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DEPARTMENT OF STATE

MEMORANDUM OF CONVERSATION

PLACE: Joint Staff Conference Room,
Department of National Defence, Ottawa.

DATE: April 30, 1957
10:00 A.M.

N136

SUBJECT: TECHNICAL PROBLEMS OF NUCLEAR TEST LIMITATION AND REGISTRATION

PARTICIPANTS: Canada Dr. Longair, Chief, Directorate Atomic Research, Defence Research Board.
 Brigadier R. P. Rothschild, Chairman, Joint Disarmament Group.
 Dr. J. Arnell, Directorate Atomic Research, DRB.
 Mr. McKenzie, Directorate Atomic Research, DRB.
 Wing Commander McLeod, Royal Canadian Air Force.
 Captain F. W. T. Lucas, Royal Canadian Navy.
 Mr. Arthur Campbell, United Nations Division, Department of External Affairs.
 Mr. Kenneth Brown, Defense Liaison Division(1), Department of External Affairs.



United States Col. Benjamin Willis, White House Disarmament Staff.
 Lt. Col. R. E. Heft, Department of Defense.
 Lt. Col. V. H. Hudgins, Atomic Energy Commission
 Mr. F. E. Somers, OSI, Central Intelligence Agency.
 Mr. Chadwick Johnson, S/AE, Department of State.
 Mr. Philip Bogart, American Embassy, Ottawa.

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By [signature] Date 4/23/96

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This meeting was the culmination of Governor Stassen's suggestion that the U.S. explain to the Canadians in Ottawa the technical obstacles to the effective monitoring of a test limitation agreement in the absence of near-site inspection and instrumentation.

As chairman of the meeting Dr. Longair opened by reviewing the Canadian concern over the effects on health of continued testing and their notion that perhaps an agreement to limit the amount of internationally significant fission products dispersed by test explosions could be worked out among the nuclear powers prior to agreement on other disarmament measures. He called upon the U.S. to explain the reasons behind its position that a separate test limitation

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agreement would not be technically feasible. He stressed the technical purpose of the meeting.

With Dr. Longair's consent, Col. Willis offered a few general remarks on the approach to nuclear disarmament being taken by the U.S. Delegation in London. He mentioned the basically defensive philosophy of the U.S. military effort and emphasized the danger that would result from a weakened U.S. military posture. On the other hand, he stressed the unacceptability of an unchecked arms race. He restated the readiness of the U.S. to agree on test cessation, test moratorium or test limitation, provided the conditions were appropriate, i.e., implementation of safeguarded agreements to cease production of fissionable materials for weapons and to transfer increments of past production to internationally-supervised stockpiles. In the meantime, we were prepared to reach agreement on registration and limited international observation of tests, as well as to exercise restraint in testing. Col. Willis concluded by summarizing the Soviet position on tests and nuclear disarmament.

Mr. Johnson pointed out that the primary reason for the U.S. position on test limitations was the necessity for having a free hand to develop improved weapons with which to counter the formidable threat posed by the existing Soviet nuclear capability and growing nuclear stockpile. The other important, but secondary, reason was the infeasibility from the technical standpoint of enforcing a test limitation agreement at the present time. He emphasized that U.S. nuclear testing was premised on the conviction that testing at the current rate has not had and will not have any appreciable effect on health. He said that the U.S. recognized the sincerity of much of the public concern over possible danger to health from continued tests and had attempted to allay this concern by pledging at Bermuda that future testing would be conducted in such a manner as not to increase world radiation to more than a fraction of the levels considered dangerous. Referring further to Annex II of the Bermuda Communique, Mr. Johnson noted that the statement on the present inability to enforce a test limitation agreement for technical reasons was inserted largely at the behest of the U.K. as justification for the switch in its position.

Mr. Johnson said that the Canadian Embassy memorandum given to the Department on April 18 specified three main questions: (1) under what circumstances would it be difficult to detect total yield; (2) why would it be difficult to detect fission product yield; and (3) could the U.S. in connection with a test registration arrangement, safely give out estimates of the fission products which would be released from a test series and which would be of international concern.

