

# F.A.S. PUBLIC INTEREST REPORT

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FREEZE HEARINGS  
PART III

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## GOING BEYOND A MINIMAL FREEZE

*What follows are excerpts from the transcript of Part III of hearings on the nuclear freeze, hosted and organized by the Federation of American Scientists in the Dirksen Senate Office Building, March 7, 1983.*

*The interrogating panel of Part III was composed of Dr. Alton Frye (Chairman of the panel), who is Director of the Washington Office of the Council on Foreign Relations; William Hyland, Senior Associate of the Carnegie Endowment for International Peace; and the Federation's Director, Jeremy J. Stone. Frye and Hyland, who are not Federation members, agreed, at FAS's request, to help question nine witnesses chosen by the Federation to discuss special topics related to the nuclear freeze, which expanded upon the core freeze proposal discussed at the Federation's second set of hearings ("Freeze SALT II and Shrink") summarized in the FAS Public Interest Report of January, 1983.*

*The discussion of a fissionable material cutoff was undertaken by FAS Chairman Frank von Hippel and Anthony Fainberg of the Brookhaven National Laboratory. The discussion of the Comprehensive Nuclear Test Ban was led by Professor Lynn Sykes of Columbia University and former Alternate Representative to the Tripartite Comprehensive Test Ban Negotiations, Alan Neidle. A discussion of the problems and advantages of controlling various kinds of weapons tests was undertaken by professors Gordon Kane and Martin Einhorn of the University of Michigan and Dr. Ashton Carter of the Center for International Studies M.I.T. (Unfortunately, this discussion could not be fitted into the much shortened newsletter). Finally, a discussion of the problems and advantages of verifying comprehensive measures, as opposed to separate measures, of freeze was led by FAS staff member Christopher Paine and commented upon by Mr. William M. Arkin of the Institute for Policy Studies.*

*These remarks have been excerpted and made more nearly grammatical by FAS for the purpose of this prompt newsletter, but should not be taken as definitive expressions of the views of the participants as they have not yet had the opportunity to review and clarify their remarks. Part II and this third part of the Federation's hearings may appear subsequently in less excerpted fashion if a suitable publisher can be found for them. (Part I of the Federation's hearings is now already published by Brickhouse Press, 34 Essex Street, Andover, MA. 01810.)*

DR. VON HIPPEL: I want to make three points. The first one is that the amounts of weapons-grade uranium and plutonium already in our weapons stockpile is so large that any operations which would be large enough to increase these amounts significantly would be very visible. It

just is out of the question that covert production operations could be effectively hidden and operated on a scale large enough to significantly increase the amounts of weapons-grade uranium and plutonium in the stockpiles today.

The second point I want to make is that operations which would be permitted after a cutoff—that is civilian operations and also military operations—particularly the production of uranium for naval reactors, would still be processing large enough quantities of potentially weapons-usable materials so that they would have to be safeguarded against diversion.

And the third point, is that such safeguards—safeguards to prevent diversion of weapons-useable materials from the large-scale nuclear operations which would continue after a cutoff of fissionable material production for nuclear weapons—are already well developed in connection with the nonproliferation agreement and have been implemented by the International Atomic Energy Agency.

Now, there is no question, I think, that the safeguards are not effective enough to prevent the production of one or a few nuclear warheads secretly. But there is no question in my view that the IAEA safeguards would be good enough to detect cheating on any scale large enough to be considered significant, again in comparison with the already existing stockpiles on both sides, which include tens of thousands of nuclear weapons.

DR. FAINBERG: First, let me make the disclaimer and say that anything I say is my own and has nothing to do with the director nor the management of Brookhaven Laboratory.



*The Panel of Interrogators  
Hyland, Frye, Stone*

In essence, a freeze on the production of fissionable materials is certainly technically verifiable from the technical point of view, not necessarily from a political point of view, given an accord between the U.S. and the U.S.S.R. which would permit on-site inspection of certain nuclear facilities.

This would be using currently available and well understood safeguard techniques. A good deal of verification could probably also be accomplished less obtrusively by means of satellite reconnaissance. In some cases, however, this is not possible, and therefore there are going to be some institutional barriers which will have to be negotiated if a verifiable freeze on fissionable material production is to take place.

Among my minor differences with Dr. von Hippel is the question of the value of limiting a production freeze, while at the same time maintaining very large stockpiles of fissionable materials. Even if one can halt the production of fissionable materials, if there are stockpiles on the order of many tens of tons on both sides, either side could significantly add to its nuclear weapons inventory by taking its existing stockpile and making warheads out of it.

In order to resolve this problem, there are at least two options. One option would be to place the stockpiles on both sides under essentially an International Atomic Energy Agency type of safeguard whereby on a periodic basis, perhaps yearly, the stockpile would be first inventoried and then later inspected, to make sure that nothing had been drawn out of it.

This, I think, is probably feasible but is quite difficult. I can imagine it taking a very long time, and, not a minor point, it would expose a lot of people to a lot of radiation. It would take a substantial amount of time to inventory, to verify 80 tons of plutonium. You don't have to verify it to a level of 1 percent, but if you are going to verify it to a level of 20 or 30 percent, it would take a long time.



Frank von Hippel

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I have an alternative suggestion which is not entirely original and perhaps somewhat naive, but perhaps it deserves more study and elaboration. That would be, in addition to or as part of a freeze on production, perhaps such an accord between the superpowers could contain an agreement for each side to submit large fractions of their plutonium and highly enriched uranium inventory each year to an international or bilateral authority for storage and later disposal.

This would take the stockpiles out of the arms race in a stronger way. Storage could be in an international facility such as the international plutonium storage facility which has been discussed for years for commercial purposes.

Nevertheless, eventually there is a problem of disposing of the material entirely, and here there are two possibilities, one of which is to try to bury it as irretrievably as possible. The other option that I can think of would be to take those stockpiles of highly enriched uranium and plutonium eventually for use as fuel in specially constructed nuclear reactors where they could be burned. They could provide power, and after running there would be no more plutonium, and they would be totally out of the arms race.

It might be a good idea to put such specially constructed reactors at various places in the third world under international control for the use of third world nations who would be capable of using such large power sources.

Given such a regime where you can verify the halt in production, and where at the same time you are able to do something about the stockpiles, either to prevent their use adequately or to dispose of them entirely, I think it is then possible to put a ceiling on the number of nuclear weapons on both sides. I suspect that ceiling will not be terribly much more than current levels.

More specifically, as to Dr. von Hippel's assessment of the verification capabilities, I am in general agreement. There are, I guess, three basic classes of nuclear facilities which are of primary interest in halting production of weapons materials.

The first are the production reactors. Dealing first with plutonium, plutonium does not occur in any quantities naturally in the world and has to be produced by nuclear reactors. There are several types of reactors. First of all, there are the military production reactors, which have been classically used by both sides specifically for production of weapons grade material. These, as Dr. von Hippel has noted, are very large. They give off a substantial amount of heat, and they can easily be checked, first of all, by satellite reconnaissance for shutdown.

On-site inspection, perhaps with ceiling, might give people like Jesse Helms a warmer feeling. I don't think it is necessary.

Light-water reactors, which are the commercial power reactors of general use in the United States, and about half of those in the Soviet Union, are easily safeguarded with on-site visits to levels of production of plutonium far below anything that we need here. In addition, light-water reactors to be used for providing weapons grade plutonium would have to be turned on and off with significant rapidity, probably every two weeks or so. And it is possible that

### A COMPLETE NUCLEAR WEAPONS FREEZE WOULD STOP

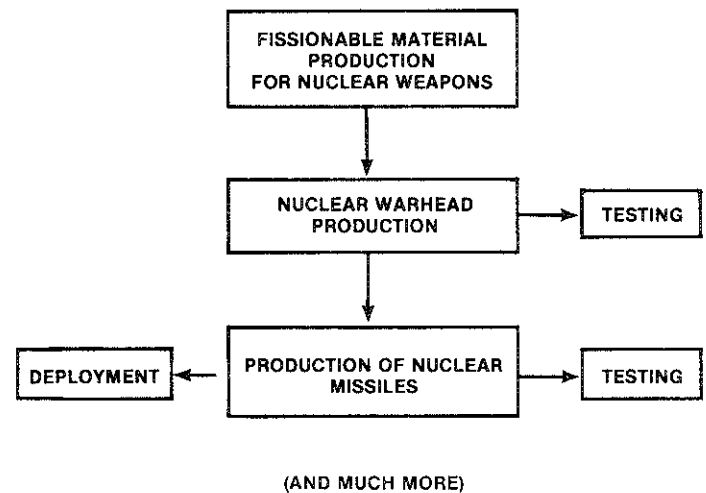


FIGURE 1

even here satellite reconnaissance could be adequate.

The Soviet continually-loaded reactors are a slightly different kettle of fish. They don't have to be shut down in order to extract weapons grade material from them. As Dr. von Hippel, however, notes in his write-up, the amount of fuel which you need to supply these reactors in a weapons producing mode is something like a factor of 20 greater than the amount that they are designed for in the normal commercial power mode.

With on-site inspection, probably a minimal on-site inspection, I think this is a very clear signal for cheating, and I don't see any problem in doing that.

The final problem with reactors: suppose somebody builds a clandestine reactor or a set of clandestine reactors which are not declared. Is this a tenable possibility: that one side could produce on the sly over, say, ten years enough plutonium to make a difference in the balance of power?

I think the answer is clearly no. You need an enormous number of reactors going for a significant amount of time. They have to be large. There have to be many of them and they probably have to number on the order of the entire current Soviet commercial power program. I do not see any possibility of clandestine reactors going undetected. So that is not viable.

