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2nd Day

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PUBLIC NOTICE BY THE

UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

DATE: Friday, January 11, 1991

The contents of this transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards, (date) Friday, January 11, 1991, as reported herein, are a record of the discussions recorded at the meeting held on the above date.

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

369TH ACRS Meeting

2nd Day

Nuclear Regulatory Commission

Conference Room, P-110

7920 Norfolk Avenue

Bethesda, Maryland

Friday, January 11, 1991

The Advisory Committee met, pursuant to notice, at 8:30 o'clock, a.m., D. Ward, Chairman, presiding.

PARTICIPANTS:

D. Ward, Chairman of the ACRS

P. Shewmon, Vice Chairman of the ACRS

C. Michelson, ACRS Member

C. Wylie, ACRS Member

H. Lewis, ACRS Member

I. Catton, ACRS Member

W. Kerr, ACRS Member

E. Wilkins, ACRS Member

J. Carroll, ACRS Member

R. Fraley, Executive Director, ACRS

D. Cool, NRC/RES

H. Peterson, NRC/RES

S. McGuire, NRC/RES

F. Costanzi, NRC/RES

S. Baggett, NRC/NMSS

C. Roecklein, NRC/RES

P R O C E E D I N G S

[8:30 a.m.]

MR. WARD: The meeting will now come to order. This is the second day of the 369th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the Committee will discuss or hear reports on the following:

Proposed revision to 10CFR, Part 20, Standards for Protection Against Radiation.

Licensing Requirements for Larger Radiation Facilities.

ACRS Future Activities.

ACRS Subcommittee Activities.

A portion of these sessions may be closed, as necessary, to discuss information for which the premature release would be likely to significantly frustrate the NRC in the performance of its statutory functions. This meeting is being conducted in accordance with provisions of the Federal Advisory Committee Act.

Mr. Al Ignne is the designated Federal Official for the initial portion of the meeting. We have received no written statements, no requests for time to make oral statements from members of the public regarding today's sessions. A transcript of portions of the meeting will be kept and it is requested that each speaker use one of the microphones, identify himself of herself, and speak with

sufficient clarity and volume so that he or she can be readily heard.

Our Subcommittee Chairman responsible for the first topic is Jay Carroll. I ask you to go ahead.

MR. CARROLL: As you will recall, at our last meeting, we discussed the status of 10CFR, Part 20 revision, and decided it would be useful to us to hear a status report from the staff. Tab 7 contains a good deal of background information and Al, I guess you also handed out the last letter the Committee wrote on the subject of 10CFR, 20, which was dated June 7, 1988.

With that, I will turn it over to Donald Cool, who will make the presentation on Part 20.

[Slide.]

MR. COOL: Good morning, gentlemen. I am Donald Cool, and I am Chief of the Radiation Protection and Health Effects Branch in the Office of Research. It is my branch which has the lead responsibility for the Part 20 rulemaking, as well as the regulatory guidance that will be coming out associated with that rule.

I am pleased to be here today to be able to provide you an update on what is no longer a proposed rule, but is now a final rule. It was approved by the Commission; they affirmed their votes on December 13th. We are now in the process of sending it down to the Federal Register for

publication.

We hope, at this point, that it will be in the Federal Register by the end of the month. That depends somewhat on what sort of additional quality assurance checks we need to make on the version which the Federal Register actually typesets, in order to have some hopes that what is published is reasonably accurate.

I'm going to talk briefly this morning about what our current schedule and implementation is going to be, our plans for regulatory guidance associated with this rulemaking, the current plans which we are developing with regard to training of the NRC staff in the Regions, and then provide you a very quick summary, once again, of the actual major provisions of the rulemaking.

[Slide.]

MR. COOL: The rule was approved by the Commission and in its approval, the Commission's decision was that the rule should be made effective -- the word that was originally used was "immediately;" it will be approximately 30 days after publication in the Federal Register. That means that the rule will be the effective rule about the end of February of this year.

The implementation dates which are down at the bottom of this slide: licensees must implement the rule, if they are NRC licensees, on or before January 1st of 1993.

The agreement states and agreement state licensees have one additional year till January 1st, 1994. That is consistent with the standing practices with the agreement states to allow them three years to get their rules in place.

MR. CARROLL: Just for my calibration, how many agreement states are there now?

MR. COOL: There are 29 agreement states.

MR. CARROLL: That number has remained fairly constant in recent times; hasn't it?

MR. COOL: Reasonably constant. Illinois was added a couple of years ago. Other than that, there have only been some slight modifications to the content of the agreement with one or two states, but not a change in the number. There are several states that are thinking about it, but none that will be coming on in the very short term, that I am aware of.

MR. CARROLL: Thank you.

MR. COOL: The Commission also has directed the staff to have final guidance in place by the end of 1991, beginning of 1992, and the staff is currently working on a schedule to attempt to do that, whereby we will have draft guides issued by the Summer of this year. Then the final guidance will be in place by the end of the year.

It's going to require somewhat expedited processing, and we will be attempting to get public comment

very early on that process.

[Slide.]

MR. COOL: We have a number of new regulatory guidance documents which we're working on.

Several of them which are brand new, and which deal with general topics related to the rule, include some explanation on the summation of internal and external doses.

Another one is the dose to the embryo/fetus. There is a new rule that contains a dose limit for embryo-fetus which has not been present in the Part 20 before, and we are working on guidance on how to assess that dose, particularly in terms of how to assess dose when the dose comes from internal radionuclides. This is an area where we are in fact in some sense pushing the science a little bit. We have research projects going on currently looking at the assessment of dose and the movement of radionuclides across the placenta to the embryo/fetus.

Also, general guidance in terms of assessing the external doses from airborne radioactive materials; and guidance associated with planned special exposures, which is another new provision of the rule.

MR. CARROLL: What is a planned special exposure?

MR. COOL: All right. I was going to address that in a little while, farther down, when I actually went through the rule provisions.

MR. CARROLL: Great.

MR. COOL: Okay. We'll save that for that point, and we'll come back to it.

[Slide.]

MR. COOL: In addition to the guidance which is sort of general to potentially all licensees, there is going to be some guidance which is more specific to certain categories of licensees.

For the power reactors, a guide with regard to radiation protection programs for power plants. Most power plants of course, in fact all of them, already have very good radiation protection programs. We don't envision that there will be much change necessary for those facilities.

There will also be guidance with regard to control of access for high and very high radiation areas in the nuclear power plants.

On the material side --

MR. CARROLL: Is the term "very high radiation areas" a new term in the revision to Part 20? We've always had high radiation.

MR. COOL: You've had high radiation areas. Very high radiation areas has been added. That is something which has been in for quite a while, but is something which the power plants have not dealt with in this particular context before. And in fact, the power plants' use of very

high radiation area cuts in at a lower value than the Part 20 value does.

The Part 20 value in this revision is at 500 rads per hour at a distance of one meter. I believe I have that correct, now.

And most of the requirements in the revision, in fact there is a whole separate subsection, Subsection 20.603, are what was contained in the old rule C.6 and C.7, dealing primarily with gamma irradiators. And we'll be talking about gamma irradiators a little more later this morning. It is the staff's plans not to pre-empt what Dr. McGuire is going to say in a little while. But eventually, we hope to move that material out of Part 20 and put it in the new Part 36 where it really belongs. But we are still in that sort of transition period.

The materials users, two new appendices to regulatory guides, which are already in place, dealing with industrial radiography and medical uses.

Once again, this will be mostly in the context of the new requirements for radiation protection programs associated with those particular types of licensees.

[Slide.]

MR. COOL: In addition to some of the new guidance --

MR. SHEWMON: Before you get into that, 20, you

would like to have apply to power plants; and 36 you would like to have apply to irradiators? Or what do you mean by the separation to get that very high exposure stuff in where it belongs?

MR. COOL: Okay. Let me go back and give you just a slight bit of history, which I think perhaps will help that.

Back a number of years ago, there were requirements added to Part 20 which dealt with access requirements, particularly for large gamma irradiators. Those were in the existing Part 20 and had been maintained in the revised Part 20, put in one specific section. It is now 20.603 in the revision. All those requirements are specific for large gamma irradiators.

And when we have a final rulemaking on large gamma irradiators, it would be the staff's intention to move those requirements from Part 20, which are specific to only one class of licensees, to the rulemaking, which is specific to that class of licensees, so that Part 20 is a document which applies to all licensees, and we don't have major sections which are specific to just one particular type.

Part 20 itself will still have basic requirements with regard to radiation protection areas and posting and access controls.

MR. SHEWMON: And Part 36 will deal only with

irradiators?

MR. COOL: Part 36 will deal only with irradiators. And starting after this presentation, Dr. McGuire is going to discuss in more detail large gamma irradiators, and we can perhaps pursue it more then, if you'd like.

MR. SHEWMON: Thank you.

MR. COOL: Okay.

There is also some revised regulatory guidance to go along with the rulemaking: Interpretation of Bioassay Measurements; some revised instructions for recording and reporting occupational exposure, including provisions for electronic media, which has been added in the final revision; some revisions on the instructions on health risks from occupational exposure; and we should note that there was a very recent revision with regard to instructions for pregnant women on some of the radiation effects to embryo/fetus.

[Slide.]

MR. COOL: As I had mentioned, the staff recognizes that there is going to be considerable need to provide training and information with regard to the revision. We plan to do that in several discrete steps.

The first one, which will take place within the next several weeks, will be a review in each of the regions,

an overview of the revision, an expanded version of the sort of discussion that we will have here today.

And we will also be providing for the regions at that time a comparative text where you have the new rule and the old rule side by side, so that inspectors and others who are familiar with the existing rule and its organization would be able to go to that particular point and immediately see what the requirements of the new rule and what the corresponding reference numbers will be.

MR. CARROLL: Now, is that comparative text to be distributed to licensees also to help them understand what's going on?

MR. COOL: We are currently discussing that, and we are currently discussing potentially making that a NUREG document and getting that on the street very quickly, because we believe that has wide benefit to a lot of people.

MR. CARROLL: Yes. I think that would be extremely useful.

MR. COOL: We've been discussing that we are currently developing that at this moment. We have a contractor working on actually putting the line-by-line togetner.

In addition to the brief overview, which we will do at or shortly after the time of publication in the Federal Register, we're currently working on developing what

will amount to probably about a two-day training session to be done both as general overview and then break out seminar-style details with regard to the rulemaking for particular classes of licensees related to inspection and enforcement.

That will be supported by not only our office, the Office of Research, but by Nuclear Reactor Regulation, Nuclear Materials, Safety, and Safeguards, and the Agreement State Program.

We would expect that individuals from the Agreement States would be welcome to come, and in fact, the Agreement State Program has indicated that it probably will be providing funding for a couple of individuals from each of the states to come to the region at the time we hold those training sessions, and participate, and be able to have that particular training also.

We also plan to hold a similar sort of two-day session here at Headquarters. That probably will be the very first one, as well as one that follows later on, and some follow-up sessions probably at the technical training session, Technical Training Center down in Chattanooga, so hat we continue to provide that information.

The Revision of Part 20 will also be incorporated by TTC into its ongoing health physics types of training courses.

[Slide.]

MR. COOL: We will now go through relatively quickly because at various times you have seen this on several occasions so we won't try to dwell on all the details.

Some of the major changes of the revision -- there is a greater emphasis on numerical risks and the equivalency of risks, internal and external exposure.

The final rule adopts the effective dose concept.

There is limitation now based on the summation of internal and external dose.

Dr. Shewmon?

MR. SHEWMON: Would you tell me how I could distinguish a numerical risk from a non-numerical risk?

You have greater emphasis on numerical risk and I don't know whether to avoid calculations or what.

MR. COOL: Okay, by that perhaps you are reading more into it than we intended.

The whole rule now is based much more closely upon the scientific evidence that has come out over the last 30 years with regards to radiation and particularly the risks in various organs as compared to a risk of a whole body exposure.

We have an emphasis on those risks and the equivalencies of those risks, for example, the equivalency of what an exposure simply to the lung would be as in

comparison to an exposure to the whole body and those numerical values and the risk coefficients that go with it.

