Volume II

Role and Direction of Nuclear Regulatory Research

Expert Panel Report

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research

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INTRODUCTION

The Nuclear Industry is currently involved in important and far reaching changes that are creating new issues and new challenges for the Nuclear Regulatory Commission (NRC). As a result, the Agency is currently involved in an internal evaluation to determine how it can meet these challenges and at the same time continue its objectives to: maintain safety; protect the environment and the common defense and security; increase public confidence; make NRC activities and decisions more effective, efficient and realistic; and reduce unnecessary regulatory burdens on stakeholders. An essential part of this effort is a thorough review of the activities of the Office of Nuclear Regulatory Research (RES). Since it was established by Congress in 1975, RES has provided a significant part of NRC's independent capability for developing and analyzing technical information related to reactor safety, safeguards, and environmental protection in support of the licensing and regulatory process.

As a means of supplementing internal planning, input from stakeholders was sought on the role and future direction of RES in this rapidly changing environment. A 17 member panel of experts (chaired by former Commissioner Kenneth Rogers and representing industry, academia, government and public interest groups) was assembled and asked to present their views and comments on the vision, mission, role, and general direction of regulatory research, and to provide insight and guidance for future activities. A list of the members, all of whom who served voluntarily, is included in Volume 1 of this report.

The work on this report was divided into two phases and the Panel was convened for two meetings for each phase. The first two day meeting was opened by NRC Chair Richard Meserve, followed by presentations from and open discussions with, senior RES staff. The panel met the next day for internal discussions and then adjourned. Individual preliminary written statements were submitted by each of the members identifying key issues and recommendations. The second meeting involved only the panel and focused on more detailed discussions of individual statements which were then finalized by the authors and included as part of this report. The objective of Phase 1 was to broadly examine the mission and role of RES and its contribution to the basic objectives of the NRC. Since this was a non- FACA panel, no attempt was made to develop a consensus report, instead each member was encouraged to present their own individual viewpoint and recommendations. However, based on the information from the written submissions and discussions during the meetings, there appeared to be several conclusions and recommendations widely shared by many of panel members. These issues were restated in the form of recommendations to the Commission, and for the Phase 2 effort, the Panel was asked for their individual suggestions and comments as to how these recommendations could be implemented. Phase 2 was conducted in a similar manner with a two-day and a one-day meeting where presentations were made to the panel by NRR, NMSS, RES, and representatives of the regions. Prior to the meetings, the panel requested and was provided with detailed information on budgets, programs, and specific activities of these offices. The panel submitted their individual comments and recommendations as included in Volume 2.

Also, at the onset of Phase 1, in his opening address to the Panel, Chairman Meserve offered three questions for the panel's consideration. There were preliminary responses to theses questions in Phase 1; however, the panel requested and was provided with, more information in order to provide more substantive answers. The three questions and the individual final responses are included in Volume 2 of this report.

It should be strongly emphasized that was a non-FACA committee and there was no attempt to reach a consensus. The material included represents unique viewpoints of each panel member based on their experience and understanding of research as it is conducted by the NRC. The views of each panel member including the Chairman, are their own with no editing or modification, and are included in their entirety in this Volume 2. Volume 1 is a summary, written by a non-member of the panel that summarizes the positions which were commonly held by a majority of the panel members, including conclusions and recommendations which appeared to be most widely shared.

SUMMARY

PHASE I

The 17 statements presented in this report are the views of individual panel members, including the Chairman. No attempt has been made to reach a consensus or establish a uniform set of recommendations. It is clear, however, many issues and conclusions were independently considered by more than one panel member, and in some cases a majority of the panel. The submissions of the individual panelists contain many unique and important comments and ideas that merit serious consideration; therefore, all the individual statements should be reviewed in addition to this summary. Issues considered most prevalent are discussed below.

The panel members were in general agreement that a strong viable RES with world class expertise must be maintained in order to ensure a sound technical base for all NRC activities and to maintain the credibility and leadership role of the NRC both domestically and internationally. Most panel members were of the opinion that RES must expand in-house expertise by adding experienced professionals, qualified in areas directly related to current and anticipated regulatory activities. There was no criticism of current personnel, but it was felt that through attrition and budget reductions, technical expertise has been steadily eroded in some technical areas. It was suggested that RES have a cadre of full time in-house technical experts available to keep abreast of worldwide technical developments that might impact on regulatory activities.

There was general concern that the physical facilities available to RES are showing their age and rapidly becoming obsolete and expensive to operate, particularly those of the National Laboratories. Many of these facilities, as well as those at universities and in private industry, are being shut down prematurely for economic reasons. NRC must work with industry and other government agencies to make a case for maintaining these facilities in preparation for future work. There was concern that in order to maintain independence, RES was forced to utilize government facilities that were obsolete or inadequate. This prompted further discussion by several members of the panel on the need for more collaborative efforts using the resources and facilities of industry and international sources. Successful collaborative efforts in the past with foreign-owned facilities were cited as examples.

There were extensive discussions regarding the question of whether NRC can maintain independence in their decision making while utilizing data and test results obtained by others. It was generally agreed that a solution to this dilemma must be found and most of the panel members commented on this topic. Most of the panel members recommended RES increase its cooperative research efforts with DOE, industry, EPRI, and international organizations. It was felt that with declining budgets, pooling research efforts with others would result in more effective use of available resources and this practice should be more frequently utilized. It was suggested that RES would not necessarily have to initiate or manage all research efforts, but it must be in on the

planning and establishing of objectives for such research programs that it needs to use. It was recommended that current working agreements with DOE and EPRI be re-examined and strengthened wherever possible and more fully utilized. There was concern, however, that RES not rely solely on the advice and guidance of those organizations which might ultimately do the research.

An underlying concern among several panel members was whether RES was operating in accordance with the intent of the original congressional mandate. The question was raised as to whether all research should be conducted in a single organization, ergo RES. Members differed on this issue; however, several felt that a single strong center conducting all research for the Agency should be considered. There was considerable discussion regarding the proper balance between anticipatory and confirmatory research and technical support. With general agreement among the members that the current mix of anticipatory and confirmatory research appears to be reasonable. There were questions on how decisions are made, what anticipatory research is done, and what objectives are sought. Several members of the panel stated that costs for anticipatory research should not be recovered through fees, but from general funds. Several panel members suggested the definition of research as it is conducted by NRC should be more clearly defined, and more transparent methods are needed to decide what research needs to be done and when to start and when to terminate research projects.

The crosscutting issue that impacted all other issues was funding the RES efforts. It was generally agreed that funding was at a dangerously low level and any further cuts would make the viability of RES questionable. The need for full cost recovery places too much burden on stakeholders, and opinions ranged from funding RES completely from general funds to at least providing a significant percentage from that source. Several panel members felt stakeholders should not be required to fund any anticipatory research, even though such research has value and may be needed for future regulatory actions. It was suggested the NRC at the highest levels increase contact and dialogue with the Congress to obtain budget relief and reconsideration of the requirement for full cost recovery. Support by the nuclear industry in this effort was regarded as essential for its success.

A majority of the panel agreed that RES must improve its communications efforts with the stakeholders, other government agencies, and internally with the Commission at all organizational levels. Concern was expressed that in many instances the public and even industry are unaware of what RES programs were underway, the objectives being pursued, the final results, and how these results were used for regulatory purposes.

Several panel members urged more active and direct leadership by the Commissioners in support of RES both internally and externally to underscore the value of the research performed at NRC in support of nuclear safety domestically and worldwide. Also, support from stakeholders, particularly the industry and DOE, is needed to achieve this objective.

Finally, it should be noted that at the first panel meeting, NRC Chairman Meserve, in his opening remarks, posed three questions to the panel and most of the members attempted to respond directly to these questions. These individual responses are included in Volume II.

PHASE II

The objective of Phase 2 of the Expert Panel was to identify key policy recommendations to the Commission that were developed in Phase 1, and suggest ways and means to implement these recommendations There was general agreement on the importance of maintaining and supporting a strong research capability to ensure the safety of U.S. nuclear facilities and contribute to U.S. leadership in nuclear technology worldwide; therefore, the panel focused on identifying strategies to achieve this objective. While there was no attempt to establish a consensus among the panel members, similar specific recommendations were made by a significant number of panel members, and in some case the majority, for actions to be taken by the Commissioners, EDO, and RES to improve and enhance RES operations. The scope of attention given by the panel members was extremely broad and covered a wide range of RES operations and interrelationships with the other program offices. In order to produce a manageable analysis, the individual panel member's comments and recommendations that appeared most often were combined into four major policy type recommendations and the Panel was asked to focus on these recommendations and present their views and suggestions as to how they might be implemented. The four recommendations are listed below, followed by brief statements on how they might be implemented. It should be emphasized that since this is a summary only the suggestions that appeared most often are included. There are other important issues and recommendations made by individual panel members that should be considered. For this reason it is important to review the individual statements of each panel member as contained in Volume 2 of this report.

Specific Recommendations

1. The NRC must maintain, as a used and useful arm of its organization, a reliable, respected office of Nuclear Regulatory Research (RES) and must support this office with the necessary people and resources so it is an unassailable source of technical information and support for regulatory actions. This is necessary not only to establish the credibility of NRC's technical decision-making and thereby ensure the safety of all NRC licensed activities, but also to ensure U.S. leadership in the technology of nuclear safety regulation.

    a. RES was established by legislation and given a mandate to ensure an independent capability for developing and analyzing technical information related to reactor safety, safeguards, and environmental protection in support of the licensing and regulatory process. The Commission should

explore ways to increase the funding for RES in order for this responsibility to be adequately carried out.

b. The Commission should direct the EDO to establish minimum requirements for RES core capabilities and resources required for maintaining the necessary people, analytical tools, and access to facilities.

c. The Commission should charge RES with monitoring the Agency's state of readiness to meet future challenges as a result of new technologies, reactor design advances, safety issues and industry initiatives, and reporting its findings to the Commission on a periodic basis (e.g., biennially).

2. RES must support the activities of other program offices, which in turn should be required to coordinate their activities with RES at least to the extent of planning new work, establishing objectives of technical studies and assessing the validity of data and analyses. At the same time, RES should be allowed to initiate anticipatory technical studies without approval by program offices, but with their cognizance and input wherever possible. RES must be able to do and be seen as able to do independent verification of data which NRC will rely on for regulatory action. RES must institute and maintain a comprehensive and effective communications program to make available their plans and activities.

a. The Commission should require RES to develop a strategic oversight system for its anticipatory research and require input from the program offices in both identifying and prioritizing anticipatory work. However, the decisions on an anticipatory research program must lie with the Director of the Office of Nuclear Regulatory Research. RES should provide the Commission with annual reports on the results of its anticipatory research program.

b. The Commission should encourage the expansion of RES activities beyond narrow technical activities, and task RES with a responsibility for identifying new systems-wide issues that could have significant safety implications and for proposing further relevant studies. Examples might be the impact of regulation on a licensee's safety culture and the positive or negative synergistic results of current or new regulations or new industry initiatives.

c. The Commission should direct RES to improve communications with stakeholders on its research program. RES programs should be described in understandable language in reports including, but not limited to, an annual RES report which describes the purpose of the research, expected use in the regulatory process, and sunset criteria for each major research program.

3. RES must continue to grow its cooperative efforts with other organizations including, but not necessarily limited to, EPRI, DOE, industry, academia, public interest groups, and international organizations. RES must seek out and, wherever possible, utilize facilities, equipment, and resources available from these entities and maximize the use of technical data and results already developed. RES, in cooperation with and supported by the Commission, must establish procedures to accomplish this while fully retaining the decision-making independence of RES.

   a. The Commission should direct RES to expand its base of contractors to include more private organizations. RES should explore innovative ways to contract with private organizations that will not significantly delay the contracting process.

   b. The Commission should direct RS to identify inhibitors to further expansion of cooperative research with the international community, EPRI, DOE, and the nuclear industry and propose for Commission consideration, strategies to implement such cooperative research without compromising NRC's independent regulatory decision-making.

4. A clear and understandable definition of what research includes and does not include at the NRC and its value to the safety of the nation's nuclear program must be established by the Commission and accepted internally by the program offices and staff personnel and effectively conveyed to all the stakeholders. Continuing efforts must be made through research to eliminate unnecessary regulatory burdens on stakeholders while at the same time focusing on areas that will benefit them through safer and more efficient operations. Charges to licensees for research costs should be on the basis of identifiable value to the efficient and effective regulation of those licensees.

   a. The Commission should establish a clear concise definition of research as it is conducted by this agency, with clear distinction among anticipatory research, confirmatory research, and technical assistance and the significance of "realistic' in a RES context.

   b. Commission should support adjustments to the fee structure to ensure that funding derived from licensee fees is used only to support the regulatory needs of those licensees. Funding for new technology and advanced designs should be independent of the fee structure.

In addition to the four policy recommendations given above, the Panel was also asked to respond to three questions posed by Chairman Meserve at the opening meeting. These questions are listed below with brief responses, representative of the most commonly held positions of the individual panel members. It should be again stressed that for the sake of brevity, only the most often expressed comments were summarized.

There are other important comments included in the individual statements by each of the panel members and these statements should be carefully reviewed.

RESPONSES TO THE CHAIRMAN'S THREE QUESTIONS

At the onset of Phase 1, the Chairman emphasized the importance of this study to assist the Commission charter future tasks of the Office of Nuclear Regulatory Research. Chairman Meserve stated that, among other things, he was seeking answers to the following questions:

1. Are we spending enough on research?
2. Are we doing the right research?
3. Are we doing research with the right people?

While most panel members provided opinions on these questions, all members indicated they did not have enough material or background information to properly address these questions. As a result, Phase 2 presentations were made by NRR and NMSS describing research activities relative to user needs and RES described the anticipatory research being done. Based on this more detailed information, the panel was able to provide more specific answers to the questions. While it should be emphasized that Phase 2, which was conducted in the same manner as Phase 1 as a non-FACA committee and a non-consensus report, there were a number of comments and recommendations by more than one member of the panel and in cases a majority of the panel. The comments and recommendations below represent a combination of Phases 1 and 2 material submitted by the expert panel. These positions are indicated as follows:

1. **Are We Spending Enough on Research**? Based on the presentation by RES, it was concluded that research in general and anticipatory research specifically are substantially under-funded. While not everyone provided numerical assessments, those who did put this shortfall in the range of $4-12 million per year. It was pointed out the research budget has been significantly reduced over the past 10 years while the challenges to research based on emerging issues have increased. It was stated that somewhere between 80-90 percent of the RES's research budget is dedicated to user-need research. The remaining 10-20 percent did not appear to be adequate for RES to undertake research on emerging issues arising from decommissioning, license transfer, license renewal and other such activities, and on advanced technologies. Several panel members felt Research should be able to challenge technical results from both NRR and NMSS technical support activities to be certain a sound technology database is being used in to license decision-making. A number of panel members expressed concern RES's budget was insufficient to maintain its technical core capabilities needed in the face of declining staff throughout the Agency. It was suggested that RES increase its technical capability and expand its contractor services as well the facilities that are used. This would require additional funding.

2. **Are We Doing the Right Research**? The majority of panel members strongly indicated that not enough anticipatory research is being done and RES is not doing enough work in the material and waste areas. It was also pointed out the ACNW should present a list of unfunded project they feel should have been done that are not planned to be done. It was suggested RES should be doing more work on the utilization of PRA results and developing improved PRA methods, and RES should be working on improved data that would permit the Commission to assume its goal of reducing the financial burden on stakeholders. Several panel members felt that regardless of the work being done by NMSS in evaluating the ability to license waste management programs, special research skills are required to review that work and verify its credibility. Decisions regarding the ultimate safety of the Yucca Mountain Project, for example, will be carefully scrutinized by stakeholders and solid research data must be available to support the decisions made by the Commission. It was felt that by placing such a strong emphasis on research applied to user needs, significant gaps in technology will result that cannot be filled because of lack of funding and personnel. Although several panel members did not feel licensees should pay for anticipatory research, they recognized the need to perform this research. It was recommended a more robust funding of research be pursued by the Commission with a larger percentage of the funding derived from the general funds appropriated by Congress instead of licensee fees. It was also recommended a systematic process of prioritizing research projects be established with greater coordination between NRR and NMSS. Some panel members suggested more communications with licensees and other stakeholders outside of NRC would increase the likelihood the necessary research is being performed.

3. **Are We Doing Research with the Right People**? Several panel members pointed out that it was the intent of Congress for NRC to use DOE's national labs to take advantage of the large DOE budget for research. However, with a reduced RES budget, it becomes more difficult to conduct research with varied contractor types and at the same time sustain some minimum funding level to ensure quality products. The Commission must continue to find ways to use DOE laboratories as well as DOE resources. This can be done through collaborative efforts suggested by the NRC, but carried out by the DOE. It was pointed out that complex contracting procedures can take too long to contract with organizations other than the national labs and NRC should find ways to reduce the time it takes to contract with industry, academia, and other private organizations. It was stressed that this must be carefully done so the NRC in general and RES specifically do not diminish their independent roles or relinquish safety objectives in any way. Several panel members felt that anticipatory, particularly long-term projects, can benefit by contribution from university teams which fit less-structured and less time-disciplined modes of operation. However, RES must continue to develop its skills in managing university research projects. RES should also review the working arrangements they currently have with EPRI

and DOE to be certain they provide sufficient flexibility to maximize the benefits of the work being done by those two agencies without losing independent verification capabilities. It was also pointed out that advice on research provided to the NRC by the ACRS and the ACNW is excellent, but both of these committees are heavily burdened and some new mechanism could be created to provide additional oversight in the form of periodic reviews of NRC's overall research programs by a broad-based group of experts every two or three years. Specifically, it was recommended that the Commission require RES to review all its programs and reassess the unfunded-but-needed efforts and develop a set of required competencies and amount of funding required to perform these projects.

INDIVIDUAL PANEL MEMBER'S STATEMENTS

Kenneth C. Rogers
Phase 1 Comments

My comments deal with precepts to be kept in mind in developing answers to the three very important questions which Chairman Meserve placed before the Panel in his opening remarks: Is NRC research being funded at the right level? Is NRC research doing the right things? Is NRC using the right performers for its research needs?

I will not attempt to give specific answers to these questions, but instead will offer observations useful in addressing them.

I begin by strongly supporting the statement of NRC Regulatory Research Mission already in place and endorsed by the Commission. It is excellent and complete.

The statement of NRC Regulatory Research Vision while very good probably should be revisited in the light of the current view, which I share, that NRC's fundamental independence in using the facts derived from research does not necessarily require that NRC be the sole source of support and owner of the research that produces those facts. The funding available to NRC for research in the near future will force the agency into new cooperative research partnerships with other domestic and international parties, and the Vision statement should not appear to rule out such arrangements. I suggest that the wording: *"RES conducts independent experiments and analyses, develops technical bases for supporting realistic safety decisions by the agency, and prepares the agency for the future by evaluating safety issues involving current and new designs and technologies" be reworked so as to include cooperative data gathering and analyses, but with independent interpretation and use of these results.*

With that clarification both statements would be excellent and complete. The challenge remains to develop a strategy and tactics to effectuate them, to translate the words into practices and results, and to convey an understanding of these results and practices to interested stakeholders.

The Commission's staff guidance in 1995-96 on Direction Setting Issue 22 of its Strategic Planning Program laid down 6 important precepts. I agree with every one of them. However, they are "should" statements and in themselves do not offer much help to the staff in "how" they are to be effectuated. (The contributions of this panel of research expert stakeholders can be very valuable in providing useful ideas on that.) Stated briefly they are:

1. The research program should continue to include elements of both confirmatory and anticipatory research.

2. RES should develop a set of core research capabilities for NRC in consultation with other NRC program offices.

3. To assist top agency management, a selected office should create and maintain an agency-wide database that contains an inventory of the core technical capabilities of the NRC staff.

4. The Commission supports increasing the percentage of the research budget executed by universities.

5. The staff should continue to support active participation in International Safety programs.

6. The staff should explore the option of performing cooperative research with both the industry and the DOE to minimize duplicative work. The staff should also examine the feasibility of improving access to research information during the early phases of the work.

Within the body of my comments I will refer to these precepts by number.

Top Notch Technical Experts

The greatest challenge and arguably the highest priority of The Office of Regulatory Research and of NRC's senior management should be in maintaining and fully utilizing a cadre of topnotch technical experts in each of the core technical disciplines NRC will employ in making regulatory decisions. It is absolutely essential that the technical quality of the NRC staff and the technical bases underpinning their regulatory decisions be unquestionable.

I recommend that Guideline 2 be broadened. The core disciplinary areas should be determined through a consultative process using help from experts both inside and outside of NRC. The number of core areas should be as small as possible, and the core technical experts should be as broad gauged individuals as possible, while at the same time possessing deep technical expertise. The number of core disciplinary areas (e.g., thermo-hydraulics, digital instrumentation and controls) is probably less than 10. Over time the list of core technical areas will change. Therefore identification of the core areas must be a dynamic process with provision for additions and deletions from the list and for changes in the members of the core cadre. Providing an intellectual environment that attracts and holds such individuals in a government agency not possessing extensive research facilities of its own is a difficult but not impossible management challenge.

Guideline 3 does not designate a specific office to be charged with the responsibility of creating the agency-wide database of NRC's core technical capabilities. From a purely administrative point of view it would be natural to assign that responsibility to the Personnel Office. But a personnel office does not have the necessary technical expertise to discharge such a heavy responsibility entirely on its own. It would have to rely on the judgments of technical experts both inside and external to NRC. It is my understanding that the NRC Human Resources office has compiled a directory of staff

technical skills at NRC, but that it was so extensive that it has not been used to identify the types of individuals I have in mind.

Once the core technical experts have been identified and recruited, if that is necessary, then that cadre of technical experts could be formally identified as NRC's in-house principal reference resource for all technical decisions and designated as the technical knowledge base on which all regulatory decisions having technical components must rely. Members of the cadre should be charged with knowing where the best research in their disciplines is being done, who is doing it, what the latest results of that work are and seeing that NRC can readily use that work as needs arise. Together they would provide the technical quality control essential for evaluating potential contractors or other sources of technical support and the quality of the work. I expect that most of these technical experts would be in RES, but some might be in NMSS and NRR. Even though they themselves would not be expected to actually carry out research, they must be individuals who are well regarded by the leading researchers worldwide. Membership in the Corps of Technical Experts should be promoted as conferring considerable professional prestige within the NRC. It should be subject to review on a periodic basis e.g., every three or four years. Special efforts by NRC management would be required to ensure that these experts are included in all relevant regulatory decision-making and never ignored either because they are not assigned managerial authority or because they do not dispense research dollars. Burdening them with heavy research management or administrative responsibilities would divert them from their principal purpose, but unless specific new mechanisms are put in place to ensure their significant participation in regulatory decisions, they could be shunted aside and rendered ineffective. This is basically a management challenge requiring leadership from the highest levels of the agency.

Means to Validate Complex Computer Codes

A second great challenge is to ensure NRC's access to physical facilities capable of testing the validity of the results of the large computer programs NRC and the industry must use in making technical decisions. I include this as a high priority because the cost of providing the physical facilities to test large computer codes is so high that NRC will be unable to support such facilities entirely on its own.

It is of fundamental importance that the users of these codes constantly guard against the "seductive" notion that the codes are reality. They are merely attenuated mathematical descriptions of real physical systems constructed to model only those features which are amenable to being included and which a priori are regarded as of greatest importance. What has been left out, in order to construct as manageable a model as possible, may prove to be very important under certain circumstances, and only experimental data from actual physical facilities can reveal such shortcomings. The in-house Corps of Technical Experts would be extremely valuable in planning and evaluating appropriate tests.

Both Guidelines 5 and 6 relate to meeting this challenge. The NRC should make strenuous efforts to work with the DOE, the nuclear industry, and the Congress to develop the means necessary to maintain or even to create the physical facilities here in the US, or elsewhere, that are increasingly necessary for testing the validity of the complex sophisticated computer codes necessary for safety decisions. Novel and nontraditional mechanisms should be explored for bringing this about. Because of its fundamental responsibility for safety, NRC should take the lead in this effort, which will require participation by decision makers at the highest possible levels in all of the organizations involved.

Financial Resources Sufficient to Maintain both Confirmatory and Anticipatory Research Programs

Short-term confirmatory research will continue to dominate NRC's research agenda. Guideline 6 offers a mechanism for dealing with the severe funding problems all research is experiencing. New ways will have to be developed of acquiring the results of the high quality objectively conducted research necessary for NEC's regulatory decision making. Duplication of research already conducted or simultaneously being conducted by responsible organizations outside of NRC can no longer be justified by NRC's need to ensure the credibility and independence of its information simply by providing sole support for the work and by having exclusive oversight of its conduct. Nontraditional new approaches to ensuring the unbiased objectivity of work performed with industry support must be found and adopted so that both the NRC and the industry can use the results of such work without a credible conflict of interest taint. Both the NRC and the industry must work much harder to find ways to do this. Clearly this is an activity that can help NRC and the industry fee payers to reduce the costs of essential studies that must be carried out to ensure safety and reliability.

Longer-term anticipatory research has become a minuscule item on NRC's research agenda. This is a serious shortcoming that leaves the Agency vulnerable to unanticipated technical developments or misadventures and diminishes its capacity to provide the highest possible degree of assurance of public health and safety. It is very important that NRC's research agenda include some research that is not immediately required to close well-defined gaps in technical knowledge or data. Guideline 4 opens the door for the encouragement of university-based research prompted by NRC's expressed interests. It needs greater attention and support. Anticipatory research is an area to which university teams can significantly contribute and which fits their less structured and less time constrained modes of operation. University research programs which directly involve students in areas of interest and importance to NRC can produce not only research results but also motivated and well trained university graduates necessary for the continued vitality and intellectual quality of the nation's nuclear activities as well as those of the NRC. National Laboratories managed by universities, while capable of excellent research, do not necessarily fit this model, because they may be physically and intellectually remote from the university's regular faculty and students. Successful management and administration of university-based research requires a kind of expertise not common at NRC. Maintaining focus and

coming to closure in the work are special challenges for all government contract administrators of university research programs.

Guideline 5 encouraging NRC's participation in International Safety Programs is relevant to the effective management of NRC's rather limited financial resources for research so as to obtain their maximum leverage. However, players in international cooperative research programs generally are welcome only if they bring significant human and/or financial resources to the project. Unless NRC is able to continue to supply one or the other of those it may not be able to continue to enjoy the inexpensive fruits of its participation in international research projects.

While the financial resources of NRC for research should be increased, the likelihood of substantial increases in the near future may be small. In the absence of a well scrubbed list of research projects that must and can be funded and a corresponding list of should be but cannot be funded projects, it is impossible to quantify the funding shortfall. However, the severe decline in NRC's RES budget in recent years strongly suggests that the RES budget has been cut too much. Unnecessary duplication of research, particularly confirmatory research, must be eliminated if NRC's minimal financial and human resources are to be able to meet the needs for both short-term and longer-term research. Funding for longer-term anticipatory research should come from General Funds rather than licensee fees, and the Commission should continue to make a strong case to Congress and the industry for such funds. A fraction, e.g., 10% - 15%, of NRC's total budget should not be met by licensee fees because there is little direct connection between some of NRC's activities and current licensees, although they may be very important to longer-term public health and safety. Support of the nuclear industry for increasing the fraction of the NRC budget derived from General Funds is probably essential.

Visibility of Research Agendas, Progress, Results and Outcomes

NRC research must do much better in communicating details of its processes both internally and externally. Guideline 6 deals with one aspect of the communication gap between NRC and its stakeholders. Simply disseminating the final results of research activities is insufficient. The processes involved in arriving at research agendas; selections of who will do the research; progress reports during the course of the work before final results are achieved; final results of the research work; the use to which it is or will be put and finally the outcomes of that utilization, should all be made available to interested parties (within the constraints of any necessary restrictions on such revelations). The costs of doing this are going to be fairly high in person hours, but the costs of not doing it well enough will continue to be very high in lost dollars resulting from the continuing successful pressure by licensees to reduce NRC's research budget.

Devices such as the present NRC Research Effectiveness Review Board are excellent and should be more broadly utilized to constantly check on how the results of research are being used, and to make recommendations for continuation of research, its expansion or for its termination. The effectiveness and credibility of such a review

board would be greatly strengthened by the addition of experts from outside of the NRC, or if that is not feasible, by routinely offering an independent NRC group such as the ACRS or the ACNW an opportunity to comment on the panel's work. In any case, much greater effort must go into systematically providing information to the stakeholders of the progress and results of NRC's research.

Kenneth C. Rogers
Phase 2 Comments

My comments deal first with the three questions which Chairman Meserve placed before the Panel in his opening remarks: Is NRC research doing the right things? Is NRC research funded at the right level? Is NRC using the right performers for its research needs? In my answers I have included some comments related to the question at hand, but are not in direct response to it simply because I feel that they should be considered in the context of the question. These are followed by some general observations and suggestions for Commission consideration.

IS RESEARCH DOING THE RIGHT THINGS?

NRC RES has worked very hard, and with considerable success, in recent years to develop a rigorous screening and prioritization process for possible research projects and has strengthened and more fully utilized the Research Effectiveness Review Board in this. Similarly, NRR and NMSS have made progress in improving their communications and cooperation with RES. There is substantial documentation in place now to formalize those processes. These efforts should be applauded.

Based on the material presented to me, I conclude the research that NRC is doing is well chosen and competently performed. However, there are a number of areas of safety related research not being pursued that have the potential for significant benefits. Research at NRC is intellectually as well as managerially fragmented with significant gaps that should but cannot be filled because of a lack of funding and differences among top level staff managers, and perhaps among Commissioners, on how the technical knowledge base of the Agency is to be maintained, advanced and utilized through research. As a result, NRC does not enjoy the full benefits that research can bring to its regulatory activities.

My answer to the Chairman's first question has to be yes, but not entirely.

Regulatory Research Mission and Vision Statements. In my First Panel comments, I strongly supported the statement of NRC Regulatory Research Mission already in place and endorsed by the Commission, but expressed my feeling that the Regulatory Research Vision should be somewhat modified. Upon further reflection, I now believe that both the Mission Statement and the Vision Statement require modification to rectify an ambiguous interpretation of the term *realistic* that both statements share.

I am concerned that the words "realistic" and "more realistic" which appear in the Regulatory Research Mission and Vision Statements, or in the accompanying explanatory material, are ambiguous and should be clarified when used in research policy statements. If the word "realistic" is used it should be followed by a parenthetical remark which explains that in the context of safety research "realistic" implies technically sound, e.g., *realistic (technically sound).* Some might interpret *realistic* as *economically affordable,* but relief from unnecessary economic burdens of regulation is dealt with elsewhere and in other more general statements of NRC's Mission, Vision and regulatory philosophy. "Technically sound" and "less economically burdensome" are different concepts and should not be conflated. Some may differ with me on this point, but if so, then confusion does indeed exist on how the Regulatory Research Mission and Vision Statements are to be interpreted by NRC staff, licensees and the general public. Mr. Thadani's presentation at the second meeting of the Panel appears to be consistent with the interpretation of "realistic" I am suggesting here.

