NUCLEAR REGULATORY COMMISSION

ORIGINAL

COMMISSION MEETING

In the Matter of: PUBLIC MEETING

BRIEFING ON SECY-81-240 - DRAFT NUREG REPORTS 0771 AND 0772 RELATING TO ACCIDENT SOURCE TERM ASSUMPTIONS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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PUBLIC MEETING

BRIEFING ON SECY-81-240 - DRAFT NUREG REPORTS 0771 AND 0772 RELATING TO ACCIDENT SOURCE TERM ASSUMPTIONS

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Nuclear Regulatory Commission
1717 H Street, N.W.
Room 1130
Washington, D.C.

Thursday, May 21, 1981

The meeting of the Nuclear Regulatory Commission was convened, pursuant to notice, at 2:05 p.m.

NRC COMMISSIONERS PRESENT:

JOSEPH M. HENDRIE, Chairman
VICTOR GILINSKY, Commissioner
PETER A. BRADFORD, Commissioner
JOHN F. AHEARNE, Commissioner

NRC STAFF PRESENT:

SAMUEL J. CHILK, SECRETARY
D. ROSS
M. SILBERBURG
W. PASEDAC
R. BLOND
A. KENNEKE
R. MINOGUE
R. BERNERO

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PROCEEDINGS

CHAIRMAN HENDRIE: The meeting will come to order.

The Commission meets this afternoon to hear a briefing from the staff on draft reports on accident source term assumptions. These matters were generated some time ago by the observation from several quarters that experience in accidents seemed to suggest that the standards accident source term assumptions were perhaps unduly pessimistic, and that we ought to take a look at those things again.

The staff was then asked to carry out an examination of what is around in the literature. They produced some draft report. The staff was on a fairly short time-leash, which may have had some effect on outcomes and so on.

Denny, you are holding the center position at the table, so let me turn to you and ask you to introduce the subject and go ahead with the briefing.

MR. ROSS: Yes, sir.

We prepared and sent down an information report, dated April 15, 1981, under the title SECY-81-240, which very briefly summarizes both the documents, NUREG-0771 and NUREG-0772.

What we had intended to do this afternoon in the approximate hour and a half schedule is to have three speakers. The first speaker will be Mel Silberburg, who will discuss the longer technical bases report. We estimate that this will take about half of the time.

The remaining half will be divided into halves again, to discuss the companion report on regulatory impact of NUREG-0771. The first speaker to speak on that will be Walt Pasedac from NRR, and the last speaker in the presentation will be Roger Blond of the Office of Research. Roger was one of the co-authors of the 0771 report.

As questions come up, it may be that any of these three gentlemen would be the appropriate respondee. So we are proceed that way, if that is all right with the Commission.

CHAIRMAN HENDRIE: Okay, Denny.

MR. ROSS: Mel will proceed.

CHAIRMAN HENDRIE: Feel free to speak vigorously, Mel.

MR. SILBERBURG: First slide please.

Draft NUREG-0772 was prepared by three of our major contractors in this area, Battelle-Columbus Laboratory, Oak Ridge, and the Sandia National Laboratory, along with some of the staff from NRC -- in research particularly Mr. Richard Sherry, Mark Cunningham, and Charles Kelber, in NRR, Walt Pasedac.

Next slide please.

In meeting the objectives shown on the slide, there are the three major accomplishments that we feel came out of the study -- two came out of the study. The first one was that we were able to respond with a very short turn-around time, and we were able to do this because we had a research program in place, and the researchers knowledgeable in these areas to be able to do this in that kind of a time schedule.

The report provides a summary of our state of knowledge at this point, and puts it together in one place.

Finally, and perhaps most important, the report provides bases and a framework for developing accident source terms in the regulatory process, and you will hear about that later.

Also very important is that it provides a focus for the research programs. As you will hear later, this document we feel is a major planning tool for our research program.

Next slide please.

The technica issues which provide the background for the report are shown on the next slide. As you might recall, there were four.

The first issue had to do with the chemical form of radio iodine under accident conditions -- is it cesium iodide with its properties, or is it elemental iodine?

The second issue dealt with, if indeed it was cesium iodide and not elemental iodine, would this mean that the iodine release was perhaps over estimated, and possibly by orders of magnitude.

Third, if indeed it were cesium iodide, would the ASFs be effective for the actual iodine behavior, rather than elemental iodine.

Finally, are the source terms, namely, the aerosol source terms which include all of the fission products that were used in past risk evaluations, perhaps one to two orders of magnitude greater than that which might be realistic for coremelt accidents.

COMMISSIONER AHEARNE: What is ASF?

MR. SILBERBURG: Accident Safety Features.

The next slide please.

The technical scope of our studies described in the report included accident sequences and then a number of areas which if one were to trace the sequence of an accident of fission product released in transport through the system, one would be going from release from the fuel in the core, associated chemistry involved at that point, transport in the reactor cooling system, transport in containment, through containment, and then the consideration of how the engineered safety features would perform under these conditions.

Under accident sequences, we chose accident sequences of the following type: We started with very low releases at terminated LOCAs to various degraded core accidents, such as TMI II, such as partial melted accidents where the accident was then terminated, and finally the coremelt accidents that are considered traditionally in WASH-1400, typically the ones that dominate risk.

I want to point out that as one traces through these various areas, in a number of cases we actually performed calculations and studies that went beyond what was the state-of-the-art at that time. A number of additional studies were done specially for the report that went just beyond the data base, using the calculational tools that we have.

I also want to point out that even though there appears to be a lot of time spent on the chemistry of cesium iodide, probably because one knows more about those than the other fission products, we nevertheless dealt with the other fission products in terms of the aerosols, which is when the solid fission products would be likely to behave during any accident sequence as we move out. So, again, I just want to note that to that extent the other fission products were covered.

Next slide please.

A number of people looking at the report at a quick glance and perhaps others might be led to believe that again most of the calculations represent a repeat of WASH-1400.

Again, I want to note that this was not the case, a shown in this slide, from thermal hydraulics to fission product release estimates from melting fuel and fission product transport in the various systems, the report represents a significant extension beyond WASH-1400 methodology, not only in data base relative to aerosols, but certainly in the methodology that was used. Although, as you will see later, I certainly do not want to leave the impression that the methodology is by any means at this point fully developed or verified.

The next slide please.

The first summary of our major findings on this slide pertain to findings and conclusions relative to the chemical of iodine and how it might impact iodine release. We found that we would expect, based on the studies, that cesium iodide as we moved away from the core to the primary system, towards the containment, that the conditions attendant to the accident, based on chemical thermo dynamic calculations, cesium iodide would be expected under those conditions.

We then proceeded from that point and looked at how cesium iodide and iodine might behave when one now took into account that particular fact and looked at a variety of accident sequences.

If the transport is through a water bounded primary system, basically like the TMI II, we would expect very low iodine releases regardless of the form. In either case, one would expect a low release.

We found that for some severe accident, there would be a high retention in the primary system for cesium iodide and, hence, a low release of iodine into the containment.

For other sequences, our calculational procedures found no difference. I want to point out, particularly here and in the next slide, that there are large uncertainties in the calculational procedures that are being used here, in the calculational models. So some of these effects may indeed be masked by that, but it is that area that is one of the major subjects of our fission products research program.

CHAIRMAN HENDRIE: What sequences would you say don't affect the retention?

MR. SILBERBURG: The sequences here where the temperatures of the primary system surfaces are high, higher than other sequences, perhaps like TMLB prime.

COMMISSIONER GILINSKY: You are talking about fuel temperatures?

MR. SILBERBURG: Primarily surface temperatures.

In other words, as we move away from the core, looking at opportunities for the cesium iodide, because of its low volatility, to deposit in the primary system, away from the core and in the primary system.

CHAIRMAN HENDRIE: Those have to be dry sequences, don't they?

MR. SILBERBURG: Yes.

MR. ROSS: The sequence that Mel just mentioned for PWR, the primary system would be boiling dry intermittently through the relief valve, and the primary pressure would be oscillating between 2400 and 2500 pounds, depending on the system. There would be a lot of core damage as the liquid level boiled down passed the top of the active fuel.

So there would be a lot of fuel damage where the only thing above the fuel to the release point would be vapor, super-heated vapor. Under those conditions, I would say the metal temperatures would be around 600 degrees Fahrenheit, give or take a bit, depending on what the super-heat temperature was.

If you follow that sequence far enough, there is a point where the melt would drop into the vessel and on down to the vessel, but there would be substantial failed fuel while the primary metal surfaces were still hot. But then once the vessel fails, there would be a big decompression and an influx of cold water from the core flooding tank system. I think it would be dependent on before or after vessel failure, you would get two different answers.

But that definitely would be a dry release except for steam.

COMMISSIONER GILINSKY: Do you have any sense for the size of these two classes? Is one significantly smaller than the other, or do you regard them as in some sense comparable?

MR. BLOND: From a very cursory analysis, and this at this point would have to go into much more detail, but from a very cursory analysis, there are still sequences which give very large releases and the probabilities are not significantly modified from what our previous practice would be.

CHAIRMAN HENDRIE: Of the basis of what?

MR. BLOND: Of groupings of accidents.

CHAIRMAN HENDRIE: On the basis of calculations as done for this study.

MR. BLOND: Yes.

COMMISSIONER GILINSKY: What is it that is not modified?

MR. BLOND: The probabilities associated with various categories or melts of radioactive material which could be released.

COMMISSIONER GILINSKY: Looking at all sequences in the aggregate?

MR. BLOND: Yes.

COMMISSIONER GILINSKY: Some have moved up, and others have moved down, or perhaps some have moved down, but it did not affect the total significantly?

MR. BLOND: Not significantly.

COMMISSIONER GILINSKY: I see.

Let me ask one more question. This is because there wasn't much change to the iodine calculations, or because there are other radioactive --

MR. BLOND: There are still dominant sequences which just have not been impacted.

COMMISSIONER AHEARNE: You are saying, it would have to be in sequence three?

MR. BLOND: Yes.

COMMISSIONER AHEARNE: You are saying that those sequences in that third category, there are still some --

MR. BLOND: Which are dominant in terms of the probabilities. But, again, this is a very preliminary look that has been taken. It will be design dependent in many ways.

COMMISSIONER GILINSKY: Let me ask you this. What if iodine were removed from the problem entirely, what would be the effect?

MR. BLOND: We do have a slide on that.

COMMISSIONER GILINSKY: Okay, we can wait for that.

MR. BLOND: We can bring it up now, if you would like.

CHAIRMAN HENDRIE: Why don't we get to it during the course of the presentation?

MR. BLOND: Okay.

CHAIRMAN HENDRIE: If we get too far afield here, we will lose the thread of Mel's discussion.

MR. SILBERBURG: The final point here is that if retention in the reactor coolant system were not influenced by chemical form, then we were just dealing with how it behaved in containment, then for early containment failure type risk dominant sequences, again we would expect no difference because cesium iodide now being a solid and working along with the other aerosols, there is not enough time for early containment failure sequences to allow the cesium iodide to be removed by the aerosol.

In other words, aerosols, you need lots of them but you also need time, and particularly when you get into the larger the building, the longer the time, so the larger the space.

CHAIRMAN HENDRIE: Why do you assume the cesium iodide is in aerosol form in the containment?

