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NUCLEAR REGULATORY COMMISSION

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BRIEFING ON STATUS OF DEVELOPMENT OF UPDATED SOURCE TERM

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PUBLIC MEETING

Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland

Tuesday, January 9, 1990

The Commission met in open session, pursuant to notice, at 10:00 a.m., Kenneth M. Carr, Chairman, presiding.

COMMISSIONERS PRESENT:

KENNETH M. CARR, Chairman of the Commission
THOMAS M. ROBERTS, Commissioner
KENNETH C. ROGERS, Commissioner
JAMES R. CURTISS, Commissioner
FORREST J. REMICK, Commissioner

STAFF SEATED AT THE COMMISSION TABLE:

SAMUEL J. CHILK, Secretary

WILLIAM C. PARLER, General Counsel

JAMES TAYLOR, Executive Director for Operations

ERIC BECKJORD, Director, Office of Research

THOMAS MURLEY, Director, Office of Nuclear Reactor Regulation

THEMIS SPEIS, Office of Research

FRANK CONGEL, Office of Nuclear Reactor Regulation

LEONARD SOFFER, Office of Research.

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

10:00 a.m.

CHAIRMAN CARR: Good morning, ladies and gentlemen. Happy new year to the staff.

This morning the Commission will be briefed by the NRC Office of Research on the status of development of updated light water reactor source term methodology and potential regulatory application. This is an information briefing and no Commission vote is planned on this issue today.

It's my understanding copies of the staff's slide presentation and the staff's paper, SECY-89-308, are available at the entrance to the meeting room.

Do any of my fellow Commissioners have any comments they wish to make before we begin?

If not, Mr. Taylor, you may proceed.

MR. TAYLOR: Good morning, sir. We also wish the Commission a happy new year from the staff.

With me at the table, to my immediate left, from the Office of Research, Eric Beckjord, Themis Speis and Len Soffer. At my immediate right, from the office of NRR, Tom Murley and Frank Congel.

What is referred to as a source term permeates reactor licensing decisions, all the way from siting to plant design to emergency planning.

The view of research efforts that have been going on over the last ten years or so, concerns have arisen regarding the reality and validity of some of the current staff practices with regard to application of the source term. It's come up primarily in the review process of the evolutionary light water reactors.

As you noted, we did provide a paper to the Commission in November outlining, as you indicated, the areas of application of updated source term methodology and proposed actions to further improve the source term. The major action arising from the paper, and which you'll hear about today, is a staff proposal to study, and that's strictly to study -- at this time strictly to study the possibility of decoupling of siting from plant design and to eliminate source terms in dose calculations in siting. Of course, source term insights would continue to be applied in plant design, containment and so forth aspects.

This is strictly a study and we intend to report to the Commission in about six months or less the results of that study effort. That is the major point made by the paper that was presented to you.

Before getting into the detailed aspects of the briefing, Tom Murley wanted to provide some

initial insights with regard to the license application.

DOCTOR MURLEY: Thank you, Mr. Chairman, Commission. The recent interest in this topic is a result of issues that arose in staff reviews of the standard designs for evolutionary LWRs and I wanted to just tell you what those were and how they come into the source term issue.

For example, a question arose, how are these plants to show compliance with Part 100? Part 100, as you recall, is NRC's siting rule. It's our earliest substantive technical rule and it dates from 1962. Its purpose was to set out the criteria for siting nuclear plants.

Part 100 allows the trade off of engineered safety features versus distance from population centers in setting the allowable site characteristics. It does this tradeoff by setting dose limits for persons in the vicinity of the plant for an unspecified accident, but which uses a source of radioactivity inside an intact containment that's assumed to leak at a specified rate.

So, the exclusion area, for example, is defined by a dose limit of 25 rem whole body and 300 rem to the thyroid for a hypothetical person at the

exclusion area boundary for a two hour period after the accident.

COMMISSIONER REMICK: Tom, could I interrupt you to just ask a question? Does that include any consideration of sheltering or evacuation? It's a fence post, okay.

DOCTOR MURLEY: Fence post person. The low population -- so, the exclusion area is the area controlled by the utility in which there's no members of the public allowed to live or normally do business.

The low population zone is defined by a dose limit of 25 rem whole body and 300 rem to the thyroid for a person at the low population zone boundary for the total duration of the plume passage, which is typically taken to be 30 days in our calculations. Now, these are calculations of hypothetical doses to hypothetical people.

The connection with population centers is the following. Once this low population zone boundary is determined by a dose calculation, then the LPZ boundary must be less than three-quarters of the distance from the nearest population center of 25,000 residents. So, that's how one couples then the plant design features to the site and the two population distances, is by means of a dose calculation.

As plant sizes grew larger in the 1960s, reactor designers added containment sprays, charcoal filters and leakage control systems. The designers became so clever with these mitigation systems that the calculated doses became so low that the exclusion area and the low population zone could be reduced very low, such that Part 100 would allow siting much nearer population centers.

In order to maintain control of siting distances and siting characteristics comparable to what the staff had already approved, the staff in those days became equally clever in implementing Part 100. They did this by means of limiting the credit given to the mitigation systems that were used in the plants. For example, it only allowed certain credit for filter systems, filter efficiencies and spray additives in the dose calculations.

So there evolved then, over the years, a highly stylized, conservative calculation with the methods that became described in some of our regulatory guides. Now, however, when we attempt to apply these conservative methods, which are some 15 to 20 years old, to the future evolutionary LWRs, we find that the technology has gotten much better and our knowledge has increased substantially over the years.

For instance, everyone agrees that filter efficiencies are much greater than we give credit for in our reg. guides.

In addition to siting, the radioactive source term release to containment in an accident is used to assess the design of much of the equipment in the plant, for example, and equipment qualification calculations. It uses a source term. So, we know that our understanding of radioactive releases in sequence probabilities has increased and Eric Beckjord and Themis Speis are going to discuss that in a second.

But these are the kinds of questions that came up. The staff is inclined to agree with the industry that we should allow some credit for current knowledge and technology, but that raises a number of licensing questions for us. How would we propose to control siting near population centers that Part 100 might permit if we were to allow full credit for these mitigation systems? If we change our reg. guides, would that allow then some relaxation of requirements for operating plants? It was questions like these that formed the impetus for the staff to undertake the study of possibly decoupling plant design from siting by possibly revising Part 100, which Jim Taylor

mentioned. The staff plans to have recommendations on this in a few months.

That then is the licensing nexus of source term. It's that background that I wanted to give the Commission before we got into it.

COMMISSIONER ROGERS: Just one question. When you talk about decoupling, I assume that really you're not talking about total decoupling but softening the coupling in a sense. I mean that --

DOCTOR MURLEY: We're going to look at range.

COMMISSIONER ROGERS: -- not to really totally consider a total independence of siting from any other considerations, are you?

DOCTOR MURLEY: That would be one of the options that we consider, I think. Irrespective of the design features of any given plant, one of the options would be that there not be a dose calculation of any kind, just population or other features to it.

COMMISSIONER ROGERS: Okay. But you would have population?

DOCTOR MURLEY: Oh, yes, yes, yes, yes, yes. And then we would -- by decoupling means we would not have a dose criterion and we would not, therefore, require a dose calculation, and therefore we wouldn't

get into plant features. But we would still have criteria on population and perhaps other things.

COMMISSIONER ROGERS: Okay. I see. Thank you. That's important.

CHAIRMAN CARR: Let's proceed.

MR. BECKJORD: Mr. Chairman, the Commission requested information on the subject of source terms in the staff requirements memos dated July 6th and 31st of this year. There were seven items.

COMMISSIONER ROBERTS: Last year.

MR. BECKJORD: Right. Excuse me, last year.

CHAIRMAN CARR: Happy new year again.

MR. BECKJORD: Right. There were seven items. First, status on updating the source term. Second, use of an updated source term to modify the requirements for the emergency planning zones. Third, improvements to the document TID-14844. Fourth, constraints which preclude application of an updated source term. Fifth, the relationship of the schedule for an updated source term to containment performance studies. Sixth, significance of uncertainties in the source term. And seventh, need for any departure in the standard review plan as applied to ABWR licensing.

We're here to summarize the key points in the paper on this subject, SECY-89-341, dated November

6th of last year. We're here to answer any questions that you may have.

I'd like to say a word about the research connection with updating the source term. Containment integrity against early failure following a severe accident is perhaps the most important consideration. We are completing evaluation of other containment types following the Mark 1 evaluation and we're making research progress in containment loadings and response to severe accidents.

We also have work and experiments underway in source terms and we are revising the long-range research effort on fission product release and transport.

You're about to hear of the study planned in the next six months for decoupling plant siting and design for future reactors. Now, I intend that the research staff will participate in this study in order to develop appropriate focus in the source term research plan.

I think Doctor Speis is ready now to commence the presentation.

DOCTOR SPEIS: Thank you, Mr. Chairman, Commissioners. I think some of the things that I was planning to say have been said much better, so I will

see if I can go through much faster than I had anticipated. I think we can dispense with viewgraph 1, which discusses the purpose of the briefing, and go to viewgraph 2, which outlines the briefing.

(Slide) We will summarize the current staff practices involving the source term. We will describe the TID source term itself and its use, specifically its relationship to design basis and its relationship to containment performance. Then we'll summarize what we have learned regarding the source term from research efforts over the last number of years. Then we'll discuss the issues associated with updating the source term, the so-called TID-14844, and the applications of this updated source term in the areas of siting, plant design and emergency planning. Then we'll again summarize the things that we have to do the next six months or so, before we come up with the decoupling study that has been mentioned already.

(Slide) So, if we go to viewgraph 3 where we summarize the current practice, and Doctor Murley already kind of has said most of it. The present siting practice again postulates the instantaneous--and that's a very important word, instantaneous release of the TID source term into containment and then, using plant and site characteristics, and by

plant we mean the leakage of the containment, the engineering safety features, and by site characteristics we mean such things as meteorology. We calculate off-site doses for site suitability according to Part 100 siting requirements. Then, these calculated doses to individuals are then compared to the Part 100 doses to determine acceptability of the exclusion area and the low population zone and the population center distance, which have been mentioned already.

The TID release has also a wide regulatory application beyond siting. For example, the source term itself determines the irradiation environment for safety-related equipment. It determines such things as the isolation of valve closure time. For example, the instantaneous appearance of the source term gives the signals to the valves to close the containment. So, we see a wide use in addition to siting.

(Slide) If we go to the next viewgraph, I have illustrated graphically basically the same things. The source term is assumed to enter the containment and immediately you see the close coupling of the source term and the containment. The assumption is that the source term goes into the containment. The source term itself, which is described in the TID

document, consists of 50 percent of iodine, 100 percent of noble gases. Now, half of the iodine is immediately deposited on interior surfaces of the containment.

So, what you have available for leakages is the 100 percent noble gases and the 25 percent of the iodine. And the leakage, of course, is assumed to take place with the designed leak rate of the containment, which is approximately a .1 volume percent per day. We have very detailed and strict requirements which define how these tests are done, like these are described in Appendix J, for example.

Let's see. The other point I want to make here is that the -- I guess it has been made by Tom, that the doses are calculated conservatively and then compared to Part 100. The implicit assumption, again, is that the containment remains intact. Shortly I will describe the design basis of the containment itself.

CHAIRMAN CARR: Let me ask you a question there.

DOCTOR SPEIS: Yes.

CHAIRMAN CARR: In page 5 of your paper you say, "In spite of a great deal of NRC and industry-sponsored research which has significantly improved

our understanding of severe accident phenomena, there is today no consensus on whether a universal source term is appropriate for regulatory use, much less on what such a source term would be."

Was there such a consensus on TID-14844?

DOCTOR SPEIS: Well, I guess I'm not a historian. I doubt it.

CHAIRMAN CARR: I doubt it too. That's the point I want to make. If we're going to wait around for a consensus, we're never going to get there.

DOCTOR SPEIS: We'll discuss what that means, Mr. Chairman, later on.

MR. TAYLOR: It was the best effort at the time --

DOCTOR SPEIS: At the time.

MR. TAYLOR: -- historically. Is that a fair way of saying it?

DOCTOR SPEIS: Yes.

MR. BECKJORD: There was no consensus in industry where I was at the time.

CHAIRMAN CARR: I'm sure there was no consensus and that's why I don't want to wait for it today.

MR. TAYLOR: You have a valid point, Mr. Chairman, but it was what, I think, historically, the

staff thought was a best effort.

CHAIRMAN CARR: Okay.

DOCTOR SPEIS: (Slide) The next viewgraph talks a little bit more, viewgraph 5, about the source term itself, the TID source term. It was largely based on experimental results of heating irradiated UO_2 pellets. It was done in the late '50s and it was done at Oak Ridge National Laboratory. I would think it was approximately based on the volatility of the radioactive species in this sample. So, the iodine gets out faster because of its temperature, its boiling point, and the source term consisted primarily of iodine.

The more recent understanding of the source term is that you have more than iodine. You have cesium, you have tellurium, you have a number of other species.

Now, the present methodology is described in Regulatory Guides 1.3 and 1.4. The TID itself tells you that you have the source term of 50 percent iodine and 100 percent noble gases, but the breakdown of the iodine, for example, is described in Reg. Guides 1.3 and .4. By the way, the iodine that is utilized is mostly molecular iodine, 95 percent or so. Maybe 91 percent is molecular iodine.

Also, these reg. guides describes its instantaneous appearance into the containment which had some of the strict requirements on valve closure, for example, that I mentioned already.

COMMISSIONER REMICK: Also, in the case of BWR, don't we assume that what goes into the reactor building immediately goes outside, is not plated out or held up in the reactor building, and assume it goes immediately into the emergency standby gas treatment system?

MR. SOFFER: Anything that -- there is a staff practice that anything that leaves the primary containment goes into the standby gas treatment system. There's no mixing --

COMMISSIONER REMICK: No mixing, yes.

MR. SOFFER: -- in the annulus of the reactor building, yes, that's correct.

COMMISSIONER REMICK: Is there any estimate of how conservative that is, to assume that?

MR. SOFFER: I can't give you a number offhand.

COMMISSIONER REMICK: Okay. Fair enough.

MR. SOFFER: I think it's generally acknowledged as conservative.

COMMISSIONER REMICK: Yes, sure.

