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Dear Mr. President:

In response to your request of September 5 we are enclosing a paper comparing the effectiveness of nuclear weapons testing in various media.

Total # of pages 13

Respectfully,

R

From NMB-P

(Signed) Glenn T. Seaborg

SEP. 19 1961

Secretary of Defense	Chairman Atomic Energy Commission

The President
The White House

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NMB 228

Enclosure:
Nuclear Test Program
SRD 1A thru 6A

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September 19, 1961

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NUCLEAR TEST PROGRAM (U)

In order to compare the effectiveness of testing nuclear explosives in various media as requested in NSC Action Memo No. 87 the various requirements for such tests must first be analyzed. Although these re[redacted]ments have been presented previously, they are reviewed here in a re[redacted]nt framework as a convenience to understanding. The United States principal aims may be categorized as follows:

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1. To improve weapons.
2. To measure the effects of weapons.
3. To explore peaceful applications of explosions.

In all of these areas some progress can be and is made without nuclear tests through theoretical analysis and laboratory experiments. However, in every case after such work, full scale nuclear tests are required for confirmation and extension of the information. By careful design of tests, while a particular test may have one primary objective, measurements can be carried out which support all of the national aims. Thus, while a test may be required to study a new weapons design concept, the explosion can be used also to obtain weapons effects data and to contribute to peaceful applications.

Let us now discuss more fully each of the national aims and indicate the kinds of testing required to obtain the measurements of interest.

The objective of nuclear weapons development in the United States is directed toward satisfying military requirements for both limited and general war. To the extent practicable, weapons are developed which are discriminating in effects and which provide flexibility in employment. Two major areas of effort in past tests which require continuing emphasis [redacted] future tests are the

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increase of weapon yield for a given weight for strategic weapons, particularly for missiles, and the reduction in size of tactical weapons. Another area of effort in tests prior to the moratorium was the development of "clean" weapons having reduced radioactive fallout. An important program which may eventually provide a whole family of "clean" weapons is the all fusion concept. These weapons would extend over the full range of desired magnitudes from the smallest tactical and defensive warheads to the largest missile warheads and bombs. Tests are urgently required in all these areas and we can expect great progress toward the following developments:

1. Missile warheads of smaller weight which will lead to smaller, more mobile, and more serviceable missiles or will allow better penetration through enemy defenses for a given total payload.

2. AICBM developments, mostly in terms of effects of nuclear explosions on incoming re-entry vehicles. The questions to be answered include more precise understanding of the effective range of known effects, the possibility of enhancing these effects by special design of the defensive weapons or choice of the circumstances of detonation, and possible unknown effects. This information is pertinent not only for defensive considerations but also is important to our own penetration of enemy defenses.

3. New types of tactical weapons, including small fusion warheads.

4. Further study and development of reliable low-fission yield (clean) warheads.

The effort of DoD and AEC will be to develop weapons pointed at specific military requirements, rather than simply to develop higher yield weapons without obvious military benefit. Yet it must be realized that frequently in the past, and possibly in the future, new concepts or ideas of great value have developed from the effort to fulfill specific weapon needs.

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An important part of development is related to increasing by all possible technical means the safety of all nuclear warheads and to incorporating various innovations to assure against unauthorized or illegal use.

Weapons systems tests will provide much needed information on the weapon system and effects in the environment in which the system will be used operationally.

Weapons effects measurements are urgently required in many areas to evaluate the effectiveness of our weapons in different environments. The areas of principal uncertainty are the effects in the atmosphere, particularly at high altitudes, which are pertinent to our missile defense, and to radio propagation and radar blackout; to effects in the oceans which are pertinent to fleet operations and anti-submarine warfare efforts; and to effects on hardened underground sites, including both blast and electromagnetic pulses. We know all too little of effects of surface and subsurface bursts on partially protected structures and communications essential to effective command and control. These data are needed to decrease the vulnerability of our missile systems and to increase the understanding of the effects associated with the vulnerabilities of our missile sites. At the same time steps will be taken toward achieving a high degree of kill probability on the enemy's delivery systems, insuring continuous communications and radar capabilities, and determining optimum employment tactics for both fleet and land warfare. Sufficient data are not available in all these cases to be able to make calculations with sufficient reliability. Also, because additional considerations in the past three years have indicated more relevance of some effects than originally believed in these areas, there is a serious deficiency in data. Furthermore, it is highly probable, as history has shown repeatedly, that new kinds of pertinent effects of great military significance may be discovered.

