

ORIGINAL

**UNITED STATES OF AMERICA**  
**NUCLEAR REGULATORY COMMISSION**

**Title:                    BRIEFING ON CONTAINMENT DEGRADATION -  
                              PUBLIC MEETING**

**Location:                Rockville, Maryland**

**Date:                     Wednesday, October 16, 1996**

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1 UNITED STATES OF AMERICA  
2 NUCLEAR REGULATORY COMMISSION

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4 BRIEFING ON CONTAINMENT DEGRADATION

5 \*\*\*

6 PUBLIC MEETING

7 \*\*\*

8  
9 Nuclear Regulatory Commission  
10 11555 Rockville Pike  
11 Rockville, Maryland  
12

13 Wednesday, October 16, 1996  
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15 The Commission met in open session, pursuant to  
16 notice, at 9:10 a.m., the Honorable SHIRLEY A. JACKSON,  
17 Chairman of the Commission, presiding.  
18

19 COMMISSIONERS PRESENT:

20 SHIRLEY A. JACKSON, Chairman of the Commission  
21 KENNETH C. ROGERS, Member of the Commission  
22 GRETA J. DICUS, Member of the Commission  
23 NILS J. DIAZ, Member of the Commission  
24 EDWARD MCGAFFIGAN, JR., Member of the Commission  
25

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1 STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:  
2 KAREN CYR, GENERAL COUNSEL  
3 JAMES TAYLOR, EDO  
4 ASHOK THADANI, Associate Director for Inspection  
5 and Technical Assessment, NRR  
6 JOSEPH MURPHY, Special Assistant, RES  
7 ANDREW MURPHY, Chief Structural and Geological  
8 Engineering Branch, RES  
9 GOUTAM BAGCHI, Chief Civil Engineering &  
10 Geosciences Branch, NRR

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

[9:10 a.m.]

1  
2  
3 CHAIRMAN JACKSON: Good morning, ladies and  
4 gentlemen. The purpose of this meeting is for the NRC Staff  
5 to brief the Commission on degradation of containment  
6 structures.

7 The containment is a fission product boundary, and  
8 it is a cornerstone of the defense in depth strategy applied  
9 at all power reactors in this country. Containment  
10 degradation, particularly if it involves a challenge to the  
11 capability of a containment to perform its safety function  
12 is of concern.

13 Additionally, our recent implementation of a  
14 performance-based 10 CFR Appendix J rule further underscores  
15 the importance of keeping abreast of this issue.

16 The Commission recognizes that a great deal of  
17 effort has been expended over the last several years in  
18 better understanding the material condition of containment  
19 structures.

20 Following the identification of examples of  
21 degraded containments and varying degrees of licensee  
22 containment inspection programs, a new inspection rule  
23 endorsing the applicable sections of the ACME Code, Section  
24 11, was made effective in September of this year.

25 During today's briefing, the Staff will inform the

1 Commission of the nature of the degradation observed to date  
2 and long-term staff efforts in this area. We are also  
3 interested in how the new inspection rule addresses these  
4 degradation mechanisms.

5 I understand that copies of the presentation are  
6 available at the entrance to the room. Do any of my fellow  
7 Commissioners have any additional comments?

8 [No response.]

9 CHAIRMAN JACKSON: Mr. Taylor, please proceed.

10 MR. TAYLOR: Good morning. Chairman, you have  
11 already outlined the important safety function of  
12 containments.

13 I would note in starting that containments are  
14 typically very robust structures designed to withstand the  
15 loading of external events such as tornadoes and hurricanes  
16 and earthquakes in addition to the internal pressures in  
17 elevated temperatures associated with design basis accident.

18 With me at the table to continue the briefing are  
19 Ashok Thadani, Goutam Bagchi from the Office of NRR, and  
20 from the Office of Research, Joe Murphy and Andy Murphy.

21 CHAIRMAN JACKSON: Are you brothers?

22 [Laughter.]

23 MR. TAYLOR: Chairman, they formally disclaim  
24 that.

25 Ashok has some additional opening comments.

1 MR. THADANI: Good morning.

2 CHAIRMAN JACKSON: Good morning.

3 MR. THADANI: Thank you, Jim.

4 This morning, the briefing will be given by  
5 members of NRR as well as members from the Office of  
6 Research.

7 Goutam Bagchi, sitting to my right from NRR, and  
8 Andy Murphy from Research will outline the containment  
9 degradation mechanisms and problems that have been detected  
10 in the operating reactors, discuss the kind of responses  
11 that the NRC has undertaken as a result of these identified  
12 problems, and in particular, will focus on the recently  
13 issued inspection requirements and to go on and talk about  
14 type of research activities that are underway now,  
15 recognizing that we are seeing a variety of degradation  
16 mechanisms in structural containment.

17 The key point is that the number of incidents of  
18 degradation is increasing. That is an important point to  
19 note.

