

UNITED STATES NUCLEAR REGULATORY COMMISSION WASHINGTON, D. C. 20555

APR 1 6 1993

Dr. David L. Morrison, Chairman Nuclear Safety Research Review Committee The MITRE Corporation 7525 Colshire Drive McLean, VA 22102-3481

Dear Dr. Morrison:

Your letter of February 10, 1993, presents the report of the NSRRC's meeting of January 14-15, 1993, mostly in the form of four NSRRC Subcommittee reports as modified after Committee deliberation on them. This response follows your report's format, presenting, enclosed, our responses, in turn, to the Subcommittee reports addressing research on Aging, Advanced Instrumentation and Controls and Human Factors, Advanced Reactors, and High-Level Waste. (Enclosures 1 to 4). If you have any question or comment on this response please call me.

With regard to steam generator tube integrity issues, the Committee decided that an entire meeting should be held to address this issue, and April 28 and 29, 1993 were the dates chosen. Since the meeting, we have chosen the Chevy Chase Holiday Inn as the venue. The meeting will focus on the status of information and research on nondestructive examination (NDE) of steam generator tubes and the pertinent background of technology and practice. In addition to the NRC staff and contractor personnel, participants will include specialists from vendors, EPRI, and elsewhere. The general agenda, developed in consultation with you, has been published in the <u>Federal Register</u> (Enclosure 5). I will send the final agenda as soon as it is ready.

Sincerely,

S. K. Jejad

Eric S. Beckjord, Director Office of Nuclear Regulatory Research

Enclosures:

- 1. Aging Research (staff response)
- 2. Advanced Instrumentation and Control
- and Human Factors Research (staff response)
- 3. Advanced Reactors Research (staff response)
- 4. High-Level Waste Research (staff response)
- Federal Register notice concerning April 28-29, 1993 NSRRC meeting

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Enclosure 1

AGING RESEARCH

(Page numbers refer to the report of the Subcommittee on Aging enclosed with the Committee report.)

NSRRC comment (p. 2):

"While several closure targets have been proposed for specific topics, the continuing influence of 'new information' keeps extending these completion dates, suggesting that a more disciplined approach to these schedular concerns has not yet been effective."

Response:

We are undertaking a thorough review of the Aging Programs in order to focus our efforts on the important safety questions and to establish the risk priorities. As part of the review, we are considering the opportunities for materials and component evaluation which have recently become possible with the equipment and structures of Yankee Rowe, San Onofre Unit 1, and Trojan. RES will continue its efforts to ensure that projects are not extended unless there is adequate justification. Most of the aging research projects have been completed on schedule. However, ongoing research programs and experience from operating reactors continue to identify new information, some of which may indicate a need for further confirmatory research. Thus, the extension of a completion date does not mean that these programs are being unnecessarily prolonged. As a result of new information, additional research may be necessary, or new aspects of a topic may be added to a project and the completion date redefined when this approach is more efficient and cost effective than stopping one project and initiating a new one to address the new information. Additionally, in many cases closure dates are extended solely as a result of reductions in budget for specific projects. At the meeting of the Subcommittee on Aging. the staff provided specific research closure dates for 22 components, 15 systems, and 13 special topic studies. For several components, such as small motors, motor control centers, and pressure operated relief valves, aging assessments were completed ahead of closure targets because the results of Phase I studies of the NPAR program were found to be sufficient. In the area of piping, low level of effort studies were expanded when it was revealed that the recirculating lines in BWRs contained very long and deep intergranular stress corrosion cracks. As a result, research projects had to be quickly mounted to study the fracture behavior to validate ASME Code rules for evaluation of cracked pipe including BWR recirculation piping, and to verify the efficacy of the industry-proposed "fixes". Additionally, the S-N fatigue life curves in ASME Code Section III are being reviewed as a result of several small research programs in the U.S. and abroad that showed which environmental factors of water coolant and temperature caused a significant decrease in fatigue life. A significant international cooperative research effort has emerged to develop the data necessary for new, accurate curves.

The Steam Generator Tube Integrity program was closed several years ago, and the results utilized for revision of two Regulatory Guides. As these revisions were ready to go forward for concurrence and CRGR and ACRS review, the staff began to evaluate industry-proposed Alternate Plugging Criteria (APC). The criteria to be used to determine when steam generator tubes should be plugged and the related technical issues, such as NDE techniques, are being evaluated by the staff as part of an effort to determine what additional actions are appropriate including identification of potential research projects.

2. NSRRC comment (p. 2):

"The Subcommittee concurs that as the present aging research programs are completed, it will be essential that RES maintain a level of awareness and competence to deal with future events. The extent of this maintenance level within the NRC and at six independent 'Centers of Expertise' requires diligence to avoid excesses."

Response:

We agree with the comment and intend to give the subject of aging a high level of management attention to avoid duplication, and at the same time ensure that the appropriate level of expertise is available. As current aging programs are concluded, this issue will be examined and will continue to receive the personal attention of the Director of RES.

NSRRC comment (p. 2):

"The Subcommittee agrees that an appropriate strategy for RES includes the following:

- Complete each research project per current schedule and estimated cost.
- 2. Document the research results in appropriate reports.
- 3. Assure results are distributed to users and industry.
- 4. Maintain awareness and technical vitality."

Response:

As discussed during the meeting, these elements are included in RES planning and will continue to be central to implementation of RES projects.

4. NSRRC comment (p. 3):

*[T]he Subcommittee was given to understand that the justification for much of the aging research program was based upon the importance attached to aging issues as phenomena unique to license renewal."

"Despite substantial probing, the Subcommittee could find no instance where an age-related degradation concern was special, singular or specific to license renewal with the possible exception of components whose design life is 40 years or less. The Subcommittee believes that the greatest value will be derived from the aging research program if its emphasis and application is directed to resolving operating plant problems."

Response:

Unfortunately, use of the terms "unique to license renewal" and "agerelated degradation unique to license renewal", has resulted in considerable confusion in numerous discussions, including the recent presentation to the NSRRC. The confusion is a result of the license renewal rule (10 CFR Part 54), which includes a definition of "agerelated degradation unique to license renewal" (copy attached). The definition in the rule gives these terms a specific meaning that differentiates, for the purposes of regulation, between the initial 40-year license and the prospective 20-year license renewal period.