Those risk coefficients you find coming into the weighting factors for individual organs which are used to compute an equivalency of a particular organ's dose and the potential for inducing a cancer in that order to a whole body dose.

MR. SHEWMON: Fine, thank you.

MR. COOL: We are trying to provide greater equality in terms of our treatment of external and internal doses. We have now provided an explicit dose limit for members of the public and there is a new explicit limit on dose to the embryo fetus.

MR. WILKINS: May I interrupt you at that point?

MR. COOL: Yes.

MR. WILKINS: Limit on dose to the embryo fetus. I don't understand what that means.

MR. COOL: I have a slide on that, as I get a little bit further down.

MR. WILKINS: Maybe I should wait.

MR. COOL: And -- yes.

MR. WILKINS: I don't even know how to ask an intelligent question yet, so maybe it would be better.

MR. COOL: I have one on that and we'll be getting back to that, as I'll be getting back to the planned special

exposure in a little bit and perhaps then we can discuss it in greater detail.

MR. SHEWMON: Let me bring up another question, which you can answer when you want to.

You have mentioned repeatedly that you are going to deal with the embryo fetus. I remember reading an article maybe in "Science," maybe in the "New York Times" within the last month. This had to do with new work on the influence of radiation on male sperm on defective -- well, offspring. They weren't necessarily dealing -- one thing that would correlate, interestingly enough, was the work that was found in England where workers' children had leukemia but the main point was that they had done work with other animals and found that indeed this seemed to be an area where there were reproducible effects though it was harder to demonstrate than it was with the fetus.

Do you know of any work that either the NRC is doing on that or that is going on within your purview?

MR. COOL: We do not have any research directly related to that particular aspect at this point.

We are well aware of the Gardner Study, which was the British study with regard to leukemia and their possible connection to leukemias of fathers who had been irradiated.

There has been some other looks at other populations here in the United States.

The National Cancer Institute did a study of leukemias around a large number of the power facilities and didn't find any trends and we're trying to keep abreast at this point of where the particular research projects are.

MR. SHEWMON: The article I had did not -- was not limited to this. They're certainly interested in other carcinogens and the effect of the exposure to the male -- to these. The thesis was interesting in that they said whenever a cell is growing rapidly or -- sorry -- whatever the structure is, the egg, that it's particular prone to mistakes and thus the influence of external events, and that the sperm grow rapidly and thus the cells reproduce quite frequently and perhaps there was an effect here that people had overlooked, which is at least interesting.

MR. COOL: Yes. You are quite correct on the scientific basis. In general, cells are more sensitive to radiation when they are growing, dividing rapidly. That is an area that, you're quite correct, is going to need continued attention.

[Slide.]

MR. COOL: The occupational dose limits in the new rule, a 5 rem total effective dose equivalent per year.

The current rule -- or the old rule at this point -- was 1.25 per quarter with the alternate provision of up to 3 rem per quarter as long as an individual was within the

proration formula of 5(N-18), which would have allowed certain individuals up to a maximum of 12 per year for a small number of years.

That is no longer possible under this rule.

It is 5 capped total.

In fact that also is a summation number, whereas before the 1.25 per quarter referred only to external radiation.

MR. CARROLL: Is my impression correct that most utilities, at least in the power reactor business have adopted the 5 rem a long time ago?

MR. COOL: Yes, that's correct. There are very few individuals who even approach 5 rem anymore. The average, in the power plants, for occupational exposures, is now down to less than 4/10ths of a rep, due to the ALARA activities. So, well below the 5 rem values. That's correct.

[Slide.]

MR. COOL: For individual organs, the primary control would be the total effective dose equivalent, the stochastic cancer risks controlling. There is an addition to that, what we call a non-stochastic secondary limit at 50 rem to prevent those sorts of effects wherein certain cases, because you have a very small waiting factor, such as thyroid, which is not particularly radio-sensitive, when you

multiply an organ dose by that small waiting factor, you could have a rather large organ dose there and still be within the 5 rem total effective dose equivalent calculation. So, we have applied an additional secondary cap of 50 rem, which would apply to any of those organs.

That compares to a variety of different organs, which were in the present rule in fact greater than most of those.

MR. KERR: Is the sense of this that the stochastic is a summation of equivalent doses and that the non-stochastic is some sort of -- I don't understand the nomenclature.

MR. COOL: Okay. The stochastic is the cancer risk -- the cancer induction risk, which is the primary risk, that is, the statistical basis, the random basis for which most of us think about in terms of radiation effects. The non-stochastic effects are the types of effects such as erythema on the skin or ablation of the thyroid or a cataract in the eye for which there is some sort of threshold which has been observable.

The 50 rem value is set to avoid those sorts of threshold types effects which would be beyond the potential for inducement of cancer. The non-stochastic is a threshold-type effect, which we are limiting by that organ cap and the primary limit is the stochastic limit, dealing

with the cancer.

MR. KERR: You said, an example of the non-stochastic limit is thyroid exposure?

MR. COOL: I'm sorry. I didn't hear you.

MR. KERR: You said an example of a non-stochastic limit is a thyroid exposure?

MR. COOL: An example of a place where you could run into, where the non-stochastic limit would take effect would be a thyroid exposure. For example, you have iodine in the body. Iodine preferentially concentrates in the thyroid and you would reach 50 rems in the thyroid before you would have a calculated equivalency.

MR. SHEWMON: But there there's a reproducible threshold. You call it non-stochastic because you could to the experiment and at least 9 times out of 10, at that threshold, you would get the same effect.

MR. COOL: At some particular value you start to have that effect -- cell killing and organ dysfunction; that's correct.

MR. KERR: So, the induction of thyroid cancer is, in contrast to other cancers, non-stochastic --

MR. COOL: No.

MR. KERR: -- and there is a threshold?

MR. COOL: No, I didn't mean to imply that.

The induction of thyroid cancer is a stochastic

effect, as the induction of any cancer in the body. Thyroids are somewhat insensitive to radiation. It takes more radiation dose to induce a cancer in the thyroid, than some other organs.

MR. LEWIS: I can tell you, I worried long ago about this misuse of the use stochastic, which seems to be standard in the trade. The interpretation I ended up with was that when the effects are sufficiently large sum of many little effects, that the statistical fluctuations can kind of be averaged out, then they call it non-stochastic. That is, that there isn't -- is my interpretation -- that it's sort of a difference in a quantitative, not a qualitative difference, but has become entrenched in the literature.

Erythema was a perfectly decent example of that that he used, where the effects on many many different skin cells sort of add up in such a way that the statistics show you a sort of uniform retinin of the skin, and then they call it non-stochastic. that's my -- the way I understood it.

MR. COOL: One of the other things you can look at in the non-stochastic area, if you have a non-stochastic effect, like erythema on the skin or an organ dysfunction, that's going to be something which you're going to observe immediately as a result of that dose or in a very short period of time. Whereas the stochastic effect, the

induction of cancer, is going to be something which you may observe 10, 20 years or so down the road because what you have really done is you've just increased the probability of a cancer at that particular site. So they're also a different kind, in that sense, in terms of when you would observe the potential effect.

MR. CATTON: Why don't they call it deterministic?

MR. COOL: In fact, the International Commission on Radiological Protection, which is currently about to issue some revised recommendations, has changed the term from non-stochastic to deterministic.

MR. CATTON: You don't want to do that?

MR. COOL: We may do that in a future revision. All of those sorts of things have to go through the public comment process and this was the -- this was and is in fact the term in the international recommendations in the Federal Guidance for Occupational Exposure at the present time. It's the term that we use.

Deterministic and any other term you can come up with, also has some potential fallacies associated with it.

MR. LEWIS: I think that the point is that the word stochastic is an ancient and honorable word in a lot of other fields and means something quite different from what you mean by it, so it just makes confusion to continue using it.

MR. SHEWMON: Patience. They'll come around.

MR. WILKINS: I have long since stopped beating my head against this particular stone wall.

MR. LEWIS: My head may have more callouses than your head.

[Slide.]

MR. COOL: There are a couple of other specific dose limits. There is a dose limit specific for the lens of the eye -- 15 rem per year. There is a specific limit associated with the extremities: hands and arms, up to the elbow; feet and ankles, up to the knee which are a different value.

The extremities, in fact, is also a 50 rem number. The lens of the eye is at 15 rem and that's particularly looking at the potential for inducing cataracts and things of that type.

[Slide.]

MR. COOL: Dr. Shewmon had talked a little bit ago about numerical risk and I had this slide which I'll tuck in here very briefly which sort of summaries some of the changes that have gone on with the dose limits and the risk factors that are currently available.

In the occupational exposure area you have, as I described before, the potential for 3 rem per quarter to a total of 12 rem per year from external and an additional

separate limitation on internal, so that you could have, actually, under the old rule, up to 17 rem per year.

Now, in fact, nobody was anywhere close to that. In fact, there are very rare situations where you ever have internal and external large quantities at the same time. Nevertheless, that was the potential.

Under the revised rule, you have the 0.5 rem, which is the summation.

In the public exposure, which we'll talk a little bit more in a moment, the value used to be a half a rem per year has been reduced to a tenth of a rem per year.

The risk factors that we used to be looking at, something on the order of 10 to the minus 4th, and now in the more recent BEIR Report UNSCEAR Reports, something more like on the order of 5 times 10 to the minus 4.

MR. KERR: When you talk about the public exposure limit, you're talking about something that is calculated and is not measurable I take it?

MR. COOL: That's correct. That's correct. You're not really measuring a public exposure. What you're doing is you're looking at TLDs on the fence line, continuous air samples at the stack and then, for the most part, going on some sort of environmental model to demonstrate.

MR. KERR: Even with a TLD on the fence post, you

have difficulty separating out the exposure, due to some source and exposure due to natural background; don't you?

MR. COOL: That's correct. You can do it, to some extent, by having another TLD at a more distance location, which you can subtract out average background. But you have -- you are -- quite correct. You are going through that sort of modeling approach and making some assumptions.

MR. SHEWMON: This 100 rem per 100 millirem per year is supposed to be over and above background?

MR. COOL: That's over and above background, that's correct.

MR. SHEWMON: Which is going to be the same magnitude or bigger; is that the point of the discussion here?

MR. COOL: Yes. It's background. In fact, it's going to be considerably bigger.

The average exposure, in the United States, natural background and average medical use in various things, as calculated by the National Council on Radiation Protection and Measurements, NCRP, is nearly 1 millirem per day, or about 360 millirem per year. Over and above that, the limit here in the revised Part 20 would be 100 millirem.

MR. CARROLL: Now, the term risk factor on the bottom one means what?

MR. COOL: That is the factor coefficient which is

used to take a dose of a given amount of radiation and translate that to the probability of inducing a cancer in an individual.

MR. WILKINS: Inducing a cancer at any time subsequently?

MR. COOL: That's correct.

MR. WILKINS: Prior to his death?

MR. COOL: From that particular dose. That's correct.

[SLIDE]

MR. COOL: Go on and look for a moment at the internal exposure.

The revision permits some flexibility with regard to assessing internal dose from radioactive materials.

The old Part 20 had said go do air sampling. The revised Part 20 says, yes, you can go do air sampling for the air borne radionuclide concentrations.

But it also has provisions for allowance of various types of bioassay body burdens, excretion measurements as well, or assessment using any combination of that, in terms of getting a dose of record for individuals.

[SLIDE]

MR. COOL: In addition to that flexibility, there is flexibility in the revised Rule with regard to the actual use of the values which are now in Appendix B. They used to

be called MPCs, or Maximal Permissible Concentrations. They are now Annual Limits of Intakes, or ALIs, which are found in Appendix B.

Those values and the estimates of dose can be adjusted if you know some more information about the exact kinds of materials that you have in your environment, or you have some further information on the actual way that the individual who is exposed actually excretes the radioactive material.

So, for example, if you knew that you had a particle, say, in a fuel fabrication facility which had an average aerodynamic diameter of something like five micrometers, then you would use that value in place of the assumption which is in the table of one micrometer, and you would be able to have a slightly different concentration value which would correspond to the dose of five rems.

