

Nevada Test Site Oral History Project
University of Nevada, Las Vegas

Interview with
Sidney Drell

July 20, 2004
La Jolla, California

Interview Conducted By
Mary Palevsky

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[00:00:00] Begin Track 2, Disc 1.

Mary Palevsky: *So we're on. The relationship between testing and treaties, historically.*

Sidney Drell: Well, testing was necessary in the beginning, as we learned how to make bombs and began to understand them. We designed more efficient ones, bombs that could be carried on bombers, then on missiles, so they had a big yield-to-weight ratio and were reliable. Then in 1963, it was realized that there was an atmosphere fallout problem, a health problem, and so the Limited Test Ban Treaty [LTBT], which confined all nuclear explosive testing underground, was signed, and that was a step which one hoped would lead to further constraints on the nuclear arms race. Then in the 1970s—I don't have the exact year—there was a so-called Threshold Test Ban [Treaty, 1974] limit, saying no tests in the ground would be larger than 150 kilotons. Always trying to somehow or other slow down the nuclear express and have treaties which would not only limit the deployment of nuclear weapons, but the other concern one had, besides that they were growing in numbers and might be used, leading to a nuclear Armageddon. As President Eisenhower said during his administration, before nuclear weapons, war was a battle to the exhaustion and surrender of the enemy, but once we had nuclear weapons, it now was a battle in which nuclear war would likely be destruction of the enemy and suicide. And so the danger of nuclear weapons was realized and efforts to control its *spread*, as well as prevent its *use*, and so the proliferation game became important.

And as you know, we signed a Nonproliferation Treaty [NPT] in 1968 and it entered into force in 1970. Now, that treaty was discriminatory because it said nuclear countries could keep

their weapons and we could benefit from nuclear power and so forth, but we said other countries should *not* become nuclear. And the carrots that went with the stick, or the bait there, was that we would *see* to it, we would *ensure* that non-nuclear countries that *obeyed* the inspection rules and the restraints of the Nonproliferation Treaty benefited from nuclear energy. And so the guarantees of the NPT, the treaty, to provide the peaceful benefits, both for medicine and energy, are in that treaty. But in there, it was explicitly in preamble, that we were going to work to *reduce* reliance on nuclear weapons, we were going to reduce *eventually* in some future, we would hope to get rid of them, and that the idea of working to stop testing was implied. So for the first time, the idea, not just of *limiting* tests but of ceasing tests. And the Nonproliferation Treaty, which came into force in 1970, had in it every five years, a mandatory five-year review for twenty-five years. There were five of them. And in 1995, the United Nations [UN], the Nonproliferation Treaty was extended into the indefinite future, and in an international consensus; 185 of the 189 nations in the world have signed on to that agreement. All but India, Pakistan, Israel, and North Korea now. But there, it was implied and explicitly stated by *many* of the signatories who were restive under the discriminatory features of the treaty, that the nuclear powers would stop testing. And so the idea not just of a moratorium that President George H.W. Bush initiated in '92, which Clinton continued and signed into a treaty in '95, but there's now a general feeling that the nuclear powers are to stop testing and developing better and newer weapons, and *reduce* reliance on them, not find new missions for them.

Which is why I have such trouble with the bunker buster idea, which is now saying, well, instead of thinking of nuclear weapons only for deterrence, for defense of last resort, we're now looking for *limited military* missions, missions against limited military targets in limited strikes. In other words, just like another weapon. And I think that's a *terrible* idea because I think once

you cross the nuclear threshold, nobody knows *where* you stop, and you've unleashed now weapons, modern weapons, a million times more powerful than pre-nuclear weapons. And what [00:05:00] the impact on civilization and the world would be in an all-out nuclear war is *absolutely unknown*. There's no history. We don't *know* what a nuclear war would do. We just know what the *trigger*, the trigger of one of our modern bombs, did to a city like Hiroshima and Nagasaki.

So there is a real implication *now* on the Nonproliferation regime and the effort to reduce reliance on these weapons and reduce their numbers. Presidents Bush and [Vladimir] Putin signed a treaty in 2002 in Moscow, the Treaty of Moscow, saying that the *deployed* weapons would decrease to about 2,000 in the year 2012. But now they have talked and made commitments, but I haven't seen a treaty, that we're going to reduce, actually, the *total numbers* of warheads, which was not part of the 2002 treaty.

