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September 26, 1980

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Director of Human Factors Safety

Dear Sirs:

This letter transmits INPO preliminary comments on draft document NUREG/CR-1580, Human Engineering Guide to Control Room Evaluation. The due date for comments was published as September 29, 1980.

These comments were produced by INPO's Criteria & Analysis Division. Leadership for the comments was provided by Jack Voyles, assisted by our Human Factors Staff - Larry Potash, Mike Tulloch, Mike Lewis and other Division personnel. We offer these as preliminary comments with more comments planned.

As noted in item 24 of the comments, we have contracted with Joseph L. Seminara for assistance in preparing comments on NUREG/CR-1580. These comments are not presently available but we plan to forward them to NRC by mid October 1980.

INPO is sponsoring a workshop on this subject on October 2nd and 3rd, 1980, entitled "Control Room Evaluation Workshop." At the workshop, we expect to receive additional comments on NUREG/CR-1580 from utility and other industry personnel. We plan to forward these to NRC by mid October 1980, also.

Sincerely,

Randall W. Pack
Acting Director
Criteria & Analysis Division

RWP/ne

cc: E. P. Wilkinson
J. L. Voyles

9/26/80

Preliminary INPO Comments on NUREG/CR-1580
Human Engineering Guide to Control Room Evaluation

1. NUREG/CR-1580 needs better coordination with other tasks listed in NUREG-0660, many of which bear direct relationship to human engineering problems. Major examples are training, simulator use and development, and operating procedures (Tasks I.A.2, I.A.4, and I.C, respectively). The Preface, pp. iii, of NUREG/CR-1580 states that 1580 is based on task I.D of NUREG-0660 and further uses the exact language of 660 section I.D.1.a for the first eight sentences. Stated then in 660, section I.D.1.a (but not in 1580) is this important statement: "This review will be performed on a schedule consistent with the implementation of other requirements for enhancing operator effectiveness including necessary retraining. This will ensure that the measures correcting control room design deficiencies will be considered in conjunction with other actions affecting the operator." The 1580 preface later adds this disclaimer: "Some material not applicable to control room reviews (e.g. guidelines for procedure content, operator training) has been omitted from the Essex report as submitted to the NRC. This material will be used in other NRC reports and guidelines dealing with human factors issues not related to control room design." From these statements we conclude that coordination with other tasks of NUREG-0660 has been deleted from NUREG/CR-1580.

We recommend that the "measures for correcting control room design deficiencies will be considered in conjunction with other actions affecting the operator" (as stated in NUREG-0660, I.D.1.a) are necessary measures to the correct application of NUREG/CR-1580, and directions be included in 1580 to coordinate these other actions. The following examples illustrate this recommendation:

a) Training. This activity is not mentioned in 1580 except that the Training Coordinator is a member of the evaluation team, with duties listed in Appendix I to coordinate implementation of training backfits. This could be corrected by including training as a part of 5.0-Reporting and 6.0-Implementation,

with adequate references to applicable tasks in section I.A.2 of NUREG-660. Backfits without proper training could be a source for human error.

b) Operating Procedures. NUREG/CR-1580 relies on operating procedures for Walk-Through & Task-Analysis but no mention is made of the nine tasks in NUREG-660, item I.C. to improve the quality of procedures. But NUREG/CR-1580, section 2.5.4 states one objective of walk-throughs is to "validate the completeness of task analyses of operating procedures." This requires coordination. Operating Procedures could be used for control room evaluation but the procedures should first be valided through tasks of NUREG-660. Substantial changes should be made to NUREG/CR-1580 to include coordination with NUREG-660 for upgrading operating procedures.

2. NUREG/CR-1580 lacks evaluation criteria to judge the acceptability by NRC of the reviews performed and the design modifications implemented. This is scheduled in NUREG-660, I.D.1 for Feb. 1981. This can be corrected by adding a section about forthcoming NRC evaluation criteria in section 5.0 of NUREG/CR-1580.