That's simply because, as you change particle size you change where it ends up in the body and the way in which it is moved about in the body. So you change the dose, depending on some of those physical parameters such as particle size and solubility and those sorts of things.

MR. WILKINS: Does that take into account the fact that the particle size would change after it gets inside the body?

MR. COOL: If you have that particular data.

MR. WILKINS: I mean, it's almost certain to happen, isn't it?

MR. COOL: It may happen in a lot of cases, you're correct. It's going to depend on the kind of particle. If it's a particle which will absorb moisture, become hydroscopic and grow, then it certainly is going to change sizes. If it's a very insoluble type particle, such as uranium dioxide high fire, there probably isn't going to be a great deal of change. So, it's going to depend on what you know about your particular kinds of radioactive material.

The behavior in the specific individual, all of the values in the tables, of course, have to go back to some sort of model and assumption, what is known as the standard man. It assumes certain kinetic parameters for movement of materials in the body.

I don't think any of us are standard. The standard person is some amalgamated average. If you have specific bioassay data that says that your particular guys drink a lot of beer and excrete very rapidly and clear things rapidly, then you can also use that information to account more accurately for the dose that they actually received as a result of a particular intake.

Adjustment of the concentration and intake values is possible, with prior NRC approval, to reflect some of the

physical and chemical characteristics. So that will be a possibility for the licensees.

[SLIDE]

MR. COOL: We will now get back to your topic, finally, planned special exposures.

A planned special exposure is a unique exposure situation outside of the confines of the routine dose limits. It requires a special series of documentation. It has its own separate limitation.

It is intended for specific situations where the licensee cannot or may not be able to conduct a particular operation that needs to be conducted within the confines of the normal radiation protection scheme and the dose limit.

There is an annual limit on what an individual can be exposed to in a planned special exposure.

Yes, Dr. Shewmon?

MR. SHEWMON: There is no comment about an effort to try to avoid younger workers in this? That's been completely removed from the document now?

MR. COOL: There is no specific wording requiring that. There is no language regarding that. That's correct.

MR. CARROLL: This is something different than emergency, once in a lifetime exposure, correct?

MR. COOL: This would be something different. This has nothing to do necessarily with what an operator of

a power plant might do in order to, in an emergency type situation.

This is more perhaps a situation where they need to go and lance out sludge in a steam generator or something. Or, for example, where they need to go and recover a radiographic device, where they can plan and think about, and take certain steps to reduce doses as low as reasonably achievable, plan partial shielding and those sorts of things, but which is a unique situation. That's why the term planned special exposure.

MR. WILKINS: It is certainly not an emergency if you've got 30 days to notify the NRC.

MR. CARROLL: The limits for the emergency, once in a lifetime, kind of exposure remain unchanged?

MR. COOL: Those have basically remain unchanged. I don't think they're even specifically addressed in the revision of Part 20.

What Part 20 says in it's scope is that nothing in this part should be construed as limiting what a licensee does to protect the public health and safety, taking actions that may be necessary in an emergency.

When you get into an emergency situation like that, you're really outside the scope of what Part 20 would cover. Now, we would like them, as much as possible, to adhere to this, the dose limits and the reporting and

recordkeeping. But when you're getting into an emergency, you're into a situation where you need to do the right thing.

MR. CARROLL: Okay. But, for these sort of exposures, these planned special exposures, it's going to be sort of a judgment call on the NRC's part as to whether people are really applying ALARA principles to these kinds of exposures?

MR. COOL: Yes, that probably will be the case. Because of the fact that there is the potential for a little bit of second-guessing, in the sense that they don't have to tell us before hand. There is no prior notification requirement.

This is that they have to tell us that they conducted a planned special exposure and what the doses were within 30 days after that takes place.

Certainly, the inspector is going to come out and look at that and what happened and how did you set it up. I think the expectation within the staff is generally that this provision is not going to be used a great deal.

Most all operations are conducted well within the dose limits presently. That's the operating experience which we have.

MR. CARROLL: Do ALARA principles apply to this?

MR. COOL: Licensees would still be expected to

apply ALARA principles, where they have some control in planning.

MR. CARROLL: I think this is going to be very messy to administer. Licensees will not use it very often. You can always say, why didn't you plan better, why didn't you do this or that.

MR. COOL: That is correct. Did I address the sorts of questions you wanted to address under this planned special exposure?

MR. CARROLL: Yes. I understand what we're talking about.

MR. COOL: Okay.

[Slide.]

MR. COOL: Individuals under 18 years of age who are working summers or something at a laboratory type job, something like that, the current Part 20 also has provisions for minors. They were 10 percent and they continue to be 10 percent, so you have 10 percent of whatever the adult limits would be, the total effective dose equivalent and similar 10 percent values in terms of skin, AI dose in the extremities and also a limitation of 10 percent of the values for the annual limits of intake for those individuals. This is an additional measure of protection.

MR. LEWIS: I believe -- I may have forgotten the exact numbers -- that your eye limit is lower than child

sitting in front of a color television set receives, if he sits there for a thousand hours a year. I believe that's true.

MR. COOL: That's possible. It's going to depend on how close your kids sit. If they're like mine and they try to cram themselves into the T.V. set, that's true.

MR. LEWIS: Well, the standard for color t.v., I think, is 5 centimeters or something like that.

MR. CARROLL: This is sort of an old pet peeve of mine on minors. It's probably something you might want to emphasize in talking to the Regions. I have been burned a few times by having contractors come onsite and having laborers work for them or guys that are high school dropouts that are not quite 18 years of age. You just don't pick this up very readily.

I think licensees have to be very careful with this one, and really have to have some positive controls to avoid this sort of thing. You also get yourself into a discrimination kind of issue here. Why can't I work on this job if it's somebody out of a union hiring hall? I'm 17 and a half and you're telling me I can't work on this job because I can't take the radiation exposure.

MR. COOL: You're quite correct in the identification of the issue. That hasn't changed from the new to the old rule, in fact.

MR. CARROLL: I know.

MR. COOL: This may be an opportunity where we can increase everybody's level of awareness with regard to it.

MR. CARROLL: Yes. I'm simply saying that I have been cited for --

MR. LEWIS: In fact, that raises a question I never thought about before, but the legal definition of a minor has no contact with the physiological definition of a child. So, one wonders if, for health purposes, one might not defer to physiology instead of law.

MR. SHEWMON: The basis for this is that children are growing faster or will live longer and therefore you don't -- or which or both or neither?

MR. COOL: You can get a little bit of both, I think. This would get back to something we are putting out earlier. Somebody was asking the question in a different context: was there any provision to avoid using younger people because they would be more likely to still be in their reproduction age and have a longer period of time for the radiation to show up.

Here is one case where there has been and the revision continues, an additional measure of protection for someone who is still fairly young.

[Slide.]

MR. COOL: Now, to the very, very young, negative

numbers in terms of months, perhaps, the limits for the embryo/fetus, which is a limit which is applied to a declared pregnant woman. Right there we need to stop and have a definition.

A declared pregnant woman is an individual who has come formally to her employer, in writing, and stated that she is pregnant.

MR. WILKINS: That has nothing whatsoever to do with whether she is pregnant.

MR. COOL: In a sense, that is correct. It may very well be correlated, but you bring up a point which is, if a woman chose for various reasons -- she wanted to get ahead in her career, she didn't really believe what was said in terms of risk of radiation -- for whatever reason -- she feared job discrimination -- and didn't come and tell her employer specifically, in writing, that she was pregnant, then the licensee would not be under an obligation to abide by the special dose limit, even if, perhaps, she were obvious.

Now, a licensee, I think, would be well advised to remind her of the information that's available, but, per se, the legal obligation is not there. Undoubtedly, this will be tested and we will be in the courts eventually. The whole protection of the unborn, not only from radiation, but from a wide variety of chemicals, is an area which has been

and is presently in the court system.

MR. CARROLL: This all presumes that she has been instructed as required by --

MR. COOL: By Part 19; that's right. The effects of radiation are one of the topics that are to be addressed there, and you have to make the assumption that she has that knowledge. There is a regulatory guide specifically dealing with the sorts of information that a woman should have in terms of effects on the unborn and some of those hazards.

The does applies over the entire period of gestation, a half a rem. There is additional wording on whether --

MR. CARROLL: What do you do in -- you say the dose is for the full period of gestation. She comes to you at Month 2 and says, hey, I'm pregnant and I have received one rem last month. Where do we stand?

MR. COOL: The rule contains a specific provision that allows an additional .05, if she is in a situation where she is, in fact, already over that particular limit.

MR. CARROLL: An additional .05?

MR. COOL: Additional .05.

MR. WILKINS: After she knows about it?

MR. COOL: After she notifies. You're exactly right, that would be a Catch 22 situation for the licensee.

MR. WARD: How are we doing on time?

MR. CARROLL: This is going to end at 9:30. He mentioned that there's another speaker.

MR. COOL: That's Dr. McGuire in the next session, yes.

MR. WARD: This is for information. This is all finished and a rule has taken effect and everything.

MR. CARROLL: We're just getting smart.

MR. WARD: We only have a limited amount of time to spend on that sort of thing.

MR. WILKINS: You may recall that I asked earlier about this subject.

MR. COOL: Yes.

MR. WILKINS: Let me say that this slide answers the question that I had.

MR. COOL: Good, I'm glad we succeeded, for once, in helping you out.

All right. As I was starting to mention, in addition to that half rem, there is some wording which encourages licensees -- it's not a requirement, per se -- that the dose should be delivered at relatively uniform rates.

Someone had mentioned earlier -- I think perhaps it was Dr. Shewmon -- that when cells are dividing very rapidly, they are more radiosensitive. In fact, there is very good evidence that says between Weeks 8 and 15 of

gestation, is a very highly sensitive time in terms of the embryo/fetus.

We really would not be very happy if the whole half rem were delivered in that particular period of time. Technically, they would be in compliance, but in the spirit of protection, perhaps, we would not be very happy.

MR. LEWIS: I thought that the evidence for that particularly narrow period of sensitivity was persuasive but not conclusive. Have I got the right word? That's from the atom bomb survivors.

MR. COOL: That's mostly from the atom bomb survivors.

MR. LEWIS: There have been fairly detailed talks about it and it's a bump on the curb, but it's by no means a conclusive effect. Am I wrong about that?

MR. COOL: No, I don't think you're wrong. There's virtually nothing about the radiation effects that you could pin down with the positive statement, this is absolutely conclusive. There is good evidence, there is persuasive evidence. I think probably you've characterize it about right. It has been sufficiently persuasive for a limit of this type of be included in the Federal guidance for occupational exposure, which was signed a couple of years ago by the President, to be included here. And our rule, NCRP has it; ICRP has it, and in fact is looking at a

slightly different number with its revised recommendations.

MR. LEWIS: I was only reacting to the fact that you said it is a fact that we do have to keep our personalities as regulators separate from our personalities as scientists.

MR. PETERSON: Let me add an amplification of that, to the uniformity of the exposure. And it has to do something with the biological effect that you don't want it all delivered during the critical period, but you have a very difficult time determining when that critical period is, because of the difficulty in determining the exact time of conception, so that you really don't know how many weeks, you could be several weeks off. So that's one thing.

Now, the NCRP has a distinct recommendation for a 50-millirem per month dose. But we felt that, from a regulatory point of view, that means if they are 45 millirem one month and 55 millirem the next month, they would be in violation for one month, when in fact the average dose is about 50 millirem.

Averaging 500 over nine months works out to about 55 millirem a month. So we achieve the same purpose, without a strict monthly limit.

MR. LEWIS: I had no problem with the regulatory end. I just didn't want us to fall into the trap of believing that, because we regulate according to the given

assumption, the assumption is true.

MR. COOL: All right.

[Slide.]

MR. COOL: We'll move on to the members of the public.

The old Part 20 had carried an implicit value of .5 rem per year. And it was couched in terms of this would be a value which the NRC would approve if it was proposed by licensees.

The revision contains an explicit limit, total effective dose equivalent, summation of internal and external. at .1 rem.

