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# **Transcript of Proceedings**

## **NUCLEAR REGULATORY COMMISSION**

BRIEFING BY REPRESENTATIVES OF DOE/ARGONNE  
NATIONAL LABORATORY ON RESEARCH REACTORS

(Open to Public Attendance)

June 7, 1978

Pages 1 - 44

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1 UNITED STATES OF AMERICA  
2 NUCLEAR REGULATORY COMMISSION  
3  
4 BRIEFING BY REPRESENTATIVES OF  
5 DOE/ARGONNE NATIONAL LABORATORY  
6 ON RESEARCH REACTORS  
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8 (Open to Public Attendance)  
9

10 Commissioners' Conference Room  
11 Room 1130  
12 1717 H Street, N.W.  
13 Washington, D. C.

14 Wednesday, June 7, 1978

15 The Commission met, pursuant to notice at 9:40 a.m.,  
16 Joseph Hendrie, Chairman, presiding.

17 PRESENT:

18 Chairman Hendrie  
19 Commissioner Gilinsky

20 ALSO PRESENT:

21 R. Lewis (ANL)  
22 R. Nack (DOE)  
23 D. Hoyle (State)  
24 W. Williamson (ACDA)  
25 J. Hoyle  
L. Gossick

P R O C E E D I N G S

CHAIRMAN HENDRIE: If we could come to order. Commissioner Kennedy, I'm afraid isn't going to make it and Commissioner Bradford will be in, in a bit. Why don't we go ahead.

The subject this morning is a briefing by representatives of DOE and Argonne National Laboratory on Research Reactors, and in particular on the development program aimed at reducing the needed level of enrichment of fuel for research reactors.

MR. LEWIS: I'm Dick Lewis from Argonne National Laboratory. Chairman Hendrie, Commissioner Gilinsky, I have taken the liberty of inviting two other gentlemen, Mr. Dixon Hoyle from Department of State and Mr. Richard Williamson from Arms Control Disarmament Agency.

They have been instrumental, particularly in policy portions of the development of this program, and I thought it might be useful for them to be here.

CHAIRMAN HENDRIE: We are very glad they could come.

MR. LEWIS: If you have in front of you the briefing documents that I prepared, and I can direct your attention to the table of contents, let me just quickly go over what we have here.

There is more detail than I will try to handle

1 verbally here, but basically I would like to start with  
2 review of the goals of the program, a few items on  
3 the research test reactor design considerations basically  
4 that feed in to the program ground rules, then a discussion of  
5 what determines the acceptability of reduced enrichment fuel  
6 in research reactors. From that, develop discussion on our  
7 current enrichment reduction strategy.

8 Then under Item 5, the program itself, I want to talk  
9 about the current organization and structure of the program.  
10 The reaction that we have had to it, both here in the United  
11 States and abroad, then the status of the program.

12 Item 6 and 7, I will just brush over very lightly  
13 and they review the current state of the art in research  
14 reactor fuel technology and the prospects for improvement of  
15 that technology. And then I want to spend just a couple of  
16 minutes talking about NRC actions that would help us in this  
17 program.

18 So to begin with the goals, this program is a part of  
19 the Non-Proliferation policy effort within the U.S. Government.  
20 In this particular case the principal goal of the program is  
21 to improve the proliferation resistance of fuels used in  
22 research and test reactors.

23 The particular concern is with highly enriched fuel  
24 during its fabrication, transport and storage prior to  
25 substantial burn up. It is felt that there is a potential for

1 diversion of the material, particularly in those activities.

2 Now generally this program is intended to provide  
3 a technical means for reducing the enrichment of the fuel  
4 substantially below 90 to 93 percent enrichment, both in U.S.  
5 and foreign reactors. The long-term goal is to reduce the  
6 enrichment below 20 percent or at least, to a minimum  
7 enrichment. Recognizing that there will probably always be a  
8 few very high power research reactors for which reduced  
9 enrichments will not be feasible.

10 Now, going to Item 2, starting on page 2, let me  
11 briefly touch on those aspects of research reactor design  
12 that can strain one's options in looking at reduced enrichments.

13 First of all the main objective of good research  
14 reactor design is maximum flux for a given cost. Because  
15 cost corolates very closely with power level in the reactor,  
16 you are generally talking about trying to maximize flux  
17 to power ratio. That is done by minimizing core volume for  
18 a given power. That is sort of the key item for research  
19 reactors. You want to have small cores which lead you, of course,  
20 to maximizing volumetric power density.

21 Now, in that situation where you have high volumetric  
22 power densities the limiting factor in the design is the  
23 temperature of the coolant at the surface of the fuel element,  
24 at the fuel plate surface, and the factors that in turn determine  
25 that maximum temperature relative to say boiling, usually you are

1 talking about a factor relative to boiling. The factors  
2 that determine that temperature are the heat flux, that is  
3 the power per unit of surface area and how fast the coolant  
4 is flowing past the surface which determines boundary layer,  
5 thickness and therefore,  $\Delta T$  (Delta T) across the boundary layer.  
6

7 So generally, the higher power of reactor you are  
8 talking about or higher power density you need to increase the  
9 heat transfer surface area per unit volume of the reactor and  
10 flow faster. So that is why for higher power reactors you  
11 typically see thin plate, thin type designs with high flow  
12 rates.

13 Now, the key performance parameters in a research  
14 test reactor from the user's point of view are the fast flux  
15 in the core and the thermal flux in the reflectors and in the  
16 core flux traps. Generally thermal flux in the core or in the  
17 fuel is not a very important parameter, and as it turns out,  
18 the incore fast flux and the excore reflector flux trap  
19 thermal fluxes are determined principally by the power density.  
20 So you come back to the power density again.

21 So much from the user's point of view, but from the  
22 physicist's point of view the problem, of course, also is to provide  
23 sufficient reactivity to overcome burn-up losses, operating  
24 losses in the temperature coefficient, xenon, samarium, the  
25 reactivity involved in the experiments in order to provide  
a certain amount of control.

1           Now, you have got a few ways to adjust reactivity  
2 and one, of course, is the core size, but here we want to  
3 minimize size, the moderator to U-235 ratio, U-235 loading  
4 in the core, the reflector type and size that you pick.  
5 Generally reactivity can be increased by increasing the core  
6 size, going to a more optimum order to U-235 ratio, increasing  
7 the U-235 loading or using better reflectors or moderators.

8           Now, burn-up losses are roughly in proportion to the  
9 fractional loss of U-235 per megawatt day. You are talking  
10 about maybe 1.25 grams per megawatt day of U-235 burn-out in  
11 the core. The reactivity loss is roughly proportional to the  
12 fraction, that is, of the total U-235 loading. So you can  
13 extend core life by increasing the total U-235 loading in the  
14 core. But this is limited by -- just putting in more U-235  
15 is limited -- you don't want to get excessive reactivity  
16 from a safety point of view and also, you are limited by the  
17 fact that the fuel volume available is limited. And after  
18 providing for moderator and cladding, you can only do a  
19 certain amount by putting more U-235 in there, especially  
20 when you need a thin-type design.

