Chapter 2
Life-Cycle of U.S. Nuclear Weapons

2.1 *Overview*

Nuclear weapons are developed, produced, maintained in the stockpile, and then retired and dismantled. This sequence of events is known as the nuclear weapons life-cycle. As a part of nuclear weapons management, the Department of Defense (DoD) and the National Nuclear Security Administration (NNSA) have specific responsibilities related to nuclear weapons life-cycle activities. The life-cycle process details the steps through which nuclear weapons development progress from concept to production to retirement. Figure 2.1 depicts the traditional joint DoD-NNSA Nuclear Weapons Life-Cycle Phases. This chapter describes the most significant activities and decision points of the traditional phases in the life-cycle of a nuclear warhead. The information presented in this chapter is a summary version of the formal life-cycle process codified in the 1953 Agreement.

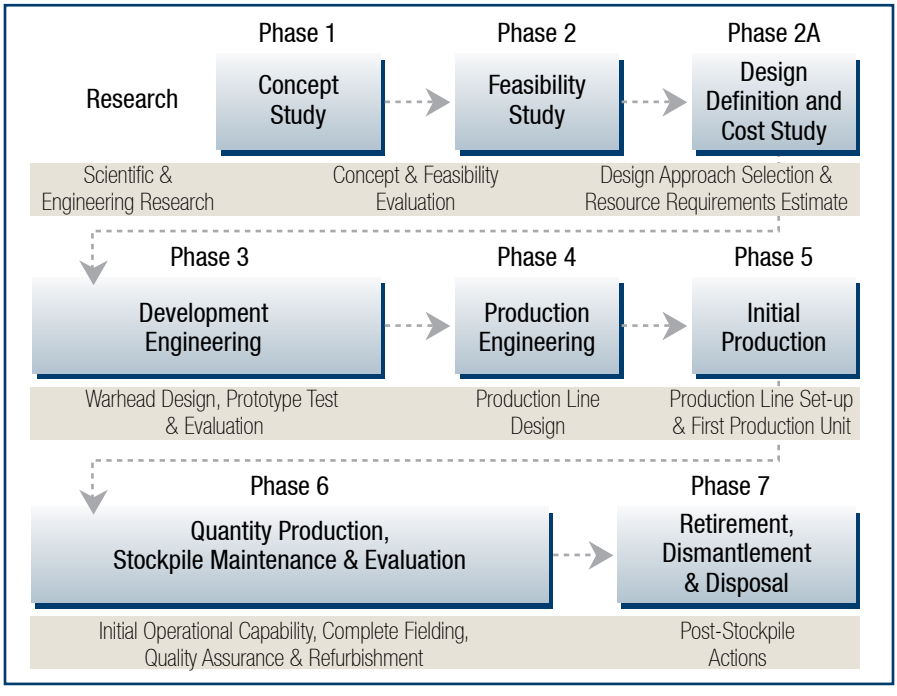

Figure 2.1 Joint DoD-NNSA Nuclear Weapons Life-Cycle Phases

2.2 1953 Agreement

The responsibilities for nuclear weapons management and development were originally codified in the Atomic Energy Act of 1946, which reflected congressional desire for civilian control over the uses of atomic (nuclear) energy and established the Atomic Energy Commission (AEC) to manage the U.S. nuclear weapons programs. Basic departmental responsibilities and the development process were specified in the 1953 *Agreement Between the AEC and the Department of Defense (DoD) for the Development, Production, and Standardization of Atomic Weapons,* commonly known as the *1953 Agreement*.

In 1974, an administrative reorganization transformed the AEC into the Energy Research and Development Agency (ERDA). A subsequent reorganization in 1977 created the Department of Energy (DOE). At that time, the Defense Programs (DP) portion of the DOE assumed the responsibilities of the AEC/ERDA. In 1983, the DoD and the DOE signed a Memorandum of Understanding (MOU), *Objectives and Responsibilities for Joint Nuclear Weapon Activities*, providing greater detail for the interagency division of responsibilities. In 2001, the National Nuclear Security Administration (NNSA) was established as a semi-autonomous agency within the DOE responsible for the U.S. nuclear weapons complex and associated nonproliferation activities. Figure 2.2 is a timeline illustrating DoD/DOE nuclear-related agreements.

