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MEMORANDUM FOR RECORD

SUBJECT: US-Russian meeting - HEMP effects on national power grid & telecommunications

1. Lawrence Livermore National Lab (LLNL) hosted the Workshop on Atmospheric Nuclear Test Experience with the Russian Electric Power Grid, 14-15 Feb. Russian attendees were Professor (Maj Gen) Vladimir M. Loborev, Director, Russian Federal Ministry of Defense Central Institute of Physics and Technology (CIPT), Moscow; and Dr. (Colonel) Valery M. Kondrat'ev, Senior Scientist, CIPT. Dr. Lynn Shaeffer, LLNL, hosted the meeting. About 20 LLNL members attended. Other US attendees were Stan Gooch, STRATCOM; Chuck Lear, Silo-Based ICBM System Project Office, Hill AFB; Maj ValVerde, USSPACECOM; Balram Prasad, Defense Nuclear Agency (DNA); Mike Zmuda, Sacramento Air Logistic Center; two translators; and me. Loborev and Kondrat'ev spoke no English, although Loborev said "Good morning" and "thank you very much" and Kondrat'ev read his paper in barely intelligible English. All Russian-English and English-Russian translations were provided by two Russian émigrés from San Francisco area.
2. Robert Barker, LLNL Dep. Dir., welcomed the Russians. Summary of his vu-graphs is at enclosure 1.
3. Shaeffer introduced the meeting with the following background:
a. Loborev and Kondrat'ev stopped at Los Alamos National Lab (LANL) before coming to LLNL on 12 Feb.
b. Loborev and Kondrat'ev both said that LANL's computers are the best in the world.
c. Loborev served at the Naval Institute and the Semipalatinsk nuclear test site before coming to CIPT in 1979. In 1963 he was awarded the title of Professor, and in 1980 became a State Prize Laureate of the USSR. Loborev is a Major General in the Army, by virtue of his being the CIPT director.
d. Loborev gave a paper on HEMP effects on the Soviet national power grid and telecommunications at Euro EM-94, Bordeaux.

4. LOBOREV - "Historical Review"
a. CIPT was created in 1950 (two years before LLNL he added), under a different name (didn't mention the original name), as part of the Ministry of Defense (MOD). The 45th anniversary will be later this year, and I would be delighted to receive congratulations from Livermore.
b. From the beginning, CIPT was responsible for nuclear weapon testing, studies on nuclear weapon effects (NWE), and possible defenses against NWE. Therefore, CIPT is not a mirror image of LANL/LLNL or of the Soviet/Russian nuclear weapons labs at Arzamas and Chelyabinsk. CIPT differs from these four labs in that CIPT was chartered to look at NWE defenses . CIPT is 17 km NW of Moscow, has about 2,000 personnel, and has sufficient autonomy. CIPT personnel live in a closed city, like that of Arzamas, which is good and bad. Good because everyone can walk to work. Bad because the lab is the community infrastructure. 500-600 personnel are the core or critical players. 45 of these have PhDs or higher.
c. CIPT investigated phenomena during atmospheric tests. Resistance of structures and materials were studied in great depth, as were medical aspects of radiation . During those years, we developed a huge cache of NWE expertise and published numerous works. Further, we developed many standards. All of the preceding were based on experiments and observation of actual tests. Atmospheric testing was good for this kind of scientific exploration, but underground is not … underground tests are always tailored for specific things.
d. After atmospheric tests were halted, Soviet rocketry made great strides, especially as regards CEPs, where we got down to a hundred meters or so. Further, mathematical and computer modeling of NWE began to be developed quickly, about the same time. Thus, we were enabled to extrapolate, with confidence, to greater distances and yields.
e. We could measure phenomena practically to the very core of the [nucleonic] reactions … I'm not claiming we did this, but it was close as man could measure. Some of the measurement techniques we borrowed from the Americans … when we were successful in getting them.
f. Like LANL and LLNL, CIPT's budget is declining . We are shifting emphasis to technology transfer into other areas. Our country's upheavals bring much uncertainty.

