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RESTRICTED DATA DECLASSIFICATION DECISIONS

1946 TO THE PRESENT

(RDD-8)

January 1, 2002

U.S. Department of Energy
Office of Health, Safety and Security
Office of Classification

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Reviewed by: Richard J. Lyons Date: 3/20/2002

NOTICE

This document provides historical perspective on the sequence of declassification actions performed by the Department of Energy and its predecessor agencies. It is meant to convey the amount and types of information declassified over the years. Although the language of the original declassification authorities is cited verbatim as much as possible to preserve the historical intent of the declassification, **THIS DOCUMENT IS NOT TO BE USED AS THE BASIS FOR DECLASSIFYING DOCUMENTS AND MATERIALS** without specific authorization from the Director, Information Classification and Control Policy. Classification guides designed for that specific purpose must be used.

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FOREWORD

This document supersedes Restricted Data Declassification Decisions - 1946 To The Present (RDD-7), January 1, 2001. This is the eighth edition of a document first published in June 1994. This latest edition includes editorial corrections to RDD-7, all declassification actions that have been made since the January 1, 2001, publication date of RDD-7 and any additional declassification actions which were subsequently discovered or confirmed. Note that the terms "declassification" or "declassification action," as used in this document, refer to changes in classification policy which result in a specific fact or concept that was classified in the past being now unclassified. As a result of each such information declassification action, potentially large numbers of documents may be declassified in whole or in part. In other words, a single information declassification may have a much broader impact than it may appear at first glance.

A New Approach. The breakup of the former Soviet Union, the end of the Cold War, and other national and international events of recent history have enabled our national leadership to reconsider the constraints placed on both classified and unclassified Government information. The Department of Energy (DOE) remains committed to a policy of responsible openness, and will continue under Secretary Abraham to declassify and release information to the public consistent with the requirements of national security.

The declassification actions that have been formally approved by the date of this document, other declassified information from earlier years, and editorial changes included in this document, are identified by a vertical line in the left margin. Declassification actions are listed chronologically in the appropriate chapter. Annual updates of this document are anticipated.

For the initial edition of the RDD series (RDD-1), a search of the Department's files for all previous declassification actions was made. The result of this search was a document which provided a compilation of information regarding the topics which had been declassified over the years up to that present time. RDD-8 updates the latest edition (RDD-7) and continues to provide historical perspective on the sequence of declassification actions performed by the Department of Energy and its predecessor agencies. It is meant to convey the amount and types of information declassified over the years. Although the language of the original declassification authorities is cited verbatim as much as possible to preserve the historical intent of the declassifications, this document is not intended nor does it provide the reader sufficient basis or authority to decide whether other documents are classified or not. These decisions can only be made by specially trained individuals who are certified by the DOE as authorized derivative declassifiers.

Historical Background. The first atomic detonation, test shot Trinity, on July 16, 1945, near Alamogordo, New Mexico, was a device developed and produced under the Manhattan Project. This was followed by detonations at Hiroshima, Japan, on August 6, 1945, and Nagasaki, Japan, on August 9, 1945; these detonations heralded the end of World War II. Immediately following World War II, the academic and industrial sectors of the country placed considerable pressure to declassify and release information developed during the Manhattan Project. It is well to remember that at this point in time there was no Atomic Energy Act, no Atomic Energy Commission, and no Restricted Data category of information.

In November 1945, General L. R. Groves, head of the Manhattan Project, asked Dr. R. C. Tolman to develop a declassification policy for the classified information which had been developed to date. Dr. Tolman, who was the Dean of the Graduate School at the California Institute of Technology and had served as a science advisor to General Groves during the war, selected a distinguished group to help him in this task. The Tolman Committee developed declassification guidance that was accepted by General Groves and published in March 1946 as a Declassification Guide for Responsible Reviewers. The declassification guidance for the year 1946 is based on the work of the Tolman Committee. The outline of topics used in the 1946 declassification guidance provided the basic outline for the topics in this compendium. Modifications have been made to accommodate additional categories of information which have been declassified since that time.

The Atomic Energy Act, approved on August 1, 1946, established the Atomic Energy Commission (AEC) and provided the historical and legal basis for its successor agencies, the Energy Research and Development Administration (ERDA) (January 20, 1975, through September 30, 1977) and the current Department of Energy. Among other things, it recognized the need for the close relationship between the AEC and the Department of Defense (DOD), and facilitated the approval of joint AEC/DOD guides containing classification and declassification actions for almost a half century. The Act also recognized that classified atomic energy information is of a special and unique type, identified it as a new and distinct category, "Restricted Data," and defined this category as all data concerning the manufacture or utilization of atomic weapons, the production of fissionable material, or the use of fissionable material in the production of power other than that information that had been declassified by an appropriate authority.

The first International Declassification Conference was held in Washington, D.C., November 14, 15, and 16, 1947, among representatives of the United States, the United Kingdom, and Canada to discuss revisions to the Declassification Guide for Responsible Reviewers. As a result of that meeting a revised guide was adopted and published as the Declassification Guide for General Application, dated March 15, 1948.

The Commission established the Weapon Effects Classification Board in August 1948, to determine the proper classification of nuclear weapon effects. Under the chairmanship of Dr. N. E. Bradbury, the Board met at Los Alamos on August 13, 1948 and recommended classification guidance for the weapon effects area. This guidance was used to declassify certain items of information recommended by the Board.

The 1946 Atomic Energy Act was amended and enacted as the Atomic Energy Act of 1954. Among other things, the new Act modified the definition of Restricted Data to include "design" of atomic weapons and changed the words "fissionable material" to "special nuclear material." It also provided for the declassification of Restricted Data following a determination that such information can be published without undue risk to the common defense and security. In addition, this 1954 Act provided for the transclassification of information related primarily to the military utilization of atomic weapons. Transclassification changes the information from Restricted Data to Formerly Restricted Data and causes it to be protected as National Security Information except when it is exchanged with a foreign country. These different categories of information are all classified but have different security requirements based on the sensitivity of information in each category.

Information Versus Documents. In the discussion of classified matters, it is important to note the distinction between "information" and "documents." Information is regarded as facts, data, or knowledge, whereas documents or material are the means through which information is conveyed. When an item of Restricted Data information is declassified, that bit of declassified information becomes eligible for public release regardless of the nature of the documents of which it may be a part. A classified document will always contain some classified information, will normally contain some unclassified information, and may contain declassified information. Such a document cannot be released until all of the classified information is deleted. The declassification of an item of information may result in the release of an entire undeleted document; then again, the declassification may have little effect due to the continued classified nature of the remaining document content. Likewise, sensitive unclassified information of many kinds contained in a document may preclude full release of the document.

Explanation of sources. This document is the result of a search reaching back for over half a century. During that time, the records were maintained under three Government agencies with differing goals and philosophies. The files were also affected by several internal reorganizations, relocations, amendments to document retention regulations, and complete personnel changes at all levels. However, with the able assistance of those responsible for records maintenance, the voluminous data contained in this document were recovered from the files.

The declassification actions were gleaned from many and varied source documents. They included staff papers, minutes of meetings, action memoranda, correspondence, classification and declassification guides, press releases, and classification bulletins. While the declassification actions themselves are not classified, most of their source documents remain classified due to the remainder of their content. Topics in this compilation are quotes from the original source documents to the extent possible. Where an exact quote is not possible, the editorial adjustments made for clarity have been kept to a minimum consistent with maintaining the intent of the declassification action. Some topics may appear terse, non-explanatory, incomplete or inconsistent, but they are copied as exactly as possible from their source document.

Each topic is followed by a reference number indicating the year of the declassification and its place in the chronological order of declassification actions for that year. For example, 49-2 is the second declassification action in 1949. Some declassification actions contain only a single topic, while most are actions with multiple topics. In addition, many topics list exceptions to the declassification action. The exceptions identify information which remained classified as of the date of the declassification action. These exceptions are printed in italics in this compendium. In many cases, the excepted topics were subsequently declassified in whole or in part. These subsequent declassifications are listed chronologically below the original topic.

As time has passed, many declassified topics were superseded by more recent declassifications. Early day exceptions often no longer apply; they have been overtaken by other events. For example, in 1955 the only declassified information concerning the Controlled Thermonuclear Reactor was the fact of interest in such a program and the sites where work was underway. In 1959, all information regarding this program was declassified. There are many such examples, but, in the interest of completeness, this compendium incorporates all of the declassifications uncovered.

Users of this compilation should note that it is possible that the files hold other declassification actions which have not yet been discovered. As additional topics are declassified or previously undiscovered declassification actions are found, they will be included in the next edition of the compendium.

Although this compendium contains declassification actions for weapon test yields where declassification documentation could be located, it is clear that not all weapon test yields are included. For those that are included, the yields quoted are taken verbatim from the declassification action, and may have been based on early estimates that were later refined as more information was obtained. A better source of weapon test information can be found in document DOE/NV-209 (Rev. 15) dated December 2000.

This document has been approved and issued by the Director, Office of Classification. Comments, recommendations, and requests for copies should be sent to the following address:

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OVERVIEW

It has long been the policy of the Department of Energy and its predecessor agencies to conduct as much of its research and development work as possible on an unclassified basis. This policy is meant to promote the free interchange of ideas essential to scientific and industrial progress while assuring that classified information is not compromised. To this end, guides have been issued to assist in the identification of the fields of research and development that are unclassified or have been declassified. RDD-8 provides a historical perspective on the sequence of declassification actions performed by the Department of Energy and its predecessor agencies. It is meant to convey the amount and types of information declassified over the years. The language of the original declassification authorities is cited verbatim as much as possible to preserve the historical intent of the declassification. In recognition of RDD-8's utility as the sole source for documenting certain declassification actions, all Derivative Declassifiers are authorized to use RDD-8 as a basis for declassifying documents and material. Because RDD-8 does not contain the detailed context for declassification actions found in guides and bulletins, it is intended that this authority be used sparingly and in accordance with the following guidelines. Derivative Declassifiers should use RDD-8 as a basis for declassification only when:

- no other classification guidance exists;

- the information being reviewed falls in a classified subject area identified in the Derivative Declassifiers' current description of authority or in an area that has no potential of containing classified or unclassified sensitive information (e.g., commercial reactors, biological effects of radiation, uranium mining and milling, etc.); and

- the declassification action identified in RDD-8 clearly pertains to the information being reviewed.

If there is any doubt as to the relevance of an RDD-8 topic or the availability of other guidance, the local classification officer, classification representative, or the Director, Information Classification and Control Policy should be consulted. When RDD-8 is used as a basis for declassifying documents or materials, it should be cited as such. RDD-8 is the source of last resort when making declassification decisions.

The following is a list of subject areas which are, for the most part, unclassified. It must be recognized that there are facets of each which must remain classified because of the relationship with nuclear weapons, nuclear materials, or nuclear propulsion programs.

• Basic science: mathematics, chemistry, theoretical and experimental physics, engineering, science, materials science, biology, and medicine;

• Magnetic confinement fusion technology;

• Civilian power reactors, including nuclear fuel cycle information but excluding certain technologies for uranium enrichment;

- Source materials (defined as uranium and thorium and ores containing them);
- Fact of use of safety features (e.g., insensitive high explosives, fire resistant pits) to lower the risks and reduce the consequences of nuclear weapon accidents;
- Generic weapons effects;
- Physical and chemical properties of uranium and plutonium, most of their alloys and compounds, under standard temperature and pressure conditions;
- Nuclear fuel reprocessing technology and reactor products not revealing classified production rates or inventories;
- The fact, time, location, and yield range (e.g., less than 20 kiloton or 20-150 kiloton) of U.S. nuclear tests;
- General descriptions of nuclear material production processes and theory of operation;
- DOE special nuclear material aggregate inventories and production rates not revealing size or details concerning the nuclear weapons stockpile;
- Types of waste products resulting from all DOE weapon and material production operations;
- Operations solely relating to the public and worker health and safety or to environmental quality; and
- Heavy water production technology.

These unclassified subject areas relate only to information that was once within the Restricted Data definition. It is obvious that many cover basic scientific information that has always been unclassified and publicly available.

This document addresses information previously classified as Restricted Data, and includes no information classified under any other information control system.

I. SCIENCE AND TECHNOLOGY

A. GENERAL

1. Information within the scope of publications, "A General Account of the Development of Methods for Using Atomic Energy for Military Purposes," by Dr. H. D. Smyth, and other accredited releases concerned with project information. (46-1)

2. Information already published in scientific or technical literature which was developed outside the Manhattan Project. (*It must be fully understood that the* <u>*mention*</u> *of particular subject matter in the Smyth Report or in the scientific or technical literature does not make it proper to release information* <u>*beyond*</u> *that which is actually disclosed in the publication concerned. Furthermore, unaccredited publication of classified Project scientific or technical information does not constitute authority for declassification or for repeated publication of that information.*) (46-1)

B. MATHEMATICS

1. Methods of applied mathematics and computation if illustrated on declassified subjects. (46-1) Examples:

   a. Shock hydrodynamics. (46-1)
   b. Integration of partial differential equations. (46-1)
   c. General diffusion theory. (46-1)
   d. Theoretical methods for determining equations of state. (46-1)
   e. Chemical kinetics including application to ordinary explosives. (46-1)
   f. Theoretical methods for calculating opacities. (46-1)
   g. General theory of blast. (46-1)

2. Methods of applied mathematics if illustrated on declassified subjects. (47-1)

3. Pure and applied mathematics including computational methods, provided it does not reveal information classified for other reasons. (48-1)

C. CHEMISTRY

1. All chemistry of non-classified substances *not directly involved in production or utilization of active materials*. (46-1)

2. Methods of chemical analysis, with illustrations on non-classified substances. (46-1)

   a. General methods of chemical analysis developed for uranium metal and graphite. (46-2)

I. SCIENCE AND TECHNOLOGY (Continued)

3. Microchemical and microscopic techniques, if illustrated on non-classified substances. (46-1)

4. Basic studies of chemical effects of radiation. (46-1)

5. Details of fission product chemistry, *omitting reference to separation processes.* (46-1)

6. Methods of isotopic analysis. (46-2)

    a. Mass spectrograph method (46-2)

        (1) Analytical procedures. (46-2)
        (2) Special instruments. (46-2)

    b. Other methods

        (1) Analytical procedures. (46-2)
        (2) Special instruments. (46-2)

    c. Mass spectrograph and other methods of isotopic analysis, including analytical procedures and special instruments *provided the procedure does not permit an accuracy of analysis better than 0.1% of the isotopic abundance for heavy elements. (Care must be taken not to reveal classified purity specifications.)* (48-1)

7. Physical instrumentation and chemical and metallurgical techniques *provided they do not reveal otherwise classified data*. (47-1)

8. All chemistry of non-classified substances not directly involved in production or utilization of fissionable materials and all methods of chemical analysis *provided these do not reveal process details by inference*. (47-1)

9. The basic chemistry of all elements *if not restricted by the following topics*: (48-1)

    a. *Reactions used, or alternates reasonably employable, in the classified technology of classified materials.*

    b. *Modifications through variations in reagents, reaction conditions, or equipment of general methods already employed in a classified process.*

    c. *New procedures reasonably employable as technological processes for the preparation of classified materials.*
    d. *Procedures used, or reasonably employable in a direct way, as analytical*

I. SCIENCE AND TECHNOLOGY (Continued)

controls in classified processes.

10. Effects of Radiation

a. Physical and chemical effects of high energy levels of radiation on matter, *except for special construction materials and chemicals used in production processes. The values of radiation levels in production piles should not be released.* (46-1)

b. Basic studies of the chemical and physical effects of radiation *but restricted by the classified information described by the following topics*: (48-1)

(1) *The effect of intense radiation on structural properties of reactor materials and all important accessory reactor equipment (such as graphite or materials used in the instrumentation inside the reactor).*

(2) *The technologically important effects of intense radiation on chemical substances as employed or reasonably employable in the extraction and purification chemistry of elements 90 and above in production and pilot plants.*

c. All theory on the effects of radiation on materials *except for theoretical recipes specifically intended to fit substances of special significance to the Project. (Care should be taken that classified experimental information is not revealed either by inclusion or by implication.)* (50-4)

d. All effects of radiation on all substances, including basic studies of the chemical effects of radiation, *except where limitations are stated in the examples below:* (50-3) (50-4)

(1) Electrical thermal conductivities, *except for materials of special interest for reactors, such as possible refractories*.

(2) Hall effect.

(3) All effects in semi-conductors.

(4) Mechanical properties, *except for creep data directly applicable to the design of reactors obtained under condition of pile irradiation or thermal effects in reactor fuel elements.*

(5) Transition effects and metastable phases in general.

I. SCIENCE AND TECHNOLOGY (Continued)

(6) Irreversible (metastable) effect on the crystal lattice, i.e., lattice disordering and studies of stored energy associated therewith.

(7) All experimental information on the changes produced by ionizing radiations of energy above 1 Kev and by neutrons on the extra-nuclear properties of:

(a) beryllium, beryllium oxide, beryllium carbide, graphite and zirconium.
(b) The extra-nuclear properties of all elements of atomic number 90 and above as well as their alloys, mixtures and compounds.
(c) The extra-nuclear characteristics in fuel-bearing solutions, slurries or suspensions and in reactor fuel elements and critical reactor components.

(8) The effect of radiation on the properties of solvents and other chemicals used in the extraction and decontamination of fissionable materials, although it is not intended to prohibit declassification of properties which are of no vital importance to the process. (Water is excluded provided conditions in reactors are not revealed.)

(9) Effects of radiation on the corrosion characteristics and heat transfer properties of coolant systems, although it is not intended to prohibit declassification of properties of basic scientific value provided these are not vital to reactor development.

11. Pure and applied chemistry including analytical chemistry of all elements *except*: (50-3) (50-4)

a. Analytical techniques for the detection of critical impurities in liquid metal coolants.

b. The quantitative aspects of the use of organic solvents, or complexing agents on elements 93 and above.

c. Technological application of ion-exchange studies for all elements of atomic number 90 and above.

d. Procedures reasonably employable in the technology of source or fissionable material or weapons, or the alternates or modifications of such procedures.

I. SCIENCE AND TECHNOLOGY (Continued)

e. *New procedures, reasonably employable in the preparation of source or fissionable material or weapon components, or important to the improvement of the process.*

f. *Analytical procedures critically important to classified processes, especially:*

(1) *The analysis for B, Li, Cd, Au and Hg in source and fissionable materials as well as in important reactor materials.*
(2) *The analysis for Li, B, Be, Na, Mg, C, Al, O and F in fissionable materials.*

g. *Important new extraction processes for uranium or thorium from either low-grade or intermediate-grade raw materials.*

h. *Important new methods and processes for separation of zirconium from zirconium-hafnium mixtures.*

i. *Overall details, flow sheets, diagrams, production rates, operating procedure and policy, engineering and construction data, of production and pilot plants making special materials for the Project.*

j. *Special precautions taken in plants producing fissionable materials with respect to critical mass.*

k. *The production technology of the following substances: deuterium, tritium, special high-purity graphite, fission products, polonium, actinium, thorium metal, uranium metal, the compounds UF_6 and UCl_4, the isotopes U^{233} and U^{235}, plutonium and its compounds, and alloys, compounds or mixtures containing fissionable materials intended for use as fuel elements. This includes description of actual manufacturing operations, or reasonable alternates, and laboratory work from which the nature of these operations could be clearly inferred.* Amounts of these vital materials less than certain established minimal quantities need not be considered classified.

NOTE: This does not prohibit the release of information on the laboratory-scale separation of the fission products from one another. *Care must be exercised not to reveal information regarding the large-scale production of specific radioactive products of fission.* It is not intended to prevent the release of basic physical and chemical work concerned with irradiation of materials which could be used for the production of tritium, nor the methods of handling tritium gas on a small scale.

12. The use of organic solvents and complexing agents on all elements. *(The significance to project technology of these agents and solvents should not be stated or implied.) Also refer to I.C.11.a above.* (50-3) (50-4)

I. SCIENCE AND TECHNOLOGY (Continued)

13. Basic chemical studies involving ion exchange resins for all elements, *excepting plutonium. Also refer to the NOTE following I.C.11.k above*. (50-3) (50-4)

14. The analysis of source and fissionable materials for other elements, *excepting those prohibited by I.C.11.f(1) and (2) above.* (50-3) (50-4)

15. The analysis of source and fissionable materials as minor constituents of samples, *provided process or other critical information is not revealed*. (50-3) (50-4)

16. Improvements in existing unclassified extraction processes for uranium or thorium from intermediate-grade raw materials. *Major improvements should be subject to review prior to their unclassified use*. (50-3) (50-4)

17. Methods for the analysis of gold and mercury in source, fissionable and reactor materials since such data are already fully covered in the open literature. (53-6)

18. Basic data on anion exchange resins used in chemical extractions. (53-6)

19. Redox separation process, to include costs information, *but not all technical details*. (55-1)

20. Information relating to the chemical processing of reactor fuels and blanket materials irradiated in civilian power reactors. (56-6)

21. Information concerning chemical processes used in chemical processing plants at Savannah River, Hanford or Arco, if it does not disclose: (57-1)

    a. Production rate data
    b. Classified characteristics of material being processed
    c. Production plant operating conditions
    d. Classified programs

22. All chemistry and chemical processing except *that revealing the quantities and specifications of the materials that are produced primarily for military purposes.* (59-6)

I. SCIENCE AND TECHNOLOGY (Continued)

D. THEORETICAL AND EXPERIMENTAL PHYSICS

1. Nuclear Data

a. All nuclear properties of non-classified substances. (46-1)

b. All nuclear and extra-nuclear properties of all isotopes *except those prohibited by the following topic and in Tables A and B.* (48-1) (Tables A and B are located in Appendix A.)

(1) *Spontaneous fission of all elements of atomic number 90 or above. Number of neutrons released per fission and thresholds and cross-sections for fission induced by neutrons below 25 Mev energy in all elements of atomic number 90 or above*.

c. Quantitative information on all thermal (n, gamma) reactions and reactions on all isotopes where Z is 90 or greater, *except where the following nuclei are targets:* (50-1)

(1) U^{235} *for which no information about these reactions may be released*.
(2) U^{233}, U^{234}, U^{236}, Pu^{239} *and* Pu^{240} *for which* only the existence of the reactions may be released. (50-1)

d. All nuclear and extra nuclear properties of all isotopes *except as prohibited by the following topics.* (50-3) (50-4)

(1) *The nuclear properties of* U^{233}, U^{235}, U^{236}, U^{238}, Pu^{239} *and* Pu^{240} except as permitted by topics II.P.7 through II.P.10, II.I.4 through II.I.7 below, and Appendix B.
(2) *The neutron absorption cross section of* Xe^{135} *for all energies.*
(3) *The absorption cross section, for thermal neutrons, of carbon isotopes, of their natural mixture, and of high purity graphite specifically manufactured for use as a moderator,* except as permitted by topic I.D.1.f below.

e. Yield information must be expressed only in terms of numbers of particles per fission and *not in terms of partial cross sections, in case the particular fission cross section is not declassifiable*. (50-4)

f. Any information on neutron cross sections concerning carbon or graphite *which does not reveal a thermal cross section of less than 4.5 mb.* (50-4)

I. SCIENCE AND TECHNOLOGY (Continued)

g. All nuclear data except: (59-6)

(1) the partial cross sections of lithium and its isotopes (for neutron energies between 1 Mev - 25 Mev).
(2) nuclear data obtained from weapon tests which would reveal significant information concerning the detonations.

h. Partial cross sections of lithium and its isotopes for neutrons of energies between 1 Mev and 25 Mev. (61-3)

2. General Physics

a. Elementary theory of neutron diffusion and general elementary pile theory *omitting reference to classified installations.* (46-1)

b. Elementary theory of neutron diffusion and general pile theory. (47-1)

c. It is the intent of these topics to release only that information which is of particular value for teaching the basic theoretical principles of reactors and for describing the use of these reactors as tools for scientific research. *This excludes the release of information on the design of small reactors*. (48-1)

(1) The theory and methods of measurement of criticality and fluctuations *insofar as they do not release knowledge of such quantities as the number of neutrons per fission.* (48-1)
(2) The theory of control rods for reactors. (48-1)
(3) All theoretical methods of treating neutron diffusion and slowing down problems for stationary media. *Care should be exercised that examples cited do not involve semi-empirical methods leading to the calculation of the optimum lattice structures of chain reacting systems. Furthermore, great care must be exercised not to reveal empirical constants or give too narrow a range of values when citing examples. (Declassification of any work carried out directly or indirectly for Los Alamos must have written approval from the Director of the Los Alamos Laboratory.)* (48-1)
(4) The theory and results obtained from the sigma pile *but not those from exponential piles. The theory of exponential experiments and the results obtained from their use for determining the design and operating characteristics of reactors must remain classified.* (48-1)

I. SCIENCE AND TECHNOLOGY (Continued)

d. Experimental studies of the equation of state of all elements with atomic number less than 90 *provided the methods used do not reveal information about applications or methods of use of items critical in the construction of weapons.* (50-3) (50-4)

e. Theoretical methods for calculating opacities. (50-3) (50-4)

f. Theory of blast in air *but without reference to theory and design of weapons.* (50-3)

g. Experimental methods of studying air blast *but without reference to theory and design of weapons, application or methods of use of items critical in the construction of weapons, or destructive effects of specific bombs* except those already used. (50-3)

h. All theoretical methods of treating neutron diffusion and slowing down problems for stationary media. *Care should be exercised that examples do not disclose constants whose release is prohibited.* (50-4)

i. Reactor theory applicable to those reactors listed below[1] including the calculation of optimum lattice structures when illustrated by values permitted under topics I.D.1.e, II.P.7, II.P.9, and II.I.4. (50-4)

j. Slowing down calculations involving neutrons produced from the thermal fission of U^{235} or neutrons from non-fission sources. (50-4)

k. The equation of state studies for all elements under conditions *other than those revealing classified information.* (67-2)

l. Information on equations of state and opacities of certain materials *not of significance to weapon design.* (72-11)

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[1] United States

Argonne National Laboratory
- CP-1 (graphite, natural uranium)
- CP-2 (graphite, natural uranium)
- CP-3 (heavy water, natural uranium)

Los Alamos Scientific Laboratory
- Low-Power Water Boiler (light water, enriched uranium)

United Kingdom: Harwell - GLEEP (graphite, natural uranium)
Canada: Chalk River - ZEEP (heavy water, natural uranium)

I. SCIENCE AND TECHNOLOGY (Continued)

m. The calculated equation of state (EOS) data from theoretical models for certain materials (for Z less than 72 all materials; *but for Z=72 and higher, only materials at pressures whose EOS data is not useful for designing nuclear weapons).* (83-6)

n. Information concerning Equation-of-State (EOS).

(1) Static data for Z of 93 and 94 at pressures equal to or less than 20 kb. (89-1)
(2) Static data for Z greater than 94 at pressures equal to or less than 1 mb. (89-1)

E. METALLURGY

1. Metallurgical techniques, if illustrated on non-classified substances. (46-1)

a. Metallurgical techniques for elements below 90 *excepting polonium. (If a treatment of an element substantially parallels a treatment of a classified element, this must not be stated or implied.)* (48-1)

2. Ceramics *without reference to uranium or plutonium production.* (46-1)

a. Ceramic techniques *except as prohibited by the following topics.* (48-1)

(1) The use of particular ceramic materials in the production or utilization of fissionable materials.
(2) The development or manufacture of new ceramic materials specifically designed for the production or utilization of fissionable materials.

3. Physical instrumentation and chemical and metallurgical techniques *provided they do not reveal otherwise classified data*. (47-1)

4. Physical and process metallurgy and fabricating techniques of elements 89 and below. (This permits the declassification of metallurgical techniques, even if the treatment substantially parallels the metallurgy of an element above 89, *provided this parallel is not stated or implied.)*[2] (50-4)

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[2] It is often necessary to reveal the purity of substances critical to the production of materials of special Project interest as well as that of materials of special Project interest in discussing basic metallurgical data. In so doing, one would be liable to reveal the specifications of production metal, uranium for example. (By specification is meant the purity requirements to which the material is manufactured and not the composition of any particular sample.) *In such cases, no mention should be made of the size of the lot of uranium the specimen came from, nor should mention be made of the fact that it is production metal or specially prepared metal of high purity for specific studies. In addition, if the content of an element in a sample is less than 0.01 percent by weight, the analytical data should not be revealed, though it would be permissible to state the content to be less than 0.01 percent.*

I. SCIENCE AND TECHNOLOGY (Continued)

5. The physical metallurgy of elements 90 and above *excepting uranium (but see I.E.7 below) and plutonium*[2]. (50-4)

6. The following items of physical metallurgy of uranium.[2] (50-3) (50-4)

   a. Thermodynamic data and phase diagrams, *unless of critical technological significance.*

   b. Crystal structures of all metal and alloy phases *except data on changes in the extra-nuclear characteristics produced by ionizing radiations of energy above 1 Kev and by neutrons on fuel bearing solutions, slurries or suspensions and on reactor fuel elements and critical reactor components.*

   c. Physical and mechanical properties, such as density, thermal expansion, melting point, elasticity, electrical and thermal conductivities, magnetic properties, self diffusion, etc. *(Care must be taken that anisotropic effects important in reactor technology are not revealed.)*

   d. Deformation mechanisms of single crystals.

7. All information in the field of ceramics, whether of a fundamental or applied character *except ceramic substances which are specifically developed for the production or technological use of fissionable materials.* (This topic is not intended to restrict unclassified development of high temperature ceramics for power piles or other devices.) (50-3) (50-4)

8. The use of MgO crucibles having a capacity of 50cc or less for metallurgical studies *provided that this does not disclose the purity specifications required for uranium or plutonium technologies.* (50-3) (50-4)

9. Non-critical fabricating techniques of elements 90 and above, *excluding plutonium.* (53-6)

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[2] It is often necessary to reveal the purity of substances critical to the production of materials of special Project interest as well as that of materials of special Project interest in discussing basic metallurgical data. In so doing, one would be liable to reveal the specifications of production metal, uranium for example. (By specification is meant the purity requirements to which the material is manufactured and not the composition of any particular sample.) *In such cases, no mention should be made of the size of the lot of uranium the specimen came from, nor should mention be made of the fact that it is production metal or specially prepared metal of high purity for specific studies. In addition, if the content of an element in a sample is less than 0.01 percent by weight, the analytical data should not be revealed, though it would be permissible to state the content to be less than 0.01 percent.*

I. SCIENCE AND TECHNOLOGY (Continued)

F. INSTRUMENTS AND EQUIPMENT

1. Physical instrumentation which may be of use in the laboratory practices of the country. *Care should be taken that the motivation for developing the instruments and the applications for which they were used should be disclosed only when the application itself is declassified.* (46-1)

   Examples:

   - Counters.
   - Ionization chambers.
   - Energy-insensitive neutron detectors.
   - Mass spectrographs.
   - Electronic circuits.
   - Electric controls and circuits of all kinds.
   - Cyclotrons, Van de Graaff and other ion accelerators.
   - Special sources of neutrons and gamma rays omitting reference to their applications.

