# UNITED STATES OF AMERICA

# NUCLEAR REGULATORY COMMISSION

Title: BRIEFING ON ACCIDENT SEQUENCE PRECURSOR PROGRAM - PUBLIC MEETING

Location: Rockville, Maryland

Date: Wednesday, November 15, 1995

Pages: 1 - 53



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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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BRIEFING ON ACCIDENT SEQUENCE PRECURSOR PROGRAM

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PUBLIC MEETING

Nuclear Regulatory Commission
Room 1F-16
One White Flint Plaza
11555 Rockville Pike
Rockville, Maryland

Wednesday, November 15, 1995

The Commission met in open session, pursuant to notice, at 10:00 a.m., the Honorable SHIRLEY A. JACKSON, Chairman of the Commission, presiding.

COMMISSIONERS PRESENT:

SHIRLEY A. JACKSON, Chairman of the Commission
KENNETH C. ROGERS, Member of the Commission

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

KAREN D. CYR, OGC/NRC

ANDREW BATES, ACTING SECRETARY

JAMES TAYLOR, EDO

EDWARD JORDAN, DIRECTOR, AEOD

PATRICK BARANOWSKY, CHIEF, RELIABILITY AND RISK ASSESSMENT BRANCH, AEOD

PATRICK O'REILLY, SENIOR REACTOR SYSTEMS ENGINEER, AEOD

DAVID MORRISON, DIRECTOR, OFFICE OF NUCLEAR REGULATORY RESEARCH

ASHOK THADANI, ASSOCIATE DIRECTOR FOR INSPECTION AND TECHNICAL ASSESSMENT, OFFICE OF NUCLEAR REGULATORY RESEARCH

P R O C E E D I N G S

[10:00 a.m.]

COMMISSIONER JACKSON: Good morning.

The purpose of this meeting is for the staff to brief the Commission on the Accident Sequence Precursor Program. The Commission was last briefed on the Accident Sequence Precursor Program in 1993.

I understand that this briefing will include the background of the ASP Program, the results of the 1994 Event Analysis, and an overview of the current status of the program. I also understand that copies of the presentation are available at the entrance to the meeting.

Commissioner Rogers, do you have any opening comments?

COMMISSIONER ROGERS: Not at the beginning, thank you.

COMMISSIONER JACKSON: Mr. Taylor, you may proceed.

MR. TAYLOR: Good morning. This Accident Sequence Precursor Program was an early application of probabilistic risk methodology, and it certainly has benefited NRC understanding of the event risk significance since we started in the early 1980s. We, as you will hear today, the methodology is continuing to be improved. As we utilize it, we believe that these improvements will help with the results, and you will hear about that today.

AEOD relies upon the program and its independent review of operating experience to help assess the safety significance of events or conditions at nuclear power plants, and AEOD has the responsibility for program oversight.

NRR utilizes the ASP methodology for screening of events and conditions and research is responsible for the development of the methodology.

Each of those offices are here represented by Mr. Thadani, Mr. Jordan, Mr. Morrison, and Pat O'Reilly and Pat Baranowsky from the AEOD staff are part of the presentation today.

Mr. Jordan will continue.

MR. JORDAN: Thank you.

We did last brief the Commission directly on the Accident Sequence Precursor Program in 1993, although we have had recently three briefings that had some comments about the Accident Sequence Precursor Program, the 1995 PRA Implementation Plan briefing identified as an element of the ongoing PRA-based program to assist in evaluation of event risk significance. The April 1995 proposed rule on reliability and availability data identified ASP as one of the PRA activities which would benefit from equipment performance data. In the August 22 briefing on changes to performance indicators, during that briefing we discussed the contribution sequence coding and search system makes to screening of events for subsequent ASP evaluation, and we discussed the role that ASP type analysis is projected to have in augmenting the significant events performance indicator with a risk perspective.

The first slide is up and, Madam Chairman, you have already identified the agenda we are going to be covering. I would like to recognize the excellent technical cooperation between the three offices in ASP and through the technical coordination group. That is a very effective mechanism to attain that level of cooperation.

I will now turn it over to Dr. Pat O'Reilly who will make the presentation and Pat Baranowsky and I will respond to questions.

Thank you.

MR. O'REILLY: Thank you, Ed.

May I have the next visual, please.

There are several objectives of the Accident Sequence Precursor Program. Two of them are original objectives, and the remainder have evolved over the years as our knowledge and our expertise in applying the ASP methodology has increased.

First of all, it identifies and ranks the risk significance of operational events. It also determines the generic implications of an operational event and characterizes risk insights. It provides supplemental information on plant specific performance. It provides a check with PRAs. In this sense, it is right now a goal. The staff, informally, on a case-by-case basis is doing this.

It also provides an empirical indication of industry risk and associated trends.

COMMISSIONER ROGERS: Just before you leave that, how is that information being provided? What is the mechanism? I noticed in the SECY 95-269 a table year-by-year of the different levels of events that might have occurred, and that is kind of a dramatic indication of a real diminution of these events.

Has that, or something like that, been communicated to the industry and to the public? Do you know what I am talking about by this table?

MR. JORDAN: Yes, I do. We have read those findings, and we have used it in a number of briefings, regulatory information conferences to indicate that there is clearly a decline. Pat is going to discuss some, I will say, somewhat subjective information in terms of numbers and types of events compared over a ten-year period that will make that clearer. We are very interested in developing, I would say, a rigorous methodology that would let us convey more clearly the change in risk, and we are not there yet. We, I think, mentioned it during the performance indicator discussion. I hope we are about two years away.

COMMISSIONER JACKSON: We will come back to that question.

MR. JORDAN: I am sure.

MR. THADANI: In fact, every time we have a regulatory information conference, this is presented during the plenary session when everyone is present, just to indicate trends. I think, as Ed said, there are other issues, of course.

COMMISSIONER ROGERS: Well, that's fine, but I do think some kind of a publication of it is also worth doing. If that is the only communication we have, it hits those people that are there, and so on and so forth, but it would be nice to have some kind of a document that contains that that is a public document.

MR. JORDAN: Right. Our annual AEOD report does compile those, and we would continue to do that. We have made comments in our annual report to Congress that we submit, performance indicators.

COMMISSIONER JACKSON: Is that also available in the public document room?

MR. JORDAN: Yes.

COMMISSIONER ROGERS: Thank you.

MR. O'REILLY: May I have the next visual, please.

There are several definitions in the ASP Program which are important. First of all, accident sequences of interest. Those are sequences which, if they had occurred, would have led to inadequate core cooling and potential core damage.

An accident sequence precursor is an event or a condition which is an important element in those sequences, such as an unusual initiating event or failures or multiple components which, when coupled with one or more postulated events, can result in severe core damage.

There is a term which is not on this slide which is important for some of the discussion we will have a little bit later, and that is conditional core damage probability. That is the conditional probability of core damage given that a failure or failures did occur.

The threshold in the ASP Program for conditional core damage probability is 1.0 times 10 to the minus 6. Any event that has a CCDP that is greater than that value is termed a precursor in the ASP Program.

There are also a number of events which we categorize as containment related event. Currently the ASP Program does not have the capability to analyze those types of events, but they are identified in the annual precursor report. Those are any events that include failures that could degrade or fail containment performance.

COMMISSIONER ROGERS: Do you draw any distinction between core damage and severe core damage in the use of those terms?

MR. O'REILLY: No.

COMMISSIONER ROGERS: No. So they are interchangeable?

MR. O'REILLY: Correct.

COMMISSIONER ROGERS: Core damage and severe core damage are essentially interchangeable?

MR. O'REILLY: That's right.

