NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF:

BRIEFING ON NEUTRON RADIATION EXPOSURES

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

PUBLIC MEETING

BRIEFING ON NUETRON RADIATION EXPOSURES

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

Thursday, 25 May 1978

The Commission met, pursuant to notice, at 3:05 p.m.

BEFORE:

DR. JOSEPH M. HENDRIE, Chairman

PETER A. BRADFORD, Commissioner

RICHARD T. KENNEDY, Commissioner

VICTOR GILINSKY, Commissioner

PRESENT:

Samuel Chilk, Secretary
L. Barrett
S. Block
H. Denton
L. Gossick
M. Grossman
A. Kenneke
R. Vollmer
G. Zimmer

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P R O C E E D I N G S

(3:05 p.m.)

CHAIRMAN HENDRIE: I would like to talk about the briefing on neutron radiation exposures.

Lee, go ahead.

MR. GOSSICK: Mr. Vollmer, as the agenda shows, we have another briefing here.

CHAIRMAN HENDRIE: A distinguished panel.

MR. BLOCK: My objective is to brief the Commission on the status of neutron dose symmetry with respect to exposure at nuclear power reactors during reactor operations.

Neutrons are present in reactor containment. We have regulations that require that radiation surveys be made prior to entry into radiation areas to prevent excessive radiation exposure.

Our regulations also require that occupational exposures be recorded for each individual exposure.

Now, these regulations are supported by regulatory guides that show how monitoring is to be performed. With respect to neutron monitoring, reg guides 8.4 and 8.14 provide the technical guidance on neutron personnel monitoring.

Additionally, in our SAR review by the NRR staff for CP and OL applications and inspection by the Office of Inspection and Enforcement for operating reactor licensees, audits of applicants and licensees are respectively made to assure

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compliance with these regulations and consistency with the recommendations of the regulatory guides.

I would first like to give a brief discussion on personnel dose symmetry so that the Commission will be aware of the technical problems associated with this type of monitoring.

Could I have the first viewgraph, please.

(Slide.)

The first one shows four systems that are recommended from regulatory guide 8.14, and I would like to go through each one of those individually.

The first is the calculated neutron dose equivalent based on measurement of neutron dose equivalent and stay-time. For this technique a rem meter instrument is used to measure the neutron dose equivalent rate. This instrument has been designed to measure the neutron rem dose rates independent of the spectral distribution of the neutrons. As will be shown later, this is a very important feature of this kind of survey meter.

This dose rate, when multiplied by the time of exposure, will give the rem dose to the individual.

The second recommended technique is the calculated neutron dose equivalent based on the neutron to gamma dose ratios.

By this technique, neutron and gamma dose rates are determined in the occupied areas of containment using a rem meter as previously described and, again, a survey meter. A

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1 neutron-to-gamma ratio is then established.

2 Since all occupational workers were gamma dosimeters,
3 the dose readout from this dosimeter is multiplied by the end
4 gamma ratio to provide the neutron dose.

5 CHAIRMAN HENDRIE: That is sort of a tricky space and
6 time averaging proposition, isn't it?

7 MR. BLOCK: Exactly.

8 CHAIRMAN HENDRIE: That ratio will vary all over the
9 place as you come out from the core.

10 MR. BLOCK: That is true, sir.

11 CHAIRMAN HENDRIE: Is there a fashion which reflects
12 how long people are in regions of various ratios?

13 COMMISSIONER KENNEDY: Is this a uniform distribution?
14 That is, the ratio will be roughly the same at eight feet out
15 from the core no matter where on the periphery?

16 MR. BLOCK: What you are saying is almost true. We
17 find that, for instance, in containment during the surveys that
18 have been made for neutron straining, the ratio seems to be
19 fairly consistent. That is for St. Lucie, as an example, it was
20 about a factor of seven, and for Farley it was a little bit less
21 than that. The neutrons were higher than the gamma doses. The
22 factor of seven was a neutron-to-gamma. In Farley, the gamma
23 was higher than the neutrons, but the ratio seemed to be pretty
24 consistent. One can get a good handle on the neutron dose if
25 one knows the gamma dose by using this ratio.

