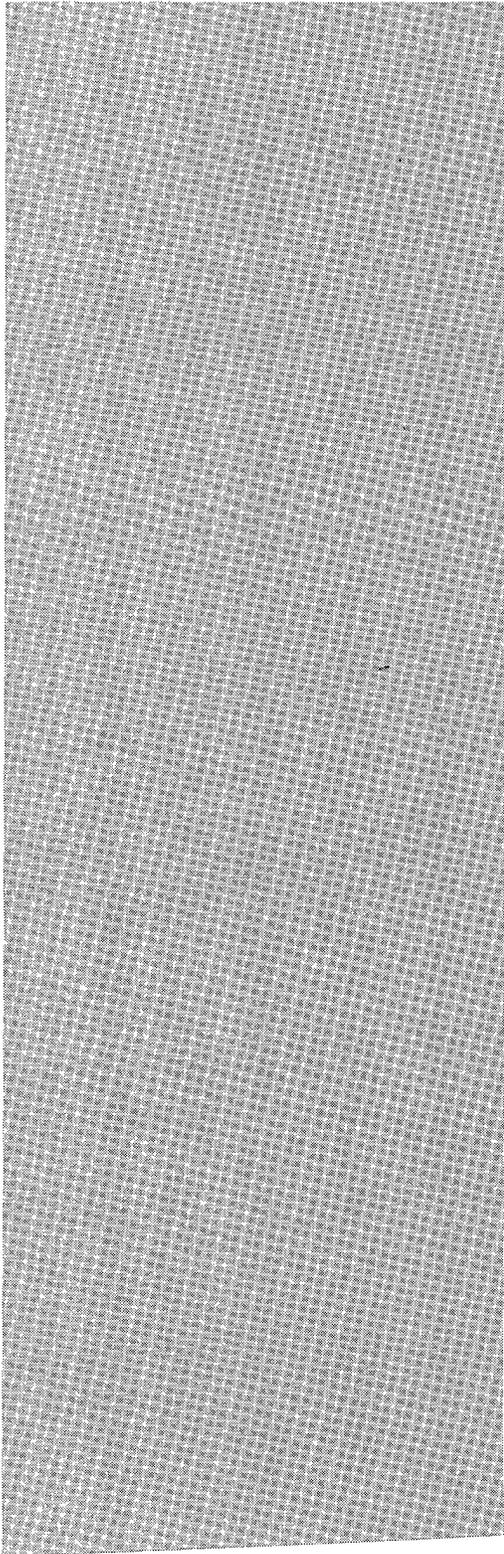


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in Space and Science*



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**Los Alamos**  
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# FORMER SOVIET REPUBLIC CAPABILITIES IN SPACE AND SCIENCE

by

Gregory H. Canavan

## ABSTRACT

Recent Department of Commerce, U.S. Space Council, and Strategic Defense Initiative Organization missions to the Former Soviet Republics (FSRs) provided an opportunity to view FSR capabilities in space and science and explore possibilities for cooperation in developing the dual-use capabilities of distributed remote sensing. This report summarizes the trips and suggests promising areas for cooperation.

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## I. INTRODUCTION

Over the summer I had the opportunity to visit Russia as a member of a Department of Commerce U.S.-Russia Space Commerce Mission resulting from the Washington Summit between Presidents Bush and Yeltsin. I later returned to Russia and the Ukraine as part of a Space Council delegation to attend technical meetings and visit scientific centers active in the exploration of dual-use applications of distributed remote sensing (DRS) for ecological monitoring.<sup>1</sup> The final trip was with the Department of Defense (DoD) Strategic Defense Initiative Organization (SDIO) to discuss issues in strategic defense, stability, and dual-use applications of defensive satellites for global awareness, warning of aggression, and natural disasters with experts from the FSRs.<sup>2</sup>

On returning from the first trip I wrote a report covering the places and institutions visited. The report was distributed to a number of colleagues. Some found it interesting; a few were stimulated to suggest further areas for cooperation, which it was possible to explore on the successive trips.

This report gives a brief summary of all of the trips and reports. It is written in the hope of stimulating thought in a wider community on how better to interact with the FSRs, which are underutilized to an awkward and somewhat ominous extent. The report first summarizes the separate trips that were performed under the leadership of the Department of Commerce, the Space Council, and the SDIO. It then offers some cross-cutting observations about travel and communication before concluding with a personal view of promising areas for cooperation.

In writing the summary report, my initial tendency was to gloss over details, generalize, and rewrite initial impressions. It is a bit embarrassing to admit even to myself how much of the information passed me by before I could become adjusted to the size and scope of the immense space and science establishments of the FSRs. Recognizing that first impressions are sometimes the most accurate, I have compensated for my tendencies towards self defense by appending the actual trip reports as well, so that those interested can examine the details, personalities, and interactions to which we were exposed. I am sure that there are a number of errors and misunderstandings in them. I would appreciate any corrections readers would like to offer.

## II. U.S.-RUSSIA SPACE COMMERCE MISSION<sup>3</sup> (APPENDIX I)

The U.S.-Russia Space Commerce Mission was initiated by the Washington Summit. It was led by the Department of Commerce; members were from the SDIO, Department of Energy, Department of Transportation, and a number of U.S. industrial firms. It visited a large number of design bureaus, institutes, and factories in and around Moscow and Saint Petersburg. It was supported by a technical staff from those agencies and from private contractors, who are compiling an integrated assessment of all of the delegates' information and views. That assessment should, when available, be a useful preparation for subsequent visitors who are not so supported and staffed, as the number of possible collaborators is very large and travel between them can be difficult and time consuming.

The mission started with meetings with the General Director of the Russian Space Agency and other high government officials and a day of briefings from the directors of a large number of design bureaus. That gave some of us our first grasp of the enormity of the space enterprise, which is said to now employ 800,000 people just within Russia. We learned that over 50% of Russian launches are now civil, and that last year's 10 billion ruble civil budget was about as big as that for military space. They discussed with considerable enthusiasm establishing new complexes for ecological and environmental measurements.

The briefings gave many of us our first direct exposure to the design bureau system that executes this program. The design bureaus can be thought of as roughly analogous to the U.S. national laboratories. Until last year, most worked for the Ministry of Machine Building, under which they served as integrating contractors with a great deal of autonomy to design and produce

hardware at some level. They still have a great deal of autonomy, but they no longer have a secure base of support. With the abolition of the Ministry of Machine Building and their transfer to the Russian Space Agency, most are struggling to secure funding and make ends meet.

The directors, although very good technically and skilled at survival in the old system, are generally confused as to how to get funding from the new Russian Space Agency and largely at a loss as to how to approach the U.S. for joint projects, even in their areas of expertise. The briefings were long, technical, and detailed; they almost seemed designed to conceal fruitful areas for collaboration rather than highlight them. There were some notable exceptions, as noted in the full trip report. Some organizations, such as Lavochkin, have some history of cooperation with the West. Some, such as Elas, have such obvious strengths in critical areas that their capabilities simply shine through tepid presentations.

The discussions highlighted contributions to known projects such as adding modules to the MIR space station and improving the developed Proton, Zenith, Energia booster and Buran shuttle systems. They mentioned with pride that the Russian Glonass and the U.S. Global Positioning System (GPS) were being adopted as the basis for navigation developments, and clearly felt that this should be an area of expansion for Russian space efforts. An area of particular emphasis was the use of decommissioned military boosters--particularly the SS-18s and -25s--for space launch, because of the ability of that approach to both generate hard currency and provide an incentive to take them off military alert. Both government and industrial members were cool to that proposal because of its potential domestic impact.

Government officials expressed pride in Russian capabilities in robotics, materials, and medicine. But they admitted candidly that due to over-classification, they were not even aware of many Russian programs. They called for the exchange of young scientists to reduce such misunderstandings. They heralded the mission, saying that "this delegation will become an important signpost for cooperation." But they admitted that there are no prototype agreements for cooperation and no policy for ownership, privatization, or intellectual property rights, although there are some initiatives in the legislature. Thus, fundamental barriers of both military and legal natures remain in the way of real cooperation.

Although the budget for civil space increased by more than a factor of 6 in the last year, that was about a factor of 2 below inflation, which is estimated to have been a factor of 20 to 30 over that period. That has forced the Space Agency to change priorities. Previously it had tried to support all of the efforts it had inherited; now it will have to prioritize. It is trying to do so according to "the priorities in basic research" and those of the Russian National Academy of Sciences. The Space Agency knows it needs a lot of external support. Thus, it is willing to treat projects as "commercial if [it] is convinced that the West will invest in them." This gives Western partners an enormous amount of potential leverage in determining which projects will get internal

Russian subsidies. They could thereby literally determine which of the design bureaus will survive.

In private sessions, they discussed the dual use of these technologies for strategic defense, although they expressed a preference for pooling information as a means of pre-empting missile threats. They also favored releasing surveillance data bases with low resolution for civil purposes. They were candid in discussing problems about the proposed collaboration with India on rocket engine development, which appears to violate the Missile Technology Control Regime (MTCR). They indicated a preference for joining the MTCR, but indicated that Coordinating Committee for International Export Control (COCOM) restrictions effectively exclude Russia from competing for the commercial space launch business and that if that continued, Russia would "have to find an outlet for its significant, cheap launch capacity somewhere" to offset decreases in military orders. They seemed encouraged by recent discussions with U.S. NASA Administrator Dan Goldin, who had just met with them.

At each of the design bureaus we visited over the next few weeks the pattern was much the same. We would first tour their bureau museum, which showed all the projects they had contributed to in the past and the decorations they had won for them. Then we would get a lecture on current projects from the director and one or two of his top people. Then we would get a tour from a few younger bright and active scientists. And then we would sit down for a meal, after which our hosts would ask us if there was anything we were interested in. It was almost up to us to suggest specific projects for collaboration. Very few of the scientists we visited had any idea of how a real collaboration with the West would have to be put together. In their defense, it should be noted that many of the bureaus we visited had been denied contact with the West until the last few years.

Scientific Production Association (NPO) Lavochkin was an interesting example, because of the breadth of its capabilities and projects. We saw some impressive facilities, competent technologies, and timely projects. We were exposed to good scientists and program managers who were grappling on a daily basis with how to formulate and advocate new projects within Russia and with the West to keep their most talented people employed. They are just making it. The visit also illustrated the problems that have been caused by their isolation. Simply due to that, many of their civil efforts seemed redundant with NASA and other programs. And many of the concepts being developed in Lavochkin's "reconversion scheme" for shifting to civil applications appeared to use dated technology or propose development of components already available in the West. Just interchange should solve many of those problems. But until they are corrected, Russia will get less than it could from whatever it spends on space.

Lavochkin also exposed us to the informal networks between design bureaus that are growing up to replace the former extensive management from Moscow. It would appear that these

less formal collaborations could be a key element in determining which of the bureaus survive and which don't. We learned more about these networks as we visited other apparently successful design bureaus. Lavochkin was also typical in that it could not provide any of the sort of information about its uses and sources of funds in any format that would be useful to potential Western collaborators. It was suggested that they might be well served by the preparation of an annual report to summarize their activities as a business. My guess is that such a report would show them--and others--as going out of business in a few months.

NPO Energia was interesting in that it is a massive bureau with about 30,000 people, which has controlled about two-thirds of civil space. It described its well-developed procedures for managing very large projects as subcontracts. They could not clearly describe how some of their new efforts fit with Lavochkin's and others' proposed efforts, with which they seemed to have large overlaps. It was remarkable to me that when they took us on a tour of their Salyut and MIR modules and a Buran mockup in which their universal docking module was being tested, we saw only three or four people working. Overall, Energia didn't seem to be able to describe itself as a business or indicate what it wanted from the U.S., other than a core role in NASA programs.

NPO Machine Building was interesting to me because it brought us into contact with the Almaz space station and its synthetic aperture radar (SAR). The data was moderately interesting, but what I found useful was the sharp definition of the barrier between civil and military applications, which enabled some estimate of the extent to which the Russian General Staff had been willing to make concessions to the end of the cold war. NPO Machine Building plans to get into mobile communications. They indicated that the Minister of Communication had a competition going with about 10 bureaus for an improved communication system. It sounded like a winner would be picked in about 6 months. The losers could be in trouble in the new system. They looked like losers to me.

NPO Elmas at Zelenograd was interesting because it is at the center of space electronics for much of the FSR programs and because it is at a technical level that could just about compete with the West, which is probably both good and bad. They talked extensively about their Sokol telecommunication system, which is based on decommissioned military satellites. They had also described Sokol in Washington in meetings before the Summit. They wanted partners, but had no description of it other than in Russian. They gave a demonstration, but it came in about half an hour late and had poor channel quality. Fax was acceptable, but voice was of a quality that might not be of interest now that AT&T has improved service out of Moscow. Because Elmas has a strong position in space electronics, it is included in a number of networks, which gave us additional insight. They are also developing visible and microwave sensors based on their own electronics as an alternative to decommissioned military systems. They gave us a cursory description, which is discussed further below.

Khrunichev Enterprise was perhaps the best organized for visits. It gave us a full color brochure. The introductory quote by its General Director that "Meeting our plans will guarantee success under any and all conditions and circumstances" indicated to me that conversion is only about a brochure deep and that the Gosplan was alive and well in the enterprises. The candor of Khrunichev and its partner KB Salyut was refreshing. When asked if they were the contact for the Indian rocket deal, they said "yes, we are the bad guys." Seeing their high bay with several MIR modules and 11 Proton rockets was impressive, but we only saw a few people working. Two of them were spray painting the hall to make the displays prettier and the third was just messing up a sheet of steel.

The Institute for Chemical Building (NIIMASH) was suggested to us strongly by the Director of the Space Agency. That was interesting, because it just had a bunch of big, old rocket engine test stands and vacuum chambers. But their management was alert. When we didn't indicate much of a prospect for profit, they asked us to pay for our own lunch.

During the Commerce mission we took some time out to discuss strategic defense issues with members of the Russian Academy of Sciences. They in turn instructed several of their institutes to brief us on their SDI projects. It was interesting to see the varying extent to which they complied, the thinness of their basis for evaluating the status of SDI, and their eagerness for cooperation--particularly on U.S. technology. Most of the work was behind that in the U.S., but there were enough small areas for collaboration to make the side visits worthwhile.

Overall, the Commerce mission was quite successful. It exposed a large number of U.S. scientists and program managers, many of whom might develop actual financial interests, to a wide spectrum of Russian commercial space facilities. The summary report should save others a lot of time. It should also serve as a rough skeleton for piecing together an outline of the civil Russian space program, which is now quite confusing. With the information we received it should be possible to put the pieces together in a way that shows the actual control mechanisms and defines the financing of the various design bureaus. Without that, a dollar added for "civil" space could just reduce Russia's required spending for military space by a like amount, which it would be desirable to avoid.

Compared to other pressing needs, Russia does not need a civil space program of anything like its current size. Russians need food, decent housing, roads, cars, schools and real jobs a lot more. The resources devoted to space are a cruel diversion from much more pressing requirements that threaten the stability of its current democratic government. The economic reforms of the Yeltsin regime have fallen heavily on the very poor; they have also wiped out the former nomenclature and reduced to poverty many of the university intellectuals who were early supporters of democracy.

That said, civil space is at least one area in which Russia has some competitive advantage for hard currencies and technologies. Their space hardware and launch services really are about an order of magnitude cheaper than those of the West--largely because of the subsidies and distortions cited above. Thus, there are some advantages for the West in working with Russian civil space over the interval until those subsidies are removed. The biggest problem is that neither the bureaus nor Koptev know how to present themselves to potential customers. The bureaus would like to simply switch from direction and block funding from the Russian government to direction and block funding from the West, and would prefer block funding from the U.S. government, since that vehicle would be a direct substitution for current vehicles. That would be convenient, but would provide no motion towards real commercialization at all.

They would be interested in joint ventures with the West, but it is not clear that their capabilities and current technologies justify that. Their integral projects probably could not withstand serious scrutiny. On a longer time scale it would be preferable to involve real western industries in honestly commercial ventures that responded to honest market signals from the Russian economy.

The problem of trying to actually convert Russia's technological infrastructure into an honestly commercial venture is related to that of trying to commercialize the U.S. military-industrial complex. But at least in the latter there is a parallel commercial market whose signals can be grafted onto the military-industrial complex to provide pseudo-price incentives.<sup>4</sup>

In Russia there is no price-driven commercial sector whose prices can be used to redirect the military technological complex. The best that can be hoped for in the near term is the use of foreign price signals to guide investment decisions within Russia. It is interesting that statements that Russia is willing to take Western indications of interest as an indication of commercial appeal worth incentivizing are consistent with this overall approach.

Conditions in Russia on the hard currency market were quite pleasant. There was adequate food, good service, and polite treatment. That was also generally the experience of Mission members around Moscow and Saint Petersburg. They felt safe, were treated politely, and experienced few unpleasant incidents. Things were worse in the soft currency sector. There were few goods and little food in the produce markets in either town. Lines were not as long as expected, but goods were fewer and of lower quality.

Things were even worse among the poor, who have been the hardest hit by recent inflation. Many have seen their real wages reduced by factors of 2 to 6; they are desperate. Around the train stations large groups of travelers were trading and eating meats, fruits, and vegetables that Westerners would be reluctant to hold in their hands. Intelligent people were informed and open about the problems.

They understand the need for reform, but feel that President Yeltsin is not even trying to explain the need to the bulk of the population who are being hit the hardest. They are concerned about reaction this fall or winter.

### III. TRIP TO DUBNA, RUSSIA, FOR GEM, 7-12 AUGUST<sup>5</sup> (APPENDIX II)

This memo reports on a trip to Dubna, Russia, for a meeting on Global Environmental Monitoring (GEM). It was the fourth in a series of non-governmental and governmental meetings to exchange information and explore joint projects in the application of distributed remote sensing (DRS) techniques for measurements of global ecology, awareness, and warning of aggression. The U.S. delegation was led by the Space Council; DOE, DoD/SDIO, NASA, Environmental Protection Agency (EPA), Bureau of Land Management (BLM), and Arms Control and Disarmament Agency (ACDA) sent delegates.

The meeting provided a useful first exchange with a large number of scientists and organizations, some of whose existence or functions were unknown a year or two ago and some of whose capabilities are quite impressive. The meeting introduced the U.S. delegates to a very large number of FSR administrators, scientists, projects, capabilities, and interests.

There were topical, technical sessions on DRS from space, air, and ground as well as specific ecological and radiological problems in the various FSRs, which are staggering. The talks broke into roughly two types. Government officials, including the Ministries of Defense (MOD) generally noted that "now that the cold war is over, we look forward to cooperating openly" (particularly on U.S. technology). Scientists generally talked about detailed programs, capabilities, or measurements, which appeared to be both good and relevant.

There was some discussion of the conversion of military boosters into launchers for GEM DRS satellites. This is of great interest to the FSRs because of its potential for generating hard currency, but it is a very divisive issue, because it cuts across U.S. commercial space issues. There was no response, other than the suggestion that it would be appropriate for the FSRs to use their converted boosters to launch their own GEM satellites.

There was also great interest in flying advanced U.S. sensors, but it was generally recognized that this would involve considerable relaxation of tension. The feeling was that it might be more practical to go through a transitional period of several years in which the U.S. and FSRs flew their own sensors, their own boosters, and worked out means of exchanging data as a step towards greater cooperation. There seemed to be fewer barriers to flying FSR sensors on developmental U.S. satellites as a way of cross-calibrating dual-use ecological measurements.

FSR speakers discussed their plans for using decommissioned military satellites for GEM measurements, but did not discuss their sensors in any detail. When asked why, it became clear that they had been unable to get approval from the MOD in time, indicating that the relaxation is far from complete.

A key question was who would want to use the new DRS capabilities and who would be willing to pay for them. All participants stressed the necessity of making information available promptly to all participants and argued for taking advantage of the greater flexibility of non-governmental activities. The FSRs seemed generally satisfied with the results of the meeting and with the use of the World Laboratory as a vehicle for coordinating Russian and FSR activities internally and internationally. There was much talk about more organization and more meetings, but no commitments were made. It will take some time and exchange of written material to digest this one.

The questions left over from the meeting were almost as numerous and interesting as the conclusions; a few are listed in the report. Partial answers to some emerged quickly. Subsequent events made it clear that the Russian MOD and Commonwealth Independent States (CIS) general staff are willing to let military satellites be used for civil purposes and that FSR governments regard the World Laboratory and its officers as useful instruments for international coordination.

The ecological problems in the FSRs are staggering. It would appear that the GEM project could contribute to them. It is a bit less clear how DRS could contribute to the pressing problems having to do with ground contamination by chemical or radiological materials. It is also unclear how the U.S. could best interact with the GEM project. No one from the U.S. stepped up to do so.

Responsibility and support for space, air, and ground sensing are split between the Ministry of Space and Ecology and others in Russia, and split along still other lines in the other FSRs. Moreover, their ministries appear to be more interested in maintaining the overall space enterprise than in supporting a new and possibly expensive thrust in ecological monitoring. In the FSRs, as in the U.S., aircraft measurements are underutilized and subordinated to more glamorous space measurements, and ground sensors are developed but their nets undersized.

There appear to be many opportunities for collaboration, but the mechanisms for developing them are still formative. Until they are in place, the World Laboratory, Ecological Station of Environmental Control (ESCOS), and GEM would appear to serve as useful default mechanisms for the exchange of the technical information needed to define useful collaborations. The representatives at the Dubna meeting would appear to be appropriate contacts for such follow-on exchanges.

#### IV. TRIP TO HARTRON AND MYASISHCHEV, 12-13 AUGUST<sup>6</sup> (APPENDIX III)

The trip to the Hartron Design Bureau was made to exchange information and view first-hand Ukrainian capabilities for dual-use applications of DRS, my having been assured by its Director that it was the center of such activities in the Ukraine. That turned out not to be the case, but the trip provided a useful look at a competent, but detached design bureau in the non-Russian Former Soviet Union (FSU) as it flounders in its attempts to adjust to the loss of central direction.

The trip also served to further the information exchanges begun with the U.S.-Russia Space Commerce Mission of July 1992,<sup>7</sup> in that Hartron was recommended but not available to the Commerce delegation. The U.S. delegation, led by EPA with members from BLM and the DoE laboratories, accompanied the Deputy Director of the World Laboratory's Russian ESCOS, a native Ukrainian, who acted as liaison.

The Deputy Director openly described Hartron as a bit of pork that resulted from Brezhnev's rise to power, which succeeded in producing the inertial guidance for the first true Soviet ICBMs and has stayed at the center of guidance and control ever since. Hartron is quite good at the hardware-in-loop simulations that it pioneered for complex systems, which are now becoming popular in the U.S.

Hartron admitted that orders from Moscow were decreasing and that orders from the Ukraine were now 70% of the total, although they had not lost any of their 11,000 people--a key metric in the FSRs. It was privately said that things were actually much worse--that they were facing "terrible money trouble." It sounded as if they had been cut adrift. Their principal tie appeared to be with Uzmash, the South Machine Building Plant, also in the Ukraine, which is much busier.

Hartron showed us a progression of technology up to about what we had seen at Lavochkin and Elas, indicating more overlap than we had been led to expect. We toured a production microelectronics "clean room," which was modest by U.S. standards, and saw an actual Energia control system on a test rack. They showed us how they model the Energia and control it in real time with "optimal algorithms" whose "details are still secret"--another sign of uneven relaxation.

Hartron echoed the comment we had often heard from Russian design bureau heads on the Commerce trip: they had "had a lot of visits...they would now like to see some results..." Hartron has some real capabilities in narrow but important control areas, but that is not well known because of its remoteness and weakness in advertising them, which is typical of FSR facilities.

Hartron understood the value of the World Laboratory and its GEM project as a vehicle for communication and wanted a piece of it. The Ukraine has serious ecological problems; the GEM project could contribute to many, although the major problems have to do with ground contamination by chemical or radiological materials for which the application of DRS is

unproven.<sup>8</sup> The Ukraine could well be served by first improving ground and air measurements. There appear to be opportunities for collaboration, but the mechanisms for developing them are still formative. Until they are in place, the World Laboratory, ESCOS, and GEM would appear to serve as useful default mechanisms.

It was very difficult getting from Dubna to Hartron, which is in Kharkov, in the Ukraine. We were unable to take a regular airline, overnight train, bus, or car, so we chartered a jet directly. Interestingly, we flew from the airport which was to be the site of Russia's first international air show that weekend, but both on departure and return, we were the only plane in the air over the airport. That was also the case with Moscow's Sheremestvo Airport, where there was only one aircraft on the runway or taxiway at a time. There was a good bit more traffic and many more passengers at the airport in Kharkov, where we saw perhaps a half dozen airplanes at a time.

Since we leased one of their planes, we got a tour of Myasishchev, a design bureau with a long but not particularly distinguished history, which is likely to be shaken out in the new regime. Its large planes were not terribly successful. It had one interesting plane, the "Geophysica," which is sort of a heavy, two-engine U-2, which could take reasonably large scientific payloads up to useful altitudes. But all they could do was show it to us and ask if we had any suggestions.

#### V. TRIP TO ELAS DESIGN BUREAU, 14 AUGUST<sup>9</sup> (APPENDIX IV)

This trip was a follow-up from the Dubna GEM that was made to view first-hand Elas's capabilities for the application of DRS dual-use sensors to global ecology and warning of aggression. It also permitted us to follow up on some questions from the information exchanges begun with the U.S.-Russia Space Commerce Mission. The U.S. delegation was led by the Space Council; members were from DoD/SDIO and DOE. We were hosted by Elas's Director and about 10 members of his staff.

Elas turned the tables on us: they asked us to give a presentation on U.S. programs. After a bit of fumbling, to the amusement of the assembled Russian experts, we got through a top-level discussion of technology and the rationale for dual uses of SDIO satellites and promised to provide written materials. Elas then discussed their plans for using decommissioned military satellites or new sensors and satellites for GEM measurements. They still couldn't give details, but they did show some moderate resolution imagery from visible sensors and synthetic aperture radars. The latter gave us some insight into the way informal networks are starting to form between the design bureaus that are likely to survive to replace the former central direction.

As a backup to military satellites and data bases, Elas is developing new sensors, whose capabilities were something like the visible-near-infrared part of a Landsat, based on their own advanced focal plane, computer, and electronics technology. They would then improve the sensors in an evolutionary manner. The simpler sensors might also be usefully flown on

developmental SDIO dual-use satellite buses as a cross-check of U.S. sensors. The weight and power of electronics and computers appear to be issues. Elas plans to put together the scientific payloads and hand them over to a partner for integration and launch, "as they have since the '50s." They have an ambitious launch plan over the decade; current launch options include small rockets and decommissioned military boosters. It is not clear that the financing for the program is secure.

The meeting provided a useful exchange on dual-use sensors with a large number of competent scientists from a very good organization, which was relatively unknown a year or two ago. Elas's people and capabilities are impressive. The ecological problems in Russia are staggering. If GEM can contribute to them, Elas could contribute to GEM.

## VI. CODA TO THE FSR TRIPS

All of the design bureaus visited in the Commerce and DRS dual-use trips appear to be in difficult financial conditions. President Yeltsin's government does not appear to have any appreciation of their problems, the outline of a solution, or any interest in communicating its concern. Discussion of these problems was open in Russia. It seemed to grow more pointed even during the interval between the two trips. That appears to be losing the support of many of the educated and managerial elites who were influential under the Soviet Union and who were early Yeltsin supporters. Zelenograd, where Elas is located, was the first area to openly support Yeltsin during the coup.

The day of the Elas visit there was an article in *The Moscow Times* about a meeting of "2,500 factory directors" with the government to "bring back aspects of the former centralized command economy, including price-fixing and bailouts for failing industries." There were indications that a number of the design bureau directors whom we had met with on these trips were involved. The Yeltsin government did not meet with them.

## VII. TRIP TO ERICE, ITALY, 19-24 AUGUST<sup>10</sup> (APPENDIX V)

This trip was for a series of International Seminars of the World Laboratory. It continued discussions begun there the previous year on dual-uses of DRS for global ecology and warning of aggression.<sup>11</sup> The U.S. delegation was led by the Director of DoD/SDIO, seconded by the Space Council; members were from DOE, DoD/SDIO, and organizations worldwide. There were three main sessions: Projects for Planetary Emergencies, Proliferation of Weapons for Mass Destruction, and International Cooperation on Defense Systems. All are reviewed in the report; this discussion concentrates on the last, which gave an opportunity for an initial technical exchange on the Global Protective System (GPS) proposed by the summit and for an initial reaction on its multilateral aspects.

The International Cooperation on Defense Systems session involved Amb. Cooper, Academician Velikhov, and a host of supporters of strategic defenses from both sides. The action starts at the bottom of page 2 of the report with Amb. Cooper's talk, which basically argued that emphasis is shifting from Mutual Assured Destruction (MAD) to proliferation and third world threats, so that the Anti-Ballistic Missile (ABM) Treaty is an anachronism, and discussed technology in exchange for concessions in the ABM Treaty. He also reviewed the rationale and main elements of the current Global Protection Against Limited Strikes (GPALS) and the progress of the "high-level group" discussions established by the Bush-Yeltsin summit to explore joint U.S.-Russian defenses, and invited participation in dual-use technologies for defense and warning of aggression.

The Russians came back with what appeared to be a non-response. The speakers did not address global defenses; they confined themselves to the issues and changes needed to permit Russia to defend itself against medium range third-world threats, coming up with a two-layer system that looked much like Patriot plus Theater High Altitude Area Defense (THAAD). When asked why they only talked about theater defenses and not those for intercontinental threats to the U.S. and others, they said that they were concerned that such discussions would get into the area of discussions for the high-level group; they wanted to restrict the discussions at Erice to multilateral issues. That restriction was largely followed for the rest of the meeting. That was a surprise and disappointment to the U.S., which kept trying to push them for some concessions. By the time the Russians did make some concessions, it was unclear whether they could deliver on them.

The summaries of the rest of the talks indicate that the Russians have some fairly limited ideas about what a GPS should and could do and apparently some fairly basic misunderstandings about what the real problems are. They also have some confusion over what stability means and is good for, which spills over into their schizoid attitudes towards changing the Treaty. Those concerns were reiterated by the worldwide participants. It will take some time before we are even talking the same language. I thought it positive that Cooper and Velikhov encouraged a dialogue. On the whole, I think it is going to be a long, cold winter, and view the situation as desperate but not serious.

There was more progress on the area of dual-use applications of DRS. Dr. E. Teller characterized the prospects for cooperation in space as "for the first time real--and short term." He argued for the rapid development (started by the U.S. and Russia) of a worldwide surveillance system with as many participants as possible,<sup>12</sup> which he wanted extended to weather, agriculture, and the like. Such a proposal (particularly the sharing of information and technology) was strongly endorsed by the Russians and other FSRs. It was also embraced surprisingly strongly by the third-world participants, leading to two formal proclamations of support.

There was also a thoughtful and deep discussion of the problems of the proliferation of weapons of mass destruction. It concluded that "The most serious present problem in the world today is the proliferation of weapons of mass destruction [and that] A solution of this problem has become more feasible..." That declaration was endorsed as strongly by the second- and third-world participants as by the first-world participants.

## VIII. ISSUES

The meetings provided a useful exchange on dual-use sensors with a large number of competent scientists from around the world. Cross-calibrating advanced dual-use SDIO sensors with Russian sensors on the same developmental buses could be useful. Global ecological problems are serious. It is clear that DRS could be effective as a means of following gross changes over the whole globe and that it would be very valuable to a large number of developing countries who could not afford separate systems. It would appear that the World Laboratory's GEM project could contribute to them. It is a bit less clear how DRS could contribute to some of the serious but surface chemical and radiological issues. It is also not clear how the U.S. could best interact with the World Laboratory and GEM.

There are opportunities for collaboration, but until the mechanisms are in place, the World Laboratory, ESCOS, and GEM would appear to serve as useful default mechanisms for the exchange of the technical information.

Lacking those mechanisms for cooperation, the FSRs appear to be awkwardly underoccupied. The design bureau structure resembles a large engine from which some prankster has removed all the interconnecting pieces, leaving the major parts spinning to no point other than the provision of subsistence wages. Governments do not appear to have any appreciation of these problems, the outline of a solution, or any interest in communicating their concern, which appears to be losing the support of many of the educated and managerial elites who were early supporters of democratic reforms.

The needs of FSRs are no more legitimate or pressing than other underdeveloped areas of Africa or Asia, whose problems are also real and desperate. But with the FSRs in general, and Russia in particular, it is disappointing to see the possibility of the elimination of catastrophic threats and the shift to productive commercial ventures hampered by small economic concerns and bureaucratic issues, while the system starts to slide slowly back to earlier modes of operation.

## IX. WORLD LABORATORY

In looking back over the series of meetings held to promote cooperation between the U.S. and the FSRs over the course of the summer, it is appropriate to note the frequent appearance and integrating role of the World Laboratory. It stimulated and supported discussion of many of the

issues that led to the thaw; publicized many of the projects in Russia and the other FSRs that are now candidates for private or governmental cooperation; provided the connective tissue between emerging collaborations; helped to maintain communication between the Russian, Ukrainian, Kazakh and other science establishments; supported the technical interchange on dual-uses of DRS technologies in Dubna; and brought together a knowledgeable group of experts to start the discussion of the multilateral aspects of GPS at Erice.

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The Space Commerce mission, 18-29 July 1992, was performed as a follow-up to agreements reached at the recent Bush-Yeltsin summit. It was led by Jim Frelk, Director of Space Commerce, Department of Commerce (DOC). The members are listed in the brochure (Attachment A), which was given to all of the bureaus and facilities visited. Col. Pete Worden, SDIO Dep. Dir for Technology, was the DoD representative. I was the DOE representative. There were also representatives from DOT, DOC, and about 17 U.S. industrial firms, largely DoD contractors.

The DOC and the support staff for the Mission from WJSA will prepare a detailed report on all of the facilities visited and briefings in 1-2 months. This memo gives a preliminary summary of my impressions as background for remote sensing meetings to be held before then. It was prepared quickly; thus, some of the observations are a bit direct.

