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ICL COMPUTERS FOR THE USSR

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Briefing Materials on ICL Computers for the USSR

Background

In December 1969 [redacted] the British computer firm, International Computers, Ltd. (ICL), was considering the export of large COCOM-embargoed computer systems to the Institute of High Energy Physics at Serpukhov, USSR. In addition to being embargoed, the computers in question contain US peripherals and components and therefore require US licenses. In August 1970 the British forwarded an aide memoire to the US outlining its proposals to export the the above-mentioned computers and asked for US agreement prior to submission to COCOM. The UK formally submitted the proposal to COCOM in September without waiting for a response from the US.

The computers proposed for export to Serpukhov include the following: two interconnected computer complexes each consisting of a 1906-A computer and a 1903-A computer linked to a 7901/3 communications processor; a free standing 1903-A; and various peripherals. The value of the transaction is about $10 million. COCOM currently limits the size, i.e., the processing data rate (PDR),* of computers that can be exported to Communist destinations without COCOM approval. The current cut-off is 8 million bits per second (mbs). The 1906-A has a PDR of 44 mbs; the PDR of a 1903-A is less than 4 mbs. (See Attachment A for characteristics of selected computers). The PDR for each of the proposed interconnected systems would be in excess of 100 mbs. The cabinet-level Export Administration Review Board (EARB) decided in early 1970 on US policy for handling exports of computers that exceed COCOM cut-offs. The EARB determined that the risk would be "low" if one computer per year in the range of 15-30 mbs were exported to the USSR, but that the risk would be

* The processing data rate is a measure of the capability of a computer to handle a specific calculation within a given time period. Peripherals and software are important determinants of the rate.

"significant" if more than one of that size were exported. A computer having a PDR of more than 30 mbs would require the endorsement of the EARB as a "blue ribbon" case.

The proposed consignee, the Institute of High Energy Physics at Serpukhov, reportedly would use these high-power computer systems to upgrade its capabilities in basic research. The British claim that the only computers now available at Serpukhov are a BESM-6 (a PDR of about 20 mbs if operating at designed capacity) and a few small Soviet and Western computers and that no large Soviet computers will be available in the foreseeable future. Additional computer power is said to be needed now for use with the 76 billion electron volt (Gev) particle accelerator, currently the largest in the World.* In defending its proposal, the UK cited the open nature of the institute's work, the institute's international standing, the Soviet need for large scale computer power to further its research, and

The US response to the British aide memoire in October 1970 was negative. The principal reason cited was that the computers would be easy to divert to strategic uses

While admitting the peaceful nature of the work at Serpukhov and its international standing, the US emphasized that it would be extremely difficult with current technology to detect diversion without full time, expert, on-site monitoring and that proper monitoring of the work of the computer would require

* The US 500 Gev particle accelerator at Batavia, Illinois will be the largest in the world when it becomes operational this year. A recent article in Business Week discusses the work at Serpukhov and its cooperation with Western institutes (Attachment B).

constant sampling of the sub-routines for evaluation by an expert.* Such an evaluation would be further complicated by the fact that high energy physics programs are similar to those for weapons development and very few experts are capable of distinguishing between the two. Bubble chamber experiments could resemble experiments on nuclear weapons effects, for example. US authorities also expressed concern at the implications which the export of these high performance computers would have on maintaining COCOM controls over advanced computers in the future.

The US formally objected in COCOM in early November 1970. Two weeks later the British forwarded another aide memoire stating that it could not accept US statements particularly with respect to the danger of diversion. In mid-December British newspapers aired the US-British dispute on the computers and indicated that Prime Minister Heath would raise the matter with President Nixon. During his visit to the United States later in December, Mr. Heath expressed his interest in getting US approval of the transaction.

ICL's use of important British government officials to influence the US to approve transactions with the USSR, as noted above, is a time-honored tradition. ICL's proposal in 1968 to sell third-generation computer technology to the USSR** was formally launched in this country by high-level Board of Trade officials. Similarly, the intercession of the Minister of Technology, Anthony Wedgewood-Benn, in 1970 with Deputy Secretary of Defense David Packard was instrumental in securing US approval of an ICL 4-70 computer for a Soviet research institute having military affiliations.