MR. SILBERBURG: The temperature in the containment is low enough, compared with the vapor pressure of cesium iodide, it should be in a condensed state at that point. It should be a solid at that point.

CHAIRMAN HENDRIE: Yes, but that suggests to me very rapid plating out on the assorted large surface area at lower temperature in the containment, rather than all of it simply magically becoming aerosol.

MR. SILBERBURG: The competing process of plate out is certainly there, but it turns out, again because of the large surface to volume ratios involved for the building versus the aerosol, it would prefer to go to the aerosols if there are enough of them there.

CHAIRMAN HENDRIE: Enough of what?

MR. SILBERBURG: If there are enough aerosol surfaces, large enough aerosol concentrations for the cesium iodide to deposit, to agglomerate along with the other solids. We have had calculations that have shown that if you wait for plating on surfaces, it is generally much slower than the nominal aerosol regime that we are dealing with here.

COMMISSIONER AHEARNE: There are experiments?

MR. SILBERBURG: Yes.

This is quite a background in that aspect of the problem.

COMMISSIONER AHEARNE: You have experiments with cesium iodide in that temperature?

MR. SILBERBURG: Not with cesium iodide, not yet; but other aerosols that would behave similarly, just looking at aerosol physics in general. The experiments that you are discussing are those that remain to be done, but they certainly are important. For example, we have seen that with sodium iodide.

Let me move on to the next slide, which deals with a summary of findings that are related to aerosol behavior, which was the third background issue.

Here, again, we find that certain accident sequences that were studied in the reactor safety study, indeed may have been overestimated, that is, the release of fission products and, hence, the source term may have been overestimated because of additional attenuation within the primary system.

Again, I want to point out that this was a very preliminary calculation done late in the study, using some of our aerosol tools. But there are large uncertainties here because the methodology that we are developing for the primary reactor coolant system has to couple the aerosol models and thermo-hydraulics and other physical properties together. This is currently in process, or currently starting.

We made, if you will, some artificial calculations to see, what if we had lots of aerosols and lots of time or little time in the primary system, and we get two different results. One, namely, where the steam flow rates are low, there is high residence times and high aerosol concentrations in the primary system, likely to get glomeration, larger particle growths and settling in the system.

In those sequences where the residence times are low, again this very simplified calculation would indicate that there would be no or little retention of aerosols, and under those circumstances, for those sequences, we would find that they generally agree with the Reactor Safety Study estimates.

Finally, I think it is important to point out that for those conditions where the containment is intact, and the containment engineered safety features are operational like the sprays, we would expect extremely high attenuation factors, indeed greater than 10 to the 5th for severe accidents.

The next slide please.

CHAIRMAN HENDRIE: Is it clear that the same is not the case where containment leakage is going on? Containment failures come in various forms, but the likely ones are the development of leakage paths through open cracking in concrete and tears in liners. So that the leakage paths themselves are not big holes but rather probably a substantial number of fairly narrow apertures. I think in that kind of case, you once more get pretty high attentuation factors.

MR. ROSS: Yes.

MR. SILBERBURG: For those conditions, we would expect high attenuation factors. Defining those conditions is related to the subject that we refer to later as containment failure modes, and some work is going now in the research program just started.

That is, if one can define the failure modes and get some feeling for those in terms of containment response and locations, then one may be able to take credit for the leakage path attentuations that you refer to. But this, again, is in the ver early stage because of the difficulty in defining just how big was the break for containment failure.

On the next slide, we find a summary of the major areas of uncertainty and limitations in both the data base and the methodology. Many of them we have already referred to in the discussion today.

These same areas of uncertain and limitations are the same areas that are now being addressed in our research program and being given emphasis. There are some other areas. For example, the effect of suppression pools on trapping, we think that is another very important area.

We have been having discussions with the General Electric people, and they indicated that they may wish to do some work in this area, but this is still at an early stage. Again, we would certainly encourage that type of work. That is another area where potentially large aerosol attenuation could occur.

Again, I have noted here containment failure modes which was a question that you raised.

The follow-on studies that we have identified from the report and the review of the report, the ones shown here, by near-term we mean that we expect that we can get them done within the 12 to 18 months, in a timeframe that is consistent with and responsive to the early phases of the rulemaking process.

What we will be doing is updating the source term estimates for a range of accident sequences in trying to define the level of uncertainty. What we will be doing is coupling the analysis as best we can with the tools available, while the research program is ongoing, trying to improve these tools, starting with release from the fuel, working down to the primary system, and into the containment -- what we call the coupled analysis -- so that we will have what we think is a best estimate to this point.

We did not have sufficient time during the course and the timeframe of the study to do that coupled analysis, but we believe that it is very significant.

COMMISSIONER AHEARNE: Mel, you used the phrase just now, and it is in the SECY paper, "in a timeframe consistent with the rulemaking schedules." Could you be more specific; do you have some timeframes in mind for developing the source term estimates, and so forth?

MR. SILBERBURG: The timeframe for the updated source term would be about 12 to 18 months, and that is what I meant by "consistent with" the front-end of the rulemaking process, as I understand it. These are the degraded core cooling, minimum engineering safety features, siting, and emergency planning.

MR. ROSS: Commissioner Ahearne, let me bring you up to date on what had been called the "Long Term Rule" at one time.

There was a steering group that has a life of about six months, the Degraded Core Cooling Steering Group, and it issued its report to EDO last month. One of the enclosures of the report was an action plan that was supposed to be an effort that would help produce at least the rudiments of a rule, that would help decide whether we needed more prevention or more mitigation, or both, and, if so, for future plants or for present plants.

We are in the process of engaging Sandia to do some work consistent with the action plan that was in that report to EDO. The work, I believe, will start in June and it will take about seven or eight months.

It is supposed to study in a systematic way different ways to reduce risk by preventing coremelt, different ways to reduce risk by mitigating the effects of coremelt, and looking at the cost of these different ways, including the features not yet incorporated anywhere, such as core catchers.

We believe that work will help us in mid-82 to focus on the rule. I can only surmise that the complete rulemaking, for which we have comments from the advance notice proposed rulemaking, is several years away. I would be surprised if it were completed by 1984 or 1985.

Some of the technical bases for this rulemaking will be needed on the time scale that Mel was talking about.

I don't believe we have a precise date as to when we would come back to the Commission with a proposed rule, but it will not be in the next 12 months, it will be after that.

COMMISSIONER AHEARNE: The updated source term development is that something separate from the Sandia effort?

MR. ROSS: Yes. One of the features to be studied in the Sandia study would be a filter vented containment, how much does it cost and what does it do to reduce risk. In order to do that study accurately, one would need to know what is the chemical specie subject to being filtered and vented. So it is an interactive piece of work, but contractually it would be separate.

COMMISSIONER AHEARNE: The updating of the source term is being done under a single effort?

MR. SILBERBURG: It is being done within one of our on-going research programs.

COMMISSIONER AHEARNE: Is it a separate contract to someone?

MR. SILBERBURG: Part of it would be part of their on-going work, part of their tasks.

COMMISSIONER AHEARNE: Being done by?

MR. SILBERBURG: At this point that would be done by Battelle-Columbus.

COMMISSIONER AHEARNE: It has not started yet?

MR. SILBERBURG: It will be starting soon.

MR. ROSS: The Sandia work that I am talking about has not been started.

COMMISSIONER AHEARNE: You expect the Battelle-Columbus work to finish somewhere within 12 to 18 months?

MR. SILBERBURG: Yes, on this subject.

MR. MINOGUE: Commissioner Ahearne, if I may. There is a related rulemaking that has not been discussed, which is on an earlier time schedule, and that is the demographic siting rulemaking, which is required by statute. That is a much more manageable problem, and that is on a time scale that we look to come to the Commission with a proposed rule at the end of this year.

That rule would not deal with many of the issues discussed here, but it certainly would deal with the elimination of the TID 14844 model and with an assessment of protective action capabilities as they would relate to different scenarios strictly in relationship to demographic factors. We were required to do that by legislation last year. It is a manageable subset that is on an earlier timeframe, and on which a great deal of work has already been done primarily by Sandia.

MR. SILBERBURG: The main point here and on my next slide --

COMMISSIONER AHEARNE: Before you get to the next slide. Bullet one was Battelle-Columbus. Bullet two?

MR. SILBERBURG: Bullet two would also be Battelle-Columbus in terms of identifying the sources of uncertainty from the specific calculations that they have made for the updated source terms.

COMMISSIONER AHEARNE: So, then, that would take longer than the 18 months?

MR. SILBERBURG: It would be done in the same timeframe, as it is basically a subset of it.

The same source terms then allow us to proceed to the third item, which is again updating the radiation source terms for safety related equipment and instrument qualifications under post-accident environments, which would follow on from that.

Finally, we will conduct as detailed review as we can of the past reactor accident experiences in the context of our modeling, and in the context of our data base, to see whether or not there is we can get information that will help evaluate the models for those situations.

COMMISSIONER AHEARNE: You did not do that in connection with this?

MR. SILBERBURG: No, we did not do that. The 0771 report looked at past reactor accidents briefly. We did not get into that in this report.

COMMISSIONER AHEARNE: Any particular reason?

MR. SILBERBURG: Just a matter of time and priority.

COMMISSIONER AHEARNE: How would you do this review of past reactor accidents?

MR. SILBERBURG: We will go back and --

COMMISSIONER AHEARNE: I meant, will it be internal staff, or contract?

MR. SILBERBURG: It will be by contract.

COMMISSIONER AHEARNE: Do you have one chosen?

MR. SILBERBURG: We have not. Right now we are trying to select one.

COMMISSIONER AHEARNE: What kind of a timeframe?

MR. SILBERBURG: Same timeframe.

COMMISSIONER AHEARNE: The 12 to 18 months?

MR. SILBERBURG: Twelve to 18 months.

COMMISSIONER AHEARNE: All right.

MR. SILBERBURG: My next slide, again, shows two levels of research in terms of a timeframe. The first, we project additional research results becoming available prior to the completion of rulemaking.

COMMISSIONER AHEARNE: In this case, by completion of rulemaking, are you talking --

MR. SILBERBURG: In the context --

COMMISSIONER AHEARNE: We have just seen a spectrum of one year to five years.

MR. SILBERBURG: On the longer.

COMMISSIONER AHEARNE: Somewhere within the next five years, you expect to get these?

MR. SILBERBURG: The first listing that you see, we see as a two to three year timeframe. The lower one, which emphasizes the verification of the methodology, we see that as longer than three years, because they involve considerable experiments that we have not done before.

COMMISSIONER AHEARNE: In thi first category, are these efforts that you already have under contract?

MR. SILBERBURG: Yes. These are a part of the on-going program that is in place now.

CHAIRMAN HENDRIE: Let's see. There appear to be several sets of vuegraphs and hand-outs. He got his from te back of the room.

Sam, would you get the other Commissioners some from the back of the room, so that we are not unnecessarily handicapped against the rest of the audience.

COMMISSIONER AHEARNE: I don't think that just getting slides would do that.

(General laughter.)

COMMISSIONER AHEARNE: Do you have contracts, then, underway for the first set?

MR. SILBERBURG: Yes, for the first set, and they are part of the on-going program.

