Central File

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

February 3, 1992

Docket No. 52-002

APPLICANT: Combustion Engineering, Inc. (CE)

PROJECT: CE System 80+

SUBJECT: SUMMARY OF MEETING ON DECEMBER 4, 1991, REGARDING SYSTEM 80+ HUMAN FACTORS ISSUES

The staff met with representatives of CE at their Rockville office to continue the meeting of November 21, 1991. The primary topic under discussion was the seven subject areas identified in a meeting of August 16, 1991. The CE response to the Human Factors request for additional information (RAI) submitted to the Nuclear Regulatory Commission (NRC) on April 12, 1991, was also discussed. The attendees are listed in Enclosure 1. Handouts given to the staff are provided in Enclosure 3.

The schedule for the development and submittal of the Human Factors System 80+ draft safety evaluation report (DSER) was discussed with CE. Final responses from CE are due February 19, 1992.

CE stated that they will try to get as much done as they can before the February deadline. Some of the information requested by the staff is already under development for the Department of Energy (DOE). When the DOE documents are completed the NRC will receive copies that are tailored to the System 80+ design. It was agreed that whatever information and documentation is owed to the NRC, but is not submitted, will be open items in the DSER.

CE asked if the design acceptance criteria was due to the NRC for inclusion in the DSER. The staff indicated that they would get back to CE on this item.

It was noted that until CE documents their human factors program plan, it will be difficult for them to develop design acceptance criteria. During the first meeting with CE in October of 1990, the importance of documenting a human factors program plan for System 80+ was stressed. As of December 4, 1991, a human factors program plan has not been received by the staff.

Enclosure 2 provides a list of subject areas identified at the August 16, 1991, meeting that required additional technical discussions. The annunciator scheme and the methods that CE will use to demonstrate operator performance were covered in the November 21, 1991, meeting (Items 1 and 4). Coding methods, methods of tracking plant configuration, task analysis, crew composition (one, three, and six person crews), and the human factors test and evaluation plan were covered at this meeting.

DF03

The CE response to the RAI question concerning information coding was incomplete. The matrix that CE provided did not identify which pieces of equipment the coding methods were used on, and did not provide a narrative description addressing the content of the chart. CE said that a rationale and application guide for the coding methods would appear in the human factors standards and guidelines document (to be submitted at a later date). The document will include a written description of the coding methods used on each piece of equipment, and across the control room. The written descriptions will address both compatibilities and incompatibilities of coding methods and will be supplemented with pictures or drawings. CE assured the staff that the rationale and descriptions provided will address the human factors aspects of the coding methods used, not the hardware characteristics of the equipment. A coding methods document is under preparation for DOE. We will be provided with a copy tailored to System 80+ in early 1992.

A discussion concerning the human performance aspects of the System 80+ coding methods led to a more general discussion of human performance. Currently, none of the CE submittals address the issue of operator performance in relation to the System 80+ control room. The staff stressed that 1) all claims such as "improved operator performance" or "improved plant comprehension" must be demonstrated during verification and validation and 2) all responses related to human factors issues must address human performance unless hardware performance or hardware reliability is specifically requested. As a result of this conversation, CE may modify or delete some of the claims in their documentation. An agreement was reached that, at a minimum, CE will demonstrate that the System 80+ supports operator performance requirements. (Note: CE did not identify operator performance requirements as part of their task analysis.)

CE is currently planning to have two operator aids in the System 80+ software for tracking plant configuration. Although neither directly track plant configuration, both contribute to maintaining an awareness of the availability of safety systems. The Success Path Monitoring System advises the operator of the impact of testing and tag-outs on reactor coolant system (RCS) safety success paths. The Computer Aided Testing Program (COMAT) monitors pre and post test plant lineups, in real time, for correctness. As the staff understands these programs, currently there are no plans to provide a maintenance database that advise operators on the projected impact of maintenance, test and surveillance activities on entire plant status.

CE brought the staff up to date on the status of the design of the panels. The design of the Reactor Coolant Panel and the Chemical and Volume Control System panels are completed. CE noted that the baseline design for the System 80+ control panels was Palo Verde. CE took the controls and displays which are currently located on the individual panels and copied the arrangement for System 80+. The major change CE believes they have made is in the technologies used for the control and display equipment.

The task analysis performed for System 80+ was performed only for indicators. Control functions were considered to be the same as the baseline design, and therefore were not addressed. System 80+ assumes credit for the task analysis performed as part of the Detailed Control Room Design Review for Palo Verde. Walk throughs have been done on the completed panels using normal operating and startup procedures. All critical safety functions are accounted for in the CE Generic Emergency Procedure Guidelines.

Within the scope of the task analysis, CE did not look at concurrent activities and individual duties performed by the one, three, and six person operating crew. CE assumed that since the functional arrangement of the controls was taken directly from a baseline design there was no need, during the design process, to look at crew performance. Several questions were raised by the staff. They included:

Question: Has CE identified the tasks that the crew will perform in the System 80+ design?

Answer: No. The functional grouping of controls and displays was taken from a baseline design, which is currently in operation. The CE generic procedures were also used in walk throughs of the RCP and chemical and value control system (the only panels designed thus far).

Question: How were the (operator) control and information requirements established for the System 80+?

Answer: The control portion of the display-control loop was taken directly from System 80. The controls on the control boards have stayed the same, except that they are now digital. The display portion of the display-control loop was evaluated using the CE generic emergency procedure guidelines.