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The VELA Program, while directed primarily toward evaluation and development of methods of monitoring a treaty of test cessation, is also related heavily to the success of our intelligence efforts. In addition the PLOWSHARE Program, which is a study of the peaceful applications of nuclear explosions, can derive large amounts of critical information from explosions for other purposes. However, to explore all the potentialities, specific explosions will be necessary to support both of these programs.

What are the necessary environmental requirements to meet the various stated objectives? In other words, can the necessary data be obtained by underground tests alone or do other environments need to be considered? These are best discussed by category, as follows:

1. Weapons Development

Many of the essential data for weapons development can be obtained through underground testing; however, tests to satisfy development requirements for our larger weapons may be and probably are beyond the capabilities of underground testing, which probably cannot be economically extended above a few hundred kilotons. The specific areas of weapons development that would require such large yields are:

a. Large "clean" bombs where propagation of the thermonuclear reaction is of critical importance;

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c. Significant steps toward bombs of 100 MT or more would require large yield above ground tests if it were decided such weapons are needed. It should be noted that a preliminary design exists, that might not require testing[redacted]

d. Proof test of strategic bombs and warheads.

e. There are no weapons systems performance tests which can be conducted in an underground environment. Systems which experience severe environments and which should be tested are the ICBM and AICBM missile systems. An example of such a test which would result in weapons development, weapons effects and weapons systems data would be to explode an antimissile warhead against our own ICBM warhead. Of course, this type test must be conducted in the high atmosphere.

For development tests at these yields either atmospheric or space shots are required. The time required to get ready for space experiments could vary from a relatively few months for simple proof tests, to at least two years for more complicated experiments.

2. <u>Weapons Effects</u>

In the consideration of weapons effects testing, great limitations appear with underground explosions. Examples of the most critical areas of desired measurements are:

a. <u>Blackout and Communication Effects</u>

A very important known area requiring above ground nuclear test is in connection with blackout and communication effects caused by very high altitude nuclear bursts. Little information is available on this subject from previous tests. Calculation of the effects is uncertain, and methods for simulation of the phenomena are unknown. Understanding of these effects is important to our own penetration capabilities as well as for anti-ICBM. To explore effects in this area would required explosions about as follows:

High yield at about 450,000 feet for effects in the D-region.

High yield at about 1,500,000 feet for effects in the upper ionospheric region.

High yield at about 3,500,000 feet to understand effects associated with magnetic containment and disturbances.

b. Anti-ICBM Effects

The kill mechanisms for anti-ICBM systems must be better defined. These include X-rays, neutrons, and possibly thermal and blast effects. While some X-ray data can be obtained through the use of vacuum pipes underground, the studies would be limited to low yields. One experiment of this type is scheduled [redacted]wever, for larger yields and to get gross effects under actual environmental conditions as well as to search for unexpected phenomena, it seems impossible to avoid the necessity of high altitude bursts. At the present time no specific experiment has been designed.

c. Atomic Demolition Munitions - Of less over-all importance but of considerable interest for atomic demolition purposes and PLOWSHARE (excavation), cratering explosions would be required to measure the throw-out and distribution of radioactivities from such underground detonations. In this case experiments can be designed in such a way that the fallout that does occur will be highly localized (for example, to the test site in Nevada). As part of the PLOWSHARE program two cratering experiments have been designed, one at 500 tons in hard rock at the Nevada Test Site

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and one at 280 KT in Alaska. While these experiments are basic to PLOWSHARE, the results would apply to the employment of atomic demolitions.

d. Hardened Sites

Finally, more data are needed for the design of hardened sites and the protection from induced electrical currents generated by surface or near surface bursts. Experiments are not yet designed, but to acquire the most useful information would require experiments involving construction in geological media characteristics of our hardened sites. Some preliminary information on structural response will be developed from the planned HARDHAT experiment, which will be 5 KT underground in granite at the Nevada Test Site, and is scheduled for early 1962.

As a final point, it should be emphasized that even for the weapons development program, particularly in the critical months ahead, the United States does not possess enough underground sites to meet all of the urgent test needs. By having the option of some surface or above surface tests, and by avoiding too conservative a policy with respect to venting, a greater rate of progress can be achieved. (Venting limits should be related to levels of off-site contamination such as meet public health and safety standards).

