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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

July 12, 2007

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, taken on July 12, 2007, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

This transcript has not been reviewed, corrected and edited and it may contain inaccuracies.

1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

5 544th MEETING

6 VOLUME II

7 + + + + +

8 THURSDAY, JULY 12, 2007

9 + + + + +

10 The meeting was convened in Room T-2B3

11 of Two White Flint North, 11545 Rockville Pike,

12 Rockville, Maryland, at 8:30 a.m., Dr. William J.

13 Shack, Chairman, presiding.

14 MEMBERS PRESENT:

15 WILLIAM J. SHACK Chairman

16 MARIO V. BONACA Vice Chairman

17 SAID ABDEL-KHALIK ACRS Member-At-Large

18 GEORGE E. APOSTOLAKIS ACRS Member

19 J. SAM ARMIJO ACRS Member

20 MICHAEL CORRADINI ACRS Member

21 THOMAS S. KRESS ACRS Member

22 OTTO L. MAYNARD ACRS Member

23 DANA A. POWERS ACRS Member

24 GRAHAM B. WALLIS ACRS Member

25 SANJOY BANERJEE ACRS MEMBER

1 NRC STAFF PRESENT:
2 JOE JONES
3 SHAWN BURNS
4 RANDY SULLIVAN
5 TONY McMURTRAY
6 MALCOLM WIDMANN
7 KATHY HEANY
8 EVA BROWN
9 ALSO PRESENT:
10 DAVID LEAVER
11 STEPHEN HESS
12 MARTY HUG
13 DAVID LANGLEY
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A-G-E-N-D-A

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

2 8:26 a.m.

3 CHAIRMAN SHACK: The meeting will now

4 come to order.

5 This is the second day of the 544th

6 meeting of the Advisory Committee on Reactor

7 Safeguards. During today's meeting the Committee

8 will consider the following:

9 Draft NUREG-9654 Supplement 3, "Criteria

10 for Protective Action Recommendations for Severe

11 Accidents";

12 Browns Ferry Nuclear Plant Unit 1

13 Restart Activities;

14 Future ACRS Activities/Report of the

15 Planning and Procedures Subcommittee;

16 Reconciliation of ACRS Comments and

17 Recommendations;

18 Subcommittee Report on the State-of-the-

19 Art Reactor Consequence Analysis (SOARCA) Project;

20 Status Report on the Quality Assessment

21 of Selected NRC Research Projects, and;

22 Preparation of ACRS Reports.

23 The meeting is being conducted in

24 accordance with the provisions of the Federal

25 Advisory Committee Act.

1 Mr. Cayetana Santos is the Designated
2 Federal Official for the initial portion of the
3 meeting.
4 We have received no written comments
5 from members of the public regarding today's
6 session. We have received a request from Mr. David
7 Leaver representing NEI and EPRI for time to make
8 oral statements regarding draft NUREG-0654.
9 A transcript of portions of the meeting
10 is being made, and it is requested that speakers use
11 one of the microphones, identify themselves and
12 speak with sufficient clarity and volume so that
13 they can be readily heard.
14 Our first topic today is the draft NUREG
15 on the criteria for protective action
16 recommendations. And I would note that Dr. Powers
17 has a conflict of interest in this since he is
18 employed by Sandia National Laboratory.
19 And Mario?
20 VICE CHAIR BONACA: Yes. Good morning.
21 Current guidance for protective action
22 accommodation is contained in Supplement 3 to NUREG-
23 0654. And this guidance right now has a high
24 emphasis on evacuation. And so the Staff is
25 concerned that the emphasis on Supplement 3 on early

1 evacuation may have added an unintended consequence
2 of not having proper consideration of sheltering at
3 subsurface sits.
4 And therefore, in addition to that,
5 since Supplement 3 was issued there have been
6 significant technological advances in emergency
7 planning and evacuation at facilities and
8 communications and so on and so forth, which really
9 make sheltering an interesting alternative in
10 certain scenarios. Because of all these issues, the
11 Commission issued an SRM in 2003 directing the Staff
12 to evaluate the NRC's prior guidance to assure that
13 it continues to reflect the Staff's current state of
14 knowledge. And what they are presenting to us today
15 is the result of this SRM, started on and conducted
16 by the Staff and Sandia. And we will hear about the
17 results of this particular study.
18 For the purpose of the meeting today
19 since we have a second presentation by the industry
20 of the same subject--and also we need to go around
21 the table and get inputs to me at the end of the
22 presentations so I can go and write a letter. We
23 have scheduled a presentation by the Staff to last
24 until 9:50 approximately this morning. And then we
25 will have a 15 minute presentation by the industry.

1 Unfortunately, they have an interesting report that
2 the Staff has not had a chance to review, and we
3 have not reviewed. But you will hear from them what
4 their views are. And finally we will go around the
5 table with some inputs to me for this letter, given
6 that time is short.
7 So with that, I'll turn it over to
8 Randy.
9 MR. McMURTRAY: Thank you, Dr. Bonaca.
10 Good morning. I'm Tony McMurtray. I'm
11 the Chief of the Emergency Preparedness Regulatory
12 Approvements and Outresearch Branch.
13 We're here today to present the results
14 of the NRC study of the protective action
15 recommendations or PARs.
16 We undertook this study to find out if
17 alternative protective actions could reduce public
18 dose compared to the current PARs available during a
19 severe accident.
20 The NRC Staff recommended a review of
21 the PAR guidance found in NUREG-0654 Supplement 3
22 several years ago. The Commission directed the Staff
23 to perform the study of PARs and the study began in
24 2004. The results of the study indicated that
25 enhancements to the current PARs could reduce public

1 dose in certain situations.

2 Following the review by the ACRS we plan

3 to provide the results to the Commission, issue a

4 NUREG providing details regarding this study and

5 eventually hope to review and update NUREG-0654 to

6 incorporate the recommendations from this study.

7 Randy Sullivan and my staff has been the

8 lead technical review of the study from the

9 beginning. I am pleased to introduce Randy

10 Sullivan.

11 MR. SULLIVAN: Thanks. And thank you to

12 the Committee for meeting with us on Thursday

13 morning. I appreciate you accommodating our

14 schedule.

15 Well, we've been through most of the

16 first couple of slides already, I'm happy to say.

17 We began in late 2004 and now we're

18 here. This is the actual SRM that we're working

19 against, and that began the PAR study, as we call

20 it.

21 I want to talk a little bit about

22 background so that we can understand how we got

23 where we are now. If you study nuclear plant

24 emergency preparedness you can tease out of the

25 regulations, the guidance, the technical basis for

1 it. There is an emergency preparedness planning
2 basis and it really can be summarized in just a few
3 bullets:
4 Accidents are unlikely, no worse than
5 the Commission safety goal.
6 Accidental releases are no greater than
7 those releases identified in WASH-1400, way back in
8 the Rasmussen study from MIT. That's the basis of
9 the emergency planning zones, both the 10 miles and
10 the 50 mile ingestion zone.
11 A little more difficult to tease out is
12 that the fast breaker, we call it, or the large
13 early release is part of the ET planning basis. You
14 find that in the notification regulations that
15 require, essentially, a 30 to 45 minute time frame
16 to be notifying the public of the need to take
17 protective actions. That is a very demanding
18 regulation. It's not so tough on the nuclear plant
19 operator to make their notifications within 15
20 minutes of declaration of an emergency, but the
21 subsequent 15 or so minutes for the state or county
22 to make notifications to the public really is quite
23 a demanding regulation. And we're going to talk
24 about that further.
25 MEMBER WALLIS: Now can I ask you, now

in Figures 3.1., 3.2 in the report you seem to show that some of these short release, short time releases were some of the more frequent ones, which rather surprised me when you have a plot of time in frequencies. And it looks as if some of these early releases were some of the more frequent releases. Is that case or did I misunderstand something?

MR. SULLIVAN: I'll defer to Shawn.

MR. BURNS: Yes. Well, we'll be going over those.

MEMBER WALLIS: You will be going over them? I wondered if you were going to do that or not.

MR. BURNS: Yes.

MEMBER WALLIS: I wasn't sure. Okay.

MR. BURNS: Maybe if we could defer it until --

MEMBER WALLIS: Because they seem to be the ones where you have to act quickly. And if they are more frequent, then it means they're more important than we thought, perhaps.

MR. BURNS: Well, based on the references that we looked at.

MEMBER WALLIS: Okay. You're going to get into that.

1 MR. BURNS: But we'll give you some more
2 details.
3 MEMBER WALLIS: Thank you.
4 MR. BURNS: Right.
5 MEMBER APOSTOLAKIS: So what is the
6 basis for the first sub-bullet? How do we know, that
7 the accident probabilities are within the bounds?
8 And even if they are not, how do they effect the
9 emergency planning?
10 I mean, the NUREG-1150 studies did only
11 five plants, right?
12 MR. SULLIVAN: My premise is that the
13 Commission's safety goal is met.
14 MEMBER APOSTOLAKIS: But if they are
15 not, how would that affect your work?
16 MR. SULLIVAN: I think we would do
17 something different.
18 MEMBER APOSTOLAKIS: Like?
19 MR. SULLIVAN: We would --
20 (Phone rings).
21 MR. McMURTRAY: That answer is coming
22 in.
23 MR. SULLIVAN: Emergency preparedness is
24 already a very demanding regimen.
25 MEMBER APOSTOLAKIS: Right.

1 MR. SULLIVAN: If you really believe
2 that the accidents were more frequent than the
3 Commission's safety goal, then I suppose you would
4 do something else. You would increase th low
5 population zone; you would demand that these plants
6 can't exist without a larger owner controlled area;
7 you would do any number of things.
8 MEMBER WALLIS: I think you've made a
9 mistake here. I mean, the Commission's safety goals
10 say nothing about frequency of accidents. They talk
11 about doses and they talk about fatalities, but
12 there could be a huge number of accidents that led
13 to not many consequences. They don't say anything
14 about frequency of accidents in their safety goals.
15 MR. SULLIVAN: Consequences then I
16 should have used. Thank you.
17 MEMBER APOSTOLAKIS: So when you say the
18 probability of accidents, you mean core damage
19 frequency and --
20 MR. SULLIVAN: I really mean the
21 probability of consequences to the public. I
22 believe Dr. Wallis is right.
23 MEMBER APOSTOLAKIS: Deaths?
24 MR. SULLIVAN: Well, the safety includes
25 --

1 MEMBER APOSTOLAKIS: Safety goal is
2 individual risk?
3 MR. SULLIVAN: Yes.
4 MEMBER APOSTOLAKIS: So you're not
5 really referring to accidents?
6 MR. SULLIVAN: Right.
7 MEMBER APOSTOLAKIS: Then I'm saying
8 that we really don't know whether these are met, the
9 goals are met because we haven't done the analyses.
10 I mean, they would have to be violated
11 in a very provocative way for your work to be
12 changed, I think. I mean, now there is this doubt.
13 MR. SULLIVAN: Really?
14 MEMBER APOSTOLAKIS: Yes.
15 MR. SULLIVAN: That -- that --
16 MEMBER APOSTOLAKIS: Well, first of all,
17 you look at 1150 and even the results they have
18 there, they say they assume evacuation of 90 percent
19 of the population. Thank you very much. Period. No
20 uncertainty whatsoever.
21 MR. SULLIVAN: So --
22 MEMBER APOSTOLAKIS: But I still don't
23 know why you need that bullet. I mean if--
24 MR. SULLIVAN: Okay.
25 MEMBER APOSTOLAKIS: --the individual

1 risk was one, I can see us doing things. But I
2 don't think that we can argue that some plants
3 probably do and some plants may not. Even core
4 damage frequency, I mean there were a significant
5 number, right?
6 MEMBER WALLIS: Well, maybe if we get to
7 these figures I was talking about, then we can be
8 clearer and it won't be based on the safety goals.
9 It will be based on something detailed.
10 MEMBER APOSTOLAKIS: Okay.
11 VICE CHAIR BONACA: But it seems to me
12 that when it was done, they selected a set of
13 accidents if the different characteristics. I mean,
14 so far as source term, release time and the time
15 between the declaration of emergency --
16 MR. SULLIVAN: That's right.
17 VICE CHAIR BONACA: -- and the plum,
18 okay, coming out of the reactor. And they're
19 covering the span of the possibilities for which the
20 emergency plan has to provide coverage. I mean, the
21 question is what is credible and incredible.
22 MEMBER APOSTOLAKIS: But what I'm saying
23 is that that work and this statement totally have
24 nothing to do with each other.
25 VICE CHAIR BONACA: That's true. It's

1 probably true.

2 MR. SULLIVAN: Right. That's right.

3 However, I would have thought that this bullet was a

4 pretty safe statement.

5 MEMBER APOSTOLAKIS: No, no. Not before

6 this Committee.

7 MR. SULLIVAN: Yes, I guess not. I mean

8 to say that there are nuclear plants out there that

9 don't meet the safety goal would be--

10 MEMBER APOSTOLAKIS: Oh, yes. Even core

11 damage frequency there were 19 BWRs that went above

12 the ten to the minus 4 --

13 MEMBER WALLIS: Well, I think we should

14 move on.

15 MEMBER APOSTOLAKIS: And that's why

16 they're goals.

17 MEMBER WALLIS: But I don't think it

18 affected your planning.

19 MR. SULLIVAN: No, it hasn't. It has

20 not.

21 This is another uncontroversial slide.

22 The emergency preparedness regimen is not risk-

23 informed. It's basically a deterministic regimen

24 that would establish.

25 MEMBER WALLIS: Should it be?

1 MR. SULLIVAN: Well, that would be a
2 policy issue. I mean, I think I know how to
3 approach the issue, but it certainly wouldn't be a
4 decision made at the staff level.
5 MR. McMURTRAY: And Randy I will bring
6 up, we have indicated the Commission in our SECY 06-
7 200, and in fact we are going to look at least some
8 performance-based -- I mean we're going to explore
9 some of that.
10 MEMBER WALLIS: And that's my question
11 later on maybe. If it's not risk-informed and
12 performance-based, what's your measure of success?
13 How do you know it's any good.
14 MR. SULLIVAN: Right. Actually that's
15 Commissioner Jaczko's point is that he would like us
16 to have a better measure of success. But to address
17 that issue I would say to you we have a standard of
18 reasonable assurance for approving emergency plans
19 and allowing plant operation. Now, if you want to
20 tease out the basis of that reasonable assurance
21 determination, I mean I suppose it might not be as
22 rigorous as some might prefer. But there is a
23 regulatory basis for it if you want to go into it.
24 It's really a defense-in-depth measure.
25 MEMBER WALLIS: Well, do you have any

1 sort of measure that without this you would kill so
2 many people and with this you would kill so many,
3 and therefore you've got a success area of so much
4 or something?
5 MR. SULLIVAN: Certainly.
6 MEMBER WALLIS: A thing like this?
7 MR. SULLIVAN: No, certainly not.
8 MEMBER WALLIS: Can't say that?
9 MR. SULLIVAN: No. Reasonable assurance
10 is -- you would have to say it's a judgment
11 standard. It's based on approval of plans and
12 procedures and demonstration of those plans and
13 procedures in biennial exercises, which most of you
14 have seen, right? They're a pretty complicated
15 affair, especially considering they started back in
16 the '80s and have been going on for 20 years.
17 MEMBER WALLIS: So it is a ritual that
18 you perform?
19 MR. SULLIVAN: There are those who might
20 call it a ritual. But there's the possibility of
21 findings. There's the possibility of consequences
22 to plant operations if the ritual is not performed
23 correctly. But I think that that wouldn't --
24 MEMBER MAYNARD: I don't think that
25 would characterize well it at all, being a ritual.

1 MR. SULLIVAN: No. No.

2 MEMBER MAYNARD: This is very demanding

3 involving state, local, plant --

4 MEMBER APOSTOLAKIS: But they are

5 demanding rituals. And you go through the motion is

6 what I'm saying.

7 Now what's the measure of how well you

8 did, that's what I was getting at?

9 MR. McMURTRAY: Well, there is criteria.

10 I mean both FEMA uses criteria to evaluate the off

11 site using the one site--

12 MEMBER APOSTOLAKIS: So you do have some

13 measure of performance?

14 MR. McMURTRAY: Oh, yes, we do. Of

15 course. And, in fact, there are criteria that the

16 NRC uses under the inspection program. And if the

17 licensees don't perform well, they're put into the

18 ROP process and they can get everything up to a

19 yellow finding with that. So there are consequences

20 for the utility as well as for the states and

21 locals.

22 MEMBER APOSTOLAKIS: Yes.

23 MEMBER MAYNARD: There are other

24 objectives that have to be met and have to be

25 demonstrated.

1 MR. McMURTRAY: Right. That's correct.

2 MEMBER MAYNARD: And some of those are

3 evaluated by the NRC, some of them are evaluated by

4 FEMA.

5 MR. McMURTRAY: By FEMA, that's correct.

6 MEMBER APOSTOLAKIS: We are the agency

7 that's I think pioneering the use of risk

8 information in regulation. And maybe, you know,

9 what you have done so far is not risk-informed, but

10 I was reading the EPRI report that was submitted was

11 on risk-informed evaluation of protective action

12 strategies and it seems to me that it's fairly

13 straightforward to risk-inform the process. And I

14 understand you have not had a chance to review this.

15 MR. SULLIVAN: Well, no, no. Actually,

16 we did review it. I think it's a nice report.

17 MEMBER APOSTOLAKIS: So we should do the

18 same thing then, shouldn't we?

19 MR. SULLIVAN: Should we?

20 MEMBER APOSTOLAKIS: Yes. Because the

21 metrics are all there. And, again, it will be risk-

22 informed. You don't have to reject everything else

23 you are doing. But I see curves, I see how they

24 change with different strategies. And that is really

25 very valuable, it seems to me.

1 MR. SULLIVAN: I thought that the report
2 is an interesting piece of work.
3 MEMBER APOSTOLAKIS: Yes.
4 MR. SULLIVAN: However --
5 MEMBER WALLIS: Let's move on.
6 VICE CHAIR BONACA: We haven't had an
7 official review of it, nor have we had an
8 opportunity to review --
9 MEMBER APOSTOLAKIS: Can't hear you,
10 Mario.
11 VICE CHAIR BONACA: I'm saying that the
12 Staff has not officially reviewed it. We have not
13 received any comments from the Staff, nor--
14 MEMBER APOSTOLAKIS: It's not safety
15 evaluation review?
16 VICE CHAIR BONACA: Yes. The other issue
17 is that --
18 MEMBER APOSTOLAKIS: So what?
19 VICE CHAIR BONACA: -- it seems that
20 emergency planning is a defense-in-depth measure.
21 They are taking some scenarios from NUREG-1150.
22 There are many reasons for accidents that may not be
23 covered by 1150. Okay.
24 MEMBER CORRADINI: That's the source of,
25 I think, of the shape of the Figure 3.1 what you

1 just said. That's my interpretation.

2 VICE CHAIR BONACA: Figure 3.1. Okay.

3 MEMBER KRESS: I would like to know just

4 out of curiosity what it is about emergency planning

5 that characterizes it as a defense-in-depth measure.

6 MR. SULLIVAN: It's quoted that way in

7 the safety goal policy. It's --

8 MEMBER KRESS: Well, does that make it a

9 defense-in-depth measure, though?

10 MR. SULLIVAN: I march to that drummer,

11 yes.

12 MEMBER KRESS: The reason I ask is that

13 if you do the PRAs and if a lot of plants wanted to

14 meet the safety goals as a criteria, then you have

15 to invoke emergency planning to meet it. If you

16 don't, you don't meet it. To me that's not a

17 defense-in-depth measure. That's required to meet

18 the safety goals. And for some plants you don't

19 need it, but you still have it and there it might be

20 a defense-in-depth measure. And that's why I was

21 asking what it is that characterizes it as a

22 defense-in-depth.

23 VICE CHAIR BONACA: Well, what I meant

24 to say before as a defense-in-depth from that

25 perspective is that the site has to be ready to deal

1 with any event, okay, even for example an early
2 release. Although if you go to 1150, you may find
3 that those accidents like the one using these
4 analyses, ten to the minus eight, you could say is
5 noncredible. Well, we unfortunately in these modern
6 times, you know there are some credible early
7 releases that are not necessarily coming from 1150.
8 So we have in my judgment some representative
9 sequences to cover the span of what the plant may
10 face and once to be prepared for. And I think that
11 was the whole purpose. I don't know how we don't
12 get there, but at some point we'll get there.
13 MR. SULLIVAN: Right.
14 VICE CHAIR BONACA: It seems to me that
15 that was the whole purpose of having the selection
16 of a certain source term and then some scenarios
17 that would cover the gamut of the possibilities. And
18 that's the reason why I used the expression defense-
19 in-depth. I mean, it's the last resort. I mean, you
20 have something happening there, you get the
21 protective -- and you have to be ready to do that.
22 MEMBER KRESS: But if it's something
23 that's required to me a goal, to me it's not
24 defense-in-depth.
25 MEMBER POWERS: There is no requirement

1 that I'm aware that meet the safety goal.

2 MEMBER KRESS: That's exactly right.

3 MEMBER POWERS: So --

4 MEMBER KRESS: So, yes, but he's talking

5 accidental.

6 MEMBER APOSTOLAKIS: I think, Tom, the

7 thing that makes it defense-in-depth is if you come

8 in and argue that you meet the safety goals simply

9 by reducing the core damage frequency by a factor of

10 X --

11 MEMBER KRESS: Yes, then I would say--

12 MEMBER APOSTOLAKIS: -- the NRC would

13 say no.

14 MEMBER KRESS: Doesn't have an emergency

15 -- yes. I would agree with that.

16 MEMBER APOSTOLAKIS: In that sense it's

17 a defense-in-depth kind of thing.

18 MEMBER KRESS: Yes. But I would say that

19 most plants don't fit that --

20 MEMBER APOSTOLAKIS: But the criterion

21 for declaring something as defense-in-depth is not

22 whether it's necessary to meet the goals.

23 MEMBER KRESS: Unless they want to.

24 MEMBER APOSTOLAKIS: It's a measure that

25 spreads the umbrella, so to speak. And you really

1 don't want to rely on one thing. And the issue
2 comes up with advanced designs where they may argue
3 that you don't need the emergency planning and
4 officially I don't think the NRC has responded yet,
5 but unofficially you hear about this defense-in-
6 depth.
7 MR. SULLIVAN: I'm not doing anything
8 deeper than quoting the safety goal policy.
9 MEMBER APOSTOLAKIS: Yes.
10 MR. SULLIVAN: When I say that--
11 MEMBER APOSTOLAKIS: You are--
12 MEMBER WALLIS: Why don't we move on.
13 MEMBER APOSTOLAKIS: Let's move on.
14 MR. McMURTRAY: Yes, we haven't got to
15 that.
16 MR. SULLIVAN: However, I know you want
17 to move on, but I just want to say that when it
18 comes to the biennial exercise of nuclear power
19 plants that's about as demanding as exercise that
20 any commercial entity is put through. So while I
21 think that there is some repetitiveness in them that
22 we're addressing now, it is a rather demanding
23 inspection. It's expensive. It involves a couple of
24 hundred people off site and on site. And it is a
25 high bar to pass.

1 Now, the industry has been doing those
2 for close to 30 years. They've gotten good at it.
3 I don't mean to demean that inspection.
4 This is all we're trying to do. We're
5 just trying to see if there's alternative protective
6 actions that could reduce public dose. Actually we
7 got all the way to consequences during severe
8 accidents.
9 We're simply going to compare the dose
10 consequences for various accident scenarios with the
11 consequences there would be -- with the current
12 regimen, the keyhole radial evacuation that's in --
13 MEMBER APOSTOLAKIS: I noticed also in
14 the report you guys are using a lot of terms that
15 are very familiar to you. But we're not all experts.
16 What's "keyhole evaluation"?
17 MR. SULLIVAN: It is an evacuation of
18 approximately a two mile ring and five mile downwind
19 around the plant. And by five mile downwind, that
20 will be either three or four 22½ degrees sector.
21 MEMBER KRESS: It looks like a keyhole
22 in the picture.
23 MR. SULLIVAN: Exactly.
24 MEMBER WALLIS: The area immediately the
25 plant and then --

1 MEMBER APOSTOLAKIS: I was sure there
2 was some connection with keyholes, but what I
3 couldn't deduce --
4 MEMBER POWERS: If you just took my
5 course --
6 MEMBER APOSTOLAKIS: Yes?
7 MEMBER POWERS: If you just took my
8 course, you'd be -- it looks like a Latin hyperkey.
9 MR. SULLIVAN: Right. That was a low
10 blow.
11 We are not assessing absolute
12 consequences. We are only doing relative efficacy.
13 Well, if you look at the EP planning
14 basis, in our vision anyway, we felt that we had to
15 do three things.
16 MEMBER WALLIS: I'm sorry. You say
17 relative efficacy is assessed not only -- that it is
18 assessed qualitatively?
19 MR. SULLIVAN: That's right. You'll
20 see--
21 MEMBER WALLIS: Not only do you have no
22 measure of consequences, but even your relatively
23 effectiveness is a qualitative judgment of some
24 sort?
25 MR. SULLIVAN: That's right. Could be.

1 MEMBER APOSTOLAKIS: Didn't you just say
2 that you will compare public doses?
3 MR. SULLIVAN: Consequences.
4 MEMBER APOSTOLAKIS: Isn't that sort of
5 a metric?
6 MR. SULLIVAN: Well, we thought that we
7 ought to do it qualitatively and look for trends.
8 Since we're not analyzing any single plant, we're
9 using source terms from NUREG-1150, we felt that we
10 ought to be looking for trends rather than exacting
11 differences between one scenario and an accident.
12 So, yes, it's qualitative.
13 If you look at our summary tables,
14 you'll see better, worse --
15 MEMBER POWERS: Beneficial, not
16 beneficial.
17 MR. SULLIVAN: Right. You know,
18 beneficial, not beneficial. This is not--
19 MEMBER APOSTOLAKIS: But you want to
20 know how much. Is it beneficial by an order of
21 magnitude or is it beneficial by a smidgeon or what?
22 MR. SULLIVAN: That's right.
23 VICE CHAIR BONACA: That's an issue that
24 it's important, I think, at some point when we get
25 to the staples to do with what is the uncertainty

1 that results. I mean, tables are crisp. They seem
2 to give a very clear -- you know, but then on the
3 other side we have implementation which is not crisp
4 at all.
5 MR. SULLIVAN: That's right.
6 VICE CHAIR BONACA: It depends on the
7 site. So, you know, I thought what would be
8 beneficial would have been to have a discussion of
9 uncertainties in the report and how that applied
10 towards implementation because you have uncertainty
11 on both ends. And it's not clear. But anyway, we
12 can talk about it when we get to there.
13 MR. SULLIVAN: Thank you. Yes. Yes.
14 MR. SULLIVAN: Rapidly developing
15 releases. I guess we have a 45 minute release to
16 have the large early releases. More slowly, which of
17 course are much more likely. And we also wanted to
18 look -- I'm not sure, the words are kind of -- you
19 have to stubble over the words. But the most likely
20 of the unlikely events is that containment doesn't
21 fail. So we assess that, too. So we essentially
22 have three kinds of events that we wanted to look
23 at.
24 MEMBER APOSTOLAKIS: And what's slowly
25 development underneath this, you are still focusing

1 on the dose?

2 MR. SULLIVAN: Consequences.

3 MEMBER APOSTOLAKIS: In terms of what?

4 Consequences in terms of what?

5 MR. SULLIVAN: Early fatalities and

6 latent cancer fatalities.

7 MEMBER APOSTOLAKIS: Under regression

8 that is slowly evolving sequences primarily

9 resulting in environmental damage?

10 MR. SULLIVAN: By slow we mean a three

11 or four hour release after general emergency. I

12 guess that might not be considered slow by some. In

13 emergency preparedness space you can do a lot in

14 three or four hours. So we can that slow.

15 MEMBER APOSTOLAKIS: I guess my question

16 is whether early fatalities is the appropriate

17 method here. Of course, the goal is in terms of

18 fatality so you're doing the right thing. But --

19 MR. SULLIVAN: We struggled with that,

20 too, Doctor. We considered throwing -- you know,

21 not assessing early fatalities. But it seemed to

22 hold information that was valuable to us.

