.1 Respiratory 5.3.2 Cardiovascular 5.3.3 Endocrine, Nutritional or Metabolic 5.3.4 Integumentary 5.3.5 Hematopoietic Dysfunction 5.3.6 Malignant Neoplasms 5.3.7 Neurological 5.3.8 Mental 5.3.9 Medication	No		STD-S.3

NOTE. SEE LIST OF NOTES ATTACHED.

OPERATOR SELECTION CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
STD-5.4	Criterion	ANS 3.4/ANSI N546 Medical Certification and Monitoring of Personnel Requiring Operator Licenses for Nuclear Power Plants	Section 5. Health Requirements and Disqualifying Conditions 5.4 Specific Minimum Capacities Required for Medical Qualifications, page 4. 5.4.1 Head, Face, Neck, Scalp. Configuration suitable for fitting and effective use of personal protective equipment. 5.4.2 Noise. Ability to detect odor of products of combustion and of tracer or marker gases. 5.4.3 Mouth and Throat. Capacity for clear speech. 5.4.4 Ears. Puretone audiometric threshold average better than 30 dB (American National Standard Specification for Audiometers, 1969) or 30 dB (International Organization for Standardization, Standard Reference 0 for Calibration of Pure Tone Audiometers, 1964), or 20 dB (American Standard Specificatio for Audiometers for General Diagnostic Purposes, 1951), for speech frequences 500, 1000, 2000 Hz in better ear. If audiometric scores are unacceptable, qualification may be based upon on-site demonstration to the satisfaction of the facility operator of the examinee's ability to safely detect, interpret, and respond to speech and other auditory signals. Qualification should be considered if a hearing aid is required to meet hearing requirements. 5.4.5 Eyes (1) Near and distant visual acuity 20/40 in better eye, corrected or uncorrected. (2) Peripheral visual fields by confrontation to 120° or greater. (3) Color vision adequate to distinguish among red, green, and orange-yellow signal lamps, and any other coding required for safe operation of the particular facility as defined by the facility operator. (4) Adequate depth perception, either by stereopsis or secondary clues as demonstrated by practical test.	No		STD-5.4

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR SELECTION CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
			Section 5. Health Requirements and Disqualifying Conditions 5.4 Specific Minimum Capacities Required for Medical Qualifications, page 4 (continued). 5.4.6 Respiratory. Capacity and reserve to perform strenuous physical exertion in emergencies, and ability to utilize respiratory protective filters and air supply masks. (In pulmonary functional studies which include a forced vital capacity and f.e.v. 1 second would be helpful to the examining physician in determining the candidates ability to perform assigned work.) 5.4.7 Cardiovascular. Normal configuration and function, capacity for exertion during emergencies, and pulse rate between 50 and 100 bpm, regular. Resting pulse rate outside this range must be specifically noted by the examining physician to be normal or of no clinical significance. Full symmetrical pulses in extremities and neck. Normotensive (160/100 or less) with tolerance to rapid postural changes. If the examination reveals significant cardiac arrhythmia, murmur, untreated hypertension (over 160/100), cardiac enlargement or other evidence of cardiovascular abnormality, a report of an evaluation by a physician proficient in cardiovascular evaluations shall accompany the medical examination report. This consultation shall include, but is not limited to, an interpretation of an ECG and check x-ray. 5.4.8 Abdomen and Viscera. If hernia is present, it must be adequately supported by appropriate device or not be of such nature as to interfere with the performance of assigned duty or present significant potential for incapacity. 5.4.9 Musculo-skeletal. Normal symmetrical structure, range of motion and power. If any impairment exists, the applicant shall demonstrate ability to effectively complete all expected duties. 5.4.10 Skin. Capability to tolerate use of personal protective covering, and decontamination procedures.			

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR SELECTION CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
			Section 5. Health Requirements and Disqualifying Conditions 5.4 Specific Minimum Capacities Required for Medical Qualifications, page 4 (continued). 5.4.11 Endocrine/Nutrition/Metabolic. Normal. Ability to change schedule or delay meals without potential incapacity. 5.4.12 Hematopoietic. Normal function. 5.4.13 Lymphatic. Normal function. 5.4.14 Neurological. Normal central and peripheral nervous system function. Tactile discrimination (Stereognosis) sufficient to distinguish among various shapes of control knobs and handles by touch. 5.4.15 Psychiatric. Normal mental status including orientation. Ability to function in emergencies and unusual environments such as: confined or crowded spaces, alone, in darkness, on elevations, on open metal grids, and on ladders. This ability is to be determined by the clinical judgment of the examining physician. 5.4.16 Laboratory (1) Normal hemoglobin, white blood cell count, and differential. (2) In urinalysis, absence of proteins and glycosuria unless the absence of a disqualifying systemic or genitor-urinary condition has been demonstrated. (3) Normal electrocardiogram (ECG) (4) Any other medical investigative procedures, including chest x-ray, which the designated medical examiner considers necessary for adequate medical evaluation shall be conducted.			

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR SELECTION CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
STD-5.5	Requirement	ANS 3.1 American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 4. Qualifications, page 3. 4.1 General. Nuclear power plant personnel shall have a combination of education, experience, health, and skills commensurate with their functional level of responsibility which provides reasonable assurance that decisions and actions during normal and abnormal conditions will be such that the plant is operated in a safe and efficient manner.	Yes	Final Safety Analysis Report Section 13.1.3.1 Memorandum of M.J. Ross - Med. Ed. Description of bases for selecting and/or recruiting	
STD-5.6	Requirement	ANS 3.1 American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 4. Qualifications 4.3 Supervisors, page 3. 4.3.1 Supervisors Requiring NRC Licenses. At the time of initial core loading or appointment to the position, whichever is later, a supervisor in this category shall hold an appropriate NRC license and have a high school diploma or equivalent, and four years of power plant experience. A maximum of two years power plant experience may be fulfilled by academic or related technical training on a one-for-one time basis. Two years shall be nuclear power plant experience. At least six months of the nuclear power plant experience shall be at the plant for which he seeks a license unless such experience is acquired on a similar unit.	Yes	Final Safety Analysis Report Section 13.1.3.1	
STD-5.7	Requirement	ANS 3.1 American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 4. Qualifications 4.5 Operator-Technical-Maintenance Personnel, page 5. 4.5.1 Operators. At the time of the initial core loading or appointment to the position, whichever is later, operators to be licensed by the NRC shall have a high school diploma or equivalent, two years of power plant experience and should possess a high degree of manual dexterity and mature judgment. One year shall be nuclear power plant experience. At least six months of the nuclear experience shall be at the plant for which he seeks a license unless his nuclear experience was acquired on a similar unit. Six months credit may be granted towards the experience requirement for individuals whose related technical training or relevant experience may warrant such credit.		Final Safety Analysis Report Section 13.1.3.1.8 Memorandum of M.J. Ross - Met. Ed. Description of bases for selecting and/or recruiting	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR SELECTION CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
RG-S.1	Recommended Practice	Proposed Revision 2 to Regulatory Guide 1.8 Personnel Selection and Training	Section C. Regulatory Position, page 7. 8. At the time of initial core loading or appointment to the position, whichever is later, the minimum qualifications for persons performing the functions of unlicensed operators, other than in a training status, should include a high school diploma or equivalent and one year of power plant experience. At least 6 months of the power plant experience should be at the plant to which the individual will be assigned or at a similar unit. The individual should also possess a high degree of manual dexterity and mature judgment.	Yes	Memorandum of M.J. Ross - Met. Ed. Description of bases for selecting and/or recruiting	
RG-S.2	Guide	Regulatory Guide 1.8 Personnel Selection and Training	Section C. Regulatory Position, page 1. The criteria for the selection and training of nuclear power plant personnel contained in ANSI N18.1-1971, "Selection and Training of Nuclear Power Plant Personnel,"[1] are generally acceptable and provide an adequate basis for the selection and training of nuclear power plant personnel except for the position Supervisor — Radiation Protection.	Yes	Final Safety Analysis Report Section 13.1.3.1	
RG-S.3	Criterion	Regulatory Guide 1.134 Medical Evaluation of Nuclear Power Plant Personnel Requiring Operator Licenses	Section A. Introduction, page 1. § 55.33 of 10 CFR Part 55 states that an application for an initial or renewal operator or senior operator license will be approved if, among other things, the physical condition and general health of the applicant are not such as might cause operational errors endangering public health and safety.	Yes	Memorandum of M.J. Ross - Met. Ed. Description of bases for selecting and/or recruiting	RG-S.1

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR SELECTION CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
RG-5.4	Guide	Regulatory Guide 1.134 Medical Evaluation of Nuclear Power Plant Personnel Requiring Operator Licenses	Section B. Discussion, page 1. Working Group ANS-3.4 of Subcommittee ANS-3, Reactor Operations, of the American Nuclear Society has developed a standard prescribing minimum requirements necessary to determine that the physical condition and general health of nuclear operators are not such as might cause operational errors.	Yes	Memorandum of M.J. Ross - Met. Ed. Description of bases for selecting and/or recruiting	
RG-5.5	Guide	Regulatory Guide 1.134 Medical Evaluation of Nuclear Power Plant Personnel Requiring Opertor Licenses	Section B. Discussion, page 2. Paragraph 55.11(a)(1) specifies, in part, that any mental or physical condition that might cause impaired judgment or motor coordination may constitute sufficient cause for denial of an operator license applic tion.	No		RG-5.5

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR SELECTION NOTES

CFR-S.1 — Met. Ed. requires "normal health, physique and use of senses including color perception as indicated by passing the physical examination given by a company physician when required" and "strength adequate to perform the duties" without specifically requiring freedom from epilepsy, insanity, etc.

STD-S.2 — Met. Ed. requires "normal health" and passing of medical examinations without stipulating specific standards.

STD-S.3 — Met. Ed. does not stipulate disqualifying health conditions.

STD-S.4 — Met. Ed. does not stipulate disqualifying anthropometric considerations.

RG-S.3 — Met. Ed. requires "normal health. . . [and] passing the physical examination of a company physician when required."

RG-S.5 — Met. Ed. requires "normal health. . . [and] passing the physical examination of a company physician when required" but does not stipulate disqualifying conditions.

APPENDIX G

TRAINING CRITERIA

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
CFR-T.1	Requirement	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 415. Licensed operators and senior operators of production and utilization facilities who have been actively and extensively engaged as operators or as senior operators shall participate in requalification programs meeting the requirements of this Appendix. Individuals who maintain operator or senior operator licenses for the purpose of providing backup capability to the operating staff shall participate in the requalification programs except to the extent that their normal duties preclude the need for specific retraining in particular areas. Licensed operators or senior operators whose licenses are conditioned to permit manipulation of specific controls only shall participate in those portions of the requalification program appropriate to the duties they perform.	Yes	Final Safety Analysis Report, Section 13.2.2 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	
CFR-T.2	Recommended Practice	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 415. The requalification program requirements involving manipulation of controls may be performed on the facility for which the operator is licensed. However, the use of a simulator as specified in Paragraphs 3e and 4d of this appendix is permissible and such use is encouraged.	Yes	Final Safety Analysis Report, Section 13.2.1.1.2 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
CFR-T.3	Requirement	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 415. Requalification Program Requirements 1. Schedule. The requalification program shall be conducted for a continuous period not to exceed two years, and upon conclusion shall be promptly followed, pursuant to a continuous schedule, by successive requalification programs.	Yes	Final Safety A alysis Report, Section 13.2.2.1	CFR-T.3
CFR-T.4	Requirement	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 416. 2. Lectures. The requalification program shall include preplanned lectures on a regular and continuing basis throughout the license period in those areas where annual operator and senior operator written examinations indicate that emphasis in scope and depth of coverage is needed in the following subjects: a. Theory a. d principles of operation. b. General and specific plant operating characteristics c. Plant instrumentation and control systems. d. Plant protection systems. e. Engineered safety systems. f. Normal, abnormal, and emergency operating procedures. g. Radiation control and safety. h. Technical specifications. i. Applicable portions of Title 10, Chapter 1, Code of Federal Regulations. Other training techniques including films, videotapes and other effective training aids may also be used. Individual study on the part of each operator shall be encouraged. However, a requalification program based solely upon the use of films, videotapes and/or individual study is not an acceptable substitute for a lecture series.	Yes	Final Safety Analysis Report, Section 13.2.2.2.1	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
CFR-I.5	Requirement	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 416. 3. <u>On-the-job training</u>. The requalification program shall include on-the-job training so that: a. Each licensed operator of a production or utilization facility manipulates the plant controls and each licensed senior operator either manipulates the controls or directs the activities of individuals during plant control manipulations during the term of their licenses. For reactor operators and senior operators, these manipulations shall consist of at least 10 reactivity control manipulations in any combination of reactor startups, reactor shutdowns or other control manipulations which demonstrate skill and/or familiarity with reactivity control systems. b. Each licensed operator and senior operator has demonstrated satisfactory understanding of the operation of all apparatus and mechanisms and knows the operating procedures in each area for which he is licensed. c. Each licensed operator and senior operator is cognizant of facility design changes, procedures changes, and facility license changes. d. Each licensed operator and senior operator reviews the contents of all abnormal and emergency procedures on a regularly scheduled basis. e. A simulator may be used in meeting the requirements of paragraphs 3a and 3b if the simulator reproduces the general operating characteristics of the facility involved, and the arrangement of the instrumentation and controls of the simulator is similar to that of the facility involved.	Yes	Final Safety Analysis Report, Section 13.2.2.3	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
CFR-T.6	Requirement	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 416. 4. Evaluation. The requalification program shall include: a. Annual written examinations which determine areas in which retraining is needed to upgrade licensed operator and senior operator knowledge. b. Written examinations which determine licensed operators' and senior operators' knowledge of subject covered in the requalification program and provide a basis for evaluating their knowledge of abnormal and emergency procedures. c. Systematic observation and evaluation of the performance and competency of licensed operators and senior operators by supervisors and/or training staff members including evaluation of actions taken or to be taken during actual or simulated abnormal and emergency conditions. d. Simulation of emergency or abnormal conditions that may be accomplished by using the control panel of the facility involved or by using a simulator. Where the control panel of the facility is used for simulation, the actions taken or to be taken for the emergency or abnormal condition shall be discussed; actual manipulation of the plant controls is not required. If a simulator is used in meeting the requirements of paragraph 4c, the simulator shall accurately reproduce the operating characteristics of the facility involved and the arrangement of the instrumentation and controls of the simulator shall closely parallel that of the facility involved. e. Provision for each licensed operator and senior operator to participate in an accelerated requalification program where performance evaluations conducted pursuant to paragraphs 4a through 4d clearly indicate the need.	Yes	Final Safety Analysis Report, Section 13.2.2.1	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
CFR-T.7	Requirement	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 416. 5. Records. a. Records of the requalification program shall be maintained for a period of two years from the date of the recorded event to document the participation of each licensed operator and senior operator in the requalification program. The records shall contain copies of written examinations administered, the answers given by the licensee, results of evaluations and documentation of any additional training administered in areas in which an operator or senior operator has exhibited deficiencies. b. Records which must be maintained pursuant to this appendix may be the original or a reproduced copy or microfilm if such reproduced copy or microfilm is duly authenticated by authorized personnel and the microfilm is capable of producing a clear and legible copy after storage for the period specified by Commission regulations. c. If there is a conflict between the Commission's regulations in this part, license condition, or other written Commission approval or authorization pertaining to the retention period for the same type of record, the retention period specified in the regulations in this part for such records shall apply unless the Commission, pursuant to § 55.7, has granted a specific exemption from the record retention requirements specified in the regulations in this part.	Yes	Final Safety Analysis Report, Section 13.2.2.5 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
CFR-T.8	Criterion	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 416. 7. Applicability to research and test reactors and non-reactor facilities. To accommodate specialized modes of operation and differences in control, equipment, and operator skills and knowledge, the requalification program for each licensed operator and senior operator of a research or test reactor or of a non-reactor facility shall conform generally but need not be identical to the requalification program outlined in paragraphs 1 through 6 of this appendix. However, significant deviations from the requirements of this appendix shall be permitted only if supported by written justification and approved by the Commission.	Yes	Final Safety Analysis Report, Section 13.2.2	
CFR-T.9	Guide	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 411. § 55.21 Content of operator written examination. The operator written examination, to the extent applicable to the facility, will include questions on: (a) Fundamentals of reactor theory, including fission process, neutron multiplication, source effects, control rod effects, and criticality indications. (b) General design features of the core, including core structure, fuel elements, control rods, core instrumentation, and coolant flow. (c) Mechanical design features of the reactor primary system. (d) Auxiliary systems which affect the facility. (e) General operating characteristics, including causes and effects of temperature, pressure and reactivity changes, effects of load changes, and operating limitations and reasons for them. (f) Design, components and functions of reactivity control mechanisms and instrumentation.	Yes	Final Safety Analysis Report, Section 13.2.1.1.2 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
			Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 411 (continued). (g) Design, components and functions of safety systems, including instrumentation, signals, interlocks, automatic and manual features. (h) Components, capacity and functions of reserve and emergency systems. (i) Shielding, isolation and containment design features, including access limitations. (j) Standard and emergency operating procedures for the facility and plant. (k) Purpose and operation of radiation monitoring system, including alarm and survey equipment. (l) Radiological safety principles and procedures.			
CFR-T.40	Guide	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 411. § 55.22 <u>Content of senior operator written examination.</u> The senior operator written examination, to the extent applicable to the facility, will include questions on the items specified in § 55.21 and in addition on the following: (a) Conditions and limitations in the facility license. (b) Design and operating limitations in the technical specifications for the facility. (c) Facility licensee procedures required to obtain authority for design and operating changes in the facility. (d) Radiation hazards which may arise during the performance of experiments, shielding alterations, maintenance activities and various contamination conditions.	Yes	Final Safety Analysis Report, Section 13.2.1.1.1 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
			Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 411 (continued). (e) Reactor theory, including details of fission process, neutron multiplication, source effects, control rod effects, and criticality indications. (f) Specific operating characteristics, including coolant chemistry and causes and effects of temperature, pressure and reactivity changes. (g) Procedures and limitations involved in initial core loading, alterations in core configuration, control rod programming, determination of various internal and external effects on core reactivity. (h) Fuel handling facilities and procedures. (i) Procedures and equipment available for handling and disposal of radioactive materials and effluents.			
CFR-T.11	Guide	10 CFR - Energy	Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 412. The operating tests administered to applicants for operator and senior operator licenses are generally similar in scope. The operating test, to the extent applicable to the facility requires the applicant to demonstrate an understanding of: (a) Pre-start-up procedures for the facility, including associated plant equipment which could affect reactivity. (b) Required manipulation of console controls to bring the facility from shut-down to designated power levels. (c) The source and significance of annunciator signals and condition-indicating signals and remedial action responsive thereto. (d) The instrumentation system and the source and significance of reactor instrument readings.	Yes	Final Safety Analysis Report, Section 13.2.1 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
			Part 55 - Operators' Licenses, Appendix A Requalification Programs for Licensed Operators of Production and Utilization Facilities, page 412 (continued). (e) The behavior characteristics of the facility. (f) The control manipulation required to obtain desired operating results during normal, abnormal and emergency situations. (g) The operation of the facility's heat removal systems, including primary coolant, emergency coolant, and decay heat removal systems, and the relation of the proper operation of these systems to the operation of the facility. (h) The operation of the facility's auxiliary systems which could affect reactivity. (i) The use and function of the facility's radiation monitoring systems, including fixed radiation monitors and alarms, portable survey instruments, and personnel monitoring equipment. (j) The significance of radiation hazards, including permissible levels of radiation, levels in excess of those authorized and procedures to reduce excessive levels of radiation and to guard against personnel exposure. (k) The emergency plant for the facility, including the operator's or senior operator's responsibility to decide whether the plant should be executed and the duties assigned under the plan. (l) The necessity for a careful approach to the responsibility associated with the safe operation of the facility.			

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
RG-T.1	Recommended Practice	Regulatory Guide 1.101 Emergency Planning for Nuclear Power Plants	Paragraph 2.3.4 Training, page 1.101-14. The training program for the emergency organization should be documented in the form of schedules and lesson plans or lesson outlines. The program should include training for licensed employees and for offsite organizations and personnel who are to provide support in the emergency response. The training for offsite personnel who may be required to enter the site should typically include familiarization with the site and instructions on site procedures necessary for their safety and for their effective interface with onsite personnel. Offsite personnel training may include emergency dosimeter issue procedures, fire main connection locations, vehicle access routes, and plant alarms. Training should include delineation of methods to evaluate its effectiveness and to correct weak areas through feedback with emphasis on schedules, lesson plans, practical training, and periodic examinations.	Yes	Final Safety Analysis Report, Appendix 13A	
RG-T.2	Recommended Practice	Regulatory Guide 1.101 Emergency Planning for Nuclear Power Plants	Paragraph 2.3.5 Tests and Drills, page 1.101-14. Procedures should provide for practice drills that use detailed scenarios to test both specific procedures and implementation of the major aspects of the emergency plan. The scenarios should be planned simulations of emergency situations, and they should be approved by plant management after they have been reviewed for scope and adequacy. The procedures should consider the utility of testing on both an announced and unannounced basis. They should require the use of an observer staff during the conduct of test drills and should contain provisions for appropriate checklists or critique sheets to be used by the observer staff.	Yes	Final Safety Analysis Report, Appendix 13A, Section 6.1.2	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
RG-T.3	Recommended Practice	Regulatory Guide 1.78 Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During A Postulated Hazardous Chemical Release	Section C Regulatory Position, page 1.78-5. Each operator should be taught to distinguish the smells of hazardous chemicals peculiar to the area. Instruction should include a periodic refresher course. Practice drills should be conducted to ensure that personnel can don breathing apparatus within two minutes.	No		RG-T.3
RG-T.4	Guide	Regulatory Guide 1.114 Guidance On Being Operator At The Controls of A Nuclear Power Plant	Section B Discussion, page 1.114-1. The operator at the controls of a nuclear power plant has many responsibilities, which include but are not limited to (1) adhering to the plant's technical specifications, plant operating procedures, and NRC regulations; (2) reviewing operating data, including data logging and review, in order to ensure safe operation of the plant; and (3) being able to manually initiate engineered safety features during various transient and accident conditions.	Yes	Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	
RG-T.5	Guide	Regulatory Guide 1.114 Guidance On Being Operator At the Controls of a Nuclear Power Plant	Section C Regulatory Position, page 1.114-2. 3. Administrative procedures should be established to define and outline (preferably with sketches) specific areas within the control room where the operator at the control should remain. The procedures should define the surveillance area and the areas that may be entered, in the event of an emergency affecting the safety of operations, by the operator at the controls to verify receipt of an annunciator alarm or initiate corrective action.	Yes	Three Mile Island Nuclear Station Administrative Procedure 1028 Operator at the Controls	
RG-T.6	Guide	Regulatory Guide 1.114 Guidance On Being Operator At the Controls of a Nuclear Power Plant	Section C Regulatory Position, page 1.114-2. 6. Prior to assuming responsibility for being operator at the controls, the relief operator should be properly briefed on the plant status. In order to ensure that proper relief occurs, administrative procedures should be written to describe what is required. The administrative procedures should include, as a minimum, a definition of proper relief (e.g., what information is required to be passed on and acknowledged between the two operators).	Yes	Three Mile Island Nuclear Station Administrative Procedure 1012 Shift Relief and Log Entries	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
STD-T.1	Requirement	ANS 3.2/ANSI N18.7 - Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants	Section 3.4 Onsite Operating Organization - 3.4.2 Requirements for the Onsite Operating Organization, page 4. Initial incumbents or replacements for members of the onsite operating organization and offsite technical support organizations shall have appropriate experience, training and retraining to assure that necessary competence is maintained in accordance with the provisions of American National Standard for Selection and Training of Nuclear Power Plant Personnel, N18.1-1971. (4)	Yes	Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	
STD-T.2	Requirement	ANS 3.5 - Nuclear Power Plant Simulators for Use in Operator Training	Section 3.1 Simulator Capabilities - 3.1.1 Normal Plant Evolutions, page 2. The minimum evolutions that shall be performed on the simulator, using only operator action normal to the reference plant, are defined in the following list. Plant startup - cold (refueling conditions of temperature and pressure) to hot standby. Nuclear startup, hot standby to 100% full power. Turbine startup and generator synchronization. Power escalation to 100% power. Reactor trip followed by recovery to 100% power. Operations at hot standby. Power system load changes (manual and automatic control). Power operations with less than full reactor coolant flow. Plant shutdown and cooldown to cold (refueling) conditions.	Yes	Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
STD-T.3	Requirement	ANS 3.5 - Nuclear Power Plant Simulators for Use in Operator Training	Section 3.1 Simulator Capabilities - 3.1.2 Plant Malfunctions, page 2. The simulator shall be capable of simulating in real time a minimum of seventy-five (75) abnormal and emergency conditions resulting from malfunctions to demonstrate inherent plant response and functioning of automatic plant controls. The abnormal and emergency conditions listed below shall be included, as applicable, to the type of reactor. Loss of reactor coolant (large and small). Loss of instrument air. Loss of electrical power (or degraded power sources, or both). Loss of reactor coolant flow. Loss of condenser vacuum. Loss of service (cooling) water. Loss of shutdown cooling. Loss of component cooling (individual components or total system). Loss of feedwater or feedwater system failure. Loss of neutron flux indication. Mispositioned control rod or rods (including rod drops). Inability to drive one or more control rods. Conditions requiring use of backup reactor shutdown systems. Fuel cladding failure or high activity in reactor coolant or off gas. Turbine trips. Failure of automatic reactivity control systems. Steam generator tube leak. Steam leak (selected sizes) inside and outside containment.	Yes	Babcock and Wilcox Nuclear Training Services Catalog	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
			Section 3.1 Simulator Capabilities - 3.1.2 Plant Malfunctions, page 2 (continued). Failure of pressure control systems. Generator trips. Reactor trips.			
STD-T.4	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 6. 5.1 General Aspects. A training program and schedule shall be established for each nuclear power plant to initially develop and maintain an organization fully qualified to be responsible for operation, maintenance, and technical aspects of the nuclear power plant involved. The program shall be formulated to provide the required training based on individual employee experience and intended position. The training program shall be such that fully trained and qualified operating, maintenance, professional, and technical support personnel are available in the necessary numbers when fuel loading commences. In all cases, the objective of training programs shall be to ensure safe and efficient operation of the facility. Training programs shall be kept up to date to reflect plant modifications and changes in procedures. A continuing program shall be used after plant startup for training of replacement personnel and for requalification training necessary to ensure that personnel remain proficient.	Yes	Final Safety Analysis Report, Section 13.2.1 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	STD-T.4

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
STD-T.5	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 6. 5.2 Training of Personnel to be Licensed by the NRC. Training goals consistent with NRC licensing requirements shall be established for personnel in these categories. Preparation of training programs shall take into account the previous experience and training of trainees. Such training programs shall cover the subject matter listed in the following subsections to the extent necessary to assure that individuals meet the requirements of 4.2.1, 4.2.2, 4.3.1, or 4.3.2.	Yes	Final Safety Analysis Report, Section 13.2.1 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	STD-T.5
STD-T.6	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 6. 5.2.1 Training of Candidates for NRC Cold Examinations for the Initial Unit at a Site. If not already eligible by experience and previous training, candidates for NRC cold examinations shall be qualified by a combination of participatory assignments at operating reactors or suitable reactor simulators, participation in preoperational or startup activities at the nuclear power plant involved, and related technical training. Applicants for cold examinations shall have had extensive operating experience at a reactor facility which is generally classified as comparable in complexity and operating characteristics to the nuclear power plant at which the examinations are to be requested.	Yes	Final Safety Analysis Report, Section 13.2.1 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	STD-T.6
STD-T.7	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 7. 5.2.2 Related Technical Training. Training programs for candidates for NRC cold examinations at the reactor operator level shall cover the following subjects: (1) principles of reactor operation (2) design features of the nuclear power plant (3) general operating characteristics of the nuclear power plant (4) instrumentation and control systems (5) safety and emergency systems	Yes	Final Safety Analysis Report, Section 13.2.1 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	STD-T.7

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFEREN	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
			Section 5. Training, page 7 (continued). (6) standard and emergency operating procedures (7) radiation control and safety provisions In addition to the above subjects, related technical training for candidates for NRC cold examinations at the senior reactor operating level shall include the following subjects: (8) reactor theory (9) handling and disposal of, and hazards associated with, radioactive materials (10) specific operating characteristics of the nuclear power plant (11) fuel handling and core parameters (12) administrative procedures, conditions, and limitations The course content shall be directly related to the plant for which he seeks a license. In addition, the applicant should be engaged in the day-to-day activities of procedure preparation and verification, construction check out and preoperational testing at the subject facility for a period of approximately one year prior to fuel loading. This time may vary depending upon the experience of the applicant. However, the minimum time shall be six months on site unless an equivalent amount of experience was obtained on a similar unit.			

NOTE: SEE LIST OF NOTES ATTACHED.