COMMISSIONER JACKSON: Let me ask you a question now, when you talk about the 10 to the minus 6 probability, are you looking at a particular sequence and you are looking at a particular branch probability and if that probability is, in fact, greater than 10 to the minus 6, then you include it as a precursor?

MR. O'REILLY: Well, you have asked me to get ahead of my presentation, but I can tell you that we will walk you through an example of the ASP methodology in just a few minutes, and I think it will make it clearer than if I just tried to respond to you without a visual.

COMMISSIONER JACKSON: Fine.

MR. BARANOWSKY: It is mostly yes, though.

COMMISSIONER JACKSON: Mostly yes.

MR. BARANOWSKY: I mean, the sequence probability is what we are talking about.

COMMISSIONER JACKSON: All right.

MR. O'REILLY: May I have the next visual, please.

A brief historical background of the ASP Program. The program was started in 1979 in response to the peer review of WASH-1400, the reactor safety study that was conducted by the Lewis Committee. Initially, Research had the responsibility for the ASP Program. They developed and issued the first two precursor reports.

The first report generated a great deal of concern among the industry when it was issued in 1982. The program matured as the techniques and the methodology was refined to respond to the comments received on the first report, and gradually the program matured and the responsibility for the program was transferred to AEOD in 1985.

MR. JORDAN: I would make a comment that it is kind of interesting to look back, and when the ASP Program was initiated it was a very controversial program. There were great concerns of the misuse of this kind of data with very simple event trees and limited numbers of models. The industry and the scientific community at large were concerned about it in terms of potential adverse effect.

MR. O'REILLY: Since its inception, the ASP Program has processed more than 50,000 LERs and has identified and documented about 585 precursors in the precursor reports.

May I have the next slide, please?

This slide shows the first cut of the ASP Program. The first two reports which covered the periods 1969 through 1979, 1980 and 1981 represent a look back into time after the Three Mile Island accident. In these reports, the ASP Program identified the more important events of these two periods as significant precursors. In that respect, I am talking about precursors that had a conditional core damage probability greater than 10 to the minus 3.

This slide shows five of those precursors. There were 19 others. This is a large number of significant precursors. They represented more or less a flag that the industry and the regulator alike had to do something or we were headed for trouble. Although these events had already received some regulatory action, the ASP Program provided a risk perspective of these events that had previously been missing.

Compared to the types of precursors that we have seen recently, these events were quite significant. Each of the events listed on that slide conveys an important lesson to the regulator and to the industry alike. For example, the 1974 Turkey Point 3 event pointed out the importance of the auxiliary feedwater system.

The 1975 Browns Ferry precursor showed the importance of cable separation for trains of redundant systems, and it also led to the promulgation of Appendix R to 10 CFR Part 50.

The 1977 Davis-Besse precursor was a precursor to the TMI 2 accident. The 1978 Rancho Seco precursor was the famous lightbulb incident. It highlighted the safety significance of the coupling between the secondary side systems and the primary systems.

The 1980 Crystal River 3 precursor also involved problems with the non-nuclear instrumentation system, but in addition it resulted in discharge of about 42,000 of coolants into the containment because the high pressure injection was left on for a long period of time. This pointed out the need that led to establishing a set of ECCS termination criteria for recovery from transients.

May I have the next visual, please?

From 1984 on, the ASP Program has monitored the operating experience of U.S. plants, and has identified the most important events from a risk significant standpoint on a yearly basis. The ASP Program was instrumental in clarifying for the staff the relatively high risk significance of two of these precursors, the Shearon Harris long-term HPI unavailability and the Wolf Creek shutdown event which occurred last year. I will say more about the

Wolf Creek event a little bit later.

Note that the conditional core damage probability for these most significant precursors exhibited a drop during the period 1986 through 1994. In other words, the higher numbers were no longer as high as a lot of the precursors that we had seen in the pre-1984 time period.

One other note, that is, the number of significant precursors also decreased, whereas there were 26 between 1969 and 1981, since 1984 there have been seven.

May I have the next visual, please?

I will now give you a brief overview of the ASP screening review and analysis process. First of all, the screening step. LERs represent the largest source of operational experience data for the ASP Program. They are not the only source. The sequence coding and search system, LER database, is screened by a computerized algorithm to identify LERs or events that are candidate precursors using search criteria which look for failures in a plant that provide protective functions for the plant against certain core damage related events.

Since this algorithm was put in use in the program in 1991, it has proven to be a very useful tool. Prior to its development, it was necessary to manually screen every LER that was received. Out of a total number of LERs that are submitted to the NRC each year, about one-fourth of the

LERs are screened out by this algorithm.

As I said, LERs are not the only source of candidate precursors. Any the event that is reviewed by either an incident investigation team or an augmented inspection team is automatically put into the ASP review process. Also, any event that the NRC staff designates as a significant event is put into the ASP review process. The results of NRC's daily screening of operational events also gets fed into the ASP process. NRR also performs selected prompt assessments of operating events and the results of those assessments are fed into the process.

Finally, any event identified by the NRC staff, regardless of its documentation, it could be a 10 CFR 50.72 phone call, could be in an inspection report, that gets fed into the review process as well.

COMMISSIONER ROGERS: Looking at that list, is it possible to analyze it for those sources which seem to be most important and most useful, or can't you say anything about that? In other words, can you prioritize these sources of candidate precursors in some way?

MR. O'REILLY: Yes. Definitely, most of them come from LERs, less than 5 percent actually have no other documentation -- I'm sorry, do not have an LER associated with them eventually.

COMMISSIONER ROGERS: And those would be fed into the SCSS program?

MR. O'REILLY: They are fed into the ASP Program directly. The LER information comes from the SCSS Program, yes.

COMMISSIONER ROGERS: I see, backwards. Okay.

MR. BARANOWSKY: Some 50.72s may be an early heads-up to an event which eventually has an LER. So I think when we say LERs are the primary source, there may be 50.72s that got us started early on it also.

MR. O'REILLY: Right. We prefer LER information because a 50.72 report, since it is very preliminary, certain details may have changed, circumstances may have been somewhat different.

COMMISSIONER JACKSON: And they don't have the full root causes analysis.

MR. O'REILLY: That's correct.

The next step in the process is an engineering review of every selected event. Right now, every LER or event is reviewed independently by two engineers against predefined criteria. The purpose of that is to determine whether this event has potential risk significance and is worthy of greater detailed analysis.

COMMISSIONER JACKSON: Now these engineers, are these our engineers or are these the ones at Sandia?

MR. O'REILLY: There are contractors. Right now

Oak Ridge National Laboratory is the prime contractor for most of the ASP Program work. The yearly screening is done at Oak Ridge. Sandia National Labs is performing the analysis of events which occurred in 1982 and 1983 to fill in the gap that exists right now in the ASP database.

Each event that is recommended for detailed analysis is then analyzed and quantified. Quantification consists of calculating the conditional core damage probability, and any event whose CCDP is greater than 10 to the minus 6 is documented and the results of the preliminary analysis are then sent out to the affected licensee, to the NRC staff, and to an independent NRC contractor for peer review.

Each comment that we receive from that review is evaluated and, if necessary, the event is reanalyzed. The final analysis is then reviewed by our independent contractor and then the final analyses are put together in the annual report, and the report is issued.

MR. JORDAN: We may be understating the reviews that the staff do and the analysis that the staff does. NRR in real time uses the ASP methodology to evaluate events on a very timely basis. My staff also do preliminary ASP analysis to identify an issue. The Wolf Creek event that we will talk a little more about was one of those, that early screening was very helpful in identifying, this is truly a risk significant event that is not being given the right attention. It is very useful tool for the staff.

COMMISSIONER JACKSON: So what really is distinguishing what you are doing in some sense from a full blown PRA has to do with the frequency of the initiator; is that right? I mean, you don't have that in your analysis?