You know, I've been spending a lot of time at the test site, so one of the questions that came up for me—tell me if this is completely off the wall—you know, when we went from atmospheric to underground [testing], this whole new science had to develop, the science of the weapons and the science of containment. Did that science of underground explosions contribute to knowledge of how to do bunker busters? Because we were underground already?

The main thing about bunker busters is to develop means of making a *rugged* structure, a rugged structure, that when you drop it from a bomber or shoot it into the ground with a missile, and it's coming in very fast, that it's strong enough that it can dig into the ground, tens of meters or something like that, without destroying itself. That's mainly a structure problem. And we've learned: look, doing earth penetrators is an important part of the conventional military. If you want to destroy an enemy airbase, make it unusable, you want to crater the runway. There are

increasing numbers of underground military targets around the world. I think the *National Intelligence Estimate*, published version, talks about the order of a thousand militarily interesting targets in seventy or more countries around the world. Digging underground has become less expensive, and there are more and more important military facilities, leadership facilities, storage facilities, that are being built underground. And you see that now in North Korea and in Iran. So that for conventional military, for normal military, we do have wars. Being able to deliver shocks underground is important, and if you can bury a weapon so that you contain a larger fraction of the energy, you can increase the shock that destroys structures underground by—put it this way: for a nuclear weapon, you can make a one-kiloton weapon have the effect on an underground structure of a *ten*-kiloton weapon, even maybe a size twenty kiloton, with a factor of ten or twenty, if you can dig it down ten, twenty feet or so before it detonates.

So that's the problem. But we certainly learned. I mean when you test underground, of course, you're testing in a different environment than in the atmosphere. But I don't think that was the main—the bunker buster wasn't the main thing we learned by that underground—
Right. No, it was one of those non-technical-person questions because, for me, it's interesting to look at the whole world of moving from atmospheric to underground testing, and the science that had to develop in order to do underground tests.

Well, we certainly developed the science to learn a lot more about underground tests. I mean the point of the underground tests was not just to get a big bang. The idea was to be able to do enough diagnostics to improve understanding, so you could design better weapons. By the time you're getting to 1990, our weapons have become pretty proficient in terms of yield-to-weight. And with the end of the Cold War, President George H.W. Bush and his national security advisor, Brent Scowcroft, General Scowcroft, they decided that we didn't have a *need* for new

designs. And that's why they called the moratorium, and I thought that was a very important step made by those leaders. One can raise a question about bunker busters as follows: I believe—this is something we've *worked* a lot on, and JASON [scientific consulting group formed in 1960 to advise the federal government on national security matters] is publicly known for a study I led on non-nuclear testing in 1995, which really made the case that a comprehensive test ban was consistent with our national security. I believe that since then, we have, with good work at the national laboratories, support for the stockpile stewardship program, we have increased confidence quite [00:10:00] a bit, certainly mine, that we can maintain our current forces as a safe, reliable, and effective deterrent without underground low-yield testing. And it's not beyond the imagination to think that some of the push that coming for bunker busters is to find a new excuse to resume underground testing.

Because of the whole, well, nuclear-industrial complex that's built up to keep those people in business, or what? What would be the rationale for resuming testing?

Well, if you're going to design better bunker busters, you're going to design new weapons. And so, I mean there is the military one that the administration said in the *Nuclear Posture Review*, [submitted to US Congress by DoD, 12/31/2001] which I discuss in the new book there [Sidney D. Drell and James Goodby, *The Gravest Danger: Nuclear Weapons*, 2003], we may need new missions for the post-Cold War world. There is a school of thought. You can always get some benefit by having a new weapon. But you also have to ask, what do you do to your national security if that helps destroy the international consensus for Nonproliferation? After all, the greatest danger this country faces really is precisely the one that President [George W.] Bush said at the U.S. Military Academy, West Point commencement in 2002: The greatest danger this nation faces lies at the crossroad of radicalism and technology. We have to keep these weapons