The focus and justification of aging research programs are on the physical processes of aging degradation in order to characterize and quantify the degradation in ways that make it possible to assess the effect of degradation on plant systems, structures, and components and thereby the safety margins of the plant as developed in design and as reviewed and approved in the licensing process. Thus, aging research is concerned with the mechanisms of degradation that are at work during plant operation whether in the initial 40-year license term or during prospective license renewal term(s).

Aging research projects were initiated before the license renewal rule was written. These projects were initiated to examine the effects of aging upon systems, structures, and components, and thereby its relationship to safety. However, over the past few years there has been an increased recognition of the importance of understanding and managing aging which potentially degrades nuclear power plant systems, structures, and components in the context of license renewal - plant operation beyond 40 years. As a result, for the past several years the focus of discussions concerning aging research projects and utilization of results has been license renewal.

While the primary focus of many current discussions of aging research projects is license renewal, the results of these projects are being utilized at operating plants. We agree that this aspect of aging research is a significant benefit: utilization of research results to address operating plant issues. We will continue our activities to make the results of aging research programs available to all interested parties. For example, in 1992 an Aging Research Information Conference was held and the results of 47 research programs were discussed. The information is included in the Aging Research Information Conference Proceedings (NUREG/CP-0122, Vols. 1 & 2, Sept. 1992).

I hope that this discussion responds to the Subcommittee's point and resolves the confusion over the terms and their definitions.

NSRRC comment (p. 4):

"As previously mentioned, the Subcommittee believes the present prioritized funding levels are appropriate, but suggests it may be prudent for RES to re-evaluate its schedule for these license renewal issues in light of recent utility application delays."

Response:

We agree and are taking steps to review aging research projects, including schedules. However, we believe that those activities which benefit operating plants should proceed on schedule. As discussed previously, while aging research has provided a significant level of technical support for many license renewal issues, it is also providing significant information concerning the effects of aging on plant components and systems during the initial 40-year license period.

6. NSRRC comment (p. 4):

"SANDIA Report SAND91-7093 issued in February, 1992 critically reviewed three risk-related NUREG documents dealing with identification and prioritization of aging components, evaluation of core melt frequencies due to aging effects and licensing renewal rule analyses. RES provided to the Subcommittee a contractor's response to SAND91-7093 that would result in no change to the NUREG reports. The Subcommittee did not pursue these differences between RES and SANDIA in detail but notes there are other areas where RES and others do not agree on research results or their interpretation. The Subcommittee suggests that RES give appropriate consideration to methods of resolving differing analyses."

Response:

In this instance, the SANDIA comments were addressed and the responses were provided to SANDIA. The resolution of these comments were in the nature of clarification, therefore, changes to the NUREG documents were not necessary. Differences are frequently identified and resolved by subsequent discussions as research results are evaluated. This process is effective in resolving comments and differing analyses that involve research results and draft and final technical (NUREG) reports. All draft reports are disseminated for internal reviews to NRR and AEOD and, subsequently to EPRI, NUMARC, IEEE, ASME (O&M), vendors as appropriate, with a copy to the public document room (PDR).

NSRRC comment (p. 5):

"There appears to the Subcommittee to be adequate understanding by RES of the consequences of functional failures of components like valves. The Subcommittee is less confident that current proposals on how to determine and deal with such functional degradation due to aging will prove adequate."

Response:

Normally, when the results of the aging research reveal significant technical safety issues related to a component's design or operability (for example, those found for MOVs), the RES staff interacts with the NRR staff and other agency staff involved in the resolution of generic safety issues, issuance of information notices or bulletins. In turn, the research results are utilized in the regulatory process as appropriate.

NSRRC comment (p. 6):

"The Subcommittee noted that significant discussions are taking place between NRC staff, industry, and others regarding environmental effects, fatigue and other aging concerns. The Subcommittee encourages RES to continue these discussions and believes that most differences in expert judgments, identified in these dialogues, can be resolved by relatively modest additional research."

Response:

RES will continue to work with NRR and industry to ensure that the discussion of aging issues continues. These discussions are held during public meetings and involve a wide variety of groups, including participation by members of utilities, consultants, national laboratories, codes and standards, and during meetings with representatives of foreign governments and utilities. Examples of recent discussions of aging issues include those with the Babcock and Wilcox License Renewal Task Group, representatives from Baltimore Gas and Electric's Life Cycle Management Group, and the 1992 Aging Conference.

9. NSRRC comment (p. 6):

"The Subcommittee noted the existence of aging data from sources other than the nuclear industry in this and other foreign countries. The inclusion of aging research results from these origins should prove technically beneficial and cost effective."

Response:

We agree with the comment. RES activities related to aging data have included a wide variety of sources and have not been limited to the nuclear industry. Examples include data from the British Welding Institute, the Pressure Vessel Research Council, various ASME bodies, and other government agencies, such as FAA and NASA. Interest and research in the area of nuclear plant aging have resulted in a very wide and growing volume of data. RES agrees that utilization of this information from all sources is valuable and we will continue to acquire such information and participate in the international evaluation of aging issues to the extent possible. However, due to resource and budget limitations, our efforts have been reduced in this area.

NSRRC comment (p. 6):

"Discussions took place on the difficulties of communicating, coordinating, and transferring information among the many participants concerned with age-related phenomena. RES is encouraged to continue and expand its activities toward resolution of these impediments."

Response:

We agree with the comment. RES is devoting substantial effort to ensure that all interested parties have access to aging research results, and to foster participation in meetings to discuss the results of aging research. We will continue our efforts in this area.

11. NSRRC comment (p. 6):

"The Subcommittee understood that effects of aging are not required to be considered in current PRA's. The Subcommittee is concerned that such an omission may leave substantial gaps in risk analyses whose significance is not defined. The Subcommittee believes it is important that the NRC determine how aging degradation is to be treated in these assessments in order not to delay or repeat the analyses required of all plants.

Response:

Current PRA's are snapshots of the current residual risk at plants and reflect the effects of aging up to the time that the PRA was done. With the new maintenance rule, licensees will be required to maintain the status of the plants, and in effect, keep the reliability and availability of systems, structures, and components (SSCs) consistent with their PRA's. Licensees will be required to mitigate and control the effects of aging to be consistent with their PRA's. The NRC is developing methods to include the effects of aging into PRA's primarily to help assess which aging effects on which SSCs have the most safety importance, i.e. have the most potential to affect core damage frequency or other measures of risk. Licensees could use such information to prioritize their testing, surveillance and maintenance. Currently this is not required, but industry has made some proposals that the NRC is evaluating which would incorporate such assessments into the operation and regulation of nuclear power plants.

