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GNRO-2011/00016

March 9, 2011

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Request for Additional Information Regarding
Extended Power Uprate
Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
License No. NPF-29

REFERENCES:
1. Email from A. Wang to F. Burford dated February 23, 2011, GG EPU Health Physics and Human Performance Branch Request for Additional Information (ME4639) (Accession Number ML110540705)
2. License Amendment Request, Extended Power Uprate, dated September 8, 2010 (GNRO-2010/00056, Accession Number ML102660403)

Dear Sir or Madam:

The Nuclear Regulatory Commission (NRC) requested additional information (Reference 1) regarding certain aspects of the Grand Gulf Nuclear Station, Unit 1 (GGNS) Extended Power Uprate (EPU) License Amendment Request (LAR) (Reference 2). Attachment 1 provides responses to the additional information requested by the Health Physics and Human Performance Branch.

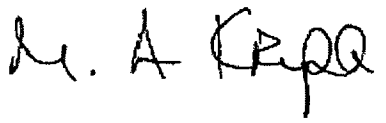
No change is needed to the no significant hazards consideration included in the initial LAR (Reference 2) as a result of the additional information provided. There are no new commitments included in this letter.

If you have any questions or require additional information, please contact Jerry Burford at 601-368-5755.

A001
NRR

I declare under penalty of perjury that the foregoing is true and correct. Executed on March 9, 2011.

Sincerely,



MAK/FGB/dm

Attachments:
1. Response to Request for Additional Information, Health Physics and Human Performance Branch

Enclosures:
1. Human Factors Design Criteria, ES-17

cc: Mr. Elmo E. Collins, Jr.
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Attachment 1

GNRO-2011/00016

Grand Gulf Nuclear Station Extended Power Uprate

Response to Request for Additional Information

Health Physics and Human Performance Branch

Response to Request for Additional Information
Health Physics and Human Performance Branch

By letter dated September 8, 2010, Entergy Operations, Inc. (Entergy) submitted a license amendment request (LAR) for an Extended Power Uprate (EPU) for Grand Gulf Nuclear Station, Unit 1 (GGNS). The U.S. Nuclear Regulatory Commission (NRC) staff has determined by correspondence dated February 23, 2011 (Accession Number ML110540705) that the following additional information related to Health Physics and Human Performance is needed for the NRC staff to complete their review of the amendment. Entergy's response to each item is also provided below.

In addition to the request for additional information (RAI) responses provided below, changes to several Abnormal Operating procedures that were not previously identified in Section 2.11.1 of Attachment 5B, "Safety Analysis Report for Grand Gulf Nuclear Station Constant Pressure Power Uprate," of the GGNS EPU LAR have been recognized. The following provides an update to a portion of Section 2.11.1, with revision bars marking the changes.

The planned changes to abnormal operating procedures (AOPs), called ONEPs at GGNS, are outlined below.

- The ONEPs listed below will be revised to rescale action points associated with reactor power; however, the event mitigation philosophy will not be changed. Affected procedures include:
    - 05-1-02-I-2, *Turbine and Generator Trips*;
    - 05-1-02-III-3, *Reduction in Recirculation System Flowrate*
    - 05-1-02-III-5, *Automatic Isolations*;
    - 05-1-02-V-5, *Loss of Feedwater Heating*;
    - 05-1-02-V-7, *Feedwater System Malfunctions*;
    - 05 -1-02-V-8, *Loss of Condenser Vacuum*; and
    - 05-1-02-V-11, *Loss of Plant Service Water.*
- 05-1-02-I-2, *Turbine and Generator Trips* – Revise generator hydrogen pressure regulator setting to reflect new EPU value.
- 05-I-02-I-4, *Loss of AC Power* – Change seal oil system nomenclature due to installation of a new seal oil system. Revise generator MVAR limits to reflect EPU values.

- 05-1-02-II-1, *Shutdown from the Remote Shutdown Panel* – Change operator response time to reflect EPU values

- 05-1-02-III-1, *Inadequate Decay Heat Removal* – Revise the decay heat curves, heat up rates and temperature related data sheets to reflect the new EPU values.

- 05-I-02-V-1, *Loss of Component Cooling Water* – Add subsequent operator actions to account for installation of CCW heat exchanger tube cleaning system.

- 05-I-02-V-2, *Loss of TBCW* – Incorporate changes required as a result of the installation of a new seal oil system.

- 05-1-02-V-5, *Loss of Feedwater Heating* – Revise the FW temperature vs. core power curve, which determines the actions to be taken in response to the event, to reflect the new EPU values.

- 05-1-02-V-7, *Feedwater System Malfunctions* – Change the RFPT critical speed parameter following replacement of RFPT. Update to reflect EPU condensate transient analysis.

- 05-1-02-V-11, *Loss of Plant Service Water* - Add subsequent operator actions to account for installation of CCW heat exchanger tube cleaning system.

- 05-1-02-V-12, *Condensate / Reactor Water High Conductivity* – Revise to reflect impact of CFFF and LEFM modifications.

RAI # 1

GGNS Current Licensing Basis

The licensee stated in its September 8, 2010 submittal that the general design criteria (GDC) in Appendix A of 10 CFR 50 effective May 21, 1971, and subsequently amended July 7, 1971, are applicable to GGNS. GGNS conformance with the GDCs may be found in Updated Final Safety Analysis Report (UFSAR) Sections 3.1 and 7.1.2.5. The human factors program is not described in any GGNS licensing basis document; however, it is governed in accordance with Engineering Standard ES-17, "Human Factors Design Criteria."

Submit Engineering Standard ES-17, "Human Factors Design Criteria." for NRC staff review.

Response

The current version of Engineering Standard ES-17, "Human Factors Design Criteria" is included in Enclosure 1.

RAI # 2

Changes to Operator Actions Sensitive to the EPU

The responses to this topic of Regulatory Issue Summary (RIS)-001, "Review Standard for Extended Power Uprates" were not complete:

a. Identify any operator workarounds that will exist after implementation of the EPU and demonstrate that they will not delay any time-critical actions (safety-significant actions required to be done in <30 minutes).

b. Identify any operator actions that are being automated.

c. Identify and justify any automated actions that will become manual after implementation of the EPU.

d. Attachment 13, Table 14.1-1 contains many "key operator actions" with allowable times of less than 30 minutes. Which of these actions will be validated with empirical data to confirm that GGNS operators are able to reliably perform these actions within the EPU allowable times in this table?

e. In Attachment 5B, Table2.5-1, "Appendix R Fire Event Evaluation Results," allowable time for Maximum Operator Action Time to Open ADS valves (minute) was reduced from 18 minutes to 14.3 minutes. Have the operator response times been validated to be less than 14.3 minutes?

Response

a. GGNS Operation's Section Guideline OPG-12, *Operator Workarounds,* defines an operator workaround as: "Any plant condition (equipment or other) that would require compensatory operator actions in the execution of normal operating procedures, abnormal operating procedures, emergency operating procedures or annunciator response procedures during off-normal conditions."

   GGNS is currently tracking two (2) operator workarounds:

   1) Radial well pumps cannot be controlled from a remote location and have to be started locally; and

   2) The Division 1 Load Shed Sequencer (LSS) switch requires declaring the Division 1 Diesel Generator INOPERABLE when it is paralleled to the grid.

   Neither workaround currently impacts time-critical operator actions. The radial well pumps telemetry operator workaround is scheduled to be resolved prior to RF18. The LSS switch operator workaround is scheduled to be resolved during RF18. If these workarounds are not resolved prior to the startup from RF18, they will continue to have no impact on time-critical operator actions following the implementation of EPU. In addition, EPU implementation does not introduce any new operator workarounds.

b. None of the existing manual operator actions evaluated in the current licensing basis for GGNS are being automated. Further, as stated in Attachment 5B, Section 2.11.1.2 of the

EPU LAR: "There are no new credited operator actions required as a result of EPU." In addition, no automated actions evaluated in the current licensing basis for GGNS become manual actions after implementation of EPU.

c. See the response to b.

d. Attachment 13, Table 4.1-11, *Re-Assessment of Key Operator Action HEPs for the EPU*, summarizes an assessment of the operator actions explicitly reviewed based on the criteria provided in Attachment 13. The increased power level reduces the time available for some operator actions by small increments. The reduction in the available time is generally small compared with the total time available to detect, diagnose, and perform the actions. The operator actions with allowable times less than 30 minutes reflected in Table 4.1-11 are Control Room actions consisting of a limited number of steps (e.g., initiation of an emergency system, repositioning of one or two valves, etc.). Because of the location and simplicity of these actions, they can easily be performed within the allowable times from a physical standpoint; however the actions are not specifically timed. Simulator training of specific accident scenarios is routinely provided and ensures the Control Room Operators can quickly detect and diagnose the need to perform these actions.

e. Operator response times were validated to be less than 14.3 minutes during the NRC Triennial Fire Protection Inspection conducted on April 11, 2005 through May 12, 2005 (reference - NRC Triennial Fire Protection Inspection Report 05000416/2005-08 dated June 21, 2005). During this inspection, NRC team members observed operators simulate performing the steps of Procedure 05-1-02-II-1, *Shutdown from the Remote Shutdown Panel*, Revision 30. The team verified that the minimum number of available operators, exclusive of those required for the fire brigade, could reasonably be expected to perform the procedural actions within the applicable plant shutdown time requirements. The shutdown time requirement contained in Revision 30 of Procedure 05-1-02-II-1 was 13 minutes.

RAI # 3

Changes to Control Room Controls, Displays and Alarms

a. Will the EPU require any operator interface changes from analog to digital? If so, list those digital changes that change, add, or delete displays used by operators, discuss any differences between the analog display and the digital display, and justify the equivalency or describe the advantages of digital display for the operator(s).

b. How will the operators be tested to determine that they can use the displays and controls reliably?

Response

a. Along with EPU, GGNS is implementing the digital Power Range Neutron Monitoring System (PRNMS) during the upcoming spring refueling outage. The PRNMS equipment is designed to replace existing Average Power Range Monitor (APRM) components in their current locations within control room panels 1H13-P669, 1H13-P670, 1H13-P671, 1H13-P672, and 1H13-P680.

Of the changes to be implemented, PRNMS introduces new graphic displays to panels P669 through P672. Four (4) displays will be installed, one in each panel, to replace the existing

Local Power Range Monitor (LPRM) analog meters. The displays are self-contained with four menu soft-keys below the screen. Each display is divided into three sections (upper, middle, and lower), which are accessed via the soft-keys. The upper section is reserved for critical information and channel status, including "INOP," "Bypass," "Trouble," and "Alarm" indications. This presentation ensures the operator is continuously provided with the status of each channel. The other two sections display additional system information such as APRM and LPRM data and Oscillation Power Range Monitor (OPRM) status information. The displays simplify data presentation to the operators compared with existing data presentation features and are consistent with guidance in NUREG-0700 Sections 1.2, "Display Formats," 1.3, "Display Elements," and 1.4, "Data Quality and Update Rate."

The displays are designed such that optical reflections, ambient noise, and control room environmental factors will not interfere with the ability of the operators to perceive and comprehend the data. This design complies with the guidance of NUREG-0700 Sections 1.5, "Display Pages," and 1.6, "Display Devices."

Adequate levels of illumination are part of the new displays and ensure that visual effectiveness is sufficient for task performance. Monitor light levels are verified as adequate to ensure visual effectiveness. Glare is almost non-existent and displays are not shadowed. Surface colors are recognizable under both normal and emergency lighting conditions. These characteristics are consistent with NUREG-0700 Section 7.2, "Information Display."

Additional information regarding the PRNMS and its associated Human Factors Evaluation is provided in Entergy letter GNRO-2010/00075 to the NRC dated December 13, 2010 (ADAMS Accession No. ML103480114).

b. Grand Gulf simulator software and hardware changes related to EPU will be installed prior to the EPU implementation outage. This will allow operator training to begin in the plant reference simulator prior to the outage. Training is expected to continue through startup from the EPU implementation outage.

RAI # 4

Attachment 5B Section 3 Pages 266/540

Please describe how the decreased time margin for the Main Condenser (MC) storage capacity (from 92 seconds at current licensed thermal power to 79 seconds at EPU thermal power) will impact the N-16 and radioiodine radiation levels within the MC.

Response

The decreased time margin for the Main Condenser storage capacity (from 92 seconds at Current Licensed Thermal Power to 79 seconds at Extended Power Uprate, i.e., 13 seconds) has insignificant impact on the iodine radioactivity levels within the Main Condenser since the shortest half-life associated with radioiodines is 52.6 minutes (applicable to I-134).

The radiation levels near the Main Condenser from N-16 are dominated by the steam vapor phase. The majority of the N-16 inventory in reactor steam which reaches the Main Condenser will primarily partition to the main condenser vapor space from where it is removed (together with the exhaust steam and non-condensibles), by the Steam Jet Air Ejectors. The vapor space N-16 inventory will not be affected by the decrease in Main Condenser liquid retention time.

A small fraction of the main condenser inventory of N-16 partitions to the condensate and will be collected in the hotwell. The N-16 activity in the condensate will increase due to the reduction in the Main Condenser retention time and associated decrease in hold-up and decay time. However, with an N-16 half-life of 7.13 seconds, even a 79 second delay results in a reduction of the N-16 activity in the condensate by a factor of 2165, which makes the contribution of the N-16 in the condensate to the radiation levels near the Main Condenser insignificant compared to contribution of the N-16 in the vapor space.

Thus, and as noted in LAR Attachment 5 Section 2.5.4.2, the radiation levels near the Main Condenser are not expected to be significantly impacted by the decreased time margin for the Main Condenser storage capacity.

Note that dose rates due to N-16 in the condenser area are expected to increase by up to 27%, as noted in LAR Attachment 5, Section 2.10.1.2.1, but as explained above, this is not due to the reduction in condensate retention time in the condenser.

Enclosure 1

GNRO-2011/00016

Grand Gulf Nuclear Station Extended Power Uprate

Human Factors Design Criteria, ES-17
(Best Copy)

Enclosure 1

GNRO-2011/00016

Grand Gulf Nuclear Station Extended Power Uprate

Human Factors Design Criteria, ES-17
(Best Copy)

STANDARD NO.: ES-17
REVISION: 2
DATE: November 3, 1989

SYSTEM ENERGY RESOURCES, INC.