Question: What approach did CE use to determine how information should be displayed on the System 80+ control boards?

Answer: It was a process of elimination. For the qualified equipment, cost was a driving factor. CRTs were chosen because they appear to be the trend in the industry, and the Electric Power Research Institute identifies CRTs in their requirements documents. Set points and parameters were taken from the System 80 design.

The question of one person operation of the control boards was discussed in some detail. Given that: (1) CE views System 80+ as an incremental upgrade of System 80; (2) System 80+ has maintained (relatively) the same functional groupings as System 80; (3) the controls were taken directly off the System 80 boards; and (4) no analyses have been performed to establish a crew size for System 80+, the staff has no basis on which to accept CE's claim that System 80+ can be safely operated with only one person at the control boards. It was suggested that CE reconsider their position on one person operation of the control boards.

CE views determination of crew size as a product of the verification and validation process. They do not foresee doing additional work on this issue until all the control boards have been designed.

CE is working on a verification and validation plan in conjunction with the human factors (program) systems flow chart. More information will be provided at a later date.

During the discussions concerning the equipment selected for the System 80+ control boards the staff asked CE to describe the features that were evaluated and the trade-off studies that were performed by the human factors group. From CE's response, it appears that the human factors group was not an active participant in the equipment selection process. They did not realize that human engineering should have been involved.

Two examples were provided by the staff where features of the equipment could directly impact its usability. The first was the calibration of the colors on the CRT. Color CRTs must be maintained on a regular basis in order for the colors to remain accurate. The greater the number of colors used the more important it is to be able to distinguish among colors. Colors that are similar such as white, cyan, and light blue can "drift" such that they can no longer be positively identified. A distortion called blossoming can also occur. This occurs when the red, green, and blue guns are no longer properly aligned. One pixel becomes a visible combination of separate colors. Both conditions degrade the clarity and readability of the display. Armed with the knowledge of how a CRT will degrade over its expected lifetime, a human factors engineer can tailor the approach used in designing displays to avoid potential problems and pitfalls.

The second example cited was the need for a screen test feature for the programmable displays. The characters on the programmable displays are composed of pixels. Over time pixels burn out. A common way of regularly monitoring the degradation of a display is to include a screen test feature. The test is usually activated by a button on the bezel of the display or by a software command entered via the keyboard. The test is a momentary flash of all the pixels. For systems that are turned off and on, a screen test feature may be included as part of a self-test program that is automatically initiated when the system is brought up from a cold start. On systems that are on for long periods of time, a screen test is usually a part of a routine equipment check, much like a lamp test.

At this point CE does not plan to look at the human factors aspects of equipment performance. They are taking the approach that the equipment installed in the delivered version of System 80+ will perform exactly as the models used in the System 80+ mock-up and that the equipment will not degrade over time. The need for human engineering input into equipment specifications was also discussed. At this point CE does not see a need to incorporate human factors requirements into the equipment procurement specifications. They see the issues of reviewing the human factors aspects of the technology used, considering the degradation of equipment over time, and providing input to equipment specifications, as being beyond the scope of designing the control room for certification.

No future meetings are planned. The staff should start receiving some of CE's new responses in early 1992.

Original Signed By:

Thomas V. Wambach, Project Manager
Standardization Project Directorate
Division of Advanced Reactors
and Special Projects
Office of Nuclear Reactor Regulation

Enclosures:
1. List of Attendees
2. List of System 80+ CESSAR-DC
Areas that require working
level meetings

cc w/enclosures:
See next page

DISTRIBUTION:

Central File	NRC PDR	PDST R/F	FMiraglia, 12G18	DCrutchfield
WTravers	RPierson	BBorchardt	TBoyce	RHasselberg
THiltz	TKenyon	MMalloy	VMcCree	RNease
CPoslusny	TWambach	JHWilson	JNWilson	PShea
JBongarra, 10D24	ACRS (10)	EJordan, 3701		DSmith, 10D24
GGrant, EDO				

OFC: LA:PDST:DAR	PM:PDST:DAR	SC:PDST:DAR
NAME: PShea PWS	TWambach:sg	JNWilson
DATE: 01/31/92	02/03/92	02/3/92

OFFICIAL RECORD COPY Document Name: CEMTG.TW

cc: Mr. E. H. Kennedy, Manager
Nuclear Systems Licensing
Combustion Engineering
1000 Prospect Hill Road
Windsor, Connecticut 06095

Mr. C. B. Brinkman, Manager
Washington Nuclear Operations
Combustion Engineering, Inc.
12300 Twinbrook Parkway
Suite 330
Rockville, Maryland 20852

Mr. Stan Ritterbusch
Nuclear Licensing
Combustion Engineering
1000 Prospect Hill Road
Post Office Box 500
Windsor, Connecticut 06095

Mr. Daniel F. Giessing
U. S. Department of Energy
NE-42
Washington, D.C. 20585

Mr. Steve Goldberg
Budget Examiner
725 17th Street, N.W.
Washington, D.C. 20503

Enclosure 1

December 4, 1991

CE SYSTEM 80+

HUMAN FACTORS WORKING MEETING

Name	Affiliation
Tom Wambach	NRR/NRR/PDST (afternoon)
James P. Bongarra, Jr.	NRC/NRR/DLPQ (morning)
Stan Ritterbusch	ABB/CE
Donna L. Smith	NRC/DLPQ/LHFB
Robert B. Fuld	ABB/CE HF
Paul M. Simon	ABB/CE HF
Daryl L. Harmon	ABB/CE HF

Enclosure 2

TO: Tom Wambach

FROM: Donna

DATE: August 28, 1991

SUBJECT: LIST OF SYSTEM 80+ CESSAR-DC AREAS THAT REQUIRE WORKING LEVEL MEETINGS

Aside from the outline that Combustion Engineering is going to provide to us, covering a new set of answers to the request for addition information, (RAI) there are several areas that require working level meetings. The CESSAR-DC roadmap provided to us is not leading us to the documentation we need to answer questions in the following areas:

1. The details of the alarm and annunciator scheme. A review of the human factors studies that contributed to the reduction in the number of alarms or at least a detailed understanding of the rationale that we used.