In addition, the statement of NRC Regulatory Research Vision should be revisited in light of the current view of most Panel members, and which I share, that NRC's fundamental independence in using the facts derived from research does not necessarily require that NRC be the sole source of support and owner of the research that produces those facts. The limited funding available to NRC for research in the near future is forcing the agency into new cooperative research partnerships with other domestic and international parties, and the Vision Statement should not appear to rule out such arrangements.

I suggest that the wording: *"RES conducts independent experiments and analyses, develops technical bases for supporting realistic safety decisions by the agency, and prepares the agency for the future by evaluating safety issues involving current and new designs and technologies"* be reworked so as to not imply exclusion of cooperative data gathering, but with independent interpretation and use of these results. For example: *"RES conducts experiments, performs its own independent analyses, develops technical bases for supporting realistic(technically sound) safety decisions by the agency, and prepares the agency for the future by evaluating safety issues involving current and new designs and technologies"*

Clarification of Terms:. Research, Confirmatory Research, Anticipatory Research. A considerable lack of understanding exists both outside and inside NRC of exactly what the words research, confirmatory research and anticipatory research mean at NRC. The Panel sought clarification from the staff on these questions with limited success.

Research as defined by U.S. NRC. In my view research conducted by the NRC differs from research as commonly understood by the public (including Congress) in that it consists entirely of technical studies specifically related to a present or future NRC regulatory purpose or safety concern. This spans from data collection required to confirm a contemplated or current NRC regulatory position on a technical issue to fundamental studies required to provide a sound technical basis for anticipated regulatory actions.

Confirmatory vs. Anticipatory Research. Because of two different types of technical studies which define research at NRC, the terms Anticipatory Research and Confirmatory Research have become labels for certain types of studies with longer term studies lumped under the Anticipatory label while short term studies have tended to be lumped together under the Confirmatory label. This has led to some confusion as to how these types of studies should be managed and how they relate to identified user needs. Further confusion has arisen because studies which NRR or NMSS have identified as necessary for their work ,through a user need letter, now are considered to be Confirmatory studies while those studies which RES has decided to pursue in the absence of a user need letter are considered to be Anticipatory Research. Further confusion in definitions arises because The Center for Nuclear Waste Regulatory Analysis conducts studies entirely related to Yucca Mountain (which could be either long term or short term). Because they are all carried out with the express approval of NMSS consistency would define them as Confirmatory Research. However, the Commission has directed that all Confirmatory Research is to be conducted under RES. Perhaps this is the reason that Mr. Kane in his presentation to the Panel contended that NMSS does not do research.

Need for High Level Waste Anticipatory Research Not all NRC research is under RES... only reactor safety research and a very small amount of nuclear waste and materials work. All studies directly related to high level waste are carried out under NMSS. These are largely directed toward licensing questions of Yucca Mountain, some of which seem to be confirmatory research. Therefore, there is essentially no High Level Waste Anticipatory Research either under NMSS or under RES. Without totally disrupting the extant organizational responsibilities for research immediately needed for Yucca Mountain regulatory decision making, a small program of Anticipatory (long term) Research might be reestablished within RES (where a number of nuclear waste experts believe it really should reside.) This would help to reduce, but not entirely eliminate, the problem with the CNWRA actually doing research and would help NRC to be better prepared for any unforeseen developments in High Level Waste disposal.

Impact of Regulation on Safety Culture. An unaddressed area of safety research pertaining to operating reactors that should be seriously considered for study is the impact of NRC's regulatory activities on licensees safety cultures. It has become increasingly clear world-wide that the decidedly improved performance of both U.S. and foreign nuclear power plants in recent years has come about in large part through developments in the corporate safety cultures at the plants. It is plausible to expect the safety culture at a licensed plant to be improved through the introduction of some degree of regulatory attention (certainly NRC believes that to be true) , however with excessive regulation (e.g., resulting in a near total loss of a sense of ownership by the licensee) a licensee's safety culture will diminish. If one accepts these premises then there must be some degree of regulation between no regulation and excessive regulation at which the safety culture is at a maximum. Studies of the impact of NRC's regulatory activities on licensees safety cultures could conceivably result in even better performance on the part of both licensees and NRC regulators, perhaps with

considerable cost savings for both. NRC has avoided studies of the safety implications of licensees' organizational structures because such studies are difficult without unacceptably intruding upon licensee's management prerogatives and diminishing their sense of ownership. Even if NRC could contract for such studies by a highly qualified contractor, it is unclear how NRC could use the results. I am not suggesting such a study, but rather a study of the effect of NRC on a licensee's corporate safety culture. The results of such studies could be used within NRC to improve its own performance without intruding upon licensee management. For such a study to be credible it should carried out under RES (e.g. in the existing Regulatory Effectiveness branch.) Clearly, the findings could lead to some institutional internal as well as external discomfort but that is not a compelling reason to avoid conducting such a potentially valuable study.

Interagency Collaborations. DOE programs in nuclear technology, in particular the Nuclear Energy Research Initiative (NERI) program, are likely to lead to new applications for licensing decisions in areas for which NRC is not well prepared. NRC has begun a closer working relationship with DOE on the NERI program so as to be able to plan and budget for new initiatives arising from NERI. NERI interests include The Pebble-Bed Gas Cooled Fast Reactor, Generation IV Reactor design issues, and AP-1000 design issues. Both NRC and DOE should work to expand their dialogue on theses matters.

Technical Resource Inventory. NRC should develop a living inventory of special facilities and experts likely to be needed by the agency in the future on a contract basis and develop a dialogue with them to signal NRC's interest and desire to be kept informed, in advance, of any developments which might result in their unavailability.

Ensuring NRC's access to large scale physical facilities capable of testing the validity of the results of the large computer programs NRC and the industry must use in making technical decisions is extremely important. I include this as a high priority because the cost of providing such physical facilities is so high that NRC is unable to support these facilities entirely on its own. The NRC should make strenuous efforts to work with the DOE, the nuclear industry, and the Congress to develop the means necessary to maintain or even to create the physical facilities here in the US, or elsewhere, that are increasingly necessary for testing the validity of the complex sophisticated computer codes necessary for nuclear reactor safety decisions. Novel and nontraditional mechanisms should be explored for bringing this about. Because of its fundamental responsibility for safety, NRC should take the lead in this effort, which will require participation by decision makers at the highest possible levels in all of the organizations involved.

The recent announcement of the contemplated permanent shutdown of a unique U.S. university reactor facility, which NRC had intended to use for important studies of reactor pressure vessel embrittlement, came as a surprise to the Agency even though NRC had invested in the facility over the years. This kind of situation is likely to occur again unless NRC takes special steps to see that it is avoided. Responsibility for developing a remedial program would be best placed in RES.

Validation of Codes and Models. Not all of the mathematical models and the computer codes which build upon them have been reviewed by NRC and validated. Many of these are proprietary. However, NRC should seek ways to ensure that they are reasonable and in fact do what they are supposed to do. In this connection I believe that there may be a disconnect between "the evaluation and validation of existing methods" which NRC has identified as Confirmatory research (and therefore under RES) and "the evaluation of a licensee's methods" which "is not considered research work" and therefore would fall under one or the other program offices, NRR and NMSS. Thought should be given to harmonizing these two interpretations of evaluative work in the area of Validation of Codes and Models. The RES staff appears to be best suited to evaluate and validate the licensees' complex computer codes in view of their up to date knowledge of available experimental data and analytical methods.

IS RESEARCH BEING FUNDED AT THE RIGHT LEVEL?

Level of funding. Rather than using a percentage of total budget as a measure of what NRC should be spending in RES, I prefer to start with a carefully screened list of meritorious projects that RES is unable to fund within its present budget. Mr. Thadani has constructed such a list and it totals between $8M and $12M per year. The range comes about because some are two-year and some three-year projects. On a $46M base this is a shortfall of 17% to 26% per year in RES funding.

However, these numbers are based entirely on currently identifiable reactor issues and do not include funds for gearing up to even define the key technical issues with which NRC will have to deal in the new reactor designs that may become adopted by U.S. power producers in the near future, nor for totally new initiatives in regulatory effectiveness or in strengthening and ensuring agency core capabilities. Furthermore, they apply only to research conducted under the auspices of RES which heavily emphasizes nuclear reactor safety with only a small nuclear waste effort and therefore do not involve any measure of an appropriate level of the research funded under the Center for Nuclear Waste Regulatory Analysis.

It seems very clear that research in general and RES in particular are substantially under funded. A more careful look at nuclear waste studies under NMSS would probably lead to the same conclusion.

Sources of support. One serious impediment to more robust funding of research is the requirement that the funds come essentially entirely from licensee fees. A substantial fraction of RES' budget, in particular funding for longer-term anticipatory research, should come from general funds appropriated by Congress, and the Commission should continue to make a strong case to Congress for this. Placing the total burden for funding research on licensees is inappropriate since they are only one of the constituencies that benefit from the research. However, specific interested parties who contemplate totally new initiatives should bear much of the funding burden for the new NRC research required.

Research prioritization .Any NRC research projects which have the explicit endorsement of either Congressional oversight committees or the Commissioners are given top priority by RES. Other possible research projects are placed on a prioritized list and funded accordingly. RES has worked very hard to establish a systematic prioritization process that is driven by the four NRC Performance Goals adopted by the Commission in its Strategic Plan. (These are: maintain safety, protect the environment and the common defense and security; insure public confidence; make NRC activities and decisions more effective, efficient and realistic, and reduce unnecessary regulatory burden.) Resources are allocated according to what is necessary to achieve the performance goals.

This policy, while apparently quite reasonable has had at least two unintended consequences. It has led to a very heavy emphasis on operating reactors safety, and it has driven almost all anticipatory research and much materials research to the bottom of the list. Without some measure of carefully selected anticipatory research, NRC becomes vulnerable to new challenges for which it may be inadequately prepared. RES should be encouraged (and permitted) to prioritize its research agenda in such a way that overall the performance goals are addressed while allowing a few research topics not meeting a performance goals test to be funded because e.g. they help to ensure the Commission's technical capability to address unforeseen issues.

NMSS and NRR apparently have established their own prioritization systems. These three systems differ somewhat. When considered in aggregate they fail to cover the total span of NRC's potential research needs. Greater coordination is needed guided by a broader overall NRC technical perspective at the Commission level.

ARE THE RIGHT PERFORMERS BEING USED?

My answer is generally yes, but greater use of collaborations with industrial centers of excellence, somewhat less use of national laboratories, and greater use of university based experts and students could strengthen NRC's research programs. When NRC decides, because of diminished funds for external contractors, to conduct a research study in- house it must be sure that it has the technical capability to do an equivalently excellent job.

NRC contracts with a diversified collection of organizations to perform most of its research, and speaking generally they are of high quality. At its inception NRC was expected to use primarily the national laboratories and universities for its contracted research. However, over time other sources of expertise in industry and overseas have become increasingly capable, and NRC must now be free to contract with and collaborate with all high quality centers of relevant expertise. Duplication of research already conducted or simultaneously being conducted by responsible organizations outside of NRC can no longer be justified simply by NRC's need to ensure the credibility and independence of its information.

Current NRC agreements with EPRI and DOE are examples of approaches for ensuring the unbiased objectivity of work performed with industry support so that both the NRC and the industry can use the results without a credible conflict of interest taint. Both the NRC and the industry must continue to find ways to do this. Clearly this is an activity that can help NRC and the industry fee payers to reduce the costs of essential studies.

Longer-term anticipatory research has become a minor item on NRC's research agenda. This is a serious shortcoming that leaves the Agency vulnerable to unanticipated technical developments or misadventures and diminishes its capacity to provide the highest possible degree of assurance of public health and safety. It is very important that NRC's research agenda include some research that is not immediately required to close well-defined gaps in technical knowledge or data. Anticipatory research is an area to which university teams can significantly contribute and which fits their less structured and less time disciplined modes of operation. University research programs which directly involve students in areas of interest and importance to NRC can produce not only excellent research results but also motivated and well trained university graduates necessary for the continued vitality and intellectual quality of all of the nation's nuclear activities. Maintaining focus and coming to closure in the work are special challenges for all government contract administrators of university research programs. Successful contract management and administration of university conducted research requires a kind of expertise not common at regulatory agencies.

The NRC Research Effectiveness Review Board has been very good in monitoring the quality of NRC research results, but it should include experts from outside of NRC who are capable of judging the quality of NRC contractor and in-house generated products as well as how well they are used within NRC. The Agency needs to constantly review its practices in selecting and monitoring research done by contractor organizations and its in house efforts. Potential conflicts of interest by research advisors who might also be candidate research contractors need to be avoided. This is increasingly more difficult as the world wide pool of suitable technical experts continues to shrink with the result that the only excellent source of advice may also be the only person or organization capable of carrying out the research. Furthermore, NRC may be the only source of funding for research in the area, and it is only NRC funding that keeps the expert active in the field and available.

Collaborations. The Agency should be encouraged to maintain collaborations with other federal government research facilities, universities, and commercial research facilities. The limited funds available to NRC for research forces the agency to engage in cost sharing collaborations as much as possible. The diminishing pool of highly experienced nuclear science and technology experts sometimes requires the engagement of individuals who can only be found in commercial or industrial laboratories. The ever smaller number of research facilities having the physical facilities required for research programs of importance to NRC forces collaborations with all of the different entities. Without their facilities important confirmatory and anticipatory research programs cannot be conducted. Without some funding from NRC an/or DOE

it is likely that most universities will have to shut down their research reactors and nuclear engineering departments which are the only assured U.S. source of highly trained nuclear engineers and scientists for the future.

While NRC staff needs access to high quality nuclear industry research to independently analyze the results, it is also important that NRC have its own core capabilities if it is to be a technically credible regulator not a captive of its contractors.

Advisory Committees. The advice on research provided to the NRC by the ACRS and the ACNW is excellent, but both Committees are already heavily burdened. Perhaps some new mechanism could be created to continue and enlarge the high level oversight provided by these Committees without totally overloading them. A process of periodic (every few years) reviews of NRC's overall research programs by a broad based group of experts should be regularized to monitor quality and progress.

ADDITIONAL GENERAL COMMENTS

Top Notch Technical Experts. The greatest challenge, and arguably the highest priority of NRC's senior management and of The Office of Regulatory Research, should be to maintain and utilize a cadre of topnotch technical experts in each of the core technical disciplines NRC employs in making regulatory decisions. It is absolutely essential that the technical quality of NRC's regulatory decisions be unassailable.

Over the last four years NRC has made extensive , but unsustained, efforts to identify core technical capabilities and to develop a strategy and tactics to ensure the technical capability of its staff. In the early stages of the development of a Strategic Plan, the Commission staff guidance in 1995-1996 on Direction Setting Issue 22 of its Strategic Planning Program stated: " RES should develop a set of core research capabilities for NRC in consultation with other NRC program offices." It further directed that "a selected office should create and maintain an agency-wide database that contains an inventory of the core technical capabilities of the NRC staff". In two thoughtful and carefully detailed papers, SECY 97-075 and SECY 98 –076, the RES staff identified two types of core capabilities, "expertise driven" and "workload driven", and produced a detailed analysis of existing and needed expertise driven core research capabilities that could serve as a template for an agency wide core capability assessment. RES' analysis resulted in the identification of 39 core technical areas which were later revised and reduced to 20 areas ,in which RES needs to have a degree of expertise. The analysis was quite extensive, and the results appeared to require a substantial number of additional professional personnel just at a time of steadily declining NRC budgets and uncertain future workloads. As a result the Commission never issued a Staff requirements Memorandum on SECY 98 – 076 and the analyses and recommendations were set aside without extending the methodology to NRR and MNSS. More recently the EDO has provided the Commission with an Action Plan for Monitoring the "net scientific, engineering and technical capacity of the NRC."

In my opinion, the work in SECYs 97 – 075 and 98 – 076 should be revisited, updated and taken to a final step of coalescing the 20 areas into a smaller, more manageable number of clusters preferably less than ten. These are what I would designate as the critical mass of Core Technical Areas in each of which NRC should have at least one world-class technical expert to ensure the credibility of its technical capability. (The 20 areas would still be identified but as subcategories within the clusters.)

As I suggested in my Panel I comments, these technical experts should be as broad-gauged as possible but also should possess deep technical expertise on a world-wide basis. The core technical areas and the world class individuals should be identified through a consultative process that uses experts from both inside and outside of NRC. The resulting cadre of Senior Technical Experts should be seen as NRC's in-house reference resource for all technical decisions that break new ground. They should be charged with knowing where the deepest expertise in their disciplines resides, where the best work is currently being carried out, and what the latest results of that work are, and with assisting access to them by NRC's regulatory decision makers. Together they would provide an in-house technical quality safety net essential for evaluating potential contractors and the work of existing contractors, and for validating all substantially new NRC in-house technical decisions. They should not be burdened with heavy research or administrative responsibilities, which would divert them from their principal purpose; but mechanisms must be put in place to ensure their meaningful participation in all technical regulatory decisions that rise to a predetermined threshold criterion.

Ideally, most members of this cadre would be in RES, but in some cases it might be preferable to leave individuals, who may already be at NRC but are not in RES, where they are rather than relocating them.

Commission approval of the concept and charter for the formalized identification of members of this cadre of Technical Experts together with a charge to the staff to consult with them would be a powerful recruiting tool for acquiring the new technical professionals NRC needs to fill out the 20 core competency areas within the smaller number of cluster areas that NRC needs for its present and future work.

VISIBILITY OF RESEARCH AGENDAS, PROGRESS, RESULTS AND OUTCOMES

NRC research must communicate better the details of its processes both internally and externally. Commissioner Merrifield has pointed out that simply disseminating the final results of completed research projects is insufficient. The processes involved in arriving at research agendas; selections of who will do the research; progress reports during the course of the work before final results are achieved; final results of the research work; the use to which it is or will be put and finally the outcomes of that utilization, should all be made available to interested parties (within the constraints of any necessary restrictions on such revelations). The costs of doing this are going to be fairly high in person hours but the costs of not doing it well enough will continue to be very high in

lost dollars resulting from the continuing successful pressure by licensees to reduce NRC's research budget because they do not understand the return to them and to NRC of an investment in nuclear safety research.

FOUR STATEMENTS FOR COMMISSION ACTION

The following four statements, if endorsed by The Commission, could be key to RES realizing its full potential as a highly valued member of NRC's decision making team. I support them all with suggestions for their implementation offered as bullets following each statement.

1. The NRC must maintain as a used and useful arm of its organization, a reliable, respected office of Nuclear Regulatory Research (RES), and must support this office with the necessary people and resources so that it is an unassailable source of technical information and support for all regulatory actions. This is necessary not only to establish the credibility of NRC's technical decision making and thereby to insure the safety of all NRC licensed activities but also to insure U.S. leadership in **the technology of** nuclear safety **regulation.** ~~technology.~~

    a. RES is under funded and the Commission should make every effort to significantly increase the RES budget.

    b. The Commission should direct the EDO to establish a living mechanism for defining and maintaining the agency's Core Technical Capabilities (people, analytical tools and access to facilities.) This should include developing a formal process for defining a small number of Core Technical Capabilities Clusters, each with at least one in-house world-class technical expert.

    c. The Commission should require the EDO to examine and report to it the extent to which NRR and NMSS program offices consult with RES experts (in residence or external) when they make regulatory decisions involving technical issues.

2. This office must support the activities of other program offices, which in turn should be required to coordinate their activities with RES at least to the extent of planning new work, establishing objectives of technical studies and assessing the validity of data and analyses. At the same time RES should be free to initiate anticipatory technical studies without approval by program offices but with their cognizance and input wherever possible. RES must be able to do and be seen as able to do independent verification of data on which NRC will rely for regulatory action. RES must institute and maintain a comprehensive and effective communications program to make available, agency wide, their plans and activities in real time.

a. The Commission should task RES with a responsibility for identifying new systems-wide issues that could have significant safety implications and for proposing further relevant studies. Examples might be the impact of regulation on a licensee's safety culture and the positive or negative synergistic results of current or new regulations or new industry initiatives.

b. The Commission should require RES to report regularly on the status of its ongoing and contemplated anticipatory research projects and their potential application.

c. The Commission should direct the Office of Public Affairs to work with the EDO on the regular dissemination of comprehensive information about research at NRC, at an easily understood level, to all stakeholders.

3. RES must continue to grow its cooperative efforts with other organizations including but not necessarily limited to EPRI, DOE, Industry, Academia, Public interest groups, and international organizations. RES must seek out, and wherever possible, utilize facilities, equipment and resources available from these entities and maximize the use of technical data and results already developed. RES in cooperation with and supported by the Commission, must establish procedures to accomplish this while fully retaining the decision making independence of RES.

   a. The Commission should direct the Offices of The General Counsel, RES and NRR to work together to develop guidelines for acceptable NRC-industry cooperative research and for its use in regulation.

   b. The Commission leadership should emphasize to industry leaders that greater cooperation with NRC in sharing technical information through cooperative research would be of benefit to them as well as to NRC.

3. A clear and understandable definition of what research includes and does not include at the NRC and it's value to the safety of the nation's nuclear program must be established by the Commission and accepted internally by the program offices and staff personnel and effectively conveyed to all the stakeholders. Continuing efforts must be made **through research** to eliminate unnecessary regulatory burdens on stakeholders while at the same time focusing on areas that will benefit them through safer and more efficient operations. Charges to licensees for research costs should be on the basis of identifiable value to the efficient and effective regulation of those licensees.

   a. The Commission should formally adopt and promulgate a definition of Research as understood by NRC.

b. Definitions of the terms "Technical Assistance", "Confirmatory Research", "Anticipatory Research" and "realistic" in a RES context should be included.

c. The Commission should avail itself of every suitable opportunity and device to increase the funding for its research programs from Congressionally Appropriated General Funds and from cost sharing by other federal agencies, principally DOE.

KENNETH CANNICOTT ROGERS

Dr. Rogers served as a Commissioner of the United States Nuclear Regulatory Commission (NRC) from 1987 to 1997. He represented the NRC for nearly ten years at the National Association of Regulatory Utility Commissioners and was a member of their Executive Committee. He has experience in working with international organizations in nuclear safety matters; has met with legislators of several foreign countries to assist them in formulating national policies on nuclear safety; and recently completed service on a small international group of experts to provide advice for the long-term to the Secretary-General of the international Organization for Economic Cooperation and Development (OECD). He has more than 40 years experience in the conduct and successful management of scientific, technological and educational activities related to technology. For thirty years he held various academic positions at The Stevens Institute of Technology in New Jersey including President of the Institute for fifteen years. As a Director of PSE&G (NJ) and as a Member of their Nuclear Oversight Committee, and later as a NRC Commissioner, he has had direct experience in the oversight of nuclear power plants' operations from the standpoint of strengthening their safety to the public. Dr. Rogers holds a B.S. degree in physics from St. Lawrence University and M.A. and Ph.D. degrees in physics from Columbia University; is a Senior Life Member of the Institute of Electrical and Electronic Engineers and was awarded two patents.

John Ahearne
Phase 1 Comments

I will address four specific points and comment on two miscellaneous issues.

1. Research. In our first meeting, Dr. Rogers asked: What does "research" mean in the NRC context? Ever since Vannever Bush wrote "Science: the Endless Frontier" (1945 report to President Truman), the science and political communities have discussed, debated, and argued about what is research and how should it be funded. The National Science Foundation (NSF) uses the following definitions for two categories of research:

   Basic research. The objective of basic research is to gain more comprehensive knowledge or understanding of the subject under study, *without specific applications in mind.* In industry, basic research is defined as research that advances scientific knowledge but *does not have specific immediate commercial objectives*, although it may be in fields of present or potential commercial interest.

   Applied research. Applied research is aimed at gaining the knowledge or understanding to *meet a specific, recognized need.* In industry, applied research includes investigations oriented to discovering new scientific knowledge that *has specific commercial objectives* with respect to products, processes, or services."[1]

   Using these definitions, the NRC research program would be classified as applied research. However, in recent years, commenters such as Harvey Brooks and Lew Branscomb have concluded these definitions are too restrictive. Branscomb, for example, has written about opportunity-driven research and need-driven research.[2] He argues that an outside observer would not notice any fundamental differences in how the researchers worked or the kinds of people doing the research, but there would be a major difference to the sponsors of the research.[3] In that sense, NSF can be seen as primarily funding opportunity-driven research and the NRC, and other federal mission agencies, as funding need-driven research.

2. Health of the foundation for application, research, and technical regulation. This includes faculty, students, and facilities at universities and staff and facilities at national laboratories.

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[1] (Science and Engineering Indicators 1998, NSB-98-1, National Science Foundation, 1998, p. 4-9, emphasis added.)
[2] These also have been called curiosity-driven and problem-solving.
[3] "Public Funding of Scientific Research," Lewis M. Branscomb, in Vannever Bush II: Science for the 21st Century, Forum Proceedings, Sigma XI, The Scientific Research Society, 1995, pp. 147-171.

There is a growing deep concern over decay and disappearance of the infrastructure and the personnel that are needed to sustain the applications of nuclear energy, including power and research reactors, medical and industrial applications, and space systems. "Over the last decade, the U.S. nuclear science and engineering educational structure has not only stagnated but has reached a state of serious decline. The number of independent nuclear engineering programs and the number of operating university nuclear reactors have both fallen by about half since the mid-1980s."[4]

But this is not just an NRC problem. The amount of DOE funding for true research in nuclear applications dropped to zero in FY 98 and has been coming back slowly under the Nuclear Energy Research Initiative (NERI). An even smaller program, NEPO, focuses on operating plants and is a far more applied program than is NERI. These dollars in total are less than $30 M per year. Added to other university programs, the total DOE investment in maintaining nuclear engineering and science in the US probably is less than $100 M per year, and this would count substantial amounts in the National Nuclear Security Administration (NNSA) such as in naval reactors and the defense national laboratories.

The NRC needs to have access to competent researchers who understand the complex phenomena that can be encountered in off-normal operations, especially accidents. Experiments to validate code-development require hot cells and other specialized facilities. As inspectors and other staff retire, they must be replaced by knowledgeable young people -- and it is they who must be attracted to and educated in that decaying infrastructure.

These problems affect many agencies (as well as several industries). Therefore, efforts to address the problems should be coordinated among the NRC and DOE, and, to a lesser extent, DOD and NSF.

3. Funding. One of Chairman Meserve's three questions was, Is the funding at the right level? Three points to be considered in answering this question.

   a. What is research funding as a percentage of the total budget? Unfortunately, it is not easy to dig out what amount of research is being funded. Perhaps by diligent reading of NUREG-1100, Volume 16 ("Budget Estimates and Performance Plan Fiscal Year 2001") the amount of research funding could be found. The following is my extract:

[4] "The Future of University Nuclear Engineering Programs and University Research and Training Reactors," Michael L. Corridini, *et al.*, report of an ad hoc NERAC panel, May 2000.

$M[5]/FTE			
	1999	**2000(est.)**	**2001(est.)**
Reactor Safety Research	59.3/172	55.5/152	56.0/151
Material Safety Research	4.4/12	2.9/12	4.1/12
Radioactive T&D Research	4.7/17	2.5/14	2.7/15
CNWRA[6]	15.7/-	15.7/-	15.7/-
Total	83.8/201	78.5/178	78.5/178

Excluding the Office of Inspector General (OIG), the NRC budget and the percent of that budget represented by the above "research" funding are as follows:

	1999	**2000(est.)**	**2001(est.)**
Total ($M)	464.0	464.9	481.9
"Research" (%)	18.1	16.9	16.3

If "research" is about 16 % of the agency budget, that is large -- if the comparison only is with industry. (Pharmaceutical companies usually lead in R&D as a percentage of sales, at about 10%.) However, this is not out of line with DOD and is, I believe, about the same as EPA.[7]

Is this "enough"? Part of the difficulty in answering that question is the separation of research into several parts of the NRC. However, Jane Long asked a better question: With this funding, what research should be done?

Regarding funding, Tom Murley made an excellent point: research should not be argued as needed to reduce regulatory burden, but to develop risk informed regulation to improve safety.

[5] The tables imply staff costs are included. They should be.

[6] From NUREG-1635, ACRS 5/24/00, p. 17: "The Office of Nuclear Material Safety and Safeguards (NMSS) contracts with the Center for Nuclear Waste Regulatory Analyses (CNWRA) for technical assistance ($15.7 million a year), much of which is, in essence, research related to licensing and regulating the proposed repository for high-level radioactive waste (HLW) at Yucca Mountain, Nevada."

[7] According to the NSF (Science & Engineering Indicators 2000), *op cit.),* the 1999 EPA Applied Research budget was $453M. According to the EPA website, the 1999 Operating Programs budget was $3.328 B. If these are appropriate numbers to use, applied research was 13.6%. In a recent conversation, a senior EPA R&D official estimated that applied research was between 13 and 14 % of the EPA operating budget.

b. Staff: EPA is a good comparison to use. EPA does both intra- and extramural research. Should NRC also? From the discussion at the first meeting, it appears that, as the research budget declined, the staff did not in the same ratio. This is appropriate, if the staff were needed to retain the necessary knowledge base. It would not be appropriate if the main purpose was to preserve jobs. However, it is difficult for the research staff to be seen by the research community as competent if the staff's experience is only in managing contracts. Therefore, staffing must be examined. One option to consider is the NSF rotator policy, where researchers are brought in for 1-2 years to serve as research program managers.

There may be a needed change in the concept of independence, in which "independence" is no longer stressed and increased cooperation, with industry and other licensees (such as DOE) will be necessary. An industry representative commented that cooperation does not compromise independence *unless* the staff does not have the competence to know the work is being done right. The staff cannot delegate responsibility for judgement to the contractor, even if another federal agency.

Thus, staff competence is a concern. One of our participants noted that the real issue is staff competence and expertise. Another recalled that, in the past, the research staff were peers of the research community. This does not seem to be the current situation, and there appear to be few, if any, managers in NRC research who have had hands-on research experience. The issue of competence is of greater importance than the funding level. Dr. Rogers concluded that the biggest challenge is maintaining a set of experts in the important core areas.

c. Ted Marston noted that, although there are many stakeholders, there is only one stake provider, referring to the requirement that the NRC recover its costs from licensees. Of course, "one stake provider" is true for all federal agencies, but that one for other agencies is the general public. The NRC is burdened by being required to obtain its funding from fees by licensees. For research, this does not seem to be appropriate. I believe there is a need to get general fund appropriations, particularly for research. But a caution: the budget now gets heavily scrutinized by industry. If research is to be funded by general fund appropriations, an independent review of the value of the research must be established.

4. The "value" of research. Explaining the value of research is a problem for all research groups, including those in DOD, DOE-EM (Environmental Management), DOE-NE (Nuclear Energy, Science, and Technology), and even in NIH. Industrial labs also have been struggling to defend their budgets (e.g., the GM research lab) and even their existence. Unless explicitly opportunity–driven, as is NSF, developing a rationale for federal funding of research has been

difficult. At one level, funding is supported by belief that research is a good thing. But after the end of the Cold War and with increased emphasis on budget accountability (such as GPRA, the Government Performance and Results Act), a better rationale is needed.

For example, the NRC should build a case for what research has accomplished. This will not solve the problem of support, but it can help. The list presented at the first meeting is weak:

Current benefits from past research:

1. Series of reg guides
2. Performance indicators
3. Analysis of DC Cook inspection findings
4. Improved understanding of steam generator behavior
5. Evaluation of dry casks integrity
6. Revised source term rule
7. License renewal, etc.