IMAGE EVALUATION
TEST TARGET (MT-3)

6″

MICROCOPY RESOLUTION TEST CHART

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
STD-T.8	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 8. 5.2.4 Hot Examinations. If not already eligible by experience and previous training, candidates for NRC hot examinations shall complete related technical training in the subject areas identified in 5.2.2. In addition, such candidates shall participate in a program of on-the-job training which involves manipulation of the nuclear power plant controls during day-to-day operation and during at least two training startups and shutdowns of the reactor; and informal programs of self-study and counseling from more experienced personnel to facilitate the candidates' understanding of overall plant operating characteristics, plant system performance characteristics, and operating procedures.	Yes	Final Safety Analysis Report, Section 13.2.1 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	STD-T.8
STD-T.9	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 8. 5.4 General Employee Training. All persons regularly employed in the nuclear power plant shall be trained in the following areas commensurate with their job duties: General Description of Plant and Facilities Job Related Procedures and Instructions Radiological Health and Safety Program Station Emergency Plans Industrial Safety Program Fire Protection Program Security Program Quality Assurance Program	Yes	Final Safety Analysis Report, Section 13.2.1	STD-T.9

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
STD-T.10	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 9. 5.5 Operator Retraining and Replacement Training. A training program shall be established which maintains the proficiency of the operating organization through periodic training exercises, instruction periods, and reviews covering those items and equipment which relate to safe operation of the facility and through special training sessions for replacement personnel to meet the requirements of Section 4, "Qualifications." In determining the staff complement, the facility management shall recognize the important relationship the training program has to the maintenance of operational safety by (a) providing experienced and knowledgeable personnel to develop and audit the training program as well as serve as training program instructors; and (b) provide sufficient personnel in classifications to permit training and requalification work. The training program shall be reviewed and evaluated at intervals not exceeding two years.	Yes	Final Safety Analysis Report, Section 13.2.1 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	STD-T.10
STD-T.11	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 9. 5.5.1 Requalification Program for Licensed Operators. Requalification training programs covering a two year period shall include preplanned lectures, on-the-job training and operator evaluation on a regular and continuing basis. Documentation of the above programs shall be maintained for all licensed individuals required to fulfill the Technical Specification requirements of a given facility.	Yes	Final Safety Analysis Report, Section 13.2.2.2.1 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	

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OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
STD-T.12	Recommended Practice	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training - 5.5.1.1 Lectures, page 9. 5.5.1.1.1 General. The minimum number of lectures in any calendar year should not be less than six, spaced throughout the year and taking into consideraton heavy vacation periods and infrequent operations such as, refueling period, forced outages, etc. Lectures may be deferred due to unanticipated shutdowns. However, these lectures shall be conducted as soon as practicable thereafter.	Yes	Final Safety Analysis Report, Section 13.2.2.2.1 Training and Certification of Met. Ed. Co.'s TMI-2 Licensed Personnel	
STD-T.13	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training - 5.5.1.2 On-the-Job Training, page 9. 5.5.1.2.1 Control Manipulation. . . However, the requalification programs shall contain a commitment that each individual shall perform or participate in a combination of reactivity control manipulations based on the availability of plant equipment and systems. PWR (1) Plant or reactor startups to include a range that reactivity feedback from nuclear heat addition is noticeable (2) Plant shutdown (3) Manual control of steam generators during startup and shutdown (4) Operation of turbine controls in manual during startup (5) Boration during power operation (6) Dilution of the reactor coolant system (7) Refueling operations where fuel is moved in the core (8) Rod drop timing tests (9) Any significant (> 10%) power changes in manual rod control (10) Manual rod control prior to and during generator synchronization (11) Plant and reactor operation that involves emergency or transient procedures where activity is changing.	Yes	Final Safety Analysis Report, Section 13.2.2.3	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

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STD-T.14	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 10. 5.5.1.2.3 Knowledge of Facility Design Changes, Procedures Changes and Facility License Changes. The program shall clearly indicate the methods to be employed to assure each licensed individual is cognizant of the above.	Yes	Final Safety Analysis Report, Section 13.2.2.2.1	
STD-T.15	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 10. 5.5.1.2.4 Review of Abnormal, Emergency and Security Procedures. The program shall indicte the methods to be employed to assure each licensed individual reviews the abnormal, emergency and security procedures. The security procedures covered shall only include those which plant personnel have a need to know as required by American National Standard Industrial Security for Nuclear Power Plants, N18-17-1973 (ANS-3.3), Section 4.2.4 and 4.7 (1).	Yes	Final Safety Analysis Report, Section 13.2.1.6	
STD-T.16	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 10. 5.5.1.3.1 Annual Examinations. The requalification programs shall provide for an annual written examination comparable in scope and degree of difficulty to an NRC examination consistent with the type of license held.	Yes	Final Safety Analysis Report, Section 13.2.2	
			The program shall provide that a grade of less than 70% overall requires mandatory participation in an accelerated requalification program. The program shall contain a provision that an individual enrolled in an accelerated requalification program shall not perform licensed duties until he has successfully completed the program.	Yes	Final Safety Analysis Report, Section 13.2.2.4	

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OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

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STD-T.17	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 11. 5.5.1.3.2 Periodic Examinations. Other written examinations shall be administered during the course of the lecture series. The program shall provide a grade criterion that the individual has learned the material presented. A grade of less than 80% will require additional retraining in that subject.	Yes	Final Safety Analysis Report, Section 13.2.2.4	
STD-T.18	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 11. 5.5.1.3.3 Observation. The program shall provide for systematic observation and documented evaluation of an individual's performance and competency in addition to the immediate supervisor's normal continuous evaluation.	Yes	Final Safety Analysis Report, Section 13.2.2.5	
	Recommended Practice		Such observations should also include evaluations including actions taken, or to be taken, during actual or simulated abnormal and emergency conditions.			
STD-T.19	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training - 5.5.1.3.4 Accelerated Requalification Programs, page 11. However, a grade criterion of 70% or greater in any written examination is required to indicate successful completion of the accelerated requalification program. As part of the requalification program, records indicative of on-the-job proficiency and performance shall be maintained. Repeated errors indicative of degraded proficiency shall be reviewed by facility management and appropraite training or other corrective actions shall be initiated.	Yes	Final Safety Analysis Report, Section 13.2.2.4	

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OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
STD-T.20	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 11. 5.5.1.5 Staff Members. Individuals who maintain operator or senior operator licenses for the purpose of providing backup capability to the operating staff shall participate in the requalification program except to the extent that their normal duties preclude the need for specific retraining in particular areas. As a minimum these individuals shall: (1) Be administered the annual written examination and participate in the lecture series based on the results thereof (2) Manipulate the control or supervise the manipulation of the controls through 10 reactivity changes (3) Systematically review design changes, procedure changes and facility license changes (4) Systematically review the content of all abnormal, emergency and security procedures on a regularly scheduled basis (5) Be systematically evaluated regarding actions to be taken during simulated abnormal and emergency conditions by a walk-through of the procedural steps.	Yes	Final Safety Analysis Report, Section 13.2.2.3	
STD-T.21	Requirement	ANS 3.1 - American National Standard for Selection and Training of Nuclear Power Plant Personnel	Section 5. Training, page 11. 5.6 Documentation. Available records of the qualifications, experience, training, retraining and operator requalification program examinations for each member of the plant organization covered by this standard shall be maintained for as long as a person performs work in job categories described in this standard.	Yes	Final Safety Analysis Report, Section 13.2.2.5	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
SRP-T.1	Recommended Practice	Standard Review Plan	Section 13.1.1, Management and Technical Support Organization, page 13.1.1-2. 2. Preoperational Responsibilities These are functions which should be substantially accomplished before preoperational testing begins and generally before submittal of the final safety analysis report (FSAR). b. Development and implementation of staff recruiting and training programs.	Yes	Final Safety Analysis Report, Section 13.2.1	
SRP-T.2	Guide	Standard Review Plan	Section 13.1.3, Qualifications of Nuclear Plant Personnel, page 13.1.3-1. II. ACCEPTANCE CRITERIA Regulatory Guide 1.8, "Personnel Selection and Training," sets forth the staff position on plant personnel qualifications and indicates that the criteria for selection (qualifications) contained in ANSI N18.1-1971 are generally acceptable.	Yes	Final Safety Analysis Report, Section 13.2.1	
SRP-T.3	Recommended Practice	Standard Review Plan	Section 13.2, Training, page 13.2-1. I. AREAS OF REVIEW The applicant's plant personnel training program, as described in his safety analysis report (SAR) is reviewed. This section of the SAR should contain the description and scheduling of the training program for initial appointees to the plant staff. The program descriptions should include the following: For the preliminary safety analysis report (PSAR): 1. The proposed subject matter of each course, the duration of the course (approximate number of weeks in full time attendance), the organization teaching the course or supervising instruction, and the position titles for whom the course is give.	Yes	Preliminary Safety Analysis Report, Section 12.2.1	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
			Section 13.2, Training, page 13.2-1 (continued).			
			2. Reactor operations experience training by nuclear power plant simulator or assignment to a similar plant, including length of time (weeks), and identity of simulator and plant.	Yes	Preliminary Safety Analysis Report, Section 12.2.1	
			3. A commitment to conduct an onsite formal training program and on-the-job training before initial fuel loading.	Yes	Preliminary Safety Analysis Report, Section 12.2.1	
			4. Any difference in the training programs for individuals who will be seeking licenses prior to criticality pursuant to Section 55.25 of 10 CFR Part 55 based on the extent of previous nuclear power plant experience. Experience groups should include the following: a. Individuals with no previous experience. b. Individuals who have had nuclear experience at facilities not subject to licensing. c. Individuals who hold, or have held, licenses for comparable facilities.	Yes	Preliminary Safety Analysis Report, Section 12.2.1	
			5. Means for evaluating the training program effectiveness for all employees. For license applicants this includes the means to be employed to certify that each applicant has had extensive actual operating experience pursuant to Section 55.25(b) of 10 CFR Part 55. This program description should also include a chart to show the schedule of each part of the training program for each functional position identified in SAR Section 13.1.2. The time should be relative to expected fuel loading and should also display the preoperational test period, and the expected time for examinations for licensed operators prior to plant criticality.	Yes	Preliminary Safety Analysis Report, Section 12.2.1	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
SRP-T.4	Recommended Practice	Standard Review Plan	Section 13.2, Training, page 13.2-2. In the final safety analysis report (FSAR):			
			1. The proposed subject matter of each course, the duration of the course (approximate number of weeks in full time attendance), the organization teaching the course or supervising instruction, and the position titles for whom the course is given.	Yes	Final Safety Analysis Report, Section 13.2.1.1.2 and 13.2.1.5	
			2. Reactor operations experience training by nuclear power plant simulator or assignment to a similar plant, including length of time (weeks), and identity of simulator and plant.	Yes	Final Safety Analysis Report, Section 13.2.1.1.2	
			3. The details of the onsite training program, including a syllabus or equivalent course description, the duration of the course (approximate number of weeks in full time attendance), the organization teaching the course or supervising instructions, and the position titles for which the course is given. The program should distinguish between classroom training and on-the-job training, before and after the initial fuel loading.	Yes	Final Safety Analysis Report, Section 13.2.1.1.2	
			4. Any difference in the training programs for individuals who will be seeking licenses prior to criticality pursuant to Section 55.25 of 10 CFR Part 55 based on the extent of previous nuclear power plant experience. Experience groups should include the following: a. Individuals with no previous experience. b. Individuals who have had nuclear experience at facilities not subject to licensing. c. Individuals who hold, or have held, licenses for comparable facilities.	Yes	Final Safety Analysis Report, Section 13.2.1.4	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
			Section 13.2, Training, page 13.2-2 (continued).			
			5. Means for evaluating the training program effectiveness for each employee. For applicants for license examinations prior to criticality, the means to be employed to certify that each applicant has had extensive actual operating experience pursuant to Section 55.25(b) of 10 CFR, Part 55.	Yes	Final Safety Analysis Report, Section 13.2.1.1.1, 13.2.1.1.2, 13.2.1.5	
			The program description section should also include a chart to show the schedule of each part of the training program for each functional position identified in FSAR Section 13.1.2. The time scale should be relative to expected fuel loading and should also display the preoperational test period, expected time for examinations for licensed operators prior to criticality, and expected time for examinations for licensed operators after criticality (13.2.1.2). The description should delineate clearly the extent to which the training program has been accomplished at the approximate time of submittal of the FSAR. Contingency plans for additional training for individuals to be licensed prior to criticality should be described in the event fuel loading is subsequently delayed from the date indicated in the FSAR. The FSAR should describe the applicant's plans for retraining of plant staff personnel including requalification training for licensed operators and senior operators (13.2.2). The detailed description of the proposed requalification training program should show how it will meet the requirements of 10 CFR Part 55, Appendix A (13.2.2.1). The FSAR should also identify the additional position categories on the plant staff for which retraining will be provided, and should describe the nature, scope, and frequency of such retraining (13.2.2.2).	Yes	Final Safety Analysis Report, Section 13.2.2	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
SRP-T.5	Criteria	Standard Review Plan	Section 13.2, Training, page 13.2-3. II. ACCEPTANCE CRITERIA The SAR should demonstrate that the training provided, or to be provided, for each position on the plant staff will be adequate to provide assurance that all plant staff personnel qualification requirements will be met as of the time needed, i.e., prior to operator license examinations, prior to fuel loading, or prior to appointment or reappointment to the position. Criteria for acceptability are: 1. The training requirements and guidance set forth in the following regulations and regulatory guides should be met or acceptable alternatives should be presented. 10 CFR Part 50 — All Employees 10 CFR Part 19 — All employees Regulatory Guide 1.8 — All Employees 10 CFR Part 55 — Licensed Operators and Senior Operators AEC Licensing Guide, "Operators' Licenses," WASH-1094 — Licensed Operators and Senior Operators 2. Formal segments of the initial training program should be substantially completed when the preoperational test program begins, with the exception of a brief formal refresher just prior to operator examinations. 3. The number of persons for whom training is planned in preparation for senior operator and operator examinations prior to criticality should be sufficient to assure that applicable technical specification conditions with respect to the numbers of licensed operators on shift crews can be met from the time of initial fuel loading of the first unit, with due allowance given for examination contingencies and the need to avoid planned overtime for supervisory personnel during the startup phase in order to meet technical specification conditions.	Yes	Preliminary Safety Analysis Report, Section 12.2.1 Final Safety Analysis Report, Section 13.2	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERION, GUIDE, REQUIREMENT OR RECOMMENDED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
			Section 13.2, Training, page 13.2-3. 4. The licensed operator requalification training program should adequately implement the requirements of 10 CFR Part 55, Appendix A. 5. Refresher training for non-licensed personnel should be periodic and not less than biannual and should include at a minimum refresher instruction on administrative, radiation protection, emergency, and security procedures.	Yes/No		SRP-T.7
SRP-T.6	Recommended Practice	Standard Review Plan	Section 13.3, Emergency Planning, page 13.3-4. All plant personnel will receive training in emergency procedures and periodic drills will be conducted.	Yes	Preliminary Safety Analysis Report, Section 12.2.4 Final Safety Analysis Report, Section 13.3.1	
SRP-T.7	Recommended Practice	Standard Review Plan	Section 13.3, Emergency Planning, Appendix A Emergency Plans for Nuclear Power Plants, page 13.3-21. 7.1 Organizational Preparedness 7.1.1 Training This section should include a description of periodic training programs to be given to all categories of emergency personnel. Specialized training for the following categories should be included: 2. Personnel responsible for accident assessment, including control room shift personnel.	Yes	Final Safety Analysis Report, Section 6.1.1.2	

NOTE: SEE LIST OF NOTES ATTACHED.

OPERATOR TRAINING CRITERIA, GUIDES, REQUIREMENTS AND RECOMMENDED PRACTICES

NUMBER	TYPE	REFERENCE	LANGUAGE OF CRITERI[illegible] [illegible]UIDE, REQUIREMENT OR RECOMME[illegible]ED PRACTICE	MET. ED IN AGREEMENT?	SOURCE	NOTES
SRP-T.8	Recommended Practice	Standard Review Plan	Section 13.3, Emergency Planning, Appendix A Emergency Plans for Nuclear Power Plants, page 13.3-22. 7.2 <u>Review and Updating of the Plan and Procedures</u> Provision should be made for an annual review of the emergency plan and for updating and improving procedures based upon training, drills, and changes onsite or in the environs. Means for maintaining all coordinate elements of the total emergency organization informed of revisions to the plant or relevant procedures should be described.	Yes	Final Safety Analysis Report, Section 6.1.2.6	
SRP-T.9	Recommended Practice	Standard Review Plan	Section 13.5, Plant Procedures, page 13.5-3. A generally acceptable target date for completion of administrative procedures and operating procedures is about six months before fuel loading, inasmuch as familiarization with these procedures is an essential part of the staff training program, including preparation for operator license examinations prior to criticality.	Yes	Final Safety Analysis Report, Section 13.5.1	

NOTE: SEE LIST OF NOTES ATTACHED.

NOTES

CFR-T.3 — Met. Ed.'s Requalification Training Program exceeds requirement, with an annual cycle of requalification program operation of "12 months, not to exceed 15 months."

STD-T.4 — FSAR makes reference to ANSI 18.1-1971, original version of ANS 3.1.

STD-T.5 — FSAR makes reference to ANSI 18.1-1971, original version of ANS 3.1.

STD-T.6 — FSAR makes reference to ANSI 18.1-1971, original version of ANS 3.1.

STD-T.7 — FSAR makes reference to ANSI 18.1-1971, original version of ANS 3.1.

STD-T.8 — FSAR makes reference to ANSI 18.1-1971, original version of ANS 3.1.

STD-T.9 — FSAR makes reference to ANSI 18.1-1971, original version of ANS 3.1.

STD-T.10 — FSAR makes reference to ANSI 18.1-1971, original version of ANS 3.1.

RG-T.3 — Drills emphasizing the donning of breathing apparatus are not listed as such in PSAR, FSAR or Program description though may be subsumed under various emergency drills, i.e., Fire Brigade Drills, etc.

SRP-T.5 — FSAR states "as time permits."

APPENDIX H

TRAINING OBJECTIVES

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2022-1.4 Loss of RC Flow/RC Pump Trip

Task	Decision	Requirement	Performance	Knowledges	Objectives
1. Verify automatic trip of RCP	o Automatic trip has occurred	o Annunciator alarm o RCP light above control switch goes from red to green o Decrease in affected loop flow	o Identify that an automatic trip has occurred	o Knowledge of display meaning o Diagnostic skill verification	o Operator should be able to determine that an RCP has tripped automatically with 100% accuracy (no time limit).
2. Manually trip RCP	o Trip decision	o Trip if motor guide bearing temperature > 185° computer points by RCPs o Motor thrust bearing temperature > 200°F (computer) o Motor station temperature > 302°F (computer) o RCP seal staying water temperature > 185°F (computer) o Air cooler leak detector alarms o Shaft vibration exceeds - 26 mils for 1 or 2 RCPs per loop - 30 mils for 1st 4 hours of 1 pump per loop operation o Seal cavity pressure > 2500 psig o Loss of total seal injection and intermediate closed cooling flow o Seal staying flow plus leak flow exceeds 1.91 gpm o Loss of cooling water to motors o Motor stand vibration > 3 mils	o Manually trip RCP	o Diagnostic skill - when to trip o Control skill	o Operator should be able to determine that an RCP trip is necessary and trip the RCP with 100% accuracy (no time limit).

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-1.5 Section B Inoperative PORV (RC-R2)

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
1. Determine PORV failed open	o PORV failed open	o RC-R2 discharge line temperature > 200° alarm point o RC pressure < 2205 psig o RC drain tank pressure and temperature above normal on control room rad waste disposal panel-8A	o Identify PORV failures	o Diagnostic skill-identify fault from cues	o Operator should be able to diagnose a failed open PORV with 100% accuracy (No time limit stated).
2. Verify automatic response	o Automatic system correct?	o Pressurizer heater status o Reactor status o HPI status	o Pressurizer heater banks on full below 2105 psig o Reactor trips at 1900 psig or variable pressure/temperature	o Diagnostic skill-correct responses at right times	o Operator should be able to verify the response of the automatic system with (No time limit stated).
3. Complete immediate response	o When to terminate action	o Pressurizer heater status o Electromatic relief isolation valve (RC-V2) status	o Close RC-V2 o Ensure PZR heaters are on below 2105 psig	o Diagnostic skill-verify heaters on	o Operator should be able to respond to an inoperative PORV with 100% accuracy (No time limit stated).
4. Complete follow-up actions	o System status	o Pressures and temperatures	o Return pressures and temperatures to normal o Reduce ICS rate of change to less than 1%/minute	o Knowledge of procedures	o Operator should be able to bring pressure and temperature back to normal with 100% accuracy (No time limit stated).

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-2.2 Turbine Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
1. Recognize Automatic Trip	o Judgment - turbine has tripped	o Indication that turbine has tripped (annunciator) o Indications that turbine throttle, intercept and reheat stop valves are closed o Indication that generator breakers are open o Indication that megawatts electric = 0 o Indication that reactor power is decreasing o Indication that PZR level is increasing above 240 inches o Indication that steam pressure is increasing above 885 psig o Indication that Tave is increasing above 582°F	o Correctly determine turbine has tripped	o Perceptual skill - read annunciators - read displays o Knowledge - symptoms of turbine trip o Diagnostic skill - judge turbine has tripped based on displays	o Operator should be able to recognize a turbine trip immediately with 100% accuracy (no time requirement stated).

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-2.2 Turbine Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
2. Determine Reason for Trip	o Determine if turbine trip is due to: - generator trip - reactor trip - both feed pumps tripped - loss of closed cooling water pumps - vacuum low - loss of 2 of 3 turbine speed signals - overspeed - thrust bearing failure trip - low bearing oil pressure trip - EHC loss of DC power - high vibration	 - trip indicators - trip indicators - both annunciators lit - water pump status - vacuum status - speed signal status - RPM readout - greater than 1998 rpm - 75-80 psig pressure - less than 5 to 7 psig - DC power status - greater than 14 mils for 10 sec.	o Integrate information from a number of sources and formulate a decision (no procedure given for this diagnosis)	o Perceptual skills - reading of displays o Diagnostic skills - formulation of hypothesis based on displays - understanding of plant status o Knowledges - display locations - display meaning - display relationships - procedures for diagnosing turbine trip - principles of operation	o Operator should be able to diagnose a turbine tripped situation and identify the cause for the trip with 100% accuracy (no response time requirement stated).

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-2.2 Turbine Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
3. Verify automatic response to trip	o Determine that correct automatic responses have been made	o Indications of: - turbine throttle stop valve closed - governor stop valve closed - reheat stop valve closed - generator breakers open - turbine bypass valves on atmospheric relief open - PZR PORV open - ICS trips to tra[illegible] - ICS runback 20%/min. - loss of FW pumps - runback is 50%/min. to 15% power - emergency feed pumps start - if both main feed pumps tripped - OTSGs at minimum level - 30" - seal oil backup pump, bearing oil lift pump and turn gear oil pump start - extraction valves closed - extraction line drain valves open	o Integrate information from a number of sources and formulate a decision that automatic response to trip is correct. (No procedure given) (No guidelines exist concerning what to do if automatic system is not responding correctly)	o Perceptual skill - reading displays o Diagnostic skill - verification of automatic response o Knowledges - display location - display meaning - display relationships - decision rules - principles of operation o Memory skill - immediate response to trip without reference to procedures	o Operator should be able to determine that the automatic response is or is not correct with 100% accuracy. (No time requirement stated.)

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-2.2 Turbine Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
4. Respond with immediate action					o Operator should be able to respond with immediate actions immediately - with 100% accuracy and without reference to procedures.
4.1 Total Feed water reduced manually to 15% neutron power (if FW stations are in hand)	o Decision to terminate reduction	o Feedback that FW reduction is in process o Indication of 15% neutron power	o Control activation (no details on procedures) control 11s while monitoring power displays	o Control skill - activation of control to achieve 15% neutron power o Memory skill - immediate response with no reference to procedures o Procedural skill	o Operator should be able to reduce feedwater to produce a 15% neutron power level with 100% accuracy (no time limit stated).
4.2 Run rods in manually to 15% neutron power (if diamond power or reactor master is in hand)	o Decision to terminate rod run-in	o Feedback that rod run-in is in process o Indication of 15% neutron power	o Control actuation (no details on procedures)	o Control skill - actuation of control to achieve 15% neutron power o Memory skill - immediate response with no reference to procedures o Procedural skill	o Operator should be able to control rods to produce a 15% neutron power level with 100% accuracy (no time limit stated).

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-2.2 Turbine Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
4.3 Runback ICS station for: - SG/reactor demand - FW demand - Main or startup FW valve demand - Feed pump speed - Reactor master - Diamond power	o Decision that stations are in hand	o Control setting o Status	o Decrease manually the valves for stations still in hand	o Control skill - control of station parameter for stations in hand o Knowledge - of controls involved - of procedures - of system status	o Operator should be able to control station parameters to shutdown status with 100% accuracy.
5. Respond with follow-up action					o Operator should be able to determine that critical parameters are or are not in tolerance with 100% accuracy (no time limit stated).
5.1 Monitor PZR level	o In limits? 240"	o Actual PZR level o PZR level limits	o Read displays o Read procedures for limits o Compare displays with limits	o Knowledge of limits o Perceptual skill-display reading o Diagnostic skill o Procedural skill	
5.2 Monitor RC pressure	o In limits? 2155 psig	o Actual RC pressure o RC pressure limits	o Same as above	o Same as above	
5.3 Monitor RC temperature	o In limits? Tave 582°	o Actual RC temperature o RC temperature limits	o Same as above	o Same as above	

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-2.2 Turbine Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
5.4 Monitor OTSG levels	o In limits? 30"	o OTSG levels - actual o OTSG level limits	o Same as above	o Same as above	
5.5 Monitor steam header pressure	o In limits? 885 psig	o Actual steam header pressure o Steam header pressure limits	o Same as above	o Same as above	
5.6 Control Tave to 582°, RC pressure to 2055 psig, and steam header pressure to 885 psig	o Terminate adjustment	o Tave = 582° o RC pressure = 2155 psig o Steam header pressure = 885 psig o Reading variations allowable	o Control PZR heaters and spray control (procedures do not identify what to do if control action does not work)	o Knowledge of rate of response o Control skills and hand-eye coordination o Industrial skill-control technique o Diagnostic skill - understanding of what's going on in the plant	o Operator should be able to control Tave, RC pressure, and steam header pressure with 100% accuracy ±? (no time limit stated).
5.7 Control pressurizer level to 240"	o Terminate adjustment	o PZR level - 240" o Reading variation (error) allowable	Adjust makeup and letdown flows to control PZR level (procedures do not identify what to do if PZR level cannot be controlled to 240")	o Knowledge of system rate of response o Control skill - hand-eye coordination o Industrial skill-control technique	o Operator should be able to control PZR level to 240"±? with 100% accuracy (no time limit stated).
5.8 Control OTSG levels to 30"	o Terminate adjustment	o OTSG levels = 30" o Precision requirements - 30" ±?	o Adjust feed flow (procedures do not address what to do if flow cannot be controlled)	o Knowledge of system rate of response o Control skill - hand-eye coordination o Industrial skill-control technique	o Operator should be able to control OTSG levels to 30"±? with 100% accuracy (no time limit stated).

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-2.2 Turbine Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
5.9 If main condensor vacuum is lost:	o Determine if vacuum is lost	o Vacuum status indication	o Determine vacuum status based on display readouts (not indicated in procedures)	o Diagnostic skill o Procedural skill	o Operator should be able to determine vacuum status with 100% accuracy
o Verify atmospheric reliefs keep header pressure at 885 psi	o Decision that header pressure is in limits	o Header pressure indication	o Judge that header pressure = 885 psi (no guidance on what to do if it does not)	o Diagnostic skill o Knowledge of setpoints	o Operator should be able to verify header pressure at 885 psi $^{\pm}$? with 100% accuracy (no time limits stated).
o Reduce reactor power to zero	o Decision that power = 0	o Reactor power indication	o Manipulate controls to reduce reactor power (no guidance on rate of change)	o Control skill - hand-eye coordination	o Operator should be able to control reactor power to zero $^{\pm}$? with 100% accuracy (no time limit).
o Control makeup	o Determination of amount of makeup required	o Makeup tank level o Tave	o Add required makeup to makeup tank as Tave is reduced to 532°	o Knowledge-rate of response o Procedural skill o Control skill	o Operator should be able to control makeup with 100% accuracy (no time limit stated).
5.10 If trip is due to loss of both feed pumps	o Determine if both feed pumps are lost	o Turbine trip annunciators indicating loss of FW pumps o Feed pump turbine RPM indications	o Check annunciators on receiving turbine trip indication	o Diagnostic skill-integrate inputs from several sources	o Operator should be able to determine turbine trip due to loss of FW pumps with 100% accuracy (no time limit).