23 WE went back and forth with peak dose,

24 population dose, throw out early fatalities, latent

25 cancer fatalities. The tables that we came up with

1 seemed to contain the best information for us. But,
2 it was a struggle, frankly.
3 MEMBER APOSTOLAKIS: Okay.
4 MR. SULLIVAN: We used NUREG-11150.
5 Actually, that was a rather controversial decision,
6 too. You know, there are those who would say NUREG-
7 1150 is outdated, the source terms are overly
8 conservative. It was the government endorsed
9 document that we could get our hands on and use.
10 And Shawn's going to talk a little bit more about
11 that. But if --
12 MEMBER APOSTOLAKIS: But it does use
13 Latin hyper--
14 MR. SULLIVAN: Yes. So I'm sure Shawn
15 has a picture of that.
16 MR. BURNS: If not the keyhole.
17 MR. SULLIVAN: And now we switch to
18 Shawn. Okay.
19 MR. BURNS: My name is Shawn Burns from
20 Sandia Labs. I was fortunate enough to help Randy
21 and Joe on selecting some of the source terms for
22 the PAR study. So I'm going to spend just a brief
23 time trying to give you some details on how we came
24 up with Figure 3.1 and so we can get back to the
25 core of the PAR study.

1 There is some technical challenges in
2 coming up with a term source that we could use or a
3 set of source terms that we could use for the PAR
4 study. Primarily the complexity and the
5 phenomenonology associated with developing or that
6 go into the source term itself. Combined that with
7 the limited scope we had for identifying source
8 terms; for example the PAR study didn't have the
9 resources really to go into a detailed accident
10 progression analysis. But yet to maintain the
11 integrity of the program we had to have some kind of
12 source term that did represent what the best
13 thinking at the time was for what a real source term
14 might look like.
15 Next slide, please.
16 So the way we met that challenge is we
17 decided to go back and mine the historical database
18 for source term data. And certainly the primary
19 source is NUREG-1150. But we also looked at the low
20 power and shutdown studies and the studies, and
21 included both internal and external initiators from
22 all those studies.
23 And this is Figure 3.1 that we've been
24 talking about. Basically this is the basis for how
25 we selected our source terms.

1 MEMBER WALLIS: Now there is no scale on
2 frequency. Are these a log scale?
3 MR. BURNS: Yes. Each division is an
4 order of magnitude.
5 MEMBER WALLIS: So that sort of
6 indicates to me that there are some of them which
7 are far more important than others.
8 MR. BURNS: That's correct. That's
9 correct.
10 MEMBER WALLIS: Because the down on the
11 bottom you can forget.
12 MR. BURNS: Exactly. And I'll go into
13 that.
14 MEMBER WALLIS: And that's where risk
15 analyses would come. I mean, you said some of these
16 you have to worry about more than others.
17 MR. BURNS: And I'll show you that in
18 the slide.
19 MEMBER WALLIS: Okay.
20 MEMBER APOSTOLAKIS: What kind of
21 numbers ar we talking about? I appreciate the
22 yellow box, but --
23 MR. BURNS: Yes. That's --
24 MEMBER APOSTOLAKIS: Well, you have a
25 bunch of them between zero and four hours. What

1 kind of frequency is that?

2 MR. BURNS: The top -- I'll point with

3 my hands.

4 MEMBER APOSTOLAKIS: We have everything

5 here.

6 MR. BURNS: NUREG-1150, this is ten to

7 the minus six.

8 MEMBER APOSTOLAKIS: Okay. And this now

9 what?

10 MEMBER WALLIS: Ten to the minus four on

11 top?

12 MR. BURNS: Ten to the minus six, ten

13 to the minus five, ten to the minus four.

14 MEMBER WALLIS: Okay.

15 MR. BURNS: Ten to the minus seven,

16 right, nine.

17 MEMBER APOSTOLAKIS: And this is a

18 release. I mean, you're showing the warning time.

19 Is that a substantial release.

20 MR. BURNS: I'll show you the details

21 of a couple.

22 MEMBER CORRADINI: So just to be clear,

23 so you gave us numbers but just to be clear all of

24 these involve some form of containment failure from

25 NUREG-1150 analyses or some of these just even

1 leakage from an intact containment?

2 MR. BURNS: There are source terms in

3 here that correspond to no containment failure.

4 MEMBER CORRADINI: So it's the whole

5 enchilada?

6 MR. BURNS: That's right.

7 MEMBER CORRADINI: And this is only

8 NUREG-1150 data?

9 MR. BURNS: No. It also includes low

10 power and shutdown and the --

11 MEMBER CORRADINI: Oh, excuse me. I'm

12 sorry. I'm sorry.

13 MR. BURNS: From the previous slide.

14 MEMBER CORRADINI: Sorry.

15 VICE CHAIR BONACA: But most of this

16 data is NUREG-1150?

17 MR. BURNS: Predominately, yes.

18 VICE CHAIR BONACA: Now 3.2 is a part of

19 the figure, right?

20 MR. BURNS: Yes, 3.2 is basically --

21 I'll show you. Go back to it, please.

22 MEMBER WALLIS: Actually, it's rather a

23 remarkable figure. I notice that the BWRs releases

24 only occur at either 1½ hour or at 7 hours? Nothing

25 else is allowed.

1 MR. BURNS: That's the way that the
2 data fell out.
3 VICE CHAIR BONACA: Go back to that
4 question I had before I didn't get, which one is
5 3.2?
6 MR. BURNS: I'm sorry. Yes. So that
7 Figure 3.2 and I'll show you in a moment -- so less
8 than 4 hours, greater than ten to the minus six
9 according to NUREG-1150 circa information.
10 MEMBER BANERJEE: What accounts for the
11 sort of vertical nature of these things?
12 MEMBER MAYNARD: Uncertainty.
13 MEMBER KRESS: Free downstream.
14 MR. BURNS: Similarities in the way the
15 calculations were done between plants.
16 MEMBER KRESS: Downstream.
17 MR. BURNS: If you go through the
18 NUREG-1150 data, one thing that struck me was a lot
19 of those source terms really did lay out very
20 similarly between plants. And I don't know if that
21 represents the way the teams that were doing those
22 simulations were interacting. But basically this is
23 just a regurgitation of the data.
24 MEMBER ARMIJO: So that string of
25 vertical data points at about six hours, that one

1 there, is that all the same accident analyzed for
2 different plants?
3 MR. BURNS: I'd have to go back and
4 look and look more carefully.
5 MEMBER APOSTOLAKIS: Well, because you
6 didn't have so many plants. There was only five.
7 MR. BURNS: Yes. Right.
8 MEMBER APOSTOLAKIS: There were three
9 PWRs and two BWRs.
10 MEMBER ARMIJO: Okay. So it's got to be
11 something else. Yes.
12 MEMBER APOSTOLAKIS: It has to be
13 something else.
14 MEMBER CORRADINI: But just to reflect
15 back on it, it was a number of accidents and a
16 number of physical events that were analyzed. And a
17 lot of it was essentially estimates by expert panels
18 as to what would be the failure mode and therefore
19 the associated release. So for any one plant you
20 would have a number of failure modes at various
21 times.
22 MEMBER ARMIJO: That controlled the
23 time.
24 MEMBER BANERJEE: It's probably five
25 hours, six hours, seven hours. So estimated five

1 hours or something.

2 MEMBER ARMIJO: Okay.

3 MR. BURNS: The next slides might

4 answer some of these questions.

5 So the way we came up with the

6 frequencies, now this is conditional containment

7 failure frequencies that I'm showing you. And it's

8 a very straightforward process that we use for

9 coming up with those numbers. First we identified

10 the core damage frequency and simply multiplied

11 that, which is a function of the plant damage state.

12 And multiplied that by the conditional containment

13 failure. And we broke it into simple bins. No

14 containment failure, early containment failure or

15 late containment failure and bypass events. So we

16 could do more frequencies for those.

17 MEMBER APOSTOLAKIS: You used just a

18 point value for the containment failure?

19 MR. BURNS: That's right. Yes. Just a

20 point value. Well --

21 MEMBER APOSTOLAKIS: There's a series of

22 frequency in 1150 that I found extremely interesting

23 there. The results of the Latin hyperkey, by the

24 way. But they really range almost from zero to one,

25 don't they?

1 MR. BURNS: You'd have to tell me
2 specifically which figures you're referring to.
3 MEMBER APOSTOLAKIS: Well, they
4 condition of containment hyper frequency. I mean,
5 it's almost --
6 MR. BURNS: Yes. What we did for here
7 is NUREG-1150 quotes specific accident progression
8 bins.
9 MEMBER APOSTOLAKIS: Yes.
10 MR. BURNS: What I did is I choose the
11 most frequent accident progression bin that
12 corresponded to a specific sequence. So let me defer
13 that --
14 MEMBER APOSTOLAKIS: So these numbers
15 are typically very close to one? Because the
16 uncertainty range there, I mean you almost get the
17 feeling that the containment is useless. Is that
18 correct?
19 MEMBER KRESS: No.
20 MEMBER APOSTOLAKIS: They were zero to
21 one almost.
22 MEMBER POWERS: The single biggest
23 conclusion I think out of NUREG-1150 was that so
24 many of accidents were actually arrested in vessel.
25 That is the single biggest conclusion.

1 MEMBER APOSTOLAKIS: But when it came to
2 failure of the containment --
3 MEMBER POWERS: Then you have to fail
4 the vessel first. That's the condition. And when it
5 does that, then yes, the uncertainty range over the
6 span of plan --
7 MEMBER APOSTOLAKIS: Right.
8 MEMBER POWERS: -- is zero to one. Now
9 most people don't look at it in the span of plan.
10 It's most people look at it as BWR versus PWR. And
11 the BWR case essentially you're guaranteed a
12 failure. I mean, essentially.
13 MEMBER CORRADINI: Yes. The 95
14 percentile is like --
15 MEMBER POWERS: Conditional on rupturing
16 the vessel. In fact, many of the BWR sequences
17 actually bust the containment before they go through
18 the vessel.
19 In the PWR situation it depends on which
20 containment you have. And the large dries, I think
21 the large dries conditional failure probability is
22 around .1, .2 someplace like that,
23 MEMBER APOSTOLAKIS: Sure.
24 MEMBER POWERS: It's quite low. And the
25 ice condenser, of course, is low normal.

1 MEMBER APOSTOLAKIS: Of these, Dana, it
2 says conditional containment failure; I assume the
3 vessel has failed. It's not what the condition is?
4 MR. BURNS: Not necessarily, no. This
5 is our no containment failure, so -- I'm sorry. So
6 you will have core damage, that's the one you could
7 have.
8 MEMBER APOSTOLAKIS: But necessarily
9 containment?
10 MR. BURNS: Not necessarily this.
11 MEMBER KRESS: Yes, but almost all of
12 this going down, it means vessel failure also.
13 MEMBER POWERS: No. No. That's the
14 biggest single conclusion coming out of 1150 is that
15 so many of the accidents were arrested in vessel. I
16 mean, that is the danger.
17 MR. BURNS: So you might have a
18 release, for example, through venting. But you
19 haven't failed the vessel necessarily.
20 So this might make it a little bit more
21 concrete. So if I picked on, for example, the Surry
22 blackout event, that's the initiating event. I know
23 what the core damage frequency for that event. Then
24 from the NUREG-1150 data I can also determine what
25 the conditional containment at failure frequencies

1 for different containment failures. So there's the
2 red box there, the red point indicates a no
3 containment failure event and the source term
4 associated with that. And the green box is what a
5 late containment failure, it would be a much longer
6 event and lower frequency. And then finally the
7 fast or the early containment failure, which in the
8 NUREG-1150 terminology simply means that the
9 containment fails at or before the vessel fails. So
10 an early containment failure for that same
11 initiating event is the blue point there.
12 MEMBER BANERJEE: And what are the
13 magnitudes of the source terms for these three
14 scenarios?
15 MR. BURNS: I will show on the next
16 slide. I'll show that.
17 MEMBER APOSTOLAKIS: So the main idea of
18 all this presentation is how soon can you have how
19 much, is that it? When you go --
20 MR. BURNS: The main purpose of what
21 I'm presenting here is how we selected the source
22 terms that we selected for this --
23 MEMBER APOSTOLAKIS: Yes, but you
24 selected them for some reason.
25 MR. BURNS: That's right. From--

1 MEMBER APOSTOLAKIS: To know how soon
2 how much is released, is that correct? Otherwise it
3 doesn't affect emergency planning.
4 MR. BURNS: What we were trying to do
5 is select high frequency -- probably scenarios to
6 add physical reality to the PAR analyses. We wanted
7 to find source terms that we thought were credible
8 rather than incredible source terms.
9 MEMBER APOSTOLAKIS: And since this is
10 not a risk-informed study, why are you doing this?
11 Why aren't you doing all of them?
12 MR. BURNS: Principally the scope of
13 the project.
14 MEMBER APOSTOLAKIS: Because it's risk-
15 informed in some respects? The sense that you are
16 looking at the dominant release --
17 MEMBER POWERS: George, everything in
18 reactor safety is risk-informed.
19 MEMBER APOSTOLAKIS: No.
20 MEMBER POWERS: Everything.
21 MEMBER APOSTOLAKIS: He's going with--
22 MEMBER POWERS: Everything is. The
23 agency does not do things because they have a wild
24 hair to do it. They do it because of some perceived
25 risk. A few things have quantitative risk

1 assessment. But everything is risk-informed.

2 MEMBER APOSTOLAKIS: But the tradition

3 is when you say risk-informed you mean quantitative.

4 MEMBER POWERS: No.

5 MEMBER APOSTOLAKIS: Of course. Or

6 otherwise we have been risk-informed since 1961.

7 MEMBER POWERS: I agree with that.

8 MEMBER APOSTOLAKIS: On November 3rd.

9 MEMBER POWERS: And we have.

10 MEMBER APOSTOLAKIS: No. That's not

11 true. That's not true. When we say we are becoming

12 risk-informed, we mean quantitative --

13 MR. BURNS: Perhaps I can answer your

14 question this way: We're selecting the high

15 frequency source term.

16 MEMBER APOSTOLAKIS: Right.

17 MR. BURNS: So we're identifying the

18 riskiest source terms.

19 MEMBER APOSTOLAKIS: I understand.

20 MR. BURNS: I that sense --

21 MEMBER APOSTOLAKIS: Yes.

22 MEMBER WALLIS: Well let me ask you,

23 since you're only doing a qualitative comparative

24 study what's sort of level of detail do you need in

25 this source term?

1 MR. SULLIVAN: Well, it's an interesting
2 question. When we started out, my initial vision for
3 this was to have a normalized source term and vary
4 the time. We could have just had one and then just
5 compare the different emergency response regimens.
6 MEMBER KRESS: And it would have
7 probably worked.
8 MR. SULLIVAN: Well, yes. I thought so.
9 But the Staff working on it felt that we ought to do
10 just want Shawn said. You know, add a bit of
11 reality to the study and pick some source terms
12 through some thought process from NUREG-1150. But
13 we did talk about that exact thing, and it was the
14 original vision.
15 We went down this path because we
16 thought it would be, you know, it would add more--
17 MR. BURNS: Credibility, yes.
18 MR. SULLIVAN: -- credibility. So that's
19 how we got where we got.
20 MR. BURNS: So let me just finish up on
21 the last couple of slides here. Can we go to the
22 next slide.
23 So as I said before, we have a 150
24 source terms on that plot, but we can't analyze them
25 all. So we need to select a couple. And so we

1 focused on that upper left corner of that plot to
2 identify the source terms that were rapidly breaking
3 or potentially rapidly breaking and the most
4 frequent rather than --
5 MEMBER BANERJEE: But also the magnitude
6 would matter, right?
7 MR. SULLIVAN: Yes.
8 MR. BURNS: Well the magnitude comes
9 along --
10 MEMBER BANERJEE: It doesn't show up
11 here in this. Does it have a dimension to this?
12 MR. BURNS: Correct. Maybe I'll show
13 you that on the next slide.
14 MEMBER WALLIS: You do have other plots
15 in your report of magnitude, too.
16 MR. BURNS: That's right.
17 MEMBER BANERJEE: Yes.
18 MR. BURNS: But the source terms
19 weren't selected on that basis. We're selecting
20 them on --
21 MEMBER BANERJEE: Frequency.
22 MR. BURNS: -- frequency and time to
23 release, and then whatever -- that's why we went
24 down this route. Because the magnitude would just
25 come out of the analyses that went into NUREG-1150.

1 MEMBER KRESS: Now when you invoke an
2 emergency plan, if you had to invoke one, does this
3 study presume that you know when you're going to
4 have your release?
5 MR. BURNS: But let me wait to the last
6 slide.
7 MEMBER KRESS: Okay.
8 MR. SULLIVAN: Actually, one of the
9 difficulties we had in dealing with NUREG-1150 is
10 they had a thing called a warning time. Well, that
11 doesn't exactly align with how we operate today and
12 post-TMI, really.
13 At the general emergency protective
14 actions are implemented. Whether there is a release
15 or not, whether the core damage is extensive or
16 not--
17 MEMBER KRESS: Well, I would have
18 thought that would have been the way to go.
19 MR. SULLIVAN: Yes.
20 MEMBER KRESS: Because I'm not so sure
21 how confident I would be in a warning time.
22 MR. SULLIVAN: Yes.
23 MEMBER KRESS: When something is going
24 on in my plant and I have to tell you well we got
25 two hours before there is going to be a release.

1 I'm not sure I'm comfortable with that.

2 MR. SULLIVAN: Right. In these events

3 we assumed in the one case 45 minutes, in the other

4 case three hours between the general emergency and

5 the release.

6 MEMBER APOSTOLAKIS: Would you repeat,

7 please?

8 MR. SULLIVAN: Yes. We assumed 45

9 minutes in the one case and three hours in the other

10 case between the general emergency and the release.

11 So protective actions got moving at the general

12 emergency. There's 15 minutes to notify, 15 minutes

13 to tell the public, some time for them to get moving

14 and we started them moving--

15 MEMBER APOSTOLAKIS: So you're going to

16 do much better than at TMI where there seemed to be

17 a lot of confusion about what was going on and

18 whether or not there should be an emergency?

19 MR. SULLIVAN: The answer is yes. Yes.

20 MEMBER APOSTOLAKIS: And this went on

21 for many hours.

22 MR. SULLIVAN: We would do much better

23 than TMI.

24 MR. BURNS: Yes. Yes.

25 MEMBER KRESS: What is the

1 characteristics that constitute declaring a general
2 emergency?
3 MR. SULLIVAN: Well, they're various.
4 I'll go through two for you.
5 The simplest one is at the BWR if water
6 level is top of active fuel, you have a general
7 emergency. Now there's been no core damage, right?
8 I mean, most probably water is going down.
9 MEMBER KRESS: Right. Yes, I like that.
10 What's the PWR one?
11 MR. SULLIVAN: I believe it's the same,
12 but let me go to station blackout because I know
13 that one better.
14 At station blackout when you lose off
15 site power and diesels and you have a site area
16 emergency.
17 MEMBER KRESS: Yes, that's pretty
18 obvious, I'd say, yes, for that.
19 MR. SULLIVAN: When you exceed the
20 committed SBO coping time you have the general
21 emergency. Now the committed coping time is the one
22 in procedures, it may be 2 or 4 hours and the
23 batteries may really last for 7 or for 12, for all I
24 know.
25 MEMBER KRESS: Yes.

1 MR. SULLIVAN: But that is the general
2 emergency. People would be evacuated at that point.
3 For instance, at Peach Bottom --
4 MEMBER CORRADINI: Could I just clarify?
5 Could I just clarify?
6 So site area I think I understood. The
7 general emergency, is that when you start this clock
8 of 15 minutes, 15 minutes and et cetera?
9 MR. SULLIVAN: Yes.
10 MEMBER CORRADINI: Okay. Fine.
11 MEMBER KRESS: So if I would
12 characterize it, we're having some sort of incident
13 going on that symptoms are such that it's severe
14 enough to declare a site emergency. There's been no
15 release, no core melt or anything. The strategy is
16 we're going to evacuate.
17 MR. SULLIVAN: That's right.
18 MEMBER KRESS: Now, that can't be a
19 keyhole evacuation; that's got to be everybody --
20 MR. SULLIVAN: No, no. It's a keyhole.
21 Right.
22 MEMBER KRESS: It's a keyhole? Because
23 you know what wind is blowing right then?
24 MR. SULLIVAN: Yes, you do.
25 MEMBER KRESS: Okay.

1 MR. SULLIVAN: Everywhere but -- well,
2 I'm sorry. I don't mean to get too deep into
3 details.
4 We expect the license to give a
5 technical protective action recommendation of two
6 and five miles.
7 MEMBER KRESS: Okay.
8 MR. SULLIVAN: The state and country may
9 do something completely different. For instance, in
10 Pennsylvania they will do nothing but a ten mile
11 360.
12 MEMBER KRESS: Okay. And I like that
13 strategy.
14 Now the second case is we have a really
15 fast developing accident and we've already released
16 fission products long before you have warning time
17 and stuff. And this is the second type of accident.
18 I mean, I'm going to talk about two types of that
19 thing. That's one.
20 MR. SULLIVAN: I'm with you.
21 MEMBER KRESS: Now it seems to me like
22 your strategy there has to be completely different.
23 MR. SULLIVAN: It should be.
24 MEMBER KRESS: Oh, okay. You're going
25 to talk about that one?

1 MR. SULLIVAN: That's the finding of the
2 study.
3 MEMBER KRESS: Okay.
4 MEMBER CORRADINI: So is that one of --
5 what he just said, is that one of the cases --
6 MR. SULLIVAN: Yes.
7 MEMBER CORRADINI: -- where before you
8 even declare the general emergency there is a
9 release?
10 MR. SULLIVAN: Well, no, we don't--
11 MEMBER CORRADINI: Isn't that what you
12 just said?
13 MEMBER KRESS: Yes, but maybe you're
14 getting close --
15 MR. SULLIVAN: Maybe. But what we
16 expect to have happen, the fast breaker or the large
17 early release that we used was 45 minute release
18 after general emergency.
19 MEMBER BANERJEE: That was the real
20 severe.
21 MR. SULLIVAN: All right. So that's
22 pretty quick. That's essentially zero, because the
23 15/15 and something is essentially --
24 MEMBER CORRADINI: That's something.
25 MR. SULLIVAN: Right.

1 MEMBER CORRADINI: So the people are
2 just beginning to move when the release starts.
3 MEMBER BANERJEE: This gives you the
4 halogen release corresponding I guess to the -- in
5 the previous slide --
6 MR. BURNS: Yes. Go back to the
7 previous slide. We looked at that top left hand
8 Figure 3.1 and we choose these two source terms.
9 The one in the lower left hand corner we choose
10 because it was the fastest breaking --
11 MEMBER BANERJEE: Use the pointer.
12 MR. BURNS: Excuse me. I'm sorry.
13 So choose this source term in the lower
14 left hand corner based on its rapid release time.
15 Now, this is the point that Randy was making; this
16 is all relative to warning time as far as NUREG-1150
17 quoted it, which really corresponds to the onset of
18 core damage. So this assumes perfect knowledge of
19 what's going on within the reactor.
20 And the last slide we'll talk about the
21 implications of that.
22 MEMBER BANERJEE: Now just to clarify
23 this, that point may or may not have a much larger
24 release than, let's say, the adjacent -- no -- no --
25 MR. BURNS: That's right.

1 MEMBER BANERJEE: Or the one above that.
2 MR. BURNS: Right.
3 MEMBER BANERJEE: So, I mean, is this
4 sort of a bounding case then or not?
5 MR. BURNS: The order of effect we're
6 looking for is this time you have to evacuate. This
7 release time relative to warning time is the time
8 you have to get people moving. So that's the zero
9 order effect we were trying to capture here.
10 MR. SULLIVAN: Dr. Banerjee, let me also
11 remind you that we're doing a comparative study
12 rather than an absolute study. So if we choose a
13 source term that was a little bit north or south of
14 this one, we're still going to normalize it against
15 the standard PAR and our ideas for new PARs and look
16 at is better or worse.
17 MEMBER KRESS: You're going to look at a
18 percent change.
19 MEMBER BANERJEE: Yes. As long as the
20 release is large enough --
21 MR. SULLIVAN: Well, yes.
22 VICE CHAIR BONACA: Yes. You're going
23 through a lot of details here, which is good, but
24 I'm saying that the dependency on estimated
25 evacuation time, it's so fundamental. I mean, if

1 you take a release like this, in 45 minutes you have
2 a release.
3 MR. SULLIVAN: Yes.
4 VICE CHAIR BONACA: And yet evacuation
5 time is six hours.
6 MR. SULLIVAN: Yes.
7 VICE CHAIR BONACA: It's a no-brainer.
8 I mean, you don't need to do -- just Supplement 3
9 has to be modified because you need to have -- the
10 only thing you can do is shelter. And you have no
11 other option.
12 So some of these sensitivities are not
13 so -- you know --
14 MEMBER BANERJEE: Those are iodine
15 tablets.
16 VICE CHAIR BONACA: It depends very much
17 on those times.
18 MR. SULLIVAN: Are you from Princeton?
19 VICE CHAIR BONACA: You could go on
20 without any specific information on that.
21 MR. SULLIVAN: Well, what you described
22 is actually in the statement of work, you know,
23 because that was the Staff's suspicion before we got
24 started. It's kind of a no-brainer.
25 VICE CHAIR BONACA: But the whole issue

1 is, you know, do you have that as a credible
2 accident? Well, I think that at the present time we
3 have to cope with a gambit of credible accidents or
4 all accidents, it seems to me. And that 45 minutes.
5 MEMBER MAYNARD: Well, I can't speak for
6 all plants, but most plants do have sheltering as
7 one of the options for corrective action, corrective
8 states.
9 MR. SULLIVAN: Yes. Yes, they do.
10 MEMBER MAYNARD: Depending on the
11 release, the timing and also weather and other
12 conditions and stuff.
13 MR. SULLIVAN: That's right. Right.
14 MEMBER KRESS: Yes, but do they have a
15 combination? If you know where the plume is going
16 and you know you've already got a release before you
17 have time to fully evacuate, can you get the people
18 out of the way of the plume but shelter everybody
19 else? That's a sort of a combination.
20 MR. SULLIVAN: You know, those options
21 are available to the plants, and that's true, but
22 we're practicing something differently. What we're
23 practicing is immediate two miles and five miles
24 downwind. That's what we practice.
25 Now if somebody were to say, whoa, wait

1 a second, hold on they have the tools and they're
2 allowed to do something different and, hopefully
3 they would. We think our PARs ought to be a bit
4 more sophisticated.
5 MEMBER MAYNARD: Most plants have the
6 ability. In fact, the PARs that you put out will
7 typically be divided into your pie shape, the two
8 and the five, and you can have a different
9 recommendation in one area than what you give for
10 another.
11 MR. SULLIVAN: That's right. Sure you
12 can. Right. Sure you can.
13 VICE CHAIR BONACA: But you have tested
14 that in the report. You have tested a number of
15 strategies, a combination of evacuation and
16 sheltering?
17 MEMBER MAYNARD: But I think the
18 emphasis has been on evacuation more than
19 sheltering.
20 MR. SULLIVAN: It really has.
21 VICE CHAIR BONACA: Exactly.
22 MEMBER MAYNARD: And that's where the
23 emphasis has been.
24 MR. SULLIVAN: And that may not be right
25 in every case.

1 MEMBER CORRADINI: So maybe this is
2 going to happen later night. I guess I'm not
3 exactly sure how to ask it. So you're talking about
4 tie-ins. The other two things that are obvious to
5 me are population density and geometric terrain.
6 MR. SULLIVAN: Yes.
7 MEMBER CORRADINI: So have you picked a
8 location or are these locations the plant sites--
9 MR. BURNS: We'll get to that.
10 MR. SULLIVAN: You're going to come to
11 that.
12 MR. BURNS: Yes, we're going to come to
13 that.
14 MR. BURNS: So now go back to the last
15 slide just one more brief second. So to bracket the
16 time sensitivity, the other source term we choose
17 was a later release. And just simply because the
18 frequency seemed to be the obvious choice.
19 MEMBER KRESS: Now the answer to that
20 one is evacuate, right?
21 MEMBER MAYNARD: Right.
22 MR. BURNS: Yes, we're trying to
23 identify of efficacy of evacuation versus
24 sheltering. So we're trying to bracket it. It's,
25 we feel, it's somewhere in the range. So getting on

1 either side of this --

2 MEMBER KRESS: You're on the inside of

3 it probably.

4 MR. BURNS: Yes. So on the next slide

5 what I've done here is just put the halogen release

6 corresponding to each of those --

7 MEMBER WALLIS: Now that's mostly

8 iodine, you say?

9 MR. BURNS: That's mostly iodine,

10 that's right.

