HR - 13

HOUSE OF REPRESENTATIVES

COMMONWEALTH OF PENNSYLVANIA

MEMO

May 2, 1979

SUBJECT:

TO: Members,
Select Committee - TMI

FROM: Honorable James L. Wright, Jr.
Chairman

I have revised the scheduling of the first two hearings of the Select Committee - TMI, as follows:

Thursday, May 3rd	10 A. M. Organization and Rules (Majority Caucus Room)
	2:30 P. M. - Dr. Warren F. Witzig, Professor and Department Head of Nuclear Engineering, Penn State University
Friday, May 4th	10 A. M. - Tour of TMI - #1 Reactor (Committee members and staff, Select Committee)

Metropolitan Edison is providing a bus for the tour. The bus will depart from the back of the Capitol at 10 A. M.

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COMMONWEALTH OF PENNSYLVANIA

HOUSE OF REPRESENTATIVES

HOUSE SELECT COMMITTEE - THREE MILE ISLAND

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Verbatim record of hearing held in the Majority Caucus Room, Main Capitol Building Harrisburg, Pennsylvania, on Thursday,

May 3, 1979

2:30 P. M.

HON. JAMES L. WRIGHT, JR., Chairman
Hon. Bernard F. O'Brien, Vice Chairman
Hon. Nicholas B. Moehlmann, Vice Chairman
Hon. Eugene Geesey, Secretary

MEMBERS HOUSE SELECT COMMITTEE - THREE MILE ISLAND

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Hon. Reid L. Bennett
Hon. Kenneth E. Brandt
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Hon. John E. Scheaffer
Hon. C. L. Schmitt
Hon. Ted Stuban
Hon. Noah Wenger
Hon. Paul J. Yahner

ALSO PRESENT:

Fred Taylor, Counsel
Marshall Rock
Joe Miller
George Ellis
Peg Foran

Reported by:
Dorothy M. Malone

CHAIRMAN WRIGHT: With your permission, we will call the afternoon session of the Select Committee on Three Mile Island to order. We are having a little technical difficulty with the slide carrousel. The engineers in charge tell me it will be solved in a few minutes. Somebody said there is a bubble in it.

With your permission, I would like to return for a few minutes to the subject we addressed this morning. The Secretary of the Committee, Representative Gene Geesey, and our legal counsel, Fred Taylor, when they were putting the amendment into the suggested rules found some problems with the language and they have suggested a change and at this point I will turn the discussion over to Representative Gene Geesey, who will address the subject.

REPRESENTATIVE GEESEY: Rule five as amended reads as follows: All witnesses shall be encouraged to present a written statement prior to the hearings in accordance with the schedule established by the Chairman.

As you recall, we inserted be encouraged. Rule six, as it presently stands, reads as follows: The Committee shall have the power to postpone the testimony of any witness who does not submit a written statement prior to the hearing at which the witness is scheduled to appear, in accordance with these rules and the orders of the Chairman.

All we are suggesting that the Committee do is to consider, and hopefully approve the deletion of the first sentence that I have just read in rule six. So that the rule then will read after amended, all written statements submitted without personal testimony shall be included, etc.

This way rule six would conform with that done in rule five and that is all we are trying to do.

REPRESENTATIVE BENNETT: I don't know what you said, but I guess it is okay.

REPRESENTATIVE GEESEY: Rule five, as approved this morning, all witnesses shall be encouraged to present a written statement prior to the hearing in accordance with the schedule as established by the Chairman. The Committee shall determine if the witness will be permitted to read into the record a previously submitted written statement. We added shall be encouraged.

Rule six, as it presently stands and approved this morning says, the first sentence, the Chairman shall have the power to postpone the testimony of any witness who does not submit a written statement prior to the hearing at which the witness is scheduled to appear, in accordance with these rules and the orders of the Chairman.

All we are doing is suggesting that that first sentence just read in rule six be deleted so that rule six then conforms with rule five where we added shall be encouraged to present.

Do you remember the discussion that everyone could not present a written statement?

The rule six, if you approve the amendment, would simply read, all written statements submitted without personal testimony shall be included in the record of the official proceedings of the Committee either by verbatim or by reference to the files of the Committee.

REPRESENTATIVE BENNETT: That is exactly what it says right now.

REPRESENTATIVE GEESEY: Pardon.

REPRESENTATIVE BENNETT: That is exactly what it says right now.

REPRESENTATIVE GEESEY: I know, but I want to delete the first sentence in rule six so it conforms to rule five.

CHAIRMAN WRIGHT: I think Reid's problem, maybe I have the same problem, the piece of paper we now have in front of us, is that your suggested final language?

REPRESENTATIVE GEESEY: That is the suggested final language.

REPRESENTATIVE BENNETT: Oh, okay. That is what I am reading.

MR. TAYLOR: If I may, just to explain what we did, this morning prior to making the amendment suggested by the Committee on rule five, rule five read all witnesses shall present a written statement, a mandatory. Now, a requirement that all witnesses are to present a written statement. Since that was amended to our provision in our rule six this morning says the Committee shall have the power to postpone the testimony of any witness who does not submit such a mandatory written statement.

This morning we amended rule five and said, all witnesses shall be encouraged to present a written statement. Since it is no longer mandatory for them to present a written statement, it would not be fair then for the Committee to have power to postpone the testimony of anybody who did not submit a written statement. Therefore, we are eliminating sentence one of rule six. But still allowing sentence two of rule six, which would read, all written statements, etc. In the case of persons who do not wish to personally appear, they can submit a written statement which we can put into the record verbatim or by reference.

REPRESENTATIVE BENNETT: Mr. Chairman, I have no problem with that. My problem was that this was handed to me and it was said to me that these are the rule changes that we adopted, which we did, indeed, adopt completely as you have them. I have no problem with that and so move that we adopt these amended rules.

REPRESENTATIVE O'BRIEN: I second it.

CHAIRMAN WRIGHT: Moved and seconded, any objections.

(No response.)

CHAIRMAN WRIGHT: So be it.

It is our pleasure to have with us this afternoon Dr. Warren F. Witzig, W-i-t-z-i-g-, who is a Professor and head of the Department of Nuclear Engineering at Pennsylvania State University. I explained to the good doctor that his role this afternoon was to give us some instructions regarding nuclear power. That I, perhaps one or two other members of the Committee, did not know how to spell the word nuclear much less understand the difference between a boiling water system and a pressure system. The good doctor was very kind and said he had trouble spelling nuclear.

He has extensive experience in Reactor Research

Testing and Design including employment with the Westinghouse Research Laboratory, the Manhattan District Project and the Knolls Atomic Power Laboratories.

He spent twelve years as a Reactor and Physics Manager at Westinghouse - Bettis and seven years as Senior Vice President and Technical Director of NUS rporation, Co-Founder.

Committee assignments include past Chairman, IEE (Professional Group on Nuclear Science), Chairman and National Committee on Public Information and National Academy of Science Committee on Radioactive Waste Disposal.

Dr. Witzig received his B.S. in Electrical Engineering in 1942 from Rensselarr Polytechnic Institute, his M.S. in Electrical Engineering in 1944 and his PhD. in Physics from the University of Pittsburgh in 1952.

Special interests include fuel management, reactor design, nuclear safety and licensing and environmental problems associated with radiation waste and thermal effects.

Doctor, we would be pleased for you to teach us something about nuclear power.

DR. WITZIG: Mr. Chairman and distinguished ladies and gentlemen, it is a privilege to be here today. I will do my best. I take the attitude back in class that if one of the members of the class does not understand what I am doing, it is my problem. So I will try to take that same attitude here today. I will try to make it as clear as I can within my abilities and within my knowledge, both of which are limited.

I thought I might start out with the general concept of talking about some nuclear power fundamentals and I want to lay a little bit of a preamble of refreshing some of the Committee's memory of what nuclear power is doing today for just a brief moment. Then we get into technical aspects of it and then, obviously, Three Mile Island is very much on everyone's mind. So we'll talk a little bit about that. I am not an expert on Three Mile Island, which always makes me reach for that definition of an expert. Somebody was telling me about it here this morning. An expert comes from that story about Woody the Woodpecker. Woody was in a woodpecker community and he wasn't making out very well. Nobody respected him and he didn't have any credibility, his peers did not think highly of him at all because Woody had difficulty in getting any kind of a hole into a tree. He just couldn't hack it.

So Woody got discouraged and left that community and went to a new woodpecker community some 25 miles away. There he started to work building his reputation in a new woodpecker community and he found a dead old tree he thought he could work on. So he started to go to work on that and at that moment it turned out that a storm came along. And the thunderbolts came down and the lightning smashed his tree that Woody was working on, really demolished it. Well his prestige in that woodpecker community went up immediately. There was nothing that Woody wasn't an expert in.

And of course, that just brings us to the definition of an expert and that is it is just any old guy who is 25 miles from home and that is kind of my category, since I am about a hundred miles from home. Here we are.

It is a privilege to be with you. If we look at society today for just a second, as background and then the energy aspect of it and then nuclear in particular. We read that the number one problem we face today is inflation and coupled with that energy so very close to it and not far behind that comes taxes, jobs and crime, and the first two, energy and inflation are very, very important. I would like to just give you a little feeling of some of the pressure that seems to be in existence in the communities today.

We take a look at the last full year, 1972, before the embargo, the last full year before the embargo and then we compare it to '78. I scribbled some notes down in here. In general, we used nine percent more energy in '78 than we did in '72. Our annual consumption is about 78 quads and we will just define that later if the Committee chooses to get into that. Energy has gone up, the consumption, from '72 to '78 by some nine percent. That is the total energy. We are not talking about electrical, just total.

If we talk about electrical, we discover, we look at the figures, that it has gone up about 26%. Remember that we had a recession in here and we had the Arab embargo where electricity production was flat for a year or two. You just divide by six and we are running about four percent a year or so increase. It used to be, in the old days, the old days meaning pre-embargo, six to eight percent a year. That was electricity increase.

We produced in oil in 1978 compared to 1972 eight percent less. According to my data, we produced for gas 13% less and coal, Pennsylvania is paramount in that, one of the paramount states, four percent increase.

Now where did all of this energy come from? Because we look and oil went down that we produced, gas that we produced went down, coal did go up a little bit, but where did we get this increase in energy, and that came from imported oil primarily and it went up to 30% on total product. If you just look at crude alone, which is only part of the total import, it is not all of it, okay, just part of it, it went up some 96%. So, indeed, we seized upon that solution.

Now, there is another number I will use, which looks very impressive, but we have got to take it in context. Nuclear actually increased by 500% during that period of time, but that really doesn't count that much, because back in '72 nuclear was a much smaller contribution than it was in '78.

In '78, nuclear produced about 12.5% of just the electrical energy, just the electrical, which in turn is about 30% of the total.

All right, if I can leave those kinds of statistics and move into the area -- with my wandering does this come across all right? I always use this as an excuse to focus the projector on. Actually, as you all know, that is Old Main Building at Penn State. I'm going to mess around with this and some of you know this symbol better than the one of Old Main. Recently, last fall the lion's right ear got chipped off by somebody with a sledge hammer. And I don't know whether you saw that picture in the newspaper, it is part of the crime problem we have in this world, the right ear was knocked off with a sledge hammer. Some coed had put a bandaid on it and a lipstick kiss. I don't know whether you saw that picture or not. It is very touching. That is a symbol and you are all familiar with the Penn State football.

I would like to say that I got the arrangement with Joe Paterno that I go out and talk about football and Paterno goes out and talks about nuclear energy. You can tell how successful I am at football because every seven or eight weekends we filled this stadium. That is a picture of the new one if any of you haven't seen it, with the cars around it. It is a rather impressive thing.

And I like to say Joe Paterno goes out and talks about nuclear reactors and here is a picture of the Penn State nuclear reactor. Let me be very specific on this point. This reactor is the only research and training reactor in the Commonwealth. It is used in just those two categories, in educational matters and training, and I know some of you people have seen that reactor. I would like to invite you all to come visit Penn State, to come see this reactor. We can give you a choice of entrees. We can give you the gee whiz tour or you can just kind of go through it in a hurry and look, or we can give you the hands on tour where you can come in and you actually create some artificial radioisotopes. You make them yourself and we actually take the machine critical and put it into operation. We have that kind of a license for instruction. Our seniors, in nuclear engineering, do have the opportunity to operate this reactor. It is one of the unique features that we have in this state. We are very, very proud of that and also very jealous of it.

But back to basics. Another kind of reactor that has been very much in the news is, of course, Three Mile Island. I would like to talk about reactors with respect to how they generate electricity, try to distinguish the difference between PWR's and BWR's particularly.