EXCERPT FROM LICENSE RENEWAL RULE

(A portion of 10 CFR 54.3, Definitions)

§ \$4.3 Definitions.

As used in this past.

Age-related degradation means a change in a system's, structure's, or component's performance or physical or chemical properties resulting in whole or part from one or more aging: mechanises. Examples of this type of change include changes in dimension, ductility, fatigue resistance, fracture toughness, mechanical strength, polymerization, viscosity, and dielectric strength.

Age-related degradation unique to license renewal is degradation---

(1) That occurs during the term of the current operating license but whose effects are different in character or magnitude after the term of the current operating license (the period of extended operation); or

(2) Whose effects were not explicitly identified and evaluated by the bicessee for the period of extended operation and the avakation found acceptable by the NRC, or

(3) That occurs only during the period of extended operation.

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ADVANCED INSTRUMENTATION AND CONTROL AND HUMAN FACTORS RESEARCH

(Page numbers refer to the report of the Subcommittee on Advanced Instrumentation and Control and Human Factors enclosed with the Committee report.)

1. NSRRC comment (p. 2):

"There should be a clearly stated management commitment to the subject of human factors throughout the NRC to further assure safety of reactor design and operations. The complex nature of the subject should be well understood by all levels of management starting with the Commission, and working downward through the Offices, Divisions, and Branches having responsibility for the development of guidance and standards for the review and regulation of advanced I&C systems.

In the past, the history of the subject has appeared to be a 'chopped sine wave.' A reasonable effort is started, but terminated or significantly reduced before useful results are obtained."

Response:

It is true that RES significantly reduced the Human Factors budget for FY 1993 on that portion addressing organizational factors. (The need for further research on organizational factors is being reviewed by NRR.)

The degree to which the NRC remains committed to human factors is indicated by the level of NRC resources dedicated to human factors. The NRC has dedicated a branch in RES, a branch in NRR, and a specialist in NMSS to human factors in nuclear applications. Additionally, AEOD resources have been committed to a program for investigating human performance during operating reactor events. The staffing level has remained rather stable over the last five years.

I agree that human influences are vital to nuclear safety and the importance of human factors should not be slighted in the commitment of resources. The NRC's commitment to human factors has been documented by the staff to the Commissioners in several reports and program descriptions including (1) NUREG-1384, The NRC's Human Factors Regulatory Research Program Plan, (2) SECY 93-020, Review of Organizational Factors Research, (3) SECY 92-008, FY 1991 Organizational Factors Research and Applications Progress Report, (4) SECY 91-105, Collecting Organizational Factors Data and Industry Interest, (5) SECY 90-349, Organizational Factors Research Progress Report, (6) SECY 90-042, NRC Participation in the 1991-1993 Halden Reactor Project, (7) SECY 89-183, NRC's Human Factors Programs and Initiatives, (8) SECY 89-066, Status of Evaluation of Candidate Performance Indicator: Safety System Function Trend, and (9) SECY 88-294, Human Factors Program. These documents (and the NRC's annual Five-Year Plan) show the level of resources that gave impetus to the current human factors research program. Once mature, the program will be stabilized at a more uniform fiscal level (the annual budget in the current FYP is approximately \$6,725K). The program is using the fiscal resources on those topics and regulatory issues that hold the best potential benefit for safety.

2. NSRRC comment (p. 2):

"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."

Response:

We take your point and are working on criteria for evaluation of safety improvements. The criteria, defined in terms of reduced accident risk (or reduced uncertainty as to risk), are the subject of a revised version of regulatory analysis guidelines which is in final stages of review at this time. The revised regulatory analysis guidelines will include guidance with respect to safety-goal application as well as safety-cost tradeoffs for evaluation of potential regulatory actions to effect safety improvements. They will also be available for evaluation of research projects, through their potential for effecting regulatory safety improvements.

Currently, the RES program is aimed at providing a comprehensive set of standards and guidelines for the licensing review of computer-based systems that affect safety functions in nuclear power plants and the technical basis for those standards and guidelines. In view of the Committee's observation, I would expect to review this with the NSRRC at the next planned review of advanced I&C research.

To assure a strategic perspective, the staff will be conducting a workshop on digital systems reliability and nuclear safety in September 1993. The purpose of the workshop is to (1) receive feedback from outside experts on proposed safety issues and regulatory positions and research associated with the application of digital systems in nuclear power plants and (2) continue the in-depth exposure of the NRC staff to digital systems reliability related to nuclear safety by discussions and feedback from experts in the state-of-the-art of digital systems. The breadth of participation and perspectives is described further in responding to item number 5.

3. NSRRC comment (p. 2):

"As stated in my letter of November 16, 'The NRC needs to identify those issues that are important to safety and <u>to develop</u> <u>criteria</u> which, if met, will assure that NRC safety concerns are satisfied.'

A principal justifice from the NRC's or industry's point of view for advanced I&C is is improvement in safety. However, as stated above, if not properly understood and applied, advanced I&C systems have a potential to exacerbate rather than cure the disease. We propose, therefore, that RES develop a <u>statement of</u> <u>criteria</u> by which I&C systems will be judged specifically as to the benefit to overall plant safety. Such criteria, properly understood, would then serve to give several research efforts toward a more focused and integral.

Response:

We believe we are carrying out your suggestion. It is totally coincident with one of the higher-level objectives for NRC's activities on instrumentation and controls. The regulatory research being done under the budget subactivity "human-systems interfaces" is to develop the technical basis for some of the cr' "ia by which instrumentation and control systems will be judged. 1 IS staff discussions at the subcommittee meeting were intended to acuress the issues currently being worked because specific regulatory criteria had been requested for immediate use on issues such as (1) verification and validation procedures for fault avoidance, (2) static and dynamic testing strategies, (3) fault tolerant architecture, (4) configuration management, (5) reliable measure for software quality, (6) algebraic specifications, and (7) alarm prioritization and filtering techniques. Additionally, guidelines had been requested on issues such as (1) evaluating the displays and information management systems for totally integrated control-room designs and local control stations including layout, (2) tools for auditing and testing software including computer aided software engineering techniques, (3) software programming languages for nuclear applications, (4) methods for allocation of functions between operators and automation, (5) non-safety control systems, and (6) shift staffing and personnel qualifications for advanced reactors. Thus, the objective of our research program in this area is to develop the criteria the NSRRC proposed.