Finally, on my last slide, I have listed here a number of key areas for my long-range research program that have a very strong and close relationship to the accident source term work.

These areas are closely related to the accident source term work, and for that reason they are being refocused and their emphasis is being re-evaluated in the context of many of the conclusions and the findings of this report.

As I noted earlier, we feel the report is a major planning tool for our long-range research program in these areas and, hence, we feel that in that regard it is very important. There is a very strong interaction between these programs and the accident source terms.

Thank you.

COMMISSIONER AHEARNE: Mel, you had this document reviewed during a several day meeting?

MR. SILBERBURG: Yes, I should have mentioned that. It was reviewed by the ACRS early in March. We had a peer review group meeting on the 17th and 18th of March. We then allowed the reviewers to provide written comments by April 1st.

We received written comments from 27 reviewers, over 160b pages of comments, very good, very worthwhile comments, which we are addressing in our revision to the report. Also, we will be providing a summary in the report of our responses to the comments.

COMMISSIONER AHEARNE: When do you expect that document to be ready?

MR. SILBERBURG: We should be going to press the first week of June. So, depending on how long it would take, in mid-June or the third week of June, it ought to be available in hard copy.

COMMISSIONER AHEARNE: Can you give a sense of what those comments were? Were they just a large number of separate comments --

MR. SILBERBURG: Back to vuegraph No. A-15, please.

The main comments from the review touch upon many of the main points that I made, and many of the areas where there are large uncertainties in the data base and the methodology. I have listed what we think are the most important at this point in terms of their impact. Most of the comments were very specific, very technical, and not general.

I think, basically, all the comments reflect the bottom line that we have got a good start, but we need lots more information.

COMMISSIONER AHEARNE: That was sort of where the ACRS came out.

MR. SILBERBURG: Yes, that is where the ACRS came out.

MR. ROSS: We will move to the companion report now, starting with Walt Pasedac, discussing the regulatory impact of NUREG-0771.

MR. PASEDAC: Would you put up the first vuegraph, please.

This companion report, in contrast to the previous report that you just heard about, which I will refer to as the technical bases report, was written by the staff, in addition to myself, Roger Blond, from the Office of Research, was one of the co-authors, and Michael Jankowski, formally from the Office of Standards Development.

The purpose of this report was to assess the impact of alternative source terms on past licensing practice. That is, the question, has past licensing practice resulted in any distortion of the design as a result of past requirements, the impact on currently regulatory requirements, and on future requirements as they are contemplated now in the rulemakings.

May we have the next slide.

The areas that we considered in this report were, first of all, a look at the historical development of source terms in accidents or resulting from accidents. We started with the famous TID 14844 document.

We tried to examine the basis, and we saw that there was some experimental information available at that time, about 20 years ago. There was some accident experience available which apparently had not been relied upon, at least not explicitly, but quite apparent from the beginning was a strong trend to attempt to be conservative. So there was a philosophy to try to develop upper bound source terms.

The current regulatory requirements, I will address a little bit more in the following slides. We looked primarily at the impact of this new information on source terms or any changes in assumptions would have on the current staff practice.

We took a look at the recent developments. We did examine the TMI experience, as well as some other accidents for which we had a little bit more information. In general, there is very little hard data on accidents, and we found this to be true for TMI as well.

The fission product release information that you could derive from TMI is virtually inconclusive, by that I mean, if we look at the staff's calculation of this kind of an accident.

We had published, prior to the accident, of course, an environmental report which discussed accidents and supposedly treated them in a realistic way in the safety evaluation, which of course is done in a very conservative way, so the values used in these two evaluations very neatly bracket to the TMI experience on the upper and on the lower sides, and TMI is somewhere in-between the environmental statement analysis and the safety analysis.

We took a look at how this information would affect the rulemakings. By that I mean, the rulemakings on siting, on the minimum engineered safety features, and the degraded core, as well as the emergency planning rulemaking.

For our technical information in this report, we relied primarily on the technical bases report that you have just heard about.

Could I have the next slide.

In addressing the current regulatory requirements, we tried to identify the places where source terms from accidents come into play, and they do affect the whole concept of the current regulatory requirements, namely, the defense and depth approach starting from design and going to the operation of the plant, the siting, and the last back-up, the emergency planning requirements.

On this slide, I have listed some of these criteria which are on the books or in reports and regulatory guides and they are discussed in greater detail in the report.

The one thing that we paid particular attention to, and which I will refer to later, is the design of engineered safety features and how this would be affected by changes in the source term assumptions.

As you know, the way in which the staff applies these criteria is to postulate a set of design basis accidents. If you will look at the next slide, you will find a description of how one would characterize design basis accidents.

They tended to be conservative, at least we think they are conservative in the way in which we postulate them. They are usually non-mechanistic. We don't say how it happens, we just say that it happens.

They are also characterized by looking at or emphasizing one part of the whole problem, rather than looking in detail at all the aspects of the problem. So we have, what I call here, surrogates, and the iodine is one of those surrogates.

We look in great detail, or have a lot of requirements concerning the calculation of iodine release and behavior following the accident. For example, when we consider aerosols, we have none, and that is based on the assumption that is made that as long as we take care of the iodine, we will have taken care of protecting against aerosols as well.

The kinds of accidents that we postulate, I have given a few examples. There are smaller events, like a fuel handling accident, or a steam generator tube rupture, and then an upper-bound loss of coolant accident, and even there we have different loss of coolant accidents postulated.

There are some postulated for emergency core cooling design purposes.

The one that I am referring to in this discussion is the first one, the siting DBA in which we postulate a release of 100 percent of the noble gases, and 25 percent of the iodines available for leakage from the containment, and no aerosols, as I indicated. Of course, we do assume that the containment stays intact.

When we try to now fit this new information that is available in the technical bases report into this concept of how we treat accidents, it doesn't really work very well.

We have tried to just look at what would happen if you substitute cesium iodide wherever elemental iodine appears, and it does not make sense if you do that, partly because these accidents are postulated and they are hypothetical, so that the conditions do not match necessarily those which would have to exist in order to have cesium iodide.

For example, Mel mentioned that the cesium iodide would tend to be in an aerosol form, and it would tend to associate with aerosols in the containment. Well, we have no aerosols in this accident, so we don't know how to treat cesium iodide in a design basis accident concept.

We very early realized that there was no way to fit this into the existing structure. So what we did was to look at what you have to do in order to take account of this new information. This is what you see in the right-hand column.

We realized that you would have to specify a spectrum of accident conditions, and you would have to analyze the different accidents, hopefully on a realistic basis, mechanistically, and you would combine their importance in a probabilistic method.

For the sake of the discussion, we have postulated five groups of accidents, which are described in greater detail in the report, which could accomplish this purpose.

In this accident spectrum, we could, then, realistically determine the curies released, the temperatures associated with it, the oxidation potential, and so forth, so that we could then determine what the form of the iodine and the other fission products would be.

If we were to consider such an accident spectrum rather than just a single design basis accident, one obvious question is what would happen to the engineered safety features which were designed for that single design basis accident.

We have taken a pretty good look at that, made a careful examination of that issue.

On the next slide you see a summary of our finding on that issue. We have looked at the engineering safety features that are listed on the left.

The slide that is titled "Summary of ESF Effectiveness," and I believe it is listed in the handout, sir, if you would look at your papers I will discuss it from there.

There are several engineering safety features list on the left. We have examined containment of course as the primary one, the contrinment spray, suppression pools, ice condenser and so forth. In each case we have looked at what would happen and how effective would that system be.

COMMISSIONER AHEARNE: How do you measure effectiveness in this?

MR. PASEDAG: The measure of effectiveness is how well does it perform by comparison over this design basis. You know, all of them are very effective for the design basis accident because that is what they were designed for by definition.

So we looked at their effectiveness under conditions which could go on either side of that design basis for different accidents in the same category and for more severe accidents all the way thrugh that spectrum of accidents that we have discussed which ranges from small to severe.

COMMISSIONER AHEARNE: Some of the accidents you looked at could be characterized as beyond the design basis?

MR. PASEDAG: Yes, definitely. Yes. The other thing that we looked at was how the effectiveness would change if we were to assume cesium iodide rather then I_2, for example, or if it were to include aerosols in the source term.

Now, I have characterized the effectiveness of these various engineering safety features and I have given an indicator here for the range. By that I mean how far can we go beyond the design basis before this system ceases to be very effective? So that is what I mean by range.

We found that the containment of course is highly effective. The range is high and this is taking into account the recent information concerning steam explosions. Prior to that perhaps the range would be a little bit less, prior to these recent findings concerning the likelihood or reduced probability for steam explosions.

We found also that containment sprays, suppression pools and ice condensers are all very highly effective even if you go beyond their design basis. For example, a containment spray system is designed to remove iodine, but it also removes very effectively aerosols, cesium iodide and any of the other fission products. This would be true whether or not the containment is entirely effective whether we postulate some containment failure or not.

So the range is also very high. We can go way beyond the design basis and that system will still provide high prtection against the fission products.

The same is true for suppression pools and ice condensers, although these systems were not specifically designed for fission product removal primarily but heat removal as the first design basis. Neverthless, they are effective and they are essentially passive systems. So their range again is very high. You can postulate more severe accidents and they will still function.

Some of the other engineering safety features which we currently have on current plans such as a secondary containment, the reactor building for example on a boiler, filter systems in the auxiliary building or main steamline isolation and our bleed collection systems on boilers, these we have marked medium in effectiveness in range because they are effective all right but they treat primarily one leakage path. If you postulate a different accident that would bypass that leakage path, then of course they would lose their effectiveness.

The one system that is marked with a low effectiveness and a low range are internal containment recirculation filters, charcoal filters that is, which we have on only a very few of the older plants.

These systems are designed for iodine removal and if you postulate the iodine to be in a cesium iodide form, for example, then charcoal filters would not be very effective, of course. So this particular system would not be effective beyond its design basis. However, that system is not used by itself. For example, we have a containment spray system in conjunction with this.

So when you take the whole package of engineering safety features, it turns out that they are quite effective against fission products other than iodine and for a wide range of accidents that you could postulate, not just a design basis.

So our findings could be summarized like this. The current practice of single design basis accidents postulated for siting and engineering safety feature design cannot really accommodate the new information that was generated in a technical basis report concerning source terms. In order to do that you would have to postulate a spectrum of fission product releases under various accident conditions.

The current set of the regulatory requirements for protection against iodine releases has resulted in effective protection against other fission products as well as I just described.

COMMISSIONER AHEARNE: You say all fission products?

MR. PASEDAG: Yes.

COMMISSIONER AHEARNE: You are pretty confident?

MR. PASEDAG: Yes, because they would be either aerosols or in a vapor form.

I perhaps should be careful there. The one area where our requirements might have to be re-examined is with respect to the fission products in the sump water. We have not postulated any aerosols in the old TID source term beyond one percent which is assumed to be in the water and that would have to be re-evaluated.

The recommendations which are contained in this report are summarized on the next slide.

The first is that we need to develop a mechanistic spectrum of accidents and source terms for the future regulatory requirements in order to take into account the information that we now have.

COMMISSIONER AHEARNE: Well now, how far would you be planning in that recommendation in carrying this mechanistic approach, going back to specific failure sequences and then calculating down the line given this particular sequence and then this is what kind of a source term would be expected?