In addition, there is a provision which would allow licensees to come in and petition for use of a .5 rem value for limited periods of time. And there is certain specific information they have to provide to us in terms of what they're doing to keep doses as low as possible, how long the situation might need to exist, and various things.

This particularly may be the case for some installed teletherapy units in hospitals, where, over the years, they have tended to design their shielding to the .5 rem value. And until such time as they go back and look at what the occupancy is, and those sorts of things, they can't really be sure, if the inspector walks in the door, that they would be in compliance with the new limit. That's why

there is the continued provision. It does match up.

MR. LEWIS: I just wonder, is there a scientific basis for going down from 500 millirems to 100 millirems, or is it pure prudence?

MR. COOL: This is prudence, also in keeping with the increased risk factors from radiation.

MR. LEWIS: Not at that level.

MR. COOL: Well, --

MR. LEWIS: There's no evidence, zero evidence at that level.

MR. COOL: You're in the linear hypothesis assumption, that's right.

MR. LEWIS: But zero evidence. So it's pure prudence.

MR. COOL: It is prudence in the establishment, and in keeping with the national and international recommendations on the subject.

MR. LEWIS: I understand. But again, I'm trying to separate scientific facts from the regulatory guidance.

MR. COOL: All of which is prudence.

MR. KERR: Does it concern you that this is inconsistent with Appendix I of 10 CFR 50?

MR. COOL: No, because in fact, I believe Appendix I of 10 CFR Part 50 is an ALARA standard which falls within the overall limit, and therefore, it follows the scheme of

total limit, subsidiary limits based on ALARA, and I believe does fit in terms of the overall scheme.

MR. KERR: What evidence is there that a similar ALARA -- because Appendix I simply said if you stay within these limits we will define that as ALARA -- why couldn't you do the same thing here?

MR. COOL: If I knew enough information about each class of licensees to define what was ALARA for each of them, then it might be possible. But what is ALARA, and that is the last slide that I was going to put up here, so maybe we should --

MR. LEWIS: Can I ask a question before you get up to that?

MR. COOL: All right.

MR. LEWIS: And you will think this is whimsical, but only because it is slightly whimsical. But if I'm a licensee with a plant in Denver, and I hire someone that requires them to move from, say, Los Angeles, where the friend to my left lives, to Denver, he'll pick up an extra more than 100 millirem. Am I in trouble?

MR. COOL: No, because what you've done is you've changed his background, and that's outside the definition of Part 20.

MR. LEWIS: No, no. I've caused an additional exposure to this individual for occupational reasons.

MR. COOL: You caused an additional exposure, yes. You've caused an additional exposure, but he also has the option of choosing that exposure when he comes up to Denver to ski, and various other things. It's not as a direct result of your occupational exposure.

And here we're limiting what we define as occupational exposure as above and beyond the background you, by virtue of your licensed activities, are contributing to the individual.

But you're quite right, that his radiation risk has gone up because you've moved him to Denver.

MR. LEWIS: That's right. So you've caused it through your plant. It's just that you haven't provided the radiation.

MR. COOL: And of course that's true whether the plant you own is a plant which uses radioactive material or a plant which produces sporting goods, or most anything else; you've induced an exposure.

MR. WILKINS: If you flew him to Denver from Hong Kong at 40,000 feet --

MR. LEWIS: At sea level is more than 100 millirem more than it is in Los Angeles, as a combination of cosmic rays and the ground.

MR. WARD: Denver is sea level?

MR. LEWIS: Denver is hot.

MR. WARD: Down in a mine, yes.

MR. PETERSON: I think the point is Denver has a higher terrestrial and a higher cosmic radiation component.

MR. LEWIS: That's right.

MR. PETERSON: And therefore, Denver, quote, "at sea level," if it were at sea level, would still be higher.

MR. LEWIS: That's correct. No, that's why I picked Denver. I was being malicious.

MR. COOL: Our friends in the Uranium Recovery Field Office thank you.

[Slide.]

MR. COOL: The last side I was going to put up dealt with ALARA, to get back to Dr. Kerr's question.

The old Part 20 contained a hortatorical licensees should reduce exposures as low as reasonably achievable. That's not very inspectable. You can't really cite against a "should."

The revised rule contains a more explicit provision, a "shall." But that "shall" is in the context of using procedures and engineering controls to ensure that doses are as low as reasonably achievable.

ALARA, as a philosophical construct of reducing exposures as low as you can get them, is something that you can't ever really pin a particular number on, because that may be changing over the course of time. We may learn in a

few years, and make a new widget, which is able to reduce exposures. If that's reasonable, then you want to use that.

What we are looking for here, and what we believe is an enforceable provision, is that licensees have in place the mechanism, both in terms of their procedures and in terms of installation of equipment, to reduce exposures and to examine that on a periodic basis as one part of their radiation protection program. That's an enforceable provision, but not any specific number.

MR. CARROLL: To the extent practicable.

MR. COOL: To the extent practicable.

MR. WILKINS: I don't know how that's enforceable. It's a judgment.

MR. COOL: There is a certain measure of judgment as to whether installing the $100,000.00 piece of equipment is practicable or not, I suppose.

MR. LEWIS: I find it amusing that you've removed the word "reasonable" in order to substitute "practicable," when "practicable" is to achieve something which is "reasonable," because you've left the word "reasonable" in.

MR. COOL: ALARA itself is "as low as reasonably achievable." Yes.

MR. LEWIS: You put it in quotes.

MR. COOL: Yes.

MR. PETERSON: "Practicable" has two components.

It's practical, that means you can do it; and then there's an economic component that it's cost effective to do it. That's implicit, the difference between practical and practicable.

MR. LEWIS: I understand that. But the point is that you say the practicable, in order to achieve as low as is reasonable, reasonably achievable. You've left the word "reasonably" in.

MR. PETERSON: Yes. that's the terminology.

MR. LEWIS: I know. I just wonder what you've accomplished.

MR. SHEWMON: Don't ask us why; it's our policy.

MR. LEWIS: It's certainly a longer sentence.

MR. COOL: That concludes the specific presentation that I had. In the minute and a half or so that we have before 9:30 I will be glad to try and answer any other questions, in addition to what we've already discussed.

MR. PETERSON: Let me make a comment just to answer the last remark regarding what the new definition of ALARA does.

One, it's a "shall," so it is enforceable.

It relates to "shall have program" so there is something definitely there to inspect.

It departs from the proposed rule. The proposed

rule said shall be as low as is reasonably achievable and of course didn't define it. We spent five years back in the mid-'70s defining that in Appendix I for power reactors so we really would have had to do that for every other application.

What we are really looking for is the process and the intent, as evidenced by actions taken by the licensee rather than some absolute minimization.

MR. KERR: By the way, you didn't define it for power reactors. You defined it for the emissions for power reactors.

MR. PETERSON: That's right.

MR. KERR: Other exposures from power reactors to the public are not covered.

MR. LEWIS: I don't quite understand regulating intent. You are supposed to be regulating exposure.

I would have been happy if the revised rule had just left out the word "reasonably" and said, you know -- I don't know. I can't think of a decent word either -- and you haven't either.

MR. CARROLL: What does the future hold in store? What -- it took us 30 years to revise Part 20. What future revisions are under consideration?

I know hot particles is in that category.

MR. COOL: Hot particles is certainly in that

category. You are correct. This revision doesn't do anything with regard to hot particles.

My group currently has an additional contract with NCRP looking at their further recommendations on particles off of the skin.

We know that ICRP is preparing a report on skin biology so there are a number of factors which will come into play so hot particles is one thing.

We know that ICRP is about to publish a revised set of recommendations. They had been working on a revision of their Publication 27 for a large number of y s. We expect that to be in print probably about March. That will not change the fundamental framework but it will change some of the numbers.

The Federal agencies as a whole and NRC is strongly participating in this through the Committee on Interagency Radiation Research and Policy Coordination, that group under the Executive Office of the President, has already put together a sub-panel to look at the new recommendations and provide some sort of identification of issues.

The Environmental Protection Agency has already indicated that it will probably within the next few months re-initiate its Federal guidance group on occupational exposure once the ICRP recommendations come out.

When we have moved through that particulr process as a whole for Federal agencies, then we will once again be at a place where we can consider whether some specific modifications are needed to Part 20 for dose limits.

We do not envision needing to go through and do a wholesale revision once again.

MR. CARROLL: Does anyone else have any additional questions? We're a little over time.

[No response.]

MR. CARROLL: If not, I would like to thank Dr. Cool.

MR. COOL: Thank you very much.

MR. CARROLL: It was an informative presentation.

MR. WARD: Thank you. Let's take a break until 15 of 10:00.

[Recess.]

MR. WARD: We return to Mr. Carroll for the next topic, "Licensing Requirements for Large Irradiation Facilities."

MR. CARROLL: Okay, well, as you recall at the last meeting someone on the Committee expressed an interest to get a little education on the subject of large irradiators. To that end we are going to hear from the Staff on the subject.

Steve McGuire is going to make the presentation.

Did you have some additional material in Tab 8 of your binder and a handout?

[Slide.]

MR. McGUIRE: Thank you. I am Steven McGuire from the Radiation Protection and Health Effects Branch in the Office of Nuclear Regulatory Research.

I am going to talk about today large gamma irradiators.

[Slide.]

MR. McGUIRE: The thing I guess that prompted this meeting was a rule that was published in the Federal Register last month, December 4th, 1990, not 1991 -- that was just an attempt to see if you would pick up a fine point.

MR. LEWIS: I was going to ask you who won the war!

[Laughter.]

MR. WILKINS: He'd probably say Yugoslavia.

[Slide.]

MR. McGUIRE: In connection with this rule, because it is a fairly long one -- it runs 25 pages in the Federal Register -- it is a whole new part, we are having a public meeting to discuss it.

We are inviting the irradiator licensees, operators, and other interested people, state regulators as

well, to kind of go over the rule, talk about the details, the fine points.

That will be in Rockville next month.

[Slide.]

MR. McGUIRE: Now I am not going to talk really too much about the regulation itself because I was told that you were interested more in just irradiators in general, okay?

I am going to start off by talking about the types of irradiators, first of all, four types.

Panoramic is the adjective that we use to say that there is a beam that shoots out in a room. The wet-source storage means that the sources are stored in a pool of water when they are not irradiating wnatever you want to have irradiated.

Dry-source storage meets that it is kept inside of a shield basically in air.

The difference between the two and the reason for using a pool is that the very large sources that you have for a commercial facility, what you'll want is a large array with perhaps six feet tall and perhaps at least six feet wide, an array, a rack covered with sources. It is really not practical to have something of this size in a kind of a dry shield because the shielding requirements would be just too difficult.

The dry-source storage is for smaller sources where you are going to be sending out a more limited beam rather than, say, a 360 degree of radiation.

These would look more like a teletherapy unit, if you are familiar with those, where you have a source inside a large shield. You open a shutter and it beams out with a limited direction.

An underwater irradiator has the sources in the pool but the sources never rise out of the pool. Instead of to irradiate the product that you want irradiated rather than lifting the sources into the air, what you do is you drop whatever you want irradiated into the pool, move them down to the sources.

This of course presents -- it is inherently less dangerous from the point of view of an employee walking into the radiation room when the source is exposed.

A self-enclosed irradiator is a device where -- it is smaller -- in which there is no possibility of a person actually becoming irradiated, so that it will have a chamber inside and opening the door will automatically close the shutter so that there is no possibility of a person being irradiated.

When you open the door there is no radiation present in the chamber. Then closing the door will allow the shutter to be opened through a mechanical interlock.

This is not covered by the regulation.

These tend to be -- well, we have described the regulation as covering large irradiators and give the criteria for those.

[Slide.]

MR. McGUIRE: Irradiators covered that could expose a person to a dose of 500 rads in one hour at one meter; well, these self-enclosed irradiators are -- inherently, you can't get one meter away from the source because of the geometry of the situation. Underwater irradiators, however, we cover. One could argue whether the person could get down to the source, perhaps, by diving, but, just by definition, they are covered in this regulation.