2. Physical instrumentation and chemical and metallurgical techniques *provided they do not reveal otherwise classified data.* (47-1)

3. Physical instrumentation which may be of use in the laboratory or industrial practice of the country. *(Care should be taken that the motivation for developing the instruments and the applications for which they were used are disclosed only when the application itself is declassified.)* (48-1)

   Examples:

   - Counters.
   - Ionization Chambers.
   - Neutron detectors including fission chambers used for this purpose. *(Care must be exercised not to reveal classified properties of the fissionable materials.)*
   - Mass Spectrographs (However, see I.F.4 below).
   - Electronic circuits.
   - Electric controls and circuits of all kinds.
   - Cyclotrons, Van de Graaffs, betatrons and other particle accelerators.
   - Sources of neutrons and gamma rays and sources of neutrons, *omitting reference to their classified applications and excepting production technology and methods of handling high intensity gamma ray sources intended for classified applications.*

I. SCIENCE AND TECHNOLOGY (Continued)

4. Mass spectrograph and other methods of isotopic analysis, including analytical procedures and special instruments *provided the procedure does not permit an accuracy of analysis better than 0.1% of the isotopic abundance for heavy elements. (Care must be taken not to reveal classified purity specifications).* (48-1) (50-4)

5. Vacuum equipment such as diffusion pumps, oils, gaskets, gauges, and leak detectors *without reference to application in classified plants.* (48-1)

6. The fact that complex and bulky cryogenic equipment was associated with the Mike test. (74-8)

II. MATERIALS

A. GENERAL

1. Simple association or simple presence of any material (i.e., element, compound, isotope, alloy, etc.) at a specified Department of Energy site. (98-1)

B. BERYLLIUM

1. Basic Chemistry. (46-1)

2. Basic Physics. (46-1)

   a. Extra-nuclear Physics. (48-1)

3. Metallurgy. (46-1)

4. Nuclear Physics. *Classification will be retained, for the present, on all data pertaining to applications for beryllium in a production pile.* (46-1)

   a. Nuclear Physics. (48-1)

5. Mere fact that beryllium may be used in weapons. (57-10)

6. Quantity of Be used outside the nuclear assembly systems. (67-2)

7. The total quantity of Be used in the nuclear weapons program. (67-2)

8. The mere fact that Be is used in the nuclear assembly system of designated weapons. (72-11)

C. BORON 10

1. Nuclear Physics. (46-1)

2. Information that sufficient Boron 10 is available for making counters can be declassified. (46-1)

3. Technology for the separation of boron isotopes, the production of boron metal, and the activities of the Boron Metal Plant when disassociated from its past connection with the weapons program. (56-8)

4. The fact of use of B-10 for hardening in unspecified nuclear weapons. (67-2)

5. The fact that B^{10} is used for reduction of neutron emission. (72-11)

II. MATERIALS (Continued)

D. DEUTERIUM INCLUDING HEAVY WATER

1. Basic Chemistry. (46-1)

2. Basic Physics. (46-1)

   a. Extra-nuclear Physics. (48-1)

3. Nuclear Physics. (46-1)

4. Production Processes

   a. The catalytic chemical exchange, water distillation, hydrogen distillation, and electrolytic processes for the large scale production of heavy water. (53-3)

   b. The composition of the catalyst and the design and actual production rates for the entire Trail plant. (53-3)

   c. The design production rates of the catalytic chemical exchange, water distillation, *(except for Savannah and Dana)*, and hydrogen distillation process plants and the electrolytic process plants associated with them. (53-3)

5. Sale price of D_20. (55-1)

6. A reasonable sale price ($28.00 per pound) for heavy water. (55-4)

7. All information on the production technology of heavy water. (56-6)

8. The fact of boosting, the fact that deuterium and tritium are used as boosting fuels in High Explosive Assembly weapons and that they are contained in components known as reservoirs or cartridges which are shipped between the Savannah River Plant and the AEC weapon facilities, the military and the United Kingdom. (72-11)

   a. Fact that gaseous deuterium (D) and tritium (T) are used as boosting fuel. (83-2)

9. The fact that the thermonuclear fuel used in the Mike test (10/31/52) of the Ivy series was liquid deuterium. (74-8)

10. The fact that the tritium - deuterium mixture of the George test (5/8/51), the first thermonuclear test explosion, burned well. (74-12)

II. MATERIALS (Continued)

E. ELEMENTS 95 AND ABOVE

1. Basic Chemistry. (48-1)

2. Extra-nuclear Physics. (48-1)

F. FISSION PRODUCTS

1. Basic Chemistry. (48-1)

2. Metallurgy. (48-1)

3. Extra-nuclear Physics. (48-1)

4. The kinetic energies and all nuclear properties of fission products may be declassified *except*: (48-1)

   a. Slow neutron capture cross sections above 100 barns for radioactive fission products.

   b. The absolute fission yield of delayed neutrons.

   c. The fission yield of any of the isotopes leading to delayed neutron fission.

5. Technology - Information on the laboratory scale separation of the fission products from one another, *but care must be exercised not to reveal information regarding the large scale production of specific radioactive products of fission.* (48-1)

6. Data on techniques for preparing and handling high intensity fission product sources so that they may be made available for industrial study as well as for studies in fundamental science and medical applications. (53-6)

G. LITHIUM AND ITS COMPOUNDS

1. Production of Critical Materials; lithium and its compounds: Normal lithium hydride in excess of 100 lbs. when associated with thermonuclear weapons. (53-4)

2. Production of Critical Materials; lithium 6: *When not revealing nature or existence of large scale production process up to and including 25 gms total.* (53-4)

3. Lithium enriched in the isotope Li^6; Material up to and including 1 Kilogram contained Li^6 total. (54-2)

II. MATERIALS (Continued)

4. Lithium enriched in the isotope Li^7; Material up to 15 kilograms total contained Li^7. (54-2)

5. Other normal lithium compounds. (54-2)

6. Mere fact that lithium is irradiated at the Savannah River or Hanford plants. (57-5)

7. 50 kg of Li^6 is now [January 1962] available for unclassified research (doubling the 25 kg previously available). Up to 1550 liters of He^3 may be released for unclassified use, in addition to the 1500 liters already declassified and made available. (62-1)

8. Partial cross sections of lithium and its isotopes for neutrons of energies between 1 Mev and 25 Mev. (61-2)

9. Any quantity of Li^6 or Li^7 allocated for unclassified research. (62-7)

10. The fact that lithium, deuterium (Li^6D, LiD) are used in unspecified thermonuclear weapons. (62-10)

11. The association of lithium hydride with the weapons laboratories. (62-10)

12. The mere fact that normal lithium deuteride (Li^nD) is used in unspecified TN weapons. (67-2)

13. The assay of top product of Li^6 production plant or the fact that this top assay is used in weapons. (67-2)

14. The fact that Li^6H is used in unspecified weapons for hardening. (67-2)

15. The fact that Li^7H or Li^nH may be used as mockup materials in the weapons program. (67-2)

16. The fact that compounds of Li^6 containing tritium are used in the design of weapons as TN fuel. (72-11)

17. General description of the processes used or investigated for the separation of lithium isotopes. (73-8) (74-10)

18. The fact that the device fired in the Bravo test (2/28/54) of the Castle series used lithium deuteride as its thermonuclear fuel. (74-8)

19. The quantity of depleted lithium hydroxide currently stored at the Portsmouth Gaseous Diffusion Plant or other Department of Energy facilities. (94-3)

20. The production rates and quantities of Li^6 and Li^7 (amalgam or hydroxide) produced by COLEX, or other processes, and information classified to protect production quantities. Such data would include, for COLEX, but not be limited to lithium tails inventories, plant capacity indicators such as number of columns, trays, pumps, etc. (94-4)

H. NEPTUNIUM

1. Basic Chemistry. (46-1)

2. Metallurgy. (46-1)

3. Basic Physics. (46-1)

   a. Extra-nuclear Physics. (48-1)

4. Nuclear Physics. (46-1)

   a. Nuclear Physics. (See Appendix A, for declassified nuclear properties of neptunium and its isotopes.) (48-1)

5. The mere fact that spent reactor fuels are "blended up" and recycled through Hanford in order to increase $Neptunium^{237}$ production. (62-1)

6. The fact that Np^{237} can be used for a nuclear explosive device. (92-5)

7. The fact that the Department of Energy requires all Government-owned Np^{237} to be treated as a special nuclear material. (92-5)

8. The fact that the United States has non-proliferation concerns about Np^{237}. (92-5)

9. "Palm" which was replaced by "Birch" which was replaced by "Brandy" which is the material nickname for Neptunium (Np^{237}). The association of any of these nicknames with either of the others is also unclassified. (96-2)

I. PLUTONIUM

1. Basic Chemistry. (46-1)

2. Extra-nuclear Physics. (*No physical or mechanical properties of solid or liquid states of plutonium metal may be declassified*.) (48-1)

3. Nuclear Physics. (See Appendix A, for list of declassified nuclear properties of

plutonium and its isotopes). (48-1)

4. All nuclear and extra-nuclear properties of all isotopes *except the nuclear properties of U^{233}, U^{235}, U^{236}, U^{238}, Pu^{239}, and Pu^{240}.* (50-3)

5. The following properties concerning U^{233}, U^{235}, U^{236}, U^{238}, Pu^{239}, and Pu^{240}: (50-4)

   a. Existence, exact mass, spin, and moment.

   b. Method of formation of isotope *insofar as this does not disclose classified nuclear constants otherwise prohibited.*

   c. Charged particle and gamma ray reactions involving these isotopes at all energies.

   d. Details of neutron reactions (including fission and scattering) involving these isotopes above 25 Mev.

   e. Details of neutron induced trans-mutations involving these isotopes for all energies (including isotopic changes *but not fission or capture*).

   f. Spontaneous disintegration properties *other than spontaneous fission.*

   g. Spontaneous fission properties, *except in the case of U^{236} and Pu^{240} for which only the existence of spontaneous fission may be admitted*.

      (1) The spontaneous fission properties of Pu^{240} and U^{236} *with the exception of data on neutron emission in the spontaneous fission of U^{236} and Pu^{240}*. (53-5)

   h. Fission Process. See topic II.I.7 below.

6. The existence *but not the magnitude* of the (n,γ) cross section in U^{233}, U^{236}, Pu^{239}, and Pu^{240}. (50-4)

7. The following information may be declassified concerning the fission process of U^{233}, U^{235}, U^{236}, U^{238}, Pu^{239}, and Pu^{240}, however initiated: (50-4)

   a. Energies and momenta of related fission fragments (including ternary and quaternary fission).

   b. Energies, angular distributions and numbers per fission of protons, alpha particles and prompt gamma rays; and <u>relative</u> yields and energies of delayed neutrons.

II. MATERIALS (Continued)

c. Frequency of occurrence of ternary and quaternary fission and angular distribution of fragments.

NOTE: Yield information must be expressed only in terms of numbers of particles per fission and *not in terms of partial cross sections in case the particular fission cross section is not declassifiable*.

8. Physical properties of plutonium metal which have little military significance but are of basic scientific interest. (53-6)

9. The fuel value of $12 per gram for plutonium metal. (56-5)

10. Information concerning methods for the reduction of plutonium compounds to metal for civil uses and for the preparation of alloys of plutonium (plutonium content 50 atomic percent or less) for civil uses. (56-6)

11. Information on the fabrication technology of plutonium alloys containing up to 50 atomic percent plutonium. (56-6)

12. Information on:

a. The physical metallurgy and the mechanical properties of plutonium alloy containing up to 50 atomic percent plutonium, *subject, however, to the restriction that no release of information on plutonium alloys of special interest to the weapons program will be made,* and (56-6)

b. The thermal conductivity of plutonium and its alloys containing over 50 atomic percent plutonium. (56-6)

13. The $12-45 "buy-back" schedule of prices and the $30 single value plutonium "buy-back" price schedule and future single value plutonium in "buy-back" prices, *which are not usable to calculate classified production rates.* (57-4)

14. Information concerning the metallurgy of plutonium:

a. Fabrication technology of plutonium alloys containing up to and including 90 atomic percent plutonium. (58-10)

b. Fabrication methods for laboratory preparation (up to about 100 gms) of plutonium and its alloys *except as prohibited by the following:* (58-10)

(1) All information on plutonium or its alloys of special interest to the weapons program.

II. MATERIALS (Continued)

(2) *Fabrication Technology for plutonium and its alloys containing more than 90 atomic percent plutonium* except the description of method used in fabrication of materials under II.I.14.b above, beyond statement of basic method used, such as rolling, casting, etc.

c. The physical metallurgy and mechanical properties of plutonium alloys containing up to and including 90 atomic percent plutonium. (58-10)

d. The following physical constants of plutonium and its alloys containing over 90 atomic percent plutonium (the pressure not exceeding 10,000 atmospheres) *except for information on plutonium or its alloys of special interest to the weapons program.* (58-10)

(1) Melting point
(2) Density
(3) Number of phases, transition temperature, and thermodynamic functions
(4) Expansion coefficients
(5) Electrical properties
(6) Elastic constants and sound velocities
(7) Magnetic properties
(8) Crystal structures
(9) Thermal conductivity

This is intended to permit the release of complete phase diagrams, including metallographic descriptions, which do not reveal additional data.

15. Information concerning the preparation, properties and use of plutonium alloys *except the phase stabilized alloys containing more than 90% of plutonium which are of specific significance to weapons*. (59-6)

16. The isotopic content of the plutonium fuel used in the Plutonium Recycle Test Reactor and in the Plutonium Recycle Test Reactor Critical Facility. (61-7)

17. The mere fact that "barter" plutonium is to be or is being obtained from the UK. (62-12)

18. The isotopic composition of "barter" Plutonium obtained from the U.K. (65-2)

19. Information concerning the composition and properties of phase-stabilized alloys of plutonium containing more than 90 atomic percent plutonium. (63-7)

20. The isotopic composition of plutonium as now produced in Hanford and Savannah River Plants. (64-4)

21. The isotopic enrichment of Pu^{238} when classified use is not revealed. (65-6)

22. Revealing the general fact of existence of nuclear weapons which contain only Pu^{239}. (67-2)

23. The mere fact that delta phase Pu has been or is used in weapons. (67-2)

24. The isotopic enrichment of Pu^{238}, *when classified use is not revealed.* (67-2)

25. The fact that reactor-grade plutonium can be used to make nuclear weapons. (67-10)

26. The mere fact that high irradiation level reactor-grade plutonium can be used to make nuclear weapons. (67-10)

27. The fact that approximately 6 kgs of plutonium were involved in the Thule, Greenland accident. (68-4)

    a. Best estimate of the amount of plutonium removed from the site. (68-4)

28. The fact that ERDA has an interest in the separation of plutonium isotopes by laser methods. (75-1)

29. The fact that a nuclear test was conducted using reactor-grade plutonium and that it successfully produced a nuclear yield. (77-4)

    Note: *Information on date, event, name, yield, etc. remain classified.*

    The DOE announced on June 27, 1994, that the event occurred in 1962.

30. Historical plutonium production information and associated rare gas releases for the decommissioned production reactors at the Hanford site for the period 1944 through 1960. (89-4)

31. Fact of use of alpha phase plutonium in unspecified weapons and test devices. (92-3)

32. That plutonium-239 or weapon-grade plutonium is used:

    a. In unspecified implosion assembled weapons or pits of unspecified staged weapons. (93-2)

    b. As the sole fissile material in unspecified implosion assembled weapons, or in the pit of unspecified staged weapons. (93-2)

33. Special nuclear materials masses: That about 6 kg plutonium is enough hypothetically to make one nuclear explosive device. (93-2)

    a. Hypothetically, a mass of 4 kilograms of plutonium or uranium-233 is sufficient for one nuclear explosive device. (94-1)

    NOTE: The average masses of special nuclear materials in the U.S. nuclear weapons or special nuclear materials masses in any specific weapon type remain classified.

34. The total quantities of plutonium produced or processed at Richland. (93-3)

35. The total quantity of weapons grade plutonium including supergrade plutonium produced at the Savannah River Plant. (93-5)

36. The Savannah River approximate total post-August 1988 plutonium inventory. (93-6)

37. The United States total production of weapon-grade plutonium. (93-7)

38. The current plutonium inventory at the Rocky Flats Plant. (93-8)

39. The current total plutonium inventory at the Argonne National Laboratory-West. (93-8)

40. The current total plutonium inventory at the Los Alamos National Laboratory and the Lawrence Livermore National Laboratory. (93-8)

41. The quantity of plutonium involved in the fire in Room 180 in Building 771 on September 11, 1957, and the quantity of plutonium involved in the fire in Buildings 776 and 777 on May 11, 1969, as represented by inventory data, the amount recovered, the amounts allocated to other disposition categories such as normal operating loss, and the amount considered inventory difference *as long as weapon design, manufacturing, material composition or properties, or other classified information that is protected by classified inventory data is not revealed.* (94-5)

42. The historical (1952 - 1993) annual inventory difference for plutonium and highly enriched uranium at Rocky Flats. (94-7)

43. The historical quantity of plutonium produced for any time period in the Savannah River reactors and information that only reveals Pu production. (94-9)

II. MATERIALS (Continued)

44. The quantity of plutonium separated, or otherwise modified, to other forms (such as oxide or metal) at the Savannah River Plant during any time period. (94-9)

45. Plutonium quantities at the Savannah River Plant for any time period, *provided other classified information such as weapons design are not revealed.* (94-9)

46. The total quantity of plutonium involved in all nuclear weapons tests performed by the United States. (94-11)

47. As part of the 1958 United States - United Kingdom Mutual Defense Agreement, there have been three barter agreements. The United States received plutonium totaling 5,366 kilograms from the United Kingdom under the Barter A, B, and C Agreements during the period 1960 - 1979. The United States gave the United Kingdom 6.7 kilograms of tritium and 7,500 kilograms of highly enriched uranium for the plutonium. (94-15)

    a. During the period of 1960-1979, the following materials were exchanged: (97-3)

       Barter A: 480 kg UK plutonium for 6 kg of U.S. tritium
       Barter B: 4,073 kg UK plutonium for 7,500 kg of U.S. HEU
       Barter C: 813 kg UK plutonium for 0.7 kg of U.S. tritium

48. The fact that plutonium combined with <u>any</u> stated weight percent gallium exists: (1) stabilized as an alloy in the delta phase in nuclear weapons, providing neither weapon or alloy nickname (other than Headwind) is specified, and (2) as an oxide in the weapons program, providing the source of the plutonium is not specified by weapon or alloy nickname (other than Headwind). (95-1)

49. The sum of the quantity of plutonium at the Pantex site and in the nuclear weapons stockpile was 66.1 metric tons on September 30, 1993. (95-6)

50. "Palmolive" which was replaced by "Birchbark" which was replaced by "Brandywine" which is the material nickname for Plutonium (Pu^{238}). The association of any of these nicknames with either of the others is also unclassified. (96-2)

51. "Olive" which was replaced by "Bark" which was replaced by "Wine" which is the material nickname for Pu^{238}. The association of any of these nicknames with either of the others. (98-13)

52. The total forecast or actual quantity of plutonium transferred in either direction under "the loan." (The mere fact of an arrangement under the 1958 Mutual Defense Agreement, which provided for the loan of plutonium to the United Kingdom during the period 1980-1985, and the fact that there was a plutonium loan

II. MATERIALS (Continued)

| arrangement between the United States and the United Kingdom referred to as "the
| loan.") (01-1)

| 53. The December 31, 2000, total inventory of 1.4 metric tons of HEU at the RFETS
| [Rocky Flats Environmental Technology Site]. (01-4)

J. POLONIUM

1. Basic Chemistry. (46-1)

2. Basic Physics. (46-1)

   a. Extra-nuclear Physics. (48-1)

3. Nuclear Physics. (46-1)

4. The fact that a polonium-beryllium initiator is used in the 280 mm and 8" gun-type nuclear weapons. (64-6)

5. Fact that Po-210 is used in weapon initiators. (67-2)

K. PROTACTINIUM

1. Basic Chemistry. (46-1)

2. Basic Physics. (46-1)

   a. Extra-nuclear Physics. (48-1)

3. Nuclear Physics. (See Appendix A, for declassified nuclear properties of protactinium and its isotopes.) (46-1) (48-1)

L. THORIUM

1. Basic Chemistry. (46-1)

2. Metallurgy. (46-1)

3. Basic Physics. (46-1)

   a. Extra-nuclear Physics. (48-1)

4. Nuclear Physics (See Appendix A, for declassified nuclear properties of thorium and its isotopes.) (48-1)

5. The sale price for thorium in billets -- $25.00 per Kg, and any proposed changes in the sale price of thorium. (55-4)

6. The general process technology for reducing either uranium or thorium compounds to metal and for preparing uranium or thorium alloys. (56-6)

7. All details of imports of uranium and thorium ores and concentrates. (60-5)

M. TRITIUM

1. Basic Chemistry. (46-1)

2. Basic Physics. (46-1)

   a. Extra-nuclear Physics. (48-1)

3. Production of critical materials; tritium (H3): Quantities up to and including 40 liters total. (53-4)

4. Research scale methods for the production of tritium and helium-3. (53-6)

5. The fact that the U.S. has a large-scale tritium production program. (59-17)

6. The fact that the Savannah River plant is the center of U.S. tritium production activities. (59-17)

7. The USAEC has a tritium production program which is centered mainly at Savannah River, Georgia. Tritium is produced in the United States in amounts beyond that produced incidentally in reactors. The operation of tritium plants and the handling of tritium involves the loss of a fraction of the tritium, some of which escapes into the atmosphere. There is no reason to believe that other countries producing tritium are more successful in avoiding a similar loss. The tritium escaping into the atmosphere may compete with cosmic ray and bomb tritium in atmospheric tracer studies. (60-2)

8. The fact that tritium in unspecified form is shipped in containers or reservoirs from Savannah River Operations. (67-2)

9. Distribution of tritium on the surface in the vicinity of the [Greenland] crash (excluding that picked up on aircraft debris). (69-2)

II. MATERIALS (Continued)

Enclosed Area[1] (square meters)	Tritium Deposition[2] (Curies)	(% of total)
1.97×10^3	365	27.2
1.10×10^4	657	49.1
2.49×10^4	986	73.7
3.90×10^4	1337	100

[1] Consecutively larger areas corresponding to the fall-out pattern.
[2] Total out to the specified boundary.

10. The fact of boosting, the fact that deuterium and tritium are used as boosting fuels in HEA weapons and that they are contained in components known as reservoirs or cartridges which are shipped between the Savannah River Plant and the AEC weapon facilities, the military and the United Kingdom. (72-11)

    a. Fact that gaseous deuterium (D) and tritium (T) are used as boosting fuel. (83-2)

11. The fact that compounds of Li^6 containing tritium are used in the design of weapons as TN fuel. (72-11)

12. The fact that the tritium - deuterium mixture of the George test (5/8/51), the first thermonuclear test explosion, burned well. (74-12)

13. The fact that the Contingency Tritium Production Program (CTPP) contemplated the possible use of commercial Light Water Reactors in the production of tritium. (89-2)

14. Fact that tritium is associated with some unspecified pits. (92-4)

15. The fact that some unspecified pits include or contain tritium, *no further elaboration*. (94-14)

16. As part of the 1958 United States - United Kingdom Mutual Defense Agreement, there have been three barter agreements. The United States received plutonium totaling 5,366 kilograms from the United Kingdom under the Barter A, B, and C Agreements during the period 1960 - 1979. The United States gave the United Kingdom 6.7 kilograms of tritium and 7,500 kilograms of highly enriched uranium for the plutonium. (94-15)

17. The amount of tritium in a reservoir is typically less than 20 gm. (95-5)

18. “Mint” was the material nickname for tritium. (96-2)

19. For the palladium diffusion process - detailed sequence of operations, including times, temperatures, or pressures used for primary separation where the nominal

conditions are: a temperature of 400°C, atmospheric pressure, and a nominal throughput rate of less than 5 standard litres per minute, *provided accurate production rate of tritium (T) is not revealed*. (98-14)

20. For the Thermal Cycling and Absorption Process (TCAP) - detailed (quantitative) sequence of operations (processing parameters), including, but not limited to, times, temperatures, or pressures, where: the nominal temperature range is from -50 to 150°C, operating pressures range from atmospheric to 8 atmospheres, nominal throughput is 0.5 standard litres per minute, *provided accurate production rate of T is not revealed*. (98-14)

21. For the thermal diffusion process - detailed (quantitative) sequence of operations, including temperature, pressure, or times of operation used for the thermal diffusion column, where: the nominal temperature range is 1000°C, nominal pressure is atmospheric, and nominal throughput is 0.1 standard litres per minute, *provided accurate production rate of T is not revealed.* (98-14)

22. For tritium transfer and storage by the metal hydride process - times, temperatures, or pressures used in metal hydride or other systems for general storing and pumping of tritium, if the nominal temperatures range from -50 to 500°C, and nominal pressures are from 0 to 2.5 atmospheres, *providing inventories in storage beds can not be determined*. (98-14)

N. UCl4

1. Basic Chemistry. (48-1)

   a. Extra-nuclear Physics. (48-1)

O. UF_6

1. Basic Chemistry. (46-1)

2. Basic Physics. (46-1)

3. Extra-nuclear Physics. (48-1)

4. Information concerning laser isotope separation research at LASL. (76-1)

   a. Fact of use of UF_6.
   b. Fact of disassociation of UF_6 to UF_5 as a result of irradiation.

II. MATERIALS (Continued)

P. URANIUM

1. Basic Chemistry. (46-1)

   a. General methods of chemical analysis developed for uranium metal and graphite. (46-2)

2. Metallurgy. (46-1)

3. Basic Physics. (46-1)

   a. Extra-nuclear Physics. (48-1)

4. Nuclear Physics. (See Appendix A, for declassified nuclear properties of uranium and its isotopes.) (48-1)

5. The value of the thermal fission cross section of natural uranium and U^{235} released without any restriction as to accuracy of measurements. (50-1)

6. All nuclear and extra nuclear properties of all isotopes *except as prohibited by the following topics.* (50-3) (50-4)

   a. *The nuclear properties of U^{233}, U^{235}, U^{236}, U^{238}, Pu^{239}, and Pu^{240}* except as permitted by topics II.I.5 through II.I.7 and II.P.7 through II.P.10 below and Appendix B.

7. The following properties concerning U^{233}, U^{235}, U^{236}, U^{238}, Pu^{239}, and Pu^{240}. (50-4)

   a. Existence, exact mass, spin, and moment.

   b. Method of formation of isotope *insofar as this does not disclose classified nuclear constants otherwise prohibited.*

   c. Charged particle and gamma ray reactions involving these isotopes at all energies.

   d. Details of neutron reactions (including fission and scattering) involving these isotopes above 25 Mev.

   e. Details of neutron induced trans-mutations involving these isotopes for all energies (including isotopic changes *but not fission or capture*).

   f. Spontaneous disintegration properties *other than spontaneous fission.*

II. MATERIALS (Continued)

g. Spontaneous fission properties, *except in the case of U^{236} and Pu^{240} for which only the existence of spontaneous fission may be admitted.*

(1) The spontaneous fission properties of Pu^{240} and U^{236} *with the exception of data on neutron emission in the spontaneous fission of U^{236} and Pu^{240}*. (53-5)

h. Fission Process. See topic II.P.10 below.

8. The existence *but not the magnitude* of the (n,γ) cross section in U^{233}, U^{236}, Pu^{239}, and Pu^{240}. (50-4)

9. That information for natural uranium and the isotopes U^{235} and U^{238} specified in Appendix B as well as the following information. (50-4)

   a. The neutron fission cross section of natural uranium over the range 0.7 to 5 Mev.
   b. The energy spectrum of fission neutrons from thermal fission of U^{235}.

10. The following information may be declassified concerning the fission process of U^{233}, U^{235}, U^{236}, U^{238}, Pu^{239}, and Pu^{240}, however initiated: (50-4)

   a. Energies and momenta of related fission fragments (including ternary and quaternary fission).
   b. Energies, angular distributions and numbers per fission of protons, alpha particles and prompt gamma rays; and <u>relative</u> yields and energies of delayed neutrons.
   c. Frequency of occurrence of ternary and quaternary fission and angular distribution of fragments.

   NOTE: Yield information must be expressed only in terms of numbers of particles per fission and not in terms of partial cross sections in case the particular fission cross section is not declassifiable.

11. U_30_8 costs. (55-1)

12. Sale price of uranium containing up to 20% U^{235}. (55-1)

13. A reasonable sale price ($40.00 per Kg.) for normal uranium metal in billet form. (55-4)

14. A price ($25.00 per gram of contained U-235) for uranium enriched to 20%U^{235}. (55-4)

II. MATERIALS (Continued)

15. Information concerning U.S. total ore production and approximate uranium production of the free world. (56-4)

16. The charges for enriched uranium of various degrees of enrichment. (56-5)

17. The fuel value of $16 per gram for U^{233} metal. (56-5)

18. The general process technology for reducing either uranium or thorium compounds to metal and for preparing uranium or thorium alloys. (56-6)

19. Information on over-all uranium ore reserves and uranium ore and ore concentrate production statistics. (56-6)

20. The 40,000 kg of U^{235} allocated by the President to peaceful applications is unclassified. (57-1)

21. Typical analysis of impurities found in normal uranium metal. This applies to metal used in the Civilian Application Program; it does not change the rules for the production reactor program. (57-8)

22. Existence of uranium of approximately 0.22 ± 0.02 wt. % U^{235} and information that may be derived by analysis of this material by any means whatsoever. (58-3)

23. That material of assay above 0.22 ± 0.02 wt. % U^{235} if specifically requested by a user. (58-3)

24. The schedule of charges and buy-back prices of depleted uranium, or any modifications thereof *which do not reveal AEC production costs.* (58-3)

25. Feed material technology: (60-5)

    a. High-alpha temperature range forming processes (600-1200°F) such as rolling and extrusion.
    b. Beta heat treating
    c. Technical efforts on development of new standard operating procedures for the above when carried on in specific equipment for production.