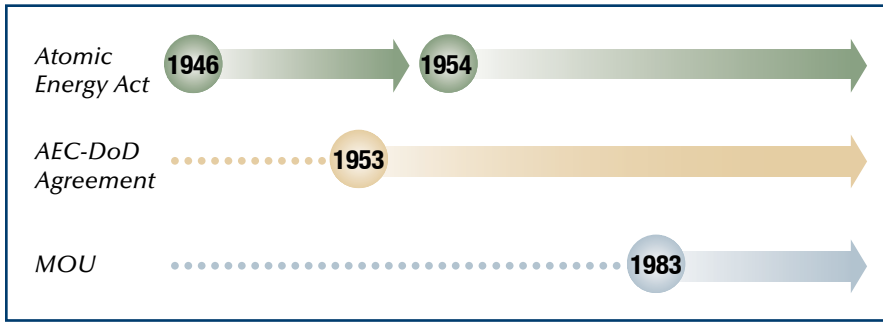

Figure 2.2 Timeline of DoD/DOE Nuclear-Related Agreements

While the basic dual-agency division of responsibilities for nuclear weapons has not changed significantly, the 1953 Agreement was supplemented in 1977 (to change AEC to ERDA), again in 1984 (to incorporate the details of the 1983 MOU), and, most recently, in 1988 (to incorporate the [then] newly-established Nuclear Weapons Council (NWC)).

Normally, a warhead development program is "associated" with a DoD program to develop and field a new delivery system. The warhead is designed to interface

with one specific delivery vehicle design, and both development programs proceed (ideally) at the same pace and in coordination with one another. On the other hand, some warhead development programs are "unassociated" with any one specific delivery system. The warhead may be designed to interface with several different, already fielded, delivery vehicles; for example, a nuclear gravity bomb may interface with several different types of delivery aircraft. The warhead may be developed to be employed without interface with any delivery system hardware; for example, an Atomic Demolition Munition (ADM) may be transported and emplaced for detonation by one or more trained persons without the use of a missile or aircraft.

If the United States proceeds with the development of the Reliable Replacement Warhead (RRW), the program will progress in accordance with the joint life-cycle process outlined in the original 1953 agreement and associated agreements. Between 1991—when the U.S. suspended its nuclear weapons production—and 2006, the U.S. engaged in a repetitive cycle of refurbishment and modification of existing weapons in the stockpile. The process used to manage weapon modifications and refurbishments is a modified version of the traditional nuclear weapons life-cycle process. This process is called the *6.X Process* and is conducted entirely within Phase 6 of the traditional life-cycle process. The Phase 6.X Process is described in detail in section 2.10.2 of this chapter.

2.3 Dual-Agency Responsibility

The DoD and the NNSA share responsibility for all U.S. nuclear weapons.[1]

The DoD is responsible for: participating in approved feasibility studies; developing requirements documents that specify operational characteristics for each warhead-type and the environments in which the warhead must perform or remain safe; participating in the coordination of engineering interface requirements between the warhead and the delivery system; determining design acceptability; specifying military/national security requirements for specific quantities of warheads; receiving, transporting, storing, securing, maintaining, and (if directed by the President) employing fielded warheads; accounting for individual warheads in DoD custody; participating in the joint nuclear weapons decision process (including working groups, the warhead Project Officer Group (POG), the NWC Standing & Safety Committee (NWCSSC), and the NWC);

[1] As a result of this dual-agency responsibility, there are some differences in terminology, standards, and practices between the DoD and the NNSA. In addition, inconsistencies in terminology and concepts arise because of the complexity of the subject matter. This book attempts to clarify such discrepancies whenever possible.

developing and acquiring the delivery vehicle and launch platform for a warhead; and storing retired warheads awaiting dismantlement in accordance with jointly approved plans.

The DOE is responsible for: participating in approved feasibility studies; evaluating and selecting the baseline warhead design approach; determining the resources (funding, nuclear and non-nuclear materials, facilities, etc.) required for the program; performing development engineering to establish and refine the warhead design; engineering and establishing the required production lines; producing or acquiring required materials and components; assembling components and sub-assemblies into stockpile warheads (if approved by the President); providing secure transport within the U.S.; developing maintenance procedures and producing replacement limited-life components (LLCs); conducting a jointly-approved quality assurance program; developing a refurbishment plan—when required—for sustained stockpile shelf-life; securing warheads, components, and materials while at DOE facilities; accounting for individual warheads in DOE custody; participating in the joint nuclear weapons decision process; receiving and dismantling retired warheads; and disposing of components and materials from retired warheads.