21           Lastly, of course, one has to be sure and maintain  
22 in any variations, the negative power coefficients and  
23 temperature coefficients which for aluminum water plate type  
24 reactors, principally come from the under-moderated design.  
25 You are running on the low side of the water to a U-235 ratio



1 and you want to maintain that. For lower enrichment  
2 designs, of course, doppler becomes a factor, and for burn-up  
3 of poison situation such as in TRIGA, you can get some  
4 substantial negative temperature coefficient through the  
5 spectral-shifts accompanying temperature changes.

6 All right, those briefly are the main factors in  
7 the design.

8 Now, with regard to acceptability of reduced  
9 enrichment of fuel, I would like to say a few things here.  
10 starting on page 4. Research/test reactors all over the world,  
11 including the United States are under intense cost pressure  
12 and they have to keep cost down and are trying, at the same  
13 time, to maximize flux levels. This is every operator you  
14 talk to. I think, in that connection it has to be  
15 recognized at the outset that the use of lower enrichment  
16 fuels causes inherently poor flux-per-unit-power performance  
17 and higher cost relative to the use of higher enrichment fuels.  
18 This is particularly true for higher power reactors.

19 The reasons for that are that there is a somewhat  
20 lower reactivity per gram of U-235 at lower enrichments,  
21 particularly if you get below about say 15 percent enrichment.

22 Secondly, and very important, is that simply putting  
23 in U-238 displaces core volume which you can't, therefore, use  
24 for other things such as clad or heat transfer surface.

25 Now, the reduced enrichment reactor design studies

1 that we are engaged in are aimed at minimizing the performance  
2 and cost penalties. In most cases, I think that acceptable  
3 reduced enrichment compromises can be found, but it has to  
4 be recognized that in all cases highly enriched fuel would  
5 still provide better performance. One example of the bind  
6 that you are in there is that we have under development higher  
7 uranium density fuel types for research reactors which we say  
8 will make it feasible to use lower enrichments in reactors.  
9 But it is true that one can turn that around and say, well,  
10 fine we can use the higher uranium density fuels, but at  
11 highly enriched uranium and get yet better performance. That  
12 is a sticky item.

13 Well, getting back to the acceptability of reduced  
14 enrichment fuels, if you simply lower the enrichment in  
15 current designs it really has a catastrophic effect. The  
16 reactivity, of course, immediately goes down and that drops  
17 core life of a given core way down or if you compensate by  
18 increasing the core size, your power density is down and  
19 therefore flux performance is down and you are faced with  
20 having to raise reactor power, a very costly item.

21 COMMISSIONER GILINSKY: Could you say something  
22 about the population of research reactors? In other words,  
23 there must be a relatively small number of higher power  
24 research reactors which are utilized to a great degree and  
25 asserts considerable pressure to perform and so on, and I would

1 guess a larger population of smaller reactors which are  
2 probably not used this intensively for which these consider-  
3 ations might be less relevant.

4 MR. LEWIS: In fact, I will get to that exact point,  
5 but to answer your question directly there are in the world  
6 on the order, I don't know, 90 or so research reactors.  
7 Of those, perhaps 20 are high power, high performance, and  
8 another 30 or so -- 40, are of intermediate power, 5 to 50  
9 megawatts and the rest are lower power, a megawatt or two  
10 and below. It definitely is true that the low power ones  
11 can go to 20 percent now. It is really the intermediates that --  
12 well, the high power it is very difficult. It is really the  
13 intermediates where a case-by-case situation has to be looked  
14 at.

15 All right, so I'm just saying here that simple  
16 reduction enrichment in current designs is basically a  
17 catastrophic situation for any research reactor and that  
18 needs to be avoided. So the criterion that we have adopted  
19 in the program that we consider practical from an acceptability  
20 standpoint for reduced enrichments is the following:

21 Use less than 20 percent enrichment fuel, or if  
22 that is not practical minimize the enrichment in a situation.  
23 Look at it case-by-case.

24 Secondly, as a basic criterion there should be  
25 no significant reactor performance reduction of flux per unit

1 power relative to high enriched fuel currently used in the  
2 existing reactor.

3 Now some reduction will probably be necessary, but  
4 no significant reduction compared to the existing highly-  
5 enriched reactor design. Now for new reactors it is less  
6 clear, but we have been taking as a working criteria that  
7 relative to high-enriched fuel designs typically used for  
8 that reactor at this time, at the same power that they should  
9 get approximately the same performance.

10 Thirdly, there should be minimum fuel cycle cost  
11 increases relative to current highly enriched fuel. There are  
12 going to be increases, but I hope not overwhelming.

13 Conversion to reduced enrichment fuel should raise  
14 a minimum of new safety and licensing issues, and this is  
15 particularly relevant to existing reactors.

16 Finally, for existing reactors there should be no  
17 requirement for reactor or facility modifications. In particular,  
18 no need to increase the power substantially because that  
19 really gets into a very costly operation.

20 So those are the criterion that we have used.

21 COMMISSIONER GILINSKY: What does that mean, no  
22 facility modification?

23 MR. LEWIS: Basically it means they should not have  
24 to raise their power levels substantially in order to reach  
25 the same or essentially the same flux performance, which means

1 from a technical point of view that the core size needs to  
2 remain the same since you have the power density.

3 CHAIRMAN HENDRIE: An interesting problem, in order  
4 to maintain the power density in these conditions, you  
5 actually have to slightly nominally hold the same, but  
6 actually slightly increase the U-235 density for unit volume  
7 of core, and what you are doing is taking out a little of the  
8 inert material in the fuel alloy and finding ways to replace  
9 it with uranium which your uranium has not got a lot of 238 in  
10 it.

11 MR. LEWIS: Exactly, you are stealing my punch line.

12 CHAIRMAN HENDRIE: Oh, sorry about that.

13 MR. LEWIS: That is exactly right, though, and that  
14 is an interesting problem and as it turns out, just to jump  
15 ahead a little bit the reason you can do something with that  
16 problem in the short run is because most reactors do not use  
17 the current state of the art with regard to uranium density,  
18 but for those who do use the current state of the art we have  
19 to go to higher uranium densities and that is what the  
20 development program is largely all about.

21 All right, so what is going on to Item 4, Enrich-  
22 ment Reduction Strategy: starting with those criterion then,  
23 what can be done? Well, if you go down the list of things  
24 you want to maintain, maintain reactor performance, flux per  
25 unit power, that requires that the reduced enrichment core must

1 have the same volume or -- and the same or perhaps somewhat  
2 more fissile mass than the highly enriched core. This  
3 implies to the first order that the U-235 density in the  
4 reduced enrichment core must be the same as or somewhat more  
5 than the U-235 density in the highly enriched core.

6 Secondly, maintaining fuel cycle cost requires  
7 that the burn-up capability for fuel element in the reduced  
8 enrichment case must be the same or greater than that in the  
9 highly enriched case and the cost of fabrication must be the  
10 same or less in the reduced enrichment case. That second one  
11 is probably not going to be met. The first one can be met  
12 though.

