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# NUCLEAR REGULATORY COMMISSION

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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OFFICE OF NUCLEAR REGULATORY RESEARCH

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BRIEFING ON STATUS OF SECOND DRAFT OF NUREG-1150

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Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland

Friday, May 5, 1989

The Commission met in open session, pursuant to notice, at 10:00 a.m., Lando W. Zech, Jr., Chairman, presiding.

COMMISSIONERS PRESENT:

Lando W. Zech, Jr., Chairman of the Commission
Thomas M. Roberts, Commissioner
Kenneth C. Rogers, Commissioner
James r. Curtiss, Commissioner

STAFF:

Denny Ross
Victor Stello
Mark Cunningham
John Hoyle
Erick Beckjord
Joseph Murphy
Joseph Scinto

P R O C E E D I N G S

(10:00 a.m.)

CHAIRMAN ZECH: Good morning, ladies and gentlemen. Commissioner Carr will not be with us today.

This is an information briefing which the staff will provide the status of the second draft of NUREG 1150, Severe Accident Risks, an assessment for five US nuclear power plants. NUREG 1150 was published as a draft for comment in February 1987. Extensive public comments were received. In addition, the draft document has been subjected to three independent peer reviews. And the staff received comments from the international community. The staff has been in the process of improving the report, to address the comments received.

In December 1988, the staff briefed the Commission on options for further peer review of NUREG 1150, the timing of release of the report and the interim use by the staff.

Following this meeting the Commission directed the staff to, first, form a new review committee under the Federal Advisory Committee Act; and second, to issue NUREG 1150, subject to prior review by the Commission, as a second draft and NUREG

1150 could be used as a reference in the interim; and three, issue the final NUREG 1150 report after the final peer review committee's recommendations are resolved, and after a final review by the Commission.

In March 1989, the staff briefed the Commission on the improvements to NUREG 1150 and the results pertaining to accident frequencies from internal events.

Today's meeting will include discussion of the improvements and results pertaining to the remainder of NUREG 1150, as well as to the status of the document itself.

In a briefing by the Advisory Committee on Reactor Safeguards, on the 3rd of May 1989, the Commission requested the ACRS to address the proposed intended uses of NUREG 1150, while the report is undergoing peer review. I understand that the staff briefed the Advisory Committee on Reactor Safeguards yesterday on the status of the second draft of NUREG 1150 and the intended uses. And we expect to hear from the ACRS on their views shortly.

When this peer review has been completed and NUREG 1150 is published as a final document, we expect that it will represent a major advance in the methodology for examining the risks associated with

five specific nuclear power plants, as well as the uncertainties associated with those risks.

Copies of the slides should be available at the entrance to the meeting room.

Do any of my fellow commissioners have any comments before we begin?

(No response)

CHAIRMAN ZECH: If not, Mr. Stello, you may proceed.

MR. STELLO: Thank you, Mr. Chairman.

We are continuing to work in setting up the fact committee. We have some further details that we need to deal with and are not prepared to tell the Commission that is finalized today, but hopefully, in the near future we will have that done. We are working with the General Counsel's office and other elements of the federal govenment to make sure that we take all the steps that are proper in setting up the fact committee and hopefully, we will have that --

COMMISSIONER ROGERS: Does that involve any changes in the composition today?

MR. STELLO: No, sir; no, sir, procedure, process. We do hope that -- and have tentatively established, at least as a target, that the first meeting, in fact, can take place in July. We still

believe that is doable and we are setting up -- it is procedural issue that we need to get through.

As we indicated in our last briefing, we would go to the ACRS and tell the ACRS what it is that we intended as the interim uses. The ACRS committed to try to advise the Commission in time for it to have that advice

-- the Commission have that advice before it finally decides where we ought to come out on that issue. You have our recommendations, of course, before you.

We met yesterday with the ACRS, and at least we are hopeful that they will, in fact, provide you with that advice. They are in session this weekend and preparing letters. And I hope that we will see a letter outlining their recommendations to you, hopefully, early next week.

I don't have a firm commitment that they will do that, but at least we are under the impression they are going to attempt to try to provide advice on this matter. I think it is a very important subject, it sets the tone of what it is you do with this vast amount of technical information that has been developed now over these last 15 years. And I think it is very, very important that we all go forward knowing exactly how we intend to proceed in the

future, while the peer review is, in fact, going on.

As we have indicated, our intent would be to have the peer review finished, get the results of the peer review and then propose to the Commission a final version that we would bring to the Commission and suggest to the Commission that this is, in fact, now the final package as it ought to go out. And that's when the Commission of course would decide finally what its views are on 1150.

CHAIRMAN ZECH: That's after this peer review?

MR. STELLO: After the peer review, and after we got the results of the peer review and had an opportunity, if we need to modify, or change the document in any way, to make those changes and then bring it back to the Commission, after we have had a chance to react and do whatever comes out of the peer review that seems appropriate to do.

CHAIRMAN ZECH: Fine.

MR. STELLO: There is one issue that I did mention at the last meeting that, again, I think is important. And you will be hearing more of it again this morning, and that's in the area of the seismic risks. We will be providing you with the core melt frequencies, including internal events, seismic as

well as fires. The difficulty we have though is, as you are aware, nuclear facilities are, in fact, very, very robust, they are designed to very, very high seismic standards, so that when you get to the point where a nuclear facility is postulated to fail, as a result of the seismic challenge, those particular seismic challenges are indeed very, very remote.

We are talking about events that are from a .5 g to 1.21 g, in terms of the challenge to the facility, which is up to 10 times the design requirements that we impose for earthquakes. So you are way out on the spectrum.

The question then becomes well, what really is the consequences of such a severe earthquake? You can't just simply analyze it by looking at a radiological consequence alone. You clearly have got to ask the question for earthquakes even less severe you have the potential for significant damage in the vicinity. And hence, risk to the public that is going to be there, even without a nuclear hazard present.

The studies that have been done do indicate that the nuclear hazard is not significant and is not controlling for these very large earthquakes. But there is a great deal of work that needs to be done in this area. And we are searching for how to be able to

present that kind of information. So we have done a correct, thorough technical analysis and not tried to deal with the problem in a vacuum.

We need to do more work on that. That is not going to be done, prior to the peer review. That is going to be something off in the future. We are really opening up a very, very difficult area, in terms of dealing with extreme seismic hazards. We need to do a lot more in that area. We will, but it is not going to be done before the peer review takes place. In my judgment, I just don't think there is a chance.

With that introduction, let me turn to Eric, who has some comments.

CHAIRMAN ZECH: This is an earthquake that is well above and beyond what we consider the design basis earthquake?

MR. STELLO: Yes. Briefly, our design basis, or so-called SSE, safe shutdown earthquake, is, in fact, a very remote earthquake to begin with. A very unlikely event.

COMMISSIONER ROBERTS: I think we are talking about something that is --

MR. STELLO: Five to 10 times more severe than even that.

CHAIRMAN ZECH: But the plants are designed to accommodate an earthquake that, as far as we know, reasonably might be expected in the area?

MR. STELLO: Well beyond that.

CHAIRMAN ZECH: Yes, but at least beyond-- at least up to that. And what you are talking about is an earthquake that is way above that.

MR. STELLO: Much more severe -- that's correct, much more severe. And the difficulty is --

COMMISSIONER ROBERTS: But much more statistically --

MR. STELLO: Remote.

COMMISSIONER ROBERTS: Yes, that needs to be constantly stated.

MR. STELLO: Yes, but the difficulty becomes how do you calculate what the consequences of that are. The reasoning is that you have a nuclear facility which is designed in a far more robust fashion than anything else -- we have far more stringent standards for design for nuclear facilities than you have for any other buildings, or structures, or facilities in the surrounding populations. Those clearly are going to create a consequence for earthquakes much less severe than the earthquake that we already design for a nuclear plant.

Now we are talking about earthquakes five to 10 times beyond that level of earthquake, which is getting us out into an area where there is very little work that has been done to truly understand what those consequences are. You are going to have failures of dams and buildings and pipelines, and chemical processing -- you name it, with earthquakes much less severe than the kind that we are talking about. We need to do more work in that area.

CHAIRMAN ZECH: All right, fine. Thank you.

COMMISSIONER ROGERS: I don't want to get into something that will come later, but I did have a question later on for the differences between the Livermore and EPRI models of these kinds of events. And will that be addressed? Will you say something about that?

MR. STELLO: Yes, we will, but I am beyond that.

COMMISSIONER ROGERS: It's a different question, but it is related to --

MR. STELLO: Agreed.

COMMISSIONER ROGERS: But beyond even that, how do you calculate what the real consequences of those earthquakes are, with either model?

CHAIRMAN ZECH: Let's proceed.

MR. STELLO: Eric.

MR. BECKJORD: Mr. Chairman, Commissioners--

CHAIRMAN ZECH: Yes, please proceed.

MR. BECKJORD: -- before you hear the report on the findings of severe accident risks, I would like to say a word about the effort involved in the completion of the project and the people who have contributed to it.

This has been a major research project and the national laboratories: Sandia, Brookhaven, Idaho, Los Alamos and Battelle Memorial Institute, and a number of contractors have applied their skills to completing the new draft. I would like to commend all of them, and mention especially the program managers at Sandia, which was the principal contributor, for their dedication to completing this work, that is Mr. Ortez, Elaine Burguron and Allen Capp. Dr. Burguron and Dr. Capp are here with us today --

CHAIRMAN ZECH: Would you stand up, please? Thank you very much, we appreciate you being with us today, too.

MR. BECKJORD: And also Dr. Denning, Rich Denning, from Battelle, who has played a very major and significant role in this --

CHAIRMAN ZECH: Thank you very much.

MR. BECKJORD: The report is of high quality. And I believe it will stand well the test of reviews and of time. I note especially the expert opinion and elicitation. This has been completely revised in the past two years, and it is unprecedented in scope. And I think it is a landmark accomplishment.

The expert elicitation process and the results have made it possible to respond to one of the major criticisms of the 1975 Rasmussen Report, WASH 1400. That is that a careful determination of the uncertainties and probabilistic risk assessment was needed.

Finally, I would like to note the efforts of the NRC Research Staff who have also worked with skill and dedication on 1150. Dr. Ross has taken the entire project, has exercised very careful oversight over the entire project. Mr. Murphy and Mr. Cunningham have been the project manager/leaders here. And I believe that all who have contributed to this effort can be very proud of their accomplishment.

CHAIRMAN ZECH: Thank you very much.

MR. ROSS: Okay, let's have our first slide, please. (Slide) This is just a Table of Contents for

this morning's purpose: present status, risk analysis, methods, perspectives and summary.

I will do the first part and then my associate on the left, Mark Cunningham, will do the last part. And I think the deputy division director of the responsible division, Joe Murphy, who has had recent eye problems, will chip in with answers, although he will have a little difficulty with reading, because of his eye surgery.

CHAIRMAN ZECH: Well, we hope you had a very successful surgery, Joe.

MR. MURPHY: It was, it was.

DR. ROSS: Next slide, please. (Slide) The purpose, as has been said -- we've already covered the first bullet -- it is our intent to publish our report as draft.

We would like to describe this morning a little bit of the summary of our methods. Certainly, we intend to use it, and for reference purpose on the third bullet, when we talk about the use as indicated, Chapter 13 of the report summarizes the uses. And when we discussed this with ACRS yesterday, in particular, they noted pages 13-1 and 13-2, which is the same uses that we have been talking to you about for many months.

On the last bullet we want to inform you that, as we discussed, following the peer review, we would do -- what we said was prepare a final version. In terms of time, that looks right now that it could be mid- to late-'90. The exact peer review schedule is a little indeterminate, but it could be on the vicinity of, perhaps, nine months, or so. And then it takes time to do what they said. So, that's just a rough projection.

CHAIRMAN ZECH: Mid- to late-1990?

DR. ROSS: Yes.

CHAIRMAN ZECH: When the final report you are projecting could be out?

DR. ROSS: Yes, that's correct.

CHAIRMAN ZECH: All right, thank you.

DR. ROSS: We go to the next slide, (slide), on the present status. Of course you have the report. The report that we gave you was stamped "pre-decisional". We have not released it to the general public.

Next Monday and Tuesday we are having a final QA review, looking for arithmetic mistakes and so on. Based on that, we expect to send a report to the printers in May and get a couple thousand copies printed. And my guess is it would be available for

distribution in early June. It will be characterized as a second draft for peer review. We will give it the same wide distribution as in '87, and that was well over 1500 copies worldwide.

Vic has already discussed the peer review organization. I would note that the ANS special committee which gave us the report on the '87 draft, is alive and well, and they also will review this '89 version and issue another report in some time element that is not known to me now.

We are going to discuss some of the methods with them next week. They do not have the report of course either. They will get it as soon as it is available to the public.

Next slide, (slide). We have done, in the '89 version, something we didn't do in the '87, the external events. And we will discuss the results, in terms of core damage frequency and risk, in a few moments.

A little more detail on the seismic analysis, especially in response to Commissioner Rogers. The main point of interest, I think, on the seismic portion of external events has to do with the way we, in effect, shock the site. We have had a research project, funded through Lawrence Livermore

lab, for a number of years that produces what we call seismic hazard curve. Now, seismic hazard curve is just a return interval, or probability per year that a given exitation is available at the plant. You can call it a probability.

For example, at the 1-g level that Mr. Stello was talking about, we are looking at return intervals of about a million years, or 10 to the minus six per year.

At about the same time, that is over the last few years, the Electric Power Research Institute has also produced hazard curves. And these are hazard curves for about 70 sites, essentially everything east of the Rockie Mountains. And both projects, the EPRI study and the NRC study, we made extensive use of the same type of expert opinion that we are going to talk to you about this morning. And the main thing is this is not an exact science, far from it.

The hazard curves that we developed and that EPRI developed, at particularly high earthquake levels, differ quite a bit. And in Appendix C-11 of our report we illustrate graphically, and in some of our slides this morning we will show you that you get factors of 20 difference in core damage frequency.

This may not be a question of who is right

and who is wrong. Both analysis methods tend to be reasonably robust and in some case, the same people were on both panels, both EPRI and Livermore. It well may be that these represent a range of plausible outcomes. It is something that merits a lot more study -- that's one of the problems.

Another problem has to do with I think what I call safety goal philosophy, the quantitative objectives in the safety goal compare nuclear risk as a desirable small fraction of non-nuclear risk. If you look in the vicinity of the site, we have the capability to calculate off-site damages from a nuclear event.

As Mr. Stello said, we don't have that capability for non-nuclear events. There have been a lot of recent developments, including a very recent publication from the National Academy entitled Estimating Losses from Future Earthquakes. We got this report about four, or five days ago, it is that recent.