11 MEMBER WALLIS: So if we said iodine, it

12 would be almost the same?

13 MR. BURNS: Yes. That's the core

14 inventory number I quote in here.

15 So the first source term, that one in

16 the lower left hand corner, is characterized by

17 early release time and a rapid rise. This is

18 actually an interfacing system LOCA accident is what

19 it really is.

20 The other source term had a later

21 release combined with a slower rate of release as

22 well. So there's still this nagging doubt about what

23 is -- we know the time has a zero order effect; what

24 is the effect of these details of how the release

25 occurs over time? So the handle in that fairly ad

1 hoc approach, we simply transposed these two source
2 terms and created two more ad hoc source terms where
3 we just took the release time for this first guy and
4 it applied it to the second release.
5 MEMBER BANERJEE: Surely you could have
6 found in those many accidents a more realistic--
7 MR. BURNS: Probably we could have.
8 But we were thinking also that the details -- what
9 we're really interested in is the efficacy of the
10 evacuation, not the details of the source terms. And
11 it seemed like this was a quick way of just--
12 MEMBER KRESS: As long as you get up to
13 that -0
14 MEMBER WALLIS: I think you're probably
15 assuming it doesn't matter too much how well you
16 define these, as we discussed earlier.
17 MEMBER BANERJEE: Well, they're trying
18 to get two bounding scenarios; one goes this way and
19 one goes that way.
20 MR. BURNS: That was the other next
21 thing about these source terms; they did have
22 different slopes after release.
23 MEMBER WALLIS: Yes, right.
24 MR. BURNS: So by transposing them we
25 felt we were kind of --

1 MEMBER WALLIS: Right. You're going to
2 look at your results and say do they make much
3 difference, and then if it did make a big
4 difference, you might want to go back and change
5 your initial assumption.
6 MR. BURNS: I don't think we went back
7 to analyze it.
8 MEMBER BANERJEE: If the shape makes a
9 difference, then that needs to be explored further.
10 But if the shape doesn't make too much of a
11 difference.
12 MR. BURNS: I'm not sure that we looked
13 and analyzed the effect of the shape. We just used
14 these. We now have four source terms to analyze--
15 MEMBER BANERJEE: Anyway we can see what
16 happens.
17 MR. SULLIVAN: The way it came out was
18 really the only source term that was different was
19 the large early release. You know, the other three
20 -- I mean, it's two source terms and then they're
21 just simply reversed, but --
22 MR. BURNS: Could I have the pointer.
23 MR. SULLIVAN: Sure. This source term
24 ended up being a special case. Everything else kind
25 of flowed together. It didn't make a lit of

1 difference as might be expected. And then, of
2 course, when we used the no containment failure
3 source term, you have time to do most anything you
4 want.
5 Now, a large source in containment will
6 result in a general emergency and could,
7 theoretically, result in exceeding the protective
8 action guides off site. But you have hours and
9 hours, you know, 20 hours or something. And the
10 wind might not blow in the same direction for 20
11 hours anyway. But --
12 MEMBER BANERJEE: But what happens?
13 Because the typically the wind does shift depending
14 on the time of the day and stuff like that?
15 MR. SULLIVAN: That's right.
16 MEMBER BANERJEE: So if you do this
17 keyhole thing and then the wind shifts, then you do
18 another keyhole or --
19 MR. SULLIVAN: We just had that
20 discussion today. In fact, the emergency response
21 organization can activate in about an hour. You'll
22 have a good organization controlling the
23 organization -- you know, controlling the response
24 in about an hour. So the operators are on their own
25 for the first hour or so.

1 The operators will come up -- if the
2 accident really moves that rapidly that you're at
3 general emergency in the first hour, perhaps
4 unlikely in most scenarios, but the large early
5 release could be this. They'll make an initial
6 protective action recommendation two and five
7 downwind.
8 As the organization comes in we have
9 people cognizant of meteorology, dose projection
10 analysts, engineering specialists, on and on and on.
11 They look at the weather forecast to see if the wind
12 is going to shift. They have a met tower, they see
13 if the wind has shifted. Then they change their
14 protective action recommendation.
15 MEMBER BANERJEE: And they have,
16 presumably, downwind monitors.
17 MR. SULLIVAN: They have at least a
18 couple of monitors in the first couple of hours.
19 MEMBER BANERJEE: Yes, so they can
20 validate these things.
21 MEMBER MAYNARD: And you're required if
22 the conditions change to revisit the protective
23 action recommendations.
24 MR. SULLIVAN: That's right.
25 MEMBER MAYNARD: And then periodically

1 you have to revisit it even if they haven't changed.
2 So there are requirements.
3 MR. SULLIVAN: So we would see either --
4 if the wind didn't change and it was a bad source
5 term, they might go out further with the evacuation.
6 If the wind did change, they might add additional
7 segments two to five miles.
8 VICE CHAIR BONACA: It depends also the
9 roads and, you know, what kind of situation you
10 have.
11 MEMBER WALLIS: It's the wind. I mean,
12 if you think of Vermont Yankee, you could easily
13 have two feet of snow that fell the night before.
14 MR. SULLIVAN: That's right.
15 MEMBER WALLIS: In which case you'd
16 probably change your response.
17 MR. SULLIVAN: Yes, you would.
18 MEMBER APOSTOLAKIS: Now let me
19 understand--
20 MEMBER WALLIS: Okay. We need to move
21 on.
22 MEMBER APOSTOLAKIS: you said earlier
23 that the rapid early release is the one that really
24 matters.
25 MR. SULLIVAN: It's different than the

1 other three in terms of results, yes.

2 MEMBER APOSTOLAKIS: Yes. In more

3 severe results?

4 MR. SULLIVAN: Yes.

5 MEMBER APOSTOLAKIS: And this is

6 primarily interfacing system LOCA?

7 MR. BURNS: That's right. Bypass.

8 MEMBER APOSTOLAKIS: Bypass frequency

9 being around --

10 MR. BURNS: Ten to the minus six

11 according to NUREG-1150. Now there's reason to hold

12 that suspect.

13 MEMBER APOSTOLAKIS: So when I see

14 results for this one?

15 MR. SULLIVAN: We're going to discuss it

16 a bit more.

17 MEMBER APOSTOLAKIS: Okay.

18 MR. SULLIVAN: It's actually a very

19 interesting --

20 MEMBER APOSTOLAKIS: I'll wait until

21 then.

22 MEMBER WALLIS: Yes. We need to move on

23 because we have --

24 MEMBER APOSTOLAKIS: Did you consider at

25 all external events here?

1 MR. BURNS: I am sorry?

2 MEMBER MAYNARD: External and internal.

3 MR. BURNS: Internal and external

4 events are represented in Figure 3.1.

5 MEMBER BANERJEE: Let me just ask --

6 MEMBER APOSTOLAKIS: I'm trying to

7 understand why yesterday in the SOARCA evaluation it

8 was the seismic contribution that was considered --

9 MR. BURNS: The differences between

10 this study and SOARCA might be because the

11 references. There's more recent data that's being

12 used in the SOARCA analyses, SOARCA selection

13 process. This is all purely NUREG-1150 data.

14 MEMBER APOSTOLAKIS: Did they go with

15 NUREG-1150, too?

16 MR. BURNS: No.

17 MEMBER APOSTOLAKIS: How do they --

18 CHAIRMAN SHACK: They cut off at ten to

19 the minus six. They are reexamining the frequencies

20 of the events which shift that axis up and down. You

21 know, they might look the same, except you just

22 moved everything up and down a few --

23 MEMBER CORRADINI: That's why their

24 graph early on had no numbers. Those numbers could

25 be two orders of magnitude lower, although the

1 source terms might be the same.

2 CHAIRMAN SHACK: And remember, we were

3 at a closed session there, George. We don't want to

4 get too -- when we discuss the results that you may

5 be talking of, just remember --

6 MEMBER APOSTOLAKIS: But didn't they

7 tell us that they looked at 1150 yesterday?

8 MR. BURNS: There was some data that

9 was --

10 MEMBER APOSTOLAKIS: It was 1150.

11 MEMBER BANERJEE: Some data.

12 MEMBER APOSTOLAKIS: For Peach Bottom.

13 MR. BURNS: They did look at NUREG-

14 1150, but in addition they looked at IPEEE --

15 MEMBER MAYNARD: IPEEE and the SPAR.

16 MR. BURNS: -- and the enhanced SPAR

17 models were also used.

18 MEMBER MAYNARD: Yes.

19 MR. BURNS: So there's new data that

20 has been put into the SOARCA analysis.

21 MEMBER APOSTOLAKIS: I mean why did they

22 choose to look at the seismic and you not?

23 MR. BURNS: We do. There are

24 seismically initiated events in Figure 3.1. In that

25 collection of that 150 source terms we have

1 internally and externally initiated events drawn
2 directly from NUREG-1150 and the study.
3 MEMBER APOSTOLAKIS: So you're not going
4 strictly by the frequency of release over --
5 VICE CHAIR BONACA: They wanted to get a
6 representative of a rapidly developing event with a
7 typical source term to test the strategies.
8 MEMBER APOSTOLAKIS: So the seismic was
9 not rapid?
10 VICE CHAIR BONACA: Well, I mean, it
11 could be. Seismic certainly would be one that--
12 CHAIRMAN SHACK: He's not worried about
13 frequency. You know, he thinks that a rapidly
14 developing event is credible, and that's almost all
15 he needs to know in terms of frequency. He needs a
16 slow release as a credible event. So he's got two
17 credible events he has to deal with to sort of
18 bound--
19 MEMBER APOSTOLAKIS: But in terms of
20 emergency planning whether you have had an
21 earthquake or not makes a big different. That's
22 release. And that's why I'm confused now.
23 Yesterday we had the seismic as being
24 the chosen one, and today we have the bypass of the
25 containment. And I'm trying to understand why.

1 It would seem to me that the seismic,
2 especially when it comes to corrective actions,
3 would be really the big one. Because you may have
4 had damage on the emergency services and all that
5 stuff.
6 MEMBER WALLIS: It depends where you
7 are.
8 MEMBER APOSTOLAKIS: These earthquakes
9 are pretty serious. They don't just damage the plant
10 and everything else is fine.
11 MEMBER BANERJEE: As long as it happens
12 in California, the state vanishes the plant keeps
13 operating.
14 MEMBER CORRADINI: Let me ask Professor
15 Apostolakis a question differently, which is if you
16 went back to the crew you had without numbers and
17 those numbers changed from ten to the minus four,
18 ten to the minus five, ten to the minus six to two
19 orders of magnitude lower and all the external
20 events remained the same, so you had a shift of the
21 population of all the greens be internal and all the
22 reds being external and it did this, would your
23 results change as to how you did protective action?
24 That's kind of what he's asking. My expectation is
25 yes.

1 MR. BURNS: It would change the source
2 terms that we selected using this procedure that we
3 described.
4 MEMBER CORRADINI: But might it also
5 change how you even choose to say what to do outside
6 of the site? Because with an external event you
7 could damage all the infrastructure that you're
8 going to start using to move people and you can't
9 move them after three hours, because there ain't
10 nothing there to move them to. That's my way of
11 thinking about what he's asking.
12 MEMBER BANERJEE: Should there be
13 another strategy that he's --
14 MR. JONES: I think you have to look at
15 seismic as a separate. Otherwise you cannot compare
16 alternative protective actions.
17 MEMBER APOSTOLAKIS: So are you looking
18 at?
19 MR. SULLIVAN: No, we're not. But we
20 heard your message from yesterday in SOARCA, and in
21 fact --
22 MEMBER APOSTOLAKIS: You'll think about
23 it.
24 MR. BURNS: That's right.
25 MR. SULLIVAN: Although not that I'm the

1 whole Staff, but yes. We'll definitely think about
2 it.
3 MEMBER BANERJEE: But is there anything
4 you can do in such a situation?
5 MEMBER MAYNARD: But seismic is like
6 weather and other things. They're considerations
7 that you have to take into account when you're
8 actually given protective action recommendations.
9 That's the point.
10 MR. McMURTRAY: And the state ultimately
11 makes the protective action guidance out there to
12 the public
13 MR. SULLIVAN: Okay. WE used the MACCS2
14 code. The model that predates what you heard about
15 in SOARCA --
16 MEMBER WALLIS: In your previous slide
17 seemed to indicate that you're going to evacuate a
18 1,000 times more likely than they're going to have a
19 major release.
20 MEMBER KRESS: Yes, I mean --
21 MR. SULLIVAN: Those are the initiating
22 events. Unfortunately, I would have had liked to
23 have had that be general emergencies.
24 MEMBER WALLIS: It's a bit like crying
25 wolf, isn't it? I mean, you have all these

1 evacuations for no purpose.

2 MR. SULLIVAN: A general emergency is a

3 pretty serious event. And there hasn't been one

4 since TMI. There's has --

5 MEMBER WALLIS: That wasn't an

6 evacuation event.

7 MR. SULLIVAN: I'm sorry?

8 MEMBER WALLIS: That was not an

9 evacuation event, right?

10 MEMBER KRESS: No, but it was --

11 MEMBER WALLIS: But it was not an

12 evacuation.

13 MR. SULLIVAN: Well the term general

14 emergency I don't think existed at TMI. The whole

15 regimen is post-TMI that we're talking about.

16 So there's been no general emergencies.

17 General emergency is a fairly serious event. Yes,

18 indeed, if you ended up with reactor coolant level

19 at TAF, you would evacuate people. And, yes, indeed

20 you might not even have core damage if you recover.

21 We haven't cried wolf too many times

22 yet, so we haven't sought to change those kind of

23 criteria.

24 MEMBER BANERJEE: But your evacuation is

25 not weather dependent, whether it's process or class

1 A or --

2 MR. SULLIVAN: It is weather dependent.

3 That's why we insist that our licensee have the

4 ability to recommend sheltering. Should the weather

5 be so terrible that evacuation is more dangerous

6 than staying put, then we would expect sheltering to

7 take place. But I have to tell you --

8 VICE CHAIR BONACA: All these issues are

9 covered by the observation you made, Bill. I mean--

10 yes, go ahead.

11 CHAIRMAN SHACK: Your ETE covers in a

12 way some of these considerations that, you know,

13 obviously with an event --

14 VICE CHAIR BONACA: The weather,

15 seismic, whatever.

16 CHAIRMAN SHACK: -- would lead to a very

17 large ETE.

18 VICE CHAIR BONACA: Very large ETE.

19 MR. SULLIVAN: Yes. Evacuation time

20 estimate.

21 CHAIRMAN SHACK: And so it is indirectly

22 within your sort of parametric study to certain

23 extent.

24 MEMBER APOSTOLAKIS: So let's look at

25 some results.

1 MR. SULLIVAN: Okay.

2 VICE CHAIR BONACA: In a way this case,
3 for example, for a rapid event like that clearly
4 will lay forth the need for sheltering simply
5 because you can't move people. So some of it is,
6 again, it's common sense.

7 MR. SULLIVAN: We used a generic site.
8 Actually, we used a vanilla site. You know there's
9 62 sites. So what we did was we took not quite a
10 median population density. We simply picked a 100
11 people in a square kilometer. And it ends up being
12 80,000. You know, we're trying to do a national
13 level study.

14 Our vision was that perhaps site
15 specific studies, you know, could flow from this by
16 the licensee. But from our point of view our options
17 were either model the top 15, which would be a very
18 expensive process, or do a national level study that
19 will show you trends. And then if necessary, go on
20 to site specific where you are. So that's how we got
21 to where we are.

22 Now we took that same 80,000 people and
23 we varied the evacuation time from four hours to ten
24 hours. Evacuation time is an artifact of both the
25 pop density and the infrastructure and, I suppose,

1 the geology, the mountains and hills and bridges and
2 that sort of thing.
3 MEMBER WALLIS: These are people within
4 ten miles of the plant?
5 MR. SULLIVAN: Yes, that's right.
6 MEMBER WALLIS: 80,000 people?
7 MR. SULLIVAN: Is pretty much median.
8 MEMBER WALLIS: Wow.
9 MR. SULLIVAN: Maybe it's not median.
10 Maybe it's on the high end.
11 MEMBER WALLIS: It seems high to me.
12 MEMBER BANERJEE: Indian Point.
13 MR. SULLIVAN: Yes, it's pretty close to
14 median. Indian Point are much higher.
15 MEMBER BANERJEE: I'm saying biased, but
16 in point.
17 CHAIRMAN SHACK: No, but median isn't
18 biased. That's why you use median.
19 MR. SULLIVAN: That's not an exact
20 median, folks. But, you know, we are in the middle
21 of the span.
22 We also varied travel speed.
23 Here's what we tested? Of course
24 shelter in place, which is within the regimen. We
25 thought about using preferred shelter; large

1 buildings, schools, gymnasium. A lot of problems
2 with that. But, you know, we thought if you have a
3 high pop density, most probably there's large
4 buildings close to you. And maybe they could be used
5 in an effective manner. It turns out to be not such
6 a good idea --
7 MEMBER BANERJEE: So why is that? In
8 the old days there were bomb shelters.
9 MR. SULLIVAN: Yes. There are several
10 reasons. Compliance of the public is one. Once
11 they get in their cars are they really going to stop
12 at the school? The logistics of getting somebody
13 there to open the facility before the public arrives
14 is not easy. In fact, you have to have ventilation.
15 If you're going to have a thousand people in a
16 building, there must be ventilation. And if you
17 have ventilation in a plume, you're almost defeating
18 your whole purpose.
19 In a house, you can shelter, you can
20 close windows, turn off ventilation and you're not
21 going to suffocate.
22 If you put a 1,000 people in a gymnasium
23 and you turn off ventilation, it's not a safe
24 environment.
25 So there's a thing that we found called

1 lateral evaluation. It's really quite effective. You
2 move perpendicular to the plume. Sometimes you can
3 reduce dose.
4 There's sort of an ironic thing. We
5 talked to several states about doing this and the
6 states with the big populations said we're already
7 using every road we got. Will you please look at
8 our map? You know, there are no alternate routes
9 that can be used.
10 And the sites where this would have been
11 useful, like out in the midwest where there's a road
12 every 160 acres, they have low population. They
13 don't need it. They could just flow.
14 So although it's a good idea on paper,
15 and there may be sites where it's applicable. I
16 mean, this could be possible at certain sites, it's
17 not universal.
18 Then we tried to model staged evacuation
19 where you evacuate the inner ring first and then
20 further out. And that showed some promise.
21 MEMBER APOSTOLAKIS: Now sheltering in
22 place includes staying in your house?
23 MR. SULLIVAN: That is what it is. In
24 your house or in school --
25 MR. BURNS: That's the next one,

1 preferred shelter at various times.

2 MR. SULLIVAN: The second bullet is

3 preferred shelter.

4 MEMBER APOSTOLAKIS: And why is not --

5 MR. SULLIVAN: Shelter in place is stay

6 in your house or stay in your house or stay in the

7 shopping mall.

8 MEMBER APOSTOLAKIS: Okay. That's what

9 I think. Right.

10 MR. SULLIVAN: The second one is leave

11 your house and go to the high school.

12 MEMBER APOSTOLAKIS: And why would I do

13 that?

14 MR. SULLIVAN: Because if you had a long

15 evacuation time, if you were going to be on the road

16 for ten hours it might reduce consequences if

17 instead you went to a substantial building and got

18 sheltered rather than get in your car for ten hours.

19 MEMBER BANERJEE: Provided you could

20 control the ventilation and take out the iodine. We

21 concluded at the end that that was not advisable.

22 MEMBER APOSTOLAKIS: What is not

23 advisable?

24 MEMBER BANERJEE: This preferred

25 sheltering in special events there. They concluded

1 at the end that it really was not advisable. Look
2 through their reasons.
3 MR. SULLIVAN: -- in large buildings it
4 turns out to be a bad idea.
5 MEMBER APOSTOLAKIS: A bad idea?
6 MR. SULLIVAN: We thought it might have
7 merit. When you study it, it doesn't.
8 MEMBER APOSTOLAKIS: Right. Right.
9 MR. SULLIVAN: We chatted with three
10 states and asked their advice so we could get off of
11 the technical paper and talk to the people who
12 actually would have to implement these plans. And
13 they gave us the benefit of their views. It was
14 really quite instructive to be brought back down to
15 earth.
16 We did a sociological review. I found
17 that particularly interesting. There's actually a
18 field of disaster response sociology and there's
19 dozens of sociologists who do this for a living.
20 You know, we've come to several
21 conclusions. The public will do what they're asked
22 to do as long as you can convince them that it's
23 convinced for them. So there's messaging issues,
24 there's credibility issues.
25 If, like at TMI that Dr. Wallis brings

1 up, you have conflicting messages and an information
2 vacuum, you will get confusion. I don't think chaos
3 is the right word, but there will be confusion.
4 However, if you message it properly, you're
5 consistent and you give the public information, they
6 will do what they're asked to do as long as they are
7 convinced that it improves their safety.
8 We learned a lot of other sociological
9 stuff. If we publish this report, we would probably
10 have a lot of advice on how to message --
11 MEMBER APOSTOLAKIS: Now when we say
12 "public" in this case, we mean a majority of people,
13 I suppose?
14 MR. SULLIVAN: Well, you know that's
15 interesting, Dr. Apostolakis.
16 MEMBER APOSTOLAKIS: I don't know what
17 the public is. Who they are.
18 MR. SULLIVAN: It's always a majority.
19 It's most. Some are going to do what they're going
20 to do. There's always a shadow evacuation. Some
21 are going to leave, you know, as soon as they catch
22 wind of the problem. Some are going to stay.
23 For the purposes of our study those
24 people normalize out. Because if they're going to
25 stay, no matter what we tell them to do, we don't

1 have to consider them. If they're going to leave
2 early, that doesn't matter either. You know, we're
3 just looking like what's better or worse.
4 Now in SOARCA we have to address those
5 issues. And I hope Joe told you what we figured out
6 yesterday.
7 But this is what our data looks like. I
8 just picked an interesting slide. This is source
9 term 2. Really what it shows is we end up with a
10 lot of zeros when you --
11 MEMBER APOSTOLAKIS: Well, let me
12 understand. This is rapid-early or what?
13 MR. SULLIVAN: This is the three hour
14 release, and it's a ten hour ETE. So it's a long
15 ETE, but it's the release that takes longer--
16 MEMBER BANERJEE: It's a slowly
17 developing release.
18 MR. SULLIVAN: Yes. Thank you.
19 MEMBER KRESS: These are the differences
20 in this --
21 MR. SULLIVAN: Early fatalities and
22 latent cancer fatalities.
23 MEMBER KRESS: Yes, but 30 fatalities
24 for this condition versus the standard?
25 MR. SULLIVAN: Perhaps I put the wrong

1 slide up. I thought --

2 MEMBER APOSTOLAKIS: We'll discuss it

3 anyway, though.

4 MR. SULLIVAN: Yes. I thought you would

5 be more interested in the normalized. Our report

6 has --

7 MEMBER WALLIS: This is just fractions

8 of some total then?

9 MR. SULLIVAN: Yes.

10 MEMBER WALLIS: Up to one.

11 MR. SULLIVAN: Our report has several

12 tables of qualitative comparisons. I thought the

13 Committee would be more interested in this

14 normalized comparison.

15 MEMBER CORRADINI: We are.

16 MEMBER APOSTOLAKIS: Normalized means

17 again?

18 MR. SULLIVAN: This is normalized

19 against the total sum. So in this case there was

20 only four early fatalities maybe against forty.

21 MEMBER APOSTOLAKIS: Okay.

22 MR. SULLIVAN: And so you get 25 percent

23 of them and 74 percent of them as shown.

24 MEMBER APOSTOLAKIS: This is a late

25 release.

1 MR. SULLIVAN: And the second column is
2 latent cancer fatalities. You get more of those.
3 We just used linear no threshold --
4 MEMBER ARMIJO: But what was the total
5 for that?
6 MR. SULLIVAN: I don't know.
7 MEMBER BANERJEE: Thousands? Hundreds?
8 Tens? Total what?
9 MR. SULLIVAN: Total consequences.
10 MEMBER ARMIJO: Thirty fatalities is the
11 example.
12 MR. JONES: It really varied for every
13 source term and every evacuation time estimate. And
14 every alternative protective action.
15 MEMBER CORRADINI: Oh, I see. Can I
16 just say it back to you because everybody else seems
17 to be quicker on this one.
18 So you took the nominal and that was the
19 EF and the LCF. And then these are all the
20 variations off of it given a timing, given a source
21 term?
22 MR. SULLIVAN: Let me say it a different
23 way. We have time and source and term on this
24 slide. It's source term two, the slowly developing
25 release.

1 MEMBER CORRADINI: Right. That I got.

2 MR. SULLIVAN: This is a ten hour

3 evacuation time, the longest that we analyzed.

4 MEMBER CORRADINI: Got that.

5 MR. SULLIVAN: We then analyzed several

6 different options for protective actions. The radial

7 evacuation there in the middle is the standard

8 keyhole, where we're at right now. All right. And

9 those are the results --

10 MEMBER WALLIS: And SIP is in place.

11 MR. SULLIVAN: So the first one is a

12 shelter in place for two hours followed by lateral

13 evacuation away from the plume. You'll see

14 normalizes out to zero.

15 Preferred sheltering for two hours

16 followed by lateral evacuation has the same result.

17 And then shelter in place for four hours

18 is till good. Preferred sheltering for four hours.

19 Finally you get to staged evacuation,

20 that's where it's the initial two mile ring followed

21 by further out later. And then you have the base

22 case radial evacuation. Now --

23 MEMBER BANERJEE: And why does preferred

24 sheltering for eight hours have such a large impact?

25 MR. SULLIVAN: You know, that was a bit

1 of a mystery. But it seemed -- you know, we didn't
2 pay attention to that because walk with me for a
3 second.
4 We've already got radial evacuation is
5 our basis right now. Anything below that we're
6 certainly not going to change our policy to. So
7 perhaps we didn't spend as much time on that as we
8 needed to.
9 MEMBER BANERJEE: But also stay in place
10 for eight hours followed by radial --
11 MR. SULLIVAN: Would be a bad thing to
12 do.
13 MEMBER BANERJEE: Yes.
14 MR. JONES: The reason for that is there
15 is some delay time associated with the preferred
16 shelter. For instance, we assumed it takes an hour
17 to get to the preferred shelter, so that's included
18 in the time line.
19 MEMBER WALLIS: Of course, it's lateral
20 it makes a difference. I mean, you can PS for eight
21 hours and then laterally evacuate, and there's no
22 result.
23 MR. SULLIVAN: That's right. Correct.
24 MEMBER WALLIS: So it's the lateral
25 versus radial is the biggest action here.

1 MR. SULLIVAN: Lateral is successful--

2 MEMBER WALLIS: Know which to go, that's

3 the most important thing, right.

4 MR. SULLIVAN: That's the difficulty.

5 Which way to go, will there be a wind shift and is

6 there roads to accommodate. The locals were telling

7 us there's not roads to accommodate it.

8 We're almost done.

9 MEMBER ARMIJO: Well, the only thing

10 that was better than your current recommend is the

11 staged, is that right?

12 MR. SULLIVAN: Staged is better.

13 MEMBER ARMIJO: But not much better?

14 MR. SULLIVAN: Not by much in all cases.

15 Initial sheltering followed by evacuation for the

16 large early release is better.

17 MEMBER ARMIJO: But, you don't want

18 people out there in the middle of a plume?

19 MR. SULLIVAN: Right.

20 MEMBER KRESS: When you did the staged,

21 what did you do? Use a different time?

22 MR. SULLIVAN: We used a different

23 speed.