We start out by saying it is easy to make electricity. And the answer to that is, like hell it is; it is hard. Because what we have to do and if I can take the liberties of stealing somebody's pencil and walking away from the microphone, what we have to do, we have to spin a magnet in a coil of wire to produce that electricity. We spin that magnet by a little pinwheel which in this case will drive by a teakettle and our source of energy to do all of this is a fire that we have put here.

So in principle, we make the statement that it is easy. In practice it is not so easy and I would like to get into some of that practice.

Here we have characterized, here we got a cartoon, which shows that we burn some form of fossil energy to create heat. We heat a boiler with it. We are all kind of familiar with this. We boil water to create steam. We have to get rid of some of the noxious characteristics of combustion which we all have to face and so we have a chimney doing that. This water which is boiled and makes steam, goes through a steam line to a turbine, the pinwheel that we saw in the earlier slides. The turbine spins a magnet inside a coil of wire, the generator, which produces our electricity. The steam is condensed after exhausting from the turbine in a condenser and the separate condenser cooling water, which comes either from a stream or from cooling towers, supplies cool water to this condenser which in turn itself is heated then and must reject that heat.

This water is cooled, it is put through a pump and put back into the boiler. So we get a system that goes around and around with only some makeup that is necessary for leakage. It is a heat pump kind of a thing. It is just a heat engine. Here is our supply of heat and here is the electrical energy that we get out of it and here is where we dump it, this thermal energy that we have not used.

Now, in a nuclear plant it is much the same in our simple schematic sketch. In reality it is quite a bit different and it is quite a bit more complicated. We have as our supply of heat the reactor core. The reactor core in this boiling water reactor. Now this is a boiling water reactor I am showing a schematic of which is the kind that is in operation at Peach Bottom and it is the kind that is under construction at, I want to make sure I get it straight, at Limerick. Three Mile is a pressurized water reactor as is Beaver Valley, as is the original Shipping Port.

Here the core supplies heat, boils the water to steam, the steam goes over, spins our turbine, turns the magnet in the coils of the wire, produces the electricity, steam is condensed in the condenser and pumped back to the reactor. So we have basically a single system here that is in operation.

Now, if I remember my slide order properly, the next one is a bit more of a detail in those schematics. It turns out for stability in a boiling water reactor you have to pump water around in a recirculation loop, some of which, most of which, doesn't go to steam at all. The control rods are in the bottom of this design, below the reactor vessel, the core is here, the water is boiled to steam, you notice we have valves here, goes over to the turbine, comes down through the condenser, has reheaters here and these pumps then put it through these reheaters, feed heaters back into the system. So it gets a little more complicated. You notice I interject a new concept, containment, at this junction. This is one of the prime defenses in the nuclear field with respect to a barrier between you and me and radioactive fission products, which are created in the reactor core. It is one of the prime barriers. The only thing that I am showing here that is a little different is, again, this is a boiling water reactor, it is called the BWR, B as in boiling. The core is here, the control rod drives below, we boil the water, we make the steam. You notice we got a pair of valves now at containment to be very sure that we can maintain integrity should that be necessary. Steam lines, turbine, turbine generator, condenser, cooling water and pumps back into the system.

Now I have shown you the containment and some of the safeguard systems like these valves and I show you what we call the wet weld. In the event there was a very large release of steam in here, there was a break in what we assume was the -- in all of these kinds of accidents, assumptions for design purposes, we take what we picture to be the world's worst kind of thing that can happen to us and we try to design to mitigate against that containment. We said that, of course, in typical boiling water reactors, we say this pipe can break. Not only can it break and leak, but it bends itself so you got two free ends. It really can lose coolant. The steam pours out of there and it comes down into this pool here and it is condensed to keep a low pressure inside the containment and to release the driving force.

Now where do you get such an idea from? Well, that has its original concept in the first reactor, the Nautilus, and in the Shipping Port reactor, both of which, as you know, were designed and built here in the State of Pennsylvania.

At that time the designers, and I happened to be a young kid at that time running around, the designers looked to see what is the worst thing that has happened in the industry. We found out at the Springdale Plant, maybe Ivan knows where that is, the Springdale Plant of West Penn that indeed they had a ten inch pipe in a superheated steam, which was made of the improper material for the design; the quality control was not as good as it should have been and it in fact had broken, it had whipped and it had really done substantial damage. And that was back in about '42 that that accident occurred in Springdale.

That was used basically as a model. The worst kind of thing that we could picture to happen.

Now let's leave the BWR and go to a PWR, the pressurized water reactor. The one thing I should say to you is this system here is designed to operate in the vicinity of a thousand pounds per square inch pressure. It is about a thousand pounds per square inch. Now the pressurized water reactor is designed to operate at about twice that pressure in its primary system, more like 2200. The system is designed for higher pressure than that, often in the vicinity of 2500 or thereabouts. These numbers are approximate numbers to describe generically boiling water or pressurized water. Here again is our containment structure that we have gotten used to by now and the pressurized water reactor has two circuits, a primary system and a secondary system. In contrast to the boiling water reactor which has one system. The primary system is kept at high pressures so the water does not boil. The hot water comes out of the reactor vessel from the core, and you notice the rods are in the top now, comes out of the core, having been heated, it goes into the steam generator where it loses heat to the secondary system. This is a sink and a sink is a very important thing. Because if you got a heat source, you better have a sink in order to put that heat.

The water goes through the steam generator, it comes back through the pump and back into the reactor vessel. It is heated here in the primary system. It is cooled here in the primary system. The cooling comes about because I boil the water in the secondary system, make steam, take the steam over to the turbines, spin the magnet in the wires, produce my electricity, condense that steam by a separate system to water, bring it back into the steam generator. So this is the secondary system which operates at a low pressure, about 700, 600 PSI's.

In principle, almost all of any radioactivity created in the primary system has a barrier between it and the secondary system of these two in the steam generator. Okay?

BY REPRESENTATIVE O'BRIEN:

Q Doctor, is that the one in Susquehanna? Can you tell us where one of these are?

A Well Three Mile Island and Beaver Valley.

Q Are pressurized?

A Are pressurized water. The Susquehanna station, which is Berwick, a PP&L is a boiling water reactor and Limerick is a boiling water reactor and Peach Bottom is a boiling water reactor. Peach Bottom is in operation, Limerick about 50% construction, Susquehanna, I think, a little bit less. I will beg off on that.

Q You are showing us the difference between the two?

A That is right.

BY REPRESENTATIVE BENNETT:

Q Doctor, if I might, just in your first system where you are running the water from the pressure vessel over into the --

A Steam generator.

Q The steam generator?

A Yes, sir.

Q Does that water, is that a sealed unit?

A Yes, sir.

Q So that water then is in there, it never gets over to the turbine generator side of that?

A Never gets over there if there is no leak between the primary and the secondary system.

REPRESENTATIVE BENNETT: Thank you.

DR. WITZIG: You can never make anything 100% except taxes and death, I think. You can't even do that.

REPRESENTATIVE BENNETT: We are working on death.

DR. WITZIG: I wish you luck. I just hope it comes around fast enough.

Now this is a picture of a pressurized water containment and it is the typical one for Three Mile Island. Three Mile Island is not necessarily built exactly like this, but it is very close to it. Three Mile Island Unit One or

Unit Two. Let's take a look at it.

This is a concrete structure, heavily reinforced, running four to six feet thick with reinforced steel. I don't know if you have ever seen one of those things, but you cannot get a hand through it for all of the iron that is in it. And the cement sort of seems to look to me like it is a caulking, I mean, it is just -- relative to quantity, it is amazing. This is this reactor vessel that we talked about, idealized form. This is one of those pumps that takes water from the steam generator which is this long column, the once-through steam generator and over here we have got a pressurizer that became rather famous during Three Mile Island and another steam generator. So we have two loops in a typical Three Mile Island type of plant, B and W plant, which generates thermally 2772 megawatts thermally and about 800, maybe somebody can correct me, about 800 megawatts electrical. It is a significant kind of power source. It is big.

BY CHAIRMAN WRIGHT:

Q What is the difference in those two numbers?

A It is the efficiency of the system. The second law of thermodynamics says, that thou shalt not convert all of your heat to work. It says that you can convert part of it if you are real good. These systems convert about one-third.

BY MR. TAYLOR:

Q You say that is a high ratio, one-third?

A No, I didn't say that. What I said was the second law says, thou shalt not convert all of your heat to work. Typical nuclear plants run at a thermal efficiency of about 33%, 32, 34, somewheres in that vicinity. The best fossil plants run about 40% in efficiency. Now this is that primary system, remember in the pressurized water, we talked about the primary system. Okay, everybody with me? I haven't put anybody to sleep, because we let the slides on too long. All right, this is this reactor vessel, this is a control rod drive mechanism above it and this system has two pumps in it; two total primary systems, one on this side, a steam generator with two pumps, one on this side, a steam generator with two pumps.

A plant has two primary systems with the reactor in the center. Hot water comes out, goes up into the top of the steam generator, comes down through the tubes, splits into two paths, goes into two pumps and comes into the reactor vessel. Over here on the secondary side, we are boiling water to feed to a turbine, all right? The same is true on this side. The hot water comes out, goes up through the top of the steam generator, goes through and comes out into two parts, goes through two pumps, these are the electric motors that you have heard so much about, 9,000 horsepower, and comes back into the reactor vessel. So you have got two primary systems.

What do you suppose this is stuck on the side? That is the pressurizer. That serves as a cushion as you heat up and cool down. So you don't have a solid water system, otherwise, you would split it. So you'd have steam volume up here, it is actually steam and hydrogen, water in here and that is hooked onto the hot leg. It doesn't, in this schematic, show that hook. That is one of the design areas that I am sure the Committee, in its deliberations in the future as it calls in people who have been involved in that area, will want to explore.

BY REPRESENTATIVE O'BRIEN:

Q I don't see any shutoff valves in this system?

A That is correct. This is all inside the containment, sir.

Q The shutoff valves are inside?

A No, there are no shutoff valves in the primary system.

Q The reason I'm asking, I want to get familiar, they claim in the Berwick plant, Susquehanna, that this could not happen because they have no shutoff valves where they do down in Three Mile Island.

A If I can --

CHAIRMAN WRIGHT: Could we hold those kind of questions until after we finish our basic education?

DR. WITZIG: It is a valid question and if I can, some of those will come out as I proceed, Mr. O'Brien. I hope, if I am a good teacher, if I am not, you come right after me and I will try to be responsive. But that whole primary system is in containment. There are no valves in the primary system to shut off from the reactor, for example, from the steam generator.

UNIDENTIFIED SPEAKER: There is a relief valve on the pressurizer.

DR. WITZIG: There is a relief valve -- okay, now that is where we are going to get to fall apart. The relief valves, gentlemen, are on top of the pressurizer on a header. At Three Mile, as I recall, this is only recollection, it is not a fact, there is one which is operator controlled and mechanically automatic and there are two that are mechanically automatic. So those are the pressure relief valves. Yes, I stand corrected on that, but not stop valves in the sense that we showed in the boiling water reactor.

Now let's get started and head back, see these valves here? I thought you were referring to those. This is the boiling water reactor and those are valves which isolate that system from the external.

BY REPRESENTATIVE O'BRIEN:

Q Okay, would these be similar to Three Mile Island?

A That is not similar to Three Mile Island. That is similar to Susquehanna.

Q That would be similar to Susquehanna?

A Correct.

Q Susquehanna, they tell me, they don't have the valves.

A Susquehanna does not have pressure relief valves on a pressurizer, that is correct, sir. But Susquehanna does have another kind of valve. These valves that I am showing you right here. Susquehanna does not have the valves on top of the pressurizer because the boiling water reactor does not have a pressurizer. It does not have that kind of a relief system, but it has to have relief.

BY REPRESENTATIVE STUBAN:

Q What is the advantage or disadvantage of the two systems with the valve there?

A That is one that industry has been wrestling with for about 20 years. If you look at the number of sales, you will discover that Westinghouse and GE have sold the same number of plants in the country, about 26 and you will discover that combustion and B and W have sold some other ones. So there is a slight three to two kind of number for pressurized water over boiling water.

BY REPRESENTATIVE BENNETT:

Q Doctor, while you were on that slide right there --

A Back up, yes.

Q The second one, the furtherest left that we are looking at is the primary one, am I correct?

A That is correct, sir. This system right here is the primary system, the water is heated, goes through the generator and comes back into the reactor core.

Q That is what you are showing us in the subsequent slide?

A Yes, sir.

BY REPRESENTATIVE O'BRIEN:

Q Doctor, I do not want to prolong this, but I am concerned and a little disturbed because I am told that PP&L and Susquehanna, that that could not happen but you're showing me that there are valves there that if they do not open, this could happen?