A quick glance at it looks like this. And perhaps in consulting relationship with the Geological Survey, we could probably do, or have the Survey do, estimates around these two plants, Surry and Peach Bottom, for non-nuclear seismic earthquake losses.

And maybe that's a good idea and maybe it isn't. This is what Mr. Stello is talking about, we've got to do a lot of thinking about it. But we do want to try to put the question of nuclear seismic risk in context with the non-nuclear. That's the thing that will take more work.

COMMISSIONER ROGERS: Well, do you expect to resolve the differences between the EPRI and Livermore models before the final report is published?

DR. ROSS: Well, as I said, I don't know that we will ever resolve the difference in saying who is right and who is wrong. Since both calculations appear to be reasonably robust, they just may represent a range of outcomes, and we will say somewhere in this range maybe the true response. And we may not try to do anything more than that. That may be the best we can push the science.

So, for that reason on the third bullet, we terminated the seismic response in 1150 to what some people refer to as Level 2, which is you do the core damage frequency, the containment response, but you don't do the off-site consequences.

We hope -- if you look at the last bullet-- we could include all of this in the final version. That may be -- it depends on how these developments

work out with Geological Survey and others.

Okay, the next slide, (slide), we talk a little bit about the methodology which has changed somewhat, mostly in response to the public comments we got from the '87 version. So, I will talk about the approach, the data base, what we call, or what is generally called Expert Elicitation and how we display the results, which is a major complaint we had from the '87 draft, and then a progress report on the supporting documentation.

The next slide, please. (Slide) This next slide is a flow chart. Starting at the top, Accident Frequency, we talked to you about that in March. Then as you run down --

CHAIRMAN ZECH: I can't see that slide very well. Does everybody have copies of the slides?

(No response)

CHAIRMAN ZECH: Could you have done any better for the slide here? It looks to me like it is really kind of useless. As long as we've got copies it is all right.

DR. ROSS: We are zooming in on it, I see.

CHAIRMAN ZECH: That will help.

DR. ROSS: From top to bottom on this chart, we started Accident Frequency, and then you take one

step down and you see how the accident progresses and you produce accident loads on the containment and the structural response of the containment. That's called an Accident Progression Bin.

And if you move one step down again, you get to the bin called Source Term Groups. And now we are transporting radioactive material around the primary system and the containment. If you march one step-- by the way at this point, you could stop and say you have a Level 2. And if you move one step down again, you get the off-site consequence and you worry about things that we call Consequence Measures, early fatalities, latent fatalities, property damage and so on.

The whole thing put together then is Risk Integration. That's a very brief snapshot of our methodology.

The next slide, please. (Slide) At our March briefing we mentioned developments in phenomenological data base and these eight bullets on here are the same we talked to you about in March. The importance I think, and this is something that I think we are going to have to make clear to the peer review committee, is that as of about March, or April of last year, '88, we, in effect, had to turn the key

off on phenomenological improvements as it affected the report and do some calculations.

So research development -- and certainly, since we are spending a lot of money, I think wisely, in producing a lot of data -- are still coming in. Technically, the report would be current as of the spring of '88. And as you would expect in any large project, you have to do this. We will have to explain that to the peer committee, make sure that they do understand it.

But I don't intend to discuss this any further, since we did cover it in March.

COMMISSIONER ROGERS: Do you have any idea of the sensitivity of the results of the report as it stands now to some of these new findings and data?

DR. ROSS: Well, no. I think there are two- - in fact, it may well be the last two bullets on this page. So, let me look at the last bullet, test on Mark-1 melt spreading and shell failure. This is one of the areas of highest uncertainty. We've learned nothing since March '88 that would change our mind.

The core concrete tests done come along all too often. There are some residual questions there regarding, I think, the overall phenomenon such as heat transfer to an overlying pool. And, again, I

don't know of any recent development that would change our mind there.

So, no, nothing has happened big to change our mind. A lot of it is going back in -- feeding back in to make the models predict better, but we don't have any new plateau, no.

(Slide) On the next page is a -- in fact, I had better look up and see -- this may be another one that may be a bit hard to read from the television monitor.

CHAIRMAN ZECH: Yes, it is.

DR. ROSS: Okay, let's zoom in on, roughly, the top half of this slide. I would say the single biggest criticism in the '87 draft was in the analysis and display of uncertainty. First, let me talk about the analysis, the changes in the analysis.

We went to a relatively mature technique elicitation of expert opinion. It has been done widely in other topics. In fact, it was done in the seismic hazard studies I previously mentioned. We had some consultants and decision analysts that helped us in this. And we went through a chain of things, starting at the front with Selection of Experts. And one of the criticisms that we had last time, that we were to incestuous, if you will, too involved, too

much NRC and laboratory people, and we needed to expand our data base and get more experts, outside of this closed community, which we did, including academia and the regulated industry, including Electric Power Research Institute.

We had a broader selection of experts. And as we follow the flow path, we selected issues which the panel of experts were free to reject, expand, or modify as they saw fit. We had to train them in the methods of elicitation, so they could convert what we call their substantive knowledge and things into normative knowledge, which means they could put a probability distribution function on their knowledge, and represent it in more or less standard ways.

We had processes where they would gather and exchange information, the technical evidence--further on to the right of this chart. From time to time, the experts -- by the way, one of the members of one of the panels is here at the table, Joe Murphy, was on one of the front end panels. They might decide that they weren't expert on that issue and just reject it and just say go find another panel that is an expert. And this did happen at least once, in fact, on the panel that Joe was on.

Let's move down to the bottom half of this

slide now.

COMMISSIONER ROGERS: It is very reassuring to find that kind of courage to make that decision. It is comforting to know that they were open enough to --

DR. ROSS: This particular issue is reactor coolant pump seals, and there is not maybe that many people that feel expert about it.

The experts would prepare their analysis, and they discuss them with each other. But when they come to the block on the slide marked "Elicitation of Experts", and this is done privately. That is each expert with a decision analyst would give his own-- convert it into the ingredients needed for the probability calculation. This private elicitation-- by the way, which is documented. Many of these -- we have 24-hours of videotape and the elicitations all on an audio recording. This avoids mob, or group psychology, where the strongest person can kind of bully or dominate the rest.

And then when we went together -- no matter how many experts we had, we treat each expert equally and averaged them arithmetically, and produced an aggregate expert opinion.

So, that's pretty much the process. It is

very time-consuming, it took many months. And in terms of money, it took a lot of money. I think it was worthwhile.

COMMISSIONER ROGERS: I understand that some other uses of this technique actually weight the experts, judging each other, in terms of their credibility. That is a weight for --

DR. ROSS: Yes, that's correct. And there is a very subtle way to weight it. I have said we average them arithmetically. You can also take the nth root of their product, "n" being however many experts. That's the so-called geometric mean, which is I think a poor use of the term. But what this does is if there are some zeros on some of the tails, one end, or the other, then that tends to squeeze the tails in. And the person with extreme views is, in effect, downgraded. But it is subtle.

And, yes, there have been studies where experts were weighted.

Now, our contractor, Los Alamos, represented by two people who have been very useful to us, Mary Meyer and Jane Booker, have essentially finished a rather -- fairly thick book. And they are going to publish this. They will put a lot of -- I think it will be of general use to the scientific community,

not just nuclear. And they have sections on this topic. They said, by far, the least controversial is to go arithmetic averaging, and that's what we did.

We did some sensitivity studies, but we didn't use them.

COMMISSIONER ROGERS: Thank you.

DR. ROSS: (Slide) On the next page another --I mentioned the display of uncertainties was criticized because we didn't show the true distribution. So, we are going to show distributions in different ways in 1150. We will show the fifth and 95th percentile ranges. We will show the mean, the arithmetic average and the median. And if you see the little histogram we have here in the middle of the chart, the median with the lower case "m" is where half the area is above and half the area is below.

And of course, if you show a histogram, then automatically the biggest one will be the mode. And if it were half, it would be the symmetric distribution shown on the right, then the mean, the median and the mode would all be the same.

Unfortunately, this almost never was the case, we had some bimodal distributions and most of the distributions were quite skewed. Nonetheless, we think we are going to show the information and

something will be useful.

(Slide) On the next page we have a very large number of backup reports. We can group these-- all of these reports, and there's about 20 of them that will be published this fiscal year, in three broad categories: accident frequency analysis, on the left, seven volumes; accident progress and risk, in the center, again, seven volumes, and supporting reports.

The frequency analysis and accident progression, and risk analysis will also be labeled "draft", for the same reason that the basic 1150 report is labeled "draft". Those will also be available, roughly July, or September is the publication date. And the peer panel will undoubtedly be interested in these reports.

CHAIRMAN ZECH: They will be available to them, you will have them for them?

DR. ROSS: Yes, that's right.

CHAIRMAN ZECH: Very good.

COMMISSIONER ROGERS: They won't all be ready by the time the panel starts it work though.

DR. ROSS: Not the first meeting, no.

COMMISSIONER ROGERS: Fairly soon?

CHAIRMAN ZECH: But they will be ready

during --

DR. ROSS: That's right.

I, as a guess, I suspect we will spend a lot of time at the first meeting in briefings, expanded briefings like we are having. But these reports are, collectively, more than a meter thick. So, I don't know anyone that will ever read them all.

(Slide) On the next slide, Perspectives, Mr. Cunningham will start the presentation here.

CHAIRMAN ZECH: Thank you very much.

You may proceed.

MR. CUNNINGHAM: I am going to provide perspectives in four areas this morning. First, I am going to summarize the core damage frequency information from internal events, which was provided to you in the March briefing.

In addition, we will talk about, or I will display the core damage frequency from external events, seismic and fire. We will then turn to containment performance in severe accident conditions; source terms and comparisons of our risk calculations with the safety goals.

In the next slide, (slide) -- as I said, this information was provided to you in the March briefing. It is estimates of the core damage frequency for our five plants from internal events.

As was noted in March, the two BWRs studied, Peach Bottom and Grand Gulf, seem to have somewhat -- appear to have lower core damage frequencies. The Zion plant as shown here, has the relatively higher core damage frequency.

As Mr. Murphy said in the March briefing, we have information from the Commonwealth Edison Company on the Zion plant, that they intend to make modifications to their design, such that their core damage frequency would be reduced. Certain dependencies in the plant design would be eliminated. Our rough estimate is that the core damage frequency from Zion would then come down by a factor of two to six, depending on how they specifically implement the modifications.

If I could have the next slide, please. (Slide)

CHAIRMAN ZECH: Are there any other modifications taking place on any of the other plants, in order to reduce core damage frequency, do you know?

MR. CUNNINGHAM: There were modifications that have been made since the draft report in 1987. For example, the Grand Gulf plant is, I believe, at roughly a factor of four in core damage frequency today, based on modifications made in 1988.

CHAIRMAN ZECH: How about the Sequoyah and Surry plants, have they made any modifications?

MR. CUNNINGHAM: I am not aware -- we are not aware of any modifications on those plants.

MR. STELLO: Didn't Sequoyah make a number of changes from the early draft?

MR. CUNNINGHAM: Yes, that's right, Sequoyah.

MR. STELLO: Weren't they the plant that probably made the most changes in the shortest time? Of course, Peach Bottom has been making changes over a longer period of time.

MR. CUNNINGHAM: Yes.

MR. STELLO: But changes from the two drafts, I would think Sequoyah would probably be -- I am asking for an opinion -- the one where probably the most changes were made?

MR. CUNNINGHAM: Sequoyah and Grand Gulf both made significant changes.

CHAIRMAN ZECH: Do these slides reflect the latest changes, or not?

MR. CUNNINGHAM: They do, except for the Zion plant.

CHAIRMAN ZECH: I see. All right, thank you.

MR. CUNNINGHAM: If we could go then to slide 16 (slide). This slide shows the external events core damage frequencies, calculated for the Surry plant. On the left is the internal events estimate for reference; in the middle are the two seismic core damage frequency estimates using the Livermore and the EPRI calculations on seismic hazard; on the right is the calculation of core damage frequency resulting from fires in the plant.

As I was indicating, it should be shown that the fire core damage frequency is somewhat lower than the contributions from internal events. The seismic analysis, if you consider median values as displayed, would have lower contributions to the median core damage frequency. The mean values tend to be somewhat higher. This is an artifact of the -- in the hazard curves, the mean values tend to be -- or the probability distributions for the hazard curves are very asymmetrical, they are skewed towards the high end, so the mean tends to be higher in the curves.

This translates then into a higher mean core damage frequency relative to the median.

The next slide provides the same information for the Peach Bottom plant (slide). At first glance, the fire core damage frequency would seem to be higher

than what was seen for Surry, or relatively more important. One thing you have to recognize in this slide is that the internal events, core damage frequency for Peach Bottom, is relatively low, relative to other PRA calculations for other plants, and other BWR Mark I's.

Again, you also see the rather broad distributions associated with seismic harzard. The median values for the seismic core damage frequencies are roughly comparable to the internal events; the means, because of the skewed distributions of the hazard curves, tend to be a good bit higher.

CHAIRMAN ZECH: In looking at those charts for Surry and Peach Bottom, it would appear that the probability of core melt in those plants is greatest in a seismic event.

Do you intend to review and involve yourself in any further actions to possibly make changes in the seismic design requirements?

DR. ROSS: Let me comment on that in two ways: we have done a number of studies in the past called the so-called A-45 Studies on decay heat removal in seismic. And when we do those we point out areas of vulnerabilities and, in fact, estimate how much good it would do if you fixed it.

And in these two plants, Surry and Peach Bottom, we have done somewhat the same thing. We point out the racks for switch gear, if you tie them down better, weld them down better, they wouldn't turn over and the seismic vulnerability would be less.

The policy though from the Commission is when we produce peer review, the individual plant external events portion of IPE. And that is under development and it is probably near the end of the year, I think that's our current schedule. If that goes through as planned, then each plant would do a study like this and identify particular vulnerabilities, and if it meets the formula, fix it.

What we have done here is to list the weaknesses --

CHAIRMAN ZECH: So it will be examined as part of the IPE program, is that what you are saying?

DR. ROSS: That's correct, yes, that's correct.

CHAIRMAN ZECH: All right, fine. Thank you. Let's proceed.

MR. CUNNINGHAM: If we could turn now to slide 18 (slide). This slide provides comparison of the core damage frequency from internal events for Surry and Peach Bottom in this version of 1150 versus

the Reactor Safety Study of 1975.

As may be seen, the Surry core damage frequency today is somewhat lower; the Peach Bottom core damage frequency is considerably lower than from 1975. There are two reasons for this, one is differences in the way in which we model plants in the PRA process. Perhaps more important though is modifications to the plants that have occurred in the last 15 years.