MR. JORDAN: We do use --

COMMISSIONER JACKSON: You are calculating a conditional core damage probability

MR. JORDAN: Right, given the event that happened.

COMMISSIONER JACKSON: Not a core damage frequency?

MR. JORDAN: That's correct.

MR. THADANI: What you said is correct.

By the way, I also want to expand on what Ed said. When 50.72, .73, reports come in and so on, there is actually a group of people, it is sort of a multi-disciplinary group of people, and AEOD also participates in that process. They first take a look and decide if the event is significant or not. One person in that group is someone who has PRA background, knows how to do ASP analyses and so on. So the initial cut is done in-house on a number of these events, and if the decision is made that we ought to do a quick ASP type analysis, then that is also done in-house.

The results of those analyses are actually fed into AEOD follow-on activities, so that we don't recreate what has already been done, unless things have changed. So that information is, in fact, looked at again by AEOD subsequently. So the initial cut on these events as they come in is done in-house.

COMMISSIONER JACKSON: Okay.

MR. O'REILLY: That is what I referred to as NRR's prompt assessments.

COMMISSIONER JACKSON: I see.

MR. O'REILLY: The last four steps in the process are currently being evaluated to determine how they could be streamlined to make the overall process more efficient and maintain, at the same time, high technical quality.

May I have the next visual, please?

This is a pictorial example of entry which was used in the precursor analysis of the Shearon Harris HPI unavailability. What it does, it allows you to map the various sequences that could occur onto a format that allows it to be quantified. The headings at the top represent the functions that must operate or must be successful in order to prevent core damage. They are the initiating event, which is a loss of coolant accident, reactor trip, auxiliary feedwater, main feedwater, high-pressure injection, high-pressure recirculation, and opening of the pressurizer PORV.

In the Shearon Harris case, the event was analyzed as an unavailability of both trains of emergency core cooling in the high-pressure injection mode for a period of one year. And the frequency of the LOCA was converted into a probability of the LOCA occurring during that period, and that turned out to be about 6.3 times 10 to the minus 3.

Now, the reactor trip function is a very highly reliable function. Going up on an event tree denotes success, so in the particular case of the Shearon Harris event, the HPI function was found failed. We assumed it was failed, so we input a probability of 1 for the failure of HPI. The probabilities of success of aux feed and the reactor trip function are almost 1 because they are the complement of a very small number. So when you multiply out the various probabilities at the branch points in that event tree, you get 6.3 times 10 to the minus 3.

The other sequences do not contribute very much because their CCDP is so small. You then add them up, and the total in this particular case is the same as that dominant sequence, 6.3 times 10 to the minus 3. That is how a condition or an unavailability is handled.

The calculation for an actual event that occurs is very similar, except you assume the event has occurred, so the probability of its occurrence is 1. That is the biggest difference.

MR. THADANI: Let me make a comment on that because it sort of comes back to what Commissioner Rogers indicated earlier, core damage and severe core damage. Basically when you get a point where you say you have inadequate core cooling, you then go on and assume that that is really going to lead to substantial damage.

In this case, it may have been, in fact, that the HPI could have delivered some flow to the core, and that that would require fairly extensive thermal hydraulic analysis to see what kinds of small breaks you might, in fact, be okay for. Whereas, there are others that you wouldn't be able to deal with. So there is a certain amount of conservatism in these analyses that way.

MR. BARANOWSKY: That's true, although we are trying to eliminate as much conservatism as we can.

I might also point out what looks pretty simple here, 1.0 for up and down on the different events. The engineers on this had to take some time to take a look at the description of the event to understand how the system would fail and whether it would satisfy the accident sequence function that we were talking about over here. The event tree depiction is fairly simple, but what goes into deriving the conditional failure probability sometimes is not, especially if human performance issues, including recovery, get tossed into the pot. So sometimes these things can take a fairly extensive amount of evaluation of each event, each branch on the tree. So we picked an easy one for you this time.

MR. JORDAN: But I think it is important to make the point that the event report was a rather benign report. The review by the region and by the staff of the event in real time did not indicate this was a significant precursor at all. And so it was the more methodological subsequent review that raised the flag and said, this is one that our normal process missed. So this illustrates the value of doing this in a rigorous fashion because we really simply missed it from a deterministic level of review. It wasn't one that rose high in significance.

COMMISSIONER JACKSON: Well, you know what is interesting, though, is there are two significant aspects to it. One is that essentially because the high-pressure injection system was unavailable, that is, in a way, a huge dominating factor in this particular sequence, coupled with the probability of a LOCA to start with, basically.

MR. JORDAN: Right. It seems blatantly clear, but the report and the initial review indicated a problem with the miniflow line. It didn't indicate that the HPSI system was unavailable during that time. So it was pulling the string and then going from, how does the miniflow problem affect the operability of the system that the real significance came out.

COMMISSIONER JACKSON: I see.

MR. JORDAN: This was the point I was going to try to make. It concentrated strictly on the miniflow line condition.

COMMISSIONER JACKSON: The question is, what is root cause?

MR. JORDAN: Right.

COMMISSIONER ROGERS: It reminds one of the story, you know, how did things go? Everything was all right except the dog died. When you go back to why the dog died, the house burned down.

MR. O'REILLY: May I have the next visual, please?

Now we move into the results of the precursor analyses of 1994 operational events. These are presented according to power level. We have divided them up into those precursors which occurred or could have occurred during power operations, and those precursors which occurred and only could have occurred because the plant was shutdown.

We have further subdivided those categories into precursors that involved conditions or unavailabilities of safety equipment, and precursors that involve actual initiating events.

The precursor in the at-power unavailabilities group with the highest CCDP is the Haddam Neck condition.

It involved degraded pressurizer PORVs and it degraded 480 volt vital bus.

This is the second year that the vulnerability of the plant's electrical distribution system has led to a precursor. Since the 1994 precursor occurred, the Haddam Neck licensee has taken measures to fix the problem permanently. The plant's PRA had also identified the same vulnerability as the dominant contributor to plant risk, and the ASP Program results have confirmed that.

May I have the next visual, please?

The next slide shows the continuation of the at-power precursors with unavailabilities.

May I have the next visual, please?

This visual shows the results from the 1994 ASP analyses for at-power precursors that involved an initiator and it shows the one precursor which occurred during shutdown. I will say more about the Wolf Creek event a little bit later.

COMMISSIONER JACKSON: It has the highest probability, I note.

MR. O'REILLY: Not just that, I can go into it now.

May I have the next visual, please?

Some of the insights that were gleaned from the 1994 ASP results, as you pointed out, Madam Chairman, the

Wolf Creek shutdown event did have the highest conditional core damage probability for 1994, and that is the highest CCDP that we have seen in the program since 1991 and the Shearon Harris condition.

MR. JORDAN: It probably also has the greatest uncertainty.

MR. O'REILLY: That's correct. There are a lot of parameters that affected the outcome of this analysis, one of which was the human performance analysis, a lot of uncertainty in that. There is also lots of uncertainty about the viability of the so-called "reflex cooling method" for getting water back into the core region from a boiling core, being the condensation from the steam generators, and there is also uncertainty about the behavior of the reactor coolant system under those conditions. We did not have a very good handle on that. So, consequently, the estimate of CCDP in the case of the Wolf Creek event has a large uncertainty associated with it.

COMMISSIONER JACKSON: Okay. I am going to come back to ask you a question about that.

MR. THADANI: I would like to comment on that. We also found this event was significant. There are two things, as you know, drain down events during shutdown are of concern and, in general, they are being addressed as part of our shutdown rulemaking activity. But this event seems to us to be significant enough that we are looking at showing generic communication to make sure that the -- an information notice was issued, of course, but I think we want to make another step, issue a generic communication, and then we would followup with some temporary instruction to make sure that attention is, in fact, being paid to events like this. We didn't think it was appropriate to wait until shutdown rulemaking activities get finalized.