DOCTOR SPEIS: (Slide) On page 6, we discuss the relationship of the TID source term to the design basis. Basically, as far as the design basis for a plant is concerned, the so-called TID source term is used in two distinct ways. First is to define the radiological environment conditions for certain plant systems. We mentioned already the environmental conditions for the safety-related equipment, for equipment qualification purposes. It sets the requirements for control room habitability. Also, the other area is to assess the effectiveness of mitigation features such as filters, sprays, the suppression pool in BWRs as related again to the evaluation of the exclusionary boundary and the low population zone acceptability.

COMMISSIONER REMICK: Themis, on this slide and in the SECY document you say design basis accident source terms, plural, but then you say TID-14844. Are there other design basis source terms that you're referring to? I realize you're talking about severe accident source terms, but is there more than one design basis source term?

DOCTOR SPEIS: We took calculations on a deterministic basis on a number of accidents, which are defined in Chapter 15, for example, of the SRP, to

make sure that the consequences of those accidents are always bounded by the TID source term. That's what I meant to say.

COMMISSIONER REMICK: I see. Okay. Aren't they always bounded by --

DOCTOR SPEIS: They're always bounded, yes.

MR. SOFFER: They are bounded by TID. But, as a matter of fact, we look at a spectrum of design basis accidents and generally source terms arise from either the reactor coolant activity, when one is talking about leakage from the reactor coolant. If one has fuel failure but without severe degradation, then there would be releases from the gap activity within the fuel. That's considered in certain types of accidents. For example, a fuel handling accident might consider only clad activity or a gap activity. So, there are other source terms, but TID is usually the bounding one and it set so many conditions on the plant that it tends to be the more --

COMMISSIONER REMICK: Certainly from siting, it would probably be the most important one.

DOCTOR SPEIS: (Slide) On page 7, we summarize the relationship of the TID source term to containment performance. Again, the key implicit assumption in Part 100 is that containment maintains

its integrity during the postulated fission product release into the containment. But, as I said, it leaks its designed rate, which is approximately the .1 volume percent a day, whereas if you really had a severe accident, it could eventually fail, as we all know.

Thus, there's a strong coupling between containment performance and the postulated fission product release into the containment. Now, this coupling is inconsistent, since the containment itself is designed based on the pressures and temperatures of the LOCA accident. But the source term or the radiation environment in the containment is that basically from a severe accident because the source term from the -- the TID source term can only come from a very severe accident. So, you have this inconsistency where the loads are those of a design basis accident but the radiation environment comes from the TID source, which can only come from a very severe accident.

COMMISSIONER REMICK: On that point, and with the concept of leak before break, which I believe the staff endorses, has any thought been given to the actual design basis of the containment for other than a double ended guillotined break or do you think it's

wise to continue that criteria?

DOCTOR SPEIS: Well, I guess I can say that it has served us -- this design basis has served us well because later on when we began to understand more about the consequences of severe accident, we found out that the capability of these containments were very robust against a very large spectrum of severe accidents. Because of conservatisms, the best estimate pressure capability of the containment probably can go up to two or three times its design pressure and that type of margin served us very well as far as severe accidents are concerned.

COMMISSIONER ROBERTS: Is the basis for that the work that was done at Sandia about four or five years ago?

DOCTOR SPEIS: Yes. Yes. This factor of two or three, yes.

MR. TAYLOR: I believe Doctor Murley would like to say a little bit more about that.

DOCTOR MURLEY: Yes. For future plants, evolutionary light water reactors, we are considering other criteria and whether or not severe accidents should be taken into consideration in some aspect of the containment design basis. We've got a fairly hefty paper that's coming up to you in the near future

that discusses this and what the design criteria --

COMMISSIONER REMICK: You said evolutionary, I believe. Do you mean that or advanced?

DOCTOR MURLEY: Evolutionary.

COMMISSIONER REMICK: Evolutionary? ABWR? You're considering --

DOCTOR MURLEY: Yes.

COMMISSIONER REMICK: Oh, I see. I wasn't aware of that.

DOCTOR MURLEY: In the leak before break criteria, I think the staff limited the ---

COMMISSIONER REMICK: Yes.

DOCTOR MURLEY: -- decision making as to how it would use that and there have been a number of documents prepared and published on that.

DOCTOR SPEIS: We did not, as far as design basis --

DOCTOR MURLEY: No, we did not go that far.

COMMISSIONER REMICK: I know you haven't in the past. I was wondering if you were giving it any thought in the future. I'm not suggesting it's a good idea, I was just curious to see if ---

DOCTOR MURLEY: We aren't proceeding in that direction currently that I'm aware of --- take more credit that we've already done for that leak before break

concept.

DOCTOR SPEIS: In fact, Tom, if I might add that this issue of the importance of the containment is being addressed in the SER or the EPRI requirements document, in Chapter 5, where you're talking about enhanced containment performance goals because of this possibility of failures to the severe accidents.

(Slide) If we go to page 8, I'll say something -- summarize the research insights. Major research efforts have been underway since the early '80s to obtain better understanding of source terms, their quantity, form, transport and release mechanisms, as well as other aspects of severe accidents because we find now that a source term is so much coupled to the containment that, for example, if containment stays intact or stays together for a number of hours, then the source term is substantially affected. That's really my last bullet.

Now, this research on source term was documented in NUREG-0956. It was reviewed by the American Physical Society back in the mid-'80s. The basic focus was on the physics and chemistry and then the application of the methodology was implemented in NUREG-1150, which is presently under review, under peer review.

We looked very carefully at such things as in vessel retention and release, the issue of revolatilization, possible decontamination in ice condensers in BWR suppression pools, in reactor buildings that you mentioned, Commissioner Remick, very carefully at the aerosol behavior in the containment.

From all this, we found out that there is not really one source term that can capture everything. In fact, you can still come up with one source term, but it's not going to be that much different than the TID source term, if you take into account all containments and all sequences and all processes.

Now, there are a number of areas though that there's no question that the staff practices have been extremely conservative. One of them is the timing, which I mentioned two or three times already. The assumption is made that the source term appears instantaneously and we know from extensive research that that is not the case. In fact, it takes ten or 20 minutes for any activity to appear in the containment in a gross way, even after total dry out of the core.

COMMISSIONER REMICK: Themis, a question.

The question of whether you can have one source term, design basis source term that might replace TID-14844 is kind of driven, isn't it, by the fact that the doses that we've set, the criteria of 25 rem and 300 rem are kind of deterministic? Suppose those were set in risk based. Then couldn't you have used some of the other source terms that have been developed in PRAs and so forth? In other words, if those doses were stated otherwise in Part 100, wouldn't that help the fact? Then you wouldn't need one design basis source term --

DOCTOR SPEIS: Well, one can come up with probabilities for the source term or for the dose, the exclusionary or the low. One can attempt to do it.

COMMISSIONER REMICK: Which you do in the severe accident analysis, right?

DOCTOR SPEIS: We do that.

COMMISSIONER REMICK: Right.

DOCTOR SPEIS: But then it's -- source term goes hand in hand with the behavior of the containment in the severe accident, which is very deterministic. Here is very arbitrary where you assume that the containment stays intact and it only leaks its design leak rate.

COMMISSIONER REMICK: But in PRAs, aren't

they assigning some probability --

DOCTOR SPEIS: Yes, of course.

COMMISSIONER REMICK: -- to certain type of containment failures?

DOCTOR SPEIS: Yes, of course.

COMMISSIONER REMICK: So, you end up with-- you can end up with postulated doses and risk based --

DOCTOR MURLEY: It's an approach.

DOCTOR SPEIS: In light of the status of PRAs and uncertainties, you can do it.

COMMISSIONER CURTISS: I'd like to follow up on that point.

DOCTOR SPEIS: Yes.

COMMISSIONER CURTISS: You have advanced the approach that was employed in the EIS for South Texas, what was essentially described here. Your next chart, your next graph, I guess, raised this question in my mind. How do you decide if you're going to use a risk based source term approach, like Commissioner Remick has described? How do you decide to use it in South Texas or the station blackout rule or other instances where it might be used and where you don't use it?

What he's describing, I take it, is an approach that would bring together the design basis

source term and the severe accident source term under a consistent philosophy of risk-based mechanistic source term methodology. I gather there's been some pursuit of that in limited instances for specific plants like South Texas.

COMMISSIONER REMICK: In the FTSs, you're correct. I think --

MR. SOFFER: It's in the environmental and the safety review, Commissioner. It's been traditional that the staff use deterministic accidents and deterministic criteria. In the environmental review, the Commission directed us in 1980 to begin a reevaluation of accidents as discussed in environmental statements and the discussion there and the direction was that the discussion of those accidents was to be given in the context of both their probabilities as well as their consequences and the staff has used that and done it in a probabilistic type of a fashion. That has not occurred in the safety review. The safety review has traditionally been a more deterministic --

COMMISSIONER CURTISS: Aside from the tradition, what is it that, I guess, has led to that result?

DOCTOR SPEIS: The basic question is whether

one would use PRA to site and license a plant. That's a very -- I guess it's a policy question as well as technical. That's what we're talking about.

MR. TAYLOR: That would be a major decision to do that. We haven't gotten to that point yet.

DOCTOR SPEIS: We're struggling through to make sure that we gain understanding in dealing these areas, in terms of probabilities, human actions that affect probabilities, consequences. But that's a very important --

MR. TAYLOR: It raises the basic question of the deterministic aspects of any of the decisions that we make in the licensing basis versus the probabilistic and the coupling thereof. It's a reasonable question, but the staff --

COMMISSIONER REMICK: One advantage is bringing it into coherence with the Commission's safety goals. The disadvantage, as you say, is relying upon PRAs and so forth for licensing decisions on individual plants, which we're not doing. But philosophically, I think it's worth exploring.

MR. TAYLOR: Right.

DOCTOR SPEIS: It has some beautiful aspects to it, yes.

COMMISSIONER CURTISS: But would it be fair

to contrast -- going back to the earlier discussion, Doctor Murley, would it be fair to contrast that approach with what the staff is going to explore on decoupling siting from source term? The question I guess I had is if you do that, and Tom's description of how that process evolved kind of suggested that as the industry became more creative at finding ways to limit the risk, we in turn found creative ways to minimize the credit that we were giving for that. I guess I read that to mean that process evolved in a manner where we got further and further away from risk-based considerations and maybe to the point where the decoupling of siting and source term, in fact, is the logical extension of that.

I guess the question I had is if you take the source term out of the process, what do you use? Is it the safety goal, is it something else that you use to articulate what it is that we're going to say are the criteria for siting plants, or is it some sort of -- arbitrary may be too strong of a word, but some sort of less mechanistic, less risk-based set of principles that we would be moving in the direction of?

DOCTOR MURLEY: Well, we could go to a siting rule that has nothing to do with risk or

nothing to do with doses or anything else. It could just be so many people per square mile out to various radii. That's been discussed in the past.

CHAIRMAN CARR: Like airports.

DOCTOR MURLEY: Sure. Now, going to the-- if you keep going to the other extreme where you use a probabilistic kind of criteria or set of criteria, I could predict what would happen. That is that the industry would get very clever in their numbers and the staff would be very clever in what we allow in PRAs and we'd wind up setting it just like we do now, and we think it would come out the way we want. If you'd like, I guess we could just --

CHAIRMAN CARR: But our limitation on credit we gave them was from a conservative basis. We say, "Hey, we don't want to relax it that much."

MR. TAYLOR: Yes.

DOCTOR MURLEY: Exactly right.

CHAIRMAN CARR: And without reason that's an arbitrary limitation and this is the way we do it. I mean we used that for an excuse to do something we wanted to do anyway. But Commissioner Curtiss is looking for a valid reason to do that, I gather.

COMMISSIONER CURTISS: I understand the shortcomings of PRA and obviously the use of PRA in

the regulatory context is a topic that cuts across a whole range of issues beyond just this one --

MR. TAYLOR: It cuts across a lot of questions.

COMMISSIONER CURTISS: -- and I guess in this particular context, in exploring the direction we seem to be going or the options that are available for us as we look at the decoupling of siting from source term, that seems to suggest to me, and with the amplification, Tom, that you provided on how we got to this point, it kind of seems to suggest that we really are, in that context, moving in the direction of decoupling our siting considerations for risk.

I'm not sure where we are today with the-- I think we're probably here with the deterministic source term that we use for a design basis and perhaps more mechanistic with the severe accident source term that we use and with the caveat that we use the severe accident approach in some specific licensing issues like South Texas and maybe the FES end of the analysis. But I think it's important to keep the eye on the ball of risk.

DOCTOR MURLEY: I think we would in this study.

CHAIRMAN CARR: What we're trying to avoid

is having that so-called passively safe reactor that's never going to have a problem from being put in downtown San Francisco, which is not good sense probably. But even if you could prove it would be perfectly safe for public health and safety to put it there, it doesn't sound like a good idea. So, we're trying to figure out some way from keeping it there.

COMMISSIONER REMICK: One possibility is to site, as you're proposing, I think, deterministically based on some kind of engineering judgment and figure your dose, calculate your doses and things from a probabilistic standpoint.

DOCTOR MURLEY: No question that if we propose deterministic criteria for siting, that risk considerations will go into those criteria. There would be a lot of analysis of doses, of accidents and so forth. But to actually set the criteria as a probabilistic number would give me --

CHAIRMAN CARR: Me too.

DOCTOR MURLEY: As a deciding factor. As long as I'm in charge of the numbers, I suppose that's okay.

COMMISSIONER REMICK: Numbers can change. That's the problem.

CHAIRMAN CARR: Let me say also that if you

decide that population is going to be a major input, sooner or later encroachment will get you there. Airports like Dulles were out where it ought to be, where nobody was, and airports draw people. Power is going to draw people.

DOCTOR MURLEY: I think clearly we have to consider that in the rule itself and considerably change it.

CHAIRMAN CARR: If not now, somewhere down the pike.

Let's proceed.

DOCTOR SPEIS: Well, the underpinning for this deterministic criteria will have to be some risk basis, even though it's all going to be explicitly there in the rule that we might come up and sets the coupling which will go forward.

(Slide) On page 8, the last item from the research insights again is the largest single factor affecting source term is containment integrity where delay in containment failure reduces source term substantially. Of course, this is due to the processes that take place in the containment, aerosol behavior and take into account agglomeration settling and things of that sort.

CHAIRMAN CARR: Before you leave that, the

draft safety evaluation report on Chapter 5, which has already been mentioned, sets a general goal of limiting the conditional containment failure probability to less than one in ten when weighted over credible core damage sequences.