GRAND GULF NUCLEAR STATION

HUMAN FACTORS DESIGN CRITERIA

ES-17

NON-SAFETY RELATED

SAFETY EVALUATION APPLICABILITY REVIEW

	Yes	No
(1) Change to Facility as Desc. in FSAR	___	✓
(2) Change to Procedure as Desc. in FSAR	___	✓
(3) Proposed Test or Experiment not Desc. in FSAR	___	✓
(4) Change to Tech. Spec.	___	✓

(If Yes, perform 10CFR50.59 Safety Evaluation)

Safety Evaluation No. N/A

SIGNATURE: _____ DATE: 8/17/89

REVIEW AND APPROVAL SHEET

STANDARD NO.: ES-17 REVISION: 02

STANDARD TITLE: HUMAN FACTORS DESIGN CRITERIA

This document specifies items related to nuclear safety Yes [X] NO [ ]

Signatures certify that the above standard was originated, verified, reviewed or waived and approved as noted below:

ORIGINATED BY: [signature] 10/12/89 DATE 8/17/89

VERIFIED BY: Vicki B Morgan VBM 10/18/89 DATE 8/29/89

REVIEWED BY: [signature] TEB 10/17/89 DATE 8/31/89
Cognizant Group Supervisor

NPE SECTION	REVIEWED BY	REVIEW WAIVED BY	DATE
ELECTRICAL	Asim Khaliqi		10/23/89
CIVIL		[signature]	10/12/89 10/10/89
MECHANICAL		[signature]	10/10/89

ANII N/A DATE:
(Insert N/A if not applicable)

APPROVED: [signature] DATE: 11/3/89
Manager, Nuclear Design

REVISION STATUS SHEET

Standard Revision Summary

REVISION	ISSUE DATE	DESCRIPTION
0	01/12/87	Issued for use
1		Rev. per NRC Comments
2	11/03/89	Rev. to increase usability

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PAGE REVISION STATUS

PAGE NO.	REVISION	PAGE NO.	REVISION	PAGE NO.	REVISION	PAGE NO.	REVISION
1	2	16	2	31	2	46	2
2	2	17	2	32	2	47	2
3	2	18	2	33	2	48	2
4	2	19	2	34	2	49	2
5	2	20	2	35	2	50	2
6	2	21	2	36	2	51	2
7	2	22	2	37	2	52	2
8	2	23	2	38	2	53	2
9	2	24	2	39	2	54	2
10	2	25	2	40	2		
11	2	26	2	41	2		
12	2	27	2	42	2		
13	2	28	2	43	2		
14	2	29	2	44	2		
15	2	30	2	45	2		

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APPENDIX/ATTACHMENT REVISION STATUS

APPENDIX NO.	REVISION	ATTACHMENT NO.	REVISION
A	2	N/A	N/A

TABLE OF CONTENTS

1.0 SCOPE

This standard contains human factors design criteria to be used for preparation and review of design changes to the GGNS main control room, upper cable spreading room, remote shutdown panel areas and the alternate shutdown control and transfer panels.

NOTE: In this standard these areas are collectively referred to as the "Control Room".

This standard may also be used for the preparation and review of design changes to other areas.

1.1 PURPOSE

Human factors engineering addresses the efficient and safe operation of the Control Room from the operator's perspective. When making design changes in the Control Room, it is important to consider how the changes will affect the operator in terms of the availability of necessary information, the adequacy of controls for the tasks performed, the efficiency of the overall panel layout, and the suitability of the environment.

1.1.1 Section 4.0 outlines criteria related to labels and location aids. A hierarchical labeling scheme, including labels for systems, subsystems, and individual panel elements, directs the operator quickly to the component he needs. Labels should be mounted securely and should not obscure other information. Mimics can be used to integrate a group of controls into a system, making functional relationships clear to the operator.

1.1.2 Section 5.0 outlines criteria related to panel layout. Controls and displays should be grouped in a way that reflects functional organization and minimizes operator movement. For instance, components that belong to the same system should be located on the same panel, in an arrangement that indicates their relationship to each other. A series of controls that are used in sequence should be positioned in sequence on a control panel. Positioning controls where the operator can find them easily reduces the time required to perform a task and the chance of operator error.

1.1.3 Section 6.0 discusses control-display integration, the association of controls and displays that are used together. Important considerations include: (1) ensuring that the operator can read a display while operating related controls and (2) labeling controls and displays used in the same sequence of actions while the same alphabetic or numeric sequence. Both Sections 4.0 and 5.0 contain many guidelines that apply to all Control Room design changes, regardless of the type of component affected.

1.1.4 Section 7.0 contains criteria specific to controls. The operator should be able to perform a required function easily with the controls available. Accidental activation of a control should be prevented. The function of a control should be clearly identified, by color or shape coding, location, and labeling. Careful selection and identification of controls are essential to efficient Control Room operation.

1.1.5 Section 8.0 includes guidelines on visual displays. Displays should also be clearly identified and easy to locate. Scales should cover the full range of possible values and provide the degree of precision needed. Light indicators should be clearly "on" or "off". The overall intent is to provide the operator with all the information he needs, without extraneous information that may distract or confuse.

1.1.6 Section 9.0 provides guidelines on annunciator systems. Annunciator warning systems, both visual and audible, should be discriminable and recognizable to operators. Window legends should be legible and succinct; annunciator response controls should be consistent in operation and placement to facilitate operator's response to alarms and subsequent remedial activities.

1.1.7 Section 10.0 contains criteria specific to the control room environment. Such factors as lighting, sound, temperature, and ventilation are important considerations. An effort should be made to create a pleasant and comfortable work setting for the Control Room personnel.

1.1.8 Appendix A is a list of standard abbreviations and acronyms to be used for labeling and equipment identification.

2.0 GENERAL INFORMATION

2.1 DEFINITIONS

2.1.1 Hierarchical Labeling - A labeling scheme usually employed in conjunction with demarcation to identify groups of functionally related controls and displays. Typically five "levels" of labels are employed: 1) panel; 2) major system; 3)subsystems or functional groups; 4) individual components; and 5) control position identifiers. See section 6.6.1.2 of NUREG-0700 for an example.

2.1.2 Mimics - A schematic diagram showing physical or functional interconnections among the components of a system. Typically controls and/or displays are imbedded in the diagram in the location of the component they control.

2.1.3 Shape Coding - The practice of using distinctively shaped objects or symbols to facilitate visual identification. Commonly used for control handles, where the distinctive shape aids visual identification and allows correct identification (or confirmation of identification) by the feel of the handle.

2.1.4 Demarcation - The use of lines or color background shading on the control panel to set off groups of functionally related controls and/or displays.

2.1.5 Succinct Labeling - Labeling using compact precise expressions without wasted words.

3.0 APPLICABLE DOCUMENTS

3.1 NUREG-0700, "Guidelines for Control Room Design Reviews".

3.2 NUREG-0737 Supplement 1 (Generic Letter 82-33), "Requirements for Emergency Response Capability".

3.3 NPEAP 01-304, "Design Change Packages".

3.4 DCRDR Human Factors Criteria, March 1985.

3.5 AECM 86/0226, "GGNS - 1 DCRDR Finally Summary Report", dated 7/31/86.

4.0 LABELS AND LOCATION AIDS

Label clearly and appropriately all controls, displays, and other equipment items that must be located, identified, and/or manipulated.

4.1 LETTERING

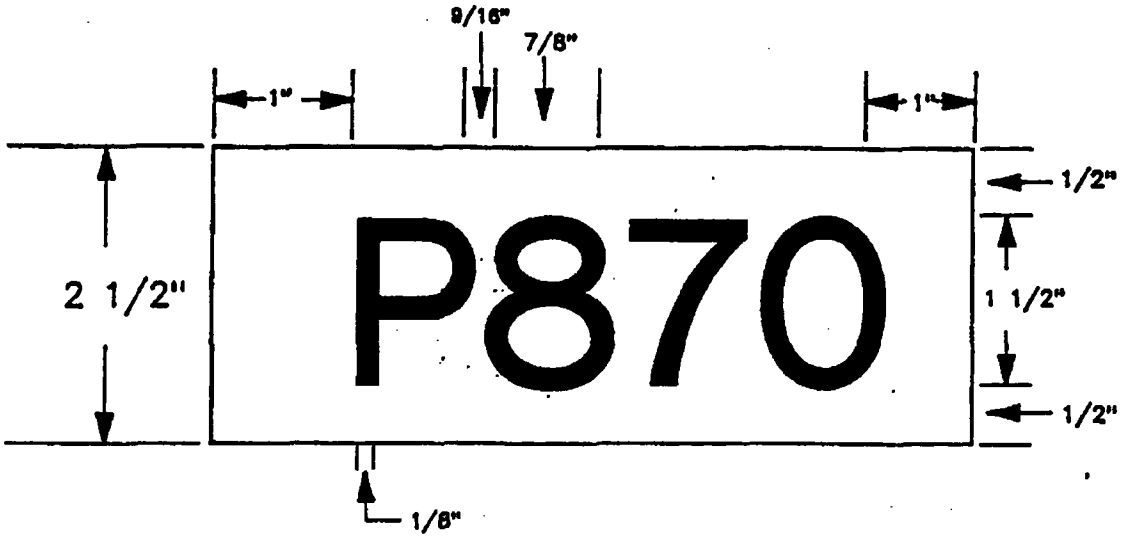
Lettering for plant lables covered under the scope of ES-17 should meet the criteria defined below for the specific types of labels. This criteria includes label height, width, letter stroke width, character height, label border and type style.

Labels should be fabricated to meet the specifications defined for the particular type of label in the system heirarchy. The label specifications listed below should be followed as closely as possible.

4.1.1 Panel Label Specifications: (See Figure 4.1-1)

1. Label Length: Varied (depends on Panel)
2. Minimum Side Borders: 1 in. $\pm$ 1/16 in.
3. Label Height: 2 1/2 in. $\pm$ 1/16 in.
4. Minimum Top an Bottom Borders: 1/2" $\pm$ 1/8 in.
5. Character Height: 1 1/2 in. $\pm$ 1/16 in.
6. Character Width: 7/8 in. $\pm$ 1/16"
7. Stroke Width: 1/8 in. $\pm$ 1/32 in
8. Minimum Distance between Characters: 9/16 in. $\pm$ 1/16 in.
9. Minimum Distance between Words: 1/4 in. $\pm$ 1/8"

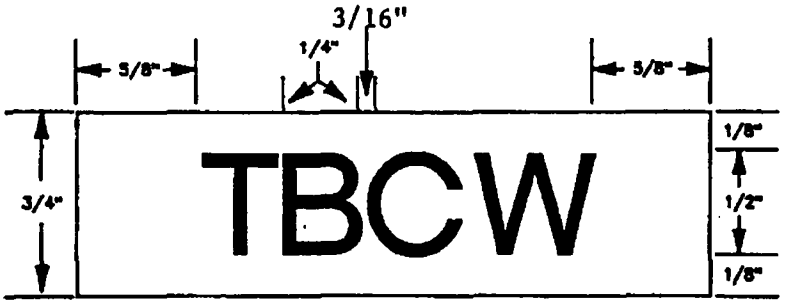
FIGURE 4.1-1
PANEL LABEL



4.1.2 System Label Specifications: (See Figure 4.1-2)

1. Label Length: Varied (depends on System)
2. Minimum Side Borders: 5/8 in. ± 1/16 in.
3. Label Height: 3/4 in. ± 1/16 in.
4. Minimum Top and Bottom Borders: 1/8" ± 1/16 in.
5. Character Height: 1/2 in. ± 1/16 in.
6. Character Width: 3/8 in. ± 1/16"
7. Stroke Width: 1/16 in. ± 1/32 in
8. Minimum Distance between Characters: 3/16 in. ± 1/16 in.
9. Minimum Distance between Words: 9/16 in. ± 1/16"

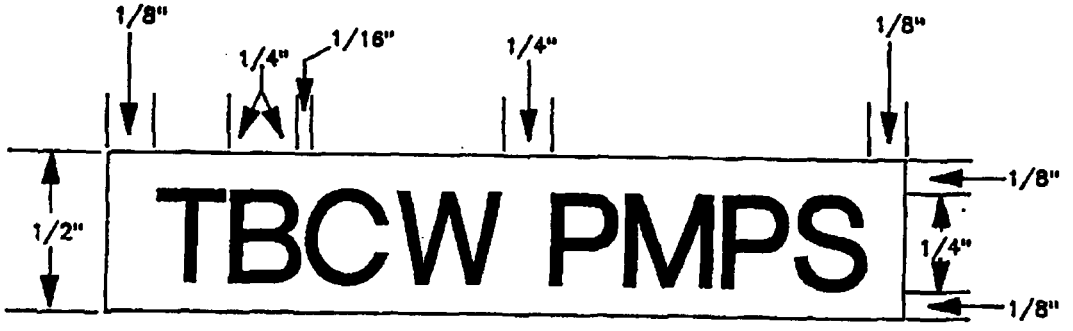
FIGURE 4.1-2
SYSTEM LABEL



4.1.3 Subordinate Label Specifications: (See Figure 4.1-3)

1. Label Length: Varied (depends on Sub-System)
2. Minimum Side Borders: 1/8 in. ± 1/16 in.
3. Label Height: 1/2 in. ± 1/16 in.
4. Minimum Top and Bottom Borders: 1/8" ± 1/16 in.
5. Character Height: 1/4 in. ± 1/16 in.
6. Character Width: 1/4 in. ± 1/16"
7. Stroke Width: 1/16 in. ± 1/32 in
8. Minimum Distance between Characters: 1/16 in. ± 1/16 in.
9. Minimum Distance between Words: 1/4 in. ± 1/16"

