

**draft**

Role and Direction of Nuclear  
Regulatory Research

Expert Panel Report

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

October 2000

# CONTENTS

- I. Introduction
- II. Executive Summary
- III. Expert Panel Members' Comments
- IV. Appendix
  1. List of Panel Members
    2. Letter of Invitation to Panel
    3. Background Information
    4. Agenda for Meetings
    5. Panel Chairman's Opening Remarks
    6. NRC Chairman Meserve's Questions
    7. SEC 205 Energy Reorganization Act

# I. INTRODUCTION

The nuclear industry is currently involved in important and far reaching changes which create emerging issues and new challenges for the Nuclear Regulatory Commission (NRC). As a result, NRC is currently involved in an internal evaluation leading to a number of important changes aimed at improving safety, regulatory efficiency, and public confidence. 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 15 member panel of experts, chaired by former Commissioner Kenneth Rogers and representing industry, academia, government, and public interest was assembled and asked to present their views and comments on the vision, mission, role, general direction of regulatory research, and provide insight and guidance for future activities. The panel convened for two meetings. The first meeting was opened by NRC Chair Richard Meserve who challenged the panel with three questions which are summarized in Appendix A of this report. This was followed by presentations by RES senior staff and open discussions. Individual preliminary written statements were submitted from 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 submitted as part of this report.

It should be strongly emphasized this is not meant to be a consensus report and the views of each panel member, including the Chairman, are their own with no modifications. The Summary was written by a non-panel member and points out those issues which were commonly held by a majority of the panel members. No order of priority or rank is intended but only those issues considered important by a number of panelists have been identified.

The material contained herein represents Phase I of a two phase program. Phase II will have the same panel members who will utilize the results of Phase I to provide more focused direction on the role of nuclear regulatory research. The results of both phases will be chronicled in a NU REG report and issued to the public.

## II. EXECUTIVE SUMMARY

The 15 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 individual panelists contain many unique and important comments and ideas that merit serious consideration; therefore, all of the individual statements should be reviewed as well as this summary. For information and as a guide to the reader, issues considered most prevalent are discussed below.

The panel members were in general agreement that a strong viable RES must be maintained in order to ensure a sound technical base for all regulatory 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. While there was no criticism of current personnel, 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.

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 research programs. 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 will ultimately do the research.

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.

An underlying concern with several members of the panel was whether RES was operating in accordance with the intent of the 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. There is general agreement among the members that it is necessary to maintain NRC leadership and that the current mix of anticipatory and confirmatory research is 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 needs to be more specifically defined, and better methods are needed to decide what research needs to be done and when to start and terminate research projects.

There was general concern that the physical facilities available to RES are aging rapidly and 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 for 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.

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.

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.

Several panel members urged more active and direct leadership by the Commissioners in support of RES.

Most panel members agreed that a strong research component with world class expertise is needed to not only support the regulatory activities of the NRC but to maintain U.S. leadership in nuclear technology. Support from stakeholders, particularly

the industry and DOE, is needed to achieve this objective. Equally important, however, research needs strong internal support from the Commissioners to underscore the value of the research performed at NRC in support of nuclear safety domestically and worldwide.

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. The questions are listed in Appendix A and the responses can be found in the individual panel member's statements.

### III. Expert Panel Members' Comments

#### John Ahearne

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.”

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.<sup>2</sup> 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.<sup>3</sup> 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.

---

<sup>1</sup> (Science and Engineering Indicators 1998, NSB-98-1, National Science Foundation, 1998, p. 4-9, emphasis added.)

<sup>2</sup> These also have been called curiosity-driven and problem-solving.

<sup>3</sup> “Public Funding of Scientific Research,” Lewis M. Branscomb, in *Vannever Bush II: Science for the 21<sup>st</sup> Century*, Forum Proceedings, Sigma Xi, The Scientific Research Society, 1995, pp. 147-171.

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.

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."<sup>4</sup>

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:

---

<sup>4</sup> "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.