In SECY-86-76, which was the implementation plan for severe accident policy statement and the regulatory use of new source term information, staff stated, "As part of the safety goal development, an effort is underway to develop a containment performance design objective." This is something the staff now, in my understanding, staff does not now believe is needed and is part of the safety goal implementation plan and the ACRS does, of course. Why did the staff change its mind and when did it?

DOCTOR SPEIS: Tom? In these evolutionary designs, we are proposing containment performance objectives, as Tom mentioned. Now you're talking about a generic one where it would be codified by rulemaking. Last year, the EDO decided to pursue these issues on a plant by plant basis before we were able to codify some of the requirements for future plants, including containment, generic containment performance requirements. That's the only thing I can say.

MR. TAYLOR: I don't know whether anybody can answer that right now.

Doctor Murley, are you prepared to answer that?

DOCTOR MURLEY: Was the question comparing the safety goal application versus comparing the design review?

CHAIRMAN CARR: Yes. It looks like on your draft safety evaluation report on the EPRI design requirements you said, "Gee, performance objective is a good thing." But in trying to get it in the implementation plan for safety goals, you didn't want a performance objective.

DOCTOR MURLEY: Yes.

COMMISSIONER CURTISS: Yes. That's a question I think we've raised at one of the earlier briefings.

CHAIRMAN CARR: I'm trying to reconcile those two positions, I guess.

COMMISSIONER CURTISS: Good question.

DOCTOR MURLEY: Well, I can give you a preliminary answer. The implementation plan for safety goals was kind of meant to be for all plants for all times, including back a year or two ago when we considered that possibility that some plants may

not have containments, some of the very advanced plants. That was the reason, and also we didn't have anything in mind at the time. But when we got down to looking at real designs for the evolutionary plants, we felt that there needed to be a design basis for the containment and that it ought to consider severe accidents. Not that severe accidents are the design basis in the classical sense that a large LOCA is, but that they be considered in the design.

When one enters into that, then you've got to give the designer some kind of criteria. We've discussed two possible ones. One is a probabilistic criteria, which has its drawbacks. The other is some kind of deterministic criteria, like that the plant should maintain its integrity for 24 hours, something like that.

We're still, I would say, discussing this with EPRI and, of course, we're still discussing with the Commissioners. It will be before you for decision in another week or so. But that was kind of the reasoning for the difference.

CHAIRMAN CARR: Okay. We don't have to settle it here.

COMMISSIONER CURTISS: Well, let me ask just one question to make sure I understand what you're

saying. Is it that the safety goal implementation plan as it's up here now before the Commission is not being applied to the individual design reviews or that the conditional containment failure criterion that you've discussed in the context of your discussions with EPRI is consistent with the safety goal implementation plan?

DOCTOR MURLEY: Yes. The EPRI guidelines for severe accidents and for core damage frequency are consistent with, in fact they're more stringent than, the NRC safety goal guidelines. They don't have, though, a containment performance guideline of any kind, nor do our safety goals. We thought, still think, that in designing the containment, you need some kind of design criterion and that's why we put that in. Also, there was the background, obviously, of the controversy over the Mark 1 containments. There was a serious public controversy where there's some indications that they had a 90 percent chance of failing in a severe accident. I didn't think that we should have that same argument 20 years from now on the advanced plants. So we said, "Make it ten percent."

CHAIRMAN CARR: And I guess that raises the question though if it's good for that, why isn't it

good for the safety goal? But I'm willing to discuss that further on.

DOCTOR MURLEY: Yes. It could be that we may want to reconsider it.

CHAIRMAN CARR: Okay.

DOCTOR MURLEY: They came at different times. They were different thought processes.

DOCTOR SPEIS: I am through with page 8.

(Slide) To summarize the design basis versus severe accident source terms, I want to give two examples for the two types of source terms. The first one, again, is the design basis accident source terms which are not released into the environment but into the containment.

The other one is the severe accident source terms which we calculate from PRAs and from all the studies in the last ten years which are released to the environment, which take into account in a deterministic way all the sequences in addition to the physics and chemistry of the source term itself. They take into account the behavior of the containment in a congruent way.

When we talk about a design basis accident source term, which I mentioned what it is, the TID source term, now based on the leak rate of the

containment, this .1 percent per day, you can get roughly three percent of the noble gases leaving the containment into the environment.

As for the iodine, because of the other engineering safety features that had been placed in the containment, we're talking about numbers like .04 percent of the iodines leaving the containment. These are from these conservative calculations. If I compare that to the iodine that left TMI, for example, it was much less than .04 percent. It was, in fact, .00002. That's how much left the containment. The basic reason there was that the sprays were operative and most of the iodine was absorbed in the water inside the containment.

Now, as for a severe accident source term where the containment integrity is an integral part of it, here we're talking for early failures of substantial releases. For example, we're talking of iodines of 22 to 50 or 60 percent of the iodine and, of course, most of the noble gases. So, these are big differences when we talk about the design basis source term versus a severe accident source term.

CHAIRMAN CARR: But TMI was severe accident. What happened, they had no containment failure. So, it fits the first category as far as --

DOCTOR SPEIS: Yes, sir. Not only that, but the iodine got into such a form that it was retained in the water and it was --

DOCTOR MURLEY: Excuse me. Sometimes it's forgotten that at TMI the containment was open at the time of the accident. So, one not only has to consider the potential for containment failure, but the fact that somebody might leave it open or there may be a path outside of it.

DOCTOR SPEIS: Now, the other problem of sequence is very important.

CHAIRMAN CARR: But the instantaneous release didn't occur.

DOCTOR MURLEY: No, it was a path. You know, they pumped sump water out into a tank out into the auxiliary building.

DOCTOR SPEIS: With this background, Len Soffer will proceed to discuss the updating of TID and its regulatory applications.

MR. SOFFER: Thank you, Mr. Chairman, Commissioners.

(Slide) If we could have viewgraph 10, please.

We'd like to turn now to the potential for updating and revising TID-14844. The first thing that

should be noted is, as has been alluded by Doctor Murley, TID-14844 has provided the stimulus to plant designers to provide very high performance fission product cleanup systems, so that as a result we have plant mitigation capability in the form of sprays and filter systems that have a very, very high capability with regard to fission product cleanup systems.

However, our research indicates and confirms to us that TID-14844 is simply not compatible with a realistic understanding of the way severe accidents progress these days. It's not merely that it is overly conservative with regard to timing. It has both conservative and non-conservative aspects at the same time. It's overly conservative with regard to timing, it's non-conservative with regard to neglecting releases, for example, of other significant fission products like cesium.

In the --

COMMISSIONER REMICK: Let me ask a question there. Do I infer from that that if we had a more realistic source term, we might be able to do a better job to actually design systems to remove the actual source terms rather than a design basis source term? Is that one possible --

MR. SOFFER: That's one possibility. I

would say, for example, right now, filtration systems, for example, are heavily oriented towards the removal of elemental iodine. If we suspect that iodine may not be all that much elemental, then one might want to reexamine some of the filtration requirements in that regard, yes.

COMMISSIONER REMICK: And if I understand, that's one of the things that's kind of driving industry. They'd like to get away with the charcoal filters. Now, what significance is that to the design or the cost or the operation of a plant? I don't have a good feeling for that.

MR. CONGEL: One of the issues is whether you have redundant trains on the filtration systems. That gets, of course, tied back into the assumptions that are based upon the reading of Part 100. So, in terms of expense, there are two aspects, the redundancy and then, of course, the efficiency of a single train. If you do things realistically and you have a clear understanding of the form that you're dealing with, then you can come up with a more proper representation of what the consequence would be.

COMMISSIONER REMICK: Is it a considerable cost consideration?

MR. CONGEL: I don't know the cost off the

top of my head. But when you're talking about redundant systems, it indeed adds up quickly.

COMMISSIONER REMICK: Okay. Thank you.

MR. SOFFER: In looking at updating and revising TID, obviously the things that we want to look at are not only the fission product timing, and that has with it two aspects. Not only the onset of the fission product release but the duration of the fission product release as well. Those are two aspects that we don't consider at all. We assume an instantaneous onset and the duration, for all practical purposes, is zero when in fact it's not.

We need to look at the chemical form of iodine in some more detail. We now believe, for example, that the assumption that the bulk of the iodine is in elemental form is probably overstated, but we don't have enough information to say just how much.

COMMISSIONER REMICK: But that surprises me because we certainly have been doing a lot of research over the years on the iodine question. Why don't we have an answer to that?

MR. SOFFER: Part of the reason is because iodine is terribly reactive and the conditions that it will be in a post accident environment probably depend

upon the accident conditions, the pH, whether there is water or not water, a number of conditions like that. So, it may be very difficult to say, "This is the speciation of iodine," and that's it, once and for all.

COMMISSIONER REMICK: Was it a question we need more research? It seems to me we know how iodine reacts and so forth. Or is it a question of thinking about what we already know and coming to some kind of a prudent decision? Is it more that rather than doing physical research?

MR. SOFFER: My own opinion is that it's probably both. I think we need to do some more research, but at some point I think we are going to have to bite the bullet, so to speak, and come to a reasonable decision in the face of some uncertainty.

COMMISSIONER REMICK: So there is chemistry research that needs to be done yet on iodine.

MR. SOFFER: On high temperatures.

DOCTOR SPEIS: Mostly high temperature.

CHAIRMAN CARR: Is that a near-term answer or is that long-term?

DOCTOR SPEIS: In our recommendations we're talking about one to two years to come up to grips with the iodine question. But I agree with Len, it's

the many, many factors that could affect the -- we know that cesium iodide comes out, but then it changes. It could change into the other forms, H- as well we molecular.

MR. SOFFER: Yes. And so, in addition to things like chemical form of iodine, we want to look at the total quantities of fission products that might be released and the presence of other nuclides in addition to noble gases and iodines.

We do not believe that a change to Part 100 would be required to revise TID-14844. We have had some discussions with the Office of the General Counsel and they have advised us that since TID is referred to in Part 100 as representing something that may be used as a point of departure, the feeling is that we would not have to change Part 100 to revise TID, but merely revise the effective regulatory guides and associated standard review plan sections. However, if we revise TID-14844, there are a few places in the regulations, in Section 50.34, that specifically refer to it and we probably would have to do something in that regard.

CHAIRMAN CARR: Suppose I just wanted to correct the timing problem so I could quit wrecking diesels and quit wrecking shutoff valves? What's the

steps I'd have to go through to just correct that piece?

MR. SOFFER: We would probably have to put out a new version of Reg. Guides 1.3 and 1.4 and possibly some standard review plan sections.

CHAIRMAN CARR: But as I understand your paper, there's enough data to say, "We can do that and we know what we're doing."

MR. SOFFER: Yes, I think so.

DOCTOR SPEIS: Yes.

COMMISSIONER REMICK: That would be a big if.

CHAIRMAN CARR: What are we waiting for?

DOCTOR SPEIS: We'll be proceeding in power with this, Mr. Chairman, when we're going to wait to complete this three to six month study on decoupling. One of their accommodations will be -- we'll start the process.

CHAIRMAN CARR: Well, we don't have to do six months to do that particular piece --

DOCTOR SPEIS: No, we'll be starting now.

CHAIRMAN CARR: -- and quit making those diesels start so fast and quit slamming those valves shut in less than two or three seconds.

COMMISSIONER CURTISS: But that's

independent of the iodine work as well, the chemical form to do that.

DOCTOR SPEIS: Yes.

CHAIRMAN CARR: I mean it seems like we ought to go ahead and do that. If we've got the research done, let's do it and fix something.

MR. TAYLOR: We'll give a commitment on that. Themis, we can speed that along.

CHAIRMAN CARR: Good.

COMMISSIONER REMICK: Your statement about not changing Part 100 is true unless you did look at changing those doses to risk-based, is that correct? If you did that, then you would require a change of Part 100.

MR. PARLER: The 25 --

COMMISSIONER REMICK: Twenty-five into 300.

MR. PARLER: That would require a change in rulemaking activity.

COMMISSIONER REMICK: Either to change those or add additional ones.

MR. PARLER: Yes.

CHAIRMAN CARR: Okay. Let's proceed.

MR. SOFFER: (Slide) If we can go to page 11.

There are a number of issues that are

associated with updating TID. We think that we have identified three of them. The first one is what kind of an accident are we talking about in defining this fission product release.

Footnote 1 to Part 100 talks about the accident representing a substantial meltdown of the core with appreciable release of fission products. We recognize today that that can encompass quite a range of accidents. Are we talking something like TMI where the pressure vessel did not fail, or are we talking something more extreme where there is a failure of pressure vessel and where one has molten core with associated core concrete interactions? That would obviously be something that has to be decided upon.

The second issue is --

CHAIRMAN CARR: Well, is that a technical decision or policy decision?

MR. SOFFER: I see that as a policy decision, although it's, of course, driven by technical factors.

CHAIRMAN CARR: There's nothing to keep us from making that policy decision now, is there? We're not waiting for research on that if it's just policy. Throw it up here. We'll see if we can make it.

MR. SOFFER: A second issue is what is or

what should be the relationship between the accident that defines the source term or release into containment and containment design criteria. Should they be related and how should they be related? A third key issue is what is the relationship between the source term and siting? Right now, they are intimately related and an issue is should they be.

COMMISSIONER REMICK: As I recall, I believe ACRS is going to talk to us Thursday about where they stand on the second bullet. If I recall, that's one of the topics.

MR. SOFFER: (Slide) Turning to page 12, I'd like to talk a little bit about regulatory applications of updated source terms. In a previous staff paper on severe accident policy implementation and the use of updated source terms, and that was SECY-86-76, the staff identified about ten areas where updated source terms might impact regulatory applications. The staff divided these into short-term areas, intermediate-term changes, long-term changes. The short-term changes identified in that paper have now been completed.

These included, as Commissioner Curtiss alluded to earlier, a discussion of severe accident risks in environmental impact statements. That was

done for the South Texas plant. There was a revision to one standard review plan section that talked about PWR spray additives. That was Section 6.5.2. There was a new SRP Section 6.5.5 that has given credit for BWR suppression pools as fission product cleanup systems, something that had not been done up until that point.

As indicated earlier, updated source term information has potential application in three major areas, siting, plant design and emergency planning. This is merely a tie-in for the next few slides that I want to talk about.