MR. PASEDAG: Yes. It is more or less what was done in this technical basis report. Obviously there are an infinite number of squences you could postulate so you have to sort of group them as was done in WASH-1400 and we have suggested a grouping in this report as well.

MR. ROSS: The framework for that work should flow from the minimum engineering safety features rulemaking. That would be an ideal time to decide whether the sprays ans filters and other items generally under the umbrella of GSF need supplemental criteria or whether the existing criteria are adequate.

COMMISSIONER AHEARNE: How are you going to go about doing this first stuff?

MR. ROSS: We had it planned, and when I say "we" I am referring to the degraded cooling steering group, that the MESF, the minimum engineering safety features process, would have to go hand in hand with the long-term rule on degraded cores.

When I say "hand in hand," now whether they are actually physically part of the same rulemaking process or whether they are separate but equal in time, I don't think we have decided yet. We will need a lot of information of the sort that Mel was talking about on characterization of fission products, such decisions as if you have an internal filter which portion of the filter is going to trap what, and, as Walt said, in terms of the circulating activity, what is the chemical form and how will it affect pumps outside of containment and simply things like radiation damage on pump seals and leakage rates if these seals degrade.

We don't have a precise plan. It is more of a light, a dim light at that at the end of a very long tunnel that looks like it will be time-wise parallel with the degraded core rulemaking.

COMMISSIONER AHEARNE: Won't this be a fairly significant major effort?

MR. ROSS: I think so, yes.

COMMISSIONER AHEARNE: I would think you would either need to allocate a large amount of NRC staff or else have some fairly major contracts.

MR. MINOGUE: The key first step in this is the development both by analysis methods and developing analysis methods and experimental work to get a much better handle on complex transients and fuel behavior and fission product behavior.

We have in the long-range plan and currently underway a very extensive experimental program and methods development program for the various computer codes to deal with that. That in a sense is input into the risk assessment work much of which is also going on concurrently in terms of the developing methodology and the developing techniques that are coming out of some of these complex analyses of systems. All of this kind of comes together to get a better handle.

The track by which I see this information feeding into the rulemaking is through the medium of risk assessment. We are developing the data base and techniques to apply risk assessment as a tool to make the kind of decisions that these gentlemen are talking about and applying it to the design of plants and requirements for the regulations of plants.

COMMISSIONER AHEARNE: Bob, I am missing something then. That sounds like what you are saying is you have a research program which has a number of individual pieces which downstream you can see beginning to mesh together to give this underlying background.

I thought this was perhaps a more specific task to really develop this spectrum of accidents laying it out in specific sequence from beginning events and so forth. That sounds to me like it would have to be some actual contract or project assigned to a specific group to develop.

MR. MINOGUE: A lot of that kind of stuff of course has been done in the licensing process. These people have looked at some of the specific sites after TMI.

COMMISSIONER AHEARNE: Crystal River.

MR. MINOGUE: I was thinking specifically of Indian Point and Zion. That is a major piece of input and I think it should be recognized as that.

Similarly in the nearer term rulemaking on the siting, it is the same kind of stuff only done in a more generic basis looking at various accident sequences and consequence models in terms of demographic capabilities. That is all current activity that throws light on these various scenarios. That is done before the longer term thing that we have just discussed.

COMMISSIONER AHEARNE: But is it your intent to have a specific group either internal or external develop something that would be this mechanistic spectrum of accidents and source terms?

MR. MINOGUE: At different stages different people. The immediate answer is yes. In terms of the siting rulemaking it would be the group to which that is assigned. Much of the work on that today has been done by NRR and they farmed at lot of this out to Sandia.

I guess in the longer term we haven't quite reached the stage of deciding exactly how we are going to implement some of this stuff.

COMMISSIONER AHEARNE: I guess what I am concluding is that you do not intend to have any specific document or set of volumes and end up saying here we have gone through all this work and this is now the spectrum of accidents and the sequence starting from these events and if those events happen these events happen, et cetera, et cetera.

MR. MINOGUE: We may well do that but I don't have anything like that planned today. It is a very complex structure that goes over a number of years. In fact, from the very beginning not only within the staff but from outside a lot of people commented on the extreme difficulty to assess such activity.

COMMISSIONER AHEARNE: It sounded like a very major undertaking.

COMMISSIONER BRADFORD: This work, incidentally, really has its basis in the Reactor Safety Study and the subsequent work.

COMMISSIONER AHEARNE: It sounded like it was follow-on work.

COMMISSIONER BRADFORD: Well, in the subsequent work the IREP questions all focus on this specific issue.

COMMISSIONER AHEARNE: Roger, I am not questioning that there is not a lot of work around that has bearing on it. This sounded like you had said how we are going to pull it all together.

MR. PASEDAG: Well, my last point there is that we have been discussing the implementation of these recommendations in the new rulemakings. We have gone a little step further. We have looked whether there is an urgent need to do something quickly now, to apply some Band-Aids here or there, to prevent going off in our own direction.

We find that there is really no urgent need for any interim measures prior to a consistent implementation of these concepts through the rulemakings. This is based primarily on our finding that these past requirements are inadequate or insufficient, as they may be judged, but nevertheless have resulted in a pretty good set of safety features.

Now, we thought that you would be very much interested in the impact of this information on the subject of emergency planning and Roger Blond is going to address that next.

COMMISSIONER AHEARNE: Before he starts, could I just put a question to the side. At some point could you refer me to where in the documents I would find this set of sequences that would show me that here are the ones with still the high probability such that they continue to dominate that are in your third category. You don't have to do it right now.

(Slide presentation.)

MR. BLOND: One of the contentions which was raised at the outset of the questions concerning the source term was emergency response and the impact that the source term relook would have in this area.

The first slide is a slide that was presented to the Commission in 1978 concerning the emergency planning basis that was devloped in NUREG 0396. At this time we came to the conclusion that a spectrum of accidents was necessary to be considered in emergency planning and that we must go beyond the design basis accidents in developing our rationale and our basis for the emergency planning questions.

As the slide indicates, we included the Class 9 accidents from the Reactor Safety Study explicitly in the considerations of this issue.

As Mel has pointed out, the Source Term Report essentially verified that there are a spectrum of events which can go from very severe to relatively benign which can occur. The assumptions that we have been making in the past, although there are large uncertainties associated with them, we still at this point in time have to essentially use the information that we have used previously and there is no justification for significantly reducing the source terms in any substantive manner. The probabilities might change, but even the probabilities we haven't found to be significant reductions.

Concerning emergency planning we have concluded the follow:

Concerning the zones, the emergency planning zones that were developed as a part of NUREG 0396 and the considerations that we have seen from the technical bases, we can't at this point justify any changes to our requirements.

For potassium iodide and the questions that have been raised in this issue, the question of cesium iodide versus iodine emphasis that there are other fission products which must be taken into account in considering emergency reponses, something that was in fact brought up at the time, and that comprehensive measures for public protection should be the premier measures that we focus on such as shelter, evacuation and respiratory protection.

I have an additional slide and if we want to get into that we can.

As part of the emergency planning role, one of the areas which was developed is the concept of emergency action level. What we are saying in this area is that there are instrumentation and diagnosis techniques which could be impacted by the questions of the source term and that we must tailor our instrumentation and our diagnostic approaches to the specific species and environments which we would find through the spectrum of events.

Concerning the rapid public notification system which has been put into our regulations, we find that there is nothing that will change the timing and the accident response characteristics that we found from the source term information and therefore we can't justify making any changes on that basis either.

That summarizes our emergency response implications.

COMMISSIONER AHEARNE: You have something here on potassium iodide.

COMMISSIONER BRADFORD: Yes. To focus a little more directly on the question of potassium iodide and the source term, it should be pointed out that potassium iodide is only effective for iodine and blockage of thyroid and that it is ineffective for other radionuclides such as the cesiums and telluriums and rutheniums and for external exposures which are a dominant pathway which cannot be dismissed which further emphasizes the need for shelter and evacuation as very important public protection measures.

In addition, the questions of the source term brings to light that there are relatively simply respiratory protective measures which can be taken such as placing a wet towel over your mouth.

COMMISSIONER AHEARNE: For how many hours?

COMMISSIONER BRADFORD: For the time required. Or a gauze mask or something along these lines. These would measures would be more effective in reducing the inhalation exposures than potassium iodide potentially would be. We would recommend that this be considered in our future policies. It also emphasizes that there are large uncertainties in the entire question and we recognize those.

Concerning potassium iodide and our current policy, the iodine/cesium iodide questions don't really change our perspectives on the issues. Given that you have iodine we want emergency workers and plant personnel to be protected and it is not a bad policy to assure that this is available at the site.

We have to assess the adverse impacts of potassium iodide and this is being done through the FDA and the Bureau of Bad Health at this time. We need more information on distribution of approaches and costs associated with the potassium iodide program.

Concerning the reports, what we now hope to do is publish the Technical Basis Report as in final form as Mel indicated in the time frame of early June.

What we would like to do concerning our regulatory impact report and NUREG 0771 is publish it for public comment. We know that there are many issues which we have raised in the report which we would like to get feedback on. It really is a report that we have generated and we need some more response and that is what we would like to do at this time.

The remaining issues or points that are brought up on the slide are those which Mel brought out concerning the specifics of the updated source terms, et cetera.

CHAIRMAN HENDRIE: This is a good place for your question.

COMMISSIONER BRADFORD: Sorry.

(Laughter.)

COMMISSIONER GILINSKY: Which question is that?

(Laughter.)

COMMISSIONER BRADFORD: We do have an additional slide which will focus on the importance of the iodine.

COMMISSIONER GILINSKY: That is the one about what happens if there is no iodine.

COMMISSIONER BRADFORD: Yes.

In this slide we have tried to indicate very briefly, and there is one section in the report which goes into significant more detail, the importance of iodine and the other isotopes to the question of various consequences which can occur during these accidents.

If we look at iodine concerning the potential for early fatalities and high doses from very large accidents, it does play a fairly dominant role. But it again is only 50 percent which is not a very big number if we think about these things. Given the other isotopes and the concern from them you will still have to worry about early fatalities even if there was no iodine.

COMMISSIONER AHEARNE: When you say risk here you are now talking about the probability and the consequences?

COMMISSIONER BRADFORD: No, this is strictly consequences at this point.

COMMISSIONER AHEARNE: Assuming which set of accidents?

COMMISSIONER BRADFORD: Again it would be the whole spectrum.

COMMISSIONER AHEARNE: So you are assuming all spectrum of accidents unweighted by the probability of the accident?

COMMISSIONER BRADFORD: Yes, but in truth they are dominated by the high release events.

MR. BERNERO: Excuse me, Roger. I think it would be worthwhile to describe how that is done. You are probability weighting. You are just telling the computer to take out the iodine and now recalculate the risk profile of the plant. You look at the effects, early fatalities, and what happened to the effects after you artificially told the computer don't count iodine contributions. So it is truly risk. It is risk. It is probability weighted consequence with an artificial change that you have made.

COMMISSIONER BRADFORD: As you can see in the slide iodine in some cases plays very little role and in other places plays a substantial role and for other measures of risk.