<b>\$M<sup>5</sup>/FTE</b>			
	<b>1999</b>	<b>2000(est.)</b>	<b>2001(est.)</b>
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 <sup>6</sup>	15.7/-	15.7/-	15.7/-
<b>Total</b>	<b>83.8/201</b>	<b>78.5/178</b>	<b>78.5/178</b>

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:

	<b>1999</b>	<b>2000(est.)</b>	<b>2001(est.)</b>
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.<sup>7</sup>

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.

---

<sup>5</sup> The tables imply staff costs are included. They should be.

<sup>6</sup> 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.”

<sup>7</sup> 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.

3. 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 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

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 has 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 of 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

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

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

**Aloysius Hogan**  
**Office of Congressman Knollenberg**

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**

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 is 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

At the beginning of the workshop conducted August 16<sup>th</sup> and 17<sup>th</sup>, 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 an 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 4<sup>th</sup>. 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 be 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.

5. 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? 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.

6. 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? 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.

7. 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.
8. 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.
9. 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.
10. 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.

## Jane C. S. Long

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., CI36 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 than 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 than 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 phenomena 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 were 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

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 which 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 scarce 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**



## Alex Marion

Chairman Meserve posed the following questions to the expert panel:

1. Is NRC funding research at the right level?
2. Is there an appropriate balance in NRC research activities - Are we doing the right things?
3. Are the right “performers” involved in NRC research activities?

In order to adequately respond 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 as 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 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. But, 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.

According to Webster's New World Dictionary, 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 tie

has not been established in all cases. A comprehensive reassessment and refocus of NRC research activities is in order.

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 does not appear that Congress intended for NRC to conduct this type of research beyond that which might 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 due a lack of an articulated basis for NRC decision-making as it relates to available research conducted by other federal agencies, and availability 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 user needs) and external stakeholders.

And, 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 sets 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).

This raises the policy-level 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. A good 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.

ALEX MARION



## Theodore U. Marston

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 raised 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, the same data (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 conservatism.

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:

1. 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.

2. 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.
3. 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.

- 4. 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 its 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

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

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**

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.

## **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.<sup>8 9</sup>
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 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.

---

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

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

## 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.<sup>10</sup>
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.

---

<sup>10</sup> 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 two fold: (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**

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

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 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

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**

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.

## Kenneth C. Rogers

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 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.

**Kristine Svinicki**  
**(Office of Senator Larry Craig)**

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 SVINICKI**

Ms. Kristine Svinicki is a legislative fellow in the Office of Senator Larry Craig (R-ID) where she is responsible for legislation impacting nuclear issues, energy policy, Department of Energy programs, nuclear waste disposal and energy appropriations. Ms. Svinicki has been 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, and past President of the University of Michigan ANS Student Chapter. Ms. Svinicki received a degree in nuclear engineering from the University of Michigan in 1988.

## Andrew Wheeler

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 105<sup>th</sup> 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 104<sup>th</sup> 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.

