REPORT OF NSC AD HOC WORKING GROUP ON THE TECHNICAL FEASIBILITY OF A CESSATION OF NUCLEAR TESTING

March 27, 1958

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March 27, 1958

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Special Assistant to the President for
Science and Technology
The White House
Washington 25, D. C.

Dear Dr. Killian:

We submit herewith for transmittal to the National Security Council the report of the Ad Hoc Working Group on the Technical Feasibility of a Cessation of Nuclear Testing established in accordance with NSC Action 1840 c. The report is concurred in by all members of the Working Group which included representation from the President's Science Advisory Committee, Department of Defense, Atomic Energy Commission, and Central Intelligence Agency.

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REPORT OF THE NSC AD HOC WORKING GROUP ON THE TECHNICAL FEASIBILITY OF A CESSATION OF NUCLEAR TESTING

SUMMARY

1. The present AFOAT-1 detection system has excellent capabilities to detect and identify surface and air burst nuclear tests up to 50,000 feet within the USSR and China of 10 KT or more and can detect 3 KT tests with about 30 per cent probability of detection. It can detect deep underground disturbances equivalent to 10 KT or over, but cannot distinguish disturbances due to nuclear explosions from earthquakes nor can it establish positively that they are not nuclear explosions of significantly higher yield. (See Conclusions, Section B 3) It is deficient in detecting tests in the southern hemisphere and in parts of the northern hemisphere remote from established test sites.

2. A practical detection system can be designed which can detect and identify nuclear explosions in the USSR and China except for some underground tests of small size (1 to 10 KT). Such a system, adequate for safeguarding a nuclear test limitation agreement, would require1/:

a. the installation of about 70 observation stations in the territories of the USSR and China;

b. the right of immediate access of mobile teams to any areas suspected of having been the location of a clandestine underground test; and

c. rights to overfly parts of the Soviet Union and China on certain occasions.

An additional system of about 30 stations and extensive air sampling coverage of the entire world would greatly improve the detection capability of the existing Long Range Detection System for test explosions in the remote areas of the world. Such a system is described in Appendix A and its capabilities are discussed in Section B of the Conclusions. With such a system agreed to and implemented, the Working Group feels that the USSR could not utilize testing to improve significantly its nuclear weapon capability, except for small yields without running a great risk of being detected.

1/ The separate views of the CIA member appears in Section B 6 of the Conclusions.

3. The Working Group considers a cessation of tests before the end of the HARDTACK series as undesirable and practically not feasible.

4. At the end of 1958, the U. S. will have tested designs for warheads of all weight classes from 100 to 20,000 lbs., should be ahead of the USSR in energy yield for nearly all warhead weight classes and will have good performance in some of the warhead weight classes that the USSR does not possess. However, the Soviet will probably have warheads by that time that will satisfy most of their major military needs. The U. S. will have usable warheads for missiles planned for early stockpile. For most missiles definitely planned for later stockpile entry, the U. S. will have the capability to design warheads of some yield, but these yields could be very substantially improved in most cases by further testing. The U. S. will need to keep ahead to offset Soviet advantages in missile requirements and surprise capability. Both countries will be able to compensate to some extent for lack of optimal development in warheads by increased capabilities in delivery systems.

5. At the end of 1958 the U. S. will still not have reached ultimate warhead performance as regards economy and weight. The U. S. will be rather close to ultimate performance in heavy warheads and reasonably well advanced in medium weight warheads. On the other hand, further very significant improvements may be required which could be obtained only by further testing in the lightweight, two-stage thermonuclear warheads for application; for example, to the Polaris, the AICBM, and second generation missiles. Areas which will not have been explored sufficiently to permit the development of usable designs are low yield clean weapons and inexpensive small weapons for tactical uses. There will also be lack of information on effects of nuclear weapons exploded at great altitudes and deep underground.

6. The rapidity of deterioration of U. S. weapons laboratories will depend on the duration of a test suspension and the belief of the laboratory staffs as to the permanency of the suspension. During a period of nuclear test cessation, there will be some improvement in Soviet capability through leaks and espionage.