FIGURE 4.1-3
SUBORDINATE LABEL



4.1.4 Component Label Specifications: (See Figure 4.1-4)

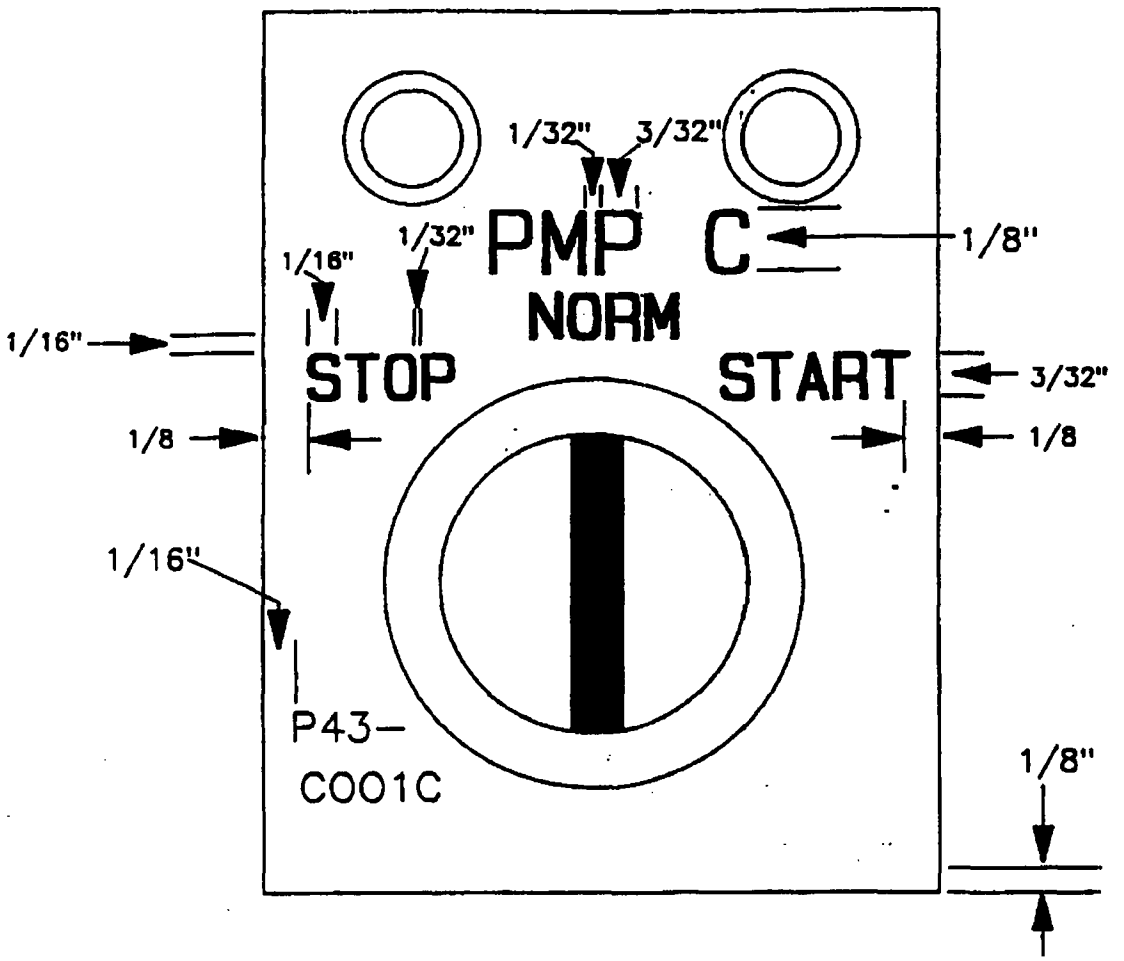
a. Component Identification Lettering

1. Label Length: Varied (depends on Panel)
2. Minimum Side Borders: 1/8 in. ± 1/16 in.
3. Label Height: See Applicable Arrangement Drawing
4. Minimum Top and Bottom Borders: 1/8" ± 1/16 in.
5. Character Height: 1/8 in. ± 1/32 in.
6. Character Width: 3/32 in. ± 1/64"
7. Stroke Width: 1/32 in. ± 1/64 in
8. Distance between Characters: 1/32 in. ± 1/64 in.
9. Minimum Distance between Words: 3/32 in. ± 1/64"
10. Minimum Distance between Lines: 1/16 in. ± 1/32"

b. Control Position Lettering on Component Labels

1. Character Height: 3/32 in. ± 1/64 in.
2. Character Width: 1/16 in. ± 1/32"
3. Stroke Width: 1/32 in. ± 1/64 in
4. Minimum Distance between Characters: 1/32 in. ± 1/64 in.
5. Minimum Distance between Words: 1/16 in. ± 1/32
6. Minimum Distance between Lines: 1/16 in. ± 1/32"

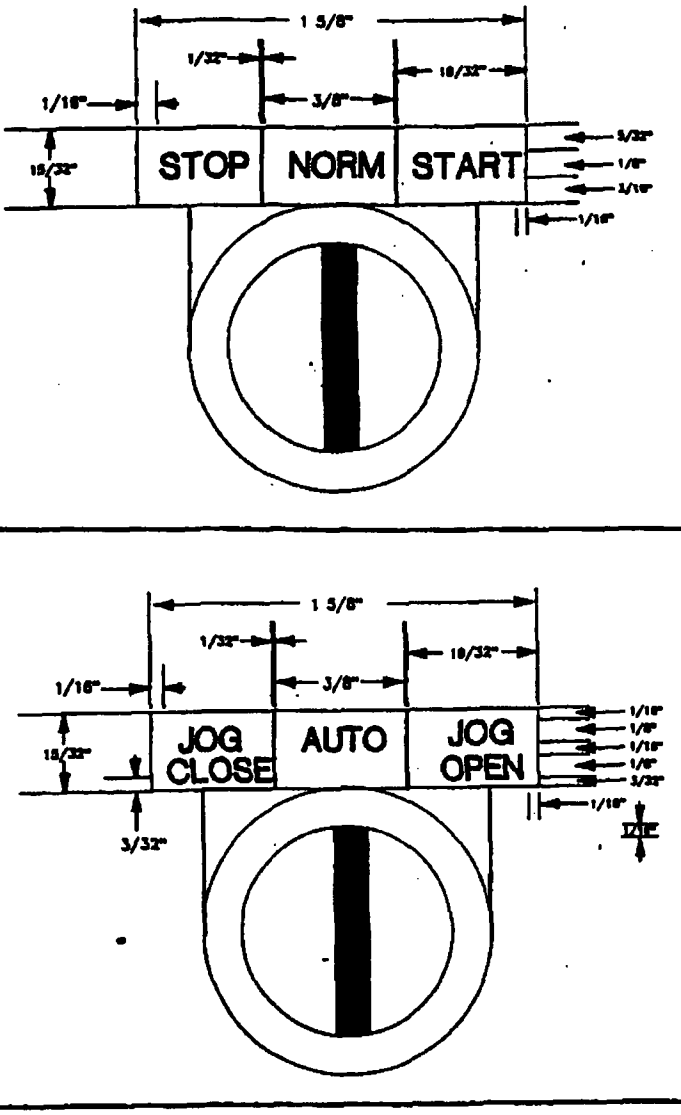
FIGURE 4.1-4
COMPONENT LABEL



4.1.5 Control Position Labels: (See Figure 4.1-5 for Typical Examples)

1. Label Length: 1 5/8 in. ± 1/32 in.
2. Side Borders: 1/16 in. ± 1/32 in.
3. Label Height: 15/32 in.
4. Top and Bottom Borders:
   i) Top Border With 1 Line of Text: 5/32 in. ± 1/64 in.
   ii) Bottom Border With 1 Line of Text: 3/16 in. ± 1/64 in.
   iii) Top Border With 2 Lines of Text: 1/16 in.
   iv) Bottom Border With 2 Lines of Text: 3/32 in.
5. Character Height: 1/8 in. ± 1/64 in.
6. Character Width: 1/16 in. ± 1/32 in.
7. Stroke Width: 1/32 in. ± 1/64 in
8. Distance between Characters: 1/32 in. ± 1/64 in.
9. Distance between Words: 1/16 in. ± 1/32
10. Distance between Lines: 1/16 in. ± 1/32"

FIGURE 4.1-5
CONTROL POSITION LABEL



4.2 LABEL SPECIFICATIONS

4.2.1 Specifications for Component Identification

a. Format for Equipment Identification Numbers shall be in accordance with General Engineering Standard GES-01 (Total Plant Numbering).
b. Abbreviations and acronyms used shall be in accordance with Appendix A.

4.2.2 Specifications for Instrument and Panel Labeling

a. Instrument and panel labeling shall not interfere with the operator's ability to read the instrument or observe panel indication.
b. Instrument and panel labels should include the following:

1. Instrument number (e.g., E31-PI-R604).
2. Instrument Description (e.g., Turbine Lube Oil Temperature).
3. Units of measurement, if not on instrument (e.g., F or C, psig, gpm).

c. Abbreviations and acronyms used shall be in accordance with Appendix A.

4.2.3 Component identification labels shall be manufactured in accordance with the specifications of Section 4.2.

4.3 LABEL CONTENT

4.3.1 Labels should provide the following kinds of information:

a. The equipment identification number (where applicable).
b. A brief function description.
c. Engineering characteristics or nomenclature, if needed for clarity.
d. Colored dots on the lower right hand of the label can be used to show equipment division.

4.3.2 Wording on labels should be selected as follows:

a. Use words that express exactly what action is intended.
b. Make instructions clear and direct.
c. Use words that have a commonly accepted meaning for all intended users.
d. Avoid unusual technical terms.
e. Abbreviate words whenever possible (See Appendix A) or spell words correctly.

4.3.3 Use consistent nomenclature in labels:

a. Use the standard part/system numbers listed in General Engineering Standard GES-01 (Total Plant Numbering).
b. Use the standard abbreviations and acronyms listed in Appendix A.
c. Use words, acronyms, abbreviations, and part/system numbers consistently within and across a piece of equipment.
d. Nomenclature in labels should be consistent with nomenclature in plant procedures (i.e. System Operating Instructions, Alarm Response Instructions, etc...)
e. Nomenclature in labels must match the label drawing, but does not necessarily have to directly correlate to the description used by the design engineer in other plant design drawings.

4.3.4 Observe the following guidelines when using symbols:

a. Use abstract symbols only if they have a commonly accepted meaning for all intended users (e.g., %).
b. Symbols should be unique and distinguishable from each other.
c. Use a commonly accepted standard configuration.
d. Use symbols consistently within and across panels.
e. Avoid using Roman numerals.

4.3.5 Wording on labels should be concise without compromising meaning.

4.3.6 When labels containing similar words, abbreviations, or acronyms are located close to each other, reduce the possibility of confusing controls by:

a. Selecting different words, or
b. Coding the controls with Equipment Identification Numbers.

4.3.7 Label control positions as follows:

a. Identify all discrete functional control positions.
b. Identify direction of motion (increase, decrease) for continuous motion rotary controls.
c. Control position information should be easy to read, without parallax, during operation of the control.

4.3.8 Label each access opening used by Control Room operators to identify the function of items accessible through it.

4.3.9 All danger, warning, and safety instruction labels should be in accordance with appropriate OSHA safety standards.

4.4 LABEL LOCATION

4.4.1 Position labels as follows:

a. Place the label above the panel component(s) it describes.
b. For components above eye level, position labels below component to ensure label visibility.
c. Place the label close to the panel component it describes.
d. Avoid placing the label on the component itself if the operator's hand will obscure the label for an extended time period or if the component is wholly removed from the panel for maintenance, recalibration, etc...
e. Separate adjacent labels so that they will not be read as one continuous label.
f. Place labels below all circular meters and position indicating lights.

4.5 LABEL MOUNTING

4.5.1 Mount labels as follows:

a. Mount labels in a manner that will prevent accidental removal.
b. Mount labels on a flat surface.
c. Mount labels using a cyan acrulate adhesive such as Eastman 910, a silicon rubber adhesive such as GE RTV-106, a double-back urethane foam tape such a 3-M Scotch Brand or NPE approved equivalent adhesive material.

4.5.2 Orient labels to prevent confusion and delays in location and identification of components.

a. Orient labels horizontally so that they may be read quickly and easily from left to right.
b. Use vertical orientation only where space is limited.
c. Avoid curved patterns of labeling.

4.5.3 Ensure the visibility of labels and other information:

a. Labels should not detract from or obscure any other information source, such as figures or scales on displays.
b. Labels should not be covered or obscured by other units in the equipment assembly.
c. Labels should be visible to the operator during control actuation.

4.6 LABEL SEQUENCE

4.6.1 If controls and displays are used in sequence:

a. Label them in alphabetic or numerical sequence (e.g. F023A,B)
b. Label associated controls and displays used in a particular sequence.

4.7 HIERARCHICAL LABELING

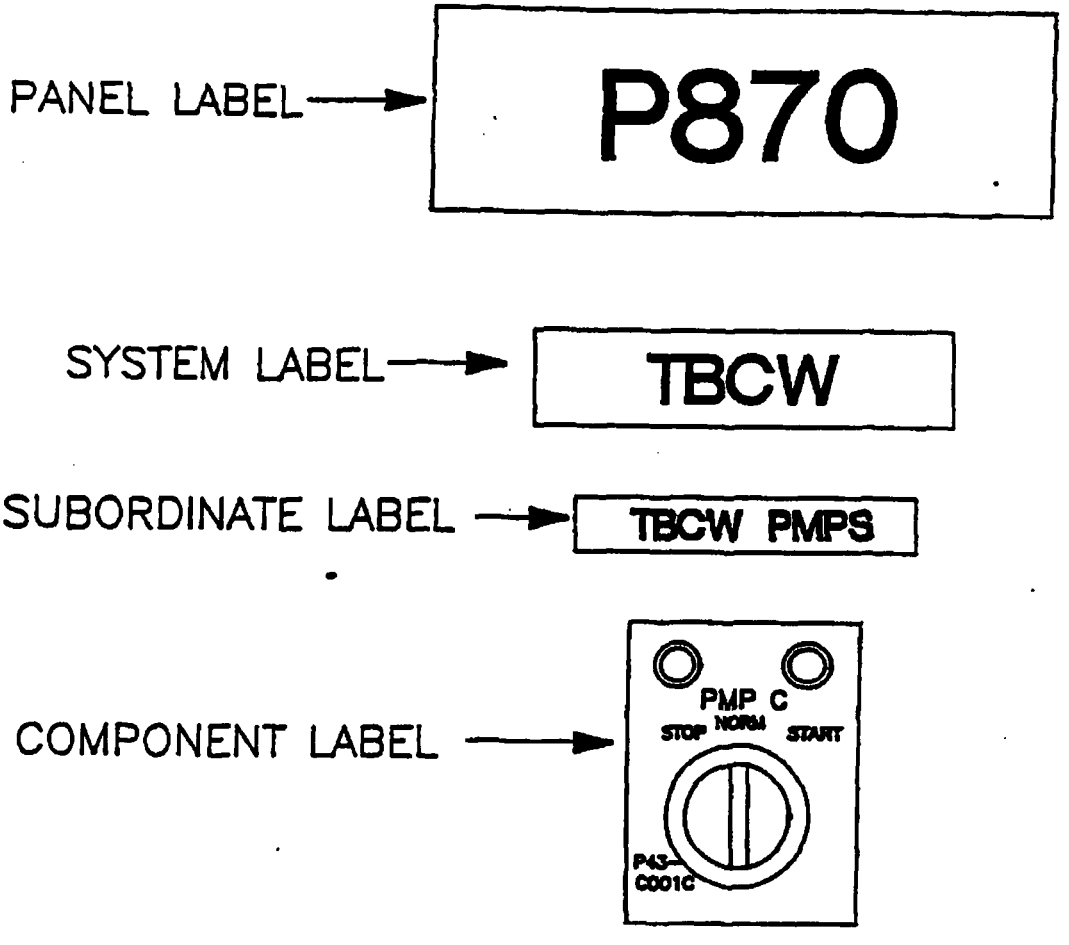
As mentioned in Section 2.1.1, hierarchical labeling is a labeling scheme often used with demarcation to identify groups of related controls and displays with the same function within the same system. Typically three "levels" of labels are employed: 1) major system; 2) subsystems or functional groups; and 3) individual components. See Figure 4.7-1 for an example.

4.7.1 Use a hierarchical labeling scheme to reduce confusion, operator search time, and redundancy (Reference Figure 4.7-1):

a. Use panel labels to identify major systems or panel bench boards.

b. Use system labels to identify major systems.
c. Use subordinate labels to identify subsystems of functional groups.
d. Use component labels to identify each discrete panel or panel component.
e. Use control position labels to identify component control positions.
f. Labels should not repeat information contained in higher level labels.