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It has been used at Lawrence Livermore laboratories, as well. It is pretty well known.

OMMISSIONER GOLINSKY: Wouldn't it vary from reactor to reactor?

MR. BLOCK: It might vary from reactor to reactor. There is some consistency in the ratio within the area of the measurement block. The various types of shielding -- in some cases, water bags, sand, or concrete blocks -- makes it vary. That will depend on the particular --

CHAIRMAN HENDRIE: Why does the ratio -- I'm surprised. You say the ratio seems to be relatively constant over --

MR. BLOCK: This is within containment, of course.

CHAIRMAN HENDRIE: Once you get away from the primary reactor, the shielding around the reactor vessel, so that you are seeing a gamma field which was primarily activation product, primary piping, plated out and so on, I would think that the neutron over a general gamma dose would drop down toward zero.

MR. BLOCK: We are talking about the ratios that have been established based on neutron streaming from the gap between the reactor pressure vessel and the primary shield. I will describe that in a little while.

MR. GRIMES: It is on the operating floor, so it is a scatter from this stream-out through the annulus around the vessel.

MR. BLOCK: In research reactors it would be a little

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bit different, but the situation we find today in containment, it seems to be fairly consistent.

The third technique used for monitoring is the albedo neutron dosimeter.

Two features need to be noted for this type of monitoring. The first is that this dosimeter is sensitive to neutrons over the entire energy spectrum. It has sensitivity down to a dose of one millirem.

Secondly, the dosimeter overestimates the neutron dose unless corrections are made in accordance to the neutron spectrum that the individual is exposed to, and the neutron source used in the calibration.

These dosimeters are rarely used in the nuclear power industry since licensees probably prefer the other three methods.

At present albedo --

COMMISSIONER BRADFORD: The dosimeters are rarely used? prefer either the badges or the first two?

MR. BLOCK: The first or the fourth. Generally, they aren't being used at DOE facilities, and each contractor has his own dosimeter.

I have one here that I would like to pass to you so you can get a look at what they look like. It is scotch-taped because it was a little difficult to get apart.

I will pass it, and you can see it.

sp6

Inside there are two TLD chips. This particular dosimeter has been designed for gamma monitoring. It can be converted into an albedo by adding two more lithium flouride chips.

Now, the final personnel dosimeter recommended by reg guide 8.14 is NTA film or the neutron film badge.

This dosimeter can only be used under the following conditions: that fading of the signal due to humidity must be controlled; that the dose contribution for neutrons with energies below .7 MEV be small -- that is, this dosimeter is not sensitive to neutrons of energies less than .7 MEV; and that a large area of the film must be scanned by a microscope so that good statistical data can be achieved.

I also have some film similar to NTA film, although NTA film looks more like dental X-ray film than it does what I am going to present you, but I thought you might want to look at these.

As mentioned earlier, during reactor operations, neutrons are present in containment. The next viewgraph shows the source of these neutrons.

(Slide.)

This is a simplified geometrical model of neutrons streaming in PWRs.

Now, as I just mentioned, the RPV or the reactor pressure vessel, and the primary shield are the confinement or

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1 confine the cavity where the neutrons are streaming. You can
2 see the pathway in which they stream into containment.
3 At present we are not sure of the fraction of the
4 spectrum where energy is less than .7 MEV, but since this is in
5 the containment area, entry is controlled by personnel when the
6 reactor is at power.
7 During initial startup comprehensive neutron measure-
8 ments are made to evaluate the effectiveness of existing shield-
9 ing. Some licensees are not installing shielding over the
10 annula gap to reduce the neutron exposures in reactor contain-
11 ment. You can see the one-foot water bag placement that several
12 reactors are using to cut the radiation levels down.
13 The staff has been reviewing submittals proposed for
14 the shielding and evaluating its effectiveness for several
15 reactors.
16 COMMISSIONER BRADFORD: They began putting --
17 recently putting in these water bags?
18 MR. BLOCK: Yes. Within the last year or two.
19 COMMISSIONER BRADFORD: Why wasn't it done before?
20 MR. BLOCK: I guess the problem was such that they
21 probably used administrative controls and found that that was
22 not an effective way of reducing the neutron explosions that --
23 COMMISSIONER BRADFORD: Limiting the --
24 MR. BLOCK: Yes. I am going to go through that in
25 one minute.