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-2.2 Turbine Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
o Verify response of emergency pumps	o Pumps are started o Pumps are delivering water to both OTSGs	o Pump start indication o OTSG level indications o OTSG input flow indications	o Check displays	o Knowledges-rate of response o Diagnostic skill	o Operators should be able to verify the response of the pumps with 100% accuracy (no time limit stated).
o Control OTSG levels to 30"	o Initiate control o Terminate control	o OTSG level indications o Flow rate into OTSGs o How much tolerance 30"±?	o Control levels using EF-V11A and EF-V11B (procedure should note that operator should ensure block valves EF-V12A/B are open - does not)	o Control skill o Diagnostic skill-to identify the problem if OTSG levels cannot be controlled o Procedural skill	o Operators should be able to control OTSG levels using the emergency feed water system to 30"±? with 100% accuracy (no time limit noted).
5.11 Control Heater Drain Pumps	o Determine if Low Heater Drain tank level alarm received	o Low heater drain tank level alarm status	o Stop heater drain pumps if alarm is received	o Diagnostic skill o Procedural skill	o Operator should be able to control heater drain pumps with 100% accuracy.
5.12 Maintain Vacuum	o Vacuum status	o Indication of vacuum status o Indication of unit speed	o Maintain vacuum until the unit coasts down to approximately 10% of rated speed (no guidance on how to maintain the vacuum)	o Diagnostic skill o Procedural skill o Control skill	o Operator should be able to maintain the vacuum with 100% accuracy.

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-2.2 Turbine Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
5.13 Control drain tanks	o Drain tanks open	o Indications of tank status o Indications of metal parts and piping temperature	o Open or assure that tanks are open	o Diagnostic skill	o Operator should be able to keep drain tanks open until turbine parts are cool.
5.14 Verify engagement of turning gear	o Turning gear control in auto o Engagement	o Turning gear control mode indication o Engagement feedback o Low bearing indication o Low lift oil pressure indication	o Manipulate turning gear control switch to auto o Verify engagement of gear unless low bearing or low lift oil pressure exists (no procedure if yes)	o Diagnostic skill - low bearing - low lift oil pressure indications o Control skill	o Operator should be able to verify engagement of turning gear with 100% accuracy.
5.15 Maintain seal oil temperature	o Seal oil temperature 90-110°F	o Seal oil temperature indication o Cooling water through seal oil cooler indication	o Manually throttle cooling water through seal oil coolers (SC-V21 or SC-V25)	o Control skill o Knowledge of rate of response	o Operator should be able to maintain seal oil temperature at 90°-110°F with 100% accuracy.
5.16 Notify HP/ chemistry to sample RC letdown	o Notification required	o Indication that a power change of greater than 15% power in a one hour period has occurred	o Notify HP/chemistry to sample for Dose Equivalent Iodine between 2 and 6 hours after the power change	o Diagnostic skill o Communications skill	o Operator should be able to determine if a notification of HP/ chemistry is required with 100% accuracy (no time limit stated).

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-1.3 Loss of Reactor Coolant/RCS Pressure
A. Leak Within System Capability

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
1. Recognize leak or rupture within capability of system operation	o Judgment that a leak has occurred	Symptoms: o Initial loss of RC pressure and decrease in PZR level becoming stable after short period of time o Possible RB high radiation and/or temperature alarm o Possible RB sump high level alarm o Makeup tank level decreasing at one inch or more in 3 minutes o Possible makeup line high flow alarm	o Monitor pressure and level immediately (based on what cues? Procedures do not state display which draws operator's attention in the first place) o Receive alarm indications	o Diagnostic skill-determine leak in RC system o Knowledge of diagnostic cues and procedures o Knowledge of display locations, meanings, relationships	o Operator should be able to recognize a leak or rupture within the RC system with 100% accuracy (No time limit stated).
1.1 Recognize leak in Reactor Building	o Isolate leak to inside Reactor Building	o RB air sample monitor alarm indications	o Receive alarm indications	o Diagnostic skill-fault isolation	o Operator should be able to isolate leak with 100% accuracy (No time limit stated).
1.2 Recognize leak in OTSG tubes	o Isolate leak to OTSG tubes	o Gas monitor alarm on VA-R-748	o Receive alarm indications	o Diagnostic skill-fault isolation	
1.3 Recognize leak in steam line	o Isolate steam line break	o Low condensate storage tank level alarm o And/or low hotwell level o FW latch system actuation	o Receive alarm indications	o Diagnostic skill-fault isolation	
2. Verify automatic actior	o MU-V17 opened? o PZR heaters on?	o MU-V17 status o PZR heater status	o Opened to compensate for reduced PZR level o Heaters come on in response to reduced RC pressure	o Memory-verify without procedures o Diagnostic skill-automatic response is correct (or not)	o Operator should be able to verify automatic responses immediately, with 100% accuracy and without reference to procedures.

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-1.3 Loss of Reactor Coolant/RCS Pressure
A. Leak Within System Capability

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
3. Respond with immediate action					
3.1 Isolate letdown	o Determine requirement to start backup MUP and close letdown isolation valve	o Isolation valve MU-V376 status o Backup MUP status	o Close MU-V376 o Start backup MU pump	o Knowledge of component location o Knowledge of procedures o Procedural skill	o Operator should be able to respond manually to an identified leak or rupture with reference to procedures, with 100% accuracy (No time limit stated).
3.2 Proceed with normal shutdown	o Load status	o Load indications	o Reduce load at 10% per minute o Proceed with normal shutdown	o Perceptual skill-load displays	
3.3 Maintain MU tank level	o Quantity required o Terminate action	o Makeup tank level	o Line up waste transfer pump from RC bleed holdup tank and pump to makeup tank	o Knowledge-system rate of response o Knowledge of procedures	
3.4 Respond to situation where tank and PZR levels cannot be maintained	o Cannot maintain levels in MU tank and pressurizer	o Low level setpoints o Actual level readings o Time required to decide	o Trip reactor o Initiate safety injection manually o Close MU-V12	o Diagnostic skill-critical situation o Knowledge of procedures o Procedural skill	o Operator should be able to determine that levels cannot be maintained and respond correctly with 100% accuracy (No time limits stated).

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-1.3 Loss of Reactor Coolant/RCS Pressure
A. Leak Within System Capability

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
4. Respond with follow-up action	o Determine if safety injection has been initiated	o Safety injection indications	o Check indications	o Diagnostic skill	o Operator should be able to respond with followup actions leading to shutdown with 100% accuracy (No time limit stated).
4.1 Safety Injection not initiated	o Initiate cooldown		o Apply EP 2/02-3.1 and 2102-3.2	o Knowledge of procedures	
4.2 Safety injection initiated	o Pumps start satisfactorily	o MU pump status o Decay heat removal pump status o Status of MU-V12 and MU-V18	o Verify that pumps start satisfactorily o Close MU-V12 and MU-V18	o Perceptual skill	
4.3 Throttle injection	o When to throttle o How much o When to stop	o Group reset pushbutton status o Makeup level indications o Pressurizer level=220" o Flow less than 250 gpm/HPI flow leg	o Bypass the safety injection by depressing the group reset pushbuttons o Throttle MU-V16A/B/C/D	o Control skill-hand-eye coordination o Diagnostic skill-judgement of amount of throttling required	
4.4 Monitor MU pump flow	o When to trip excess MU pumps	o MU pump flow below 95gpm	o Manually trip MU pumps	o Diagnostic skill	
4.5 Verify safety injection is in ESF position	o Status of 62 indicators on panels 13 and 8	o Indicators in white for ESF position	o View all 62 indicators	o Perceptual skill o Diagnostic skill-status of 62 indicators	

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-1.3 Loss of Reactor Coolant/RCS Pressure
A. Leak Within System Capability

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
4.6 Maintain PZR level and RC pressure above minimums	o Pressure > 1640 psig o Level > low level alarm point	o Pressurizer level	o Determine if level and pressure are within limits (no guidance on what to do for low pressure-high level)	o Diagnostic skill-integration of pressure and level indications o Knowledge of principles of operation o Understanding of plant status	o Operator should be able to determine that pressurizer level and RC pressure are within limits with 100% accuracy (no time limit stated).
4.7 Control make-up	o Determine if throttling is necessary to maintain PZR level o Determine if additional MU is needed	o Pressurizer level o Effects of throttling o MU pump flow o MU-V36 and 37 status o MU tank level o MU-V12 status	o May have to throttle the 16's to maintain PZR level o As RC pressure decreases - possible to secure HPI o If MU pump flow drops below 95 gpm open MU-V36 and 37, monitor MU tank level and open MU-V12 as required	o Diagnostic skill - understanding plant status - verifying plant response o Control skill - throttling o Procedure skill o Knowledge of display location -relationships	o Operator should be able to control makeup with 100% accuracy.
4.8 Bring Decay Heat System on line	o When to bring on line o When to trip RC pumps	o DH status o RC pump status o RC pressure o RC temperature	o Only one DH string used for decay heat removal -the other on standby - recirculate water from RB pump to RC system o Trip RC pumps before pressure decreases below pump NPSH	o Diagnostic skill o Knowledge of procedures o Procedural skill o Industrial skill	
4.9 Control BWST	o When to control	o BWST level o MU/HPI pumps status o RC pressure	o When BWST level decreases to 12' shift MU/HPI pump suction from BWST to RB pump if RCS pressure is greater than 200 psig	o Diagnostic skill o Knowledge of procedures o Procedural skill o Industrial skill	

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2203-1.3 Loss of Reactor Coolant/RCS Pressure
A. Leak Within System Capability

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
4.10 Throttle HPI string flow rate	o When to throttle	o HPI flow rate o MU-V status	o Throttle HPI strings flow rate to at least 500 gpm using MU-V16 A/B/C/D or MU-V17	o Control skill - throttling o Knowledge of procedures	
4.11 Control HPI flow	o When to control o When to terminate	o HPI flow rate	o Open DH-V7B(A) in crossover line from string B(A) to HPI string B(A) o Reposition HPI flow control valves (16s) o HPI flow increases due to increased pump suction	o Knowledge of components and relationships among components o Control skill - control sequences	
4.12 Shift to RB Sump	o Verify automatic shift	o Indication of transfer o Suction valve status	o When BWST level decreases to 7' - Verify auto transfer to RB sump o Verify open suction valve for string B(A)	o Knowledge of procedures o Diagnostic - verification	
4.13 Continue monitoring RC pressure and PZR level	o In tolerance	o RC pressure = 200 psig o MU-V 16A/B/C/D status o DH-V7A/B status o DH-V128A/B status o Pressurizer level - 220" o LPI flow 3000 - 3300 gpm	o Close ECCS suction valve o When RC pressure = 200 psig throttle HPI discharge flow o Close MU-V16A/B/C/D o Stop high pressure injection pumps o Close DH-V7A/B o Throttle DH-V128A/B to maintain PZR level 220" and LPI flow of 3000-3300 gpm	o Knowledge of procedures o Knowledge of plant status o Diagnostic - understanding plant configuration and status	o Operator should be able to bring the RC system under control from LOCA with 100% accuracy.

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-1.1 Reactor Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
1. Detect Reactor Trip	o Diagnose reactor trip	o In-limit lights o Decrease in neutron level o Turbine trip o Unit load indications - decrease o Rods inserted o Generator breakers open	o Detect reactor trip from pattern of cues	o Diagnostic skill o Knowledge of trip symptoms	o Operator should be able to identify a reactor trip with 100% accuracy (no time limit stated).
2. Respond immediately	o Selection of actions				o Operator should be able to respond immediately to a reactor trip with 100% accuracy and without reference to published procedures.
2.1 Manually trip		o Switch location	o Actuate manual trip	o Motor skill	
2.2 Verify in-limit lights lit	o Lights lit	o Lights indications	o Verify lights lit	o Perceptual skill	
2.3 Verify turbine trip - generator breakers open	o Verify displays	o Turbine trip status	o If not tripped - manually trip, start lift pumps and turning gear oil pump	o Diagnostic skill	
2.4 Control make-up	o Maintain 100" in PZR	o Pressurizer level	o Close let down isolation valve MU-V376 o Start second MUP	o Control skill	
2.5 Verify header pressure	o Maintain at 1010 psig	o Head pressure	o Verify turbine bypass control valves are maintaining 1010 psig pressure	o Diagnostic skill	
2.6 Control OTSG	o Maintain at 30"	o OTSG levels	o Control feedwater	o Control skill o Knowledge of procedures o Procedural skill	

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-1.1 Reactor Trip

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
2.7 Verify PZR heaters off	o PZR level at 80"	o Heater status	o Verify heaters off at 80" in pressurizer	o Diagnostic skill	
2.8 Control PZR level	o When to control	o Pressurizer level	o If PZR gets to 20" - open DH-V5B and start 3rd MUP - open MU-16 C/D to increase PZR level	o Diagnostic skill o Control skill o Knowledge of procedures	
2.9 Runback ICS stations	o Determine stations in hand to be runback	o Knowledge of ICS stations in hand	o Runback ICS stations in hand	o System knowledge o Memory—system status	

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-2.2 Loss of Main Feedwater

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
1. Recognize and respond to loss of main feedwater	o Loss of main feedwater				o Operator should be able to recognize and respond to a loss of main feedwater and determine immediately whether loss is to one or both OTSGs with 100% accuracy.
2. Recognize loss of main feedwater to both OTSGs	o Judgement - loss of main feedwater flow to A&B OTSGs	o Indication that levels decreasing in both OTSGs o Indication that feedwater flow to both OTSGs decreasing o Indication of either feed pump turbine speed decreasing or both main feed valves closing o Indication of both feed pump turbines tripped (annunciator) o Indication that reactor coolant pressure and temperature increasing o Indication of reactor-turbine runback o Indication of turbine trip following both feed pumps trip	o Correctly determine that loss of main feedwater flow is to both OSTGs	Perceptual skill - read annunciators - read displays Diagnostic skill - judge loss of feedwater to both OTSGs Knowledge - symptoms of loss of feedwater - feedwater system principles of operation	o Operator should be able to recognize a loss of main feedwater flow to both OSTGs with 100% accuracy (no time requirement stated).

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-2.2 Loss of Main Feedwater

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
3. Verify automatic response. Determine cause of loss of main feedwater flow to both OTSGs	o Determine cause of loss of feedwater flow		o Integrate information and formulate decision about cause of loss of flow	Perceptual Skill - reading displays Diagnostic Skill - diagnosis of causal factors given displayed information Knowledge - symptoms of loss of pumps - symptoms of valves closing Knowledge of decision rules	o Operator should be able to determine the cause of loss of main feedwater flow to both OTSGs immediately and with 100% accuracy given displays of status and automatic actions.
	o Decision that flow loss is due to loss of both feed pumps	o Indication of Reactor/turbine trip due to high RC pressure o Indication of startup of emergency feed pumps EF-P-1/2A/2B maintaining OTSG level at 30" (S/U range indication)			
	o Decision that loss of feedwater flow is due to valves closing	o Indication of ICS trip to track due to FW X-limits			
4. Respond with immediate action					o Operator should be able to respond with immediate actions immediately and with 100% accuracy and without reference to procedures.
4.1 Response if loss of feedwater is due to loss of both feed pumps	o Decision to respond to condition of loss of both feed pumps			o Memory Skill - immediate response without reference to procedures o Perceptual-Motor Skill - actuation of reactor trip control	
	o Decision to trip reactor	o Feedback of rod status	o Control actuation (no details on procedure)		

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-2.2 Loss of Main Feedwater

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
	o Decision to verify automatic response to reactor trip	o Indication of turbine trip (annunciator) o Indication of status of stop valves	o Verify turbine trip and stop valves closed		
		o Indication of pump discharge pressures	o Verify automatic actuation of emergency feedwater pumps, EF-P-1/2A/2B		
		o Indication of valve status o S/U range indication of OTSG level	o Verify feedwater valves EF-11A/B in automatic - controlling OTSG level at 30" (no procedures given in case of failure of system to respond accurately)		
4.2 Response if loss of feedwater is due to valves closing	o Decision to open closed main and startup feedwater valves if closed	o Indication of status of main and startup feedwater block valves FW-V-17A & 17B/14A & 14B/19A & 19B/26A & 26B	o Open main and startup feedwater block valves if closed	o Control skill - manipulation of valve controls	o Operator should be able to respond to loss of feedwater due to valves closing with immediacy and 100% accuracy and without reference to procedures.
	o Decision to verify plant status	o Indication of reactor power level and trend (Nuclear Instrumentation)	o Verify the MWe and reactor power decreasing	o Perceptual Skill - reading displays o System Knowledge - understanding system functions	
	o Decision to attempt regaining feedwater flow	o Indication of status of main feed regulating valves	o Attempt opening of main feed regulating valves	Control skill - manipulation of controls	

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-2.2 Loss of Main Feedwater

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
	o Decision to start emergency feed pumps based on a judgement of one or more of:		o Start emergency feed pumps	o Perceptual Skill - reading displays o Control Skill - operating control o Diagnostic Knowledge - determining system response needs given displayed information	
	- RC temperature and pressure cannot be maintained	o Indications of RC temperature and pressure			
	- Unable to restore feedwater flow	o Indication of feedwater flow			
	- Reactor trips	o Indication of control rod status			o Operator should be able to perform follow-up loss of feedwater flow actions with 100% accuracy (no time requirement stated).
5. Respond with follow-up action					
5.1 Initiate repairs to system	o Determine repairs required (no guide as to procedure for this determination given) o Following repairs, restore normal feed to OTSG	o Report of repairs completed	o Restore normal feed to OTSGs	o Control skill - operate controls	
5.2 Cooldown plant, if required	o Determine necessity of plant cooldown (no guide for determining necessity stated, only reference to procedure)	o Refer to 2102-3.3 Decay Heat Removal via OTSG	o Use emergency feed system for cooldown	o Knowledge of decision rules	

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-2.2 Loss of Main Feedwater

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
5.3 Insure OTSG components ready for start-up	o Decision to check for water accumulation in OTSG components	(No informational requirements stated)	o Insure OTSG steam annulus space and steam lines are drained	o Diagnostic skill	o Operator should be able to determine that OTSG components are ready for startup with 100% accur cy.
6. Recognize loss of main feedwater flow to one OTSG	o Loss of main feed water flow to OTSG A or B (OTSG A or B specific diagnostic information not stated)	o Indication that steam generator level decreasing in one OTSG o Indication that feedwater flow to one OTSG decreasing o Indication of one main feedwater valve closing o Indication of RC pressure and temperature increasing o Indication of increasing temperature differential across RC cold legs o Indication of reactor-turbine runback	o Read displays	Diagnostic Skill - determine loss of flow - determine which OTSG affected Perceptual Skill - reading of displays System Knowledge - understanding of symptoms displayed	Operator sho d be able to re ognize a lo of main feedwa flow to one OT with 100% acc without refe e to published procedures.
7. Verify automatic action	o Verify ICS into track - due to feedwater cross limits	o Indication of ICS in tracking mode - hand and auto lights lit on unit load demand H/A station o Indication of reduction in generated MWe and reactor power matching available feedwater flow	o Read displays o Verify ICS in tracking mode (no procedure g en for failure of automatic system response)	Perceptual Skill - reading displays System Knowledge - determining system responding accurately Procedural Knowledge	o Operator should be able to verify system automatic response with immediacy and 100% accuracy without referring to procedures.

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-2.2 Loss of Main Feedwater

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
8. Respond with immediate manual action		o Indication of MWe and reactor power (Nuclear Instrumentation)	o Verify the MWe and reactor power are decreasing	Motor Skill - operation of controls Perceptual Skill - reading displays System Knowledge Procedural Knowledge Control Skill	o Operator should be able to respond to loss of feedwater flow to one OTSG with immediacy and 100% accuracy, without reference to procedures.
	o If OTSG level greater than 30" attempt regain of feedwater flow	o Indication of OTSG level	o Go to manual on H/A station o Increase demand to associated main and startup FW regulating valve o Attempt regain of feedwater flow		
		o Controls and displays of FW-V-14A & 14B/17A & 17B/19A & 19B/26A & 26B	Verify associated feedwater block valves are open		
		o Indication of ICS stations in hand	o Runback ICS stations in hand		
9. Respond with follow-up action to loss of feedwater flow to one OTSG					o Operator should be able to respond with appropriate follow-up action with 100% accuracy (no time requirements stated).
	o Decision to continue normal operation if FW flow restored prior to reading OTSG level of 15"	o Indication of OTSG level o Indication of FW flow restoration	o Continue normal operation	Perceptual Skill - evaluation of system status given displays Operational Knowledge - decision to continue operation based on status displayed	

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-2.2 Loss of Main Feedwater

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
	o Decision - unable to restore normal FW flow prior to OTSG level of 15"	o Indication of reactor power trend (Nuclear Instrumentation) o Indication of FW flow o Indication of OTSG level	o Reduce reactor power to less than 8% full power while restoring feedwater flow to affected OTSG using emergency FW pump EF-V11A/B o If OTSG boils dry, establish feed flow using emergency feedwater pump through emergency feed valves slowly (2"/minute)	Perceptual Skill - interpretation of displays Operational Knowledge - decision to reduce power level based on understanding of system status	
	o Decision to raise OTSG level to 25"	o Indication of Emergency FW pump status o Indication of FW flow	o Use emergency feedwater pump and EF-V-11A/B o Restore normal FW flow through FW-V-30A/B and/or FW-V-25A/B o Shutdown emergency feedwater system - stop emergency FW pump and close EF-V-11A/B	Perceptual Skill - read displays Control Skills - manipulation of controls System Knowledge - operation of feedwater systems	
	o Decision to check for water accumulation in OTSG components	(No informational requirements stated)	o Insure OTSG components ready for startup o Insure OTSG steam annulus space and the steam lines are drained	Component Knowledge - location and function of OTSG components	

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-1.3 Loss of Reactor Coolant/RCS Pressure
B. Leak or Rupture of Significant Size Such that ESF Systems are Initiated

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
1. Detect leak or rupture	o Leak or rupture exists	o Rapid continuing decrease of RC pressure o Rapid continuing decrease of pressurizer level o High radiation alarm in RB o RB ambient temperature alarm o High RB sump level o High RB pressure o Rapidly decreasing MU tank level o Core flood tank levels and pressures decreasing		o Diagnostic - detection o Knowledge of symptoms	o Operator should be able to detect a leak or rupture with 100% accuracy (no time limit).
2. Initiate small break LOCA response	o LOCA response is correct	o SFAS initiation indication o MUP status	o Verify that a LOCA exists - SFAS initiation and only one MUP started - SFAS initiation and loss of 2-1E or 2-2F	o Diagnostic skill o Detection of LOCA	o Operator should be able to verify LOCA within 2 minutes of initiation with 100% accuracy.
2.1 Open MUP crossconnects	o When to open	o Discharge crossconnect status	o Discharge AO to open MUP discharge crossconnect	Diagnostic skill	o Operator should be able to access MUP cross-connects within 3 to 5 minutes with 100% accuracy.
2.2 Proceed to MU-V16A/B or C/D	o Valve identification	o Valve status o Valve identifiers/location	o Proceed to valves	o Knowledge of valve position/location	o Operator should be able to access MU-V16S within 4.5 minutes with 100% accuracy.

TRAINING REQUIREMENTS ANALYSIS

Procedure: 2202-1.3 Loss of Reactor Coolant/RCS Pressure
B. Leak or Rupture of Significant Size Such that LSF Systems are Initiated

Task	Decision	Information Requirement	Performance	Skills/ Knowledges	Training Objectives
2.3 Open cross-connects	o Valves opened	o Valve status	o Open discharge crossconnect valve o Open 1 of the MU-V16 valves on the side of the failure - 2 turns	o Control skill - valve handling	o Operator should be able to access and activate valves to control discharge cross-connect with 100% accuracy within 5 minutes of the LOCA.
2.4 Establish communications	o Verify communications	o Reception	o Link between MU-V-16s and CR established	o Communication skill	
2.5 Open MU-V16s to get 125 gpm per leg while throttling controls	o Levels attained o Pump runout prevented	o Flow per leg	o Open valves to establish 125 gpm per leg o In CR - throttle MU-V16 C&D or A & B to prevent pump runout	o Communications skill o Control skill coordination	o Operator should be able to establish a flow of 125 gpm per leg within 10 minutes of the LOCA with 100% accuracy.
3. Verify HPI	o HPI operating properly	o Injection flow in each leg	o Flow indicated on MU-23 FE-1, 2, 3, 4	o Perceptual skill o Diagnostic skill	
4. Trip RC pumps	o When to trip	o RC pressure	o Trip pumps before reaching 1200 psig	o Diagnostic skill	
5. Verify RB cooling and isolation	o Cooling and isolation operating properly	o RB temp pressure	o Verification	o Diagnostic skill	

APPENDIX I

STANDARD REVIEW PLAN CRITERIA

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975.

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-IC-1	Instrumentation and Control Criterion	Section 2.3.3 Onsite Meteorological Measurements Programs, page 2.3.3-4. The reviewer determines that there are provisions for proper monitoring of wind direction, wind speed, and vertical temperature difference in the control room during plant operation.	1975		
SRP-IC-2	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 2.4.14 Technical Specifications and Emergency Operation Requirements, page 2.4.14-1. 3. The appropriate water levels and conditions at which action is to be initiated.	1975		
SRP-IC-3	Instrumentation and Control Criterion	Section 3.6.1 Plant Design for Protection Against Postulates Piping Failures in Fluid Systems Outside Containment, page 3.6.1-14. (4) All available systems, including those actuated by operator actions, may be employed to mitigate the consequences of a postulated piping failure. In judging the availability of systems, account should be taken of the postulated failure and its direct consequences such as unit trip and loss of offsite power, and of the assumed single active component failure and its direct consequences. The feasibility of carrying out operator actions should be judged on the basis of ample time and adequate access to equipment being available for the proposed actions.	1975		
SRP-IC-4	Instrumentation and Control Criterion Control Room Environment Criterion	Section 3.6.1 Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment, page 3.6.1-14. c. The effects of a postulated piping failure, including environmental conditions resulting from the escape of contained fluids, should not preclude habitability of the control room or access to surrounding areas important to the safe control of reactor operations needed to cope with the consequences of the piping failure.	1975		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975.

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-IC-5	Instrumentation and Control Criterion	Section 3.7.4 Seismic Instrumentation, page 3.7.4-2. 2. Location and Description of Instrumentation For the construction permit review there should be a commitment by the applicant to provide the following (seismic) instruments at the given locations: a. A triaxial time history accelerograph in the free field or at the containment foundation, with readout in the control room. b. A seismic switch on the containment foundation, with readout in the control room. c. A triaxial response spectrum recorder on the containment foundation, with readout in the control room.	1975		
SRP-IC-6	Instrumentation and Control Criterion	Section 3.7.4 Seismic Instrumentation, page 3.7.4-3. 3. Control Room Operator Notification To be acceptable, the seismic switch located at the foundation of the containment should be connected to event indicators that are located in the control room, so that a signal is given when the preset threshold level (OBE acceleration level) resulting from the earthquake is exceeded. Also both audio and visual signals should be provided to the control room operators in the event of an earthquake. In addition, the triaxial time history accelerograph located in the containment foundation or in the free field should be connected to the control room.	1975		
SRP-IC-7	Instrumentation and Control Criterion Control Room Environment Criterion Operator Support Equipment Criterion	Section 3.11 Environmental Design of Mechanical and Electrical Equipment, page 3.11-3. Simply stated, the general requirements for environmental design and qualification are as follows. (1) The equipment shall be designed to have the capability of performing design safety functions under all normal and accident environments.	1975		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975.

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-IC-8	Instrumentation and Control Criterion	Section 3.11 Environmental Design of Mechanical and Electrical Equipment, page 3.11-5. c. Normal and Accident Environmental Conditions Both the normal and accident environmental conditions must be explicitly defined for each item of equipment. These definitions must include the following parameters: t operature, pressure, relative humidity, radiation, chemicals, and vibration (non-seismic).	1975		
SRP-IC-9	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 4.3 Nuclear Design, page 4.3-5. d. GDC 13 requires provision of instrumentation and controls to monitor variables and systems that can affect the fission process over anticipated ranges for normal operation and accident conditions, and to maintain them within prescribed operating ranges.	1975		
SRP-IC-10	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 4.3 Nuclear Design, page 4.3-5. e. GDC 20 requires automatic initiation of the reactivity control systems to assure that acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences and to assure automatic operation of systems and components important to safety under accident conditions.	1975		
SRP-IC-11	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 4.3 Nuclear Design, page 4.3-5. g. GDC 26 requires that two independent reactivity control systems of different design be provided, and that each system have the capability to control the rate of reactivity changes resulting from planned, normal power changes. One of the systems must be capable of reliably controlling anticipated operational occurrences. In addition, one of the systems must be capable of holding the reactor core subcritical under cold conditions.	1975		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975.