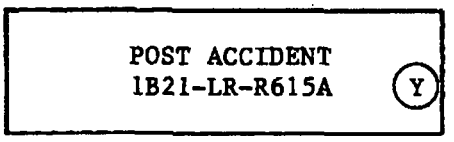
FIGURE 4.7-1
HIERARCHICAL LABELING SCHEME



4.8 POST ACCIDENT MONITORING (R.G. 1.97) LABELING

4.8.1 Label "Regulatory Guide 1.97" Control Room equipment (i.e equipment that is to be used to follow the progress of transients and accidents), with a red label with white lettering, "Post Accident" above the component number. (Reference Figure 4.8.1)

FIGURE 4.8.1
POST ACCIDENT MONITORING LABEL



4.9 COLOR CODING

4.9.1 Color coding can be used to allow the operator to locate equipment quickly as well as alert them of criticality of the component. Color coding may also be used to identify functional relationships among components and between controls and displays. Keep color codes simple by selecting colors that conform to the common usage in everyday life.

a. Plant labels should conform to the color coding criteria defined in Table 4.9-1.
b. Plant control panel mimics should conform to the color coding criteria defined in Table 4.9-2.

TABLE 4.9-1
LABEL COLOR CODING CONVENTIONS

Color	Meaning
White with black characters	Summary labels (Main Control Area)
Black with white characters	Summary labels (Back Panels)
Yellow with black characters	Division 1
Blue with white characters	Division 2
Green with white characters	Division 3, HPCS
Orange with white characters	Division 4
White with black characters	All other component labels (Main Control Area)
Black with White characters	All other back panel component labels

TABLE 4.9-2
MIMIC COLOR CODING CONVENTIONS

Color	Process/Electrical
*Red	Steam
*Blue	MSL Drains/RWCU-Safety Related
*Light Blue	Chilled Water Service Water/Standby Service Generator/Transformer
+White	Turbine Symbol Drain Symbol Pump Symbol RPV Symbols HX Symbol
*Orange	Ventilation Air
*Yellow	480 V
*Yellow	4.18 KV
*Light Brown	6.9 KV
*Orange	13.8 KV
*Light Green	34.5 KV
*Dark Brown	115 KV
*Dark Green	500 KV

*Use white arrows as required
+Use black arrows as required

4.10 USE OF MIMICS

4.10.1 Use mimics to serve the following functions:

a. To integrate system components into functionally oriented diagrams that reflect component relationships.
b. To decrease the operator's decision-making load.

4.10.2 Observe the following guidelines when using color in mimics:

a. Color code flowpaths according to the conventions in Table 4.9.2.
b. Use colors that are distinguishable from each other.
c. Ensure adequate contrast between the mimic colors and the panel.
d. Ensure that no more than four mimic lines of the same color run in parallel if the operator must quickly identify any one of the lines.
e. Mimic lines should be no wider than 1/4" and no smaller than 1/8" wide to ensure visibility.

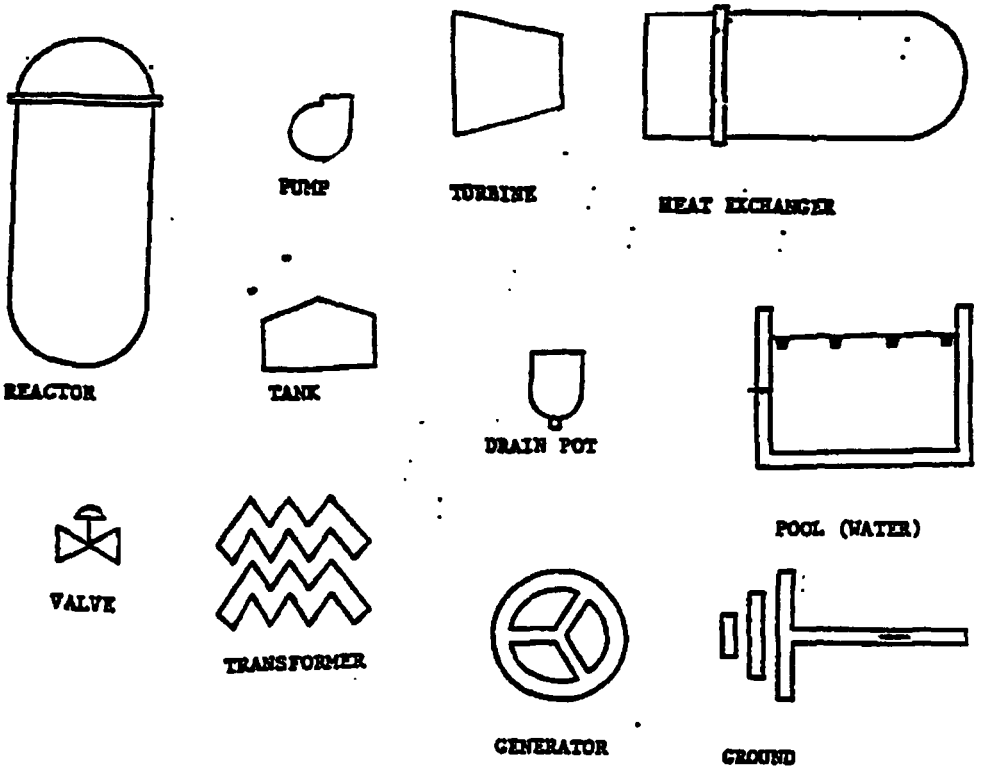
4.10.3 Mimic lines should conform to the following guidelines:

a. Use different line widths to code flowpaths (e.g., significance, volume, level).
b. Avoid overlapping mimic lines.
c. Clearly indicate flow directions with distinctive arrowheads.
d. Label all mimic origin points that do not begin at labeled components.
e. Label all mimic destination or terminal points that do not end at labeled components.
f. Identify component representations on mimic lines.

4.10.4 Symbols used with mimic lines should be: (See Figure 4.10-1

a. Readily understood and commonly used.
b. Used consistently.

FIGURE 4.10-1
COMMONLY USED MIMIC SYMBOLS



4.11 TEMPORARY LABELING

4.11.1 Use a temporary label when necessary to identify out-of-service equipment, to accommodate unique, one-time plant activities, or to improve operator understanding and efficiency:

a. Use a temporary label only until a permanent label is available or until the temporary label is no longer necessary.
b. Temporary labels should conform to good human engineering principles defined in this Engineering Standard.
c. A temporary label should not obscure a prior permanent label unless the old label is to be replaced.
d. Tag-outs should:

1. Clearly identify out-of-service components and equipment.
2. Be securely affixed.

5.0 PANEL LAYOUT

5.1 CONTROL/DISPLAY GROUPING

5.1.1 Group controls and displays according to the following:

a. Task sequence.
b. System function.
c. Importance and frequency of use.

5.1.2 Separate controls in order to:

a. Allow access to adjacent controls.
b. Allow simultaneous actuation where necessary.
c. Prevent inadvertent actuation of adjacent controls.

5.1.3 Arrange strings or clusters of similar components as follows:

a. Group components in horizontal rows no more than 20 inches long.
b. Break up strings of more than five components into smaller strings by spacing or demarcation.
c. Label left and top coordinate axes of large matrices to identify components.

5.2 CONTROL LAYOUT ENHANCEMENT

5.2.1 Use the following methods to assist recognition and identification of controls.

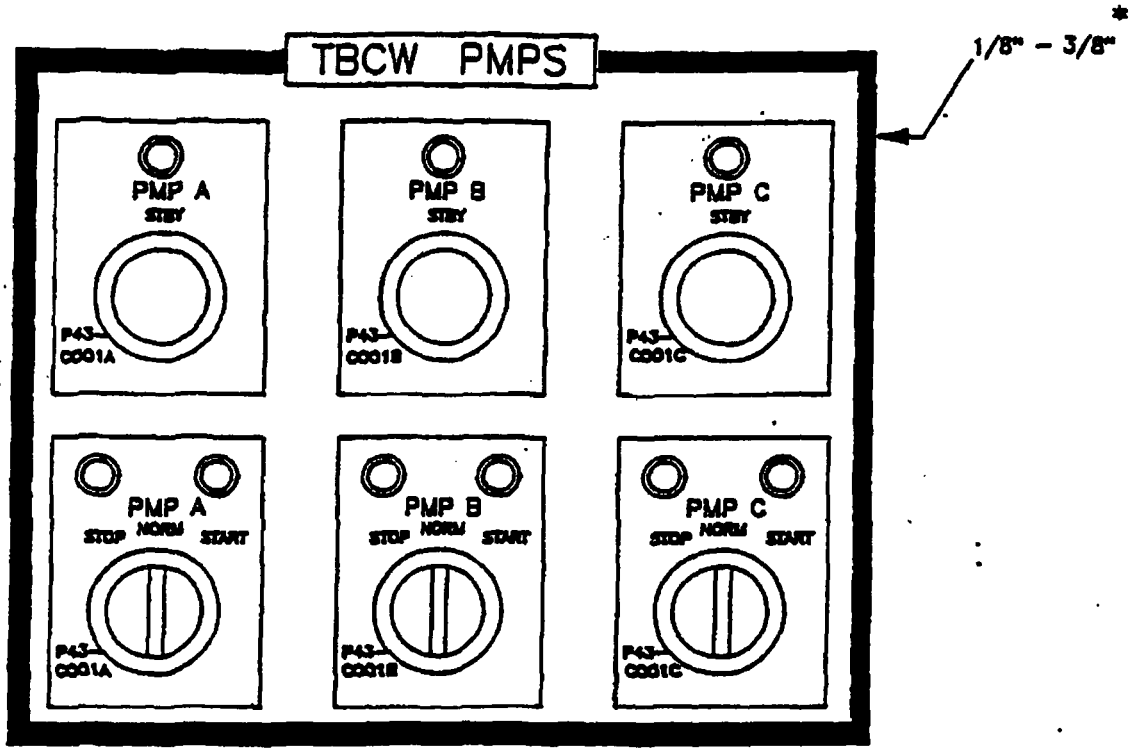
a. Spacing between groups of components.
b. Demarcation of groups of controls and displays with a contrasting line consistent with the demarcation conventions defined in Table 5.2-1. See Figure 5.2.2 for an illustration of demarcation.
c. Color shading consistent with the color coding conventions defined in Tables 4.9.1 and 4.9.2.

TABLE 5.2-1
DEMARCATION CONVENTIONS

Size:	
Width	1/8"-3/8"
Depth	1/16"
Color:	
Green*	HPCS on 870 panel
Light Gray	All others

*Green should be the same shade as labels for HPCS on 601 panel.

FIGURE 5.2.2
PANEL DEMARCATION



*NOTE: Line size will vary due to space limitations

5.2.2 Denote emergency controls with distinctive enhancement techniques. For example:

a. Color coded handles.
b. Different shaped handles.

5.2.3 Arrange controls and displays:

a. In a logical order.
b. In sequence, such as left-to-right or top-to-bottom, if appropriate.

5.2.4 Standardize the layout of controls and displays:

a. When possible, use a consistent layout for identical or similar control or display sets at all locations.
b. Avoid mirror-imaging.
c. Use consistent layouts for the simulator and the actual Control Room.

6.0 CONTROL - DISPLAY INTEGRATION

6.1 LOCATION

6.1.1 Position associated controls and displays as follows:

a. Position the control below or to the right of its associated display so that the display is not obscured during control manipulation.
b. Position the display close enough to the control to be read clearly and without parallax during operation.

6.1.2 Establish the association of controls and displays by:

a. Location.
b. Labeling.
c. Demarcation.
d. Consistency with operator expectations.

6.1.3 The following should be immediately apparent to the operator:

a. The association of displays with controls.
b. The direction of movement of displays and controls.
c. The rate and limits of movement of displays and controls.

6.1.4 Use a symmetrical layout for associated controls and displays that are used in the same sequence.

6.1.5 If a single display is associated with multiple controls:

a. Center the controls on the display.
b. Group the controls in a line or matrix.
c. Mount controls directly below or to the right of the display.

6.1.6 If a single control is associated with multiple displays:

a. Center the control below or to the right of the display area.
b. Group the displays in a line or matrix.

6.1.7 Observe the following guidelines when using a display selector:

a. Control position sequence should be consistent with display sequence.
b. Control position sequence and display should have corresponding labels.

6.1.8 If controls and displays are in separate planes:

a. Displays should be on adjacent upper panel from associated controls. (whenever possible)
b. Associated controls and displays should never be on facing panels.

6.2 CONTROL/DISPLAY RESPONSE

6.2.1 If there is a display response time lag:

a. Displays should reflect in real time the time lag between actuation of the control and the change in system condition.
b. There should be no time lag between a system condition change and the display indication.
c. If there is a lag time between control actuation and ultimate system state, there should be an immediate indication of the process and direction of the parameter change.

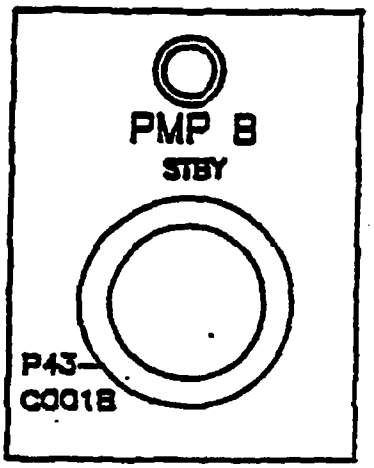
6.3 CONTROL/DISPLAY ENHANCEMENT

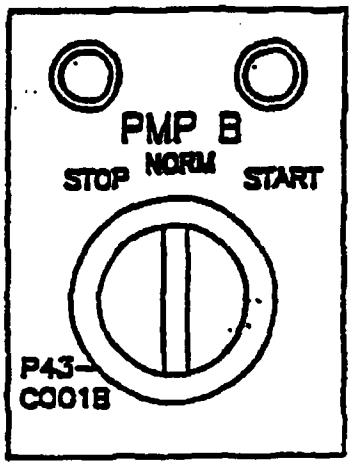
6.3.1 Controls or displays that do not follow color or shape coding conventions should be identified and reviewed with the operators when that system is reviewed during training sessions.

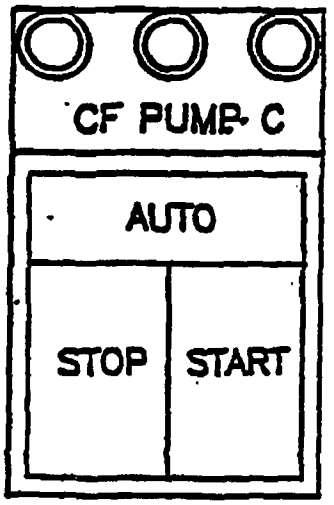
6.4 TYPICAL SWITCH/INDICATOR CONFIGURATION

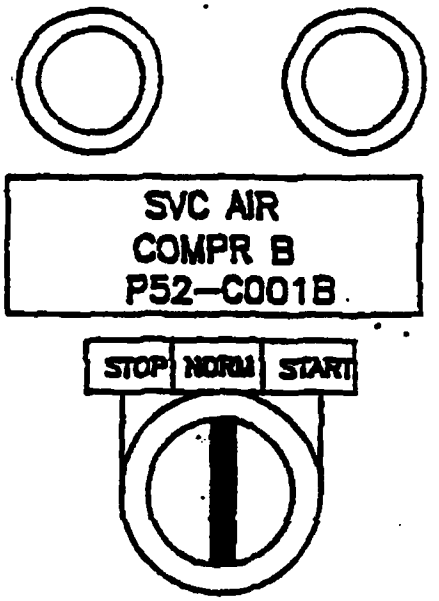
6.4.1 The switch/indicator light configurations as shown in Figure 6.4-1 should be used whenever feasible.