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A recent telephone survey of all regional offices with respect to entry into containment brought forth the following information.

Entry is usually made about two to three times a month. Generally, teams of two to four people make the entry, with one of these people being a house physics technician with a rem meter so he can determine where the dose rates are and keep people out of trouble at the higher areas.

The time in containment runs from five to 60 minutes.

Neutron surveys are normally made prior to anybody entering the area or for dosimetric techniques are used with the NTA film, used in about 30 to 40 percent of the reactors. And doses generally have been running about 10 millirem per person per entry.

Individual annual doses for those that make the entries normally run from 100 to 500 millirem per year.

From the above we estimate that neutron occupation exposures contributes less than 1 percent of the total annual occupational exposure burden at a plant. They don't provide at present a very large occupational burden. That is a man rem.

COMMISSIONER BRADFORD: Out of the people who worked for the plant?

MR. BLOCK: Yes.

COMMISSIONER BRADFORD: It is higher for those going into containment?

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MR. BLOCK: Compared to all that work at the plant, that's right. I think the average plant now brings in the order of 500 man rem per year, and we estimate less than five man rem per neutrons per year.

COMMISSIONER BRADFORD: What percentage of the total plant personnel go into containment?

MR. BLOCK: I would say -- I have tried to find out that data, and I think of the 30 some odd thousand people, maybe 400, go into containment to make these kinds of measurements.

Is Barbara Brooks here? I believe she gave me that information last week.

CHAIRMAN HENDRIE: They make the measurements --

MR. BLOCK: To make the routine adjustments and inspections.

COMMISSIONER KENNEDY: There are how many thousand?

MR. BLOCK: 22,000.

MR. BARRETT: We had 22. That would have been 4- to 500 with neutron exposure.

MR. BLOCK: There aren't that many people --

COMMISSIONER BRADFORD: That is spread across the 30,000?

MR. BLOCK: The one percent is spread across the 500 man rem per plants.

COMMISSIONER BRADFORD: That is spread across the 30,000.

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MR. BLOCK: If you want to do the arithmatic that way, it would be.

COMMISSIONER BRADFORD: So that the relevant figure which is -- it would be the percentage of those people actually exposed to it would be much higher.

MR. BLOCK: I think you can say that the 500 man rem per plant would have to be multiplied by, say, 68 operating reactors, in that order of magnitude. And then the five man rem would also be multiplied by -- I don't think all of the reactors have this problem, but I am just basing that one percent on an individual reactor where, if we assume that the average reactor is providing 500 man rem gamma dose, the neutron dose would be on the order of less than five man rem.

MR. GRIMES: I think it is much less than one percent, but assuming that it was one percent for the 30,000 people, then it would be less than 10 percent for the 500, if you figured it that way -- it would be a little more than that.

COMMISSIONER BRADFORD: I don't know how to do the mathematics, but that doesn't leap out at me from the ratio of 500 for 30,000.

MR. BLOCK: The 500 is man rem and the 30,000 are people.

I haven't done that arithmatic.

CHAIRMAN HENDRIE: I don't think that you can calculate it from those ratios. It is certainly true that those

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plant personnel who get the neutron exposures will also be high-exposure individuals among the population of the 30,000.

MR. GRIMES: That's right. I think, typically, a few hundred millirem compared to several rem for the people that go into containment.