While underlying some of these examples are important research results, the list does not make the case for benefits from a quarter century research program that has used hundreds of millions of dollars. Furthermore, the list does not make the case as to why NRC had to do this work, rather than industry or DOE. I think the case can be made, but much more care has to be put into developing the case.

Other comments. As noted by one of the Congressional staff, perhaps the NRC interprets "confirmatory" too strictly. Research whose results may be necessary in 4-5 years, anticipatory research, might be included in the confirmatory category.

The nuclear energy office in DOE has been working on new reactor concepts. As new reactor designs come closer to development, the NRC should request funding from the DOE to prepare for these designs, for example, the pebble bed reactor.

Summary

The NRC research program has been reduced substantially over the last decade, as the future of nuclear power was seen as consisting of power plants being shut down early and the NRC shifted to licensee funding. However, as owners have applied for relicensing, generating companies are being formed, some new designs are being developed, and risk-informed, performance-based regulation is transforming the way NRC interacts with reactor licensees, the NRC research program faces new and expanding challenges.

I cannot comment on whether the current program is adequate, since I did not perform the necessary detailed review. I conclude:

1. A strong research program will be necessary;

2. A technically and scientifically respected research staff is essential;

3. The entire NRC research effort – including that conducted in NRR and NMSS – should be examined in detail; and

4. Research should be funded by general appropriations, not by user fees.

John Ahearne
Phase 2 Comments

1. RES should be sufficiently integrated with the program offices (NMSS and NRR) so they can and will rely on RES.

2. RES needs to be forward-looking and must be able to perform work on what RES believes will be needed (which may or may not be right, that is the essence of research).

3. The letter of November 2000 to the ACRS describes the approach as a cliff -- work that will definitely be needed but is not being done due to lack of either funding or priorities.

4. In some way, RES must retain the ability to do independent verification. This can be done by repeating tests, having separate codes, or having RES experts at the experimental sites and by reviewing the experiments in detail.

There is a concern that high burn-up fuel, the South African pebble bed reactor (PBR), and other new developments will find the NRC not ready. If that comes about, the Congress and the public can charge that the Commission is at fault, unless it has made the case to Congress (and OMB). This does require showing that the NRC has scrubbed current activities.

Comments on the Proposed Four Principals

1. Requests RES support "all regulatory actions." This implies support for the licensing review for Yucca Mountain and, therefore, that RES replace NMSS in this role.

2. Requires the other program offices "coordinate their activities with RES." As in Number 1, this implies that NMSS coordinate with RES. RES is to have the "cognizance" of the other program offices. Does "cognizance" imply sign-off? At the end of Number 2, I recommend adding something like the following: "RES

must be able to do, and be seen as able to do, independent verification of data on which the NRC will rely for regulatory action."

3. The last sentence states "RES in cooperation with and supported by the Commission, must establish procedures... while fully retaining their decision making independence." This is confusing. Is it RES that is to retain independence? That would be wrong in that decision-making is a Commission function. If the statement is to imply the Commission is to retain its independence ("Commission" is the antecedent of "their"), the sentence is meaningless, since RES cannot threaten the Commission's authority.

4. Recommend changing the first sentence to read: " must be established by the Commission and effectively conveyed..."

These four principles need some implementing actions. I recommend:

1. A RES, NRR, NMSS task force report in six months to the Commission on how to implement the recommended policies. "We are already doing this" is an unacceptable answer.

2. RES review all its programs based on the letter to the ACRS forecasting a large number of unfunded but needed efforts.

   a. Rerank all current and "needed" programs.

   b. (Perhaps already being done) develop a set of required competencies and compare these with those of the current staff.

   c. Based on (a) and (b), propose a budget and a staffing plan (in time for NRC budget review).

Regarding SECY-99-281, Travers memo to the Commission on the vision for RES:

1. Noticeably missing in the list of actions to be done by RES (page 3) is any two-way interaction with the program offices. The list is one-way, from RES to the program offices. There must be a two-way interaction.

2. In the bolded vision statement on page 4, "conducts" should be replaced with "supports." RES does not conduct experiments. A better phrasing would "supports experiments, conducts and supports analyses,..."

Additional Comments

1. Ashok Thadani said that 80-90% of the RES budget is dedicated to projects initiated by user-need letters. At the same time, Thadani has estimated about $8M of RES-desired projects were unable to be started due to a lack of funds.

Furthermore, the ACRS has listed many unfunded projects whose work the ACRS expects will be needed in the future. Their letter describes a cliff whose edge the NRC is approaching. An obvious solution would be to give RES more money. However, without a visible effort to scrub the projects lists, more funding is unlikely, and may be unwise. RES should review all the projects, including those started with user-needs letters, the ACRS list, and the RES list. This review should be led by RES, but include representatives from NRR, NMSS, and the outside community. RES must lead since the issue is what *research* needs to be done. The perspective must be the needs of the NRC, not of any one office, but the focus must be on both near and long-term. Based on this review, a budget can be proposed.

2. A 5 February 2000 letter to Chairman Meserve from ACNW chair John Garrick included the following statements:

   a. "Part of the $15.5M in FY2000 funding allocated for HLW technical assistance [done by the Center for Nuclear Waste Regulatory Analyses] is for work the Committee considers to be 'research."

   b. "The HLW program needs to be expanded to have a modest long-term 'anticipatory' research component, perhaps through collaboration between NMSS and RES."

   c. "The RES waste-related program is not large enough to support the full spectrum of NRC needs."

   d. "We have concern about the partitioning of high-level waste work in NMSS and non-HLW work in RES. We believe it is essential to coordinate these two programs to obtain the most value for the NRC."

   e. "Another aspect of partitioning the HLW and non-HLW issues is the potential for ignoring anticipatory needs in the HLW area. NMSS focuses on the relatively short-term goal of analyzing what the DOE is doing. RES, on the other hand, is prohibited from doing any work on HLW even if it is anticipatory and arguably focused on the long term. There is potential for a gap in the NRC program because of the separation of the NMSS and RES programs."

These are issues raised by the NRC group chartered to review the waste programs. I believe these comments should alert the Commission to a serious potential for the NRC becoming a major obstacle to moving forward with HLW disposition for reasons other than sound science. Rather, the NRC may be found unprepared to address issues which arise because of the exclusion of a research-perspective.

The Commission should require a review of the separation and of the exclusion of RES from any Yucca Mountain work. NMSS does need technical assistance. But the NRC needs research. Such a review could be done under the auspices of the ACNW.

The Value of and the Necessity for Research in a Regulatory Agency

In 1999, I chaired a committee of the CSIS that examined the operations of the NRC. (*The Regulatory Process for Nuclear Power Reactors: A Review*). This review focused on how to improve the operating efficiency and effectiveness of the NRC and examined such areas as relicensing, license transfer, and risk-informed regulation. It became clear that significant opportunity exists for improving the overall regulatory system, particularly if a better understanding can be developed on how to move from deterministic to risk-informed regulation. But this is not an information-need that is visible to those at the operations level, the resident inspectors, field office inspectors, or licensing personnel in NRR or NMSS. The press of daily business forces them to concentrate on current issues. However, the nuclear industry has had unfortunate surprises, in which safety was or could have been challenged. To keep ahead of those events is the role of research.

The NRC should not be developing new technologies for the benefit of the nuclear industry. To the extent that is a federal role, it belongs to the Department of Energy. However, it is the responsibility of the NRC to be prepared to address the safety questions that arise when new nuclear technologies are introduced by the industry or another federal agency. Meeting this responsibility requires looking beyond the current problems and requires personnel who keep abreast of and understand the new technical developments.

The research office should respond to the NRR and NMSS user-need letters. But RES also must be able to look beyond the horizon of those two offices, so the NRC will be prepared when the distant problems have become current and the Commission is called upon to handle these problems in its regulatory practices.

JOHN F. AHEARNE

Physicist, former NRC commissioner and chair. Served in Departments of Defense and Energy and as Vice-President, Resources for the Future. Former Executive Director, Sigma XI, The Scientific Research Society. Currently Adjunct Professor and Lecturer, Duke University.

Robert J. Budnitz
Phase 1 Comments

I will only address a few of the issues that arose during the discussions of the "NRC Research Expert Group." These few are issues where I feel particularly strongly that a potential or actual problem exists that could benefit from top-level attention, either from the NRC Commissioners and senior NRC staff, or from leading figures in the regulated industry (or from both) in order to bolster the effectiveness of the Office of Nuclear Regulatory Research (RES).

1. Need for agency-wide support for RES within NRC itself. In my view, one crucial factor in enabling RES to perform its role successfully is that it have the overt support of (a) the Commissioners and (b) the leadership in the regulatory offices (NRR and NMSS). As I see it, the reason is as follows. It is almost inevitable that some members of the NRR and NMSS staff will not understand the value of an independent and competent RES -- given the day-to-day pressures faced in these offices, it is natural that many staffers will wonder why money is being "wasted" on long-term inquiries and methods-development projects whose short-term payoff is admittedly unlikely to help them right-away. Although regrettable, this attitude is sure to exist among some staffers in the regulatory offices, especially among those with difficult short-fuse assignments that don't necessarily require new knowledge in order to be successfully completed.

   Given the inevitability of this problem, there is an ongoing need for strong and overt support for the RES mission at the top of NRC. In my view, the senior officers -- the Commissioners and the Directors of NRR and NMSS -- must speak out forcefully and convincingly, and often, about the need for an independent and competent Office of Research, and in favor of an adequate budget and staff to perform RES's part of the agency's mission. They need to speak out in ways that are recognized as such elsewhere within NRC.

   Regrettably, during the NRC's 25 years, there have been periods when support for RES has not been strong across-the-board among the senior officers (Commissioners, senior NRR/NMSS staff.) Even during the periods when many of these senior officers did strongly support RES, a few regrettably did not. Crucially, in my view those who did support RES sometimes did not "speak out" strongly enough or often enough against the others -- typically because such confrontations were judged not-important-enough to merit "wasting" a political chit on the issue of RES.

   The results speak for themselves. When senior agency officers who actually feel strong support for RES do not speak out against those who believe otherwise, the environment down in the ranks of NRR and NMSS becomes an environment where the negative images of RES, even if held by only some staffers, gain currency. In my view, this has unfortunately sometimes been the situation. To

me, this failure to speak out helps to explain why, as the RES budget has declined, both in absolute terms and as a percentage of NRC's budget, there has not been a strong outcry from the rest of NRC speaking clearly as an agency, which outcry would if heard loudly have been a strong force toward reversing the trends. In my view, the long decline in RES's budget and capabilities has sometimes just not been all-that-important-enough to the others in NRC's senior management group.

It also helps to explain an aspect of NRC's culture, wherein technical staffers in RES often get a clear if unspoken message that their career advancement within the agency will be expedited if they transfer from RES to NRR or NMSS, and retarded if they remain in RES. (Not everyone in RES hears this message, or responds to it if they do hear it. But in my view enough have heard and responded to make a difference over the years.) This ugly little fact-of-life has been there from the start. An important counter-force occurs when senior NRC managers outside of RES create an environment in which RES's contributions are given their due recognition, often and loudly, from the top. This needs to continue as a high-priority activity at the top.

2. Technical strength of the RES staff. I want to open this part of my comments by noting that several RES staffers whom I've known for a long time are technically very strong. Some of them are world-class in their technical fields. However, the number of these has diminished significantly in the last 10-15 years. When I was RES Director (1979-1980), we could point to world-class experts in almost every technical area of reactor safety, and in many areas related to fuel-cycle and materials safety also. These experts were true "peers" of the very best researchers anywhere -- and were recognized as such by all. They not only planned and monitored RES projects done by national labs, universities, and contractors, but participated in the intellectual work of most of the important RES projects.

While this is still true in part, both the absolute number and the percentage of RES staffers with this type of research stature and experience have declined a lot. The reasons for this change are complex, but I can point to two key factors. First is the environment within NRC that I discussed above, in which all-too-often the NRR and NMSS staff at lower levels have openly demonstrated lack of respect for RES, and have not been corrected/contradicted by senior NRC management. And second, the budget has been declining precipitously, depriving the RES staff of the flexibility (to explore innovative ideas) that was a factor in recruiting the world-class folks back in the 1970s; today, why would a world-class expert choose to come to RES as a career path? [I know why -- but all-too-often the best reason, "to serve the greater good of society", apparently isn't enough.] Thankfully, some of the very best still do choose a career with RES, but not as many as earlier and certainly those who do are too few.

3. Need for flexibility in the RES program. When I was RES Director (1979-1980), there was enough flexibility to enable RES to embark on a reasonable number of new projects each year that could be characterized as (i) innovative, exploring new ideas that might be of future benefit to the whole agency, or as (ii) intending to challenge the existing regulatory framework of NRR or NMSS, or as (iii) trying to anticipate vital technical issues that might be crucial 5-10 years out, so as to equip NRC with tools/methods/understanding far ahead of time. While such work, taken as a whole, comprised only a minor fraction (perhaps several percent) of the overall budget back then, it served two key functions: It enabled NRC to stay "ahead of the wave" on key emerging issues, and it energized the RES staff's morale and self-esteem in a way that nothing else can. And quite often, the rest of NRC was saved from embarrassment (or worse) by RES. There are many examples of this. [One good example was the time that RES embarked on research on pressurized-thermal-shock-in-PWR-vessels several years before the issue really emerged as crucial. This PTS work was undertaken over the objection of NRR, who argued when it began in 1980 during my term as RES Director that it was not needed, at least not for a few years! Boy oh boy, were they wrong. And without the flexibility to allow RES to forge ahead over the objections of the regulatory offices, projects like this will not be undertaken].

   Unfortunately, to obtain the needed flexibility the Office of Research needs strong support for a program of innovative research from the top, from both NRR/NMSS and the Commissioners. This support was present when I left in 1980, but by 1982 or 1983 had nearly vanished, supplanted by a mistaken policy that required every new RES project to obtain a so-called user-need-letter from either NRR or NMSS. That policy was nuts and thankfully has been dropped. But the psychology that led to it remains today in all-too-many quarters at NRC -- where the notion persists that if NRR or NMSS doesn't need a new project to support an identified current regulatory need, RES should not embark on it. Again, in my view it isn't enough that senior officers agree (as apparently they now do) that RES should have the needed flexibility -- it is crucial that they speak out on this subject loudly and often, to overcome the inevitable and natural tendency of some of the staff-on-the-regulatory-firing-line to oppose such work. The benefits, to both the RES program and RES staff morale, have always been huge.

4. Support from the regulated industry. It has always been difficult to obtain the support of the regulated industry for the RES mission and budget. It will probably always be this way. About the best that I can propose is that senior NRC officers make special and ongoing efforts to inform industry leaders of the scope, breadth, and importance of RES's work. This cannot be taken-for-granted, or allowed to lapse for a few years between efforts to make-the-case. It is a responsibility of the Commissioners and of the Directorate level in NRR/NMSS to make this case publicly, often. In today's new de-regulated environment, the need for this is greater than ever. (This of course requires that the Directorate level in RES provide the supporting information so that their colleagues elsewhere in NRC know the facts and understand the philosophy.)

When I was RES Director, I recall turning to the enabling NRC legislation, the 1974 Energy Reorganization Act and its supporting legislative history, to make this case to both Congressional staffers and senior NRC officials. But 1974 was only "a few years ago" then. Now it is over 25 years ago, which makes it much harder. Nevertheless, this is no less important now than it was then.

And finally, obtaining even a minor fraction of the RES budget from general appropriations rather than from fee recovery would help a lot in this regard.

Robert J. Budnitz
Phase 2 Comments

I offer here my comments on the four high-level "Proposed Recommendations" that our panel as a whole will be discussing at its meeting on February 21. An important "Additional Comment" about NMSS' current administration of the Yucca Mountain-related research program is at the end.

1. **Proposed Recommendation**. The NRC must maintain as a used and useful arm of its organization, a reliable, respected office of Nuclear Regulatory Research (RES), and must support this office with the necessary people and resources so that it is an unassailable source of technical information and support for all regulatory actions. This is necessary not only to establish the credibility of NRC's technical decision making and thereby to insure the safety of all NRC licensed activities but also to insure U.S. Leadership in nuclear safety technology.

   Comment. I agree with this statement wholeheartedly. I would suggest one addition to it, which would be in the form of an additional statement citing that this is embedded in the original Congressional legislation that established both NRC itself and an independent Office of Research within NRC.

2. **Proposed Recommendation**. This office must support the activities of other program offices, which in turn should be required to coordinate their activities with RES at least to the extent of planning new work, and establishing objectives of technical studies. At the same time RES should be free to initiate anticipatory technical studies without approval by project offices but with their cognizance and input wherever possible. RES must institute and maintain a comprehensive and effective communications program to make available, Agency wide, their plans and activities in real time.

   Comment. I agree with this statement, but would use the word "must" instead of "should" as the fifth word in the second sentence. I would also modify the third sentence by adding the phrase "a modest number of..." after the word "initiate",

so the text would read, "...free to initiate a modest number of anticipatory technical studies...".

3. **Proposed Recommendation**. RES must increase its cooperative efforts with other organizations, including but not necessarily limited to, EPRI, DOE, Industry, Academia, Public interest groups, and international organizations. RES must seek out, and wherever possible, utilize facilities, equipment and resources available from these entities and maximize the use of technical data and results already developed. RES, in cooperation with and supported by the Commission, must establish procedures to accomplish this while fully retaining their decision making independence.

   Comment. This comment now reads as if RES is not trying hard to do what we asked for. In fact, as far as I can tell, they are trying very hard to do as much along these lines as they can, and this has been true for the past several years. So don't make this part sound as if the RES management is a problem! The problem has been that higher-level policies, originating with the Commission or the General Counsel, have hindered certain cooperative initiatives. I suggest that this be rewritten to capture two ideas: (a) that RES is now trying to do a lot, and (b) is hindered by policies that ought to be revisited.

4. **Proposed Recommendation**. A clear and understandable definition of what research includes and does not include at the NRC and its value to the safety of the nation's nuclear program must be established and accepted internally by the Commission, project offices, and staff personnel and effectively conveyed to all the stakeholders. Continuing efforts must be made to eliminate unnecessary financial burdens to sponsoring stakeholders (industry) while at the same time focusing on areas that will benefit them through safer and more efficient plants.

   Comment. This bullet has two different thoughts that should be separated. On the first thought, I agree 100 percent. I even suggest it be elevated to number 1 in this list of 4 or 5 bullets. The second thought is more complex. I am not sure that as phrased this sentence captures the thought we want to convey. What specific Commission action is sought? I suggest making this more direct. Are you speaking mainly of the desirability of RES getting money from the treasury instead of from licensing fees, or is there more involved here? I suggest this be a major topic for discussion at our meeting on February 21.

Additional Comments: I feel very strongly that the Commission made a serious mistake in its decision to allow NMSS to manage the research aspects of the agency's overall program to support its regulatory decision concerning Yucca Mountain. NMSS is not suited to managing long-range research as a matter of culture, staff-incentive structures, and management skills (neither is NRR). RES is the appropriate place for managing such research, as it is for all the other research efforts that the agency undertakes. I believe that in the long run the entire agency will pay a grievous price for this unfortunate decision, if and when technical issues arise that NMSS has not

anticipated and therefore will not know enough about. My rationale is that the current "research" program related to Yucca Mountain is not long-range enough in its thinking (this is almost inevitable when it is managed by folks whose primary mission is to make a licensing decision in the very short term), and thus technical issues that may be important 10, 20, or even 100 years from now are being given short shrift due to near-term pressures. But this is exactly what the existence of a separate statutory Office of RES was intended for, as Congress set it up in 1974-75; 25 years of evidence throughout NRC have reaffirmed Congress' wisdom in this regard.

A crucial aspect of RES's role is to recommend and then to manage longer-range research (exploration of new and emerging issues) that NMSS and NRR staffers sometimes overlook due to their inevitable short-term perspective, driven as it is by near-term decision needs. (I could cite reams of evidence on this, if asked.) The Commission decision to take Yucca Mountain research away from RES, driven by budgetary and other expediencies, was and is a serious mistake that will hurt NRC over the long term, but it is not too late to correct it. [As a Commissioner, I would worry about the following scenario: a technical safety issue important only 25 years after operations begin, but not being explored now, emerges during shaft-construction activities in the first year after waste-emplacement operations begin. Doubts about the long-term viability of the repository require an independent NRC decision. Operations must cease for five years of study, because NRC has not anticipated the issue, since nobody at NRC has been looking systematically at technical issues that might emerge that far out. NRC will thus have failed in its public duty as a regulator to be technically equipped to make vital safety decisions.] But looking "beyond the licensing offices' headlights" is RES's Congressionally assigned role! I urge the Commission to revisit this decision, and in doing so to hear from people like me who can provide it with another view, to balance what I believe to be the distorted and incorrect view that now emerges from senior staff management in NMSS and at the EDO level, few if any of whom are researchers.

ROBERT J. BUDNITZ

Dr. Robert J. Budnitz, an experimental physicist by training, has been involved with nuclear reactor safety and radioactive waste management for many years. His work has emphasized risk analysis, safety analysis, and nuclear security issues. From 1967 to 1978, he was on the staff of the Lawrence Berkeley Laboratory, including three years as Director of LBL's Energy and Environment Division. In 1978-1980, he was the Deputy Director and then the Director of the Office of Nuclear Regulatory Research at the U.S. Nuclear Regulatory Commission. Since he left NRC, Dr. Budnitz has been a private consultant on reactor safety and radioactive waste management, as President of Future Resources Associates, Inc., a firm that he founded in 1981. His clients include both industrial and governmental organizations. He has chaired numerous national and international advisory committees.

David R. Helwig
Phase 1 Comments

1. The role of NRC research should be sharply focused on support of the NRC's defined mission of regulating the current fleet of reactors. The research needs of the Staff in support of existing reactors can be anticipated with a fairly high degree of certainty through situation analysis and dialog with the various industry constituencies (NRR, utilities, EPRI, etc). More fundamental or exploratory research should be performed by others and monitored by NRC.

2. It is imperative that NRC Staff maintain its expertise and competence in key technical areas in order to effectively fulfill its mission. It is not necessary for the staff to actually perform research in order to meet this need. In fact, it would be more effective for the staff to maintain a cadre of "scholars" knowledgeable about the breadth of operating experience and research in their field. These individuals would be uniquely capable of advising on topical matters and research needs. Specific action should be taken to identify these key areas, assess current skill levels, and to develop or recruit to fill any identified voids.

3. Nuclear industry research should be conceived and conducted as cooperative and collaborative in order to maximize its use and benefit. It is apparent that much more can be done to coordinate the research efforts of NRC, DOE, EPRI, and suppliers. The mindset that NRC must conduct independent research in order to endorse technological advancement is fundamentally flawed and will continue to stifle progress if not addressed.

4. Given the above observations, the Staff's current research challenges should not be framed in terms of levels of funding but, rather, in terms of effectiveness. Lessons learned in the definition of the EPRI Nuclear Power research program might be useful in developing appropriate measures of effectiveness (usefulness, cycle times, deliverables, etc).

5. The guidance already provided in the DSI-22 regarding the focus and conduct of the NRC research program appears to be well conceived and appropriate. It is not clear that this guidance is being followed effectively.

6. Efforts should be pursued to rationalize the number of federal and international nuclear research facilities. Consolidation should be pursued as a matter of efficiency but efforts should be made to maintain the appropriate "critical mass" of capability.

7. The Staff's risk-informed research efforts are substantial and offer great promise. However, it does not appear that the RES efforts are yet practically focused or aligned with industry interests and NRR priorities. A major opportunity has thus far been missed in the area of risk insights. The Staff has not followed through

effectively on risk insights available from plant IPEs (now over 10 years old) and has not kept up with industry risk evaluation advances.

8. Closer involvement and improved dialog with the industry is required in order to better define and focus NRC research efforts. Only through such interactions will it be possible to obtain broader support for the research program.

9. The current process of funding NRC research exclusively through user fees has the unintended impact of discouraging user support in the face of economic pressures. This arrangement should be reconsidered; however, the imperative for closer scrutiny and interaction described above should not be diminished. The NRC has not effectively lobbied Congress on this matter.

10. The placement of responsibility for standards work within RES should be reconsidered. This work is inherently about the practical application of technology and other perspectives to a particular subject. The role of RES should be limited to technical input and advise in such matters to be consistent with their role.

DAVID R. HELWIG

Mr. Helwig is now the Executive Vice President, ComEd Energy Delivery for Exelon Corporation and is former chairman of the NEI Risk informed Regulation Working Group. He is also a member of the EPRI Research Advisory Council. Mr. Helwig has previously held senior management and executive positions with ComEd, General Electric, and PECO Energy in the areas of Nuclear Generation and Power Delivery. He is a graduate of the University of Delaware, University of Pennsylvania and Duke University.

W.H. Bohlke
Phase 2 Comments

Following are general and specific comments regarding both the four recommendations and the Chairman's three questions. For clarity, the changes made at the February 21st meeting to the original January 24 requirements have been highlighted in Italics.

General Comments

The four requirements are reasonable statements of principle regarding the role of RES vis-a-vis the program offices and expectations for how collaboration and cooperation could be useful in a time of budget constraints. More difficult is the issue of how the Agency responds culturally to the requirements. Specific points for each requirement follow:

Comments on Four Recommendations

1. The NRC must maintain as a used and useful arm of its organization, a reliable, respected office of Nuclear Regulatory Research (RES), and must support this office with the necessary people and resources so it is an unassailable source of technical information and support for all regulatory actions. This is necessary not only to establish the credibility of NRC's technical decision making and thereby to insure the safety of all NRC licensed activities but also to insure U.S. leadership in nuclear safety technology.

   Comments:

   The placement of responsibility for standards work within RES should be reconsidered. This work is inherently about the practical application of technology and other perspectives to a particular subject. The role of RES should be limited to technical input and advise in such matters to be consistent with their role.

   Beyond reaffirming the role of RES which has the responsibility to support all program offices, including NRR and NMSS, as directed under their congressional mandate, the Commission should put in place a mechanism and budget to ensure that this responsibility should and can be carried out.

   Emphasis on such a mechanism should be more culturally oriented vis-a-vis structurally. A culture focus is both more important and longer lasting. Re-structuring alone could take years. If structure changes are necessary, then the Commission should move in parallel by breaking down cultural barriers and focusing on a unified culture across all areas of research within NRC.

The Commission should ensure that all regulatory decisions involving technical issues are made in concert among the RES, NMSS, and NRR.

It is imperative that NRC Staff maintain its expertise and competence in key technical areas in order to effectively fulfill its mission. It is not necessary for the staff to actually perform research in order to meet this need. In fact, it would be more effective for the staff to maintain a cadre of "scholars" knowledgeable about the breadth of operating experience and research in their field. These individuals would be uniquely capable of advising on topical matters and research needs.

RES should inventory its skill sets, both for the current industry needs and for those expected to be required in the 5-8 year planning horizon. Detailed action plans to address gaps identified would be an appropriate product from this effort.

The term "unassailable" does not fit the context of these requirements. For some it could be a pejorative term, implying that RES is not liable to doubt, attack, or question (Webster definition). That context appears to be in conflict with NRC's role of being an open agency in support of the public interest.

2. This office must support the activities of other program offices, *that* in turn should be required to coordinate their activities with RES, at least to the extent of planning new work, establishing objectives of technical studies, *and assessing the validity of data and analyses.* At the same time RES should be free to initiate anticipatory technical studies without approval by project offices, but with their cognizance and input wherever possible. *RES must be able to do and be seen as able to do independent verification of data on which NRC will rely on for regulatory action.* RES must institute and maintain a comprehensive and effective communications program to make available, agency wide, their plans and activities in real time.

Comments:

The Commission should require NRR, NMSS and RES to produce a list of prospective issues that will need to be adjudicated by the NRC. Input from stakeholders should be encouraged in the development of this list.

Research projects required to be conducted to support these issues should be identified and prioritized with responsible organizations and managers assigned by name. The demarcation between "anticipatory" and "confirmatory" needs to be gauged again during this review and prioritization.

The Staff's risk-informed research efforts are substantial and offer great promise. However, it does not appear that the RES efforts are yet practically focused or aligned with industry interests and NRR priorities. A major opportunity has thus far been missed in the area of risk insights. The Staff has not followed through

effectively on risk insights available from plant IPEs (now over 10 years old) and has not kept up with industry risk evaluation advances.

RES must use PRA more in selecting competing R&D projects. The NRC needs to work towards a universally accepted PRA procedure.

The Commission should establish a senior internal position to coordinate all research done Agency-wide similar to a Chief Technical Officer (CTO) in industry. This person would all three NRC areas, RES, NMSS, and NRR.

This position would also manage the overall NRC Strategic plan for research that would consist of a clear, concise, well communicated research strategy that is linked to the overall Commission strategy, including:

a. Identifying senior manager champions;

b. Establishing a portfolio management approach to an R&D strategy and programs that include basic research; research partnerships and alliances; and collaborative research;

c. Identifying the short and long term (ST and LT) R&D elements necessary to meet the overall strategic objectives and with the LT elements, identify the gaps that must be filled to accomplish the goal; and

d. Using existing models to help formulate the NRC Strategic Plan elements, e.g., airline industry and FAA with Boeing, et al. and the drug industry and FDA. Both have similar safety & regulatory requirements; neither is perfect; choose elements that work best.

3. RES must *continue to* increase its cooperative efforts with other organizations including but not necessarily limited to EPRI, DOE, Industry, Academia, Public interest groups, and international organizations. RES must seek out, and wherever possible, utilize facilities, equipment and resources available from these entities and maximize the use of technical data and results already developed. RES, in cooperation with and supported by the Commission, must establish procedures to accomplish this while fully retaining *the* decision making independence *of RES*.

Comments:

In conjunction with 2 above, the ongoing or anticipated research by other industry organizations, including international entities should be examined at least annually, in conjunction with preparation of budget requests.

When projects address the same topics or scope of research, evaluation of the projects should be conducted to determine the most effective way to make the research results available to satisfy needs of affected parties.

There must be established within the Agency a bias favoring collaboration and cooperation.

An independent panel may be useful in bringing additional objectivity to the review of the projects.

RES must work more with private organizations and universities rather than concentrating on national labs.

4. The Commission leadership should emphasize to nuclear industry leaders that greater cooperation with NRC in sharing technical information through cooperative research will be benefit them as well as the NRC.clear and understandable definition of what research includes and does not include at the NRC and its value to the safety of the nation's nuclear program must be established *by the Commission and accepted internally by the program* offices and staff personnel and effectively conveyed to all the stakeholders. Continuing efforts must be made to eliminate unnecessary *regulatory* burdens *on (sponsoring)* stakeholders (industry) while at the same time focusing on areas that will benefit them through safer and more efficient operations. *Charges to licensees for research costs should be on the basis of identifiable benefits to them.*

Comments:

The Commission must approve or reaffirm a clear, concise definition of research, technical assistance, confirmatory research, and anticipatory research and realistic research in the research context.

The Commission should review the wording and intent of one of their major goals, "reducing unnecessary financial burdens to stakeholders," to make clear exactly what is meant. Is the concern about regulatory burdens, technical burdens, or financial burdens?