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* Early in 1970, as a result of Soviet interest in a CDC 6600 for Serpukhov, US authorities tentatively adopted a set of operational conditions whereby a high performance computer could be installed at Serpukhov without prejudice to national security (Attachment C). These conditions apparently form the basis for US objections relating to diversion. An earlier report by the National Academy of Sciences concluded that it would be impossible to guarantee a CDC 6600 against the possibility of diversion.

** Recent Soviet efforts to obtain large Western computers are summarized in Attachment D.

British government support is not surprising because ICL is the only major British-owned computer manufacturer and it has had difficulty in meeting foreign competition. Although this transaction is valued at only $10 million and ICL total sales in the entire East European market in 1970 were only about $10 million, ICL believes that a vast market can be tapped in the USSR and Eastern Europe. Consequently, it is making a major sales effort in the area and is the first and only Western computer firm to be permitted to open a sales office in Moscow. ICL also plans to help the USSR to develop software -- an area in which the USSR is particularly weak -- for a new series of Soviet-designed computers.

The ICL computers are not the first choice of the USSR for the Serpukhov installation. The Soviets would prefer the CDC 6600. Despite the fact that the throughput of the two ICL systems reportedly would exceed that of a CDC 6600, the large amount of accumulated Western experience with the latter in similar applications would prejudice the Soviets toward the 6600. Moreover, the use of interconnected computers -- the ICL 1906 and 1903 -- rather than a single machine could introduce additional complications. The CDC would also cost the Soviets less than half what they are prepared to pay for the ICL computers. The negative US response to informal Soviet inquiries concerning the installation of a CDC 6600 at Serpukhov evidently led the USSR to seek the ICL computers.

CIA Intelligence Contributions

CIA has not been called on to make a formal intelligence input in this case, but has made a number of them on Soviet computer capabilities in connection with [redacted] in recent years. Attachment E is a summary statement of current Soviet capabilities in the computer field.

Recommendation to the NSC Undersecretaries Committee

The Under Secretaries Committee was asked by Mr. Kissinger on 25 January to review the question of the export of the ICL computers to Serpukhov. Mr. Nathaniel Samuels, Deputy Undersecretary of State and acting chairman of the committee, drafted a recommendation of approval for consideration of the

Undersecretaries Committee at a meeting to be held on 23 February.

The "pros" and "cons" of lifting the US objection to the export of the computers to Serpukhov listed in Mr. Samuels' draft are in Attachment F. It is believed that an important "con" is omitted and namely that the upgrading of high-energy physics programs at Serpukhov would also enhance the international prestige of the USSR in this important area of research.

Comments on the OST Report

The recommendation for approval was based largely on a technical report submitted by the President's Office of Science and Technology (OST). The rationale for approval is contained in a sentence in the OST report: "...on technical grounds the degree of potential security risk to the US represented by this transaction is extremely low..." On the whole the technical analysis contained in the report is good, but certain considerations appear to have been overlooked. The OST report lists seven conclusions:

The first conclusion states that the Soviets could not extract equipment technology from the machines. Our technical experts agree.

Conclusion 2 states that the effort required to effect clandestine diversion could not be justified by the Soviets unless use of the order of 25% of the machines were obtained. This assumes that a benefit will accrue only if available machine time is adequate for the complete design of one warhead.

Conclusion 3 states that the diversion of one-quarter of Serpukhov's computing time is in the range where the loss of computer time for legitimate high energy physics needs would be noticeable by Western scientists working and familiar with the research program. We believe that it is doubtful that a scientist [redacted] could detect diversion of sizeable parts of the computer's capability. There is greater merit to OST's contention, however, that the Soviets would be reluctant to take the risk of revealing Soviet weapons codes to Westerners.

Conclusion 4 states that if diversion attempts were being planned, provision for core dumps on demand and examination of the printout by US specialists would increase the chances for detection and further reduce the risk that the Soviets would make the attempt. We believe that the dump provision can be a control only if a dump can be made when a US monitor wishes. It does not follow that an ICL employee could be trusted to perform security functions. The OST report implicitly shows a need for US participation on a contractual basis. The British, however, state that "they would not wish to extend these contractual rights to persons other than ICL employees." Unless there is available a US monitor who is competent to interpret a large dump, this provision has little value.

Conclusion 5 states that the software systems for the machines should be readily adaptable to use of Western high energy physics programs and would be inappropriate for Western weapons codes compiled in machine language (CDC 6600). The very tight security controls on US weapons codes, in general, would preclude their falling into Soviet hands. It is believed that further consideration should be given to the possibility of Soviet access to British-designed codes; the extent of ICL 1906-A compatibility with computers used for British weapons codes is not known.