24 MEMBER KRESS: A different speed. Okay.

25 MR. SULLIVAN: So we felt given our

1 limitations of the computer model, we thought the
2 best way to -- the only way we could represent it is
3 the people in the two miles moved fast and then,
4 perhaps they slow down when they get further out.
5 So here's our recommendations:
6 We think NUREG-0654 Sup 3 should be
7 changed. Now that's a recommendation we'll make to
8 the Commission and the Commission will tell us what
9 they want us to do.
10 VICE CHAIR BONACA: Yes. All the other
11 recommendations below that really they are just a
12 subset.
13 MR. SULLIVAN: That's right.
14 VICE CHAIR BONACA: What you learned
15 from the study and that's the basis for the --
16 that's the big recommendation that should be
17 changed?
18 MR. SULLIVAN: Right.
19 MEMBER APOSTOLAKIS: The purpose of this
20 study is to decide whether to make the first
21 recommendation, right?
22 MR. SULLIVAN: That's right.
23 VICE CHAIR BONACA: Right.
24 MEMBER APOSTOLAKIS: So if the
25 Commission decides that yes it should be revised,

1 then the way to revise it might be doing a study
2 like this but in a risk-informed way?
3 MR. SULLIVAN: Well, I believe that
4 where we sit right now we would be able to make
5 recommendations and those recommendations follow--
6 MEMBER APOSTOLAKIS: But these
7 recommendations are based on one possible release or
8 two. Two actually. Rapid early and then late. And
9 I don't know. I mean, you got too many zeros. And
10 the EPRI report, which we'll hear about soon, say
11 that you really have to include all the sequences to
12 get a better picture.
13 VICE CHAIR BONACA: Certainly they would
14 have to -- if you went in to modify NUREG-0654, you
15 would have to consider stakeholders' comments --
16 MR. SULLIVAN: Yes. Yes.
17 VICE CHAIR BONACA: -- which would
18 include, it seems to me, the EPRI report.
19 MR. SULLIVAN: Yes. Exactly.
20 VICE CHAIR BONACA: I mean they would
21 have to really look at what --
22 MEMBER APOSTOLAKIS: But you wouldn't
23 rely only on two typical sequences, would you?
24 VICE CHAIR BONACA: I don't think --
25 that's why I asked the question about -- I think

1 that, you know, when I look at this work it seems to
2 me, yes, I agree with the first recommendation.
3 MEMBER APOSTOLAKIS: That's fine as far
4 as this recommendation is concerned.
5 VICE CHAIR BONACA: Now how it's being
6 supported is not clear from what you told us that it
7 will be the only source of information that is risk-
8 informed.
9 MEMBER KRESS: I think I would rely on
10 two, George. And one condition would be I've got a
11 problem that leads to an emergency. And I would
12 evacuate. That's one strategy.
13 Then I've got another problem; it's
14 already happened and I've started releasing stuff
15 into containment, I would have a different strategy
16 there. I would rely on the RASCAL and track the
17 plume and move people as best I can out of the way
18 in shelter, and things. What else did you need?
19 VICE CHAIR BONACA: Yes, I agree with
20 that 100 percent.
21 MEMBER KRESS: And that covers the whole
22 -- right.
23 VICE CHAIR BONACA: I mean I think there
24 is information here. Now, the other thing again that
25 you have to think about is the releases I saw

1 briefly in the EPRI report, they start in two hours
2 or three or whatever, but I think we're facing other
3 conditions that are not covered by the analyses of
4 NUREG-1150 or other analyses of that kind. I mean
5 there are safeguard issues that say you should be
6 prepared for all kinds of accidents, it seems to me.
7 And that's why I thought that it was prudent to
8 simply pick up from somewhere some representative
9 limiting events that will drive in the emergency
10 plan.
11 MEMBER BANERJEE: But from what you're
12 showing us it seems to me that every site, you know
13 the plan they make is very site specific, if they
14 can use the lateral and then followed by radial that
15 would be really a good way to do it.
16 MR. SULLIVAN: Yes. We would make the
17 recommendation. However, that's got to be a site
18 specific.
19 MEMBER BANERJEE: Yes.
20 MR. SULLIVAN: It's a complicated thing
21 to implement. But if you preplan it --
22 MEMBER BANERJEE: Yes.
23 MR. SULLIVAN: -- it's doable at some
24 sites, so we wouldn't take it off the table.
25 But, for instance, we studied Oyster

1 Creek. Oyster Creek is using every road they got.
2 Now there are no roads for them -- there's the
3 Pines, the bay, the ocean so it wouldn't work for
4 Oyster Creek even though they're a big population.
5 MEMBER BANERJEE: What would they do at
6 Indian Point?
7 MR. SULLIVAN: I didn't study Indian
8 Point.
9 MR. JONES: They're pretty much using
10 every road.
11 MR. SULLIVAN: They use every road that
12 they have.
13 VICE CHAIR BONACA: It seems to me,
14 however, going back to the report, is that again all
15 the strategies are being discussed in the report,
16 all the basis of the report results. And when you
17 look at them in a qualitative fashion as they're
18 presented, it gives you a level of crispness about
19 the outcomes that really is not supported by the
20 uncertainties. I mean, you have uncertainties
21 there. So I think it's important that, it seems to
22 me, the report there should be some discussion of
23 how that plays against the uncertainty in the
24 implementation. Because you may have a strategy
25 that on paper looks great. And then when you go to

1 implement it at a specific site, it looks very lousy
2 and it cannot be implemented. I think those are
3 issues that should be left to the site to consider
4 to have a justification for maybe. But still, I
5 mean to consider.
6 MR. SULLIVAN: We believe that, too.
7 VICE CHAIR BONACA: And I think that
8 the--
9 MEMBER APOSTOLAKIS: We do have the
10 results for the early rapid release?
11 MR. SULLIVAN: Sure. We sent you the
12 study.
13 MEMBER APOSTOLAKIS: Well, you have a
14 slide?
15 MR. SULLIVAN: No, I sure don't.
16 MEMBER ARMIJO: Well, could you put that
17 chart with the numbers on it, the EF and LCF?
18 MR. SULLIVAN: Yes.
19 MEMBER ARMIJO: On that same thing, just
20 for comparison, what if nothing was done for these
21 events? Absolutely nothing? What would the
22 normalized numbers be?
23 MR. SULLIVAN: Not good.
24 MEMBER ARMIJO: Yes, just show the
25 benefit. I'm not recommending it. I'm just saying

1 just if nothing actually --

2 MR. SULLIVAN: If people would

3 actually--

4 MEMBER ARMIJO: Numbers. For example,

5 early fatalities would that be --

6 MR. SULLIVAN: This is normalized. But

7 are you looking for numbers? You can injure and

8 kill people with a large release from a power plant

9 if they simply sit there for 30 minutes.

10 MEMBER ARMIJO: For these events.

11 MEMBER MAYNARD: These aren't events.

12 These are different protective action strategies.

13 MR. SULLIVAN: Or for particular events.

14 MEMBER MAYNARD: Or one event.

15 MR. SULLIVAN: For one release in time.

16 MEMBER KRESS: If the source there was

17 big enough to --

18 MEMBER BANERJEE: The question is if you

19 did not do anything, what would that be? Would it

20 be .9 --

21 MEMBER KRESS: Nine, nine, nine.

22 MEMBER CORRADINI: It wouldn't be -- but

23 it would be pretty big.

24 MEMBER KRESS: It would be pretty big.

25 MR. SULLIVAN: Yes, you can --

1 MEMBER CORRADINI: To show the benefit,
2 yes.
3 MEMBER MAYNARD: I would like to echo
4 Mario's comment and expand a little. I believe there
5 is a lot of good information here and I would like
6 to see a little less emphasis on evacuation and a
7 little bit more sheltering in place and use of that.
8 However, I think we have to be careful in how do we
9 do revise the documents or change any requirements.
10 Because if we make this too complex, too many
11 options, too complex and then we try to evaluate to
12 a specific criteria with hundreds of people, many
13 states, different -- we're going to create, really,
14 a bigger problem than what we're solving here.
15 I think the options are good. I think
16 we have to be careful about being too prescriptive
17 about what has to be done and then how to evaluate
18 it.
19 CHAIRMAN SHACK: Well, I thought that's
20 why they did that bidding, then you would look at
21 the strategies that gave you roughly equivalent
22 benefit and you decided which of those was the one
23 that was easier to implement. And that's the
24 judgment that you would make in a particular
25 situation.

1 MEMBER MAYNARD: The problem comes in on
2 how this gets put out is that in the exercises that
3 you have, the NRC has to evaluate, FEMA has to
4 evaluate. They're looking for criteria.
5 It's very easy to go to these things and
6 say, you know, this is what we would have expected
7 you to do in this case. And you can't do that in
8 all cases.
9 VICE CHAIR BONACA: Yes. I would like to
10 move a moment to the number 20, because I think it
11 may answer George's question. If you could move to
12 that slide.
13 MR. SULLIVAN: Because.
14 VICE CHAIR BONACA: Because the rest I
15 mean --
16 MR. SULLIVAN: Number 20?
17 VICE CHAIR BONACA: No, no.
18 MR. SULLIVAN: I'm sorry, Doctor.
19 VICE CHAIR BONACA: Yes, yes. That one.
20 I'm sorry. You were right. This one here.
21 MR. SULLIVAN: Okay. Yes. If I could
22 just talk about this for a little while. It's the
23 same crew that's doing the emergency response in
24 SOARCA that did this project. Now this project
25 predates SOARCA by a couple of years and the power

1 study informed the work that we're doing in SOARCA.
2 Joe and I have been working together now for three
3 years. We're also working on SOARCA together.
4 There's obviously a nexus between the
5 two studies. And SOARCA is the more sophisticated
6 study. We're modifying our computer program to be
7 able to better model emergency response. The source
8 terms are more realistic in SOARCA than these source
9 terms that we used in NUREG-1150.
10 VICE CHAIR BONACA: Absolutely.
11 MR. SULLIVAN: There's a possibility
12 that SOARCA may determine that the large early
13 release is not credible. Now should that be the
14 case, and it would have to be fully examined, the
15 Staff would be prepared to recommend that the
16 Commission consider changing the EP planning basis.
17 MEMBER CORRADINI: Just so I am clear
18 about your use of that terminology, your use of
19 large early release is essentially the way Tom
20 described it, which is it occurred so quickly that
21 you used up your less than an hour time and already
22 we have releases to the environment? Is that what
23 your definition is? I'm trying to understand your
24 definition versus the SOARCA definition.
25 MR. SULLIVAN: My definition is simply

1 that there's a serious release before evacuation can
2 be effected close into the plant.
3 MEMBER BANERJEE: But how could that--
4 MR. SULLIVAN: And that would be on the
5 order of less than hour.
6 MEMBER BANERJEE: -- equivalence with an
7 earthquake or something? I mean, it seems like a
8 long shot. If SOARCA did that, I would say you know
9 you have to reexamine SOARCA.
10 VICE CHAIR BONACA: The other thing is
11 that SOARCA is only looking at the same sources of
12 accidents. I mean internal events, external events.
13 I believe the emergency planning covers other
14 possibilities.
15 MR. SULLIVAN: That's exactly right.
16 VICE CHAIR BONACA: Okay. And we have
17 to be aware of those, I mean even if we don't talk
18 about them. But we have be aware of those, and we
19 don't know what they are --
20 MEMBER BANERJEE: It seems a long shot.
21 VICE CHAIR BONACA: Yes.
22 MR. SULLIVAN: Before there's any change
23 to the EP planning basis that would have to be
24 addressed. You cannot ignore those other
25 possibilities.

1 VICE CHAIR BONACA: Right.

2 MR. SULLIVAN: And so as a matter of

3 fact when we did our post-911 analyses we were

4 comfortable in saying that a terrorist event cannot

5 create a larger source term or a source term that

6 develops more quickly than the ones we are already

7 considering in the EP planning basis. Now, I don't

8 mean to say that we've analyzed every situation, but

9 we felt that the EP planning basis remained valid.

10 It remained credible.

11 VICE CHAIR BONACA: It seems to me that

12 those considerations that are the one that are

13 important. George for, you know, this confirming

14 means that you have a clear understanding of

15 probably a dozen consequences of certain limiting

16 events and --

17 MEMBER APOSTOLAKIS: You mentioned

18 earlier the uncertainties. I mean it seems to me

19 the uncertainties that would could to mind, of

20 course, are litigate whether people will do this and

21 that. But also the sequences themselves, isn't that

22 an uncertainty, too? I mean, when you pick one, and

23 then if you pick five you will have some different

24 thing.

25 MR. SULLIVAN: Right. Right.

1 MEMBER APOSTOLAKIS: That's what I'm
2 saying. Yes. So this idea that there is something
3 that's bounding is not convincing to me.
4 MEMBER KRESS: I think an LER due to the
5 terrorist thing is probably the reason you would
6 still keep it in your emergency plan.
7 MR. SULLIVAN: Could be.
8 MEMBER KRESS: It's a defense-in-depth
9 issue.
10 MR. SULLIVAN: True.
11 MEMBER KRESS: So, you know, whether
12 it's credible from the normal accidents or not, it
13 probably wouldn't matter. You'd probably need it in
14 the plan anyway.
15 MEMBER CORRADINI: I was going to modify
16 -- I was going to ask if you would modify your
17 statement from the SOARCA discussion we had on
18 whatever day it was.
19 MEMBER APOSTOLAKIS: Yesterday.
20 MEMBER CORRADINI: Was it yesterday?
21 MEMBER BANERJEE: The day before.
22 MEMBER CORRADINI: That in the absence
23 of some sort of security or terrorist event, in the
24 absence of a large seismic event probably what
25 you're saying, I keep on hearing from the Staff

1 fairly consistently. But when you start rolling
2 those in, then I think Tom's point is important to
3 consider.
4 VICE CHAIR BONACA: Okay. I think we
5 need to move on to the next presentation.
6 MR. SULLIVAN: Yes. Thank you so much.
7 VICE CHAIR BONACA: Yes. Thank you.
8 MEMBER BANERJEE: Because even that
9 French plan which had a storm surge come and --
10 MEMBER CORRADINI: You talking about the
11 one that could have flooded? Yes, but that's for
12 this location, that would be the equivalent of a
13 seismic. But I don't think that would be a large
14 early release, though. It would be a release.
15 (Whereupon, a short recess)
16 VICE CHAIR BONACA: Come on now. We have
17 short time and we would like to hear. We didn't
18 really have the time to give you for making a
19 presentation that will be sufficient, I guess, for a
20 whole report.
21 MR. HESS: Thank you, Dr. Bonaca. And
22 we will be brief. And our intent is to provide a
23 very summary level presentation for the ACRS. And
24 we appreciate your time in letting us do so.
25 For those who don't know me, I'm Stephen

1 Hess. I'm with the Electric Power Research
2 Institute. I am the Project Manager for the work
3 that was performed here. It was also sponsored by
4 the Nuclear Energy Institute. And Marty Hug is
5 representing them today.
6 Dr. David Leaver was the principal
7 investigator who performed the work, and I'll let
8 him provide the technical presentation. But to get
9 to the end, I guess, we appreciate the time to do
10 this.
11 We have a report that is going in
12 publication that you have a draft copy. I realize
13 you have not had, certainly, a close to sufficient
14 time to look at it. We also need to interact with
15 the Staff. And we'd like to put out for
16 consideration after this high level view is as we
17 get the report published, we would like to interact
18 with the Staff. And offer up we would be willing to
19 come back and do a more in depth presentation at a
20 later time.
21 VICE CHAIR BONACA: And we would like to
22 very much to support that.
23 MR. HESS: With that, I'll turn it over
24 to Dave. And we realize we're short of time, so
25 we'll try to get through this rather quickly. And

1 it is a summary level presentation.

2 DR. LEAVER: Okay.

3 MEMBER APOSTOLAKIS: I don't know why

4 we're short of time. I think this is a very

5 important piece of information for the Committee.

6 VICE CHAIR BONACA: It was not provided

7 in time. This was a meeting to review 0654, okay.

8 And then --

9 MEMBER APOSTOLAKIS: We were notified--

10 VICE CHAIR BONACA: -- the industry

11 asked for time to make comments with us on 0564.

12 And then at the last minute came out that there was

13 a report being issued that the Staff has not

14 reviewed. We have not reviewed. A review today

15 recommendations are going to be on 0654 on what the

16 Staff has done. So just there wasn't time.

17 I mean, we could have --

18 MEMBER APOSTOLAKIS: I understand that.

19 But it seems to me this is an important piece of

20 work.

21 DR. LEAVER: We have given the time that

22 we've need.

23 MEMBER APOSTOLAKIS: Well, keep going.

24 Welcome to the --

25 DR. LEAVER: Okay. In our work in

1 considering protective action strategies and the
2 central question was how do we measure their
3 effectiveness to try to get some insights on what
4 works well and doesn't, we decided to take a bit of
5 a different approach than what is embodied in 0396,
6 0396 as, I'm sure you know, utilizes technology and
7 a state of knowledge that was basically early '70s,
8 WASH-1400 sequences that we believe that the results
9 significantly overestimate the risks associated with
10 nuclear plant accidents. The 0396 approach is not
11 risk-informed. It's a little bit risk-informed, but
12 not very much risk-informed.
13 It uses condition probability of core
14 melt of unity. There's been an awful lot of PRA work
15 done, particularly since TMI, the last 30 years,
16 that's not reflected in it. The source terms are
17 out of date. It uses a MAX 2 or a MAX -- actually it
18 was a CRAC, but the same thing that exists on MAX 2
19 today. It's a peak dose, which is completely
20 realistic. And the impact protective actions is not
21 in there.
22 So when you look at the information in
23 0396 it gives you a grossly exaggerated sense of the
24 risk of nuclear power plant accidents. So that led
25 us to want to look at this problem from a more risk-

1 informed standpoint.

2 We had three objectives in this work.

3 One was to quantify the relative effectiveness of

4 various protective strategies using on some kind of

5 a risk-informed basis. Our idea here was that this

6 could provide a framework for the off site agencies

7 to implement in their emergency planning process.

8 We recognize that there are a lot of practicalities

9 that need to be considered in that, and you

10 discussed some of that a moment ago with the NRC

11 presentation. But nonetheless, we think that needs

12 to be addressed and put on the table when you start

13 debating it.

14 Secondly, we believe and I think

15 everyone recognizes there's a need to clarify the

16 guidance that is given to both the plants and the

17 off sites. The plants make the protective action

18 recommendations, the off site make the decision. The

19 guidance is fuzzy, ambiguous that exists today. And

20 I think we can do a better job of that.

21 And finally, there's just been a

22 revolution in communication technologies just in the

23 last few years. And it's just going to keep

24 accelerating. And I think it presents opportunities

25 to do things in the way of notifying the public with

1 a bit more intelligence on protective actions
2 compared to what we do today.
3 Our second objective was going back to
4 the 0396 and the basis for the 10 mile EPZs. We
5 believe that the time has come to update the basis
6 for emergency planning and to understand. And what
7 we've tried to do is look at one approach for doing
8 that that we think is a risk-informed approach. And
9 also, we're interested in looking at the margin in
10 the ten mile EPZ.
11 And finally we looked --
12 MEMBER WALLIS: Presumably risk-informed
13 might lead to a desire to modify this ten mile
14 emergency planning zone.
15 DR. LEAVER: I beg your pardon?
16 MEMBER WALLIS: Presumably if you risk-
17 informed and then you looked at what you could
18 achieve, you might want to redefine your definition
19 of the emergency planning zone.
20 MR. HESS: That's a possibility.
21 DR. LEAVER: We didn't go there --
22 MEMBER WALLIS: I'm saying that if you
23 get enough insights, it might lead to something --
24 DR. LEAVER: It's possible. I think at
25 a minimum it would behoove us to understand the

1 margin in the ten mile frame for sure. And the new
2 plants are very interested in the question that you
3 are asking, we know that.
4 Finally, we would welcome the
5 opportunity to provide input and insights to the
6 Supplement 3 revision which Randy Sullivan and the
7 NRC are considering.
8 Our approach was we used generic source
9 terms. We developed what I would characterize as a
10 representative set of accident sequences for a
11 variety of plant types and a spectrum of accidents.
12 We looked at NUREG-1150. We looked at the IPEs. We
13 looked at more recent information. And then we took
14 our best shot at coming up with a set of sequence
15 types that covered a spectrum of release magnitudes,
16 timing and that sort of thing. We think probably
17 one could refine it more if you spent more time and
18 effort, but we think it's not a bad representative
19 set of sequences that would cover pretty much all
20 plant types and a spectrum of different kinds of
21 events.
22 Our risk-informed approach, the central
23 thing there was risk metrics. That's what you need.
24 You need a measurable metric, risk metric. We looked
25 at early fatality risk. We looked at early injury

1 risk. And we look at latent cancer fatality risk.
2 MEMBER KRESS: When you talk about early
3 fatality risk, was this the individual risk or --
4 DR. LEAVER: Yes.
5 MEMBER KRESS: -- a total known?
6 DR. LEAVER: Individual.
7 MEMBER KRESS: It's individual?
8 DR. LEAVER: Right.
9 MEMBER KRESS: Like the safety goals?
10 DR. LEAVER: Right.
11 MEMBER KRESS: Okay.
12 DR. LEAVER: We wanted to be able to
13 make comparisons to the safety goals. It's
14 certainly an interesting thing to do.
15 MEMBER APOSTOLAKIS: That's true. But in
16 this kind of evaluation, Tom, don't you think that
17 an F-M curve would be more appropriate when you're
18 dealing with people and evacuation and all that? Do
19 we really have to stick to the individual risk?
20 MEMBER KRESS: Well I think there are
21 other risks that are of interest, yes.
22 DR. LEAVER: One could do the type of
23 study we did for a number of different risk metrics.
24 Just to get on with it, we choose early fatality
25 risk and, as I said, latent cancer risk and early

1 injury risk. We also looked at thyroid cancer risk.
2 That's an interesting one because it plays into the
3 whole question of KI and how far out you might need
4 it. We have that data, we just didn't have time to
5 process it.
6 MEMBER BANERJEE: So how do you model
7 the early? Do you use PROBITs for the risk? Or how
8 is the actual modeling done? How do they do their
9 calculations. Are there PROBITs?
10 DR. LEAVER: Yes. We used the health
11 risk models from MAX, that's what we used.
12 MEMBER BANERJEE: What are those models?
13 VICE CHAIR BONACA: PROBIT.
14 MEMBER BANERJEE: PROBIT. Okay.
15 MEMBER APOSTOLAKIS: Why do you decide
16 to consider injury? I mean, that's kind of unusual,
17 isn't it?
18 DR. LEAVER: We did it because we felt
19 that possibly in understanding better the margin
20 that exists in ten miles that stakeholders might be
21 interested in that, early injury being a symptom
22 from radiation exposure that occurs quickly.
23 Actually, that injuries I believe are quantified in
24 0396 as well. So you wouldn't have to, but we just
25 thought it would be interesting to have that

1 information.

2 MEMBER APOSTOLAKIS: So they are not

3 essential to drawing conclusions?

4 DR. LEAVER: Well it depends on what

5 conclusions you want to draw.

6 MEMBER APOSTOLAKIS: Would the

7 conclusions we saw ten minutes ago from the Staff

8 change if they --

9 DR. LEAVER: Probably not. Our

10 conclusions don't change. But what you do see if

11 you're looking, for example, if you are interested

12 in the margins that exists in ten miles, you see the

13 effects from early injuries are seen further away

14 from the site than from early fatalities. That could

15 be of interest to the public.

16 We developed --

17 MEMBER APOSTOLAKIS: But would be of

18 interest to the public to the degree that it would

19 effect our decisions regarding evacuation?

20 DR. LEAVER: My guess is that the

21 decisions that we would reach with this type of an

22 approach on protective action strategies and what's

23 effective would not be different --

24 MEMBER APOSTOLAKIS: Okay.

25 DR. LEAVER: -- between early fatality

1 and early injury.

2 To do this work we developed a model

3 which we used the acronym DoRMET, which stands for

4 dose rate mapping and evaluation tracking. This is

5 basically an extension of MAX. The MAX 2 plume

6 dispersion modeling to do a couple of things. It

7 gives us a more detailed and realistic distribution

8 of activity. Pretty much a continuous distribution

9 activity throughout the ten mile EPZ.

10 It gives us more realistic movement of

11 population. We move -- MAX is a polar coordinate

12 based system. We used the MAX plume dispersion

13 model, but we have imposed on that a cartesian

14 coordinate system for evacuation tracking so we have

15 the ability, though this is work that we're hoping

16 to do later this year and early next, for a

17 representative, an individual, to actually follow at

18 least a course road network around a site so that

19 one could do this type of work based on the actual

20 paths that people would follow when they move,

21 evacuees.

22 Also the DoRMET model allows coupling of

23 the protective action strategy to conditions at the

24 time of the accident. Perhaps the most interesting

25 one which Randy and his people discussed is in

1 regard to wind direction. What our model can do is
2 it can allow you to select a strategy in which you
3 move people in a direction lateral to the wind
4 direction at some time. For example, at the time
5 that the order to -- the decision to evacuate is
6 made or at the time that the accident starts or
7 whatever time you want to pick. And certainly the
8 wind can change, and so the wind calculation takes
9 that into account in its results. But it turns out,
10 as I'll say in a moment, the most effective strategy
11 particularly for people close to the site is to move
12 away from lateral to the wind.
13 MEMBER WALLIS: Does this weather
14 conditioning include snow and ice and that kind of
15 thing?
16 DR. LEAVER: Well, we didn't try to get
17 into to those sorts of things. Let me get to the
18 end because we have such a short time and we can
19 talk about that a little bit.
20 So then we evaluated protective action
21 strategies on the basis of relative risk. So we're
22 comparing strategies. We can say, for example, one
23 strategy is an order of magnitude more effective
24 than another strategy on the basis of reducing early
25 fatality risk or latent cancer fatality risk or

1 whatever.

2 And finally we looked at the ten mile

3 EPZ and the margin in the ten miles on the basis of

4 absolute risk. And we recognized this is a bit of a

5 slippery slope because there certainly are

6 uncertainties in all these numbers, but we believe

7 that's the kind of thing that one would need to do

8 to quantify the margin that exists in the ten miles

9 or possibly to look at a distance inside ten miles.

10 These are the four primary strategies we

11 looked at. We looked at shelter in place, we looked

12 at what I call away from reactor evacuation which is

13 evacuation along radial stream lines emanating out

14 from the site. We looked at away from plume

15 evacuation, which is lateral to the wind direction.

16 And finally we looked at keyhole.

17 This diagram here shows the keyhole,

18 which is this -- I believe this diagram came from --

19 it may not be the exact diagram on the NRC website,

20 but there is a keyhole picture on the NRC website.

21 MEMBER BANERJEE: Does the cone angle

22 there or whatever the angle of that keyhole depend

23 on the wind conditions?

24 DR. LEAVER: Well, the keyhole strategy,

25 I don't remember. I think it's probably maybe

1 defined different from side-to-side. But the general
2 idea is you evacuate all around out to some
3 distance, say two miles. And then downwind for
4 perhaps three or four 22½ degree sectors you
5 evacuate. And then everybody else stays put.
6 MEMBER MAYNARD: Well, that typically
7 depends on the dispersion of the plume.
8 DR. LEAVER: Right.
9 MEMBER MAYNARD: There's stability
10 factors there as to how wide that keyhole is.
11 DR. LEAVER: But I think the idea that
12 we could --
13 MEMBER BANERJEE: That's whether it's
14 different from weather.
15 DR. LEAVER: One of the things we
16 learned from our work, or at least this is kind of
17 where I am on it, is I think the idea that you could
18 refine a keyhole to add a sector or subtract a
19 sector, that somehow that that's going to make it
20 better is, I think, overdoing. Our conclusion is
21 the keyhole isn't a very good approach. Because
22 people in this area --
23 MEMBER APOSTOLAKIS: No, no. You have to
24 just sit down.
25 DR. LEAVER: The people in the two to

1 five mile region outside of the three sectors that
2 evacuate, the risk goes up dramatically for those
3 people relative to any other evacuation strategy. So
4 one of our conclusions was it doesn't look like a
5 great strategy.
6 Next slide.
7 So these are the conclusions we came to.
8 This is not new information, but it's important.
9 There is a dramatic reduction in risk as a function
10 of distance. It varies depending on -- for early
11 fatality risk what we found depending on the
12 protective action strategy used, we found from one
13 to two or even three orders of magnitude per mile
14 distance from the reactor.
15 MEMBER WALLIS: What does that mean?
16 That means if you're 10 miles away, it's 20 orders
17 of magnitude? I don't think I quite understand.
18 That's what it means?
19 DR. LEAVER: That tends to be in the
20 first few miles. I'm not sure that it would apply
21 all the way up.
22 MEMBER WALLIS: You multiple it by
23 miles?
24 DR. LEAVER: But from zero to five miles
25 is what we're saying, out to five miles.

1 MEMBER WALLIS: You got ten orders of
2 magnitude?
3 DR. LEAVER: You get ten orders of
4 magnitude for certain strategies, yes.
5 VICE CHAIR BONACA: If I remember, your
6 fastest release is --
7 DR. LEAVER: The one that gives you that
8 is away from the plume where you're evacuating
9 laterally to plume. The shelter in place is the
10 least effected, but that's giving you about one
11 order of magnitude per mile.
12 VICE CHAIR BONACA: But the point I
13 wanted to make is that if I remember, your earliest
14 release, I mean the fastest release is two hours
15 after the determination of general --
16 DR. LEAVER: Yes, I can show a slide on
17 the source terms. Let me get through these
18 conclusions.
19 VICE CHAIR BONACA: Because I mean one
20 of the main conclusions of the Staff is that the
21 dependency between the timing of release and the
22 estimated --
23 DR. LEAVER: The single most important--
24 MR. HESS: This is the slide that's
25 subject to your comment.