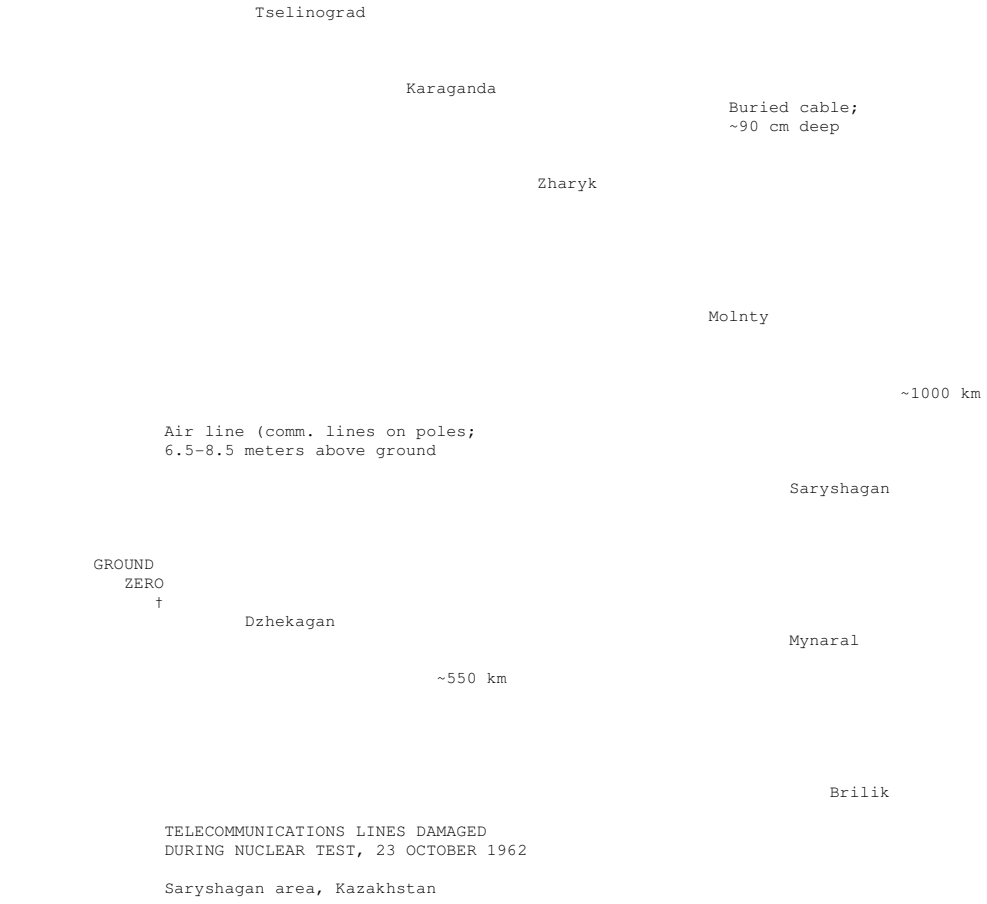
5. LOBOREV - Nuclear Weapon Effects (spoke for about two hours)
a. CIPT has all phenomenological data from nuclear detonations, as do LANL and LLNL; therefore, I won't try to teach you anything. Instead, I'll give you some examples of how we solve problems.
b. Start at the beginning of a nuclear detonation. We look at the initial stages, at the boundary of the nuclear device and within that boundary. Several vu-graphs were used to show pressure-temperature relationships (all in Cyrillic) near the earth's surface and underwater. Loborev gave an elementary tutorial on energy distribution at the air-ground interface, on how craters are formed, and how soil acts as a fluid in the initial stage, e.g., at about 10 P (~100 kilobars) the strength of the soil comes into play when its elastic and plastic properties become important. He said CIPT spent much time and effort in this area to determine kill mechanisms for silos and buried command centers. Examples were mostly 0.5 mt, with 100 m depth of burst.
c. Recap of where we got our data: direct measurement, modeling, US data, and chemical explosive tests.
d. Loborev then gave a tutorial on formation of the nuclear cloud and the near-ground effect. CIPT traditionally divided the cloud into three regions: the cloud itself ("mushroom"), the long stem, and the layer near the ground. A vu-graph showed a computer scan of movies from the "Sakharov bomb," which Loborev preceded with words to the effect that the Sakharov bomb was the world's first TN deliverable weapon. The 0.5 mt scan showed the major vortices in the three regions. Loborev said he'd seen all nuclear detonations and the Sakharov bomb was the only one that had such a distinctive condensation cone projecting downward from the stem. We've defined all the boundary conditions of the cloud in three dimensions and verified the results with rocket and airborne sampling. Verification was done jointly with another lab of the Academy of Sciences. Abrasive effects of dust and particles on reentry vehicle nose cones and aircraft were studied extensively.
e. Radioactive modeling is extensive, with spatial and temporal distribution of particles rather than gas dynamics computations. We showed the correlation of turbulence and gravitational characteristics. Dosage field measurements (footprints) are based on original experimentation. Underground test experiments were quite important to us, especially the US PLOWSHARE detonations at Nevada Test Site. Our motivation in this area was mainly to keep our facilities and personnel safe.
f. Loborev compared US SMALL BOY event's fractioning coefficient (of strontium-90 and zirconium-45) with the Soviet model of superimposing nuclear fission which is occurring at the same time. Correlation of US experimental data and Soviet/Russian mathematical model is quite good. Measurements of the Sakharov bomb and early Soviet model were good, too. We've used our model in all foreign atmospheric detonations. Conclusion: our model is adequate.