There must be a clear procedure established to separate research on future program or anticipatory research from work on current licensing problems.

Elimination of unnecessary financial burdens is an area where the NRC needs outside assistance. Clearly the commercial nuclear industry has entered a period of maturity reflected in high performance and optimized investment. The current NRC research budget, and that of industry, could easily be judged to be appropriate for the needs of licensed facilities. Recent developments in the energy sector, however, would suggest the nuclear industry might experience a

revival of new construction such as with the new South African pebble bed gas technology. Is the NRC prepared for this resurgence? If the answer lay in a new generation of light water reactors, one might conclude that the groundwork is in place. However, the current movement to risk-informed regulation has not played out in the licensing of ALWR's since those licensing actions predated most of the current work. It is therefore unclear how those designs would benefit. It is clear, however, the NRC is unprepared to license a pebble bed modular reactor or any other emerging technology that is not light water based. To achieve the desired state of preparation will require an investment in skills and information. Under the present fee structure, the retooling of the NRC would put a significant burden on the parties desiring to develop a new technology. This burden must be lifted.

The federal government must quickly consider means to encourage the development of advanced nuclear technology. These means should include alternate funding approaches to allow the NRC to determine the appropriate technology-specific regulatory criteria for licensing, including the funding for research, either independently or in collaboration with others. This is also necessary to separate conflicts in prioritization that would inevitably occur between the current fleet and the emerging technologies. The NRC does not bear the obligation to fund research on new reactors and clearly needs to avoid an advocacy position regarding any new technology. The Agency does, however, holds the responsibility to inform Congress and the Executive Branch of the emerging needs so plans can be developed to meet the needs. The required action by the NRC is to make its needs in this area understood by those who control the budget and the fee structure. A joint effort by NRC and Department of Energy would be useful, if NRC can avoid being perceived as assuming an advocacy role.

Comments on the Chairman's Three Questions

1. **Are we Spending Enough on Research**?

   A detailed assessment of what RES is doing is required before a definitive statement can be made as to whether there is adequate funding for research.

2. **Are we Doing the Right Research**?

   No. Not enough anticipatory research is being done. Ninety percent of RES's budget is for user needs.

   A required funding level for research on licensee related activities to be at 80% and non-licensee research at 20% is needed to effect a change within NRC that is based on the "Best Practice" industry model for short term and long term research.

Alternatively, emphasis on LT research for non-licensee regulatory direct research should be funded by Congress.

On the other hand, a broader question would be, "Are we doing the right things at about the right times?" If the announced purpose of NRC-sponsored research is to assist in the framing of appropriate regulatory standards and acceptance criteria, then the answer must be "not often enough." There is little argument from the industry regarding the role of the NRC in setting regulatory criteria. Most of the tug of war between regulator and regulated revolves around the bases and determination of margins of safety and control of those margins. Failure to provide data to support those arguments results in conservative margin setting. When subsequent data become available to support reduced (but still amply conservative) margins, licensees may have already invested substantial sums in designing and constructing solutions to the original criteria. Extreme examples of this are now playing out in the form of alternate source term and risk-informed large break LOCA.

There needs to be more visibility on the status of research to support effective regulation. RES and the program offices should prepare performance indicators which measure (qualitatively, at least) the timely delivery of research results to support regulatory standard setting. Adverse performance should result in focused efforts to improve the ability of RES and the program offices to support the resolution with appropriate and timely research activities. All involved recognize that it is not possible to "manage" research results to deadlines. Nevertheless, when issues languish, there needs to be some accountability in place to stimulate closure.

The RES's current research challenges should not be framed in terms of levels of funding but, rather, in terms of effectiveness. Lessons learned in the definition of the EPRI Nuclear Power research program might be useful in developing appropriate measures of effectiveness (usefulness, cycle times, deliverables, etc).

3. **Are we Doing Research with the Right People**?

RES must find ways to work with industry and international organizations and still maintain independence.

As a result of complex contracting procedures, it takes too long to contract with organizations other than national labs and they do not always work towards the same objectives, and very often have their own agendas.

WILLIAM BOHLKE

Mr. Bohlke is Senior Vice President of Nuclear Services for Exelon Generation LLC. He also serves as Vice Chair of the EPRI Nuclear Power Council. Mr. Bohlke has previously held senior management and executive positions with ComEd, Stone & Webster and Florida Power & Light in nuclear power generation and construction. He is a graduate of the Massachusetts Institute of Technology and Rensselaer Polytechnic Institute

Aloysius Hogan
Office of Congressman Knollenberg
Phase 1 Comments Only

REACTOR FOCUS
As we all know, our examination of research did not delve much, if at all, into the numerous responsibilities of the NRC other than reactor safety. Thus my comments are directed to the reactor side of the NRC equation.

RESEARCH ISSUES SYMPTOMIZE NEED FOR MAJOR NRC OVERHAUL
I frankly think that this effort to improve research at the NRC is one key indicator and yet just a small symptom of the need for a major overhaul of the NRC.

It struck me that rather the current effort aimed at reformation of research at NRC, my thoughts led me in the direction of a counter-reformation. I was struck really by a comparatively tangential discourse we had on the CANDU reactor. In retrospect, that brief discourse was the crux of the matter for me.

RESEARCH AUTHORITY & CREATION & PURPOSE
What research one does at NRC relates directly to the statutory authority and purpose. The Energy Research Reorganization Act became law on October 11, 1974. It established the Nuclear Regulatory Commission and its current structure: an Office of Nuclear Reactor Regulation; an Office of Nuclear Material Safety and Safeguards; and an Office of Nuclear Regulatory Research.

The Office of Nuclear Regulatory Research was created to perform such functions as the Commission shall delegate, including developing recommendations for, and engaging in or contracting for, research that the Commission deems necessary for the performance of its licensing and regulatory functions. It is to ensure "an independent capability for developing and analyzing technical information related to reactor safety, safeguards and environmental protection in support of the licensing and regulatory process."

TECHNICAL ANALYSIS V. RESEARCH
If a certain type of reactor is developed outside the United States and has operated perfectly safely outside the United States, let's say for a decade or two or three or four, then I believe it becomes possible to empirically determine that such a reactor design is fit for licensing. In such a case, research in the sense of a scientific effort to project/predict how such reactor design would function in the future is not needed so much as a retroactive analysis of existing data.

I believe there is good consensus that most people, including the research scientists, would categorize such retroactive technical analysis of data as quite different than experimental research to discover and develop new data.

THE CANDU EXPERIENCE

I have read in *Science Magazine* that the CANDU reactors have been successfully operated in Canada since 1962 (*The CANDU Reactor System: An Appropriate Technology*, J. A. L. Robertson, Science, Feb 10 1978: 657).

The attempt to license the CANDU reactors should not have been so difficult and ultimately impossible in any effective way. A benefit-cost-risk analysis of the United States Nuclear Regulatory Commission licensing process was apparently done by the concern that applied for a US license of the CANDU reactor. The US NRC licensing process failed the benefit-cost-risk analysis, and the licensing effort was abandoned. It just wasn't worth it. The US NRC licensing process was too laborious, too expensive -- ineffectual, in a word.

RELICENSING V. LICENSING

In contrast, the licensing process developed for light water reactors is, by many accounts, proving at least workable and even increasingly efficient for relicensing LWRs. The task of licensing a reactor other than an LWR, such as the CANDU design which has operated successfully for about 40 years at this point, should not be significantly more complex than a relicensing, for in fact, that is all the United States would be doing at this point -- relicensing a design that has worked for 40 years and has already received licensing from other authorities.

Once one accepts that reactors can be developed outside the United States and operate safely and environmentally soundly outside the United States, then one must see that that achievement can be replicated inside the United States, and it ought not be so difficult to get permission to do so.

LICENSING PROCESS HAS HALTED U.S. RESEARCH

In fact, the NRC's licensing process is so garbled that the NRC licensing process itself has been stifled and in many ways halted nuclear research in the United States. I consider it a shame the pebble bed reactor is being developed in South Africa and not in the United States. I consider it a shame the High Temperature Gas Reactor is being developed, or at least planned for development, in Russia. However, any wise business decision must be that such research and development occur outside the United States, because the US licensing process is now ineffectual for new designs. Even after the research and development of these new designs is complete, and they are licensed elsewhere and are operated successfully for decades, they still will never operate in the U.S. without a major overhaul of NRC licensing.

WORLD CLASS PANEL OF EXPERTS

It occurs to me that rather than the quest for a panel of world-class, in-house experts at the NRC, it might actually be more useful to go the opposite direction to world-class, extramural experts. By that I mean perhaps the NRC should have teams of researchers that go wherever in the world the new reactor designs are being developed. With international cooperative agreements and U.S. taxpayer funding (rather than NRC

licensee funding), the NRC researchers could conduct scientific testing on-site at these foreign locations. Such testing might well result in better, safer, more efficient designs. NRC researchers would be on the cutting edge of new research by examining the new theories of containment, for example, and putting them to the test in laboratories on or near the foreign site of new reactor R&D.

RESEARCH FIX SUBORDINATE TO LICENSING FIX

To close on the larger point here, any true fix of research at NRC must be subsequent to and a direct result of a complete reorganization of the entire NRC licensing process and structure.

ENERGY POLICY OVERHAUL

Furthermore, U.S. energy policy needs an overhaul, if one exists, now. I believe strongly that any such energy policy must be developed with expert, scientific advice. That means the use of energy research advisory committees populated by scientists. I believe strongly, too, that any such energy policy must be developed in a coordinated fashion. That means the cohesive coordination of ALL nuclear research, including storage. Right now there are various nuclear research scientific advisory boards. They vary in effectiveness and need to be coordinated with an official structure.

The cohesive coordination of all nuclear research is only the beginning. All the different energy sources should, if they do not already, have these scientific advisory boards. These boards should all be tied together under the President's Council of Advisors on Science and Technology or via some other means.

Our energy policy would thus be advised by the scientists more effectively, and funding could be better allocated to reduce duplication and effectively appropriate money among different spending bills and effectively divide the research among the appropriate agencies.

ALOYSIUS HOGAN

Aloysius Hogan is an environmental attorney who serves as Legislative Director for Congressman Joe Knollenberg. Having previously worked as an environmental text author/editor, environmental attorney at private firms, Counsel to the National Republican Senatorial Committee, the Senate Rules Committee, and the House Resources Committee, he now focuses on energy, resources, and environment issues in the House Appropriations Committee. Mr. Hogan graduated with Distinction from the Honors Program at the University of Notre Dame in 1987 and from Notre Dame Law School in 1991.

Michel Livolant
Phase 1 Comment Only

I would like to take some points which are relevant on this topic in the SESAR's first report on Nuclear Safety Research in OECD countries, made by a group of OECD senior experts and representing an internationally accepted view on the research to be done by government agencies. To fulfill their responsibilities, the government agencies must:

1. Respond in a competent and timely fashion as and when safety issues are raised (so, keep competence, if possible inside Agency).

2. Anticipate and be prepared for safety issues that may arise in the future.

3. Review and assess the acceptability of new technologies.

4. Stimulate the development of an informed public opinion.

Concerning the relation with the necessary research work of operators or vendors, Government Agencies need to establish independently their position, which can be done by independent research or by independent analysis of basic data obtained by others. The objective is to be able to confirm or refute operators analysis and obtain a clear understanding of main issues.

An important responsibility of the Government Agencies is to take care of the development and maintenance of suitable expertise, and to the transfer of that expertise to regulators and inspectors. Government Agencies have also a role in promoting forward-looking research.

Concerning the NRC situation and the questions asked by NRC Chairman. First of all, I want to recall that NRC has always played an international role and is a model for many countries. A reduction of NRC role or NRC possibilities of actions has detrimental consequences in the safety all over the world.

Level of Funding

Concerning the level of RES budget, I think it has to be considered staff included. For that, the presentations made by Dr Power confirm my previous opinion:

1. The actual budget does not allow NRC to fulfill completely all its missions.

2. Some additional money preferably coming from a public source would be of great help, especially to stimulate anticipatory research.

3. The staff reduction is also a big concern: some fields have no specialist available now and the ability to transfer expertise to regulators and inspectors appears insufficient.

Doing Right Things

I know the NRC research program and generally agree. I want to point out that the relative importance of research topics is not strictly connected to the importance for safety of the topic. For example, operational experience follow-up and analysis have to be done by utilities and people involved in licensing work but don't constitute by itself a research work.

Compared to NRC, we do more work in France on severe accidents, where we consider that some issues are still not correctly solved and that it is the responsibility of official bodies to do the best efforts to protect population.

We do less on aging where industry has interest to do the largest part of the work So, we mainly do what is necessary to keep competence and independent view. In some cases, like flaw detection, we made some advanced research to stimulate the utilities to do better, by proving it possible. In my opinion, NRC has to consider the following items:

1. Progress on sharing the burden with industry or international.

2. Give more consideration to the need for uncertainties treatment associated with best estimate methods.

3. Take initiative of anticipatory or scientific community stimulation research: ex. Next generation of thermal hydraulics codes.

Right Performances

The RES personnel are generally competent, with the following remark: it is difficult to stay competent at the top level by subcontracting research. The expertise is generated outside. It would probably be necessary to have a better equilibrium between internal and external share of the work, with more people circulating between the two positions (and also with licensing people).

At last, I would like to rise an important point for maintaining research activities in the nuclear field, which is shared by all the safety responsible persons in Europe (at least in France): our goal is not only maintaining safety, but continue to try to increase safety, as an answer to the request of the population for higher levels of security.

Such a position plays an important role in the justification of maintaining high-level safety research, even in a stable industrial nuclear situation, with the corresponding positive effect to attract good young people in the field.

MICHEL LIVOLANT

After an engineer degree from Ecole Polytechnique, Michel Livolant obtained a more specialized degree in Reactors Physics (1963) and entered at the same time at the Commissariat à l'Energie Atomique where he participated in the development of the thermal reactor cores advanced calculation methods. In 1971 he moved to the Département de Mécanique et Thermique, where he worked mainly on vibrational and seismic studies. He took the direction of the Department in 1983. In 1989, he became manager for research in nuclear safety at the Institut de Protection et de Sûreté Nucléaire, and successively Deputy Director and Director of the Institute. He is presently the Chairman of the Committee for the Safety of Nuclear Installation at OECD/NEA.

David Lochbaum
Phase 1 Comments

At the beginning of the workshop conducted August 16th and 17th, NRC Chairman Richard Meserve told our panel that the Commission was seeking input on three questions. Here are my responses to those questions:

1. Is the funding level for research at the right level? The presentations made by the Director of the Office of Research and the three division directors were very informative, but they did not provide me with sufficient details to answer this question on a quantitative basis. The formal presentations focused on ongoing and recently completed NRC research. There was some limited, informal discussion of research projects that the NRC had wanted to undertake, but did not due to various reasons. However, without a better understanding of research conducted and research not funded, it is impossible for me to independently evaluate if the line between funded and unfunded research is at the proper level.

   There was considerable talk during the workshop about the trend in NRC research funding. The majority of these references were to three data points: $205 million in FY 1981, $100 million in FY 1993, and $42 million in FY 2000. When plotted, those three data points suggest a drastic reduction in research funding. However, there was very little discussion of research demands in 1981, in 1993, and this year. Absent an understanding of research demands, it is meaningless to use these three data points to draw any conclusions regarding the appropriateness of today's funding level. For example, my father will be 70 years old next May. If I plotted the money he spent on hair care in 1981, 1993, and 2000, I would probably get a trend very similar to the research funding plot. But I can tell by observation that my father probably has a hair care budget surplus this year. As with many balding men, my father's hair care demand has decreased considerably with time. Unfortunately, I cannot quantify the demand for NRC research via observation, as I can for my father's hair care needs.

   In summation, I do not possess and was not provided sufficient information to independently determine if the NRC research funding is at the right level.

   Many of my colleagues on this panel expressed their opinions that the current funding level is too low to sustain the necessary staff expertise and research facility availability. Their arguments are compelling and the consequences appear severe if these concerns are valid. Thus, I recommend that the funding level question be definitely answered.

2. Is the balance between confirmatory and anticipatory research at the right place? According to the Director of the Office of Research, the NRC's balance between confirmatory and anticipatory research is 80%/20%. I do not possess and was not provided sufficient information to independently determine if this balance is

appropriate. However, two of my fellow panelists made observations that I found instructive. Dr. Ahearne commented that private companies with large research programs spend about 10% of their annual income on research. Mr. Marston reported that EPRI spends about 5% of its nuclear plant research budget on long-term or anticipatory research, with the remainder going towards short and intermediate term research. Thus, it would appear that the current NRC balance does not slight anticipatory research.

On a related note, I thought that the concept introduced by Mr. Hogan for a formal advisory committee evaluating nuclear plant research conducted by all federal agencies (i.e., NRC, DOE, EPA, USGS, etc.) might provide the best opportunity to answer this question. Attempting to answer this question by exclusively examining the NRC's research budget has the potential for drawing the wrong conclusion, if for example the DOE is or is not conducting considerable anticipatory research that would otherwise be performed by NRC. I am not endorsing this concept at this early stage, but think it has potential that should be explored further.

3. Is the research being conducted by the right performers? My response must be prefaced with the remark that the work performed by the Office of Research is of high quality. I cannot recall a single instance where I found a research product to be deficient or unsound. The Office of Research appears to me to be staffed by talented and capable people who perform their work impartially.

Having said that, I believe it is possible for NRC research to be conducted more efficiently. While some savings might be realized by better utilization of research abilities at the national labs and at universities, it seems that the largest economy can be found in reducing the duplication between industry research and NRC research.

NRC reliance on research conducted by the industry must be undertaken carefully. Public confidence in the NRC will be eroded if it is widely perceived that the agency is merely "rubberstamping" or blindly accepting the word of the industry. As several of the panelists remarked, the NRC should be directly involved in defining the scope and methodology of industry research that the agency will use in lieu of conducting its own research. More importantly, the public must have equivalent access to research conducted by industry that would otherwise have been performed by NRC. This does not mean the threshold for withholding proprietary information should be adjusted. But the public must not lose access to information simply because industry instead of NRC conducts the research.

As an example, UCS was recently called by an activist who was seeking an EPRI report that had been referenced in a NRC document. The activist conducted the local public document room (a public library), but it did not have the EPRI report. The activist had the public library contact EPRI about obtaining a copy of the

report. EPRI offered to sell the public library a copy of the report for tens of thousands of dollars. Obviously, this sale did not proceed. I was able to send the activist a copy of the report. Not because UCS has such a substantial budget that I can purchase high-priced EPRI documents but because I had found the EPRI document in the main public document room attached to an NEI submittal. The NRC cannot turn over research to the industry if it results in such barriers to the public.

This concern is apparently not limited to public access to industry research. Mr. Farouk reported that EPRI barred NRC staff from attending an industry research meeting. Mr. Marston agreed that EPRI would reconsider its policy for allowing NRC to attend its meetings. Neither the public nor the NRC should lose access in the bargain.

Lastly, both Chairman Meserve and Mr. Thadani stated that a $4 million dollar investment by NRC in foreign research yielded a return to the NRC of more than $50 million of research benefits. This factoid implies that a dollar spent on US research is worth a dollar, but that a dollar spent on foreign research is worth $12.50. If this impression is valid, it would seem that investing the entire FY 2000 research budget of $42 million overseas would return $525 million of research benefits.

While Chairman Merserve indicated that he was not interested in recommendations for NRC reorganization, I must point out one organizational issue. On the first day of the workshop, the panelists were given a binder by the NRC staff. The binder included the Energy Reorganization Act of 1974 (Public Law 93-438). Section 205 of this act covered the Office of Nuclear Regulatory Research, which was created by the act. Paragraph (b) reads as follows:

(b) Subject to the provisions of this Act, the Director of Nuclear Regulatory Research shall perform such functions as the Commission shall delegate including:

(1) Developing recommendations for research deemed necessary for performance by the Commission of its licensing and related regulatory functions.

(2) Engaging in or contracting for research which the Commission deems necessary for the performance of its licensing and related regulatory functions.

During the workshop, we heard from the NRC Director of Research that his office performs this role for the Office of Nuclear Reactor Regulation. We also heard that the NRC's Office of Nuclear Material Safety and Safeguards performs this same role independently from the Office of Research.

I do not know what the Congress intended when it created an Office of Nuclear Regulatory Research headed by a Director reporting to the Commission. However, it seems reasonable that the Congress intended for all research conducted by the NRC to be under the auspices of the Director of the Office of Nuclear Regulatory Research. Otherwise, the NRC could "comply" with this law by having the Office conduct say one percent (1%) of the agency's research with the remainder performed by whoever performed it before this public law was enacted.

I am sending a copy of this letter to the NRC's Inspector General because of the potential for the NRC not to be in compliance with this federal law.

Several members of the panel commented that the NRC's research budget, or at least a portion of it, should come from the general fund instead of from licensee fees. I disagree with the proposition that the entire budget should come from the general fund. The federal government has subsidized the nuclear industry for many decades. All research conducted with application to the existing fleet of nuclear plants should continue to be funded from licensee fees. All research conducted with application to any next generation of nuclear plants probably should continue to be funded from licensee fees since it is very likely that one of more of the existing licensees will be the licensees for any new nuclear plants pursued in this country.

Mr. James W. Johnson of the NRC's Office of Research sent members of the expert panel a list of 12 questions by letter dated August 4, 2000. I am providing the following responses to the 12 issue questions he posed:

1. Do you believe this [the NRC's Office of Research statutory mission, its research categories, and its reliance on User Need Letters] is generally understood by most stakeholders? Speaking for UCS, I can say that we knew the Office of Research was embodied within the Atomic Energy Act of 1954 as amended but we had no understanding of its research categories and never heard about the User Need Letters until I became involved in this specific effort.

   After consulting with several colleagues in the public interest community at both the national and local levels, I can report that some knew about the Office of Research's statutory history but like UCS, none knew about the research categories or the User Need Letters.

   We have very little understanding of how NRC research is relied upon by the NRC in making regulatory decisions. Almost without exception, we note that NRC research products (e.g., NUREGs, former AEOD reports, etc.) are referenced within other NRC research products and not within non-NRC research products (e.g., SECY papers, NRR safety evaluations, etc.). Thus, it appears that NRC research promulgates more NRC research and NRC regulatory decisions are reached independently.

2. What is your understanding of the type of work labeled as research, as it is conducted by the NRC? It is my understanding that "NRC research" includes work conducted by NRC staff as well as work conducted by external entities under contract to NRC. The type of NRC research I'm most familiar with is that work performed by the group formerly known as AEOD. I'm also familiar with NRC research work on plant aging.

   The largest, most significant gap in my understanding of NRC research is in how the results of that research is then used by the agency in carrying out its regulatory responsibilities. With the exception of the research performed by the group formerly known as AEOD, it seems to UCS that NRC research is conducted independently -- not only of the nuclear industry but also of the rest of the NRC staff.

3. What criteria should be used by the NRC in deciding to initiate a specific research project and to establish priorities? The first screen should be that the research project has a direct link to some NRC's regulatory action. The threshold need not be extremely high, but there should be some tangible link.

   The second screen should be whether the NRC need conduct the research or "piggyback" on research performed or being conducted elsewhere.

   The third screen should consider the safety benefits that could be derived from the regulatory action (not the research itself but the application of that research).

   The final screen should consider the research project relative to ongoing and pending NRC research projects so as to allow efficient "combinations" or "two-fers."

4. What in-house professional capabilities must the NRC possess to ensure that research conducted under its auspices (either in-house or by contractors) is technically sound, up-to-date and useful in support of the NRC's capacity to make sound regulatory decisions? No opinion.

5. Are the facilities and resources available to the NRC either in-house or through subcontract sufficient? I had very little knowledge of the facilities and resources available to the NRC prior to reviewing the material provided by Mr. Johnson with his letter of August 4th. Now having had the opportunity to review this material, it is not clear how the complete and utter removal of all of these facilities would adversely affect any NRC regulatory process. For example, the write-up on PUMA (page 16) stated that:

   Portions of the facility are adaptable to separate effects testing and are currently being used to address two phase flow behavior for the improvement of modeling in the consolidated thermal hydraulic code, TRAC-M.

These statements, and in fact the entire appendix on research facilities, provide extremely little information to answer the fundamental question, "How would things be different today absent the research obtained from these facilities?" This information makes it abundantly clear that NRC research sires more NRC research, but it is extremely hard to figure out what role, if any, that NRC research played in NRC regulatory actions. Thus, the existing facilities and resources appear more than sufficient.

6. How can NRC stakeholders be kept well informed of the NRC's research activities, their quality, relevance, and adequate topical coverage? Four suggested methods:

   a. Annual report like that prepared by the NRC Office of Enforcement and the Agency Allegations Advisor which would document research projects completed, status of ongoing research projects, and research projects initiated.

   b. Periodic conferences like the Water Reactor Safety conference but without its barriers to non-industry stakeholders (i.e., the high attendance fee) that should communicate—in plain English, non-nukespeak—NRC research accomplishments and priorities.

   c. Within research reports themselves, there should he a brief discussion of why the research was undertaken and how the results are expected to be used by the NRC.

   d. Within applicable other NRC products (e.g., SECY papers, NRR safety evaluation reports, etc.), there should be some explicit statement of NRC research relied upon. Such citations would "close the loop" on links between research and NRC regulatory actions.

7. <u>How can the NRC and its congressional oversight committees objectively determine if seriously inadequate or excessive resources are being allocated to NRC's research activities</u>? The annual NRC research report discussed in response 6 above could include a section describing research projects that were not initiated due to resource limitations (e.g., tasks for which the User Need Letters were rejected or not acted upon) and research projects that were cancelled/terminated in progress due to resource limitations and reprioritization. This information could be supplemented with estimates of the resources.

8. <u>What aspects of a specific NRC research project should differentiate it from work technically similar but initiated and conducted by industrial, academic, or government laboratories independently of NRC interests</u>? The NRC is uniquely positioned to research different approaches taken by the industry on common problems. For example, owners of boiling water reactors elected to take different paths towards solving the ECCS suction strainer-clogging problem. As the sole

receiver of these various analyses (which generally include proprietary portions), the NRC alone can evaluate the various strengths and weaknesses. The goal would not be to "ratchet" the industry into the "best of the best" techniques and assumptions, but rather to ensure that any weaknesses in particular approaches do not represent safety margin compromises.

9. Should the NRC collaborate more with industry, academia, and the national labs and utilize their results to a greater extent? To what extent should the NRC do this without losing its independence and credibility? Based on the seemingly infinite number of NUREG/CRs written by industry, academia, and the national labs under contract to the NRC, it would appear that more collaboration may not be physically possible without substantial resource infusions.

10. To what extent should the NRC do its own research with its own staff versus contracting out all research work and simply monitoring its progress? I do not have the information with which to evaluate this question.

11. Does the NRC have an immediate and continuing obligation to help to ensure its future needs to technical expertise will be adequately met through anticipatory research and by providing sustained support to selected, focused high quality academic, government laboratory or industrial research teams? No to both the immediate and continuing aspects of this question.

12. How can the NRC perpetuate the knowledge base through its research programs to ensure it is not lost or ignored as future needs arise? The better question is should the NRC perpetuate its knowledge base through its research programs. At this time, I do not see enough evidence to answer this question affirmatively.

DAVID LOCHBAUM

Dr. David Lochbaum is Nuclear Safety Engineer for the Union of Concerned Scientists. Dr. Lochbaum leads UCS's efforts to ensure the safety of nuclear power in the United States by monitoring licensed commercial nuclear plants to identify and publicize safety risks. Dr. Lochbaum has more than 17 years of experience in commercial nuclear power plant start-up testing, operations, licensing, software development, training, and design engineering. He has worked on safety issues at the Hope Creek and Salem (New Jersey), Brunswick (North Carolina), Perry (Ohio), Limerick and Susquehanna (Pennsylvania), Wolf Creek (Kansas), Haddam Neck (Connecticut), Fitzpatrick and Indian Point 3 (New York), Grand Gulf (Mississippi), Browns Ferry (Alabama), and Hatch (Georgia) nuclear plants. In 1992, he and a colleague identified deficiencies in the design for spent fuel pool cooling at the Susquehanna plant and reported their concerns to the plant owner, to the Nuclear Regulatory Commission, and then to Congress. Their efforts resulted in safety improvements at Susquehanna and at other nuclear plants with similar problems.

Edwin Lyman
Phase 2 Comments

1. In order to ensure public confidence in the technical competence and intellectual breadth of the NRC, it is essential that it maintain an independent capability to conduct research on a wide range of nuclear safety issues not necessarily linked to regulatory actions. The Nuclear Control Institute (NCI) endorses the work of Office of Research (RES) in support of this function, and encourages efforts to stabilize the RES budget at a level necessary to effectively carry out its mission and defend it against licensee pressure.

2. As a scientist, I believe that the office will be most effective if its staff is allowed to function as scientists. This means that RES should not only be reactive -- responding to NRR and NMSS research "needs" concerning specific regulatory issues -- but should have access to resources that would enable RES staff to freely pursue avenues of scientific interest. The value of this activity, which other panelists have characterized as "poking and prodding," is somewhat analogous to the value of pure research in comparison to applied research. Conventional wisdom in nuclear safety research can sometimes be wrong -- as is the case in any technical field -- and the consequences can be disastrous. The exercise of scientific curiosity is the best remedy for this condition.

   It is essential that resources be made available so that RES staff can be kept fully abreast of emerging safety issues worldwide on a timely basis, through participation in scientific conferences, broad access to scientific literature and regular information exchanges here and abroad with scientists in academia, industry and government. These activities help to strengthen the image of NRC as an organization that is dynamic, cognizant of the most recent developments and capable of responding promptly to them.

3. The meaning of "independence" with regard to NRC research has been the subject of much discussion. I agree with Ted Marston that the word has several different meanings in this context, but I disagree with his assertion that it is appropriate only in reference to the NRC's interpretation of data in making regulatory decisions, and not to actual data collection or analytical work.

   There is no question that the NRC must come to its own conclusions when interpreting industry-supplied data. However, one can identify circumstances in which the NRC may also find it necessary to reproduce experimental or analytical data generated by the industry, especially if there is reason to question the techniques, experimental conditions or assumptions used.

   To cite an example, information recently came to the NRC's attention showing that a Russian-origin cladding material containing niobium, similar to the ZIRLO and M5 advanced claddings that have been approved for use in U.S. reactors,

becomes embrittled at a much lower oxidation level than standard Zircaloy. This raised the concern that the embrittlement criteria specified in 10 CFR 50.46 do not provide adequate safety margin for these new materials. When asked about this issue, the fuel vendors claimed that the concerns did not apply to their materials and provided largely proprietary data -- which had not been included in the original NRC-approved topical reports -- to back up their claims.

Despite the fact that NRR appears to have accepted the vendors' data and considers the issue to be resolved, it is our understanding that outstanding technical issues remain, and RES has asked both vendors (Westinghouse and Framatome) to supply samples of both unirradiated and high-burnup cladding so that it can perform its own experiments. At public meetings on this issue in February 2001, both vendors expressed great reluctance to comply with this request. Given the potentially serious nature of this problem, as well as the questions raised about the credibility and completeness of the original topical reports submitted by the vendors, the NRC is well within its rights to require that the vendors provide M5 and ZIRLO samples for testing before any more fuel with these cladding types are loaded in U.S. reactors. Moreover, such testing should become a routine part of the qualification process for new fuels.