1 DR. LEAVER: Go back to the one before.
2 MR. HESS: Oh, the one before?
3 DR. LEAVER: The single most important
4 parameter along those lines, Mario, is the
5 difference between the number in this column and
6 this column.
7 VICE CHAIR BONACA: Yes.
8 DR. LEAVER: It's not the absolute
9 number. It's the difference. So the sequence that
10 was the toughest for us is this one. We had a
11 declaration of general at 1.5 hours and the
12 beginning of release at 3 hours. So you have an hour
13 and a half.
14 VICE CHAIR BONACA: Yes.
15 DR. LEAVER: And that's really not
16 enough time to get the word from the plant to the
17 off sites and for the off sites to figure out what
18 they want to do, put that word out. And then the
19 people who receive this, it takes them some time to
20 get organized and do what they're going to do. So
21 that's where you tend to -- it's that delta that
22 tends to really control --
23 VICE CHAIR BONACA: Yes, the point I was
24 making is that the Staff most severe release was the
25 one which happened 45 minutes after the declaration

1 of general emergency. So that they have even less
2 time. So for that scenario and for significant
3 evacuation times clearly sheltering looks like the
4 only solution for that scenario. You don't have
5 that scenario here. You have as a minimum 1½ hour.
6 DR. LEAVER: The scenario that was most
7 demanding from the standpoint of timing was the one
8 that I showed you.
9 VICE CHAIR BONACA: Yes, that's right.
10 DR. LEAVER: Which was an hour and a
11 half from the time of declaration of general to when
12 the release begins.
13 VICE CHAIR BONACA: So my comment was
14 that would affect your conclusion in a way? I mean,
15 the fact that you have these timing differences
16 between --
17 MR. HESS: That's correct. If it's a
18 shorter time to release.
19 DR. LEAVER: I'm not sure how much it
20 would affect these conclusions. If anything, it
21 would make the away from plus the lateral
22 evacuation, even more important that's probably
23 true. But it's quite important as it is, as you'll
24 see.
25 The second bullet is an interesting one.

1 What that says is that evacuation provides about two
2 orders of magnitude lower early fatality risk than
3 shelter in place for the region inside five miles.
4 That says to me -- I mean, I think one would need to
5 kind of mentally process all of this and think about
6 it. And I think it gets into the comment that one
7 of the members made about implement weather
8 conditions, for example, snow and ice in the middle
9 of the night, you know, what do you tell people to
10 do. But our data is pretty clear that it's just not
11 a good idea for people close to the site to hang
12 around.
13 So I think we need to be thinking about
14 that in terms of whatever provisions we make to
15 Supplement 3 of 0654.
16 The third bullet is that the away from
17 plume strategy that is lateral to the wind provides
18 one to two orders of magnitude lower early fatality
19 risk than the away from reactor, the away from
20 reactor being the model that's at max, which is
21 along the radial streamline.
22 Now, probably --
23 CHAIRMAN SHACK: Excuse me. When you do
24 shelter in place, when do you do an evacuation
25 together with that?

1 DR. LEAVER: Well, we looked at
2 different combinations to those things. But the
3 conclusion on the second bullet is strictly
4 evacuation versus sheltering in place and staying
5 there.
6 I mean, you could look for example at a
7 shelter in place for two hours and then evacuate.
8 There's all kinds of things you could do. And we
9 did a number of those things, but we clearly don't
10 have time to go into that here. But it's in our
11 report. But we're really trying to do is just get
12 some insights here as to how to begin to think about
13 this problem. Because it's a complicated problem
14 because there's a lot of different options and
15 different things that need to be considered. But I
16 completely agree with one of the comments I believe
17 Otto Maynard made that ultimately what we need to do
18 is translate this information, these insights we get
19 about protective action strategies and the relative
20 effect to a simple metrics of possibilities that an
21 off site person who is under the gun to make a
22 decision quickly when all hell is breaking loose can
23 maybe look at the weather and the time of day and
24 commute and no commute and those sorts of things and
25 say okay, this what we're going to do. And put the

1 word out. That's where I think we need to head.

2 VICE CHAIR BONACA: You seem to differ

3 in your recommendation from the one that we received

4 in the previous presentation. That is, that for an

5 early release and long estimated time of evacuation,

6 sheltering in place is better than evacuating

7 immediately; you seem to disagree with that?

8 MR. HESS: Well, I think, Dr. Bonoca,

9 that we need to engage in talk with the Staff and

10 understand.,

11 VICE CHAIR BONACA: Yes, okay.

12 MR. HESS: On the surface it may appear

13 that way. I'm not sure that that's true or not.

14 VICE CHAIR BONACA: That's right.

15 MR. HESS: We need to have those

16 discussions.

17 DR. LEAVER: The evacuation that we

18 looked at here in preparing with shelter in place

19 assumes that people delay. And some portion of their

20 delay time is shelter.

21 VICE CHAIR BONACA: Yes.

22 DR. LEAVER: This is not a shelter in

23 place where they're told to shelter for some number

24 of hours and then go. The sheltering occurs because

25 they go inside and they gather their things up and

1 so we take some credit for modest sheltering during
2 the delay time.
3 VICE CHAIR BONACA: Right.
4 DR. LEAVER: Next slide. Keyhole
5 strategy. I'm on the top bullet now.
6 We see that as relatively ineffective
7 from two to five miles compared to other evacuation
8 strategies due to wind shift. This is a bit of a
9 surprise to us. And, you know, the keyhole strategy
10 is out there everywhere. It's in 0654, its on the
11 NRC website. It's a number plants and off site
12 agencies have it as kind of their basic strategy.
13 It's possible that it could be made to be more
14 effective by expanding the number off azimuthal
15 sectors that you include in the down wind, but I
16 guess this sort of reflects my view of it is what we
17 say here.
18 MEMBER WALLIS: How does this keyhole
19 differ from away from plume strategy? I mean, they
20 both seem to depend on knowing where the plume is.
21 DR. LEAVER: Well, you need to know the
22 wind direction at some point in time. That's all
23 you really know. I think it would be way too
24 complicated to try to update wind direction. And so
25 you say wind direction, for example, at the time of

1 the beginning of release. That was the one we used
2 in most of our work.
3 The lateral strategy, if the wind is
4 blowing this way at the time of release, lateral
5 strategy would say generally tell people to go that
6 way. The keyhole strategy is different. What it
7 says is people who are sectors that are centered
8 around the direction of the wind, and choose the
9 number of sectors you want, you people go.
10 MEMBER WALLIS: And you don't tell them
11 which direction to go.
12 DR. LEAVER: Yes, that's right. You
13 don't tell which direction. Yes. Yes. And it isn't
14 those people that have high risk. It's the people
15 who are outside of the two mile all around a
16 pattern, but who are outside the sector that is
17 supposed to evacuate. They're the ones that are at
18 risk.
19 Another interesting conclusion we came
20 to was, and I believe this is similar to a
21 conclusion to Randy Sullivan's conclusion was the
22 idea of a delayed evaluations -- we call it delayed
23 evacuation skirt for the far field. What's this is
24 is it's the people inside close to the site, and we
25 used four miles, evacuate immediately or as quickly

1 as they can. And we believe that if one were to
2 develop the system's communication systems and
3 management systems to implement something like this,
4 that that could be done. That people closer to the
5 site could be alerted faster. Those people go
6 immediately. Don't wait around to see what's going
7 to happen. And then outside four miles people
8 shelter.
9 The calculation we did is we evacuated
10 people inside four miles quickly. People outside
11 four miles sheltered until two hours after the
12 release began. So for each of the sequences we
13 adjusted the time of evacuation for the people
14 outside four miles to start. Their trip started two
15 hours after the release began. We figured that as a
16 sort of a conservative approach.
17 And what we found is that the overall
18 risk of this delayed evacuation start for the far
19 field was comparable to and no greater than the
20 risks of where other execution strategies were used
21 where you were evacuating the entire ten miles.
22 MEMBER WALLIS: It's different risks for
23 different people. I mean, the overall risk may be
24 the same, but some people think --
25 DR. LEAVER: Well, not as much as you

1 think. It definitely helped the people inside four
2 miles because the roads are less clogged and the
3 speed increases. The people outside four miles you
4 have the benefit of time from the time it takes the
5 plume to get out there. And you have intelligence
6 about the wind direction so you can tell them what
7 direction to go.
8 So I think this is worth looking at, or
9 that was our conclusion.
10 Breathing masks we looked at. We found
11 some reduction in health risk. I think it's a
12 matter of high practical it would be, but probably
13 worth thinking about. We found about a factor of
14 three reduction in early fatality and a factor of
15 ten reduction in latent cancer, which is important.
16 I think latent cancer risk is going to turn out to
17 be a very important pat of this whole story and we
18 need to pay attention to it in whatever we end up
19 doing here.
20 Finally, we looked at preferred shelters
21 and came I think to the same conclusion that Randy
22 did. WE looked at four hardened -- not hardened but
23 higher DF type shelters such as you'd get in a large
24 public building. One in each quadrant located one
25 mile from the site. And we had people inside two

1 miles walk to these shelters. And it just doesn't
2 work very well.
3 MEMBER ARMIJO: Is it the same
4 fundamental problem that it's ventilation that makes
5 --
6 DR. LEAVER: No. It's the dose they're
7 getting there.
8 MEMBER ARMIJO: Okay. But once they're
9 there, there's a ventilation problem?
10 DR. LEAVER: We didn't model the
11 ventilation problem. We just assumed the DF. A
12 higher DF. It's in our report. A higher DF than what
13 you'd get, for example, in a residential structure.
14 Okay. This is the slide, this is
15 intended to just give you a rough idea, an example,
16 of what we did on evaluating the margin in the ten
17 mile EPZ with a risk informed approach.
18 This graph plots absolute early fatality
19 risk i the Y axis, that's per year. And then the X
20 axis is distance from the reactor.
21 MEMBER CORRADINI: This is for an
22 individual, is that correct?
23 MR. HESS: Yes.
24 DR. LEAVER: Right. Individual risk.
25 Yes. Well, it's different kinds of risk.

1 There are six curves in the legend, but
2 only four of them show up. The first two, which are
3 early fatality risk and early injury risk, we
4 imposed a cut off in frequency. Because we were
5 interested in understanding what the effect of a
6 frequency cut off would be, and the frequency cut
7 off is a very interesting subject in itself, one
8 which I think we should talk about. And what we
9 found is that there is zero early fatality risk and
10 zero early injury risk if you cut off the accident
11 sequence frequency at ten to the minus seven for the
12 set of representative frequencies that we used.
13 MEMBER APOSTOLAKIS: Now these are the
14 frequencies of sequences all the way to deaths? Or
15 which frequencies are these? The ten to the minus
16 seven applies to core damage frequencies?
17 DR. LEAVER: It applies to the --
18 MEMBER APOSTOLAKIS: The total?
19 DR. LEAVER: -- total.
20 MEMBER APOSTOLAKIS: All the way to the
21 consequences?
22 DR. LEAVER: No. To the release.
23 MEMBER APOSTOLAKIS: From the initiating
24 even to the release?
25 DR. LEAVER: To the release, yes.

1 MEMBER WALLIS: So what you've said
2 really is that this is a very rare big event --
3 MR. HESS: That's right.
4 MEMBER WALLIS: -- which are the risk?
5 MR. HESS: Right.
6 MEMBER WALLIS: And you shouldn't cut
7 them off. Or maybe once you --
8 DR. LEAVER: I am not saying one way or
9 the other.
10 MEMBER WALLIS: Well if you do cut them
11 off, the risk goes away, that's what you said?
12 DR. LEAVER: The early fatality and
13 early -- well, let me finish because this is -- you
14 can't forget about latent cancer fatality. We are
15 going to be held -- I mean the nuclear community,
16 you guys, the Staff, the Commission, the industry by
17 the public for latent cancer fatality risk. We need
18 to pay attention to that.
19 It's true for early fatality risk and
20 early injury risk. For latent cancer fatality risk
21 what we find is that as the curves -- one of these
22 is no cut off, the purple one. And then the light
23 blue one has a cut off. And it doesn't make much of
24 a difference.
25 MEMBER BANERJEE: No cut off gives you

1 that square early fatalities, right? The square
2 symbols up there? The top curve is the no cut off
3 early fatality?
4 DR. LEAVER: Yes, that's right.
5 MR. HESS: No, latent cancer.
6 DR. LEAVER: No. The top curve is latent
7 cancer.
8 MEMBER APOSTOLAKIS: The problem, David,
9 is that, and that confused the hell out of me when I
10 read the report, these little boxes there. People
11 think that you are labeling --
12 MEMBER KRESS: Curves.
13 MEMBER APOSTOLAKIS: -- the curves.
14 MEMBER KRESS: What you're labeling.
15 MEMBER APOSTOLAKIS: And what you mean
16 is, you know, that this is the safety goal and you
17 are, in fact, over a 100 --
18 DR. LEAVER: Oh, these boxes here?
19 MEMBER APOSTOLAKIS: Yes.
20 MEMBER CORRADINI: Yes, that's what I
21 understand.
22 MEMBER APOSTOLAKIS: Really, they are so
23 confusing.
24 DR. LEAVER: Okay. All right. Well, let
25 me try to --

1 MEMBER APOSTOLAKIS: And I struggled to
2 understand and then I --
3 DR. LEAVER: Let me try to clarify.
4 This line is the latent cancer --
5 MEMBER APOSTOLAKIS: Right.
6 DR. LEAVER: -- safety goal divided by
7 1,000.
8 MEMBER APOSTOLAKIS: By a 1,000. It has
9 nothing to do with the curve?
10 DR. LEAVER: Right. So the point --
11 MEMBER CORRADINI: It just happened to
12 be near the curve.
13 MEMBER APOSTOLAKIS: That's right.
14 MEMBER BANERJEE: That was a legend.
15 DR. LEAVER: I could have selected--
16 MEMBER APOSTOLAKIS: Yes, put it
17 somewhere else. Put it somewhere else. Because--
18 DR. LEAVER: The point I wanted to make
19 is while latent cancer fatality risk extends -- that
20 you don't have the dramatic drop off that you do for
21 the early fatality and early injury, the numbers are
22 so small --
23 MEMBER APOSTOLAKIS: Yes, but it's --
24 you're right. You're right.
25 DR. LEAVER: Yes. Now it turns out that

1 if you can -- this was for a rather slow evacuation,
2 it was 1.5 miles an hour which is a meandering walk.
3 But if it's a little bit faster, these curves start
4 to come down at about three, four or five miles.
5 MEMBER APOSTOLAKIS: By the way, when
6 you're saying "no cut off," do you really mean no
7 cut off? I mean, how did you --
8 DR. LEAVER: When I say "no cut off," I
9 mean we considered all of the accident sequence, the
10 seven that I showed you on the graph, which we feel
11 is representative in a generic sense of what we
12 had--
13 MEMBER APOSTOLAKIS: So you went down a
14 couple of orders from -- down to three to the minus
15 nine?
16 DR. LEAVER: I think we have one that's
17 a few times ten to the minus to the eight and one
18 that's five or six ten to the minus nine. So those
19 were screened out. With -- without the cut off --
20 MEMBER APOSTOLAKIS: So without cut off
21 you meant the table that you have these things?
22 DR. LEAVER: That's correct.
23 MR. HESS: Right. That's correct.
24 MEMBER APOSTOLAKIS: Okay. Okay.
25 DR. LEAVER: That's correct. Yes.

1 MEMBER APOSTOLAKIS: So if one included
2 all the sequences then with a real no cut off, then
3 you would move a little bit higher, but it maybe
4 just a little bit?
5 DR. LEAVER: So, you know, one
6 conclusion that one could come to here is that
7 without the cut off, that is if you consider all the
8 sequences, your early fatality risk and early injury
9 risk are pretty much over at about three miles are
10 so. Latent cancer doesn't have this dramatic drop
11 off, but the risks are very, very low, three orders
12 of magnitude lower than the safety goal. I think
13 that's a significant thing that maybe would be a way
14 to --
15 MEMBER WALLIS: Let's go back to your --
16 this is a person in the open walking at 1.5 miles an
17 hour away from the reactor?
18 MEMBER BANERJEE: Radial evacuation.
19 MEMBER WALLIS: No suits or anything No
20 vehicles or --
21 DR. LEAVER: No, this person, this is
22 the lateral.
23 DR. LEAVER: This is away from the
24 plume.
25 MEMBER BANERJEE: Oh, lateral.

1 DR. LEAVER: Away from the plume. And
2 they're walking at 1.5 miles an hour.
3 MEMBER BANERJEE: Well lateral.
4 DR. LEAVER: Yes, away from the plume.
5 When I say away from plume, I mean they're walking i
6 a direction that is perpendicular to the wind
7 direction at the time the release begins. And the
8 wind --
9 MEMBER BANERJEE: You assumed the wind
10 shifts a lot?
11 DR. LEAVER: And shift, and that's taken
12 into account in the calculation.
13 MEMBER BANERJEE: How much can the wind
14 shift?
15 DR. LEAVER: The wind shifts per the
16 meteorological data for the site. It can shift--
17 MEMBER APOSTOLAKIS: This is a genetic
18 site?
19 DR. LEAVER: This site I can't -- don't
20 know if I can tell you what it is, but it is a U.S.
21 site.
22 MEMBER APOSTOLAKIS: It's a real site?
23 DR. LEAVER: It's a real site. And we
24 had two years --
25 MEMBER APOSTOLAKIS: One can touch it?

1 DR. LEAVER: You could touch it.

2 MEMBER KRESS: You can go and visit.

3 MEMBER BANERJEE: So you have

4 meteorological data for that site?

5 DR. LEAVER: We do. We have

6 meteorological data for this site, that's correct.

7 For most sites, I don't think that our results would

8 be sensitive to the weather at the site. I mean,

9 the wind shifts; we know that, and the risk results

10 reflect that.

11 MEMBER WALLIS: This guy is going to

12 walk at this speed in two or three minutes, no?

13 DR. LEAVER: Well, yes. Maybe --

14 MEMBER BANERJEE: Maybe with cross

15 country skies on.

16 VICE CHAIR BONACA: WE need to move on.

17 Because right now he's ready --

18 CHAIRMAN SHACK: Right. We are already

19 behind schedule here, so --

20 MEMBER APOSTOLAKIS: So what have we

21 learned from all this that is different --

22 MEMBER BANERJEE: Lateral evacuation --

23 MEMBER APOSTOLAKIS: Well, let's hear

24 the conclusions.

25 MEMBER WALLIS: We have the conclusions

1 already.

2 DR. LEAVER: We've gone through the

3 conclusions.

4 MR. HESS: Our next steps will be to

5 finalize the report in August and we're looking at

6 possibly partnering with some utilities to develop a

7 more realistic model to take into account roadmaps--

8 in the area of a nuclear power plant.

9 And look forward to furthering our

10 research on this risk-informed protective action

11 strategy study and presenting our work with the

12 Staff in detail. And then we'd look forward to

13 going back and doing a little bit longer session

14 with this Committee.

15 Thank you.

16 MEMBER APOSTOLAKIS: I heard so many

17 conclusions today, so many bullets. So would

18 someone tell me did industry disagree with what the

19 NRC Staff said half an hour ago?

20 DR. LEAVER: I would say, no, we don't

21 disagree. I think that we need to read the report

22 and understand it better. But --

23 MEMBER APOSTOLAKIS: Yes. But if the

24 Staff goes and recommends --

25 DR. LEAVER: For example, do we disagree

1 with revising Supplement 3?

2 MEMBER APOSTOLAKIS: No, you don't.

3 DR. LEAVER: We don't. No.

4 VICE CHAIR BONACA: Yes. In fact, that's

5 the message I get.

6 DR. LEAVER: Well part of it.

7 MEMBER APOSTOLAKIS: Was there any

8 benefit to doing this in a risk-informed way. Let me

9 put it that way.

10 MEMBER CORRADINI: That's not a leading

11 question, though.

12 MEMBER APOSTOLAKIS: No. I'm willing to

13 go along with the Staff did if these gentlemen say,

14 you know, we gained more insights. I know what the

15 insights mean.

16 VICE CHAIR BONACA: The way I see it,

17 George, is this, okay, Supplement 3 in my judgment

18 has to be amended. Okay? It has to be modified.

19 MEMBER APOSTOLAKIS: They all agree and

20 I do agree.

21 VICE CHAIR BONACA: Okay. Second, the

22 basis for the amendments shouldn't be only what we

23 have seen before, but there will be interaction with

24 stakeholders, including EPRI, NEI and this report.

25 And I think this material should be reviewed to

1 assure that there is a lot of inconsistency that we
2 -- in fact this is very useful because it comes at
3 the time unfortunately the Staff hasn't had yet the
4 time to review it, but it should.
5 MEMBER APOSTOLAKIS: I understand.
6 VICE CHAIR BONACA: And we should also--
7 I would be very interested in seeing how that report
8 will effect the conclusions that you use as a basis
9 for the modification to Supplement 3.
10 DR. LEAVER: George, I think that the
11 NRC's approach to revising Supplement 3 is a good
12 approach. The reason that we went more strongly to
13 risk-informed was, I guess, because we think that
14 there would be some benefit to considering the
15 question of protective action strategies with risk-
16 informed. That's not to say that the NRC approach
17 isn't a good approach. But perhaps even more
18 importantly we're also interested in the basis for
19 the EPZ.
20 We think that the basis that exists
21 today does not properly characterize the risk from
22 reactor accidents. That it can create unfounded
23 fears on the part of the public. And it's 40 years
24 old. And I think it's time to update it. And so we
25 think the question --

1 MEMBER APOSTOLAKIS: The question is do
2 you update it to this level or to the level we heard
3 half an hour ago? That's my question to you?
4 DR. LEAVER: Well, what the NRC
5 presented a half an hour ago was not a process for
6 updating the basis. What they were trying to do is
7 fix Supplement 3, that's my understanding.
8 MEMBER APOSTOLAKIS: When I said that
9 people objected. I said I agreed with that, but
10 then if we decide to update it, we should do it in a
11 risk informed way. And I heard some people say no.
12 And that's what bothers me now.
13 Anyway, it's going to come to that.
14 VICE CHAIR BONACA: My meaning was it
15 depends on the range of events to consider. You
16 know, if you review all the accident analyses
17 performed to date for severe accidents and you
18 conclude that really you should not consider a
19 release that is earlier tan two hours after the
20 declaration of emergency or three hours, or
21 whatever, I would have a problem with that because
22 it may be a security event of some nature that, in
23 fact, may need that. And so I see the importance of
24 having a spectrum of scenarios including maybe some
25 which seem by this analyses realistic not covered.

1 That was my only comment.

2 And so far as the risk-informing or the

3 basis of the --

4 MEMBER APOSTOLAKIS: But we will hear if

5 they decide to update it, we will have other

6 opportunities to comment on how they will update it.

7 VICE CHAIR BONACA: And I think that as

8 part of the technical basis to date, they should

9 consider this material.

10 MEMBER APOSTOLAKIS: I mean, what they

11 did should have an impact on the SOARCA, too. The

12 SOARCA doesn't do it that way.

13 DR. LEAVER: I hope so, yes. We were

14 thinking about that as were doing --

15 MEMBER APOSTOLAKIS: But we're not

16 writing the letter.

17 VICE CHAIR BONACA: On this.

18 MEMBER BANERJEE: This suggests that we

19 should give everybody a bicycle within a three mile-

20 -

21 MEMBER CORRADINI: They'd probably live

22 longer anyway.

23 VICE CHAIR BONACA: Talking about a

24 letter, because I need to go and write it. I have a

25 draft, but I want to clearly we can recommend that

1 as a technical basis is being developed for
2 modifying Supplement 3, this information be
3 considered?
4 MEMBER APOSTOLAKIS: Yes.
5 VICE CHAIR BONACA: Right.
6 MEMBER APOSTOLAKIS: Yes.
7 VICE CHAIR BONACA: I have no problem
8 with that at all. And I would think that you and
9 Randy wouldn't have a problem with that.
10 MR. SULLIVAN: In the brief time I've
11 had to look at the EPRI report I find it very
12 interesting. I mean, of course we would consider
13 it.
14 MR. HESS: I think all we're asking for
15 consideration is that we actually interact with the
16 Staff and look at their work in detail and they look
17 at our work in detail. And I think as Dave said, we
18 may find there's an awful lot of common ground here.
19 And I think superficially there is. And I think
20 where there's differences, they may just be because
21 -- they may be very understandable and --
22 VICE CHAIR BONACA: You know, maybe once
23 we have developed the final technical basis for the
24 update of Supplement 3, it would be worthwhile for
25 you to come back here and have an understanding. We

1 could review this report in detail, get those views
2 and see what final technical basis for the
3 Supplement 3 modifications are.
4 MR. HESS: Thank you.
5 DR. LEAVER: Thank you very much.
6 CHAIRMAN SHACK: Thank you.
7 We're running a little behind schedule.
8 So if we can be back at 11:00 after our break.
9 (Whereupon, at 10:47 a.m. a recess until
10 11:01 a.m.)
11 CHAIRMAN SHACK: We can come back into
12 session.
13 We're going to be discussing the Browns
14 Ferry Nuclear Plant Unit 1 Restart Activities, and
15 Otto's going to be leading this in this discussion.
16 MEMBER MAYNARD: Well, thank you.
17 First of all, let me tell you what this
18 is not. This is not about the Browns Ferry power
19 uprates. This is about the regulatory activities
20 associated with the restart of Browns Ferry 1 after
21 it was shutdown for a number of years and they're
22 bringing it back. And it's the regulatory aspects
23 associated with that.
24 Some of the reasons it may be of
25 interest to us, this is an informational briefing.

1 This is not something that we have any actions that
2 we're required to take or need to take on it. It's
3 an informational briefing for us. It's of interest
4 because there is a potential of another plant, a
5 near finished plant being completed and that being
6 brought on line in a few years.
7 We also have with the new plants
8 potentially coming in for construction the NRC's
9 going to have to gear up again for the inspection
10 process and the activities that they need to go
11 through to evaluate the plant and the licensee and
12 everything before the plant starts up. So it does
13 have some applicability, a little bit like the
14 ITAACs that we talked about yesterday. So I think
15 it would be of interest to hear what the Staff, the
16 process they went through and everything. And
17 without taking away all their introduction, I'll
18 turn it over to Kathy Heany to introduce the Staff
19 and the subject.
20 MS. HEANY: Sure. My name is Kathy
21 Heany. I'm the Division Director in NRR that's
22 responsible for licensing the operating fleet.
23 With me today I have Malcolm Widmann who
24 has been our point of contact in Region II relative
25 to the Browns Ferry restart activity. And then Eva

1 Brown, who is a Project Manager in NRR for the
2 Browns Ferry restart.
3 What we'd like to do today is really, as
4 Dr. Maynard said, is bring you up to date on what's
5 gone on with the Browns Ferry restart. The last
6 time we were sitting up here we were talking to you
7 about the 5 percent uprate. Since that time the
8 licensee has gone on line. And just from the
9 standpoint of an informational brief, tell you some
10 of the activities which have been primarily in the
11 inspection area which is why we'll have Malcolm do
12 the majority of the presentation. But if you do
13 have questions on the licensing, Eva and I are
14 prepared to do.
15 I'll keep my opening remarks short and
16 turn it over Malcolm.
17 MR. WIDMANN: Thank you. Good morning,
18 gentlemen.
19 MEMBER MAYNARD: One thing we might
20 mention. We do have an individual for TVA that's
21 here, but there's not going to be a presentation
22 from TVA.
23 MS. HEANY: Correct.
24 MR. WIDMANN: That's right.
25 MEMBER MAYNARD: But there is somebody

1 here.

2 MR. WIDMANN: Yes. Tony Langley is

3 supporting me from TVA. He's the licensing manager

4 currently at Browns Ferry and wanted to come up in

5 case there was questions for TVA. I didn't want to

6 speak for them.

7 With that, next slide.

8 I just wanted to go through a little bit

9 of how we got where we're at with the restart

10 history and how we did the oversight program, a

11 little bit. How we went through the licensing and

12 the amount of inspection, which was quite large, as

13 well as the licensing. I will talk a little bit

14 more about that. How we actually got through the

15 recommendation. And then I also understand you guys

16 would like to hear a little bit about the current

17 status and some issues that they have. So I've

18 added that as well.

