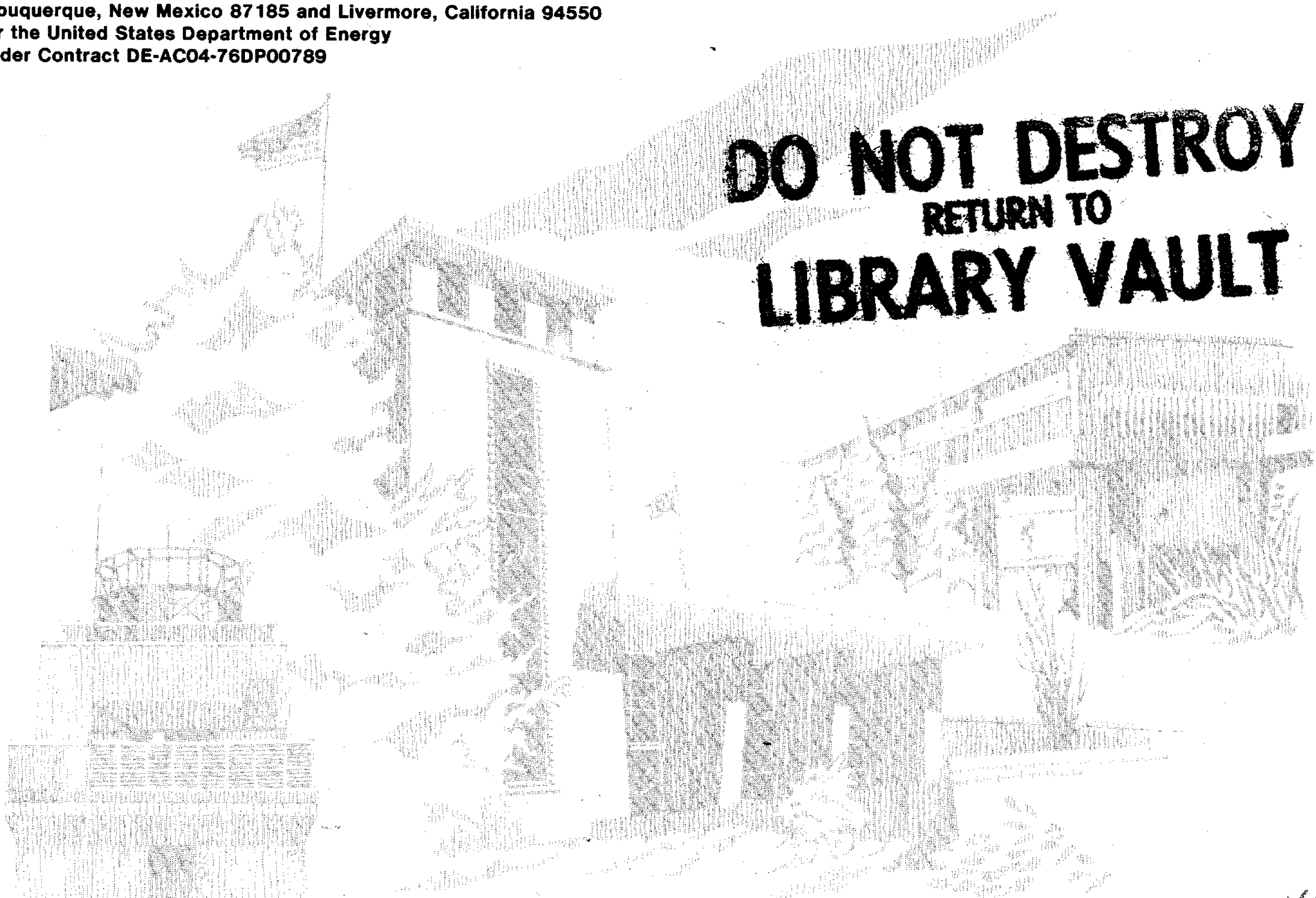
SANDIA REPORT

SAND89—1243 • UC—700
Unlimited Release
Printed March 1989

DOE Nuclear Weapon RD&T: Objectives, Roles, and Responsibilities

Glen R. Otey

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789



SF2900Q(8-81)

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

Printed in the United States of America. This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from
Office of Scientific and Technical Information
PO Box 62
Oak Ridge, TN 37831

Prices available from (615) 576-8401, FTS 626-8401

Available to the public from
National Technical Information Service
US Department of Commerce
5285 Port Royal Rd
Springfield, VA 22161

NTIS price codes
Printed copy: A03
Microfiche copy: A01

SAND89-1243
Unlimited Release
July, 1989

DOE Nuclear Weapon RD&T: Objectives, Roles, and Responsibilities

Glen R. Otey
Advanced Weapon Systems
Department 5160
Sandia National Laboratories
Albuquerque, NM 87185

Abstract

An overview of the DOE nuclear weapons research, development, and testing program is given along with a description of the program objectives and the roles and responsibilities of the various involved organizations. The relationship between the DoD and DOE is described and the division of responsibilities for weapon development as well as the coordinated planning and acquisition activities are reviewed. Execution of the RD&T program at the nuclear weapons laboratories is outlined.

TABLE OF CONTENTS

FOREWORD

The primary objective of this document is to provide an overview of the DOE nuclear weapons research, development, and test (RD&T) program and insight into the vital role this program plays in national security. To achieve this objective, it is necessary to describe the complimentary roles of the DOE and DoD as well as the unique relationship between the DOE and its government-owned, contractor-operated laboratories because these relationships are key in defining the work and creating the environment for successfully executing that work. The result is a fairly complex story for the uninitiated, and author asks the reader's patience as the picture gradually unfolds.

The original draft of this document was developed during the 1988 Congressionally mandated "Modernization Study" as background material at the request of Everet Beckner, Vice President for Defense Programs. The manuscript benefited from Everet's review and from suggestions made by Arlyn Blackwell and Dick Brodie. The exercise of reshaping the manuscript to the form presented herein was facilitated by the numerous beneficial comments and corrections resulting from a review by Dick Hahn, Director of the DOE WRD&T Program.

Finally, I am particularly grateful to Pablita Padilla for typing the original manuscript and to Juanita Padilla for preparation of the final document.

DOE NUCLEAR WEAPON RD&T:
Objectives, Roles, and Responsibilities

I. Introduction

The unique structure of the DOE nuclear weapons research, development, and testing (RD&T) program is best approached by first describing the role of the Department of Energy (DOE) with respect to the Department of Defense (DoD) in meeting national needs related to nuclear weapons. For that reason, the roles of the two departments are outlined in this introduction. The strategic long-term objectives of the RD&T program then follow logically. Subsequent sections describe how these long-term objectives are achieved within the framework of the basic DoD and DOE structure. The nuclear weapon acquisition process is outlined and the provisions for improving weapons in the stockpile and for generating DoD long-range guidance for DOE research are explained. The management approach of the DOE and the weapons laboratories for executing the RD&T program is described in the final section.