20 Some of these problems have actually been  
21 identified by the NRC. Many of them, of course, have been  
22 identified by the licensees themselves.

23 Mr. Bagchi will describe the mechanisms involved,  
24 as well as the degradation rates, and this is clearly a  
25 time-dependent phenomenon, and that is another important

1 element to where we are going.

2 While the degree of degradation that has been  
3 observed to date has not been significant, but it is  
4 critical that early attention be given because, as I said,  
5 it is a time-dependent phenomenon and there could be a  
6 problem over the long term in terms of maintaining the types  
7 of margins we believe that exist with robust containment.

8 You have indicated, Chairman Jackson, that  
9 Appendix J does, in fact, call for inspections, particularly  
10 when you do integrated leak rate testing prior to and  
11 afterwards, but there is no specific guidance provided  
12 either in Appendix J or elsewhere as to what does that  
13 really mean, what do we mean by inspections, and that is  
14 where the need for this rule became evident. There is a  
15 need for specific guidance, and it is captured as part of  
16 the ASME 1993 addendum codes.

17 So what we have proposed here -- in fact, not  
18 proposed -- the final rule actually calls for adoption of  
19 this 1992 addendum, 250.55(a) requirement of the  
20 regulations.

21 Now, the other issue that is important is to make  
22 sure that what we do is properly integrated in terms of our  
23 activities. The maintenance rule scope includes structural  
24 systems and components, in particular. That means the  
25 containment structure is certainly part of the maintenance

1 rule requirements. It is within the scope of the  
2 requirements.

3 The role of containment is going to be obviously  
4 critical for reactors as they continue to operate.  
5 Therefore, it becomes an important issue as part of the  
6 license renewal activities, and whatever we do in terms of  
7 our inspections or monitoring licensees' performance needs  
8 to recognize that. There is no need to have separate  
9 programs to deal with these issues. So what we are looking  
10 at is one -- at least from our side -- one inspection  
11 approach that would be good enough in terms of maintenance  
12 rule considerations, would be good enough in terms of  
13 license renewal considerations. That is an important  
14 element that work is currently ongoing.

15 I will go to Mr. Bagchi to give you some of the  
16 details of what we are seeing and the actions that we have  
17 taken.

18 MR. BAGCHI: Thank you, Mr. Thadani.

19 Good morning, Chairman Jackson and Commissioners.

20 Containment structures, as was pointed out, are  
21 designed to withstand the effects of conservative loads and  
22 combinations of extreme loads while remaining essentially  
23 within elastic limits.

24 For example, the design basis internal pressure  
25 caused by loss of coolant accidents and the large seismic

1 loads are applied simultaneously. These structures are  
2 built with high-quality materials and construction  
3 techniques. However, as good as the structures are, they  
4 are showing signs of degradation, but the integrity of  
5 containment structures is being maintained through timely  
6 repairs.

7 Next slide, please.

8 This is the outline of our presentation. I am  
9 going to cover the problems encountered so far, the safety  
10 significance, NRC response, and the summary, and Dr. Murphy  
11 will speak about the inspection rule and the research  
12 programs.

13 Next one, please.

14 Prior to the issuance of the containment  
15 inspection rule, the Commission was informed about the need  
16 for the rule to ensure that degraded condition are detected  
17 in a timely manner using uniform and technically sound  
18 methods, such as those incorporated in the ASME criteria,  
19 but today's presentation is intended to provide the details  
20 of degradation and the status of containment structures at  
21 operating plants.

22 The next picture, please.

23 I would like to go over very quickly with some  
24 sketches and pictures, so that I can set the context of our  
25 --

1           CHAIRMAN JACKSON: Could we have the next slide,  
2 please? I think there is a list of the problems detected.  
3 It is the previous slide.

4           MR. BAGCHI: Let me go over this one. This is a  
5 Mark I, BWR metal containment structure. It is light  
6 bulb-shaped, and it is the bottom of the light bulb where  
7 vent lights come out and go into the torroidal shape wet  
8 wells. Corrosion has been found in the sand cushion area  
9 which transitions from the embedded concrete just below the  
10 vent pipes. That is on the outside surface of the steel  
11 shell.

12           MR. THADANI: If I may make a comment, those areas  
13 are being pointed on the screen as Mr. Bagchi is describing  
14 them.

15           MR. BAGCHI: Also, inside the wet well, near the  
16 free surface of the water, that is where the water is in  
17 contact with the steel shell. That is where corrosion has  
18 been found.

19           They are coded primarily, except for one plant,  
20 but they are regularly, generally inspected frequently, and  
21 they are being monitored with respect to their condition,  
22 measuring thicknesses by non-destructive techniques and so  
23 forth.

24           The next picture, please.

25           Programs, of course, have been implemented to

1 maintain the integrity of the containment. There have been  
2 some repairs, but in other cases, they are being monitored  
3 through surveillance to make sure that the thickness  
4 required is maintained.

