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AEC 597/23

October 1, 1953

COPY NO. 1

ATOMIC ENERGY COMMISSION

CASTLE PROGRAM

Note by the Secretary

1. The attached report by the Director of Military Application is circulated for consideration by the Commission at an early date.

2. The CASTLE program will be discussed at the AEC-MLC conference scheduled for 2:00 p.m., Thursday, October 1, 1953.

ROY B. SNAPP

Secretary

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*Carl Wilson* 5/2/84  
REVIEWED BY *HR Schmidt* 7/9/85

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This document consists of 26 Pages

Copy No. 1 of 20 Series A

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ATOMIC ENERGY COMMISSION

CASTLE PROGRAM

Report by the Director of Military Application

THE PROBLEM

1. To determine the scope and timing of Operation CASTLE.

SUMMARY

2. Operation CASTLE embraces both short-term and long-term goals for the thermonuclear program. The short-term goal is to prove in an emergency capability with one or more thermonuclear weapons currently being engineered for production and delivery. The long-term goal is to test new designs which should lead to thermonuclear weapons that are smaller, lighter, more deliverable, and perhaps of higher yield in the future. The tests of the ~~TOP SECRET~~ are directed toward determining the content of the emergency capability program. The test of the ~~TOP SECRET~~ may enable the weight of the emergency capability weapons to be reduced and, together with the tests of the ~~TOP SECRET~~ should point the way to the next generation of thermonuclear weapons. The earliest feasible date for the start of the CASTLE tests is March 1, 1954. The CASTLE program recommended is believed to be the maximum practicable program.

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RECOMMENDATION

3. That the Atomic Energy Commission:

a. Approve the scope of the CASTLE program to include tests of the [redacted] with the test of the [redacted] to be contingent on the performance of the [redacted]

b. Approve the scheduling of the first CASTLE test for March 1, 1954, the sequence, exact dates, and locations of the various tests to be determined by the Commander of the Joint Task Force Seven in conjunction with the Los Alamos and UCRL-Livermore Laboratories.

c. Note that copies of this staff paper will be forwarded with a memorandum such as that in Enclosure "D" to the Chairman of the Military Liaison Committee, requesting concurrence by the Department of Defense in the scope and timing of the CASTLE program.

d. Note that the Joint Committee on Atomic Energy and the General Advisory Committee will be advised of this action by appropriate letters.

*The Military Liaison Committee*

LIST OF ENCLOSURES

ENCLOSURE "A"

Background, discussion, and conclusions

ENCLOSURE "B"

Letter of September 22, 1953, from Los Alamos

ENCLOSURE "C"

Letter of September 21, 1953, from UCRL-Livermore

ENCLOSURE "D"

Draft Memorandum to the Chairman, MLC

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ENCLOSURE "A"

BACKGROUND, DISCUSSION, AND CONCLUSIONS

BACKGROUND

1. In a letter of June 23, 1952, the AEC requested MLC agreement to proposals for an urgent program to (1) fabricate the first deliverable version of a thermonuclear weapon, the ~~TOP SECRET~~, for test toward the end of 1953 and (2) establish an "emergency capability" for use of this device shortly after its first test if this turned out to be successful (AEC 493/5). The MLC advised of concurrence by the Department of Defense in a letter of July 3, 1952 (AEC 493/8). The possibility was envisaged at that time that other radiation-implosion devices might be included in the test operation.

2. The successful MIKE shot in Operation IVY on November 1, 1952, ~~TOP SECRET~~

~~TOP SECRET~~ patterned after the MIKE device and called the ~~TOP SECRET~~

~~TOP SECRET~~ Subsequently, calculations on the feasibility of combining the virtues of a dry fuel, as in the ~~TOP SECRET~~ with the favorable implosion characteristics of the ~~TOP SECRET~~ as in the ~~TOP SECRET~~, led to a dry, ~~TOP SECRET~~ called the ~~TOP SECRET~~ which would utilize normal lithium. Finally, the possibility of

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3. In order to explore ~~TOP SECRET~~ for emergency capability and thereby improve the odds of achieving at