The agenda for the Mission is Attachment B. Technical exchanges started on the morning of 20 July with an exchange between Frelk and Yuri Koptev, General Director of the Russian Space Agency. Koptev repeated at some length a number of the points that he had made at the CSIS meeting in Washington last month. He noted that over 50% of Russian launches are now civil, and that last year's 10 billion ruble civil budget was about as big as that for military space. He discussed establishing new complexes for ecological and environmental measurements.

Koptev talked about adding modules to MIR and continuing Proton, Zenith, Energia, and Buran development. He mentioned Glonass and GPS being adopted as the basis for navigation developments. He argued for the use of decommissioned military boosters, particularly the SS-18 and -25s, for space launch. He indicated that there was an adequate understanding with the Ukraine for space launch. He expressed interests in robotics, materials, and medicine, but said that due to over-classification, he was not aware of many Russian programs. He called for the exchange of young scientists to reduce misunderstandings.

He said that "this delegation will become an important sign post for cooperation," but admitted that there are no prototype agreements for cooperation and no policy for ownership, privatization, or intellectual property rights, although there are some initiatives in the legislature. There isn't even a firm mission for the space agency.

He said that in the last year the budget for civil space increased by a factor of 6.5, but that was about a factor of 2 below inflation, which is estimated by others to be a factor of 20-30 over that period. This has forced him to change priorities. Previously he had tried to support all efforts; now he will have to prioritize. He is trying to do so according to "the priorities in basic research" and those of the Russian National Academy of Sciences. He knows he needs a lot of external support. He is willing to "treat projects as commercial if he is convinced that the West will invest in them."

Later, in a private session with government representatives, which is reported in a separate cable, Koptev expanded on these themes. He also discussed dual use of these technologies for strategic defense, although he expressed a personal preference for pooling information as a means of

preempting missile threats. He also favored releasing surveillance data bases with 2 m resolution for civil purposes.

Koptev was candid in discussing the problems about the Indian rocket engine collaboration. He indicated a preference for joining the MCTR, but indicated that COCOM restrictions effectively exclude Russia from competing for the commercial space launch business. He indicated that if that continued, Russia would "have to find an outlet for its significant, cheap launch capacity somewhere" to offset decreases in military orders. He seemed encouraged by his recent discussions with U.S. NASA Administrator Dan Goldin.

Koptev was optimistic about simplified licensing procedures. He also gave us the attached flow diagram for managing space budgets (Attachment C). The real process still seems to involve a lot of personal relations, which are still sorting themselves out.

NPO Lavochkin. At the Lavochkin Enterprise we toured the Enterprise museum, a large [roughly (20 m)<sup>3</sup>] microwave 40-50 db anechoic chamber, a competent propulsion lab for small engines, some nice heat pipes, and a 100-g centrifuge. We saw only 2-3 people working. We got a series of briefings. The Deputy General Director, Igor P. Zaitsev, gave us an overview. Then the 1st Deputy Rogovski (sp? The names will be corrected in the final Commerce report) gave us a fast summary of Russian missions from planet Earth, which to me seemed redundant with NASA and other programs. It seemed as if Russia was maintaining--at least on paper--the competition in deep space probes and instruments.

Dr. Rodin, who is in charge of Lavochkin's "reconversion scheme" then briefed us on the six projects that they are counting on to generate additional support, which are:

1. Banker (БАНКЪ), which is a constellation of 2-3 Coupon (КУПОН) satellites at GSO with active, phased-array 16 beam antennas to transmit information for the Russian central bank. One of the Banker Coupon satellites was undergoing antenna tests in the anechoic chamber. They are to be launched by Protons; the first is to be launched in 1993. Each is about 0.5 ton and 1 KW.

2. Pilot (ПИЛОТ), which has 3 GSO and 4 elliptical satellites using Glonass for air traffic control over Russia. Lavoschkin is cooperating with U.S. and French partners and is competing with Krasnoyarsk.

3. Flame (ФЛАМЪ) for forest fire detection satellites. The satellites sounded like early-warning 3 micron infrared (IR) detection satellites, but each is to have 1 m primaries to give detection of about 300 m<sup>2</sup> fires.

4. Microgravity experiments (ТЕКОР) using the "Venir" apparatus to replace the 3rd stage of an SS-18 for about 1.5 tons of microgravity product for a few \$M.

5. Ecol (ЭКОЛ) ecology monitoring satellites with some suite of ecological sensors that was not specified.

6. Communication satellites like Motorola's IRIDIUM.

A source of some concern was that Coupon is Lavochkin's first Earth-looking satellite. There were questions about Lavochkin's capabilities and collaborators. They said that they were cooperating with ELAS (ЭЛАС), used Nikopre (?) Institute for Space Devices Telemetry, Hartron (ХАРТРОН) stabilization, KVANT (КВАНТ) solar, and KHIMASH engines. Their relationships were, as usual, a bit diffuse.

Lavochkin was fairly open in discussing these concepts, although some seemed somewhat loosely defined. They did not have any detailed handout materials on their reconversion projects in either English or Russian.

Lavochkin seemed quite interested in cooperation, but did not seem to know what to ask for or expect, which was also typical of other organizations.

On the basis of what I heard about the conversion projects, I could not in good conscience suggest U.S. cooperation. Bankir sounded like the civil application of decommissioned military satellites. If so, Russia might do better by starting over with current technology. Air traffic would seem to be better served by GPS than Glonass. The forrest fire detection system seemed very complicated and expensive for the market. The microgravity work had no fundamental basis and its viability depended on getting the decommissioned SS-18s essentially for free. The ecology sensors were not defined. It would seem that Russia's advantage might be in launching NASA's EOS satellites, if they remain large.

The discussion with Lavochkin exhibited some confusion between the concepts of conversion or reconversion, diversification, and commercialization. Koptev's goal is the latter. He would like some viable commercial projects to augment government resources. Lavochkin's projects seemed instead to stress reconversion from military to non-military projects, which might not be commercially viable. Lavochkin also expressed an interest in branching out into other areas in which they perceived a need, independent of any corporate strength.

Lavochkin did not have any discussion of their uses and sources of funds. Frelk suggested that they and others might be well served by the preparation of an annual report to summarize their activities as a business. My guess is that such a report would show them--and others--as going out of business in a few months.

NPO Energia. Director Semenov claims to have about 30,000 people and control about 2/3 of civil space. He reviewed their management of MIR, Energia, and Buran. His deputy Tiktorenko (?) then gave more details on MIR additions, Soyuz upgrades, and the new intermediate Energia M engine designed to put about 34 tons into LEO and 3-6 tons into GSO. He talked about the Priroda (ПРИРОДА) remote sensing and Spectr (СПЕКТР) MIR modules as simple subcontracts, and gave no details.

Tiktorenko also talked about their Integrated Satellite Information System of about 18 tons (8 tons payload) in LEO with 15 kW into 0.1 degree phased-array beams. He did not clarify how that fit with Lavochkin's proposed Banker or with Elsas's proposals for communications systems. We had an interesting but indeterminate discussion of the advantages of different space station Freedom inclinations, and Energia's advantages for each, which had apparently been rehearsed earlier with Goldin.

Tiktorenko then took us on a tour of Salyut and MIR modules and a Buran mockup in which their universal docking module was being tested. We saw only 3-4 people working. After lunch I stayed on to tour a laboratory in which the docking modules were undergoing very thorough 6-degree-of-freedom testing. They also gave us a demonstration of their automated system for slaving or independently moving quad rocket engines. They seemed rather impressive, but I do not know the comparable U.S. technologies.

Overall, Energia didn't seem to be able to describe itself as a business or indicate what it wanted from the U.S., other than a core role in NASA programs.

NPO Machine Building. We met with General Constructor, General Director Dr. Herbert A. Yefremov, Vice General Designer E. Kamen, 1st Vice General designer V. Tsarev, Vice General designer m. Grishko, Vice Chief of Division V. Ivashin, Department Chief J. Degtyarev, Main Leader Designer I.

Postnikov, Chief of Research-Processing Center P. Shirokov, and Advisor for General Designer A. Dergachev. I have their names because Machine Building was the only place that thought to provide them rather than just exchanging dozens of cards. Yefremov talked us through their museum and the traumatic history of the design burea occasioned by the personal quarrels of its founder Chelomen (Челомей) with Ustinov and the rest of the Soviet hierarchy.

Yefremov then reviewed the history of the Almaz (Алмаз) space stations, escape capsules, and their attempts to sell them from "everyone from Bill Perry to Sen Nunn." He discussed the history of the Almaz synthetic aperture radars (SARs), which he said had been developed in conjunction with Professor Gusev of Space Instruments. The first was launched in 1988 as Cosmos 870. Almaz-1 was launched on 31 March 1991 and still has about 6 months life on orbit. Almaz-1a is scheduled for '94 (?); -2 for about '97. Each will weigh about 18.5 tons and carry a lot of visible imaging as well as SAR sensors. When I asked how Almaz could compete with the European, Japanese, and Canadian SARs up or going up, Yefremov indicated that they would compete on the basis of multiple frequencies (3, 10, and 70 cm) and weight for additional IR sensors, as yet unspecified.

Almaz data is brought down wideband through the General Staff in Moscow. It is not clear whether Machine Building gets all of it. Yefremov showed me some pretty good (roughly 10 m resolution) images of the ocean bottom, one of which is attached along with a description in Russian (Attachment D). When I asked if he had enough resolution to see submarines, he laughed and said yes, but that he could not discuss it there.

Machine building has plans to get into mobile communications, a 4 ton comm satellite at GSO with about 20 beams of about 1/2 degree, something like IRIDIUM, perhaps launched with the decommissioned SS-19s they had made. Yefremov indicated that the Minister of Communication had a competition going with about 10 bureaus for an improved communication system. It sounded like a winner would be picked in about 6 months. The losers could be in trouble under the new system. They looked like losers to me.

NPO Elas (Элас) at Zelenograd (Зеленоград). Most of the presentation was by Director Academician G. Guskov, who reviewed their early work in computers and surveillance. He then talked about their Sokol (Сокол) 400 channel communication system based on old Geyser satellites at GSO with about 20 phased-array 10-14 GHz beams each. A description of the system in Russian is Attachment E. Attachment F gives a description and picture of the satellite; Attachment G gives a description and picture of the ground terminal. Guskov said that Socol US had gotten approval and offered a demonstration. When it came through (1/2 hour late) the channel quality seemed poor, particularly for its 9.4 Kb/s capacity. It was suggested that its error correcting codes had not been upgraded from the initial military links, which about a decade ago apparently had roughly comparable quality. The FAX worked OK, but I am not sure that the voice communication was of a quality that would be of interest to Western customers, particularly now that ATT has improved service out of Moscow.

Guskov mentioned the collaboration with Rodin of Lavochkin on Bankir Coupon satellites, which are described in Attachment H. He also talked about the 400 MHz Courier (Курьер) relay system they are developing, largely for electronic mail, which is shown in Attachment I, which is in English. The first system will enter test this year. A follow-on at 1.5 GHz is planned for voice. He also discussed a low-altitude competitor for IRIDIUM.

Mr. Karasov discussed a low-altitude Salyut (САЛЮТ) sensor suite from 0.4 to 2.5 micron in the IR. They also have an interesting set of microwave radiometers that they have tested on aircraft for the detection of changes in surface emissivity as a predictor of cyclone activity, as described by Prof. Kaldalev (?). They are planning a 3 satellite experimental environmental constellation for a '93-4 launch, but had no details on the IR sensors, other than they thought that they needed about 40 bands. It sounded like this could be a useful precursor to NASA's EOS, but it is hard to tell without more detail. Funding also sounded shaky.

We also toured their museum, which covered all the way from their earliest computers to their latest 30 GHz GaAs 1000 transistor integrated circuits. It also contained a picture of the relay satellites they used to bring back intelligence imaging in real time, although their comments on visible imaging resolution seemed quite naive. While the past work looked good, we were not able to tour current production facilities, which were located north of Zelenigrad. Thus, I could not assess how hard they are working now.

Elas had the most crisp and organized presentations. They covered a lot of material quickly. They have a lot of conversion projects that are better defined than the other bureaus. Still, they didn't have English descriptions of their main projects, which makes it difficult to assess their actual performance and overlap with Western capabilities. It is not clear what they wanted from us other than some endorsement for Socol and the follow-on Courier systems. They seemed to feel that our evaluation would help in winning support from Koptev. At this point I would have a hard time giving an evaluation.

Khrunichev Enterprise was perhaps the best organized for visits. It had a full, color brochure, which is Attachment J. The opening quote by General Director Kislev that "Meeting our plans will guarantee success under any and all conditions and circumstances" seems to indicate that conversion is only about a brochure deep and that the Gosplan was alive and well in the enterprises. Their candor was refreshing. When we asked if they were the contact for the Indian rocket deal, they said "yes, we are the bad guys," without apology. Seeing a high bay with a few MIR modules and 11 Proton rockets was impressive, but we only saw a few people working: two of them were spray painting the hall to make the displays prettier and the third was just messing up a sheet of steel.

Institute for Chemical Building (NIIMASH) was suggested by Koptev. It had a lot of big, old rocket engine test stands and the biggest vacuum chamber outside of Houston. They seemed competent but limited. It was an interesting change. They had been visited by about 60 groups with no contracts or money as yet. They asked us if there was any chance with us. On the basis of our answer, they asked us to pay for our own lunch.

SDI discussion with Russian Academy. The DoD representative arranged for a discussion with Academician Velikhov, members of the Russian Academy of Sciences, and institute members who were available. He briefed them on the status and main elements of the SDI program and indicated areas where cooperation seemed appropriate. Academician Velikhov, Dep Dir of the Russian Academy of Sciences, was quite interested and instructed the institute directors present to cooperate with us fully during our visits.

Efremov Institute (NIIEFA). At the Efremov we met with Dir V.A. Glukhikh, Dr. Yu. P. VAKhrushin, head of neutral particle beam (NPB) work, G. Manykyan, head of lasers, and V. Maksimov of the ministry of atomic energy. We were shown their NPB and laser programs. The lasers were just a bunch of

10-30 KW carbon dioxide laser welders that resembled U.S. technology of about two decades ago. The NPB was a source and 2 MeV acceleration stage with old 100 MHz power. It had poor emittance and lost most of its current at low energy. It had apparently been built in 1989 and used through about 1991; it didn't look active at the present. It seemed to represent U.S. NPB technology of about a decade ago; it was quite primitive. We also saw a new 440 MHz RFQ undergoing tuning tests. We were told that this was all the Efremov had. If so, there would appear to be little basis for the institute director Glukhikh's repeated statements that NPBs could never be put in space or weaponized. Stan Schriber went back for a second day without the ministry of atomic energy representative and will have a more detailed assessment.

Ioffe Institute. The Ioffe was the most fundamental of the facilities visited. Director Alferov and Deputy for Science Gardev discussed their overall programs, which were largely in GaAs lasers (Dr. Karazov) and solar converters, Si and SiC switches (Dr. Vinogradov), and railguns (Dr. Closhevsky?). They also do gamma astronomy and space physics, which we did not visit. Their lasers were quite nice and efficient; Livermore was to visit and arrange support the next day. The solar work seemed competent.

The railgun work was cute. They had apparently accelerated a 1 gram plastic cube to about 7 km/s, although their diagnostics were quite crude. They explained their good performance relative to others on the basis of "proper confinement of the rails" during acceleration. There was some discussion of SDIO funding them so they could start experiments again and perhaps do some orderly lethality studies.

Institute of Electric Machine Building. Dir Rudberg, who was quite dynamic, took us through their projects, which were not. He showed us an electro-thermal gun that he said had gotten 2-10 g up to 6.3 km/s. He also showed us a 20 MJ capacitor bank like the old Los Alamos Scyllac that drove a larger conventional railgun to somewhat lower velocities. He hoped to use the electro-thermal gun as an injector for the railgun, so that with 3-4 km/s in he would get an additional 2-3 km/s for a total of 5-7 km/s with large projectiles. He had little data, just a bunch of fractured and penetrated plates. He would like to go for 10 km/s "when we get the money."

He showed us some large 6,000 rpm electric generators that he would like to use as homopolar generators. He said that the Kurchatov already had 4 of them that he had built. In his current facility in downtown St. Petersburg he showed us a lot of experiments with sparks and arcs with applications like those GE and Westinghouse had looked at about 20 years ago.

Overall, I got the impression that Russia had very little hardware that would add much to SDI. They didn't even seem to have enough experiments or theory to perform an independent evaluation. Their negative evaluation of directed energy concepts seemed to be based on the prejudices given to them by largely anti-defense scientists, who seem to have visited them in large numbers.

Summary comments. The Commerce mission was quite successful. It exposed a large number of U.S. scientists and program managers, many of whom might develop actual financial interests, to a wide spectrum of Russian commercial space facilities. The overall report from the mission should be quite helpful. It should prepare a catalog of facilities, pictures, and capabilities that could save others a lot of time.

It is very inefficient to visit the facilities. They are spread out and hidden. And once you spend an hour or two getting to them, the data rate from the staff presentations is very low. Most potential customers would be served

as well be looking at a catalog of capabilities and a few pictures. Then they could just visit the one or two relevant ones.

Commerce's report should also serve another purpose: as a rough skeleton for piecing together an outline of at least the civil Russian space program. Right now it is very confusing. Whoever one talks to tends to describe himself as the prime for all projects with all of the other design bureaus as somewhat of a cloud surrounding them. With the information we received on this tour we should be able to put the pieces together in a way that shows the actual control mechanisms so that it would not be necessary to receive duplicative information from all of the component agencies. That should also help to define the financing of the various design bureaus, which is at present quite confusing. It appears that with some of them, a dollar added for "civil" space would just reduce Russia's required spending for military space by a like amount. It would be desirable to avoid such direct offsets.

There is still another use for the report. The Russian design bureaus are obviously having a very difficult time understanding what sort of information Western industries expect to have before making financial decisions. Symptomatic of that was the fact that the Russians spent most of the time briefing us on ventures for which there was no obvious opening for Western investment. Even for those that did offer some opening, there were, with few exceptions, no technical descriptions in English.

That was particularly bothersome in the area of environmental sensing, which is clearly an area in which many of the bureaus have major thrusts, and one in which Koptev expressed particular interest in Western involvement. We did not get a detailed list of sensor suites, let alone their characteristics, from any of the bureaus. Until such information is available, it will not be possible to assess the extent to which Russian capabilities could complement NASA EOS or other programs. By compiling and translating the information received on the mission, it should at least be possible to define the areas in which more detailed presentations should be requested.

Commercialization. A few concluding comments are in order about efforts towards commercialization and the role of civil space in it. As to the latter, compared to its other pressing needs, Russia currently has little need for a civil space program. Russians need food, decent housing, roads, cars, schools, buildings that aren't falling down, and real jobs a lot more than anything in space. The resources devoted to space are a cruel diversion from much more pressing requirements that threaten the stability of its current democratic government. The economic reforms of the Yeltsin regime have fallen most heavily on the very poor. They have also wiped out the former nomenclatura and reduced to poverty many of the university intellectuals who were early supporters of democracy.

That said, civil space is at least one area in which Russia has some competitive advantage in the competition for hard currencies and technologies. Their space hardware and launch services really are about an order of magnitude cheaper than those of the West--albeit largely because of the subsidies and distortions cited above. Nevertheless, there are advantages for the West in working with Russian civil space over the interval until those subsidies are removed.

It will not be easy. The biggest problem is that neither the bureaus or Koptev know how to present themselves to potential customers. The bureaus would simply like to switch from direction and block funding from the Russian government to direction and block funding from the West. They would prefer block funding from the U.S. government, since that would be a

direct substitution for current vehicles. That would be convenient, but would provide no motion towards real commercialization. They would be interested in joint ventures with the West, but it is not clear that their capabilities and current technologies justify that. In interacting with the DoD contractors represented, it would appear that Russian bureaus could offer little more than piecemeal testing services. Their integral projects probably could not withstand serious scrutiny.

On a longer time scale it would be preferable to involve real western industries in honestly commercial ventures that responded to market signals from the Russian economy. The closest thing to that which we saw was the GE venture to assemble, under license, GE Japanese tomography kits in Russia for sale to Russian hospitals.

The problem of trying to actually convert Russia's technological infrastructure into an honestly commercial venture is related to that of trying to commercialize the U.S. military-industrial complex. But at least in the latter there is a parallel commercial market whose signals can be grafted onto the military-industrial complex to provide pseudo-price incentives. In Russia there is no price-driven commercial sector whose prices can be used to redirect the military technological complex. The best that can be hoped for in the near term is the use of foreign price signals to guide investment decisions within Russia. It is interesting that Koptev's statement that he is willing to take Western indications of interest as an indication of commercial appeal worth incentivizing is consistent with this overall approach.

Comments on conditions observed. Conditions in Russia on the hard currency market were quite pleasant. There was adequate food, good service, and polite treatment. That was generally the experience of Mission members around Moscow and St. Petersburg. They felt safe, were treated politely, and experienced few unpleasant incidents.

Things were worse in the soft currency sector. There was little food and few goods in the Produce (πρoδyκτv) markets in either town. Lines were not as long as expected, but goods were fewer and of lower quality. Things were even worse among the poor, who have been the hardest hit by recent inflation. Many have seen their real wages reduced by factors of 2-6; they are desperate. Around the train stations large groups of travelers were trading and eating meats, fruits, and vegetables that Westerners would be reluctant to hold in their hands. Intelligent people were informed and open about the problems. They understand the need for reform, but feel that President Yeltsin is not even trying to explain the need to the bulk of the population who are being hit the hardest. They are concerned about reaction this fall or winter.

## ■ Welcome to the U.S.-Russian Space Commerce Mission

*A personal message from  
Secretary of Commerce  
Barbara H. Franklin*



On behalf of the United States Department of Commerce, it is a pleasure to welcome you to the U.S.-Russian Space Commerce Mission. At their recent summit, President Bush and President Yeltsin declared that this U.S. Government-sponsored space industry mission to Russia was an important step toward broadening our commercial space business ties.

Today, after lunar landings and visits to other planets, a new space era is opening. A diverse private space industry is emerging from a distinguished array of government programs. Space commerce is expected to generate U.S. revenues of about \$5 billion in 1992, or about as much as the receipts from all the movie theaters in the United States. The commercial space industry is growing rapidly and looking to international ventures for future opportunities.

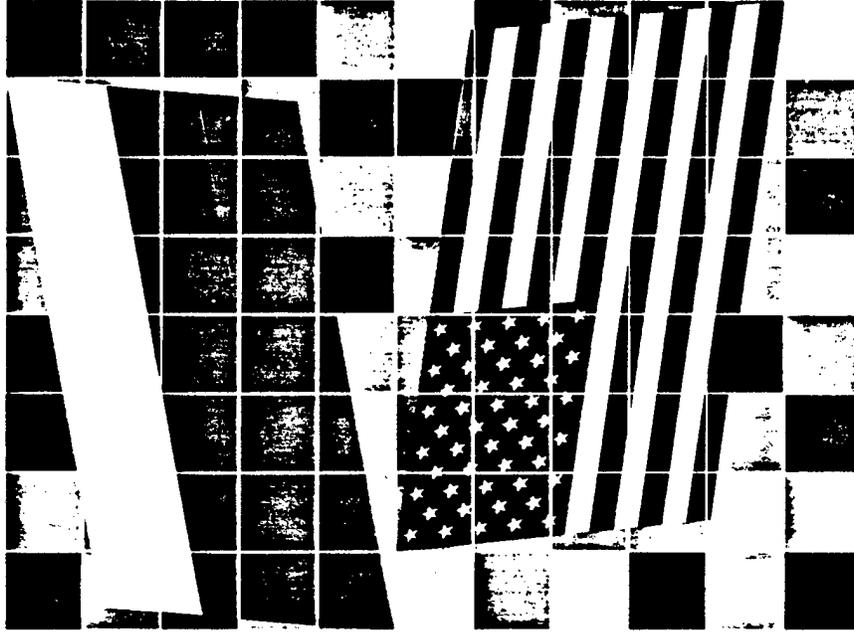
The former Soviet Union pioneered space exploration by sending the first satellites and manned spacecraft into orbit. With the emergence of an independent Russian Federation, the resources and skills of Russian space industry have vast commercial potential. The space industry can create economic growth and promote a peaceful, democratic future. We have much to learn from each other, and I can think of no better way than by creating forums where businessmen, scientists, and engineering can meet.

This historic beginning will help U.S. industry gain a better knowledge of Russian space technology and its commercial applications. The mission breaks new ground in U.S.-Russian commercial relations and sets the stage for an exciting and prosperous 21st century. Best wishes for your continued success.

*Barbara H. Franklin*



# U.S. Department of Commerce



## Directory of U.S.-Russian Space Commerce Mission

## ■ U.S.—Russian Space Commerce Mission Delegation

July 18-28, 1992  
Russia

James J. Freilk  
Head of Delegation

### ■ U.S. Industry

Mr. Dana G. Andrews, *Boeing*  
Mr. Harry N. Andrews, *Westinghouse*  
Mr. Leland F. Belew, *UTC*  
Mr. Milton Berkowitz, *GE Astro Space*  
Dr. David Berwald, *Grunman*  
Dr. William Bozich, *McDonnell Douglas*  
Mr. William F. Cashman, *Fairchild*  
Mr. Robert P. Di Nal, *General Dynamics*  
Mr. John Garvey, *McDonnell Douglas*  
Mr. Fred Giessler, *SAIC*  
Mr. Richard L. Grant, *Boeing*  
Dr. Jan Grinberg, *Hughes*  
Mr. John A. Hargrave, *TRW*  
Mr. Frederick Hauck, *INTEC*  
Mr. William L. Hoffman, *Aerojet*  
Mr. Edmund Jurkiewicz, *COMSAT*  
Mr. Norman E. King, *Honeywell*  
Mr. Peter McCourt, *Rockwell*  
Mr. John H. Nunnally, *Westinghouse*  
Dr. John D. O'Keefe, *TRW*  
Dr. Krzysztof W. Przytulka, *Hughes*  
Dr. Harry L. Reynolds, *Rockwell*  
Mr. John C. Schoep, *General Dynamics*  
Mr. Stanley O. Schreiber, *Grunman*  
Mr. Henry M. Tharpe, *FIER*  
Mr. Alan Toepfer, *SAIC*  
Mr. Harvey J. Willenberg, *Boeing*  
Mr. David V. Wilson, *Honeywell*

### ■ U.S. Government

Mr. Ray Arnold, *NASA*  
Mr. Stephen Cambone, *DOD*  
Dr. Gregory Canavan, *DOE*  
Mr. Michael T. Garstka, *DOT*  
Dr. Scott N. Pace, *DOC*  
Mr. Peter C. Pajor, *DOC*  
Ms. Brenda A. Parker, *DOT*  
Mr. Courtney Stadd, *The White House*  
Ms. Kathryn Sullivan, *DOC*  
Col. Simon P. Worden, *DOD*

### ■ Mission Support Staff

Dr. William H. Evers, *WJSA*  
Mr. John Hersey  
Mr. Phillip Mace, *WJSA*  
Ms. Angela McGahan  
Mr. Zinovy Shnaper  
Dr. Peter M. Silvaggio, *WJSA*  
Mr. Timothy Smith  
Dr. Joseph M. Stregack, *WJSA*  
Dr. Lawrence J. Zajac, *WJSA*

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(7/18 13.00)

**AGENDA****U.S.-RUSSIA SPACE COMMERCE MISSION**

Moscow and St. Petersburg  
 Russian Federation  
 July 18-29, 1992

**Saturday, July 18, 1992**

- 5:05 p.m. Delegation Arrives at Sherevmetevo-2 Airport  
 (Met by Kathryn Sullivan and Angela McGahan)
- 6:00 p.m. Arrive at Radisson Slavyanskaya Hotel  
 --Registration
- 7:30 p.m. Meet in Lobby for Bus to Dinner at Russian Restaurant  
 "Usad'ba" is a cooperative (non-state) restaurant in  
 the carriage house of a former palace. Approximate  
 cost per person is R3,000.
- 10:30 p.m. Return to Hotel

**Sunday, July 19**

- 9:30 a.m. Bus Departs Hotel for Izmailovskiy Park (optional)  
 Izmailovsky Park is an active open air market  
 featuring a wide variety of souvenirs, arts and  
 crafts. The bus will remain at the park, departing  
 at 12:00 to return passengers to the hotel.
- 2:30 p.m. Bus Departs Hotel for Moscow City Tour (2 1/2 hours).  
 (optional; \$6/per person)
- 6:15 p.m. Cocktails\*, Tchaikovsky Room, 2nd Floor
- 7:00 p.m. Team Dinner\*, Tchaikovsky Room, 2nd Floor

**Monday, July 20**

- 8:15 a.m. Coffee and Doughnuts, 2nd Floor Foyer, Radisson
- 8:45 a.m. Welcome, Composers' Hall (Mussorgsky Room), 2nd Floor  
 James J. Freik, Director, Office of Space Commerce,  
 U.S. Department of Commerce
- 9:00 a.m. Yuri N. Koptev, General Director, Russian Space Agency 

\*Mission event, no charge.

9:30 a.m. Konstantin V. Frolov, Vice-President, Russian Academy of Sciences

10:00 a.m. Ivan M. Bortnik, Russian Deputy Minister for Science, Technology and Higher Education

10:30 a.m. Aleksandr A. Titkin, Minister of Industry of the Russian Federation

11:00 a.m. Coffee Break

11:15 a.m. SESSION I: Industry Briefings:

Pushkin Room -- NPO PM  
Institute of Lightweight Metals

Tolstoy Room -- Venadski Institute  
NPO Elas

Checkov Room -- NPO Cryogenmash  
NPO Tekhnomash

12:45 p.m. Break

1:00 p.m. Lunch\*, Mussorgsky Room, 2nd Floor

2:00 p.m. SESSION II: Industry Briefings

Pushkin Room -- NTIIP  
VIAM  
NPO Pluton  
NPO Istok

Tolstoy Room -- Institute for Biomedical Problems  
NPO Elas  
VNII Gidromash  
VNII Instrument

Checkov Room -- Institute of Chemical Machine Building  
Cryoexport  
Electrointorg  
NIIP Radiophys.cs

4:00 p.m. Coffee Break

4:15 p.m. SESSION III: Industry Briefings

Pushkin Room -- NPO Toriy  
NPO Elma

Tolstoy Room -- NPO Splav  
NIIP

Checkov Room -- Microvolna Enterprise

\*Mission event, no charge.

5:30 p.m. Last session concludes.