Therefore, in summary, as far as plutonium production is concerned, making sure that nobody cheats on plutonium production should be possible because reactors are so easy to monitor and to safeguard.

It is certainly possible to make sure whether or not reprocessing plants are working. You probably have to have on-site inspection for those. However, if you have cut off the supply of plutonium, which is the output of the reactors, it is of less importance to be able to monitor the reprocessing plants very carefully. The reprocessing plants are useless without any supply. The same would apply for construction of clandestine reprocessing plants.

Therefore, a clandestine plant might possibly be built and even operated without detection, but it is very difficult

to see how it would be of any use if you can control the fuel input to it. So, for the whole plutonium side of the question, I don't think there is any problem.

The problem with the halt in fissionable materials is, I think, on the uranium side. On the uranium side, what you are dealing with is the question of enrichment facilities and how well they need to be monitored. In particular, uranium enrichment is needed to a very low level. You have to enrich uranium from its natural levels of about seven-tenths of a percent to on the order of 3 percent for commercial purposes. And there are many enrichment facilities in the world now. The largest ones are in the U.S. and U.S.S.R., which are used for commercial purposes.

These would have to be monitored by on-site means—there is no question about that—to make sure that they are not being used to produce highly enriched uranium.

There are two additional problems. There are things that require highly enriched uranium, as Dr. von Hippel noted, and one of these is the naval fuel reactors on both sides. At present, we certainly cannot say that the nuclear submarines on both sides can be immediately disposed of. They are part of the overall balance, and one has to think of how one can supply them.

There are two good things in this regard, one of which is, as was noted already, that for those submarines, and in fact for the other non-military uses of highly enriched uranium, the amount that is required for these purposes is very small compared even to the current stockpiles.

Therefore, perhaps for a very long time, the required material could be drawn down from existing stockpiles without the need for producing any more. If this is not possible, then some means would have to be found for reaching an agreement to be sure that no highly enriched uranium is being produced on either side in large quantities that is not for these so-called legitimate purposes, that is, certain power reactors, some research reactors, and basically naval fuels.

This could be done in principle, but in practice there may be some difficulty.

I want to make a brief comment. In Dr. von Hippel's written notes, he expresses some hope that almost all the high enriched uranium demands could be satisfied with redesign by lower enriched non-weapons-grade uranium. I am not sure this is necessarily true for naval reactors without sacrificing the Navy's specifications of power and endurance which they would like.

It is possible, and perhaps something that should be looked into in some detail, but I don't think we can assume that at this point.

There is an additional problem which I think would be more serious as time goes on, and that is the existence of clandestine enrichment plants. The main current way of enriching uranium is to use a diffusion plant. Diffusion plants are enormous in terms of size and energy requirements. And I think you can safely say that there is no way that a diffusion plant could be clandestinely built without detection.

A more recent development is the technology of cen-

trifuge enrichment plants, which are approximately an order of magnitude smaller both in size and energy requirements. This is a question that has to be looked into, if a clandestine centrifuge plant could be produced and function for many years without detection. I tend to think not, but it is a matter that has to be looked into in some detail.

However, what is more serious is that five, ten, or fifteen years from now laser enrichment technologies might become mature. There are currently laser enrichment programs going on at the Department of Energy with a time scale of about ten years for large-scale operations. These use far less area, even in the centrifuge plants, and substantially less energy.

I have a feeling that such plants would be rather difficult to find, and it probably would be nice to try to reach an agreement long before those things come on line. I think verifying that these things, that laser enrichment plants, are not functioning would be considerably more difficult.

In conclusion, let me switch for a second from the technical problems to possible institutional barriers to verification of such a freeze on fissile material production as we propose. One possible barrier is that there has to be on-site inspection for a number of things, particularly for the Soviet continually fueled reactors.

The weapons grade military reactors and light-water reactors probably don't even need on-site inspections, although it would be nice to have them. However, I think the Soviet continually fueled reactors probably do. This creates an asymmetry between the superpowers. In other words, the Soviets then would have to accept more inspection than the United States, and that may be an institutional problem to overcome.

A second problem is that there will have to be on-site verification of enrichment plants at least to make sure that they are not producing highly enriched uranium. I think whatever scheme they come with, we are left with that, and

#### FLOWS OF FISSIONABLE MATERIALS IN A NUCLEAR WEAPONS STATE

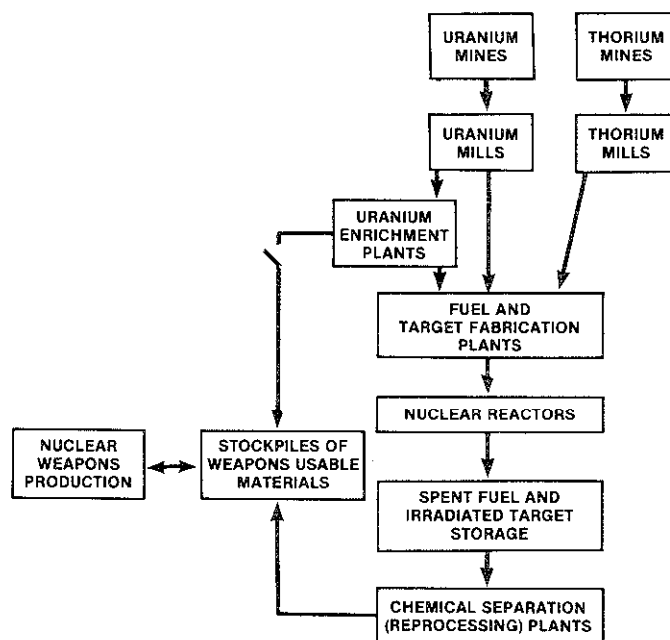


FIGURE 2

that has to be agreed to, and it is not at all certain that that is possible.

Finally, there will have to be an arrangement somehow for supplying non-weapons-bound highly enriched uranium in a controlled way so that each side feels the other side is not cheating to a large degree. Each side needs to be assured the other one is not cheating in large amounts. This could be done either by perhaps drawing down from stockpiles or by means of safeguarding some plants, and I think this last problem is the most serious.

MR. FRYE: I also want, just to be clear in building the record, to understand the definition of the stockpile which you have used in drawing your estimates. Am I correct in assuming that the stockpile numbers you have given—500 tons for U.S. uranium in a highly-enriched form and 80 tons or so of plutonium—that those estimates do not include material fabricated into existing weapons?

DR. von HIPPEL: It includes material both inside and outside of weapons. In the case of plutonium, I think most of that material is probably actually in weapons. In the case of the highly-enriched uranium, I think a large fraction of it, a significant fraction of it, is not in nuclear weapons.

MR. FRYE: With regard to the point of some minor dispute between you and Dr. Fainberg, is it your assumption that Naval reactors, as a principal security application for enriched uranium, could operate with 60 percent enrichment? What estimate do you have that leads you to conclude that those reactors could be operated, and the submarines particularly maintained in the fleet efficiently, without the kind of highly-enriched uranium already available to them?

One doesn't lose very much in terms of longevity of the fuel in a research reactor. But if one is really pushing the technology to its limits—and I think Dr. Fainberg suggests that, in fact, the submarine fuel has been pushed closer to what one can do with the technology than a research reactor—then one gets into tradeoffs. Maybe the submarine, the Trident, is supposed to be able to run for nine years without refueling. Maybe it could only run 20 percent enriched fuel for seven years. That may be an unacceptable tradeoff for the Navy.

I wonder if Dr. Fainberg has some knowledge of current Naval opinion with regard to that. Is there a U.S. Navy position bearing on this question, that you are familiar with?

DR. FAINBERG: No, I am not familiar with it. However, I am aware that the Navy is trying to go in the direction of longer and longer times between refueling. I think they would find this rather onerous.

MR. FRYE: Well, the downtime associated with refueling is significant for Naval operations, and you can understand why they would want to stretch the time and avoid that arduous and technically complex task.

Dr. Fainberg, may I ask you one additional question? You have highlighted a prospective problem with regard to an environment in which fissile material production has been suspended in your discussion of laser enrichment. You have highlighted that as a particularly difficult potential problem if it succeeds because it could operate on a



*Dr. Anthony Fainberg*

scale that might permit clandestine production.

As you have thought about that problem, is the only solution you foresee strangling that technology in the cradle, or is there any way to verify and maintain control if it comes into being?

DR. FAINBERG: That would require significantly more thought than I have given it in the last couple of days. I would just say as a matter of general principle, I think it's absolutely impossible to strangle anything in the cradle. You cannot keep knowledge silent. If one person doesn't find it, another will, and very many countries are, in fact, investigating laser techniques. It is not just the U.S. and U.S.S.R. A number of other countries in the world are doing that.

I think that the way to go, then, would be—and I think probably Dr. von Hippel suggested that in his write-up—would be to try to control the input of uranium fuel to those plants. That is the most likely thing I could find. If you could control uranium mining at that point, and you probably would have to mine a significantly large amount, as he said, to upset the balance of power, that would be the way to go in terms of laser enrichment. I don't really see any other way.

MR. HYLAND: I would like to start with a question to Dr. Fainberg. Do you consider this cutoff a vital element to a freeze on nuclear weapons?

DR. FAINBERG: That is a good point. I don't think so, but the experts who can speak to that more are those who are able to say how well one can verify deployment and non-deployment of weapons. I would consider this as a backup.

If you can verify deployment of weapons to a confidence level of, say, 95 percent, and if you can at the same time verify that no more fissionable material is being produced also to 95 percent, your assurance is the product of 5 percent times 5 percent. You have a much greater assurance against cheating on any freeze if you include this cutoff in fissionable materials.

