THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC.

POWER ENGINEERING SOCIETY

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February 11, 1980

SUBJECT: IEEE/Nuclear Power Engineering Committee (NPEC)
Subcommittee SC-1, Working Group SC-1.2,
Control Room Criteria

TO: Mr. R. B. Minogue
Director of NRC Office of Standards Development
U.S. Nuclear Regulatory Commission
Washington, DC 20555

You or your representative are invited to attend the initial meeting of the subject recently reorganized IEEE/NPEC working group on February 20, 1980. The meeting will be held at Sargent & Lundy offices, 55 East Monroe, Chicago, Illinois, 60603 (in the 26th floor conference room - 26018) and will convene at 9:00 a.m. Please plan on attending a full-day session.

The following is a partial listing of the items that will be addressed at the meeting:

1. General discussion of the working group's organizational relationship within the IEEE and the scope of the working group's activities leading to the preparation of a revision to IEEE Std. 566 (1977).

2. Establishment of a preliminary schedule for working group meetings through the end of 1980.

3. Preparation of a draft project charter, for the revision to IEEE Std. 566 (1977) to be submitted to the IEEE/NPEC Administrative Committee for approval at their March 4, 1980, meeting.

Should you have any questions or require additional informatic please contact Mr. D. J. Cardinale who is the S&L representati on the working group, acting as coordinator for this initial meeting. His telephone number is (312/269-6930)

I request that you confirm your attendance to him by February 15, 1980.

Expected Attendance
Organizational Meeting - 2/20/1980
IEEE PES/NPEC SC-1, C. M. Chiappetta - Chairman
Working Group 1.2

Organization	Attendees	
Southern California Edison P. O. Box 800 Rosemead, CA 91770	Thomas White (213) 572-3405	
Commonwealth Edison Company P. O. Box 767 Chicago, IL 60690	R. L. Squires (312) 294-8563	
Duke Power Company P. O. Box 33189 Charlotte, NC 28242	R. S. Darke (704)-373-4401	
United Engineers & Constructors, Inc. P. O. Box 8223 Philadelphia, PA 19101	John Kinginger (215) 422-3820	
Stone & Webster Engineering Corp. P. O. Box 2325 Boston, MA 02107	Larry Bright (617) 973-5332	
Bechtel Power Corp. P. O. Box 3965 San Francisco, CA 94119	Larry Johnson (415) 768-0797	(Cannot Attend the 2/20 Mtg)
General Electric Company 175 Curtner Ave. MC013 San Jose, CA 95125	Dave Riegel (408) 925-3094	
Westinghouse NES P. O. Box 355 Pittsburgh, PA 15230	Gar Lilly D. C. Richardson	(Will Attend Mtg.) (Will be on Working Group)
Combustion Engineering 1000 Prospect Hill Road Windsor, CT 06095	G. Grant (203) 688-1911 Tom Gates	(Will be on Working Group) (Will Attend Mtg.)
Electrical Power Research Institute P. O. Box 10412 Palo Alto, CA 94303	John O'Brien H. L. Parris (Jack)	(Member) (Will attend Meeting)
Atomic Industrial Forum 7101 Wisconsin Avenue Washington, DC 20014		
NRC Office of Standards Development U. S. Nuclear Regulatory Commission Washington, DC 20555	Don Sullivan (Attended part of Meeting)	
Detroit Edison 2000 Second Avenue Detroit, MI 48226	No Attendee	

Organization	Attendees
General Public Utilities 100 Interpace Parkway Punchbowl Road Parsippany, NJ 07045	R. J. Chisholm (201) 334-7888
Babcock & Wilcox Co. P. O. Box 1260 Lynchburg, VA 24505	John A. Castanes
Ebasco Services	John Nicosia (212) 785-5035
Gilbert Associates	W. J. Kerchner (Will not Attend Mtg) (215) 376-3837
Sargent & Lundy Engineers 55 East Monroe Chicago, Illinois 60603	D. J. Cardinale (312) 269-6930

ORGANIZATIONAL MEETING - 2/20/80
IEEE PES/NPEC SC-1, C. M. Chiappetta - Chairman
Working Group 1.2

Scope & Purpose

(1) Question #1 How much specificity in the listing of specific displays (parameters), and controls in the main control room (MCR).

Choice 1A Do not address the question of what displays and controls should be available in the MCR. Leave it to ANS 4.6

Choice 1B Provide criteria for selection of specific displays and controls.

Choice 1C Provide lists of specific parameters for display and control in the MCR (as in RG-1.97 Proposed Rev. 2)

(2) Question #2 Principles of Human Engineering.

Choice 2A Address questions of Human Engineering which impact on the MCR and MCB design.

Choice 2B Restrict standard to address question of hardware design and system design.

(3) Question #3 Question of Instrument Ranges.

Choice 3A Address questions of instrument ranges upon the operator-machine interface.

Choice 3B Delegate instrument range questions to the RG-1.97.

Discussion in this area: Imposition of expanded ranges introduces substantial problems in the: Human engineering layout of the MCB in that multiple instruments may be required for individual parameters: acreage of MCB required for display devices.

(4) Question #4 Conventional control room designs vs. advanced control room designs.

Choice 4A Prepare the standard to be equally applicable to both designs.

