UNITED STATES
NUCLEAR REGULATORY COMMISSION
Nuclear Safety Research Review Committee
Washington, D.C. 20555

January 14, 1994

Mr. Eric S. Beckjord, Director
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Beckjord:

Enclosed is the report from the November 29–30, 1993 meeting of the Subcommittee on Advanced Instrumentation and Controls and Human Factors of the Nuclear Safety Research Review Committee (NSRRC). This report was discussed at considerable length at the January 13–14, 1994 meeting of the NSRRC. The Committee, after its deliberations of the subcommittee report, endorsed it and has accepted it as a report of the NSRRC.

A report of the Committee meeting as well as reports from the Advanced Reactor Subcommittee and the Severe Accident Subcommittee will follow at a later date.

Sincerely,

David L. Morrison
Chairman
Nuclear Safety Research
Review Committee

DLM/lm

Enclosure

January 14, 1994

REPORT ON THE MEETING OF THE SUBCOMMITTEE ON ADVANCED INSTRUMENTATION & CONTROLS AND HUMAN FACTORS NOVEMBER 29-30, 1993 AS ADOPTED BY NUCLEAR SAFETY RESEARCH RFVIEW COMMITTEE JAN'JARY 13, 1994

Sub-Committee members in attendance:

Mr. Edwin E. Kintner, Chairman
Dr. David Morrison
Dr. Neil E. Todreas
Dr. Robert E. Uhrig

NRC staff participants:

Mr. Eric S. Beckjord, Director, RES
Dr. Brian Sheron, Director, Division of System Research, RES
Mr. Tom King, Deputy Director, Division of System Research, RES
Mr. George Sege, Technical Assistant to the Director, RES
Mr. Frank Coffman, Chief, Human Factors Branch, DSR/RES
Mr. Leo Beltracchi, Senior Human Factors Engineer, HFB, DSR/RES
mr. Robert Brill, Human Factors Engineer, HFB, DSR/RES
Mr. John Gallagher, Electrical Engineer, HISB, NRR/SICB
Mr. Terry Jackson, General Engineer, HFB, DSR/RES
Mr. Carl Johnson, Jr., Senior Reactor Engineer, HFB, DSR/RES
Mr. Joel Kramer, Section Chief, HFB, DSR/RES
Dr. Paul M. Lewis, Engineering Psychologist, HFB, DSR/RES
Ms. Dolores Morisseau, Human Factors Analyst, HDBFB, DSR/RES
Dr. J. Persensky, Section Chief, HFB, DSR/RES
Mr. Milton Vagins, Branch Chief, EMEB, DE/RES
Mr. Jerry Wachtel, Senior Engineering Psychologist, HFB, DSR/RES
Mr. Mike Waterman, Senior Electrical Engineer, NRR/HICB

Contractor Participants:

Dr. Valerie Barnes, Compa
Dr. J. Callan, Pacific Science & Engineering
Mr. Kerm Henriksen, CAE-Link Corp.
Dr. Lee Ostrom, Idaho National Engr. Lab
Dr. J. O'Hara, BNL
Mr. Paul E. VanHemel, CAE-Link Corp.
Mr. Dolores Wallace, NIST

The Nuclear Safety Research Review Committee (NSRRC) Subcommittee on Advanced Instrumentation and Controls and Human Factors met with NRC staff members on November 29-30, 1993 in Bethesda, MD to review the RES program on those areas of research. The meeting was intended as a follow-up of the meeting on December 9, 199? reported to you in my letter of January 28, 1993. This is a summary report of the meeting of November 29-30, 1993.

The meeting was intended to be a broad review of the RES programs in the subject areas, not to reach specific conclusions on individual programs or projects. In particular, the Subcommittee was seeking to determine how its suggestions contained in the report of January 28, 1993 were acted on. In addition, it reviewed the "birth to grave" history of one significant RES project to try to determine the effectiveness in resources and time with which such projects are managed.

The Subcommittee found that some progress is being made in correcting the weaknesses and needs for action previously identified, but more is needed and urgently. To provide perspective for this statement, it is helpful to review some of the comments of the report of January 28, 1993.

> "The application of advanced computer controlled, digital software dependent instrumentation and control to modifications of the control systems of the present generations of reactors and to the design of the next generation of Advanced Light Water Reactors (ALWR's) is very likely to be the single most significant technological advance over presently operating plants."

> "The NSRRC has counseled on several previous occasions that the Commission's research activities (RES) should recognize the necessity to view this areas as requiring a systems approach which integrates the human perspective (operator and designer) with that of the instrumentation and control hardware and software. An important potential for improvements in integration appears to be offered by advanced I&C systems."

"An agency-wide strategic vision of the concept of integration of the human, hardware, and software aspects of reactor control and operations must be developed and clearly articulated. Such a strategic vision is an essential first step if the NSRRC's recommendation in its November 1992 report is to be achieved, i.e., "criteria to define what is meant by improved safety need to be established prior to undertaking major expenditures or function allocation research." The management process must proceed from a shared vision, to the establishment of requirements, to the setting of criteria. Research programs can then be defined, and performance expectations can be set for individual research projects."