A There are other valves, Mr. O'Brien, that are very important. I am not contradicting the BWR people or PP&L people. I am not contradicting them. They do not have the same kind of valves that Three Mile Island does, but they have valves. In fact, valves are the biggest problem, in my opinion, in the nuclear industry today.

We showed that primary system. Now I want to show you that steam generator because it comes to your mind what is the steam generator that he talks about. We are talking about the pressurized water reactor system, we are talking about the kind of system at Three Mile Island and you remember that the reactor coolant came over to the top of the steam generator, comes down through a whole myriad number of tubes, comes out at the bottom, splits into two coolant paths, will pump the feed back to the reactor vessel. Water comes into the secondary side, is preheated, goes through what we call nuclear boiling, film boiling, and there is slight superheating and then it comes out to the turbine. That is the steam generator which serves as a sink. It is a very important item in the Three Mile Island or any pressurized water reactor. Because it is the unit which separates the water which goes through the reactor core, and is radioactive, from the water which goes through the turbine and has only trace amounts of radioactivity in it. The primary system goes through the core and is radioactive. The secondary system does not go through the core, goes through the steam generator back to the turbine, condenses steam generator, back to the turbine condenser, like so, and has only trace amounts of radioactivity in it.

These are the cooling towers which in turn cool the condenser water and it is still a third system.

Now I just wanted to show you some quick ones. This is the turbine generator at Three Mile Island. This we took while we were on a trip through there with a class just very, very quickly. This is the generator. These are the turbine housings and this is the generator, this is the high pressure and this is the low pressure turbine, these are the turbines, and this is an electrical generator. So it is a very substantial kind of thing. You can see from a picture of the men, etc., in the photographs.

This is the picture of the control room. It is a substantial affair which requires, obviously, a certain amount of skill to handle it properly.

Now if I can return to the primary system, I am back in the primary system. I got a reactor vessel and that is a picture of the pressurized water reactor vessel. It maybe runs 26, 30 feet in height, maybe weighs 400 tons, it has got a wall thickness of about ten inches. It may be 14 feet in diameter. In it is the uranium housed in what we call a core. I have some of these pictures here that you may want to look at later. Here is a detail of a pressurized reactor vessel with its core and the control rod connections on top shows grid structures for support top and bottom. This is a very substantial kind of a piece of equipment. 400 tons. It is not small.

In Three Mile, pressurized water reactor, that core is composed of some 177 of these units. They are called fuel assemblies. Fuel assemblies, and these are installed in here when this reactor vessel head is taken off. It is under water, these are installed in here, like so.

Let's talk about those for just a second. There are 177 fuel assemblies in the reactor core. There is a lower spacer grid fitting, which goes next down into an egg crate type of an arrangement, likewise at the top, which fits into an egg crate type of arrangement. It holds the fuel assembly. That fuel assembly has, and I don't know whether it shows it on this one, I am going to make a guess, I think it is about 14 positions along here and 14 along here. So we have in here something like 200 fuel rods in one fuel assembly. Now let's start again. This is the core. We got 177 of these units.

In each one of these units called the fuel assembly, we maybe got 200 fuel rods. Now a fuel rod is like a fishing pole. It is a 12 foot pole. It is made of zirconium, zircalloy. It is an alloy of zirconium. It is about three-eighths of an inch, a half inch in diameter and it has the thickness of about 30 mils, .03 for cladding thickness. It would wiggle like this if we were holding it out. Now we put uranium pellets in that and we will come to that in a second. There are some structural supports that come down through here, there are intermediate spacers here for structure, and a control rod assembly with neutron absorbers comes down in here with long fingers that control the nuclear reaction within the reactor, within this particular assembly.

Let's look at that 12 foot long fuel rod. We are going to put in that 12 foot long fuel rod uranium dioxide, UO2. It is a ceramic that looks like this rock that I brought along for another purpose. Ceramic, like one of your ash-trays, have you got any ceramic ashtrays around? This is laying in a tablespoon. It is about three-quarters of an inch long, this UO2 ceramic and it is about three-eighths of an inch in diameter. There may be 200 of them, did I get that right, three-quarters of an inch, maybe 180 of them in this 12 foot rod. Are you with me now? We got a 12 foot rod, we got 180, maybe 200 of these little pellets stacked in them, at the end I put in a plug and I weld them up so it is tight. Then I put 200 of them into a fuel assembly. Then I put 177 of the fuel assemblies into a core. That is how we build the unit together in the core.

Now all the fissioning process takes place inside that U02. Inside the U02. And that fissioning process is very crudely the following. Some elements are like a disco dancer. The atom is always restless, it is nervous, it is always moving, sort of like me when I am talking, I never sit still. Some of those elements, when we throw a neutron into it, actually fissions, splits into two ways. One chain here, which is first is radioactive and then becomes less and less until it finally becomes stable and another chain here. It can split in some over 30 ways and can produce over some 200 different radioactive isotopes. In the process of splitting, it also produces a neutron. In fact, uranium produces 2.5 neutrons on the average. Now since we have about ten, hang on now, ten to the 20th fissions per second to produce a thousand megawatts, a large number of fissions per second, one with 20 zeros is behind it, per second. We get a good statistical basis for these things. About two and a half for uranium, 235 and about 2.9 neutron per fission for plutonium. One of these goes on and creates another fission, so we have a self-sustaining chain reaction. And the second one, usually on the average, gets absorbed in the cooling water structure, leaks out to the reflector or it is absorbed and two and a half is usually eaten up in the control rods for control purposes.

So if I can go to the blackboard here. I don't know if there is enough light on here. What we have is a U235, the neutron comes in and it splits up into two chains like so. At the same time, it emits some gamma rays, maybe a little beta and some nukes come out, about two and a half on the average. Now of these two and a half, one comes in, hits another uranium 235 which in turn splits and so we have our continual of the chain reaction occurring.

Now, I am not going to go too much into the reactor theory aspect of it. But that is a general idea, one creates another.

Now the thing I do want to touch on though is these products, these fission products, are radioactive. I want to make real sure that we have a feeling for radiation.

Like Gaul, radiation is divided into three parts. We have alpha, beta and gamma. Now what the heck are they? Alpha radiation is one of these nervous nuclei spitting out a helium nucleus or helium atom, all right. I don't want to say helium atom, I'll just say nucleus. So we will take helium nucleus. Now beta is an electron, a beta particle is an electron and a gamma particle, I am going to say is like. Notice I am saying light. I said alpha is helium and beta is an electron and a gamma ray is like an x-ray. It is electromagnetic radiation. Light, heat, microwaves, all fit into this broad category of electromagnetic radiation and these are the ones with a certain kind of energy.

Now what does it take to stop these particles? Just to give us, again, a feeling. In the case of alpha particles, a piece of paper will do it. For electrons, I was looking for one of your metal ashtrays, a sheet of metal foil will stop the electrons. Gammas are something else. The gammas require inches of lead, feet of water, concrete, and 100 or more yards of air to stop the gammas. In fact, the gammas, really in principle I can't ever say that we ever totally stop, because we just absorb a given fraction of whatever comes in. We absorb and remove a given fraction. We always leave some. It gets down so low that it disappears.

Now this is for a situation where we have a reactor here, a containment, we have a defense line and we have you or me standing here. We are talking about any kind of radiation that comes through by shining process.

Now there is one other kind of process. That is radiation can come to us if there is a release in the form of the product itself. So we release the atom out of, say, containment and let them go out on the air or on the water and then you and I can be in an atmosphere of it, like so. So the second way is through ingestion, that is breathing, eating, all right, or the direct shine on our external.

Now there are only three precautions that one can take with respect to radiation. One is distance. You know the further away you get from a light the dimmer it gets. So you get an inverse wear relationship, distance is one way you can handle radiation. The second is you can shield it. For example, these kinds of things. And lastly, is the time that you are exposed to it or the time that you allow for it to decay. So there is three things that you can do about radiation - distance, shielding and time. Those are the only tools that we have.

BY REPRESENTATIVE DININNI:

Q Could I ask a question?

A Yes, sir.

Q I notice under your protection there you did not list anything underground like a fallout shelter or anything, would that be of any kind of protection?

A Yes, shielding.

Q But your definition of shield does not fall into the category of so many feet underground?

A Water, concrete, do you want me to put earth?

Q That's very important to me.

A I am not belittling your point, sir. Feet of earth. There are a lot of materials I can use like wood, brick, lots of things, iron, water, concrete, lots of different things.

BY REPRESENTATIVE O'BRIEN:

Q What is a serious dose and when should you determine --

A Let me talk about that in sequence if I may. The first thing I want to say to the Committee, it is a good question you can ask me. That is not my field of expertise. I am not the Woody Woodpecker in that area, sir. So if you really want to have a good feeling for that, I would suggest you get Radford from Pittsburgh or you get DeLiniman (phonetic) from the University of Pennsylvania or you get --

Q Can you give us the names of some of the --

A Radford, DeLiniman, there is another guy Neal Wald (phonetic) at Pittsburgh. I'll think of it. Pennsylvania has a lot of good resources in this area. Sagen (phonetic) on the west coast if you want to get, you know, more than 25 miles away. Those men are really sharp in that area. They are very good at it. I will take a brush at it to try to answer your question. But you must understand, I am adjacent to that. That is not my principal thrust.

I think that what I would like to do at this juncture is come to, well, let me answer part of your question if I can, Chairman O'Brien. I am no radiologist, I am no epidemiologist, I can't even spell that word, but I am told by the experts that there are four gates for cancer. If I can remember correctly, the first one is that we have a genetic predisposition. Now that doesn't say it is hereditary, genetic predisposition. In other words, if your parents did not die of cancer until they were 85, it is unlikely that you are going to because that's the way you're put together. Secondly, I am told that there is some immune deficiency that we must possess because we have some ten to 20 cells in our bodies and for sure a couple of them are cancerous at any given time. So we have a certain immunity system. Thirdly, I am told that a virus infection is important, and lastly, I am told that there needs be an environmental insult.

Now that environmental insult can occur through anything carcinogenic, something we eat, something we breathe, radiation, things of this nature. But these, as I understand it, and I must repeat to the Committee, this is hearsay, are the four principal gates that are involved in cancer. Radiation, of course, is involved with one of them. As you know, radiation can cause cancer, well, I'll back off on that. Radiation is suspect as a cause of cancer. Radiation is also used in the cure of cancer.

I brought along with me some of my grandchildren's toys because I thought it might serve a purpose in reinforcing the idea that we have been trying to build up here by telling you, here are the intensely radioactive fission products and we got to keep them out of the biosphere. So I brought along my grandchildren's plastic barrels. And this first barrel I am going to call containment and inside of it I got another barrel. So the first one we will call containment. What is containment? Remember that is that four to six foot thick reinforced structure, it has got pipes through it, so it has got to have valves. Keep it tight.

The blue one I would like to call the safety system and containment. We have heard a lot about those safety systems containment. The coolers, the sprays, the sodium hydroxide, the hydrogen recombiners, the safety systems inside of containment is another barrier. I would like to call my red one the primary system and the primary system, you will recall, is the heavy steel structure of the reactor vessel, the pipes and the steam generator and motors running the pumps in there. That is the primary system, the red one, a very massive, a very thick system, which is in between you and me and the fission products.

Now I like to look at this yellow barrel as the cladding. Remember that 12 foot fishing rod that I had out there and that is that zircalloy cladding? There is the cladding, the yellow one.

BY REPRESENTATIVE BENNETT:

Q Doctor, you are saying cladding?

A Cladding, yes sir, hollow tubes, plugs welded on each end, expansion devices inside, UO2 pellets where the fission process takes place.

Here is the cladding and inside of that I have got UO2. And here is a UO2 and inside of the UO2 I have got the fission products. We've got to be careful with that. It looks like coffee to him. It is coffee. So I put out some of the fission products. This is UO2 cladding. Now UO2 is a ceramic, remember, and it will allow the volatile, the highly volatile stuff, like the noble gases will go out of it fairly readily and then they are contained inside of the cladding as long as the cladding is in tight and that is contained inside the primary system. Now we have got the safety systems in the primary. Then we got the primary system itself and then we got the safety system, the containment, and then we finally got the containment.

What happened at Three Mile Island? Well, through some design error, through some human error, hardware, we lost some of these and some of these fission products got out. That is what happened at Three Mile Island. Now that is a very general kind of a statement. But I think it is important that we get a generalized feel for what went on there. It went on in a lot of confusion.

Now, I want to touch on two more things. The Committee did not know it, but I am going to assign them some homework. As a Professor I felt that that was perhaps my prerogative. And so, Mr. Chairman, if you would distribute to your Committee members, this is a homework sheet and I would like very much for the Committee members to take it home tonight and fill it out. I have extra copies for some if they would like. This homework sheet familiarizes you with the amount of radiation that we receive in our natural environment. I don't want you to spend time on it now, I want you to fold it over and do it for homework tonight. That is not for now. If I may, that is a Professor's prerogative.