II. MATERIALS (Continued)

26. All information concerning the conversion of ore concentrates to uranium metal at the Destrehan Street, St. Louis and the Weldon Spring, Mo. feed materials facilities. Maintain as classified *technological details concerning the process used at Fernald. This declassification does not include production rates for years prior to 1955.* (58-12)

27. Past and current production rates or capacities concerning these same facilities for the production of uranium metal and intermediate compounds. (58-12)

28. The fact that the Commission is stockpiling uranium ore concentrates. (59-13)

29. Statistics on the production and procurement of U_3O_8. (59-14)

30. Use in weapons of normal, depleted or fully enriched uranium and the identification of the fissionable materials used in a specific fission weapon. (59-16)

31. All details of imports of uranium and thorium ores and concentrates. (60-5)

32. The existence of 97.5% highly enriched uranium (HEU); the fact that it is produced at the Portsmouth Gaseous Diffusion Plant for use in weapons research and development; and the fact that it may be used in a device for NTS test. (62-1)

33. Fact of use in specified or unspecified weapons of normal uranium or depleted uranium of any assay. (67-2)

34. Uranium-zirconium hydride reactor technology (SNAP). (72-3)

35. The quantity of depleted uranium on-site and processed at Rocky Flats, as represented by periodic inventory data and processing totals, *as long as weapons design, production rate or quantities, or other classified information that is protected by classified inventory data is not revealed.* (94-6)

36. The historical (1952 - 1993) annual inventory difference for plutonium and highly enriched uranium at Rocky Flats. (94-7)

37. The historical (1947 - 1993) annual inventory difference for highly enriched uranium at the Y-12 plant. (94-8)

38. The fact that intermediate enrichments of uranium are used in U.S. nuclear weapons. (94-10)

39. The amount of uranium element that was enriched by the Portsmouth and K-25 Gaseous Diffusion Plants to above 20 percent in U^{235}. (94-10)

II. MATERIALS (Continued)

40. The total Y-12 highly enriched uranium inventory as of December 31, 1993 in terms of the quantity of uranium element enriched to above 20 percent in U^{235}. Also declassified is the maximum amount of enriched uranium stored at the Y-12 plant in the past. (94-10)

41. The total current Portsmouth uranium inventory enriched to 20 percent U^{235} and above, expressed in terms of uranium element. (94-10)

42. The Rocky Flats Plant current total uranium inventory enriched to over 20 percent, provided quantities in weapons components or other classified data is not revealed. (94-10)

    NOTE: Declassified uranium inventory quantities in the specified assay ranges may be broken down into any unclassified forms or quantities (e.g., uranium, metal, fuel, spent fuel, UF_6, etc.)

43. As part of the 1958 United States - United Kingdom Mutual Defense Agreement, there have been three barter agreements. The United States received plutonium totaling 5,366 kilograms from the United Kingdom under the Barter A, B, and C Agreements during the period 1960 - 1979. The United States gave the United Kingdom 6.7 kilograms of tritium and 7,500 kilograms of highly enriched uranium for the plutonium. (94-15)

44. The quantities of uranium, actual or planned, from the U.S. nuclear weapons program, that is enriched to greater than 20 percent in U^{235}, that will be offered to the International Atomic Energy Agency for inspection or used for other unclassified purposes. (94-16)

45. The specific assays of intermediate enriched uranium (enriched to between 20 percent and a nominal 90 percent) that were produced for weapons usage. (94-16)

46. Quantities of uranium element enriched to over 20 percent produced in any time period by the K-25 and Portsmouth Gaseous Diffusion Plants. (94-16)

47. The total quantity of highly enriched uranium element and U^{235} isotope transferred from the United States to the United Kingdom under the Mutual Defense Agreement from 1944 to 1996. (98-4)

48. The total forecast or actual quantity of plutonium transferred in either direction under "the loan." (The mere fact of an arrangement under the 1958 Mutual Defense Agreement, which provided for the loan of plutonium to the United Kingdom during the period 1980-1985, and the fact that there was a plutonium loan arrangement between the United States and the United Kingdom referred to as "the loan.") (01-1)

II. MATERIALS (Continued)

Q. MISCELLANEOUS MATERIALS INFORMATION

1. Machining techniques in handling graphite. (46-2)

2. For elements of atomic number 90 or above declassification of those aspects of their behavior under neutron bombardment, of their spontaneous fission, and of the number and energy of neutrons emitted in their fission *which do not have any bearing on weapons or production information.* (47-1)

3. Information that AEC projects have up to 1 milligram of Am-241. (50-1)

4. New isotopes in microgram quantities or less may be revealed *provided that their half lives are shorter than 6 months.* (50-1)

5. Production of Critical Materials; Helium 3: Quantities up to and including 15 liters total. (53-4)

6. Certain production methods for uranium, graphite and heavy water. (53-6)

7. All information on the production technology of the separation of zirconium-hafnium mixtures. (56-6)

8. Fact that the ORNL Fission Product Pilot Plant Facility (F3P) is separating large quantities of Ce^{144}. (58-1)

9. Declassifications concerning yttrium: (58-6)

   a. AEC interest in yttrium (Y) and its compounds
   b. Centralized procurement of yttrium
   c. Identification of yttrium suppliers
   d. Basic research on yttrium or its compounds
   e. Identification of yttrium metal as a special reactor material.

10. The mere fact that $Cerium^{144}$ is used in the ANP and SNAP programs. (58-6)

11. The fact that up to 20,000 curies of Krypton is trapped at the Idaho Chemical Processing Plant and shipped to Oak Ridge for radioisotope sale. (58-7)

12. The association of yttrium in quantities no greater than 1 kilogram with the Aircraft Nuclear Propulsion Program. (58-7)

II. MATERIALS (Continued)

13. Information on the use of Tungsten (W) in weapons research and development: (58-7)

    a. Mere interest of the weapons laboratories in tungsten;
    b. Procurement of high density tungsten by the weapons laboratories;
    c. The fact that tungsten is used in weapons;
    d. The quantities of tungsten processed in the weapons laboratories.

14. Two items on the program for production of research quantities of transplutonium elements: (60-5)

    a. Total quantity of transplutonium element produced by HFIR-ORO.
    b. Mere fact that 12 kg. of Pu^{239} has been irradiated in the SROO reactors for this program.

15. In connection with the program on transplutonics, the mere fact that there is or has been a high Pu^{240} irradiation and recovery program at Savannah River for the Hanford PRTR. (60-6)

16. The fact that plastic cases are used in weapons. (62-10)

17. Interest in the procurement of ceramic cloth or fibers by a research activity or facility stores [sic] not associated with weapons. (74-5)

18. Fact of interest in hydriding of fissile materials. (88-4)

19. Information about mercury inventories procured for use in Li^6 enrichment at the Oak Ridge Y-12 plant (or their value). (93-1)

20. Size (area) of the amalgamaker system and its operating temperature. Included is the number and size of the amalgamaker trays. (93-1)

21. Mercury/thallium information:

    a. The fact of use of mercury and/or thallium (Hg-Tl) in electrical switches in specified or unspecified weapons. (93-2)

    b. The fact of use of Hg and/or Tl in weapons, *use unspecified, quantity per weapon unspecified.* (93-2)

    c. The quantity of mercury or thallium in an unclassified component. (93-2)

II. MATERIALS (Continued)

d. The total quantity of mercury or thallium involved in normal operations at a specified Department of Energy facility (e.g., production or weapon dismantlement) *provided other classified information is not revealed*, even though it may reveal that there are classified uses of mercury and/or thallium in weapons or production processes. (93-2)

22. The fact that certain specified transplutonic isotopes are potential weapon - useable materials. (94-14)

23. The sweeping process used to remove impurities from quartz crystal material. (95-4)

24. "Pork" is the material nickname for bismuth. (96-2)

    a. "Pork Chops" is the project nickname for the irradiation of bismuth. (96-2)

25. The use of engineered materials of construction in gas centrifuges: (97-2)

    a. specified glass and/or carbon fibers (filaments) in rotor construction;
    b. specified aluminum foil (and other base material) alloy thin rotor tube liners;
    c. specified aluminum alloys associated with rotor construction;
    d. unspecified aluminum alloys in end caps and baffles; and
    e. unspecified ball bearings.

26. The presence of and a maximum amount of non-SNM hazardous materials used in nuclear weapons or weapon components in the event of an accident or other emergency situations. (98-5)

III. ISOTOPE SEPARATION

A. ELECTROMAGNETIC PROCESS (Y-12)

1. Physics

a. Experimental and theoretical work on general phenomena of discharges in magnetic fields. (46-1)

b. Experimental and theoretical work on ion optics *omitting references to classified installations.* (46-1)

(1) Experimental and theoretical work on ion optics *excepting novel features developed for plant operations and omitting references to classified installations.* (50-3)

c. Experimental data on ionization cross section, etc. (46-1)

d. Experimental data on high voltage breakdown in vacuum, insulator characteristics in vacuum, etc. (46-1)

(1) Experimental data on high voltage breakdown in vacuum. (50-3)

e. Electrical controls and circuits of all kinds *omitting reference to classified installations*. (46-1)

f. Experimental and theoretical physics of the electromagnetic separation plant *provided they do not reveal production details or processes.* (47-1)

g. Electrical insulators of high-voltage, high-temperature type, *without disclosure of design details actually used and without reference to classified installations.* (50-3)

h. Experimental and theoretical physics and chemistry, engineering designs and operating performance of single electromagnetic process units *without identification as components of the Electromagnetic Production Plant.* (52-3)

Note: The AEC staff paper explained that this permitted the declassification of the following:

(1) Experimental and theoretical work on general phenomena of discharges in magnetic fields, experimental and theoretical work in ion optics, data on high-voltage breakdown in vacuum, characteristics of electrical insulators of the high-voltage, high-temperature type, research on filament and insulator failure, and theory and design of magnetic shims. (52-3)

III. ISOTOPE SEPARATION (Continued)

(2) Full design data on basic components of a single calutron, ion source, filament, power supply and heater system, *but without revealing the exact system for drain control.* (52-3)

(3) Design data on single magnetic coils including shims. (52-3)

(4) Full operating data on a single calutron unit (Alpha or Beta) *but without identification as a component of the Electromagnetic Production Plant.* Data may include ion current, enrichment, collector efficiency, and performance of magnetic shims. (52-3)

(5) Feed material chemical composition and recycle chemistry processes. (52-3)

(6) Feed material technology: (60-5)

(a) High-alpha temperature range forming processes (600-1200°F) such as rolling and extrusion.
(b) Beta heat treating.
(c) Technical efforts on development of new standard operating procedures for the above when carried on in specific equipment for production.

2. General theory and experimental work for other methods of isotopic separation for elements of atomic number below 90, but see Table A. *(Care should be exercised that the information released for non-classified isotopes does not substantially aid work on classified isotopes.)* (Table A is located in Appendix A) (48-1)

3. General theory and experimental work for other methods of isotopic separation for elements of atomic number below 90, *except deuterium, tritium, special purity graphite, polonium and actinium.* (50-4)

4. Information about the "isotron" isotope separator experiments and theory. The "isotron" is an electromagnetic separation device. (52-1)

5. The calutron drain control system (at Y-12 Plant). (53-8)

6. The design of large magnet arrays (at Y-12 Plant). (53-8)

7. The theory, engineering design, capacity, and performance of electromagnetic plants including high intensity ion sources. (56-6)

III. ISOTOPE SEPARATION (Continued)

B. DIFFUSION PROCESSES

1. Physics

a. Basic theoretical work on reflux separation processes, *without reference to diffusion cascades.* (46-1)

(1) Basic theoretical work on reflux separation processes *without specific reference to diffusion cascades.* (50-4)

b. General theory of thermal diffusion in gases *without application to classified installations.* (46-1)

(1) Information concerning the theory of the thermal diffusion method of isotope separation. (55-2)

c. Basic theoretical work on cascade design, kinetic chemistry, and thermal diffusion *not revealing production methods in the diffusion plant.* (47-1)

d. General theory of thermal diffusion in gases *without reference to* UF_6 *or the application to classified installations.* (50-3)

2. Chemistry

a. Theoretical work on chemical kinetics such as was developed in connection with corrosion problems, *but without reference to the conditioning of barriers.* (46-1)

(1) Theoretical work on chemical kinetics *without reference to fluoride corrosion problems or conditioning of plant equipment.* (50-3)

b. Fluorocarbon chemistry and manufacture, *but without reference to application in plants for the production of classified substances.* (46-1)

(1) Fluorocarbon chemistry and manufacture *but without reference to* UF_6 *or to application or requirements in plants for the production of fissionable material.* (50-3)

c. Fluorine chemistry, including industrial preparation, (*but without reference to application in plants for the production of classified substances), except for the methods of preventing barrier plugging and corrosion .* (46-1) (50-4)

d. Fluorine and fluorocarbon chemistry and technology. (47-1)

III. ISOTOPE SEPARATION (Continued)

e. Design and construction of a fluorine cell plant and a fluorine packaging, storage, and compression plant. (50-3)

f. Analytical methods for materials used in the gaseous diffusion plant *except insofar as they may reveal plant practice and production*. (50-3)

g. Some information in the fields of fluoride surface chemistry and gas bearings. (53-6)

3. Industrial Aspects

a. The technique of plating inside of pipes so as to protect against corrosion. (46-2)

b. Vacuum pumps and compressors *without reference to characteristics which may be unique to the diffusion plant.* (46-2)

c. Bellows-sealed reciprocating pumps. (46-2)

d. Special high speed rotary pumps. (46-2)

e. Special precautions in handling process gas. (46-2)

f. The fact of cooling the enriched stream (A-line cooling) in diffusion plants. (76-2)

g. The fact that diffusion process pressures may exceed atmospheric pressure. (76-2)

h. The fact of use of fluorine and chlorine trifluoride in the cascade areas. *(No elaboration.)* (76-2)

C. CENTRIFUGE

1. General theory of centrifuge. (46-1)

a. Theory of centrifuge, *except that experimental work on, and detailed mechanical design for, the centrifuge method of isotope separation for elements 90 and above must remain classified.* (48-1)

2. The total annual construction and operating dollars in the gas centrifuge program commencing with FY-1971. (71-4)

3. The fact that the Equipment Test Facility and the Component Preparation Laboratories are associated with the U.S. gas centrifuge program. (71-4)

III. ISOTOPE SEPARATION (Continued)

4. The fact that the U.S. does not have and has not had a gas centrifuge pilot plant. (71-4)

5. The fact that the Component Test Facility is a gas centrifuge pilot plant. (72-2)

6. The financial breakdowns of construction projects in the gas centrifuge program. (72-2)

7. The AEC total annual funding for capital equipment *not related to construction for the gas centrifuge program for uranium enrichment.* (72-2)

8. The total annual operating and capital equipment funding for each minor contractor (the University of Virginia, Yale, and Electro-Nucleonics, Inc.) active in gas centrifuge work on uranium enrichment. (72-2)

9. The following information concerning the gas centrifuge program.

   a. Pilot plant construction and operating costs. (73-5)

   b. Full-scale production plant separative capacity, separative work costs, and costs for construction and operation. (73-5)

10. Information concerning the gas centrifuge program. (74-2)

    a. Rotor diameter studied through the pilot plant stage.
    b. Fact that upper suspension contained a magnet.
    c. Fact of interest in bearings other than pivots.
    d. Fact of interest in composite materials for rotor construction.
    e. Fact of rotor and end cap balancing.
    f. Fact of use of aluminum alloy.
    g. Fact of supercritical operation.
    h. Procurement quantities which may imply the number of machines in a pilot plant.

11. Total power level required for a centrifuge enrichment facility. (76-5)

12. Information concerning the gas centrifuge program. (78-3)

    a. The number of centrifuge machines in a plant of specified capacity.
    b. The approximate length of a production-class centrifuge.
    c. The electrical power usage within a centrifuge plant.
    d. The cascade service module.

III. ISOTOPE SEPARATION (Continued)

13. Information concerning the gas centrifuge Component Test Facility (CTF).

    a. The design separative capacity (50,000 SWU) of the Component Test Facility at Oak Ridge. (77-2)

    b. The total number of machines in the CTF. (83-7)

    c. The total number of SWUs (Separative Work Units) produced in the facility during operation. (83-7)

    d. The unit cost of a machine. (83-7)

    e. Cost/SWU. (83-7)

    f. The nominal separation capacity of a machine. (83-7)

    g. The length of the casings in CTF. (83-7)

14. Information concerning the gas centrifuge program. (85-5)

    a. The chemical identities and on-hand quantities of epoxy resins and hardeners used in the centrifuge program.

    b. The machine floor mount.

    c. The electronic lower suspension concept, including rotor levitation controls, to the extent now developed for this gas centrifuge application.

15. Centrifuge construction. (97-2)

    a. The use of engineered materials of construction in gas centrifuges:

        - specified glass and/or carbon fibers (filaments in rotor construction;
        - specified aluminum foil (and other base material) alloy thin rotor tube liners;
        - unspecified aluminum alloys in end caps and baffles; and
        - unspecified ball bearings.

| 16. The fact that gas centrifuge rotors are fabricated on mandrels. (01-3)

III. ISOTOPE SEPARATION (Continued)

D. GASEOUS DIFFUSION

1. Techniques of particle size and surface area measurements without reference to barrier construction. This information should be of a scientific character and *should not include data from which information could be inferred as to the size of the particles used in barrier construction.* (46-1)

2. Specifications, performance data, and useful design features of compressors, filters, pumps, blowers, motors, valves, diffusers, heat exchangers, piping, flow meters or other process equipment *when their release can be made without reference to characteristics which may be unique to a diffusion plant and without disclosing the contribution of the equipment concerned to the productivity or capacity of a plant.* (52-4)

3. Arrangement of stages in series ("badger arrangement" and modifications thereto). (53-2)

4. Arrangement of cells in series within each building. (53-2)

5. Total number of stages and cells. (53-2)

6. Information concerning gas bearings.

    a. Some information in the fields of fluoride surface chemistry and gas bearings. (53-6)

    b. Certain information concerning the theory of gas bearings for compressible gases for both journal and thrust bearings, as well as some experimental work on journal and thrust bearings. (55-2)

    c. The theory, design, manufacture and operation of all types of gas bearings, *subject to the restriction, however, that no release will be made on:* (56-6)

        (1) Features of gas bearing technology specially relating to the diffusion plant, and
        (2) Specifications and performance data of complete gas bearing compressor units for use in a gaseous diffusion plant.

7. A charge for separative work of $30 per kilogram of uranium. (62-8)

III. ISOTOPE SEPARATION (Continued)

8. That independent work[3] (and all data resulting therefrom) on the development of porous materials not developed for but suitable for use as gaseous diffusion barrier may be published without undue risk to the common defense and security. (66-1)

9. Production rates of uranium enriched in the isotope U^{235} subsequent to January 1, 1967. (66-6)

10. Gaseous diffusion plant separative capacity *subsequent to January 1, 1967, or any portion thereof.* (66-6)

11. Information on separative work production, capacity, and associated costs of the existing and projected future gaseous diffusion plants, or portions thereof, applicable to periods subsequent to January 1, 1967, *provided classified technology is not revealed*; and information on gaseous diffusion plant material flows and assays. (67-3)

12. The barrier tube length for gaseous diffusion plants. (69-3)

13. The compressor cost figures as a percentage of total capital costs for a conceptual gaseous diffusion plant using U.S. technology: (72-5)

Estimated Capital Cost Breakdown of
Process Stage Components for an 8.75 Million SWU/Yr
New Gaseous Diffusion Plant Using 1970 Technology

Stage Size	Small	Medium	Large
Shaft Power, HP	1250	2200	4050
Number of Stages	340	290	550
Separative Work Distribution (%)	9	20	71
Capital Cost Distribution (%)	20	23	57

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3 Independent work is non AEC-sponsored work performed without the use of any classified data.

III. ISOTOPE SEPARATION (Continued)

Stage Equipment Costs (%)	Small	Medium	Large
Gas Diffuser	6.1	8.0	10.2
Gas Compressor	10.6	12.0	13.4
Compressor Drive Motor	5.5	7.0	8.5
Electrical System	13.8	13.5	12.7
Heat Removal System	3.4	4.2	4.8
Process Building and Enclosures Process	5.9	6.8	7.7
Piping and Valves	10.2	8.6	6.9
Instrumentation	3.3	2.5	1.8
Miscellaneous Systems	3.9	3.1	2.4
Plant Start-Up and Support	1.3	1.0	0.7
Process Support Facilities	11.6	8.9	6.5
Engineering	3.4	3.4	3.4
Contingency	11.8	11.8	11.8
Interest During Construction	9.2	9.2	9.2
	100.0	100.0	100.0

14. The rates of production of uranium enriched in the isotope U^{235} and the separative capacity of gaseous diffusion plants prior to January 1, 1967. (73-8)

15. Information concerning the gaseous diffusion program. (85-3)

    a. All cascade uranium hexafluoride pressures.

    b. All cascade barrier and uranium hexafluoride temperatures of 240 degrees Fahrenheit or higher and all those below 240 degrees Fahrenheit if the barrier forepressures are 10 psia or lower.

    c. Cascade and stage gas-phase inventory values.

    d. Cascade stage separation factors, interstage flows, and power levels.

    e. Cascade side and top purge rates, and vent rates, total.

    f. Compressor blade angles and tip clearances.

    g. Fact of use of vented cavity seals.

    Note: All declassifications related to the cascades apply to information generated since October 1, 1980. *Corresponding information before this date remain Confidential to protect certain enriched uranium stockpile quantities and other classified information.*

16. The fact that U.S. gaseous diffusion plant compressor shaft seals operate on the gas bearing principle. *The detailed seal design will remain classified.* (92-6)

III. ISOTOPE SEPARATION (Continued)

17. Gas compressor nozzle internal guide vanes and their specifications. (92-6)

18. HEU production information: (98-10)

    a. Historic HEU production by assay.

    b. The amounts and assays of materials returned to the gaseous diffusion plants (refeed material) and of cascade feed rates at the Portsmouth Gaseous Diffusion Plant for the period September 1, 1971, through September 30, 1977, for intermediate assay feed; Note: This action declassified all historic refeed activities at the gaseous diffusion plants.

    c. Cascade tails withdrawal rates at the Portsmouth Gaseous Diffusion Plant for the period September 1, 1971, through September 30, 1997.

    d. Estimates of special nuclear material masses in weapons which are obtained by indirect methods involving production rates.

E. LASER ISOTOPE SEPARATION (LIS)

1. Information concerning the LIS program: (74-1)

    a. The fact of AEC interest in the separation of uranium isotopes by laser methods is unclassified.

    b. General descriptions of excitation methods based on scientific data published in the literature as of July 1, 1973.

    c. Papers dealing with fundamental science, including spectroscopy of uranium and its compounds, *where there is no recognizable association with or application to successful isotope separation*.

    d. Laser schemes for uranium isotope separation, *where the processes do not show a reasonable potential for the separation of practical quantities of special nuclear material*.

    e. Total AEC dollars budgeted for research and development in uranium isotope separation using lasers, broken down by installations, and showing separate identification of operational, equipment or construction costs.

2. The fact that ERDA has an interest in the separation of plutonium isotopes by laser methods. (75-1)

III. ISOTOPE SEPARATION (Continued)

3. Information concerning molecular laser isotope separation. (75-3)

   a. Fact of interest in UF_6 as a candidate for laser isotope separation.
   b. Laser frequencies of interest to three significant figures.
   c. Use of any form of cooling for high-resolution spectroscopy.

4. Information concerning laser isotope separation research at LASL. (76-1)

   a. Fact of use of UF_6.
   b. Fact of adiabatic expansion cooling by means of a nozzle.
   c. Fact of two-step laser irradiation of the cooled gas in the ultraviolet and infrared regions.
   d. Fact of disassociation of UF_6 to UF_5 as a result of irradiation.

5. Information concerning the AVLIS process: (90-2)

   a. The fact that iron or other specific commonly used element is alloyed with uranium to lower the melting point of the uranium and concentrations of the alloying element at the enrichment facility boundary, *provided feed or product concentrations or other classified information is not revealed.*

   b. Dye laser system characteristics for Atomic Vapor Laser Isotope Separation and Laser Demonstration Facility that do not provide significant information about process performance or separator design. Specifically:

      (1) For the dye laser modulator:

         (a) The fact that the dye laser beam is phase modulated,
         (b) The position of the modulator in dye laser chain,
         (c) The association of a specific commercially available design with AVLIS.

      (2) The AVLIS dye oscillator design.

      (3) The following dye laser performance parameters:

         (a) Conversion (copper laser to dye laser) efficiency,
         (b) Dye chain power output for AVLIS facilities,
         (c) Amplifier power gain,
         (d) Dye temperature and dye flow rates,
         (e) Dye chain pulse repetition frequency (PRF).

III. ISOTOPE SEPARATION (Continued)

c. Additional information concerning the AVLIS process: (96-2)

(1) Unaltered uranium AVLIS product from demonstration system separator pod and from a production plant module during activation or operations;

(2) Unaltered uranium AVLIS tails from a production plant module during activation or operation;

(3) The quantity (mass) of uranium and the U^{235} assay in a uranium-AVLIS separator melt;

(4) The current technique used to address the first metastable level (state) in the uranium-AVLIS process and the identity of the laser system used to do so;

(5) The identity of the dyes selected for the dye lasers chosen from a uranium-AVLIS plant; and

(6) The general shape of the waveform, the number of waves, and the frequency of each wave used to drive the electro-optic modulator for the dye laser chains.

d. The materials of construction used for AVLIS separator parts, not identifying the choice of material used for a specific part. (98-6)

e. The process laser power or powers (power balance between process wavelengths) required for or delivered to a uranium separator module. (98-7)

f. Information concerning an AVLIS Production Plant: (98-8)

(1) Actual or demonstrated values of energy per SWU for a production stage or separator module, or for a production facility;
(2) Actual or demonstrated values of the cost of separative work for a production facility; and
(3) Actual or demonstrated values of the separative or SWU capacity of a plant separator or separator module.

g. The current design of a simple tails collector for a uranium AVLIS pod. (Other designs, materials, or surface treatments remain classified.) (99-1)

h. The Uranium AVLIS separator pod throughput, feed rate, product and tails assays and rates, cut and yield, and fraction staged. (99-2)

III. ISOTOPE SEPARATION (Continued)

i. The uranium AVLIS electron beam gun operating voltages. (99-3)

F. MISCELLANEOUS ISOTOPE SEPARATION INFORMATION

1. Non-critical details for constructing production and pilot plants if they are similar to ordinary plant construction. (53-6)

2. All information relating to the thermal diffusion method of separating uranium isotopes. (56-6)

3. Information regarding the Materials Testing Accelerator (MTA) Project, including information regarding the Cloverleaf Cyclotron, *which does not reveal classified production reactor information or other classified project information*. (56-7)

4. Research and development work on any method of isotope separation *(other than gaseous diffusion and gas centrifuge)* (unless declassified by the Commission) would be unclassified as long as the Commission is satisfied that the method does not have a reasonable potential for the separation of practical quantities of special nuclear materials. *After a method has advanced to the point of having such potential, all additional work would be classified Secret Restricted Data until specifically declassified by the Commission.* (67-4)

5. Research on novel methods of isotope separation -- i.e., it is unclassified *until it has a "reasonable potential for the separation of practical quantities of special nuclear-material." (See III.F.3. above) This policy does not apply to information and methods previously declassified by Commission action, e.g., electromagnetic and liquid thermal diffusion.* (72-7)

6. General description of the processes used or investigated for the separation of lithium isotopes. (73-8)

7. Information concerning the Plutonium Special Isotope Separation (SIS).

    a. The possibility or fact that the plutonium AVLIS process will access one or more metastable levels in the excitation and ionization of plutonium atoms and that the wavelength range of interest for plutonium AVLIS is 560 to 800 nm. (88-1)

    b. The fact that the capability to use staging in the AVLIS process exists and is being implemented for the separation of plutonium. (88-1)

IV. REACTORS

A. SMALL EXPERIMENTAL PILES

1. Design and operating characteristics of small experimental piles in which enriched material or heavy water is used, *provided the pile generates power at a level under 100 KW. No information is to be released beyond the minimum necessary for the successful design and operation of such a small unit and in information essential for the successful design and operation of a production pile.* (46-1)

2. Information can be released as to which non-classified isotopes and fission products can be produced in a pile. *Caution must be exercised not to reveal production capabilities by disclosing critical data as to the amounts of such substances on hand or the rate at which they can be made.* (46-1)

3. Design and operating characteristics of small experimental piles in which enriched material or heavy water is used, *provided the pile generates power at a level under 100 KW. The chemistry of decontamination is not included.* (47-1)

4. Information on small reactors may be released (declassified) if it is of a particular value for teaching the basic principles of small reactors. *This excludes the release of information on the design of small reactors.* (47-1)

5. The neutron fluxes for the following reactors only (48-1):

<u>United States</u>

- Argonne National Laboratory
  - CP-1 (graphite)
  - CP-2 (graphite)
  - CP-3 (heavy water)
- Clinton Laboratory
  - Graphite Air Cooled Pile
- Los Alamos Laboratory
  - Low Power Water Boiler
  - High Power Water Boiler

<u>United Kingdom</u>

- Harwell
  - GLEEP
  - BEPO

<u>Canada</u>

- Chalk River
  - ZEEP
  - NRX

a. The <u>design</u> power of these reactors may also be declassified *but in no event are actual operating power levels to be released. Neutron distributions in space should be limited to smooth trends without details which might reveal lattice cell sizes.* The external dimensions of these reactors and the thickness of shielding may be revealed. (48-1)

b. The dimensions, neutron fluxes and velocity distributions of the thermal columns for all of the reactors listed above. (48-1)

IV. REACTORS (Continued)

6. The dimensions of lattices, rods and their assemblies, and of the hole diameters through which the rods are mounted for the following reactors: (50-1)

   United States - Argonne National Lab CP-3 (Heavy Water)

7. The critical mass of the reactors listed in IV.A.5. above. (50-4)

8. ("Class I" REACTORS). All information necessary for the design, construction and operation of the following reactors as designed at January 1, 1950, *but not necessarily the results of work done with the reactor.* (50-3) (50-4)

   <u>United States</u>

   Argonne National Laboratory
   CP-1 (graphite, natural uranium)
   CP-2 (graphite, natural uranium)
   CP-3 (heavy water, natural uranium)