6. Questions & answers:
a. Question: Based on your understanding of what the US has published, can US models be improved by Russian models and/or data? Answer: We follow world literature, in this area, assiduously. I suspect the US doesn't have close-in data on even the Soviet detonations. I'm convinced US-Russian specialists' discussions in this area would be absolutely beneficial to both sides with regard to improving methodologies. But this type of collaboration is in the bailiwick of

higher ups in both our governments. Such could occur if they agreed. The fact that I'm standing before you and that you have some Russian scientists at the lab says that the process has begun, as President Yeltsin recently said. We both should pursue this through out respective chains.
b. Q: On your diagram of cloud dynamics, there were three regions (cloud, stem, and near ground). You said you didn't use hydrodynamic codes, please elaborate. A: The drawing represents about thirty years of knowledge and data. It was derived in uniform and nonuniform atmosphere. It was expedient to use Lagrangian and Euler equations in some places, then to particles in cells. The actual depiction was dependent on the limits of the computer used.
c. Q: In US nuclear detonation diagnostics, the blue light is called "Teller light." What do you call it: A: We differ. We don't name physical phenomena after those who predicted them although Sakharov richly deserved such an honor. We call the light "the lit-up region" or "light portion." Originally, we called it the fireball, but got away from that. While on that subject, I always liked the way the US identified their nuclear test events (by a unique name). We identify ours by date only. By the way, "Sakharov bomb" is my idiosyncrasy; you won't find that in the Soviet/Russian literature.
d. Q: Has your ground shock work been translated? How could we get it? A: Translated? You're better off going to your American specialists. We only write reports, not translate them! Our Academy of Sciences (Institute of Applied Mathematics, specifically) published many jointly with CIPT. Excerpts, of course, have been presented at symposia held in the former USSR, especially those on gas dynamics. Two authors to search for are Yetsev and Nauka (?).

7. KONDRAT'EV - History of EMP Effects (via an interpreter)
a. Kondrat'ev has been at CIPT since 1964, and is a Colonel in the Army by virtue of the position he holds (Senior Scientist) at CIPT. His Doctor of Science thesis was EMP Investigation.
b. EMP was observed in the first Soviet nuclear test. In the near zone, we were fighting it more than studying it, e.g., our shock sensors often were knocked out. EMP was initially looked at as a method of locating a nuclear burst and not as a means of crippling military systems. Fighting EMP effects, in both air and surface bursts, gave us good experience with shielded cables and boxes.
c. Because we could find nothing about US experiences with EMP effects, we thought you were treating it as extremely secret or that you really had no data on it. Later, we concluded that you had no data; and that our data are far better than yours .
d. Our measurements gave a wave form similar to [US] Morganstern's. Therefore, we concluded you got your data from our secret reports.
e. The work of [US] Radasky, Baum, and Longmeyer were well known to us. We couldn't repeat or verify their work because we didn't have the same computer power. Therefore, we had to finesse some areas. Our approach differs from that of the US.
f. Last May, I presented the Soviet/Russian approach at the Euro EM94 conference and think you're all familiar with it. So I'll switch to the basic part of my report rather than repeat