BY REPRESENTATIVE BARBER:

Q Doctor, you mentioned, you knocked one of the containers over, one of those defenses?

A Yes.

Q How could man do that?

A How does man do that?

Q Yes.

A By not following a procedure that he is supposed to follow, sir.

Q My next question then, why couldn't that --

A That is an example of human error.

Q Why couldn't that be automatic; in case he made a mistake, that we could be protected?

A This is an age-old question that the technical community and society in general has been attempting to answer, sir, and it is a tough question. We say, hey, since humans are fallible, let's go to automation. Let's put in hardware, the hardware can only do what it is supposed to do.

Q I am saying both.

A We have both now. Obviously, we are going to get done with all this and you are going to squeeze me for some suggestions or ideas and that has kept me awake last night. I am thinking, what am I going to say to you men. I have done my best and I will try to summarize at that point. But it is, hey, it is an easy question, hard answer, sir. It is not that easy.

REPRESENTATIVE O'BRIEN: I think you should stay on that with Jim Barber. That board you showed, the control room, why don't you move back to that? Why wouldn't the control room, they spend millions of dollars on it, show the flow on every operation?

DR. WITZIG: Mr. O'Brien, I think this is one of the conclusions, I think it is one of the conclusions that we are bound to come to in this and that is that the visual indications on these systems, you see, here is one. These are all visual indicators. They are not the kind of indicators that you are referring to. Actually, I believe this is the control room that actually has a little primary system on here. The answer is obviously with hindsight today that we need, what I would say, to improve our visualization for the operator, but I don't think it stops there. I think we need to improve the visualization so he has a better feeling of what is going on in this complex plant. We get into some of these circuits and piping and it becomes obvious why we have got to have really good communications. Would somebody help me here? I have for the Committee a little bit of additional information, Mr.

Chairman, that I have put together for the Committee. I think you should compliment my good secretaries. They worked like dogs yesterday after Colonel Rock had talked to me. What I put together for the Committee is just a bit of reference.

That reference consists of four sections, sir. The first one is the primary system. So if you will look in your booklet, the first tab should read primary system and it says TMI Primary System. Now this material comes directly from their final safety analysis report. Let me state to you that the licensing process is a very complex or difficult one. There are reams of paper that go everywhere. You will see in that the primary system. The next tab should be secondary system. If I encourage you to leave that and it says TMI Secondary System and then it shows a couple of diagrams for those secondary systems.

The third one is reactor containment, TMI's reactor containment. It shows you some of the schematics of the reactor containment. And the fourth one is emergency core cooling system, ECCS. Again, you will see the complexity that the operator must be able to deal with, Mr. O'Brien, substantially.

Mr. Chairman, I have got a couple more thoughts I wanted to leave with the Committee and then make up some wrap-up suggestions and stand at your pleasure for questions. Is that all right?

The next thing I want to say to the Committee is nuclear energy is unique. It is absolutely unique. We take one carbon atom, combine it with oxygen and we get a release of energy and we measure that in what we call electron volts, a couple of electron volts, as much as we can get out of it. From one carbon atom, combining with oxygen, we get a couple of electron volts. We take one uranium 235 atom, split it, have it undergo this fission process. We receive 200,000,000, 200,000,000 electron volts. What do we get for carbon? A couple of electron volts. So you are in the order of a hundred million times more energy per event, okay, a hundred million times more energy per event. It is unique. It is very unique. One of the things that I wanted to show you was that fuel consumption and then compare it to a coal burning plant that we are a lot more familiar with. Now I am not putting up or down. I am just giving the Committee the best knowledge that I possess in this area. What we have here is a table of fuel consumption and waste generators for a thousand megawatts power plant, it is a big plant, that will roughly run a city of a million people.

REPRESENTATIVE ITKIN: TMI?

DR. WITZIG: TMI is about 870.

CHAIRMAN WRIGHT: You can compare that with what at Keystone? Is that one unit or two units?

DR. WITZIG: I would say two. I am a little vague, I am not positive, I think it is two.

Fuel consumption for coal, if you got a thousand megawatts plant, it takes 8,300 tons of coal a day. Let me repeat that, 8,300 tons of coal a day for this plant.

Now actually, there are few plants that can do that well. Mostly it is more like 9,000 tons and that is the equivalent, very closely, of a unit train of 100 cars carrying nearly 100 tons per car, 90 tons a car, 100 cars. That is a lot of coal.

Uranium takes about 7.4 pounds on a day. If you would store it all in there, initially, and that is one of the things that makes it efficie . In waste production the coal, if you got ten percent ash, you would have 830 tons. I am not a coal man, but when I go to Montoursville and PP&L they tell me they run about 14% ash. When I asked what they got down at Keystone I think they told me it was around 12% ash. So this is a low number, this 830 tons. About ten percent of that would go up the stack, 83 tons, except if they put in electrostatic gatherers and then only maybe one percent will go up.

So you get about eight tons. Remember that coal has trace amounts of uranium and its decay products which are radioactive. Uranium generates about 64 pounds, some six pounds of it is intensely radioactive fission products we talked about. We have got to keep those out of the biosphere. It is not a debatable subject. The low level waste is about 58 pounds and you will notice it is most of this waste. The low level waste, the low level waste is the kind of thing that does not require all of the complicated treatment for high level waste storage.

CHAIRMAN WRIGHT: Can you give us an example or two?

DR. WITZIG: Yes. Low level waste, sir, the guys run around in the coveralls and hats and stuff, they put that on to protect them from picking up radiation which is on the wall or something like this. So then when you take those off it is contamined. What are you going to do with it? Are you going to wash them? Then it is in the water, then you got to evaporate that water and concentrate it or you can take the coveralls and simply put them in a satisfactory subsurface waste disposal area. This is, incidentally, in my opinion one of the bigger bottlenecks that is fast going to loom in the nuclear area. The Committee may wish to take a look at this particular area.

I am going to move from this slide to my next one. And I am not minimizing this problem, I want to highlight it to you. This is the high level radioactivity which must be kept out of the biosphere and if we are talking just about fission products, it takes about 700 or 800 years for that to decay, for that to decay to a level of radioactivity which is about the same as our soil now. All right, 700 to 800 years to fall away to that level of radioactivity.

Now, if you have plutonium in it, if you have it reprocessed, that plutonium has a much longer lifetime, so it takes much longer. On the other hand, that, too, can be dealt with and that is why I brought along this rock.

Here is a picture of a technician at Penn State in the Materials Research Laboratory. She is holding a rock. I call it a rock. The material science people don't like that, they like me to say mineral. Apparently there is a difference between rocks and minerals. I am not a geologist. They have successfully taken fission products that are non-radioactive, have put it in rock form and then have taken and put it at high temperature and high pressure in an autoclave, those little blue spheres inside of a gold foil for it to avoid chemical reaction and then they look for those fission products in the water that they were autoclaved in and with the most effective kinds of equipment, they cannot find them. It means they are pretty well tied up in rocks. Now the piece of rock that I wanted to bring along was one of these, but another chap was out talking and since he outranked me, I don't have that piece of rock. So what I did do is pick up a piece of slag from my living room. This is a piece of manmade rock, another kind of a mineral, just to bring it along to show you that man has been making rocks for some time.

This is one of the ways that we can get out of that problem. Now, I would like to very quickly make another --

BY REPRESENTATIVE BENNETT:

Q Doctor, you left me hanging.

A I don't mean to.

Q I don't know about the rest of this Committee. You put this stuff into a rock, what are you going to do with the rock now?

A There have been a series of studies in this area almost since I have been in the field which moves into four decades now. One has it in what I will call a form where, if ever water got a hold of it, much would not happen to it. You wouldn't get it out for we humans to get a hold of it. Once you have got it into that kind of form, there are several kinds of geological storages which, I believe, are feasible. In

March, I was out in the salt mine in Hanford where they are setting up tests to see if this isn't a reasonable place to locate these radioactive kinds of rocks that we could bury there.

To me, this is perhaps one of the areas where the federal agency has been the most derelict and perhaps to a degree, industry. But certainly the federal agency because for several decades we have had this problem. We have passed legislation on it, we have given it to agencies to do, it hasn't been done.

REPRESENTATIVE O'BRIEN: Doctor, I think what he is talking about that is over in France they do it similar to rocks, reducing it to liquid radiation into a glass form and then they bury it because it is easier to bury under those conditions.

DR. WITZIG: The French have, indeed, such a situation. The Germans have experimented with a similar one, putting it in salt. There are some indications of progress there that is a little bit further along than we are.

CHAIRMAN WRIGHT: Would you conpare the amount of commercial waste versus military waste?

DR. WITZIG: I can make a rough approximation. In volume, military waste is very much larger, in volume, at this point in time. In the total amount of radioactivity, they are not that much dissimilar. They are much the same in the total amount of radioactivity. But in volume the military waste is by volume a lot higher.

REPRESENTATIVE BENNETT: Are you suggesting then that commercially we are disposing of it better than militarily?

DR. WITZIG: I am saying commercially we are not disposing of it at all, sir. Where are the spent fuel elements from reactors today? They are inside of the spent fuel pits at each reactor. Now I ask you is that the safest place for them? And why are they there? Because federal law has said there will be no reprocessing and has said it some years ago. And despite repeated charges over several decades, our federal agencies, the people you and I send to Washington, and our tax money that goes to Washington, has not dealt with this problem. I mean, there has been renewed commissions --

REPRESENTATIVE O'BRIEN: In fact, we have that figure in our Committee on military waste and the government 'as 88% against 12%.

DR. WITZIG: That is probably right on a volume. I'm going to say it is about ten times as big.

CHAIRMAN WRIGHT: It is an interesting point on a radioactive basis that they are almost equal.

DR. WITZIG: They are very close on being within how much radioactivity you got in commercial and how much radioactivity you've got in military. That is not fair, exactly, because commercial waste is recent. So it is more intensely radioactive. This stuff has been around a little while. You know, time it gets less. Most of the military waste, we produce military waste today, but not the same volumes we used to do when we were gung-ho on atmospheric testing and all of that stuff.

REPRESENTATIVE FOSTER: Doctor, isn't it true that a lot of plants do not have enough facilities, maybe two, three, four years --

DR. WITZIG: I believe, from what I have read, that there is a nuclear plant that will run out fuel storage space in '82.

REPRESENTATIVE FOSTER: I am not so sure that Three Mile Island can go beyond that.

DR. WITZIG: I feel that it probably can. Three Mile Island has not been active very long.

REPRESENTATIVE COWELL: Doctor, is that a Pennsylvania plant or don't you recall?

DR. WITZIG: I don't recall.

BY REPRESENTATIVE COHEN:

Q Doctor, is the recency of the commercial waste, is that the sole factor, the difference between commercial waste and military waste, is that the prime factor or what?

A Yes, sir.

Q Yes it is --

A It is a prime factor.

Q What are the other factors?

A Well the other factors are how much military activity is there, how much weapon production and how much electrical power generation do we have from the commercial end. Those are the two biggest ones.

I want to move into the safety records of the nuclear field, some of the safety aspects in life in general. The nuclear field has a unique safety record today, to date, including Three Mile Island. It has the unique safety record because we have, in this country, USA, approximately 400 reacting years of operation. Reactor years, is reactor A, it has been five years, so you have five reactor years, reactor B would be ten to 12 years, you would have 12 reactor years. Now I have altogether five plus 12 is 17. So I add up all of our reactor years experience. This is commercial. When I say commercial I should say electrical production. Overseas there is about 700 reactor years and it amazes me because originally, of course, it was much smaller. But many countries today now produce more of their electricity by nuclear power than we do in the United States. You saw my number of 12½% in the U.S. in electricity. In countries like France and Germany it is up in the 20's, 25%. So they are accumulating a substantial number of reactor years. They are passing us very clearly in experience. We have in USA Navy about 1600 reactor years. You add those all up and you come up with about 2700 reactor years without any fatalities that have been associated with radiation. This kind of thing that we are all very much concerned about.

Now, let's try to put that in some perspective of the life about us as we go along.

CHAIRMAN WRIGHT: Would it be appropriate to take a break for a couple of minutes?

DR. WITZIG: Yes sir. I am about 20 minutes.

(Brief recess.)

CHAIRMAN WRIGHT: Doctor, you are back on.

DR. WITZIG: Thank you, sir. Before we left off, we were [illegible]king about safety and some of the uniquenesses of it and we were talking about the experience where we have accumulated well over 2,000 reactor years of operations, going on 3,000. Wherein the production of electricity, there has not been any overexposure to radiation let alone any kind of a fatality associated with radiation. Now there have been fatalities in plants. People have fallen off of scaffolds, people have been scalded, all of those kinds of things have happened. Those are not good. The kinds of problem that are associated with construction of any large type, but not the problems that are associated uniquely with nuclear. It can happen in a coal or oil plant or anything of that nature.