The nuclear weapons program is a national effort involving both the DoD and the DOE. The complementary responsibilities of the two departments are derived from the Atomic Energy Act of 1954,[1] as amended, and include understandings from agreements--principally the 1953 Agreement Between the Atomic Energy Commission and the DoD for the Development, Production, and Standardization of Atomic Weapons[2,3]; the Missile and Rocket Responsibilities Agreement[4,5]; and the MOU between the DoD and DOE on the objectives and responsibilities for Joint Nuclear Weapon Activities.[6]

The DoD is responsible for nuclear weapon delivery systems and the training and deployment of forces for their use; for custody and specified maintenance of the nuclear weapons stockpile; for definition of the Military Characteristics (MCs) which state the performance requirements and physical characteristics of a nuclear weapon; and for development priority, suitability and acceptability of nuclear weapons. The DoD also conducts nuclear vulnerability and effects activities to establish threat definitions for nuclear weapons and to assess nuclear weapon system performance.

The DOE is responsible for the design, development, testing, and production of nuclear weapons; for conducting a vigorous exploratory and advanced development program; for surveillance and certification of the technical quality of the nuclear weapons stockpile; and for provisioning of limited-life components (LLCs) and certain ancillary equipment. The DOE is also responsible for assessing nuclear-related threats posed by other nations or by terrorist groups. Execution of a research program sufficiently broad to avoid technological surprise is fundamental to fulfilling this responsibility.

The DoD and DOE each has responsibility for fostering the technology base by conducting research and pursuing the investigation of new and innovative concepts for weapons-related application of nuclear energy and related technology.[6] Both have complementary responsibilities for developing certain nonnuclear components of nuclear weapons. The division of responsibility is, to the extent permitted by law, by joint agreement between DoD and DOE on each weapon or class of weapons.

The obligation of the DoD and the DOE to protect public health and safety provides the basic premise for dual-agency judgment and responsibility for safety, security, and control of nuclear weapons.[6]

The National Defense Authorization Act for Fiscal Year 1987 (PL99-661)[7] established an interdepartmental Nuclear Weapons Council (NWC) to coordinate nuclear weapon program activities. (This Act also abolished the DoD Military Liaison Committee which had previously performed certain coordination functions.) The NWC is chaired by the Director of Defense Research and Engineering (to ensure high-level DoD scrutiny of capabilities and costs of proposed new weapons, and to ensure that appropriate trade-offs are considered). The other NWC members are the Vice Chairman of the Joint Chiefs of Staff (JCS) (to ensure that the requirements for nuclear weapons established by field commanders are accurately reflected in specifications for new weapons), and one senior DOE representative (to ensure that the views of the DOE weapon laboratories and field organizations supporting the production complex are brought before the Council).[8] The Assistant to the Secretary of Defense (Atomic Energy) [ATSD(AE)] serves as the NWC Staff director.

The NWC is responsible for coordinating nuclear weapons acquisition activities; providing guidance on priorities; considering safety, security and control issues for existing and proposed nuclear weapons; and providing comments to the appropriate Department Secretaries on proposed annual budget levels for research on nuclear weapons and on improved conventional weapons. In short, the NWC provides oversight to ensure that the DoD and DOE are coordinated and economic of resources in meeting defense needs.

A Nuclear Weapons Council Standing Committee (NWCSC) has been established to conduct day-to-day actions between the DoD and DOE and to prepare actions for NWC consideration.[9] The Standing Committee is chaired by the ATSD(AE) and has members from the staffs of the JCS, the Military Services, and the DOE.[10] This arrangement is depicted in Figure 1.

Within DOE, the Assistant Secretary for Defense Programs (ADSP) is responsible for the nuclear weapon program including nuclear weapon production, nuclear material production, intelligence, security affairs, and nuclear verification and control technology as well as the nuclear weapon RD&T effort. The Deputy Assistant Secretary for Military Application (DASMA) provides major program guidance and direction and determines the levels of effort and priorities for both RD&T and production. Under this guidance, the weapons laboratories - Los Alamos, Lawrence Livermore, and Sandia - develop RD&T programs and the Nevada and Albuquerque Operations Offices manage the testing and production programs respectively.

The DOE structure of laboratories, manufacturing plants, and government field offices is based upon a unique combination of Government-Owned-Contractor-Operated (GOCO) facilities, a level-of-effort funding philosophy, and decentralized federal oversight. Laboratory and production contractors are provided continuity and stability through multi-year contracts and are given considerable flexibility in directing their operations.

The RD&T portion of the DOE nuclear weapon program is conducted primarily through the three weapon laboratories. The strategic long-term objectives of this work are to [11]:

- Insure continued and improved safety, security, and reliability of the existing stockpile of nuclear weapons;
- Provide design, engineering development, and testing for new weapon concepts and engineering support for new weapons entering the stockpile;
- Maintain the scientific and engineering capability to provide a continuing flow of technical knowledge and innovations to support the development of new weapons; and
- Avoid technological surprise by an adversary.

II. DOE RD&T Roles and Missions

A. DOE Management Organization

The DASMA provides oversight and direction for RD&T of nuclear weapons. DASMA functions include [12]:

- Providing programmatic and policy direction to DOE field offices on nuclear weapons and related programs.

- Providing programmatic and policy direction and institutional guidance to the three weapons laboratories for the conduct of nuclear weapons and nuclear weapons-related programs.

- Providing assistance and technical guidance in the development, evaluation, and implementation of DOE activities in support of strategic defense and inertial confinement fusion research.

- Preparing requests for Presidential approval of the underground nuclear test program, preparing for the ASDP the underground test planning directive, and providing programmatic approval of each underground nuclear test.

- Coordinating DOE participation in the national nuclear command and control system.

- Administering the program for cooperation on nuclear weapons with the United Kingdom.

- Participating in preparation of the Nuclear Weapon Stockpile Memorandum.

- Representing the DOE on the Nuclear Weapon Council Standing Committee (NWCSC).

- Developing budget proposals and financial plans.

- Directing the program for operational support to the intelligence community and assisting with associated special national security operations.

- Coordinating the weapons program research and development (R&D) activities relating to safeguarding special nuclear materials.

- Providing programmatic direction for the DOE nuclear weapons accident response group, the DOE nuclear emergency search team, and the DOE portion of the joint nuclear accident coordinating center.

In executing these responsibilities, the DASMA is assisted by a staff of about 70 people located in the Forrestal building in Washington and at Germantown, MD. The DASMA is, in compliance with the Atomic Energy Act, an active duty Flag Rank Officer. About one quarter of the DASMA professional staff are active duty military personnel.

The Albuquerque Operations Office (AL) is responsible for DOE field level planning and coordination of nuclear weapons R&D, and field-level direction of nuclear weapons safety, surveillance, and production.[13] AL directs the seven plants of the nuclear weapons production complex, and is responsible for administering the contract for Los Alamos National Laboratory (LANL) and for Sandia National Laboratory (SNL). (The Lawrence Livermore National

Laboratory (LLNL) contract is administered by the DOE San Francisco Operations Office, as delegated by agreement by the AL Office.)