MR. DENTON: What was the highest individual neutron exposure that you have?

MR. VOLLMER: I think of those that get exposed to neutrons, about 90 percent of their exposure is gamma and about 10 percent is neutron. Of those who do get exposed.

COMMISSIONER BRADFORD: At one particular plant?

MR. VOLLMER: I think that is a general average.

MR. BLOCK: On the average.

Now, there are some individuals who get higher than

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10 percent, but there aren't too many of those

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1 In reference to the points just mentined, the I&E
2 staff, in addition to their normal licensing audits, are
3 reviewing -- will review the neutron dosimeter procedures at
4 individual reactors during their normally-scheduled
5 inspections to determine whether licensees are performing
6 neutron measurements in accord to the reg guides.
7 More detailed information will be available on the
8 status of neutron occupational exposure, including
9 occupational man-rem, when I&E concludes their studies.
10 Hopefully, Commissioner Bradford will have better data in the
11 future on that.
12 NRR has also asked research to fund the program to
13 collect information on the neutron energy spectral
14 distribution and the capability of existing systems to monitor
15 these distributions accurately. This will be a confirmatory
16 study to determine whether or not our present guidance gives
17 adequate safety margins. If the program shows that a major
18 fraction of dose contribution is from energies less than .7
19 Mev, MEA film may not be a monitoring device we will continue
20 to recommend to nuclear reactor licensees.
21 The research would also allow evaluation of the
22 degree of overestimation of neutron exposures whenever albedo
23 dosimeters are worn by the licensees who are using or who plan
24 to use these devices.
25 The next view graph indicates the proposed research

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1 program.

2 (Slide.)

3 This is a synopsis of the program which is much more
4 detailed in scope. But what we plan on doing is having the
5 contractor measure the neutral spectral distribution inside
6 and outside the reactor containment. From the spectral
7 distribution he will calculate the dose equivalent rate, which
8 I put "theoretical" in quotes. Actually, we call that in
9 quotes "true."

10 He will then measure the neutron dose equivalent
11 rates with the survey meters or the rem meters, and compare
12 the theoretical or true dose rate with the measured dose
13 equivalent to show the effectiveness of the survey meters.
14 After these operations are performed, he will compare the four
15 neutron personnel dosimetric techniques which I have just
16 outlined with the theoretical and the survey meter values, to
17 determine the degree of accuracy of each system. And Leslie
18 will provide conclusions with respect to each of the
19 measurement techniques.

20 COMMISSIONER KENNEDY: Assuming calculations were
21 actual values.

22 MR. BLOCK: Yes, we will assume that the theoretical
23 numbers are the true, quote, "true", values.

24 At present, a contractor has not been selected to
25 perform this research. But we have -- we will have our

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1 research people -- they are very active in trying to get this
2 resolved.
3 One final technical point that should be brought to
4 the Commission's attention. Dr. Harry Rosse of Columbia
5 University has proposed, based on his review of Hiroshima and
6 Nagasaki data, among other data, that the biological
7 effectiveness of neutrons should be increased. He suggested
8 an increase of a factor of ten.
9 COMMISSIONER GILINSKY: A factor of ten?
10 MR. BLOCK: Yes.
11 CHAIRMAN HENDRIE: Across the board?
12 MR. BLOCK: Yes.
13 CHAIRMAN HENDRIE: All the way up and down the
14 spectrum?
15 MR. BLOCK: That's what I understand.
16 If this increase is accepted by the scientific
17 community, including the NRC, it will mean that assigned doses
18 to personnel exposed to neutrons would be greater than those
19 presently calculated or measured using our present values for
20 biological effectiveness of what we now call quality factor.
21 Other scientists, however, feel that Dr. Rosse's
22 factor of ten should be reduced to a factor of about two to
23 four, based on risk factors. Still others feel that no
24 changes --
25 COMMISSIONER KENNEDY: What was that?

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1 MR. BLOCK: Leukemia.