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least one successful weapon, the Los Alamos Scientific Laboratory proposed on November 28, 1952 (AEC 597/2) that CASTLE be expanded to include the [REDACTED]. In order to accomplish this program, Los Alamos recommended that CASTLE be held in the Spring of 1954. UCRL-Livermore proposed on November 24, 1952 (AEC 597/2) that two thermonuclear devices, the [REDACTED] be tested in CASTLE to investigate the potentialities of [REDACTED] and stated that these devices probably could not be ready for test until late Winter or early Spring of 1954. By letter of January 2, 1953 (AEC 597/7) the Commission proposed to the MLC that CASTLE be held as early in 1954 as technical progress permitted, and by letter dated January 19, 1953 (AEC 597/11) the MLC advised of Department of Defense concurrence.

4. In the course of further study of various thermonuclear weapon designs at Los Alamos in 1953, consideration was given both to a [REDACTED] containing normal lithium and to a [REDACTED] containing lithium partially enriched in lithium-6. The latter would have a better chance of success and would give a higher yield, but would be dependent on lithium-6 production. Meanwhile, in the Spring and Summer of 1953, the Air Force indicated the importance of reducing the weight of thermonuclear weapons for delivery by the B-47, a medium bomber being produced in large numbers, and for delivery by the Hustler, a new medium bomber under development. Los Alamos responded by proposing that the enriched [REDACTED] be scaled down to about a 3/4 scale version called the [REDACTED] with a reduction in weight from 42,000 to 25,000 pounds. Since the [REDACTED] has been under design for only a few months, engineering for production and delivery is not as far advanced as in the case of the [REDACTED] which are the emergency capability weapons.

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5. The program for thermonuclear development, testing, and emergency capability have been going forward with great emphasis and speed. The importance of these programs is increased by the fact that the Soviet Union conducted an atomic test on August 12, 1953, that involved both fission and thermonuclear reaction.

DISCUSSION

6. Following a meeting on September 17, 1953, at Los Alamos among representatives of the Atomic Energy Commission, Los Alamos, UCRL-Livermore, Oak Ridge, and Joint Task Force Seven, proposals for the CASTLE tests were formally submitted by Los Alamos and UCRL-Livermore and are attached as Enclosures "B" and "C". These proposals recommend testing the ~~SECRET~~

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7. The purpose of the ~~SECRET~~ tests is to prove in emergency capability weapons. The third emergency capability weapon, the ~~SECRET~~ was not included in the Los Alamos proposals because of considerable doubt as to its nuclear performance and because of the previous assumption that Los Alamos would be limited to four shots in the CASTLE Operation. However, if the ~~SECRET~~ were successful it would have the advantage of being a dry weapon independent of lithium-6 production; it would be a hedge against failure or limited availability of the ~~SECRET~~ and it would also be a hedge against logistic and delivery problems that may arise from the ~~SECRET~~. Because the ~~SECRET~~ offers the greatest assurance of good nuclear performance, it must be heavily depended on in the early emergency program. However, better decisions regarding the relative merits ~~SECRET~~ and future production can be made after CASTLE on the basis of actual results and experience gained from

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testing each type. This is particularly important since the present situation indicates a large military requirement for emergency capability weapons soon after CASTLE.

8. A preview of the performance of the [redacted] will be afforded by the test of the [redacted] is essentially a [redacted] design reduced in scale but enriched in lithium-6. If the yield of the [redacted] were to be low because of inadequate propagation of the thermonuclear reaction, then the [redacted] would not merit testing. On the other hand, if the yield of the [redacted] were high, the chances for the [redacted] would be increased. Since the test of the [redacted] is to be the most thoroughly instrumented one in CASTLE detailed information should be available on its performance. Because of the potential advantages of the [redacted] in the emergency capability program, it therefore appears advisable to include a test of the [redacted] in CASTLE, contingent on the performance of the [redacted]

9. The tests which are intended primarily to provide information for the future development of thermonuclear weapons are the [redacted]. The goal is to obtain data which will enable the next generation of thermonuclear weapons to be of smaller size, lighter weight, higher efficiency, or greater yield. Results of the test of the [redacted] which has a [redacted] [redacted] to be redesigned and their weight reduced by as much as 10,000 pounds, with a smaller reduction in weight possible for the [redacted]. The tests of the [redacted] [redacted] are aimed at the development of weapons having yields of a megaton or more for weights and sizes in the range of present fission weapons. Detailed discussions are contained in Enclosures "B" and "C".