CHAIRMAN HENDRIE: These calculations have built into it the sort of assumptions that have been there in good part since WASH-1400 days. That is, this is the same calculation that goes out and lays down a lot of other fission products as a ground deposition layer and in which you then infer, you know, what short of people removal assumptions are in here, for instance.

MR. BLOND: Again, that would influence the range of impact that the specific isotopes would have and what mechanisms you would allow for the people if you would evacuate them or whatever. That would influence that range of events.

You will see in this type of order across that many spectrums of emergency response, for instance. The iodine does come into play in approximately this type of a manner. But there are many isotopes, as you have pointed out, which enter into the calculation.

COMMISSIONER AHEARNE: The point I am trying to make is not that there are a lot of isotopes but rather that these calculations and the indeed the whole conclusions that you and Walter are arriving at are that the other isotopes as well as cesium iodide will in fact behave in the way that they have been calculated to behave in the models used by the staff over the past five years.

COMMISSIONER BRADFORD: That is correct.

COMMISSIONER AHEARNE: One of the propositions that folks have made to us is that there are in those models an assortment of assumptions about chemical behavior and aerosol behavior and what the pathways look like and what the processes are in the pathways which in total are grossly conservative.

So when you come back and say, well, we have recalculated and we don't find any basis for change, I am compelled to say, wait, you have done essentially the same calculation that we did before. So, you know, you in effect haven't dealt with the proposition and isn't it time to re-examine those things.

Now, Mel is saying, yes, we are going to look at those in the research program. Your conclusion is, and you recognize those things, but your conclusion I must say approaches the trivial. You did a certain calculation five years ago and got certain results and said, hey, let's make some rules on that basis. Now we come to today and we say let's reconsider that. So you do the same calculations essentially and get the same results and say, what do you know, it is the same. I could have told you that three months ago, Roger.

MR. PASEDAG: Dr. Hendrie, I should point out that in the Technical Bases Report it is not quite fair to say that we have used the same codes and the same calculations. There was quite an advance in the state of the art of calculating a fission product transport.

CHAIRMAN HENDRIE: I must say that the peer community I don't think would agree with you that in fact there has been really the kind of consideration they had in mind when they recommended the re-examination with regard to the chemistry, the pathways, the aerosol properties and so on.

Now, you know, nobody is saying that it is there to be done and you just are negligent in not doing it. I think there is a recognition that there is a lot to be learned and so on. I am just saying that, you know, you don't surprise me with your results, although in some ways I am a little depressed that one goes ahead and then throws up slides saying we have recalculated and there is no need to change.

Come on, the bases on which you did the calculation haven't changed so I wouldn't have expected the results to change.

MR. PASEDAG: I object to that a little bit.

CHAIRMAN HENDRIE: There is a trimming in there.

MR. PASEDAG: There is quite a bit of trimming. We have taken all of the information into account.

CHAIRMAN HENDRIE: You are still projecting some of the dominant sequences to lay down across the land really splendid layers of material. You know, I have always thought that those were grossly conservative sorts of propositions and I still think so.

If there is one thing in the world that is tough to make, by God it is really tough to make an aerosol which will hand together and go down wind like a vapor. The chemical warfare people, you know, used to labor just on and on and on to make aerosols. And guess what? They would do the pop explosion to create the initial conditions, you know simulate the bomb dropping and stuff, and all of their carefully devised schemes would go up in the air and come down within a hundred yards.

You know, it is tough to make an aerosol that hangs together. Now, that doesn't mean that it can't happen. It does suggest that the cheerful assumption that we move to, probably not inappropriately at various stages in our regulatory process, that you know sort of the worst can happen and it means that it is fair to look at that from time to time as technical knowledge progresses.

What I guess you are telling me here is that your look at at least a part of the current literature leaves you feeling you would like to do some more work before you do very significant things with the source terms for accidents. I guess I can't object to that as a proposition.

I think also that it is not just source term chemistry that is involved here. One of the propositions that in some fashion we have got to work on over time are those accident sequence and pathway calculations.

You know, in WASH-1400 and still the way you calculate things in the code sequences TMI-2 is a melt-down. That is that whole range of core damage events is simply not treated. You lose certain engineering safety features at low probability, to be sure. You lose certain engineering safety features and that takes it on over into melt-down and melt-down then creates these conditions with aerosols up in the containment.

MR. PASEDAG: Well, in this particular study we did look at the TMI event and other events which would be say terminated by getting the ECCS to function and so forth. We did not eliminate them. It is just that they tend not to be on the upper part of the curve as far as the consequences go.

CHAIRMAN HENDRIE: Well, they tend not to have high consquences and hence tend not to be a dominant sequences in the risk. Nevertheless, it surely must be true that the enormous fraction of core damage sequences fall in that category rather than in the everything went to hell, the vessel went dry and you got melt-downs and you have got these conditions where you would propose that you in fact substantial aerosols out of them. I don't know quite how that reflects in the calculations these days. I suspect it isn't really reflective.

MR. PASEDAG: In the Technical Bases Report we did analyze those sequences.

CHAIRMAN HENDRIE: Well, you have come to the conclusion that certain severe accidents, cesium iodide may result in higher retention of iodine and lower release and so on.

MR. PASEDAG: The thing that is missing here that we have not looked at is the probability of these events and that is something, as you point out, that needs to be done next. We have just looked at the consequences, but we have looked at all of them, not just the worst case assumptions but we have looked at a TMI-like sequence and other sequences as well, some where the ECCS functions or partially functions, and so forth.

COMMISSIONER AHEARNE: What was the result for the TMI sequence?

MR. PASEDAG: In terms of the consequences?

CHAIRMAN HENDRIE: Yes.

MR. PASEDAG: That very little gets out as long as the containment stays together. This is the point that Mel had on his slide. As long as the containment hangs together we have tremendous attenuation. That is the conclusion.

CHAIRMAN HENDRIE: How well do you think it modeled TMI?

MR. PASEDAG: Well, I think we did a reasonable job in the thermohydraulics area.

CHAIRMAN HENDRIE: In terms of the iodine behavior is what I had in mind particularly.

MR. PASEDAG: I think we have done a good job.

CHAIRMAN HENDRIE: Does it show much iodine in the containment atmosphere at some stage or is that an intermediate result which is available?

MR. PASEDAG: I don't know if that is specifically in the report. I believe it is and, if not, it certainly can be pulled out of the computer runs which we have made.

CHAIRMAN HENDRIE: I see a standing staff member.

MR. PASEDAG: Dr. Dennings would have a better answer to that.

MR. DENNING: This is Rich Denning. We did look at what the airborne iodine concentration would be as a function of what the assumed chemical form of the iodine was. In either case, whether it is elemental iodine or cesium iodide, well, if it is cesium iodide you would expect virtually no iodine to be airborne in the containment atmosphere. If it is elemental iodine you would expect a very small amount.

CHAIRMAN HENDRIE: Either of those would be consistent.

MR. DENNINGS: Either of those would be very small. Actually when you look at the amount that was measured you see probably a higher amount than you would estimate from an elemental iodine because of the presence of organic iodine. So that it is a very small amount.

Actually you would have a higher amount than you would actually expect. If you assumed the only form is elemental iodine you actually have a higher amount because of the presence of organic iodine.

CHAIRMAN HENDRIE: Bob is next.

MR. MINOGUE: I would like to make two general comments on some of the points that you made, Mr. Chairman.

First, you ought to recognize that the scope of the study began with the question of iodine and we extended it intentionally to look at the other fission products.

CHAIRMAN HENDRIE: I understand that. Furthermore, it was a 60-day wonder.

MR. MINOGUE: One of the major things that came out of this is that we must learn a lot more about the behavior of the other fission products. And as we develop that better data base, and there is an ongoing program to do that, we can begin to feed that into the kind of analysis that you are talking about.

The other point I would like to comment on is in the longer term context of the degraded core cooling rulemaking, it is certainly is our intention to look very carefully at the whole range of accidents. We are not just going to focus on the extreme cases where the core melts but the whole range of accidents that involve any kind of core or clad damage or activity release in an effort to develop a better understanding of t e phenomenology and a better understanding of the probabilities of releases.

I guess though that the point the staff is making here is that nothing that came out of this study, particularly with relationship to the issue of iodine that was raised would suggest that we need any Band-Aids. In fact, that is the term that Mr. Pasedag used. Nobody is sugesting that we don't need to develop a better understanding of some of these phenomena and develop a more rational basis for regulation. In fact that is a major activity that we see being carried under the degraded core cooling rulemaking.

COMMISSIONER GILINSKY: Bob, to what extent are our assumptions about aerosol behavior backed up by experimenting?

MR. MINOGUE: There has been a lot of experimental work done on aerosol behavior and I will have to turn to these gentlemen for a specific answer.

MR. SILBERBERG: Commissioner Gilinsky, in the area of aerosol behavior our largest experience is with the dry aerosols of the type that we have studied for the advanced reactors, particularly the LMFBR. That is where in this country and in Europe our aerosol methodology and physics methodology comes from.

We have a very large, if you will, experimental data base in terms of separate effects test and also in terms of tests actually in fairly large volumes, certainly not containment size but getting fairly large, a reasonable scale that allows you to test the model itself.

On aerosol behavior in containment we have our best knowledge in the dry environment. We are now backing this up to get it into a steam environment. We are doing these and the Federal Republic of Germany is doing work along the same lines. We are using one of their methodology and in fact we use it in this report.

Now, as we move into the regime of the reactor coolant system we have the problem of thermohydraulic conditions that now are superimposed and are complex. We are going into a lot of other dynamics taking place, and it is the methodology that I noted, what we call the Track Code being developed at Battelle Columbus which is now trying to factor in thermohydraulic conditions, the specific vapor pressure of the various species as well as the aerosol behavior that we have learned from our contaminant work.

We believe we have got the technology to put this together in the 12 to 18-month time period that I noted for Commissioner Ahearne for the updating of source terms. We are going to be bringing these into play. Where indeed these effects should be dominant and important I believe that we may show these in those sequences.

COMMISSIONER GILINSKY: Where do we stand right now? In other words, to what extent are our current assumptions backed up?

MR. SILBERBERG: In the reactor coolant system we are at a much earlier stage. We are just starting to bring to bear the aerosol methodology under those types of conditions. So on balance they are not as far along as, say, the aerosol behavior under containment conditions. That is where we see the real serious information.

As Bob Minough pointed out, the work on severe fuel damage and the work on the accident sequences will also drive the input to making those calculations of aerosol depletion in the primary system, the types that Jim Hendrie has referred to as the fact that the aersols may not go much further. That part of the technology at this point is weakest.

We have a program ongoing that is addressing that now and very hard. I expect that we will in that 12 to 18-month time frame show from the sequences that are indeed dominant that there will probably be lower releases of aerosols into the containment but I can't quantify that at this time.

COMMISSIONER AHEARNE: Let me go back to an earlier question. Roger's point I thought, as very well characterized by that backup slide that he showed, was that even if iodine were removed from the calculation you would still have a lot of serious effects.

Your earlier point didn't really depend upon the significance of removing iodine. I thought the point that you had made was, and let's see if I have it straight, that because of some accident sequences we still have to consider at this stage the release of iodine as essentially unchanged from what we previously had thought.