"RES has responded by taking steps in organizing and consolidating its program management. However, based on our review, we believe there is much more to be done in establishing an overarching commitment to system integration between the reactor plant and its operators via I&C systems. Indeed, it appears to us that the NRC does not presently possess in-house capability to address adequately complex issues introduced by modern I&C technology."

The important safety questions of application of modern I&C systems fall into two time frames: first, the system-by-system replacement of analog with digital equipment in presently operating plants; and second, the design of modern digital I&C systems into next-generation reactors. This report is directed primarily toward the first.

The Subcommittee concluded from its review on November 29-30 that the fundamental need for an overarching strategy integrating the human with the plant through I&C has not been met. There are several reasons, in our opinion, why this is so:

a) The NRC as a whole has not arrived at a consensus strategy for new I&C systems. (See the letter of the ACRS to Chairman Selin of November 16, 1993.) In the absence of such an overall strategy it is difficult to organize and conduct a cohesive research program.

b) The RES program in these areas is made up almost entirely of small projects answering a large number of user needs, not themselves integrated as to basic objectives. As a result, the program is splintered and diffuse.

c) The responsible branch does not within itself possess the requisite technical and executive capability to develop and apply such a strategy.

It appears to us that until these difficult but basic problems are corrected, the RES program cannot make a needed contribution to reactor safety through the systems integration of modern control equipment with human operators. Meanwhile, good work will continue to be done on individual questions without the synergism of a comprehensive strategic plan. For example, the development of an advanced control room design review guideline and the cognitive environment simulation investigation are efforts producing useful results in important areas. On the other hand, many projects are spending a significant effort in literature familiarization, while one project is entirely devoted to identifying and assessing human factors research facilities and capabilities. It was hoped by the Subcommittee that by this time such background information would be known by RES, so that it could be integrated into projects in a quicker and less costly manner, as would be typical of a more synergistic program.

The Committee recognizes the difficulty to RES of establishing an overall research strategy in this relatively new (to reactor plant design and operation) field of technology. Nevertheless, there are opportunities available to HFB to work more effectively toward carrying out the ACRS recommendation in its letter to the Chairman of March 18, 1993 that a "fresh start was called for in developing an effective approach to this new and difficult subject." One possibility is to assemble a group of recognized outside experts in systems engineering of modern control systems with the specific goal of establishing a strategic vision of what is needed in a broad program of research in combining modern I&C hardware with reactor operators, with total improvement of safety as the objective. RES did conduct a meeting

organized by the National Institute of Standards and Technology, but this meeting was more in the nature of a short technical society meeting than a goal oriented workshop.

The full Committee was advised during its meeting on January 13 that the National Academies are being requested to organize a 14 month study on this subject. The Committee recommends that the Charter for this National Academy study be broadened to include the entire system of human operations, I&C software and hardware, and their combined relationship to plant safety.

Another opportunity is for RES to consolidate several projects already underway with a specific goal of achieving such "an effective approach to this new and difficult subject."

Insights gained from synergizing several selected individual projects could provide bases for better understanding the implications of modern I&C systems as improved connecting links between operators and the complexity of a power reactor plant and establishing an appropriate overall strategic vision.

The Subcommittee reviewed the history of the Human Performance Investigation Process research project from its inception. It found that the contract in this area was originally $300K and ended with a total expenditure of $450K. The life of the contract was about 4 years. Another 6 months will be required to formally close it out. Thus, this relatively small project will have required 4 1/2 years to initiate and complete. We were told that it normally requires 1 year to put into place a competitively bid contract, with an effort on the part of the RES staff of about 0.3 of a full time employee spent on developing and executing the contract.

The Subcommittee and the full Committee need to examine these matters further, but on the basis of what has been heard, it would appear that an excessive amount of time and personnel resources are required to carry out the required formalisms of administrative and financial matters. We recognize from our own experience the constricting effects of the Federal bureaucracy and

regulations, but the cost in time and resources to conduct the HPIP research is greatly out of proportion with the result. It appears to us that the administrative services are not viewing themselves as "service" organizations, but rather as offices which must themselves be "serviced." We suggest that RES prepare a summary list of times and costs to carry out administration of RES contracts and use that list to obtain some greater assistance and cooperation. Research results have a time value -- like news or perishable foods. Research staff is needed for hard technical judgment, not administration. The need for correction of these problems will inevitably increase with the projected staff reductions and broader technical questions which will develop if the recommendations of the Subcommittee given above are carried out. In particular, if the HFB is already hampered by lack of technical and executive capability in this area, it will be weakened rather than strengthened as projected staff reductions throughout the NRC take place. Our point is that the HFB needs to be treated separately and preferentially to strengthen its personnel capabilities both technically and managerially, and given calculated assistance in carrying out its programs with the least unnecessary expenditures of time and personnel resources on non-technical matters.

The Subcommittee appreciated the considerable effort of the RES staff in preparing and presenting the extensive information during the meeting of November 29-30.