2. Information coding methods used in the System 80+ control room. The matrix provided in the response to the RAI was incomplete. Witnout a written explanation describing what coding methods are used on each type of instrument, the matrix is meaningless.

3. Methods of tracking plant configuration. Many "human error" LERs have been generated because the configuration of the plant was different than operations or maintenance personnel believed. Currently components can be tagged out on control boards. How will plant configuration be tracked with the System 80+ design? Will it be done in software? Will it be done via an expert system? How will operations, maintenance, testing and surveillance personnel be kept current on plant configuration?

4. Methods that CE will use to show that System 80+ control room design improves or maintains the status quo of operator performance.

5. A detailed review of how the task analysis was used in the design of individual panels. Perform an in-depth review of the documentation describing the design of the RCP and one other panel.

6. A detailed review of the task analysis documentation supporting one, three, and six person crews.

7. Review the human engineering test and evaluation or the verification and validation plan for scope, parameters that will be tested, pass/fail criteria, and the documentation path identifying the originating design requirement/performance specification.

VERIFICATION

- Associated with task execution; two types defined (NUREG 0700).

- Availability verifies that MMI elements in ICCR inventory correspond to task elements in Task Analysis, procedures, etc. (i.e., MMI elements are necessary), and vice-versa (i.e., MMI elements are sufficient).

- Suitability verifies that characteristics and relations of MMI elements satisfactorily support task accomplishment.

- In a design process, tradeoffs occur between suitability and other constraints, both from other disciplines (e.g., accounting) and from HFE (conflicting needs or guidance).

- In a design (rather than review) process, verification must be an iterative review-comment-resolution loop for MMI elements in development. Initiation of review loop can be a scheduled milestone, or an ad hoc opportunity (both ways are necessary)

- "Final" verification is only final till the next design change.

VALIDATION

- Associated with function execution (NUREG 0700).

- Concerned that operating ensemble (MMI, procedures, trained operators) is satisfactory, if not optimal.

- Preliminary validation evaluates characteristics & emergent features of ensemble operation, to ensure adequacy of design & embodied tradeoffs.

- Final validation tests the ensemble operation against acceptance criteria for functional performance.

- Like a hypothesis test, validation can be positively failed, but only incrementally passed (i.e., not "truth testable"); testing cannot identify all significant combinations of initial conditions ("n+1" scenarios); all variables and interactions not understood/modeled.

- An item's true validity is thus determined over time, to the extent that non-failing evidence accumulates. Validation of the design continues throughout plant life as experience accrues, concerns arise, and design changes are implemented.

- In contrast, acceptance testing is a finite decision-making activity. Thus, plans for final human factors validation utilize acceptance criteria based on satisfactory execution of operating function.