All of these activities have been categorized into the specific "phases" of the joint nuclear weapons life-cycle that are described sequentially below.

2.4 *Phase 1 - Concept Study*

Phase 1 of the joint nuclear weapons life-cycle process is a study to: make a preliminary assessment of the effectiveness and survivability of a weapon concept; identify delivery system/nuclear warhead trade-offs; develop an initial program schedule; and develop draft documents for the Military Characteristics (MCs)[2] and the Stockpile-to-Target Sequence (STS)[3].

A Phase 1 Study usually begins as a result of a major DoD program start for a nuclear weapons system, although the NNSA may also initiate a Phase 1 Study. Alternatively, a Phase 1 Study can begin by mutual agreement between a DoD component organization (a Military Service, the Defense Threat Reduction Agency (DTRA), the Joint Staff, or an Office of the Secretary of Defense (OSD)) and the NNSA. There is no formal requirement for any approval to start a Phase 1 Study. Normally, a Phase 1 Study Group (SG) is formed that consists of representatives from all interested agencies.

[2] The MCs define the operational characteristics of the weapon.

[3] The STS defines the normal peacetime, wartime employment, and abnormal environments to which the warhead may be exposed during its entire life-cycle.

Normally, the results of the Phase 1 analysis are published in a Concept Study Report. Regardless of the results of a Phase 1 Study, there is no automatic commitment to proceed to the next phase.

2.5 Phase 2 - Feasibility Study

Phase 2 is a study to determine the technical feasibility of a weapon concept. At this stage, there may be many alternative concepts. The Lead Military Service initiates the request to begin Phase 2, and the NWCSSC considers the request. If approved by the NWCSSC, both DoD and NNSA are agreeing to participate. The DoD provides draft MCs and STS documents, major weapon and warhead parameters, and program milestones, including the date of the Initial Operational Capability (IOC), warhead quantity at IOC, and total quantity required.

A Phase 2 Study is usually conducted by a Project Officers Group (POG). A senior OSD official appoints the Lead Service to represent the DoD and forwards this request to the NWCSSC. Both Groups are conducted as "committees" and are chaired by a Lead Project Officer (LPO) from the Lead Service designated by the OSD. POG members may come from any Service or NNSA organization with an interest in the program. The Joint Staff, DTRA, and the OSD may attend the meetings as observers.

Normally, prior to the completion of Phase 2, the DOE issues a Major Impact Report (MIR) that provides a preliminary evaluation of the significant resources required for the program, and the impact that the program may have on other nuclear weapons programs. At the conclusion of Phase 2, the findings are published in a report.

A Phase 2 Report may include a recommendation to proceed to Phase 2A. If appropriate, the Lead Service will initiate a recommendation to proceed to Phase 2A. Regardless of the results of a Phase 2 Study, there is no automatic commitment to proceed to the next phase.

2.6 Phase 2A - Design Definition and Cost Study

NWCSSC approval is required to begin Phase 2A. Phase 2A is a study conducted by the POG to refine warhead design definition, program schedule, and cost estimates.

At the beginning of Phase 2A, the NNSA selects the design team (physics laboratory—either Los Alamos National Laboratory (LANL) or Lawrence Livermore National Laboratory (LLNL)) for the remainder of the program. The selected physics lab and its Sandia National Laboratories (SNL) counterpart

participate in the POG activities to refine requirements and resource trade-offs, establish a warhead baseline design, and make cost estimates. In some cases, the NNSA may choose to retain two design teams beyond the beginning of Phase 2A.

At the end of Phase 2A, the NNSA publishes a Weapon Design and Cost Report (WDCR) that identifies baseline design and resource requirements, establishes tentative development and production schedules, and estimates warhead costs. The POG publishes a Phase 2A Report that: provides a trade-off analysis between DoD operational requirements and NNSA resources; identifies a division of responsibilities between the DoD and the NNSA; and makes a recommendation concerning continued development. The Report also considers existing designs, required SNM, and safety factors. The Phase 2A Report is transmitted to the NWCSSC.