Surry, for example, has made extensive modifications to cross-connect important piping systems and emergency core cooling systems between the two units of the plants. So in some circumstances, if the equipment in one plant fails, they have the ability to go to the other plant, the other unit and provide cooling water, auxillary feedwater, what have you.

Peach Bottom also has had a lot of changes in the last 15 years. Perhaps one of the most important is one of the dominant sequences in the reactor safety study, it was a long-term loss of decay heat removal. That accident sequence has essentially disappeared by our analysis today because of modifications to the plant since then. One aspect of those modifications has been the ability to vent the

containment in this particular accident sequence that has a significant impact on the core damage frequency.

If I could move now to the next slide (slide). This slide provides the frequency of early containment failure for each of the five plants. This is one measure of containment performance, in general, in severe accidents. What can be seen here is, for example, the three PWRs seem to have a comparable absolute frequency of early containment failure. The two BWRs seem to be somewhat lower. This is principally due to the fact that the core damage frequency of the two BWRs is a good bit lower, as we have estimated them.

The next slide (slide) provides another measure of containment performance. This is the traditional probability of early containment failure, in effect, given a core melt. So, if you were to have a core melt in these plants, here is a measure of how the containment will perform.

On the left is comparison of the reactor safety study values for a particular accident, a station blackout accident at Surry. In 1975 the estimate was on the order of 80 percent of early containment failure with a station blackout accident. Today our estimates are significantly lower, the mean

value on the order of a few percent, something like that. This is also quite a distinct difference from the draft NUREG-1150 of two years ago, where we saw that the containment performance was not as good as it appears to be today. There was one particular issue, the issue of direct containment heating, that we understand better today, and believe that it is not as serious a threat to early containment failure as we estimated two years ago.

On the right-hand half of the slide is a comparison of the reactor safety study likelihood, or probability of early containment failure in an ATWS event in the Peach Bottom plant, relative to today. It is a little difficult to see, but the Reactor Safety Study, in effect, said that given an ATWS induced core melt, essentially the containment would fail with unity probability and early.

Today we see a very broad distribution of that containment failure probability, stretching from a few percernt to essentially 100 percent.

This was -- the phenomena that lead to this early containment failure are quite different today relative to 1975. In the Reactor Safety Study their estimate was that the dominant failure mode would be from an over-pressurization of the containment from

steam. Today we are seeing a combined effect of some steam over-pressurization failures, also, over-pressurization from the failure of the drywell by direct contact with the molten core as it comes out of the vessel. This is the so-called drywell shell failure mechanism.

COMMISSIONER CURTISS: Is this difference between '75 and today explained entirely because of different view about the phenomenon, or is it attributable, in part, to the fixes that have been adopted since then?

MR. CUNNINGHAM: It is a combination of both, I think. The way that we analyze an ATWS event today is different, such that we would not see the extent of steam over-pressurization as we did in '75. That is an analysis difference.

I suppose, also, the second aspect is more a different understanding of severe accident phenomena today. Also, the drywell shell failure mechanism was not identified in the Reactor Safety Study as a threat. So I guess it is mostly our understanding of severe accident phenomenology that has made the change.

I should note that the broad distribution that we see here for the Peach Bottom early

containment probability is the result of a rather polarized set of judgments in the technical community on the potential for drywell shell failure by contact with molten material. There are experts that we used who believed that, in effect, it would never occur. There are also an equal number of experts who believed that essentially it would occur with unity probability. Thus, you get a very, very broad distribution. This is a case of a very bimodal distribution that Dr. Ross alluded to a little while ago.

The next slide (slide) shows a measure of the plant performance for the Surry plant in terms of the potential for radioactive release fractions, the amount of radioactive release that could occur in an early containment failure in the Surry plant. The comparison is made here with the Reactor Safety Study, the triangles in the figure are the Reactor Safety Study values for a comparable type of accident. The distributions then are shown in the way that we have done it in other areas for the 1150 study.

In this particular circumstance, for the early containment failure it appears that the values-- our assessment today is that the source terms are lower than what 1400 would have estimated. The mean

values of our present distributions tend to be somewhat lower than the Reactor Safety Study values. The median values are significantly lower than the Reactor Safety Study values.

In contrast to this display of radioactive releases for an early containment failure, the next slide (slide) provides an estimate for late containment failure. As can be seen here, the most apparent thing is the late containment failure has a dramatically reduced potential for radioactive release relative to early release, orders of magnitude lower in potential release.

The comparison with the Reactor Safety Study is not so clear for this type of containment failure. However, given that this type of release, or this type of containment failure is relatively unimportant to risk relative to the early ones, the differences don't seem to make much difference.

COMMISSIONER ROGERS: What was really the reason for the big difference from the earlier study, the Reactor Safety Study, which are the triangles?

MR. CUNNINGHAM: Yes.

COMMISSIONER ROGERS: All pushed up higher- - why is that?

MR. CUNNINGHAM: It is probably mostly the

result of our improvements in the understanding of severe accident phenomenology. We took credit, we now have physical models for certain parts of the process that we did not have in 1975. For example, retention of radioactive material in the reactor coolant system was not really considered in the Reactor Safety Study, or it was considered, but it was basically said at the time that we did not have enough information to give it anything, other than to say that everything that is released from the core will be released out of the reactor coolant system.

Today, we model the physics and the chemistry of those events that can have an effect on these releases. I think, in addition, there is just a general improvement in our understanding of containment and containment source term analysis.

MR. STELLO: Commissioner Rogers, I would just simply say that the short answer is we have 15-years of research that we have put into this area that we are now using to provide that.

COMMISSIONER ROGERS: Is this one of the few cases, or are there others where the later study begins to show a little less favorable results than the earlier study, in terms of release fractions?

MR. CUNNINGHAM: I'm sorry, I didn't

understand.

COMMISSIONER ROGERS: Looking at Slide 22, things get worse?

MR. CUNNINGHAM: Things get worse for very small releases. It could be that you are in a regime here, the release fractions are so small that this may be, in effect, almost all noise. There is no --

COMMISSIONER ROGERS: I see.

MR. CUNNINGHAM: -- discernible difference. There is no real difference between the safety study and the present calculations at this level. These are very small --

COMMISSIONER ROGERS: That's a helpful way to put that in some perspective.

MR. CUNNINGHAM: Slide 23 provides a similar type of display of early containment failure in the Peach Bottom plant. In this case there are two sets of triangles indicating that our way of analyzing the plant now is not directly correlatable to a specific release category in WASH-1400, so we kind of display two that appear to be the closest. This has more of the characteristic of the slide for early containment failure for Surry, the triangles tend to be between the mean and the 95th percentile on our present calculations. The median values tend to be a good bit

less.

COMMISSIONER ROGERS: Do these later studies include direct containment heating?

MR. CUNNINGHAM: Yes, they do, yes.

Turning to Slide 24 (slide), Slides 24 through 29 provide estimates of overall risk of the five plants relative to the safety goals and to a proposed probability of large release.

Slide 24 compares --

MR. STELLO: Excuse me, let me -- I was trying to find a way to characterize -- an easy way to characterize what this number means. And I think the total of all accidents, the probability of someone in the United States, as I recall, being a fatality is about like one chance in 2,000. The average in the United States for all accidents: automobiles, earthquakes, lightning, whatever, per year.

So you are looking at where this ranks in terms of getting a fatality. The risk that we take from all sources of all accidents -- I think, if my memory serves me, is about one in 2,000, Bill?

DR. ROSS: Yes, 2,000 is right.

MR. STELLO: Okay.

MR. CUNNINGHAM: As can be seen from this slide, the first slide, Slide 24 is a measure of the

average individual early fatality risk for each of these plants compared with the safety goals, that specific safety goal. It can be seen the five plants we've studied are well beneath the safety goals. The two BWRs tend to be signficantly lower than the three PWRs. That is a combination of the lower core damage frequencies and the fact that these particular plants have somewhat lower population distributions about them.

Slide 25 (slide) is a comparison with this same safety goal for the two fire risk calculations that we performed for the Surry and Peach Bottom plants. When we are using this specific initiating event, the risks are well below the safety goal.

Slide 26 (slide) compares the five plants with the individual latent cancer fatality safety goal. These are well, well lower, much lower than the safety goals.

Slide 27 (slide) is the same type of thing for the fire external event, very low compared with the safety goals.

Slide 28 (slide) provides comparison of the five plant risks with one specific definition of a probability of a large release. The release is, in effect, the probability of having one, or more early

fatalities as a result of accidents at the plant.

What can be seen here is in the two BWRs, they are a good bit lower. I should also note that the Zion plant would be expected to come down, because of the modifications that they are making in the design as we speak.

COMMISSIONER ROGERS: On the other hand, Surry and Sequoyah are just added, or even a little bit higher probability.

MR. CUNNINGHAM: That's correct. The Sequoyah plant -- it tends to be somewhat higher because of the combination of -- Sequoyah is kind of the moderate plant, if you will, it is a moderate relative -- among the five, it has a moderate core damage frequency, not high, not low, moderate containment performance and moderate site, in terms of population. The three of them together tends to keep it somewhat higher than the others.

COMMISSIONER ROBERTS: How do you compare Slide 24 and Slide 28? And doesn't Slide 28 give credence to what the ACRS says that you use in a definition of a large release that is a level 10 times more conservative?

MR. CUNNINGHAM: That's exactly correct.

MR. STELLO: They think we're too

conservative in what you were using for a suggested proposed large release, and I think at the meeting with the Commission they made a point rather clear, they think we've gone too far.

COMMISSIONER ROBERTS: Well, do you agree with them?

MR. STELLO: This is the subject of much debate for many years. I would like to find a way to come to grips with this. I tend to want to be a little bit more conservative, so I lean that way.

DR. ROSS: It is also true that their advice and their hierarchy -- would a lower hierarchy, such as the probability of a large release -- shouldn't dominate something like Slide 24. So I think it is the same point. But this is a measure that we used in '87, and for consistency, I think it would be useful to compare '87 versus '89. The distributions are lower than they were in '87.

COMMISSIONER ROBERTS: Okay.

MR. CUNNINGHAM: The final slide (slide) --

COMMISSIONER ROGERS: Just on that, because this is an important point, this large release thing. In defining a large release is it the same -- do you have a standard set of meteorological and geological, or geographic factors that are not plant-specific for

that, or are they plant-specific in doing a large release -- in doing this calculation?

MR. CUNNINGHAM: For the large release calculation and all of our calculations we use plant-specific.

COMMISSIONER ROGERS: Entirely, including the meteorology, local meteorology --

MR. CUNNINGHAM: The geography, the population distributions were all plant-specific.

COMMISSIONER ROGERS: Everything is plant-specific?

MR. CUNNINGHAM: Everything is plant-specific.

MR. STELLO: You really can't do the calculation unless you are using plant-specific. In some cases...

MR. CUNNINGHAM: The final slide of this package, Slide 29 (slide), is simply a comparison of the fire risk calculation compared with this same probability of the large release definition.

If there are no other questions --

DR. ROSS: In summary, I think there are four points, (slide). After our QA next week, we expect to clean up the report and be ready to issue it in early June. We hope the peer review can start in

July. As I said, it could go onwards of a year. And then sometime after that, to fix the report.

And in the interim, we would expect to use the report as per the guidance we got from the Commission. And then eventually, we will, as the peer review is complete, we will modify it and reissue it as a final report.

That's our summary.

We are available for questions.

CHAIRMAN ZECH: All right. Thank you very much.

Thank you.

Questions, my fellow commissioners, Commission Roberts?

COMMISSIONER ROBERTS: I have no questions. This is a tremendous project, I wish you success.

CHAIRMAN ZECH: Commissioner Rogers?

COMMISSIONER ROGERS: Well, I will just take questions at the moment because I would like to compliment you,too, I will do that separately.

The Reactor Safety Study was criticized for the way it handled severe accidents source term calculations, and not being able to follow those, that the reader had a great deal of trouble replicating how that was done. Now, do you see this report in its

final form, including appendices, or whatever else, supplementary documents, as really being able to provide a transparency to exactly how all of the calculations were done?

Will it be possible to read this report with understanding of the details of how the results came about?

MR. MURPHY: Well, that's our goal at least. We have a complex problem, so it is difficult to explain it. I think we will have a -- well, we will have an appendix in the NUREG-1150 itself. So we will try to walk through one problem, so you can see how things were calculated.

The details in the contractor reports, I think will be sufficient for somebody -- an expert in the field, who wants to replicate the work. So you have enough information to go forward.

COMMISSIONER ROGERS: I don't think it should be a tutorial, but it should be possible for an expert to do it.

MR. MURPHY: I think an expert will be able to do it. It will be difficult for a man in the street to get through all of the details.

MR. STELLO: I would answer Commissioner Rogers, what I have seen thus far, I don't believe at

this time anyone can say that there will inadequate documentation. However, the complexity of the issue, of what we are trying to calculate is going to make it a real challenge to have that information displayed in such a way where we are going to satisfy everyone.

I do hope -- we are trying very hard not to have that kind of criticism. But it is going to be very, very difficult because of the massive amount, 15-years of very complex research that is, in fact, embodied within this study.

COMMISSIONER ROGERS: Well, I think it is terribly important that an expert, not the man on the street, but an expert, be able to go through it, because as Dr. Ross said, this tremendous amount of material says that it is very daunting to someone to try to go through the whole thing.

Well, that is something one worries about, because if it isn't possible for an individual to go through it, you know, a hearty soul, who is willing to take the time and effort to do it, one worries that in the hand-off from one part of it to another, to another person, that somehow that total integrated evaluation and confidence that it all hangs together has just got a question mark over it.

And I think that it is important that at

least recognized experts can go through the whole thing, if they so choose to do so.

MR. STELLO: That was one of the early comments that we have worked very hard to fix up. I am confident that we have made a lot of progress. I believe that we will succeed.

MR. BECKJORD: I can add a bit to that, Commissioner Rogers. I used, or attempted to use 1400 to teach a graduate course in PRA and it was extremely difficult. I really finally went to other sources. I have looked through several cases here, and I think it is far clearer and will be much easier to trace.

I don't know that it will reach the conceivable limit, but I think for recognizing what it is doing, I think it has done a better job in that respect, a much better job.

COMMISSIONER ROGERS: On this question of using it, I don't know if it is premature to ask the question, but it seems to me that you should have in mind how it could be used in connection with IPEs, and what the relationship between this effort, which is a research effort, should have, will have with NRR activities. And it seems to me that we must make sure that there is a good connect there, so that whatever insights and helpful results have come out of this

1150 work are fully available, transportable into the NRR work of the agency. And I think that is very important that that take place.