2 Still others feel that no change should be made from
3 the present value. The National Council on Radiation
4 Protection, the NCRP and the ICRP, both are reviewing Rosse's
5 position. While the NRC is developing a staff paper on the
6 subject, it will be some time before a final decision is made.

7 However, even if a change is made in the biological
8 effectiveness of neutrons, it would still not be a very
9 important factor, as compared to the total occupational
10 exposure to all workers from gamma radiation.

11 CHAIRMAN HENDRIE: It would, however, bring up the
12 exposed, that smaller exposed population who routinely enter,
13 do maintenance work and spotchecks at containment operations.
14 It would take the equivalent up to the gamma and the beta
15 exposure.

16 MR. BLOCK: Yes.

17 CHAIRMAN HENDRIE: Yes. That would mean that it
18 would be large enough so that it would, in effect, cut in half
19 their burnout times.

20 MR. BLOCK: Would reduce their occupancy time, that
21 is exactly true. There would have to be some strong
22 regulatory measures taken if this is consummated.

23 CHAIRMAN HENDRIE: There are some incentives to
24 improve the shielding a little bit. You have got enough
25 neutrons bouncing around up there so you are getting

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1 noticeable personnel exposures. You're getting a mild
2 activation of all of the structural materials. The whole
3 place begins to --
4 MR. GRIMES: If the stay-time method is used, it is
5 applied in a conservative manner. In other words, you take
6 the highest dose rate in the area. It makes it more
7 worthwhile to get accurate measurements of the actual --
8 CHAIRMAN HENDRIE: And to knock down the high spots.
9 MR. GRIMES: Yes.
10 MR. BLOCK: Absolutely.
11 The bottom line of this presentation with respect
12 to the Washington Post column can be summed up as follows:
13 that those licensees using NTA film are receiving a fraction
14 of their dose from neutrons of energies less than .7 Mev, and
15 that this fraction is not being recorded on their film. So
16 that there is some underestimation of dose to workers using
17 NTA film.
18 We expect that our research effort will resolve the
19 magnitude of this fraction based on the spectrum measurement.
20 Nevertheless, since the neutron exposures recorded from other
21 dosimetric methods have shown the neutrons to be small in
22 comparison to the gamma exposures, we do feel this is not a
23 significant problem.
24 Since the effectiveness of the albedo dosimeters,
25 which is the alternative to NTA film, is also strongly

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1 dependent on the energy spectrum, but provides overestimation
2 of the neutron dose, the research program will indicate the
3 correction factor that need be applied to provide a correct
4 occupational neutron dose.
5 This issue was discussed with the ACRS on April 7th
6 of this year, and we have received no recommendations beyond
7 those taken by the staff.
8 That concludes my formal presentation.
9 CHAIRMAN HENDRIE: Vic?
10 COMMISSIONER GILINSKY: No.
11 COMMISSIONER BRADFORD: I'm trying to get some idea
12 of the history of this problem. You said licensees have been
13 installing additional protections against radiation over the
14 last year or two?
15 MR. BLOCK: Yes, we have been putting in these water
16 bags that I showed you in the second view graph.
17 COMMISSIONER BRADFORD: What triggered that?
18 MR. BLOCK: The thing that triggered that, for
19 instance, in St. Lucy they were getting dose rates as high as
20 65 rem per hour, and that was intolerable. They had to reduce
21 the dose rates to --
22 MR.BARRETT: What happened in the last few years has
23 been the changes in design in the cavity out in here. Really,
24 our designed plants, let's say, of ten years ago, they had
25 smaller gaps between the reactor vessel and the wall. As