7. The Working Group has discussed the military effects of the deficiencies in nuclear weapons due to a test cessation but has not been able in the time available to assess these defects in detail. Thus it has not come to an agreement as to whether a suspension or cessation of tests would be a net military advantage or disadvantage to the U. S.

CONCLUSIONS OF THE AD HOC WORKING GROUP ON THE TECHNICAL FEASIBILITY OF A CESSATION OF NUCLEAR TESTING

In response to the action taken by the National Security Council meeting on January 6, 1958, a technical panel of the President's Science Advisory Committee, the Department of Defense, the Atomic Energy Commission, and the Central Intelligence Agency has made a study of the technical factors affecting an international agreement for the cessation of nuclear tests.1/ The following conclusions have been reached:

A. Capabilities of the Present U. S. Long Range Detection System

1. A long range detection system consisting of seismic, acoustic, electromagnetic and air sampling components is presently deployed around the USSR. This system can detect and identify nuclear tests of 10 KT or larger conducted within the USSR and China as shallow subsurface, surface or air bursts up to 50,000 ft with an estimated reliability of 90-100 per cent. Nuclear tests as small as 3 KT in the same environments can be detected and identified with a reliability of 30 per cent.

Underground disturbances equivalent to 10 KT or larger can be detected with a certainty of 90-100 per cent but for about 70 such events per year, it is not possible to decide whether they are earthquakes or nuclear explosions.

Underwater explosions of 20 KT or larger conducted in deep ocean areas of the Northern Hemisphere and some parts of the Southern Hemisphere can be detected with 90-100 per cent certainty and probably identified as an explosion rather than an earthquake.

Since the present system was designed to detect tests conducted in the USSR, its capabilities for tests outside the USSR are limited. Nuclear tests as large as a few hundred kilotons and possibly even one megaton might be missed if conducted in areas remote from the present detection network.

1/ A complete transcript of the proceedings of the Working Group has been deposited with the Office of the Special Assistant to the President for Science and Technology

B. The Technical Feasibility of Monitoring a Test Suspension, Including the Outlines of a Surveillance and Inspection System

This involves detection and identification of nuclear explosions carried out in the following physical environments.

1. At the Earth's Surface and at Low Altitudes within the USSR and China. It would be feasible to detect and identify explosions at the earth's surface and at low altitudes, having yields down to about 1 kiloton, with the net of seismic, acoustic and electromagnetic stations located within the USSR and China, described in Appendix A. Positive identification requires the collection of nuclear debris which may in some cases involve overflight of the USSR or China.

2. At Very High Altitudes Over the USSR and China. Electromagnetic detection techniques, based on theoretical predictions, show great promise of detecting and identifying nuclear explosions created at very high altitudes. This is discussed in detail in Appendix B. A close net of some 40 electromagnetic detection stations would suffice, subject to confirmation of actual capabilities. Earth satellites could carry instrumentation for detecting and identifying the nature and location of nuclear detonations both within and outside the earth's atmosphere.

3. Below the Earth's Surface. Nuclear explosions conducted well below the earth's surface are most difficult to detect. (See Appendix C) With present seismic techniques it is possible to detect underground disturbances above 10 kilotons size with seismic stations located outside the USSR and China but not to identify such disturbances as nuclear explosions. With a net of seismic stations inside the USSR and China, it would be possible to detect earth shocks equivalent to 1 kiloton. But there would be a large number of earthquakes of 1 kiloton energy and above that could not be distinguished from a nuclear detonation. Of some 2500 earth disturbances in the USSR and China annually of 1 kiloton and above, about 88 per cent could be positively identified as earthquakes with about 45 seismic stations properly placed within the USSR, leaving about 300 which could not be so identified. Above a 5 kiloton limit, however, there would be only about 35 earth disturbances each year that could not clearly be distinguished from a sub-surface nuclear test. (See Appendix A)