And I know there is some concern about that, but whether it has gone as far as it should --

MR. STELLO: The ACRS has clearly suggested we ought to even go further than we have suggested going in that regard, I think. At least Hal Lewis left me with that impression in briefing the Commission, he thinks -- he may be right, but we are being a little bit cautious, and I think it might be warranted to have a little caution.

COMMISSIONER ROGERS: Well, as to just, you know, the detailed way in which it is applied. But it seems to me the understanding of it should be something -- MR. STELLO: There is no doubt that everyone that will read 1150 will, in fact, be moved in a way that will -- it will provide those kinds of views and insights, I am convinced. In that context, yes.

COMMISSIONER ROGERS: Good, good.

Well, I would just like to add my praise to those of Commissioner Roberts, also. This has been a monumental effort. A great deal of courage to embark on it, in the first place. I am sure that you've

taken a lot of criticism because something new does properly become criticized. But the perseverance .... displayed in pursuing this, and I am sure it is something that at time may not have looked like it was ever going to come to a satisfactory closure, is really more than commendable. And I would certainly like to say that it really is a great piece of work, even though it may not be perfect, because nothing ever is.

MR. BECKJORD: If I could add just one point to your question about the insights. There has been some work done on that, a fair amount actually, there is more to come. And now that the work is done, I think we can concentrate on it. We are giving a presentation at the next Senior Management Meeting on Insights of PRA from 1150, and that's coming up the week after next. And NRR is very interested in that.

COMMISSIONER ROGERS: I hope they have a good turnout.

CHAIRMAN ZECH: Commissioner Curtiss?

COMMISSIONER CURTISS: I don't have any questions. Thank you.

CHAIRMAN ZECH: Well, I believe the staff has accomplished a major milestone in improving NUREG-1150 and addressing the comments that you have

received. I commend the staff for this effort. I think it is a very, very significant undertaking.

And as far as I know, we are the only country in the world that has really taken the initiative in this regard anyway. I know other countries are very interested in what we do, but it is an undertaking that, in my view, has a real contribution to more solid understanding of severe accidents and making a contribution to the safety of reactor operations. There is just no question about it, in my view. And I think it is a very, very commendable undertaking.

I, too, congratulate the staff and all of those from Sandia and others who have contributed so significantly to your efforts. I know it has been a contribution of a lot of people. I commend all who are involved in this very significant and very important undertaking.

You've told us that you are in the process of conducting a final quality assurance review of the document, and you plan to issue the report as a second draft for peer review in June. The Commission will be requested to formally appoint the individuals that will make up the peer review group in the near future.

We recognize, Mr. Stello, that you are still working on this. You've indicated that you believe the peer review group will take approximately 12-months, maybe a little less, but approximately 12-months, or perhaps less. And unless you have major deficiencies identified by the group, that the final version of NUREG-1150 could be expected to be completed sometime towards the end of 1990.

The second draft of NUREG-1150 represents a significant effort and I believe the NRC's best understanding to-date on severe accident progression. Therefore, I continue to believe that the staff should be allowed to use the report while it is undergoing peer review, and recognizing that the final version of NUREG-1150 might require some modifications. I believe it would be useful to the industry to have the document and be able to use it for consideration and comment, while the peer review is ongoing. Those are my personal views, however, this is a matter that we have asked the ACRS staff to provide their views on.

So we will take into consideration whatever information we receive from the ACRS. And, hopefully, as Mr. Stello pointed out earlier, we will receive that information, perhaps as early as next week. And we will act on it promptly to get back to the staff,

so that you can expect that we will, the Commission, will provide you our views and our position on whether you can proceed with interim use by the licensees and o[illegible]s when we receive the ACRS views.

So you can expect to receive our final position on that then and I want the SRM to so note that we have made that decision here at this meeting.

But I would just like to conclude by thanking the staff, not only for an excellent briefing, but a tremendous amount of work since the original WASh-14 study and attempting to update that. It is a very commendable undertaking and a real contribution, I think, to understanding, as well as to safety of nuclear power operations. It certainly is something that I am very proud to have been a small part of during my time here on the Commission. And I commend the staff for a very courageous and important undertaking that I do believe can make a significant contribution to future operations at nuclear reactors, not only in our country, but around the world.

Are there any other comments from my colleagues?

(No response)

CHAIRMAN ZECH: Thank you very much for an excellent briefing.

We stand adjourned.

(Whereupon, at 11:23 a.m., the meeting was adjourned)

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 STATUS OF SECOND DRAFT OF NEUREG-1150

PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: MAY 5, 1989

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.

Barbara Rector

Reporter's name: MILES ANDERSON

# Commission Briefing on NUREG-1150

Office of Nuclear Regulatory Research

May 3, 1989

# Elements of Presentation

- Purpose
- Present Status
- Risk Analysis Methods
- Perspectives
- Summary

# Purpose of Presentation

- To inform the Commission of staff's intent to publish NUREG-1150 as second draft for peer review.
- To provide a summary of methods used and results obtained.
- To inform the Commission that the present version of NUREG-1150 will be used as indicated in Commission guidance in February 9, 1989 memorandum.
- To inform the Commission that following peer review, staff will prepare a final version of NUREG-1150 and submit to Commission.

# Present Status

- Report assembled and delivered to Commission
- Final QA review on May 8-9
- Plan to send to printers in May, issue in June
- To be published as second draft for peer review
- Same wide distribution as February 1987 draft

- Peer review organization proceeding smoothly
  first technical meeting week of July 10
- ANS special committee to be briefed in May

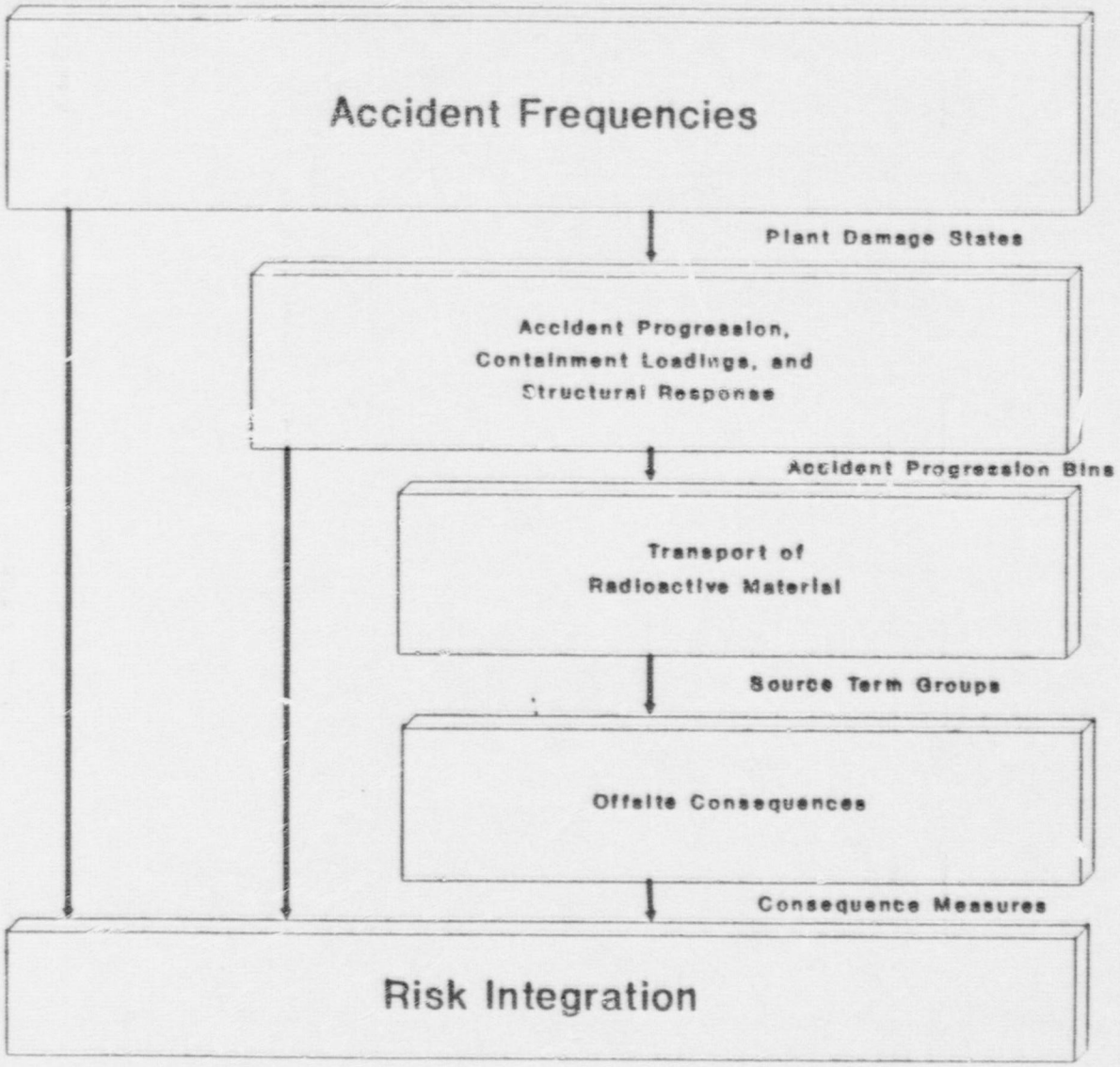
## Present Status (continued)

- NUREG-1150 has performed external events analysis on 2 plants: Surry and Peach Bottom.
- Seismic analysis includes consideration of low probability, high intensity earthquakes which could have significant consequences in surrounding population.
- Pending further review, seismic analysis in NUREG-1150 will be limited to core damage frequency and containment performance.
- To aid review of work, contractor documents will include sensitivity studies on seismic risk.
- Final version of NUREG-1150 should include results of seismic risk analyses.

# Risk Analysis Methods

- Overall Approach
- Phenomenological Data Base
- Expert Elicitation Process
- Display of Results
- Supporting Documentation