## IV. APPENDIX

## Expert Panel Members

<p>Dr. Kenneth Rogers 6202 Perthshire Court Bethesda, MD</p>	<p>Tel: 301-530-4489 Fax: 301-530-4033 EM: <a href="mailto:kcrogers@aol.com">kcrogers@aol.com</a></p>
<p>Raymond W. Durante, President Durate Associates, Inc. 1925 North Lynn Street, Suite 725 Arlington, VA 22209</p>	<p>Tel: 703-276-8447 Fax: 703-276-8447 EM: <a href="mailto:durantes@aol.com">durantes@aol.com</a></p>
<p>Dr. John Ahearne, Director Sigma XI 99 Alexander Drive Research Triangle Park, NC 27709</p>	<p>Tel: 919-547-5213 Fax: EM: <a href="mailto:ahearne@sigmaxi.org">ahearne@sigmaxi.org</a></p>
<p>Dr. Robert J. Budnitz, President Future Resources Associates Inc. 2039 Shattuck Avenue, Suite 401 Berkeley, CA 94704</p>	<p>Tel: 510-644-2700 Fax: 510-644-1117 EM: <a href="mailto:budnitz@pacbell.net">budnitz@pacbell.net</a></p>
<p>Mr. David Helwig Commonwealth Edison 1400 Opus Place, Suite 900 Downers Grove, IL 60515</p>	<p>Tel: 630-663-7277 Fax: EM: <a href="mailto:david.r.helwig@ucm.com">david.r.helwig@ucm.com</a></p>
<p>Dr. Michel Livolant, Director Institute de Protection et ed Surete Nucleaire (IPSN) BP #6 92265 Fontenay-aux-Roses Cedex, France</p>	<p>Tel: 011-33-1-46-54-71-79 Fax: 011-33-1-46-54-95-11 EM: <a href="mailto:michel.livolant@ipsn.fr">michel.livolant@ipsn.fr</a></p>
<p>Dr. David Lochbaum Nuclear Safety Engineer Union of Concerned Scientists 1707 H Street, NW, Suite 600 Washington, DC 20006-3919</p>	<p>Tel: 202-223-6133 X137 Fax: 202-223-6162 EM: <a href="mailto:dlochbaum@ucsusa.org">dlochbaum@ucsusa.org</a></p>
<p>Dr. Jane C.S. Long, Dean Mackay School of Mines University of Nevada, Reno Room 304, Mail Stop 168 Reno, NV 89557-0047</p>	<p>Tel: 775-784-6987 Fax: 775-784-1766 EM: <a href="mailto:jcslong@mines.unr.edu">jcslong@mines.unr.edu</a></p>
<p>Dr. William D. Magwood, IV, Director Nuclear Energy, Science and Technology U.S. Department of Energy 1000 Independence Avenue, SW Washington, DC 20585</p>	<p>Tel: 202-586-6630 Fax: 202-586-8353 EM: <a href="mailto:william.magwood@hq.doe.gov">william.magwood@hq.doe.gov</a></p>

<p>Mr. Alex Marion Nuclear Energy Institute 1776 I Street, NW Washington, DC 20006</p>	<p>Tel: 202-739-8080 Fax: 202-785-1898 EM: am@nei.org</p>
<p>Dr. Theodore U. Marston, VP and Chief Nuclear Officer Electric Power Research Institute 3412 Hillview Avenue Palo Alto, CA 94304-1395</p>	<p>Tel: 650-855-2997 Fax: 650-855-2774 EM: tmarston@epri.com</p>
<p>Dr. Kenneth L. Mossman, Director Office of Radiation Safety Arizona State University PO Box 873501 Tempe, AR 85287-3501</p>	<p>Tel: 480-965-0584 Fax: 480-965-6609 EM: ken.mossman@asu.edu</p>
<p>Dr. Dominic J. Monetta Resource Alternatives, Inc. 800 25<sup>th</sup> Street, NW, Suite 801 Washington, DC 20037</p>	<p>Tel: 202-466-3900 Fax: 202-337-7777 EM: 73324.1374@compuserve.com</p>
<p>Dr. Thomas Murley 9106 McDonald Drive Bethesda, MD 20817</p>	<p>Tel: 301-469-7573 Fax: 301-469-5002 EM: temurley@erols.com</p>
<p>Mr. Harold B. Ray, Executive VP Southern California Edison PO Box 800 Rosemead, CA 91770</p>	<p>Tel: 626-302-1695 Fax: 626-302-2782 EM: rayhb@sce.com</p>
<p>Kristine L. Svinicki (Senator Craig) Legislative Fellow 313 Hart Building Washington, DC 20510</p>	<p>Tel: 202-224-2752 Fax: 202-228-1067 EM: kristine_svinicki@craig.senate.gov</p>
<p>J. Aloysius Hogan (Congressman Knollenberg) Legislative Director 2349 Rayburn Building Washington, DC 20515</p>	<p>Tel: 202-225-5802 Fax: 202-226-2356 EM: aloysius.hogan@mail.house.gov</p>
<p>Andrew R. Wheeler, Counsel Senate Committee on Environment and Public Works 415 Hart Senate Office Building Washington, DC 20510-6175</p>	<p>Tel: 202-224-0146 Fax: 202-224-2322 EM: andrew_wheeler@EPW.senate.gov</p>

# Opening Remarks

Expectations/Plans/Mode of Operation

August 16, 2000

K.C. Rogers

Once again, welcome to you all who have generously agreed to contribute your time and thoughts to this NRC effort to ensure that its research activities are as valuable as possible in supporting the agency's responsibilities with regard to public health and safety and the environment.