Choice 4B — Prepare standard for applicability principally to conventional design since the bulk of existing control rooms are of this design.

Choice 4C — Prepare the standard to be primarily applicable to advanced control room designs on the basis that this approach can handle more data and is more amenable to prioritizing the displays.

(5) Question #5 — Operating and Emergency Procedures. What should be the role of the standard in this area?

Choice 5A — (Least Involved) Recognition of the interface between MCR design and procedure/checklist design. Remind the designer to iterate his design with operating/emergency procedure review.

Choice 5B — (More involved) Preparation of criteria and specific guidance on reviewing the interface between procedures and physical MCB design.

Choice 5C — (Most Involved) Requirements to include interface review before MCB designs are finalized.

(6) Question #6 — Main Control Room design basis document. This requirement is presently in 566.

Choice 6A — Retain and expand the requirement.

Choice 6B — Delete the requirement from Std. 566.

ORGANIZATIONAL MEETING - 2/20/1980
Liaison Activities for Working Group 1.2

Power Generation Committee - Control Room Activities Working Group

Liaison: W. J. Kerchner (Bill)
Gilbert Associates
525 Lancaster Avenue
Reading, Pennsylvania 19603

(215) 376-3873

Atomic Industrial Forum - Control Room Considerations Subcommittee

Liaison: Temporary D. J. Cardinale

PES/NPEC SC-6 Safety Related Systems

Liaison: Open

ANS 4.6 Functional Criteria for On Line Monitoring For Light Water Reactors.

Liaison: G. Grant
Combustion Engineering Company

IEEE

Standards Project Authorization

1. _____ Date of Request

Project No

Approved: _____ Date

For Standards Committee Use Only

2. [ ] New Standard
   [ ] Revision of _____ Standard No
   [ ] Reaffirmation of _____
   [ ] Withdrawal of _____ Standard No

3. Project Title:

4. Scope and Purpose of Proposed Standard:

5. Sponsor:
   _____ Technical Committee
   _____ Society

5a. Proposed ANSI Committee:

ANSI Project #: _____
Date Approved: _____

6. Proposed Coordination:

Method of Coordination:

7. Name of Group that will Write the Standard:
   _____ Subcommittee
   _____ Working Group

8. Estimated Final Ballot Date:
   _____ To Technical Committee
   _____ To Standards Board

9. Person Delegated to Receive Communications and Conduct Liaison with Interested Bodies:
   _____ Name
   _____ Company
   _____ Street address
   _____ City State Zip Code Telephone

10. Submitted by:
    _____ Name
    _____ Company
    _____ Street address
    _____ City State Zip Code Telephone

Form SF1-1A-1978

NSMB PCB 31

Date 1979-12-31

NUCLEAR STANDARD PROJECT CHARTER

TI : Functional Criteria for On-Line Monitoring in LWR's, ANS-4.6

SCOPE:

This standard defines the criteria for on-line monitoring for nuclear power generating stations and the functional requirements for use of this data in monitoring important plant parameters and performing advisory functions for the operator. The standard includes requirements for verification of monitored parameters.

SPONSOR: ORGANIZATION American Nuclear Society
COMMITTEE: ANS-4.6 (NUPPSCO)

END USE OF STANDARD:
JUSTIFICATION:
This standard provides criteria for plant designers and operators to determine which parameters should be monitored in the control room (and elsewhere), and the frequency of monitoring, for all plant conditions. The standard also provides criteria on the extent and methods for use of a computer or other device in providing diagnostic and advisory aid to operators.

PRIORITY STATEMENT: ANS Category I
NSMB Category A

COORDINATION AND INTERFACES ANS-3, ANS-51, ANS-52; IEEE 566-1977; IEEE SC-6; Instrument Society of America; Health Physics Society

PROPOSED SCHEDULE (MUST BE COMPLETED FOR CATEGORY A PROJECTS)

Initiation date: September 1979
Charter approval date: November 1979
Release of first draft by Working Group:
Consensus body approval date:
ANSI/BSR approval date:
} To be established

WORKING GROUP CHAIRMAN: W. J. Harris, Combustion Engineering, Inc.

AFFILIATIONS OF WORKING GROUP MEMBERS: Specific affiliations to be established, but will be drawn from:

NSSS Designers
Utilities
A/E's
U.S. Nuclear Regulatory Commission
National laboratories
Consultants

STAFF ONLY

: Planning Committee approval DATE: NSMB Approval

July 12, 1974

PROJECT NO: 566

For Standards Committee Use Only

SC1

IEEE STANDARDS PROJECT AUTHORIZATION REQUEST

2. Sponsor:

Technical Committee: Nuclear Power Engineering Committee

Group/Society: Power ~~Energy Systems~~ Engineering Society

3. Project Title: Guide for the Design of Display and Control Facilities for Central Control Rooms of Nuclear Power Generating Stations

4. Scope and Purpose of Proposed Standard: This document establishes guidance to Control room designers on what information shall be made available to the operator, in what fashion and where it shall be located, so that the operator can most reliably interpret the information and take the proper course of action. Purpose This document is intended to ensure a design which minimizes potential for operator error and adequately enables operating personnel to meet their responsibilities* under all modes of operation.