   Los Alamos Scientific Laboratory
   Low Power Water Boiler (light water, enriched uranium)
   High Power Water Boiler (light water, enriched uranium) versions 1, 2, and 3

   <u>United Kingdom</u>

   Harwell - GLEEP (graphite, natural uranium)

   <u>Canada</u>

   Chalk River - ZEEP (heavy water, natural uranium)

9. ("Class II" REACTORS). The following reactors are primarily used for research purposes but incorporate features of value in the design of production, power or mobile reactors ("Class III" reactors). For Class II reactors, only certain features can be declassified while other features must remain classified. (50-3) (50-4)

   <u>United States</u>

   Brookhaven National Laboratory
   Graphite Air Cooled Reactor

   Oak Ridge National Laboratory
   Graphite Air Cooled Reactor

   Los Alamos Scientific Laboratory
   Plutonium Fast Reactor

   <u>United Kingdom</u>: Harwell - BEPO

   <u>Canada</u>: Chalk River, N.R.X. Pile

IV. REACTORS (Continued)

10. Critical mass of Class II reactors on an individual basis to facilitate the teaching of reactor technology in universities and engineering institutions. (53-6)

11. The Argonne Low Power Reactor. (57-10)

B. ENRICHED REACTORS

1. The qualitative characteristics of fast, intermediate and thermal reactors, *provided that such information was of the same general type as has already been released on natural uranium reactors and provided it does not reveal information about composition and design of projected reactors or about relative merits of individual materials of construction or about relative merits of possible combinations of materials.* (50-1)

2. The qualitative principles of breeding, *but* <u>*excluding*</u> *numerical information on actual gain factors likely to be achieved. Whether a particular system will not breed is not declassifiable*. (50-1)

3. Examples of possible moderators, ceramics, coolants, and structural materials *but not including information about composition and design of projected reactors or about relative merits of individual materials of construction or about relative merits of possible combinations of materials.* (50-1)

4. The general problems of refueling *but not to include any detailed information on chemical reprocessing.* (50-1)

C. EXPERIMENTAL BREEDER REACTORS

1. The power density is 250 KW per liter. (52-2)

2. The reactor core is the approximate size of a regulation football. (52-2)

3. The neutron flux is approximately 10^{14} neutrons/sq. cm/sec. (52-2)

4. The coolant is sodium potassium alloy. (52-2)

5. Electromagnetic pumps and flow meters are used in the liquid metal circuits. (52-2)

6. The temperature of the coolant leaving the reactor is 350 degrees C. (52-2)

7. Super-heated steam of 400 psi pressure is generated in a boiler heated by sodium-potassium alloy. (52-2)

IV. REACTORS (Continued)

8. The generator is of 250 KW size and excess electrical power not required by the reactor is used for building service or dissipated to the atmosphere by electrical heaters. (52-2)

9. The power load required to operate the reactor is approximately 85 KW. (52-2)

D. LIQUID METAL COOLANTS

1. Laboratory-scale corrosion data in the absence of reactor or simulated reactor radiation. This includes static, dynamic and other types of corrosion data in monometallic or small multimetallic systems *except corrosion data involving uranium and plutonium.* (50-4)

2. Basic theoretical and experimental heat transfer and pressure-drop data of simple round-tube, flat-plate, or annuli configurations, including constructional details of laboratory equipment used, *provided that the actual construction details of a reactor or full-scale heat exchanger are not revealed.* (50-4)

3. Any component part of a large-scale liquid metal heat transfer system *except for drawings, design data, and performance and operating data of individual components of the large-scale liquid metal heat transfer system insofar as they reveal details of the reactor, their relationship to a reactor coolant system or the over-all design.* (50-4)

4. Applications of liquid metal coolants in connection with uses *other than as primary or secondary reactor coolants.* (50-4)

5. The revelation of interest in a given element or alloy as a heat transfer fluid *provided that no reference is made to the special reactor or the reactor system for which this element or alloy is intended.* (50-4)

6. The remaining classified technology developed in the Lithium Cooled Reactor Experiment (LCRE) and the SNAP-50 program. (73-3)

E. ARMY NUCLEAR POWER PACKAGE PROGRAM

1. Fact that application of nuclear energy to production of electric and other power to meet military needs is under investigation. (53-4)

2. Fact that program is joint effort of Army and AEC. (53-4)

3. Contractor involved. (53-4)

4. Reactor concepts being considered for use. (53-4)

5. *All equipment within the reactor container (Reactor container is vessel enclosing nuclear reactor and its controls together with primary coolant contained therein) and designed data pertaining to this equipment is classified* except: (53-4)

   a. Fact that a particular material is to be studied as coolant.

   b. Fact that a particular type of fuel is being considered for use.

   c. Control activating mechanisms *except as they reveal dimensions and size of core, location and nature of control elements and nature of control problem*.

   d. Reactor container *except as it reveals design of core, reflector and control*.

6. Declassification of all information concerning the Army Nuclear Power Package Program *except the following:* (55-3)

   a. *Information revealing strategic defense plans (i.e., the fact that such a reactor is to be located at a specific defense outpost, etc.).*

   b. Information revealing the non-declassifiable nuclear properties of fuel materials (i.e., on the cross-section of U^{235} *for neutrons having an energy above .1 Mev).*

   c. Information revealing the exact degree of U^{235} *enrichment if the assay is greater than 90%.*

   d. Information on the methods to be used to inhibit, control, or alleviate the effects of radiation on materials to be used in the construction of the reactor.

   e. The methods developed to fabricate the fuel elements.

   f. The method to be used to inhibit or control corrosion, erosion, crud formation, or activity in the coolant stream.

   g. Information developed as a result of shielding studies which materially helps solve the problem of developing a shield of limited size and/or weight.

7. Army Package Power Reactor No. 2. (58-17)

8. The currently envisioned design, construction and operation of the GCRE-1, GCRE-II, and ML-1 prototype reactors are declassified. (59-10)

IV. REACTORS (Continued)

9. The GE-ANP Shield Test Pool Facility (Susie Reactor) at the Idaho Test Station. (59-12)

10. All information concerning the design and associated technology developed to date for the Military Compact Reactor concept. (67-8)

F. CONTROLLED THERMONUCLEAR REACTORS - PROJECT SHERWOOD (Also called Magnetic Fusion Energy)

1. The AEC interest in Project Sherwood and the identification of the sites at which the work is underway. (55-5)

   a. Cost information and breakdown of the Controlled Thermonuclear Reactor (CTR) program. (58-2)

2. The fact that Sherwood work is concerned with thermonuclear reactions between "the isotopes of hydrogen." (55-5)

3. Code names, e.g., Sherwood etc., and their association with thermonuclear reactions between isotopes of hydrogen.

   a. Possibility of direct conversion of above phenomena to heat. (57-3)

   b. Possibility of direct conversion of above phenomena to electrical energy. (57-3)

4. General Scientific Information

   a. Design of present or future models revealing components or portions which do not disclose the connection of such items in the Controlled Thermonuclear Reactor (CTR) program. (55-5)

   b. Detectors and diagnostic equipment by themselves *(and not revealing their connection to the Sherwood program).* (55-5)

   c. Energy balance considerations based on Maxwellian distributions. (57-3)

   d. All theoretical analyses of the equilibrium of a quiescent pinch. (57-3)

   e. Theory of hydrodynamic and hydromagnetic shock waves. (57-3)

   f. Widely known techniques for achieving high temperatures such as shock tubes and simple discharges. (57-3)

IV. REACTORS (Continued)

g. Fundamental experiments, *but excluding any method developed for the achieving of high plasma temperatures which represent a significant step on the road to the production of a CTR.* (57-3)

h. Designs of components of portions of present or future models *which do not disclose the connection of such items in the CTR. program.* (57-3)

i. General theory of diffusion of ions in a magnetic field. (57-3)

j. Scientific investigations of a general nature on plasma instability. (57-3)

k. Existence and theory of simple pinch effect. (57-3)

l. Existence and theory of skin effect in an ionized gas. (57-3)

m. Fact of production of thermonuclear neutrons. (57-3)

n. Technology of energy storage and release, using capacitors, homopolar generators, Kapitza-type batteries, or electric guns *when not specifically associated with classified CTR. devices.* (57-3)

o. Methods of measurement *not revealing significant information concerning classified CTR. devices.* (57-11)

p. The design, construction, performance, or operating characteristics of other CTR. devices. For example: (57-11)

(1) Nuclear reaction rates
(2) Theoretical studies
(3) Models
(4) Plasma densities
(5) Magnetic field configurations

5. Programs Involving Pinch Effect

a. Experimental work in the pinch effect prior to May 1, 1956 (such as Columbus, Perhapsatron, Cousins and Ware). (57-3)

b. Theoretical work on controlling instabilities by applied uniform axial magnetic fields produced by direct current. (57-3)

IV. REACTORS (Continued)

6. Stellarator Program

   a. Conventional radio frequency excitation of plasma (electrodeless discharge). *This does not mean magnetic pumping.* (57-3)

   b. Frequency of, and power for, magnetic pumping components *when unrelated to CTR. apparatus.* (57-3)

7. Magnetic Mirror

   a. Switching methods. (57-3)

   b. Shock wave experiments *(if unrelated to the rest of the program)*. (57-3)

8. The "Astron" device (a CTR device to be exhibited at the 1958 Geneva conference). (58-11)

9. Declassification of the controlled thermonuclear reactor project (Project Sherwood). *Any device employing thermonuclear reactions which has a weapons application will remain classified*. (58-13)

10. All information on controlled fusion. (59-6)

G. OTHER CIVILIAN NUCLEAR POWER

1. Certain data concerning natural and slightly enriched uranium reactors necessary in studying the feasibility of power reactors. (53-6)

2. Fabrications of fuel elements--limited to U-Al elements, and uranyl sulphate solutions for a homogeneous reactor. (55-1)

3. Certain data concerning reactors necessary in studying the feasibility of power reactors. (55-2)

4. Additional information concerning research reactors including necessary fuel element fabrication techniques. (55-2)

5. Production technology *not important to classified programs.* (55-2)

6. All information necessary to the design, construction, and operation of civilian power reactors with the *exception of that information primarily applicable to military propulsion, production reactors, or Army Package Power Reactors.* (56-6)

IV. REACTORS (Continued)

7. Information relating to the chemical processing of reactor fuels and blanket materials irradiated in civilian power reactors. (56-6)

8. All nuclear data (concerning reactor technology) *except that which has or may have significance to the weapons program*. (56-6)

9. All chemistry and chemical processing except *that revealing the quantities and specifications of the materials that are produced primarily for military purposes.* (59-3)

10. All work and information originated in the civilian reactor field for civilian purposes, *provided no classified information from other sources is incorporated in the work or information*. (61-3)

11. Information developed in the Medium Power Reactor Experiment (MPRE) program. (67-12)

H. PRODUCTION REACTORS

1. The mere fact that Savannah River routinely ships enriched fuel elements to the Idaho Chemical Processing Plant for reprocessing. (58-8)

2. The fact that tritium is produced in the control rods of the Savannah River reactors, incident to reactor control. (58-16)

3. The fact that the AEC produces high Pu^{240} content plutonium for research purposes, and the quantities produced for the research program. (59-1)

4. The power level (thermal MW) of the NPR. (59-5)

5. The fact that tritium is produced at Hanford incident to the operation of the production reactors. (63-1)

6. The following information concerning the New Production Reactor (N-Reactor). (65-3)

   a. Operating power level
   b. Pu production that can be calculated from the operating power level down time and previously declassified information
   c. Steam flow rate
   d. Steam and condensate temperatures and pressure
   e. Steam availability
   f. Total water flow

IV. REACTORS (Continued)

g. Inlet and outlet water temperatures and pressures
h. Average neutron flux
i. Time operating efficiency

7. The uranium content of irradiated NPR fuel elements which have been determined by the Director, Division of Production, to be non-representative of routine NPR dual purpose production. (65-7)

8. Nominal power levels during reactor operation and corresponding flux levels. (68-2)

   a. All Savannah River Reactors - each 2000 MW
   b. Small Hanford Reactors - each 1500 MW
   c. Hanford K-Reactors - each 4000 MW

9. Reactor production capabilities for certain isotopes *(excluding Pu^{239} and tritium)* based on nominal power levels so that one could reveal the extent to which these isotopes, having specific peaceful applications, could be produced on a large scale. (68-2)

10. Unit costs for production of certain isotopes *(excluding Pu^{239} and tritium)* having peaceful applications, *when not revealing production rates (or costs of weapon materials) more accurately than estimates derivable from the nominal reactor power levels*. (68-2)

11. Integrated and/or peak flux for specific tubes in a reactor, *provided it does not reveal actual reactor power level or actual production rates of material for military use*. (68-2)

12. Value of average flux in specific tubes, or time cycles, when influencing a particular experiment *but not revealing time operated efficiency of the reactor*. (68-2)

13. Location of specific tests within a reactor *when this does not reveal flux pattern or flux distribution for the reactor.* (68-2)

14. Coolant flow rates and temperature rises corresponding to declassified nominal power levels -- Hanford only *(those for Savannah River will remain classified)*: (68-2)

Small Hanford Reactors	
Nominal coolant flow	84,000 gpm
Nominal temperature	68ºC

IV. REACTORS (Continued)

Hanford K-Reactors

Nominal coolant flow	210,000 gpm
Nominal temperature rise	72ºC

15. Items of less sensitive reactor technology, *not related to power levels or production rates*, would also become unclassified such as: (68-2)

    a. Zoning of grades and stacking patterns for graphite
    b. Dimensions of thermal or biological shield
    c. Design features of shield, such as apertures, labyrinths, ducts, plugs, cooling tubes, and taper bore process tube entry
    d. Percentage composition of reactor atmosphere and relations of atmosphere to graphite temperature, growth and annealing

16. The following information concerning the N-Reactor: (71-5)

    a. Power levels of the N-Reactor before December 1, 1965.
    b. All N-Reactor production and production rate information.
    c. All direct and residual costs of operating the N-Reactor such as:

        (1) The cost of fuel element manufacture at Fernald and Ashtabula.
        (2) The cost of operating the extrusion line.
        (3) The cost of running the reactor.
        (4) The cost of reprocessing.

17. Total quantities of Krypton and Xenon per site as released to the atmosphere as a result of the operation of production reactors and associated operations at Hanford, Idaho Falls and Savannah River beginning March 1, 1971. (71-6)

18. The fact that we do not <u>now</u> trap Krypton and/or Xenon produced in production reactors and associated operations. (71-6)

    a. Krypton and Xenon releases from F and H canyons [at the Savannah River Site] and whether any rare gases were or were not trapped prior to March 1, 1971. (94-9)

19. Items of N-reactor technology (including fuel fabrication) not previously declassified. (72-1)

    Note: This action does not apply to production reactors other than N-reactor.

20. The Hot Die Size (HDS) process for cladding fuel and target elements, including the end bonding operation. (85-2)

IV. REACTORS (Continued)

21. Historical plutonium production information and associated rare gas releases for the decommissioned production reactors at the Hanford site for the period 1944 through 1960. (89-4)

22. Information concerning Hanford reactors:

    a. Plutonium production and associated reprocessed quantities of products and rare gas releases, from 1961 to the shutdown of the decommissioned Richland reactors, and Hanford-produced tritium quantities. This action will declassify all Hanford weapons materials production quantities from the decommissioned reactors and amounts recovered. *Comparisons with Savannah River production and any associations with intelligence activities will remain classified*. (92-1)

    b. All process times, temperatures, pressures, and classified compositional parameters for the early Hanford-developed cladding and canning technology including the hot press bonding, triple dip, lead dip (including the similar parameters for the Savannah River triple dip and lead dip processes), and the unbonded "B" and "C" processes. (92-1)

23. Information concerning Savannah River reactors:

    a. The total quantity of weapons grade plutonium including supergrade plutonium produced at the Savannah River Plant. (93-5)

    b. The historical quantity of plutonium produced for any time period in the Savannah River reactors and information that only reveals Pu production. (94-9)

    c. The quantity of plutonium separated, or otherwise modified, to other forms (such as oxide or metal) at the Savannah River Plant during any time period. (94-9)

I. MISCELLANEOUS REACTOR TOPICS

1. All shielding studies *except*: (50-4)

    a. Shielding studies carried out with neutrons from a reactor.
    b. Complete reactor shields.
    c. Details of reactor shields, including such items as heat generation and removal within shields, apertures, labyrinths, ducts, plugs, etc., when such design details reveal the design criteria or the overall design of specific reactor shields.
    d. Detailed discussion of distribution of various shield elements for reactor shielding purposes.

IV. REACTORS (Continued)

NOTE: The above exceptions do not refer to the reactors listed in paragraph IV.A.5. Rather, it is the intent of these exceptions to classify advances in the solution of the problem of developing a shield of limited weight and/or size for submarine and aircraft reactors.

2. Materials Test Reactor (MTR) and Low Intensity Test Reactor (LITR)

   a. The thermal neutron and gamma flux distribution in all experimental holes outside the reactor core. (53-3)

   b. The fast neutron flux available for irradiation experiments. (53-3)

   c. The design power; the design inlet and outlet water temperature and water flow rate. (53-3)

   d. The reactor cooling system (primary cooling system) external to the reactor tank, *except for specific points of sabotage vulnerability, and excepting data on procedures used to insure quality control of water and data on the effects of radiation on decomposition of water as well as on the corrosive action of water.* (53-3)

   e. Auxiliary reactor systems such as the raw water and air system (*except sabotage vulnerability points*). (53-3)

   f. Description of the reactor container <u>per</u> <u>se</u> *except insofar as it reveals details of the core reflector, the core cooling system, and controls*. (53-3)

   g. Identification of materials used as moderator or reflector, or for structural support *(no elaboration beyond mere identification)*. (53-3)

   h. All side faces of the reactor; the reactor top with the top plug in place. (53-3)

   i. The general type of control rods (*except sabotage vulnerability points*). (53-3)

   j. The control actuating mechanisms (*insofar as they do not reveal core details and specific nature and location of control elements, and excepting sabotage vulnerability points*). (53-3)

   k. The shield composition, geometry, and method of cooling, *not including radiation attenuation data*. (53-3)

IV. REACTORS (Continued)

l. Descriptions of beam holes and associated equipment (pneumatic tubes, "rabbits", etc.). (53-3)

m. Description of thermal column. (53-3)

n. Existence of holes in beryllium reflector, located in the region of maximum thermal nuclear flux and provided with cooling water at reactor coolant temperature. (53-3)

3. Operating and performance data for the lattice and fuel elements. (54-1)

   a. The core lattice spacing of Gas Cooled Reactor Experiment No. 1 (GCRE-1). (58-14)

4. Data on procedures used to insure quality control of water. (54-1)

5. Data on the effects of radiation on reactor components and on the decomposition of water as well as on the corrosive action of water. (54-1)

6. The technology of fabrication and testing of fuel elements including specifications of fissionable material contained therein. (54-1)

7. All information on the design, construction and operation of the Hanford Plutonium Recycle Reactor except: (57-1)

   a. Information on Pu fuel element design and fabrication technology if alloys containing more than 50 atomic % Pu are involved.
   b. Information on design and construction of reactor shield if based on military reactor shield design.

8. Information on molten salt reactors not relating specifically to Aircraft Nuclear Propulsion (ANP). (58-1)

9. Design studies on a Gas-Cooled Reactor at ORNL, Kaiser Engineers, and American Machine and Foundry may be conducted on an unclassified basis. (58-1)

10. ORNL Homogeneous Reactor Program technology. (58-1)

11. General Atomic Division, General Dynamics Corporation research and isotope producing reactors TRIG-A, REGA 10-30, and IRGA. (58-1)

12. The fact that the SNAP-III project proposed by Westinghouse Electric is for the development of a small power supply for Vanguard. (58-6)

IV. REACTORS (Continued)

13. The Merchant Ship Reactor, a pressurized water reactor built by Babcock and Wilcox. (58-6)

14. ZPR-IV, ZPR-V, ZPR-VII and the Three Foot Exponential project at Argonne National Laboratory. (58-8)

15. Boiling Reactor Experiment No. V (BORAX V) reactor. (58-15)

16. The fact that Atomics International is investigating the potential of thermocouples for direct conversion in the SNAP-II program. (59-1)

17. The Enrico Fermi and Fast Oxide Breeder Reactors. (59-1)

18. Design engineering studies on systemized organic-cooled and pressurized water reactors at Argonne National Laboratory. (59-1)

19. The Neutron Irradiation Facility at Argonne National Laboratory. (59-3)

20. The Argonne High Flux Research Reactor AHF-1. (59-7)

21. The experimental Organic Cooled Reactor (EOCR). (60-1)

22. The following areas of reactor research: (60-5)

    a. Army Power Reactor PM-3A for McMurdo Sound, Antarctica
    b. Development of AL_2O_3 coated UO_2 dispersed in graphite under BMI contract
    c. Development of pyrolytic graphite-coated UO_2 and UC_2

23. The BONUS (Boiling Nuclear Superheat) Reactor. (61-1)

24. Identification of lithium as a coolant in the Indirect Cycle Reactor. Also, the fact of use of columbium-1% zirconium alloy in fuel elements, coolant piping, container or structural materials in the Pratt and Whitney reactor program. (61-2)

25. The isotopic content of the plutonium fuel used in the Plutonium Recycle Test Reactor and in the Plutonium Recycle Test Reactor Critical Facility. (61-7)

26. The mere fact that Pu^{238} can be used in isotopic SNAP devices and was used in the Transit 4A device, including the quantity used. (61-5)

27. Research and development on the coating with BeO of UO_2 particles ranging in size from microns to spheres required for the Pebble Bed Reactor. (61-6)

IV. REACTORS (Continued)

28. The Westinghouse 1000 Mwe Supercritical Once-Through Pressure Tube Reactor (SCOTT-R) (if unclassified reactors). (62-3)

29. The fact that the Pu^{238} used in Transit IVA [SNAP] was from Hanford-derived material. (62-7)

30. The Ultra-High Temperature Reactor (UHTREX). (62-7)

31. The Bare Reactor Experiment, Nevada (BREN) effects test reactor and the Liquid Fluidized Bed Reactor, Critical Experiment facility (LFDR-CX). (62-13)

32. In the area of basic reactor materials research, i.e., the investigation of the property of materials, the work should be conducted on an unclassified basis. (62-5)

33. Features of heat exchangers which have universal application in heat exchanger design and fabrication [re:SNAP]. (62-13)

34. The 10 MWt Experimental Beryllium Oxide Reactor and the Prototype Maritime Gas-Cooled Reactor. (62-18)

35. The ANL Fast Reactor Test Facility (FARET) and the Argonne Advanced Research Reactor (AARR). (63-1)

36. The oxygen and nitrogen content of pyrocarbon coated UC_2 [for reactor fuels]. (63-10)

37. The Hanford Fast Flux Test Facility (FFTF). (66-2)

38. Information concerning the electric power reactor and isotopic heat source. (67-6)

    <u>SNAP 2, 4, 8, 10 and 10A</u>

    a. Detailed descriptions of key problems or their solutions;
    b. Identification of specific technical difficulties causing schedule slippage;
    c. Detailed reactor performance, including coolant outlet temperatures above 1350°F;
    d. Fuel element fabrication processing and performance information, including the composition of improved fuel materials and additives;
    e. Hydrogen retention barrier composition and techniques of application;
    f. Details of hydriding process and welding techniques specifically developed for SNAP claddings;

IV. REACTORS (Continued)

g. Certain reactor subsystem design information; e.g., new control mechanisms, use of "honeycomb" in SNAP shields;
h. Changes in shield design or material which result in the development of a shield of reduced size and/or weight;
i. Processing and fabrication techniques specially developed for SNAP shield materials;
j. Significant new concepts and technology; and
k. Military mission data.

Isotopic Heat Source

a. Detailed specifications of the manufacturing processes for radioisotopic heat sources which reveal the effects of isotopic heat and radiation on the process.

39. The concept of a self-energized thermoelectric converter where a semi-conductor and Pu^{238} (as an isotopic heat source material) are combined in an integral body of semi-conducting material and research and development work on such a device; *provided significant advances, breakthroughs or information that reveals the fact or manner of use of these systems where necessary to protect information classified by the user agency are not revealed*. (68-6)

40. Information concerning the compatibility of fuels and fuel containers above 1200° F for all radioisotope fuels. (69-4)

41. Space Electric Power Reactor Program:

    a. Uranium-zirconium hydride reactor technology (SNAP). (72-3)

    b. Thermionic converter reactor technology. (72-3)

    c. Advanced liquid metal cooled reactor technology. (72-3)

    d. The remaining classified technology developed in the Lithium Cooled Reactor Experiment (LCRE) and the SNAP-50 program. (73-3)

V. NUCLEAR WEAPONS AND RELATED TECHNOLOGY

A. GENERAL

1. General Features

a. Super - speculation outside Armed Forces and AEC organizations. (48-2)

b. Fact that development of atomic warheads for guided missiles or artillery is underway - *Any elaboration must be cleared by AEC and DOD prior to publication.* (51-1)

c. Mere fact that gun assembly may be used to achieve criticality. (51-1)

d. Mere fact that implosion may be used to achieve criticality. (51-1)

e. Mere fact that either method may be used to achieve criticality *Component parts of the system will be accorded a classification corresponding to the extent that the part reveals essential nature of the system*. (53-1)

f. In-flight insertion; mere fact that U.S. has a system for nuclear arming of bombs while carrier is in flight *(no other details)*. (56-3)

g. Weapon reliability; Inspection of weapons: Mere fact that such inspections are made. (56-3)

h. Mere existence of the phenomenon of predetonation. (56-3)

i. The term “one point detonation” is declassified in connection with 1955 safety experiments. Use in connection with either planned safety experiments or a weapon accident is also unclassified. (58-14)

j. The fact of existence of weapons with tailored outputs, e.g., enhanced x-ray, neutron or gamma-ray output; that we are hardening our weapons to enhanced weapon outputs and that high-Z materials are used in hardening nuclear weapons against high-energy x-rays. (72-11)

k. The fact of existence of a deep-earth penetration fuzing option. (72-11)

l. Limited Try - That feature of a coded switch which permits insertion of code possibilities only up to an established number; code tries in excess of an established number may result in a delay or lockout. (73-4)

m. The fact that the IFI (in-flight insertion of a nuclear material capsule or other nuclear part) safing method was applied to designated, retired weapons. (80-1)

n. The term "dial-a-yield" (DAY) and fact of its applicability to undesignated weapons. (89-3)

o. Fact that non-spherical parts are used in some weapons, part unidentified, weapon undesignated. (91-1)

p. Fact that multipoint detonation systems are used in undesignated weapons. (91-1)

q. The fact of the use of high explosives in pure fusion weapon research. (98-2)

r. Experiments done with High Explosive (HE) systems which do not resemble implosion assembled device HE systems. (98-12)

s. Specially designed systems intended to create strong shocks propagating down a cylinder that do NOT use classified material properties in design calculations and do NOT drive materials with classified material properties into classified regions of their equations-of-state. (98-12)

t. The experiments that were accomplished with systems listed in r. and s. above unless they (the experiments) drove materials with classified equation-of-state properties into regions which in themselves (the regions) were classified. (98-12)

2. Materials Usable/Used

a. Type of fissionable materials used *(no reference to quantities; detailed assembly, etc.)*. (53-1)

b. Identification of the type of fissionable materials used in Trinity, Hiroshima, Nagasaki, Bikini-Able, and Bikini-Baker models. (53-1)

(1) Mere fact that Pu^{239} alone was used in the Trinity, Nagasaki, and Crossroads events. (65-6)

c. Use in weapons of normal, depleted [any assay] or fully enriched uranium [>90% U235] and the identification of the fissionable materials used in a specific fission weapon. (59-16) [60-4]

d. Lithium and its compounds:

(1) The fact that lithium, deuterium (Li^6D, LiD) are used in unspecified thermonuclear weapons. (62-10)

(2) The mere fact that normal Lithium Deuteride (Li^nD) is used in unspecified TN weapons. (67-2)

(3) The assay of top product of Li^6 production plant or the fact that this top assay is used in weapons. (67-2)

(4) The fact that Li^6H is used in unspecified weapons for hardening. (67-2)

(5) The fact the Li^7H or Li^nH may be used as mockup materials in the weapons program. (67-2)

(6) The fact that compounds of Li^6 containing tritium are used in the design of weapons as TN fuel. (72-11)

e. Fact of use of Pu^{238} in milliwatt isotopic power sources for possible use in the Prescribed Action Link (PAL) program. (63-5)

f. Revealing the general fact of existence of nuclear weapons which contain only Pu-239. (67-2)

g. Use of normal cascade top product in specific weapons. (67-2)

h. Fact of use in specified or unspecified weapons of normal uranium or depleted uranium of any assay. (67-2)

| (1) The fact that intermediate enrichments of uranium are used in U.S. nuclear weapons. (94-10)

i. Quantity of Be used outside the nuclear assembly systems. (67-2)

j. The total quantity of Be used in the nuclear weapons program. (67-2)

k. The fact of use of B-10 for hardening in unspecified nuclear weapons. (67-2)

l. The mere fact that delta phase Pu has been or is used in weapons. (67-2)

m. The fact that reactor grade plutonium can be used to make nuclear weapons. (67-10)

n. The mere fact that high irradiation level reactor-grade plutonium can be used to make nuclear weapons. (67-10)

o. The mere fact that Be is used in the nuclear assembly system of designated weapons. (72-11)

p. The concept of storing hydrogen isotopes in solid or liquid compounds in undesignated weapons. (88-4)

q. Fact of use of boron carbide in undesignated weapons. (91-1)

r. Fact that the thermal stability of pentaerythritol tetranitrate (PETN) in an undesignated weapon is improved by baking or by adding tripentaery thritol octanitrate, polysaccharide, or other specific additions. (92-2)

s. Fissile shell information: The fact of use of thin spherical shells of fissile materials in weapons, *without elaboration.* (93-2)

t. Special nuclear materials masses: That about 6 kg plutonium is enough hypothetically to make one nuclear explosive device. (93-2)

u. Hypothetically, a mass of 4 kilograms of plutonium or uranium-233 is sufficient for one nuclear explosive device. (94-1)

NOTE: The average masses of special nuclear materials in the U.S. nuclear weapons or special nuclear materials masses in any specific weapon type remain classified.