MR. HYLAND: How long do you think it would take, given the record of arms control negotiations, to negotiate a satisfactory agreement, one that you would be satisfied with, between the United States and the Soviet Union on this particular subject?

DR. FAINBERG: If you mean what are the technical barriers to such negotiation, I would suspect that that could probably be accomplished within a year. But, of course, the main barrier is not technical, but political.

MR. HYLAND: So given political goodwill, it would take a year. How much diversion of material to weapons in a year could the Soviet Union accomplish without our knowing it?

DR. FAINBERG: You mean if such a freeze were enacted?

DR. HYLAND: Not enacted, but being negotiated.

DR. FAINBERG: Oh, during the negotiations.

MR. HYLAND: In a year's time.

DR. FAINBERG: This is something that I am unable to answer right now. However, what one can calculate is how much plutonium the Soviet Union has produced in the past 30 years, figure out how much that comes to in a year, and maybe double or triple it (because technology has increased), and compute an answer probably of a few tons.

MR. HYLAND: A few tons? For the layman, can you translate that into weapons? Are we talking about 100 missiles or two missiles? I just don't know.

DR. FAINBERG: If you're talking about, say, 2000 kilograms, two tons, and if you figure roughly 5 kilograms per weapon, which is a very rough number, that would come, I guess, to 400 weapons.

MR. HYLAND: Four hundred weapons. Okay. Now, I would like to ask—

DR. FAINBERG: Could I emphasize that there are currently about 20,000 or 30,000 on each side.

MR. HYLAND: Just one last question. Dr. Fainberg suggested that there might be a possibility to create 400 new missiles while you were negotiating this one aspect of a freeze. Would you consider that a significant drawback?

DR. von HIPPEL: I think I would probably increase the number that he was suggesting. In a year's time, both sides could currently produce on the order of enough material for 1000 warheads.

MR. HYLAND: A thousand warheads?

DR. von HIPPEL: Right. Every year's delay makes the situation that we're trying to control that much worse. So I think it's unfortunate that we can't instantly mandate a freeze and a cutoff. But it would take time and I don't think that such an increase in the amount of material, in the weapons-usable material, which could be on the order of 10 percent in the stockpiles of the two superpowers, would undercut the value of stopping this production after this 10 percent increase.

MR. HYLAND: So you don't think that the 1000 warheads that might be produced in this period are significant?

DR. von HIPPEL: I think it's significant, but I don't think a 10 percent increase in the stockpiles on each side would undercut the value of seeking such an agreement.

MR. HYLAND: My last question, then, is why wouldn't it be better to use that year to get a reduction, even if it was a reduction of less than what Reagan has proposed, than to use a year arguing about the freeze—if in that year you would have no confidence that they would not divert material to 1000 new warheads?

DR. von HIPPEL: I am all in favor of any way that we can speed up a halt to the production of these weapons. I think that you have to have verification under any of these agreements, and that is what is going to be taking the time and causing the delay in the negotiations.

MR. HYLAND: Then isn't it fair to say that one of the biggest drawbacks to the freeze is that, in the period required to negotiate it, both sides might have an incentive to circumvent the spirit and intent of the freeze and stockpile weapons, increase production, divert materials and so forth?

DR. von HIPPEL: My personal view is that we should not wait to enact partial agreements until we have a comprehensive agreement in place. Any element of freeze that we can stop, we should agree as quickly as possible to stop. Any reductions, similarly.

DR. STONE: Mr. Hyland has raised one of the most interesting reasons for having moratoria precede the freeze, while negotiations go forward to make more ironclad the restrictions which might under the moratorium be weaker. The purpose would be, in effect, to prevent preemptive circumvention. One interesting question, of course, is to what extent this could be done.

A second point that Mr. Hyland's questions raised is whether the United States or the Soviet Union is capable of negotiating about more than one thing at one time, at the same time.

In particular, it seems to me there was a time in the mid-fifties when there were working groups working on a varie-

**Table 1. Superpower Plutonium Stockpiles and Annual production Rates (tonnes)**

	Stockpiles		Production Rates	
	US	USSR	US	USSR
Weapons-Grade Plutonium from Dedicated Reactors(a)	80	?	1-2	?
Weapons-Grade Plutonium from Dual-Purpose Reactors	0	up to 20	about 0.7	up to 12
Plutonium-239 in Light Water	36	2.7	6.4	1.1
Miscellaneous Fuel Grade	17			



ty of different things simultaneously with the Soviet Union so as to see which were the technically most ripe areas.

I agree with the implication in Mr. Hyland's questions, if that was the implication, that one would not want to spend a year on fissionable material restraints if one had then to work in series on everything else. If one did that, fissionable material would not, I agree with Mr. Hyland, be the first priority.

My question is this. If one did have a cutoff on fissionable material, would the Soviet Union, if it wanted more nuclear weapons, violate the agreement or just circumvent it?

Is it not true that any number of thousands of warheads that they might want would be available, either from stockpiles of fissionable material already produced which were not in weapons, or by using existing fissionable material more effectively (e.g., by taking old bombs and subdividing them into newer and more efficient bombs)?

DR. FAINBERG: Yes. As far as recycling from other weapons is concerned, I agree. I am not sure how much of a scope that would give them. I tend to doubt that they would be able to double their number of warheads, for example, by doing that. Also, in some cases they would have to open reprocessing facilities if some of the fissionable materials built up unwanted isotopes that would have to be separated by reprocessing.

That would give one, perhaps, a handle on preventing that kind of thing.

DR. STONE: But doubling, of course, is a very high measure since, as you pointed out, they have tens of thousands of nuclear warheads.

DR. FAINBERG: The question is how much would alter the strategic balance. I think you would have a hard time arguing that less than, say, a 50 percent increase in warheads would really have any effect on the strategic balance.

DR. STONE: I agree if you are talking about what would affect the strategic balance. That is a measure which is very supportive of a freeze. The strategic balance is so robust that so long as you prevent an anti-ballistic missile system on each side—against which we already have a treaty—it is very hard to change the strategic balance.

But if real senators were sitting here, and they were contemplating a 50 percent increase on the Soviet side during your fissionable material freeze, and they knew they had tens of thousands of warheads and 50 percent meant more thousands of warheads, that would be more than this Senate office building would tolerate.

So what I want to know is this: is it not true that they could get, for example, a 10 percent expansion in warheads just by reshuffling? Dr. von Hippel?

DR. von HIPPEL: Yes. I think the limit on warhead production that a fissionable material cutoff would impose is a loose one, as you imply. It puts an overall ceiling. But this ceiling can be helpful. I think it is useful to look back in history. President Eisenhower first proposed this in 1956. If we had, in fact, implemented a freeze at that time on the amount of fissionable materials—which in the stockpiles was on the order of 10 percent of what they are



Jeremy J. Stone

today—we would probably not have gone as far down the road in counter-force multiple warheads and all these kinds of things that are giving us nightmares now.

So in the longer term it does cut off certain enormous expansions that one could have nightmares about. In the shorter term, it is supportive to other aspects of a freeze. If you want to stop the production of warheads, then it will be very helpful to eliminate unsafeguarded flows of weapons-usable materials which would continue in the absence of a cutoff of weapons-usable materials.

DR. STONE: As part of the preparations for negotiating this proposal, you would like to see the United States Government inform the public in greater detail of the knowledge available on Soviet past production and the amount of fissionable material that might have been produced?

DR. von HIPPEL: Yes.

DR. STONE: If we were trying to persuade senators in this building to support the fissionable material cutoff, perhaps complemented with the kinds of things that would make it tighter, like warhead fabrication agreements and so on, what would be the supportive hawkish arguments that might be used in this building—the so-called hard-nosed arguments?

DR. von HIPPEL: Because of an historical accident, perhaps, in the way the Soviet Union's nuclear power program has evolved, about half of their nuclear capacity is closely related to plutonium production reactors. We don't have such an easily convertible capability to produce large amounts of weapons-usable material in our civilian sector. But they do and we could get inspectors into those plants to make sure that they weren't producing weapons-usable materials.

DR. STONE: So we are *less* ready now to go forward to manufacturing a great deal more plutonium than the Russians but, in the absence of a freeze, will need to do so, whereas the Soviet Union is ready to go ahead with it, now.

MR. HYLAND: To pick up an earlier point of Jeremy's, if you are worried about weapons, and not

material, during any moratorium or negotiation it is possible to change your weapons mix significantly, radically. You don't have to keep a fixed amount of plutonium in a given weapon, and there is no possibility of the United States verifying that change, is there?

DR. von HIPPEL: Yes, that is right. It is a very loose limit. This is not a tight limit. It is a limit which becomes important over a period of a decade or so rather than an immediate limit. It is complementary to limits which come into force more quickly, as, for example, testing and production, warhead production cutoffs would.

DR. FAINBERG: In this area it is probably also important to remember that the large amount of stockpiles should be taken care of in one way or another. Also, there is a possibility, I suppose, to make sure that weapons production facilities are not in operation during the moratorium. That is a possibility. I don't really know how feasible it is, but it is something that one could look into.

That is, if you were going to reshuffle within weapons, you have to have some facility which is able to handle plutonium in the large scale and it has to be operating. Perhaps that can be verified. I don't know.

### TESTIMONY ON COMPREHENSIVE TEST BAN



*Dr. Lynn Sykes*

DR. LYNN SYKES: What I would like to discuss today in terms of what can be verified with a comprehensive test ban is down in this very low region, well below the sizes of weapons that opened the atomic age in 1945, and, of course, well below the sizes of many existing weapons today. So that will be in the range of about a tenth of a kiloton to one kiloton.

Consider this final slide. One of the main breakthroughs in the 1960s in seismology was of devising ways of comparing different types of seismic waves, and this comparison allows a good comparison of two different populations, one being explosions and the other being earthquakes.