FIGURE 6.4-1
TYPICAL SWITCH/INDICATOR LIGHT CONFIGURATIONS









7.0 CONTROLS

7.1 GENERAL

7.1.1 All controls should meet the following criteria:

a. Sufficient ease of adjustment.
b. Sufficient range of control relative to the controlled parameter.
c. Required level of precision needed to meet normal transient and emergency operating procedure requirements (as applicable) without excess precision.
d. Operability in sufficient time, under expected dynamic conditions, and within the limits of manual dexterity , coordination, and reaction time.
e. Sufficient durability to retain their appearance, "feel," and functional characteristics during their service life.
f. Compatible with emergency gear.
g. Clear and direct display of control position.

7.2 COLOR CODING

7.2.1 Observe the following guidelines when using color coding:

a. Color coding can be used to provide unambiguous, easily discriminable information to the operator, and to aid in the following:

   1. Perception of warning signals.
   2. Identification of functional relationships.
   3. Association of displays with related controls.
   4. Organization of information.
   5. Identifying probability or importance of events.

b. Follow the color coding conventions defined in Exhibit 7.2-1.
c. Use color only to provide redundant information; the pertinent information should be available from some other source (e.g. label information).
d. Avoid using more than 11 colors for coding.
e. Narrowly define the meaning attached to a particular color.
f. The meaning of a particular color should be consistent throughout the control room, whether applied to panel surfaces or projected in signal lights or on CRTs, within and among systems.
g. Select colors that are recognizably different from each other.
h. Select colors that contrast well with the background on which they appear.
i. Evaluate each color selected for coding under all illumination under which it will be used; ambient lighting will influence the apparent color of the coded element.

EXHIBIT 7.2-1
CONTROL COLOR AND SHAPE CODING

Color	Meaning
Gray	On
Black	Off
White	Auto
Red Flag	Start
Green Flag	Stop
Red Switch/Red Border	Emergency
Gray	Closed
Black	Open
Gray	Closed
Black	Open
White	Stop
Gray	Run
Black	Auto
White	Off/Reset
Gray	Manual
Black	Auto
White	Off
Gray	Stop button
Gray	Trip button
Black	Start button
Shape	**Meaning**
Extended Handle	Throttle Valve

7.3 SHAPE CODING

7.3.1 Observe the following guidelines when using shape coding:

a. Shape code controls that the operator must operate without looking (e.g., while observing a display).
b. Control shapes should be:

1. Visually identifiable
2. Tactually identifiable

7.4 DIRECTION OF MOVEMENT

7.4.1 Use the conventions in Tables 7.4.1 and 7.4.2 to determine the direction of movement of a control.

TABLE 7.4.1
CONTROL DIRECTION OF MOVEMENT CRITERIA

FUNCTION	CONTROL ACTION: RIGHT	FORWARD	CLOCKWISE	PUSH	PULL	LEFT	BACKWARD	UP	COUNTER CLOCKWISE	CENTER	DOWN
ON	●	●	●	●							
START	●	●	●	●							
RUN	●	●	●	●							
AUTO										●	
OPEN	●	●	●	●							
OFF				●	●	●	●		●		
STOP				●	●	●	●		●		
CLOSE				●	●	●	●		●		
RAISE	●		●					●			
LOWER						●			●		●
INCREASE	●	●	●					●			
DECREASE						●	●		●		●
IN		●		●							
OUT					●		●				

TABLE 7.4.2
SWITCH POSITION CRITERIA

NORMAL - INOPERATIVE
NORMAL - RESET
CLOSE - STOP - OPEN (Throttle Valves)
TEST - STOP - OPEN
CLOSE - NORMAL - OPEN
CLOSE - AUTO - OPEN
NORMAL - OPEN
NORMAL - TEST
AUTO - STANDBY
AUTO - RUN
NORMAL - BYPASS
OFF - TEST
OFF - AUTO

7.5 CONTROL ENHANCEMENT

7.5.1 Prevent accidental activation of a control:

a. Locate the control where the operator will not strike or move it accidentally.
b. Recess, shield, or otherwise surround the control with a physical barrier so that the control is entirely within the envelope described by the recess or barrier.
c. Use a movable cover or guard; the guard should not interfere with the operation of the control.
d. Avoid safety or lock wires.
e. Use interlocking controls.
f. Make the control resistant to movement.
g. When a strict sequential activation is necessary, provide locks to prevent the control from passing through a position.
h. Use rotary action controls where linear or pushbutton controls would be subject to inadvertent activation and fixed protective structures cannot be used.

7.5.2 To ensure the visibility of a control:

a. The control should be easy to locate.
b. The control setting should be easy to read, without parallax, from the operating position.

7.5.3 Provide some indication of activation for a control:

a. Physical feedback such as a position detent or snap feel.
b. Audible feedback such as a click or snap.
c. Integral light.
d. Pointer, if rotary control.

7.6 PUSHBUTTONS

7.6.1 Pusbuttons

a. Position pushbuttons in a logical order or in an order related to procedural sequence.
b. Use a slip-resistant or concave surface.

7.6.2 Legend Pushbuttons

a. Follow the criteria in Section 8.7.2, Legend Light Indicators.
b. Use barriers with rounded border edges when legend pushbuttons are contiguous.

7.7 KEYSWITCHES

7.7.1 Key-Operated Controls

a. Use Key-operated controls only where necessary for security. Avoid using key-operated controls, as a means for shaping coding.
b. Keys with a single row of teeth should be inserted into the lock with the teeth pointing up or forward (Preferred).
c. Keys with teeth on both edges should fit the lock with either side up or forward.
d. If possible and practical, orient locks so that the switch is OFF or SAFE when the key is in the vertical position.
e. If possible and practical, operators should not normally be able to remove the key from the lock unless the switch is turned to the OFF or SAFE position.
f. Label control positions.

7.8 ROTARY CONTROLS

7.8.1 Continuous Adjustment Rotary Controls

a. Use continuous adjustment rotary controls to ensure precise control along a continuous variable.
b. Use round knobs with knurled or serrated edges, to aid in gripping the control.
c. Use a pointer if an indication of position is desirable; if more accuracy is required, a line should be engraved and filled with a contrasting pigment both on the top and bottom sides of the pointer.

7.8.2 Rotary Selector Controls

a. Use rotary selector controls when three or more detented positions are required; they may also be used for two-position operation.
b. Provide detents at each control position to ensure proper positive positioning and functioning of a discrete rotary control.
c. It should not be possible to position a control between detented positions.
d. A rotary selector control should not have more than 24 positions.
e. Provide stops at the limits of the control range to minimize the possibility of placing the control in an unused position.
f. Use a moving pointer and fixed position settings to maximize readability.
g. Provide position indication by one of the following methods:

    1. Indicator lights.
    2. A line engraved both on the top and bottom of the knob.
    3. A pointer shape.

h. Mount pointers close to position settings to minimize parallax.
i. Knobs for spring-loaded, momentary contact, rotary selector controls should be large enough to be easily held against the spring torque, without fatigue, for as long as necessary to accomplish the control action. (i.e. gloved hand operators on throttle valve controls).

7.9 THUMBWHEELS

7.9.1 Thumbwheels should adhere to the following conventions:

a. Thumbwheel readouts should be visible from the thumbwheel operating position. All readings should be direct without scaling or table lookup needed to determine the setting or position.
b. If the thumbwheel is used as an input device, code the OFF, zero, or normal position to facilitate visual recognition of status.
c. Provide a detent at the OFF position for feedback.
d. Thumbwheel controls that have discrete settings should be detented between positions.

7.10 SLIDE SWITHCES

7.10.1 Slide switches should have serrated or knurled surfaces.

7.11 TOGGLE SWITCHES

7.11.1 Toggle switches should have an elastic resistance that increases as the control is moved and decreases as the switch snaps into position.

7.12 ROCKER SWITCHES

7.12.1 Rocker switches should adhere to the following conventions:

a. Orient rocker switches vertically.
b. Activation of the upper part should control the ON or INCREASE function. Activation of the lower part should control the OFF or DECREASE function.
c. In the ON position, the top of the switch should be flush with the panel surface.

8.0 VISUAL DISPLAYS

8.1 GENERAL

8.1.1 All displays should meet the following criteria:

a. Capability to distinguish significant levels of the system parameter controlled.
b. Required level of precision, without excess precision.
c. Feedback for any deliberate movement of a control.

8.2 COLOR CODING

8.2.1 Use the following scale color coding convention:

a. Amber is used for out of normal operating range, but not in abnormal condition (e.g. pump coming up to speed).

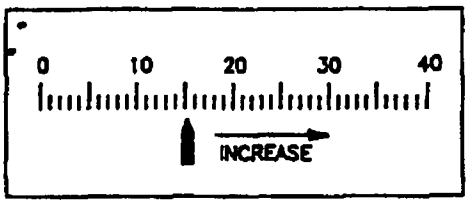
8.3 DIRECTION OF MOVEMENT

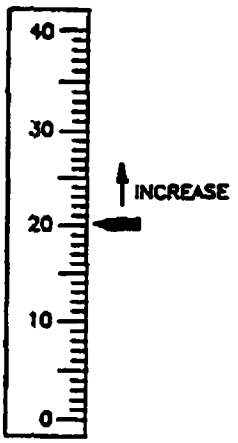
8.3.1 Follow the conventions in Figure 8.3-1 to determine the direction of movement of a display.

8.3.2 Failure mode of instruments - Where possible and practical, provide indication of display failure (e.g., failure light or off-scale indication). A failed instrument which indicates an on-scale value, especially zero is not recommended.

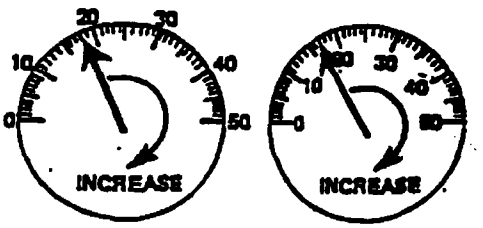
FIGURE 8.3-1
DISPLAY MOVEMENT CONVENTIONS

DIRECTION OF NUMBERING AND POINTER MOVEMENT FOR HORIZONTAL FIXED SCALES





DIRECTION OF NUMBERING AND POINTER MOVEMENT FOR VERTICAL FIXED SCALES



DIRECTION OF NUMBERING AND POINTER MOVEMENT WITH CIRCULAR SCALES

8.4 DISPLAY VISABILITY

8.4.1 To ensure the visibility of a visual display:

a. Displays should be easy to locate.
b. Displays should be easy to read, without parallax, from the operating position.

8.4.2 Limit information printed on the display face:

a. Include only an identification of the parameter displayed, the units shown, and any transformation required.
b. Omit unnecessary information and extraneous items such as patent notices or manufacturer's trademark.
c. Limit redundancy to cases where it is needed for backup or to avoid excessive operator movement.
d. Word messages as briefly as clarity permits.
e. Use the standard abbreviations and acronyms listed in Appendix A.

8.5 DISPLAY SCALES

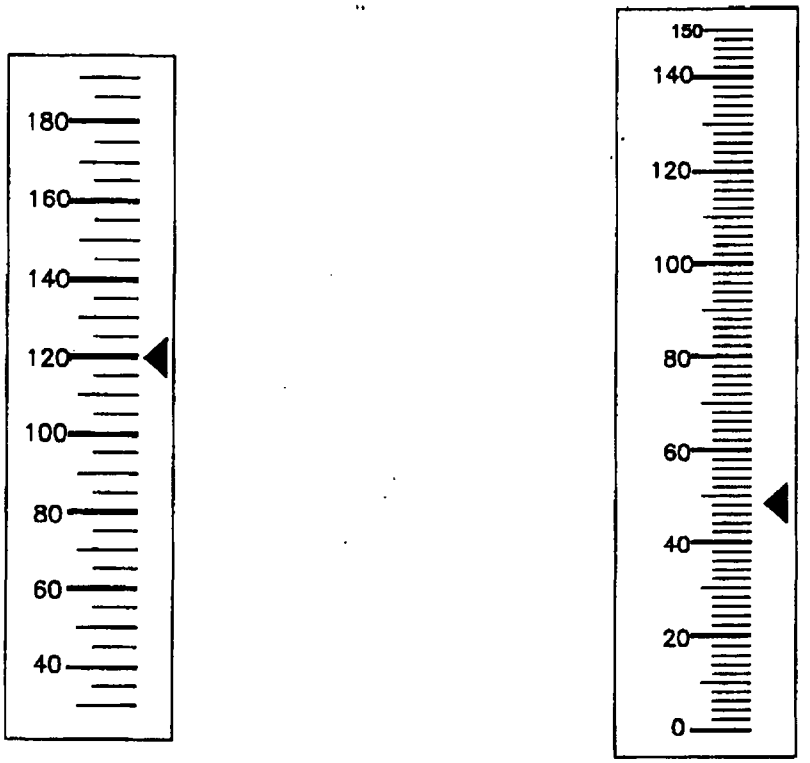
8.5.1 Scale readings should relate in a direct and practical way to the operator's tasks.

a. Provide the degree of precision and accuracy needed.
b. Avoid conversions.
c. Use percentage indication only when the parameter is meaningfully reflected by percentage.
d. Provide for the display of all possible values:

1. Select scales that clearly indicate the critical parameters needed by the operators (e.g. setpoints, action levels, etc...).
2. Select scales that span the expected range of operational parameters, or
3. Employ appropriate scale ranging techniques, or
4. Support normal range displays with auxiliary wide-range instruments.
5. Provide numbers at the beginning and end points of the scale whenever possible. Upper end points should correspond to normally marked scale divisions or the next major subdivision, as shown in Figure 8.5-1.

e. A displayed value may be multiplied or divided by a power of 10, if the transformation is clearly marked on the display.
f. Minimize the display of normal random variations in display performance.
g. Use compatible scales for displays of the same parameter.
h. Avoid logarithmic scales, except where necessary for range and accuracy.
i. Avoid multiscale indicators.