v. The presence of and a maximum amount of non-SNM hazardous materials used in nuclear weapons or weapon components in the event of an accident or other emergency situations. In concert with this declassification, currently unclassified information pertaining to the amount of HE in nuclear weapon assembly systems likewise may be released in the event health, safety, or environmental concerns arise. (98-4)

w. Estimates of special nuclear material masses in weapons which are obtained by indirect methods involving production rates. (98-10)

x. Fact that all U.S. weapon pits that contain plutonium have at least 500 grams of plutonium, no elaboration. (99-4)

3. External Characteristics

a. Visible size and shape only of specifically listed obsolete weapons of historic interest including replicas and miniatures including nickname, code and model designations: (53-1)

Trinity
Nagasaki
Hiroshima
Bikini-Able (w/o external antenna)
Little Boy
Mk-3

b. Nuclear test device shipping and handling containers *not revealing nuclear or military characteristics.* (53-1)

c. Visible size and shape of externally carried bombs[4] when object is not specifically identified as an atomic weapon and no other information concerning the nature or purpose of the object is revealed to observers. (53-1)

(1) The size, weight and shape of externally carried atomic bombs. (54-2)

d. Thermonuclear test devices shipping and handling container *not revealing nuclear or military characteristics. When object is not specifically identified as an atomic weapon and no other information concerning the nature or purpose of the object is revealed.* (53-4)

e. The size, weight and shape of the 280 MM Atomic Artillery Shell, Mod 0-22 (Army designation: M-354, AEC designation Mark 9). The declassification of the size, weight and shape of artillery-fired atomic shells *other than the MK 9* will be considered by AEC-DOD on an individual basis. (54-2)

f. The actual shape, dimensions and weight of the 8-inch artillery shell. (Army designation T317, AEC designation TX 33) (56-2)

g. Mere mention of a nuclear weapon by mark, model, service nomenclature number, or code word, whether or not it reveals the device as a nuclear weapon. (56-3)

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[4] This item is included in recognition of the fact that operationally it is impossible to prevent unauthorized observers from seeing or photographing objects externally carried by airplanes. However, it is not necessary to identify the object for such observers or photographers or to reveal to them detailed specifications concerning the size and shape of the object. Such information can and should be protected.

h. Actual size, weight, center of gravity or moments of inertia of <u>fission</u> weapons when identifiable as nuclear weapons *provided information classified by other topics is not included.* (56-3)

   (1) Obsolete weapons (Fat Man, Little Boy, MK 3 and MK 4 only). *Provided external antennae removed.* (56-3)

   (2) Externally carried weapons. (56-3)

   (3) Warheads when completely covered by ballistic case. (56-3)

   (4) Shipping and handling containers *not revealing nuclear or military information.* (56-3)

i. Visible size and shape only of externally carried thermonuclear weapons *when not identifiable as such.* (57-2)

j. Actual size, shape, weight, center of gravity, or moments of inertia of fission or boosted fission weapons when identifiable as nuclear weapons *provided other classified information is not included. Fat Man, Little Boy, MK 3, MK 4, MK 5 and MK 6 only*. (57-7)

k. The actual shape, dimensions and weight of any artillery (or naval rifle) shell whose diameter is equal to or greater than 8 inches. *This information will be classified only if the existence of the delivery system is considered classified by the DoD*. (57-7)

l. The size, weight and shape of some thermonuclear weapons *(Any information which reveals the existence of thermonuclear weapons with diameter less than 24 inches or weight less than 2000 lbs. is classified)*. (59-16)

   (1) Size, weight and shape of some thermonuclear weapons *(Any information which reveals the existence of thermonuclear weapon with diameter less than 18 inches or weight less than 690 pounds is classified).* (60-3)

m. Only such information on the weight of the assembled Davy Crockett weapon as revealed by observation of the physical handling. *Note should be taken of the great importance of safeguarding the yield of the Davy Crockett*. (60-3)

n. The size, weight, and shape of weapons or missile warheads when in the hands of troops for training, or when final flight test configuration is reached. (62-10)

o. Moments and Products of Inertia for free-fall bombs in production or stockpile prior to July 1, 1967. *Remarks: The Moments and Products of Inertia for new weapons of these types which are produced on or after July 1, 1967 will be evaluated on an individual basis and the appropriate classification listed in individual guides as is the case with size, weight and shape of these weapons.* (67-11)

4. Design Process /Tools

a. The idea of the implosion, *not including compressional properties*, need not be considered classified. *However, direct reference to it is not permitted.* Rather it is intended that subjects otherwise declassifiable should not continue classified solely because, by implication, they might reveal the idea of implosion. *Details of the implosion are to continue to be treated as highly classified information.* (50-3) (50-4)

- All theoretical equation of state studies *if not of specific interest to the implosion.* (50-3) (50-4)

- Explosive studies *if not of specific interest to implosion or to other special weapon studies.* (50-3)

- Theoretical work on shock hydrodynamics *if not of specific interest to the implosion.* (50-3)

b. The fact that a weapon is in an AEC-DOD Weapon Program Phase. (62-10)

c. Fact that multidimensional radiation - hydrodynamic codes are used for weapons design. (83-5)

B. FISSION WEAPONS

1. Gun-Type

a. The description of the propellant material of gun-type weapons. (62-10)

b. The fact that the 280 mm and 8 inch gun-type nuclear weapons contain four rings. (64-6)

(1) The fact that in the 280 mm gun-type nuclear weapons, the projectile (solid cylinder) is fired into the target rings. (64-6)

(2) The fact that during the firing cycle of the 280 mm, "one portion is detained for a fraction of a second while it is being moved forward." (64-6)

c. The fact that a specific weapon is gun-type. (67-2)

2. Implosion-type

a. Moments of inertia of HE implosion type weapons. (62-10)

b. The fact the MK 7 is an implosion-type nuclear weapon; (64-6)

(1) The fact that the MK 7 contains 92 detonators; (64-6)

(2) The fact that two hemispheres "A" and "B" are used in the MK 7 nuclear weapon. (64-6)

c. Fact that a specific weapon is implosion type *except for one classified weapon*. (67-2)

d. Explosive system; raw materials and detonator cables *(unless revealing classified information)*. (56-3)

e. The definition of a capsule. (67-2)

f. The fact that (various explosive materials) TNT, RDX, HMX, PETN, RDX COMPOSITION B, RDX COMPOSITION B3, 75/25 CYCLOTOL, BARATOL, TETRYL, PBX 9007, PBX 9010, PBX 9011, PBX 9404, PBX 9407, LX-04, and LX-07, are used in specific weapons. (67-2)

g. Fact of use of extrudable explosives in unspecified weapons. (67-2)

h. The mere fact that hollow pits are used as nuclear components. (72-9)

(1) The concept and definition of a "split levitated" pit, with no elaboration. (98-2)

i. The mere fact that weapons may be safed by the insertion of inert materials into the pit. (72-9)

j. The mere fact that some of our nuclear weapons are inherently safe. (72-9)

k. The fact of use in high explosive assembled (HEA) weapons of spherical shells of fissile materials, sealed pits; air and ring HE lenses; that multipoint detonation systems may be used in weapons, and a definition of pre-initiation-proof weapons (weapon, the yield of which is not sensitive to initiation of the nuclear reaction at a time earlier than the planned time). (72-11)

(1) The concept or existence of preinitiation-proof nuclear weapons and the term "preinitiation-proof weapon." (98-2)

l. The fact of boosting, the fact that deuterium and tritium are used as boosting fuels in HEA weapons and that they are contained in components known as reservoirs or cartridges which are shipped between the Savannah River Plant and the AEC weapon facilities, the military and the United Kingdom. (72-11)

(1) The fact that some high-explosive assembled (HEA) weapons (specified or unspecified) may be boosted or are boosted. (83-2)

(2) Physical state of boosting fuel in HEA weapons. (83-2)

(3) Fact that gaseous deuterium (D) and tritium (T) are used as boosting fuel. (83-2)

(4) The fact that gas boosting is used in specified weapons. (83-3)

(5) Declassification of reservoir information: The safety factor, defined as the ratio of test pressure to maximum working pressure that a reservoir is calculated to experience during its use, for unspecified or specified reservoirs. (93-2)

(a) General gas boost reservoir design information, including such technologies as helium-3 filtering and solid storage, that do not reveal boost gas quantities, composition, or technology deployed on specified weapons. *(Hardware and test information which would reveal engineering details or the technology used in specified weapons remains classified.)* (98-2)

(b) Vessel lifetimes of unspecified or specified reservoirs. (98-11)

(c) Maximum service life of fill for unspecified or specified reservoirs. (98-11)

(d) The fact that some tritium reservoirs will last the expected weapon service life for unspecified or specified weapons. (98-11)

(6) The term "hollow boosting." (93-2)

(a) Its definition: "A method wherein the boost gas is in a hollow pit at detonation time." (93-2)

m. The fact that the MK7 nuclear weapon employed an in-flight-insertion, "levitated pit" design of the type having an airspace between the tamper and core. (79-2)

n. Fact of use of slapper detonators in specified weapons. (83-5)

o. Fact of use of multiport valves in specified weapons. (83-5)

p. Information concerning LLNL's Waxwing device or similar insertable nuclear component (INC) concepts.

(1) The fact that the (HE) used for imploding fissile components of the INC is stored as a paste in the missile body awaiting transfer to a final location. (85-1)

q. The existence of, or the capability to design, implosion assembled weapons with diameters of 6 inches or more. (88-4)

r. Fact that tritium is associated with some unspecified pits. (92-4)

s. The fact that some unspecified pits include or contain tritium, *no further elaboration*. (94-14)

t. Declassification of pit bonding information:

(1) Fact that bonding of plutonium or enriched uranium to materials other than themselves is a weapon production process. (93-2)

(2) Fact that such bonding occurs or may occur to specific unclassified tamper, alpha-barrier or fire resistant materials in unspecified pits or weapons. (93-2)

(3) Fact that plutonium and uranium may be bonded to each other in unspecified pits or weapons. (93-2)

(4) Fact that such bonding may be diffusion bonding accomplished in an autoclave or may be accomplished by sputtering. (93-2)

(5) Fact that pit bonding/sputtering is done to ensure a more robust weapon or pit. (93-2)

(6) The use of autoclaves in pit production. (93-2)

(7) The fact that plutonium is processed in autoclaves. (93-2)

(8) The fact that sputtering of fissile materials is done at or for any Department of Energy facility as a production process. (93-2)

(9) The fact of a weapons interest in producing a metallurgical bond between beryllium and plutonium. (93-2)

(10) The fact that beryllium and plutonium are bonded together in unspecified pits or weapons. (93-2)

(11) Routine data concerning concentrations of beryllium in plutonium higher than 100 ppm. (93-2)

u. That plutonium-239 or weapon-grade plutonium is used:

(1) In unspecified implosion assembled weapons or pits of unspecified staged weapons. (93-2)

(2) As the sole fissile material in unspecified implosion assembled weapons, or in the pit of unspecified staged weapons. (93-2)

v. Trinity test device:

(1) The fact that the Trinity test device and Fat Man had 32 detonators with each detonator having two bridgewires that independently initiated the same point. (00-1)

(2) The fact that the mass of plutonium in the Trinity test device and Fat Man was about 13½ pounds (6 kilograms). (00-1)

w. Declassification of the association of plutonium-only pits with designated weapons. (00-3)

3. Initiators

a. The fact that a modulated external initiator is possible or is used and the fact that initiators of the accelerator type are feasible or are used. (59-16)

b. Fact that an initiator may or may not be needed in gun-assembled weapons. (59-16)

(1) Fact that initiators may or may not be needed in gun-type weapons. (62-10)

c. The existence and use of modulated initiators of the alpha-n type and that they can use Ac-227, Po-210, Ra-226 and Pu-238. (62-10)

(1) The fact that a polonium-beryllium initiator is used in the 280 mm and 8" gun-type nuclear weapons. (64-6)

(2) Fact that Po-210 is used in weapon initiators. (67-2)

d. The mere fact that specific rare earths are or may be used in targets for neutron generators. (63-5)

e. The fact that accelerator-type initiators are used in gun-assembled weapons. (71-10)

f. The fact that mechanically operated power supplies for accelerator-type initiators are used in gun-assembled weapons. (71-10)

g. The fact that accelerator-type initiators are used in specific weapons. (71-10)

h. The fact that designated weapons are internally initiated. (72-11)

i. Number of neutron generators used in specified weapons. (83-5)

j. External weapon initiator information: The weights, volumes, and physical dimensions of external weapon initiators (neutron generators). (93-2)

k. The fact that serrations on the inside wall of ceramic neutron tube cylinders are assembled adjacent to a specified end of the tube. (95-2)

4. Fuzing and Firing Systems

    a. The fact that baro, radar, timer, impact, etc., elements may be included in the fuzing systems of atomic weapons. *Does not include other details of fuzing system.* (53-1)

    b. The fact that specific models of nuclear depth bombs or nuclear depth charges use hydrostatic switches to effect a nuclear detonation. (59-11)

    c. New developments in non-radiating fuzing for nuclear weapons when evaluation by AEC and DoD indicates no classified information involved. (67-2)

    d. The fact of use of ferroelectric or ferromagnetic devices as firing sets in specific weapons. (71-10)

    e. Fact of use of compressed-magnetic-field firing sets in specified weapons. (83-5)

    f. Fact of use of varistors as high voltage limiters. (91-1)

    g. The design of the improved Sandia quartz cantilevered beam accelerometer. (95-3)

    h. The fact that parts of the firing set may be located inside the nuclear system of an unspecified weapon. (98-2)

C. THERMONUCLEAR WEAPONS

1. Principles

    a. Physics of the light elements (includes reactions involving deuterium and tritium). (51-1)

    b. General statements concerning the relationship of commonly known nuclear reactions of the light elements to developmental work on thermonuclear weapons. (51-1)

    c. The date or estimate of the date when a thermonuclear weapon may be an actuality. (54-2)

d. The fact that in thermonuclear (TN) weapons, a fission "primary" is used to trigger a TN reaction in thermonuclear fuel referred to as a "secondary." (72-11)

e. The fact that, in thermonuclear weapons, radiation from a fission explosive can be contained and used to transfer energy to compress and ignite a physically separate component containing thermonuclear fuel. (79-2)

Note: *Any elaboration of this statement will be classified.*

f. Fact that fissile and/or fissionable materials are present in some secondaries, material unidentified, location unspecified, use unspecified, and weapons undesignated. (91-1)

g. Information on the DOE's pure fusion program:

(1) The mere fact that the AEC is doing research on pure-fusion weapons (67-1)

(2) Explosively driven flux-compression generators, *per se* (67-1)

(3) Design of explosively driven flux-compression generators when the method of application to the production of nuclear energy is not revealed (67-1)

(4) The fact that explosively driven flux-compression generators are of interest in pure-fusion weapon research. (67-1)

(5) Fact that the DOE made a substantial investment in the past to develop a pure fusion weapon (98-15)

(6) That the U.S. does not have and is not developing a pure fusion weapon; and (98-15)

(7) That no credible design for a pure fusion weapon resulted from the DOE investment. (98-15)

2. Weapon Characteristics

a. The fact that certain of our operational missiles have thermonuclear warheads. (62-10)

b. The fact that tests were conducted of designs which could lead to an entirely new class of U.S. weapons which could have relatively low weights and extremely high yields, with the fission contributions decreased to only a few percent of the total yield. (63-2)

c. The fact that the yield-to-weight ratios of the new class of weapons would be more than twice that which can now be achieved in the design of very high yield weapons using previously developed concepts. (63-2)

d. "The United States, without further testing, can develop a warhead of 50-60 Mt for B-52 delivery." (63-6)

e. "... some improvement in high yield weapons design could be achieved and that new warheads -- for example a 35 Mt warhead for our Titan II -- based on these improvements could be stockpiled with confidence." (63-6)

f. Information revealing the mere existence of TN devices with total yield equal to or greater than 5 KT. (68-8)

g. The fact that the thermonuclear fuel used in the Mike test (10/31/52) of the Ivy series was liquid deuterium. (74-8)

h. The related fact that complex and bulky cryogenic equipment was associated with Mike. (74-8)

i. The fact that the device fired in the Bravo test (2/28/54) of the Castle series used lithium deuteride as its thermonuclear fuel. (74-8)

j. The existence of, or the capability to design, a thermonuclear (TN) weapon assembly system with a diameter of 8 inches or more. (88-4)

k. Primary/secondary information: The identity of a designated device nickname/acronym as a primary or secondary. (93-2)

   (1) The statement that the interval time for a staged weapon is between 0.001 microseconds and 100 microseconds, with no elaboration. (98-2)

l. Secondary information: The fact that fissile and/or fissionable materials are present in some secondaries, materials unidentified except for uranium (depleted, natural, and enriched including highly enriched uranium), location unspecified, use unspecified, and weapon undesignated. (93-2)

m. Radiation case material information for unspecified weapons only:

(1) The fact of use of specific elements with atomic number (Z) greater than 71 as radiation case materials. (93-2)

(2) The fact of use of specific unclassified alloys as radiation case materials. (93-2)

n. The fact that intermediate enrichments of uranium are used in U.S. nuclear weapons. (94-10)

o. The fact that materials may be present in channels and the term "channel filler," with no elaboration. (98-2)

p. The existence of secondary designs containing liquid or gaseous isotopes of hydrogen, with no elaboration. (98-2)

q. The presence of enriched uranium, any assay, in unspecified weapon secondaries, without elaboration. (00-5)

D. PHENOMENOLOGY AND EFFECTS

NOTE: Some declassifications in this area refer to "nominal data," defined as values pertaining to a 20 kt burst, or to similar data for any other assumed yield which are derived from 20 kt data by application of well-known physical concepts (scaling). Nominal data also includes data on all pre-SANDSTONE shots (Trinity, Hiroshima, Nagasaki, Bikini-Able, Bikini-Baker) and to data taken from SANDSTONE and Post-SANDSTONE shots when these data are scaled up or down to 20 kt equivalent bursts. Another term used is "hypothetical yield," defined as any yield not identifiable as the yield of an actual detonation, weapon, or device.

1. Source Characteristics

a. Partition of energy; In air, below 15,000 ft. Mean Sea Level (MSL). As among thermal, visible, nuclear radiation, and shock. (56-3)

(1) Partition of energy: in air, below 50,000 ft. MSL, as among thermal visible nuclear, etc. (59-2)

b. Precursor and related phenomena: the word "precursor" when used in connection with atomic weapons phenomena or effects. (56-3)

(1) Precursor and related phenomena. (59-2)

c. The fact that the X-ray output of nuclear weapons may contain a significant amount of energy above 10 kev *provided that elaboration on this fact continues to be classified.* (77-3)

d. Blackbody temperature information for use in discussions concerning nuclear weapons:

(1) The fact that nominal (or normal) nuclear weapon temperatures are 1 to 2 keV. (93-2)

(2) Hypothetical 2 keV and below single temperature blackbody equivalent x-ray spectra. (93-2)

2. Blast and Shock Phenomena

a. Blast, shock, acceleration, etc. Nominal *(not related to any specific event)*. (48-2)

(1) Values at specified distance or specified part of target - Nominal. (48-2) (51-1)

(2) Character of attenuation with distance, altitude and depth - Nominal. (48-2) (51-1)

(3) Gravity waves, height, velocity, and attenuation - Nominal and Bikini Baker. (48-2) (51-1)

(4) Special phenomena such as Mach front - Nominal. (48-2) (51-1)

(5) Blast data necessary for defensive studies - Nominal (20kt burst). (49-1)

(6) Base surge - Nominal. (48-2)

(a) Base surge - Nominal and Bikini Baker. (51-1)

b. Mathematical expressions or graphical presentations resulting from a compilation of blast and shock data as a function of distance and hypothetical yield. (*Provided height of burst or depth of burst is not specified.*) (56-3)

(1) Peak overpressure.
(2) Peak dynamic pressure.
(3) Time of arrival of shock front.
(4) Positive phase duration of overpressure and dynamic pressure.
(5) Peak density or peak material velocity.

(6) Mach characteristics and height of triple point.
(7) Overpressure and dynamic pressure impulse.
(8) Crater dimensions for surface bursts.
(9) Variation of crater dimensions with depth of burst as obtained from unclassified TNT data.

c. Variations of the following air blast and shock parameters at surface level with distance or time as a function of height or depth (including composite curves for a number of heights or depths of burst), or in free air with distance or time, as a function of yield. *Classification depends on classification of yield.* (59-2)

(1) Peak overpressure
(2) Peak dynamic pressure
(3) Time of arrival of shock front
(4) Positive phase duration of overpressure and dynamic pressure
(5) Peak density or peak material velocity
(6) Mach characteristics and height of triple point
(7) Overpressure and dynamic pressure impulse
(8) Crater dimensions for other than surface bursts.

d. Variation of any of the parameters under (c) above or other shock or wave characteristics with distance or time as a function of depth of burst (including composite curves for a number of depths of burst) in ground or water as a function of yield. *Classification depends on classification of yield.* (59-2)

e. Relative efficiencies of any of the parameters in c. or d. with respect to TNT or other standard of comparison. (59-2)

3. Fireball

a. Rate of growth - more than 1 second - Nominal. (48-2)

b. Temperatures (but no more specific than 2 to 6 KV) - Nominal. (48-2)

c. Size, rate of growth, temperature and other characteristics - Nominal. (51-1)

d. Mathematical expression or graphical presentations resulting from a compilation of fireball data as a function of hypothetical yield. (56-3)

(1) Maximum fireball radius.
(2) Radius of fireball related to time for scaled time.

4. Thermal Phenomena

a. Mathematical expressions or graphical presentations resulting from a compilation of thermal data as a function of hypothetical yield. (56-3)

(1) Shape of radiation pulse
(2) Thermal yield

b. Incident thermal radiation energy at a given distance for a hypothetical yield. (56-3)

c. Existence of, and circuitry used in devices such as bhangmeters. (56-3)

(1) Bhangmeter design criteria. (59-2)

(2) Bhangmeter calibration data or records. *Classification of bhangmeter records identified with classified yields depends on the classification of the yield.* (59-2)

d. Mathematical expressions or graphical presentations resulting from a compilation of thermal data as a function of hypothetical yield. Thermal radiation as a function of time after the 1st millisecond. (59-2)

5. Radiation

a. Types and amounts of radiation *(not resolved beyond one second)* - Nominal. (48-2)

(1) Nominal data for .01 second and greater. (51-1)

b. Values at specified distances and gamma and neutron irradiated samples taken at specified distances - Nominal. (48-2)

(1) Values at specified distances (Nuclear and thermal) Nominal. (53-1)

c. Attenuation, atmospheric absorption - Nominal. (48-2)

(1) Attenuation, atmospheric absorption. Ground and water scattering and absorption (Nuclear and Thermal) Nominal. (53-1)

d. Ground and water scattering and absorption spectral distributions- Nominal. (48-2)

e. Spectral distributions - Nominal. (48-2)

(1) Spectral distributions (Nuclear and Thermal) Nominal. (53-1)

f. Relative intensities of types of radiation - Nominal. (48-2)

(1) Relative intensities of types of radiation (Nuclear and Thermal); Nominal. (53-1)

g. Alpha radiation. Fission product concentrations; Nominal. (48-2) (53-1)

h. Intensity rates of increase or decrease - Nominal. (48-2)

i. Intensity, rate of increase or decrease. (53-1)

(1) Nuclear; Nominal data for .01 second and greater.
(2) Thermal; Nominal data and data for 1 second and greater.

j. Gamma and neutron irradiated samples taken at specified distances; Nominal. (53-1)

k. Mathematical expressions or graphical presentations resulting from a compilation of nuclear radiation data as a function of distance and hypothetical yield. *Information will be classified on the basis of classification of diagnostic information that may be involved.* (56-3)

(1) Gamma intensity vs. time (after 0.01 seconds from detonation), integrated dose and effective energy spectrum.
(2) Neutron total dose (rad or rem). It is permissible to indicate “high,” “medium,” or “low” neutron yield detonation.
(3) Neutron dose as a function of energy spectrum as measured by activation, threshold and fission detectors having thresholds 3 Mev or below. Unclassified for unboosted fission weapons only.
(4) Neutron induced activity as determined by type or composition of exposed material.
(5) Character and degree of attenuation, scattering or absorption in various media.

l. Neutron and gamma ray fluences at least 1,000 meters from ground zero. (98-9)

6. Radioactive Fall-out

a. Mathematical expressions or graphical presentations resulting from a compilation of radioactive fall-out or residual radiation data as a function of hypothetical yield and burst conditions. *“Clean” and “salted” weapons or devices will not be included.* (56-3)

(1) Pattern

(2) Iso-intensity and iso-dose contours, total activity, residual radiation energy spectrum, or decay rate for fission weapons, devices, or detonations.
(3) Beta to gamma ratio

b. Information concerning the residual radiation contours near ground zero for yields up to five megatons. (55-5a)

7. Atmospheric/Oceanographic Phenomena

a. Bomb clouds and column - Nominal. (48-2)

(1) Shape, rate of ascent, dimensions at specified times - Nominal. (48-2)

(2) Cloud chamber effects - Nominal. (48-2)

(3) Cloud chamber effects. (56-3)

(4) Base surge, *except when related to yields*. (56-3)

b. Meteorology

(1) Extent of downwind travel - Nominal (20KT). (48-2)

(a) Pre-Sandstone. (51-1)

(2) Exact meteorological conditions at detonation time - Nominal. (48-2)

(a) Pre-Sandstone. (51-1)

(3) Cloud fallout studies - Nominal. (48-2)

(a) Cloud fallout data - Nominal (20kt burst). (49-1)

(b) Pre-Sandstone. (51-1)

(c) Cloud fallout data necessary for defensive use. (51-1)

(4) Long range spread of material - Nominal. (48-2)

c. Oceanography

(1) Velocities of surface and bottom currents and their relation to spread of material - Nominal. (48-2)

(a) Internal circulation and flushing lagoon - Nominal. (48-2)

8. Damage

a. Burn and blast damage to animate objects (General) - Nominal (Japan). (48-2)

b. Burn and blast damage to inanimate objects (General) - Nominal (Japan and Trinity). (48-2)

c. Crater size- Nominal, Japan and Trinity. (48-2)

(1) Fact that crater is formed. (53-1)

(2) Crater size; Nominal. (53-1)

(a) Crater sizes; Underground and surface shot Buster/Jangle. (54-2)

d. Damage radii - Nominal, Japan and Trinity. (48-2)

e. Degree, range and cause of overall damage - Nominal, Japan and Trinity. (48-2)

f. Relative importance of damage producing phenomena - Nominal, Japan and Trinity. (48-2)

g. Points of great structural weakness - General. (48-2)

(1) Structural weakness. (53-1)

h. Internal mechanical damage - General. (48-2)

(1) Susceptibility to internal mechanical damage - General. (53-1)

i. Medical aspects subject to other categories - Nominal, Japan and Trinity. (48-2)

j. Radiation damage to inanimate objects- Nominal, Japan and Trinity. (48-2)

k. Repair (physical problems). (48-2)

l. Decontamination problems - General. (48-2)

(1) Decontamination data necessary for defensive use - Nominal (hypothetical 20,000 ton burst). (49-1)

(2) Decontamination studies including water purification. (49-1)

(3) General principles and techniques of decontamination *without reference to specific agents.* (49-2)

m. Monitoring techniques. (48-2)

n. Shielding studies - Nominal. (48-2)

(1) Shielding data necessary for defensive use - Nominal (20Kt burst). (49-1)

o. Other protective devices - Nominal. (48-2)

(1) Studies of protective devices, individual and collective. (49-1)

p. Damage to and description of specific material and ships - Nominal, Japan and Trinity. (48-2)

q. Comparisons of damage effectiveness of the different bombs. All of the same order, but acknowledge that the U.S. has now achieved explosives up to twice the strength of Hiroshima and Nagasaki bombs. (48-2)

r. Effects which would have been produced in City and Harbor of New York, Nominal (20KT). (48-2)

s. Speculations on deep water and underground explosions, Nominal (20KT). (48-2)

t. Military Defense - Nominal. (48-2)

u. Civil defense problems - Nominal. (48-2)

(1) Civil defense problems, *not related to a specific agent or weapon.* (49-2)

v. 100 ton test and scale tests including radiological. (48-2) (49-1)

w. Effects of 20,000 ton explosion described in the Weapon Effects Handbook of the U.S. or the Civil Defense Handbook of the U.K., *unless classified characteristics of the weapon can be determined therefrom.* (50-3)

x. Resurvey information *except quantitative statements on amount of fissile material*. (48-2)

(1) Resurvey information at test sites *except: quantitative statements on amount of fissile material*. (49-1)

E. RELATED DEVELOPMENTS

1. Enhanced Radiation Weapons (ERW)

   a. The mere fact that the U.S. is interested in pursuing a program to determine the characteristics of an "enhanced radiation" weapon (neutron bomb). (63-9)

   b. The fact that the W-79 is an enhanced radiation weapon. (78-1)

2. Minimum Residual Radiation (MRR) Weapons

   a. The fact that we are interested in and are continuing studies on a weapon for minimizing the emerging flux of neutrons and internal induced activity. (67-2)

   b. The fact of weapon laboratory interest in MRR devices. (76-3)

   c. The fact of successful development of MRR devices. (76-3)

3. Nuclear Directed Energy Weapons (NDEW)

   a. The fact that DOE weapon laboratories are engaged in a research program to explore the feasibility of a nuclear explosive driven directed energy weapon. (82-2)

   b. The fact that research is being conducted on the specific concept of a nuclear pumped X-ray laser. (82-2)

   c. The fact that the DOE is interested in or conducting research on NDEW concepts of certain specified generic types of output; i.e., visible light, microwaves, charged particles, kinetic energy. (85-4)

   d. The fact that underground tests at the Nevada Test Site have been and are a part of the NDEW research program. (85-4)

   e. The fact that a specified NDEW could engage multiple targets by using multiple beams from a single platform and hence is a high leverage system. (85-4)

   f. The fact that an NDEW could have lethal ranges of thousands of kilometers. (85-4)

g. The fact that a kill mechanism for an x-ray laser is ablative shock. (85-4)

h. The fact that standard laser techniques (e.g., lenses, rods, slabs, and oscillators) were considered in the nuclear-pumped x-ray laser program without discussion of details or experimental results. (94-2)

i. The use of materials for the x-ray laser program, *provided otherwise classified information about nuclear device performance is not revealed*. (98-3)

4. Nuclear Directed Energy Systems (NDES)

a. Generalized description of DNES principles, as well as general qualitative or quantitative information on the physics and technology of low-power DNES research, *that does not substantially:* (86-1)

(1) Assist others in development of DNES weapons; or
(2) Contribute to feasibility assessment of DNES weapon development; or
(3) Reveal programmatic directions.

b. General qualitative descriptions of DNES program goals or objectives *that do not reveal classified milestones or achievements or specific design characteristics. Classified milestones and their achievements will be reviewed for release on a case-by-case basis.* (86-1)

c. General studies of DNES special nuclear materials and their physical properties. *Specific special nuclear materials which are developed for (and the specific conditions of their association with) classified DNES projects and test device designs will remain classified*. (86-1)

d. General studies of other DNES materials and their physical properties. *No material identities or associations will be declassified where such information may be used to infer classified DNES characteristics.* (86-1)

e. General DNES computational techniques or analytical procedures. *Computational techniques and procedures which utilize or reveal specific design or operational characteristics will remain classified.* (86-1)

5. Radiological Warfare

a. General definition of radiological warfare agents, their purpose and effects. (49-2)

b. Fact that the U.S. is studying its possibilities. (49-2)

c. Existence and purpose of the Joint AEC-National Military Establishment Panel on Radiological Warfare. (49-2)

d. General limitations. (49-2)

e. General potentialities. (49-2)

f. Medical aspects (of RW), *except where governed by other classification topics*. (49-2)

g. General principles of tactical deployment, *without reference to a specific agent, weapon, or vehicle.* (49-2)

h. Procurement of basic materials *prior to irradiation* when purpose is not revealed. (51-1)

F. MILITARY USE OF NUCLEAR WEAPONS

1. Hiroshima and Nagasaki (48-2)

a. Delivery method: (B-29 at 30,000 ft. w/o parachute)
b. Heights of burst: (Hiroshima 600 meters; Nagasaki 500 meters)
c. Time of detonation
d. Zero Point
e. Ranges, Slant and Horizontal
f. Target. Alternate for Nagasaki target “Kokura”
g. Accuracy of drop

2. System Concepts

a. The fact that a military weapons system (such as the 280 mm gun, airplanes of various types including fighters and fighter bombers, and guided missiles of various types) has a capability to deliver atomic weapons *provided that the existence of the military weapons system itself is not classified and that any elaboration of the statement of capability will be classified in accordance with the nature of the additional information revealed.* (53-1)

b. Mere fact that the U.S. has developed a munition suitable for demolition work. (57-9)

c. The fact that one of the proof tests of a complete nuclear weapons system involved the ASROC (Anti-Submarine Rocket) weapons system. (63-2)

d. Information related to the Polaris:

(1) The fact that the POLARIS MARK 2 Re-entry System may have more than one nuclear warhead. (66-5)

(2) The actual number of MARK 58 nuclear warheads which the POLARIS MARK 2 Re-entry System may have. (66-5)

e. The term or concept of clustered or multiple nuclear warheads *when not associated with a specific missile system or project.* (67-2)

f. MIRV concept associated with Polaris MK2, Poseidon, and Minuteman III re-entry system. (68-1)

g. The fact that the total number of Spartan and Sprint interceptors planned for the 4-site option at Minuteman sites is 120 Spartans and 264 Sprints. (71-3)

h. The nuclear device to be tested in the Cannikin event is related to the optimum development of a warhead for the Spartan missile of our Safeguard Ballistic Missile Defense Program. The measurements of device performance which will be obtained from the test are essential to our optimum defense deployment of safeguards for protection of our Minuteman missile sites. (71-9)

i. The maximum number of warheads the Poseidon and Minuteman III are designed to carry. (73-4)

j. The fact that ICBMs and SLBMs are hardened. (73-4)

k. The mere fact, without elaboration, that the U.S. has had in development a long-range interceptor with a high-yield warhead which kills by X-ray, and that the missile is named Spartan. (74-4)

l. The mere fact, without elaboration, that the Sprint warhead is designed to use air blast which may destroy the reentry vehicle, and neutrons which penetrate the reentry vehicle. (74-4)

m. Interest in the procurement of ceramic cloth or fibers by a research activity or facility [sic] not associated with weapons. (74-5)

n. The fact that a designated nuclear weapon or missile system is hardened against specified nuclear effects. (77-1)

o. The fact that the Navy RB500 has a maneuvering capability. (80-2)

p. The fact that the Trident I missile has a design capacity for 8 Re-entry Bodies. (80-2)

q. Information related to the W68 Mark 3 re-entry vehicle:

(1) The Mk3 heat shield which consists of the machined shell and nose assembly. The Mk3 heat shield features, including the part itself, heat shield thickness, base diameter, and material physical or performance characteristics. (00-2)

(2) Mk3 jacket (cold Photon filter) materials and dimensions, including nose radius and thickness. (00-2)

3. Nuclear Weapons Stockpile

a. Existing storage site.