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-IC-12	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 4.3 Nuclear Design, page 4.3-5. h. GDC 27 requires that the reactivity control systems have a combined capability, in conjunction with poison addition by the emergency core cooling system, of reliably controlling reactivity changes under postulated accident conditions, with appropriate margin for stuck rods.	1975		
SRP-IC-13	Instrumentation and Control Criterion	Section 4.3 Nuclear Design, page 4.3-6. It is a branch position that these limiting power distributions may be maintained (i.e., not exceeded) administratively (i.e., not by automatic scrams), provided a suitable demonstration is made that sufficient, properly translated information and alarms are available from the reactor instrumentation to keep the operator informed.	1975		
SRP-IC-14	Instrumentation and Control Criterion	Section 4.3 Nuclear Design, page 4.3-6. The acceptance criteria in the area of power distribution are that the information presented should satisfactorily demonstrate that: (2) A reasonable probability exists that in normal operation the design limits will not be exceeded, based on consideration of information received from the power distribution instrumentation; the processing of that information, including calculations involved in the processing; the requirements for periodic check measurements; the accuracy of design calculations used in developing correlations when primary variables are not directly measured; the uncertainty analyses for the information and processing system; and the instrumentation alarms for the limits of normal operation (e.g., offset limits, control bank limits) and for abnormal situations (e.g., tilt alarms for control rod misalignment).	1975		
SRP-IC-15	Instrumentation and Control Criterion	Section 4.3 Nuclear Design, page 4.3-7. c. Acceptance criteria relative to control rod patterns and reactivity worths include: (2) Equipment, operating limits, and procedures necessary to restrict potential rod worths or reactivity insertion rates should be shown to be capable of performing these functions. It is a CPB position to require, where feasible, an alarm when any limit or restriction is violated or is about to be violated.	1975		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975.

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-IC-16	Instrumentation and Control Criterion	Section 5.2.2 Overpressurization Protection, page 5.2.2-1. The EICSB, as described in SRP 7.6, evaluates the adequacy of controls and instrumentation of the overpressure protection components with regard to the required features of automatic actuation, remote sensing and indication, remote control, emergency onsite power, and connections to the reactor protection system.	1975		
SRP-IC-17	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 5.2.5 RCPB Leakage Detection, page 5.2.5-2. 5. System Sensitivity and Response Time Since leakage detection methods or systems differ in sensitivity and response time, prudent selection of detection methods should include a sufficient number of systems to ensure effective monitoring during periods when some detection systems may be ineffective or inoperable. Some of these systems should serve as early alarm systems which signal the operators that closer examination of other detection systems is necessary to determine the extent of any corrective action that may be required.	1975		
SRP-IC-18	Instrumentation and Control Criterion Operator Procedure Criterion	Section 5.2.5 RCPB Leakage Detection, page 5.2.5-3. 7. Quantitative Interpretation of Indicators and Alarms It is important to be able to associate a signal or indication of a departure from the normal operating conditions with a quantitative leakage flow rate. Except for flow rate or level change measurements from tanks, sumps, or pumps, signals from other leakage detection systems do not provide information readily convertible to a common denominator. Approximate relationships converting these signals to units of water flow are formulated to assist the operator in interpreting signals. The instrumentation associated with the leak detection system is reviewed by EICSB in SRP 7.5 (Ref. 4). Procedures for operator evaluation of leakage conditions are reviewed by RSB.	1975		

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SRP-IC-19	Instrumentation and Control Criterion Operator Procedure Criterion	Section 5.2.5 RCPB Leakage Detection, page 5.2.5-4. 7. Indicators and Alarms Indicators and alarms for each leakage detection system should be provided in the main control room and procedures for converting various indications to a common leakage equivalent should be available to the operators. The calibration of the indicators should account for the independent variables such as, in the case of an air particulate monitor, the isotope being monitored, plateout, and decay rate. Each system should be set to alarm on an increase in leakage of 1 gpm above the background level determined at the time of calibration.	1975		
SRP-IC-20	Instrumentation and Control Criterion Operator Support Equipment Criterion	Section 5.4.7 Residual Heat Removal (RHR) System, page 5.4.7-3. It must be shown that adequate equipment, control, and sensing information is available to allow the operator to properly execute any required manual operations during operation or test.	1975		
SRP-IC-21	Instrumentation and Control Criterion	Section 5.4.7 Residual Heat Removal (RHR) System, page 5.4.7-4. 5. Suitable valve position indication should be provided for the above (check) valves in the control room.	1975		
SRP-IC-22	Instrumentation and Control Criterion	Section 5.4.7 Residual Heat Removal (RHR) System, page 5.4.7-5. EICSB is contacted to confirm that independent and diverse interlocks and trips are provided on any motor-operated valve used for overpressure protection and that valve position indication is adequate.	1975		
SRP-IC-23	Instrumentation and Control Criterion	Section 5.4.7 Residual Heat Removal (RHR) System, page 5.4.7-5. Specifically, EICSB confirms that automatic actuation and remote-manual valve controls are capable of performing the functions required, and that sensor and monitoring provisions are adequate. The instrumentation and controls of the RHR system are to have sufficent redundancy to satisfy the single failure criterion.'	1975		

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SRP-IC-24	Instrumentation and Control Criterion	Section 5.4.11 Pressurizer Relief Tank System, page 5.4.11-3. 5. High temperature, high pressure, high and low liquid level alarms for the pressurizer relief tank have been provided.	1975		
SRP-IC-25	Instrumentation and Control Criterion	Section 6.2.1.1.A PWR Dry Containments, Including Subatmospheric Containments, page 6.2.1.1.A-3. 10. Instrumentation capable of operating in the post-accident environment should be provided to monitor the containment atmosphere pressure and temperature and the sump water temperature following an accident. The instrumentation should have adequate range, accuracy, and response to assure that the above parameters can be tracked throughout the course of an accident. Recording equipment capable of following the transient should be provided.	1975		
SRP-IC-26	Instrumentation and Control Criterion	Section 6.2.2 Containment Heat Removal Systems, page 6.2.2-4. 9. Instrumentation should be provided to monitor containment heat removal system and system component performance under normal and accident conditions. The instrumentation should be capable of determining whether a system is performing its intended function, or a system train or component is malfunctioning and should be isolated. The instrumentation should be redundant and where practical, diverse, and should have readout and alarm capability in the control room.	1975		
SRP-IC-27	Instrumentation and Control Criterion	Section 6.2.4 Containment Isolation System, page 6.2.4-4. For engineered safety feature or engineered safety feature-related systems, isolation valves in the lines may remain open or be opened. The position of an isolation valve in the event of power failure to the valve operator should be the "safe" position. Normally this position would be the post-accident valve position. All power-operated isolation valves should have position indication in the main control room.	1975		

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SRP-IC-28	Instrumentation and Control Criterion	Section 6.2.5 Combustible Gas control in Containment, page 6.2.5-4. 10. Combustible gas control system designs should include instrumentation needed to monitor system or component performance under normal and accident conditions. The instrumentation should be capable of determining that a system is performing its intended function, or that a system train or component is malfunctioning and should be isolated. The instrumentation should have readout and alarm capability in the control room.	1975		
SRP-IC-29	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 6.3 Emergency Core Cooling System, page 6.3-3. The primary mode of actuation for the ECCS must be automatic, and actuation must be initiated by signals of suitable diversity and redundance. Provisions should also be made for manual actuation, monitoring, and control of the ECCS from the reactor control room.	1975		
SRP-IC-30	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 6.3 Emergency Core Cooling System, page 6.3-7. b. Confirm that there are sufficient instrumentation and controls available to the reactor operator to provide adequate information in the control room to assist in assessing post-LOCA conditions, including the more significant parameters such as coolant flow, coolant temperature, and containment pressure. If ECCS flow is diverted as a backup to other safeguards systems, the reviewer confirms that instrumentation and controls are available to provide sufficient information in the control room to determine that adequate core cooling is being provided.	1975		
SRP-IC-31	Instrumentation and Control Criterion Operator Procedure Criterion	Section 6.4 Habitability Systems, page 6.4-4. 1. Control Room Emergency Zone The reviewer checks to see that the zone includes the following: a. Instrumentation and controls necessary for a safe shutdown of the plant, i.e., the control room, including the critical document reference file.	1975		

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SRP-IC-32	Instrumentation and Control Criterion	Section 7.3 Engineered Safety Feature Systems, page 7.3-3. The GDC and IEEE Std 279-1971 set forth requirements that must be met by all designs for the ESFAS. In addition, these are also used for essential auxiliary supporting system instrumentation and controls. One purpose of the review is to verify that the applicant has committed to designing the ESFAS and the essential auxiliary supporting system instrumentation and controls in accordance with these mandatory criteria.	1975		
SRP-IC-33	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 7.3 Engineered Safety Feature Systems, page 7.3-11. Generally, completion consists of starting or energizing the components in the ESF system. Verify that once initiated, the protective action will continue until terminated by deliberate actions of the operator and that operator action cannot prevent the initiation of the protective action when the ESFAS determines the need for that action. Exception: "pull-to-lock" control switches have been acceptable even though their manipulation could prevent the protective action from going to completion.	1975		
SRP-IC-34	Instrumentation and Control Criterion	Section 7.3 Engineered Safety Feature Systems, page 7.3-11 For those protective actions which are initiated solely by manual means, there are no specific criteria to judge acceptance at present. In practice, the requirements of IEEE Std 279 are applied to all equipment used by the operator to detect the need for the protective action, to accomplish the protection action, and to confirm completion of the protective actions.	1975		

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SRP-IC-35	Instrumentation and Control Criterion	Section 7.4 Systems Required for Safe Shutdown, page 7.4-3. The instrumentation and control systems required for safe shutdown are acceptable when it is determined that these systems satisfy the following requirements: 1. They have the required redundancy. 2. They meet the single failure criterion. 3. They have the required capacity and reliability to perform intended safety functions on demand. 4. They are capable of functioning during and after certain design basis events such as earthquakes, accidents, and anticipated operational occurrences. 5. They are testable during reactor operation.	1975		
SRP-IC-36	Instrumentation and Control Criterion	Section 7.4 Systems Required for Safe Shutdown, page 7.4-8. Specific items to be considered include: 2. Separation of actuating switches in control panels for redundant safety-related equipment such as inboard and outboard isolation valves, coolant pumps, diesel-generator sets, etc.	1975		
SRP-IC-37	Instrumentation and Control Criterion	Section 7.5 Safety-Related Display Instrumentation, page 7.5-2. II. ACCEPTANCE CRITERIA The safety-related display instrumentation design is acceptable when it can be concluded that it conforms to the criteria listed in Table 7-1 and that the operator will be provided with sufficient information to perform required manual safety functions should such action be necessary. Specific points with regard to these criteria are detailed below.	1975		

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		Section 7.5 Safety-Related Display Instrumentation, page 7.5-2 (continued). 1. The SRDI should cover appropriate variables, consistent with the assumptions for accident analyses and with the information needs of the operators in normal, transient, and accident conditions. The design of the SRDI should conform to the recommendations of Branch Technical Position EICSB 23. The accuracy and range of indicating instrumentation should be consistent with the assumptions of the accident analyses. Any exceptions to these requirements will be referred to the appropriate branch for resolution on an individual case basis. 2. All monitoring channels should be redundant, to assure that wrong indication due to device malfunction will not cause false action or inaction on the part of the operator. Identification malfunctions can be identified by cross checking between redundant channels. 3. Redundant channels of indicating instrumentation should be isolated physically and electrically to assure that a single failure will not result in complete loss of information about a monitored variable. Single failures might include such possible faults as shorting or opening circuits or interconnecting signal or power cables. It also includes single credible malfunctions or events that might cause a number of subsequent component, module, or channel failures. The post-accident SRDI should be capable of operating from onsite power. If signals from the post-accident monitoring equipment are used for control, the required isolation devices will be classified as part of the post-accident monitoring instrumentation. No credible failure at the output of an isolation device should prevent the associated monitoring channel from meeting minimum performance requirements considered in the design bases. 4. Capability should be provided for checking, with a high degree of confidence, the operational availability of each system input sensor during reactor operation. An acceptable way of accomplishing this would be by: a. Perturbating the monitored variable and observing the resulting indications.			

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		Section 7.5 Safety-Related Display Instrumentation, page 7.5-2 (continued). b. Introducing and varying a substitute input to the sensor of the same nature as the measured variable. c. Cross checking between channels that bear a known relationship to each other and that have readouts available. For channels which monitor a normally static parameter, provisions should be ma e to allow periodic testing in accordance with Regulatory Guide 1.22, thereby verifying channel operability.			
SRP-IC-38	Instrumentation and Control Criterion	Section 7.6 All Other Instrumentation Systems Required for Safety, page 7.6-2. 5. On-line testability of the systems and indication of bypassed or inoperable status of the systems required for safety are provided.	1975		
SRP-IC-39	Instrumentation and Control Criterion	Section 7.6 All Other Instrumentation Systems Required for Safety, page 7.6-7. b. Separation of actuating switches in control panels for redundant safety-related equipment such as inboard and outboard isolation valves, coolant pumps, diesel-generator sets, etc.	1975		
SRP-IC-40	Instrumentation and Control Criterion	Section 7.7 Control Systems Not Required for Safety, page 7.7-2. 1. Conformance with GDC 13 for Instrumentation and Control Requirements Instrumentation should be provided to monitor variables and systems over their anticipated ranges for normal operation and for anticipated operational occurrences as appropriate to minimize challenges to safety systems. Appropriate controls should be provided to maintain these variables and systems within prescribed operating ranges.	1975		

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SRP-IC-41	Instrumentation and Control Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-4. 1. Instrumentation and electric equipment essential to safety which must function in an accident environment should be analyzed or tested to demonstrate this capability.	1975		
SRP-IC-42	Instrumentation and Control Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-7. 4. Suitable valve position indication should be provided in the control room for the interface valves.	1975		
SRP-IC-43	Instrumentation and Control Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-9. B. BRANCH TECHNICAL POSITION The following features should be incorporated in the design of MOIV systems for safety injection tanks to meet the intent of IEEE Std 279-1971: 2. Visual indication in the control room of the open or closed status of the valve. 3. An audible and visual alarm, independent of item (2) above, that is actuated by a sensor on the valve when the valve is not in the fully-open position.	1975		
SRP-IC-44	Instrumentation and Control Criterion Operator Procedure Criterion Operator/System Integration Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-13. d. Minimize the coordination required between unit operators in order to accomplish (a), (b), and (c) above. Although each design will be evaluated on an individual basis in this regard, all shared onsite power systems should meet the following: (1) Coordination between the unit operators should not be necessary in order to provide for (a) and (b), above. (2) Complete information regarding the status of the shared system should be provided for each operator.	1975		

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SRP-IC-45	Instrumentation and Control Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-27. 3. Electrically-operated valves that are classified as "active" valves, i.e., are required to open or close in various safety system operational sequences, but are manually-controlled, should be operated from the main control room.	1975		
SRP-IC-46	Instrumentation and Control Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-28. 4. When the single failure criterion is satisfied by removal of electrical power from valves described in (2) and (3), above, these valves should have redundant position indication of the main control room and the position indication system should, itself, meet the single failure criterion.	1975		
SRP-IC-47	Instrumentation and Control Criterion Operator/System Integration Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-31. B. BRANCH TECHNICAL POSITION 1. A design that provides manual initiation at the system level of the transfer to the recirculation mode, while not ideal, is sufficient and satisfies the intent of IEEE Std 279-1971 provided that adequate instrumentation and information display are available to the operator so that he can make the correct decision at the correct time. Furthermore, it should be shown that, in case of operator error, there are sufficient time and sufficient information available so that the operator can correct the error, and the consequences of such an error are acceptable.	1975		
SRP-IC-48	Instrumentation and Control Criterion Operator/System Integration Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-32. 1. The bypass indicators should be arranged to enable the operator to determine the status of each safety system and determine whether continued reactor operation is permissible.	1975		

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SRP-IC-49	Instrumentation and Control Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-32. 2. When a protective function of a shared system can be bypassed, indication of that bypass condition should be provided in the control room of each affected unit.	1975		
SRP-IC-50	Instrumentation and Control Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-32. 3. Means by which the operator can cancel erroneous bypass indications, if provided, should be justified by demonstrating that the postulated cases of erroneous indications cannot be eliminated by another practical design.	1975		
SRP-IC-51	Instrumentation and Control Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-34. B. BRANCH TECHNICAL POSITION The safety-related display instrumentation for post-accident monitoring and safe shutdown should be: 1. Redundant, with indicators in the control room for both channels and with at least one channel recorded.	1975		
SRP-IC-52	Instrumentation and Control Criterion	Section 8.2 Offsite Power System, page 8.2-2. 4. The instrumentation required for monitoring and indicating the status of the preferred power system is reviewed to assure that any change in the preferred power system which would prevent it from performing its intended function will be immediately identified by the control room operator. Also, all instrumentation for initiating safety actions associated with the preferrred power system is reviewed.	1975		

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SRP-IC-53	Instrumentation and Control Criterion	Section 8.2 Offsite Power System, page 8.2-8. 10. To assure that the requirements of GDC 13 are satisfied, the preferred power system instrumentation provided to monitor variables and systems over anticipated ranges for normal operation, anticipated abnormal occurrences, and accident conditions should be identified during the electrical schematic and system description review. It should be ascertained that these instruments present status information that can be used to determine the condition of the preferred power system at all times. Review of the electrical schematics should determine that controls (automatic and manual) are provided to maintain these variables and systems within prescribed operating ranges. It should also be determined during the review of the electrical schematics that single failures of these controls and instruments will not violate the requirements of GDC 17.	1975		
SRP-IC-54	Instrumentation and Control Criterion	Section 8.3.1 A-C Power Systems (Onsite), page 8.3.1-3. 6. Vital Supporting Systems The instrumentation, control circuits, and power connections of vital supporting systems are reviewed to determine that they are designed to the same criteria as those for the Class IE loads and power systems that they support. This will include an examination of the vital supporting system component redundancy; power feed assignment to instrumentation, controls, and loads; initiating circuits; load characteristics; equipment identification scheme; and design criteria and bases for the installation of redundant cables.	1975		
SRP-IC-55	Instrumentation and Control Criterion	Section 8.3.2 D-C Power Systems (Onsite), page 8.3.2-5. 5. Vital Supporting Systems The instrumentation, controls, and electrical equipment for those supporting systems identified as vital to the proper functioning of the safety-related systems are acceptable if the design conforms to the same criteria as for the safety-related system supported.	1975		

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SRP-IC-56	Instrumentation and Control Criterion	Section 9.2.1 Station Service Water System, page 9.2.1-2. d. Provisions for system and component operational testing, including the instrumentation and control features that determine and verify that the system is operating in a correct mode (i.e., valve position, pressure and temperature indication).	1975		
SRP-IC-57	Instrumentation and Control Criterion	Section 9.2.2 Reactor Auxiliary Cooling Water Systems, page 9.2.2-2. c. The provisions for detection, collection, and control of system leakage and the means provided to detect leakage of activity from one system to another and preclude its release to the environment.	1975		
SRP-IC-58	Instrumentation and Control Criterion	Section 9.2.2 Reactor Auxiliary Cooling Water Systems, page 9.2.2-2. f. Instrumentation and control features necessary to accomplish design functions, including isolation of components to deal with leakage or malfunctions, and actuation requirements for redundant equipment.	1975		
SRP-IC-59	Instrumentation and Control Criterion	Section 9.2.3 Demineralized Water Makeup System, page 9.2.3-3. g. Instrumentation (e.g., a conductivity monitor) has been provided together with the capability to isolate the system should planned operating conditions be exceeded.	1975		
SRP-IC-60	Instrumentation and Control Criterion	Section 9.3.1 Compressed Air System, page 9.3.1-2. b. Instrumentation and control features provided to determine and verify that the system is operating in a correct mode (e.g., valve position indication, pressure).	1975		
SRP-IC-61	Instrumentation and Control Criterion	Section 9.3.4 Chemical and Volume Control System (PWR) (Including Boron Recovery System), page 9.3.4-2. 8. Provisions for operational testing are evaluated, as are the instrumentation and control features that determine and verify that the system is operating in the correct mode.	1975		

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SRP-IC-62	Instrumentation and Control Criterion	Section 9.3.4 Chemical and Volume Control System (PWR) (Including Boron Recovery System), page 9.3.4-2. The EICSB evaluates the controls, instrumentation, and power sources with respect to capability, capacity, and reliability to perform safety-related functions during normal and emergency conditions.	1975		
SRP-IC-63	Instrumentation and Control Criterion	Section 9.4.1 Control Room Area Ventilation System, page 9.4.1-5. (1) The system PID's show monitors located in the system intakes that are capable of detecting radiation, smoke, and toxic chemicals. The monitors should actuate alarms in the control room.	1975		
SRP-IC-64	Instrumentation and Control Criterion	Section 9.4.3 Auxiliary and Radwaste Area Ventilation System, page 9.4.3-2. a. The capability to detect and monitor radiation levels.	1975		
SRP-IC-65	Instrumentation and Control Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-39. (b) Fire detection systems should give audible and visual alarm and annunciation in the control room. Local audible alarms should also sound at the location of the fire. (c) Fire alarms should be distinctive and unique. They should not be capable of being confused with any other plant working system. Equivalent Statement: Section 9.5.1 Fire Protection System, page 9.5.1-88.	1975		
SRP-IC-66	Instrumentation and Control Criterion Operator Support Equipment Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-47. Fire detection systems should alarm and annunciate in the control room. These systems should utilize detection and location most suitable to the particular type of fire expected from the identified hazard. A primary containment general area fire detection capability should be provided as backup for the above described hazard detection. To accomplish this, suitable smoke detection (e.g., visual obscuration, light scattering, and particle counting) should be installed in the air recirculation system ahead of any filters.	1975		

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SRP-IC-67	Instrumentation and Control Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-50. Fire detection in the control room, cabinets, and consoles should be provided by smoke and heat detectors in each fire area. Alarm and annunciation should be provided in the control room. Fire alarms in other parts of the plant should also be alarmed and annunciated in the control room. Equivalent Statement: Section 9.5.1 Fire Protection System, page 9.5.1-101.	1975		
SRP-IC-68	Instrumentation and Control Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-51. Such drains should be provided with means for closing to maintain integrity of the control room in event of other accidents requiring control room isolation.	1975		
SRP-IC-69	Instrumentation and Control Criterion Operator Support Equipment Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-57. 12. New Fuel Area Hand portable extinguishers should be located within this area. Also, local hose stations should be located outside but within hose reach of this area. Automatic fire detection should alarm and annunciate in the control room and alarm locally.	1975		
SRP-IC-70	Instrumentation and Control Criterion Operator Support Equipment Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-57. 13. Spent Fuel Pool Area Protection for the spent fuel pool area should be provided by local hose stations and portable extinguishers. Automatic fire detection should be provided to alarm and annunciate in the control room and to alarm locally.	1975		

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SRP-IC-71	Instrumentation and Control Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-57. 14. Radwaste Building The radwaste building should be separated from other areas of the plant by fire barriers having at least three-hour ratings. Automatic sprinklers should be used in all areas where combustible materials are located. Automatic fire detection should be provided to annunciate and alarm in the control room and alarm locally.	1975		
SRP-IC-72	Instrumentation and Control Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-58. 15. Decontamination Areas The decontamination areas should be separated from other areas of the plant by fire barriers having at least three-hour ratings. These areas should be protected by automatic sprinklers. Automatic fire detection should be provided to annunciate and alarm in the control room and alarm locally.	1975		
SRP-IC-73	Instrumentation and Control Criterion Operator/System Integration Criterion Operator Procedure Criterion	Section 9.5.2 Communications Systems, page 9.5.2-1. There are no general design criteria or regulatory guides that directly apply to the safety-related performance requirements for the communication system.	1975		
SRP-IC-74	Instrumentation and Control Criterion	Section 9.5.6 Emergency Diesel Engine Starting System, page 9.5.6-3. c. Alarms should be provided which alert operating personnel if the air receiver pressure falls below the minimum allowable value.	1975		
SRP-IC-75	Instrumentation and Control Criterion Operator Procedure Criterion	Section 10.2 Turbine Generator, page 10.2-3. b. Main steam stop and control valves and reheat stop and intercept valves should be exercised at least once a week by closing each valve and observing by the valve position indicator that it moves smoothly to a fully closed position. At least once a month, this examination should be made by direct observation of the valve motion.	1975		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975.

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-IC-76	Instrumentation and Control Criterion	Section 10.4.2 Main Condenser Evacuation System, page 10.4.2-2. 4. Provisions to control and monitor releases of radioactivity to the environment from the MCES must conform to General Design Criteria 60 and 64 (Ref. 1).	1975		
SRP-IC-77	Instrumentation and Control Criterion	Section 10.4.5 Circulating Water System, page 10.4.5-1. c. Provisions for instrumentation to permit operational testing of the system and to annunciate abnormal and unsafe operating conditions.	1975		
SRP-IC-78	Instrumentation and Control Criterion	Section 10.4.5 Circulating Water System, page 10.4.5-2. 1. Means should be provided to detect and control flooding of safety related areas due to leakage from the CWS.	1975		
SRP-IC-79	Instrumentation and Control Criterion	Section 10.4.7 Condensate and Feedwater System, page 10.4.7-3. f. The CFS design, or other plant systems, provide the capability to detect and control leakage from the system.	1975		
SRP-IC-80	Instrumentation and Control Criterion	Section 10.4.9 Auxiliary Feedwater System (PWR), page 10.4.9-2. 11. The instrumentation and control features are provided to verify the system is operating in a correct mode.	1975		
SRP-IC-81	Instrumentation and Control Criterion	Section 10.4.9 Auxiliary Feedwater System (PWR), page 10.4.9-3. 4. General Design Criterion 19, as related to the design capability of system instrumentations and controls for prompt hot shutdown of the reactor and potential capability for subsequent cold shutdown.	1975		

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SRP-IC-82	Instrumentation and Control Criterion Operator Procedure Criterion	Section 11.5 Process and Effluent Radiological Monitoring and Sampling Systems, page 11.5-2. b. For a pressurized water reactor (PWR) the following process streams or effluent release points should be monitored or sampled continuously: (1) Main condenser air ejector offgases. (2) Waste gas treatment system effluent. (3) Equipment vents routed directly to the environment (e.g., steam generator blowdown flash tank vent, liquid waste tank vents). (4) Ventilation air exhausts from all buildings having the potential to contain airborne radioactivity. (5) Turbine building floor drain effluents. (6) Liquid effluents from the steam generator blowdown system. (7) Boron recovery system effluents. (8) Liquid waste effluent streams. (9) Service water effluent stream. (10) Component cooling water loop.	1975		
SRP-IC-83	Instrumentation and Control Criterion	Section 11.5 Process and Effluent Radiological Monitoring and Sampling Systems, page 11.5-3. 4. Continuous monitors on liquid effluent lines and gaseous release points should alarm when radionuclide concentrations exceed a predetermined level in the discharge line.	1975		
SRP-IC-84	Instrumentation and Control Criterion Operator Procedure Criterion Control Room Environment Criterion Operator/System Integration Criterion	Section 13.1.1 Management and Technical Support Organization, page 13.1.1-2. 2. Preoperational Responsibilities These are functions which should be substantially accomplished before preoperational testing begins and generally before submittal of the final safety analysis report (FSAR). a. Development of human engineering design objectives and design phase review of proposed control room layouts.	1975		

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SRP-IC-85	Instrumentation and Control Criterion Operator Procedure Criterion Operator/System Integration Criterion	Section 15.1.5 Spectrum of Steam System Piping Failures Inside and Outside of Containment (PWR), page 15.1.5-2. The sequence of events described in the applicant's safety analysis report (SAR) is reviewed by both RSB and EICSB. The RSB reviewer concentrates on the need for the reactor protection system, the engineered safety systems, and operator action to secure and maintain the reactor in a safe condition. The EICSB reviewer concentrates on the instrumentation and controls aspects of the sequence described in the SAR to evaluate whether the reactor and plant protection and safeguards controls and instrumentation systems will function as assumed in the safety analysis with regard to automatic actuation, remote sensing, indication, control and interlocks with auxiliary or shared systems. EICSB also evaluates potential bypass modes and the possibility of manual control by the operator. Equivalent Statement: Section 15.2.6 Loss of Non-Emergency A-C Power to the Station Auxiliaries, page 15.2.6-1. Section 15.2.7 Loss of Normal Feedwater Flow, page 15.2.7-1. Section 15.2.8 Feedwater System Pipe Breaks Inside and Outside Containment (PWR), page 15.2.8-2. Section 15.3.1 Loss of Forced Reactor Coolant Flow Including Trip of Pump and Flow Controller Malfunctions, page 15.3.1-2. Section 15.3.3 Reactor Coolant Pump Rotor Seizure and Reactor Coolant Pump Shaft Break, page 15.3.3-2. Section 15.4.4 Startup of an Inactive Loop or Recirculation Loop at an Incorrect Temperature, and Flow Controller Malfunction Causing an Increase in BWR/CORE FLOW RATE, page 15.4.4-2. Section 15.4.6 Chemical and Volume Control System Malfunction That Results in a Decrease in the Boron Concentration in the Reactor Coolant (PWR), page 15.4.6-1. Section 15.5.1 Inadvertent Operation of ECCS and Chemical and Volume Control System Malfunction That Increases Reactor Coolant Inventory, page 15.5.1-2. Section 15.6.1 Inadvertent Opening of a PWR Pressurizer Safety/Relief Valve or a BWR Safety/Relief Valve, page 15.6.1-1.	1975		