5. [x] New Standard [ ] Revision of IEEE Std _____ (Number)

6. Proposed Coordination: ANSI N 41

Method of Coordination: via J. T. Boettger

7. Estimated Schedule: Document to be balloted in NPEC Summer 1975

8. Person delegated to receive communications and conduct liaison with interested bodies:

J. T. Boettger
Name

Public Service Electric & Gas Co.,

80, Park Place
Street Address

Newark, New Jersey 07101
City State Zip Code

9. Name of working group that will write the standard:

Nuclear Power Engineering Committee Sub Committee 1.0 Working Group 2

10. Submitted By:

A. J. Spurgin, Chairman of SC1.2
Name

General Atomic Company

P.O. Box 81608
Street Address

San Diego, California 92138
City State Zip Code

IEEE Recommended Practice for the Design of Display and Control Facilities for Central Control Rooms of Nuclear Power Generating Stations

1. Scope

This document establishes guidelines to be used by power plant system designers in selecting information and control devices to be made available in the central control room, and in determining how and where they shall be made available so that they can most reliably and quickly be used by the operator. The guide addresses the functional requirements of the information systems, controls, and displays, but not the selection of specific devices or equipment. It does not apply to the physical design of the control room enclosure or structures mounted therein.

2. Purpose

To provide uniform guidelines for the functional selection, coordination, and organization of control and information systems in a nuclear power plant central control room.

3. References

The reference section is divided into two parts. The first contains the references mentioned in this document, and the second contains a set of related references to which reference is not made.

3.1 Specific to Document.

[1] IEEE Std 27[illegible]-1971 (ANSI N42.7-1972), Criteria for Protection Systems for Nuclear [illegible]ng Stations.

[2] IEEE Std 308-1974, Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations.

3.2 Other References.

[3] Code of Federal Regulations, Title 10, Part 50.

[4] General Design Criteria (Appendix A); Criterion 13, Instrumentation and Controls; Criterion 19, Control Room.

IEEE Standards and Guides:

[5] IEEE Std 336-1971 (ANSI N45.2.4-1972), Installation, Inspection, and Testing Requirements for Instrumentation and Electric Equipment During the Construction of Nuclear Power Generating Stations.

[6] IEEE Std 338-1975, Trial-Use Criteria for Periodic Testing of Nuclear Power Generating Station Class 1E Power and Protection Systems.

[7] IEEE Std 384-1974 (ANSI N14.14), Trial-Use Standard Criteria for Separation of Class 1E Equipment and Circuits.

[8] IEEE Std 420-1973, Trial-Use Guide for Class 1E Control Switchboards for Nuclear Power Generating Stations.

4. Definitions

4.1 accessibility. Relates to the accessibility of information to the operator on a "continuous," "sequenced," or "as called for" basis.

4.2 central control room. A continuously manned and protected enclosure from which actions are normally taken to operate the nuclear generating station under normal and abnormal conditions.

4.3 displays. Devices which convey information to the operator.

4.4 emergency operations area(s). Functional area(s) allocated for the displays used to assess the status of safety systems and the controls for manual operations required during emergency situations.

4.5 functional area(s). Location(s) designated within the control room to which displays and controls relating to specific function(s) are assigned.

4.6 information. Data describing the status and performance of the plant.

4.7 normal operations area. A functional area allocated for those displays and controls necessary for the tasks routinely performed during plant startup, shutdown, and power operation modes.

4.8 operating modes. The nuclear power plant modes as defined by the technical specifications for the plant.

4.9 operator. A person licensed to operate the plant.

4.10 supporting operations area(s). Functional area(s) allocated for controls and displays which support plant operation.

4.11 sensory saturation. The impairment of effective operator response to an event due to excessive amount of display information which must be evaluated prior to taking action.

5. Design Bases

5.1 General. The design bases for the control and display facilities in the control room should be established and documented, before beginning the detailed control room design, and updated as needed.

5.2 Contents. The design bases should include but not be limited to the following items:

5.2.1 The operating modes for which the central control room display and control facilities should be designed.

5.2.2 The number of operators and the responsibilities assigned to them under each operating mode.

5.2.3 The functional areas into which the control room is to be organized. These may include the normal, emergency, and supporting operations areas.

NOTE: These functional areas need not be physically separate.

5.2.4 The basis for grouping of display and control devices within any functional area. (See Section 6.)

5.2.5 The limiting number of display devices which can be active at the same time, by type, established as a design goal for each functional area of the control room to avoid operator sensory saturation. (See Appendix B.)

5.2.6 A listing and classification of the safety related display and control instrumentation and any post accident monitoring instrument for which specific requirements are already established by regulatory requirements, industry standards, or safety analysis reports. (See Ref [1], [2].)

5.2.7 The requirements which are mandated by, or directed by, user company policies or contracts or both.

5.2.8 The anthropometric relationship to be used for design of the control boards.

5.2.9 The list of functions, the controls for which may be transferred from the central control room facilities to remote facilities.

5.2.10 The sequence of events for the postulated design basis events.

5.2.11 Data to be used for trend and historical record purposes.

6. Usage Analysis

The designer should establish and document a systematic method for the assignment of types and locations of the controls and displays. This method should include:

6.1 An identification of each function by its usage characteristics, including but not necessarily limited to:

(1) priority and importance of information or action
(2) plant systems
(3) operating modes
(4) frequency of use
(5) response time
(6) safety classification
(7) the grouping of displays and controls in a functional area.