It should be noted that the experimental results that triggered the review were not new but in fact had been published in English in a scientific journal in 1992. One wonders why the NRC did not become aware of these results in the course of its M5 review, in which case the technical issues could have been resolved before -- and not after -- the cladding was approved. This demonstrates that efficiency gains can be achieved by providing the resources to keep RES staff well-informed of global developments.

4. The M5 incident raises issues that are relevant to the process for licensing the loading of MOX fuel in Duke Power's Catawba and McGuire reactors (the fuel for which, incidentally, is being designed by Framatome and will use M5 cladding). Ashok Thadani stated before this panel that without the availability of (largely proprietary) data on MOX fuel performance from abroad, the NRC would not have the technical basis to license MOX fuel in the U.S. However, given the significant differences between the U.S. and other nations with regard to the way MOX fuel will be licensed and utilized, the relevance of the foreign data is unclear. Moreover, in light of Framatome's role in the M5 incident, the public may have doubts about the completeness and accuracy of data supplied by it and the other self-interested foreign companies in the MOX consortium, especially if the bulk of the data will not be publicly available. The NRC must be afforded every opportunity to locate gaps or discrepancies in the data and analysis provided by foreign vendors, to resolve them and ensure public access to its findings.

Resolution of the many technical issues associated with MOX fuel use in the U.S. may require a level of testing which goes beyond the capabilities and

availabilities of either domestic or foreign facilities. However, the necessary level of confirmation should not be driven by the availability of facilities or resources but by the fundamental questions that need to be resolved. If the users in this case (DOE and DCS) are not willing to provide the funding necessary for NRC to conduct all research it deems necessary to safely license MOX fuel, then MOX fuel should not be licensed. It should be noted that DOE has already rejected a November 2000 request from RES that DOE provide NRC samples of irradiated MOX lead test assemblies for independent testing at Argonne, implying that it would be a duplication of efforts.

A major obstacle to increased reliance on international cooperation for NRC research purposes is the restriction on public release of data that is a characteristic of international cooperative agreements. These restrictions need to be removed, or the NRC's reliance on such agreements to supplement domestic research activities may have to be reduced. Such restrictions are a severe hindrance to members of the public who closely track safety issues. For instance, the results of the ARIANE program, in which destructive analysis of spent LEU and MOX fuels was carried out in European facilities to validate fuel irradiation codes in common use, have been withheld from the public for several years. Members of the public such as myself who routinely use these codes should not be denied immediate access to data concerning their accuracy.

5. Some panelists have expressed the concern that independent NRC testing to verify industry data is tantamount to a duplication of effort. However, in most scientific disciplines, reproducing results under the different conditions of a different laboratory setting (where possible) is considered essential for confirming the observations. For tests of phenomena that could affect nuclear safety, it does not seem too much to ask that similar standards be applied.

   Similar considerations apply to analytical studies and computer simulations, especially when the codes have only been validated to a limited extent. Independent NRC capability is necessary to resolve discrepancies between the results of industry models and those of other observers. For example, a Sandia report, commissioned by the NRC as part of its program to resolve outstanding severe accident issues, found that PWRs with ice condenser containments were much more vulnerable to early containment failure from hydrogen combustion than PWRs with large dry containments, whereas the Individual Plant Examination (IPE) studies submitted by ice condenser plant operators implied the opposite. Sandia's report confirmed the intuition of RES staff, expressed in the IPE Insights report, that the IPE submissions underestimated the early containment failure potential of ice condensers.

   This example also raises additional issues associated with the role of external contractors in RES activities. Duke Power, operator of the Catawba and McGuire ice condenser plants, has challenged the findings of the Sandia report, continuing to claim that its own proprietary PRA studies are more realistic, even

though the Sandia study was extensively peer-reviewed. It is not clear that RES can serve as a definitive referee in this dispute, since budget cuts and misplaced priorities have resulted in the "sunsetting" of many NRC core capabilities in severe accident research. It was pointed out at the first meeting of this panel that NRC no longer has in-house expertise on containment performance and combustible gas issues. Thus the public cannot depend on the NRC to provide an independent assessment of this controversy.

Even with adequate resources, the opinion of RES will not be credible unless it is fully depoliticized. There are troubling indications that RES staff at NRC headquarters pressured the Sandia researchers to dilute the findings of the ice condenser report and attempted to delay its release, which finally occurred only after it was requested by a Congressional office. Unless RES is able to insulate itself more effectively from industry pressure, accepting and disseminating its products no matter which way "the chips fall," it will not be able to fulfill the functions discussed above and would not deserve a budget increase.

6. Independence also pertains to the ability of RES to initiate studies on its own to examine issues that neither industry nor NRR wishes to explore. Such studies have been fruitful in the past, one good example being a RES-funded study at Sandia which found that certain environmentally qualified electrical cables were unable to survive design-basis LOCA conditions after being subjected to typical in-service conditions. Another issue in this category is the safety of extended power uprates, taking into account potential synergism with high-burnup fuel and aging-related degradation of structures and components.

   Neither NRR nor industry should be able to supersede RES judgment concerning which safety issues should be explored and which should not. Thus, efforts to provide safety research funding independent of user fees are critical. Funding should flow based on a determination of issues that need to be resolved -- not the other way around. If such sources cannot be found, then users should be obligated to fund research which the NRC determines to be necessary to support the safe operation of their facilities or face restrictions on their operating licenses.

7. On the issue of research funding to support the licensing of advanced reactors, it is clear that nuclear utilities that have no interest in such reactors should not have to share the financial burden of licensing them. However, if this means that government funding through agencies like DOE is necessary to take up the slack, such funding -- which would essentially be a government subsidy of new reactor development -- needs to be the subject of public debate. The research and licensing costs associated with new reactors must be considered an essential element of their economics, and taxpayers should not be obligated to pay those costs without their consent.

With regard to the Chairman's questions: Questions 1 and 2 are closely related and can be answered simultaneously.

1-2. Is NRC Research doing the right things and is NRC funding research at the right level?

NCI is deeply concerned about the precipitous drop in the RES budget over the last decade and the loss of in-house core capabilities that has ensued, including expertise in important areas such as containment performance during severe accidents. We are also concerned about how fiscal constraints have left research areas unfunded which we consider to be crucial, such as synergisms between extended power uprates and high-burnup fuel performance, an expanded capacity to do independent experiments on reactor materials subject to age-related and environmentally-assisted degradation, and a systematic process for assessing the safety of higher-burnup fuels and new fuel types. There are also major gaps in the probabilistic risk assessment program -- if this tool is to be used more widely in regulation, the flaws in the ways PRAs are conducted today -- for instance, the neglect of aging effects -- must be addressed. We are also concerned that the NRC will not get the resources necessary from the Department of Energy to conduct a full evaluation of the safety of using weapons-grade MOX fuel in U.S. reactors.

However, we are concerned that an undue emphasis on "reducing unnecessary regulatory burden," while obviously meant to appeal to the licensees who will end up paying for the programs, is not an appropriate goal for NRC research. The goal of research should be to reduce uncertainties and therefore increase knowledge. If this results in an increase in the precision of safety margins, allowing a better quantification of the conservatism (or lack thereof) in a particular regulatory requirement, then a justifiable reduction in conservatism could be a consequence of the research. However, it should not be a stated objective.

NCI believes that most of the research projects pursued by RES are sensible and technically justified, and favors funding for many of the worthy projects that RES would like to pursue but remain unfunded. However, in the future, it may be worth thinking about the institution of a new structure, such as an independent peer-review panel, to insulate the choice of RES projects from licensee pressure. Such a panel should have a broad membership, including members of the public.

3. Is NRC using the right performers for research?

This is a difficult question to address, given that the universe of professionals with the necessary expertise in each specialty is a small one. Without passing judgment on the quality of the work performed by RES and its contractors, on which I am not qualified to comment, the absence of competition for studies in many technical areas does raise the issue of whether excellence is always

achieved. This is a problem not only for the nuclear regulatory sector, of course, but for the industry overall.

Having said this, it is clear that the accumulated expertise within the national laboratories on nuclear safety issues is formidable, and it is hard to imagine a robust regulatory research program in this country that did not continue to draw upon this resource. I believe that the EPRI suggestion that private contractors are superior to national laboratories raises serious issues regarding conflict of interest. While the national laboratories are not immune to conflicts of interest, as has been pointed out during the course of this panel, they are far less vulnerable than private contractors whose primary source of support is the industry. NEI is usually able to find a private contractor to support any technical position it chooses to take.

An increase in the involvement of universities, however, might pose less of a problem (although one cannot pretend that conflict of interest does not extend to the ivory tower as well). One approach for engaging the academic community in general areas of nuclear safety research would be to obtain funding to initiate a competitive grant program analogous to DOE's Nuclear Energy Research Initiative (NERI) that would focus on safety issues for the current generation of reactors.

EDWIN LYMAN

Dr. Lyman is scientific director of the Nuclear Control Institute, a Washington, DC-based nuclear non-proliferation research and advocacy organization, a position he has held since 1995. He earned a doctorate in physics from Cornell University in 1992, where he was an A.D. White Scholar. From 1992 to 1995, he was a postdoctoral research associate at Princeton University's Center for Energy and Environmental Studies. His research focuses on security and environmental issues associated with the management of nuclear materials and the operation of nuclear power plants. He has published articles in journals and magazines including *The Bulletin of the Atomic Scientists* and *Science and Global Security*. He is an active member of the Institute of Nuclear Materials Management. From 1997-1998, he participated in the Processing Needs Assessment conducted by the Department of Energy's Nuclear Material Stabilization Task Group.

Jane C. S. Long
Phase 1 Comments Only

My remarks will be brief for two reasons. The first is that my area of expertise is nuclear waste storage. I am not in any way an expert in reactor safety. From my point of view, a review of NRC research should include all research, whether or not RES conducts the work. It makes little sense to me to try to answer Chairman Meserve's questions without review *all* research at NRC. However, the NRC research program in nuclear waste lies outside of RES and was not discussed or presented at our meeting. Secondly, the material presented at the meetings seemed to have little to do with the three questions asked of us by Chairman Meserve at the beginning of the meeting. My comments below reflect my thoughts and conclusions based on the data as I received it and understand it and related as much as possible to the questions posed by Chairman Meserve, but the basis for my remarks is clearly limited.

1. **Are we doing the right research?** I have a difficult time answering this question as we did not review research in my area of expertise. Consequently, I have looked at the question from this point of view: The current research budget is vastly reduced. Under such a reduced budget, how should NRC make decisions about what research to do? In other words, with the money that NRC does have in its research budget, what principles should it use to decide what to fund? I think that NRC should conduct research that meets the following criteria:

    a. High priority should be given to research no one else is motivated to do.

    b. The research should be research that illuminates issues affecting safety.

    c. The research should be of high quality.

Much of the discussion during the two-day meeting covered the decline in NRC research capability. With small research budgets, it is important to recognize that NRC may be the research agency of last resort. If there is an issue that industry or DOE is not motivated to explore and this issue has a major effect on safety, then NRC should make it a high priority. An example of such research for the nuclear waste program would be the development of conceptual models for flow and transport in the fractured vadose zone at Yucca Mountain. DOE has not successfully defined a conceptual model that explains the behavior (e.g., Cl36 presence at depth). Such a model will be critical to deciding if the site is safe. NRC should make such research a high priority. With small research budgets, NRC should be careful to fund that research which has a critical role in insuring the safety of nuclear facilities, but is not of interest, or is overlooked by other institutions.

Discussion of research designed to optimize safety of reactors, i.e. achieve equal or increased safety at lower cost, strikes me as a lower priority for NRC to fund. This is simply because industry should be very motivated to do this research on their own.

NRC might then restrict their efforts limited confirmatory studies designed to give necessary and sufficient confidence in the research conducted by others.

Also, it is much more desirable in my mind to have expertise in industry than in NRC. If the operator is more knowledgeable that NRC, this seems to me to be more likely to produce safety than having poor understanding on the part of the operator and rely on NRC for expertise. So if you find situations where NRC is falling behind and industry expertise is well established, these might be less important areas for NRC.

2. **Who should do this research?** In order to ensure research of high quality, the research should be *competitive*. Further, there is a conflict between high quality research and research conducted by investigators that work solely for NRC in order to maintain clear independence. The need for independent researchers strikes me as less important than achieving high quality research. Thus, independent, mediocre research is less desirable that cooperative, high quality research. The need for confirmatory, independent analysis is vastly reduced by having the work be of high quality and carefully peer reviewed. Especially under reduced budgets, it is less necessary for NRC to have their own cadre of researchers than to have high quality research. However, it is also the case that long-term funding of a series of related experiments can be the only way to unravel key problems in nuclear waste transport.

3. **Is the funding sufficient?** In the area of geologic repository research, there is insufficient research into the conceptual models governing transport of radionuclides in the environment. Recent investigations showing that Cl36 has been found at the repository horizon call into question the physical laws that have been thought to govern behavior. A new paradigm for describing this phenomenon has not been shown to be robust. From this standpoint alone, there is evidence that the funding is not sufficient.

JANE C. S. LONG

Dr. Jane C.S. Long is currently Dean of the Mackay School of Mines, University of Nevada, Reno. The school has three academic departments of Geological Sciences, Mining Engineering and Chemical and Metallurgical Engineering as well as the Seismological Laboratory and the Nevada Bureau of Mines and Geology. Prior to this appointment, Dr. Long was a department chair at Lawrence Berkeley National Laboratory where she managed the Energy Resources Technology Program and then the Environmental Research Program. Dr. Long has been investigating fluid flow in fractures for over 20 years. Her Ph.D. thesis work was done with Paul Witherspoon who used statistical models of fracture networks to examine the viability of using continuum assumptions to model fluid flow in fracture networks. Subsequent work on inverse models was applied successfully to a number of fractured sites throughout the world. Dr. Long has been extensively involved in the issue of how to characterize fractured systems and incorporate interdisciplinary information. She has been a principal investigator in the Stripa Project and the Hard Rock Laboratory. She led a project to characterize fracture flow in the Snake River Basalts. For the National Academy of Sciences, Dr. Long was chairman of a committee for Fracture Characterization and Fluid Flow and a committee to recommend a research program for the Environmental Management Science Program for DOE. Dr. Long also sits on the Board on Radioactive Waste Management and had been a member on the Board on Engineering and Environmental Systems.

William D. Magwood, IV
Phase 1 Comments

Chairman Meserve asked the panel to consider three questions relative to the research activities of the NRC. Is the current level of research funding appropriate? Is the appropriate research being conducted? And, are the appropriate researchers engaged in the research?

The answers to these questions are entirely dependent on one's view of the appropriate mission of NRC research. It is our view that a fundamental change is needed in the way NRC views its research mission. That is, the research activities be truly collaborative with industry and/or other government agencies such as the Department of Energy. The idea of independent research conducted solely to provide data for regulatory purposes no longer makes the best use of the Agency's finite resources and foregoes the benefits available through leveraging NRC research funds with those of industry. Therefore, one cannot make a judgement regarding the appropriateness of the NRC research program and budget without NRC first re-examining the issue of independence and verification.

When the NRC was established, the commercial industry was still in the early stages of its development. Plant orders, license applications, and construction projects were ramping up; new plant designs were being developed by government and industry; and the regulatory environment was growing in parallel to meet the new and projected demands. During this time, it was incumbent on NRC to develop an internal subject-matter expertise and maintain cognizance in the advances in the nuclear technologies that were being planned for commercial deployment. In addition, independent research by both industry and NRC was needed to develop the quality data archives needed to support the design, operation and regulation of commercial nuclear power plants.

Much has changed, however, in the U.S. nuclear power industry over the past three decades. Significant technical expertise now resides within industry, academia, and government laboratories that did not exist when the NRC came into being. The technology is now better understood by both the nuclear utilities and the regulator. As such, the need to conduct separate, independent research has become less important than the need to ensure the appropriateness of the research being conducted.

It should also be recognized that economic forces, in addition to regulatory requirements, are driving the nuclear utilities to maintain and operate their facilities in a safe and responsible manner. The historic changes occurring in the electricity marketplace as a result of deregulation coupled with the relatively inexpensive cost of nuclear-generated electricity has transformed commercial nuclear power plants into incredible financial assets. It is, therefore, in the best interest of the owner/operators to pursue cooperative research with the NRC to ensure the facilities continue to be available to operate safely and reliably.

Given these fundamental changes in conditions, it is an appropriate time for NRC to re-examine their role in participatory research with industry. As part of this re-examination, NRC needs to develop and implement a new concept of "independence." One obvious possibility is for NRC to team with industry in identifying and planning research activities to assure that the needed data is acquired in a cooperative, cost-shared manner while assuring "independence" through separate analysis of the resulting data.

An example of acceptable, cooperative research in which the NRC should actively participate is the Department of Energy's Nuclear Energy Plant Optimization (NEPO) program. The NEPO program is a cost-shared research program with the commercial nuclear industry that was initiated in fiscal year 2000. The NEPO program is aimed at ensuring that U.S. nuclear power plants can continue to deliver adequate and affordable energy supplies up to and beyond their initial license period by resolving issues related to plant aging, and by applying new technologies to improve plant reliability, availability, and productivity. The research conducted under the NEPO program is governed by a strategic research and development plan jointly produced by DOE and EPRI and peer-reviewed by the industry's Nuclear Power Council and DOE's Nuclear Energy Research Advisory Committee (NERAC).

Government sponsored nuclear energy research and development to address outstanding technical issues is good public policy that benefits the industry as well as the general public. To this end, the NRC should pursue establishing a new mechanism to enable special industry contributions to specific, joint research projects. Research of interest to fewer utilities, such as anticipatory research and development focused on new technologies, could also be supported this way.

Recently DOE's NERAC completed a long-term nuclear energy research and development plan to guide DOE's nuclear energy research programs. This plan recommends several major new undertakings that might prove fertile ground for future DOE-NRC-industry partnerships. We would encourage NRC to consider a new relationship with DOE and industry and become a more integral part of the U.S. nuclear energy research and development community. Teaming with industry allows both DOE and NRC to leverage scare funding resources to address issues of common concern. It is vital that NRC and DOE and industry begin to work more closely in the research arena to ensure that clean, safe and economical nuclear power maintains its place in our nation's electric generation infrastructure.

William D. Magwood, IV
Phase 2 Comments

The three questions posed to Expert Panel 1 by Chairman Meserve are interdependent, and should be addressed by Expert Panel 2 looking first at what type of research is appropriate for the Nuclear Regulatory Commission (NRC) and how it should be conducted. When these determinations have been made, then the level of funding necessary will follow.

NRC research should focus on technical and procedural areas which directly relate to its oversight function or in areas where an element of independence is key to the acceptance of the research results by the public. Such areas would include research to strengthen the basis for moving the risk-informed philosophy for regulations and their implementation forward; to develop a deeper understanding of Probabilistic Risk Assessment, how it can be best put to use, and its limitations; or to determine the level of environmental regulations pertaining to radiation needed to adequately protect public health and safety. It does not seem appropriate for NRC to conduct by itself research leading to the same end as that currently being carried out by industry or other government agencies, such as research into improved reactor technologies. If there is a need for NRC collaboration with industry or other agencies on certain research, funding for NRC participation would be proper, but only if NRC's independence will not appear to be compromised. The Department of Energy's (DOE) Nuclear Energy Research Advisory Committee's plan on long-term nuclear energy research and development recommends several suggestions that might reasonably be accomplished through DOE-NRC-industry partnerships. This would permit NRC to leverage limited research funds during the data acquisition phase, at a minimum, even if the assurance of independence required a separate NRC analysis of the resulting data.

NRC should consider all sources for completion of its research: universities, national laboratories, and private consultants. The competitive contract awarding process, or sole-sourcing when appropriate, should be used to ensure that research activities are conducted where the most expertise can be applied to resolution of the issues at hand.

Regarding the level of funding for research, it is probably not appropriate to use the measure of percentage of total budget or comparisons with previous years to determine a dollar level that should be dedicated to research. The nuclear energy industry has changed significantly over the last several years and the current situation presents research challenges considerably different from those of 20 or even 10 years ago. The level of research funding for NRC should be developed from a zero-based process, thoroughly assessing the specific areas and extent of research for each, in accordance with the above principles.

WILLIAM D. MAGWOOD, IV

William D. Magwood, IV is the Director of the Office of Nuclear Energy, Science and Technology in the U.S. Department of Energy (DOE). He was appointed to this position by Secretary of Energy Bill Richardson, on November 8, 1998. As the Director of Nuclear Energy, Science and Technology, Mr. Magwood is the senior nuclear technology official in the U.S. government and the senior manager for all the Office's programs. Under Mr. Magwood's leadership, the Office of Nuclear Energy, Science and Technology has led the Nation in a new consideration of nuclear technology as a means to address difficult problems facing the Nation in the 21st Century. The Office has also reasserted a leading role for the U.S. in the international discussion regarding the future use of nuclear power technology to generate secure supplies of energy without emitting air pollutants that can damage the environment, both regionally and globally. Prior to assuming his current position, Mr. Magwood served as the Associate Director for Technology and Program Planning in the Office of Nuclear Energy, Science and Technology for four years. He also served as the Executive Secretary of the interagency Highly Enriched Uranium Oversight Committee.

Alexander Marion
Phase 1 and 2 Comments

In order to adequately respond to Chairman Meserve's questions, it was necessary to review the legislative history of the Energy Reorganization Act of 1974 to gain a fundamental understanding of the intent of Congress in providing NRC authority and responsibility for conducting research. With this understanding one should be able to relate this statutory responsibility to an operating plan for the Office of Research.

Clearly, Congress intended the NRC to engage in or contract for research that is "necessary for performance by the Commission of its licensing and related regulatory functions." The concept of "confirmatory assessment relating to licensing and other regulation" as a specific responsibility is cited in Section 201 (b)(2)(g)(2).

Of particular note was the establishment of the Energy Research and Development Administration (ERDA) to conduct and coordinate fundamental research and development on the various sources of energy. The October 8, 1974, Conference Report made clear the desire for ERDA and other federal agencies to "cooperate" with the Commission in sharing research findings and assistance. It was not intended that NRC "build its own laboratories and facilities for research and development or try to duplicate the research and development responsibilities of ERDA." ERDA was subsequently absorbed by the Department of Energy and became the Office of Energy Research in accordance with the Department of Energy Organization Act of 1977. In conclusion, NRC was authorized to:

1. Conduct research that relates to licensing and regulatory functions of the Commission

2. Conduct confirmatory assessment related to licensing and regulation.

3. Avail itself of research findings and assistance from other federal agencies

With this foundation, one would expect the Office of Nuclear Regulatory Research (RES) operating plan or specific research projects be clearly related to regulatory decision-making. At the September, 2000, meeting the RES staff presentations highlighted a number of research projects currently underway and linked these to the NRC organizational goals to:

1. Maintain safety.
2. Increase public confidence.
3. Make NRC activities and decisions more effective, efficient and realistic.
4. Reduce unnecessary regulatory burden.

It is recognized that the NRC is striving to finalize a coherent and workable 5-year strategic plan describing the Agency strategic and performance goals. A necessary next step is to describe how such strategies and goals relate to resource needs, specifically budget and staffing levels. The Planning, Budgeting and Performance Measurement Process (PB&PM) should be useful in achieving that necessary next step. This has not been accomplished to-date.

The staff presentations and the operating plan report lacked the specificity necessary to establish why the research project is undertaken and how the results will be used to support the Commission's licensing and regulatory functions. This must be clearly established if the value and relevance of current research projects as well as future research activities is to be legitimately assessed. Unfortunately, the January 11, 2001, report of NRC research activities does not adequately describe why the research activities are being pursued and how they may be used as part of the Commission's licensing and regulatory functions. There is a lack of clarity and understanding of how the results of these research activities will be transferred to the office of NRR. Aside from my direct knowledge of several of the research activities, it appears at this point research reports are issued but not much thought is given to integrating the results into the regulatory decision making process.

There appears to be a lingering question on the separate research activities conducted under the auspices of NMSS. A number of the members of the Expert Panel commented on this area about the separate research conducted by this office. Further clarity needs to be provided because it appears the NRC may be conducting research in manner that is contrary to the statutory mandate.

Research is defined as "careful, systematic study and investigation in some field of knowledge undertaken to discover facts or establish principles." In the case of NRC research activities, what facts or principles are adequate and sufficient for NRC to make decisions on licensing and regulatory matters? This is fundamental in determining the value and relevance of research activities. Now back to the Chairman's questions:

1. **Is NRC Funding Research at the Right Level**? I suggest that the Office of Nuclear Reactor Regulation (NRR) and the Office of Nuclear Material Safety and Safeguards (NMSS) may be in a better position to respond to this question. These two offices have the lead responsibility to review license applications and submittals and develop and implement NRC regulatory requirements. These responsibilities clearly relate to NRC licensing and regulatory functions.

   From my perspective a definitive answer cannot be provided at this time because NRC research activities appear to be different than what was intended by Congress. The necessary linkage to NRC objectives and goals has not been clearly defined. NRC's budget should be established to support only those research projects that relate to NRC licensing and regulatory functions. That linkage has not been established in all cases. A comprehensive reassessment and refocus of NRC research activities is in order.

There appears to be a tendency for RES representatives to be somewhat defensive especially in light of the significant budget reductions. And, this is to be expected. However, the reality is that the office has been provided a $42 Million budget for this fiscal year. And the focus of attention and effort should be on the optimal expenditure of those funds – not necessarily what the budget figure was 5 or 10 years ago. The review conducted under the auspices of Direction Setting Issue 22 appeared to identify a number of the same issues raised by the expert panel. This review should be completed and ultimately integrated with NRC's overall planning and budget process.

2. **Is there an appropriate balance in NRC research activities - Are we doing the right things**? Yes and no. Some research activities are understood in terms of applicability to licensing and regulatory functions while others are not. A policy level question has been identified that relates to NRC conduct of open-ended "anticipatory" research. NRC reported that approximately 20% of its research budget is allocated to anticipatory research. It is not clear if Congress intended for NRC to conduct this type of research beyond that which may be necessary to support licensing and regulatory decisions. The Commission should evaluate the merits of this form of research in light of its statutory mandate.

   The value and relevance of current research activities is limited. In some cases it is clear that research provided new insights to support regulatory decisions. For example, the application of the revised source term was clearly relevant in improving the understanding of fission product release. Yet it has taken an extraordinary length of time for these insights to be applied to NRC's regulatory process. NUREG-1465 was published in draft form in 1992 and finalized in 1995. The regulation allowing optional use of the alternative source term for current operating plants became effective in 2000.

   NRC RES personnel noted the need to reevaluate 10 CFR 50.61, Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock, and the associated Regulatory Guides 1.99 and 1.154. How much time will it take to apply the latest research insights into these regulations? The cycle time or the delivery of research to practical application must be improved. This is increasingly important especially in research associated with the application of new technologies, e.g., digital instrumentation and control, non-destructive examination techniques.

3. **Are the right "performers" involved in NRC research activities**? This is difficult to answer. It is not clear how decisions are made relative to available research conducted by other federal agencies and the choice of national laboratories, universities and other facilities.

One key element that should be considered is seeking opportunities for increasing cooperative and collaborative research between industry and NRC. The industry can no longer afford to pay for completely "independent" NRC research that is recovered from user fees assessed on licensees. In today's environment, the challenge is to seek new opportunities to conduct research in a systematic, disciplined manner that yields results that provide practical insights, value and relevance to end-users. In NRC's case, the end-users would include internal (NRR and NMSS user needs) and external stakeholders.

NRC and the industry's research organization, Electric Power Research Institute, executed a memorandum of understanding to pursue joint research activities. Progress has been slow and more effort needs to be applied to share resources, exchange data and research results on projects of common interest. This would call for a disciplined process that establishes priorities based upon safety significance and a collaborative approach to confirmatory research. The industry and NRC collaborated successfully in the 1980's on research projects under the auspices of the Nuclear Plant Aging Research Program (NPAR). It can been done.

This raises the policy issue of NRC research activities being pursued in an independent manner. An appropriate balance needs to be established by the Commission in recognizing the benefit of collaborative research. Future research should be conducted in an open and collaborative manner that includes sharing of resources and data. The subsequent application of research results to NRC decision-making, as part of its licensing and regulatory function, can be independent. The current process is inefficient and counterproductive resulting in unnecessary duplication of effort by industry and NRC. An example is the independent development of analytical computer codes by NRC contractors (national laboratories) to replicate codes submitted by licensees for NRC review and approval. A more efficient and effective process should be established.

NRC and other federal agencies, specifically the Department of Energy, must seek further opportunities for cooperation/collaboration on fundamental research and development.

Other Comments: One issue raised during the panel discussion related to NRC staffing and necessary levels of technical expertise within the Office of Research, e.g. critical core competencies. This is a management issue that must be addressed by the Commission in assuring NRC maintains the necessary knowledge base to carry out its mission. This has been and continues to be an area of constant criticism by external stakeholders on the staff resources necessary for the Commission to carry out its mission, strategic goals and objectives. The following comments on the proposed recommendations in the order they appear in the January 2001 memorandum distributed to the Expert Panel:

1. The point could be stated more directly, e.g., NRC must maintain the necessary level of technical competence to effectively carry out its regulatory responsibility. This, of course, would apply to internal NRC staff as well external resource needs.

2. Improved coordination between NRC offices has been clearly identified as an area for improvement. Each of the offices (RES, NRR and NMSS) must demonstrate an integrated set of research programs and related activities that clearly relate to licensing and regulatory functions.

3. RES should not "increase its cooperative efforts" with public interest groups. Cooperative efforts undertaken by RES should primarily involve research and development organizations. The Commission has established a goal of increasing public confidence. This is commendable. A key element of success in achieving public confidence and trust is the ability of the NRC to externalize its regulatory decision-making. This includes opportunities for public input as part of a scrutable regulatory process associated with NRC licensing and regulatory functions. A complementary aspect of this is access and availability of information. NRC has separate initiatives underway to achieve this goal.

4. The Expert Panel identified several fundamental issues requiring clarification by the Commission. These should be included in the recommendation, e.g., type of research (anticipatory and confirmatory) and independent research (independent of other NRC offices and/or independent of industry).

In conclusion, the NRC will have great difficulty determining a future direction for research if a firm foundation is not established today.

ALEXANDER MARION

Alexander Marion is the Director of the Licensing and Programs Department in the Nuclear Generation Division of NEI. NEI is the organization responsible for establishing unified nuclear industry policy on matters affecting the nuclear energy industry, including regulatory aspects of generic operational and technical issues. Previously he was Director of the Programs Department and the Engineering Department. He was with NUMARC for six years as Manager in the Technical Division prior to the consolidation of Washington based industry organizations. Before joining NUMARC, Mr. Marion spent 15 years at Baltimore Gas and Electric Company where he held various positions in the electric engineering department including activities in industry codes and standards, plant electrical design, and licensing and safety issues.