Tuesday, July 21

9:00 a.m. Meet in Lobby

9:15 a.m. Buses Depart for Facility Visits

Launch Vehicles: NPO Energomash (10:00-3:00)  
Institute of Thermal Physics (3:00)

Science: NPO Lavochkin (10:00-4:00)

Space Systems: NPO Lavochkin (10:00-4:00)

Support Systems: NPO Lavochkin (10:00-4:00)

5:00 p.m. Return to Hotel

Wednesday, July 22

9:00 a.m. Meet in Lobby

9:15 a.m. Buses Depart for Facility Visits

Launch Vehicles  
Morning: NPO Energia (10:00-3:00)  
Afternoon: NPO Molniya (3:00)

Science: NPO Energia (10:00-4:00)

Space Systems: NPO Energia (10:00-4:00)

Support Systems  
Morning: NPO Energia (10:00)  
Afternoon: NPO Cryogenmash (2:00)

5:00 p.m. Return to Hotel

7:30-9:30 p.m. Reception, Tchaikovsky Room, 2nd Floor

Host: James F. Collins  
Charge d'Affaires ad interim of  
the United States of America

Thursday, July 23

9:00 a.m. Meet in Lobby

9:15 a.m. Buses Depart for Facility Visits

**Launch Vehicles**

Morning: CIAM (10:00)

Afternoon: CNII Machinostroeny (2:00)

**Science**

Morning: Lebedev Institute (10:00) → Kopylov

Afternoon: NPO Splav (2:00)

**Space Systems**

Morning: KB Salyut (10:00)

Afternoon: NPO Machine Building (2:00) ←

**Support Systems**

Morning: NPO Kvant (10:00)

Afternoon: NPO Machine Building (2:00)

5:00 p.m. Return to Hotel

Friday, July 24

9:00 a.m. Meet in Lobby

9:15 a.m. Buses Depart for Facility Visits

**Launch Vehicles**

Morning: TsAGI

Afternoon: NPO Salyut/Krunichev Enterprise

Science: NPO ELAS (all day)

Space Systems: NPO ELAS (all day)

**Support Systems**

Morning: NPO Machine Building

Afternoon: NPO Salyut

5:00 p.m. Return to hotel

Saturday, July 25

9:00 a.m. Meet in Lobby

9:15 a.m. Bus Departs for Facility Visit

10:00 a.m. Support Systems: NII Khimmash (all day)

Follow-on tour of Zagorsk Monastery (tentative)

5:00 p.m. Return to Hotel

FREE DAY FOR ALL OTHERS

Sunday, July 26

**For Departure to St. Petersburg:**

6:00 a.m. Bus Departs Hotel for Sherevmetevo-1 Airport

7:00 a.m. Depart Moscow via Aeroflot

8:30 a.m. Arrive St. Petersburg

10:30 a.m. Arrive at Grand Europe Hotel

FREE DAY FOR ALL OTHERS

Monday, July 27

**Moscow:**

9:00 a.m. Meet in Lobby

9:15 a.m. Buses Depart for Facility Visits

Launch Vehicles

Morning: Institute of Thermal Physics

Science: IKI (10:00-4:00)

Space Systems

Morning: NPO Komposite (10:00)

Afternoon: Institute of Electromechanics (2:00)

5:00 p.m. Return to hotel

**St. Petersburg:**

Support Systems

Morning: Efremov Institute

Afternoon: Ioffe Institute

Tuesday, July 28

9:00 a.m. Meet in Lobby

9:15 a.m. Buses Depart for Facility Visits

Space Systems

Morning (only): Institute of Precision Instruments  
(10:00)

Support Systems

Morning (only): Institute of High Temperature/  
Scientific Institute of Thermal Processes (10:00)

Wednesday, July 29

*For Departure on LH 3213:*

5:00 a.m. Car Departs from Hotel for Sherevmetevo-2 Airport

7:40 a.m. Depart Moscow

*Departure on Delta Flt. 15:*

5:45 a.m. Bus Departs Hotel for Sherevmetevo-2 Airport

8:25 a.m. Depart Moscow

9:45 a.m. Arrive Frankfurt

Thursday, July 30

*For Departure on Delta Flt. 15:*

5:45 a.m. Bus Departs Hotel for Sherevmetevo-2 Airport

8:25 a.m. Depart Moscow

9:45 a.m. Arrive Frankfurt

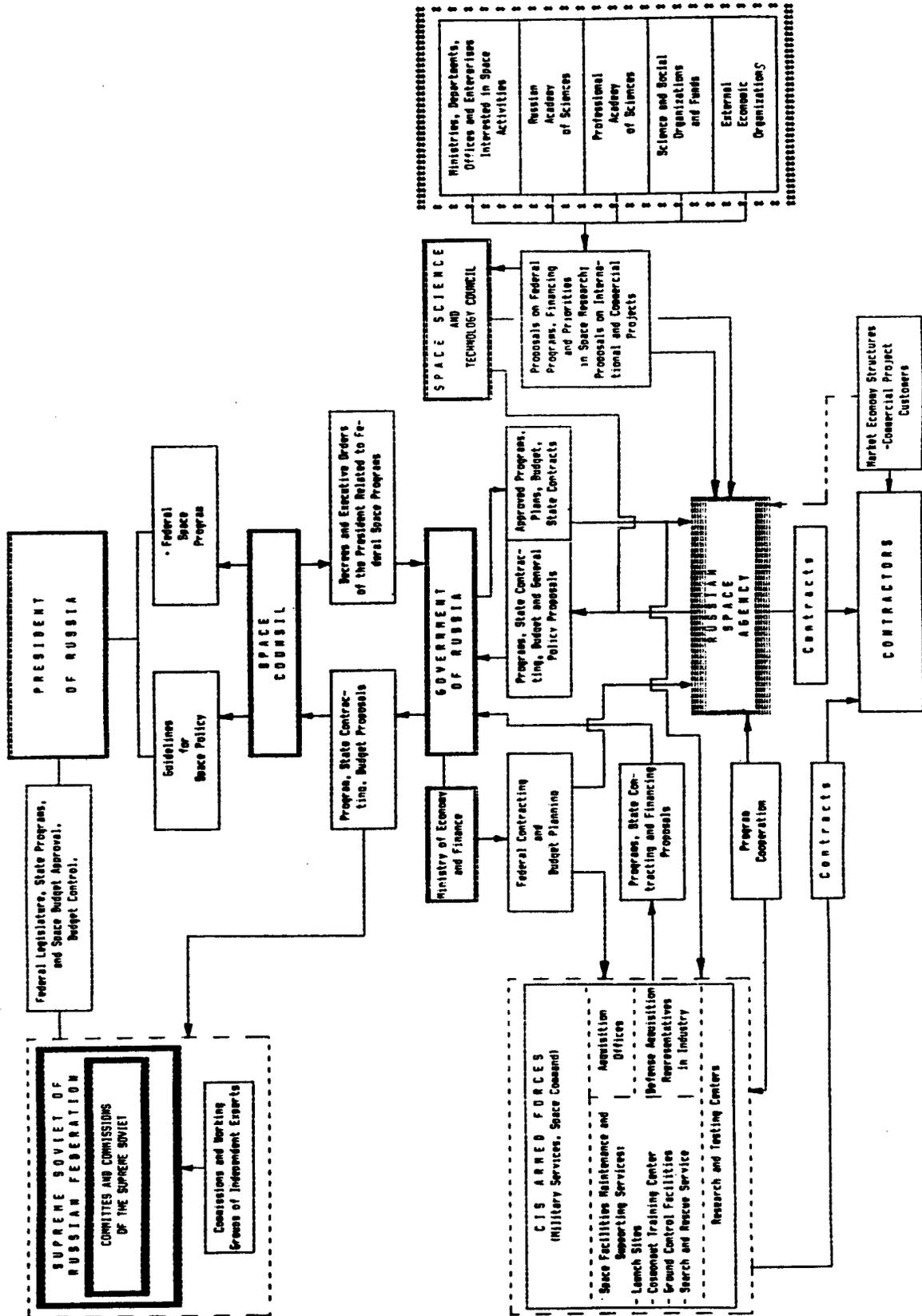
*For Departure on Delta Flt. 31:*

10:00 a.m. Bus Departs Hotel for Sherevmetevo-2 Airport

1:00 p.m. Depart Moscow

4:40 p.m. Arrive Dulles Airport

MANAGEMENT STRUCTURE OF SPACE ACTIVITIES IN RUSSIA



Дата ..... 29.06.9  
 Виток ..... 1435 Н  
 Время ..... 09.31.4±  
 Угол визирования ..... 41°  
 Дальность визирования ..... 382,28

## ГЕРМАНИЯ РАЙОН ГЕЛЬГОЛАНДСКОЙ БУХТЫ

На радиолокационном изображении представлен район Гельголандской бухты в устье реки Эльба (Северное море). Время съёмки приходится на конечную фазу отлива. Изображение морской поверхности состоит в основном из древовидной структуры более сильного отраженного радиосигнала. Сравнение РЛ-изображения с батиметрическими картами этого района позволило установить, что на РЛИ видны мелеющие в результате отлива участки акватории бухты (дающие более слабый отраженный от водной поверхности сигнал) и разветвленные участки оттоки вод в результате отлива (дающие более сильный отраженный от поверхности отливных протоков, сигнал). Наличие на водной поверхности, видимой на РЛИ, фронтальной волновой дугообразной линии доказывает наличие ветра и показывает его направление со стороны бухты к берегу, т.к. дуга выгибается в сторону выхода массы речной воды из бухты. Ветер, дующий в направлении обратном направлению оттока вод в результате отлива и в результате движения водных масс из реки Эльба, создает на поверхности участков с движением водных масс волновую шероховатость, которая, в свою очередь, и дает более сильный отраженный радиолокационный сигнал.

За банками, в направлении оттока отливных вод, на РЛИ заметны образования "дорожки Кармана" — более скоростные, огибающие препятствия, протоки воды. На их поверхности волны, образуемые ветром, более крутые и имеют обрывной характер. Такие волны сильнее отражают радиолокационный сигнал, поэтому на данном РЛИ дорожки Кармана видны в виде тонких светлых полос.

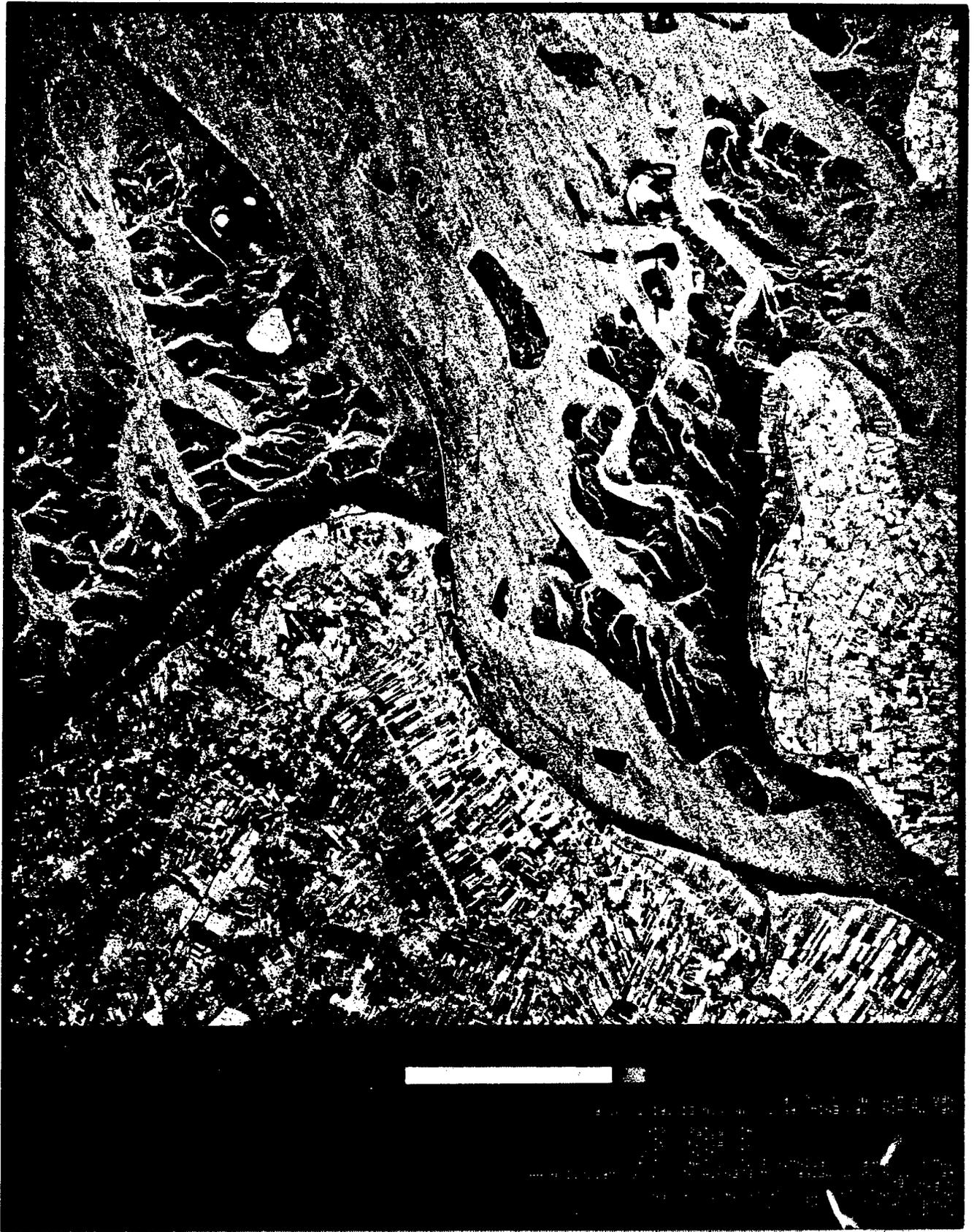
Полученные на РЛИ очертания мелеющих в результате отлива прибрежных участков в основном совпадают с картой этих участков и дополняют ее в деталях.

В центральной правой части изображения виден полуостров Дикланд с четко различимой береговой дамбой на нем, защищающей берег от наводнения. Северное полуострова на морской поверхности видны более светлые очертания бухты Мельдорф, также являющейся руслом оттока вод в результате отлива.

В центре изображения видны портовые сооружения города Дунен, северное которого вытягивается море четко видимое в виде тонкой светлой линии дамбы.

В центральной северной части снимка виден остров Нойверг и два мелких острова, на месте которых, на карте, обозначен остров Шархерн.

На представленных на РЛИ участках суши хорошо просматривается разветвленная сеть автомобильных и железных дорог, а также сельскохозяйственные угодья.



МЕЖДУНАРОДНАЯ КОММЕРЧЕСКАЯ СИСТЕМА  
СПУТНИКОВОЙ СВЯЗИ «СОКОЛ»

Э Т О :

- телекоммуникации между деловыми, информационными, общественными центрами в СССР и за рубежом;
- разнообразные услуги международной связи отдельным организациям и частным лицам;
- автоматическая телефонная связь абонентов г.Москвы с абонентами США, Европы, Юго-Восточной Азии и Австралии.

Советские геостанционные спутники и волоконнооптические линии связи и новейшее коммутационное оборудование ведущих зарубежных фирм обеспечат оперативную, надежную, высококачественную телефонную связь и предоставят пользователям закрепленные каналы связи для передачи цифровой информации со скоростью от 9,6 Кбит/с до 2,018 Мбит/с.

Специально оснащенным абонентам система «СОКОЛ» предоставит каналы для телеинформации.

Э Т О :

- космический сектор, включающий земную станцию в районе г.Москвы, земные станции в различных регионах планеты и советские спутники-ретрансляторы на геостационарной орбите;
- наземный сектор электросвязи г.Москвы, включающий центральный узел связи, периферийные концентраторы, волоконнооптические линии связи;
- магистральные линии связи, обеспечивающие связь земной станции с центральным узлом связи;
- центр управления системой «СОКОЛ».

103482 МОСКВА НПО "ЭЛАС"  
тел. 532-87-70  
тел. 5341235. Четверик Владимир  
Николаевич.



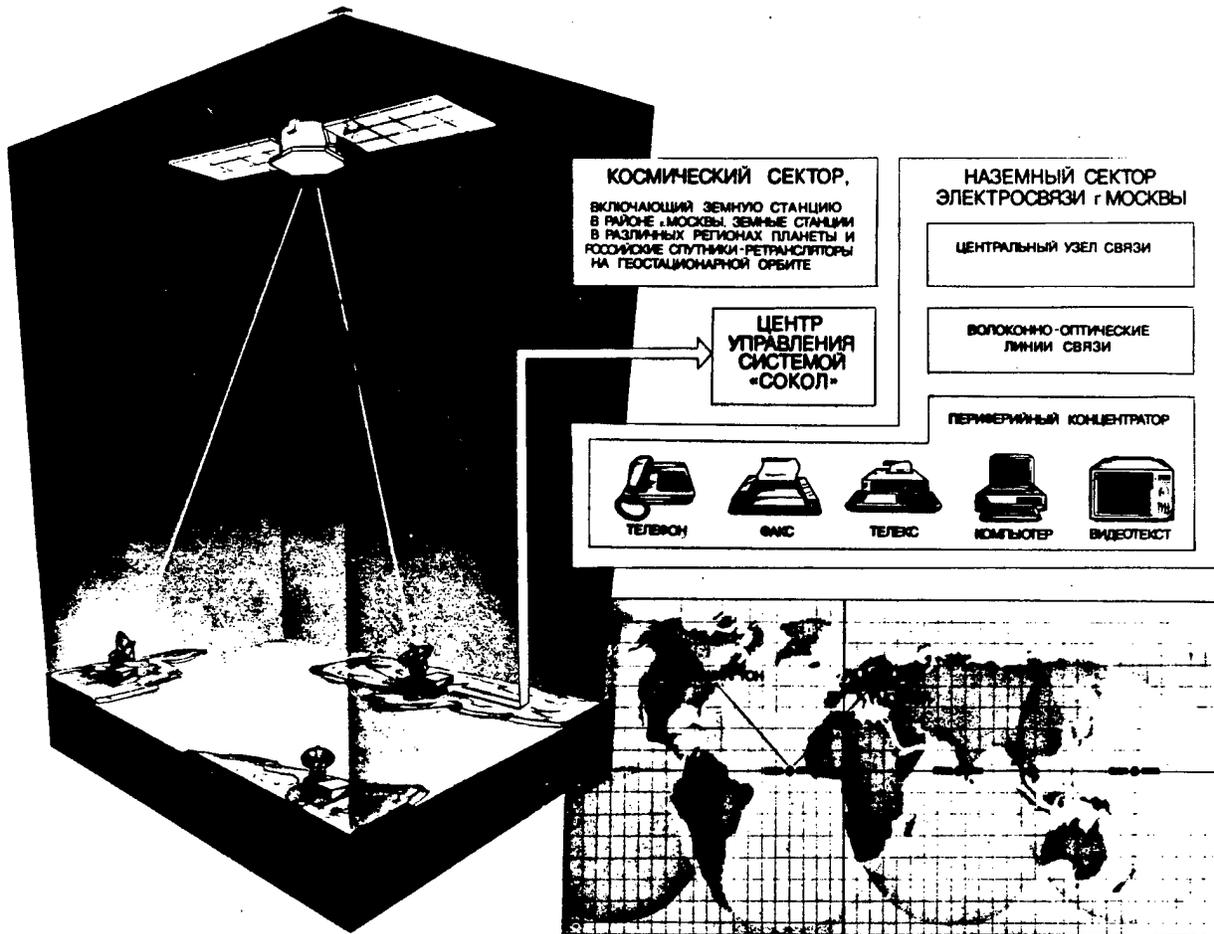
ТЕЛЕКОММУНИКАЦИИ  
МЕЖДУ  
ДЕПОВЫМИ  
ИНФОРМАЦИОННЫМИ  
ОБЩЕСТВЕННЫМИ  
ЦЕНТРАМИ В СНГ  
И ЗА РУБЕЖОМ

РАЗНООБРАЗНЫЕ  
УСЛУГИ  
МЕЖДУНАРОДНОЙ  
СВЯЗИ  
ОТДЕЛЬНЫМ  
ОРГАНИЗАЦИЯМ И  
ЧАСТНЫМ ЛИЦАМ

АВТОМАТИЧЕСКАЯ  
ТЕЛЕФОННАЯ  
СВЯЗЬ  
АБОНЕНТОВ  
МОСКВЫ И США

РОССИЙСКИЕ ГЕОСТАЦИОНАРНЫЕ СПУТНИКИ  
И ВОЛОКОННО-ОПТИЧЕСКИЕ ЛИНИИ СВЯЗИ.  
НОВЕЙШЕЕ КОММУТАЦИОННОЕ ОБОРУДОВАНИЕ  
ЗАРУБЕЖНЫХ ФИРМ ОБЕСПЕЧАТ ОПЕРАТИВ-  
НУЮ ВЫСОКОКАЧЕСТВЕННУЮ ТЕЛЕФОННУЮ  
СВЯЗЬ И ПРЕДОСТАВЯТ ПОЛЬЗОВАТЕЛЯМ  
ЗАКРЕПЛЕННЫЕ КАНАЛЫ СВЯЗИ ДЛЯ ПЕРЕ-  
ДАЧИ ЦИФРОВОЙ ИНФОРМАЦИИ СО СКО-  
РОСТЬЮ ОТ 8,6 КБИТ/С ДО 2,048 МБИТ/С

МЕЖДУНАРОДНАЯ  
КОММЕРЧЕСКАЯ  
СПУТНИКОВАЯ  
СИСТЕМА  
СВЯЗИ  
«СОКОЛ»



## КОММЕРЧЕСКАЯ СИСТЕМА РЕГИОНАЛЬНОЙ КОСМИЧЕСКОЙ СВЯЗИ

## Назначение:

- обеспечение региональной телефонной и факсимильной связи и передачи данных.

## Состав системы:

- высокоорбитальный спутник-ретранслятор "ГЕЙЗЕР", размещенный на геостационарной орбите;
- центральная станция, размещенная вблизи регионального административного центра;
- сеть абонентских станций ( терминалов ).

## Технические параметры:

- количество спутников-ретрансляторов	1;
- количество центральных станций	1;
- количество терминалов	до 1500;
- масса терминала, кг	до 8;
- габариты терминала, мм	500 x 400 x 20;
- электропитание терминала, В:	
от аккумулятора	
от сети	220;
- диапазон рабочих температур, град	минус 40 - +50
- скорость передачи информации терминала, бит/с	9600;

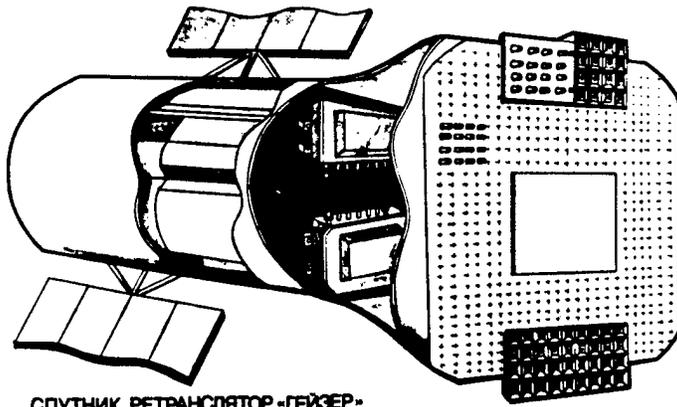
## Услуги системы:

- телефонная связь абонентов "каждого с каждым";
- факсимильная связь абонентов "каждого с каждым";
- передача данных в реальном масштабе времени;
- доступ любого абонента к базам данных фирм-операторов материально-технического снабжения, справочного характера.

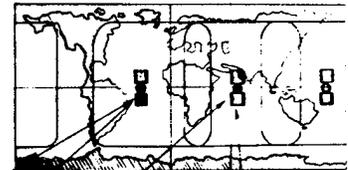
## Особенности системы:

- система обеспечивает круглосуточную всепогодную связь в реальном масштабе времени абонентов, находящихся в любой точке региона, включая труднодоступные районы;
- абонентские станции малогабаритны, легко переносимы, просты в эксплуатации, не требуют специальной подготовки персонала. Предназначены для работы в полевых условиях;
- аналогов в СССР не имеется;
- сроки развертывания системы:
 

на 150 терминалов	1992 год;
на 1500 терминалов	1993 год



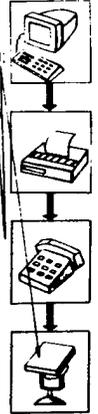
# КОММЕРЧЕСКАЯ СИСТЕМА РЕГИОНАЛЬНОЙ КОСМИЧЕСКОЙ СВЯЗИ «СОКОЛ»



**СПУТНИК РЕТРАНСЛЯТОР - ГЕИЗЕР -**  
 ОРБИТА ГЕОСТАЦИОНАРНАЯ  
 КООРДИНАТЫ ПОДСПУТНИКОВЫХ ТОЧЕК 135 з.д., 80 в.д., 168 з.д.  
 ТОЧНОСТЬ ОРИЕНТАЦИИ В ПРОСТРАНСТВЕ 40"  
 ТОЧНОСТЬ УДЕРЖАНИЯ НА ОРБИТЕ ПО ДЛИНОТЕ 40"  
 ПО ШИРОТЕ 3 ГОДА

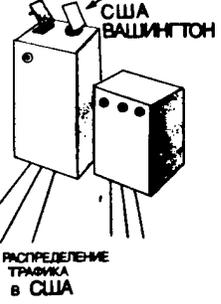
**БОРТОВОЙ РЕТРАНСЛЯЦИОННЫЙ КОМПЛЕКС**  
 ДИАПАЗОН ЧАСТОТ НА ПРИЕМ 2  
 НА ПЕРЕДАЧУ 6  
 КОЛИЧЕСТВО ПЛУМЕР НА ПРИЕМ И ПЕРЕДАЧУ 18  
 ШИРИНА ДИАГРАММЫ НАПРАВЛЕННОСТИ, ГРАД 6  
 ПРИЕМ ПЕРЕДАЧА АЗАР  
 ТИП АНТЕННЫ ПРЕДЕЛЫ ЭЛЕКТРОННОГО СКАНИРОВАНИЯ  
 ЗНАЧ. дБ/Вт +8; мВт/с 31  
 С/Т, дБ/к

**ОБЕСПЕЧИВАЕТ:**  
 ТЕЛЕФОННУЮ, ТЕЛЕВИЗИОННУЮ СВЯЗЬ И ПЕРЕДАЧУ ДАННЫХ В ИНТЕРЕСАХ РАЗЛИЧНЫХ ВЕДОМСТВ;  
 ПЕРЕДАЧУ ДАННЫХ МЕЖДУ ВЫЧИСЛИТЕЛЬНЫМИ ЦЕНТРАМИ;  
 МАГИСТРАЛЬНЫЕ ЛИНИИ СВЯЗИ МЕЖДУ ДРУГИМИ ЗЕМНЫМИ СТАНЦИЯМИ;  
 РАДИАЛЬНЫЕ СЕТИ СВЯЗИ С ОДНОЙ ЦЕНТРАЛЬНОЙ ЗЕМНОЙ СТАНЦИЕЙ 113 Станции располагаются в региональных зонах до 1500 км от центра подспутниковой зоны;  
 РЕГИОНАЛЬНЫЕ РАДИАЛЬНЫЕ СЕТИ СВЯЗИ С ИСПОЛЬЗОВАНИЕМ ОДНОЙ АБОНЕНТСКОЙ ЗС Е ЮНЕСТВЕ ЦЕНТРАЛЬНОЙ РЕГИОНАЛЬНОЙ СВЯЗИ - КАЖДАЯ КАЖДЫМ В ПРЕДЕЛАХ РЕГИОНАЛЬНОЙ ЗОНЫ ОБСЛУЖИВАНИЯ;  
 РЕЖИМНАЯ СПОСОБНОСТЬ: 20 МБ БИТ/С, 8 КМБ БИТ/С - В РЕЖИМЕ МАГИСТРАЛЬНОЙ СВЯЗИ;  
 2 КАМ. \* 90 КМБ/С В ОСТАЛЬНЫХ РЕЖИМАХ

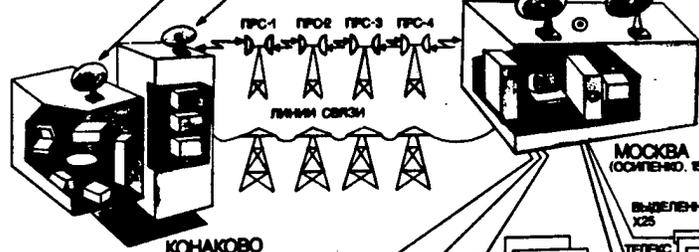


**АБОНЕНТСКИЕ СТАНЦИИ**  
 РАБОЧАЯ ЧАСТОТА, ПРИЕМ С  
 ПЕРЕДАЧА 26,6  
 ЗНАЧ. дБ/Вт мВт/с 31  
 С/Т, дБ/к 430-410  
 РАЗМЕР АНТЕННЫ, ММ 9,6  
 СКОРОСТЬ ПЕРЕДАЧИ ИНФОРМАЦИИ КБТ/С

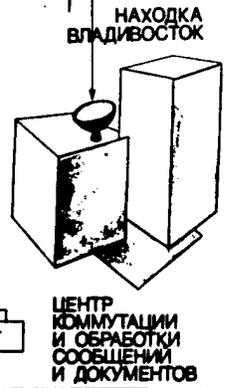
**ЦЕНТР КОММУТАЦИИ И ОБРАБОТКИ СООБЩЕНИЙ И ДОКУМЕНТОВ**



**ЦЕНТРАЛЬНЫЕ МАГИСТРАЛЬНЫЕ ЗЕМНЫЕ СТАНЦИИ**  
 РАБОЧАЯ ЧАСТОТА ПРИЕМ С  
 ПЕРЕДАЧА 54: 65  
 ЗНАЧ. дБ/Вт мВт/с 31  
 С/Т, дБ/к 2000-8000; 2x9,6  
 СКОРОСТЬ ПЕРЕДАЧИ, КМБ/С



МОСКОВСКАЯ ГОРОДСКАЯ ТЕЛЕФОННАЯ СЕТЬ  
 АБОНЕНТ  
 ТЕЛЕГРАМ  
 АБОНЕНТ



**ЦЕНТР КОММУТАЦИИ И ОБРАБОТКИ СООБЩЕНИЙ И ДОКУМЕНТОВ**

# ELAS

## INFORMATION BILL

Small ground satellite communication station.

Carrier frequency for reception	C
Carrier frequency for transmission	C
Modulation type	Relative phase telegraphy + Noise like signal
Information transmission rate, kbit/s	9,6
Clock frequency of the noise-like signal, MHz	1,25
Station quality for reception, db/K	-6
EIRP, dbW	26
Antenna dimension, m	0,424 x 0,394
Directional pattern width, dgr:	
for reception	18° x 12°
for transmission	36° x 9°

<< ELAS >>

Scientific & Industrial Corporation

Address: Moscow, 103482 USSR

tel.: 531-17-49; 5342582. Кравченко

Борис

Григорьев

факс: 531-32-13.

**ИНФОРМАЦИОННЫЙ ЛИСТОК****АФАР СПУТНИКОВ - РЕТРАНСЛЯТОРОВ****1. Назначение и область применения**

Приемо - передающие АФАР формируют независимо управляемые лучи, ориентируемые на подвижные объекты и наземные станции. Используются в системе спутниковой связи на геостационарном спутнике.

**2. Технические характеристики**

Число лучей	3;
Управление лучами	электронное;
Сектор обзора, град	+10;
Энергетика на прием, дБ/К	> +9;
Энергетика на передачу, дБВт	> 32;
Рабочая полоса частот, МГц	100;

**3. Эксплуатационные характеристики**

Окружающая среда	коммос;
Допустимая эксплуатационная температура, С	+5;
Метод охлаждения	комбинированный;
Габаритные размеры АФАР, м	диаметр 3;
Общая масса, кг	250;
Суммарное потребление, Вт	300.

103 482, МОСКВА, НПО "ЭЛАС"

тел.

**532-87-70**

тел. 5369644. Гончаров Вячеслав Георгиевич.

**МАЛАЯ ЗЕМНАЯ СТАНЦИЯ  
СПУТНИКОВОЙ СВЯЗИ**  
ВЫПУСКАЕТСЯ СЕРИЙНО

НЕСУЩАЯ ЧАСТОТА НА ПРИЕМ	ДИАПАЗОН С
НА ПЕРЕДАЧУ	ДИАПАЗОН С
ВИД МОДУЛЯЦИИ	ОФТ-ШПС
СКОРОСТЬ ПЕРЕДАЧИ ИНФОРМАЦИИ	9,6 бит/с
ТАКТОВАЯ ЧАСТОТА ШПС	125 МГц
КАЧЕСТВО (ДОБРОТНОСТЬ) СТАНЦИИ НА ПРИЕМ	- 6 дБ К
ЭНЕРГЕТИЧЕСКИЙ ПОТЕНЦИАЛ НА ПЕРЕДАЧУ	26 дБВт

РАЗМЕР АНТЕННЫ	435-405 мм
АНТЕННА	ПЛОСКАЯ МИКРОПОЛОС- КОВАЯ С КРУГОВОЙ ПОЛЯРИЗАЦИЕЙ
ШИРИНА ДИАГРАММЫ НАПРАВЛЕННОСТИ НА ПРИЕМ	18°-12°
НА ПЕРЕДАЧУ	36°-9°
МАССА	14,6 кг
ВИДЫ УСЛУГ	ТЕЛЕФОН ФАКС
<b>ПЕРЕДАЧА ДАННЫХ</b>	



## КОММЕРЧЕСКАЯ СИСТЕМА ГЛОБАЛЬНОЙ КОСМИЧЕСКОЙ СВЯЗИ

### Назначение:

обеспечение глобальной, региональной и зонавой телефонной, факсимильной связи и передачи данных

### Состав системы:

- высокоорбитальный спутник-ретранслятор "КУПОН", размещенный на геостационарной орбите;
- зонавые станции, размещаемые в любой точке внутри зоны;
- сеть абонентских станций ( терминалов ).

### Технические параметры:

количество спутников-ретрансляторов	1;
количество зонавых станций	до 8;
количество терминалов (на территории СССР)	до 100 000
масса терминала, кг:	
с антенной	до 15
без антенны	8
габариты терминала без антенны, мм	500 x 400 x 200
диаметр антенны терминала, м	1.5
диаметр антенны зонавой станции, м	2.5 - 3
масса зонавой станции с антенной, кг	до 150
напряжение сетевого питания, В	220
диапазон рабочих температур, град	минус 40 - +50
скорость передачи информации терминала, бит/с	9600

### Услуги системы:

- телефонная связь абонентов "каждого с каждым";
- факсимильная связь абонентов "каждого с каждым";
- передача данных в реальном масштабе времени;
- доступ любого абонента к базам данных финансового, материально-технического снабжения справочного характера.

### Особенности системы:

- система обеспечивает круглосуточную всепогодную связь в реальном масштабе времени абонентов, находящихся в любой точке зоны, региона и СССР и ряда зарубежных стран;
- абонентские станции малогабаритны, легко переносимы, просты и удобны в эксплуатации, не требуют специальной подготовки персонала. Предназначены для работы в полевых условиях;
- система мобильна; зонавые станции могут быть перевезены любым транспортом и развернуты в любом месте, не требуют строительства сооружений.
- аналогов в СССР не имеется;

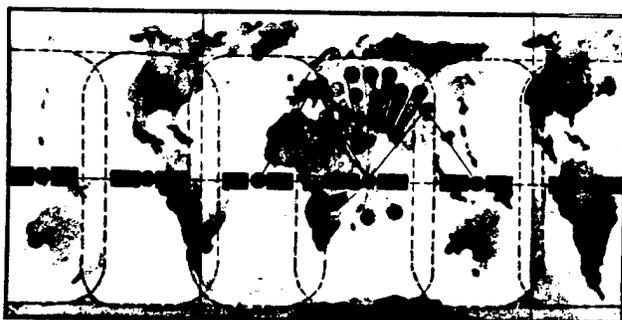
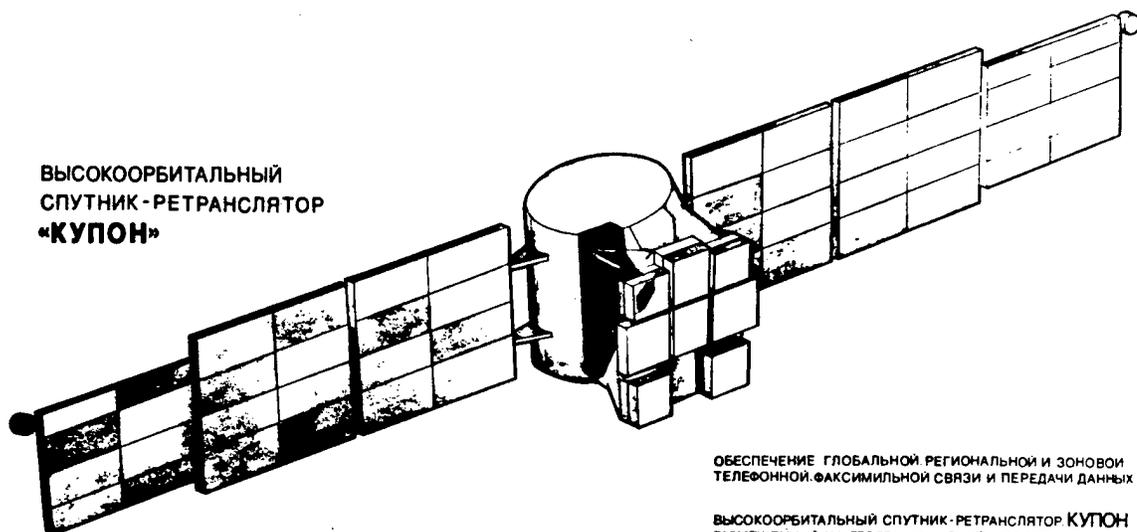
103482, МОСКВА, НПО "ЭЛАС"

тел. 5341235. Четверик Владимир Николаевич.