5 This is a picture looking at the dry well shell  
6 from the outside, putting a camera inside the sand cushion  
7 area. It is a very small opening, and it does show  
8 extensive area of rusting.

9 Next one, please.

10 This picture shows the steel shell area which is  
11 in contact with the sand cushion. The lower portion of the  
12 picture, you see the sand cushion, and in the upper  
13 right-hand corner, the interface goes right through the  
14 middle of the picture. You can see the steel shell.

15 In some cases, corrosion has been extensive, but  
16 as I pointed out earlier, rust has been scaled off and it  
17 has been repainted.

18 Next picture, please.

19 I am trying to give you instances of what the  
20 containment structures look like, what their specialties  
21 are. This is a distressed, as they call it, post-tension  
22 reinforced concrete containment structure.

23 The thing to point out is that this is such a  
24 large volume. The entire inside surface of this prestressed  
25 concrete containment structure is lined with steel liner.

1 That provides the barrier against radionuclides coming  
2 outside. Even on the top of the base mat, the liner goes  
3 underneath a little bit of cover of concrete, and those  
4 areas were being pointed out as we were looking at the  
5 picture.

6 The next picture, please.

7 Now, this is instructive. People think that  
8 structures are built forever, especially those made out of  
9 concrete. One is built to last forever, but this one  
10 clearly didn't. It is on the top of a dome somewhere on the  
11 containment structure, and that is the extent of spalling of  
12 concrete that was observed.

13 Now, this has, of course, been repaired and  
14 resurfaced.

15 Next picture, please.

16 This picture shows grease coming out of the  
17 outside surface of the containment structure. This is in a  
18 prestressed concrete containment structure. Grease is used  
19 to protect the tendons that go through the sheaths embedded  
20 inside the concrete, and the grease itself is supposed to  
21 prevent chemical contaminants that might attach and corrode  
22 the free-stressing tendons.

23 Please note here that the streaks line up with the  
24 locations of the tendon ducts.

25 CHAIRMAN JACKSON: Is it that this leaching of the

1 grease out -- is it evidence of corrosion or is it partly a  
2 corrosive mechanism itself?

3 MR. BAGCHI: It is neither, and this is an  
4 intriguing thing. The grease comes out of the concrete, and  
5 therefore, the presence of grease, whether or not it changes  
6 mechanical properties of the concrete itself so that it  
7 might affect the compressive behavior of the sheer transfer  
8 behavior -- it is something that is being studied, and Dr.  
9 Murphy is going to talk about that in his research program.

10 We are not sure how this affects the safety of the  
11 containment, but to some extent, the mechanical properties  
12 of concrete could be affected.

13 Next picture, please.

14 This is an ice condenser containment. It has a  
15 steel shell inside an outside concrete shield building.  
16 Corrosion has been observed on the outside surface of the  
17 steel shell near the bottom where the pointer is being  
18 pointed, and then, also, on the inside near the upper floor,  
19 that is where there is a piece of core that is going around  
20 it, the containment shell, which attracted water and,  
21 therefore, had local corrosion, but this has since been  
22 repaired, and they are being monitored and so forth.

23 Next picture, please.

24 This is probably trying to go into a little more  
25 detail than necessary, but it would show how free-stress

1 concrete containments look.

2           This is a cross-section between the wall and the  
3 base mat, and if you notice right through the inside core of  
4 the concrete, there is some hollow ducts that are going on  
5 and the tendons go through those ducts and anchor on the  
6 underside of the concrete so that the concrete is  
7 compressed, and when the inside pressure pressurizes inside  
8 the containment, the pressure would be released somewhat,  
9 but the concrete would still essentially remain in  
10 compression.

11           In French practice, pre-stress concrete  
12 containments are used without any liners, but here, we do  
13 use liners.

14           Next picture, please.

15           This is a cross-section through the vertical wall  
16 of a prestressed concrete containment, the upper one, and  
17 again, please note the tendon duct going through the  
18 concrete, right through there.

19           Then, the lower portion is a cross-section through  
20 the buttress, and the buttress is an area of tensions that  
21 go horizontally around the containment structure. These are  
22 very large, 130-foot-diameter structures, and usually, they  
23 use three of them. This is one buttress where the tendon  
24 steel is anchored on the concrete.

25           Next slide, please.

1 Well, this is another cross-section through a  
2 reinforced concrete containment wall. In the picture, you  
3 don't see the effective scale, but in the reinforced  
4 concrete, the wall thickness is bigger. It is 4 feet 6 as  
5 opposed to 3 feet 6 in a prestressed concrete containment  
6 because concrete is being compressed, and it is used in a  
7 different manner, but this is a typical cross-section.

8 Next slide, please.

9 I pointed out earlier incidents of local corrosion  
10 of scale through the pictures in the Mark I containment.  
11 That is the typical degradation.