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		Section 15.1.5 Spectrum of Steam System Piping Failures Inside and Outside of Containment (PWR), page 15.1.5-2 (continued). Section 15.8 Anticipated Transients Without Scram, page 15.8-1.			
SRP-IC-86	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 15.1.5 Spectrum of Steam System Piping Failures Inside and Outside of Containment (PWR), page 15.1.5-9. 2. Review of the signals available to the reactor operator that indicate the occurrence of the accident and the state of the system throughout the recovery procedure. Automatic and required manual operations by the operator as a function of time must also be determined.	1975		
SRP-IC-87	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 15.4.6 Chemical and Volume Control System Malfunction That Results in a Decrease in the Boron Concentration in the Reactor Coolant (PWR), page 15.4.6-2. d. From the time an alarm makes the operator aware of unplanned moderator dilution, the following minimum time intervals must be available before a loss of shutdown margin occurs: (1) During refueling: 30 minutes. (2) During startup, cold shutdown, hot standby, and power operation: 15 minutes.	1975		
SRP-IC-88	Instrumentation and Control Criterion Operator/System Integration Criterion	Section 15.6.3 Radiological Consequences of Steam Generator Tube Failure (PWR), page 15.6.3-2. 2. Review of the signals available to the reactor operator that indicate the occurrence of the accident and the state of the system throughout the recovery procedure. Automatic and required manual operations by the operator as a function of time must also be determined.	1975		

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SRP-OG-1	Operator/System Integration Guide	Section 5.2.5 RCPB Leakage Detection, page 5.2.5-3. If a seismic event comparable to a safe shutdown earthquake (SSE) occurs, it is important that the operator be able to assess the condition within the containment quickly. The proper functioning of at least one leakage detection system is essential in evaluating the seriousness of the condition within the containment in the event leakage has developed in the RCPB.	1975		
SRP-OG-2	Operator/System Integration Guide	Section 7.3 Engineered Safety Feature Systems, page 7.3-11. In judging the adequacy of any manual initiation features, the other tasks that the operator may be required to perform should be determined and then a judgment made as to whether it is reasonable to rely on the operator to perform all necessary actions. In most situations, automatic actuation, backed up by provisions for manual initiation or manual termination, is more reliable than manual initiation alone, no matter how much time is available to take the protective action.	1975		
SRP-OG-3	Operator/System Integration Guide Instrumentation and Control Guide	Section 10.4.9 Auxiliary Feedwater System (PWR), page 10.4.9-9. 3. The piping arrangement, both intake and discharge, for each train should be designed to permit the pumps to supply feedwater to any combination of steam generators. This arrangement should take into account pipe failure, active component failure, power supply failure, or control system failure that could prevent system function. One arrangement that would be acceptable is crossover piping containing valves that can be operated by remote manual control from the control room, using the power diversity principle for the valve operators and actuation systems.	1975		
SRP-OG-4	Operator/System Integration Guide Human Factors Test and Evaluation Guide	Section 15.1.5 Spectrum of Steam System Piping Failures Inside and Outside of Containment (PWR), page 15.1.5-5. Since auxiliary feedwater system designs are diverse and may require both automatic and manual actuation, preoperational tests should be specified to identify any necessary operator actions and to establish times required for their completion.	1975		

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SRP-IG-1	Instrumentation and Control Guide	Section 7.2 Reactor Trip System, page 7.2-17. 19. Section 4.[illegible] - The method of identification of status at the channel level may be accomplished by lights, indicators, and annunciators.	1975		
SRP-IG-2	Instrumentation and Control Guide Operator/System Integration Guide	Section 10.4.9 Auxiliary Feedwater System (PWR), page 10.4.9-9. 3. The piping arrangement, both intake and discharge, for each train should be designed to permit the pumps to supply feedwater to any combination of steam generators. This arrangement should take into account pipe failure, active component failure, power supply failure, or control system failure that could prevent system function. One arrangement that would be acceptable is crossover piping containing valves that can be operated by remote manual control from the control room, using the power diversity principle for the valve operators and actuation systems.	1975		
SPP-IG-3	Instrumentation and Control Guide	Section 13.3 Emergency Planning, page 13.3-12. To avoid false alarms or to minimize their frequency of occurrence, the levels may be defined so as to require corroborating evidence from two independent sources having input to the control room.	1975		

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SRP-CC-1	Control Room Environment Criterion Operator Support Equipment Criterion	Section 3.5.1.4 Missiles Generated by Natural Phenomena, page 3.5.1.4-7. Those structures, systems, and components, including foundations and supports, which should be designed to withstand the effects of a design basis tornado (as defined in Regulatory Guide 1.76), including tornado missiles, without loss of capability to perform essential safety functions are listed below. g. The control room, including its associated vital equipment, cooling systems for the vital equipment and life support systems, and any structures or equipment inside or outside of the control room whose failure could result in an incapacitating injury to individuals occupying the control room.	1975		
SRP-CC-2	Control Room Environment Criterion Instrumentation and Control Criterion	Section 3.6.1 Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment, page 3.6.1-14. c. The effects of a postulated piping failure, including environmental conditions resulting from the escape of contained fluids, should not preclude habitability of the control room or access to surrounding areas important to the safe control of reactor operations needed to cope with the consequences of the piping failure.	1975		
SRP-CC-3	Control Room Environment Criterion	Section 3.6.1 Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment, page 3.6.1-21. 12. Assurance should be provided that the control room will be habitable and its equipment functional after a steam line or feedwater line break or that the capability for shutdown and cooldown on the unit(s) will be available in another habitable area.	1975		
SRP-CC-4	Control Room Environment Criterion Operator/System Integration Criterion	Section 3.6.1 Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment, page 3.6.1-25. (1) For a postulated pipe failure, the escape of steam, water, and heat from structures enclosing the high-energy fluid containing piping does not preclude: 1) the accessibility to surrounding areas important to the safe control of reactor operations, 2) the habitability of the control room, 3) the ability of instrumentation, electric power supplies, and components and controls to initiate, actuate and complete a safety action. In this regard, a loss of redundancy is permissible but not the loss of function.	1975		

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SRP-CC-5	Control Room Environment Criterion Instrumentation and Control Criterion Operator Support Equipment Criterion	Section 3.11 Environmental Design of Mechanical and Electrical Equipment, page 3.11-3. Simply stated, the general requirements for environmental design and qualification are as follows. (1) The equipment shall be designed to have the capability of performing design safety functions under all normal and accident environments.	1975		
SRP-CC-6	Control Room Environment Criterion	Section 6.4 Habitability Systems, page 6.4-1. The zone serviced by the control room emergency ventilation system is examined to ascertain that all critical areas requiring access in the event of an accident are included within the zone (control room, kitchen, sanitary facilities, etc.) and to assure that those areas not requiring access are generally excluded from the zone.	1975		
SRP-CC-7	Control Room Environment Criterion	Section 6.4 Habitability Systems, page 6.4-1. 2. The capacity of the control room in terms of the number of people it can accommodate for an extended period of time is reviewed to confirm the adequacy of emergency food and medical supplies and self-contained breathing apparatus and to determine the length of time the control room can be isolated before CO_2 levels become excessive.	1975		
SRP-CC-8	Control Room Environment Criterion	Section 6.4 Habitability Systems, page 6.4-1. 3. The control room ventilation system layout and functional design is reviewed and flow rates and filter efficiencies are determined for input into the AAB analyses of the buildup of radioactive or toxic gases inside the control room, assuming a design basis release. Basic deficiencies that might impair the effectiveness of the system are examined. In addition, the system operation and procedures are reviewed. The APCSB has primary responsibility in the system review area under Standard Review Plan (SRP) 9.6.1. The APCSB is consulted when reviewing hardware and operating procedures.	1975		

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SRP-CC-5	Control Room Environment Criterion	Section 6.4 Habitability Systems, page 6.4-2. 2. Control Room Personnel Capacity Food, water, and medical supplies should be sufficient to maintain the emergency team (at least 5 men) for 5 days. Also see Section III.2 of this plan.	1975		
SRP-CC-10	Control Room Environment Criterion	Section 6.4 Habitability Systems, page 6.4-2. 5. Relative Location of Source and Control Room In general, the control room inlets must be spaced in relation to the location of potential release points as to minimize control room contamination in the event of a release. Specific criteria as to radiation and toxic gas sources are as follows: a. Radiation Sources As a general rule the control room ventilation inlet should be separated from the major potential release points by at least 100 ft. laterally and by 50 ft. vertically. However, the actual distances must be based on the dose analyses. Refer to Section III of this plan and Reference 7 for further information. b. Toxic gases The minimum separation distance is dependent upon the gas in question, the container size, and the available control room protection provisions. Refer to Regulatory Guide 1.78 (Ref. 3) for general guidance and to Regulatory Guide 1.95 (Ref. 4) for specific acceptable design provisions related to chlorine. 6. Radiation Shielding See discussion of General Design Criterion 19 below. 7. Radioactive and Toxic Gas Hazards a. Radiation Hazards The dose guidelines (see General Design Criterion 19, Appendix A of 10 CFR Part 50) used in approving emergency zone radiation protection provisions are as follows:	1975		

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		Section 6.4 Habitability Systems, page 6.4-2. (continued) (1) Whole body gamma: 5 rem (2) Thyroid: 30 rem (3) Beta skin dose: 30 rem* The whole body gamma dose consists of contributions from airborne radioactivity inside and outside the control room, as well as direct shine from fission products inside the reactor containment building. b. Toxic Gases For acceptance purposes, three exposure categories are defined: protective action exposure (2 minutes or less), short-term exposure (between 2 minutes and 1 hour), and long-term exposure (1 hour or greater). Because the physiological effects can vary widely from one toxic gas to another, the following general restrictions should be used as guidance: there should be no chronic effects from exposure, and acute effects, if any, should be reversible within a short period of time (several minutes) without benefit of medication other than the use of self-contained breathing apparatus. The allowable limits should be established on the basis that the operators should be capable of carrying out their duties with a minimum of interference caused by the gas and subsequent protective measures. The limits for the three categories normally are set as follows: (1) Long-term limit (1 hour or greater): use a limit assigned for occupational exposure (40-hour week). (2) Short-term limit (2 min. to 1 hour): use a limit that will assure that the operator will not suffer incapacitating effects after a one-hour exposure. (3) Protective action limit (2 min. or less): use a limit that will assure that the operator will quickly recover after breathing apparatus is in place. In determining this limit, it should be assumed that the concentration increases linearly with time from zero to two minutes and that the limit is attained at two minutes.			

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		Section 6.4 Habitability Systems, page 6.4-2 (continued). The protective action limit is used to determine the acceptability of emergency zone protection provisions during the time personnel are in the process of fitting themselves with self-contained breathing apparatus. The other limits are used to determine whether the concentrations with breathing apparatus in place are applicable. (They are also used in those cases where the toxic levels are such that emergency zone isolation without use of protective gear is sufficient.) As an example of appropriate limits, the following are the three levels for chlorine gas: Long-term: 1 ppm by volume Short-term: 4 Protective action: 15			
SRP-CC-11	Control Room Environment Criterion	Section 9.4.1 Control Room Area Ventilation System, page 9.4.1-1. 1. The APCSB reviews the CRAVS to determine the safety significance of the system. Based on this determination, the safety-related part of the system is reviewed with respect to the functional performance required to maintain a habitable control room area during adverse environmental occurrences, during normal operation, anticipated operational occurrences, and subsequent to postulated accidents. The review includes the effects of radiation, combustion and other toxic products, and the coincidental loss of offsite power.	1975		
SRP-CC-12	Control Room Environment Criterion	Section 9.5.1 Control Room Area Ventilation System, page 9.4.1-2. b. The capability to detect in-leakage of radioactivity or airborne chemical contaminants to the control room and the ability to isolate the system to preclude their entrance.	1975		

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SRP-CC-13	Control Room Environment Criterion Operator Support Equipment Criterion	Section 9.5.1 Fire Protection Systems, page 9.5.1-32. 5. Lighting and Communication Lighting and two way voice communication are vital to safe shutdown and emergency response in the event of fire. Suitable fixed and portable emergency lighting and communication devices should be provided. Equivalent Statement: Section 9.5.1 Fire Protection Systems, page 9.5.1-87.	1975		
SRP-CC-14	Control Room Environment Criterion Operator Support Equipment Criterion	Section 9.5.1 Fire Protection Systems, page 9.5.1-49. Manual fire fighting capability should be provided for both hazards. Hose stations and portable extinguishers should be located in the control room to eliminate the need for operators to leave the control room. Equivalent Statement: Section 9.5.1 Fire Protection Systems, page 9.5.1-100.	1975		
SRP-CC-15	Control Room Environment Criterion	Section 9.5.1 Fire Protection Systems, page 9.5.1-50. Manually operated venting of the control room should be available so that operators have the option of venting for visibility.	1975		
SRP-CC-16	Control Room Environment Criterion Operator Support Equipment Criterion	Section 9.5.1 Fire Protection Systems, page 9.5.1-86. (h) Self-contained breathing apparatus, using full face positive pressure masks, approved by NIOSH (National Institute for Occupational Safety and Health - approval formerly given by the U.S. Bureau of Mines) should be provided for fire brigade, damage control and control room personnel. Control room personnel may be furnished breathing air by a manifold system piped from a storage reservoir if practical. Service or operating life should be a minimum of one half hour for the self-contained units.	1975		

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SRP-CC-17	Control Room Environment Criterion	Section 9.5.3 Lighting Systems, page 9.5.3-1. There are no general design criteria or regulatory guides that dir... apply to the safety-related performance requirements for the lighting system.	1975		
SRP-CC-18	Control Room Environment Criterion Operator/System Integration Criterion Operator Procedure Criterion Instrumentation and Control Criterion	Section 13.1.1 Management and Technical Support Organization, page 13.1.1-2. 2. Preoperational Responsibilities These are functions which should be substantially accomplished before preoperational testing begins and generally before submittal of the final safety analysis report (FSAR). a. Development of human engineering design objectives and design phase review of proposed control room layouts.	1975		
SRP-CC-19	Control Room Environment Criterion Operator Support Equipment Criterion	Section 13.3 Emergency Planning, page 13.3-4. "In-plant monitors will provide the first indication of a radiological emergency. Provisions will be made for surveys by portable meters and air sampling devices on a timely basis. The plant control room has been designed for continuous occupancy and will be the principal emergency control center. One alternate center will be designated. Emergency kits will be stored at the primary assembly area. Decontamination facilities and a first aid room will be provided.	1975		

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SRP-OC-1	Operator/System Integration Criterion	Section 2.4.14 Technical Specifications and Emergency Operation Requirements, page 2.4.14-1. 2. The actions to be taken, and the effect of such actions on the protection of safety-related facilities.	1975		
SRP-OC-2	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 2.4.14 Technical Specifications and Emergency Operation Requirements, page 2.4.14-1. 3. The appropriate water levels and conditions at which action is to be initiated.	1975		
SRP-OC-3	Operator/System Integration Criterion	Section 3.6.1 Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside Containment, page 3.6.1-25. (f) For a postulated pipe failure, the escape of steam, water, and heat from structures enclosing the high-energy fluid containing piping does not preclude: 1) the accessibility to surrounding areas important to the safe control of reactor operations, 2) the habitability of the control room, 3) the ability of instrumentation, electric power supplies, and components and controls to initiate, actuate and complete a safety action. In this regard, a loss of redundancy is permissible but not the loss of function.	1975		
SRP-OC-4	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 4.3 Nuclear Design, page 4.3-5. d. GDC 13 requires provision of instrumentation and controls to monitor variables and systems that can affect the fission process over anticipated ranges for normal operation and accident conditions, and to maintain them within prescribed operating ranges.	1975		
SRP-OC-5	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 4.3 Nuclear Design, page 4.3-5. e. GDC 20 requires automatic initiation of the reactivity control systems to assure that acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences and to assure automatic operation of systems and components important to safety under accident conditions.	1975		

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SRP-OC-6	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 4.3 Nuclear Design, page 4.3-5. g. GDC 26 requires that two independent reactivity control systems of different design be provided, and that each system have the capability to control the rate of reactivity changes resulting from planned, normal power changes. One of the systems must be capable of reliably controlling anticipated operational occurrences. In addition, one of the systems must be capable of holding the reactor core subcritical under cold conditions.	1975		
SRP-OC-7	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 4.3 Nuclear Design, page 4.3-5. h. GDC 27 requires that the reactivity control systems have a combined capability, in conjunction with poison addition by the emergency core cooling system, of reliability controlling reactivity changes under postulated accident conditions, with appropriate margin for stuck rods.	1975		
SRP-OC-8	Operator/System Integration Criterion	Section 4.6 Functional Design of Reactivity Control Systems, page 4.6-4. In addition, the reviewer determines that inadvertent operation of any component or system (e.g., inadvertent scram of axial power shaping rods of inadvertent dilution of boron concentration) would not cause degraded system conditions beyond the capabilities of the safety systems.	1975		
SRP-OC-9	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 5.2.5 RCPB Leakage Detection, page 5.2.. 5. System Sensitivity and Response Time Since leakage detection methods or systems differ in sensitivity and response time, prudent selection of detection methods should include a sufficient number of systems to ensure effective monitoring during periods when some detection systems may be ineffective or inoperable. Some of these systems should serve as early alarm systems which signal the operators that closer examination of other detection systems is necessary to determine the extent of any corrective action that may be required.	1975		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-OC-10	Operator/System Integration Criterion	Section 5.2.5 RCPB Leakage Detection, page 5.2.5-4. 4. Intersystem Leakage Provisions should be made to monitor systems connected to the RCPB for signs of intersystem leakage. Detection methods include radioactivity monitoring and indicators to show abnormal water levels or flow in the potentially affected systems and unaccountable increases in reactor coolant make-up flow.	1975		
SRP-OC-11	Operator/System Integration Criterion	Section 5.2.5 RCPB Leakage Detection, page 5.2.5-4. 5. System Sensitivity and Response Time The sensitivity and response time of each leakage detection system employed for monitoring unidentified leakage to the containment should be adequate to detect an increase in leakage rate, or its equivalent, of one gpm in less than one hour.	1975		
SRP-OC-12	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 6.3 Emergency Core Cooling System, page 6.3-3. The primary mode of actuation for the ECCS must be automatic, and actuation must be initiated by signals of suitable diversity and redundance. Provisions should also be made for manual actuation, monitoring, and control of the ECCS from the reactor control room.	1975		
SRP-OC-13	Operator/System Integration Criterion	Section 6.3 Emergency Core Cooling System, page 6.3-6. 19. The complete sequence of ECCS operation from accident occurrence through long-term core cooling is examined to see that a minimum of manual action is required, and where manual action is used, a sufficient time (greater than 20 minutes) is available for the operator to respond.	1975		

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SRP-OC-14	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 6.3 Emergency Core Cooling System, page 6.3-7. b. Confirm that there are sufficient instrumentation and controls available to the reactor operator to provide adequate information in the control room to assist in assessing post-LOCA conditions, including the more significant parameters such as coolant flow, coolant temperature, and containment pressure. If ECCS flow is diverted as a backup to other safeguards systems, the reviewer confirms that instrumentation and controls are available to provide sufficient information in the control room to determine that adequate core cooling is being provided.	1975		
SRP-OC-15	Operator/System Integration Criterion Operator Procedure Criterion	Section 7.2 Reactor Trip System, page 7.2-13. a. Automatic initiation is required for all protective functions. Manual initiation is also provided and is a requirement. (See Section 4.17 and Regulatory Guide 1.62.)	1975		
SRP-OC-16	Operator/System Integration Criterion	Section 7.2 Reactor Trip System, page 7.2-15. 9. Section 4.9 - The most common method used to verify the availability of the RTS input sensors is by cross checking between redundant channels that have readout available. When only two channels of readout are provided, evaluate the applicant's analysis of the effect of the operator choosing the incorrect readout as a basis for operator actions.	1975		
SRP-OC-17	Operator/System Integration Criterion	Section 7.2 Reactor Trip System, page 7.2-16. 12. Section 4.12 - The requirement for automatic removal of operational bypasses means that the reactor operator shall have no role in such removal. The operator may be required to take action to prevent unnecessary initiation of a protective action and this is acceptable. In no circumstance should a design be approved where action or inaction of the reactor operator is required to make available the protective actions needed in any operational or shutdown mode of the plant.	1975		

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SRP-OC-18	Operator/System Integration Criterion	Section 7.2 Reactor Trip System, page 7.2-16. In the case of manual means, the design must be such that no action or inaction on the part of the reactor will prevent the more restrictive set point from being available. It is acceptable for the design to be such that incorrect action or inaction by the operator will cause an unnecessary protective action or prevent placing the plant in an operating mode for which there is inadequate protection.	1975		
SRP-OC-19	Operator/System Integration Criterion	Section 7.3 Engineered Safety Feature Systems, page 7.3-11. 15. Section 4.15 - This requirement is similar to Section 4.12. The phrase "positive means" can be interpreted as either automatic or manual. In the case of manual means, the design must be such that no action or inaction on the part of the reactor will prevent the more restrictive set point from being available. It is acceptable for the design to be such that incorrect action or inaction by the operator will cause an unnecessary protective action or prevent placing the plant in an operating mode for which there is inadequate protection (as defined by the accident analysis). See BTP EICSB 12 for specific guidance on set point changes required with a reactor coolant pump out of service.	1975		
SRP-OC-20	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 7.3 Engineered Safety Feature Systems, page 7.3-11. Generally, completion consists of starting or energizing the components in the ESF system. Verify that once initiated, the protective action will continue until terminated by deliberate actions of the operator and that operator action cannot prevent the initiation of the protective action when the ESFAS determines the need for that action. Exception: "pull-to-lock" control switches have been acceptable even though their manipulation could prevent the protective action from going to completion.	1975		

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SRP-OC-21	Operator/System Integration Criterion	Section 7.4 Systems Required for Safe Shutdown, page 7.4-3. The RSB should review the system identified as required for safe shutdown, and confirm that the configuration and design bases of these systems are correct, and that all design parameters such as temperature, pressure, flow rate, and reactivity can be controlled within acceptable limits.	1975		
SRP-OC-2	Operator/System Integration Criterion Instrumentation and Control Criterion Operator Procedure Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-13 d. Minimize the coordination required between unit operators in order to accomplish (a), (b), and (c) above. Although each design will be evaluated on an individual basis in this regard, all shared onsite power systems should meet the following: (1) Coordination between the unit operators should not be necessary in order to provide for (a) and (b), above. (2) Complete information regarding the status of the shared system should be provided for each operator.	1975		
SRP-OC-23	Operator/System Integration Criterion Instrumentation and Control Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-31. B. BRANCH TECHNICAL POSITION 1. A design that provides manual initiation at the system level of the transfer to the recirculation mode, while not ideal, is sufficient and satisfies the intent of IEEE Std 279-1971 provided that adequate instrumentation and information display are available to the operator so that he can make the correct decision at the correct time. Furthermore, it should be shown that, in case of operator error, there are sufficient time and sufficient information available so that the operator can correct the error, and the consequences of such an error are acceptable.	1975		
SRP-OC-24	Operator/System Integration Criterion Instrumentation and Control Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-32. 1 The bypass indicators should be arranged to enable the operator to determine the status of each safety system and determine whether continued reactor operation is permissible.	1975		

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SRP-OC-25	Operator/System Integration Criterion Operator Procedure Criterion Instrumentation and Control Criterion	Section 9.5.2 Communications Systems, page 9.5.2-1. There are no general design criteria or regulatory guides that directly apply to the safety-related performance requirements for the communication system.	1975		
SRP-OC-26	Operator/System Integration Criterion Instrumentation and Control Criterion Operator Procedure Criterion Control Room Environment Criterion	Section 13.1.1 Management and Technical Support Organization, page 13.1.1-2. 2. Preoperational Responsibilities These are functions which should be substantially accomplished before preoperational testing begins and generally before submittal of the final safety analysis report (FSAR). a. Development of human engineering design objectives and design phase review of proposed control room layouts.	1975		
SRP-OC-27	Operator/System Integration Criterion	Section 15.1.1 Decrease in Feedwater Temperature, Increase in Feedwater Flow, Increase in Steam Flow, and Inadvertent Opening of a Steam Generator Relief or Safety Valve, page 15.1.1-3. d. An incident of moderate frequency in combination with any single active component failure, or single operator error, should not result in loss of function of any barrier other than the fuel cladding. A limited number of fuel rod cladding perforations is acceptable.	1975		
SRP-OC-28	Operator/System Integration Criterion Operator Procedure Criterion Instrumentation and Control Criterion	Section 15.1.5 Spectrum of Steam System Piping Failures Inside and Outside of Containment (PWR), page 15.1.5-2. The sequence of events described in the applicant's safety analysis report (SAR) is reviewed by both RSB and EICSB. The RSB reviewer concentrates on the need for the reactor protection system, the engineered safety systems, and operator action to secure and maintain the reactor in a safe condition. The EICSB reviewer concentrates on the instrumentation and controls aspects of the sequence described in the SAR to evaluate whether the reactor and plant protection and safeguards controls and instrumentation systems will function as assumed in the safety analysis with regard to automatic actuation, remote sensing, indication, control and interlocks with auxiliary or shared systems. EICSB also evaluates potential bypass modes and the possibility of manual control by the operator.	1975		

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		Section 15.1.5 Spectrum of Steam System Piping Failures Inside and Outside of Containment (PWR), page 15.1.5-2 (continued). Equivalent Statement: Section 15.2.6 Loss of Non-Emergency A-C Power to the Station Auxiliaries, page 15.2.6-1. Section 15.2.7 Loss of Normal Feedwater Flow, page 15.2.7-1. Section 15.2.8 Feedwater System Pipe Breaks Inside and Outside Containment (PWR), page 15.2.8-2. Section 15.3.1 Loss of Forced Reactor Coolant Flow Including Trip of Pump and Flow Controller Malfunctions, page 15.3.1-2. Section 15.3.3 Reactor Coolant Pump Rotor Seizure and Reactor Coolant Pump Shaft Break, page 15.3.3-2. Section 15.4.4 Startup of an Inactive Loop or Recirculation Loop at an Incorrect Temperature, and Flow Controller Malfunction Causing an Increase in BWR CORE FLOW RATE, page 15.4.4-2. Section 15.4.6 Chemical and Volume Control System Malfunction That Results in a Decrease in the Boron Concentration in the Reactor Coolant (PWR), page 15.4.6-1. Section 15.5.1 Inadvertent Operation of ECCS and Chemical and Volume Control System Malfunction That Increases Reactor Coolant Inventory, page 15.5.1-2. Section 15.6.1 Inadvertent Opening of a PWR Pressurizer Safety/Relief Valve or a BWR Safety/Relief Valve, page 15.6.1-1. Section 15.8 Anticipated Transients Without Scram, page 15.8-1.			
SRP-OC-29	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 15.1.5 Spectrum of Steam System Piping Failures Inside and Outside of Containment (PWR), page 15.1.5-9. 2. Review of the signals available to the reactor operator that indicate the occurrence of the accident and the state of the system throughout the recovery procedure. Automatic and required manual operations by the operator as a function of time must also be determined.	1975		

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SRP-OC-30	Operator/System Integration Criterion	Section 15.2.6 Loss of Non-Emergency A-C Power to the Station Auxiliaries, page 15.2.6-4. The EICSB reviewer evaluates automatic initiation, actuation delays, possible bypass modes, interlocks, and the feasibility of manual operation if the SAR states that operator action is needed or expected.	1975		
SRP-OC-31	Operator/System Integration Criterion	Section 15.3.1 Loss of Forced Reactor Coolant Flow Including Trip of Pump and Flow Controller Malfunctions, page 15.3.1-3. The description of each of the loss of reactor coolant flow transients presented by the applicant in the SAR is reviewed by RSB regarding the occurrences leading to the initiating event. The sequence of events from initiation until a stabilized condition is reached is reviewed to ascertain: 5. The extent to which operator actions are required. Equivalent Statement: Section 15.3.3 Reactor Coolant Pump Rotor Seizure and Reactor Coolant Pump Shaft Break, page 15.3.3-4. Section 15.4.4 Start-up of an Inactive Loop or Recirculation Loop at an Incorrect Temperature, and Flow Controller Malfunction Causing an Increase in BWR CORE FLOW RATE, page 15.4.4-4. Section 15.4.6 Chemical and Volume Control System Malfunction That Results in a Decrease in the Boron Concentration in the Reactor Coolant (PWR), page 15.4.6-4.	1975		