13 Now, the first of these requirements, that is burn-up  
14 capability again implies you need the same U-235 loading in the  
15 fuel element. Now the extent to which new safety and licensing  
16 issues are raised in any redesign are minimized by minimizing  
17 reactor design changes, particularly in the area of safety  
18 parameters, reactivity coefficient, safety margins and the  
19 physical barriers to fission product release. This implies  
20 avoiding changes, to among other things, core moderator to  
21 fuel ratio, heat transfer area per unit power and cladding  
22 materials.

23 Generally we would like to limit changes to just  
24 changing the fuel element and maybe increasing the flow rate.

25 Facility modifications can be avoided if the reactor

1 power doesn't have to be increased or if you don't have to  
2 have substantial thermal-hydraulic changes such as very much  
3 larger flow rates.

4 Now, these factors suggest an enrichment reductions  
5 strategy that is based on the working criterion that is necessary  
6 to maintain the U-235 loading per fuel element at least as  
7 large in the reduced enrichment design as in the current highly  
8 enriched design. It is true, as you point out, that reactivity  
9 or cost considerations may dictate somewhat higher U-235 load-  
10 ings per fuel element in the lower enriched designs.

11 Now, U-235 loading can be maintained by increasing  
12 the uranium density in the fuel in proportion to the decrease  
13 in the enrichment, and/or by increasing the useable fuel meat  
14 volume per fuel element. This is the practical working  
15 criterion that we are using.

16 COMMISSIONER GILINSKY: What is fuel meat?

17 MR. LEWIS: If you think of a fuel plate, a typical  
18 research reactor has a cladding and then there is a region  
19 inside which is usually a mixture of some form of uranium  
20 and aluminum and that is called the fuel meat. It is thought  
21 of in the sandwich analogy, the clad is bread.

22 We have looked at a lot of these research reactor  
23 designs and at fuel capabilities and we feel that increased  
24 uranium density sufficient to permit enrichment reduction from  
25 90 to 93 percent to 30 to 45 percent using this criterion can be

1 achieved in many existing MTR-plate-type fuel designs in  
2 the 5 to 50 megawatt range without changing the fuel meat  
3 volume, and that is substitution of state-of-the-art high  
4 uranium density  $U_3O_8$  aluminum or  $UAl_x$  aluminum fuel meat  
5 technology for currently used relatively low uranium density,  
6 uranium aluminum alloy technology. Currently proven state-of-  
7 the-art fuel technology is not sufficient, however, to permit  
8 enrichment reduction below 20 percent for reactors, generally  
9 speaking, for reactors greater in power than 5 to 10 megawatts  
10 without substantial reduction in the U-235 density, therefore,  
11 we consider use of 20 percent for that range of power, say  
12 5 to 50 megawatts probably -- well, it is not practical at the  
13 moment.

14 COMMISSIONER GILINSKY: Given the various constraints  
15 you have imposed on them.

16 MR. LEWIS: That's right.

17 Now, for reactors where there exists an excess  
18 design margin in power per unit of heat transfer area, that  
19 is typically for plate-type reactors of less than 5 to 10  
20 megawatts, additional enrichment reduction to less than  
21 20 percent I would say is possible by increasing the fuel  
22 thickness and maintaining moderator to fuel ratio or somewhat  
23 reducing that ratio and that means reducing the number of plates  
24 per fuel and increasing the flow somewhat. But I think that is  
25 quite practical for virtually all reactors in that -- almost



1 all reactors in that power range, say below 10 megawatts.

2 Now, very high uranium density uranium fuel meat  
3 technologies currently under development in the U.S. and  
4 in Europe, show promise of providing sufficient uranium density  
5 to permit enrichment reductions from 90/93 percent to below  
6 20 percent while maintaining U-235 density regardless of the  
7 power level of the reactor, while maintaining reactor  
8 performance, I think, for virtually -- well, let's say 90-95  
9 percent of the reactors in the world. That's what we are  
10 doing in a large part of the DOE programs, developing that  
11 new very high uranium density fuel.

12 A brief overview in Section 5 of the Program  
13 Organization, the budget and the schedule of the program.  
14 There are four major elements to the program. The first one  
15 is generic analytical studies of reduced-enrichment designs.  
16 Looking at them in four broad classes, aluminum plate water,  
17 the TRIGA, zirconium hydride designs, D<sub>2</sub>O and UO<sub>2</sub> designs.  
18 Really, all aspects of designs are being looked at.

19 Then secondly, there are case studies being done  
20 for a very large number of new and existing reactors. For  
21 each one, looking at the enrichment reduction options for  
22 that specific reactor. The reactors fall very nicely into  
23 those classes, so these specifics are not an overwhelming job  
24 to do. We are doing these case studies also to support the  
25 Executive Branch reviews of export license applications and for

1 domestic reactors, reviewing their enrichment reduction  
2 options.

3         Thirdly, there is a portion of the program which  
4 provides technical support to intermediate enrichment  
5 reductions from 30 to 45 percent, and I should add there  
6 that that task has also taken the reduction to 20 percent  
7 enrichment where that can be done right away. And within  
8 that maybe near-term enrichment reduction effort which applies  
9 to all U.S. or foreign reactors supplied from the U.S., we  
10 are doing generic fuel engineering design studies, procurement  
11 specification sample preparations, safety analysis sample  
12 preparations, and also undertaking demonstration fuel  
13 fabrication programs where appropriate. And then there is  
14 the large low enrichment fuel development program which is  
15 aimed at developing uranium -- well, fuel meat technologies  
16 of sufficiently high density, uranium density to permit 20  
17 percent enrichment use under our criteria in virtually all  
18 reactors except the highest power ones.

19         In that advance fuels program, we are looking at  
20 a wide variety of fuels and they are listed here, the  $U_3O_8$   
21 and the  $UAl_x$  fuels, they are currently the state of the art  
22 fuels. Silicide, uranium moly fuels,  $UO_2$ , TRIGA fuel developments  
23 also. We are seeking international participation and we are  
24 engaged not only in the metallurgical developments and associated  
25 burn-up tests, but also generic fuel design studies in looking

1 at fuel specs and safety analysis effects and undertaking  
2 demonstration programs.

3 Now, as currently structured this is invisioned  
4 to be a five-year, \$10 million program initiated March 1st of  
5 this year. The budget break down, it is on page 11, should  
6 be taken, I think, with -- well, it is a tentative budget  
7 break down, for years beyond 1979 it is, of course ---

8 COMMISSIONER GILINSKY: This is DOE money?

9 MR. LEWIS: This is DOE money, but I included it so  
10 you can get a feeling for the general distribution of efforts  
11 between the design analysis, the intermediate enrichment  
12 application study efforts and the low enrichment work; and  
13 also the various organizations that are involved here.

14 COMMISSIONER GILINSKY: Do you have any where a list  
15 of these 90 reactors with an indication of which class they  
16 fall in to and what you think can be done with them?