While AL does not manage the laboratories' nuclear weapon RD&T program, it does actively participate in the weapon development process to ensure that:

- The DASMA is provided, throughout the development process, with impact and cost estimates for production of weapons.

- The laboratories provide the production facilities with adequate design information, and that

- Adequate production capability and capacity exist for each new weapon.

To facilitate executing these responsibilities, the AL staff keeps informed of those laboratories advanced development activities which generate process development requirements, ensures that the laboratories place development support work at the proper production plants, and directs production plant process development activities. The AL staff participates in joint DoD-DOE Project Officers Groups (POGs) as a member insofar as weapon production capability, capacity, and cost are concerned. (See Section III.)

AL has about 1300 Federal employees including 350 in the six area offices that report directly to the AL Manager.

The DOE Nevada Operations Office, located in Las Vegas, NV, is responsible for the operation of the Nevada Test Site (NTS), and for managing the underground nuclear testing program. This office has about 300 Federal employees and directs about 5000 contract employees engaged in NTS operations.

B. The Nuclear Weapon Design Laboratories

The design laboratories (LANL, LLNL, and SNL) are GOCO facilities. LANL and LLNL are operated by the University of California and SNL is operated by Sandia Corporation, a wholly-owned subsidiary of AT&T Technologies. These laboratories are collectively responsible for formulation and execution of the nuclear weapon RD&T technical program.

LANL and LLNL design the nuclear physics packages for nuclear weapons. SNL is responsible for weaponization including designing and developing arming, fuzing, and firing components and packaging them with the nuclear physics packages in warheads and bombs capable of being used by the military.

Nuclear testing is a primary responsibility of LANL and LLNL. Both conduct underground nuclear experiments at NTS to investigate the feasibility of new weapons technologies and to develop and proof test weapons. SNL provides the arming and firing systems for these tests. The three laboratories join with the DoD in conducting nuclear weapons effects tests and confidence tests for nuclear weapons in the stockpile.

LANL is located in Los Alamos, NM, and has approximately 8100 employees and facilities occupying over 43 square miles.[13] LLNL is located in Livermore, CA, and has approximately 8000 employees and facilities occupying about 7,600 acres.[13] SNL consists of the headquarters and laboratory facilities in Albuquerque (SNLA) NM; a laboratory facility in Livermore (SNLL) CA; the Tonopah Test Range (TTR) in NV; and several quality assurance teams in weapons productions plants. SNL has approximately 8300 employees.[13]

III. The DoD-DOE Nuclear Weapon Development Process

A. Planning Documents

Two important planning documents for the RD&T program are developed through joint DoD-DOE actions: the NWSM and the Nuclear Weapon Development Guidance (NWDG). The FY87 National Defense Authorization Act[7] which formed the NWC also charged that group with preparing the NWSM. This document, which is prepared at least once each year, contains the planned nuclear weapon builds and retirements for the current year and the next five years, and a projection of builds and retirements for the subsequent five years. Significant changes from the previous year and projected special nuclear material requirements are also given.

After preparation under NWC supervision, the NWSM is jointly submitted to the President by the Secretary of Defense (SECDEF) and the Secretary of Energy not later than September 30. The NWSM is reviewed by the National Security Council (NSC) staff and a National Security Decision Directive (NSDD), which authorizes production for the current year and preparation to support production for the next five years, is prepared for the President's signature. This NSDD is usually received in the October-March time frame, and may contain requests for special studies on various nuclear weapons issues.

The NWDG is prepared biennially by the Defense Nuclear Agency (DNA) under the supervision of the ATSD(AE). The purpose of the NWDG is to provide guidance in the 10 to 20-year time frame which will help the DOE align its RD&T program with anticipated DoD needs. It identifies broad planning considerations and technologies to support a wide range of future weapons development options.

The process, illustrated in Figure 2, for developing the NWDG is perhaps as important as the resulting biennial document. The dialog among the DoD operational commands, the staffs from the Military Departments, and DOE officials and laboratory personnel is particularly useful.

B. The Nuclear Weapon Acquisition Process

Two of the strategic objectives of the DOE RD&T program are focused directly on nuclear weapon acquisition:

- Insure continued and improved safety, security, and reliability of the existing stockpile of nuclear weapons;

- Provide design, engineering development, and testing for new weapon concepts and engineering support for new weapons entering the stockpile.

To achieve these objectives DOE development work must be responsive to the DoD acquisition process. This meshing of DoD-DOE activities is shown in Figure 3.

Each new major system acquisition requires a mission need statement approved by the SECDEF before it is included in the DoD budget submission. Proceeding with the demonstration/validation phase requires review by the Defense Acquisition Board (DAB) and SECDEF approval.[14,15] Similar procedures are followed for Milestones II and III. A report assessing the adequacy of the operational test and evaluation and effectiveness and suitability of a weapon system must also be submitted prior to Milestone III approval for production. (See References 14 and 15 for a detailed description of the DoD acquisition system.) The warhead development is also divided into phases, with similar approvals required, so that the weapon and the weapon system advance toward production together in a controlled manner.[2,16,17,18]

The DOE laboratories generally work with the Military Services in assessing the potential for meeting new mission needs with existing weapons or new weapons concepts. These pre-Phase 1 activities provide insights for focusing laboratory advanced development work and lend realism to the military mission need statement.

Phase 1 concept definition studies may be performed by any DoD component, by the DOE laboratories, or conducted jointly. In addition to studying potential weapons applications, Phase 1 studies may be conducted to investigate broader mission area needs or application of nuclear-related technology. These studies usually involve preliminary effectiveness analyses, delivery system and warhead trade-offs, and development of a preliminary draft of the MCs which state the warhead performance requirements. The report written by the Phase 1 study group provides information needed by the DoD to determine whether to proceed into Phase 2 and also helps the DOE laboratories in shaping their RD&T activities.

The Phase 2 Feasibility Study is a crucial step in determining how best to meet national security needs. This joint DoD-DOE study determines both the technical feasibility of meeting the need and identifies those aspects of nuclear design, development, testing, production processes, and resource availability likely to be determining factors in developing and producing a nuclear weapon of the characteristics needed for a particular weapon system.[3]

A Phase 2 study is initiated only after a Military Department request is approved by the NWC. One of the most important tasks for the joint DoD-DOE study group is to conduct trade-off studies and to ensure that total weapon system cost and performance are considered in establishing the military requirements and design objectives.[17]

Candidate warheads are proposed by two competing design teams. (The rationale for this competition is explained in Section IV.) The advantages and disadvantages of each candidate are analyzed and economic and nuclear material savings that would occur from changes in requirements are identified. Preliminary warhead designs and testing, including underground nuclear tests, are frequently needed to establish feasibility.

The Phase 2 study usually takes about one year and culminates with a report to the NWC. This report (which contains the study group findings and updated draft warheads MCs) should be available for DAB Milestone I deliberations. The DOE also develops comparative warhead costs so that the NWC is able to consider cost/benefit trades.