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SRP-OC-32	Operator/System Integration Criterion	Section 15.4.6 Chemical and Volume Control System Malfunction That Results in a Decrease in the Boron Concentration in the Reactor Coolant (PWR), page 15.4.6-1. I. AREAS OF REVIEW Unborated water can be added to the reactor coolant system, via the chemical volume and control system (CVCS), to increase core reactivity. This may happen inadvertently, because of operator error or CVCS malfunction, and cause an unwanted increase in reactivity and a decrease in shutdown margin. The operator must stop this unplanned dilution before the shutdown margin is eliminated. Since the sequences of events that may occur depend on plant conditions at the time of the unplanned moderator dilution, the review includes conditions at the time of the unplanned dilution, such as refueling, startup, power operation (automatic control and manual modes), hot standby, and cold shutdown.	1975		
SRP-OC-33	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 15.4.6 Chemical and Volume Control System Malfunction That Results in a Decrease in the Boron Concentration in the Reactor Coolant (PWR), page 15.4.6-2. d. From the time an alarm makes the operator aware of unplanned moderator dilution, the following minimum time intervals must be available before a loss of shutdown margin occurs: (1) During refueling: 30 minutes. (2) During startup, cold shutdown, hot standby, and power operation: 15 minutes.	1975		

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SRP-OC-34	Operator/System Integration Criterion	Section 15.4.6 Chemical and Volume Control System Malfunction That Results in a Decrease in the Boron Concentration in the Reactor Coolant (PWR), page 15.4.6-4. With the aid of the EICSB reviewer, the timing of the initiation of those protection, engineered safety, and other systems needed to limit the consequences of each boron dilution incident to acceptable levels is reviewed. The RSB reviewer compares the predicted variations of system parameters with various trip and system initiation set points. The EICSB reviewer evaluates automatic initiation, actuation delays, possible bypass modes, interlocks, and the feasibility of manual operation where the SAR states that operator action is needed or expected. Equivalent Statement: Section 15.5.1 Inadvertant Operation of ECCS and Chemical and Volume Control System Malfunction That Increases Reactor Coolant Inventory, page 15.5.1-4.	1975		
SRP-OC-35	Operator/System Integration Criterion Instrumentation and Control Criterion	Section 15.6.3 Radiological Consequences of Steam Generator Tube Failure (PWR), page 15.6.3-2. 2. Review of the signals available to the reactor operator that indicate the occurrence of the accident and the state of the system throughout the recovery procedure. Automatic and required manual operations by the operator as a function of time must also be determined.	1975		
SRP-OC-36	Operator/System Integration Criterion	Section 15.6.5 Loss-of-Coolant Accidents Resulting From Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary, page 15.6.5-2. For postulated break sizes and locations, the RSB review includes the postulated initial reactor core and reactor system conditions, the postulated sequence of events including time delays prior to and after emergency power actuation, the calculation of the power, pressure, flow and temperature transients, the functional and operational characteristics of the reactor protective and ECCS systems in terms of how they affect the sequence of events, and operator actions required to mitigate the consequences of the accident.	1975		

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SRP-HC-1	Human Factors Test and Evaluation Criterion	Section 3.11 Environmental Design of Mechanical and Electrical Equipment, page 3.11-3. (2) The equipment environmental capability shall be demonstrated by appropriate testing and analyses. (3) A quality assurance program shall be established and implemented to provide assurance that these requirements are met. The environmental design of safety-related mechanical and electrical equipment is acceptable when it can be ascertained that all three requirements are met.	1975		
SRP-HC-2	Human Factors Test and Evaluation Criterion Instrumentation and Control Criterion	Section 7.4 Systems Required for Safe Shutdown, page 7.4-3. The instrumentation and control systems required for safe shutdown are acceptable when it is determined that these systems satisfy the following requirements: 1. They have the required redundancy. 2. They meet the single failure criterion. 3. They have the required capacity and reliability to perform intended safety functions on demand. 4. They are capable of functioning during and after certain design basis events such as earthquakes, accidents, and anticipated operational occurrences. 5. They are testable during reactor operation.	1975		

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SRP-MC-1	Policy, Planning and Management Criterion	Section 3.7.4 Seismic Instrumentation, page 3.7.4-1. The procedures that will be followed to inform the control room operator of the peak acceleration level and the input response spectra values shortly after occurrence of an earthquake are reviewed. Also reviewed are the bases for establishing predetermined values for activating the readout of the seismic instrumentation to the control room operator.	1975		
SRP-MC-2	Policy, Planning and Management Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-21. 2. Plants with designs not in accordance with the above should have included in the plant technical specifications a requirement that the reactor be shut down prior to changing the set points manually.	1975		
SRP-MC-3	Policy, Planning and Management Criterion Operator Procedure Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-3. 2. APCSB reviews the analysis in the SAR of the fire potential in safety related plant areas and the hazard of fires to these areas to determine that the proposed fire protection program is able to maintain the ability to perform safe shutdown, functions and to minimize radioactive releases to the environment.	1975		
SRP-MC-4	Policy, Planning and Management Criterion Operator Procedure Criterion	Section 13.1.2 Operating Organization, page 13.1.2-3. b. Operator license qualifications of persons assigned to operating shift crews should be as follows: (1) A licensed senior operator who is also a member of the station supervisory staff should be onsite at all times when a least one unit is loaded with fuel. (2) For any station with more than one reactor containing fuel, (1) the number of licensed senior operators onsite at all times should not be less than the number of control rooms from which the fueled units are monitored, and (2) the number of licensed senior operators should not be less than the number of reactors operating. (3) For each reactor containing fuel, there should be at least one licensed operator in the control room at all times. Shift crew compositions should be specified such that this condition can be satisfied independently of licensed senior operators assigned to shift crews to meet the criteria of (1) and (2) above.	1975		

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		Section 13.1.2 Operating Organization, page 13.1.2-3 (continued). (4) For each control room from which one or more reactors are in operation, an additional operator should be onsite and available to serve as relief operator for that control room. Shift crew compositions should be specified such that this condition can be satisfied independently of (1), (2), and (3), and for each such control room.			

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SRP-PC-1	Operator Procedure Criterion	Section 2.4.14 Technical Specifications and Emergency Operation Requirements, page 2.4.14-1. 4. The appropriate emergency procedures, and the amount of time required to implement each procedure.	1975		
SRP-PC-2	Operator Procedure Criterion	Section 3.7.4 Seismic Instrumentation, page 3.7.4-3. If the instrumentation shows that the peak acceleration or the response spectra experienced at the foundation of the containment building or in the free field exceed the OBE acceleration level or response spectra, the plant should be shut down pending permission to resume operations.	1975		
SRP-PC-3	Operator Procedure Criterion Instrumentation and Control Criterion	Section 5.2.5 RCPB Leakage Detection, page 5.2.5-3. 7. Quantitative Interpretation of Indicators and Alarms It is important to be able to associate a signal or indicaton of a departure from the normal operating conditions with a quantitative leakage flow rate. Except for flow rate or level change measurements from tanks, sumps, or pumps, signals from other leakage detection systems do not provide information readily convertible to a common denominator. Approximate relationships converting these signals to units of water flow are formulated to assist the operator in interpreting signals. The instrumentation associated with the lead detection system is reviewed by EICSB in SRP 7.5 (Ref. 4). Procedures for operator evaluation of leakage conditions are reviewed by RSB.	1975		
SRP-PC-4	Operator Procedure Criterion Instrumentation and Control Criterion	Section 5.2.5 RCPB Leakage Detection, page 5.2.5-3. 7. Indicators and Alarms Indicators and alarms for each leakage detection system should be provided in the main control room and procedures for converting various indications to a common leakage equivalent should be available to the operators. The calibration of the indicators should account for the independent variables such as, in the case of an air particulate monitor, the isotope being monitored, plateout, and decay rate. Each system should be set to alarm on an increase in leakage of 1 gpm above the background level determined at the time of calibration.	1975		

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SRP-PC-5	Operator Procedure Criterion	Section 6.3 Emergency Core Cooling System, page 6.3-5. 6. The criteria, supporting analyses, plant design provisions, and operator actions that will be taken are reviewed to ensure that there will not be unacceptably high concentrations of boric acid in the core region (resulting in precipitation of a solid phase) during the long-term cooling phase following a postulated LOCA.	1975		
SRP-PC-6	Operator Procedure Criterion Instrumentation and Control Criterion	Section 6.4 Habitability Systems, page 6.4-4. 1. Control Room Emergency Zone The reviewer checks to see that the zone includes the following: a. Instrumentation and control necessary for a safe shutdown of the plant, i.e., the control room, including the critical document reference file.	1975		
SRP-PC-7	Operator Procedure Criterion Operator/System Integration Criterion	Section 7.2 Reactor Trip System, page 7.2-13. a. Automatic initiation is required for all protective functions. Manual initiation is also provided and is a requirement. (See Section 4.17 and Regulatory Guide 1.62.)	1975		
SRP-PC-8	Operator Procedure Criterion	Section 7.6 All Other Instrumentation Systems Required for Safety, page 7.6-6. 4. For manually-controlled electrically-operated valves in safety-related systems, the acceptability of proposed designs is based on Branch Technical Position EICSB 18. This position basically states that it is acceptable to disconnect eletric power to a safety-related valve as means of removing the possibility of an active failure of that valve.	1975		

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SRP-PC-9	Operator Procedure Criterion Instrumentation and Control Criterion Operator/System Integration Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-13. d. Minimize the coordination required between unit operators in order to accomplish (a), (b), and (c) above. Although each design will be evaluated on an individual basis in this regard, all shared onsite power systems should meet the following: (1) Coordination between the unit operators should not be necessary in order to provide for (a) and (b), above. (2) Complete information regarding the status of the shared system should be provided for each operator.	1975		
SRP-PC-10	Operator Procedure Criterion	Appendix 7A Branch Technical Positions (EICSB), page 7A-21. B. BRANCH TECHNICAL POSITION 1. If more restrictive safety trip points are required for operation with a reactor coolant pump out of service, and if operation with a reactor coolant pump out of serivce is of sufficient likelihood to be a planned mode of operation, the change to the more restrictive trip points should be accomplished automatically.	1975		
SRP-PC-11	Operator Procedure Criterion	Appendix 7A Branch Technical Positions (EICSB) page 7A-32. 4. Unless the indication system is designed in conformance with criteria established for safety systems, it should not be used to perform functions that are essential to safety. Administrative procedures should not require immediate operator action based solely on the bypass indications.	1975		
SRP-PC-12	Operator Procedure Criterion Operator/System Integration Criterion Policy, Planning and Management Criterion	Section 9.5.1 Fire Protection Systems, page 9.5.1-3. 2. APCSB reviews the analysis in the SAR of the fire potential in safety related plant areas and the hazard of fires to these areas to determine that the proposed fire protection program is able to maintain the ability to perform safe shutdown, functions and to minimize radioactive releases to the environment.	1975		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standa (Re . z Plan for the Review of Safety Analysis Reports for Nuclear Power Pl., s. NRC, 1975

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-PC-13	Operator Procedure Criterion Operator/System Integration Criterion Instrumentation and Contro. Criterion	Section 9.5.2 Communications Systems, page 9.5.2-1. There are no general design criteria or regulatory guides that directly apply to the safety-related performance requirements for the communication system.	1975		
SRP-PC-14	Operator Procedure Criterion	Section 10.2 Turbine Generator, page 10.2-2. 1. A turbine control and overspeed protection system should be provided to control turbine action under all normal or abnormal operating conditions, and to assure that a full load turbine trip will not cause the turbine to overspeed beyond acceptable limits. Under these conditions, the control and protection system should permit an orderly reactor shutdown either by use of the turbine bypass system and main steam relief system or other engineered safety systems. The overspeed protection system should meet the single failure criterion.	1975		
SRP-PC-15	Operator Procedure Criterion Instrumentation and Control Criterion	Section 10.2 Turbine Generator, page 10.2-3. b. Main steam stop and control valves and reheat stop and intercept valves should be exercised at least once a week by closing each valve and observing by the valve position indicator that it moves smoothly to a fully closed position. At least once a month, this examination should be made by direct observation of the valve motion.	1975		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-PC-16	Operator Procedure Criterion Instrumentation and Control Criterion	Section 11.5 Process and Effluent Radiological Monitoring and Sampling Systems, page 11.5-2. b. For a pressurized water reactor (PWR) the following process streams or effluent release points should be monitored or sampled continuously: (1) Main condenser air ejector offgases. (2) Waste gas treatment system effluent. (3) Equipment vents routed directly to the environment (e.g., steam generator blowdown flash tank vent, liquid waste tank vents). (4) Ventilation air exhausts from all buildings having the potential to contain airborne radioactivity. (5) Turbine building floor drain effluents. (6) Liquid effluents from the steam generator blowdown system. (7) Boron recovery system effluents. (8) Liquid waste effluent streams. (9) Service water effluent stream. (10) Component cooling water loop.	1975		
SRP-PC-17	Operator Procedure Criterion Instrumentation and Control Criterion Control Room Environment Criterion Operator Support Integration Criterion	Section 13.1.1 Management and Technical Support Organization, page 13.1.1-2. 2. Preoperational Responsibilities These are functions which should be substantially accomplished before preoperational testing begins and generally before submittal of the final safety analysis report (FSAR). a. Development of human engineering design objectives and design phase review of proposed control room layouts.	1975		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safe: , Analysis Reports for Nuclear Power Plants, NRC, 1975

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-PC-18	Operator Procedure Criterion Policy, Planning and Management Criterion	Section 13.1.2 Operating Organization, page 13.1.2-3. b. Operator license qualifications of persons assigned to operating shift crews should be as follows: (1) :. licensed senior operator who is also a member of the station supervisory staff should be onsite at all times when at least one unit is loaded with fuel. (2) For any station with more than one reactor containing fuel, (1) the number of licensed senior operators onsite at all times should not be less than the number of control rooms from which the fueled units are monitored, and (2) the number of licensed senior operators should not be less than the number of reactors operating. (3) For each reactor containing fuel, there should be at least one licensed operator in the control room at all times. Shift crew compositions should be specified such that this condition can be satisfied independently of licensed senior operators assigned to shift crews to meet the criteria of (1) and (2) above. (4) For each control room from which one or more reactors are in operation, an additional operator should be onsite and available to serve as relief operator for that control room. Shift crew compositions should be specified such that this condition can be satisfied independently of (1), (2), and (3), and for each such control room.	1975		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-PC-19	Operator Procedure Criterion Instrumentation and Control Criterion Operator/System Integration Criterion	Section 15.1.5 Spectrum of Steam System Piping Failures Inside and Outside of Containment (PWR), page 15.1.5-2. The sequence of events described in the applicant's safety analysis report (SAR) is reviewed by both RSB and EICSB. The RSB reviewer concentrates on the need for the reactor protection system, the engineered safety systems, and operator action to secure and maintain the reactor in a safe condition. The EICSB reviewer concentrates on the instrumentation and controls aspects of the sequence described in the SAR to evaluate whether the reactor and plant protection and safeguards controls and instrumentation systems will function as assumed in the safety analysis with regard to automatic actuation, remote sensing, indication, control and interlocks with auxiliary or shared systems. EICSB also evaluates potential bypass modes and the possibility of manual control by the operator. Equivalent Statement: Section 15.2.7 Loss of Normal Feedwater Flow, page 15.2.7-1. Section 15.2.8 Feedwater System Pipe Breaks Inside and Outside Containment (PWR), page 15.2.8-2. Section 15.3.1 Loss of Forced Reactor Coolant Flow Including Trip of Pump and Flow Controller Malfunctions, page 15.3.1-2. Section 15.3.3 Reactor Coolant Pump Rotor Seizure and Reactor Coolant Pump Shaft Break, page 15.3.3-2. Section 15.4.4 Startup of an Inactive Loop or Recirculation Loop at an Incorrect Temperature, and Flow Controller Malfunction Causing an Increase in BWR CORE FLOW RATE, page 15.4.4-2. Section 15.4.6 Chemical and Volume Control System Malfunction That Results in a Decrease in the Boron Concentration in the Reactor Coolant (PWR), page 15.4.6-1. Section 15.5.1 Inadvertent Operation of ECCS and Chemical and Volume Control System Malfunction That Increases Reactor Coolant Inventory, page 15.5.1-2. Section 15.6.1 Inadvertent Opening of a PWR Pressurizer Safety/Relief Valve or a BWR Safety/Relief Valve, page 15.6.1-1. Section 15.8 Anticipated Transients Without Scram, page 15.8-1.	1975		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-TG-1	Human Factors Test and Evaluation Guide Operator/System Integration Guide	Section 15.1.5 Spectrum of Steam System Piping Failures Inside and Outside of Containment (PWR), page 15.1.5-5. Since auxiliary feedwater system designs are diverse and may require both automatic and manual actuation, preoperational tests should be specified to identify any necessary operator action and to establish times required for their completion.	1975		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-EC-1	Operator Support Equipment Criterion Control Room Environment Criterion	Section 3.5.1.4 Missiles Generated by Natural Phenomena, pages 3.5.1.4-6 and 3.5.1.4-7. 1. Those structures, systems, and components, including foundations and supports, which should be designed to withstand the effects of a design basis tornado (as defined in Regulatory Guide 1.76), including tornado missiles, without loss of capability to perform essential safety functions are listed below. 9. The control room, including its associated vital equipment, cooling systems for the vital equipment and life support systems, and any structures or equipment inside or outside of the control room whose failure could result in an incapacitating injury to individuals occupying the control room.	1975		
SRP-EC-2	Operator Support Equipment Criterion Instrumentation and Control Criterion Control Room Environment Criterion	Section 3.11 Environmental Design of Mechanical and Electrical Equipment, page 3.11-3 Simply stated, the general requirements for environmental design and qualification are as follows. (1) The equipment shall be designed to have the capability of performing design safety functions under all normal and accident environments.	1975		
SRP-EC-3	Operator Support Equipment Criterion Instrumentation and Control Criterion	Section 5.4.7 Residual Heat Removal (RHR) System, page 5.4.7-3. It must be shown that adequate equipment, control, and sensing information is available to allow the operator to properly execute any required manual operations during operation or test.	1975		
SRP-EC-4	Operator Support Equipment Criterion	Section 6.4 Habitability Systems, page 6.4-2 3. Ventilation System Criteria (See III.3 of this plan) Self-contained breathing apparatus for the emergency team (at least 5 men) should be on hand. A six-hour onsite bottled air supply should be available with unlimited offsite replenishment capability from nearby location(s). Refer to References 3 thru 6, and see Section III.3 of this plan.	1975		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-EC-5	Operator Support Equipment Criterion Control Room Environment Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-32. 5. Lighting and Communication Lighting and two way voice communication are vital to safe shutdown and emergency response in the event of fire. Suitable fixed and portable emergency lighting and communication devices should be provided to satisfy these requirements.	1975		
SRP-EC-6	Operator Support Equipment Criterion Instrumentation and Control Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-47. Fire detection systems should alarm and annunciate in the control room. These systems should utilize detection and location most suitable to the particular type of fire expected from the identified hazard. A primary containment general area fire detection capability should be provided as backup for the above described hazard detection. To accomplish this, suitable smoke detection (e.g., visual obscuration, light scattering, and particle counting) should be installed in the air recirculation system ahead of any filters.	1975		
SPP-EC-7	Operator Support Equipment Criterion Control Room Environment Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-49. Manual fire fighting capability should be provided for both hazards. Hose stations and portable extinguishers should be located in the control room to eliminate the need for operators to leave the control room.	1975		
SRP-EC-8	Operator Support Equipment Criterion Instrumentation and Control Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-50. Fire detection in the control room cabinets, and consoles should be provided by smoke and heat detectors in each fire area. Alarm and annunciation should be provided in the control room. Fire alarms in other parts of the plant should also be alarmed and annunciated in the control room.	1975		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-EC-9	Operator Support Equipment Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-50. Breathing apparatus for control room operators should be readily available. Equivalent Statement: Section 9.5.1 Fire Protection System, page 9.5.1-101.	1975		
SRP-EC-10	Operator Support Equipment Criterion Instrumentation and Control Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-57. 12. New Fuel Area Hand portable extinguishers should be located within this area. Also, local hose stations should be located outside but within hose reach of this area. Automatic fire detection should alarm and annunciate in the control room and alarm locally.	1975		
SRP-EC-11	Operator Support Equipment Criterion Instrumentation and Control Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-57. 13. Spent Fuel Pool Area Protection for the spent fuel pool area should be provided by local hose stations and portable extinguishers. Automatic fire detection should be provided to alarm and annunciate in the control room and to alarm locally.	1975		
SRP-EC-12	Operator Support Equipment Criterion Control Room Environment Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-86. (h) Self contained breathing apparatus, using full face positive pressure masks, approved by NIOSH (National Institute for Occupational Safety and Health - approval formerly given by the U.S. Bureau of Mines) should be provided for fire brigade, damage control and control room personnel. Control room personnel may be furnished breathing air by a manifold system piped from a storage reservoir if practical. Service or operating life should be a minimum of one half hour for the self-contained units.	1975		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, NRC, 1975

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SRP-EC-13	Operator Support Equipment Criterion Control Room Environment Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-87. 5. Lighting and Communication Lighting and two way voice communication are vital to safe shutdown and emergency response in the event of fire. Suitable fixed and portable emergency lighting and communication devices should be provided.	1975		
SRP-EC-14	Operator Support Equipment Criterion Control Room Environment Criterion	Section 9.5.1 Fire Protection System, page 9.5.1-100. Manual fire fighting capability should be provided for both hazards. Hose stations and portable water and Halon extinguishers should be located in the control room to eliminate the need for operators to leave the control room. An additional hose piping shut off valve and pressure reducing device should be installed outside the control room.	1975		
SRP-EC-15	Operator Support Equipment Criterion	Section 9.5.2 Communications Systems, page 9.5.2-1 The APCSB will use the following criterion to assess the system design capability: the communication system is acceptable if the integrated design of the system will provide effective communication between plant personnel in all vital areas during the full spectrum of accident or incident conditions under maximum potential noise levels.	1975		
SRP-EC-16	Operator Support Equipment Criterion Control Room Environment Criterion	Section 13.3 Emergency Planning, page 13.3-4. "In-plant monitors will provide the first indication of a radiological emergency. Provisions will be made for surveys by portable meters and air sampling devices on a timely basis. The plant control room has been designed for continuous occupancy and will be the principal emergency control center. One alternate center will be designated. Emergency kits will be stored at the primary assembly area. Decontamination facilities and a first aid room will be provided.	1975		

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APPENDIX J

10 CODE OF FEDERAL REGULATIONS CRITERIA

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-IC-1	Instrumentation and Control Criterion Operator/System Integration Criterion Operator Procedure Criterion	Paragraph 50.36 "Technical Specifications," page 325. (ii)(A) Limiting safety system settings for nuclear reactors are settings for automatic protective devices related to those variables having significant safety functions. Where a limiting safety system setting is specified for a variable on which a safety limit has been placed, the setting shall be so chosen that automatic protective action will correct the abnormal situation before a safety limit is exceeded. If during operation, the automatic safety system does not function as required, the licensee shall take appropriate action, which may include shutting down the reactor.	1968	60	
CFR-IC-2	Instrumentation and Control Criterion Operator/System Integration Criterion Operator Procedure Criterion	Paragraph 50.36 "Technical Specifications," page 326. (2) Limiting conditions for operation. Limiting conditions for operation are the lowest functional capability or performance levels of equipment required for safe operation of the facility. When a limiting condition for operation of a nuclear reactor is not met, the licensee shall shut down the reactor or follow any remedial action permitted by the technical specification until the condition can be met.	1968	60	
CFR-IC-3	Instrumentation and Control Criterion Operator Procedure Criterion	Paragraph 50.36 "Technical Specifications," page 326. (3) Surveillance requirements. Surveillance requirements are requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within the safety limits, and that the limiting conditions of operation will be met.	1968	60	
CFR-IC-4	Instrumentation and Control Criterion Operator Procedure Criterion	Paragraph 50.36a "Technical Specifications on Effluents from Nuclear Power Reactors," page 327. It is expected that in using this operational flexibility under unusual operating conditions, the licensee will exert his best efforts to keep levels of radioactive material in effluents as low as practicable.	1971	57	

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-IC-5	Instrumentation and Control Criterion	Paragraph 50.44 "Standards for Combustible Gas Control System in Light Water Cooled Power Reactors," page 330. (b) Each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within cylindrical zircaloy cladding shall be provided with the capability for (1) measuring the hydrogen concentration in the containment, (2) insuring a mixed atmosphere in the containment, and (3) controlling combustible gas concentrations in the containment following a postulated LOCA.	1979		
CFR-IC-6	Instrumentation and Control Criterion Operator Procedure Criterion Policy, Planning and Management Criterion	Paragraph 50.54 "Conditions of Licenses," page 335. (j) Apparatus and mechanisms other than controls, the operation of which may affect the reactivity or power level of a reactor shall be manipulated only with the knowledge and consent of an operator or senior operator licensed pursuant to Part 55 of this chapter present at the controls.	1967	59	
CFR-IC-7	Instrumentation and Control Criterion Operator Procedure Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 353. Criterion 10 — Reactor design. The reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.	1967	61	
CFR-IC-8	Instrumentation and Control Criterion Operator Procedure Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 353. Criterion 12 — Suppression of reactor power oscillations. The reactor core and associated coolant, control, and protective systems shall be designed to assure that power oscillations which can result in conditions exceeding specified acceptable fuel design limits are not possible or can be reliably and readily detected and suppressed.	1967	61	

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Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-IC-9	Instrumentation and Control Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 353. Criterion 13 — Instrumentation and control. Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions as appropriate to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.	1967	61	
CFR-IC-10	Instrumentation and Control Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 353. Criterion 15 — Reactor coolant system design. The reactor coolant system and associated auxiliary, control, and protection systems shall be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences.	1967	61	
CFR-IC-11	Instrumentation and Control Criterion Control Room Environment Criterion Operator Procedure Criterion Operator/System Integration Criterion Operator Support Equipment Criterion	Appendix A "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 354. Criterion 19 — Control room. A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident. Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.	1967	61	

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Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-IC-12	Instrumentation and Control Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," III. Protection and Reactivity Control Systems, page 355. Criterion 24 — Separation of protection, and control systems. The protection system shall be separated from control systems to the extent that failure of any single control system component or channel, or failure or removal from service of any single protection system component or channel which is common to the control and protection systems leaves intact a system satisfying requirements of the protection system. Interconnection of the protection and control systems shall be limited so as to assure that safety is not significantly impaired.	1967	61	
CFR-IC-13	Instrumentation and Control Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," IV. Fluid Systems, page 356. Criterion 34 — Residual heat removal. A system to remove residual heat shall be provided. The system safety function shall be to transfer fission product decay heat and other residual heat from the reactor core at a rate such that specified acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded. Suitable redundancy in components and features, and suitable interconnections, leak detection, and isolation capabilities shall be provided to assure that for onsite electric power system operation (assuming offsite power is not available) and for offsite electric power system operation (assuming onsite power is not available) the system safety function can be accomplished, assuming a single failure.	1979		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-IC-14	Instrumentation and Control Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," IV. Fuel and Radioactivity Control, page 359. Criterion 63 — Monitoring fuel and waste storage. Appropriate systems shall be provided in fuel storage and radioactive waste systems and associated handling areas (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions.	1967	61	
CFR-IC-15	Instrumentation and Control Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," IV. Fuel and Radioactivity Control, page 359. Criterion 64 — Monitoring radioactivity releases. Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculation of loss-of-coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.	1967	61	
CFR-IC-16	Instrumentation and Control Criterion Operator Procedure Criterion	Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," page 362. XIV. INSPECTION, TEST, AND OPERATING STATUS Measures shall be established to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the nuclear power plant or fuel reprocessing plant. These measures shall provide for the identification of items which have satisfactorily passed required inspections and tests, where necessary to preclude inadvertent bypassing of such inspections and tests. Measures shall also be established for indicating the operating status of structures, systems, and components of the nuclear power plant or fuel reprocessing plant, such as by tagging valves and switches, to prevent inadvertent operation.	1970	62	

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(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-IG-1	Instrumentation and Control Guide	Appendix E, "Emergency Plans for Production and Utilization Facilities," page 366. C. Means for determining the magnitude of the release of radioactive materials, including criteria for determining the need for notification and participation of local and State agencies and the Atomic Energy Commission and other Federal agencies, and criteria for determining when protective measures should be considered within and outside the site boundary to protect health and safety and prevent damage to property.	1970	63	

