DISCLAIMER

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HUMAN RELIABILITY ANALYSIS: SESSION SUMMARY

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Abstract

The use of Human Reliability Analysis (HRA) to identify and resolve human factors issues has significantly increased over the past two years. Today, utilities, research institutions, consulting firms, and the regulatory agency have found a common application of HRA tools and Probabilistic Risk Assessment (PRA). The "1985 IEEE Third Conference on Human Factors and Power Plants" devoted three sessions to the discussion of these applications and a review of the insights so gained.

This paper summarizes the three sessions and presents those common conclusions that were discussed during the meeting. The paper concludes that session participants supported the use of an adequately documented "living PRA" to address human factors issues in design and procedural changes, regulatory compliance, and training and that the techniques can produce cost effective qualitative results that are complementary to more classical human factors methods.

Introduction

In 1979 and again in 1981 the Institute of Electrical and Electronics Engineers, IEEE, co-sponsored the first two workshops on Human Factors and Nuclear Safety. Both meetings were forward looking in that they addressed questions of relevant future research needs and potential future application of human factors techniques to issues facing the nuclear industry. The first workshop, chaired by Dr. J.R. Penland, had the narrow goal of characterizing the state of knowledge and identifying needed research specific to the commercial nuclear industry[1]. The results of that meeting were heavily directed toward the evaluation of human performance and the quantification of error rates. Workshop Two broadened its goals by including more in the area of classical human factors and the techniques included within that field. Dr. T.B. Sheridan, Chairman, included such then-current issues as control room reviews, safety parameter display systems, and automated control issues.[2]

During the planning stages of the third meeting in the series, the organizers, under the direction of Dr. H.L. Parris, decided that enough time had elapsed to allow the industry to review and evaluate the application of human factors in power plants. The primary thrust of this conference, therefore, was to have individuals that have utilized human factors to resolve specific problem areas report on their success and share their lessons learned. To accomplish this, the conference planners abandoned the workshop form of the first two meetings and used paper and panel sessions to transfer knowledge. Five technical areas, along with respective session organizers, were identified (e.g., three to address specific issues: control room operations, organizational effectiveness, and maintenance effectiveness, and two to review methods: human factors methods and human reliability analysis.) It is the sessions that include this latter subject area, Human Reliability Analysis, that is reported on herein.

Background

To meet the stated goals of the conference, three sessions were devoted to review the use of Human Reliability Analysis (HRA) and Probabilistic Risk Analysis (PRA) in the industry's decision process for resolving current issues. Sessions one and two, titled "Application of HRA in Risk Management" and "Enhanced Reliability Through HRA," presented case studies of HRA/PRA results and their use in resolving human factors concerns. The third session, "Human Reliability Models" reviewed the analytical process and performance model development and validation. The author organized the sessions and chaired the first two, Dr. D.H. Worledge chaired session three, and Mr. E. O'Hare performed the needed administrative duties during the meeting. In order to treat the ongoing efforts in this area evenly, papers were submitted that represented the consolidated work of four utilities, the Electric Power Research Institute, two consulting firms, two National Laboratories, the U.S. Nuclear Regulatory Commission, and the U.S. Military Academy.

Program Summary

Sessions one and two, concentrating on case studies, presented the experience of four utilities. Those represented were Long Island Lighting Co., Boston Edison Company, Duke Power Company, and Northeast Utilities. Each of the four papers used an integrated approach that merged the human reliability analyst directly into the team. This resulted in an optimizing of the PRA process by reducing the need for iteration as well as increasing the possibility of identifying all potential man-machine influences. Although each application was quantitatively based, the authors stressed the value of the qualitative insights gained through the exercise. Mr. Fragola stressed in his presentation that the qualitative finding drove the study and identified relatively easy fixes to the Shoreham internal flooding problem. Dr. Dykes stated that the majority of cost effective selections that were found in his study on the Pilgrim HPCI system were also qualitative. This is demonstrated by the significant reduction in unavailability of the auto isolation valves in the HPCI system by a change in the test procedure to staggered in place of sequential valve testing. The study was able to identify potential over-testing due to the systems impact of independent test procedures. Mr. Dougherty's presentation showed how the use of new techniques such as SLIM[3], and OATS/TRC[4], were used at the McGuire power plant to modify procedures by using a closed loop approach of analysis and training simulator runs. This concept of integrating probabilistic risk assessment with the use of training simulator runs was also shown to be very useful in the last utility sponsored paper by Dr. Beveridge. In his