MR. SILBERBERG: Yes, within the large uncertainties that we have there, yes, we would say that they are unchanged.

COMMISSIONER AHEARNE: During one of those interchanges I skimmed Appendix A and I still go back to my question, and it is not here at least what I was looking for. Do you have something that would say here is your set of accident sequences and here is are the rough probabilities of those sequences and those are the ones that come in your category three?

MR. SILBERBERG: No. We have described a range of sequences.

COMMISSIONER AHEARNE: I am looking for something that would enable me to answer the question which obviously some of us will be asked.

MR. SILBERBERG: We can certainly provide that.

COMMISSIONER AHEARNE: The specific question I would like to be able to have the answer for when asked is you have looked at this and the NRC staff has done this Technical Bases Study and they have reached that conclusion, what is the probability of which sequences which are in this category three?

MR. BERNERO: Mr. Ahearne, you realize of course that that is going to be plant specific. For a given plant you are going to have a catalog of accident sequences set up by -- estimate and you will identify that that transient b- -out sequence is dominant in this fashion and that is one of those dry times.

COMMISSIONER AHEARNE: Fine. But you have reached a general conclusion and the base of that general conclusion has to have some sort of an envelope that has enabled you to reach the conclusion that independent of plant specifics it has still come to bear because it doesn't say that for some plants. This is just in general.

CHAIRMAN HENDRIE: We are ready for the long list of questions I know you have, Peter.

(Laughter.)

COMMISSIONER BRADFORD: I wasn't sure John was finished.

(Laughter.)

COMMISSIONER BRADFORD: I will save mine for the affirmation.

CHAIRMAN HENDRIE: Do you have any more?

COMMISSIONER AHEARNE: No.

CHAIRMAN HENDRIE: Vic?

COMMISSIONER GILINSKY: No.

CHAIRMAN HENDRIE: Let me suggest something to you as you work forward on these enterprises. Some of these subjects are ones which take us into technical areas that not all that many of us have worked in. I would recommend that this enterprise look about and see if it wouldn't be useful to you to form an informal sort of advisory and review group of folks from outside the organization who, you know, have the appropriate credentials to help you pick apart what you are doing and make sure it is sound and suggest things, comment, complain and generally carry on.

I know, for instance, that the American Institute of Chemical Engineers is trying to pull together a review group in this area of fission product chemistry source terms of half-way dynamics in the chemistry that goes on in those conditions and so on. The National Academy is a possible source.

MR. MINOGUE: We have established such a group perhaps with a little narrower scope than you are describing. This kind of work involves a lot of experiemental work and there are a number of facilities available to do it. So the present group has put a little more of the emphasis on designing an effective program that will make maximum use of facilities and minimize cost and use the right kind of facilities for the right kind of programs.

Certainly as we have used this report for seeking broader input we could broaden the scope of that group or look to another group that would look for a broader input. Our thinking is along the same line.

CHAIRMAN HENDRIE: One publishes a draft report and people will comment as they will. The guy who knows more about the subject than anybody else in the whole world may have been canoeing when your report comes in and he comes back and he has got other things to do and you never hear from him and that is too bad. Whereas if once in a while, every month or two, why you can get him to stop by the office and just talk with you about what you are doing and what you might watch out for and why are you doing that and so on, why you are able to tap those sources.

It is useful both from the standpoint of you having better assurance that you are making reasonable progress in an efficient way and it is also useful from the standpoint of allowing some of the really good people who have an interest in this area to have some ongoing familiarity with it rather than waiting 18 months producing your results and then encountering their criticisms.

MR. MINOGUE: We are obviously doing this in an outlooking mode. Obviously what you are describing would run us right into the Federal Advisory Committee Act which would begin to impose very severe constraints.

Let me give another example.

CHAIRMAN HENDRIE: You can always engage paid, unpaid or partially paid consultants.

MR. MINOGUE: Well, you can structure such a committee with a narrower scope. We have also had a number of discussions with specifics groups that work in the same areas, specifically the ID Core effort in this same area. We have opened channels of communication in the context of the planning and the experimental program and the fact-gathering part of the activity. We are operating in a frame of complete cooperation them.

CHAIRMAN HENDRIE: You might try to track, and I don't know who they are, but you might try to track down the AICHE group.

MR. MINOGUE: We will run that down.

CHAIRMAN HENDRIE: If they are going to try to do something in this area, why it is clearly a benefit. They will end up coming to you anyway and you may find it useful to reach them before they reach you.

MR. MINOGUE: We will run that down.

CHAIRMAN HENDRIE: Other comments?

COMMISSIONER AHEARNE: I think Joe's suggestion is something you ought to follow up on.

First, I would like to say the problem certainly was a lot larger than I thought it was when I asked you to look at it. But, as I think the ACRS has also said, you have got a very good start on it. It certainly is a very usful product and has been mentioned, it was a 60-day wonder. Very good.

As you go forward in it you are either going to run into a situation where there are going to be significant changes made and there will be a lot of people who don't think there should have been or you are going to not make significant changes and there will be a lot of people who think there should have been.

Therefore, Joe's suggestion is well worth following up on. Having some outside group of people who are going to be involved obviously in the results and trying to participate early on in providing their criticism I think will help us all in the long run.

CHAIRMAN HENDRIE: Thank you very much.

(Whereupon, at 3:55 p.m., the meeting concluded.)

* * *

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

COMMISSION MEETING

in the matter of: Public Meeting - Briefing on SECY-81-240 - DRAFT NUREG Reports 0771 and 0772 Relating to Accident Source Term Assumptions

Date of Proceeding: May 21, 1981

Docket Number: ____________________

Place of Proceeding: Washington, D. C.

were held as herein appears, and that this is the original transcript thereof for the file of the Commission.

Patricia A. Minson

Official Reporter (Typed)

Patricia A. Minson

Official Reporter (Signature)

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

COMISSION MEETING

in the matter of: Public Meeting - Briefing on SECY-81-240 - Draft NUREG Reports 0771 and 0772 Relating to Accident Source Term Assumptions

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Mary C. Simons

Official Reporter (Typed)

Mary C Simons

Official Reporter (Signature)

Accession # 8104290263

April 15, 1981

SECY-81-240

Dup 7pp

POLICY ISSUE
(Information)

For: The Commissioners

From: W. J. Dircks, Executive Director for Operations

Subject: DRAFT NUREG REPORTS 0771 AND 0772 RELATING TO ACCIDENT SOURCE TERM ASSUMPTIONS

Purpose: To transmit to the Commission for information, Draft NUREG-0772, "Technical Bases for Estimating Fission Product Behavior During LWR Accidents" and Draft NUREG-0771, "Regulatory Impact of Nuclear Reactor Accident Source Term Assumptions."

Discussion: Background and Summary - Development of these reports was directed by the Chairman and the Executive Director for Operations, as a consequence of several events. On August 14, 1980, a letter sent to the Chairman from three scientists at Oak Ridge National Laboratory (ORNL) and Los Alamos Scientific Laboratory (LASL) proposed that, under accident conditions in LWR reactors, the expected chemical form of the iodine released from the fuel would be cesium iodide (CsI), rather than the elemental iodine form which is currently assumed in some accident analysis models. Since CsI is much less volatile than molecular iodine and very soluble in water, they hypothesized that much less iodine would escape from the plant during LWR accidents, and indicated that they believed that the "iodine risk to the general public may, in fact, be lower than previously estimated, possibly by orders of magnitude."

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These scientists also recommend that the engineered safety features designed for iodine control be reexamined to assure effectiveness and optimization for actual iodine behavior, rather than the behavior currently assumed.

A second letter, sent to Commissioner Hendrie on September 2, 1980 from Chauncey Starr, Vice Chairman of the Electric Power Research Institute (EPRI), transmitted evaluations attempting to show that "the theoretical source term traditionally used in nuclear risk evaluations is one to two orders of magnitude greater than the realistic magnitude which might actually result from the ultimate accidents."

Principally as a result of these two letters a Commission meeting was held on November 18, 1980, with the authors of these two letters, the NRC staff, and other interested persons to discuss the behavior of iodine and to determine the adequacy of current methods for estimating the release of fission products during reactor accidents.

The initial steps taken to resolve the issues presented were directions to the staff to prepare a Technical Bases Report (NUREG-0772) and a companion report addressing the regulatory impact (NUREG-0771).

The principal findings and conclusions of these reports can be summarized as follows:

(1) Cesium iodide is expected to be the predominant iodine form released from the reactor coolant system (RCS) under accident conditions, but the formation of some more volatile iodine species cannot be precluded.

(2) For accident sequences in which the release is transported through water (e.g., similar to TMI-2), very little iodine is released to the containment atmosphere regardless of the chemical form. The assumption of CsI as the dominant iodine form may result in increased retention of iodine in the RCS for certain severe accidents.

For other severe accident sequences, however, the assumed form of iodine may not significantly influence the quantity released from the RCS. For these sequences iodine depletion processes in the containment (with or without operation of engineered safety features) were found to be comparable regardless of chemical form.

(3) For certain accident sequences considered in the Reactor Safety Study (RSS), the release of aerosols to the environment may have been overestimated. The degree of overestimation cannot be quantified at this time without further research.

For other sequences, however, the findings of NUREG-0772 generally agree with the RSS estimates.

(4) The appropriate vehicle for the introduction of these research findings into the regulatory framework is the ongoing effort of rulemaking in the siting, minimum engineered safety features, equipment qualification, emergency planning, and degraded core areas.

The staff is now planning to use these reports as the starting point for follow-on studies to provide information for rulemaking. The nature of the results to date indicates that it is appropriate to be deliberate in further actions.

This information will be used to improve source term modeling and other technical support used for sitting and other related rulemaking.

Having summarized, we will not discuss the findings of each report in more detail.

Technical Bases Report (Draft NUREG-0772)

The objective of the report is to provide the Commission and the public with a description of the best technical information currently available for estimating the release of radioactive material during hypothesized severe accidents in commercial LWRs.

The principal findings and conclusions of this report are the following:

(1) The current data base (with some qualifications) supports the hypothesis that cesium iodide is expected to be the predominant iodine form under postulated light water reactor accident conditions, although the formation of some, more volatile, iodine species (e.g. elemental iodine and organic iodines) cannot be precluded under certain conditions.

(2) The assumed chemical form of iodine can influence the predicted attenuation within the boundaries of reactor coolant system, where, for some accident sequences, the attenuation factor will be substantially greater for cesium iodide than for elemental

iodine. For other accident sequences, where retention in the RCS is not substantially infleunced by chemical form (either ceisum iodide or elemental iodine) comparable iodine attenuation is also estimated in the containment when containment integrity is maintained. This is also found for severe accident sequences with early containment failure in which there is little time for natural fission product retention mechanisms to be effective.