In harmony with the DoD weapon system demonstration and validation work, the DoD and DOE conduct a joint Phase 2A study to identify a baseline design which best balances resources and requirements.[3] The DOE normally selects a single design team to work with the cognizant Military Department and its contractors. The study is conducted by a POG which oversees the trade-off studies and refines the warheads MCs. Tentative development and production schedules are established and a DoD-DOE division of responsibilities for development and production is drafted.

The POG is charged with producing a report to support DAB Milestone II deliberations.[3] The DOE provides a Weapon Design and Cost Report which describes the baseline design and decision cost estimates and reports the results of trade-off analyses involving requirements, costs, and nuclear material cost and availability.

The DOE laboratory team conducts design activities in sufficient depth to support the trade-off studies and cost analyses.[3] Prototyping and testing are conducted as necessary.

DOE Development Engineering (Phase 3), which normally occurs concurrently with DoD full-scale development, begins after the Secretary of Energy accepts a formal request for this work from the SECDEF. The POG, with oversight by the NWCSC, continues to be responsible for coordination of DoD-DOE activities.

Early in Phase 3, SNL, on behalf of the POG, prepares a Preliminary Weapon Development report which provides design objectives, a weapon description, test plans, requirements for ancillary equipment, and a program schedule. This report is submitted for review to the DoD Design Review and Acceptance Group (DRAAG). (The DRAAG will, during Phase 5, assess design compliance with the MCs and recommend on acceptance of the warhead as a standardized design to the DoD.)

During Phase 3, the DOE laboratories conduct intensive design, prototyping, and testing activities including joint testing with the DoD weapon system. Warhead interfaces are firmed up and studies are conducted to ensure that the design will meet the stringent safety requirements specified in the MCs. The DOE establishes a baseline cost for warhead production during the early part of the Phase 3.

The NWC reviews each program annually during Phase 3 and 4.[17] It considers the impact of the MCs and the Stockpile-to-Target Sequence (STS) (which describes the logistical and operational evolutions and the resulting physical environments the weapon may encounter) on the design and engineering effort and the resources needed to meet the design requirements and goals. Specific DoD requirements or DOE design/production decisions causing resource expenditures to increase over previous estimates are given particular attention.

Formal establishment of Phase 4 (Production Engineering) gives the DOE production complex authority to proceed with expenditures for procurement and fabrication of materials and components for a portion of the production schedule as specified by AL.[16] The DOE laboratory design team supplies the production complex with complete drawings and engineering releases during this phase, and continues with joint DoD-DOE testing initiated in Phase 3. DoD-DOE interfaces and activities on trainers, spares, special equipment, manuals, and post-development testing are also established during this phase.

Phase 5 (First Production) is a period in which the DOE evaluates the production processes and the resulting product to determine if all quality requirements are met.[16] During this period, the laboratory design team prepares and submits a Final Weapon Development Report to the DoD DRAAG. If the DRAAG determines that the design meets the approved MCs and STS to the extent that no further DOE development effort is required, it recommends to the NWC that the design be accepted as a standard stockpile item. During Phase 5, the Military Department Nuclear Weapon System Safety Group conducts a preoperational safety study to determine the adequacy of safety features in the nuclear weapon system and of the procedures for operation of the system. This group prepares Safety Rules for approval by the SECDEF and makes recommendations for any needed improvements in nuclear safety.

Phase 5 culminates with the issuance of a Major Assembly Release, which is prepared by the DOE design laboratories, stating that the weapon is satisfactory for release to the DoD for specified capabilities and uses.[16]

In Phase 6, the DOE maintains full-scale production at the rates necessary to meet directed schedules.[16] This phase follows Milestone III (production and deployment) approval by the SECDEF based on deliberations of the DAB.

Stockpile evaluation is a major Phase 6 activity. It ensures, through stockpile sampling and laboratory and flight testing, that stockpiled weapons continue to meet quality requirements.

Should deficiencies be found and corrective action be deemed necessary, the DOE laboratories prepare production change proposals with specific solutions. From time-to-time, technical advances require that portions of the stockpile be modernized. These design actions are also handled by the DOE laboratories as will be discussed in the next section.

Retirement, denoted as Phase 7 in a weapon life, begins with the first physical withdrawal of the weapon from stockpile.[16] Weapons are returned to the DOE's Pantex Plant where they are disassembled. Inspections performed provide additional information which can guide R&D for future designs.

Certain ancillary equipment, e.g., Permissive Action Link (PAL) controllers, may be needed by DoD on schedules different than major system development. This development work by DOE laboratory designers is conducted under informal DoD-DOE arrangements. By the same token, DoD frequently utilizes existing nuclear weapons on new aircraft or platforms. And while, little or no warhead redesign may be required, a great deal of compatibility testing may be needed to establish the operational capability.

C. Stockpile Improvement Program (SIP)

Modifications to stockpiled weapons to modernize safety or use control features are incorporated under the SIP. Deficiencies that are identified during the course of stockpile sampling programs are normally corrected by either a field retrofit by DoD or DOE laboratory teams or at DOE production facilities.

Existing weapons, lacking modern nuclear safety or control features, that are not scheduled for timely retirement have been identified as candidates for SIPs. Recent SIPs include the B28, W31, B53, and B61 where changes have included combinations of improved nuclear safety features, insensitive high explosive, and new control devices. DOE and DoD meet annually to review the status of ongoing SIPs and to determine if there have been any changes in stockpile environments, employment plans or hardware assessments that would make it advisable to include additional weapons in the program.

Capability improvement may include the incorporation of limited life components with extended service life or features for additional military utility. In the future,the nuclear stockpile may benefit from the use of preplanned improvement (PPI) programs designed to extend the capability of nuclear weapons to meet changing threats, exploit weapon system growth, or incorporate newly evolved nuclear safety or control enhancements.

IV. Laboratory Execution of RD&T*

In the previous section, the directed weapon development efforts of the laboratories were identified, and it was explained how the first two DOE strategic RD&T objectives are

*This section draws heavily on references 19-22.

accomplished through the phased acquisition process. The second two strategic objectives are:

- Maintain the scientific and engineering capability to provide a continuing flow of technical knowledge and innovations to support the development of new weapons; and

- Avoid technological surprise by an adversary.

These objectives are more deeply embedded in the research, exploratory development, and testing programs planned and executed by the laboratories with DOE federal employee oversight.

Tested ideas are a prime output of the RD&T program. These ideas can be engineered into warheads or contribute to the two objectives listed above. While the value of latter use is frequently less visible, its relative importance in meeting strategic objectives and hence national security needs may not differ by much.

Several important functions in exploratory development take place between the conception of an idea and its emergence as a tested idea. First, a new idea undergoes theoretical evaluation. Many new ideas do not meet this test and are discarded as being impractical, unlikely to succeed, or because supporting data and techniques are not sufficiently advanced to proceed into development. Those that pass must undergo management judgment to determine if they are important enough to receive further attention. The better ideas then proceed to the calculational stage. With the use of large, high-speed computers, sophisticated models and the existing data base, an approximation to the design can be assessed. A modified theoretical design may result. Some ideas, however, do not pass this computational test.