КОММЕРЧЕСКАЯ  
МНОГОФУНКЦИОНАЛЬНАЯ  
СИСТЕМА  
СВЯЗИ  
«БАНКИР»

ВЫСОКООРБИТАЛЬНЫЙ  
СПУТНИК-РЕТРАНСЛЯТОР  
«КУПОН»



ОБЕСПЕЧЕНИЕ ГЛОБАЛЬНОЙ РЕГИОНАЛЬНОЙ И ЗОНОВОЙ  
ТЕЛЕФОННОЙ, ФАКСИМИЛЬНОЙ СВЯЗИ И ПЕРЕДАЧИ ДАННЫХ

ВЫСОКООРБИТАЛЬНЫЙ СПУТНИК-РЕТРАНСЛЯТОР КУПОН  
РАЗМЕЩЕННЫЙ НА ГЕОСТАЦИОНАРНОЙ ОРБИТЕ

КОЛИЧЕСТВО СПУТНИКОВ-РЕТРАНСЛЯТОРОВ	3
КОЛИЧЕСТВО ЗОНОВЫХ СТАНЦИЙ	до 16
КОЛИЧЕСТВО ТЕРМИНАЛОВ	до 100 000
МАССА ТЕРМИНАЛА, КГ	до 15
С АНТЕННОЙ	8
БЕЗ АНТЕННЫ	500-400 000
ГАБАРИТЫ ТЕРМИНАЛА БЕЗ АНТЕННЫ, ММ	1,5
ДИАМЕТР АНТЕННЫ ТЕРМИНАЛА, М	2,5-3
ДИАМЕТР АНТЕННЫ ЗОНОВОЙ СТАНЦИИ, М	до 150
МАССА ЗОНОВОЙ СТАНЦИИ С АНТЕННОЙ, КГ	220
НАПРЯЖЕНИЕ СЕТЕВОГО ПИТАНИЯ, В	минус 40-50
ДИАПАЗОН РАБОЧИХ ТЕМПЕРАТУР, ГРАД	64/56
СКОРОСТЬ ПЕРЕДАЧИ ИНФОРМАЦИИ ТЕРМИНАЛА, К БИТ/С	

ТЕЛЕФОННАЯ СВЯЗЬ АБОНЕНТОВ КАЖДОГО С КАЖДЫМ  
ФАКСИМИЛЬНАЯ СВЯЗЬ АБОНЕНТОВ КАЖДОГО С КАЖДЫМ  
ПЕРЕДАЧА ДАННЫХ В РЕАЛЬНОМ МАСШТАБЕ ВРЕМЕНИ

## COURIER SYSTEM MAIN CHARACTERISTICS

Characteristic	Dimension	Value	
		Courier 1	Courier
Number of satellites	-	8 - 12	60 - 70
Orbit Altitude	km	800	700-800
Type of orbit	-	circular	
Inclination	degree	76	74-86
Footprint diameter	km	4012	5000
Frequency band	-	UHF	L
Number of channels			
per a satellite	-	8	400
in the system, not less than	-	64	12000
Information speed ratio	kbit/sec	9.6	9.6. 64
Type of information	-	packet digital	
Type of chanel	-	half duplex	duplex
Intersatellite links	-	absent	present
Message delivery time	hour		
within footprint		0.05	0.05
to any point of the Earth			
maximum		12	0.05
average		6	0.05
Average time between sessions (средние широты)	hour	30	continucus
Mass	kg		
satellite		180	700-950
communication equipment		50	210-280
Power consumption	Watt		
total		200	900-1100
communication equipment		110	700-900

Bit error rate		
in radio channel		$10^{-4} - 10^{-5}$
with error protecting coding		$10^{-8} - 10^{-9}$
Unfailure probability within 10 000 hour time interval		0.98
Time resource	year	5

#### DEPLOYMENT SCHEDULE

Courier-1 experimental satellite launch	1 Q	1992
Courier-1 first operating satellite launch	2 Q	1993
Courier-2 experimental satellite launch	1 Q	1994
Courier-1 complete deployment	4 Q	1994
Courier-2 complete deployment	4 Q	1997

#### SERVICES

##### COURIER - 1

- electronic mail
- automated data collection
- mobile users locating
- specialized applied services

##### Courier - 2

- electronic mail
- telex. teletext, faximile
- virtual-terminal and remote file control
- mobile users locating
- specialized applied services
- telephone

Cryptic protection, authentication, data corruption.



#### НАЗНАЧЕНИЕ

СВЯЗЬ С РАЙОНАМИ СТИХИЙНЫХ БЕДСТВИИ РАЗЛИЧНЫМИ ЭКСПЕДИЦИЯМИ ЭЛЕКТРОННАЯ ПОЧТА ДЛЯ БАНКОВСКИХ ОПЕРАЦИЙ УДАЛЕННЫХ РАЙОНОВ ПЕРЕДАЧА ДАННЫХ МЕЖДУ ЛОКАЛЬНЫМИ ИНФОРМАЦИОННЫМИ СЕТЯМИ СБОР ДАННЫХ С ЭКОЛОГИЧЕСКИХ МЕТЕОРОЛОГИЧЕСКИХ И ДРУГИХ ДАТЧИКОВ

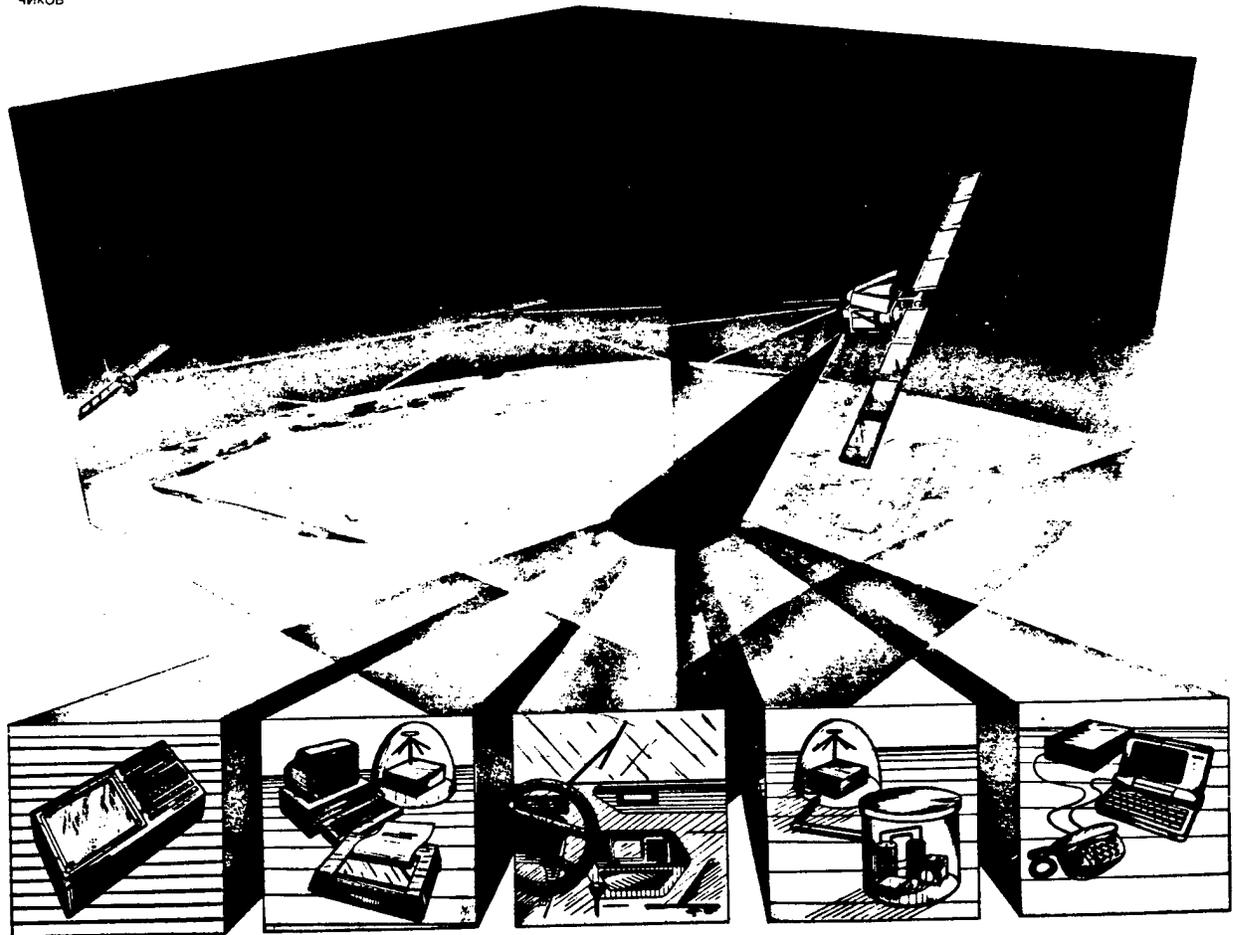
#### ВИДЫ УСЛУГ

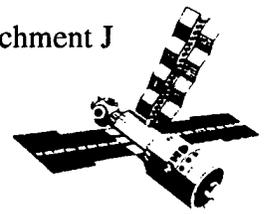
ПЕРЕДАЧА ДАННЫХ ТЕКСТОВЫХ СООБЩЕНИИ СБОР ДАННЫХ С РАЗЛИЧНЫХ ДАТЧИКОВ ТЕЛЕФОННАЯ СВЯЗЬ ПРОВЕДЕНИЕ ВИДЕОКОНФЕРЕНЦИЙ ОПРЕДЕЛЕНИЕ МЕСТОПОЛОЖЕНИЯ АБОНЕНТОВ

#### СОСТАВ

КОСМИЧЕСКИЕ АППАРАТЫ - КУРЬЕР ДО 60 ШТ И ТЕРМИНАЛЬНЫЕ СТАНЦИИ РАЗЛИЧНЫХ МОДИФИКАЦИЙ (НОСИМАЯ МОБИЛЬНАЯ СТАЦИОНАРНАЯ ДЛЯ ВХОДА В НАЗЕМНЫЕ СЕТИ СВЯЗИ) КОЛИЧЕСТВО АБОНЕНТОВ 5 - 10 МЛН

## НИЗКООРБИТАЛЬНАЯ ГЛОБАЛЬНАЯ КОСМИЧЕСКАЯ СИСТЕМА СБОРА, ПЕРЕДАЧИ ДАнных И СВЯЗИ «КУРЬЕР»





# KHRUNICHEV ENTERPRISE



# Los Alamos

Los Alamos National Laboratory  
Los Alamos, New Mexico 87545

DATE: 31 August 1992  
IN REPLY REFER TO: P/AC:92-468  
MAIL STOP: E545  
TELEPHONE: 505 667 3104  
505 665 2014 FAX

To: Distribution  
From: G. Canavan *cc*  
Subject: Trip to Dubna, Russia, for GEM meeting, 7-12 Aug 1992

This memo reports on a trip to Dubna, Russia, for a meeting on Global Environmental Monitoring (GEM). It was the fourth in a series of non-governmental and governmental meetings to exchange information and explore joint projects in the application of distributed remote sensing (DRS) techniques for measurements of global ecology, awareness, and warning of aggression. The series has been sponsored by the World Laboratory, which also supports the annual meetings on Planetary Emergencies in Erice, Sicily.

The meeting was successful in that it introduced a number of U.S. government and non-government participants to a very large number of Russian and other Former Soviet Union/Republic (FSU/R) scientists, administrators, projects, capabilities, & interests.

Participants. The US delegation was led by Col. Steve Harrison of the U.S. Space Council. Members were Fenton Carey, Tom Crimmins, and Ari Patrinos (DOE); Jordan Katz and Scott Larrimore (DoD/SDIO); Greg Wilson and Peter Backlund (NASA); Courtney Riorden and Gene Meier (EPA); Stan Coloff (BLM); William Schneider (GAC/ACDA); Doyle Evans and Greg Canavan (Los Alamos); Lowell Wood, Edward Teller, Walter Scott, and William Zagotta (LLNL); and Andy Boye and John Vitko (SNL).

U.S. participants received late and not completely consistent guidance. DOE indicated that the purpose of the trip was to "assess FSU capabilities for global environmental monitoring and for cooperation in early warning concepts for a global protective system (GPS)."<sup>1</sup> DoD indicated that the SDIO would "only support discussions directly related to...guidance"<sup>2</sup> on Dual Use of Distributed, Space-based Global Defense Sensors. The Space Council and State just said not to make proposals or commitments. Nevertheless, it was possible to have a fairly productive meeting. There is a formal trip report by the U.S. delegation and a separate report by D. Evans of Los Alamos.<sup>3</sup> This memo just covers a few additional technical issues.

The FSR, Chinese, and other delegates are listed in Russian and English in the preliminary List of Participants (Attachment A). It is fairly complete, although in some cases principals, particularly ministers, were substituted for by their deputies, in part because of uncertainties over the occurrence and format of the meeting, which were known to them.

1. T. Crimmins, "Instructions for Participants in Dubna Workshop, DOE Office of Space memo, Aug 9-12 1992.
2. S. Larrimore, "SDIO Contribution to GEM Trip, Russia, SDIO memo; P. Worden, "Dual Use of Distributed, Space-based Global Defense Sensors," SDIO memo.
3. D. Evans, Los Alamos memo ADEE-DE:92-002, 18 August 1992.

President Yeltsin's greeting (Attach B) was translated and read by Dr. Barenboim, the Russian World Laboratory and program chairman, to open the meeting. There were opening statements by Col Harrison, Dep. Russian Minister of Ecology Ivinchenko, Academician Velikhov (VP Russian Academy of Sciences, Dir. Kurchatov, and Pr. Yeltsin's advisor on arms control), Dr. Abdus Salam, Dr. E. Teller, and others from the Ukraine, Lithuania, etc. That by Dr. Sultanyazin, Pr. Kazakh Academy of Sciences, was particularly good. It reviewed the wide-spread devastation of his country and the loss of the Aral Sea.

Scope of the meeting is indicated by the Program (Attach C). There were topical, technical sessions on DRS from space, air, and ground as well as specific ecological and radiological problems in the various FSRs.

Dr. G. Barenboim opened the meeting with a lengthy review of the goals and elements of the GEM project and of the various environmental catastrophes underway in the FSRs (Attch D gives the title page; the 56 page document is available on request.) His colleague Dr. V. Roujansky of the Ecological Station of Environmental Control (ESCOS, the World Laboratory's branch in Russia) provided further information on the "Contamination of the Arctic Environment from the territory of the FSU" (Attch E gives the title page. The 10 page document, which is available on request, even shows where the Soviet Union disposed of its spent submarine reactor cores.) Attachment F shows the overall scope of ESCOS projects and laboratories.

Dr. Barenboim pushed hard for the establishment of several GEM laboratories in the FSU, as he has in previous meetings in the series. He indicated that Russia would commit the funds required. That point was contentious. Several countries and locations would like to compete, and several different groups would like to be the points of contact.

Talks. Most of the attendees then talked in the technical sessions over the next three days. The talks broke into roughly two types. Government officials, including the Ministries of Defense (MOD) generally noted that "now that the cold war is over, we look forward to cooperating openly" (particularly on U.S. technology). Scientists generally talked about detailed programs, capabilities, or measurements. A few are noted below.

Dr. Rodin from Lavochkin talked about the conversion of SS-18s into launchers for GEM DRS satellites, a subject that he has covered in previous meetings of this series, as well as in the U.S.-Russia Space Commerce Mission in July.<sup>4</sup> The use of converted military boosters for GEM is viewed as an important issue, particularly to Russian and Ukrainian institutes, design bureaus, politicians, and scientists, because of its potential for generating hard currency. But it is a very divisive issue, because it cuts across U.S. domestic commercial space issues.

There was no response, other than the suggestion that it would be appropriate for the FSRs to use their converted boosters to launch their own GEM satellites. While the Russians, in

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4. G. Canavan, "U.S.-Russia Space Commerce Mission," Los Alamos memo P/AC:92-420, 31 July 1992.

particular, expressed great interest in flying advanced U.S. sensors, it was generally recognized that this would involve considerable relaxation of tension, and that it might be more practical to go through a transitional period of several years in which the U.S. and FSRs flew their own sensors on their own boosters and worked out means of exchanging data as a step towards greater cooperation.

Dr. Yuri Zlatkin, Chief Designer of Hartron, stressed the strong support for GEM in the Ukraine. The Ukraine is interested in separate interactions with the U.S., as discussed in a separate trip report.<sup>5</sup>

Academician Guskov's group from Elás discussed their plans for using decommissioned military satellites for GEM measurements, but did not discuss their sensors in any detail. When I asked Velikhov why they did not, he said that he and Barenboim had been unable to get approval from the Ministry of Defense (MOD) in time. Elás also discussed an alternative new sensor whose capabilities were something like the visible-near-infrared (IR) part of a Landsat, which Elás hopes to launch in 1994. Such sensors might also be usefully flown on developmental SDIO dual-use satellite buses as a cross-check of small sensors.

There were many very thoughtful technical talks from the scientists in the List of Participants. Unfortunately, there was no printed agenda, and my notes of the speakers and topics are unreliable due to spelling and uneven translation. I have asked Dr. Barenboim to prepare a list of speakers and topics and short synopses of their talks, and will make it available.

Lowell Wood gave a review of advanced U.S. DRS sensors and communications at about the level that had been discussed at Erice the previous year.<sup>6</sup> It was a useful update for most of the audience, and well received, as was John Vitko's presentation of ARMSAT. My talk was restricted to a discussion of the space and time resolution requirements for dual uses and DRS's capabilities as shown in the final figure of last year's Signal article.<sup>7</sup>

Scott Larrimore's discussion of SDIO dual use satellites provoked a lively discussion of the impact of false alarms and failures on defensive systems, to which Dr. Wood contributed usefully. Great interest expressed in more detailed discussions. William Schneider gave a thoughtful discussion of the reasons for increasing support for dual-use applications in the West.

Cyclones. One of the most interesting discussions was that by the Elás group of the possibility of using DRS information to predict the development of hurricanes like the one that damaged Florida. Elás reviewed their aircraft measurements of microwave

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5. G. Canavan, "Trip to Hartron, Myasishchev, and Elás Design Bureaus, 12-14 August 1992," Los Alamos memo P/AC:92-469, 1 September 1992.

6. G. Canavan and L. Wood, "Distributed Remote Sensing from Constellations of Small Satellites," A. Zichichi, ed., Proceedings of the XII Erice Symposium on Global Problems, Majorana School of Physics, Erice, 19-23 August 1991.

7. G. Canavan and E. Teller, "Distributed Remote Sensing for Defense," Signal, August 1991.

reflectivity changes, which appear to be a precursor to cyclone formation.<sup>8</sup> Several Russians gave Dr. Teller and I some papers on the geophysical phenomena involved<sup>9</sup> and the physical observables that could be monitored remotely<sup>10</sup> and asked us to sketch out the compact microwave sensors needed to monitor them. I said that I would do so, confer with Dr. Teller, and let them know if satellite remote sensing looked promising and how to test it.

In the summary session Dr. Teller concentrated on who would want to use and who would be willing to pay for the new DRS capabilities. He identified FEMA as a likely and valuable customer. He stressed the necessity of making information available to all and argued for taking advantage of the greater flexibility of non-governmental activities. The FSR comments seemed to split on that issue.

Velikhov expressed satisfaction with the results of the meeting and with the use of the World Laboratory as a vehicle for coordinating Russian and FSR activities internally and internationally. He pushed on defining dual-use satellites, aircraft, and ground stations and combining their data in integrated data banks. There was much talk about more organization and more meetings; no commitments were made.

Questions left over from the meeting were almost as numerous and interesting as the conclusions. Among them were:

1. Is the Russian MOD (and CIS general staff) willing to let military satellites be used for civil purposes?

2. How much real influence or control do Velikhov and the World Lab have over the MOD?

3. What are the capabilities of current Russian satellites for DRS?

4. What are Russia's plans for using them or advanced satellites for DRS?

5. Who speaks for the World Lab (GEM) in Russia? FSRs? Is it strong enough to coordinate (lead) efforts?

6. Do Russia or the FSRs have any idea of how to use remote sensing for radiological, chemical, or biological catastrophes-- or must they be monitored from the ground?

7. What are the actual sensors on FSR aircraft? Could FSR airplane measurements be usefully joined with the U.S. DoE's ARM program?

8. What are the actual FSR ground sensors? Could FSR ground measurements be usefully joined with U.S. EPA ground measurements?

9. Could FSR satellites provide useful precursor information for the U.S. Earth Observing System (EOS)?

10. Is "dual use" of warning satellites cost effective?

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8. G. Canavan, "U.S.-Russia Space Commerce Mission," op. cit.

9. V. Zimin, et. al., "Investigation of Large-Scale Ecologically-Hazardous Eddy Flows in the Earth Atmosphere," USSR Academy of Sciences Space Science Research report Pr-1778, 1991.

10. S. Moiseev, "The Helical Mechanism of Generation of Large-Scale Structures in Continuous Media," Proceedings of International Workshop on Nonlinear and Turbulent Processes in Physics," Kiev, 1989.

Answers. As a partial answer to the first question, after the Dubna meeting I was told by Dr. Barenboim that during the meeting Grigorov, chief of the ecological department of the MOD, and his deputy A. Unaic had established a coordinating committee for dual use of military assets under Wolkov, and that Gen Ivanov, who controls special equipment (satellites), is on the coordinating committee. Their first meeting, the Monday after the Dubna meeting, was held to approve the agenda for the subsequent meeting in Erice.

As a partial answer to the second question, Dr. Barenboim has been made the deputy to Wolkov for ecological applications. There will be another deputy from within the MOD for military applications. The MOD does seem to take DRS seriously, and Pr. Yeltsin does appear to view the World Laboratory and its GEM project as useful coordinating mechanisms.

Issues. The Dubna meeting provided a useful first exchange with a large number of scientists and organizations, some of whose existence or functions were unknown a year or two ago. Some of their capabilities are quite impressive. The ecological problems in the FSRs are staggering. It would appear that the GEM project could contribute to them. It is a bit less clear how DRS could contribute and how the U.S. could best interact with the GEM project.

Many of the FSRs' problems have to do with ground contamination by chemical or radiological materials. It has been shown that DRS can remotely sense gross migration through vegetation, emissivity, and reflectivity changes, but it is not clear that current capabilities are sufficiently direct to replace ground measurements.<sup>11</sup> The FSRs, particularly Russia, could well be served by first improving ground measurements, perhaps using satellites for data readout and transmission. The next step might be augmented aircraft measurements.

Such steps could provide time for definition of more direct space measurements. Nevertheless, even Russia's problems are effectively global. When all of the FSRs are included, that is even more true. Thus, DRS could be effective as a means of following gross changes over the FSU's whole land mass. DRS has already been effective in monitoring the disappearance of the Aral Sea and the growth of the dust bowl and erosion problems produced thereby.

Organizational issues were raised but not addressed. Responsibility and support for space, air, and ground sensing are split between the Ministry of Space and Ecology and others in Russia and split along still other lines in the other FSRs. Moreover, the Russian Minister of Space Koptiev appears to be more interested in maintaining the overall enterprise than in supporting a new and possibly expensive thrust in ecological monitoring. Aircraft measurements are underutilized and subordinated to more glamorous space measurements in the FSRs as in the U.S. Ground sensors are developed, but measurement nets are undersized, as in the U.S.

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11. G. Canavan, Los Alamos letter P/AC:92-372, 20 June 1992 to N. Fortsun and D. Eardley; Subject: JASON Study of DRS.

There appear to be many opportunities for collaboration, but the mechanisms for developing them are still formative. Until they are in place, the World Laboratory, ESCOS, and GEM would appear to serve a useful default mechanisms for the exchange of the technical information needed to define useful collaborations. The representatives at the Dubna meeting would appear to be appropriate contacts for such follow-on exchanges. Thank you for your time and attention.

INTERNATIONAL WORKSHOP  
GLOBAL ECOLOGICAL  
MONITORING PROJECT

August 8-12, Dubna, Russia

Organised by  
Ecological Station of Environmental  
Control, MOSCOW, Russia  
Lawrence Livermore National Lab,  
California, USA

LIST OF PARTICIPANTS

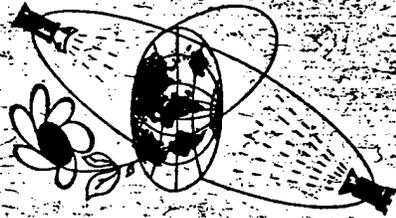
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Attach A



СПИСОК УЧАСТНИКОВ

РАБОЧЕГО СОВЕЩАНИЯ "ГЛОБАЛЬНАЯ ЭКОЛОГИЧЕСКАЯ МОНИТОРИНГ"  
ОТ ВЕДОМСТВ И НАУЧНЫХ УЧРЕЖДЕНИЯ США

Лауренсовская Ливерморская Национальная лаборатория

(координатор проекта)

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2. Д-р. Лоуэлл Вуд (Lowell Wood) - руководитель программы.
3. Д-р. Вальтер Скотт (Walter Scott) - зам. дир. по космическим исследованиям.
4. Д-р. Вильям Заготта (William Zagotta) - административный директор.

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7. М-р. Томас Е. Креминс (Thomas E. Cremins) - аналитик, отд. космических исследований.

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11. М-р. Питер Баклунд (Peter Backlund) - должность будет сообщена позже.

Attachment A

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15. М-р. Джордан С. Катц (Jordan S. Katz) - заместитель руководителя.

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22. М-р. Харрисон (Harrison) - сведения будут сообщены позже.

**СПИСОК УЧАСТНИКОВ РАБОЧЕГО СОВЕЩАНИЯ ОТ  
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3. Rybalskii N. G. - Deputy Minister.
4. Petrov N. N. - Head of Scientific Division.  
Ministry of Defence of Russia.
5. Grigorov S. I. - Head of Department.
6. Ponomarenko A. P. - Scientific Director of "EKOS - Konverce".
7. Yunak A. I. Deputy Head of Department.  
Russian Space Agency.
8. Milov Yu. G. - Deputy General Director.  
State Committee for Water Resources of Russia.
9. Mikheev N. N. - Chairman of Committee.  
Foreign Policy Association.
10. Sergeev R. A. - Head of Ecology Center.
11. Kocharyan M. A. - Head of Division.  
Ministry of Environmental Protection of Ukraine.
12. Tscherbak Yu. N. - Minister.
13. Pasadskii V. I. - Chief of Scientific Department.  
Ukrainian Academy of Science.
14. Kalmikov A. I. - Chief of Department.
15. Kalenchuk-Porkhanova A. A. - Chief of Laboratory.  
National Space Agency of Ukraine.
16. Gorbulin V. P. - Chairman.  
Ministry for Scientific and Technical Progress of Ukraine.
17. Kuleshov V. I. - Head of Scientific Division.

Ministry of Ecology and Bioresources of Kazakhstan.

18. Medvedev S. A. - Minister.  
Kazakhstan Academy of Science.
19. Sultangazin U. M. - President.
20. Zagarin E. A. - Deputy Director of Space Research Institute
21. Spivak M. M. -  
World Laboratory Branch, ESCOS.
22. Barenboim G. M. - Director.
23. Shelest V. P. - Executive Director.
24. Roujansky V. E. - Executive Director of the Arctic  
Environmental Project.
25. Sadikov M. A. - leading scientist, SPb Center.
26. Sarychev P. D. - Director of Far-East Center of ESCOS.
27. Sidorov K. S. - leading scientist.  
World Laboratory Branch in Kazakhstan.
28. Baygarin K. A. - Director.
29. Akhazarev M. - Deputy Director.  
Scientific and Production Association "Khartron".
30. Borushko Yu. M. - Head of Division.
31. Zlatkin Yu. M. - Deputy General Director.
32. Silaev Eu. V. - leading scientist.  
Khar'kov Scientific Center "Ensol".
33. Krainov I. P. - Scientific Chief of Center.  
Deputy Director of SPA "Monokrystal".  
Lavochkin Scientific and Production Association.
34. Rodin A. L. - First Deputy of General Designer.
35. Yanitskii A. A. - Chief of Division.  
Myasitshev Scientific and Production Association.
36. Novikov V. K. - General Director.
37. Kravchenko G. M. - Head of Division.

Supreme Ecological Council, Associated to the Supreme Soviet of Russian Federation.

57. Petrosyan V.S. - Deputy Chairman.  
Moscow Energy Institute.
58. Zimin E.P. - leading specialist.  
Institute for Earth Magnetism, Ionosphere, and Radiowaves Propagation of Russian Academy of Science.
59. Givishvili G.V. - Chief of Laboratory.  
Institute for Atmospheric Physics of Russian Academy of Science.
60. Mal'kov I.P. - Deputy Director.  
Institute for Global Climate and Ecology of Russia.
61. Rovinskii Ph. Ya. - Deputy Director.  
Institute "Delphin".
62. Bogomolov O.D. - General Director.
63. Smirnov A.A. - Chief of Laboratory.
64. Burlakov V.I. - Chief of Division.  
Committee for Ecology and Rational Usage of Natural Resources of the Supreme Soviet of the Russian Federation.
65. Grakovich V.Ph. - leading specialist.  
Joint-stock Company "Roskomeerogeo".
66. Djanibakov V.D. - Chief of Division.
67. Bogdanov V.V. - President.
68. Kuznetsov S.V. - General Director.
69. Vinogradov V.V. - Program Chief.
70. Morschanova I.V. - Chief of Foreign Affair Department.
71. Khodarev Yu.K. - Director of Engineer Center "INAS".  
Federal Ecological Fund of Russia.
72. Mozhin V.P. - Chairman of Administration Board.
73. Semekhin I.I. - Executive Director.

Scientific and Production Association "ELAS".

38. Gus'kov G. Ya. - General Director.
39. Karasev V.I. - Deputy General Director.
40. Kondranin T.V. - leading scientist.
41. Tatarinov K.V. - leading scientist.
42. Chernii I.V. - leading scientist.  
Central Air Hydro Dynamic Institute (TSAGI).
43. Neiland V. Ya. - Deputy General Director.
44. Kogan M.N. - Head of Division.  
Research Institute for Electro-Mechanics.
45. Adat'ko V.I. - Director.
46. Trifonov Yu. V. - Vice Director.
47. Dubrovinskii Ya. V. - Head of Division.  
Scientific and Production Association "Tayphun".
48. Volkovitskii O.A. - Director.  
Merculovich V.M. - Head of Division.
49. Space Research Institute, Russian Academy of Science.
50. Moiseev S.S. - Head of Department.
51. Managadze G.G. - Chief of Laboratory.
52. Sharkov E.A. - Chief of Laboratory.  
Institute for Spectroscopy, Russian Academy of Science.
53. Kompanež O.N. - Vice Director.
54. Koloshnikov V.G. - Head of Laboratory.  
Institute for Chemical Physics, Russian Academy of Science.
55. Revelskii I.A. - Head of Division.  
Council on crisis situations analysis and State Programs drafts, associated to the Russian Government.
56. Moiseev N.N. - Scientific Head of the Association  
"ECOPROJECT", ESCOS.

Town Council of Pereslavl-Zaleski.

74. Rybakov A. V. - Vice Mayor.

Branch of the Institute for Nuclear Energy named after Kurchatov.

75. Dykhne A. A. - Chief of Department.

Moscow Aircraft Institute.

76. Kyrilin A. N. - leading scientist.

General Physics Institute.

77. Bunkin A. Ph. - leading scientist.

Institute for Scientific and Technical Information.

78. Losev K. S. - Chief of Department.

Member Supreme Ecological Council of the Ecology  
Committee of SS of RF.

Scientific and Technical Center for the Control and the Usage  
of Physical Fields and Radiation (Saratov).

79. Bukatin A. Ph. - General Director.  
World Data Center.

80. Mikhailov N. N. - Chief of Laboratory.

International Financial Organization "MENATEP".

81. Sychev V. V. - Chairman of the Board.

82. Arbatov G. A. - Academician.

Joint Institute for Nuclear Research.

83. Romanov A. I. - Deputy Director.

Local Coordinator of the Workshop.

84. Makhankov V. G. - Chief of Division of LCTA.

Chief of Local Group.

85. Mescheryakov M. G. - Director Emeritus of LCTA.

86. Morozov V. V. - Local Coordinator of the Workshop.

87. Makhankov A. V. - Chief of Gests Receiving Group.

88. Lukianov S. O. - Workshop Administrator.

89. *Dzivilin J. V. - Vice Director of LCTA.*

Organizing Group.

89. Sanyuk V. I. - Chief.

90. Ptukha A. R. - Responsible Secretary.

91. Grebeshkova E. V. - Secretary.

92. Panfilova O. - Interpreter.

Press Center.

93. Socorro Delgado - Chief.

94. Serdyuk I. A. - Coordinator.



**ПРЕЗИДЕНТ**

**РОССИЙСКОЙ ФЕДЕРАЦИИ**

« 3 » августа 19 92 г.

№ Пр-1387

г. МОСКВА

**Участникам  
Международного рабочего совещания по Проекту  
"Глобальный Экологический Мониторинг"**

Приветствую участников совещания по Проекту "Глобальный Экологический Мониторинг", собравшихся на гостеприимной земле России.

Руководство Российской Федерации придает особое значение деятельности в области экологии. Мы убеждены в том, что решение крупных экологических проблем является общей заботой человечества, и всемерно поддерживаем международное сотрудничество в этой области.

Обсуждаемый Вами проект экологического мониторинга, где в единую систему объединены космические, авиационные и наземные средства наблюдения на основе новейших разработок науки и техники, значительная часть которых совсем недавно предназначалась исключительно для оборонных целей, открывает новые возможности для достижения одного из основных прав человека - права жить в благоприятных экологических условиях в гармонии со всей природой.