6.2 An agreed set of criteria for the determina-

tion of the device assignment and location based on an analysis of these characteristics.

6.3 Evaluation of criteria to ensure consistency with design bases.

(An example of one such systematic approach is described in Appendix A.)

7. Functional "Considerations"

7.1 General. The operator should be considered as one part of an integrated system that is necessary for the proper and efficient operation of a nuclear power plant.

7.2 Display Facilities. In support of the operator needs, the control room designer should arrange the display facilities so that the operator can readily observe the displays and analyze the status of any system.

7.2.1 *Accessibility*. As appropriate, the operator should have information available on a "dedicated," "intermittent – periodic," or "intermittent – as called for" basis. The need for information to be displayed and its accessibility to the operator depends on: (1) the consequence of the operator not taking corrective action, (2) the importance of the data to the operator in determining the plant status, (3) the degree of automation to be used in control system design, and (4) the use of such display techniques as "display by exception."

7.2.2 *Readability and Comprehension*. The display equipment should provide means to facilitate operator comprehension. These include consistent use of the following: (1) Physical differentiation of data which are presented, using such techniques as color coding, size, and shape. (2) Formats keyed to and consistent with the physical representation should be used, for example, a vertical bar indicator for level. (3) Graphic displays for: flow diagrams, one-line electric diagrams, bar charts, etc.

7.2.3 *Abnormal Conditions*. The operator should be alerted to abnormal or unsafe conditions or significant changes in the plant and its process systems or safety systems or both.

7.2.3.1 *Alarms*. The alarm function should be based (to the greatest extent possible) on a true abnormal condition (for example, low oil pressure on a shaft-driven oil pump on a condensate booster pump should be alarmed only when the booster pump is in service).

7.2.3.2 *System Modes* Alarms should also be terminated or suppressed during modes of operation when they would be meaningless, due to changes in the operating mode (such as startup, power operation, shutdown, etc), so that information priority for the current mode of operation can be readily assessed.

7.2.3.3 *Limit Monitoring*. In addition to normal equipment protective limits, plant operational limits established by technical specifications and by plant administrative procedures shall be monitored by the operator. Provisions should be made to facilitate these requirements.

7.3 Control Facilities.

7.3.1 Control devices and their functionally associated displays should be located to facilitate operator action.

7.3.2 In determining whether control devices should be made available to the operator in the control room, the following factors should be considered: (1) the safety functions of the controlled equipment, (2) consequences of the operator not being able to take necessary action, (3) the degree of automation to be used for control, (4) the frequency of usage of the controls, and (5) the number of controls required to accomplish a given function.

7.3.3 Where the controls of equipment or devices which are part of safety systems can be transferred to points of control outside the control room, the mode of the active control should be indicated in the control room.

7.4 Device and Display Identification. Identification of control and display functions should be easily associated with the physical devices being monitored or controlled. Where alphanumeric identification systems are used, they should be supplementary to a functional identification.

7.5 Convention for Control Devices. A convention should be established to provide consistency in the operation of controls that perform similar functions, for example, control switches are to be turned clockwise to "close" (for circuit breakers).

7.6 Display and Control Facilities – Special. Special requirements such as safety surveillance, post accident monitoring, and remote shutdown should be considered in the design analysis described in Section 6.

7.6.1 *Safety System Status*. The operator

should be clearly informed of the status of the safety system by means of a display. This display should be used to enhance the normal plant administrative procedures.

7.6.2 *Redundant and Diverse Information.* Where a number of critical parameters require redundant or diverse displays as a means of checking the reasonability of information, the alternative information sources should be located to allow the operator to use both sources in arriving at a conclusion.

7.7 Area Arrangement. The normal operations area should be centrally arranged within the control room to provide the operator with surveillance and access capability to other operating areas within the control room. The emergency operations area should be readily accessible and visible from the normal operations area. This area should not be in a separate room or enclosure from the normal operations area.

7.8 Device Arrangement. Individual devices or groups of individual devices should be arranged to minimize operator motion including changes in direction of vision.

7.9 Equipment or System Status. Consideration should be given to provide indication when non-safety-related equipment is taken out of service for maintenance, calibration, or inspection, and when it is returned to service.

7.10 Communications. The methods provided for communication between the operator and various other personnel should not divert the operator from his principal duties.

7.11 Internal Security. Where display and alarm devices are provided within the central control room to alert the operator to unauthorized entry into vital areas, the devices should be clearly differentiated from any devices provided for plant functions by color, arrangement, or location.

Appendix A

(This appendix is not part of IEEE Std 566-1977, Recommended Practice for the Design of Display and Control Facilities for Central Control Rooms of Nuclear Power Generating Stations.)

Implementation of a Usage Analysis Method

Introduction

The prerequisites required for the performance of any usage analysis are:

(1) The determination of the plant display and control requirements to be included in the design basis (see Section 5).

(2) The determination of a set of characteristics which will subsequently be used to convert the plant control and display requirements into specific determinations of devices and their locations. Table 1 shows one possible set of characteristics. The columns show the characteristics and the rows show the various systems or subsystems. In deciding the appropriate characteristics to be recorded such questions as what is the system involved, what are its constituent parts, when does the operator need access to the systems controls, etc., have to be answered.