It should be noted that the preceding discussion refers to the magnitude of seismic signals, rather than the magnitude of nuclear detonations. It is quite possible that a 50 kiloton nuclear explosion could look like 5 kilotons to a detection seismograph due to the nature of the coupling between the explosion and its surrounding medium. The signal recorded by the seismic stations may not indicate the actual nuclear energy yield because (a) the relationship between the seismic signal and underground weapon yield is not sufficiently known and (b) the coupling between the underground explosion and the seismic disturbances might be poorer than predicted due to the presence of a compressible material and could be substantially lower than the underground test at Rainier. Signal to noise reductions as high as a factor of 10 could be experienced especially at the lower yields. On the other hand, it can be expected that further research and development will result in systems permitting improved discrimination between nuclear explosions and natural disturbances. Resolution of uncertainties of shock coupling will require additional nuclear tests conducted for the purpose of exploring this phenomenon. It is important that future U. S. nuclear test programs include such special effects shots. If an international authority is established, it should undertake controlled nuclear testing aimed at improving detection capabilities.

Identification of seismic signals of unknown origin would require an on-the-spot investigation for each of these events. With present techniques the location of the source of the disturbance could be determined within a 5 mile radius. Positive identification of the nuclear test would require direct access by inspection teams to the suspected location of the test, and the acquisition of radioactive samples by drilling. Even with access of inspection teams to the suspected area, location of the precise spot sufficiently accurate for drilling operations will be difficult. Conventional intelligence will provide an important and possibly essential back-up for physical detection means. Local, low-level overflight for immediate post-test reconnaissance will be required. Even with this assistance one cannot count on 90 per cent success of identifying an individual shot.

4. Tests Conducted Outside the USSR and China. Detection of nuclear tests conducted in the Southern Hemisphere will require a net of about 30 detection stations with components similar to those in the Northern Hemisphere and air sampling coverage extended to both hemispheres. This system will be limited in detection and identification to yields of 20 KT and above. A very great difficulty with respect to nuclear tests conducted in the ocean areas would be in proving the nationality of the test, after a nuclear explosion had been identified (e.g. a Soviet nuclear test at Eniwetok). The possibility of a successful clandestine test by the USSR in the Southern Hemisphere would be

considerably lessened by conventional intelligence back-up of the detection net.

Detection of nuclear explosions and the identification of surface and air bursts occurring in Red China could be accomplished by means of the proposed net of stations in the USSR and other neighboring countries with some degradation in capabilities. But, identification of sub-surface bursts would not be possible without direct access of inspectors to the sites.

5. Detection Net. A net of about 70 detection stations located within the USSR and China, as described in detail in Attachment A, backed up by inspection teams and aerial reconnaissance, would be essential for monitoring possible Soviet tests conducted in all feasible environments within those countries. Full operational status would require approximately two years after an international agreement is reached although a few stations could be installed earlier. Without such a detection system located inside the USSR and China, the detection coverage would be inadequate for safeguarding a nuclear test limitation agreement. Should there be an international agreement to pursue technical studies and design of the detection system of the type described in Appendix A, a substantial amount of information could be disclosed by the U. S. without revealing Atomic Energy Restricted Data although it would be necessary to disclose presently classified detection techniques and capabilities.

6. Risk of Detection. The detection system described above has been designed to achieve a high probability of detection and identification of all nuclear shots in the USSR and China which give signals equivalent to 1 KT and above. For the actual enforcement of a moratorium, such a high probability may not be required since it may only be necessary to achieve a situation where the Soviets cannot afford to take the risk of being caught in a clandestine nuclear test. This risk would increase rapidly if several tests were required.

The CIA member of the panel believes that while a much lesser number of observation stations within the USSR, coupled with ground inspection teams, will not guarantee detection and proof of a very low yield, underground Soviet clandestine test, such a reduced system would provide such a high probability of detection as to deter the Soviets from a significant clandestine test program. The CIA member of the panel also believes that aerial overflight of the USSR for purposes of air sampling should not be considered an essential adjunct to an elaborate inspection system within the USSR.

The U. S. has estimated (SNIE 11-7-57) that if the Soviets have an over-riding need for the conduct of nuclear tests and if the risk of detection is reasonably high, then they would probably prefer to denounce openly the moratorium and minimize the political disadvantages of such action by false accusations against the West.