Once the present lack of readiness and backlog of test requirements have been overcome, it would probably be possible, assuming a large investment in facilities, to carry out an adequate program at a satisfactory rate underground except for the large scale tests. There may, however, be unforeseen obstacles which could make this more difficult than now anticipated. For example, our first underground shot in the present series gave a greater yield than expected; some of the diagnostic data were lost; and what was more serious, an unsuspected underground pool of water seems to have vented into the cavity or tunnel, causing contaminated steam to permeate that entire tunnel system. This may delay work in that tunnel complex for a few weeks.

It is important to recall that nuclear technology is a rapidly changing science -- that surprises are in store. It is important that our opponents not be the ones to make the first major discoveries and we can assume that their present test series include tests of the advanced ideas they have been able to develop over the past three years. It is also important to recall the major surprises the United States has had in every test series, and that major steps can be taken only by testing. The present Soviet tests could easily put them ahead of the United States in important areas, and by testing above the surface with large yields they have a substantial advantage in ease of experimentation and rate of progress under present circumstances.

In the past the Atomic Energy Commission - Department of Defense in conducting their experiments on the surface, underground, in the atmosphere, and in the oceans have developed operational procedures which have assured the public health and safety. These were accomplished by appropriately controlling areas of fallout or other disturbance, by development of reliable prediction methods, by using explosive yields as small as possible consistent with the experimental objectives, and by limiting the number of explosions to those required for development or effects data. A great deal can be accomplished to limit contamination through the firing of scaled-down versions. The safety record is extraordinary. Future tests will be given the same careful consideration as in the past. The amount of radioactivity released will be limited to a minimum and in all cases will be very much below the concentrations at which there is judged to be a public health and safety hazard.

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This does leave the question of genetic effects, which may exist down to any dose level. Past tests have increased temporarily the natural background of penetrating radiation by a few percent, which may have produced calculable but not observable genetic effects. For the foreseeable atmospheric shots it would appear that the total expected fallout would be smaller than for the U.S. HARDTACK series of 1958.

In summary, optimum progress in weapon and device development and in obtaining effects information, would involve a diversified test capability, underground, atmospheric, underwater, and ultimately exoatmospheric.

In addition to minimizing problems of contamination, underground testing has advantages in certain cases; for example, to deny intelligence information to the enemy, for diagnostics in specific instances, and for relative freedom from weather delays. Atmospheric tests are essential for large yield tests, for most effects determinations, particularly in regard to nuclear weapons on nuclear weapons and on equipment. Determination of effects against underground installations should be possible largely through underground tests.

It must be recognized, however, that even those tests which can be done underground can in many instances be done much faster and less expensively in the atmosphere. Accordingly, in the event that large fission yield weapons are authorized in the atmosphere, small weapon tests not requiring heavy instrumentation might just as well be conducted on balloons in the interest of speed since they will contribute little additional activity to worldwide fallout.

The above considerations lead to the need to take immediate steps to ready ourselves for the whole spectrum of tests even though the actual decision to test other than underground may be made later and be based on other than

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technical or economic considerations. It is important that the President have the flexibility of decision inherent in a readiness posture.

For example, with some procurement and equipment maintenance actions, it should be possible to improve our readiness to test on balloons at the NTS so that we could test on one week's notice. Limited preparedness steps with respect to Eniwetok could put us on a three months' readiness posture for that site.

In any event, if a decision is made to resume testing in the atmosphere, tests should and can be confined to total yields that will not have too great an effect on worldwide fallout.

We therefore recommend that:

1. The presently planned test program proceed under the assumption that it will be conducted underground during the next year. Too conservative a policy with respect to venting should not be required.

2. Exploration and appropriate preparatory steps be taken toward providing an underground test capability for the indefinite future.

3. Preparations be made for possible atmospheric tests in the range up to a few tens of kilotons at the Nevada Test Site. This capability should be available in the near future to give the President flexibility of decision in case of necessity.

4. Plans be made and steps be taken by the AEC and DoD to bring the Eniwetok Proving Ground to a three months' readiness posture. At least for the time being, these steps should be of such a nature as not to imply a commitment to early resumption of testing at Eniwtok.

5. The possibility of completely seaborne operations be given some attention.

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6. VELA (detection) and PLOWSHARE (peaceful uses) tests should proceed underground. Some experiments may be only partially contained under such conditions that fallout can be confined on-site (or nearby in remote areas).

7. Particularly because of the high altitude effects tests which will have great military significance, the United States should make no public statement foreclosing the possibility of carrying out a limited number of atmospheric nuclear explosions.

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NUCLEAR TEST PROGRAM (S/RD)

Prepared 9/19/61 - GJohnson/ Haworth/Betts/vcj

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