presentation, Dr. Beveridge discussed the use of PRA scenarios to drive event-based use of the simulator to review crew response and ability to solve new problems. This in turn aided in training and supplied success and error rates back to the PRA process. Dr. Beveridge also underscored the need to have the HRA specialist involved throughout the analysis process and felt that some operator actions should be placed in the event tree to be treated adequately. This paper also introduced the "Living PRA Model" that, through a corporate commitment should be maintained to the real plant state and used to review the new designs and regulatory impacts as well as to assess operational crew performance. The four authors/presenters all agreed that the use of HRA allows the introduction of the all important but not obvious multi-failure scenario when it could be overlooked by more classical qualitative human factors techniques.

To conclude the two sessions on application, Ms. Spettell, representing Dr. Ryan, presented the results of NRC research into the usefulness of currently documented PRAs in directly resolving regulatory issues. The results supported the fact that although completed PRAs could be used, the poor and incomplete way in which they are reported would require major reanalysis prior to their use. This, along with the above success stories of the use of these techniques, suggests that if the industry is to conduct future PRAs, it would be more cost effective to consider better documentation. This would allow the plant model, data, and operating assumptions to be effectively used in future regulatory or availability issues.

The third session in Human Reliability Analysis was titled "Human Reliability Models" and had four papers addressing the development and validation of analytical engineering models that could be used in the review of human performance. Dr. Worledge chaired the session and presented his perspective of the future in the area of modeling. Dr. Worledge developed a framework that linked psychological knowledge, human slips, time dependent mistaken actions, and crew predominant mental states. A family of such models was proposed to the audience. Next Dr. Samanta presented a human performance model for multiple failures. The difference in this paper was that for one of the first times it presented the results of a small scale laboratory controlled model validation study. This theme was also discussed as part of Dr. Hannaman's paper on a new cognitive reliability model. Both authors discussed the details of the models and the results of cost effective, small scale laboratory experiments. The last paper, by Dr. Schurman, addressed the level to which an engineering model of human performance should be anchored to psychological constructs. This question has remained unresolved since the first in this series of meetings back in 1979 and is a major discrepancy between the psychological and engineering communities. Is a black box approach reasonable? The conclusion of this presentation, the correctness of the use of a non-psychologically based statistical model, is totally dependent on the objectives of the analyst. The question remains generally unanswered.

Conclusion

A total of nine papers plus this author's introductory remarks were presented. In all a common thread was seen. A commonality that shows that the HRA/PRA community is converging on useful products from techniques that were mere research tools back in 1979 and 1981. In summary:

1. The approach must integrate man and system.

2. Currently qualitative results are more useful in decision making than the absolute numerical ones.

3. Engineering models are useful and can and should be validated prior to use in decision making.

4. PRA and simulation make an optimum analysis and training tool.

5. A PRA or HRA must be correctly documented and considered as a living study to be useful.

In closing, I conclude that HRA has matured to a level that makes it a viable tool to be considered as one of the standard techniques to address human factors issues. Although it cannot at this time address all questions, it does add a new and different color to human factors studies. However the industry should be cautioned on indiscriminate use of HRA techniques. Although major successes have been reported, further research and validation studies are needed to use the full potential of these techniques. Lastly, a lack of communication between the engineering community practicing HRA and the human factors community has led to a general lack of acceptance of the approaches reported herein by human factors specialists. Where in 1979 the IEEE attempted to open dialogue between the nuclear industry in general and human factors specialists, there is now an equally critical need to enhance communication between these two technical specialties.

This in itself could be the subject of yet another meeting.

References

1. "The Human. The Key Factor in Nuclear Safety," 1979 IEEE Standards Workshop on Human Factors and Nuclear Safety.

2. "The Man-Machine Interface and Human Reliability: An Assessment and Projection," 1981 IEEE Standards Workshop on Human Factors and Nuclear Safety.

3. Embrey, Humphreys, Rosa, Kirwan, and Rea, "SLIM-MAUD: An Approach to Assessing Human Error Probabilities Using Structured Expert Judgment," Vols. 1 & 2, NUREG/CR-3518, March 1984.

4. Hall, Fragola, and Wreathall, "Post Event Human Decision Errors: Operator Action Tree/Time Reliability Correlation," NUREG-CR-3010, November 1982.