Мы считаем, что конверсия существующих технических средств обороны, опытных разработок, мощностей военной промышленности и переориентация на мирную сферу интеллекта специалистов, занятых в оборонной сфере, могут быть интенсивно использованы для увеличения интеллектуального и технического потенциала современной экологии. Будем оказывать этому необходимую поддержку.

Мы ценим деятельность международных неправительственных организаций, в частности, - Всемирной Лаборатории в этой области, поддерживаем усилия российских ведомств и организаций, принимающих участие в Проекте. Надеемся, что и другие страны, организации которых участвуют в Проекте "Глобальный Экологический Мониторинг", окажут ему поддержку.

Выражаю особое удовлетворение участием в совещании видных представителей США, Украины, Казахстана и других стран, которые наряду с российскими специалистами заложили основы Проекта. Желаю участникам совещания успешной работы.

**Б.ЕЛЬЦИН**

**Program of the International Workshop on the Project "Global  
Ecological Monitoring"**  
Dubna, Russia, August 8 - 12.

*Sessions*

- p. 1
- August 9th: 11.30 - 13.00 - Opening of the Workshop  
 15.00 - 18.00 - The talks "Project GEM" - 1 h. *Slutskiy UK*  
 Discussion A1 - 1 h. *1st Dep Dir Hartm*  
 Discussion B7 - 1 h. *Prof Sula Gorze*
- August 10th: 9.00 - 13.00 - Discussion A3 - 1,5 h. *Kozakishin*  
 Discussion A4 - 1,5 h. *Chern Pr. Acad Sci*  
 Discussion A5 - 1 h. *+ Inst. Sp. Acad*  
 16.00 - 18.00 - Discussion A2 - 0,5 h.  
 Discussion A6 - 1 h.
- August 11th: 10.00 - 13.00 - Discussion B8 - 1,5 h.  
 Discussion B9 - 1,5 h.  
 15.00 - 17.00 - Discussion C10 - 1 h.  
 Concluding session - 1 h.

*Social events*

- August 9th: 13.00 - 14.00 - Press Conference.  
 19.30 - Welcome Party.
- August 10th: 18.30 - 19.30 - Dr. Teller's Press Conference in Russia.
- August 11th: 18.00 - 19.00 - Concluding Press Conference.  
 19.30 - Banquet.

*Discussion Blocks*Block A. Scientific and technological aspects of the Project.

- A1 - Space in the GEM System.  
 A2 - Aircrafts in the GEM System.  
 A3 - Ecological Stations on the Earth surface in the GEM System.  
 A5 - Communication and information assurance of the GEM Project.  
 A6 - Systems of strategic defence; the possibility of its usage for the GEM purposes.

Block B. Ecologo-geographical aspects of GEM; ecological disaster zones as GEM objects.

- B7 - National problems and politics in the ecological field.  
 B8 - Regional ecological problems.

Block C.

- C9 - Political and legislative aspects of GEM.

# INTERNATIONAL WORKSHOP GLOBAL ECOLOGICAL MONITORING PROJECT

August 8-12, Dubna, Russia

Organized by  
Ecological Station of Environmental  
Control, MOSCOW, Russia  
Lawrence Livermore National Lab.  
California, USA

GLOBAL ECOLOGICAL MONITORING PROJECT.

SCIENTIFIC, TECHNOLOGICAL, CONVERSIONAL AND ORGANIZING PRINCIPLES

Some materials for

REPORT

by Prof. Barenboim G.M.

(with assistance of Dr. Zimin E.P.)

DRAFT

V.E.Roujansky, G.M.Barenboim  
 Ecological Station of  
 Environmental Control (ESCOS)  
 Moscow, Russia

Contamination of the Arctic Environment from the territory of the Former Soviet Union. The ways of pollution movements towards the neighbouring countries. (Arctic Environmental Project).

### I. Background

The necessity of conducting complex ecological investigations within the Arctic region of Russia by scientists from all interested countries is determined by various factors, in particular, by the following ones:

- . continuing contamination of the Russian part of the Arctic ocean, which has an unique structure and specific patterns of natural processes (for example, regular character of the ocean currents), and represents the termination point for major river systems (the Ob, Yenisey, Lena, Kolyma), and, therefore, the accumulative zone for most of the industrial pollutants;
- . transregional river runoff (rivers of the Northern European part of Russia and Siberian rivers) and groundwater flow into the Arctic ocean);
- . extreme geographic, geologic and climatic conditions, which are responsible for the specific polar effects, when natural conditions are overlapped by anthropogenic activity: acceleration of the greenhouse effect, ozone depletion, lack of the oxygen, etc.
- . occurrence of the thick and vast permafrost zone;
- . location of many toxic and hazardous industries within vast-barren polar regions of Russia, and in southern parts of Siberia, but within the basins of the major rivers flowing northward into the Arctic ocean.

### II. Existing and Potential Sources of the Arctic Contamination

The primary existing and potential sources of the contamination of the Arctic environment from the territory of the Former Soviet Union are as follows:

- . three nuclear enterprises in Siberia and the Ural region (Chelyabinsk, Tomsk, Krasnoyarsk);
- . the Novaya Zemlya nuclear testing ground;
- . the Semipalatinsk nuclear testing ground;
- . Navy bases for nuclear submarines in the Arctic (two bases on the Kola Peninsula, and one - in Severodvinsk);

ЛОЗАННА - ЭРИЦЕ - МОСКВА - ПЕРЕСЛАВЛЬ - ЗАЛЕССКИЙ

„It is unprecedented in human history that mankind has accumulated such a military power to destroy, at once, all centers of civilization in the world and to affect some vital properties of the planet.  
The danger of a nuclear holocaust is not the unavoidable consequence of the great development of pure science.  
Technology can be for peace and for war. The choice between peace and war is not a scientific choice. It is a cultural one: the culture of love produces peaceful technology. The culture of hatred produces instruments of war...”

Erice Statement, 1981,  
Erice, Italy.

ECOLOGICAL STATION OF ENVIRONMENT CONTROL (ESCOS) is a part of International Centre for Scientific Culture — World Laboratory (World Lab). Established in Geneva in 1986 the World Lab has become a prototype of the organization called to unite the efforts of the scientists from various countries to solve the problems of great interest to the mankind without frontiers and without secrecy between the science of West and East, North and South. This cooperation was initiated by the authors of the Statement,, Nobel Laureates P. Kapitza (USSR), D. Dirac (Great Britain), an outstanding physicist and public figure A. Zichichi (Italy) and other physicists.

The World Lab's Scientific Committee is one of the most authoritative in Europe. There are 9 Nobel Laureates out of its 18 members representing 9 countries.

The World Lab is an associate member of the United Nations Organization. Its activities are directed towards the development of important international scientific projects in the field of searching new energy sources, hydrometeorology (first of all global climatic change), physics, medicine, ecology as well as reducing nuclear and chemical war dangers.

AIDS, ozone holes, greenhouse effect, chemical weapon destruction, development of an international ecological control network and many other up-to-date scientific questions are on the agenda of annual conferences.

The main Coordination Centre of the World Lab is located in Lausanne (Switzerland) and it has an Information and Education Centre in Erice (Italy). The President of the World Lab is Prof. Antonino Zichichi (Italy).

World Laboratory has established an annual prize of Erice "Science for Peace". The prize fund amounted to \$1 100 000. The first prize "Science for Peace" was awarded in 1990. One third of the prize was awarded to scientists P. Kapitza (USSR), P. Dirac (Great Britain) and A. Sakharov (USSR) posthumously. One third of the prize also went to E. Teller (USA) and W. Weisskopf (USA).

The World Lab has its branches in various countries. The World Lab Branch in USSR was established in 1989. Its status was determined by Authorization of the Council of Ministers № 486 of June 16, 1989, which stated that the World Lab Branch is an International Non-Governmental Organization located in the territory of the USSR with the right to interior and exterior activity (exempted from taxes, customs duties etc).

The Branch President is Academician E. P. Velikhov (Vice-President of the USSR Academy of Sciences, Kurchatov Nuclear Energy Institute Director, the USSR Supreme Soviet deputy). The Branch Director General is a corresponding member of the USSR Academy of Sciences V. A. Gelovany (specializes in mathematics, macrosystem models). The Branch Headquarters is located in Moscow (9, Prospect 60 let Otyabria). The Branch has its subsidiaries in 12 soviet cities. Subsidiaries in the Ukraine and Lithuania have become independent Branches.

ECOLOGICAL STATION OF ENVIRONMENT CONTROL (ESCOS) is a subsidiary of World Laboratory Branch in USSR. It is an independent juridical person and functions since January 1, 1990. ESCOS enjoys all the rights of the Branch. ESCOS has its residence in an ancient Russian city of Pereslavl-Zalesky which is a part of the Golden Ring of Russia [130 km distance from Moscow] with the Presentation Office in Moscow and regional centers in other soviet cities.

ESCOS Director is Doctor of Physics and Mathematics Professor G. M. Barenboim (simultaneously occupying the post of the Chief of the Chair "Ecology" at Moscow Physical and Technical Institute).

ESCOS does scientific research in the field of methods and systems of environment control, mathematical modelling of the ecological situation. It deals with the questions of ecological education, organizes and carries out independent international examinations in the ecologically damaged areas.

An important aspect of ESCOS's activity is a development of independent network of international stations of environment control in the USSR and other countries as well as promotion and realization of various international ecological projects.

LAUSANNE - ERICE - MOSCOW - PERESLAVL - ZALESSKY

## ESCOS INTERNATIONAL PROJECTS

(acting or at the stage of formation are open for any new organization from any country to join).

**"Green farm"**: ecological education by means of ecological tourism and joint agricultural work of international youth teams.

**"University"**: creation and functioning of International University of ecological culture, policy and management (on the basis of 14 century monastery being restored in Pereslavl-Zalessky).

**"Brilliant eyes" — "World picture"**: development of the Ground and Aerospace Ecological Monitoring System for ecological risk estimation (using technical facilities available due to disarmament).

**"Ecological network"**: development in the USSR of an international network of regional centers of environment control and expertise (creation in Pereslavl-Zalessky of an exemplary Research Center) with further extension into other interested countries.

**"Arctic ecology"**: experimental study and modelling of the Arctic pollution (with regard for Zapoliarie industry impact as well as oil and gas prospection on the shelf and the shore, nuclear weapon tests in the Novaya Zemlya testing area, pollution transfer by the rivers of the Arctic Basin, subterranean flow e. t. c.) and carrying-out (western and eastern) of this pollution to global ocean to the coasts of other countries.

**"Ecomodels"**: formation of data bases on the ecological situation in the regions, creation of mathematical models and situation optimisation.

**"Water protection laws"**: creation of joint soviet-french group on water legislation to implement european methods and the results of the work of this group in the form of Tomsk Experimental Basin Agency (Tomsk and Kemerovo regions).

**"Ecological village"**: creation of International Scientific and Public Center for environmental problems in Pereslavl-Zalessky (on the engineering basis of an ecologically clean village with the renewed energy sources).

**"Ecological product"**: ecologically pure food-stuffs production (technology elaboration, production, expert examination of food-stuffs' ecological purity in various countries).

## ECOLOGICAL SCHOOLS, CONFERENCES, SYMPOSIUMS

**International Children Ecological School**  
(participants: Belgium, Canada, USSR, USA, France),  
Pereslavl-Zalessky, USSR, July, 1989.

**International Scientific and Practical Ecological School on Heavy Metals In Environment**  
(lecturers, representatives of the companies representing control instruments: Germany, USSR, USA, Japan;  
auditory: USSR), Moscow, USSR, February, 1990.

**International Scientific and Practical Ecological School on Water Quality**  
(lecturers: USSR, France, auditory: USSR), Moscow, USSR, February, 1991.

**International Scientific and Practical Ecological School "Methods and Models in Ecology"**  
(organized by "Ettore Majorana" International Scientific Culture Center jointly with ESCOS).  
Erice, Italy, October, 1991.

**Summer Students Ecological Workshop**  
(lecturers and students: USSR), Pereslavl-Zalessky, USSR, July, 1989.

**International Summer Students Ecological Workshop**  
(lecturers and students: USSR, France), Pereslavl-Zalessky, USSR, July, 1990.

**International Summer Students Ecological Workshop**  
(lecturers and students: Great Britain, USSR, USA, France),  
Pereslavl-Zalessky, Kemerovo, Nalchik, USSR, July, 1991.

**International Symposium "Clear Water to the World Capitals"**  
(organized by Moscow City Council, Paris Town Hall, ESCOS),  
Moscow, USSR, February, 1991.

**Italy - USSR Round Table "Ecological Problems In the USSR and World Community"**,  
(organized by Ettore Majorana" International Scientific Culture Center jointly with ESCOS),  
Erice, Italy, October, 1991.

**ECOLOGICAL EXPERTISES**

were made by the groups of either soviet specialists or by joint international groups; analyses were made either in the USSR or in foreign analytical centers.

**Complex Expertises** (environment quality, population health level, mathematical models of ecological situation and programs of its improvement e t c.)

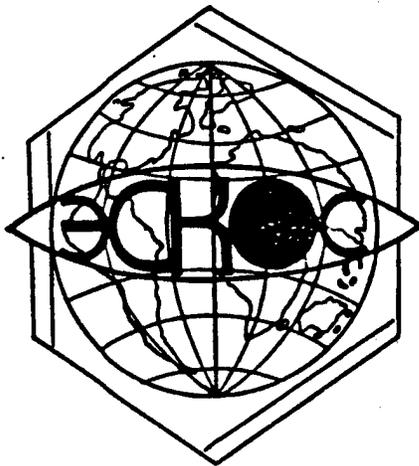
Ust-Kamenogorsk (Kazakhstan), Yurmala (Latvia), Zima, Sayansk, Ust-Ilimsk (Irkutsk region, RSFSR), Astrakhan (gas condensate works area, Astrakhan region, RSFSR), Kemerovo, Novokuznetsk (Kemerovo region RSFSR), Tursunzade (aluminum works area, Tadzhikistan etc).

**Local expertises** (quality of separate environment components)

Water quality: Moscow, Leningrad, Yaroslavl, Pereslavl-Zalessky, Novokuznetsk, Mezhdurechensk, Leninsk-Kuznetsky, Yurga e t c.

**Radon contamination:** Kuzbas, Pereslavl-Zalessky.

**Food-stuffs contamination:** children dried dairy produce (key groups of enterprises in some Republics).



## Los Alamos

Los Alamos National Laboratory  
Los Alamos, New Mexico 87545

DATE:  
IN REPLY REFER TO: 1 September 1992  
MAIL STOP: P/AC:92-469  
TELEPHONE: E545  
505 667 3104  
505 665 2014 FAX

To: Distribution  
From: G. Canavan *cu*  
Subject: Trip to Hartron and Myasishchev Design Bureaus

This memo reports on a trip to the Hartron and Myasishchev Design Bureaus on 12-13 August 1992 for further discussions of satellite and sensor technologies that resulted from the 7-12 August meeting in Dubna, Russia, on Global Environmental Monitoring (GEM).<sup>1</sup>

The trips were made to exchange information and view first-hand additional Russian and Ukrainian capabilities for the application of distributed remote sensing (DRS) for measurements of global ecology and warning of aggression.

The trips also served to further the information exchanges begun with the U.S.-Russia Space Commerce Mission of July 1992, allowing us to visit the Hartron Design Bureau in the Ukraine, which was commended but not available to the Commerce delegation and follow up on some technical questions left over from the earlier Commerce visit to Elas.<sup>2</sup>

The trips were successful in that they allowed us to view a good bit of current Russian and Ukrainian hardware and software and meet a number of the scientists developing DRS capabilities relevant to U.S. and global problems. They introduced a number of U.S. government and non-government participants to a number of Russian and Ukrainian scientists, administrators, projects, capabilities, and interests.

Scope. The U.S. group followed the guidance received for the Dubna trip,<sup>3,4</sup> of which this was an extension. The guidance was restrictive, but it was possible to have productive meetings, because the discussions at the Hartron and Myasishchev Design Bureaus were largely technical and informative. I do not know if there is a formal trip report by the U.S. delegation; This memo just covers a few technical issues.

Participants. The US delegation was led by Gene Meier of the U.S. EPA. Members were Stan Coloff (BLM); Greg and Barbara Canavan (Los Alamos); Walter Scott (LLNL); and John Vitko and Andy Boye (SNL). We were accompanied to Hartron by Ms. Katya Bowers, first secretary of the U.S. Embassy in Kiev, who is a native Ukrainian and quite proud of the facility and an excellent

1. G. Canavan, "Trip to Dubna, Russia, for GEM meeting, 7-12 August 1992," Los Alamos memo P/AC:92-468, 31 August 1992.
2. G. Canavan, "U.S.-Russia Space Commerce Mission," Los Alamos memo P/AC:92-420, 31 July 1992.
3. T. Crimmins, "Instructions for Participants in Dubna Workshop, DOE Office of Space memo, Aug 9-12 1992.
4. S. Larrimore, "SDIO Contribution to GEM Trip, Russia, SDIO memo; P. Worden, "Dual Use of Distributed, Space-based Global Defense Sensors," SDIO memo.

technical translator. We were also accompanied by Academician Dr. V. Shelest, Dep Dir of the World Laboratory's Russian Ecological Station of Environmental Control (ESCOS), also a native Ukrainian, who acted as liaison for the trip.

At Hartron we were met by First Deputy General Director and Designer Dr. Vladimir G. Simagin and the members of his staff and of the staffs of the Radioelectronic Institute and RPA MONOLIT listed in Attachment A. A group picture of most of the U.S. and Ukrainian participants is at Attachment B, in which the first row (left to right) is B. Canavan, V. Simagin, E. Meier, K. Bowers, and W. Scott; the second row is Y. Borushko, Hartron's translator, A. Krivonosov, Y. Zlatkin, S. Coloff, and A. Boye; and the third row is J. Vitko, G. Canavan, and V. Shelest. Attachment C is a brochure that gives an overview of Hartron's current activities.

Talks. There were opening statements by Simagin, Krivonosov, and Borushko. Simagin reviewed the history of Kharkov and Hartron, which was described essentially as a bit of pork that resulted from native son Brezhnev's rise to power. Hartron produced the inertial guidance for the first true ICBMs "when those in the room were young and enthusiastic." They have stayed close to guidance and control ever since, through Cyclon and Zenit (though not Proton) apart from recent  $\approx 50\%$  reconversion into civilian controls and light manufacturing activities and "collaborative efforts with Allen-Bradley and Rockwell" in which their contribution is cheap labor. They do the controls for the projects that Lavochkin and Elas described to the U.S.-Russia Space Commerce Mission.<sup>5</sup>

Simagin talked animatedly, mostly on their capability for hardware-in-loop simulation, which they pioneered for complex systems, and which is now becoming popular in the U.S. He described their work for Energia and in conjunction with Uz mash, or the South Machine Building Plant. He described Hartron as developing the control systems for all missiles and satellites, saying that "they cannot be put into orbit without Hartron."

They do controls for observatories, communication satellites, MIR, and "stations of complex manufacture." He described the completion of work on two such satellites, but professed not to know their names. When I asked if they were the Priroda and Spektyr for MIR, which we saw earlier at Khrunichev Enterprise,<sup>6</sup> he only seemed to recognize the former--curious.

Simagin said that orders from Moscow were decreasing and that orders from the Ukraine had now increased to 70% of the total. He had not lost any of his 11,000 people, but had to shift them into civilian controls and light manufacturing. Ms. Bowers privately said that things were actually much worse--that they were facing "terrible money trouble," although the 65,000 man NIPRO was "very busy" with work for Australia and India.

Tours. Hartron showed us their museum, which had a progression of technology up to about what we had seen at Lavochkin and Elas. We also toured a production microelectronics

5. G. Canavan, "U.S.-Russia Space Commerce Mission," op. cit.

6. G. Canavan, "U.S.-Russia Space Commerce Mission," p. 5.

"clean room," which was primitive by U.S. standards. We asked and were allowed to see the actual control system for an Energia, which was about one cubic foot on a test rack.

Most of the tour was led by Dr. Luchenko, the First Deputy Chief of the Controls Department, who was young, technical, and quite good. He did all of the technical discussion of controls and computers. He briefly took us through how they broke the Energia down into 24 fuel tanks modelled by about 300 differential equations which they actively controlled through the "real-time solution of both linear and nonlinear optimal algorithms" on a  $\approx$  15 year old "64 matrix processor computer." He said that the details of the solutions are still secret.

He also showed us the large bay of actuators and weights for hardware-in-loop simulations. He also showed us through the separate test facilities for simulating wind and other loads and for the development and testing of satellite stabilization (horizon, sun, and star) sensing systems good to about a minute.

Zlatkin indicated that a lot of the actuators and sensors are "built to our specifications" and then Hartron "tests them to see if they perform to our design," indicating an intermediate level of aggregation appropriate for such a design bureau. Once their controls and sensors are tested out, they are "sent to South Machine for integration." Zlatkin said that they "had access to data from earth-looking sensors...but do not make use of it." It looked to me like 30-50% of Hartron was still inside an electrified fence, where such data might be used.

Hartron was quite proud of its connections with the local university and aviation college. It regards those connections, as well as those with Kiev, as good and stimulating.

Issues. The discussions were mostly technical, but Hartron did raise a few broader issues. Simagin echoed the comment we had often heard from Koptev and Russian design bureau heads on the Commerce trip: they had "had a lot of visits from French, Germans, Italians, U.S., and Japanese, but they would now like to see some results--not necessarily right now, but soon enough to do them some good." Hartron does have some real capabilities in some narrow but important control areas. Unfortunately, that is not well known because of their weakness in advertising those capabilities and the difficulty of getting there.

At the Dubna meeting, as he had in previous meetings in the series Dr. Barenboim pushed hard for the establishment of several GEM laboratories in the FSU, indicating that Russia would commit the funds required--in which Velikhov seemed to back him. As noted in the earlier report, that point was contentious.<sup>7</sup> Several comments by Simagin, Zlatkin, and others indicated that the Ukraine would like to compete for such contacts.

The Ukraine has serious ecological problems; it would appear that the GEM project could contribute to them, but many of them have to do with ground contamination by chemical or radiological materials. It has been shown that DRS can remotely sense gross migration through vegetation, emissivity, an reflectivity changes, but it is not clear that current capabilities are

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7. G. Canavan, "Trip to Dubna, Russia, for GEM meeting, op. cit.

sufficiently direct to replace ground measurements.<sup>8</sup> The Ukraine could well be served by first improving ground measurements, perhaps using satellites for data readout and transmission. The next step might be augmented aircraft measurements.

Such steps could provide time for definition of more direct space measurements. Nevertheless, even the Ukraine's problems, such as the destruction of the SS-18s and their large volumes of dangerous fuels, are effectively global, so DRS could be effective as a means of following changes over the whole Ukraine.

In the Ukraine, as in Russia and the other FSRs, the responsibility and support for space, air, and ground sensing are split between the Ministry of Space and Ecology and others. Moreover, the Ukraine government appears to be more interested in maintaining the overall space enterprise than in supporting a new and possibly expensive thrust in ecological monitoring. Aircraft measurements are underutilized and subordinated to more glamorous space measurements in the FSRs as in the U.S. Ground sensors are developed, but measurement nets are undersized, as in the U.S.

There appear to be many opportunities for collaboration, but the mechanisms for developing them are still formative. Until they are in place, the World Laboratory, ESCOS, and GEM would appear to serve a useful default mechanisms for the exchange of the technical information needed to define useful collaborations. The participants at Hartron would appear to be appropriate contacts for such follow-on exchanges.

At Hartron we were hosted by First Deputy General Director and Designer Dr. Vladimir G. Simagin. It was explained that General Director Professor Yakov Y. Aizenberg was "on vacation." That seemed a bit odd in that one of the reasons I went to Hartron was Aizenberg's insistence that it was a center for DRS (which proved to be incorrect).

When we returned to Moscow the next day there was an article in The Moscow Times (Attachment D) about a meeting of "2,500 factory directors" with the Yeltsin government to "bring back aspects of the former centralized command economy, including price-fixing and bailouts for failing industries." There were indirect indications that Aizenberg, Guskov of Elas, and other design bureau directors who we had met with on the Commerce trip were involved in that meeting.

The design bureaus appear to be in desperate financial condition, and current governments do not appear to have any appreciation of the problems or the outline of a solution. That is losing the support of many of the educated and managerial elites who were influential under the Soviet Union and who were early Yeltsin supporters. Discussion of these problems was quite open in the Ukraine, as it had been earlier in Russia. It seemed to grow more pointed even during the interval of the two trips.

Travel. It was very difficult getting from Dubna to Hartron, which is in Kharkov, Ukraine. The original plan was to take a regular airline, but Aeroflot was grounded for lack of JP-4. We then planned to take an over-night train down and back,

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8. G. Canavan, Los Alamos letter P/AC:92-372, 20 June 1992 to N. Fortsun and D. Eardley; Subject: JASON Study of DRS.

but there weren't enough berths. Then we tried to take a bus, but we couldn't be sure of enough gasoline. Finally we chartered a three-engine jet Yak directly from the Myasishchev Design Bureau. We flew from the Zhukovsky Airport 40 km from Moscow, which was to be the site of Russia's first international air show that weekend. Both on departure and return, we were the only aircraft in the air over the airport.

That was also the case with Moscow's Sheremestvo Airport, where there was only one aircraft on the runway or taxiway at a time for both this and the Commerce trip. There was a good bit more traffic and many more passengers at the airport in Kharkov, where we saw perhaps a half dozen airplanes at a time.

Myasishchev Design Bureau. Since we leased one of their planes, we got a free tour of the Myasishchev Design Bureau. We were briefed by General Designer Valery Novikov and his staff. Myasishchev has a long ( $\approx$  '50) but not particularly distinguished history. It introduced jet engines on bombers early--too early. Its engines were not up to the loads and its bombers had not been produced in volume. It has the cargo plane which carries Energia tanks. Myasishchev had one interesting plane, the "Geophysica," which is sort of a heavy, two-engine U-2, which gets up to about 20 km for about 6 hours with a scientific payload of about 1.5 tons for infrared sensors, cameras, and the like taking up to 40 kWatt (?) of power. Not much else to say. Thank you for your time and attention.

## L I S T

of participants of the meeting with representatives of Ynternational  
GEN Conference , 13.08.92.

from RPA "HARTRON":  
-----

1. Vladimir G. Simagin - First Deputy General Director,  
First Deputy Chief Designer, Doctor.  
*talked animatedly on most but simulation*
2. Anatoly I. Krivonosov - Department Chief of computer systems,  
Professor. *best on control sys*
3. Yriy N. Zlatkin - Chief of theoretical Department, Doctor. *Dubman guy*
4. Oleg A. Luchenko - First Deputy Chief of Department *young, thin*  
*did all talking on control + computers*
5. Yriy M. Borushko - Department Chief of information and gating  
systems, Doctor. *talented - Dubman thin build a*
6. Yevgeniy V. Galkin - Bureau Chief of Foreign Economic Links. *thin*  
*quiet, said little*

from Radioelectronic Institute of Academy of Sciences, Ukraine:  
-----

1. Anatoly I. Kalnykov - Chief of Department, Professor.

from RPA "MONOLIT" :  
-----

1. Igor P. Kraynov - Deputy Director General.

*iev (native  
good Ukr.)*



# HARTRON

RESEARCH AND  
PRODUCTION ASSOCIATION  
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СИСТЕМЫ УПРАВЛЕНИЯ  
И ЧИСЛИТЕЛЬНЫЕ  
ИНФОРМАЦИОННЫЕ  
КОМПЛЕКСЫ

CONTROL SYSTEMS,  
COMPUTER AND  
INFORMATION CENTRES

ПРОГРАММНОЕ ОБЕСПЕЧЕНИЕ  
И ВЫСОКОПРОИЗВОДИТЕЛЬНАЯ  
МОНОПРОЦЕССОРНАЯ  
ТЕХНИКА

SOFTWARE AND  
HIGHLY PRODUCTIVE  
MULTIPROCESSOR TECHNIQUE

АСУ ИЛИ НЕПРЯМОЙ  
ПРОМЫШЛЕННОСТИ

COMPUTER-AIDED  
CONTROL SYSTEMS FOR  
GAS-AND-OIL INDUSTRY

ЭЛЕКТРОННОЕ ОБОРУДОВАНИЕ

ЭЛЕКТРОННАЯ  
МЕДИЦИНСКАЯ АППАРАТУРА

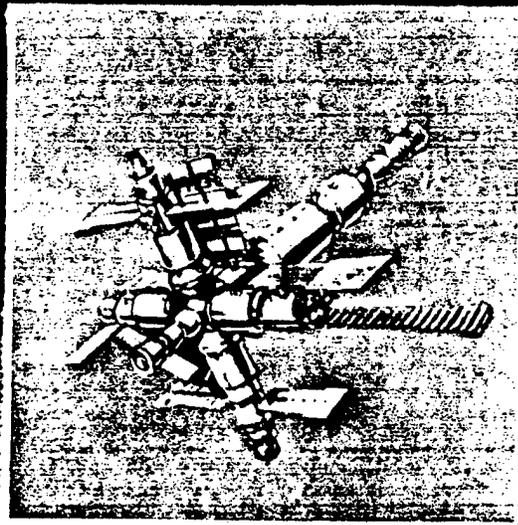
ELECTRONIC  
MEDICAL EQUIPMENT

АВТОМОБИЛЬНАЯ  
ЭЛЕКТРОНИКА

VEHICLE ELECTRONICS

ИГРОВЫЕ КОМПЬЮТЕРЫ  
РАДИОУПРАВЛЯЕМЫЕ  
ИГРУШКИ

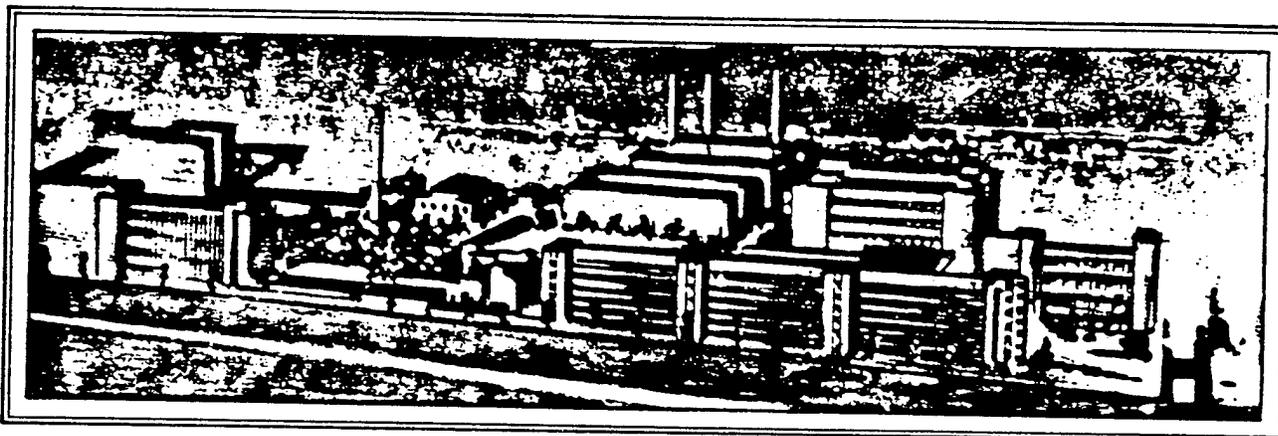
GAME COMPUTERS,  
RADIO-CONTROLLED TOYS





Фирма ХАРТРОН — объединение двух конструкторских бюро, двух опытных заводов — является одной из ведущих в СССР по созданию систем управления, вычислительных и информационных комплексов, сложного электронного оборудования для космических объектов.

HARTRON, an association of two designing bureaus and two experimental plants, is one of leading in the USSR engaged in production of control systems, computer and information centres, sophisticated electronic equipment for space objects.



Нами разработаны системы управления самой мощной в мире ракеты-носителя «Энергия», многофункциональных станций «Квант» и «Кристалл», метеоспутников. Мы ведем работы по созданию систем управления для космических аппаратов нового поколения, назначение которых — астрофизические исследования (аппараты серии «Спектр»), глобальная радио- и теле связь, экологический мониторинг.

We have developed control systems for the most powerful in the world booster of ENERGIA, multi-functional stations KVANT and KRYSTAL, meteorological satellites.

We are working at the development of control systems for space vehicles of the new generation the designation of which is global radio and tele-communication, ecological monitoring, astrophysical surveys (SPEKTR series).



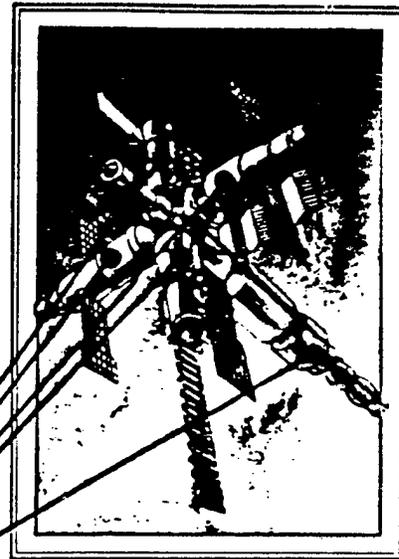
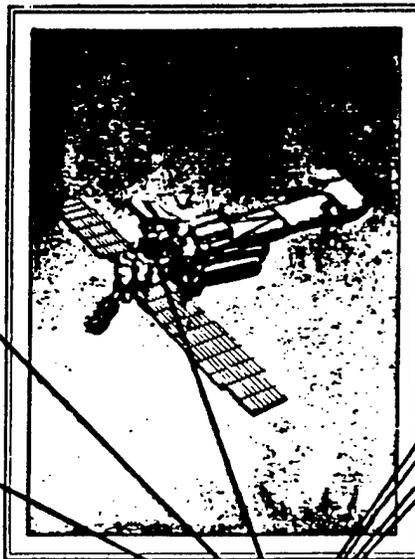
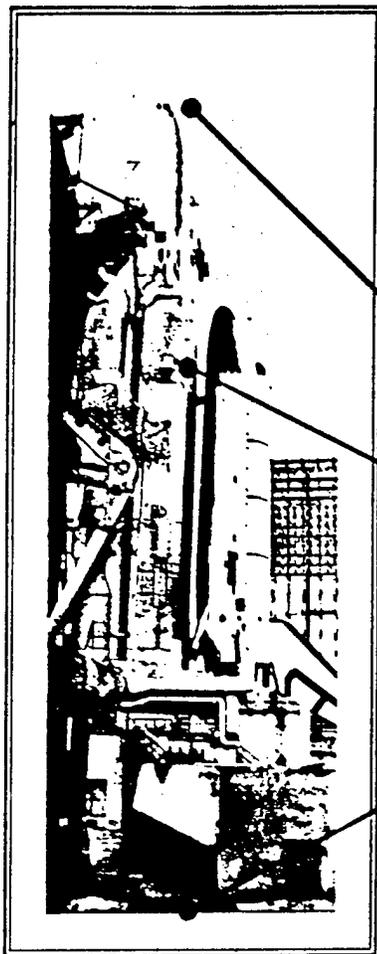
Тридцатилетний опыт разработки аппаратуры для космических систем, высокая квалификация специалистов, современная производственная база позволили нашей фирме на профессиональном уровне включиться в решение других народно-хозяйственных проблем.