8. KONDRAT'EV - Formal paper (read by Kondrat'ev, with some difficulty)
a. USSR EMP theory was developed 1961-62. The Ministry of Communications did EMP experiments on communications lines.
b. The attached diagram approximates a vu-graph used to discuss damages. Dimensions shown and information in the three boxes were provided verbally by Kondrat'ev and/or Loborev.
c. Amplifiers, spaced 40-80 km apart were damaged as were spark gap tubes. The latter were commonly used to protect the system from lightning damage. Spark gaps saw more than 350 volts for 30-40 microsecs; parts of the line saw more than kiloamps, and the rise time was 30-40 microsecs - these were actual measurements.



Not to scale

d. Experiments were set up specifically to study protection measures for critical items. We experienced fires from EMP and loss of communications gear Seven-wire cables were common in telecommunications networks.
e. Destruction of power supply at Karaganda. Fuses failed during the test, as they were designed to do; actually, they burned.
f. Height of burst was 300 km, and total gamma output was 1025 (no units were provided).

9. Questions & answers:
a. Question: You referred to 1.5-3.4 kiloamps and 20-40 microsecs.; were these values from injected current tests or induced from actual detonations? Answer: Observation of gas-discharge tubes, which were designed to break down at 1.5 kiloamps. Actual measurements showed destruction or triggering of some at 3.4 kiloamps.
b. Q: How long was the phone line and high were the wires off the ground? A: 550 km long, at 6.5-8.5 m from the ground. Buried cable was 1,000 km long and buried about 90 cm.
c. Q: On the buried cable, was it inside a conduit? A: It was sheathed in lead and spiral-wound steel tape.
d. Q: What was the yield and time of burst? A: No direct answer. The date was 23 Oct 1962 and the time was about 0600.
e. Q: Have you fixed the problems? A: The loss of communications was not a problem of our interest or responsibility. The air line and cable were for civilian use. All trunk lines are now underground, which was a Ministry of Communications initiative to protect civilian communications.
f. Q: Was the damage done to fuses only? A: Fuses were associated with air-suspended lines only. The cable system switched itself off; resetting required manual operation. The line was equipped with relays and were designed to switch off if they experienced a power surge of more than 30 percent than the specification required.
g. Q: Clarify 20-40 microsecs.? A: 20 microsecs was the maximum power.
h. Q: What were the effects on electricity generation and associated field strength? A: Military generators (fixed diesel plants) and substations were damaged. Several kV/m were experienced.
i. Q: Would you make a judgment on whether early or late EMP caused the damage? A: The air line was damaged by early EMP and the cable by late-arriving EMP
j. Q: Do you know the ground conductivity for the area? A: It changes from point to point. On the average, surface conductivity is 10-3 siemens /m. Characteristic of late-arriving EMP: 10-90 secs. and about 12 V/m. Characteristic of early-arriving EMP: 20-100 microsecs. and 10-50 kV/m.
k. Q: Were there other cables and air lines that were not affected during the test(s)? A: There were very few telecommunications networks in Kazakhstan. Most follow rail lines. The only ones monitored were the ones discussed. We presume others were damaged, but not reported.
l. Q: What was the assumed earth conductivity for the late time component? A: Same for both early and late - 3 siemens/m on the average.
m. Q: Were the military generators damaged by early or late EMP? A: Early.
n. Q: One of yours slides showed “UP-7,” “UP-10,” and “UP-17” with distances between them. What do these represent? A: They are discharge units, designed to protect amplifiers from lightning strikes, with the typical distances between them.
o. Q: Did any other atmospheric tests damage communications lines? A: Yes, at differing altitudes. Lower altitudes gave similar results.
p. Q: What about failure of power lines from other tests? A: I have no information on that, with the exception of the military generator plant I already spoke of.
q. Q: Is the north-south and east-west orientation of lines is important? A: Definitely yes. They are unambiguously tied to the geomagnetic field.