We concur with Conclusion 6 that further explanation is needed from the British on why such large storage capacity is needed.

We have no comment on Conclusion 7 which notes that Western scientists could benefit from cooperative projects at Serpukhov.

Operating Characteristics of Selected Computers

Model	CPU Bus Rate (mil. bits/sec) a/	COCOM Processing Data Rate (mil. bits/sec) b/
CDC 6600	600	c/
IBM 360/75	164	61.9
CDC 6400	600	c/
ICL 1906-A	128	44.1
IBM 360/65	160	29.4
ICL 4/70, 4/75	70	21.1
CDC 3600	39	19.9
BESM-6	13	d/
CDC 3300	19	10.2
IBM 360/50	16	9.3
ICL 1903-A	16	3.2

a. Central Processing Unit (CPU) bus rate is the rate that data can be exchanged from the CPU to the internal memory. Computers with a bus rate of 40 or more exceed COCOM guidelines.
b. COCOM Processing Data Rate (PDR) is a measure of the capability of a computer to handle a specific calculation within a certain time period. Peripherals and software are major determinants of the rate. Computers with a PDR of 8 or more exceed COCOM guidelines.
c. Because of the architecture of the CDC 6000 series, the PDR cannot be calculated. The rankings are the presumed relative positions based on a number of factors including the rental fees.
d. The USSR claims a PDR similar to that of the CDC 3600, but the BESM-6 probably does not perform at maximum design levels because of failure to provide adequate memory and software and lack of provisions for input-output.

Pooling brains to study the atom

Foreign scientists are participating in a project at Russia's reactor center

The soaring cost of research in high energy physics is activating unprecedented international cooperation.

Next month, five American scientists will travel to Protvino, near Serpukhov, 60 mi. south of Moscow and site of the world's biggest atom smasher, or "particle accelerator." They will work with Russian counterparts on a six-month project studying the pi meson, a tiny subatomic particle that is thought to contribute to the forces that hold the atom's nucleus together. The Americans will be a part of a group of 300 foreign scientists at Protvino, where the Russians have carved a "science city" out of birch forests to house the giant accelerator.

Meanwhile, in Switzerland, the Russians have been working with the Geneva-based CERN (Conseil Européen pour la Recherche Nucléaire) since 1959, and using CERN's atom smasher. And physicists all over the world are eagerly awaiting the completion of another new atom smasher in the U. S., at Batavia, Ill. next year (box). Two Russian scientists spent several weeks at Batavia this summer, planning possible experiments on the accelerator.

Because each of the new machines will cost $250-million or more to build, the giant atom smasher is not the kind of research equipment every country can have. In fact, the high cost has made high-energy physics the most expensive of all fields of scientific research. Thus the cooperation.

Method. The basic concept of atomic particle research is simple. To learn more about the nature of matter, physicists have to understand the particles that make up the atom. More than 100 new particles have been discovered in the past 20 years, ranging from neutrinos to heavy baryons. Their sizes are measured in billionths of inches, their lives in billionths of seconds.

Because they are so tiny and short-lived, the subatomic particles are on the borderline between energy and matter. The only way to produce them is, in effect, for the physicist to hurl together bigger, more manageable particles, such as protons, at close to the speed of light. Energy that comes flying out of the crash is converted briefly into the subatomic particles.

The physicist achieves the speeds necessary for this process by "accelerating" the protons in a circular tunnel, which is lined with magnets to hold the protons away from its walls and speed them up. He detects the subatomic particles by the "tracks" they leave as they travel through a gas-filled or liquid-filled "bubble chamber." To push protons up to the speed of light requires huge equipment, however. The tunnel ring at Protvino is nearly a mile in diameter and the facility cost an estimated $150-million to build. Physicists all over the world covet this accelerator's enormous energy of 76-billion electron volts (or 76 Gev, for Geneva electron volts). But they insist that they need an even more powerful atom smasher, one with an energy of 1,000 Gev or more to really study subatomic particles. And applying a rule of thumb that a particle accelerator costs up to $2-million per Gev, such a machine would cost $2-billion.

Achievements. The precedents for the international cooperation that might achieve this goal have already been set at Protvino and CERN. Although the accelerator at Protvino is only three years old, scientists there have achieved some impressive results.