Мы создаем надежные системы управления для нефтегазовой промышленности, специализированную электронную технику для медицинской и автомобильной промышленности, игровые компьютеры, радиоуправляемые игрушки.

Thirty years long experience of the development of space systems equipment, high qualification of specialists, modern production base allowed our firm to solve diversified problems of our national economy.

We are creating reliable control systems for gas-and-oil industry, special electronic devices for medicine and automotive industry, game computers and radio-controlled toys.

Я.Е. Айзенберг  
Генеральный директор, профессор  
Yakov Y. Aizenberg  
Director General, Professor



**ВЫСОКОЭФФЕКТИВНАЯ ТЕХНОЛОГИЯ  
ПРОГРАММИРОВАНИЯ ВСТРОЕННЫХ ЦВМ  
СИСТЕМ РЕАЛЬНОГО ВРЕМЕНИ**

Интегрированные технологические среды, созданные в объединении, реализуют передовые мировые тенденции в программировании 90-х годов и обеспечивают инструментальную поддержку полного жизненного цикла ПО создаваемых систем управления.

Современная методология и технология программирования определяют сроки, качество, стоимость программных средств, в значительной степени — уровень разрабатываемых систем управления в целом.

**HIGHLY EFFECTIVE TECHNOLOGY OF  
PROGRAMMING BUILT-IN DIGITAL COM-  
PUTERS OF REAL-TIME SYSTEMS**

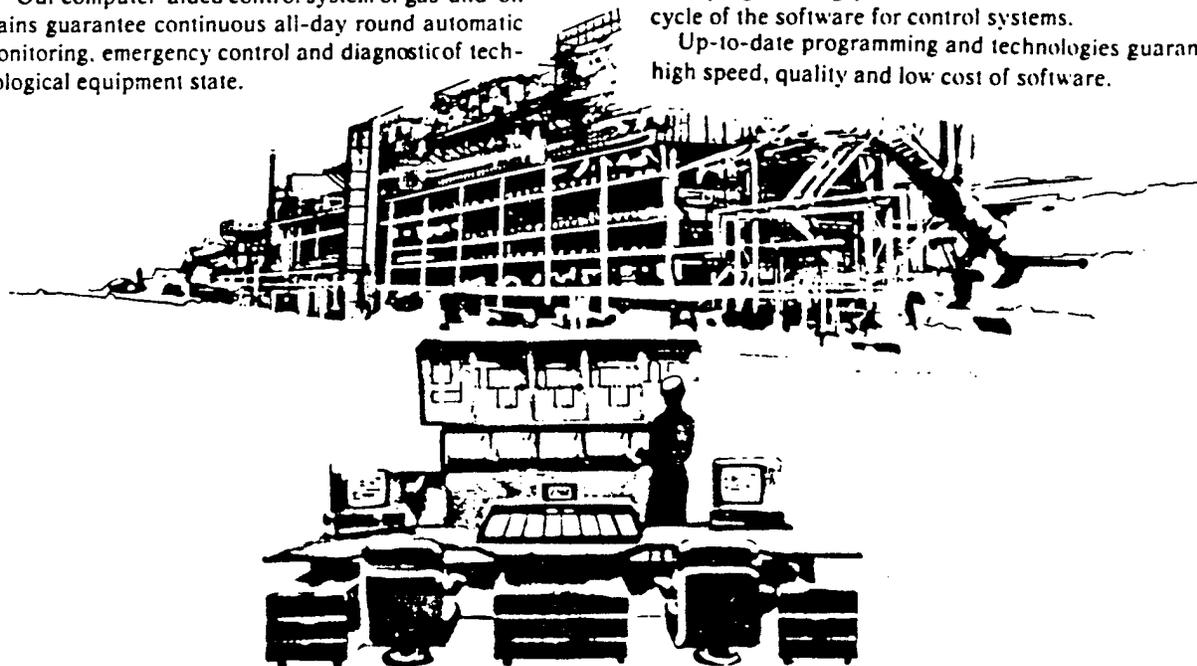
Created by our Association integrated technological environments based on advanced world trends in the 90-s programming provide the hardware of full life cycle of the software for control systems.

Up-to-date programming and technologies guarantee high speed, quality and low cost of software.



АСУ магистральными и нефтегазопроводами нашей разработки надежно обеспечивают непрерывное круглосуточное автоматическое управление, аварийный контроль и диагностику технического состояния технологического оборудования.

Our computer-aided control system of gas-and-oil mains guarantee continuous all-day automatic monitoring, emergency control and diagnostic of technological equipment state.



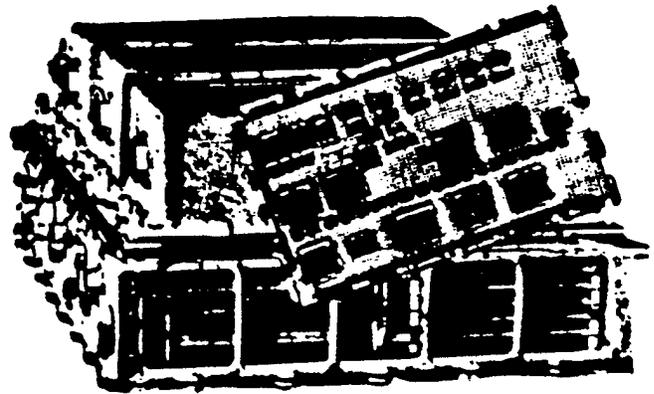


## ЭЛЕКТРОННОЕ ОБОРУДОВАНИЕ

Вычислительные комплексы с производительностью от сотен тысяч до миллиарда операций в секунду созданы нами с использованием микроэлементной базы собственной разработки.

### ELECTRONICS

Computer centres with processing power from hundreds of thousand to a billion of operations per second with utilization of microelemental base of our own design have been created by the Association.



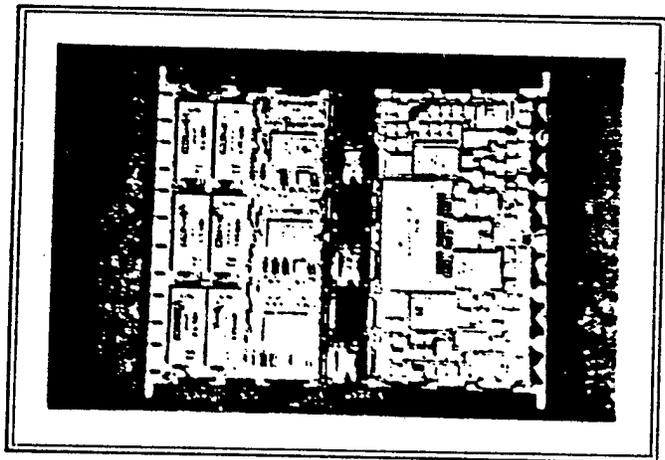
Системы электронных платежей «СИКАР» с использованием бесконтактных интеллектуальных карточек.

Systems of electronic payment SIKAR with utilization of non-contact smart cards.



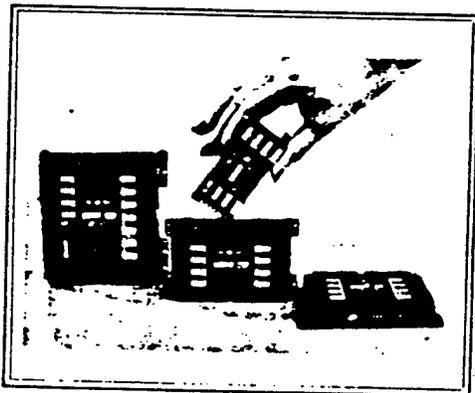
Интерфейсная плата для систем передачи информации, использующих код «МАНЧЕСТЕР», программно и технологически совместима с интерфейсами ряда ЭВМ.

The interface board for data transfer systems, based on Manchester code, software and technology compatible with interfaces of a number of computers.



Унифицированные модули вторичного электропитания и сетевые блоки питания используются при разработке устройств с высокой надежностью.

A series of unified D C power supply modules proved to be excellent at operation on space complexes, network power supplies used for the development of high reliability devices.

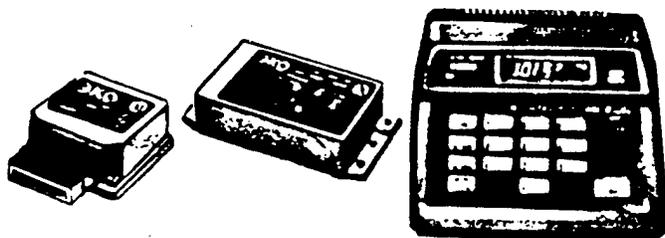


### АВТОМОБИЛЬНАЯ ЭЛЕКТРОНИКА

«ЭКО» — электронные системы зажигания  
«ОКА» — дозатор отпуска топлива на АЗС

### AUTOMOTIVE ELECTRONICS

For automotive industry we have created electronic devices: electronic ignition systems EKO, fuel doser OKA for fuel stations.





## МЕДИЦИНСКАЯ АППАРАТУРА

Система адаптивного биорегулирования «БАРС» обеспечивает безмедикаментозное лечение и профилактику сосудистых заболеваний.

Система иммуно-ферментного анализа «СИКАР-ИММУНО» диагностирует особо опасные заболевания типа СПИД, гепатит и другие.

Система «Радий-2» служит для радиоизотопных исследований органов человека.

### MEDICAL EQUIPMENT

The system of adaptable bioregulation BARS provides non-medicamental treatment and prevention of vascular diseases.

Immuno-enzymatic analysis system SIKAR-IMMUNO provides diagnosis of especially dangerous diseases like AID, hepatitis, etc.

RADIY-2 serves for radioisotope surveys of human organs.



## ИГРОВЫЕ КОМПЬЮТЕРЫ

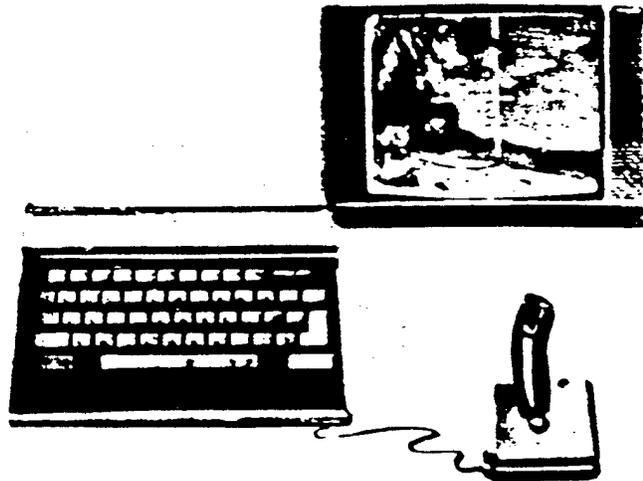
Созданный нами компьютер «Икар» надежен в эксплуатации, программно совместим с бытовыми компьютерами отечественных и зарубежных фирм.

Может использоваться как автоматизированное обучающее, рабочее место программиста, электронный консультант или программный калькулятор, информационный, творческий и игровой центр.

### GAME COMPUTERS

Computer IKAR is reliable in operation and software compatible with home computers of Soviet and foreign firms.

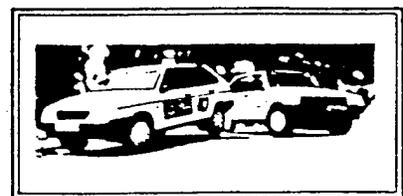
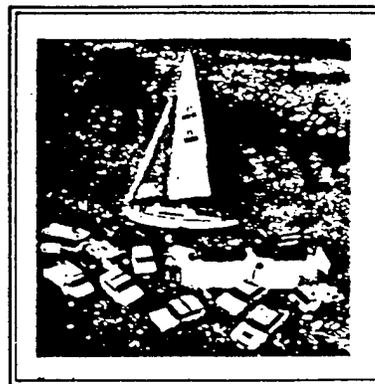
It may be used as a programmer workstation, an electronic consultant or programmed calculator, information, creative and game centre.



## РАДИОУПРАВЛЯЕМЫЕ ИГРУШКИ

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# The Moscow Times



SINCE 1992

Friday 14 August 1992

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Issue 47

## Industrialists send new challenge to Yeltsin

BY BETSY MCKAY  
STAFF WRITER

Powerful Russian industrialists called on the Yeltsin government Thursday to bring back aspects of the former centralized command economy, including price-fixing and bailouts for failing industries.

The move marked the latest stage in a confrontation between President Boris Yeltsin and a growing political-industrial coalition that opposes the fast-track economic reform program of acting Prime Minister Yegor Gaidar.

Some of the delegates to a two-day conference demanded the Gaidar cabinet's immediate resignation, but most were content to send a telegram to

Yeltsin asking him to order Gaidar to appear before the gathering of 2,500 factory directors, employees and politicians. Both Gaidar and Russian Khasbulatov, the parliament speaker, were scheduled to attend, but neither appeared.

In a published resolution, the delegates denounced the government's course of reform as "a mistake" and said that it had "paralyzed all forms of production and created a critical social environment in society."

But while sharply criticizing the Gaidar team for failing to adopt measures to ease state enterprises through the difficult first stages of economic reform, the delegates also urged coop-

eration with the government to bring industry into the market economy. They included Arkady Volak, the outspoken head of Russia's Union of Industrialists and Entrepreneurs, and Igor Klochkov, the head of the Russian Federation of Independent Trade Unions.

"This is not the time to think about whether you are a true democrat or a national patriot," Volak declared. He said he would continue to oppose Yeltsin's advisers, all of whom "disagree with us."

"Unless enterprises are included in the economic system, successful reforms in the economy are just not possible," he said.

Among the measures the delegates called for were a system to clear debts, credit emissions from the Central Bank, price fixing on consumer goods, a favorable tax policy, funds to pay all outstanding employee salaries by the end of August, and employee health- and life-insurance programs.

"People are going to return from their vacations in August and want an answer: How are we supposed to keep going?" said Klochkov.

"Reforms must be approved by our own people and not the IMF," declared Viktor Barabash, head of the Industrialists' Union of Irkutsk.

Russian commodity producers also met this week to strengthen their hand

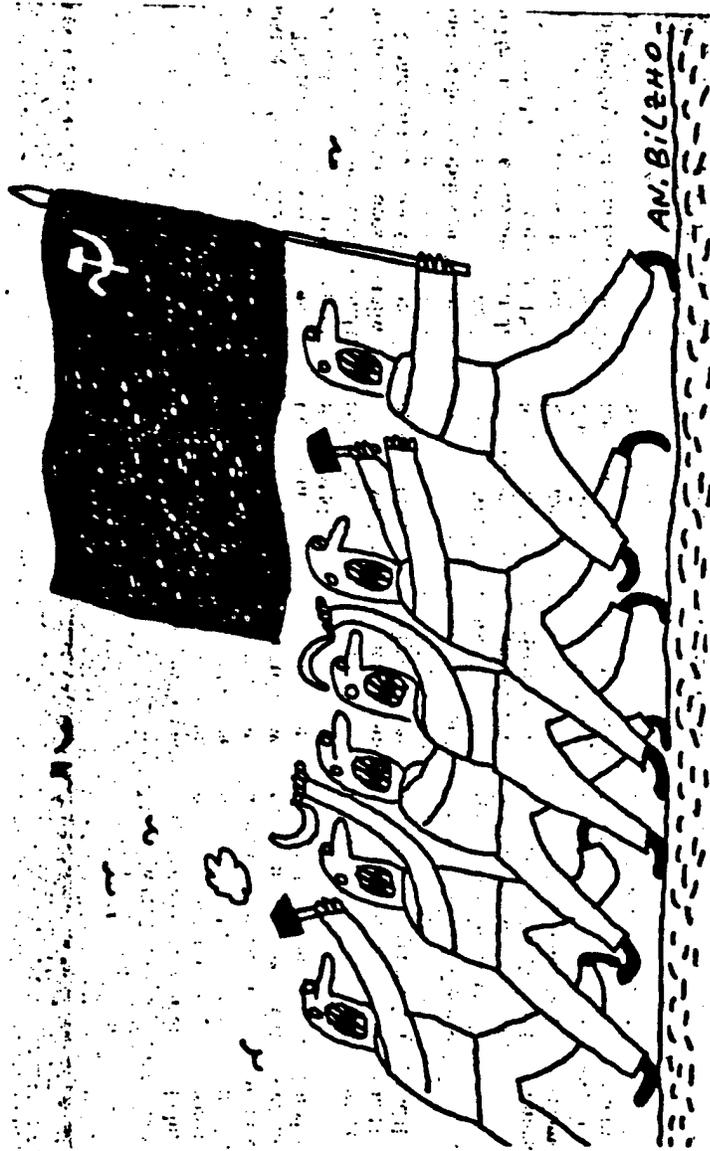
in the ongoing debate over economic reforms and pledged to organize an umbrella lobby to protect their interests in the face of sharply declining productivity.

The new lobby could bring together the interests of 1,086 separate union organizations, said Vladimir Bezpalov, a member of the conference's organizing committee.

State-run enterprises have become paralyzed in the eight months since the government introduced market reforms. Debts between enterprises had reached such proportions by July 1 that most would do trade only on an

See CHALLENGE, page 4

Attachment D



## Challenge

Continued from page 1

advance-payment system.

Many turned to barter long ago. SeverGazprom, in Komi, for example, has traded gas for metals for months, and the sprawling refinery amassed owed debts totalling 5 billion rubles for the first six months of 1992 alone. In turn, it owes 2.5 billion which it can't pay.

Workers all over the country have been sent on long "vacations" because there is no money to pay them.

"Whether we make it through the winter or not depends on what decisions the government makes on the enterprises," said Vasily Podyuk, the refinery's general manager and a con-

ference participant.

In their draft resolution, the delegates argue that the government must give industry "the chance to transform their production in line with the rest of

*'Unless enterprises are included in the economic system, successful reforms in the economy are just not possible.'*

— Arkady Volsky

the world," the Interfax news agency reported. But critics say the industrialists are merely trying to strongarm the

government into reestablishing its cozy relationship industry had with the state under a centralized economy.

"These people are used to working one way: give, give, give," said Viktor Golubev, a member of the parliament anti-monopoly committee. "Give an order, give me raw materials. It's just an attempt to prevent the separation of these enterprises from the state."

Nikolai Gonchar, the chairman of Moscow City Council, argued that the resolution's authors were politicians whose views did not reflect those of enterprise employees.

"Sometimes I ask these people where are you from?" he said. "They say 'The Workers of Russia party,' say, no, what factory? And there's no answer."

# Los Alamos

Los Alamos National Laboratory  
Los Alamos, New Mexico 87545

DATE:  
IN REPLY REFER TO: 1 September 1992  
MAIL STOP: P/AC:92-470  
TELEPHONE: E545  
505 667 3104  
505 665 2014 FAX

To: Distribution  
From: G. Canavan *cc*  
Subject: Trip to Elas Design Bureau, 14 Aug 1992

This memo reports on a trip to the Elas Design Bureau on 14 Aug 1992. The trip was a follow-up from the Global Environmental Monitoring (GEM) meeting in Dubna on 7-12 August.<sup>1</sup> It was made to view first-hand Elas's capabilities for the application of distributed remote sensing (DRS) technology to measurements of global ecology and warning of aggression.

The trip also served to follow up on some questions from the information exchanges begun with the U.S.-Russia Space Commerce Mission of July 1992.<sup>2</sup> The meeting introduced a number of U.S. government and non-government participants to a breadth of Elas's satellite communication and sensor capabilities.

Participants. The US delegation was led by Col. Steve Harrison of the U.S. Space Council. Members were Tom Crimmins (DOE); Jordan Katz and Scott Larrimore (DoD/SDIO); Greg Canavan (Los Alamos); and others. We were hosted by Academician Gennadi Guskov, the Director of Elas. About 10 other members of his staff were present; I do not have all of their names.

Scope. The U.S. group followed the guidance received for the Dubna trip,<sup>3,4</sup> of which this was an extension. The guidance was restrictive, but it was possible to have productive meetings, because the discussions at Elas were largely technical and informative. I do not know if there is a formal trip report by the U.S. delegation. This memo covers a few technical issues. There were technical discussions of DRS from space, air, and ground as well as specific ecological and radiological sensors.

Academician Guskov asked that we begin with a review of U.S. programs. Mr. Jordan Katz of SDIO gave a good discussion without charts of the MSTI buses and the development opportunities they offer, Techsat and the possibilities for small payloads on it, and the rationale for dual uses of SDIO satellites for ecological observations and warning of aggression as well as midcourse measurements for missile defense. He also indicated how developments in dual use might lead into additional sensors for "brilliant eye" applications. There were a large number of questions from the assembled technical experts, which Katz

1. G. Canavan, "Trip to Dubna, Russia, for GEM meeting, 7-12 August 1992," Los Alamos memo P/AC:92-468, 31 August 1992.
2. G. Canavan, "U.S.-Russia Space Commerce Mission," Los Alamos memo P/AC:92-420, 31 July 1992.
3. T. Crimmins, "Instructions for Participants in Dubna Workshop, DOE Office of Space memo, Aug 9-12 1992.
4. S. Larrimore, "SDIO Contribution to GEM Trip, Russia, SDIO memo; P. Worden, "Dual Use of Distributed, Space-based Global Defense Sensors," SDIO memo.

arranged to satisfy most of by making copies of the vugraphs from Dr. Wood's sensor technology review talk from Dubna available.<sup>5</sup>

Academician Guskov's group from Elás discussed then their plans for using either decommissioned military satellites or new sensors and satellites for GEM measurements. Elás has a strong communication focus; thus, his discussion emphasized 400 MHz and 2 GHz communications components.

As in Dubna, he did not discuss the sensors on military satellites in any detail, but he did show us some overhead imagery of  $\approx$  5 meter resolution from the visible sensors and 10-20 meter resolution from synthetic aperture radars (SARs). Elás did not elaborate on how the visible imagery was obtained, but some of the charts in their museum showed that they had developed the relay satellite communication system with which current imagery is brought back in real time.

The SAR imagery was much the same product that I had seen at NPO Machine Building on the Commerce trip.<sup>6</sup> The connection seems to be that NPO Machine Building and Space Instruments (with Prof. Gusev) build the SARs, NPO Machine Building flies them on Almaz stations, and the ministry of defense (MOD) collects the data with special Elás CMOS communication hardware. A portion of the data (the unclassified part) is then stripped out and reduced at NPO Machine Building. Elás showed us some of that SAR product.

Elás would like to use the existing military satellites and data bases, but is apparently running into some opposition. For that reason Elás is developing new satellites and sensors based on their own advanced focal plane, computer, and electronics technology. They plan to put together the scientific payloads [sensors, communications, controls (with Hartron), and computers] and hand them over to Lavochkin for integration and launch, "as they have since the '50s."

Elás has an ambitious launch plan of 3-10 launches per year over the decade. There are three current launcher options: 1. R-65s from Omsk Paliot, 2. SS-25s from Moscow Thermal Physics, of which there is a "great quantity," and 3. Decommissioned SS-18s as discussed by Academician Rodin at Dubna.<sup>7</sup>

At Dubna, when I asked Velikhov why the Russians did not give details about decommissioned military sensors, he said that he and Barenboim had been unable to get approval from the MOD in time. The situation was apparently still the same for this visit (they were to have the first meeting of the new dual-use committee the following Monday.<sup>8</sup>) As a backup, Elás discussed an alternative new sensor whose capabilities were something like the visible-near-infrared (IR) part of a Landsat, which Elás hopes to launch in 1994.

New sensors were discussed in some detail by Chief Designer of Space Information Systems Vladimir Ivanovitch Karasev. His presentation boiled down to a plan to start with about 5 narrow band (0.01-0.02 micron) sensors in the visible to near IR and

5. G. Canavan, "Trip to Dubna, Russia, for GEM meeting, op. cit.
6. G. Canavan, "U.S.-Russia Space Commerce Mission," pp. 3-4.
7. G. Canavan, "Trip to Dubna, Russia, for GEM meeting, op. cit.
8. G. Canavan, "Trip to Dubna, Russia, for GEM meeting, op. cit.

gradually build (over 3-5 years and many launches) to sensors with about 40 bands through the SWIR and MWIR. The simpler sensors might also be usefully flown on developmental SDIO dual-use satellite buses as a cross-check of small U.S. sensors. It was suggested that the more capable sensors could have some utility for the waste issues discussed at Dubna. The sensors were also thought to be relevant to the search for space debris. It is not clear that the financing for the program was secure.

The technology planned for use appeared to be a slightly dated version of that developed by SDIO. They planned to start with visible arrays of 512 x 256 ten micron detector Si CCDs. The weight of their electronics and computers appeared to be an issue. The posited visible-near-IR camera was about 3-6 kg for performance that LLNL would plan to put on MSTI for about 0.5 kg. Some of that was in what appeared to be an oversized aperture, but there was no time to go into details. More of them are in a proposal submitted to LLNL by Elas which I saw at the meeting but of which I do not have a copy.

Guskov presented a careful discussion of signal processing at the focal plane, secondary, and data base or decision making level, which seemed to correspond closely to the distinctions Academician Velikhov had drawn at the Dubna summary.

Issues. The meeting provided a useful first exchange on dual-use sensors with a large number of competent scientists from a very good organization, which was relatively unknown a year or two ago. Elas's capabilities are quite impressive. The ecological problems in Russia are staggering; it would appear that the GEM project could contribute to them. It is a bit less clear how DRS could contribute and how the U.S. could best interact with the Russia's GEM project.

Many of the FSRs' problems have to do with ground contamination by chemical or radiological materials. It has been shown that DRS can remotely sense gross migration through vegetation, emissivity, an reflectivity changes, but it is not clear that current capabilities are sufficiently direct to replace ground measurements.<sup>9</sup> Russia could well be served by first improving ground measurements, perhaps using satellites for data readout and transmission. The next step might be augmented aircraft measurements. Such steps could provide time for definition of more direct space measurements. But Russia's problems are effectively global. Thus, DRS could be effective as a means of following gross changes over the whole land mass.

When we returned to Moscow that day there was an article in The Moscow Times about a meeting of "2,500 factory directors" with the Yeltsin government the previous day to "bring back aspects of the former centralized command economy, including price-fixing and bailouts for failing industries."<sup>10</sup> I was told that Guskov was at that meeting.

9. G. Canavan, Los Alamos letter P/AC:92-372, 20 June 1992 to N. Fortsun and D. Eardley; Subject: JASON Study of DRS.

10. "Industrialists send new challenge to Yeltsin," The Moscow Times, 14 August 1992, pp. 1-4.

Like other design bureaus, Elas appears to be in difficult financial conditions. Pr. Yeltsin's government does not appear to have any appreciation of the problems, the outline of a solution, or any interest in communicating its concern. That is losing the support of many of the educated and managerial elites who were influential under the Soviet Union and who were early Yeltsin supporters. Zelenograd, where Elas is located, was the first area to openly support Yeltsin during the coup. Discussion of these problems was quite open in Russia. It seemed to grow more pointed even during the interval of the two trips.

There appear to be opportunities for collaboration, but the mechanisms for developing them are still formative. Until they are in place, the World Laboratory, ESCOS, and GEM would appear to serve a useful default mechanisms for the exchange of the technical information needed to define useful collaborations. Cross-calibrating advanced dual-use SDIO sensors with Russian sensors on the same developmental buses could also be useful. Elas would appear to be an appropriate contact for such follow-on exchanges. Academician Guskov appears particularly important because of his academic credentials, position, connections, and technical interests. Thank you for your time and attention.

# Los Alamos

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From: G. Canavan *G. Canavan*  
Subject: Trip to Erice, Italy, 19-24 August 1992

This memo reports on a trip to Erice, Italy, 19-24 August 1992 for a series of Erice International Seminars of the World Laboratory. The trip was a continuation of the Global Environmental Monitoring (GEM) meeting in Dubna on 7-12 August<sup>1</sup> and subsequent trips to the Hartron<sup>2</sup> and Elas<sup>3</sup> Design Bureaus. It was made to continue discussions begun the previous year at Erice on the dual-use applications of distributed remote sensing (DRS) technology to measurements of global ecology and to warning of aggression.<sup>4</sup>

Participants. The US delegation was led by Ambassador Henry F. Cooper, Dir DoD SDIO, seconded by Col. Steve Harrison of the U.S. Space Council. Members were Tom Crimmins (DOE); Col. Pete Worden, Col. Rod Liesveld, Capt. Scott Larrimore, and Jordan Katz (DoD/SDIO); Greg Canavan (Los Alamos); Drs. Edward Teller, Lowell Wood, Robert Andrews, Bill Barletta (LLNL). Other world-wide participants are listed in Attachment A.

Scope. The U.S. group followed the guidance received for the Dubna trip,<sup>5,6</sup> of which this was an extension. The guidance was restrictive, but it was possible to have productive meetings, because the discussions at Erice were largely technical and informative. I do not know if there is a formal trip report by the U.S. delegation. This memo covers technical issues.

Presentations. There were three main sessions: Projects for Planetary Emergencies, Proliferation of Weapons for Mass Destruction, and International Cooperation on Defense Systems. The specific presentations are listed in Attachment B.

The AIDS session was detailed and informative. Dr. Robert Gallo of the NIH gave the (largely negative) progress of the last few years, his guesses at which way to go, and negative prognosis

1. G. Canavan, "Trip to Dubna, Russia, for GEM meeting, 7-12 August 1992," Los Alamos memo P/AC:92-468, 31 August 1992.
2. G. Canavan, "Trip to Hartron and Myasishchev Design Bureaus," Los Alamos memo P/AC:92-469, 1 September 1992.
3. G. Canavan, "Trip to Elas Design Bureau, Los Alamos memo P/AC:92-470, 1 September 1992.
4. G. Canavan and L. Wood, "Distributed Remote Sensing from Constellations of Small Satellites," A. Zichichi, ed., Proceedings of the XII Erice Symposium on Global Problems, Majorana School of Physics, Erice, 19-23 August 1991.
5. T. Crimmins, "Instructions for Participants in Dubna Workshop, DOE Office of Space memo, Aug 9-12 1992.
6. S. Larrimore, "SDIO Contribution to GEM Trip, Russia, SDIO memo; P. Worden, "Dual Use of Distributed, Space-based Global Defense Sensors," SDIO memo.

on vaccines. Dr. Guy DeThe of the French CNRS Immunovirology Laboratory gave a few positive results on HTLV, which suggest that there are some resistant individuals, although they appear to be children bordering on midgets. Africa is imploding; South America appears to be next. The only promising global approach seemed to be changes in global sexual habits to resemble more those areas (Russia, China, etc.) where there is less incidence of HIV. I was surprised to learn that Japan uses half of the world's condoms. Seems to help with HIV; not with HTLV.

The Energy session was interactive. Dr. Huo Yuping discussed Chinese pollution and energy problems with a few comments on the advantages of fusion. Dr. E. Teller disagreed with him on the limits on fossil fuel burning, the safety of fission reactors, and the timing and economics of fusion.

Dr. Viktor Baryakhtar talked about the safety problems of reactors in the Ukraine, which is bothersome. About half of the plants are shut down. Academician Euginy Velikhov discussed why Russia and the Ukraine will have to keep the rest of them on line for 10-20 years despite known problems. He reviewed the spotted history of the Soviet nuclear program and the prospects for a smaller commercializable VVR or Naval-reactor-derivative PWR.

Russia is making up reductions in supply and growth in demand with gas turbines, like everyone else--and counting on reconverting military aircraft engine production to fill the need. The problem is how to pay. Academician Velikhov is eager to use the HEU in Russian weapons as collateral for  $\approx$  \$5B loans. Dr. Kay of the Uranium Institute took him to task on the difficulty of upgrading RBMKs to inter-national safety standards in the absence of adequate data and analysis.

In Land, Ocean, and Atmosphere Dr. E. Boschi proposed using peaceful nuclear explosions as seismic sources. Dr. T. Laevastu reviewed what we understand (and what we are not doing about) pollution of the Mediterranean. Dr. J. Soderman discussed the difficulty of adequately predicting the deposition of chemical and radiological releases, many of which are sub-grid for models. Dr. A. Longhetto talked about qualitative synergisms between aridity and acid rains, which wash out nutrients. Dr. Q. Zeng reviewed the positive value of global models in predicting the precipitation anomalies important to farming but criticized global models as being of little value for predicting climate change. Dr. A. Wong of UCLA had an interesting suggestion for precipitating out Cl in the ozone layer, but Dr. Lowell Wood and I noticed that he had made a factor of 1,000 error in his estimates, and that his design would actually take  $10^3$ - $10^6$  blimps about 1 km on a side, which seems excessive.

In International Cooperation on Defense Systems Amb. Cooper argued that emphasis is shifting from MAD to proliferation and third world threats and that the ABM Treaty is an anachronism. [The term "third-world" was used so often in conjunction with defenses by later speakers that third-world participants finally objected to being labelled collectively as aggressors. The term "developing nations" was used thereafter.]

