

Lockheed

MISSILES
& SPACE
COMPANY,
INC.

November 21, 1979

Dear Gordon:

Attached is the detailed critique of the ESSEX first draft. In summary:

- o Essex did a good job of evaluating the TMI-2 control room in terms of causal elements in the man-machine aspects. That work is sound and should be expanded with good photodocumentation that is already available.
- o The comparison between TMI-2 and the other two plants is far too shallow to draw meaningful conclusions of the type made. A more representative selection of comparison plants is needed. Use the EPRI NP-309 report and the Zion evaluation to bolster your conclusions. I think the wrong conclusions have been drawn. The report seems to say that TMI-2 is significantly worse than the other two plants and hence we should have expected an accident. My view is that none of the power plant control rooms (the twenty that I have seen) is properly designed in terms of the man-machine interface considering the nature of the potentially disastrous consequences. We should be concluding that a more formal and systematic approach to designing for the operator is needed across NRC/A-E/NSSS/Utility realms of responsibility.
- o The NRC comes off as an innocent bystander. What has the NRC done to safeguard the public in terms of the human factors aspects of the control room. Are there any human factors people (with bone fide credentials) on the staff? Has a Branch been created to deal with the development of human factors data, application of HF yardsticks in the review process, raise the awareness level of inspectors for HF problems, etc.? The answer is NO! When EPRI NP-309 surfaced several years ago, why didn't the NRC take some positive steps in the HF area? In my contacts with NRC folks there has been no understanding of HF. To the people I have met HF is something of a "black art."
- o The report leaves me in a quandry as to what to do with respect to plants already in existence, those on the drawing boards, and those of the future. Should everyone go to CC and Duke and try to copy their style of management? Do we shut down all the existing plants until the control rooms are redesigned? Can the CRs be enhanced in some significant way? Do we make some quick fixes in added displays, training, procedures and say the problem has gone away?

I will now review your draft of the report over the holidays. My best wishes for a most ple. Turkey Day.

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CONTENTS ON FIRST DRAFT SUBMITTED BY ESSEX DATED OCTOBER 22, 1979

| <u>PAGE</u> | <u>PARAGRAPH</u> | <u>REMARK</u> |
|-------------|------------------|--|
| 5 | 1 | Human factors is the science and technology of applying behavioral and physiological ... |
| 7 | 2 | Same as above |
| 11 | 3 | This paragraph may be misleading. What have been identified as applicable human engineering criteria were not generally recognized as belonging to any systematic focus on the man-machine interface. |
| 13 | 2 | How many interviews administered? Breakdown of interviewees? |
| 14 | 3 | In discussing "Industry Standards" you might note that no bona fide human factors specialists were involved in formulating these standards. |
| 14 | 2 | What was the role of the NRC in applying the SRP. To my knowledge the NRC had no specialists in human factors and no yardsticks for assessing human engineering aspects of control room design. If the NRC had an impact in reviewing man-machine aspects of control room designs, the twenty designers that I interviewed were not aware of it. |
| 15 | 2 | I don't believe Calvert Cliffs and Oconee in contrast to TMI-2 constitute a representative sample on which to base comparisons. You should factor in the five plants covered in EPRI NP-309. It wouldn't hurt to visit several others as time and money allow. |
| 33-62 | | Comments on these pages were covered during our November 15-16 meetings |
| 43 | 7 | It might also help to have professional human engineering/industrial design assistance in the analyses, design and review processes. In many cases the HF/ID team assumes the responsibility for the mockup and all integration on the CR design effort. Perhaps this is a more critical factor than the distinction between a "systems engineering" vs a "discipline-requirements" approach. Look what CC did with mirror imaging, backpanels, annunciator panels, etc. despite the so-called systems engineering approach. I would put my money on a "discipline-requirements" type approach if the Lead Engineer had a strong HF/ID component on the project design team vs. a "systems engineering" approach with no formal human factors or ID. |

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| 64 | 1 | Incorrect assumption that the utility will do a better job than A/E. The worst plant that I have seen (not TMI-2) had the greatest utility participation in the design process. The utilities know less about HF than the NSSS vendors but client preference dominates CR design in many cases and destroys good design features proposed by the NSSS vendors. Please read my design practices survey. We need to educate the utilities and the NRC so that good HF design is demanded from designers. |
| 64 | 2 | Who says the A-E has little responsibility for operational concerns? Why can't an A-E apply the "systems approach"? This is totally erroneous. |
| 64 | 2 | What is wrong with the CR reflecting one design philosophy (assuming that it is the correct philosophy)? This whole page reflects the notion that the A-Es are the villains in the piece. Have you looked at CRs designed by B&W? That Lynchburg simulator design is nothing to write home about. |
| 65 | (3) | Don't know what you mean by extraordinary documentation. |
| 65 | 2 | Don't believe that you ever make the case for one form of management vs another. |
| 65 | (c) | While CC is better than TMI-2, there are too many glaring deficiencies to hold it up as a paragon of virtue. |
| 65 | 2 | The writer has a tendency to equate a mockup with Human engineering. While HF specialists tend to use mockups for design and evaluation, the mockup doesn't in and of itself make for good human factors engineering. There was no human engineering in any formal sense in any of the three plants being discussed. |
| 66 | 3 | Again you are saying that the client influences plant design in a positive way. This is not necessarily so. You can have a stubborn, ignorant client who places CRTs on standup consoles because it is the utility's philosophy to keep the operators on their feet at all times. Some utilities insist on placing controls at floor level within easy kick range, etc. etc. |
| 66 | (d) | Why single out TMI-2 management for lack of consideration to human engineering factors. The problem is epidemic. Don't understand what you are saying in last sentence. |
| 70 | (g) | Even before TMI-2, the standard was a joke in the industry. There were no HF people on the committee that put the standard together. |