FIGURE 8.5.1
METER SCALE CRITERIA



8.5.2 The specifications for several meter scales can be found on the drawings listed in table 8.5.2

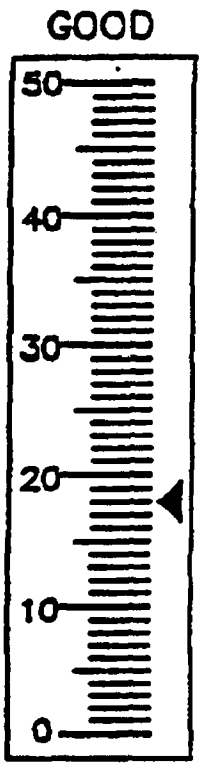
TABLE 8.5.2
METER SCALE SPECIFICATIONS

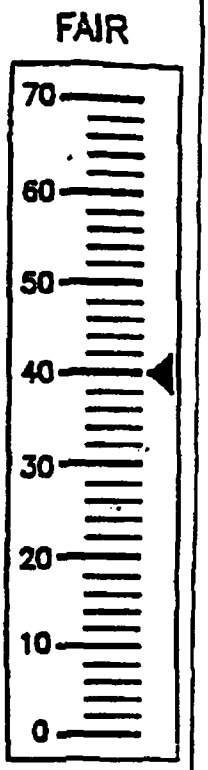
METER	SCALE-DRAWING
GE-180	J-7134
GE-185	J-7135
Rosemount Trip Unit	J-7135
Bailey Drum Recorder	J-7136

8.5.3 Scale graduations should conform to the following guidelines: (See Figure 8.5.3)

a. No more than nine graduations should separate numerals.
b. Major and minor graduations should be used if there are up to four graduations between numerals.
c. Major, intermediate, and minor graduations should be used if there are five or more graduations between numerals.
d. Successive values indicated by unit graduations should be in increments of 1, 2, 5, or 10 or those values multiplied by some power of 10. Increments of 1, 5 and 10 are preferred. However, increments of 2 are acceptable.

FIGURE 8.5.3
METER SCALE GRADUATION GUIDELINES





VALUES INDICATED BY UNIT GRADUATIONS

— Successive values indicated by unit graduations should be one of those shown in the following table or those multiplied by some power of 10.

GOOD					FAIR				
1	2	3	4	5	2	4	6	8	10
5	10	15	20	25	20	40	60	80	100
10	20	30	40	50					

8.5.4 Orient scale markings as follows:

a. Orient numerals vertically on linear and circular scales.
b. Where pointer movement is more than 360°, the zero point should be located at the 12 o'clock position.
c. Where positive and negative values are displayed around a zero or null position, the zero or null point should be located at the 12 o'clock position.
d. Where the scale covers less than full rotation of the pointer, scale endpoints should be indicated by a break in scale at least one number interval in length, oriented at the 6 o'clock position.

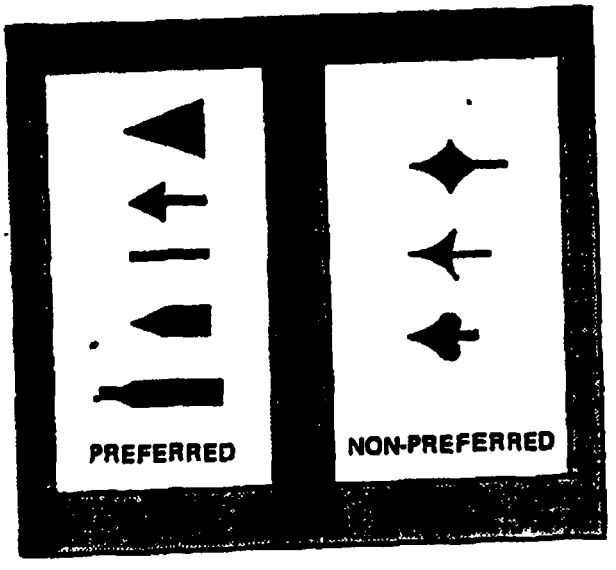
8.5.5 Mark and color code out of normal operating ranges on meter scales as described in Section 8.2.

8.6 DISPLAY POINTERS

8.6.1 Pointers on visual displays should meet the following:

a. Use simple pointer tips as shown in Figure 8.6.1
b. Select pointer tips to minimize concealment of scale graduation marks or numerals.
c. Where possible, pointer tip should extend to within about 1/16 inch of, but not overlap, the smallest graduation marks on the scale.
d. Mount pointers so as to avoid parallax errors.
e. Pointer/background contrast and pointer size should be adequate to permit rapid recognition of pointer position.
f. Avoid moving-scale, fixed-pointer meters.

FIGURE 8.6.1
POINTER TIP CONVENTIONS



Examples of pointer tips.

8.7 LIGHT INDICATORS

8.7.1 Observe the following precautions when using light indicators:

a. To ensure the availability of light indicators, provide for rapid and convenient bulb replacement with power on and without hazard to personnel or equipment (to encourage immediate replacement of burned-out bulbs).
b. Ensure that reflections or refractions from light sources do not cause light indicators to appear to be glowing when they are off or unlit when they are actually on.
c. Avoid misinterpretation:

1. System/equipment status should be inferred from illuminated indicators, never from the absence of illumination.
2. Provisions (design or procedural) should be made to prevent interchanging indicator lenses.

d. Avoid using light indicators to alert operators to unfavorable status; use annunciators.
e. Valve position indicating lights should be arranged such that GREEN (meaning closed) is on the left side and RED (meaning open) is on the right side.
f. Label indicator lights whose meaning is not apparent.
g. Light intensity should be at least 10% greater than surrounding panel. (Light intensity can be measured with a photometer.)
h. Color may be provided by a tinted cover glass or by a layer of colored material inside the cover according to the conventions in Table 8.7.1.
i. The color of the light should be readily identifiable.
j. For valves with both a red and green position indicator light, fed by a limit switch, mid-position of the valve should be indicated by both indicators illuminated simultaneously. The green light is illuminated when the valve is not fully open and the red light is illuminated when the valve is not fully closed.

TABLE 8.7.1
INDICATOR LIGHT COLOR CODING CRITERIA

COLOR	MEANING
Red	Valve open
Red	Breaker closed
White	Power available
Red - Green	Mid or transitional position
Red	On or operating
Red	Not secure
Green	Valve closed
Green	Breaker open
Green	Breaker trip
Green	Off or not operating
Green	Remote (or local only)
Green	Trip or failure

8.7.2 Legend Light Indicators

a. General legend design should be consistent throughout the control room.
b. Light intensity should be at least 10% greater than the surrounding panel.
c. Legends should be legible under ambient illumination with the indicator light off.
d. Provide adequate contrast between lettering and background under ambient and transilluminated lighting.
e. Symbolic legends should be unambiguous.
f. If possible, limit text to no more than three lines.
g. Word legends to tell the status indicated by the glowing light.
h. Follow the lettering guidelines in Section 6.5 of NUREG-0700.
i. Distinguish legend light indicators from legend pushbuttons using rounded corner borders.

8.8 RECORDERS

8.8.1 Graphic Recorders

a. Use graphic recorders to record trend information and material that may be needed for later reference.
b. Ensure that pen, inks, and paper provide a clear, distinct, and reliable marking.
c. The recording paper and the recorder should use compatible scales.
d. See Section 8.5 for guidelines on scale design.
e. Provide a takeup spool and means for tearing off completed records.
f. Ensure the availability of expendables (paper, ink, etc.).
g. Paper and ink should be easy to replenish.
h. It should be convenient to annotate recordings with date, time, paper speed, parameter identification, etc.
i. Data should be visible through the window of the recorder.
j. Mark and color code abnormal operating zones as described in Section 8.2.
k. When possible, place recorders displaying critical information in the main control room or backpanel area for easy access when monitoring plant parameters.

NOTE: Continuous recorders provide pen-and-ink lines on the moving paper, one being dedicated full time to each channel that inputs to the recorder. Discrete recorders provide time-phase recording of a number of input channels, plotting them in sequence. Using a number-stamping device, they plot on the moving paper the instantaneous parameter value and the number of the channel it represents.

8.8.2 Continuous Recorders

a. Label the parameter recorded.
b. If using a multiple-pen recorder, list the parameters in the order of the associated scales on the recorder.
c. Use a different ink color for each pen; colors should be easily distinguished and provide good contrast with the paper.
d. Use pen colors uniformly throughout the Control Room where possible.

8.8.3 Discrete Recorders

a. Do not load the recorder beyond the designed channel capacity.
b. Identify the channel on the instrument.
c. Identify the channel on the recording medium.
d. Provide channel selection and indication capability.

8.9 COUNTERS

8.9.1 Drum-Type Counters

a. Use drum-type counters when quick, precise reading of a quantitative value is needed and trend information is not needed.
b. Numerals should read horizontally.
c. Width-height ratio should be 1:1.
d. Separate numerals with commas and a decimal point if appropriate.
e. Provide contrast between the numerals and the background.
f. The surface of the drum and the surrounding area should be matte finish to minimize glare.
g. Mount the counter perpendicular to the operator's line of sight because of the restrictive viewing angle.
h. Mount the counter as close as possible to the panel surface to minimize shadows and maximize viewing angle.
i. Window size should allow only one digit at a time to appear.
j. Numbers should change by snap action, not continuous movement.
k. Counter drums should move upward with increasing values.

8.9.2 Electronic Counters

a. Numerals should read horizontally.
b. Use a simple character style.
c. Rate of change should be less than two per second.
d. Character-to-background contrast ratio should be sufficient to allow reading the counter under normal and emergency lighting conditions 15:1 (minimum) and 20:1 (preferred).

9.0 ANNUNCIATORS/VISUAL ALARMS

Annunciators serve as an interface to alert the operator to out-of-tolerance changes in plant conditions. The annunciator system consists of three major subsystems: 1) an auditory alert subsystem, 2) a visual alarm subsystem, and 3) an operator response subsystem. Together, these three should be designed to provide the operator with plant information needed to mitigate the consequences of plant transients without excessive effort, mental stress and time.

9.1 LETTERING

9.1.1 Annunciator lettering should meet the following criteria:

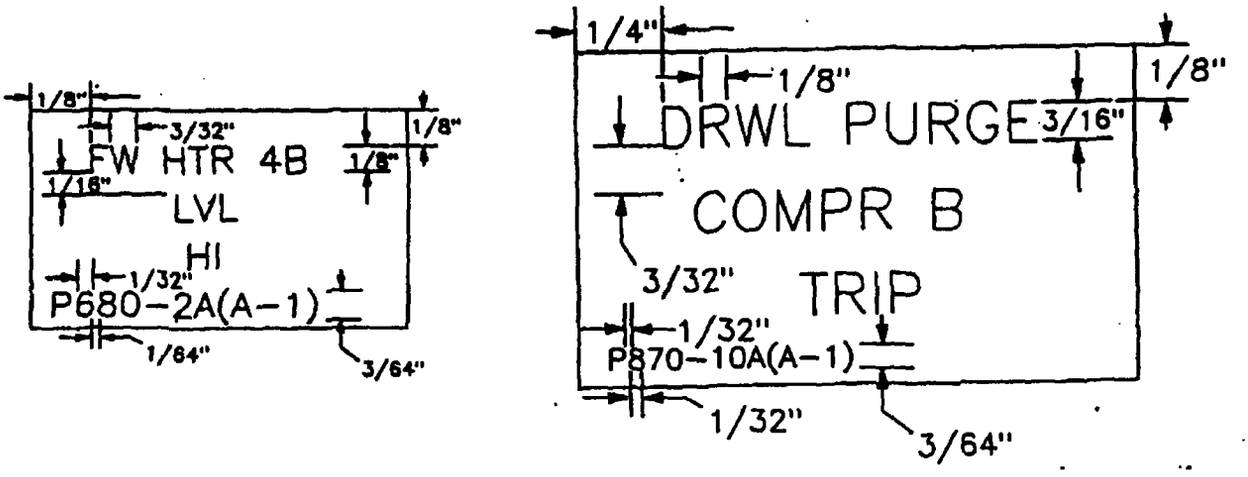
a. Letter height should subtend a minimum visual angle of 15 minutes, or .004 X viewing distance. The preferred visual angle is 20 minutes, or .006 X viewing distance.
b. Type styles should be simple.
c. Type styles should be consistent on all annunciator tiles.
d. Only upper-case type should be used on annunciator tiles.
e. Legends should be engraved, not hand written.
f. Annunciator lettering and spacing should meet the criteria in Table 9.1-1. See the examples in Figure 9.1-2.

TABLE 9.1-1
ANNUNCIATOR LEGEND LETTERING

All Control Room Panels (Except 1H13-P680)
1. Text Character Height: 3/16"
2. Text Character Width: 1/8"
3. Location Character Height: 3/64"
4. Character Width: 1/32"
5. Stroke Width: 1/32"
6. Minimum Distance Between Characters: 1/32"
7. Minimum Distance Between Words: 3/16"
8. Minimum Distance Between Lines: 3/32"

Panel 1H13-P680
1. Text Character Height: 1/8"
2. Text Character Width: 3/32"
3. Location Character Height: 3/64"
4. Location Character Width: 1/32"
5. Stroke Width: 1/64"
6. Minimum Distance Between Characters: 1/64"
7. Minimum Distance Between Words: 1/8"
8. Minimum Distance Between Lines: 1/16"

FIGURE 9.1-2
ANNUNCIATOR LEGEND LETTERING



9.2 ALARMS

9.2.1 When establishing alarm set points:

a. Set points should be established to give operators adequate response time, as required.
b. Set points should not occur so frequently as to be considered a nuisance by operators.
c. When possible, alarms requiring a control room operator to direct an auxiliary operator to perform a local operation should be avoided.
d. General alarms should be used only for conditions that allow adequate time for auxiliary operator action.
e. Inputs from more than one plant parameter set point should be avoided.
f. Where multi-input alarms must be used, an alarm printout capability should be provided, as appropriate to provide information needed by the operator, which could affect plant safety and availability.
g. For critical multi-input annunciator, reflash capability should be provided to allow subsequent alarms to activate the auditory alert mechanism and reflash the visual tile (even if first alarm has not cleared).

9.2.2 For first out alarms:

a. Alarms printed on the BOP Computer Alarm printout should print in the same order which they occurred.
b. In the event of a reactor trip, the trip sequence associated with the event should print out on the Sequence of Event (SOE) printer.

9.2.3 When prioritizing alarms:

a. Base prioritization on a range of importance, severity, or need for operator action in one or more dimensions (e.g., likelihood of reactor trip, release of radiation).
b. Visual signals for the various priority levels should be coded by color or location.

9.2.4 For cleared alarms:

a. A dedicated, distinctive audible bell signal of finite duration should be used.

9.3 AUDITORY SIGNALS

Auditory signals are used to attract operator attention and to present information independent of operator position or head orientation. Discrimination among these types of signals can be accomplished by using different frequencies, intensities, and temporal profiles. Auditory signals should rapidly penetrate the operator's awareness.

9.3.1 For auditory signals (see Table 9.3-1 for center frequency, bandwidth, and volume criteria):

a. Intensity should be such that operators can reliably discern the signal above ambient Control Room noise (10 dBA above ambient).
b. Signal intensity, if adjustable, should be controlled by administrative procedures.
c. The signal should capture the operator's attention but should not cause irritation or a startled reaction.
d. Signals should be adjusted to result in approximately equal detection levels at normal operator work stations in the primary operator area.
e. Auditory alert mechanism should be automatically reset when it has been silenced.
f. Separate auditory signals at each work station within the primary operating area are recommended.