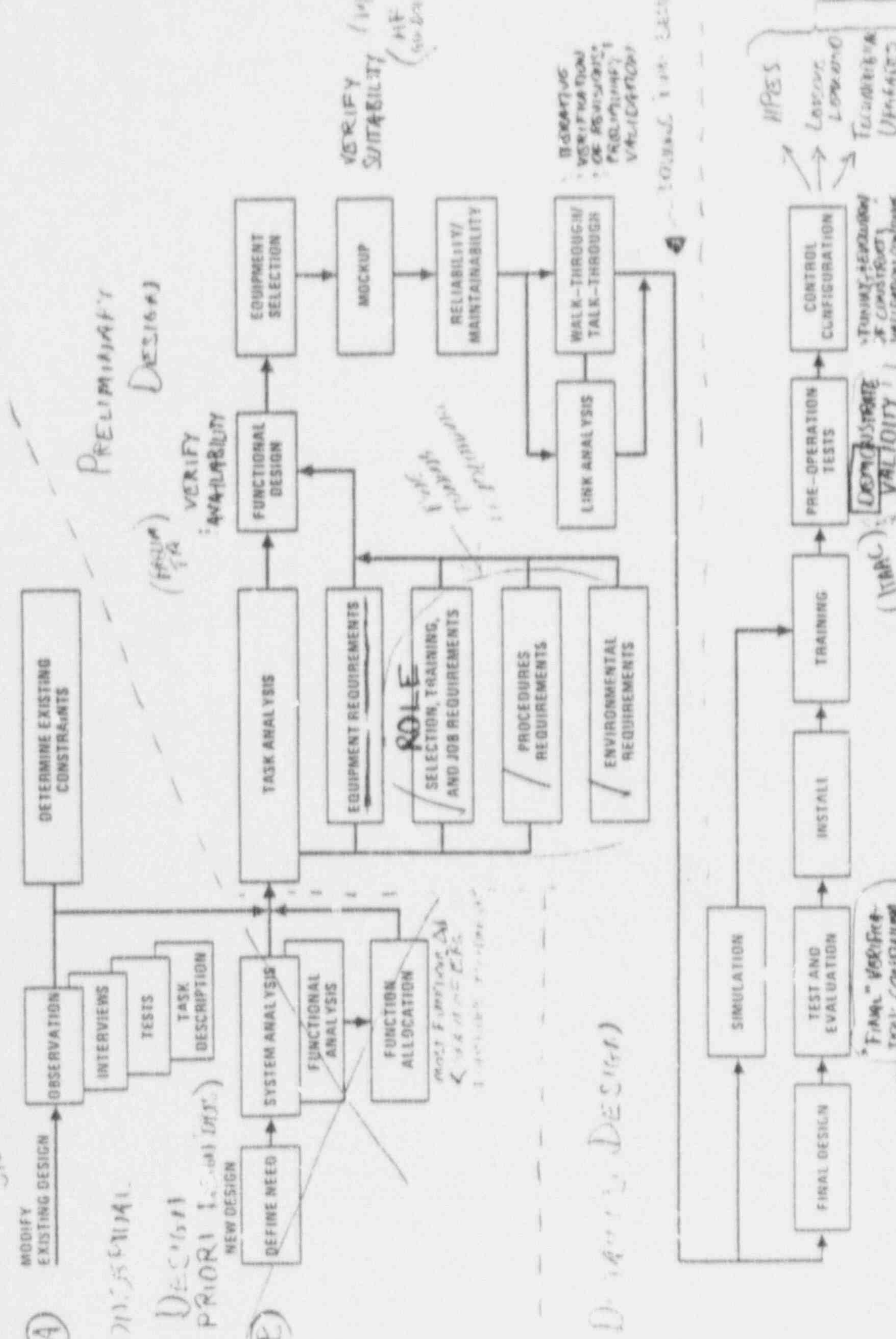

Fig 1
Typical Comprehensive Application of HFE in the Design Process

To: R. M. Manazir
M. S. Novak
T. M. Starr

From: R. B. Fuld
9341-09BB
10/07/91

xc: D. L. Harmon
P. L. Yanosy
D. L. Van Olinda
F. J. Safryn
R. P. Harvey
K. Scarola

SUBJECT: **HWRF Touch Target Standards for NPX80+**

Among comments received on the draft HFE Standards & Guidelines was that a more specific definition of touch target dimensions was needed. In response, the standards and guidelines have been amended to satisfy this and other associated requirements. The basis for the changes and additions follows.

Definitions

The amended Standards & Guidelines define the following touch target states:

Available - A touch target is available when it can be activated and selected.

Activated - A touch target is activated when a physical object (e.g., the user's finger) touches an available, software-defined VDU target area. This causes the VDU touch sensing system to generate a signal that the display software responds to by changing the target image to the "touched" (i.e., preselected) state.

Selected - A touch target is selected when, following the target's activation, the physical object breaks contact with the VDU screen touch sensor system (as opposed to moving outside the area of defined target coordinates while maintaining contact with the touch sensor system.) The display software responds by instantiating the display function that the touch target symbolizes, and changing the target image to the "selected" state.

Unavailable - A touch target is unavailable when, despite having a defined area on the VDU screen, it is not available for activation or selection under the current logical conditions of the information (i.e., software) system. The display software responds to such input by changing the target image to the "unavailable" state. The target is insensitive to touch contact when unavailable.

Assumptions

The amended Standards & Guidelines incorporate the following assumptions:

- Touch targets are rectangular, to maximize useful text area.
- Touch targets utilize a select-on-exit convention.
- Touch targets provide positive visual indications of touch activation, selection, and touch unavailability.
- Activation and selection time delays to visual feedback are less than .3 seconds.
- The combination of Visual Display Unit (VDU) and touch screen technologies does not result in significant z-axis touch error.
- Only one target may be activated on a VDU screen at the same time.

Amended Standards & Guidelines

The amended standards and guidelines for touch target size are as follows:

.25 SQ INCHES IN AREA; AT LEAST .25 INCHES HEIGHT

FOR COMPONENT CONTROL/COMMAND ENTRY BUTTONS, THE...

- Touch targets shall be at least .5 inches on a side.
- Touch target centers shall be separated by at least .75 inches, "city block" fashion (in both the vertical and horizontal dimensions).
- Text within touch targets shall be separated from the target borders by at least one-third the character height, and should be separated from the target borders by at least one-half the character height.
- TOUCH TARGETS SHALL BE RECTANGULAR, WITH HEIGHT LESS THAN OR EQUAL TO WIDTH.
- In a group of targets that share a similar purpose or importance (e.g., equivalent menu alternatives), touch

target size should be standardized to the dimensions of the largest label in the group.

Bases

A fairly well validated choice for button size can be found on commercial typewriter keyboards (approximately .5 inches on a side, .75 inches between centers), and has served as a basis for this guidance.

Available guidance on touch target sizes in the human factors literature is taken from studies on similar legend switches (Reference 1). This guidance accommodates the use of protective barriers (enabling a large finger to fit within the boundaries of the switch area), the use of the switch by operators wearing certain gloves, and the prevention of inadvertent actuation of neighboring switches.