(Slide) So, if you'll turn to page 13.

An updated source term, an updated version of TID-14844, could be used in siting exactly the same as we have in current practice today without changing Part 100. However, there are a number of staff concerns and a number of these have been alluded to by Doctor Murley and by previous speakers. Number one, it doesn't address the question of containment performance, the fact that one assumes implicitly in the Part 100 calculation that the containment is leaking but remains intact and yet this is a severe accident.

Secondly, as has also been stated, we know

that if the staff gave its best estimate evaluation of these fission product cleanup systems, that this would permit much smaller exclusion areas, much smaller population zones than has been previously allowed in previously licensed sites. This is where the, as has been stated, the staff has gotten clever and has restricted its use of credit, so to speak has pulled its punches in giving credit for these kinds of systems.

As a result, we have begun to lean towards the idea of decoupling siting from plant design and eliminating dose calculations in siting. This is not an absolutely new idea. The Siting Policy Task Force that was set up in 1979 proposed the very same kind of idea. They never got around to making any formal recommendations in this regard. The work was discontinued for a number of reasons. Number one, nobody was terribly interested in siting in the time period around 1980, 1981. Secondly, the Commission directed that this effort be put on hold until the safety goal was in better shape and until source term studies were in better shape. What we would like to do is we would like to reexamine this idea and look at it in some more detail.

COMMISSIONER REMICK: It wasn't clear to me

in the SECY document. I can infer advantages, but I don't think the staff indicated what you perceive as potential advantages of looking at siting separately. What do you see as the potential advantages? I understand you say that you're concerned that the LPZ could otherwise become too small and this is one way of some kind of judgment defining it. Are there others?

DOCTOR MURLEY: Yes.

CHAIRMAN CARR: Let me quote you here, the paragraph that says, "Decoupling of siting from plant design would contribute to enhance safety for future LWRs by focusing on those plant and site aspects that are important in achieving safety and in assuring a very low level of risk." I don't understand that.

COMMISSIONER REMICK: Yes, it's not very specific.

DOCTOR MURLEY: Well, the benefits that we've seen and potential benefits, we were still doing the study, but one is you can have a design that's more closely tied to the unique aspects of the reactor. That is, you can have the plant design, the cleanup systems and that sort of thing tied to the particular design of the reactor. That's more likely to be a relaxation of certain features.

The benefits, I think, come in two ways. One is you don't allow near-term siting by trading off engineering features. So, you would just arbitrarily -- whatever you set, you would arbitrarily limit siting to some certain population criteria and so forth.

At the same time, I think there's going to be a benefit in the early site -- what's the part of Part 52, early siting --

CHAIRMAN CARR: Permits.

DOCTOR MURLEY: -- permits, yes. Because right now what we'd have to do if we were evaluating a site --

CHAIRMAN CARR: You'd have to have a design to get a permit.

DOCTOR MURLEY: We'd have to put a plant there of some kind and it would have to have certain characteristics and certain something or other. I think it would make it a lot easier, although I must say we haven't explored that in a lot of detail. That's why we want to do this study.

CHAIRMAN CARR: Well, I guess the thing that concerns me is that when you do that it seems that you're going to automatically have to be more conservative in both of them since neither one of them

can give credit to the other one. So, you'll be more conservative in picking your site because you don't know what the reactor design is going to look like and the reactor design, since you don't know where it's going to be sited, you'll -- I'm just concerned about that, making it more conservative on both sides than it would have to be.

DOCTOR MURLEY: That's exactly where we're at today. When we're evaluating the designs, we have to evaluate it for an envelope of sites. So, we tend to pick seismic features and that sort of thing that will cover most of the areas of the United States. Likewise, if we were to do an early siting review, we'd have to envelope all the plant designs that could possibly go there.

I guess I don't see too much of a change because if we were to write a rule that decoupled the thing, we would still do the kinds of enveloping calculations, I think. So, I don't --

CHAIRMAN CARR: I can see that if you put the conservatism into the sites, then you could probably relax it, a plants. But --

MR. TAYLOR: In the design itself, yes.

CHAIRMAN CARR: Well, it's probably worth studying to see where the tradeoff is.

DOCTOR SPEIS: In this paper, Mr. Chairman, we have to address this question, this existing flexibility between design and siting and we'll have to consider a number of options, retain it, eliminate it or something between and kind of think very carefully about the pluses and minuses.

CHAIRMAN CARR: Siting is going to be subjective in the end, I believe.

COMMISSIONER CURTISS: Whether the objective or the result is to do this, what it boils down to is that you are going to really moot the siting question, it sounds like. We're not going to focus on the siting question strictly from the standpoint of risk or we might not decouple it altogether. It sounds to me like the undertow here is that we just never want siting to become an issue at all, which it might if it were carefully premised on strict risk considerations. We just want these facilities to be so remote that, for all intents and purposes, we will have mooted the siting question.

CHAIRMAN CARR: Well, there are certain factors that determine the site automatically. It seems to me you've got to have a water source. You want to be seismically okay and you want to be a certain distance from populations and you don't want

to be in the line of airplanes landing and you end up putting crash doors in front of --

But those things, I can see, can be independent of the plant. It's only when there's no transmission line around that then it becomes a problem.

MR. TAYLOR: I think we won't know the answers to those kinds of things until we work on this a little more.

CHAIRMAN CARR: Yes, it's going to be an interesting study.

MR. TAYLOR: We wanted the Commission to be aware that we wanted to conduct this type of study. I don't think we know the answers right now.

COMMISSIONER CURTISS: Just a question on the mechanics and the timing issue. DOE was up here and indicated that they have some -- are thinking about exploring the concept of trying out an early site permit process with an actual application. I guess the last we heard it was subject to OMB review. Presumably we'll learn here shortly whether that's included in the budget. Does the DOE initiative and this initiative fit with one another?

DOCTOR MURLEY: Well, what we would do now if we received such an application is we would use

Part 100 the way it is. We'd have to select a plant or a group of plants and envelope them with regard to the calculations.

COMMISSIONER CURTISS: Yes. They indicated that they've had -- if they were going to pursue this, that the environmental data gathering would take place in the 1990, '91 time frame and the application wouldn't come in until '92. Is that beginning to fit? Is this the kind of initiative that you all have that specific a target for yet?

DOCTOR MURLEY: I think we -- I'm just not --

COMMISSIONER CURTISS: Too early to say? Okay.

DOCTOR MURLEY: I haven't thought it all through.

COMMISSIONER CURTISS: All right.

DOCTOR MURLEY: There's a lot of ramifications.

CHAIRMAN CARR: You want to pull them from the site permit in our new Part 52. I mean if a guy can come in and apply for a site and get it approved, then he can look around and see which kind of plant he'd rather build there and so he can get his site permit approved before he has to worry about having a

plant to put on it. I think it's a valuable thing if the study shows it's worthwhile to do it.

DOCTOR MURLEY: There was one question that Commissioner Remick asked. Actually, he asked it in different forms twice. What are the benefits of perhaps removing some of this equipment? I think we're probably not giving the industry proper credit for one aspect that they want in their new designs and that is simplicity, simplicity in design and operation. I think by removing things like MSIV leakage systems, by removing redundant trains where you don't really need them, that goes in the direction of plants that are simpler to --- designed simpler to operate and therefore presumably safer. We could cut down even diesel size as a result of that simplicity and so forth

CHAIRMAN CARR: It cuts down on site actuators when you've got to slam valves shut.

MR. SOFFER: (Slide) Let's go on. We go to page 14.

Updated source term insights could have impact on a number of plant systems. I won't read the list. The question of isolation valve closure time has already been discussed. Let me just point out, for example, that containment isolation valves typically

are required to close within ten to 15 seconds at the present time, primarily as a result of the impetus of this large fission product source term that is going to come along and result in horrendous consequences. If that eases, then it could conceivably result in more reliable valve designs, better valve designs where you don't have tremendous hunks of metal that are slamming up against each other or required to slam up against each other in short periods of time.

The staff intends to examine the source term insights and apply these as appropriate to these designs. I believe that these will be discussed in a forthcoming paper from NRR.

CHAIRMAN CARR: Well, I hope we're going to apply them to operating reactors as well as advanced design.

MR. TAYLOR: I think -- yes, yes, as appropriate, right. Now, we have closure time can be relaxed, we have diesel starts.

MR. SOFFER: (Slide) Let's go on to number 15.

With regard to updated source terms and emergency planning requirements, the sizes of the present EPZs were based on both policy and technical considerations. These included the consequences of a

range of accidents ranging from the design basis accidents as well as the severe accidents considered in WASH-1400.

Looking at updated source term information from NUREG-1150, it indicates that for those sequences that have the greatest impact on risk, and those are early containment failures and containment bypass events, the revised source terms in 1150 are somewhat lower than predicted by WASH-1400. However, the staff does not recommend changes to existing EPZs.

COMMISSIONER CURTISS: Aside from the technical considerations, what were the policy considerations that led to that?

COMMISSIONER ROBERTS: Excellent question. They're not articulated.

DOCTOR MURLEY: The policy questions, well, there is a paper before the Commission --

COMMISSIONER ROBERTS: Well, let's say it. Let's talk about it. Excuse me.

DOCTOR MURLEY: I'm really not prepared to answer in great detail, but there's a paper, I noticed, in front of the Commission. SECY-89-277(a) has a lot of discussion of the things in there and NUREG-0654 is quoted. It says, "The choice of the size of the emergency planning zones represents a

judgment on the extent of detailed planning which must be performed to assure adequate response bases.

In a particular emergency, protective actions might well be restricted to a small part of the planning zone. On the other hand, for worse possible accidents, protection action would need to be taken outside the planning zone."

There was, I'm told, by people who were involved in the discussions at the time, of things like the desire to get a representative number of local communities involved. When you look at the kinds of sizes of zones, that went beyond a mere technical calculation.

CHAIRMAN CARR: But I think the problem we've got right now, if somebody tried to change the ten mile zone down to two or three miles, it would be poor policy to make that effort right now. If you're going to find some reason to do that, you've got the same reason then to just take different emergency actions within the same zone as it exists today. Rather than having to evacuate everybody inside ten miles, you'd evacuate them inside a half a mile.

DOCTOR MURLEY: You could do that. In fact, some states --

CHAIRMAN CARR: But trying to take that on

in today's political atmosphere and from my policy standpoint is dumb policy.

COMMISSIONER ROBERTS: It's what?

CHAIRMAN CARR: Dumb policy.

COMMISSIONER ROBERTS: Well, that may be but that's a policy issue. Let's talk about it. The staff won't even touch that.

COMMISSIONER CURTISS: My question really went to a threshold issue, and that is -- since I wasn't here at the time, I'm just curious to know what those policy considerations were. I understand the technical considerations and, frankly, my own view is that we do better as an agency when we rest our decisions on purely technical considerations because that's the charge that we've got.

This may be one that, as the Chairman has suggested, is water over the dam or under the bridge or wherever it's gone. It may be an issue that, at least at this point, doesn't deserve to be revisited. But I would be curious to know, A, what the technical information suggests today about where we've been and where we're going on emergency planning, and B, what the additional non-technical policy considerations were when the decision was originally reached.

I'll go back and take a look at that paper.

DOCTOR MURLEY: There's a lot of good discussion in here. It might not satisfy you with regard to a listing of all the policy issues that were taken into consideration. I'm not sure such a list exists.

MR. PARLER: By the way, that paper was-- the Commission was acting on petitions for rulemaking in which, if my memory is correct, one of the petitions was that the EPZs should be doubled from ten to 20. So, that paper is indeed, as Doctor Murley pointed out, important to the discussion, at least to the contemporaneous discussion.

CHAIRMAN CARR: Well, you know ten wasn't a technical number or it would have been 9.836 or something.

COMMISSIONER REMICK: I agree with Commissioner Curtiss. If we had NUREG-1150 at that time, what would we have selected from a technical standpoint? It would be interesting to know, or what we would pick as a technical point now based on 1150.

MR. TAYLOR: We are trying to approach this in a better or pragmatic way and take the things that we think we can work on and deliver. That's one of the reasons why, at this time -- we use those words-- at this time we don't recommend a great deal of staff

effort to go back.

I was not at the center of that discussion which took place, as Themis Speis mentioned, about the mid-'80s, when this whole subject came before the Commission and the staff based on a lot of work. But part of what we're doing here is to outline what we think we need to do with source term as it applies to the current work the staff will be doing. You will see more of this in the paper on the evolutionary reactors. That's very important.

As Chairman Carr has brought up, as we do better work on the source term and what it means in plant systems, there may be some basis to change requirements on existing operating plants. So, those are sort of very pragmatic and I think the staff's position is at this time, and it is a policy question, we wouldn't recommend taking on that subject.

COMMISSIONER CURTISS: It seems to me that is a difficult issue to come to grips with. But I can envision for the current generation of plants how that issue might come up in a more subtle but important way. The Chairman has already alluded to the encroachment of populations.

Depending upon how broadly we craft the plant life extension rulemaking, it does seem to me

that there's an opportunity that may exist for the issue to be revisited, perhaps relocated with questions such as encroachment of populations getting tossed onto the table for debate and consideration.

What I'm suggesting is that if the sum and substance of the original decision was or should be based in large part on technical considerations, it would be valuable to know, if we reach that juncture, what those technical considerations suggest today if we're going to relitigate that question as we go through the plant life extension proceedings. It's something that --

CHAIRMAN CARR: Well, I think it's valuable to have the technical number that says what it ought to be. My position is if that's 1.6 miles or 2 miles, that doesn't mean we should enter into changing it to that, but we ought to have it on the record. Then, if we want to change it, we know what we're working with.

COMMISSIONER CURTISS: Is there such a number or is that --

MR. TAYLOR: We don't have --

COMMISSIONER CURTISS: Okay.

CHAIRMAN CARR: Yes. It would undoubtedly today depend on the individual plant. But I think that there's general agreement it probably wouldn't be

ten. It would be something less than ten for whatever individual plant you picked, but you'd have to go figure it out. I'm not sure that's worth the effort in today's shortened environment of personnel and resources.

Let's proceed.

MR. SOFFER: That concludes my presentation, Mr. Chairman. I'll turn it over to Doctor Speis for the concluding remarks.

DOCTOR SPEIS: (Slide) Well, basically, the last viewgraph on page 16 summarizes what we'll be doing. The item number 1, we'll be undertaking this study to decouple siting from plant design for future reactors. We anticipate that this should be done in about six months.