2.7 Phase 3 - Full-Scale Engineering Development

Phase 3 is a joint DoD-NNSA effort to design, test, and evaluate the warhead to engineering standards. It is intended to develop a safe, reliable, producible, maintainable, and tested nuclear weapon design based on the requirements of the MCs and STS and the guidance in the Nuclear Weapons Stockpile Plan (NWSP). The start of Phase 3 is requested by the Lead Service, reviewed by the NWCSSC and the NWC, and approved by the Secretary of Defense. The 2003 Defense Authorization Act requires the Secretary of Energy to request funding in the President's Budget for any activities relating to the development of a new nuclear weapon or modified nuclear weapon. This requirement effectively mandates Congressional approval to proceed into and beyond Phase 3.

During Phase 3, the warhead is designed to meet the MCs and STS requirements with engineering specifications sufficiently complete to enter initial production. Prototypes of each component are tested and evaluated. Estimates of the schedule, technical risk, and life-cycle cost are refined.

In the past, a Phase 3 would include at least one developmental nuclear test to confirm that the design was meeting requirements. If significant redesign was required, it may have led to a second developmental nuclear test.[4]

Prior to the completion of Phase 3, the DOE issues a Preliminary Weapon Development Report (PWDR). Based on this report, the DoD conducts a preliminary Design Review And Acceptance Group (DRAAG) evaluation to determine if the expected warhead characteristics will meet DoD requirements.

[4] In some cases, the second nuclear test may have been conducted after the beginning of Phase 4.

The NWCSSC reviews each weapon program annually during Phase 3 and Phase 4. The POG addresses weapon system requirements relevant to weapon characteristics and required delivery schedules. All issues related to the weapon development program are reviewed jointly by the two departments.

2.8 Phase 4 - Production Engineering

Phase 4 consists of an internal NNSA effort to transition the developmental warhead design into a manufacturing process. During this phase, the required production line equipment and tools are designed to ensure that all required components can be produced. The NNSA notifies the NWCSSC, the POG, and the Military Services of the start date for Phase 4.

Non-nuclear test and evaluation of component prototypes continues through Phase 4. The POG continues to meet as needed to share information and to solve problems concerning competing characteristics and trade-offs.

At the end of Phase 4, the appropriate NNSA Labs issue a Complete Engineering Release (CER) for each component, assembly, and sub-assembly. The CER must be issued before the start of Phase 5.

2.9 Phase 5 - First Production

Phase 5 is a transition period during which the NNSA procures raw materials, establishes the production line, starts producing components, evaluates the production processes and products, and makes modifications if necessary. Before a new weapon program can enter Phase 5, it must be authorized by the President; this is normally done as a part of the annual NWSP. The start is determined by the NNSA based on the production time required to meet the warhead IOC date. The NWC notifies the DoD of the NNSA decision to begin Phase 5. Normally, the NNSA produces all the components for the nuclear warhead, but in some cases, the DoD may produce some non-nuclear components necessary for warhead function (such as the parachute in certain gravity bombs).

During Phase 5, the NNSA conducts tests and evaluations of the warhead components from the production line. The POG meets as required to solve any problems concerning competing characteristics and trade-offs.

Most warheads produced in Phase 5 are used for Quality Assurance (QA) testing. Some warheads produced in Phase 5 may be delivered to the DoD as War Reserve (WR) warheads to meet the IOC. During this Phase, the Nuclear Weapon System Safety Group (NWSSG) conducts a pre-operational safety study to determine the adequacy of safety features in the nuclear weapon system and reviews procedures for operation of the system.

Prior to the completion of Phase 5, the DOE issues a Final Weapon Development Report (FWDR). Based on this report, the DoD conducts a final DRAAG evaluation to determine if the warhead characteristics will meet DoD requirements.

Phase 5 culminates in the issuance of a Major Assembly Release (MAR) in which the NNSA formally states that the weapon is satisfactory for release to the DoD for specific uses. The MAR is prepared by the design physics laboratory and approved by NNSA Headquarters. Following issuance of the MAR, the First Production Unit (FPU) is released.

2.10 Phase 6 - Quantity Production and Stockpile Maintenance and Evaluation

The beginning of Phase 6 is determined by the NNSA after NWC approval of the final DRAAG Report. The NNSA notifies the NWCSSC, the POG, and the Military Services of the start date for Phase 6.

Normally, the IOC occurs shortly after the start of Phase 6. The conditions to achieve IOC include the requirement that a specific number of WR warheads are deployed with an operationally-certified military unit. IOC conditions usually differ for each warhead-type and IOC dates are usually classified until after they occur.