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10. In regard to the timing of the CASTLE Operation, Los Alamos proposes in Enclosure "B" that March 1, 1954, be set as the target date for the first test. This is based on the rate of supply of lithium-6, the time required for fabrication, shipment, and assembly of weapon components, and the schedules for construction of test sites and installation of equipment at Bikini and Eniwetok. Although there is no one phase of the preparations which prohibits the start of CASTLE a little earlier, every phase is so tight that March 1 seems the best target date to set for the initial detonation. Tentatively establishing a less realistic date would lead to confusion in planning and conducting the operation and would probably not result in an earlier successful completion of the operation.

11. Scheduling the date of the first CASTLE test for March 1 does not adversely affect the time when the first emergency capability is to be achieved. The plan is to initiate emergency capability with ~~██████████~~, and these are the thermonuclear weapons that can be stockpiled with greatest assurance of their nuclear performance prior to the CASTLE tests. In accordance with the directives of the Commission on September 23, 1953, every effort will be made to have ~~██████████~~ available for emergency capability in January 1954.

12. Consideration was given to limiting the CASTLE program to a maximum of four shots and deferring the remaining tests to a later operation. While this would be favorable from the point of view of simplifying and shortening the CASTLE Operation, it would not be consistent with the maximum effort toward thermonuclear progress. It would also involve greater expense inherent in two separate operations. As to the relative difficulty of seven versus six shots, it now appears that a seventh shot would

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be feasible, at reasonable cost in time, dollars, and effort, if the barge technique used for the ~~██████████~~ shots proves favorable enough to extension to an additional barge shot at essentially the same site. Radiation hazard of these over-water shots appears sufficiently low to permit firing at the close time intervals anticipated. The instrumentation mounted on the islands could, if not damaged, service three shots probably as well as two.

13. The CASTLE program recommended in this paper is believed to be the maximum practicable program. It covers all available possibilities for providing an emergency capability and should furnish an excellent basis for the future development of thermonuclear weapons.

CONCLUSIONS

14. A seven shot CASTLE program provides the greatest assurance of achieving an "emergency capability" by minimizing the possible consequences of unanticipated problems with ~~██████████~~ and assures earliest development of better weapons to exploit AEC's programmed capacity to produce lithium-6.

15. Any alternative plan such as postponing a portion of the shots until the Fall of 1954 would be wasteful, costly, and harmful to either the immediate "emergency capability" program or future progress in the field of thermonuclear weapons.

16. The magnitude and complexity of a seven shot program is not to be underestimated, but must be reconed with in view of the importance of thermonuclear weapon progress. It therefore appears ill-advised to consider anything short of a maximum effort for the CASTLE program.

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17. For the above reasons the Division of Military Application concludes that the CASTLE Operation should be planned to include seven test shots rather than six as proposed by the Laboratories in Enclosures "B" and "C".

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ENCLOSURE "B"

UNIVERSITY OF CALIFORNIA  
Los Alamos Scientific Laboratory  
P.O. Box 1663  
Los Alamos, New Mexico

22 September 1953

Brig. General K.E. Fields  
Director of Military Application  
U.S. Atomic Energy Commission  
Washington 25, D.C.

Dear General Fields:

As you are aware, extended discussions regarding the CASTLE operation took place at the Los Alamos Scientific Laboratory on 17 and 18 September between representatives of Holmes and Narver, the Eniwetok Field Office, the Santa Fe Operations Office, the San Francisco Operations Office, the Radiation Laboratory (Livermore), the Oak Ridge Operations Office, Carbide and Carbon Chemicals Company (ADP Plant), Joint Task Force 7, the Los Alamos Scientific Laboratory, and your office. As the result of these discussions, conclusions were reached regarding the proposed content and schedule of the CASTLE program which it is the purpose of this letter to report.