The main problem that we have in identification of the many signals that are recorded by seismic stations is to distinguish the signals of many smaller quakes from the signals of underground atomic tests. As you can see, this one method, which compares the size of certain long waves with the size of certain short waves, allows a very good segregation here in these two populations.

You will see that this decision line separates the earthquakes from the underground tests with one exception of

two events that are either on the line or close to it. This was a whole set of worldwide events. These two anomalies were in the Southwest Pacific. They were small events and they were outside of the main area in which the network was aimed.

So, depending upon the purposes of networks, it certainly is possible to deal with the problem of events of that type, by designing networks with good coverage.

All right. Returning to the problem of what can be identified reliably by seismic methods, if we look at a set of seismic stations that are solely external to the Soviet Union, perhaps like the situation that exists today, we have the following approximate limitations on identification.

Explosions in hard rock can be identified down to about 1 kiloton, those in soft rock down to about 2 kilotons, and if we assume the worst cases of possible cheating (which in this case is governed by the so-called Big Hole theory, i.e., setting off explosions in large cavities) this is about 10 kilotons.

If instead we have a network of 15 stations that supplement those stations within the Soviet Union, it is possible to constrain testing in hard rock to well below 1 kiloton—to some small fraction of 1 kiloton in soft rock, i.e., to smaller than 1 kiloton. And the main limitation then is set by the Big Hole idea, which would be assuming the worst case of cheating, in which case the limitation would be about 1 kiloton.

So we are talking about a size of test, even under the worst cases of cheating, that is well below the sizes of tests that opened the atomic age in 1945. Nonetheless, we must always admit that—even if we have better technology than this—that there will always be some lower limit; so we will not be able to identify all tests no matter how tiny.

There has been long debate about how best to determine the size or yields of Soviet explosions. There are two main types of seismic waves that have been used in estimating size. One is the short period waves, P waves, that travel through the deep part of the earth; another is long waves called surface waves.

One of the problems with the P waves is that they are very sensitive to regional variations in the geology of the earth within the outer 100 kilometers.

It does happen that most of the United States' testing experience, in places for which we have yield information, is from Nevada—a region that has undergone geologic activity quite recently and volcanic activity within the last millions of years. That is a place in which the P waves are absorbed more than in other areas of the world; so when the waves come out of Nevada, a seismic station will generally see smaller waves for a given size test than they will see for the waves that come out of the two main Soviet test sites. These are generally in areas of more competent rock that have not been affected by as recent earth activity.

So if we use the United States data on yield, and on the size of these waves, which come mainly from Nevada, and apply it to the Soviet data, the size of the P waves from Soviet explosions will lead to overestimates of the yield of Soviet explosions.

On the other hand, we can turn to surface waves. These



are a less biased way of determining size because they are not so sensitive to regional variations in geology. And if we apply the data from Nevada on those types of waves to the Soviet Union, we come out with a smaller yield of the same test than one would get by blithely applying the P wave data.

I think we know enough, from our knowledge of large-scale regional geology and the hypothesis or theory of plate tectonics, to understand why Nevada is more absorbing than the relevant areas in the Soviet Union; thus we know why there is this systematic overestimation of the size of tests if we apply the Nevada curve to the Soviet Union.

So clearly, if we are not going to overestimate the size of Soviet tests and we want to use these P waves, we have to do so with considerable care to correct for this regional bias in geology. And if we do use the surface waves, we find that there is no evidence that recent Soviet tests, since the time that the threshold test ban went into effect in 1976, are above the 150-kiloton limit. Hence, we believe that there is no substance to the contention that the Soviet Union has been repeatedly cheating on the threshold test ban.

Also one of the questions that I have found is rarely raised in these discussions is how accurately we need to know this yield anyway. There is always the unspoken presumption that we need to know it as accurately as possible, but we never describe with what limit we need to know this.

Very often, arguments are presented as if 151 kilotons represents a significant military advantage over 150 kilotons. It needs to be borne in mind, in addition, that there is a probabilistic problem involved in estimating size, and that we are probably talking about an uncertainty, at one standard deviation, of about 50 kilotons. So clearly, 151 kilotons plus or minus 50 kilotons is, from a scientific viewpoint, not very different than 149 plus or minus 50. But it clearly rings a political bell, the 151 compared to 149!

It should be remembered that many of the effects, such as the amount of overpressure from an atomic weapon, go as yield to the one-third power. So if we have a certain uncertainty in estimating yield, the uncertainty in terms of overpressure in the design of one of these weapons will be much smaller than that.



*Alan Neidle*

**MR. ALAN NEIDLE:** I would like not to comment on the very, very competent and supremely expert technical presentation of Dr. Sykes. So far as I know, everything he said is sound, but I am not capable of that myself.

The freeze could provide the kind of consensus that would support a President, support members of the Senate in supporting a test ban. Conversely, I think the freeze needs the test ban. You can be a supporter of the freeze and its goals, as I am, for example, and yet have very considerable doubts about how long it would take to negotiate a comprehensive freeze.

I know the merits and the logic of putting the freeze all together. They have been explained very cogently by Ms. Forsberg, and I see merit in them. But I also see very great difficulty from a practical standpoint in working out in a reasonable time span all the things that would need to be worked out to have a comprehensive freeze.

Now, in my view, every movement, every important cause needs some successes. And if the freeze concept is to be adopted and to be useful, I think it would be very important to do something that you could do relatively quickly.

So I agree with Dr. Sykes. So much has been worked out about a comprehensive test ban, there have been so many years of discussion, so many studies on all aspects of the issue, not just verification, that if you could develop the political consensus within the U.S. government and within the U.S. to do it, you could do it rather rapidly.

I think during the 1977 to 1980 negotiations if there had been a real readiness on both sides to compromise and move forward rapidly, it could have been completed in a year.

**MR. HYLAND:** But it is your view, as I heard it, that the Soviet Union has not exceeded the 150 kiloton limit, plus the 50 kiloton factor, since the treaty was signed?

**DR. SYKES:** That's right.

**MR. HYLAND:** Is that view, to your knowledge, shared by a wide variety of people who deal with seismology and the relevant sciences, or is this in debate?

**DR. SYKES:** It is in debate, but there are, I think, a large number of people, both in the university community and, interestingly enough, within the federal agencies, who agree. But there is not unanimity on this question. For example, there is one well-known paper written in 1979 in the *Geophysical Journal* by Peter Marshall of the U.K. Atomic Weapons Establishment, and two scientists from Livermore, Springer and Rodean. The method that they propose for calibrating the size of P waves gives just about the same estimates of yields as we would get from surface waves.

So there we have two prominent scientists, seismologists at Livermore, taking a point of view that would give estimates of yields very similar to what we would propose.

**MR. FRYE:** Bill, may I offer a follow-on question to the point you raised? When you asked whether the range of uncertainty surrounding Soviet testing is such that we do not believe they have gone beyond 150-kiloton range by more than 50, there's another uncertainty that needs to be introduced.

Is there also such uncertainty with regard to the likely yield of weapons in a test program, such that even if the Soviets had intended not to exceed 150 kiloton limits they might have done so inadvertently? Is it a possibility?

DR. SYKES: Well, of course there *is* uncertainty in the final determination of the yield of atomic weapons. One does one's very best attempts to make those measurements, and clearly the uncertainties are higher than the one percent level.

DR. FRYE: So there are two uncertainties.

MR. HYLAND: Would that uncertainty be greater than 50 kilotons?

DR. SYKES: I think that the actual methods are classified, so it's not a number that we can speak to here.

DR. FRYE: The unclassified rumor mill has it that it can indeed be off by that factor.

MR. HYLAND: Is that the real issue about the threshold test ban—that in fact tests that are nominally 150 kilotons may be 300 or 400 kilotons—and this badly undermines confidence?

DR. SYKES: Well, if you take the Nevada curve, and apply that to the Soviet tests in what I think is an incorrect way, you will come out with those tests being several times over 150 kilotons. But, again, I think that this is solely a product of the geology there.

MR. HYLAND: Is it your guess that, if there were a comprehensive test ban agreed to between the United States and the Soviet Union roughly along the lines that have been proposed, with certain seismic stations and so forth, that there would continue to be a dispute among scientists about whether the test ban was being abided by? Would there be many unexplained, low-level events?

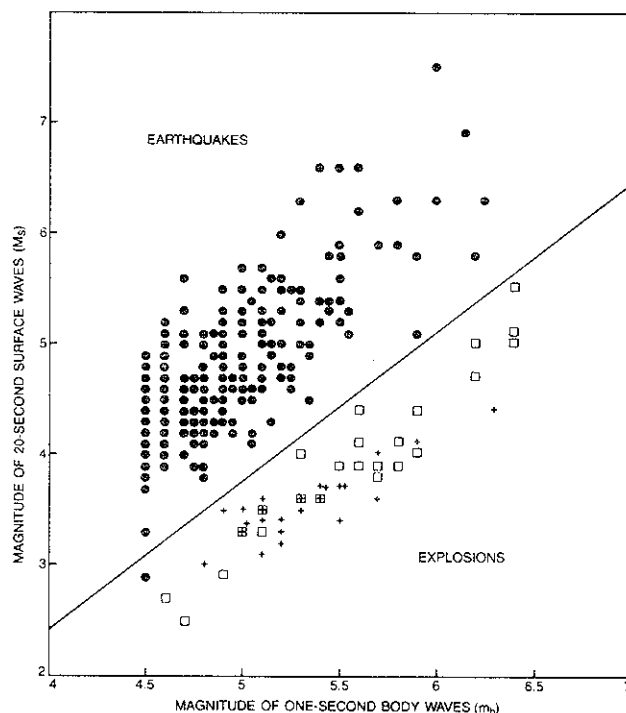
DR. SYKES: Well, for example, in our Scientific American article, we took 1,000 events in one period of time. Dr. Evernden worked very hard on various methods of identifying those events, and of those 1,000 events every one of them could be distinguished. So we are clearly talking about methods that are extremely reliable provided they are above those threshold numbers that I gave. They're not something which precludes, with absolute certainty, an occasional anomalous event.