For one thing, they have discovered matter called anti-helium-3—roughly comparable to ordinary helium, but with opposite electrical charges. And they have cast serious doubts on accepted theories of how negatively charged particles interact with other particles at high energies.

Dr. Roman Sulayev, 44-year-old deputy director of the Center of High Energy Physics at Protvino, is proud of the scientific successes at his accelerator. But he says his colleagues are al-

A massive smasher at a bargain price

The U. S. will acquire the world's most powerful atom smasher—sooner, cheaper, and with a higher energy level than its planners originally expected. Construction at Batavia, Ill., is going "exceedingly well," says Edwin L. Goldwasser, deputy director of the installation, known as the National Accelerator Laboratory.

The atom smasher, being built for the U. S. Atomic Energy Commission, is due to start operations next July, a year ahead of schedule. Its costs are running below the $250-million originally estimated. Its designers anticipate that it will provide energy levels up to 500-billion Geneva electron volts (Gev), way over the 200 Gev they had looked for in early planning.

Luck, good management, and advancing technology have all helped to brighten an otherwise bleak scene in U. S. physics, hard-hit by budget cutbacks. Several large construction contracts were let for the accelerator just before President Nixon's order last September to cut back federal construction by 75% in fiscal 1970. Other contracts have come in below estimates. Says Goldwasser: "In a recession, contractors are hungry. Moreover, they are ready to move in with no delay."

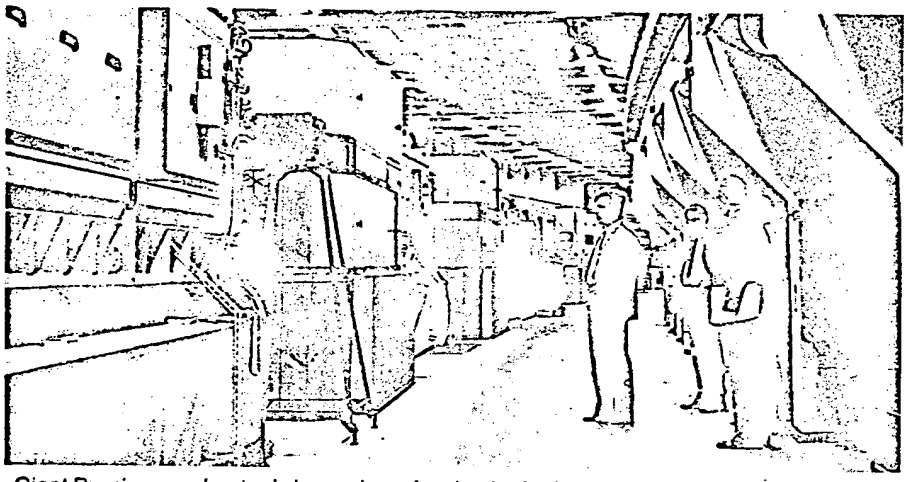
Economies. So far, about $89-million has been spent on the NAL, almost entirely on the accelerator. No money has even been allocated for a 400,000-sq. ft. main research building, which has been given a lower priority by NAL Director Dr. Robert Rathbun Wilson. Labs are temporarily housed in other buildings.

Also to promote economy, Wilson is encouraging competition between his contractors. As one example, he has ordered only two-thirds of the 1,000 magnets needed for the accelerator's main ring, from two separate companies. The company that does the best production job will get the order for the remaining third.

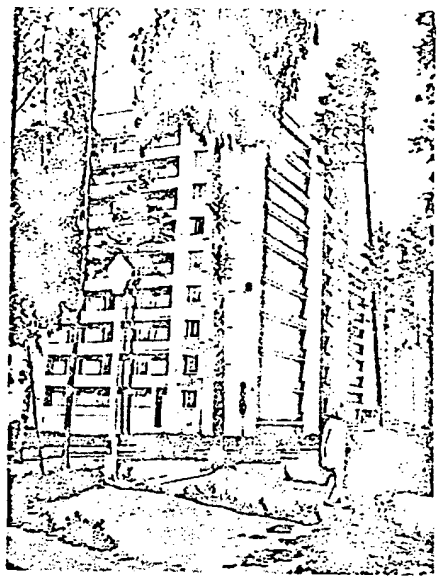
Technical advances account for the boost in the accelerator's rating to 500 Gev. Designers found that circuit-switching devices called thyristors could take higher electrical loads than anticipated, permitting use of much greater electric power.