3. NUREG/CR-1580 outlines a guide for a one-time review for control room evaluation. No method is suggested for changes and modifications that occur for other reasons in control rooms after the review is complete. Many changes are postulated for nuclear control rooms, some of which are already outlined in NUREG-660 and more will be following from studies and other tasks in NUREG-660. Although the intent of NUREG/CR-1580 (to find current human factors deficiencies in control rooms) will be met by a one-time review, we recommend that all subsequent changes and modifications be evaluated for adherence to human factors standards and evaluations.

4. The overall content of NUREG/CR-1580 appears overstructured and overcomplicated. We agree and endorse the statement of V.A. Moore in the preface to 1580, page iv, stating: "We also expect that the format will be revised to simplify the application of the guidelines and

procedures to a control room design review." We are concerned that the overstructure and complications envisioned as possibilities for NUREG/CR-1580 will make application difficult, almost like losing the forest for the amount of trees. Simplifying will certainly aid in the application of this guide.

5. The forward on page xi of NUREG/CR-1580 states in the second paragraph: "Part I suggests a procedure for applying the guidelines "Part II" to uncover potential human engineering problems... This procedure is suggested and should not be considered as an NRC requirement." We agree with this statement because it should be recognized that there may be other acceptable programs for doing control room evaluations. Since the preface on page iii states "final guidelines will be issued as NUREG-0700," we are concerned that all of the material will be issued as a final NUREG and will leave little room for other procedures for applying guidelines. We suggest that statements such as "stating that this is only a suggested procedure" be moved to the introduction on page 1., and clarified by adding "Other programs for performing control room reviews will be considered by NRC but such programs must comply with the intent of this NUREG."

6. The major thrust of NUREG/CR-1580 is to find and correct control room items that are wrong. A major concern should also be to find information or controls that are missing and information or controls that are too extensive. Certainly the reviews against generic problems, operator interviews, control room survey procedures, check list procedures and walk-throughs (we are intentionally leaving task analysis out of this list) will find some missing or too much information. It is very probable that some will be overlooked. Special emphasis should be made to this point. We suggest that the management organization (section 2.0) include a review team charged with the responsibility of reviewing systems on a walk-through basis using important team members supplemented by a system engineer who is completely knowledgable of the system being considered. The team should also be supplemented by I & C maintenance personnel who can identify equipment problems and consult on backfits. Such a group review has many advantages as the expertise

flows between team members and questions can be asked as the operation is reviewed by the team. (This question supports the comments in the Preface, page iv, stating "Other modifications and revisions planned at this time...determine if the control room provides adequate status information to the operator.")

7. We estimate the manpower expertise requirements to perform control room evaluations according to NUREG/CR-1580 to be 1½ to 2 man years. This appears excessive. The excessive manpower requirements are caused by: overstructured, overcomplicated content and by extensive use of task analysis. Simplifying the applications (see item 4) will also reduce manpower requirements. We are also recommending further to reduce the manpower requirements for task analysis; this is discussed in the following section.

8. We seriously question the use of extensive task analysis in control room reviews. Task analysis is a recognized human factors tool. However, its use has mainly been in the early stages of the design process and then throughout the design process to assure that all man/machine interfaces are correct and that human factors are duly recognized. Task analysis could also be an extremely useful tool in evaluating operating procedures. As used in NUREG/CR-1580 (sections 2.5.6 and 3.6) task analysis is applied to yield baseline requirements on: Staffing, Information Display, Control, Task Timing, Training, and Procedures. Staffing requirements are covered in NUREG-660 (task I.A.1) so task analysis should not cover staffing in 1580. Training requires coordination (as discussed in item 1) but should not be expanded by task analysis in 1580. Operating procedures are covered by task I.C. of NUREG-660 so task analysis should not be used in 1580 to validate procedures. The remaining items of the base line list, Information Display, Control, and Task Timing can be addressed by combining a simplified task analysis with an expanded walk-through of selected tasks. We recommend this approach to identifying human error and name this walk-through/talk-through. Walk-through/talk-through replaces the sections on procedures walk-through and task analysis, retains some of the elements of procedures walk-through and uses a simplified version of task analysis. Walk-through/talk-through will be discussed in more detail in the next item, 9.