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1 sub-compartment pressure analyses were being done on LOCAs,
2 the concern came up that there might be high pressures that
3 would blow these walls out. So this gap was opened up in
4 newer designed plants. Calvert Cliffs is one of the first
5 ones where they opened this up to several feet instead of
6 several inches.
7 This allowed streaming to start coming out. That's
8 when people started backfitting the shields.
9 COMMISSIONER BRADFORD: The particular matter that
10 triggered the article was in part a memorandum that suggested
11 that this information should be passed on to the licensing
12 boards. Is that being done?
13 MR. BLOCK: Except for the briefing of the ACRS, I
14 am not too sure what measures have been taken.
15 MR. VOLLMER: A memorandum was sent to the project
16 management. I don't know if they have forwarded it yet --
17 MR. DANTON: It has been recommended that it be
18 forwarded to the boards. I don't know the exact status of
19 whether it has arriveD there or not.
20 MR. GROSSMAN: I don't remember if I have seen the
21 recommendation or not. I will check.
22 COMMMISSIONER GILINSKY: Who recommended it?
23 MR. GRIMES: NRR recommended to ELD that appropriate
24 board be notified.
25 COMMISSIONER GILINSKY: They were notified?

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MR. DANTON: Yes.

COMMISSIONER GILINSKY: It is held up in ELD?

MR. GRIMES: The paper is someplace between the originator and the board.

CHAIRMAN HENDRIE: You want to defend yourself?

MR. GROSSMAN: I just don't know whether it is with us or, if so, how long.

CHAIRMAN HENDRIE: When in doubt, always say it is in transit.

COMMISSIONER KENNEDY: The paper we are talking about, the memo of January 25th, 1978?

MR. GRIMES: I believe so. Do you have the chronology?

MR. BLOCK: Yes. Would you show Slide 7, View Graph 7? We have a chronology of events coming up. I think it started on January the 25th with the Zimmer memo and --

COMMISSIONER KENNEDY: There were two memoes on the 25th. One went to Bob Minogue, the other to Roger Boyd.

MR. BLOCK: The Roger Boyd is the one that is mentioned there. I think then on March the 6th the memo was written from Vollmer to Higgenbotham from I&E, requesting I&E reviewing the licensing monitoring program to confirm the statements made in the Zimmer memo.

June Allen then sent a letter to Roger Boyd regarding the Zimmer memo, too, and asked several questions to

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1 the staff. The Levine research was signed on April the 3rd.
2 However, that particular letter started through the staff in
3 mid-February, and it took until April 3rd to get it to
4 research.
5 On April 7th, I briefed the ACRS on this data. On
6 April the 14th, Howard Rosenberg called me on the Zimmer memo
7 and we spent considerable time on the telephone during the
8 rest of that month and into May, going through questions he
9 raised and some comments he made in his column that were
10 shocking to me. But as I pointed out to him, he had the
11 freedom of the press and there wasn't too much that I could do
12 with respect to what he was going to say, except suggest that
13 they were incorrect.
14 (Slide.)
15 On May the 9th, he called me after the column had
16 been released on May the 8th and asked me NRC's reactions,
17 which I suggested to him were not -- at least my personal
18 reaction was not very good.
19 On May the 12th, we sent June Allen the response to
20 her question.
21 COMMISSIONER KENNEDY: What did that response say?
22 MR. BLOCK: I have a copy of it.
23 MR. GRIMES: It essentially transmitted the internal
24 memoranda which had requested that inspection and enforcement
25 do the review, and memo to research requesting and giving the

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scope of the research required; and answered several specific questions, most of the material that we have given to you in this briefing.

MR. DANTON: I recall that this item was a category two, in our original response to Congressman Dingell. And category two is in the process of — the boards are being notified. Let me get back and see when the boards were notified. That was some time back. We just don't have people here today who can remember the exact date.

CHAIRMAN HENDRIE: I am not sure what the boards are going to do with it. I assume they would be following it with a staff comment rather rapidly as to its place and meaning in the scheme of things, which I don't find to be very significant, but —

COMMISSIONER BRADFORD: What is the relevant occupational exposure standard? I gather that the reg guide will tell you how to meet the regulation, but —

MR. DANTON: Part 20.