I have pulled together a series of statistics from many sources. Some place along the way here, I have pulled together a series of statistics from many sources, labor, scientific America, etc.; reasonably accurate. The probability of fatality per million people per year; all forms of disease, about 10,000 people per million die every year. That is about one in 100. There are over a hundred people in here, we know that if we came back in one year, on the average, statistically, one of us wouldn't be here. I don't know about you, but I don't plan that that be me.

Now, we have a death toll on the highway, which you are all familiar with, which is very substantial. It is one in a sociological sense, it is one of the modern tragedies of our time. They run about 265 per million people per year. Just to check it out, if we have got 200,000,000, multiply that by x amount, you come out with 52,000 people.

Falls, mostly in our home, mostly on stairways, about a hundred. Air pollution, that is interesting, that air pollution is primarily, well, the consumption of fossils, mostly the consumption of fossil fuels, either in automobiles, power plant production or chemical production. Firearms, we hear a lot about the Second Amendment. Maybe you were told you cannot bring your gun along, 15 per million per year, firearms.

Medical accidents, I always like to show this to my physician friends. Now medical accidents, six per million per year. I think the probability of dying while under anesthesia are somewhere around one in a thousand. I had some serious surgery a year and a half ago, I was a three time loser to this sort of a problem. So I asked the surgeon, I said, how many times have you done this surgical procedure? He was a little amazed, well, he said -- he though for a minute or two, I have done it about 2500 times, 3,000. I thought that was pretty good. At least it wasn't a guy who had only done it five times or a few hundred times. I had somebody who did it at least a couple thousand. I asked him, well, how many do you lose under anesthesia alone? Well, he was shocked that I even asked that question. It is a very practical question. An anesthesist better be on the ball because he can sniff you out just like that.

Electricity, about five.

CHAIRMAN WRIGHT: You didn't tell us the doctor's answer.

DR. WITZIG: He fumbled with that one. He really didn't answer that one for me. I did not have much choice.

Natural disasters, we have had that by the barrel full with the tornados, the hurricanes, etc., about one per million per year.

Lightning about a half. Radiaction about one millirem a year. This is the best estimate that can be made, about one-tenth of a person per million people per year.

Radiation accidents, probability of a fatality, comes out of Washington 1400, the famous Rasputin Report, which in recent times has come under fire. Is this still credible, some people have said -- well, the guy who wrote, it was the Chairman of the Committee who investigated it, testified that he felt that the error band should have been larger in that report, but he felt that the report probably was on the conservative side. That it portrayed a greater risk than actually existed. This was Lewis from California.

This is five zeros and a six. And even if it is off by a factor of ten, I am just portraying it for you, you get some sense of perspective in the kinds of risk that we have in society today.

Another way of looking at those risks, in the next table that I put together, that the average risk of fatality and the accident type and your individual chance per year. All accidents, all of them, on the average of one in 1600. You know, you get out the dice and you throw them. You throw it 1600 times and one blip, you got it. Motor vehicle - one in 4,000. Just stop and think with me for a minute. How many times do you close the door on your automobile in a year, meaning you are taking a trip? Do you do it once a day, do you do it twice a day, do you accumulate a thousand a year; easy? One in 4,000, gentlemen.

Falls one in 10,000. Firearms, one of the big ones, and air travel. Let me tell you a story on relative risks that just shocked me. At the time of the Three Mile Island accident there was a woman in Coburn who was very upset. In fact, she was so upset she wrote a letter to the editor and she said that living in Coburn which is from Three Mile Island, how far is Coburn, about a hundred miles, 150, I don't know. It's a hundred miles, okay. She was so upset about that and so concerned about her children and the radiation they might receive, and a valid concern, a mother should have, a father, too, that she took her children in an automobile, five of them, took them to an airport, put them aboard an airplane, put them in an airplane, moved to California where they picked up and stayed with their grandparents for a couple of weeks and flew them back. Now they picked up five millirems. What is a millirem? I can still see that in the news conference, what is a milliren? Picked up five millirems, so she did this and this to avoid this kind of thing. And that was the perception of risk and benefit that was involved. She made that decision. I am not sure that she had as much of the information as she should have had, which is one of the problems that we face.

BY REPRESENTATIVE BARBER:

Q Doctor, isn't it a fact, I can go along with that, but what bothers me is this. Maybe it would be 30,000 people killed at once if an incident would occur. That would make a difference. I think that is the fear the people have.

A This is one of the fears. And Madam Curie had an expression for that, sir. She said that the unknown is not to be feared, but it is to be understood. And that, as an educator, is the role that I am trying to take. I do not say that those fears are justified or unjustified. I am simply saying we have got to get at the root of understanding. To me that is education.

BY REPRESENTATIVE O'BRIEN:

Q What if the bubble did explode? What are you talking, would there be --

A Mr. O'Brien, I am glad you brought that up. I got the Evening News, Harrisburg, Wednesday, May 2, and it says, "Explosion risk at TMI was 'error'."

They are talking about the hydrogen bubble and on Tuesday of this week Mr. Mattson of the NRE said to the Advisory Committee and the active safeguards through the NRC, and I quote, "The chance of a hydrogen oxygen explosion in the nuclear reactor at Three Mile Island was miscalculated by the NRC, according to an NRC official who served as chief aide to Harold Denton.

Roger Mattson Tuesday told an NRC Advisory Committee on reactor safety that he and his colleagues has 'fouled up' and that 'there never was the potential for an explosion'."

REPRESENTATIVE O'BRIEN: I don't trust the NRC.

DR. WITZIG: There is more than enough blame to go around. On the other hand, let me pursue that just for a second more.

The state has a very competent nuclear engineer by the name of Bill Dornsife. I was trying, during Three Mile Island, I was up in Geisinger getting a minor surgical procedure and three x-rays and I was watching Jane Paulie run an exciting interview in Middleboro. I got more radiation up there at Geisinger for what I perceive to be a benefit risk than the nearest resident at Three Mile Island. On the other hand, I then tried to get away from some of these problems, spend a weekend at a cabin up in Ligonier and Bill Dornsife tracked me down and found me there. He was very upset about this hydrogen. We went over it together. Now, we did not have firsthand information. All we had was the information that the NRC was publishing, all right. And on the basis of what NRC was publishing we could not see an explosion problem with the hydrogen within the reactor pressure vessel in the primary system. Now, I am not talking about hydrogen in containment. I am talking about the one in the primary system. Now it does appear that there was a bubble there, it does appear that it was interfering with the flow process, but it does not appear that there was an explosion hazard.

REPRESENTATIVE O'BRIEN: I am asking the question what if it did happen, would it be worse than the China fall-out or, you know, I don't think this Committee knows enough about what radiation is, what it will do if it does explode. Let's take the worst that could happen.

DR. WITZIG: Mr. O'Brien, the what if question has been one of the hallmarks of the nuclear field. I think it has been one of the things that has made it the safest industry that we have in this country today. There are other parts of the fuel cycle that have problems in nuclear business. I am not trying to get away from any of those nor am I trying to whitewash those or put them over. They are real and they exist.

We have been looking at what if questions. I cannot answer your what if questions because I can postulate the same kind of questions in any endeavor that I take. All I can deal with is reality. I cannot deal with these other, forgive me, but tales of Alice in Wonderland. I can only deal with my barrel, I can only deal with finite things, I can deal with that kind of thing as a technical guy. I cannot deal with the what if.

REPRESENTATIVE GEESEY: Well doctor, if I may get just a little technical at this point, we then have self-confessed evidence on the part of the NRC that they overestimated the dangerous situation.

DR. WITZIG: And that is a very serious thing when one is on one hand balancing, excuse me for interrupting, sir, but it is a very serious thing when on one hand you are balancing an action like evacuation against staying put and the risk associated with either one.

REPRESENTATIVE GEESEY: What then is the possibility, or for that matter the probability, under a similar set of circumstances or something a little bit more severe of the NRC underestimating the situation?

DR. WITZIG: I think it is possible to err on either side of good judgment. Don't you?

REPRESENTATIVE GEESEY: I certainly do, but since they overestimated the situation you certainly then have to assume that they can underestimate a situation and that, quite frankly, just bothers the hell out of me.

DR. WITZIG: I think it should bother you, not only in the nuclear field, but I think it should bother you in a lot of other fields. Like in drugs, HEW, and things of that area.

REPRESENTATIVE GEESEY: It does indeed.

REPRESENTATIVE BENNETT: Doctor, would it help this Committee, it would help me, I think, if you are so disposed, would you elaborate a little bit on the famous or infamous bubble?

DR WITZIG: I am not in a good position to do that. And I am not ducking the question. All the information I have is second-hand, the kind of things that come out of NRC, etc. I have got a time sequence, give me 30 seconds more and I can go through a time sequence which has been published for Three Mile Island, if you would like it. But it is nothing, I mean -- for me, it is second-hand, you understand. I have not been at Three Mile Island. I have not studied the record, okay.

REPRESENTATIVE BARBER: Doctor, did you see the program on CBS? A doctor received the Nobel Prize and he had the fear really, I think, like you do, I think it is something we need --

DR. WITZIG: You notice I haven't said that, you said that, sir.

REPRESENTATIVE BARBER: I said that, I think you alluded to that, I am sorry if I am wrong. But did you see that particular program?

DR. WITZIG: Yes, sir.

REPRESENTATIVE BARBER: Are you familiar, I know that you should be, this famous doctor who won the Nobel Prize.

DR. WITZIG: I don't know which one you are referring to.

REPRESENTATIVE BARBER: Well they had this one that won the Nobel Prize.

DR. WITZIG: The chap that was here in Harrisburg the night after the -- the guy from Boston? Well, I will look. My answer to that is real simple. What did he get his Nobel Prize in? Was it in reactors? Was it in hardware, was it in accident analysis or was it in genetics or peace, or what was it in?

REPRESENTATIVE BARBER: I thought it was in physics.

DR. WITZIG: That may be great, but can he build a pipe and weld it? Just like, you notice, that when we start talking about cancer, etc., and any professional that moves outside of his field no longer becomes a professional.

REPRESENTATIVE BENNETT: He's an expert.

DR. WITZIG: He is an expert. So any man that moves into these areas, my wife says there is two kinds of experts. She says there is the kind of guy who works hard and studies, writes papers on it, runs an analyses and slowly over 20, 30 years he becomes an expert. And the other way is to instantly become one by opposing something. ",", Bernadette O'Sullivan, that is her attitude towards it.

Now you gentlemen have to make these decisions. You have got a weighty thing to do.

BY CHAIRMAN WRIGHT:

Q Can I pose a question I think that might have been implied? If there was an explosion, would it rupture the vessel?

A Well, let me ask you a question and I will answer yours. How much hydrogen was there? Now figure it out. Okay, a cubic foot, ten or a hundred cubic feet. There certainly is some amount of hydrogen. Suppose it was all full. We had to sit down and calculate.

Q There would be some oxygen?

A Yes, but the thing is there wasn't any oxygen on the best information that I have second-hand, there wasn't any oxygen. So why then do I postulate an explosion?

REPRESENTATIVE ITKIN: I'm concerned, I think the thing is to go back and find out if there was hydrogen, where did it come from? Now there has been some comments made to the fact that hydrogen developed through the zircalloy, zirconium and zircalloy, reacting with the water temperature pressure, you know, when the coolant dropped below the fuel assembly height and then it becomes a question as to, I am not that familiar with the chemistry involved in zirconium water reaction. How much could you form and to determine what that type of concentration might be? If it should turn out that such a reaction does generate sufficient hydrogen for an explosion. The question is whether the primary system can stand such an explosion, number one, and if it could not, the question goes back to the planning design as to whether zircalloy is the only type of clad material to be used or whether some other material could be used which does not create such a reaction or some retarding agent could be added to prevent this from occurring. I think there are a variety of questions. If there was a problem in this design, because of unforeseen chemical reactions taking place as demonstrated on the blackboard, then there are options available at least to be studied as to how to improve the clad design. I don't think we ought to get into this question now because if it is real, that can be determined and should be able to be dealt with rather effectively.

DR. WITZIG: I think that is absolutely right, Ivan, and I would agree with everything you said in that area. Hydrogen is something that must be dealt with. Now, I might also refresh the Committee, that hydrogen in a pressurized water reactor is a common thing. It is used as an overpressure, hydrogen is a normal thing. It is highly likely that the hydrogen was in that pressure vessel. It did come from this reaction. Notice how I phrase that, it is highly likely. It can also come from the radiolytic disassociation of water, but that is not too likely.