out of the hands of very bad people, terrorists or rogue nations. And that's going to take an international consensus working together. Because we're going to have to have international collaboration, recognizing through political pressure, through sanctions, and strengthened means of verifying the Nonproliferation Treaty, that countries are obeying this treaty. We want to make stronger, more stringent requirements so that future countries—and particularly I'm talking about Iran, North Korea—*don't* go nuclear. But we're going to have to have the help of other countries doing it. They're going to have to agree not to *ship* them (would-be proliferators) that material. They're going to have to agree that if they *do* try to become nuclear nations, economic sanctions will be invoked. They, the supporters of the NPT, have to make it politically uncomfortable for countries to acquire nuclear weapons. The US also will have to diplomatically work to remove some of the *motivation* for these countries to want to be nuclear. If it's their economy or their security assurance they need, then we have to work together. You can't, [as] one country alone, say nobody else is going to be nuclear. And so it's important that we maintain this international consensus if we want to strengthen the nonproliferation regime and *keep* the worst material out of the hands of the worst people. And that means we have to obey the pressures that these 185 countries agree, that we can't just go continue tests, develop new weapons, have new missions, and they get nothing. So it's a very strong diplomatic challenge, but in this case, in my mind, it's a serious one for us because we *can* maintain, I believe, I *assert*, confidence in our deterrent without testing. And we've had success. I mean President Kennedy, I think, in the sixties said, obviously before he was assassinated, that he thought that by the end of the decade, there'd be a dozen or more countries with nuclear weapons. The end of the century, there are only eight. Many countries had started down the road—Sweden, Switzerland, South Korea, Taiwan, countries like that—walked away. Argentina and Brazil walked away. South Africa gave up.

And then there's a graph on page six or so in that little book [*The Gravest Danger*] which shows you that there's no increase in countries with nuclear weapons for almost twenty years now. But we have new problems with countries like Iran and North Korea, and we'll have to give the Nonproliferation Treaty more severe powers to verify compliance. The Additional Protocol has been talked about, which is going to allow us to inspect *suspect* facilities, not just declared ones. The proliferation security initiative has been talked about. That is, in order to intercept, what do you do, in seas, you put embargoes on—like we did with Castro in Cuba. You have to intercept shipments of things that would make it possible for them to build a nuclear infrastructure. Also, the greatest difficulty for a would-be proliferant to make a nuclear weapon is to get his hands on the *material*—plutonium, enriched uranium. *That's* the hardest thing. And so we have the Nunn-Lugar [Cooperative Threat Reduction Program, 1991] Program to try and get better protection of the largest arsenal in the world, namely of materials sitting in the former Soviet [00:15:00] Union [USSR]. It's a big deal, diplomatic, and so I think that the importance, now, of trying to *work* to preserve the nuclear nonproliferation regime, that is the greatest challenge we face. And the test ban is very central to that, I believe.

Right. That was going to be my next question. So a piece of that is that no one's testing, including the great nuclear powers.

That's right, and now, you know, the Comprehensive Test Ban Treaty [CTBT] has been signed by many countries; 173 have signed and 120 have ratified it. What's important is for the Comprehensive Test Ban Treaty to come into force, all forty-four nations in the world that are declared nuclear capable. The eight or nine with nuclear weapons plus those with reactors for research or power. Of those forty-four, thirty-three have ratified the treaty. Russia's ratified the

treaty. Germany, England, France ratified the treaty. China said it would. Japan has. We have not ratified it.

What do you think are our chances? I mean the people that I've talked to down in Nevada have said they're opposed to the CTBT because it doesn't give us enough safeguards for other people, the same argument that's always made against those treaties, that other people could break it even though we never would.

When we sign a treaty, there's always a national security clause in it which says that if, in the need for national security, due to new political or technical conditions, we can say we're going to withdraw from the treaty. We did that with the ABM [Anti-Ballistic Missile] Treaty. The main thing is to have better means of verifying compliance with the treaty, and that's why all these enforcement steps are important. President Bush has endorsed them, but you must accompany these steps, which are sticks with carrots, to invite other countries and that's where we have to work. But the Additional Protocol to challenge and inspect any suspect site and the Proliferation Security Initiative, to be able to interdict any troubling cargo, and trade restraints, sanctions and whatnot, is doing a better job. But also, very important, saying that complete fuel cycles will not be allowed in new countries. That is, you won't have the ability to completely enrich the uranium or reprocess plutonium. There could be *regional* centers, *guaranteeing* the materials are there for peaceful uses. We have to build a world order on this. It's very difficult. It's *not* impossible. For fifty years, through the Cold War, we *did* build a consensus of nonproliferation that held us to eight countries. That's a terrific record.

