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BRIEFING ON NRC RESEARCH PROGRAMS
ON HUMAN FACTORS

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PUBLIC MEETING

Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland

Wednesday, November 10, 1993

The Commission met in open session, pursuant to notice, at 2:00 p.m., Ivan Selin, Chairman, presiding.

COMMISSIONERS PRESENT:

IVAN SELIN, Chairman of the Commission
KENNETH C. ROGERS, Commissioner
FORREST J. REMICK, Commissioner
E. GAIL de PLANQUE, Commissioner

STAFF SEATED AT THE COMMISSION TABLE:

JOHN HOYLE, Assistant Secretary

KAREN CYR, Office of the General Counsel

JAMES TAYLOR, Executive Director for Operations

WILLIAM RUSSELL, Associate Director for Inspection and Technology Assessment, NRR

THEMIS SPEIS, Deputy Director, Office of Research

THOMAS KING, Deputy Director, Division of Systems Research, RES

GARY HOLAHAN, Director, Division of Safety Programs, AEOD

FRANKLIN COFFMAN, JR., Chief, Human Factors Branch, RES

FRED COMBS, Chief, Operations Branch, NMSS

P-R-O-C-E-E-D-I-N-G-S

2:07 p.m.

COMMISSIONER ROGERS: Good afternoon, ladies and gentlemen.

Chairman Selin is not here and has asked me to open the meeting.

I am pleased to welcome members of the staff to brief the Commission on the NRC Research Program on Human Factors. The research program is intended to provide improved understanding of the capabilities and limitations of personnel involved in the operation of nuclear power plants.

A large number of safety-related events continue to involve human performance. It is therefore important that the non-engineering activities which relate to safety in nuclear plants and operations be given proper consideration.

The Human Factors Research Program is divided into five interrelated areas: One, personnel performance; two, human system interface; three, reliability assessment; four, organizational factors; and five, material's licensees' performance. An important element of the research program also includes the development of standards for reviewing and evaluating advanced control systems.

The Commission was briefed on the organizational factors portion of the research program in January 1991 and the results of a comprehensive review of the organizational factors research was provided in a SECY paper earlier this year. I understand that research products from this research are being considered for possible use in routine inspections and diagnostic evaluations. The Commission is interested in hearing about the progress you are making in this area.

Today's briefing will focus on users' needs, research products, and the future outlook of the research program. The briefing will concentrate on significant research accomplishments over the past two years.

I understand that copies of the viewgraphs are available at the entrances to this room.

I think the Commissioners would very much appreciate to hear specific results that have come out of the program and anything that has actually been completed would be very good to hear a little bit more about.

Are there any other opening comments?

Mr. Taylor?

MR. TAYLOR: Good afternoon. With me at

the table are members from the Office of Research who will give the major presentation this afternoon, but in addition there are members of the Office of NRR, AEOD and NMSS who are user offices of the results of this research.

Doctor Speis has some opening remarks.

DOCTOR SPEIS: Thank you.

Commissioners, Mr. Chairman, it might be useful to provide some background regarding NRC's Human Factors Regulatory Research Program. If you recall back in 1981, RES established a branch to conduct human factors research. In 1985, budget limitations and completion of several projects led to a sharp reduction of resources dedicated to human factors research, leaving only work on human reliability analysis from 1985 to 1987.

But by 1987 the persistence, as you mentioned, Commissioner Rogers, of human errors in reportable events and the recommendations of the National Research Council's National Academy of Sciences led to a revitalization of human factors research.

In 1987 then, RES reestablished a Human Factors Regulatory Research Program. Research projects were initiated based upon user needs request,

past research experience and, where applicable, recommendations of a second report from the National Research Council in 1988 entitled, "Human Factors Research in Nuclear Safety." The research projects addressed the regulatory office needs at that time and most of the National Research Council's specific recommendations. By 1989, all of the National Research Council's applicable recommendations were being addressed. Basically, they had a number of recommendations, I think somewhere around 50, and the majority of them really overlap with our regulatory needs. So, that's why we went ahead and addressed most of their recommendations.

Since then, the Human Factors Research Program has been mostly directed toward addressing regulatory needs identified by the user offices. Progress and experience has served to stabilize the funding level for this research and we'll be talking about the funding level in our presentation.

I would like to mention to you one area where our research has reached an impasse and that is in the area of organizational factors research. As Commissioner Rogers said, we reported to you on this issue in SECY-93-020 in February of this year. The ultimate objective of that research was to see whether

and how we can translate organizational performance into risk. That is, whether we're able to explicitly account in PRA management effectiveness as explicitly as possible.

Even though the research on organizational factors has provided some insights, the direction we took turned out to be very resource intensive and we have reached the point where we have to decide where we go from here basically.

At the present time we are still trying to decide if there is something practical or physical which we might do in this area. Mr. Coffman will discuss this topic further in his presentation.

Again, the briefing will focus mostly on recent progress from the research program and the current plans for the future. Mr. King and Coffman will proceed with the detailed presentation.

MR. KING: Thank you, Themis.

(Slide) On page 2 is an outline of the content of the briefing. Basically I'm going to provide a little background and introductory material on the Human Factors Research Program. Frank Coffman, who is the Chief of the Human Factors Branch in Research, will then talk about the content of the Human Factors Research Program broken into the five

topical areas that Commissioner Rogers mentioned in his opening remarks, and he'll focus on the issues, the approach to research, the products so far and then our plans for the future in those areas. Then at the end I'll say a few words about the long-term plans for human factors research.

(Slide) Beginning on page 3, as Doctor Speis mentioned, the Human Factors Branch was formed in 1987. It is in the Office of Research and Frank Coffman is the Branch Chief.

The overall objectives of the Human Factors Branch, there are basically three. The first is to develop technical bases for regulatory requirements and guidance in areas related to human performance. Basically that means generate information that can be used to establish and support regulatory positions in the human factors area. That includes looking at a range of issues involving human performance, both reactor and materials licensees in those areas, man/machine interactions, and that includes the use of advanced instrumentation and control systems, human factors generic safety issues, and it covers both current and future plant issues.

Secondly, an objective of the branch is to develop techniques and data that accurately measure

human performance. That includes development of human reliability, analysis techniques and a database on human performance.

Thirdly, the branch provides staff expertise on human performance. Basically they're a resource of human factors talent that supports the program offices in licensing activities and responding to questions.

Currently, all of the human factors research is driven by regulatory needs or user needs, as we sometimes call them, that come from the program offices. We received 100 user need requests over the past five years, of which 42 are currently active. These user need requests are usually specific requests in scope, schedule and desired end product. The breakout of how many of those came from the various program offices is shown at the bottom of page 3. But I do want to mention that in receiving those user need requests, we do -- it's been our experience that there's been good cooperation and coordination among the offices to provide requests that meet maybe multiple needs and are not contradictory to each other.

COMMISSIONER REMICK: Would these offices have any technical assistant efforts in human factors

also, in addition to research? Would it be extensive or --

MR. KING: Maybe Bill wants -- NRR has a branch that has human factors --

MR. RUSSELL: We have a Human Factors Branch and we have technical assistance. Most of it relates to activities associated with design certification, current licensing review activities that are ongoing. But there is some significant interface back and forth between the two and we conduct frequent meetings with research to ensure that these are coordinated and they're done at least at the division director level quarterly.

COMMISSIONER REMICK: Do we know if NMSS and AEOD have any?

MR. HOLAHAN: AEOD has, in effect, one section dedicated to human performance and it has contract assistance at INEL. Most of that is used to have human factors experts go out to plants to follow-up on specific events and we're also developing a database of human performance and that's on the order of a few hundred thousand dollars a year.

MR. COMBS: NMSS has two human factors specialists involved in coordinating with Research and also with some contractor support with Lawrence

Livermore and INEL for human factors and risk work.

COMMISSIONER REMICK: Thank you.

CHAIRMAN SELIN: I would like to follow-up.

First of all, I'd like to thank you on a different topic, for the preparation you gave me before I went overseas. You tripled my knowledge of breeder reactors in about three minutes, which was not much of a challenge, but it was very helpful.

On this topic, following up on Commissioner Remick's questions, I'm sort of concerned about what looks superficially at being either not the right placement or some duplication of some of the database and some of the empirical work. A lot of the data come in through AEOD and you would expect that the toting up of the empirical data would be sort of a natural function for the AEOD section to carry out and that Research would have two functions. The first is to do what I'll call non-heuristic, you know, synthetic research on the factors, experiments or what have you to supplement the information that comes in from our licensees. The second is to try to be the single source of contact and knowledge on everything the Agency knows in this area and some other points.