During Phase 6, the production rate of WR warheads and components increases and the warheads are stockpiled. In the past, the production portion of Phase 6 has lasted from a few years to 10 years or more. Phase 6 continues beyond the production of the last warhead and lasts until all warheads of that type are retired.

During Phase 6, the NNSA continues to test and evaluate components as part of the Quality Assurance and Reliability Testing (QART) Program, which includes Stockpile Laboratory Tests (SLT) and Stockpile Flight Tests (SFT). Normally, the DOE would continue component production beyond those required for WR warheads, to establish an inventory of components intended for future-year surveillance item rebuild under the QART program. For more information on the QART program and its associated tests, see Chapter 6, *Quality Assurance and Non-Nuclear Testing*.

Each warhead-type is reviewed continuously in Phase 6. The POG meets as required to solve problems that arise during or after production. Stockpile maintenance, such as the replacement of LLCs, is routinely performed.

Safety, security, personnel reliability, use control, transportation, supply publications, accountability, inspections, emergency response preparation and exercises, and technical operations training are also performed during Phase 6.

2.10.1 Limited-Life Components (LLCs)

Some age-related changes affecting various nuclear warhead components are predictable and well understood. During Phase 6, these components are replaced periodically throughout the lifetime of the warhead and are called Limited-Life Components (LLCs). LLCs are similar to the components of an automobile that must be replaced at periodic intervals, such as oil filters, brake pads, and tires. These components are replaced during scheduled LLC exchanges (LLCEs). LLCs in any given warhead-type may include power sources, neutron generators, tritium reservoirs, and gas-transfer systems. These components must be replaced before their deterioration adversely affects warhead function and/or personnel safety.

Tritium

Tritium gas is used in nuclear weapons as a fusion fuel for "boosting" the nuclear yield. See Appendix A, *Basic Nuclear Physics*, for a more detailed discussion of nuclear weapon design and function. Tritium is a radioactive isotope of hydrogen. Tritium has a 12.33 year half-life, which means that it decays at an annual rate-loss of 5.5 percent. For this reason, tritium reservoirs (also called tritium bottles) must be replaced at periodic intervals. The overall tritium inventory must be replenished to sustain the stockpile's military capabilities.

All of the current tritium work to support the U.S. nuclear weapons stockpile is accomplished at the NNSA Savannah River Site. This one-acre underground facility became operational in 1994. A new reservoir loading line was put into operation at the facility in July 1998. Activities include: unloading of gas from old reservoirs; separation of the useful isotopes of hydrogen (tritium and deuterium) from other materials; purifying the two hydrogen isotopes; mixing the gases to exact specifications; loading reservoirs; and retaining the remaining tritium and deuterium as a part of the national inventory for future use. Several different types of reservoirs are processed at the Savannah River Site.

The NNSA has a new tritium production source to supply tritium for the U.S. stockpile. The new tritium production system produces tritium in nuclear power reactors owned and operated by the Tennessee Valley Authority (TVA). The TVA has made one reactor available for tritium production at its Watts Bar Nuclear Station (see Figure 2.3) with two additional reactors available at the

Figure 2.3 Watts Bar Nuclear Station

TVA Sequoyah Nuclear Station. The production of tritium is accomplished by irradiating NNSA-designed, commercially manufactured Tritium-Producing Burnable Absorber Rods (TPBARs). After irradiation is complete, the rods are removed from the reactors and transported to the new Tritium Extraction Facility located at the Savannah River Site.

2.10.2 The Phase 6.X Process

The NWC has a major role in the refurbishment and maintenance of the enduring nuclear weapons stockpile. Between 1992 and 2006, the NWC concentrated its efforts on research related to the maintenance of the existing weapons in the legacy stockpile and oversight of the refurbishment activities in the absence of UGT. To manage and facilitate the refurbishment process, the NWC approved the *Phase 6.X Procedural Guideline* in April 2000.[5] Figure 2.4 is an illustration of the Phase 6.X process.