The main difference is that the panoramic and the underwater type are basically large facilities; they are large buildings. The self-enclosed tend to be something, a device which you can -- they'll be heavy because of the shielding, but something that sits in the corner of a room. You buy it as a device. You buy a model of such and such an irradiator.

The other categories that are covered are something where you basically build the facility from scratch. Now, the sources that they use; the most common is Cobalt 60. The second most common or really about the only

other one that's ever used with isotopes is Cesium-137.

The quantities of the materials that are generally used -- these are for the large commercial production irradiators, would be between half a million and 15 million curies. Another possible irradiation source in an irradiator is to use an accelerator or an X-Ray machine.

These are not regulated by the NRC, because they don't use radioactive materials. They are regulated by OSHA and the states. This one, of course, is not subject to the requirements of the rule.

Now, the uses of irradiators: the main use, about 85 percent, is for the sterilization of medical products, so that surgeons' gloves, which have to be sterile, might go through an irradiator. The sutures or the thread that they use to sew up wounds might be irradiated. Basically, anything that they want to be sterile.

With the gloves, what they will do is package them first in a plastic container and then put them in the irradiator and give them a dose which will kill all the germs. Then it will remain sterile until the plastic bag that it's in is opened up, unsealed.

MR. CARROLL: What sort of dose is required for that?

MR. McGUIRE: I think what they're looking for is about 3 million rads. These are heavy, big doses.

MR. WILKINS: They know, of course, that, empirically that that doesn't destroy the gloves or the packaging.

MR. McGUIRE: Yes, that's correct. Actually, these facilities are also regulated, not only by the NRC but by the FDA which checks very carefully to make sure that they deliver precisely the right amount of dose. Their concern is quality control on the dose, so they will be checking dosimeters that go in with the gloves to make sure that they're not receiving too much which would destroy or perhaps ruin the rubber gloves, or too little, which would not sterilize the product.

The other main use, aside from sterilization, is to induce chemical changes, such as polymerization. For example, there's in Virginia, an underwater irradiator and they impregnate wood for flooring with plastic resin type material and then irradiate it. What this does is, it makes the plastic much harder so it can be used in very high traffic areas like airports and lobbies of office buildings, this type of a process.

Food irradiation is the third potential use. You can kill trichinosis in pork, for example, and other insect or pests of that type. There's very little of this being done in the United States at the present time. In fact, I don't think there's any being done on a commercial basis

right now.

The Department of Energy has been authorized by Congress to start a program of about 6 irradiators that would be for food irradiation, but that's still in the process of being developed and none of those are -- I don't believe any of them are under construction yet, but it's possible that that is outdated information.

MR. CARROLL: You said, "in the United States." Is it being done elsewhere in the world?

MR. McGUIRE: Yes.

MR. CARROLL: To a great extent?

MR. McGUIRE: Yes.

MR. SHEWMON: Where?

MR. McGUIRE: Europe, India, China.

MR. SHEWMON: Western Europe or Eastern Europe?

MR. McGUIRE: Western Europe. Do you know what countries?

MR. McGUIRE: Not offhand.

MR. BAGGETT: My name is Steve Baggett. I helped Mr. McGuire in this rule. On the issue about foreign countries, primarily China and UK does some, Russia does some and the Belgium area. What they do -- I think the Swedes were doing some to some degree. They're looking for prolonged shelf life because refrigeration is not available, so they're dose rates are much higher than what they are in

the USA, and actually for potatoes and things like that that they're irradiating.

Canada, as well, if you consider them a foreign entity, there is about 100 -- I think Mr. McGuire will get to this and show you the number of the facilities in the world that are commercial like this. Most of them are outside of the country, okay?

MR. WILKINS: I thought that at one time the military, the U.S. military, had an interest in food irradiation; has that disappeared?

MR. McGUIRE: Do you know, Steve, about that?

MR. BAGGETT: That industry is very slow right now. One of the problems with it is that I guess the freeze-drying came into effect and it's a little easier to digest a piece of pork that turns kind of green after irradiation, after long shelf life. So, they're looking really for edibility of the food, so the freeze-dry superceded that.

The Department of Agriculture does most of that research in that area and with fish, it's the Department of Fisheries. They are still doing some irradiation for persons who have basically immunology deficiencies where they can't be exposed to any type of infectious germ or anything, so they will irradiate the food and give it to that. I think some of the astronauts in these space shuttle

missions have tried irradiated food, some of the earlier ones.

MR. McGUIRE: Another area is research on the radiation effects and they tend to be large doses. Some of it is military, some of it is just material science type studies. Medical uses: the National Institutes of Health, for example, has about 11 irradiators in use.

I must admit that I don't know enough about the medical field to know exactly what they --

MR. KERR: I know of one medical application that's sort of interesting; that is, the irradiation of cartilage and bone which is used in bone transplants and, in some cases, the cartilage even in cosmetic surgery.

MR. SHEWMON: What's the advantage of irradiating cartilage?

MR. KERR: Rather than heat it, to sterilize it. This doesn't damage as much.

MR. SHEWMON: Out of the body?

MR. KERR: It's done out of the body, yes.

MR. WILKINS: Prior to putting it into the next body.

MR. McGUIRE: Another minor use is sterile insects, fruit flies that are released, for example.

MR. CATTON: Most of California's sterile fruit flies come from Mexico. Do they do that in Mexico?

MR. KERR: Yes. I could assure you they do.

[Slide.]

MR. McGUIRE: The number of irradiators in the United States of the large commercial production ones that irradiate large volumes of material where basically they're a conveyer type of a system, there are 38 presently operating in the United States. Fourteen are licensed by the NRC; 24 are licensed by Agreement states.

Then the smaller irradiators that are covered by this rule but which are basically research type of reactors, the ones for example that National Institutes of Health would be in this one and Bethesda. Here we have the AFRBI, I guess Armed Forces Radio-Biology Research Institute has one. University of Maryland has a research irradiator. National Bureau of Standards. Harry Diamond Laboratories. The Department of the Army. These are just some of the local ones.

Worldwide, this is the large commercial production irradiators. There are about 160 as of a year or two ago in 46 different countries.

[Slide.]

MR. McGUIRE: Now I will show you a diagram of what a -- this would be the large commercial production type of an irradiator.

It's really not much to it. It's basically inside

of a concrete room, concrete on the ceiling. It's typically about six feet thick, pool. The large ones that will use pool storage. The source rack will be at the bottom of the pool. It will be pulled up by a motor when they want to irradiate the product in the room.

This is a roof plug for putting in new sources. Cobalt has a five year half-life so they have to every few years replenish the sources. They'll pull the roof plug out, drop a cask down into the pool, and then using manipulators under water take the sources out of the shipping cask and put them on the rack and if they want to return spent sources they'll put those back in the shipping cask and pull it out again when they are done.

MR. SHEWMON: The irradiators are some cobalt-rich alloy inside a hunk of stainless steel or stainless steel cladding or what?

MR. McGUIRE: Yes. Yes, basically, exactly -- they'll double encapsulate them but it's basically a piece of stainless steel rod inside side of a stainless steel cladding.

MR. SHEWMON: These can be reused several times?

MR. McGUIRE: Do they reuse them, Steve? I don't know.

MR. BAGGETT: You mean reuse taking the source and raising it up and down or --

MR. SHEWMON: No, just after it's been there for five years and they want to do something to it, they can put it back in the reactor and activate it again?

MR. BARRETT: They typically do not do that. It is sent back to the manufacturer for storage.

MR. SHEWMON: Thank you.

MR. McGUIRE: Now what we have got over here is a maze for entering. This is for shielding purposes, of course. There is a door over here which will have various interlocks that I'll describe a little bit later.

When this is operating, typically there will be a set of conveyers, packages going in and packages coming out, so that this maze during operation will be totally blocked so that you, with only just a few inches of clearance between the walls, and basically the packages going from the floor to fairly high, so that if the product is in here there would be no way that a person could actually get into the room -- just because it would be blocked.

In order to enter the room, they would have to clear out the product on the conveyor first.

I am going to talk a little bit more, as I say, later on about the access control because that's probably the most important safety feature of this, in addition to this they'll have a water purification system over here and this is a ventilation system.

The ventilation system's because ozone builds up in the room and if when people want to enter it they have to clear the ozone out first in order to meet OSHA requirements.

MR. CARROLL: Then that is a control panel?

MR. McGUIRE: Yes -- well, it is a control panel. They tend not to have viewing windows. This one has no viewing window.

MR. CARROLL: Okay. What are the things on the walls? TVs?

MR. McGUIRE: Generally you can't see in there at all. Generally there is no visual thing.

There will be a -- I don't know exactly what these are. Do you know?

MR. BAGGETT: The small box on the right is a high radiation flashing light. The radiation area when the sources are up, the light flashes.

The box to the immediate left is a switch in where the calibration and the instrumentation is kept so that they test the equipment before they go into the room.

It has a kill switch as well as a lock key on it.

It is the first phase of getting in the door.

MR. CARROLL: All right.

[Slide.]

MR. McGUIRE: The most significant potential

radiation hazards are an overexposure to a person who might walk into the room while the sources are exposed.

The doses are enormous and you can get a lethal exposure in a matter of seconds if you walk into the room while the sources are exposed.

The second most significant potential hazard would be a leaking source.

I am going to talk now about some of the incidences, accidents that we have had.

MR. CARROLL: What leaks from a source? As I understand it, we're talking about cobalt-rich stainless steel that's been irradiated and encapsulated.

MR. MCGUIRE: There is surface corrosion on the cobalt which will dissolve in water.

MR. BAGGETT: What we mean by leakage is when the capsule fails.

MR. CARROLL: Yes, I understand.

MR. MCGUIRE: Or cesium.

MR. WILKINS: Water leaks into the capsule and dissolves whatever is there and comes back out again?

MR. KERR: Yes. You can see cobalt-60 in the water. We have a small source and you can see it.

MR. MCGUIRE: We will talk a little bit more about leakage after we talk about over-exposures.

MR. WARD: But that's what you mean by leakage, you

mean contamination leakage, not radiation leakage because of defects in the shielding or something, is that right?

MR. MCGUIRE: Correct. That's correct.

MR. WARD: Why isn't that a problem, what I call radiation leakage?

MR. MCGUIRE: Well, it could be a potential problem. They have to make, after they build the shield they have to do a survey.

MR. KERR: Water has no holes in it. That's the reason it is not.

MR. WARD: Well, these aren't all underwater things.

MR. MCGUIRE: They will raise them out of the water.

MR. KERR: But then what you get is not leakage.

MR. BAGGETT: Typically, these buildings are very large concrete structures, and they're built to some building codes, I think will be discussed, that will withstand quite a bit of impact.

We have in, I guess, the operational history of X-number of years, since the '40's and '50's, have never seen a concrete crack to develop and external radiation exposure.

[SLIDE]

MR. MCGUIRE: This was the first serious over-exposure in the United States. An operator walked into the

room with the source exposed. He saw it, and he turned around and quickly went out.

He suffered acute radiation syndrome that was not fatal. It was estimated to be somewhere in the 150 to 300 rems range.

The root causes. There was no automatic access control system. I'll describe that, really, on the next slide.

This was the accident that really convinced the United States, the manufacturers, the regulators, and really world-wide, that this was a necessary precaution.

The alarm system had been turned off. Procedures were not followed. For example, using a survey instrument. And the worker was fatigued. He had been on duty for a long time.

The remedy in Part 36, and actually is something that has been really implemented for many years now, was the extensive access control requirements. I'll go over these.

[SLIDE]

MR. MCGUIRE: Now, for the most part these are not new with Part 36. They're really in the existing Part 20. When the Part 36 goes final, what we'll do is just delete them from Part 20, and leave them entirely in Part 36.

There is a requirement that there be a door or a physical barrier so that you -- not just an open maze. That

would be not acceptable.

If the door opens, there must be automatic source retraction. In other words, an interlock on the door that will automatically cause the -- if it's pool irradiator, the source to drop into the pool. Or, if it's dry source storage, the source to retract into the shield, or a shutter to close.