# Elements of NUREG-1150 Risk Analysis Process

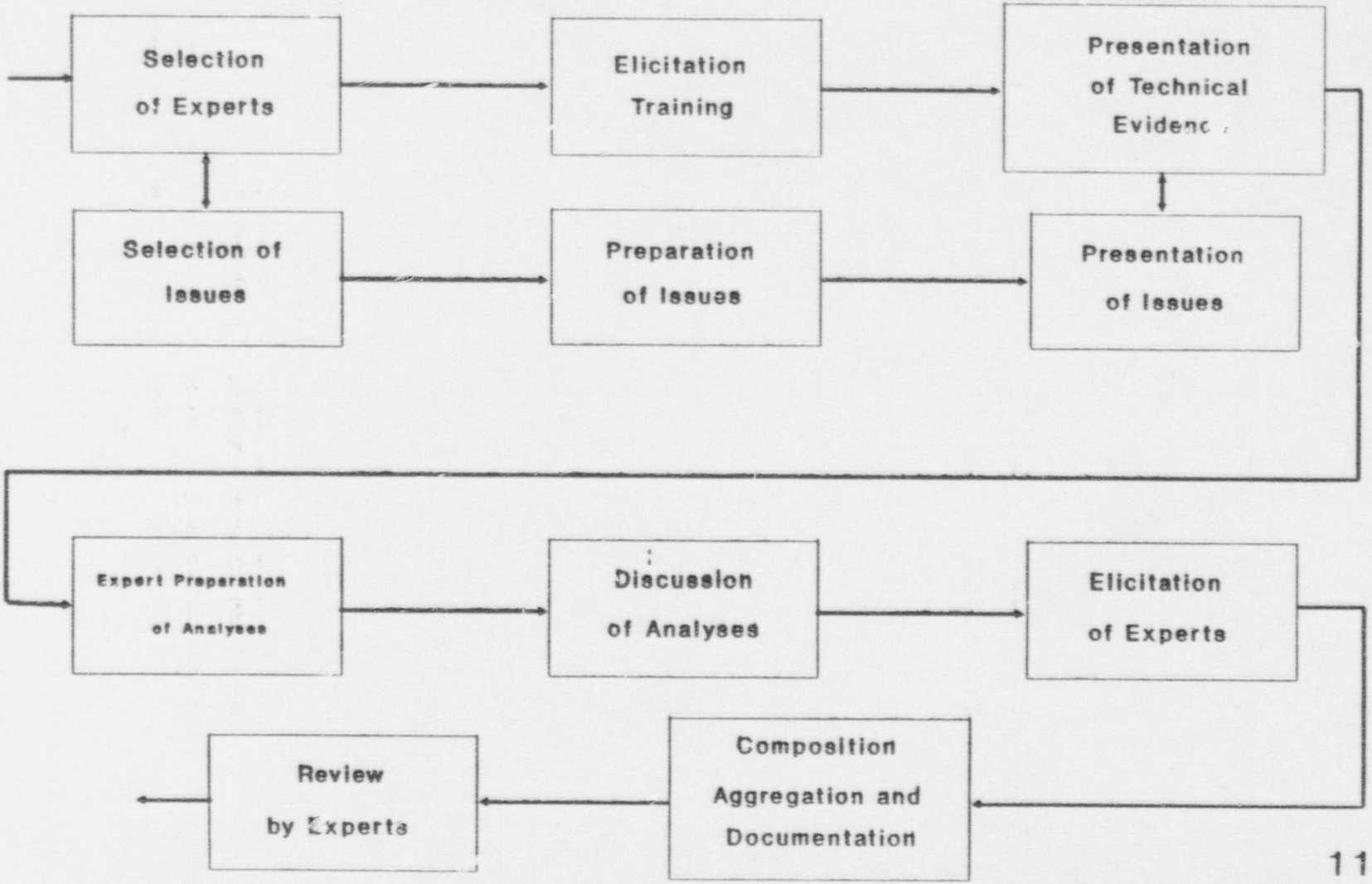


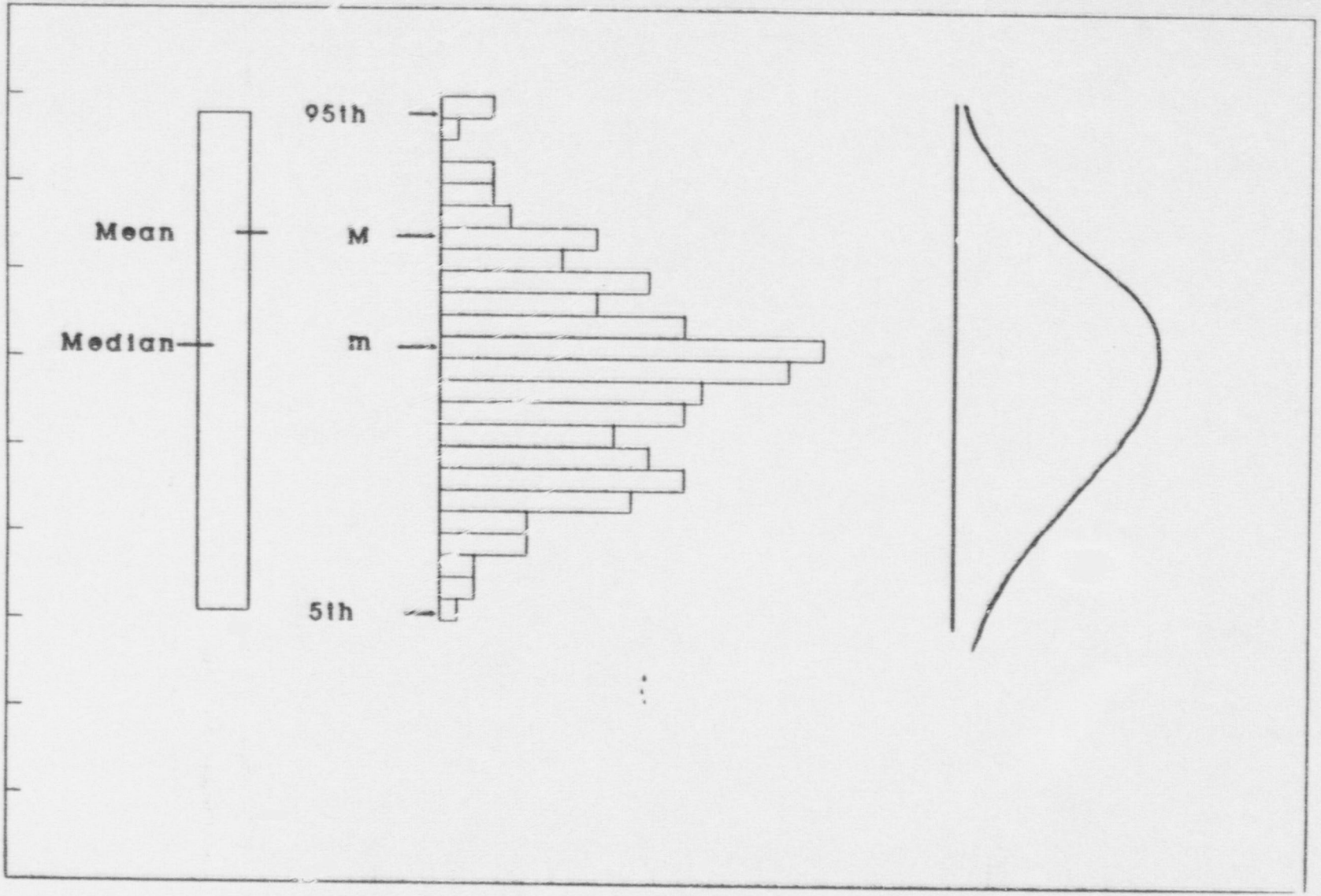
## Phenomenological Data Base

Since the completion of draft NUREG-1150, new research information available includes:

- In-vessel melt progression analyses (TRAC/MELPROG, RELAP/SCDAP, MELCOR, BWRSAR)
- BWR severe fuel damage test in ACRR
- Full-length coolant boildown tests in NRU
- Hydrogen DDT and high temperature detonation limits
- Direct containment heating tests in SURTSEY
- Small-scale cavity dispersal tests
- Core-concrete tests with sustained heating
- Tests on BWR Mark-I melt spreading and shell failure

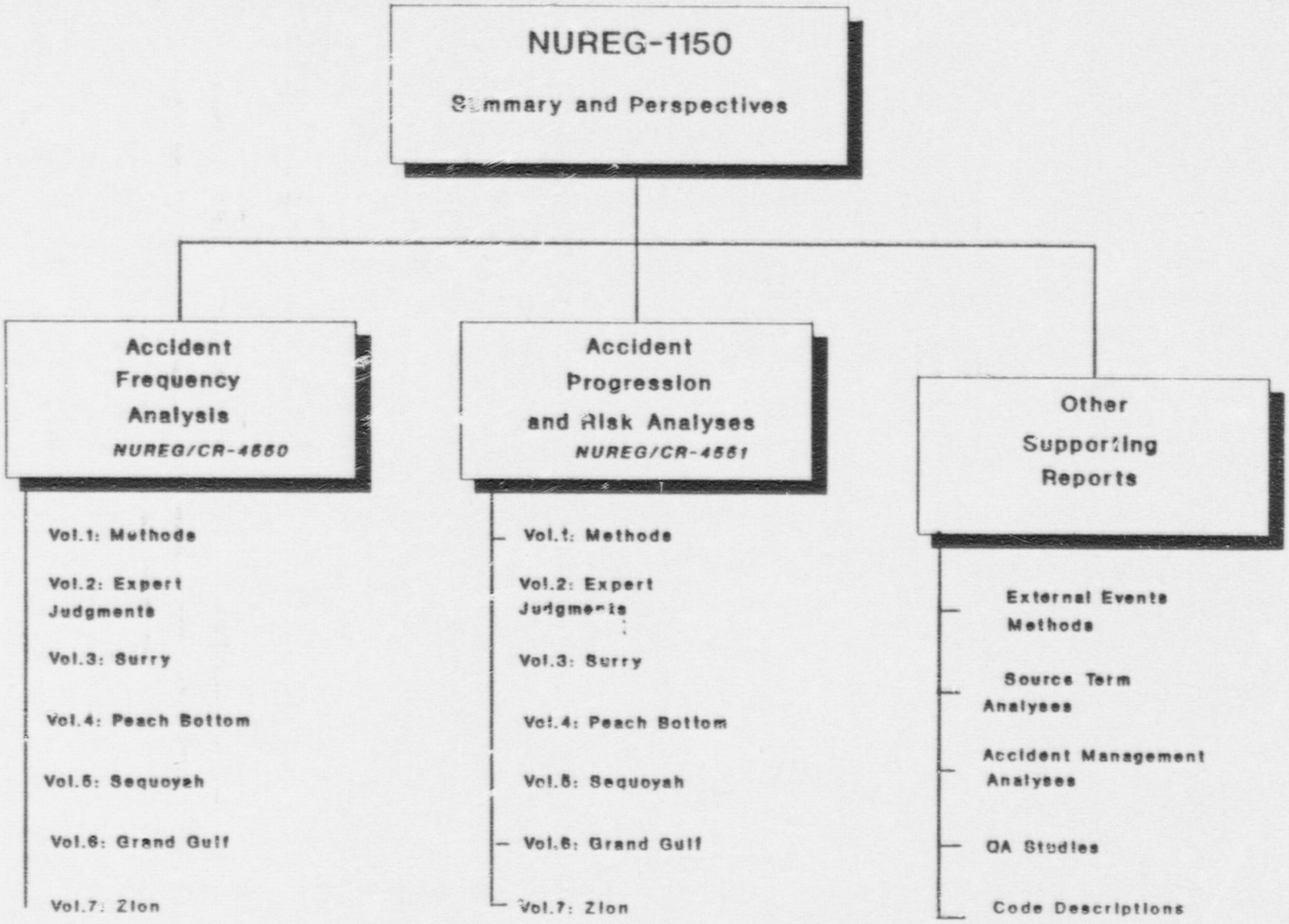
# Steps in NUREG-1150 Expert Elicitation Process





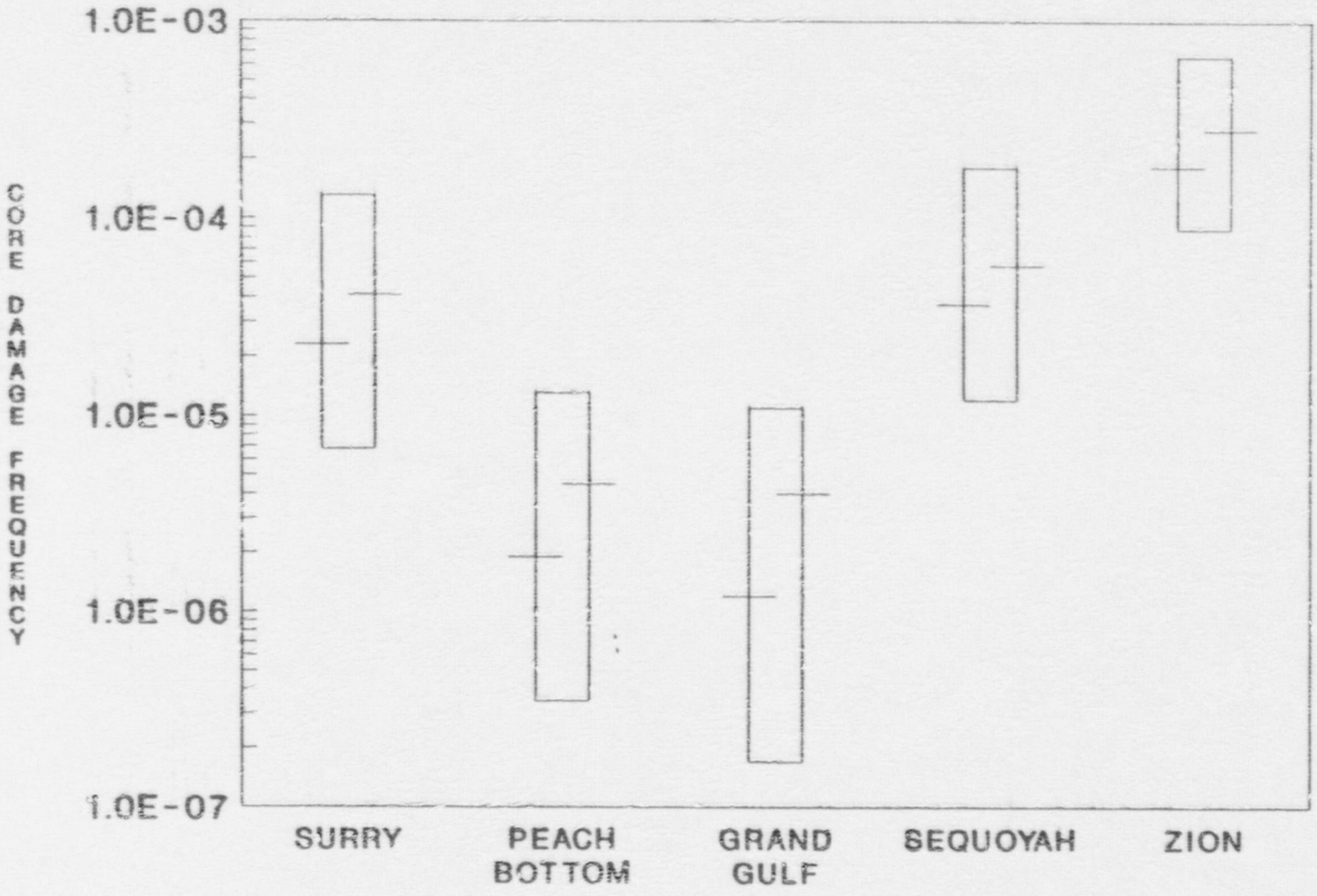

Example Display of Probability Distribution

# Reports Supporting NUREG-1150



# Perspectives

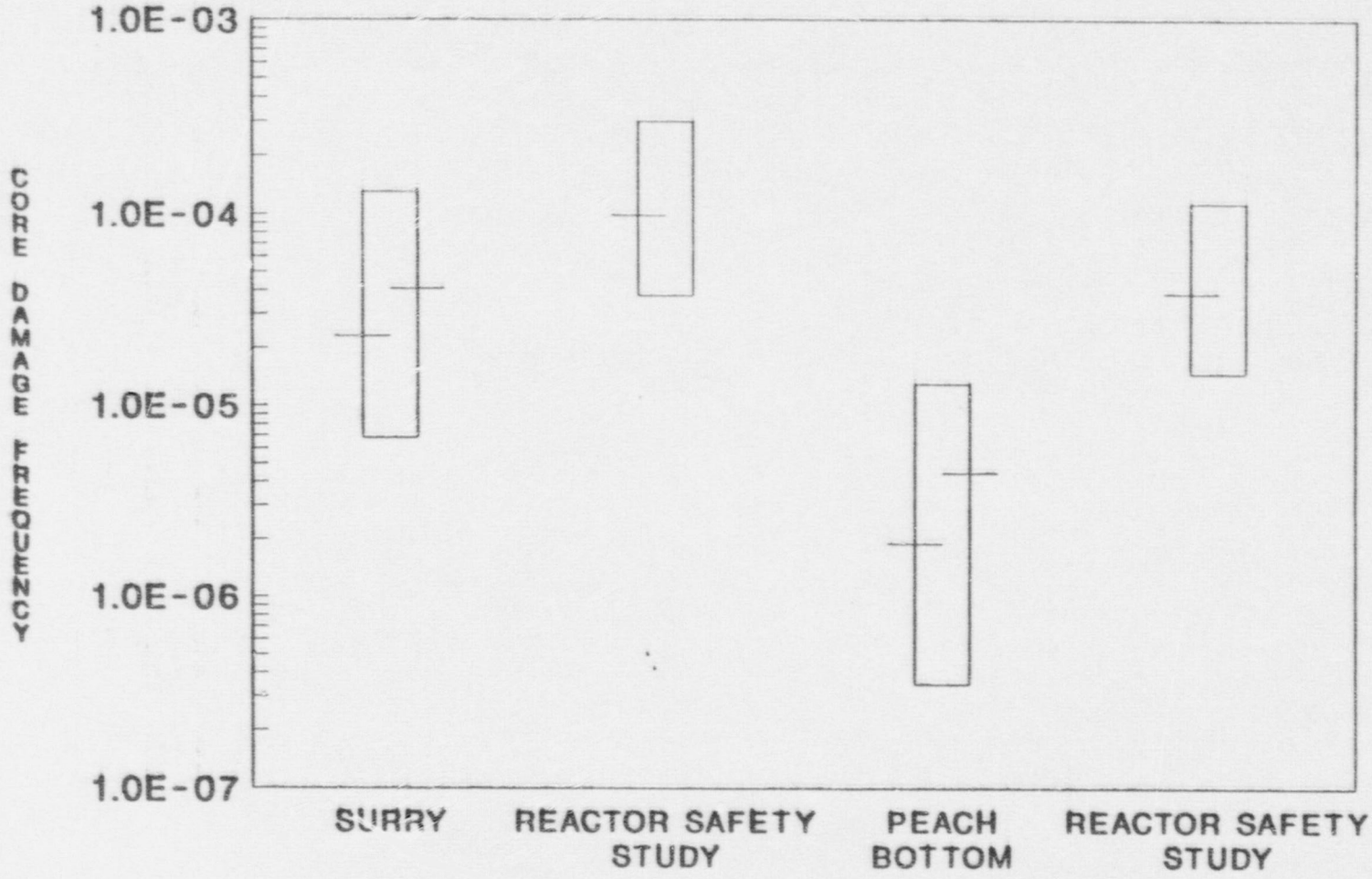
- Core Damage Frequency
- Containment Performance
- Source Terms
- Risk
- Safety Goal Comparisons