MR. HYLAND: And those threshold numbers, as I recall, were between one and ten kilotons?

DR. SYKES: It was ten kilotons for the worst case of Soviet cheating—if we do not have stations in the Soviet Union. If we *do* have stations there, even in the worst case, it is one kiloton.

DR. STONE: Professor Sykes, the differences that you testified to on the seismic methods of verification are so large that it makes me wonder whether or not there isn't a certain amount of ideological motivation, and political motivation, among the people in the Administration that are fighting over these differences.

If we got all these people up here before some sort of science court, or if they were asked to discuss this in front of the American Physics Society, and all classification limits were disregarded, would we continue to find such enormous differences—with some people announcing a 150-kiloton shot while others called the same event several



times larger?

DR. SYKES: I think you have raised a very important point. We could probably achieve a much greater narrowing of opinion if we could have a full airing of some of these views.

For example, I believe that we have attempted to fully publish our results. Dr. Jack Evernden published an extensive series of papers on possibilities of Soviet evasion, in 1976. To my knowledge, no one has ever replied to those articles with some type of scientific letter as is normal scientific procedure.

DR. STONE: How much better off are we now, numerically, than we would have been in 1963, twenty years ago. How much better can we do now in identifying and detecting underground nuclear tests, without any on-site inspection, than we would have been in 1963, even with those four additional on-site inspections that caused the collapse of the negotiations?

DR. SYKES: We are down to about half a percent of the world's earthquakes, that we have to deal with (that would be equivalent to 1 ton explosion or larger in hard rock).

DR. STONE: If we took 95 percent confidence intervals, and asked what level earthquake can be identified and separated from an explosion with 95 percent confidence, you assert that we are now down to a kiloton or 2 kilotons?

DR. SYKES: Right.

DR. STONE: What were we down to in 1963 at that same confidence level?

DR. SYKES: I would say probably on the order of 20 kilotons at that time.

DR. STONE: So our ability to monitor the comprehensive test ban has increased by a factor of 20 in the last 20 years?

DR. SYKES: Right.

DR. STONE: And this is far more helpful to us than would have been, I would suspect, those four disputed on-site inspections—which are, after all, of no use to you

whatsoever unless you know where the site of the problem is?

DR. SYKES: You have to contend with the possibility that, very occasionally, earthquakes will mask other signals, perhaps from other earthquakes, for example, and that you might want to have the assurance of having an on-site inspection to make sure that that event was in fact an earthquake.

DR. STONE: So on-site inspections do have use, but the sensitivity of your equipment, and your ability to distinguish earthquakes from tests, has improved by a factor of 20 in the last 20 years?

DR. SYKES: Well, certainly, many of the questions related to verification of a comprehensive test ban are in the public domain. The main methods and the problems with determinations of yield are in the public domain.

### TESTIMONY ON THE FREEZE



*Christopher Paine*

MR. PAINE: The burden of my testimony today is that a comprehensive approach to ending the nuclear arms race is both politically and technically feasible, and in fact, offers distinct verification and security advantages over more limited approaches.

Although traditional thinking about arms control comes encased in a veneer of purportedly technical constraints, close examination reveals that these are not purely technical constraints, but rather, limits based on subjective and, indeed, highly political determinations of the national interest and the fragility of the nuclear balance.

For example, if you believe that the balance in specific measures of nuclear capability is an oracle of geopolitical fortune, you will probably demand high levels of on-site inspection to monitor each and every incremental improvement in the Soviet nuclear arsenal on the grounds that the United States must be able to respond promptly to Soviet efforts to change the balance, no matter how small these may be in relation to the total arsenals.

On the other hand, if you believe, as I do, that the destiny of world affairs depends far less on the balance of nuclear capabilities than on the dangers arising from the race to maintain these capabilities, then you are likely to

have a far different set of preferences.

Specifically, if one reaches the conclusion that the nuclear balance is, within a fairly broad range of disparities, inherently stable with respect to deliberate initiation of nuclear conflict, then one is willing to tolerate a comprehensive agreement characterized by low levels of monitoring confidence for marginal changes in the Soviet arsenal, in exchange for a halt in the overall process.

Between these two extremes lies a wide and fertile ground for exploration and compromise. I think it behooves us all to examine the actual range of possibilities that really do exist rather than to continue to dwell in the small box defined by the present Administration's ideological and strategic preoccupations.

For example, it is often said that in addition to national technical means, the freeze will require on-site inspection which the Soviets will presumably be unwilling to grant. What kind of national technical means, what kind of on-site inspection, and can these be used in combination?

There are many possible combinations which I have set forth in Table 1 of my prepared statement; combinations of current and feasible near-term national technical means, intrusiveness, frequency of coverage, cooperative measures and information exchange—yielding a wide range of possible confidence levels when applied to a broad spectrum of possible agreements. Some of these possibilities are also spelled out in Table 2 of my prepared testimony, and I will talk about these later. (See below)

Similarly, the problem of treaty compliance is not a simple yes or no. There is, in fact, a wide range of possible forms of treaty non-compliance, and a wide range of possible responses to treaty violations. I have listed those in Tables 3 and 4 of my prepared statement.

**Table 2**  
**Illustrative**  
**Modes of Monitoring Compliance**

1. *Remote* monitoring by National Technical Means *outside* Soviet territory
2. *Remote* monitoring by tamper proof NTM located *within* Soviet territory
3. *On-site* monitoring by *non-intrusive inspections* using technical means
4. *On-site* monitoring by *mildly intrusive* inspections using technical means
5. Intrusive "Quota" Inspections
6. Intrusive Continuous On-Site Inspection
7. Inspection by the Public (report a violation if you've seen or heard of one)
8. Data base exchanges
9. Cooperative measures on request (removal of shielding against NTM)
10. Inspection by Interrogation, hierarchy of requests for clarification and responses, with the right to request inspection to resolve doubts.

We need to know, for example, which violations should be paired with which remedies; what kinds of treaty violations threaten our security such that they would justify an abrogation of the treaty and what kind of violations would merit lesser actions.

However, I would like to suggest that there are sound technical and political grounds for believing in the validity of the comprehensive approach. This is set forth in detail in the outline of a comprehensive nuclear weapons freeze agreement and reductions.

What we really care about and what we are really trying to stop is represented at the far righthand side of the chart under the column labeled "Deployment." We are trying to freeze the number and the characteristics of deployed nuclear weapons and delivery vehicles. We are very concerned about this, with or without a treaty.

A treaty limiting numbers alone is fine, but this in no way addresses the dangers arising from Soviet improvements in the performance characteristics of their weapons, which you would continue to monitor with a great deal of interest. At a minimum, a deployment freeze which also prohibited modernization would allow us to probe the Soviets concerning these characteristics, thereby improving our intelligence concerning the Soviet nuclear threat.

However, if we are really serious about limiting Soviet improvements, we would obviously pursue test restrictions. Presumably these would greatly impede the flow of improvements filtering into deployed Soviet nuclear forces, increasing our confidence in the deployment freeze, and increasing our knowledge of Soviet missile capabilities through national technical means, non-interference clause in the agreement, non-encryption of telemetry, provisions for advanced notification of tests, and data exchange under the agreement.

However, a testing and deployment freeze would leave an unconstrained Soviet production potential for a rapid break-out from the treaty constraints, a frequently recurring nightmare among those who are inclined towards intense distrust of the Soviets.

Since this potential would exist with or without an agreement, as would the potential for an American response, and presuming one makes the judgment that the prevailing nuclear balance is not all that delicate, why not freeze the production of dedicated nuclear delivery vehicles, nuclear warheads and fissionable materials? Why not freeze production?

That question needs to be addressed. As long as the Soviet clandestine production potential remained below a given threshold over a given period of time and we felt comfortable with both those estimates, a production ban would seem to offer nothing but advantages, increase the confidence that the deployment freeze was limiting future as well as present deployments, and increase confidence that the Soviets were not running a secret test program on the grounds that they are not likely to produce something they have not tested.

In short, while certain individual provisions of a freeze agreement might be monitored with only a moderate

degree of confidence, the increased scope of the freeze generates increased opportunities for monitoring Soviet compliance, multiple requirements, indeed serial requirements for cheating to increase deployed military capability, and multiple chances for detecting Soviet violations.

Thus, the overall chance of detecting Soviet cheating on the agreement could be as high or higher for the freeze than for more limited agreements, and under the verification provisions of a freeze agreement, we could seek clarification of a far wider range of Soviet military activities than we can at present or than we could under the President's START proposal.

These observations add up to the conclusion that the main task of arms control negotiations at the present time is not to rework the strategic balance through a combination of selective nuclear reductions and broad-based modernization, but rather to coordinate a halt in the offensive nuclear weapons programs of the two sides.

This would complement the defensive ABM freeze we already have in place and close the loopholes in the SALT II structure. Reductions could be negotiated and implemented simultaneously with a freeze, resolving stability problems by throwing away weapons rather than building more of them.

MR. WILLIAM M. ARKIN: My conclusion is that clandestine production or clandestine deployment of any military significance or, indeed, of any significance that might impede what Dr. Stone referred to as perhaps a five-year time line on a freeze is impossible given our already routine monitoring of Soviet capabilities.