BY REPRESENTATIVE FOSTER:

Q Doctor, I think your equation there answered by question, it says that there is no oxygen present, I think by your equation the oxygen was absorbed --

A Tied up in the zirconium.

Q I understood --

A Now I say it appears there is no oxygen present, second-hand, okay.

Q Well, initially, the reports were there came about, through the disassociation of water, the breaking down of the water in the hydrogen-oxygen, did that occur?

A That will occur any time there is radiation, but the magnitude of it is very small. And in a pressurized water reactor, they do use overpressure substances like hydrogen to force that reaction back. Any of these reactions can go either way. So it depends on the chemic ondition. I can force the situation this way or this way.

Q I think that answers my question where the oxygen went.

A No, hydrogen is not an uncommon thing, it is very common in a pressurized water reactor.

I wanted to leave this thought with you and then a couple of comments, you can chew on me as long as you would like to. This is a table that was pulled together by Wilson at Harvard. It was published in the New Technology this spring, I think the name of the magazine is New Technology. Taking the best data that we have today with respect to risk, and if you are going to take a risk which increases your chance of death by one part in a million, you do that if you smoke less than two cigarettes, not two cigarettes per day, not two cigarettes per year, but if you smoke two cigarettes. You increase your likelihood of death by cancer or heart disease by one part in a million. Now, when you get down to such fine numbers, it doesn't make sense, but when you get it up into the higher numbers on a big population, it does make a lot of sense. Drinking a half a liter of wine, spending an hour in a coal mine, spending three hours in a coal mine, it doesn't matter whether we are talking about black lung or whether we are talking about an accident.

REPRESENTATIVE O'BRIEN: You mean, if I spend only an hour in a mine I can get black lung?

DR. WITZIG: You take that chance. Living two days in New York or Boston, instead of some place where there is no air pollution. Flying by jet for a thousand miles by jet, by an accident. Living two months in Denver on a vacation from New York City, cancer caused by cosmic radiation, an increase in radiation. Living two months in an average stone or brick building, cancer caused by natural radioactivity. How much time do you spend in the Capitol? One chest x-ray taken at a good hospital, cancer caused by radiation. Two days after Three Mile I got three shots. So there we go.

Living two months with a cigarette smoker, eating 40 tablespoons of peanut butter, liver cancer caused by a toxin. Drinking Miami water for one year, cancer caused by chloroform. How does it get chloroform in Miami water? As I understand it is a reaction between chlorine and hydrocarbons which exist in the water. Well, you can go on drinking, and so the nuclear kinds of accidents that are postulated here.

That is, I think, the end of what I have to say. If I can, I would like to leave that with the light and make a couple of comments to the Committee and then you can chew on me for whatever you like, gentlemen.

I got a poor crystal ball, so I don't know what is going to happen in the future. But I think if wise heads prevail in the State Houses throughout the land and if wise heads prevail in Washington, we are likely to see this kind of thing occur on an immediate basis. I made this table up about two weeks ago. Short range, which I am going to call two to three years, and then long range, which I will call till 2,000. I am a lousy prophet, but here is what I propose will happen.

You are going to see many investigations. I think it is appropriate. I think the activity that you ladies and gentlemen are involved in is very important. I hope you ask some real good questions of some real smart people because they need to be asked. I think you are going to immediately see demonstrations. Watch May 6th in D.C. I think we are going to see a shutdown and, of course, that has come. I know that looks like hindsight, but at the time I made this up, two weeks ago, it wasn't.

In short range, I don't think there is any question that we are going to see legislation. I think we're going to see regulation, I think we're going to see increased costs and I'm referring now to energy totally, not only nuclear. I am going to go right across the board, and I say this, because I work in the nuclear field and I say it with some caution with some personal emotion. I suspect that there will be no new nuclear starts.

In the long range to 2,000, I don't know. I hate this word, I'm going to write it, I think there is going to be a crisis in energy. And the reason I say that is, you know, we got spinning reserves now of 30 to 35%. If you take the nukes out, it runs to about 30% spinning reserves.

BY REPRESENTATIVE BENNETT:

Q Doctor, would you tell me what you mean by spinning reserves?

A That means that we have got a capacity with that pinwheel running, that I can throw a switch and put out of line. 30% roughly in this nation today. Now hang on, 30% roughly. Because you have to take any mechanical-electrical device out of service and repair it, I don't care what it is, you need a certain amount of reserve. All right, if you are going to keep, unless you want to walk up to a switch and not get juice, you have got to have a certain amount of reserve. Experience teaches us that reserve must be in the order of 18 to 20%. As an old electrical engineer that is the kind of numbers I remember, 20%, roughly. Now I said I had 30, so what is the sweat? Well, remember it was growing at about four percent a year and four into the difference between 20 and 30 runs about five years, six years. How long does it take to build a coal plant today or a nukey plant? When was the last oil refinery of any size built in this country? About ten years ago, gentlemen, and no wonder we can only buy five dollars worth on the turnpike. It has been ten years since we built a major refinery.

I think we are going to see a slowly emerging energy policy. You know, we have been wrestling mightily with it since the embargo in '72 and what have we produced?

REPRESENTATIVE BENNETT: Zero.

DR. WITZIG: We have produced a lot of paper. There is going to be heavy conservation. That is a nice word for curtailment, heavy conservation, and heavy examination of all alternative sources. We are going to see an increase in coal, and I believe, contrary to the present climate, that we are going to see nuclear being additionally counted on. That is my look into the ball. I think that in order to bring this about, gentlemen, something is favorable as what is there is going to be a steady stable regulatory climate for design and operation. I think we are going to have to have design reviews and I think we are going to have to have improvement in it. I think we are going to have to have more testing. I think we have obviously got to have an operator and regulator education. I think we have got to have energy management. I think we have got to have, and this is not a new thought, it is an ancient one with me, I think there must be independent safety review teams for each plant made up of people like government people, utility people, health, academic, energy people, to review these things. Not a big unwieldy thing, but to have an in-depth penetration and I think that low level radioactive waste sites as well as high level radioactive waste sites are things that must be dealt with in this country. If we don't do that, the picture, in my view, is even going to be worse than what I would project for the long range.

Now, I am not a pessimist, I am an optimist. I have got great confidence in the American people to recognize a problem ultimately and to deal with it. The time situation does worry me.

I am at your disposal, Mr. Chairman.

CHAIRMAN WRIGHT: Thank you, doctor. I am going to try to control the questions. Seeing that I'm the Chairman, I have got the prerogative to ask the first one.

BY CHAIRMAN WRIGHT:

Q Can you briefly define for us breeder reactors and fusion?

A I will try. If you recall, when we had the fissioning nucleus and we said that it slid off into two parts and on the average some two to three neutrons came out. All right, let's make this uranium 235, Mr. Chairman. Neutrons that are emitted from that fission process, one we know we have to use up in continuing the process, right? So we have got to have one neutron to go on and split the next one. I got that one taken care of. So we know we cannot make the system perfect, there is parasitic absorption and there is control I must have of it and so I am going to lose one or a fraction of one. So I take care of that one. Now this one here, however, I want to take and put into uranium 238. And when I do that, I can move it ultimately into plutonium.

Now, plutonium exists in Three Mile Island, it exists in every light water reactor because we build it in in place. In fact, when it gets to an equilibrium cycle after about four or so refuelings, about 35% of the energy in a typical light water slightly uranium reactor, 35% of that energy comes from plutonium, not from uranium. Because in the next one that splits, U235, a couple of nukes come out, I can hit this one and it will fission. So you see I can lose a fissionable isotope to produce energy, keep my chain reaction going, use the neutron from that and an isotope which is not fissionable, normally, and convert it into one that is. I can do this also with thorium, to uranium 233, either one of these two.

Now Rickover's light water breeder in Shippingport is working in this chain here. That is a tough thing to do in light water reactors. It is much easier to do this if you are doing it in what we call a liquid metals reactor.

Now what is fusion? Fusion is just the opposite of fission. Instead of splitting an atom, I take two atoms and I throw them together with such force that I make a new one. I take hydrogen, throw it together and make helium. Actually, this is a heavy hydrogen item. I will call that H2. In that process of putting these together to form one, I release about 17 to 18 MEV's of energy. Noticeably, considerably less than what I do in fission. But that is all right because I can make more of them. I have got a lot of water t o g e t t h e deterient (phonetic) from. That is the fusion process.

REPRESENTATIVE BENNETT: Doctor, you're going to have to slow down because I am a layman.

DR. WITZIG: I'm sorry. Do you want me to back up?

REPRESENTATIVE BENNETT: Just a little bit, sir.

DR. WITZIG: We were talking about fission. What is fission? Fission, if I take my barrels and use them, here is uranium 238, I throw a neutron in it and it splits and releases energy. Now, I am going to take, and because they are smaller, I am going to take hydrogen isotopes, I am going to throw them together. I'm going to throw them together, here they are. I am going to throw them together and it becomes one a helium, are you with me, and it releases energy. One of the questions that typically follows on that is where do we stand in this business today and when is it going to happen? The answer to the question is I don't know. Now, there are breakthroughs, well, we retract from that word. Maybe not breakthrough, but good accomplishments recently, in the last year or so. At Princeton where they have gotten up to fairly high temperatures, 70 to 90 million degrees Fahrenheit, which is necessary, you have got to have them running at high speed. If you don't have them running together, they won't stick. You have got to have them running at high speeds. It takes a lot of energy to do this. So we have yet to get that to happen on a self-sustaining basis. But it gives up as much energy as it takes to create it. Let me say that again. We have, yet in the laboratory, to get this at a basis where it releases as much energy as it took to stick them together. So the net result so far is an energy consumer, not a producer. Now, when will that come out of the lab as a net balance so that we can do it. I don't know. Five years, ten years, I don't know. I do know this. That it took from Firmey (phonetic) in '42 to Shippingport, well, let's take commercial Yankee or Indian point, it took from '42 to the early sixties, it took 20 years, two decades, to move from the lab to a first commercial unit, 20 years.

The fusion business is tougher to handle than the fission. We think that is complicated in those books, fusion is at least as complicated if not more. Some people think it is ten times as complicated. Some think it is only a factor of two. So from the moment it is released in the lab on a share basis, the best I could ever hope for would be 25 years from then until I get the first commercial unit. So I think we are talking 20, 20, 20, 50 without any difficulty at all for the first one. I'll not see it. I hope my grandchildren do.

BY REPRESENTATIVE O'BRIEN:

Q How long have you been in the business, doctor, the nuclear business?

A 37 years, since 1942.

Q Do you feel that technology that we have in America, maybe that we went out too quick to put these nuclear plants out and are you familiar with the NRC years ago, because they are very critical. Number one, why were they allowed to build a plant, Three Mile Island, with an airport in the vicinity? So why, there are many many changes today, are being made facing nuclear plants, and why can't they have a standard plant like Westinghouse was in the process of building?

A How can I answer that question, Mr. O'Brien?

Q You're the expert, I'm not. If I were in your class, what would you say to me?

A Well, what I would say to you, I think I would respond this way. That any new technology has a learning experience, a learning curve. There is no exception.

Q Do you think your statement there, that this is fair to the American public to say that we are putting a plant such as something like this and say, we are putting a plant out to learn what is going to happen?

A I'm sorry, I didn't hear your question.

Q You said like learning from experience.

A No, I said any technology has a learning period, yes, sir.

Q They did not put a man on the moon or try to put a man on the moon until they knew how to do it. I just feel that when you say put a plant up, do they really know that they had control on that plant?

A I would say that, Mr. O'Brien, respectfully, first let me point out to you, that we killed a couple of men getting some men to the moon, too.

Secondly, I would say that as a responsible professional man, I can only tell you that there is risks in anything we do. We never have a risk-free way of generating electricity in my opinion. There will never be a risk-free way to generate electricity. I think that the fact that electricity and energy prolongs our life, through many ways, is a benefit of electricity. And I think society has to make that judgment. As Einstein said, nuclear energy has got to go to the public square and it is there.

Q I'm for it. I want to make it clear. I feel like you. I feel, and I think, Pennsylvania is between 12 and 15%.

A It is about 15%, sir, capacity-wise.

Q But I am not getting the answers. I am not blaming you. I think it is a hard question.

A You bet you it is a hard question. And let me turn it around the other way, Mr. Committee Member, respectfully. What kind of safety level do you want?

Q I want a certain amount of security that I feel and I think the people are entitled to, number one. Where was NRC when they looked over the area of the airport and large planes coming in and then decide later that they have to double the expense to maybe make it safe enough, say, if a bomber or an airplane hit it?

A I would say, if you believe that that is an improper situation, then I would say that they are not doing the job that you want them to do. That is what I would say.

Q I am only giving out one example.