There has to be a single key to open the door and to operate the source, so that the key is in the control panel to activate the source once that, in order to open the door, to unlock the door, the operator has to take the key out of the control panel, and this will automatically cause the source to drop back into the pool. He can then walk over and then unlock the door.

There has to be a back up light.

MR. CARROLL: Is the practice to use very unique keys?

MR. MCGUIRE: Yes. And to have control. There should be only one key.

MR. CARROLL: Obviously. It's not a common key that some guy, for convenience reasons or whatever, could go down to the hardware store and get a new one made.

MR. MCGUIRE: No. Aside from the interlocks on the door, there has to be a back up device that will, if a person attempts to enter, that it will also sound an alarm

and it will also automatically cause the source to retract into the shielded position.

MR. MICHELSON: Are all these provisions designed with certain kinds of redundancy rules in the circuitry and that sort of thing, and the reliability of power supply, so that when power supply doesn't cause several interlock features to be lost? Are there any rules at all on how you design this? Or, do you just make such provisions all on a single track system?

MR. BAGGETT: They are not on a single track system. They are independent systems.

MR. MICHELSON: Are there requirements that they be independent systems, separate power supplies, that sort of thing?

MR. BAGGETT: We did not particularly spell it out.

MR. MICHELSON: Well, how do you know they are, then? Or, how do you know they will be in the future.

MR. BAGGETT: Well, in part of the licensing there is a Regulatory Guide that explains the need for this. You know, there's an interpretation of what's --

MR. MICHELSON: But there is no necessity of spelling it out here?

MR. BAGGETT: Well --

MR. MICHELSON: Because Regulatory Guides are

guidance but not requirements.

MR. BAGGETT: Typically, to meet these parameters -- and there's a parameter for power failure that you can't access the facility until power is restored, which means the door has got a physical bolt that holds it shut until the power comes back on and all these safety systems will in fact check themselves.

MR. MICHELSON: You mean it requires power to extract the bolt?

MR. BAGGETT: Right. That's typically it, or to gain access.

MR. MCGUIRE: There is no requirement that there be a back up power supply. There is a requirement that, if the power is off for more than several minutes, that the source will automatically retract.

MR. MICHELSON: Is it conceivable that the winching arrangement can hang up and not reinsert, even though there may be indications, because of a power supply failure or whatever, that you thought it was reinserted?

In other words, on loss of power, does it give you the reinsert signal, reinserted signal.

MR. BAGGETT: On loss of power, yes. It's supposed to let the sources go back to fully shielded position.

MR. MICHELSON: Do mean it naturally, by gravity,

reinserts them?

MR. BAGGETT: Gravity. Most system -- well, there are two types of systems. One is the pneumatic --

MR. MICHELSON: But gravity doesn't always work. It depends upon what's gone wrong with the system. It might have even caused the loss of the power, such as a motor burn-out.

MR. SHEWMON: They could tell you what kind of system.

MR. BAGGETT: They have basically a pneumatic system. When there is no power to it, it bleeds off the air and the system drops, the cable operated.

There is also an electric wench that has a clutch in it, much like an elevator, except it doesn't have the brakes that an elevator does in case of power failure. It just drops naturally.

There are cases where it hangs up. I think Mr. McGuire will talk about those in a few minutes.

MR. MICHELSON: But there are apparently, from what you said much earlier, there's no requirement that I'd be able to visually confirm that the thing is inserted. Is that correct?

MR. BAGGETT: That's correct.

MR. MICHELSON: That seems like a kind of a fundamental and a simple thing to provide, a periscope or

whatever, to visually inspect that the source is really reinserted.

MR. BAGGETT: I guess, in practice, it's not as easy as it seems. You've got to put another hole in the shielding. There's streaming coming out.

The source is what -- well, in the answer --

MR. MICHELSON: Well, a periscope is easy to design, so streaming is not a problem.

MR. BAGGETT: It ruins mirrors.

MR. MICHELSON: Oh yeah. [illegible] protect the periscope when you're not using it [illegible] that's easy enough to do. It seems like the fundamental thing is to just look to see if it's in before you go in the room, and you can't do that. You have to depend upon instruments and interlocks and everything to protect you.

Apparently, if you open it and it isn't reinserted, you're dead.

MR. MCGUIRE: No, not quite. Not quite. The other thing is that --

MR. MICHELSON: Well, death against agony.

MR. MICHELSON: Well. Basically, the sources are also basically surrounded by these, uh, the product being there. So, just looking into the room you wouldn't see anything.

MR. KERR: Carl, almost invariably you have a

labyrinth. You'll notice that a the radiation survey upon entry is required. I know the facility we have it's 10,000 curies, it's small. In fact, you can't see the thing for two stages of the labyrinth, but you can see radiation.

MR. MICHELSON: Enough shine to tell you something is wrong.

MR. KERR: Immediately. So, if you do carry an indicator instrument, at least that's one additional protection.

MR. McGUIRE: Going on, I will kind of slip down to here.

This is your last control to make sure that, indeed, all the indicators that you have are telling you the right answer. There is a required radiation survey upon entry.

I was talking about the back-up device. This could be something like, most typically, a pressure mat on the floor, where if, somehow, the source -- if the door has been opened and the source hasn't retracted, for some reason, there will be an independent back-up device, where any pressure on it will cause the source to automatically lower and will cause an alarm to ring.

There will also be a source position indicator, and there will be a radiation monitor in the room which will tell you the levels that are in there.

The way we have really handled loss of power, aside from this -- you know, the source is supposed to retract -- is that there -- it's basically on the basis of emergency procedures, and it's not so -- which would include a survey.

It wouldn't be very attractive to enter the room. The emergency procedure would be don't enter the room. There would be no reason to go in. There would be no lights in the room if you've lost power, and in addition to which you would have the carriers, the conveyors, basically, blocking the maze.

[Slide.]

MR. McGUIRE: Let me go over a few of the other accidents that would happen.

The second one, also in New Jersey, at another facility, worker starting the shift entered the room while the door was opened, assuming the source was not exposed.

This was, again -- even though the '74 accident convinced people that there had to be this automatic source retraction, it was not in effect at this time.

This worker suffered acute radiation syndrome, but again, it was not fatal.

The interlocks had -- the interlocks, basically, had been by passed -- it looks like I left out a word there -- so that they could open the door.

This, of course, is a gross violation of the regulations.

The warning light source position indicator was obscured from view by construction activity, and the procedures were not followed.

MR. WILKINS: This reminds me of a question I wanted to ask about the earlier accident.

You said it was not fatal. Are these individuals still alive in 1990?

MR. McGUIRE: Well, I don't know. They were alive years afterwards.

MR. WILKINS: What I am leading up to is maybe there are some long-term effects which took 10 years, 15, 20 years to manifest themselves.

MR. McGUIRE: In one of these cases -- I think it was the '74 one -- the worker was -- he was about 70, wasn't he, Steve? He was fairly old. He may not be alive.

Yes, there may have been long-term effects.

MR. SHEWMON: It's harder to establish cause of death, anyway.

MR. WILKINS: Yes, unless he was shot by a jealous husband.

[Slide.]

MR. McGUIRE: Those are the only two accidents of this nature that we have had in the United States, and we

actually have had no inadvertent injuries of this nature since the current access-control requirements became a regulation.

But I am going to discuss a few accidents that have happened in foreign countries. There have been several fatalities outside the United States.

Italy, 1975: This was a food irradiator. Maintenance was attempted on a conveyor belt system while the source was exposed, which is just a -- with the current requirements, it would be mind-boggling, inconceivable, but it did happen. And the operator, as he was trying to fix the conveyor belt, the guy says, okay, move it backwards, and he moved it forward and moved the guy under the beam, with fatality being the result.

Basically, with the access control requirements that we have, the idea of going into the room with the source exposed is just totally unacceptable.

[Slide.]

MR. McGUIRE: Norway, 1987. Maintenance worker opened the door and entered the room with the source exposed, and he died.

There were two locks on the door, but there was no automatic source retraction. One was disconnected due to a malfunction in the system previously. A second door, the switch that should have kept the door closed malfunctioned.

There was no back-up entry control system, no alarm to alert a person that he was entering with the source exposed.

MR. LEWIS: Part 36 has no remedy, because it doesn't regulate Norway.

MR. WILKINS: On the other hand, the 1977 accident in the United States had occurred several years earlier. Didn't the Norwegians learn anything from our experience?

MR. McGUIRE: Apparently not.

MR. WILKINS: This man didn't, anyway.

[Slide.]

MR. McGUIRE: Okay. We had, I guess, about two years ago, in El Salvador. A jam-up of boxes on the conveyor system knocked off several -- the source off the source rack onto the floor.

The operators entered the room to clear the jam while the sources remained on the floor. As such, they received a very un-uniform irradiation.

Normally, these irradiators are set up to give a very uniform radiation field. In this case, it was basically the 1 over R-squared point source type of an irradiation, so that they had extremely high doses to their feet and legs but not above that.

Nevertheless, one operator died. The legs had to be amputated off another. The third one had radiation burns, and I don't know if there was any followup on that.

Do you know, Steve, whether he had amputations?

MR. BAGGETT: I don't know.

MR. MICHELSON: Which devices will prevent this from happening in the future, in the case of the U.S.?

MR. McGUIRE: Let me go back to the access control.

MR. MICHELSON: You still get the radiation level when you went in the door.

MR. McGUIRE: In this case, the automatic source retraction wouldn't do it. He has -- basically, in the regulation -- I didn't mention it -- there is a source shroud that is required that basically protects the sources from being run into by the product being irradiated. So, that was --

MR. MICHELSON: That's one way.

MR. McGUIRE: That's one way.

A second way is there is a radiation monitor in the room. Now, they had one, but it was inoperable. Basically, this facility was crumbling.

Another way would be a radiation survey meter. They had a survey meter, but it wasn't operable, also.

So, basically, they've got -- what I heard was that the Government had been notified about this, and they said don't bother us. We've got a civil war running. We can't worry about things like this.

Is that, Steve, about what you heard?

MR. BAGGETT: That's about right.

MR. McGUIRE: The manufacturer was ALCL, they went down there to essentially put the sources back.

MR. WARD: They went down there to take their nameplate off, probably.

[Laughter.]

MR. McGUIRE: There was gunfire in the area, continually, as they were working and they just wanted to get out of there.

MR. WARD: What kind of facility was it? What was being processed here?

MR. McGUIRE: Medical stuff, which the country felt it desperately needed, bandages and things like that. It's not really a good example, because it was occurring in the midst of a civil war, really.

[Slide.]

MR. McGUIRE: Last year in Israel, a product jammed on a conveyor system and the operator entered the room, intentionally bypassing the interlocks and a fatality resulted.

MR. LEWIS: On that one -- I have been thinking as we go through this. I would really disagree with the root cause -- correct me where I'm wrong -- because the interlock was deliberately bypassed in this case because he had a

reason. If I had to count all the times I've deliberately bypassed an interlock to accomplish something, I'd be out of my ability to count.

MR. WARD: You are not licensed, though.

MR. LEWIS: The point is that interlocks are to avoid inadvertent entry into something that's hazardous, and you should bypass them if you have to get in there to do something. You just adopt other cautionary procedures when you do.

Every time you fix a television set, you bypass an interlock to get into the inside of it, so I wouldn't call that a root cause. Bypassing an interlock without knowing what you're doing, is a bad thing to do.

MR. WILKINS: That's a human factors issue.

MR. LEWIS: Pardon?

MR. WILKINS: That's a human factors issue.

MR. LEWIS: That's right.

MR. KERR: I think that the root cause was that they had a gamma radiation facility in El Salvador. I can't attribute it to that. Maybe it should have been in El Salvador.

MR. LEWIS: I am just reacting to bypass interlocks as a sort of root cause that's running through all these things. It's not necessarily a bad thing to do, per se.

MR. WILKINS: I wonder about this particular one, because it seems to me that products with conveyor belts, things are going to jam. You've got to expect them, every now and then, to jam.

So, what should they have done?

MR. LEWIS: Well, they should have bypassed the interlocks, taken an exposure meter with them and minimized their exposure, presumably.