MR. O'REILLY: Most of the precursors for 1994 involved problems with electrical equipment. In fact, seven out of nine had that trait. This is consistent with the ASP results over the last five years when we find that about 60 percent of the precursors on the average involve electrical equipment problems of one type or another.

We also observed that the number of precursors that involved initiators has continued to decrease. In 1992, there were 12 of these. That went down to eight in 1993, and now we have two for 1994.

COMMISSIONER ROGERS: Any thoughts on why?

MR. JORDAN: Well, the overall trip rate is down for plants, and so it is in that same sort of line in terms of the initiators. The feedwater transients are those things that initiate a sequence of events, their frequency is down.

COMMISSIONER ROGERS: Do you think it is just a collection of improvements that has given rise to this?

MR. JORDAN: Yes.

MR. TAYLOR: I think it is a collection.

MR. JORDAN: Operational reliability reduces those.

COMMISSIONER JACKSON: Right, the trips.

MR. O'REILLY: Next, I would like to give a very brief overview of the Commission paper that we submitted on the status of the ASP Program which is designated SECY 95-269.

One important aspect of the program which we feel has really helped the success of the program has been the interoffice technical coordination group. Ed referred to it in his opening remarks, and I can't emphasize the role that this group plays enough. It meets monthly. We discuss the results of analysis of operational events. We get feedback from NRR. We keep our finger on NRR's pulse. We know what they are dealing with in terms of important events. It also gives an interoffice coordination for guiding research programs.

One of the things that the interoffice technical coordination group did was recommend that various model and methods development efforts be coordinated in research. That was done and we coordinated the transfer of some projects from other offices to research.

The 1994 precursor report is scheduled for publication in late November. The screening review and analysis of 1995 events began in May of this year, and that is the earliest that such a process has been initiated during the year.

The review and analysis of 1982 and 1983 LERs to fill in the missing ASP data is winding down at Sandia National Laboratories. A draft report is scheduled for submittal in late November. This effort used current models. It used current search and review techniques. As a result, the preliminary results indicate that there will be a larger number of precursors than we found in either 1981 or in 1984.

COMMISSIONER ROGERS: Can you just say a bit about the interoffice technical coordination group, how many people are involved in that?

MR. O'REILLY: Commissioner Rogers, it is around 10 or 12.

COMMISSIONER ROGERS: Total?

MR. O'REILLY: Correct. We have several representatives from each office and from each branch within the office that deals with PRA or performs the risk assessment of events on a daily basis.

COMMISSIONER ROGERS: Is that a fixed collection of people or do you designate people depending upon the event?

MR. O'REILLY: Usually, it is the same group, but the same group is doing the work internally anyway. If we find that someone else is interested in the ASP methodology, the application of the methodology, we reach out and bring them in. But basically it consists of representatives from the two branches in NRR who are using the ASP methodology in their daily assessment of events, staff from our branch in AEOD and staff from the PRA branch in research.

COMMISSIONER JACKSON: I noted that you mentioned and you have on your slide that the models and methods development is now centered in research, and you have been talking about the interoffice technical coordination group. I guess the question I would have is, is there coordination at high levels between the offices in terms of looking at not just ASP but looking at it within the context of PRA and its propagation throughout the agency, and that there is consistency of approach and standards?

MR. JORDAN: I would say yes, and I would ask my associates.

COMMISSIONER JACKSON: Who comprises that group?

MR. JORDAN: The three of us, in part, and then our division director and branch chiefs are involved in the PRA Program plan development. So these things are flowing very, very nicely from top level management.

COMMISSIONER JACKSON: And the three of your are working together in developing this overall PRA framework for the agency?

MR. JORDAN: Yes.

MR. THADANI: Yes.

COMMISSIONER JACKSON: Okay. I am going to put you on the record on that.

COMMISSIONER ROGERS: One could ask a nasty question like when was the last time you met together?

COMMISSIONER JACKSON: I am not even going to do that.

MR. JORDAN: What we have is a working group that meets, what did you say, monthly, Pat?

MR. BARANOWSKY: The PRA coordinating?

MR. JORDAN: Yes.

MR. BARANOWSKY: Yes, monthly.

MR. JORDAN: And I called them a luncheon society at one time, but I like it. They are close technically and also organizationally, and that is who brought you the PRA program plan and policy statement and gets coordination on all PRA related activities. So I identify it as a model in your shop.

MR. O'REILLY: To continue, in the area of new model development, we developed a set of simplified plan-specific models which were used for the first time in the

ASP Program in the analysis of 1994 events. We made several improvements to models and methods. We are constantly striving to obtain models or develop models that are more realistic.

May I have the next visual, please?

MR. JORDAN: Could I back up a little to the models, and we sort of urged Pat to rush through that. I would want to state that the models, although they are not detailed PRAs, we do have a site-specific model for every site. So it is I think a reasonable level of detail with respect to the plant configurations now, whereas when we started the program they were extraordinarily generic and broad models that had to be tuned each time you used them for a specific plant. So I think that is a very beneficial improvement.

COMMISSIONER ROGERS: Did you say you have one for every plant now?

MR. O'REILLY: Every site.

COMMISSIONER ROGERS: Every site.

MR. O'REILLY: Right. We have 75 plant specific models. We have one for every site. Obviously, for Millstone we have three models.

One other thing I would like to add to Ed's comment there, and that is, we are striving for realism. In the comments that we receive from licensees, oftentimes they refer to their own PRAs or their IPEs in generating their comments, and the PRA/the IPE has been a very useful tool. That is one of the improvements that we are making to existing models. We reviewed IPE results to see if any equipment that had not previously been included in our models had been added to the plant as a result of an IPE, and we have identified those and those will be incorporated in the models in the future.

For 1995, we are implementing a new strategy to improve the timeliness of the final ASP analyses being available generally. What we are doing is, the preliminary analysis will be performed as usual. We will send the analysis out to the licensee, the staff, and to our contractor for comment. As soon as we receive the comments from those sources, we will develop and complete the final analysis.

At that time, we will send it to the licensee for their information and release it publicly. So these will be done an individual basis rather than waiting until the end of the fiscal year and putting together a large report. At the end of the year, when it is time for us to report to you on the status of the ASP Program, we will simply compile the final analyses that we have sent out during the last 12 months and put a cover on it and issue that as a NUREG CR report.

COMMISSIONER JACKSON: So this is going forward change?

MR. O'REILLY: Yes, it is. We hope to reduce the time between an event's occurrence and when the final analysis is issued from the current 10 to 22 months to six to eight months.

COMMISSIONER JACKSON: That would also be particularly important if you could also add on to it any generic implications, because if there are, you would want to get those out.

MR. JORDAN: Exactly, yes. We learned a lot lessons out of the Shearon Harris event popping up because it popped up in the contractor's report. We said, well, what was Shearon Harris. So we really need to have that kind of information in real time and that is one of the reasons for moving this up to a very short response time.

MR. THADANI: And a few other plants actually have the same miniflow design. So we did followup on that for those plants.

COMMISSIONER ROGERS: Well, that is quite a significant change in timing. What makes it possible for you to do that? I mean, do you have to add more people? Does this maturation of your PRA models make it possible to do that? It is a big jump from six to eight to 10 to 22.

MR. JORDAN: Right. I would say that 1995 was a high spending year with regards to ASP because we both filled in the two missing years, and you might say we did analyses for 1994 and started 1995. So we got spending support from the Commission and the EDO to move it up in that fashion. So we put more contractor work on it and more staff work on it. The cost subsequently will be equal to or less than, once we have gotten back to equilibrium.