A That is what I would say. But I come back, that is a fair question and I think a fair answer. If we are looking for blame in this situation, there is more than enough blame to go around. It can fall on the utility, it can fall on the NRC, it can fall on the manufacturer, it can fall on the architect-engineer, it can fall even on the educator. Because in the words of John Dunn, do not ask for whom the bell tolls, the bell tolls for thee. You remember in the early days when the bell would ring, you wondered who it was who had died.

We are all involved in it. I think we all got to do it and I think you have got a special responsibility like I feel I share with you as an educator. You may consider that remote, but I don't, because I have been in the field a long time. I think we got a special, special care. So when you ask for safety, what is safety? You accept this as safe now. Would you accept that for a nuclear plant? The answer is hell no. Would you? In my belief, the technology and human education can bring it to where you want it, but that costs and we have to pay that price. You may decide that it is cheaper to do without it. So pull out every light out of six and every motor out of six.

We are holding hearings today on Three Mile Island across the land. Are there any hearings being held for that time when we run out of rolling reserves, spinning reserves, and somebody has to decide that this hospital will not get energy and that one will? This industry and its jobs are okay and that one isn't? I don't think so. I ask for balance and judgment and perspective and reason. All those good words, I know they sound like words, but I am very sincere. What the hell do I got to lose? I'm 58 years of age, all right, if I live till the good book, three score and ten, I have got 12 more to go, if I'm lucky.

CHAIRMAN WRIGHT: Representative Geesey.

BY REPRESENTATIVE GEESEY:

Q Doctor, throughout your presentation, which I might add was very excellent, very informative, there was one thing that you touched on very briefly, but in the way you touched upon that subject it seemed to me as though that particular thing that was your most serious point of concern within the plant operation itself, and that is valves valves were a problem?

A I did say that, yes.

Q Valves apparently were a problem?

A That is correct.

Q What is the problem with valves? What happened with the valves, to your knowledge?

A We cannot make them so they operate reliably. You look at the one in your bathroom. The damn thing is always leaking. Valves are tough. I'm not being smart. It is hard to make a good valve. That's the kind of foreign to me because I am an electrical engineer, an old physicist and I have been in the nuclear business, true, I have welded a little bit here and there but nothing very much. It is hard to make a good valve.

Q Is there a substitute for a valve?

A I don't know of any.

Q I have the same kind of a problem with radioactive waste that you have touched on. So I won't get into that, but something did bother me, again, throughout the presentation, the NRC and its role. Would you please comment for my edification, the pluses and the minuses of the NRC not only as its respective action with TMI, but its overall action in regulating the nuclear industry within this country?

A They are the regulators. That is a tough question, representatives. The NRC has done some very good pieces of work. They have sponsored some excellent research. While we are, at the moment, on a little bit of a witch hunt, let's take a look at some of the loft tests, it took a little long in coming. They ran some loft tests in December of last year and this is the kind of problems, two phase flow kind of problem, the meltdown, etc., with the nuclear core, and I don't know if you gentlemen know about this, the fact that they predicted temperatures that were by conservative, knowledgably conservative basis, within four or five hundred degrees hotter than what actually occurred. When they looked at the most realistic model they found that they were within 50 degrees or so of what actually occurred. So they erred, they tend to err on the safe side. If I'm going to err, I sure want to err on the safe side. So when somebody is thinking about a hydrogen bubble how do you err on the safe side? They say, well, gee, it might explode. If it explodes, what if it explodes, what if the primary system breaks and what if the containment breaks and what if I distribute fission products out in the populous? So they say let's move out. I do not know how much training the NRC has had in emergency management. I suspect not a great deal, not a great deal. And I don't know how you move many people. I see them move in and out of State College, in State College they bring in 70,000 people in the morning on a Saturday and they take them out in the afternoon, 70,000. There isn't a single accident. Well, that is not true. There isn't any fatalities.

So it is a tough -- it is well orchestrated, it is well planned. There is not much panic. There is usually only joy in that situation.

Q Hopefully.

A Usually, not always. I don't think the NRC has a lot of experience in that area. I don't think we do either. I don't think our own Department of Environmental Resources has a lot of experience there.

Q Doctor, I am talking about within the confines of their sphere of influence?

A Yes, sir.

Q The pluses and minuses there, they have no influence nor responsibility over evacuating individuals, but they do have --

A Yeah, but they sure can influence somebody who does have.

Q They can do that, but as far as plus or minuses within their own confines of responsibility, for example, radioactive disposal.

A That is not solely their responsibility but --

Q Well it isn't, but it is.

A It is the old AEC and now I'm not sure, DOE mostly with a little NRC, no, it is mostly DOE. I have to --

Q But what are the other pluses and minuses within their sphere? What I don't want, doctor, is the word that you used, witch hunt. I don't want a witch hunt.

A No, that doesn't do anybody any good.

Q I want to find out what the problems are. I want to find out, hopefully, what the solutions are. I would like to try to find out how those problems can be corrected, hopefully, at the state level if we do have responsibilities there. If not, perhaps, we also can make recommendations at the federal level and that is why I am trying to find out your opinion of the NRC, plus, minus, in their sphere.

A In general I have to say I think they do a pretty good job.

REPRESENTATIVE O'BRIEN: I'm glad you think so.

BY REPRESENTATIVE GEESEY:

Q You are not going to pinpoint --

A I can sit with you and run through a litany of errors that NRC has made. You know, we have a research reactor at Penn State, all right, and we get inspected. We use to get inspected once every two years. Now we get inspected five or six times a year. Is that bad? Well, probably not. It costs a bit, but maybe the benefit is worth it. I am not going to quarrel over that. That is the kind of thing that is happening. They made a substantial effort. Is their judgment always the best in the world? Probably not. They need the best minds that they can get. They have got some pretty good ones. I will say this that I don't suspect that an environmentalist is necessarily the best qualified to be a commissioner. He is not very good with valves.

Q Or evacuation plans.

A I don't know about that. A lawyer has a good place because on the Commission you have got to obey the law. You have got to obey the law and sometimes I don't know what the law says. It is so complicated. So I need somebody to tell me what the law says. Usually, they always tell me what I can't do. That is one of the biggest problems. What I want a lawyer to tell me is what I can do. This thing comes home to roost.

My son is coming to Harrisburg and he is going to be living here for a couple of years, he is going to be graduating from Pitt Law School, I hope, and he is going to be clerking for a judge here. So he asked me, post Three Mile Island, so he said, dad, I want to start a family. He's married, he wants to start a family. Where should I live in Harrisburg? The guy in Germany was right when he said we all live in Pennsylvania.

Q He should live in a frame house directly adjacent to his place of employment.

A So my answer was you can live any place you want to. I understand there is some good real estate down in Highspire. My answer was you can live any place you want to.

My wife looked at me and said, how can you say that? I do not know where he is going to live.

Q Well, you essentially said that one of the minuses is the composition of the Commission itself.

A I think that the Commission composition has to be looked at very carefully.

Q That took a lot.

A Well, I tell you, I am kind of dragging my feet because I live in a glass house like anybody else does.

Q Yes, but doctor, so do we in our job as we try to find solutions.

A Yes, I think its composition is one -- I think education and training, which I made in my summary statement, is absolutely, it is very, very important.

Q What are the other minuses? How can we --

A I think they need increased, you know, there is that old expression that says those who can do, those who cannot teach and those who can do neither are consultants. Maybe you could say regulate. I think those people need a real hard course in what a nuclear plant is. Not just tour one, they ought to have an internship for a year or so in a plant. I don't know how you can inspect a plant if you don't, I think you ought to work in it, live in it, breathe in it. I don't believe in paper wonders.

I think you ought to have an increased analytical capability. I remember going before in the NRC and they had to take everything that we calculated, I mean, I was a consultant, I started a small consulting firm.

Q What was the definition of a consultant?

A One that can do neither. They would have to take what we calculated. They d in't have the capacity to calculate on their own. That is greatly improved. But I think that has to be. I think the NRC staff man has to be at least as knowledgeable as a designer-manufacturer. You talk about having an NRC man in the power plant, I think you ought to have them in the manufacturer's.

Q Including the --

A At least internship. Let him figure out how much cladding thickness you need. Let him calculate the hydrogen production. Those are things we all have to do.

I wrote the safety analysis report that brought the Nautilus into the New York harbor after its transpolar voyage. That was a big sweat. We shut that reactor down at sea. I have forgotten now, if it's ten percent or 20% power. We came in on low power because we did not want that fission product in the sewers or in the harbor. So I took my family, my wife and my kids and we went out on a tug and welcomed her with the hatch open.

Q What responsibility should the state play in this situation? Should the state have a role in nuclear plants? For example, should they have a say in the siting of a plant?

A This is a problem I have been wrestling with for a couple of years. I guess my answer is this. I think that the fabric of society is an extremely complicated and interwoven one. I am dependent upon what happens in Detroit, in Arkansas, Iowa, South Carolina, wherever I get my food, my clothing, my hardware. And they are dependent on me even though I am in a service activity today. Our products are graduates which go there. So we cannot build fences around ourselves. We are a fabric of a nation which is greater than the sum of its parts. So in my view, I believe that the federal authorities should retain the ultimate responsibility in this area. But I think the state ought to have a complete advisory role in those matters. Now whether advisory role you deem is reasonable enough today, I don't know. There is that role today, as you know, a state --

Q Minimal.

A A state, the licensing process allows for, and I am not a lawyer so somebody help me, allows for a friend of the court or allows for an intervener. The states can intervene. Not necessarily -- and the interveners become a sense of a negative response. The state does not have to be a negative intervener. I believe the state was an intervener in Three Mile Island.

REPRESENTATIVE GEESEY: No, I don't think so. It may have been, I don't recall that. Thank you, doctor.

CHAIRMAN WRIGHT: Representative Schmitt.

BY REPRESENTATIVE SCHMITT:

Q I would like to ask a couple of quick questions. I realize it is late and I do not want to prolong this. I think the first question I would like to ask is three parts. Are we training enough people in this field? Or are we doing as, perhaps, aviation did, they hired anybody that could fly. The net result was that ten percent of the untrained aviators were killing the other 90% that were trained and skilled. Do we have a similar situation in the energy field today?

A I don't think we have that kind of a situation, but I do think rigorous training and education in the energy field, nuclear in particular, but energy in general.

Q Who teaches the teachers?

A It is very important. That is a good question. It is like who guards the guards, right? I will stand up and take a rap on that. I was in the industry 25 years and then at the University for 12. I would think that is a reasonable set of credentials.

Q As a teacher though, how many of you are there?

A At Penn State, I am fortunate to say that nuclear engineering, we average over ten years of industrial experience in our faculty, over ten years.

Q I think the training goes through, not only in your field, but should go beyond big labor, the bricklayers and concrete, the man that puts up the towers and a week later they fall in after they are put up.

A I agree, no debate.

Q I don't think we can trust and place our safety in their hands until we have assurance this has been taken care of.

A And I just hope that you feel of that same conviction when it comes to fund those responsible.

Q That is a question, incidentally, I want to develop. I wouldn't have time to do it tonight. The question I want to raise is we invest the money in the utilities in order to build these things and then after the explosion they expect us to come back and pay for them again. I don't think that is fair. I think the stockholders ought to.

A Who would you like to have pay for them?

Q The stockholders.

A Sock it to them, make them pay it. And the next plant that is going to be built, will he invest?

Q That's a good question. The only way to find out is to do it. One final question. What do we do about storage or what have we done about storage?

A I think there can be a very strong -- you are talking about storage of high radioactive wastes. I think there can be a very firm policy. This is one place you are going to stop reprocessing, you can say thou shalt store and get about it with a target date that has got some realism and some purpose behind it. Not the shifting one that moves back two years for every year that passes. We have wish-washed, willy-nilly, and have not proceeded in a way which I think is responsible. I am very disappointed in it. I have served on two national academies, subcommittees, you know, way down low and we have made recommendation after recommendation of solid, technical facts. You know, it is throwing it to the winds.

BY REPRESENTATIVE O'BRIEN:

Q That is strictly federal government, not our decision?

A Yes, sir.

REPRESENTATIVE SCHMITT: That is all.

DR. WITZIG: But you can put pressure on the federal government.

REPRESENTATIVE O'BRIEN: You are kidding.

CHAIRMAN WRIGHT: Representative Stuban.

BY REPRESENTATIVE STUBAN:

Q One of the things that you mentioned that Representative Geesey said, the intervener type in licensing, would it be possible that the consumer advocate that intervenes in rate cases could intervene, you know, like PP&L and Susquehanna is now licensing. That we could ask our consumer advocate in behalf of the people?

A I think it would be very wise if the state intervenes on behalf of the people. But I don't like your choice of intervener. I would like to have somebody that is competent. Why not get somebody in DER like a nuclear engineer. You've got them? Why not use them? He is in nobody's pocket. I don't know who the consumer advocate is now, but if he is no better trained than the previous one, I have serious reservations on that being a viable way to go. That goes back to your education.