10. LOBOREV - Special Meeting, “fishing expedition:”
a. Shaeffer invited me to attend this small-sized meeting. All he knew was that Loborev wanted to discuss a problem relating to chemical-biological matters. Paul Herman, LLNL Treaty Compliance chief, and Bill Tao, an HE and chemistry expert, were the chief US participants.
b. Loborev said he wanted to know if there was any interest in international cooperation on (1) destruction and storage of radioactive waste , and (2) an international standard on personnel reliability (for storage of active materials).
c. Destruction and storage of nuclear waste:
This is an extremely acute problem in Russia, e.g., naval reactors residue and tons of active material from dismantled nuclear weapons. I assume the latter is a problem in the US as well. I’m not concerned about traditional methods of storage and destruction.
We’re now concerned about remediation of property and people. American administration and scientists should be or are interested in the same things … I’ve heard this from DNA and LANL. Nuclear test sites are of particular concern
The main task is to reconstruct the radiation dosage that was visited upon the sites. Bottom line: we’d like to see some international standards and computer or theoretical models in this area
Initially, I’d like to see an American-Russian effort, with later involvement of the other nations having nuclear weapons
This area was discussed with Ashton Carter in October 1994 and with the American delegation (Gloria Duffey) in January 1995
US question: What do you expect from the US from a technological standpoint, if you’re not interested in the process? Answer: Evaluation and magnitude of what transpired at the tests, and what’s happening today in the contaminated area. This is first step to any rehabilitation
US question: Are you saying Russia is now ready to release details of all nuclear tests in Semipalatinsk, e.g., height of burst, yield, meteorological conditions, etc.? Answer: Good question! But I am only the head of an institute and not the President. DNA is now spending money in Russia, but I don’t know what Russia is willing to release. I am concerned about Russian land closest to Kazakhstan and not necessarily Kazakhstan as such. I don’t know why Kazakhstan is approaching the US and not Russia about this
US question: If you have data, why don’t you share it? Answer: We’ve not been approached. You need to ask my government, not me. US response: LLNL was at Chelyabinsk a year ago. We were negotiating a data base on biological and health effects of nuclear contamination (of the accidental explosion in nuclear waste storage). We asked for detailed data and Russia apparently agreed. So what are you proposing, I’m confused.
Measurements have been taken in Novosibirsk and other areas that are contaminated (in the water shed, soil, etc.). The data show that, except for the test site itself, there are no standards. When we speak of rehabilitation we don’t mean “clean up .” We’re not concerned with a Palomares or Thule. We’re concerned with the long-term picture

(people living in contaminated areas and what is good or bad standard. We want US scientists to verify what we've done, with comparable personnel, with experimentation, that would lead to an international standard. We think it could be done quickly

I will leave a written proposal with you, as I did with LANL last week, but you will need to have it translated. I talked about this with Dr. Hecker, Dir., LANL, but he was not enthusiastic

Herman's suggestion: The Russian delegation in Geneva should table a suggestion to take this approach as a part of the Comprehensive Test Ban Talks (CBT). Lobrorev's response: You're absolutely right. There is an extremely unpleasant aspect though. Everyone is terrified of the number of nuclear weapons in existence. The parties may be afraid that a nuclear explosion may occur and thus proscribe any further work

China wants "peaceful detonations" of nuclear devices [at the CBT]. The British are ready to proscribe testing. The French are too emotional and thus are not predictable. We in Russia are ready to agree to no further testing. You Americans are showing no initiative because there's no political advantage

Herman's counter: Get agreement on the Nonproliferation Treaty extension. Then propose that the methodology be adopted under international control. Loborev's response: Thank you! At last I've talked with a competent, knowledgeable person. Now, we need to get our scientists together and develop proposed project plans (economic, ecological, etc.). There are probably only two dozen such experts in the world capable of doing this

Dr. Tao's aside to me: "We've been through these kinds of things before. Each institute wants to get the US funding and none is particularly interested in an integrated approach"

d. Personnel Reliability

Personnel reliability is at the heart of the storage and destruction problem, e.g., psychological and political stability

US question: Are you talking about the US Personnel Reliability Program (PRP) as such? Answer: I'm concerned about dismantlement and usage of the existing stockpile