My second conclusion is that there is required a tremendous amount of research, not only, I should say, among proponents of the freeze but among those who are in charge of our arms control policy now, to understand the significance of nuclear warhead technology and its application to numerous weapons systems.

MR. FRYE: May I just pursue a couple of the points that you have mentioned here? The freeze as you have now described it is one which would contemplate some option for replacement of systems by similar or identical types. Would it contemplate replacement by less capable types? Would you try to build in a stabilizing emphasis that says ideally the next generation of weaponry, for example, should be biased against MIRV missiles?

MR. PAINE: Yes. I think that, first of all, the replacement provisions I would put in the initial agreement would be very limited. I wouldn't even call them replacement provisions, as much as just kind of equalization provisions, as you suggested. We want to get the forces on a sort of equal basis with respect to their age.

I think that a single warhead missile, in the context of a replacement provision down the road under a freeze agreement, would be a good idea. If one was going to replace the missiles, it would be better to do it with single warhead missiles than new MIRV missiles. But whether they are of a less capable type or the same types of the same capability, the important thing is that they not be types with better capabilities.

## OUTLINE OF A COMPREHENSIVE NUCLEAR WEAPONS FREEZE AND REDUCTIONS AGREEMENT: WHAT, WHY, WHEN, AND HOW

**INTENT OF THE AGREEMENT:** The intent of the freeze segment of the agreement is to end the dangerous competition between the United States and the Soviet Union in the *testing, production, and deployment of nuclear weapons and their primary delivery systems*. A freeze would prevent the deployment of new nuclear weapons systems designed for preemptive strikes on the nuclear weapons systems of the opposing side, and stop additional deployments of existing types of nuclear weapons and delivery vehicles. By putting an end to the counterforce weapons race, the freeze would place a *cap* on the threat to both the *deterrent forces* and the *population* of the superpowers and of other nations affected by superpower nuclear arsenals. *Circumvention* of this intent through the increase by either party of "dual-capable" delivery systems configured for nuclear strike would be considered a violation of the agreement, and thus a non-circumvention clause is included to reflect this understanding.

*Reducing* the nuclear threats to each side's deterrent forces and population is the task of the *reductions* segment of the agreement. (It is *not* the intent of the *freeze* portion of the agreement to significantly reduce the nuclear *deterrent* threats posed by both side's nuclear arsenals by preventing the maintenance of these systems, thereby degrading their reliability. However, the tight test restrictions called for in the agreement would prevent the attainment of the high levels of confidence required for preemptive attacks on hardened targets. In short, the freeze would not impede *deterrent confidence*, but it would impede *first-strike* confidence.) Issues of crisis stability arising from the asymmetrical nature of the respective nuclear forces *can* and *should* be solved through reductions of the most threatening and vulnerable forces rather than through mutual expansion and modernization.

**DURATION OF THE AGREEMENT:** The proposed agreement on a comprehensive nuclear freeze would be of indefinite duration—like its nuclear defensive counterpart, the ABM Treaty—with provision for a review conference every five years which would consider possible revisions of, or withdrawal from, the agreement. In the interim, the Standing Consultative Commission would deal with compliance questions and any other pertinent issues raised by either party. The need for renewal of production of existing types for the purposes of *replacement* could be raised by either party at any time and considered in the light of ongoing and planned reductions. Renewed production would be authorized only by *negotiated exceptions* to the Freeze Agreement, and would take effect at the conclusion of each five-year review conference and expire at the beginning of the next review conference.

**MAIN PROVISIONS:** The proposed Comprehensive Nuclear Freeze and Reductions Agreement would have the following main provisions:

PROVISION	WHY	WHEN	HOW VERIFIED
<b>I. Deployment</b>			
The proposed agreement would freeze the <i>number and characteristics</i> (within certain agreed limits) of dedicated nuclear delivery vehicles deployed by both sides, and the number and characteristics of their associated reentry vehicles and nuclear warheads. This freeze would include the following categories of weapons:	Will enhance both "crisis stability" and "arms race stability" by reducing reciprocal fears of surprise attack; end diversion of resources; improve East-West relations; assist non-proliferation objectives.		Monitoring the number of deployed systems would be achieved primarily through national technical means (NTM) including Imaging Electronic Reconnaissance Satellites, and Ocean Surveillance Satellites. While some characteristics could be monitored directly, others would be monitored indirectly by monitoring Soviet missile tests.
1. Intercontinental Ballistic Missiles	MX and new Soviet ICBM would threaten hardened silos and command posts. So would Trident II.	Before 1986	
2. Submarine Launched Ballistic Missiles		Before 1988	
3. Intermediate-Range Ballistic Missiles	Pershing II poses destabilizing short warning threat.	Before 1984	
4. Long-Range (600m. ±) Ground, Sea, and Air-Launched Cruise Missiles	Cruise complicates arms control	Before 1984	Aircraft and ships equipped with a wide range of surveillance devices would be useful for monitoring deployment of cruise missiles.
5. Medium-Range and Battlefield Ballistic Missiles	Represent nuclear warfighting escalation threat and threat to allies	Before 1984 or ASAP	Ground-based listening posts assist in monitoring Soviet battlefield missile units.
6. Nuclear Air Defense Missiles	Could undermine deterrence	ditto	

PROVISION	WHY	WHEN	HOW VERIFIED
<b>II. Strategic Bombers</b>			
The proposed agreement would place a ceiling on strategic bombers at the levels contained in the SALT II agreement. Each side would be permitted to deploy one new strategic bomber, but with no net increase in the number or the total payload of the bombers.	Bomber modernization could also be precluded by agreement, but U.S. bombers are old and also have conventional roles, as do Soviet bombers.	1984-1990	Primarily by national technical means; number of new bombers could not exceed SALT Limits, <i>and</i> total payload of new bomber force could not exceed total payload of older force.
<b>III. Non-Circumvention Provision</b>			
Each side would undertake not to significantly increase the number or alter the roles and missions (e.g., conventional-to-nuclear) of the following types of weapons from those prevailing at the time the agreement enters into force:	To prevent circumvention of long-range delivery vehicle freeze and stabilize nuclear balance in specific "theaters."	before significant deployment of long-range SLCMs	Primarily by national technical means, but also by non-intrusive or mildly intrusive inspections for the presence of nuclear weapons on ships and subs using advanced portable detection technology.
Intermediate/Medium Range Bombers and Strike Aircraft	Because these systems are used in combat in their conventional roles, they pose perhaps greatest danger of nuclear escalation in Soviet-American crisis confrontation.		Ban on production of nuclear warheads and bombs (Section V) would increase monitoring confidence.
Howitzer units equipped for firing AFAPs			
Subs equipped with Short-Range Cruise Missiles, SUBROC nuclear-tipped torpedoes, etc.			
Surface ships with ASROCs, Nuclear Air Defense Missiles, Short-Range Cruise Missiles, etc.			To ease verification requirements, both sides could agree to ban long-range conventionally-armed cruise missiles, or restrict their deployment to vessels whose non-nuclear status could be monitored with high-confidence.
Anti-sub and Anti-ship aircraft equipped with short/medium range ALCMs and nuclear depth charges.			
<b>IV. Testing</b>			
1. The Agreement would ban the flight testing of all "new types" of delivery vehicles included in the deployment freeze (Section I above) whose characteristics exceed certain permitted variances from agreed baselines, using previously tested types as the standard for measurement.	To stop the development of new more accurate and reliable weapons which could be used in a preemptive strike; increases confidence that deployment freeze is being observed.	Immediately	Primarily by national technical means, including ground-based telemetry listening posts and Cobra Talon, Cobra Dane, and Cobra Judy radars. Strong provision banning interference with NTM and encryption of telemetry would facilitate monitoring.
2. A low annual limit, with appropriate provisions for advance notification, could be set for reliability tests of currently operational missiles.	Optional provision if considered necessary by one or both sides.	soon after above	Same as above.
3. All nuclear explosive testing would be banned, with possible negotiated exceptions for reliability tests of existing warheads.	To prevent development of new sizes and types of warheads for new RVs and "war-fighting" nuclear missions; furtherance of non-proliferation objectives.	Immediately	Primarily by NTM, including global and on-site remote monitoring networks; provisions for data exchange, query inspection, leading if necessary to on-site visit.



PROVISION	WHY	WHEN	HOW VERIFIED
<b>V. Production</b>			
The proposed agreement would ban:			
1. the production of intercontinental and submarine-launched ballistic missile stages and final assembly of all nuclear missile types included in the dedicated nuclear delivery vehicle development ban;	To enhance verification of the nuclear weapons system deployment ban; limit and vastly complicate breakout potential; save money.	1984-1988	Primarily by NTM, with provisions for data exchange, cooperative measures, leading to on-site inspection of facilities whose output cannot be adequately determined.
2. the fabrication of fissile and fusion components for nuclear weapons, and their final assembly into nuclear warheads and bombs;	Same as above; also impedes violation of non-circumvention provision by restricting supply of warheads for tactical/theater systems.	1984-1988	Same as above. Existing facilities would be closed and replaced by single maintenance facility for warheads.
3. the production of special nuclear materials for weapons purposes, except for strictly limited production of tritium and enriched uranium under effective safeguards.	Same as above, but also enhances non-proliferation by strengthening IAEA.	1984-1988	NTM plus IAEA safeguards, declarations of existing stocks, bilateral on-site visits to ambiguous facilities.
<b>VI. Reductions</b>			
1. Reductions in the limits and sublimits of SALT II would begin immediately upon entry into force of the agreement. A 7.5% annual reduction would yield, for example, a 50% reduction in ten years.	Without reductions, freeze over time could become unstable; reductions can also ameliorate stability concerns arising from asymmetrical forces and capabilities.	1983-?	Primarily by NTM
2. Soviet reductions of SS-4, SS-5 and SS-20 missile launchers associated with 572 European INF warheads would begin immediately in accordance with a two-year schedule of 24 warheads per month.			Primarily by NTM
3. Reductions in forward deployed nuclear warheads in Europe and elsewhere.	Reduces chances for nuclear escalation, terrorist seizure of weapons.	?	Non- or mildly-intrusive on-site inspections using portable NTM such as neutron generators.