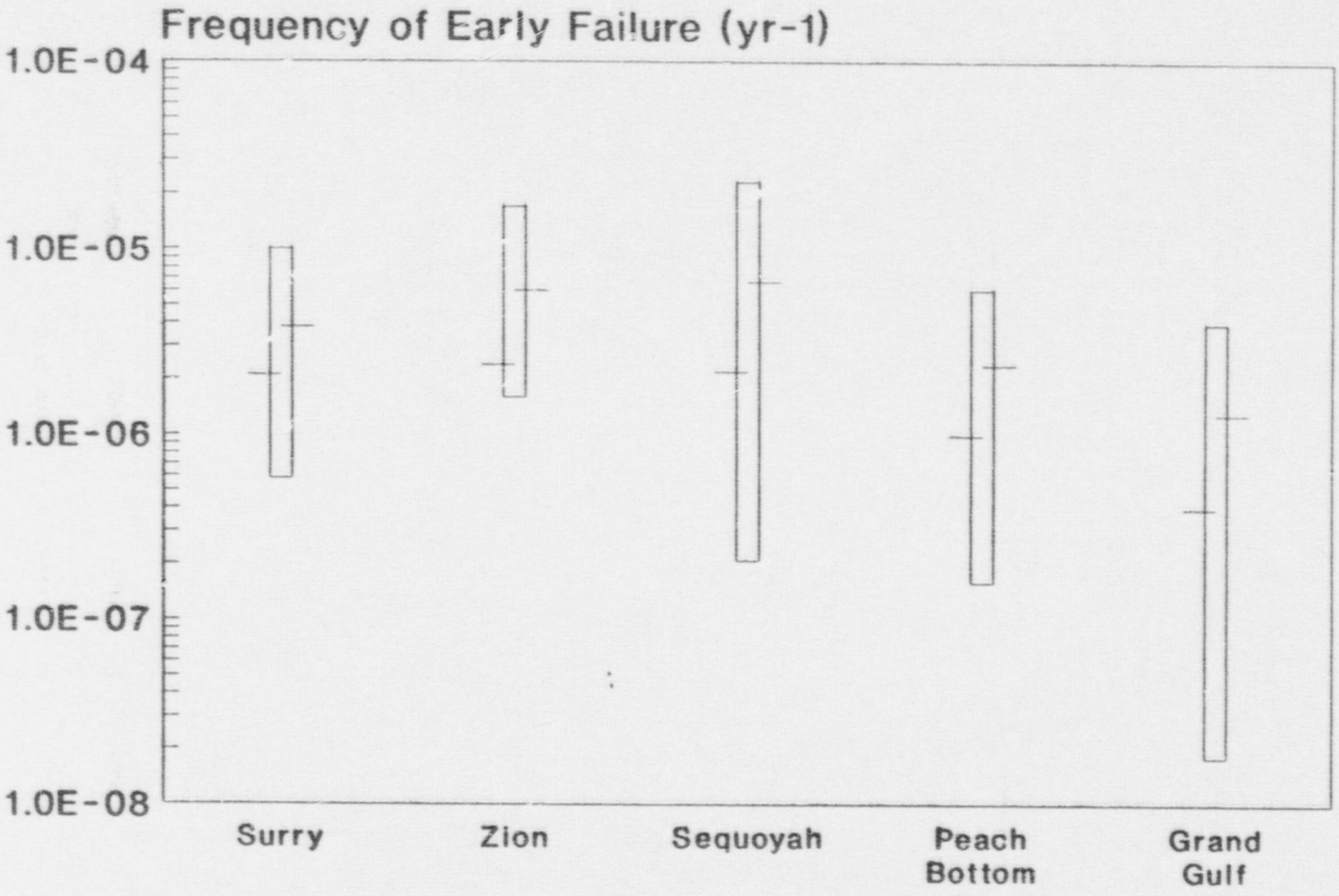

Internal core damage frequency ranges


Surry external events core damage frequency ranges

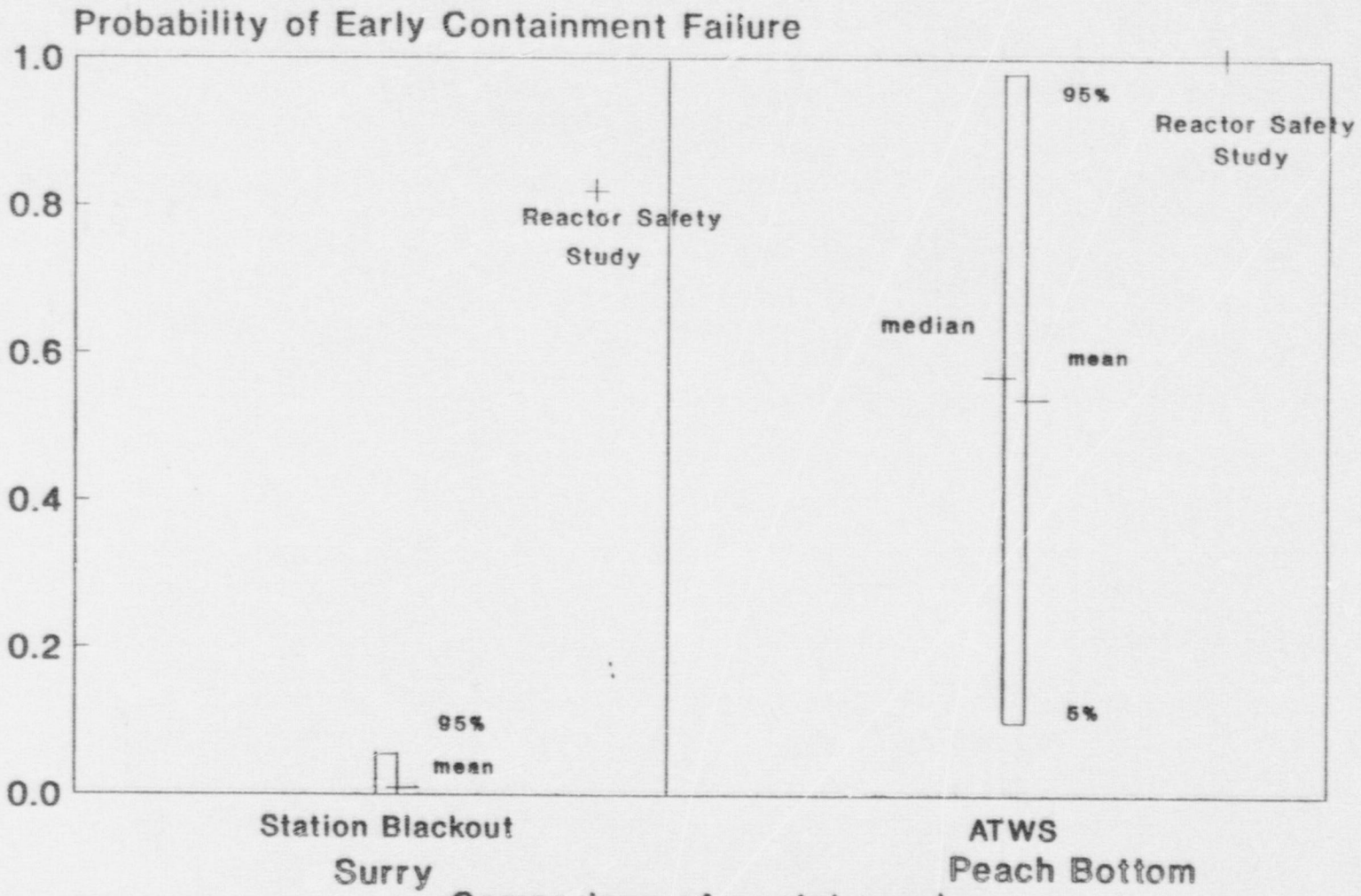

Peach Bottom external events core damage frequency ranges




Core damage frequency ranges
compared to Reactor Safety Study

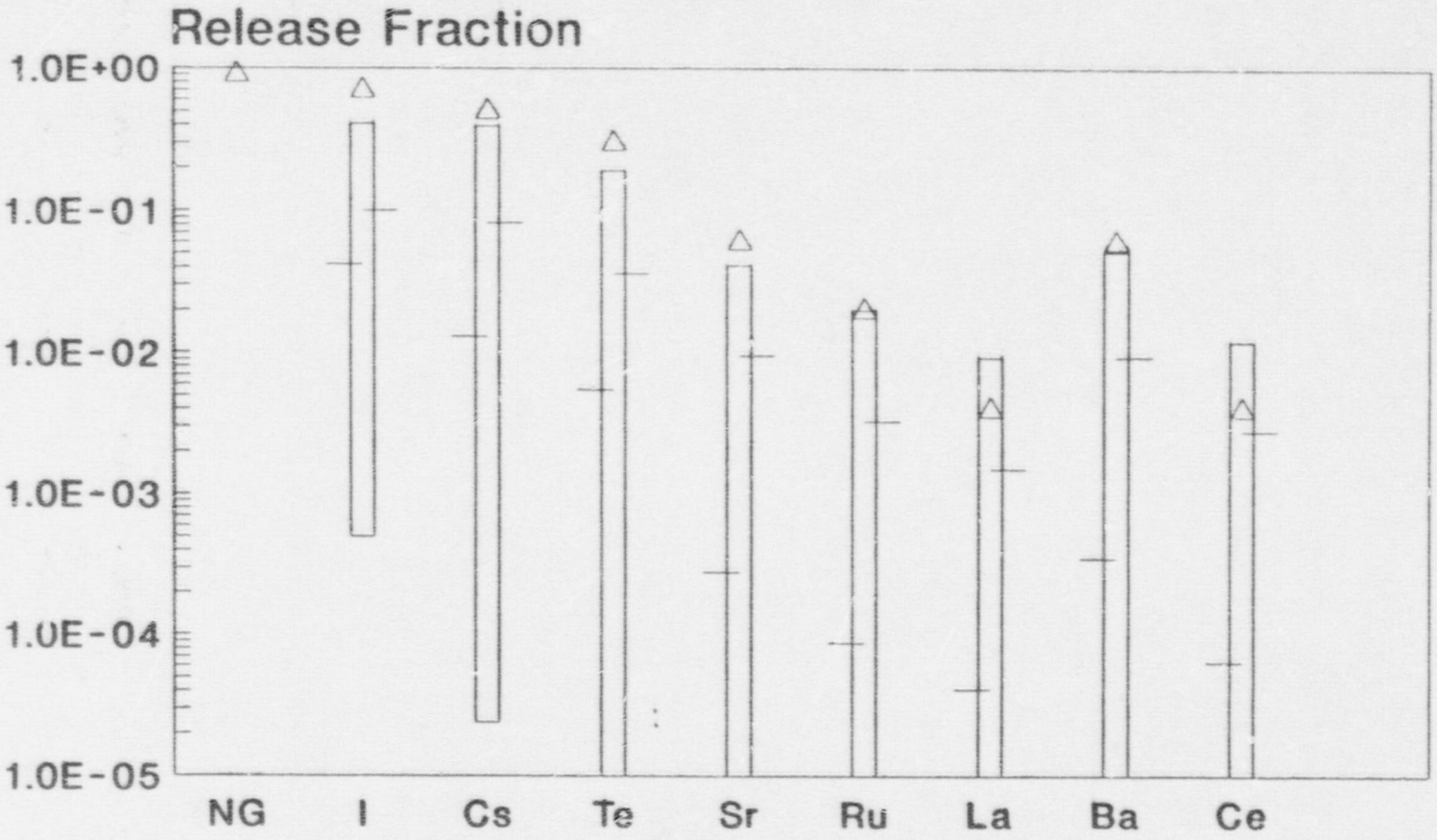



Frequency of early containment failure or bypass




Comparison of containment performance results with Reactor Safety Study

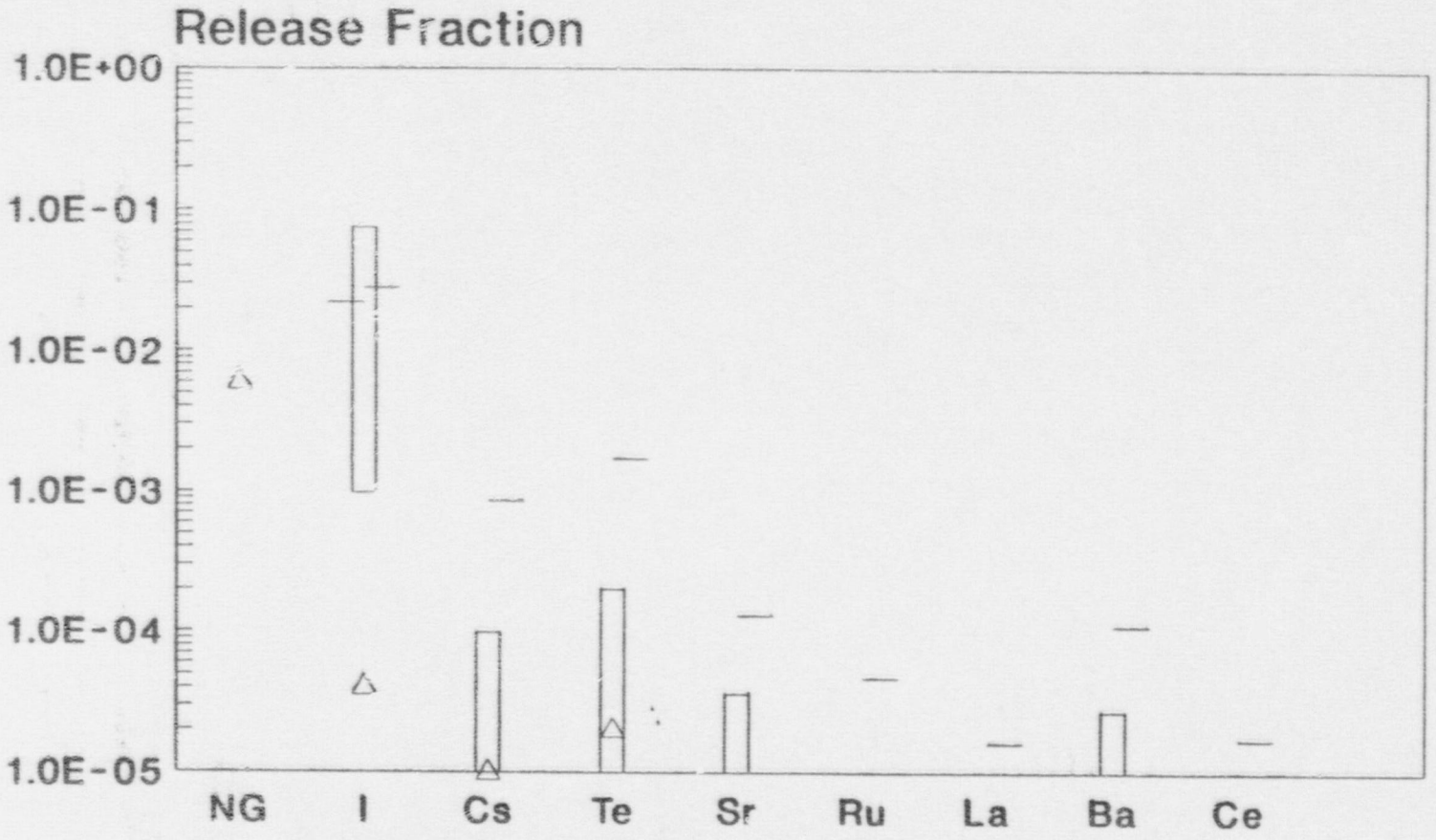