MR. GRIMES: Three rem per quarter combined neutron gamma exposure. There is also a limitation, an integrated limitation on age, which averages out about five rem per year.

COMMISSIONER BRADFORD: Where does "as low as reasonably achievable" fit into that?

MR. GRIMES: In our review of the licensee's operating license applications, we review a program to assure

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that they have a system within their facilities to review operations that they are going to perform within the containment or anyplace else for maintenance, to try to maintain exposures as low as reasonably achievable.

COMMISSIONER BRADFORD: Then those that are ongoing now are in fact looking for the kind of devices that were shown on that other slide?

MR. GRIMES: We are looking for -- I would say yes, and in the cases where that is not provided, there would have to be perhaps a cost-benefit analysis done to justify that the exposures saved would not -- it would not be beneficial to spend the money, which is not great, to install the shield.

COMMISSIONER BRADFORD: What have you been saying in the last few months, to the extent that there have been reviews going on in most plants?

MR. GRIMES: New plants have the shields, yes.

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1 CHAIRMAN HENDRIE: I can remember Stone and
2 Webster long ago;about the balance off between the opening
3 up compartment so they didn't pressurize much in case the
4 pipe blew against the -- inevitably you get some operational
5 exposure problems that derive from that opening.
6 It was probably recognized as a general way of --
7 COMMISSIONER BRADFORD: In Zimmer's memo, he says
8 that it has come to his personal attention that personnel
9 at commercial power reactors are achieving some neutron
10 exposure which heretofore has been unknown.
11 Does he mean all reactors or some reactors? It is
12 sort of a cryptic phrase.
13 MR. GRIMES: We took it to mean all reactors. I
14 believe Mr. Zimmer is in the audience, if he wishes to speak
15 up and contribute. He was given our briefing materials
16 also. I think he is in general agreement.
17 MR. ZIMMER: What I meant by that was that the
18 reactor that I was informed of, they were using NTA film
19 and it was suspected that the neutron exposure spectrum
20 was below the 700 KV that is usually able to be read with
21 the NTA.
22 Therefore, the neutron exposure was not known
23 because of the use of NTA film.
24 COMMISSIONER BRADFORD: What percentage of the
25 reactors, in fact, use the film?

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1 MR. BLOCK: 30 to 40 percent.

2 CHAIRMAN BRADFORD: Very few use the dosimeters?

3 The rest are about equally divided?

4 MR. BLOCK: The stay time and the end gamma ratio

5 are the preferred methods. The albedos, we are going to

6 hope that the albedo systems will be used by all because

7 passive dosimeters are much better than making measurements

8 and then timing them, in what Commissioner Kennedy thought

9 was an unknown time and a varying field.

10 However, the albedo dosimeters at the present time

11 are about three to four times more expensive than NTA film

12 and there is perhaps a cost benefit that we are going to

13 try to resolve. It will be resolved if we find in our

14 research that 90 percent of the doses received by energies are

15 less than 0.7 MEV.

16 That being the case, we would have to disallow the

17 use of NTA film. And, hopefully, at that point, the albedo

18 dosimeter system would be used upon more licensees.

19 MR. GRIMES: Probably with a different calibration

20 technique than presently used that tends to overestimate

21 by perhaps a factor of 50 what the neutron dose is.