But, you know, we've been running this

large database for a long time at quite a significant expense. I hope today you'll address whether we still think that's a good idea and, if so, how does that compare to what's going on at AEOD and, if not, what we should do about it.

The second question I have you haven't really gotten to yet, but something we addressed last February or March and that was where to do the PRA work or the human factors work that's part of the PRA. I know these are more organizational and management questions than they are research questions, but they do have to do with the management of the research functions. So, I hope you'll address those as we continue our discussion this afternoon.

MR. KING: All right. Perhaps when we get to the right part of the briefing --

CHAIRMAN SELIN: However you wish to do that.

MR. KING: -- we can come back to this.

(Slide) Let me continue on page 4.

I need to mention that user needs change with time. I think it's a fact of life that as research results come in, other new issues are raised and so forth, that user needs will change. To some extent, our research program has been an evolving

program over the past several years to respond to these changes. Currently, we have 51 projects or separate contracts, if you will, that are being directed by the Human Factors Branch. There are ten project managers in that branch, mostly with human factors backgrounds. It involves 26 contractors that include a broad spectrum of organizations, both domestic and foreign.

In addition to formal contract work out of the branch, the branch does maintain extensive interactions with other organizations on human factors subjects. Those are both formal and informal. By formal I mean they participate in formal information exchange agreements or participate in committees, working groups, standards committees and so forth in the human factors area. By informal, they maintain good working relationships with a number of organizations that provides for a free exchange of information. All of this results in most of the active regulatory needs being addressed in accordance with the priorities from the user offices. I put the word "most" in there because we've had to negotiate on schedule sometimes due to work load in other areas and priorities in other areas.

Page 5 shows the FY '94 funding for the

branch, broken out by the five topical areas. The five year plan shows pretty stable funding in the human factors area. We have about the same level of funding in there for FY '95 and anticipate approximately a $6 million program in the years beyond that.

Now I'd like to turn it over to Frank Coffman who will go through each of these five topical areas and try and highlight the major points and focus on the progress and plans. I do want to emphasize the slides are not a comprehensive list of everything that they've done, but we tried to pick out the more visible and important items.

MR. COFFMAN: For each of the five topical areas I'll cover the issues and then kind of a characterization of the research program, then focus in on recent products and then what our plans are. In the first area, which is personnel performance, this deals with the issues, primarily the fact that has been mentioned already, that a large number of operating events involve human errors. The Agency is aggressively pursuing a determination of the causes. So, there was a need determined for a method, a standardized method to be used across the Agency for investigating events to determine what, in fact, are

the root causes of those that involve human performance.

Then there's also the need to characterize the predominant areas of human error. This might be an appropriate place to mention briefly what we're doing, how the Office of Research is involved with the databases. That is that we're involved with AEOD and NRR on task force looking at the possibility of a coordinated database. In addition to that, the Office of Research maintains the NUCLAR database, which is not so much data on causes as it is data for human probability, human error rates for comparison with those human error rates that are used in probabilistic risk assessments. Then we're also trying to provide--trying to automate a technique to get the data that's collected from one of our projects, which I'll mention, the human performance investigate process, to get the data that's collected from that and fold it into the database that NRR uses as HFIS, Human Factors Information System.

Another issue addressed in the personnel performance area has resulted from the review of recent events. More specifically, the New Years Eve event where there was a simultaneous scram of both Units 1 and 2 at Sequoyah and there were questions

raised about the adequacy and the utilization of staff. So, the research program is addressing that issue also.

Then the next item is the regional offices have requested guidance on the effects of plant environments on performance. This is short of the health effects, but how does specific things like heat, light, lighting -- heat and lighting, noise and vibration, how do they affect performance short of having health effects.

Then there remains some uncertainty about the fatigue effects of shift length and overtime as far as it might affect safety. So, the research program is addressing that also.

COMMISSIONER REMICK: Frank, hasn't that research been going on for a decade, the eight hour, 12 hour shift question and so forth on fatigue?

MR. COFFMAN: It has been going on for some time, yes, sir.

COMMISSIONER REMICK: When do you foresee that some resolution of the question --

MR. COFFMAN: We didn't list that. On page 8 I'll touch on -- at the top of page 8 I'll touch on that.

COMMISSIONER REMICK: Next a facetious

question on the bit of noise and so forth. Is music included in that? You need not answer that.

MR. COFFMAN: No, sir.

COMMISSIONER REMICK: Has there been a report on the staffing to handle significant events? Is there a report out on it yet? I think an information notice went out, but does Research have a report on that?

MR. COFFMAN: We do not have a report on that.

COMMISSIONER REMICK: AEOD? Does AEOD have a --

MR. HOLAHAN: I believe it has come up as an issue on some individual diagnostic evaluations and IIT teams, but I don't think there's a specific study on the subject.

COMMISSIONER REMICK: Okay. The reason I ask, on some recent foreign visits I felt some staffing was minimal and if there was a report, I'd like to be able to send it to the people.

MR. RUSSELL: I recall we have recently sent a SECY paper to the Commission where we addressed issues of staffing, particularly the role of the STA and the dual role STA or the stand-alone STA and we identified some events which occurred and the approach

was essentially that we would follow-up on events and where necessary we would look at allocations of tasks to staff. If we concluded that there were insufficient staff to meet and carry out the existing regulatory requirements, then that would be a basis for concluding potentially that they would need staffing beyond the minimums that are required by the regulation.

We are also waiting for, and Frank will mention this later, in FY '94 there is supposed to be a report that's completed, which we'll talk about in just a moment, in which we agreed to provide feedback to the Commission once we receive that report.

MR. HOLAHAN: It may be worth mentioning that in some of the operating experience we've looked into it's not so much the number of people on shift as the task allocations. You might find one individual that is simply overloaded and can't do the tasks assigned when there might be other people available, but they're just not trained or assigned to the right tasks.

COMMISSIONER REMICK: Yes. But there's not a document available yet that one could send out?

MR. RUSSELL: Not yet.

COMMISSIONER REMICK: Yes. Okay. Thank

you.

MR. COFFMAN: (Slide) I think we're on page 7.

To characterize the research program as involving learning from the experience of others, both inside and outside the nuclear industry and then to perform some individual studies of our own. To emphasize recent product, as was requested at the beginning by Commissioner Rogers. We have been quite successful in the development of the human performance investigation process as a standard method for investigating events that involve human error. This has been used and is currently being used in Region I and by Headquarters personnel.

MR. RUSSELL: In fact, if I could expand on that, we've been using it in the Human Performance Evaluation Branch where we provide assistance in follow-up of events in the regions. But in the last two months it's been used at the Vermont Yankee AIT in October, Comanche Peak special team inspection in November, McGuire AIT in September, Big Rock Point special inspection in October and Susquehanna in November. In each case the feedback that we've been getting is that this has been helpful in looking into the contributing factors to the human performance

problems. So, this is one where we have seen a benefit in organizing our approach to evaluating events.

COMMISSIONER ROGERS: But is that process used in the absence of an event that triggers a look at --

MR. RUSSELL: No. It is oriented to follow-up to events.

COMMISSIONER ROGERS: Well, that's fine, but we always ought to be striving to anticipate things rather than simply react to them. I just wonder what processes we have that might possibly discover causes that would be unearthed by this human performance investigation process that we have in place.

MR. HOLAHAN: Well, AEOD is using, in effect, the same process from the same research. Although I think you might say we're following events, it's not necessarily a reactor scram or some significant event like that. We're looking for situations in which you can learn something about human performance. It might be as simple as miscommunications in the control room that didn't really result in a significant reactor event. But we have found that the best way to get this kind of human

performance information is to go and talk to the people who did something right or something wrong very shortly after they did it. But that's also a very resource intensive way to collect information.

MR. COFFMAN: I think the research program gets ahead or the Agency gets ahead of some of the areas by looking at some of these events. For example, we have been requested to look into those events that specifically communications has been called out as a contributing element to really clarify what is meant by the communications, how did it in fact contribute to the event. I mentioned that part of the research products on this effort was development of training material because training was done for some of the regions and at headquarters and that material is being incorporated in the curriculum at the technical training center.

(Slide) The plant on the next viewgraph, number 8, this shifts over to take a look at our plans and we're doing the study of shift duration and overtime. There are two studies involved. One is looking at the experience that has occurred in the industry and the other is a laboratory experiment, actually we're wrapping this up, where we looked at performance degradation between eight hour and 12 hour

shifts at the Institute for Circadian Physiology. Basically there was no difference discovered, no significant difference discovered in the performance on different tests by the operators, actual operators during that laboratory experiment on a part test simulator.

