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THROUGH: M. Silberberg, Branch Chief
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FROM: James T. Han
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SUBJECT: A BRIDGE BETWEEN RESEARCH ACCOMPLISHMENTS AND PLANT OPERATIONAL SAFETY BY PROVIDING A TECHNICAL BASIS FOR UPDATING THE EMERGENCY OPERATING PROCEDURES AND OPERATOR TRAINING

REFERENCES:
1. Memo from Eric S. Beckjord to Thomas E. Murley and Edward Jordan Dated July 13, 1987, "Accident Management Research Program Plan (AMRPP)."
2. E. Beckjord, and T. Speis, "Briefing for Commissioner Asselstine on Status of Containment Performance Improvements (E.G., MARK-I) and Individual Plant Examination (IPE) Efforts," June 18, 1987.

As a follow-up of our August 18, 1987 meeting in which subjects on accident management were discussed, this memo is prepared to focus on the enhancement of plant operational safety. The memo proposes the establishment of a bridge between the research accomplishments and the plant operational safety by providing a technical basis for updating the PWR emergency operating procedures and the companion operator training. This work is in support of the objectives of both the Accident Management Research Program Plan (AMRPP) and the program on the Individual Plant Examination (IPE), as discussed in Ref. 1 and Ref. 2 respectively. The work, which is outlined in the Work Statement below, is proposed for your consideration as a complementary task in the AMRPP.

I. Background Information

The IPE program calls for the licensees' systematic examination of their plants to identify the plant-specific vulnerabilities to severe accidents (for both core damage and containment performance), to find effective means to cope with those vulnerabilities, and to implement corrective actions including the revision of emergency operating procedures and operator training. The AMRPP correctly points out that most operating plants currently do not have plans in place for managing severe accidents. One of the AMRPP objectives is to provide technical bases and other regulatory tools for evaluating licensees' response to the IPE requirements. A number of research programs are recommended in the AMRPP and the results of those programs are expected to be included in the emergency operating procedures and operator training for severe accident regimes.

The task proposed in this memo totally supports the above needs to cover the severe accident regimes in terms of revising the emergency operating procedures and operator training. However, it would also include the improvement of those portions of the emergency operating procedures which handle the high-probability events (e.g., loss of feedwater to steam generator, steam generator tube rupture, stuck-open or leaking PORV or SRV, etc.) by using the defense-in-depth approach. For example, the current emergency operating procedures call for the use of high-pressure injection system (HPIS) to provide adequate core cooling should all feedwater be lost; but no instructions are given if HPIS also fails. The procedures should be expanded by providing instructions to cover the loss of HPIS and beyond until core melt termination and plant recovery.

II. Work Statement

A technical basis should be developed from the existing research accomplishments in the areas of severe accidents and thermal-hydraulics, and it will be revised as the additional results become available in the future. The purpose of this technical basis is twofold. First, it would provide necessary information for the updating of the PWR emergency operating procedures by including instructions for "core melt" termination and subsequent plant recovery. Two phases of core melt are considered: (1) core melt contained in the intact vessel, and (2) vessel failure with core melt in the containment. Second, equally important, the technical basis would also provide necessary information on the optimal use with prioritization of "all" existing equipment, water sources, and manpower for the systematic improving of the emergency operating procedures. The technical basis should be focused on the procedures for managing the risk-dominant severe accidents (e.g., TMLB' - station blackout and no auxiliary feedwater, etc.) and the high-probability events (e.g., loss of feedwater to steam generators, steam generator tube rupture, stuck-open or leaking PORV or SRV, etc.). Other events would be included should the need

arise. Hardware fixes would be considered, evaluated, and recommended as the last resort.

The technical basis would also be used in the training programs for the operators (including safety engineers and management as in a broader sense) to understand and learn the use of the updated emergency operating procedures, which would include instructions on the management of core melt situations and on the optimal use of all existing equipment, water sources, and manpower.

Note that the PWR emergency operating procedures are based on the ATOG for B&W plants, the ERG for Westinghouse plants, and the EPG for CE plants.

III. Research Accomplishments To Be Used

Since the 1979 TMI-2 accident the nuclear community, and NRC in particular, has sponsored a number of research programs addressing the severe accidents including core melt in the nuclear power plants. A significant amount of data and analyses has been obtained from PBF, LOFT, NRU, ACRR, TMI-2 core examination and the standard problem exercise, the development of SCDAP/RELAP5 and MELPROG/TRAC and CONTAIN, SASA, direct containment heating study, containment venting and integrity studies, core-concrete interactions, fission product behavior, etc. In addition, extensive thermal-hydraulic data and analyses regarding the plant transients and design-basis accidents are available from LOFT, SEMISCALE, MIST, 2D/3D, the development of TRAC and RELAP5, and etc.

Those valuable data and analyses, which are worth hundreds of millions of dollars, should be systematically reviewed, selected, and integrated to form the technical basis for the proposed work to update the emergency operating procedures and the companion operator training. I believe that now is the time for us to establish the technical basis for the updating of the emergency operating procedures, while the need for additional data and analyses will also be identified for future funding consideration.