Right. That's one of the things that's coming across as you're talking to me, because with the worst of the Cold War, and when you're looking at the huge numbers of weapons that were built,

there was slowly this—and I think you or [Freeman J.]Dyson or someone referred to the “tradition of non-use.”

That’s right, the norm of non-use and non-possession. Both.

Right. And so it’s interesting historically to see you’ve got this really scary thing with the build-up and then slowly, slowly, slowly, fifty years later, you do have this regime—

Countries understood that the likelihood of our *surviving* in a *world* is greater without nuclear weapons all over the world. The material spreads, countries can get their hands on it. And as I said, the hardest step for a new country to become nuclear is to get their hands on the material. Once you got it, it’s not trivial, but it’s easier, particularly if you want to make a Hiroshima-type bomb, the gun-type uranium bomb, which doesn’t have even an implosion mechanism. So we have to really work to keep the worst material, the most dangerous material, out of the most dangerous hands. *That’s* our priority.

Just two sort of general questions are raised by what you’ve said so far. One is, you’re talking about the bunker buster and the fact that it’s a weapon for a particular use. But all through the Cold War, wasn’t the military coming in and saying, you know, give us a weapon that can do this?

Thank you. The answer is we have bunker busters now. They’re called high-yield weapons of hundreds of kilotons. I mean we *have* very powerful weapons, up to the megaton class.

Non-nuclear?

Nuclear. Oh, no, no, I mean we have very high-yield nuclear weapons. The idea of the bunker buster—and that’s the insidious part of it; it’s a good point to pull out—is to make a *lower-yield weapon* which will produce less collateral damage and, apparently to some people, *therefore be more usable*. *That’s* the problem. I mean you give me a megaton weapon and I’ll bust a lot of

stuff that way. You're not going to be safe anywhere. But, of course, it makes a huge fallout. But let me [00:20:00] tell you, if I wanted to take—well, typically when one talks about low-yield, one's talking about less than five kilotons. Hiroshima was about thirteen kilotons. Take one kiloton, just one kiloton—really a small weapon. If I can drive that into hard rock, which if you're going to build a hard underground target, you're not going to build it in sand. First of all, the limits of material strength—and this is in the things I've given you, spelled out in more detail—means there's no way I can get that to survive intact if it is dropped from a bomber or a on a missile warhead and driven more than fifty feet into the ground. If I detonate that at fifty feet depth, first of all, I'm not going to destroy a target, say, a thousand feet deep, that's hardened to a thousand atmospheres, which is the kind of things that one talks about. But secondly, I'm going to tell you, that one kiloton detonated about fifty feet underground is going to create a radioactive debris cloud with about 10^6 cubic feet, a million cubic feet of radioactive debris. That's not small, minor damage when that gets out. That's not small, minor damage. But it's true. It could do the damage of a ten-kiloton bomb that isn't detonated that deep—that's detonated on the surface. So indeed, one kiloton is less bad than ten or twenty. But a million cubic feet of radioactive debris is not minor collateral damage. Not if it's near a city. So one has to put these things in perspective. There would be certainly a *limited* military advantage, if you really wanted to take that incredible step of using a nuclear weapon in a limited scenario. I think that's an obscene idea. But what it would do to our effort at nonproliferation to keep the worst from also going nuclear— because if we go around saying, Well, we need a new weapon for new kinds of military missions, that increases the attraction for other countries to say, Hey, if they're going to talk about doing that for limited military missions we'd better get some too. So it doesn't help a nonproliferation consensus. Now, I'm not a politician, but I think that's common sense.

Yes. Well, for a non-technical person, the mind sort of boggles because you've realized there are all sorts of weapons that have already been created that aren't this general bunker buster notion that seems so important now that can do all sorts of horrific things.

You know, I work at JASON. I think national security is very important. I'm not a disarmer or anything. And I think making better conventional weapons and giving conventional weapons a better capability to take care of underground targets because they are a growing danger. And improving our intelligence above all, so we know where they are. There's plenty of evidence that when we go after underground targets, we sometimes get the wrong one. The main thing about getting an underground target, you have to know precisely—we can deliver a weapon where we say we will, but we have to know where that target is *accurately*. And so there are other challenges than just building a bomb. But, to me, it's not a matter of denying a military capability, because we have it. We have it with *big* nuclear weapons and we have it in a limited way with non-nuclear weapons. It's important that we *not* create this notion that I can be *more* likely to use a *low*-yield nuclear weapon in a *limited* conflict because it's *less* collateral damage. I just reject that notion.