(3) A number of accident sequences are examined in this report including several which had been found to be the most important contributors to risk in the Reactor Safety Study (RSS). Reevaluation of fission product release from the fuel indicates the RSS may have underpredicted the release from the fuel of certain important radionuclide species during core melt events. Mechanistic analyses of fission product transport in the containment atmosphere were found to be in reasonable agreement with the empirically-based analysis in the RSS. Predictions of the retention of radioactive material within the reactor coolant system (which was not accounted for in the RSS for most accident sequences) range from very little to substantial retention for specific accident sequences involving a water-bounded reactor coolant system (e.g., TMI). For core melt sequences where steam flow rates through the reactor coolant system are low and aerosol generation is high, attenuation of fission products within the reactor coolant system could be substantial as a result of agglomeration and fallout of aerosols within the reactor vessel. Consequently, for certain accident sequences considered in the RSS, the release of radionuclides to the environment may have been significantly overpredicted. However, for other accident sequences (such as large or medium size pipe break accidents), the estimated releases are in approximate agreement with the RSS estimates.

The extent to which fission product release to the environment may have been overestimated in previous studies is difficult to quantify since the range of uncertainty associated with these predictions is large as a result of limitations in the data base and the early state of development and verification of the predictive methodology. Gaps and limitations in the available data base are identified in the report as a guide to future research.

The draft report was reviewed by the ACRS Subcommittee on Reactor Radiological Effects on March 10, 1981 and by the full committee on March 13, 1981 and comments were provided by letter to Chairman Hendrie on March 17, 1981. On March 17 and 18, 1981, the draft report was reviewed by a peer review group of independent technical experts. The results of both reviews were favorable and the principal comments are currently being considered and will be addressed in the final report.

Regulatory Impact Report (DRAFT NUREG-0771)

The objective of this report has been to lay the groundwork so that the findings of the Technical Bases Report can be incorporated into the regulatory framework. Principal findings and conclusions of the report are as follows:

(1) Radioiodine has played a dominant role in licensing evaluations of the radiological consequences of design basis accidents (DBA), and has, for some accident analyses, been assumed to be released predominantly in elemental form. The assumed nature and magnitude of this source term has been intended to serve as a simplifying and conservative surrogate for a broad range of non-gaseous fission product species not specifically included in the accident consequence evaluations.

Because the DBA's are defined as hypothetical events with non-mechanistic characteristics, they are not intended to be best estimates. Changing one isolated factor (e.g., I_2 into CsI) is, therefore, not necessarily justified solely on the grounds that it is more realistic. In order to account properly for specific research results, such as the information concerning CsI, similar information regarding the releases of other fission products is needed. Since the mix of fission products released varies with core, primary system, and containment conditions, a spectrum of accidents must be considered to account for the range of possible source terms. Such considerations are already working their way into the regulatory process through probabilistic risk assessments, emergency planning requirements and environmental impact statement evaluations.

(2) The concern that this regulatory emphasis on iodine may have resulted in a distortion of engineered safety feature design was examined. ESFs used in current LWR designs are found to be effective for all postulated combinations of iodine source terms under Design Basis Accident (DBA) conditions. In addition, most ESFs prove to be functional for postulated accidents substantially more severe than the DBA. The containment spray, ice condenser, and suppression pool systems appear to be effective for a broad accident spectrum. Quantification of the fission product removal effectiveness under conditions exceeding their design basis requires additional data and model development.

(3) Qualification requirements for safety-related equipment and instrumentation operability in post-accident high radiation environments are also dependent upon source term considerations. Current requirements merit further examination in the light of the findings of the Technical Bases Report.

(4) Current emergency preparedness requirements have been based upon considerations of a broad spectrum of accident consequences, and radioiodine source term considerations have not been a dominant influence in the structuring of the current rules. Preliminary conclusions suggest that the previously expressed staff judgment on these matters, including potassium iodide as a thyroid blocking agent, would not be materially affected.

(5) In probabilistic risk assessment studies, such as the Reactor Safety Study (WASH-1400) and the more recent Indian Point study (NUREG-0715), the role of radioiodine, while important, is by no means dominant as a contributor to calculated health effects and property damage consequences of severe accidents. Source terms used in these studies include many other fission products such as cesium and tellurium radionuclides. Better understanding of the physical and chemical environments through which all of these fission products can be released and transported in accidents is necessary to reduce some of the uncertainty currently present in the calculated consequences of these accidents. The findings of the Technical Bases Report are potentially useful in this regard.

(6) The report concludes that the appropriate place for the introduction of these research findings affecting source terms is the risk studies supporting the ongoing rulemaking activities on degraded core cooling, siting, and minimum engineered safety features and that it is important to adopt a consistent approach to all of them.

Follow-on Staff Actions:

The staff is planning to proceed with the following actions related to these draft reports:

- Publication of NUREG-0772 in final form in early May 1981, concurrent with publication for public comment of NUREG-0771. Comments received will be utilized in the preparation of the proposed rules.

- Development of updated source term estimates for all the radiologically important radionuclide releases to the environment for a range of LWR accident sequences (including quantification of the uncertainties in these estimates) in a time frame consistent with rulemaking schedules.

- Identification and quantification of the major sources of uncertainty in the estimates, and prioritization of data needs as a guide to future research efforts.

- Development of revised radiation source terms for the design and environmental qualification of equipment and systems having safety significance.

- Review and evaluation of past reactor accident experience.

William J. Dircks
Executive Director
for Operations

Enclosures:
NUREG 0771 and 0772
(Commissioners, GC, PE & SECY only)

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Commissioners
Commission Staff Offices
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ACRS

OUTLINE FOR: May 21, 1981 Commission Briefing on SECY-81-240-
Accident Source Term Assumptions

Commission Meeting Agenda

May 21, 1981

Accident Source Terms

1. Technical Bases for Source Terms (Draft NUREG-0772)	Mel Silberberg (RES)
2. Regulatory Impact of New Source Term Information (Draft NUREG-0771)	
A. Current Requirements and Future Rulemaking	Walt Pasedag (NRR)
B. Emergency Planning Perspective	Roger Blond (RES)

DRAFT NUREG-0772 - TECHNICAL BASES FOR
ESTIMATING FISSION PRODUCT BEHAVIOR DURING LWR ACCIDENTS

BATTELLE COLUMBUS LABORATORY
OAK RIDGE NATIONAL LABORATORY
SANDIA NATIONAL LABORATORY

U.S. NUCLEAR REGULATORY COMMISSION
- RES
- NRR

TECHNICAL BASES FOR ESTIMATING FISSION PRODUCT BEHAVIOR
DURING LWR ACCIDENTS

OBJECTIVE

- PROVIDE BEST TECHNICAL INFORMATION CURRENTLY AVAILABLE FOR ESTIMATES

ACCOMPLISHMENTS

- SHORT TURN-AROUND
- SUMMARY OF OUR STATE-OF-KNOWLEDGE
- BASES AND FRAMEWORK FOR DEVELOPING ACCIDENT SOURCE TERMS AND FOCUSING RESEARCH

BACKGROUND OF TECHNICAL ISSUES

- IS CsI RATHER THAN ELEMENTAL IODINE THE PREDOMINANT CHEMICAL FORM OF RADIOIODINE?
- IF IT IS CsI, IS RELEASE OF IODINE (AND IODINE RISK) OVERESTIMATED - POSSIBLY BY ORDERS OF MAGNITUDE?
- WILL ESFs BE EFFECTIVE FOR ACTUAL IODINE BEHAVIOR?
- IS THE AEROSOL SOURCE TERM USED FOR PAST RISK EVALUATION ONE TO TWO ORDERS OF MAGNITUDE GREATER THAN REALISTIC VALUES FOR CORE MELT ACCIDENT?

SUMMARY OF TECHNICAL SCOPE OF STUDIES

- ACCIDENT SEQUENCES
- FISSION PRODUCT RELEASE FROM FUEL
  - NEW ESTIMATES FOR FISSION PRODUCTS AND OTHER AEROSOLS
- CHEMISTRY OF Cs AND I (AQUEOUS/VAPOR PHASE)
  - CHEMICAL-THERMODYNAMICS CALCULATION (VAPOR PHASE)
- FISSION PRODUCT TRANSPORT IN REACTOR COOLANT SYSTEM (RCS)
  - RETENTION ESTIMATES CALCULATIONS
- FISSION PRODUCT TRANSPORT THROUGH CONTAINMENT
  - NATURAL REMOVAL MECHANISMS (AEROSOL BEHAVIOR) INCLUDING STEAM CONDENSATION CALCULATIONS
- ENGINEERED SAFETY FEATURE EFFECTIVENESS

SIGNIFICANT EXTENSIONS BEYOND WASH-1400 METHODOLOGY

	WASH-1400	NUREG-0772
THERMAL-HYDRAULICS	(HAND CALCULATIONS)	o MARCH CODE
FISSION PRODUCT TRANSPORT		
o RCS	----------	o TRAP, QUICK
o CONTAINMENT	CORRAL	o HAARM-3, QUICK, NAUA, CORRAL
FISSION PRODUCT RELEASE FROM MELTING FUEL	EARLY ORNL	o EARLY AND RECENT ORNL, GERMAN DATA o SANDIA DATA ON MELT-CONCRETE AEROSOLS

SUMMARY OF FINDINGS

- o CsI IS THE EXPECTED PREDOMINANT FORM OF RADIOIODINE UNDER POSTULATED ACCIDENT CONDITIONS
- o PRESENCE OF CsI DOES NOT ASSURE LOWER IODINE RELEASE (RISK)
  - IF TRANSPORT THROUGH WATER (E.G., TMI-2) - VERY LOW IODINE RELEASE REGARDLESS OF FORM
  - CERTAIN SEVERE ACCIDENTS, CsI, MAY RESULT IN HIGHER RETENTION OF IODINE IN RCS - LOWER RELEASE (CsI RELATIVE TO IODINE)
  - OTHER SEVERE ACCIDENT SEQUENCES CsI DOES NOT SIGNIFICANTLY INFLUENCE RETENTION OF IODINE IN RCS - NO CHANGE IN RELEASE (SAME)
- o FOR SEQUENCES WHERE RETENTION IN RCS IS NOT INFLUENCED BY CHEMICAL FORM, COMPARABLE IODINE ATTENUATION IS ALSO PREDICTED IN THE CONTAINMENT
  - EARLY CONTAINMENT FAILURE

SUMMARY OF FINDINGS

- o FOR CERTAIN ACCIDENT SEQUENCES IN THE REACTOR SAFETY STUDY (RSS), THE RELEASE OF FISSION PRODUCTS (AS AEROSOLS) MAY HAVE BEEN OVERESTIMATED BECAUSE OF ADDITIONAL ATTENUATION WITHIN PRIMARY SYSTEMS
  - TRANSIENTS AND SMALL BREAKS (LOW STEAM FLOW RATES - HIGH RESIDENCE TIMES, HIGH AEROSOL GENERATION)
- o FOR OTHER ACCIDENT SEQUENCES, RESULTS OF NUREG-0772 GENERALLY AGREE WITH RSS ESTIMATES
  - LARGE OR MEDIUM-SIZE BREAKS
- o EXTREMELY HIGH ATTENUATION FACTORS ($>10^5$) FOR SEVERE ACCIDENTS WITH:
  - CONTAINMENT INTACT
  - CONTAINMENT ESFs OPERATIONAL