The next is the second quarter of '94 we expect to have completed this handbook for the inspectors on the effects of environment and we're supporting -- on that next item we're supporting AEOD in their study looking at the effects of high-intensity lighting. Actually it's programmed high-intensity lighting at the operations center and how it might be advisable or unadvisable to use such a system.

There are no existing reports, but the reports are planned that is minimum staffing levels and the utilization of the staff and that's the last item there. Our work is to provide a technical bases. We were asked to provide a technical bases to either confirm or that could be used to modify 10 CFR 50.54(m) for both the operating staff and the functions that are required to directly the support the operating staff.

I'd like to change to a new topical area,

if I could.

COMMISSIONER REMICK: Frank, before you leave that, on the bit of the lighting for the Op Center, how do we decide whether we're going to do or sponsor independent research versus hiring outfits that are expert in these areas? One that comes to mind is Circadian, that the staff had work done a decade ago in some of these areas, I believe. How do we decide whether we're going to conduct research or call in people that that's their area of expertise to help us?

MR. COFFMAN: I think there are two parts to your question. One is how do we decide on what research we're going to conduct. It's basically driven by the user offices. When they have an interest or a need, then that's primarily what drives us. As far as who does the research, that is -- we have several contracting processes and it's a rather rigorous process for determining who might be the best for doing the research. Perhaps I didn't address the question.

COMMISSIONER REMICK: Yes. I guess my question is is research needed in the effects of lighting on Op Center personnel? I thought there were outfits that specialize in that knowledge as basically

consultants and you need not do research, but --

MR. COFFMAN: Well, these are the folks that are involved. They approached --

MR. TAYLOR: Do you want to answer it?

MR. HOLAHAN: I'll give you my best understanding of the situation. I wasn't there at the time the user need was written, but my understanding is in effect this is AEOD asking Research to run such a contract because of their expertise in dealing with the contractor. So, the contract is being let by someone who understands the technology better than just those of us who are trying to put together the operation sector.

COMMISSIONER REMICK: It's really not a research project.

MR. HOLAHAN: It's not really research in the sense of most other ones, but it's a service that they're providing.

MR. COFFMAN: (Slide) The next topic area is the human system interface, which is our largest area in the branch and is the highest priority area for us. We've continued to work closely with NRR and their activities on digital INC.

The overall issues you can see as we characterize them as the digital systems are being

included in the plants. There is a need for technical bases for the review and certification of advanced designs and also for the upgrading of current plants. The technical bases work that we're doing is in two areas. One is the first being on the systems themselves, what should be the regulatory positions on systems, and then for the effects on the operator. So, we're working on both aspects of that.

We're headed toward -- the research program is headed toward the development of standards for both the software and the interface design or the displays and the effects they might have on personnel.

COMMISSIONER REMICK: You'd be a good one to understand now, how would that contrast with the technical assistance that NRR is seeking to help, I assume, in these same areas versus what is being done for Research and will the Research results be helpful to NRR in their evaluation --

MR. RUSSELL: Let me illustrate with some background. We briefed you on what we had learned when we visited France and the Bugey simulator for the N-4, which is an advanced simulation facility. Some of the work that they did comparing operator performance in normal control rooms, the advanced control rooms and looking at the tasks they had to

perform, they found that there was a significant difference in how an operator would spend their time, navigating through menus, et cetera, to gather information as compared to walking over to a panel and having a lot of information displayed at one time. That had the potential for change.

We've also talked about some of the work that's been done at Halden, at the research facility, where they are specifically looking at some of the implications for human performance of using displays and advanced technology. In most cases the perception has been that introduction of advanced technology is always a good thing to do and improves the situation. But there has not been a lot of good research done and so we have some requests that are supporting us in those areas broadly.

We also have work going on which is technical assistance which is assisting us in review of the process of how they are developing control room design reviews, in particular, how they have handled the layouts of displays and things and we've used guidance that currently exists, much of which is being updated and we have requests to research to update that guidance based upon information display technology and things that are happening. So, the old

guidelines that we had are in the process of being updated.

So, one I would characterize is trying to understand broadly how the roles of the operators may change with the introduction of new technology, what they may be doing with their time, how that might affect things. Secondly, how are they interfacing with the displays, how is the information portrayed? In both cases, research is providing information which is then being incorporated into publications which we then factor into the reviews as we're applying them on a case basis.

COMMISSIONER REMICK: So it is coming in a timely manner that you can incorporate in the current reviews?

MR. RUSSELL: We've incorporated the processes in the current reviews and in most cases we have put the standards in what we have called tier 2 materials, so that if there are improvements in the standards or changes in technology, we've been careful in the advanced reactor reviews not to lock in a particular technology, but to rather focus on a process for how that technology is proven and how the operator interfaces with it and what their roles are.

So, we've been very cognizant of that and

there's been a lot of interaction back and forth between the staff and the Human Factors Branch doing those reviews and the Research staff.

COMMISSIONER REMICK: Thank you.

MR. COFFMAN: (Slide) If I could go to page 10 and talk about the recent products in this area. There are a lot of items actually on pages 10 and 11 and I was just going to hit the highlights of them, which basically are the first three items on page 10. That is that the staff has developed draft guidelines for the human engineering reviews of advanced control rooms and these have already been used for the review of the ABWR and the System 80+ for the design certification. They will be used for evaluating upgrades of operating plants.

The second item deals with the fact that in the past, coming out of the Halden project has been reports on the development of computer-based operator support systems. What we have motivated is reports on the insights and the guidelines that might be used by regulatory organizations of which there are some members in the Halden project. The first report that we've received is this one on lessons learned out of ten years of experience at Halden at the test and evaluation methods that they've used on computer-based

systems. There are two more reports scheduled and we've asked them actually for a total of six reports and I'll mention the other two here in a few minutes.

Also, the staff held a workshop in September on digital system reliability and nuclear safety. From that workshop we received feedback from those experts that the Agency had not previously heard from concerning the potential safety issues. We also provided them proposed regulatory -- well, frameworks for proposed regulatory positions and then we heard from them also on research. So, this was a way of continuing the in-depth interaction with experts in the state-of-the-art. The experts pointed to some potential sources of errors for us. We knew about these, but it was the emphasis that was given to them. One is in the ability to capture specifications for software, the need for tools for computer-aided software engineering tools during the design and during the audit. There is a trend toward the use of modules or blocks of previously developed and used code and that appears to be something that is growing in use. Then they suggested the need for an error collection and tracking and analysis system or activity so that characterization of what kind of errors have been occurring and where the emphasis

should be put could have a solid basis.

These points are being considered primarily for what should be the relative emphasis in the regulatory activities and in the research activities. And then the other products are there, are listed there.

(Slide) I was going to go on to page 12, which begins to discuss the plans. The plans are broken up into two areas. One is the systems area, which is covered on page 12, and then the operator effects is on the next page.

Again, the emphasis is on technical bases and one of the requests that we received was what should be the technical bases or what is the technical bases for requirements on software error analysis. There are two parts to this, both of which the research program is addressing. One deals with the classification of errors to guide the acquisition of error data and then the other is the study of detection and analysis techniques, how one might detect and analyze the errors that might occur during the life cycle development of the software.

The next area is to develop guidelines for verification and validation of expert systems. This has focused primarily upon application of verification

and validation for the knowledge-based portion of expert systems.

I'll go on. There are --

COMMISSIONER ROGERS: How are you doing that? How are we getting at that basic knowledge that you want to fold into the expert system?

MR. COFFMAN: Let me call on an expert. Let me ask Leo Beltracchi, who is our project manager on this project.

MR. BELTRACCHI: What we actually did was to conduct an experiment and we had a control group and an experimental group. We actually had seated errors in two expert systems and compared the performance of these two groups in terms of being able to determine errors. We found that through the use of the experimental system where they had equivalent of case tools, they were actually able to detect most but not all of the errors. We found it was an effective way of assessing the knowledge base.

COMMISSIONER ROGERS: Well, I was really thinking of how you develop your -- you know, how you get your original collection of material that you're building the knowledge base on.

MR. BELTRACCHI: Oh, you're talking about knowledge acquisition then.

COMMISSIONER ROGERS: Yes, right.

MR. BELTRACCHI: Okay. We did not look into that aspect of it with regards to this -- in this program. We were looking at the existing expert systems and how we would verify and validate them.

COMMISSIONER ROGERS: I see.