17 MR. LEWIS: Yes, we do, both for the U.S. and for  
18 foreign reactors.

19 The list is relatively easy to come by. As to  
20 specific statements as to what class they fall in, we need to  
21 be somewhat hesitant on that. This is a matter of very great  
22 sensitivity to many reactors, and we have taken the tact that  
23 we do our own studies internally at Argonne, but before we  
24 publish a definitive statement on how far down enrichment they  
25 can go, we do studies jointly with the reactor involved. I

1 wouldn't mind sending you our internal working documents  
2 on that, but you have to realize that it is not easy to get  
3 all of the details of fuel design in a particular reactors,  
4 let's say BR-2 in Belgium. We found that when we were in  
5 Europe we did not have the current fuel design specifications  
6 on that reactor and as the result they were not a candidate  
7 for substantial enrichment reductions in the near term.  
8 It turns out ---

9 COMMISSIONER GILINSKY: Which is a lack of infor-  
10 mation?

11 MR. LEWIS: Well, we thought they were using the  
12 old uranium aluminum alloy technology. It turns out they  
13 had switched to uranium aluminide technology at the highest  
14 currently available uranium density, and as the result they  
15 are at 93 percent enrichment, whereas the result in the  
16 short run there is no way to reduce their enrichment under our  
17 criteria. It will have to await the development of the  
18 higher density fuels. But it is that sort of thing that I  
19 really hesitate to give definitive answers on exactly how much  
20 enrichment reduction a given reactor is capable of without  
21 a study involving the reactor operation themselves. But  
22 broadly, any reactor below 5 megawatts can almost certainly  
23 go to reduced enrichments.

24 Now, the only exception is that there are a few  
25 cases and MIT is a good example, where even at 5 megawatts

1 they have gone for performance reasons, to high expense  
2 fuels, the state of the art ULA<sub>x</sub> fuel at 93 percent enrichment.  
3 And they have very good performance at that power level.

4 Now for them, there is no technology switch you can  
5 make now that won't move them back in performance. But there  
6 are only very few of those.

7 COMMISSIONER GILINSKY: Well, it would be useful to  
8 have your internal working notes.

9 MR. LEWIS: I can give you those, the listing and  
10 they really are listed as our current thing is that they can  
11 go to such and such an enrichment.

12 COMMISSIONER GILINSKY: Haven't we sent out  
13 questionnaires asking for information.

14 MR. D. HOYLE: These have been done -- this information  
15 has normally been expected at the time the export license  
16 application is made.

17 We have, in some cases said that if they want to  
18 expedite the export licensing procedure when it occurs that  
19 they could give us that information in advance so that it  
20 could be reviewed by the Argonne people and we wouldn't have to  
21 start from scratch at the time the export license application  
22 was made. In fact, there are some people coming in from the  
23 European community, particular the NUKEM people in a couple  
24 of weeks, to go over all of the reactors for which they provide  
25 fuel to determine what information is lacking on those reactors

1 that we need for these analysis.

2 COMMISSIONER GILINSKY: Does the NRC staff get to  
3 take a look at this?

4 MR. D. HOYLE: Certainly the information is  
5 available. We have not actually to date gotten -- we have  
6 gotten sort of the details of the Argonne information, but  
7 I see no reason that -- we have gotten summaries, if you will.

8 COMMISSIONER GILINSKY: Is that normally sent  
9 forward with the applications or with your advice?

10 MR. D. HOYLE: Well, I think the problem that Dick  
11 hasn't yet hit on is that there are no fuel fabricators for  
12 most of these fuels. We have got a very practical problem.  
13 Even though the fuels exist, the fabricators don't exist, and  
14 this has been one of the things we have been trying in the last  
15 few weeks to help resolve.

16 The manufactures have been manufacturing the fuels  
17 in accordance largely -- of course, there is no U.S. fuel  
18 fabricators of plate-type fuels any longer since U.S. Nuclear  
19 has gone out of the business, except those which utilize  
20 DOE-owned equipment and do this on a cost-plus, fixed-fee basis  
21 and their capacity is rather limited. So most of the  
22 capacity for plate-type fuel exists in Western Europe, NUKEM  
23 and CERCA specifically, and of course, they have even been  
24 fabricating the GETR fuel and for the Sterling Forest carbide  
25 reactor in Germany.

1                   COMMISSIONER GILINSKY: Well, where do we go from  
2 here then, suppose Argonne concludes that a certain class  
3 of reactors with no degradation in performance accept lower  
4 enrichment fuel, what happens then?

5                   MR. D. HOYLE: Well, I think it is a carrot and  
6 stick proposition, again. We ultimately are going to have  
7 to force the issue. On the other hand, in our recent visit  
8 to Europe to NUKEM and CERCA we found that these companies  
9 had anticipated this development and were in the process of  
10 getting ready, at least in terms of looking at advanced  
11 developments and so on.

12                   Now, again, one of the real problems is they are  
13 handling one enrichment currently, 93 percent, and it  
14 complicates their manufacturing life substantially to go to  
15 two or even to three enrichments. Some have indicated they  
16 don't want to handle more than the maximum of two under  
17 any circumstance. In this intermediate enrichment which Dick  
18 has briefly alluded to, we have told everyone that we are not  
19 going to have 17 intermediate enrichments. We are going to  
20 ultimately, after some screening, decide on one enrichment  
21 so there will only be basically three, 20, something between  
22 say 30 and 45, and a 93 percent.

23                   They are moving toward this certainly, and General  
24 Atomic has announced a 20 percent fuel which would be  
25 a replacement for its current 70 and 93 percent fuels. In

1 some cases this is based on an extrapolation of really, a  
2 state of the art technology, but they seem to have a high  
3 degree of confidence in this, going from essentially 12  
4 weight percent uranium to 45 weight percent uranium in their  
5 fuel.

6  
7 So some of these fuels conceivably could be used  
8 in reactors currently using plate-type fuels, but again to  
9 some extent that the reactor operator has -- he may be  
10 reluctant to change for a number of reasons, including the  
11 necessity of getting new regulatory approvals and so forth of  
12 his national authorities. So it is going to take a little  
13 while and it is a number of sort of coordinated and parallel  
14 actions, I think, are going to be necessary to ---

15 COMMISSIONER GILINSKY: But this other aspect is  
16 also being addressed, in other words, how to implement it?

17 MR. D. HOYLE: Oh, yes. We have talked with these  
18 fabricators, there is consideration being given to a meeting  
19 of fabricators from around the world, perhaps at Argonne in  
20 the fall.

21 I believe the European community is going to ask  
22 us to talk to users in the European community. The users,  
23 in fact, seem somewhat more reluctant, for understandable  
24 reasons, I think, than the fuel fabricators. The fuel  
25 fabricators' only concern is can they still make a profit,  
and that's their major concern.



1 MR. LEWIS: Okay, that brings us well in to this  
2 second point under the program, U.S. and Foreign Reaction  
3 to the Program. Briefly it has been following -- page 5,  
4 Section 5.2.