NSRRC comment (p. 3):

"There is great deal of information and experience in the area of advanced I&C outside the nuclear industry in the U.S. and outside

the U.S. Canada, France, Germany, and Japan in particular are well ahead of the U.S. in developing an experience base. Within the U.S., the military, aviation, and other activities are well ahead of the nuclear industry in studying and applying modern I&C technology. Ther s also information being developed in Russia on error proneness in digital as compared with analog systems.

It seems obvious, therefore, that there should be a vigorous, focused effort in RES to obtain, assimilate and apply the large amount of experience and information available from these other sources. Certainly some of that is being done, but not enough. We propose that specific directed management steps be taken to strengthen these activities.

In that regard, members of RES staff, however limited in available effort, should accept as a personal responsibility the objective of becoming technically knowledgeable and <u>expert</u> in the several subspecialties of advanced I&C, rather than relying mainly on presumed laboratory or contractor capabilities."

Response:

I agree that it is important that the NRC understand what information is available outside the nuclear industry and from sources other than the U.S. We have established a network, and we are continuing to expand our network among experts from several industrial applications of digital technology both within and outside the U.S. As indicated, we consistently use information from other industries on most topics of regulatory interest. We are aware of current events in advanced I&C as facilitated by meeting and discussing technology and safety issues with experts over a broad spectrum of advanced I&C issues. Many of these interactions include perspectives of (1) developers that also develop advanced I&C for other industries, (2) users from the petro-chemical and fossil-power industries, and (3) other government agencies such as the Federal Aviation Administration, the US Air Force, and the National Aeronautics and Space Administration, plus nuclear agencies in France, Germany, Japan, England, Canada, Sweden, and Finland. RES plans to maintain a broad base in this technology by (1) contracting with those researchers that are experienced in other industries which employ advanced I&C and are able to apply their experience to the nuclear industry, (2) participating with other signatory members of the OECD Halden Reactor Project, (3) participating with other international experts on panels, standards committees, and in conferences, and (4) conducting extensive discussions with individual experts.

Specifically on the Russian information, the staff has reviewed reports from Russia and met in 1992 with experts that have worked with the Russians on their experience. So far the information describes designs employing digital technology that are contrary to important guidelines recommended for human-systems interfaces. We understand that the implementation was constrained resulting in the digital displays being separately located from the controls. Thus, we do not find it surprising that the operator error rates in the digital control-room design were higher than the error rates in the analog control-room design where the displays and controls were located in closer proximity to each other.

Maintaining a highly qualified, technical staff which possesses expertise in the broad range of issues is increasingly challenging for RES as well as other NRC offices, because the field is rapidly advancing. While the RES staff members are highly qualified and knowledgeable, the NRC is initiating a number of actions to meet this challenge. The NRC recently issued a Human Resources Strategic Plan that discusses the disciplines and skills which will be needed to regulate a nuclear industry experiencing evolutionary changes.

5. NSRRC comment (p. 3):

"There are within the U.S. institutions which have established reputations as centers of knowledge and competence in the field of advanced I&C. These include Carnegie-Mellon University and the Crew System Ergonomics Information Analysis Center (CSERIAC) at Wright-Patterson Air Force Base. The RES activities could benefit from closer working relationships with such centers--not necessarily by contract, but by visits, personal contacts, organized workshops, participation in expert reviews and the like. We note that three members of the ACRS have proposed recently a special workshop on this general subject to be organized and conducted by the National Academies."

Response:

The RES activities could benefit from closer working relationships with such centers (Carnegie-Mellon University and Crew Systems Ergonomics Information Analysis Center)--not necessarily by contract, but by visits, personal contacts, organized workshops, participation in expert reviews and the like.

We, too, see the need to continue close working relationships with all manner of experts in digital instrumentation and controls and human factors, and where possible to increase such interactions. RES has already participated in individual discussions with experts from the Software Engineering Institute at Carnegie-Mellon, the Crew Systems Ergonomics Information Analysis Center at Wright-Patterson AF Base, the National Science Foundation, the National Institute of Standards and Technology, several universities, and other centers of expertise on digital technology that are in addition to those organizations with which we have contracts and plan contracts. We plan to continue such interactions as they have been very informative. Specifically, we will sponsor a workshop this year that will involve both domestic and international experts on digital instrumentation and controls from a number of industries including nuclear, aerospace, defense, and telecommunications. The workshop will focus on digital systems and software reliability related to nuclear safety including issues such as verification and validation techniques, fault avoidance techniques, and functionally diverse designs.

6. NSRRC comment (p. 3):

"Consideration should be given to additional steps to strengthen the RES organization with the objective of furthering integration of human factors with machine considerations, such as providing additional personnel with recognized capabilities in both I&C and human factors fields."

Response:

I agree that the emphasis on integrating human, hardware, and software into a total systems approach to regulatory research is a proper objective. I believe we have adequate coordination at this time and that we have some degree of integration by retaining work on both the software and human factors issues within the same branch in RES and by reorganizing NRR to combine the I&C Branch and the Human Factors Branch into the same Division of Reactor Controls and Human Factors. To date, we have been able to add two professionals to the RES staff. However, in view of staff reductions over the next 3 years, some user needs will not be met. Available resources are being applied mainly to meet higher priority user needs.

Beyond the six specific suggestions itemized, the Subcommittee reflected on some information that merits clarification.

7. NSRRC comment (p. 3):

"During the discussions on December 9, the subcommittee was told that there were certain RES products of special early interest to NRR, e.g., Reg. Guide for Class 1E Digital Computer Systems, and a basis for establishing criteria for regulatory positions on software. These did not appear to be receiving priority attention for completion."

Response:

The product referred to was to be the deliverable from a project that developed difficulties. The difficulties received immediate attention but eventually required us to change contractors in order to complete the work. The project received priority attention including repeated meetings of senior managers from both the NRC and the contractor.

NSRRC comment (p. 4):

*If the advanced I&C program is to provide timely input to the certification process greater management attention to program planning, execution and completion seems needed.