7. Weapons Development Implications of Detection Capabilities. If, pursuant to a nuclear test limitation by the end of 1958, a detection system were installed sufficient to detect and identify nuclear explosions above 5 KT, it would be extremely difficult for the USSR to develop higher yield boosted warheads, assuming no further Soviet advances in this field are tested prior to test cessation. Further Soviet development of megaton weapons would also be seriously impaired except insofar as this can be accomplished by improving the primaries (the lower yield first stage of a two-stage high yield nuclear weapon). On the other hand the aforementioned developments would be possible to a limited extent if the detection capability were limited to yields above 10 KT. In the case of boosted warheads, however, uncertainties in the precision of predicting actual yields of test devices in the 10 KT region would complicate the problem of evasion.

Efficient warheads below 1000 pounds in weight which may be needed for applications such as AICBM and Polaris, will require testing at yields considerably higher than 10 KT. In the case of lightweight thermonuclear warheads it is probable that test of a device at a substantial fraction of the actual yield will be required, such as one-fourth. For tests of two-stage non-propagating designs, somewhat smaller fractions of the actual yields would be sufficient, such as one-eighth, though substantially more than 10 KT would be required.

C. The Losses to the U. S. and to the USSR That would Accrue From Cessation of Nuclear Testing

1. U. S. and USSR Nuclear Warhead Capabilities. Table 1 compares the present and expected position of the U. S. and the USSR nuclear weapons developments according to warhead weight class; it is based on Appendices D and E. The yields of present U. S. warhead developments are measured yields unless otherwise noted. Throughout this report, dates given for U. S. nuclear warhead developments correspond to technical capabilities rather than dates they enter the U. S.

stockpile. Present yield capabilities attributed to the Soviets are based on acoustic observations from the tests conducted prior to January 1, 1958. The estimates of weights of Soviet nuclear devices are uncertain even if deduced from tests, and in addition in several cases the warhead capabilities are extrapolations from test experience. Such a tabulation of Soviet nuclear warhead developments is necessarily speculative and its surety cannot be comparable to the tabulation of U. S. capabilities.

U. S. capabilities indicated as of the end of 1958 reflect the best estimates of the weapons laboratories concerned (see Appendix D). In those weight classes where there is major doubt of results in the forthcoming HARDTACK tests, models of different degrees of conservatism will be tested. The estimates given in Table 1 of the USSR position at the end of 1958 are mere extrapolations from the rate at which they have been improving their weapons technology (Appendix E). It is not at all clear that such tests will in fact be made. Unless necessary tests are conducted before the end of 1958 the Soviets will not have a capability in the lower weight classes or at the 20 MT level. For example, unless the Soviets successfully test in 1958 a 1000 pound high yield warhead or if a test suspension is inaugurated prior to such test, we would not credit them at the end of 1958 with the estimated capability which infers a thermonuclear or two-stage fission weapon capability at that weight.

2. Asymmetries in U. S. and USSR Nuclear Warhead Needs. With respect to the development of ballistic missile warheads, considering warhead alone, it appears that the U. S. will be in a better position than the USSR based on relative yield-to-weight ratios, and on U. S. development of lightweight warheads in weight classes that do not appear in the Soviet family of warheads. However, the U. S. has military requirements not shared by the USSR. For example: (a) the U. S. requires a ballistic missile of 1500 mile range, compared with the apparent Soviet development of a missile with about 1000 mile range. Thus, for an equivalent propulsion system, a smaller warhead must be developed by the U. S. Similarly, the U. S. requires a submarine launched missile of range twice that needed by the USSR for a comparable geographical coverage. (b) The comparative status of long range missile development gives the USSR the ability to carry a heavier warhead; (c) more compact and ready ICBM's and IRBM's would greatly improve U. S. retaliation capability against surprise attack--the Soviets may not suffer this strategic disadvantage to the same extent; (d) small nuclear weapons are perhaps of greater value to the U. S. than to the USSR, because of our need to offset Soviet bloc superiority in manpower in a limited military operation.