19 The restart history, as you're all well

20 aware of, that all three units did shut down in

21 March of '85. They had a number of performance

22 issues. They had successive SALP periods with

23 category 3 ratings. The management there made the

24 decision to shut it down voluntarily back in '05.

25 They had a number of escalated

1 enforcement actions and a number of significant
2 events. And with that they shutdown all three
3 units.
4 As far as Unit 1 was concerned, they
5 made the decision to bring back Unit 1 much later
6 after bringing Unit 2 up first in '91 and then Unit
7 3 in '95. After Unit 2 had started up, they had
8 come to us with the regulatory framework of how they
9 wanted to approach Unit 1 and Unit 3. And we
10 accepted that. Then they established how they would
11 go about addressing Unit 1 after Unit 3 was
12 restarted.
13 So we reviewed all that, and that's what
14 that time line is laying out for you. And you can
15 see there that in May they were shooting for a May
16 restart, which they did make. And then we authorized
17 the actual restate on May 15th of this year.
18 The agreement we had with TVA, which was
19 quite unique, was a verbal agreement that was
20 documented in a SALP report back in 1985. That is
21 the only documentation there is that TVA agreed to
22 get our concurrence prior to restarting this unit,
23 which is quite unique nowadays. But that's what
24 there was. And that quote that's up there is what
25 came out of the SALP report, and TVA did do that.

1 As I had mentioned a second ago, the
2 restart regulatory framework was established back in
3 August of '03. The Staff did review that and did
4 adopt that regulatory framework. It identified the
5 things that TVA needed to do before we would
6 consider restart. And it included things like the
7 special programs, of which there were 27 special
8 programs. There was NRC generic communications,
9 obviously we would want to know how TVA
10 dispositioned those generic communications before
11 the unit would come back, as well as the action
12 items and any licensing amendments. And I believe
13 there was something like over 18 licensing
14 amendments that they needed to bring the unit up to
15 speed.
16 The actual restart oversight we decided
17 to issue a manual chapter of 2509, which was
18 specific to the Browns Ferry restart project
19 inspection program. That issued in September of '03.
20 And it laid out how we were going to go about
21 reviewing Unit 1 for restart and how we would
22 implement the inspection program.
23 It parallels very much what you may be
24 familiar with the Manual Chapter 350. But there were
25 some exceptions to it because 350 did not take into

1 consideration this was a nonoperating unit. 350 only
2 recognized operating units. 2509 allowed us to
3 craft it more specific Browns Ferry Unit 1.
4 It had a number of objectives, ten
5 specifically laid out in 2509. And it touched all
6 the things you would expect it to touch. You know,
7 reviewing calculations to design changes, some
8 modifications, look at open issues that were
9 remaining on Unit 1 prior to allowing it to restart
10 and verified that they had in fact addressed those
11 open items.
12 It also required us to do an ORAT and
13 establish what I consider to be an important aspect,
14 which was the NRC Restart Oversight Panel which I
15 was a member of, as well was Kathy as a co-chair and
16 Joe Shea from Region II, the head of Division
17 Reactor Safety as the Chair. We had five members on
18 that panel.
19 So that 2509 allowed us to have the
20 authority to have that oversight panel, which we
21 were the panel that recommended to the Regional
22 Administrator and the NRR Director and EDO to allow
23 the unit to restart.
24 The basis for the recommendation for the
25 restart took in a number of different areas. We had

1 to, obviously, consider the NRC licensing reviews
2 that we had to do. The numerous amount of
3 inspections that were required to be performed, as
4 well as the TVA actions and their commitments and
5 their completion of those actions, as well as
6 complete the ORAT that was required. And I'll talk
7 more about the ORAT. And then, obviously, keeping
8 stakeholders informed. So it was those five
9 elements that we felt that would be important to
10 consider before the panel would recommend restart.
11 As far as the licensing reviews,
12 obviously the status of that is complete and the
13 Staff spent an enormous amount of hours reviewing
14 the license amendments and a lot of other
15 commitments that were put before the Staff as well
16 as exemptions and different conditions.
17 Responses to generic communications took
18 a lot of effort. And I think there was other
19 licensing actions that happened as a result of Staff
20 reviewing what TVA submitted. And TVA did that and
21 completed that.
22 The restart inspections. We touched on
23 many of the same things that NRR had to do but from
24 an inspection standpoint and looking at their
25 generic communications and special programs, as well

1 as something you may not be familiar with, the
2 system turnover and preoperability checklist, as TVA
3 referred to it as SPOC turnover where they took
4 system and made it preoperational. It wasn't turned
5 over to Operations. It was a construction turnover.
6 And then we would inspect that. And then after it
7 was turned over to Operations we would complete
8 inspection of it for operability. As well as doing
9 the plant turnover, as they turned over the plant
10 back to Operations to keep it in an operational
11 mode. So there was a lot of effort that had to go
12 into the restart inspections to verify how the
13 licensee went about getting the plant ready.
14 The status of that, obviously, is
15 complete again. And the post-restart inspections
16 are still ongoing, and I'll talk a little bit more
17 about that.
18 And like NRR spent, the Region spent
19 about 30,000 hours, a little more, on inspections
20 over the five year period.
21 The resident inspectors continue to
22 monitor what TVA does. I'll talk about some of the
23 issues that they had bringing the unit back and
24 where they plant stands now.
25 MEMBER WALLIS: That's 15-man years, is

1 that what that is?

2 MR. WIDMANN: Yes, sir.

3 MS. HEANY: Sure.

4 MEMBER WALLIS: That's an awful lot of

5 time.

6 MR. WIDMANN: Yes, sir, it is. You're

7 correct. And the last count I had, I had a 119

8 inspectors touched the plant over that period of

9 time.

10 MEMBER MAYNARD: Now is this all

11 inspection at the plant or does this also include a

12 lot of the reviews that were done back here?

13 MS. HEANY: No. The reviews done back

14 here were in themselves about 30,000 hours. So the

15 NRR staff --

16 MEMBER MAYNARD: So 60,000 hours?

17 MR. WIDMANN: Over 60,000 hours was

18 spent on Browns Ferry Unit 1. Now we did do a

19 comparison of that to the other units, what we

20 spent. It was not out of line with that at all.

21 But it's an enormous amount of staff time.

22 Inspection-wise, it may be unprecedented. I'm not

23 sure.

24 MEMBER WALLIS: It may be what?

25 MEMBER BANERJEE: Unprecedented.

1 MR. WIDMANN: It may be unprecedented as
2 far as inspection. I'm sure TVA would gladly admit
3 we touched them a lot of times.
4 CHAIRMAN SHACK: Now some of this is
5 almost like a construction inspection. I mean, you
6 know they did a significant amount of repiping and--
7 MR. WIDMANN: Oh, absolutely.
8 MEMBER CORRADINI: So from a
9 construction standpoint, was this also equivalent in
10 terms of inspections and --
11 MR. WIDMANN: Well, we kept it focused
12 on operations because it was a Part D
13 construction/reconstruction, the piping as you
14 talked about. All the primary piping was pulled
15 out, replaced. All of the electrical, all of the
16 cables were repulled.
17 And, Tony, if you have any specifics on
18 that, you can offer them up.
19 MR. LANGLEY: Like you said, all the
20 cable for the program -- all instrumentation was
21 replaced, all the cabling was replaced, the majority
22 of the equipment, pumps, valves were replaced as
23 well. The piping on the balance-of-plant side like
24 Malcolm referred to was replaced.
25 Not only were we going for an uprate --

1 I may be jumping ahead here, but we also went and
2 did our license renewal at the same time. So that
3 exacerbated the inspections for them as well.
4 MEMBER CORRADINI: So at the risk of
5 going in -- so how did you determine what to
6 inspect?
7 MR. WIDMANN: Well, as the systems would
8 come back, we treated it like any other operational
9 inspection. We treated the piping, the seismic
10 upgrades, all of that as plant modifications. We did
11 all of that under the operational inspection.
12 MEMBER WALLIS: An 100 percent
13 inspection?
14 MR. WIDMANN: No, sir. It would be
15 sampling. But there was a lot of programs that was
16 100 percent completed.
17 MEMBER CORRADINI: So how did you
18 sample?
19 MR. WIDMANN: You'd look at the risk-
20 significant systems. When we talk about the SPOC
21 systems that we looked, we picked the ten most risk-
22 significant systems that we felt --
23 MEMBER CORRADINI: Okay. I'm feeling
24 better. Thank you.
25 MR. WIDMANN: Okay.

1 VICE CHAIRMAN BONACA: You said all the
2 cabling has been replaced.
3 MEMBER APOSTOLAKIS: The golden
4 question.
5 MR. LANGLEY: Yes, sir. All the safety
6 related cabling.
7 CHAIRMAN SHACK: Now is the old cabling
8 gone?
9 MR. LANGLEY: No. If it was in conduit,
10 the answer is yes it is gone. Some of the old cable
11 trays and stuff we elected to leave the cabling in
12 there and actually put in trays in a lot of cases
13 and routed the new cabling on those new trays.
14 MEMBER WALLIS: So it's still as
15 flammable as it was?
16 MR. WIDMANN: That's a loaded question.
17 MEMBER CORRADINI: We'll get to that one
18 in the afternoon.
19 MEMBER CORRADINI: No less flammable
20 than --
21 MEMBER WALLIS: Someone decided that it
22 was riskier to take it out than to leave it there or
23 something?
24 MR. LANGLEY: It was actually -- as part
25 of the fire recovery plan, we actually put a

1 Flamastic material over the cabling associated with
2 the cables in question. And as a result, it makes
3 it more difficult to actually remove it.
4 MEMBER WALLIS: Yes.
5 MR. LANGLEY: By removing the Flamastic
6 and then the cabling. As such, it was simpler and
7 there were more straightforward by new tray systems.
8 MR. WIDMANN: Any questions on that for
9 now? I understand.
10 MEMBER MAYNARD: Are you going to be
11 getting into -- I'm sure there were a number of open
12 items, a number of things that TVA had yet to
13 complete. Are you going to be going over how you
14 guys reviewed that, prioritized that, what things
15 were okay to leave maybe open until later in the
16 process.
17 MR. WIDMANN: The short answer to that
18 is we didn't leave anything open. We went back and
19 looked at every program. Any open item that had been
20 on the books prior to the decision by TVA to bring
21 the unit back, we went back and pulled out old open
22 items lists. We looked at including items like the
23 IPEEE open items. Everything that we felt that was
24 important was addressed and closed at one point.
25 MEMBER MAYNARD: Now a little bit of a

1 shift here.

2 MR. WIDMANN: Yes.

3 MEMBER MAYNARD: Not talking necessarily

4 about the regulatory identified or hit list of

5 things to look at. In any of these plants you never

6 have everything completely a 100 percent at anytime.

7 You always have some open items. Was there a review

8 of TVA's open items list that to make sure there

9 wasn't really something on their list that wasn't on

10 your list that needed to be completed?

11 MR. WIDMANN: Yes, we did do that. And

12 we would compare lists on a very frequent basis. And

13 as the unit got closer to restart, we compared that

14 list. We started on a quarterly basis and then we

15 moved it to a monthly basis and literally at the end

16 there we were weekly and daily basis. So, yes, we

17 did do that. And we wanted to be comfortable with

18 that. What we felt that we dispositioned was the

19 things that mattered. The other nonsafety-

20 significant administrative items, of course, we

21 didn't touch those. We separated those out. And

22 they still have those.

23 Yes, sir.

24 MEMBER CORRADINI: So this is just more,

25 again, to learn. So as Otto mentioned the potential

1 for other plants that would come back and be
2 reconstructed.
3 MR. WIDMANN: Yes.
4 MEMBER CORRADINI: But for the new
5 plants are you taking away lessons learned that
6 you're passing it to other parts of Staff? And are
7 you going to address that, or is this not the
8 appropriate time to address that?
9 MR. WIDMANN: Well, I was only going to
10 touch on the fact that as an activity we're
11 undertaking now and that we're currently building
12 that lessons learned so that we can, on the short
13 term, pass it along to Watts Bar Unit 2.
14 MEMBER CORRADINI: Okay.
15 MR. WIDMANN: People, Staff that will be
16 involved in that certainly because that's certainly
17 very, very similar to what we did here. Watts Bar 2
18 will be a major deconstruction/reconstruction
19 project where this is more recovery.
20 For the new plants, you know, I'll leave
21 it to the Watts Bar people. Hopefully be able to
22 pass our lessons learned on and whatever they learn
23 to the people that are dealing with new
24 construction.
25 MEMBER CORRADINI: Okay.

1 MS. HEANY: And one thing I would add to
2 what Malcolm said is at least here in NRR and to a
3 certain extent in the Region, there is a very large
4 overlap between the people that were involved with
5 Browns Ferry moving on to the Watts Bar project. I
6 would say it's close to 100 percent of my staff
7 that's moving from one project right over to the
8 next. I don't think it's that high a percentage in
9 the Region, but it is fairly high. The timing,
10 actually, is working out nice for us. We can move
11 from one to the next.
12 MR. WIDMANN: We're going to give other
13 people opportunities in the Region.
14 MS. HEANY: Okay.
15 MR. WIDMANN: And I did want to mention,
16 just for the benefit of the type of staff we kept at
17 Browns Ferry for the last five years, we've had --
18 let's see, in the last four years we've had five
19 residents at that site. That's unlike any other
20 resident site where you have the same number of
21 residents as you do units.
22 We had three residents assigned to Unit
23 1 only. And then two residents assigned to the two
24 operating units for this duration so that the
25 operating resident staff wasn't burdened with trying

1 to do construction. And, as I mentioned earlier,
2 over the years I went back and looked at how many
3 inspectors actually come to the site. We've had a
4 lot of help from a lot of the regions. All the
5 regions supported us. I just wanted to put --
6 CHAIRMAN SHACK: Do you ever just hire
7 contractors to help with specialized inspections or
8 is this really all done internally with NRC people?
9 MR. WIDMANN: It was done internally. I
10 can't speak for the NRR side of it. But it was done
11 internally. In the Region we used our own people.
12 We did have some retired that we brought back. We
13 had some really good expertise in the Region. And,
14 obviously, when you touch on something like a unit
15 that once operated that wants to operate again, the
16 guys that had that experience as that unit was
17 built, fortunately we were able to touch some of
18 those. But none of those were, if you will, outside
19 the contractors. Former NRC employees. Okay.
20 The next slide.
21 As I mentioned in the Manual Chapter
22 2509 charter we had the need to do an ORAT. We
23 approached this operationally in the assessment team
24 a little differently, which was a good lessons
25 learned coming from other inspections. The approach

1 being that we would make a multi-disciplined team
2 multi-regional team. It was lead by Region IV out of
3 Texas. As Region II we did not want to be the lead
4 on our own effort. So we thought it best if we
5 built a team that was largely of other regions and
6 other people that had not touched the plant. So we
7 then again went out and got inspectors that hadn't
8 contributed to the previous years inspections to
9 come in and look at it. And we were very lucky to
10 build a team the way we were.
11 They completed that inspection. It was
12 narrowly focused. We eliminated issues like fire
13 protection from the ORAT team because fire
14 protection was something that we were doing lots of
15 independent inspections of separate to what the tea
16 would do.
17 We took out things like power ascension
18 activities because the team would be focused on
19 operational readiness, not startup and post-startup
20 type things. So we changed the way the team would be
21 constructed and the things they would look at and
22 keep them focused on what we felt was necessary for
23 a restart decision.
24 MEMBER WALLIS: How much of this
25 inspection is what I call a paperwork inspection and

1 how much of it is a hardware type of inspection?
2 MR. WIDMANN: On the ORAT, sir? On the
3 ORAT or all of this inspection?
4 MEMBER WALLIS: Yes, on the overall
5 thing here. I mean, how much of it is mostly
6 paperwork and how much of it is actually devoted to
7 really looking at what's there and how --
8 MR. WIDMANN: Oh, I would say --
9 confidentially I would tell you 85 to 90 percent was
10 in the field.
11 MEMBER WALLIS: Was in the field?
12 MR. WIDMANN: Yes. It was very little --
13 MEMBER WALLIS: It's not just like going
14 to an office and being reassured with some
15 paperwork?
16 MR. WIDMANN: Absolutely not. Just to
17 give you an idea, we had three different offices at
18 Browns Ferry for resident inspectors because they
19 would be out in the field, they would be out with
20 the craft, out in some shops --
21 MEMBER WALLIS: Okay. That's all right.
22 MR. WIDMANN: Okay.
23 MEMBER ABDEL-KHALIK: Two extra resident
24 inspectors --
25 MR. WIDMANN: Yes, sir?

1 MEMBER ABDEL-KHALIK: -- time five
2 years, that's 20,000 hours. Is that part of the
3 30,000 hours that you're reporting?
4 MR. WIDMANN: No, sir. Well, of course--
5 excuse me. Yes. Their time would be included in the
6 30,000 hours of inspection because it would be
7 charged Unit 1. The 30,000 hours I told you is
8 anybody that charged to Unit 1.
9 Now those two extra inspectors were not
10 there for the entire five years. If I said that, I
11 misspoke. They were not there for the entire five
12 years. Two years ago the additional inspector was
13 added to double encumber. So for the last two years
14 you've had the two extra inspectors.
15 If I said that wrong, I apologize.
16 MEMBER ABDEL-KHALIK: Okay.
17 MR. WIDMANN: But the 30,000 is people
18 who charged to the Unit 1 docket. That's how we
19 came up with that number.
20 MEMBER MAYNARD: But those three were
21 doing some of the required inspections, too?
22 MR. WIDMANN: Absolutely. Oh,
23 absolutely.
24 On the ORAT team the licensee, we issued
25 a prerequisite letter to the licensee to charge them

1 with letting us know when they thought they were
2 ready for the ORAT. We delayed this ORAT almost
3 four months -- three months from the original date
4 because they were not ready and we were working very
5 closely with TVA to bring this team in the right
6 time so that we didn't waste an effort.
7 Some lessons learned from the other unit
8 restarts showed that we can go in too early and be
9 looking at the wrong things and end up wasting a lot
10 of man effort. So we specifically wrote a very
11 detailed letter asking them to tell us when they're
12 ready. They did that and the team came in in April
13 and did this inspection.
14 And as I mentioned, we did eliminate a
15 number of things from what the team would look at.
16 Okay.
17 The fourth piece of the restart decision
18 was the TVA implementation of their actions and what
19 they had to do, you know including the modifications
20 and extensive testing that they had to perform, the
21 inspections we would have to do observing the type
22 of work they were doing. TVA completed that in May.
23 They sent us a letter telling us they completed
24 everything. Obviously, we had been working with
25 them. We knew where they were. But this was their

1 official way to tell us they had completed
2 everything. They had a restart checklist, as they
3 referred to it, that annotated and there was some
4 questions as to what open items there were. That
5 list contained what they had as open, and they would
6 report to us that they had addressed it, completed
7 it and closed the items. And we would go in and
8 inspect those items. That's a large part of that.
9 Questions on that?
10 MEMBER MAYNARD: That's really an
11 important letter, and it's a tough one to sign from
12 the utility.
13 MR. WIDMANN: Absolutely.
14 MEMBER MAYNARD: I mean, you put a lot
15 of effort in making sure things really are done
16 before you certify that they're done.
17 MR. WIDMANN: That's correct. Yes. And
18 Tony would own up to that. That letter was -- each
19 letter came out, to give you an idea, in the
20 neighborhood of 150 pages every time?
21 MR. LANGLEY: Right. The letters were
22 extensive.
23 MR. WIDMANN: Very extensive telling us
24 what they did. And our inspectors would be closely
25 integrated with TVA and know exactly what that

1 letter was going to stay and what the status was.
2 Because our guys were going out and touching that
3 plant. So you're right. So that May 12th letter
4 was all important.
5 The fifth piece of the decision was the
6 interactions and our efforts to make sure that we
7 reached out to the public as well as internal
8 stakeholders. We conducted a number of meetings. We
9 had eight public meetings on Browns Ferry Unit 1,
10 and we would change the locations of where we did
11 those meetings. We did those in Washington. We did
12 them in Atlanta. We did them at the site. We did
13 them in the day. We did them in the evenings. We
14 also did 13 internal panel meetings. It was all an
15 effort to make sure that we were touching the plant,
16 the needs of the stakeholder so that we tried to
17 make ourselves available to them so they knew what
18 we were doing.
19 We also created our own website to stay
20 up with and show the amount of reports out of there.
21 I think we, at last count, had 30 inspection reports
22 that dealt with Unit 1 only.
23 And then we also reached out to people
24 like Department of Homeland Security and FEMA and
25 looked for their buy-in as well as touch base with

1 the local officials and state officials who attend
2 one of the last public meetings near the site.
3 MEMBER MAYNARD: In general what was the
4 public reaction to restarting Unit 1?
5 MR. WIDMANN: In the South it was very
6 respective. We had hardly any intervenors of
7 negative assent. We would have a couple show up at
8 just a couple of meetings. For the most part the
9 sentiment is when are you going to build the next
10 one kind of thought. I don't know if that would be
11 true in the Northwest, but it was in the South.
12 MEMBER CORRADINI: Doubtful.
13 MEMBER BANERJEE: Not in Brattleboro.
14 MR. WIDMANN: I just got back from
15 Indian Point, and I can tell you wouldn't happen
16 there. Very respective.
17 MEMBER ARMIJO: Why?
18 MR. WIDMANN: Why is that?
19 MEMBER ARMIJO: Yes.
20 MR. WIDMANN: The South welcomes the
21 work, the energy. They look at the resources.
22 They're just not against it. They're just not
23 against nuclear power. I mean, there's more of--
24 MEMBER WALLIS: There are various other
25 hypothesis we won't go into.

1 MR. WIDMANN: Okay.

2 MEMBER KRESS: Please don't. We know

3 what those are.

4 MR. WIDMANN: Okay.

5 MEMBER BANERJEE: He's a Vermonter.

6 MR. WIDMANN: Right. The current status

7 of the plant is that, obviously, the plant is

8 operating now and we did authorize that back in May.

9 The first time they went critical was May 22nd. And

10 I say "first time," because there was a number of

11 planned evolutions. As they brought the unit back,

12 they would take it offline to do a number of

13 testing. And I'll speak to that in a second.

14 All three units are currently operating.

15 And all of the cornerstones have been transitioned

16 to the reactor oversight process as it now. Prior to

17 the restart, that was not the case. There were

18 three cornerstones remained. Four were under the

19 ROP since 2004, December of 2004. And as of the

20 restart here, they're in the reactor oversight

21 process.

22 And as I put there, there's three

23 resident inspectors. And I'll speak to it a little

24 bit more about how we're offsetting that also. But

25 three resident inspectors will be permanently

1 assigned when the unit's back and operating at a 100
2 percent.
3 MEMBER ABDEL-KHALIK: So what was done
4 between May first and May 15th?
5 MR. WIDMANN: Between May 1st and May
6 15th? The internal panel meetings and public
7 meetings on May 2nd and --
8 MEMBER ABDEL-KHALIK: No. Between the
9 issuance of the inspection report and the
10 authorization to restart?
11 MR. WIDMANN: The authorization happened
12 on the 15th. If you were saying the issuance of the
13 report, of the ORAT report?
14 MEMBER ABDEL-KHALIK: Right.
15 MR. WIDMANN: It was TVA having to
16 complete a short list of, I believe it was 11 items
17 that we had from their open items list that we
18 considered to be important enough for us to hold up
19 our decision. So until we got that certification
20 from TVA that they were done on May 12th, we were
21 not going to go forward with a decision. And then it
22 took us a couple of days to get our decision and get
23 the right aligned before we gave that okay. So we
24 stayed, if you will, on top of that issue until we
25 felt comfortable that what they said was closed were

1 closed.

2 MEMBER MAYNARD: How far were they

3 allowed to go before the restart was operating? I

4 take it by this they probably had loaded the fuel?

5 MR. WIDMANN: Oh, yes, sir. They

6 loaded the fuel -- if you will, technically speaking

7 it was an operating unit back in December.

8 MEMBER MAYNARD: So they loaded fuel,

9 they'd done a lot of the pre-op tests or --

10 MR. WIDMANN: As systems came back, they

11 did the pre-op tests. That was part of the system

12 preoperability checklist that we would do, the SPOC

13 reviews.

14 December of '06 they loaded fuel. We

15 did a special inspection for that, if you will. Not

16 special, a specific inspection for that fuel reload.

17 And then they had to maintain certain systems. That

18 put them in tech specs. So they were an operating

19 unit at that point. And then we would verify

20 compliance. And as they brought other systems back,

21 they had a minimum amount of systems obviously they

22 had to have operational at that time. We would

23 maintain oversight of those as well as the new ones

24 they brought back to make sure there was no impact.

25 So it was a significant decision by them

1 to put fuel in the pot so early. Does that answer
2 the question?
3 MEMBER MAYNARD: Yes.
4 MEMBER ABDEL-KHALIK: So it took you
5 only three days between May 12th and May 15th to
6 verify that everything they said they had done was
7 indeed done?
8 MR. WIDMANN: That's not exactly true.
9 We were working with them day in and day out. We
10 literally had inspectors on site darn near 24 hours
11 a day looking at what they looked at. At any one
12 time I could have anywhere from 12 to 15 inspectors
13 on site. I was going to look to TVA to say I can't
14 remember all the numbers. But we had guys there
15 until the last hour verifying what they were telling
16 us so that we knew when we got that letter that we
17 were confident where they were.
18 Yes, sir.
19 MEMBER ABDEL-KHALIK: Thank you.
20 MR. WIDMANN: Okay. Just to give you a
21 perspective of issues, they had two issues in
22 bringing the unit back that were not planned. They
23 did have a number of issues that they planned to
24 take the unit offline. Two causing them to offline
25 that was unanticipated, one being a manual scram

1 back in May right after the startup at 3 percent
2 power. They had a fitting, a tubing fitting separate
3 on them on a combined intercept that caused them a
4 300 gallon spill and for them to go back and do a
5 100 percent sample of those kind of fitups, make
6 sure they didn't have other issues. They did that,
7 found some other issues and solved this problem and
8 then restarted the unit.
9 A second transient happened in June. As
10 they were bringing the unit back from some other
11 testing they were at 80 percent power and they had a
12 false indication on the drain tank. A moisture
13 separator drain tank which caused them to get an
14 automatic trip. They have subsequently redesigned
15 that level switch that caused the failure and that
16 has brought the unit back.
17 Other than that, those are the only
18 transients that have happened to bring this unit
19 back after 22 years and 3 months. So we thought that
20 was a little bit remarkable and a testament to the
21 job they do, the job we did inspecting it.
22 MEMBER MAYNARD: You said they
23 redesigned that switch.
24 MR. WIDMANN: Yes, sir.
25 MEMBER MAYNARD: Was that something that

1 was unique or different that Unit 2 and 3? I'm kind
2 of wondering why this wasn't the same as 2 and 3.
3 MR. LANGLEY: I'll answer that. This is
4 Tony Langley with Browns Ferry.
5 The difference between the units was the
6 support arrangement. They were a little bit
7 geometrically different. As a result, we had some
8 vibration that was causing this scram to occur on
9 the instrumentation. Went and added some additional
10 time back supports and that choose to be very
11 successful at this time.
12 MR. WIDMANN: Thanks. Any other
13 questions on those?
14 And to give the ACRS just a feel of the
15 type of testing they've done since they started up
16 the unit, they have successfully completed the first
17 five I've listed there or the turbine overspeed
18 testing in early June and then a couple of very
19 important core injection full flow test as well as
20 secondary pump tests that they had a trip off line
21 one at a time and then an all important MSIV closure
22 test, which they completed successfully and
23 recovered from. The remaining post art of test that
24 they had to do was a load reject test which they are
25 currently asking the Staff to review based on the 80

1 percent trip they had as a transient to take credit
2 for that transient and not do this particular test.
3 Of course, this test is not as severe as the MSIV
4 closure, so --
5 MEMBER WALLIS: When they do this MSIV
6 closure, they do this at reduced power, do they?
7 MR. WIDMANN: No, sir.
8 MEMBER WALLIS: It's full power?
9 MR. WIDMANN: Yes, sir.
10 MEMBER WALLIS: And then they bypass the
11 condenser, is that what they do?
12 MR. WIDMANN: Yes, sir.
13 MEMBER WALLIS: Okay.
14 MR. WIDMANN: They did.
15 MEMBER BANERJEE: Do they have
16 instrumentation related to the steam dryer
17 vibration?
18 MR. WIDMANN: Yes, sir, they did. And I
19 continue to collect data off of that. So they had--
20 was it 16 strain gauges?
21 MR. LANGLEY: That's correct. As well as
22 some instrumentation off of some of the stand paps.
23 MR. WIDMANN: So they had welded strang
24 gauges on the pipes --
25 MEMBER WALLIS: So what happens when you

1 do MSIV closure to those strain gauges?