5 The reaction of U.S. and foreign research reactor  
6 operators and fuel suppliers to the thrust of the U.S. program  
7 has been favorable, I think it is fair to say, but cautious.

8 ANL is currently initiating reduced enrichment  
9 studies for new reactors, jointly with the Japanese and the  
10 Australians. In fact, personnel exchanges on those programs  
11 start this month. They are both designing new reactors, the  
12 only two new ones in the world that I know of.

13 We are also undertaking at ANL a numerous case  
14 studies of reduced enrichment conversions of existing U.S.  
15 and foreign reactors. Many of these are or will be joint  
16 studies with the affected groups.

17 Now, the U.S. and European fuel suppliers, I think,  
18 are moving quickly, much more quickly than I had expected  
19 to be in a position to supply high uranium density, low enriched  
20 replacement fuels for existing and new reactors at 20 and 45  
21 percent enrichment starting in one to two years, maybe even  
22 a little less than a year.

23 The fuel fabricators, the commercial ones, are, of  
24 course, General Atomic for zirconium hydride uranium fuels.  
25 They have moved out very quickly, partly due to DOE sponsorship

1 of work there, but they are now talking about a complete line  
2 of 20 percent enriched fuel for all of their reactors. They  
3 plan not to produce any more highly enriched fuel.

4 MR. D. HOYLE: Incidentally, if I could interrupt,  
5 Dick, one of the major motivations in this has been the ever-  
6 increasing cost of physical security in highly enriched  
7 uranium fuel, and they now believe that about 40 percent of  
8 their fabrication costs are related to accountability and  
9 physical security. Now, while this won't entirely be  
10 eliminated by going to 20 percent or less, a major portion  
11 will.

12 MR. LEWIS: Especially if any of their work is 93.

13 MR. D. HOYLE: Yes.

14 COMMISSIONER GILINSKY: It seems to me to make a lot  
15 more sense by having lower enrichment fuel than by having a  
16 lot of policemen around and that really is a very desirable  
17 development.

18 MR. D. HOYLE: Well, that's the idea, that's the  
19 overall point of all of this.

20 COMMISSIONER GILINSKY: So it is a terribly important  
21 thing to do.

22 MR. D. HOYLE: We have sold the lowering of HEU  
23 largely to foreign countries not on the aspect that we mistrust  
24 your intentions, but rather we all have problems with  
25 terrorism and irresponsible parties. So really this program

1 is basically a physical security sold program, if you will.

2 MR. LEWIS: Now, NUKEM in Germany and CERCA in  
3 France have moved, I think, very quickly in doing -- they  
4 both produce ULA<sub>x</sub> aluminide fuel types, and they have done  
5 an amazing amount of work in the last few months looking at  
6 very high uranium loadings. They won't tell us everything  
7 they know for proprietary reasons, but they are preparing  
8 for this coming up.

9 Reactor operators are much less up-beat. They  
10 are concerned, of course, primarily about reliability of  
11 fuel supply and about the performance of the reactors and  
12 very leery about problems that might be raised in safety and  
13 licensing reviews associated with going to the lower enrich-  
14 ments. They, of course are worried about the ratcheting  
15 effect that when the safety and licensing reviews are reopened,  
16 even for this item that other things would be brought in that  
17 would basically put them out of business. They are cautious,  
18 to say the least.

19 Then skipping on to page 15, as an overview statement,  
20 though most reactor operators in the U.S. and abroad, can  
21 see the feasibility of the U.S. enrichment reduction strategy  
22 broadly. Many operators of existing reactors at 30 megawatts  
23 and above feel that near-term enrichment reduction is  
24 infeasible for them, that is, enrichment reductions must  
25 await development of higher uranium density fuels. We generally

1 agree with that, especially for those reactors currently  
2 using the highest state of the art uranium density fuel  
3 technologies. So I think there is pretty much a meeting of  
4 the minds if you stick to the no reduction in performance  
5 criteria, but perhaps some increase in fuel cost if you  
6 go that way.

7 Now, let me skip over this area of Program Status,  
8 you can read that if you are interested, but it is underway --  
9 substantially underway.

10 All right, let me just very briefly say with regard  
11 to Item 6, starting on page 18, there is an overview here of  
12 State-of-the-Art of Research Reactor Fuels Technology, we  
13 are talking about basically three fuel types: Aluminum  
14 plate fuel loaded with either uranium aluminum alloy at say  
15 18 or 20 weight percent uranium,  $U_3O_8$  aluminum or  $UAl_x$   
16 aluminum and the latter two the state of the art is 42 to 45  
17 weight percent.

18 Secondly, there are the U-ZrH TRIGA type rodged fuels  
19 that curenly are produced at 8 and a half and 10 weight  
20 percent uranium and at 20, 70 and 93 percent enrichment and this  
21 is the GAI line. Then there us  $UO_2$  rodged fuel that is used  
22 for a couple of reactors in the U.S., the so-called pulsor  
23 reactors. Well, the  $UO_2$  rodged fuel is basically power  
24 reactor fuel.

25 Now, jumping over to page 21 let me just say a few

1 about the prospects for development of higher uranium loading  
2 fuels. First of all, increasing the weight percent of  
3 uranium in any one of these fuels increases the uranium  
4 density, both because the fuel meat density increases and  
5 because a fraction of the density, that is, the uranium  
6 increases.

7 The figure on the next page shows the effect, that is,  
8 there is a compounding effect, as you go to higher weight  
9 fractions of the dispersed fuel phase the uranium loadings  
10 in grams per cubic centimeter go up more rapidly than the  
11 weight fraction. It also illustrates how very low the  
12 uranium loadings are in these fuel meats, not only on the  
13 order of 2. ---

14 COMMISSIONER GILINSKY: Why is that, in order to get  
15 an alloy with good properties?

16 MR. LEWIS: Well, basically you want -- it is either  
17 metallurgical limits in the case of zirconium hydrides  
18 situation or what they thought were metallurgical limits, but  
19 in the aluminum plate-type arrangements what you need is  
20 very thin, very uniform distributions of fuel in the fuel  
21 meat to avoid hot spots and get a lot of heat transfer surface.  
22 And you need a reasonable economical fabrication technique  
23 such as rolling. But that's why this comes out -- I mean this  
24 compared with, for example, maybe 9 grams per cc, maybe 9 or 10 --  
25 it would be 9 grams per cc in  $\text{UO}_2$ . So you see, you are

1 fighting that problem right off the bat.

2 CHAIRMAN HENDRIE: But the answer principally is  
3 yes to your question. The properties of your fuel meat under  
4 radiation -- temperature and radiation conditions are what  
5 you are fighting. You are also fighting fabrication probably  
6 to a certain extent. You load the meat compact up, you  
7 get to progressively harder materials to roll out and maintain  
8 in a fuel flight, the uniformity of distribution and the  
9 thickness properties and so on, the dog-boning, the fish-  
10 tailing out at the ends of the plates is getting to really be  
11 a fierce problem.