The LASL proposes to test at CASTLE four thermonuclear systems of which certain details are given in Appendix I. These systems are as follows:

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It will be noted that the LASL program as presented here differs slightly from earlier prognostications which have generally anticipated the test of a  or unenriched LiD, thermonuclear system. A number of developments have led us to the conclusion that, within a framework of four experiments, the  experiment provides more important and useful information than the  experiment. Our reasons for this opinion are summarized below.

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The Radiation Laboratory (Livermore) proposes to test at CASTLE the two radiation implosion devices, namely the ~~TOP SECRET~~ and the ~~TOP SECRET~~ which they have described elsewhere. The total CASTLE program thus remains at six shots. The schedule of these six shots was established, after a thorough review of the status of construction at Eniwetok-Bikini, the rate of availability of  $\text{Li}^6$ , the design and fabrication status of the test shots, and the logistic problems of the Task Force, as follows:

March 1, 1954

March 11

March 22

March 29

April 7

April 14

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Pre-eminent among the factors which have led to the adoption of this schedule are the following:

1. The construction program at Eniwetok would require joint occupancy of test structures by the contractor and by scientific personnel for at least two weeks before shot date if an earlier schedule were to be attempted. Such joint occupancy (e.g. wiring going in by the contractor at the same time electronic equipment is being tested by scientific personnel) is believed to be completely impractical. From a security point of view, it is most undesirable to have construction workmen present during weapon assembly and placement operations. The proposed schedule eliminates (or minimizes) such joint occupancy.

2. The supply of  $\text{Li}^6$  for the proposed experiments should be complete (according to present predictions) for the proposed schedule at least 50 days in advance of actual shot date. Approximately 40 days is regarded as minimal time for shipment, fabrication, local assembly and test, overseas shipment by air, and assembly and test overseas. The proposed schedule allows a slight degree of freedom in this respect.

3. The proposed schedule will permit the Task Force to send the major portion of its personnel overseas immediately after Christmas rather than sometime before. This is a matter of some concern to the Task Force Commander for obvious reasons of morale. It will also permit a considerable degree of logistic simplification, particularly with regard

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to the shipment of certain construction materials for the contractor. Airlift requirements in the weeks after 1 January 1954 are extremely heavy and it is not obvious that MATS can satisfy these requirements. The proposed schedule will ease this problem.

4. Design, fabrication, assembly, and local test of both the proposed LASL and Livermore devices can probably meet the above schedule unless presently unforeseen delays are encountered. Similarly, the diagnostic experimentation will probably be ready by these dates. Earlier dates would be extremely problematical in terms of actual accomplishment.

5. To attempt to meet earlier dates and then postpone at the last minute is wasteful of time, money, and logistic effort. The present schedule represents the best proposal which can be made at this time for the earliest practicable schedule which can be met if no unforeseen difficulties are encountered.

We have attached to this letter as appendices (1) a table of the general character and requirements of the proposed LASL devices, as well as some additional general information on other weapon systems which may be of interest for comparison; and (2) a somewhat revised production schedule for the emergency capability period based upon the inclusion of the ~~TOP SECRET~~ only in the CASTLE test program. Although the active material requirements for these tests are fairly precise, it may be well to postpone the specific request to higher authority for permission to expend these materials until the exact amounts have been determined.