12 Degradation of bellows. Now, bellows are typical  
13 devices that are connected to penetrations, usually  
14 processed piping and things like that. For example, the  
15 vent pipe that you saw is connected through bellows to the  
16 wet well portion. The purpose of the bellows is to allow  
17 the containment to grow and breathe when the  
18 accident-induced load is going to pressurize the containment  
19 from inside.

20 Now, these bellows are an integrate part of the  
21 containment boundary, and during some integrated leak rate  
22 testing, there have been instances of bellows leaking, and  
23 they have eventually been replaced and then the integrity  
24 has been restored, but nevertheless, those have been  
25 observed.

1           Also, in concrete area, cracking of anchors for  
2 post-tensioning tendons, corrosion and relaxation of  
3 tendons, tendon wires and wire anchor head failures have  
4 been encountered.

5           Something to remember with respect to prestressed  
6 concrete containments is that the tendon itself is a  
7 collection of a large number of wires, individual wires that  
8 ended up in the head, and the head is anchored through an  
9 anchoring plate, and then it deposits its compressive load  
10 on the concrete through that plate.

11           Those anchor heads or buttons, those are the ones  
12 that have been found to be cracked, but because they are so  
13 numerous, one or two crackings is not a problem.

14           Next slide, please.

15           For steel, the degradation mechanism are generally  
16 an accelerated corrosion in normal and corrosive  
17 environments. Corrosive environments are encountered when  
18 the steel is in contact with perhaps spilled or borated  
19 water or some other kind of water that contains  
20 contaminants.

21           In cases of stainless steel bellows, they are  
22 subjected to transgranular stress corrosion cracking, and  
23 this is a very common degradation mechanism in stainless  
24 steel.

25           Next slide, please.

1           Degradation of concrete is perhaps best understood  
2 in case of environment specifics. There is some crack that  
3 develops and moisture gets in, and in the case of very cold  
4 weather, when it freezes, it expands in volume, and the  
5 crack is aggravated, and then the cycle goes on and the  
6 degradation takes place.

7           The other mechanisms are creeping of the concrete  
8 when subjected to large compressive force as it is in case  
9 of a prestressed concrete containment. The deformation of  
10 the concrete in response to the load applied to it remains  
11 proportional to some extent, but after a while, it begins to  
12 creep, even without an increase in load. So that is the  
13 phenomenon that causes loss of pre-stressing force.

14           Shrinkage cracks are very common on concrete. Any  
15 time you build a structure out of concrete, your shrinks and  
16 cracks develop, very minute cracks. These are not  
17 structural.

18           Spalling of concrete and anchorage cracking, I  
19 talked about those before.

20           Next slide, please.

21           These are degradation rates. I wanted to put it  
22 in perspective by saying the steel shells vary in thickness  
23 from half an inch to 1-3/4 inch or, in other words, 500 to  
24 1,750 mils, and the liner plate itself varies in thickness  
25 from a quarter inch to half an inch or 250 to 500 mils.

1           So the general degradation rate of 1 mil per year  
2 does not really pose a safety concern. However, the  
3 accelerated degradation rates that have been observed  
4 require an effective inspection program to be put in place,  
5 and the need for the inspection rule and the fact that we do  
6 have a rule in place has been spoken to before.

7           Next slide, please.

8           The load-bearing capacity of the containment can  
9 be reduced as a result of degradation, but it is a  
10 time-dependent phenomenon, a Mr. Thadani pointed out and Mr.  
11 Taylor. In steel shells, localized corrosion and pitting do  
12 not significantly affect the strength of the containment.  
13 For instance, one could have a pin hole in the containment  
14 and not necessarily reduce the capacity of the containment,  
15 but we don't want any compromise of the pressure boundary of  
16 the containment. That is why inspection and monitoring is  
17 necessary.

18           In case of concrete structure, spalling and  
19 cracking of concrete has been observed, and the effect is to  
20 generally expose the reinforcing bars which can then corrode  
21 in a typical reinforced concrete containment, the  
22 reinforcing bars, the main reinforcing bars, the No. 18's.  
23 These are 2-1/4-inch-, 2-1/2-inch-diameter bars. They are  
24 huge, and to date, we have not had any instance of corrosion  
25 of the reinforcements inside the containment, but it is the

1 reinforcing bar that takes the load. The major loading is  
2 inside pressure, and it is subjected to tension, and the  
3 entire tension load is taken by the reenforcing bars.

4 Concrete does not take or carry any tensile load.  
5 In post-tension containments, premature loss of pre-  
6 stressing force is an area of concern, but as we have wisely  
7 incorporated the design feature that our containments are  
8 mostly designed with non-grouted tendons. That means we can  
9 later on go in and re-tension those steel wires and  
10 reintroduce the force that might have been lost.