Also, we'll be assessing issues and implications for current plants. At the completion of our study, we'll be making recommendations to the Commission. We plan to interact with the ACRS during this time to get their views. Some of the things that we will be addressing have been discussed to some extent, but we will be doing a lot of thinking about this whole issue.

Item number 2, we will be pursuing changes to a number of issues which are affected by source

terms. And as we said, we think we have most of the information in hand to pursue changes which affect the timing of the appearance of the source term, which will have an effect on a number of plant design, equipment, and so on.

Again, we plan to complete this in about six to nine months. We have to interact with the ACRS. We go to CRGR. But we are confident we can do this short-term effort, dealing with the timing of the fission product source term.

The longer-term changes involve the iodine chemical form and may take up to two years, could possibly require additional resource. But I think, as has been discussed earlier, we have to distill what we know and put it into a decision-making format and then see if there are any residual issues that we want to pursue before we undertake any research.

So with that, Mr. Chairman, Commissioners, we have completed our presentation.

CHAIRMAN CARR: Any questions?

Commissioner Remick?

COMMISSIONER REMICK: Not questions, just a couple, I guess, final comments. I certainly encourage looking at decoupling. I think there are potential advantages. I don't know if in that--

certainly, that's going to be a deterministic decision based on some risk insights, no question.

But one question that I would have, is there any advantage of equating the LPZ distance to the EPZ distance? Would this make any sense? That's just off the top of my head. I haven't thought about it, but if the LPZ was equivalent to the EPZ --

DOCTOR MURLEY: Well, the LPZ was -- in Part 100, was the area where they did require that there be some capability to take protective actions. But my sense is that they're much smaller than ten miles.

COMMISSIONER REMICK: But if you're going to be deterministic in setting those, I was saying is there any advantage of that. I'm not saying it's a good idea, just the thought went through my mind as we were talking today that is there any advantage if you're going to come up with a siting rule of tying EPZ distance with LPZ. Maybe it's too large a distance. I don't know.

DOCTOR MURLEY: That would be one way of reducing the EPZs.

COMMISSIONER REMICK: It would be helpful, when we eventually look at what you come up with on decoupling, if we had some kind of a feeling what a current design, like an ABWR, would lead us to

logically for an LPZ distance, what a current plant would lead us to so we have some kind of a feeling.

And I'm glad to hear from Themis that you will involve the ACRS. These are the type of technical questions I think you should involve them. I would encourage you to have them involved early on, so they might provide some thought input rather than wait until you're ready to put something up to the Commission and give them an accomplished fact that they react to. I think it's a good area in which they might have some helpful suggestions.

MR. TAYLOR: Yes, sir.

CHAIRMAN CARR: Commissioner Roberts?

COMMISSIONER ROBERTS: Well, I don't have a question, but a comment.

On your slide 15 of the presentation, your first bullet, "sizes of present emergency planning zones based on both policy and technical considerations," if you go to the SECY paper 89-341 and go to the summary, the last paragraph -- I'm excerpting something -- "source terms for the most severe accident releases are estimated to have decreased somewhat, compared to the" current "Reactor Safety Study..." It would appear to me that is a technical consideration.

Now, you have very artfully and skillfully not quantified that in any way, and I understand the difficulty to do so, but continuing the sentence, "current regulatory requirements for EPZs are based on other policy considerations..." I think that's intellectually dishonest. The "other" should be struck. You're equating a technical judgement, not quantified admittedly, but the fact that releases are estimated to have decreased, and you're including that as a policy consideration. That's not true.

That's all I have.

CHAIRMAN CARR: Okay.

Commissioner Rogers?

COMMISSIONER ROGERS: Yes. Based on the current source term considerations, that's TID-14844 and the Reg. Guides 1.3 and 1.4, do you believe that deviations from the current regulations will be required for the GEABWR?

DOCTOR MURLEY: Deviations for what purpose, Commissioner?

COMMISSIONER ROGERS: Well, to satisfy those regulations.

DOCTOR SPEIS: As they exist today?

COMMISSIONER ROGERS: As they exist today, yes.

DOCTOR SPEIS: For example, their proposal to remove the clean-up system.

DOCTOR MURLEY: We can -- as I understand it, we have the latitude within our guidance to do that sort of thing. We're viewing it as a policy issue, though, and so we're -- at your instructions, we're sending it up to the Commission to request approval. But our inclination is to relax some of the requirements in this area for the advanced plants. I guess that's as far as I can say right now.

COMMISSIONER ROGERS: But that would be necessary in approving that ABWR design then, to make that relaxation? In other words -- is that what you're saying?

DOCTOR MURLEY: Yes. In the past, I mean, the staff had certain latitude in the reg guides and that sort of thing, but because -- for the advanced plants, all of these issues are very, very closely coupled: the severe accident issue, the containment criterion, and also what you use for mitigation systems.

I guess I can't give you a real clear answer. We're kind of viewing it all as one big package, and I don't think we need a rule change or anything like that. But if we're going to relax in

one area, you kind of need to see the big picture.

COMMISSIONER ROGERS: But you wouldn't need a rule change, at any rate? You would not?

DOCTOR MURLEY: I don't believe so, no.

COMMISSIONER ROGERS: You don't think so?

DOCTOR MURLEY: No.

COMMISSIONER ROGERS: How about any of the others, the System 80+?

DOCTOR MURLEY: I just haven't thought enough about that one.

COMMISSIONER ROGERS: All right, just curious to know how that's shaping up.

What about the BEIR V report? How is that affecting your current strategy in source term update?

MR. CONGEL: I can answer in a more general sense.

COMMISSIONER ROGERS: None at all?

MR. CONGEL: Not for the source term at all.

COMMISSIONER ROGERS: Not for the source term?

MR. CONGEL: No. And we're just looking at the potential implications. And in fact, they're preparing an information paper for your consideration.

COMMISSIONER ROGERS: What about Part 100? Do you think that the basis for Part 100 would be

affected by the conclusions of the BEIR V report?

MR. CONGEL: No. And it may be worthwhile reemphasizing that the dose numbers that are in Part 100 are for hypothetical individuals and were intended to provide a basis for the equipment that's evaluated at each of the specific plants at a specific site, but it's for hypothetical individuals.

COMMISSIONER ROGERS: Okay. Thank you.

CHAIRMAN CARR: Commissioner Curtiss?

COMMISSIONER CURTISS: I don't have any questions. I just have, I guess, four areas that I'd like to follow-up on or emphasize.

First, this subject that we talked about earlier, the risk-based approach to source term, it seems to me that's an area that's worth at least fleshing-out in more detail than we've got to date. There are some advantages and disadvantages of that that I think we've talked about in a quick way here, but I'd like to see at some point a further amplification on the details of an approach that would focus on risk as a central consideration.

That, in turn, would entail the use of -- or greater reliance, I take it, on PRAs, and that generally is a subject I guess I'd like to suggest that at some point -- I know we have the paper up here

from the staff on that subject, but perhaps it would be worthwhile to have-- because it comes up in a lot of areas -- have the Commission get back together at some point and have a specific briefing devoted to the question of the use of PRAs in regulatory decision-making to try to get a better feel for that.

Two other quick comments. When the paper comes up here on decoupling siting from source term, I guess I'd like to see in particular what your thoughts are or your focus on what you would characterize as the purely risk-based considerations that are driving you, an effort to try to distinguish those things that may be what we call policy here, or just, "We're going to moot the citing issue," distinguish those from the considerations that are strictly risk-based or risk-driven.

And then finally, in the research area, I'd like to see a discussion on the chemical form of iodine, maybe just a brief response on what the schedule and the price tag is for the research work that remains to be done, what it is specifically that we intend to look at in that area.

MR. BECKJORD: We're preparing an update to the research plan, particularly the long-range plan, and the work on iodine is one of the key aspects.

COMMISSIONER CURTISS: Okay. If it's addressed, that's fine.

MR. BECKJORD: I think the schedule on that is May.

MR. TAYLOR: We'll highlight that.

COMMISSIONER CURTISS: Good. That'll do it. That's all I have.

CHAIRMAN CARR: On that similar subject there, it seems to me that in the current reviews you're going on on the advanced reactors or evolutionary reactors and the EPRI requirements, that some of that you're taking into effect source term--new source term ideas, and some of it you're not. Is there some research-associated area of the source term that we can get behind us so you can use it in these designs that will help you make those judgments?

What I'm trying to do is emphasize some of that research that's nearer-term than others, so that instead of having to be overly conservative in these reviews we can take what we know or what we're almost about to know, speed it up so that we can not have to do this ten years down the pike, look back and say, "Gee, if we had known then what we know now." I realize some of that research is distant, but some of it we might be able to get done in time for them to

use.

MR. BECKJORD: I think we can do that separation. That's why I'd like to have some research people working on this decoupling study.

DOCTOR SPEIS: The timing is one of the things that we can pursue as soon as possible. And it is probable that these evolutionary plants will be able to use that information.

DOCTOR MURLEY: Mr. Chairman, there's an enclosure attached, enclosure 1 to the Commission paper, which is a memorandum from Beckjord to me which discusses the source term issues that have been brought up by EPRI and what the staff view of those issues is. And it turns out that there are -- you're quite right -- there are a number of areas that we can agree with now. Or it lists some, like in the iodine area, that needs more research.

CHAIRMAN CARR: But one to two years is a-- you know, one year is one year and two years is two years. That's a long range in there. I'd like -- I'd be happy to say six months to a year, you know. I guess what I'm asking is can you get it done in a year if we give you the money? I'm trying to find is one-- that's the question I've got is --

MR. BECKJORD: As a general question, I

think producing something within a year, probably it doesn't involve research. I mean, it's working with information that we have now and putting it in the right form and evaluating it.

CHAIRMAN CARR: Well, that's your paper we're looking at. It says one to two years. I don't know. But all I'm trying to do is, I don't want them to make an overly-conservative decision. Or do I want them to make a non-conservative decision, based on research that isn't quite done yet? And so, if you see an opportunity to speed that issue up, I guess we'd like it.

I don't think I have any -- we've already mentioned the fact that on the fission product timing you say you've got enough data to go ahead and move out, and I would certainly encourage you to do that without waiting the six to nine months for the --

Well, I certainly want to thank the staff for a very informative briefing. It helped. The paper needed a little amplification as far as I was concerned. I support the staff's six month study of decoupling, so that the policy questions in payoff of separating siting from plant design for future reactors can be fully explored and the Commission can make an informed decision.

In conjunction with that, some of the issues I believe need to come up when you address that study are:

What criteria would you use in siting, if you didn't tie them together?

Would such criteria be unnecessarily conservative for all future designs?

And what would be the impact on existing plants?

For those areas where we already have research results and changes to regulatory positions are appropriate, such as fission product timing, I think the staff should make those changes on an expedited basis so that we can quit breaking equipment out in the field that seems to fail when we shut it, slam it hard or start it quickly or whatever. We need to get that done. And if the data's there to support it, let's go ahead and get it out.

Also, we should ensure we meet or exceed our research schedule of two years if we can in order to come to a decision on the chemical form of iodine and other areas in TID-14844 that may need updating.

In pursuing potential source term modifications, staff should be looking at the effect on existing plants as well as future plants.

I think it's important the Commission be kept informed on the status of updating source term methodology and the regulatory positions on a periodic basis, and I wish to encourage you to keep coming back when you've got enough data to tell us.

Are there any other comments from my fellow Commissioners?

COMMISSIONER ROGERS: Just -- I think the point that Commissioner Roberts made, I wouldn't be quite so emphatic about it being deceptive as he was. But I think that this question of when there are policy considerations referred to, I think we ought to understand what they are. Because maybe we agree with them, maybe we don't.

So I just -- I think it is a point to be sensitive on, and I think that it's well made. And if there are other policy considerations here, then could you flush them out and let them float to the surface so we can identify them and see whether in fact we do buy them or not? Because, I think that is important to understand.

I just also want to second the Chairman's view that this was an excellent meeting. I think I got a lot out of it, and I thank the staff very much.

CHAIRMAN CARR: In that case, we stand

adjourned.

(Whereupon, at 11:46 a.m., the above-entitled matter was concluded.)

CERTIFICATE OF TRANSCRIBER

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

TITLE OF MEETING: BRIEFING ON STATUS OF DEVELOPMENT OF UPDATED SOURCE TERM
PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: JANUARY 9, 1990

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

Carol Lynch

Reporter's name: Peter Lynch

COMMISSION BRIEFING ON STATUS OF EFFORTS TO DEVELOP AN UPDATED SOURCE TERM

OFFICE OF NUCLEAR REGULATORY RESEARCH
U.S. NUCLEAR REGULATORY COMMISSION

JANUARY 9, 1990

PURPOSE OF BRIEFING

- PROVIDE RESPONSES TO COMMISSION REQUESTS FOR INFORMATION (SRM, JULY 31, 1989, ITEM (A); SRM, JULY 6, 1989).

- PROPOSE FUTURE STAFF ACTIONS/RECOMMENDATIONS TO STUDY DECOUPLING SITING FROM PLANT DESIGN, AND TO APPLY UPDATED SOURCE TERM INSIGHTS, AS APPROPRIATE.