MR. BARANOWSKY: Plus we did a critical path analysis, if you will, of our whole process, and looked for dead bands and eliminated them, or we are trying to eliminate them.

MR. O'REILLY: May I have the next visual, please?

Finally, a word about future plans. The future plans for the ASP program include continuing efforts to shorten the time between the occurrence of the event and the availability of the final analysis. We want to incorporate the estimation of consequences into the ASP quantification process. That is scheduled now for some time late in 1997.

We want to improve the analysis capability so that the ASP Program can look at and consider uncertainties, support systems independencies. We want to improve the treatment of common cause failure and improve the analysis of human performance during recovery. Those are scheduled to be completed and incorporated in the models sometime in 1998.

COMMISSIONER JACKSON: Let me ask you a little bit of questions on the uncertainties. The uncertainties and incorporating them into quantification depends on many things.

MR. O'REILLY: That's right.

COMMISSIONER JACKSON: Updated data, it depends on the models you use. It depends on what kind of statistics you use. Can you comment a little bit about that?

MR. O'REILLY: Well, this particular uncertainty that we are talking about here is parameter uncertainty and the basic events that are in the models. There is also process uncertainty which is related to how you perform the analysis.

COMMISSIONER JACKSON: What kind of statistical distributions do you end up using?

MR. JORDAN: Currently we are using point estimates in our analysis.

COMMISSIONER JACKSON: I see, so you use point estimates.

MR. JORDAN: But I believe we go into some sort of a Bayesian update approach.

COMMISSIONER JACKSON: Right.

MR. JORDAN: And exactly what distributions we would use, I can't say but they would probably be empirically derived.

COMMISSIONER JACKSON: Because those distributions, as you are doing your update, your Bayesian update, it is model-dependent, but we can talk about that as a separate topic. You should know, I gave a talk at MIT recently on PRA, and so I have been digging into this. That makes a Commissioner or Chairman very, very dangerous.

MR. JORDAN: Well, I have to tell an anecdote about the risk values and the uncertainties with the Wolf Creek event, and my staff will cringe. I asked, once we had established that this seemed to be a pretty bad event, to get a preliminary estimate. So there was an awful lot of foot shuffling. Finally, the staff came back and said, well, it was somewhere between 10 to the minus 2 and 10 to the minus 5. I said, well, everything is. But we finally did get to a value.

MR. O'REILLY: The last two points, we also want to include the capability to analyze shutdown and low-power events. We have a development effort underway now. That should be completed, and we will be able to incorporate the methods into our models in early 1998.

We also want to have the capability to analyze external events and conditions or, rather, the vulnerabilities to certain conditions such as fires, floods and seismic events. That is also underway and is scheduled to be completed in mid-1998.

COMMISSIONER JACKSON: Let me walk you through a couple of questions I have. Has the ASP Program identified any previously unrecognized vulnerabilities that could lead to a core damage accident?

MR. O'REILLY: I think you could point to the Shearon Harris event as one example and Wolf Creek also.

COMMISSIONER JACKSON: And I there a process for having any specific information that comes out of these analyses fed back to inspectors?

MR. THADANI: There have been isolated cases where things have come out and they have been fed back into the inspection procedures, particularly if something important comes out. Sometimes what we do is, in order to make sure there is heightened awareness, we issue what we call temporary instructions, and they would highlight what the issue were, what we found, and why it was important for the resident inspectors to go take a look at certain areas.

COMMISSIONER JACKSON: It is kind of on a judgment basis at this point as opposed to some specified methodology?

MR. THADANI: It is largely on a judgment basis, that's right.

MR. JORDAN: I would add that the training program accepts the precursor events and then uses it in subsequent training as these are events of interest and are significant from the standpoint of risk to utilities.

COMMISSIONER JACKSON: Right, but no specified methodology at this stage for feedback?

MR. JORDAN: No, but I think we still may be underplaying it because when my office or NRR meet with resident inspectors on a periodic basis, we discuss and we have, for instance, discussed in great detail the Wolf Creek event. The Wolf Creek event I discussed at a senior management meeting among the senior management, so those are feedback.

COMMISSIONER JACKSON: That leads me naturally to my next question, and that is, how is the ASP information used in the plant performance reviews in SALP and in the senior management meeting process?

MR. THADANI: At all the screening meetings, first of all, that we have prior to our senior management meetings, there is explicit identification of any precursor events and how significant they were. So that is an input to the process that tries to integrate a lot of information in arriving at some judgments about the plant.

I would say that senior management probably pays, in a way, much more attention to that information than in terms of the large staff level. I think we need to do better in that area. But management does focus in on the insights that come out of these evaluations.

The other issue we are trying to make sure we push is the timing because it is important to react relatively quickly, particularly if they are significant events. So we get out staff and management discussions going once a week to try to get those aspects understood and followed up on.

COMMISSIONER JACKSON: Because you mentioned methodology for sort of informing the industry if there are generic issues, but it strikes me that if they are generic issues that relate to unavailability of certain systems that it is important that the people who are out where the rubber meets the road have that to focus on.

MR. THADANI: Yes. If I can give you an example, it doesn't always happen that way, but occasionally if we find an issue is pretty significant, and the one that comes to mind is, in 1987, Diablo Canyon midloop problems, and that is the first time we really understood the significance of what was happening because we did a number of internal thermal hydraulic analyses to see what could happen under different sets of conditions, and so on, and we did do a precursor-type analysis as well.

At that point we thought it was so significant and because the various groups get involved, particularly the control room people, operators really need to know what is going on in the plant at all times including during shutdown if testing is going on, do they know what is happening to the plant. We prepared letters that were signed, then Director of NRR was Tom Murley, letters that he signed out to individual operators just to try to make sure. They are the ones who are right on the front lines, they need to understand the significance of some of these things. That is an example.

We have done that on occasion. We did it on online maintenance as well. There have been a few examples like that.

COMMISSIONER JACKSON: I noted that one of the objectives of the ASP Program, you say, is to provide a check with PRAs. How, in fact, do ASP Program results compare with IPE results?

MR. O'REILLY: Pat, that seems like a question you should answer.

MR. BARANOWSKY: Good. Actually, what we have seen is accident sequences that are fairly representative of what PRAs have predicted, but we don't always see the stack up in terms of importance as being the same, for one.

A second thing is, the ASP events usually are identifying unique ways in which these sequences can occur that are not always evident by putting together the block-by-block models that you see from IPEs or PRAs.

So, what we try to do is to make sure that the PRA people are aware of ASP results and the characteristics, not just the numbers, but the characteristics of the events, and we have had some meetings in which we have talked with PRA practitioners and the ASP folks to exchange information. We have had at least a couple of them over the last three or four years. Generally, we think that the availability of the report and the insights which is widely distributed is used based on just general talking to the people that are in the PRA community.

COMMISSIONER JACKSON: Do you have any consistent way to feed the information back?

MR. BARANOWSKY: I don't know that there is a document that I could point to that says, here is the insights.

COMMISSIONER JACKSON: Last question, as the facilities get older, we have been talking and the maintenance rule is oriented to this, the effect of component degradation on performance, but it is also not just aging, it has to do with maintenance. Are there efforts to enhance ASP Program capabilities in this area?

MR. O'REILLY: Do you mean to look for aging effects?

COMMISSIONER JACKSON: Well, the effect of component degradation and how that plays into it?

MR. BARANOWSKY: I think ASP represents sort of a sample and a sparse sample of experience because we are only looking at the incidents that occur in combinations, and they are fairly rare. The system and equipment reliability work that we are trying to do, and AEOD would address, I think, the concerns that one has about the performance of equipment and systems over time and whether or not they are changing. We would need a higher data density in order to detect that stuff in a timeframe that would be consistent with us taking a regulatory action or finding insights that we could use.