Task analysis as presently used in NUREG/CR-1580 is an extensive effort requiring some four to twelve man months to complete and greatly complicates the task of reviewing the control rooms. We recognize that task analysis was used by Essex Corporation in formulating NUREG/CR-1580 but this was before NUREG-660 was published. We know it was useful in doing control room reviews in the past. Now with NUREG-660 being issued to improve operating procedures, training and many other aspects, we suggest that task analysis can be simplified and incorporated in walk-through/talk-throughs.

9. Item 8 discussed simplifying task analysis and expanding walk-throughs with walk-through/talk-throughs. This would modify sections 2.5.4, 2.5.6, 3.5 and 3.6 of NUREG/CR-1580. Walk-through/talk-throughs should not be based soley on operating procedures. Operating procedures should be supplemented by system descriptions. Walk-through/talk-throughs require analysis as a team effort utilizing additional expertise as discussed in item 6. The team should evaluate each emergency task and sample normal operations tasks. These tasks employ a number of sub-tasks, with many sub-tasks appearing in several tasks. Sub-tasks (such as reactor trip) analysis should be conducted only once and need not be repeated. The team should use simplified task analysis as suggested in 8. Simplified task analysis should use a simple form (that includes information such as Figure 2.5) but used mainly to show the task has been analyzed by the team. The team method will surface human engineering discrepancies and also recognize situations not covered in either system descriptions or operating procedures.

We question the need for video-taping walk-through/talk-throughs. This may be a time saving tool so we recommend that its use could be adequately described in an Appendix.

We also recognize that walk-through/talk throughs will take a great deal of time in operating plants. To simplify and reduce the time needed in operating plants, we recommend that walk-through/talk-throughs be conducted either on a simulator or on a control room mockup. Simulators are mentioned in 1580 as a possibility but it should also be recognized that the extensive training requirements of NUREG-660 will

keep simulators in constant use so that availability for walk-through/ talk-throughs is questionable. Some utilities have found mockups to be extremely valuable in conducting walk-throughs and we are suggesting that NUREG/CR-1580 include a recommendation for mockups of control rooms. The mockups should be full scale and use photographic reproductions of all controls and instruments with complete labeling. Rehearsal activities can then be done using the full scale mockup and greatly improve the efficiency while reducing actual time in the control room. We will have more to say about mockups when we talk about evaluation techniques (item 18 & 19).

10. Section 1.2 lists a taxonomy of errors based on a list of general catagories. We suggest that this list be expanded to also include communication errors. Such errors are mentioned in the Appendix supporting this list and since they are extremely important should be added to the list.

11. The evaluation team structure outlined in section 2.1 should only be shown as a suggestion. We are sure that many forms of organization could satisfy the composition of the team. We see the need for 2 additional members of the team as discussed in item 6. We recommend that the structure be left to the individual review teams, but add to the existing list I & C maintenance personnel and system engineers.

12. The section on generic problem reviews as covered by 2.5.1 and 3.1 presents a good method for review. We only suggest that 2.5.1 be devoted only to this and that operator interviews be structured in another paragraph.

13. Operator interviews as covered by 2.5.1 and 3.2 are another excellent tool and method for collecting data. The method is outlined on page 23, section 3.2.3. However, it says that every licensed operator should be interviewed and the necessity for this is unknown. We suggest changing this to some much smaller percentage perhaps in the order of 33% (or 6 minimum) to provide a valid sample. Also some means should be provided where any operator could supply comments to a designated lead operator for control room problems. The interview process takes

approximately 5 hours and reducing the number of interviews would substantially reduce the work without degrading the effort.

14. Items 2.5.3 and 3.4 describe the use of check lists. We agree that check lists should be used. Before we can analyze check lists, they should be published. We note that with major concern that they were to be published in Appendix V, but are not available. We recommend that these check lists be published immediately.

15. Section 2.5.7 concerns photographic support. We agree whole heartedly with the objectives of compiling many photographs. Their use becomes very valuable in later stages for identifying problems, writing reports, etc. We think the information on cameras and photographic methods is probably too detailed and should be left to either the utility photographic departments or commercial photography. Section 2.5.7.1 says that the photographs provide the evaluation team with photographs for mockup construction. However, the mockups are not mentioned elsewhere in the report. Also see items 9, 18, and 19.