11 COMMISSIONER ROGERS: Is that being done?

12 MR. BAGCHI: That has been done in one plant. The  
13 entire tendons in the vertical direction were re-tensioned,  
14 all of the tendons.

15 COMMISSIONER ROGERS: Does everybody agree that  
16 that is a good thing to do?

17 MR. BAGCHI: That is a good thing to do when the  
18 loss has been predicted to be beyond a certain rate. We  
19 used to have technical specification which required that the  
20 stressing force be monitored and trended.

21 When the design was initially conducted, there was  
22 an expectation that creep and shrinkage would bring down the  
23 pre-stressing force below a certain point after 40 years,  
24 and that is being monitored, and if the degradation rate  
25 seems to be accelerated, then the best thing to do is to re-

1 tension them.

2 COMMISSIONER ROGERS: My understanding is that in  
3 the Russian containments, where the tendons are helical  
4 rather than just simply circular, that the studies that have  
5 been done there seem to indicate that it's not a good idea  
6 to re-tension.

7 MR. BAGCHI: The designs are different. The  
8 helical design requires that the wires go in a tortuous way,  
9 in a very narrow, restricted path. It is very difficult to  
10 rethread the wires if substantial numbers get broken, but  
11 here, we have mostly buttresses that I indicated, and the  
12 ability to go and tension the wires is very simple.

13 COMMISSIONER ROGERS: It doesn't introduce any new  
14 problems?

15 MR. BAGCHI: It does not introduce any new  
16 problems. Even if large amounts of wires break, we can  
17 introduce new tendons and re-tension them. It is important  
18 to ensure that the pre-stressing force remains in place and  
19 the design condition is maintained and the margins are  
20 maintained.

21 Next slide, please.

22 These are the NRC responses. I won't go over the  
23 details of every one of those, but I will touch upon the  
24 important aspects, so that I save your time and everybody's  
25 time.

1           The information notices, the first two were  
2 related to Mark I dry well and wet well steel containments,  
3 and the last one, the third one, is with respect to  
4 corrosion and steel shell for ice condenser containments. I  
5 introduced the picture and showed where these corrosions  
6 occurred.

7           The Generic Letter that was prepared was to gather  
8 information from licensees with respect to corrosion and  
9 conditions that existed at their plant. This was for Mark I  
10 containments. Once this information was received, the staff  
11 evaluated the responses and determined that Mark I and Mark  
12 II steel containments should be under some kind of an  
13 inspection program, required inspection program, and that  
14 led to the proposed Generic Letter.

15           However, around this time, the work was continuing  
16 on a rule for inspection of containment structures of all  
17 types rather than just the Mark I and II. They were already  
18 underway.

19           So the proposed inspection of Mark I and II steel  
20 containments through the Generic Letter was canceled, and  
21 the whole effort was subsumed in the new rule that endorsed  
22 the semicode criteria for all containment types.

23           Next slide, please.

24           From 1991 to 1992, the Staff conducted audits of  
25 six older plant sites to assess conditions of structures.

1 The results of these audits are discussed in NUREG 1522. It  
2 is pointed out here in this NUREG that surveillance and  
3 maintenance of structures is essential to maintain their  
4 functional performance.

5 This document was influential in the development  
6 of structural maintenance guidelines prepared by the  
7 industry.

8 NUREG 1540 provides a history of BWR steel  
9 containment corrosion and endorses the need to adopt the  
10 ASME Section 11 inspection criteria.

11 The new rule on containment inspection endorsing  
12 IWE for steel shell and steel liners and IWL for reinforced  
13 concrete containment structures became effective as of  
14 September 9, 1996.

15 Now Dr. Murphy is going to go over the rule itself  
16 and the research program that is in place and will address  
17 some of the complex issues.

18 DR. ANDREW MURPHY: Good morning. Thank you,  
19 Goutam.

20 This morning, I will describe the content of the  
21 two ASME subsections on containment inspection that were  
22 recently incorporated by reference into 10 CFR Part 100.

23 The two subsections that I will be talking about  
24 are Subsection IWE which covers metal containments and the  
25 steel liners of concrete containments and Subsection IWL

1 which covers concrete containments, both reinforced concrete  
2 and prestressed concrete containments and the  
3 post-tensioning systems that are used for the prestressed  
4 concrete containments.

5 This rule became effective, as Goutam noted, on  
6 September 9, 1996. With an expedited implementation period,  
7 the inspections are to be completed by all utilities by  
8 September of 2001. Those inspections require 100-percent  
9 inspection of all accessible metal areas. There is also a  
10 requirement for inspection, an augmented inspection of areas  
11 of special interest.

12 Two examples of these would be areas with no  
13 codings or areas that have suffered repeated loss of coding,  
14 leading to substantial corrosion or pitting.

15 A second example would be areas subjected to  
16 excessive wear or erosion that would cause, again, the loss  
17 of the coding and corrosion degradation.