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| 71 | 2 | How did you establish that all three control rooms were designed for one man operation? While many tech specs call for one man operation, the utilities generally have two men on hand per shift. The basis for the one-man determination is obscure. It is not based on work load analyses during different operational modes. In fact many operations call for the one operator to be in two places at once. |
| 73 | 2 | You haven't made the case. CC and Oconeec should have been compared very specifically in terms of the causal elements uncovered in the TMI-2 accident. |
| 76 | (e) | Lack of reach and visibility were not the problems at TMI-2. What point is being made? See above remark. In my view all three power plants reviewed are not optimized from a human factors standpoint. I can envision a serious accident happening at CC or Oconeec. The fact that the latter may be slightly better overall than TMI-2 doesn't reassure me. The point is that all three plants allow for human error and not that two are good and the third is poor. |
| | (a) | Please recheck the red or green status of annunciator lights to see if the code has any meaning that we might accept as useful. Most control rooms provide red or green indicator lights for valve position. Are these red/green notations consistent with the annunciator system coding? I suspect that CC is contradicting your rule #2 below on this page. |
| 77 | Fig. 16 | I don't believe you found 14 meanings for red at TMI-2. These probably can be subgrouped into two or three meanings. |
| 78 | 1 | Green means no-flow of fluid, electricity, etc. and hence is consistent |
| 78 | 2 | Are you really happy with the coding of any of the annunciator systems observed? |
| 78 | 3 | The real point is that deviant conditions are not manifest at a glance as would be the case with the Green Board concept. There is no logic built into the display system so that the operator is told that a valve is open but should be closed, etc. |
| 78 | (b) | The operator must memorize "Immediate Actions" and should always have available procedures for guidance if needed. |
| 79 | 1. | <u>Fidelity</u> ---What the writer thinks is reasonable to assume here differs from my experience. |
| 81 | 1 | State-of-the-art for utilities but not for military settings |

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| 81 | 2 | Are you saying that written procedures are a thing of the past? |
| 87 | (h) | I don't agree with the implications of the summary, namely, that TMI-2 was so inferior to CC and Oconee that we shouldn't be surprised that an accident happened at TMI. The fact is that TMI-2 is quite typical of power plants in general. We should be highlighting the fact that none of the three plants reviewed measure up to the degree of attention to human factors required of nuclear power. The comparison between the three plants was too superficial to be meaningful. |
| 88 | 2 | <u>Categorical disregard</u> is not too strong for me. However, <u>I would not direct this language solely at TMI.</u> |
| 90-94 | | Most of these observations of deficiencies are noted in EPRI NP-309. You should draw from earlier work to substantiate the case that nuclear power plant control rooms in general do not live up to human engineering standards and that this cannot be tolerated in so vital and dangerous a case. |
| 110 | 2 | You are being unfair to Met. Ed. There is a general <u>ignorance in the industry regarding procedures.</u> In any case, it doesn't necessarily follow that because operators are not in the loop to update procedures then Met. Ed. is clearly downgrading operators. |
| 110 | 3 | Fuzzy statement. We could rely on training if it were adequate and the control room was optimized. |
| 112 | 2 | Very weak statement on selection. Is it true that most operators are former Navy? I know that many are but am not sure that <u>Most</u> are. TMI is a Navy ship but many plants are not. There is a strong need for valid selection techniques for operators. There isn't even a decent job analysis of the operator's role. There is no reason to believe that the NRC licensing process is a valid screening approach. In fact, there are indications to the contrary. |
| 121 | 3 | Some words might be said about negative transfer of training, the value of standardization in control room designs, the use of identical procedures in the simulator and the operational control room. |
| 126 | 2 | None of the present simulators provide performance scores. EPRI has funded General Physics to come up with an objective performance measurement approach using the TVA simulators. |
| 127 | 2 | These generalizations apply to the whole industry and not just TMI |

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| 131 | 2 | "Thoughtful" should be: systematic human factors analysis. |
| 131 | 4.2 | Why should trainers be involved in the writing or the revision of procedures? Have you checked the qualifications of trainers? I would prefer that operators reviewed or initiated procedures given some guidance in the formatting of procedures. |
| 132 | 3-4 | The approach to training paralleled the <u>industry's</u> approach to information display. This is not a uniquely TMI problem or deficiency. |
| 133 | 1 | Same as above |
| 134 | 2 | Is there some formula based on evidence for determining what percentage of the training should be simulation? |
| 134 | 5 | If your last two sentences are true, then there are many disasters on the horizon. You are indicting the whole industry. |
| 138 | 3 | The report ends on a note of total despair. Do we shut down all operational control rooms because proposed quick fixes fail to address fundamental problems? Is there a way out of this pit short of halting power generation until new control rooms are developed? If TMI-2 can't be fixed or patched up, neither can most of today's CRs. |