Dr. Longair stated that even if agreement were reached on cessation of future production for weapons purposes, it would still be possible to test with fissionable material already on hand. He stressed that the principle of test limitation was for the Canadians one of reducing the danger to health.

At this point, Mr. Somers responded to question (1) above. He related that the U.S. atomic energy detection system is made up of four different methods of detection, viz, seismic, acoustic, electro-magnetic and nuclear debris. The seismic method is designed and installed to discriminate against ocean surf, earthquakes, etc. Its efficiency is dependent upon significant yield, good "coupling" and low background. The acoustic system is oriented toward the USSR, filters in a way to eliminate background, and is based on variations in atmospheric pressure. Its efficiency is determined by pulse duration, level of background, yield, height of burst, meteorological conditions, etc. Still very much in the experimental stage is the electro-magnetic method which, when equipment and interference problems are solved, will establish the "zero" time of the nuclear shot. The last method, sampling nuclear debris, is dependent upon prior notification, favorable meteorology and timely intercept. It furnishes the only positive proof that seismic, acoustic or electro-magnetic phenomena were nuclear in character. In summarizing the worth of each of these methods, Mr. Somers said that seismic was good for detecting underwater, underground or low altitude shots but poor for high altitude shots or for shots in highly seismic areas; acoustic was good for medium to high altitude, ~~for~~ high-yield shots and poor for very high altitude, underwater, underground and low-yield shots; electro-magnetic is still experimental and unreliable and nuclear is excellent as long as an intercept is made but poor for determining the time and place of a shot. Hence, the circumstances under which it would be questionable whether we would be able to detect the fact of a nuclear explosion or its total yield are where a shot is exploded at a very high altitude, the test location is unfavorable or unsuspected (e.g. Southern Hemisphere or Antarctic), the testing operation is carefully staged (e.g. destruction of obsolete naval vessel simultaneously with underwater explosion of a nuclear device), two or more shots are set off simultaneously, or the meteorology is adverse. Mr. Somers cited a few examples of Soviet shots which were unsatisfactorily recorded by the detection system. He added, however, that he did not mean to depreciate the system, which was certainly capable of detecting important shots in certain areas of the world and would force the Soviets into elaborate efforts to avoid detection.

In response to Dr. Longair's question whether the energy of a high altitude megaton explosion would not reach the lower atmosphere and be recorded in some manner, Mr. Somers gave his opinion that in the rarified atmosphere the explosion would not create a shock wave and hence would not be detected by the acoustic system. Seismic would not record the shot nor would there be readily identifiable debris. Dr. Longair asked what was the dividing line between medium and high altitude explosions. Mr. Somers and Col. Hudgins indicated that high altitude for megaton devices began at about 100,000 feet. Dr. Longair asked how accurately the U.S. detection system could measure the total yield. Mr. Somers said the accuracies of intelligence estimates normally carry a reliability of a factor of two (if the system recorded a one megaton explosion, the explosion in fact may have been either as small as 500 kilotons or as great as two megatons) but that the reliability of the yield figure for each shot is assessed on an individual basis. Factors affecting the reliability are the number of signals received, their strength, and the number of methods by which indicators are received.

At this point, Col. Heft addressed himself to question (2) above, i.e. the reasons why the yield of fission products from a nuclear test would be difficult to detect. Col. Heft said his answer was based on the following assumptions:

1. The major source of fission products is the megaton-class of weapons; hence, we need only to consider these.
2. The yield of all megaton-class weapons derives partly from fission and partly from fusion.
3. Physical detection methods measure the total yield.