18 These augmented inspections are required until the  
19 areas examined have remained substantially unchanged, no  
20 further corrosion, for at least three inspection periods.  
21 At that time, they would fall back into an unaugmented  
22 inspection, a simple visual inspection.

23 There is also a requirement for a visual  
24 inspection of seals, bolts, and gaskets that are integral to  
25 the containment system.

1           For IWL, the inspection of the concrete  
2 containments and the post-tensioning systems, they are  
3 required to be inspected twice in 10 years. Again, it is  
4 100-percent visual inspection of all accessible concrete  
5 areas. There is also a requirement for an inspection of the  
6 post-tensioning system. This includes tendon monitoring,  
7 monitoring of the forces on the tendons, sampling and  
8 removal of tendon wires for further laboratory testing, and  
9 for the re-tensioning of tendons as they have become exposed  
10 to creep.

11           We will go to the next viewgraph No. 12.

12           Here, we will talk for a few moments about three  
13 research projects that we have ongoing at the moment. The  
14 first at Oak Ridge National Laboratory and the second at  
15 Sandia Laboratory are coupled, one being the first phase and  
16 the other being a second phase, of a general degradation of  
17 containment research effort.

18           The program at Oak Ridge is intended to identify  
19 corrosion mechanisms to assess the available techniques,  
20 both destructive and nondestructive, for evaluating the  
21 corrosion or detecting the corrosion, for the establishment  
22 of the effectiveness and/or the limitations associated with  
23 techniques to prevent or mitigate damage.

24           Looking at the viewgraph itself, the contractors  
25 involved in the analysis and evaluation of these

1 nondestructive and destructive techniques, at this time,  
2 particular emphasis is being given to areas that are called  
3 inaccessible. These would be areas of the containment  
4 shells that are below concrete floors or, in the case of the  
5 steel liners, behind the liner itself.

6 CHAIRMAN JACKSON: What kinds of techniques are  
7 used to do that?

8 DR. ANDREW MURPHY: At this stage, they fall under  
9 the general category of ultrasonics and associated  
10 techniques. The sophistication isn't so much in the  
11 technique or the transducers that are involved, but in my  
12 opinion, in the analysis that is able to be done with that.

13 Another part of the program, another task that is  
14 ongoing is a subcontract from Oak Ridge to Johns Hopkins  
15 University to enlarge or expand upon a program and technique  
16 that we had developed under our structural aging program,  
17 which was a concrete aging program, again at Oak Ridge, to  
18 assess the residual strength and service life of a  
19 containment, given its past history and the current  
20 condition of degradation.

21 Looking at the next program, the next phase in  
22 this program, I will return to Sandia National Laboratory  
23 and their efforts. They are working to provide for the NRC  
24 reviewers as means to assess the current structural capacity  
25 of a containment or the margins associated with that

1 capacity and to estimate the residual capacity of a degraded  
2 containment. This would be as a service tool for the NRR.

3 We will drop down to the fourth bullet for a  
4 moment. We participate in a program at CNSI. This is the  
5 principal working group, three subgroups on concrete  
6 structures. That is a newly formed subgroup, and it is  
7 becoming very active. It has already scheduled a specialist  
8 meeting on NDE techniques for inaccessible areas that will  
9 be held in March of next year, and it's in the fairly  
10 well-developed program stages, planning stages for a  
11 specialist meeting in July, probably on the tendon issues  
12 that we spoke about earlier.

13 We also have been making overtures and contacts  
14 with the folks in Germany at GRS, NUPEC in Japan, INER in  
15 Taiwan, and the KIND's folks in Korea to develop cooperative  
16 exchange programs on containment degradation and the general  
17 aging of the structures.

18 Dropping back to the third bullet, which is a  
19 topic that we have already touched on a little bit, this is  
20 the grease intrusion into the concrete on the prestressed  
21 containments.

22 As Goutam noted and showed you in the photograph,  
23 we are seeing grease, the protective grease in the tendons  
24 leaking through to the concrete surface. Our concern is for  
25 the degradation of the concrete. We have a program ongoing

1 at Oak Ridge where they are in the process of collecting  
2 approximately 60 core samples from the Trojan containment.  
3 These will be tested to failure using, I'll say, standard  
4 structural techniques, materials testing techniques, to tell  
5 us whether or not we have got a problem here and whether  
6 there is an issue that needs to be addressed.

7 CHAIRMAN JACKSON: So it is too early to say  
8 whether there is a direct linkage?

9 DR. ANDREW MURPHY: Yes, there is. We have done a  
10 lot of, I'll say, background studies, industry in general,  
11 that makes use of concrete structures, including the oil  
12 industry where leakage and the presence of grease has been  
13 found on concrete structures. A number of studies in that  
14 area have been done, and at this moment, it would probably  
15 be best to call those equivocal as to whether or not there  
16 is a significance to our problems.