22 COMMISSIONER KENNEDY: The present estimate --

23 MR. BLOCK: That is what we hope to find in our

24 research. But Millstone did a study using threshold

25 detectors and found that a very large fraction of their

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1 spectrum based on their methods was of energies less than
2 0.7 MEV.
3 It is inevitable that a great deal of the neutrons
4 are going to be of energies less than 0.7 MEV because of the
5 scattering. You have a shield that is scattering where the
6 neutrons are being scattered from — they scatter as they
7 go from the annulus and in containment.
8 So there has to be a fraction of that energy.
9 CHAIRMAN HENDRIE: There is an awful lot of hydrogen
10 bearing material around in that concrete.
11 MR. GRIMES: Of course this is balanced somewhat
12 by the fact that the higher energy neutrons are much more
13 effective in delivering dose than the lower energy neutrons.
14 Even though there may be more neutrons below 0.7, the
15 effective dose, it's not necessarily much larger.
16 MR. BLOCK: NTA is not completely bad. Oak Ridge
17 uses it. They use albedos in parallel with it, because, you
18 see, the NTA film at least can tell you the fraction of
19 neutrons that are greater than say a half MEV.
20 If you are very careful in your analysis of an
21 NTA film, you can read energies down to one-half an MEV.
22 So, they can look at the fraction of their doses that are
23 being contributed by neutrons of a half MEV closer, because
24 the albedo gives you everything and you don't know which
25 fraction is of low or high energies.

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1 That is a nice trick that they use to isolate the
2 fraction due to higher energies.
3 Now some of the licensees are using the stay-time
4 in parallel with the NTA film. Even those these 30 to 40
5 percent may be using NTA film, they perhaps aren't all basing
6 the dose on that particular device. They are just using that
7 as perhaps a back-up to look at the higher energies.
8 COMMISSIONER BRADFORD: Dr. Zimmer, let me ask you
9 what would you take away from your sentence in your memo to
10 Mr. Board? I understand from another source that
11 neutron fields of 25 KV neutrons, superimposed on the one
12 over E neutron's spectrum existed at PWR which is known
13 about.
14 What is the significance of that in terms of what
15 we have been talking about?
16 DR. ZIMMER: Generally, it is accepted or expected --
17 COMMISSIONER BRADFORD: Is that the Millstone study
18 you were just referring to, or is that another?
19 MR. BLOCK: That is Farley.
20 DR. ZIMMER: Normally, they expect there one over
21 E spectrum for distribution of neutrons from a reactor.
22 What had been found in that case from Lawrence
23 Livermore was that there was a 25 KV neutron spectrum
24 superimposed on the one over E spectrum.
25 So that what I understood from Dale Hankins was it

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1 was a substantial 25 KV spectrum which is not monitored
2 with NTA film. Whereas, with the one over E spectrum, a major
3 portion of your --
4 CHAIRMAN HENDRIE: That is also something you
5 expect around this kind of shielding because there is a
6 25 kilovolt window in the iron neutron cross-section.
7 So you expect to see a little blip.
8 MR. BLOCK: Yes. I had a copy of their data and
9 you can see that little blip.
10 CHAIRMAN HENDRIE: Yes.
11 COMMISSIONER BRADFORD: Would that be a unique
12 at Farley --
13 CHAIRMAN HENDRIE: No. It depends on whether the
14 shield designer has paid any attention to it. It is no
15 great shakes to avoid having pathways out of the reactor
16 cavity which are pretty much iron. You can take things around
17 corners and make sure that you have got good chunks of
18 concrete, hydrogen-bearing material that intercept all such
19 pathways.
20 It complicates shield design a little bit. Sometimes
21 you get to the point where you are balancing between mechanical
22 simplicity and strength and the seismic resistance into
23 fancier shapes for shielding.
24 Furthermore, those calculations get pretty tricky.
25 Until you get it build and run it, you'd never know whether

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you have covered everything.

That's why a foot of water put in later on, or if you leave a place where you can get a tank with a foot of water in it, that is a nice thing to have.

Anything further?

COMMISSIONER BRADFORD: I would like to know the answer to that question about the licensing boards.

MR. GRIMES: I will supply that.

CHAIRMAN HENDRIE: Thank you very much.

(Whereupon, at 4:45 p.m., the hearing was adjourned.)

DISCLAIMER

This is an unofficial transcript of a meeting of the United States Nuclear Regulatory Commission held on MAY 25, 1978 in the Commission's offices at 1717 H Street, N. W., Washington, D. C. The meeting was open to public attendance and observation. This transcript has not been reviewed, corrected, or edited, and it may contain inaccuracies.

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