Theodore U. Marston
Phase 1 Comments

This letter will provide a short background on EPRI's unique perspective on the issues being addressed in this review. EPRI has had a long and constructive working relationship with the NRC's Office of Nuclear Regulatory Research (RES). Our experiences in implementing a Memorandum of Understanding (MOU) between EPRI and RES in November 1997 are particularly germane to the current effort, because they addressed many of the policy issues considered by the Commission in 1996-97 under Direction Setting Issue (DSI) 22 on Research -- policy issues that are relevant today. For example, the MOU addresses the question of collaboration and how this can be done while maintaining sufficient process independence, essential to the integrity of NRC's decision processes and to public confidence. A copy of this MOU will be provided for your final report.

Following the background discussion, I will attempt to answer the three questions posed by Chairman Meserve at the beginning of our meeting on 16 August. The letter concludes with some specific thoughts on key issues raise during the meeting, including user fees, responsibility for NMSS research, and R&D on advanced reactor issues as they relate to research needs.

BACKGROUND: POLICY BASIS FOR THE RES-EPRI MOU

Throughout the 1970s and early 1980s, cooperation among NRC, DOE and industry on research objectives was active and mutually beneficial. Major technical issues were addressed during this period, some with a need for major test facilities, which were often funded and managed jointly. However, between the mid-80s and mid-90s, legal concerns about NRC's "independence" created a major obstacle to communications and cooperation. This in turn caused a significant degradation in the regulatory process. It caused major delays in technical issue closure because of lack of substantive communications and up-front understanding of the definition and scope of a technical issue, as well as a lack of agreement on R&D needs, data needs, appropriate assumptions and models, etc., to resolve the issue. NRC and industry were reduced to conducting independent studies based on their own understanding of the issue and critiquing the merits of each others' work, which often led to costly re-analysis on both sides and inevitable delays in issue closure. Open communications and a healthier attitude toward appropriate means to manage cooperation could have avoided these costly and unnecessary delays. A number of factors came together in the mid-90s and late 90s to correct this situation:

1. The Commission's Strategic Assessment and Rebaselining initiative.

2. Diminished resources for R&D at NRC, EPRI and DOE, suggesting leveraging, cost-sharing.

3. Utility executive direction to EPRI to seek improved R&D cooperation with NRC, DOE.

4. Move toward risk-informed regulation and more realistic inputs to decision making, which placed NRC and industry approaches to R&D on a more common footing (i.e., increased mutual appreciation of common R&D goals, need for more realistic data, assumptions, and models, in contrast to the "bounding" approaches of past).

An enlightened view of "independence" emerged in the public discourse on DSI-22 that led to NRC acceptance of the premise that the critical element of the regulatory process that requires independent action is the regulatory decision-making phase. The information gathering phase, which may include testing or operating experience data collection, scientific analysis, etc., can be done collaboratively as long as NRC staff is actively engaged in managing or monitoring the activity. NRC can share the costs of a test program or a data collection effort with DOE, industry, or international entities, as long as the cooperation is restricted to the scientific, data collection phase of the research. When a research effort reaches a point where data have been collected and interpretation of that data is ready to start with regard to what that data show about adequacy of safety or the potential need for additional regulation, NRC must do its work independently.

This understanding became the foundation for a greatly improved level of communication between industry and NRC staff on technical issue resolution. It enabled an MOU between RES and EPRI to be executed that committed us to increased cooperation, sharing of existing data and costs of generating new data, when required. It established mechanisms for selecting areas for cooperative R&D and for periodically reviewing status and progress of RES and EPRI R&D.

In keeping with the improved understanding of "independence" discussed above, the RES-EPRI MOU focused on meeting data needs, not solutions, to specific regulatory issues or decisions. The practical implication of this approach is that when data collection is complete and the scientific information is ready to support decision making, <u>the same data</u> (because it was collected and analyzed jointly) would be turned over by RES to NRR, and by EPRI to NEI, for their actions in determining proper NRC and industry responses, respectively. Note that a major part of the problems of the past (arguing about whose data are right) is now eliminated, because all parties agree to the underlying data provided to the decision-makers. Open communication at the front end of the R&D enables a more complete understanding of the issues to be resolved, and a consensus on the objectives and design of any R&D programs, if needed, to address them.

NRC-industry cooperation in the data phase is very important to the success of risk-informed regulation, because many of the opportunities for regulatory improvement involve bringing best-estimate data to bear on issues for which the original regulations were based on bounding assumptions. Scientific data and real plant experience did not

exist when many of the original regulations were developed. More recent research results or experience data will also help reduce the uncertainties assumed in older regulations, thus removing unnecessary conservatisms.

Absolutely essential to the above logic that allows NRC to show that it has independently arrived at its regulatory decisions, while cooperating with others in the data collection phase, are the knowledge, competency, integrity, and active engagement of NRC's technical staff in the R&D. Note that these essential qualities of staff expertise are no less important to the quality of NRC's regulatory decisions in cases where NRC is not cooperating with industry. NRC staff capability must be unassailable in all areas impacted regulatory decision-making. When these qualities are above reproach, then NRC's capacity for correct decisions is assured and its opportunities for cooperation, information sharing, and cost-sharing are all unconstrained.

CONCLUSIONS FROM MOU EXPERIENCE

1. Relative to many of the key policy issues that were discussed by attendees at the 16 August meeting, there appears to be less than a full appreciation for the implications of DSI-22 and the RES-EPRI MOU. These implications relative to open communications and cooperation in the data collection phase of issue resolution are vitally important to many of the issues raised in this current initiative and by the Chairman's questions to the group.

2. A restrictive interpretation of the requirement for independence (one that unnecessarily required that the R&D itself must be independent -- vs. cooperative) created R&D overlap, redundancy, and delay, in a time of decreasing R&D budgets. The situation is much improved but continued improvement is required.

3. Cooperation in R&D between RES and industry is necessary. We both need objective information, but we must be independent in decision making. When information is developed independently and duplicatively, there is little or no added value.

4. With few exceptions, RES, EPRI, and the NSSS Owners Groups work on the same issues.

5. Industry is equally concerned with the protection of the health and safety of the public as is NRC. The industry has a huge investment in its nuclear plants and that investment is put at great risk when the health and safety of the public is challenged. The focus of industry R&D is coincident with the focus of RES, i.e., both have an obligation to seek objective scientific information. Industry has no interest in not getting to the "truth" on any issue, even if the answer is that some costly action is needed. Nuclear operating companies have the ultimate responsibility to the public for protection of their health and safety, and to their

stockholders for the protection of their assets. Therefore, utility companies (and organizations like EPRI that conduct collaborative R&D for them) need to understand any new technical issue and learn what actions might be required for prudent public safety and investment protection.

6. There is national and international pressure to reduce the cost and amount of R&D. This is true for both industry and government R&D organizations.

7. International cooperation and collaboration in R&D has improved greatly in the last 5 years and must continue to increase.

8. It is absolutely essential for NRC RES to attract and retain highly qualified and respected technical staff members. This is particularly true for critical core competencies. Reasonable people might disagree over the question of what the size of the RES budget should be with regard to contracted R&D activities, but there can be no disagreement that NRC's budget for research activities must never fall below a level that would weaken NRC's ability to attract and retain highly qualified staff members in all critical areas. This must include areas where staff technical expertise will be required to address risk-informed regulatory improvements.

9. Maintaining close coordination and communications between industry and RES on all areas of potential R&D cooperation is hard work. EPRI and RES have scratched the surface of what is possible via cooperation. There is no lack of commitment by management on both sides to do more and to do it better. The practical day-to-day demands and challenges on both organizations often forces us to defer opportunities to explore joint approaches to issues.

RECOMMENDATIONS

Based on the above, two recommendations are offered:

1. NRC should modify its Vision Statement as follows: change "... RES conducts independent experiments and analyses ..." to "RES conducts experiments and analyses to support independent decision making by NRC..."

2. NRC and industry should both review existing and planned R&D to seek more opportunities for cooperation, especially in areas that can expedite resolution of issues and save resources for both NRC and industry.

ANSWERS TO THE CHAIRMAN'S QUESTIONS

1. **Are we funding research at NRC at the right level?** EPRI's nuclear R&D budget is nearly twice the size of the NRC's research budget (depending on how internal costs are allocated), and we know from personal experience that there are many important R&D needs and opportunities that are not being met

because of budget restrictions. EPRI's responsibilities in R&D are quite different than those of RES, because we are tasked with developing technology solutions to a large number of problems with no safety consequences but with significant investment protection implications. Nevertheless, I can extrapolate EPRI's experience to the large budget declines experienced by RES over the last 5-10 years and conclude that extraordinary insight, planning, and management would have been necessary to adjust the program to keep the highest priority efforts on track.

It is, however, impossible for me to select an appropriate budget number for NRC's research program. That optimum number may be larger than what it is today, but we don't have enough information to decide how much. NRC itself must account for all the valid user need requests that provide the basis for judging the minimum necessary research activity to address those needs. Those needs must include the research necessary for NRC to achieve its goals in regulatory effectiveness and efficiency, including regulatory reform, increased realism in the inputs to decision-making, etc.

I am concerned there is essentially no RES budget to support the licensing of new plant technologies. The U.S. may be on the cusp of a decision for a new nuclear plant. There will be inevitable technical questions raised during the licensing process and the NRC must have knowledgeable technical staff to raise the proper questions and assess the answers proposed by the designer and the licensee.

It might be useful to NRC to account explicitly for all leveraged funds from other organizations, both international and domestic, that can be brought to bear in meeting those user needs. Such leveraged funds, in cases where RES clearly has adequate management involvement and access to results, should "count" as part of the overall funding being applied to meet those needs.

Again, funding levels must never fall below the level needed to maintain adequate "in-house" technical expertise in all critical areas. This is essential to the integrity of NRC's decision processes and public confidence in them. Ultimately, the confidence the Commission has that its staff has made correct decisions does not rely on whether or not NRC paid for the data, but whether or not its experts can vouch for the integrity of that data and how it was obtained.

2. **Are we doing the right kinds of research?** EPRI's experience with the culture of an R&D organization provides a partial answer:

It is always easier to start research on a given issue than to stop it. Research, like so many other human endeavors, is subject to the 80-20 rule: 80% of what we need to know can often be obtained with about 20% of the investment. Without strong management involvement and client oversight, some research may continue beyond its useful life. This is true for all R&D organizations.

Most researchers are more comfortable working on areas for which they are acknowledged experts. Challenging researchers to take on new issues that may stretch that expertise base, or challenging them to attack future issues that must be addressed inevitably but are not now urgent, are both challenges in themselves for management.

Many researchers (particularly contractors) would rather develop new data than search the archives for existing data that adequately answer the question -- at much less cost.

These truths point to the importance of establishing the right culture in an R&D organization and in the importance of effective management guidance. Both require a clear and common sense of vision and mission at all levels in the organization.

Even with a clear mission and organizational commitment to high value research, it is difficult to align research priorities to needs. The former requires stability for planning and budgeting and the latter rarely cooperates because issues are dynamic and tend to outpace the programmatic realities of an R&D process.

A general impression in industry is that NRC's research program sometimes lags the important issues which NRR and industry are engaged in at any point in time. NRC has worked very hard at improving the coordination and information flow between NRR and RES, especially on emerging issues. Industry recognizes significant improvements in this area, but also continues to observe isolated cases where communications could be improved. In this regard, RES (and EPRI) benefit from monitoring emerging issues, especially ones likely to require research inputs, from both an NRR perspective and an industry perspective.

The distinctions that NRC uses for research categories may be confusing to some people. For example, the term "confirmatory research" implies to the layman that the work is confirming something that is already supported by other research. However, in some cases the label is actually used for a short-fused research need for which there is no existing scientific information. In this context, "confirmatory" really means "short-term." Likewise, NRC's term "anticipatory" has become associated with a programmatic situation in which research is self-directed within RES, as opposed to being directly associated with a request from NRR. If NRC's program offices improve their ability to identify emerging issues further in advance, then promptly communicating these needs to RES (as would be expected) self-limits the "anticipatory" label.

We suspect there may be a need for increased focus within NRC's research priorities in the rapidly growing areas of digital I&C, advanced sensors, advanced monitoring and diagnostics, digital information management, telecommunications applications, etc. Industry needs to exploit these technologies more rapidly to

improve reliability and overall system performance, and NRC needs to support a more rapid infusion of these technologies into more plant applications. A second area of rapid growth is risk-informed applications, in almost every area of plant design and operations. Again, more openness to risk-informed findings is needed, without re-applying unnecessary conservatism.

3. **Are we using the right R&D performers?** EPRI asks itself the same question, and for the same reasons as NRC. We both need to identify contractors with the requisite level of expertise to do a high quality job. We both need contractors who are responsive, objective, and who exercise good judgment. We both seek contractors who possess these qualities and offer them at competitive costs. We generally subject research projects to competitive solicitation in order to keep R&D costs down.

   EPRI, like NRC, contracts with three types of contractors: universities, private sector companies, and national laboratories. However, the relative mix of these types of contractors varies significantly between EPRI and NRC. Our experience has shown that private contractors generally provide the above qualities most consistently and at competitive costs. In contrast, NRC is much more dependent on national laboratories for is contractor support.

   In general, both NRC and EPRI attempt to use university resources when feasible, because of the value to our future provided by exposing graduate students to the real problems at play in nuclear energy research, and because of the relatively lower costs associated with grad school talent.

One old paradigm surfaced during the 16-17 August meeting that should be drummed out of our thinking by the more enlightened view of "independence" discussed above. A pre-regulatory reform view was expressed that the integrity of NRC's decision-making process is provided by its contractors. EPRI does not shirk from its ultimate responsibility for the work it publishes by delegating responsibility to contractors, and we assume NRC would not do this either. As discussed on 16 August, NRC staff (and EPRI staff) must retain sufficient in-house expertise to be as competent on a given issue as its contractor. Our staff should never become "brokers of discussions" between contractors. They should have the expertise and willingness to assume the responsibility to drive the research effort to its objectives.

Another related pre-regulatory reform paradigm was also expressed or implied during the 16-17 August meeting -- that NRC's integrity is assured by hiring a federal employee or national lab as the contractor. Again, an enlightened view of independence should reject the notion that NRC's obligation for high quality and objective data are automatically guaranteed by hiring a particular class of contractor. NRC staff bears the responsibility to assure the integrity of its decision process and cannot abdicate that responsibility. EPRI's experience is that stereotypes like this are not accurate and no class of contractors provides a guarantee of automatic objectivity and assured high quality. Contractor selection should be based on the technical expertise of the principle

investigators and their company's commitment to integrity, irrespective of class of employer or other labels.

In summary:

1. RES must not delegate its responsibility for the integrity of its decision processes to its contractors. RES must not become dependent on contractors to cover for gaps in staff expertise. The staff must always be able to synthesize results, make learned, independent judgments and decisions.

2. RES must assure that all contractors and national laboratory personnel are objective in their work, and are not pursuing a separate agenda from that of the NRC to protect the health and safety of the public. RES has stated that it should use the "best available" contractors.

OTHER DISCUSSION ISSUES: THOUGHTS AND RECOMMENDATIONS

1. User Fees. NRC and Congress must revisit the full fee recovery basis for NRC revenues. Much of NRC's research program is of general interest to the U.S. public. No other regulatory body, such as EPA and OSHA, recover full fees from their regulatees. On 15 September this problem was discussed in more detail with concerns expressed that the current situation will never get resolved unless the nuclear industry and NRC work together. We offer the following suggestion to help facilitate a common position around which an NRC-industry consensus might develop: Propose that Congress modify the current fee basis for NRC's operating costs such that half of the full expenses to run the Office of Research (project management plus contractor support) be funded by user fees; the other half through appropriation. This solution addresses all problems cited, by providing federal assistance to NRC Research for longer-term research for which industry sees little or no direct value, but continues to draw some funds from licensees in order to maintain sufficient industry interest in the research agenda to encourage input, participation, and respect for its value.

2. NMSS Research. This became a major issue during the 16-17 meeting. I don't see a major problem with the status quo, namely NMSS managing its own research. From an organizational policy standpoint, it would be more consistent with the reactor side of NRC if RES managed NMSS research. However, industry would be naturally concerned if NRC undertook a major organizational change in "mid-stream" in the process of preparing for and responding to a DOE application for a repository at Yucca Mountain. No changes should be made that would create a loss of continuity or a delay in NRC's ability to manage and make decisions on these issues.

3. Advisory Bodies. NRC relies on independent advisory bodies for review of its programs. These Committees also advise on the scope, content, and priorities for research. My view is that too many of the Committee members selected by

NRC are not truly independent, and that many of them lack a real-world perspective on issues on which they advise. Lack of independence is created in situations where advisors come from organizations under contract to NRC and end up advising on issues that could effect their employer. I believe the advisory bodies would better serve the NRC if the members were more independent and experienced in real-world nuclear power plant situations.

4. Advanced Reactors. RES is showing great interest in conducting anticipatory research on "Generation IV" reactor concepts. This interest has been articulated as exclusive to Generation IV. This interest should be more balanced. Industry is keenly interested in having viable options to support new orders when needed. Industry has consistently advocated a balanced approach to the R&D investments and other elements of strategic planning to enable this future. Two basic options are on the horizon. The first is the ALWR category, based on three currently certified designs, plus potential for more. R&D required in this category include allowing modifications to design basis requirements based on risk-information (akin to Option 3 to risk-informing regulations for current plants), and R&D to allow more state of the art technology (e.g., advanced I&C concepts) into these designs. The second option is the broad class of non-LWR cooled options, which would require a new set of regulations and prototype reactor demonstration prior to certification. Many of these options rely on a fundamentally different safety basis than LWR technology, thus requiring differing skill sets. It is important to have these advanced reactors as viable designs because they present an important alternative strategy to ALWRs. We must have robustness in the new reactor portfolio.

5. Industry-NRC collaboration. Both NRC and industry must redouble their efforts to jointly review and coordinate R&D plans to identify and implement increased cooperation between RES, EPRI, and the NSSS Owners Groups.

Theodore U. Marston
Phase 2 Comments

Assessing Future Regulatory Research Needs

This letter provides EPRI's comments on the NRC Research Program, provided as part of the second phase of our Expert Panel review. I appreciate the continuing efforts of you and Ray Durante in leading this important effort, as well as the excellent support that Ashok Thadani and his management team have continued to provide to our group.

Per your request, our comments are focused on the three questions that the Chairman asked us to consider when he spoke to the Expert Panel at the beginning of Phase One. In addition, we address the proposed four requirements for NRC Research that could be provided to the Commission as recommendations. Comments are also

provided on certain presentation materials and other documentation provided to the Panel and discussed at its meetings on 24-25 January and 21 February 2001.

Prior to addressing these points, I would like to comment on the degree of cooperation and coordination between EPRI and RES. Over the last year, there has been significant improvement in the scope and content of cooperation and coordination between the respective research and development activities. I attribute much of this to the leadership provided by Ashok Thadani and his senior staff. This increased interaction leads to a better utilization of joint resources. While there have been significant improvements, there is still room for improvement. We must improve, if we are to meet the future challenges.

I reiterate a few points from my October 2nd letter where appropriate to the scope of Phase Two comments. Some of these points refer to the MOU between EPRI and the NRC's Office of Nuclear Regulatory Research (RES). Please refer to the prior letter for background.

However before commenting on the Chairman's three questions, I want to comment on one of the documents handed out and discussed at our January meeting, because it is fundamental to other comments that follow. That document is SECY-99-281, "The Vision of the Office of Nuclear Regulatory Research." It uses the word "independence" numerous times in various contexts, and shows that the NRC policy on this concept remains somewhat confounded. For example, in the vision statement itself, we believe the word "independence" is in the wrong place. Following is the vision statement as we believe it should be corrected:

> "The Office of Nuclear Regulatory Research furthers the regulatory mission of the NRC by providing technical advice, technical tools, and information for identifying and resolving safety issues, making independent regulatory decisions, and promulgating regulations and guidance. RES conducts ~~independent~~ experiments and analyses, develops technical bases for supporting realistic safety decisions by the agency, and prepares the agency for the future by evaluating safety issues involving current and new designs and technologies. RES develops its program with consideration of Commission direction and input from the program offices and other stakeholders."

The reasons for this important change are discussed in my October 2nd letter: "A refined view of "independence" emerged in the public discourse on DSI-22 that led to NRC acceptance of the premise that the critical element of the regulatory process that requires independent action is the regulatory decision-making phase. The information gathering phase, which may include testing or operating experience data collection, scientific analysis, etc., can be done collaboratively, as long as NRC staff is actively engaged in managing or monitoring the activity. NRC can share the costs of a test program or a data collection effort with DOE, industry, or international entities, as long as the cooperation is restricted to the scientific, data collection phase of the research.

When a research effort reaches a point where data have been collected and interpretation of that data is ready to start with regard to what that data show about adequacy of safety or the potential need for additional regulation, NRC must do its work independently."

The Commission has clearly indicated that it is the decision-making that must be independent, not the data collection. This is clear from DSI-22, Commission support for the RES-EPRI MOU which embraces this distinction as our basis for cooperation, and the Energy Reorganization Act (ERA) of 1974, which uses the word "independence" only once (a quote by Dixie Lee Ray about "an independent capability..." The ERA places significant emphasis on leveraging other federal agencies: "In keeping with the concept of confirmatory assessment, it is not intended that the Commission build its own laboratories and facilities for R&D, or try to duplicate the R&D responsibilities of ERDA." The Commission has extended this principle to logically include international collaboration and domestic industry collaboration, as long as that collaboration is limited to data collection and preparation, and does not extend into the decision-making process.

Absolutely essential to the above logic that allows NRC to show it has independently arrived at its regulatory decisions, while cooperating with others in the data collection phase, are the knowledge, competency, integrity, and active engagement of NRC's technical staff in the R&D. NRC staff capability must be unassailable in all areas impacting regulatory decision-making. When these qualities are above reproach, then NRC's capacity for correct decisions is assured; and its opportunities for cooperation, information sharing, and cost-sharing are all unconstrained.

We agree with SECY-99-281 that "The value of research lies in its contribution to the quality and technical independence of the regulatory decisions made by NRC." However, the SECY uses the word "independence" elsewhere in a confusing and inconsistent manner. As discussed at the 25 January meeting, it is useful to distinguish among the following three circumstances:

1. Use of the word "independence" in the context of the independence of RES from licensees and vendors in the context of their license submissions to NRC for approval.
2. Use of the word "independence" in the context of the independence of RES from the other program offices in decisions regarding which issues RES should address in its R&D program.

3. Use of the word "independence" in the context of the independence of RES contractors from the contractors of licensees and vendors who submit licensing requests to NRC.

EPRI's views on these three situations, which clearly call for different treatment, are as follows:

1. Independence from Licensees and Vendors: The ERA requires RES to not engage in research that is a licensee/vendor responsibility in support of a submittal: "The regulatory agency should never be placed in a position to generate, and then have to defend, basic design data of its own. The regulatory agency must insist on the submission of all of the data required to demonstrate the adequacy of the design contained in a license application or amendments thereto. This requires professional competence in the regulatory agency to make such determinations as whether substantive data are lacking or whether experimental or analytical data provided by an applicant or licensee are scientifically adequate."

   There is no hint of concern in the ERA about a conflict of interest between RES and industry with regard to cooperating on data needs for resolving generic safety issues. The sole concern relates to licensee submittals and the potential that RES could get in a position of "assume [ing] any part of the burden of the applicant to prove the adequacy of a license application." Congress and the Commission clearly had no problem with RES and industry working together to resolve generic safety issues, given the major cooperative effort in the 1970s on ECCS testing. Objections to RES and industry working together on generic issue research (i.e., not tied directly to a license application) have no basis in law or Congressional appropriations language; but rather are overly conservative legal positions that were taken in the 1980s, and led to very adverse consequences, as articulated in my October 2nd letter.

2. Independence from Program Offices: The NRC groups its R&D activities in two categories: "confirmatory" and "anticipatory." Possibly a more appropriate labels for these two categories, based on what types of research are actually assigned to each, are: "user-requested" and "self-directed." During our discussion on Jan. 25th, we concluded that the current labels are not accurate and could be misleading, since a user need often involves investigating a new issue, not confirming the work of a licensee or vendor, as was envisioned to be the role of RES in the ERA. Since we agree that the role of RES must definitely include user needs from the program offices, we think that the more restrictive historical term should be replaced with one that more accurately reflects the real nature of research in this category. Clearly, self-directed research is almost by definition anticipatory in nature.

   The definition of Confirmatory Research provided by NRR on Jan. 24th is enlightening. It lists five attributes of confirmatory research, starting with "develop new methods or new data." Four of the five, including this first one, would probably not qualify as "confirmatory" based on the definition in the ERA. The fifth, "evaluate/validate existing methods" comes closest to the definition in the ERA, but is not considered by NRR to be research at all: "The evaluation of a licensee's methods is not considered research work."

We also learned on January 24th from NRR that the process governing the "confirmatory" category (user-need requests by program offices) works very well, and continues to improve. Extensive, constructive interactions between RES and the program offices take place. Our experiences on the industry side prove the value of close interactions with end-users of R&D is critical to delivering results that meet the need. However, the last slide presented by NRR is troubling. It in effect says that the program offices have no input or involvement in any work done by RES outside the work RES does to specifically address a user need:

a. NRR does not review or concur on RES's anticipatory research, and is not involved with the monitoring of the progress of these activities.

b. NRR is not involved with establishing the fraction of RES resources associated with resolving NRR User Needs.

c. NRR is not involved with RES's decisions in choosing operational data to assess."

We believe that this disengagement of program offices from work that RES labels as "anticipatory" is not appropriate. It suggests that NRC has adopted a bi-modal policy for working relationships between RES and the program offices – either close and effective collaboration, or no collaboration at all. The RES Vision (SECY-99-281) reinforces this picture in its discussion of "anticipatory" research: "RES has a unique role in independently identifying anticipatory research needs." It has been our experience that "customer" involvement in even the most strategic aspects of our research is necessary and appropriate to assure a reality check for the work. Clearly, the program offices' oversight should be of a different nature than for the user-defined research, but it should be there.

We believe that NRC could define a more strategic oversight of anticipatory research, where the program offices have input in both identifying and prioritizing anticipatory work, and in providing user advice during the conduct of the research. Some members of our Expert Panel have argued passionately that RES must have the ability, in the end, to work in an area that it believes must be "poked and probed," even in cases where there is little or no program office support or involvement. Examples have been cited where RES took that long-term view and was proven right by history. I won't argue that RES should not have some ability to work in an area where none of the program offices or other stakeholders concur, if RES feels strongly that it must "poke and probe." But some form of Commission review may be appropriate for such situations. Further, any "poke and probe" effort should have demonstrable risk significance in order to best utilize scarce resources to assist in the overall NRC mission. We have found that industry oversight of strategic R&D assists greatly in the eventual deployment of developed technology. While our respective research missions may be different, the notion of 'all hands on the bag' is still appropriate for both organizations.

3. Independence of Contractors. This issue is not addressed explicitly in SECY-99-281 as a policy issue, but it has been debated extensively in our Expert Panel deliberations, and is central to the Chairman's third question to our Panel. We believe that it logically follows the requirements of the ERA that RES cannot use the same contractor used by a licensee or vendor in support of a submittal, for purposes of reviewing that submittal. That would clearly violate the principles of the ERA with regard to NRC's roles and responsibilities in response to such submittals. However, it also follows that industry and RES can cooperate on the data-gathering phase of investigating a generic issue. There is a clear congressional intent to avoid duplicate tests and other forms of data collection to better utilize scarce resources. In such cases we can use the same contractor. NRC and industry need to closely and jointly manage the contractor and monitor work in progress in ways that assure RES of the quality of the research and its ability to support independent decisions by NRC.

Answers to the Chairman's Questions.

1. **Are we Funding Research at NRC at the Right Level?**

I believe my answer to this question in our October 2nd letter remains valid today. In that letter, I stated: "It is, however, impossible for me to select an appropriate budget number for NRC's research program. That optimum number may be larger than what it is today, but we don't have enough information to decide how much." I also listed a couple areas (e.g., advanced reactors and I&C) where I believe RES needs to do more work.

On January 24th, Ashok presented a list of "Potential Research Initiatives Currently Unfunded." Although I would concur in the need for RES to undertake research in many of the areas listed, it is beyond the mission of this Expert Panel to examine the program in sufficient detail to answer the Chairman's question. However, Margaret Federline described the process for research management that includes evaluations of research project effectiveness, satisfaction of user needs, balance between confirmatory and anticipatory research, balance between planned and emergent research, and effectiveness of research within "arenas". Furthermore, both NRR and NMSS expressed satisfaction with the level of support and quality of RES research. RES management could not cite occurrences of problems linked to unfunded research.

There remains a clear impression, nonetheless, that RES believes anticipatory research funding has become too low. Anticipating heavy regulatory activity on license renewal, risk informing, and hopefully licensing and design reviews of new reactors; I am respectful of this RES concern. Also, NRC might review and re-style its research management processes to use risk-benefit considerations for planning and allocation of resources. More importantly, NRC might formulate performance-based approaches to ensure safety and allow burden reduction in light of risk insights. Many research resources can be wasted chasing low risk concerns and unresolvable uncertainties that

could be managed best by NRC and licensees through risk-informed and performance based regulatory activities.

One key point from my prior letter that must be re-emphasized:
"Again, funding levels must never fall below the level needed to maintain adequate "in-house" technical expertise in all critical areas. This is essential to the integrity of NRC's decision processes and public confidence in them. Ultimately, the confidence the Commission has that its staff has made correct decisions does not rely on whether or not NRC paid for the data, but whether or not its experts can vouch for the integrity of that data and how it was obtained."

2. Are we Doing the Right Kinds of Research?

It is difficult for this Expert Panel to give a complete answer to this question any better than the answers provided in Phase 1. I believe there are areas that RES is not currently addressing that are appropriate to be added to RES plans for future research, but I do not have enough information to come to a conclusion that all the work currently underway is the "right kind of research."

In addition to the advanced reactor and I&C programmatic areas mentioned above as potential areas of expansion, we believe that RES is not placing sufficient emphasis on research supporting reduction of unnecessary regulatory burden. None of the areas of potential new research are targeted at reducing unnecessary regulatory burden. None of the three case studies presented focused on eliminating unnecessary regulatory burden. Under the weighting scheme presented on Jan. 24th for prioritizing research, the lowest safety category (monitor safety performance) ranks higher as a prioritization metric than the highest burden reduction category (cumulative savings >$10M/year). Research is key to injecting more realism into regulations.

More communications with licensees and other stakeholders outside of NRC would increase the likelihood that necessary research is, in fact, being performed. Equally important, these stakeholders can question the value of certain RES projects during their planning stage, at design or project reviews, or at research milestones. This sunshine policy would benefit all parties: NRC would have a valuable resource to optimize its program, and stakeholders would have a better understanding of impending research results in anticipation of their application.

For those areas of research that are currently under the collaborative umbrella of our RES-EPRI MOU, we are very satisfied that RES is in fact "doing the right kinds of research." I believe that further expansion of this collaboration process into other areas will help give industry more confidence in the appropriateness and value of our joint research efforts.