COMMISSIONER JACKSON: Are you able to take into account equipment interaction, I mean, as opposed to an availability/non-availability as it relates to the degradation issue?

MR. JORDAN: Yes, I would comment and say that the equipment itself, the safety system equipment is better off than it was a few years ago because of the maintenance activities, the utilities recognition, and the initiators are down. So I am searching back to identify where we are seeing now age related ASP insights, and I don't see much there.

COMMISSIONER JACKSON: So you haven't noted any particular correlation between aging and the number of precursors that are due to equipment unavailability?

MR. JORDAN: No, I don't think so.

COMMISSIONER JACKSON: I said that was the last question, but I do have one more. I note in your own documentation you note, when you looked at the Shearon Harris case, that the ASP models do not really currently address the potential of secondary side depressurization in this particular case in low-pressure injection for core cooling success. Is that a kind of thing that is worth considering?

MR. O'REILLY: Yes, it is. We currently are working so that our models will have the ability to do that. In the past, when we received comments from utilities, and that has been going on since 1992, that was one of the recovery methods that several utilities claimed for their particular event that they were dealing with. We were only able to model it in a very coarse way.

COMMISSIONER JACKSON: Right. You just put in a probability for it.

MR. O'REILLY: Right. That was when we were using the event trees solely. Now we have event trees and we use the fault tree linking methods to get a more realistic view of the plant's response, and it will enable us eventually to do something about this deficiency that we have had.

COMMISSIONER JACKSON: If you are going to look at failure to recover from or recovery from, then that has significant potential impact, but it also shows where human reliability comes into play.

MR. THADANI: That's correct. In fact, that was an issue on one precursor analysis where if you took credit for secondary site cooling it would make a significant enough difference.

COMMISSIONER JACKSON: That is assuming that the human factors were --

MR. THADANI: That is what would control it, exactly right.

I would like to go back to your earlier question, just a little caveat. I am probably a little more concerned about aging effects and making we are seeing some precursors or some problems, I think, not that they are quantified. I look at boiling water reactor internals and we are seeing cracking of certain components. I see steam generator tubes, we are seeing new degradation mechanisms. I think what it means is that certainly the margins are probably not where we thought they were at one point. How significant is that, I think, remains to be seen.

Part of the difficulty, I think, in the technology in terms of the probabilistic assessments, we are not there, I don't believe, to draw some firm conclusions.

COMMISSIONER JACKSON: I will smile at Dave Morrison as you say that.

DR. MORRISON: There is a lot to be done.

MR. THADANI: Yes.

MR. BARANOWSKY: Some of the more recent precursor results have been at the older plants, but let's also recognize that the more recent precursor results have not been as significant as the ones that occurred 15 or 20 years ago when we were really concerned. So it is hard to say whether that is degradation or just the old plants at their level of performance. That is why I was not able to detect it.

COMMISSIONER JACKSON: Commissioner Rogers?

COMMISSIONER ROGERS: Yes. A couple of things just on this, and then a few general questions.

I wonder if you could go back to the consequences question, the second bullet. Could you elaborate a little bit about what you are thinking about there? You are not talking about Level 3 PRAs on this?

MR. O'REILLY: No. What we are trying to do is get a very simple yet efficient way of getting a handle on consequences. We don't envision a detailed Level 3 PRA. We are looking for some way to transform from Level 1 results to the point where we could get some sort of consequence bands, or consequence regions, if you want to call them that, and it is just in the infancy right now. But we are not trying to reinvent the wheel because the models we have are simplified plant models. They are not as detailed as a PRA would be.

MR. BARANOWSKY: I think we foresee having some BINs and some guidance as to how to put the events into damage states, if you will, that could be related to releases without doing the detailed Level 2, 3, types of analyses.

DR. MORRISON: I might comment that we did take a look at the kind of modelling that would be required to do that, and we had a feasibility study this past fiscal year which did indicate that there were some feasible approaches and so we will be trying during this next fiscal year to see if that can't be implemented into the broader methodology and look at things like what is the containment failure, what is the possibility of health-effects aspects of it, so that it does move more towards the risk side rather than just simply the conditional core damage failure.

COMMISSIONER ROGERS: And this presumably would be useful also as management guide for licensees.

DR. MORRISON: I certainly would hope so because if you overlook what is happening in the secondary side and in the containment, there is a big gap.

COMMISSIONER ROGERS: Just coming back to the human performance analysis that you want to incorporate more fully, will you need additional information, additional data and, if so, how will you get that to do these?

MR. O'REILLY: We are coming up with an approach which, unfortunately, tends to be very subjective if you don't have the detailed information. We are in the same boat you would be in no matter what when you are talking about trying to improve the analysis of human performance. So is there enough detail in what we get now? Some there are and some don't have it. I am not really sure how to answer your question.

COMMISSIONER JACKSON: Well, one way to get at it would be, are the models sufficiently developed that you know what data would improve your uncertainty bands, would narrow them, in your analysis in cases where you have to worry about human performance?

MR. BARANOWSKY: The models are simple, but they reflect our best understanding of the factors that shape human performance, and we have default values which, if we don't have information on how to adjust the parameters, we would use them and that would make the analysis more uncertain.

On the other hand, we do contact licensees and sometimes extensively to discuss events in order not to have an overly conservative or an improper underestimate of the likelihood of human performance.

But certainly our models suffer from the same limitations that the PRA state-of-the-art does in human reliability analysis anyhow. so I think it is not on the edge of the state-of-the-art, not advancing it, but it is using the things that have been more or less understood and I will call "proven."

COMMISSIONER ROGERS: So you are doing the best you can, really, with what you have got?

MR. BARANOWSKY: That's right.

DR. MORRISON: Well, this is an important area within research to try to get a better understanding of the human reliability. I wouldn't be surprised at the end of the day considerably more data are going to be required.

COMMISSIONER ROGERS: Absolutely.

MR. THADANI: We had at least two distinct areas, actually the three officers, we had a meeting not too long ago after the last senior management meeting where we discussed some of the personnel errors at Cooper as well as at River Bend, and we had a heck of a time trying to take that information and try to quantify it, an we realized we didn't know how to do it. So we had a meeting with Dave and others to make sure, how can we go forward in research as a task to see how those types of personnel errors -- these were not necessarily operators in the control room, nevertheless, they had an impact on safety. That is one area.

The other area, as I think, Commissioner Rogers, you have been briefed on before, is the organizational factors impact, and that is a complex area. That is going to be a while.

COMMISSIONER JACKSON: Even if you could just migrating from personnel areas of a given type in terms of their implication for given accident sequence and somehow figuring out a way to incorporate to see how that changes your guesstimate would be an important step forward, it strikes me.

COMMISSIONER ROGERS: I think you have to inch ahead here on this, and it sounds to me like you are doing what is reasonable. The organizational one, I don't think we want to talk about that today. That is a tough one.

I wonder, what is the relationship of this program now to the need for the data from the proposed reliability data rule? In other words, in refining this ASP Program -- and I don't like ASP, that gives me a bad connotation, I can only think of Cleopatra -- but, at any rate, the reliability data rule or proposed reliability data rule, how does that, the kinds of data in that rule, relate to your thoughts about improving the ASP Program?

MR. BARANOWSKY: The data would be used to improve what I have called the standing system reliability models that would be in the ASP methodology, and they would also provide the ability to look at trends amongst equipment that couldn't be seen because of the rarity of ASP events. So it would be a way to improve the accuracy of the models in terms of our baseline that we start with when we look at events, and then it supplements ASP's snapshots of rare events by giving us some trends in-between these things. We might not see an event at a plant that involves auxiliary feedwater for four or five years, which doesn't mean that there aren't some conditions going on at the plant that indicate auxiliary feedwater degradation. So it is really complementary and also a part of the baseline, if you will, of the model.