For touch targets, however, the user's finger does not need to be contained entirely within the target border (or even be entirely separate from the adjacent target) for proper operation. Also, design basis habitability requirements rule out the use of protective gear by operators in the HWRF control room. Most significantly, the computer can discriminate and provide rapid visual feedback as to which target is being sensed and activated, while striking multiple keys simultaneously can be prevented logically. This "stretches" the effective size and separation of the touch target working surface. *

On the issue of touch target spacing, pushbutton data can be found (Reference 2) to indicate that when display space is tight, increasing edge separation and decreasing button diameter can, within limits, have a beneficial effect on maintaining speed/accuracy. A crude guideline for shrinking from the typewriter-based guidance down towards wrist calculator size is to decrease button diameter by twice the amount that you increase edge separation, until they equal one another at about .167 inches.

References

1) Human Engineering Design Criteria for Military Systems, Equipment and Facilities (1981). Entry 5.4.6.4, MIL-STD-1472D.

2) <u>Pushbuttons: Effects of Spacing, Diameter, & Orientation on Error Rate</u>. Entry 12.401, Engineering Data Compendium (1988). K. R. Boff and J. E. Lincoln (Eds.). Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH.

ABB

ASEA BROWN BOVERI

Inter-Office Correspondence

To: K. Scarola

xc: D. L. Harmon
R. P. Harvey
P. L. Yanosy
D. L. Van Olinda
F. J. Safryn
R. M. Manazir
M. S. Novak
T. M. Starr

From: R. B. Fuld
9341-09BB
9/12/91

IC-91-271

SUBJECT: **HWRF Text Size Standards for NPX80+**

Among comments received on the draft HFE Standards & Guidelines was the concern that the generic standard proposed for text size (i.e., visual angle equal to at least 15 minutes-of-arc at the designer's defined reading distance) was too restrictive. Rather than justify the NPX80+ design's departure from the standards, additional standards will be provided and the guidance adjusted as follows.

Revised Standards & Guidance

The guidance ("should") will become 16 minutes-of-arc.

The standard ("shall") will become 12 minutes-of-arc.

A caveat will be included to explain that size of text interacts with other variables to determine text legibility and readability. Control of these variables is embodied, to the extent practical, in other design standards and guidance. For example, the legibility of an electronic presentation is strongly influenced by screen resolution. The standard for text size assumes that a "high resolution" VDU display (i.e., greater than 12 lines of vertical resolution per character) is being used, which conforms to guidance offered elsewhere in the document.

NPX80+ Implementation

The following reading distances have been stated as part of the NPX80+ design basis:

1) "At the panel" (95%ile Male touch distance) = 36 inches
2) "From adjacent panel" (between panel centers) = 50 inches
3) "Across MCC" (from far side of horseshoe) = 151 inches

The 12 minutes-of-arc value and the above reading distances produce the following text sizes:

1) "At the panel" = .125 inches
2) "Adjacent panel" = .175 inches
3) "Across MCC" = .527 inches

In addition, .14 inch text is identified as a defensible compromise between the .125 inch and .175 inch text sizes that satisfies HFE bases (most importantly, that .14 inch text read from 50 inches is not data-limiting; see Item 2 under Bases, below) as well as existing constraints on the size and resolution of the DIAS electroluminescent (EL) displays. Use of the .14 inch text size should be considered where:

a) to-be-monitored "adjacent panel" data cannot be fit using the .175 inch standard, or

b) increased visibility of "at the panel" data is desired because of concern for degraded legibility (e.g., low resolution of the device), or

c) increased salience of "at the panel" data is desirable because of its informativeness (e.g., for alarm tile labels).

Generic touch target features (e.g., a "clear" button), alarm messages, diagnostic-level detail, etc. should continue to use the standard for "at the panel" display. Figure 1 shows the use of .125 inch and .14 inch text for a DIAS alarm window, approximately to scale. Note that the printout resolution vastly exceeds that of the actual EL display.

Bases

The formula relating visual angle, reading distance, and character height is:

$$\text{Visual Angle (minutes-of-arc)} = 3438 \; \frac{\text{Char. Height (inches)}}{\text{Reading Distance (inches)}}$$

Numerous studies have examined text legibility as a function of character size and reading distance, and the added impact on legibility of such variables as screen resolution, contrast, color, lighting, viewing angle, font, stroke width, etc. In addition, familiarity with the displayed text can have a powerful impact on performance. In general, the literature suggests the following generalizations for individuals with 20/20 vision viewing unfamiliar text under good reading conditions:

1) The threshold (i.e., > 50% correct) for legibility (i.e., identification of random letters) is around 5 or 6 minutes-of-arc.

2) Relatively fast (i.e., nominally within 3 times simple reaction time) and accurate (i.e., > 95% correct) legibility is possible above 8 to 9 minutes-of-arc with the full effort of the reader. (That is, the crossover from data-limited to resource-limited performance appears to occur at about 1.5 times the legibility threshold.) This is the most important limit on text size; furthermore, some margin needs to be provided to this limit in order to account for routine degradation of actual (vs. assumed) reading conditions.

3) Reading effort (i.e., for sequential text) declines with larger text size over a relatively wide range of values. Many guidelines quote values from 15 to 20 minutes-of-arc as preferred. Such a value provides acceptable readability for a range of +/- 50% of the expected reading distance.

4) Reading effort begins to increase again as 30 minutes-of-arc is approached and exceeded. This occurs because the larger text begins to interfere with the smooth flow of saccadic eye movements, which is due to the limited range of sharp foveal vision.