MR. FRYE: If the important and more urgent concern is to move toward the kind of freeze and reductions concept you have described at a pace which heads off new technological developments, or at least begins the reductions program before those new technologies further compound the instabilities that you are worried about, how do you feel about the kind of immediate effort that Senator Cohen and Senator Nunn are putting forward, endorsed yesterday by Secretary of State Muskie, to take as the first step a movement towards a guaranteed build-down in which any change would be constrained to be accompanied by disproportionate reductions? The idea is that, in case the complicated and comprehensive agreement of the character you have described takes too much time to negotiate, an immediate short-term but useful measure might be to seek agreement by both parties that they will introduce no new nuclear warhead without eliminating two from their present inventory. [Ed. Note: See pg. 19 for an FAS response to this idea]

MR. PAINE: I guess I feel that, in the present context or any foreseeable context, given the alignment of political forces and sentiment in our society, that this would be abused. It would constitute an enormous loophole, and a blanket over the modernization of our nuclear forces. I think one needs the freeze because really, 75 to 80 percent of the arms race now is capability, and maybe only 20 percent is numbers. And those numerical balances are in specific theaters, rather than overall numbers.

So I feel a guaranteed mutual build-down is really not where we need to go in arms control.

MR. FRYE: Would you say that, even if you are doubtful that the kinds of qualitative limitations you favor can be achieved in the next two to eight years?

MR. PAINE: Yes, even then, because I feel as though the proposal would be abused. It would in fact sort of pave the way for modernization of forces, and make it easier for each side to introduce new weapons, rather than more difficult to do so. And I don't see a great deal of virtue in throwing away obsolescent warheads. There may be a real



William Arkin

vice in it in that it accelerates the process. It may accelerate the process of modernization by making it easier, and giving it a kind of politically acceptable gloss.

I don't mean to be terribly down on the idea, but from my perspective it doesn't really treat the outstanding issues before us in arms control.

MR. FRYE: Mr. Hyland, your turn.

MR. HYLAND: Is your freeze proposal tied directly or in an organic way to subsequent or fairly quick reductions, or can it stand without reductions?

MR. PAINE: I think it can stand without reductions, but I think the reductions are desirable.

MR. HYLAND: Desirable or mandatory?

MR. PAINE: Desirable.

MR. HYLAND: Without reductions, do you think that over time the strategic balance would become unstable?

MR. PAINE: I think the freeze might become unstable. I'm not sure about what the balance will do, because that depends on what the weapons programs on each side look like after ten years. But politically, after I don't know how long, I feel as though the arms race either has to be going up or going down.

MR. HYLAND: Could it be frozen?

MR. PAINE: Indeed, from the point of view of a long-term solution—the freeze, you see, is nothing more than a verified moratorium, and stability depends on a lot of things that will happen in the future, whether there are reductions, what is the future of Soviet-American relations, a whole host of factors that we cannot foresee.

MR. HYLAND: Let me make sure I understand your proposal. You would permit under your freeze replacements, some replacements of strategic vehicles?

MR. PAINE: Right. What I have done is, I have said that the question of replacements over the long term would be a subject of negotiation between the two sides.

MR. HYLAND: You would permit the production of some nuclear submarines as long as the number of missile tubes did not increase?

MR. PAINE: Right, or was reduced if we had a reductions program.

MR. HYLAND: You would permit the development of one new strategic bomber?

MR. PAINE: That's right. I'm not advocating that. I'm saying if there was a need for compromise, that's where I would bend.

MR. HYLAND: And finally, I think I heard you say to Alton Frye, and I'm not sure of this, that you would permit the development of a single-warhead ICBM as a replacement for a MIRV ICBM?

MR. PAINE: If it could be mutually agreed.

MR. HYLAND: I'm assuming that all of this is agreed. Then why do you really call this a freeze? Isn't this not a freeze? Isn't enough permitted on both sides in the testing and development of new bombers, ICBMs, submarines, and perhaps other replacements, that this is really not correctly labeled?

MR. PAINE: I disagree. I think if you look at what is actually stopped in the range of current weapons systems, every current weapons program save for the B-1 bomber

and the Trident submarine would be stopped by this proposal. That encompasses a range of programs.

We're not talking about strategic weapons; we're also talking about theater weapons and tactical weapons. The scope of the freeze is quite large. We're also talking about testing of warheads, testing of systems, the production of fissionable materials and the fabrication of warheads.

So I see no resemblance between this modified, if you will, freeze or less than totally catastrophic freeze and the previous SALT II way of doing arms control. It grows logically out of SALT II, but it is far more reaching. It goes into the areas of the arms race we have never attempted to control before.

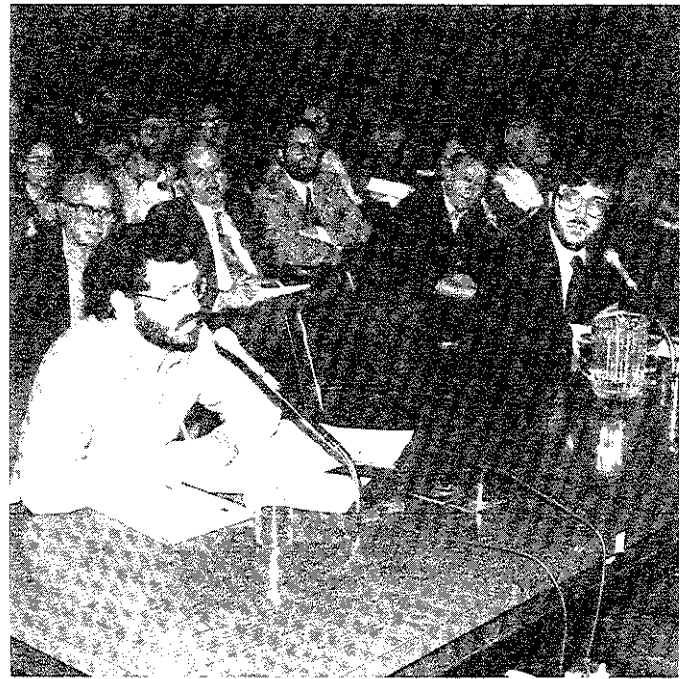
DR. STONE: First of all, on this question, Mr. Paine, of whether this agreement is a freeze or not, what is the difference between a freeze approach and the more traditional arms control approach? How would you characterize that difference?

MR. PAINE: Most fundamentally, a shift in the underlying presumption more than anything else. What we're doing here is saying we are going to stop everything and then seeing what the two sides absolutely insist on continuing for very, very strong reasons.

The previous presumption has been we will continue everything except those weapons which are most susceptible and easiest to control. That has left large areas of the arms race uncovered. And also the criterion has not been applied to weapons as to whether they are for the purposes of retaliatory deterrence, or nuclear war-fighting and escalation. And the freeze implicitly tries to make those kinds of distinctions.



*William Hyland*



*Arkin & Paine*

DR. STONE: Now, you have discussed two different approaches to agreements. In one case you told Dr. Frye that a certain proposal might be abused to permit continued building, but at another time you talked about the goal being to coordinate a halt between the two superpowers.

Now, if you take the first image, you can imagine these two superpowers, like semi-reformed alcoholics, who are attempting to maintain their alcoholic intake while persuading the watching world that they are not going to go on a binge. They then construct the agreement in such a way as to permit it to be abused. Whereas your other image, about coordinating a halt, is very much like two drowning men who are desperately eager to stop the arms race, and they are trying to reach out to each other in a way that permits just that—on the implicit assumption by each that the other feels similarly.

Now, which is it? It can hardly be both.

MR. PAINE: It can be both, depending on which political conditions one is laboring under at the time. We are now laboring under a situation where there is very little mutual interest perceived in the national interests of the Soviet Union and the United States.

I think, largely, that this lack of perception of mutual interest is stemming from the American side rather than the Soviet side. But, be that as it may, a certain high-level presidential, executive perception of the importance of arms control in our mutual interest is necessary to reach any kind of agreement, much less a freeze, which would require an even greater degree of perception of the mutual interest.

DR. STONE: I don't quite understand that. Up until now we have been failing on the first approach. Now the freeze approach is supposed to rectify this. Why would the freeze approach persuade everyone that it's just a problem of coordinating a halt, whereas the earlier approaches seemed to excite the interest of those alcoholics in alcohol?

MR. PAINE: As I say, the freeze offers advantages, demonstrable advantages, for example in verification, that are not available in other agreements. As I tried to show, for each limited agreement that you consider, whether it be on deployment alone or deployment and testing or deployment and other measures, for each hole you plug you create a breakout or a cheating opportunity.

DR. STONE: So the freeze is easier to verify. But that assumes these alcoholics really had very serious reasons for not wanting to go forward, they are not abusers, they are people who are very concerned about verification.

MR. PAINE: Political will is also involved, mass political support, political will. But that is obvious.

DR. STONE: I think that is not so obvious. It is the right answer. We may give him a makeup exam later.

[Laughter.]

DR. STONE: It seems to me that this freeze is only going to make a big difference if it excites much more political support than the other agreements did. Because while it is true, technically, that it may be easier to verify a freeze, it doesn't seem to me that it's going to be that much easier to get through the Senate, all things considered.