Because of computational limitations and limits on knowledge of materials properties, designs optimized through calculation must be checked with experiments. Some of this experimentation can be done using nonnuclear devices, e.g., hydrodynamic testing with high explosives to measure implosion time histories. Other designs can be evaluated only in underground nuclear tests where very sophisticated diagnostics measure both primary and secondary performance in real-time and radiochemistry yield analysis can be performed on the debris. Several iterations through this design-analyze-test-analyze-redesign cycle may be needed before the original idea becomes a sound element available for consideration in meeting future needs.

The tested nuclear device provides only the conceptual heart of the nuclear weapon. It must be engineered to achieve compatibility with the military weapon system as described in section III.B.

Technical processes and evaluations needed for both advanced development and weaponization are based primarily on a foundation of specialized information, techniques, and materials generated by supporting R&D activities within the laboratories. This technology base consists primarily of highly skilled scientific and engineering personnel from many technical disciplines together with existing data bases, special facilities, and requisite equipment. A large continuing effort within the laboratories is devoted to this vital activity. From this work comes the new ideas in metallurgy and materials; fundamental nuclear information; programs for the powerful computers; concepts for new instruments, diagnostics and measurement techniques; analytical methods in radiochemistry; and new concepts in engineering and weaponization.

Sophisticated test and simulation facilities are required for research and for weapon design, certification, and stockpile evaluation. Weapons must be safe, secure, and reliable after exposure to a great variety of logistic and operational environments, including nuclear attack by our adversaries. The existing data base and computation capabilities are very important, but testing, in simulations as close as possible to the requirements, is vital. The facilities needed for this testing are many and varied--a range for rocket and gun tests, sled tracks, drop towers, high explosive facilities, etc. Many of these facilities are unique national capabilities. Facilities for generating outputs which simulate some aspects of a nuclear explosion are one example of the specialized capabilities needed by the R&D workers. Pulsed high-energy machines are used to generate x-rays and gamma-rays. Pulsed reactors create bursts of neutrons similar to those emitted from a nuclear weapon. These facilities provide a vital supplement to underground testing capabilities at the Nevada Test Site (NTS).

There is a particular dependence on NTS since it is the only facility available for conducting nuclear explosion testing. The tests there are used to verify the predicted nuclear performance of new designs, to assess the effects of various factors on nuclear yield, to assure the reliability of stockpiled weapons, and to assess potential nuclear threats. For instance, an underground test might be required to measure the change (if any) in yield due to the extreme cold temperatures experienced by a weapon carried externally on a high-flying aircraft.

The nuclear test program has four major technical elements. Prompt diagnostics is the design and development of the experiments and measurements for determining the real-time performance of the nuclear device. Nuclear chemistry is the analysis of device performance based on radiochemistry measurements of debris acquired by drilling back into the cavity left by the nuclear detonation. Field operations include site preparation, device emplacement and countdown, and test execution. Finally, there is a somewhat separate and independent containment activity to ensure that there is no leakage of radiation into the environment. (There is also a scientific containment panel consisting of scientists from the laboratories, the Environmental Protection Agency, and the National Oceangraphic and Atmospheric Administration to recommend to the DOE test controller on whether or not a test should proceed based on the panel members concerted judgement regarding containment of radioactivity and other factors.)

Underground tests are a limited resource. Within the laboratories, there is intense competition for the available experiments which can be performed in underground tests (typically about 10 per year). Laboratory management passes judgment on which ideas will proceed into the underground test phase. Each year the laboratories provide DOE with a one-year plan and a five-year projection of intended tests. The DOE coordinates the resulting test plan with the Department of State and DoD, and submits it through the National Security Council to the President for approval.

It does not appear that nuclear weapons technology is reaching a plateau. Advances are being made on several fronts and, consequently, laboratory management must carefully choose in allocating resources. For example, nuclear directed energy weapons represent an entirely new generation of concepts. Understanding the conversion and focusing of the nuclear output (so that the energy can be directed at distant targets) presents fundamental challenges to laboratory scientists and engineers. These investigations are basic to meeting the four RD&T objectives.

In all of the activities previously discussed, up through the Phase 2 weapon feasibility studies, the flow of new ideas is stimulated by competition between LANL and LLNL as well as competition within the laboratories. This competition is beneficial not only for the new ideas it generates, but also for the peer review it provides as the teams from the two laboratories assess the other's ideas and subsequent implementation. Meaningful outside review is limited because the nuclear design information is so tightly controlled (by law and regulation) and the supply of knowledgeable peers is small. When both laboratories are exploring options and making proposals, at least two views are presented on every project. DoD and DOE decision makers benefit because they get more options and a second opinion on any given concept if they want one. However, it is the scientists and engineers themselves who benefit the most by having knowledgeable peers to critique their work. This is a key factor in advancing the state-of-the-art in any technology.

Verification R&D needed to support the technical aspects of arms control proposals and possibilities has been vigorously supported by the DOE laboratories. Nuclear test ban proposals in the late fifties resulted in the establishment of a research effort to support the Defense Advanced Research Projects Agency (DARPA) satellite-based nuclear test monitoring program called Vela. Satellite monitoring activities became institutionalized in the DOE R&D program when Vela became a principal element for verifying the Limited Test Ban Treaty of 1963. An R&D program for in-country seismic monitoring of nuclear tests has been supported since the mid-seventies. DOE laboratory contributions to the verification technology of late have been focused on supporting the INF Treaty and START negotiations. Much of the DOE's current emphasis is on new technologies because the options being discussed for START are going to be very difficult to verify with confidence using the means presently available.

Because the DOE laboratories operate their RD&T programs under the level-of-effort concept, laboratory management is always faced with detailed tradeoffs on allocation of resources to the various technical efforts. Directed development/

production engineering (Phase 3/4) efforts almost always receives top priority in this competition. But when management decides to increase one effort, another must be decreased. Thus, continuous tradeoffs among various RD&T initiatives result in a healthy competitive atmosphere. Moreover, when technical problems arise, they usually will be solved within a constant set of resources. Budgetary relief can only be attained through the supplemental appropriations process that requires Congressional approval, and this is rarely exercised. Level-of-effort funding permits the laboratories to quickly respond to changes in guidance from DOE Headquarters.

The President's Blue Ribbon Task Group (BRTG) on Nuclear Weapons Program Management reaffirmed in their finding and conclusions the soundness of the DOE RD&T program structure. The Group stated in their July 1985 report:

> "The advantages of the current arrangement include checks-and-balances for nuclear weapon safety, security, and control; excellence and vitality of the national laboratories; and unique facilities of the production complex. The three national laboratories that conduct nuclear weapon R&D -- Lawrence Livermore, Los Alamos, and Sandia -- have long traditions of managerial discretion in defining research programs and in allocating resources quite unlike most of the nations's defense laboratories.
>
> Their technical accomplishments have been impressive. Successive generations of weapons have been introduced into the nation's stockpile,

> generally on schedule, while meeting increasingly high standards of nuclear safety and high performance specifications."[23]

The BRTG did, however, recommend several measures to enhance fiscal responsibility and cost discipline that apply to DOE RD&T work. Initiatives such as more JCS participation on the tradeoff and resource allocation process have been implemented through the NWC, which was formed in response to BRTG recommendations.