12 MR. WILLIAMSON: I think it is also safe to say  
13 frankly, that you are also fighting a lot of inertia. You  
14 could fabricate good fuels this way reasonably and cheaply,  
15 there wasn't much point in trying to do anything else until  
16 a couple of things happened once the development of the very  
17 very high flux reactors, on the one hand, and second the  
18 non-proliferation concerns.

19 MR. D. HOYLE: Well, this is not a big business.  
20 It is run on pretty profit margins, so the margin for research  
21 and development has witnessed the fact that some 9 fabricators  
22 have come and gone in the U.S. since the beginning days, 9 or  
23 10.

24 NUKEM, for example, said that under the impetus of  
25 the new U.S. policy, when they first started looking at this

1 about a year ago, they now have learned a technique which  
2 they did not describe, which permits higher uranium loadings  
3 in all types of fuels, even and including the alloy fuels  
4 with yields which are as least as good or better than they  
5 had been getting before. So I agree with Rick, it is just  
6 sort of an inertia which is largely borne of economic  
7 considerations.

8 MR. LEWIS: That's why I think it is fair to say  
9 that the inertia comes from economics and conservatism.  
10 After all, you have got to have very reliable fuel and when  
11 you get one that works, you don't change that unless there is  
12 a very good reason.

13 COMMISSIONER GILINSKY: Well, there's a good reason.

14 MR. LEWIS: Okay, now you have a new criterion.

15 But briefly, what are the prospects for increased  
16 uranium loadings, and I would break this into three areas.  
17 The aluminum plate-type fuels, the TRIGA type fuels and  
18 special fuels.

19 Now, you can start with the state-of-the-art  
20 aluminum plate-type fuels,  $U_3O_8$  or aluminide dispersions in  
21 aluminum, and you can raise the weight percent. And it is  
22 felt by the experts in the U.S. and I find now in Europe also,  
23 that you can probably go successfully from the 42 weigh  
24 percent uranium up to perhaps 60 or maybe 65 weight percent,  
25 particularly the aluminide looks attractive, but both are being

1 looked at. There are the problems that you alluded to in that  
2 but I think that will be successful. And that in itself would  
3 permit 95 percent of the reactors in the world to go to 20  
4 percent, if you could just do that.

5 Now, in the second area of TRIGA, uranium zirconium  
6 hydride fuels, of course TRIGA has less of a problem. They  
7 are inherently a lower reactor. It is a rodged reactor and  
8 inherently you have got less heat transfer surface per gram  
9 of fuel and that sort of design, even though you make the pins --  
10 we are talking about very small pins for their high power  
11 reactor. So they can more easily go to 20 percent for their  
12 market, but they have undertaken partially at DOE expense,  
13 development of higher uranium loading of zirconium hydride  
14 fuel, they have under development 20 weight percent, 30 weight  
15 percent and 45 weight percent.

16 They are very optimistic as it typical of General  
17 Atomic, I think generally, about all of those fuels. I guess  
18 I am less sure, but I'm sure that the 20 percent is feasible,  
19 maybe the 30 percent and hopefully the 45. They say they are  
20 ready to give a fixed price bit on fuel delivered at 45 weight  
21 percent and I can just say, well, I've got my fingers crossed  
22 for them.

23 There is a lot of testing, of course, that has to be  
24 done yet on that, in my view.

25 Now, going on then to the special fuels  $\text{UO}_2$  -- one



1 way that you can use  $\text{UO}_2$  is in platelet form, thin plats  
2 clad in Zircalloy. I am told that at various points in the  
3 U.S. fuel development program for power reactors such as  
4 EBWR, this was part of our program and it may be part of the  
5 military program for all I know, but the French, as a matter  
6 of fact, seriously plan to use thin plate  $\text{UO}_2$ , they call it  
7 their caramel fuel design, so seriously that CEA is currently  
8 fabricating a full core of this type of fuel for a Asyris  
9 which is a 70 megawatt reactor. It is currently using MTR,  
10 uranium aluminum plate type fuel and it will go too this  
11 thin  $\text{UO}_2$  plate fuel at somewhere in the 7 to 8 percent  
12 enrichment range.

13 MR. D. HOYLE: If I might interject there, I think  
14 the big question perhaps is not whether this fuel will work,  
15 but what it will cost. What they are doing is on strictly  
16 a bench scale and most people think this will be a very  
17 expensive fuel to fabricate on a commercial scale.

18 MR. LEWIS: There is also the question of fuel reliab-  
19 ility, because in order to make it reasonable economical, they  
20 are going to have to back off on quality of the fuel. And if  
21 they do that there are real questions as the French can see  
22 it whether the fuel can stand the power densities that are  
23 in these cores. So it is a test which is one of the French  
24 answers to the reduced enrichment problem.

25 Now, beyond the  $\text{U}_3\text{O}_8$  and  $\text{ULA}_x$  work in the area of

1 special fuels the U.S. is currently looking at uranium 10  
2 percent molly, uranium silicide and UC for fuel meats, either  
3 as platelets -- directly as platelets or as distributions in  
4 aluminum. Those are quite a bit more speculative, but they  
5 do hold out the prospect of much higher thermal conductivity  
6 than  $\text{UO}_2$  and very high uranium densities.

7 If they were successful, I think you could talk  
8 about reducing all of the research reactors down, if not to  
9 20 percent, at least to say 45 percent enrichment. But that  
10 has got to await the success of those developments.

11 I noticed in our discussions with the French that  
12 the CEA people were also looking at the U-10 molly for this  
13 application.

14 Well, in conclusion, let me just go to page 24 and  
15 make a pitch for a few things that the NRC could do to help  
16 us in the program.

17 Firstly, as we have already discussed with Bill Ross  
18 in Reactor Safeguards Branch in NRC, it would be very useful  
19 to have the NRC promulgate safeguards regulations, specifically  
20 for test and research reactors in the first place, reflecting  
21 their particular situation. But beyond that, regulations  
22 that would give credit for enrichment reductions below 93  
23 percent, but substantially above 20 percent. And I think  
24 specifically 45 percent, but the optimum would be a sliding  
25 scale of, let's say the trigger quantity of fuel as a function

1 of enrichment.

2 Secondly, you are going to be receiving license  
3 applications for use of ULA<sub>x</sub> aluminum, and probably U3O8  
4 aluminum fuels in licensed reactors replacing uranium aluminum  
5 alloy fuels within the U.S. And these license applications,  
6 especially the first few would be very helpful to expedite  
7 these. The University of Michigan, in fact, has one now in  
8 and pending for a UAL<sub>x</sub> conversion that happens to be at 93  
9 percent enrichment and a very low weight percent. That is  
10 a particular situation, and when United Nuclear went out of  
11 business there were no sources for their fuel, so DOE asked  
12 Atomics International to make them fuel. Atomics International  
13 makes only aluminide fuels. So what they did, they backed off  
14 from the state-of-the-art weight percent way down to, I don't  
15 know, 5 weight percent or something, uranium a very low mix,  
16 but at 93 percent enrichment and gave them fuel that has their  
17 same U-235 per plate. But that conversion, there is a safety  
18 analysis report or license in for license review now, an  
19 addendum.