TABLE 9.3-1
AUDIBLE ALARM CODING CRITERIA

PANEL	CENTER FREQUENCY	BANDWIDTH	VOLUME OF ALARMS*
P845 (ARMs)	250 Hz	200-300 Hz	77 dB
P842	450 Hz	400-500 Hz	75 dB
P855, P854	1000 Hz	950-1050 Hz	80 dB P856, P862
P680	1500 Hz	1450-1550 Hz	78 dB
P870	2000 Hz	1950-2050 Hz	75 dB
P601	2500 Hz	2450-2550 Hz	74 dB
P807	3000 Hz	2950-3050 Hz	72 dB

*Assumes Control Room ambient noise environment of 50 dB. Alarms should exceed ambient noise by 10 dB.

9.3.2 When using auditory coding:

a. Coding techniques should be used when the panel associated with the alarm is not in the primary operating area.
b. Coded signals from a single source should not be used to identify individual panels within the primary operating area.

9.4 VISUAL ALARMS

Visual signals (i.e. flashing annunciators) are used to attract operator attention and present distinct information. These alarms can be discriminated by using different flash rates and colors.

9.4.1 For visual alarm recognition:

a. Tiles should use flashing illumination to indicate an alarm condition.
b. Flash rates should be from 3 to 5 flashes per second with approximately equal on and off times.
c. A tile should illuminate and burn steadily in case of flasher failure when in an alarm state.
d. There should be high enough contrast between illuminated and nonilluminated tiles, so that operators can discriminate between these conditions.
e. Avoid tiles which are illuminated under normal operating conditions.

f. If an annunciator tile must be energized for an extended period of time during normal operations it should be controlled by Administrative Procedure. (i.e.identified in shift turnover records).

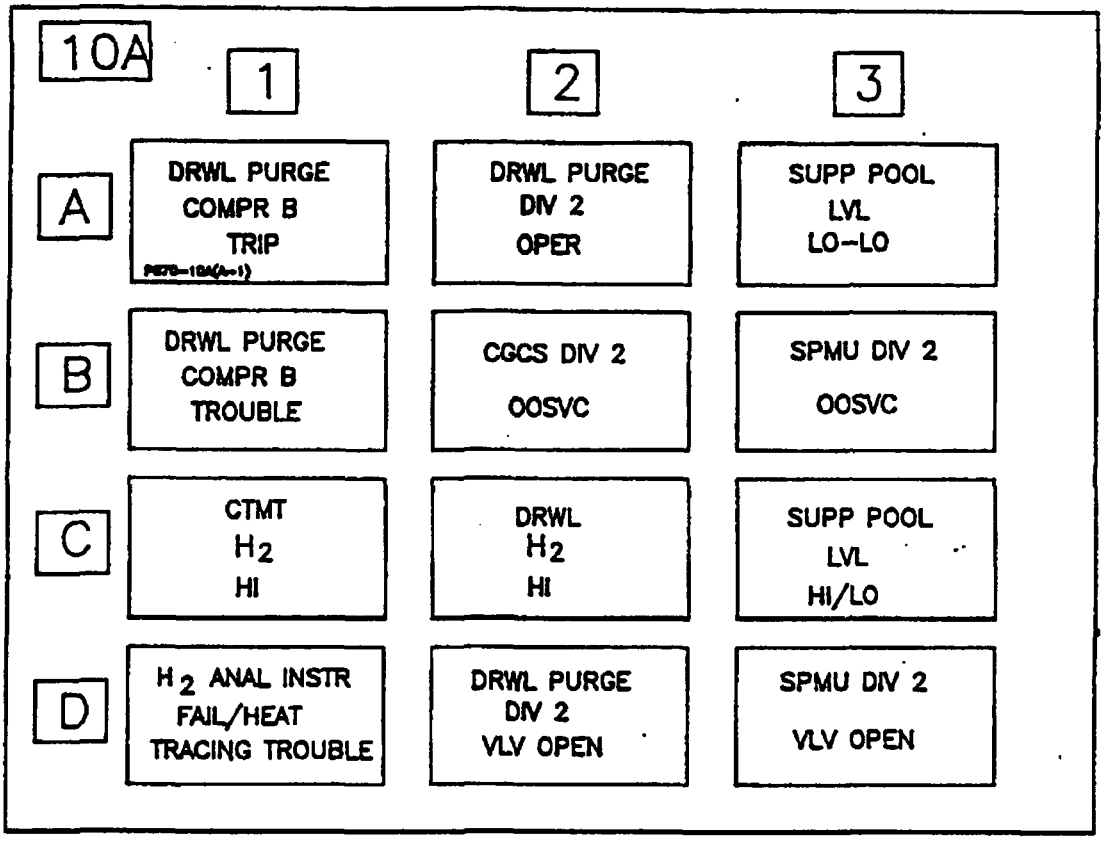
9.4.2 For annunciators on panels:

a. The panels should be located above the related controls and displays that are required for corrective or diagnostic action in response to the alarm, whenever possible.
b. If lamp replacement requires tile removal, there should be a way to ensure that the tile is replaced in the correct location (i.e. Panel Arrangement Drawings) .
c. Lamp replacement should not subject the operator to a shock hazard.
d. Operator aids should be provided if needed for lamp replacement (i.e. Electrical Devices List (EDL)).

9.4.3 When arranging visual alarm tiles:

a. Visual alarm tiles should be grouped by function or system within each annunciator panel.
b. Vertical and horizontal axes of annunciator panels should be labeled with alphanumerics as shown in Figure 9.4-1.
c. Coordinate designation is preferred on the left and top sides of the annunciator panel (See Figure 9.4-1).
d. Letter height for coordinate designation should be consistent with arrangement drawing labeling criteria.
e. If possible, the number of alarm tiles and the matrix density should be kept low (a maximum of 50 tiles per matrix is suggested).
f. Tiles within an annunciator panel matrix should be grouped by subsystem, function, or other logical organization.
g. Blank or unused annunciator tiles should not be illuminated (except during annunciator testing).

FIGURE 9.4-1
ANNUNCIATOR TILE CONFIGURATION



9.4.4 For visual tile legends:

a. Annunciator visual tile legends should be specific and unambiguous. Wording should be in concise, short messages.
b. Alarms that refer the operator to another, more detailed annunciator panel located outside the primary operating area should be minimized.
c. Where possible, avoid tile legends which don't address specific conditions; for example, avoid using one alarm for HIGH-LOW, TEMPERATURE-PRESSURE.
d. Abbreviations and acronyms should be used whenever possible, and should be consistent with those listed in Appendix A.
e. Legends should be color coded according to the conventions in Table 9.4-2.

TABLE 4.6-5
ANNUNCIATOR/VISUAL ALARM COLOR CODING CRITERIA

COLOR	MEANING
Red with black letters	Requires immediate response for any condition which may lead to a hazard to plant or public safety, such as a reactor scram signal/condition, ECCS/ESF initiation, isolation, or component trip.
Amber with black letters	Requires immediate response for any condition, which if not corrected, may lead to a reactor scram signal/condition, ECCS/ESF initiation, isolation, or component trip.
White with black letters	Conveys a system/component abnormal condition or trouble.
Light blue with black letters	Conveys a logic permissive condition or system status such as manual override, manual initiation armed, switches in test, etc...

9.5 ANNUNCIATOR RESPONSE CONTROLS

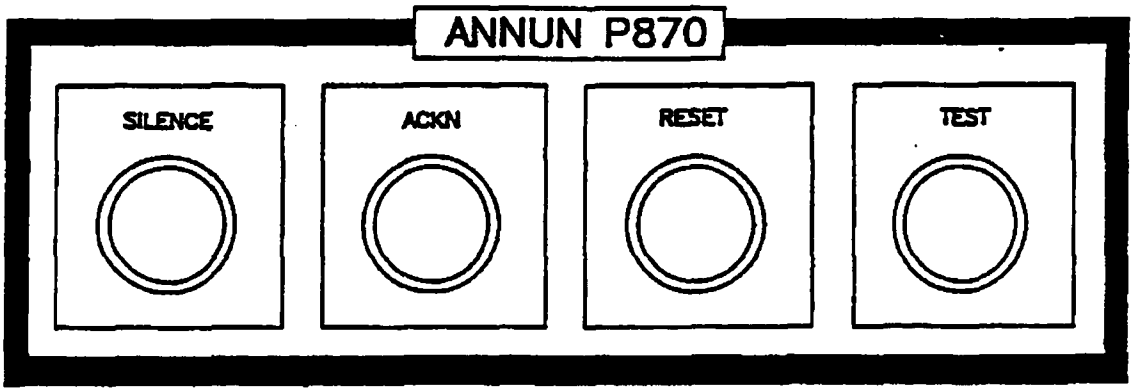
9.5.1 For annunciator response controls:

a. Each set of operator response controls should include a silence control.
b. A control should be provided to terminate the flashing of a visual tile and have it continue at steady illumination until the alarm is cleared.
c. Acknowledgement should be possible only at the work station where the alarm originated.
d. If an automatic cleared alarm feature is not provided, a control should be provided to reset the system after an alarm has cleared.
e. The reset control should silence any audible signal (indicating clearance) and should extinguish the illumination.
f. The reset control should be effective only at the work station for the annunciator panel where the alarm initiated.
g. A control to test the auditory signal and flashing illumination of all tiles in a panel should be provided.
h. Periodic testing of annunciators should be required and controlled by administrative procedure.
i. Repetitive groups of annunciator controls should have the same arrangement and relative location at different work stations (i.e. Silence, Acknowledge, Reset, Test). This is to facilitate "blind" reaching (see Figure 9.5-1).

j. Controls should be coded for easy recognition using techniques such as one of the following:

1. Color coding.
2. Color shading the group of annunciator controls.
3. Demarcation of the group of annunciator controls.
4. Shape coding, particularly the silence control. Control designs should not allow the operator to defeat the control. For example, some pushbuttons used for annunciator silence and acknowledgement can be held down by inserting a coin in the ring around the pushbutton. This undesirable design feature should not be used.

FIGURE 4.6-6
ANNUNCIATOR CONTROL ARRANGEMENT

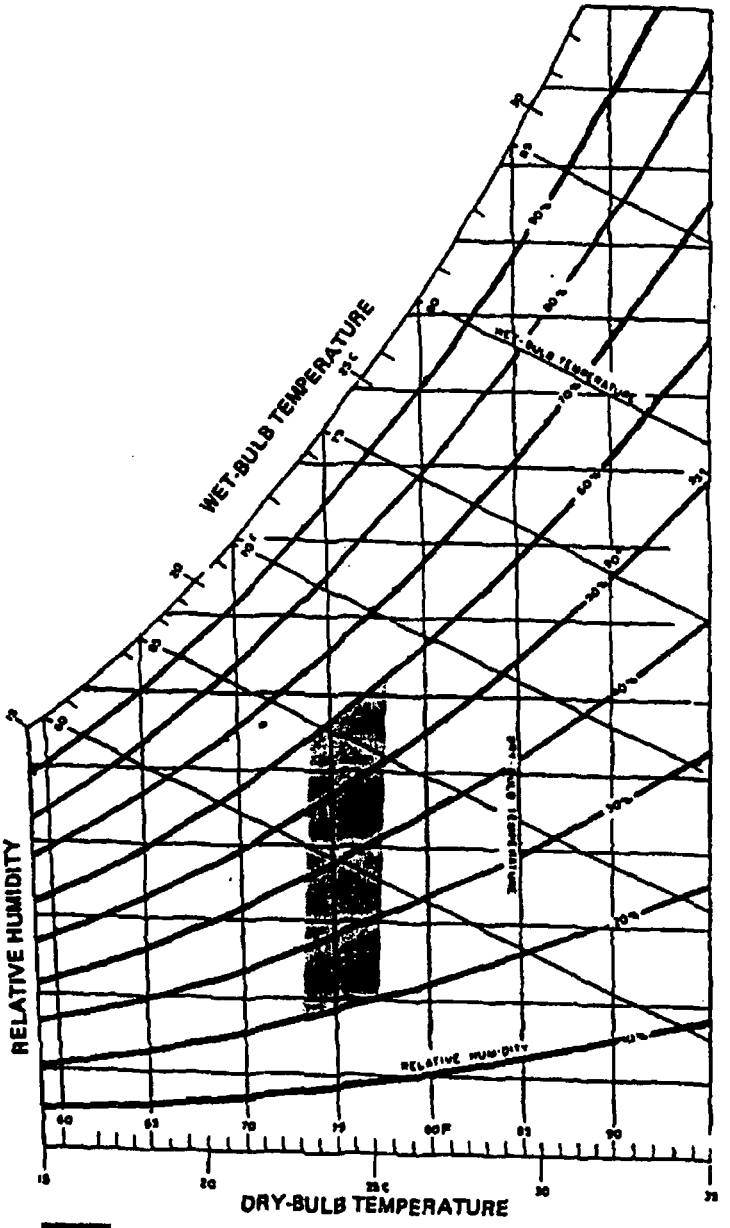


10.0 ENVIRONMENT

10.1 CLIMATE

10.1.1 During normal plant operations Control room temperatures should be maintained within the ASHRAE "Comfort Zone" shown in Figure 10.1-1.

FIGURE 10.1-1
CONTROL ROOM WORKSPACE ENVIRONMENT



10.1.2 Air temperature at floor level and a head level should not differ more than 10F.

10.1.3 Air velocities in the primary operating area should not exceed 45 feet per minute (fpm) measured at operator head level and should not produce a noticeable draft.

10.2 LIGHTING

10.2.1 The illumination levels, in footcandles, shown in Table 10.2-1 are recommended:

TABLE 10.2-1
RECOMMENDED ILLUMINATION LEVELS

WORK AREA OR TYPE OF WORK	TASK ILLUMINANCE (IN FOOTCANDLES)		
	MIN	RECOMMENDED	MAX
Panels, primary operating area	20	30	50
Auxiliary panels	20	30	50
Scale indicator reading	20	30	50
Seated operator stations	50	75	100
Reading:			
Handwritten (pencil)	50	75	100.
Printed or typed	20	30	50
Writing and data recording	50	75	100
Maintenance and wiring areas	20	30	50
Emergency operating lighting	10	As Above for area/task	

(Source: Illuminating Engineering Society of North America, IES Lighting Handbook, 1981 Application Volume).

10.2.2 The level of illumination should not vary greatly over a given workstation.

10.2.3 Ensure supplemental lighting for personnel performing specialized visual tasks is available in areas where fixed lighting is not adequate (i.e. Flashlights, Lamps etc...).

10.2.4 Avoid illumination that will cause shadows and glare.

10.2.5 Do not exceed the task area luminance ratios listed in Table 10.2.2. The task area luminance ratio is the ratio between the level of lighting at the area the task will be completed versus the lighting level of the surrounding area.