MR. FRYE: I think that this exchange does call attention to the fact that the virtue of complexity and comprehensiveness is matched in some degree by the political vice associated with having to persuade enough people over a period of time to sustain the support for an arrangement of this sort.

It seems to me that if one is able to shift the quantitative balance onto a parallel reductions curve, both sides start down. There are some interesting propensities which will then emerge. They are interesting in much the way that the expansive dynamics were very interesting and troubling.

For example, if there is an emphasis on reductions as the forces are brought down, very intricate tradeoffs have to be made with regard to which weapons are retained. I would suggest to you that as the forces shrink, if we are able to negotiate reductions, the smaller force that will

emerge will force the military planners on both sides to emphasize survivability, to emphasize force dispersal, and all of those kinds of calculations argue for transforming the deployed forces in somewhat more stabilizing directions.

MR. ARKIN: Well, I would say that I think that reductions in weapons, particularly once the bureaucracy gets their hands on tradeoffs, are largely influenced by quantitative criteria, and I think this can be evidenced by Dr. Hyland's questions. The primary concern of professional arms controllers is the numbers.

My feeling is that we have never had a numerical reduction in warheads that has made any qualitative change in the arms race. Providing some sort of a reduction scheme that is based upon nuclear warheads, without having a concomitant freeze on new production and new warheads, is this: you get rid of your old weapons, you get rid of your old warheads, and you apply the physics packages, the guts of the warheads, to new weapons and to new capabilities.

So, in fact, there isn't even any benefit to the build-downs, as you call them, unless you accompany those build-downs with a comprehensive freeze on weapons systems which those warheads would be deployed on.

MR. HYLAND: I must say that I think Mr. Arkin finally put his finger on what has been missing in almost all of this discussion. That is that all nuclear weapons are not equal, and that to treat nuclear weapons only as objects of a freeze or a build-down or whatever misses some important points.

That is, if you are going to reduce nuclear weapons, there are certain nuclear weapons that are a hell of a lot more dangerous and destabilizing than others. And we haven't really gotten into that at all.

Second, I think you have pointed out the dilemma in an earlier answer of the freeze movement. If the freeze movement is to be effective, it should in fact propose a true freeze. You mentioned numerous categories of weapons that are really not being covered, or at least not being debated, F-15's and F-16's, for example, which are hardly ever mentioned or discussed in a freeze movement.

So, to get political support, the freeze movement has to be rather straightforward and comprehensive to secure political support from the general public, and political support in the Congress. But as it moves in that direction, it seems to me there is a terrible dilemma. That is what we have heard all day from all of the witnesses. Everything is much more complicated than it seems. Every testing scheme is a little bit more complicated.

DR. STONE: Well, as part of my closing remarks, I want to thank Alton Frye and Bill Hyland very much for participating in this. They are not members of the Federation, but they are among the people I most listen to, and enjoy discussing these issues with, in all of Washington. Since we wanted this day of hearings, as with our other freeze hearings, not to be just a Federation affair, but wanted it to have the cool and very informed analysis of people we respected, it really made our hearings to have Bill Hyland participate and to have Alton Frye preside over them, as they have.

I want to spare them any suggestion that they are part of



Alton Frye

our Federation, while thanking them very much for participating in this particular operation of ours.

[Applause.]

Finally, on this Catch 22 issue that Bill Hyland raised, I think that our witness, Mr. Paine, is right that the difference between the freeze approach and the arms control approach lies in the presumption. If our negotiators go out and try to reach some kind of freeze agreement, and they use that freeze presumption as their basis for negotiating, they can maintain political support even if they are not completely successful. If they come back and say, one agreement had to have a lot of loopholes in it—partly things we felt both sides were obliged to do, and partly things we didn't know how to control, and partly things we will deal with next time—but it's the best we could do in trying to make an historic end to the arms race, that would be enough, I think, to surface, arouse, and maintain the political support that would be necessary to give us a fighting chance to get that treaty through the Senate.

I don't think the treaty has to be completely comprehensive to satisfy everyone in Wyoming and Oshkosh. But I think it has to be based on a real effort, and it has to be one that the negotiators can say was the best that they could do. This announcement would, by itself, be so broad, far-reaching, and historic that it would still, it seems to me, maintain this public support all the more.

So I think the solution to the Catch 22 depends a great deal on the intention of the Administration that does the work. If the Administration that is doing it seems not to be doing it seriously, that is one thing. Then, I agree, the treaty would appear either to be too comprehensive or too shallow. But if it is an Administration that really tries its best, I think they can, in alliance with the public, persuade even our Senate, with its two-thirds rule on treaties, to push through an agreement that was labeled one as close to a first stage of a freeze as reasonable men could get.

## GUARANTEED BUILD-DOWN VERSUS FREEZE?

*The May, 1983 PIR will discuss, in greater detail, the various new ideas for strategic arms plans; but the rising interest in the Senate in advancing a notion quite at odds with the philosophy of the freeze led the Federation to send this letter to the Senate leaders of the Freeze movement who placed it in the Congressional Record.*

Dear Senator Kennedy & Senator Hatfield:

We write to draw your attention to a number of considerations with regard to the so-called "guaranteed nuclear build-down."

As strategic analysts, we know quite well that this proposal to eliminate two already deployed warheads for each "newly deployed" warhead is not yet a defined proposal. Its implications and effects depend entirely upon a number of premises and assumptions evidently not yet articulated, much less agreed even among its backers. In this connection, we are, quite frankly, astonished to see so many Senate co-sponsors for a resolution whose results on either

U.S. or Soviet forces cannot be known, at this stage, by anyone!

For example, if SALT counting rules for warheads are to be utilized, as seems to be indicated and is repeatedly mentioned, a large pool of non-existent (or wholly unnecessary) warheads would be available as fodder for false reductions. For example, the Poseidon missiles currently being phased out (counting for 14 warheads each) could easily justify, at two for one, the remaining Trident I missiles (8 warheads each) that are already planned as a substitute. Similarly, a number of Soviet SS-18s which actually have less than one warhead would still count for ten. In any case, the 308 heavy missiles alone would permit 1540 new single warheaded Soviet missiles to be deployed, more than the entire present Soviet ICBM force.

There is also serious question whether this method of substitution will be applied to bomber arms control, where very large numbers of warheads are planned.

We do intend to study this proposal, in all of its variants, quite closely, as we try to study all other proposals. But alarmed at the speed with which many seem to be embracing a proposal with so many uncertain implications, we write this word of caution at this time.

Whatever form this build-down principle takes, it certainly is not—and we hope it is not intended to be—a substitute for the freeze approach. In treating all warheads equally, it encourages larger warheads. In permitting modernization, it permits not only stabilizing modernization but de-stabilizing modernization—such as hard-target kill capability (of Soviet ICBMs and SLBMs as well as ours) and short-time-to-target missiles (e.g. Pershing II). It gives each side such freedom to mix as to make it unpredictable what the other side can be expected to do.

Its "guaranteed" reductions are not, in fact, guaranteed in the sense that a freeze followed by reductions would guarantee reductions. On the contrary, it guarantees reductions only to the extent that one considers modernization guaranteed. It seems to involve, for some, withdrawing from SALT II limits and sublimits as suggested by Senator Charles Percy. And it raises the possibility of new inequalities in warhead totals, arising from the possibility that one side might modernize more than the other.

There is not, of course, any reason why the Senate could not endorse *two* quite different approaches both of which it wished the President to put before the Soviet Union with a view to negotiating whatever one could. We cannot, after all, prejudge or dictate which approach, if any, might be negotiable.

But we consider it evident that a freeze approach, which permitted maintenance but foreswore modernization, would be a more comprehensive halt to the arms race than an approach which simply bought reductions at the price of new weapons. And, obviously, the freeze could, would, and should be linked to subsequent reductions that truly guaranteed to shrink the frozen balance in a stabilizing fashion.

In this regard, your Kennedy-Hatfield proposal is the more fundamental answer to the dilemma that afflicts the

world. Accordingly, we hope that you will not cease and desist in your efforts in the face of this new, and unexplored, approach.

Sincerely,

Frank von Hippel

Jeremy J. Stone

**ADRIAN (BUTCH) FISHER & H.K. HARTLINE DIE**

FAS Sponsor Adrian Fisher died on Friday, March 18 of cancer. He had been the first Deputy Director of ACDA, and had played a leading role in both the 1963 Atmospheric Test Ban Treaty negotiations and the 1968 Treaty for the Nonproliferation of Nuclear Weapons. Perhaps most significant, in contemporary terms, it fell to Fisher, as Ambassadorial representative, in 1964, to relay the call of the Johnson Administration to the Soviet Union for a "verified freeze of the number and characteristics of strategic nuclear offensive and defensive vehicles". Thus he became the first statesman to call formally for the nuclear freeze—not, as President Reagan has alleged, Mr. Leonid Brezhnev.

Ambassador Fisher worked diligently in arms control to the last week of his life, even participating in September, in Part I of the very hearings to which this newsletter is dedicated, despite difficulties in breathing related to his illness. In his persistent and never-ending efforts to round up support for arms control, Fisher employed a good-old-boy, down to earth, folksy manner, combining the acuity



*Ambassador Adrian Fisher at the FAS Freeze Hearings  
September 21, 1982*

of the law professor he was with a wealth of homey stories that brought issues down to earth. His death is a real loss to our community.

**H.K. Hartline**

On March 17, at the age of 79, FAS Sponsor H.K. Hartline died of a heart attack in a Maryland hospital. His 1967 Nobel Prize award was for advancing our knowledge of the primary chemical and physiological processes in the eye. He had sponsored FAS since 1971 out of a quiet, undemonstrative but deeply felt concern that scientists fulfill their professional responsibilities to the public.

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