3. AICBM Warheads. Neither the U. S. nor apparently the USSR currently possess a satisfactory anti-ballistic missile defense system nor is the U. S. certain as to the character of an effective over-all system. The main problem here is one of detection of an enemy ICBM and discrimination between it and possible decoys, of getting the AICBM to its target in time and of destroying the enemy ICBM without adequate knowledge of its design, rather than of obtaining any specified yield in the AICBM. However, it is likely that a lightweight, high-yield warhead will be needed to improve the effectiveness of the over-all weapon system based on the use of a ready, solid propellant rocket system. Two different shots at HARDTACK are directed toward the highest yield obtainable in 350 pounds, estimated to be 200-300 KT. If successful it will fill in a gap in our warhead family to permit selection of a warhead of this yield and weight. This is our current approach to the AICBM problem; however, it is not a guaranteed solution. The Soviets have not demonstrated a capability in this weight class although it is possible that they could test a 350 pound warhead of about 100 KT yield by the end of 1958.

If the high altitude shots at HARDTACK are successful, the U. S. will possess weapons effects information important to AICBM and other military developments that will not be available to the same extent to the USSR until a similar test is conducted. But much more effects information will be needed than HARDTACK is likely to provide because the instrumentation for the HARDTACK tests is incomplete, and there are likely to be further important effects that will not have been tested (e.g. ARGUS).

4. Very Small Warheads. As regards very small weapons, the U. S. has tested but not stockpiled satisfactory warheads of 11 inch diameter. To parallel the U. S. development in this field, the USSR needs to fully exploit the technique of boosting. Smaller diameters than 11 inches or lower weights with substantial yield (kilotons) can be achieved by the U. S. at present with increased expenditure of fissionable material. Relatively cheap weapons of low weight and [redacted] cannot be developed without further testing.

5. Boosted Warheads. It is estimated that by the end of 1958 the USSR will have a gas boosted device which is proof against predetonation and, therefore, usable as a primary for thermonuclear weapons. The Soviets started to test boosting developments early in 1957 and can be expected to make considerable progress in a number of directions consequent on these developments.

Boosting is highly important both to the development of cheap, very small warheads and cheap warheads of moderate size. Large numbers of small warheads will be needed for air and missile defense systems and solid propellant long-range missiles. The amounts of fissionable material required to satisfy substantial weapons capabilities in these systems may not be reasonable in terms of the planned U. S. stockpile unless a way can be found further to reduce the amount of fissionable material required for each warhead. To do this will require further nuclear tests beyond those planned for 1958.

6. Summary of Relative Position. To summarize the nuclear warhead position as of the end of 1958: the U. S. should be ahead of the USSR in nearly all weight classes but will not have reached ultimate performance, particularly with respect to economy of nuclear materials for the smaller, lighter weight warheads and clean weapons (see paragraph C-7). However, the Soviets will probably have warheads by that time that will satisfy most of their major military needs. The U. S. will need to keep ahead in lightweight, high-yield warheads to offset Soviet advantages in missile requirements (see paragraph C-2) and surprise capability.

Both countries will be able to compensate to some extent for the lack of optimal development in warheads by increased capabilities in delivery systems.

Unless some unforeseen breakthrough occurs indefinite continuation of nuclear testing will result in each country's achieving comparable capability in each weight class approaching the limits of what is practically achievable, differing only in relative time of accomplishment. There is a practical limit to the yield that can be achieved at any given weight. For large weights, the U. S. is now close to that limit; in lower weights there is far to go. The Soviet rate of improvement after 1958 in all weight classes is likely to be greater than the U. S. due to their inferior position as of the end of 1958. However, it may take a longer time for the USSR to achieve a comparable position for such special requirements as economy of design, cleanliness, and special effects. Some of these features, such as cleanliness, may not be of prime interest to the USSR. The limits for improvement in the economy of use of costly materials are set more by ingenuity than by laws of nature.