5) Note that there is sufficient variability of professional opinion for the range of preferred values to overlap with limiting values at either end of the scale (see Table 1). These values could vary further as more of the interacting variables are considered.

6) As a point of reference in common experience, Wordperfect provides approximately .125 inch lowercase letters and .188 inch uppercase letters on a 13 inch screen with a VGA adapter; this translates to a range of 12 to 18 minutes-of-arc at a 36 inch reading distance. (Note that workstation guidelines anticipate reading distances ranging well below half this value; reading from a distance of 16 inches, the uppercase letters subtend over 40 minutes-of-arc.)

Source	V.A. (min)	Recomm.	Specif. Qualif.
Nureg 0700 (6.7.2.2.b)	5	threshold	CRT
ansi/hfs 100-198	5-6	threshold	Non-time Critical
NASA-STD-3000 / VOL I / REV a / 9.4.2.3.3.2d6	10	min	Large screens
MIL-STD-1472D (5.2.6.6.4.2)	10	min	
ansi/hfs 100-198	10	min	non-time critical
ansi/hfs 100-198	11-12	threshold	Readability
ansi/hfs 100-198	11-12	threshold	Legibility
Nureg 0700 (6.7.2.2 b)	12	min	CRT
Ergonomic Design For People At Work (pg 101 4a(1))	15	min	
MIL-STD-1472D (5.2.6.9.2)	15	min	EL Displays
MIL-STD-1472D (5.2.6.6.4.2)	15	pref	
NASA-STD-3000 / VOL I / REV a / 9.4.2.3.3.9 i 3a	15	min	VDT
NASA-STD-3000 / VOL I / REV a / 9.4.2.3.3.2d6	15	pref	Large Displays
Nureg 0700 (6.7.1.3 a)	15	min	
Use 1000 Ver 2.1	15	min	
MIL-STD-1472D (5.2.6.8.4)	16	min	Dot Matrix
User Computer Interface In Process Control	16	min	
ansi/hfs 100-198	16	min	Legibility
ansi/hfs 100-198	16	min	Readability
Use 1000 Ver 2.1	20	pref	
Nureg 0700 (6.7.2.2 a)	20	pref	Symbols
Ergonomic Design For People At Work (pg 101 4a(1))	20	max	
Nureg 0700 (6.7.1.3 a)	20	pref	
MIL-STD 1472D (5.2.4.1)	20	min	
ansi/hfs 100-198	20-22	pref	readability
ansi/hfs 100-198	20-22	pref	Legibility
Use 1000 Ver 2.1	22	max	
NASA-STD-3000 / VOL I / REV a / 9.4.2.3.3.9 i 3a	22	max	VDT
MIL-STD-1472D (5.2.6.8.4)	24	pref	Dot Matrix
ansi/hfs 100-198	24	max	Readability
MIL-STD-1472D (5.2.6.9.2)	24	pref	EL displays
User Computer Interface In Process Control	26.8	max	
ansi/hfs 100-198	45	max	Legibility

LOWEST ACCEPTABLE

LOWEST PREFERRED

HIGHEST MIN

LOWEST MAX

HIGHEST PREFERRED

HIGHEST ACCEPT

TABLE 1

10x

IF YOU BELIEVE ANYBODY
THEN ACCEPTABLE SIZE SPANS
AN ORDER OF MAGNITUDE (5-45)

.1x

IF YOU BELIEVE EVERYBODY
THEN ACCEPTABLE SIZE CAN
VARY BY LESS THAN 10% (16-22)

All window tile text is .14 in high.
Message and 'touch button' text below the tile array is .125 in high.