A formal prioritization, with schedule dates and progressing actions to meet them, would improve productivity of contractors and RES staff and lead to a more timely availability of research results to those who must make informed regulatory judgments."

Response:

RES prioritizations occur in tiers and include formal prioritization schemes for generic issues, budget activities, and tasks within individual research projects. Since there is not a single generic prioritization scheme, the continuous managing of each project by the project manager becomes a key ingredient to keeping the regulatory reviewers informed. By continuous interactions, participation in status meetings and the exchange of draft reports and comments, the opportunity is provided for timely input of needed information and for the direction of the research in response to current regulatory developments. I would expect that the majority of the information resulting from research that is used to make informed regulatory judgments is provided first and in a timely manner by these informal paths if we were to formally measure it. The prioritization of research activities for the purpose of keeping regulatory reviewers informed is part of our daily activities. We remain open to adapting formal techniques that apply to regulatory research.

Overall, we believe we are giving proper management attention to the issues raised by the Committee. We are prepared to discuss this in more depth with the Committee.

Enclosure 3

ADVANCED REACTORS RESEARCH

(Page numbers refer to the report of the Advanced Reactors Subcommittee enclosed with the Committee report.)

Thermal-Hydraulic Systems Activities

 NSRRC comment (ROSA Facility Preparation for AP-600 Confirmatory Tests, p. 1):

> "Information pertaining to this activity should be communicated to the NSRRC over the life of this program."

Response:

We will keep the NSRRC informed on the ROSA/AP600 testing program at every opportunity in which you can put this topic on your meeting agenda. Let me suggest that the best times for this to occur would be as follows:

Date	Topic	
September 1993	Test matrix and pre-test predictions; status of construction	
February 1994	Results of acceptance testing	
August 1994	Results of first tests; post-test predictions	
February 1995	Completion of planned ROSA/AP600 testing; Discussion of results	

 NSRRC comment (SBWR Thermal-Hydraulic Assessment Activity - GE's Test Program, p. 2):

> "The overall presentation was thorough; however, interdependencies among RES, NRR and GE were not adequately addressed. In particular, the Subcommittee is quite concerned with the communication aspects of this endeavor. Communication between RES and GE required routing through NRR, which has apparently slowed the exchange process. Control of information is clearly required, but it should not significantly hamper timely information flow. We are concerned that several subtasks identified by RES regarding this effort are awaiting receipt and review of data from GE. Also, GE is awaiting NRC comments on certain of their test configurations that they indicated would be useful if received by GE in a timely manner."

Response:

There has indeed been a delay in establishing effective communications with GE on their SBWR testing program. NRR has recently assigned the SBWR technical review to a new branch and they are currently meeting with RES staff to come up to speed. We expect to get our detailed information on SBWR test programs from GE in May and NRR expects to transmit staff comments and questions to GE within a month later. Meanwhile, we have been able to obtain complete information on the completed GE GIST test program and sufficient information on the SBWR design to develop an initial input deck.

3. NSRRC comment (NRC's Proposed SBWR Integral Test Facility, p. 2):

"In general, the NSRRC supports NRR's need for independent expertise and for confirmatory research programs. However, on the basis of the presentation at this meeting, which were essentially technical judgments, NRR and RES were not able to convince the Subcommittee that the proposed facility was justified. The Subcommittee believes that RELAP5 evaluations of the GIST facility and of the SBWR or of a test facility with the appropriate feature would improve the basis for justifying whether the NRC's facility is needed. The Subcommittee would like to be kept informed on this matter."

Response:

On January 13, 1993, we sent Subcommittee Chairman Todreas a letter providing additional technical bases for the SBWR integral loop. We have also followed the Subcommittee's suggestion and initiated a program at BNL to analyze the configuration of the proposed SBWR loop, once the final proposal is chosen and the contract is established in June. These analyses will be similar to those done for the ROSA facility and will be used to see how well the scaled facility simulates predicted SBWR behavior in order to provide adequate data for code assessment.

NSRRC comment (Code selections and assessment, p. 2):

"The Subcommittee believes that the plans for code selection and code assessment need to be established in parallel because the high cost of an effective assessment process will directly influence the number of codes that can be selected. While the selection process appears essentially complete, the planning for the assessment process has large voids. These specifically include:

 a) The assessment plans for all AP-600 and SBWR transients except LOCAs by RELAP 5 are not established.

b) The assessment plan for RAMONA is not established.

Further, while the coupled CONTAIN/RELAP 5 strategy for containment analysis was not reviewed, we understand that the detailed assessment plan for this code is also not established. The Subcommittee would like to be informed of the progress being made in this task by the branches involved.

The Subcommittee's interest in an effective coordinated selection and assessment process was detailed in the letter of the Subcommittee to Dr. Morrison dated October 7, 1992, which was provided to RES well in advance of this meeting From the RES presentations it is obvious considerable progress has been made since our July 1992 review; however, it is disappointing to see that RES has completed the Selection process without concurrently completing the assessment plan. This comment should not be read to infer that we believe that a full CSAU type assessment is needed in every case; rather, we ask only that a timely, technically supported and disciplined approach be developed and presented for our review."

Response:

We agree with the Subcommittee that an effective coordinated selection and assessment process should be followed for thermal-hydraulic codes used to analyze the safety performance of the AP600 and SBWR designs. Let me describe the process that was followed, and I believe you will agree that it has the features you suggest.

The first step in such a process was to review the new design and its expected performance and to identify the important scenarios. At this stage almost all the information was supplied by the vendors. Since ooth designs (AP600 and SBWR) employ depressurization systems to allow injection of water sources once inventory is lost, it was clear that the key scenario to be investigated was the small-break loss-of-coolant accident (SBLOCA). Primary concern during a SBLOCA was found to be system interactions among the new safety injection components. For the AP600, this was especially true at high pressure, both before and during the depressurization process. For the AP600, other scenarios which could initiate the automatic depressurization system (ADS) include the steam generator tube rupture (SGTR) and main steam line break (MSLB). For the SBWR these include the MSLB and loss of feedwater (LOFW). In addition, for the SBWR the question of stability was raised, especially for ATWS. Stability will be discussed separately below.