20 MR. D. HOYLE: Dick, if I could just interject one  
21 other thing here.

22 Not only do I think it is important to get some of  
23 these fuels in and demonstrated, I think that is going to be  
24 the proof test for the reactor operators, but since so many  
25 regulatory bodies abroad do look to the NRC's rule-making and

1 decisions in their own practice, that this would have  
2 sort of a double-barrel positive effect going toward lower  
3 enrichments, I believe.

4 MR. WILLIAMSON: In some places in the world that  
5 may well be the pacing item. In some countries, we were  
6 told the reactor operators are doing almost anything to not  
7 change anything, because they don't want to void their  
8 licensing set up as long as they don't change anything, you  
9 know, their license continues. The minute they change  
10 anything, even in the direction of greater safety, they need  
11 an entirely new license.

12 COMMISSIONER GILINSKY: We have that problem too.

13 MR. WILLIAMSON: We were rather surprised by the  
14 degree to which, when we talked to people at the IAEA  
15 advisory group meeting that we all attended, how much the  
16 reactor operators were more concerned by the licensing and  
17 safety implications than they were by fuel cycle costs or  
18 whether the fuel would work or anything else.

19 COMMISSIONER GILINSKY: Well, who is in charge of this  
20 here, do we have somebody who is overseeing this here?

21 MR. GOSSICK: No, I think NRR is generally aware of  
22 what is going on, but I'm not sure. You talked to, I believe,  
23 Ross in Reactor Licensing.

24 MR. LEWIS: We gave a briefing similar to this to  
25 J. Miller?

1 MR. GOSSICK: Yes.

2 COMMISSIONER GILINSKY: Isn't he in Security?

3 CHAIRMAN HENDRIE: That's on the security side,  
4 to see what differences you might make with regard to 93  
5 versus 45 to 20 on the security, maybe. The questions of  
6 reviewing applications for changeover to increased uranium  
7 loading decreased enrichment of fuels would come ---

8 MR. GOSSICK: Out of the operating reactor branch,  
9 probably, Stello, wouldn't it?

10 CHAIRMAN HENDRIE: Yes.

11 COMMISSIONER GILINSKY: It would seem to me it would  
12 be good if there was just somebody who is a contact point for  
13 others.

14 MR. LEWIS: So far, Bill Ross has done this.

15 MR. GOSSICK: Bill Ross has done that?

16 MR. LEWIS: Yes, but that's more in the safeguards  
17 area. But he has taken the initiative on that.

18 MR. GOSSICK: I will talk to Ed Case and see.

19 COMMISSIONER GILINSKY: See if this isn't important  
20 enough that there just out to be one person that you can go  
21 to.

22 MR. WILLIAMSON: One of the recommendations coming  
23 out of the advisory group meeting was that the IAEA consider  
24 holding a further special group, whether it be an advisory  
25 group or a meeting of consultants it wasn't clear, to assist

1 countries that wanted to look into questions of regulation,  
2 safety and what have you with respect to research reactors  
3 and the use of the low enriched fuels. I assume that the  
4 agency will accept that recommendation. We will be scheduling  
5 a meeting of experts and I think it is very clear that the  
6 countries concerned will be looking to the U.S., and that means  
7 in this case the NRC, for some leadership in how you go about  
8 making safety analysis for these new fuels and how you draft  
9 regulations to conform to the new fuels, et cetera. I don't  
10 know how quickly the IAEA will be moving on this, but I  
11 anticipate we will be having a meeting probably within 6 months  
12 to year in this area. So I think some preparatory work will  
13 probably be needed.

14 COMMISSIONER GILINSKY: This is all terribly impor-  
15 tant, unfortunately there are artifical constraints that  
16 impede this job.

17 Who is handling this at DOE?

18 MR. LEWIS: The people involved are Sal Ceja (C-E-J-A)  
19 in International Affairs and Wade Ballard (B-A-L-L-A-R-D) in  
20 Nuclear Energy. Wade is ---

21 COMMISSIONER GILINSKY: The research people aren't  
22 involved in it?

23 MR. LEWIS: No, this is all within Thorne's -- well,  
24 International Affairs is separate, but within Thorne's area.

25 COMMISSIONER GILINSKY: I would have thought that --

1 wouldn't John Deutch be funding some of this work here in  
2 the sense that ---

3 MR. LEWIS: Let me defer that---

4 COMMISSIONER GILINSKY: I guess I meant that some  
5 of the research efforts in the labs would only fall under  
6 him.

7 MR. LEWIS: Oh, the uses of reactors, definitely  
8 do.

9 CHAIRMAN HENDRIE: Yes, but John's research empire  
10 in the lab stems towards the basic research. I guess it is  
11 the non-biomedical basic research, physics, chemistry ---

12 COMMISSIONER GILINSKY: Well, is there some informal  
13 group of something that pursues this?

14 MR. D. HOYLE: Do you mean within DOE or otherwise?

15 There is a subgroup, the NSC ad hoc group on  
16 nonproliferation which follows HEU matters. In fact, I chair  
17 that group and it has interagency representation including the  
18 NRC, I might add. We are going to have a meeting on Friday  
19 to bring people up to speed of that group.

20 CHAIRMAN HENDRIE: Who is our representative?

21 MR. D. HOYLE: Jim Shea or one of his people has  
22 participating in that.

23 MR. WILLIAMSON: Much of that same group, in turn,  
24 overlaps the same group on nuclear export control. So a lot  
25 of the same representatives are involved. So this gets cranked

1 into that quite heavily.

2 CHAIRMAN HENDRIE: Let's see, you are in touch with  
3 that group, that's fine. You have a good reason then to have  
4 contact in Reactor Safeguards Branch or the security aspects  
5 are covered. I think it would be useful to sort of bring on  
6 board the safety side reviewers in NRR who have to deal with  
7 applications to go over from the highly enriched flow direction--

8 MR. GOSSICK: I will talk with Ed and see what he  
9 wants to set up.

10 CHAIRMAN HENDRIE: -- the plate forms and so on and  
11 get a lead contact there. I think if NRC could do, particularly,  
12 work on the like, could do an effective job in reviewing  
13 amendments, or at least the first few when they finally come  
14 in, the reactors that will be coming in attempting to do this  
15 that that might encourage others to set forward and talk  
16 to fuel suppliers.

17 Are all the research reactors contracting -- they  
18 are having to contract in Europe, I guess, for elements?

19 MR. LEWIS: No, well, the ones that are privately  
20 funded, I think generally are, but those that could get their  
21 funding through DOE are generally now still going through DOE  
22 and DOE is setting up Atomics International to provide their  
23 fuel supplies.