A supplement to the 1953 Agreement for the Development, Production, and Standardization of Atomic Weapons has been developed to formalize implementation of BRTG recommendations for better cost performance trade-offs, Secretarial-level decisions to initiate development engineering (Phase 3), and establishing and monitoring baseline cost.

However the BRTG recommended that "the introduction of measures to increase fiscal discipline should not be allowed to override requirements in critical areas such as nuclear weapon safety, to inhibit innovative and aggressive technology base activities, or to change a management style that allows discretion to the nuclear weapon laboratories and field offices."[23]

Technical competence for nuclear deterrence rests heavily on the three DOE laboratories. Under almost every conceivable arms control scenario, the responsibilities of the laboratories are likely to increase, not decrease. Smaller nuclear arsenals still need to be safe, secure, effective, survivable and perhaps have features for accountability -- which requires modernization.[24] Laboratory expertise will be required for maintaining the stockpile and verifying compliance with arms control agreements. Most important, the laboratories will be required to guard against technological surprise, which becomes even more critical in a world with fewer nuclear weapons, but perhaps a world where more nations have a nuclear weapon capability. All of the present inherent flexibility of the DOE RD&T system will be required to deal with the inevitable technical and political changes. This flexibility is the best mechanism for achieving the modernization and for meeting the four DOE RD&T strategic objectives:

- Insure continued and improved safety, security, and reliability of the existing stockpile of nuclear weapons;

- Provide design, engineering development, and testing for new weapon concepts and engineering support for new weapons entering the stockpile;

- Maintain the scientific and engineering capability to provide a continuing flow of technical knowledge and innovations to support the development of new weapons; and

- Avoid technological surprise by an adversary.

THE NUCLEAR WEAPONS COUNCIL'S STRUCTURE

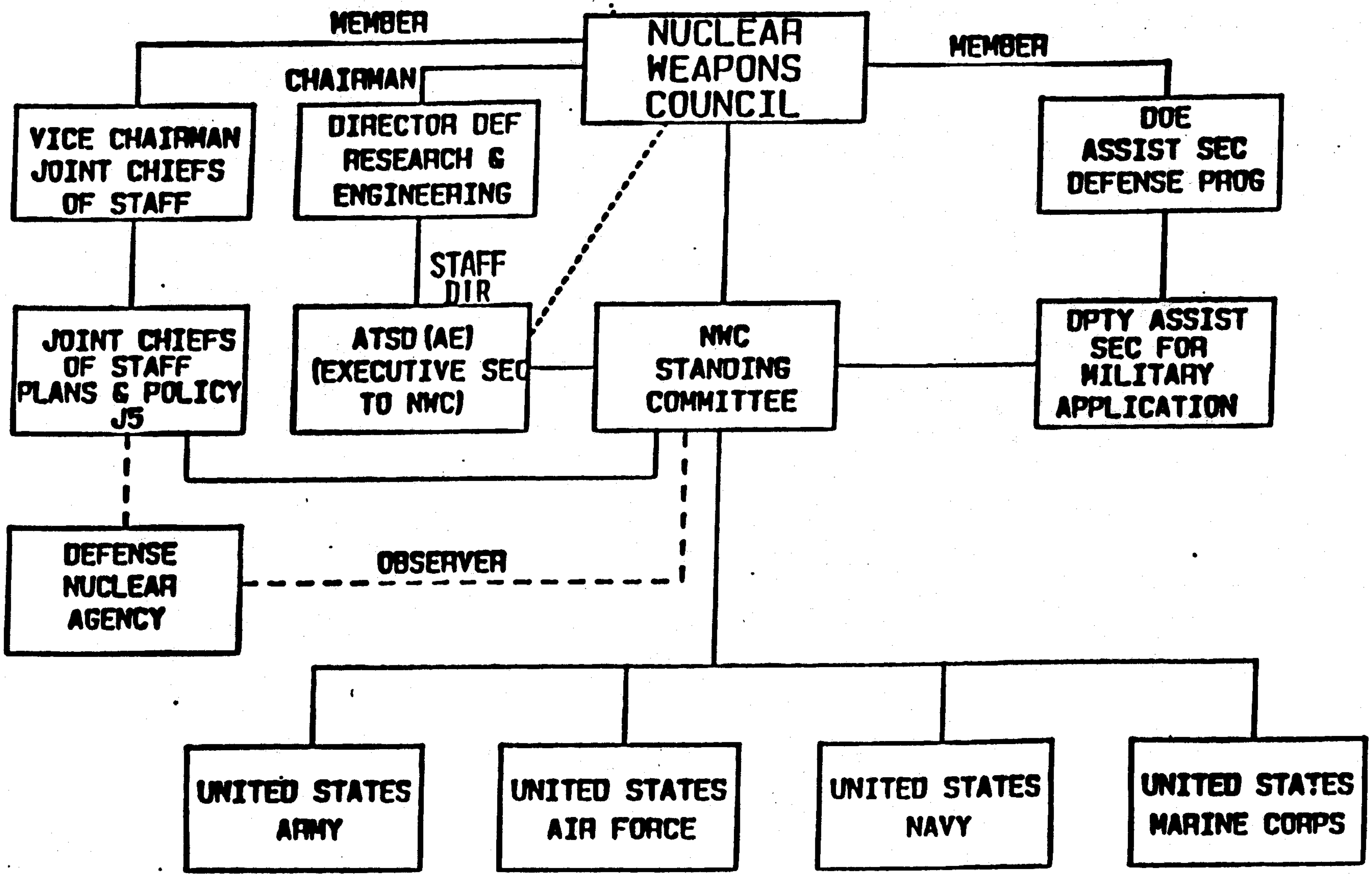
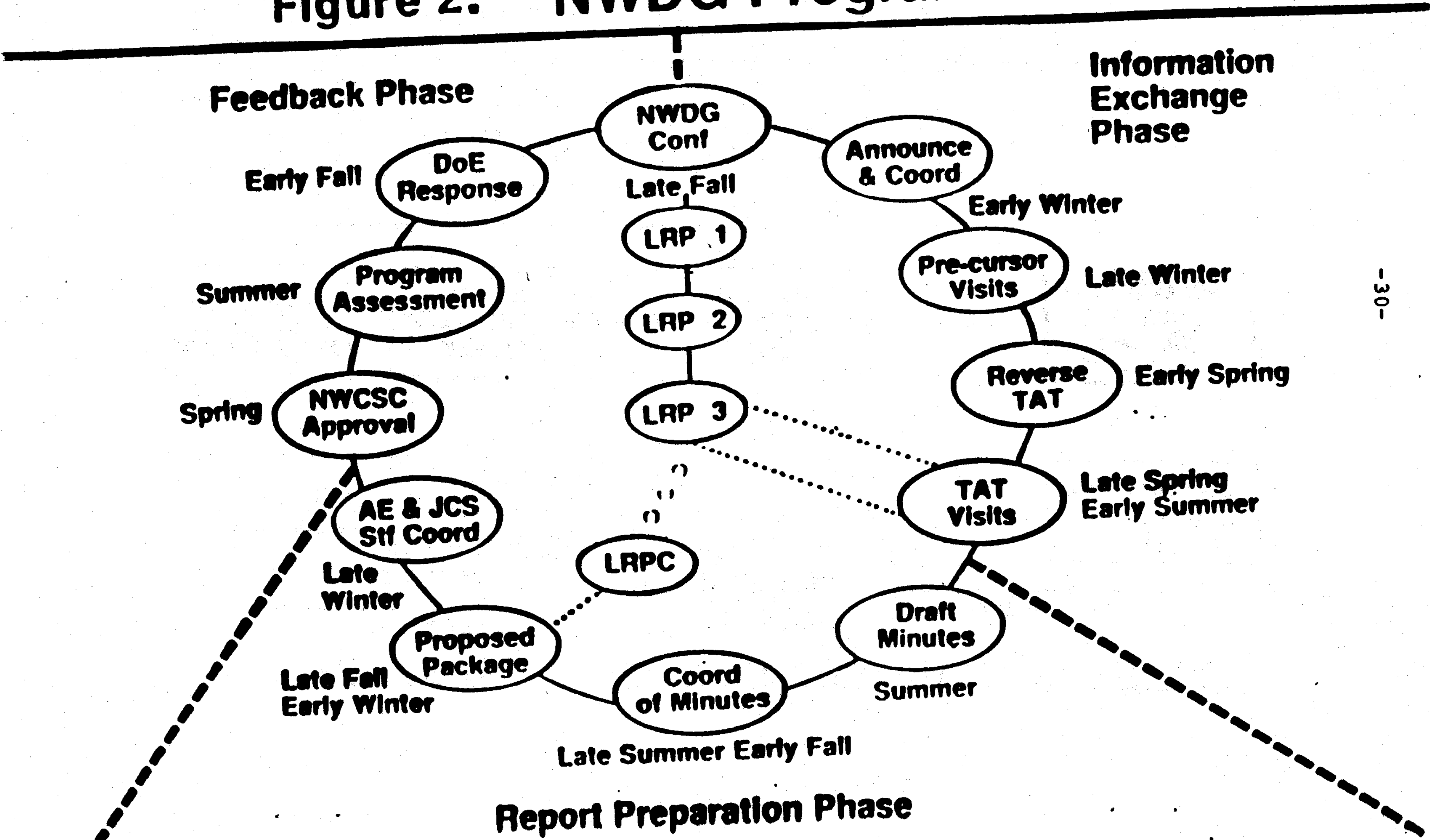