17 Like I say, I expect that we will have preliminary  
18 results from this Oak Ridge study probably by the beginning  
19 of next summer.

20 With those comments, I will turn it back to  
21 Goutam.

22 COMMISSIONER DICUS: I would like to ask a  
23 question on the time frame for these research projects. You  
24 have mentioned the one that you hope to have your results  
25 next summer.

1           The other ones are ongoing. Do they have finite  
2 limitations on the time limits to complete them?

3           DR. ANDREW MURPHY: We expect to have the results  
4 from the other two programs, the other two phases of the  
5 program within two to three years.

6           COMMISSIONER DICUS: I have raised the question  
7 because of the aging nature of our plants. These research  
8 projects do not need to be too long term. They may outlive  
9 the plant.

10          DR. ANDREW MURPHY: I understand the point, and  
11 the projects are intended to provide results in a timely  
12 fashion.

13          CHAIRMAN JACKSON: Let us put the question another  
14 way.

15          DR. ANDREW MURPHY: Okay.

16          CHAIRMAN JACKSON: Given the general and  
17 accelerated rates that you talked about, how long would it  
18 take for there to be corrosion below some acceptable wall  
19 thickness level or strength level?

20          MR. BAGCHI: We can discover one tomorrow.

21          CHAIRMAN JACKSON: I see.

22          MR. BAGCHI: That is not to say that we don't have  
23 a process in place to take care of it. The repairs will  
24 take care of it.

25          CHAIRMAN JACKSON: So, if it does go below, it can

1 be mitigated. That is what you are telling us?

2 MR. BAGCHI: That is correct.

3 CHAIRMAN JACKSON: Okay.

4 MR. BAGCHI: The last slide, please.

5 We have talked about the importance of the  
6 containment structure, what kinds of degradations we will  
7 observe, and all of the NRC responses. I would like to  
8 really emphasize the point that we have an integrated  
9 approach.

10 We are attacking this problem from several fronts.  
11 One was the performance-based Appendix J rule which looks at  
12 the containment leak rate and integrity from the tightness  
13 standpoint. Also, visual examinations are required as a  
14 result of that rule.

15 We have containment inspection rules specifically  
16 endorsing the ASME Section 11, the Subsections IWE and IWL.  
17 This would provide a uniform and technically sound method of  
18 performing these inspections.

19 We also have the maintenance rule, which is an  
20 overall rule requiring not only the pressure boundary  
21 portions of the containment structure, but also things like  
22 foundation and other pertinence that might have impact on  
23 the safety significance or safety performance of these  
24 containment structures.

25 We also have a license renewal rule, license

1 renewal activity that is in process to think about what  
2 kinds of things the Commission needs to take care of in  
3 terms of aging management.

4 But in summary, then, the integrity of containment  
5 structures is being maintained, and their conditions are  
6 generally good. Where degradations were observed, they have  
7 been repaired to restore their integrity. Our monitoring  
8 and surveillance programs have been implemented to ensure  
9 that degraded conditions are detected in time.

10 With the implementation of the new rule,  
11 containments will be inspected routinely, and degradation  
12 will be detected and appropriate corrective actions will be  
13 taken. Thus, inspection and maintenance are essential to  
14 ensuring the current licensing basis or margins that these  
15 structures have been designed with, and research programs,  
16 of course, are going to give us insights with respect to  
17 what kind of overall margin we can get, what is the behavior  
18 of degraded conditions given that certain local degraded  
19 conditions could be simulated and assessed in analytical  
20 models and tests, as necessary.

21 We are also exchanging information with  
22 international entities, and these will address other  
23 long-term issues.

24 CHAIRMAN JACKSON: Thank you.

25 Commissioner Rogers?

1                   COMMISSIONER ROGERS: Have any of the lessons  
2 learned from our experience here with existing reactors been  
3 translated into any design feature requirements for the  
4 advanced reactor?

5                   MR. BAGCHI: Primarily, the access to inspection,  
6 but this structural engineering aspect is old, if I may say  
7 so, and they have bene utilizing the traditional methods,  
8 use of good materials, good construction practice, and the  
9 ability to inspect the containments. That is one area where  
10 I have personally put emphasis on.

11                   The engineering aspects of advanced reactor  
12 application review is being conducted in my branch, and I am  
13 quite familiar with that area, but that is an area where we  
14 have put some emphasis.

15                   COMMISSIONER ROGERS: Good.

16                   MR. BAGCHI: And also, related to fracture  
17 toughness of the material, that is required by the general  
18 design criteria. That is nothing new.

19                   CHAIRMAN JACKSON: Do ice condenser containments  
20 present any particular inspection challenges?

21                   MR. BAGCHI: They are smaller in size. They are  
22 smaller pressure; for example, 15 pounds per square inch  
23 accident pressure, design basis pressure, as opposed to 45  
24 to 55, 67 PSI and prestressed dry concrete containments.