MR. COFFMAN: Thank you, Leo.

The second report from Halden is mentioned there in the middle and that's on lessons learned from verification and validation experience that they have had at Halden over the last ten years and it will address such things as the use of formal methods and testing techniques and the use of testing.

One project we have is to develop a software audit tool or the prototype of a software audit tool for use by NRC reviewers where they would be looking for common code within the element that's supporting different functions, different outputs from that code. Then a project which we're trying to get underway which has been requested is to look at programming languages, looking at their characteristics and how, in fact, the unique characteristics of the language might be problematic in a safety application so that coming out of this would be guidance for the reviewers that when a

program comes in in a given language that they would have some hints as to what could be the potential problem areas for that language.

(Slide) Then to look at the plans on page 13, for the effects on operator workload. A typographical error in that first line is that it's the fourth quarter. It's not the first quarter of fiscal '94, it's the fourth quarter of fiscal '94 that we'd expect to complete draft guidelines for human engineering reviews. These are -- this is because we will be going through CRGR and public comment. A lot of the material coming out of Halden was used in the development of these guidelines.

We have reports, two reports on the effects of computerized procedures on human performance. We're assessing the effects of digital systems on operator workload and the third lessons learned report from Halden deals with what they've learned over the ten years on man/machine interfaces. It summarizes their experience with workload and how they have made decisions between allocating tasks to automation versus to the operator. It includes other things such as large screen displays.

COMMISSIONER REMICK: Since those items have to do with staff review, and I look at the time

scale, how is that going to help NRR in its review of the evolutionary and passive plants?

MR. RUSSELL: I believe the comments I made earlier, we are not locking in a particular technology, we're using design acceptance criteria as the approach to the control room design and to the INC system designs so that there is the capability to incorporate both newer technology from the standpoint of types displays, et cetera, and also to factor in the lessons learned from the standpoint of how you display those on the instrumentation and tools that you use. So, we have been careful not to specify particular man/machine interface technology, but rather a process for evaluating that and going through a V&V, and how you do testing, including man-in-the-loop testing with simulation.

Now, we concluded for the evolutionary plants that the role of the operator was not going to substantially change from the standpoint of their involvement, use of systems, et cetera. That is the approach to emergency procedures are still pretty much the same, but we did feel that for the passive plants that they were sufficiently different in the context of using non-safety systems, et cetera, that we would require more extensive man-in-the-loop testing as a

part of the V&V process, where they would be using the actual displays and information.

COMMISSIONER REMICK: So, you do not need this information for reviewing the DACs themselves?

MR. RUSSELL: That's correct.

COMMISSIONER REMICK: It's the implementation of the DACs that you'll need this for. Is that it?

MR. RUSSELL: We did review standards and information that's available based upon current technology that would be used and to the extent that technology is used, we have approved the standards associated with that technology. But as we did that review, we put it into a tier 2 status, that it's resolved if that's used, but we did not lock it in to the point where we'd need to go back to a rulemaking if they wanted to introduce new technology. So there is a process for handling that.

COMMISSIONER REMICK: Okay. Thank you.

MR. RUSSELL: I might comment, and I know some of you have been to Halden. But I think it's probably one of the better research facilities from the standpoint of conducting these types of experiments. They have a simulator that they can reconfigure quite easily to different display

technologies using projection screens, et cetera. They have access to operators that operator the plant that is simulated and they've done quite a bit of work in alarm reduction and other things. So, it's an area where I think from a program office standpoint we get a lot of results for relatively modest cost and it's one that is not duplicated here in the U.S.

MR. COFFMAN: (Slide) I'll shift to the next area, which is organizational factors, a topical area on page 14 and just mention that by organizational factors we mean such things as the quality of communication of the organizational internally and externally, coordination of the work, that is the degree to which the coordination of the work is formalized, decision making, such things as the degree to which the decisions are centralized, the making of the decisions are centralized, assignment of personnel and resources and then some more vague things more difficult to measure, like culture, the values and practices.

The initial issue, as was mentioned, was to measure these factors and then fold them into PRAs. The products to date have -- well, we've identified factors. We've kind of somewhat got convergence among our contractors on the factors and we have developed

methods to qualitatively measure those factors. The methods at this point have been used by behavioral scientists. We've tried these methods at two plants. They've been good performer plants and documented our results. We've got some preliminary attempts at developing a method for the quantification of the risk, and this is what I might call the creative step in the process and it's very difficult. We have been able to discover how organizational factors can create dependencies across systems so that you can have dependencies that occur between dissimilar components and dissimilar systems. So, there has been some progress. But as was mentioned, we did this comprehensive evaluation of the program and concluded that there was progress but it's resource intensive, that the current project should be focused on what might be useful for inspections and diagnostic evaluations. We should monitor the work of others and that NRR and RES should continue to coordinate on what further work might be done.

(Slide) So, on page 15 that's what you'll see. That's what we've been doing. The monitoring of the work of others has been even the activities of Institute for Nuclear Power Operations, looking at their activities. They do not have any research going

on, but basically their activities are to do plant and utility evaluations using peers. We've been aware of NUMARC's activities in this area to survey the industry on this topic. We're aware of what MIT is doing in their program. We're aware of what SKI is doing in Sweden and U.K. AEA technology work. Then there's work going on at the National Research Council.

The plans are to develop the training materials for incorporating the organizational factors, measures into diagnostic evaluations, but that will in all likelihood require some demonstrations. But the key questions in this area are the validation of the methods and the resource-intensiveness of collecting the data. So, we're in the process of meeting across the offices and trying to prepare recommendations for senior management later this calendar year.

COMMISSIONER ROGERS: What's the smallest organizational unit that you can focus on in this program?

MR. COFFMAN: The unit has been the power plant, not to go beyond the power plant. Within that power plant we have focused on departments and I don't think we've gone -- it's just departments.

COMMISSIONER ROGERS: Just departments.

MR. COFFMAN: Yes, sir.

COMMISSIONER ROGERS: It doesn't include, say, the operating crew as an organization?

MR. COFFMAN: No, sir. I guess I misheard the question. It includes the operating crew, but --

COMMISSIONER ROGERS: As an organizational unit.

MR. COFFMAN: The answer is yes. What I was thinking is we also have -- we had another project looking at trying to evaluate the performance of the operating team itself, which is a separate project.

COMMISSIONER ROGERS: Would that be in this --

MR. COFFMAN: It would be in this area, yes. It's not tied in with the attempt to quantify the risk.

COMMISSIONER ROGERS: It isn't? Why not? Isn't that one of the biggest things that you ought to be looking at?

MR. KRAMER: Joel Kramer, Human Factors Branch in Research.

Some of our work at Brookhaven looked at measuring operator crew performance and the organization factors associated with that and

developing an algorithm to play that into risk to recalculate core damage based upon the organizational influences on both operations and maintenance errors.

COMMISSIONER ROGERS: So you are trying to get a quantitative risk measure out of an examination of the operating team as an organizational unit. Is that correct?

MR. KRAMER: Right.

MR. COFFMAN: (Slide) To go to the fourth area, human reliability analysis with the probabilistic risk assessment methods and applications, page 16. The issues here are focused primarily on two items. One is to develop methods that can be used in the evaluation of the tech specs, and the other is to try and improve or validate human reliability estimates. The program has focused on the development of these methods for looking at changes in such things as surveillance test intervals and the effects of dependent failures, the configuration of systems and the methods that are applicable to low power and shutdown -- application of the methods to low power and shutdown operations.

That's on the tech spec aspect. As far as the issue dealing with the validity and ways to improve human reliability estimates, we're finishing

up some projects on evaluating the errors of commission where we're trying to model the errors of intent, the formation of these intentions by the operators and what might contribute. We've looked at 28 teams by way of trying to validate that model and we're trying to analyze at this point the empirical evidence from those evaluations.

The last item there is to determine the feasibility of inferring error rates from the data available to the NRC through the simulator portion of the requalification examinations that take place.

By way of recent products in this are covered on page 17 --

MR. RUSSELL: Frank, if we could go back to the last one for just a moment because this came about as a request from NRR. We were seeing -- after we made revision to the simulator portion of the scenario reevaluating crew performance, we were still seeing a fairly high failure rate on some scenarios, indicating that human performance, even in a crew environment, was not satisfactory. If you just look at the number of exams that we give and the number of times that they fail, particularly if you're in a requalification examination scenario, it gave an indication of an error rate that was much higher than

the typical error rates that are used in probabilistic risk assessment analyses. Maybe an order of magnitude higher or so.