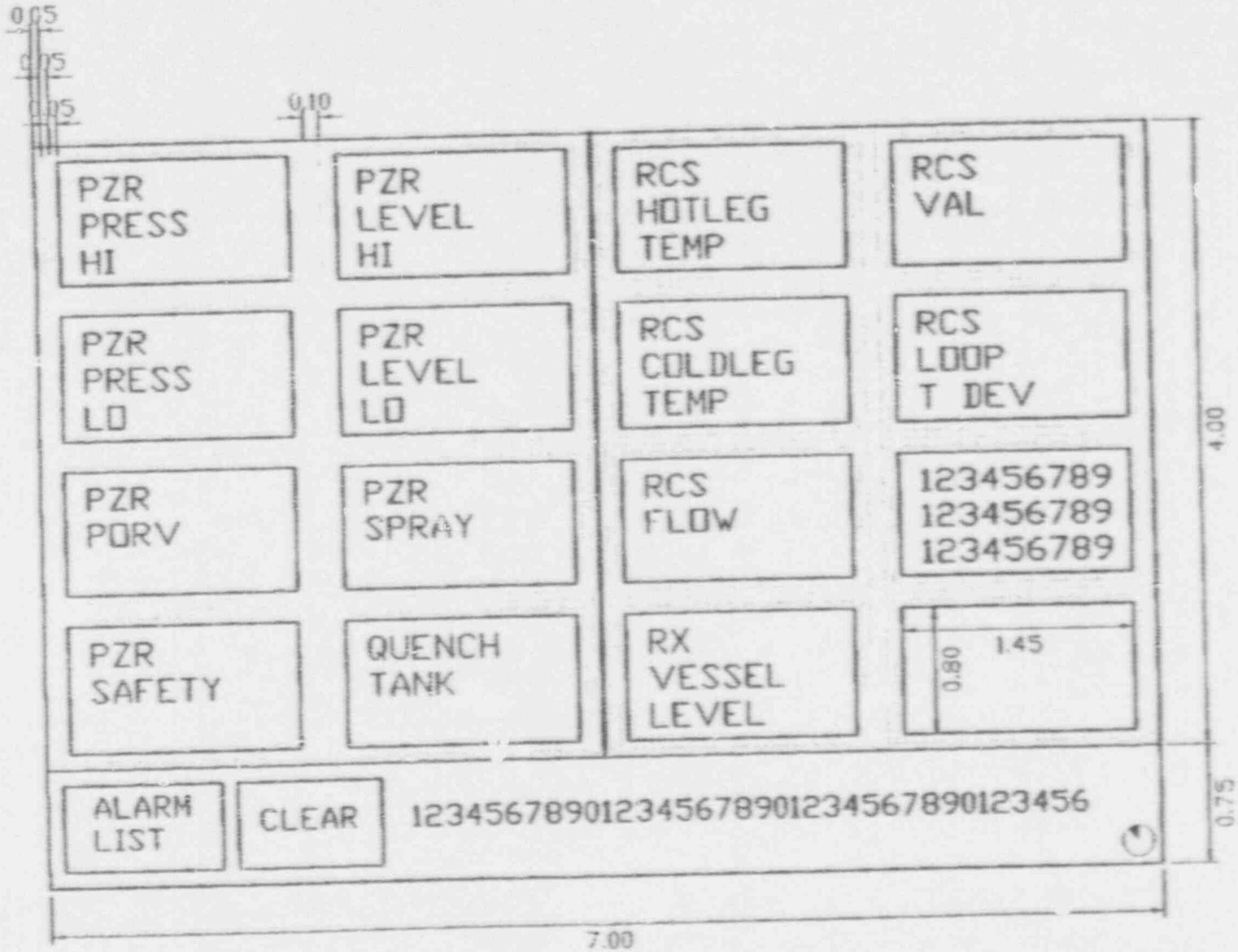

FIGURE 1

9/11/91

ALARM

Number: 620.14

Question: What is the projected reliability of the controls and displays in the control room?

Response: The reliability of all Nuplex 80+ control and display systems is documented based on representative hardware (final hardware selections are not made for certification). Typical of Nuplex 80+ system reliability is the availability of control room information from the DPS which has been calculated to be 99.98% with an MTTR of 4 hours. The DPS availability analysis report documenting this calculation has been made available to the NRC in the C-E Rockville, MD office. It is important to note that in the Nuplex 80+ design, information is presented through two separate system interfaces (DIAS and DPS) so the availability of information and reliability of the ensemble in providing it is higher than individual system availabilities.

Control systems (Process-CCS, ESF-CCS and PCS) have redundant controls available in the MCR via dedicated controls and system operators' modules, thus the availability of a given control function is significantly greater than in present control rooms

PLANT CONFIGURATION TRACKING

SUCCESS PATH MONITORING

- DETERMINES AND INDICATES IMPACT ON ALL MAINTENANCE, TAG-OUTS AND TESTING ON SAFETY SUCCESS PATHS

- DATA GATHERED AUTOMATICALLY OR OBTAINED THROUGH MANUAL ENTRY

- PERFORMED IN DPS SOFTWARE ALGORITHMS; NOT AN EXPERT SYSTEM

ESF COMPUTER AIDED TESTING (COMAT) PROGRAM

- MONITORS PRE-TEST PLANT LINEUP FOR CORRECTNESS

- MONITORS POST-TEST PLANT LINEUP FOR CORRECTNESS

- IMPLEMENTED IN DPS

PLANT CONFIGURATION TRACKING (CONT'D.)

INTEGRATED SYSTEM MANAGEMENT SYSTEM

SYSTEM 80+ WILL ALSO HAVE A SOFTWARE BASED INTEGRATED INFORMATION MANAGEMENT SYSTEM THAT INCLUDES MONITORING OF MAINTENANCE, TAG-OUTS AND TESTING FOR ALL SYSTEMS

- NOT PART OF CERTIFICATION
- EPRI IS STILL WORKING ON REQUIREMENTS

SY TEM 80+
Task Analysis Information

1. New Designs and Evolutionary Designs Have Different Requirements

    -New Plant Design (e.g.-passive PWR) Requirements

        *Full Systems Analysis

        *Generate all-new Information and Control inventory

        *More Detailed Function Allocation and Analysis

        * A 'Critical" Task Analysis must be performed

    -Evolutionary Plant (e.g.-ABWR or Syst m 80+ PWR)

        *Information and Control Inventor already exists
        some modification, but not a major one

        *Operating and Design Experience supplements TA

        *Critical TA Not Needed (Critical scenarios have been evaluated in original design)

        *Systems Analyis not needed (systems and their functions are already known)

2. What Has Been Done For System 80+

    -Full Function and Task Analysis
        *Considering all EOG scenarios
        *Information Needs Identified
        *Gross and Subfunction Groups Identified
        *Task Sequences Identified

    -Board Layouts Based on TA

    -System Designs (mainly MMI portion) modified based on FTA
        *Info Systems Generic Displays
        *RCS
        *CVCS

3. Future System 80+ Task Analysis Activities

    -Full Human Factors Analysis
        *will include more TA/walkthroughs
        *continuing HF review of design

    -Validation and Verification

6. A Detailed review of the task analysis documentation supporting the 1,3, and 6 person crew sizes.

The Function and Task Analysis for Nuplex 80+ (1989) examined the matter of 1, 3, and 6 person crew size, concluding that the one-person operating crew was the limiting ("worst case") condition of operation. In other words, if the controlling workspace of the Nuplex control room could be adequately managed by a one-person crew during the full range of anticipated plant operation scenarios, then a three or six person crew would have no difficulty in operating the plant. This limiting case analysis was used in the FTA for Nuplex 80+. The use of such limiting case analyses is common practice for Safety Analysis Reports.