OUTLINE

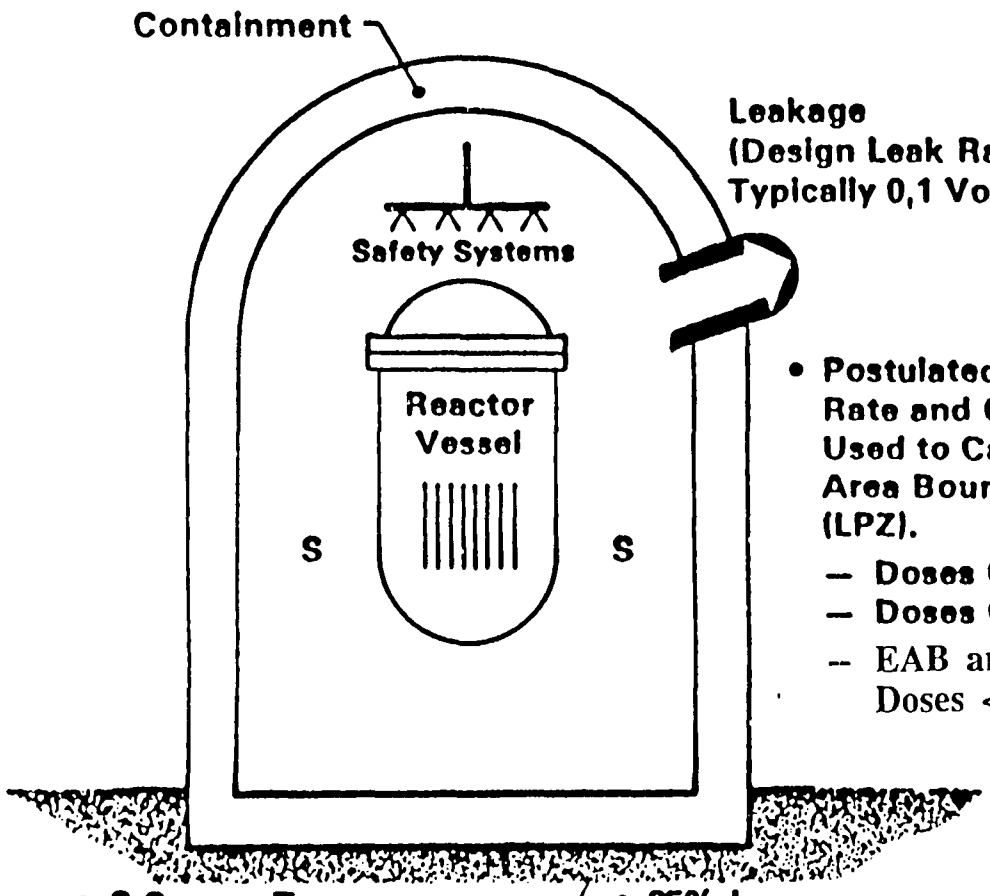
- o CURRENT PRACTICE
  - TID-14844
  - RELATIONSHIP TO DESIGN BASIS
  - RELATIONSHIP TO CONTAINMENT PERFORMANCE
- o RESEARCH INSIGHTS - ACCIDENT SOURCE TERMS
- o UPDATING TID-14844 - ISSUES
- o APPLICATIONS OF UPDATED SOURCE TERM
  - SITING
  - PLANT DESIGN
  - EMERGENCY PLANNING
- o FUTURE STAFF ACTIONS

CURRENT PRACTICE

- PRESENT SITING PRACTICE POSTULATES INSTANTANEOUS TID-14844 RELEASE INTO CONTAINMENT AND ITS USE TO CALCULATE OFFSITE DOSES FOR SITE SUITABILITY DETERMINATION ACCORDING TO PART 100 SITING REQUIREMENTS.

- TID-14844 RELEASE HAS ALSO HAD WIDE REGULATORY APPLICATIONS BEYOND SITING. THESE INCLUDE CONTROL ROOM HABITABILITY, EQUIPMENT QUALIFICATION, POST-ACCIDENT SAMPLING SYSTEMS, AND ISOLATION VALVE CLOSURE TIME.

TID-14844 SOURCE TERM



- Postulated Release Plus Design Containment Leak Rate and Other Fission Product Cleanup Systems Used to Calculate Doses to Individuals at Exclusion Area Boundary (EAB) and Low Population Zone (LPZ).
  - Doses Calculated Conservatively
  - Doses Compared with Values in 10 CFR 100
  - EAB and LPZ Boundaries Acceptable if Doses < 10 CFR 100 Values

- S-Source Term
  In Containment
  (Available for Leakage)

- 25% I_2
- 100% Noble Gases
- Timing and Iodine
  Chemical Forms Prescribed

TID-14844 SOURCE TERM
(CONTINUED)

- TID-14844 LARGELY BASED ON EXPERIMENTAL RESULTS OF HEATING UO_2 PELLETS (LATE 1950'S).

- PRESENT STAFF METHODOLOGY IS DESCRIBED IN REGULATORY GUIDES 1.3 AND 1.4 AND SRP SECTION 15.6.5 APPENDICES.

RELATIONSHIP OF TID-14844 SOURCE TERM TO DESIGN BASIS

- DESIGN BASIS ACCIDENT SOURCE TERMS (TID-14844) USED IN LICENSING IN TWO DISTINCT WAYS:

  - TO DEFINE RADIOLOGICAL ENVIRONMENT/ CONDITIONS FOR CERTAIN PLANT SYSTEMS.

  - TO ASSESS EFFECTIVENESS OF MITIGATION FEATURES AS RELATED TO EXCLUSION AREA BOUNDARY (EAB) AND LOW POPULATION ZONE (LPZ) ACCEPTABILITY.

RELATIONSHIP OF TID-14844 SOURCE TERM TO CONTAINMENT PERFORMANCE

- KEY IMPLICIT ASSUMPTION IN PART 100 IS THAT CONTAINMENT MAINTAINS ITS INTEGRITY DURING THE POSTULATED FISSION PRODUCT RELEASE INTO CONTAINMENT.

- CONTAINMENT DESIGN BASIS IS TEMPERATURE/ PRESSURE ASSOCIATED WITH LOCA, WHILE RADIOLOGICAL SOURCE TERM (I.E., TID-14844) IS MORE NEARLY THAT ASSOCIATED WITH A CORE MELT.

RESEARCH INSIGHTS

- MAJOR NRC RESEARCH EFFORT UNDERWAY SINCE ABOUT 1981 TO OBTAIN BETTER UNDERSTANDING OF FISSION PRODUCT QUANTITY, FORM, TRANSPORT AND RELEASE MECHANISMS.

- THERE ARE MANY SOURCE TERMS, DEPENDING UPON PLANT DESIGN AND ACCIDENT SEQUENCE.

- CONSENSUS THAT CURRENT STAFF PRACTICE REGARDING TIMING OF FISSION PRODUCT RELEASE IS OVERLY CONSERVATIVE.

- LARGEST SINGLE FACTOR AFFECTING SOURCE TERM IS CONTAINMENT INTEGRITY. DELAY IN CONTAINMENT FAILURE REDUCES SOURCE TERM. CONTAINMENT PERFORMANCE CRITERIA FOR FUTURE PLANTS (SECY-89-228).

DESIGN BASIS VS. SEVERE ACCIDENT SOURCE TERMS

- DESIGN BASIS ACCIDENT SOURCE TERMS ARE RELEASES NOT TO THE ENVIRONMENT, BUT RATHER INTO THE CONTAINMENT. THESE ARE POSTULATED TO OCCUR AND ARE USED IN LICENSING TO ASSESS SITE SUITABILITY AND EVALUATE CERTAIN PLANT SYSTEMS (EXAMPLE-TID-14844).

- SEVERE ACCIDENT SOURCE TERMS ARE RELEASES TO THE ENVIRONMENT. FIRST STUDIED IN RISK ASSESSMENTS (E.G., WASH-1400) WHEN EXAMINING SEQUENCES INVOLVING CORE MELT AND CONTAINMENT FAILURE. NOT USED IN INDIVIDUAL PLANT LICENSING, BUT SIGNIFICANT REGULATORY APPLICATIONS IN AREAS SUCH AS EMERGENCY PLANNING.

UPDATING TID-14844

- RESEARCH INSIGHTS CONFIRM THAT THE TID-14844 RECIPE, WHILE PROVIDING SUBSTANTIAL PLANT MITIGATION CAPABILITY, IS NOT COMPATIBLE WITH A REALISTIC UNDERSTANDING OF THE PROGRESSION OF SEVERE ACCIDENTS.

- AREAS TO BE INVESTIGATED FOR UPDATING TID-14844 INCLUDE FISSION PRODUCT TIMING, IODINE CHEMICAL FORM, QUANTITIES OF FISSION PRODUCTS RELEASED, NUCLIDES OTHER THAN NOBLE GASES AND IODINE.

- NO CHANGE TO PART 100 IS REQUIRED TO REVISE TID-14844, BUT REVISION OF REGULATORY GUIDE 1.3/1.4 AND ASSOCIATED SRPs WOULD BE NEEDED TO INCORPORATE REVISED INSIGHTS.

ISSUES ASSOCIATED WITH UPDATING TID-14844

THREE KEY ISSUES NEED TO BE ADDRESSED WITH REGARD TO UPDATING TID-14844:

- WHAT KIND OR TYPE OF ACCIDENTS SHOULD BE USED TO DEFINE RELEASE INTO CONTAINMENT?

- WHAT SHOULD BE THE RELATIONSHIP BETWEEN ASSUMED ACCIDENT CONDITIONS, RELEASE INTO CONTAINMENT AND CONTAINMENT DESIGN/ PERFORMANCE CRITERIA?

- WHAT SHOULD BE RELATIONSHIP OF UPDATED TID-14844 TO SITING?

REGULATORY APPLICATIONS OF UPDATED SOURCE TERMS

- STAFF PREVIOUSLY IDENTIFIED (SECY-86-76) POTENTIAL CHANGES MAKING USE OF UPDATED SOURCE TERM INFORMATION. SHORT-TERM CHANGES IDENTIFIED IN SECY-86-76 HAVE BEEN COMPLETED.

- UPDATED SOURCE TERM INFORMATION HAS POTENTIAL APPLICATION IN THREE MAJOR AREAS, NAMELY: SITING, PLANT DESIGN AND EMERGENCY PLANNING.

SITING

- o UPDATED TID-14844 COULD BE USED FOR SITING PURPOSES, AS IN CURRENT PRACTICE. HOWEVER, SOME STAFF CONCERNS ARE:
  - DOES NOT DIRECTLY ADDRESS CONTAINMENT PERFORMANCE.
  - BEST ESTIMATE EVALUATION OF FISSION PRODUCT CLEANUP SYSTEMS, WITH LARGE IN-CONTAINMENT RELEASE, WOULD PERMIT MUCH SMALLER EXCLUSION AREAS THAN PREVIOUSLY LICENSED SITES.
- o STAFF BELIEVES DECOUPLING SITING FROM PLANT DESIGN AND ELIMINATION OF DOSE CALCULATIONS IN SITING MAY HAVE MERIT. INTEND TO EXAMINE IN MORE DETAIL.

PLANT DESIGN

- o UPDATED SOURCE TERM INSIGHTS COULD HAVE SIGNIFICANT IMPACT UPON CERTAIN PLANT SYSTEMS, SUCH AS:
  - CONTROL ROOM HABITABILITY
  - FISSION PRODUCT CLEANUP SYSTEMS
  - ISOLATION VALVE CLOSURE TIME
  - CONTAINMENT LEAK RATE
  - EQUIPMENT QUALIFICATION
- o STAFF INTENDS TO EXAMINE UPDATED SOURCE TERM INSIGHTS AND APPLY THESE, AS APPROPRIATE.

UPDATED SOURCE TERMS AND EMERGENCY PLANNING REQUIREMENTS

- SIZES OF PRESENT EMERGENCY PLANNING ZONES (EPZ) BASED ON BOTH POLICY AND TECHNICAL CONSIDERATIONS INCLUDING CONSEQUENCES OF DESIGN BASIS AND SEVERE ACCIDENTS, USING THOSE FROM WASH-1400.

- UPDATED SOURCE TERM INFORMATION FROM NUREG-1150 INDICATES THAT, FOR EARLY CONTAINMENT FAILURES INCLUDING BYPASS THAT HAVE THE GREATEST IMPACT ON RISK, REVISED SOURCE TERMS ARE SOMEWHAT LOWER THAN PREDICTED BY WASH-1400.

- HOWEVER, CHANGES TO EXISTING EPZ REQUIREMENTS ARE NOT RECOMMENDED.

FUTURE STAFF ACTIONS

1. STAFF INTENDS TO STUDY DECOUPLING OF SITING FROM PLANT DESIGN FOR FUTURE REACTORS. SIX MONTH INTERNAL STUDY WILL ALSO ASSESS ISSUES AND IMPLICATIONS FOR CURRENT PLANTS AND MAKE RECOMMENDATIONS TO COMMISSION (JUNE 1990).

2. STAFF INTENDS TO PURSUE POTENTIAL SOURCE TERM MODIFICATIONS FOR FUTURE LWRS BASED UPON UPDATED RESEARCH INSIGHTS. SHORT-TERM CHANGES (E.G., FISSION PRODUCT TIMING) TO BE COMPLETED WITHIN 6 TO 9 MONTHS. LONGER-TERM CHANGES (E.G., IODINE CHEMICAL FORM) MAY TAKE UP TO 2 YEARS AND REQUIRE ADDITIONAL RESEARCH.

POLICY ISSUE
(Information)

November 6, 1989

SECY-89-341

For: The Commissioners

From: James M. Taylor
Acting Executive Director for Operations

Subject: UPDATED LIGHT WATER REACTOR (LWR) SOURCE TERM METHODOLOGY AND POTENTIAL REGULATORY APPLICATIONS

Purpose: To respond to Commission requests (Reference, M890620, SRM dated July 31, 1989, Item (a); and SRM dated July 6, 1989) by presenting the status of efforts to develop an updated source term methodology and to discuss potential regulatory applications for evolutionary and advanced LWRs; and to discuss the potential for modification of current regulatory requirements for EPZs.

Summary: Present regulations (10 CFR Part 100) require that a fission product release into the containment (derived from report TID-14844) be postulated and that its radiological consequences, considering both plant design and site characteristics, be evaluated. Although a great deal of effort has been expended by both the NRC and the industry to obtain a better understanding of fission product transport and release mechanisms, there is today no consensus on whether a universal source term is appropriate for regulatory use, much less on what such a source term would be. There is agreement, however, that the present recipe given in TID-14844 is no longer compatible with a realistic understanding of severe accidents.

The staff has considered pursuing the development and utilization for siting of a replacement for the TID-14844 release which makes use of the insights obtained by recent research. However, the staff concludes that an alternate approach should be considered. A short-term study (about 3 to 6 months) will be undertaken to examine the implications of decoupling siting from plant design for future reactors and to provide recommendations to the Commission. Under this proposal, reactor site characteristics would be reviewed and approved separately from the reactor to be located there without utilizing source terms or dose calculations. This

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492-3916

would require revision of Part 100 and other regulatory staff practices which could involve significant resources to implement. These will be assessed as part of the study. In the interim, the staff plans to continue to carry out its review of evolutionary designs in a manner that is consistent with current regulatory practice.

Decoupling of siting from plant design would contribute to enhanced safety for future LWRs by focussing on those plant and site aspects that are important in achieving safety and in assuring a very low level of risk.