FIGURE 1

Figure 2. NWDG Program



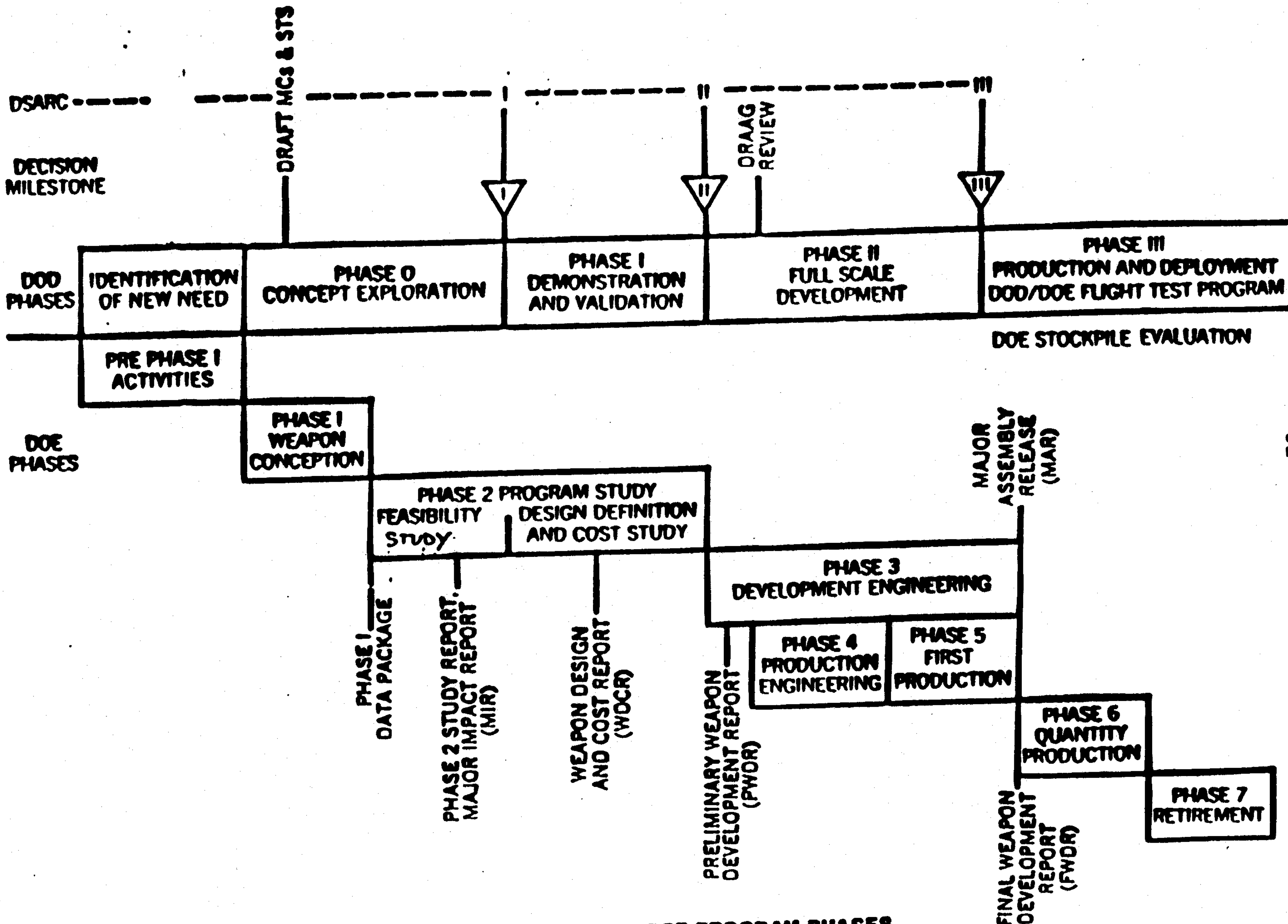


FIGURE 3. COMPARISON OF DOD AND DOE PROGRAM PHASES

REFERENCES

1. Public Law 83-703, "The Atomic Energy Act of 1954," as amended.

2. "An Agreement between the AEC and the DoD for the Development, Production, and Standardization of Atomic Weapons," March 21, 1953.