The NAL will be operated for the AEC by Universities Research Assn., Inc., a consortium of 50 universities. While some experiments will be carried out by the NAL staff, most will be performed by scientists from these and other research facilities.

French technicians supervise the installation of the Mirabelle "bubble chamber."



Giant Russian accelerator is becoming a focal point for international research.



Protvino, the site of the accelerator, is one of the Soviet's "science cities."

ready working to expand its capacity. They have initiated:

- A series of international nuclear projects, under which both men and supplementary research equipment are being shipped to Protvino from Europe and the U. S.
- A program to explore whether superconducting magnets, now experimental, can be used to boost its rating.

Cooperation. The closeness of the Russian-European cooperation is illustrated by the projects under way at Protvino. A dozen French scientists there are installing a huge, 6,000-liter bubble chamber called Mirabelle. Another 40 Frenchmen will join them when components of the $9-million sphere, built at the French Atomic Energy Commissariat's Saclay Research Center outside Paris, are shipped to Russia and assembled there. Mirabelle will remain French property, but will be used by the French and Russians under a five-year agreement.

Soviet-CERN cooperation is even closer. High energy physicists shuttle back and forth between Russia and Switzerland, where CERN has a 28-Gev atom smasher. A formal CERN-Soviet agreement has been in effect for three years. And a dozen CERN scientists at Protvino have launched the second of a series of projects, begun in 1968, to study particles called heavier neutral mesons. Last April, the CERN group took 200 tons of equipment to Protvino, including an IBM 1800 computer, all to be returned to CERN.

At the same time, 12 Soviet scientists in Geneva are working with highly sophisticated systems that have been developed at CERN—a fast ejector system to switch particles out of the accelerator and radio frequency particle separators. These systems will be shipped to Protvino in about a year for permanent installation there.

Payoff? Soviet ties with CERN could pay off for the Russians if and when a 300-Gev European accelerator is built. Years of argument over financing and locating this proposed atom smasher caused seven of CERN's 13 partners, including England, to opt out of the project.

Superconducting magnets would sharply boost atom smashers' energy

Last June, however, project director Dr. John B. Adams, a Briton, urged CERN to adopt a radically new proposal. Under its terms the new accelerator would straddle the Swiss-French border at Meyrin and use a 28-Gev atom smasher that is already there as part of its system.

The Adams plan looks cheaper and quicker than earlier proposals; it could mean only eight years' construction and a cost of $251-million. Therefore, CERN officials hope that it will lure the nonparticipating countries back into the fold, and they look for a CERN decision by this Christmas on whether to go ahead.

A vital part of the Adams plan is that, initially, the CERN accelerator would get only half the number of magnets it is capable of using. This would give it a rating of only 150 Gev. But space would be left for installation later of much more powerful magnets—cryogenic superconducting magnets.

These magnets are still in the experimental stage but could permit energy levels of 500 Gev to 800 Gev. If they do not work out, the accelerator would get another set of iron-core magnets, for a maximum rating of 300 Gev.

Russia, too. Superconducting magnets, which are under intensive research at Britain's Rutherford High Energy Laboratory, among other places, are at the heart of Soviet research to boost the rating of the Protvino accelerator, too. According to Sulayev, use of superconducting magnets would boost the atom-smasher's energy level three to eight times—that is, to a maximum of more than 600 Gev. "A lot of work remains to be done in this field—but it is a definite possibility," he says.

Officially, the U. S. has made no commitments to cooperate with Protvino. This winter's visit of the American team, headed by Dr. Darrell J. Drickey of the University of California, Los Angeles, is based on an exchange of letters between Dr. Glenn T. Seaborg, chairman of the U. S. Atomic Energy Commission, and A. Petrosyants, chairman of the Soviet State Committee on the Utilization of Atomic Energy. But scientists in both countries are hoping for stronger links. Says Sulayev: "A wider, more formal agreement would be useful." ■

Proposed Safeguards for High Performance Computers

In January 1970 US computer experts agreed that installation of a computer of the CDC 6600 class would proceed without threat to national security provided the conditions noted below prevailed. These safeguards are described in a report dated 14 November 1969 by [redacted] to the President's Office of Science and Technology:

1. Closed shop, with systems programming done by US personnel only, adequate surveillance and assurance of non-use during any off hours.

2. Batch computing only (no terminals).

3. Fortran programs only, with adequate documentation required to ensure efficient operation and for verification purposes.