25                   They do provide a challenge in the sense that the

1 accessibility is restricted.

2 When we went out to look at the corrosion at the  
3 bottom of the shell, this was about 12 to 18 inches above  
4 the base mat. So it was hard to inspect, but folks who had  
5 the plan really did a very good job.

6 CHAIRMAN JACKSON: Commissioner?

7 COMMISSIONER DICUS: Yes. How well do you feel  
8 that -- I just need to get a feel for this. How well do you  
9 feel that you think we understand the effects of  
10 degradation, particularly with concrete, and how well we are  
11 really able to quantify the effects of what we are seeing?

12 MR. BAGCHI: With concrete, degradation for  
13 containments, it is not a problem that I can see.

14 COMMISSIONER DICUS: What about with steel?

15 MR. BAGCHI: With steel containments, the emphasis  
16 would have to be on local corrosion, and areas of extended  
17 corrosion, areas where aggressive environmental conditions  
18 exist, it is a concern that we have to keep our eyes open  
19 and look for areas of degradation and do a thorough  
20 inspection.

21 CHAIRMAN JACKSON: Commissioner McGaffigan?

22 COMMISSIONER MCGAFFIGAN: Could I just ask on the  
23 research programs, what is the total amount of money in FY  
24 '97 going to these four projects? Do you know?

25 DR. ANDREW MURPHY: Let me start with the easy

1 one. The tendon, grease tendon work at Oak Ridge, we have  
2 got about \$120,000 set aside for fiscal '97. If there are  
3 additional problems identified, we hope that the basic work  
4 will be paid for with fiscal '96 money. The two programs,  
5 one at Oak Ridge and Sandia, are funded at about the 250- to  
6 \$300,000-a-year level.

7 MR. BAGCHI: May I take that question back to  
8 Commissioner Dicus? You are probably aware that we had,  
9 again, through a research program, conducted ultimate  
10 strength test of the reinforced concrete containment scaled  
11 one-sixth or scaled one-eighth --

12 MR. THADANI: One-eighth.

13 MR. BAGCHI: One-eighth scale. Fairly large, and  
14 it retained pressure three and a half times more than it was  
15 designed for. We have substantial margin in concrete  
16 containments.

17 MR. THADANI: Since this issue is up, I might note  
18 that is really important, and a lot of the studies that are  
19 done to really understand risks from severe accidents, that  
20 margin to be able to handle certain loads is quite important  
21 in terms of the risk to public health and safety, and that  
22 is an important element that I think the containments here  
23 provide. That may not be the case in some other places.

24 MR. TAYLOR: I think that structure is still  
25 standing out at Sandia. We haven't been able to rent it to

1 anybody.

2 COMMISSIONER ROGERS: It's got a crack in it.

3 MR. TAYLOR: Right. If you go out there, it's  
4 worth a short ride out to look at it. You can actually see  
5 it was, I believe, at some type of penetration into the  
6 containment that the first damage occurred, and it was at  
7 quite a high pressure. So it is an interesting model.

8 COMMISSIONER DICUS: The important issue here is  
9 that we are able to identify in a timely fashion when we  
10 have lost our margin of safety.

11 MR. THADANI: Thank you.

12 CHAIRMAN JACKSON: So, in fact, that anticipates a  
13 comment. Is it fair to say that what you are trying to tell  
14 us is that an appropriate focus has to be on detection  
15 because if there is detection, there can be mitigation?

16 MR. BAGCHI: Absolutely.

17 CHAIRMAN JACKSON: With respect to looking at  
18 degradation mechanisms, we are particularly interested in  
19 the effect of degradation on the strength to withstand the  
20 pressures under accident conditions. Is that a fair  
21 statement?

22 MR. BAGCHI: Yes.

23 CHAIRMAN JACKSON: Okay. Well, let me thank you.  
24 I thank the Staff very much for a very informative briefing.  
25 You have presented a great deal of information today on the

1 mechanisms, the significance, and the impact of containment  
2 degradation and the research that is being done to assess  
3 all of these issues.

4 I believe the challenge now is how best we are  
5 going to review and understand, if there is further  
6 understanding needed, the licensee's containment inspection  
7 programs. That is what we all seem to be saying or  
8 understanding; that that is where the focus has to be. So  
9 it is critical in that sense that our initial reviews of  
10 licensee and inspection programs be timely and provide  
11 feedback to other licensees, as well as to our inspection  
12 programs.

13 So, unless my fellow Commissioners have any  
14 closing comments, we stand adjourned. Thank you.

15 [Whereupon, at 9:59 a.m., the briefing concluded.]

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CERTIFICATE

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

TITLE OF MEETING: BRIEFING ON CONTAINMENT DEGRADATION -  
PUBLIC MEETING

PLACE OF MEETING: Rockville, Maryland

DATE OF MEETING: Wednesday, October 16, 1996

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

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