(A) The first step in the approach is, therefore, to identify the characteristics of the matrix and then fill in the matrix appropriately for each system and subsystem.

(B) The criteria for assignment or location of the display and control devices or both are then established to ensure that a consistent design results.

Typical criteria are:

(1) All control devices used frequently during startup, power, or hot standby modes of operation shall be located in the normal operations area.

(2) Functional controls shall be laid out on a system or subsystem basis.

(3) Safety system control devices shall be located in the emergency operations area.

(C) The selection and application of appropriate devices plus the specific layout of the control boards can proceed on a logical basis.

(D) A digital computer can be used advantageously to manipulate the developed data base to:

(1) store the characteristics of the system functions

(2) apply the criteria to the above characteristics, implementing the analysis by sorting techniques

(3) document any portion of the results.

Appendix B

(This appendix is not part of IEEE Std 566-1977, Recommended Practice for the Design of Display and Control Facilities for Central Control Rooms of Nuclear Power Generating Stations.)

Example of Operator Sensory Saturation

B.1 Steam Generator Tube Rupture on a Pressurized Water Reactor. In the event of a steam generator tube rupture the operator will be required to evaluate the information provided following the incident and take effective action to: (1) ensure that the plant is safely shut down and (2) minimize primary to secondary plant leakage. His response could be impaired by the number of displays to which he may be subjected. The alarms, indicators, and status lights

which will confront him in the event of the incident are listed below. The symbols *, T, and S are used to indicate which information will be presented after the rupture and prior to the trip (*), after the trip (T), and following safety injection (S).

B.2 Alarms — (Annunciator Window Engravings).

- * PSZR CONTROL HI/LO PRESSURE DEVIATION
- * PSZR CONTROL LO LEVEL
- * PSZR PROTECTION LO LEVEL
- * PSZR PRESS LO/BACKUP HTRS ON
- * PSZR LO LEVEL HTR CUTOFF AND LD ISOLATION
- * VCT HI/LO LEVEL
- * VCT HI/LO PRESS
- * CENT CHG PUMP 1 AUTO START
- * CENT CHG PUMP 2 AUTO START
- * PSZR PROT LO PRESS.
- * SG HI-HI/LO-LO LEVEL
- * FEEDWATER ISOL
- * SG ACTUAL LEVEL — SETPOINT HI/LO DEVIATION
- * SG FLOW MISMATCH FS > FW
- * CONDENSER 1 CONDUCTIVITY HI
- * CONDENSER 2 CONDUCTIVITY HI
- * HI TURB BLDG RADIATION
- * HI RAD AIR EJECTOR

- T ROD BOTTOM
- T TWO OR MORE RODS AT BOTTOM
- T ROD BOTTOM — ROD DROP AUTO WITHDRAWL STOP
- T TURBINE STM STOP VALVE CLOSED
- T REACTOR TRIP FROM TURBINE TRIP
- T REACTOR TRIP PSZR LO PRESS
- T REACTOR TRIP BKR A/B TRIPPED
- T SG HI HI LEVEL TURBINE TRIP
- T TURBINE TRIP REACTOR TRIP
- T GENERATOR MOTORING
- T FAST CLOS INTERCEPT VALVE ON
- T UNIT TRANS 1 TRIP
- T UNIT TRANS 2 TRIP
- T GENERATOR TRIP
- T TRIP OF 4kV BKRS TO UT
- T CLOSURE OF 4kV BKRS TO ST
- T TRIP OF 480V BKRS TO UT
- T CLOSURE OF 480V BKRS TO ST
- T TURBINE EXH LO VAC

- S RHR PUMP 1 AUTO START
- S RHR PUMP 2 AUTO START
- S RHR PUMP 1 DISCH HI PRESS
- S RHR PUMP 2 DISCH HI PRESS
- S REACTOR TRIP PSZR SAF INJ
- S CONDENSATE PUMP 1 TRIPPED
- S CONDENSATE PUMP 2 TRIPPED
- S DIESEL GEN 1 START
- S DIESEL GEN 2 START
- S AUX FEED PUMP START
- S PHASE A CONT ISOL
- S VENT ISOL
- S CCW PMP 1 AUTO START
- S CCW PMP 2 AUTO START
- S REACTOR TRIP PSZR SAF INJ (SI)

B.3 Analog Indicators.

- * INCR CHG FLOW
- * DECR PSZR VAPR TEMP
- * DECR PSZR LIQ TEMP
- * DECR PSZR LEV (4)
- * DECR PSZR PRESS (4)
- ○ INCR CHG PMP AMPS
- * DECR WIDE RANGE PRESS (RECORDER)
- * INCR SG LEV (3)
- * DECR SG FW FLOW (4)
- * DECR SG WIDE RANGE LEVEL (R)
- * INCR CONDENSATE CONDUCT (R)
- * DECR COND VAC (R)
- * DECR FW VALVE POS
- * DECR RCS TEMP

- T DECR NEUT FLUX (4)
- T DECR IMPULSE CHAMBER PRESS (2)
- T INCR/DECR SG HDR PRESS
- T DECR FW TEMP (R)
- T DECR COND FLOW (R)
- T INCR SG REL VALVE FLOW
- T INCR/DECR STEAM LINE PRESS (12)
- T DECR ELEC OUTPUT
- T DECR TUR-GEN SPEED
- T PWR DIST SYSM STATUS (UNIT/STARTUP TRANS — AMPS, WATTS, VARS VOLTS ~30 INDICATORS)

- S INCR SI FLOW
- S INCR SI DISCH PRESS
- S DECR RWST LEVEL
- S AUX FEED PUMP FLOW (2)
- S CCW PMP AMPS
- S SI PMP AMPS
- S AUX FW PMP AMPS (2)
- S COND PMP AMPS (3)
- S COND BOOSTER PMP AMPS (3)
- S D/GEN STATUS (~60 INDICATIONS OF PWR, VOLTS, ETC)
- S CONT FAN COOLER AMPS

B.4 Breakers/Valves Position Indicators (~200).