## Early Containment Failure




Comparison with Bin PWR2

Comparison of source terms with Reactor Safety Study, Surry

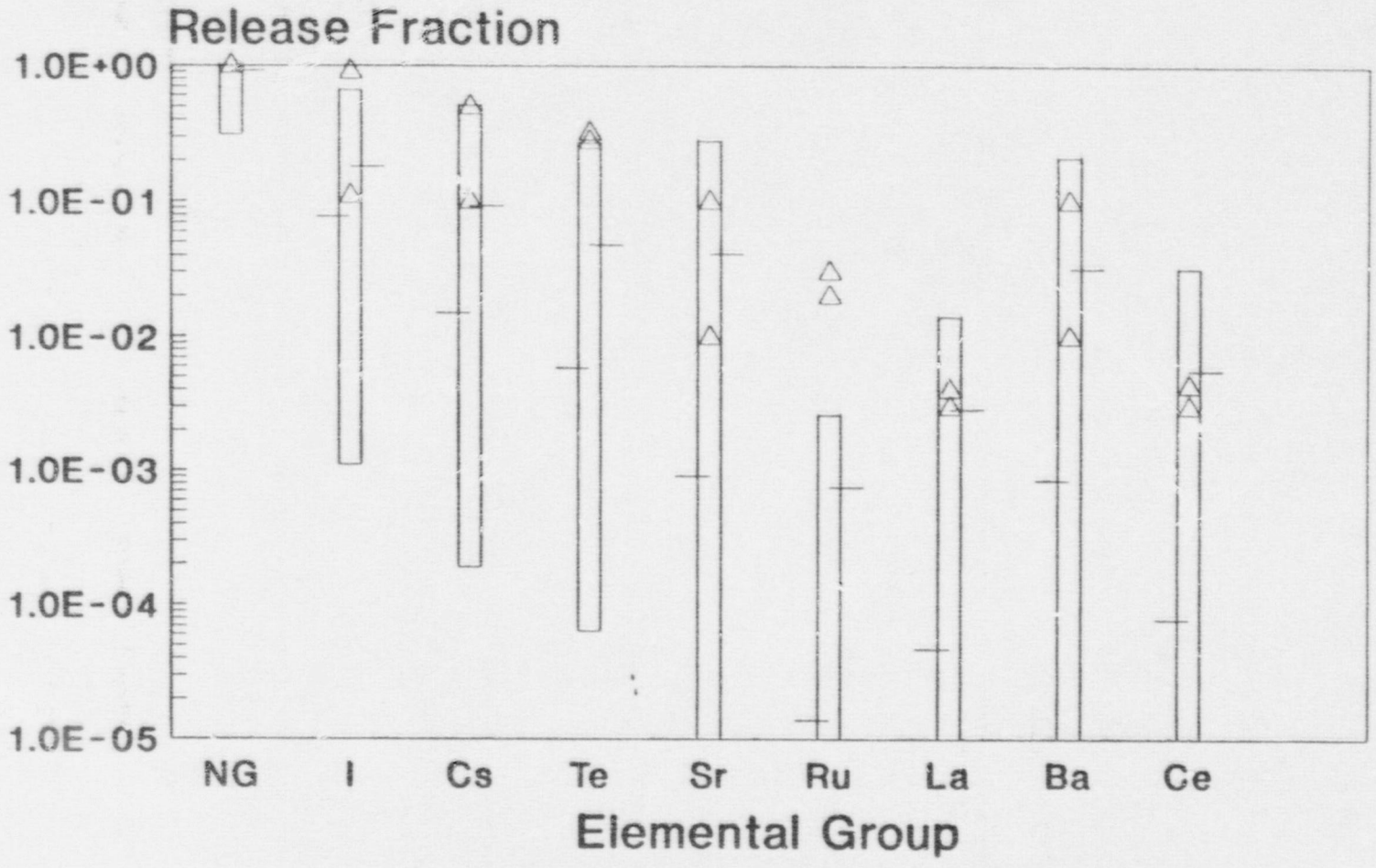
## Late Containment Failure




Comparison with Bin PWR7

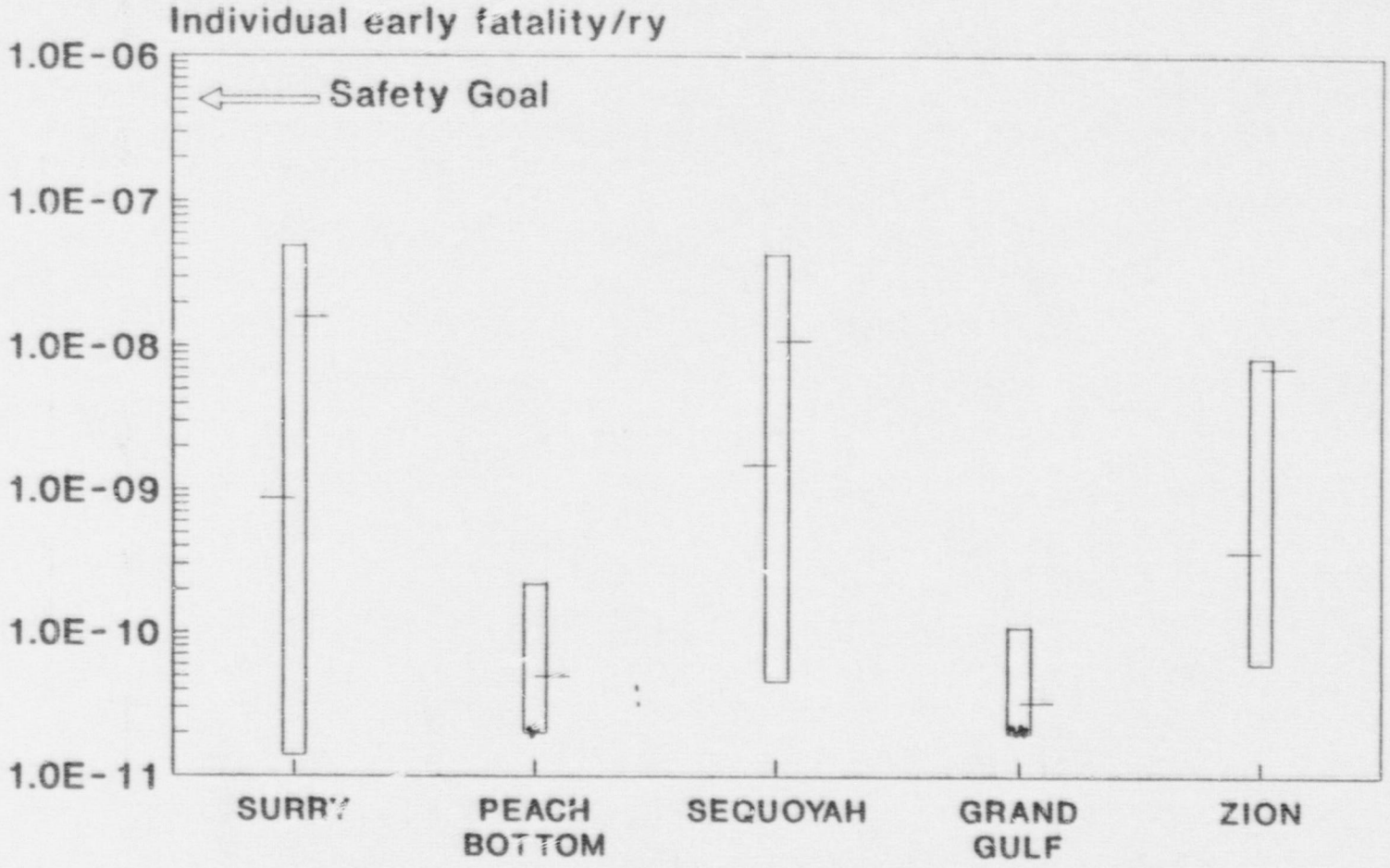
Comparison of source terms with Reactor Safety Study, Surry

## Early Containment Failure

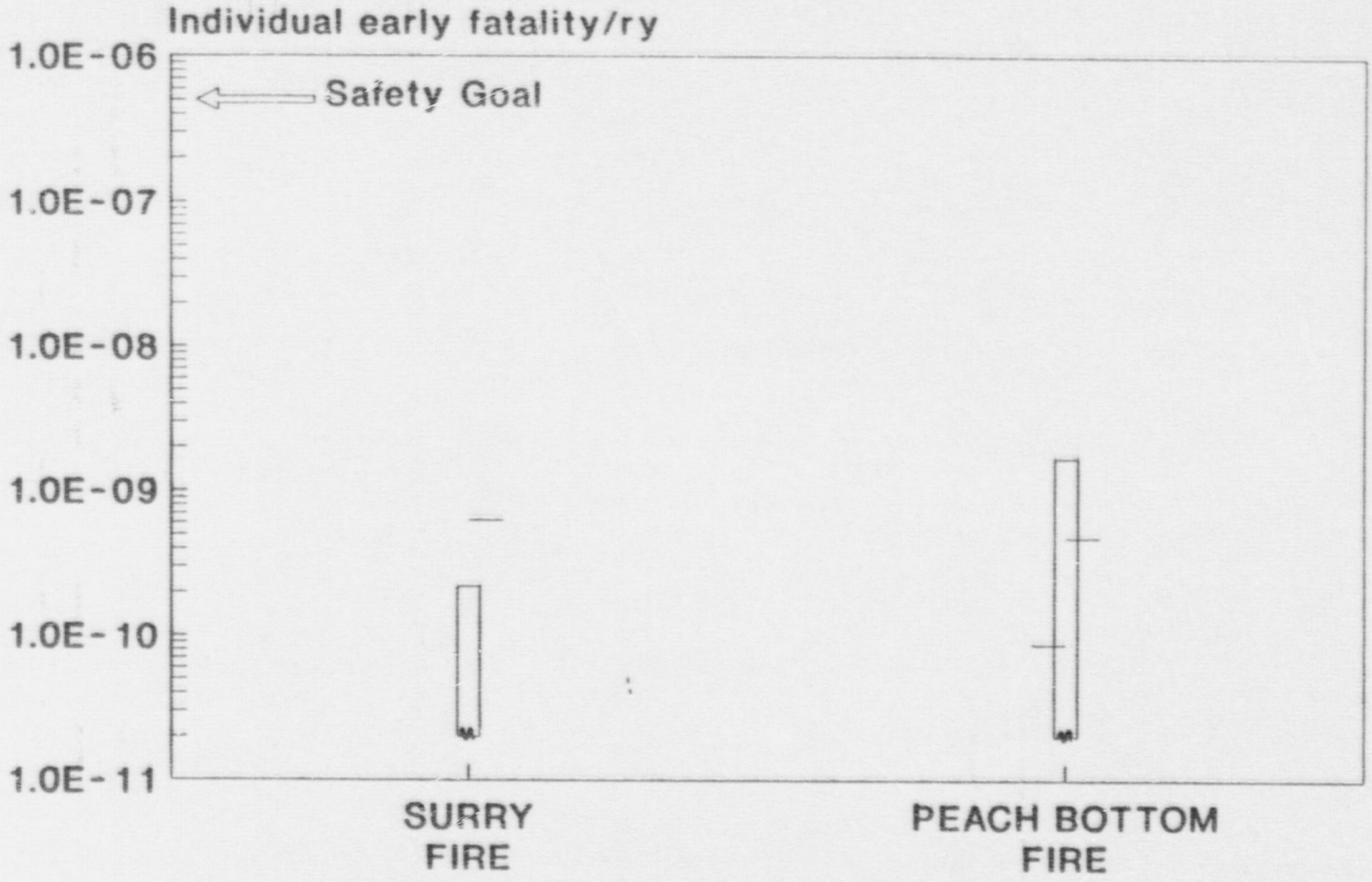



Comparison with Bins BWR2 and BWR3

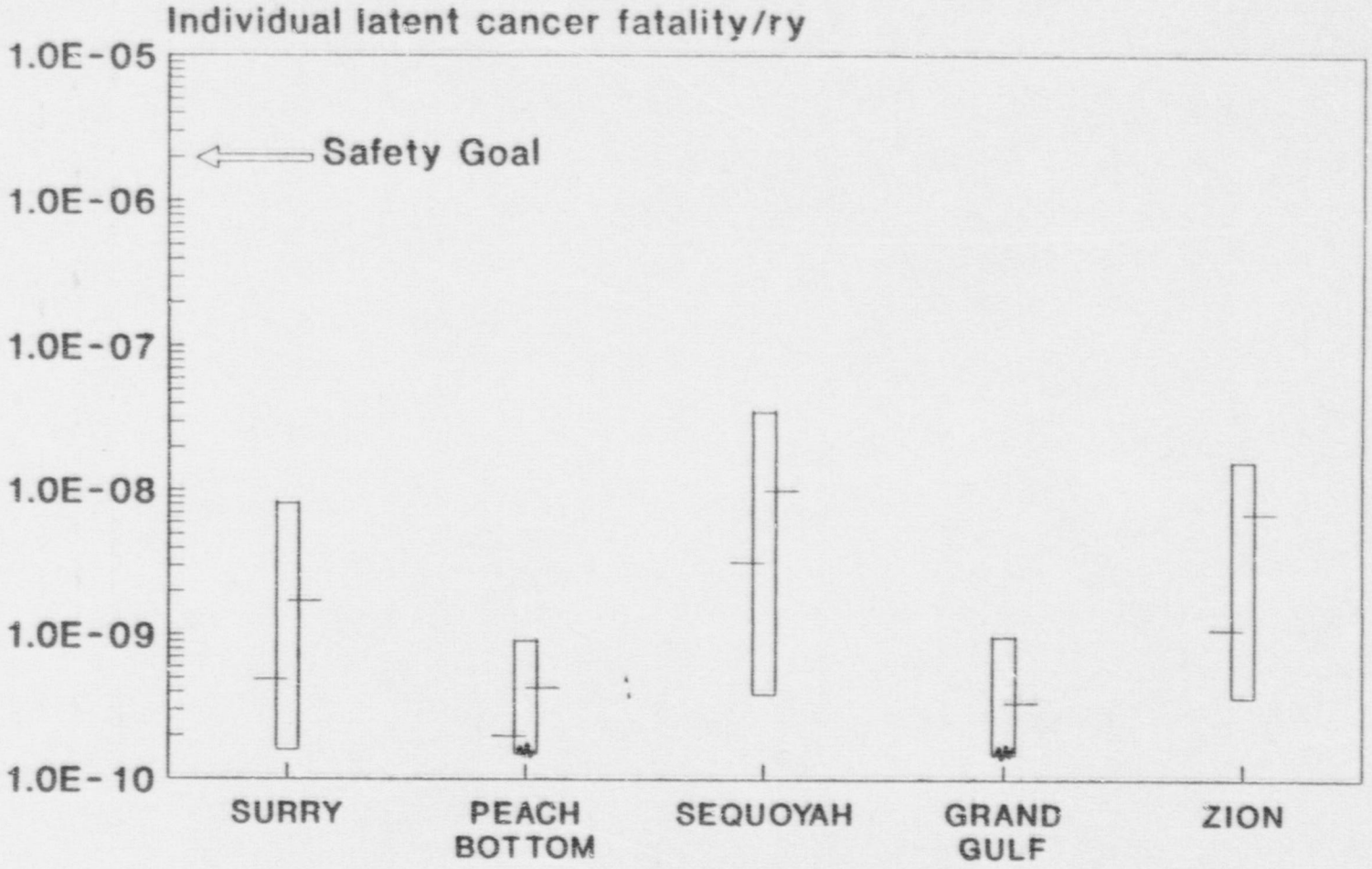
Comparison of source terms with Reactor Safety Study, Peach Bottom