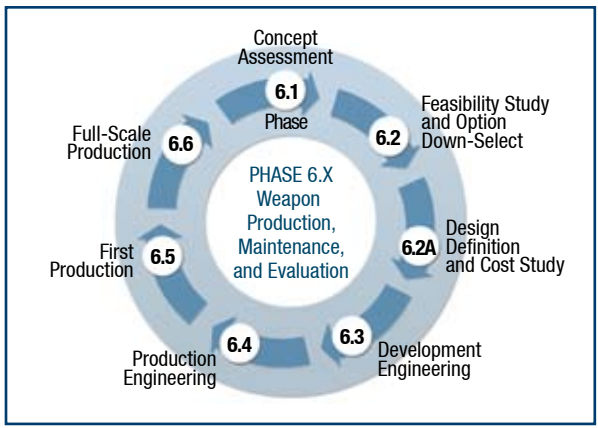

Figure 2.4 Phase 6.X Process

The Phase 6.X Process is based on the original Joint Nuclear Weapons Life-Cycle Process, which includes Phases 1 through 7. The 6.X phases are a "mirror image" of Phases 1 through 7; the basic process is used to develop a complete warhead, but the 6.X Process is intended to develop and field only those components that must be replaced as a part of the approved refurbishment program for a legacy warhead-type. Each refurbishment program is different, some involve the replacement of only one or two key components, while others may involve the replacement of many key components. As a part of the Phase 6.X Process, the NWC reviews and

[5] This description of the Phase 6.X Process is excerpted from the *NWC Procedural Guideline for the Phase 6.X Process*, April 2000.

approves proposed Alterations (Alts) and Modifications (Mods)[6], including Life Extension Programs (LEPs), for weapons in the existing stockpile. The NWC monitors progress to ensure that the stockpile continues to be safe and reliable.

2.10.3 Phase 6.1 - Concept Assessment

This Phase consists of continuing studies by the DoD, the NNSA, and the POG. A continuous exchange of information, both formal and informal, is conducted among various individuals and groups. This exchange results in the focusing of sufficient interest on an idea for a nuclear weapon or component refurbishment to warrant a Program Study.

For Phase 6.1, activities that are jointly conducted by the DoD and the NNSA, the NWCSSC is informed in writing before the onset of the activity.[7]

The DoD, the NNSA, or the POGs are free to develop ideas within the following limitations:

- Should the DoD pursue an idea that would involve the modification or alteration of a nuclear warhead, the DoD must ask the NNSA to examine the feasibility of at least that part of the concept; and
- Should the NNSA pursue an idea which would require the development of a new or modified weapon delivery system or handling equipment, the NNSA must ask the DoD to examine the feasibility and impact of at least that part of the concept.

After the Concept Assessment Phase for a Phase 6.X program is complete, the DoD, the NNSA, or a POG may submit a recommendation to the NWCSSC to proceed to Phase 6.2. The NWCSSC determines whether a Phase 6.2 Study should be authorized.

2.10.4 Phase 6.2 - Feasibility Study and Option Down-Select

After the NWCSSC approves entry into Phase 6.2, the DoD and the NNSA embark on a Phase 6.2 Study, which is managed by the POG for that weapon system. In a Phase 6.2 Study, design options are developed and the feasibility

[6] Normally, a replacement of components is called a "Mod" if it causes a change in operational characteristics, safety or control features, or technical procedures. A replacement of components is called an "Alt" if it does not change these factors, and the differences are "transparent" to the user (military units).

[7] Technically, the NWC has the authority to approve Phase 6.X program starts. In practice, the NWC may delegate this authority to the NWCSSC.

of a Phase 6.X refurbishment program for that particular nuclear weapon is evaluated.

The NNSA tasks the appropriate DOE laboratories to identify various design options to refurbish the nuclear weapon. The POG performs an in-depth analysis of each design option. At a minimum, this analysis considers the following:

- Nuclear safety;
- System design, trade-offs, and technical risk analyses;
- Life expectancy issues;
- Research and development requirements and capabilities;
- Qualification and certification requirements;
- Production capabilities and capacities;
- Life-cycle maintenance and logistics issues;
- Delivery system and platform issues; and
- Rationale for replacing or not replacing components during the refurbishment.

The Phase 6.2 Study includes a detailed review of the fielded and planned support equipment (handling gear, test gear, use control equipment, trainers, etc.) and the technical publications (TPs) associated with the weapon system. This evaluation is performed to ensure that logistics support programs can provide the materials and equipment needed during the planned refurbishment time period.

Military considerations, which are evaluated in tandem with design factors, include (at a minimum): operational impacts and/or benefits that would be derived from the design options; physical and operational security measures; and requirements for joint non-nuclear testing. During this phase, the MCs, STS, and Interface Control Documents (ICDs) are updated as necessary.