IV. Who Would Be Involved?

The work would involve both NRC and the nuclear industry. NRC/RES, in my opinion, should take the lead to establish the technical basis, because most of the above information is obtained at various national laboratories under the NRC's sponsorship or agreement with the foreign partners. NRC/RES and its laboratory contractors have the expertise needed for reviewing and selecting the relevant information for the technical basis. NRC with the laboratories' assistance should also perform some scoping studies to evaluate what changes are needed in the emergency operating procedures. However, the owners and the vendors would take the lead for determining what changes will be made, and they would be also responsible for implementing those changes in the emergency operating procedures and the companion operator training.

V. Why This Work Is Needed?

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There are three reasons. First, a terminated core melt accident has occurred in the TMI-2 reactor. Since its recurrence in the future cannot be totally ruled out, we should be prepared for it. Second, a significant amount of relevant data and analyses already exists, but the current emergency operating procedures in several aspects have not benefited from this valuable up-to-date information. By integrating the results from our research programs to form the technical basis for the expansion and improvement of the emergency operating procedures, a bridge is built and through it our research programs will have direct impact on the enhancement of plant safety. This bridge will significantly increase the application of our research results upon the plant safety. Third, there are areas in which improvements can be and should be made on the current emergency operating procedures. For example, the procedures handling the total loss of feedwater event instruct the operators to use the high-pressure injection system (HPIS) to supply core cooling, but the procedures do not provide instructions on what to do next "if" HPIS also fails. In reality, other means for core cooling probably exist under the situation involving the loss of all feedwater and the HPIS, and the instructions should be provided to the operators in a defense-in-depth approach until core melt termination and subsequent plant recovery.

Let me elaborate further. The TMI-2 accident demonstrated in 1979 that a "core melt " accident occurred because "wrong actions" were taken by the operators due to lack of understanding on what was happening in the plant, where multiple equipment had failed. The post-TMI core examination reveals that approximately 30% of the reactor core became molten during the accident and about 20 tons of the molten materials reached the vessel lower head and later froze due to the presence of water. The TMI-2 accident belongs to the first phase of core melt as defined in the Work Statement, namely, core melt contained in the intact vessel. However, the core examination also reveals that a number of instrumentation tubes which penetrated the TMI vessel lower head were plugged. In view of the plugged instrumentation tubes and the estimated 20 tons of molten materials resting on the vessel lower head, the accident might have progressed to the second phase of core melt - vessel failure with core melt in the containment, if recovery actions were further delayed. It is therefore necessary for us to be prepared for the both phases of core melt - molten core contained in the vessel, and vessel failure with molten core materials in the containment. Note that the issue on direct containment heating will be addressed in the second phase of core melt, and the issue on PWR depressurization will be addressed either in the first phase of core melt or before any core melt.

It should also be pointed that the need for revising the current emergency operating procedures to address severe accident concerns is echoed in a July

1987 report "Risk Management Actions to Assure Containment Effectiveness at Seabrook Station," which was sponsored by the utility involved. (In this report, a new procedure and modest hardware modifications are proposed for providing fire water cooling of the steam generators and for using the PORV for depressurization under the TMLB' accident.)

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Another core melt accident is extremely unlikely because since the 1979 TMI-2 accident extensive and significant improvements have been made to increase plant safety. As a result, the emergency operating procedures and the operator training have been scrutinized and substantially improved. Therefore, there is little justification either to further improve the emergency operating procedures or to expand them to cover the core-melt accidents. Why bother to spend the time and effort on this?

While we certainly think that another core melt accident is highly unlikely to occur, it can not be precluded. Like the airline industry, the nuclear industry simply cannot allow complacency. We have to work vigorously to keep our plants accident free. It is in this context that we should also be prepared for the worst possible situations involving core melt and vessel failure. Before the TMI-2 accident, most people in the nuclear community probably felt that a core melt accident would be very unlikely. Before the 1986 Chernobyl accident, most people in the Russian nuclear community probably felt the same way. But both accidents did occur and created monumental impacts around the world. Furthermore, the risk associated with the operation of a nuclear power plant will probably be reduced with the updating of the emergency operating procedures and operator training. An example is given in the report on Seabrook cited earlier - if the numbers there are correct. It should also be pointed out that an example on the potential improvement of the current emergency operating procedures has been discussed earlier and will not be repeated here.

VI. Incentives for Industry Participation

It is expected that with the implementation of an improved and expanded version of the emergency operating procedures and the companion operator training, the risk will be significantly reduced for the operation of a nuclear power plant.

VII. Any Conflict of Interest?

The thrust of this work is to "share" our research results with the industry in updating the emergency operating procedures and the operator training. As a result, the risk associated with the plant operation will be reduced. Any conflict of interest does not and should not exist.

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VIII. Conclusions

A task is proposed for your consideration to be part of the Accident Management Research Program Plan that you are putting together. This task calls for the development of a technical basis for updating the emergency operating procedures by including instructions to handle core melt situations and by making improvements to evaluate the optimal use of all existing equipment and water sources. The work involved will be based mostly on the NRC research accomplishments - worth hundreds of millions of dollars. If the task is carried out, a bridge is built between the research accomplishments and plant operational safety, and a basis will also be provided for identifying additional research needs for future funding consideration.

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