COMMISSIONER ROGERS: Well, it sounds like it is important.

MR. BARANOWSKY: I think it is.

COMMISSIONER ROGERS: I think you have touched on it, but I wonder if you might want to say anything else about how this program is helpful in our improving how we regulate? What are the consequences of this so far in how we do our job as regulators? We are starting to look at everything we do through the Chairman's rebaselining effort, but are there any perceptions that you have with respect to already the effect of this program on our regulatory procedures or emphasis?

MR. THADANI: Let me say a few words, at least, from an NRR perspective. We think this program is extremely valuable. It has helped us many times in terms of our discrimination of events and their importance, what resources we should be applying in terms of followup of these activities. You have heard some examples here.

I think that, in itself, is absolutely invaluable, that we are doing a much better job of putting our resources on more important issues than I think we were doing before. This program plays an important part in those decisions.

I might add, in 1987, NRR took a very strong position that is a very valuable program, we really want to make sure there is agency support, interoffice support for this program, because most of our activities are really oversight of operating reactors. Design certification is sort of going away, and this is probably one of the more useful tools in us being able to discriminate what we should do.

I don't mean to say just point estimates, but broadly speaking, more important, less important, plant-specific versus generic implications, it helps, I think, and to me that is invaluable.

COMMISSIONER ROGERS: Well, I have been very pleased to see the development of the program and we are coming to that conclusion that it is very helpful. But when you get to a situation like that, now you have to start to begin to think about how far is far enough. It is an excellent program, it looks like it has great potential for additional improvements. But now, it seems to me, is the time to start thinking about where will we decide and can we begin to identify how far we ought to go but probably no further than that. Again, it is going to be a resource question. So that when you get a hold of something that seems so good and tastes so good, it is time to start thinking about, what bounds do you put on this.

MR. JORDAN: I do have a ready answer for that. Ideally, it would go away in terms of a tool that the NRC would have to apply primarily, and that it would become a tool that the industry would apply for each event so that a they screen and review their events, if they reported to us a conditional core damage probability using their IPE, their more plant-specific PRA, that would be a much better process than for the NRC to do it, and cause them to do a peer review based on their PRAs.

So if I were making a long-term projection of where I would like to be, it would be reviewing a utility submittal of the risk of their events. We have to maintain a methodology to review because it does take several cuts at these events to try to see and find the real important ones, but that is the ideal I would be headed towards.

COMMISSIONER JACKSON: But, if you were going to apply it in such a review, this connection or the insight it gives you into IPEs and utility PRAs --

MR. JORDAN: Right a living PRA arrangement.

COMMISSIONER JACKSON: Right.

COMMISSIONER ROGERS: Well, it sounds like that is something that we ought to be starting to talk to the industry about.

MR. THADANI: I would just note that the comment that you made about ASP is really applicable to all of the activities related to the use of probabilistic techniques. That, to a certain extent, we are also trying to make sure we integrate these concepts and ideas. That is why we developed the plan the way we did.

COMMISSIONER ROGERS: Well, I would just like to say, I have enjoyed this enormously. I thought it was an excellent presentation.

MR. JORDAN: I want to thank you for this update. You know, I have previously mentioned in some of my speeches that I believe that the capability of this agency to effective accomplish its mission is in part based on our ability to do performance and risk-based assessments, and I believe that as a learning organization that the review and analysis of risk significant accident sequences is an integral part.

I think continued refinement is important, and thinking of where the appropriate transfer points are in terms of how the industry might make use of what we do, but also how it informs our day-to-day activities, because then when it is proliferated in that sense, then that is when one is getting the most effectiveness out of that.

Unless you have any further closing comments, thank you very much.

[Whereupon, at 11:18 a.m., the meeting was concluded.]

# CERTIFICATE

This is to certify that the attached description of a meeting of the U.S. Nuclear Regulatory Commission entitled:

TITLE OF MEETING: BRIEFING ON ACCIDENT SEQUENCE PRECURSOR PROGRAM - PUBLIC MEETING

PLACE OF MEETING: Rockville, Maryland

DATE OF MEETING: Wednesday, November 15, 1995

was held as herein appears, is a true and accurate record of the meeting, and that this is the original transcript thereof taken stenographically by me, thereafter reduced to typewriting by me or under the direction of the court reporting company

Transcriber: Jessa Munson

Reporter: Mark Mahoney

UNITED STATES NUCLEAR REGULATORY COMMISSION

# ACCIDENT SEQUENCE PRECURSOR PROGRAM

## November 15, 1995 Commission Briefing

## Office for Analysis and Evaluation of Operational Data

# AGENDA

- Background
- 1994 ASP Results
- Overview of Commission Paper on ASP Program Status

# OBJECTIVES OF THE ASP PROGRAM

- Identify and Rank Risk Significance of Operational Events
- Determine Generic Implications of an Operational Event/ Characterize Risk Insights
- Provide Supplemental Information on Plant-Specific Performance
- Provide a Check with PRAs
- Provide an Empirical Indication of Industry Risk and Associated Trends

# DEFINITIONS

- Accident Sequences of Interest - Those sequences that, if they had occurred, would have resulted in inadequate core cooling and potentially severe core damage

- Accident Sequence Precursors - Events or conditions that are important elements in the above sequences (e.g., an unusual initiating event or failures of multiple components that, when coupled with one or more postulated events, could result in a plant condition leading to severe core damage)

- Containment-Related Events—Failures that could result in reduced containment performance (e.g., unavailability of a containment cooling, containment spray, or post-accident hydrogen control).

# HISTORICAL BACKGROUND

- Program Started in 1979 in Response to Peer Review of WASH-1400; First Reports Developed and Issued by RES; ASP Program Transferred to AEOD in 1985

- More Than 50,000 LERs Processed, and 583 Precursors Identified.

- Precursor Reports Covering the Years 1969-79, 1980-81, and Every Year Since 1984

- Review and Analysis of 1982-83 LERs for Precursors Underway at Sandia National Laboratories (SNL)

# HISTORICAL BACKGROUND
# IDENTIFICATION OF SIGNIFICANT PRECURSORS
## (CONTINUED)

- **Yearly Monitoring of Precursor Events after 1984:**

| Year | Plant | Description | CCDP |
|---|---|---|---|
| 1984 | La Salle 1 | Error Caused Scram, RCIC Failed, RHR Valve Failed Closed. | $2.3 \times 10^{-3}$ |
| 1985 | Hatch 1 | HVAC Water Shorted Panel, Safety-Relief Valve Failed Open, HPCI Failed, RCIC in Maintenance | $1.8 \times 10^{-3}$ |
| 1985 | Davis-Besse | Loss of All Feedwater, Stuck-Open PORV | $1.1 \times 10^{-2}$ |
| 1986 | Turkey Point 3 | Load Loss, Manual Trip, Control Rod Drive Auto Insert Failed, PORV Stuck Open | $1.4 \times 10^{-2}$ |
| 1990 | Vogtle | Loss of Offsite Power, Both Emer. Diesel-Generators Inop. | $1.0 \times 10^{-3}$ |
| 1991 | Shear.Harris | High Pressure Injection Unavailable 1 Fuel Cycle | $6.3 \times 10^{-3}$ |
| 1994 | Wolf Creek | Reactor Coolant System Blowdown during Shutdown | $3.0 \times 10^{-3}$ |