Refurbishment options are developed by the POG in preparation for the development of the option down-select package. This package includes any major impacts on the NNSA nuclear weapons complex and is documented in an NNSA-prepared MIR.

The NNSA and the Lead Service coordinate regarding the down-select of the Phase 6.2-preferred option(s) and authorize the start of Phase 6.2A. The POG writes a Phase 6.2 Report and briefs the results to the NWCSSC, which considers the selected option(s) for approval.

2.10.5 Phase 6.2A - Design Definition and Cost Study

The NNSA works with the Labs and the facilities of the nuclear weapons production complex to identify production issues and to develop process development plans and proposed workload structures for the refurbishment. The Labs continue to refine the design and to identify qualification testing and analysis in order to verify that the design meets the specified requirements.

With coordination through the POG, the Lead Service develops the necessary plans in its area of responsibility (such as flight testing, maintenance and logistics, and the procurement of trainers, handling gear, and new DoD components). The POG incorporates NNSA and Service inputs into a Joint Integrated Project Plan (JIPP). The NNSA, the Labs, and the production facilities develop NNSA cost estimates for the design, testing, production, and maintenance activities for the projected life of the LEP refurbishment. These estimates are reported in the Weapon Design and Cost Report (WDCR).

The POG presents this information together with the estimated DoD costs to the NWCSSC. Included is a recommendation to the NWCSSC about whether to proceed to Phase 6.3. The NWCSSC evaluates the request based on the results of the Phase 6.2/6.2A Report(s), the WDCR, and the Phase 6.2 MIR. The NWCSSC then determines whether Phase 6.3 should be authorized.

2.10.6 Phase 6.3 - Development Engineering

Phase 6.3 begins when the NWC prepares a Phase 6.3 letter requesting joint DoD and NNSA participation in Phase 6.3. The request letter is transmitted together with the draft MCs and STS to the DoD and the NNSA; the two must then respond to the NWC. If the DoD and the NNSA agree to participate in Phase 6.3, comments on the proposed MCs and STS are included in their positive responses to the NWC. The NNSA, in coordination with the DoD, conducts experiments, tests, and analyses to validate the design option(s). Also at this time, the production facilities assess the producibility of the proposed design, initiate process development activities, and produce test hardware as required.

The WDCR is then formally updated and called the Baseline Cost Report, which reflects the current design under development. The Draft Addendum to the Final Weapon Development Report (FWDR) is also prepared. It reports on the status of the weapon refurbishment design and provides refurbishment design objectives, refurbishment descriptions, proposed qualification activities, ancillary equipment requirements, and project schedules.

The DoD DRAAG reviews the Draft Addendum to the FWDR and publishes a Phase 6.3 Preliminary DRAAG Report with its recommendations regarding the

status of the project. The Preliminary DRAAG Report and recommendations are forwarded by the appropriate Service to the NWCSSC for approval.

During Phase 6.3, the MCs (and the STS if a change to a weapon subsystem or component is required) are approved by the NWCSSC, after which the POG updates the JIPP and a final Product Change Proposal (PCP) is prepared.

At the end of Phase 6.3, the weapon refurbishment design is demonstrated to be feasible in terms of safety, use control, performance, reliability, and producibility. The design is thereby ready to be released to the production facilities for stockpile production preparation activities. These activities are coordinated with parallel DoD activities (if required) in the POG. The Lead Service may decide that a Preliminary Safety Study of the system is required in order to examine design features, hardware, and procedures as well as aspects of the concept of operation that affect the safety of the weapon system. During this Study, the Nuclear Weapon System Safety Group (NWSSG) identifies safety-related concerns and deficiencies so that timely and cost-efficient corrections can be made during this Phase.

2.10.7 Phase 6.4 - Production Engineering

When development engineering is sufficiently mature, the NNSA authorizes the initiation of Phase 6.4. This Phase includes activities to adapt the developmental design into a producible design as well as activities that prepare the production facilities for refurbishment component production. During this Phase, the acquisition of capital equipment is completed; tooling, gauges, and testers are properly defined and qualified; process development and Process Prove-In (PPI) are accomplished; materials are purchased; processes are qualified through production efforts; and trainer components are fabricated. Phase 6.4 also defines the methodology for the refurbishment of the weapon and production of the components. Production cost estimates are updated based on preliminary experience from the PPI and product qualification.