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(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-MC-1	Policy, Planning and Management Criterion	Paragraph 50.34 "Contents of Applications; Technical Information," page 321. (6) A preliminary plan for the applicant's organization, training of personnel, and conduct of operations.	1968	60	
CFR-MC-2	Policy, Planning and Management Criterion	Paragraph 50.34 "Contents of Applications; Technical Information," page 323. (8) A description and plans for implementation of an operator requalification program. The operator requalification program shall, as a minimum, meet the requirements for those programs contained in Appendix A of Part 55 of this chapter.	1979		
CFR-MC-3	Policy, Planning and Management Criterion	Paragraph 50.34a "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents - Nuclear Power Reactors," page 323. (a) An application for a permit to construct a nuclear power reactor shall include a description of the preliminary design of equipment to be installed to maintain control over radioactive materials in gaseous and liquid effluents produced during normal reactor operations, including expected operational occurrences.	1971	57	
CFR-MC-4	Policy, Planning and Management Criterion	Paragraph 50.34a "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents - Nuclear Power Reactors," page 324. (c) Each application for a license to operate a nuclear power reactor shall include (1) a description of the equipment and procedures for the control of gaseous and liquid effluents and for the maintenance and use of equipment installed in radioactive waste systems, pursuant to paragraph (a) of this section;	1971	57	

NOTES: (1) 1967 or more recent.
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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-MC-5	Policy, Planning and Management Criterion Instrumentation and Control Criterion Operator Procedure Criterion	Paragraph 50.54 "Conditions of Licenses," page 335. (j) Apparatus and mechanisms other than controls, the operation of which may affect the reactivity or power level of a reactor shall be manipulated only with the knowledge and consent of an operator or senior operator licensed pursuant to Part 55 of this chapter present at the controls.	1967	59	
CFR-MC-6	Policy, Planning and Management Criterion	Paragraph 50.54 "Conditions of Licenses," page 335. (k) An operator or senior operator licensed pursuant to Part 55 of this chapter shall be present at the controls at all times during the operation of the facility.	1967	59	
CFR-MC-7	Policy, Planning and Management Criterion	Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," page 362. XVI. CORRECTIVE ACTION Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, the corrective action taken shall be documented and reported to appropriate levels of management.	1970	62	

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-HC-1	Human Factors Test and Evaluation Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," IV. Fluid Systems, page 356. Criterion 37 — Testing of emergency core cooling system. The emergency core cooling system shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leaktight integrity of its components, (2) the operability and performance of the active components of the system, and (3) the operability of the system as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated cooling water system.	1967	61	
CFR-HC-2	Human Factors Test and Evaluation Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," IV. Fluid Systems, page 356. Criterion 40 — Testing of containment heat removal system. The containment heat removal system shall be designed to permit appropriate period pressure and functional testing to assure (1) the structural and leaktight integrity of its components, (2) the operability and performance of the active components of the system, and (3) the operability of the system as a whole, and under conditions as close to the design as practical the performance of the full operation sequence that brings the system into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of the associated cooling water system.	1967	61	

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-HC-3	Human Factors Test and Evaluation Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," IV. Fluid Systems, page 357. Criterion 43 — Testing of containment atmosphere cleanup systems. The containment atmosphere cleanup systems shall be designed to permit appropriate periodic pressure and functional testing to assure (1) the structural and leaktight integrity of its components, (2) the operability and performance of the active components of the systems such as fans, filters, dampers, pumps, and valves, and (3) the operability of the systems as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the systems into operation, including operation of applicable portions of the protection system, the transfer between normal and emergency power sources, and the operation of associated systems.	1967	61	

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-CC-1	Control Room Environment Criterion Operator Procedure Criterion Instrumentation and Control Criterion Operator Support Equipment Criterion Operator/System Integration Criterion	Appendix A "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 354. Criterion 19 — Control room. A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident. Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.	1967	61	

NOTES: (1) 1967 or more recent.
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(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-PC-1	Operator Procedure Criterion Operator/System Integration Criterion Instrumentation and Control Criterion	Paragraph 50.36 "Technical Specifications," page 325. (ii)(A) Limiting safety system settings for nuclear reactors are settings for automatic protective devices related to those variables having significant safety functions. Where a limiting safety system setting is specified for a variable on which a safety limit has been placed, the setting shall be so chosen that automatic protective action will correct the abnormal situation before a safety limit is exceeded. If during operation, the automatic safety system does not function as required, the licensee shall take appropriate action, which may include shutting down the reactor.	1968	60	
CFR-PC-2	Operator Procedure Criterion Operator/System Integration Criterion Instrumentation and Control Criterion	Paragraph 50.36 "Technical Specifications," page 326. (2) Limiting conditions for operation. Limiting conditions for operation are the lowest functional capability or performance levels of equipment required for safe operation of the facility. When a limiting condition for operation of a nuclear reactor is not met, the licensee shall shut down the reactor or follow any remedial action permitted by the technical specification until the condition can be met.	1968	60	
CFR-PC-3	Operator Procedure Criterion Instrumentation and Control Criterion	Paragraph 50.36 "Technical Specifications," page 326. (3) Surveillance requirements. Surveillance requirements are requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within the safety limits, and that the limiting conditions of operation will be met.	1968	60	
CFR-PC-4	Operator Procedure Criterion Instrumentation and Control Criterion	Paragraph 50.36a "Technical Specifications on Effluents from Nuclear Power Reactors," page 327. It is expected that in using this operational flexibility under unusual operating conditions, the licensee will exert his best efforts to keep levels of radioactive material in effluents as low as practicable.	1971	57	

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-PC-5	Operator Procedure Criterion Instrumentation and Control Criterion Policy, Planning and Management Criterion	Paragraph 50.54 "Conditions of Licenses," page 335. (j) Apparatus and mechanisms other than controls, the operation of which may affect the reactivity or power level of a reactor shall be manipulated only with the knowledge and consent of an operator or senior operator licensed pursuant to Part 55 of this chapter present at the controls.	1967	59	
CFR-PC-6	Operator Procedure Criterion Instrumentation and Control Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 353. Criterion 10 — Reactor design. The reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.	1967	61	
CFR-PC-7	Operator Procedure Criterion Instrumentation and Control Criterion	Appendix A, "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 353. Criterion 12 — Suppression of reactor power oscillations. The reactor core and associated coolant, control, and protective systems shall be designed to assure that power oscillations which can result in conditions exceeding specified acceptable fuel design limits are not possible or can be reliably and readily detected and suppressed.	1967	61	
CFR-PC-8	Operator Procedure Criterion Instrumentation and Control Criterion Control Room Environment Criterion Operator Support Equipment Criterion Operator/System Integration Criterion	Appendix A "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 354. Criterion 19 — Control room. A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident. Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.	1967	61	

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-PC-9	Operator Procedure Criterion Instrumentation and Control Criterion	Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," page 362. XIV. INSPECTION, TEST, AND OPERATING STATUS Measures shall be established to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the nuclear power plant or fuel reprocessing plant. These measures shall provide for the identification of items which have satisfactorily passed required inspections and tests, where necessary to preclude inadvertent bypassing of such inspections and tests. Measures shall also be established for indicating the operating status of structures, systems, and components of the nuclear power plant or fuel reprocessing plant, such as by tagging valves and switches, to prevent inadvertent operation.	1970	62	

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-EC-1	Operator Support Equipment Criterion Operator Procedure Criterion Instrumentation and Control Criterion Operator/System Integration Criterion Control Room Environment Criterion	Appendix A "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 354. Criterion 19 — Control room. A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident. Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.	1967	61	

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: 10 Code of Federal Regulations, January 1, 1979

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
CFR-OC-1	Operator/System Integration Criterion Instrumentation and Control Criterion Operator Procedure Criterion	Paragraph 50.36 "Technical Specifications," page 325. (ii)(A) Limiting safety system settings for nuclear reactors are settings for automatic protective devices related to those variables having significant safety functions. Where a limiting safety system setting is specified for a variable on which a safety limit has been placed, the setting shall be so chosen that automatic protective action will correct the abnormal situation before a safety limit is exceeded. If during operation, the automatic safety system does not function as required, the licensee shall take appropriate action, which may include shutting down the reactor.	1968	60	
CFR-OC-2	Operator/System Integration Criterion Instrumentation and Control Criterion Operator Procedure Criterion	Paragraph 50.36 "Technical Specifications," page 326. (2) Limiting conditions for operation. Limiting conditions for operation are the lowest functional capability or performance levels of equipment required for safe operation of the facility. When a limiting condition for operation of a nuclear reactor is not met, the licensee shall shut down the reactor or follow any remedial action permitted by the technical specification until the condition can be met.	1968	60	
CFR-OC-3	Operator/System Integration Criterion Operator Procedure Criterion Instrumentation and Control Criterion Operator Support Equipment Criterion Control Room Environment Criterion	Appendix A "General Design Criteria for Nuclear Power Plants," II. Protection by Multiple Fission Product Barriers, page 354. Criterion 19 — Control room. A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident. Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.	1967	60	

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APPENDIX K

SAFETY/REGULATORY GUIDES CRITERIA

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Safety Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SG11-IC-1	Instrumentation and Control Criterion	SG 11 Instrument Lines Penetrating Primary Reactor Containment, 3/10/71, page 2. The status (opened or closed) of all such isolation valves should be indicated in the control room. If a remotely operable valve is provided, sufficient information should be available in the control room or other appropriate location to assure timely and proper actions by the operator.	1971		

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(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Safety Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
SG22-IG-1	Instrumentation and Control Guide	SG 22 Periodic Testing of Protection System Actuation Functions, 2/17/72, page 2. b. Each bypass condition should be individually and automatically indicated to the reactor operator in the main control room.	1972		

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(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.68-HG-1	Human Factors Test and Evaluation Guide	RG 1.68 Initial Test Programs for Water-Cooled Nuclear Power Plants, Revision 2, August 1978, page 4. Plant operating and emergency procedures should, to the extent practical, be developed, trial-tested, and corrected during the initial test program prior to fuel loading to establish their adequacy.	1978		
RG1.68-HG-2	Human Factors Test and Evaluation Guide	RG 1.68 Initial Test Programs for Water-Cooled Nuclear Power Plants, Revision 2, August 1978, page 11. j. Instrumentation and Control Systems The nomenclature applied to instrumentation and control systems varies widely with different plant designs; however, the primary functions are similar for all reactors. The principal functions of instrumentation and control systems are to (1) control the normal operation of the facility within design limits, (2) provide information and alarms in the control room to monitor the operation and status of the facility and to permit corrective actions to be taken for off-normal plant conditions, (3) establish that the facility is operating within design and license limits, (4) permit or support the correct operation of engineered safety features, and (5) monitor and record important parameters during and following postulated accidents. In the design of nuclear power plants, postulated accident assumptions are often explicitly or implicitly bounded by the design of control and instrumentation systems (e.g., pressurizer level or feedwater flow control). In such cases, operation of the instrumentation and controls over the design operating range should be performed, and the effects of limiting malfunctions or failures should be simulated to demonstrate the adequacy of design and installation and the validity of accident analysis assumptions. Tests should be conducted, as appropriate, to verify redundancy and electrical independence.	1978		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.68-HG-3	Human Factors Test and Evaluation Guide	RG 1.68 Initial Test Programs for Water-Cooled Nuclear Power Plants, Revision 2, August 1978, page 12. k. Radiation Protection Systems Appropriate tests should be conducted to demonstrate the proper operation of the following types of systems and components used to monitor or measure radiation levels, to provide for personnel protection, or to control or limit the release of radioactivity:	1978		
RG1.68-HG-4	Human Factors Test and Evaluation Guide	RG 1.68 Initial Test Programs for Water-Cooled Nuclear Power Plants, Revision 2, August 1978, page 12. l. Radioactive Waste Handling and Storage Systems Appropriate tests should be conducted to demonstrate the functional operability and design flow rates of systems and components used to process, store, and release or control the release of radioactive liquid, gaseous, and solid wastes. Testing should demonstrate, to the extent practical, that the pumps, tanks, controls, valves, and other equipment, including automatic isolation and protective features and instrumentation and alarms, will operate and function in accordance with design.	1978		
RG1.68-HG-5	Human Factors Test and Evaluation Guide	RG 1.68 Initial Test Programs for Water-Cooled Nuclear Power Plants, Revision 2, August 1978, page 14. The control rod or poison removal sequence should be accomplished using detailed procedures approved by personnel or groups designated by the licensee. For reactors that will achieve initial criticality by boron dilution, control rods should be withdrawn before dilution begins. The control rod insertion imits defined in the technical specifications should be observed and complied with.	1978		
RG1.68-HG-6	Human Factors Test and Evaluation Guide	RG 1.68 Initial Test Programs for Water-Cooled Nuclear Power Plants, Revision 2, August 1978, page 15. d. Determination that adequate overlap of source- and intermediate-range neutron instrumentation exists and verification that proper operations of associated protective functions and alarms provide for plant protection in the low-power range (if not previously performed).	1978		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.53-HG-1	Human Factors Test and Evaluation Guide	RG 1.53 Application of the Single-Failure Criterion to Nuclear Power Plant Protection Systems, June 1973, page 1. "The detectability of a single failure is predicated on the assumption that the test results in the presence of a failure are different from the results that would be obtained if no failure is present. Thus, inconclusive testing procedures such as "continuity checks" of relay circuit coils in lieu of relay operations should not be considered as adequate bases to classify as detectable all potential failures which could negate the functional capability of the tested device."	1973		
RG1.79-HG-1	Human Factors Test and Evaluation Guide Policy, Planning and Management Guide Operator Procedure Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-19. 9.5.2.3 Inspection and Testing Requirements. The inspection and testing requirements for the communication systems should be provided.	1972	66	

NOTES: (1) 1967 or more recent.
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(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.114-OG-1	Operator/System Integration Guide	RG 1.114 Guidance on Being Operator at the Controls of a Nuclear Power Plant, Revision 1, November 1976, page 1. 1. The operator at the controls of a nuclear power plant should have an unobstructed view of and access to the operational control panels,[2] including instrumentation displays and alarms, in order to be able to initiate prompt corrective action, when necessary, on receipt of any indication (instrument movement or alarm) of a changing condition.	1976		
RG1.114-OG-2	Operator/Systems Integration Guide	RG 1.114 Guidance on Being Operator at the Controls of a Nuclear Power Plant, Revision 1, November 1976; page 1. This is faciliated by control room design and layout in which all controls, instrumentation displays, and alarms required for the safe operation, shutdown, and cooldown of the unit are readily available to the operator in the control room.	1976		
RG1.97-OG-1	Operator/System Integration Guide	RG 1.97 Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident, Revision 1, August 1977, page 1. At the start of an accident, the operator cannot always determine immediately what accident has occurred or is occurring and therefore cannot always determine the appropriate response. For this reason, the reactor trip and certain safety actions (e.g., emergency core cooling actuation, containment isolation or depressurization) are designed to be performed automatically during the initial stages of an accident. Instrumentation is also provided to indicate information about plant parameters required to enable the operation of manually initiated safety-related systems and other appropriate operator actions.	1975	65	
RG1.62-OG-1	Operator/System Integration Guide Instrumentation and Control Guide	RG 1.62 Manual Initiation of Protective Actions, October 1973, page 1. 1. Means should be provided for manual initiation of each protective action (e.g., reactor trip, containment isolation) at the system level, regardless of whether means are also provided to initiate the protective action at the component or channel level (e.g., individual control rod, individual isolation valve).	1973		

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(2) If checked, see list of references attached
(3) If checked, see list of notes attached

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.62-OG-2	Operator/System Integration Guide Instrumentation and Control Guide	RG 1.62 Manual Initiation of Protective Actions, October 1973, page 1. 2. Manual initiation of a protective action at the system level should perform all actions performed by automatic initiation such as starting auxiliary or supporting systems, sending signals to appropriate valve-actuating mechanisms to assure correct valve position, and providing the required action-sequencing functions and interlocks.	1973		
RG1.62-OG-3	Operator/System Integration Guide Instrumentation and Control Guide	RG 1.62 Manual Initiation of Protective Actions, October 1973, page 2. 5. Manual initiation of protective actions should depend on the operation of a minimum of equipment.	1973		
RG1.62-OG-4	Operator/System Integration Guide	RG 1.62 Manual Initiation of Protective Actions, October 1973, page 2. 6. Manual initiation of protective action at the system level should be so designed that once initiated, it will go to completion as required in Section 4.16 of IEEE Std 279-1971.	1973		
RG1.47-OG-1	Operator/System Integration Guide Instrumentation and Control Guide	RG 1.47 Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems, May 1973, page 2. Bypass indication should aid the operator in recognizing the effects on plant safety of seemingly unrelated or insignificant events. Therefore, the indication of bypass conditions should be at the system level, whether or not it is also at the component or channel level.	1973		
RG1.47-OG-2	Operator/System Integration Guide Instrumentation and Control Guide	RG 1.47 Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems, May 1973, page 2. In a given plant design it may be best to group the bypass indicators according to the safety systems' dependence on a common electric power supply; for example, locating the bypass indicators for all engineered safety feature systems that are assigned to one standby power source near the bypass indicator for that source. There are other groupings which could be acceptable. In any design, it may be necessary to include an audible, as well as visual, alarm to attract the operator's attention when the status of the safety system changes.	1973		

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(2) If checked, see list of references attached
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.78-OG-1	Operator/System Integration Guide	RG 1.78 Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During A Postulated Hazardous Chemical Release, June 1974, page 5. Each operator should be taught to distinguish the smells of hazardous chemicals peculiar to the area. Instruction should include a periodic refresher course. Practice drills should be conducted to ensure that personnel can don breathing apparatus within two minutes.	1974		
RG1.70-OG-1	Operator/System Integration Guide Instrumentation and Control Guide Policy, Planning and Management Guide Control Room Environment Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-9. 9.4.1.1 Design Bases. The design bases for the air treatment system for the control room and other auxiliary rooms (e.g., relay rooms and emergency switchgear rooms) considered to be part of the control areas should be provided. Include the design criteria (e.g., single failure), requirements for the manual or automatic actuation of system components or isolation dampers, ambient temperature and humidity requirements, criteria for plant operator comfort and safety, requirements for radiation protection and monitoring of abnormal radiation levels and other airborne contaminants, and environmental design requirements.	1972	66	

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.68.2-EG-1	Operator Support Equipment Guide	RG 1.68.2 Initial Startup Test Program to Demonstrate Remote Shutdown Capability for Water-Cooled Nuclear Power Plants, Revision 1, July 1978, page 2. b. Communications should exist between the control room observers and the remote shutdown locations.	1977	67	
RG1.108-EG-1	Operator Support Equipment Guide Instrumentation and Control Guide	RG 1.108 Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants, Revision 1, August 1977, page 2. (4) A surveillance system should be provided with remote indication in the control room as to diesel generator unit status, i.e., under test, ready-standby, lockout. A means of communication should also be provided between diesel generator unit testing locations and the main control room to ensure that the operators are cognizant of the status of the unit under test.	1976	68	
RG1.95-EG-1	Operator Support Equipment Guide Control Room Environment Guide Operator Procedure Guide	RG 1.95 Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release, Revision 1, January 1977, page 2. Adequate protection of the control room operators against the types of accidental chlorine release discussed above will be achieved if features are included in the plant design to (1) automatically isolate the control room if there is a release, (2) make the control room sufficiently leak tight, and (3) provide equipment and procedures for ensuring the use of breathing apparatus by the control room operators.	1975	69	
RG1.70-EG-1	Operator Support Equipment Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-19. 9.5.2.2 System Description. A description and evaluation of the communication systems should be provided. The FSAR should provide a detailed description and drawings.	1972	66	

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.97-IC-1	Instrumentation and Control Criterion	RG 1.97 Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident, Revision 1, August 1977, page 4. 17. The instrumentation should be designed to facilitate the recognition, location, replacement, repair, or adjustment of malfunctioning components or modules.	1975	65	
RG1.139-IC-1	Instrumentation and Control Criterion	RG 1.139 Guidance for Residual Heat Removal, May 1978, page 3. a. The design should be such that the reactor can be taken from normal operating conditions to cold shutdown using only safety-grade systems that satisfy General Design Criteria 1 through 5.	1978		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.33-PC-1	Operator Procedure Criterion	RG 1.33 Quality Assurance Program Requirements (Operation), Revision 2, February 1978, page 2. 5. The guidelines (indicated by the verb "should") of ANSI N18.7-1976/ANS-3.2 contained in the following sections have sufficient safety importance to be treated the same as the requirements (indicated by the verb "shall") of the standard: h. Section 5.3.2 -- The guidelines that describe the content (excluding format) of procedures, except for the guidelines that address (1) a separate statement of applicability in Section 5.3.2(2), (2) inclusion of references in procedures, as applicable, in Section 5.3.2(3), and (3) inclusion of quantitative control guides in Section 5.3.2(6). i. Section 5.3.9 -- The guideline concerning emergency procedures requiring prompt implementation of immediate operator actions when required to prevent or mitigate the consequences of a serious condition. j. Section 5.3.9.1 -- The guidelines that describe the content (excluding format) for: the title in Section 5.3.9.1(1); the inclusion of symptoms to aid in identification in Section 5.3.9.1(2); automatic actions in Section 5.3.9.1(3); immediate operator action, excluding those guidelines contained in the examples, in Section 5.3.9.1(4); and subsequent operator actions in Section 5.3.9.1(5).	1977	64	

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.101-IG-1	Instrumentation and Control Guide Policy, Planning and Management Guide	RG 1.101 Emergency Planning for Nuclear Power Plants, Revision 1, March 1977, page 7. In particular, action levels (based on readings from a number of sensors including the pressure in containment, the response of the ECCS, etc.) for notification of offsite agencies should be described.	1977		
RG1.97-IG-1	Instrumentation and Control Guide	RG 1.97 Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident, Revision 1, August 1977, page 2. 1. For the postulated accidents listed in Chapter 15 of Regulatory Guide 1.70 (Ref. 2), the applicant should perform detailed safety analyses necessary to determine the parameters to be measured and the instrument ranges, responses, accuracies, and length of time required to provide the operator with the information necessary to: a. Assist in determining the nature of an accident. b. Determine whether the reactor trip and engineered-safety-feature systems are functioning properly. c. Determine whether the plant is responding properly to the safety measures in operation. d. Determine the potential for breaching the barriers to radioactivity release. e. Decide on the need to take manual action if an engineered safety feature malfunctions or the plant is not responding effectively to the safety systems in operation, and f. Allow for early indication of necessary action to protect the public and for an estimate of the magnitude of the impending threat. *NOTE: Item (f) was not included in the December 1975 RG 1.97.	1975	65	*

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached
(3) If checked, see list of notes attached

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.97-IG-2	Instrumentation and Control Guide	RG 1.97 Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident, Revision 1, August 1977, page 2. 2. The instrumentation necessary to provide the information noted in regulatory position 1 should be specified along with justification to show that the instrumentation is adequate to provide the operator with the necessary information.	1975	65	
RG1.97-IG-3	Instrumentation and Control Guide	RG 1.97 Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident, Revision 1, August 1977, page 3. 10. The accident-monitoring instrumentation should be specifically identified on control panels so that the operator can easily discern that they are intended for use under accident conditions.	1975	65	
RG1.97-IG-4	Instrumentation and Control Guide	RG 1.97 Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident, Revision 1, August 1977, page 4. 16. The accident-monitoring instrumentation design should minimize the development of conditions that would cause meters, annunciators, recorders, alarms, etc., to give anomalous indications confusing to the operator.	1975	65	
RG1.62-IG-1	Instrumentation and Control Guide Operator/System Integration Guide	RG 1.62 Manual Initiation of Protective Actions, October 1973, page 1. 1. Means should be provided for manual initiation of each protective action (e.g., reactor trip, containment isolation) at the system level, regardless of whether means are also provided to initiate the protective action at the component or channel level (e.g., individual control rod, individual isolation valve)	1973		

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(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.62-IG-2	Instrumentation and Control Guide Operator/System Integration Guide	RG 1.62 Manual Initiation of Protective Actions, October 1973, page 1. 2. Manual initiation of a protective action at the system level should perform all actions performed by automatic initiation such as starting auxiliary or supporting systems, sending signals to appropriate valve-actuating mechanisms to assure correct valve position, and providing the required action-sequencing functions and interlocks.	1973		
RG1.62-IG-3	Instrumentation and Control Guide	RG 1.62 Manual Initiation of Protective Actions, October 1973, page 1. 3. The switches for manual initiation of protective actions at the system level should be located in the control room and be easily accessible to the operator so that action can be taken in an expeditious manner.	1973		
RG1.62-IG-4	Instrumentation and Control Guide Operator/System Integration Guide	RG 1.62 Manual Initiation of Protective Actions, October 1973, page 2. 5. Manual initiation of protective actions should depend on the operation of a minimum of equipment.	1973		
RG1.47-IG-1	Instrumentation and Control Guide Operator/System Integration Guide	RG 1.47 Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems, May 1973, page 2. Bypass indication should aid the operator in recognizing the effects on plant safety of seemingly unrelated or insignificant events. Therefore, the indication of bypass conditions should be at the system level, whether or not it is also at the component or channel level.	1973		
RG1.47-IG-2	Instrumentation and Control Guide Operator/System Integration Guide	RG 1.47 Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems, May 1973, page 2. In a given plant design it may be best to group the bypass indicators according to the safety systems' dependence on a common electric power supply; for example, locating the bypass indicators for all engineered safety feature systems that are assigned to one standby power source near the bypass indicator for that source. There are other groupings which could be acceptable. In any design, it may be necessary to include an audible, as well as visual, alarm to attract the operator's attention when the status of the safety system changes.	1973		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.47-IG-3	Instrumentation and Control Guide	RG 1.47 Bypassed and Inoperable Status Indications for Nuclear Power Plant Safety, May 1973, page 2. 1. Administrative procedures should be supplemented by a system that automatically indicates at the system level the bypass or deliberately induced inoperability of the protection system and the systems actuated or controlled by the protection system.	1973		
RG1.47-IG-4	Instrumentation and Control Guide	RG 1.47 Bypassed and Inoperable Status Indications for Nuclear Power Plant Safety Systems, May 1973, page 2. 3. Automatic indication in accordance with C.1. and C.2. above should be provided in the control room for each bypass or deliberately induced inoperable status that meets all of the following conditions: a. Renders inoperable any redundant portion of the protection system, systems actuated or controlled by the protection system, and auxiliary or supporting systems that must be operable for the protection system and the systems it actuates to perform their safety-related functions; b. Is expected to occur more frequently than once per year; and c. Is expected to occur when the affected system is normally required to be operable.	1973		
RG1.47-IG-5	Instrumentation and Control Guide	RG 1.47 Bypassed and Inoperable Status Indications for Nuclear Power Plant Safety Systems, May 1973, page 3. 4. Manual capability should exist in the control room to activate each system-level indicator provided in accordance with C.1. above.	1973		
RG1.108-IG-1	Instrumentation and Control Guide Operator Support Equipment Guide	RG 1.108 Periodic Testing of Diesel Generator Units Used as Onsite Electric Power Systems at Nuclear Power Plants, Revision 1, August 1977, page 2. (4) A surveillance system should be provided with remote indication in the control room as to diesel generator unit status, i.e., under test, ready-standby, lockout. A means of communication should also be provided between diesel generator unit testing locations and the main control room to ensure that the operators are cognizant of the status of the unit under test.	1976	68	

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(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.45-IG-1	Instrumentation and Control Guide Operator Procedure Guide	RG 1.45 Reactor Coolant Pressure Boundary Leakage Detection Systems, May 1973, page 4. 7. Indicators and alarms for each leakage detection system should be provided in the main control room. Procedures for converting various indications to a common leakage equivalent should be available to the operators. The calibration of the indicators should account for needed independent variables.	1973		
RG1.139-IG-1	Instrumentation and Control Guide	RG 1.139 Guidance for Residual Heat Removal, May 1978, page 2. Under these circumstances (safe shutdown earthquake), a plant safe shutdown (including cooldown) within a reasonable time requires systems designed to safety grade standards and operable from the control room.	1978		
RG1.139-IG-2	Instrumentation and Control Guide	RG 1.139 Guidance for Residual Heat Removal, May 1978, page 4. a. Isolation of the suction side of the RHR system should be provided by at least two power-operated valves in series, with valve positions indicated in the control room. Alarms in the control room should be provided to alert the operator if either valve is open when the RCS pressure exceeds the RHR system design pressure.	1978		
RG1.139-IG-3	Instrumentation and Control Guide	RG 1.139 Guidance for Residual Heat Removal, May 1978, page 4. Independent diverse protective measures should be provided to close any open valve in the event of an increase in the RCS pressure above the RHR system design pressure.	1978		

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(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.12-IG-1	Instrumentation and Control Guide	RG 1.12 Instrumentation for Earthquakes, Revision 1, April 1974, page 1. Since the zero-period acceleration of the containment foundation design response spectra representing the OBE may not fully describe the seismic event, it is important to have a triaxial response-spectrum recorder installed at an appropriate location in the basement of the plant capable of providing immediate signals for remote indicating in the control room if any significant portion of the foundation design response spectra has been exceeded.	1974		
RG1.70-IG-1	Instrumentation and Control Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 4-14. 4.4.6 Instrumentation Requirements The functional requirements for the instrumentation to be employed in monitoring and measuring those thermal-hydraulic parameters important to safety should be discussed. The requirements for in-core instrumentation to confirm predicted power density distribution and moderator temperature distributions, for example, should be included. Details of the instrumentation design and logic should be discussed in Chapter 7 of the SAR.	1972	66	
RG1.70-IG-2	Instrumentation and Control Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 6-59. 6.7.4 Instrumentation Requirements The system instrumentation and controls should be described. The adequacy of safety-related interlocks to meet the single-failure criterion should be demonstrated.	1978		