2 MEMBER CORRADINI: They wiggle. They

3 see a transient.

4 MR. WIDMANN: Yes, sir, they do. You're

5 correct. It's a impressive test --

6 MEMBER BANERJEE: What are these spin

7 gauges showing right now? Is a quiet plant or is it

8 going to be --

9 MR. LANGLEY: What the initial

10 information shows at low frequencies we do have some

11 noise, but in the upper frequencies it shows to be

12 fairly quiet.

13 MEMBER ABDEL-KHALIK: What is low? When

14 you say low frequency.

15 MR. LANGLEY: Low frequencies in the 124

16 hertz range. 124 or less.

17 MR. WIDMANN: Okay. Any other

18 questions?

19 Upcoming activities. We have -- out of

20 the Region as one of the members asked is documented

21 lessons learned. We are having a two day meeting to

22 collect about 75 of the more important contributors

23 to the overall inspections to gather those lessons

24 learned. We've been working on that all along, but

25 we're going to actually have a concentrated meeting

1 on trying to gather that so we can pass that along
2 to our Unit 2 staff.
3 We also have -- we have yet -- the
4 Restart Oversight Panel, which Kathy and I are still
5 members of and we still need to bring closure to
6 that following the startup and successful testing.
7 At some point we will disband the Restart Oversight
8 Panel.
9 And as I mentioned earlier, we'll
10 continue to do performance assessment under the ROP
11 of all cornerstones now. And the additional item is
12 enhanced performance indicator inspectors. Because
13 the unit hasn't been operating, there isn't
14 performance data to collect and review. So we've
15 offset that with additional inspections which
16 required to us to assign a temporary inspector to
17 the site for additional one year. So there's
18 actually going to be four inspectors there for one
19 year until those PI inspections are complete and the
20 licensee has had an opportunity to collect enough
21 data to call it valid PIs. And that's the plan.
22 With that, that's what I have for my
23 prepared remarks. Is there additional questions?
24 MEMBER POWERS: Can you tell me --
25 MR. WIDMANN: Sir?

1 MEMBER POWERS: Can you tell me what
2 lesson you learned from this manual scram due to the
3 electrohydraulic control fitting separating and the
4 subsequent examinations which you indicated that
5 additional APs you're planning.
6 MR. WIDMANN: Yes, sir.
7 MEMBER POWERS: Besides all these
8 thousands of hour of extra and you still had this
9 problem, and apparently additional problems that had
10 not been found?
11 MR. WIDMANN: Well, in looking at the
12 type of failure that this was on this tubing, the
13 fitup of those tubings, you're familiar with how a
14 flared tubing mates up. This particular one was
15 cross threaded. And until you have that system
16 under the 1500 pounds of pressure that's required to
17 operate that system, that fitting will not show you
18 it has a problem.
19 The other issues I mentioned was a
20 matter of them taking apart some additional fittings
21 and looking to see if they had bottomed out any of
22 those fittings and see if they had caused some other
23 problems. They saw ones that they do not believe
24 would have separated but they didn't like, so they
25 decided to refit them.

1 So it was just part of their extended
2 condition that they decided to do to verify for
3 themselves that they had no additional problems.
4 None were really found, but they were just being
5 cautious, I felt and conservative. But this one
6 fitting did in fact separate.
7 And I would even go as far to say that
8 the original arrangement wasn't understand it was
9 under stress and caused the flare fitting to fail.
10 Otherwise, I don't think it would have separate.
11 MEMBER POWERS: And as long as we're on
12 that slide, we're frequently assured that this plant
13 will be much like Units 2 and 3, but obviously it is
14 not.
15 MR. WIDMANN: In what respect, Dr.
16 Powers?
17 MEMBER POWERS: Well, this auto trip
18 from 80 percent power due to a false high level
19 indication on the moisture separator and we're told
20 the reason for that is that it's mounted
21 differently.
22 MR. WIDMANN: Yes. You're talking about
23 the units being the same and operating the same,
24 that is a true statement. Configurations like a
25 seismic arrangement of a particular of a particular

1 instrument, that kind of subtly small differences is
2 not something that's part of what they said would be
3 -- the unit would be the same. That would have
4 separated. But that's not the level I would think
5 that they would feel that that would be worth noting
6 and saying this unit is different because this
7 seismic fitting is different. I don't think that
8 level is the same.
9 MEMBER POWERS: Well, they're the same
10 or redid the same?
11 MR. WIDMANN: They're the same in
12 operationally they're the same.
13 MEMBER POWERS: But manifestly it's not
14 the same for Units 1 and 2 because control rooms are
15 different. Things are on the left on one, on the
16 right on the other.
17 MR. WIDMANN: That's correct.
18 MEMBER POWERS: And so they're
19 manifestly are not the same.
20 MR. WIDMANN: Yes, sir.
21 MEMBER MAYNARD: Well, nothing is ever
22 identical. If they replaced a lot of piping even if
23 you replace something with like piping to the same
24 design, you can end up with different areas where
25 you have vibration levels and --

1 MEMBER POWERS: No. See, the problem I
2 have is what does it mean to be the same?
3 MEMBER MAYNARD: Yes.
4 MEMBER POWERS: I can't -- it's not
5 evident to me I could draw any comfort from that at
6 all.
7 MR. WIDMANN: Well, I'm not going to
8 speak for TVA, Tony. You can speak up if you'd like.
9 But the Staff's view was it was operationally the
10 same. Not necessarily physically the same.
11 MEMBER POWERS: Yes, but it's even that
12 I don't agree with you on.
13 MR. WIDMANN: Okay.
14 MEMBER POWERS: Because in the control
15 room if I operate Unit 2 with my right hand, I got
16 to use my left hand when I'm in Unit 1.
17 MEMBER MAYNARD: Well, I think you have
18 to be careful in any of these that you rely too
19 heavily on it being the same. Because even something
20 that is very close, there can be subtle differences
21 that make it -- so you have to look at each one of
22 these for its own thing, too.
23 MEMBER POWERS: I mean, I agree with you
24 on that a 100 percent. I'm just trying to understand
25 why some people tell me to derive some comfort out

of the sameness of these when they manifestly are not.

MEMBER ARMIJO: Were any of the items replaced after the May 24th on your original list of items to be inspected?

MR. WIDMANN: Were anything replaced, sir?

MEMBER ABDEL-KHALIK: Right. Were any of the changes made after this trip on May 24th on your list of items to be inspected?

MR. WIDMANN: No, sir. That list remained the same. Nothing is added as a result of that. And we did go back and ask that question of ourselves.

MEMBER BANERJEE: This remind me. Do these units have the DSSCD system for stability control or is it solution 3?

MR. LANGLEY: No, it's solution 3. DSSCD is in on Unit 1, the software's available. But it's been jumpered out. We used the option 3 based on because we're not MELLA+.

MEMBER BANERJEE: No, but for EPU are you going to just use --

MR. LANGLEY: We will use option 3 until -- one of my future plans is to come in with MELLA+.

1 And as part of that, we would go to DSSCD for the
2 oscillations power into monitor.
3 MEMBER BANERJEE: And how would that be
4 effected?
5 MR. WIDMANN: I couldn't answer that. I
6 don't have the answer for that.
7 MEMBER BANERJEE: What's your answer?
8 MR. LANGLEY: Obviously, we would go
9 through and do a -- it's a firmware situation. The
10 software would be obviously validated and verified
11 as well as we would monitor the system for a while.
12 It's actually in monitoring now. It doesn't have
13 the ability to strip. So if there any problems
14 associated with it, we could recognize it before we
15 allowed it to initiate a trip.
16 MEMBER BANERJEE: Okay. Thank you.
17 MEMBER MAYNARD: You may not have the
18 people here to answer this in detail, but the fire
19 protection. One of the -- we heard yesterday that
20 Browns Ferry was allowed to startup with a large
21 number of manual operator actions under enforcement
22 discretion, which I don't think is probably an exact
23 characterization. But just comment on how fire
24 protection, was there anything unique with Unit 1
25 compared to the fire protection and use of manual

1 operator actions different from 1 than what for 2
2 and were there any special considerations for this
3 startup for operator manual actions for fire
4 protection.
5 MR. WIDMANN: And, Tony, you can put our
6 two cents in also.
7 MR. LANGLEY: Yes, sir. You want to go
8 ahead? I'm sorry.
9 The manual actions are consistent
10 between the units. There wasn't any uniqueness
11 associated with Unit 1. A lot of cases it would be,
12 you know, as simple as maybe taking the HPCI system
13 and ensuring it didn't operate for a spurious
14 operation, or attributes such as tripping loads to
15 ensure that there wasn't an exceedence of the board
16 limits associated with the electrical equipment.
17 Those kind of things. But there wasn't a uniqueness
18 associated with Unit 1 with respect to those type of
19 manual actions.
20 MR. WIDMANN: Does that answer your
21 question?
22 MEMBER ABDEL-KHALIK: The decision to
23 retain the old cabling side-by-side with the new
24 cabling, obviously that was done a long time ago.
25 And the question is was that done in consultation

1 with the Staff?

2 MR. LANGLEY: The Staff was cognizant of

3 our decisions. Obviously then -- when we go through

4 this and we elect to put in new tray systems, we

5 have criteria that we're going to follow with

6 regards to seismic, with regards to separations.

7 And if we meet those criteria, they're going to

8 inspect those criteria to make sure I don't -- I

9 have not done anything that's inappropriate.

10 MEMBER MAYNARD: Typically -- you have

11 to be careful in terminology because you don't work

12 together on these.

13 Typically the licensee will propose,

14 they will identify what they're doing and they will

15 propose an item and then it's up to the NRC to

16 decide whether they inspect that, review it further

17 or approve it or not.

18 MEMBER ABDEL-KHALIK: That's what I

19 meant.

20 MR. WIDMANN: We spent a lot -- I can't

21 give you exact hours, but the Staff spent a number

22 of dedicated inspections. I want to say it was four

23 or five. Phil, do you remember how many inspections

24 we did? It was four or five inspections that were

25 dedicated to fire protection alone and looking at

1 the count measures as well as fire loadings,
2 separations, cable separation. And cable separation
3 by itself was a separate special program that was
4 reviewed. And we did have some issues, and TVA
5 resolved those before that restart occurred.
6 CHAIRMAN SHACK: Yes, I was going to say
7 I mean if your manual actions are consistent, you
8 weren't able to get better separation or pass the
9 fire barriers as you did the rewiring of the plant?
10 MR. LANGLEY: Obviously, on the
11 modifications that we did, yes, we did meet that
12 criteria. But in some cases with the physical
13 makeup of the plant there is going to be those same
14 type of manual actions.
15 MEMBER MAYNARD: Are there any other
16 questions?
17 Well, I believe that, personally, I look
18 at this as a success for the Staff. I think they
19 have a big job to do. I think this is something that
20 hadn't been done for some time. It's been a long
21 time since we completed a plant and brought a new
22 plant on line. So I think the Staff did an admiral
23 job of putting together their program, meeting the
24 requirements and putting the effort in it to assure
25 that the licensee had done what they were supposed

1 to do.

2 And so I would say that this was a good

3 job by the Staff. And I really hope that the lessons

4 learned are passed along. Because I think they're

5 not only applicable to the other TVA plant, I think

6 it's also applicable somewhat to the new generation

7 of plants that may be coming on line later on.

8 So, with that I'll turn it back over to

9 you, Mr. Chairman.

10 CHAIRMAN SHACK: All right. Thank you

11 very much. It was a very good presentation.

12 Before you take off, Mario would like to

13 get some input about the PAR.

14 VICE CHAIRMAN BONACA: Yes. Just to get

15 an input about the PAR.

16 CHAIRMAN SHACK: We're finished. So

17 thank you very much.

18 VICE CHAIRMAN BONACA So if you can give

19 me some input and see if that has changed.

20 MEMBER APOSTOLAKIS: Do you need the

21 reporter?

22 VICE CHAIR BONACA: Don't need the

23 reporter.

24 MEMBER APOSTOLAKIS: Comments or you

25 want us to read the draft.

1 VICE CHAIRMAN BONACA: I read it over.

2 MEMBER APOSTOLAKIS: You have a draft

3 letter?

4 VICE CHAIRMAN BONACA: Yes.

5 MEMBER APOSTOLAKIS: Where is it?

6 VICE CHAIRMAN BONACA: I mean if we're

7 together, so I want to make sure there's some

8 feedback from your guys.

9 CHAIRMAN SHACK: We're finished.

10 (Whereupon, at 11:48 a.m. the meeting

11 was adjourned.)

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## CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on Reactor Safeguards

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Charles Morrison
Official Reporter
Neal R. Gross & Co., Inc.

U.S.NRC

UNITED STATES NUCLEAR REGULATORY COMMISSION

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# Browns Ferry Unit 1 Restart/Recovery Summary and Plant Status

July 12, 2007

Presented by: Malcolm T. Widmann
Branch Chief, Region II/DRP

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# Agenda

- Restart History
- Restart Oversight Program
- Licensing
- Inspection
- Restart Process

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# Restart History

8/01/1974 – U1 Commercial Operation

March 1985 - All 3 BF Units shutdown

May 1991- U2 Restart

November 1995- U3 Restart

May 2007- U1 Restart

1974 1982 1991 1999 2007

9/17/1985 - SALP Letter

4/01/1992 – NRC letter: Return to service for U1 and U3

8/14/2003 – NRC Regulatory Framework Letter for Restart of U1

5/15/2007- NRC Authorized U1 Restart

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# Restart Agreement

"You currently have the units at Browns Ferry…in cold shutdown to correct various plant specific deficiencies and management problems. Through verbal agreements between Region II and TVA, we understand that none of these units will be restarted without NRC concurrence…"

September 17, 1985 - Systematic Assessment of Licensee Performance Letter

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# Restart Regulatory Framework

- Established in August 2003
- Identified actions to be completed by TVA prior to NRC consideration of restart authorization
  - Special Programs
  - NRC Generic Communications
  - TMI Action Items
  - License Amendments

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# NRC Restart Oversight

- Inspection Manual Chapter 2509
  - Issued September 2003
  - Policies and Requirements
- Ten Specific NRC Oversight Objectives
- NRC Restart Oversight Panel

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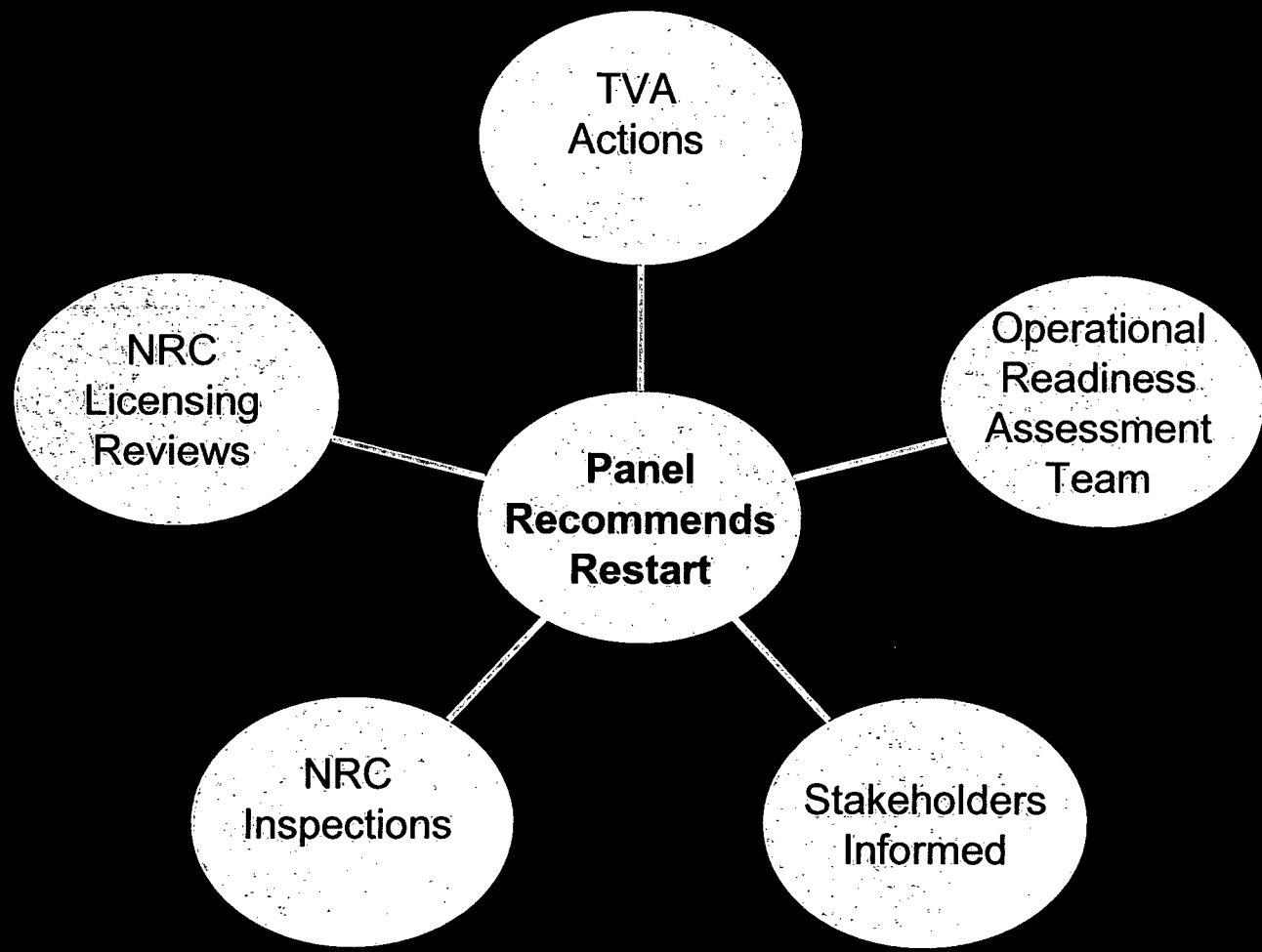
# Basis for Recommendation



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# NRC Licensing Reviews

- Status
  - Complete
  - Approximately 30,000 staff hours
- Scope
  - License Amendments
  - Exemptions
  - Conditions
  - Responses to Generic Communications
  - Commitments

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# NRC Restart Inspection

- Scope
  - Generic Communications
  - Special Programs
  - Plant Modifications
  - Renovation Work
  - System Pre-Operability Checklist (SPOC) Process
  - Area Turnover

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# NRC Restart Inspection (cont'd)

- Status
  - Restart Items Complete
  - Post-Restart Ongoing
  - Approximately 30,000 staff hours
  - Resident Inspectors continue to monitor ongoing TVA activities

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# Operational Readiness Assessment Team

- Status
  - Complete
  - Inspection Report issued May 1, 2007
  - Multi-Regional Team
- Report Conclusion
  - "TVA has adequately prepared Browns Ferry for a return to three unit operation"

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# TVA Implementation Actions

- Status
  - Complete
- TVA Completion Letter
  - May 12, 2007
  - Letter Certified that all items defined in the regulatory framework letters including testing associated with the Restart Test Program were complete

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# Stakeholder Interaction

- Public Panel Meetings
- Public Website
- Department of Homeland Security
- FEMA
- Local Officials
- State Officials

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# Current Status

- Restart authorized on May 15, 2007
- Reactor critical on May 22
- All three units operating
- Assessment under the Reactor Oversight Process
- Three resident inspectors onsite

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# Startup Issues/Transients

- Manual scram on 5/24 from 3% power due to failed electro hydraulic control fitting separated on #6 CIV

- Auto trip on 6/9 from 80% power due to false hi level indication on moisture separator 2A drain tank.

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# Startup Testing

- Turbine over speed test (6/2)
- Reactor core isolation cooling injection (6/13)
- High pressure coolant injection / reactor pressure vessel injection (6/19)
- FW, condensate & boosters pump trip test (6/23)
- MSIV closure (6/23)

- Pending: load reject test (TS amendment submitted)

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# Upcoming Activities

- Document Lessons Learned
- Termination of IMC 2509 and Restart Oversight Panel
- Ongoing Performance Assessments under Reactor Oversight Process
- Ongoing enhanced performance indicator (PI) inspections

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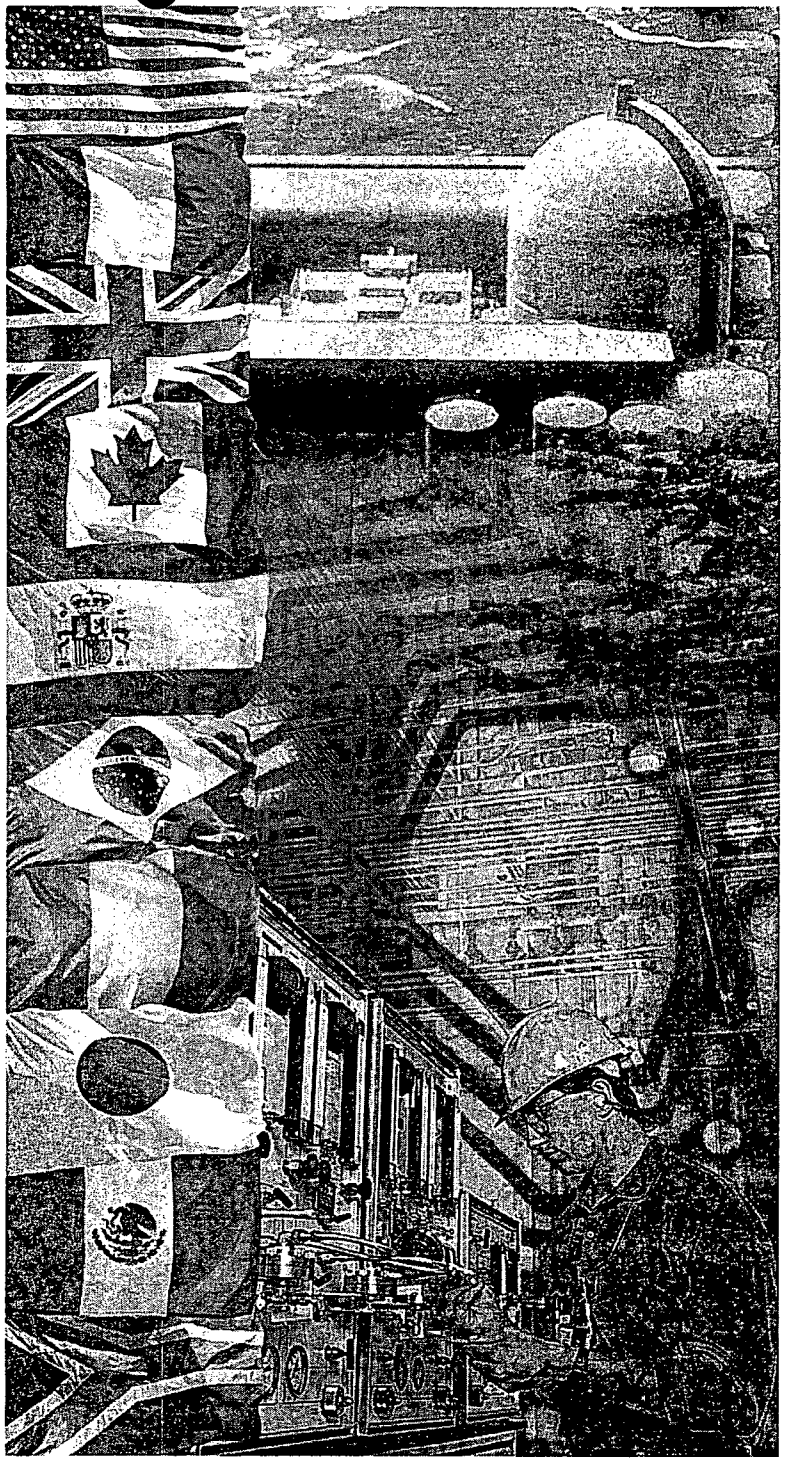
# QUESTIONS



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# Risk-Informed Evaluation of Protective Action Strategies for Nuclear Plant Offsite Emergency Planning

Presented to Advisory Committee on Reactor Safeguards – 12 July 2007

Dr. David E. Leaver - Polestar Applied Technology, Inc.
Dr. Stephen M. Hess – Electric Power Research Institute
Mr. Alan P. Nelson – Nuclear Energy Institute

# EP Technical Basis

- Existing EP technical basis is contained in NUREG-0396.
  - Employs technology and state of knowledge that is over 30 years old.
  - Results significantly overestimate the risks associated with nuclear plant radiological accidents.
- Basis for the NUREG-0396 10-mile plume exposure planning distance:
  - Not risk-informed: uses conditional probability and does not reflect PRA results from the last 30 years.
  - Uses out-of-date source terms and a MACCS2-type peak dose, both of which are unrealistic.
  - Impact of EP actions not addressed: approach does not credit implementation of protective actions.

# Objectives

1. Conduct initial research to develop a risk-informed (R-I) methodology for quantifying the relative effectiveness of offsite Protective Action Strategies (PAS).
   - Provide framework for potential implementation in offsite emergency planning (EP) process.
   - Support guidance clarification for protective action recommendations and decisions.
   - Take advantage of advanced communication technologies.

# Objectives, continued

2. Provide framework for updated technical basis for EP, including consideration of a R-I approach and quantification of the margin in the 10-mile emergency planning zone (EPZ).
3. Provide technical input / insights to NUREG 0654 Supplement 3 revision.

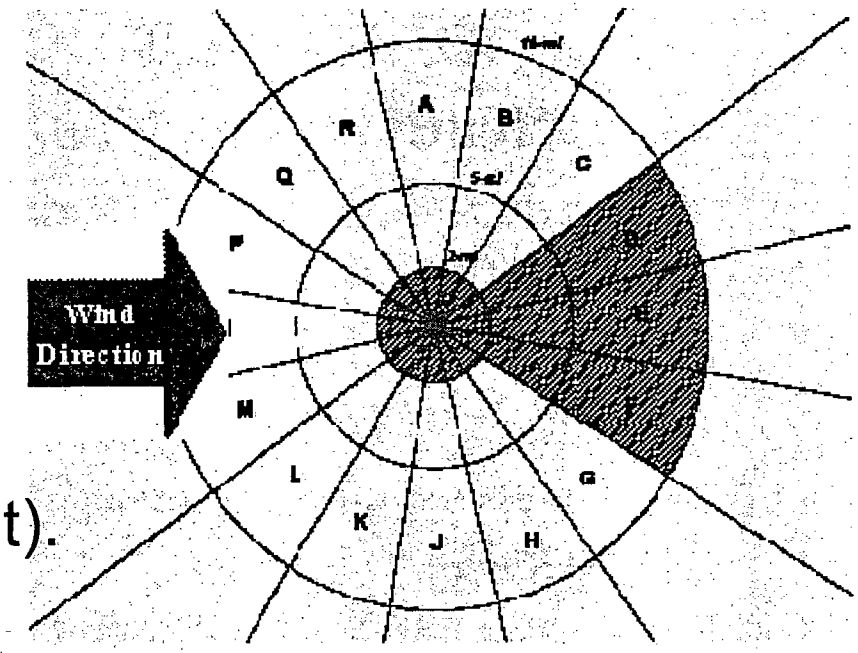
# Approach

1. Model utilized generic site and source terms.
2. Risk-informed using the following risk metrics:
   a. Early fatality risk.
   b. Latent cancer fatality risk.
   c. Early injury risk.
3. Model developed (DoRMET) to extend MACCS2 plume dispersion modeling to provide:
   - More detailed (and realistic) distribution of activity.
   - More realistic movement of population.
   - Coupling of PAS to conditions at time of accident (e.g., wind direction).
4. Evaluate PAS on basis of relative risk.
5. Provide evaluation of 10-mile plume exposure EPZ margin on basis of absolute risk.

# Protective Action Strategies

## Four Primary Strategies

1. Shelter-in-Place.
2. Away from Reactor Evacuation (evac. along radial streamlines).
3. Away from Plume Evacuation (used to approximate realistic road networks which essentially always have a lateral component).
4. "Keyhole" Evacuation.