MR. SHEWMON: Or they should have lowered the source.

MR. BAGGETT: Let me interject something here. In the United States, anyway, we've had one case in New Jersey in a facility where they did administratively bypass interlocks. The man was criminally prosecuted and just got out of jail here last year.

I don't think there's any NRC inspector that would not cite a facility for bypassing an interlock. The licenses are very strict. They have to be operational if you're going to use that piece of equipment.

If they want to do service, then they have to come in with the extra administrative procedures that you're talking about, administrative controls and training and experience.

MR. SHEWMON: In any of the cases where we've seen interlock bypass, if they had lowered the source, then they

could have gone in to clear the fault.

MR. LEWIS: That's my point.

MR. SHEWMON: Fine.

MR. McGUIRE: These are basically the worldwide serious accidents with irradiators.

[Slide.]

MR. McGUIRE: The other potential hazard that I talked about was leaking sources. We've had irradiators in the U.S. -- four cases, spanning a number of years. Three of them were with Cobalt and one with Cesium. The cesium, because it's more soluble, released the largest quantity of activity into the material -- into the water.

They estimate 4 to 10 curies as the latest estimate. Now, that came from a single source that was 50,000 curies. I guess the total amount in the irradiator was 10 or 15 million curies.

MR. SHEWMON: This is the cracking of the cladding, the stainless steel that is enveloping these?

MR. McGUIRE: No. It was a hydrostatic rupture, basically. There was a crystal change -- well, they're not entirely sure exactly what happened. They are still studying it.

My interpretation of what they are trying to tell us or seemed to be arriving at, is basically that the material, due to impurities that were in it, underwent a

crystal change which caused it to expand. When water freezes in a pipe, it expands and cracks --

MR. SHEWMON: I thought that was a sequence of events, and I couldn't see why they fire extinguisher would affect crystal structure.

MR. McGUIRE: These were four different events.

MR. BAGGETT: This 1988 event is the Georgia facility, the RSI and the WESF capsules. The current situation with WESF capsules, DOE has required their total recall. We won't see any reoccurrence of that event.

MR. KERR: You said that it was the Georgia event that involved what?

MR. BAGGETT: The facility was located in the state of Georgia. It was called RSI. DOE had supplied WESF capsules which were from Hanford encapsulation storage facilities. These things were relatively 50,000 curies.

The changes that Mr. McGuire is talking about are the actual radioactive material itself within the cladding, the double-encapsulated stainless steel which basically ruptured.

MR. KERR: Thank you.

MR. McGUIRE: In these other instances, in one case, the sources tend to be long and skinny and in this case, it was bent and it caused the cladding to crack. In this case, a fire extinguisher was discharged into the pool

because of a fire caused by welding sparks in the facility.

Immediately afterwards, Cobalt contamination was noted. Perhaps some sort of cracking occurred. They never really did -- they just removed the sources and never really did pinpoint what happened.

Again, another one in 1976, they never really found out what happened in this case, too. It may have only been surface contamination or it was a source with a loose cap which they removed, and that got rid of the problem.

However, in these accidents, if I try to compare these in severity with the access control, had large exposures and fatalities, there's been no exposure of the public and not even a millirem, and the highest worker dose -- this was in the case of one cleanup worker -- was .25 or a quarter of a rem over a year's worth of cleanup work. We're not talking about large doses resulting from these leaks because we basically contain them pretty well.

[Slide.]

MR. McGUIRE: I will now move on to the precautions against leaking sources.

The first is prevention. We have -- the seal sources are designed to be rugged. We have performance specifications for that. Double encapsulation.

We have controls on pool water purity to prevent corrosion and we have a source shroud to prevent conveyor

carriers from banging into the sources and perhaps damaging them in some way.

For detection of leaks, we also -- we're looking -- if we fail to prevent it, we're looking for early detection. So we have basically daily monitoring of the pool water in the case of the pool. This usually will be done by putting a radiation detector on a demineralizing system on the pool water purity system.

In the event that we do detect it, we -- we look for a containment. There's a pool liner, so that contaminated water doesn't go into the ground. It's pretty much confined within a shielded room. Of course, there are emergency procedures that basically call for the room to be closed off until decontamination efforts can start.

MR. CARROLL: Are these liners designed like spent fuel pool liners, where you can -- the liner stands off from the well of the cavity and you can sample for leakage and that sort of thing?

MR. McGUIRE: No, we don't go to that extent for these.

MR. CARROLL: The experience has been pretty good with liner integrity?

MR. BAGGETT: Well, what we do is a check for, I guess, leakage is, they monitor the amount of water that goes in and out of the pool and if they suspect a leak,

that's when they start taking, I guess what you'd call ground water samples investigation.

MR. McGUIRE: We're talking about, you know, less -- well, there's a lot of material in there, but this water is usually pretty clean, so, we're not as concerned with water leaks as they are fuel.

MR. CARROLL: Do they typically have installed monitoring wells around a facility like this?

MR. McGUIRE: No.

MR. CARROLL: If you did have an incident, you would sink some wells?

MR. McGUIRE: What did they do in Georgia, did they drill wells under?

MR. BAGGETT: I don't think they did. They basically monitored the pool to see if there was any water leakage and determined there was no leakage of water and came to that conclusion.

MR. CARROLL: That's sometimes a little tricky with evaporation taking place.

MR. McGUIRE: These are not reactors, and they don't have the same standards.

That's really all I had to say. I'd be happy to answer any -- or try to answer any other questions you may have.

MR. CARROLL: Anybody have additional questions?

[No response.]

MR. CARROLL: Okay. If not, we -- thank you, Steve, that was a very interesting presentation. It's sort of a different aspect of the nuclear industry for us and I think most of us learned something.

Back to you, David.

MR. WARD: Okay. Thank you very much.

That's the end of the record for January 1991.

[Whereupon, at 10:44 o'clock a.m., the meeting was adjourned.]

REPORTER'S CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission

in the matter of:

NAME OF PROCEEDING: 369th ACRS Meeting

DOCKET NUMBER:

PLACE OF PROCEEDING: Bethesda, Maryland

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.

Marilynn Estep

Official Reporter
Ann Riley & Associates, Ltd.

10 CFR PART 20 REVISION

Presented to the Advisory Committee
on Reactor Safeguards

January 11, 1991

Dr. Donald A. Cool, Chief
Radiation Protection and Health Effects Branch
Office of Nuclear Regulatory Research
(301) 492-3785

10 CFR PART 20 REVISION

Implementation Schedule

- Rule Effective shortly after publication
- Draft Regulatory Guides issued by summer of 1991
- Final Regulatory Guides by beginning of 1992
- Final Implementation Date (NRC Licensees):
  January 1, 1993
- Final Implementation Date (Agreement States):
  January 1, 1994

10 CFR PART 20 REVISION

New Regulatory Guides (General)

- Criteria and Procedures for Summation of Internal and External Occupational Doses
- Dose to Embryo/Fetus
- Assessing External Radiation Doses from from Airborne Radioactive Materials
- Planned Special Exposures

10 CFR PART 20 REVISION

New Regulatory Guides (Specific)

Nuclear Power Plants

- Radiation Protection Programs for Nuclear Power Plants
- Control of Access to High and Very High Radiation Areas in Nuclear Power Plants

Radioactive Materials Users

- Appendix to R. G. 10.6, Rev. 2, "Preparation of Applications for Use of Sealed Sources and Devices for Performing Industrial Radiography
- Appendix to R. G. 10.8, Rev. 1. "Preparation of Applications for Medical Uses"

10 CFR PART 20 REVISION

Revised Regulatory Guides

- R. G. 8.9 (Rev. 1), "Interpretation of Bioassay Measurements
- R. G. 8.7 (Rev. 1), "Instructions for Recording and Reporting Occupational Radiation Exposure Data (including formats for "Electronic Media").
- R. G. 8.29 (Rev. 1), "Instruction on Health Risks from Occupational Radiation Exposure"
- Note: R. G. 8.13 , "Instructions to Pregnant Women" was revised in 1989.

10 CFR PART 20 REVISION

Training Plans

- Overview and comparison of revised rule with existing rule to be given to the Regions shortly after publication of final rule
- 2 day seminar style tra ing covering both general topics and topics specific to reactors or materials licensees to be given twice in each Region.
- Seminar training to be given at Headquarters, and makeup sessions at TTC

10 CFR PART 20 REVISION

Major Changes

- Greater emphasis on numerical risks
- Adopts "effective dose concept"
- Control is on sum of Internal + External Dose
- Greater equality in treatment of external and internal doses
- Explicit limit on public doses
- Explicit limit on dose to embryo/fetus

10 CFR PART 20 REVISION

Occupational Dose Limits

- Current Rule: 1.25 rem/quarter (5 rem/year)
  or
  3.0 rem/quarter and
  5(N-18) cumulative lifetime dose
  (with prior dose history)

- Revised Rule: 5.0 rem Total Effective Dose Equivalent per year

• sum of internal + external

10 CFR PART 20 REVISION
ORGAN DOSE LIMITS

- Current Rule:

Whole body, blood-forming organs	1.25 rem/quarter (5.0 rem/year)
Thyroid, Skin	7.5 rem/quarter (30.0 rem/year)
Other Organs	3.75 rem/quarter (15.0 rem/rem)

- Revised Rule: (stochastic) 5.0 rem/year *
  (nonstochastic) 50.0 rem/year *

*Total Effective Dose Equivalent

10 CFR PART 20 REVISION

Other Dose Limits

- LENS OF EYE

  current rule — 1.25 rem/quarter (5.0 rem/year)

  revised rule — 15.0 rem/year

- EXTREMITIES

  current rule — 18.75 rem/quarter (75.0 rem/year)

  revised rule — 50.0 rem/year

COMPARISION OF CURRENT & REVISED RISK FACTORS & DOSE LIMITS

	Current Part 20	Revised Part 20
Occupational Exposure Limit	external:12 rems/yr internal: 5 rems/yr total: 17 rems/yr	external+internal: 5 rems/year
Public Exposure Limit	0.5 rem/yr	0.1 rem/yr
Risk Factor	10^{-4} (ICRP 1977)	5×10^{-4} (BEIR V)

10 CFR PART 20 REVISION

Determination of Internal Exposure

- Paragraph 20.204(a) permits flexibility in methods used for assessing internal dose
- In assessing internal doses, the licensee shall use:
  (1) airborne radionuclide concentrations; or
  (2) body burdens; or
  (3) excretion measurements; or
  (4) any combination of the above.

10 CFR PART 20 REVISION

Modification of Dose/Exposure Relationships

- Dose estimates may be adjusted on the basis of measurements of:
  - physio-chemical properties (e.g. particle size, solubility)
  - behavior in a specific individual (e.g. clearance and retention).

- Concentration or intake limits may be adjusted (with prior NRC approval) to reflect measured physical and chemical characteristics.

10 CFR PART 20 REVISION

Planned Special Exposures (PSEs)

- Permit doses to workers in excess of routine annual limits under special circumstances
- Annual and Lifetime Limits on PSEs:
  5 rems per year; 25 rems lifetime limit
  (includes PSEs and any overexposures)
- Requires prior exposure history on worker
- Requires prior notification of employee
  (does not require employee to volunteer)
- Requires 30-day notification of NRC

10 CFR PART 20 REVISION

Dose Limits for Minors*

- Dose Limits for Minors who are occupationally exposed.

- Dose limits are 10 % of limits for adult workers:

whole body	0.5 rem/year	(TEDE)
skin	5.0 rems/year	(SDE-skin)
eye	1.5 rems/year	(DE-eye)
extremities	5.0 rems/year	(SDE-ext)

- Concentration and Intake Limits are also 10 % of adult workers.

*less than 18 years of age.

10 CFR PART 20 REVISION

Limits for the Embryo/Fetus

- Limits apply to the embryo/fetus of a declared pregnant woman*.
- Dose to the embyro/fetus over entire period of gestation (9 mos) is 0.5 rem.
- Dose should be delivered at a fairly uniform rate over entire gestation period and not be delivered in a few large doses.