The subject of RES research in support of NMSS high level waste issues also deserves comment. We understand the complex issues associated with the question of whether RES should be responsible for conducting research for NMSS as it does for NRR. After

careful consideration of the comments in our prior letter, as well as the comments from Mel Silberberg and John Garrick in their letters to the Chairman dated January 16, 2001 and February 5, 2001 respectively, we believe the arguments for restoring a role for RES in the conduct of research for NMSS has merit. It would ensure in-house expertise in these important technical areas, would reestablish a consistent policy basis for the role of RES vis-à-vis the program offices, and perhaps most importantly, could help bring a more consistent approach to risk-informed, performance-based regulations between the two program offices. We are also mindful of potential industry concerns about shifting horses in mid-stream and the negative impact that could have on current programs, especially research support for decisions regarding a spent fuel repository. Given these boundary conditions, we believe the Commission could consider an incremental approach that would broaden the professional capability and technical activity of RES staff in the scientific areas within NMSS scope, in a manner that could lead to assuming responsibility for all NMSS research support other than for the spent fuel repository. Further changes could be made in future years as the situation warranted.

3. **Are we Using the Right R&D Performers**?

Again, I believe that our answer to this question in the October 2nd letter is still correct. However, given the Expert Panel discussions in January, we believe that a more direct answer to the Chairman is needed. In complete candor, we believe that too often, and perhaps increasingly, RES is not using the right R&D performers. We believe that RES (as well as the program offices) may have become too dependent on traditional NRC contractors and have not placed sufficient emphasis on the fundamental contractor selection criteria discussed in our earlier letter: requisite expertise, quality performance, responsiveness, objectivity, good judgment, etc., all at competitive costs.

Many aspects of the nuclear power regulation are changing very rapidly, such as the reactor oversight process and associated risk-informed, performance-based regulation. As such, we believe that some of the traditional NRC contractors are simply not "up to speed" on issues. Consequently, they require extensive learning before they understand an issue at a level equivalent to those working in the field on a daily basis. For example, they are situations where NRC goes to the national laboratories for work on an issue where that lab does not meet the "unique facilities or capabilities" prerequisite for direct lab selection, and has significantly less experience and capability than private sector contractors. We suspect this trend will continue, as user need requests to RES trend toward more risk and performance information requirements, as-built configuration information, equipment reliability, obsolescence and other plant issues, etc.; and trend away from the large scale DBA and severe accident test programs of the past.

We suggest that the Commission support RES in reemphasizing the importance of finding the most qualified contractor to do the job, even if that means expanding NRC's traditional contractor base. If process or legal arguments arise to resist this important element of regulatory reform, we urge the Commission to take appropriate steps and

push for a paradigm shift in contractor selection. Some current NRC contractors appear to resist efforts toward regulatory reform, including increased realism in research, efficiency and effectiveness measures, etc. These elements are central to achieving NRC's current mission.

Specific examples of areas where we believe NRC did not select the best contractors to do the job include the Option 3 Regulatory Framework, some GSI closure analyses, and some operating experience analyses reports (i.e., old AEOD function). It is important to note that operating experience data are data – meaning that RES and industry should discuss the mutual benefits of collecting and collating this data as a joint effort. It is also important to note that the most experience and the best expertise on PSA and risk-informed applications at our plants resides in the private sector.

COMMENTS ON THE FOUR "REQUIREMENTS FOR NRC RESEARCH" (POTENTIAL RECOMMENDATONS TO THE COMMISSION)

Following are proposed wordings for the four potential Expert Panel recommendations to the Commission. These statements were originated by Chairman Rogers and have evolved with comments and suggestions from most panel members. These statements conform closely to the latest draft received from Ray Durante on March 1, with suggested changes clearly noted. Below each statement are specific implementation recommendations for Commission consideration. In every case, the implementation recommendations are supported in considerable detail by earlier sections of this letter and by the October 2nd letter.

1. The NRC must maintain as a used and useful arm of its organization, a reliable, respected Office of Nuclear Regulatory Research (RES), and must support this office with the necessary people and resources so that it is an unassailable source of technical information and support for all regulatory actions. This is necessary not only to establish the credibility of NRC's technical decision making and thereby to insure the safety of all NRC licensed activities, *[add comma]* but also to insure U.S. Leadership in nuclear safety technology. Implementation recommendations in support of Statement 1:

    a. The Commission should determine whether sufficient resources are available for RES self-directed (anticipatory) research needs to support extended plant life, challenges of deregulation, and opportunities for new plants. Current low ratios of anticipatory to total RES funding create concern.

    b. The Commission should establish a living mechanism for defining and maintaining the necessary core in-house technical capabilities to support the challenges above.

    c. The Commission should define the appropriate expanded role of RES in support of NMSS high level waste needs.

2. This office must support the activities of other program offices, who in turn should be required to coordinate their activities with RES at least to the extent of planning new work, defining open issues and R&D needs, and establishing the objectives of technical studies. At the same time, RES should be free (within guidelines that include program office input and Commission review) to initiate anticipatory technical studies without formal approval by project offices, but with their cognizance and frequent input ~~wherever possible~~. RES must institute and maintain a comprehensive and effective communications program to make available, agency-wide, their plans and activities in real time, and to make this information available to a broader range of stakeholders. Implementation recommendations in support of Statement 2:

   a. The Commission should require a formal "review and advise" role for NRR and NMSS for the selection, scope, and deliverables of RES anticipatory research. This role has the purpose of focusing needs, enhancing productivity, and challenging both RES and the regulatory offices to optimize their resources.

   b. The Commission should require RES to establish an effective process for employing risk-informed and performance-based approaches throughout its program and project management processes. The process must address selection of anticipatory projects, prioritization given scarce resources, defining clear objectives, and knowing when to stop. RES must also provide technical leadership in risk-informed decision making throughout NRC

   c. The Commission should sponsor an initiative to improve communications of RES activities to stakeholders outside NRC. Effective two-way communications will enhance RES productivity and the quality of their work. It will also improve industry responsiveness to NRC in both generic and plant-specific regulatory issues.

3. RES must increase its cooperative efforts with other organizations including but not necessarily limited to EPRI, DOE, Industry, Academia, and international organizations. RES must seek out, and wherever possible, *[add comma]* utilize facilities, equipment and resources available from these entities and maximize the use of technical data and results already developed. RES should subject its research to a wider audience of peer reviewers; and NRC should clearly communicate research results, its potential implications and its known limitations to affected licensees and other stakeholders. RES should reevaluate its policies with regard to contractor selection and independent advisory oversight, in order to obtain the best qualified, most objective, and most effective talent possible. RES in cooperation with and supported by the Commission, must establish procedures to accomplish this while fully retaining the decision making

independence of RES. Implementation recommendations in support of Statement 3:

a. The Commission should encourage RES to implement and employ agreements for cooperative research such as the MOU between RES and EPRI. Limitations imposed by requirements for "independence" should be critically reviewed and challenged to achieve the maximum level of beneficial collaboration.

b. The Commission should require that RES retain the best-available contractors. This effort will require clarification of "independence" and "conflict-of-interest" rules, streamlining of contracting procedures, and critical review of the capabilities and experience of current and potential contractors.

4. A clear and understandable definition of what research includes and does not include at the NRC and its value to the safety of the nation's nuclear program must be established by the Commission and accepted internally by the program offices and staff personnel and effectively conveyed to all the stakeholders. Continuing efforts must be made to eliminate unnecessary regulatory burdens on (sponsoring) stakeholders (industry) while at the same time focusing on areas that will benefit them through safer and more efficient operations. Charges to licensees for research costs should be on the basis of identifiable benefits to them. Implementation recommendations in support of Statement 4:

a. The Commission should initiate a dialogue with industry to specifically prioritize research opportunities at RES that would lead to the elimination of unnecessary regulatory burden consistent with the drive for maintenance of safety, increased effectiveness and efficiency of regulation, and improved realism.

b. The Commission should consider jointly advocating with industry a concept of "balanced resources" for RES programs, such that specific licensees, the aggregate of licensees, and taxpayers share the resource burden equitably.

THEODORE U. MARSTON

Dr. Marston is Chief Nuclear Officer and Vice President of EPRI. Previously, he was a Senior Vice President of EQE International, Inc. and the President and CEO of PLG, Inc., a wholly owned subsidiary of EQE until January 2000. EQE International, Inc. acquired PLG, Inc. in September of 1997. Dr. Marston has more than 25 years of international experience in the assessment and management of risk for industrial facilities. Specific industrial experience includes major incident investigation, independent power plant development, railroad risk, design, manufacturing, maintenance and operation of commercial nuclear and conventional power plants, design and licensing of advanced reactors, component and system reliability, failure analysis and margin assessment, life cycle management, fatigue and fracture of metallic and polymeric components.

Dominic J. Monetta
Phase 1 Comments

NRC Chairman Richard Meserve told your panel that the Commission was seeking input on its research program. As a precursor to responding to his challenge, a set of fundamental questions seems to be: What is the burden to be assumed by NRC? Is it only to establish that licensees are technically competent, or is it to achieve some level of independent verification of plant safety, and ongoing confirmation of safety performance? When the NRC licenses a plant, how well is the NRC supposed to understand its design? When the NRC oversees performance, what level of accountability is NRC supposed to accept? The ACRS has asked: When will the NRC conduct independent assessment rather than license submittal review?

Historically, the NRC conducted more technical analysis of safety issues than is expected today. Risk-informing and performance-basing should permit the agency's mission to be carried out more effectively, however, this must not compromise safety assurance, yet some industry proposals would appear to have that effect. Plants ought to put reviewed, accepted, in-depth safety cases on the record, and live by them under oversight that is performance-based insofar as this can be achieved consistent with regulatory assurance of safe operation.

A lot of time has been spent analyzing acceptable risk associated with a given approach to regulatory oversight, that is, how does risk actually depend on performance, and does a given regulatory protocol detect risk-significant performance changes? Certain issues need to be addressed to set the stage for more focused comments that will provide real added value. These are:

1. Nuclear power is of strategic importance to the national economic and environmental well-being.

2. Independent confirmatory safety research is crucial to nuclear power. The history of nuclear research attests to this.

3. The congressional mandate for the NRC to conduct independent safety research is being challenged because of funding cuts over the past decade.

4. Independence is threatened as a result of these cuts.

5. The nuclear industry is not at steady state.

6. Major changes to 10 CFR 50 are underway and these changes are predicated on the essential validity of PRA, but PRA is still in transition from a tool to identify vulnerabilities to a tool to develop comprehensive, detailed safety cases. The agency is still developing its own plant models, and even these are based largely on the IPEs that were aimed at identification of vulnerabilities. In order to support

risk-informed regulation, PRA mission success criteria need to be valid. Serious questions have been raised about them at various plants, and programmatic evolutions have not led to resolution of those questions. PRA matters less in licensing than accident analysis.

7. An integrated, full-scope PRA model has not been produced. Various on-line "Safety Monitor" models come closest, but even "Safety Monitors" do not capture transition risk. PRAs are long-term averages of plant risk, and implicitly argue that crosscutting licensee performance issues do not affect redundant defense-in-depth barriers.

8. NRC may lack the ability to independently verify vendor information on the effects of higher burnup fuel and cladding.

9. Up to 80 units are being considered for license renewal with all the safety issues that arise from life extension -- aging being the primary one.

10. Software-based digital control systems have not kept pace with the safety implications of major improvements to existing analog systems.

11. An upcoming new plant design certification is anticipated.

Over the last 25 years the NRC has labored over the balance between applied research and technical support? With billet caps and salary freezes, the NRC will become less capable of maintaining a technically qualified staff unless it develops a small team of internationally recognized experts in various core competencies the Commission calls upon during licensing decisions. A research budget must be deliberately focused on keeping those experts world class. How to do this is challenging. Many research facilities are aging; consequently their M&O costs are exponentially rising. National Labs are in a transition. Person year costs are heavily burdened with overhead. National Labs operate unique internationally recognized one-of-a-kind research facilities; this is what they do best. CERN and the CRF are examples of unique world-class open user research facilities. Universities need boutique, highly focused new test facilities. Contractors currently offer a cost-effective solution if properly selected and managed.

In summary, a NRC research effort, funded by the Congress from the general fund for the common good, is definitely in order. Rules of thumb are hard to come by and ultimately justify, however, 8 to 12% of the total operating budget is usual.

Dominic J. Monetta
Phase 2 Comments

It appears the key issue is there is not enough federal basic and applied research funding available. However, there is never enough money to do it all. Where it resides

and consequently managed in NE/RES/NMSS/YM is secondary. The general fund, not the fee base, is certainly the source of the future R&D funding.

1. A critical issue for NRC is to focus on maintaining a federal civil service capability of nationally recognized experts doing important, relevant R&D. Relevant can be determined by an independent, nationally-recognized panel that looks at the totality of the federal nuclear R&D activities. Once this is done, organizational location and individual leadership is very pertinent. Currently, the federal programs are located in certain organizations and with particular individuals because Congress specifically wants it this way to maximize results. There is a definite need to have exploratory discussions with the NRC Commissioners to broach the establishment of a NRC Office of Chief Technology that will integrate all R&D Agency efforts.

2. Dr. Thadoni definitely needs to document RES cooperation with all other nuclear R&D organizations throughout the world. He is not receiving the appropriate recognition for his exceptional coordinating work and there is incomplete managerial understanding of the RES network.

3. End item oriented DOE construction projects must fund the NRC to prepare for licensing. This is not a new idea, however, it is not currently a consistent DOE/NRC policy. The NRC should not be expected to fund the confirmatory R&D alone.

4. The NRC must continue to drive the RES project appraisal methodology using PRA and risk based assessment in selecting candidate projects. Reactor reinvestment must focus on safety risk. This could then minimize unnecessary procedural regulation.

5. RES should strive to narrow the scope of competing PRA models and increase emphasis on the surviving options. At minimum, there needs to be better intermodel calibration.

6. Most current RES projects are chronically under-funded. Specifically, I would suggest greater emphasis on spent fuel management, advanced sensors, and digital instrumentation and controls. They appear to have the greatest return for industry.

7. Research and regulation must go hand-in-hand. It is one coin with two sides. Changing regulatory behavior is essential for the new emerging national nuclear utilities and without confirmatory research, there will not be an acceptable comfort level in the minds of NRC Commissioners and other oversight organizations, including ultimately the public.

8. RES needs to be aware of keeping facilities warm. It is a trap that will drain the nuclear R&D budgets without the promised advantages.

9. A study needs to be commissioned to consolidate the nuclear engineering education program at the three strongest universities with significant reinvestment in these facilities. The selected institutions need to focus these educational efforts around a solid core based on a reactor physics syllabus.

DOMINIC J. MONETTA

Dominic J. Monetta, during his 37 year career, has held senior executive line positions in the Departments of the Navy , Energy and Defense. He has extensive project management and acquisition experience as well as the operations of large RDT&E laboratories and manufacturing facilities. Currently, Dr. Monetta, President of Resource Alternatives, Inc. consults for CEOs on their critical managerial and technological issues impacting profitability.

Kenneth L. Mossman
Phase 1 Comments

INTRODUCTION

The U.S. Nuclear Regulatory Commission (USNRC) conducts a broad research program in support of its licensing and regulatory activities. In 1974, Congress mandated the formation of the Office of Nuclear Regulatory Research (RES) to ensure independent capability for developing and analyzing technical information related to reactor safety, safeguards, and radiation protection.

The declining RES budget during the 1990s ($100M in 1993 to about $42M in 2000) is alarming and should be viewed with serious concern. Has RES funding now dropped below the threshold to carry out its research mission? Are personnel resources adequate? The importance of an appropriately funded and staffed research program cannot be over-emphasized. The Agency must have sufficient resources to support research programs unique to agency needs and to monitor, analyze and incorporate research findings derived from programs funded outside the Agency that are relevant to USNRC licensing and regulatory activities.

A Panel of Experts, representing a variety of interested and/or affected constituencies, was assembled by the USNRC to assess the role and direction of regulatory research in light of a declining funding environment. In introductory remarks, USNRC Chairman Richard Meserve discussed three broad questions for the Panel's consideration: (1) Is research funding at the right level? (2) Are the right research questions being asked? (3) Are the right performers being used?

Detailed presentations of research programs were presented by RES staff. Presentations focused on various aspects of reactor operations and reactor safety. However, some programs under RES were not covered. For instance, there was little discussion of research activities pertaining to radiation protection (part of the Radiation Protection, Environmental Risk, and Waste Management Branch under the Division of Risk Analysis and Applications). It is unclear whether program omissions were necessitated by time constraints, or reflected low priority of the program within RES.

PHILOSOPHICAL OVERVIEW

I have taken the view that it is not possible for Panel members to provide specific answers to the questions offered by Chairman Meserve. RES and other USNRC offices are better equipped to do that. However, the Panel can provide guidance to the Agency regarding factors that should be considered in responding to the questions and determining the future course of research within the Agency. In this regard I offer a set of overarching principles that should be considered in planning and evaluating future

research. I also provide similar thoughts for consideration in addressing the three questions offered by Chairman Meserve.

OVERARCHING PRINCIPLES

The following general principles should be given consideration in addressing future research needs of the Agency:

1. *Support for research in a declining budget environment.* Strategies should be developed to maximize extramural collaborations. Support for research may be leveraged by coordinating research activities among agencies with common interests. Although RES deals with research problems unique to USNRC (e.g., reactor safety) there are many other regulatory research problems (e.g., worker health and safety) that cross agency boundaries for which a coordinated research effort may be useful.

2. *Consider all research programs.* Any review of USNRC research should include all research programs. The panel was provided a detailed review of programs in RES (particularly reactor safety) but research activities in the Office of Nuclear Material Safety and Safeguards (NMSS) were not discussed or considered.

3. *Maintain public confidence in Agency activities.* Research initiatives should be subject to stakeholder input. The planning of research programs and the implementation of research findings in licensing/regulatory activities should include affected/interested stakeholders. To enhance quality, research findings should be subject to peer review. Support of independent research enhances public confidence in regulatory decision-making by minimizing perceived or real conflict of interest.

4. *Coordination of regulatory programs.* Over a dozen federal agencies have regulatory responsibility for radiological health and safety. Because of differences in philosophical approaches to standards setting and statutory authorities, some regulations among various federal agencies are conflicting or overlapping. Federal agencies should work closely together to minimize regulatory conflicts. For instance, EPA and USNRC have sometimes differed over how restrictive U.S. protection standards should be.[8] [9]

5. *Research staff expertise.* A review of the RES organizational chart indicates a very broad range of research responsibilities in the areas of reactor engineering, risk analysis, radiation protection, etc. Research leadership within the Agency should have broad experience and have a strong background in all technical

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[8] *Nuclear Health and Safety: Consensus on Acceptable Radiation Risk to the Public Is Lacking* (GAO/RCED-94-190, September 19, 1994).

[9] *Radiation Standards: Scientific Basis Inconclusive, and EPA and NRC Disagreement Continues* (GAO/RCED-00-152, June 30, 2000).

areas. In addition, the directors need to be well-networked with the international engineering and scientific community in order to remain current in advances in reactor technology and other related engineering and scientific disciplines.

IS RESEARCH BEING FUNDED AT THE RIGHT LEVEL?

1. *Right level of funding?* Determining whether the Agency is conducting research at the right level is difficult and necessitates a thorough understanding of short-term and long-term research problems. The Agency must be able to critically evaluate what it can and cannot do. The Agency should also carefully look at opportunities for collaboration with other Federal agencies and with industry where joint efforts may be considered mutually beneficial. As discussed by other panelists, research budgets for some industries have been estimated to be about 10% of the total budget. Using this as a guideline, the USNRC research budget should be about $50 million for FY 2001 based on an USNRC budget of $488 million for FY 2001.[10]

2. *Congressional support.* Research should be funded by Congressional appropriations rather than from licensing fees. Placing the burden for research on licensees is inappropriate since they are but one of the constituencies that benefit from the research.

3. *How is research defined by USNRC?* How is research conducted by the Agency different from research commonly understood by the public (including Congress)? Anticipatory and confirmatory research needs to be clearly distinguished.

4. *How should research be prioritized?* Appropriateness of funding should be based on a rational system of prioritization of research projects. In a climate of declining research support, not every project can be funded at the desired level, and unfortunately many excellent research projects go unfunded. The Agency currently uses a prioritization system that emphasizes safety significance, scope of licensees impacted, realistic decision making, industrial participation/leverage, and economic impacts. Are these appropriate priority determinants?

ARE THE RIGHT QUESTIONS BEING ASKED?

1. *Agency commitment.* The importance of research in support of regulatory and licensing activities carried by the Agency must come from the top. The Commissioners must clearly articulate research goals of the Agency and the significance of research as part of the Agency's mandate. The goals however should be broad enough so as not to constrain needed flexibility within research programs. Anticipatory research requires flexibility.

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[10] U.S. Nuclear Regulatory Commission, *Budget Estimates and Performance Plan Fiscal Year 2001*, NUREG-1100, Volume-16, Washington, DC: U.S. Nuclear Regulatory Commission, February 2000.

2. *Anticipatory research.* Asking the right scientific questions is a characteristic of quality research. For confirmatory research, problems are likely to be self evident and it is clear what direction the research should take. In the case of anticipatory research, the investigative direction may not be clear.

3. *Interagency Collaborations.* An USNRC Office of Interagency Research should be established to deal with broad research questions of health and safety and co-ordinate research programs with other federal agencies with radiological health and safety mandates.

4. *Policy/science research.* The Agency should consider broadening its research scope to include research in the communication sciences, statistical modeling, and issues pertaining to bridging policy and science. Examples of research questions in the science-policy arena include: what is safe? Can and should the agency attempt to target a particular dose level (e.g., 1 mSv/y) as safe? What are the advantages and disadvantages of returning to a dose based system of radiation protection? Is the linear no-threshold theory (LNT) an appropriate basis for setting radiation standards? What is the cost of retaining LNT as the basis for standard setting?

ARE THE RIGHT PERFORMERS BEING USED?

1. *Quality of research.* The Agency should review its practices in selecting and monitoring research done by contractor organizations. The Agency may wish to use a two-pronged review process -- internal and external. External review would be most effective by establishing advisory committees made up of nationally recognized scientific and engineering experts (discussed below). A key litmus test for any research supported by the Agency is: Are the research findings technically defensible?

2. *Collaborations.* The Agency should be encouraged to maintain collaborations with universities. The reasons for this are twofold: (1) Unique research facilities (e.g., research reactors) are located at universities. Without these facilities important confirmatory and anticipatory research programs of interest to the Agency cannot be conducted. Without funding from USNRC, it is likely that universities would have to shut down these facilities. (2) Support of university-based research is important in education and training of future nuclear engineers and scientists.

3. *Establish Advisory Committees.* The USNRC should establish science/engineering advisory committees to advise the Agency on matters of research. Each advisory committee would deal with a single, broad issue such as reactor safety or nuclear waste. Members (nationally recognized experts from universities, other government agencies, and industry) would be appointed by the Commissioners (with input from appropriate USNRC offices). The committee

would have two major functions: (1) to provide independent advice to the Commission on research matters (including ongoing evaluation of extramural research), and (2) to coordinate peer review of USNRC-funded research proposals. Based on independent, peer review the advisory committee would recommend proposals for funding to the Agency.

Kenneth L. Mossman
Phase 2 Comments

RES research activities should be supported by congressional appropriations.

Comment. Currently RES research activities are supported through licensing fees. Requiring licensees to support broad research programs is inappropriate particularly when the research may provide no direct benefit to the licensees. The Agency funds research in support of its licensing and regulatory activities that protect the public health. Congress should support research that protects public health.

Reorganize all research into a single office in the Agency

Comment. Currently research activities are in 2 offices (RES and NMSS). RES accounts for about 80% of the total research effort. Centralizing research into a single office facilitates coordination of research programs within the Agency, and interagency programs. RES activities are supported by licensing fees. Research in NMSS (nuclear waste research conducted at the Southwest Research Institute) is supported through congressional appropriation. The different funding streams may present difficulties in combining all activities into a single research office.

The Commission should publicly support research

Comment. Research is essential if the Agency is to respond effectively to changes in technology, engineering, and scientific advances that have implications for licensing and regulatory activities. The Agency's commitment to research should come from the top. The Commissioners should have the responsibility for articulating the vision and mission of the Agency and for advocating research in support of the vision and mission. It is particularly important the Commission be able to explain clearly how research outcomes advance the mission of the Agency. The above recommendations are based on consideration of the following four issues that formed the basis of Panel II deliberations.

Issue 1: The NRC must maintain an organizational unit devoted to nuclear regulatory research.

1. Research programs are supported by several offices within the Agency (e.g., NMSS and RES). Is this the most effective organizational structure? The research vision of the Agency should be reflected in its organizational structure.

Would the Agency be better served by centralizing all research into a single office?

2. The Phase I Panel addressed the question of research staff expertise as an important requirement of Agency research. Is the current RES organization appropriate? To reflect the importance of research, the director of research should report directly to the Chairman. What characteristics should the agency look for in its research leaders (given there is little or no bench research being conducted within the Agency itself as far as I know)?

3. Congressional funding for all of RES research programs should be vigorously pursued. Eliminating licensing fees as a source of RES funding will enhance independence of RES research programs.

4. Is the research infrastructure adequate to carry out confirmatory and anticipatory research? Are current research facilities (including space and equipment) at universities and other collaborating institutions adequate or is substantial upgrading required? What additional research facilities are needed? Are personnel resources adequate? Are we training adequate numbers of nuclear engineers and scientists? What needs to be done to support training so that the pipeline remains full. Does budget planning adequately consider current and future facilities and personnel costs?

Issue 2: The research unit must support activities in other program offices

1. The Agency has a well thought out prioritization plan to evaluate research programs for funding. Are the right factors being considered in prioritizing research? Should other factors be considered?

2. Since research activities are informed to a certain extent by programmatic activities, research planning and evaluation should be closely integrated with relevant licensing and regulatory programs.

Issue 3: Cooperative efforts with extramural organizations must increase.

1. The Agency should support coordination of research with other federal agencies. Although the Agency has a number of unique research needs, there are also a large number of research problems (e.g., nuclear regulatory standards) that cross agency boundaries. How can research problems of common interest to several federal agencies be coordinated? Is ISCORS an effective forum for interagency exchange?

2. Communication with stakeholders and the general public must be enhanced. What information regarding Agency activities should/should not be disseminated? How should proprietary information be handled?

Issue 4: A clear vision of research must be articulated by the Commission

1. The Agency research goal statement should clearly articulate the mechanism(s) by which RES supports the Agency's front-line regulatory activities.

2. There should also be a clear statement how RES informs the Agency strategic plan and responds to changes in the strategic plan. Any research response to changes in the strategic plan must consider infrastructure impacts. Objective measures of performance need to be clearly articulated for research programs.

3. Public confidence is a key RES performance goal. How is public confidence measured? Is the annual Water Reactor Safety meeting an effective way to inform the public about Agency activities?

4. Agency research support almost exclusively addresses science/engineering problems. Should the Agency broaden its research scope to include specific non-science/engineering research in support of its licensing and regulatory activities? For instance, is there value in supporting social science research to address risk communications problems?

5. In the international radiation protection community there is an ongoing debate about the appropriateness of the linear no-threshold theory (LNT) as a basis for regulatory decision-making. The USNRC supports LNT in its decision making. Should the Agency consider modifying its philosophical approach? If so, on what bases should it do so?

6. Although rulemaking requires public comment (public comment period), is input from the public used effectively in decision-making? When during the decision-making process should various stakeholder and general public input be considered?

7. The Commission should publicly support research making it clear why research is important and how funds will be used. Protect public health, environment, and security.

KENNETH L. MOSSMAN

Dr. Kenneth L.. Mossman is Professor of Health Physics and Director, Office of Radiation Safety at Arizona State University in Tempe, Arizona. From 1990-1992, he served as Assistant Vice President for Research at Arizona State. During the period 1973-1990, Dr. Mossman was on the faculty at Georgetown University in Washington, DC and was Professor and founding Chairman of the Department of Radiation Science in Georgetown's Graduate School from 1985-1990. Dr. Mossman's research interests include the biological effects of low level radiation, radiation exposure in pregnancy, health effects of environmental radon, and radiation protection and public policy. Dr. Mossman has over 125 publications in the open literature including six books and proceedings related to radiation health issues. He has presented testimony before the U.S. House of Representatives and the U.S. Senate. Dr. Mossman has taken a prominent role in the international debate on the appropriateness of the linear no-threshold theory in public policy and regulatory decision-making. He was an organizer of the 1997 Wingspread Conference "Creating a Strategy for Science-Based National Policy: Addressing Conflicting Views on the Health Risks of Low-Level Ionizing Radiation," and the 1999 international Airlie Center Conference "Bridging Radiation Policy and Science." In 1984, Dr. Mossman was awarded the prestigious Elda Anderson Award from the Health Physics Society and in 1994 was elected a Fellow of the Society in recognition of outstanding contributions to the field of Health Physics. In 1995, he received the Marie Curie Gold Medal. From 1996-1998, Dr. Mossman served as a Sigma XI Distinguished Lecturer. Dr. Mossman served as president of the Health Physics Society from 1993-1994.

Thomas E. Murley
Phase 1 Comments

1. It is important for NRC to have an effective research program and a competent research staff to manage the program. NRC is a technical regulatory agency. The staff must routinely make safety judgments on highly complex issues and often on issues that involve phenomena beyond normal engineering experience, such as severe accidents and long-term nuclear waste behavior. The staff making these judgments has to know what they are talking about, and a robust regulatory research program is an essential part of that knowledge base.

2. The research program must be stabilized at its current funding level, or it will be in danger of collapsing to a subcritical state, in my judgment. Just as serious would be the attendant demoralization of the research staff and the effective loss of a major technical asset of the agency.

3. The material presented to the group shows that the individual research tasks support NRC's regulatory mission. In particular, the PRA research is vital to NRC's new directions in risk-informed regulation. In this regard, it seems to me that NRC should emphasize more the benefits of risk-informed regulation in improving operational safety, and not merely reducing unnecessary regulatory burdens.

4. The research staff should have some flexibility to conduct exploratory safety research on matters that are not necessarily current regulatory issues. Who in NRC is looking 5-10 years ahead, if not RES? It has been reported that DOE and US industry are supporting plans for a fourth generation reactor design. What is NRC's knowledge of the physics, heat transfer, fuel, containment and severe accident behavior of such plants? Must NRC wait until it has an actual application before it begins to investigate these questions?

5. It will take leadership by the Commissioners themselves to make the case in the Administration, the Congress and with industry that NRC must have an effective research program that is adequately funded. I believe Chairman Meserve had it exactly right when he said, "I do not believe that the NRC would have either the reputation that it enjoys as a world leader in nuclear regulation, or the credibility and technical wherewithal to proceed with the implementation of a risk-informed regulatory structure, were it not for the contributions of the Office of Research."

As long as the funding for NRC's research program must be paid by fees on licensees, the program will be under relentless challenge by the industry. In the new competitive electricity environment, where these fees cannot be passed through to ratepayers, a nuclear generator cannot justify the diffuse benefits of regulatory research to their

shareholders. The only logical endpoint of such a situation over time, it seems to me, is a shrinking research budget and a research program that is dismantled and absorbed into the regulatory offices.

The Commission will have to expend some political capital with the Administration and Congress to have some portion of NRC's budget covered by general revenues in place of license fees.