Very truly yours,

/s/

N.E. Bradbury  
Director

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APPENDIX I

<u>OX (93.5%)</u> <u>(KG)</u>	<u>Pu</u> <u>(KG)</u>	<u>T</u> <u>(G)</u>	<u>B10</u> <u>(KG)</u>	<u>Li (KG) at --%</u>	<u>Warhead</u> <u>Weight</u> <u>(lbs.)</u>	<u>Warhead</u> <u>Diameter</u> <u>(Inches)</u>	<u>Warhead</u> <u>Length</u> <u>(Inches)</u>	<u>Warhead</u> <u>Anticipated</u> <u>Yield Range</u> <u>(MT)</u>	<u>Comment</u>
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APPENDIX (2)

Omitting the ~~DELETED~~ from the CASTLE series suggests a revision in the production schedules for the emergency capability program. In considering this change, it should be remembered that the major mechanical parts for the ~~DELETED~~ are essentially identical and thus an ~~DELETED~~ could be introduced into the program after CASTLE with comparative ease.

The proposed production plan is based upon the following assumptions:

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4. Delivery of units (E.C., practice, flight and drop) to begin in January 1954.

5. Delivery of the first set of field assembly equipment for assembly teams in January 1954, not later than delivery of the first E.C. unit.

Table I shows the monthly rate of deliveries to stockpile and development work as well as the cumulative numbers in stockpile. The numbers of units opposite each month are those delivered in that month.

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TABLE I

	Flight and Drop	Emergency Capability	Total Per Mo.	Cumulative Emerg. Capab.
JAN.	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
FEB.	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
MAR.	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
APR.	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
MAY	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
JUNE	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
JULY	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
AUG.	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]
SEPT.	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]

JAN.  
 FEB.  
 MAR.  
 APR.  
 MAY  
 JUNE  
 JULY  
 AUG.  
 SEPT.

\*Includes 2 practice units.

Such a table would be followed during this period if the results of CASTLE indicate a satisfactory behavior of both the [REDACTED]. It gives an a priori preparedness [REDACTED] as well as capabilities for both a cheap and an expensive (in terms of scarce materials) system. Presumably, if successful and if wanted in larger numbers, [REDACTED] could be made in whatever greater numbers the fabrication facilities involved would permit.

There remains the possibility that the [REDACTED] shows unsatisfactory behavior and that it is not desired to put Li<sup>6</sup> into this emergency capability system. On this basis, it could be recommended that the 95% Li<sup>6</sup> produced up to that time be stockpiled for future use in [REDACTED] or similar systems, and that the ADP plant immediately revert to the production of [REDACTED] which could be used for enriched [REDACTED] whose behavior is certain to be satisfactory if [REDACTED] is satisfactory, and which in any case will give higher yields than similar systems of no enrichment. Table II shows the production schedule which would result if CASTLE should suggest by 1 May 1954 the advisability of making [REDACTED]. Alternatively, more [REDACTED] could be recommended for production and 95% Li<sup>6</sup> continued in production and stockpiled for use in systems such as the [REDACTED].

[REDACTED]

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TABLE II

Flight and Drop	Emergency Capability	Total	Cumulative Emerg. Capab.
<del>DELETED</del>	<del>DELETED</del>	<del>DELETED</del>	<del>DELETED</del>

MAY

JUNE

JULY

AUG.

SEPT.

It may finally be noted that if case difficulties interfere with the successful performance of both the ~~██████████~~ and the ~~██████████~~ then the ~~██████████~~ would certainly not have worked and we would have to face the fact that there would be no emergency capability in this field because of the 50,000 lb. weight limitation.

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ENCLOSURE "C"

UCRL-LIVERMORE LABORATORIES

September 21, 1953

General Kenneth E. Fields, Director  
Division of Military Application  
U. S. Atomic Energy Commission  
Washington, D. C.

Dear General Fields:

The University of California Radiation Laboratory proposes to explode two thermonuclear devices at Operation Castle, Pacific Proving Ground, Spring, 1954. One of these, [REDACTED] is hoped to be the prototype of a class of weapons having a wide range of yields, weights, and diameters. The other, the [REDACTED] is similar to [REDACTED] except for the composition of the thermonuclear fuel. [REDACTED] It is designed to give information which is unattainable from [REDACTED] alone, but which is essential in order to design weaponized versions of [REDACTED] especially if this is to be done over as wide a range of parameters as we plan.

I. Design

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IV. Material Requirements Summary (Expended Material Only)

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Sincerely yours,

HERBERT F. YORK