MAJOR UNCERTAINTIES/LIMITATIONS IN THE DATA BASE AND METHODOLOGY

- THERMAL-HYDRAULIC CONDITIONS OF ACCIDENT SEQUENCES
- HIGH TEMPERATURE FISSION PRODUCT RELEASE RATES (INCLUDING MELT)
- FISSION PRODUCT CHEMISTRY
  - VAPOR PHASE (TO 1000°C)
  - AQUEOUS PHASE (TO 300°C)
- FISSION PRODUCT/AEROSOL TRANSPORT AND RETENTION IN RCS (DATA AND MODELS)
- COUPLED ANALYSIS OF RELEASE FROM CORE, RCS, CONTAINMENT, AND ESF
- FISSION PRODUCT/AEROSOL REMOVAL IN SUPPRESSION POOLS AND ICE BEDS
- CONTAINMENT FAILURE MODES

NEAR TERM FOLLOW-ON STUDIES

- DEVELOP UPDATED SOURCE TERM ESTIMATES FOR RANGE OF ACCIDENT SEQUENCES (INCLUDING UNCERTAINTIES)

- IDENTIFY/QUANTIFY MAJOR SOURCES OF UNCERTAINTY TO PRIORITIZE DATA NEEDS FOR RESEARCH PROGRAM

- DEVELOP REVISED RADIATION SOURCE TERMS FOR QUALIFICATION OF EQUIPMENT/ INSTRUMENTS HAVING SAFETY SIGNIFICANCE IN POST-ACCIDENT ENVIRONMENT

- REVIEW/EVALUATE PAST REACTOR ACCIDENT EXPERIENCE

ADDITIONAL RESEARCH RESULTS BECOMING AVAILABLE PRIOR TO COMPLETION OF RULEMAKING

- FISSION PRODUCT RELEASE FROM IRRADIATED LWR FUEL (TO 2000°C)
- FISSION PRODUCT TRANSPORT CODE (TRAP-MELT) EXTENDED TO MODEL PROCESSES FROM CORE TO ENVIRONMENT
- HIGH TEMPERATURE FISSION-PRODUCT VAPOR PHASE CHEMISTRY (REACTIONS, RATES)
- FISSION PRODUCT AND AEROSOL RELEASE FROM SIMULATED IRRADIATED FUEL TO 2800°C
- AQUEOUS FISSION PRODUCT CHEMISTRY TO 300°C
- VERIFICATION OF AEROSOL MODELS IN STEAM ENVIRONMENT
- FACTOR IN RELATED RESEARCH

LONGER TERM RESEARCH

- EXPERIMENTAL VERIFICATION OF FISSION PRODUCT TRANSPORT CODES IN RCS
- RELEASE OF FISSION PRODUCTS AND AEROSOLS FROM IRRADIATED LWR FUEL TO 2600°C (IF NEEDED)
- REASSESSMENT OF SOURCE TERMS

LONG RANGE RESEARCH PROGRAM
RELATED TO ACCIDENT SOURCE TERMS

- o SEVERE ACCIDENT ANALYSIS CODES
- o SEVERE ACCIDENT SEQUENCE ANALYSIS
- o THERMAL-HYDRAULICS BEYOND LOCA
- o SEVERE ACCIDENT PHENOMENOLOGY
  - SEVERE FUEL DAMAGE AND COOLABILITY
  - FUEL MELT INTERACTIONS
- o SEVERE ACCIDENT MITIGATION
- o CONTAINMENT STRUCTURAL RESPONSE
- o RISK ASSESSMENT
- o EQUIPMENT QUALIFICATION

REGULATORY IMPACT OF NUCLEAR REACTOR ACCIDENT

SOURCE TERM ASSUMPTIONS

NUREG-0771

PURPOSE:

TO ASSESS THE IMPACT OF ALTERNATIVE SOURCE TERM ASSUMPTIONS ON:

- PAST LICENSING PRACTICE

  (DISTORTED DESIGN BASIS??)

- CURRENT REGULATORY REQUIREMENTS

  (REGULATIONS, REG. GUIDES)

- PROPOSED RULEMAKINGS

  (EMERGENCY PLANNING, SITING, MIN. ESF., DEGRADED CORE)

AREAS CONDISERED

HISTORICAL DEVELOPMENT

- TID-14844, PHILOSOPHY
- EXPERIMENTAL DATA/ACCIDENT EXPERIENCE

CURRENT REGULATORY REQUIREMENTS

- REGULATIONS
- REG. GUIDES
- STAFF PRACTICE

RECENT DEVELOPMENTS

- TMI EXPERIENCE
- CURRENT RULEMAKINGS
- TECHNICAL BASES REPORT - NUREG 0772

REGULATORY REQUIREMENTS RELATED TO ACCIDENT SOURCE TERM ASSUMPTIONS

DEFENSE IN DEPTH	BASIC CRITERIA	ACCEPTANCE MEASURES
DESIGN		
• System Effectiveness (Engineered Safety Features)	10 CFR 50 (General Design Criteria) 10 CFR 100	Regulatory Guides - 1.3, 1.4, 1.5, 1.7, 1.25, 1.52, 1.77, 1.96, 1.97, 1.145 Standard Review Plan - 6.4, 6.5, 9.4, 15
• Equipment Qualification		
• Instrumentation		
• Shielding Requirements		
• Habitability Specifications		
OPERATION	10 CFR 50	Technical Specifications
SITING	10 CFR 100	Reg. Guide 1.3, 1.4, 4.7
EMERGENCY PLANNING	10 CFR 50, Appendix E	NUREG-0654

	DESIGN BASIS ACCIDENTS	ACCIDENT SPECTRUM
DESCRIPTION	Conservative Non-Mechanistic Surrogates	Realistic Mechanistic Probabilistic
ACCIDENT TYPES	Steam Line Break Steam Generator Tube Rupture Fuel Handling Loss of Coolant Accidents 1. Emergency Core Cooling 2. Containment Structural Design 3. Siting/Engineered Safety Features (ESF)	Group 5 - DBA Equivalent Group 4 - TMI Like Group 3 - Containment Meltthrough Group 2 - Containment Failure Group 1 - Containment and ESF Failure
RELEASE CHARACTERISTICS	1) Coolant Activity 2) Gap Activity 3) 100% Noble Gases, 25% I_2 No Aerosols	Curies Released Temperatures Pressures Chemical Environment Particle Sizes & Loadings Chemical Forms Dynamics & Timings Energies Daughter Products

SUMMARY

OF ESF EFFECTIVENESS

• CONTAINMENT	EFFECTIVENESS - VERY HIGH RANGE - HIGH
CONT. SPRAYS SUPPRESSION POOL ICE CONDENSER	EFFECTIVENESS - HIGH RANGE - HIGH
SECOND CONTAINMENT AUX. BLDG. FILTERS ~~MSIV LEAK COLLECTION~~	EFFECTIVENESS - MED. RANGE - MED
INTERNAL CONT. FILTERS	EFFECTIVENESS - LOW RANGE - LOW

TO ACCOMODATE NEW INFO CONCERNING SOURCE TERMS:

- CURRENT PRACTICE OF SINGLE DBA FOR SITING AND ESF DESIGN CANNOT ACCOMODATE NEW INFO ON SOURCE TERMS
- A SPECTRUM OF FISSION PRODUCT RELEASES UNDER VARIOUS ACCIDENT CONDITIONS IS NEEDED
- THE CURRENT SET OF REGULATORY REQUIREMENTS FOR PROTECTION AGAINST IODINE RELEASES HAVE RESULTED IN EFFECTIVE PROTECTION AGAINST ALL FISSION PRODUCTS.

RECOMMENDATIONS

1. DEVELOP A MECHANISTIC SPECTRUM OF ACCIDENTS AND SOURCE TERMS FOR FUTURE REGULATORY REQUIREMENTS

2. INCORPORATE NEW SOURCE TERMS IN CURRENT RULEMAKINGS ON SITING, MINIMUM ESF, DEGRADED CORE, EMERGENCY PLANNING

3. INTERIM MEASURES TO CORRECT SPECIFIC REGULATORY REQUIREMENTS, PRIOR TO CONSISTENT IMPLEMENTATION VIA RULEMAKINGS, SHOULD NOT BE MADE.

SINGLE ACCIDENT SEQUENCE SHOULD NOT BE USED AS BASIS FOR EMERGENCY PLANNING

There is a spectrum of accidents that could result in exposures exceeding PAGS:

- Design basis accidents
- "Class 9" accidents

SOURCE TERM IMPLICATIONS FOR EMERGENCY PLANNING

- EMERGENCY PLANNING ZONES CONSIDERED ACCIDENT SPECTRUM - NO CHANGE REQUIRED

- POTASSIUM IODIDE - EMPHASIZE OTHER COMPREHENSIVE MEASURES FOR PUBLIC PROTECTION
  SHELTER
  EVACUATION
  RESPIRATORY PROTECTION

- EMERGENCY ACTION LEVELS
  INSTRUMENTATION AND DIAGNOSIS TECHNIQUES MUST BE TAILORED TO SPECIFIC SPECIES AND ENVIRONMENTS

- PUBLIC RAPID NOTIFICATION SYSTEM
  TIMING AND ACCIDENT RESPONSE NOT IMPACTED BY SOURCE TERM - NO CHANGE REQUIRED

SOURCE TERM IMPLICATIONS FOR POTASSIUM IODIDE (KI)

- FOCUS ON ACCIDENT SPECTRUM
  1) KI ONLY EFFECTIVE FOR IODINE
  2) KI INEFFECTIVE FOR OTHER RADIONUCLIDES (EG. Cs, Te)
  3) EXTERNAL EXPOSURE PATHWAYS IMPORTANT (EMPHASIZE SHELTER AND EVACUATION)
  4) RESPIRATORY PROTECTION (EG. WET TOWEL) MORE EFFECTIVE THAN KI

- LARGE UNCERTAINTIES
  - TIMING
  - CHEMICAL FORM
  - DISPERSION
  - DEPLETION

- I_2 VERSUS CsI DOES NOT CHANGE CURRENT PERSPECTIVES ON KI:
  1) PLANT WORKERS
  2) EMERGENCY PERSONNEL
  3) ADVERSE IMPACTS?
  4) DISTRIBUTION & COSTS?

TRANSMITTAL TO: *XXX Document Control Desk, 016 Phillips

☐ The Public Document Room

DATE: May 22, 1981

Attached is a Commission meeting transcript and related meeting document/s/. These are available for placement in the Document Control System so they will appear on the Public Document Room Accession List. Any document not stamped original should be checked for possible prior entry into the system. Before Being Sent To DMB

1. Transcript of Briefing on SECY-81-240 - Draft NUREG Reports 0771 and 0772 Relating to Accident Source Term Assumptions, May 21, 1981. (1 cy)

   a. SECY-81-240, Policy Issue Paper dated April 15, 1981, Subject: Draft NUREG Reports 0771 and 0772 Relating to Accident Source Term Assumptions. (1 cy)

   b. Outline for May 21, 1981 Commission Briefing on SECY-81-240, Accident Source Term Assumptions. (1 cy)

   c. Viewgraphs, Subject: Draft NUREG-0772, Technical Bases for Estimating Fission Product Behavior During LWR Accidents. (1 cy)

   d. Viewgraphs, Subject: Regulatory Impact of Nuclear Reactor Accident Source Term Assumptions. (1 cy)

   e. Viewgraphs, Untitled. (1 cy)

Sheri Porter
Office of the Secretary

* These items have been checked and ~~where~~ if appropriate the accession no. has been added