You mentioned JASON, and I think that was set up in '60, is that right, 1960?

Nineteen sixty, it was started.

So you're close to forty-five years. And what would you say, looking back, do you think you have been able to operate for what you consider to be the good in advising—?

I wouldn't have stayed through JASON all the years I did and, you know, I wouldn't want anybody to think I do this work because I like associating with people in Washington, or I find this *more* interesting than the scientific work I would do at home. I think, as I've said in some of my writing, I think scientists have given the world problems with our advances and the technical

developments. And I think as a community, we have an obligation to try and see that they are put to good use. I mean science has improved the *medical* standards and given us an era of presumptive good health. It's improved the standard of living. It gives us a much higher standard of living with the industrial-technological spin-off. And in some ways, you can say it's helped [00:25:00] our security. But it's also created new problems, both in the environment and in medical abuses and in military. We have to try and help society understand *all* the implications of the advances we're responsible for. We *understand* them better than non-scientists because we know the possibilities. We also know the *limits*, which was involved in the big ABM fights, because we understood the *limits* as well. And so I think as a community, we bear a special obligation. Not everybody, but some of us find that in a way, we can convince ourselves we're making an important contribution, or a worthwhile one, and we do it.

And so JASON has continued. JASON now, of course, are a much *younger* organization. There are a few of us old Neanderthals around, but success depends upon getting *very* bright young people coming in, with a lot of skills *we* don't have, because nuclear physics was everything when we started, and radar. Now, it's computers and biology and information technology, oceanography, many, many other areas where one need skills. And so JASON succeeds because we convince people who may not agree with what we're doing that we're doing *good* technical work, and that we're not just politicians. We're doing good technical work that helps serve the national security interest of the country. And as long as there are people who believe that, JASON will stay healthy.

That's interesting because the big political divide is—the reason I think you're interesting, and you talk about it when you talk about what happened during the Vietnam era, this is notion that if you are talking to defense people, then you must be on that side of the divide.

Well, I got thrown out of classrooms. Some JASONs were attacked on the campuses during the Vietnam War. At Stanford, I got along very well. I guess I was too well known for my work opposing the ABM. In Europe in 1972, in Rome at the university and in Corsica at a summer school, I got thrown out of classrooms because I was a war professor. But that's another story.

Yes. So do you think, during sort of the worst days of the Cold War, did you envision where we are now, what would've happened to the Soviet Union? Because a lot of the rhetoric back then was, you know, we have to avoid this nuclear holocaust. It's certain to come if we don't really come to some sort of understanding. And things sort of unrolled differently than people expected generally.

No, the fact is that it (a nuclear holocaust) died with diplomacy. It started with the Atoms for Peace with Eisenhower. Kennedy. It continued with Ronald Reagan after all, when he decided he could deal with [Mikhail] Gorbachev. I think this country worked, and it worked successfully, to prevent the use and help control the spread of weapons. And I think we had leadership, but we *understood* that it took diplomacy. Multilateral diplomacy, arms control treaties, nonproliferation treaties, arms limitation treaties. It was slow and there were times we lost opportunities and we can always yell, and we yelled at the time, and we did our best—we got through fifty-nine *terribly*, terribly dangerous years. The danger really went away, I would say, probably in the 1990s, so I should say—I mean but certainly there were forty-five to fifty very dangerous years. We made it through. And that gives me faith that we *can* make it through now, if we don't lose our direction. And I think now, more than ever, because we're dealing with people—you know, the problem's more difficult. Deterrence worked because we realized that, I mean, the Soviet Union wasn't going to just go nuclear and get blown out of the earth. Deterrence worked, as awful as it is, but it worked. But now we're dealing with a culture which has terrorists, and some

irresponsible nation leaders, who really don't have much to lose or who have shown they're willing to be suicidal. And so how do we make a policy that goes beyond deterrence? We *do*, in fact, have to be prepared to wage preemptive, or even preventative, war. But it's got to be done very carefully in a way which, because we depend upon international collaboration, has the world understanding what we're doing, helping support what we're doing. We have to do it based upon intelligence that *we* believe and the world believes, if it is to be viewed as legitimate. There are a number things we've been learning, we should have known before Iraq, and I think in Iraq, to my mind, having Mr. Saddam Hussein gone is a great thing. But being there by ourselves and having fractured the world diplomatic scene by doing it the *way* we did, I think is a terrible mistake, and I think it was an unnecessary one, but that's an area I'm not an expert in.