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(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.70-IG-3	Instrumentation and Control Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 7-3. 7.2.1.1 System Description. Provide a description of the reactor trip system to include initiating circuits, logic, bypasses, interlocks, redundancy, diversity, and actuated devices. Any supporting systems should be identified and described. Those parts of any system not required for safety should be identified.	1972	66	
RG1.70-IG-4	Instrumentation and Control Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-9. 9.3.5.5 Instrumentation Requirements. The system instrumentation and controls should be described. The adequacy of safety-related instrumentation and controls to fulfill their functions should be demonstrated.	1972	66	
RG1.70-IG-5	Instrumentation and Control Guide Policy, Planning and Management Guide Operator/System Integration Guide Control Room Environment Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-9. 9.4.1.1 Design Bases. The design bases for the air treatment system for the control room and other auxiliary rooms (e.g., relay rooms and emergency switchgear rooms) considered to be part of the control areas should be provided. Include the design criteria (e.g., single failure), requirements for the manual or automatic actuation of system components or isolation dampers, ambient temperature and humidity requirements, criteria for plant operator comfort and safety, requirements for radiation protection and monitoring of abnormal radiation levels and other airborne contaminants, and environmental design requirements.	1972	66	

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(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.95-CG-1	Control Room Environment Guide Operator Support Equipment Guide Operator Procedure Guide	RG 1.95 Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release, Revision 1, January 1977, page 2. Adequate protection of the control room operators against the types of accidental chlorine release discussed above will be achieved if features are included in the plant design to (1) automatically isolate the control room if there is a release, (2) make the control room sufficiently leak tight, and (3) provide equipment and procedures for ensuring the use of breathing apparatus by the control room operators.	1975	69	
RG1.78-CG-1	Control Room Environment Guide	RG 1.78 Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release, June 1974, page 1. Human tolerance for hazardous chemicals should be considered in the design stage of nuclear facilities.	1974		
RG1.70-CG-1	Control Room Environment Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 6-45. The habitability systems for the control room should include shielding, air purification systems, control of climatic conditions, storage capacity for food and water, and kitchen and sanitary facilities. Detailed descriptions of these systems should be included in the SAR together with an evaluation of their performance. The evaluation should provide assurance that the systems will operate under all postulated conditions to permit the control room operators to remain in the control room and to take appropriate actions as required by General Design Criterion 19. Sufficient information should be provided to permit an independent evaluation of the adequacy of the systems. Information and evaluations in other sections of the SAR that relate to the adequacy of the habitability systems should be referenced (see Sections 6.5.1, 9.4.1, and 15.X.X, paragraph 5).	1978		

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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.70-CG-2	Control Room Environment Guide Instrumentation and Control Guide Operator/System Integration Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Cor ent of Safety Analysis Reports for Nuclear Power Plants, LWR Ed tion, Revision 3, November 1978, page 9-9. 9.4.1.1 Design Bases. The design bases for the air treatment system for the control room and other auxiliary rooms (e.g., relay rooms and emergency switchgear rooms) considered to be part of the control areas should be provided. Include the design criteria (e.g., single failure), requirements for the manual or automatic actuation of system components or isolation dampers, ambient temperature and humidity requirements, criteria for plant operator comfort and safety, requirements for radiation protection and monitoring of abnormal radiation levels and other airborne contaminants, and environmental design requirements.	1972	66	
RG1.70-CG-3	Control Room Environment Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-19. 9.5.3 Lighting Systems A description of the normal lighting system for the plant should be provided. A description of the emergency lighting system, including design criteria and a failure analysis, should also be provided.	1972	66	

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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.114-PG-1	Operator Procedure Guide Policy, Planning and Management Guide	RG 1.114 Guidance on Being Operator at the Controls of a Nuclear Power Plant, Revision 1, November 1976, page 1. 2. The operator at the controls should not normally leave the area where continuous attention (including visual surveillance of safety-related annunciators and instrumentation) can be given to reactor operating conditions and where he has access to the reactor controls. For example, the operator should not routinely enter areas behind control panels where plant performance cannot be monitored. The operator at the controls should not under any circumstances leave the surveillance area defined by regulatory position 3 for any nonemergency reason (e.g., to confer with others or for personal reasons) without obtaining a qualified relief operator at the controls. In the event of an emergency affecting the safety of operations, the operator at the controls may momentarily be absent from the defined surveillance area in order to verify the receipt of an annunciator alarm or initiate corrective action, provided he remains within the confines of the control room.	1976		
RG1.114-PG-2	Operator Procedure Guide	RG 1.114 Guidance on Being Operator at the Controls of a Nuclear Power Plant, Revision 1, November 1976, page 2. 4. Prior to assuming responsibility for being operator at the controls, the relief operator should be properly briefed on the plant status. In order to ensure that proper relief occurs, administrative procedures should be written to describe what is required. The administrative procedure should include, as a minimum, a definition of proper relief (e.g., what information is required to be passed on and acknowledged between the two operators).	1976		

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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.101-PG-1	Operator Procedure Guide Policy, Planning and Management Guide	RG 1.101 Emergency Planning for Nuclear Power Plants, Revision 1, March 1977, page 5. Emergency action levels for declaring a Site Emergency should be defined (1) in terms of instrument readings or alarms that annunciate in the control room, including indications of the functioning of safety systems and the readout from effluent monitors and (2) alternatively in terms of specific contamination levels in environmental media, e.g., water, soil, vegetation, milk. To avoid unnecessary response to false alarms, the activation criteria for control room monitors should be defined so as to require corroborating evidence from two independent sources that provide input to the control room. The bases and criteria used to specify these emergency action levels should be described and their relationship to protective action guides explained. Licensees should use, and should recommend to local and State authorities for use, protective action guides incorporated in Federal agency guidance.	1977		
RG1.101-PG-2	Operator Procedure Guide	RG 1.101 Emergency Planning for Nuclear Power Plants, Revision 1, March 1977, page 7. In some emergency situations, actions can be taken to correct or mitigate the situation at or near the source of the problem (for example, to prevent an uncontrolled release of radioactive materials or to reduce the magnitude of a release). Such actions should be considered as a supplement to design features and as both a backup and an extension of automatically initiated actions. Proficiency in corrective actions should constitute a major objective of the training effort and onsite drill program.	1977		
RG1.101-PG-3	Operator Procedure Guide Policy, Planning and Management Guide	RG 1.101 Emergency Planning for Nuclear Power Plants, Revision 1, March 1977, page 10. This section should describe provision for the conduct of periodic drills and exercises to test the adequacy of timing and content of implementing procedures and methods, to test emergency equipment, and to ensure that emergency organization personnel are familiar with their duties. Preplanned descriptions or simulations of accidents or similar events should be used to prepare scenarios appropriate to the objectives of each drill or exercise.	1977		

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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.101-PG-4	Operator Procedure Guide Policy, Planning and Management Guide	RG 1.101 Emergency Planning for Nuclear Power Plants, Revision 1, March 1977, page 12. There should be a separate procedure for each identified class of emergency to specify and implement the preplanned response actions required for that emergency condition. Each procedure should (1) clearly identify the action level, the protective action guide, or the conditions for declaring the emergency condition; (2) list by priority the individuals and elements of the emergency organization that are to be notified and mobilized; and (3) specify the emergency actions that are to be taken by designated individuals and elements of the emergency organization. Communications procedures should require formality, acknowledgements of orders and reports, designation of relative priority of communications with the scene of the emergency, site emergency control center, control room, outside activities, etc. Effective methods for rapid internal and external transmission of information may include prepositioned messages (fill in the blanks in specified sequence); instructions for use of voice (telephone and radio transmission) and telewire facsimile (TWX); use of manual status boards for details of the emergency; and use of maps, charts, and plant configuration drawings for site and local areas required by Annex A.10.3.	1977		
RG1.97-PG-1	Operator Procedure Guide	RG 1.97 Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident, Revision 1, August 1977, page 1. Monitored variables and systems are used by the operator in accident surveillance to (1) assist in determining the nature of an accident; (2) determine whether the reactor trip and engineered-safety-feature systems are functioning properly; (3) determine whether the plant is responding properly to the safety measures in operation; (4) provide information to the operator that will enable him to determine the potential for breaching the barriers to radioactivity release; (5) furnish data for deciding on the need to take manual action if an engineered safety feature malfunctions or the plant is not responding effectively to the safety systems in operation; (6) allow for early indication of the need to initiate action necessary to protect the public and for an estimate of the magnitude of the impending threat; and (7) aid in determining the cause and consequence of the event for postaccident investigation.	1975	65	

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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.45-PG-1	Operator Procedure Guide Instrumentation and Control Guide	RG 1.45 Reactor Coolant Pressure Boundary Leakage Detection Systems, May 1973, page 4. 7. Indicators and alarms for each leakage detection system should be provided in the main control room. Procedures for converting various indications to a common leakage equivalent should be available to the operators. The calibration of the indicators should account for needed independent variables.	1973		
RG1.95-PG-1	Operator Procedure Guide Operator Support Equipment Guide Control Room Environment Guide	RG 1.95 Protection of Nuclear Power Plant Control Room Operators Against an Accidental Chlorine Release, Revision 1, January 1977, page 2. Adequate protection of the control room operators against the types of accidental chlorine release discussed above will be achieved if features are included in the plant design to (1) automatically isolate the control room if there is a release, (2) make the control room sufficiently leak tight, and (3) provide equipment and procedures for ensuring the use of breathing apparatus by the control room operators.	1975	69	
RG1.139-PG-1	Operator Procedure Guide	RG 1.139 Guidance for Residual Heat Removal, May 1978, page 5. The design and operator procedures of the RHR system should include provisions to prevent damage to the RHR system pumps due to overheating, cavitation, or loss of adequate pump suction head.	1978		
RG1.139-PG-2	Operator Procedure Guide	RG 1.139 Guidance for Residual Heat Removal, May 1978, page 5. The programs for pressurized water reactors should include tests with supporting analysis to confirm (a) that adequate mixing of borated water added prior to or during cooldown can be achieved under natural circulation conditions and permit estimation of the times required to achieve such mixing and (b) that the cooldown under natural circulation conditions can be achieved within the limits specified in the emergency operating procedures.	1978		

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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.139-PG-3	Operator Procedure Guide	RG 1.139 Guidance for Residual Heat Removal, May1978, page 6. The operational procedures for bringing the plant from normal operating power to cold shutdown should be in conformance with Regulatory Guide 1.33. For pressurized water reactors, the operational procedures should include specific procedures and information required for cooldown under natural circulation conditions.	1978		
RG1.78-PG-1	Operator Procedure Guide	RG 1.78 Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release, June 1974, page 5. 15. Emergency procedures to be initiated in the event of a hazardous chemical release within or near the station should be written. These procedures should address both maximum concentration accidents and maximum concentration-duration accidents and should identify the most probable chemical releases at the station.	1974		•
RG1.70-PG-1	Operator Procedure Guide Human Factors Test and Evaluation Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-19. 9.5.2.3 Inspection and Testing Requirements. The inspection and testing requirements for the communication systems should be provided.	1972	66	
RG1.70-PG-2	Operator Procedure Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 13-15. 13.5.2.1 Control Room Operating Procedures. This section should describe primarily the procedures that are performed by licensed operators in the control room. Each such operating procedure should be identified by title and included in a described classification system. The general format and content for each class should be described. The following categories should be included, but need not necessarily form the basis for classifying these procedures: 1. System procedures. 2. General plant procedures. 3. Off-normal operating procedures. 4. Emergency procedures.	1972	66	•

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(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

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Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
		RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 13-15. 5. Alarm response procedures. 6. Temporary procedures. *NOTE: (13.5.2.1) No categories (1-6) were listed or suggested in the 1972 Regulatory Guide 1.70.			
RG1.70-PG-3	Operator Procedure Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 13-16. In category 5, individual alarm response procedures should not be listed. However, the system employed to classify or subclassify alarm responses and the methods to be employed by operators to retrieve or refer to alarm response procedures should be described. Immediate action procedures required to be memorized should be identified.	1978		
RG1.70-PG-4	Operator Procedure Guide Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 13-16. 13.5.2.2 Other Procedures. This section should describe how other operating and maintenance procedures are classified, what group or groups within the operating organization have the responsibility for following each class of procedures, and the general objectives and character of each class and subclass. The categories of procedures listed below should be included. If their general objectives and character are described elsewhere in the FSAR or the application, they may be described by specific reference thereto. 1. Plant radiation protection procedures. 2. Emergency preparedness procedures. 3. Instrument calibration and test procedures. 4. Chemical-radiochemical control procedures. 5. Radioactive waste management procedures. 6. Maintenance and modification procedures. 7. Material control procedures. 8. Plant security procedures.	1978		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.114-MG-1	Policy, Planning and Management Guide Operator Procedure Guide	RG 1.114 Guidance on Being Operator at the Controls of a Nuclear Power Plant, Revision 1, November 1976, page 1. 2. The operator at the controls should not normally leave the area where continuous attention (including visual surveillance of safety-related annunciators and instrumentation) can be given to reactor operating conditions and where he has access to the reactor controls. For example, the operator should not routinely enter areas behind control panels where plant performance cannot be monitored. The operator at the controls should not under any circumstances leave the surveillance area defined by regulatory position 3 for any nonemergency reason (e.g., to confer with others or for personal reasons) without obtaining a qualified relief operator at the controls. In the event of an emergency affecting the safety of operations, the operator at the controls may momentarily be absent from the defined surveillance area in order to verify the receipt of an annunciator alarm or initiate corrective action, provided he remains within the confines of the control room.	1976		
RG1.114-MG-2	Policy, Planning and Management Guide	RG 1.114 Guidance on Being Operator at the Controls of a Nuclear Power Plant, Revision 1, November 1976, page 2. 3. Administrative procedures should be established to define and outline (preferably with sketches) specific areas within the control room where the operator at the controls should remain. The procedures should define the surveillance area and the areas that may be entered, in the event of an emergency affecting the safety of operations, by the operator at the controls to verify receipt of an annunciator alarm or initiate corrective action.	1976		
RG1.114-MG-3	Policy, Planning and Management Guide	RG 1.114 Guidance on Being Operator at the Controls of a Nuclear Power Plant, Revision 1, November 1976, page 2. 5. A single operator should not assume the operator-at-the-controls responsibility for two or more nuclear power units at the same time.	1976		

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(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.101-MG-1	Policy, Planning and Management Guide Operator Procedure Guide	RG 1.101 Emergency Planning for Nuclear Power Plants, Revision 1, March 1977, page 5. Emergency action levels for declaring a Site Emergency should be defined (1) in terms of instrument readings or alarms that annunciate in the control room, including indications of the functioning of safety systems and the readout from effluent monitors and (2) alternatively in terms of specific contamination levels in environmental media, e.g., water, soil, vegetation, milk. To avoid unnecessary response to false alarms, the activation criteria for control room monitors should be defined so as to require corroborating evidence from two independent sources that provide input to the control room. The bases and criteria used to specify these emergency action levels should be described and their relationship to protective action guides explained. Licensees should use, and should recommend to local and State authorities for use, protective action guides incorporated in Federal agency guidance.[5]	1977		
RG1.101-MG-2	Policy, Planning and Management Guide Instrumentation and Control Guide	RG 1.101 Emergency Planning for Nuclear Power Plants, Revision 1, March 1977, page 7. In particular, action levels (based on readings from a number of sensors including the pressure in containment, the response of the ECCS, etc.) for notification of offsite agencies should be described.	1977		
RG1.101-MG-3	Policy, Planning and Management Guide Operator Procedure Guide	RG 1.101 Emergency Planning for Nuclear Power Plants, Revision 1, March 1977, page 10. . This section should describe provision for the conduct of periodic drills and exercises to test the adequacy of timing and content of implementing procedures and methods, to test emergency equipment, and to ensure that emergency organization personnel are familiar with their duties. Preplanned descriptions or simulations of accidents or similar events should be used to prepare scenarios appropriate to the objectives of each drill or exercise.	1977		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
R[illegible].101-MG-4	Policy, Planning and Management Guide Operator Procedure Guide	RG 1.101 Emergency Planning for Nuclear Power Plants, Revision 1, March 1977, page 12. There should be a separate procedure for each identified class of emergency to specify and implement the preplanned response actions required for that emergency condition. Each procedure should (1) clearly identify the action level, the protective action guide, or the conditions for declaring the emergency condition; (2) list by priority the individuals and elements of the emergency organization that are to be notified and mobilized; and (3) specify the emergency actions that are to be taken by designated individuals and elements of the emergency organization. Communications procedures should require formality, acknowledgements of orders and reports, designation of relative priority of communications with the scene of the emergency, site emergency control center, control room, outside activities, etc. Effective methods for rapid internal and external transmission of information may include prepositioned messages (fill in the blanks in specified sequence); instructions for use of voice (telephone and radio transmission) and telewire facsimile (TWX); use of manual status boards for details of the emergency; and use of maps, charts, and plant configuration drawings for site and local areas required by Annex A.10.3.	1977		
RG1.78-MG-1	Policy, Planning and Management Guide	RG 1.78 Assumptions for Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release, June 1974, page 5. Criteria should be defined for the isolation of the control room, for the use of protective breathing apparatus or other protective measures, and for orderly shutdown or scram.	1974		

NOTES: (1) 1967 or more re[illegible]
(2) If checked, see li[illegible] references attached
(3) If checked, see list [illegible]otes attached

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.16-MG-1	Policy, Planning and Management Guide	RG 1.16 Reporting of Operating Information — Appendix A Technical Specifications, Revision 4, August 1975, page 3-4. Information provided on the licensee event report form should be supplemented, as needed, by additional narrative material to provide complete explanation of the circumstances surrounding the event. (6) Personnel error or procedural inadequacy which prevents or could prevent, by itself, the fulfillment of the functional requirements of systems required to cope with accidents analyzed in the SAR. The following are examples: (a) Failure to restore a safety system to operability following test or maintenance. (b) Improper procedure leading to incorrect valve lineup which resulted in closure of one manual valve in each of two redundant safety injection subsystems and would have prevented injection on demand.	1975		
RG1.70-MG-1	Policy, Planning and Management Guide Instrumentation and Control Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 4-14. 4.4.6 Instrumentation Requirements The functional requirements for the instrumentation to be employed in monitoring and measuring those thermal-hydraulic parameters important to safety should be discussed. The requirements for in-core instrumentation to confirm predicted power density distribution and moderator temperature distributions, for example, should be included. Details of the instrumentation design and logic should be discussed in Chapter 7 of the SAR.	1972	66	

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.70-MG-2	Policy, Planning and Management Guide Control Room Environment Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 6-45. The habitability systems for the control room should include shielding, air purification systems, control of climatic conditions, storage capacity for food and water, and kitchen and sanitary facilities. Detailed descriptions of these systems should be included in the SAR together with an evaluation of their performance. The evaluation should provide assurance that the systems will operate under all postulated conditions to permit the control room operators to remain in the control room and to take appropriate actions as required by General Design Criterion 19. Sufficient information should be provided to permit an independent evaluation of the adequacy of the systems. Information and evaluations in other sections of the SAR that relate to the adequacy of the habitability systems should be referenced (see Sections 6.5.1, 9.4.1, and 15.X.X, paragraph 5).	1978		
RG1.70-MG-3	Policy, Planning and Management Guide Instrumentation and Control Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 6-59. 6.7.4 Instrumentation Requirements (BWR) The system instrumentation and controls should be described. The adequacy of safety-related interlocks to meet the single-failure criterion should be demonstrated.	1978		
RG1.70-MG-4	Policy, Planning and Management Guide Instrumentation and Control Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 7-3. 7.2.1.1 System Description. Provide a description of the reactor trip system to include initiating circuits, logic, bypasses, interlocks, redundancy, diversity, and actuated devices. Any supporting systems should be identified and described. Those parts of any system not required for safety should be identified.	1972	66	

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(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.70-MG-5	Policy, Planning and Management Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 7-3. Provide analyses, include a failure mode and effects analysis, to demonstrate how the requirements of the General Design Criteria, IEEE Std 279-1971, applicable regulatory guides, and other appropriate criteria and standards are satisfied. In addition to postulated accidents and failures, these analyses should include, but not be limited to, considerations of instrumentation installed to prevent or mitigate the consequences of: 1. Spurious control rod withdrawals, 2. Loss of plant instrument air systems, 3. Loss of cooling water to vital equipment, 4. Plant load rejection, and 5. Turbine trip.	1972	66	
RG1.70-MG-6	Policy, Planning and Management Guide Instrumentation and Control Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-9. 9.3.5.5 Instrumentation Requirements. The system instrumentation and controls should be described. The adequacy of safety-related instrumentation and controls to fulfill their functions should be demonstrated.	1972	66	

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(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.70-MG-7	Policy, Planning and Management Guide Instrumentation and Control Guide Operator/System Integration Guide Control Room Environment Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-9. 9.4.1.1 Design Bases. The design bases for the air treatment system for the control room and other auxiliary rooms (e.g., relay rooms and emergency switchgear rooms) considered to be part of the control areas should be provided. Include the design criteria (e.g., single failure), requirements for the manual or automatic actuation of system components or isolation dampers, ambient temperature and humidity requirements, criteria for plant operator comfort and safety, requirements for radiation protection and monitoring of abnormal radiation levels and other airborne contaminants, and environmental design requirements.	1972	66	
RG1.70-MG-8	Policy, Planning and Management Guide Operator Support Equipment Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-19. 9.5.2.2 System Description. A description and evaluation of the communication systems should be provided. The FSAR should provide a detailed description and drawings.	1972	66	
RG1.70-MG-9	Policy, Planning and Management Guide Human Factors Test and Evaluation Guide Operator Procedure Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-19. 9.5.2.3 Inspection and Testing Requirements. The inspection and testing requirements for the communication systems should be provided.	1972	66	
RG1.70-MG-10	Policy, Planning and Management Guide Control Room Environment Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 9-19. 9.5.3 Lighting Systems A description of the normal lighting system for the plant should be provided. A description of the emergency lighting system, including design criteria and a failure analysis, should also be provided.	1972	66	

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S. NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.70-MG-11	Policy, Planning and Management Guide Operator Procedure Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 13-15. <u>13.5.2.1 Control Room Operating Procedures</u>. This section should describe primarily the procedures that are performed by licensed operators in the control room. Each such operating procedure should be identified by title and included in a described classification system. The general format and content for each class should be described. The following categories should be included, but need not necessarily form the basis for classifying these procedures: 1. System procedures. 2. General plant procedures. 3. Off-normal operating procedures. 4. Emergency procedures. 5. Alarm response procedures. 6. Temporary procedures. *NOTE: (13.5.2.1) No categories (1-6) were listed or suggested in the 1972 Regulatory Guide 1.70.	1972	66	*
RG1.70-MG-12	Policy, Planning and Management Guide Operator Procedure Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 13-16. In category 5, individual alarm response procedures should not be listed. However, the system employed to classify or subclassify alarm responses and the methods to be employed by operators to retrieve or refer to alarm response procedures should be described. Immediate action procedures required to be memorized should be identified.	1978		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: U.S NRC Regulatory Guides

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RG1.70-MG-13	Policy, Planning and Management Guide Operator Procedure Guide	RG 1.70 Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition, Revision 3, November 1978, page 13-16. 13.5.2.2 Other Procedures. This section should describe how other operating and maintenance procedures are classified, what group or groups within the operating organization have the responsibility for following each class of procedures, and the general objectives and character of each class and subclass. The categories of procedures listed below should be included. If their general objectives and character are described elsewhere in the FSAR or the application, they may be described by specific reference thereto. 1. Plant radiation protection procedures. 2. Emergency preparedness procedures. 3. Instrument calibration and test procedures. 4. Chemical-radiochemical control procedures. 5. Radioactive waste management procedures. 6. Maintenance and modification procedures. 7. Material control procedures. 8. Plant security procedures.	1978		

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APPENDIX L

REACTOR TECHNOLOGY MEMORANDA CRITERIA

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Reactor Technology Memo's

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RTM-6-EC-1	Operator Support Equipment Criterion	RTM No. 6, Control Room Design Considerations, June 1969, page 2. Fire fighting equipment including fire extinguishers and breathing apparatus should be available to the control room.	1969		

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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Reactor Technology Memo's

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RTM-4-HC-1	Human Factors Test and Evaluation Criterion	RTM No. 4, Emergency Core Cooling System Evaluation Guidelines, June 1968, page 11. 3. Periodic system tests - The design of the ECCS should provide for functional tests of all active components except the last isolation valves during normal plant operations. During plant shutdown for refueling each subsytem should be tested for delivery of coolant into the vessel to demonstrate that the coolant flow path through the last isolation valve can be opened.	1968		
RTM-8-HC-1	Human Factors Test and Evaluation Criterion	RTM No. [illegible], Combustible Gas Control System, July 1968, page 7. An installed CGCS shall be periodically tested to demonstrate its continued ability to perform its design function. Such tests shall include operation of the entire system, and to as great a degree as possible shall simulate post-LOCA conditions. This requirements is not intended to specify that hazardous, or near hazardous gas mixtures be created for such tests, but that sufficient combustible gas input be simulated to demonstrate minimum acceptable CGCS performance.	1969		

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(2) If checked, see list of references attached.
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HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Reactor Technology Memo's

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RTM-4-IC-1	Instrumentation and Control Criterion Operator/System Integration Criterion	RTM No. 4, Emergency Core Cooling System Evaluation Guidelines, June 1968, page 10. Automatic actuation of the ECCS should be provided because the loss of coolant accident can proceed rapidly once a break has occurred. For example, in the event of an instantaneous double-ended pipe rupture, pumping subsystems and diesel generator may be required to operate within 30 seconds after the break. This is not sufficient time for a reactor operator to assess the accident conditions and take the proper actions. Smaller breaks place less stringent timing requirements on the ECCS, but because of severe pressure upon the opertor to make the right decision in a time span of minutes, it is preferable to remove the element of human error and require automatic actuation. The manual actuation, monitoring, and control provisions in the reactor control room enable the operator to control long-term cooling based on his firsthand knowledge of the accident conditions. The actuation sensors and signals should be of sufficient diversity to insure that an unanticipated failure common to one type of sensor cannot prevent organization of the accident signal.	1968		
RTM-8-IC-1	Instrumentation and Control Criterion Operator/System Integration Criterion	RTM No. 8, Combustible Gas Control System, July 1969, page 6. Provisions for automatic initiation of the CGCS need not be required, unless the predicted time to the onset of excessive combustible gas mixtures is so short (1 hour) as to preclude assured manual start up. System controls and instrumentation shall be designed to protection system standards and shall be adequate to determine the performance of the system, to indicate component failures, and allow for switching to nonfailed subsystems. Redundancy requirements shall be similar to those for the CGCS as a whole.	1969		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.

HUMAN ENGINEERING AND RELATED CRITERIA AND GUIDES

Reference: Reactor Technology Memo's

Number	Type of Criterion or Guide	Language of Criterion or Guide	Earliest Known Publication Date (1)	Other Reference (2)	Notes (3)
RTM-4-OC-1	Operator/System Integration Criterion Instrumentation and Control Criterion	RTM No. 4, Emergency Core Cooling System Evaluation Guidelines, June 1968, page 10. Automatic actuation of the ECCS should be provided because the loss of coolant accident can proceed rapidly once a break has occurred. For example, in the event of an instantaneous double-ended pipe rupture, pumping subsystems and diesel generator may be required to operate within 30 seconds after the break. This is not sufficient time for a reactor operator to assess the accident conditions and take the proper actions. Smaller breaks place less stringent timing requirements on the ECCS, but because of severe pressure upon the opertor to make the right decision in a time span of minutes, it is preferable to remove the element of human error and require automatic actuation. The manual actuation, monitoring, and control provisions in the reactor control room enable the operator to control long-term cooling based on his firsthand knowledge of the accident conditions. The actuation sensors and signals should be of sufficient diversity to insure that an unanticipated failure common to one type of sensor cannot prevent organization of the accident signal.	1968		
RTM-8-OC-1	Operator/System Integration Criterion Instrumentation and Control Criterion	RTM No. 8, Combustible Gas Control System, July 1969, page 6. Provisions for automatic initiation of the CGCS need not be required, unless the predicted time to the onset of excessive combustible gas mixtures is so short (1 hour) as to preclude assured manual start up. System controls and instrumentation shall be designed to protection system standards and shall be adequate to determine the performance of the system, to indicate component failures, and allow for switching to nonfailed subsystems. Redundancy requirements shall be similar to those for the CGCS as a whole.	1969		

NOTES: (1) 1967 or more recent.
(2) If checked, see list of references attached.
(3) If checked, see list of notes attached.