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September 23, 1980

Dr. Stephen Hanauer, Director
Division of Human Factors Safety
U S Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Hanauer:

Attached are my specific comments regarding the draft of NUREG/CR-1580.

In addition, I particularly wished to comment about three issues the importance of which, I feel, transcends the wording of particular draft recommendations themselves.

1. Color conventions

NUREG/CR-1580 draft unabashedly recommends that the military standard of red for abnormal and green for normal be adopted. I feel that this would be costly, unnecessary, unwise and indeed dangerous. The convention of red for active and green for inactive is well established in the power industry and is properly associated with "hot" and "cold" metaphors in operators' heads. What is normal and what is abnormal, of course, depends on circumstances. "Active" and "inactive" indications can be provided directly and reliably, whereas "normal" and "abnormal" indications can be provided only with some additional logic and in some cases not at all for off-power situations - where emergencies are just as likely to occur. In the future it may well be advisable to have both active/inactive and normal/abnormal color conventions simultaneously, e.g., on CRT graphics. I would propose the following, which I believe makes the present boards consistent with what some have recommended for CRT displays:

- . red - active
- . green - inactive
- . magenta - significantly abnormal, serious warning (magenta is a "nasty" color which is easily distinguishable from red)
- . yellow - marginally abnormal, caution
- . blue - normal - (or background lines on graphics)
- . white - advisory

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2. Control-display compatibility in panel layout.

In performing control room reviews, I have noted frequent violations of commonsense principles of left-to-right ordering of displays and controls marked A,B,C,D, or 1,2,3,4, and of position correspondence of controls with their associated displays. A common reason cited by architect/engineers is that back-of-the-board separation rules preclude the ideal human factors arrangements. If this is so I think it is time to rethink the separation rules, for in many cases I would guess that the safety decrement (supposedly) forced by the separation rules is greater than had no such rules been imposed and some other form of protection of the wires or lines used. In any case I feel there is some clarification or tradeoff work to be done here.

3. Conformance to human engineering analysis and design standards.

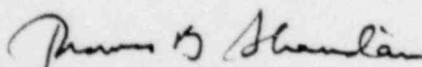
I believe that some of the techniques for control room audit recommended by NUREG/CR-1580 draft are not realistic in terms of time and cost. My experience with control room review has led me to conclude that slavishly videotaping and analyzing all procedural walk-throughs wastes time which might better be spent thinking or discussing procedures with different operators. The same is true of spatial-charting or other task analysis. When time is critical or when widely separated controls and displays must be coordinated, videotaping and spatial task analysis are more relevant. Videotaping is generally inadequate to record where an operator is looking from moment to moment. NUREG CR/1580 might better serve the industry by offering estimates of the man-hours required to perform various recommended practices. I fear that by casually recommending that so many techniques be employed in such detail for all combinations of displays and controls for all procedures, etc. the document may lose credibility. To make human factors not only mandatory, but also credible and acceptable is an important objective.

4. Provision of control and display examples common to nuclear plants.

Much of NUREG/CR-1580 draft dwells on examples of control and display instruments which are not common to nuclear plant control rooms, and many types of instruments commonly found in these control rooms are not pictured or even mentioned. Clearly in the interests of time 1580 had to be gleaned mostly from the military human engineering sources. But the nuclear plant context is different from the military context and the guidelines should reflect this difference. Again credibility of human factors may suffer if this is not done.

None of the above or the attached criticisms of the NUREG/CR-1580 draft should be taken to mean that I do not favor its issuance. I feel that it is a critically important document, mostly appropriate and well written. I offer these comments only in hopes to help make it more beneficial to the utilities and the public.

Sincerely,


Thomas B. Sheridan
Professor of Engineering
and Applied Psychology

Detailed Comments Re NUREG CR-1580 Draft

page xi third Para.

The term "safety-related" is confusing here. There are situations where a violation is not directly "safety-related" in NRC parlance where control panel design is sufficiently compromised or the operator is sufficiently aggravated or penalized in time or mental load that safety is affected indirectly.

page 15; also 3.5.1 on page 34

Videotaping the operator's eye movements is practically impossible and observing all of his hand movements is difficult with one camera. It is not clear that videotaping all procedures is warranted. Audio-taping should use radio transmitting microphones, and operators should be encouraged to use "verbal protocols" to verbalize their thoughts and intents as they perform.

page 17, 18

There should be more detailed examples of task analyses described, including time-lines and spatial mapping of operator's hands and body positions. However, as with videotaping, it is not clear that detailed task analyses is warranted for all procedures. Page 18 and 43 call for specification or "frequency" of each activity, which is ambiguous: some procedures call for single discrete actions, others are time-continuous, others are discrete monitoring occasionally until some criterion is fulfilled.

Page 2

page 27; also page IV-6

A major concern here is reflections of overhead room lights in glass paneled instruments, especially curved panel meters. This is not mentioned.

page 45, last para.

Estimating and plotting performance and/or error probability as functions of cost for alternative backfits for each HED sounds impressive but is not economically realistic.

page I-16

This is a good list but has omitted errors of cognition and memory such as forgetting, remembering wrong things, having wrong assumption etc.

III-17

At the end of the questionnaire should be a section where operator is asked to indicate any relevant concern not otherwise covered which is a potential source of human error, etc.

IX-2

The HED priority determination procedure requires 1-0 judgements on seven questions: whether plant safety is jeopardized, etc. and then a complex rating scheme is to be followed. I suggest that the individual tendency for the rater to swing toward 1 or toward 0 will be much more significant. Perhaps the possibility of some levels intermediate between 0 and 1 would be appropriate. This rating scheme clearly is not immune

Page 3

from "opinion" (as depicted in an earlier section of 1580 draft), and is fraught with subjective scaling problems. Nevertheless subjective scaling is essential here, and provided proper "meaning anchors" and careful exploration of procedures are given it should prove useful.

Detailed Comments, Appendices

CRE 12

Need ordinate label on figure.

CRE 20, 21, also VD-2

Not realistic that an instrument can always tell you when it has failed.

WA1 through WA6

These sections seem to be based on military systems where operator is seated in one location. What if there is no seated operator? What if the panel is entirely vertical? Even if seating is a possibility, what if he is free to move - in which case "lateral displacement" makes no sense?

VD-2

Sentences under "redundancy" are non-sequitur.

VD-30

Update section to include LED's and current technology

VD-52, OCI

Update statements re color display technology

VD-55 and OCI

Update section re new computer input devices other than light pens (e.g. touchpads, mouse, bit-pad, etc.)

Page 4

VD-75, 107, 110

The military standards for color coding cannot be adopted so easily to nuclear power plants. The commonly accepted convention that red-green means active-inactive in the nuclear power industry is in direct conflict with what is recommended here.

VD-80

There is too much emphasis on circular dials compared to present or future displays in nuclear plants.

VD-99

Too much emphasis on 28 inch viewing distance

AD-

Too much detail on auditory displays. This should be limited to practical voice communications and to auditory warnings.

CON-2

"highly frictionalized" is neither clear (it needs operational definition) nor good English.

CON-

Many control types discussed are not commonly used in nuclear plants. Some controls common in nuclear plants are not mentioned (e.g. multi-way slides switches used on valve auto-control stations)

CDI-8,9

The stated principles are often in direct conflict with one another. The important point is not simply to be in conformance with one of these, but to make the best tradeoff between them.

PA-41

Moving scales should be avoided. Why give in on this point?

PA-56

Need examples of good and bad use of words.