Updated source term insights would be pursued and used to modify, as appropriate, regulatory guidance for advanced light water reactors on plant design aspects such as containment isolation valve closure time, efficacy of fission product cleanup systems and control room habitability. Short term changes (e.g., fission product timing) are expected to be completed within about 6 to 9 months. Longer term changes, such as the chemical form of iodine, may take up to 2 years and may require additional research. Conclusions that are reached within timeframes that are compatible with the review schedules identified in SECY 89-334 will be factored into the review of the evolutionary plants.

Finally, although source terms for the most severe accident releases are estimated to have decreased somewhat, compared to the Reactor Safety Study, current regulatory requirements for EPZs are based upon other policy considerations as well. Therefore, changes to the existing requirements based solely on source term insights are not expected.

Background: Radionuclide releases to the environment, that is, the type, quantity, timing and energy characteristics of the release of radioactive material from reactor accidents ("source terms") are deeply embedded in the regulatory policy and practices of the NRC. Consideration of source terms entered the regulatory process because the Commission's reactor site criteria (10 CFR 100) require that an accidental fission-product release from the core into the containment should be assumed to occur and that its radiological consequences should be evaluated assuming that the containment leaks at its "expected demonstrable leak rate", with the implicit assumption that the containment remains intact against the maximum credible accident. Evaluation of the consequences is used to assess both plant mitigation features such as fission product cleanup systems as well as the suitability of the site. The criteria for the release into the containment, which must be distinguished from a "source term," or release to the environment, is contained in Regulatory Guides 1.3 and 1.4, but is derived from the 1962 Atomic Energy Commission (AEC)

report TID-14844 ("Calculation of Distance Factors for Power and Test Reactor Sites"), and consists of 100% of the noble gases and 50% of the iodines (half of which are assumed to deposit on interior surfaces very rapidly). Footnote 1 to 10 CFR Part 100 states that the fission product release to be assumed for Part 100 calculations should be "based on a major accident... that would result in potential hazards not exceeded by those from any accident considered credible. Such accidents have generally been assumed to result in substantial meltdown of the core with subsequent release of appreciable quantities of fission products." The end note to 10 CFR Part 100 indicates that TID-14844 should be used for further guidance; that it contains a calculation method that results in distances roughly reflecting current (1962) Commission siting practices; and that TID-14844 may be used as a point of departure for calculations of siting requirements. Thus, from the outset the source term contained in TID-14844 has been tied, as guidance, to Part 100 siting requirements.

Although the consequences from the TID-14844 release into containment was considered to represent the bounding accident, in terms of credibility, other accident types were also evaluated to verify that these did not result in greater consequences. This practice led eventually to the development and consideration of a group of accidents, referred to as "design-basis" accidents, which were evaluated by the staff as part of the safety review.

Use of the TID-14844 release has not been confined to an evaluation of plant mitigation features and site suitability alone. The regulatory applications of this release cover a wide range, including the basis for (1) the post-accident radiation environment for which safety-related equipment should be qualified, (2) post-accident habitability requirements for the control room, and (3) post-accident sampling systems and accessibility. In addition, Regulatory Guides 1.3 and 1.4 specify instantaneous release, which has significantly affected containment isolation valve closure times as well as diesel generator start times.

In contrast to a single specified source term for design basis accidents, severe accident source terms first arose in probabilistic risk assessments (e.g. Reactor Safety Study, WASH-1400) in examining accident sequences which involved core melt and where containments could fail. Severe accident source terms represent mechanistically determined "best estimate" releases to the environment, including estimates of failures of containment integrity. This is very different from the combination of the non-mechanistic conservative release to containment postulated by TID-14844 coupled with the assumption of very limited containment leakage used for

Part 100 siting calculations for design basis accidents. The worst severe accident source terms resulting from containment failure or containment bypass can lead to consequences that are much greater than those associated with a TID-14844 release into containment and where the containment is assumed to be leaking at its "demonstrable" leak rate for its design conditions. Indeed, some of the most severe source terms arise from some containment bypass events, such as "event V" and steam generator tube ruptures.

Although severe accident source terms have not been used in individual plant licensing safety evaluations, they have had significant regulatory applications. Source terms from severe accidents (beyond-design-basis accidents) entered into regulatory consideration and usage shortly after the issuance of WASH-1400 in 1975, and were accelerated by the aftermath of the Three Mile Island accident. Current applications of severe accident source terms rely to a large extent on those of WASH-1400 and include (1) part of the basis for the sizes of emergency planning zones for all plants, (2) the basis for staff assessments of severe accident risk given in plant environmental impact statements, and (3) part of the basis for staff prioritization and resolution of generic safety issues, unresolved safety issues, and other regulatory analyses. Source term assessments based on WASH-1400 methodology appear in many probabilistic risk assessment studies performed to date.

Discussion: The discussion that follows is organized to respond, item by item, to the staff requirements memos dated July 31, 1989, Item (a) and July 6, 1989. Future staff actions are discussed within the context of these topics.

1. Status of Efforts to Develop an Updated Source Term Methodology

The in-containment fission product release given in TID-14844 was largely based upon experiments performed in the late 1950's involving the analysis of fission products released from irradiated uranium dioxide (UO_2) pellets heated to high temperatures. These releases were taken to be representative of "substantial meltdown of the core", in keeping with the guidance of Footnote 1 to 10 CFR 100. The staff's current methodology for evaluation of design basis accidents, given in Regulatory Guides 1.3 and 1.4, has retained the same release fractions for the noble gases and iodines as TID-14844, with additional assumptions on instantaneous fission product release and iodine chemical form. The 1% of the remaining fission products specified in TID-14844 was dropped since it was used only to calculate a direct gamma dose transmitted through the thin containment walls of 1960-type designs.

TID-14844 did not consider the escape of aerosols into the environment.

LWR source terms from severe accidents were first systematically studied in connection with probabilistic risk assessment, primarily in the Reactor Safety Study (RSS) published in 1975. Source term estimates under severe accident conditions began to be of great interest shortly after the Three Mile Island accident when it was observed that only relatively small amounts of iodine were released to the environment compared with the amount predicted to be released in licensing calculations. This led a number of observers to claim that severe accident releases were much lower than previously estimated.

A major NRC research effort began about 1981 and has been under way since then to obtain a better understanding of fission-product transport and release mechanisms in LWRs under severe accident conditions. This research effort has included a very large and extensive staff and contractor effort, involving a number of national laboratories as well as nuclear industry groups, and has resulted in the development and application of several new computer codes to examine core-melt phenomena and containment loadings in LWRs. Work by the NRC staff has also included significant review efforts by peer reviewers, foreign partners in NRC research programs, industry groups, and the general public. An independent evaluation of the NRC results was also performed under the auspices of the American Physical Society. An NRC report assessing and detailing this revised methodology (known as the Source Term Code Package or STCP) to calculate accident source terms for LWRs was published in July 1986 as NUREG-0956, "Reassessment of the Technical Bases for Estimating Source Terms." This latest methodology has also been utilized in the recently released second draft for peer review of NUREG-1150. In spite of a great deal of NRC and industry-sponsored research which has significantly improved our understanding of severe accident phenomena, there is today no consensus on whether a universal source term is appropriate for regulatory use, much less on what such a source term would be.

2. Potential for Improving and Updating TID-14844

Two key issues need to be addressed with regard to a replacement of the TID-14844 release. The first issue is the kind or type of accident that should be used to define a replacement. The "substantial meltdown" guidance in Footnote 1 to Part 100 may be insufficient in this regard since core melt accidents both with and without reactor pressure vessel failure are possible and can result in significantly different releases into containment, as well as in significantly different

containment loads, i.e., pressures and temperatures associated with such accident conditions. Consequently, the second issue is what accident conditions should be used to define the containment design criteria or containment loads, and how should these be related to the chosen source term?

The staff indicated in SECY-86-228, "Introduction of Realistic Source Term Estimates into Licensing," that it intended to use the methodology of the Source Term Code Package (STCP) to examine the rates of release of fission products into the containment for a set of severe accident sequences that could be considered to dominate degraded core and core melt events. The stated objective was, for future LWRs, that the releases into containment from these sequences would be used to set the performance levels of certain engineered safety features, and to determine containment leakage limits and site suitability, replacing the assumptions in TID-14844.

A contractor study has analyzed the timing, magnitude and duration of fission product releases calculated for a series of LWR severe accident sequences using the STCP methodology. The major results were that large fission product releases are estimated to appear in containment no earlier than about 5 minutes after core uncovery, that the duration of these releases from the core ranged from about 40 minutes to about 5 hours, and, depending upon the accident sequence and whether reactor pressure vessel failure occurs, essentially all of the noble gases would be released into containment as well as large fractions of the iodine and cesium fission products, substantial fractions of the tellurium, and lesser quantities of the non-volatile fission products. The results of this work were reported as NUREG/CR-4881 in March 1988.

This study has confirmed that although the TID-14844 release is very substantial and has resulted in a very high level of plant capability, nonetheless, based upon the large amount of information obtained on severe accidents since the publication of TID-14844 over 25 years ago, the present recipe is no longer compatible with a realistic understanding of severe accidents. There also remains considerable uncertainties on iodine chemical form. This is discussed further in Item 5, below.

Although some research on the technical aspects of a replacement for the TID-14844 formulation has been completed, there are significant policy implications involved in a potential replacement and the impacts of these would require a full exploration prior to any piecemeal changes.

The staff proposes to pursue potential source term modifications for LWRs based upon updated research insights.

Additionally, site criteria would be established without the need for individual dose calculations, as discussed in Item 3, below. Revised source term insights would be used to modify, as appropriate, regulatory guidance for advanced light water reactors on plant design aspects such as containment isolation valve closure times, efficacy of fission product cleanup systems, and control room habitability. Short-term changes (e.g., fission product timing) are expected to be completed within about 6 to 9 months. Longer-term changes, such as questions of the chemical form of iodine, may take up to 2 years and may require additional research. Conclusions that are reached within timeframes that are compatible with review schedules identified in SECY 89-334 will be factored into the review of evolutionary plants.

3. Constraints Precluding Regulatory Application of Updated Source Terms

The staff discussed regulatory use of improved information on source terms in "Implementation Plan for the Severe Accident Policy Statement and the Regulatory Use of New Source-Term Information" (SECY-86-76) and identified 10 areas of potential change in terms of short-term, intermediate-term, and long-term changes. Potential short-term changes included (1) revised treatment of severe accidents in near-term environmental impact statements, (2) removal of spray additives in PWRs, and (3) credit for fission product scrubbing in BWR suppression pools. Potential intermediate-term changes included (1) emergency planning, (2) containment leak rates, (3) control room habitability and air filtration requirements, (4) environmental qualification of equipment, and (5) safety issue evaluation. Potential long-term changes identified included (1) siting and (2) accident monitoring and management.

At the present time, all three short-term changes identified in SECY-86-76 have been completed. A revised treatment of accident risks, based on updated source terms, was provided in the Environmental Impact Statement for the South Texas Project (NUREG-1171) which was issued August 1986. Revised sections of the Standard Review Plan (SRP) were also issued in December 1988 to address removal of spray additives in PWRs (SRP Section 6.5.2), and credit for fission product scrubbing in BWR suppression pools (SRP Section 6.5.5). The intermediate and long-term changes identified in SECY-86-76 have been deferred, pending availability of updated source term information.

Potential regulatory changes to incorporate updated source term knowledge would not necessarily require rule changes. For example, significant technical justification exists for

some relaxation with regard to fission product timing, and this could be implemented by revision of Regulatory Guides 1.3 and 1.4, without a rule change. Similarly, any changes in the assumed chemical form of the iodine fission products could be implemented by revision of these Regulatory Guides. As noted earlier, however, there remain considerable uncertainties on the question of iodine chemical form that would require substantial staff and contractor resources to evaluate in an appropriate manner. Recent staff memoranda on these as well as related source term issues raised by the Electric Power Research Institute (EPRI) for the evolutionary LWRs are attached as Enclosures 1 and 2.

Although TID-14844 could be changed without requiring a change in Part 100, updating of TID-14844 would require revision of portions of 10 CFR 50.34(f) (Additional TMI-Related Requirements), which specifically references TID-14844.

Virtually all sites for U.S. power reactors have been evaluated using the TID-14844 release to containment combined with plant mitigation features to calculate radiological doses at several hypothetical locations, as specified by Part 100. This practice could be continued making use of a revised in-containment release utilizing updated source term knowledge. However, this does not directly address the central importance of containment performance and its relationship to source terms, as discussed in Item 4 below. The following additional concerns should also be noted.

Over the course of the years, fission product cleanup and leakage prevention systems have improved and the data concerning the performance of these systems has shown that they provide very large reduction factors. Direct application of this information on a best estimate basis would result in very low offsite dose estimates, in turn permitting much smaller exclusion area distances and much more limited distances to population centers than previously licensed sites. In order to maintain siting characteristics similar to, or at least no worse than, those licensed in the past, the staff granted only limited "credit" to such systems in siting calculations.

Since the middle 1970's the staff has been working on siting criteria that would supplement the Part 100 standard. Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," issued in 1975, recommended minimum exclusion area and low population zone sizes of 0.4 miles and 3 miles, respectively, and population density criteria of 500 persons per square mile, out to 30 miles from the reactor. In 1979 the Siting Policy Task Force (NUREG-0625) recommended that source terms and dose calculations should be eliminated

from siting, including early site permits. Under this proposal, site characteristics (exclusion area size, low population zone size and population density characteristics) would be reviewed and approved separately from the reactor to be located there.

None of these efforts to develop an alternative or supplement to the Part 100 standard have been fully developed as a regulatory requirement modifying or supplementing Part 100.

The application of best estimate source term information to current Part 100 siting calculations would leave NRC to face questions of siting policy with a siting regulation which has outlasted the technical information used to implement the AEC's 1962 siting policy decision. The staff proposes to undertake a short term study of about 3 to 6 months duration to address these siting issues and to examine the issues related to decoupling siting from reactor design. The staff will present its recommendations to the Commission upon completion of this effort. In the interim, the staff plans to continue to carry out its review of evolutionary designs in a manner that is consistent with current regulatory practice.