The next step was to list the important phenomena and processes that could occur during each scenario and compare these to the phenomena and processes occurring during the dominant SBLOCA scenario. It was found

that almost all the key phenomena and processes were directly related to those expected during the SBLOCA, and the latter scenario could serve as the primary test vehicle for the code, with only spot checks on the other scenarios.

Next, a table was made of the key phenomena and processes and for each of the latter an entry was made of the data which could be used to assess a code's (at this point any code) capability to mode¹ these under the thermal-hydraulic and geometric conditions expected to occur in the new designs. The data survey included both the existing literature and the proposed vendor-sponsored testing programs.

Also, at this point, the usefulness of confirmatory integral FHFP testing for AP600 and low-pressure testing for SBWR was determined. No new separate affects testing was identified beyond that proposed by the vendors.

To summarize the process so far, the important new components of the design were identified, the key scenarios were identified, the key phenomena and processes were identified, and the data sources to assess the latter were identified, <u>all</u> before any code was chosen. That is, all this could be done without reference to any specific code.

Note that although the data sources were identified and the types of scenarios to be tested were determined (primarily SBLOCA) the number of tests and the detailed test initial and boundary conditions were not necessarily fixed for each test facility.

SBWR stability is a special case, and only existing data sources will be used for code assessment; no new data needs were identified. The data for stability is different than the data for SBLOCA. We have not yet established the RAMONA assessment plan. BNL is developing one and it should be ready by the end of April.

Now, for the code selection. For AP600, SBLOCA is the key scenario. RELAP5 has traditionally been the NRC code for SBLOCA; a code scaling, applicability, and uncertainty (CSAU) evaluation on RELAP5 was performed for a B&W plant using results of the MIST test program. Thus, the modeling in RELAP5 for SBLOCA, with its existing assessment, was reviewed for applicability to the AP600. It was found that no new models were needed, but some improvements could be made in modeling thermal stratification, level tracking, etc. These improvements are currently being incorporated. The accuracy and scalability of the improved code will then be assessed against the test data and a CSAU performed for a SBLOCA scenario. A modified CSAU has been developed and is being followed during the current code improvement and assessment process. This will collapse into a regular CSAU once the assessment process is completed and the code is frozen. Again for AP600, LBLOCA was felt to be of lesser importance, and the phenomena would not be that much different from that occurring in existing PWRs. Thus, TRAC-PWR was chosen since it is the traditional LBLOCA code. The CSAU performed previously on TRAC-PWR is planned to be used directly for AP600.

For SBWR SBLOCA, the two candidate codes were TRAC-BWR and RELAP5. NRR requested that RELAP5 be evaluated for use, so that they would only have to use one code for in-house analyses. Also, they were concerned that since GE was using their version of TRAC-BWR (TRAC-GE) for SBWR analyses, RELAP5 would provide a more independent audit capability than would TRAC-BWR. Upon an INEL evaluation of both codes, RES determined that either code was adequate. Thus, RELAP5 was chosen based primarily on the NRR request. This also made technical sense since many of the processes during AP600 and SBWR SBLOCA transients were similar and would require the same modeling improvements to the code.

For SBWR stability and ATWS, neutron kinetics feedback was known to be important and the RAMONA code was chosen, since it had a known capability to analyze thermal-hydraulic behavior in BWR's including kinetics feedback. TRAC-BWR would play a back-up role, if needed, since Penn State had independently installed kinetics capability. However, this code version is not yet documented or assessed and has not been reviewed by the NRC.

5. NSRR

NSRRC comment (p. 3):

"The ongoing approach could lead to a repeat of the unfortunate situation RES experienced with the TRAC and MELCOR codes in which RES funded and completed their developments without assuring the conduct of a parallel assessment process. This led to the very late and costly conduct of assessment programs for both codes--in the case of TRAC as part of the development of the CSAU procedure, and in the case of MELCOR by a peer review process that is only currently being concluded."

Response:

I would like to review our experience and lessons learned from the original application of the CSAU to TRAC-PWR for LBLOCA. At the time the CSAU was applied, over 15 years of development assessment and documentation of TRAC-PWR had been completed. The code was necessarily frozen for the CSAU process to have any meaning. The determination of scalability and uncertainty was based on previous assessment studies already performed before CSAU started; no new code assessment studies were performed. However, some individual modeling was assessed during CSAU (See appendices of NUREG/CR-5249) without the need for new code assessment studies. The only code calculations performed were plant sensitivity calculations for determining the response surface for uncertainty.

Passive System Reliability

1. NSRRC comment (p. 3):

"The initial objective of the study at Sandia National Laboratories is to compare reliability of ECCS systems (including any decay heat removal systems) of the Surry plant with the reliability estimated for the AP-600, using core damage frequencies from transients and LOCAs assuming that the reactor protection systems function successfully. The study is to determine, in particular, the uncertainties associated with the state of knowledge involving the functioning, for example, of the natural circulation and gravity fed injection systems. Work is underway modifying the MELCOR code, using the CSAU methodology. This project has been underway since October, 1990, and an estimated \$800K has been expended to date. The Subcommittee, while recognizing that the study seeks to evaluate the advantage of greater reliability that the advanced passive reactor should have relative to that associated with current reactors, has the following concerns with the conduct of the current program:

- The MELCOR code has been selected for this study...*
- *• The meaning of the concept of 'uncertainties in natural processes' and their evaluation in this program is a concept that still eludes the Subcommittee..."

Response:

RES management has reviewed the Sandia study of passive systems reliability and the related NSRRC comments. Based on this review, it was decided to discontinue all analyses and bring the project to an orderly conclusion (involving final publication of project reports, etc.) in the next few months.

We intend to pursue this matter, and take a more basic approach to develop the reliability of passive systems for use in PRAs. As part of this we plan to organize a workshop sometime this Fall to discuss and exchange views on the different ideas/approaches that have been developed on this issue so far and based on that decide what further efforts to pursue, if any. We will provide additional information to the Subcommittee as our plans are further developed and will advise the Subcommittee of our final plans in this area. When we have developed this approach we will advise the Subcommittee in the Fall, 1993.

Seismic Design

 NSRRC comment (Seismic design: Appendices B and S to 10 CFR Part 50, p. 4):

> "The Subcommittee has serious concerns that the manner in which the deterministic approach is included in the new proposed seismic regulations does not take into account relevant research carried out over the last twenty years."