- * CHG PMP
- * PSZR HEATERS ON
- * PSZR HEATERS OFF
- * LETDOWN ISOL VALVE
- * SG REL VALVE

- S FAN COOLERS
- S CONT ISOL VALVES
- S SI VALVES
- S FW ISOL VALVES
- S AUX FW PUMP
- S COND SYST PMP
- S CONTRL ROOM VENT
- S CCW PMP
- S PWR DIST SYST BKR POS

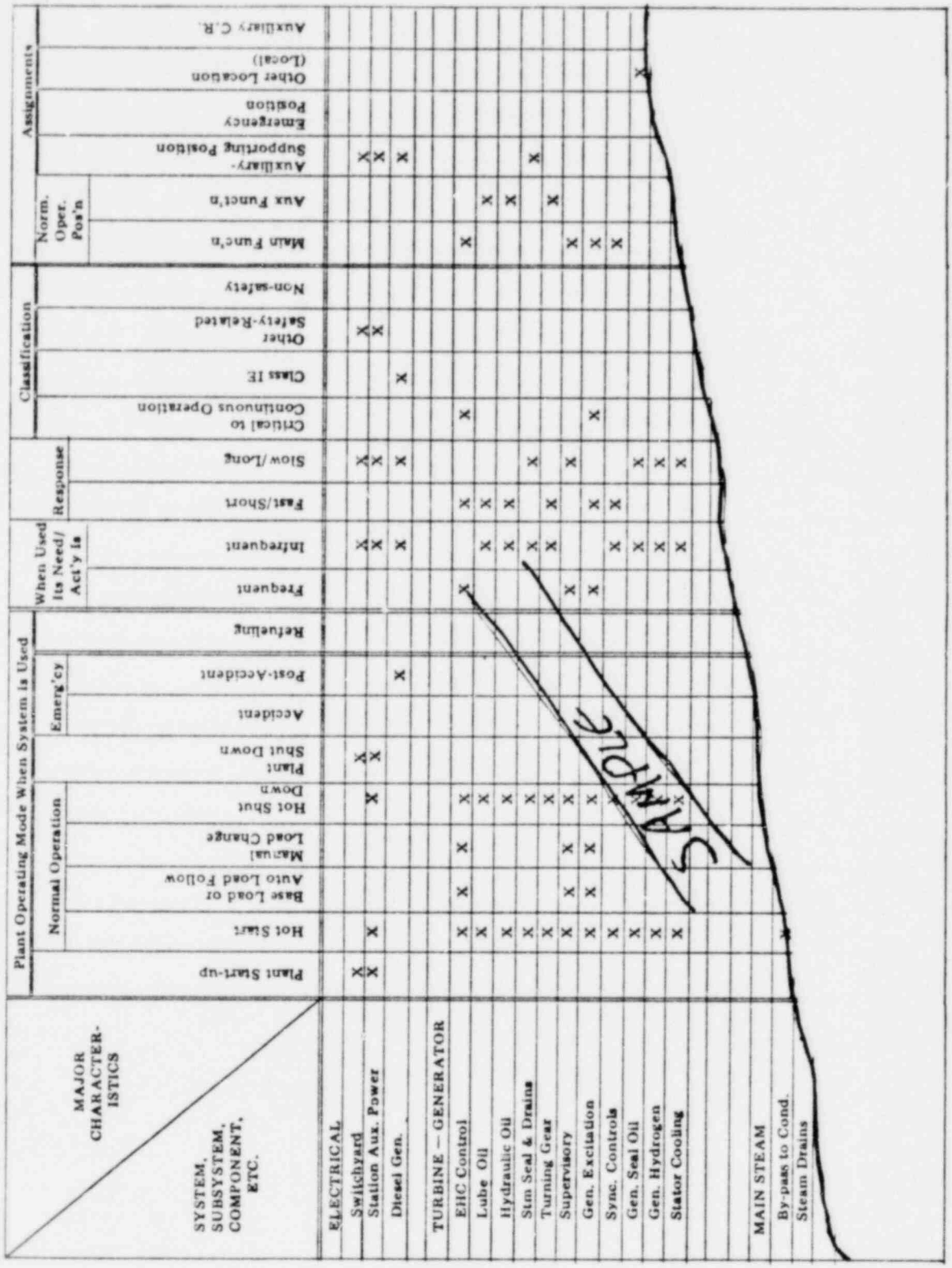


Table 1
System-Subsystem-Component Usage Analysis

First SC1.2 mtg.