24 CHAIRMAN HENDRIE: Plate-type?

25 MR. LEWIS: Plate-type.



1 MR. D. HOYLE: On a cost-plus, fixed-fee basis.

2 Well, actually they would provide it, whereas before  
3 they have been giving a financial grant toward the procurement  
4 of such fuel when U.S. Nuclear and others were operating.  
5 Now, they would simply just be providing the fuel ---

6 COMMISSIONER GILINSKY: We are still supporting ---

7 MR. D. HOYLE: Oh, yes. About a dozen or something  
8 like that. Ten, I think, something 8 or 10 which the University  
9 of Missouri of one of them, University of Michigan and so forth.  
10 This fortunately gives us a little additional leverage in  
11 trying to encourage the reactor operators to reduce enrichments,  
12 and we are going to try to make maximum use of that as well.

13 CHAIRMAN HENDRIE: Let's see, there is an outfit in  
14 Massachusetts that makes the ---

15 MR. LEWIS: Yes, that's Texas Instruments.

16 That's also CPFF.

17 CHAIRMAN HENDRIE: -- makes the HIFR fuel.

18 MR. LEWIS: Well, also they are going to production  
19 for HFRB in Brookhaven and ORR. Then again, there is no  
20 commercial fabricators, they want to use higher uranium density  
21 fuels but highly enriched. So they are going to Texas  
22 Instrucment, but that's CPFF.

23 Of course, AI in California primarily makes ATR fuel  
24 for the Naval facilities, and they are sort of branching in to  
25 this research reactor thing as means to divert some of the

1 overhead costs.

2 MR. D. HOYLE: But they made it very clear to us,  
3 although they were totally uninterested in getting in to this  
4 in a commerical basis, that it was again, a very small  
5 potential profit and a very high equipment investment.

6 MR. WILLIAMSON: I might make one or two other quick  
7 observations.

8 In the first place, with respect to safeguards and  
9 security, to the extent that there were matters that were  
10 either within the Executive Branch purview or in the combined  
11 purview of the Executive Branch and the NRC, we have already  
12 moved in several cases, away from the use of contained U-235  
13 as a standard that we would set towards effective kilograms  
14 as a means of encouraging use of lower enrichments. I think  
15 that's one possible solution to the problem for domestic  
16 application here, as well.

17 MR. D. HOYLE: We will, by the way, shortly be  
18 requesting the NSC to interpret the Presidential threshold  
19 approval levels as being effective rather than contain kilograms.  
20 So that will encourage the use of lower enrichments.

21 CHAIRMAN HENDRIE: Let's see, a kilogram of 20 percent ---

22 MR. D. HOYLE: This only applies to above 20 percent.

23 CHAIRMAN HENDRIE: -- is zero effective kilograms?

24 MR. D. HOYLE: Right, right.

25 So even 70 percent, roughly, would be only a little

1 more than half, in terms, that means you could go twice  
2 as much U-235 as you could ---

3 MR. WILLIAMSON: Six times the 45 percent, et cetera.

4 Secondly, we have talked briefly to the IAEA and  
5 to the Austrians about the possibility of a demonstration,  
6 a foreign demonstration at the Dedesivorsdorf Reactor.  
7 That is not the only candid, but it is one for a fairly early  
8 demonstration that these higher weight percent fuels can be  
9 used effectively. We do think that it is important to have  
10 a fairly early demonstration.

11 MR. LEWIS: I think it is worth saying that from  
12 a safety and license point of view that the intermediate  
13 enrichment reductions either to 45 percent or in some cases  
14 at 20, mean the introduction of existing technology. It is  
15 used in ATR, it is used in HIFR, HFBR and so on, so it is not  
16 totally new, but it is new for the reactors involved. They  
17 have to be assured of the safety and for many countries it is  
18 a new technology for them.

19 MR. D. HOYLE: We also believe that there will ---

20 CHAIRMAN HENDRIE: I don't think there is that  
21 much safety involved.

22 MR. LEWIS: I don't either.

23 CHAIRMAN HENDRIE: If you can run a 40 weight percent  
24 UAL mix in aluminum with uranium fully enriched and drive it out  
25 to high burnout, you sure don't look for much problem by taking

1 the same metallurgical mix that on a 20 percent enrichment  
2 and running that out until the reactivity is run down and  
3 you have to turn the machine off and reload, because you just  
4 will have fewer fissions per cubic centimeter of that matrix  
5 material for radiation damage ---

6 MR. LEWIS: But I have argued a fact on that basis  
7 that you probably don't need any demonstrations, big large  
8 scale demonstrations, full scale burnouts, but reactor  
9 operators are more conservative. They want to ---

10 CHAIRMAN HENDRIE: Ah, they talked to our licensing  
11 people.

12 (Laughter)

13 MR. D. HOYLE: I might also add that we expect some  
14 proposals for cooperation from the foreign fabricators,  
15 perhaps from CEA as well, which is developing the caramel fuel.  
16 The limitations are largely as one would suspect in the  
17 proprietary information area, but there might be exchanges of  
18 sample and some irradiations and reactors of the respected  
19 countries. We are kind of open, in a way, for proposals and  
20 there seems to be an interest in this area.

21 MR. WILLIAMSON: There is one final thing which has  
22 not been publicly announced which I think I can say here, and  
23 that is we hope to have an announcement, perhaps this week,  
24 at the UN special session on disarmament of a program of  
25 expanded cooperation in the nuclear field, modest program.

1           It is largely in the nature of a gesture, but  
2 included in that would be some money by the IAEA for  
3 20 percent fuel and for fabrication services, so that  
4 instead of relying exclusively on the stick of not making  
5 HEU available, we will also have some carrots to offer  
6 people as a positive encouragement to lower enrichments.

7           COMMISSIONER GILINSKY: And you said that you  
8 may organize a seminar at Argonne?

9           MR. LEWIS: Well, there are two meetings that are  
10 coming up that are planned, one is primarily for fuel  
11 fabricators and for major R&D organizations such as CEA and  
12 the like where we would look at, first of all, generic  
13 problems in reduced enrichment designs, physics and  
14 engineering, and secondly, try to get the manufacturers to  
15 give us as much information as they will on where they stand  
16 on being able to manufacture this stuff.

17           We had planned to maybe organize such a thing in  
18 September or October of this year, probably by invitation only,  
19 but invite particularly the French, the Germans and the  
20 Japanese. Those are the main categories.

21           Then a broader meeting is planned probably next  
22 year by IAEA of reactor operators on the broad subject of  
23 upgrading and renewal of existing reactors and new reactors,  
24 the problems there. That will include case studies in  
25 enrichment reduction. So there are those things coming up.

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2 CHAIRMAN HENDRIE: Okay. Lee, if you would look  
3 in to the NRR licensing side so that all of the NRC group  
4 ought to have interest in and participation in this so it  
5 could be brought forward and understand this effort and the  
6 usefulness of moving ahead with things like the specific case  
7 now in hand, the University of Michigan, that would be very  
8 good.

9 I thank you very much for coming, Dick.

10 COMMISSIONER GILINSKY: Thank you, that was a very  
11 nice briefing.

12 CHAIRMAN HENDRIE: We appreciate it very much. It  
13 was very informative and very helpful.

14 (Whereupon, the Commission took a brief recess at  
15 10:45 then proceeded on to other business.)  
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