(1) Official names(s), nickname(s), and/or location, when association with the Armed Forces Special Weapons Project (AFSWP) or AEC is not revealed. (53-1)

(2) [Location of] AEC storage sites (as pertains to all weapons in custody of AEC at a National Storage Site (NSS) and an Operational Storage Site (OSS)). (56-3)

(a) When information does not explicitly reveal installation is a storage site for nuclear weapons. (56-3)

(3) [Location of] DoD storage sites (as pertains to weapons in DoD custody only). With delivery organizations and operating forces in the U.S. or overseas. (56-3)

(a) Fact that particular aircraft squadron, naval vessel, or special weapons organization has capability of storing or handling nuclear weapons. (56-3)

(4) The approximate location of some of the national stockpile sites and operational stockpile sites *provided no indication is given as to the total number of storage sites.* (59-16)

b. Future storage sites.

(1) Official name(s), nickname(s), and/or location, when association with AFSWP or AEC is not revealed. Future storage sites become existing storage sites at the time of administrative manning. (53-1)

c. Surveillance program. Mere existence of maintenance or surveillance program. (53-1)

d. "In certain areas Soviet nuclear technology equals and in some areas even exceeds that of the U.S., although our overall capability and means of delivery are believed to be superior to the Soviets." (62-2)

e. "The U.S. has a nuclear weapon in stockpile with a yield of approximately 25 megatons." (62-6)

f. "The world was shocked by the 60 megaton test on October 30th. The U.S. analysis has shown that this device used a lead jacket around the fusion materials, and gave only a few megatons fission. Thus the Russians reduced the fallout, especially that which might have fallen on their own country. If lead were replaced by uranium, the Russian device would give 100 megatons or slightly more." (62-6)

g. The identification of U.S. TX, XW, or Mark numbers with U.S. missile names. (62-10)

h. "In order to achieve it, we maintain a total number of nuclear warheads, tactical as well as strategic, in the tens of thousands." (63-6)

i. The fact that we have deployed thousands of tactical nuclear weapons in Europe. (63-7)

(1) The fact that the total kiloton yield of these weapons is well in excess of ten thousand times the total yield of the nuclear weapons used at the end of World War II. (63-7)

j. "This country and the Soviet Union already have produced enough explosive force to equal ten tons of TNT for every man, woman and child on the face of the earth." This statement was to be used by the President on January 21, 1964 at a Disarmament Conference in Geneva. (64-2)

k. The fact that during the period December 1960 - January 1961 two nuclear artillery shells were in stockpile, the 280 mm and the 8 inch gun-type nuclear weapons. (64-6)

l. "In presenting this proposal, it could be stated that 'several thousand' nuclear weapons could be involved." This statement is contained in a U.S. Position paper on the Destruction of Nuclear Weapons to Obtain Fissionable Materials for Transfer Under a Cutoff and Transfer Agreement. (65-4)

m. "The number of nuclear warheads in strategic alert forces has increased from 850 on June 30, 1961 to 2700 estimated as of June 30, 1965." (65-5)

n. "The fact that U.S. strategic forces have an inventory of nuclear warheads in excess of 5,000, that the number of nuclear warheads furnished to the Alliance and stored in inventory in Western Europe has exceeded 5,000 nuclear warheads, and that this number will increase by more than 20% during the next six months." (65-8)

o. The minimum spacing for specific nuclear weapons or nuclear components in storage or transit. (67-2)

p. Statements that qualitatively reveal that a nuclear weapon is satisfactory. (67-2)

q. Statements that quantitatively reveal specific component quality or reliability requirements. (67-2)

r. The fact that U.S. nuclear artillery shells are located in Germany. (73-6)

s. The estimated costs for the proposed improved nuclear artillery shells as $452,000 each for the MK-74 (155mm) and $400,000 each for the MK-75 (8 inch). (73-6)

t. The fact that any particular reactor product is being or has been stockpiled for military use. (73-8)

u. Program dates of a Complete Weapon are now unclassified: (74-6)

(1) Advance Information Release (AIR)
(2) Advance Engineering Release (AER)
(3) Complete Engineering Release (CER)
(4) Initial Release
(5) General Release
(6) Interim Release
(7) First Production Unit
(8) Entrance of a weapon into a program phase

Because of the tactical value, scheduled *Operational Availability Date remains classified* until released by AEC or DoD.

v. Information concerning the weapons stockpile: (81-1)

	Fiscal Year			
Number of non-nuclear components	1945	1946	1947	1948
1. Gun-type	0	0	(0)	(2)
2. Implosion	2	9	(29)	(53)
Number of nuclear components				
3. Gun-type	0	0	0	0
4. Implosion-type	2	9	13	50

Numbers in parentheses declassified in 1976.

w. Descriptions of historical and future trends in the total number of nuclear weapons in, or megatonnage of, the total stockpile which are: (82-1)

(1) Qualitative.
(2) Expressed as a percentage change over any time period or on an unscaled graph with a scaled time axis for the past, present, or future up to and including the approved period of the current Nuclear Weapons Stockpile Memorandum (usually five fiscal years beyond the current fiscal year). *Note: Remains classified if dramatic trend changes result from significant unplanned events such as major technical or production problems, sabotage, natural or man-made disasters, etc.*

x. Descriptions of trends for any time period in nuclear weapon production or retirement rates which are qualitative, including relative comparisons of the production rate versus the retirement rate. (82-1)

y. The fact that the total nuclear weapons stockpile contains a few tens of thousands of weapons *(no numbers specified).* (82-1)

z. The unelaborated fact of the presence of U.S. nuclear weapons in the U.K. (84-1) aa. The megatonnage of the United States nuclear stockpile, by year, for year 1945 to 1994. (94-12)

Note: See the data table at Appendix D for exact data released. Inactive weapons are attributed zero yield. *Megatonnage value different from the attached table must be approved by Headquarters prior to public release. Specifications by weapon type remains classified.*

bb. The total quantity of the United States nuclear stockpile, indicated by year, for years 1949 to 1961. The total stockpile quantities for years 1945 to 1948 were already unclassified. (94-12)

Note: *Total quantity values that are different from the table at Appendix D must be approved by Headquarters prior to public release. Specification by weapon type remains classified.*

cc. The total number of nuclear weapons built by the United States, for weapon types fully retired, by year, for years 1945 to 1989. (94-12)

Note: These are total builds per year only. *Specification by weapon type remains classified. Total build numbers that are different from the table at Appendix D must be approved by Headquarters prior to public release.*

dd. The total number of nuclear weapons retired by the United States, by year, for years 1945 to 1989. (94-12)

Note: *Retirement numbers declassified do not include weapons retired from active status and placed in the inactive stockpile or inactive weapons returned to active status as shown in some classified databases. Retirement numbers that are different from the table at Appendix D must be approved by Headquarters prior to public release. Specification by weapon type remains classified.* The table at Appendix D includes the number of weapons disassembled by year for years 1980 through 1994. Disassemblies listed in the Appendix reflect only those weapons dismantled for actual disposal. Total disassemblies by year have been unclassified for some time.

ee. The total number of nuclear weapons in the United States active and inactive stockpile, by year, for years 1945 to 1961. (94-12)

Note: There were no inactive weapons in the stockpile during this time frame. However, it does allow comment that prior to 1962, all weapons were 'active' and that there were no inactive weapons.

V. NUCLEAR WEAPONS AND RELATED TECHNOLOGY (Continued)

4. Accidents

a. The salvage value of the Mark 28 Nuclear Weapon recovered off the coast at Palomares, Spain, was $164,000. (67-5)

b. The fact that approximately 6 kgs of plutonium were involved in the Greenland accident. (68-4)

(1) Best estimate of the amount of plutonium removed from the site. (68-4)

(2) Distribution of Tritium on the surface in the vicinity of the crash (excluding that picked up on aircraft debris) (69-2)

Enclosed Area[1] (square meters)	Tritium Deposition[2]		
	(Curies)	:	(% of total)
1.97×10^3	365		27.2
1.10×10^4	657		49.1
2.49×10^4	986		73.7
3.90×10^4	1337		100

[1] Consecutively larger areas corresponding to the fall-out pattern.
[2] Total out to the specified boundary.

c. The following information concerning the Palomares, Spain accident. (74-9)

- The fact that four TN bombs were involved.
- The fact that two bombs experienced HE detonation on ground impact.
- Presence in the bombs of U-235 and Pu-239.

VI. NUCLEAR TESTS/NUCLEAR TESTING

A. GENERAL

1. Instrumentation - technique only. (48-2)

    a. Overall preparations - Trinity through Sandstone. (48-2)

    b. Blast Instrumentation. (48-2)

    c. Instantaneous radiation instrumentation. (48-2)

        (1) *Except radiation as a function of time for the first 1/100 second; e.g., Rossi, Teller, Wilson methods*. (51-1)

    d. Meteorological instrumentation. (48-2)

    e. After - radiation instrumentation. (48-2)

    f. Photographic instrumentation. (48-2)

    g. Sample collection devices - less than 100 miles (fact and method). (48-2)

    h. Instruments

        (1) Instruments when issued to depots or troops. (49-1)

        (2) Production contracts for issue or stockpile quantities. (49-1)

        (3) Long range detection instrumentation. Design and development projects - acoustic and seismic (can range from U-S). (50-2)

        (4) Existence of Sound Fixing and Ranging Instrumentation (SOFAR). (50-2)

    i. Instrumentation. *Except when the various instruments or their array reveal classified information*. (56-3)

2. Organization.

    a. Trinity through Sandstone excluding the Fitzwilliam project. (48-2)

    b. For future operations without context revealing meaning. (56-3)

    c. Site or vehicle code words, e.g., for weather stations, monitor locations, airplanes and the like (Standing alone). (56-3)

d. Construction contractor work.

(1) Existence of AEC contracts and names of contractors for construction and maintenance work at Nevada or at Pacific Proving Ground *(without indicating date of test program).* (56-3)

(2) Total force of job site. (56-3)

(3) Routine personnel administration. (56-3)

(4) Procurement of routine construction items. (56-3)

(5) Length of time of employment. (56-3)

(6) Layout of camp site. Facilities; e.g., power houses and systems, telephone exchanges and systems, etc. (56-3)

e. Project contractors and Agencies; Association with test organizations. (56-3)

(1) Incomplete DOD-fiscal listing. (56-3)

3. Operations.

a. Test site; Location of ground zero. (56-3)

(1) Tower construction and drawings *not revealing nature of installation to be placed thereon.* (56-3)

(2) Layouts of individual instrument buildings *which do not reveal purpose for which building is erected, or radiation or other weapon effects it is to withstand.* (56-3)

(3) Layout of laboratory buildings *which do not reveal nature of activities conducted therein so as to indicate scope of scientific program.* (56-3)

b. General Scientific Information; Shipping and handling container for assembled nuclear test device, *providing it is not identified, and providing details giving size, weight, or shape of device are not divulged.* (56-3)

c. Developmental and test detonations at NTS. *If detonation is clearly identifiable as an actual or probable stockpile weapon (such as detonation of an air-to-air rocket or gun-fired projectile) the yield is Secret.* (57-7)

d. Currently classified information about historical device locations and movements at the Nevada Test Site or other U.S. nuclear weapons test sites. (98-9)

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

4. Long Range Detection - Monitoring Data.

    a. Continental tests. (53-1)

    b. U.S. overseas tests after announcement of occurrence. (53-1)

    c. Number and sizes of particles collected. (53-1)

    d. Quantitative reports of activities of fission products. (53-1)

        (1) Total activity or total beta activity.

        (2) Breakdown of total activity by time and location.

    e. Long range detection techniques that only involve the following: (53-1)

        (1) Tray

        (2) Gummed paper

        (3) High volume air sampler

B. TEST CONDITIONS

1. Delivery.

    a. Method

        (1) Trinity - 100 ft. steel tower. (48-2)

        (2) Crossroads/Able - B-29 at about 30,000 ft. (free fall). (48-2)

        (3) Crossroads/Baker - Steel caisson below a landing ship (LSM-60). (48-2)

        (4) Sandstone - 200 ft. tower. (48-2)

        (5) Greenhouse - Steel towers. (53-1)

    b. Heights of Burst

        (1) Crossroads/Able - several hundred feet. (48-2)

        (2) Tower heights - Continental tests. (53-1)

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

(3) Surface and underground shots (Buster-Jangle). Mere fact that such a shot had been fired. (53-1)

c. Time of detonation

(1) Trinity, Crossroads/Able and Baker - all released. (48-2)

(2) Sandstone - within one hour or nearest hour. (48-2)

(3) Post-Sandstone - Continental. (53-1)

(a) Within 12 hours of detonation - Scheduled time to within 5 minutes.
(b) After detonation - General.

d. Zero Point

(1) Trinity released. (48-2)

(2) Crossroads - General location. (48-2)

(3) Sandstone - General location. (48-2)

(4) Post Sandstone - General or approximate. (53-1)

(5) Tower shots. (53-1)

(6) Surface/Underground Shots

(a) Continental - General or approximate. (53-1)

e. Target

(1) Bikini - partial release (no distance). (48-2)

(2) Crossroads target array - General. (53-1)

f. Accuracy of drop

(1) Crossroads/Able - within 100 ft. of chosen altitude but 1500-2000 ft. off target. (48-2)

(2) Test air drops. Within 100 feet of chosen altitude and approximate relation to ground zero. (53-1)

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

C. TEST DESCRIPTIONS/RESULTS

1. Policies on Yield Declassification.

a. TNT Equivalents of Pre-Sandstone - General (48-2)

(1) Kiloton yield

(a) Pre-Sandstone - General statement. (51-1)

(b) Trinity and Crossroads; 20 Kt. (53-1)

(2) Yields of developmental and test weapons or devices as follows: (56-1)

(a) Sandstone, Trinity, and Crossroads. (56-1)

(b) Approximate yield for any shot under 1MT *when not identifiable with a specific shot* (identification of yield with named test operation or proving ground is not considered "identification with a specific shot") The Number 1 or nearest whole number multiple of 10 or 100; i.e., 1Kt, 10 Kt, 20 Kt, etc., 100 Kt, 200 Kt, 300 Kt, etc. (56-1)

b. *Developmental and test weapons or devices are classified* except as follows: Sandstone, Trinity, Crossroads, and Ivy Mike. The number 1 or nearest whole number multiple of 10 or 100, i.e., 1 Kt, 10 Kt, 20 Kt, etc., 100 Kt, 200 Kt, 300 Kt, etc. (56-3)

c. Hypothetical yields. A hypothetical yield is any yield not identifiable as the yield of an actual detonation, weapon or device. (56-3)

d. Provides for the announcement of yields "In terms of low yield, low intermediate yield, intermediate yield, or low megaton yield" for events that are officially announced. (68-8)

2. Specific Events.

a. Trinity, first test of atomic bomb at Alamogordo, NM, 16 July 1945. One shot. Type of fissionable material used and yield. (56-3)

b. Hiroshima, first actual combat drop in Japan, 6 August 1945 from B-29 at approximately 30,000 ft. altitude. One shot. Type of fissionable material used, yield, and height of burst. (56-3)

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

c. Nagasaki, second actual combat drop in Japan, 9 August 1945, from B-29 approximately 30,000 feet altitude. One shot. Type of fissionable material used, yield, and height of burst. (56-3)

d. Crossroads, atomic weapons test at Bikini Pacific Proving Ground in July 1946. Two shots. Type of fissionable material used and yield. Height of burst, target array (General). (56-3)

e. Sandstone, atomic weapons test at Eniwetok Island at the Pacific Proving Ground in April and May 1948. Three shots and yields. *No other details* except as provided in Appendix C. (56-3)

f. Ranger, atomic weapons test at Nevada Proving Ground in January and February 1951. Five shots. *No other details* except as provided in Appendix C. (56-3)

g. Greenhouse, atomic weapons test at Eniwetok, in April and May 1951. Four shots. Approximate yield. Shot Easy. *No other details* except as provided in Appendix C. (56-3)

h. Buster/Jangle, atomic weapons test at Nevada Proving Ground in October and November 1951. Seven shots. *No other details* except as provided in Appendix C. (56-3)

i. Tumbler-Snapper, atomic weapons test at Nevada Proving Ground in April, May and June 1952. Eight shots. *No other details* except as provided in Appendix C. (56-3)

j. Ivy, atomic weapons test at Pacific Proving Ground, 1 November 1952. *No other details* except as provided in Appendix C. (56-3)

k. Upshot/Knothole, atomic weapons test at Nevada Proving Ground in March through 4 June 1953. Eleven shots. *No other details* except as provided in Appendix C. (56-3)

l. Castle, atomic weapons test at Pacific Proving Ground in March and April 1954. Approximate yield of March 1 shot (15 MT). *No other details* except as provided in Appendix C. (56-3)

Note: This is Test Bravo, dated elsewhere as February 28, 1954.

m. Teapot, atomic weapons test at Nevada Proving Ground in Feb-May 1955. Thirteen nuclear shots and one HE detonation. *No other details* except as provided in Appendix C. (56-3)

(1) Yield May 5, 1955 shot in Teapot test series, as 30-35KT. (57-7)

n. Wigwam, atomic weapons test May 1955 in Eastern Pacific Ocean. One shot. *No other details* except as provided in Appendix C. (56-3)

o. Redwing, atomic weapons test May-July 1956 at Pacific Proving Ground. (57-2)

(1) Approximate yield of May 21 shot--several megatons. (57-7)

p. Actual yield of shot "Smoky." (57-8)

q. Plumbbob, atomic weapons test. May-Oct 1957 at NTS. Yields of all shots *except John*. (58-4)

r. The following information concerning the Pinon shot of Operation Hardtack nuclear test operation. These declassifications were related to a special shot for UN observers.

(1) The location and scheduled and actual time of shot. (58-5)

(2) The device to be tested is contained in a cylindrical container about 5 feet in diameter, and 12 feet long which will weigh about 8 tons including the contents. Also the center of gravity to the extent that it may be revealed by weighing under each of the four corners of the cradle. (58-5)

(3) The bomb fraction tracer will be 20 tons of uranium *(isotopic composition will remain classified)*. (58-5)

(4) The total yield as measured by fireball photography *(Only the predicted range of yield will be announced in advance of the test)*. (58-5)

(5) Cloud samples as collected on filter paper and any information which might be derived from analyzing them *without the use of any classified information.* (58-5)

(6) Fission yield as determined by radiochemistry at UCRL, Berkeley. The participants will observe this determination and may actually assist in carrying out the analyses and in this determination. (58-5)

(7) Identification of the device being tested as a stockpile weapon. (58-5)

(8) The fact that at some unspecified previous test a five megaton total yield device was detonated. (58-5)

Note: The Pinon test was never carried out.

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

s. Hardtack Phase II event yields: (59-4)

Event	Date	Location	Type	Purpose	Yield
Eddy	9/19/58	NTS	Balloon	Weapons Related	83 tons
Mora	9/29/58	NTS	Balloon	Weapons Related	2 KT
Tamalpais	10/8/58	NTS	Tunnel	Weapons Related	72 tons
Quay	10/10/58	NTS	Tower	Weapons Related	79 tons
Lea	10/13/58	NTS	Balloon	Weapons Related	1.4 KT
Hamilton	10/15/58	NTS	Tower	Weapons Related	1.2 tons
Logan	10/16/58	NTS	Tunnel	Weapons Related	5 KT
Dona Ana	10/16/58	NTS	Balloon	Weapons Related	37 tons
Rio Arriba	10/18/58	NTS	Tower	Weapons Related	90 tons
Socorro	10/22/58	NTS	Balloon	Weapons Related	6 KT
Wrangell	10/22/58	NTS	Balloon	Weapons Related	115 tons
Rushmore	10/22/58	NTS	Balloon	Weapons Related	188 tons
Sanford	10/26/58	NTS	Balloon	Weapons Related	4.9 KT
De Baca	10/26/58	NTS	Balloon	Weapons Related	2.2 KT
Evans	10/29/58	NTS	Tunnel	Weapons Related	55 tons
Mazama	10/29/58	NTS	Tower	Weapons Related	Zero
Humboldt	10/30/58	NTS	Tower	Weapons Related	7.8 tons
Sante Fe	10/30/58	NTS	Balloon	Weapons Related	1.3 KT
Blanca	10/30/58	NTS	Tunnel	Weapons Related	22 KT

t. Argus high altitude nuclear test: (59-8)

(1) Yield: 1-2 Kt
(2) Altitude: 300 nautical miles
(3) Latitude and Longitude: Each location to the nearest degree of latitude and longitude
(4) Time: given approximately to the nearest 10 minutes.

u. The mere fact that the Johnston Island shots introduced tritium into the atmosphere. (59-15)

v. The yields and time of the Hard Hat, Antler and Fisher events in Nougat test series. (62-4)

Events	Time & Date	Medium	Yield
Hard Hat	1700:00.12 Z 15 Feb. 1962	Tuff	4.5 Kt
Antler	2304:59.63 Z 15 Sept. 1961	Alluvium	2.4 Kt
Fisher	1800:0010. Z 3 Dec. 1961	Granite	13.5 Kt

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

w. The depth and yields of the Agouti and Aardvark events of Operation Nougat. (62-9)

Event	Time and Date	Medium	Yield	Depth	Surface Collapse
Agouti	1800:00.13 Z 18 Jan. 1962	Alluvium	5.9 Kt	835'	Yes
Aardvark	1800:00.10 Z 12 May 1962	Alluvium	40 Kt	1434'	Yes

x. The yield of two high altitude events: Starfish Prime (1.4 MT) and Urraca. (Note: Urraca was never carried out.) (62-11)

(1) Height-of-burst (about 250 miles) of the high altitude event in Operation Dominic: Starfish Prime. (62-15)

y. The yield and associated information concerning six underground events at NTS in order to assist seismologists in their study of the detectability of nuclear tests. (62-14)

Name	Yield	Date	Depth	Medium
Haymaker	48 Kt	6/27/62	1351 ft	Alluvium
Cimarron	11 ± 2 Kt	2/23/62	1000 ft	Alluvium
Armadillo	6.6 ± .7 Kt	2/9/62	796 ft	Alluvium
Stillwater	2.8 ± .3 Kt	2/8/62	625 ft	Alluvium
Chinchilla	1.8 ± .2 Kt	2/19/62	504 ft	Alluvium
Mad	430 ± 40 tons	12/13/61	603 ft	Alluvium

z. The yield and associated information concerning six underground events at NTS in order to assist seismologists in their study of the detectability of nuclear tests. (62-16)

Name	Yield	Medium
Dormouse II	9.7 Kt	Alluvium
Brazos	7.8 Kt	Alluvium
Stoat.	4.5 Kt	Alluvium
Hoosic.	3 Kt	Medium Tuff
Platte	1.6 Kt	Medium Tuff
Danny Boy	0.430 Kt	Alluvium

aa. For NTS, expected or actual yield of detonations, prior to September 15, 1961, but note that *the weight of the HE contained in a weapon is CRD.* (62-17)

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

bb. The fact that the August 12, 1958, ORANGE event of Hardtack-I produced 2.8 X 10^{24} atoms of $Rhodium^{102}$. (62-18)

cc. Johnny Boy. Date: July 11, 1962. Yield: 500 $\pm$ 20 tons. Depth: 2 ft. Medium: Alluvium. (63-4)

dd. Bilby. Date: 9/13/63. Yield: 200 Kt. Depth: 2314 ft. Medium: Tuff. (64-1)

ee. Yield of the "Mike" shot in the Ivy test series at 10.4 megatons. (64-5)

ff. Parrot event. Date: December 16, 1964. Depth: 600 ft. Yield: 1.2 Kt. (65-1)

gg. Petrel event. Date: June 11, 1965. Depth: 600 ft. Yield: 1.5 Kt. (65-1)

hh. Pacific Proving Ground Test Events: (66-3)

Test Event	Date	Operation and Location	Yield
KOON	April 7, 1954	Castle-Bikini	110 kt
LACROSSE	May 4, 1956	Redwing-Eniwetok	40 kt
ZUNI	May 27, 1956	Redwing-Bikini	3530 kt
SEMINOLE	June 6, 1956	Redwing-Eniwetok	12 kt
TEWA	July 20, 1956	Redwing-Bikini	5010 kt
CACTUS	May 6, 1958	Hardtack-Eniwetok	18 kt
KOA	May 13, 1958	Hardtack-Eniwetok	1370 kt
OAK	June 29, 1958	Hardtack-Eniwetok	8900 kt

ii. The yield of the Pile Driver event (55$\pm$ 11 KT). (67-9)

jj. Yield of the Mudpack (2.4 $\pm$ 1 KT) and the Discus Thrower (17 KT) events. (68-5)

kk. Yield of the Pommard event (1.5 KT). (68-7)

ll. Information concerning NTS test events. (69-1)

Event	Date	Predicted	Actual
Benham	12/19/68	1.1 MT	1.1 MT (est.)
Boxcar	4/26/68	1.1 MT	1.2 MT
Chartreuse	5/6/66		70 KT
Duryea	4/14/66		65 KT
Greeley	12/20/66	830 KT	825 KT
Halfbeak	6/30/66		300 KT
Knickerbocker	5/26/67		71 KT
Rex	2/24/66		16 KT
Scotch	5/23/67		150 KT

mm. The yield of the Merlin event (10 KT). (71-1) nn. The device to be tested in Cannikin will have a yield less than five megatons. (71-2)

oo. The predicted (80Kt) and the actual yield of the Miniata event. (71-7)

pp.