CHAIRMAN MERSERVE QUESTIONS

1. Is the research funding level right? I did not attempt a detailed analysis of the right funding level, but it seems clear to me that there is no fat in the research budget, and any reductions would result in the loss of important programs. I believe an increase in funding level could be justified for more exploratory research.

2. Does the research program have the right balance? Based on a review of the research topics, it seems to me that RES is looking at the right things. We should acknowledge that the experts of the ACRS conduct periodic reviews of the research program in addition to the internal NRC staff reviews. In this regard, the analysis and guidance provided in DSI 22 seems to me to be sound.

3. Does RES have the right mix of contractors doing the research? There is no correct answer for this question, but the current mix of universities, government labs and private industrial research organizations appears about right.

The NRC staff should have access to nuclear industry research, which in my experience was of excellent quality, in order to independently analyze the results. But it is also important that NRC have access to its own research information and expertise in order to be seen as credible technical regulators. Otherwise, as was noted in our meetings, the NRC staff will become merely brokers of outside opinions on highly complex safety issues.

Thomas Murley
Phase 2 Comments

The Expert Panel meetings on January 24-25 and February 21, especially the presentations by the Directors of RES, NRR and NMSS, have been critically important in clarifying earlier questions of the Panel.

It now seems clear to me there are no fundamental problems in the way research is conceived, planned, authorized, carried out and used in NRC. Both licensing office directors told the Panel that RES is meeting their regulatory needs. Of course, there are many improvements that can and should be made, but the major issues facing

Research are policy matters for the Commission. Thus, it is most useful if the Panel's comments are aimed at the Commissioners because it is they who must provide direction in research policy.

Recommendations and Comments

1. The Commission should reinforce its support for a strong research program in NRC and a capable research staff to manage the program. This would give the research staff clear support for their mission and, further, it would give guidance to the rest of the staff on the need to support research within NRC. The Commissioners command great deference and respect when they speak forcefully and with a single voice on a matter of nuclear safety, which I believe includes the role of regulatory research in NRC.

2. The Panel was reminded that RES is not the only organization in NRC that has been subjected to staff reductions and program cuts in recent years. Several NRC members, as well as Panel members, commented on the need for NRC to maintain core competencies within the staff. With a large portion of the staff at or nearing retirement age, this issue could become serious in a short period of time. After a thorough review of future critical skill needs throughout the agency, the Commission should forcefully press the case with OPM, OMB, and Congress for the authority to begin recruiting critical skills now.

3. The Energy Reorganization Act of 1974 contemplated that DOE (then ERDA) would maintain safety research facilities and staff at the national laboratories that NRC could call upon for regulatory research. Over the years, DOE support for reactor safety research has virtually disappeared. In light of DOE's support for the development of Generation IV reactor concepts, the Commission should consider writing a letter to the Secretary of Energy making it clear that safety research facilities will be needed to support NRC's confirmatory research needs as part of its certification review.

4. As long as the funding for NRC's research program must come from fees paid by licensees, the program will be under relentless challenge by the industry. The Panel was told that Congress has agreed that a small portion of NRC's budget (rising to 10 percent) can come from general revenues in place of license fees. Chairman Meserve and the Commissioners deserve high credit for winning this important change, and they should continue to seek authority to have the entire research budget paid from general revenues.

5. With regard to high level waste research, the office of NMSS focuses its program on the relatively short-term goal of analyzing what DOE is doing at Yucca Mountain. While this work has many of the apparent characteristics of research, it is in fact programmatically technical assistance to the licensing staff. The Center for Nuclear Waste Regulatory Analyses (CNWRA) program was placed under NMSS years ago, and the Advisory Committee on Nuclear Waste (ACNW)

judges the CNWRA work to be of very high quality. Since the office of RES does not have the staff to manage the CNRWA program, it would simply be too disruptive to move the program to RES. For these reasons, it would not, in my judgment, be productive to revisit the past policy decisions on placement of CNWRA research in NMSS. I do, however, support the ACNW recommendation for more coordination between RES and NMSS on their respective programs.

Is Research Doing the Right Things?

I agree with Ken Rogers that the research NRC is doing is well chosen and competently performed. To support this view, I would like to comment that I have recently reviewed an extensive set of NRC documents relating to revision of the Pressurized Thermal Shock rule, 10CFR50.61. This work is regulatory research of the highest order. It is comprehensive, innovative, and directly relevant to a fundamental safety responsibility of NRC – assuring the integrity of reactor pressure vessels. This is, in my judgment, a premier example of the kind of research that has earned NRC its high technical respect throughout the world and which must be preserved in the Office of Research.

Is Research Being Funded at the Right Level?

First, it is clear to me the research budget is not over-funded, and any reductions would result in the loss of important programs. The Directors of NRR and MNSS told the Panel the research program is meeting their needs, implying they have no unfunded research requests. The Director of RES presented a list of unfunded research needs. About $4M/yr appears to me to be high priority needs, dealing largely with advanced cladding performance, new reactor design issues, and digital I&C issues. If DOE and the industry are truly serious about proposing new reactor designs for NRC certification, the research needs could easily rise by another $5M/yr. On balance, I conclude that research is under-funded by about $4M/yr.

Are the Right Performers Being Used?

The current mix of universities, government labs and private industrial research organizations appears about right. If applications for new reactor design certification are contemplated, then safety research in support of the applications must be paid for by some combination of the applicant, EPRI and DOE. The NRC staff should have access to this industry research data in order to independently analyze the results. But it is also important the NRC have access to its own research information and expertise, and this might require NRC to sponsor research at the same facilities the applicant uses.

THOMAS E. MURLEY

Dr. Thomas E. Murley was Director of the Office of Nuclear Reactor Regulation of the U.S. Nuclear Regulatory Commission from April 1987 until his retirement in February 1994. In that position he was responsible for licensing and inspection activities associated with the construction and operation of all nuclear power plants in the United States. Previously he was Administrator of the Region I Office King Prussia, Pennsylvania, a position in which he was responsible for inspection and oversight of 31 nuclear power plants in the northeastern United States. Currently Dr. Murley is a consultant on nuclear safety and management matters. His clients have included the U.S. Department of Energy, USNRC, foreign safety organizations, nuclear utilities, fuel cycle companies, an OECD Nuclear Energy Agency. He is on the Board of Directors of a U.S. nuclear utility.

Harold B. Ray
Phase 1 Comments

The expert panel is very well balanced, representing the diverse viewpoints relevant to the question of the future role and direction of NRC regulatory research. Accordingly, I believe it is appropriate for me to limit my input to the perspective of a power reactor licensee in a restructuring electric industry. This is not the perspective of the traditional, cost-of-service, utility member of a so-called "nuclear industry" which existed from the beginning of commercial nuclear reactor development until recently. Rather, it is the perspective of a producer of a commercial commodity which must rely on market-based revenue to recover all costs and to justify its continued existence. My comments are as follows:

1. Regulated licensees should not be able to limit the availability of resources needed by regulatory agencies to perform functions important to their mission. However, to the extent that research is funded by user fees paid by the licensees, the regulatory agency has a responsibility to justify the resources used, in terms of necessity and benefit to the regulation of the licensees. It is thus clear, where regulatory agencies need to engage in research which is not necessary or of benefit to the regulation of the current population of licensees, that sources of funding should be provided other than the user fees imposed on these licensees. They are not responsible for, and cannot justify, costs not directly related to their ongoing business and which may ultimately be for the benefit of others, including their competitors. I believe it is the case that the significant decline in NRC research funding which was described to the panel is a direct consequence of reliance on user fees imposed on current licensees. This decline is likely to continue unless research is either made more directly relevant to these licensees or an alternative source of funding is provided.

2. Much has been accomplished to improve the efficiency and effectiveness of power reactor regulation recently by the acceptance of the principle that regulatory requirements should be informed by risk significance. However, much more remains to be done in this regard, especially since it is impossible to base decisions concerning high consequence, low probability events on subjective experience. Too often extended, unproductive debates lead to frustration and ineffective resolution of regulatory uncertainty in areas where research could provide quantification of risk significance. The list of examples where this is the case is too long to cite here, but I believe the research budget should be increased further in areas related to quantification of risk significance. I also believe this would be in the interest of power reactor licensees who would bear the cost in their user fees but who would ultimately benefit from more rational regulatory requirements. However, reduction of so-called "regulatory burden" should not be the exclusive goal or justification for this research.

3. An example of research work that is urgently needed to address risk significance

is that associated with the prospective material clearance rulemaking. Especially as this relates to the cost of decommissioning, the importance of resolution of the present regulatory uncertainty in this area exceeds any three other areas combined. And, the work would be directly related to the current population of power reactor licensees. Although some may argue that this is a political issue which is unlikely to benefit from research, I believe the scope of regulatory research should include issues which go beyond the narrow bounds of traditional, hard science, nuclear research and should include social-political issues related to nuclear regulation.

4. Radical changes in the electric utility industry, and in the supplier industries and associations which depended upon that industry as it existed formerly, make it impractical to refer to a "nuclear industry" today, even if it was appropriate at one time. The result should be that the NRC research mission increases in importance in order to anticipate and address issues which arise due to these radical changes, and to ensure that technical competence is maintained in areas no longer supported by the separate, competitive elements of a changed industry. However, the contrary appears to have occurred, as though the only mission for research is related to the development of advanced technologies. This is not the case, and there are important areas for research related to the life cycle needs of existing technologies. This research is not the same as it was 10 to 20 years ago, and new skills may therefore be required.

5. Research is needed to address the role of uncertainty in evaluating risk significance in most areas. It is likely that this would allow reduction in deterministic margins for uncertainty in some areas and increase them in others. There is no fundamental difference between deviations which violate assumptions in deterministic regulation and deviations which violate assumptions in risk-informed regulation. But, the quantification of uncertainty is essential to use of risk significance to inform the regulatory process. (This includes uncertainty associated with human performance.)

Regulatory research is essential to anticipating future needs in an era of change. Exclusive reliance on experience as a basis for deterministic regulation when significant, synergistic change is occurring means that unexpected events will continue to occur which undermine the credibility and effectiveness of the regulatory process. Even if events cannot always be prevented, they can be anticipated and placed into a context based on research that allows for stability in the process, as contrasted with the instability that often follows from an unexpected event. I appreciate the opportunity to contribute to the important work of the expert panel, and I commend the respective inputs of the panel members to consideration by the Commission and staff. I also look forward to the opportunity to make any further contribution desired in this respect.

Harold B. Ray
Phase 2 Comments

My comments are provided in two separate but related areas: (1) questions addressed to the panel by Chairman Meserve, and (2) a set of five "requirements" that you synthesized from the prior discussions among members of the panel which, if satisfied, could be key to RES realizing its full potential as a highly valued member of NRC's decision making team." (You also refer to the latter as "recommendations.")

Is the NRC Doing the Right Research?

The research being done is not wrong - although the purpose of some of the work should be further clarified - but there appears to be some important areas of under emphasis, or possible omission. The separation of "technical assistance," which is obtained independently by program offices, and "research" which is performed by RES, is inevitably somewhat arbitrary. The Expert Panel looked only at the RES program and, therefore, it may be that work which this panel member would consider "research" is actually being done elsewhere by the NRC under the guise of "technical assistance" to program offices.

With this caveat, and giving consideration to the RES list of "potential research initiatives for operating plants currently unfunded," it appears to me there is insufficient attention given to the synergistic effect on regulatory objectives of multiple factors, many of which are subject to independent change. To cite just one example, changes in both the Maintenance Rule and in the NRC's oversight program have greatly increased the widespread use of probabilistic assessment tools. This promises to be a profound change that will significantly increase the effectiveness of the regulatory process, while providing safer, more reliable and more efficient plant performance. However, there is insufficient fact-based information to guide the determination of "how much is enough" when it comes to both the precision and the accuracy required in the tools used, or what is the proper balance between risk analysis and deterministic methods. The NRC is participating in both ASME and ANS efforts to develop standards in this area, but the RES FY 2001 program does not appear to include support for this work. At the same time that this change is occurring, the resource base, ownership and source of revenue to the power industry are all changing.

As a second example, the FY 2001 RES program omits an item from the FY 2000 program entitled, *Systematic Assessment of Future Changes In Regulatory Environment*. Without commenting on the prior value of this item as research, it does reflect an apparent effort to examine issues broader than the specific technical questions identified by other program offices. Based on the panel's review, it seems essential that RES maintain a reasonable agenda for inquiry on its own initiative.

Finally, the separation of research related to waste management from the RES program seems arbitrary, potentially inefficient, and of uncertain statutory foundation. During panel deliberations it was stated that this separation resulted from a policy decision based on practical considerations. The reasons for this remain unclear. The panel received input from an NRC employee in NMSS who suggests it maintains substantially more in-house expertise in at least one core competency than does RES. The reasons for this separate, and potentially redundant, capability should be validated by the Commission.

Is the NRC Using the Right People and Facilities?

The work being done is performed by competent people and qualified facilities. In this sense, the NRC is using the right people and facilities. However, it is inevitable that the pressure to use and maintain what are viewed as core competencies will influence the selection of work to be performed. Important questions, which lack availability of the right people and facilities to provide answers, will tend to not be performed, since to do otherwise would further reduce the funds available to maintain core competencies and continue existing programs. The question is not whether these core competencies should be retained (some should), but whether those which exist presently are the most efficient and effective resources to support regulatory decision-making related to current licensees and regulatory needs.

The panel received considerable input suggesting that in-house RES resources can become insular and too isolated from the current regulatory needs and experiences, suggesting possible benefit from systematic cross-training experiences. Also, the Commission might consider a formal inventory of existing competencies and resources which would be matched to anticipated future regulatory needs.

The fundamental problem for people and facilities looking to RES for funding presently is the lack of adequate funding by the DOE. It simply is not feasible for licensee fee-based funding, which must be directed to the regulatory needs of those licensees, to also support competencies required for continued U.S. leadership in nuclear safety generally. (This is underscored by review of the legislative history of the Energy Reorganization Act of 1974 and the Department of Energy Organization Act of 1977.) Finally, technology of all kinds is increasingly international-based and market-driven. It cannot be maintained based on domestic regulatory needs alone.

As the totality of available resources continues to contract, increasing the need to rely on collaborative research, it is vital that discipline be exercised to minimize conflicts of interest where independence of regulatory decision-making is important. The increasing use of risk insights in the regulatory process underscores this need.

Is the NRC Spending at the Right Level?

As indicated above, the panel did not examine work being done outside RES either as "technical assistance" or as related to waste issues. Insofar as the amount is limited by

funds available from licensee fees, aggregate spending should not be increased without adequate justification of the regulatory need related to those licensees. Such justification can be developed, as it is apparent that the gain in regulatory efficiency and effectiveness that could be achieved would justify the societal cost of the supporting research.

I cannot estimate what increase would yield the right level for NRC spending on research, but I conclude from the work of this panel that substantially more could be done to support and expedite regulatory decision-making and that this could be viewed as cost-effective by all concerned.

Potential Requirements/Recommendations

1. The NRC must maintain as a used and useful arm of its organization, a reliable, respected office of Nuclear Regulatory Research (RES), and must support this office with the necessary people and resources so that it is an unassailable source of technical information and support for all regulatory actions. This is necessary not only to establish the credibility of NRC's technical decision making and thereby to insure the safety of all NRC licensed activities but also to insure U.S. leadership in nuclear safety technology.

   Comment. RES must not be limited to the role of an office which merely contracts tasks assigned to it by others, although it must do this well. Rather, it must be able to exercise discretion, under direction from the Commission itself, to justify and perform work it deems essential to meet regulatory objectives. The corollary to this is that it must be held to a high standard of accountability for the value and relevance of its work to meeting these objectives. With respect to leadership in nuclear safety technology, this objective needs to be qualified by the needs of the regulatory process.

2. This office must support the activities of other program offices, that in turn should be required to coordinate their activities with RES at least to the extent of planning new work, establishing objectives of technical studies and assessing the validity of data and analyses. At the same time, RES should be free to initiate anticipatory technical studies without approval by technical offices, but with their cognizance and input wherever possible. RES must be able to do (and be seen as able to do) independent verification of data on which NRC will rely for regulatory action. RES must institute and maintain a comprehensive and effective communications program to make available, agency wide, their plans and activities in real time.

   Comment. This recommendation is complimentary to 1 above. The key is "data on which NRC will rely for regulatory action," with emphasis on "will rely." This would exclude work on matters unlikely to provide current value to the regulatory process, except as that work is directly and fully supported by funding from its sponsor. Also, it must be recognized that other program offices may have an

interest in considering some issues as already settled and therefore not wish them to be subject to further research which could challenge assumptions. The independence of RES can play a critical role in overcoming this myopia.

3. RES must continue to increase its cooperative efforts with other organizations including but not necessarily limited to EPRI, DOE, industry, academia, public interest groups, and international organizations. RES must seek out and, wherever possible, utilize facilities, equipment, and resources available from these entities and maximize the use of technical data and results already developed. RES, in cooperation with and supported by the Commission, must establish procedures to accomplish this while fully retaining their decision making independence.

   Comment. In circumstances where resources are limited, it is essential duplication of effort and inefficiency be minimized. In this context, I would emphasize the above mentioned need for RES to be held to a high standard of accountability for the value of its work to the regulatory mission of the NRC. However, it is also necessary, that discipline be exercised to avoid conflict of interest where independence is necessary.

4. A clear and understandable definition of what research includes and does not include at the NRC, and its value to the safety of the nation's nuclear program must be established and accepted internally by the Commission, project offices and staff personnel and effectively conveyed to all the stakeholders.

   Comment. I prefer to address the value of NRC research in terms of its contribution to the efficiency and effectiveness of the NRC in performing its mission, rather than in the more general terms of its value to the safety of the nation's nuclear program. The two descriptions should be the same, but the former is more narrowly focused and I believe gives better justification to the resources used.

5. Continuing efforts must be made to eliminate unnecessary financial burdens to sponsoring stakeholders (industry) while at the same time focusing on areas that will benefit them through safer and more efficient plants. Charges to licensees for research costs should be on the basis of identifiable benefits to them.

   Comment. I disagree that charges to licensees should be on the basis of benefits to them, except in the broadest sense of the word "benefits." I prefer to say that charges to licensees for research costs should be on the basis of identifiable value to the efficient and effective regulation of those licensees. The fundamental point is that licensees should not be charged for research that is not needed for their regulation. Even more important is that other sources of funding must be identified and justified to support research needed to regulate prospective licensees or to address other matters. Only in this way will this important work receive adequate funding. The easy path of diverting a small

portion of fees paid by current licensees for this purpose is ultimately self-defeating because it results in unwarranted opposition to the work itself.

HAROLD B. RAY

Harold B. Ray is executive vice president of Generation, one of Southern California Edison's business units. He joined SCE in 1970 and assumed his current role in 1995. Before joining SCE, Ray was a reactor plant engineer for the U.S. Navy, assigned to the staff of Admiral Hyman G. Rickover in the Naval Reactors Division of the U.S. Atomic Energy Commission. Ray began his career at SCE in 1970 as a supervising engineer overseeing licensing and safety at the San Onofre Nuclear Generating Station (SONGS). He has held a variety of management positions, including manager of Quality Assurance, project manager for SONGS Units 2 and 3 and SONGS station manager. He was elected vice president and site manager of SONGS in 1983. Other executive positions include vice president of Fuel and Material Management; vice president of Nuclear Engineering; Safety and Licensing; senior vice president of Nuclear; and senior vice president of Power Systems. In his current role as executive vice president, Ray is responsible for all power generating facilities, including nuclear and related fuel supplies. Additionally, he is responsible for wholesale purchases and sales of electricity.

Kristine Svinicki
(Office of Senator Larry Craig)
Phase 1 Comments

It became apparent as this panel met to hear presentations on the role and direction of regulatory research, that the Nuclear Regulatory Commission has struggled with this issue, as an agency, for many years and that thoughtful analyses have been laid out in past reviews. As a first step, NRC may benefit by collecting the recommendations of these previous review groups (such as Direction Setting Issue 22, from September 1996) and examining if any of these recommendations would have beneficial application at this time.

1. The amount of anticipatory research performed by NRC, the funding of which is recovered through licensing fees, should be minimized because the requirement to fund these activities places a burden on current licensees, not shared by other power generators. This unique burden may become more pronounced as electricity markets are deregulated and become more cost competitive.

2. However, the NRC needs to be able to participate in those "forward looking" or anticipatory research activities which will allow it to be in a position to perform its regulatory role in the future, or with a future generation of reactors.

3. To fund its involvement in anticipatory research activities, the NRC should seek an appropriation of general treasury funds in its budget request to Congress. It should also pursue a programmatic relationship with the Department of Energy's Office of Nuclear Energy which may allow DOE to fund NRC involvement in forward looking research and development.

4. Beyond the issue of "who pays," there is a legitimate policy question regarding the extent to which a regulatory agency should guide or direct the future of an industry, which is more appropriately led by market forces.

5. The NRC is to be commended for its progress in the direction of risk-based regulation, and the contributions that NRC's research program have made to this effort. NRC should now begin to position itself to develop risk-based "licensing" approaches. Some of this activity would not be design specific and therefore would not put NRC in the position of picking technology "winners and losers."

6. NRC collaborative research with the international community is an effective way to leverage limited U.S. federal research funding and should be continued.

7. NRC use of universities in the execution of its research program provides a double benefit because it is a reinvestment in the educational infrastructure and cultivates the "pipeline" of students and future industry personnel.

8. NRC has noted a decline in the domestic infrastructure with respect to available personnel and research facilities. The Department of Energy, in both its civilian and defense nuclear programs, as well as industry observers have noted the same brain drain issue, coupled with an aging facilities infrastructure and reduction in accredited university programs. This overall, national decline will be much more difficult to reverse than the narrow issue of the scope of NRC's research program; but, having funds available for exciting research, coupled with perceptions of a brighter future for nuclear energy, will be necessary to begin to arrest this decline.

9. NRC has tried to retain expertise around the core competency areas it has defined, but has trouble retaining experienced personnel and attracting young staff. Because this problem is government and industry wide, NRC should participate with other organizations in looking upon the entire U.S. as a resource base versus whatever core competencies are needed domestically, and develop recommendations to create what is lacking.

10. Although the decline in the human, or "intellectual" capital, is alarming, equally compelling is the reduction in the number of physical facilities to perform the experiments necessary to keep the frontiers of knowledge moving forward. As has been acknowledged in the DOE nuclear weapons Stockpile Stewardship program, computer modeling cannot entirely supplant the need for some physical testing. Congress receives individual requests to provide the funding to keep specific facilities operating, but a joint NRC, DOE and industry report, with university participation, laying out a comprehensive forecast of needed facility capabilities versus existing facility capabilities would be helpful in informing government and Congress as funding is allocated. The definition of "confirmatory" research needs to contemplate a sufficient time horizon, given the long lead time for industry or government (DOE, in the cases of its licensed activities) decision making and investment. If knowledge of the "licensability" of a process or facility (e.g., MOX) is needed within two to five years, this need may be more "confirmatory" than "anticipatory."

11. In light of funding constraints on all effected parties (industry, DOE and NRC) the issue of "independence" and the development of "independent" tools needs a thorough re-examination.

12. Given the increasing market dominance of a smaller and smaller number of companies in the business of operating DOE national laboratories and a similar concentration of activity in the nuclear industry, NRC cannot allow its contracting activities to be overly constrained by a narrow legal definition of "independence." The benefit of a larger number of potential participants in NRC's research program, and the improvement in quality inherent in that competition, far outweighs any drawbacks associated with a presumed lack of independence. This is especially true when administrative controls can be put in place to control any perceived conflict of interest.

13. On the development of independent tools, such as computer codes, NRC would benefit by collaborative development with industry of these tools. Independent development by NRC may be merely duplicative and add limited value in terms of safety.

14. There is an important public confidence value in the NRC's role as an intellectual leader (domestically and abroad) on the issue of nuclear safety. The NRC should have the necessary resources at its command to recruit and retain leading experts in its mission critical core competency areas.

Kristine L. Svinicki (Senator Craig)
Phase 2 Comments

The NRC must maintain as a used and useful arm of its organization, a reliable respected office of Nuclear Regulatory Research (RES) and must support this office with the necessary people and resources so that it is an unassailable source of technical information and support for all regulatory actions. This is necessary not only to establish the credibility of NRC's technical decision making and thereby to insure the safety of all NRC licensed activities, but also to insure U.S. leadership in nuclear safety technology.

Comment: I agree with the goal of having a vigorous research organization within NRC. I am troubled with the term "all regulatory actions." The language, taken at face value, would seem to endorse the inclusion of research associated with the development and licensing of the deep, geologic repository. In my view, this research is distinct and is housed in a separate NRC organization for reasons unique to the nature of the research and the repository program. I have not heard any persuasive reasoning for folding this research back into RES.

This office must support the activities of other program offices, which in turn should be required to coordinate their activities with RES at least to the extent of planning new work, and establishing objectives of technical studies. At the same time RES should be free to initiate anticipatory technical studies without approval by project offices but with their cognizance and input wherever possible. RES must institute and maintain a comprehensive and effective communications program to make available, agency wide, their plans and activities in real time.

Comment: There is value in NRC participation in those "forward looking" or anticipatory research activities which will allow it to be in a position to perform its regulatory role in the future, or with a future generation of reactors. Funding for these activities should not be recovered from the fees of current licensees, but rather from appropriated general funds. Building support for these appropriations, with Congress and with industry, will require better communication and dissemination of research plans

and results, and the public commitment of NRC Commissioners to seek this support from Congress.

RES must increase its cooperative efforts with other organizations, including but not necessarily limited to, EPRI, DOE, industry, academia, public interest groups and international organizations. RES must seek out, and wherever possible, utilize facilities, equipment and resources available from these entities and maximize the use of technical data and results already developed. RES, in cooperation with and supported by the Commission, must establish procedures to accomplish this while fully retaining their decision making independence.

Comment: Given the costliness of research experiments and the limited availability of facilities, experts and financial resources, it is not necessary for NRC to reinvent the wheel, where their front end participation in experiment design and data collection, and NRC observation of research execution can adequately inform the regulatory process.

A clear and understandable definition of what research includes and does not include at the NRC and its value to safety of the nation's nuclear program must be made to eliminate unnecessary financial burdens to them sponsoring stakeholders (industry) while at the same time focusing on areas that will benefit them through safer and more efficient plants.

Comment- Ambiguity associated with the terms "confirmatory" and "anticipatory" appears to exist to a sufficiently pervasive degree that clarification would benefit all NRC organizations and industry. I am not comfortable with elimination of "financial burdens" as a research objective because it appears to presume the outcome of the research. A more reasonable objective may be the establishment of sound technical bases (not conservatism masquerading as understanding) for agency regulatory actions.

KRISTINE SVINICKI

Ms. Kristine Svinicki is a Senior Policy Advisor in the Office of Senator Larry Craig (R-ID), United States Senate, where she is responsible for legislation impacting nuclear energy, nuclear waste, energy research, Department of Energy programs, and science and technology. Prior to that, Ms. Svinicki was employed as a nuclear engineer at the U.S. Department of Energy in both nuclear energy and nuclear waste disposal programs. Prior to joining the U.S. DOE, Ms. Svinicki was employed as an energy engineer by the State of Wisconsin, Public Service Commission. Ms. Svinicki is a member of the American Nuclear Society. She received a degree in nuclear engineering from the University of Michigan in 1988.

Andrew Wheeler
Senate Committee on Environment and Public Works
Phase 1 Comments Only

In general, I thought the presentations offered by the NRC staff during the Meeting of Experts was very interesting although not necessarily on topic to answer the questions posed by Chairman Meserve of the NRC. I did find interesting, and refreshing, the cultural bias of the NRC scientists to reach realistic safety decisions as stated in the NRC Vision Statement. Too many regulatory bodies in the U.S. government err on the side of conservative decisions instead of what is realistic and practicable.

While I was impressed with the amount of coordination of the Research Office with other agencies, I was concerned about an apparent lack of coordination with other offices within the NRC. The Research Office stated that research is conducted within other areas of the NRC in conjunction with regulatory issues, in particular they pointed to the NMSS. Since the Meeting of Experts, I have requested basic information from the NRC on the research programs outside the Research Office and I have been told that no other research is performed by the NRC. I believe the simple question of who else conducts research at the NRC and the conflicting responses underscores my concerns that research efforts at the NRC are not well coordinated.

One area of research which was not addressed during the formal presentations is any research on the issue of radiation standards. This is particularly interesting since this question is basically the only nuclear safety issue that has captured the interest of anyone in the public sector over the last few years. Without regards to the importance of the issue for regulatory purposes, it is still the only major issue of interest to the general public today. It is important for the scientists at the NRC to address the question, *what is safe?*

On the question of funding for research, it is unfortunate but levels for funding are not likely to increase in the future. As long as the proponents of safe nuclear energy must spend their time advocating for the mere existence of the program, it will be almost impossible to argue for increased resources. There are too many members of congress and people within the Administration who do not value a strong nuclear component to our national energy mix. Recently, a top aide to Vice President Gore, Katie McGinty (former chair of CEQ), took credit on behalf of Vice President Gore for changing the focus of the Department of Energy away from nuclear and coal towards solar and renewable energy sources.

A major problem for the future is the decreasing number of researchers, scientists, and engineers entering into the nuclear field. While asking the question, are the right people involved in nuclear research? is important, a more important question is whether there will even be enough people in the field in the near-term. As the researchers at the NRC and in universities retire, are they being replaced? This is an issue that will greatly affect the ability of nuclear power to compete in the energy mix of the future.

ANDREW WHEELER

Andrew Wheeler has served as the Staff Director for the Subcommittee on Clean Air, Wetlands, Private Property Rights, and Nuclear Safety on the Senate Environment and Public Works Committee, since the beginning of the 105th Congress in 1997. He is the designee of Senator James Inhofe of Oklahoma, to the Committee. He served as Senator Inhofe's General Counsel in the 104th Congress. Prior to that he was a Special Assistant in the Office of Pollution Prevention and Toxics at the Environmental Protection Agency. Andrew completed his undergraduate education at Case Western Reserve University, obtained his law degree from Washington University in St. Louis, and his MBA from George Mason University. He is a member of the District of Columbia Bar.

APPENDIX

APPENDIX

The following background material was provided to panel members.

SECY-99-281	"The Vision of the Office of Nuclear Regulatory Research Role"	12/09/99
ACRS Letter	"Review and Evaluation of the Nuclear Regulatory Commission Safety Research Program"	05/24/00
Report No. 93-1252	"Energy Reorganization Act of 1974"	
COMSECY-96-066	"Staff Requirements-Research"	03/28/97
No. S-00-25	Remarks of Commissioner Jeffrey Merrifield at the Water Reactor Safety Information Meeting	10/25/00
Letter	"Update to Advisory Committee on Nuclear Waste Report on Nuclear Waste Related Research"	02/05/01
Excerpts from NUREG 1100, Vol. 1	Budget Estimates and Performance Plan for FY2001	02/2000
Letter	M. Silberberg to Chairman Meserve, Management Strategy, Oversight and Resources	01/16/01
Memorandum of Understanding	EPRI & NRC on Cooperative Nuclear Safety Research	02/16/01
NRR	Organization Chart	01/20/99
NMSS	Organization Chart	01/01
RES	Organization Chart	