7. Clean Weapons. Clean nuclear weapons are being developed for special military purposes, primarily to reduce the hazard of

radioactive fallout to troops and friendly populations when it is necessary to detonate the weapon near the ground. The U. S. has in its stockpile a clean weapon yielding 6 megatons in 17,000 pounds weight (compared to 19 megatons in the standard version of this warhead with the same investment of critical material). The clean version will derive only some 4 per cent of its yield from fission so that its residual fission product radioactivity is equivalent to a standard weapon of about 250 kilotons. There is no evidence of Soviet intention to develop clean weapons.

As far as reduction of fallout is concerned, clean bombs exploded near the surface may be replaced by standard weapons exploded in the air in such a way that the fireball will not touch the ground. However, certain hard targets require ground bursts, such as airfield runways if it is desired to make a crater, railroad yards if severe destruction of tracks is to be accomplished, or heavily entrenched troops. Where ground bursts are required, clean weapons are needed if reduction of fallout is necessary because of future military operations or other cogent reasons such as protection of non-belligerants.

The use of clean weapons in strategic situations may be indicated in order to protect the local population, especially to protect our European allies from the consequences of attacks on the Western USSR or the satellite countries. In tactical situations, some hard targets may exist close to our own troops or friendly populations which would then call for the use of clean weapons.

Possession of a clean tactical weapons capability may also contribute to a political climate favorabl e to the introduction of nuclear weapons in a limited engagement. If both the USSR and the U. S. possessed clean weapons, a convention to use them rather than standard megaton weapons is conceivable.

The HARDTACK tests if successful will provide us with clean weapons of 7 megatons yield in 10,000 pounds and 2-3 megatons in 6500 pounds. It may result in a design for weapons in the 2000-3000 pound range which could be weaponized satisfactorily, though this is less certain. Improvements in yield especially for the lower weights referred to above could be obtained by further testing. Still lighter, clean weapons also will have to await further test series. With decreasing weight, the weapons become relatively less clean. Although the degree of cleanliness can generally be expected to improve with further tests, it will be limited by the amount of neutron induced activity in the ground. There was a divergence of view among members of the Working Group as to the military importance of small clean weapons for tactical situations.

8. Military Effects of a Test Cessation. The foregoing conclusions have been concerned with current and prospective warhead performance characteristics. The Working Group has not attempted to assess the military effects that would flow from stoppage of further weapons tests. In other words, it has not examined the effects on performance and availability of weapons systems and alternate systems and strategies that might be devised to compensate for warhead performance limitations. It believes that detailed systems evaluation studies should be undertaken by the Department of Defense on a priority basis with the necessary allocation of a number of experienced scientific and military personnel to this task.

9. Effects of a Cessation on Weapons Laboratories. The effects of a test suspension on the weapons research laboratories will depend on the terms of the moratorium, its duration and the general political climate and, in particular, on the belief of the laboratory personnel on the permanency of the test suspension. If laboratory personnel believe that the suspension is temporary, which might be the case if the agreement called for the automatic resumption of testing if progress were not achieved on the general problem of disarmament, considerable work might be possible, leading to a backlog of ideas and untested developments to be tested upon resumption of tests. If the laboratory personnel believed that the test cessation would be made permanent, the weapons groups in the laboratories would certainly deteriorate rapidly.

10. Soviet Gains Through Espionage. Some improvement in the Soviet position through leaks and espionage carried out over a period of years seems unavoidable. It should be assumed that, in time, USSR capabilities will tend to approach those of the U. S. even without testing.

TOP SECRET - RESTRICTED DATA

TABLE 1

U. S. AND USSR TECHNICAL CAPABILITIES
IN THE FIELD OF NUCLEAR WEAPONS

(Heavy and Mediumweight Warhead Capabilities)

DELIVERY VEHICLE	NOW				END OF 1958				FUTURE 2/	REMARKS
	U. S.		USSR		U. S.		USSR			
	Warhead Weight (1000 lbs.)	Yield (Megatons)	Warhead Weight (1000 lbs.)	Yield (Megatons)	Warhead Weight (1000 lbs.)	Yield (Megatons)	Warhead Weight (1000 lbs.)	Yield (Megatons)		
Heavy Bombers	17		5.5 (15) 1/		10		10 (20) 1/			
Medium Bombers	6.5		5.5		6.5		10		"	
Light Bombers & Fighters	3.1		(3)		3		3		"	A light bomber may carry about 4000 lbs. warhead with correspondingly higher yield.
ICBM	1.6		2		1.6		2		"	
IRBM	1.6*		2-3**		1.6		2-3		"	*The U.S. has chosen the same weight warhead for its IRBM as the ICBM although the IRBM could carry a heavier warhead. **The weight is now estimated to be 2000 lbs. and could be 3000 lbs. with a larger engine within USSR capabilities.