Team #1 Shell 2/20/15

Purpose - Chicago 2/21

Purpose of this document is to provide ~~uniform~~ criteria for ~~the design of~~ functional selection, coordination, and organization of controls ~~and information systems~~ displays in a nuclear power plant control room ~~so~~ as to optimize operator performance (human-machine interface)

Scope

This document establishes criteria to be used by power plant system (and equipment) designers in the selection of the information and control features to be made available to plant operators in the central control room, and the methods to be used to provide such features. The criteria reflects the application of human engineering principles as they apply to power plant man-machine interfaces during normal and abnormal plant conditions. ~~This includes certain~~ the design bases ~~inputs to the design as well as the test and verification results.~~ The document addresses the functional requirements of the systems, controls and displays but does not apply to the physical design of the control room enclosure or structures mounted therein.

This includes the requirements for iterative, systematic procedures to verify and validate the design process.

H Hewitt. Team # 1. Sheet # 2.

Scope.

The document establishes criteria to be used by power plant system designers in the selection of system optimization and control features to be made available to plant operators in the central control room and the methods to be used to provide such features. The criteria reflect the application of human engineering principles as they apply to power plant man machine interfaces during ~~normal~~ all defined operating modes. This ~~criteria design~~ ~~guide~~ includes an literature ~~guide~~ approach including systematic verification procedures to validate the design and operating procedures.

Design Team #2.

This document establishes criteria and design requirements for use by designers in selecting and arranging information and control to be made available for the operator in the central control room. Human engineering principles, as they relate to power plant operations, are incorporated in the criteria ~~developed~~ required in this standard. This Standard addresses the ~~functional~~ design requirements of the information systems, controls, and displays and the design bases for selecting specific devices or equipment. It does not apply to the physical design of the control room enclosure or structures mounted therein except as they impact the ~~Man~~ - machine ~~=~~ interface.

2/20/80

Design Team #3 Sheet 1.

Scope: This document provides criteria, derived from Human Engineering principles, for the selection and arrangement of, and interaction among, the display and control facilities at main control rooms for nuclear power generating stations so that the operator can perform his functions under all plant conditions. [Also include last sentence of present scope]

Team #3 Sheet 2

Scope -

This document provides criteria to the control room designer for the selection, arrangement and interaction of displays and controls using human factor engineering principles to assure that the operator responds to plant conditions

Team #5

Minority View #1

Sheet 3

to Control Room Design

This document establishes criteria for the development of the design layout and arrangement ~~location~~ relationships of displays and controls using human factor engineering principles to assure that the operator responds properly to plant conditions.

Purpose: To assure the operating pe

This document ~~is~~ is intended to assure that the plant operator ~~is provided~~ plant information and controls in the control room to maintain plant conditions

2/19/80

SC 1.2 pre meeting notes —

1) Recommend Essex for membership
(They are coming out with newer guidelines

2) Create use of process computer - i.e. in retrieving data (not just printout of current status), in showing trends

3) Use of menu displays (Device on one CRT (eg schematic of equipment, each with a code) and data on second CRT by interrogating the code for the specific equipment)

4) Improve labeling

5) Color coding -

6) Rev to 567 ?

Initial Mtg. of WG SC1.2, Feb 20, 1980
Chicago:

Background:
Dec 567 is being developed separately by Spurgin's group. His group is exclusively PGC. SC1.2 is strictly NPGC

Ken Mallory is an "associate" member of SC1.2 who will review our draft.

There will be a meeting in Atlanta in the next couple of months when EMD will present their findings on St Lucie.

Poll of SC1.2 - should 576 be a Std, guide?
I stated that it should be a standard with expressable positions. Unanimous for a standard

Dec 567 has been approved by Stds Bd.

Discussion of Mtg at Essex (AIF Meeting) with Spurgin + Cardinals in attendance. Essex described their findings on MI. There is a checklist in Vol III? of HF engineering consideration in the review of a plant. The Check off list is being used in the

review of 6 plants. Also, the review of 4 plants in high population areas is currently underway.

The Essex criteria will be developed by March 15 - Then published ~ April 1 after two pre mtg meetings (east + west coast) and public input ?? Check into this

Discussion of issues - See "handouts"

Questions for discussion:

1) How much specificity in displays?