With your indulgence, I will call to mind some of the history behind our being here today. The Energy Reorganization Act of 1974 replaced the Atomic Energy Commission by two new entities The Energy Research and Development Administration and the Nuclear Regulatory Commission. The AEC was a very large, powerful and heavily funded agency with activities in all areas of nuclear technology including promotion and development of the uses of nuclear materials as well as the regulation of their safe use. These functions were divided between the two new agencies with safety regulation of civilian uses assigned to the NRC and military uses and development and promotional activities for civilian uses assigned to ERDA. Both new agencies were supported by appropriations derived from general funds rather than from licensee fees, an important difference for NRC today.

The Act directed the establishment of the Office of Nuclear Regulatory Research with a Director reporting to the Commission and charged with:

**Developing recommendations** for research deemed necessary for performance of the Commission of its licensing and related regulatory functions

**Engaging in or contracting for** research which the Commission deems necessary for the performance of its licensing and regulatory functions.

The NRC was not given any substantial laboratories of its own but other Federal agencies were expected to meet those needs of the NRC which require access to physical laboratories.

The Act further stated "... **the head of every other federal agency shall cooperate** with respect to the establishment of priorities for the furnishing of such research services as requested by the Commission..."

**"furnish** to the Commission, on a reimbursable basis, through their own facilities or by contract or other arrangement, such services as the Commission deems necessary..."

**"consult and cooperate** with the Commission on research and development matters of mutual interest and provide such information and physical access to its facilities as will

assist the Commission in acquiring the expertise necessary to perform its licensing and related regulatory functions"

Clearly the Congress expected the NRC to have access to all Federal facilities to obtain research information and to be billed for these services.

It left up to the Commission to decide what kinds of research it would need and how and where it would acquire them.

Over the nearly 30 years that have passed since the NRC and the Office of Nuclear Regulatory Research were created there have been vast changes in NRC's needs for information derived through the Office of Research and how meeting those needs is funded. The role of NRC research in the scientific and technological community world-wide has evolved , and a number of NRC sponsored studies have had great impacts on the entire nuclear technology community and have resulted in NRC becoming regarded as a leading world-class authority .

Various reviews of NRC's research programs have been carried out. The most comprehensive study was conducted under the auspices of the National Research Council in 1986. Two of our own panel members were associated with that study, John Ahearne and Robert Budnitz. That study made a number of recommendations, and although the context in which they were made has changed considerably, many of its recommendations have relevance to today's world. In my view, two of the study's most far reaching statements were the call for **routine use of peer review to instill confidence in the quality of research results**, and **establishment of a strong advisory group that includes independent experts from industry and academia along with representatives of organizations performing research.**

The NRC has been striving to strengthen all of its activities, and in my opinion, the convening of this panel is testimony to NRC's genuine effort towards continual self-improvement. I believe that the establishment of this panel is neither an exercise in self-justification by the NRC nor is it a response to an immediate acute problem. Rather, I view it as NRC's search for constructive criticisms from each and all of you as knowledgeable stakeholders. I see my role as chairman as facilitating their development through a process involving **presentations** by NRC staff with ample opportunities for you to raise questions and to seek clarifications **and the sharing of your own thoughts with your fellow panelists.** I do ask you to forego taking issue with the NRC staff on any of the matters in their presentations and to reserve expression of those thoughts for **your** individual presentations to the panel on Thursday. Today should be directed towards probing, discovery and clarification with analysis and recommendations for reinforcement or remediation put off until tomorrow. I will be amenable to accepting recommendations for improvements in today's process after it has had a chance to evolve during the day.