3. "Supplement to the 1953 Agreement for the Development, Production, and Standardization of Atomic Weapons," September 5, 1984.

4. Chairman, Atomic Energy Commission Memorandum for the Chairman, Military Liaison Committee, "Missile and Rocket Responsibilities," January 22, 1953.

5. "Statement of the Division of Equipment Responsibilities between the Atomic Energy Commission and the Armed Forces," March 4, 1954.

6. Memorandum of Understanding between the Department of Defense and the Department of Energy on Objectives and Responsibilities for Joint Nuclear Weapon Activities," January 17, 1983.

7. Public Law 99-661, "The National Defense Authorization Act for Fiscal Year 1987," November 14, 1986.

8. National Defense Authorization Act for Fiscal Year 1987 Report, July 8, 1986.

9. Secretary of Defense Memorandum, "Establishment of the Nuclear Weapons Council and Nuclear Weapons Council Standing Committee," February 9, 1987.

10. Nuclear Weapons Council Report to Congress on "Implementation of the Recommendations of the President's Blue Ribbon Task Group on Nuclear Weapons Program Management," March 16, 1987.

11. "Weapons Research, Development and Testing Program Plan," U. S. Department of Energy, March, 1987.

12. "Missions and Functions Statement for Deputy Assistant Secretary of Energy for Military Application," February 25, 1988.

13. "Information Digest," U. S. Department of Energy Albuquerque Operations Office, October 1986.

14. DoD Directive 5000.1, "Major System Acquisitions," March 12, 1986.

15. DoD Instruction 5000.2, "Major System Acquisition Procedures," March 12, 1986.

16. The Development and Production of Nuclear Weapons," U. S. Department of Energy, September 1984.

17. DoD Directive 3150.1, "Joint Nuclear Weapons Development Studies and Engineering Projects," December 27, 1983.

18. DoD Instruction 5030.55, "Joint AEC-DoD Nuclear Weapons Development Procedures," January 21, 1974.

19. "The Weapons Program at LLNL," J. D. Immele, et al., Energy and Technology Review, Lawrence Livermore National Laboratory, September 1986.

20. "The Role of the DOE Weapons Laboratories in A Changing National Security Environment," S. S. Hecker, Center for National Securities Studies Paper No. 8, Los Alamos National Laboratory, April 1988.

21. "Nuclear Test Program," UCID-20837, Lawrence Livermore National Laboratory, 1986.

22. "Radiation Facilities," Sandia National Laboratories Report SAND83-0598, December 1985.

23. "Report of the President's Blue Ribbon Task Group on Nuclear Weapons Program Management," William Clark, Chairman, July 15, 1985.

24. "Nuclear Weapon Engineering," O. E. Jones, Sandia Report SAND88-3318, March 1989.

Distribution:

US Dept of Energy
Albuquerque Operations Office
Attn: R. L. Hymer, OOW
S. J. Guidice, WPD
P. O. Box 5400
Albuquerque, NM 87115

US Dept of Energy
Attn: R. Hahn, DP-24
I. L. Williams, DP-242.1
J. E. Rudolph, DP-242
C. Belote, DP-242
DP-242.2
Weapons Testing Branch
Office of Weapons Research, Development & Testing
Washington, DC 20545

Los Alamos National Laboratory
Attn: J. H. Birely, A102
C. M. Gillespie, F630
M. G. Henderson, B218
G. G. Hill, P945
J. C. Hopkins, A105
J. Norman, F670
T. A. Sanford, F618
T. P. Seitz, A105
P. O. Box 1663
Los Alamos, NM 87545

Lawrence Livermore National Laboratory
Attn: L. Woodruff, L6
W. Scanlin, L20
W. B. Shuler, L20
S. Peglow, L6
P. O. Box 808
Livermore, CA 94550

1	A. Narath
20	O. E. Jones
30	L. E. Bray
100	P. M. Stanford
110	P. E. Rosenkoetter
140	W. W. Hollis
200	G. J. Simmons
400	A. N. Blackwell (5)
1000	V. Narayanamurti
1100	F. L. Vook
1200	J. P. VanDevender
1230	J. E. Powell
1270	J. K. Rice
1400	E. H. Barsis
1410	P. J. Eicker
1500	W. Herrmann
1510	J. W. Nunziato
1520	L. W. Davison
1530	D. B. Hayes
1550	C. W. Peterson
1800	R. J. Eagan
1810	D. W. Schaefer
1820	J. B. Woodard
1830	M. J. Davis
1840	R. E. Loehman
2000	G. T. Cheney
2100	H. J. Saxton
2300	J. L. Wirth
2310	M. K. Parsons
2320	J. H. Renken
2340	M. W. Callahan
2360	P. A. Longmire
2500	R. L. Schwoebel
2510	D. H. Anderson
2520	N. J. Magnani
2530	G. M. Ferguson
2560	J. T. Cutchen
2600	L. D. Bertholf
2800	W. E. Alzheimer
3000	D. Roth
3100	L. H. Pitts
3141	S. A. Landenberger (5)
3151	W. I. Klein (5)
4000	M. R. Kestenbaum
5000	E. H. Beckner
5100	H. W. Schmitt
5110	C. C. Burks
5120	W. R. Reynolds
5130	G. N. Beeler
5140	C. M. Tapp
5150	K. D. Hardin
5161	K. D. Nokes (12)
5165	J. M. Freedman (6)
5166	R. C. Hartwig (6)
5170	T. A. Sellers
5200	J. Jacobs
5210	C. C. Hartwigsen
5260	J. R. Kelsey
6000	D. L. Hartley
6010	D. E. Arvizu
6200	V. L. Dugan
6300	R. W. Lynch

6400	D. J. McCloskey
6500	A. W. Snyder
7000	R. L. Peurifoy, Jr.
7100	C. D. Broyles
7200	C. H. Mauney
7230	J. F. Ney
7400	J. C. King
7410	T. J. Young
7470	J. L. Ledman
7480	J. K. S. Walter
7500	D. M. Olson
8000	J. C. Crawford
8100	E. E. Ives
8100A	R. L. Rinne
8130	L. A. Hiles
8150	J. B. Wright
8160	D. J. Bohrer
8170	J. W. Hickman
8171	C. B. Layne (6)
8200	R. J. Detry
8300	P. L. Mattern
8400	R. C. Wayne
8430	J. Vitko
8450	J. F. Barham
8500	P. E. Brewer
8524	J. A. Wackerly
9000	R. L. Hagengruber
9011	G. S. Brown
9010	W. C. Hines
9012	C. C. Carson
9013	W. H. Ling
9014	J. W. Keizur
9015	R. R. Preston
9100	R. G. Clem
9110	C. W. Childers
9120	M. M. Newson
9130	R. D. Andreas
9140	D. J. Rigali
9200	W. C. Myre
9240	P. A. Stokes
5160	G. R. Otey (30)

Org.	Bldg.	Name	Rec'd by	Org.	Bldg.	Name	Rec'd by
~~8524~~							
~~8451~~		~~J Harrison~~					
8524-2		CTF					

Sandia National Laboratories