Russia has developed a process for dismantlement of weapons containing hexogen HE . It uses diamond dust in a slurry of water or lubricating oil. This would be a good area for international cooperation. Our economic analysis shows it would pay for itself in 1-2 years. We have hundreds of thousands of tons of this HE in Russia. The problem of safe storage is especially acute, not to mention the impact on the ecology. Yes, this is a Russian problem, but it can enhance internal stability if the material can be disposed of. Collaboration already has been arranged. Our military hasn't been brought into it fully yet

US comment: DOE labs are already involved with MINATOM, but your MOD is not involved. Therefore, we [LLNL] believe this is wholly a Russian problem and the US cannot help. It would be more efficient if we could do these things together (MOD-DoD-MINATOM-DOE) instead of doing one-on-one

US question: On the safety of nuclear weapons PRP, are you also talking about physical safety, e.g., many steps are needed to build nuclear weapons, with associated hazards. We do risk analyses, is that what you propose? Answer: No. Unauthorized actions can be disastrous around stored, dismantled nuclear materials. I'm really concerned with psychological stability of anyone coming into contact with those stored materials

11. DISCUSSION ON JOINT US-RUSSIAN PAPER ON EMP EFFECTS ON THE CIVILIAN INFRASTRUCTURE

a. Background: Loborev gave a paper at EURO EM-94, Bordeaux, which excited some US attendees, several of whom had met Loborev and Kondrat'ev in 1993 when they toured some Russian EMP test facilities. A passing comment was made that the US-Russia should think about doing a joint paper on HEMP effects on telecommunications and national power grids. Last fall, Professor Ianoz, University of Lausanne, Switzerland, wrote to Loborev formally proposing the paper. Ianoz is well known to the Russians and Americans and is held in high esteem.

b. Randy Barnes, Oak Ridge National Labs (ORNL), began this session by providing the Russians with copies of Charlie Vitito's papers on EMP and an ORNL report of Barnes's work on EMP testing of civilian infrastructure components. He then turned the meeting over to Dr. Fred Tesche, who summarized the ORNL work and the computer models developed (on electromagnetic coupling for overhead lines, signal cables, shielded cables, buried cables, and antennas). He discussed areas that are difficult to model and how measurements were made instead (surge protection, transformers, and power subsystems).

c. Tesche proposed a joint scientific paper to further understand EMP effects on infrastructure systems. Elements of the proposal:

Get details of the configuration (power grid & telecommunications) of the Russian systems damaged during atmospheric testing

Use existing ORNL models to predict responses

Evaluate ability of models to predict the observed system effects (Russian)

Document in an appropriate journal, e.g., IEEE Transactions in Power Delivery, and simultaneously in an equivalent Russian journal

d. Proposed approach

Summarize system configuration (connection topology, etc.)

à Length & radii of conductors

à Orientation of lines

à Load information

Particulars on Russian observations

à Flashovers/upsets vs. full system failures

à Limited burst information, e.g., HOB, yield & ground zero location

Develop parametric inputs for models; run models; & compare results with observations

Jointly assess adequacy

Document authors

à Professor Loborev

à Professor Ianoz

à Tesche

à Mr. Volska (representative of US power industry)

e. Tesche said US participation would be unfunded, but still have a high priority. Where to from here? Assuming Russia will participate, can you provide additional power and/or communications system data?, e.g., system dimensions, loads, connections, flashover characteristics, etc.?

f. Loborev's response:

We want a lengthy discussion with Tesche, whether or not we pursue the joint paper

What would be the role of US power companies in this problem area? More appropriately, what would the role of Dr. Saul Rabinowitz of the [US] Electric Power Research Institute (we know his views on EMP are quite radical and controversial)? Answer: Rabinowitz is no longer a factor. The power companies would play no role because this effort is meant to be a scientific venture

We're not interested in protecting the Russian national power grid from HEMP. We think hurricanes pose more of a problem

What would be the purpose of the paper, to call attention to the problem area, get

power companies to resolve the problems, or do a scientific paper to further technical knowledge and enhance cooperation between Russian and the US? Answer: The latter. We would like to validate our models for the benefit of the worldwide power and telecommunications industries. That is, we would share the results with everyone