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(Heavy and Mediumweight Warhead Capabilities Cont'd)

DELIVERY VEHICLE	NOW				END OF 1958				FUTURE 2/	REMARKS
	U. S.		USSR		U. S.		USSR			
	Warhead Weight (1000 lbs.)	Yield (Megatons)	Warhead Weight (1000 lbs.)	Yield (Megatons)	Warhead Weight (1000 lbs.)	Yield (Megatons)	Warhead Weight (1000 lbs.)	Yield (Megatons)		
Polaris Type	(0.6) 1/		(0.6) 1/		0.6		(0.6) 1/			
700 NM Missile	Not Applicable		6*		0.6		6			*A 700 NM missile capable of carrying a 6000-lb. warhead is actually reported.
75-350 NM Missiles	6.5		2-3		6.5		2-3			Lesser yields are available, of course, to both U.S. and USSR. The weights given for USSR are those for which there is some evidence. The disparity in missile weights makes comparison difficult.
Air-to-Surface Missile	2.8		3		1.5-2.8		3			
Clean Weapons	17		(None)		1.0-1.2 2 3 6 10		(None)		Improvements in high warheads and development of small yield warheads by the U. S.	

1/ Those characteristics given in parenthesis refer to capabilities where there is no evidence of intention to develop a corresponding weapon.
2/ For "Future" capabilities, both the U.S. and the USSR will be able to make these improvements in time, sooner for the U.S. and later for the USSR.
3/ Yield estimated, not test result.

U. S. AND USSR TECHNICAL CAPABILITIES IN THE FIELD OF NUCLEAR WEAPONS

(Lightweight Warhead Capabilities)

DELIVERY VEHICLE	NOW				END OF 1958				FUTURE 2/	REMARKS
	U. S.		USSR		U. S.		USSR			
	Warhead Weight (Pounds)	Yield (Kilotons)	Warhead Weight (Pounds)	Yield (Kilotons)	Warhead Weight (Pounds)	Yield (Kilotons)	Warhead Weight (Pounds)	Yield (Kilotons)		
Anti-ICBM Missiles & Solid Fuel ICBM	350	[redacted]	350	[redacted]	350	[redacted]	(350) 1/	[redacted]		
Surface-to-Air Missiles	945		600		(400)		(600)			These yields and weights correspond to cheapness in use of fissionable materials required for large numbers of weapons. More expensive warheads giving higher yield in this weight class could be of the Polaris type.
Air-to-Air Missiles	218		(600)		100		250			
ASW	150 [redacted]		450 [redacted]		150 [redacted]		400 [redacted]			

(Lightweight Warhead Capabilities Cont'd)

DELIVERY VEHICLE	NOW				END OF 1958				FUTURE[2]	REMARKS
	U. S.		USSR		U. S.		USSR			
	Warhead Weight (Pounds)	Yield (Kilotons)	Warhead Weight (Pounds)	Yield (Kilotons)	Warhead Weight (Pounds)	Yield (Kilotons)	Warhead Weight (Pounds)	Yield (Kilotons)		
Small, Cheap, Tactical Weapons (less than 100 lbs.)		NO CAPABILITY FOR EITHER THE U. S. OR THE USSR THROUGH THE END OF 1958							In the near future a weapon [redacted] might be developed by the U. S. Also a weapon having less than 10-inch diameter.	

1/ Those characteristics given in parenthesis refer to capabilities where there is no evidence of intention to develop a corresponding weapon.
2/ For "Future" capabilities, both the U. S. and the USSR will be able to make these improvements in time, sooner for the U.S. and later for the USSR.