A description of the analysis can be found in Section 18.5.1.8 of CESSAR-DC with full details in the aforementioned FTA report (NPX80-IC-DP-790-02). The basis for designing a controlling workspace for a one-person crew was provided by Requirement 4.2.4, Chapter 10 of EPRI-ALWR-URD. The Nuplex 80+ Function and Task analysis found that, for anticipated conditions, the one-person crew was able to handle the workload demands of operation.

Separate analyses were not performed for the one, three, and six person crew sizes. Although the assignment of tasks and the number of crew members may change, depending on a given utility's preference, the number and nature of the tasks do not. Nor is there a difference in the functions the plant systems must perform or the control room information needs based on task size.

The allocation of tasks between multiple crew members is a legitimate issue. CE has addressed this in the design of the NUPLEX 80+ control complex, through the floor plan design and allocation of systems to panels. With the crew size of three, there is still only one operator envisioned to be in the MCC (controlling workspace) area, hence the task analysis would not change at all for the bulk of normal operations, since these are all controlled from the MCC. The remaining two operators in the 3-person crew size would likely include one operator assigned to the safety and auxiliary consoles and one senior reactor operator at the control room supervisor's console.

The crew size of 6 is envisioned to include two operators at the MCC. However, these individuals will not interfere with one another since every section of the MCC has it's own spatially dedicated displays and any CRT display can be called up on each CRT screen. Further, since the panel layout mimics plant energy flow, the task sequence moves logically around this 'horseshoe', allowing for an even break-off of tasks without interference.

The other four crew members are envisioned to be one each at the Safety and Auxiliary consoles, and two at the Control Room supervisor's console. The crew at Safety and Auxiliary consoles will have no job overlap since the functions assigned to these two sets of panels are quite different. The two crew members at the supervisor's console are envisioned to be supervisory and STA/advisor personnel. They will have the ability to call up any CRT display on their own two CRTs and to monitor the plant via the IPSO display, however, they will not perform any control tasks. CE believes that the 6-person crew is not a routine staffing level but might represent extra consulting and/or backup personnel brought in by a given utility should an abnormal transient occur.

Further human factors analyses are planned for the NUPLEX 80+ control room. These will include walk-through/talk-through type analysis and further review of the control room design using Emergency Operating Guidelines as the task basis. For this analysis, a simulated full operating crew will be used.

It should be noted that, as pointed out in Sections 1-4 of the FTA report, the nature of tasks which must be performed for the System 80+ plant, and the information needs in Nuplex 80+ do not vary significantly from previously-licensed System 80 plants such as Palo Verde 1,2,& 3. The Nuplex 80+ control complex is evolutionary and not revolutionary. The control room is designed to capitalize on newer technologies and lessons learned in the nuclear and other process industries. Hence, it improves human factors engineering through wise design, the correct application of human factors analyses, and appropriate use of newer technologies to improve the man-machine interface. However, much of the documentation and experience gained from the current generation of CE power plants remains relevant to the operator of Nuplex 80+.

A further discussion of the operating crew options for Nuplex 80+, potential roles of additional operators (allocation of tasks), and workload analyses for Nuplex 80+ may be found in CE's responses to RAI's 620.24 and 620.25.

TASK ANALYSIS AND PANEL LAYOUT
NUPLEX 80+

I. **FTA IS THE FIRST STEP IN NUPLEX PANEL LAYOUT**
(*RCS Panel is the Example)

1.-Assignment of Functions

A. Review of FTA/Computer sort of FTA data to identify functions

B. Evaluate Functions; determine applicability to RCS

C. Engineering/ Operations review of Reactor Coolant System functions

D. Compile function list

2.-Functions Organized Into Groups

A. Reactor Coolant Pumps

B. Reactor Coolant Seal/Bleed

C. Reactor Coolant System

3.-Functions Organized On Panel

* The most frequently used functions are on the central portion of the panel, others on the periphery, based on their functional relationships with the adjoining panel sections.

4.-F Level Function Analysis

A. Review list of functions and subfunctions to determine adequacy of groups

B. Focus on operating mode

II. DETERMINATION AND ASSIGNMENT OF ALARMS, INDICATIONS, AND CONTROLS

1.-Develop List of Needed Alarms, Indications, & Controls

A. Review Function and Task Analysis

B. Computer Sort:
*Identify Parameters and Characteristics for the RCS

C. Evaluate Parameters and Characteristics:
* Assign to functional groups

D. Independent Evaluation for Other Parameters and Characteristics; for example:
* I&C design requirements
* System 80+ RCS P&ID
* Support system P&IDs
* System 80 operating procedures

E. Engineering and Operator Evaluation
*of parameters and characteristics

F. Compile Information Requirements List

G. Review FTA Results and Other Documents:
* to identify controls for RCS panel function

H. Engineering and Operations Evaluation:
*evaluate list
*modify list

2. Further Engineering Performed

-In addition to the FTA