What would be role of the IEC's 77C committee (currently drafting an international standard on EMP). Answer: We'd need to explore that, but probably would play no role as such

Why do you want particulars on our yields, etc. Are you aiming for an IEC/other standard? Answer: we need a starting point for the environment under consideration

Very interesting proposal, and very complex. It is more complex than we'd been led to believe. We thought we could summarize and generalize (or augment) what we presented at Bordeaux. You've proposed a deeper and broader program, which we welcome, of course. But, first, we need to coordinate this with our masters

Request we be given time to review your proposal and background data. In a very short time we will give you an answer

If we do this, the co-authors must be equal in numbers from each side (because they affect the outcome). Also, we want parity in materials or information presented by the US and Russia. Traditionally, Russian-US collaboration, on any subject, is parity on data given to the other side. Therefore, our masters must be made aware, consider all implications, and give their approval to our recommendations

g. Agreement: Loborev and Kondrat'ev will maintain contact with the US principals via Professor Ianoz (he speaks Russian and English and is a subject area expert).

h. Tesche told the Russians that it would be acceptable to scale down the proposed paper because nothing was set in concrete. Loborev's response: The paper proposal appears thorough and well-founded; therefore, I see no reason to change the proposed structure. You have included the elements that I would require if we were to do an independent project of this nature

SUMMARY OF DR. BARKER'S ORGANIZATIONAL BRIEFING

1. Copies of all vu-graphs used were given to the Russians.
2. LLNL: employs about 9,000 persons; has about a $1-billion budget, down from preceding years; and has a $4-billion physical plant.
3. Pie chart on FY1995 budget, showed core weapon, supercomputer efforts, etc. Showed that roughly 70 percent of the current budget is attributable to "DOE Atomic Energy Defense Activities"
4. Chart compared budgets for fiscal years 1954 vs. 1974 vs. 1994.
5. DOE guidance: No new nuclear weapons. Dismantlement, safety and security assessments are priorities. Support verification, arms control, and nonproliferation initiatives, and provide emergency radiation/accident team and support.
6. Chart on fusion energy (vis-à-vis international programs), e.g., NOVA, a $1 billion project was just approved that "we hope to have installed at Livermore."
7. Chart on biotechnology, e.g., radiation effects on humans, and genome R&D (one of the few labs in the world for this).
8. Chart on mixed waste management facility. Incredible problem in this country because we have no facilities for disposal and storage of mixed radiological and toxic components
9. Chart on industrial collaboration, e.g., biomedicine/pharmaceutical, precision machining, materials, and an electric vehicle

Encl 1

He used the terms "protection" and "defense against" NWE in the two days and never mentioned "survivability," "vulnerability," or "hardening." Several times he referred to work done by DNA but never referred to DNA's missions

I understood from LANL that Loborev's doctorate was in "radiation physics"

Loborev said he told Dr. Hecker, Director, LANL, the week before that CIPT is being cut 15 percent this year

Neither Kondrat'ev nor Loborev made mention of the fact that Soviet HEMP data were obtained over land and US data from over water

Glasstone's The Effects of Nuclear Weapons (1964 edition), page 681b, shows a high-altitude test in central Asia, 22 Oct. 1962, of "a few hundred kilotons." The next one in central Asia, announced by the AEC, was 28 Oct. 1962, high altitude, and "intermediate yield." The same day a low-altitude, "low" yield, test was conducted at Semipalatinsk. I have a little more classified data.

"mho" in the CGS system (for those who took physics long ago)

This later became "rehabilitation" of soil in areas around former Soviet test sites. Loborev, Tao, and Herman couldn't agree on the definition of rehabilitation. Loborev was convinced the US side was defining it as packing contaminated soil into drums and storing it someplace safe as done at Palomares and North Star Bay. The US side seemed convinced Loborev was not being clear as to what he really wanted to collaborate on

Loborev jokingly said he understands that political stability isn't a pressing concern in the US; however, neither is financial indebtedness of such concern in Russia as it is in the existing US nuclear weapons Personnel Reliability Program

Commonly known in the US as RDX

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