TABLE 10.2-2
RECOMMENDED TASK AREA LUMINANCE RATIOS

AREAS	LUMINANCE RATIO
Task area versus adjacent darker surroundings	3:1
Task area versus adjacent lighter surroundings	1:3
Task area versus more remote darker surfaces	10:1
Task area versus more remote lighter surfaces	1:10
Luminaries versus surfaces adjacent to them	20:1
Anywhere with in normal field of view	40:1

10.2.6 Reflectance levels (measured in foot-lamberts) should conform to the guidelines in Tables 10.2.3 and 10.2.4.

TABLE 10.2-3
RECOMMENDED WORKPLACE REFLECTANCE LEVELS

SURFACE	REFLECTANCE PREFERRED	REFLECTANCE PERMISSIBLE
* Ceiling	80%	60-95%
Upper Wall	50%	40-60%
Lower Wall	15-20%	
Instruments/Displays	80-100%	
Cabinet/Consoles	20-40%	
Floor	30%	15-30%
Furniture	35%	25-45%

* Recommended reflectances are for finish only. Over-all average reflectance of acoustic materials may be somewhat lower. The upper walls (one to two feet below the ceiling) may be painted with the same paint as is used on the ceiling.

TABLE 10.2-4
RECOMMENDED SURFACE COLOR REFLECTANCE LEVELS

COLOR	REFLECTANCE
White	85
Light:	
Cream	75
Gray	75
Yellow	75
Buff	70
Green	65
Blue	55
Medium:	
Yellow	65
Buff	63
Gray	55
Green	52
Blue	35
Dark:	
Gray	30
Red	13
Brown	10
Blue	8
Green	7
Wood Finish:	
Maple	42
Stainwood	34
English Oak	17
Walnut	16
Mahogany	17

10.2.7 Surface colors should be recognizable under both normal and emergency conditions.

10.2.8 Emergency lighting is an alternate system that should automatically activate upon failure of the lighting in the control room. It should be independent of other plant lighting systems, and should meet the following guidelines:

a. Activate automatically and immediately upon failure of the normal Control Room lighting system.
b. Failure of the normal Control Room lighting system should not degrade operability of the emergency lighting system.
c. Emergency illumination should provide a minimum of 10 footcandles at all work stations in the primary operating area.

10.3 AUDITORY ENVIRONMENT

10.3.1 The auditory environment of the Control Room should adhere to the following standards:

a. Background noise should not impair verbal communications between any two points in the primary operating area.
b. Background noise levels should not exceed 65 dB(A).
c. Further reductions in background noise, or addition of sound powered phone jack stations, may be required where communications between the primary operating area and other Control Room locations are necessary and no sound powered phone jack stations are available.
d. Minimize noise distractions generated inside or outside the Control Room.
e. The acoustical treatment of the Control Room should limit reverberation time to one second or less.

10.4 DECOR

10.4.1 The following features of the decor in the Control Room and break/eating facilities should be considered:

a. Color coordination.
b. Use of color and lighting to create a cheerful atmosphere.
c. Visual relief from arrays of instrumentation.
d. Comfortable seating.
e. Carpeting/padded flooring (durability).

11.0 Appendices

11.1 Appendix A - Standard Abbreviations and Acronyms.

ES-17

APPENDIX A

"STANDARD ABBREVIATIONS AND ACRONYMS"

ES 17 APPENDIX - A

REVISION STATUS SHEET

PAGE REVISION STATUS

PAGE	REVISION	PAGE	REVISION
A-1	2	A-7	0
A-2	2	A-8	2
A-3	2	A-9	0
A-4	1	A-10	0
A-5	1	A-11	0
A-6	1	A-12	0

APPENDIX A. STANDARD ABBREVIATIONS AND ACRONYMS

ABBREVIATION	MEANING
ABS	absolute
ABV	above
A/C	Air Conditioning
ACCUM	accumulator
ACKN	acknowledge
ACT	active/activated
ADHRS	Alternate Decay Heat Removal System
ADJ	Adjustment
ADS	Automatic Depressurization System
AFT	after
AFTCLR	aftercooler
AH UNIT	Air Handling Unit
AIRB	airborne
ALM	alarm
ALT	alternate
AMPL	amplifier
ANAL	analyzer
ANNUN	annunciator
APRM	Average Power Range Monitor
ARI	Alternate Rod Insertion
ASSOC	associated
ATWS	Anticipated Transient Without Scram
AUTO	automatic
AUX	auxiliary
AVAIL	available
AVG	average
BAL	balance
BCV	Bypass Control Valve
BKW	backwash
BLDG	building
BLU	blue
BLW	below
BLWDN	blowdown
BOIL	boiler
BOP	Balance of Plant
BOT	bottom
BPC	Bypass Control
BRG	bearing
BRKR	breaker
BSCV	Bypass Stop and Control Valve

APPENDIX A
(Continued)

ABBREVIATION	MEANING
BST	booster
BTFL	butterfly
BTRY	battery
BTV	Bleeder Trip Valve
BYP	bypass
CAB	cabinet
CAL	calibration/calibrate
CAV	cavity
CCW	Component Cooling Water
CF	Control Fluid (*same as EHC)
CFM	Cubic Feet per Minute
CGCS	Combustible Gas Control System
CHAN	channel
CHAR	charcoal
CHEM	chemical
CHEMWST	chemical waste
CHG	change
CHILL	chiller
CHK	check
CHLD	chilled
CHLOR	chlorination/chlorine
CHRG	charger/charging
CIRC	circulating/circulation
CKT	circuit
CLG	cooling
CLNR	cleaner
CLOSE	closed/closure
CLR	cooler
CMPTR	computer
CNDCT	conductivity
CNDS	condensate
CNDSR	condenser
COLL	collecting
COMB	combined
COMPR	compressor
CONC	concentration
COND	conditioner/condition
CONF	confirmed
CONN	connection
CONT	control
CONTR	controller
CONV	converter
CO_2	carbon dioxide
COOL	coolant
CPLG	coupling
CRD	Control Rod Drive
CRT	Cathode Ray Tube
CSG	casing

APPENDIX A
(Continued)

ABBREVIATION	MEANING	
CST	Condensate Storage Tank	
CTCS	Condenser Tube Cleaning System	| SCN 03/0002
CTMT	containment	
CTR	center	
CU	Clean Up	
CUR	current	
CV	Control Valve	
CW	Cooling Water	
d	differential	
dP	Differential Pressure	
dT	Differential Temperature	
DD	Diesel Driven	
DE	Diesel Engine	
DEG	degrees	
DESIC	desiccation	
DET	detected/detection	
DEV	deviation	
DEWPT	dew point	
DFCS	Digital Feedwater Control System	| SCN 95/0001
DG	Diesel Generator	
DGTL	digital	
DIAPH	diaphragm	
DIFF	difference	
DISC	disconnect	
DISCH	discharge	
DIV	division	
DMIN	demineralizer	
DMPR	damper	
DNSC	downscale	
DOM	domestic	
DR	drain	
DRTR	deaerator	
DRWL	drywell	
DRYR	dryer	
DSL	diesel	
DVC	device	
DWCW	Drywell Chilled Water	| SCN 03/0002
Depressr	depressurization	
E	east	
ECC	eccentricity	
EFL	effluent	| SCN 99/0001
EHC	Electro-Hydraulic Control	
ELEC	electric/electrical	
EMERG	emergency	
ENCL	enclosure	
ENG	engine	
ENT	enter	
EQUIP	equipment	
ESF	Engineered Safety Feature	

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ABBREVIATION	MEANING
EVAL	evaluation
EVAP	evaporator
EXH	exhaust
EXP	expansion
EXTR	extraction
F	Fahrenheit
FAIL	failure
FCV	Flow Control Valve
FDR	feeder
FH	Fuel Handling
FL	front left
FLO	flow
FLR	floor
FLTR	filter
FM	from
FO	Fully Open
FP	Fuel Pool
FPC	Fuel Pool Cooling
FPCC	Fuel Pool Cooling and Cleanup
FR	front right, front
FT	foot / feet
FUNC	function / functional
FW	feedwater
GD	guard
GEN	generator
GL	gland
GND	ground
GOV	governor
GR	gross
G-R	green-red (status light lamacoids) | SCN 03/0001
GRAD	gradient
GRN	green
HD	head
HDR	header
HEPA	High Efficiency Particulate Air
HI	high
HP	High Pressure
HPCS	High Pressure Core Spray
HPU	Hydraulic Power Unit
HTG	heating
HTR	heater
HTWL	hotwell
HVAC	Heating, Ventilation, Air Conditioning
HX	Heat Exchanger
HYD	hydraulic
HCU	Hydraulic Control Unit
HWC	Hydrogen Water Chemistry | SCN 98/0001

APPENDIX A
(Continued)

ABBREVIATION	MEANING
HYPCHL	hyperchloride/hyperchlorinated
H_2	Hydrogen
ICNDSR	intercondenser
INACT	inactive
INBD	inboard
INC	incomplete
INCM	incoming
INDIC	indicator
INDIV	individual
INFL	influent
INFO	information
INIT	initiate/initiated/initial
INJ	injection
INL	inlet
INOP	inoperable/inoperative
INPT	input
INSTR	instrument/instrumentation
INTK	intake
INTLK	interlock
INTRPT	interrupt
INVRTR	inverter
IP	Intermediate Pressure
IRM	Intermediate Range Monitor
ISOL	isolation/isolator
JT	joint
KV	kilovolt
L	Left, lube
LC	Load Center
LCS	Leakage Control System
LDS	Leak Detection System
LEAK	leakage
LFMG	Low Frequency Motor Generator
LIQ	liquid
LO	low
LOSCNT	loss of continuity
LP	Low Pressure
LPCS	Low Pressure Core Spray
LPRM	Local Power Range Monitor
LPSV	Low Pressure Stop Valve
LS	Left Side
LSS	Load Sequencing and Shedding
LTD	limited
LUBE	lubrication
LVL	level

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APPENDIX A
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ABBREVIATION	MEANING
M/A	manual - automatic
MAINT	maintenance
MAN	manual
MAX	maximum
MCC	Motor Control Center
MD	Motor Driven
MECH	mechanical
MG	Motor Generator
MIN	minimum
MN	main
MOIST	moisture
MON	monitor
MOV	Motor Operated Valve
MSCV	Main Stop and Control Valve
MSIV	Main Steam Isolation Valve
MSL	Main Steam Line
MSR	Moisture Separator Reheater
MSV	Main Stop Valve
MTR	motor
MU	Make-Up
N	north
N_2	Nitrogen
NEG	negative
NORM	normal
NSSSS	Nuclear Steam Supply Shutoff System
O_2	Oxygen
O/A	outside air
OG	Off Gas
OOF	out of file
OOSVC	out of service
OPER	operating/in operation
OTBD	outboard
OTPT	output
OUTL	outlet
OVERCUR	overcurrent
OVERLD	overload
OVERRD	override
OVERSP	overspeed
PART	particulate
PB	pushbutton
PC	Precoat
PCW	Primary Chilled Water
PDISCH	pressure discharge
PDM	pressure differential monitor
PENETR	penetration

PBDS ← PB
PC → PERIOD BASED DETECTION SYSTEM

APPENDIX A
(Continued)

ABBREVIATION	MEANING
PERM	permit/permissive
PERS	personnel
PH	phase
pH	pH
PMP	pump
PMPHS	pumphouse
PNL	panel
POS	position
POT	potential
PREHTR	preheater
PREP	prepare/preparation
PRESS	pressure
PRI	primary
PRL	parallel
PROC	process/procedure
PROD	product
PROT	protective/protection
PSW	Plant Service Water
PT	point
PW	Primary Water
PWR	power
PWRLOSS	loss of power
R	right
RAD	radiation/radioactivity
RADWST	radioactive waste
RCDR	recorder
RCIC	Reactor Core Isolation Cooling
RCV	receiving
RCVR	receiver
RDL	radial
RE	rear
REC	record
RECIRC	recirculating/recirculation
RECOMB	recombiner
REDUC	reduction
REDUN	redundant
REF	reference
REFRIG	refrigeration
REFUEL	refueling
REG	regulator/regulation
REGEN	regenerative
REM	removal
RESVR	reservoir
REV	reverse
RFP	Reactor Feed Pump

APPENDIX A
(Continued)

ABBREVIATION	MEANING
RFPT	Reactor Feed Pump Turbine
RHR	Residual Heat Removal
RHTR	reheater
RL	Rear Left
RLF	relief
RM	room
RMT	remote
RPS	Reactor Protection System
RPT	Recirc Pump Trip
RR	Rear Right
RS	Right Side
RTN	return
RWCU	Reactor Water Cleanup
RX	reactor
S	South
SANI	sanitary
SCV	Stop and Control Valve
SEC	secondary
SEL	select/selector
SENS	sensor
SEP	separator
SEQ	sequence
SFGD	safeguard
SGTS	Standby Gas Treatment System
SHUTDN	shutdown
SIG	signal
SJAE	Steam Jet Air Ejector
SLC	Standby Liquid Control
SMP	sump
SMPL	sample
SOL	solenoid
SP	speed
SPCU	Suppression Pool Cleanup
SPLY	supply
SPMU	Suppression Pool Makeup
SPR	spray
SQRT	square root
SRM	Source Range Monitor
SRV	Safety Relief Valve
SS	Seal Steam
SSBV	Seal Steam Bypass Valve
SSC	Seal Steam Control
SSCV	Seal Steam Control Valve
SSS	Seal Steam Supply
SSW	Standby Service Water
STA	station

SETPT → SETPOINT

APPENDIX A
(Continued)

ABBREVIATION	MEANING
STBY	standby
STG	stage/staging
STM	steam
STOR	storage
SU	Start Up
SUBLP	subloop
SUBST	substitute
SUCT	suction
SUM	summer
SUPP	suppression
SUPV	supervisory
SV	Stop Valve
SVC	service
SW	Service Water
SWGR	switchgear
SWYD	switchyard
SYNC	synchronized
SYS	system
TBCW	Turbine Building Cooling Water
TEMP	temperature
TERM	terminal
THR	thrust
THROT	throttle
TK	tank
TNL	tunnel
TOT	total
TRBY	turbidity
TREAT	treatment
TSE	Turbine Stress Evaluator
TURB	turbine
TURN	turning
TVR	Thyristor Voltage Regulator
TWR	tower
UNDERFREQ	underfrequency
UNDERVOLT	undervoltage
UPSC	upscale
V	volt
VAC	vacuum
VAC/VDC	volts AC/volts DC
VENT	vent/ventilation
VIBR	vibration
VLV	valve
VM	Volt Meter
VOL	volume

APPENDIX A
(Continued)

ABBREVIATION	MEANING
VOLT	voltage
VOLTLOSS	loss of voltage
VR	Voltage Regulator
VSL	vessel
W	west
WC	Water Column
WR	wear
WST	waste
WTR	water
X	exchanger
XFER	transfer
XFMR	transformer
XOVER	crossover
XTIE	cross tie