*has formally notified her employer of pregnancy

10 CFR PART 20
DOSE LIMITS FOR PUBLIC

- Current Rule (Implicit) 0.5 rem/year
- Revised Rule (Explicit) 0.1 rem/year (0.5 rem/year limit available upon NRC approval)
- Both: EPA generally-applicable environmental standards in 40 CFR Part 190

10 CFR PART 20 REVISION
"ALARA"*

- Current Rule:
  Licensees should make every reasonable effort to maintain exposures ALARA

- Revised Rule:
  Each licensee shall use, to the extent practicable, procedures and engineering controls to ensure that doses are "as low as is reasonably achievable."

* As Low As is Reasonably Achievable

LARGE GAMMA IRRADIATORS

A BRIEFING FOR THE ACRS

JANUARY 11, 1991

STEPHEN A. MCGUIRE AND DONALD A. COOL
RADIATION PROTECTION AND HEALTH EFFECTS BRANCH
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PART 36 - LICENSES AND RADIATION SAFETY REQUIREMENTS FOR LARGE IRRADIATORS

PROPOSED RULE WAS PUBLISHED IN THE FEDERAL REGISTER FOR 90-DAY PUBLIC COMMENT PERIOD ON DECEMBER 4, 1991.

PART 36 - PUBLIC MEETING

A PUBLIC MEETING TO DISCUSS THE PROPOSED RULE WILL BE HELD IN ROCKVILLE, MD ON FEBRUARY 12 AND 13, 1991.

TYPES OF IRRADIATORS

1. PANORAMIC, WET-SOURCE STORAGE.
2. PANORAMIC, DRY-SOURCE STORAGE.
3. UNDERWATER.
4. SELF-ENCLOSED.

PART 36 - WHO IS COVERED?

IRRADIATORS THAT COULD EXPOSE A PERSON TO A DOSE OF 500 RADS IN ONE HOUR AT ONE METER.

UNDERWATER IRRADIATORS ARE COVERED. SELF-ENCLOSED IRRADIATORS ARE NOT COVERED.

COMMON RADIATION SOURCES

1. Cobalt-60
2. Cesium-137
3. Accelerators and X-ray machines

Generally, 0.5 to 15 million curies are used for commercial production irradiators.

USES OF IRRADIATORS

1. STERILIZATION OF MEDICAL PRODUCTS.
2. CHEMICAL CHANGES (SUCH AS POLYMERIZATION).
3. KILLING PESTS IN FOOD OR PROLONGING SHELFLIFE.
4. RESEARCH ON RADIATION EFFECTS.
5. MEDICAL USES.
6. STERILE INSECTS.

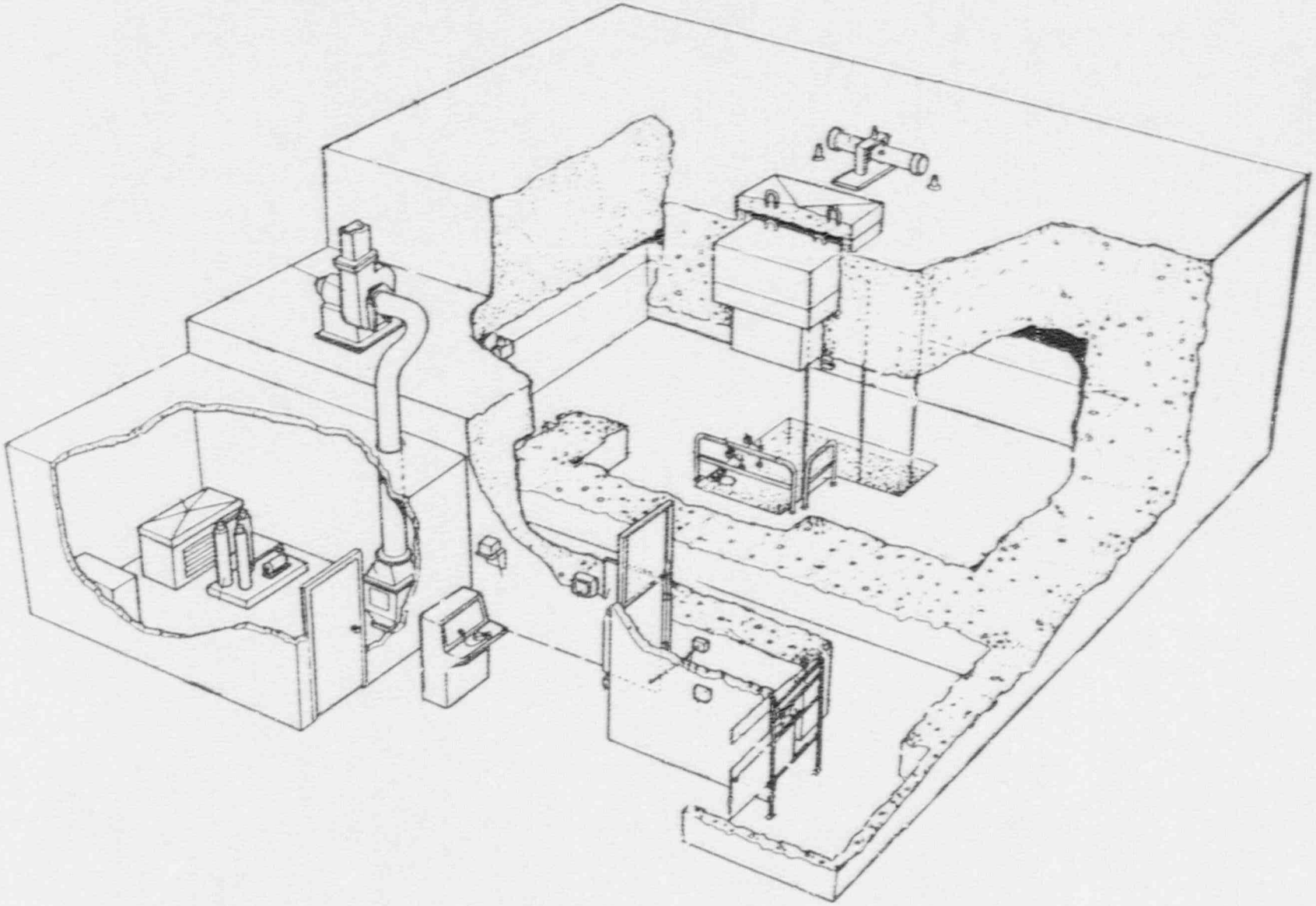
NUMBER OF LARGE IRRADIATORS

LARGE COMMERCIAL IRRADIATORS.....38
(14 LICENSED BY NRC; 24 BY AGREEMENT STATES)

SMALLER IRRADIATORS (ESTIMATE).....40

WORLDWIDE (1989) 160
(IN 46 COUNTRIES)

DIAGRAM OF A PANORAMIC, WET-SOURCE STORAGE IRRADIATOR



MOST SIGNIFICANT POTENTIAL RADIATION HAZARDS

1. OVEREXPOSURE DUE TO ENTRY WHILE THE SOURCE IS EXPOSED.

2. LEAKING SOURCE.

OVEREXPOSURE: NEW JERSEY - 1974

DESCRIPTION: Operator walked into room with source exposed, saw it, and quickly exited.

CONSEQUENCES: Acute radiation syndrome, but non-fatal.

ROOT CAUSES: No automatic access control system. (This accident demonstrated the need for automatic access control.) Alarm system turned off. Procedures not followed. Worker fatigued. On duty for 12 hours.

PART 36 REMEDY: Access control requirements.

ACCESS CONTROL REQUIREMENTS IN PART 36

DOOR OR PHYSICAL BARRIER.

AUTOMATIC SOURCE RETRACTION IF DOOR OPENS OR PERSON ENTERS.

SINGLE KEY TO OPEN DOOR AND TO OPERATE SOURCE.

BACKUP DEVICE TO ALARM AND LOWER SOURCES.

SOURCE POSITION INDICATOR.

RADIATION MONITOR IN ROOM.

RADIATION SURVEY UPON ENTRY.

NEW JERSEY - 1977

DESCRIPTION: WORKER STARTING HIS SHIFT ENTERED ROOM WHILE DOOR WAS OPENED ASSUMING SOURCE WAS NOT EXPOSED.

CONSEQUENCES: ACUTE RADIATION SYNDROME, BUT NOT FATAL.

ROOT CAUSES: SOURCES WERE EXPOSED WITH INTERLOCKS AND DOOR OPENED. WARNING LIGHT OBSCURED FROM VIEW BY CONSTRUCTION ACTIVITY. PROCEDURES NOT FOLLOWED.

PART 36 REMEDY: ACCESS CONTROL REQUIREMENTS.

ITALY - 1975

DESCRIPTION: MAINTENANCE ATTEMPTED ON CONVEYOR BELT SYSTEM WHILE SOURCE WAS EXPOSED. OPERATOR MISTAKENLY MOVED CONVEYOR BELT FORWARD INSTEAD OF REVERSE, MOVING THE MAINTENANCE WORKER INTO THE BEAM.

CONSEQUENCES: FATALITY RESULTED.

ROOT CAUSES: ENTRY INTO THE ROOM WHILE THE SOURCE WAS EXPOSED.

PART 36 REMEDY: ACCESS CONTROL REQUIREMENTS.

NORWAY - 1982

DESCRIPTION: MAINTENANCE WORKER OPENED DOOR AND ENTERED ROOM WITH SOURCE EXPOSED.

CONSEQUENCES: FATAL.

ROOT CAUSES: ONE AUTOMATIC DOOR LOCK HAD BEEN DISCONNECTED DUE TO MALFUNCTION. SECOND DOOR LOCK FAILED DUE TO MICROSWITCH MALFUNCTION. NO AUTOMATIC SOURCE RETRACTION DEVICE. NO ALARM TO ALERT PERSON ENTERING.

PART 36 REMEDY: ACCESS CONTROL REQUIREMENTS.

EL SALVADOR - 1989

DESCRIPTION: A JAM-UP OF BOXES ON THE CONVEYOR SYSTEM (CAUSED BY THE USE OF OLD AND DAMAGED BOX CARRIERS) KNOCKED SEVERAL SOURCES OFF THE SOURCE RACK. OPERATORS ENTERED THE ROOM TO CLEAR THE JAM WHILE THE SOURCES REMAINED ON THE FLOOR.

CONSEQUENCES: ONE FATALITY. LEGS AMPUTATED ON ANOTHER OPERATOR. RADIATION BURNS ON A THIRD OPERATOR.

ROOT CAUSES: DEFECTIVE BOX CARRIERS WERE USED. INTERLOCKS WERE BYPASSED. NO SURVEYS WERE MADE. IN-CELL RADIATION MONITOR INOPERABLE.

PART 36 REMEDY: ACCESS CONTROL REQUIREMENTS.

ISRAEL - 1990

DESCRIPTION: Product jammed on conveyor system. Operator entered room by bypassing interlocks to clear jam.

CONSEQUENCES: Fatality resulted.

ROOT CAUSES: Interlocks bypassed.

PART 36 REMEDY: Access control rquirements.

LEAKING SOURCES

YEAR	ISOTOPE	DESCRIPTION
1974	Co-60	Source damaged in handling.
1976	Co-60	Occurred after fire extinguisher was discharged into pool.
1976	Co-60	Research irradiator. May have been surface contamination or due to a source with a loose cap.
1988	Cs-137	Source ruptured due to change in crystalline structure due to thermal cycling.

SUMMARY: NO EXPOSURE OF PUBLIC. MAXIMUM WORKER DOSE WAS 0.25 REM.

PRECAUTIONS AGAINST LEAKING SOURCES

PREVENTION	PERFORMANCE SPECIFICATIONS FOR SEALED SOURCES.
	DOUBLE ENCAPSULATION.
	POOL WATER PURITY CONTROL TO PREVENT CORROSION.
	SOURCE SHROUD.
DETECTION	DAILY MONITORING FOR LEAK DETECTION.
CONTAINMENT	POOL LINER.
	EMERGENCY PROCEDURES.