Yes. Yes. That's interesting. The intelligence piece is interesting, but that's something else I'll tell you later, too. Down in Nevada, you hear people say, and they've written in some of the [00:30:00] test site [publications, for example: Origins of the Nevada Test Site, DOE/MA-0518, Feb. 2002, p. 86], that the test site was really a battleground, a major battleground, of the Cold War. In other words, because of the testing and the creation of a valid, a believable, deterrent, I guess, the worst was avoided.

I agree. I agree. No, no, I think developing a reliable and *safe*—you know, one of the things you don't talk much about is that we've had a very *safe* deterrent. We've had no nuclear accidents producing yield. Planes have gone down when we had the air alert B-52 force and whatnot. There's been never an accidental nuclear detonation that wasn't supposed to go off that killed people or did anything. That's a tremendous record. I've worked on that one very hard, too. In 1990, I led a three-man study that went over the safety of our entire arsenal, and pointed out how to make it safer and things to do. It's in the *Congressional Record*. [National Defense

Authorization Act for Fiscal Year 1991. 101st Cong. 2nd Session. 136 Cong Rec H 7778. Vol. 136, No. 15].

How do you do that? I mean in layperson's terms. Do you have to analyze the structural things?

Well, Congress asked me to do it with two other people. One was Charlie Townes; the other was Johnny Foster. I ended up being the chairman because they voted two to one against me. But what we did is we went to all the bases and we went to all the labs, and we went over in detail what was going on, and we did nothing else for about four months. We just worked hard. I mean you do it by working. And we convinced ourselves and we wrote a report. It's an unclassified report. It's in the *Congressional Record*. And we said what we said.

Now, was that related—no, that's reliability.

That's safety.

So the stockpile stewardship thing is about reliability.

About reliability *and* safety. I mean because there are ways weapons that age or rust or whatnot could cause damage and fatalities. And so it's safety, reliability, effectiveness, yes, the whole ball of wax.

I mean because it seems to me that, based on the wealth of this nation and the billions that we've put into nuclear weapons, that you would say, even if we don't have the most advanced weapon, we certainly have weapons sufficient for deterrence.

That's right. We have good weapons for deterrence, and that's why the president [George H.W. Bush] said in 1992, Papa Bush, we don't have any need for new designs. And that started the testing moratorium, which is now the treaty, although by us still unratified.

Right. Now, what about the—OK, I'm going to change the subject a little bit, unless there's another thought you have on what we're talking about.

No. No.

On something again that strikes me in Nevada, is a whole series of levels of culture of secrecy about nuclear weapons, layered on top of how impossible it is for non-experts to understand what's going on.

Don't overplay the "impossible for non-experts understanding what's going on." Technology is spreading in the world, and the level of understanding around the world of how to make a nuclear weapon is spreading. I don't think it's impossible at all. I think that any—I have no doubt that North Korea, Iran, or Iraq could make a nuclear weapon if they had the material. They need the material. Iran is building this big centrifuge complex to try and enrich uranium. They say it's for power reactors but, you know, some of that is also available to make weapons. And North Korea clearly has made reactors to make plutonium, and was caught *trying* to make uranium enrichment. No, I think the hardest part is to get your hands on—I mean some countries have uranium ore. Then they can enrich it. That's why you have to have challenge inspection and whatnot, what they're doing. Other countries don't have uranium ore; someone's got to sell it to them. And then you have the terrorists who probably—I mean a small terrorist organization isn't going to build one. They have two options. One is they can steal one. That's where the Nunn-Lugar program and, you know, there's material for fifty thousand or more nuclear weapons sitting in the former Soviet Union now. It's not all under high protection. There's the Nunn-Lugar Program, now supported by the G-8, other countries around the world. We're putting in a *billion* dollars a year—we have for ten years, twelve years—they're putting in a billion a year to try and protect that material better, not only in the former Soviet Union but *wherever* there is that material. That's very important but, you know, the billion a year is peanuts. It's a quarter of a percent of our defense budget. It's only ten percent of what we're putting in to some useless

ABM system up in Alaska right now. So we ought to be doing much more on that. That's an example of wrong priorities.