So, we started collecting this data through our examination activities. Where there were critical tasks that were not performed that were crew critical tasks, collecting that data, and trying to understand because these scenarios were scenarios that had been validated, reviewed by management prior to administration and given to crews that were qualified crews.

So, we've been collecting that data, putting it into a database and we've asked Research to look to see what they can discover from that and what it might imply by way of error rates or what it might imply by way of potential regulatory changes either in how you address some of these, are we putting too much reliance on operators and should there be some design changes. So, this was an area that we were exploring where we wanted to make use of our data from examinations and see what we could learn from it. So, we thought this was as close as you can get to the actual scenario. You've got the tension, the stress, the sweaty palms and everything else from the standpoint of the operators being evaluated, and we

were finding that the error rates were different than that which you would get out of handbooks or cookbooks.

So that's why this is being investigated. We feel that this is one that should be completed relatively quickly to see what we can learn out of it and whether it makes sense to continue to collect the data from our exams on failure rates and compare scenarios, et cetera.

MR. COFFMAN: (Slide) On page 17 there's a list of reports which compose methods or rules for use in improving the way the tech specs are evaluated using risk-based evaluation methods. The first two of these, on allowed outage times, surveillance test intervals were used already on the ABWR on the South Texas reviews. In addition, there have been over ten topical reports from the vendors on individual systems that these method were used in the evaluation. The dependent failures is a method to sort information available to us about different events for there being candidate, common cause events. So, it's a screening methodology.

The item there mentioned as checklists is for evaluating -- it came out of this work on trying to model the errors that occur during operator

formation of intent to act and it's a checklist for what makes events mentally or cognitively demanding. For example, such things as the sequence of queues that the operator receives, the time interval between the queues and maybe his predisposition to focus on safety systems when problems occur in the balance of plant. Then we're also maintaining this human error database that I mentioned before. By the way, the human error database, NUCLAR, also contains hardware failure rates, just for convenience of use or review.

COMMISSIONER REMICK: Just for clarification, I can conclude the way the words are in here that the Human Factors Branch is doing the risk-based tech spec improvement program. I assume that Research is doing that and you're talking about the human factors input to that. Am I correct?

MR. COFFMAN: No. Most of that work was done actually in the branch.

COMMISSIONER REMICK: It was?

MR. COFFMAN: And the branch used to be called Reliability and Human Factors Branch.

COMMISSIONER REMICK: Ah-ha. I see. Okay. But it's broader than human factors.

MR. COFFMAN: Yes.

COMMISSIONER REMICK: All right. Okay.

MR. COFFMAN: (Slide) As far as our plans, they're listed there. Report on the risk perspective of tech specs that require shutdown. We plan to complete the documentation of a report on the study of the risk impact of diesel generator maintenance experience that has occurred during -- actually it's already been used where we evaluated experience during power operations and we plan to complete the work by looking at experience during outages.

We plan to issue a handbook because these methods might -- because there might be an inventory of methods or there will be an inventory of methods on how to evaluate tech specs using risk-based methodology. We plan to issue a handbook to guide the reviewers as to which method might be appropriate.

Then if we analyze -- as we complete the analysis of the simulator portion of the requalification data, we're going to have characterized that data and then we're going to determine the feasibility of making inferences on human error rates. If that's successful, then there would be more work planned to follow-on and actually use a more empirically-based approach. If not, then that would define the limits, the capabilities of the

information we have.

(Slide) I'd like to go the last area, which is on page 19, which is a topic called performance of materials licensees and it addresses issues relating to actual and potential human errors in medical misadministrations and in unnecessary exposures during industrial radiography processes.

The research program at this point involves studying the functions and tasks performed during the medical application as remote afterloading brachytherapy, manual brachytherapy and teletherapy, and then the industrial radiography. This would include -- the research includes looking at procedures, the human system interface itself, the training involved, the organization and the management involved and then the impacts of malfunctions. We have draft reports on teletherapy and remote afterloading brachytherapy. Those have been completed.

If you look over on the next page at the plans, the plans include --

COMMISSIONER REMICK: Excuse me. Before you go to the plan, any major findings in the draft report?

MR. COFFMAN: Well, no, I don't think so,

but Jay, do you want to -- there are major findings, but whether they're surprises or not is --

MR. PERSENSKY: I'm Jay Persensky of the Human Factors Branch.

Yes, there are a number of findings in each of the areas that Frank mentioned as far as some weaknesses in training, weaknesses in the human system interface. One of the things that has come out, particularly because of the remote afterloading brachytherapy incidents that have occurred lately, is issued related to the treatment planning, the treatment planning computer and how it interfaces with the other systems. That seems to be across all the different types of therapy. So, there will be a number of recommendations that come out of these reports and issues that should be followed up on or addressed in the near future.

COMMISSIONER REMICK: Thank you.

COMMISSIONER ROGERS: How do you see a follow-up taking place? Say once your report is out and the findings are there, what do you see happening after that?

MR. PERSENSKY: Well, that will be dependent on the user office primarily, the follow-up in terms that we will provide the information to the

user office, NMSS in this case. We've talked about different kinds of things. Some might include further research. Others might include the use of voluntary standards or voluntary changes on the part of the industry. But perhaps Fred can address that better.

MR. COMBS: Right. We're currently reviewing the draft report on remote afterloading brachytherapy at this particular point. Where we don't have the results of that review yet, but what we envision is that by taking a look at the human factors aspects, it gives us another perspective to somewhat validate some of the things that we've seen or would see empirically. It could very well be that we may end up having to change procedures. We may end up requiring additional training, depending on exactly what we're finding as the source of serious error in the field of brachytherapy.

COMMISSIONER ROGERS: Well, I guess the question is is this work stimulating any kind of companion activities in the industry itself that would follow-on on this, or are we the sole players in this game?

MR. COMBS: At this particular point we appear to be almost the sole players. A member of my staff has worked with the Association for the

Advancement of Medical Instrumentation in looking at the human factors aspect of the design of medical devices. We understand that that work which is done by Amy will soon be the source of a new ANSI standard. So, there is work going on and we are a part of it, albeit a small part of this particular point.

COMMISSIONER ROGERS: Okay. Thank you.

MR. COFFMAN: There are always research findings, whether they're surprises or not.

(Slide) By way of completing this, on page 20, to discuss the plans, is to in fact complete the results on remote afterloading brachytherapy and teletherapy. But we have plans to do the work on manual brachytherapy, but that's pending some confirmation of the user need that has occurred recently, that has come up recently.

There has been an interest expressed in the development of an inspection method somewhat of the type like the human performance investigation process for use by materials licensees. So, that's potential work that is planned. NMSS is reconsidering the need for any future work on industrial radiography. The user need on that came out about the same time that the rule changed and so there's been evidence to show that might be effective, the rule

might be effective and no further research is needed.

I've covered a lot of items because the program is quite diverse. But if I were to emphasize the major items, I think I should say that this human performance investigation process has been a useful product that's come out of the work and it is affecting the way we do business, the way the Agency does business. The guidelines for the review of the human engineering aspects of advanced control rooms and displays has come out of the work and is currently being used for those reviews and then the methods for the risk-based evaluation of the tech specs as major products.

MR. KING: Thank you, Frank.

Let me just take two minutes and complete the briefing with a few words on the long-term outlook. We see a stable budget as projected over the next several years at about $6 million per year, as I had mentioned before. We anticipate over the next couple of years that the work in the branch is going to be dominated by user need requests. Beyond that point in time we think there will still be some user need requests, but like other research programs we need to start thinking about the long-term goals once we get over this hump of being dominated by user need

requests, things like identifying the long-term human factors needs, looking at what are the issues in front of us, human performance, advanced instrumentation control, man/machine interface, whatever it may be, what kind of staff and contractor expertise do we want to maintain, what kind of facilities do we want to have access to or maintain ourselves, what do we want to do with the human reliability database and also do we want to continue on and is there a need for additional work in the human reliability analysis development and methodology in that area. And continue to look at our involvement in standards activities and international programs. I think at this point these items are more questions on the table. We don't have any answers yet, but we would anticipate over the next year or to to be working on these and trying to come up with our long-range plans in this area.

With that, we complete the briefing and respond to any questions you have.

CHAIRMAN SELIN: Commissioner Rogers?

COMMISSIONER ROGERS: Well, have you ever suggested any studies or any additional information that might be brought to bear on our application here in NRR or NMSS that did not come from a user need

request?