Amb. Cooper reviewed the rationale and main elements of the current GPALS, the progress of the "high-level group" discussions

established by the Bush-Yeltsin summit to explore joint U.S.-Russian defenses, and the charter of the three groups set up under them to work concepts for a Global Protective System (GPS), technical cooperation towards GPS, and proliferation. He invited participation in dual-use technologies for defense and warning of aggression. The main questions were whether the threat was really growing, we were prepared to give up MAD (and should we?), and we were willing to give up nuclear weapons and how to define stability in a multipolar world.

Academician A. Bastitov then gave the first of a set of presentations by Russian anti-ballistic missile (ABM) experts brought by Velikhov. His charts are Attachment C. They do not address global defenses. Academician Bastitov instead talked about the technologies and ABM Treaty modifications necessary to allow the defense of cities in Russia against theater threats from up to about 3,000 km away--using CIA data to argue that those were the only threats of concern. He admitted the utility of low-altitude satellite sensors for depressed trajectories, but put most of his emphasis on radars, his area of expertise. He argued that either should only communicate with interceptors through Missile Early Warning Centers.

Academician Bastitov came up with a two-layer system that looked much like Patriot plus THAAD. He thought that 2-3 complexes with about 32 ABMs costing about \$300M each would be needed for each large, defended city and that could be provided in 6-8 years. He ended with an argument that the "stability reasons that led to the ABM Treaty remain valid" and that "it should be retained under new threats." His most novel proposal was the extension of the power-aperture limit of the ABM Treaty to a power-aperture-velocity limit that would make the radars smaller for longer-range theater missiles. He called for joint modelling and simulation, exchange of technology and algorithms, and search for effective (nonnuclear) warheads. He felt that the initial version of GPS should be largely ground-based, because "SBIs do not guarantee the destruction of warheads."

When asked why his group of experts only talked about theater defenses and not those for intercontinental threats to the U.S. and others, Academician Velikhov said that he was concerned that such discussions would get into the area of discussions for the high-level group, so that he wanted to restrict the discussions at Erice to multilateral issues. That restriction was largely followed for the rest of the meeting.

Mr. Tom Cremmins of DOE gave a direct and understandable discussion of "Current Thinking about Missile Defense Systems," DOE's capabilities in DRS, and how they could fit into joint dual-use systems for ecology and defense.

Dr. E. Teller characterized the prospects for cooperation in space as "for the first time real--and short term." He argued for the rapid development (started by the U.S. and Russia) of a world-wide surveillance system with as many participants as possible.<sup>7</sup> He wanted them extended to weather, agriculture, and

7. G. Canavan and E. Teller, "Distributed Remote Sensing for Defense," Signal, August 1991.

the like. He did not argue for ground versus space defenses; he just argued that it was time to start with early warning and proliferation. He argued against disarmament as an answer to peace on the basis of 400 years of European history going back to Wallenstein. He argued that technology could serve peace and that GPALS could make war less possible. Dr. Y. Neeman of Tel-Aviv Univ. in Israel agreed that SPOT-like capabilities could give one a "feeling of security."

Academician G. Chernavskii discussed "Cooperation in Defense Technology," defining a concept of Mutual Assured Protection (MAP) to replace MAD. He argued for the U.S. sharing advanced technology because that would "support democracy in Russia." He argued against secrecy and continued COCOM restrictions. He endorsed "small-sized surveillance satellite system" ("S<sup>4</sup>") in the context of GEM for detecting ballistic missiles, arms control, surveillance, and ecological monitoring, proposing a constellation of about 40 satellites much like those discussed at Dubna and Elsas by Academician Guskov, who was also present.<sup>8</sup> He advocated their launch by decommissioned SS-18, -19, -25, and -23s, in accord with Academician Rodin's Erice proposal of the previous year, as modified at Dubna.<sup>9</sup>

Academician Chernavskii then went through a proposal for cooperation on precisely the electric jets, thrusters, reactors, etc. that SDIO had previously proposed for cooperation. He proposed a joint management structure for work on natural backgrounds, survivability, lethality, and atmospheric studies. He was quite knowledgeable on these issues, having been the director of the Molniya Design Bureau for a number of years. Academician Chernavskii and Dr. Bychkov were kind enough to preview his talk with me at dinner the previous night.

Dr. A. Mak talked about problems in high brightness lasers and proposed cooperation on issues and techniques for phase conjugation, linear adaptive optics, and optical coupling. Most of the main U.S. results in these areas were declassified several years ago. He also proposed cooperation on IFF and survivability, which would be more difficult. Cooperation on theater defenses looked more promising.

Dr. Lowell Wood gave a discussion of advanced technology along the lines of the review he had just given at Dubna, which was an update of the DRS discussion of the previous year<sup>10</sup> and extension to dual uses.<sup>11</sup> He documented the claim that Brilliant Pebbles (BPs) could have intercepted each of the SCUDs launched in the Gulf War. Constellations of 200-400 BPs would have given single coverage; 500-1000 BPs would have given multiple coverage at a cost of  $\approx$  \$10B, below that of a carrier battle group. He also discussed the use of RAPTOR drones for shorter-range

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8. G. Canavan, "Trip to Elsas Design Bureau," Los Alamos memo P/AC:92-470, 1 September 1992.

9. G. Canavan, "Trip to Dubna, Russia, for GEM meeting."

10. G. Canavan and L. Wood, "Distributed Remote Sensing from Constellations of Small Satellites," op. cit.

11. G. Canavan and E. Teller, "Distributed Remote Sensing for Defense," op. cit.

missiles. When questioned about their vulnerability, Dr. Wood cited my work on making BPs survivable,<sup>12</sup> which isn't directly related. The biggest question was where the money would come from for an international defense.

Academician B. Bunkin discussed "Cooperation in Tactical Ballistic Missile Defense." He was the head of the design bureau that is trying to upgrade the SA-10 (or PM1/G-300) into a TBM killer; thus, his talk was a bit of a sales pitch for the SA-10. He discussed the planned software changes and hardware improvements, which are along the lines implemented in Patriot. He understood the problems booster fragments can cause for the radars, but glossed over the warhead maneuver issues that appear to be more serious in the SA-10's intercept regime.<sup>13</sup>

Academician Bunkin understood that it would be very difficult to kill nuclear, chemical, or biological warheads and was rather vague in suggesting how he would proceed. He favored space craft for early warning, but was not interested in good impact point predictions or battle management. He suggested cooperation in millimeter and IR homing sensors, discrimination, highly maneuverable interceptors, nonnuclear warheads ("warheads must be nonnuclear") for chemical and biological weapons, and mobile, low-cost systems that would also work against aircraft, which he thought was possible.

I discussed "Steps Towards Global Air Defenses" as a logical complement to limited missile defenses (Attach D). There was considerable interest in cooperation. Academician Velikhov and others were quite interested in the possibility of integrating air defenses with upgraded national or international FAA systems.

Dr. A. Piontkovskii's discussion of "Global Defence and Strategic Stability" (Attach E) mostly illustrated that Russia and the U.S. do not do stability analyses in the same way--or even mean the same thing by the word stability. In his analysis stability became largely synonymous with strategic superiority, leading to an apparently unstable relationship between the U.S. and Canada. Perhaps the main point was that in his analysis the current situation is stable--as that produced by the cuts of the Bush-Yeltsin summit--and apparently that produced by defenses.

Dr. Piontkovskii mostly discussed the desirability of moving from MAD to an era of MAP-type strategic stability with "joint protection against unacceptable damage" and characteristics that are largely the complement of those of the MAD era. He presented three options, which I do not find to be exhaustive or even mutually exclusive--attributing one to me. But at least he was not dogmatic. Academician Velikhov gave me a copy of Dr. Piontkovskii's analysis<sup>14</sup> and asked that we correspond and keep him and Amb. Cooper apprised of our progress.

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12. G. Canavan and E. Teller, "Strategic defence for the 1990s," Nature, Vol 344, pp. 699-704, 19 April 1990.

13. G. Canavan, "Technical Issues in Theater Missile Defense," Los Alamos report LA-12299-MS, 1992.

14. A. Piontkovskii and A. Skorokhodov, "Global Defense and Global Security," Strategic Research Centre, Moscow Branch of the World Laboratory report; Voennyi Vestnik, No. 7(133), 1992.

Dr. A. Kuzmin's discussion of "Possible Cooperation in Early Warning Systems and Space Control" (Attach F) gave the Vympel Design Bureau's top-level objectives in improving joint Early Warning. He put high priority in confidence building, understanding the sources and cures for false-alarm rates, and the integration of space sensors. His issues and approaches were roughly the same as those identified in my survey for the U.S.<sup>15</sup>

Col. S. Worden discussed "Dual-Use Technologies," starting with the results and technologies discussed in the Los Alamos Workshop on the interception of near-earth objects,<sup>16</sup> and proceeding through a review of MSTI, Techsat, Clementine, brilliant eyes, and probes of the solar system. There was considerable interest in the deflection of asteroids and in exploring for possible lunar resources. For some reason the questions then veered back off onto an indeterminate discussion of stability in a multipolar world.

Proliferation of Weapons for Mass Destruction started with a bit of a sales pitch by Dr. R. Andrews on LLNL's efforts to make portable mass spectrometers and gas chromatographs. The main question was how we could safely share results of international inspection efforts, on which Dr. Andrews was not expert.

Dr. V. Baryakhtar talked about problems in the "Elimination of Nuclear Weapons in the Ukraine." His biggest concern was the toxicity of the heptyl fuel and amyl oxidizer in the 150 SS-18s based there. He tried to argue that since  $10^{-7}$  g/L was toxic, they represented a global problem, but since there are about  $10^{22}$  L in the atmosphere, the total would only amount to about a ppb. His real interest was in how to use the SS-18s peacefully.

Dr. David Kay, Secretary General of the Uranium Institute, gave a very interesting talk on "Improvements in On-Site Inspection" based on the lessons learned from the inspection of Iraq, as detailed in his article in last month's Physics Today. He reviewed why Iraq concluded that membership in the NPT would not get in the way of--and could actually be used to conceal--its large nuclear weapons program. He also discussed why mirror imaging had undercut clear intelligence signals.

In Dr. Kay's graphical evaluation, all of the limiting factors in weapons proliferation--other than availability of fissile materials--have evolved out from under controllability in the last decade, and the dissemination of centrifuge technology will probably release the last in the next decade. He downplayed the importance of personnel and information. He addressed honestly how U.S. concerns over Iraq's nuclear program have boosted the political status of nuclear weapons in the eyes of the developing world and perhaps Japan and Germany.

Dr. Kay expressed concerns about errors in FSU mass balances--particularly when applied to the release of \$5B worth of HEU. His first priority was "credible inspection for

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15. G. Canavan, "Steps Towards a Global System of Defense," Los Alamos report LA-12384-MS, 1992.

16. G. Canavan and J. Solem, "Interception of Near-Earth Objects," Mercury (the Journal of the Astronomical Society of the Pacific) Vol. XXI, Number 3, May/June 1992, pp. 107-9.

clandestine programs." The questions were largely challenges to his premises along the lines of conventional arms sales to the third world, political stability, and export controls being bigger problems.

Prof. Y. Neeman spoke on the un-reliability of the NPT as a defense for those actually threatened, drawing on two decades of Israeli history. Building on Dr. Kay's talk, he made a case that the NPT actually assists and accelerates proliferation--and acts as a "stamp of acceptability for suppliers." Although the argument is not above suspicion of self-service, it was widely persuasive.

Prof. Neeman argued for a regime in which those who were threatened by the spread of nuclear technology had an equal voice with the buyer in interacting with the supplier--as well as a right to continuing inspection. A key element was that suppliers should have to share information openly with those threatened.

In Prof. Neeman's assessment, these issues must be addressed, because nuclear energy is an essential component of future energy mixes. He felt that safety and waste were solvable on the relevant time scales and that it might still be possible to develop proliferation-resistant fuel cycles. [This is at variance with U.S. evaluations in NASAP and INFCE, but Prof. Neeman is pretty good at neutronics.] He was "aggressive on the defense imperative for proliferation."

Prof. Neeman listed his concerns over emerging proliferators, "including Israel," putting Iraq at the top, followed closely by Iran, Algeria, and North Korea. He argued that Argentina and Brazil may have "contained" one another and that the China-Pakistan-India triangle may have done likewise. Questions largely had to do with his pessimistic assessment of solar energy, which was quite important, given Israel's strong expertise in that area, about which Prof. Neeman was well informed and knowledgeable.

Dr. E. Teller discussed his "Updated Baruch Plan." He reviewed the original plan; Truman, Acheson, Lilienthal, Oppenheimer, and Baruch's key contributions to it; and the key checks and balances in it. He argued that the key ingredient was now available: "If people work together on hard problems, it is impossible to keep secrets from each other." Thereby, international cooperation and openness would become key ingredients of detecting and preventing the proliferation of nuclear weapons.

Concluding from the previous talks that "the NPT does more harm than good," (which he acknowledged to be opposite to U.S. policy), he argued for a concrete proposal that "one agency keep nuclear weapons...for use under extreme conditions," with that agency possibly being an autonomous staff of the U.N. But when Academician Velikhov then suggested establishing international control over all nuclear materials, Dr. Teller disagreed on the basis that he was suspicious of putting so much power in the hands of an unaccountable bureaucracy. Prof. Zichichi then made the subject the topic of a separate, special meeting.

Science and Technology for Developing and Developed Countries was reviewed by Prof. T.D. Lee through the work of the World Laboratory-T.D. Lee fellows in China and elsewhere. He

also reviewed his work with his global students on integration of the fundamental forces and on the group theoretical foundations for the superconductivity of Buckeyballs.

In Problems Relating to the CIS and East Europe, Dr. V. Baryakhtar reviewed problems with the "Chernobyl Sarcophagus" and the current competition to replace it. Dr. K. Rebane explained the dissolution of the on the basis of entropy arguments. Dr. Z. Rudzikas talked about the "Ecological Sustainability of the Lithuanian Region," given the problems left by the dissolution of the Soviet Union.

In Soil, Food, and Improvement of Modern Life, Dr. G. Fierotti talked about the rapid degradation and depletion of the world's soil. Dr. R. Clark reviewed the World Laboratory's quite practical and successful project to install a set of sensors, communication links, and computers to predict floods in the disaster region of the Yellow River. Dr. C. Ponnampereuma talked about Food Biodiversity and the efforts to develop new foods such as the flying bean for use where supplements like soybeans do not grow well. Dr. M. Graetzel talked about solar panels with elements of photosynthesis. M. Borthagary documented the World Laboratory's argument that "Metropolis is the Most Dangerous Place on Earth" due to instabilities and vulnerabilities to terrorism.

Finally, Prof. Antonino Zichichi, President of the World Laboratory, reviewed the efforts he has made over the last few years to use modern quantum mechanics and renormalization group theory to make more precise (and lower) predictions of the energies at which new physics could be expected in future machines of high-energy physics and estimate the energies at which the coupling constants for the fundamental forces converge. I have a full set of his bound notes, which can be borrowed.

The Concluding Session was informative. Ambassador Qian Jiadong started by commenting on the irony that we had declared the cold war over last year after the coup [which occurred during that meeting] but that many of the papers were "revisiting nuclear war"--albeit from the perspective of defenses. He noted Dr. Teller's advocacy of world-wide surveillance for stability and the environment, and said that was the first place to start. He stressed the symbolic and practical importance of a nuclear policy of no first use--particularly against NPT signatories--and the primacy of the destruction of nuclear weapons.

Dr. H. Dalafi of Iran noted that "9 of the 12 titles involved defense," but argued that the main issues were the management, safeguarding, and dismantling of excess nuclear weapons. He agreed that conflict has shifted to proliferation, and that scientists should try to contribute to that problem, but argued that the goal is to withdraw from nuclear weapons, in which non-nuclear weapons have a key voice. He emphasized the roles of religion, education, science, and internal life as guides to the transition and regretted that so many have such primitive worries every day.

Dr. Siegbahn reviewed the menu of many topics presented, noted the solid progress in each, and thanked the World Laboratory for making such a solid fare possible.

Dr. E. Teller argued that the "Bush-Yeltsin summit meant that a new world could be opened." He argued that science and technology are making the world smaller and constantly interacting. That could lead, in the extremes, either to complete order (world government) or complete disorder (chaos)-- and that he worried as much about either extreme. He was hopeful that scientists could help steer a middle course. He drew comfort from the example of Niels Bohr, who had sought to apply the principle of complementarity to social problems of comparable complexity. However, he argued that by trying to oversimplify problems, scientists had done more harm than good in areas such as the Rio Environmental conference and population. He felt scientists could help screen "fantasy from reality" and help thereby to avoid the extremes, which would be a useful service.

Academician Velikhov started by reflecting that the move from MAD to MAP was a historic step. He was concerned by Dr. Kay's discussion of how close Iraq had been to a weapon and that "some country building one weapon could make it a superpower." He felt it was time for a discussion between people who know how to build weapons and other friendly countries on what to do with them. He endorsed the continuing relevance of last year's Erice statement on "brilliant eyes," broadened it to dual-use sensors, and discussed the contents and importance of the statement from the Dubna meeting. He reiterated the need for integrated data from space, air, and ground sensors and praised the Russian MOD for their openness on these matters and the willingness of U.S. organizations such as EPA to cooperate with them. He again affirmed the value of the World Laboratory in coordinating those activities, which "could be significant for the FSU."

Prof. Zichichi gave a brief review of the status of the World Laboratory projects ending with a call to arms: "Real projects happen--bureaucracies just try to stop them." He stressed the seriousness of proliferation and multipolar threats and the relevance of GPS to them, praised Pr. Bush's foreign policy achievements, and wished that they were more widely appreciated. He concluded by looking forward to discussions next year of the further conversion of military resources for planetary emergencies.

Conclusions. On the basis of the discussion of the proliferation threat at the meeting, a statement that "The most serious present problem in the world today is the Proliferation of Weapons of Mass Destruction [and that] A solution of this problem has become more feasible..." (Attch G) was written, circulated, and signed by many participants.

On the basis of the discussion of the prospects for international collaboration on GPS and the potentially important role of dual-use technologies in it, a statement (Attach H) presenting the scope, conclusions, and recommendations of the Dubna meeting was written, presented, and signed by Academician E. Velikhov, Dr. E. Teller, and Prof. A. Zichichi for delivery to the governments of the U.S., Russia, Ukraine, Kazakhstan, Lithuania and the Peoples Republic of China.

Issues. The meeting provided a useful exchange on dual-use sensors with a large number of competent scientists from around

the world. Global ecological problems are serious; it would appear that the World Laboratory's GEM project could contribute to them. It is a bit less clear how DRS could contribute to some of the serious but surface chemical and radiological issues. And it is also not clear how the U.S. could best interact with the GEM project. It is clear that DRS could be effective as a means of following gross changes over the whole globe and that that would be very valuable to a large number of developing countries who could not afford separate systems.

There appear to be opportunities for collaboration, but the mechanisms for developing them are still formative. Until they are in place, the World Laboratory, ESCOS, and GEM would appear to serve a useful default mechanisms for the exchange of the technical information needed to define useful collaborations. Cross-calibrating advanced dual-use SDIO sensors with Russian sensors on the same developmental buses could also be useful.

For the last few decades the Erice Seminars have been a convenient place for informal discussions between Soviet and U.S. scientists on strategic issues. For the last few years they have been quite useful in exchanging views on strategic defense. Now, those discussions have matured to the point where the bilateral aspects have properly been shifted into a more appropriate framework. Nevertheless, Erice could continue to be a useful forum for discussing the multilateral aspects of global defenses and other issues such as proliferation and arms control as well as the non-military dimensions of current global emergencies.

In looking back over the series of meetings held to promote cooperation between the U.S. and the FSRs over the course of the summer, it is appropriate to note the frequent appearance and integrating role of the World Laboratory. It stimulated and supported discussion of many of the issues that led to the thaw; publicized many of the projects in Russia and the other FSRs that are now candidates for private or governmental cooperation; provided the connective tissue between emerging collaborations, such as those between Lavochkin and Elas; helped to maintain communication between the Russian, Ukrainian, Kazakh and other science establishments; supported the technical interchange on dual-uses of DRS technologies in Dubna; and brought together an knowledgeable group of experts to start the discussion of the multilateral aspects of GPS at Erice. Not bad for an informal collection of scientists working toward a common global goal. Thank you for your time and attention.



GALILEO GALILEI FOUNDATION  
WORLD FEDERATION OF SCIENTISTS  
ETTORE MAJORANA CENTRE FOR SCIENTIFIC CULTURE  
INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

Attachment A

**GALILEO GALILEI CELEBRATIONS**

*Four Hundred Years Since the Birth of  
MODERN SCIENCE*

## ERICE INTERNATIONAL SEMINARS

- *Projects for Planetary Emergencies*
  - *Proliferation of Weapons for Mass Destruction (WMD)*
  - *International Cooperation on Defense Systems (ICDS)*
- 19-24 August 1992 - 16th Session - 2nd Seminar after Rio*

In collaboration with the World Laboratory  
and under the auspices of the Presidency of the Council of Ministers of Italy

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INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

Attachment B

**GALILEO GALILEI CELEBRATIONS**

**1991-1994**

*Four Years to Celebrate Four Hundred Years Since the Birth of  
MODERN SCIENCE*

## ERICE INTERNATIONAL SEMINARS

- *Projects for Planetary Emergencies*
  - *Proliferation of Weapons for Mass Destruction (WMD)*
  - *International Cooperation on Defense Systems (ICDS)*
- 19-24 August 1992 - 16th Session - 2nd Seminar after Rio*

In collaboration with the World Laboratory  
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**PROGRAMME**

August 20, 1992

## OPENING SESSION

10.00-11.00

### SESSION N° 1

- Antonino ZICHICHI  
*The Planetary Emergencies: Status and Prospects*

## AIDS

11.00-12.00

### SESSION N° 2

- Guy DE THE  
*The Public Health Challenge: from Epidemiology to Prevention by Vaccine*
- Robert C. GALLO  
*The Scientific Antisense Challenge: the Molecular Biology of Retroviruses: Latest Developments*

## ENERGY

12.00-13.00

### SESSION N° 3

- HUO Yuping  
*Chinese Fusion and the Environment*
- Viktor BARYAKHTAR  
*Safety of Nuclear Power Plants in the Ukraine*
- Eugenij P. VELIKHOV  
*Safety Problems of Nuclear Plants in the Russian Federation in the Context of Energy Policy in Time of Crisis*

LAND, OCEAN, ATMOSPHERE

16.00-17.30

SESSION N° 4

- Enzo BOSCHI  
*Peaceful Use of Nuclear Explosions for Fundamental Research on the Interior of the Earth*
- Taivo LAEVASTU  
*Effects of Waste Disposal on the Mediterranean Sea and its Beaches - What We Know and What We Do Not: Solutions Offered by the LAND-3 Project*
- J.K. Daniel SÖDERMAN  
*Simulation and Prediction of Extreme Atmospheric Events and of the Transport of Atmospheric Pollutants*

LAND, OCEAN, ATMOSPHERE

18.00-19.30

SESSION N° 5

- Arnaldo LONGHETTO  
*Synergisms Between Arid Climate, Air Pollution and Acid Rains*
- WANG Mingxing  
*Monitoring of Greenhouse Gases and Associated problems*
- ZENG Qing-cun  
*Global Climate Change: A Planetary Problem*
- Alfred Y. WONG  
*How to Mitigate the Ozone Depletion in the Upper Atmosphere*

August 21, 1992

**INTERNATIONAL COOPERATION  
ON DEFENSE SYSTEMS (ICDS)**

09.00-10.30

**SESSION N° 6**

- Henry F. COOPER  
*Prospects for International Cooperation on Defense Systems*
- Anatoliy BASISTOV  
*International Cooperation in Ballistic Missile Defence*
- Tom CREMINS  
*Current Thinking About Missile Defense Systems*

**INTERNATIONAL COOPERATION  
ON DEFENSE SYSTEMS (ICDS)**

11.00-12.30

**SESSION N° 7**

- Edward TELLER  
*A Proposal for International Cooperation in Space*
- Grigori M. CHERNAVSKII  
*Cooperation in Defence Technology*
- Arthur MAK  
*Problems of High Brightness Laser Beam Generation and Precision Control*

INTERNATIONAL COOPERATION  
ON DEFENSE SYSTEMS (ICDS)

16.00-17.30

SESSION N° 8

- Lowell WOOD  
*Advanced Concepts in Defense*
- Boris BUNKIN  
*Cooperation in Tactical Ballistic Missile Defence*
- Greg CANAVAN  
*Steps Towards Global Air Defense*

INTERNATIONAL COOPERATION  
ON DEFENSE SYSTEMS (ICDS)

18.00-19.30

SESSION N° 9

- Andrei A. PIONTKOVSKII  
*Global Defence and Strategic Stability*
- Alexey A. KUZ'MIN  
*Possible Cooperation in Early Warning Systems and Space Control*
- Simon P. WORDEN  
*Dual-Use Technologies: Defence Technologies Applied to Space Research*

**PROLIFERATION OF WEAPONS FOR MASS  
DESTRUCTION (WMD)**

09.00-10.30

**SESSION N° 10**

- Robert ANDREWS  
*Current Aspects of Proliferation*
- Viktor BARYAKHTAR  
*Elimination of Nuclear Weapons in the Ukraine*
- David KAY  
*Improvements in On-site Inspection*

**PROLIFERATION OF WEAPONS FOR MASS  
DESTRUCTION (WMD)**

11.00-12.00

**SESSION N° 11**

- Yuval NE'EMAN  
*Open Nuclear Energy Programs and Effective  
Non-Proliferation*
- Edward TELLER  
*Updated Baruch Plan*

**SCIENCE AND TECHNOLOGY FOR DEVELOPING  
AND DEVELOPED COUNTRIES**

12.00-13.00

**SESSION N° 12**

- Tsung Dao LEE

PROBLEMS RELATING TO THE CIS AND OTHER  
EASTERN EUROPEAN COUNTRIES

16.00-17.30

SESSION N° 13

- Viktor BARYAKHTAR and J. POZELA  
*Chernobyl Sarcophagus*
- Karl REBANE  
*Some Instabilities Arising from the Dissolution of the Soviet Union: Specific Problems for Estonia Global Instabilities and the Entropy Law*
- Zenonas RUDZIKAS  
*Ecological Sustainability of the Lithuanian Region*

SOIL, FOOD, AND  
IMPROVEMENT OF MODERN LIFE

18.00-19.30

SESSION N° 14

- Giovanni FIEROTTI  
*The Status of the Soil in the World*
- Robert A. CLARK  
*An Example to Defend the Population from Natural Disasters: The Yellow River Project*
- Cyril PONNAMPERUMA  
*The Role of Biodiversity with Regard to Underutilised Food Sources*

August 23, 1992

SOIL, FOOD, AND  
IMPROVEMENT OF MODERN LIFE

09.00-10.30

SESSION N° 15

- Michael GRAETZEL  
*Artificial Photolysis*
- Manuel BORTHAGARAY  
*METROPOLIS - The Most Dangerous Place on Earth*
- Antonino ZICHICHI  
*Recent Progress in Understanding Nature*

CONCLUDING SESSION

11.00-12.30

SESSION N° 16

- QIAN Jiadong
- Hassan R. DALAFI
- Kai M.B. SIEGBAHN
- Edward TELLER
- Eugenij P. VELIKHOV
- Antonino ZICHICHI

## **Menace consists in ballistic missile warheads (up to 200)**

---

**Defence of culture centers, economics and population against the death under nuclear explosions and against a contamination including one from plutonium.**

---

**Regions of stable confidence of the Great Power and of regional State communities.**

---

**Possibilities of Ballistic Missile Defence (BMD) creation against medium range ballistic missiles (MRBM):**

**experience and technologies developed, terms, costs, performances.**

---

**Limitation problems of the Treaty on the Ballistic Missile Defence, 1972:**

**- parameter differentiation between "Ballistic Missile Defence Radar" and "Missile Early Warning System Radar";**

**- possibilities limits for BMD components used against MRBM.**

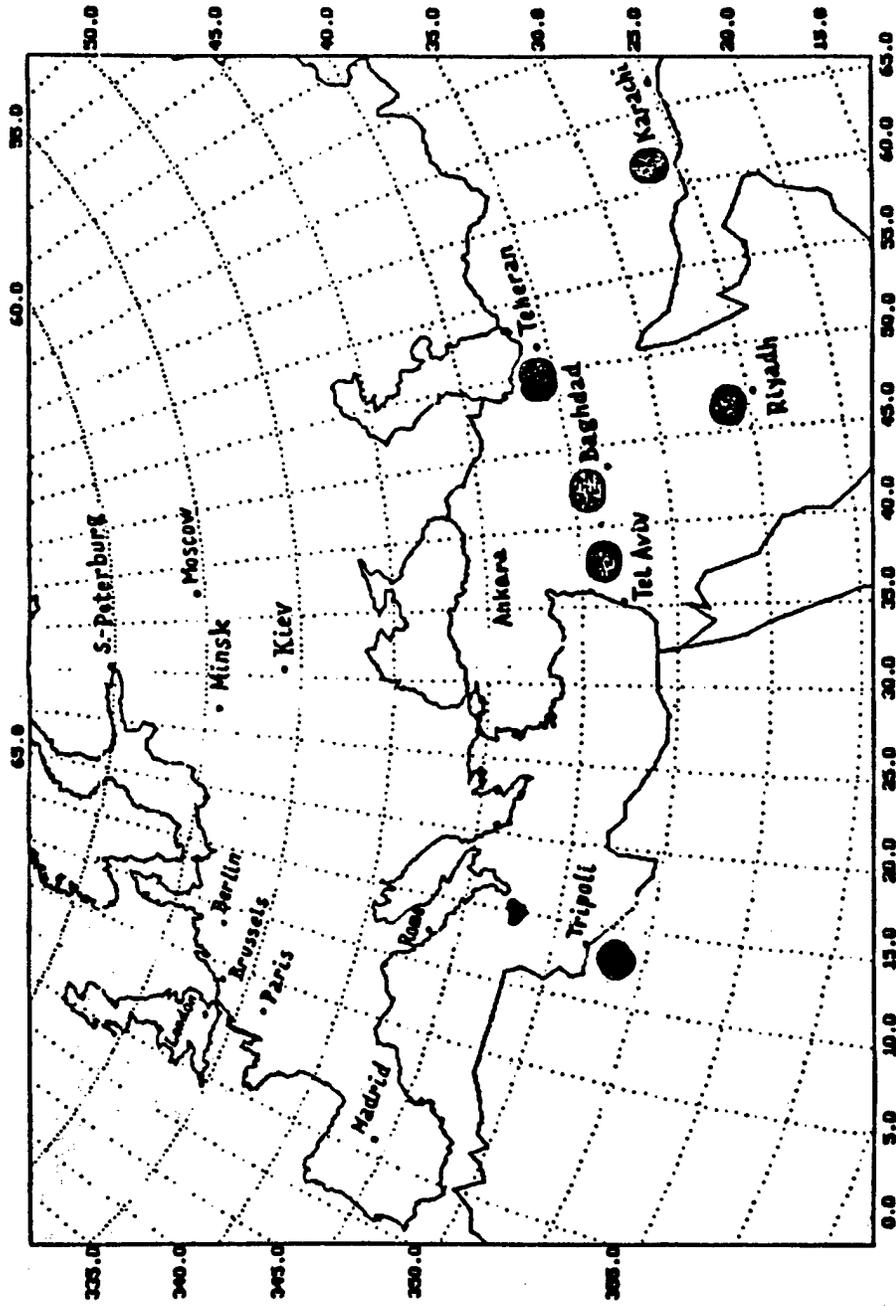
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**Co-operation fields:**

**- BMD architecture designing for cities defence against MRBM;**

**- BMD components development, systems' creation and operation;**

**- tests on target selection, interception and non-nuclear destroy;**





**Two echelons of acquisition means will be necessary for the city BMD against MRBM:**

- optical means mounted on low orbite satellites used for ballistic missiles start place location, identification, warhead following;
  - surface antimissile radars on duty used for acquisition of attacking warheads.
- 
- 

**Satellite data. Prediction errors:**

- in warhead landing place < 30 km;
- in launch angle < 5°, in azimuth < 3°;
- in travel time to H 100 km: < 10 s.