"The Subcommittee is concerned that the proposed dual approach makes the new regulations less well defined than the old regulations and provides no real basis for assessing seismic risks."

"Of particular concern to the Subcommittee is the potentially limited role of the National Research Council Review Panel on Seismic Hazard Evaluation."

Response:

We agree that the proposed revisions have resulted in confusion and apparent conflicts as reflected in numerous public comments. We are in the process of reevaluating the proposed dual approach. The Subcommittee made several comments concerning the proposed revisions to Appendices B and S. These comments are being given serious consideration as the staff revises these documents. We are continuing to receive public comments to Appendix B. The revision of these documents will provide additional clarification. U.S. Geological Survey has expressed major concerns with the probabilistic approach. We are meeting with USGS to try to resolve these concerns.

 NSRRC comment (Analysis and design of reactor internals and piping systems, p. 5):

> "While the suggested review program presented to the Subcommittee is reasonable, caution is needed in how the review is conducted. The application of unduly conservative and cumulative criteria could lead to an unrealistic damage model that might led to an unnecessary reapplication of requirements that have been removed in the past decade."

Response:

RES agrees that this is an issue which should be examined closely. It will be. The Subcommittee's comments on the rulemaking package will be given serious consideration. Clarifications of vague or unclear terms will be made.

 NSRRC comment (Reliability of modular construction - placing this work at BNL, p. 5):

> "The Subcommittee understands that special circumstances can justify a limited number of such placements, but that such placements must not be allowed to become the rule. In this case, RES should investigate the benefits of engaging other more competent investigators, should they exist, to assist or direct subsequent phases of this modular construction project."

Response:

RES has a continuing commitment to ensure that the objective of placing research project with the most competent investigators including, but not limited to, those at the DOE operated national laboratories is realized. RES is reviewing current procedures to facilitate using the competitive procurement process for research projects.

Enclosure 4

HIGH-LEVEL WASTE RESEARCH

(Page numbers refer to the report of the Waste Subcommittee enclosed with the Committee report.)

1. NSRRC comment (p. 2, concerning performance assessment):

"The Subcommittee would like to receive briefings on the strengths and limitations for models being used in performance assessments by EPRI, and DOE contractors, as well as by CNWRA."

Response:

Note: An overview briefing on the model concepts will be arranged with the Subcommittee Chairman.

NSRRC comment (p. 2):

"Although it is recognized that IPA's can be used to prioritize research, examples were not presented."

Response:

The mathematical models used in IPA Phase 1 were not robust enough to be trusted as guides for either prioritizing existing research or identifying additional research. However, the modeling results from Phase 2 (the current phase) and future phases are expected to be used in HLW research planning, particularly as detailed auxiliary analyses identify areas where significant reductions in uncertainty are warranted and can be achieved.

NSRRC comment (p. 2, Specific Comment 1):

*[T]here was some concern that analog information is not being incorporated into IPA in a sufficiently rapid manner. For example, why is a greater emphasis not being given to the OKLO site? Here we can locate the daughter species of long ago decayed fission products and actinides and get a reading on the migration."

Response:

We agree that incorporating the results of the natural analogue work into the IPA process as quickly as possible is an important objective. The integration of the results from the natural analogue work into IPA is evolving as information is processed on the analogues and IPA becomes capable of addressing more complex systems. The Alligator Rivers Analogue Project (ARAP), for example, which is only now completing the documentation of the data collected in that five year study, will provide data which will be systematically applied to the results of the IPA program as the IPA models become capable of addressing the complexities displayed by this natural system. At Oklo the current phase of study is only in its second year. Information from the earlier studies at Oklo are largely only of qualitative and conceptual value because little quantitative hydrologic information was collected. However, of particular interest to NRC will be information being developed from studying the effect of dolerite dike intrusions into the ore body, which may be useful in testing the IPA approach to considering igneous intrusion at Yucca Mountain. (Other information may be less directly applicable because the deeper reactor zones currently under study are in a saturated environment.) In the CNWRA Natural Analogue and PA projects an attempt is being made to integrate the Pena Blanca analogue studies with a modeling task in the PA project. Furthermore, we agree that natural analogues should be viewed not only for what can be learned about the physical processes important to repository performance, but also as potential sources of data against which PA models, or components thereof, can be tested.

NSRRC comment (p. 3, Specific Comment 2):

"The Committee was concerned that in the IPA process, too much emphasis may be placed on complex computer models. The vast amount of data required to run such codes in a predictive manner is almost never available. Simply fitting models to data (see comment 1) provides only a limited degree of validation. The committee intends to re-evaluate this concern on a regular basis in the future, and it asks the NRC to do likewise."

Response:

We share the Subcommittee's concern. Our approach in response to it is to identify, in the course of the IPA process, the minimum data needs and minimum complexity needed for a safety assessment that can be made with confidence. Some experimentation with complexity of models and their data demands will be done to make this identification. The staff agrees with the Subcommittee's view that simply fitting models to data provides no validation, only calibration. We are keeping this concern in mind as the work progresses.

NSRRC comment (p. 3, Specific Comment 3):

"Volcanism in the Basin and Range environment is poorly understood, and it appears that a statistical approach is required. The distribution of volcanics (size and ages) within a distance of 500 to 1000 Km should be determined in detail and can form the basis of probabilistic hazard assessment for the site. This approach follows directly from the current work (as presented by Drs. Birchard and Kovach) and should be given a high priority."

Response:

We expect that the DOE will determine the distribution of volcanics (size and ages) and that this will be part of the DOE's license application. The NRC HLW licensing staff is monitoring DOE's work to see that sufficient data are collected. The volcanic research program at the CNWRA has examined available data and models on the distribution of volcanics and is compiling this information into a computerized data base. The CNWRA will begin soon limited field investigations aimed at understanding the mechanisms controlling the style and magnitude of igneous activity in the Basin and Range. In the final phase of this program, the CNWRA will apply the results of the field investigations, the regional data base. and data collected by the DOE to existing models of mantle dynamics to develop an independent assessment of volcanic hazard.

NSRRC comment (p. 3, Specific Comment 3):

"The subcommittee also recommends that a probabilistic risk assessment be carried out with regard to seismic hazards. One can use as models the Livermore and EPRI studies. The subcommittee questions whether the integrity of the repository to large volcanic eruptions can be established. Thus the probabilistic hazard assessment must be the basis of defusing attacks on the site based on volcanic disruption."