MR. COFFMAN: I don't think so. I can't think of any. So much of this area kind of couples together that sometimes the user need will be focused in on one thing and through the conduct of the research and maybe even experiences that occur it will finally refocus a little to get at the heart of an item that wasn't explicitly called out in the user need. But no, I think most of it's driven by user needs and most of the items have been identified as user needs.

COMMISSIONER ROGERS: Do you say anything about the human cognitive reliability techniques that some people have been using and their possibly application here to some of these studies, in particular the one I noticed with respect to some question about the -- on page 11 of your report, research plan report, you mentioned the human system interface, that you couldn't seem to see a difference between different display types. I think that was where it was on page 11, but at any rate someplace in here. Have you thought about actually doing some studies using human cognitive reliability techniques there?

MR. COFFMAN: The work you're referring

to, I believe, is the work done at University of Illinois where we were looking to find a measure that would be used to evaluate the displays themselves. Those measures would be tied to how they affect operator performance. That was partially successful. It was not -- we were not able to tie it to the quantitative recall of the operators, but there was some indication it could have affected his ability to diagnose a problem.

So, that's going to complete it. But the work that is ongoing and appears promising is the work at Halden, looking at measures for the ability of the operator to remain aware of the status of the plant systems. It's referred to as situational awareness. So, there is work underway at Halden to explore a means, a method, to assess this and use it as a way to then evaluate designs.

COMMISSIONER ROGERS: I guess I'm just puzzled about this diesel generator testing program, where that fits in. I've often wondered why we couldn't ever come to closure on that thing. I see that it still turns up as part of your studies, the plans for the future report on the risk impact of diesel generator maintenance strategies. What's involved?

MR. COFFMAN: I'd like to ask Carl Johnson, who is project manager on that, to explain it.

MR. JOHNSON: I'm Carl Johnson. I believe we did come to closure on that. This report that's referenced here is to document some work which was -- the bulk of this was reported to you in a SECY paper last February on the proposed diesel generator rule where the question came up AEOD observed substantially higher maintenance unavailability of diesels than was used or was estimated at the time the original blackout rule was developed and what about that? NRR collected the data. This project evaluated it, found that there is a substantial amount of time out of service during operation and evaluated the risk of that. That was summarized in the SECY paper that showed that although maintenance unavailability is important, that diesel reliability is more important.

The thing that has not been done or it was not done at that time was what about the maintenance unavailability during plant shutdown and the risk significance of that. The data that NRR collected showed that diesels were out of service about 12 percent of the time during shutdown. The shutdown PRAs which are being done in another branch in

research have reached completion and this project and a couple of related projects are looking at what's the risk significance of that and, in particular, when is the better time to do different kinds of maintenance. That's being wound up now.

So, I think we are -- yes, we have reached closure on that.

COMMISSIONER ROGERS: Okay. I guess I understand what you're looking at.

That's all I have.

CHAIRMAN SELIN: Commissioner Remick?

COMMISSIONER REMICK: I found the use of the requalification exam error rates quite interesting, although those are not necessarily validated data. I don't know any better source of data than that perhaps. But it raised a question in my mind. Do we ever use our own simulators at the training center to do any research, although I realize we don't have certified or licensed operators there? We're probably using trainees most of the time. But do we ever use our own simulators for data acquisition?

MR. COFFMAN: Yes, we have and it was an attempt to again look for measures of how the design would affect performance. So, we have on a past

project. There are difficulties in scheduling and in reconfiguring simulators that are intended to retain a high --

COMMISSIONER REMICK: Yes. Okay.

Jim, I found it very helpful to have the various offices here at one time so we can get some specific examples or responses to questions. I found that very helpful.

As a general matter in all the research presentations, I'm always interested in knowing what you're doing. I become more interested when I hear why you're doing it and I become almost excited when I hear about results and uses. So, just as a general matter, I would ask that in the future you plan on giving us more specific results and how they're being used. I continue to be impressed how the Human Factors Branch, I think, is an excellent example of using a variety of research providers. You don't go just to one laboratory, national laboratory, but I think through the years you have used a variety of research providers, depending on what expertise they offered and I compliment you on that.

Thank you for the presentation.

COMMISSIONER de PLANQUE: I would also second the notion. If you can give us some nice juicy

results occasionally, I think it would be very interesting to all of us.

I'm wondering if you can give me a general impression. It's clear that some of the problems you're dealing with are unique to a power plant situation, whereas others are extremely general, like the effects of lighting, the effects of noise, sequence of computer commands and things like that. Can you give me some qualitative idea of how much of what you do can draw from research that's already out there and be applied versus research that has to start from scratch for your particular application?

MR. COFFMAN: Well, obviously, the first step we always take is to try and assess what is out there --

COMMISSIONER de PLANQUE: Right.

MR. COFFMAN: -- so we don't reinvent anything. I'd say in most cases, in the majority of cases that we find information available out there, but sometimes it has to be adjusted.

COMMISSIONER de PLANQUE: Given the fact that -- I'll follow-up on Commissioner Rogers' question, I guess. Given the fact that you often do this, comb the literature, it's also a little surprising to me that there's not more information

going back in the opposite direction, that most of what you're doing is coming from a user request rather than, "Oh, look what we discovered out there in the literature and you folks ought to know about it."

MR. COFFMAN: Well, I think it may not have come out in the briefing, but I think what you'll find is that there's a lot of interaction in the draft products and results as they come in are shared with the user offices and that's why we find ourselves sometimes in -- we're still finishing up the formal documentation of the report when the method is already being used. So, I think there is a lot of flow.

MR. RUSSELL: Let me add one other thing. That is I think as a result of the interactions, and I'm speaking now to the NRR/Research interactions, that there are a lot of times when you're not able to point to which individual in the dialogue back and forth identified the need, but once there's an agreement on our part that this is something that needs to be done, we generally document that and provide it to them in a user's request.

COMMISSIONER de PLANQUE: So your user's requests are easier to count than their ideas that come to you. Is that sort of what you're saying?

MR. RUSSELL: Well, no. I think part of

it also maybe goes back in the past in that there was a perception that was important to have the program office endorsement of the activity. So, what its genesis was is less important than the fact that both agree that this is something that needs to be done. So, the fact that there are a lot of user requests from NRR doesn't mean that we're sitting over here and thinking up all the research that needs to be done. It's more a two way street and there is a standing frequent meeting back and forth where they talk about the research products, what's going on and many of the people that are over there now used to be in NRR and it works both ways.

So, I would characterize this as one area that has been working well between the program office and Research. So, I'm sure that they could point to sentences and things that are in NRR user requests --

COMMISSIONER de PLANQUE: That sound familiar.

MR. RUSSELL: -- that were written by folks from Research.

COMMISSIONER de PLANQUE: Okay. Fine. Thank you.

CHAIRMAN SELIN: I have to admit to being a little bit puzzled at the end of this discussion.

I agree with my colleagues' remarks, particularly Commissioner Remick's remarks about on one hand the utility of having users and researchers here, although according to Mr. Russell you guys keep switching places, so I'm not sure who is who.

On the other hand, the characterization of the program I really find very confusing. Sometimes it sounds as if we have a budgety kind of -- oh, what shall I call it. It's not petty, but a cash fund. We've got $6 million to answer users' requests and the objective of the program is to do what we can within a given budget, which on the one hand is not a trivial amount of money, on the other hand if we're able to get some real insight into these very concrete questions on the human factors, given the enormous amount of work that goes into the engineering and the maintenance, it's certainly a justifiable amount of effort.

On the other hand, we talk about the program, about long-term goals and the program is years old. We still don't have the long-term goals and that makes it sound more like a self-starting research program that has a number of objectives which might be put out. But there aren't many results that are long-term results that are on the table. A lot of

the discussion about the objective is to validate methods. It's basically internal, validate methods and establish a database, et cetera. I wouldn't say it's research for research sake, but it is research, building up both methods and a database that could then be applied afterwards.

So, I really don't know, I don't know today, I didn't know when we had the meeting almost a year ago, exactly what kind of a human factors research program we have. Obviously it's some combination of these two, but it's still not clear to me the top down approach. A different kind of a discussion that talks a little bit less about the researchers speaking to research junkies and more from a point of view, "Here are the objectives we're trying to carry out. Some of it is customer satisfaction, some of it is internal. Here's how we're putting the resources together. Here's what we have found out. Here are the issues," would eventually be very helpful. In particular, there are some of these activities, particularly the database activities, that have been going on for a very long time. How do we know when we're done? Maybe we're never done. Maybe the idea is that we're just continually investing in a better database so we can gather the answers to the

users and as long as the users are satisfied, if they had to pay the bill themselves, then we have a good program or maybe we have some concrete objectives. But I have to admit that it's not that much clearer to me now than it was two years ago what kind of program we have, what drives it and how do we measure satisfaction. How do we know that we're doing a good job? How do we know that we're doing a reasonable job but could do better? It's just not that clear.