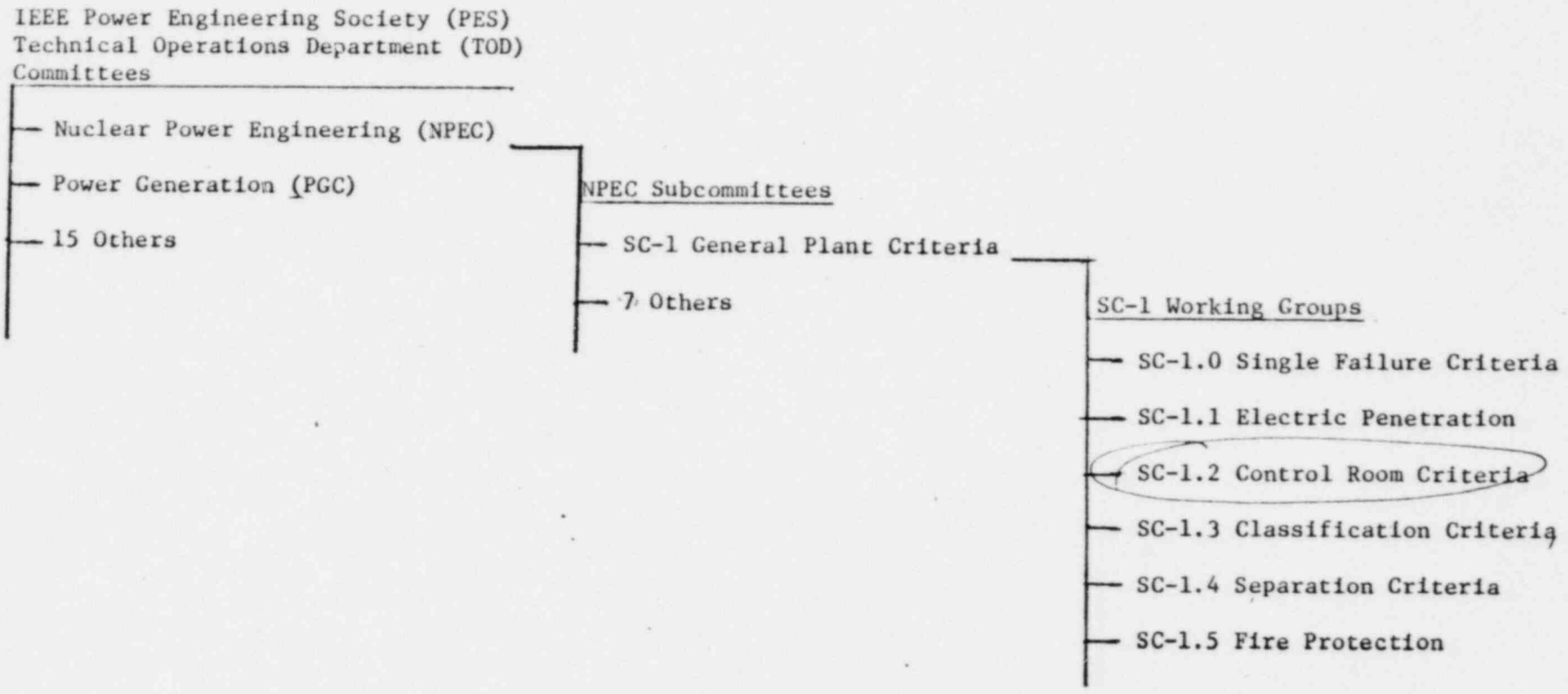
Proposed Scope: ~~Det~~ Design ~~of~~ based on HFE principles

Scope: ~~HFE~~ criteria for the selection, ~~arrangement and interaction~~ and arrangement of, and interaction among, display and control systems.

Discussion of process computer - This will be addressed by the W.G.

Deleted "central" control room - it is now "Main Control Room"

IEEE/NPEC/SC-1 Working Group
SC-1.2 "Control Room Criteria"
Organizational Relationship



The Essex Corporation found that a significant number of industry standards relating to human factors were developed during this time. As in the other cases discussed, however, few of these standards were thought to be important by those at whom they were aimed. The standards were too vague to require effectively the application of human engineering in the design process. They were narrowly drawn guidelines addressing a specific component or group of components and did not adequately address the man-machine system interface problems.

The most significant industry guidelines in existence during the operating license review of TMI-2 are found in IEEE Standard 566, "Recommended Practice for the Design of Displays and Control Facilities for Central Control Rooms of Nuclear Power Generating Stations." 50 This standard contains guidance directly related to human engineering, but the Essex Corporation's review of it found serious deficiencies. The Essex Corporation noted that the standard was incomplete and that it did not include guidance on the use of some very important human factors tools 51 such as:

- o Analysis of the tasks operators must perform.
- o The use of existing human engineering standards. 46
- o Control and Display layout conventions.
- o Alarm placement rules.

The Essex Corporation concluded that the generalizations, ambiguities, and oversights of IEEE 566 result in little more than an admonishment that the designer consider the operator, with little guidance on just how to prevent operator error. 52

Nearly all of the industry standards were published after the application for the operating license for TMI-2 had been submitted to the NRC in 1974. Thus, none of the more recent standards were applied to the TMI-2 design except as deemed necessary by the NRC or the utility to address significant safety issues.

Conformance of TMI-2 to Human Factors Criteria and Standards

As noted previously, the TMI-2 design was found by the AEC to meet the applicable criteria prior to issuance of the construction permit in 1968. Furthermore, the design development by the utility and its contractors, and the review of this design by the AEC were conducted with essentially no human engineering considerations. Thus, NRC found that TMI-2 satisfied the existing criteria even though a review of the current design today by human engineering specialists against these limited criteria would find serious deficiencies.

When a nuclear powerplant application is received by the NRC for an operating license, the practice has been to require conformance of the design to the criteria specified at the time the construction permit is issued, and to address the necessity for meeting subsequent criteria on a case-by-case basis. The necessity to conform to post-CP criteria is determined by the NRC and the industry on the basis of a perceived level of safety improvement that can be achieved by such conformance. Given the absence of any human engineering expertise on the NRC staff, it is not surprising that the NRC had no perception that human factors criteria could improve safety.

In summary, we found a lack of substantive human factors criteria and guidance both within the NRC (AEC) and the nuclear