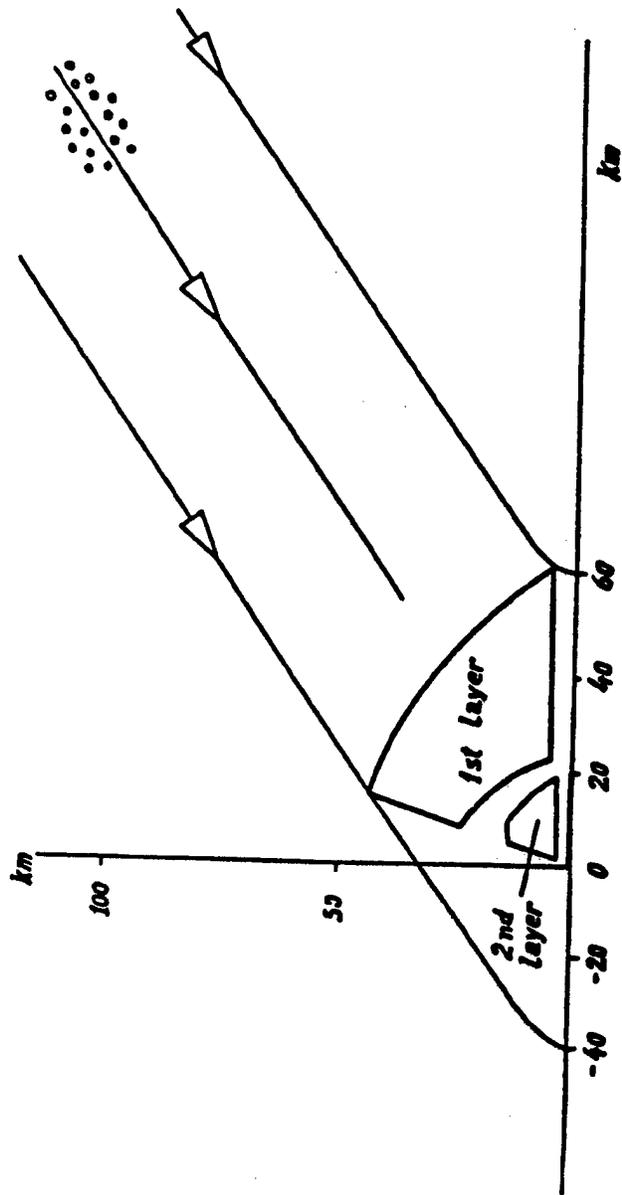
**Data output to BMD launch complex: 5 min before landing.  
Troops and population notification: 7 to 10 min before landing.**

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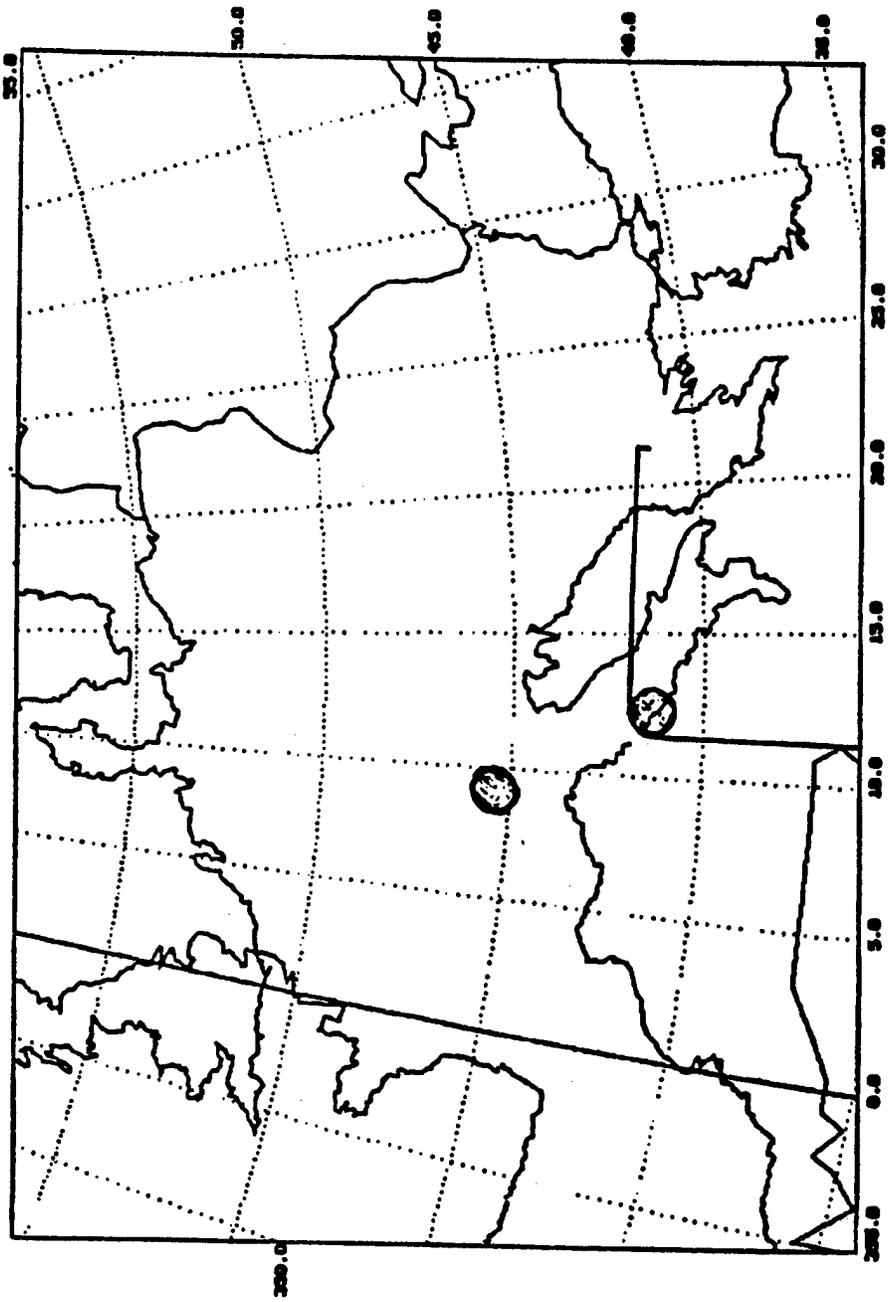
**Surface radar data:**

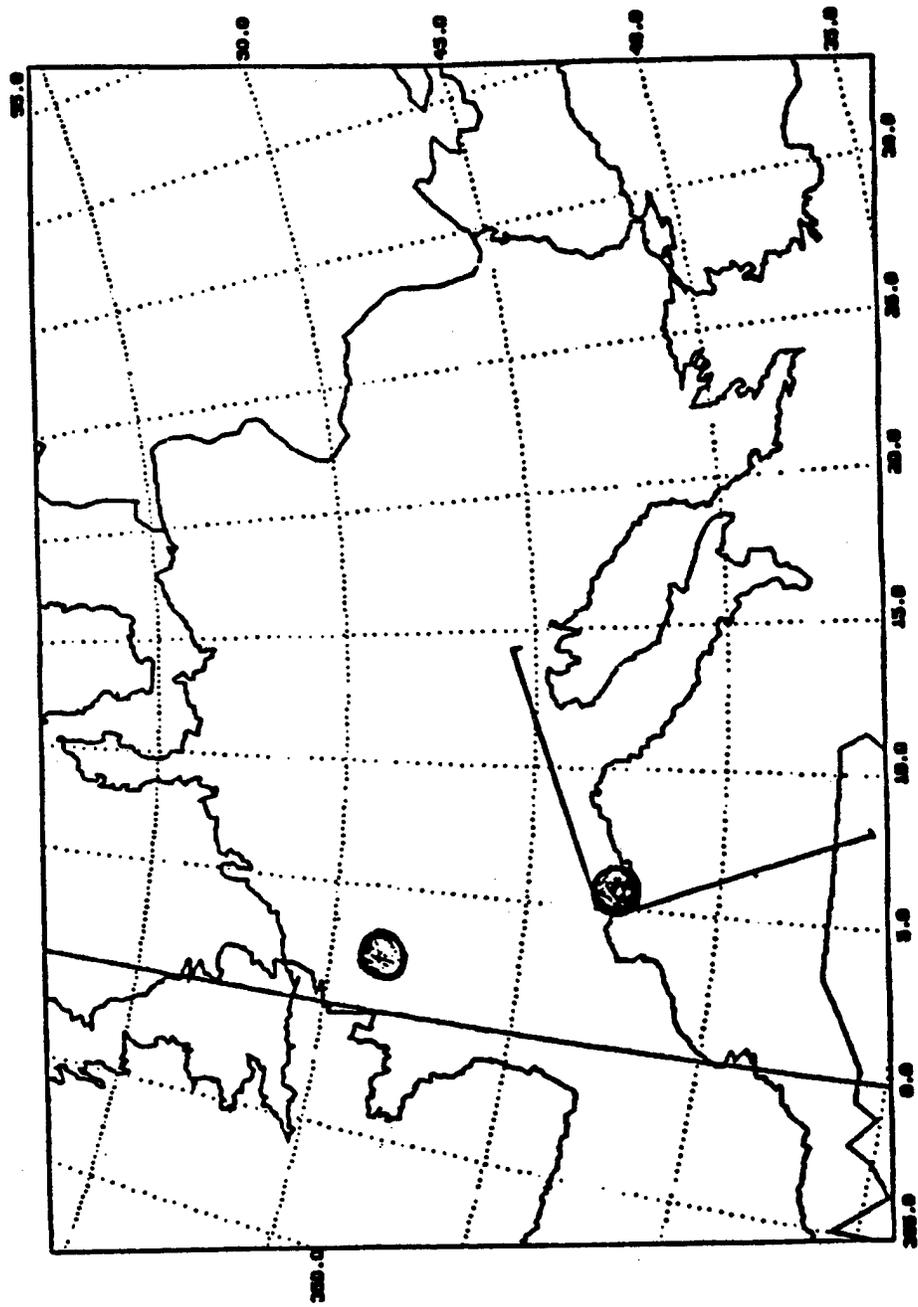
**BMD launch complex notification: by the range of 700 km.  
Data output about attacking warheads: by the range of 500 km.**

*Lethal areas*



<b>Antimissile (2 types) number in the fighting complete set:</b>	<b>32</b>
<b>Number of ballistic missiles being hit: (including being within a 60° azimuthal sector simultaneously)</b>	<b>15</b>
<b>Hitting sector is rotational within an angle:</b>	<b>± 180°</b>
<b>Time for establishing on a position:</b>	<b>5 days</b>
<b>Cost of one complex: (defined from first ten units, taking into account development costs)</b>	<b>300 mln.\$</b>
<b>Creation terms:</b>	<b>6 - 8 years</b>
<b>Defence against medium or less range ballistic missiles and shock aircraft</b>	





« ETTORE MAJORANA »  
 INTERNATIONAL CENTRE FOR SCIENTIFIC CULTURE

**Limitations for missiles early warning system (MEWS) on using its information to guide antimissiles against ballistic missiles:**

**for space based means:**

- acquisition means are for common use, data are distributed to MEWS center only;
- time, velocity and landing area data are distributed to users, as well as BM elevation and azimuth angles, every 10s.

**for surface radars**

- bandwidth >25 cm;
  - radar was not used for antimissile guidance.
- 
- 

**Condition for launch complex used against MRBM intended to limit their possibility to hit intercontinental ballistic missiles (ICBM):**

- ICBM hitting tests are not conducted;
- product  $P \cdot S \cdot V < 4 \cdot 10^6 \text{ kw} \cdot \text{m}^2 \cdot \text{m/s}$ ;
- number of launch complexes in the area defence is limited

**Initial stage is to select an architecture, define a system composition and its components characteristics, conditions and tasks for city, area or state BMD system.**

**Components development, mutual exchange by technologies, full-scale component and BMD complex tests.**

**Algorithms development, programs compilation for the launch complex and BMD system fighting control, military operations modelling.**

**Search of effective decisions to select warhead and provide an effective non-nuclear warhead hitting.**

---

**Our meetings and conversations are evidence that those specialists who devote their lives to the creation of defence systems, will be able to unite their efforts for the progress of their work with full observing all the laws, rules and commercial interests of their companies.**

LA-UR- 92-2527

Title: STEPS TOWARDS GLOBAL AIR DEFENSES

Author(s): Gregory H. Canavan

Submitted to: For discussions outside the Laboratory

Date : 2 August 1992

**Los Alamos**  
NATIONAL LABORATORY



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## STEPS TOWARDS GLOBAL AIR DEFENSES

Gregory H. Canavan

Defenses against aircraft and cruise missiles are a necessary adjunct to protection or defense against missiles. It would not make sense to eliminate the effectiveness of theater or intercontinental missiles but not address air-breathing threats that already exist.<sup>1</sup> Still, air defenses have received much less attention and development than missile defenses in recent decades. The reason is partly historic. The U.S. previously had significant air defenses, but abandoned them for logical reasons. It made no sense to spend a great deal of money on air defenses that could be suppressed by missile attacks long before the arrival of the aircraft they were intended to defend against. If, however, missile attacks are reduced and defenses are deployed, that is no longer a compelling argument. The attacker may no longer have excess missile weapons to devote to air defense suppression or confidence that he could do so thoroughly.

The elimination of missile threats would not eliminate all threats; other means of delivering weapons of mass destruction would remain: ships, trucks, borders, etc.<sup>2</sup> A popular favorite is smuggling the weapons into the U.S. in a bale of marijuana for high probability of delivery. But these means are likely to remain open until something is done to close the obvious gaps at the top. Once missile and air delivery avenues are closed, the technology exists to close most of the other avenues, too. And as the need arose those avenues could readily be closed, starting with the top and working down to the least likely avenues.

Along the way they could also close one annoying gap in missile defenses. GPALS concentrates on ICBMs and SLBMs over about 2,000 km. That leaves a gap in defenses against existing short-range missiles, which could also be launched from ships closer to shore. From such ranges the use of clustered chemical and biological payloads could be at least as effective as they appear to be in theaters. Air defenses of the type discussed

below and missile defenses for such threats could also form the basis for closing off such missile threats to CONUS.

Air defenses should be less difficult once offensive reductions and defensive deployments have started--in part because the threat is reduced; in part because a reduced number of missiles cannot afford to give full air defense suppression. But the greatest reduction is because against theater, accidental, and unauthorized attacks of reduced scope and complexity, air defenses need no longer be fully survivable against missile threats.

Many of the technologies for air defenses against such reduced threats already exist in development in the U.S. Air Defense Initiative (ADI). For theater air defenses, Patriot and its upgrades could fulfill most local requirements. The Strategic Defense Initiative's (SDI) Theater High-Altitude Area Defense (THAAD) could give broad area coverage against theater ballistic missiles. The primary extension needed for air defenses is something analogous to it for cruise missiles, some with reduced signatures. The essential need is for an advanced sensor for use against low-observable aircraft and cruise missiles masked in theater terrain. Such sensors are in development; advanced radars with the ranges around 100 km needed for area coverage exist.

What has been lacking is a survivable basing mode. Against non-suppressing threats, defended transmitters on drones or aerostats, advanced high-frequency over-the-horizon radars, or other sensors far short of space-based radars or wide-area surveillance systems could achieve adequate sensitivity for theater or coastal fences.<sup>3</sup> With such warning, existing interceptors could suffice.<sup>4</sup>

For homeland defense the number of potential targets is significant. Any tanker or freighter could be a plausible carrier for the close-in launch of a cruise missile; out-of-bastion submarines would also increase demands. For wide-area coverage, the assets required would not be insignificant, but

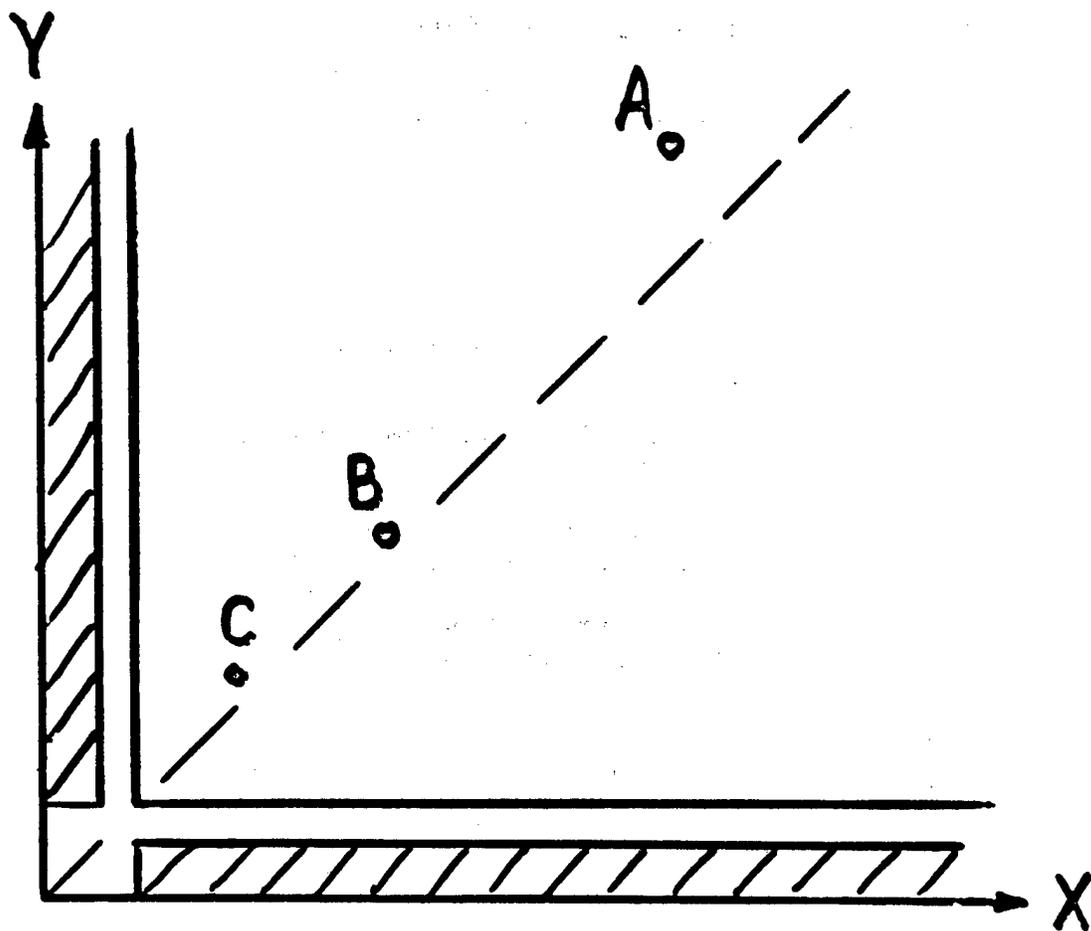
with modest intelligence on the threat, adequate screening should be able to bring them into line with affordable assets.

With time, threats could grow to the point at which the need for more survivable air defense sensors and interceptors would again emerge. But by that time, the means for protecting those defenses could also evolve. Protection against aircraft that is complementary to GPALS missile protection is not too much to expect in the near term. Although the outcome of the offense-defense competition over the next few decades is not clear, it is obvious that whatever air defenses are deployed should be integrated with missile defenses. No integrated architecture exists as yet, outside of the thinking of those who have separately worked air and missile defense issues for the last decade, but that could readily be remedied.

#### REFERENCES

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2. "Countering Missile Threats," House Armed Services Committee R&D Subcommittee hearing summary, 30 April 1992.
3. G. Canavan, "Cruise Missile Surveillance Options," Los Alamos National Laboratory report LA-12163-MS, June 1992.
4. G. Canavan, Los Alamos letter P/AC:91-248, 7 May 1991, to J. Drake, RDA Logicon, Subject: Handover issues for cruise missiles.

# Traditional conception of Strategic Stability (MAD doctrine)

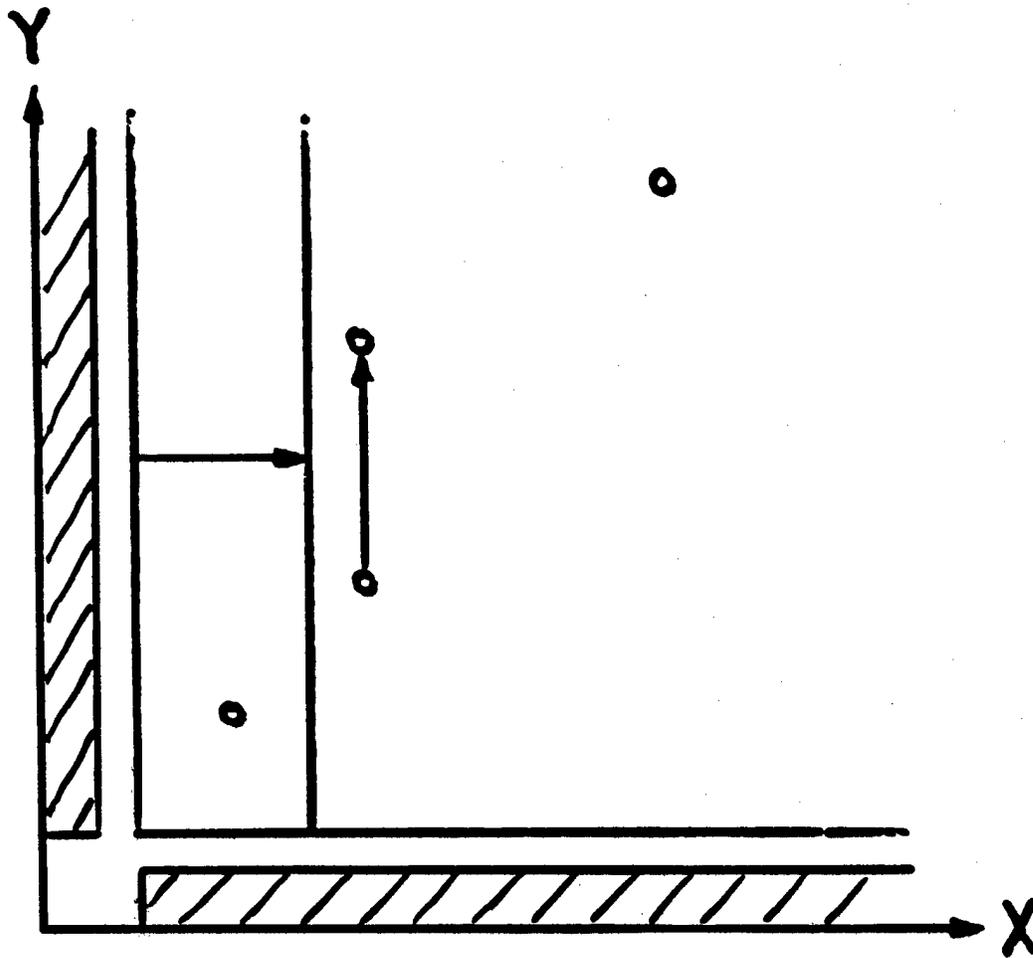


A - Current state (4268, 5123)

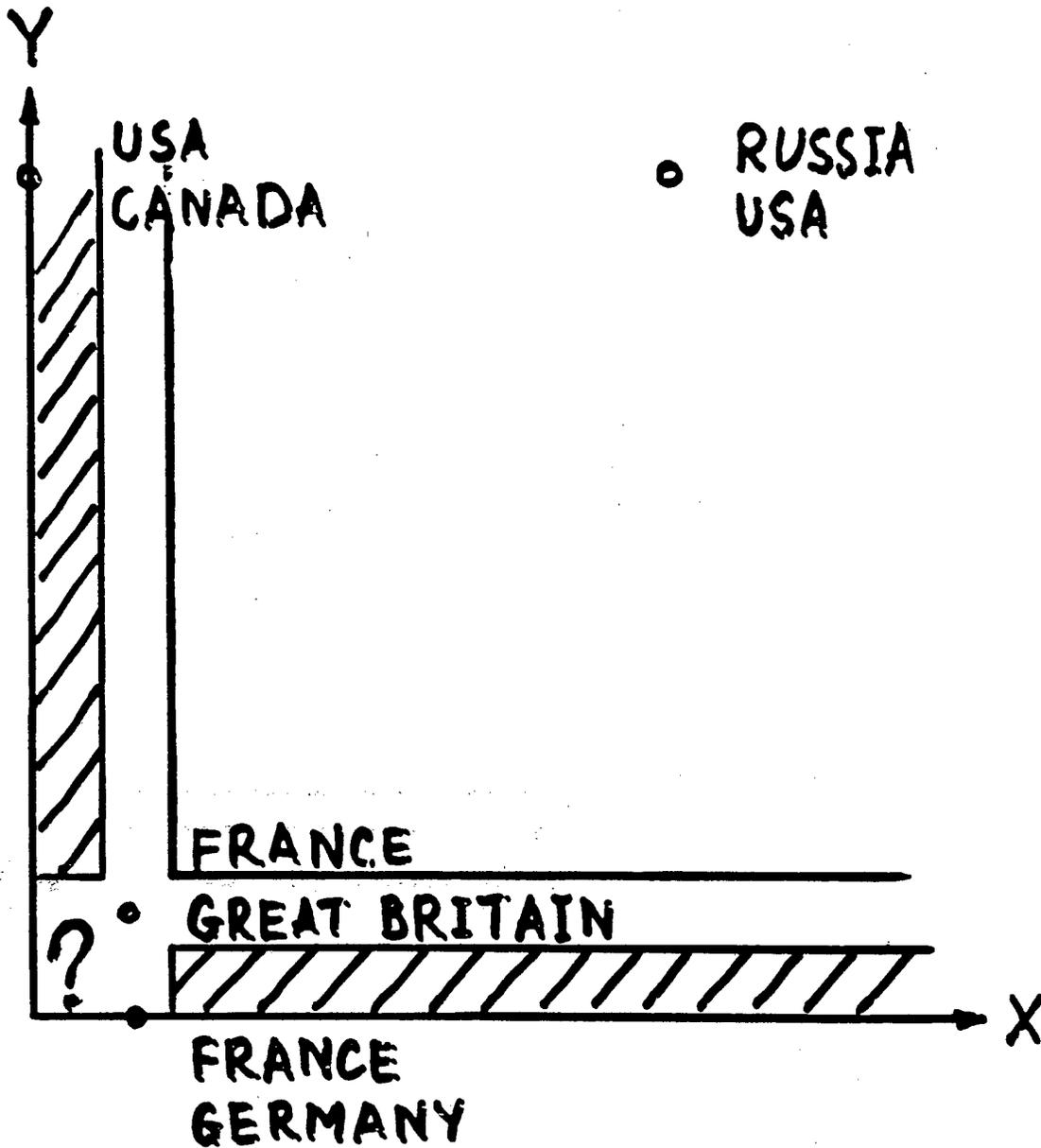
B - START Treaty (2269, 2444)

C - Washington agreement  
(1302, 1524)

# ABM systems and Strategic Stability



Is MAD-type Strategic  
Stability conception  
universal ?



MAD-type  
Strategic Stability



Mutual Openness to  
unacceptable damage

- Deep geopolitical conflict
- Mutual distrust
- Large arsenals of  
offensive arms

# MAP - type Strategic Stability



Joint Protection  
against  
unacceptable damage

- global cooperation
- Mutual confidence
- Deep cuts of offensive arsenals

# OPTIONS

1. MAD-doctrine maintenance
2. Transition to Mutual Assured Protection stability
3. MAD-doctrine plus joint protection against limited threats

**PROPOSALS  
ON RAISING STRATEGIC STABILITY**

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1. One of the main ways of raising strategic stability and providing the security of the World Community is developing of a whole complex of measures directed to prevention conflicts with using of missile and nuclear-missile weapons, conflicts in space or their limitation in case of having sprung up.

2. Actuality of the task can be explained by following:

- continuous improvement of strategic offence weapons of leading nuclear states in the direction of raising their counter-power potential, i.e. in the direction of creating first strike weapons;

- missile and nuclear-missile technologies proliferation in the third-world countries and, as result of that, increase of using such weapons hazard in conflicts;

- continuous ~~making~~ out to the details and testing by various countries new kinds of missile weapons, accident launches of such can lead to false interpretation of missile-space situation;

- possibility of false alarm in national ballistic missile warning systems;

- increasing significance of space in the task of ensuring national security, possibility of presence in it destabilizing kinds of weapons and, as result of those, converting it into potential military operation theatre.

3. The fulfilment of this complex of measures should provide the achievement of strategic stability with the minimum level of strategic weapons and create real base to stop arms race in the field of missile weapons and to limit their proliferation.

These measures should provide the following:

- to reduce the probability of the accidental (unadequate) launch of ballistic missile;

- to increase the effectiveness of control over the proliferation, testing and deployment of missile weapons;

- to increase the effectiveness of control over the adherence to the international obligations and treaties in the field of creation and development of the nuclear and missile weapons;

- to increase the effectiveness of the identification of the combat use of missile to prevent conflicts escalation, to reduce damages caused by its use;

- to increase the effectiveness of the identification of missile launch into space or its combat application against space or land objects.

4. Great importance for practical fulfilment of the above mentioned measures can have international cooperation in the field of early warning systems of missile attack and control of outer space with the purpose of raising completeness and authenticity of missile-space situation assessment in the national warning systems and prompt providing of the United Nations with data about all missile and nuclear weapons usage cases.

On the first stage should be done information cooperation between ballistic missile warning system of the C. I. S. and nuclear missile warning system of the USA.

The main task of the information cooperation on this stage is to decrease the probability for each side to adopt a false decision on the use of nuclear-missile weapons because of the

incorrect interpretation of the usual activity of the sides, false alarms, unnotified BM launches and jamming , as well as to organize mutual control over the works on the programs of development and improvement of nuclear-missile weapons and to observe the limitations achieved in the field.

On the second stage the creation of the International Center of early warning of ballistic missile attack takes place, that enable the creation of the International system of missile and space threat warning.

## 5. TASKS OF THE INTERNATIONAL CENTER

The International Center in accordance with the data obtained from national space surveillance and ballistic missile warning systems, independent information sources of different organisations, international facilities that can be formed to control regions and objects not properly covered by the existing national means, should exercise the following tasks:

- to detect test, combat-training missile weapons launches and to check their correspondance to the announced goals;
- to detect the undeclared missile launches and to determine their movements parameters;
- to detect cases of the combat missile application, to establish the state that used this weapon and evaluate the threat of missile falling down on the territory of this or that states;
- to provide other states (including through UN Channels) with the information on the proliferation, testing, deployment and military application of missile weapons.

The Center information can be used to increase the authenticity of the space-missile situation assessment within the national ballistic missile early warning systems.

Taking into account that settlement of the problems on the detection of ballistic missiles (BM) that are within the competence of the Center in the most effective way depends on how complete the data on space situation is, and that information equipment that exercises control over BM automatically fulfills the tasks of the surveillance of space objects, all this means that the Center responsibilities should include tasks on the control of outer space, namely:

- to keep the unified space objects catalogue containing information obtained judging on the objective data on their purpose, type, operation regimes, orbit parameters and their alterations, as well as mass, dimensions, signal and other characteristics;

- to calculate safe launch and flight trajectories of the space vehicles, and to forecast dangerous approach of space vehicles;

- to forecast regions of space objects falling and warning about their falls;

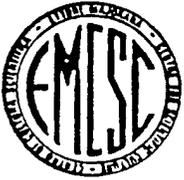
- to participate in control over security measures on space objects equipped with nuclear power units during their putting into orbit and maintenance there;

- to analyse off-optimum situation in outer space, to provide with the information on space objects conduct in such situations and to warn on dangerous consequences.

It can be considered as a possible task of the Center the participation in control over announced launch goals and purpose of space vehicles.

In the whole Center operation could make a considerable contribution to the development of the existing system of measures to strengthen trust and to foresee space and military activity of the countries.

It's reasonable to elaborate works program on the wide international cooperation in the field of space surveillance and ballistic missile warning systems.



«ETTORE MAJORANA» CENTRE FOR SCIENTIFIC CULTURE  
ERICE INTERNATIONAL SEMINARS

- *Projects for Planetary Emergencies*
  - *Proliferation of Weapons for Mass Destruction (WMD)*
  - *International Cooperation on Defense Systems (ICDS)*
- 19-24 August 1992 - 16th Session - 2nd Seminar after Rio

23 August 1992

The most serious present problem in the world today is the Proliferation of Weapons for Mass Destruction (WMD). A solution of this problem has become more feasible due to the birth of freedom in large areas of Europe and Asia.

We scientists:

- 1) Would like to call the attention of all governments and of public opinion to consider this threat against innocent populations the world over.
- 2) Declare that Science and Technology can ensure the protection of human beings against this danger.
- 3) Emphasize that a world-wide cooperation among free nations, without secrecy and borders, must be implemented for the benefit of mankind. This effort should be extended to protect our planet against ecological calamities and to the prediction and alleviation of natural and man-made disasters.

*Securus*  
*Yuzel Helen*  
*Henry L. Cooper*  
*Stanpadoung*  
*Wai Sintang*  
*Hoich*  
*M. N. Lili*  
*T. O. Lee*  
*141*  
*Howard Toller*  
*Kim Pam am. berumen*  
*L.H.R. Dijk*  
*KRikene*



## ICSC - WORLD LABORATORY

The Global Ecological Monitoring Program can benefit greatly from coordination with existing international projects, ongoing governmental ecological and environmental programs, as well as those of industry.

We commend this Program to the governments addressed, all of whom were represented by active participants in the Workshop, for consideration of material support of the consensus plan to develop a global ecological monitoring system within the framework of this Program.

National sensing assets could be assigned to addressing ecological problems in various countries through the structure of this Program, either exclusively or in a dual-use mode. Indeed, there appears to be major synergism opportunities available to the governments addressed, if they encourage to their respective ecological authorities to collaborate with the Global Ecological Monitoring Program and to give necessary authorizations to the individual national components of this Program.

We suggest that the governments addressed may wish to assist in the conversion of military-supporting enterprises to the solving of ecological problems, such as those of concern to the present Program.

The Program would enable the monitoring of the entire world with common standards and with modern high technologies, with all countries having unrestricted access to the ecological information gathered.

We believe that this Program would help to ensure one of the most fundamental human rights, the right to a safe environment in which to live.

This Program would be conducted in congruence with the letter and the spirit of the International agreements signed by the governments addressed at the UN Conference on the Environment and Development in Rio de Janeiro in June, 1992.

E. TELLER

*Edward Teller*

E. VELIKHOV

*Велихов*

A. ZIBHICHI

*А. Зибичи*



## ICSC - WORLD LABORATORY

### ***To the Governments of the USA, Russia, Ukraine, Kazakhstan, Lithuania and the Peoples Republic of China:***

A Workshop took place in Dubna, Russia, in August 1992 under the auspices of the World Laboratory, an international non-governmental organization, on the Global Ecological Monitoring Program. This was the most recent in a series of such Workshops which have taken place during the past year, at several locations around the world.

Representatives of governmental and non-governmental agencies of the USA, Russia, Ukraine, Kazakhstan and Lithuania, participated in the Workshop, as did an observer of the Peoples' Republic of China.

The participants in the Workshop reviewed evidence that there is real danger to human life and welfare in major regions of our planet associated with extreme ecological damage, especially in areas of Republics in the territory of the former Soviet Union.

An essential condition for diminishing the hazards to human welfare of these damaged ecosystems is monitoring major changes in the indigenous biota and the overall health of resident people, along with measurement of ongoing anthropogenic changes in environmental quality indices. Obviously, the acute effects of technologically engendered and natural catastrophes must also be monitored.

An important step in addressing these problems would be the creation of the integrated ecological monitoring system which would include space-, air- and land-based sensors, all transmitting their measurements to a common data bank. Such a system would allow all interested governments to participate in this monitoring activity, even if they have no direct access to advanced space- or air-deployed sensor system technologies.

Creation of this sophisticated system would be facilitated if, as national security expenditures are reduced in all concerned nations, components of the military-industrial complexes can be oriented toward support of this work. Quite importantly, some present and future national defense systems may well be able to make major contributions to the functioning of this global ecological monitoring system, via dual-use approaches. Specific reference is made in this respect to ongoing plans for air- and space-based systems for warning and actively defending against ballistic missile-based aggression.

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