Q Would it be possible that the consumer could take up the legal --

A Oh, in the legal formality sense, yes.

Q Ask the people with the expertise to come forward. Another question I would like to ask you is to go back to the coal chart you had on the coal burning of plants.

A Yes, sir. Do you want me to flip it on?

Q Yes, if you would.

A If I can find it here. Go ahead.

Q And you did say that you spent some time at Geisinger Hospital and you talked about the Montour plant.

A This one?

Q Yes. Now you talk about uranium and coal. Is there radiation that is being sent out into the atmosphere when you burn it?

A In the burning of coal?

Q Right.

A Yes, sir, there is.

Q What percentage do you say is being sent out?

A The studies that have been made that I have read on say that if you take the small amounts of uranium inpurities, which is in coal initially, you see, it is a tremendous volume even if you have a small volume you accumulate a large amount of it. If you take uranium impurities and they wind up in this ash, the daughter product, primarily radon and some of its daughters, I have to get out the radioactivity chain and refresh my own memory, all right. Radium is one of them. In general it is a bone seeker. So if you take a dose, depending on, if you take a dose, a radiaction dose of an individual who lives near a coal plant, a large coal plant, and compare it to an individual living next to a large nuclear plant, the doses are very comparable. The coal plant is a little bit less than a boiling water reactor and just a little more than a pressurized water reactor, very comparable. But there is no regulation on that at all. But I think there is a good reason, as the gentleman over here had asked earlier, there isn't much radioactivity totally in the coal as there is in a nuclear plant. But the doses, as to what is actually released from coal, is about the same as what is actually released from a nuclear plant under normal operating conditions.

Q Now we got the condition of the Susquehanna boiling water reactor?

A Yes sir.

Q We got the Montour coal burning facilitiy?

A Yes, sir. About 1500 megawatts at Montour.

Q You go right on up to (inaudible) you have another coal burning facility. How much radioactivity are we going to have in the atmosphere in that area?

A A very small amount compared to the background situation we have experienced up in that region.

I have an interesting story. Penn State has a mobile radioisotope laboratory that we seek to get federal funds every year. It is a 35 foot trailer. It was parked over here from the first of February by the Education Department until the 15th of March. In that, we bring young people in, by hands on, we teach them two things. What radiaction is, the beta, gamma, etc., and the other is how mankind can manage it. This is part of the education that we are trying to get across to the public. It is a tough fight because of the money situation.

But in that, our instructor comes up in the coal country, up around Scranton, with this van up there. And he could not get one young lady to come into the van because she said, that is radioactive. I don't want to do this. She would only come as far as the steps. She would not go inside. Well, Joe had to run a class so he ran a class for that and he said, if you wait, I would like to talk with you. Afterwards he talked with her and had no luck. The next week she came back again, she sat outside. He said, will you wait? That evening Joe took a counter, a fairly sophisticated counter, and where this girl lived and played in the culm piles, Joe took his counter and measured the radioactivity. She saw the amount of radiaction that was there. And he walked with her back to the lab. He got her on the step and measured the radioactivity. He stepped inside and measured the radioactivity. Inside our lab was no higher than out of the culm pile. This young lady learned a real lesson. Where she had been playing as a youth, was quite a bit more radioactive than what we were doing by way of a teaching exercise.

It turned out that she was the editor of a school newspaper and she gave our lab quite a writeup afterwards. Now we do not always have such success stories.

Another part, the western part of the state, again in a coal mining area, there was a biology teacher who would tell the kids, don't go into that lab. It is radioactive. The kids told our teacher about this. So he went and talked to the biology teacher, went to the school to talk to them. He said, can I show you the lab? The biology teacher wouldn't talk to him, wouldn't talk to him.

REPRESENTATIVE O'BRIEN: But it is not really the radiation that is the hazard in coal, it is the sulphur dioxide.

DR. WITZIG: I think there is both hazards, Mr. O'Brien.

REPRESENTATIVE O'BRIEN: That is the first time --

CHAIRMAN WRIGHT: He could talk about the greenhouses, too, CO2 production.

DR. WITZIG: CO2 production, greenhouse effect, a slow warming of the earth. That is in effect, not a hundred, you know, that is kind of a guessing kind of thing. I can't say for sure. You know, if O'Brien pushes me hard to get the risks down on that, that is hard to answer.

BY REPRESENTATIVE STUBAN:

Q One last question. What would your opinion be on the feasibility of changing Three Mile Island to coal?

A I'd say forget it. Next question.

Q What would be your reasoning?

A The only thing that Three Mile Island has that would be attractive to a coal situation might be river transportation, I doubt that. The second thing is it has got a turbine, which isn't designed for high temperature high pressure coal burning. I can see very little to recommend.

Q Would you say the same thing for the Susquehanna steam plant?

A Yes, sir.

REPRESENTATIVE STUBAN: That is all.

DR. WITZIG: These are just apples and oranges.

CHAIRMAN WRIGHT: Any other Member of the Committee? Mark Cohen.

BY REPRESENTATIVE COHEN:

Q I would like to know about what kind of training you give people? Do you train people to become licensed nuclear operators, senior licensed operators?

A We train people for our own facility to be NRC licensed reactor operators, our own research reactor facility. The Nuclear Regulatory Commission has a three phase program for reactor operator training, which I suspect will be modified. Penn State has taught and still does some teaching in the phase one part of the three phases of the Nuclear Regulatory training program. Now that is just in reactor operator training. We, of course, go into the professional and paraprofessional aspects of engineering as well.

Q Did you train any people at Three Mile Island?

A Yes.

Q How many of the people at Three Mile Island did you train?

A Oh, I'm going to make a guess, in that part of phase one that we undertook with them, I would guess, maybe, 20.

Q What happened to the others at Three Mile Island?

A I can't answer that.

Q Are you familiar with the Center for Nuclear Studies at Memphis, Tennessee?

A Yes -- I have heard of them.

Q Do you have any feeling on the quality of their work in terms of training?

A I would think that Pennsylvania does at least as good a job if not better.

Q The Center of Nuclear Studies of Memphis was founded by a consortium of southern states trying to provide training for nuclear reactors in their area. Do you think there would be any benefit for Pennsylvania to enter a similar consortium with other states or proceed with training on our own?

A I think it ought to be examined. We have an excellent facility that exists today. It can be modified, it can be improved, it can be further utilized.

Q You would have the ability to enter and further train?

A We think we do, yes.

Q Have you been involved in training people for other nuclear plants in Pennsylvania besides Three Mile Island?

A Yes, we have trained a few from PP&L, a few from Met Ed and we have done some out-of-state that have come here.

We actually have trained operators that have been licensed in some 22 countries across the world. Maybe that's 32, it is one or the other.

Q Do you do testing of the people that you train?

A I beg your pardon.

Q Do you do testing of the people that you train?

A Yes, sir.

Q But the NRC, you know the results of their scores or their tests?

A Yes, sir.

Q Do plants who get these people know the scores of the people that you test?

A Yes, sir.

Q The NRC does not require people, the NRC tests I am told, does not require that the NRC give the nuclear plants the scores of the people?

A I don't know that to be true.

Q You don't know whether it is true or not?

A I do not know whether that is true or not. I, for one, would certainly want to know and then when they are educated at Penn State they know. Incidentally, I think it is about 99.5% of the people that have gone that we have passed at Penn State, that we have passed, have subsequently gotten the NRC licenses.

Q When you pass them, what is the passing score, 70%?

A We, in general, use 70 to 75, depending on their circumstances. But that is a question, which can only really be analyzed in the total context of what the test does.

Q What percentage of people are getting 80% or more?

A I can't answer that; I don't know.

Q Are there statistics that you have compiled on that?

A I don't know whether we have retained them. We may have. We may have just given them to the company. I don't know.

Q Could you check your files?

A Sure.

Q And notify Mr. Wright?

A If we have them, you can have them.

REPRESENTATIVE COHEN: I have no further questions.

CHAIRMAN WRIGHT: Representative Foster.

BY REPRESENTATIVE FOSTER:

Q Doctor, the principal means of controlling a nuclear reaction is the shutting down of the reactor in the case of an emergency. The first thing is injection of the fuel rods in the core?

A You're speaking of the nuclear chain reaction? The first step to shut it down is the insertion into the core of the neutron absorber which we call the control rods.

Q They do that through the absorption of neutrons?

A Yes, sir.

Q Is there then any technology that you are aware of, anything that might be on the horizon that would, after that fact, bring about a faster control of the existing reaction? That sort of breaks the chain?

A That is correct, sir.

Q Now, there is the existing reaction ongoing, I guess, until it is dissipated. Would that be correct?

A That is correct.

Q Maybe in layman's terms that is correct?

A That is correct.

Q Is there then any possibility that you could come up with technology that would arrest that ongoing process at a greater rate so that you at least, if not eliminate, you could not eliminate, at least markedly reduce the possibility of meltdown, is there any such technology?

A No, sir.

Q I was afraid there wasn't.

A If we have a reactor operating at 100% power, and we at this point initiate what we call scram, we shut the reactor down at that point. It immediately falls in power to about six percent. So when Three Mile Island was scrammed, it fell six percent of 2772 megawatts. That's about 20 megawatts. Then it falls off for a little while at about 86 seconds, 88 seconds. It is a period which it falls off, that is, goes in one-half in 88 seconds. Then the next 88 seconds goes one-half, etc. So it falls off like that, but then it gets longer and longer. This is what we call decay power. We must have a sink to place that power in, otherwise, temperatures go up. And Three Mile Island lost their sink, temperatures went up in the core and it is pretty clear that an extensive amount of that cladding, that fishing rod, has been opened. It also appears that very little of the fuel has gone into the primary system's water, very little.

Q So in reality then our technology has to be directed at emergency cooling systems?

A Yes, sir. That is just as crystal clear as it can be.

REPRESENTATIVE FOSTER: That answers my questions.

CHAIRMAN WRIGHT: One quick question, Representative Geesey.

BY REPRESENTATIVE GEESEY:

Q How are they going to clean this thing up? The question was brief, I didn't say the answer would be. We are sitting here with a problem.

A I don't know how they are going to clean it up. I have not played a role in that. I think one of the things that I would do, if I were going to have to clean that job up, I would probably take and convert as much of that water in containment to solid concrete case, and then I would ship those to satisfactory burial grounds which exist today. Once you've got that done, I think you probably are going to have to, you know, it is not just easy to do either, you know, because there is, what, 400,000 gallons in that. Just think of the number of septic tanks, 1,000 gallons. You are going to have to have 400,000, I mean, 400 of those 1,000 gallon septic tanks. If you put them in concrete, ship it by truck, something like that, it is going to be tough.

Then you have got to get inside then and you have got to clean it up. Well the only way you can clean it up is you have got to decontaminate it. You have got to scrub the radioactivity off the walls. I imagine all of the wiring inside will have to be replaced. I imagine all the instrumentation inside will have to be replaced. Not to mention if there is any damage to the primary components which may have to be replaced. It is a very sizable job. It is going to take a lot of good engineering and if there is not good engineering, we will have another thing on the front page.

Q Can that water be solidifed while it is inside the vessel?

A Possibly.

Q Chances?

A I'll have to study it, I don't know. I don't know. I have to look at it, study it, worry about it. Figure it out what is the best way to do it. It is possible, maybe, to solidify it. It gets remote and that gets tough. The moment you bring it outside of containment, do it in a special shed or shanty or something, then you are getting it out. It isn't in containment any more. You have got to have special precautions. It is a very severe job. You know, there is tens of thousands of curies in there. I don't know how many there are. There are a lot of curies in there. You have got to pay attention to this.

Q How can you get it out?

A It is no kid's play. Oh, it can be done.

Q To solidify?

A Oh yes, it can be done. We have done a hundred thousand gallons out in Idaho Falls area. But you are aware that Pennsylvania had a nuclear incident at Walls Mills years ago, the Westinghouse test reactor. You are aware that over a million gallons of radioactive water was a result of that? You are aware that those were all processed in hand. So it isn't something that is a totally new experience. It sure is uncomfortable.

CHAIRMAN WRIGHT: Doctor, I think we are talked out. Hope you are a little bit too. We thank you very sincerely. I have heard a number of remarks from the Members of the Committee and I think it was meant as a compliment that you brought the discussion down to our level of comprehension. We, obviously, know more about the subject today than we did. Thank you very much for that. The Committee is adjourned until 10:00 o'clock tomorrow morning.

(Whereupon the meeting was adjourned at 5:40 p.m.)

I hereby certify that the proceedings and evidence taken by me in the within matter are fully and accurately indicated in my notes and that this is a true and correct transcript of the same.

Dorothy M. Malone

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