And so the—I had two points but I forgot the second one. [laughter] Oh, yes, the other one is spread of technology, why a terrorist would have trouble getting nuclear weapons. Why would he want a nuclear weapon when he can *much* more easily make bio-agents? And even [00:35:00] though they're not weapons of mass *destruction*, in the sense that a nuclear weapon is, they are certainly weapons of mass *terror*. And after all, that's what they want to do. And so for the purposes of a terrorist, it's so much *easier*, cheaper, and the knowledge is spreading, to make biological agents. And they don't have to work very well. They just have to be a threat and work *at all* and they've had a profound effect. It's easier to hide where it came from, who did it, *et cetera, et cetera*.

Yes, you don't need the chain reaction—

No, it's really time for nuclear weapons to begin to become less *important* in the world, and we can do it, but we'd better not splinter the nonproliferation consensus. As I say, 186 nations have signed on to that for the indefinite future. We have to *build* on that, and that means *not* taking steps like finding new missions for nuclear weapons that are going to obviously *strain* the restiveness of many countries under the discriminatory nature of our nonproliferation regime. So that's where I put my priority concern.

Right. Now, when you're doing your JASON work, as much as you can tell me, this is something that's persisted through—you persist through administrations somehow and you have relations—

Absolutely. We appoint our own members. We continue or don't continue our own members.

And the different agencies of the government with whom we've had obviously now long contact,

they either value us or not. If they don't value us, there's no work for us to do; we don't exist. In fact, we live on the credibility of our product.

And do you all together choose what you're going to think about, or you are asked to look at certain things?

It's a wonderfully informal process. That's why it's worked. *We* have ideas where we think we have something to contribute. The government agencies, they have ideas where they want help. And we iteratively work it out. We have meetings in Washington twice during the fall and the spring, and then we have our summer studies. We even have short winter studies now for a week or two. And so it's iterative. They have to have confidence in us, and one of the things that's very important is that we're *not* out there blabbering about what we do.

Right. And you actually are working—because you're scientists, you're working on the actual science of things?

Oh, absolutely. Sometimes we have program meetings. Sometimes we're working on new science, what are possibilities in new technologies or whatnot. Sure. We're scientists looking at what new things are coming and what new possibilities there are, what new challenges there are that we might do something about, and it covers the whole range of problems.

Now, as an individual, and obviously you're working on things that are classified, and I suppose as an individual, every individual doing this kind of work would say, Well, I'm a moral person and I'm not going to abuse this—

We have to go through very rigid security reviews, too.

Right, but how does that sort of work—it's a different class of person in our democracy that is allowed to have access to secrets, it seems to me.

Yes. Well, yes, that's right. That's right. I mean we have to be judged to be good scientists, trustworthy people, sensible people, and loyal people, that we understand our responsibility. But that's true of every scientist working in government problems. It's not unique to us.

Oh, I know that. I'm talking about the larger question of—because again it's something you come right up against in Nevada, all sorts of people who've been cleared to do all sorts of things for so many years, and it's a whole other—to an outsider, it's another culture.

Yes. It is true. I mean there is a problem if your whole life is spent in the culture of being secretly walled off, whether in nuclear problems or intelligence. It is again a problem, and it is a difficult one, and we would do better if we spent more time figuring out how to be *less* secret.

That's one thing Edward Teller and I completely agree on. I mean Edward's right. You do *better* when you're not walled off by secrecy from the criticism other people give on what you're doing. And so one works to try and help define sensible *boundaries* between the classified and the unclassified. That's particularly difficult in the last few years because, with 9/11 and the terrorist threat and whatnot, we're hurting ourselves. We've become so *consumed* with security concerns and classifying information. So one has to work that problem, and in a way it's also a [00:40:00] responsibility we have, we can help try and argue the case for where a security line should be drawn and not be drawn. But you don't win very many of those battles in the present climate. We hurt ourselves. We're hurting ourselves also because of the visa problems, meaning that we're isolating ourselves more and more from the world community, with which the strength of American science *grew* in the thirties and through the war with immigrants coming here. That's why we became so great, and students flocked here, and the best ones stayed. We're *not* educating enough of our own students in science. You know, the Hart-Rudman Report said [that] a greater danger we face than in any conventional war is from the eroding science base in

this country. Hart and Rudman in their 2001 report. A great report. I quote it all the time. [*Road Map for National Security: Imperative for Change*, The Phase III Report of the U.S. Commission on National Security/21st Century, Jan. 31, 2001]. Science education and research is eroding. We're living off the past. The budgets haven't kept up, and now, since 9/11, the visa problem is quite severe.