Response:

Estimates of the risk to the Yucca Mountain repository from volcanic and seismic events will be part of the DOE license application. The NRC HLW licensing staff has provided guidance to DOE on seismic hazard assessments and has used RES results in developing this guidance. NRC will collect limited data to confirm the technical analyses and supporting data used by the DOE in estimating the seismic hazard at Yucca Mountain.

NSRRC comment (p. 3, Specific Comment 4):

"Some but not all subcommittee members were concerned about the recently proposed idea of high temperature storage and the resulting need for high temperature canisters. Although high temperature, in principle, could provide a dry environment, the thermohydrologies in a partially saturated medium with a variety of matrix and fracture porosity may not be understood well enough to assure dryness under a variety of weather and climatic conditions. A high temperature environment may be viewed as a high risk environment, should anything perform in an unexpected way in the future. If in the future it should become desirable to approach the repository, high temperatures could make this difficult or impossible. It seems more sensible that the design of the repository should conform to the natural environment as closely as practical."

Response:

It is RES' view that high temperatures will make the confident demonstration of acceptable long term repository performance much more difficult than it would be if repository temperatures were nominal. The RES staff's concern in this regard has been communicated informally to staff of the DOE. I have asked the Director, NMSS to bring NSRRC's comment to DOE's attention.

NSRRC comment (p. 3, Specific Comment 5):

"NRC should continue to maintain a detailed awareness of external high-level waste programs, both nationally and internationally, and how they relate to NRC and DOE work. For this and related purposes it might be a good idea to develop milestone charts of considerable greater detail than has been done in the past. Such milestone charts should identify the customer for the activity, the time the results are needed and the identification of interim results. Furthermore, the charts should cover not only the NRC program but also the DOE and other programs."

Response:

NRC, through NMSS, maintains a detailed awareness of HLW programs conducted by the State of Nevada and EPRI. In addition, primarily through RES, NRC maintains a detailed awareness of HLW programs in other countries and has bilateral information-exchange agreements with several of them. However, RES believes that preparation of milestone charts would be only marginally useful since all but the most generic of foreign HLW research is focussed around sites, designs, and schedules significantly different from the Yucca Mountain repository.

9. NSRRC comment (p. 4, Specific Comment 6):

"A great deal of chemistry is involved in the HLW program. This includes corrosion of containment, speciation of important nuclides and the adsorption-desorption characteristics of the appropriate nuclides. The speciation of the nuclides requires the identification of the pH, the temperature and the oxidation potential in the aqueous transporting media. The extensive report of uranium results was somewhat discomforting. Some uranium results are of course useful but not readily extrapolated to, for example, plutonium. The chemistry base may be in the program but it was not apparent to the subcommittee."

Response:

The sorption modeling work that has concentrated so far on uranium is providing a methodology that should be applicable to other radionuclides such as plutonium. RES agrees that the uranium data are not suitable for estimating plutonium transport and that data specific to transuranics and actinides will be needed as input to the modeling approach developed using the uranium data base. It should also be noted that the near field chemistry will be dominated by the presence of large amounts of uranium and that processes such as co-precipitation with uranium may be significant. NUCLEAR REGULATORY COMMISSION

Nucleer Selety Research Review Committee: Meeting

The Nuclear Safety Research Review Committee (NSRRC) will hold its next meeting on April 28-29, 1993, in the Pelladian Center at the Chevy Chase Holidey Inn, 5520 Wisconsin Avenue, Chevy Chase, MD. The meeting will be held in accordance with the requirements of the Federal Advisory Committee Act (FACA) and will be open to public attendance. The NSRRC provides ed vice to the Director of the Office of Nuclear Regulatory Research (RES) on matters of overall management importance in the direction of the NRC's program of nuclear safety research. The purpose of this meeting is to review the status of information and research on nondestructive examination (NDE) of steam generator tubes and the pertinent beckground of technology and practice.

The planned schedule is as follows:

Wednesday, April 28, 1993

9:30 e.m.-9:45 e.m.: Opening remarks:

NSRRC Chairman, RES Director. 9:45 s.m.-12 noon: Beckground and overview.

General background of the different steem generator designs employed in pressurised-wear-reactor success power plants and the types of desage experienced over the years for different generators. Theory of eddy current testing as applied to steam prostator tube impections; NDE methods, procedures, equipment, and personnel used; practical espects and logistics for conducting these inspections.

1:15 p.m .-- 5:30 p.m.: Current prectices.

Discussion by providers of inspection services. Current steen generator tabe inspection practices; advantages and disadvantages of the techniques; reliability of flaw detection and accuracy of flaw sizing. experiences and findings from field inspections.

\$:30 p.m.-6 p.m.: Committee discussion.

Thursday, April 29, 1993

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8:30 a.m.--11:45 a.m.: Research programs and recention.

Rocess, current, and future research mans and savelts related to coversate for nondestructive testing of a generator tales. WHC independent wate Program: activities of the MDE mobile interstory.

rging technologies. 1 p.m.-4 p.m.: 6m

peopleg sectade and technology that relaa the mear term and in the fatero.

4 p.m.-6:50 p.m.: Pend discuss here . NETE bounds, including the ston webs and weekmanne of current methods, y improvements and intere research projects. 4:30 p.m.-6 p.m.: Ozianimes discussion.

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Participants in the presentations to and discussions with the Committee will include representatives of the NRC staff, industry, and research organizations.

Members of the public may file written statements regarding any matter to be discussed at the meeting. Members of the public may also make requests to speak at the meeting, but permission to speak will be determined by the Committee chairperson in accordance with procedures established by the Committee. A verbetim transcription will be made of the NSRRC meeting and a copy of the transcript will be placed in the NRC's Public Document Room in Washington, DC.

Inquiries regarding this notice, any subsequent changes in the status and schedule of the meeting, the filing or written sistements, requests to speak at the meeting, or for the transcript, may be made to the Designated Federal Officer, Mr. George Sage (telephone: 301/493-3904), between 8:15 a.m. and 5 p.m.

Detod: March 18, 1993.

Jahn C. Hoyle,

Advisory Committee Management Officer. [FR Doc. 93-6575 Filed 3-22-93; 8:45 am] BELLING CODE 7889-01-6

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