Event:	Date:	Yield:
Hupmobile	January 18, 1968	7.4 kt (71-8)
Packard	January 15, 1969	10 KT (71-8)

qq. The nuclear device to be tested in the Cannikin event is related to the optimum development of a warhead for the Spartan missile of our Safeguard Ballistic Missile Defense Program. The measurements of device performance which will be obtained from the test are essential to our optimum defense deployment of safeguards for protection of our Minuteman missile sites. (71-9)

rr. Unannounced atmospheric tests conducted at Eniwetok Atoll. (72-8)

Event Name	**Date**	**Type of Burst**
Yuma	05/27/56	Tower
Kickapoo	06/13/56	Tower
Inca	06/21/56	Tower
Mohawk	07/02/56	Tower
Pisonia	07/17/58	Barge
Fig	08/18/58	Platform
Quince	08/06/58	Platform
Safety Experiment:		
Scaevola	07/14/58	Barge

ss. The following information concerning NTS test events: (73-9)

Event	Yield	Date
Mississippi	110 Kt	10/5/62
Commodore	250 Kt	5/20/67
Calabash	110 Kt	10/29/69
Flask	105 Kt	5/26/70
Carpet Bag	220 Kt	12/17/70
Delphinium	15 Kt	9/26/72
Starwort	79 Kt	4/26/73

tt. Information concerning three previously unannounced tests. (74-7)

Event Name	Date	Time GCT	Location	Type of Burst	Remarks
Bernal	11/28/73	15:30	NTS	Underground	Under 20 kt
Misty North	5/2/72	19:15	NTS	Underground	Under 20 kt
Ming Blade	6/19/72	16:00	NTS	Underground	Under 20 kt

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

uu. The fact that the yield of the King test (11/15/52) of the Ivy series was 500 kt. (74-8)

vv. The fact that the Hybla Fair test event occurred at NTS on October 28, 1974, at a yield under 20 kt. (74-11)

ww. The fact that the tritium - deuterium mixture of the George test (5/8/51), the first thermonuclear test explosion, burned well. (74-12)

xx. The mere fact that the Item event of the Greenhouse series was the first test of the boosting principle. (75-2)

yy. Information concerning nuclear test event yields. (75-4)

Event	Date	Location	Type of Burst	Yields
Baneberry	12/18/70	NTS	Underground	10.0 kt.
Cruet	0/29/69	NTS	Underground	11.0 kt.
Cyathus	03/06/70	NTS	Underground	8.7 kt.
Labis	02/05/70	NTS	Underground	25.0 kt.

zz. Information concerning the Cambric nuclear test event: (76-4)
(1) Fact of detonation (May 14, 1965)
(2) Yield (best current value 0.75 kt.).
(3) Amount of post detonation tritium (best current value 6.0 $\pm$ 0.3 grams).

aaa. The fact that a nuclear test was conducted using reactor grade plutonium and that it successfully produced a nuclear yield. (77-4)

Note: *Information on date, event, name, yield, etc. remain classified.*

DOE announced on June 27, 1994 that the event occurred in 1962 and gave a yield <20 Kt.

bbb. The fact that Campos was fired on February 13, 1978 with a yield of less than 20 kt. (78-2)

ccc. The following Castle series event yields have been declassified: (78-4)

Name	Date	Location	Type of Burst	Yield
Romeo	March 26, 1954	Bikini	Barge	11 Mt
Union	April 25, 1954	Bikini	Barge	6.9 Mt
Yankee	May 4, 1954	Bikini	Barge	13.5 Mt
Nectar	May 13, 1954	Eniwetok	Barge	1.69 Mt

ddd. The Drill event at NTS on December 5, 1964 with a yield less than 20kt. (79-1) eee. Information concerning nuclear test yields. (88-2)

Event	Date	Yield (Kt.)
Jornada	January 28, 1982	139
Atrisco	August 5, 1982	138
Chancellor	September 1, 1983	143
Cybar	July 17, 1986	119
Hearts	September 6, 1979	140

fff. The association of Halite and/or Centurion with ICF experiments using nuclear explosives at Nevada Test Site (NTS). *No further elaboration.* (88-3) ggg. Declassified yields of tests conducted in Pacific prior to 1958-61 Moratorium: (93-4)

Name	Date	Location	Type	Yield (in kilotons)
Operation Greenhouse				
Dog	4/07/51	Eniwetok	Tower	81
George	5/08/51	Eniwetok	Tower	225
Item	5/24/51	Eniwetok	Tower	45.5
Operation Redwing				
Cherokee	5/20/56	Bikini	Airdrop	3800
Yuma	5/27/56	Eniwetok	Tower	0.19
Erie	5/30/56	Eniwetok	Tower	14.9
Flathead	6/11/56	Bikini	Barge	356
Blackfoot	6/11/56	Eniwetok	Tower	8
Kickapoo	6/13/56	Eniwetok	Tower	1.49
Osage	6/16/56	Eniwetok	Airdrop	1.7
Inca	6/21/56	Eniwetok	Tower	15.2
Dakota	6/25/56	Bikini	Barge	1100
Mohawk	7/02/56	Eniwetok	Tower	360
Apache	7/08/56	Eniwetok	Barge	1850
Navajo	7/10/56	Bikini	Barge	4500
Huron	7/21/56	Eniwetok	Barge	250

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

Name	Date	Location	Type	Yield (in kilotons)
Operation Hardtack I				
Yucca	4/28/58	Pacific	Balloon	1.7
Fir	5/11/58	Bikini	Barge	1360
Butternut	5/11/58	Eniwetok	Barge	81
Wahoo	5/16/58	Eniwetok	Underwater	9
Holly	5/20/58	Eniwetok	Barge	5.9
Nutmeg	5/21/58	Bikini	Barge	2.51
Yellowwood	5/26/58	Eniwetok	Barge	330
Magnolia	5/26/58	Eniwetok	Barge	57
Tobacco	5/30/58	Eniwetok	Barge	11.6
Sycamore	5/31/58	Bikini	Barge	92
Rose	6/02/58	Eniwetok	Barge	15
Umbrella	6/08/58	Eniwetok	Underwater	8
Maple	6/10/58	Bikini	Barge	213
Aspen	6/14/58	Bikini	Barge	319
Walnut	6/14/58	Eniwetok	Barge	1450
Linden	6/18/58	Eniwetok	Barge	11
Redwood	6/27/58	Bikini	Barge	412
Elder	6/27/58	Eniwetok	Barge	880
Hickory	6/29/58	Bikini	Barge	14
Sequoia	7/01/58	Eniwetok	Barge	5.2
Cedar	7/02/58	Bikini	Barge	220
Dogwood	7/05/58	Eniwetok	Barge	397
Poplar	7/05/58	Bikini	Barge	9300
Scaevola	7/14/58	Eniwetok	Barge	0*
Pisonia	7/17/58	Eniwetok	Barge	255
Juniper	7/22/58	Bikini	Barge	65
Olive	7/22/58	Eniwetok	Barge	202
Pine	7/26/58	Eniwetok	Barge	2000
Teak	8/01/58	Johnston	Rocket	3800
Quince	8/06/58	Eniwetok	Surface	0**
Orange	8/12/58	Johnston	Rocket	3800
Fig	8/18/58	Eniwetok	Surface	0.02

*safety experiment

**weapons related, yield was not up to expectation

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

hhh. Information concerning weapon test yields. (94-13)

Yields of Tests Conducted in Pacific
After the 1958 - 1961 Moratorium

Test	Date	Location	Type	Purpose	Yield (kilotons)
Operation Dominic					
Adobe	04/25/62	Christmas Is.	Airdrop	Weapons Related	190
Aztec	04/25/62	Christmas Is.	Airdrop	Weapons Related	410
Arkansas	05/02/62	Christmas Is.	Airdrop	Weapons Related	1090
Questa	05/04/62	Christmas Is.	Airdrop	Weapons Related	670
Yukon	05/08/62	Christmas Is.	Airdrop	Weapons Related	100
Mesilla	05/09/62	Christmas Is.	Airdrop	Weapons Related	100
Muskegon	05/11/62	Christmas Is.	Airdrop	Weapons Related	50
Encino	05/12/62	Christmas Is.	Airdrop	Weapons Related	500
Swanee	05/14/62	Christmas Is.	Airdrop	Weapons Related	97
Chetco	05/19/62	Christmas Is.	Airdrop	Weapons Related	73
Tanana	05/25/62	Christmas Is.	Airdrop	Weapons Related	2.6
Nambe	05/27/62	Christmas Is.	Airdrop	Weapons Related	43
Alma	06/08/62	Christmas Is.	Airdrop	Weapons Related	782
Truckee	06/09/62	Christmas Is.	Airdrop	Weapons Related	210
Yeso	06/10/62	Christmas Is.	Airdrop	Weapons Related	3000
Harlem	06/12/62	Christmas Is.	Airdrop	Weapons Related	1200
Rinconada	06/15/62	Christmas Is.	Airdrop	Weapons Related	800
Dulce	06/17/62	Christmas Is.	Airdrop	Weapons Related	52
Petit	06/19/62	Christmas Is.	Airdrop	Weapons Related	2.2
Otowi	06/22/62	Christmas Is.	Airdrop	Weapons Related	81.5
Bighorn	06/26/62	Christmas Is.	Airdrop	Weapons Related	7650
Bluestone	06/30/62	Christmas Is.	Airdrop	Weapons Related	1270
Sunset	07/10/62	Christmas Is.	Airdrop	Weapons Related	1000
Pamlico	07/11/62	Christmas Is.	Airdrop	Weapons Related	3880
Androscoggin	10/02/62	Johnston Is.	Airdrop	Weapons Related	75
Bumping	10/06/62	Johnston Is.	Airdrop	Weapons Related	11.3
Chama	10/18/62	Johnston Is.	Airdrop	Weapons Related	1590
Calamity	10/27/62	Johnston Is.	Airdrop	Weapons Related	800
Housatonic	10/30/62	Johnston Is.	Airdrop	Weapons Related	8300

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

Yields of Underground Tests Conducted at the Nevada Test Site
Released Radioactivity Detected Off Site

Test	Date	Location	Type	Purpose	Yield (kilotons)
Feather	12/22/61	NTS	Tunnel	Weapons Related	0.15
Pampas	03/01/62	NTS	Shaft	Joint US-UK	9.5
Eel	05/19/62	NTS	Shaft	Weapons Related	4.9
Des Moines	06/13/62	NTS	Tunnel	Weapons Related	2.9
Bandicoot	10/19/62	NTS	Shaft	Weapons Related	12.5
Yuba	06/05/63	NTS	Tunnel	Weapons Related	3.1
Eagle	12/12/63	NTS	Shaft	Weapons Related	5.3
Oconto	01/01/64	NTS	Shaft	Weapons Related	10.5
Alva	08/19/64	NTS	Shaft	Weapons Related	4.4
Alpaca	02/12/65	NTS	Shaft	Weapons Related	0.33
Tee	05/07/65	NTS	Shaft	Weapons Effects	7
Fenton	04/23/66	NTS	Shaft	Weapons Related	1.4
Derringer	09/12/66	NTS	Shaft	Weapons Effects	7.8
Nash	01/19/67	NTS	Shaft	Weapons Related	39
Umber	06/29/67	NTS	Shaft	Weapons Effects	10
Pod	10/29/69	NTS	Shaft	Weapons Related	16.7
Scuttle	11/13/69	NTS	Shaft	Weapons Related	1.7
Snubber	04/21/70	NTS	Shaft	Weapons Effects	12.7
Riola	09/25/80	NTS	Shaft	Weapons Related	1.07
Glencoe	03/22/86	NTS	Shaft	Weapons Related	29

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

3. Miscellaneous Test Information

a. Nuclear weapon test yields of U.K., U.S. and Soviet nuclear events through 1958. (59-9) (63-3)

UNITED STATES, UNITED KINGDOM, AND SOVIET NUCLEAR EVENTS (Yield in Kilotons)

	Fission Yield*			Total Yield	
Inclusive Years	**Air Burst**	**Ground Surface Burst**	**Water Surface Burst**	**Air Burst**	**Surface Burst**
1945-1951	190	550	20	190	570
1952-1954	1000	15000	22000	1000	59000
1955-1956	5600	1500	6000	11000	17000
1957-1958	31000	4400	4600	57000	28000
1959-1960	TEST MORATORIUM				
1961	25,000**			120,000	
Subtotal	63,000	54,000		189,000	105,000
1962	76,000**			217,000	
Subtotal	139,000	54,000		406,000	105,000

* A value of 50% has been arbitrarily selected for the fission to total yield ratio for all Soviet thermonuclear tests. As indicated in the tables, 50% is about the average fission to total yield ratio for all US/UK thermonuclear tests.

** The small yield tests conducted in Nevada do not contribute significantly to the worldwide distribution of strontium-90 to which this summary is related.

SOVIET NUCLEAR EVENTS (Yield in Kilotons)

Inclusive	Total Fission Yield*
1945-1951	60
1952-1954	500
1955-1956	4000
1957-1958	21000
1959-1960	Test Moratorium
1961	25,000
1962	60,000

* A value of 50% has been arbitrarily selected for the fission to total yield ratio for all Soviet thermonuclear tests. As indicated in the tables, 50% is about the average fission to total yield ratio for all US/UK thermonuclear tests.

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

UNITED STATES AND UNITED KINGDOM NUCLEAR EVENTS
(Yield in Kilotons)

Year	Total Fission Yield	Total Fission Yield From Greater than 1MT Total Yield Events
1945	60	
1946	40	
1948	100	
1951	500	
1952-1954	37000	36000
1955	200	
1956	9000	8000
1957-1958	19000	14000
1959-1960	TEST MORATORIUM	
1961	The small yield tests conducted in Nevada in 1961 do not contribute significantly to the worldwide distribution of strontium-90 to which this summary is related.	
1962	16,000	16,000

A value of 50% had been arbitrarily selected for the fission to total yield ratio for these thermonuclear tests.

b. The fact that tests were conducted of designs which could lead to an entirely new class of U.S. weapons which could have relatively low weights and extremely high yields, with the fission contributions decreased to only a few percent of the total yield. (63-2)

c. The fact that one of the proof tests of a complete nuclear weapons system involved the ASROC (Anti-Submarine Rocket) weapons system. (63-2)

d. Other total and fission yields of 1962 tests. (63-3)

Approximate Fission and Total Yields of Atmospheric Tests Conducted in 1962
(Yield in Megatons)

	Fission Yield	Total Yield
U.S.	16	37
USSR	60	180
Total	76	217

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

Approximate Fission Yields Injected into the Stratosphere in 1961 and 1962 (Yield in Megatons)

	Lower Stratosphere** (MT)	Upper Stratosphere** (MT)	Total (MT)
USSR (1961)	17	8	25
USSR (1962)	30	30	60
U.S. (1962)	10	1	11

** The lower stratosphere occupies the first few tens of thousands of feet above the tropopause and the upper stratosphere continues to about 150,000 feet. The tropopause, on the average, is located at 30 - 40,000 feet in the temperate and polar zones and 50 - 55,000 feet in the tropical and the equatorial zones. Debris injected above 150,000 feet is omitted from this table.

e. The fact that a specific event which has been approved for announcement by the Commission is a "nuclear weapons related, PNE device development, or Vela test". (68-8)

f. The emplacement of a nuclear weapon at some point above the bottom of the hole for purposes of debris containment. *Information revealing the effectiveness of debris containment techniques is not being proposed for declassification and remains classified Secret Restricted Data*. (68-8)

g. Mechanical closure mechanisms, fast gates, and hydrodynamic closures per se including number used on a specific event and their location on systems currently in use. *However, modifications to existing Line of Sight systems which could result in a major improvement in underground testing techniques or capabilities should be reviewed by the Division of Classification, HQ, for classification prior to unclassified release*. (68-8)

h. For the future, the mere fact that the United States conducts simultaneous underground nuclear tests. (70-1)

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

i. Information on foreign nuclear tests. (70-2)

Year	Country and Location	Number of Tests	Approximate Yields (Megaton) Fission	Total
1966	Communist China-Lop Nor	35	0.5	0.6
	France-South Pacific		0.8	0.9
1967	Communist China-Lop Nor	23	2.0	3.0
	France-South Pacific		0.2	0.2
1968	Communist China-Lop Nor	15	1.5	3.0
	France-South Pacific		4.2	4.7
1969	Communist China-Lop Nor	1	1.5	3

j. The fact that one or more hohlraums are on a specified nuclear test for auxiliary experiments. (98-9)

k. The concept of a closure system for nuclear tests or experiments. (98-9)

l. Currently classified information about past test event associations with the United Kingdom. (98-9)

m. Currently classified information [about] event yields inferred from seismic measurements made by non-U.S. Government agencies or contractors. (98-9)

n. Currently classified estimates of radiation doses from debris in the atmosphere. (98-9)

o. Hypothetical unclassified values of normally classified weapon parameters, such as time dependence of reaction rates, *provided well defined constraints are followed*. (98-9)

p. Specific information concerning the "hydronuclear experiments" conducted at the Nevada Test Site (NTS) by the Lawrence Livermore National Laboratory (LLNL), including: (00-4)

(1) the fact that these experiments included equation of state (EOS) and nuclear weapon safety experiments in which high explosives (HE) were used (no elaboration);

(2) the fact that the experiments were conducted in Area 6 and sites Anja, Charlie, Charlie Prime, and Dog in Area 27;

(3) this information concerning the Area 6 experiments:

Time Period	September 1954 to September 1960
Number of expended holes	20
Number of experiments	23 (NOTE: one test was on surface; two were in previously used holes)
Depth of holes	Minimum: 25 feet
Maximum:	50 feet
Total mass of HE expended	930 pounds
Total mass of plutonium	Less than 100 grams
Total mass of depleted uranium	172 kilograms

(4) this information concerning sites Anja, Charlie, Charlie Prime, and Dog in Area 27:

Time period	August 1960 to January 1966
Number of expended holes	76
Number of experiments	76
Depth of holes	Minimum: 45 feet
	Maximum: 80 feet
Total mass of HE expended	3,962 pounds
Total mass of plutonium	38 kilograms
Total mass of enriched uranium	11 kilograms
Total mass of depleted uranium	433 kilograms
Total mass of natural uranium	117 kilograms
Total mass of uranium oxide	66 kilograms

(5) the date, specific area location, hole number, and hole depth of each experiment conducted from September 15, 1954, to January 6, 1966. [See Appendix E.] (00-4)

D. NEVADA TEST SITE (NTS) SOURCE TERMS

1. The sum of estimated fission yields for all events conducted underground at the Nevada Test Site through 1993, with an effective date of January 1, 1994, that were detonated below or within 100 meters of the water table: (94-2)

   a. on Pahute Mesa
   b. on testing areas other than Pahute Mesa

2. The sum of estimated masses, by isotope, of unfissioned fissile materials, fission products with a half-life in excess of 1 year, and neutron-activated radionuclides with a half-life in excess of 1 year either left in or created in the detonation cavities formed by events described in VI.D.1.a above through 1993 with an effective date of January 1, 1994. (94-2)

VI. NUCLEAR TESTS/NUCLEAR TESTING (Continued)

3. The sum of the estimated mass of tritium either left in or created in the detonation cavities described in VI.D.1.a above through 1993 with an effective date of January 1, 1994. (94-2)

4. The estimated activity, in curies, through 1993, with an effective date of January 1, 1994, of each of the isotopes described in VI.D.1.b above. (94-2)

5. The estimated activity, in curies, through 1993, with an effective date of January 1, 1994, of the tritium described in VI.D.3 above. (94-2)

6. The total estimated mass of reportable toxic or hazardous materials either left in or created in the detonation cavities formed by events described in VI.C.3.i.(1) above through 1993, with an effective date of January 1, 1994. (94-2)

7. Sum of estimated fission yields for all weapons tests-detonations conducted underground at the Nevada Test Site (NTS) through-September 23, 1992*: (01-02)

   a. under Frenchman Flat (Areas 5 and 11)
   b. under eastern Pahute Mesa (Area 19)
   c. under western Pahute Mesa (Area 20)
   d. under Ranier Mesa (Areas 12, 16, 18, 29 and 30)
   e. under Yucca Flat (Areas 1, 2, 3, 4, 6, 7, 8, 9, 10, 15 and 17) in cavities more than 100 meters above the water table
   f. under Yucca Flat (Areas 1, 2, 3, 4, 6, 7, 8, 9, 10, 15 and 17) in cavities below or within 100 meters above the water table

8. Sum of estimated mass or activity as of January 1, 1994, by isotope, of tritium, fission and activation products with a half-life in excess of 1 year, unburned fissile material and actinide tracers either left in or produced in the detonation cavity formed by tests/detonations conducted underground at the NTS through September 23, 1992, in the 6 areas specified in 7. above*. (01-02)

9. Sum of estimated mass of reportable toxic or hazardous materials either left in or produced in the detonation cavity formed by tests/detonations conducted underground at the NTS through September 23, 1992, in the 6 areas specified in 7. above*. (01-02)

~~OFFICIAL USE ONLY~~

* This declassification does not pertain to the mass or activity of any isotope present in an individual nuclear weapon or collection of weapons or collection of weapons prior to a nuclear test; to any nuclear test conducted off the NTS; to any atmospheric nuclear test; nor to any individual nuclear test or simultaneous detonation conducted on the NTS including hydronuclear tests. This declassification pertains only to the sum of the fission yield (not total yield) in each of the six areas and does not pertain to yield of an individual test or detonation. As a result of this declassification, the national laboratories can release at unclassified a detailed characterization of the NTS source term, an essential element of the remediation strategy to which the Department is committed under the terms of the Federal Facility and Consent Order signed May 10, 1996.

VII. HEALTH, SAFETY AND ENVIRONMENT

A. All reports on medical research and all health studies omitting such items as might disclose information beyond that authorized for declassification at this time. (46-1)

B. Medical information as to the effects of the bomb on Hiroshima and Nagasaki. (46-1)

C. All medical studies including those concerning Hiroshima and Nagasaki *if no information otherwise restricted is revealed.* (47-1)

D. Medical aspects subject to other categories - Nominal, Japan, and Trinity. (48-2) (51-1)

E. Radiation casualty figures - Nominal, Japan and Trinity. (48-2)

F. Medical information pertinent to safeguarding health of personnel *except: Emergency medical tolerance for military personnel under operational conditions*. (49-1)

G. Medical tolerance and toxicity studies. (49-1)

H. Internal and external radiation effects. (49-1)

I. Medical aspects (of RW), *except where governed by or unless subject to other classification topics*. (49-2)

J. Medical and biological research and all health studies including medical information as to the effect of the bombs of Hiroshima and Nagasaki. (50-3) (50-4)

K. Plant effluent disposal, *but care must be taken not to include data which by implication might reveal production rates or classified processes.* (50-3) (50-4)

L. Information on the geology and mineralogy of radioactive ores and methods of prospecting, *provided no indication is given of reserves or output*. (50-3) (50-4)

VIII. NAVAL NUCLEAR PROPULSION INFORMATION

A. PROJECT NEPS (Nuclear Energy Propulsion for Submarines)

1. Fact that application of nuclear energy to submarines is under investigation. (51-1)

2. Fact that NEPS is a joint project of the Navy and the AEC. (51-1)

3. *All equipment within the reactor container (Reactor container is a vessel enclosing nuclear reactor and its controls together with primary coolant contained therein) is SRD* except:

   a. Fact that a particular material is to be used as coolant (applies only to STR and SIR reactors). (51-1)

   b. Fact that a particular material is to be used in the reactor core. Applies only to STR and SIR reactors. *The particular use and function should not be revealed.* (51-1)

   c. Control actuating mechanisms *except as they reveal dimensions and size of core, location and nature of control elements.* (51-1)

   d. Reactor container *except as it reveals design details of core, reflector, and control*. (51-1)

4. Status and schedules of specific projects. (53-1)

   a. Existence of project. (53-1)

      (1) STR (Submarine Thermal Reactor). (53-1)

      (2) SIR (Submarine Intermediate Reactor). (53-1)

      (3) CVR (Large Ship Reactor). (53-1)

      (4) ISR (Improved Submarine Reactor). (53-1)

   b. Assignment of Projects to Specific Contractors. (53-1)

      (1) STR, SIR, and CVR. (53-1)

c. Date construction will be undertaken (land-based prototype). (53-1)

(1) STR Mark I and SIR Mark A.
(2) Other projects. *No unclassified disclosure of this information may be made without specific authorization by AEC and DOD.*

d. Information about laying of keel or completion date of nuclear powered vessels. (53-1)

(1) SSN (571) (STR Mark II) - Keel.
(2) Completion Date. *No unclassified disclosure of this information may be made without specific authorization by the AEC and the DOD.*
(3) SSN No. 2 (SIR Mark B).
(4) Other nuclear powered vessels.

5. Shield: Constructional features of shielding arrangements exterior to the reactor container although they may reveal the location and thickness of lead or water, or other materials in the secondary shield[5]. Access to working areas where tanks, lead sheeting, etc., exterior to the reactor container are revealed would not require the safeguards of Restricted Data (R.D.). Drawings or correspondence involving the same information would likewise not constitute R.D. (53-1)

6. All other equipment outside reactor container *except as they reveal reactor design criteria and reactor core characteristics other than design temperatures*[5]. (53-1)

7. Reactor Core Design

a. Blanket-to-seed power ratios. (77-5)

b. The mere fact that existing cores utilize Zircaloy 2, 3, or 4. (77-5)

8. Reactor metallurgy

a. Properties of silver, indium, cadmium or elemental boron from an operating prototype or ship reactor. (77-5)

9. Throughput of special nuclear material at Nuclear Fuel Services (NFS). (83-1)

10. Use of the S5G Reactor Plant in the USS Narwhal (SSN 671). (83-8)

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[5] Confidential when such items reflect the ship's operating characteristics, i.e., depth, speed, diving time, etc.

IX. INERTIAL CONFINEMENT FUSION

A. Research and development on lasers will be classified if *power level exceeds 100 gigawatt, or pulse energy exceed 1 kilojoule. Any laser application (for any power whether or not classified) that achieves DT ignition will be classified RD. DT ignition is defined to be a 1% rise in temperature or mean charged-particle kinetic energy at any point in the gas [target].* (64-7)

B. Summaries and results of two-dimensional calculations of laser heating on slab geometries composed of either homogeneous or non-homogeneous materials without inertial compression. (72-4)

C. The implosion of a pellet of homogeneous material by the interaction of laser radiation with the outer layers of material and the subsequent confirmation of the density and temperature condition required for efficient burn of the thermonuclear fuel. (72-4)

D. Time shaping of the laser pulse. (72-4)

E. Radial propagating burn in homogeneous "micro-spheres" and infinite cylinders. (73-2)

F. Information in connection with the publication of the Laser-Fusion Classification Guide, CG-LF-2.

   1. The design and performance of pushers on spherical and non-spherical pellets. (74-3)

   2. The design and performance of multi-layered spherical and non-spherical pellets. (74-3)

   3. Two and three dimension calculations on spherical and non-spherical pellets. (74-3)

G. The fact that, in some ICF targets, radiation from the conversion of the focused energy (e.g., laser or particle beam) can be contained and used to compress and ignite a physically separate component containing thermonuclear fuel. (79-2)

H. The fact that implosion symmetry and stability are usually considered in the design of X-ray driven targets. (83-4)

I. The fact that fuel preheat is usually considered in the design of X-ray driven targets. (83-4)

J. The association of Halite and/or Centurion with ICF experiments using nuclear explosives at Nevada Test Site (NTS). *No further elaboration.* (88-3)

IX. INERTIAL CONFINEMENT FUSION (Continued)

K. The fact that ICF targets located in a hollow chamber may be driven by trapped energy, nature unspecified, created in the chamber by one or more energetic beams penetrating the chamber through holes in the chamber walls. *No further elaboration.* (88-3)

L. Laboratory Hohlraums

1. Fact of holes, their number, relative location and function (entrance, diagnostic) in the hohlraum wall. (90-1)

2. Fact that hole closure is an issue in laser-driven hohlraums, as well as the fact that either laser or x-ray (or both) mechanisms may play a significant role in hole closure. (90-1)

3. For particle-beam drive, fact that the particles pass through the radiation container and deposit energy in a converter material. (90-1)

4. Fact that only portions of a hohlraum may be illuminated. (90-1)

5. Hohlraum particle-beam and laser-plasma interactions and laser-plasma physics issues, calculations consistent with code classification, and experimental results *that do not otherwise reveal classified information,* for densities <0.1 solid density. (90-1)

6. Generic scale sizes (e.g. today's laboratory hohlraums are mm scale; hohlraums for high gain are cm scale). (90-1)

7. That hohlraums are/may be of simple shapes (e.g., spherical, cylindrical, ellipsoidal). (90-1)

8. That a hohlraum is made of a specific material, provided $Z<86$. (90-1)

9. Approved generic sketches of hohlraums, without dimensions. (90-1)

   Note: "Trapped energy" targets (which use a structure to reflect or trap energy but have a small ($<10\%$) conversions to x rays) are to be treated as direct drive targets and declassified accordingly.

10. Declassify all information pertaining to laboratory inertial confinement fusion hohlraums that achieve, either by calculation or experiment, a peak temperature 350 eV or less, *except for:* (93-9)

    a. *Experimental data that reveal classified mid-Z ($36<Z\leq71$) near local thermodynamic equilibrium (LTE) or LTE spectral data.*

IX. INERTIAL CONFINEMENT FUSION (Continued)

b. *Experimental data that provide spectrally resolved opacity for Z>71 above 50 eV.* Mean values such as Rosseland mean for all Z with T≤350 eV are allowed.
c. *Results from calculations that would reveal classified opacity data.*
d. *Laboratory data, experiments, or designs aimed at obtaining information on weapons physics or clarifying radiation transport issues related specifically to weapons.*
e. *Results from classified codes (pending review by the Office of Declassification).*

M. Laboratory Capsules (Indirect or Direct Drive): The pre-ignition threshold is revised as follows: specific DT yield of 1kj/g; and peak fuel-averaged rho-R of 0.03 g/cm^2. Establish three categories of capsule performance, as follows: (90-1)

Category	Fuel Mass (mg)		Capsule Dia.(cm)		Pre-Ignition Threshold
1	<20	and	≤0.6	and	below
2	<20	and	≤0.6	and	above
3	>20	or	>0.6		immaterial

1. Category 1 Indirectly Driven Capsules: The following parameters are added to the list of unclassified performance parameters: (90-1)

   a. Core symmetry (measurement, such as x-ray image, with no size scale identified).
   b. Physical state of DD or DT fuel.
   c. Identification of capsule materials as glass and/or plastic *(other materials may be considered on a case-by-case basis)*.
   d. Neutron output spectra.
   e. Peak fuel rho-R (average spatial value).
   f. Experimentally measured values of fuel radial convergence (ratio of initial to final fuel-pusher radii). *Calculated fuel radial convergence values will remain classified.*

   Note: Calculated performance values derived from a classified code (e.g., LASNEX) for the above list are unclassified *(except for fuel radial convergence, which is experimental only)* for one- or two-dimensional calculations, even when identified as coming from a classified code.