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# Study PAS Conclusions

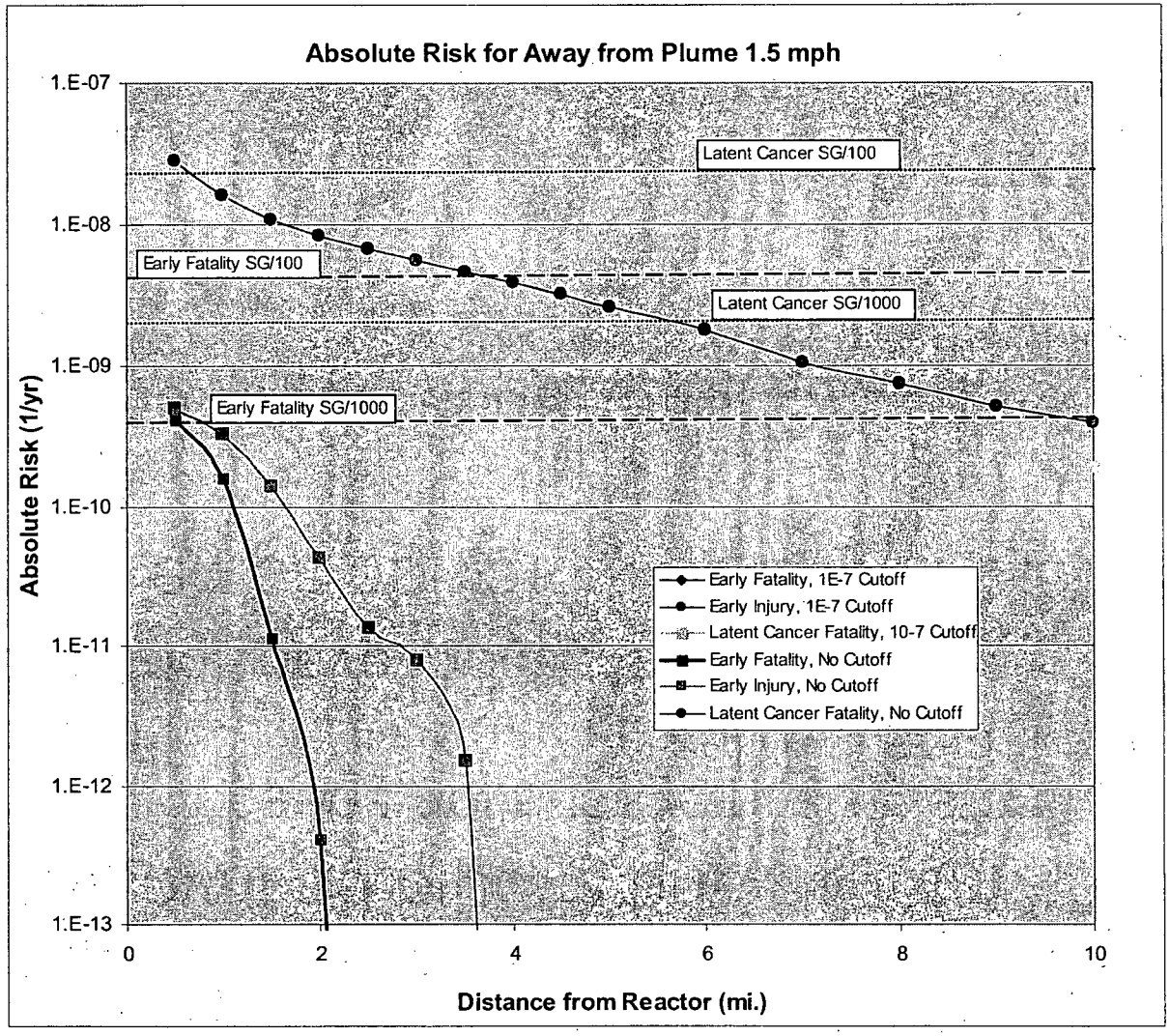
- All PAS reduce Early Fatality Risk 1 to 2+ orders of magnitude per mile distance from reactor.
- Evacuation provides ~2 orders of magnitude lower Early Fatality Risk than Shelter-in-Place for region inside 5 miles.
- Away from Plume Strategy provides 1 to 2 orders of magnitude lower Early Fatality Risk than the Away from Reactor strategy near the site.
  - Away from Plume more like actual road network.
  - Away from Reactor overestimates dose.

# Study PAS Conclusions (cont.)

- Keyhole Strategy is relatively ineffective from 2 to 5 miles compared to other evacuation strategies due to wind shift.
- Delayed evacuation start for far field has potential advantages and should be investigated further:
  - Increases in evacuation speed for those most at risk (inside 4 miles).
  - May avoid unnecessary evac. for those outside 4 miles.
- Breathing Masks provide some reduction in health risks.
- Preferred Shelter does not offer significant risk reduction.

# EP R-I Tech. Basis Example Results

**Risk vs. Distance (Away from Plume Evacuation – 1.5 mph).**





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# Status / Next Steps

- EPRI report in final draft – to be published in August.
- Next steps under consideration:
  - Add model for a coarse, realistic road network.
  - Couple traffic engineering studies to evacuation speeds.
  - Perform site-specific pilot applications.
  - Investigate technical research necessary to support risk-informed EPZ specification.

# Items for ACRS Consideration

- Public and industry could both benefit from development of a modern, R-I technical basis for EP.
  - Update EP basis to incorporate knowledge / experience obtained over past three decades of plant operation and severe accident research.
  - Replace assumptions and conservative bounding analyses with updated models, improved analytical methods, and operating data.
  - Incorporate knowledge obtained from plant PRAs into EP decision-making framework.
  - Present R-I EP basis in a way that properly characterizes risks and avoids unfounded fears on the part of the public.
- Would welcome opportunity for detailed presentation at future ACRS meeting.

# US NRC
# Protective Action Recommendation Study

## ACRS Briefing
## July 12, 2007

**Randolph L. Sullivan, CHP**
**Office of Nuclear Security and Incident Response**

# Introduction

- Staff recommended a review of protective action recommendation guidance as found in NUREG-0654, Supplement 3
- Commission directed that the study proceed
- Sandia chosen to support study
- Study began in late 2004

# Background

Commission Direction

"Continue to evaluate the NRC protective action recommendation guidance to assure that it continues to reflect our current state of knowledge with regard to evacuation and sheltering. Update the guidance, as necessary."

# Background

**Emergency Preparedness Planning Basis:**

- Key technical elements of EP planning basis:
  - Reactor accident probability is within the bounds of the Commission's Safety Goals (they are unlikely)
  - Accidental radiological releases (including security events) are no greater than identified in WASH-1400 (EPZ basis)
  - Radiological releases from accidents are no faster than those identified in WASH-1400, i.e., 30 minutes. (notification basis)

# Background

- EP is not risk informed
- Defense-in-depth measure from Safety Goal Policy
- Regulations largely prescriptive

# PAR Study

Objective

Investigate if the use of alternative protective actions can reduce public dose during severe accidents

# Technique

- Compare public dose consequences for alternative PAR regimens to the Supp 3 standard (radial keyhole evacuation)
- Absolute consequences not assessed
- Relative efficacy assessed qualitatively

# Technique

- Analyses for rapidly developing releases
- Analyses for more slowly developing releases
- Analyses for accidents w/o containment failure

# Technique

Establish source terms to be used

- Reflect EP Planning Basis (large early release)
- Used NUREG-1150 source terms
  - Desired a more current NRC reference

# Shawn Burns- Sandia

# Technique

- Used the NRC MACCS2 code
  - Models population movement
- Standard US meteorology
- Generic EPZ with about 80,000 people
- Varied Evacuation Time (ETE) from 4-10 hours
  - Varied travel speed accordingly

# Alternative PARs Tested

- Shelter in place (SIP) for various times – (within current regimen, but limited use)
- Preferred sheltering for various times (in large public buildings, etc.)
- Lateral evacuation (crosswind)
- Staged evacuation (evacuation nearby, initially shelter others)

# Stakeholder Input

- Discussed alternative PARs with State EP personnel
  - Practicality of implementation
  - Cost-benefit
  - Applicability to physical site

# Sociological Review

- Public likely to implement as directed
- Public requires consistent emergency information
- Other sociological factors for consideration

# Results for 10 Hr Evac

| Protective Action | Normalized to Total Sum | |
|---|---|---|
| | EF | LCF |
| SIP-2 hrs/Lateral evac | 0.00 | 0.00 |
| PS-2 hrs/Lateral evac | 0.00 | 0.00 |
| SIP-4 hrs/Lateral evac | 0.00 | 0.00 |
| PS-4 hrs/Lateral evac | 0.00 | 0.00 |
| Staged Evacuation | 0.00 | 0.02 |
| Radial Evacuation (constant speed) | 0.00 | 0.03 |
| SIP-2 hrs/Radial evac | 0.00 | 0.05 |
| SIP-8 hrs/Lateral evac | 0.00 | 0.05 |
| PS-2 hrs/Radial evac | 0.00 | 0.07 |
| PS-8 hrs/Lateral evac | 0.00 | 0.08 |
| SIP-4 hrs/Radial evac | 0.00 | 0.11 |
| PS-4 hrs/Radial evac | 0.00 | 0.13 |
| SIP-8 hrs/Radial evac | 0.26 | 0.23 |
| PS-8 hrs/Radial evac | 0.74 | 0.24 |

# Recommendations

- Consider revision of NUREG-0654, Supplement 3
- Evacuation remains the major element
- Consider early and staged evacuation
- Precautionary actions at Site Area Emergency are prudent
- Consider action regarding strategies that reduce evacuation times in order to reduce consequences

# Recommendations

- Enhance usefulness of ETEs for the planning process
  - Develop ETE for each potential protective action to improve the information for decision makers
- Planning for special needs groups not in special facilities should be enhanced

# Recommendations

- Shelter in place followed by evacuation is more protective than standard PAR for large early release at sites with longer evacuation times
- Sheltering of special needs individuals followed by evacuation can result in fewer consequences.
- Enhancements to emergency communication with the public were identified

# Next Steps

- ACRS Comments
- Revise draft NUREG
- Develop SECY Paper with recommendation

# SOARCA Considerations

- The SOARCA project may show that LER does not credibly exist
  - Staff may propose changes to the EP planning basis for Commission consideration
- Test efficacy of staged evacuation and sheltering in SOARCA project

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# Questions?

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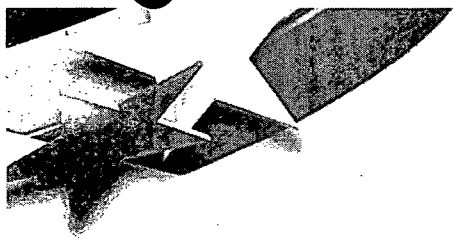
rxs3@nrc.gov



# Protective Action Recommendation Project

## Source Term Identification Effort

Presented to the

**Advisory Committee on Reactor Safeguards**

July 12, 2007

by

**Shawn P. Burns**

Sandia National Laboratories

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

# Identification of source term data represents a technical challenge.

- Complex phenomenology
  - Initiating event
  - Plant damage state
- Limited scope available
  - Accident progression analysis not possible
- Intellectual integrity required
  - Ad hoc source term definition to credible

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# Challenge was met by mining historical source term analyses.

- Severe accident risk study
  - NUREG-1150
- Low Power and Shut Down
  - NUREG/CR-6143
  - NUREG/CR-6144
- Phenomenology and Risk Uncertainty Evaluation Program
  - NUREG/CR-5305
- Internal and externally initiated events

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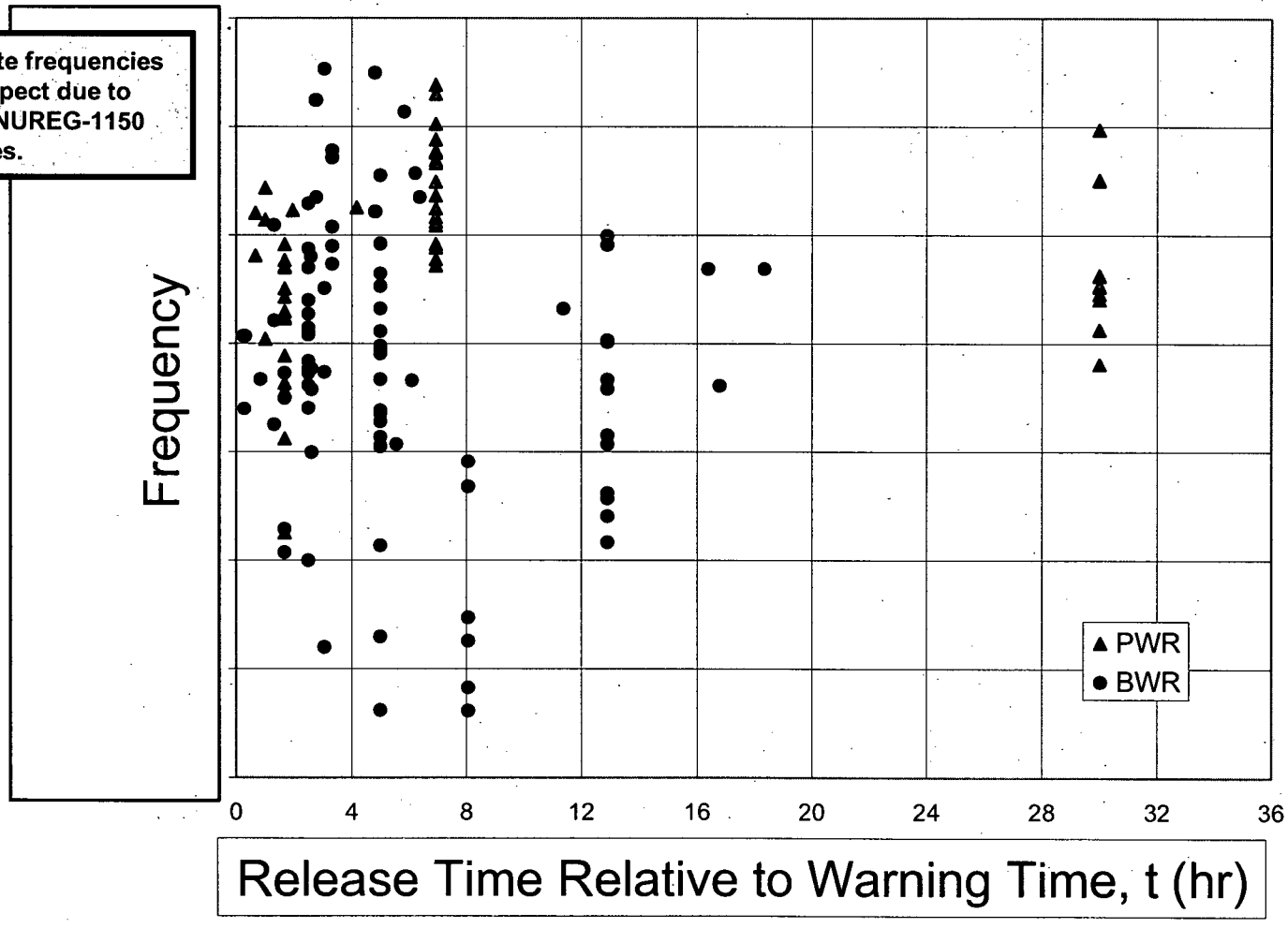
# Accumulation of source term frequency data provides a basis for selection.

Absolute frequencies are suspect due to age of NUREG-1150 analyses.

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# Source term frequencies were obtained from site risk analysis documentation.

- Determine core damage frequency
  - $f_n$(plant damage state)
- Determine conditional containment failure frequency
  - $f_n$(plant damage state, accident progression)
- Identify characteristic source term

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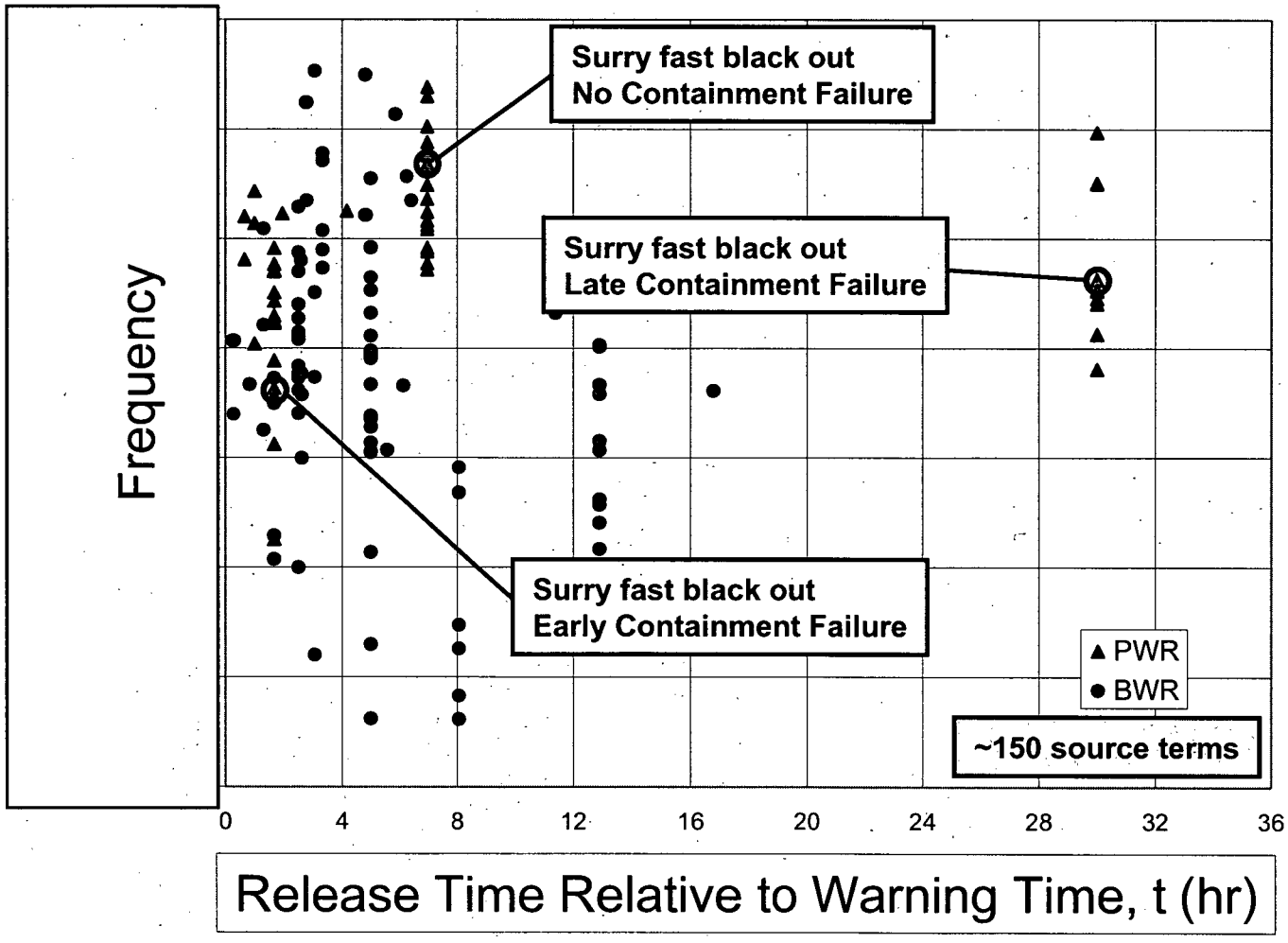
# A total of 150 individual source terms were identified from reference literature.

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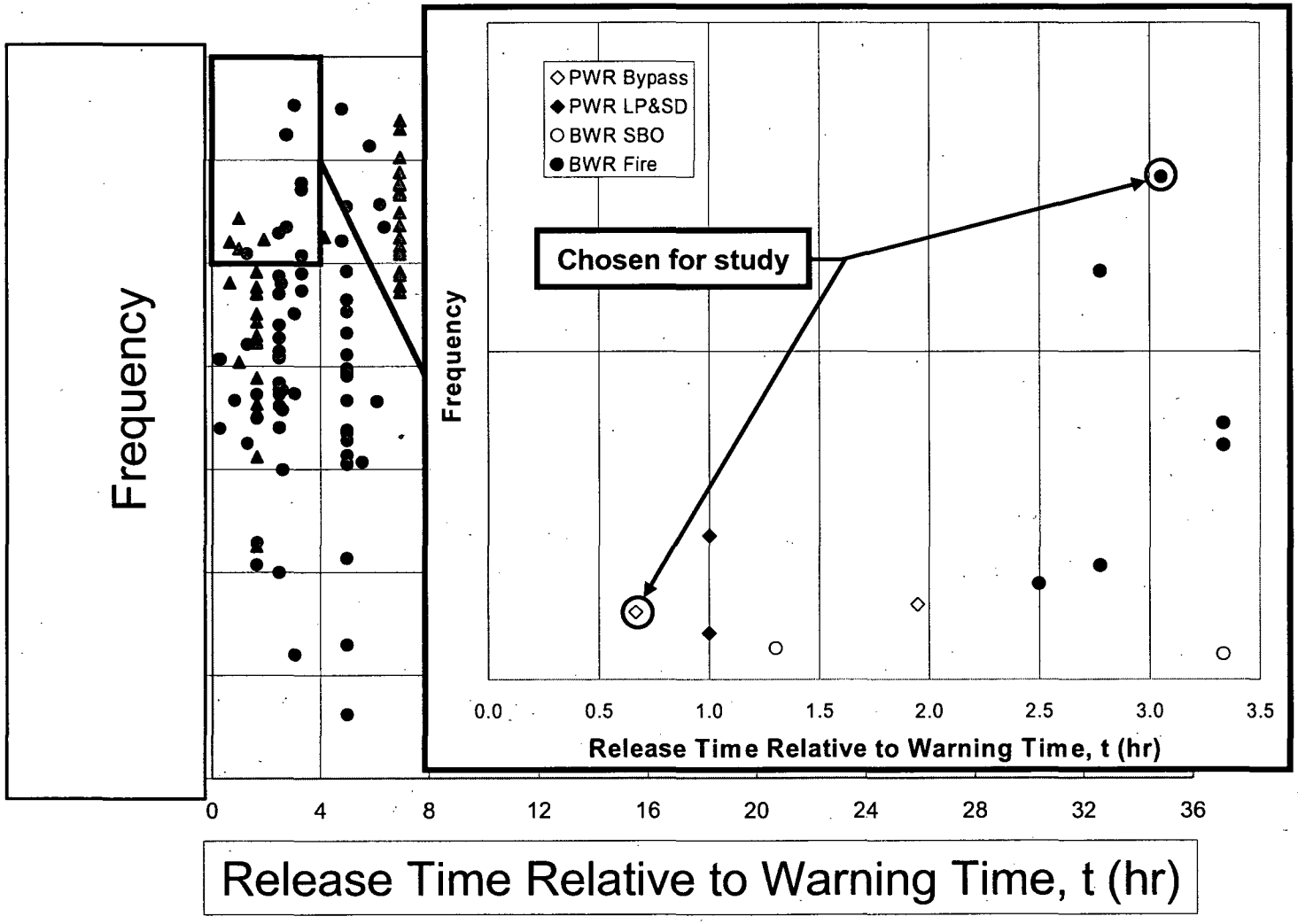
# Short time scale, high frequency events are the most compelling for this study.

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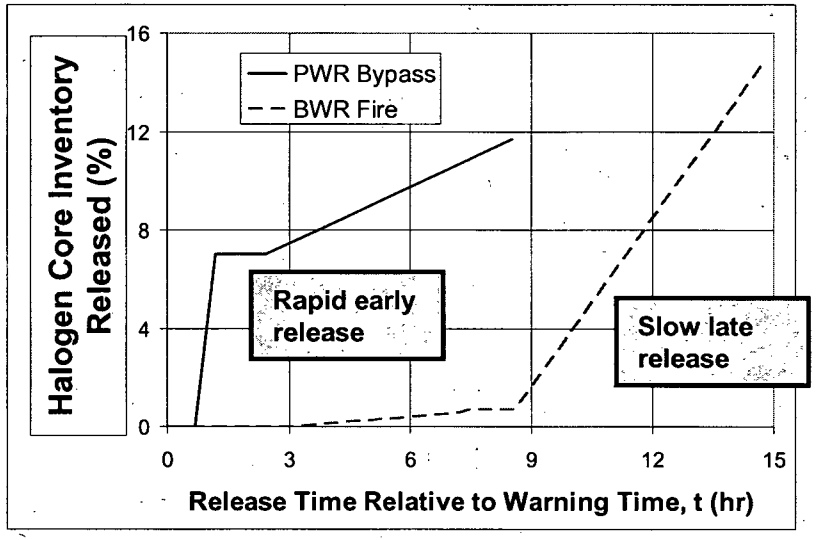
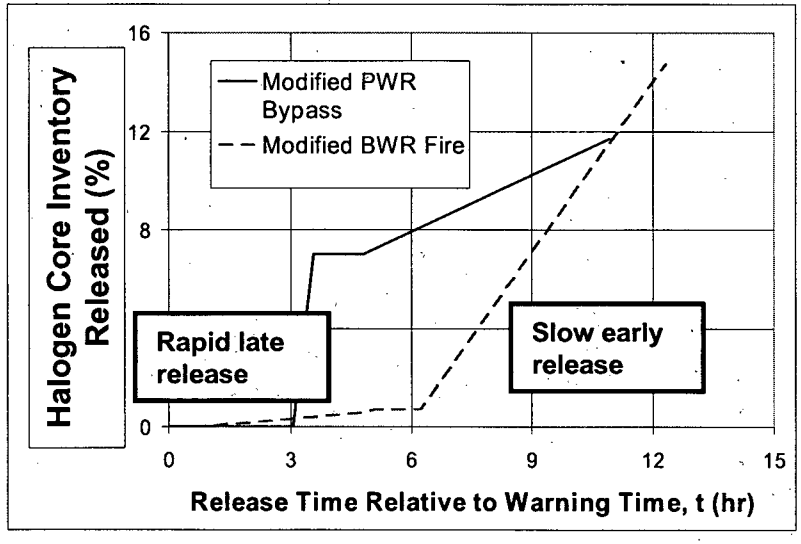
# Sensitivity to release details was explored by transposing release times.

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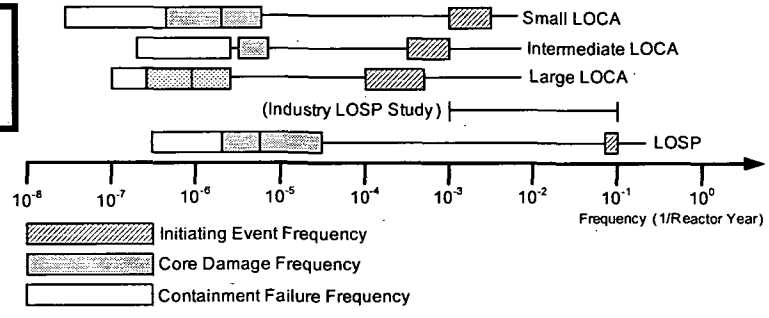
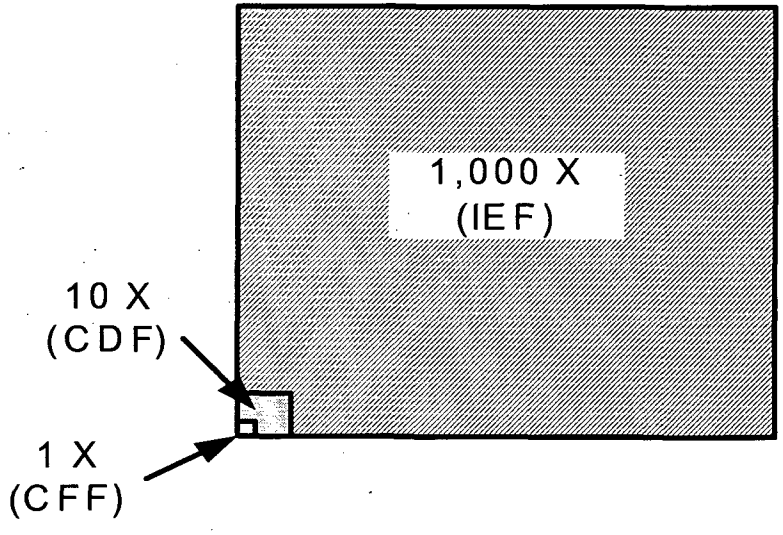
# General emergency declarations are based on emergency action levels.

Emergency action levels correlate to initiating event frequencies.




Declarations of general emergencies may exceed core damage frequencies by several orders of magnitude.

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