4. Relationship of Source Term Update to Containment Performance

It is important to recognize that design basis accident source terms are used in the licensing process in two distinctly different ways. The first is as a means to define the radiological environment or conditions under which certain plant systems must function. Examples of this include the evaluation of fission product cleanup systems, control room habitability, and equipment qualification.

The second area of application is its use, together with plant performance and site characteristics, to assess the consequences of an accident or group of accidents in order to form a judgment on overall risk. This has been one of the key applications envisioned by Part 100. Central to this evaluation is the assumption that in the presence of such a fission product release the containment maintains its integrity.

It is in this second area of application that containment performance and source terms become linked. The present formulation may be inconsistent since the containment design basis is the temperature and pressure conditions associated with a loss-of-coolant accident (LOCA), while the radiological environment associated with the fission product release is more nearly that associated with a core melt. In order to address directly the central importance of containment

integrity for LWRs in reducing risk, the staff has proposed a position in its Safety Evaluation Report on Chapter 5 of the EPRI Requirements Document (see SECY-89-228). Implementation of this position is expected to facilitate a finding of very low risk.

5. Source Term Uncertainties and Significance for Regulatory Application

Fission product releases or source terms arise as a result of a highly diverse group of phenomena involved in any particular severe accident sequence. For LWRs these include core heatup, fuel element degradation and melting, pressure vessel attack and failure, possible high pressure melt ejection, interaction of core debris with concrete, retention of fission products within the reactor coolant system, effects of hydrogen burns or detonations, retention of fission products by suppression pools or ice beds, late revolatilization of fission products from deposited surfaces, and clearly, the effect of containment integrity or containment bypass and time of containment failure, if it occurs.

Because of the multiplicity of accident sequences that can occur for a given plant as well as the diversity of the, as yet, imperfectly understood severe accident phenomena, it is not surprising that NUREG-1150 has noted that "the uncertainty in radionuclide source terms is large and represents a significant contribution to the uncertainty in the absolute value of risk." In addition to uncertainties in the absolute magnitudes of releases, another major source of uncertainty is the chemical form of iodine. Present LWR severe accident codes treat fission product iodine as being released from the fuel as cesium iodide (CsI). It is known, however, that subsequent accident conditions such as the presence or absence of water and the pH level can markedly affect the chemistry, and relative retention, of iodine fission products.

Regulatory applications have traditionally accommodated considerable uncertainty by selection of a reasonable upper bound in order to obtain a conservative value. With regard to the TID-14844 formulation, in particular, present assumptions on fission product timing and the amount of release of noble gases are clearly conservative. Recent research suggests that fission product timing for LWRs could be relaxed somewhat, while still maintaining an appropriate degree of conservatism. Similarly, recent research suggests that other nuclides presently neglected, such as cesium, would be present under such conditions. The staff believes that examination and consideration of the appropriate sequences can lead to selection of quantitative estimates of nuclides released into containment that takes account of the uncertainties in our

knowledge and provides an appropriate degree of conservatism. Hence, the staff believes that uncertainties in LWR source term magnitudes could likely be accommodated in any proposed revisions.

Uncertainties in iodine chemical form are difficult to quantify at this time. This principally affects iodine filtration requirements which presently assume that fission product iodine is largely (91 percent) in elemental (I_2) form. While present research suggests that elemental iodine is probably less important than previously supposed, the staff has insufficient basis for the complete removal of elemental iodine filtration systems (employing charcoal absorbers), as has been suggested. In addition, there are other volatile forms of iodine, such as HI, other than elemental iodine. Additional research studies under way in this area may lead to a better understanding of this area within about 1 to 2 years.

6. Application of TID-14844 to ABWR Licensing

In SECY-89-311, "Resolution Process for Severe Accident Issues in Evolutionary Light Water Reactors," dated October 10, 1989, the staff proposed to provide a paper on the subject of proposed departure from current regulations by December 29, 1989. The staff is assessing whether there will be a need, based on source term considerations, to require deviations from current regulations and regulatory review guidance documents for the ABWR. The results of the staff's assessment will be presented in the paper to be submitted on December 29, 1989.

7. Potential Use of Updated Source Terms to Modify Current Emergency Planning Requirements

The sizes of the present emergency planning zones (EPZ) were based on a number of policy and technical considerations including an examination of the consequences of both design basis and a spectrum of severe accidents. The spectrum of severe accidents was taken from WASH-1400 so that Reactor Safety Study (RSS) results on accident probabilities and consequences were considered in the recommendations on EPZs.

Updated LWR severe accident source terms reflecting the latest methodology have been utilized in the recently issued second draft for peer review of NUREG-1150. In comparison with RSS source terms, NUREG-1150 notes:

"Overall, the comparison indicates that the source terms in the RSS were in some instances higher and in other instances lower than those in the current study. For the early containment failure accident progression bins that have the

greatest impact on risk, however, the RSS source terms appear to be larger than the mean values of the current study and are typically at the upper bound of the uncertainty range."

For example, a comparison of RSS and NUREG-1150 results for a core melt with an early containment failure at the Surry plant show that the RSS release fractions are about three times greater than the mean values predicted by NUREG-1150 for the important volatile nuclides of iodine, cesium and tellurium. Although indicating that mean values of source terms for the early containment failure bins were somewhat over estimated in the RSS, NUREG-1150 also notes the large uncertainty in these estimates. In addition, while source terms for the most severe releases may have decreased somewhat, these sequences as well as the remainder of the spectrum of accident events can, nevertheless, result in doses within the EPZ that produce early health effects or that are in excess of the Protective Action Guide (PAG) values.

In view of the fact that EPZ sizes are based not only upon source terms but other policy considerations as well, changes to the existing requirements are not expected.

Future Staff Actions

1. The staff intends to study the issues related to decoupling siting from plant design for future reactors. A short-term study of about 3 to 6 months duration involving a small staff group will be performed to assess the issues and implications both regulatory and resource related, which could be substantial. Recommendations from this study will be presented to the Commission.

2. The staff intends to pursue potential source term modifications for LWRs based upon updated research insights. Revised source term insights would be used to modify, as appropriate, regulatory guidance for advanced light water reactors on plant design aspects such as containment isolation valve closure times, efficacy of fission product cleanup systems, and control room habitability. Short-term changes (e.g., fission product timing) are expected to be completed within about 6 to 9 months. Longer-term changes, such as questions of the chemical form of iodine, may take up to 2 years and may require additional research.

3. In the interim, the staff plans to continue to carry out its reviews of evolutionary designs in a manner that is consistent with current regulatory practice.

Coordination: The Office of the General Counsel has reviewed this paper and has no legal objection to it.

James M. Taylor
Acting Executive Director
for Operations

Enclosures:
1. Memorandum, Eric S. Beckjord to Thomas E. Murley, July 13, 1989
2. Memorandum, Thomas E. Murley to Eric S. Beckjord, August 21, 1989

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ENCLOSURE 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUL 13 1989

MEMORANDUM FOR: Thomas E. Murley, Director
Office of Nuclear Reactor Regulation

FROM: Eric S. Beckjord, Director
Office of Nuclear Regulatory Research

SUBJECT: SOURCE TERM ISSUES RAISED BY EPRI FOR EVOLUTIONARY ADVANCED LIGHT WATER REACTORS (ALWRs)

As requested, we have performed a preliminary assessment of the ALWR source term issues raised by the Electric Power Research Institute (EPRI). This assessment is independent of the staff positions given in the draft SER on Chapter 5 of the ALWR Requirements document, and is based on our view of the present state of research knowledge in these areas.

EPRI has listed source term issues as optimization subjects, which EPRI states are "technically supportable alternatives to current regulatory requirements that have been adopted by the ALWR Requirements Document." The EPRI source term issues cover six items as follows: (1) PWR spray additives, (2) fission product scrubbing by BWR suppression pools, (3) iodine chemical form, (4) fission product retention within the reactor coolant system (RCS) and natural removal mechanisms within containment, (5) fission product timing and (6) a proposed replacement for the in-containment release specified in TID-14844.

A table listing each source term issue, EPRI's position, and a preliminary RES assessment is attached. As can be seen from the table we (and the draft SER) are in essential agreement with EPRI with regard to Issues 1 and 2, deletion of PWR spray additives and fission product scrubbing by BWR suppression pools, based upon the issuance of revised sections of the Standard Review Plan (SRP) covering these areas.

For the remaining four issues, RES believes that Issue 5 (fission product timing) is the one where some relaxation could most readily be technically justified and furthermore that the potential plant impacts of relaxation (delayed isolation valve closure times and diesel generator start-up) would be likely to lead to improved equipment reliability and performance in these areas. As stated in the notes following the table, no rule change would be required for this change.

With regard to Issue 4, fission product retention in the reactor coolant system (RCS) has been found to be highly variable by plant and accident sequence and we believe it may be difficult to account for this in a generic way. Further, natural processes affecting fission product removal in containment (e.g., gravitational settling) are accounted for (although conservatively) in the recently revised SRP section 6.5.2.

With regard to Issues 3 and 6 (iodine chemical form and replacement of TID-14844, respectively), we believe that significant time (about 1 to 2 years) and staff resources will be needed to confirm EPRI's positions, or to provide the basis for a staff alternative. There are significant policy implications involved in a potential replacement of the TID-14844 source term, and we urge that piecemeal changes in this area be avoided without a full exploration of the potential impacts. Nevertheless, on the basis of significant severe accident research insights obtained over the past fifteen years, we conclude that the TID-14844 release has serious flaws, that technical revisions more in conformity with accident phenomenology and insights can readily be identified, and that the effort to revise it should begin.

In summary, we believe that significant justification exists for some relaxation with regard to fission product timing and that this could be implemented without a rule change. We also believe that the issues of iodine chemical form, and possible replacement of TID-14844, while considerably more resource intensive, should also be initiated. We would be pleased to discuss these items and to provide you with further assistance.

Eric S. Beckjord, Director
Office of Nuclear Regulatory Research

Enclosure: As stated

cc: V. Stello, Jr.

EPRI-ALWR Source Term Issues*
(Continued)

* Notes

1) With regard to Issues 3 and 5, TID-14844 does not address either the chemical form of iodine or the timing of fission products into the containment. These are given in Reg. Guides 1.3/1.4. Hence, these changes would not require rule changes.

2) There are other volatile forms of iodine than elemental iodine (e.g., HI). Effectiveness of charcoal filters for HI should be determined. Alternatively, we could tell industry what research studies are needed to support removal of charcoal filters.

3) With regard to Issue 6, the NOTE at the end of Part 100 refers to TID-14844 as "reflecting current siting practices" but that it may be used "as a point of departure". A legal interpretation may be required to determine if TID-14844 could be changed without requiring a change in Part 100.

4) Part 100 contemplates calculation of whole body and thyroid doses only. It is not clear if a rule change is required if other organ doses (e.g., lung, bone) are added. (Staff did this for Clinch River review, however).

5) If TID-14844 is revised, then sections in 10 CFR 50.34 (f) will also need to be revised, since 50.34 (f) specifically references TID-14844.

6) There is some staff sentiment that Part 100 should be revised to eliminate source term and dose calculations from siting (including early site permits). Efforts would then focus on a revised source term for a licensing design basis to assess the efficacy of engineered safety features, control room habitability, etc. This effort would be consistent with a recommendation of the Siting Policy Task Force (NUREG-0625) in 1979, and would be more compatible with the scope of the EPRI ALWR document that focuses on matters that affect plant design.

EPRI-ALWR Source Term Issues*

	Issue	EPRI Position	Preliminary NRC Staff Assessment
1.	PWR Spray Additive	Delete-not necessary	Agree (but pH control). See revised SRP 6.5.2
2.	Fiss. Prod. scrubbing by BWR suppression pools	Should be given credit	Agree. See new SRP 6.5.5
3.	Iodine Chemical Form	Little or no elemental iodine. Delete charcoal filters.	° Elemental iodine probably less important than presently indicated, but EPRI position presently unsupported. (See notes 1 & 2) ° Will require fair amount of confirmatory research (presently at ORNL) estimate 1-2 yrs.
4.	Fiss. product retention in RCS and natural removal mechanisms in containment	These should be accounted for in realistic fashion	° Fiss. product retention in RCS is highly variable by sequence ° Natural removal processes are conservatively allowed in SRP 6.5.2
5.	Fission product timing	Fission product release into containment in large amounts takes at least one hour after reactor scram	° Some relaxation justified, but don't agree with EPRI value (one hour) ° This could be implemented quickly (six months) (See Note 1)
6.	Replacement for TID-14844	Should be 75% noble gases 10% I, CS, Rb 4% Te, Sb	° TID-14844 could be modified within about 1-2 years, assuming availability of resources ° Don't agree with EPRI numbers ° This has major policy implications. (See notes 3,4,5,6)

ENCLOSURE 2

AUG 2 1 1989

MEMORANDUM FOR: Eric S. Beckjord, Director
Office of Nuclear Regulatory Research

FROM: Thomas E. Murley, Director
Office of Nuclear Reactor Regulation

SUBJECT: SOURCE TERM ISSUES BY EPRI FOR EVOLUTIONARY ADVANCED LIGHT WATER REACTORS (ALWRs)

Reference: Memorandum from E. Beckjord to T. Murley, dated July 13, 1989, same subject.

In the referenced memorandum, you provided your preliminary assessment of the six ALWR source term issues raised by EPRI as optimization subjects in the ALWR Requirements Document. NRR agrees with the RES assessment of the impact of these issues on both the evolutionary plant designs and the licensing process for ALWRs. We agree it is appropriate and, therefore, plan to pursue the relaxations proposed by EPRI as part of the ongoing licensing reviews for the ALWRs based on your recommendations. We agree that Issues (1) PWR spray additives, (2) fission product scrubbing in BWR suppression pools, (3) fission product retention within the reactor coolant system, and (4) fission product timing can be readily considered in our ALWR technical review without a major impact on past licensing precedent, and this will be done during the review process.

However, we also agree with the RES determination that Issues (3) iodine chemical form, and (6) replacement of the TID-14844 source term will have significant impact on licensing precedent and will require substantial resources to evaluate in an appropriate manner. We, therefore, concur with RES that an effort to research these Issues further should begin at this time.

We suggest a meeting between RES and NRR be held shortly to set out a course of action for this effort and to ensure close coordination between the two offices. I request that you work through A. Thadani and F. Congel on this issue.

Original signed by
James H. Sniezek

Thomas E. Murley, Director
Office of Nuclear Reactor Regulation

cc: J. Taylor