2. Category 2 Indirectly Driven Capsules: *All information, experimental or calculational, remains classified,* except for the following: (90-1)

   a. That the target is indirectly driven.
   b. The driver energy and power.

IX. INERTIAL CONFINEMENT FUSION (Continued)

c. Total yield and gain. (90-1)

Note: Category 3 Indirectly Driven Capsules: All information, experimental or calculational, remains classified.

3. Additional Indirectly Driven Capsule Descriptors: The following are added to the existing unclassified set of general descriptions of all indirectly driven targets: (90-1)

   a. The use of spherical capsules containing DD or DT fuel.
   b. That the fuel capsule may resemble single- or double-shell direct-drive targets and may be made from the same materials.
   c. That the fuel capsule can use low-density silica or polymeric foam to support a liquid or solid fuel layer.
   d. That fuel preheat problems can be, and are, reduced in some hohlraum targets when they are irradiated with light of sufficiently short wavelength.
   e. Approved generic sketches, without dimensions, of an indirectly driven implosion target (i.e., a hohlraum with a capsule).
   f. That single-beam irradiation of particle-beam targets may be adequate for symmetric implosion of capsules.

4. Category 1 Directly Driven Capsules: Except as noted below, all information, such as designs, calculations with unclassified codes, and experimental results, is unclassified (See Note). For calculations with classified codes, existing classification guidance continues to apply. (90-1)

   Note: Some aspects remain classified; e.g., (1) fissile material driven to criticality, (2) conversion of driver energy to other forms.

5. Category 2 Directly Driven Capsules: *All information, experimental and calculational, remains classified* except for the following:(90-1)

   a. Driver energy and power.
   b. Total yield and gain. (90-1)

N. Declassify all information for laboratory capsules absorbing ≤ 10 MJ of energy and with a maximum dimension ≤ 1 cm, *except for:* (93-9)

   1. *Capsules containing fissile materials.*
   2. *Capsules intended to mockup specific nuclear weapon designs, simulate nuclear weapon outputs, or address specific weapon physics issues.*
   3. *Targets that involve weapons concepts that are still classified.*

IX. INERTIAL CONFINEMENT FUSION (Continued)

4. *Calculations or measurements where classified equation of state or opacity information would be revealed.*
5. *All information for indirect-drive capsules for which the peak radiation drive temperature is greater than 400 eV.*
6. *Results from classified codes, other than driver energy and power, and the following unclassified integrated (time, spacial) quantities:*

   a. Yield
   b. Gain
   c. Fuel gain
   d. Neutron yield
   e. Neutron output spectra
   f. X-ray output
   g. X-ray spectra (no more specific than a three-temperature blackbody fit)
   h. N-tau, average spatial value
   i. Peak average spatial value of fuel density
   j. Peak average spatial value of fuel Rho-R
   k. Peak average spatial value of fuel temperature
   l. Reaction products
   m. Target debris
7. *Detailed x-ray spectra, and*
8. *Capsules derived from high-explosive or nuclear driven systems that are classified by other capsule guidance.*

O. All calculations, modeling, and experimental data on hydrodynamic instabilities and mix in all unclassified inertial confinement fusion targets, *except results from classified codes for convergent targets. The association with, applicability to, or actual use of mix data or mix models in nuclear weapon design remains classified.* (93-9)

P. All information relevant to the energy applications of inertial confinement fusion, consistent with the other declassification recommendations, *except for results of classified codes (pending review by the Office of Declassification).* (93-9)

1. For unclassified targets, this would include time-dependent output spectra of:

   a. Neutrons
   b. Gamma rays
   c. X rays *(limited to no more than a three-temperature blackbody fit)*
   d. Fuel atoms
   e. Reaction products
   f. Target debris

IX. INERTIAL CONFINEMENT FUSION (Continued)

Output information for targets that have been tailored for weapons effects remain classified.

2. Inertial confinement fusion fabrication techniques *unless they reveal classified target design information or a specific classified weapon design, experiment, or fabrication method.* (93-9)

Q. Centurion/Halite data on capsule performance for unclassified capsules. (98-9)

X. MISCELLANEOUS

A. ROCKET AND AIRCRAFT NUCLEAR PROPULSION (ANP) PROGRAM (includes NEPA)

1. Fact that application of nuclear energy to aircraft is under consideration. (51-1)

   a. Fact that application of nuclear energy to aircraft is under investigation. (53-1)

2. Fact that ANP program is joint program of USAF, AEC, National Advisory Committee for Aeronautics (NACA), etc. (51-1)

3. Contractors involved. (51-1)

4. *All equipment within the reactor container (reactor container is a vessel enclosing nuclear reactor and its controls together with primary coolant contained therein) is SRD* except:

   a. Fact that a particular material is to be studied as a coolant (Coolants developed subsequent to January 1, 1951 are not included). (51-1)

   b. Reactor container *except as it reveals design details of core, reflector, and control*. (51-1)

5. *Characteristics, design, and functional information pertaining to components and equipment within the reactor container is classified*, except:

   a. Coolants *except new or unusual coolants.*

   b. Control actuating mechanisms *except as reveal dimensions and size of core, location and nature of control elements and the nature of the control problem. It is intended to retain classification on the overall control system and on the control elements themselves*. (51-1) (53-1)

6. Information concerning Aircraft Nuclear Propulsion (ANP):

   - Fact that GE-ANP is studying the direct cycle for aircraft propulsion
   - That PWAC is studying the liquid-cooled indirect cycle for aircraft propulsion.
     - - Fact that liquid coolants under consideration are
       - - Supercritical water
       - - Liquid metals: Li, Na, Na-K, Bi, and Pb. (57-6)

7. Association of Project Pluto with the Nuclear Ramjet Program. (58-6)

X. MISCELLANEOUS (Continued)

8. Financial information and the approximate number of scientists at work on Project Pluto and Project Rover. (58-7)

9. The mere fact of operation of HTRE-2 and HTRE-3 reactors in the ANP program, without stating when or for how long. (59-1)

10. The mere fact that the Idaho Chemical Processing Plant (ICPP) can or will process reactor fuel from the Aircraft Nuclear Propulsion (ANP) program. (59-1)

11. Design and operation of the Aircraft Reactor Test *per se*. (59-13)

12. Mere association of yttrium and zirconium hydrides with the Aircraft Nuclear Propulsion program. (59-13)

13. The fact that beryllium and/or beryllium oxide are used in the Aircraft Nuclear Propulsion program as moderator or reflecting materials, and that lithium hydride and tungsten are used as shielding materials. (59-13)

14. Association of any quantity of europian and gadolinium with the Aircraft Nuclear Propulsion program. (59-13)

15. ANP research on basic chemistry and metallurgical properties (including the phase diagram) of yttrium binary systems. (59-15)

16. Schedule objectives, dates or anticipated dates, and budgetary and fiscal information and forecasts for Project Rover. (60-2)

17. Advanced Core Test (ACT) Reactor and the Heat Test Reactor Experiment-2 (HTRE-2). (61-4)

18. The Folded-Flow Reactor designs (excluding light-weight shielding data). (61-4)

19. The mere fact that graphite is used as either fuel matrix or structural material in the KIWI-B, NERVA, and Phoenix reactors. (63-5)

20. Information on Project Rover: (63-10)

    a. Nominal performance values

        (1) Power: 1000 Megawatt
        (2) Specific impulse > 700 seconds
        (3) Nominal thrust 50,000 lbs.

X. MISCELLANEOUS (Continued)

b. The fact that vibrations occurred and their cause in KIWI-B tests.

21. The reactor and other technology developed in the course of the ANP program *except*: (67-7)

    a. Certain design and performance information concerning the PWAR-11 and 11C indirect cycle reactors (the most advanced lithium-cooled reactor in the ANP program).
    b. Lightweight shielding technology related to specific military systems.

22. The Aircraft Nuclear Propulsion (ANP) Program. (72-10)

    a. The design and performance data concerning the PWAR-11 and 11C indirect cycle reactors.
    b. The light weight shielding technology that is related to specific military systems.

    Note: This completes declassification of all ANP information.

23. All nuclear rocket propulsion technology not previously declassified. (73-1)

24. Information concerning the nuclear ramjet program (Project Pluto). (73-7)

    Note: With this declassification, all technology developed in military reactor programs not used in operational military systems is now unclassified. *There is no change in the naval nuclear propulsion program classification policy.*

B. THE PLOWSHARE PROGRAM

1. Mere fact that the U.S. has developed atomic munitions suitable for use in demolition work. (58-8)

2. The cost of fabricating and firing a device 30 inches in diameter and of a few Kt yield, all from fission, would approximate $500,000 when made available in small numbers. (58-9)

3. The cost of fabricating and firing a device 30 inches in diameter of a few 10s of Kt yield, all from fission, would approximate $750,000 when made available in small numbers. (58-9)

4. The cost of fabricating and firing a device 60 inches in diameter in the yield range up to 5 Mt, of which 5% of the yield was from fission and 95% from fusion, would be approximately $1,000,000 in small quantities. (58-9)

X. MISCELLANEOUS (Continued)

5. In the event of multiple firing in the same location, or in using large numbers of devices, the cost per firing would be substantially reduced. (58-9)

6. The fact that the AEC can supply a Plowshare device having a diameter of 30 inches and a yield of 300 kt. (59-3)

7. These costs are only those incident to the fabrication of the device, emplacing it in its firing location, making the firing attachments, firing, and studies to assure public safety and to determine the results of the detonation. It does not involve such possible activities as preparing a hole or other structure for the firing or studies to determine the results of industrial utility. (58-9)

8. The mere fact that a specific PNE device will have no more than a few kt of fission. (64-3)

9. The fact that the yield of PAR, an October 9, 1964 Plowshare NTS development test, was "about 30 kt". Also any later yield based on new data. (65-2)

10. The following information regarding the KANKAKEE Event:

    The fact that it was detonated on June 15, 1966
    The fact that a U-238 target was used
    The fact that the flux achieved was 10-12 moles of neutrons/cm^2 (66-4)

11. "Nuclear explosives have not been designed specifically for underground engineering applications. When conditions warrant, such special designs could be undertaken. It is reasonable for industry to assume, for first generation designs, that yields of 100 Kt could be obtained in a canister with an outside diameter of 11 inches, suitable for emplacement in a standard 13-3/8 inch OD casing designed with at least a 12-1/8 inch clear inside diameter, or when appropriate, an open hole of the same minimum size. Unusual formation pressures and temperatures may present special problems requiring larger diameters than the above." (66-7)

12. The following data relative to the synthesis of heavy elements through exposure of target material such as U^{238} to a high neutron flux of a nuclear detonation: (68-3)

    a. Target mass (if 300 grams or less).
    b. Mere fact that the target is located within the device.
    c. Target isotopic composition.
    d. Identities and quantities of nuclides formed or expected to be formed by neutron induced radiation in the target.

X. MISCELLANEOUS (Continued)

e. Neutron fluence (integrated neutron flux) in the target.

13. Buggy (3/12/68) was a nuclear row charge experiment with five 1.2 Kt charges. (68-9)

14. Yield of Gasbuggy (12/10/67) was 26 Kt. (68-9)

15. Cabriolet (1/20/68) was a 2.5 Kt hard-rock cratering experiment. Schooner was to be a higher-yield hard-rock cratering experiment. (68-9)

16. Four plowshare yields: (68-10)

Sedan (7/16/62)	100 Kt
Sulky (12/19/68)	100 tons
Palanquin (4/14/65)	4 Kt
Schooner (12/8/68)	35 Kt

17. Information on nuclear explosion data for underground engineering applications. (70-1a)

<u>Event</u>	<u>Date</u>	<u>Medium</u>	<u>Yield</u> (kt)
Blanca	10/30/58	Tuff	23.
Cyclamen	5/5/66	Alluvium	13.
Gnome	12/10/61	Halite	3.0
Logan	10/16/58	Tuff	5.1
Longshot	10/29/65	Andesite	85.
Par	10/9/64	Alluvium	38.
Salmon	10/22/64	Halite	5.3
Tamalpais	10/8/56	Tuff	.072
Rulison	9/10/69	Shale	40.

18. The predicted (80Kt) and the actual yield of the Miniata event. (71-7)

19. The external appearance (size, weight, and shape) and the expected and actual yields of the Diamond explosive for Rio Blanco and Wagon Wheel. (72-6)

    a. The fact that the Diamond device will be enclosed in an approximately 16-foot long container, not less than 7.8 inches in diameter, between two slightly smaller diameter sections, such that the total package will be about 30-feet long.
    b. The fact the yields ranging from 20-100 kt can be obtained within the 7.8 inch by 16-foot container.
    c. The fact that the Diamond device is of the fission type.
    d. The fact that the produced Carbon-14 per explosive is expected to be small in comparison with the 7.5 curies observed in the Gasbuggy experiment.
    e. Post-shot measurement of Carbon-14.

X. MISCELLANEOUS (Continued)

f. The predicted and actual amounts of the following radioactivities:

(1) Krypton - 85 - approximately 23 Ci/kt.
(2) Total tritium - current upper limit number based on expected rock composition are: less than 3,000 curies from the three 30 kt explosives in Rio Blanco and less than 10,000 curies from the five 100 kt explosives in Wagon Wheel.

g. The three charges of Rio Blanco (5/17/73) each yielded 30 Kt for a total event yield of 90 Kt. (73-3a)

h. The yields without elaboration, of the following nuclear tests/detonations conducted underground at the Nevada Test Site as part of the Plowshare Peaceful Nuclear Explosion (PNE) program: (97-1)

Test/Detonation	Date	Yield (kt)*
Anacostia	11/27/62	4.0
Kaweah	02/21/63	2.6
Tornillo	10/11/63	0.34
Klickitat	02/20/64	80.
Ace	06/11/64	2.5
Dub	06/30/64	11.
Templar	03/24/66	0.27
Saxon	07/28/66	1.2
Simms	11/05/66	2.5
Switch	06/22/67	2.9
Stoddard	09/17/68	31.
Flask-Yellow	05/26/70	0.09
Flask-Red	05/26/70	0.035

*NOTE: The yields listed above are the best values available as of December, 1997.

APPENDIX A. TABLES A & B OF THE 1948 DECLASSIFICATION GUIDE FOR GENERAL APPLICATION

TABLE A
LIST OF CLASSIFIED SUBSTANCES

Substance (1)	Basic Chemistry	Metal-lurgy	Extra-Nuclear Physics	Nuclear Physics	Technology (2)
Deuterium	Yes	--	Yes	Yes	No
Tritium	Yes	--	Yes	No	No(3)
Beryllium	Yes	Yes	Yes	Yes	No
B^{10}	--	--	--	Yes	No
Graphite(4)	Yes	--	Yes	No	No
Fission Products	Yes	Yes	Yes	No(5)	No(6)
Polonium(7)	Yes	No	Yes	Yes	No
Thorium	Yes	No	Yes	No(8)	No
*Protactinium	Yes	No	Yes	No(8)	No
Uranium	Yes	No	Yes	No(8)	No
Neptunium	Yes	No	Yes	No(8)	No
Plutonium	Yes	No	Yes(9)	No(8)	No
Elements 95 and above(10)	Yes	No	Yes	No(8)	No
UF_6	Yes	--	Yes	--	No
UCl_4	Yes	--	Yes	--	No

Yes - Declassify; No - Retain Classification at present; -- Not Applicable.

(1) - Classification will be retained on all information on production capacity and stocks available.
(2) - This includes description of actual manufacturing operations or reasonable alternates, and laboratory work from which the nature of these operations could be clearly inferred.
(3) - Classification will be retained, for the present, on small scale production methods.
(4) - This refers only to high purity graphite manufactured specifically for use as a moderator.
(5) - The kinetic energies and all nuclear properties of fission products may be declassified (but see 10-181) except: (a) Slow neutron capture cross-sections above 100 barns for radioactive fission products. (b) The absolute fission yield of delayed neutrons. (c) The fission yield of any of the isotopes leading to delayed neutron fission.
(6) - This does not prohibit the release of information on the laboratory scale separation of the fission products from one another, but care must be exercised not to reveal information regarding the large scale production of specific radioactive products of fission.
(7) - No information is to be disclosed from which the interest of the Project in the use of this substance for classified purposes or its large scale production may be inferred.
(8) - Unless permitted by Table B.
(9) - No physical or mechanical properties of solid or liquid states of plutonium metal may be declassified.
(10)- Information concerning new elements should not be released until approval is received from the Declassification Office.

APPENDIX A

TABLE B
NUCLEAR PROPERTIES

SUBSTANCES / PROPERTY	All Isotopes listed in box below: (Note restriction on amounts!)	U^{236}
Nuclear Properties		
Existence	Yes	No(1)
Exact Mass	Yes	No
Spin	Yes	No
Moment	Yes	No
Methods of Formation of Isotope		
Charged Particle and γ-ray reactions	Yes	No
Neutron reactions		
Above 25 Mev	Yes	No
Below 25 Mev	No	No
Reactions Involving Isotopes [Including properties (such as existence of the reaction, cross-section and its energy independence, etc.) of reactions, including scattering, fission, etc.]		
Charged particle and γ-ray reactions	Yes	No
Neutron reactions		
Above 25 Mev	Yes	No
Below 25 Mev	No	No
Spontaneous Disintegration Properties		
Spontaneous fission	No	No
Other than spontaneous fission	Yes	No
Energy Levels	Yes(2)	No

LIST OF ISOTOPES TO WHICH FIRST COLUMN APPLIES
(Information obtainable only by the use of amounts greater than those in the table below or which otherwise reveals the existence of greater amounts may not be declassified.)

Tracer Quantities	Micrograms	Milligrams	Grams	No Limit(3)
Th^{226},Th^{231},Th^{233}	Th^{227},Th^{229},Th^{234}	Th^{228}	Th^{230}	Th^{232}
Pa^{229},Pa^{230},Pa^{232},Pa^{234}		Pa^{233}	Pa^{231}	
U^{230},U^{231},U^{239}	U^{232},U^{237}	U^{234}	U^{233},U^{235}	U^{238}
Np^{233},Np^{234},Np^{236}	Np^{235},Np^{238},Np^{239}		Np^{237}	
Pu^{234},Pu^{235},Pu^{236},Pu^{237}	Pu^{238},Pu^{240},Pu^{241}		Pu^{239}	
	Cm^{240},Cm^{241},Cm^{242}			
Am^{238},Am^{239},Am^{240},AM^{242}	Am^{241}			

(1) It is permissible to reveal the existence of U^{236} as an alpha decay product of Pu^{240}, but not as a product of any other reaction.
(2) Excepting neutron induced.
(3) But see Table A, Footnote (1).

APPENDIX B. APPENDIX A TO THE 1950 DECLASSIFICATION GUIDE FOR GENERAL APPLICATION AND THE 1950 DECLASSIFICATION GUIDE FOR RESPONSIBLE REVIEWERS

APPENDIX A TO THE 1950 DECLASSIFICATION GUIDE FOR GENERAL APPLICATION AND THE 1950 DECLASSIFICATION GUIDE FOR RESPONSIBLE REVIEWERS

The following information is declassified concerning the nuclear properties of uranium which are of importance in connection with Class I Reactors.

1. Thermal neutron cross sections for uranium

   (These are currently accepted values in barns for an approximately Maxwellian neutron spectrum with an average energy corresponding to a neutron velocity of 2200 meters/second.)

Thermal Neutron Cross Section For	U^{235}	U^{238}	Natural U
Fission	545	0	3.9
Capture	100	2.6	3.3
Scattering	8.2	8.2	8.2

2. Neutron per thermal neutron fission

   $v = 2.5 \pm 0.1$ for U^{235}

3. Fast Fission Effect

   The following are typical values of the fast fission contribution to the reactivity of research reactors:

   a. In a reactor of the "CP-2" or "GLEEP" type: 2.9%

   b. In a reactor of the "CP-3" or "ZEEP" type: 3.1%

4. Resonance Absorption Integral

   An approximate empirical formula for the effective value of the resonance absorption integral in natural uranium is:

   $\int \sigma^c (E)(dE/E) = 9.25 [1 + 2.67 (S/M)]$

   Where the value is in barns, the integral is over the range of neutron energy from fission energy to thermal energy, and where S = uranium surface area in cm^2 and M = uranium mass in grams.

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APPENDIX C. PARAGRAPH 5 OF THE 1956 JOINT AEC/DOD CLASSIFICATION GUIDE

SUBJECT	CLASS	REMARKS
a. Yields		
1) Developmental and test weapons or devices are classified except as follows:		
a) Sandstone, Trinity, Hiroshima, Nagasaki, Crossroads, and Ivy Mike	U	
b) Approximate yield for any shot under 1 MT when not identifiable with a specific shot (identification of yield with named test operation or proving ground is not considered as identification with a specific shot	U	The number 1 or nearest whole number multiple of 10 or 100, i.e., 1Kt, 10Kt, 20Kt, etc., 100Kt, 200Kt, 300Kt, etc.
2) Hypothetical yields	U	A hypothetical yield is any yield not identifiable with an actual detonation, weapon or device. (See 4a for limitations and exceptions.
b. Thermal Phenomena		
1) Mathematical expressions of graphical presentations resulting from a compilation of thermal data as a function of hypothetical yield		
a) Shape of radiated pulse	U	
b) Thermal yield	U	
2) Incident thermal radiation energy at a given distance for a hypothetical yield	U	
3) Existence of, and circuitry used in devices such as bhangmeters	U	
c. Fireball characteristics		
1) Mathematical expression or graphical presentations resulting from a compilation of fireball data as a function of hypothetical yield		
a) Maximum fireball radius	U	
b) Radius of fireball related to time for scaled time	U	

SUBJECT	CLASS	REMARKS
d. Bomb clouds and columns		
1) Casual observations on height, shape, rate of ascent and dimensions.	U	
2) Cloud chamber effects	U	
3) Base surge	U	Except when related to yields
e. Nuclear Radiation		
1) Mathematical expressions or graphical presentations on the following:		
a) Gamma intensity vs. time (after 0.01 seconds from detonation), integrated dose and effective energy spectrum	U	
b) Neutron total dose (rad or rem)	U	It is permissible to indicate "high," "medium," or "low" neutron yield detonation.
c) Neutron dose as a function of energy spectrum as measured by activation, threshold and fission detectors having thresholds 3 Mev or below.	U	Unclassified for unboosted fission weapons only.
d) Neutron induced activity as determined by type or composition of exposed material.	U	
e) Character and degree of attenuation, scattering or absorption in various media	U	
f. Radioactive Fall-out		
1) Mathematical expressions or graphical presentations resulting from a compilation of radioactive fall-out or residual radiation data as a function of hypothetical yield and burst conditions		"Clean" and "salted" weapons or devices will not be included.
a) Pattern	U	
b) Iso-intensity and iso-dose contours, total activity, residual radiation energy spectrum, or decay rate, for fission weapons devices, or detonations		

SUBJECT	CLASS	REMARKS
(1) For fission weapons, devices or detonations.	U	
c) Beta to gamma ratio	U	
g. Blast and Shock Phenomena		
1) Mathematical expressions or graphical presentations resulting from a compilation of blast and shock data as a function of distance and hypothetical yield.		Provided height of burst or depth of burst is not specified.
a) Peak overpressure	U	
b) Peak dynamic pressure	U	
c) Time of arrival of shock front	U	
d) Positive phase duration of overpressure and dynamic pressure	U	
e) Peak density or peak material velocity	U	
f) Mach characteristics and height of triple point	U	
g) Overpressure and dynamic pressure impulse	U	
h) Crater dimensions for surface bursts	U	
I) Variation of crater dimensions with depth of burst as obtained from unclassified TNT data	U	
2) Partition of energy		
a) In air, below 15,000 feet MSL	U	As among thermal, visible, nuclear radiation, and shock
3) Precursor and related phenomena		
a) The word "precursor" when used in connection with atomic weapons phenomena or effects	U	

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APPENDIX D. NUCLEAR WEAPONS STOCKPILE DATA TABLE

NUCLEAR WEAPONS STOCKPILE DATA TABLE

YEAR	TOTAL	MEGATONAGE	BUILDS	RETIREMENTS	DISASSEMBLIES
1945	2	0.04	2	0	
1946	9	0.18	7	0	
1947	13	0.26	4	0	
1948	50	1.25	43	6	
1949	170	4.19	123	3	
1950	299	9.53	264	135	
1951	438	35.25	284	145	
1952	841	49.95	644	241	
1953	1169	72.80	345	17	
1954	1703	339.01	535	1	
1955	2422	2879.99	806	87	
1956	3692	9188.65	1379	109	
1957	5543	17545.86	2232	381	
1958	7345	17303.54	2619	817	
1959	12298	19054.62	7088	2135	
1960	18638	20491.17	7178	838	
1961	22229	10947.71	5162	1571	
1962		12825.02	4529	766	
1963		15977.17	3185	830	
1964		16943.97	3493	2534	
1965		15152.50	3519	1936	
1966		14037.46	2429	2357	
1967		12786.17	1693	1649	
1968		11837.65	536	2194	
1969		11714.44	684	3045	
1970		9695.20	219	1936	
1971		8584.40	1073	1347	
1972		8531.51	1546	1541	
1973		8452.00	1171	544	

YEAR	TOTAL	MEGATONAGE	BUILDS	RETIREMENTS	DISASSEMBLIES
1974		8325.22	959	807	
1975		7368.38	748	2240	
1976		5935.51	427	2181	
1977		5845.00	221	998	
1978		5721.16	50	1148	
1979		5696.34	170	730	
1980		5618.86	0	904	732
1981		5832.91	30	1887	1577
1982		5358.89	338	1537	1535
1983		5232.47	217	749	1120
1984		5192.20	187	1143	994
1985		5217.48	195	1322	1075
1986		5414.54	140	1224	1015
1987		4882.14	0	958	1189
1988		4789.77	0	1023	581
1989		4743.34	0	1794	1208
1990		4518.91			1154
1991		3795.94			1595
1992		3167.88			1856
1993		2647.31			1556
1994		2375.30			926 as of April

APPENDIX E. LAWRENCE LIVERMORE NATIONAL LABORATORY EXPERIMENTS CONDUCTED AT THE NEVADA TEST SITE

DATE	AREA	HOLE NUMBER	HOLE DEPTH (feet)
9/15/54	6	T-A	40
7/22/55	6	T-B	50
8/26/55	6	T-C	50
12/18/58	6	surface	surface
2/27/59	6	T-B	25
3/27/59	6	T-C	25
6/11/59	6	T-D	50
8/21/59	6	T-E	50
9/5/59	6	14	50
10/28/59	6	11	50
11/19/59	6	9	50
12/17/59	6	5	50
1/21/60	6	3	50
3/31/60	6	6	50
8/12/60	6	15	50
8/16/60	6	16	50
8/19/60	6	1	50
8/26/60	27 (Charlie)	1	50
8/28/60	27 (Charlie)	2	50
8/30/60	27 (Charlie)	3	50
6/24/60	6	4	50
7/7/60	6	2	50
7/21/60	6	10	50
7/29/60	6	8	50
8/2/60	6	12	50
8/5/60	6	13	50
9/60	27 (Dog)	63	80
9/60	27 (Dog)	65	80
9/26/60	27 (Charlie)	4	50
9/27/60	27 (Charlie)	5	50
10/60	27 (Dog)	68	80
10/20/60	27 (Charlie)	6	50
10/25/60	27 (Charlie)	7	50
11/11/60	27 (Charlie)	8	50

DATE	AREA	HOLE NUMBER	HOLE DEPTH (feet)
12/60	27 (Dog)	69	80
12/60	27 (Dog)	34	80
12/1/60	27 (Charlie)	9	50
1/61	27 (Dog)	35	80
1/61	27 (Dog)	70	80
1/61	27 (Dog)	67	80
2/61	27 (Dog)	68-A	80
2/24/61	27 (Charlie)	10	50
3/61	27 (Dog)	36	80
5/61	27 (Dog)	69-A	80
5/25/61	27 (Charlie)	11	50
6/61	27 (Dog)	66	80
7/61	27 (Dog)	33	80
7/61	27 (Dog)	61	80
8/61	27 (Dog)	32	80
8/61	27 (Dog)	63-A	45
8/2/61	27 (Charlie)	12	50
8/16/61	27 (Charlie)	13	50
9/61	27 (Dog)	72	80
9/61	27 (Dog)	63-B	45
9/28/61	27 (Charlie)	14	50
10/61	27 (Dog)	26	55
10/61	27 (Dog)	26-A	55
10/7/61	27 (Charlie)	15	50
11/61	27 (Dog)	25	55
11/61	27 (Dog)	27	55
11/61	27 (Dog)	28	55
11/2/61	27 (Charlie)	16	50
11/5/61	27 (Charlie)	17	50
11/18/61	27 (Charlie)	18	50
12/61	27 (Dog)	24	55
12/16/61	27 (Charlie)	19	50
12/20/61	27 (Charlie)	20	50
1/18/62	27 (Charlie)	21	50
1/26/62	27 (Charlie)	22	50
2/62	27 (Dog)	23	55

DATE	AREA	HOLE NUMBER	HOLE DEPTH (feet)
2/8/62	27 (Charlie)	23	50
3/8/62	27 (Charlie)	24	50
3/10/62	27 (Dog)	22	55
3/10/62	27 (Charlie Prime)	1	50
3/15/62	27 (Charlie Prime)	2	50
3/22/62	27 (Dog)	22-A	55
3/29/62	27 (Dog)	21	55
4/3/62	27 (Charlie Prime)	3	50
5/10/62	27 (Charlie Prime)	4	50
7/18/62	27 (Charlie Prime)	5	50
8/16/63	27 (Charlie Prime)	6	50
10/21/63	27 (Charlie Prime)	7	50
3/6/64	27 (Anja)	2	50
3/10/64	27 (Anja)	3	50
3/12/64	27 (Anja)	4	50
3/20/64	27 (Anja)	5	50
3/20/64	27 (Anja)	6	50
3/24/64	27 (Anja)	7	50
3/26/94	27 (Anja)	8	50
4/4/64	27 (Charlie Prime)	8	50
7/9/64	27 (Charlie Prime)	9	50
8/11/65	27 (Anja)	1	50
8/13/65	27 (Anja)	10	50
8/19/65	27 (Anja)	11	50
8/20/65	27 (Anja)	12	50
8/24/65	27 (Anja)	13	50
8/26/65	27 (Anja)	14	50
9/1/65	27 (Anja)	15	50
1/6/66	27 (Charlie Prime)	10	50

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