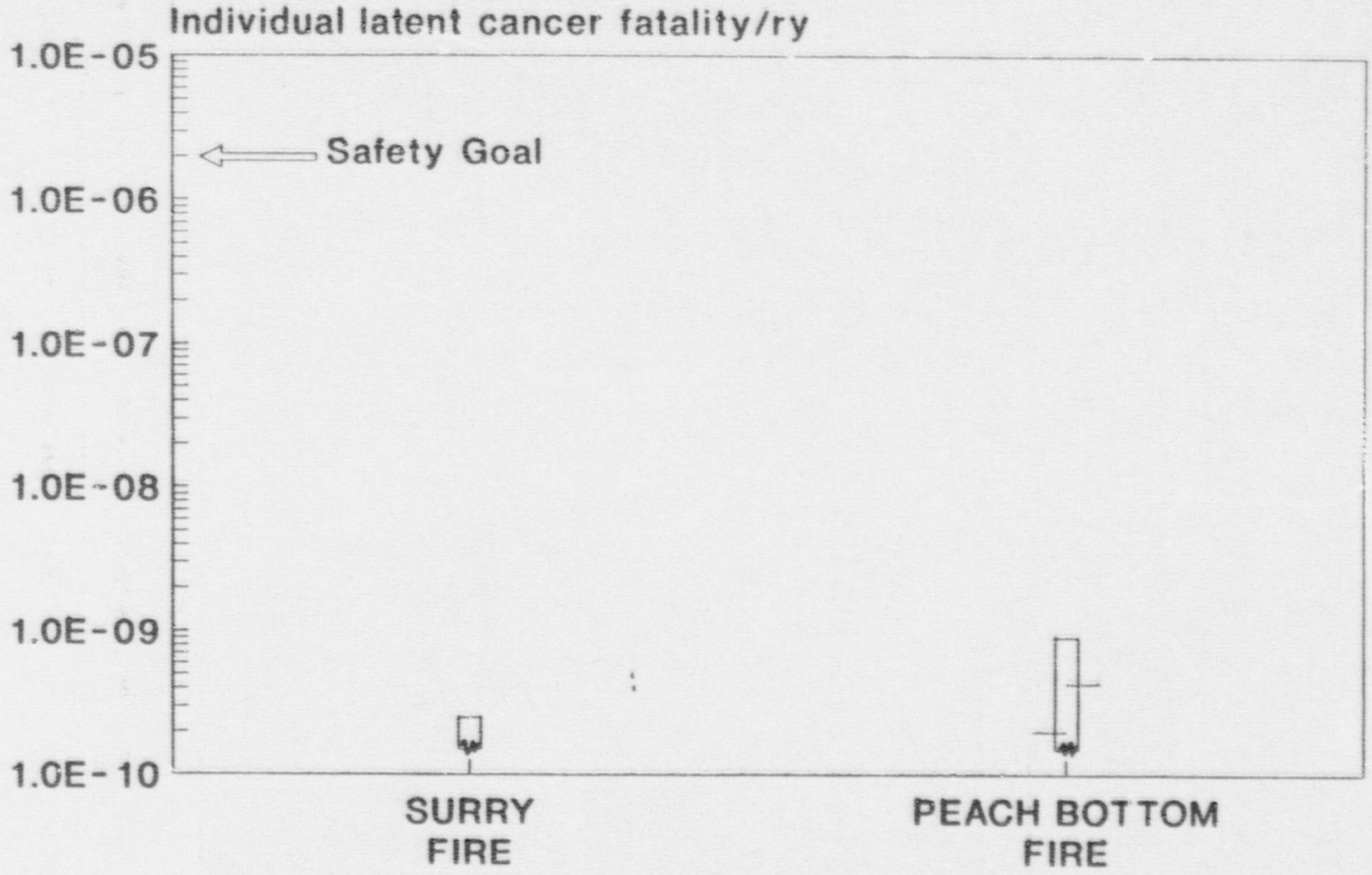

Comparison of individual early fatality risks -
all plants (internal initiators)



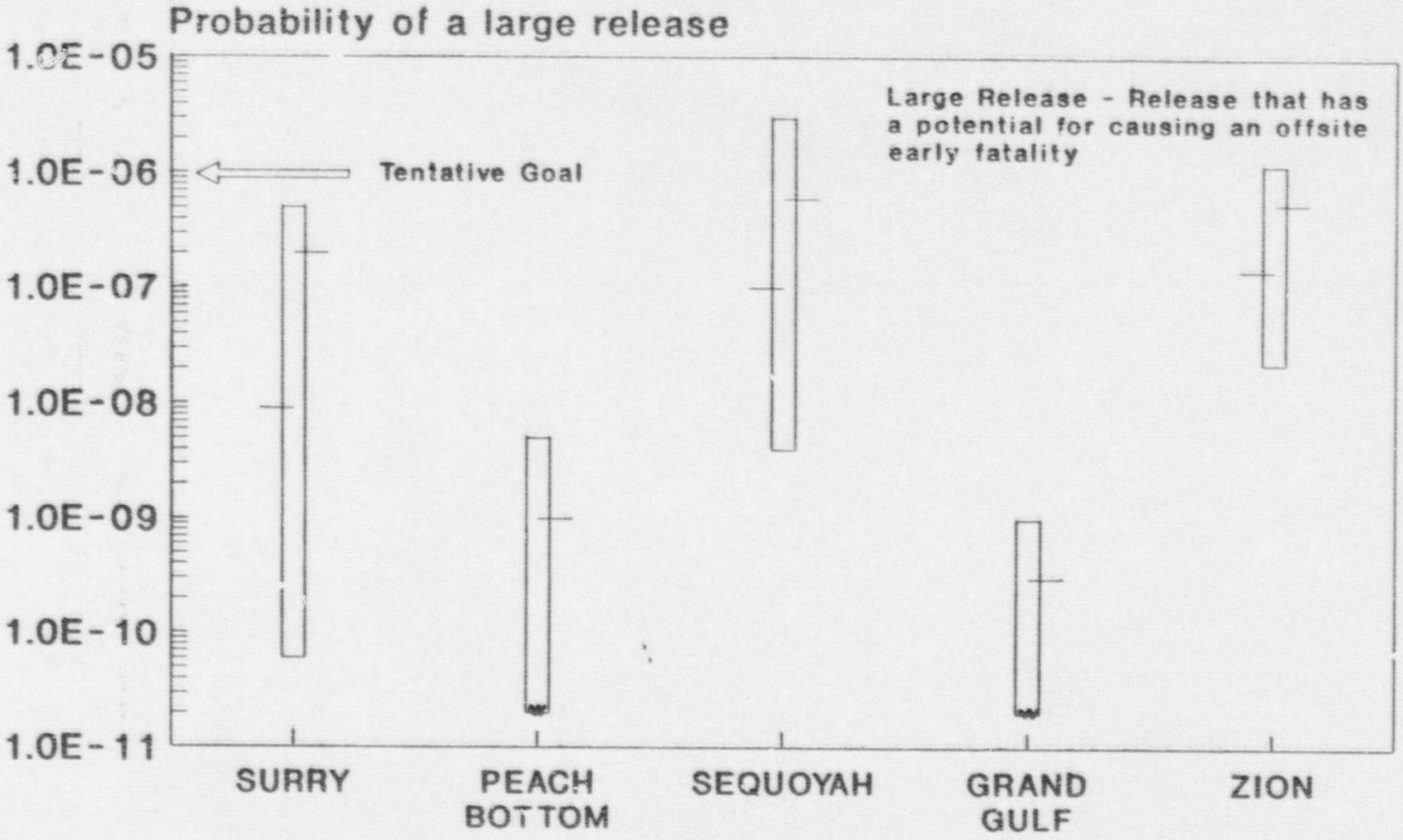

Comparison of individual early fatality risks -
Surry and Peach Bottom (fire initiators)



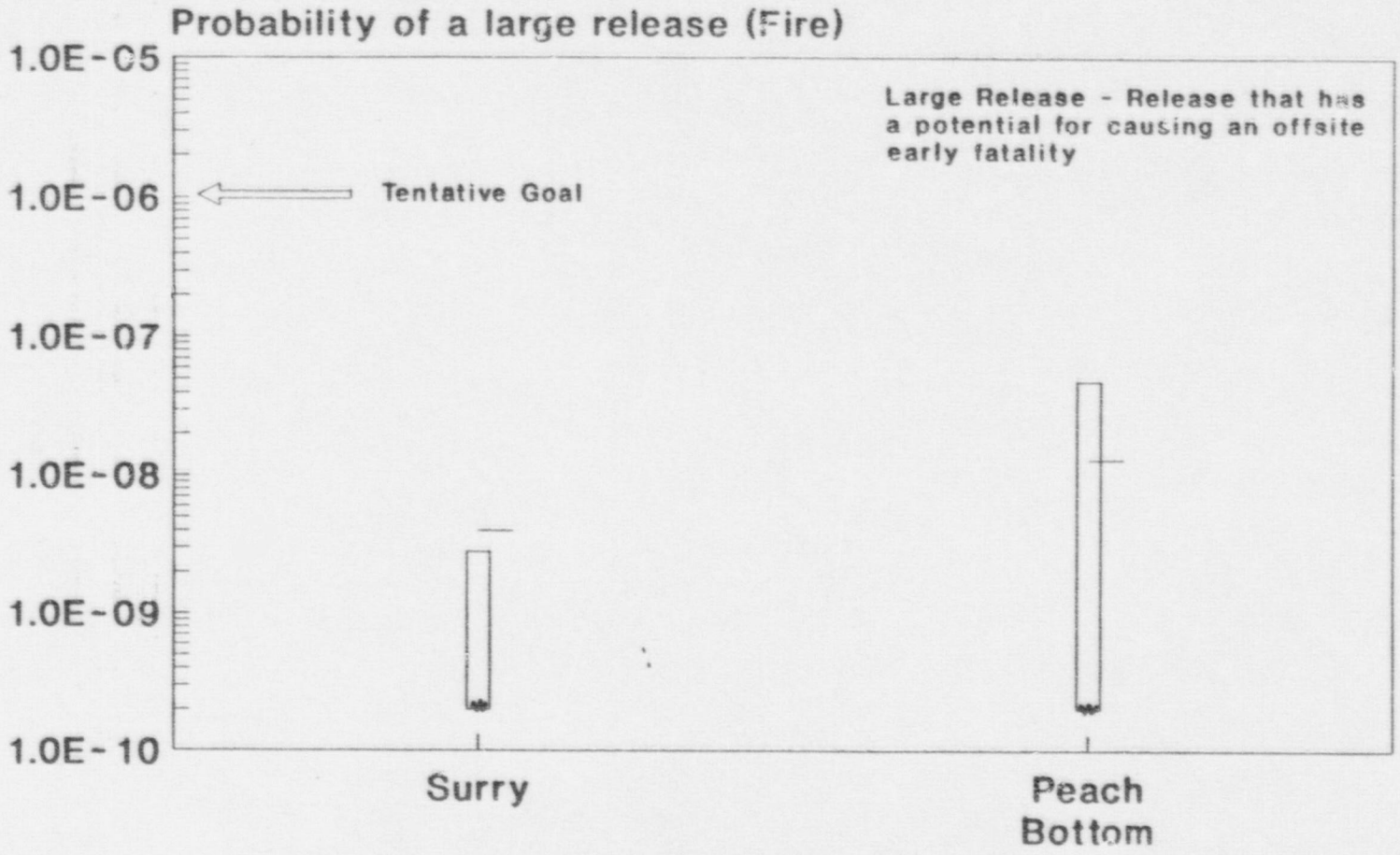

Comparison of individual latent cancer fatality risks - all plants (internal initiators)




Comparison of individual latent cancer fatality risks -
Surry and Peach Bottom (fire initiators)




Comparison with tentative safety performance guideline




Comparison with tentative safety performance guideline

# Summary

- After final QA, report will be ready to issue as second draft for peer review (June).
- Peer review to begin in July.
- Interim use of report per Commission guidance.
- Plan to complete peer review, modify report as needed and reissue as final report by end of CY 1990.

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DATE: 5/23/89

FROM: SECY Correspondence & Records Branch

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Meeting Title: Brief on Status of Second Draft of Nureg-1150

Meeting Date: 5/5/89 Open X Closed _____

| Item Description*: | Copies Advanced to PDR | DCS Copy |
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| 1. TRANSCRIPT w/viewgraphs | 1 | 1 |
| 2. | ___ | ___ |
| 3. | ___ | ___ |
| 4. | ___ | ___ |
| 5. | ___ | ___ |
| 6. | ___ | ___ |

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