Right. Yes, I've heard about that.

We just have to keep working. These are the kinds of vigilant problems, problems you have to be vigilant about and do your best.

Now, do you still do science up at Stanford?

Well, I try to, but these young guys are so bright in theoretical physics. It's hard to keep up with the young guys. They're off in eleven dimensions with strings and branes (as in membranes) and whatnot. And your father would've known the name [Paul] Dirac, the Dirac equation, the man who joined relativity and quantum mechanics. And next to Einstein, in my book, he's the greatest of the twentieth century physicists. He used to write ditties when he was a student at Cambridge, in the student plays, and one I always remember. He uses the word "physicist" but he means "theorist" because that's what he was. "Age is of course the fever chill that every physicist doth fear. He's better dead than living still when once past his thirtieth year." So I look at these young guys around me and I try and understand what they're doing, but in terms of really creative research, I think I published my last real original science paper about ten years ago.

Well, that's OK. That's twice thirty, at least.

I enjoy keeping up with science, so I don't want to lose touch. I enjoy it very much.

Did you know, or do you know, much about this Joint Verification Experiment [JVE] that was done between the Soviets and the United States?

I don't know any of the real details about it. But I mean it was an effort for them to get a signal from a test in our area and us to get a signal from a test in their area so we could calibrate seismically what's going on in each other's test ranges. So I mean we could do much more in there. I hear the Russians—I don't know where it stands now, politically, but there should be access to each other's test sites now, with instruments, just to give more confidence that neither side is cheating on the test moratorium. But that's a very delicate subject and it's one I really don't know what to say in the last few years.

Because one of the interesting things—I've got a graduate student there at UNLV [University of Nevada-Las Vegas] who's really interested in that. She's talking to a lot of people about it. What was interesting to me, to hear some of what she's coming back with, was how exciting on a personal level it was for some of these long-time test site guys, working on these technical problems, to meet these—

I've seen that, yes. I'm aware of that. I mean both at Los Alamos and Livermore and Sandia [National Laboratories], the relations—I mean scientists are scientists and they talk and they are trusted, and it was great. It was great. We're doing a little less of it now, ever since 9/11, I'm afraid. Mostly with the Chinese, it's become more contentious. That's a loss. That's a loss. That was great.

And one of the things about that was, that I was curious about, because I don't really know from a scientist's point of view, was I know that there were efforts from the beginning, non-governmental efforts, Pugwash or even other kinds of things that people like you were doing, outside this testing regime, and so I've said to her, you know, You really need to look at the kinds of across-the-barrier relations that Soviet and American scientists

were having, even before something like this. And you were someone who was concerned about that for a long time, I think.

Yes, yes. No, no, these relations were *extremely* important. Certainly my friendship with [00:45:00] [Andrei] Sakharov was the richest of all, for me.

Yes, I've read about that. But remind me of how you first got in touch with each other or met each other.

I hadn't been to the Soviet Union but once, in 1959, for the first of the international conferences that was there. And I stayed away. There were various reasons. I got upset when they resumed testing in '60, '61 when I was supposed to go. Then I was very much involved in government work and didn't feel comfortable with it. There was a seminar in '74 at the Academy, the Soviet Academy of Sciences. It was a small meeting. And there was Sakharov. And he came to me and clearly, through some means or other, he felt he could trust me, and we talked, and he invited me to his house. I had dinner, met the family, and I just got involved with him. And so I did what I could.

That's so great. Because I've read some of those things that you—

Yes, he became a very close friend and I did all sorts of things, carrying material of his out of the Soviet Union illegally whenever he wanted me to, in my underwear or wherever else I could put it. We published all his papers. We translated them into English at SLAC [Stanford Linear Accelerator Center] when he was exiled in Gorky and so forth. And he came to visit us at Stanford. Just a great man. Good. I've run out.

Well, we're just about a quarter of. I think I should release you.

Yes, OK. I'll be glad to talk to you another time when you can come over to Stanford, but that gives you a general idea where I come from.

Great.

[00:46:37] End Track 2, Disc 1.

[End of interview]