At this point, provisions for spare components are made in conjunction with the DoD. Technical Publications are updated and validated through an evaluation by the Laboratory Task Group and Joint Task Group. The NNSA Stockpile Evaluation Program (SEP) plan is updated and the POG maintains and updates the JIPP.

Generally, Phase 6.4 ends after the completion of production engineering, basic tooling, layout, and adoption of fundamental assembly procedures, and when NNSA engineering releases indicate that the production processes, components, subassemblies, and assemblies are qualified.

2.10.8 Phase 6.5 - First Production

When sufficient progress has been made in Phase 6.4, the NNSA initiates Phase 6.5. During this Phase, the production facilities begin production of the first refurbished weapons. These weapons are evaluated by the DoD and the NNSA. At this time, the NNSA preliminarily evaluates the refurbished weapon for suitability and acceptability. Except in an emergency, the preliminary evaluation does not constitute a finding that the weapons are suitable for operational use.

If the DoD requires weapons for test or training purposes prior to final approval by the NNSA, the weapons or items would be utilized with the understanding that the NNSA has not made its final evaluation. The POG coordinates specific weapons requirements for test or training purposes. A final evaluation is made by the NNSA and the Labs after the completion of an engineering evaluation program for the weapon.

The POG informs the NWCSSC that the LEP refurbishment program is ready to proceed to IOC and full deployment of the refurbished weapon. The Lead Service conducts a Pre-Operational Safety Study at a time when specific weapon system safety rules can be coordinated, approved, promulgated, and implemented 60 days before IOC or first weapon delivery. During this Study, the NWSSG examines system design features, hardware, procedures, and aspects of the concept of operation that affect the safety of the weapon system to determine if the DoD nuclear weapon system safety standards can be met. If safety procedures or rules must be revised, the NWSSG recommends draft revised weapon system safety rules to the appropriate Military Departments.

The responsible Labs prepare a Final Draft of the Addendum to the FWDR and submit the document for final DRAAG review. The DRAAG reviews the Final Draft of the Addendum and issues a Final DRAAG Report with comments and recommendations to the NWCSSC through the Lead Service. The DRAAG, in coordination with the Lead Service and through the NWCSSC, informs the NNSA that the weapon meets (or does not meet) the requirements of the MCs.

After receiving comments from the DRAAG, the responsible Labs complete the Final Addendum to the FWDR. The Labs then issue the Final Addendum to the FWDR together with a certification letter. The POG also updates the JIPP.

After the evaluation of the limited production run and other reviews are completed, the NNSA issues a MAR for the refurbished weapon. Upon approval of the Final DRAAG Report by the NWCSSC and issuance of the MAR, the first refurbished weapons are released to the Service. With the MAR, the NNSA advises the DoD that the refurbished weapon is suitable for use and notes any limitations. This Phase terminates with DoD acceptance of

the refurbished weapon. The POG then requests approval from the NWC to proceed to Phase 6.6.

2.10.9 Phase 6.6 - Full-Scale Production

Upon NWC approval to initiate Phase 6.6, the NNSA undertakes the necessary full-scale production of refurbished weapons for entry into the stockpile. The POG prepares an End-of-Project Report for the NWCSSC to document the refurbishment activities carried out in the Phase 6.X Process. Phase 6.6 ends when all planned refurbishment activities, certifications, and reports are complete.

2.11 *Phase 7 - Retirement and Dismantlement*

Phase 7 begins with the first warhead retirement of a particular warhead-type. At the national level, retirement is the reduction of the quantity of that warhead-type in the NWSP for any reason other than to support the QART Program. However, the DOE may be required to initiate Phase 7 activities to perform dismantlement and disposal activities for surveillance warheads that are destructively tested under the QART program. This phase initiates a process that continues until all warheads of that type are retired and dismantled. From the DoD perspective, a warhead-type just beginning retirement activities may still be retained in the Active and/or Inactive Stockpiles for a period of years.

In the past, when the retirement of a warhead-type began, a portion of the operational stockpile was retired each year until all the warheads were retired, because at that time, most of the warhead-types were replaced with "follow-on" programs. Currently, Phase 7 is organized into three sub-phases:

- Phase 7A, Weapon Retirement;
- Phase 7B, Weapon Dismantlement; and
- Phase 7C, Component and Material Disposal.

While the NNSA is dismantling and disposing of the warheads, if appropriate, the DoD is engaged in the retirement, dismantlement, and disposal of associated nuclear weapons delivery systems and platforms.