# OVERVIEW OF ASP SCREENING, REVIEW, AND ANALYSIS PROCESS

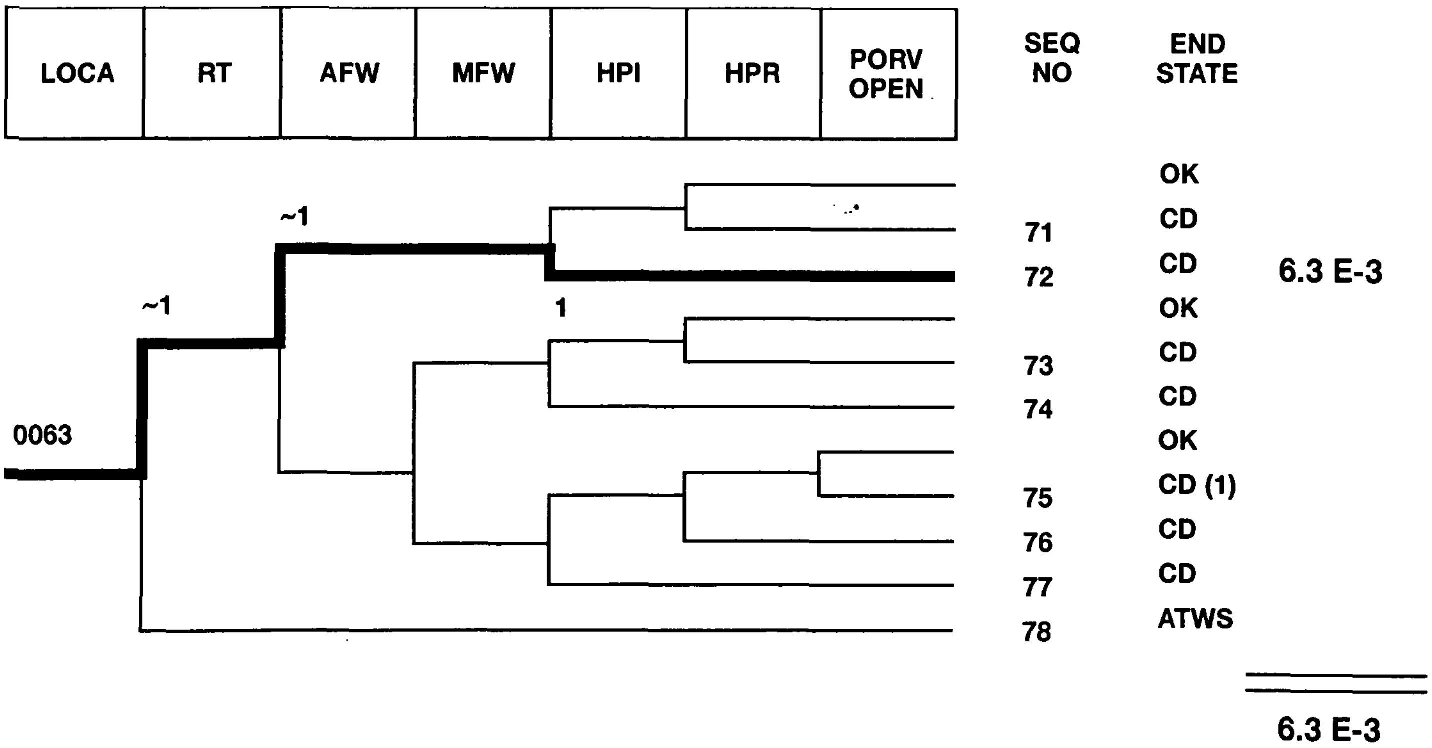
- Screening of LER Database by Sequence Coding and Search System (SCSS) Algorithm
- Other Sources of Candidate Precursors
  - Incident Investigation Team (IIT) or Augmented Inspection Team (AIT) review
  - Significant Events
  - NRC's daily screening of operational events
  - NRR's prompt event assessments
  - Events identified by NRC staff as candidates, regardless of method of documentation (e.g., inspection report, 10 CFR 50.72 report)
- Engineering Review of Screened Events
- Detailed Analysis and Quantification
- Licensee, NRC Staff, and Independent Contractor Reviews
- Final Analyses Published in Annual Precursor Report

**LER No:** 400/91-008

**Event Description:** HPI unavailablity for one refueling cycle because of inoperable miniflow lines

**Date of Event:** April 3, 1991

**Plant:** Harris 1



# 1994 AT-POWER PRECURSORS INVOLVING UNAVAILABILITIES

| PLANT | CCDP | DESCRIPTION |
|---|---|---|
| Haddam Neck | $1.4 \times 10^{-4}$ | Power-Operated Relief Valves and Vital 480-V ac Bus Degraded |
| Zion 2 | $2.3 \times 10^{-5}$ | Unavailability of Turbine-Driven Auxiliary Feedwater Pump and Emergency Diesel-Generator |
| Point Beach 1 and 2 | $1.2 \times 10^{-5}$ | Both Diesel-Generators Unavailable |
| Dresden 2 | $6.1 \times 10^{-6}$ | Motor Control Center Trips Due to Improper Breaker Settings |

# 1994 AT-POWER PRECURSORS INVOLVING UNAVAILABILITIES (CONTINUED)

| Plant | CCDP | Description |
|---|---|---|
| Dresden 2 | $3.1 \times 10^{-6}$ | Long-Term Unavailability of High Pressure Coolant Injection |
| Turkey 3 and 4 | $1.8 \times 10^{-6}$ | Load Sequencers Periodically Unavailable |

# 1994 AT-POWER PRECURSORS INVOLVING AN INITIATOR

| Plant | CCDP | Description |
|---|---|---|
| River Bend | $1.8 \times 10^{-5}$ | Scram, Main Turbine-Generator Fails to Trip, Reactor Core Isolation Cooling and Control Rod Drive Systems Unavailable |
| Calvert Cliffs 2 | $1.3 \times 10^{-5}$ | Trip, Loss of 13.8 Kv Bus, and Short-Term Unavailability of Saltwater Cooling System |

# 1994 SHUTDOWN PRECURSORS INVOLVING AN INITIATOR

| | | |
|---|---|---|
| Wolf Creek | $3.0 \times 10^{-3}$ | Reactor Coolant System Blows Down to Refueling Water Storage Tank During Hot Shutdown |

# SUMMARY OF INSIGHTS FROM 1994 ASP RESULTS

- Wolf Creek Shutdown Event Was Highest Conditional Core Damage Probability Since 1991
- Majority of 1994 Precursors Involved Electrical Equipment Problems
- Conditions or Unavailabilities of Equipment Produced More Precursors than Initiators
- Number of Precursors Involving Initiators Continued to Decrease

# PROGRAM ACCOMPLISHMENTS

- ASP Program Coordination
- Analysis of 1994 Operational Events
- Acceleration of 1995 Review
- ASP Analysis of 1982-83 LERs
- Evaluation of ASP Results and Trending
- Model and Methods Development – Now Centered in RES
- Development of New Models – Revision 1.0 Completed
- Improvements to Existing Models

# NEW APPROACH FOR IMPROVING TIMELINESS OF FINAL ASP ANALYSIS

- Shorter Schedule for Resolution of Peer Review Comments and Final Analysis
- Goal - Final ASP Analysis of an Event Issued within 6-8 Months vs 10-22 Months
- NUREG/CR - Compilation of All Final Analyses Completed over Past 12 Months

# FUTURE PLANS

- Continue to Reduce Time between Event Occurrence and Final Analysis
- Include Consequences in ASP Quantification Process
- Improve Analysis Capability to Incorporate:
  - Uncertainties in quantification
  - Support systems and other dependencies
  - Improved treatment of common cause failures
  - Improved human performance analysis during recovery
- Include Analyses of Shutdown/Low Power Events
- Include Analyses of External Events/Conditions
  - Fires
  - Floods
  - Seismic events