Now, this is not a huge program, so I'm not so much concerned about how we're spending one percent of our budget, although it's a fair amount of money. I am more concerned that everybody has identified management and human factors as the huge uncharted area at least of reactor performance and now with Mr. Combs here on the material side. The real question is how much of a dent are we making this area? Should we be doing more or less or are we doing the right thing by responding to the users' requests or should we have more of a research-driven program? At some point we really have to address those questions. Or maybe you just have to explain to me why it is clear to everybody else and it's not clear to me and then I'll go away happy. But I still have sort of -- it's an hour after a Chinese meal. It was

very tasty, but I have this empty feeling in my -- not stomach, but my mind at this point because I really don't know what we have in front of us and it's not the highest priority.

MR. TAYLOR: We'll take that challenge. We'll take that.

CHAIRMAN SELIN: Doctor Speis, did you want to add something?

DOCTOR SPEIS: No. We'll take the challenge.

I just want to add one point that you mentioned earlier, tell me more about the PRA aspects of human factors. The only thing I would like to say, that there are two aspects to a PRA. One of them is human errors in performing operations and doing tasks and what errors could be made that could lead to an event, and also during the event itself, what wrongful interventions can take place that could lead you to the wrong result.

In that area, the classic work that has been around for a long time has been a handbook by Swain, a cookbook as Bill mentioned earlier, and this has been based on Air Force data which was adopted to some extent to nuclear operations. So, one of the programs -- in fact, the bulk of our effort has been

to improve on that handbook, to come up with human errors that are more relevant to what's going on in the nuclear industry basically.

CHAIRMAN SELIN: But before you get off that, I had a question last year --

DOCTOR SPEIS: I was going to say one more thing about that.

CHAIRMAN SELIN: Okay. Sure.

DOCTOR SPEIS: The other thing was the other aspect is the organizational factors, whether we can point --

CHAIRMAN SELIN: I want to talk to the first part because you --

DOCTOR SPEIS: Go ahead. All right.

CHAIRMAN SELIN: And that is that I asked you last year, I didn't really get an answer then, I didn't get an answer now, what happens if we went away? Is the industry doing this work and are we doing -- are we just doing sort of regulatory confirmation or are we trying to do basic work that you would have expected the operators to be doing? If you can run a power plant, you're going to train dozens of operators, you would think that you would want the best factors yourself. Why does this fall upon us? Why is there such a gap out there or is

there a bigger program to which we're just doing the last ten percent?

DOCTOR SPEIS: I think quite a bit of improvements and understanding has been gained to make this data more relevant to nuclear plant operations. But even though that experience and that feedback goes back to the plants, we still see errors and problems coming up. The objective, I guess, like in every other area, is to keep improving and seeing --

CHAIRMAN SELIN: But I'm missing something. Is there a major industry-funded research program in this area and we're just trying to validate it or are we doing front line research that no one else has done?

DOCTOR SPEIS: I'm not so sure that there is any coherent and concentrated effort on the part of the industry.

MR. RUSSELL: I'm not aware of any.

DOCTOR SPEIS: We're doing most of the work in this area basically, yes.

MR. RUSSELL: In fact, because of the concern about human error rates, and this came up -- we had some very interesting information presented to us by the French regulatory authorities where they had spent literally 100 staff years or better running

experiments for the advanced control room and then running them on a hybrid control room and then on the Bugey control room simulators and looked at the error probabilities under normal conditions and under stress, and we found that these were significantly different than the kinds of numbers that were coming out of the handbooks that you would generate from the process of using either Alan Swain's methods or other HRA methods with the handbook data.

As a result of some of that uncertainty, what we've done is we've essentially requested that they do sensitivity studies as a part of the PRA reviews that are being performed for the advanced plant designs to try and look at the importance of the particular human actions, to see which ones are really important from a risk perspective. So, we're essentially varying the error rate from zero to one to try and get measures of the importance to overall risk of these tasks that have to be performed and then we're looking at it from the standpoint of whether that task should be automated or not to eliminate it and so we're using this as part of task allocation and that's the way we're using the tool because there is a great debate over what you use for numbers and what is the uncertainty when you're putting human error

probabilities in.

So, because of this lack of good data, we find that often we have to look beyond that, do sensitivity studies, look at other alternative approaches because you cannot put high reliance on recovery actions or some of these other things.

CHAIRMAN SELIN: Well, I'm not surprised to hear that say the vendors come up with some analyses and we have to do a lot of work to check that, to look at some sensitivities, to explain that. I am more surprised to hear that in terms of the operation of today's plants there isn't a lot more work than there seems to be going on funded by the industry itself to take a look at the effectiveness of their own training methods. I mean they spent a fortune on the training and the operations that result.

So, the question is is there more going on than we know about, is there not going on? Have they tried it and it just turns out to be very hard to invest money usefully?

DOCTOR SPEIS: No. We know that there isn't that much work because, for example, we're reviewing the IPEs now and the information that the people are using are that derived from this classic

Swain handbook. Okay?

CHAIRMAN SELIN: I see.

DOCTOR SPEIS: So, the reason I mentioned it is because a sizeable part of our work is focused in this area and trying to understand and improve better on human errors and then translate them into quantitative attributes.

CHAIRMAN SELIN: I'm very glad you brought that out. Obviously the less confidence you have in the supply of information, the more you have to be sensitive to the sensitivity of the use, the way these figures figure into the PRA. But if the situation is as you describe it, I guess I'm sort of concerned that we have this rather large research vacuum out there that we're trying to fill ourselves rather than also encouraging the license community to take steps to fill that on their own.

I did interrupt you, Doctor Speis. You were talking about organizational factors also.

DOCTOR SPEIS: Well, that's another area that there is nothing in PRAs right now as far as quantifying the effectiveness or non-effectiveness of organizational factors. That's where we discussed today we spend a sizeable amount of money, for example, something like between $4 and $5 million the

last three or four years and we have basically reached an impasse. That's the area that we're kind of taking an step back and trying to decide where we go now basically.

The point I was trying to make, that in some of these areas the work was kind of exploratory. It wasn't -- the answer wasn't obvious the moment we started pursuing those areas. So, unfortunately this work has those attributes, the human factors work. I guess I'm not trying to justify everything, but those things have to be taken into account.

MR. RUSSELL: I guess I could just illustrate how extreme the situation is. At the time we had our senior management meetings to review plant performance, one of the facilities that ultimately ended up identified as a facility that needed additional attention by the NRC has, if you believe point estimates, the safest plant based upon their IPE in the United States. So, you have the two extremes where the IPE is telling you one thing and yet on the other hand here's a facility that we're extremely concerned about from the standpoint of management performance errors and other things. So, that situation is one that exists and has for some time. We've seen that even back at the time of Zion, Indian

Point action plan and the concerns there where we were doing the PRA reviews at Indian Point and looking at the difference between the two units and there were very different performance between the two units and yet you could not recognize that through the PRAs that were being done.

CHAIRMAN SELIN: They must have hired the same people who did the RBMK PRAs.

Look, in addition to the point that I first threw out, which is what's the motivation of the program, I continue to be quite concerned about if this stuff is so terrific why are we the only people doing it, to put it in simple terms. So, I would add to Commissioner de Planque's consideration about the general literature on human factors not specific to nuclear plants, a concern about whether there is or if there isn't, why isn't there more work being done and sponsored not by other federal agencies but by the industry on the human factors work as applied specifically to nuclear power plants?

Maybe one of the alternatives is not so much to try to do this all ourselves. Maybe it is the most efficient way for us to do it and then in effect charge this back out to the industry through our fee structure with all its overhead. But maybe a better

way would be for the industry to take on some of these questions themselves directly and see if they can satisfy us with their results as well as our doing the work.

Fine. Thank you very much, Mr. Taylor.

(Whereupon, at 3:38 p.m., the above-entitled matter was concluded.)

CERTIFICATE OF TRANSCRIBER

This is to certify that the attached events of a meeting of the United States Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING ON NRC RESEARCH PROGRAMS ON HUMAN FACTORS
PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: 11-10-93

were transcribed by me. I further certify that said transcription is accurate and complete, to the best of my ability, and that the transcript is a true and accurate record of the foregoing events.