16. Section 3.1 concerns review against generic problems. The method described in 3.1.2 is much too detailed by requiring analysis of every control display, etc., and this does not agree with the objectives stated in 3.1.1, to give a broad and general review. We suggest that the section 3.1.2 be modified to note only typical characteristics which violate human engineering practices.

17. Section 3.3.4 concerns Emergency Garments. We feel more emphasis should be placed on operation with face masks and less on fully suited operation as smoke or gaseous releases throughout ventilation systems are more probable than full scale contamination of the control room. Suit-up time for a single operator may be a useful measure. The "suited" voice communication measures might more appropriately be conducted using two members wearing face masks than by two fully suited operators. Due to the off-normal nature of operations requiring protective clothing, we also feel the communication test should be conducted for use of telephone, P.A., and radio while

wearing the mask. At plants lacking simulator activity, we doubt the utility of a suited procedure walk-through and suggest that a suitable test could be conducted using the mockup in section 9 of this report.

18. Section 4.0 discusses "Evaluation of Human Engineering Discrepancies". The final step listed in 4.1.2 is the identification of suitable backfits and several potentials are listed for reducing operator error. Human engineers typically can consider two, three, or four different methods of correcting problems. The best method is not often readily apparent. For evaluation of these different backfits, we suggest another use for mockups first discussed in item 9. A mockup can be used to show several changes without impacting on the actual control room. Backfits can be evaluated by the review team to come up with the best suggested backfit and also can be photographed to document the backfit. Therefore, we again recommend that mockups (full scale) be recommended for NUREG/CR-1580 and the evaluation section recommend using mockup for evaluating the best backfit.

19. Section 4.2 describes the method for prioritizing human engineering discrepancies. Although some of the ideas relating to prioritization are good, such as using safety-relatedness and probability to correct an error, this section is inadequate and sometimes confusing. The likelihood that the deficiency will result in an error is not discussed. Appendix IX-2, section B, items 4-7, discuss a few of the many possible "shaping factors" that should be considered in assessing the probability of an error. No acceptable prioritization scheme has yet been proposed. We suggest that the full scale mockup discussed in items 9 and 18 above will be extremely useful in determining prioritization requirements to simplify them and make them more understandable because this is necessary in the development of criteria for an acceptable evaluation.

20. Section 4.2 also requires "a second phase of prioritizing" stating "an independent panel of plant experts should examine the data used to assign priorities to HED's..." As independent panel will be difficult to staff because the best "plant experts" will be on the evaluation review team, will add substantial manpower requirements to control room evaluation, and will add little to the efforts of a properly structured review team. We recommend the requirements for an "independent panel" be deleted.

21. Section 6.0 concerns implementation. As we discussed in section 3 of this report, the entire report deals with a one-time effort. We suggest that implementation should be revised to require analysis or documentation that analysis has been performed for modifications and changes implemented after the review is completed. Also, as discussed in section 1.a of this report, section 6.0 should also discuss training for backfits.

22. Section II presents a host of "Human Engineering Guidelines." Most are adopted from MIL-STD-1472B(1974). While applicable to military systems, many items are not directly applicable to nuclear control rooms. For instance, WA-23 limits panel (standing) height to 72". EPRI reports have suggested panel height limited to 76". Utilities have used even higher panels by enlarging displays above 76", so WA-23 is of questionable validity. Another instance, VD-94 states, "it is not necessary to have a pilot light indicating ON, if the condition is indicated on a meter." ON lights also show power for safety systems and cannot be removed in most instances. We recommend that Section II needs extensive review by personnel with nuclear plant expertise.

23. The above comments have been collected by INPO personnel while using the information in NUREG/CR-1580 to prepare for the workshop being presented October 2nd and 3rd for Utility personnel. These comments reflect actual experiences while conducting a pilot control room review in an operating nuclear plant.

24. INPO has also contracted with Joseph L. Seminara to review and provide additional comments. These comments are not yet available because of Seminara's commitment to the EPRI and INPO workshops. They will be available sometime during the second week of October and will be forwarded to Nuclear Regulatory Commission for additional consideration.