4. Complete recording of input and sampling of output.

5. Sampling of internal computer executions.

6. Creation in the United States of a part-time group of high-energy physicists, computer center managers, and weapons designers to analyze a small sample of the recorded data.

Recent Soviet Efforts to Obtain Large Western Computers

In July 1968 the UK informed the US that it was considering the sale of technology to the USSR to produce the third-generation ICL-4 series of computers -- initially the 4-50 series and eventually 4-70's. The ICL 4 machines are produced under license from RCA. They are compatible with the IBM 360 series and can accommodate a full range of peripherals. The US opposed the sale on the grounds that the acquisition of Western state-of-the-art computer production technology would facilitate Soviet production of computers which could have both military and civilian applications. The British subsequently withdrew the proposal.

In the Spring of 1969 Control Data Corporation applied for a US license to export a CDC 6400 scientific computer for use at Yerevan, USSR to process data generated from experiments using a 6 Gev synchrotron. Consideration of the case was delayed pending a study of the risks of diversion involving the proposed installation of a CDC 6600 at Serpukhov where the USSR has a 76 Gev particle accelerator. The USSR had inquired informally whether the US would export such a computer to Serpukhov if application were made. US officials concluded that it would be extremely difficult to detect diversion without full-time, expert, on-site monitoring and such monitoring would be impractical. No application was made to export the CDC 6600 and the CDC 6400 application was denied in the summer of 1970.

In 1969 the UK asked for COCOM and US approval to export two ICL 4-70's to the USSR, one to the USSR State Planning Committee (Gosplan) and the other to the Institute of Automation and Telemechanics (now called the Institute of Control Problems). The Gosplan case was approved by the US and COCOM in relatively short order, but because of evidence that the Institute of Control Problems was engaged in military-related research, the US refused to approve the case. Following the intercession of the British Minister of Technology with Mr. Packard at Defense, however, the case was approved in mid-1970.

Computer Capability of the USSR

By the end of 1970 the USSR had produced from 6,000 to 7,000 digital computers. This is less than one-tenth of the number of computers installed in the United States. About half of the computers in the USSR are small, the other half being in the medium range with fewer than one percent being classified as large computers. Of the approximately 70,000 computers installed in the United States, about two-thirds are small (in the IBM 360-20 range) and most of the remainder are medium-size (IBM 360-30 to 360-50). The United States also has about 2500 large computers.

These comparisons are not entirely meaningful, however. The majority of the computers installed in the United States are third generation machines equipped with a variety of input/output devices which permit relatively full use of the central processor's capabilities. Soviet computers are almost entirely second and first generation machines with inadequate peripherals and software. Largely because of inadequate peripheral equipment and software, but also becuase of obsolete design and limited memory capacity, a Soviet computer has significantly less capability to perform useful work than does a US computer with virtually the same operating characteristics, bus rate, or processing data rate.

In terms of the COCOM processing data rate, the USSR is known to have produced only limited numbers of one model which exceeds the 8.0 megabit cutoff. That computer is the BESM-6, of which fewer than 30 units are thought to have been produced. Even these few machines are unable to perform at maximum design levels because of the failure of the Soviets to provide them with adequate memory and software.

The major shortcoming in Soviet computer production is their inability to develop satisfactory production technology, as opposed to design technology. As a result, the USSR in 1971 is able to produce only limited numbers of obsolete machines with poor reliability. They are in no position to begin producing large numbers of third generation computers comparable to those produced in the US from 1965 through 1970. Without substantial Free World assistance, the USSR probably will not produce large numbers of third generation computers of acceptable quality and performance before the mid-1970's.

"Pros" and "Cons" of US Approval

"Pros"

1. Would be responsive to Prime Minister Heath's personal approach to the President.

2. The on-site inspection arrangements could establish a possibly useful precedent for future arms control negotiations.

3. Would provide increased opportunities for Western cooperation in high energy physics at Serpukhov and might cause some general improvement in the Soviet attitude toward cooperative scientific ventures.

4. Would ease pressures for sales of computer production technology to Communist countries by demonstrating that occasional sales of advanced hardware can be approved when adequate safeguards are available.

"Cons"

1. Would incur the security risk referred to above.

2. Would encourage U.S. and other firms to attempt sales of large computers to research institutes in the USSR and Eastern Europe.

3. Would cause some increased pressure principally by American manufacturers for relaxation of the embargo limits.