Carol Lynch

Reporter's name: PETER LYNCH

COMMISSION BRIEFING ON

HUMAN FACTORS

REGULATORY RESEARCH PROGRAM

NOVEMBER 10, 1993

CONTENT

BACKGROUND

CURRENT RESEARCH ISSUES, APPROACH, PRODUCTS, AND PLANS

- Personnel Performance
- Human-System Interface
- Organizational Factors
- HRA/PRA Methods & Applications
- Performance of Materials Licensees

FUTURE OUTLOOK

BACKGROUND

- HFB formed in 1987.
- Overall Objectives of HFB:
  - Develop technical basis for regulatory requirements/guidance in areas related to human performance
  - Accurately measure human performance
  - Provide staff expertise on human performance in commercial nuclear activities
- Human factors research driven by regulatory needs. Have received 100 regulatory need requests of which 42 are currently active.

AEOD	2 active requests
NMSS	4 active requests
NRR	36 active requests

BACKGROUND
Continued

- Regulatory needs change with research results and regulatory circumstances

- Current research program consists of 51 projects directed by HFB/RES (10 Project Managers) and involves 26 contractors (Gov't agencies, Nat'l Labs, private firms, universities) and international organizations

- Maintain interactions on human factors subjects:

  - formal (2 foreign countries plus domestic industry and government organizations)

  - informal (5 foreign countries plus domestic industry and academic organizations)

- Currently most of the active regulatory needs are being addressed in accordance with priorities from user offices

HUMAN FACTORS RESEARCH FUNDING

Topic	FY 1994
• Personnel Performance	$1,037K
• Human-System Interfaces	2,919K
• Organizational Factors	308K
• HRA/PRA Methods & Applications	1,258K
• Performance of Materials Licensees	976K
Total	$6,498K

PERSONNEL PERFORMANCE

- Issues
  - Over 50% of reportable events involve some form of human error:
    - -- Need for a standard inspection method to determine root causes of events involving human error
    - -- Need to characterize predominant areas of human error
  - Adequacy of plant staffing to handle significant events
  - Effects of plant environment on human performance
  - Fatigue effects of shift length and overtime

PERSONNEL PERFORMANCE
Continued

- Research Program

  - Involves learning from experience both in and outside the nuclear industry and studies of human performance

  - Will broaden staff's knowledge in areas related to human performance

- Recent Product

  - Human Performance Investigation Process; NUREG/CR-5455 (being used by inspectors during event inspections)

PERSONNEL PERFORMANCE
Continued

- Plans

  - Study of effects of shift duration and overtime on human performance; 2Q/FY94

  - Handbook on effects of environment on human performance; 2Q/FY94

  - Study of effects of hi-intensity lighting on Ops Center personnel; 4Q/FY94

  - Reports on basis for minimum staffing levels for current and advanced designs; 4Q/FY95

HUMAN-SYSTEM INTERFACE

- Issue
  - Digital control/display systems are being developed for use in current and advanced plants
    - -- What should be the technical basis for regulatory positions on the use of digital control/display systems in safety-critical functions
    - -- What are the effects on operator workload/performance
- Research program is directed toward the development of standards and guidelines for both software development and interface design, and considers existing standards/guidelines and experience (nuclear and non-nuclear)

HUMAN-SYSTEM INTERFACE
Continued

- Recent Products

  - Draft guidelines for human engineering reviews of advanced control rooms (Draft NUREG/CR-5908)

  - Report on lessons learned from test and evaluation experience on computer-based systems at Halden; HWR-336

  - Workshop on digital systems reliability and nuclear safety

  - Report on review of current standards for development of safety-critical software; NUREG/CR-5930

HUMAN-SYSTEM INTERFACE
Continued

- Report on evaluation of conventional software verification and validation techniques; NUREG/CR-6018

- Resolution of human factors generic issues on annunciators, local control stations, and procedures; NUREG/CR-5458 and 5572

- Graphic display software developed at Halden is being used at Technical Training Center to create displays of simulation data

HUMAN-SYSTEM INTERFACE
Continued

- Plans
  - Technical basis for digital systems in safety-critical functions
    - -- Develop technical basis for requirements on software error analysis; 2Q/FY94
    - -- Develop basis and guidelines for Verification and Validation of Expert Systems, 3Q/FY94
    - -- Report on lessons learned on verification and validation during software development at Halden; 4Q/FY94
    - -- Develop software audit tool prototype for use by NRC; 1Q/FY95
    - -- Report on safety attributes of programming languages; 4Q/FY95

HUMAN-SYSTEM INTERFACE
Continued

- Effects on operator workload/performance

  -- Complete guidelines for human engineering reviews of advanced control rooms; 1Q/FY94

  -- Reports on effects of computerized procedures on human performance; 3Q/FY94

  -- Assess effects of digital systems on operator workload; 3Q/FY95

  -- Report on lessons learned on man-machine interfaces with computer-based systems at Halden; 4Q/FY95

ORGANIZATIONAL FACTORS

- Issue involves the feasibility of (1) measures and criteria to consistently evaluate nuclear power plant organizational performance and (2) methods to translate organizational performance into risk

- Research Program reviewed work of others and focused on identifying organizational factors important to safety and their impact on risk

- Products

  - Identified organizational factors and developed methods to rate their relative importance. Tried at two plants; NUREG/CR-5538

  - Preliminary attempt at developing a methodology to quantify risk

  - Evaluation of research program; SECY 93-020

ORGANIZATIONAL FACTORS
Continued

- Plans

  - Monitor work of others in this area

  - Develop training for incorporating organizational factors into diagnostic evaluations

  - RES/AEOD/NRR are evaluating the feasibility and practicality of further research. Key questions:

    -- Validation
    -- Resources required for application

  - Recommendations to senior management this calendar year

HUMAN RELIABILITY ANALYSIS/ PROBABILISTIC RISK ASSESSMENT METHODS AND APPLICATIONS

- Issues include the need for methods to evaluate Tech Specs from a risk perspective and for means to improve and validate human reliability estimates

- Research Program

  - Focused on developing methods to evaluate Technical Specifications using risk assessment in the areas of surveillance test intervals, dependent failures, configuration of systems, and low-power/shutdown operations

  - Evaluating factors important to errors of commission.

  - Inferring error rates from data available from requalification examinations

HUMAN RELIABILITY ANALYSIS/ PROBABILISTIC RISK ASSESSMENT METHODS AND APPLICATIONS Continued

- Recent Products

  - Methods to improve Tech Specs using risked based evaluations:

    -- (NUREG/CR-5425), allowed outage times
    -- (NUREG/CR-5775), surveillance test intervals
    -- (NUREG/CR-5993), dependent failures
    -- (NUREG/CR-5641), configuration management

  - Checklist for evaluating conditions that could lead to human error in cognitively demanding events; NUREG/CP-0126

  - A computerized library of error probabilities; NUREG/CR-4639

HUMAN RELIABILITY ANALYSIS AND PROBABILISTIC RISK ASSESSMENT Continued

- Plans
  - Report on risk perspective of Tech Specs requiring shutdown; 2Q/FY94
  - Report on risk impact of diesel generator maintenance strategy; 3Q/FY94
  - Handbook of methods for evaluating Tech Specs; 4Q/FY94
  - Analysis of operator requalification data for error rates; 4Q/FY94

PERFORMANCE OF MATERIALS LICENSEES

- Issues relate to identifying actual and potential human errors leading to medical misadministrations and unnecessary exposures associated with industrial radiography

- Research program involves studying the functions and tasks performed during remote afterloading brachytherapy, manual brachytherapy, teletherapy, and industrial radiography

- Recent Product

  - Draft reports on human performance in teletherapy and remote afterloading brachytherapy

PERFORMANCE OF MATERIALS LICENSEES
Continued

- **Plans**

  - Reports on potential errors and preventive actions on remote afterloading brachytherapy and teletherapy; 2Q/FY94

  - Report on potential errors and preventive actions on manual brachytherapy; 3Q/FY95 (Pending confirmation of continuing user need)

  - Develop human error inspection methods for materials licensees; 4Q/FY95

  - Reconsidering the need for further research on industrial radiography in light of experience with the rule change to 10CFR 34

FUTURE OUTLOOK

- Five year plan projects stable budget at approximately $6 million per year
- User need requests will continue to dominate research program in FY94-96 time frame
- Beyond FY96 some user need requests are still expected
- Development of long term goals
  - Identify long term NRC human factors needs
    - -- Technical issues
    - -- Staff and contractor expertise
    - -- Facilities
    - -- Human reliability data base
  - Assess level of involvement in standards and international programs