He said that if these assumptions are accepted, it must be concluded that information on fission yield must come from analysis of nuclear debris. There are two ways of going about this: (1) determine the absolute fission yield from debris analysis; or (2) determine the ratio of fission yield to fusion yield from debris analysis; which ratio when combined with an independent total yield measure could be used to deduce the fission yield. However, Col. Heft noted, both of these methods are inadequate. Regarding the first method (absolute yield from debris analysis), he pointed out that debris consists of condensable residue from the test. By analysis we can determine the number of fissions per atom of uranium or per atom of plutonium or per atom of iron or per atom of any of a number of possible components. However, unless we know the original total number of atoms of uranium, plutonium or iron in the weapon, we cannot determine the total number of fissions which have occurred. The original amount of material in a foreign weapon are unknown; therefore, absolute fission yield determination fails. As for the second method (fission-fusion ratio from debris analysis), Col. Heft stated as follows. Debris contains condensable residues of a test. The products of fusion reactions are such things as alpha particles, tritium and neutrons, which do not condense. Therefore, the debris samples contain no direct indicator of the amount of fusion which may have occurred. An indirect indicator of fusion reactions may be the reaction products produced from the heavy elements by high energy neutrons from fusion. However, these products represent only a fraction of the total such neutrons which may have been produced and hence can only be used to set a lower limit on the fusion-energy-to-fission-energy ratio. If the high energy neutron reaction products tell us that a minimum of 5% of the energy came from fusion, and if we assume the existence of the possibility that almost 100% of the energy may have come from fusion, then the uncertainty about the fusion-fission ratio is a factor of almost 20%. Therefore, one could not disprove a statement by the USSR that only 100 KT of a 10MT test was fission if they chose to misrepresent the actual fission yield.

Mr. McKenzie asked if amounts of heavy element neutron capture products could not be used as an index of the fusion yield. Col. Heft replied that the amounts of these are dependent only on the number of neutrons which actually entered the heavy material and still left you without information on the number of neutrons which had not left the fuel.

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Dr. Longair asked if we were prepared to discuss the distribution of fission products through the troposphere and stratosphere. Col. Heft replied that distribution from the stratosphere was the subject of an intensive experimental study at the present time. He added that the tropospheric storage time was short -- on the order of 30 days.

Dr. Longair asked if it would not be possible to detect gross deviations from the terms of a limitation agreement, inasmuch as it is the great explosion that is of concern from the health standpoint. Col. Heft referred back to his statement on the possibility of being accurate in your measurements of fission yield only to within a factor of 20.

Dr. Longair then asked how "clean" the "clean" weapons were. Col. Hudgins said that we can see right now really clean weapons. He noted that at the last test series fallout had been greatly reduced by modifications in the bomb design and the method of firing. In this connection, he noted, the announcement of the fission yield from a test might disclose classified weapons data.

Dr. Longair asked if access to the testing site would give as much as 25 per cent accuracy. Mr. Somers said to obtain accurate measurements even from a position near the testing site would require rather elaborate instrumentation.

Dr. Arnell interjected that the existing system could not detect explosions in the Southern Hemisphere and asked, rhetorically, Who was going to pay for the extension of the system to that area.

Captain Lucas asked if the amount of potentially dangerous fallout was directly proportionate to the size of the device tested. In other words, would the explosion of 100 weapons of 10 KT yield produce as much dangerous radiation as a 1 megaton explosion. The answer to this was generally affirmative, although it was suggested that since small weapons normally have a higher percentage of fission than the larger ones it could be expected that in toto the fission products from the small weapons would exceed those from one large weapon of equivalent total yield. Dr. Arnell noted, however, that the small-yield surface shot was safest from the point of view of the health of people not in the vicinity of the shot.

Mr. Campbell asked as to the feasibility of giving out, as part of a test registration scheme, estimates of the total amount of fission products of international concern resulting from a test series to be given either before or after the series.

Col. Hudgins replied that although announcing the total fission yield of a test series would not reveal as much weapons design detail as would the

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announcement of the fission yield of each shot, it would provide information on the average ratio of fission yield to total yield of the weapons tested during the series, and thereby reveal some design information. Col. Hudgins also noted that by agreeing to announce estimates of fission yield we would have to contend with charges that our estimates were too low or that we were releasing amounts of fission products dangerous to health. There is also the technical problem of deciding where to draw the line between on-site and off-site fallout, or fallout of international concern.

Dr. Longair thanked the U.S. group for its presentation and the meeting ended at 11:40 A.M.

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